

JANUARY • 1955

PRICE 75 CENTS

electronics

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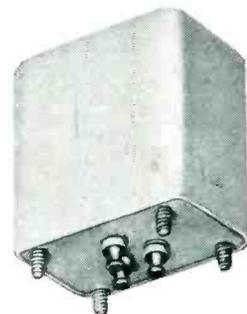


**PORTABLE TV CAMERA
FOR NAVY FROGMEN**

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Military Components FOR EVERY APPLICATION

A HUNDRED STOCK UNITS in our catalog B...30,000 special designs

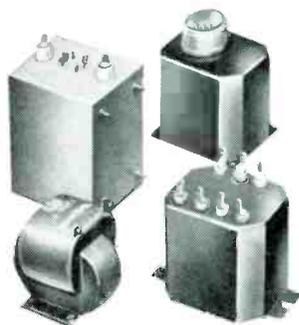


FILTERS

UTC filters, equalizers and discriminators are produced in designs from .1 cycles to 400 mc. Carrier, aircraft, and telemetering types available in standard designs.

POWER COMPONENTS

The scope of military power components produced at UTC ranges from 500 lb. plate transformers to miniaturized 2 oz. units... hermetically sealed and encapsulated... molded types.

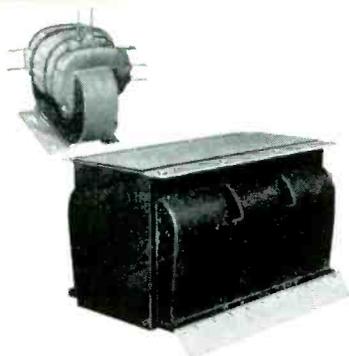


ENCAPSULATED UNITS

8 years of encapsulation experience assure maximum reliability in this class of UTC material.

MOLDED UNITS

UTC molded units range from 1/2 oz. miniatures to the 100 lb. 3 phase unit illustrated.



PULSE TRANSFORMERS

UTC pulse transformers cover the range from molded structures weighing a fraction of an ounce to high power modulator applications.



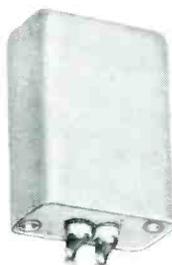
AUDIO COMPONENTS

UTC military audio units range from 1 ounce subminiatures to high power modulation transformers. Standard, high fidelity, sub-audio, and super-sonic types.



HIGH Q COILS

Unequaled stability is effected in UTC high Q coils thru special processes and materials. Toroid, mu-core, and variable inductors are available to military standards.



MINIATURIZED COMPONENTS

UTC H-30 series audios are the smallest hermetic types made. Class A, B, and H power components of maximum miniaturization are regular production at UTC.



MAGNETIC AMPLIFIERS

In addition to a stock line of servo motor magnetic amplifiers, UTC manufactures a wide variety to customer specifications. Saturable reactors are supplied for frequencies from 1 cycle to 40 mc.



WRITE FOR UTC CATALOG B

...includes complete line of hermetic audios, reactors, magnetic amplifiers, filters, high Q coils, pulse transformers, etc.

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PORTABLE TV CAMERA FOR NAVY FROGMAN—Bureau of Ships engineers test new waterproof television camera developed for use by free swimmers and divers. Super-pressure gaseous discharge lamp on top of camera provides illumination. Details on p. 184.COVER

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ADDED ATTRACTION—Response of readers to our articles on component design trends has been like the proverbial snowball. Engineering data obtained for the article on relays, in this issue, snowed under author Rockett but when the skies cleared he found that a good deal of the material covered choppers. So, he convinced us that they should be the subject of an additional article in the series. Frank, incidentally, is a former associate editor of *ELECTRONICS*.

AUTHOR, AUTHOR—Permanent contributions to the art and industry were made by nearly 500 engineer-authors of bylined articles published last year in these columns. Busy as they were with routine technical emergencies, these men found time to gather material and prepare manuscripts describing their designs for the benefit of others.

Contributing engineers can be identified by referring to the list of authors in the annual index published in the December, 1954 issue. This index also contains a cross-index of feature articles, and shorter articles that appeared in *Electrons at Work*, *Production Techniques* and *Backtalk* during the year. Totalling 1,730 entries, the index was prepared by assistant editor Findlay who, in the final stages of preparation, often rushed off screaming into the night.

CATALYSTS—Many developments of interest to our readers are diffi-

electronics

JANUARY, 1955 Vol. 28, No. 1



Member ABC and ABP

January, 1955 — ELECTRONICS

TALK

cult to latch onto for publication because several engineers are involved in the original work. Although each may deliver a paper on his own portion of the project, he is understandably reluctant to prepare one covering the complete equipment.

Editors perform an important function when such a situation arises, that of tying several papers together into a unit, a complete article for the magazine. Such a wedding of papers is to be found in the article "Repeater Amplifies in Either Line Direction" in this issue. A colleague of the authors tells us that we have a technical scoop. We thank Bell Laboratories for photographs taken to order.

カラーテレビ受像機の設計法

OVERSEAS—The hieroglyphics above seem to be the Japanese translation of the title of an ELECTRONICS article, "Design Techniques for Color Television Receivers" (Feb. 54). Permission to reprint an article from the magazine is sometimes given to foreign publications and, when proof pages are sent in, amateur linguists in the office try their skill (?) at pronunciation. Not a peep resulted when proofs came in from *Electrician*, published in Tokyo.

The title looks like this.

電子工業

LOOKING BACK—Plaudits from readers may be more welcome than brickbats, but sometimes these



EDITORIAL STAFF plans a coming issue. Standing: D. Findlay, E. Palmquist, W. Arncid, H. Manoogian. Seated: J. Markus, W. O'Brien, A. McKenzie, W. MacDonald, V. Zeluff, J. Carroll

plaudits strain our modesty a bit.

The special Mechanical Design section that appeared in the October issue got its share of comments, "extremely well done . . . grand issue . . . wonderful job . . . our engineers devoured it enthusiastically." We gagged a bit on that last one.

NOT FOR CASUAL READING

Most readers of ELECTRONICS select and study first the features and departments that deal with subjects involved in their own current work. To help them locate articles of particular interest we have expanded and rearranged our contents page so that page numbers for both feature and department articles are now found in one place, in the front of the book.

Sympathy is extended to the casual reader. Our editorial coverage for the year 1954 achieved the rather staggering total of 1,717 pages. Allowing only one minute for a glance at each editorial page, it would take 28.6 hours to go through the year's issues. One

couldn't do much actual reading in this time, and would have no time at all to study circuit diagrams, curves or tables. Yet readers often tell us that they read the magazine "from cover to cover". We feel proud of our work when it happens.

CASTING SHADOWS BEFORE

Just three years ago the department *Production Techniques* began. Periodically, associate editor Markus sallies forth into plants around the country in assiduous search for the latest manufacturing methods. Seldom less than ten and as many as 85 photographs are taken in each plant. Thanks are due to the many companies that have cooperated in making their techniques available, and to engineers that have contributed production articles.

An IRE professional group has now been set up to study this same subject. The scope of Group G-22 is to promote technical progress . . . by collecting and distributing information on advances in methods, processes, materials and components.

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and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; \$1.50 for Latin America; \$2.00 for all other foreign countries. Buyers' Guide \$3.00. Subscription rates—United States and possessions, \$6.00 a year; \$9.00 for two years. Canada, \$10.00 a year; \$16.00 for two years. Other western hemisphere countries and the Philippines, \$14.00 a year; \$25.00 for two years. All other countries \$20.00 a year; \$30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1955 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E. C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

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NEW!**

**MAGNETIC
VOLTAGE REGULATORS**

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

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



ELECTRICAL SPECIFICATIONS

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

MECHANICAL SPECIFICATIONS

Model MVR15	Length 6 $\frac{1}{2}$ "	Width 2 $\frac{7}{8}$ "	Height 3 $\frac{1}{2}$ "
Model MVR30	Length 6 $\frac{1}{2}$ "	Width 2 $\frac{7}{8}$ "	Height 3 $\frac{1}{2}$ "
Model MVR60	Length 8 $\frac{1}{2}$ "	Width 3 $\frac{1}{2}$ "	Height 4 $\frac{1}{4}$ "
Model MVR120	Length 9 $\frac{5}{8}$ "	Width 3 $\frac{1}{2}$ "	Height 4 $\frac{1}{4}$ "

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

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

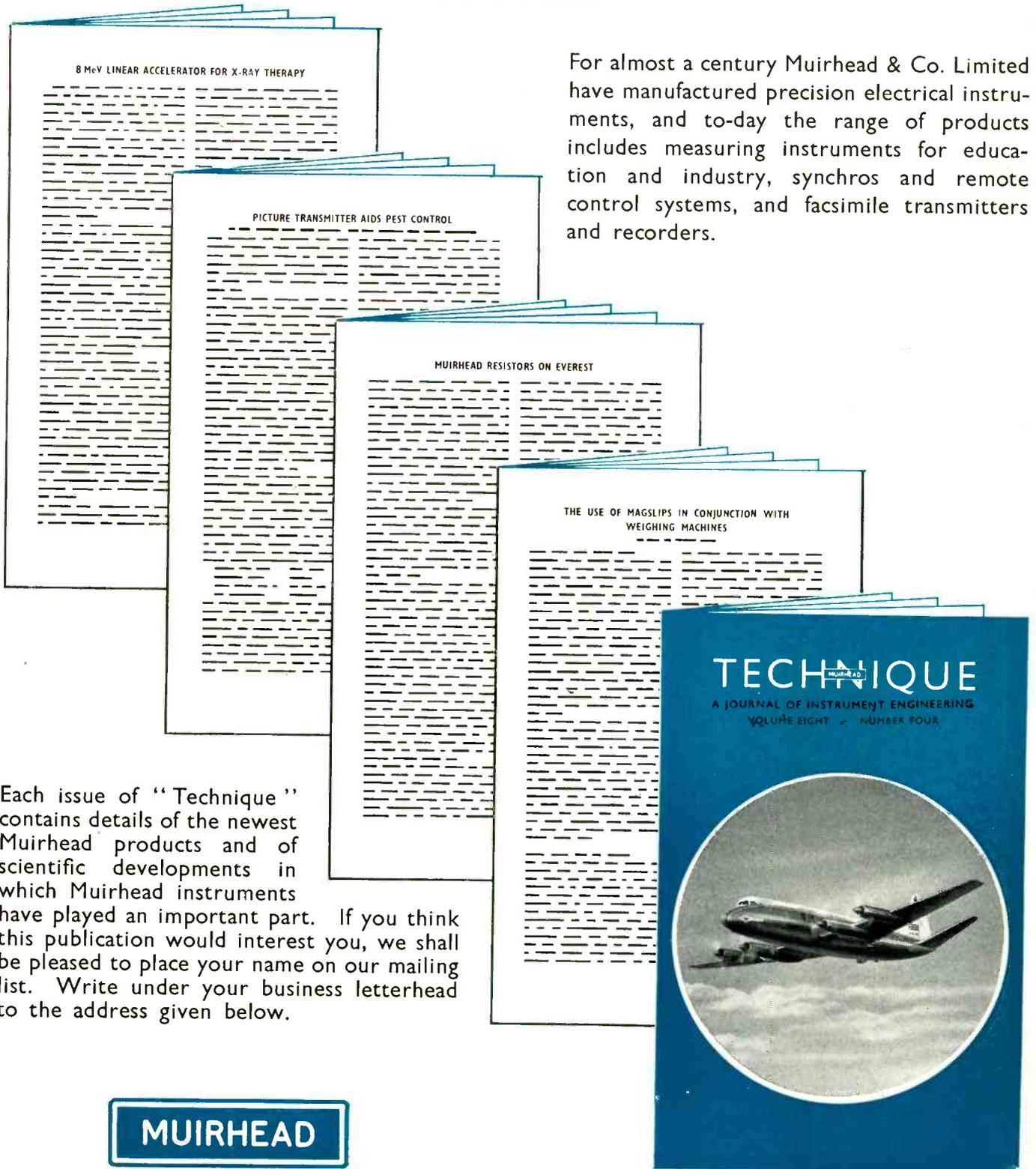
SORENSEN

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Want more information? Use post card on last page.

January, 1955 — ELECTRONICS

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For almost a century Muirhead & Co. Limited have manufactured precision electrical instruments, and to-day the range of products includes measuring instruments for education and industry, synchros and remote control systems, and facsimile transmitters and recorders.

Each issue of "Technique" contains details of the newest Muirhead products and of scientific developments in which Muirhead instruments have played an important part. If you think this publication would interest you, we shall be pleased to place your name on our mailing list. Write under your business letterhead to the address given below.

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PRECISION ELECTRICAL INSTRUMENTS

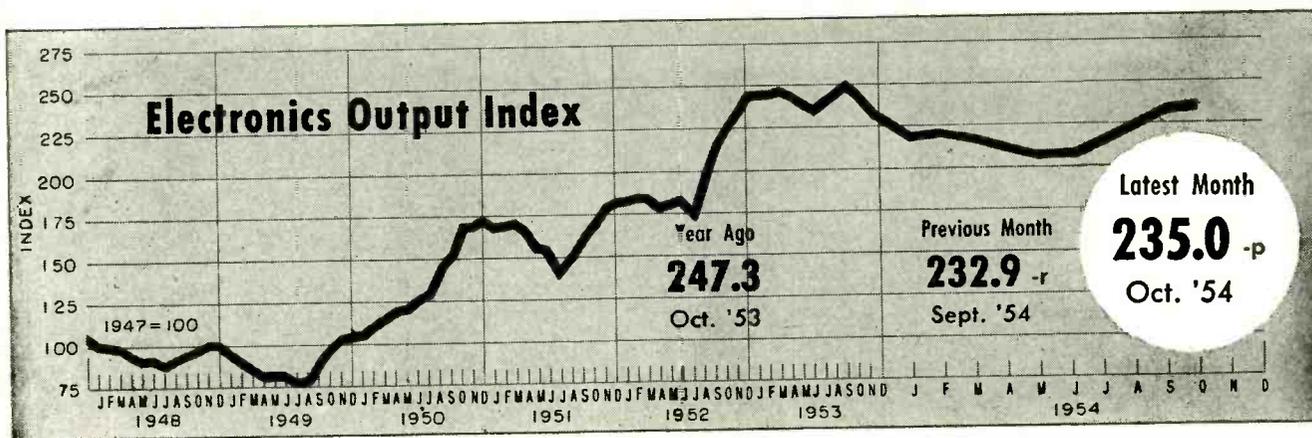
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ELECTRONICS — January, 1955

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5



FIGURES OF THE MONTH

	Latest Month	Previous Month	Year Ago
RECEIVER PRODUCTION			
(Source: RETMA)			
Television sets, total	921,476	947,796	680,433
With UHF	161,431	136,613	202,605
Color sets	2,907	14,538*	—
Radio sets, total	997,788	932,323	1,052,493
With F-M	12,151	17,644	19,797
Home sets	343,269	352,499	370,178
Clock radios	220,505	207,226	189,230
Portable sets	97,331	76,271	135,009
Auto sets	336,683	296,327	358,076

	Latest Month	Previous Month	Year Ago
RECEIVER SALES			
(Source: RETMA)			
Television sets, units	799,164	986,136	621,768
Radio sets (except auto)	570,285	763,589	385,229

	Oct. '54	Sept. '54	Oct. '53
RECEIVING TUBE SALES			
(Source: RETMA)			
Receiv. tubes, total units	42,347,794	40,966,063	34,928,108
Receiv. tubes, value	\$29,228,992	\$28,953,592	\$25,393,879
Picture tubes, total units	1,269,674	1,149,791	948,593
Picture tubes, value	\$26,597,702	\$23,892,469	\$23,994,184

	Sept. '54	Aug. '54	Sept. '53
SEMICONDUCTOR SALES			
Germanium diodes, units	1,433,021	1,156,114	870,555
Silicon diodes, units			

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

	Latest Month	Previous Month	Year Ago
TV SETS INSTALLED			
(Source: NBC Research Dept.)			
Total sets	32,262,000	31,674,000	26,364,000

	Oct. '54	Sept. '54	Oct. '53
BROADCAST STATIONS			
(Source: FCC)			
TV stations on air	431	428	315
TV stations CPs—not on air	147	150	230
TV stations—new requests	167	167	424
A-M stations on air	2,627	2,616	2,497
A-M stations CPs—not on air	126	121	106
A-M stations—new requests	137	137	187
F-M stations on air	558	559	566
F-M stations CPs—not on air	10	14	20
F-M stations—new requests	2	2	5

	Sept. '54	Aug. '54	Sept. '53
COMMUNICATION AUTHORIZATIONS			
(Source: FCC)			
Aeronautical	39,900	40,695	42,427
Marine	47,882	47,360	42,931
Police, fire, etc.	16,308	16,109	14,094
Industrial	22,339	22,132	18,868
Land transportation	7,012	6,982	6,201
Amateur	123,163	121,762	113,909
Citizens radio	8,229	8,143	3,987
Disaster	306	305	251
Experimental	607	600	476
Common carrier	1,730	1,699	1,327

	Sept. '54	Aug. '54	Sept. '53
EMPLOYMENT AND PAYROLLS			
(Source: Bur. Labor Statistics)			
Prod. workers, comm. equip.	365,200-p	357,000-r	408,200
Av. wkly. earnings, comm.	\$69.95 -p	\$69.03	\$68.38
Av. wkly. earnings, radio	\$68.57 -p	\$67.66 -r	\$66.17
Av. wkly. hours, comm.	40.2 -p	39.9	40.7
Av. wkly. hours, radio	40.1 -p	39.8 -r	40.1

	Nov. '54	Oct. '54	Nov. '53
STOCK PRICE AVERAGES			
(Source: Standard and Poor's)			
Radio-tv & electronics	454.6	360.4	253.4
Radio broadcasters	408.1	400.7	252.3

p—provisional; r—revised
N.R.—not reported *9 mos.

FIGURES OF THE YEAR

Television set production	5,654,791	6,204,803	— 8.9	7,214,787
Radio set production	8,040,230	11,201,656	—28.2	13,368,556
Television set sales	5,444,227	4,922,128	+10.6	6,375,279
Radio set sales (except auto)	4,602,989	4,911,415	— 6.2	7,064,485
Receiving tube sales	308,398,701	382,080,558	—19.3	437,091,555
Cathode-ray tube sales	7,746,240	8,501,445	— 8.9	7,582,835

	1954	1953	Percent Change	1953 Total
Television set production	5,654,791	6,204,803	— 8.9	7,214,787
Radio set production	8,040,230	11,201,656	—28.2	13,368,556
Television set sales	5,444,227	4,922,128	+10.6	6,375,279
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INDUSTRY REPORT

electronics—January • 1955

Projection Receiver Enters Color Television Field

Plug-in Schmidt system gives 13 x 18½-in. picture. Cost may rival that of direct-view

DEMAND for large-screen color television sets has revived interest in projection television. The set in the photograph is one of two models built by Hazeltine and recently demonstrated to nearly 30 receiver manufacturers.

► **Plug-in Optics**—The complete projection system ready to plug into the set would be furnished to set manufacturers by the American Optical Co. Unit price in quantity of 100,000 per year would be \$250. This compares with an estimated \$225 for a direct-view tricolor tube with its yoke.

Six receiver manufacturers have ordered sample optical systems at \$900 each for their engineering departments. Production optical systems would be available

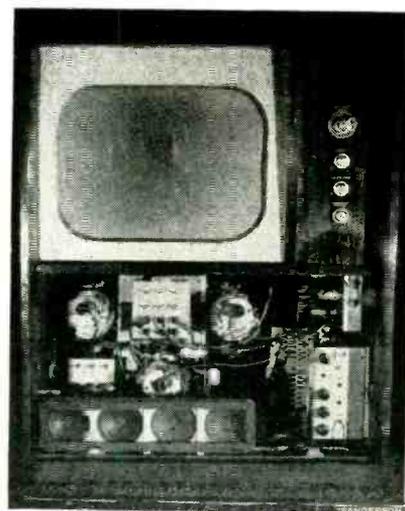
in four months with consumer production possible in 10 months.

The three 2.5-in. projection tubes will be supplied initially by North American Philips and later by Tung-Sol Electric. The tubes now cost \$12.50 each but sell in Europe for \$5.

The Liberty mirror division of Libby Owens Ford will manufacture the dichroic mirrors.

► **Electronics**—The receiver chassis will be similar to present direct-view color chassis. Four additional tubes are required to keep the color tubes in registry. However, Hazeltine engineers claim that a 12AX7 and a ballast will do the trick. The set requires a 25-kv power supply with 100 microamperes going to the blue and green tubes and 200 to the red.

The set provides a 13 x 18½-in (240 sq in.) picture, equivalent to that of a 21-in. direct-view tube. The cabinet is only 24 in. deep. A

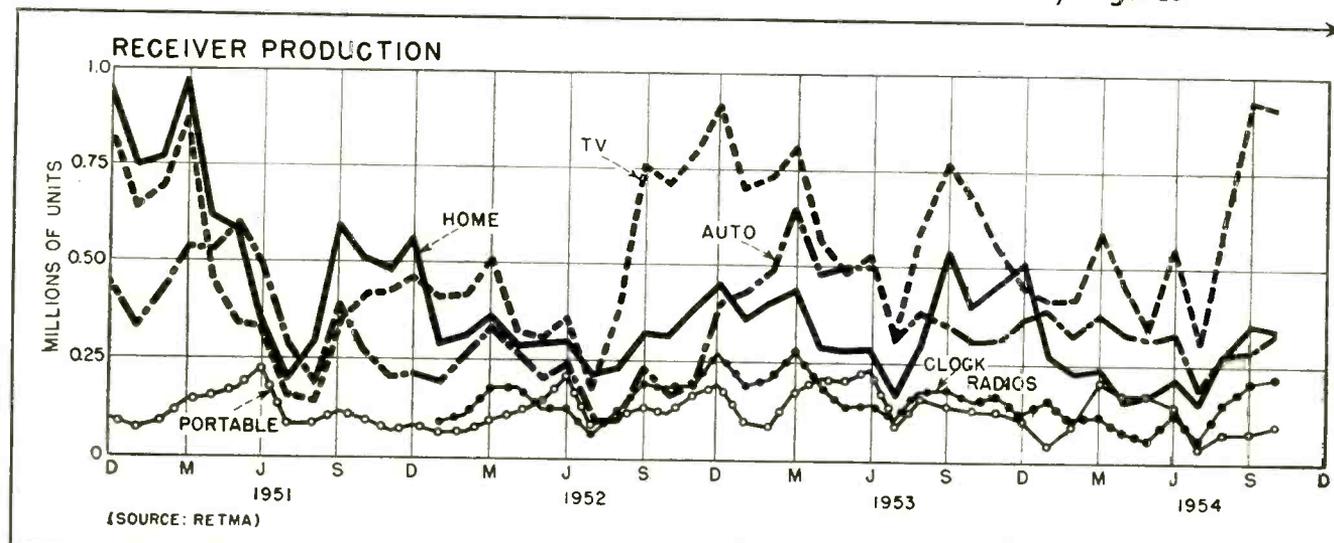


Receiver employs three projection tubes (left) and 25-kv power supply

15 x 20-in. (285 sq in.) picture can be provided, corresponding to a 24-in. picture tube.

► **Performance**—When observed receiving films and slides over a closed circuit, the set showed

ELECTRONIGRAPHS—A Year-End Glance at Electronics Industry Figures



More charts following

excellent registration, good color reproduction and good monochrome reproduction. Screen directivity is largely in the vertical direction and there was no apparent difficulty in viewing the

picture in normal room illumination.

The lowered contrast inherent in projection systems did not seem objectionable. The twin color receivers demonstrated showed pic-

tures of equal color values. In projection television, colored filters can be placed in front of the projection tubes to correct the spectral distribution of light from different phosphors.

Engineers Humanize Research Computer

Navy's \$2-million machine performs arithmetic like a person—but much faster

DEVELOPMENT of large-scale computers has been largely a quest for speed, capacity, accuracy and reliability. The NORC, Naval Ordnance Research calculator, provides all these things and what's more, makes life easy for its operator.

The machine is completely decimal in all operations outside its electronic heart. It performs arithmetic a digit at a time much like a human being. Continuous write out of results during calculation enables the operator to follow the work and modify it when necessary. The computer can point off decimal places as desired.

► **Performance**—The NORC is a special-purpose computer designed



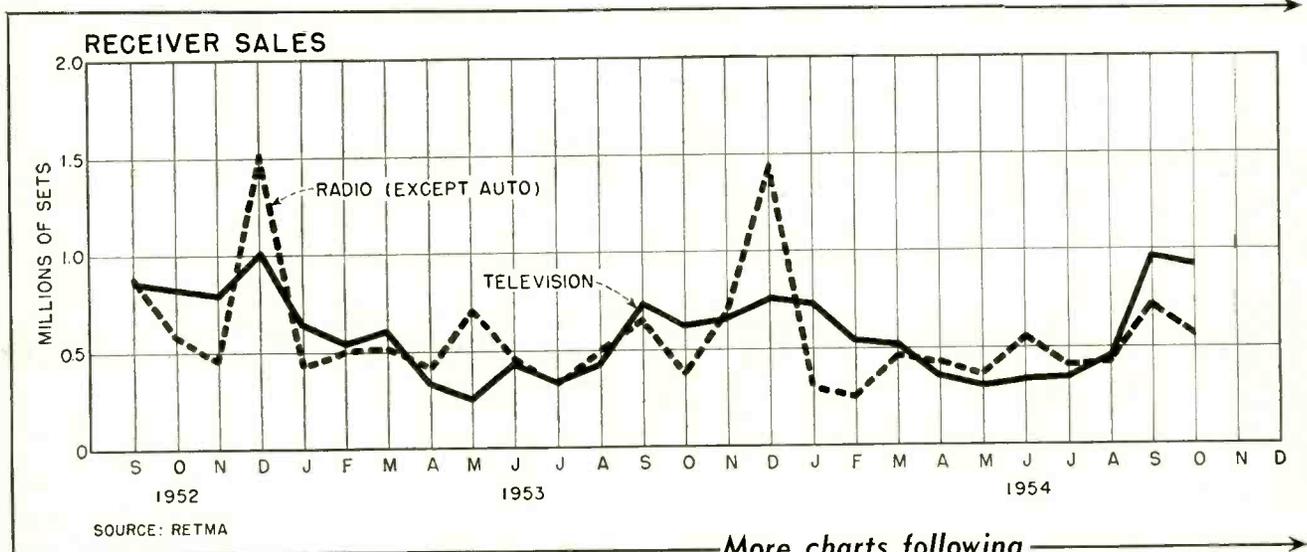
Operator can study computing processes in slow-motion detail

to tackle scientific problems that would be unreasonably lengthy even when done on the largest general-purpose machines. It can

add two 13-digit numbers in 15 microseconds and multiply them in 31 microseconds. Characters are read in from eight high-speed mag-

(Continued on page 10)

ELECTRONIGRAPHS Continued



NOW!

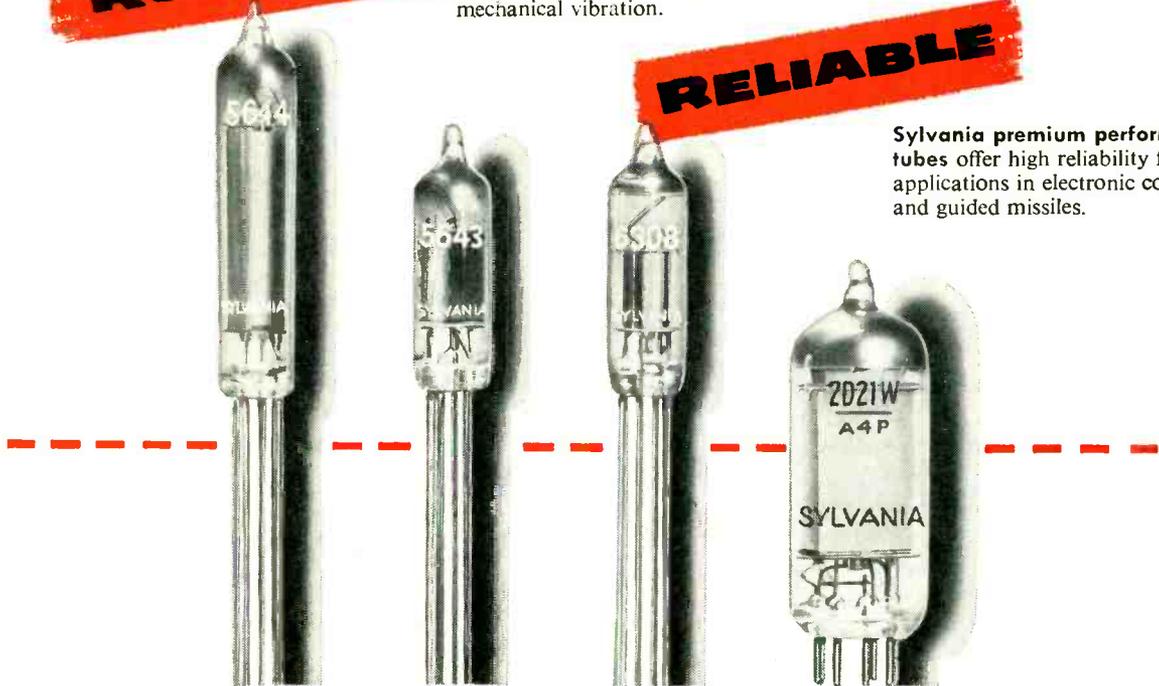
For your most important electronic control applications

RUGGED

Completely ruggedized tubes developed especially for the Armed Forces to operate under conditions of severe shock and mechanical vibration.

RELIABLE

Sylvania premium performance tubes offer high reliability for applications in electronic computers and guided missiles.

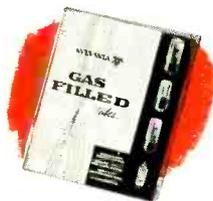


SYLVANIA GAS TUBES

To MEET your electronic control equipment needs, whether military or commercial, Sylvania offers a wide selection of gas tubes engineered to meet the most rigid specifications. These include tubes for commercial use in applications where reliable performance is required under difficult conditions of shock and vibration. Some Sylvania gas tubes have been especially designed to meet MIL-E-1 specifications.

Whatever your needs, you can select any Sylvania gas tube with confidence that it is manufactured under the same standards of quality and dependability which recommend their use in vital military equipment.

Sylvania's complete line offers you dependable tube types for your most important control functions.



A SYLVANIA TYPE FOR EVERY NEED

Type	Application
0A2	voltage regulator
0A4G	relay and grid controlled rectifier
0B2	voltage regulator
0B3	voltage regulator
0C3	voltage regulator
0D3	voltage regulator
1B59/R1130B	glow modulator diode
1D21/SN4	strobatron
2D21	relay and grid controlled rectifier
2D21W	relay and grid controlled rectifier
R4330	strobatron
S413	strobatron
SA309	strobatron
1237	full-wave rectifier
20A5	trigger tube
5643	relay tube
5644	voltage regulator
5651	voltage reference
5823	relay, rectifier
6D4	relay, relaxation osc. noise generator
6308	voltage reference
6483	trigger tube

Send for new bulletin for complete data on Sylvania Gas Tubes.

SYLVANIA



SYLVANIA ELECTRIC PRODUCTS INC. • 1740 BROADWAY, NEW YORK 19, N. Y.

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

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

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

Please send Technical Data on Sylvania Gas Tubes.

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

netic tape units at 70,000 per second while the two output printers can type 18,000 characters per minute. The NORC is a development of IBM's Watson Laboratory.

The machine will be installed at the Naval Proving Ground, Dahlgren, Va., where one of its first tasks will be computing ballistics tables. The NORC contains 8,000 electron tubes and 25,000 diodes.

► **Reliability**—A bank of 3-in. cathode-ray tubes comprising the register shown at the left in the photograph enables the operator to check any number in the computer. The NORC installation includes a room devoted to dynamic testing apparatus for servicing the plug-in units that make up the computer.

Dynamic testing subjects the

circuits to all conditions to be anticipated in service and pinpoints trouble. Maintenance is simplified by using only 60 circuit types throughout the computers. Actually six circuit types account for nearly half the circuits. In four hours of errorless operation, NORC can do more work than a computer of 10 years ago did in its entire lifetime.

Early Warning Radar Goes Airborne

Super Constellations flying round the clock serve also as CIC's for Air Force and Navy

GROUND-BASED and shipborne long-range radar stations are being transferred to aerial command posts for earlier detection of an enemy's air or ocean approach, along with combat information centers (CIC) for directing interception efforts.

WV-2 Super Constellations, modified to take 6 tons of radar gear and a 26-man operating crew, are used for this purpose by the Navy, and almost identical RC-121's are in service for the Air Force. Release of this story coincided with a report from Washington that the Navy recently awarded Lockheed Aircraft Corp. the largest order ever placed



One of Navy's new WV-2 Super Constellations, on which belly blister is search radar antenna, fin atop fuselage is for height-finding and nose blister contains storm-detection radar



Interior of flying CIC, showing some of the radar stations in the 48-ft cabin

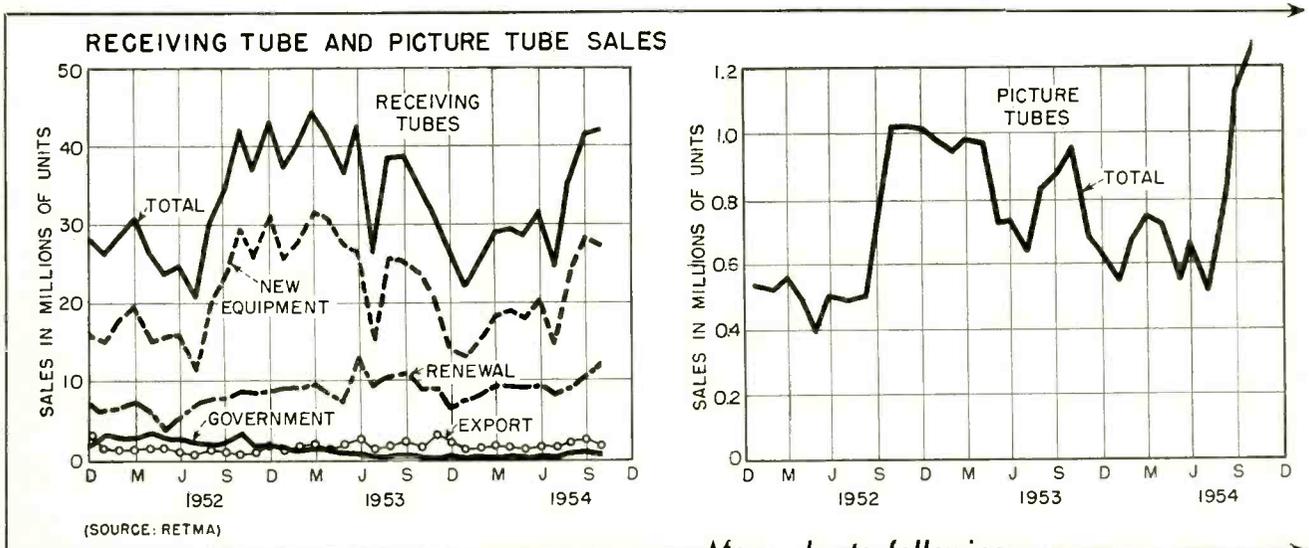
for Super Constellations up to now.

► **Demonstration**—From Barber's Point Naval Air Station on Oahu a WV-2, delivered across the Pacific only the day before, took off before dawn in squally skies to find its flat-top quarry "somewhere south of Hawaii" in the first simulated exercises for newsmen. Capitalizing on altitude to sweep an area vastly greater than could any mast-high or land-based radar, the radar scopes soon picked up the target.

Speed and course were determined by technicians at five plotting consoles, each viewing a different presentation or segment of the basic radar picture. These and other auxiliary radars also monitored positions of accompanying jet fighter and torpedo bomber squadrons, to

(Continued on page 12)

ELECTRONIGRAPHS Continued



More charts following

Here's What's New in Vitamin Q[®] Capacitors



Now you can have Sprague's famous subminiature paper capacitors in new styles that make vibration-proof mounting simple . . . make harness wiring faster. New straddle milled flats on standard threaded neck units let you insert the neck in flatted openings. A simple nut and lock washer permanently locks the capacitor to the chassis. In addition, you can now obtain Sprague subminiature paper capacitors with solder tab terminals, eliminating the problem of splicing leads to wires. Insulating outer sleeves for 125°C mounting are also available.

Sprague's Vitamin Q capacitors are available in ratings and mechanical designs far beyond

those called for in specification MIL-C-25A. For example, both inserted tab and extended foil designs are available in working voltage ratings up to 1000 vdc.

Positive hermetic closure is assured by glass-to-metal solder seals, which unlike rubber compression-type terminals, cannot be twisted during wiring assembly.

Complete information on Sprague subminiature paper capacitors in all thirteen case styles, is provided in Engineering Bulletin 213C, available on letterhead request to the Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

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

NEW

subminiature paper capacitor mounting styles speed and simplify circuit assembly with—

- **Flatted Necks**
 - **Solder Tab Terminals**
 - **Insulating outer sleeves**
- for 125°C applications**

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

whom went radioed flight orders.

More instructions went out as the fighters closed in from various angles for optimum surprise and minimum retaliation. In a matter of minutes after sighting by radar, the target Kearsarge was theoretically crippled.

► **Significance**—Though total orders have not been revealed, it is evident that six tons of lightweight

electronic equipment in each airborne CIC will mean sizable business for the electronic industry. In addition to search radar, the orders will include height-finding radar working from a 7-foot-high fin-shaped antenna blister atop the fuselage, storm-warning radar, loran and other navigation aids, multichannel radio communication equipment, radar scope cameras, intercoms and a small electronic shop.

prove a sleeper, owing to the high fidelity and extreme versatility of which only this medium is capable. Multiplexing makes possible both a home program and a functional program (from which advertising revenue can be obtained) to serve two different audiences.

For superhigh-fidelity listeners, the pair of channels can be used for binaural musical effects. Multiplexing other services (like police, fire or other mobile radiocommunications) has been suggested as a means of conserving radio spectrum and increasing revenue from f-m.

► **Cutting Costs**—The average a-m plant is probably very much more efficiently run than its prewar counterpart. Development of new and reliable electronic equipment has played a major part in economical operations.

The FCC recognizes reliability by reducing necessary technical qualifications for most operating personnel. It further allows unattended remote control of many f-m and a-m transmitters (using wire lines or radio links). Some 720 stations have remote authorization—nearly a quarter of the total stations on the air.

Latest electronic aid is exemplified in a type of multiple magnetic recorder that programs the non-network station from prerecorded

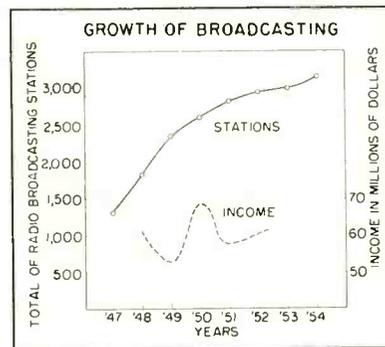
(Continued from page 14)

Soundcasting Continues Profitable

Number of a-m and f-m stations continues to show a net increase

DESPITE dire predictions that a-m broadcast networks may be on the verge of dissolution, standard broadcasting stations themselves are generally healthy and growing in number. Total of a-m and f-m stations on the air at the last count is 3,185—more than double the 1947 total. Broadcasting revenue (before Federal taxes) has fluctuated both sides of \$60 million (as shown in the graph) and was down only 8.4 percent in 1953.

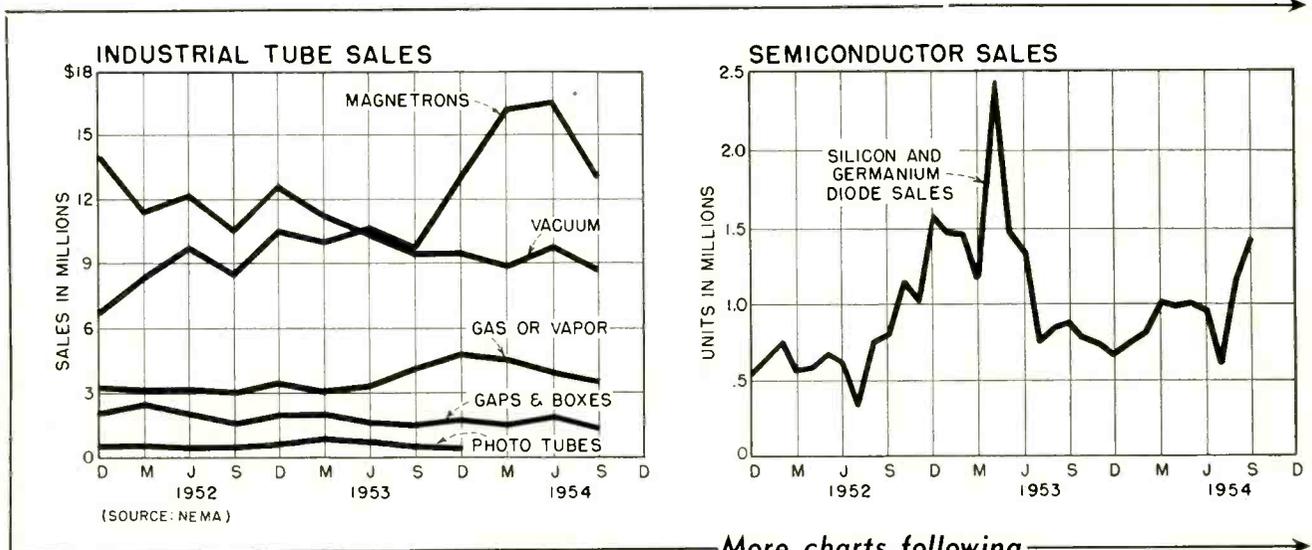
► **Staying Afloat**—Growth of television undoubtedly slowed f-m just



as it cut revenues immediately available to a-m. Many f-m outlets are merely adjuncts to the a-m moneymaker and do not add significantly to income production. Average income per station is therefore less as stations increase.

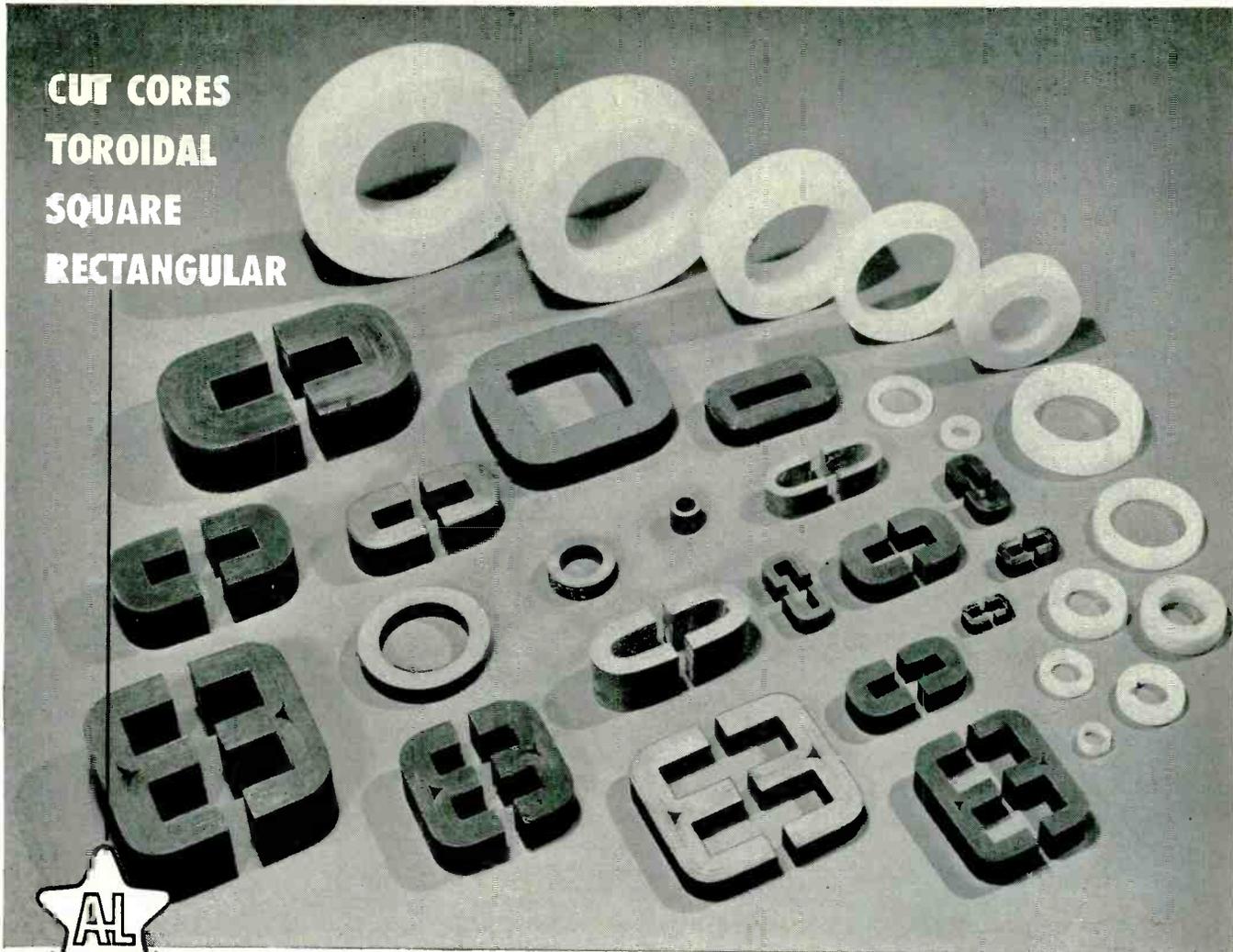
Frequency modulation may

ELECTRONIGRAPHS Continued



More charts following

**CUT CORES
TOROIDAL
SQUARE
RECTANGULAR**



Anything You May Need in **TAPE-WOUND CORES**

RANGE OF MATERIALS

Depending upon the specific properties required by the application, Arnold Tape-Wound Cores are available made of DELTAMAX . . . 4-79 MO-PERMALLOY . . . SUPERMALLOY . . . MUMETAL . . . 4750 ELECTRICAL METAL . . . and SILECTRON.

RANGE OF SIZES

Practically any size Tape-Wound Core can be supplied, from a fraction of a gram to several hundred pounds in weight. Toroidal cores are made in twenty-seven standard sizes with protective nylon cases. Special sizes of toroidal cores—and all cut cores, square or rectangular cores—are manufactured to meet your individual requirements.

RANGE OF TYPES

In most of the magnetic materials named, Arnold Tape-Wound Cores are produced in the following standard tape thicknesses: .012", .004", .002", .001", .0005", or .00025", as required.

For complete details, write for Bulletins TC-101A and SC-107.

Applications

Let us help with your core problems for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, etc.

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SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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

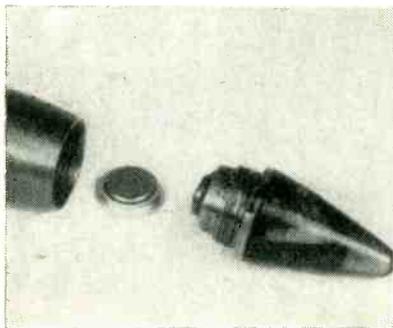
Los Angeles: 3450 Wilshire Blvd.

Boston: 200 Berkeley St.

tape during a whole evening. An ultrasonic tone following each musical selection shuts off program and turns on the local announcement tape.

Following the announcement, the same kind of ultrasonic tone cues in the program again. Personnel who have recorded announcements early in the day can be freed for other tasks—or allowed to go off duty, without payment of overtime wages. Network line charges are likewise eliminated.

20-MM Transmitter Rides The Range



Plastic potted transistorized radio transmitter goes in the nose of 20-mm projectiles to aid U. S. Naval Ordnance Lab study of projectile flight properties. Its signals are picked up on antenna strung along the firing range. Button battery in center powers unit

Color Set Makers Get Set For '55

Field is relatively quiet as manufacturers weigh commercial introduction dates

WITH monochrome set sales reaching healthy proportions during the Christmas rush, tv set makers were inclined to do little worrying about 1955 and color. However, in December two companies announced color set production plans and there were signs that others were preparing to jump off the color fence.

► **Sets**—RCA began commercial production in December of receivers using its 21-inch tricolor tube and scheduled shipments to distributors for late in the month. Sets are expected to be available in dealer stores in January at \$895. Only limited production is planned initially and work is continuing to further reduce cost.

As a result of improvements in the convergence and focusing circuits, the control knobs, previously on the side of the cabinets, have been placed inside the cabinet as an adjustment for servicemen only.

Hoffman Electronics, formerly Hoffman Radio, also introduced a new 21-inch color tv set in Decem-

ber and planned limited production for the first quarter of 1955. The set utilizes the 21-inch three-gun RCA tube and will retail between \$895 and \$995.

► **Future**—What tv set manufacturers expect for sales in 1955 was evident in RETMA's annual informal poll of guess estimates. Results indicate industry sales expectations for 1955 of 6.9 million tv sets and 10.7 million radio receivers. An average of the guesses set 1955 black and white sales at 6.6 million and color sales at 300,000. The color guesses ranged from a high of 750,000 units to a low of 50,000. Estimated radio sales were 6.9 million home sets and 3.8 million auto sets.

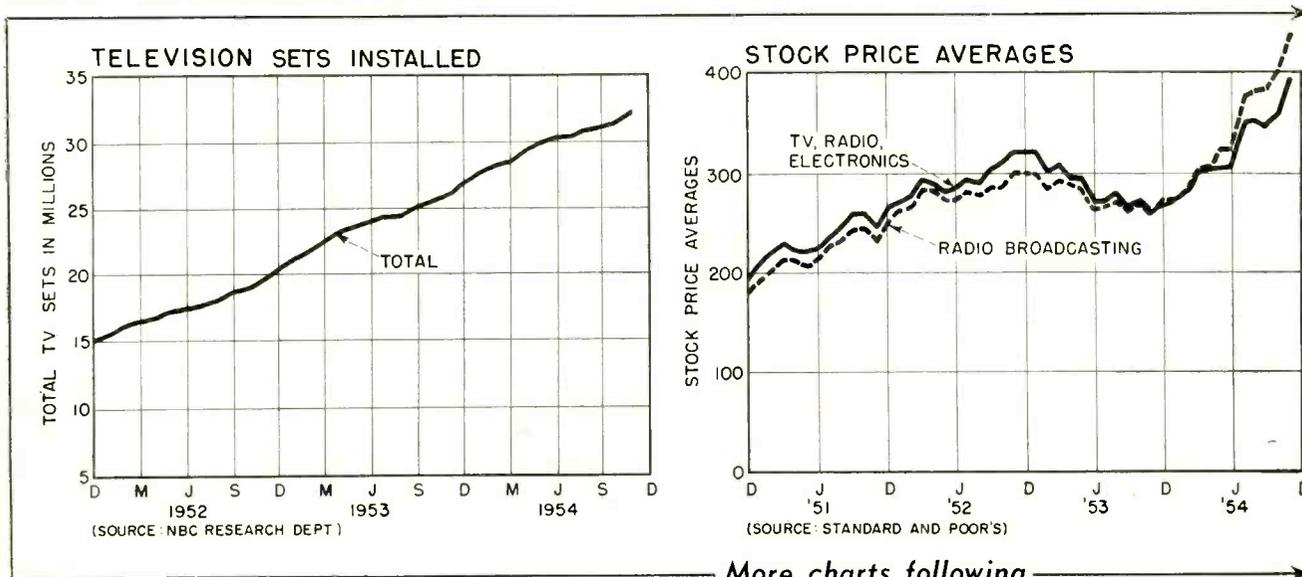
Parts Distributors Keep Growing

More companies enter the field as sales volume increases and markets enlarge

PORTION of total electronics industry sales accounted for by electronic parts distributors has

(Continued on page 16)

ELECTRONIGRAPHS Continued



More charts following

**If You Manufacture
Diodes, Transistors,
Electronic Tubes**

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largest manufacturer
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Experience with the widest
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glass-to-metal seals — makes Kahle
your logical source for
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Kahle automatic combination machines
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produce up to 2000 units
each hour! Regardless of your product
or production requirement,
write **KAHLE**.

**SPECIAL EXPERIMENTAL
AND RESEARCH SERVICES
OFFERED BY KAHLE INCLUDE:**

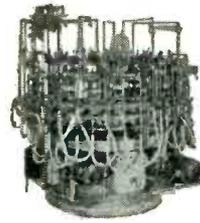
- Special glass parts and accessories
- Special tools for research
- Special models
- Small-lot manufacture of special items for research or development
- Regular industrial engineering at regular fee or contract rates
- Special tubes, lamps, etc. for research purposes including elements and parts
- Any special equipment for manufacture or research for tubes or lamps

Kahle
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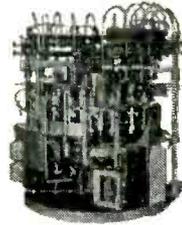
SUB-MINIATURE TUBES 24 HEAD



MERCURY LAMPS



HERMETIC SEAL 8 HEAD



RADIO RECEIVING TUBES
SEAL EXHAUST MACHINE



FLUORESCENT LAMPS 8 HEAD



CR TUBES 16 HEAD



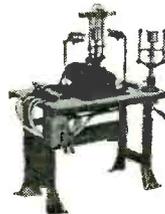
CR TUBES SINGLE HEAD



LIGHTHOUSE TUBES
HIGH FREQUENCY SEALING



SUB-MINIATURE 12 HEAD



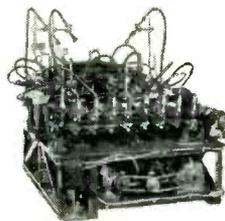
BI-POST LAMPS SINGLE HEAD



FLUORESCENT LAMPS 24 HEAD



MOULDED NECK LAMPS



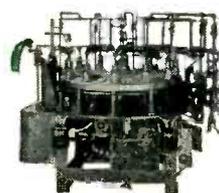
CR TUBE FACE PLATE SEALING
SINGLE HEAD FOR COLOR TV TUBES



POWER TUBES 8 HEAD



MINIATURE TUBES 12 HEAD



HERMETIC SEAL 12 HEAD



POWER TUBES SINGLE HEAD



VACUUM BOTTLES

©NTI

grown steadily in the past few years and may reach a record volume this year.

According to Market Planning Service, a division of National Credit Office, sales of these outlets totaled \$327.9 million in the first 9 months of 1954 compared to \$313.0 million for the same period in 1953 for an increase of nearly \$15 million. The total for the full year of 1953 reached \$450.4 million, representing a 25-percent increase over 1952 business.

► **Number**—According to National Credit, there were approximately 160 electronics parts distributors prior to 1931 while today there are more than 1,100 in the U.S. Growth of individual distributors has also been substantial. There are now more than 250 branch locations.

► **Business**—Tube sales have represented approximately 24 percent of sales followed by 27 percent for electronic components. The remainder is accounted for by various end products such as test equipment.

The industrial market has been responsible for a substantial part of the sales gains made by distributors. An estimated 18 percent of the national distributor sales volume in 1954 was accounted for by industrial elec-

tronic parts and equipment.

► **Failures**—Only a relatively small number of firms have failed in the past few years. In 1953, 8

parts distributors experienced financial difficulties. In the manufacturing side of the business, 33 companies failed during the same period with higher liabilities.

Aluminized Tubes Dominate TV

Nine out of ten tubes for new sets are aluminized; automatic machinery cuts costs

RESPONDING to demand for brighter pictures, picture tube manufacturers are currently applying light-reflecting aluminum mirrors to screens of up to 95 percent of their output for the original-equipment market. Automatic machinery capable of handling up to 120 tubes

per hour, for synchronization with existing tube production lines, has made possible this upping of aluminized output in many tube plants.

► **Mechanization Setup**—Typical of the new machines is that made by Stokes for RCA, costing \$36,000. On a 30-second cycle, only one man is needed to service the 22 self-contained mobile aluminizers that travel around an oval track in endless procession. After unload-



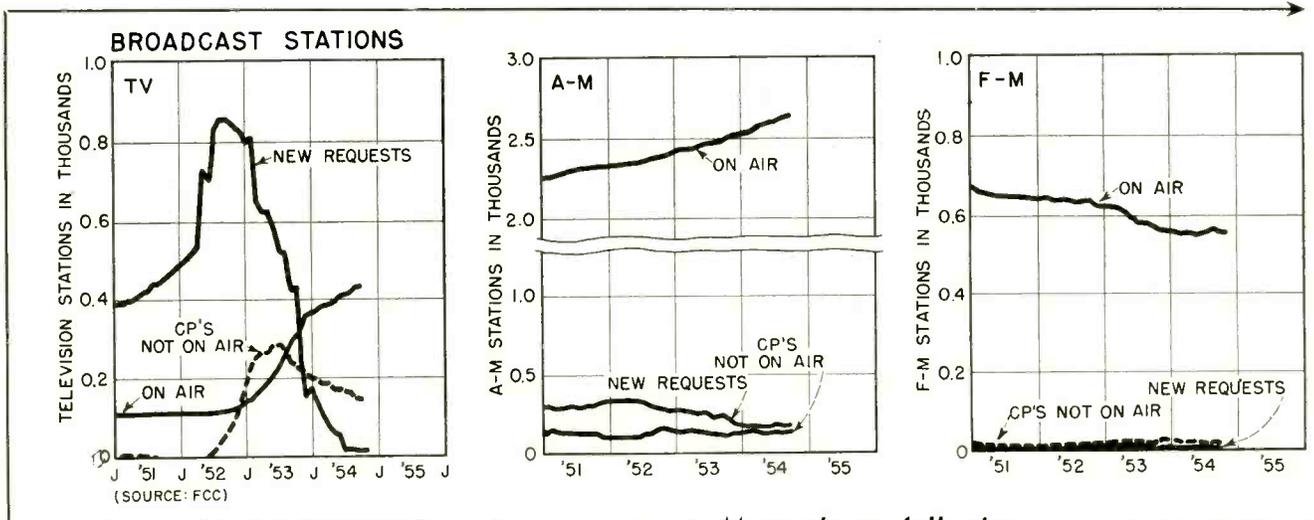
Loading position on automatic aluminizer in RCA Marion, Indiana plant



Aluminum slug placed in coiled filament is vaporized by heating filament, so that molecules of aluminum are deposited on screen

(Continued on page 20)

ELECTRONIGRAPHS Continued



More charts following



Balanced-Line measurements!

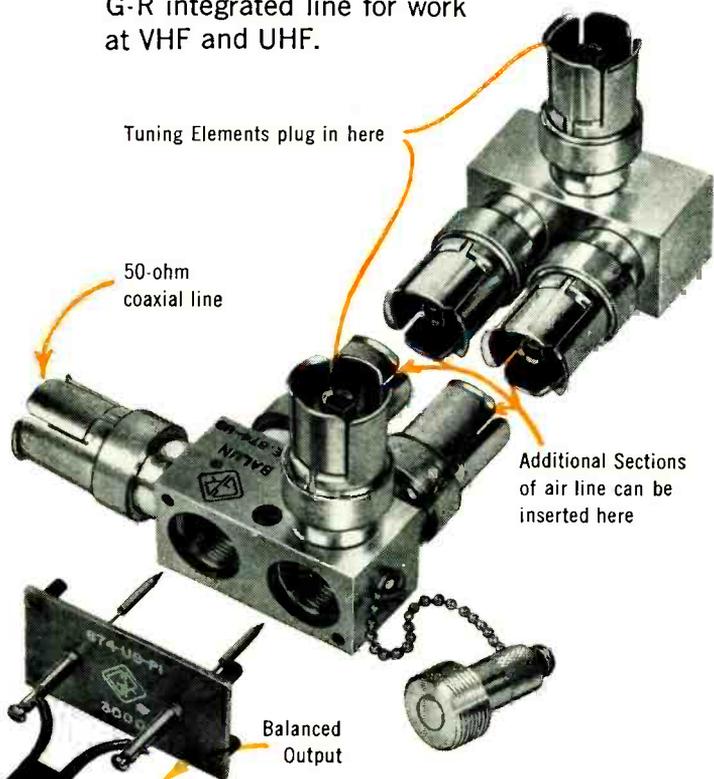
VHF-UHF TUNABLE BALUN

Used with the ^{G-R} Admittance Meter

and New ^{G-R} High-Frequency Null Detector . . .

The G-R High-Frequency Measuring System is useful for many types of measurements on both balanced and unbalanced circuits.

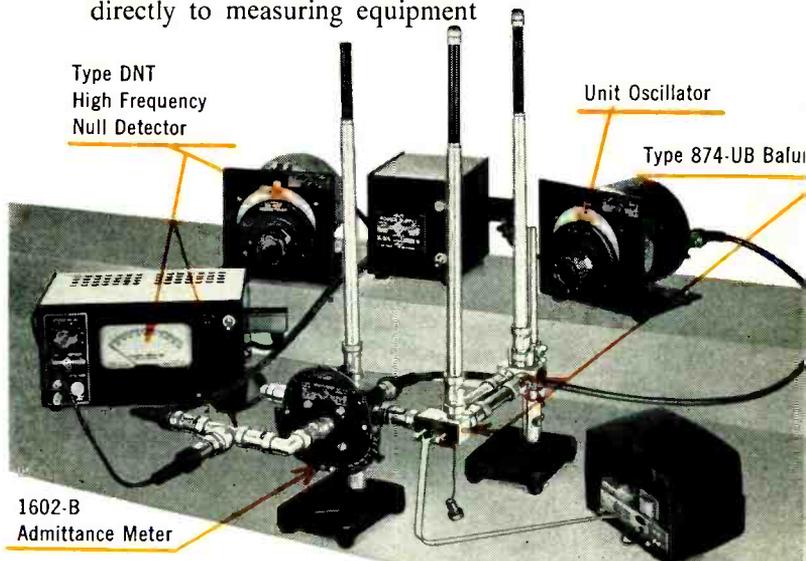
Write for our bulletins describing the Admittance Meter, Slotted Line, Balun, High-Frequency Detector and many other instruments of the G-R integrated line for work at VHF and UHF.



The Type 874-UB Balun is a unique device for connecting from balanced to unbalanced systems over a wide 54 to 1000 Mc range. The balanced to unbalanced transformation is obtained by using a semi-artificial, half-wave line made up of two sections of 50-ohm coaxial line and two shunt tuning elements.

The Balun is made tunable so that the best possible accuracy can be obtained at any frequency over its range. This unit is precision tooled and is of the same high caliber workmanship which has become synonymous with the G-R trademark.

- . . . makes possible accurate impedance, VSWR, gain and sensitivity measurements on balanced systems
- . . . converts grounded signal generators to signal sources with balanced outputs
- . . . permits accurate measurement of attenuation as well as impedance of balanced twin-lead, twin-line, other tv transmission lines, and on tv receiver inputs and other communication equipment. Write for the booklet "The Measurement of Cable Characteristics"
- . . . determines VSWR introduced into 300-ohm twin-lead by filters, lightning arrestors, etc.
- . . . facilitates measurement of inaccessible balanced circuits such as tv receiving antennas which cannot be connected directly to measuring equipment



Type 1602-B Admittance Meter and Balun setup to measure admittance or impedance of converter input. One Type 1208-A Unit Oscillator supplies the vhf power, while the local oscillator in the Type DNT Null Detector Assembly beats with the Admittance Meter output to provide a 30-Mc difference frequency. This signal is detected by the new Type 1216-A Unit I-F Amplifier, also an element of the Null Detector Assembly.

874-UB Balun	\$75.00	with appropriate local oscillators for coverage from 50 Mc to 950 Mc on fundamental frequencies and to 5000 Mc using oscillator harmonics . . . \$628 to \$667 depending on frequency range
For use with the Balun		Unit Oscillators
874-D50 Adjustable Stub (50 cm)	12.00	1211-A 500 kc to 50 Mc \$295.00
874-L10 50-ohm Coaxial Air Line (10 cm)	5.00	1215-B 50 to 250 Mc 190.00
874-L20 50-ohm Coaxial Air Line (20 cm)	5.50	1208-A 65 to 500 Mc 190.00
1602-B Admittance Meter and accessories	295.00	1209-B 250 to 920 Mc 235.00
Type DNT Detector Assembly . . . available		

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

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| FREQUENCY STANDARDS | POLARISCOPES | UNIT INSTRUMENTS |
| IMPEDANCE BRIDGES | PRECISION CAPACITORS | VARIACS® |
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| MEGOhmmeters | R-L-C DECADES | WAVE ANALYZERS |
| | R-L-C STANDARDS | WAVE FILTERS |



RAYTHEON FLAT PRESS SUBMINIATURE TUBES provide freedom from catastrophic glass failures. The Flat Press is your Seal of Reliability.

Raytheon has 15 years experience in manufacturing over 10,000,000 Flat Press Subminiature Tubes.

The Record shows:

Operation Life. Only 0.0017% glass failures per hundred hours life — only one failure per 6,000,000 tube hours in 4,200 Raytheon Flat Press Subminiature Tubes operated for 10,000 hours each during the past nine years as part of Raytheon's quality control procedures.

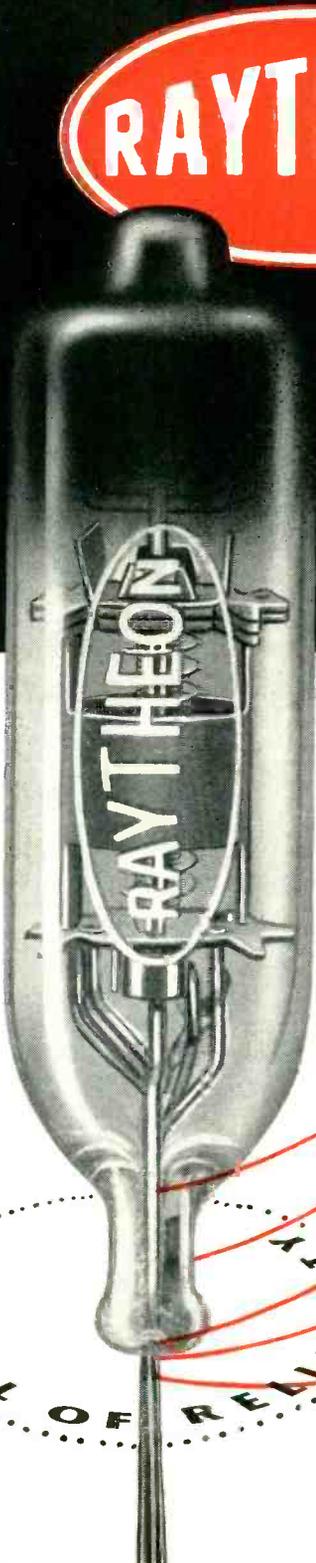
Shelf Life. Less than 0.05% failures for glass envelopes and seal defects out of 151,600 Raytheon Flat Press Subminiature Tubes subjected to six years of shelf life. No other known tube design has equalled this performance.

RAYTHEON'S FLAT PRESS SEAL offers these time-proven advantages over conventional miniature tube metal-to-glass seals.

- Longer length of lead sealed to glass.
- The lead material matches the coefficient of expansion of the glass throughout the entire seal length. No nickel is

sealed into the glass thus eliminating one of the major sources of button cracks.

- Flexible leads on Raytheon's Flat Press Subminiatures permit socketing without stressing the glass seal.
- This eliminates glass button fatigue failure.



RAYTHEON

FLAT PRESS

SUBMINIATURE TUBES with the **SEAL OF RELIABILITY**

Note these advantages over subminiature button types:

Longer glass to metal seal

Glass heated only once

- no button
- no glass strain
- no lead burning

Reentrant seal eliminates
breakage from short bends

Leads completely tinned
right to glass seal by
dipping in hot solder pot —
an automatic glass strain
test — no lead corrosion

Flat press with in-line lead
arrangement means easier
socketing, easier wiring, and
adaptability to printed circuits

* Raytheon makes all varieties of reliable, high quality tubes yet countless users testify that none have the reliability of Raytheon Flat Press Subminiature Tubes with the Seal of Reliability.

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass. Bldg. 4-7500

For application information write or call the Home Office 4935 West Fullerton Avenue, Chicago 39, Illinois, National 2-2770
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RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES



Excellence in Electronics

ing a flashed tube, the operator pushes a small slug of aluminum into the coiled vaporizing filament, then drops in a new tube. Timing of the pumping and flashing operations is controlled by length of track contacts.

► **Figures**—RCA's tube division, supplying picture tubes for other manufacturers as well as for its own sets, reports that between 80 and 90 percent of its current black-

and-white production for new sets will be aluminized. GE's c-r tube department says 90 to 95 percent of its 1955 production of 21-inch and larger tubes will be aluminized.

Sylvania, which recently added CRC automatic aluminizers to give an additional 25,000 tubes a month, says 90 percent of its total tv picture tube production is aluminized, with concentration on 21-inch and 24-inch sizes.

Computer Men Scan Low-Price Field

PINT-SIZED brother of giants like Univac and the IBM 700 series, the medium-priced electronic computer is becoming more significant in business and industry. A major automobile manufacturer is considering buying nearly two dozen machines for inventory accounting at widely separated parts warehouses. A large oil producer may purchase several machines.

Computers in the middle-price range cost between \$75,000 and \$150,000 and handle about 2,000 ten-digit numbers. Input is usually manual or by punched cards instead of magnetic tap.

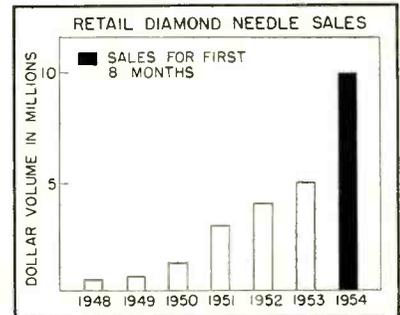
► **Recent Jobs**—The Underwood Corp. will deliver its first Elecom

125 in March to Mallory Air Force Depot, Memphis, Tenn. It rents for \$10,000 monthly and will be used in inventory control.

Electrodata of Pasadena, Calif. is installing a \$150,000, 1,500-tube machine at the Socony-Vacuum Oil refinery, Paulsboro, N. J. This is the fifth of these Electrodata machines to be installed. Others are at Cal Tech, Purdue, Naval Ordnance Lab, Corona, Calif. and Wright Field. The Socony computer, christened Mobilac, will work on refinery control problems.

Marchant Calculators recently demonstrated their entry in the middle-price field. This machine, called Miniac, sells for \$85,000-\$100,000.

Diamond-Needle Market Is Booming



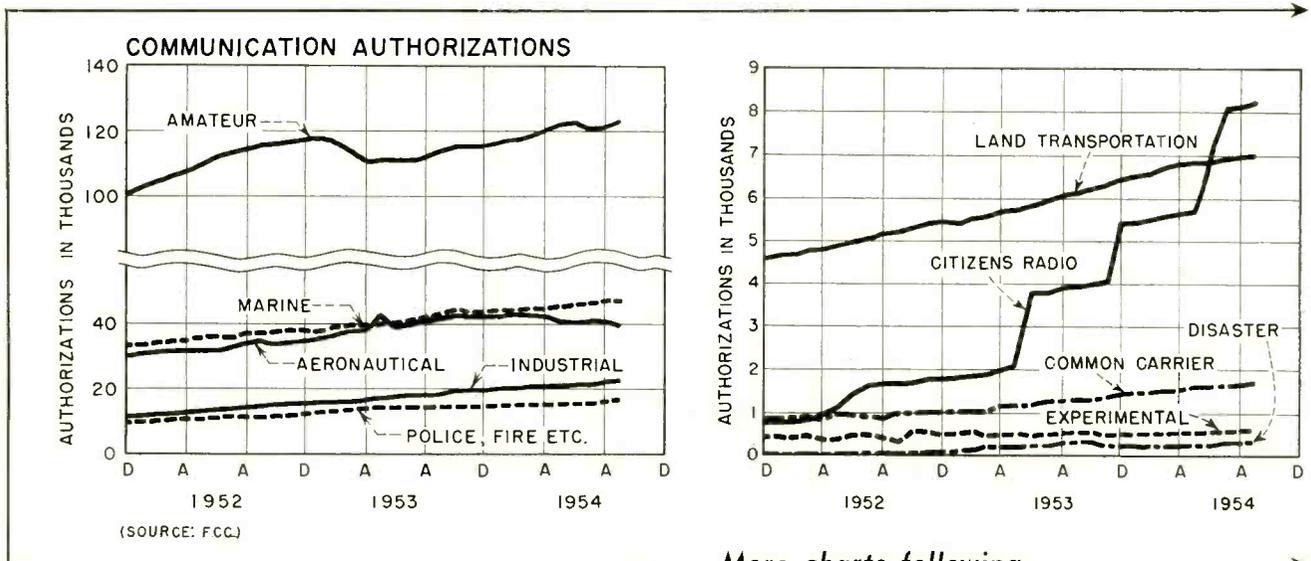
USE of long-playing records and hi-fi equipment has hypoed the needle business. Diamond phonograph-needle sales have jumped more than tenfold in the last six years. Since 1948, over \$29.5-million dollars worth of such needles have been sold, at approximately \$20 a needle.

► **Other Markets**—In addition to phonograph-needle sales, about 70,000 diamond needles are sold each year for use in disk and belt-type office dictating machines. An estimated 40,000 needles per year are sold for original equipment and replacements in juke boxes.

A handful of companies supplies most of the diamond needles sold

(Continued on page 22)

ELECTRONIGRAPHS Continued



More charts following

Shock and Vibration ISOLATORS

BARRY **B** MOUNT

effective
in all
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Type 1000-2000-4000-3000 Barrymounts isolate short-duration shock and high-frequency vibration above 45 cps.

Four sizes: Load ranges of 7 to 50 lbs., 15 to 125 lbs., 100 to 450 lbs., and 70 to 350 lbs.

Positive self-captivation security is a feature obtained by the design and assembly of the metal parts.

Smooth load-deflection curves through rubber-in-compression construction, assure protection of sensitive equipment in vehicular and shipboard installations. Vertical natural frequency at rated loads is 25 to 30 cps.

Equal stiffness in all directions permits use in any attitude.

Write today for information on these Barrymounts.

Do you know about these Barry services?

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SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

in this country. One of these specializes in phonograph-needle production and the others supply needles for dictating machines.

► **Competition**—The most important competitor of the diamond is the sapphire needle. One magnetic-cartridge manufacturer reports that its sapphire-needle unit sales in 1954 have been 3.5 times as great as its diamond-needle sales.

Approximately 12-million sapphire needles are sold each year in the U. S. Of this number, 4 million

in 1953 and 3 million in 1954 were manufactured in this country. The majority of the balance were imported from Switzerland.

All domestic needles are made of synthetic sapphire and are produced from rods available from one company in this country. Swiss needles are natural sapphire and most are supplied by a New Jersey importer. The average cost of a finished but unmounted sapphire is ten cents for both domestic and imported needles. Retail price varies from \$1.50 to \$2.00.

► **Future**—Diamond needles are sold mostly as replacements, with only a small fraction going into original equipment in high-priced phonographs. In 1955, at least two large phonograph manufacturers are planning to use diamond needles as original equipment in their \$150-range equipment.

It is estimated, on the basis of replacement sales and original equipment use, that in 1960 there will be a potential market for 2.2-million diamond needles at a retail value of 44-million dollars.



Civil-Defense Helmet

Experimental helmet for civil defense has an insulated antenna on top and a small loudspeaker inside. The fireman wears a gas mask with a built-in microphone and carries a nine-pound radio

More Two-Way Radio Goaled

GROWTH of radiotelephone communications with moving vehicles is a phenomenon often charted or displayed graphically. Users who find themselves crowded or those who would like to become users take cold comfort in being considered mere statistics.

There is continual pressure upon the Federal Communications Commission to find more space and allow more occupancy of the radio spectrum.

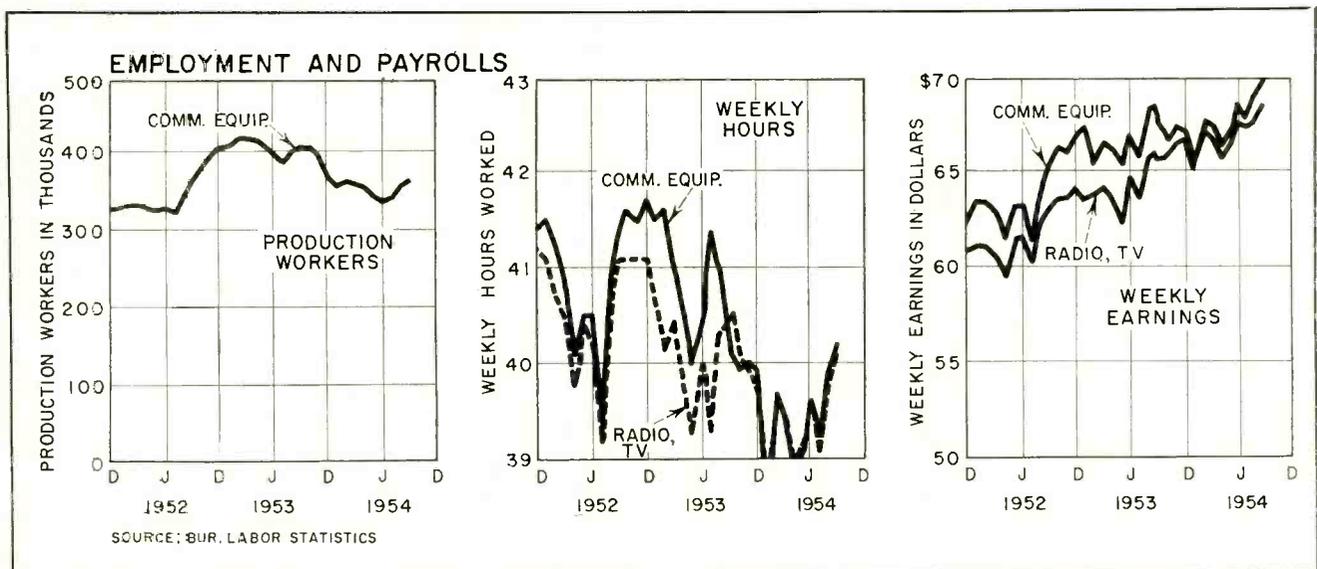
Among the most vocal of all groups is one whose use is classified by FCC as industrial. It encompasses services denoted power, petroleum, forest products, motion picture, relay press, industrial

radiolocation, low-power industrial and special industrial radio service. The Commission now proposes to broaden the scope of eligibility in the special industrial radio category. More than a hundred industry comments have been received and acted upon.

► **Who Gets In**—In general, use of two-way radio under Part 11 of FCC Rules is still limited to big-scale operations and to areas outside a standard metropolitan area of 500,000 or more. But there are some exceptions. Eligibility is now proposed for those engaged in agricultural activities. While assuring use of radio by heavy

(Continued on page 24)

ELECTRONIGRAPHS



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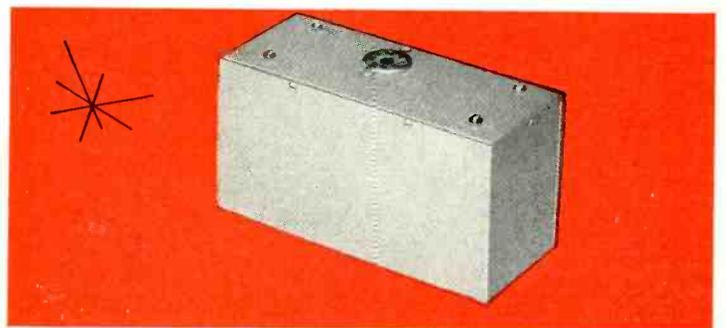
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ROTOROIDS® A continuously variable, stepless toroidal inductor which can provide a 4:1 range of maximum to minimum inductance in 180° rotation of a shaft. Write for new brochure which gives complete technical data.



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



TELEMETERING FILTERS

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

construction (bridges, sewers, railroads) two-way radio for plasterers, masons and general contractors is ruled out.

Included in the proposal are those engaged in manufacturing, like factories, shipyards or mills. Despite protests, FCC wants to hold communications down to yard areas if the plant is in a metropolis. Only exception is use of radio outside the yard for safety purposes. Operators of mining, quarrying and dredging operations are likewise included. Ready-mix concrete and hot asphalt are favored over sand and gravel deliveries, because the former are perishable commodities.

Engineering activities (encompassing radio field intensity and proof of performance surveys) are in, but the civil engineer who wishes to communicate from field

to main office to get his computations done is out.

► **Fuel Deliveries**—Among those eligible is a group whose enterprises affect the public health or welfare. Stations authorized in this category must be outside an area of only 50,000 population. Chief beneficiaries are the operators of fuel oil and liquified petroleum gas distributing trucks. They are being transferred from the highway truck radio service, on the grounds that they are not in the trucking business, but merely use trucks as an instrument of industry.

As FCC points out, in denying eligibility to some individuals or groups, they can always make use of Citizens Radio—that is available to anyone who doesn't qualify elsewhere under the rules.

Industry Looks At 1955 Business

WITH another growth year under their belts, manufacturers in the electronics industry are taking time to assess business prospects for 1955. Surveys of the field indicate that most companies expect sales to increase during the year. One estimate by a leading manufacturer in the field forecasts an eight-percent rise for the industry.

► **Companies**—Survey by the McGraw-Hill department of economics of electrical machinery companies which include electronic manufacturers shows the optimism of firms in the field. A total of 59 percent of the companies surveyed expect sales to increase in 1955, 35 percent saw volume in 1955 remaining about the same and only six percent expected any drop in business. For all manufacturing 66 percent of companies surveyed expect their sales to pick up and only 8 percent think that they will decline.

► **Radio and TV**—At the Business Forecast Seminar of the U. S. Chamber of Commerce, James D. Secrest of RETMA sized up the electronics industry's prospects for 1955 and saw the year as having all the promise of being equally good as 1954 in production and sales and perhaps better in profits. He saw the 1955 set sales outlook as cloudy because of the uncertainty of color developments but agreed with the output guess of a group of RETMA manufacturers of 300,000 color sets for 1955.

He predicted that the dollar return from tv sets in 1955 will equal and probably surpass that of 1954 because prices in '54 were at rock bottom and any higher mix of color receivers will boost total income at a ratio of about 4 to 1 compared with monochrome sets.

Radio receiver sales except auto sets are not expected to change greatly in 1955. High fidelity phonographs and radio-phonograph combinations will probably continue to increase in popularity.

He expects fewer new tv sta-

(Continued on page 26)

Synthetic Mica Output To Expand

Construction begins on 150,000 sq ft mica plant to increase U. S. mica self-sufficiency

ANOTHER forward step was taken to decrease U. S. dependence on India for mica when construction began on what is believed to be the world's first plant for the production of synthetic mica on a commercial scale. According to Mycalex Corp. which has set up a subsidiary, Synthetic Mica Corp. for the operation, the estimated annual output of the new plant will be 1,000 tons of high-grade synthetic mica, representing about 5 to 10 percent of the nation's current requirement.

► **Hopes**—It will be some time, however, before synthetic mica will be a complete replacement for Indian mica. Synthetic mica cannot yet be made in crystal size large enough for all applications and at present it costs more than natural mica. It is believed however that crystal size will increase as the size of the melt increases and cost, in turn will decrease as

production facilities become larger and more efficient.

In addition to production furnaces in the new plant the firm plans to operate an experimental furnace simultaneously. It will be kept in operation full time for the development of large single crystals and to take advantage of the many different synthetic micas available for experiment.



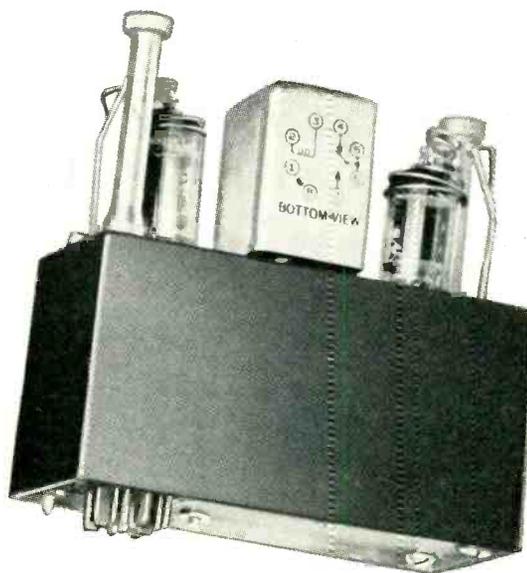
Much larger melts than this four ton pig of crystalline synthetic mica will have to be made before crystals large enough for all uses are produced

Centralized Operations Control...

Economical with Modular Design Multi-Gate®



Plug-in Tone Transmitter



Plug-in Tone Receiver

When planning a system to operate apparatus at a remote location from a central master station, it is important not only that the equipment perform as required, but also that it be easy and economical to install and service. On the first count, Hammarlund Multi-Gate equipment assures fast-acting, fail-safe operation of a practically unlimited number of control functions over a single circuit. On the second count, it's a snap to install and maintain because of its new modular construction. And that means lower operating and maintenance costs.

Each rugged, compact standard audio tone generator and receiver unit, as well as each relay section, is designed for simple plug-in. While easily removed, it is positively secured in service.

To provide complete protection against interruption, it is only necessary to have one spare of each of the basic components. That's because frequencies of the tone receivers and transmitters are determined by completely separate packages. As a result of this design, maintenance of these plug-in units is a simple operation and does not disturb the control system.

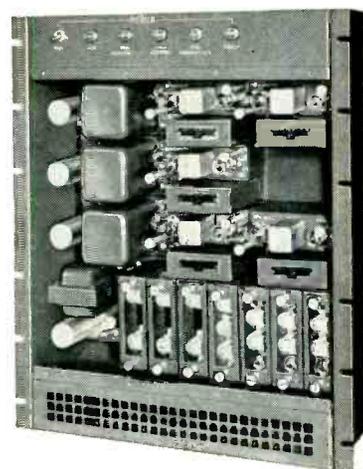
Because of its modular design, a complete system of any size is quickly assembled. Also, after installation, it may be easily expanded at any time by the addition of the required modular sections.

Your modern centralized control system will be low in initial cost, provide highly reliable performance, and be most economical in maintenance as a result of the many fine design features in Multi-Gate equipment.

You can get full details by writing to The Hammarlund Manufacturing Company, Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin E-1.

Typical Multi-Gate Receiving Terminal

This unit takes little space and is readily accessible when mounted in a standard 19" rack. Special window covers protect all relays from dust. Control of ventilation maintains conservative temperature levels throughout the equipment.



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tions to open in 1955 than in 1954 with a consequent decline in the manufacture and sale of transmitters, except for higher power replacements. Barring unforeseen changes, he said it was unlikely that military electronics expenditures would decrease in 1955.

Financial Roundup

MORE companies in the electronics field reported net profits for the first nine months of 1954 during the past month. Reports indicated that those firms connected closely with the radio-tv set side of the industry fared less well than other firms in the field for the first three quarters of this year, compared to the same period in 1953.

Following are the net profit reports of 12 companies for the fiscal periods indicated:

Company	Net Profit	
	1954	1953
Admiral 9m	\$4,382,175	\$6,564,848
Am. Cable & Radio 9m	1,286,494	839,915
Am. Electronics 9m	190,186	109,869
Am. Phenolic 9m	414,361	717,039
Beckman Instruments 3m	290,786	223,422
CBS 9m	7,299,130	6,411,343
Du Mont 4Q	612,000	935,000
Electronic Corp. Am. 9m	181,700	114,161
Philco 9m	2,275,000	15,418,000
Servomechanisms 9m	400,603	305,089
Sperry 9m	18,869,220	11,793,259
Weston Inst. 9m	802,993	825,395

► **Securities**—Cavitron filed with SEC covering 10,000 shares of \$1.50 cumulative sinking fund preferred stock (par \$25) and 20,000 shares of common (par 10 cents) to be offered in units of one share of preferred and two shares of common at \$27 per unit. Net proceeds will be used to retire bank loans, to purchase machinery and equipment and for working capital.

Servomechanisms registered with SEC covering \$2 million in 5-percent convertible debentures due Dec. 1, 1966. Net proceeds will be used to finance growth and expansion of the business.

Panellit offered 105,000 shares of \$1 par value common stock at \$1.50 per share. Net proceeds from the sale of 60,000 shares will initially be added to general funds and may be later used to expand activities in California and finance the new Canadian operations. The balance will be added to working capital for general corporate purposes.

MEETINGS

- JAN. 8: New York IRE Symposium on Design Principles of Transistor Circuits, Engineering Societies Bldg., New York, N. Y.
- JAN. 12-15: World Symposium On Applied Solar Energy, Westward Ho Hotel, Phoenix, Ariz.
- JAN. 17-19: Fourth Biennial Conference On High Frequency Measurements, IRE, AIEE, URSI, NBS; Hotel Statler, Washington, D. C.
- JAN. 17-19: Hight Frequency Measurement Conference, sponsored by IRE, AIEE, NBS; Hotel Statler, Washington, D. C.
- JAN. 20-21: RETMA Symposium On Printed Circuits, University of Pennsylvania Auditorium, Philadelphia, Pa.
- JAN. 23: First Annual Industrial Amateur Electronics Show, Park Sheraton Hotel, New York, N. Y.
- JAN. 31-FEB. 4: AIEE Winter General Meeting, Hotels Statler & Governor Clinton, New York, N. Y.
- FEB. 10-12: Seventh Annual Conference and Electronics Show, Southwestern region of IRE, Baker Hotel, Dallas, Texas.
- FEB. 11-13: Los Angeles Audio Fair, Hotel Alexandria, Los Angeles.
- FEB. 14-16: Conference On High-Speed Computers; Louisiana State University, Baton Rouge, La.
- FEB. 17-18: National Conference On Transistor Circuits sponsored by IRE, AIEE, U. of Penn.; Irvine Auditorium, University of Pennsylvania and Penn Sherwood Hotel, Phila., Pa.
- FEB. 20-22: Institute of Surplus Dealers' Fourth Annual Trade Show and Convention, 212th AAA Armory, New York, N. Y.
- MARCH 1-3: Joint Western Computer Conference and Exhibit sponsored by IRE, AIEE, ACM; Statler Hotel, Los Angeles, Calif.
- MARCH 21-24: 1955 IRE National Convention, Waldorf Astoria Hotel & Kingsbridge Armory, New York, N. Y.
- APRIL 15-16: Ninth Annual Spring Technical Conference, Cincinnati IRE; Engineering Society Bldg., Cincinnati, Ohio.
- APRIL 25-27: Eighth Annual Conference for Protective Relay Engineers, A & M College of Texas, College Station, Texas.
- MAY 2-5: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.
- MAY 4-6: Fourth International Aviation Trade Show, 69th Regiment Armory, New York, N. Y.
- MAY 6: American Association of Spectrographers Sixth Annual Conference, Chicago, Ill.
- MAY 16-19: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.
- MAY 18-20: Annual National Telemetering Conference and Exhibit sponsored by IRE, AIEE, IAS, ISA; Hotel Morrison, Chicago, Ill.
- MAY 19-21: Global Communications Conference, sponsored by AFCA; Hotel Commodore, New York, N. Y.
- SEPT. 6-17: Production Engineering Show, Navy Pier, Chicago, Ill.

Industry Shorts

- **Grants** to researchers up to \$300 a month, extending for 36 months, are not taxable as income under the new tax law.
- **Industrial tv** is now being used to spot empty spaces in car parking lots and as a classroom aid in teaching dental surgery.
- **World Plastics Fair** estimates that 50 percent of materials purchased in the electronics industry are plastics.
- **Citizens Radio** rules amended to spell out requirements effective in other services regarding citizenship, lighting antennas and emer-

gency communications, show how this service has matured.

- **Electronic camera** made by a British firm for the U. S. Army is said to produce exposures in one ten-millionth of a second.
- **First International Automation Exposition**, attended by some 10,000 people, featured displays by 70 manufacturers of equipment ranging from amplifiers to x-ray.
- **Hum-free light bulbs** for use in tv studios have been developed by GE's lamp division.
- **Million-watt uhf tv station**, WBRE-TV, uses RCA pylon antenna with a gain of nearly 50.

AIRPAX C747 MIDGET

400 CYCLE CHOPPER

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

*✓ note
these facts...*

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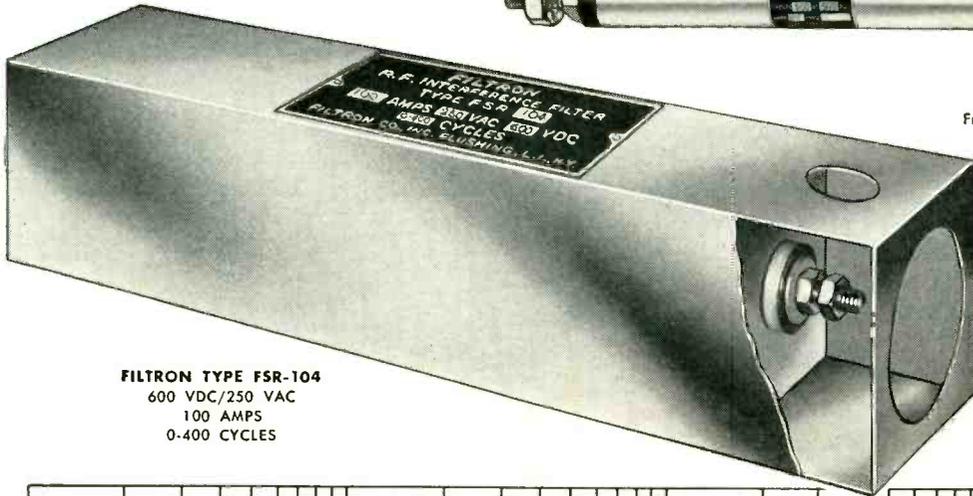
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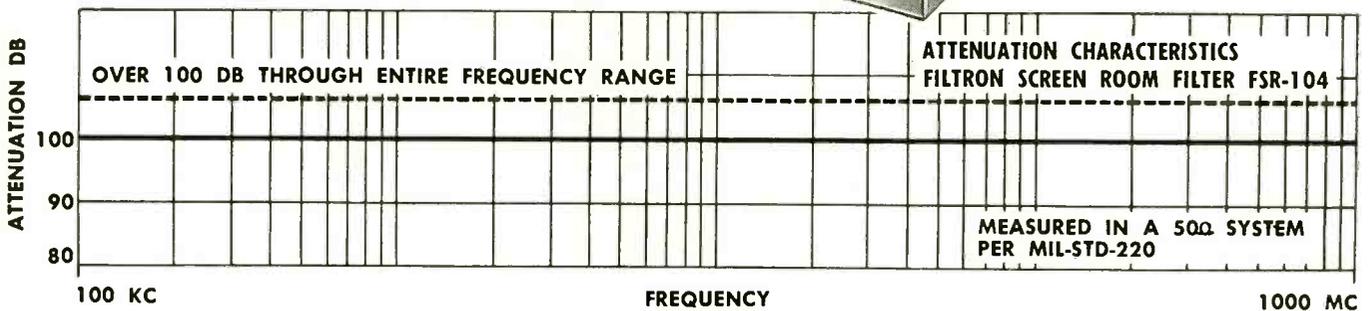
SCREEN ROOM FILTERS



FILTRON TYPE FSR-502
500 VAC/DC
100 AMPS
Frequency Range 1000 to 15,000 MC



FILTRON TYPE FSR-104
600 VDC/250 VAC
100 AMPS
0-400 CYCLES



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This 20 page catalog contains valuable data on FILTRON RADIO INTERFERENCE FILTERS for SCREEN ROOMS, INDUCTION HEATING EQUIPMENT, DIATHERMY SETS, X-RAY UNITS and other electrical interference-producing equipment. Included are illustrated installation recommendations, essential information on applications, attenuation characteristics and mechanical dimensions... Your copy gladly sent free upon request.



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Screen room manufacturers specify and install FILTRON Screen Room Filters as standard equipment.

FILTRON Screen Room Filters are used in the majority of industrial, government and military screen rooms, to meet the requirements of specification MIL-S-4957, and wherever critical RF measurements are required.

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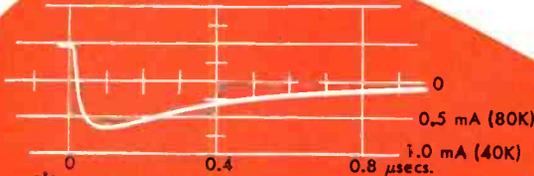


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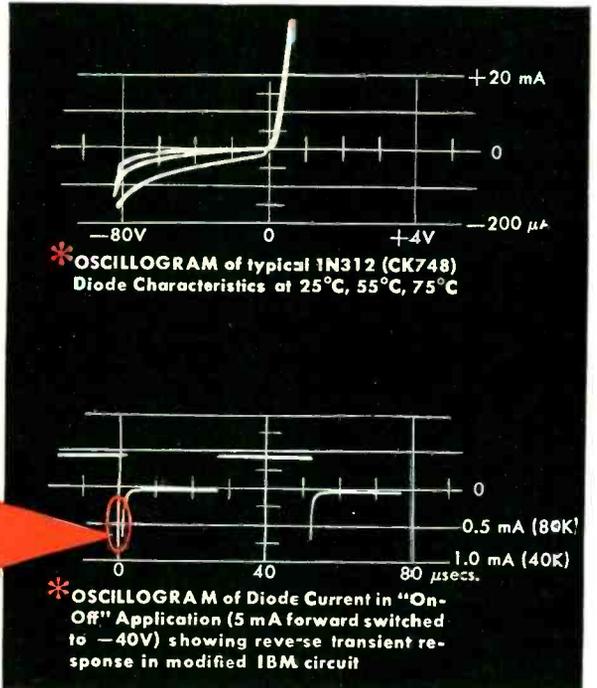
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Look at the "specs"! Look at the actual, unretouched oscillograms. These pre-tested Raytheon Gold Bonded Diodes have the characteristics and the uniformly dependable performance to make them your No. 1 choice. Many other Raytheon Gold Bonded point contact and silicon diodes are available. Write for data.

* These are unretouched photographs taken in the Raytheon Semiconductor Diode Laboratory.



* CLOSE-UP of Reverse Transient Response showing recovery to 80K ohms in less than 0.3 μ secs.



* OSCILLOGRAM of typical 1N312 (CK748) Diode Characteristics at 25°C, 55°C, 75°C

* OSCILLOGRAM of Diode Current in "On-Off" Application (5 mA forward switched to -40V) showing reverse transient response in modified IBM circuit

Representative Gold Bonded Types	FORWARD	REVERSE	
	25°C ma. at +1 volt	25°C μ a at volts	55°C μ a at volts
1N308 (CK741) with 50% higher conduction than its nearest competitive type	300	500 at -8	1500 at -8
1N310 (CK745) for high voltage, high resistance	15	20 at -20 100 at -100	150 at -20 300 at -100
1N309 (CK747) with unbeatable transient characteristics	100	100 at -20	350 at -20
1N312 (CK748) 100% tested for forward and reverse transient response	30	50 at -50	200 at -50
1N313 (CK749) high voltage, extra high resistance	20	10 at -20 50 at -100	50 at -20 200 at -100

ALL with 150 milliwatt dissipation rating
ALL with -50°C to +90°C ambient temperature rating



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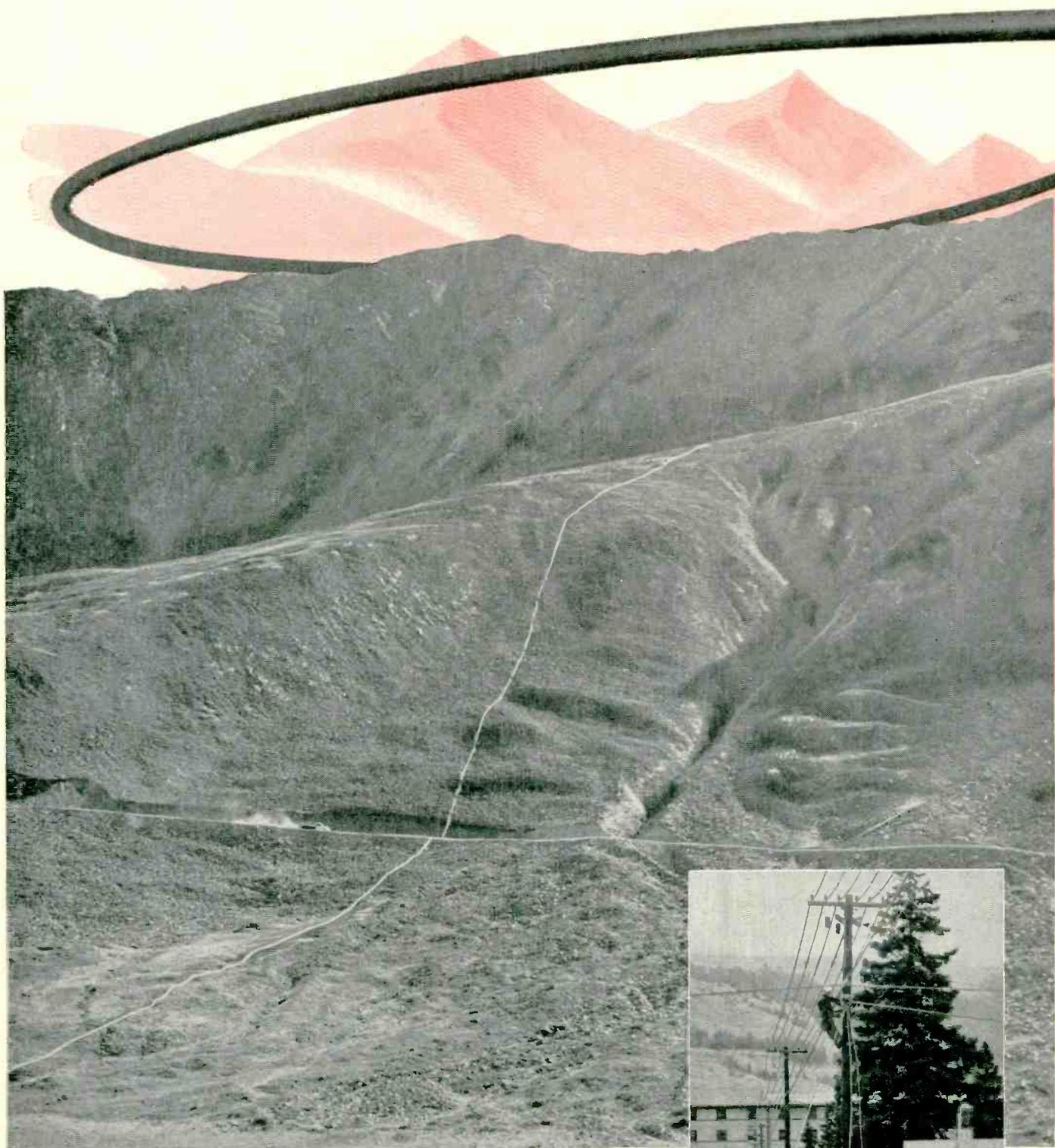
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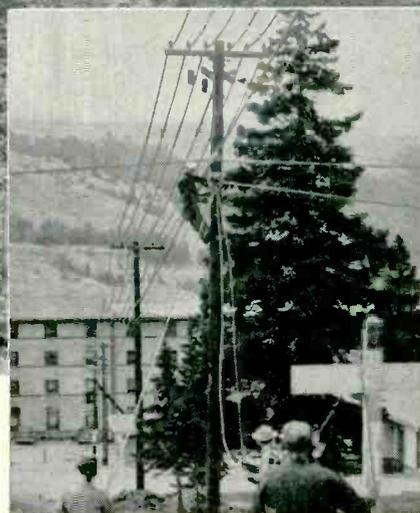
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THE WORLD'S HIGHEST COMMUNITY



Reflected sunlight makes the primary cable look like a white line running down the slopes of Mt. McNamee. Except for a section of conduit that is buried beneath the road, at center, the entire 4300 ft. of cable between summit and mine lies exposed on the ground.

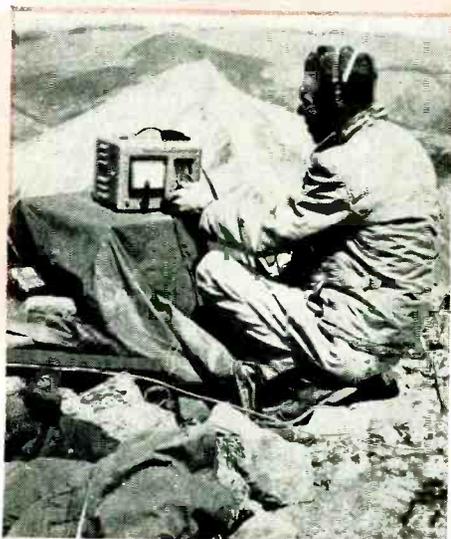


Stringing RG-11U cable on existing telephone poles. RG-11U was used as secondary lead, and as drop cable to individual outlets.

TV SYSTEM IS ROUGH ON CABLE



COAXIALS MUST WITHSTAND RUGGED TERRAIN, SNOW, HIGH WINDS, AND LIGHTNING IN THE 13,783 FT. INSTALLATION AT CLIMAX, COLORADO



Taking antenna field strength readings atop 13,783 ft. Mt. McNamee.

This unique TV distribution system, provided for its employees by the Climax Molybdenum Co., makes use of two transmission cable types. Both are insulated with BAKELITE Polyethylene and jacketed with BAKELITE Vinyl Plastic — providing service that underscores the outstanding electrical and mechanical properties of these wire covering materials.

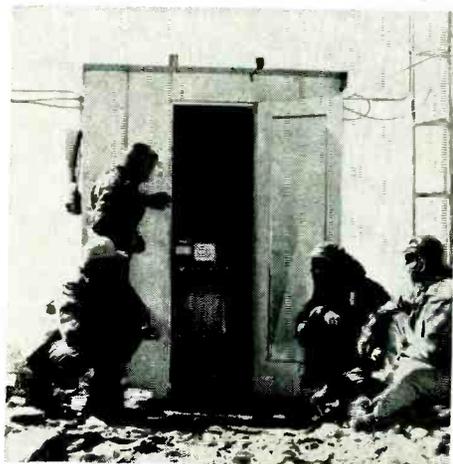
From the antenna site at the peak of nearby Mt. McNamee, the primary lead — Federal K-14 cable — descends 11,000 linear ft. to the community. During its course, this cable lies on the ground, exposed to the elements . . . is buried in conduit . . . and for 4900 ft. runs through the underground workings of the mine in conduit and on messenger. From the edge of town, 80,000 ft. of

pole-strung Federal RG-11U cable, serving as secondary lead and drop cable, continues the transmission to some 500 TV receivers. Throughout these long cable runs, the superior mechanical characteristics, the constant impedance, low line loss, and low power factor of BAKELITE Vinyl Plastics and BAKELITE Polyethylene prove big factors in maintaining the TV signal at essentially the same quality as received at the antennas. The first amplifier necessary in the primary cable is 2400 ft. from the front end equipment on the mountain peak.

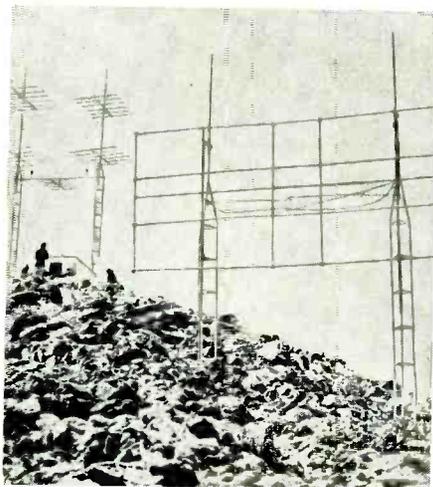
Wire and cable jacketing made of BAKELITE Vinyl Plastics is wax-smooth — for easier pulling and stripping. Compounds can be formulated to stay pliable in very low temperatures . . . resist deformation in extreme heat. Lasting colors provide permanent coloring. BAKELITE Polyethylene is light, permits smaller diameters — for easier handling, savings in space and weight. Cores of this material stay tough and flexible . . . hold their excellent electrical properties through a wide temperature range.

For all the facts on BAKELITE Vinyl Plastics and BAKELITE Polyethylene for wire coverings, and names of your nearest suppliers, write Dept. AC-79.

Data courtesy of: Climax Molybdenum Co., Climax, Colorado; Federal Telephone and Radio Company, Clifton, N. J., a division of IT&T.



Installation crew watching the first TV reception on test equipment in the amplifier shack. In normal operation, the insulated 6' x 6' metal building houses the front end amplifier equipment for the community antenna system.



Two antenna groups receive channels 2, 4, 7, and 9 from Denver stations, about 60 air miles away. The first antennas suffered considerable damage from icing and high winds, and had to be replaced with sturdier structures. The coaxial cables however, insulated with BAKELITE Polyethylene and jacketed with BAKELITE Vinyl Plastic, measured up to expectations from the very first. Note the loose, broken rock, typical of the terrain along the course of the primary cable.

BAKELITE

TRADE-MARK

PLASTICS



BAKELITE COMPANY

A Division of

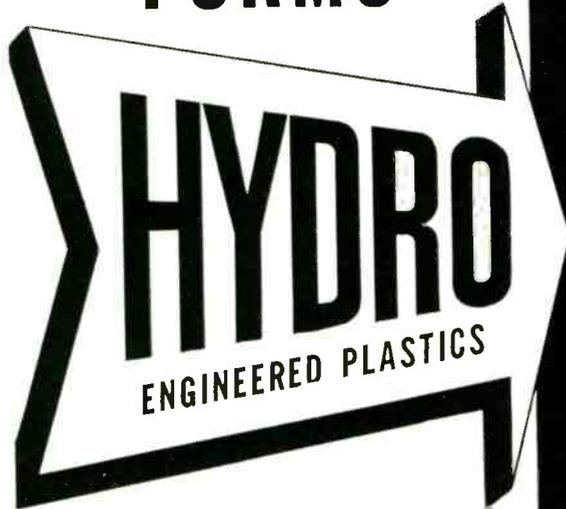
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comprising delicate
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The use of "universal molds" of exclusive HYDRO design assures low-cost tooling and quick delivery of all types of coil forms. Precision tooling insures a flash-free product held to close tolerances. This service is particularly attractive for short runs where high mold costs can raise unit prices of component parts substantially. Similar savings are possible on many other electronic components. *May we quote on your requirements?*

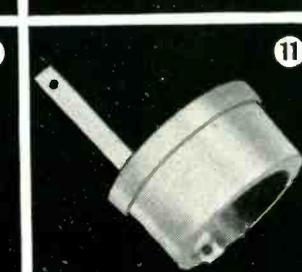
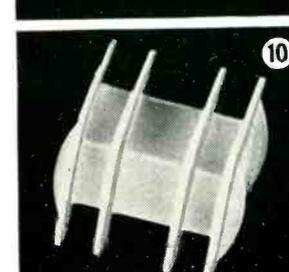
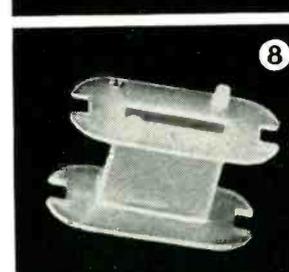
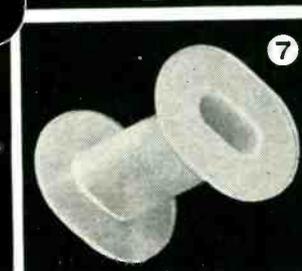
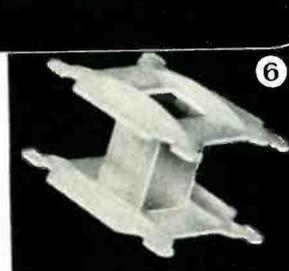
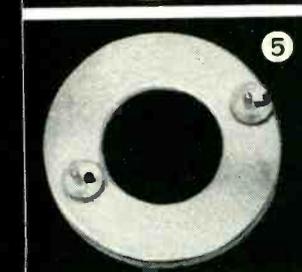
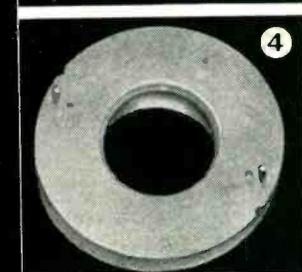
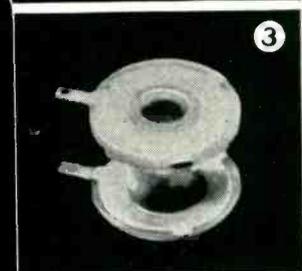
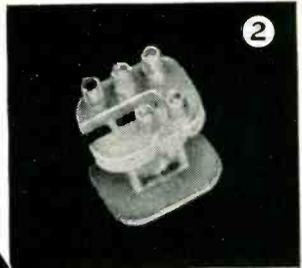
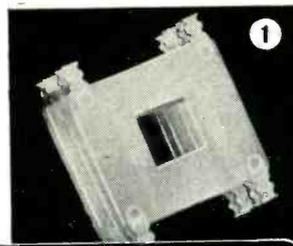
HYDRO MOLDING CO.

Engineering and Manufacturing in Plastics
PLATTSBURGH, NEW YORK

KEY TO ILLUSTRATIONS—1—2—3 Nylon bobbin with molded-in inserts . . . 4—5 Fiberglass bobbins with molded-in inserts . . . 6—7—8—9 Nylon bobbins . . . 10—Multiple flange Nylon bobbins . . . 11—Kel-F slider with molded-in insert.

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**LOW COST
FAST
PRECISION
MOLDING**
of
NYLON*
KEL-F*
FIBERGLAS*
and other plastic
materials



color

tv



CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART • INDIANA

*Specialists in Precision Mass Production
of Variable Resistors • Founded 1896*

controls

THE ONLY COMPLETE LINE FOR ALL COLOR TV APPLICATIONS

- 1. SIZES—"dime size" to 2 1/2" diameter.
- 2. WATTAGES—2/10 watt to 4 watt.
- 3. TYPES—carbon and wirewound with and without attached switch.
- 4. MOUNTINGS—conventional bushing, twist ear and snap-in bracket for printed circuits.

- 5. TERMINAL STYLES—for conventional soldering, printed circuits and wire wrap.
- 6. COMBINATIONS—an endless variety of tandems, both single and dual shaft.

A CTS control can be tailored to your specific requirement.

FURTHER DETAILS ON OTHER SIDE





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



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

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



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



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



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



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



Higher Wattage Carbon Controls With Exceptional Stability Available

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

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



THE ONLY COMPLETE LINE FOR ALL COLOR TV APPLICATIONS

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



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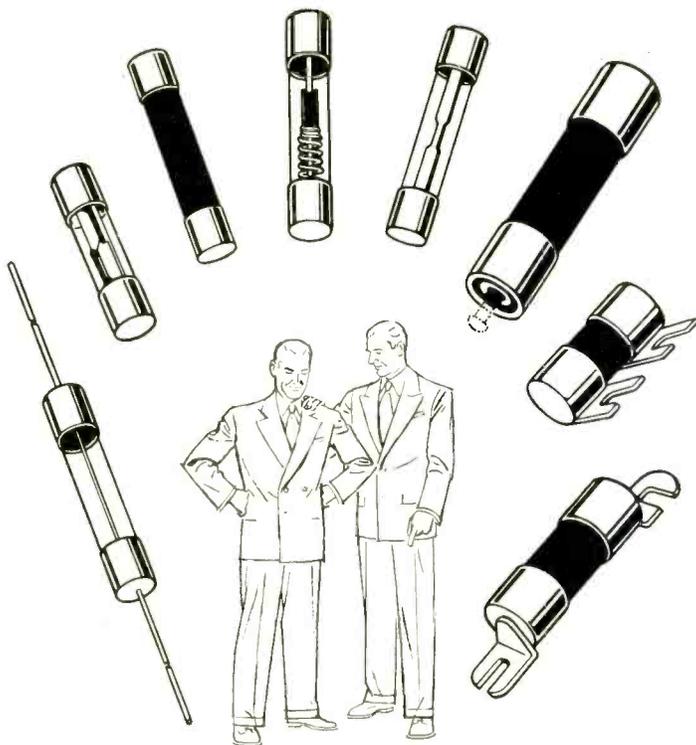
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Specialists in Precision Mass Production of Variable Resistors • Founded 1896



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

It's convenient to get all your fuses from one source. Purchasing, stock handling and records are simplified.

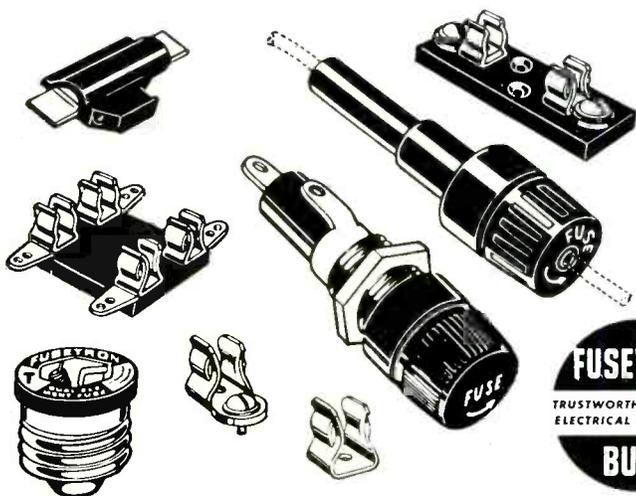
And to make sure that the BUSS reputation for quality is maintained, every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

If you are designing a new device — or have a special problem in electrical protection — BUSS may be able to save you considerable engineering time. To help you determine the right fuse or fuse mounting for the job, BUSS places at your service the world's largest fuse research laboratory and its staff of experienced engineers.

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

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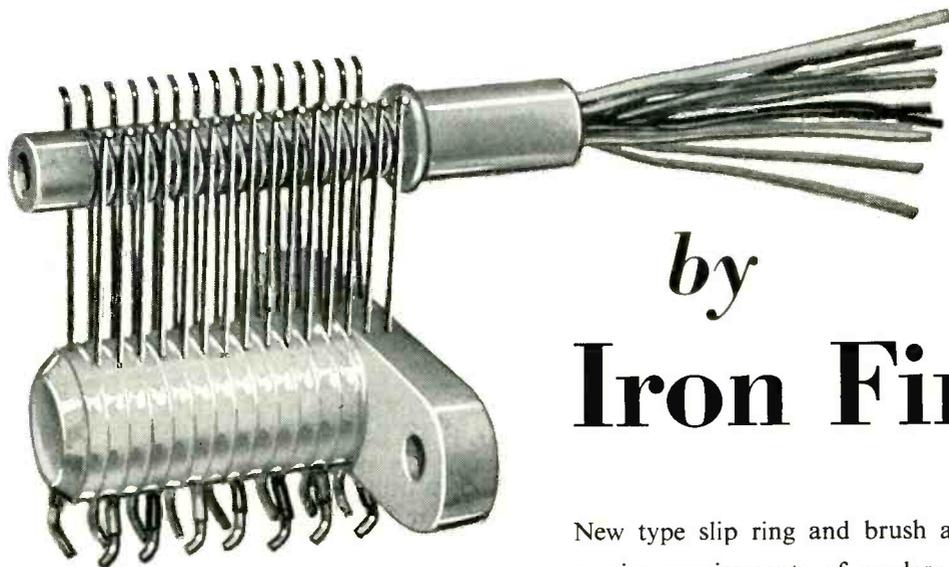
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ELRC155



Miniature Slip Rings and Brushes



Drawing of typical assembly.

by
Iron Fireman

Send for informative catalog



This catalog contains complete data on Iron Fireman miniature slip rings and brushes. Write for your free copy today.

New type slip ring and brush assemblies to meet the precise requirements of modern control systems! Iron Fireman has developed a new production technique which makes possible these improved features:

- ★ Low cost
- ★ Extremely low static and dynamic friction
- ★ High dielectric strength between adjacent circuits
- ★ Multiple circuits in unusually compact assemblies
- ★ Matched color coded leads

TYPICAL APPLICATIONS

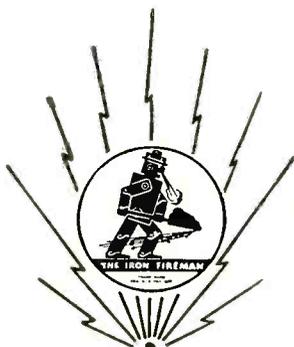
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Custom made to your requirements

We will design and produce slip rings and brushes to meet the exact requirements of your project.

Other Iron Fireman Electronic and aircraft components

Vertical Gyros	Special Motors	Sensitive Relays
Fire & Heat Detectors	High Speed Relays	Choppers



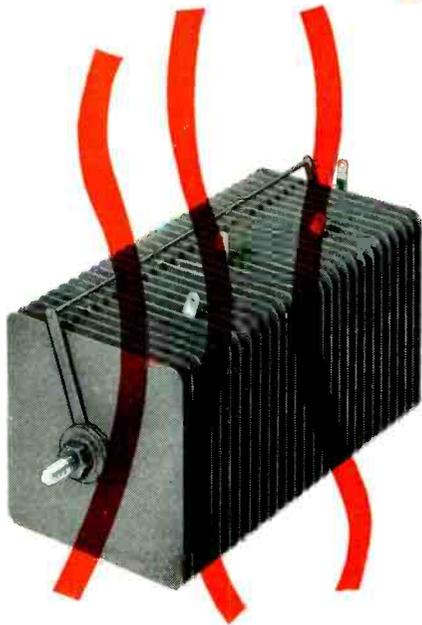
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Want more information? Use post card on last page.

January, 1955 — ELECTRONICS

latest result of **RADIO RECEPTOR** research



Now... **HIGH TEMPERATURE RECTIFIERS** in the **LARGER CELL SIZES** up to 5" x 6" (to operate without derating at 125° C.) and...

AT REDUCED COST!



Also available in cartridge type

RADIO RECEPTOR high temperature rectifiers when first introduced less than three years ago were expensive and limited to 3" x 3". Now intensive research has brought the cost down and the cell sizes UP. That means the field is wide open for their use in many applications once considered prohibitive because of size and price.

At 125° C. these rectifiers have a minimum life of 500 hours without derating and at *normal* temperatures their span is almost indefinite...They can be hermetically sealed without derating, too.

That's why RRco. high temperature rectifiers are selected more and more for military and special industrial requirements by such blue-chip companies as Aeronautical Division of Minneapolis-Honeywell, Motorola Inc., Hamilton Standard Division of United Aircraft and many others.

If you have one of those "tricky" applications where high temperature rectifiers are needed, take advantage of RADIO RECEPTOR's continuing research and development in this field. Write now for full details about these as well as embedded rectifiers to section E-5.

We also manufacture transistors and silicon and germanium diodes

AMBIENT TEMPERATURE	POTENTIAL LIFE WITHOUT DERATING
125° C	500-1000 hours
100° C	1500-2500 hours
85° C	2500-4000 hours

CELL TYPE	CELL SIZE (Inches)	CONTINUOUS DC AMPERES SINGLE PHASE		MAX. REVERSE RMS VOLTS PER CELL
		Half Wave	Bridge or Center Tap	
X	¼ (Diam.)	.005	.010	24
Y	½ x ½	.025	.050	24
J	⅛ x ⅛	.065	.130	24
M	1 x 1	.075	.150	24
P	1⅜ x 1⅜	.150	.30	24
Q	1½ x 1½	.30	.60	24
S	2 x 2	.50	1.0	24
U	3 x 3	1.2	2.4	24
W	4 x 4	2.25	4.5	24
T	4¼ x 6	3.35	6.7	24
H	5 x 6	4.0	8.0	24



Semi-Conductor Division
RADIO RECEPTOR COMPANY, INC.
In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH STREET, NEW YORK 11, N. Y., WATKINS 4-3633, FACTORIES IN BROOKLYN, N. Y.

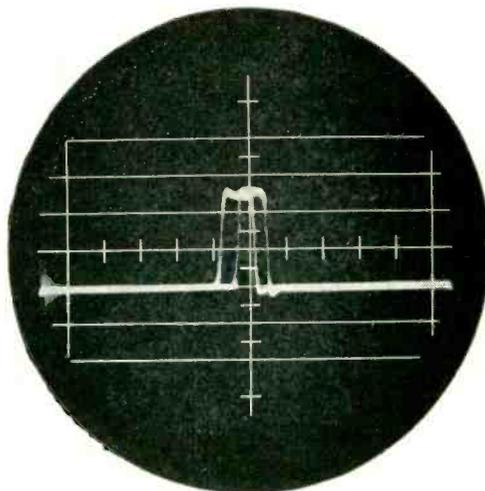


Figure 1. Unique modulating fidelity of *-hp-490A* is shown in double-exposed oscillogram of $0.1 \mu\text{sec}$ pulses. First pulse (applied by *-hp-212A* Pulse Generator) is modulating pulse having rise time of $0.02 \mu\text{sec}$; delay through tube approximately 50 millimicroseconds. Second pulse is rf output; note absence of deterioration.

NOW!

Broad band amplification

-hp-490A and *491A* Traveling-Wave Tube Amplifiers are precision broad band linear instruments making readily available a group of measurements hitherto almost unobtainable.

These distinctly different new amplifiers provide a convenient, straightforward method of amplification, modulation or power increase to 1 watt. They are ideal rf amplifiers for receiver and detector applications, and greatly simplify measurement of antenna patterns and wide range attenuators. They are also exceptionally useful as general purpose, low level, low noise laboratory amplifiers. Connected to a signal generator of 1 milliwatt output, *-hp-490A* amplifier will provide a full watt of output for high level measurements.

COMPLETELY NEW DESIGN

Since 1946, when traveling-wave tube amplifiers were first described, the radio industry has been unable to benefit from

them because of the difficulty in coupling signals in and out of the tube. *-hp-* has developed a simple new broad band coupling method employing helices. (See Figure 3.) There is no mechanical connection to the inner helix, yet full energy transfer is effected. The difficulties found in previous experimental amplifiers using multi-element networks, tapers and direct vacuum leads have been overcome. Thus, for the first time, a practical broad band high gain traveling-wave tube amplifier has been produced.

TWO AMPLIFIERS OFFERED

-hp-490A is designed for high gain, low level applications. It provides at least 35 db gain, noise level is less than 25 db, and pulse modulation characteristics are remarkably good. (See Fig. 1.)

-hp-491A has 1 watt output full range. Minimum gain is 30 db. Thus, the equipment, together with a 1 mw "S"

band signal generator such as *-hp-616A*, provides a versatile 1 watt source for high power testing throughout the 2 to 4 kmc range.

Both instruments include simple controls for varying traveling-wave tube anode and helix voltages for best performance. Further, a panel meter and selector permit ready measurement of cathode, anode, helix, and collector currents for performance evaluation or continuous monitoring. No adjustments are necessary during operation.

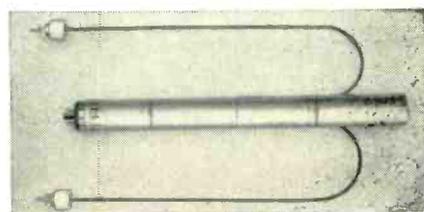


Figure 2. *-hp-* capsulated Traveling-Wave Tube. Note input and output coaxial lines with Type N plugs for connection to front panel of amplifier.

COMPLETE
COVERAGE

HEWLETT-PACKARD

New 490/491A

Traveling-Wave Tube Amplifiers

- Radically new coupled-helix design
- Full "S" band coverage—2 to 4 kmc
- 1 watt output; 30 and 35 db gain
- Millimicrosecond pulse modulation
- Compact, portable, easy to use

high gain low noise for "S" band!

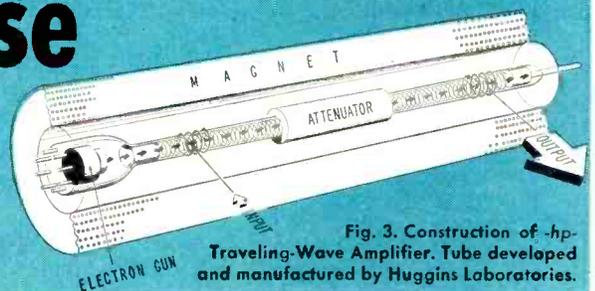


Fig. 3. Construction of -hp- Traveling-Wave Amplifier. Tube developed and manufactured by Huggins Laboratories.

REPLACEMENT TUBES

To eliminate critical adjustments and assure that tubes and coupled helix com-

ponents are properly matched, -hp- replacement tubes are capsulated in a unit wherein the tube and coupling helices

are integral. When delivered, the replacement tube is thoroughly tested, ready to plug in and use.

SPECIFICATIONS

-hp- 490A

Frequency Range: 2 kmc to 4 kmc.
Gain: 35 db minimum.
Output Power: 25 milliwatts minimum.
Noise Figure: Less than 25 db.
Pulse Rise & Decay Time: Order of a few millimicroseconds.
Pulse Delay: Approximately 50 millimicroseconds.
Modulating Voltage: Requires approx. 50 volts peak negative to reduce output to 0.1% of initial value. Input impedance: 50 ohms.
Hum, Spurious Modulation: At least 30 db below signal level.
Meter Monitors: Cathode Current, Anode Current, Helix Current, Collector Current.
Connectors, RF: Input and Output, Type N; Modulation Input, BNC.
Size: Approximately 7" wide x 10¾" high x 18" deep.

Weight: Approximately 70 pounds net, 90 pounds packed.
Power Supply: 115 volts $\pm 10\%$, 50-60 cps, approximately 125 watts.
Replacement Tube Price: Including Capsulation, \$650.00 less \$125.00 credit for return of defective tube and capsule. Specify -hp- 490A-73A.
Price: Traveling-Wave Tube Amplifier, complete including capsulated tube. \$1,100.00 F.O.B. factory.

-hp- 491A

Frequency Range: 2 kmc to 4 kmc.
Gain: 30 db minimum.
Output Power: 1 watt minimum.
Noise Figure: Less than 30 db.
Pulse Rise & Decay Time: Modulation not provided.
Pulse Delay: Modulation not provided.
Modulating Voltage: Modulation not provided.
Hum, Spurious Modulation: At least 30 db below signal level.

Meter Monitors: Cathode Current, Anode Current, Helix Current, Collector Current.

Connectors, RF: Input and Output, Type N; Modulation Input, not provided.

Size: Approximately 7" wide x 10¾" high x 18" deep.

Weight: Approximately 75 pounds net, 95 pounds packed.

Power Supply: 115 volts $\pm 10\%$, 50-60 cps, approximately 250 watts.

Replacement Tube Price: Including Capsulation, \$650.00, less \$125.00 credit for return of defective tube and capsule.

Price: Traveling-Wave Tube Amplifier, complete including capsulated tube. \$1,100.00 F.O.B. factory.

Above Data subject to change without notice

HEWLETT-PACKARD CO.

2997A Page Mill Road • Palo Alto, Calif., U.S.A.
 FIELD ENGINEERS IN ALL PRINCIPAL AREAS



INSTRUMENTS

COMPLETE COVERAGE

COMMON CHARACTERISTICS OF ALL
TYPE 2028B MOTOR GENERATOR UNITS

Pinion Data..... 10T.96P. 20° P.A.
O.D. of Case..... 1.000 inch
Overall Length..... 2 37/64 inches
Weight..... 5 ounces
Frequency..... 400 cycles
No. of Poles (Motor)..... 6
No Load Speed (Min.)..... 6500 rpm
Rotor Inertia..... 1.1 gram-cm²



ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2028B MOTOR GENERATORS

TYPE NO.	MOTOR				GENERATOR			
	EXCITATION FIXED	CONTROL	INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration AT STALL	EXCI- TATION FIXED	INPUT	OUTPUT PER 1000 rpm
0411110	26	26	2.3	0.4	25600	26	1.8	.51
0412120	26	26	4.0	0.6	38500	26	2.2	.68
0413120	26	26	1.8	0.3	19200	26	2.2	.68
0460600	115	115	4.0	0.6	38500	115	2.6	1.00
0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec ²	volts	watts	volts

OUTSTANDING FEATURES OF
TYPE 2028B MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt -115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

**a new peak of efficiency
in small servo motors**

Input per phase only 1.8 watts

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

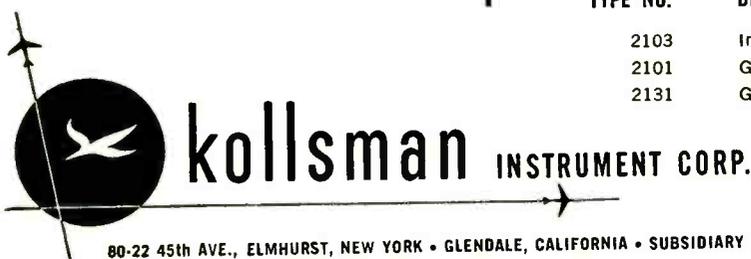
One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

Another unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2131	Geared Motor Generator

Latest catalog and/or complete specification drawings will be sent upon request.



General Ceramics

offering **3** complete services...

ENGINEERING-DESIGNING-PRODUCTION

on these **3** basic components...



ELECTRICAL INSULATORS
FERRAMIC® CORES
SOLDERSEAL TERMINALS

1. ELECTRICAL INSULATORS

STEATITE—For low power loss at high frequency. High dielectric strength through wide temperature range. Low thermal expansion.

PORCELAINS—An economical high voltage material of great hardness. Low thermal expansion. Wet or dry process.

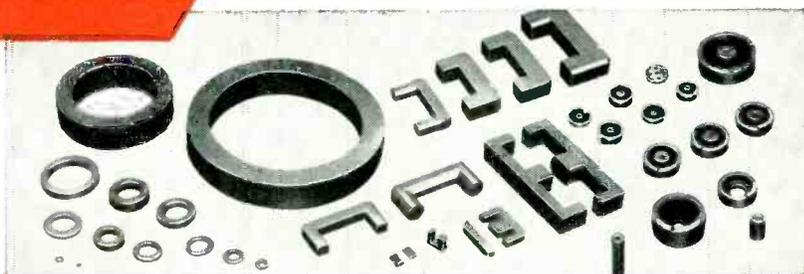
ALUMINA—Characterized by great hardness and chip resistance. Will withstand very high temperatures.

ZIRCON—Has low loss properties that vary inversely with frequency. An excellent high frequency material having good thermal shock resistance.



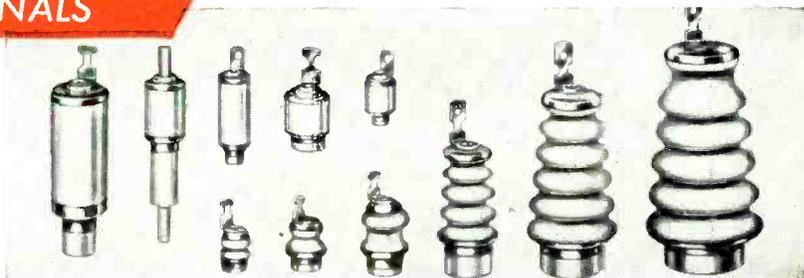
2. FERRAMIC CORES

General Ceramics Ferramic Cores are available in standard toroid, cup core and TV components. Standardization simplifies design problems, speeds delivery and lowers costs. The types illustrated are supplied in many grades of Ferramics for specific applications,



3. SOLDERSEAL TERMINALS

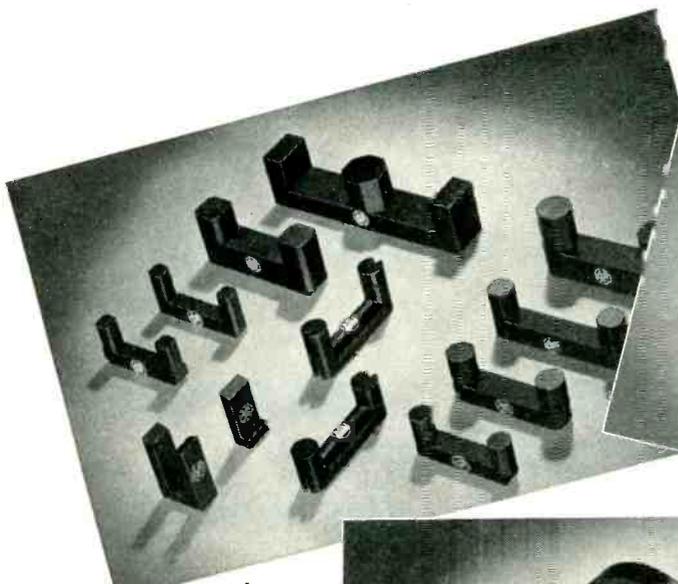
Featuring high mechanical strength, resistance to thermal shock and permanent hermetic sealing. Installation is easy and fast. Terminals are made of glazed Alumina Ceramic with lugs and eyelets hot tinned brass. Metallized areas are silver fired on ceramic, copper electroplated and tin fused for soft soldering.



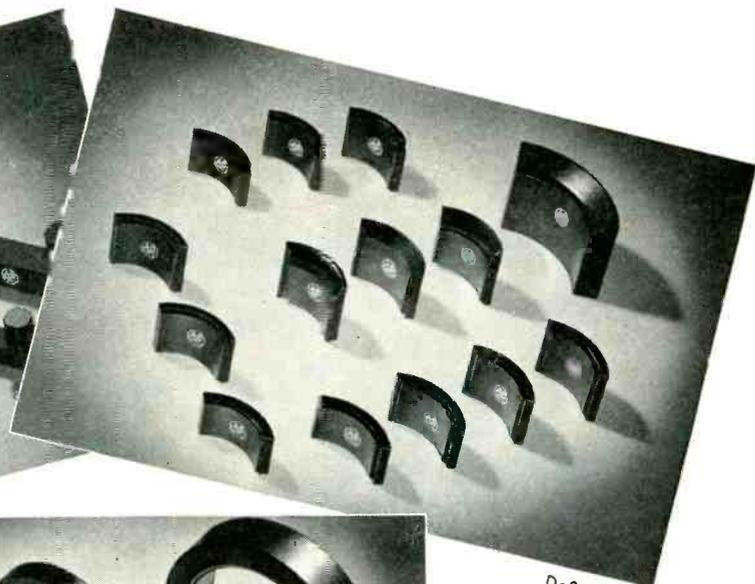
Makers of STEATITE,
ALUMINA, ZIRCON,
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TERMINALS, CHEMICAL
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For complete information on standard components, and recommendations on specific applications, call or write today; there is no obligation.

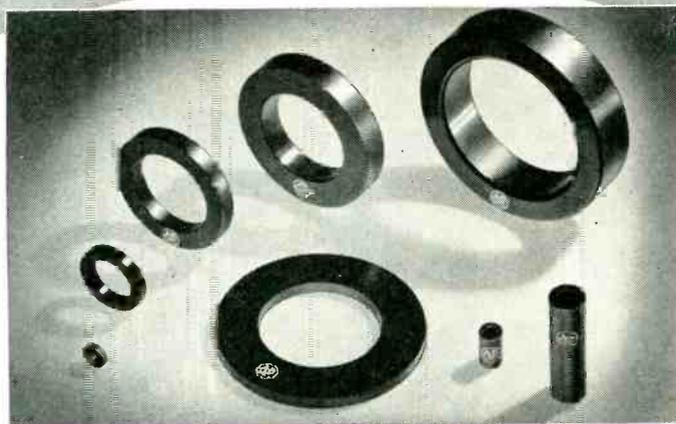
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Deflection
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Toroid, cylindrical,
and ring cores

FERRITE COMPONENTS of HIGH EFFICIENCY for COLOR TV CIRCUITS

A greatly broadened line of Allen-Bradley Quality ferrite parts is now available to electronic and television set manufacturers. Some standard pieces are shown above.

Three performance standards—WO-1, WO-2, and WO-3 have been established for the electrical and magnetic characteristics of Allen-Bradley ferrite component parts:

WO-1 and WO-3 are somewhat more efficient but still interchangeable with other makes of ferrite parts.

WO-2 parts have much lower losses and higher

permeability with greater flux density at maximum operating temperatures. Their higher magnetic efficiency permits reduction in size of these ferrites and the use of less copper. A lower over-all cost is often the result. In some color television circuits, the use of Allen-Bradley WO-2 ferrites has eliminated two tubes and related parts.

Allen-Bradley has grown rapidly as a dependable producer of Quality ferrite parts. It will pay you to investigate the performance of Allen-Bradley ferrites in your electronic circuits.

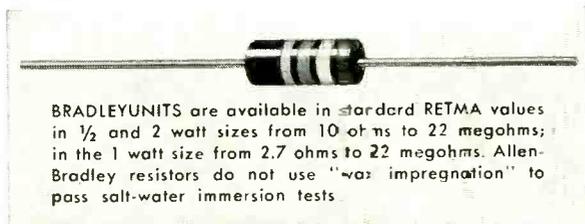
Allen-Bradley Co.

110 W. Greenfield Ave., Milwaukee 4, Wis.

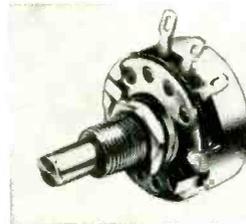
In Canada—

Allen-Bradley Canada Ltd., Galt, Ont.

OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



BRADLEYUNITS are available in standard RETMA values in 1/2 and 2 watt sizes from 10 ohms to 22 megohms; in the 1 watt size from 2.7 ohms to 22 megohms. Allen-Bradley resistors do not use "vac" impregnation" to pass salt-water immersion tests



BRADLEYOMETERS can be supplied as single units or in dual and triple construction. Built-in line switch can be provided. Corrosion-resistant metal used throughout. No riveted, welded, or soldered connections.

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RADIO, ELECTRONIC AND TELEVISION COMPONENTS

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Widest selection of latest materials. Constant addition of new special-purpose bodies. Over 50 years accumulated experience and "know how." A highly trained staff, alert for improvements and new techniques.

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True cost is what you get for what you pay. It's risky to buy ceramics by price alone. It may mean mediocre material and outdated design. You'll profit by investigating the recent "giant steps" taken in the ceramic field.

cost...

ALSiMag offers the best possible ceramic for your job at a price that's right. Modern, large-scale equipment cuts production costs. Shipments are on time and to specification. ALSiMag extra services include free redesign service and use of open dies.

Ceramics

Assembly lines run on deliveries, not promises. That's why we're careful to make delivery estimates that are dependable. True, ceramics are temperamental. But you'll find ALSiMag's "shipment as promised" average is high. Ask any of our customers.

- Send a blueprint and outline of operating conditions and see what American Lava can do to save you money.

53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

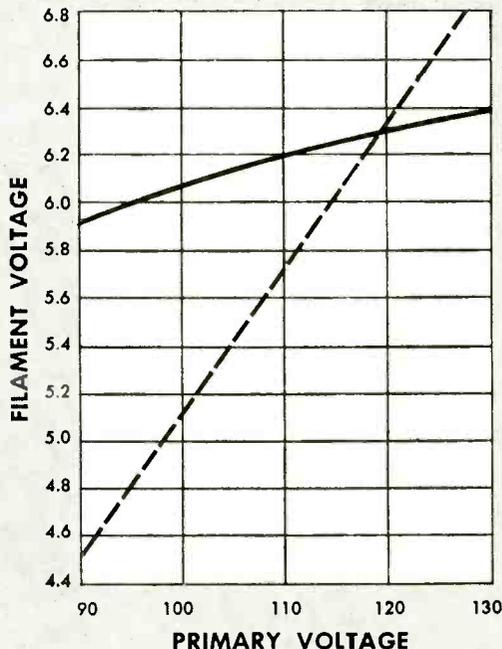
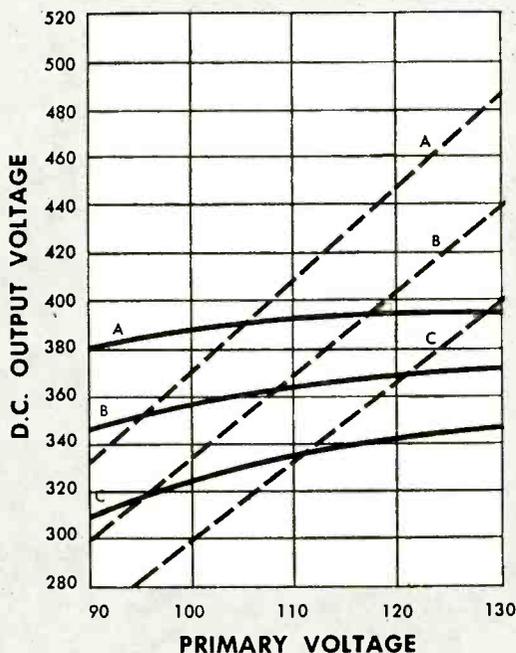
CHATTANOOGA 5, TENNESSEE

Branch offices in these cities (see your local telephone directory):

Cambridge, Mass • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas
Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia-Pittsburgh, Pa.
St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla.

A: 50% Load
B: 100% Load
C: 150% Load

———— SOLA CONSTANT VOLTAGE TRANSFORMER
----- CONVENTIONAL POWER TRANSFORMER



These curves contrast the plate and filament supply voltages obtained from a Sola and a conventional power transformer when line voltage is varied from 100v to 130v.

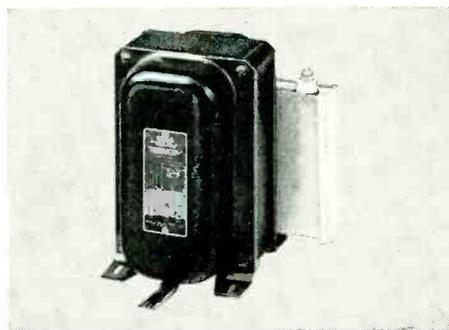
Improve Performance of electronic products with built-in regulating power transformer

You can make sure your product will always receive correct plate and filament voltages by building in a Sola Constant Voltage Power Transformer (Type CVE) in place of a conventional, non-regulating power transformer.

The Sola CVE provides $\pm 3\%$ regulation of plate and filament supply, with line voltage variations of 100 to 130 volts. Regulation is completely automatic, continuous and substantially instantaneous (1.5 cycles or less). Sola CVE stabilizers have no moving parts or tubes, require no manual adjustments or maintenance, and are self-protecting against short circuits.

Three stock units (all with high voltage ct, 5.0v and 6.3v regulated windings) are stocked by your electronic distributor. You can order production quantities of special units manufactured to your specification. We invite your inquiry.

TYPICAL STOCK UNIT: Sola Electronic Power Transformers are made for chassis mounting. They are furnished complete with separate capacitors and capacitor mounting brackets.



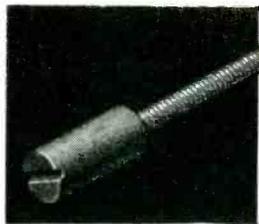
Automatic, Maintenance-Free Voltage Stabilization

SOLA *Constant Voltage* TRANSFORMERS



SEND FOR FOLDER:
Please write for folder which gives complete data.
Ask for CIRCULAR 7A-CVE-195

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • LIGHTING TRANSFORMERS for All Types of Fluorescent and Mercury Vapor Lamps. • SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • BOSTON: 272 Centre Street, Newton 58, Massachusetts • NEW YORK 35: 103 East 125th Street • LOS ANGELES 26: 2025 Sunset Boulevard • PHILADELPHIA: Commercial Trust Building • CLEVELAND 15: 1836 Euclid Avenue • KANSAS CITY 2, MISSOURI: 406 West 34th Street • Representatives in Other Principal Cities



CUT IRON CORE COSTS

with Stackpole

"PREFERRED TYPES"



"EE" SERIES . . .
FOR
ENGINEERED ECONOMY



Made to well-known Stackpole quality standards, these new "EE" Cores are available only in commonly needed grades and sizes. They're ready for delivery from stock . . . at low prices . . . and without the usual set-up charge for custom-engineered cores.

Mechanical specifications conform to the latest MPA recommendations. Electrical standards fully meet 8 out of 10 requirements of radio, TV, and communications equipment. Write, wire, or 'phone for details.

Electronic Components Division

STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE

the KEY to your problem

phastron "555" metal-cased MULTIMETERS

the NEW LOOK in



POCKET SIZE WITH A 4 7/8" LENGTH SCALE

WE LEAVE IT TO YOU

WOULD YOU BUY A PLASTIC-CASED WRIST WATCH . . .

if you could buy the finest movement in a magnetically shielded metal case?

Phastron, world famous manufacturer of ENVIRONMENT FREE PRECISION AIRCRAFT EQUIPMENT for Military and Industrial uses introduces a new concept in Multimeters. This magnetically shielded, metal-cased "555" compares with plastic-cased multimeters as a fine watch in a precious metal case would compare with a plastic wrist watch.

The shielded, shatterproof and anti-magnetic case insures continued accuracy and integrity of this instrument for years to come.

Phastron "555" Multimeter incorporates more ranges, including AC current, greater visibility, simplified and functional controls and the greatest value offered to date.

See the Phastron "555", note its many outstanding features, its beautiful satin chrome case, its compactness and light weight, and you will know why

"YOU CANNOT BUY BETTER"

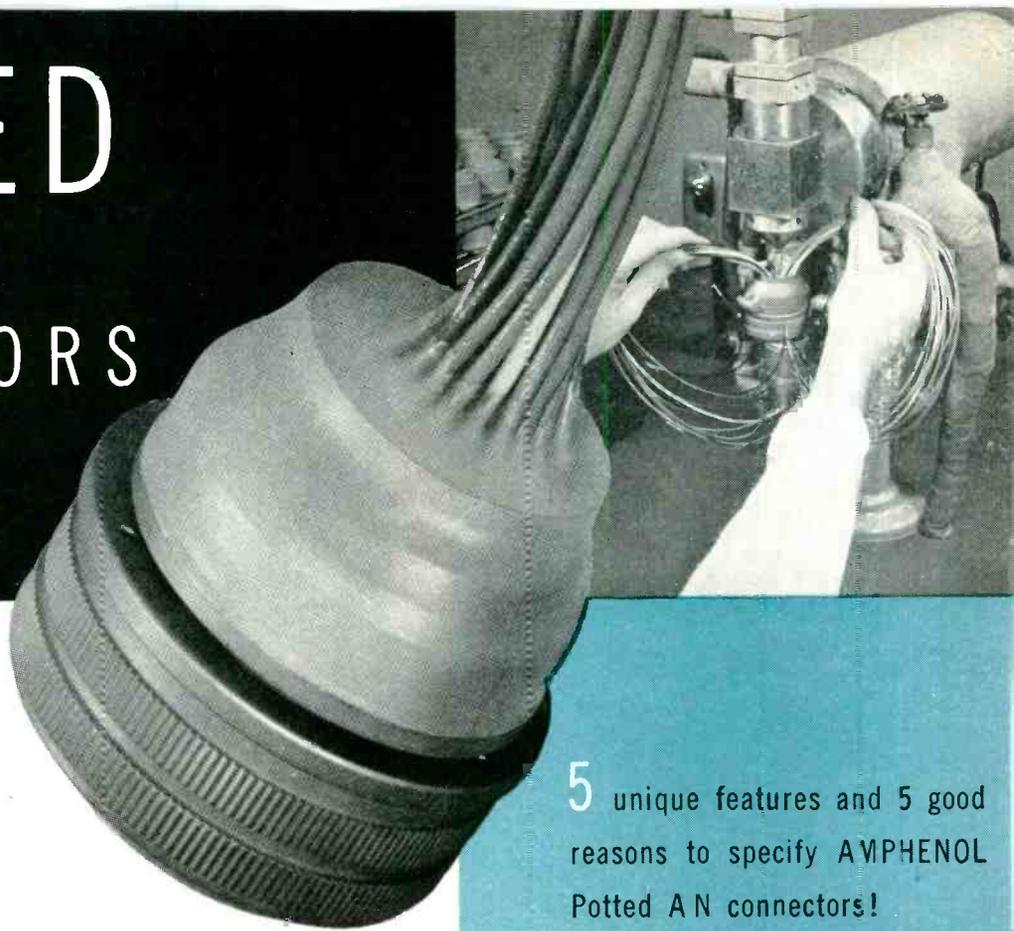
the KEYS to your problems

- phastron AC CURRENT RANGES
- phastron ANTI-MAGNETIC . . . DOUBLY SHIELDED
- phastron LARGE SCALES . . . COLOR CODED
- phastron SIMPLICITY . . . ONLY 2 JACKS
- phastron ACCURACY . . . 3% DC, 4% AC
- phastron GREATER RANGES . . . 3 TO 1 STEPS
- phastron FASTER & FUNCTIONALLY EASIER to use and read

\$39.95 at your PARTS DISTRIBUTOR

Manufactured by PHAOSTRON COMPANY • 151 Pasadena Avenue • South Pasadena, Calif., U.S.A.

POTTED A-N CONNECTORS



gain greater
electrical reliability
with moisture-proof
AMPHENOL
Potted AN Connectors

At right are listed the outstanding features of AMPHENOL Potted AN connectors. What is Potting and how can it offer these advantages to AN users? Potting simply replaces the usual backshells of any AN3106, AN3101 and AN3100 plug with a hemispherically shaped synthetic rubber sealant. It completely encloses the contact terminals in an AN cable assembly with a rugged moisture-proof housing.

The primary achievement of AMPHENOL Potting is an *electrically reliable moisture-proof* connector—but its other advantages are almost as desirable and open the possibilities of the use of Potted ANs in applications where moisture-proofing is not important. For not only is the Potted AN completely resistant to salt water but also to stronger fluids such as fuel oil and gasoline. Elimination of the usual backshell and cable-clamping components reduces both the size and the weight of an AN connector—and weight reduction is all important to engineers in every field of electronics today. Potting also provides a resilient mass at the wire terminals of the connector which not only isolates each individual contact and its wire lead in a sealed resilient chamber but permits the AN assembly to withstand severe vibration and to operate efficiently under unusual conditions. And, finally, if these were not enough reasons for specifying AMPHENOL Potted AN connectors, a Potted connector is not only more efficient, lighter in weight and smaller, but costs far less than so-called mechanically sealed connectors which are dependent upon auxiliary parts for moisture sealing!

1830 South 54th Avenue, Chicago 50, Illinois
AMERICAN PHENOLIC CORPORATION
In Canada: AMPHENOL CANADA LTD., Toronto

AMPHENOL

5 unique features and 5 good reasons to specify AMPHENOL Potted AN connectors!

- 1 New efficient moisture-proof design
- 2 Greater electrical reliability in all kinds of weather
- 3 Weight-saving, space-saving construction
- 4 Ability to withstand severe vibration
- 5 Lower cost than standard or mechanically "sealed" connectors



REQUEST BULLETIN 2555
Full details on Potting of AN connectors

New!

LAMBDA MODEL 71 PORTABLE POWER SUPPLY



**A VERSATILE, HEAVY-DUTY
PORTABLE WITH BROAD FIELD
AND LABORATORY APPLICATIONS**

Cannot be damaged by external overloads! No down time! Circuit breakers provide complete protection!

WIDE RANGE! 0-500 VDC @ 0-200 MA
LIGHT! Weighs only 49 lbs.
COMPACT! 13" high, 8 3/4" wide, 14 1/2" deep

A de luxe unit that combines every good engineering feature with maximum compactness and portability.

\$289⁵⁰ F.O.B. Factory, Corona, N. Y.

SPECIAL FEATURES

- Overload Circuit Breakers. AC and DC Circuit Protection
- No "Down Time" due to External Overloads
- Stable 5651 Reference Tube
- Vernier High Voltage Control
- Hermetically-Sealed, Oil Filled Condensers
- Time Delay Tube Protection
- All-Aluminum Construction
- Made by America's Leading Power Supply Specialists

SPECIFICATIONS FOR LAMBDA MODEL 71 PORTABLE

INPUT.....105-125 VAC, 50-60 CPS, 475 W (max)

DC OUTPUT NO. 1 (regulated for line and load)

Voltage.....0-500 VDC (continuously variable)

Current.....0-200 MA (over entire voltage range)

Regulation (line).....0.15% or 0.3 volt (whichever is greater)

Regulation (load).....0.15% or 0.3 volt (whichever is greater)

Internal Impedance.....Less than 4 ohms

Ripple and Noise.....Less than 5 millivolts rms

Polarity.....Either positive or negative may be grounded

DC OUTPUT NO. 2 (regulated for line only)

Voltage ranges: Internal Impedances:

(a) 0-50 VDC (no load) 5,500 ohms

(b) 0-200 VDC (no load) 25,000 ohms

Current range:

Any value of external load impedance may be used including continuous low impedance or short-circuit. Insignificant inter-action on Output No. 1 Short Circuit Current: 9 MA (Max.)

Regulation (line).....Better than 0.1%

Ripple and Noise.....Less than 5 millivolts rms

Polarity.....Positive terminal connected internally to negative terminal of DC Output No. 1.

AC OUTPUTS (unregulated)

Two outputs, isolated and ungrounded. Each is 6.5 VAC at 5A (at 115 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6V (nominal) at 5A, or in parallel for 6.3V (nominal) at 10A.

AMBIENT TEMPERATURE AND DUTY CYCLE:

Continuous duty at full load up to 40°C (104°F) ambient.

OVERLOAD PROTECTION:

External overload protection.....AC and DC magnetic circuit breakers. Trip-Free. Instant manual reset. Front panel.

Internal failure protection.....Fuses, access through rear of of cabinet.

INPUT AND OUTPUT CONNECTIONS:

Input.....8 foot heavy duty rubber covered line cord with integral molded plug, rear of cabinet.

Output.....Sturdy insulated "5-way" binding posts, front panel.

METERS:

Output voltage.....Multi-range 3 1/2" rectangular voltmeter calibrated 0-50 VDC, 0-200 VDC, 0-500 VDC.

Output current.....3 1/2" rectangular milliammeter calibrated 0-200 MA.

VOLTAGE REFERENCE TUBE:

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

TIME-DELAY RELAY CIRCUIT:

A 30 second time delay circuit is provided to allow tube heaters to come to proper operating temperature before high voltage can be applied.

SIZE AND WEIGHT AND FINISH:

Size.....13" H x 8 3/4" W x 14 1/2" D

Weight.....49 lbs.

Finish.....Two-tone gray



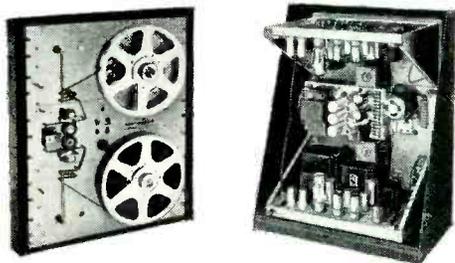
LAMBDA Electronics Corp.

THE FIRST NAME IN POWER SUPPLIES

103-02 NORTHERN BLVD. • CORONA 68, NEW YORK • TWINING 8-9400

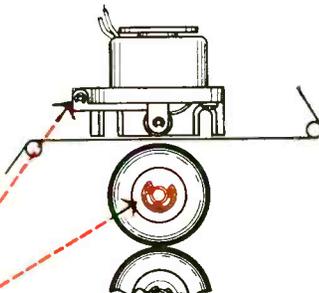
30 Waldes Truarc Rings Save Space and Time... Simplify Assembly and Disassembly

Potter's New Digital Magnetic Tape Handler



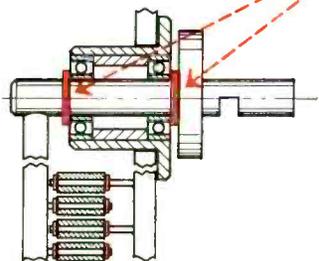
■ Prime requirements: fast starts, fast stops, fast tape speeds, great accuracy. Using Truarc rings, this new model starts and stops the tape within 5 milliseconds has tape speeds up to 60 inches per second.

Solenoid Mount and Capstan Assembly



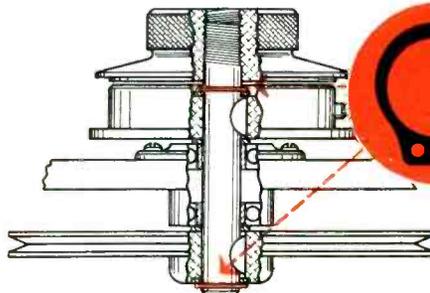
■ Miniature Truarc E-Rings on .040 diameter shaft and on continuously running capstans eliminate projecting bolts and screws. Rings permit rapid assembly and disassembly, fast replacement of worn rubber capstans.

Tension Shaft Assembly



■ Truarc E-Rings snap quickly into place, act as shoulders for the ball bearings with a minimum of friction. Additional Truarc Rings are used as spacers on shafts, can be located accurately to extremely close tolerances.

Reel Shaft Assembly



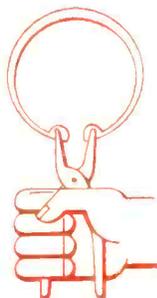
■ Truarc Standard Rings (Series 5100) hold the reel shaft assembly firmly in place and permit the use of quick-lock hubs so that the reel tapes can be changed in seconds as they are finished.

Potter Instrument Company, Inc., of Great Neck, L. I., uses 30 Waldes Truarc Retaining Rings in their new Model 902 High Speed Digital Magnetic Tape Handler. In addition to solving a variety of fastening problems, Truarc Rings facilitate the rapid acceleration and fast stopping needed in these machines.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining

Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble. They save time and increase operating efficiency.

Find out what Waldes Truarc Retaining Rings can do for you, toward saving costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.



SEND FOR NEW CATALOG

WALDES
TRUARC

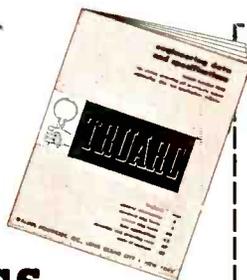
REG U S PAT OFF

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING
U. S. PATENTS: 2,382,847; 2,382,949; 2,416,852; 2,420,921; 2,426,341; 2,439,785; 2,441,846; 2,455,165;
2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,061 AND OTHER PATENTS PENDING

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



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

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name

Title

Company

Business Address.....

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

E017

PHELPS DODGE UP-TO-DATE SIMPLIFIES YOUR MAGNET



First for Lasting Quality—from Mine to Market!

WAREHOUSE SERVICE

WIRE INVENTORY PROBLEM



 **COMPLETE WAREHOUSE STOCKS**
*strategically located on East Coast,
West Coast and in Central Region.*

 **OVERNIGHT DELIVERY TO THE
MAJOR MARKETS**

 **"ONE-PHONE-CALL" SERVICE**
*via nearest Phelps Dodge district
office. See list below:*

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Los Angeles, Calif. • Milwaukee, Wis. • New Orleans, La.
New York, N. Y. • Philadelphia, Pa. • Pittsburgh, Pa. • Portland, Ore.
San Francisco, Calif. • Seattle, Wash. • St. Louis, Mo. • Washington, D. C.



PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA



MAKE *Wire-Wrap*^{*}
CONNECTIONS
in half the time!

WEIGHS
 ONLY
 ONE POUND

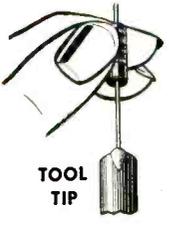
^{*}Trademark

Keller "Wire-Wrap" Tools produce electrical connections that need no soldering

ZIP . . . and this amazing new power tool wraps wire around a terminal to make a permanent electrical connection. Costly hand wrapping and soldering are eliminated . . . production goes up while costs go down.

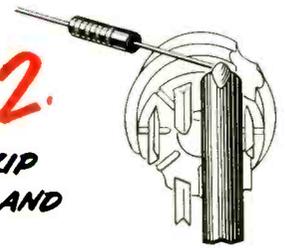
Hour after hour, this new lightweight "Wire-Wrap" Tool makes uniform connections without fatigue to the operator. Wire-Wrap connections retain their characteristics under severe conditions of corrosion, vibration, or aging.

For lower costs, fewer rejects, faster production, product compactness, and strong, low-resistance connections, investigate this revolutionary new tool.

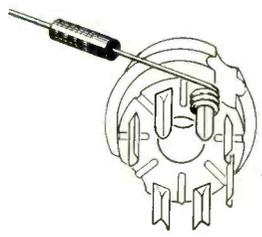


1.
INSERT WIRE

TOOL TIP



2.
ZIP
...AND



3.
IT'S FASTENED

Available in air or electric models

SOLDERLESS WIRE-WRAP CONNECTIONS

are made by wrapping wire tightly around rectangular terminals. Each quarter turn is locked under tension, providing a permanent mechanical and electrical bond. These clean, high-pressure connections have a contact area greater than the cross section of the wire . . . yet can be easily removed when desired. Send for Bulletin No. 11 for detailed information.

Wire-Wrap Tools are now available from Keller—the original manufacturer

Wire-Wrap Division

KELLER TOOL COMPANY
 1335 Fulton Street Grand Haven, Michigan



Eimac Klystron Report

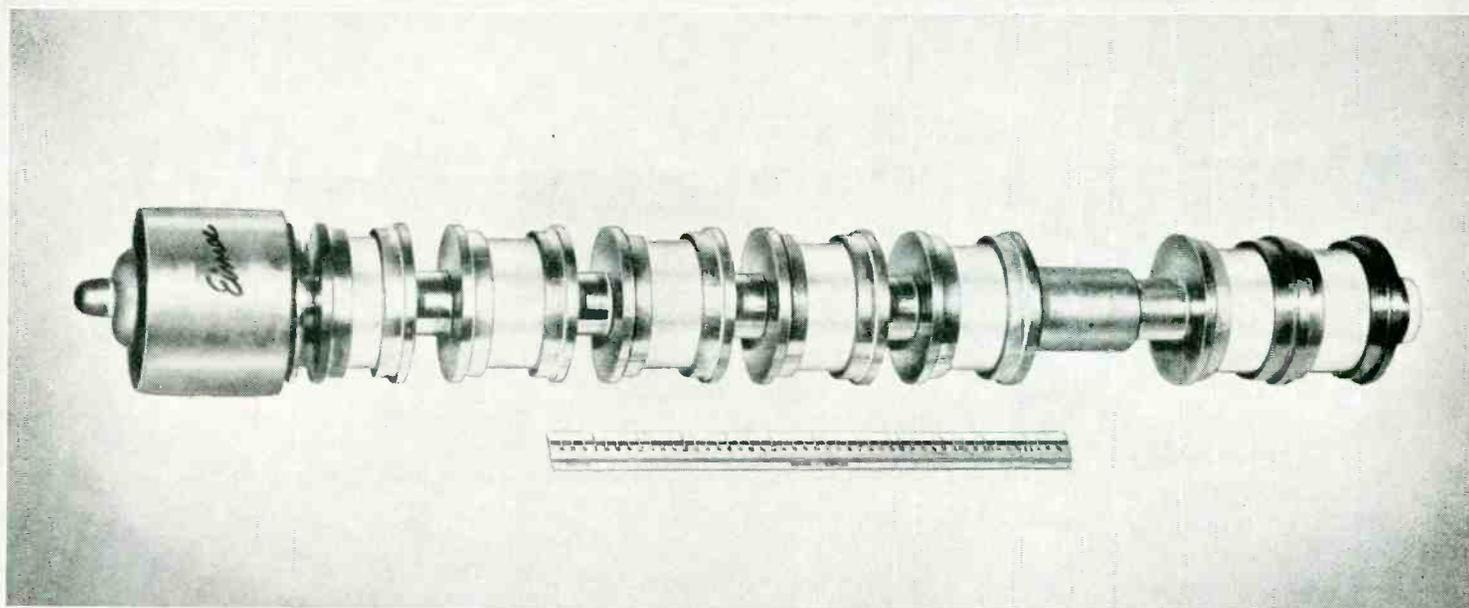
X566

20kw

modulating anode
pulse klystron

• High power gain of 53db

• UHF operation — 960-1400mc



EIMAC X566 UHF klystrons have consistently obtained peak pulse power outputs of more than 20kw with over 40% efficiency at 960-1400mc. Many times more powerful than any other tube intended for similar operation, such as aircraft navigational aid Distance Measuring Equipment, the air-cooled X566 requires only 100 milliwatts driving power for a 20kw output — a power gain of 53db with bandwidth adequate for most pulse applications. Of special significance is the high average power capability of one kilowatt, allowing the duty cycle to be raised to 5% with a 20kw peak output, or 10% with 10kw output, and so on. Outstanding pulse capabilities of the X566 are made possible through the use of the Eimac modulating anode — an insulated anode between the cathode and drift tube section — permitting the klystron to be pulse modulated with

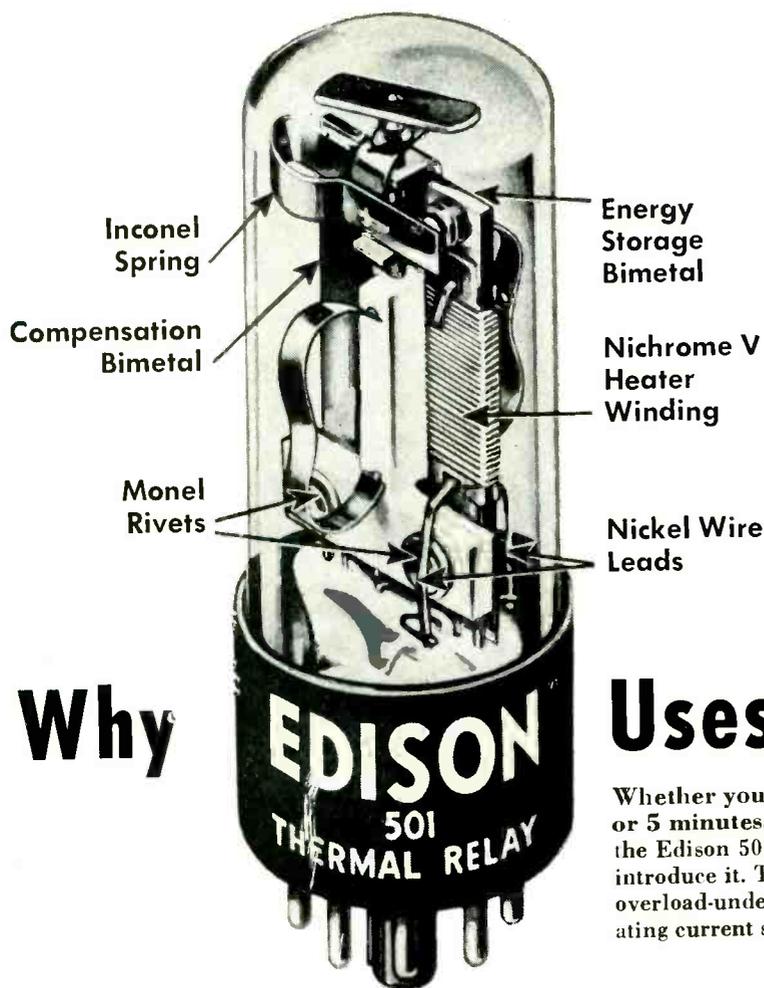
low pulsing power. In Eimac high power amplifier klystrons using ceramic and copper construction, the resonant cavities are completed outside the vacuum system, which is left free of RF tuning devices — permitting easy wide range tuning and uncomplicated input and output coupling adjustment. This simplicity of design and rugged construction minimize replacement costs as well as making the Eimac X566 suitable for mass production techniques.

The X566, another Eimac high power klystron achievement, is now available with circuit components for experimental purposes.

- For additional information, contact our Technical Services Department.

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA

Eimac
THE WORLD'S
LARGEST MANUFACTURER OF
TRANSMITTING TUBES



Why Uses 7 Nickel Alloys

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

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

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

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

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

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

Wilson High Heat 47**, a bimetal. It consists of Invar, a low expansion alloy, and Wilson alloy #20**, a high expansion alloy. Both are nickel alloys.

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

If you have a design problem

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

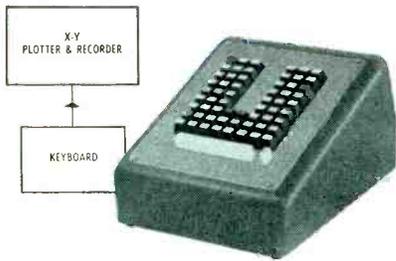
*Reg. U. S. Pat. Off. Driver-Harris Co.
**Products of H. A. Wilson Co.

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

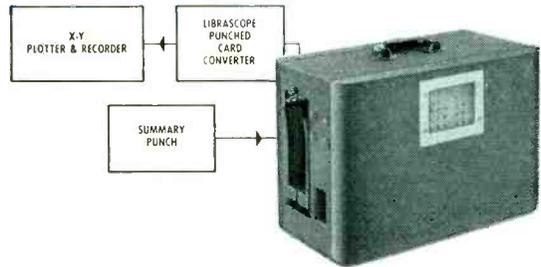


Nickel Alloys

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



DECIMAL KEYBOARD: Consists of a three-decimal bank for each axis with associated plus-minus keys. Depressing plot bar initiates plot and clears keyboard automatically. Also manual clear button. Size: 8½ x 11 in., Weight: 12 Lbs.



PUNCHED CARD CONVERTER: Converts punched card data to an analog form suitable for input to X-Y Plotter from Gang Summary or Reproducing punches. Display Monitor. Total tube complement 26 tubes.

X-Y plotter and recorder

simplified recording of two independent variables with greater selection of input devices

A compact, desk-size unit that accepts either analog or digital inputs. Standard digital converters: Decimal keyboard, Decimal punched card, and Binary for Computer Outputs. Handles remote mechanical shaft rotations directly without modification. Modifications available to customer specifications. Full chart visibility allows observer to view curve generation at all times. Unique pen travel for fast, dependable performance. Write for full catalog information.

Engineers, physicists and mathematicians in search of interesting assignments, rapid advancement, and job security are requested to write Dick Hastings, Personnel Director.

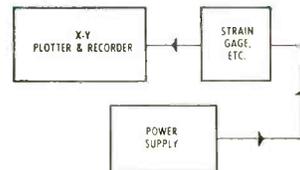


LIBRASCOPE, INCORPORATED A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION 1607 FLOWER STREET, GLENDALE, CALIFORNIA

Computers & Controls

LIBRASCOPE

DESCRIPTION:
 Desk or Rack Mounted (RCA or RMA)
 Accuracy: .1%
 Weight: 70 lbs.
 Uses Standard Graph Papers: 11" x 16½", or 8½" x 11"
 Power Consumption: 150 watts, 115 volts, 60 cycles



D.C. INPUTS: 5 millivolt full scale sensitivity on both axes. Infinite input impedance for signals to .5 volts. 2 megohms input impedance above .5 volts.

from VACUUM MELTING—
improved alloys with exceptional properties

WHAT ARE VACUUM-MELTED METALS?

Vacuum-melted metals are a familiar family of alloys with new, improved characteristics. For during high-vacuum melting, gaseous impurities are literally sucked from the molten metal. The result is cleaner, purer metals with desirable properties not previously attainable . . . in, for example, superalloys, bearing steels, high-strength steels, electronic metals, or magnetic alloys.

WHAT ARE THEIR ADVANTAGES?

Many characteristics of a specific alloy can be improved by vacuum melting and casting . . . for impurities that limit an alloy's potential are removed. Tensile and impact strength, stress rupture strength at elevated temperatures, and fatigue life can all be substantially improved . . . and creep and brittleness minimized by vacuum melting.

HOW CAN I BEST USE THESE IMPROVED ALLOYS?

Frankly, vacuum-melted metals are so new that many applications for them have not yet been explored. But where they have been used, they've *proved* their effectiveness in improved performance. Superalloy jet engine turbine blades, for example, have given more than *twice* the performance life of blades made of conventional air-melted alloys. And ball bearing rejects dropped from 50% to 3% when vacuum melted steels were used.

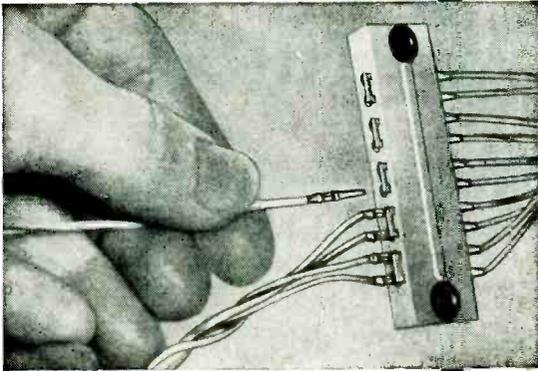
WHERE CAN I GET VACUUM-MELTED METALS?

Now, Vacuum Metals Corporation, pioneer in the development and production of vacuum-melted and cast alloys, is producing tool, high-speed, stainless and alloy steels — in most sizes and grades — as well as special ferrous and nonferrous alloys. If you have a metals problem that vacuum-melted alloys might solve, please describe it in as much detail as possible. Write *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*



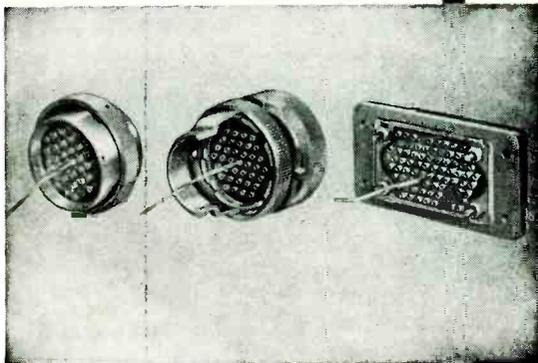
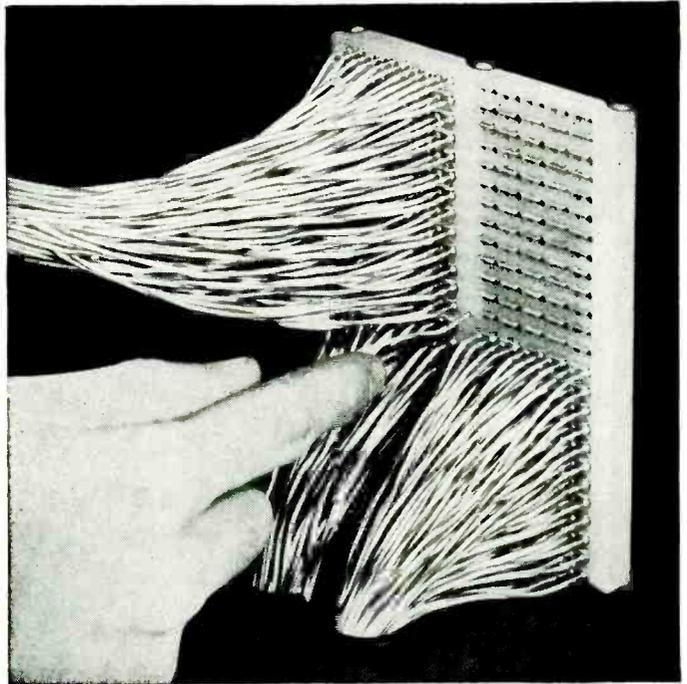
VACUUM METALS CORPORATION

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



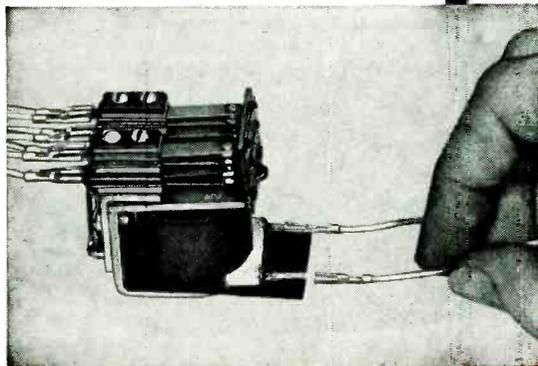
BASIC 10 CONNECTOR TAPER-BLOK WITH DUAL CONTACTS

Photo shows TAPER-BLOK with A-MP TAPER PINS in place. Strip measures only .610" x 2". Blocks, made of NYLON 10001, can also be stacked to accommodate hundreds of circuits.



TAPER PINS FOR MULTIPLE CONNECTORS, AND OTHER TYPES

Amphenol, Cannon, Continental and Winchester Connectors now are available with tapered receptacles for A-MP self-locking TAPER PINS. Saves over 80% of your wire assembly time and provides uniformly higher quality connections at lower cost.



TAPER TAB RECEPTACLE APPLICATIONS

More and more flat tabs on relays, switches and other components are being tapered to receive A-MP TAPER TAB RECEPTACLES. Fast easy assembly reduces costs and provides higher quality connections.



NEW
MINIATURE
TAPER-BLOK
For AMP Taper Pins

(Wire Ranges: #26 to #18)

NEW TAPER-BLOK FOR A-MP'S TAPER PINS HELPS YOU SAVE SPACE AND WEIGHT, SPEEDS UP WIRING ASSEMBLY, SIMPLIFIES DESIGN, AND REDUCES COST!

The TAPER-BLOK shown has receptacles for 1000 connections, yet measures only 4" x 5" x 5/8"! Receptacles are designed to receive A-MP self-locking Taper Pins which can be easily pushed in place with A-MP's CERTI-LOK measured energy insertion tool.

Extremely high contact pressure assures dependable, uniform, low resistance connections for electric and electronic circuits.

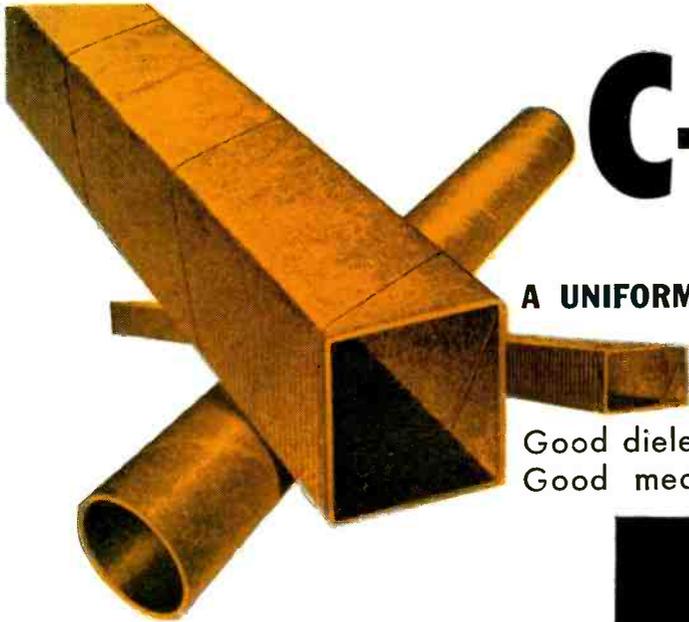
Assembled TAPER-BLOKS are available in 10 and 20 connector sizes with single or dual receptacles. TAPER-BLOK strips can be assembled by stacking to provide the number of connections required for your design. Write for specific information and latest prints.

AMP Trade Mark Reg. U.S. Pat. Off. © AMP



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C-D-F SPIRAL TUBING

A UNIFORM, HIGH QUALITY PRODUCT AT LOW COST

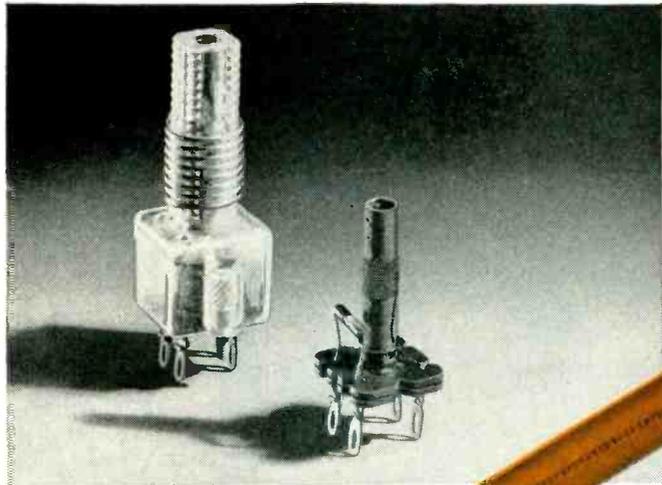
Good dielectric strength • Low dielectric loss properties
Good mechanical strength and moisture resistance

C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform, high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating.

Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14" to take .248" to .250" core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples.

Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores.

C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information.



SELECTION OF THE PROPER GRADE

While the differences between some of the grades are not great, they are quite distinct when specific requirements are considered. For most uses, the proper grade can be selected from the descriptions, size range, and properties tables in our catalog. If this should prove difficult in some cases, it is desirable for our C-D-F sales engineer to have as much information as possible about the application, especially fabricating requirements, in order that we may make suggestions. Your blueprint is usually sufficient if it carries some indication as to the quality desired. In other cases, the following check list will be found to be helpful:

Type of Application.

Properties required or the customer's specification for the material. Fabricating quality desired. This is important where stapling, riveting, punching, or forming operations are to be performed by the customer.

Any unusual conditions which may affect the suitability of the material for the job. For tubing that is to accommodate tuning cores, actual samples of the cores are essential along with torque requirements (if known).

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for 8-page Technical Folder ST-53 showing all grades of C-D-F Spiral Tubing, free test samples, or send us your print for quotation.

AVAILABLE GRADES

IMPREGNATED

- 1 General Electrical and Mechanical Grade.
- 1A Electrical and Mechanical Grade—Special Punching.
- 2 Mild Stapling, Riveting, and Post Forming Quality.
- 2A Intermediate Fabricating and Stapling Quality.
- 3 Severe Stapling, Riveting, and Post Forming Quality.
- 5 Constant Torque and Formed-to-Shape Coil Form Tubing. 
- 6 Special for High Humidity Applications.
- 6A Extra Hard, High Strength Tubing.
- 7 Soft Varnished Kraft Tubing.
- 7A Hard, Rigid Rectangular Tubing.
- 8 Varnished Diamond Insulation—Tubing.
- 9 "Deflection Coil" Tubing.
- 10 Larger Size, Heavy Wall Tubing for Mechanical Uses.

UNIMPREGNATED

- 20 Special Wound in Specified Combinations of kraft paper, fish paper, etc.
- 21 Plain Kraft Paper Tubing.
- 22 Plain Diamond Insulation Tubing.
- 23 Plain Chipboard Tubing.

Round Formed and Notched Square, Rectangular
 Formed (fluted shape)

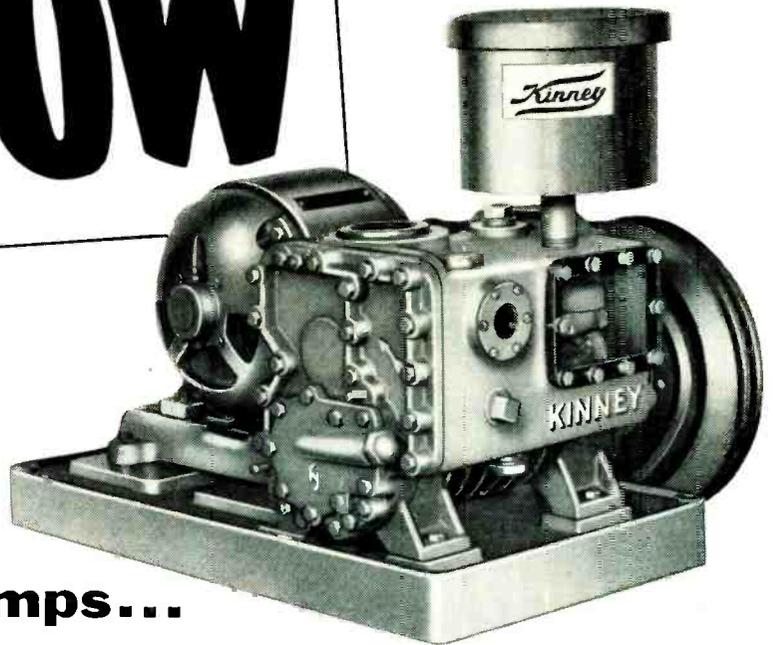
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CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 16, DELAWARE

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two new features
for**

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reduced vibration

Kinney dynamic balance has reduced vibration on compound pumps to an acceptable amount for all practical purposes. These pumps are ideal for use on such applications as dollies and carts.

Feature for feature, no other vacuum pumps can match Kinney. Bring us your vacuum problems. We have competent vacuum engineers in each of our district offices who will gladly help you. Contact one of our engineers or send the coupon for full details.



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THE NEW YORK AIR BRAKE COMPANY

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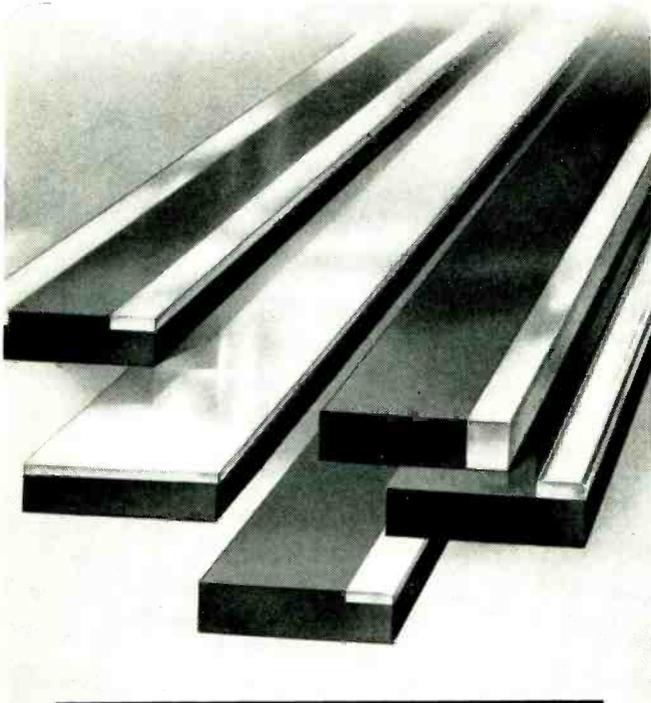
Company

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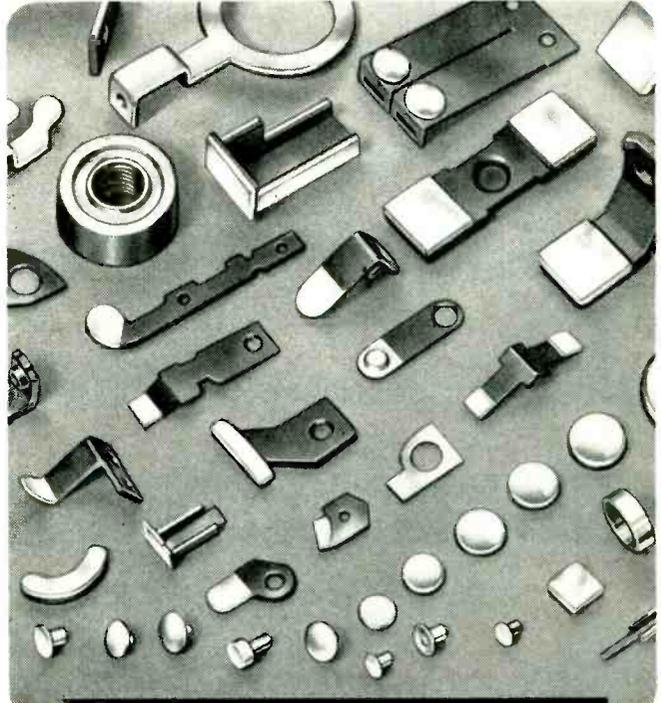
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GENERAL PLATE DIVISION
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Frequency measurement to 10 Mc./sec.;

20 millivolt sensitivity

± 1 count ± 0.3 ppm per month

absolute accuracy

Automatic decimal point

Remote, local, continuous or manual

measurement cycle control

Measures directly:

Frequency, Period, Elapsed Time,

Ratio of two Frequencies.

Dimensions: $19\frac{1}{2}$ " w x 15" h x 18" d

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ANDREW S. SZUCS, Inc.

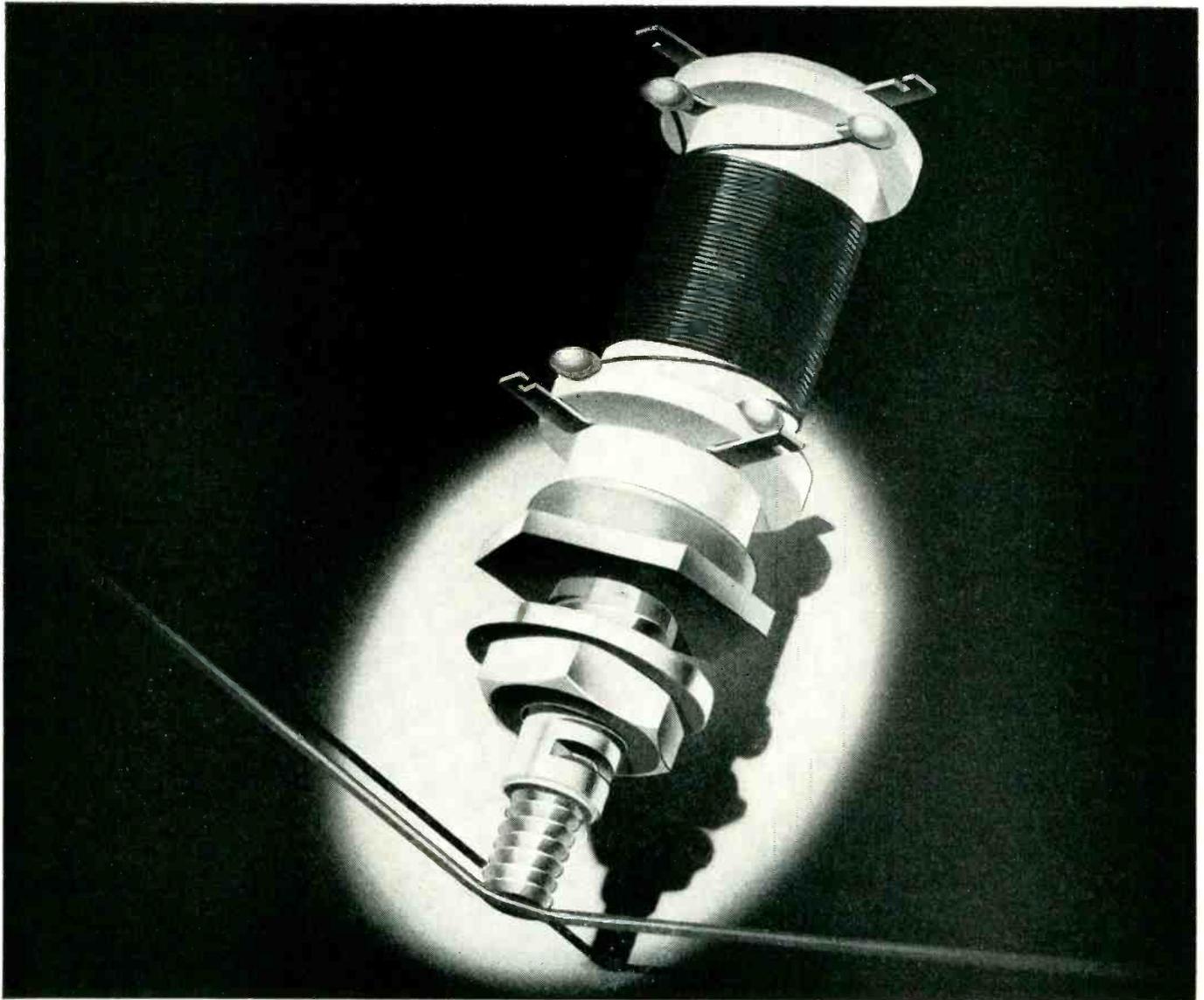
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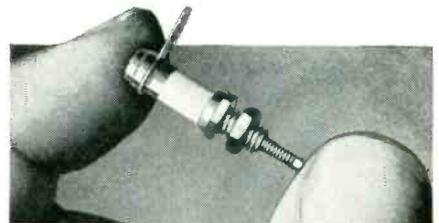
The mounting stud of every C.T.C. coil is fastened to the ceramic body in a special way that does away with weaknesses of ordinary coil fastenings. This special fastening makes C.T.C. coils vibration-proof. What's more, their tightness is preserved in hot, cold, dry or damp weather. All C.T.C. coils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

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all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

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



New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only $\frac{1}{2}$ " high when mounted, is less than $\frac{1}{4}$ " in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

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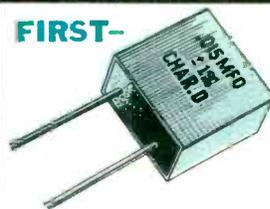
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In the parade of progress as in the manufacture of capacitors it takes vision to lead. That is why, we, at Cornell-Dubilier, have proven our leadership with constant foresight . . . by always being first to develop new and more efficient capacitors to meet tomorrow's demands. Too, this vision has given

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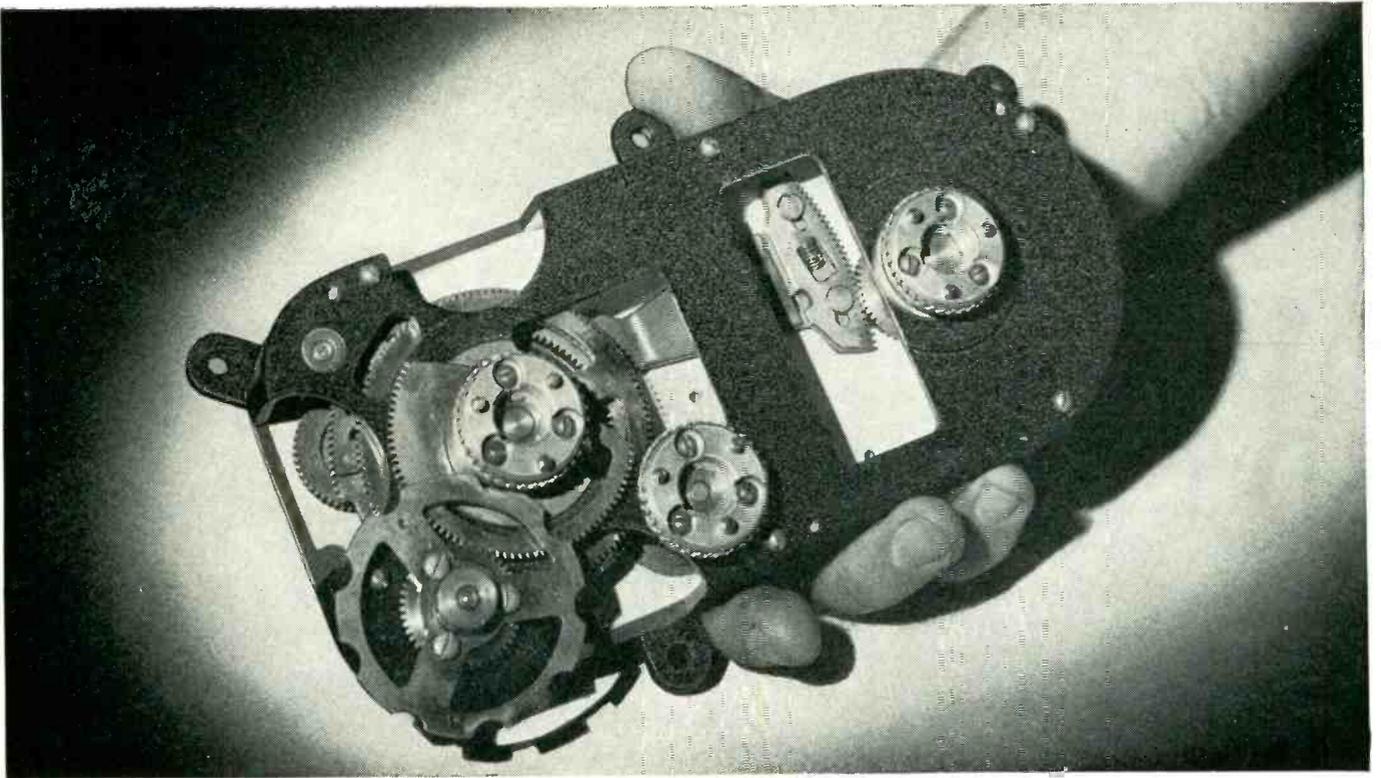
Shown here are three examples of C-D's "Famous Firsts" — proof that whatever your capacitor requirements, a C-D engineer can show you money saving answers. Write to Cornell-Dubilier, Dept. K-15, South Plainfield, N. J.



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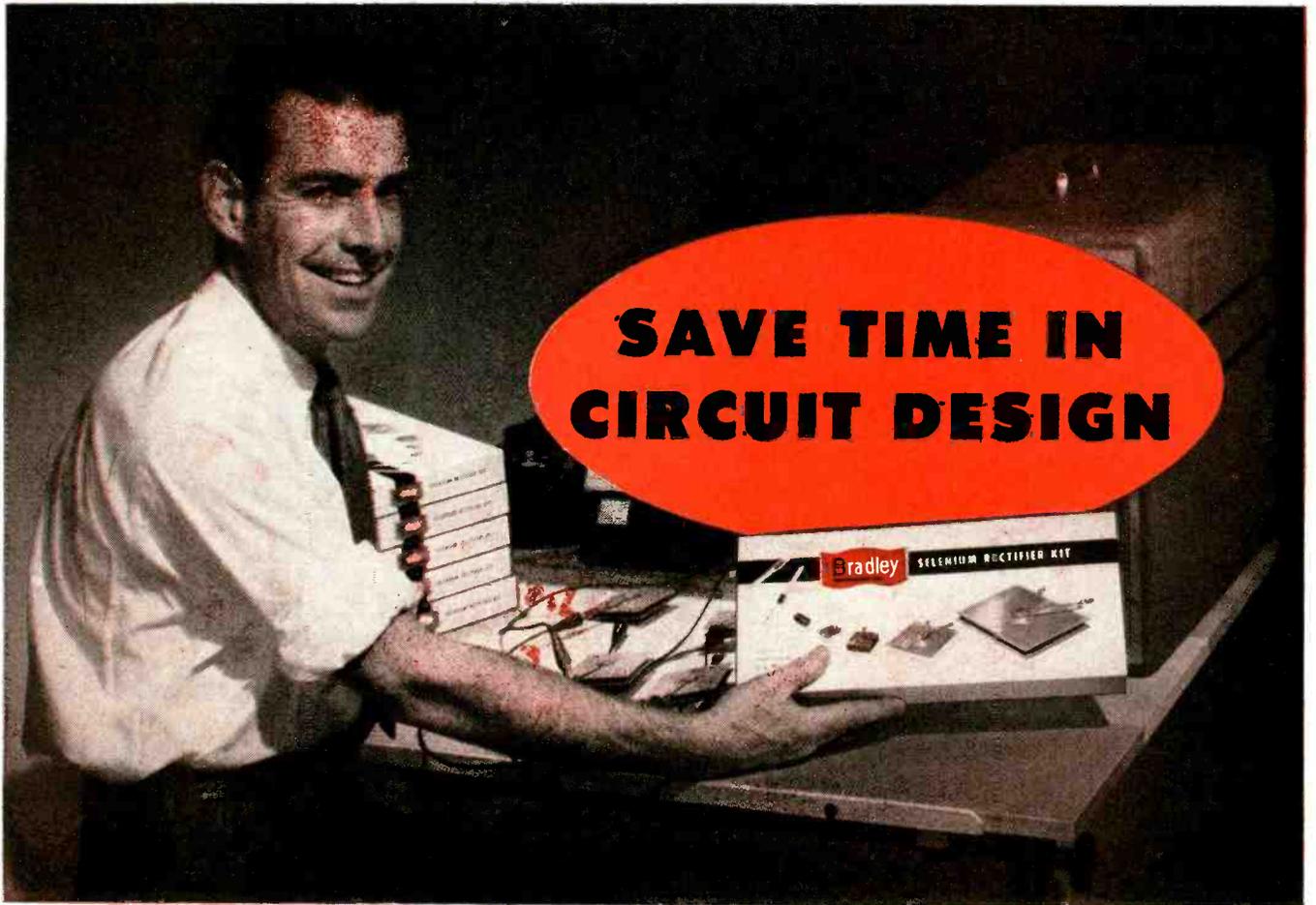
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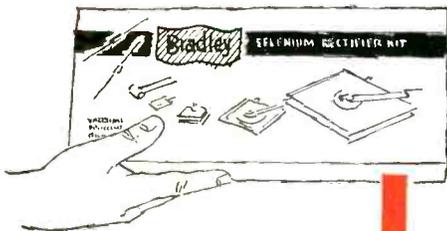
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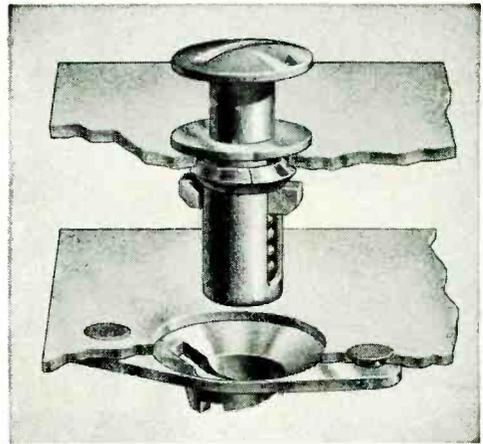
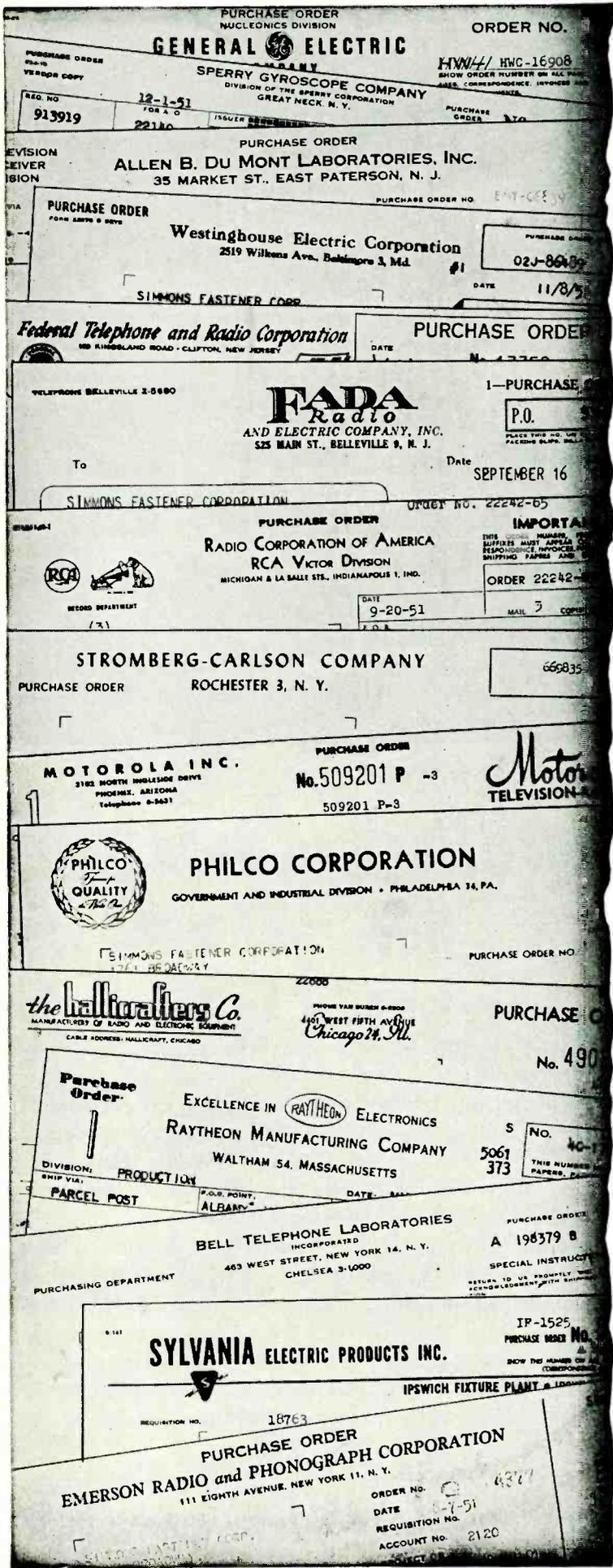
Bradley Selenium Rectifier Kits are time-savers for the design and development engineer. Seven different kits offer a broad choice of types, all complete units, all with standard commercial coding. Miniature rectifiers from 1.5 ma D.C. up to 3700 volts peak inverse. Power rectifiers from 100 ma D.C.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

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

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



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- Initial loads taken by helical spring. Increased loads carried on solid supports.
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Capital Spending Plans for 1955 . . .

Here is Good News About Business Prospects

In 1955, American industry is now planning to spend within 5 per cent of the amount it is spending this year on new plant and equipment. This is the tensely awaited result of a check-up just completed by the McGraw-Hill Department of Economics.

Hundreds of companies, by far the largest number in the eight-year history of these McGraw-Hill surveys, cooperated in the check-up. Combined, they represent 29 per cent of all industrial employment and over 60 per cent of employment in the industries where capital investment is highest. Such a broad cross section constitutes

a reliable gauge of the plans of industry as a whole.

What is the meaning of these plans, detailed by the table below, for capital investment next year? Is it good or bad news, so far as it concerns the prospect of continuing prosperity? It is to this crucial question that this editorial is addressed.

Key to Prosperity

It is not only good but very important business news that American industry plans to spend in 1955 almost as much for new plant and equipment as it is spending this year. The reason it is important is that a high level of activity in the capital goods industries is universally recognized as a particularly potent ingredient of prosperity for the nation as a whole. A dollar spent for capital goods is spent again and again for wages and materials. Its stimulating effects, called by economists multiplying effects, move through the economy in much the same way that a pebble tossed into a pond creates a widening circle of ripples. This is one reason why there is such intense business interest in the surveys of plans for capital investment.

Here are the principal reasons why the results of the McGraw-Hill survey are a good omen for continuing prosperity:

PLANS FOR CAPITAL INVESTMENT

	MILLIONS OF DOLLARS			Percent Change 1954- 1955
	1953 ACTUAL*	1954 ESTIMATED*	1955 PLANNED	
All Manufacturing	\$10,026	\$ 9,249	\$ 8,598	-7%
Petroleum Industry†	4,600	4,875	4,920	+1
Mining	506	380	311	-18
Railroads	1,312	851	769	-10
Other Transportation and Communications	2,954	2,922	2,640	-10
Electric and Gas Utilities	4,548	4,274	4,206	-2
ALL INDUSTRY	23,271	21,784	20,727	-5

*United States Department of Commerce; Chase National Bank; McGraw-Hill Department of Economics

†Petroleum refining, included under both "All Manufacturing" and "Petroleum Industry," is included only once in the total

1. American industry is demonstrating that it does not need the stimulus of war-created shortages, or a rearmament boom, in order to maintain a very high level of capital investment.

The slight decrease now planned for 1955 will still maintain a level only about 11 percent below the all-time peak attained in 1953 under the stimulus of a defense expansion boom.

2. Capital investment promises not merely to stabilize at a high level, but actually to increase as 1955 goes on and thus give renewed stimulus to business.

The level of investment now planned for 1955 by *industry* — manufacturing, petroleum, mining, transportation, communications and utilities — is within 5 per cent of 1954. Contract awards for *commercial* construction — stores, office buildings, warehouses and other service establishments — as compiled by the McGraw-Hill publication ENGINEERING NEWS-RECORD, indicate a substantial increase in 1955. Thus total capital expenditures by *all business* may be very close to this year's total.

Actually, in the fourth quarter of 1954, business capital expenditures, as reported to the U. S. Department of Commerce, are down about 2.5 per cent from the average for the year as a whole. So there is a good chance that during 1955 the annual rate of capital investment will rise above this present level.

Effect of Tax Changes

The plans reported by the McGraw-Hill survey are preliminary plans, reported at the beginning of the period of business budgeting for 1955. As budgets are completed, new projects may bring the total expenditure that is planned even closer to this year's figure and thus make an even greater contribution to continuing prosperity.

But it also cannot be too strongly emphasized

that these are plans; they are not accomplished investments. As such they have the vulnerability to changed conditions that characterize any plans.

There is some indication in the results of the McGraw-Hill check-up that one change in conditions recently made by the United States government has had an important stimulating effect on plans for business investment next year. It is a liberalization of the allowances for depreciation. Apparently encouraged by this provision, most of the smaller companies are planning to maintain or increase their purchases of new equipment next year, whereas during the past three years their expenditures have been declining. This is obviously a development that strengthens our economy.

A government insensitive to the key importance of capital investment by business, both in providing prosperity and in raising our standard of living, might easily destroy the present plans. One of the easiest and surest means to do this is excessive taxation of business profits which are the key ingredient of business investment. Whether the extraordinarily constructive program recently enacted by the federal government in the field of business taxation can be sustained remains to be seen. **If it can be sustained, the remarkably cheering plans of business for capital investment in 1955 can readily become firm foundations for a continuing prosperity.**

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

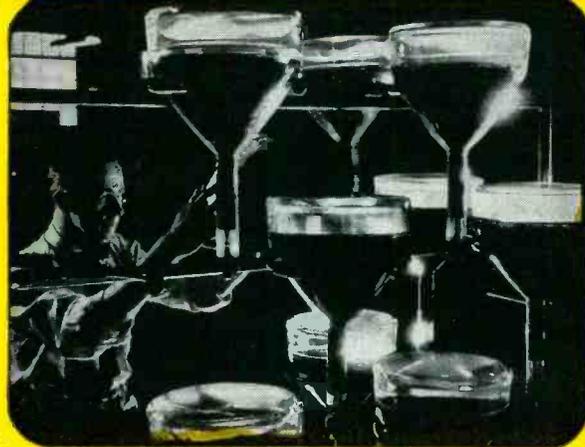
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Adherent, Opaque



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Dispersions of molybdenum disulfide are available in various carriers.

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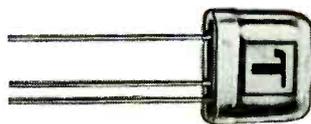
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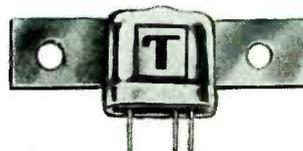
Less than 1 microsecond is required to switch 100 ma collector current with type 2N92. Smaller collector currents can be switched efficiently with type 2N91. Careful manufacturing and conservative ratings insure reliability in excess of vacuum tubes.



1½ x actual size

MEDIUM POWER TYPES

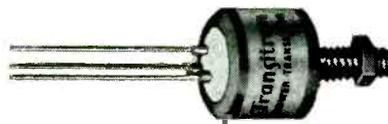
For applications requiring up to 750 milliwatts dissipation and alpha cutoff up to 1 megacycle, the type 2N85 and 2N86 are ideal. They provide a linear transfer characteristic up to 20 ma collector current and can be operated at ambient temperatures up to 75°C.



1½ x actual size

HIGH POWER TYPES

The 2N83 and 2N84 are intended for high-power applications and are conservatively rated at 10 watts dissipation. A Class B amplifier using these types would be capable of 5.0 watts output at 60°C. The 2N83 is comparable electrically to the 2N57.



¾ actual size

SUBMINIATURE TYPES

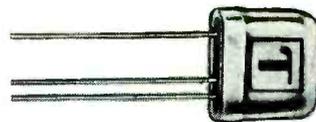
Types 2N88, 2N89, and 2N90 are especially useful where small size and excellent low level performance is desired.



actual size

STANDARD TYPES

A wide variety of RETMA types including the 2N34, 2N43, and 2N65 are available for most general purpose applications.



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Two of these tubes just declassified

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RK6410/QK338 — fixed frequency, pulse magnetron (2750-2860 Mc), 5 megawatt average peak power



RK2J51 — tunable pulse magnetron (8500-9600 Mc), 50 Kw average peak power



RK5976 — mechanically tunable klystron (6250-7425 Mc), average power 100 milliwatts



RK6116 — thermally tuned ruggedized klystron (8500-9660 Mc), average power 25 milliwatts



RK5721 — klystron tunable with external cavities from 3600 to 10,500 Mc. Average power 125 milliwatts in the 2 $\frac{3}{4}$ reflector mode (4290-8340 Mc)



Raytheon also manufactures transmitting tubes, storage tubes and square law tubes

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Characteristics of Unclassified
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Complete data on tube type available upon request



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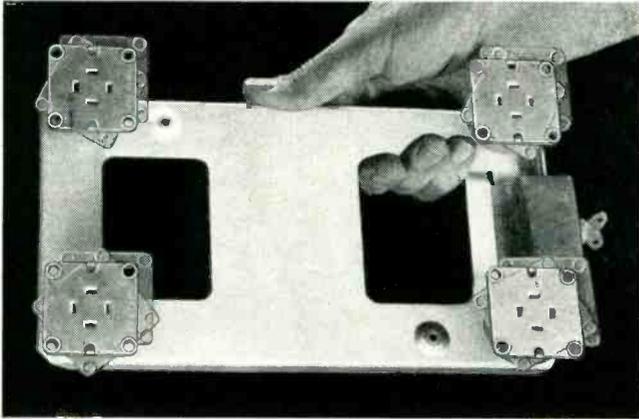
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PLAIN FACTS ABOUT VIBRATION AND SHOCK MOUNTINGS

FOR AIRBORNE ELECTRONIC EQUIPMENT

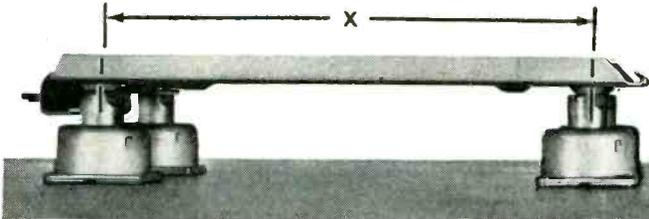


OUT-DATED UNIT MOUNT BASE

16 mounting holes and 16 bolts required.

Unit mountings may be improperly attached to the rack, and are very likely to be seriously misaligned during attachment to aircraft or missile structure.

Even minor discrepancies in spacing and attachment of unit mounts can defeat the whole purpose of the mounting base, and result in poor performance and deterioration of equipment.



Excessive height required. Unit mount bulk imposes reduced spacing (X) between support centers, resulting in impaired stability (critical in lateral direction). Greater sway space required.

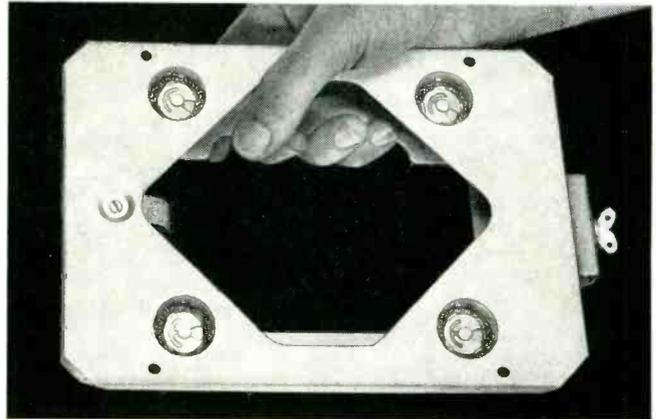
**Well Designed Electronic Equipment,
If Poorly Mounted,
Too Often Operates Inefficiently and Unreliably**

Failure also can result from use of inadequate mountings which are not engineered for the particular equipment and purpose. Conventional shock mounts or so called "isolators", reasonably effective when installed under ideal laboratory conditions, become dangerous trouble makers when installed by usual production line methods.

Attachment of a base plate to unit mounts to achieve spacing control is a makeshift arrangement resulting in excessive weight with no height reduction.

Failure also can result from obsolescent unit mounts employing internal rubber, organic or synthetic materials which deteriorate rapidly and are susceptible to temperature and environmental changes.

The importance of today's electronic equipment surely justifies the use of integrated mounting systems designed to meet specific problems rather than the unreliable application of assembled "catalogue" mounts.

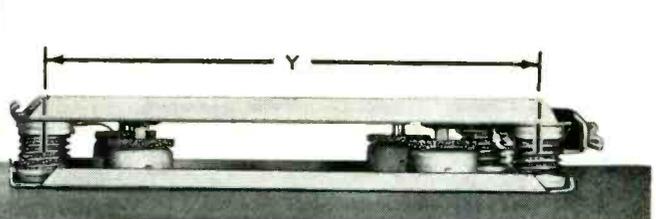


TODAY'S ENGINEERED MOUNTING SYSTEM

Only 4 mounting holes required.

Prespaced holes in a one piece base plate assure quick, accurate attachment. Relationship of all 4 holes is definitely fixed (holes spaced for interchangeability with unit mounts).

No installation errors or misalignment can occur to disturb the precise performance of the mounting system as checked and approved on acceptance tests.



Note reduction in mounting height. Important space saved. Maximum spacing (Y) of resilient elements at extreme corners provides stability. Less sway space required.

**Robinson All-Metal Engineered
Mounting Systems Assure Outstanding Performance
and Reliability of Equipment**

The Robinson concept of vibration and shock control is the design and application of 100% all-metal mounting systems. Engineered with careful understanding of the equipment to be protected and performance expected, Robinson mounting systems come to you completely manufactured, ready to receive the electronic equipment or instrument.

The integration of these mounting systems into the electronic equipment of aircraft and missiles results in reduction of elapsed design time and basic development cost.

Robinson Mountings utilize, as main resilient elements, metal wire cushions (MET-L-FLEX), exclusive with Robinson. This construction has been thoroughly proven by years of use in nearly all military and commercial aircraft.

Some other important characteristics of Robinson Mountings: inherent high damping, non-linear spring rate, performance unaffected by grease, oil, water, dust, extreme temperatures or environmental changes.

USE OF ROBINSON ENGINEERED MOUNTING SYSTEMS results in:

- A. Reliable and uniform performance in every installation under all types of environmental conditions.
- B. Reduced cost through "de" ruggedization of equipment — substantial reduction of size and weight is possible by simplified and compact design.
- C. Simplified installation — only four attachment holes required—pre-spaced to save time and assure accuracy.

For full information about this new concept of vibration and shock control, write or wire today.



West Coast Engineering Office:
3006 Wilshire Boulevard, Santa Monica, California

Consider the tinker:

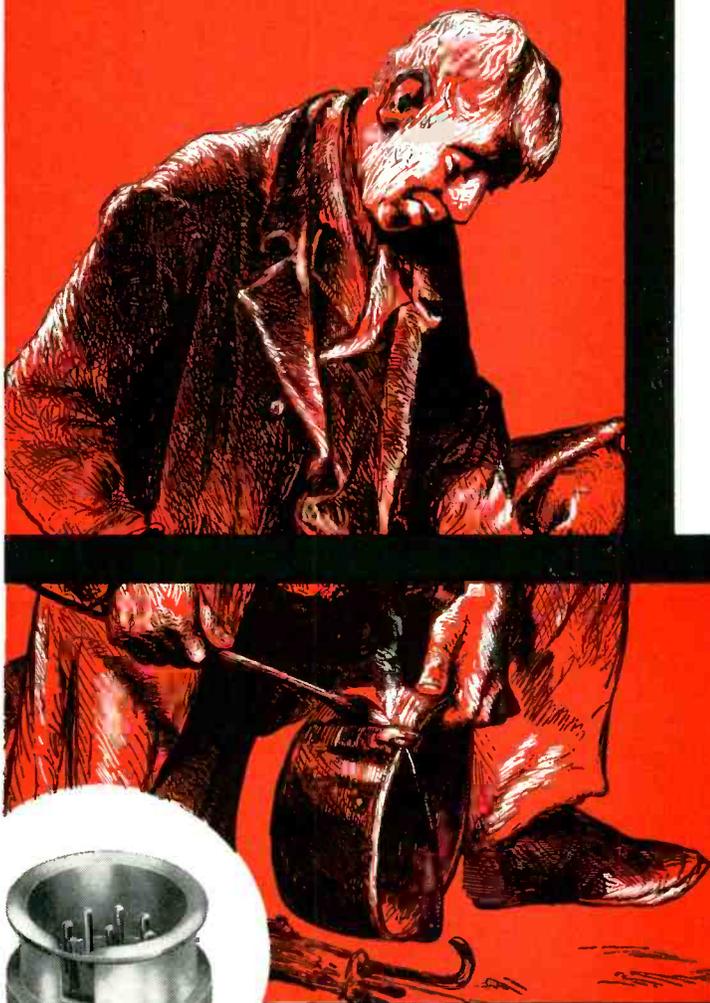
he spread himself too thin...

One early example of the non-specialist was the Traveling Tinker. Unlike the blacksmith, the gunsmith or other engineering-minded specialists of that day, the Tinker did everything. His work was just good enough to last his pioneering customers until someone better equipped came along. Sooner or later someone always did . . . and the Tinker lost his customers. Then he drifted on. Finally progress overtook him completely and we see him no more.

We have seen similar changes in our times too. Before specialized component manufacturers came on the scene a few years ago, leading engineers had to spread themselves pretty thin . . . the designer of complex new equipment had to devise from scratch on the tiniest details. Designing a hermetic seal, say, was part and parcel of developing a sensitive relay. This is no longer so.

Like many in the electronics industry, Hermetic Seal Products Co. has specialized in a particular product and related service. Our concentrated effort has resulted in producing, for other engineers' use, hermetic seals with performance characteristics undreamed of a few years ago. This specialized attention continually brings forth new advances in our products and those of our customers.

Hermetic's specialized engineering of VAC-TITE* and matched glass seals can be applied to your particular problems, too. Why not write today for particular information and for our latest addition to the "Encyclopedia Hermetica"? . . . Sent free when requested on company letterhead.



*Vac-Tite — Hermetic's exclusive glass-to-metal, chemically bonded compression construction. Available on headers and seals from 1-1/2 in. down to .090 in. diameter, and with 1 to 53 terminals.

BETTMANN ARCHIVE

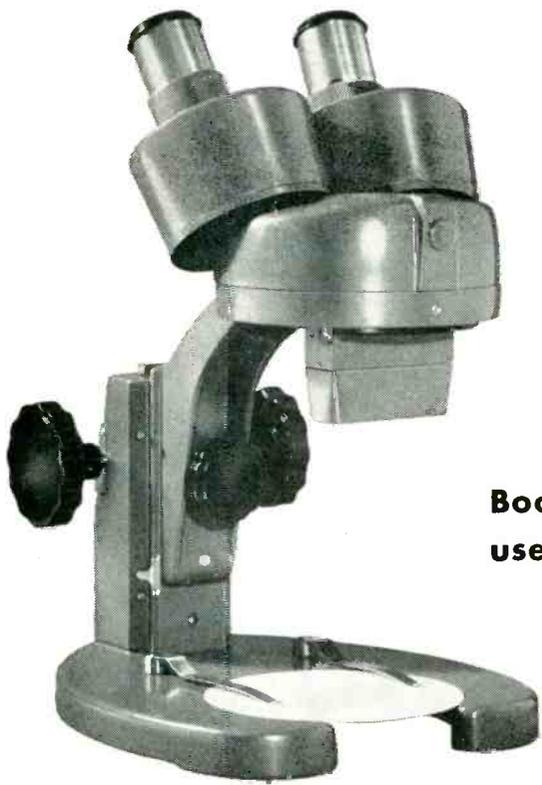


Hermetic Seal Products Company

33 South Sixth Street • Newark 7, New Jersey



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Full **3-D** detail for **FASTER, EASIER ASSEMBLY and INSPECTION**

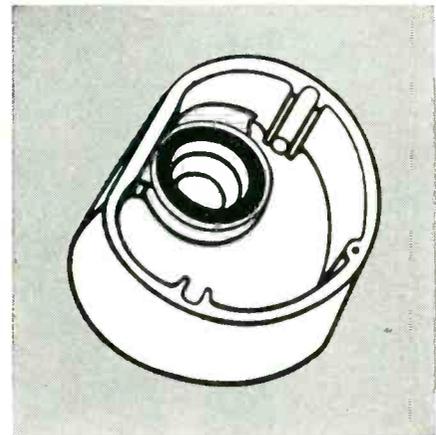
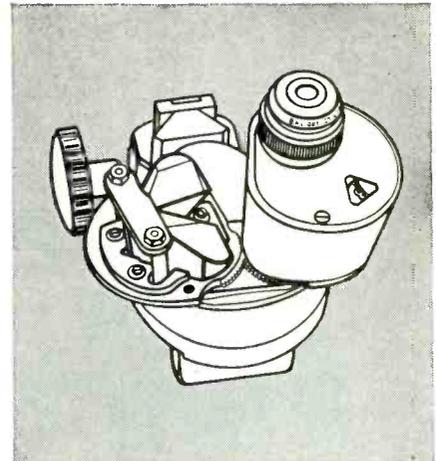
Boost production...save on lifetime trouble-free use...with a Bausch & Lomb Stereomicroscope

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Ready whenever you need it... in the lab, or mounted in machines or fixtures... because prisms *can't* jar loose despite the punishment of year-after-year practical use. Double support locks them into lifelong alignment... clamps at the top, gibs at the bottom.

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WRITE for Catalog D-15 and demonstration. Bausch & Lomb Optical Co., 61437 St. Paul Street, Rochester 2, N. Y.

STEREOMICROSCOPES



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, alkalis, 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.

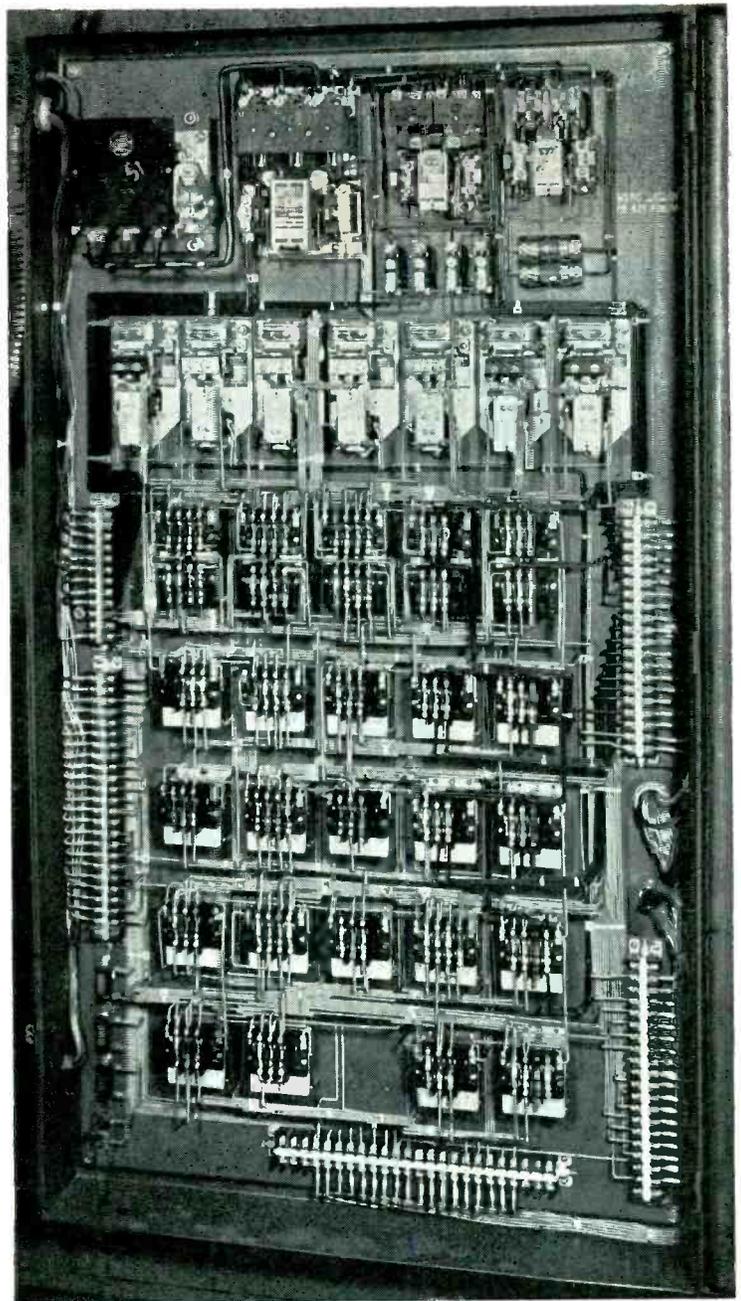
Also, Rome makes Rome Hi-Temp, a rubber insulation with great heat and moisture resistance—UL approved for 75°C. . . . and a full line of special and standard commercial and military hook-up wires.

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.

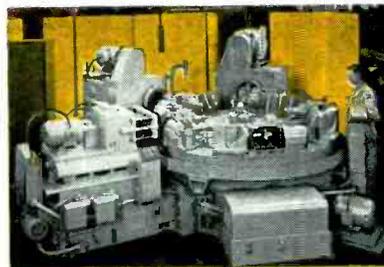
Send for complete data and specifications on Rome Hook-Up Wires, Machine Tool and Control Wires. They're available in special and standard constructions.



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.



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.



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.

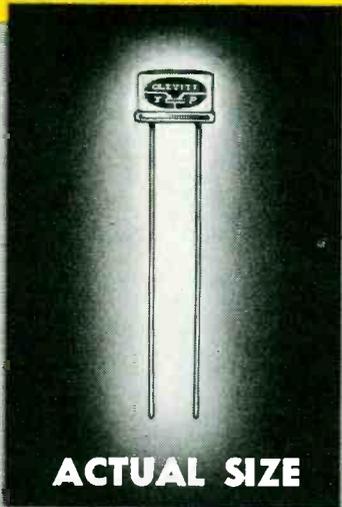
It Costs Less to Buy the Best



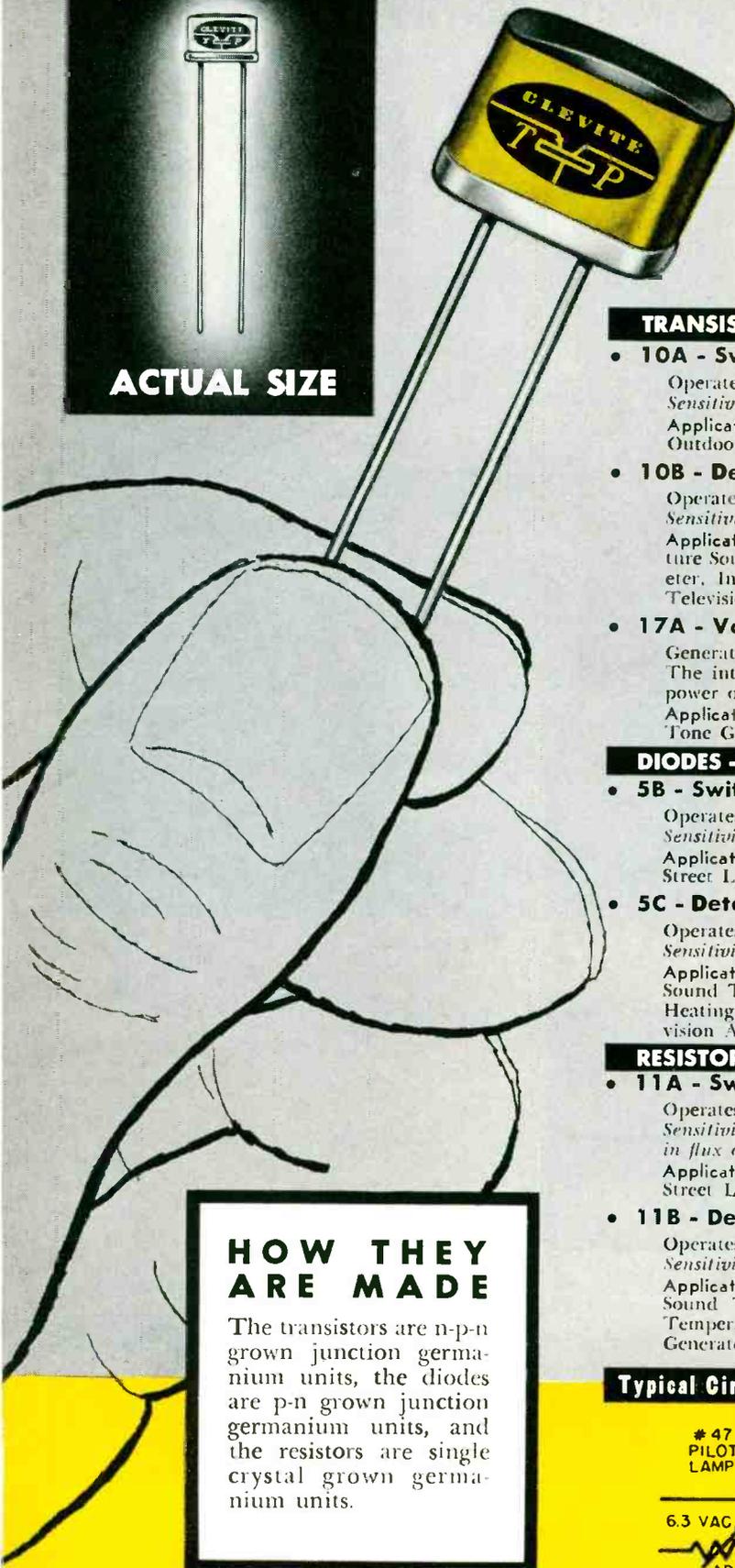
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GERMANIUM PHOTO TRANSISTORS DIODES

Available in



ACTUAL SIZE



HOW THEY ARE MADE

The transistors are n-p-n grown junction germanium units, the diodes are p-n grown junction germanium units, and the resistors are single crystal grown germanium units.

These versatile light sensitive photo cells, characterized by their electrical stability, long life, and low cost, are now available for commercial applications in production quantities. They are grown germanium units designed to operate in the visible and infrared spectrum and are suitable for most photo tube applications. These units can be used to simplify circuits by eliminating vacuum tubes and other equipment. They are made in the following variations:

TRANSISTORS — For Greater Output Signal

- **10A - Switch (FORMERLY X-25A)** — A Constant Current Device
Operates a relay upon exposure to a preset amount of light.
Sensitivity greater than 4 ma. per 300 ft. candles.
Applications — Counting or Sorting Devices, Digital Recording Systems, Outdoor Light Control, Door Openers.
- **10B - Detector (FORMERLY X-25B)** — A Constant Current Device
Operates an amplifier in response to minute changes in light intensity.
Sensitivity 50% change per 10 ft. candles.
Applications — Photo Scanning, Digital Recording Systems, Motion Picture Sound Track Detectors, Street Light Control, Transparency Densitometer, Infrared Photography, Heating Chamber Temperature Regulator, Television Automatic Brightness Control.
- **17A - Voltaic Cell** — A Constant Voltage Device
Generates an electric voltage (up to .15 V. max.) in response to light. The internal resistance decreases above this point thereby increasing the power output.
Applications — Photo Voltaic Source, Street Light Control, Door Opener, Tone Generator, Fire Indicator Safety Device.

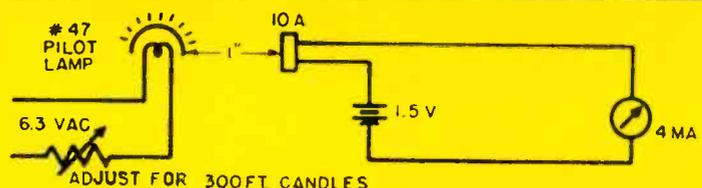
DIODES — A Constant Current Device

- **5B - Switch**
Operates a relay upon exposure to a preset amount of light.
Sensitivity greater than 1 ma. per 300 ft. candles.
Applications — Counting or Sorting Devices, Digital Recording Systems, Street Light Control, Door Openers.
- **5C - Detector**
Operates an amplifier in response to minute changes in light intensity.
Sensitivity 50% change per 40 ft. candles.
Applications — Photo Scanning, Digital Recording Systems, Motion Picture Sound Track Detectors, Street Light Control, Transparency Densitometer, Heating Chamber Temperature Regulator, Infrared Photography, Television Automatic Brightness Control.

RESISTORS — A Variable Current Device

- **11A - Switch**
Operates a relay upon exposure to a preset amount of light.
Sensitivity — Resistance changes from 4000 ohms to 2000 ohms when placed in flux of 300 ft. candles.
Applications — Counting or Sorting Devices, Digital Recording Systems, Street Light Control, Door Openers.
- **11B - Detector**
Operates an amplifier in response to minute changes in light intensity.
Sensitivity 100% change in resistance per 300 ft. candles.
Applications — Photo Scanning, Digital Recording Systems, Motion Picture Sound Track Detectors, Transparency Densitometer, Heating Chamber Temperature Regulator, Television Automatic Brightness Control, Tone Generator, Automatic Automobile Headlight Dimmer.

Typical Circuit to Measure Current Flow in 300 Ft. Candle Flux.



SENSITIVE DEVICES

RESISTORS

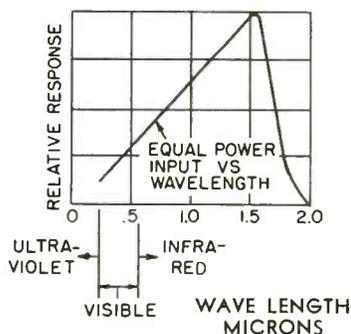
Production Quantities

CHARACTERISTICS

	Photo-Transistor		Photo-Diode		Photo-Resistor	
	10A	10B	5B	5C	11A	11B
Operating Temperature Range	0° +50° C	0° +50° C	0° +50° C	0° +50° C	0° +50° C	0° +50° C
Operating Range	1 - 10 V	1 - 10 V	1 - 10 V	1 - 10 V	1 - 10 V	1 - 10 V
Maximum Operating Voltage	15 Volts	15 Volts	50 Volts	50 Volts	15 Volts	15 Volts
Dark Current	500 micro amp. max.	50 micro amp. approx.	20 micro amp. max.	2 micro amp. approx.	4000 ohms approx.	4000 ohms approx.
Sensitivity	Greater than 4 ma. per 300 ft. candles	50% minimum increase in current per 10 ft. candles	Greater than 1 ma. per 300 ft. candles	50% minimum increase in current per 40 ft. candles	Resistance changes from 4000 to 2000 ohms when placed in flux of 300 ft. candles	100% change in resistance per 300 ft. candles
Operating Current	10 ma.	2 ma.	5 ma.	1 ma.	10 ma.	10 ma.
Maximum Internal Power Dissipation	100 milliwatts	100 milliwatts	100 milliwatts	100 milliwatts	50 milliwatts	50 milliwatts

SPECTRAL RESPONSE

Tungsten, neon or carbon arc light sources are ideal for these units.

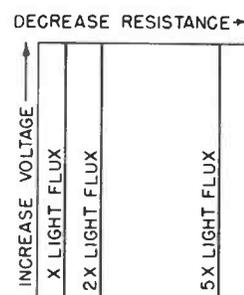
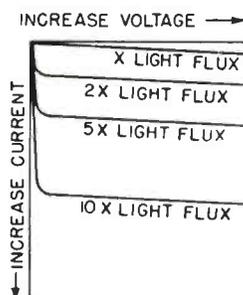
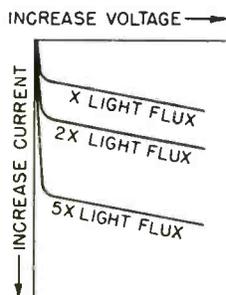


CURRENT VS LIGHT PLOTS

Transistor

Diode

Resistor



The characteristics of these devices have been thoroughly tested and proved in our laboratories for many applications. Consult our engineering staff for further information on these products. We will be happy to send you all our technical bulletins as they are released, if you will send us your name and address today.

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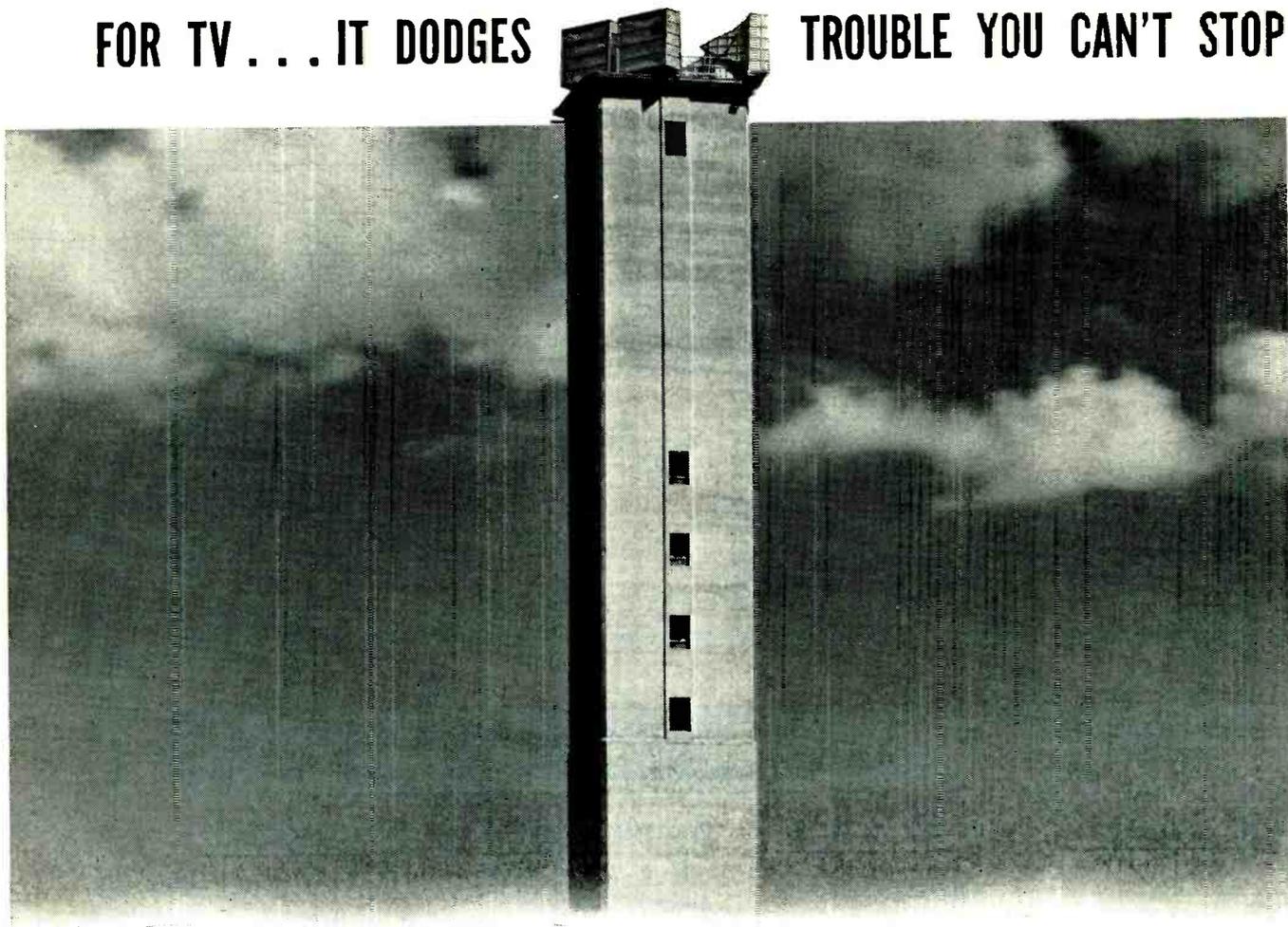


241-257 CRESCENT STREET, WALTHAM 54, MASSACHUSETTS
AN OPERATING UNIT OF CLEVITE CORPORATION

TRANSISTORS • DIODES • SEMI-CONDUCTOR MEASURING EQUIPMENT

FOR TV . . . IT DODGES

TROUBLE YOU CAN'T STOP



Radio Relay station on route between Chicago, Ill., and Des Moines, Iowa. Every fifth or sixth relay-tower is a control station, where high-speed

switching equipment enables a TV picture to skip out of a troubled channel and into a stand-by protection channel faster than the eye can wink.

There's no way to stop atmospheric changes that threaten television with "fade." But, for TV that travels over Bell's Radio Relay System, Bell Laboratories engineers have devised a way to sidestep Nature's interference.

When a fade threatens—usually before the viewer is aware—an electronic watchman sends a warning signal back by wire to a control station perhaps 200 miles away. An automatic switching mechanism promptly transfers the picture to a

clear channel. The entire operation takes 1/500 of a second. When the fade ends, the picture is switched back to the original channel.

This is an important addition to the automatic alarm and maintenance system that guards Bell's Long Distance network for television and telephone calls. It marks a new advance in Bell Laboratories' microwave art, developed to make your Long Distance telephone service, and your TV pictures, better each year.

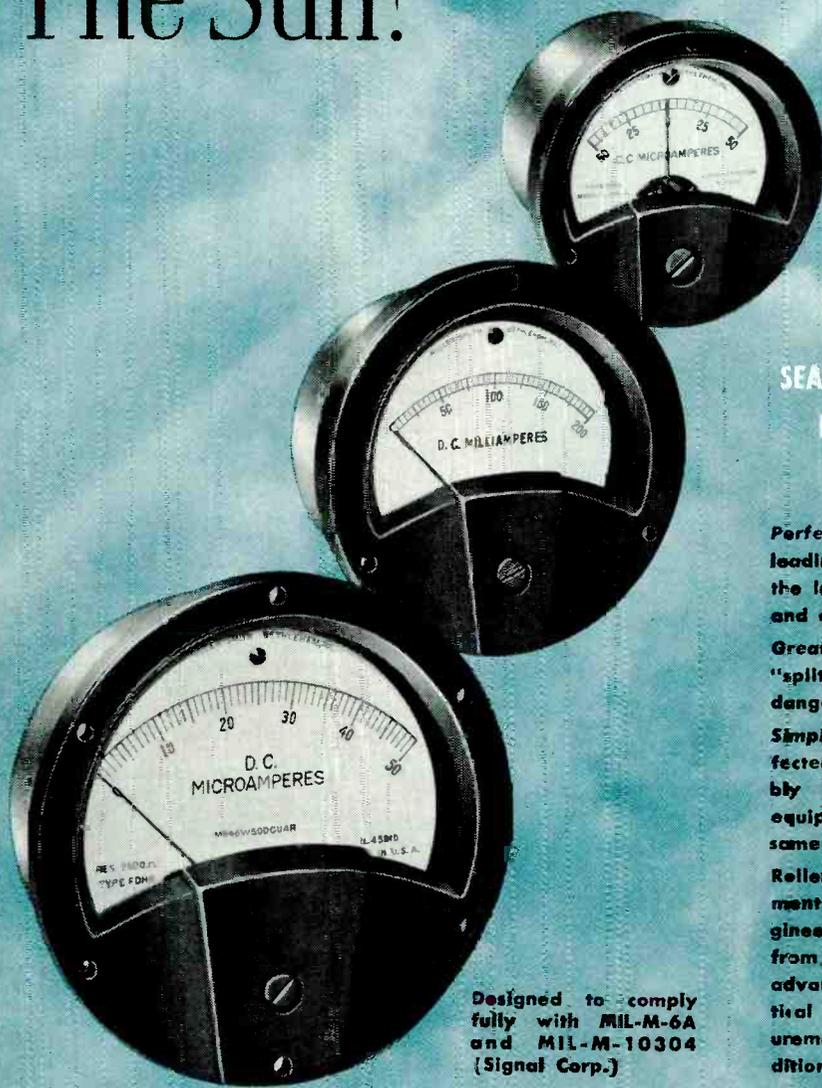
BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.



Want more information? Use post card on last page.

Something New Under The Sun!



SEALED—RUGGEDIZED INSTRUMENTS BY ROLLER-SMITH HAVE THAT “NEW LOOK” FOR

Perfect Readability: New shrouds designed by leading industrial designers focus attention to the large dial, assuring “one look” readability and enhanced appearance.

Greater Accuracy: New zero adjuster permits “split-second” adjustment from the front. No danger of leaks.

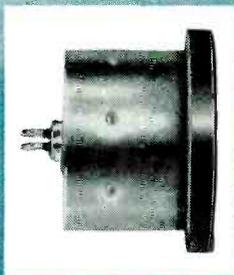
Simplified Maintenance: New gasket seal perfected by Roller-Smith permits easy disassembly for service—NO expensive soldering equipment—NO wasted glass—you use the same glass over and over. Costs are reduced.

Roller-Smith sealed and ruggedized instruments feature these three outstanding engineering and design improvements in all sizes from 1½ to 4½ inches to make them the most advanced on the market. Available in all practical ranges of AC and DC for accurate measurements under extreme environmental conditions.

Consult our engineering staff with over 50 years experience to solve your specific research and development problems.

Designed to comply fully with MIL-M-6A and MIL-M-10304 (Signal Corp.)

An extra feature—new “wrap around” shroud with gasket seal makes these meters as modern in appearance as they are in performance. Precisely built, their neat functional form expresses the forward thinking of our engineers.



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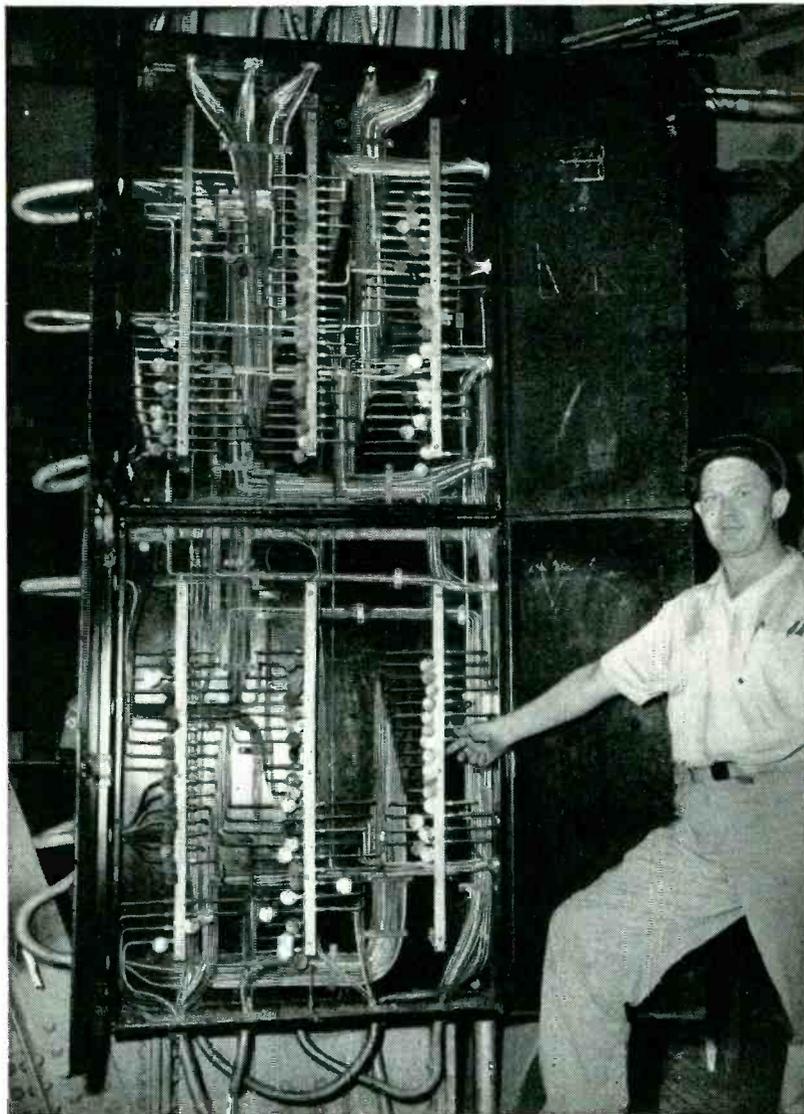
Instrument Division

1925 WEST MARKET STREET BETHLEHEM, PENNSYLVANIA
Precision Products Since 1908

See these and other outstanding Roller-Smith products featuring the “new-look” at Booth 702 I. R. E. Show, Kingsbridge Armory, New York City, March 21-24, 1955.

FOR INSTRUMENTATION AND CONTROL

Cabled Tube



Control Junction Box at Power Station of Long Island Lighting Company, showing use of Crescent Armored Multitube. Note that relatively sharp bends can be made without damage to the cabled copper tube. 

Construction of Crescent Armored Multitube. 



Some time ago Revere ran an advertisement featuring Crescent Armored Multitube for use in pneumatic and hydraulic instrumentation and control systems. The advertisement created so much interest that we thought you might like to see a photograph of an actual installation. The Control Board Junction Box shown here has 22 runs of Multitube coming into this box comprising 224 Revere Copper Tubes of 1/4" O.D. The picture was taken in the Glenwood Landing, N.Y. Power Station of the Long Island Lighting Company. The tubes go to instruments that report information on temperature, main and reheat steam pressure, boiler feed and condensate pump pressure, fuel oil and gas pressure, liquid levels, tide level and for the control of fuel feed, draft dampers, boiler drum water level and various control valves.

This is a relatively new use for Revere Copper Tube, but it is an important one in these days when new ways are being found to obtain process information more quickly and accurately, or to achieve automatic control. Crescent Armored Multitube is made by Crescent Insulated Wire & Cable Co., Inc., Trenton 5, N.J., in lengths up to 1,000 feet. It consists of a group of long tubes twisted together in cable form, protected by a flexible interlocked galvanized steel armor, or by plastic, or both. As many as 19 tubes, 1/4" O.D., can be cabled, with one tube in each layer color-coded. Larger tubes can also be cabled, including 5/16", 3/8" and 1/2". This construction affords protection during shipment, installation and use, and speeds up installation greatly. For further information, write Crescent, and for tube in copper and aluminum, see the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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

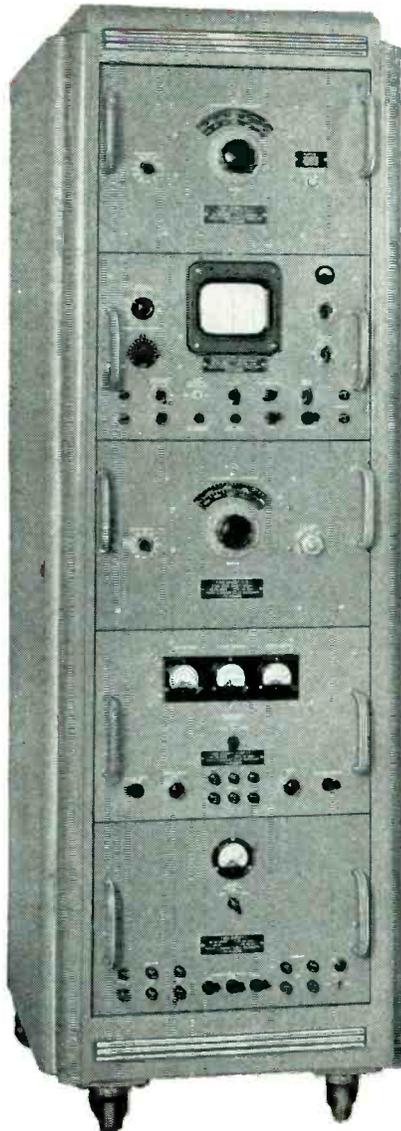
**The Only
All Band**

**10 mc
to
33,000 mc**

**Direct Reading
Single Control**

SPECTRUM ANALYZER

Model LSA



The Model LSA provides direct means of rapid, accurate measurement of spectral display of r. f. signals from 10 to 33,000 MCS

Saves Engineering Manhours

The Model LSA Spectrum Analyzer is Polarad's answer to rising engineering costs when high performance and economy are essential.

This unique engineering tool helps get results faster with fewer personnel and in less space. Because of its ultra simplicity, tremendous frequency coverage and remarkable instrumentation the Model LSA can handle almost any problem in the radio spectrum (10 mc to 33,000 mc) with the greatest of ease, reliability and accuracy.

How The Model LSA Cuts Production Costs

In the factory, Model LSA's simplicity of operation, direct reading and "GO-NO-GO" electronic display speeds production and cuts costs. Uniform quality and high performance of your complete equipment is assured by checking it with a Polarad Spectrum Analyzer.

Expensive personnel training programs are eliminated by the Model LSA, which often actually takes the place of the microwave specialist and frees engineers for other work. For further details contact your nearest Polarad representative or write direct to us.

FEATURES:

Frequency Range 10 mc-33,000 mc; 5 tuning heads
Accuracy Frequency
Calibration—1%
Spectrum Display variable from 250 kc to 25 mc
Frequency Marker for measuring frequency differences of 0-25 mc
Broad Band R.F. Attenuators 10 mc-12,000 mc
Automatic Voltage selector for each tuning head
Single Dial Control
Direct Frequency Reading
Spectrum Displayed on 5" cathode ray tube

USES:

Examine pulse spectrum of magnetrons and klystrons
Measure noise and interference spectrum
Act as broad band receiver from 10 mc to 33,000 mc
Observe and measure harmonic frequency differences
Measure band width of microwave cavities
Calibrate microwave oscillators and preselectors

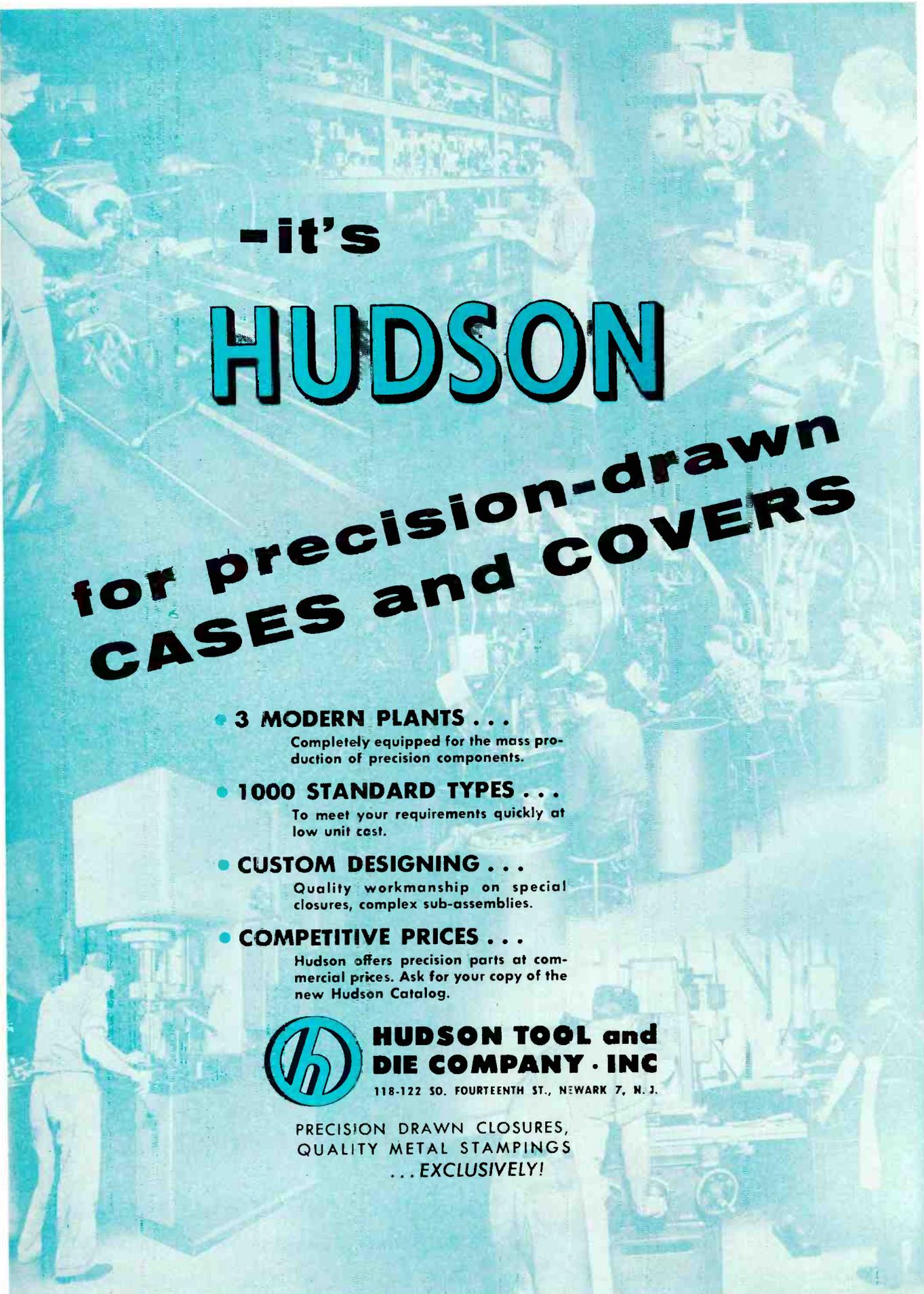


Available on Equipment Rental Plan

Polarad Electronics Corporation

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

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HUDSON

**for precision-drawn
CASES and COVERS**

● **3 MODERN PLANTS . . .**

Completely equipped for the mass production of precision components.

● **1000 STANDARD TYPES . . .**

To meet your requirements quickly at low unit cost.

● **CUSTOM DESIGNING . . .**

Quality workmanship on special closures, complex sub-assemblies.

● **COMPETITIVE PRICES . . .**

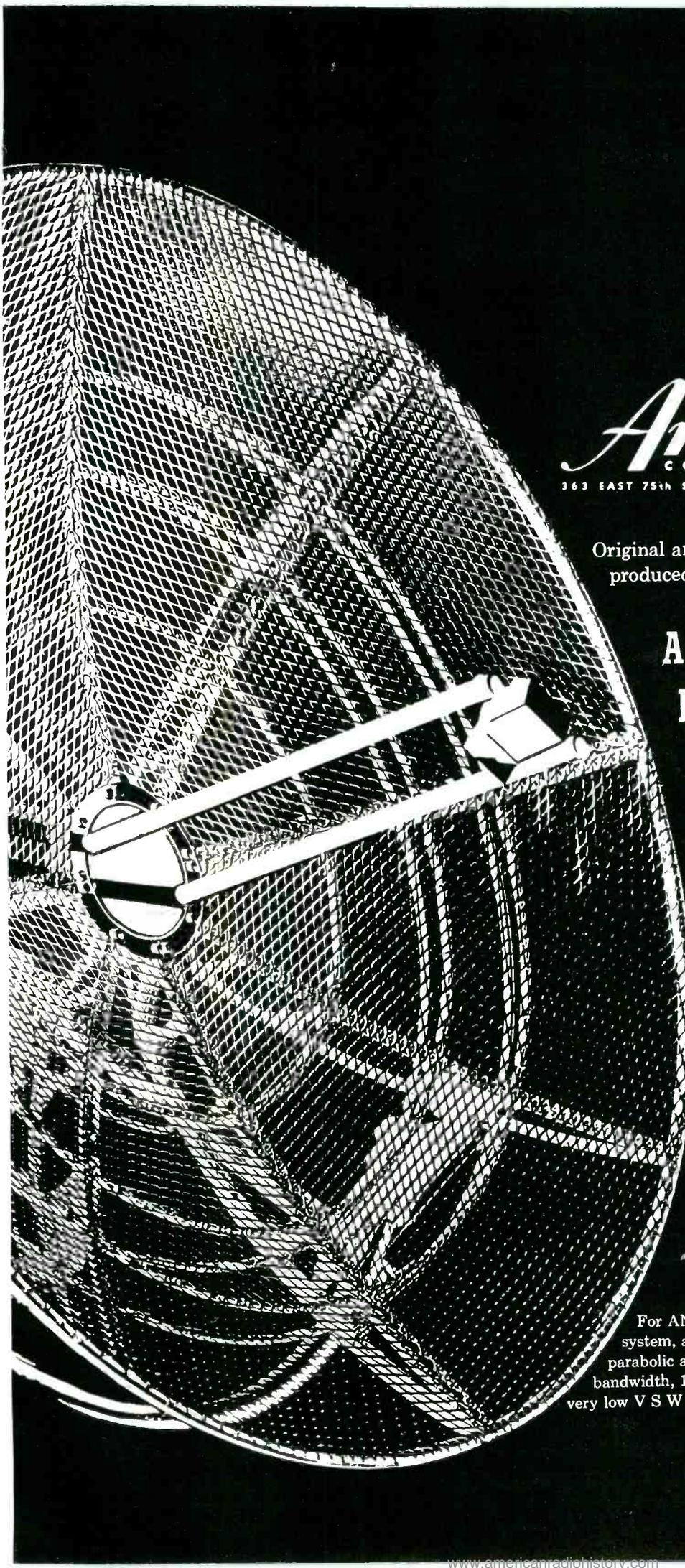
Hudson offers precision parts at commercial prices. Ask for your copy of the new Hudson Catalog.



**HUDSON TOOL and
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PRECISION DRAWN CLOSURES,
QUALITY METAL STAMPINGS
... EXCLUSIVELY!



Andrew
CORPORATION

363 EAST 75th STREET · CHICAGO 19

Original antenna system specially
produced for the Military

A MAJOR ANDREW ENGINEERING- PRODUCTION ACHIEVEMENT.

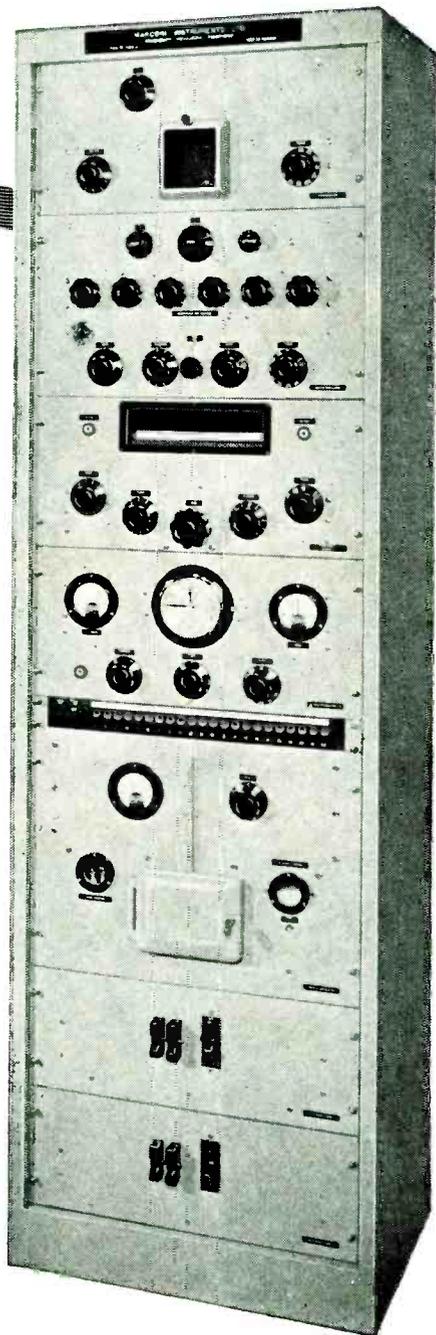
Only one of many proofs-in-use
that Andrew is thoroughly qualified
to take on your major *antenna*
design-production projects.

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manufacture of complete antenna
systems for communications
including Andrew designed and
produced flexible and semi-flexible
coaxial cables and rigid
transmission lines.



For AN/TRC-29 Military Microwave
system, an 8' aluminum mesh
parabolic antenna, unique for its
bandwidth, 1700-2400 MC,
very low V S W R.

**“READ FREQUENCY TO 1 PART IN 10^7 directly
from the stroboscope”**



SIMPLE TO USE—direct reading to nearest cycle per second.

ACCURATE—1 part in 10^7 (3.15 seconds per year).

RELIABLE—Marconi makes it.

FREQUENCY RANGE—1 ke to 30 mc.

NO CALCULATIONS — NO INTERPOLATION

DIRECT READING to nearest cycle per sec:

This is the achievement of MARCONI in the

PRECISION FREQUENCY MEASURING EQUIPMENT—type TME 2.

Designed to be the best of its kind in the world, the TME 2 combines extreme accuracy with ease of operation previously unknown in its field.

F is locked to sub-harmonics of the master crystal down to the nearest 100 cps by means of 6 decade dials which directly indicate frequency. The nearest 10 cps and 1 cps are read directly from the photo-electric strobe unit. A further two figures (0.1 cps and 0.01 cps) can be obtained, if necessary, by counting strobe transits against 10 sec and 100 sec timing pips which are also locked to the master crystal. A non-technical operator can make a measurement to 8 significant figures in about 40 seconds.

Here is a Precision Frequency Standard which handles like Production Test Gear.

Let us mail you full details:—

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WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

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ENGLAND: HEAD OFFICE: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE

CANADA: CANADIAN MARCONI COMPANY, MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL

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

POWER in a pillbox



EAD's new *miniaturized* *1/8 inch* *servo-gear* *motor*

For high output torque in a miniature package EAD's tiny servo-gear motor has been designed for applications where size and weight are at a premium.

The various RPM and torque combinations are transmitted through precision cut gears mounted in miniature precision ball bearings.

For instant response and maximum torque in a tiny package this gear motor is well adapted for missiles, auto pilots, instrumentation and control devices.

Modifications are available in hysteresis - synchronous and induction designs.

EAD specializes in adapting its designs to meet unusual applications... Tell us your requirement.

Write for our new catalog today!

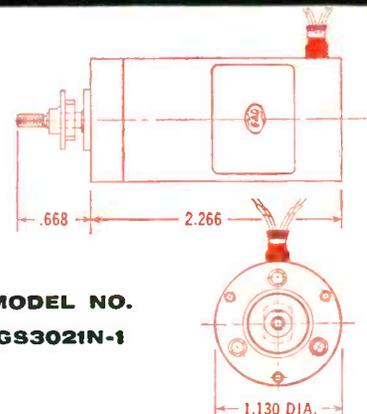


EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



387 CENTRAL AVENUE, DOVER, NEW HAMPSHIRE



MODEL NO.
GS3021N-1

CHARACTERISTICS

Input Voltage	115	Stall Torque	7 oz. in.
Phase	2	Rated Torque	3 oz. in.
Frequency	400 cycles	Size	1 1/8" dia.
No Load Speed	180 rpm		2 17/64" long
Full Load Speed	135 rpm	Gear Reduction	28.4
Rotor Inertia	1.25 gm. cm ²	Weight	4 1/2 oz.
		Duty	Continuous

FOR MEN OF VISION . . .

TOMORROW'S GYRO

A New **H**ermetically-sealed
Integrating
Gyro

the first **10³** in production

by **Greenleaf**



ACTUAL SIZE

TODAY!

Now in production . . . the world's smallest and lightest Hermetically-sealed Integrating Gyro . . . Greenleaf's new 10³! It requires less power. Size and weight are drastically reduced . . . in fact, a complete 3-axis control can now be made so small you can cover it with your hat.

The new 10³ has undergone extensive and rigorous testing in our laboratories and is now in production. Also in production is the Greenleaf 10⁴ gyro, product of the same skill and ingenuity that went into the making of the new 10³. Please write us on your letterhead and we will be happy to send you information and performance data on either or both.

Prepared By: E.S. THE GREENLEAF MFG. COMPANY Page 2 of 12
Checked by: J.A.V. Aircraft Division Model 10³
Date: 8-6-54 ST. LOUIS, MISSOURI Report

Engineering Report

10³ INTEGRATING GYRO
SPECIFICATIONS
SECTION I
GYROSCOPIC ELEMENT

1. Outline Dimensions
Diameter 1 inch
Length 2 1/32 Inches (less connections)
2. Weight
4 1/2 ounces (maximum)
3. Angular Velocity Range
± 1 Radian/second
4. Power Consumption
Spin Motor 0.5 watts (maximum)
5. Gimbal Deflection
± 6° (Maximum)
6. Drift Rate
Less than 0.5 milliradian/second
a. Mass unbalance 0.5 milliradian/second, per G maximum
7. Operating Temperature
200° Fahrenheit

Engineering Report

Where quality control works on the production line . . . producing Gyros (rate and integrating), Pressure Transmitters, Accelerometers, Synchros, Air Speed Indicators, Actuators, and many other precision-built components.

ENGINEERING • DEVELOPMENT • PRODUCTION

THE *Greenleaf* MANUFACTURING CO.

7814 Maplewood Industrial Court • Saint Louis 17, Missouri

GRE-11

for
**HEARING
AIDS**



or
**RECORDING
HEADS**



or ANY MAGNETIC MATERIALS JOB ...

Write for
your Copy

**"MAGNETIC
MATERIALS"**

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

ADDRESS DEPT. E-61

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-permea-

bility 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

Tubeless Magnetic Amplifier DC Supplies



Here
are prices for
the
Latest
additions
to the
SORENSEN
line!

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

MODEL MA640 (illustrated above)

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

\$365.00

MODEL MA65

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

\$165.00

SPECIAL UNITS

Sorensen is engaged in a heavy program of research and development leading to continuous expansion of its standard line of Magnetic Amplifier DC Supplies. It is accordingly in a favorable position to develop special magnetic amplifier supplies for use in computer systems or other products requiring the utmost in reliability. If you have special requirements along these lines you will benefit by taking advantage of Sorensen's experience in this power field. Write or call the Applications Engineering Department, and your problems will receive prompt attention.

MODEL MA2850

Input 190-230, 3 ϕ , 4-wire wye, 60 ν
Output 23 - 32 VDC, adjustable
Load Range 0-50 amperes
Ripple 3% maximum
Regulation Accuracy $\pm 1.0\%$ for any combination of line and load conditions
Recovery Time 0.5 seconds under worst conditions
Size 16 $\frac{3}{4}$ " wide, 28 $\frac{3}{4}$ " high, 15" deep. Unit is self contained and mounted on casters. Meters are standard with this unit.

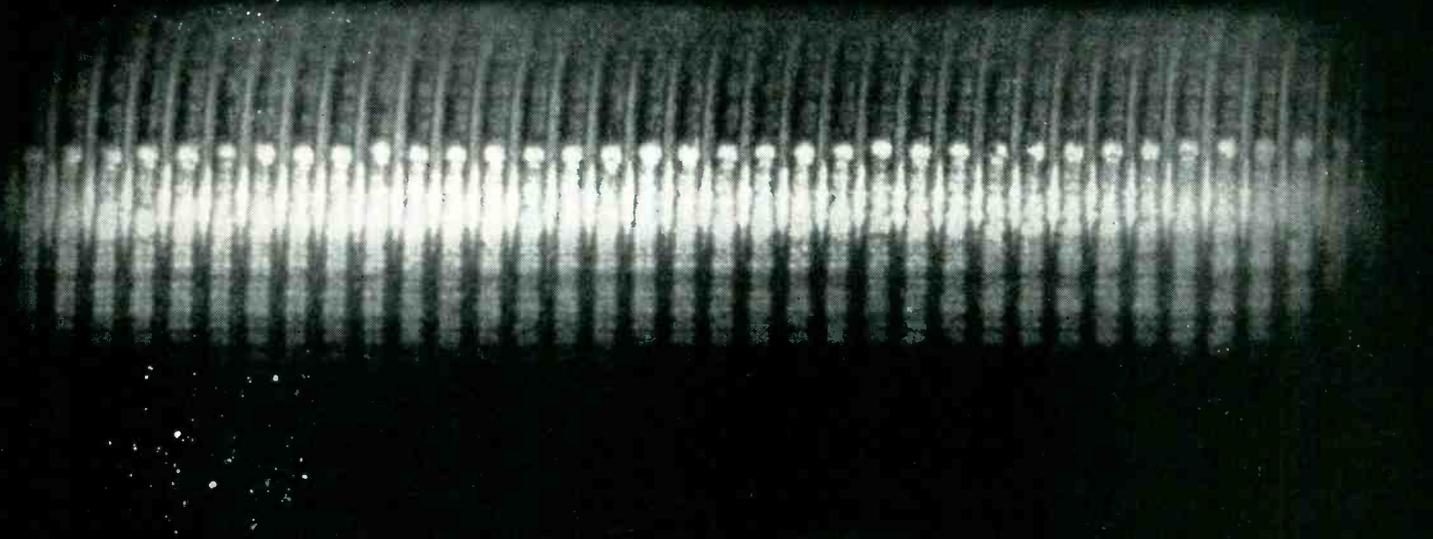
\$985.00

WRITE FOR MORE DATA

For further information about the Sorensen line of tubeless magnetic DC supplies, and for your copy of the latest Sorensen catalog, write Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, address inquiries to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

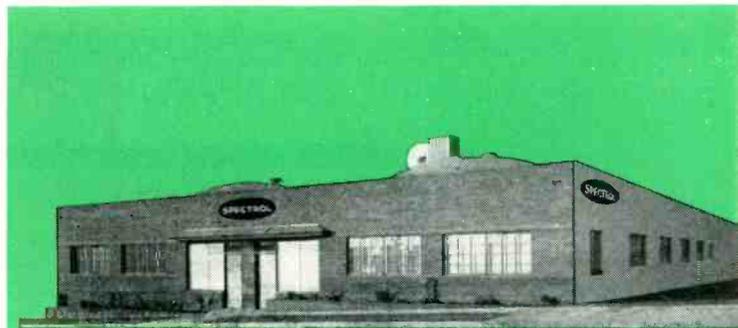


Photomicrograph highly magnified of this actual section of a Spectrol coil.

ARE YOU GETTING THIS PRECISION WINDING IN YOUR POTENTIOMETERS?

This unretouched actual photomicrograph of an average Spectrol coil section using .001 wire with .001 spacing dramatically illustrates the high precision winding you always receive in Spectrol potentiometers. Spectrol manufactures only high precision potentiometers, in both stock and custom models, carefully tested for accuracy and exacting specification.

The heart of your potentiometer is the winding; make sure you are receiving only the finest by using Spectrol precision potentiometers.



New modern Spectrol plant with complete facilities for the manufacture of precision potentiometers. Staffed with personnel having years of experience in the electronics field.

SPECTROL DIVISION

AFFILIATED GAS EQUIPMENT INC.

1704 South Del Mar, San Gabriel, Calif.

Write, wire or phone for complete information on the full range of Spectrol precision potentiometers or request our service representative in your area to call and assist you.

SPECIFICATIONS
(Common to Models "200" & "400")

Standard Linearity Tolerance	±.3%**
Voltage Breakdown	1000 V RMS
Maximum Number of Sections	15
Life Expectancy	1,000,000 cycles

MODEL "200"

Standard Resistance Range & Tolerance	5Ω to 75KΩ ± 3%*
Power Rating	2.5 watts
Electrical Rotation & Tolerance	353° Min.
Maximum Number of Taps	23
Weight per Section	Single = 2.36 oz., 1.12 oz. ea. additional sect.
Moment of Inertia	2.2 GM. CM ²
Starting Torque	1.5 oz./in. Max. (single sect.)
Running Torque	.8 oz./in. Max. (single sect.)

MODEL "400"

Standard Resistance Range & Tolerance	100Ω to 100KΩ ± 3%*
Power Rating	5 watts
Electrical Rotation & Tolerance	357° Min.
Maximum Number of Taps	35
Weight per Section	Single = 5.6 oz., 2.00 oz. ea. additional sect.
Moment of Inertia	30.0 GM. CM ²
Starting Torque	1.65 oz./in. Max. (single sect.)
Running Torque	1.20 oz./in. Max. (single sect.)

Special resistance tolerance as low as ±½%

* Special linearity tolerances on request

Years of experience are represented by these clean, compact instruments which were conceived to give a fine degree of long and reliable performance under varying conditions. Spectrol's rugged all aluminum constructed case and lid has a distinct advantage in its ability to dissipate high heat and maintain the maximum stability of the resistance element. The Spectrol high temperature terminals are completely insulated from the case by an assembly capable of withstanding 1000 volt breakdown and 250° Centigrade heat. Spectrol's consistent accuracy of close linearity and resistance tolerances is guaranteed by the new precise winding and testing equipment used in their manufacture.

GANGED ASSEMBLIES:

Spectrol models "200" and "400" may be ganged at the factory with 2 to 15 sections with any variety of resistance and phasing desired.

SHAFT EXTENSIONS:

When specified front and rear shaft extensions of any length may be ordered.

MULTIPLE TAPS:

As many as 23 or 35 taps may

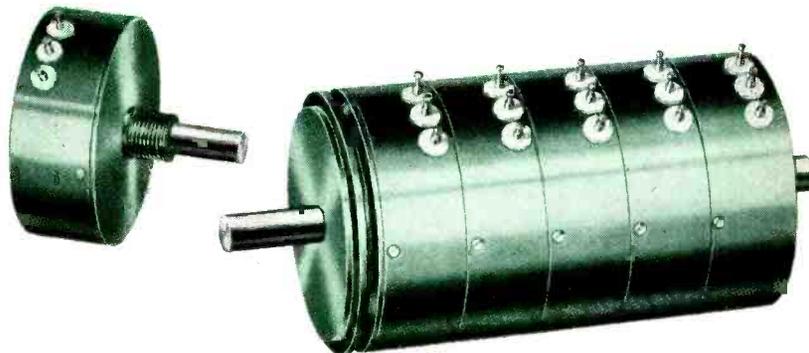
be added to Models "200" and "400," respectively. These taps may be located to nearly any specified location on the coil.

BEARING CONSTRUCTION:

Oilite bearings are furnished in the standard models. Ball bearings are optional when specified.

LID CONSTRUCTION:

Servo lids and threaded bushing type lid are standard. Special lid of your design when ordered.



THE SPECTROL MODEL "400" is a precision 3" dia. single turn potentiometer, with the above specifications and features.

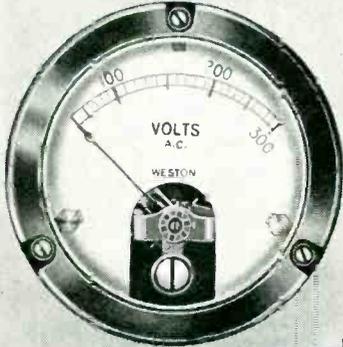
THE SPECTROL MODEL "200" is a precision 1¾" dia. single turn potentiometer, with the above specifications and features.

Manufacturers of a Complete Range of Single Turn Precision Potentiometers



1 1/2"

APPROVED



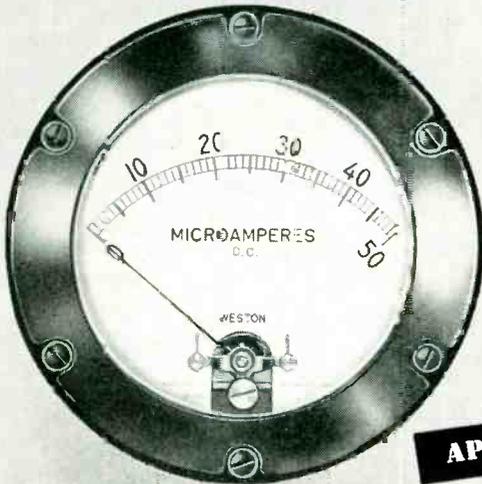
2 1/2"

APPROVED



3 1/2"

APPROVED



4 1/2"

APPROVED

APPROVED
- in all sizes

WESTON
Ruggedized
PANEL
INSTRUMENTS
(A-C • D-C • RF • THERMO)

Available in *all* standard panel instrument sizes, equipment designers now can specify ruggedized meters in the exact size required for any built-in equipment need. For complete information on WESTON Ruggedized Panel Instruments, including types and ranges available, communicate with the Weston representative in your vicinity, or write direct to . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

WESTON INSTRUMENTS

HERE'S IMPORTANT NEWS!

PESCO "COORDINATED-FRAME" MOTORS PROVIDE MAXIMUM POWER WITH MINIMUM WEIGHT AND SPACE

For AC or DC motors that pack *dependable* power into a small space—Contact Pesco!

Whether your problem is one of space, or of weight, you will find that Pesco "coordinated-frame" motors will give you the one BEST answer to your specific problem.

To begin with you can rely on Pesco motors to deliver dependable maximum rated power—from the smallest and lightest practical unit! And Pesco can meet your installation and operating requirements *exactly* by custom building your motor from standardized parts—using any of a series of coordinated frame sizes. This will provide lower unit cost and greatly simplify the problem of stocking service parts.

Pesco engineers will be glad to show you the great advantages that Pesco "coordinated-frame" motors will bring to your product—in installation, in operation, and in servicing. Simply call or write the Home Office, Bedford, Ohio.



PESCO AC OR DC ELECTRIC MOTORS

Various types are available to fit any specific requirement, combining all advantages of custom design with standard parts. AC Induction: 1 or 3 phase, 400 cycle at various voltages, .01 to 9.0 hp. DC Series, Shunt or Compound: 6 to 120 volts, .01 to 11.0 hp at various speeds—all types of enclosures, continuous or intermittent duty.

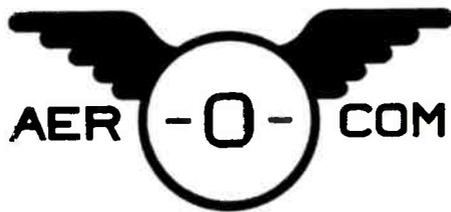


Call or write the Home Office, Bedford, Ohio for full information on these outstanding PESCO products.



PRODUCING THE BEST IN HYDRAULIC EQUIPMENT AND ELECTRIC MOTORS

BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO



DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon

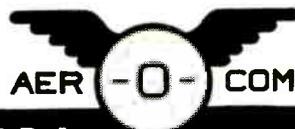
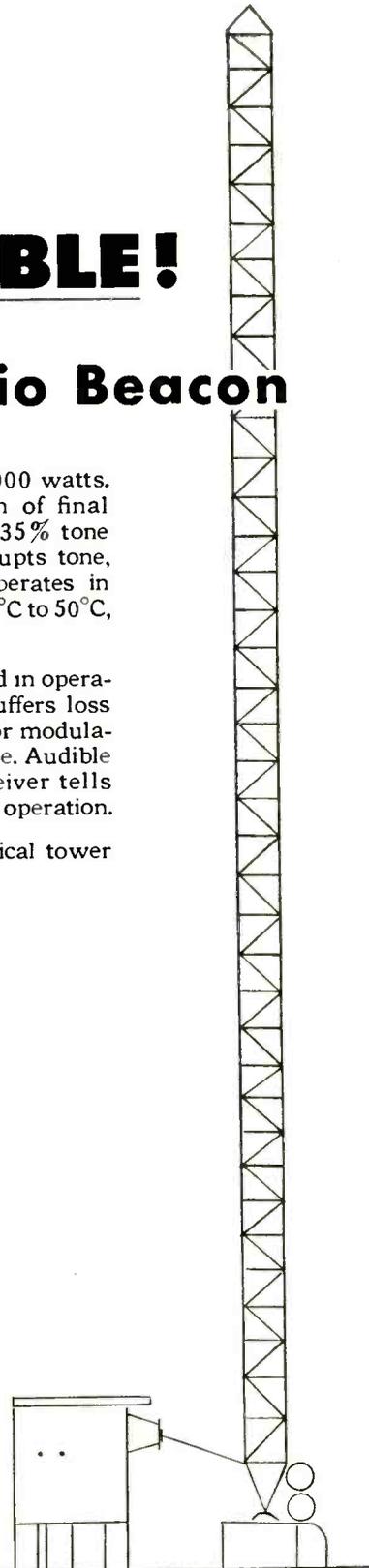
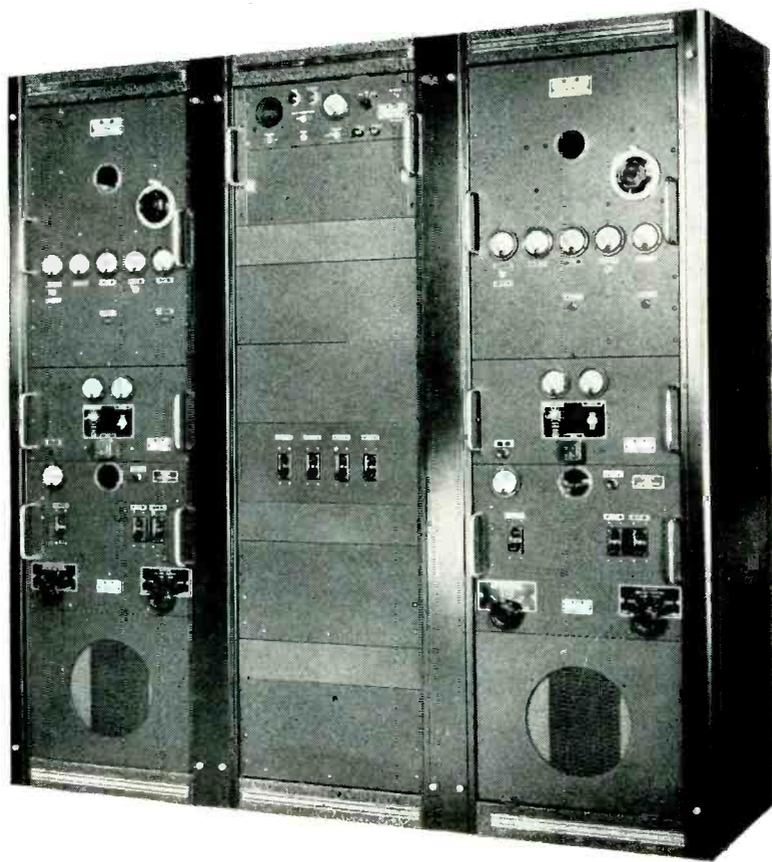
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.

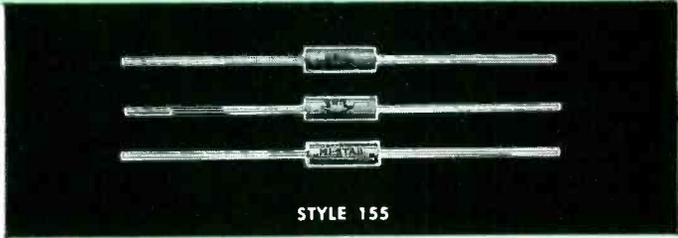


A-101

3090 S. W. 37th AVENUE • MIAMI, FLORIDA

COLOR TV demands

... exacting quality in capacitors and resistors

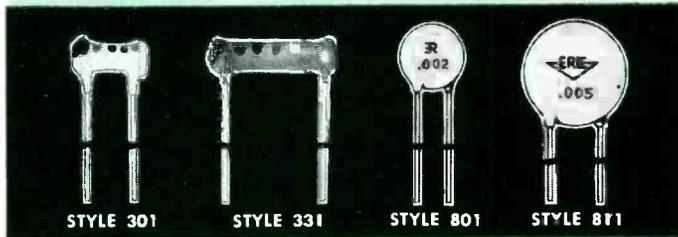
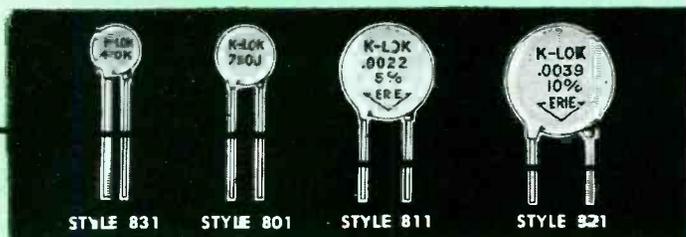


ERIE High Voltage Capacitors
Erie offers a wide selection of disc and molded type ceramicons for high voltage service up to 30 KV.

ERIE "Hi-Stab" Deposited Carbon Resistors
The Style 155 Pyrolytic resistor fulfills a long standing need for an extremely stable, moderately priced, molded insulated 1/2 watt resistor. Available from 100 ohms to 1/2 megohm in tolerances as close as $\pm 1\%$.



dependable electronic components



ERIE "K-LOK" High-stability Disc Ceramicons
Values up to .0047 mfd at 500 volts are available in tolerances as close as $\pm 5\%$. Capacity variations with temperature, age, and voltage are exceptionally small. A truly premium capacitor.

ERIE By-Pass and Compensating Ceramicons
To meet the exacting temperature compensation and by-pass requirements of color circuitry. Compensating units available from .75 to 1380 mmf. "Hi-K" by-pass units available from 100 mmf. to .01 mfd.



ERIE Trimmer Capacitors
The largest and most versatile family of plastic and temperature compensating ceramic trimmer capacitors are available from Erie, to meet difficult tuner and converter requirements.

ERIE Stand-off and Feed-thru Ceramicons
Manufactured in values up to 1500 mmf. to overcome radiation and critical by-passing problems.

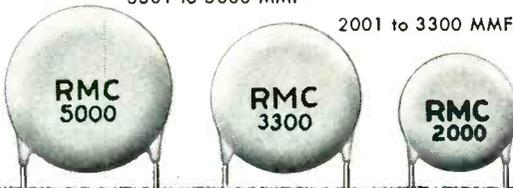


ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION
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Ashland, Ohio • Fort Wayne, Ind. • Los Angeles, Calif. • Toronto, Ontario
Manufacturing Subsidiaries:
HOLLY SPRINGS, MISS. • LONDON, ENGLAND • TRENTON, ONTARIO

3301 to 5000 MMF

2001 to 3300 MMF

1501 to 2000 MMF



extended temperature range

Close TOLERANCE

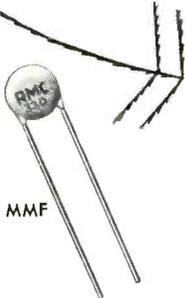
Type JL RMC DISCAPS®

Type JL DISCAPS have a very small capacity variation over an extended temperature range. The maximum capacity change between -60°C and $+110^{\circ}\text{C}$ is only $\pm 7.5\%$ of capacity value at 25°C . With a standard working voltage of 1000 V. D. C., they are manufactured in capacities between 220 MMF and 5000 MMF.

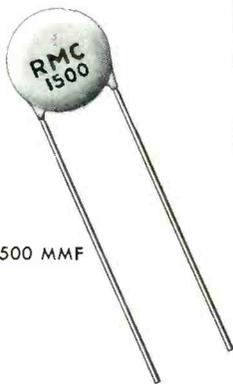
Offering the advantages of longer life, dependability, and lower initial cost, their smaller size and greater mechanical strength provide additional economies in assembly line operations.

Specify Type JL DISCAPS as the cost-saving replacement for paper or general purpose mica capacitors.

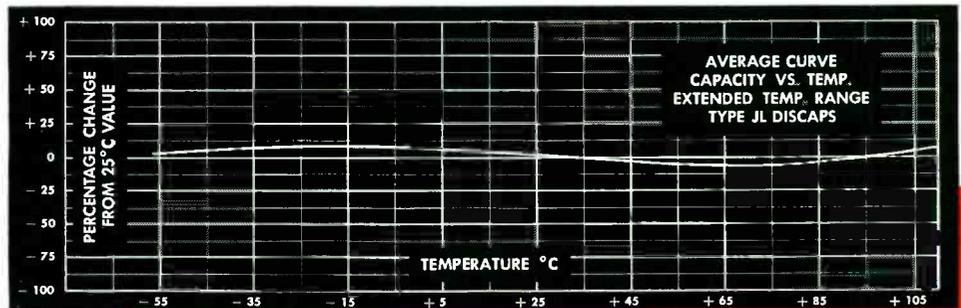
220 to 330 MMF



801 to 1500 MMF



331 to 800 MMF



POWER FACTOR: 1% max. @ 1 K C (initial)
 POWER FACTOR: 2.5% max. @ 1 K C, after humidity
 WORKING VOLTAGE: 1000 V.D.C.
 TEST VOLTAGE (FLASH): 2000 V.D.C.
 LEADS: No. 22 tinned copper (.026 dia.)
 INSULATION: Durez phenolic—vacuum waxed
 INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
 AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
 CAPACITY TOLERANCE: $\pm 10\%$ $\pm 20\%$ at 25°C

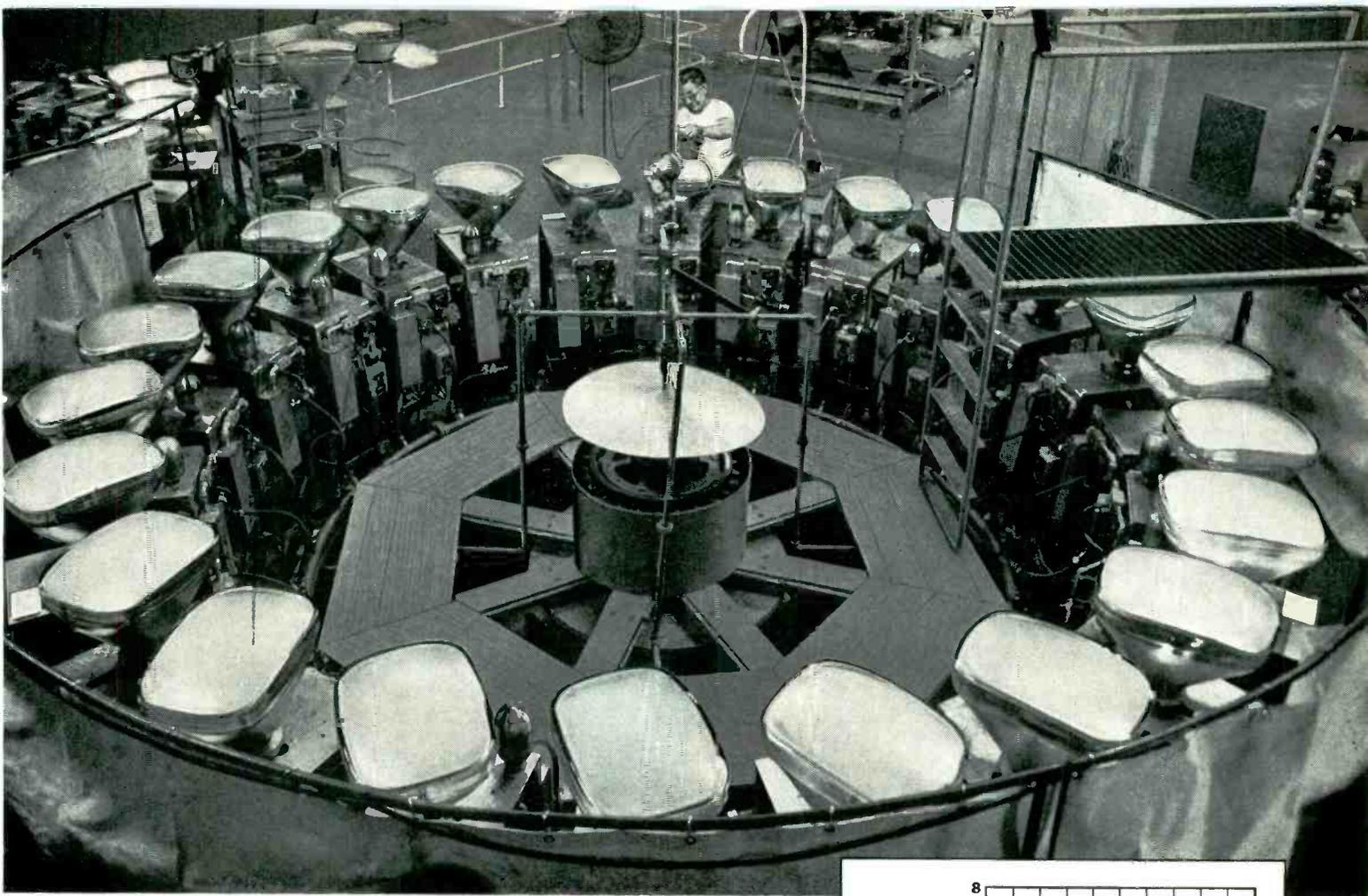
DISCAP CERAMIC CAPACITORS



RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

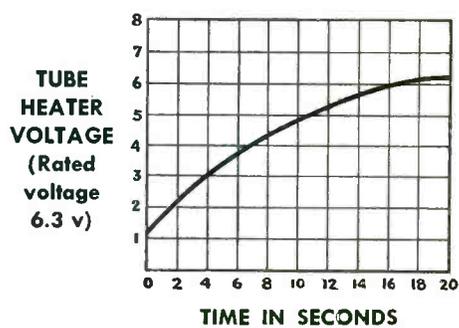


Now . . . "Series-String" Warm-Up Time For All G-E Picture Tubes!

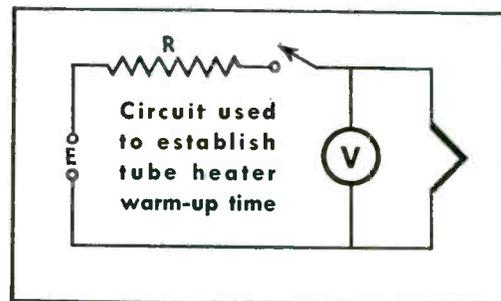
YOUR whole TV circuit can have tubes with the same heater warm-up time . . . picture tube and receiving tubes! G.E. makes this possible by introducing, on all picture tubes now coming off the line, new heavy-duty heater windings with a voltage rise which follows the same pattern as General Electric 600-Series receiving tubes, designed for "series-string" use.

You save on transformer and circuitry—you save on tube failures—because tube-heater voltage during warm-up will not become excessive *anywhere in your chassis*.

Get quality TV performance with fewer in-line rejects, fewer servicing call-backs, plus "series-string" design economy . . . by specifying *both* G-E picture tubes and G-E 600-Series receiving tubes! Types available for every socket. See your G-E tube representative! *Tube Dept., General Electric Co., Schenectady 5, N. Y.*



● G-E picture-tube voltage rise, after switch-on, follows approximately the time curve shown above. G-E 600-Series receiving tubes have a similar voltage-rise pattern—for example, heaters rated 6.3 v reach 5 v in approximately 10.5 sec. Means uniform heater voltage *throughout your circuit*—fewer tube failures! . . . In test circuit below, $E=25$ v and $R=31.5$ ohms.



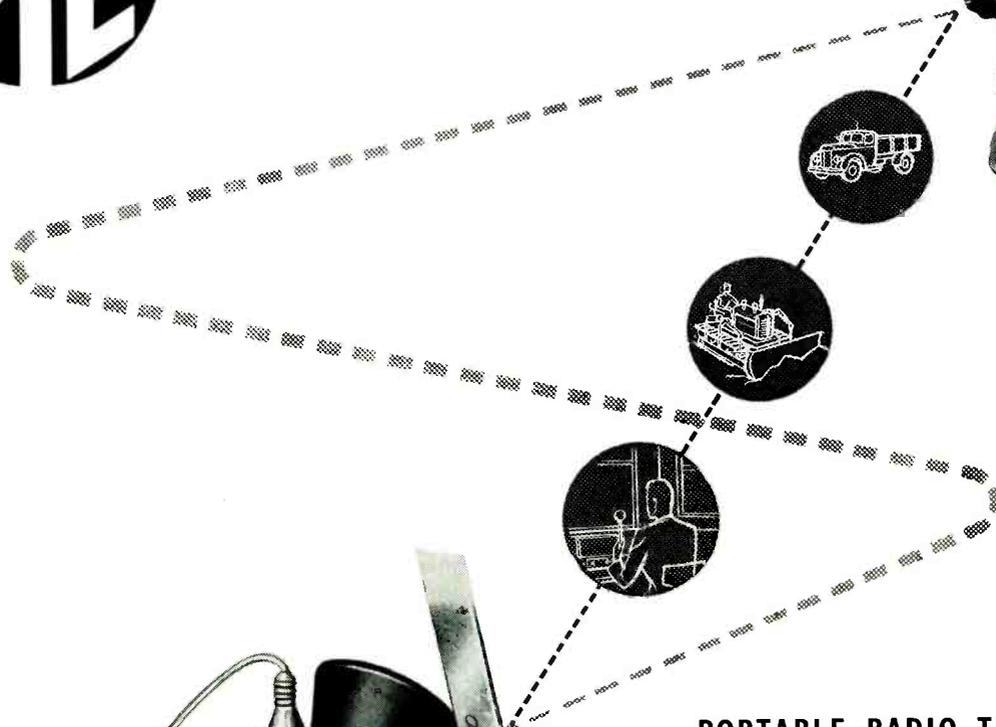
Progress Is Our Most Important Product

GENERAL  ELECTRIC

162-1A1



WALKIEPHONE



PORTABLE RADIO-TELEPHONE FOR CIVIL ENGINEERING COMMUNICATIONS

For purposes of routine inspection and maintenance the Pye V.H.F. Walkiephone makes a valuable but inexpensive addition to any V.H.F. scheme. Unimpeded by this light-weight equipment one man becomes a constant source of information and, when required, a centre of control. In places both unexpected and inaccessible the Pye "Walkiephone" ensures the smooth control of emergency operations. Robust, reliable, and economical in use, the complete equipment weighs only 10½ lbs. with batteries.



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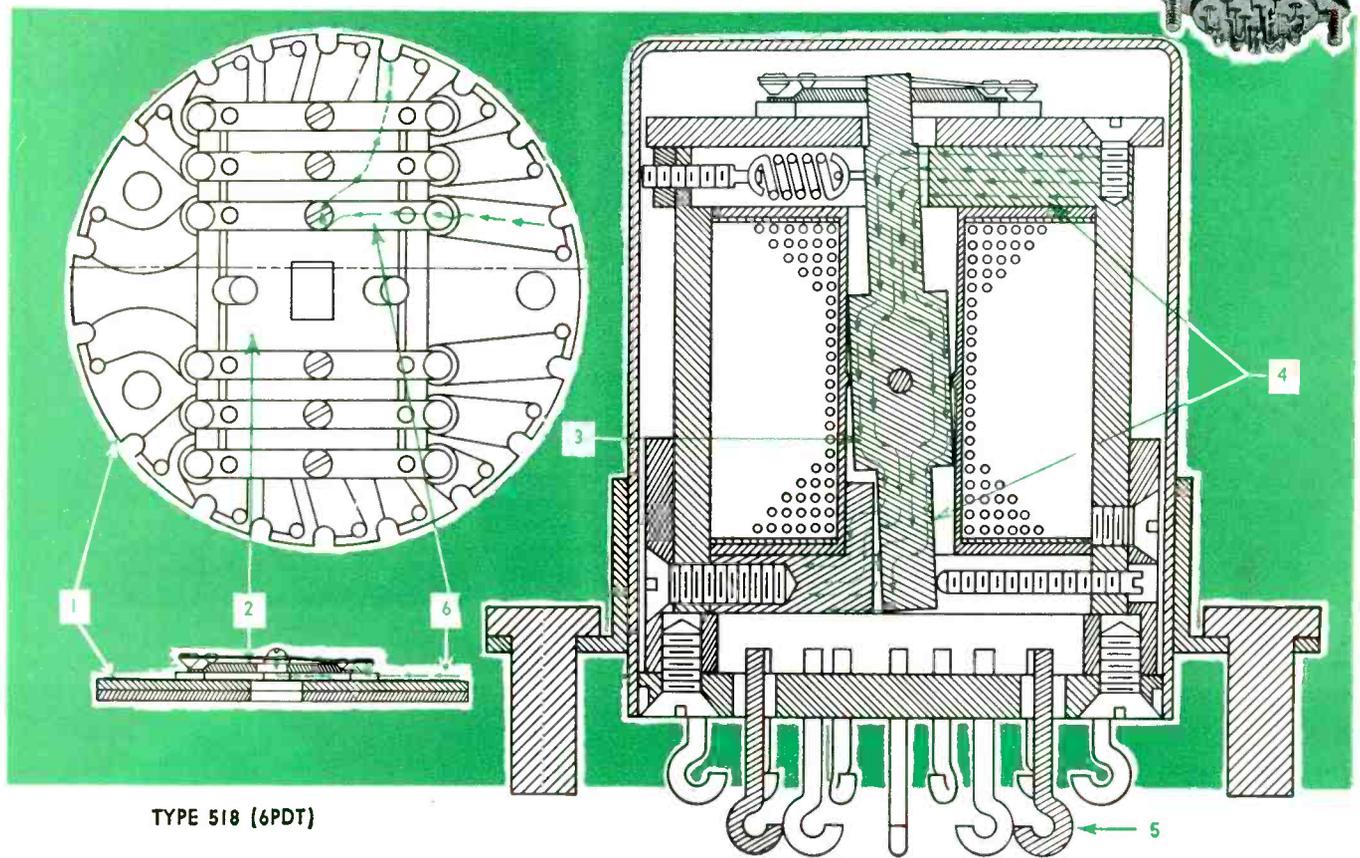
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January, 1955 — ELECTRONICS

AT LAST . . . Something really **NEW in RELAY DESIGN!**



TYPE 518 (6PDT)

HUSKY SUB-MINIATURE INCORPORATES MANY EXCLUSIVE PATENTED FEATURES!

DESIGN FEATURES

1. Printed circuit contact carrier. Saves space and simplifies wiring.
2. Sliding interrupter leaf opens contacts, assures ultimate resistance to shock and vibration. This achieves high insulation resistance and contributes toward increased arc suppression and diminishing contact "bounce".
3. Balanced armature, center-pivoted, prevents failures due to shock, vibration and acceleration.
4. Powerful magnetic circuit.
5. Terminal location not dependent on contact arrangement. Can be adapted to any customer requirement.
6. Unique contact circuits. (Shown normally closed.)
7. Exceeds requirements of latest military specifications.

SPECIFICATIONS

OPERATING VOLTAGES: Up to 150 VDC
 COIL RESISTANCE: Up to 10,000 Ohms
 SENSITIVITY: As low as 0.080 Watts
 ALTITUDE: Up to 85,000 feet
 SHOCK: 50 G's Operating
 250 G's Mechanical
 VIBRATION: 30 G's up to 2,000 c.p.s.
 POLE COMBINATIONS: 2 PDT to 6 PDT
 TEMPERATURE RANGE: MIL-R-5757B
 Class A . . . — 55 C to + 85 C
 Class B . . . — 65 C to + 125 C
 Class C . . . — 65 C to + 200 C

SEND TODAY FOR COMPLETE DATA
ON THE NEW HUSKY SUBMINIATURES!

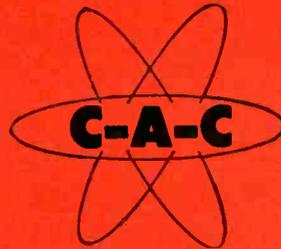


Price Electric
CORPORATION

1500 CHURCH
FREDERICK, MARYLAND

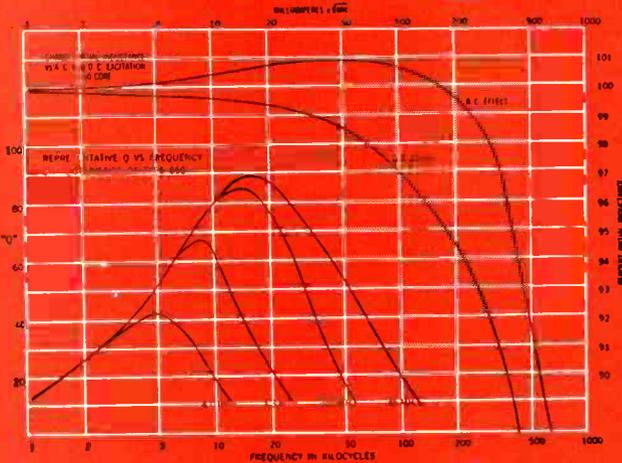
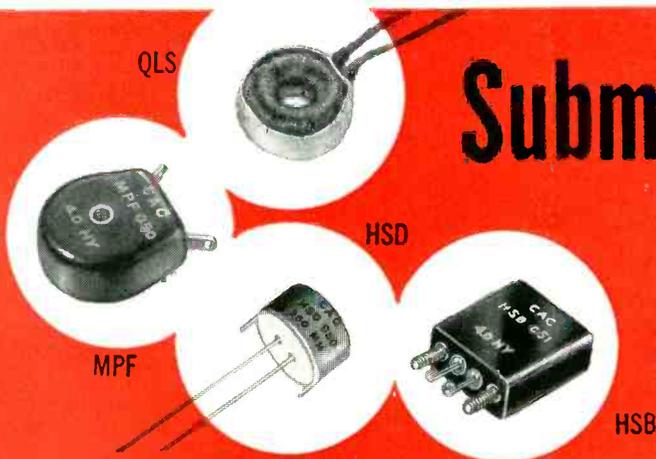
Subminiature Toroids

**HIGH PRODUCTION
PROTOTYPES
ENGINEERING DEVELOPMENT
RESEARCH**



TRANSISTOR TRANSFORMERS

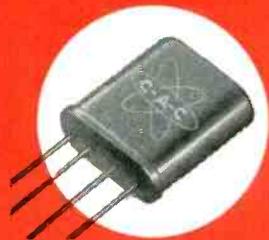
Consistent with **advanced** engineering in subminiaturization, CAC offers transistor transformers in hermetically sealed cases, molded or cast type construction—designed to meet military requirements—temperatures (-) 55° C to (+) 105° C. Enclosed magnetic field afforded by toroidal form. Frequencies and impedances to your specifications . . . utilize our **advanced** engineering and modern high speed production facilities. See your CAC representative now.



TYPICAL PULSE TRANSFORMER

IMPEDANCE RATIO	RISE TIME (MICRO SEC)	WIDTH (50% PEAK)	DROOP % PEAK	OVERSHOOT % OF 1-PEAK	INPUT PULSE TIME MICRO SEC.	% RING
200/800	3	8.1	10.4	0	8	3
700/2800*	3	8.1	0	4.1	8	2.5
5000/20000	1.3	8.0	10.0	20.0	8	0

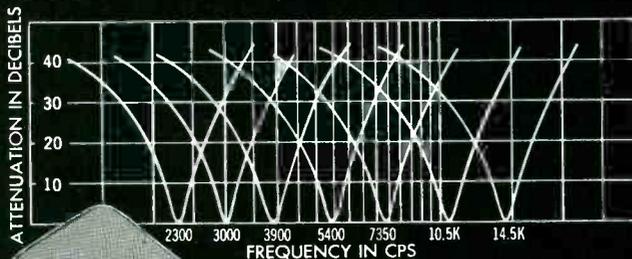
*Nominal Design
A TYPICAL PULSE TRANSFORMER—ONE OF MANY CUSTOM DESIGNS DEVELOPED BY CAC ENGINEERS — HIGHLY STABLE TOROIDAL UNITS — EXHIBIT EXCELLENT CHARACTERISTICS



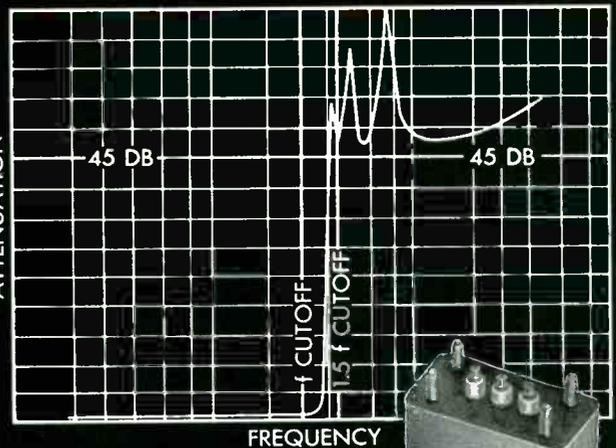
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STANDARD LOW PASS SERIES — DESIGNED & PACKAGED TO MIL T27 SPECIFICATIONS — OFFERS OVER 45 db ABOVE f_c ($f_c = 1.5 f_c$). HERMETIC SEALED — STUD MOUNTED — TEF-LON TYPE TERMINALS, CIGARETTE SIZE PACKAGE, 3, 6, 10 & 15 KC STD. UNITS, ALSO AVAILABLE IN SUBMINIATURE VERSION.



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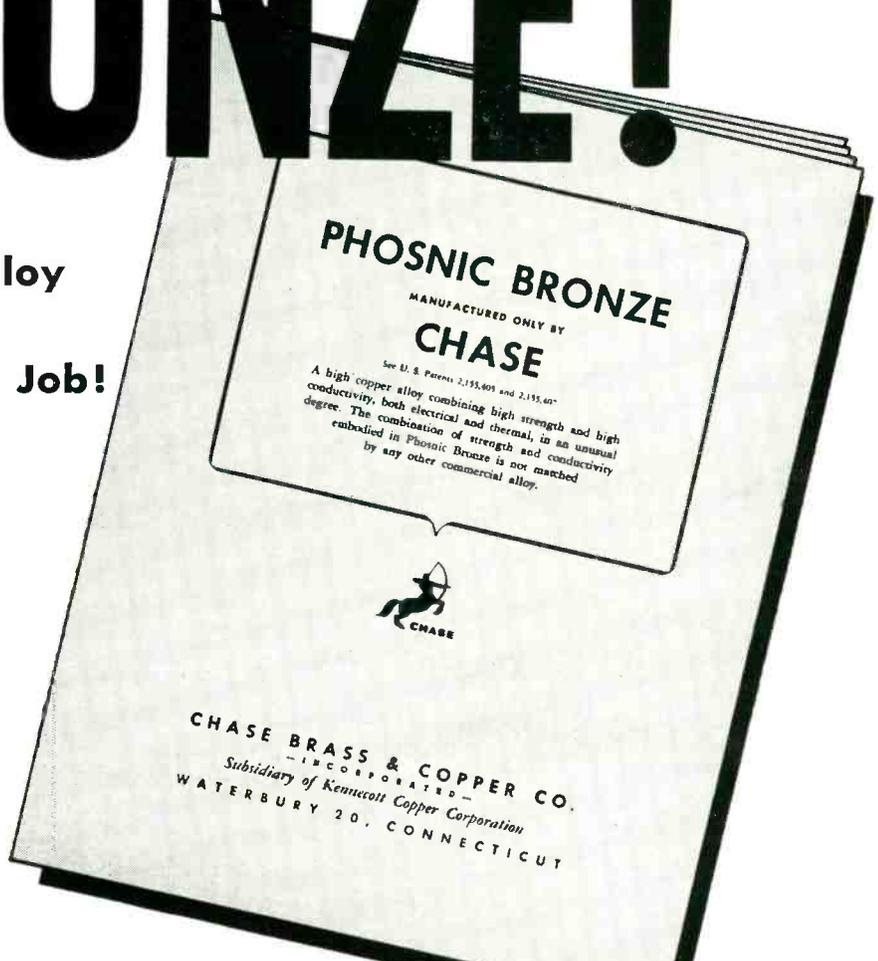
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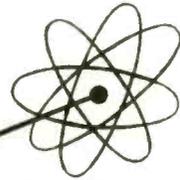
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per millimeter

VOLTAGE SENSITIVITY
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per millimeter

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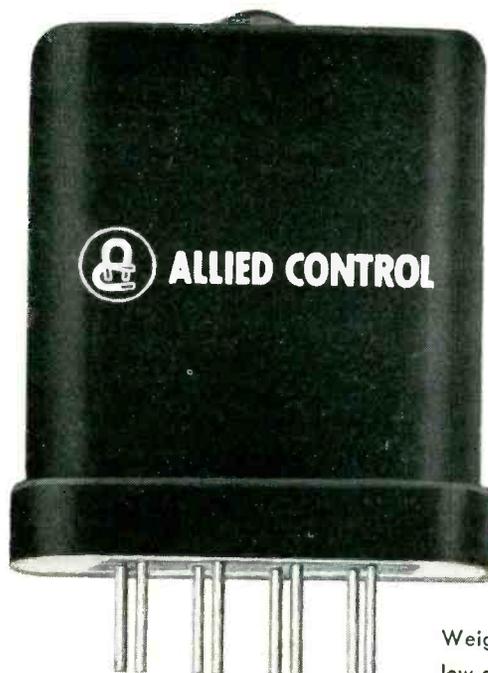
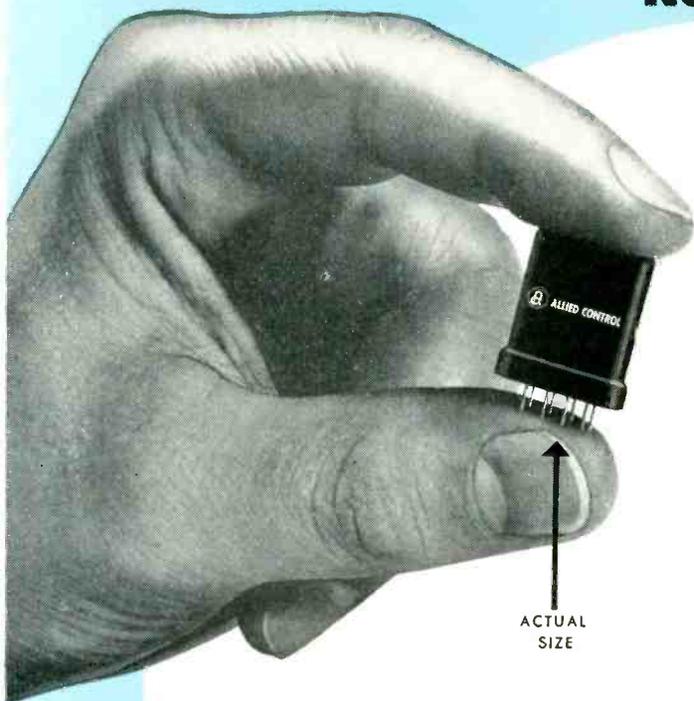


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CONTACTS: Double pole double throw rated at 0.5 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms standard

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10 G up to 500 cycles

SHOCK: 100 G plus (operating)

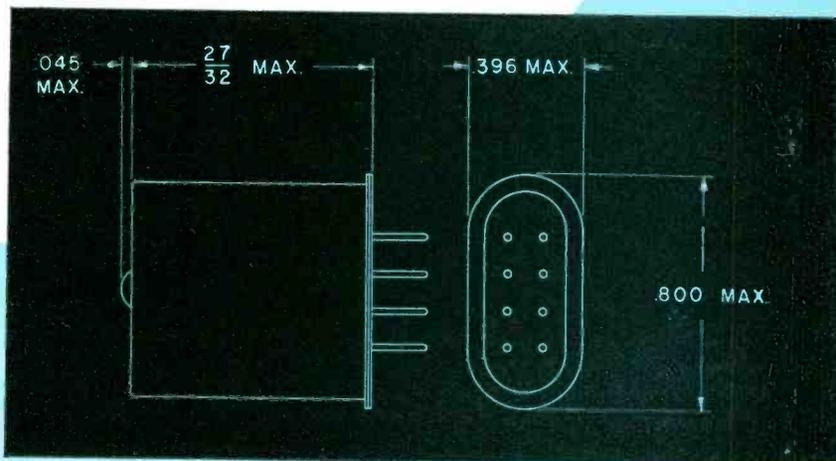
SPEED OF OPERATION: 2 milliseconds at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 350 volts rms at 80,000 feet

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

CAPACITY: N. O. contact to case 0.6 mmf.

Weights 0.33 oz.—has low capacity for RF switching. Applicable to printed circuits.



Write for catalog sheet giving complete information



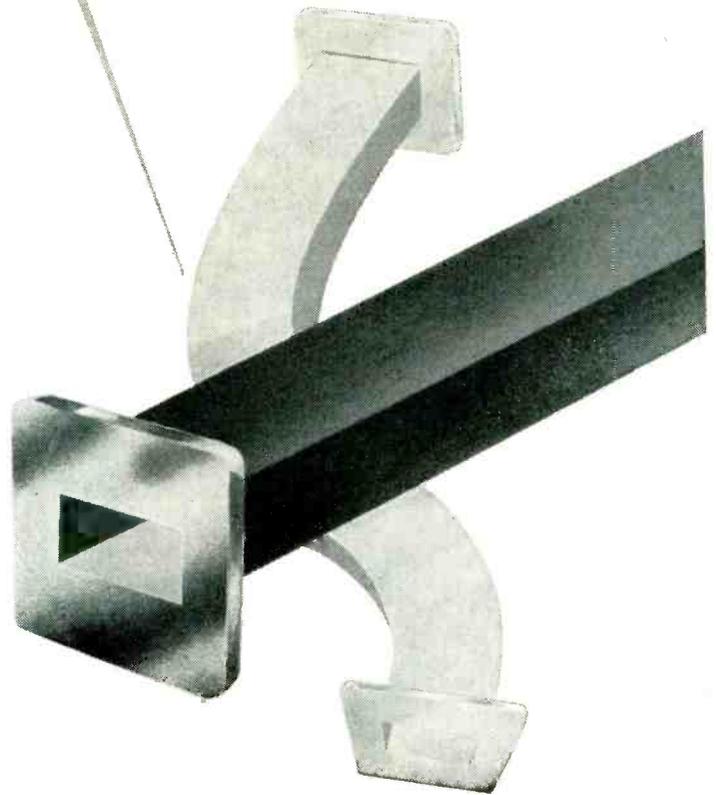
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before you start we consider the finish

Not a riddle, but a fact . . . the above statement. We mean simply this. The mechanical design of a waveguide structure . . . its size, shape and weight, are of equal importance to its electronic properties and performance. Thus accurate design and production planning to suit the finished end product is highly important. We at Budd Stanley exist solely to produce the finished structure you design . . . exactly as you specify it. And we are uniquely qualified to do so. Our long experience in microwave components and specialized tooling and manufacturing facility is devoted solely to producing microwave components to your design . . . simple or complex . . . in light or heavy metals . . . manufactured and tested to your specification. But check for yourself. A phone call, letter, or wire will put our entire staff at your service. Why not call us in today?



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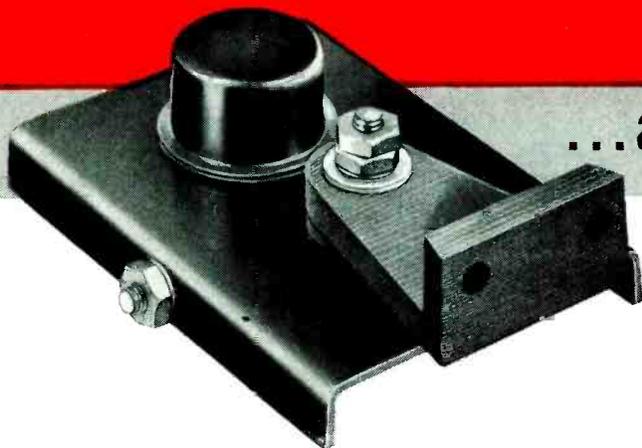
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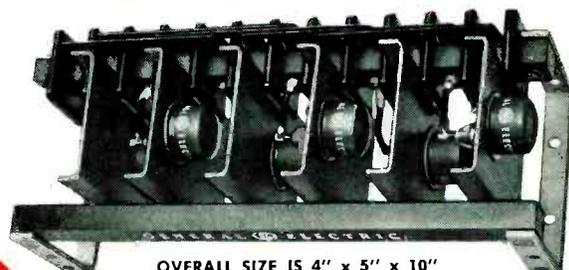
SAMPLE DELIVERIES ARE SCHEDULED FOR FEB. 1955!

These rectifiers are available in standard combinations consisting of one or more rectifying elements. A few typical ratings are listed below.

CIRCUIT	D-C OUTPUT AT 55° C (Resistive Load)
Half Wave	30 amps @ 60 V
	15 amps @ 120 V
	10 amps @ 180 V
Full Wave Center Tap	30 amps @ 60 V
	10 amps @ 180 V
Full Wave Bridge	10 amps @ 125 V
Three-Phase Half Wave	30 amps @ 95 V
	15 amps @ 190 V
Three-Phase Bridge	15 amps @ 190 V
Three-Phase Star	30 amps @ 95 V



GERMANIUM POWER RECTIFIERS



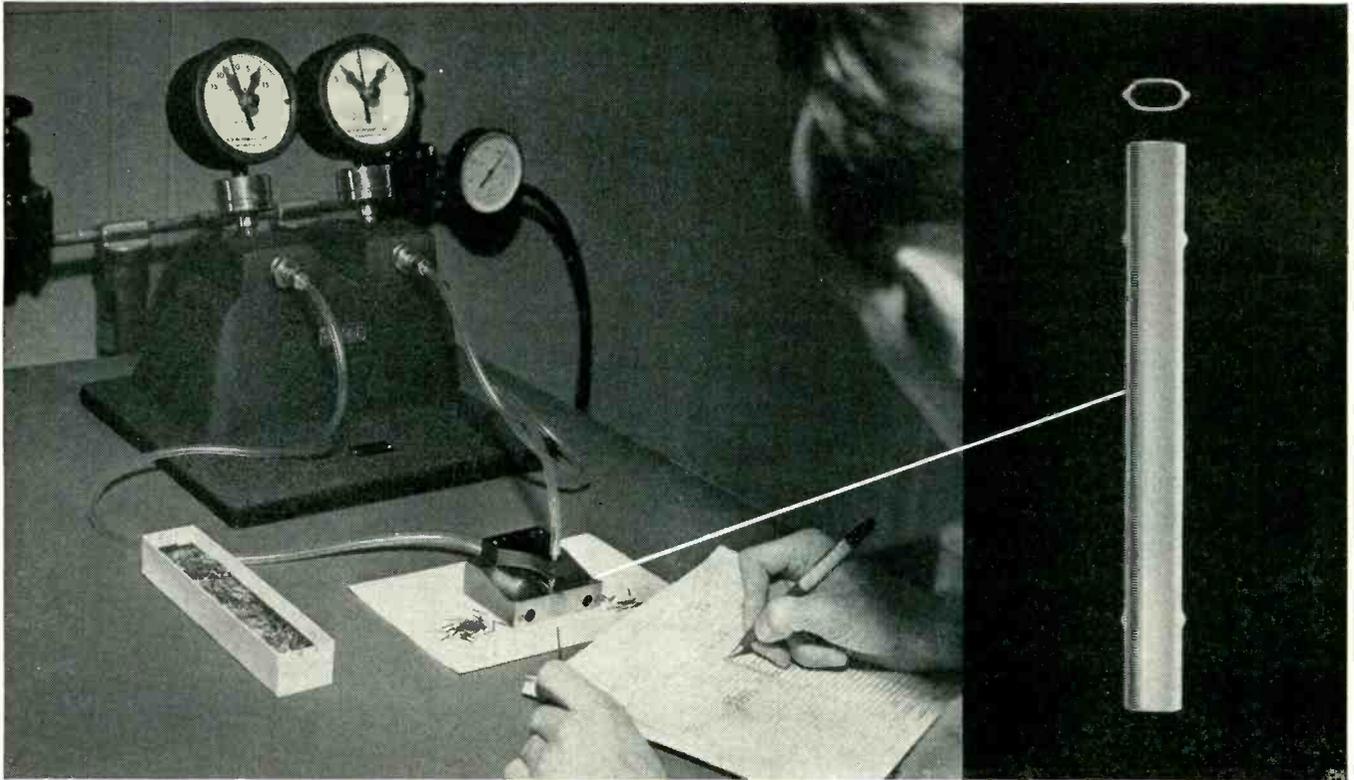
OVERALL SIZE IS 4" x 5" x 10"

Be "money-wise" and "pound-wise" too, with these stand-out design features:

- Weight and volume reduced 75%
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- No forward aging effects...no need for age-compensating devices

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GENERAL  ELECTRIC



On this specially designed pneumatic comparator gage, the operator can check dimensions of elliptical cathodes to an accuracy of .0001" major axis and .00005" minor axis on mass production runs.

SUPERIOR TUBE dimension control means better fitting cathodes

We were called upon to mass manufacture high performance seamless nickel alloy elliptical cathodes (shown above) with major and minor axes of .048" and .025" respectively, only 12 mm. long.

During the formation of the tiny beads shown above, the cathode underwent microscopic dimensional distortion of no more than .00125".

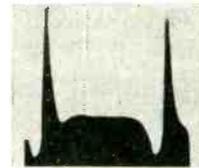
The development of this cathode required us not only to change to novel manufacturing methods and new processes, but to design new machinery.

Precision, accuracy and speed were also required in the functioning of a start-to-finish dimension control system. The pneumatic air comparator has proved that cathodes produced at Superior are now free from distortion, and 99% of the entire production is well within the tolerance limits specified even on repeat orders running into the millions.

The resultant cathodes offer a better fit for the heater, less likelihood of heater-cathode shorts, reduced microphonics, and improved electrical characteristics for the vacuum tube.

We are willing to go a step or two beyond the accepted and established practices to solve problems in electronics involving the use of cathodes and fabricated parts for the industry which are made from small metal tubing. This extraordinary attention to detail is given to many types of Superior specialty tubing and parts. We are equipped to manufacture products controlled to the most modern standards of variation. This elliptical cathode is one such product. We invite requests for Data Memorandum #5 on Cathode Materials and for Bulletin #40, a guide to the selection and application of small diameter tubing. Superior Tube Company, 2500 Germantown Avenue, Norristown, Pa.

75 to 1 diameter vs. length comparison plot illustrates the improved bead conformity in new Superior Tube cathodes.



OLD cathodes. Note distortion near beads.



NEW cathodes. Note uniform bead heights and cathode diameter.

Superior Tube

The big name in small tubing

All analyses .010" to 5/8" O.D. — Certain analyses in light walls up to 2 1/2" O.D.

6738 ... First again in the field of tube miniaturization, Bomac developed a new type TR tube designated the 6378. Designed specifically for airborne radar equipment, the 6378 is a miniaturized version of the 1B24A (another Bomac first), 1B60 and the 1B24. Size was cut in half, and weight was reduced by one fifth with no sacrifice in performance or efficiency.



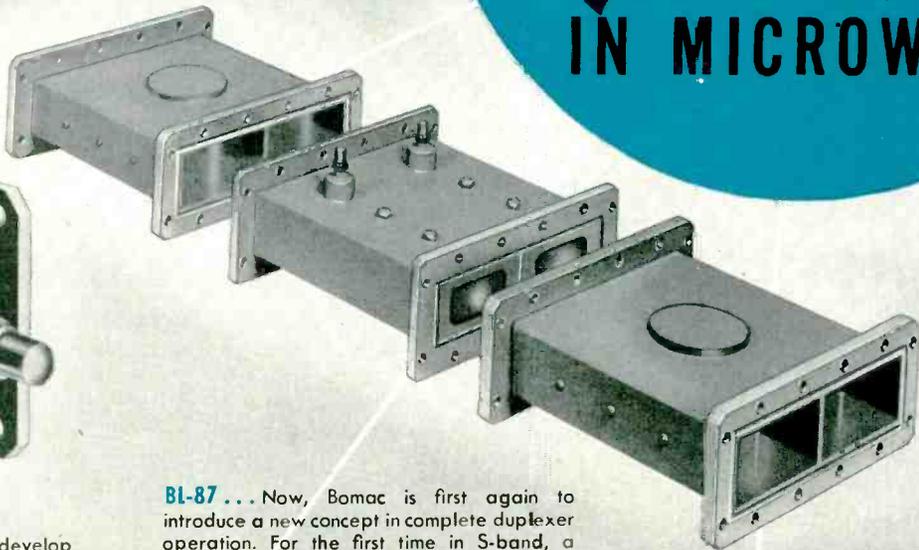
1N23D ... Bomac was the first to manufacture the 1N23D silicon diode. System designers, for the first time, could obtain a diode with greatly increased sensitivity and superior electrical characteristics in relation to existing types.



BL-25 ... The BL-25 TR tube, designed and developed by Bomac, was the first cell-type tube system — engineered to withstand high power levels and maintain recovery time over a long period of life. The BL-25, although originally designed for a specific piece of equipment, has proven its versatility in various applications within the industry.



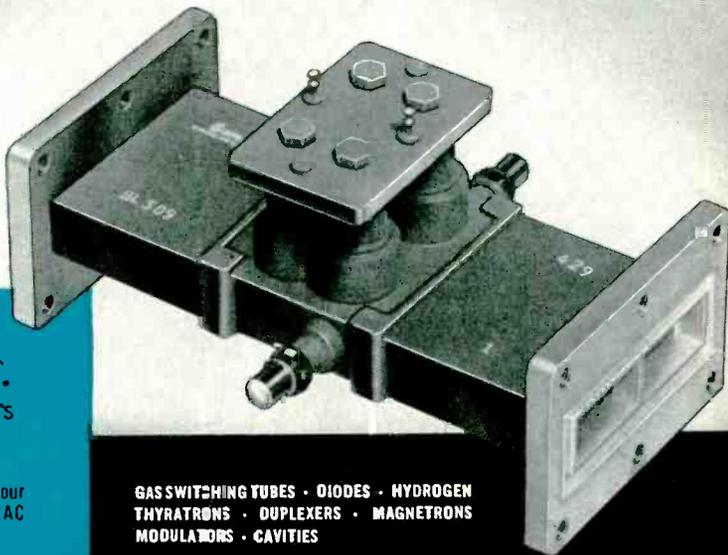
BL-58 ... Bomac was the first to develop shutter tubes and integral TR-shutter combinations for continuous crystal protection. The BL-58 was the first integral TR-shutter combination developed by Bomac. With integral TR-shutter operation, bulky waveguide shutters could be eliminated at considerable savings in size and weight. This tube has now been superseded by improved models.



BL-87 ... Now, Bomac is first again to introduce a new concept in complete duplexer operation. For the first time in S-band, a complete duplexer is offered to the industry. The BL-87 is a dual TR tube, complete with perfectly matched hybrids to assure maximum efficiency and long life. Systems designers can now be assured of reliable duplexer operation because Bomac's hybrids are designed specifically for their dual TR tubes. Bomac is first again in design and development of microwave tubes.

BOMAC DUAL TR DUPLEXERS			
Tube	Frequency (MC)	Tube	Frequency (MC)
6334	8490-9578	BL71	8500-9600
(BL-27)		BL78	8490-9578
BL29	9325-9425	BL87	2700-2900
BL35	15000-17000	BL507	8490-9578
BL47	9325-9425	BL600	8490-9578
BL60	5400-5900		

BL-509 ... Bomac's BL-509 was the first complete duplexer offered in one compact unit. Combining a Bomac dual TR tube having integral shutters with two perfectly matched hybrid junctions in a single unit, the BL-509 provides duplexer operation and continuous crystal protection in one package. Light weight and compact, the BL-509 assures superior electrical performance and mechanical simplicity.



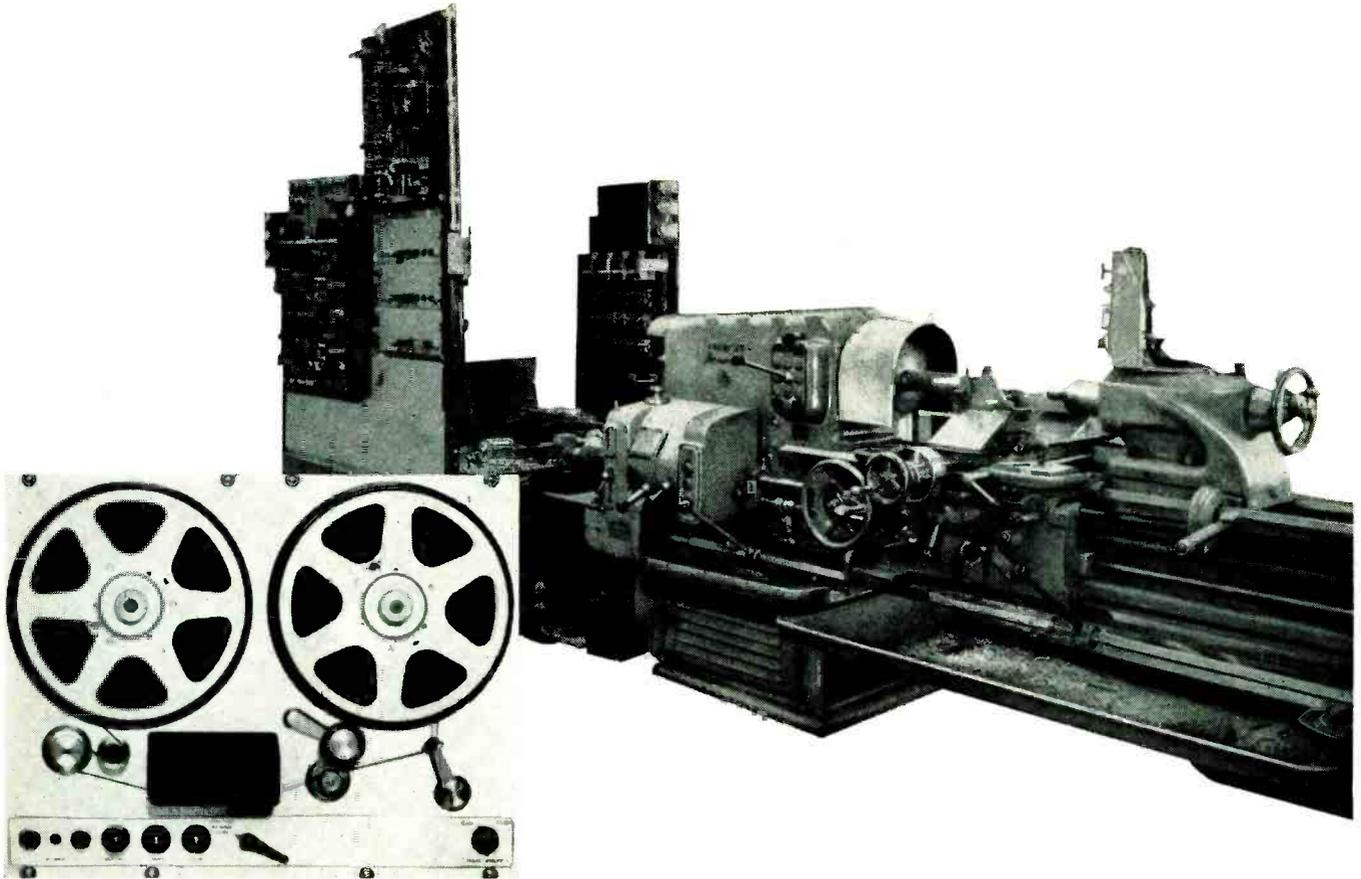
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MAGNETIC TAPE CONTROLS MACHINES LIKE THIS

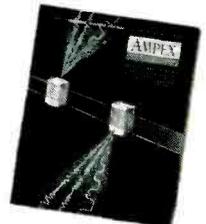
An Ampex Magnetic Tape Recorder programmed all operations of this 16" lathe. The Ampex machine was selected by General Electric, who designed and built the control system, to provide the "memory" which helped guide the machine flawlessly through the accurate motions involved in machining irregular parts. For each part to be manufactured, a skilled machinist made the first unit. The Ampex recorder "remembered" his motions and could thereafter direct the lathe in the manufacture of one part or a thousand — now or twenty years from now.

Other exacting work programs of drilling, jig boring, tapping, or gear cutting can be converted into electrical signals by existing tracer techniques . . . and permanently recorded on magnetic tape. The control system using the memory characteristics of this tape can give you an exact duplication of the original work sequence, again and again . . . wherever and whenever you want it.

Result: machine tool setup time is shortened . . . print reading and "miking" times are reduced . . . operator errors and rejects are eliminated . . . and simultaneous operation of two or more feeds, on two or more machines is possible.

For Your Automation Needs: **Ampex Precision and Durability**

Ampex recorders retain precision even after thousands of hours of use. And they can be adapted to almost any automation need. Let our application engineers determine whether magnetic tape can provide a more efficient control system for your operation — or write for our 16-page bulletin on "Data Recording, Machine Control and Process Regulation."



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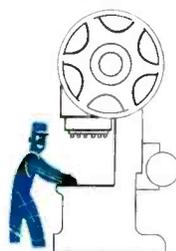
"Know-how" at Karp is the incomparable ability of trained specialists and engineers to produce quality-controlled, engineered sheet metal fabrications at the lowest possible cost.

Into each of your requirements for cabinets, enclosures, housings and chassis go the proven Karp procedures of —



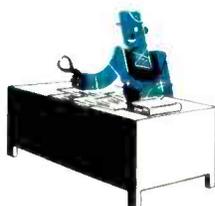
1. consultation

that irons out the "wrinkles" to prevent high production costs, bottlenecks and delivery delays.



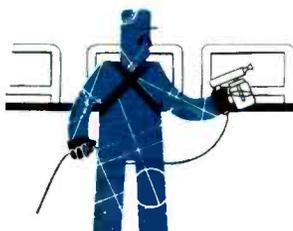
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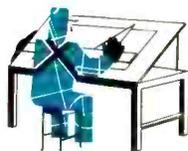
2. estimating

that analyzes each specification and suggests the Karp facilities and available dies that keep your costs low . . .



5. finishing

of the most modern type that permits each Karp enclosure to "reflect the skills within . . ."



3. engineering

whose function it is to transfer your plans and samples into actual, economical, production runs . . .



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that assures safe handling and transportation to your destination.

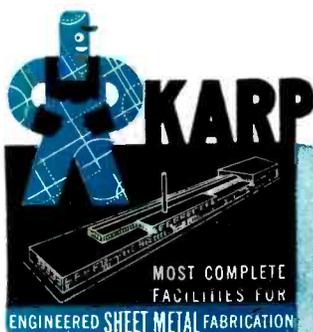
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KARP METAL PRODUCTS CO.

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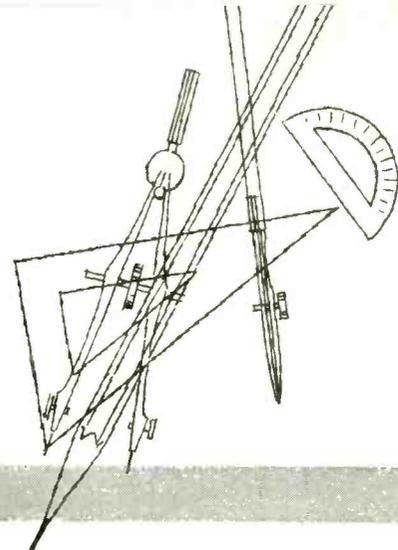


**enclosures reflect the skills within*

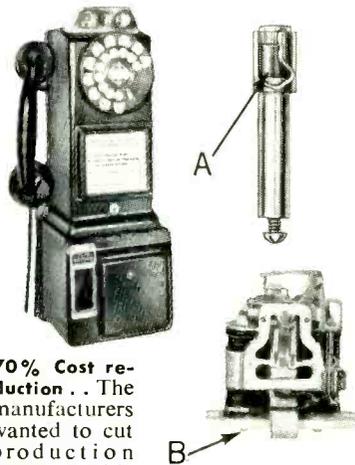
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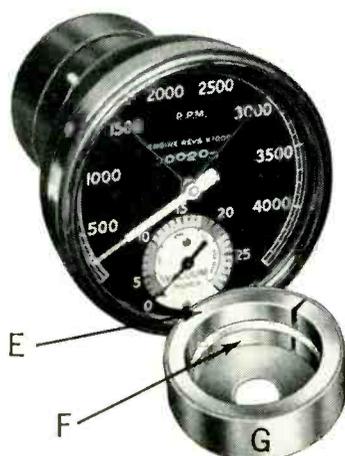


TELEPHONE PAY STATION



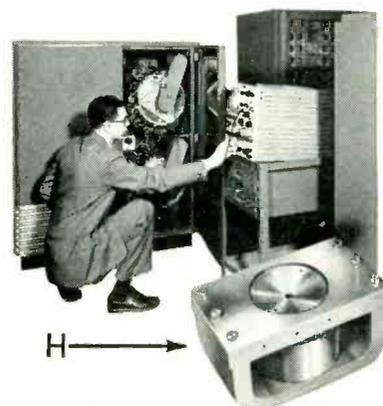
70% Cost reduction . . The manufacturers wanted to cut production costs on this pay station. They wanted more positive mechanical action built into the unit . . to minimize service calls. So their engineers, cooperating with Indiana Permanent Magnet engineers, designed a new magnet assembly using specially designed Indiana Permanent Magnet (A), replacing a conventional type steel magnet. Assembly functioned as a part of coin return assembly (B). Results were (1) flux increase 27% . . from 2750 Maxwells with steel magnet to 3500 with Indiana Permanent Magnet using Alnico III, (2) magnet cost reduced 70%, (3) weight saving, (4) simpler design, (5) fewer service calls required.

TACHOMETER



Improved stability . . This company wanted a permanent magnet assembly that would produce sufficient torque and give added stability to this tachometer. By varying the analysis and heat treatment of the magnet material, Indiana Permanent Magnet engineers developed special Cunife permanent ring-magnets (E) and (F) which, as component parts of permanent magnet assembly (G), provided the necessary torque and improved stability. Results were: (1) the desired torque and improved stability; and (2) the redesigned magnet lent itself better to the limited space resulting from the new design.

ELECTRONIC DATA PROCESSING MACHINE



Immediate signal pickup . . This computer manufacturer required a permanent magnet to build up a magnetic surface of the drum used in Magnetic Reader and Recorder . . a unit of its Electronic Data Processing Machine. Indiana Cunife Permanent Magnets were selected. Results: Strong, dependable signals because of the high coercivity and permanence of Indiana Permanent Magnets. Another permanent magnet (Indiana Alnico) was used for the housing (H) in the magnetic tape Reader and Recorder unit of the processing machine. Results: Immediate signal pickup . . sensitivity high because of magnet's high efficiency.

Here are six thumbnail case histories of permanent magnet applications. You'll notice they all have one thing in common. *Special engineering and design service* by Indiana Permanent Magnet engineers . . design service that reflects original thinking, creative thinking, imaginative thinking . . was an important part of each story!

This specialized service is available to you without obligation. Indiana Permanent Magnet engineers, with more than 45 years experience in designing permanent magnets

for some 40,000 applications, will welcome the opportunity to assist you in the development of *your* permanent magnet designs.

Indiana maintains the *world's largest engineering staff devoted solely to the design and application of permanent magnets . .* and the world's largest and most complete permanent magnet research and production facilities.

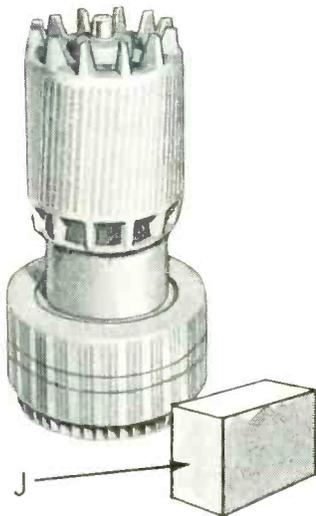
For additional details and a copy of Engineering Design Manual 4-A-1, write The Indiana Steel Products Co., Valparaiso, Ind.

World's largest Manufacturer of Permanent Magnets

Permanent Magnet Design

*helped these original equipment manufacturers
reduce costs . . improve performance . . simplify design*

GENERATOR



Permits uninterrupted service . . This permanent magnet generator uses 28 Hyflux Alnico V, bar-shaped Indiana Permanent Magnets. Minimum maintenance and long service are two "musts" in generators . . and Indiana Permanent Magnets help insure these qualities. These magnets (J) eliminate necessity for slip rings and commutators, which in turn eliminate sparking and resulting radio or TV interference. And there's no heat from the field coils . . nor is excitation power needed.

WATT-HOUR METER



Insures field stability . . This watt-hour meter is typical of hundreds of different types of instruments and meters using permanent magnets. A single phase, 15-amp, 240-volt unit, it uses an Alnico I Indiana Permanent Magnet weighing only 0.2 lb. Uniformity and stability of field, so necessary for maintaining the initial accuracy of this meter over a long period of years, is provided by magnets of the type shown above. Similar magnets are widely used in mass spectrometers, vibration pickups, galvanometers, medical instruments, speedometers, fluxmeters, etc.

SOUND-POWERED TELEPHONE



Compactness . . was an important consideration in the design of this electric self-powered telephone. It is powered not by batteries nor other outside power sources . . but rather by sound waves which initiate a series of electrically activated impulses. Working with Indiana Permanent Magnet engineers, the manufacturer, by selecting Indiana Sintered Alnico II, was able to use extremely small magnets while maintaining high performance requirements. "Indiana Sintered Alnico II," reported this company's sales manager, "made possible small magnets of high coercive force, the greatest single factor in size reduction of transducers compared to that possible with other alloys."

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**INDIANA
PERMANENT
MAGNETS**

THE INDIANA STEEL PRODUCTS COMPANY, VALPARAISO, INDIANA

EVERY ELECTRONICS ENGINEER HAS DESIGNED COILS TO UTILIZE
MOLDITE CORE "STANDARDS"

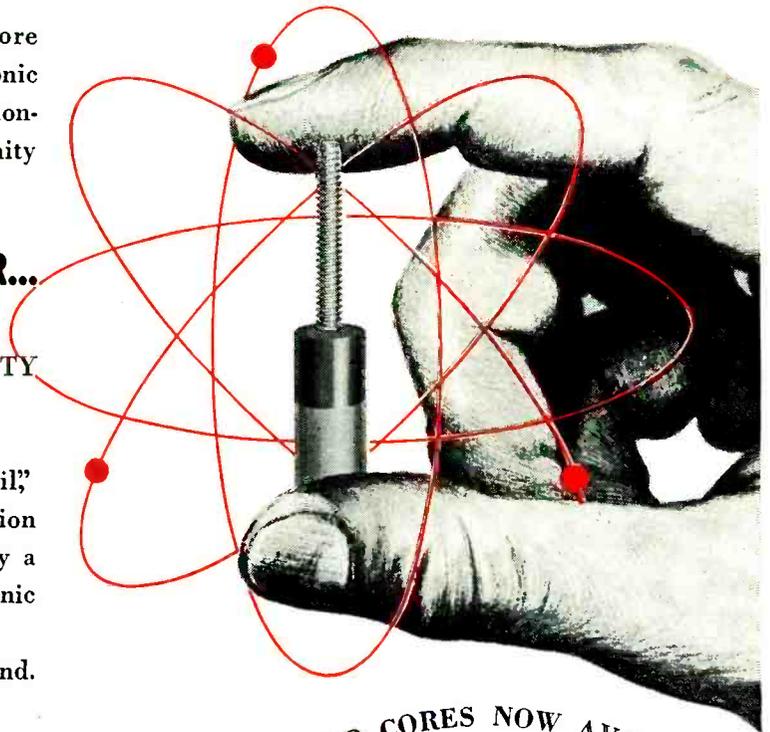
Consistently dependable, Moldite core "Standards" are in demand wherever electronic engineering requires the finest in precision-manufactured cores with absolute uniformity from first to last.

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| AVAILABILITY | INTERCHANGEABILITY |
| UNIFORMITY | FLEXIBILITY |

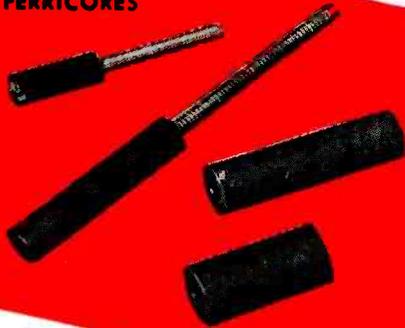
"The right Moldite core for the right coil," is a byword at National Moldite whose precision production facilities have given the industry a superlative core or coil form for every electronic application.

Design with Moldite Core Standards in Mind.

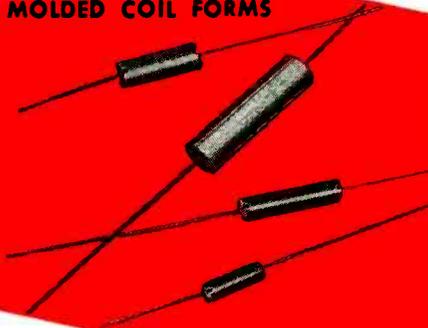


COMPLETE LINE OF MOLDITE ECONOMY-ENGINEERED CORES NOW AVAILABLE

FERRICORES



MOLDED COIL FORMS



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- MAGNETIC IRON CORES
- FILTER CORES
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THE MOST COMPLETE LINE OF
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"Best Suited" for
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VARGLAS SILICONE CLASS H TUBING and SLEEVING

for applications requiring prolonged heat endurance at temperatures up to 260°C.

Varglas Silicone tubing and sleeving were developed by Varflex for applications involving continuous operating temperatures up to 260° C. Exceptional stability is combined with the following qualities . . .

Flexibility — sharp turns and 90° bends cause no cracking or peeling — no loss of dielectric strength.

Dielectrically-Strong — All grades conform to NEMA and MIL-I-3190 standards.

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be made self-extinguishing on special order.

Cold-Resistant — Excellent resistance to chafing and abrasion, flexible to -35°C.*

*For temperatures down to -65°C, and for applications requiring extraordinary flexibility, we recommend our new Varglas Silicone Rubber sleeving and tubing. Inquiries invited.

Send for FREE SAMPLES

Mail coupon today for free folder containing 25 different test samples of Varflex insulating sleeving, tubing, lead wire and tying cord.



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CORPORATION

Makers of
Electrical Insulating
Tubing and Sleeving

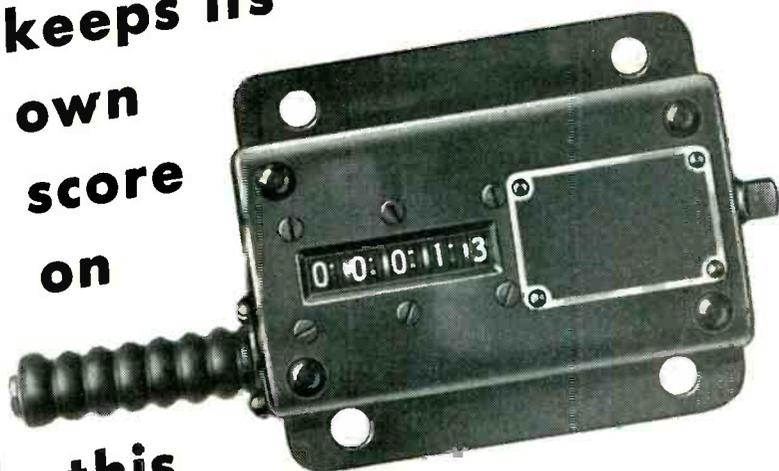
VARFLEX SALES CO., INC.
308 N. Jay St., Rome, N. Y.
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Please send me free folder containing samples of your electrical insulating tubing and sleeving.
I am particularly interested in insulation for _____

Name _____
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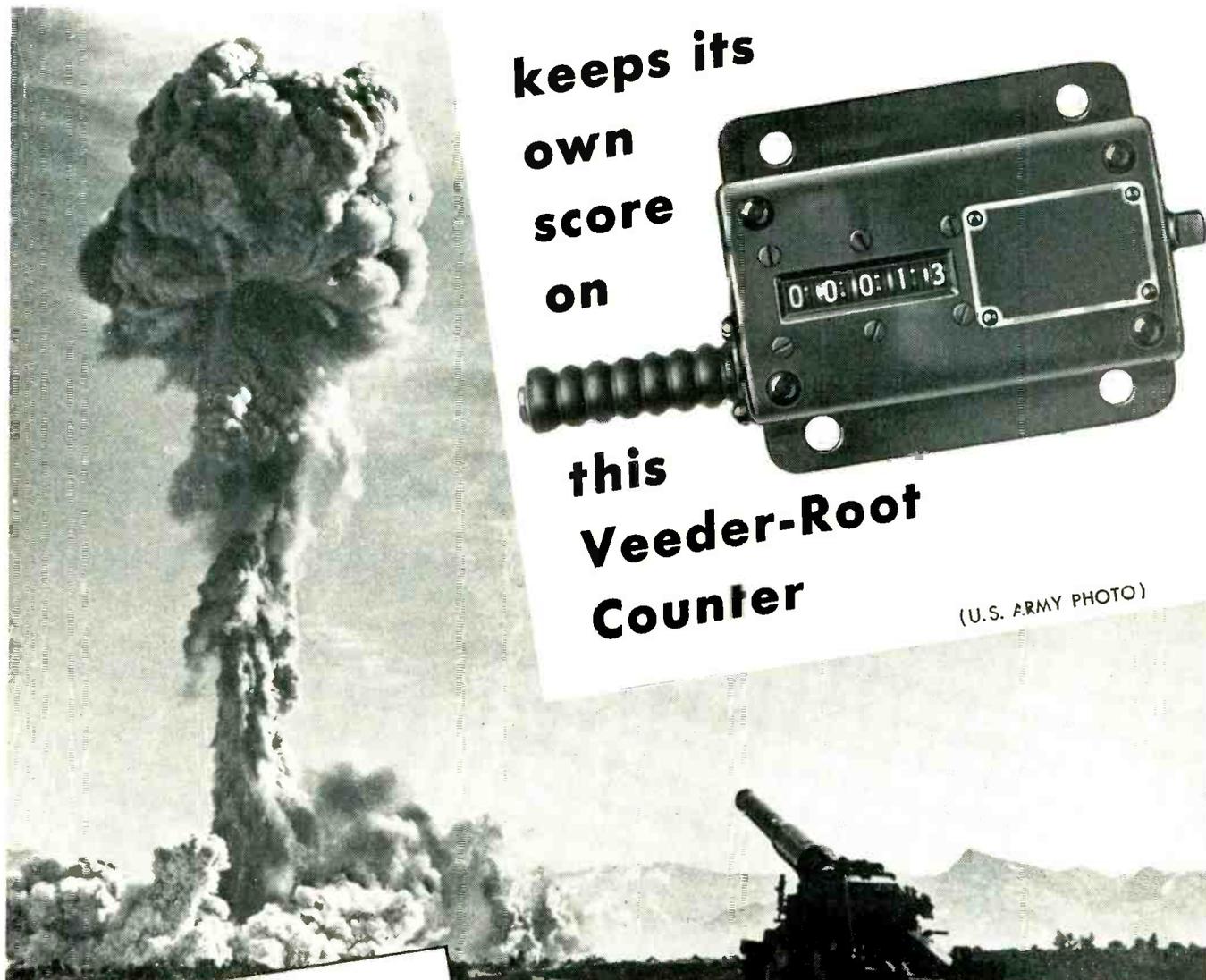
NEW ATOMIC CANNON

keeps its
own
score
on



this
Veeder-Root
Counter

(U.S. ARMY PHOTO)



Added Evidence
that—

Everyone Can Count on **VEEDER-ROOT**

This mobile 280 mm. atomic cannon has *two* recoil motions. The primary recoil absorbs the cannon's "kick". The secondary recoil (something new in artillery) absorbs the forces created by the primary recoil. And each recoil motion is recorded by this special Veeder-Root Counter designed with a plunger-action shaft . . . which keeps the score on the cannon's use and indicates

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This again points up the fact that "Anything Worth Making — or Worth Doing — *Is Worth Counting.*" And Veeder-Root has the experience and resources *you* can count on, to give you any counter you need . . . for any mechanical or electrical application . . . in any field from Atomics to Automation. Write:

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HARTFORD 2, CONNECTICUT

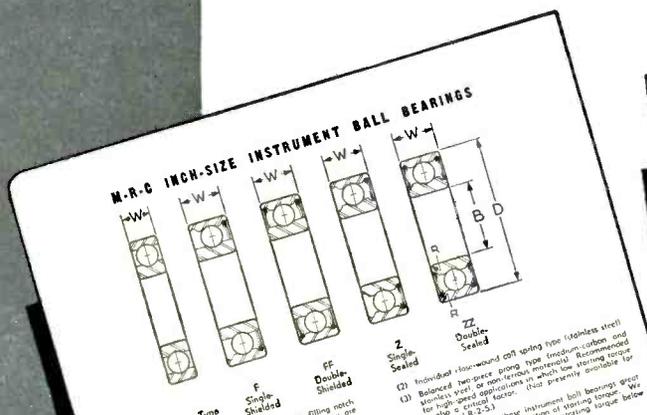


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"The Name that Counts"

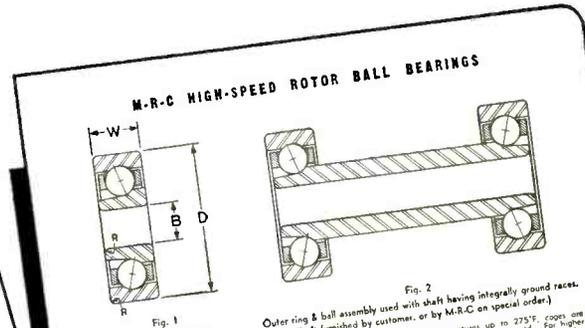
New

M-R-C SUPER-PRECISION Instrument Ball Bearing CATALOG



M-R-C INCH-SIZE INSTRUMENT BALL BEARINGS

These ball bearings are of the symmetrical manufacturing process, made in each size for shafts from .25 to .100". They are available with or without shields on both ends and shields on one end with metal inserts. Ball cages are available in three precision types as follows: (1) Open type heat-treated titanium carbon and stainless steel. Recommended especially for applications involving moderate speeds or oscillating motion. (2) Single-shielded type with synthetic rubber elements. (3) Double-shielded type with synthetic rubber elements. In the design of these instrument ball bearings great emphasis has been placed upon reduction of starting torque for high-speed applications in which low starting torque is a major design factor. Their primary application is for high-speed rotors. Their primary application is for high-speed rotors.



M-R-C HIGH-SPEED ROTOR BALL BEARINGS

M-R-C High-Speed Rotor Ball Bearings have been especially designed for applications requiring rigid bearing mountings and a minimum of vibration. They are recommended for gyro rotors and similar installations. These bearings have the same external dimensions as some of the inch-size series shown on page 4 and the 30 series shown on page 6. The internal design, however, differs from that of the conventional bearings in that the inner ring is completely super-elastic, hence that the bearing is of the contact-type with a relatively small angle.

M-R-C BEARING NUMBERS				DIMENSIONS in inches			BALLS	
Open Type	Single-Shielded	Double-Shielded	Double-Sealed	Bore B + .0000 - .0001	Outside Diameter D + .0000 - .0001	Width W + .0000 - .0001	Radius R	Ball Size
R-15	R-15-F	R-15-FF	R-15-Z	.0937	.3125	.1094	.1406	.012 6 3/4
R-2	R-2-F	R-2-FF	R-2-Z	.1250	.3125	.1094	.1362	.012 7 3/4
R-2-A	R-2-A-F	R-2-A-FF	R-2-A-Z	.1250	.3125	.1094	.1362	.012 7 3/4
R-3	R-3-F	R-3-FF	R-3-Z	.1375	.3125	.1094	.1362	.012 7 3/4
R-4	R-4-F	R-4-FF	R-4-Z	.1500	.3125	.1094	.1362	.012 7 3/4
R-4-A	R-4-A-F	R-4-A-FF	R-4-A-Z	.1500	.3125	.1094	.1362	.012 7 3/4
R-6	R-6-F	R-6-FF	R-6-Z	.1875	.3125	.1094	.1362	.012 7 3/4
R-8	R-8-F	R-8-FF	R-8-Z	.2188	.3125	.1094	.1362	.012 7 3/4
R-10	R-10-F	R-10-FF	R-10-Z	.2500	.3125	.1094	.1362	.012 7 3/4
R-12	R-12-F	R-12-FF	R-12-Z	.2812	.3125	.1094	.1362	.012 7 3/4

M-R-C BEARING NUMBERS	DIMENSIONS			Radius R	No. Balls	Ball Size
	Bore B + .0000 - .0001	Outside Diameter D + .0000 - .0001	Width W + .0000 - .0001			
R-15-B	.0937	.3125	.1094	.1406	6	3/4
10R-15-B	.1250	.3125	.1094	.1362	6	3/4
R-2-B	.1250	.3125	.1094	.1362	7	3/4
10R-2-B	.1250	.3125	.1094	.1362	7	3/4
R-3-B	.1375	.3125	.1094	.1362	7	3/4
10R-3-B	.1375	.3125	.1094	.1362	7	3/4
R-4-B	.1500	.3125	.1094	.1362	7	3/4
10R-4-B	.1500	.3125	.1094	.1362	7	3/4
R-6-B	.1875	.3125	.1094	.1362	7	3/4
10R-6-B	.1875	.3125	.1094	.1362	7	3/4
R-8-B	.2188	.3125	.1094	.1362	7	3/4
10R-8-B	.2188	.3125	.1094	.1362	7	3/4
R-10-B	.2500	.3125	.1094	.1362	7	3/4
10R-10-B	.2500	.3125	.1094	.1362	7	3/4
R-12-B	.2812	.3125	.1094	.1362	7	3/4
10R-12-B	.2812	.3125	.1094	.1362	7	3/4

INTERCHANGEABILITY TABLES

M-R-C BEARING NUMBER	BEARING NUMBER
R-15	R-15-F
R-15	R-15-FF
R-15	R-15-Z
R-15	R-15-ZZ
R-2	R-2-F
R-2	R-2-FF
R-2	R-2-Z
R-2	R-2-ZZ
R-3	R-3-F
R-3	R-3-FF
R-3	R-3-Z
R-3	R-3-ZZ
R-4	R-4-F
R-4	R-4-FF
R-4	R-4-Z
R-4	R-4-ZZ
R-6	R-6-F
R-6	R-6-FF
R-6	R-6-Z
R-6	R-6-ZZ
R-8	R-8-F
R-8	R-8-FF
R-8	R-8-Z
R-8	R-8-ZZ
R-10	R-10-F
R-10	R-10-FF
R-10	R-10-Z
R-10	R-10-ZZ
R-12	R-12-F
R-12	R-12-FF
R-12	R-12-Z
R-12	R-12-ZZ



M-R-C MILLIMETER-SIZE BALL BEARINGS—30 SERIES

The M-R-C 30 series bearings are of the symmetrical manufacturing process, made in each size for shafts from .0075 to .0031". They are available with two types of cages: (1) In the type in medium carbon steel, stainless steel, bronze, and more metal. (2) Two-piece, medium carbon steel. They are particularly suitable for use in high speed motors and similar applications. Check availability of bearings fitted to your application.

M-R-C MILLIMETER-SIZE BALL BEARINGS—30-SERIES				DIMENSIONS			BALLS	
Open Type	Single-Shielded	Double-Shielded	Double-Sealed	Bore B + .0000 - .0001	Outside Diameter D + .0000 - .0001	Width W + .0000 - .0001	Radius R	Ball Size
34-R	34-F	34-FF	34-Z	.0075	.0275	.0125	.0160	5
35-R	35-F	35-FF	35-Z	.0087	.0287	.0137	.0160	5
36-R	36-F	36-FF	36-Z	.0100	.0300	.0150	.0160	5
37-R	37-F	37-FF	37-Z	.0112	.0312	.0162	.0160	5
38-R	38-F	38-FF	38-Z	.0125	.0325	.0175	.0160	5
39-R	39-F	39-FF	39-Z	.0137	.0337	.0187	.0160	5

M-R-C Instrument Ball Bearings

Plainville, Conn. Plant

New Super-Precision Plant Falconer, N.Y.

MARLIN-ROCKWELL CORPORATION
Executive Offices: Jamestown, N.Y.
Factory: Jamestown, N.Y., Falconer, N.Y., Plainville, Conn.

Form 1543

Write for Form 1543

MARLIN-ROCKWELL CORPORATION
Executive Offices: Jamestown, N.Y.

COSTS LESS INSTALLED
and
OUT-PERFORMS
ANY HERMETIC SEAL TERMINAL MADE

the
NEW *Heldor*

**RIVET TYPE
 LOCK-IN TERMINALS**

FIVE STYLES

STYLE #1



STYLE #2



STYLE #3



STYLE #4



STYLE #5



- **CUT COSTS . . .** can be supplied installed at a lower cost than solder seal terminals.
- **FAR SUPERIOR . . .** will outperform any other terminal made.
- **MEET MIL-T-27 TWIST TEST . . .** will not turn, crack or leak!
- **CONSERVE SPACE . . .** ideal for condensers, capacitors, transformers and similar applications.
- **AVAILABLE IN RIVET OR THREADED STUD TYPES. . .** can be adapted to fit individual specifications.

HELDOR has perfected a new bushing design with all the quality advantages of lock-in terminals . . . yet they are so *outstandingly practical* that now, for the first time, you can use them in many places where you could never before afford compression type, hermetic seal bushings. These new, rivet-bottom terminals will cut big chunks out of your production costs and can be used for *any* application requiring quality bushings . . . with far lower installed-costs and far better performance than comparable terminals.

GET THE FACTS! Mail your prints or "specs" today for an eye-opening, money-saving quotation. **DO IT NOW!**

WRITE FOR DETAILS!

HELDOR MANUFACTURING CORPORATION

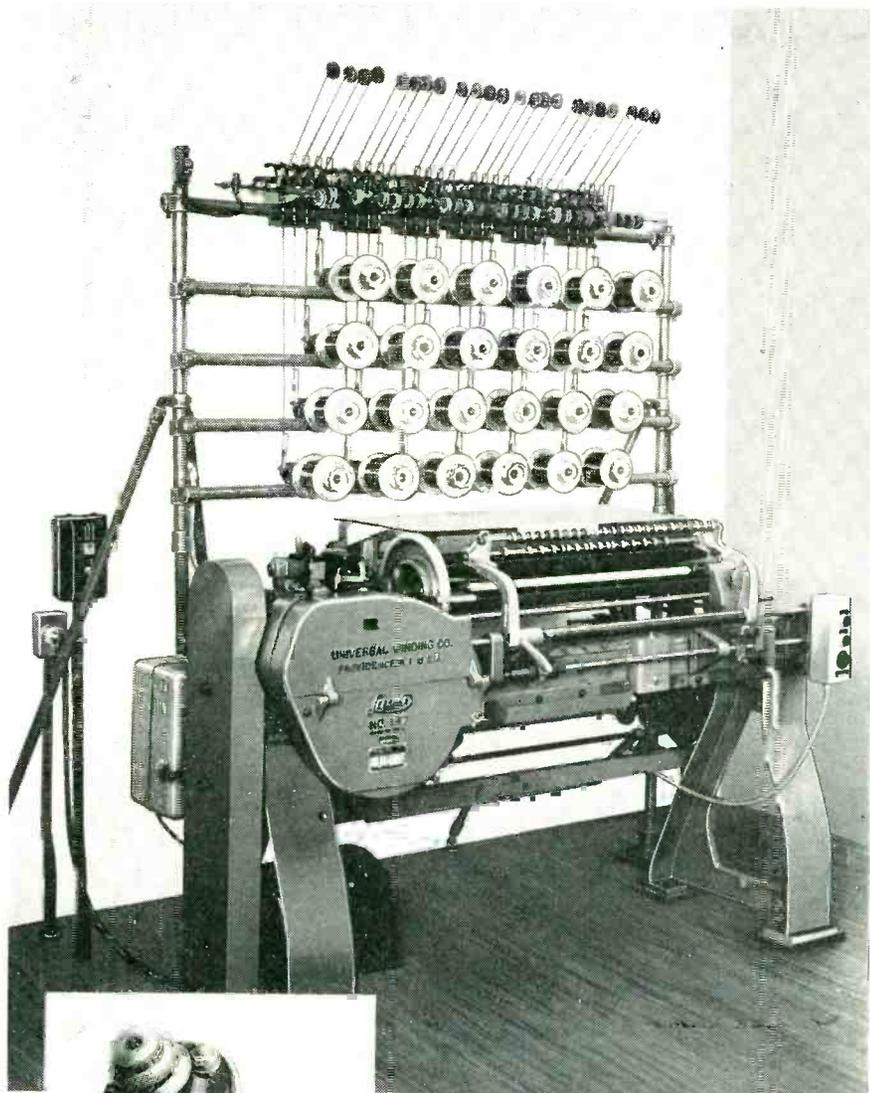
HELDOR HERMETIC SEAL COMPANY, INC.

238 Lewis Street

Paterson, N. J.



New Coil Winders Aid Production Flow



The Leeson No. 107 Automatic Coil Winder winds 4 to 30 paper-insulated coils in stick form simultaneously. Handles wire sizes from No. 19 to No. 42 (B&S). Automatic operation eliminates human error, and the smooth electronic drive reduces wire breakage to a minimum. Standard Motor Products' installation of fast, accurate No. 107 machines is speeding production of Blue Streak and Standard ignition coils (inset).

**Standard Motor
Products Inc. uses
Leesona No. 107 Automatic
Coil Winders to integrate
production output**

Once again Leesona Coil Winders prove their ability to deliver faster, more efficient performance.

Here is what H. O. Rosenstein, V.P., of Standard Motor Products Inc., Long Island City, N. Y., has to say about their No. 107 Coil Winders:

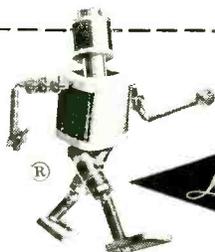
"Perfect timing with our production schedule has been achieved by the installation of Leesona No. 107 Automatic Coil Winders for winding our ignition secondaries. Results have lived up to every expectation. The new Leesona No. 107 Machines are great performers. Their automatic operation gives us exactly the precision accuracy we want — plus perfect coordination with our general production flow."

Reports like this are familiar stories wherever plants have modernized with Leesona No. 107 Coil Winders. And they give you a good idea of how these advanced machines can benefit your own coil winding operations.

Get All The Facts

on the Leesona No. 107 Coil Winder. Send the coupon for a new, illustrated bulletin describing how every feature is designed to produce compact, uniform paper-insulated coils — in fastest time — with minimum operator attention — at lowest cost.

Read how you can step up your coil winding production to new, profit-boosting efficiency — with the machine that's the last word in automatic coil winder design. The coupon also lists other helpful coil winding information. Why not check and mail it today?



FOR WINDING COILS
IN QUANTITY... ACCURATELY
... AUTOMATICALLY... USE
UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 11

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 of leading modern coil winding machinery.

Name.....Title.....

Company.....

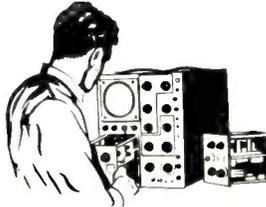
City.....Zone.....State.....

NEW!

Two more PLUG-IN UNITS for Tektronix Type 531 and 535 Oscilloscopes

Type 53E Low-Level Differential Preamplifier

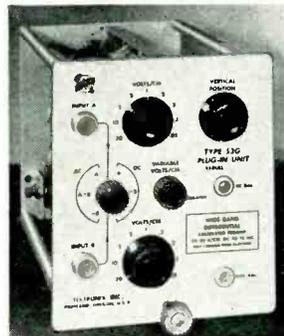
50 microvolt/cm to 10 millivolt/cm calibrated sensitivity. Frequency response, 0.06 cycles to 60 kc. Rejection ratio, 80,000 to 1 for in-phase signals at full gain. 7 μ v rms maximum combined noise and hum with input grids grounded at the input connector \$165



A new micro-sensitive preamplifier, Type 53E . . . and a new wide-band differential preamplifier, Type 53G . . . greatly expand the working range of Type 531 and Type 535 Oscilloscopes. Application areas entered with these new plug-in units ordinarily require the acquisition of cumbersome auxiliary equipment or separate specialized oscilloscopes. But you can equip your Type 531 or Type 535 for either or both types of work for just the cost of the plug-in unit . . . without loss of performance in its other applications. *Your Type 531 or Type 535 becomes potentially more useful to you each time Tektronix announces a new plug-in unit.*

Type 53G Differential Wide-Band DC Preamplifier

DC to 10 mc, risetime 0.035 μ sec. 0.05 v/cm to 20 v/cm calibrated sensitivity. Separate step attenuators for both inputs. Better than 100-to-1 common-mode rejection at full gain for the entire passband \$175



OTHER PLUG-IN UNITS

- Type 53A** — DC to 10 mc, 0.035 μ sec risetime; 0.05 v/cm to 50 v/cm, calibrated \$85
- Type 53B** — Same as Type 53A with additional calibrated ac-sensitivity to 5 mv/cm \$125
- Type 53C** — Dual-trace unit. Two identical amplifier channels, dc to 8.5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep . . . or free running at about 100 kc \$275
- Type 53D** — Differential input, high gain. DC to 350 kc at 1 mv/cm — passband increasing to 2 mc at 50 mv/cm. Full range — 1 mv/cm to 125 v/cm \$145

OSCILLOSCOPE CHARACTERISTICS

Advanced Cathode-Ray Tube

Entirely new metallized crt provides full 6cm x 10cm undistorted viewing area . . . 50% more vertical deflection than previous high-sensitivity tubes. 10 kv accelerating potential permits single-sweep photography at the fastest sweep speed.

Wide Range of Triggered Sweeps

0.02 μ sec/cm to 12 sec/cm, continuously variable. 24 calibrated sweeps from 0.1 μ sec/cm to 5 sec/cm, accurate within 3%. Accurate 5-x magnification.

Wide-band Output Amplifier

DC-coupled amplifier designed for use with all Type 53-series Plug-in Units.

Balanced Delay Network

0.25 μ sec signal delay in vertical amplifier.

Sensitive Horizontal Amplifier

0.2 v/cm to 20 v/cm sensitivity.

Versatile Triggering

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

Square-Wave Amplitude Calibrator

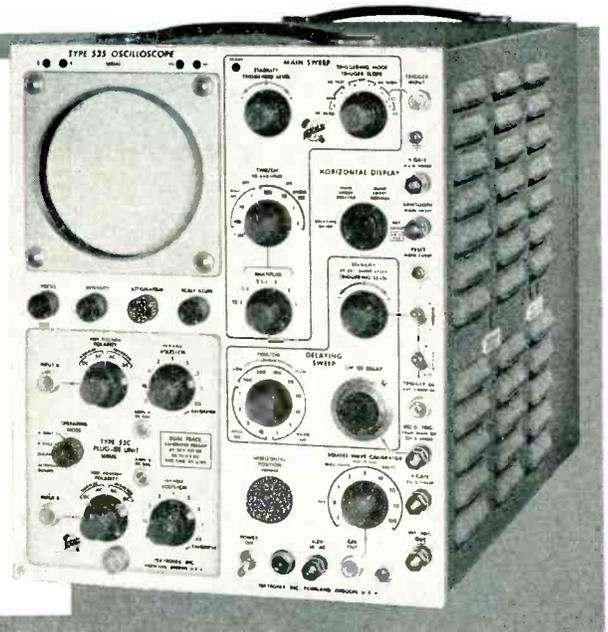
0.2 mv to 100 v in 18 steps, accurate within 3%.

DC-Coupled Unblanking

CRT Beam Position Indicators

Electronic Voltage Regulation

Write for A-101, free 12-page specification booklet



TYPE 535

➡ Your Tektronix Field Engineer or Representative will gladly arrange a demonstration at your convenience . . . call him today.

Tektronix, Inc.

P. O. Box 831A • Portland 7, Oregon
 CYPRESS 2-2611 • Cable: TEKTRONIX



Type 531 — \$995 plus price of desired plug-in units.

Type 535 — Same characteristics — plus delayed sweeps. 1 μ sec to 0.1 sec calibrated delay in 12 ranges, incremental accuracy within 0.2% of full scale. Conventional or triggered operation \$1300 plus price of desired plug-in units. Prices f.o.b. Portland (Beaverton), Oregon.

**TUNING FORK
RESONATOR**



**NEW DRIVE
PRINCIPLE**



TRANSISTORS

7

**ADVANCED
FEATURES**

Audio IN
FREQUENCY STANDARDS

1 COMPACTNESS

Complete audio frequency standard, ready to operate, takes as little space as 2 cubic inches—weight as low as 4 ounces. Available in vacuum sealed packages if desired.

2 5MW. POWER INPUT

Only one energy source of 3 to 6 volts needed. A series resistor may be used for a higher voltage source.

3 10 VOLT SIGNAL OUTPUT

Several times the direct output of conventional drives. In many applications, unit eliminates the need for intermediate amplifiers

4 0.2% TOTAL DISTORTION

Excellent wave form does away with need for “clean up” filtering—makes these standards an ideal tone source for distortion measurements, communications and telemetering applications.

5 Q: 12,000

New drive principle virtually eliminates magnetic stress and eddy current drag on the resonator—results in an operating Q heretofore unattainable.

6 0.001% ACCURACY

Substantial reduction of external influences and use of temperature compensated alloy resonators combine to make the most of the inherent precision of the tuning fork principle.

7 LONG LIFE EXPECTANCY

Silicon or germanium transistors operate conservatively in these standards, to take full advantage of a life expectancy generally recognized as being many times that of vacuum tubes.

WIDE DESIGN
FLEXIBILITY
TO MEET
SPECIAL
REQUIREMENTS

ADVANTAGES IN AUDIO FILTERS

Improved linearity and high efficiency make these mechanical resonators particularly suitable for filter applications. Features include: (1) Q and stability exceeding toroid-capacitance combinations; (2) space and weight savings below 2,000 cycles; (3) magnetic circuit distortion -54 db. at rated level; (4) ratio of equivalent electrical resonance impedance to winding impedance up to 300:1; (5) taps and multiple windings if desired; (6) no need for matching two components for a specified frequency.

Requests for full information or assistance on special applications invited without obligation.

McSHAN DEVELOPMENT CORPORATION
71 MURRAY STREET
NEW YORK 7, N. Y.

A ROUGH RIDE FOR THE
ELECTRONIC UNIT!

So DOELCAM makes sure it rides safely
with **NOPCO[®] LOCKFOAM**

When you're building a guided missile, you have to find a way to protect from terrific vibration and shock the sensitive resistors, capacitors, vacuum tubes, and transistors that make up the electronic circuit—the "brains" of the giant projectile.

Let Doelcam Corporation, Boston, Mass., tell you why they choose Nopco Lockfoam for this important task.

Says Doelcam: "The electronic parts, firmly bound in this light-weight plastic, withstand tests of vibration in 3 planes from 0 to 500 cycles per second at 10 G and shocks of 50 G. The advantages of Lockfoam in such electronic airborne applications are its light weight, inherent strength, and its ability to grip the electronic components firmly enough to protect them from vibration and shock and yet gently enough not to crush them."

Plus, of course, ease of assembly; the liquid Lockfoam is simply poured into a mold which contains the electronic circuit, and hardens around it.

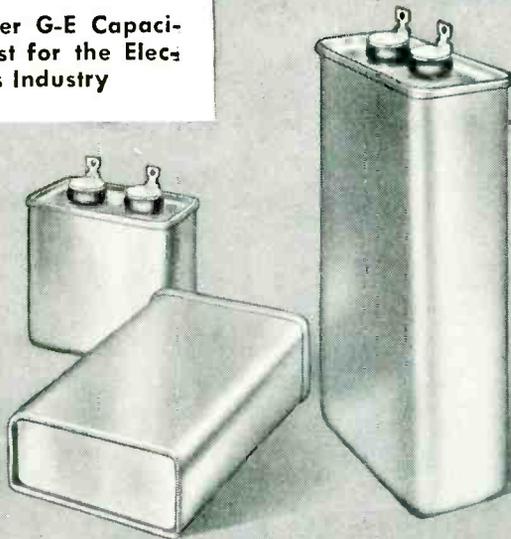
Each of Lockfoam's 50 different formulations is highly consistent and reproducible. Perhaps the rare combination of properties of this versatile plastic can help with some product *you* have in mind. Write today for the Nopco Lockfoam booklet.

Nopco Chemical Co., Plastics Division,
248 Stier St., Harrison, N. J.

NOPCO

California Office: 4858 Valley Blvd., Los Angeles 32

Another G-E Capacitor First for the Electronics Industry



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

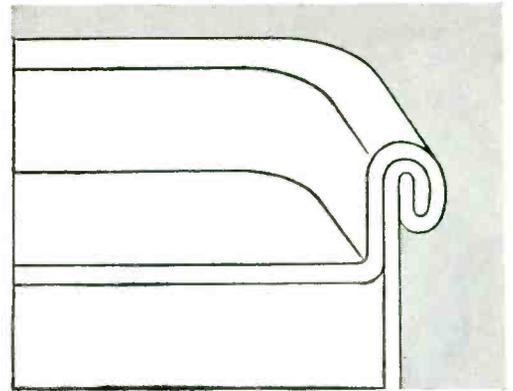
new... G-E CAPACITORS IN DRAWN-RECTANGULAR CASES

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

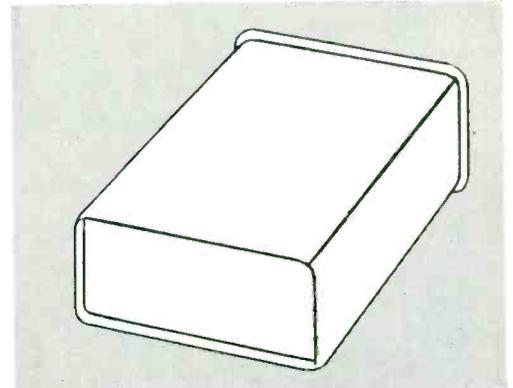
General Electric is now producing fixed paper-dielectric capacitors in seamless, solderless cases with standard dimensions that comply with or exceed MIL specifications. For complete information contact your G-E Apparatus Sales Office or write for Bulletin GEC-809A to Section 442-24, General Electric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

Progress Is Our Most Important Product

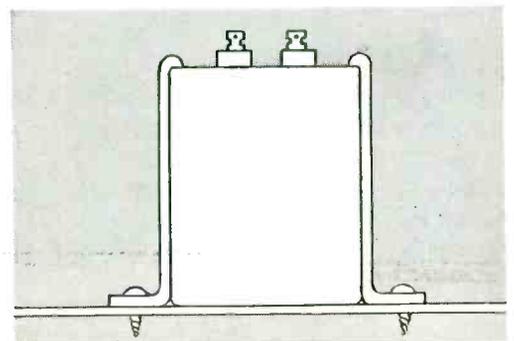
GENERAL  ELECTRIC



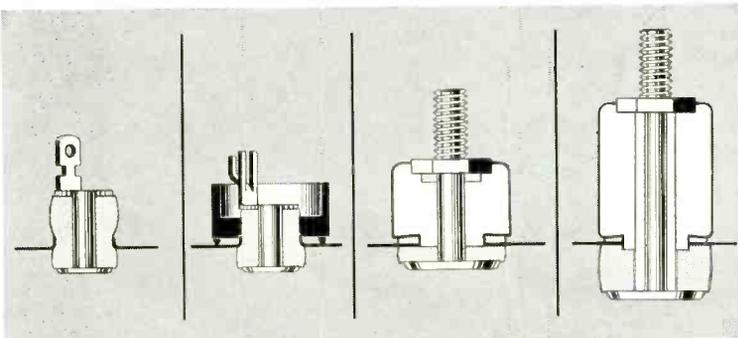
SOLDERLESS DOUBLE-ROLLED COVER SEAM makes a mechanically strong, hermetic seal.



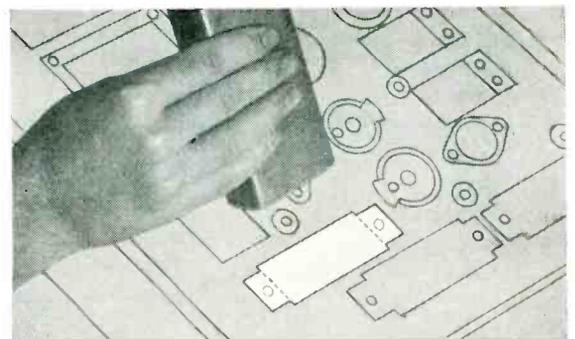
BOTTOM OF CASE IS INDENTED to permit mounting in inverted position.



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



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



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



Joseph H. Snyder, President of the Color Corporation of America, tells:

“How we set a record with the Thunderbird!”

“When news got out about the Thunderbird, Ford dealers scheduled a big preview at Palm Springs, California,” relates Joe Snyder of Color Corporation of America.

“But as the date drew near, it became clear to Ford that the one Thunderbird then in existence—a hand-made model—would have to stay there in Detroit!

“The solution? Giant natural color prints—and Air Express.

“Films were rushed to the Color Corporation in Tampa,

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Are the contacts you use

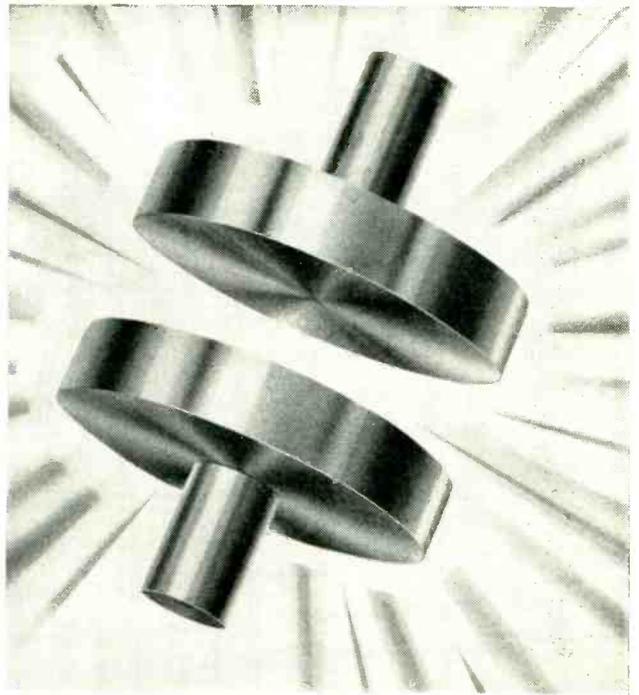
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CROSS
TALK

► **CONTENTS** . . . If you look up front to pages 1, 2 and 3 of this issue of **ELECTRONICS** you will see that we have doubled the space devoted to the indexing of editorial contents.

In addition to listing featured articles we also give the location within the magazine of shorter but no less important items appearing in the *Industry Report*, *Electrons At Work*, and *Production Techniques* departments. This, we think, will make it easier to find ideas of specific interest despite continued growth of the industry which we serve.

To further flag the contents for busy readers these same front-of-book pages will contain a new department called *Shoptalk*, in which significant activities of the magazine, its editors and its authors, past, present and future, will be briefly outlined.

This is the first and not the last improvement in service planned for 1955 beginning, appropriately, in January.

► **RECOGNITION** . . . The week of February 20-26 has been designated National Engineers Week.

The purpose of this observance is to bring to the attention of the public the importance of the engineering profession to the country's future. The future prosperity of the United States, and her very safety, are largely dependent upon continued ingenuity in the engineering application of scientific discoveries to increased produc-

tivity and to military preparedness.

We are happy to join in the effort to focus attention on these obvious facts.

► **WASHINGTON** . . . In the nation's capital for the better part of a week, we did our best to determine what lies ahead business-wise, and it looks like this:

Government orders for electronic equipment should be larger in 1955 than in 1954. Orders placed in 1953 and earlier were deliberately stalled while the Department of Defense took stock after Korea. Resumption of buying after stock-taking occurred around mid-1954. It is likely to increase, although not sharply, during the coming year, and present planning would tend to level out purchases roughly two years later.

The nature of products ordered may be somewhat different than in recent years; emphasis is at the moment shifting from stockpiled staples for masses of men to more specialized equipment representing what might be considered the electronic equivalent of increased firepower, from long-range offensive weapons to short-range defense weapons. There are some notable exceptions, but they are exceptions.

► **MEN OF PARTS** . . . Experienced components engineers are extremely scarce. Even recent graduates are not readily interested in such specialized design

work, preferring the glamor of systems, circuits, tubes and semiconductors.

There is a real opportunity for men who thoroughly understand parts (see p 2), not only with companies that make them but also with assemblers who can profit by intimate knowledge of the types and qualities of components available.

We know of several men who have recently leaned in this direction; there should be more.

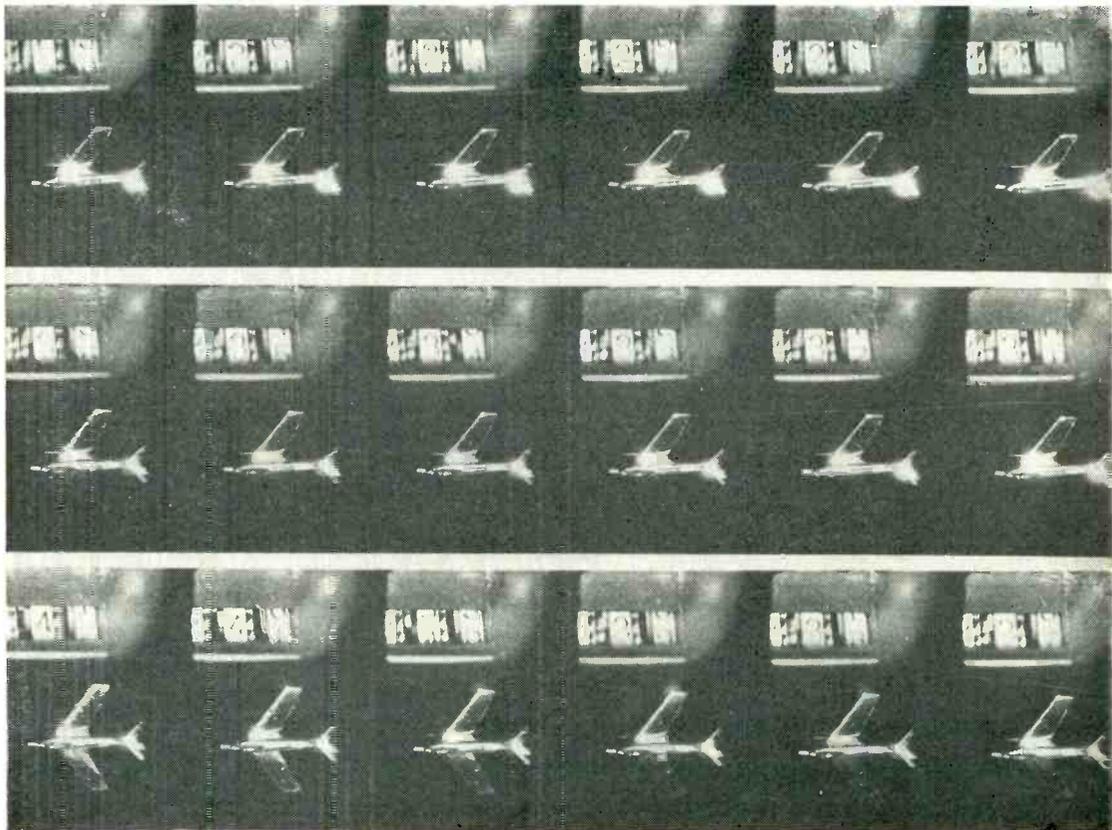
► **COUNT 'EM** . . . Traveling wave tubes are not yet used in sufficient quantity to warrant mass production, but they are so promising for many applications that quite a few companies are producing such tubes for the experience.

This, a friend of ours on the west coast tells us, accounts for the fact that in that area at least there are almost as many traveling wave tube engineers as there are traveling wave tubes.

► **CONTRACTS** . . . A manufacturer who is reputed to have an uncanny ability to handle even the most complex government contracts and get out with a whole skin says his system is simple:

"Get everything in the record. Then render frequent status reports."

Contracting officers, it seems, come and go at fairly frequent intervals. And new ones have nothing much to guide them except what they see written down.



Specular photographs of a fighter aircraft present continuous information as to source of reflection from target

Airplane Models Reveal

Simple, rapid and inexpensive method of estimating regions of high and low radar reflection by light reflection technique indicates which surface of an aircraft must be modified to reduce the susceptibility to detection by radar

By **ELWOOD B. COLE, JR.**

*Electronics Department
The Glenn L. Martin Company
Baltimore, Maryland*

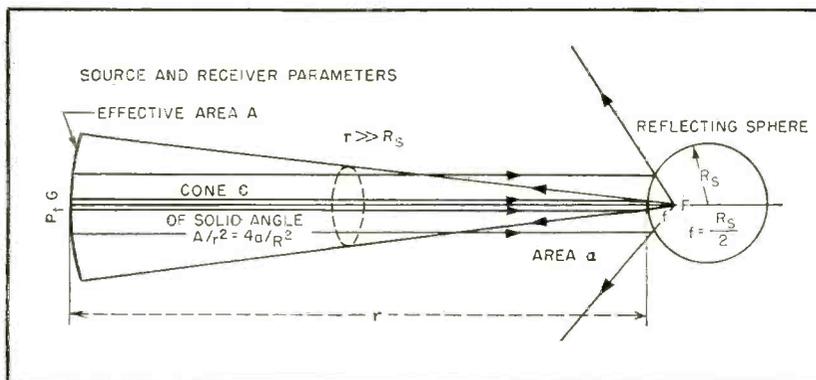


FIG. 1—Geometrical optics of a reflecting spherical target. Distance between the reflecting sphere and light source is much greater than the sphere radius

CROSS SECTION in radar parlance is a measure of the amount of power reflected from the target to the receiver. By definition, radar cross section is the intercepting area which an isotropically scattering target must have to produce the same signal at the receiver as the actual target.

The radar cross section of an aircraft, or any target of complex shape, in general will vary substantially according to the aspect at which it is illuminated. If illuminator and receiver are physically

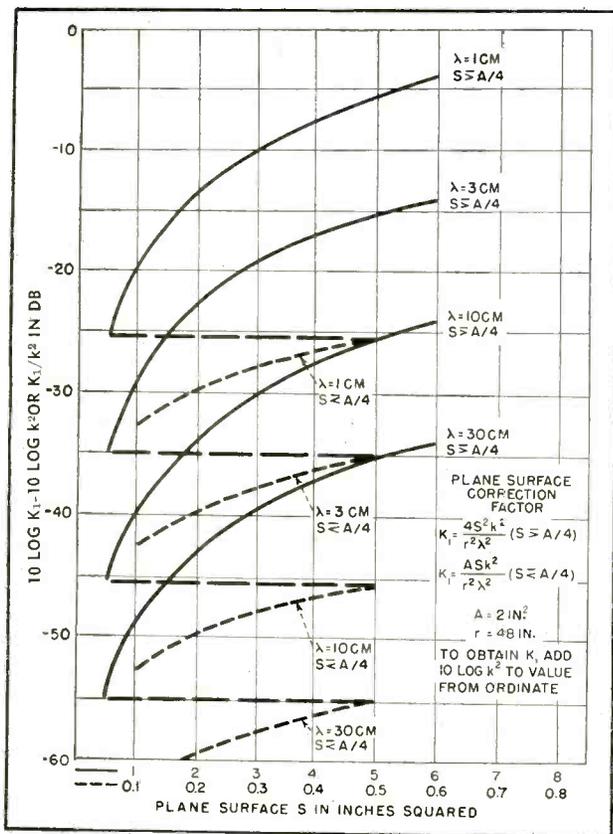


FIG. 2—Plot of $10 \log K_1/k^2$ versus plane surface S

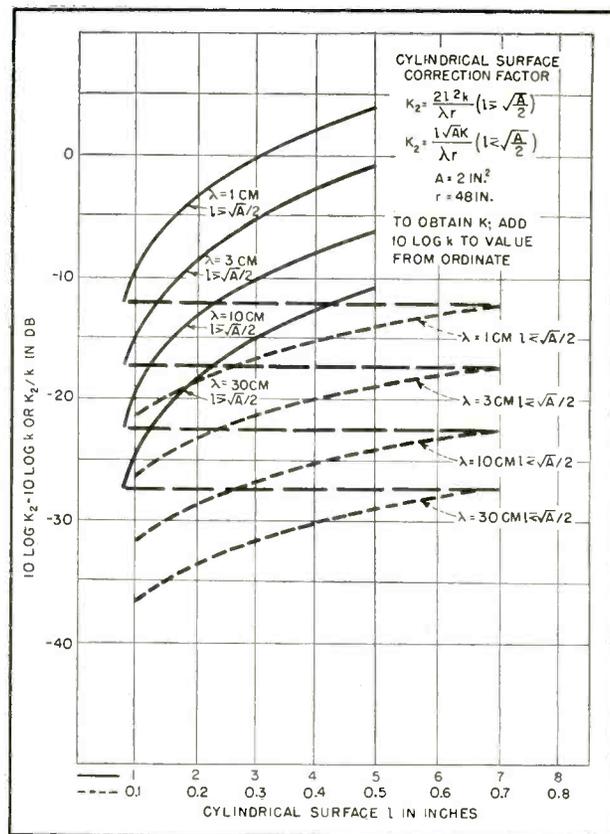


FIG. 3—Plot of $10 \log K_2/k$ versus cylindrical surface l

How to Avoid Radar

separate the radar cross section will also vary as a function of the viewing aspect.

Radar cross-section measurements of aircraft in flight have produced results which are not altogether consistent or compatible with theory.¹ Furthermore, airborne tests are expensive and introduce errors and unknown variables.

The use of specular models is a relatively simple technique for approximating radar cross section and recording simultaneously the major source of reflection.

A specular scale model of an airplane is totally illuminated by a beam of white light having approximately the same divergence as a radar beam. The reflected light is then measured as a function of target aspect. The model is rotated, and simultaneously a photographic record of the illuminated model is made for every degree of rotation

with respect to receiver position. The recorded received signal is an approximation of the radar cross section.

To estimate cross section magnitudes for large reflection lobes, corrections are required for measured values from certain geometric surfaces, depending on the particular full-scale frequency. The specular model method of approximating radar cross section may be used to formulate a program for reducing the reflectivity of certain portions of an aircraft.

Spherical Target

Figure 1 shows the geometric optics of a reflecting sphere at a distance r from an illuminating and receiving point. The spherical radius R_s is much larger than the wavelength of illuminating energy. The distance r is so much larger than the radius R_s , that the sphere

may be considered to be illuminated by parallel rays. This geometry is shown out of scale for clarity. The incident energy is reflected back toward the receiver as if from focus F to a first approximation.

Only the reflected energy in cone C with area a on the surface of the sphere, will be intercepted by effective receiver area A . When P_T is the source power and G is the gain over an isotropic source, the received power P_r is given by

$$P_r = P_T G R_s^2 A / (4\pi r^2 \times 4r^2)$$

For unit power density incident on sphere

$$P_r = R_s^2 A / 4r^2$$

The familiar radar range equation may be expressed as

$$r^4 = G^2 \lambda^2 P_T \sigma / (4\pi)^3 P_r \quad (1)$$

where λ = wavelength and σ =

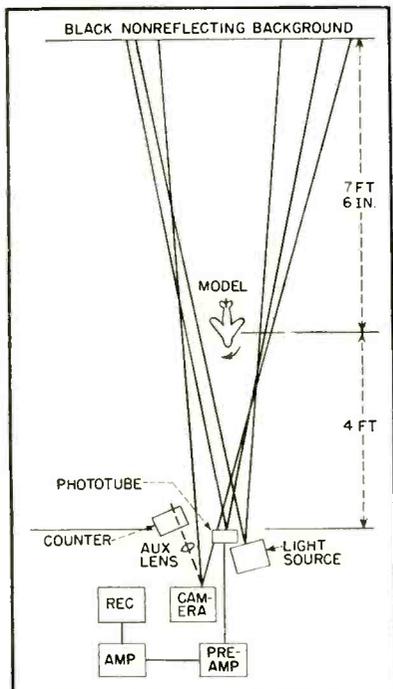


FIG. 4—Reflection measuring setup for analyzing the reflection characteristics of different shapes

radar cross section of target, or

$$P_r = P_t GA \sigma / (4\pi r^2)^2$$

or for unit power density

$$P_r = A \sigma / 4\pi r^2 \quad (2)$$

Equating Eq. 1 and 2

$$\sigma = \pi R_s^2 \quad (3)$$

The derivation of the radar cross section of a sphere by electromagnetic considerations yields essentially the same results when $R_s \gg \lambda$.^{2,3,4} Under the conditions specified, the scattering cross section of a sphere is the same, whether illuminated by white light or by r-f.

In geometric optics, note that when the sphere is entirely within the illuminating beam, the energy will be scattered isotropically by the sphere, to a first approximation. Since only a portion of the isotropically scattered energy is received, the same energy is received when a spherical sector of the same spherical radius scatters the incident energy, provided the receiver is wholly included within the scattering solid angle. This requires the same power density incident on the scatterer in both cases, and the same power per unit solid angle scattered back toward the receiver.

Arbitrary Target

An airborne target will not be geometrically simple in shape, and the received signal will be a com-

posite of signals reflected from numerous surfaces of various configurations. However, under a particular set of conditions, and for a given target aspect, the received power regardless of the sources will have a value P_r . There is then, a sphere of radius R_s which will produce the same signal at the receiver

$$P_r = AR_s^2/4r^2$$

When illuminated with r-f energy, various regions of the target cause constructive and destructive interference effects at the receiver as the target makes slight changes in relative position. Such interference effects, due to relative phase differences of the returns from the various surfaces, will be present when the interfering echoes reach the receiver within a time difference less than the pulse duration. When the pulse duration is 1 microsecond, the signals interfere if their range difference is less than 491 feet. Such is the case for a single aircraft target.

Within a target aspect range where interference lobes are predominant (absence of intense signals which obliterate the interference pattern), an average received power, P_r , exists. Since the amplitudes and not the intensities add, the received power, P_r , at any particular aspect may be more or less than the average, P_r . The probability that the received power exceeds a certain value, P_r , may be expressed as^{5,6}

$$P(p) = e \exp(-P_r/P_r)$$

When a similar target is illuminated with white light, the reflections from various surfaces are incoherent and the received power over a range of aspect angles is equal to the average, P_r .

In the absence of intense reflections, detection of an aircraft target will be governed primarily by the average received power, P_r , rather than interference maxima or minima due to aircraft vibration, rapid relative motion with respect to the receiver or changes in attitude and aspect. For a target as qualified above, light reflection methods will give a good approximation of the average cross section in the interference region, a measure of P_r . The reflected signal from the rotated model is recorded; the model is removed and a sphere

of radius, R_s is substituted and the reflected signal from the sphere is recorded. The sphere represents a cross section of πR_s^2 , or a full-scale cross section of $\pi k^2 R_s^2$, where k is the scale factor. Thus, the average return from the target may be calibrated, and the average cross section, σ expressed in full-scale area. The recordings are made proportional to $10 \log P_r$, so that the pattern may be calibrated in db.

An aircraft target will present plane and cylindrical reflecting surfaces at certain aspects and large received signals will be observed from these surfaces at normal incidence. Reflections from such surfaces, when illuminated with white light, are not in the same proportion to the returns from spherical surfaces, as they are in the case of radar illumination. Therefore, a correction must be made to the measured light values to restore the correct proportionality.

Radar cross sections of several basic shapes have been derived and are listed in Table I along with white light cross sections derived from geometric optics. The correct proportion for a plane surface with respect to a sphere, is then

$$4S^2/\lambda^2 R_s^2$$

and for a cylinder

$$2l^2 R_c / \lambda R_s^2$$

The measured proportionality by white light reflection for a plane surface is

$$r^2/R_s^2 \text{ for } S \cong (A/4)$$

or $4Sr^2/AR_s^2$ for $S \cong (A/4)$

and for a cylinder

$$rR_c/R_s^2 \text{ for } l \cong (\sqrt{A}/2)$$

or

$$2lrR_c/\sqrt{A}R_s \text{ for } l \cong (\sqrt{A}/2)$$

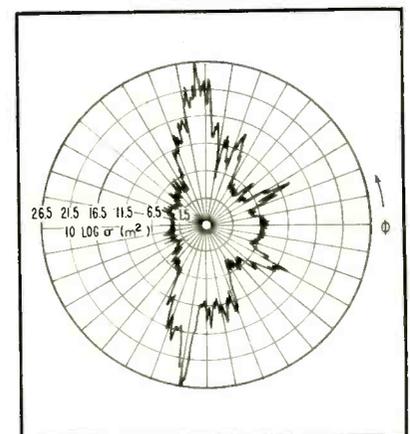


FIG. 5—A representative reflection pattern of a fighter aircraft

Measured returns by white light reflection must be corrected by a factor, K , the ratio of radar cross section to light cross section. For plane surfaces

$$K_1 = 4S^2k^2/\lambda^2r^2 \text{ for } S \geq (A/4)$$

and

$$K_1 = ASk^2/\lambda^2r^2 \text{ for } S \leq (A/4)$$

and for cylinders

$$K_2 = 2l^2k/\lambda r \text{ for } l \geq (\sqrt{A}/2)$$

and

$$K_2 = l\sqrt{A}k/\lambda r \text{ for } l \leq A/2$$

Plots of $10 \log K_1/k^2$ and $10 \log K_2/k$ are shown for a particular set of measurement parameters in Fig. 2 and 3. Full scale wavelengths of 1, 3, 10 and 30 cm are shown.

For any single plane or cylindrical reflecting surface, r has a particular value which gives the correct proportionality. It is not practical to make r variable, since models usually have more than one such surface. The particular values of r can be inconveniently large or small depending on wavelength.

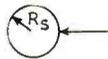
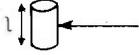
When radar cross section is measured with a scale model aircraft illuminated with scaled r-f energy, no correction is necessary to preserve the proper proportionality of the plane-surface return to the spherical return. Therefore, the λ term in the factors K should be the particular scaled wavelength.

A photographic recording of the rotating model is made to determine which portions of the reflection pattern are due to plane surfaces, cylinders and so forth. The aircraft model is photographed for each degree of rotation, and a reference counter, photographed simultaneously, translates the picture to the receiving location. A reflecting surface with at least one flat dimension at normal incidence is indicated by a sharp increase in return intensity and shows up as a flash on the picture. The picture will show the portion of the aircraft responsible; measurement may be made to determine the value of K .

Measurement Procedure

The reflection measuring apparatus is illustrated in Fig. 4. A light source illuminates the model. The light beam is mechanically chopped at 800 cycles per second to facilitate amplification of the returned signal and permit rejection of sig-

Table I—Cross Sections

Surface	Radar Cross Section	Light Cross Section	Radar Cross Section / Light Cross Section = K
Spherical 	πR_s^2 (when $R_s \gg \lambda$)	πR_s^2	1
Plane Surface Area S 	$\frac{4\pi S^2}{\lambda^2}$ (smallest linear dimension of least several λ)	πr^2 (when $S \geq A/4$) $4\pi r^2 S/A$ (when $S \leq A/4$)	$\frac{4S^2}{\lambda^2 r^2}$ $\frac{SA}{\lambda^2 r^2}$
Cylindrical Radius R_c Length l 	$\frac{2\pi R_c l^2}{\lambda}$ (when $R_c \geq \lambda/4$, $l \geq 2\lambda$)	$\pi R_c r$ (when $l \geq \frac{\sqrt{A}}{2}$) $\frac{2\pi R_c l r}{\sqrt{A}}$ (when $l \leq \frac{\sqrt{A}}{2}$)	$\frac{2l^2}{\lambda r}$ $\frac{l\sqrt{A}}{\lambda r}$
Doubly Curved Surface, Principal Radii R_1, R_2 	$\pi R_1 R_2$ (when $\frac{d^2}{2R} > \lambda$)	$\pi R_1 R_2$	1

nals from extraneous sources. The model, supported by a nonspecular stand, is rotated by a turntable below the illuminating light beam. Reflections from the model are detected by the phototube, passed through a preamplifier and selective main amplifier. The amplifier output signal is fed into the recorder which is synchronized with the turntable. Recordings may be made on linear or polar coordinates and the pen recording function is proportional to $10 \log P_r$. Dynamic recording range may be 20, 30 or 40 db or full scale.

Photographs of the rotating model may be taken with the camera which records on the counter the angular position of the model. The auxiliary lens permits simultaneous focusing on the model and the counter. The optical axis of the phototube and the axes of the light source and camera are separated by approximately 3 degrees. When recording photographically, the counter reading is adjusted so that the pictures are referred to the detector position.

A representative reflection pattern is shown in Fig. 5. In evaluating measurements, good correlation is obtained between the photographs and the reflection pattern.

In order that adequate reflected signals may be present at the de-

detector, the model must be approximately four feet from the source.

Sources of Measurement Error

The angle subtended by the model at the detector is probably large enough to introduce some error in the return intensities as the model is rotated. The angle may be smaller, without sacrifice of sensitivity by moving the model away from a more intense light source.

Measurements have been made with the source and receiver separated up to 45 degrees, with no great change in pattern shape when the separation is less than about 20 degrees. The pattern will rotate in relation to the receiver, an amount equal to half the angle of separation. No appreciable error is introduced by the 3-degree separation, provided the pattern rotation is compensated.

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Recording and Tabulating

Listener's tuning information is recorded to provide film for high-speed tabulation. System is applicable to precise recording of slowly changing variables such as atmospheric data and cosmic ray or radioactive radiation densities

By **A. C. LEWIS BROWN**

*A. C. Nielsen Co.
Chicago, Ill.*

ARAPIDLY growing branch of the marketing research field is the production of data on radio and television listening. The most accurate information is obtained from recording devices attached to receivers in the listeners' homes.

A large number of these recording devices have been installed and maintained in a representative sample of homes on a nation-wide basis.

The recording instruments are electro-optical in operation and record listening information on unperforated 16 mm microfilm in the form of exposed or nonexposed areas so that the information is essentially binary in nature. This recording medium was chosen because of advantages in size, accuracy, permanence of record and speed of decoding. Figure 1 shows a portion of a typical listening record.

In channel 1, the minute-mark channel, one rectangular black mark is laid down on the continuously moving film each minute. In channel 2, the time-mark channel, one nine-minute black mark is laid down each 24 hours under the control of a separate clock for time accuracy checking. The next 20 channels can record radio or television listening time on any of 15 stations on one to four receivers.

Channels 3 to 7 record listening to receiver 1 as follows: Channel 3, the on channel, becomes dark when the receiver is turned on. The next four channels are assigned binary numerical values of 1, 2, 4 and 8, and record the assigned number (1 through 15) of the station. The remaining channels operate in the

same way with the other three receivers. For instance, Fig. 1 indicates listening by receiver 1 to station 6, by receiver 2 to station 10, receiver 3 off and listening by receiver 4 to station 1. The receiver on channels provide for the possibility of listening to a station which is not one of the calibrated 15, in which case no station number appears.

A pickup unit mounted on or near each receiver obtains tuning information from the receiver and converts it to electrical form for transmission to the recorder. Up to four pickups can be connected to one recorder unit.

Pickups

There are several methods of obtaining voltages corresponding to receiver tuning. One uses an adjustable position switch driven mechanically by a link with the receiver tuning device. The position switch consists of a central common drum having 15 angularly adjustable contact cams placed along its axis. Drive ratios are adjusted so that tuning the receiver through its entire range results in one rotation of the drum.

The angular positions of the 15 cams are adjusted at the time of installation so that tuning to each station on the receiver results in the application of voltage from the common drum to one cam at a time. For each of the stations only one of the wipers will be energized which is essentially decimal coding of the information. By means of a resistance matrix shown in Fig. 2, this decimal information is converted to binary information.

Matrix resistance values are chosen to give satisfactory ratios of correct to incorrect binary output voltages with a reasonably large magnitude of correct voltage.

Another method for collecting listening information from a radio involves the use of a hunting receiver which seeks the local-oscillator frequency of the radio by means of a motor-driven tuning capacitor. When the correct frequency is found, a detector-operated relay stops the hunting action until the receiver is re-tuned to another station. A position switch accepts tuning information from the motor-driven capacitor.

This method requires only simple electrical connections to the receiver rather than mechanical connections which are more complex from the field installation viewpoint.

Recorder

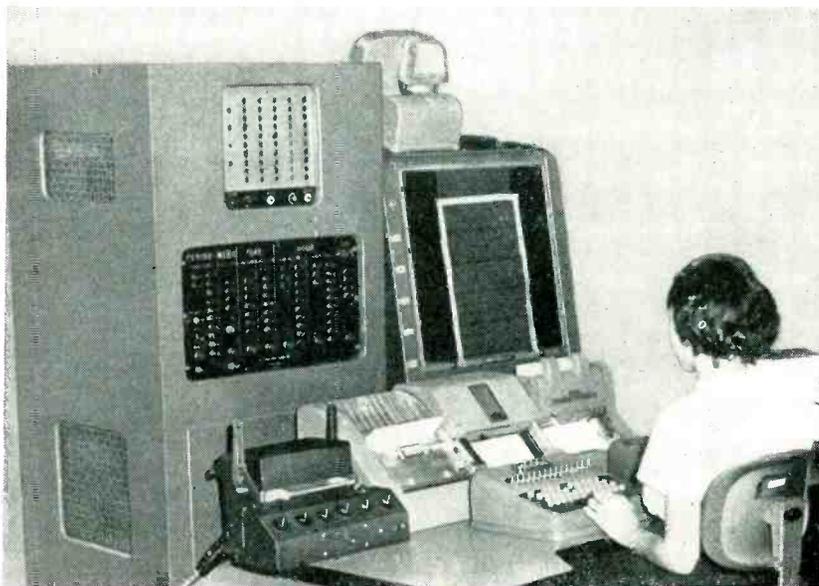
Figure 3 is a sketch of the basic parts of the recorder. The light source is an argon bulb whose rays are passed through a collimator, a slit disk and a shutter disk to an objective lens which focuses the image of the slit across the film. The shutter disk is opaque except for a spiral row of 22 clear patches whose radial positions correspond to the lateral channel positions on the film. As the shutter disk makes a complete revolution, each channel will be exposed provided the argon bulb is lighted at the correct shutter-disk position.

The shutter disk is driven continuously at 1 rpm in synchronism with a 22-contact commutator switch having contacts at the same angular positions as the shutter

the Radio-TV Audience



Pick-up unit behind receiver feeds tuning information to unit recorder in cabinet



Semiautomatic film decoding unit supplies time data to card punch. Operator inserts station listening information from film projected on screen

disk holes. The common terminal of the switch is connected to the grid of a thyratron having the argon light source in its plate circuit. The 22 contacts are connected to the proper cables from the resistance matrices in the 4 pickups.

As the commutator switch and shutter disk rotate, each receiver is interrogated in turn, and its listening is recorded in the proper film channel. Film speed is 0.013 inches per minute, and sufficient spot overlap is provided that the listening record appears as continuous black lines. The portion of the slit which controls the minute-mark exposure is one-half the width of the other slits. Thus the black minute-mark area is one-half that of the other spots, and film motion during the rest of each scanning cycle causes the clear gaps between the minute marks.

The listening time for each receiver is thus recorded on a minute-by-minute basis which allows the checking of short commercials as well as longer programs.

Film is stored within the recorder on a two-hundred foot supply reel. It is pulled from this reel by a drive roller past the point of exposure, and then into a separate removable magazine. Light seals prevent unwanted exposure. One reel of film

will record a two-week listening period. At the end of this period pulling a lever on the recorder cuts the film and winds the cut end past the light seal into the magazine. The home owner has only to insert the new magazine after which the feeding of film continues as before. The used magazine is mailed in to the central tabulating office. An important advantage is that no film is lost, and that there is no interruption of the time base produced by the minute marks.

Decoding and Tabulating

As film magazines come in from the field, they are opened and the films spliced into continuous lengths in a dark room. They are then developed in a continuous process machine.

The decoding and tabulating process must be much faster than the recording process. This is essential also because the value of the data is directly proportional to its freshness. Since punched-card equipment is a satisfactory high-speed tabulating method, the major problem is the translation of listening data from film form to the basic punched-card input.

Part of the tabulation process necessitates the correlation of film

time with the times of appearance of various programs. Because program changes occur most frequently at the quarter-hour, it is desirable to use the four quarters of each hour as the basic decoding intervals. This means that one card is punched for each station listened to in any given quarter-hour, or for each quarter-hour of continuous listening to any one station. No cards are punched for quarter-hours in which no listening occurred.

Each card punched shows calendar time, the minutes listening started and stopped, the station tuned from and tuned to, a five-digit code number for the station listened to and data on the home where listening occurred.

An accurate count must be kept of each minute elapsed since the beginning of the recording period, and the instantaneous total count must be converted to calendar time, that is quarter-hour, hour, day and week units. This information must be punched into one card for each listening increment, and the minutes at which the increment began and ended must also be included.

Much of the film contains no useful listening information other than the time base, and it should be skipped over rapidly so that atten-

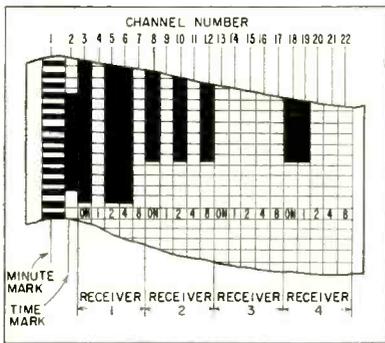


FIG. 1—Section of 16-mm microfilm used to record time and listening information from up to four receivers

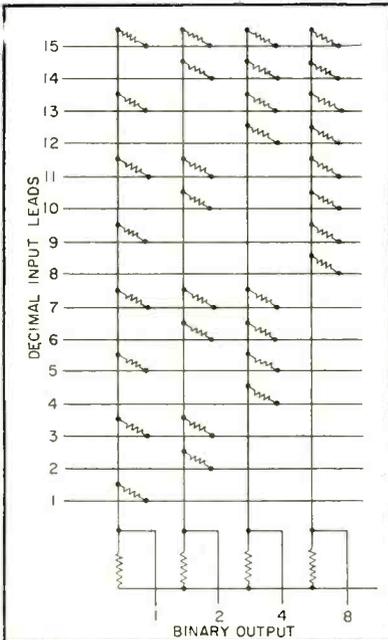


FIG. 2—Resistor matrix converts digital output of pick-up into binary form

tion can be concentrated on the listening periods.

Film Viewer

A modified microfilm viewer having a motor-driven film transport mechanism is the heart of the decoding system. It is connected to a standard card punch. Film moves through the viewer at high speed, but the drive mechanism is under the control of associated electronic equipment. Electrical signals obtained from the film provide minute-mark counting at all times, and stops the film automatically when listening information appears. The listening is decoded quarter-hour by quarter-hour with extra cards being punched for station changes between quarter-hour points. Each time a card is punched, the minute and station information is provided to the card

punch by the operator from the optical display, while calendar time information is automatically fed to the punch by the reading circuits. The operator initiates film advance, but stopping is always automatic.

The film speed used in the viewer is 1.3 inches or 100 minute-marks per second which is an increase of 6,000 to 1 in decoding over recording rate. However, since each of the four receiver channels is decoded separately, the ratio is actually 1,500 to 1. A counter to follow 100 counts per second must necessarily be electronic in nature, and the requirements on film stopping distance also dictated the use of electronic techniques. When a receiver-on exposure appears, the film must stop just after another minute mark is counted or within about ten-thousandths of an inch or 7.5 milliseconds.

Figure 4 shows a block diagram of the viewing control and count system. The film passes from a supply reel around a drive roller, through the film gate to a take-up reel. The supply and take-up reels are impelled in opposite directions by means of torque motors to maintain film tension but film travel is always under control of the drive roller. Light from the projection lamp passes through the film in the gate and an optical system to a half-silvered mirror.

This mirror splits the image

sending half the light to a viewing screen observed by the operator, and the other half to a group of six apertures each masking a 931A multiplier phototube. The magnification is 15 times to both apertures and viewing screen. The apertures are arranged so that the areas of film viewed by the phototubes are all along a transverse reference line. The channels read by these phototubes are minute mark, time mark and the on columns for the four receivers. The minute-mark phototube feeds the counting channel and the other five feed the stop channel.

Counting Channel

As the film moves through the film gate, the minute-mark phototube develops a pulse for each mark passing the aperture. These are shaped by a monostable trigger circuit and passed to the counters.

Each decade counter is of the binary type with two feedback circuits arranged to give decade operation. Five decades are used to give a total possible registration of 99,999. These counters display their count to the operator by means of a neon-lamp bank.

A modified binary counter which counts to fifteen and then recycles is also driven by the monostable trigger circuit and thus converts the count to quarter-hours. Each time this counter recycles, an output pulse is taken through a cathode

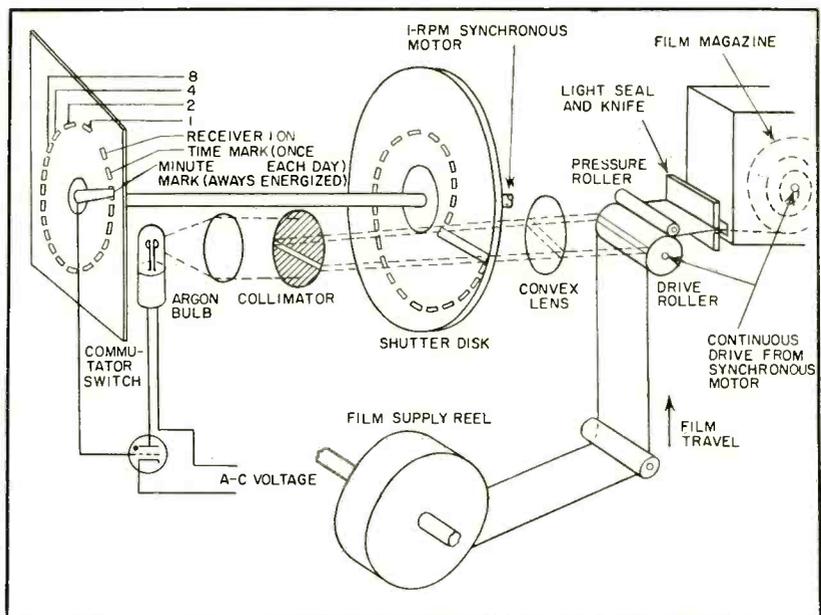


FIG. 3—Listening data is recorded on film by thyatron-controlled argon bulb synchronized with rotating shutter

follower to operate a relay. This relay drives a four position quarter-hour stepping-switch register which in turn drives similar registers having the appropriate number of steps in each case to record hours, days and weeks. One bank of contacts in each of these registers is used to feed instantaneous film time to the punch.

Stop Circuits

In the stop channel of Fig. 4, the outputs of the time-mark phototube and a receiver-on phototube are combined in a mixer and fed to a pulse-forming monostable trigger.

This trigger is only operated at the appearance of listening or time-mark information. Its output feeds a coincidence circuit consisting of a triode normally biased beyond cut-off which is also fed by each minute-mark count. The coincidence circuit causes the next minute mark after the appearance of listening to appear at its output, and is necessary so that the stop pulse always occurs at a definite point in a minute-mark cycle. This prevents a possible few-thousandths of an inch of stopping randomness which is undesirable because minute information is read by the operator from the magnified film image by means of a calibrated grid.

The stop signal output from the coincidence circuit then proceeds to a relay contact which acts as a selector to obtain either receiver-on stopping or stopping at the quarter-hour points. Another contact on the relay is fed recycle pulses from the fifteen-minute counter to provide this choice. The selected stop pulse from the relay is amplified and applied to one grid of a bistable trigger circuit. The same relay which performs the stop-selection function also connects a pulse to the other grid of this trigger to start the film. This insures that the stop selection is made before the film is started. Thus the two stable states of the trigger represent film moving or film stopped.

The plates of the trigger are separately connected to the grids of a pair of 807 amplifiers having solenoids in their plate circuits to control the film drive system.

The drive roller is driven by a continuously operating d-c motor

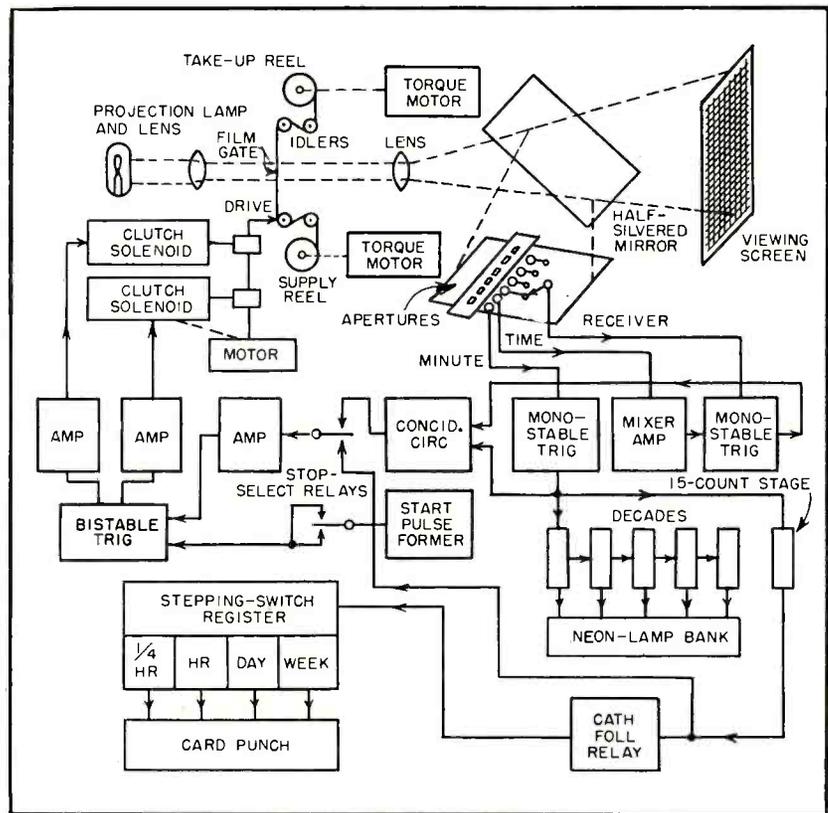


FIG. 4—Film reading unit provides visual inspection of film and feeds time data to punch-card equipment

through a clutch-brake system controlled by the solenoids in the 807 plate circuits. The clutch coil is de-energized when the brake coil is energized and vice-versa. The trigger circuit provides the fast rise time and the 807 amplifiers provide the pulse energy necessary to change the coil currents rapidly. Thus the control loop is closed, and the appearance of a receiver-on indication produces a pulse which passes through a shaping trigger, coincidence circuit, through amplifiers to the bistable trigger and finally to the clutch-brake assembly to stop film motion.

When the film stops, indicating the appearance of a listening mark, the operator proceeds through the listening period by quarter-hour intervals, providing the minute and station information from the magnified image, and relying on the electronic control to stop the film at the quarter-hour points for reading and to feed the rest of the time information to the punch.

The card punch is programmed to reproduce the relatively constant data for each home from card to card and to accept time information from the registers automatically as

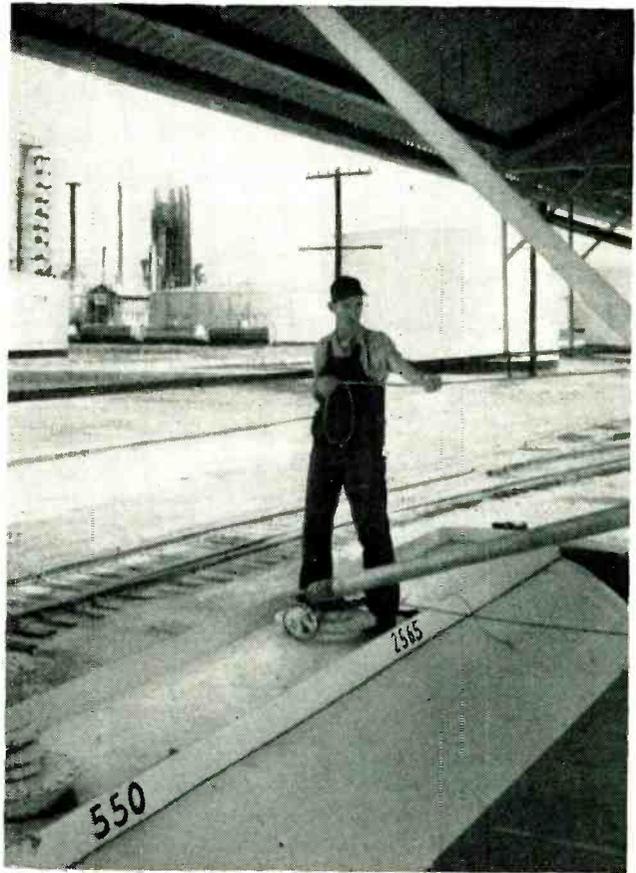
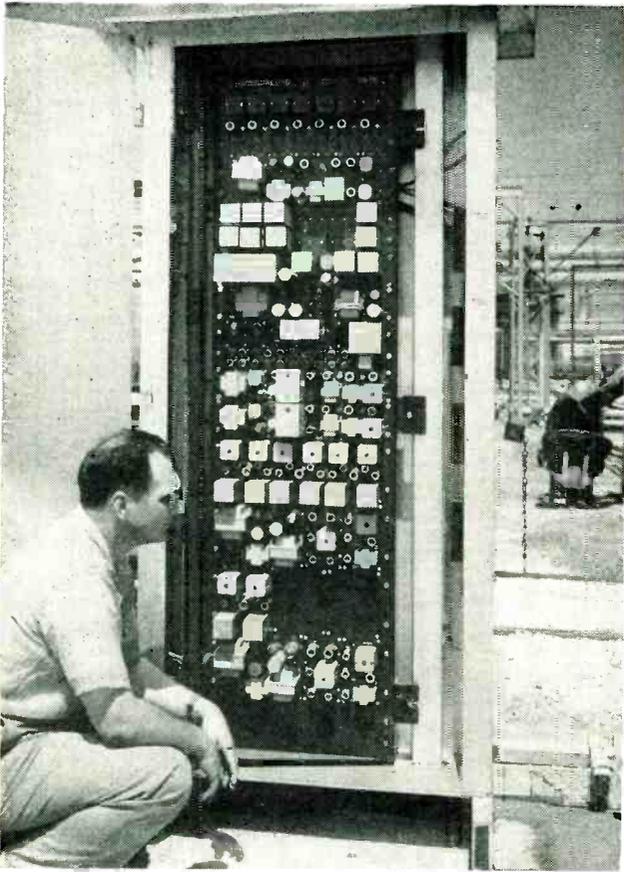
the proper card columns are reached.

Cards from the keypunch machines then undergo standard operations of sorting, collating and tabulation in conventional punched-card equipment to produce the final report of radio and tv listening.

Other Applications

For other applications the precision with which information is recorded could easily be increased from the one part in fifteen for four variables at present to one part in five hundred for two variables by reappportioning the binary digits. Time resolution could be improved if necessary by increasing the scanning speed and film speed in the recorder. Such a system would find application in wide-spread studies of atmospheric data, and in recording cosmic ray or radioactive radiation densities.

The equipment described in this article has been developed by the A. C. Nielsen Company Engineering Department under the direction of H. A. Rahmel and R. L. Freeman. The microfilm viewer and its optical and clutch-brake assemblies were supplied by Eastman Kodak Co.



Remote control system (left) employs audio tones. Desired type of fuel is delivered to waiting oil truck (right)

Audio Tones Control

Equipment using audio tones sent over telephone lines enables operator at refinery loading dock to select desired type of fuel for delivery to waiting oil truck. Equipment features repeat-back and interlocking fail-safe operation

REMOTE CONTROL of fuel pumps at Magnolia Petroleum's Beaumont, Texas refinery permits the truck loading terminal to be located out of the congested tank area without requiring an additional pump operator. The truck rack operator merely pushes a button and the pumps at the tank site deliver the desired type of fuel.

The system not only eliminates the possibility of human error in passing pumping orders over the telephone but also provides for immediate shutdown in an emergency.

The 2 to 6-kc audio tones used avoid the danger incurred when using d-c pulses in the refinery area, provide a number of signaling channels on a single leased telephone line and can conveniently be extended by adding channels or using a radio link.

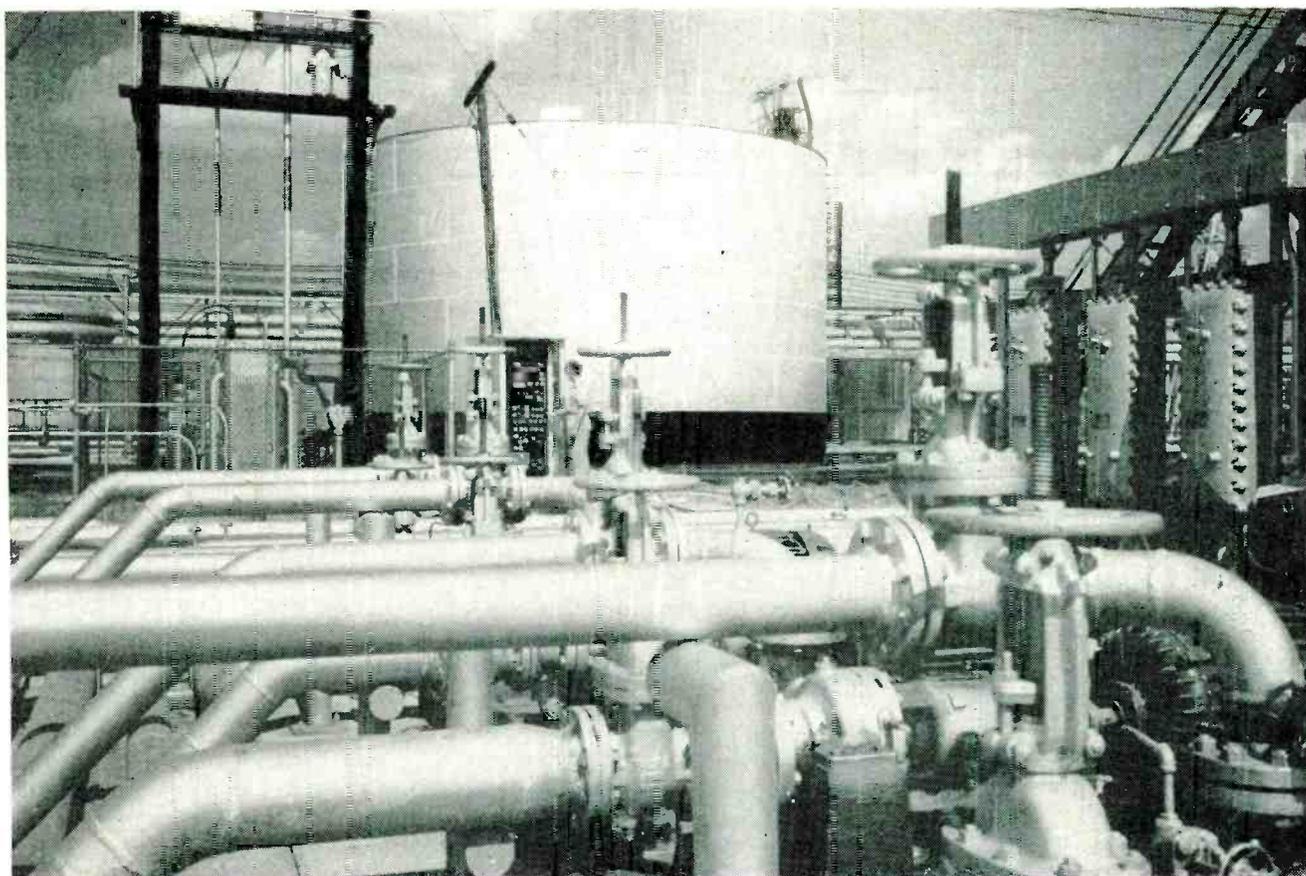
Two tones are used to select a given function.

The first or primary pulse selects one or more receiver stations at the remote point and through the operation of an electronic gate signal makes the desired receivers re-

sponsive to subsequent signals.

Up to 21 on-off functions can be performed by a single system making use of seven different frequencies, taking two at a time. Dual-tone operation reduces to a minimum the possibility of false operation resulting from noise or interference.

The system consists basically of a transmitter, to send automatically a standard sequence of two pulses at frequencies corresponding to the called station and one or more receiving channels, and a receiving



Pumps at oil-refinery tank farm (right, foreground) are operated remotely through relays in explosion-proof housings (extreme right)

Refinery Operations

By **S. H. VAN WAMBECK**

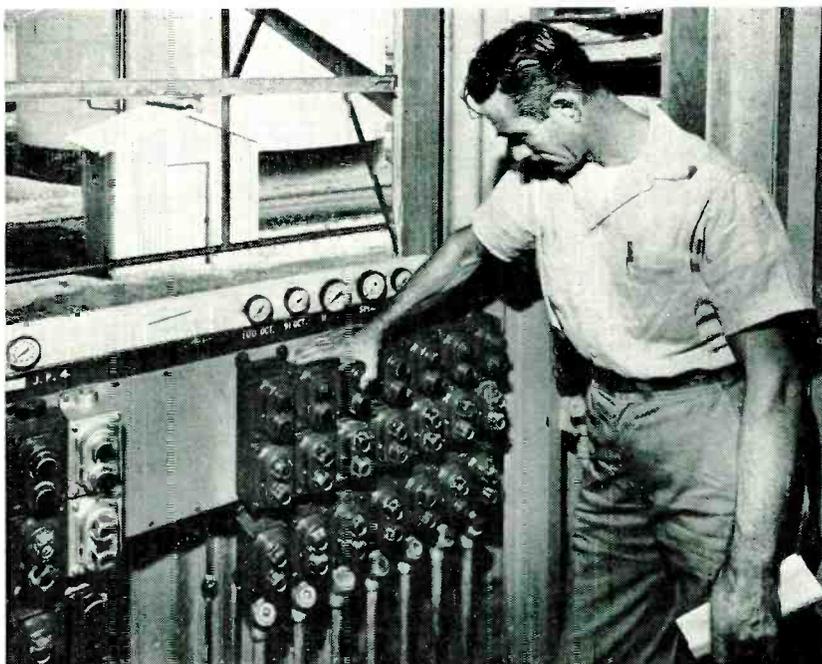
*Hammarlund Manufacturing Co.
New York, N. Y.*

station installed at each of two remote points.

The seven tone generators at the master station have frequencies from 2,000 to 2,600 cycles, 100 cycles apart. Frequency assignments for verification signals from the two remote stations are between 2,700 and 3,300 cycles, 100 cycles apart.

Tone Transmitter

The tone transmitter when keyed sends the two tones to activate a remote receiver. An external programming system selects the proper



Operator on truck rack pushes button to select fuel. Lamps below buttons provide repeat-back and failure-alarm information

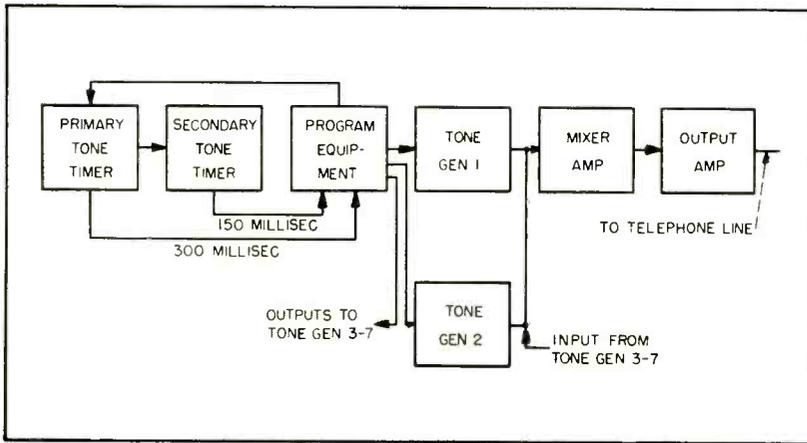


FIG. 1—Tone transmitter keyed by program equipment contains primary and secondary timing circuits, mixer and output amplifiers

tones to be transmitted and keys the tone transmitter at the desired instant. The tone transmitter as shown in Fig. 1 is equipped with tone generators, pulse timers, amplifiers and power supply.

The programming equipment initially sends a positive pulse to the transmitter primary tone timer. This timer operates a keying relay for 300 milliseconds and then sends a negative pulse to the secondary tone timer. The secondary timer operates a different keying relay for 150 milliseconds. These relays are connected to the proper tone generators by the programming equipment. The outputs of only these generators are sent through the mixer amplifier to the output amplifier. The output amplifier feeds the telephone line.

Tone Timers

The primary tone timer circuit is shown in Fig. 2A. This circuit

is a one-shot multivibrator with the relay placed in the circuit of V_2 to be energized during operation. When the multivibrator is triggered the relay will be held energized 300 milliseconds—the period of the multivibrator. The relay deenergizes as the multivibrator returns to its original condition. When this occurs, a negative pulse is sent to the secondary tone timer to start the 150-millisecond timing operation.

The secondary tone timer differs from the primary timer only in that it has a different R-C timing combination.

Tone Generator

When the tone generator (Fig. 2B) is keyed from the program equipment it will oscillate at a frequency determined by that of tuned circuit designated Z_o . The output from the tone generator is coupled in parallel with that of the other

tone generator units and fed to the common mixer amplifier.

Mixer and Output Amplifiers

The mixer and output amplifier schematic is shown in Fig. 2C. Mixing is accomplished in the grid circuit of the mixer amplifier. The transformer-coupled output of this stage drives the output amplifier. The output is bridged to the line using transformer coupling and two series resistors.

The power supply for the tone transmitter supplies all B potential, filament potentials and also 150 v regulated. The 150-volt regulated supply is used to supply the tone generators and also supplies the relay circuits keying the primary tone generator. The primary power transformer is fused and has a fuse-alarm indicator.

Tone Receiver

Each remote control tone receiver has a maximum capacity of three on-off control pairs per receiver. The required input is a 300-millisecond tone pulse followed by a 150-millisecond pulse. These pulses must each be of the proper frequency and amplitude to operate the desired channel. Each tone receiver consists of a compressor amplifier, primary gate, secondary gate and power supply.

The block diagram of the tone receiver is shown in Fig. 3. The compressor amplifier is operated by the incoming signal to establish the output of the compressor amplifier between certain limits. This output

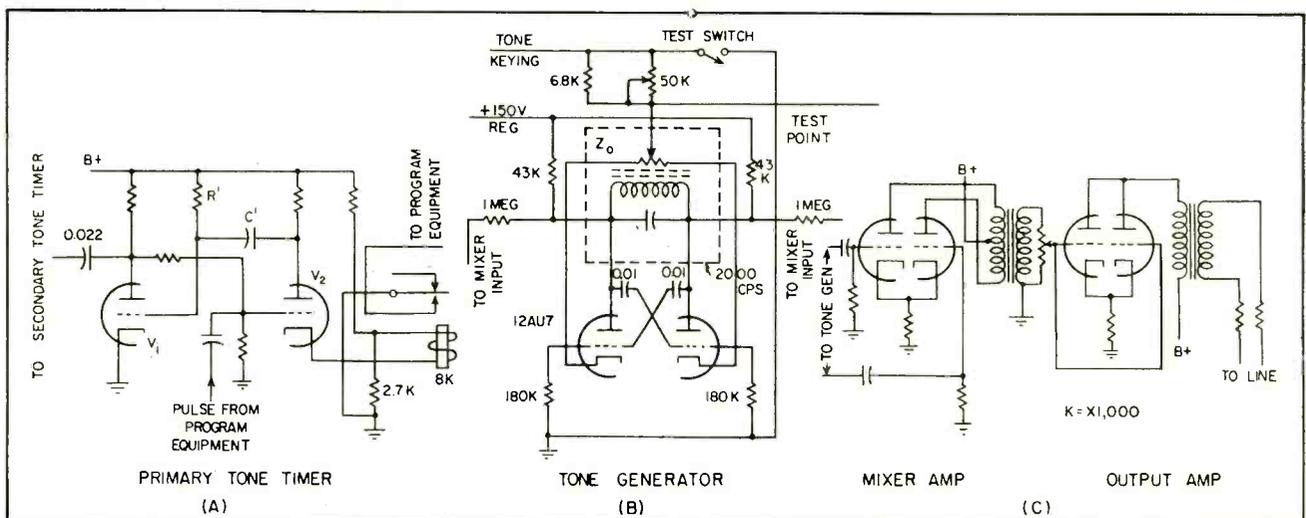


FIG. 2—Transmitter circuits include primary tone keyer (A), tone generator (B) and mixer and output amplifiers (C)

is fed to the primary gate unit. When the correct signal frequency is received the primary gate will operate and pass the signal to the secondary gate. Here, the second pulse of the signal is fed through the proper channel and operates the desired output relay.

Compressor Amplifier

The compressor maintains a primary gate input within predetermined limits, using a level control designed around a 12AU7 as an electronic attenuator. This basic attenuating circuit, shown in Fig. 4A, is capable of handling large inputs with relatively little distortion. The second amplifier employs cathode degeneration to obtain the proper gain to stabilize the lower compression limit.

The primary gate consists of the

input amplifier that raises the input signal level to the desired value, the filter, the gate tone amplifier that drives the 6AL5 demodulator, the signal-limiter, an R-C network for timing the gate action and the gate driver that operates the gate tube. The input amplifier, filter and tone amplifier are shown in Fig. 4B.

Primary Gate Circuits

The input amplifier is stabilized and set for proper gain by an un-bypassed cathode resistor. The proper amount of degeneration is obtained by a voltage divider that lowers the cathode impedance and maintains proper bias potential.

Resistor R' and the tuned transformer are arranged so that the insertion loss is constant regardless of the filter frequency. This

eliminates the need for gain compensation. The filters discriminate against adjacent channel tones by 30 db. These filter units are identical to those used in the primary gates except for frequency settings.

The gate tone amplifier isolates the filter output and drives the 6AL5 demodulator. The demodulator, signal limiter and R-C timing circuits are shown simplified in Fig. 4C. The demodulator circuit is a voltage doubler biased so that an a-c signal of approximately 15 volts peak is required before voltage is developed across R_L . Thus noise and signal below this level are rejected. The demodulated signal voltage is integrated in the R-C network until the output is sufficient to operate the gate. After the termination of a gate tone, this R-C timing network holds the gate

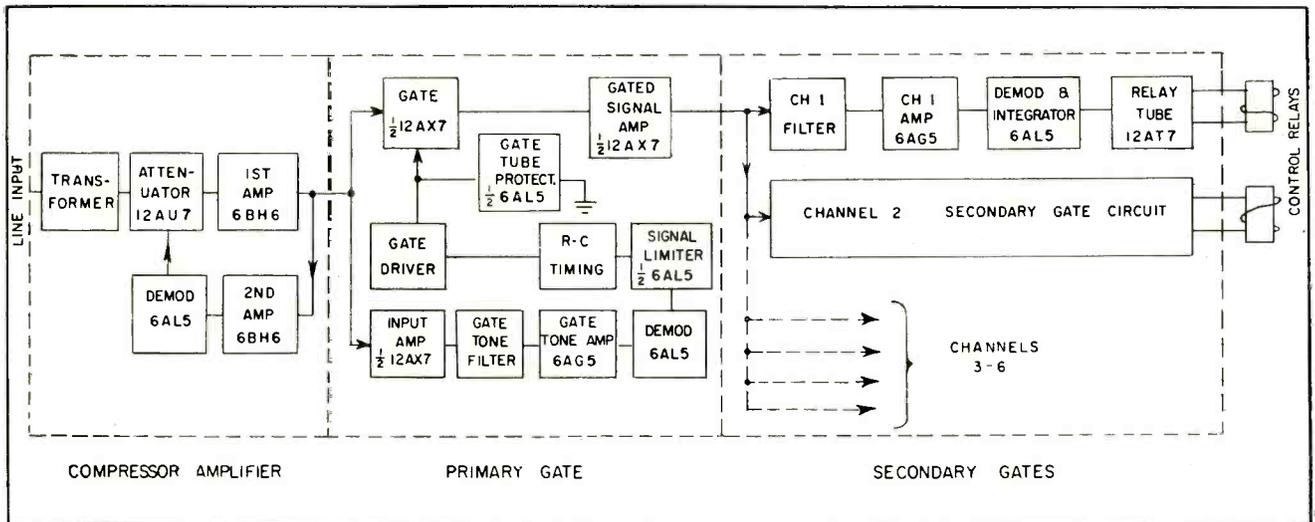


FIG. 3—Block diagram of receiver. Correct tone opens primary gate. Second tone passes through to secondary gate filters which apply tone to selected control circuit

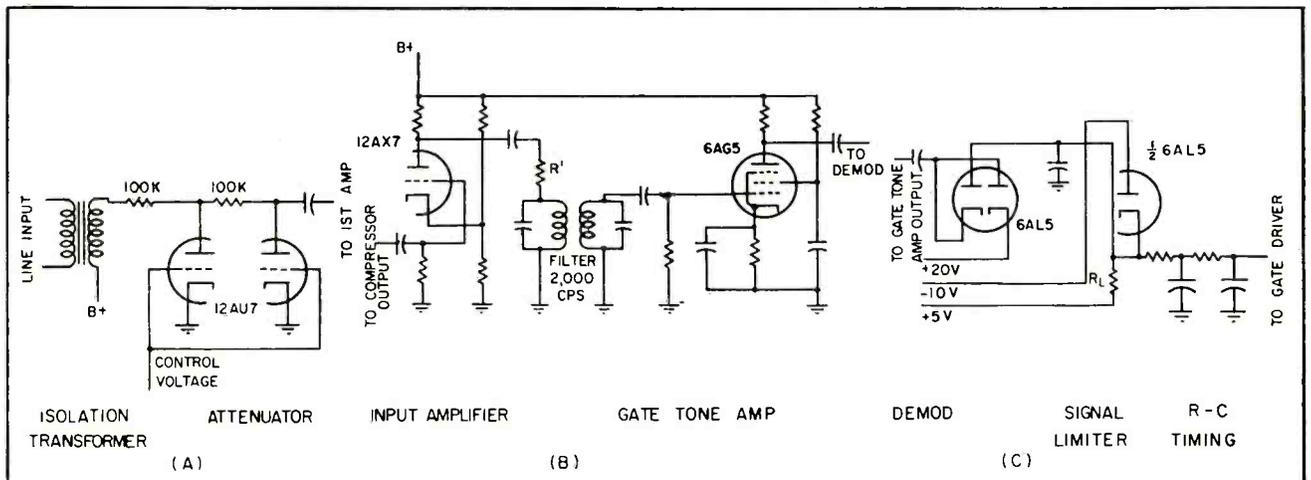


FIG. 4—Receiver circuits include isolation transformer and electronic attenuator (A), input amplifier and gate tone amplifiers (B) and demodulator, signal limiter and R-C timing circuit (C)

open for 150 milliseconds.

Each pair of secondary gate channels comprises one subchassis and implements a composite on-off function. Each receiver contains a maximum of three secondary gate subchassis.

Secondary Gate

The entire signal output of the primary gate unit is fed to all secondary gate channels in parallel. It is then fed through the proper channel filter and amplifier, and demodulated by a 6AL5. The signal proceeds into the integrator, which requires that the signal be present for at least 60 milliseconds before operating the relay tube and energizing the output relay.

The power supply for each tone receiver unit provides filament voltage in the compressor-amplifier and primary gate from the power transformer. Filament voltages for the secondary gates are supplied from two separate filament transformers.

Data Storage

A system of data storage is provided to make it possible to select simultaneously a number of functions to deliver any of the number of different types of fuel to the loading dock. The system is made up of a group of memory relays terminating in on and off memory lamps on the control panels. The master station incorporates two data memory storage units. One is capable of storing seven pairs of on-off functions but is set up at

present to provide only five pairs. The second unit, also capable of being expanded to seven on-off functions, stores three on-off functions.

After the fail-safe system has been placed in operative condition, pushing any of the function selector buttons at the master station will operate the data storage relays. These relays energize the memory indicators which visually indicate the functions that have occurred.

If the system is not busy transmitting verifications from the remote stations to the master, the master-station programming system allows the function program to seek out the stored orders and transmit the orders in coded pulses to the remote stations.

Lock-Out Operation

When the function programming section starts its seeking operation, the station program keys the busy coder and places a busy tone on the transmission line. This prevents the remote stations from sending until the master station has transmitted all stored orders and removed the busy tone. The busy tone is produced by the duplex signaling unit whose block diagram is shown in Fig. 5. The unit's receiver and transmitter both operate on 3,400 cps.

The tone and pulse coded orders are received at both remote stations and are translated into relay operations in the function decoder. If the required function is not in

operation, the control machinery is immediately required to perform that function. If that function is already occurring, the machinery remains in that condition. In either case, information stored in the data storage indicates the order has been performed. If the busy tone is present, the verification program is held inoperative until the busy tone is removed from the line. After the tone ceases, the station program allows the verification program to seek out the verifications. The local busy tone is placed on the line until all verifications are sent. The verifications are sent to the transmission line and then to the master station. Here, the verifications are decoded by the verification decoder and presented visually by lamps.

Fail-Safe Provision

A fail-safe system insures that all equipment performing operations at the remote stations will be turned off if the transmission line should fail, if power fails at either master or remote station or the emergency button is operated at either the master or one of the remote stations. A second duplex signaling unit of the type described, operating at 3,500 cps. provides the fail-safe protection.

Fail-safe indications may be initiated from any station by depressing the emergency button for approximately one second. If no failure has occurred in the telephone line or fail-safe units, the fail-safe indications will lock-in all stations, allowing the remote stations to cease their off function output and to turn operations on or off as ordered by the master station. If failure should occur in the telephone line or fail-safe equipment after starting, the fail-safe indications will be removed, producing off-function output in all channels of the remote stations.

Should failures occur elsewhere than in the telephone lines or fail-safe units, the remote stations are forced to produce off-function outputs by depressing the emergency stop button on the master control board or at either remote station.

When fail-safe indications are not present, the failure alarms in the master and both remote stations will light.

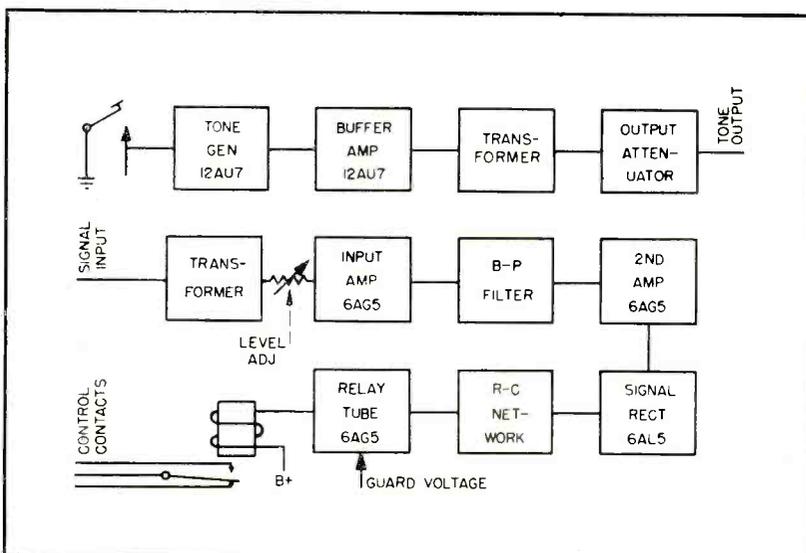


FIG. 5—Duplex signaling unit provides lockout during receiver repeat-back operation as well as fail-safe protection

Tunable Cavity for X-Band Oscillators

Rectangular waveguide tuner for external cavity reflex klystrons has generous clearances between moving parts. Cavity plunger and repeller voltage potentiometer are ganged for single-knob tuning over operating range of 8,500 to 9,600 mc

By **NED A. SPENCER**

*Wheeler Laboratories, Inc.
Great Neck, N. Y.*

NEED HAS EXISTED, for some time, for an X-band oscillator with single-knob frequency control and accurate calibration. These features have been realized by the application of a newly developed waveguide tuner for external-cavity reflex klystrons. The tuner eliminates the need for sliding contacts in regions of high r-f intensity and is of simple, yet rugged, construction.

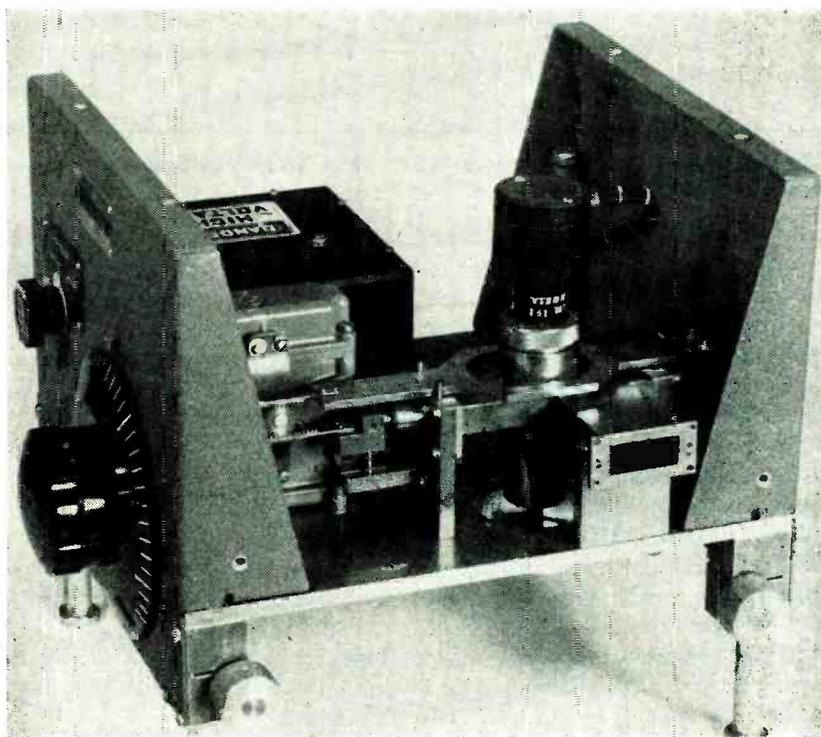
Tube

A reflex-klystron tube was desired in the oscillator design because of its relatively simple requirement of only one tuning cavity and its adequate power output. The RK-5721 shown in Fig. 1A was designed for the 4 to 8-kmc range, but it has been found to give useful power to at least 10 kmc.

The grids of the tube are operated at d-c ground potential and the cathode structure at a negative potential of 1,000 volts. The electron stream passes through the interaction gap, after which it is turned around by a repeller electrode operated negatively with respect to the cathode.

Figure 1B shows the role of the repeller voltage for oscillation. The conditions where oscillation may occur are shown as lines. Actually, the lines are bands, indicating some latitude for adjustment.

It can be seen from Fig. 1B that at one frequency the conditions for oscillation are met for any of sev-



Commercial model of oscillator using waveguide tuner has push-pull rack drive, spring-loaded to reduce backlash

eral values of repeller voltage (vertical dotted line). Also, for one value of repeller voltage, the conditions for oscillation are provided at many frequencies (horizontal dotted line).

The cavity provides a resonant circuit coupled to the tube, which permits r-f oscillation to be sustained. This condition is met when the cavity is short-circuited an odd number of quarter waves from the tube. A voltage loop then appears at the interaction gap, the proper condition for coupling. The proper values of repeller voltage and cavity length must be met simultaneously for oscillation to occur.

Two more features are required of the cavity. First, the cavity must not introduce any incidental, loosely coupled, low-loss resonances into the circuit; otherwise, irregularities in tuning or sharp dips in power output may occur. Secondly, the cavity must resonate at only one of the many frequencies at which the repeller will permit the tube to oscillate. This latter requirement is particularly difficult, as the resonant frequencies of a cavity are not too far separated.

A convenient method of observing compliance with this latter requirement is to construct an operating mode chart, as in Fig. 1C. This

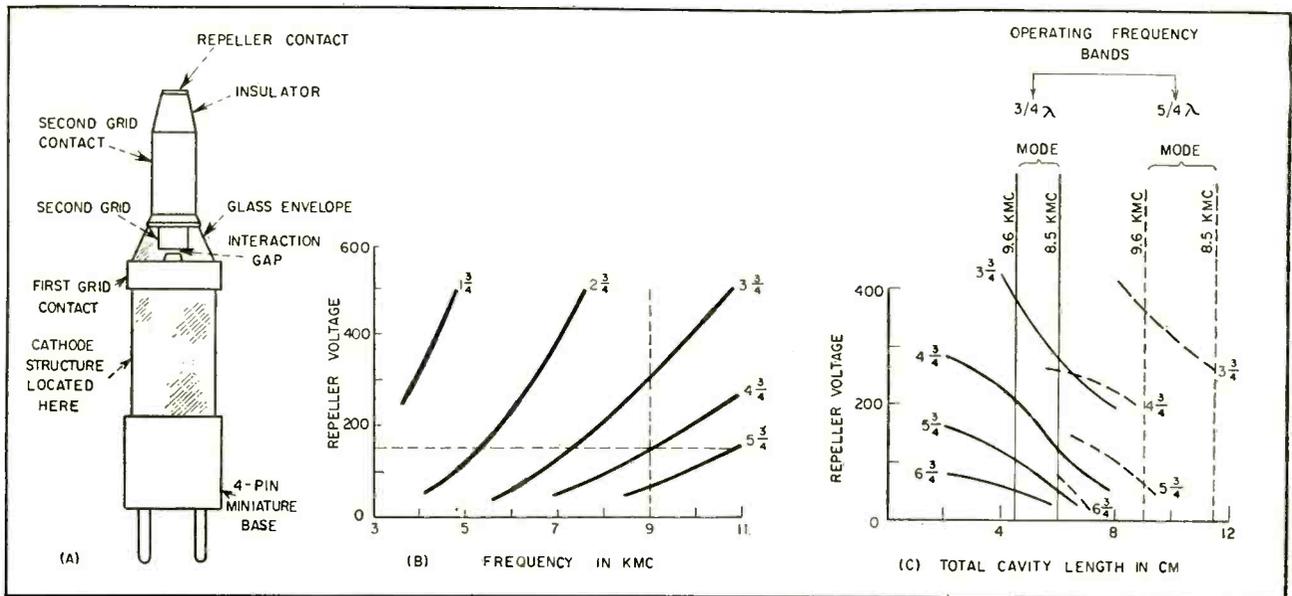


FIG. 1—Outline drawing of Raytheon RK-5721 reflex klystron (A) and repeller characteristics (B, C). Repeller voltages are shown as volts below cathode voltage

chart shows the two frequency-determining variables, repeller voltage and cavity length. Oscillation is represented by a family of lines. The solid lines indicate oscillation for a $3/4\lambda$ cavity in the various repeller modes and the dashed lines indicate oscillation as a $5/4\lambda$ cavity in the various repeller modes. Other cavity modes could be constructed.

The interference-free region is readily indicated by the absence of crossing or closely adjacent lines. For example, the $3/4\lambda$ cavity mode and the $4\frac{3}{4}$ -cycle repeller mode (heavy line) are free from spurious oscillations over the required frequency band. A check of power output in the selected mode is also necessary to test its level and uniformity.

Cavity

In designing the cavity, two designs were explored, a coaxial line and a rectangular-waveguide cavity. The coaxial-line cavity was of usual design but the high frequency of operation imposed several problems. The most troublesome of these was mechanical. For a non-contact tuning plunger, the clearance gaps must be small and the center conductor accurately aligned within the outer conductor. When the clearance between conductors was made large enough to reduce this problem, trouble was encountered with higher modes.

In the waveguide cavity the ab-

sence of an inner conductor greatly simplified the design of the tuning plunger and enabled specification of larger mechanical tolerances.

Simplified cross-sectional views of the oscillator are shown in Fig. 2. The tube is placed across the wide faces of a section of rectangular waveguide. The first grid ring is connected firmly to the cavity by a collet-type clamp. The second grid ring is connected to the cavity by a choked r-f coupling and a set of spring fingers for d-c paths. Since this grid ring can be only lightly clamped without danger of

breaking the tube, the choke is employed to enable the contact fingers to be located at a low-current point.

The tuned choke, which incorporates a block of powdered-iron absorbing material, narrows the band of possible oscillation so that the oscillator may not operate in spurious modes far removed from the desired frequency band. This is one reason for showing only two cavity modes in Fig. 1C.

Connection to the repeller lead is by a banana plug at the top of the tube.

The tuning plungers are located

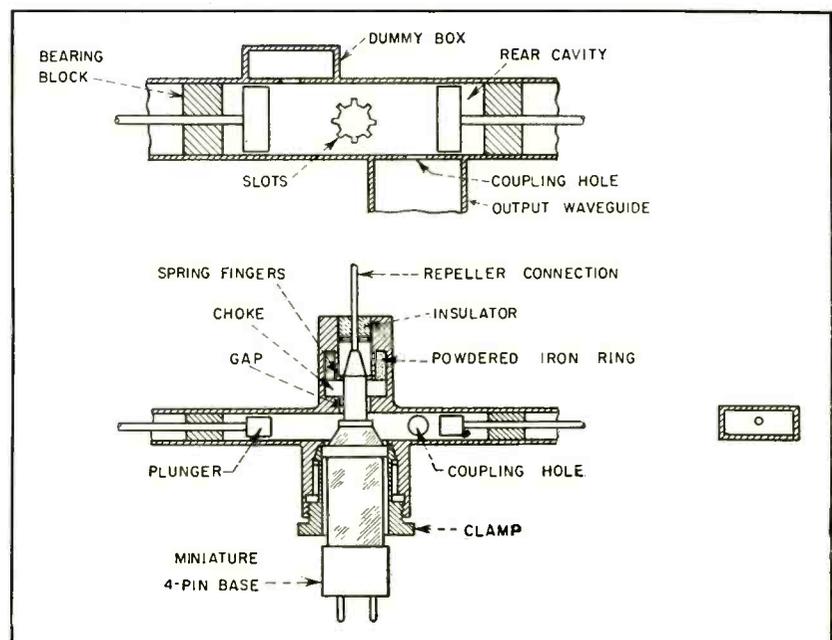


FIG. 2—Top, front and side sectional views of tunable waveguide oscillator

effectively $\frac{3}{4}$ wavelength in the guide from the tube, making the cavity effectively $1\frac{1}{2}$ wavelengths long. The plungers are solid blocks, $\frac{1}{4}$ wavelength long.

The oscillator is coupled to the output waveguide by a hole in the side wall of the cavity, located $\frac{1}{4}$ wavelength in front of the mid-position of the plunger. A second hole on the other side of the tube is incorporated to maintain symmetry. This port may be used for a second output; otherwise, it is shielded by an antiresonant box.

Resonance Elimination

For smooth, continuous operation the cavity must be free from incidental, loosely coupled undamped

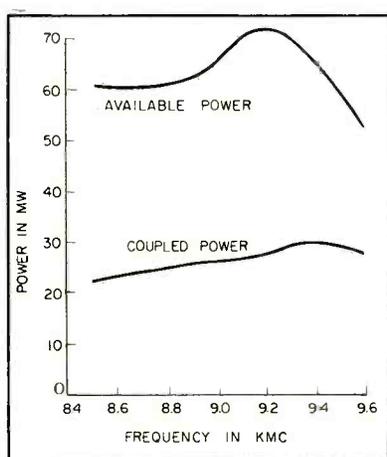


FIG. 3—Typical power output characteristic for tunable cavity oscillator

resonances. Theory and experiment disclosed four such resonances in the oscillator.

The first resonance occurs in the choke coupling to the second grid ring. Here, a thin circular gap exists which is 1 wavelength in circumference in the band. This resonance was moved below the band by slots, which effectively increase the circumference.

A second resonance occurs in the thin gap between the tuning plungers and the cavity walls. The perimeter of this gap is 2 wavelengths in the band. Here, too, the resonance was moved below the band by slots.

A third resonance could occur in the region behind the tuning plungers (the rear cavity). This space is intentionally lossless so that a

simple block plunger may be used. The limited tuning range, however, permits the choice of an antiresonant length of the rear cavity at midband with assurance that no resonance occurs in the band.

Finally there is a resonance caused by tube loading. The loading is such that, for oscillation to occur, the plungers must physically be $\frac{1}{2}$ wavelength from the tube; although they are still effectively $\frac{3}{4}$ wavelength away. In the symmetrical-waveguide tuner, this means that the two plungers would be 1 wavelength apart. The cavity can now support a new mode which is uncoupled to the tube except by slight asymmetries. This mode is damped by the output coupling, but not sufficiently to prevent its causing a hole in power output. In the cavity chosen, this resonance is at 10 kmc and has no effect in the desired frequency band.

Model Oscillator

An oscillator embodying the principles described is shown in the photograph. This model has a push-pull rack drive, which is spring loaded to reduce backlash. The push-pull drive reduces the effect of bearing backlash in that only the angle of the pinion is important—not its inadvertent lateral motion. The cavity is driven by a National PW-O dial and gear box to provide an expanded scale with approximately 6-mc divisions. A potentiometer voltage control ganged to the cavity drive provides proper repeller voltage at every frequency. The voltage control and its adjustments are located in the Bakelite box behind the gear box. Tuning is resettable to within about 5 mc and free from sharp variations.

Figure 3 is a plot of the coupled power output and available power output for a typical tube in the band from 8.5 to 9.6 kmc. Coupled power is that power which is delivered to a load matched to the output waveguide. If the impedance of the matched load is adjusted by a tuner, it is possible to obtain more power and even to overload the oscillator until it stops oscillating.

Maximum power obtainable by tuning the load is called the available power. For an average tube,

the coupled power is about 20 mw, with a variation of less than ± 1 db, from 8.5 to 9.6 kmc.

The oscillation frequency can be changed slightly by varying the repeller voltage. When this is done, however, the power output drops. For oscillators tuned entirely by mechanical means, such as this one, it is desirable for stability to keep this electronic tuning as small as possible.

The electronic tuning range between half-power points is about 8 mc. This is obtained with a variation of about 25 volts on the repeller. The sensitivity to voltage fluctuations is, therefore, 0.3 mc per volt. In contrast, the internally-tuned tube usually used at these frequencies, the 2K25, tunes at least 25 mc between half-power points, or over three times as much.

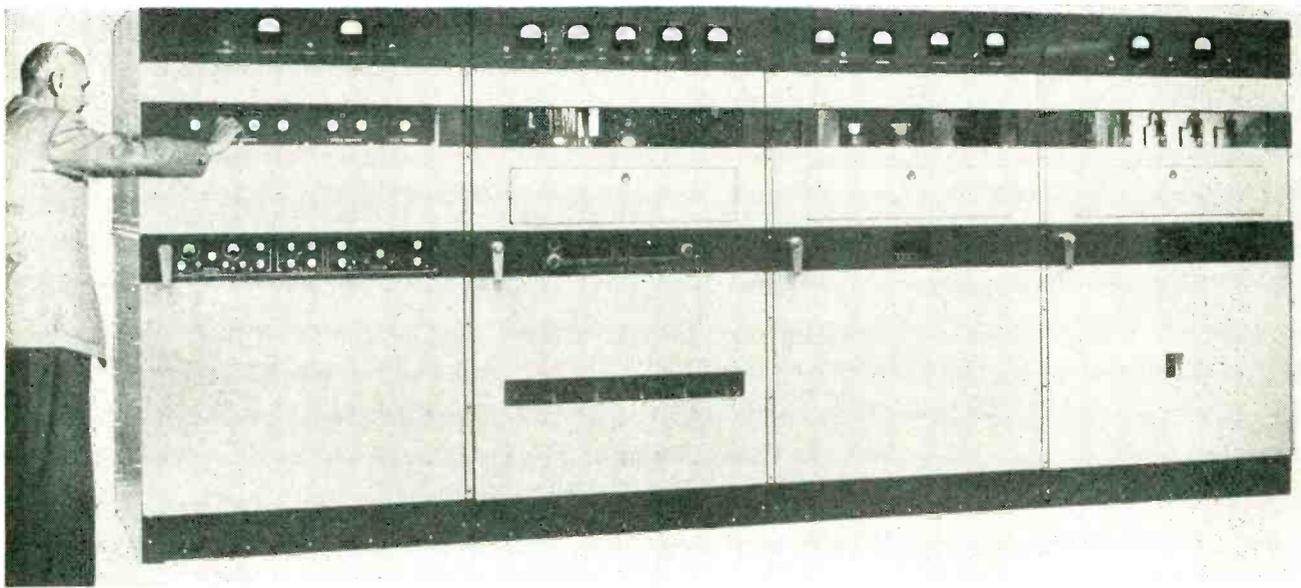
A natural extension of this oscillator is the addition of a motor drive and sweeping the entire X-band rapidly enough for oscilloscopic presentation.⁷

This oscillator was designed for Bell Telephone Laboratories under a prime contract between Western Electric Company and the Ordnance Corps of the U. S. Department of the Army. It has been used extensively in laboratory test equipment and in factory testing of components. More recently it has been used as the basis for a rapid-sweeping oscillator now being manufactured by Polarad Electronics Corp. from Wheeler Laboratories design information.

The author acknowledges the efforts of H. A. Wheeler, who directed the overall program and D. Dettinger, under whose supervision the work was performed.

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Complete four-bay 15-kw transmitter, with operator adjusting decade dial knobs of frequency generator to change carrier frequency. Keyer unit is in same bay. Next three bays house 3-kw amplifier and its power supply, 15-kw amplifier and 20-kw rectifier

Navy Transmitter Uses

By HUGO ROMANDER and ROBERT WATSON

*Sierra Electronic Corp.
San Carlos, Calif.*

EXPANDED USE of the low radio-frequency spectrum is made possible by a transmitter developed to meet specific communication requirements of the Navy. Of relatively high power output, this transmitter is intended for fixed point-to-point communication by telegraphy, teleprinter or facsimile picture transmission in the frequency range of 30 to 600 kc. All methods of signaling used by modern transmitters in these categories of communication are provided, including on-off keying (c-w and tone-modulated c-w), frequency-shift keying (unmodulated and tone-phase modulated) and frequency modulation for picture transmission.

Basic Navy requirements include a power output of 3 kw in the frequency range of 30 to 600 kc and a power output of 15 kw in the frequency range of 30 to 300 kc. The

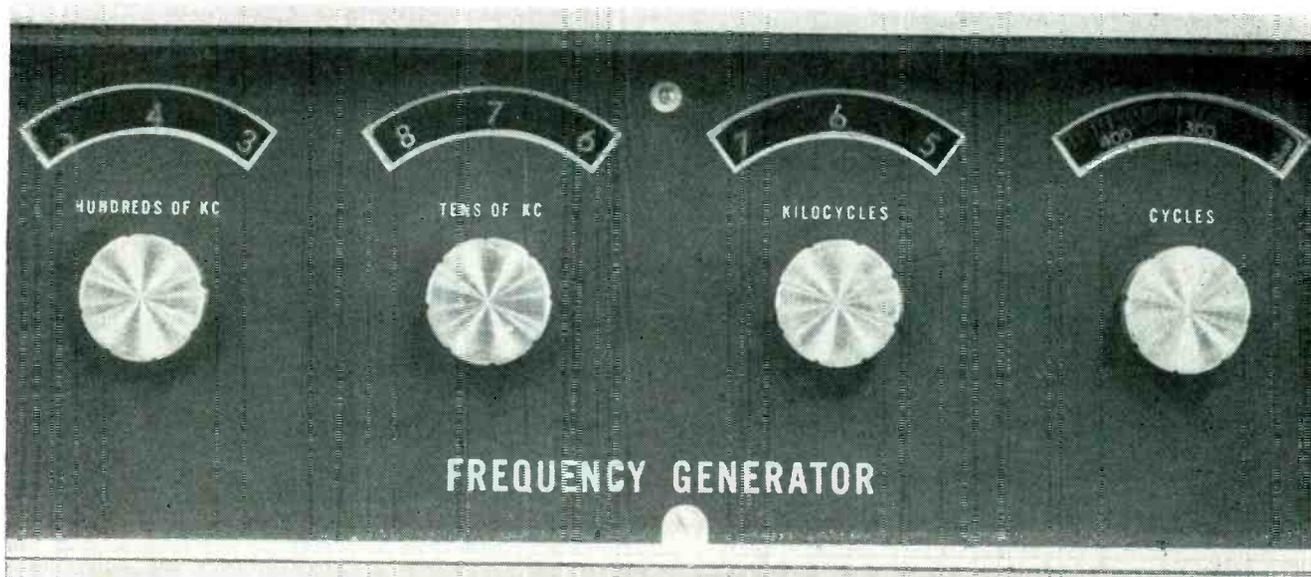
transmitter is sectionalized so that it may be operated as a 3-kw unit with the 15-kw amplifier shut down. Facilities are provided for resonating ungrounded tower-type antennas of various heights over the frequency range of 30 to 300 kc while matching the antenna resistance to a 600-ohm balanced transmission line. This adjustment may be made locally at the antenna tuning house or remotely by controls located on the transmitter.

Signal Generator

The signal generator unit in the transmitter generates any frequency in the range of 30 to 600 kc. The frequency control is so designed that the operator may adjust to any desired frequency by four decade dials with an error not greater than 3 cycles. The desired frequency is obtained by the synthesis of selected multiples of 1,000

cycles accurately generated by a fork oscillator. Continuous frequency coverage between multiples of 1,000 cycles is obtained by a variable resistance-capacitance (Wien bridge) oscillator using well stabilized and accurately controlled circuit elements. The manner in which frequency synthesis is accomplished is shown by the block diagram of Fig. 1.

Synthesis of multiples of a basic frequency can be done in many ways, but the plan adopted must not mix frequencies whose harmonics, directly or in combination with each other, can produce frequencies within the pass-band of subsequent filters that are stronger than 60 db below the desired product. The plan adopted permitted, in many instances, the use of simple band-pass filters such as a single pair of coupled tuned circuits. In no instance was it necessary to use more



Carrier frequency can be read directly on dials visible through windows above knobs of frequency generator. Reading showing here is 476.325 kc. Synthesizer combines harmonics of 1,000-cps oscillator with 2,000-3,000-cps output of Wien-bridge oscillator

Frequency Synthesizer

Broadband long-wave transmitter for point-to-point telegraph, teleprinter or facsimile communication can be set to any desired frequency from 30 kc to 600 kc by setting four dials to digits of desired value. Accuracy is within 3 cps

than two pairs of band-pass coupled circuits. Figure 2 is a simplified schematic diagram typical of the bandpass filters.

Filter Design Criteria

To evaluate the attenuation requirements of the filters, several different types of balanced modulator were tried. It was found that the so-called linear mixer gave the best compromise between adequate sideband output, good carrier balance and low production of spurious mixing products. This mixer uses multigrid tubes with the input signals applied to different grids and with their peak voltage swings less than the bias voltage so that the grids do not draw current.

Calling the lower input frequency f_1 and the higher input frequency f_2 , f_3 must be greater than 5 percent of f_2 to keep spurious responses down 60 db. Also, in the expression $nf_1 \pm mf_2 = f_3$, where n and m are

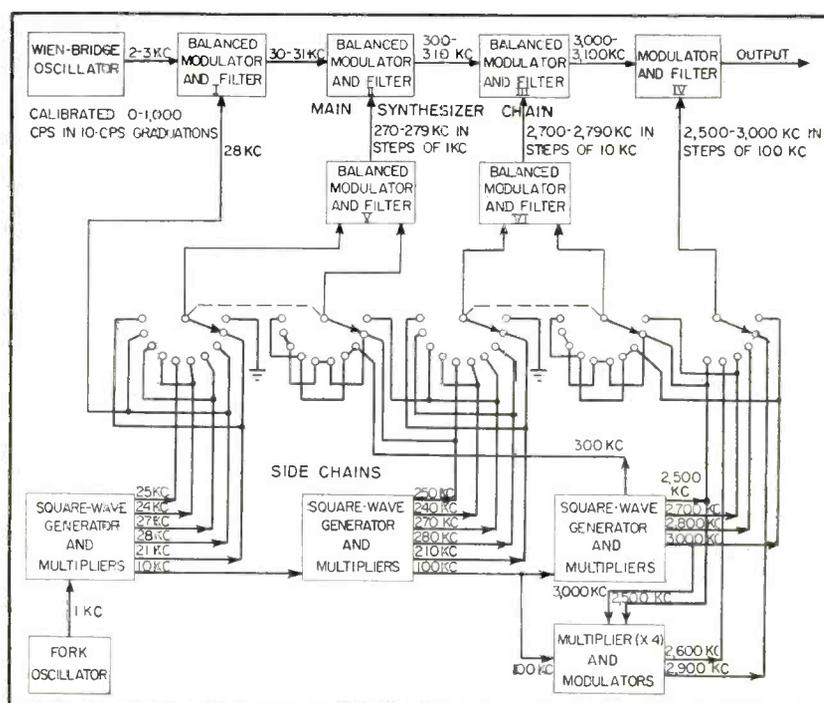
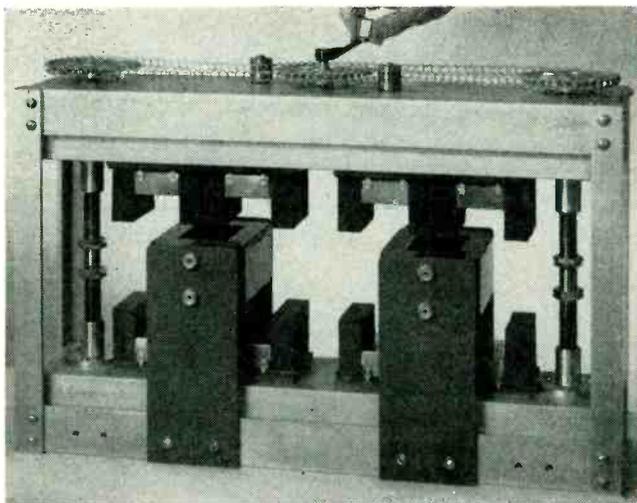
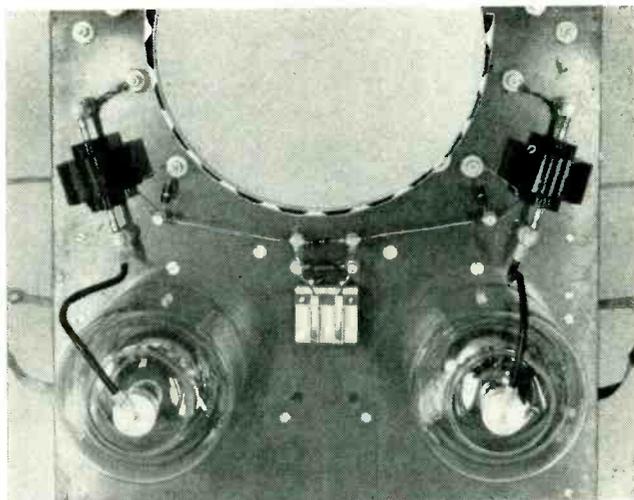


FIG. 1—Decade system of frequency generation used for synthesizing desired carrier frequency from the oscillators at upper and lower left



Construction of ferrite-core variometer unit for 3-kw amplifier. Changing air gap between ferrite core sections varies inductance over range of 100 to 1 and gives Q over 50 at 30 to 600 kc



Method of using wide-band directional couplers in anode leads of two 4-1000A tubes in the 3-kw amplifier to obtain usable indicating voltages for adjusting pi networks in this broadband amplifier

independent and may be zero or any positive integer, if f_1 and f_2 are so chosen that any frequency f_3 falls in or near the filter passband, then the sum of m and n must be greater than 8. The desired product ($f_1 + f_2$) must, of course, fall in the passband. While the numbers given in these rules are unique only to the circuitry chosen for this unit, they illustrate the type of design criteria that must be established for similar equipment.

An important factor was the limitation of the upper frequency of the variable oscillator to approximately 3,000 cycles to meet the accuracy requirements. The experience of manufacturers of Wien bridge oscillators has indicated that an accuracy of 0.1 percent under field service conditions is the best that should be expected.

With the exception of the continuously variable portion, all signals must be derived from a single high-stability source. Two independent signal sources cannot be expected to maintain a 30-kc frequency difference, for instance, within a small fraction of a cycle at 2 or 3 mc, as is required at the end of the synthesis chain. This stability in the fixed-frequency components is necessary to allow sufficient latitude for the accuracy of the variable oscillator.

The side chain arrangement shown in Fig. 1 was ultimately developed as a result of the foregoing considerations. A system using a

1,000-cycle fork oscillator as the primary source was chosen because it offered advantages in stability and reduction of overall circuit complexity in comparison with other methods.

The fork unit used has the fork itself sealed in vacuum, with the drive coils and fork assembly shock-mounted within a hermetically sealed shield can. It has a negligible frequency change from aging and a very low temperature coefficient of frequency (approximately 0.5 part per million per degree C). The third, fifth and seventh harmonics of the 1-kc source are all that are required to feed all subsequent stages. This permits squaring the signal waveform to produce rich odd harmonics with minimum even harmonics, thus simplifying the filtering of the desired signals.

Harmonic Generator

A pentode tube with a high series grid resistor is driven by a 20-volt rms sine-wave signal from the fork oscillator, resulting in sharp limiting of both positive and negative excursions of the signal. The output of the pentode, a reasonably good square wave of 150 volts peak-to-peak amplitude, is applied to the grid of a triode where it is further squared by both saturation and cutoff limiting. The plate circuit of the triode contains three resonant circuits tuned to the third, fifth and seventh harmonics of the 1-kc driv-

ing signal. The three tuned circuits are driven in parallel from the plate through individual isolating resistors which were chosen to equalize the output voltages at the three harmonics. Following the harmonic generator are conventional triode and pentode harmonic multipliers which deliver 10 kc, 21 kc, 24 kc, 25 kc, 27 kc and 28 kc.

The 10-kc signal is fed to a harmonic generator and frequency multiplier system identical to that just described except that all operating frequencies are multiplied by ten. The output frequencies of this section are, therefore, a group ten times the first group.

The 100-kc signal from the second group is used in two ways. First, it drives a harmonic generator and multiplier group similar to those above to derive 300 kc, 2,500 kc, 2,700 kc, 2,800 kc and 3,000 kc. Second, it is quadrupled in a separate multiplier whose 400-kc output is subsequently mixed with 2,500 kc to produce 2,900 kc and also with 3,000 kc to give 2,600 kc.

With the exception of the outputs of the 2,600-kc and 2,900-kc mixers, all of the frequency-selective circuits in the groups described above are capacitively coupled double-tuned circuits with operating Q 's well in excess of 100 and with less than critical coupling. The exceptions noted have triple-tuned circuits with similar Q and coupling coefficient values. The output signal for each of the frequencies pro-

duced by these multiplier groups is taken from a tap on the output coil at an impedance level of approximately 50 ohms to minimize capacitive cross-coupling in the associated switching circuits.

Main Synthesis Chain

The Wien bridge oscillator is continuously tunable with a dial marked CYCLES (0 to 1,000, corresponding to actual oscillator frequencies of 2,000 to 3,000 cps). This tunable oscillator output is

ended mixer which is fed with the 3,000 to 3,100-kc signal at one input grid and a signal selectable in six 100-kc steps from 3,000 to 2,500 kc at the other grid. The inverse frequency order of this group provides, by difference mixing, frequencies corresponding to the HUNDREDS OF KILOCYCLES dial markings from 0 to 5. The passband of the fourth filter covers the 30-kc to 600-kc frequency range of the synthesizer.

At the output of the fourth filter the desired signal is present to-

quartz crystal units which, with the associated circuitry, may be selected in lieu of the synthesizer (or external frequency source) as a crystal-controlled frequency generator. Fixed frequencies may thus be selected quickly or the quartz oscillators may serve as auxiliary sources of stabilized frequency in the event the synthesizer requires servicing.

Frequency-Shift Keyer

The method used to obtain frequency-shift keying or frequency modulation is shown by the block diagram in Fig. 3. Here the problem is to convert the incoming frequency from the synthesizer (or external source) to a frequency which may be shifted about a center frequency which is identical to the incoming frequency. This is accomplished by mixing the incoming frequency with 3,100 kc from a doubler following a 1,550-kc crystal-controlled oscillator whose frequency may be shifted plus and minus 250 cycles by a reactance tube. The sum frequency is se-

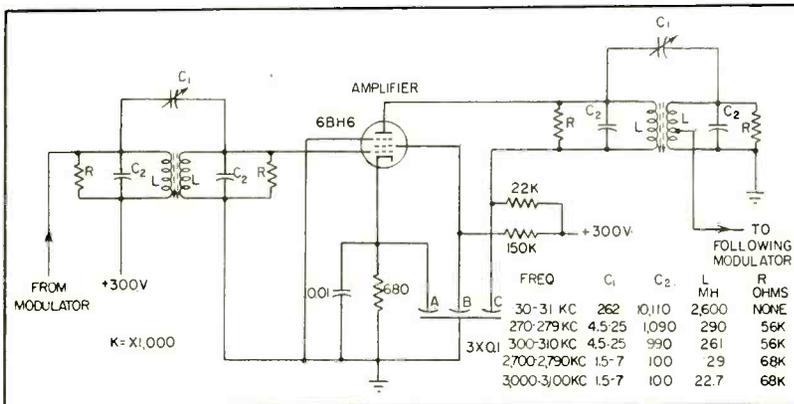


FIG. 2—Typical band-pass filter circuit, with component values for the five bands

mixed with a fixed frequency of 28 kc in the first balanced modulator and the sum frequency, tunable from 30 to 31 kc, is selected in the following filter.

In the second balanced modulator the 30 to 31-kc tunable signal is mixed with any one of ten frequencies from 270 to 279 kc, selectable in 1-kc steps by the switch marked KILOCYCLES. The sum frequency in the range from 300 to 310 kc is passed by the following filter. In this manner the variable oscillator tuning combined with the 1-kc fixed steps provide continuous coverage of a 10-kc interval.

Similarly, the third balanced modulator receives the 300 to 310-kc signal and adds one of ten frequencies from 2,700 to 2,790 kc, selectable in 10-kc steps, to give at the output of its filter continuous coverage of a 100-kc band from 3,000 to 3,100 kc. The switch dial selecting the fixed frequency signal to this balanced modulator is marked TENS OF KILOCYCLES.

The fourth modulator is a single-

gether with its harmonics, but these harmonics are removed later in the unit.

As a specific example of the way that a signal is put together in the synthesizer, assume that an output frequency of 476.325 kc is desired. The CYCLES dial would then be set at 325, which means the Wien bridge oscillator would be operating at 2,325 cps. Mixing this frequency with 28 kc gives 30.325 kc at the output of the first filter. The KILOCYCLES dial would be set for the 6 digit, supplying 276 kc to the second balanced modulator, which would in turn produce 306.325 kc as the mixed product. The TENS OF KILOCYCLES dial would be set at 7 to deliver 2,770 kc to the third balanced modulator, from which a frequency of 3076.325 kc would appear at the output of the third filter. Setting the HUNDREDS OF KILOCYCLES dial at 4 will select a 2,600-kc mixer injection frequency, completing the settings necessary for 476.325 kc.

Facilities are provided for ten

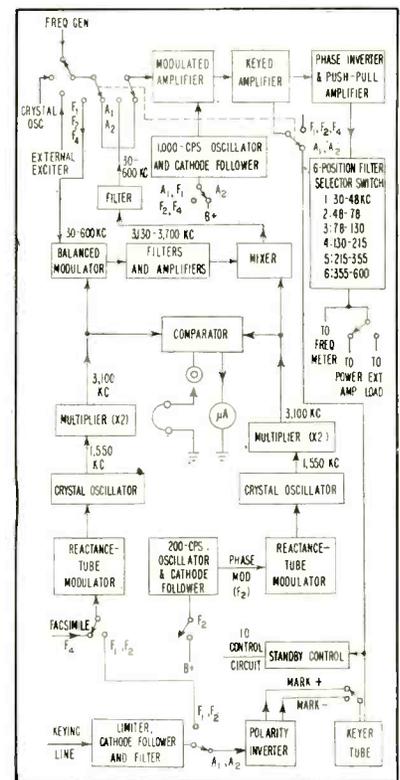


FIG. 3—Method of accomplishing frequency shift. Incoming signal is mixed with crystal-controlled frequency that is shifted by reactance-tube modulator

lected by a high-pass filter having a relatively steep attenuation characteristic at the cutoff frequency so that frequencies below 3,070 kc are attenuated at least 60 db and frequencies above 3,130 kc have minimum attenuation. This frequency is mixed with the frequency-doubled output of a second 1,550-kc crystal-controlled oscillator to recover the original incoming frequency with the frequency shift added.

Following the frequency-shift circuits, or directly from the signal generator, is a broadband amplifier where the signal may be keyed or tone-modulated if desired. The first two stages are untuned pentode amplifiers, with provision for tone modulation on the suppressor grid of the first stage and provision for application of a keying signal to the suppressor grid of the second stage by means of a vacuum-tube keyer.

The keyed amplifier drives a resistance-coupled split-load phase inverter and push-pull amplifier combination resembling an ordinary a-f amplifier circuit. This type of circuitry was made possible largely by the use of an output transformer having a ferrite core. It provides transformation from the 10,000-ohm plate-to-plate impedance for class AB pentodes to a 50-ohm load and has a frequency response flat within ± 0.25 db over the operating range.

One of a group of six filters may be selected at the 50-ohm terminals of the output transformer to attenuate harmonics of the desired output frequency. Each filter consists of a low-pass constant-k section with m-derived terminating half-section. The filter cutoff frequencies are so arranged that the operating frequency is never less than 60 percent of the cutoff frequency of the correct filter, resulting in a 2.5-w output signal that is substantially free of harmonics.

All circuit elements comprising the synthesizer, the quartz oscillators and the keyer are maintained at a constant elevated temperature to assure maximum stability.

3-Kw Power Amplifier

The 3-kw power amplifier is required to deliver full power output

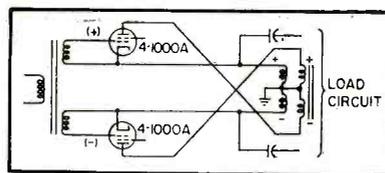


FIG. 4—Grid-driven inverse-parallel amplifier circuit in simplified form

in the range of 30 to 600 kc and does not require more than 2.5 w excitation power. This high power gain is attained with complete stability and with broadband frequency response. Additionally, the amplifier is simple to adjust. Its output power is relatively linear in respect to the excitation power in order to preserve the amplitude variations from the signal generator and avoid generation of excessive r-f harmonics.

For this amplifier two Eimac 4-1000A tetrodes operate as a class AB-1 push-pull amplifier with 1,000 volts on their screens and 5,000 volts anode voltage, using the inverse-parallel cathode-separation circuit shown in Fig. 4. Here the cathode is the common element between the excitation circuit and the output circuit. Where an element is grounded, the cathode-separation circuit would be recognized as the conventional grid-driven amplifier. Transformer coupling from the signal generator to the grid-cathode circuits and from the anode-cathode circuits to the output circuit is employed. Both transformers use ferrite cores.

This circuit offers several advantages over the more conventional grounded-cathode push-pull amplifier where transformer coupling is used in broadband circuitry. Primarily, the output impedance is only one fourth that of the grounded-cathode circuit, thus permitting operation at higher frequencies with a given amount of distributed capacitance. The effect of leakage reactance between the windings of the output transformer is very much reduced, and this also extends the high-frequency limit of the amplifier. The design of the output transformer is such that virtually no r-f voltage exists between adjacent windings, thus making insulation problems easier. Complete shielding of the grid-

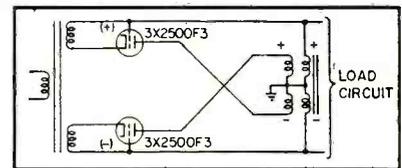


FIG. 5—Cathode-driven inverse-parallel amplifier with low harmonic distortion

cathode excitation windings on the driver transformer was necessary to attain amplifier stability.

The output of the amplifier is directly coupled to the input of a pi network that matches the load impedance to the 2,500-ohm output impedance of the amplifier. The pi network also serves to attenuate r-f harmonics from the amplifier. It comprises a variable vacuum capacitor and a group of fixed oil-dielectric capacitors at both input and output, with series inductors composed of fixed windings whose inductance is varied by varying the air gap of ferrite cores surrounding the windings. Where the load is a balanced 600-ohm transmission line, the pi network must accommodate a maximum standing wave ratio of two-to-one over the 30 to 600-kc frequency range.

15-Kw Power Amplifier

The power amplifier is designed to deliver a power output of 15 kilowatts in the range of 30 to 300 kc. High power gain is not required, since 3 kw of excitation power is available, but the amplifier is operated in such manner as to obtain good linearity and low r-f harmonic distortion. It also has broadband frequency response with complete stability.

Two Eimac 3X2500F3 triodes were chosen for this amplifier. When operating these tubes in class AB-2 push-pull with an anode voltage of 6,000 volts a power output of about 15 kw may be obtained. To provide some margin of power a grid-separation circuit is used so that about 1 kw of the excitation power is contributed to the output. As with the 3-kw amplifier, the inverse-parallel type of circuit is employed as shown in Fig. 5. Additional advantages of the grid-separation circuit are greater linearity and lower r-f distortion due to a more constant input impedance

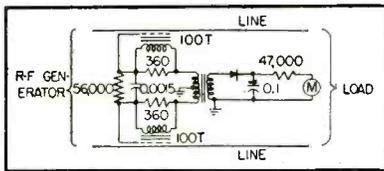


FIG. 6—Balanced directional coupler, adjustable to indicate null for any load

over the r-f cycle, and excellent stability.

When operating at full power output the grid current of each tube is between 100 and 150 ma and the bias is such that the tubes are actually operating in the class B region. This results in some r-f distortion, but the increase (as compared with class AB operation) is mainly in the higher-order harmonics where the pi network has high attenuation. Measured harmonic content in the r-f output when a purely resistive load is used indicates that the third harmonic is normally more than 55 db below the fundamental, the second and higher order harmonics generally being much weaker. The antenna tuning circuit provides greatly increased attenuation of all harmonics.

Transformer coupling from the 3-kw unit to the grid-cathode circuits and from the anode-cathode circuits to the output pi network is employed, using ferrite cores. The problems here are similar to those with the 3-kw amplifier, with less emphasis on the need for shielding of the excitation windings. The r-f voltages are only slightly higher, but much larger r-f currents are involved and some advantage was obtained from using Litzendraht cable for some of the windings.

Amplifier Adjustment

When the transmitter is properly adjusted to a given frequency the bandwidth over which the amplifiers will respond depends almost entirely on the characteristics of the pi networks. The best compromise between bandwidth and harmonic attenuation occurs with 90-degree pi networks. With a load resistance of 600 ohms on the 15-kw amplifier the 3-db points at 30 kc are 11 kc apart and at 300 kc are 50 kc apart.

A 3-phase, full-wave rectifier provides 6,000 volts d-c for the 15-kw

power amplifier. A single-section choke-input filter is used with the lowest practical amount of filter inductance in order to provide a low impedance for the surges of current when amplitude-keying the transmitter. Type 4B32 gas-filled rectifier tubes are used here and in the 5,000-volt rectifier for their ability to operate in wide ranges of ambient temperature.

Directional Couplers

Proper adjustment of the pi networks so that the amplifiers are loaded by their most favorable impedances presents a problem which is not satisfactorily answered by observing cathode currents or r-f line currents. This is largely due to the broadband nature of the amplifier. There is no pronounced dip in cathode current or peak in r-f output current to indicate proper adjustment. The directional coupler of Fig. 6 is therefore needed to indicate when the impedance presented to each amplifier is correct both in amplitude and phase angle.

A coupler is placed in each anode lead of both the 3-kw and the 15-kw amplifiers, as close as practical to the tubes in order to reduce the amount of stray capacitance on the anode side of the coupler to that of the anodes themselves.

A coupler is, in effect, a shielded r-f current transformer wound on a toroidal ferrite core. The shield provides capacitance coupling to the line voltage and the winding provides inductive coupling to the line current. By terminating the winding with a resistance much lower than the reactance of the winding, the voltage across this resistance will be in phase with the line current. By connecting the shield to a relatively large capacitance the resultant capacitance divider will produce a voltage that is in phase with the line voltage. It remains, therefore, to adjust the voltage divider and the terminating resistor so that their respective voltages are equal when the ratio of line voltage to line current has the optimum desired value.

By connecting the two voltage sources in series and in phase opposition the resultant voltage will null out only when the amplitude and phase of the line voltage and

current have the desired values; that is, the impedance presented to the line is purely resistive and of the desired value.

Antenna Tuning

Equipment for resonating and coupling to antenna towers is provided, to be installed in a tuning house located adjacent to the antenna. The principal function of this equipment is to provide the proper amount of inductance to resonate with the capacitive reactance of ungrounded towers less than a quarter wavelength high. At full power the voltage at the tower base may be 85,000 peak volts. By inductive coupling the resultant antenna circuit resistance is transformed to 600 ohms for termination of the balanced r-f transmission line.

The antenna tuning inductance consists of seven coils and a variometer designed to carry 100 amperes r-f current. All coils are wound with Litz cable about 0.5 inch in diameter, supported on a framework of plasticized glass matt. Each coil has connected across it a magnetically operated switch the contacts of which operate in a vacuum. The coupling transformer obtains the required variation in coupling between primary and secondary by variation of the air gap in movable ferrite core sections.

The antenna tuning inductors are completely separate coils mounted along a line at such angle to each other that there is virtually no mutual inductance between any of the coils. The coils are tapered in value such that, starting with the largest coil, each successive coil has approximately half the inductance of the preceding coil. The smallest coil is about 50 microhenrys, which is also the range of variation in inductance of the variometer. A binary system is thus established, since any combination of coils may be cut into the antenna circuit and any multiple of 50 microhenrys up to the maximum inductance available thus obtained. The variometer takes care of inductance values in between the 50-microhenry multiples. Remote control of the binary system is accomplished by rotary switches used with an eleven-pair cable.

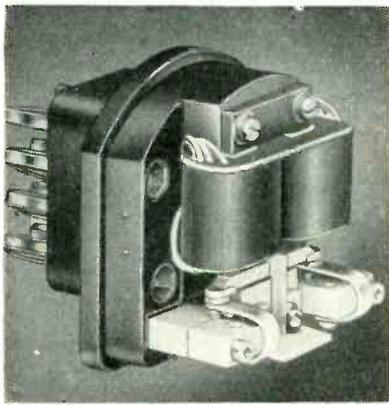


FIG. 1—Compact polar relay (Automatic Electric) operates on 16.8 ampere-turns (2 to 12 ma depending on coil connections), using magnetic flux paths as shown

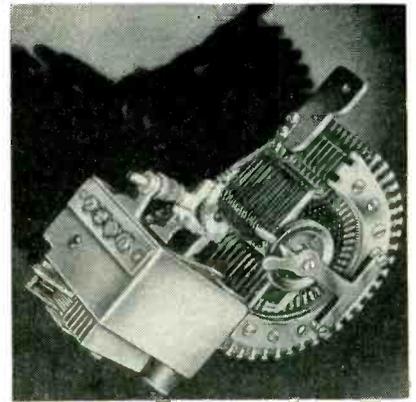
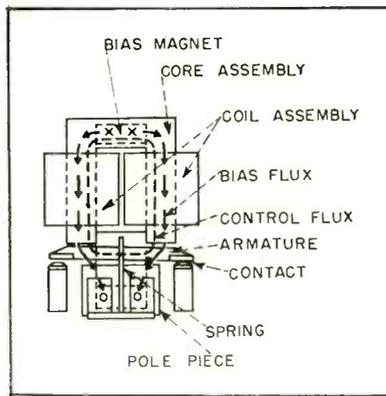


FIG. 2—High-speed stepping rotary switch (Automatic Electric) gives 75 pps

COMPONENT DESIGN TRENDS

New Relay Materials

Tungsten-carbide contacts, nickel-iron armatures, stainless steel springs, silicone damping fluids and self-shielded cores are examples of the many new materials that have improved relay reliability, sensitivity, life and versatility for use in electronic equipment

By **FRANK ROCKETT**

*Research and Engineering Division
Airborne Instruments Laboratory, Inc.
Mineola, N. Y.*

TWO PRACTICES common to the relay industry suggest that a case-study method of presenting modern trends in relays is appropriate. First, most basic relay structures are available for a variety of functions. Especially is this true of coil impedances; operating power can be developed at any impedance level from a few ohms to thousands of ohms for most relays.

The second industrial practice is that of adapting basic structures to the needs of customers. Virtually all relay manufacturers provide design assistance to their customers. Experience shows that, in many instances where a stock item is inadequate, a regrouping of standard parts produces a wholly satisfactory relay. Manufacturers will almost always undertake to modify a structure to meet unusual requirements.

Examples of communication relays will be considered first—the polar relay long used in telegraphy, the stepping relay used in automatic exchanges and the so-called telephone leaf-spring relay. Next will be described two unusual relay actions—a relay using mercury for contacts and a time-delay relay using an unusual form of hydraulic damping. Finally will come a variety of sensitive relays, including those with instrument-type movements, and then a brief look into the future of subminiature relays. This bypasses power relays, because this article is chiefly concerned with units that can be actuated by electron tubes at moderate levels or that can replace certain electron tubes.

Polar Relay

Most relays respond to the presence or absence of current regardless of direction. Polar relays are sensitive to direction of current flow; a common application is in the reception and repeating of bipolar

telegraph signals. In such service the unit of Fig. 1 operated without servicing for 18 months, averaging about five million operations daily.

The magnetic circuit consists of an Alnico permanent bias magnet extending the length of and carried in the molded phenolic base and held in position by its own attraction to the laminated core assembly at one end and the pole piece at the other. The resulting lines of flux are shown greatly simplified in the diagram. The pole piece distributes the bias flux equally between the two branches of the circuit. The coil assembly consists of several windings that can be variously connected for operation at various impedance levels.

The nickel-iron bar-armature carries tungsten-carbide contacts and rocks on a stainless steel spring through which electrical connection is made to the common terminal. This construction causes a small longitudinal motion of the armature in addition to a rocking motion, thus tending to prevent bounce. It

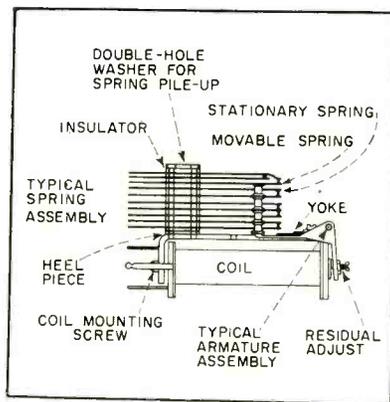
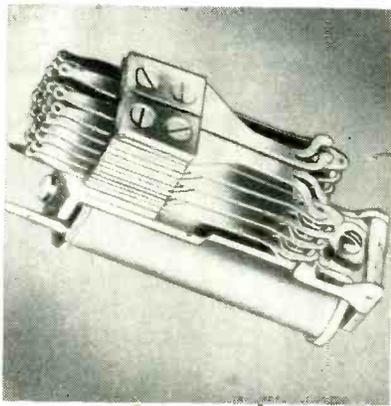


FIG. 3—Telephone-type relay (Automatic Electric) can have up to 13 springs arranged in two stacks yet require space only 4 in. long, 1 in. wide and 2½ in. high

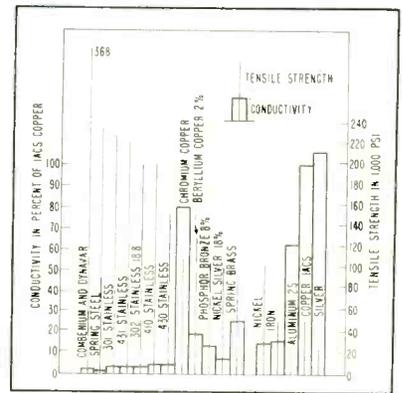


FIG. 4—Characteristics of current-carrying spring materials (Price Electric Corp).

Improve Performance

also avoids bearing wear which required frequent adjustment of older units. The sliding motion also provides wiper action, so that, after months of operation, the contact surfaces usually appear polished and free of pits or material transfers.

Rotary Switch

Basically, relays are mechanized switches. The simplicity of the electromagnet and solenoid as drive mechanisms has resulted in their widespread use, even in rotary switches. An important part of the design is then the ratchet and pawl whereby the translation produced by magnetic action is converted into rotation. Another feature of these multiposition switches is the holding mechanism whereby the switch is positively restrained to its set position.

These two functions are combined in the rotary switch of Fig. 2. The ratchet wheel is held positively in position by a set of stopping teeth on the end of the armature. When the switch is active, the stopping teeth pull away and the pawl indexes over a tooth of the ratchet wheel; energy is then stored in a spring. Demagnetization of the coil allows the driving spring to advance the pawl on the next ratchet tooth to move the wiper as-

sembly to the next bank of contacts (indirect drive).

The bank is mounted on one side of the one-piece open frame so that as many levels as desired can be built up. Contacts and brush springs are assembled between laminated plastic spacers that have been coated with Bakelite varnish. The bank is then tightened for a pressure and baking cycle, after which the bank assembly is as strong and moisture-resistant as a molded assembly. This method of construction withstands voltage breakdown tests between adjacent contacts and between contacts and ground of 2,000 rms volts. Ten-level switches operating self-interrupted at 70 steps per second were tested over one million half-revolutions of the wipers without failure.

General-Purpose Relay

For switching a variety of low-level or signal circuits, the telephone-type relay of Fig. 3 is com-

monly used. To insure positive contact, each of the twin contacts on each spring is independent and self-cleaning. Such slight bounce or chatter as may exist is largely masked by the difference in length and stiffness of the dissimilarly shaped spring tips.

The contacts are welded to the springs for high strength and low resistance. To aid in the self-cleaning action, the contacts are dome-shaped. Considerable progress has been made in developing new alloys for contacts and in learning the limitations of conventional materials. Many variables influence the life of contacts; there is probably no universal contact material. Materials like silver have excellent conductivity but are subject to filming, transfer and pitting. Tungsten, on the other hand, is highly resistant to mechanical wear and arc erosion but requires relatively high contact pressure and applied voltage.

In the relay of Fig. 3, the springs

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- Part III: Fixed Resistors Show Stability Improvements, p 132, Sept. 1954
- Part IV: Precision Potentiometers Use New Materials, p 144, Oct. 1954
- Part V: Iron-Core Transformers Run Smaller and Hotter, p 136, Nov. 1954
- Part VI: High-Frequency Coils Use New Core Materials, p 140, Dec. 1954

COMPONENT DESIGN TRENDS

- Bakelite cementing varnishes for insulating wafers simulate molded assemblies
- Offsetting and angular stacking reduce capacitance between contact blades of r-f relays
- Iron core floating in silicone fluid minimizes temperature effects in time-delay relay

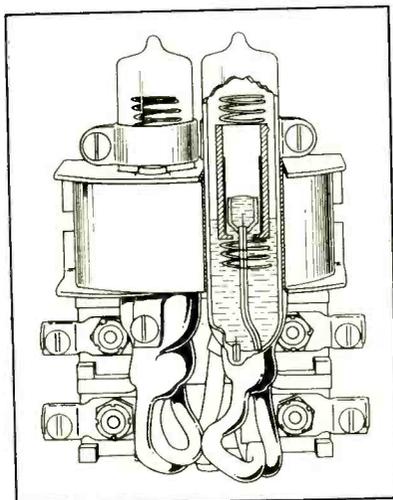


FIG. 5—Two-pole single-phase mercury plunger relay made by Ebert Electronics. Each tube is rated for 35 amp at 115 v

are nickel silver. The choice of spring material depends on the relative values of many factors, chief of which are conductivity and tensile strength. The temperature range over which a material retains its tensile strength may force a compromise, as also may its chemical compatibility with other materials. Figure 4 compares conductivity and tensile strength of common spring materials.

For switching high-frequency signals, the capacitance between springs or contact blades of a pair must be minimized. Two of the techniques used involve offsetting the springs over most of their common length, and stacking the movable and fixed springs in separate piles so that they overlap only at their contacts (as in the video relay recently introduced by Clare).

Mercury Relay

Although most relays make or break contact between solid conductors, other principles of opera-

tion are used. The mercury-type switch can be mounted on an actuable holder as a relay for use in equipment that is always operated in a level position.

A further modification of the mercury relay is shown in Fig. 5. A plunger floats in mercury above which is an alumina cup. The cup contains mercury in contact with one terminal of the relay. The main pool of mercury is in contact with the other terminal. When the coil circuit is closed, the plunger is driven into the pool, thereby displacing the mercury upward to flood over and into the cup and complete the circuit. The mercury contacts are completely enclosed in an hermetically sealed glass tube, thereby permitting operation in explosive atmospheres. A weighted plunger is lifted from the mercury pool in a normally closed relay. With a coil resistance of 6,950 ohms, the relay pulls in at 180 v d-c and 26 ma.

Time-Delay Relay

Outwardly the relay of Fig. 6 appears to be a conventional lever-action unit. However, it also includes an iron solenoid core inside the coil form, as shown in the diagram. Silicone fills the remaining space inside the nonmagnetic coil form. When the coil is energized, the movable iron core is drawn into the magnetic field against the damping action of the silicone fill. As the core moves into the coil, it reduces the air gap, thus reducing the reluctance in the magnetic circuit. When the core is drawn fully into the coil, the relay is actuated.

This operation is used in over-load relays to prevent the relay from responding to momentary surges, and in time-delay relays to

provide a unit that can be recycled promptly. Operation is affected by ambient temperature only indirectly as the temperature affects the viscosity of the silicone; the effect is only slight because of the relatively stable viscosity of silicones. A check valve in a center channel of the core (not shown in the drawing) provides the full damping effect during the timing cycle yet allows the relay to be reset quickly by the spring; this construction assures full timing cycle immediately after reset.

Sensitive Relays

Illustrative characteristics for sensitive relays are: contacts rated at 2 amperes, 26.5 v d-c or 115 v a-c with resistive load, coil sensitivity of 40 mw in dpdt service (22 mw in spdt) and resistance up to

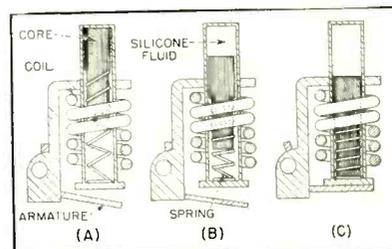
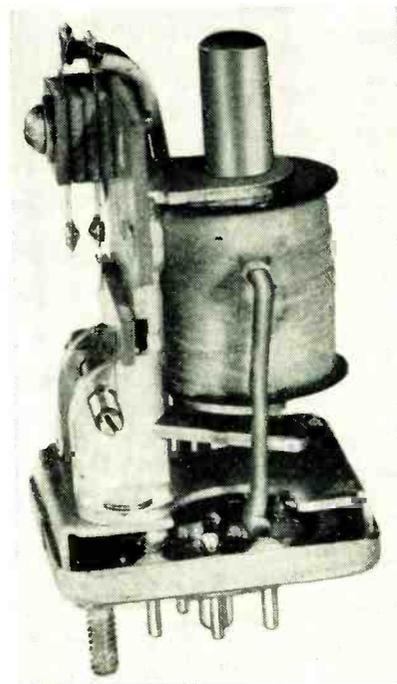


FIG. 6—Plug-in-Heinemann time-delay relay uses hydraulic-magnetic operation to actuate after designed time delay at 125 percent of rating and instantly at 8 times rating. Spring holds iron core away from armature (A) until current is applied (B); when core is drawn fully into coil, armature closes (C)

14,000 ohms, operation from -60C to $+125\text{C}$ to withstand vibrations of 10 g up to 500 cps or shocks to 50 g. One such relay made by Allied Control is $1\frac{1}{4}$ in. long by $\frac{3}{4}$ in. diameter, weighs 2 oz and operates up to altitudes of 80,000 ft (1.3 in. of Hg).

Relay Life

The life of a relay depends on its environment and operating conditions as well as on its design and construction. One representative hermetically sealed relay that plugs into a standard 7-pin miniature socket is rated by the manufacturer for a million operations at 1 amp, 24 v d-c; the unit is insulated for 500 v from any terminal to ground. The design characteristics of the coil for this relay are presented in Fig. 7. Threshold of operation is 60 mw; maximum continuous power to the coil should not exceed 150 mw, and thus any point on the graph between the two constant-power curves defines a suitable operating point. However, a more practical operating point can be obtained by selecting conditions between the 60 and 90-mw curves. The coil is then designed to these parameters to produce the needed ampere-turns at the chosen impedance. Release current is half the energizing current. Over 150 mw, the coil is used in intermittent or pulse service only.

Meter Relays

Where the utmost in sensitivity is required, a meter movement is generally employed. With such a design, the relay can often be actuated directly from the control source without electronic amplification and consequently with considerable simplification to the equipment. Usually, if a circuit can be metered, a meter relay can be used to supervise the circuit automatically. Most indicating instruments consume less than 1 mw, which is more than one order of magnitude below the operating level of sensitive relays and insufficient to produce adequate torque for contact pressure. A principal distinguishing feature of meter relays is, consequently, the means for assuring positive contact.

One of the oldest such relays

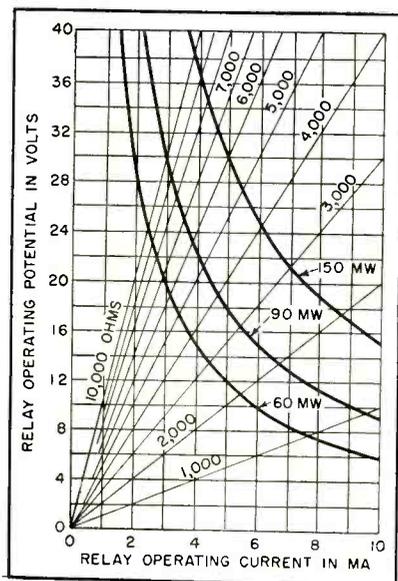


FIG. 7—Coil characteristics for miniature sensitive relay, showing contours of constant power and coil resistance on voltage-current coordinates (Terado Micro Relay)

is the Sensitrol (trademark of Weston). A modern version has a self-shielded-core magnetic assembly for the movement and a self-contained release solenoid. The fixed contact is a small silver-coated permanent magnet. The moving contact is the instrument pointer fitted with a silver-plated soft iron sleeve. When the meter movement brings the pointer near the fixed contact, magnetic attraction closes the contacts with a force in the order of a gram, compared to a few milligrams available from a meter movement directly at a comparable low power.

To force apart the contacts, a 6-volt release solenoid is energized by an external control circuit. The re-

lease mechanism is rated to operate at 75 ma but will operate if the supply voltage drops to 4.5 volts. For a-c operation, a rectifier is built in with the release mechanism; here about 1 watt is required for release.

Contacts can be arranged to close on high or low signal levels. In the newer models that serve both as indicating instrument and relay, platinum-iridium contacts are rated 35 ma at 6 v d-c noninductive and, if auxiliary equipment permits, can be set to close within ± 1 percent of full scale; usual accuracy is ± 5 percent.

Normal test voltage between coil and contacts is 500 v at 60 cps. Sensitivities are as high as 4 microamperes full scale with a contact capacity of 100 milliamperes.

In the instrument of Fig. 8, which has in some applications provided over 7.5×10^7 operations, a locking coil is wound over the normal moving coil and connected, for example, in series with the coil of a booster relay as shown. As soon as the contacts of the instrument relay touch, even at high resistance, some current flows in the locking coil to increase the closing torque. The action is cumulative (positive feedback) and builds up a contact force of up to 3 grams from about 5 milligrams produced by the meter coil alone. As in all such relays, the locking action produces a wipe to assure low-resistance contact and, in this design, loads the brass spring mount of the adjustable contact so that, when the locking circuit is opened, the contacts are thrown open. The indicating coil then repositions the pointer to

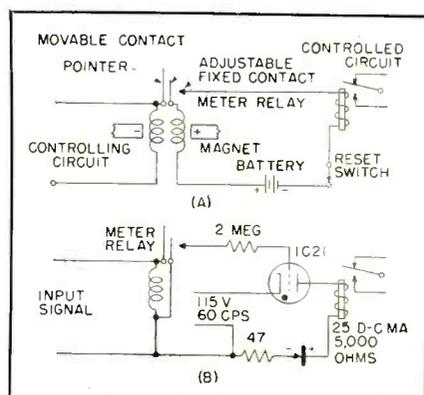
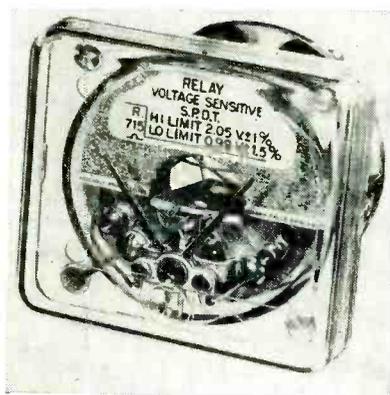


FIG. 8—Meter relay is basically a d'Arsonval movement with the pointer serving as moving contact (Assembly Products). For control of current-operated devices such as relays, auxiliary coil assures positive contact (A); for voltage-operated devices such as grid-controlled tubes, light contact pressure of relay may be sufficient (B)

COMPONENT DESIGN TRENDS

- Inverted d'Arsonval movement with pivoted permanent magnet eliminates need for release or reset circuits in meter-type relay
- Electrostrictive relay responds to sum of applied charges
- Subminiature relays approach size of transistor
- Glass housings increase relay life

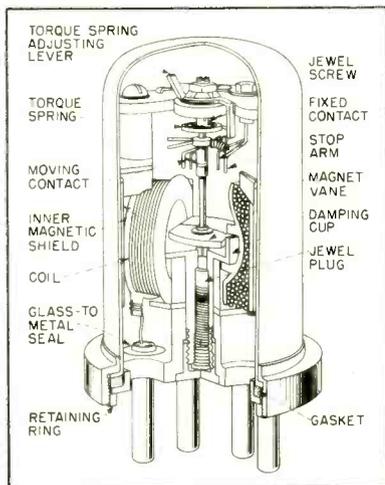


FIG. 9—Instrument-type relay in sealed case develops sufficient torque in milliampere range for reliable contact pressure; unit is widely used in aircraft fire detection equipment with thermocouple as control element (Instrument Division, Thomas A. Edison)



FIG. 10—Relays housed in glass jars achieve protection from dust yet are visible for inspection and accessible for adjustment. Modern glasses withstand usually encountered shock, vibration and temperature (Telectro Industries)

wherever it belongs, either away from the contact or at it ready to lock again.

Where over a milliampere is available for the meter coil and contact current can be held below 100 microamperes with a low open-circuit voltage, the locking feature may be unnecessary, as in the thyatron circuit shown in Fig. 8. This mode of operation is feasible, however, only in a mechanically quiet environment. Even with the locking coil, a shock-mounted version, now being developed, is preferable for use in industrial and military environments.

Moving-Magnet Meter Relay

For applications in which an input power of about 25 microwatts is available, pull-in and drop-out operation is provided without release or reset circuits by the relay of Fig. 9; it gives a power amplification of about 5×10^5 . Basically it is an inverted d'Arsonval movement in that the permanent magnet is the moving member while the coils are stationary, thus reducing the weight and facilitating the use of a wide range of coil resistances (60.5 to 21,000 ohms).

Electrostrictive Relay

These are current-operated devices. Recently a voltage-sensitive electrostrictive relay was introduced by Mullenback Electrical Manufacturing. It presents an impedance of about 0.1 microfarad shunted by about 500 megohms and is actuated by about one milliwatt-second (one millijoule) of energy and is held by 50 microwatts. A feature of particular interest in this relay is that it accumulates energy so that it can respond to the sum of applied charges. Present units are designed for operation at

from 150 to 175 v d-c; contacts are rated for 1 ampere at 125 v a-c non-inductive.

Subminiature Relays

For use in transistorized equipment, subminiature relays are being developed. One such unit, introduced by Allied Control, weighs 0.032 oz and is about an inch high, $\frac{1}{16}$ in. wide and $\frac{3}{4}$ in. long. Nominal coil sensitivity is rated as 1 watt; contacts are rated for 0.25 amp at 26.5 v d-c or 115 v a-c noninductive. Polytron Engineering is in production on a line of relays with similar characteristics.

Another such relay, being developed by Neomatic, has overall dimensions of 0.187 in. by 0.392 in. by 0.500 in. and a weight of 0.035 oz, about the size of a transistor. Operating power is reported to be under 0.25 watt with coil resistances to 2,000 ohms. The spdt contacts are rated for 0.25 amp noninductive.

Many subminiature relays are hermetically sealed; in fact, many relays manufactured today for use in electronic equipment are enclosed or are available with dust covers, dust and other airborne contaminants being a common cause of failure of these low-current units. The life of some relays can be substantially increased, however, if they are accessible for minor adjustments and repair.

Sealed Relays

The relay of Fig. 10, while meeting all environmental requirements for such devices, is arranged to permit examination of its internal structure through the case. The glass cover is readily removed without tools and without the removal of the relay from the circuit, thus facilitating observing the relay in operation and adjusting it in the field.

The connecting leads are brought to a terminal panel through a plastic header which is molded as an integral part of the base member. The leads are sealed into the header during the molding cycle to minimize leakage. To insure internal rigidity, the relay and the base member are mounted to the chassis by a common support stud.



Production-line testing of plug-in type three-stage flip-flop counters



Three-stage (left) and two-stage counters

Flip-Flop Counter Has Expanded Range

Counter may have up to six stable states without using feedback or matrixing. Sequential operation of counter stages requires only one tube to conduct at a time resulting in greatly reduced plate power consumption

MOST COUNTERS in use today are of the Eccles-Jordan flip-flop type. Although proven invaluable in the field of electronics, the flip-flop has disadvantages in certain applications. For example, to divide a given frequency by a nonbinary number, feedback is necessary, which tends to be cumbersome and requires additional circuitry, power and space. Further, if sequential output is required of more than one binary stage, a matrix is necessary. The expanded flip-flop counter to be described overcomes some of the disadvantages that are encountered in the use of ordinary binary counters. In addition, it may have not only two, but three, four, five or any integral number of stable states.

The flip-flop has two stable states and requires one tube per state. A counter that has more than two, for example N , stable states similarly requires one tube per state or

By **HOWARD BECKWITH**

*Chief Engineer
The Walkirt Company
Inglewood, California*

N tubes. The conduction of one tube will prevent all other ($N - 1$) tubes from conducting.

Input pulses cause the N -stage counter to advance through its N states sequentially; even in the flip-flop where $N = 2$ the count advances sequentially from 0 to 1. If there are N stages, the count advances sequentially from 0 to 1, 2, 3, . . . N , advancing one position with each input pulse. In this respect, the counter may be thought of as a linear or ring counter. In this case, $N = 3$ would be a ring counter with a capacity of three. If $N = 2$ (flip-flop) the ring would have a capacity of two.

The same types of input coupling systems used with flip-flops

may be used with N -stage counters. One method is to apply the input to the grids through diodes; one diode for each grid or a total of N diodes. Another method is to apply the input through a capacitor to a common junction of the grid or plate resistors. This method is economical since only one capacitor is needed for any number of stages.

Most of the devices that are used to increase speed or reliability of flip-flops may also be applied to the expanded counter. For example, catching diodes may be used at the grids and plates to discharge coupling capacitors more rapidly. Reset to any of the N states may be accomplished by applying a positive pulse to the grid of that tube.

Three-Stage Counters

Figure 1 shows an N -stage counter with $N = 3$. Each grid is connected through a resistor to every plate except its own. These

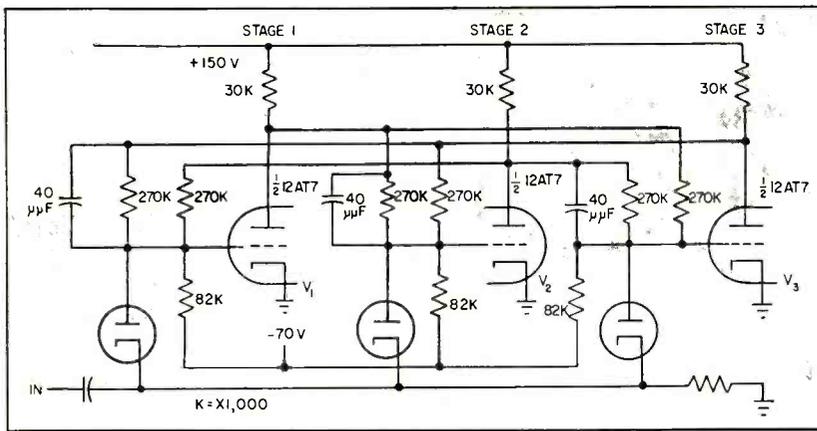


FIG. 1—Input coupling to three-stage flip-flop counter is through diodes

resistors are of such a value that if one stage is conducting all other stages will be nonconducting. For example, if stage 1 is conducting, the resultant low plate potential will cause the potential on each of the other grids to be low since they are connected to one high potential and one low potential plate. On the other hand, the grid of stage 1 is connected to two high potential plates, therefore, it remains at a high potential and assures conduction. Input coupling is through diodes connected to each grid.

The counter of Fig. 1 has several advantages over other methods of achieving a count of three. The power consumption is low because only one tube conducts at a time, the number of tubes required is only three, the output is in sequential form and the speed is relatively fast considering the circuit time constants since each tube conducts only one-third of the time.

A three-stage ring counter of comparable speed requires six tubes, three of which are always conducting, with a resultant tripling of plate current and doubling of heater current.

A system used to obtain a count of three with binary counters requires four tubes, two of which are always conducting. The output is in binary form, requiring a matrix to convert it to sequential count. The feedback limits speed and abates reliability by increasing complexity.

By supplementing flip-flops with $N = 3$ counters, total capacities of 2^n , 3^n or $2^n \times 3^n$ may be achieved with ease; n in this case being the number of binary or ternary counters used.

The usefulness of the expanded flip-flop type of counter extends beyond the three-stage counter to four, five, and six-stage counters. When $N = 4$, four tubes are needed, the same number required by a like capacity binary counter. However only one tube conducts at a time instead of two as in the binary-counter system. Only half the plate power is required and in addition, the output is sequential eliminating the need for a conversion matrix. A four-stage ring counter requires four times as much plate power, and twice as many tubes.

A five-stage counter requires five tubes of which only one conducts at a time. The output is sequential, the plate power required is about one-third of that required by a similar binary system of equal speed and the complexities of feedback are avoided.

Circuit advantages for the expanded flip-flop do not continue indefinitely however. For values of N greater than six, the number of tubes required is greater than that required by binary counters of equal capacity. This point of diminishing returns can be illustrated by considering that the number of grid-to-plate resistors (Fig. 1) required for a counter with N stages is $N(N - 1)$. A five-stage counter requires $5(5 - 1)$ or 20 grid-to-plate resistors, a six-stage counter requires 30 grid-to-plate resistors and a seven-stage counter requires 42 resistors.

As the number of stages is increased, the voltage swing at the grids is decreased due to the interaction between grid-to-plate resistors. A five-stage counter may be

designed for long term reliability, however, using 1-percent resistors.

The loss in grid voltage swing, for values of N greater than two may largely be eliminated by replacing the grid-to-plate resistors with nonlinear devices such as diodes. Figure 2 is an example of this system applied to a five-stage counter. The same number of diodes is required as grid-to-plate resistors, $N(N - 1)$.

The diode matrix operates at plate-voltage levels where the impedances are relatively low and the voltage swings are relatively high. It is required that one resistance divider be connected from each matrix line to the appropriate grid.

Another possibility is to divide the plate voltages down to grid voltage levels with resistors, with a matrix providing the proper grid voltages. The higher impedances involved in this type of circuit require different characteristics of the diodes or other nonlinear devices than the circuit of Fig. 2.

The power efficiency of the expanded flip-flop counter can be deduced from Fig. 2. During operation, each tube conducts only one-fifth of the time.

High-speed reliability of this counter is increased because each tube in the circuit has an available recovery time that is equivalent to four input pulses.

Design Equations

The prime consideration of the design equations given below is long-term reliability. Design is based on the assumption that all resistors may vary by an amount ρ and that all supply voltages may vary by an amount σ , in the most unfavorable direction. It is assumed that all of these worst conditions are present simultaneously. The simplest form of counter (Fig. 1) will be used to derive design equations.

Taking first the grid circuit, Fig. 3A, of a conducting tube, the conditions that tend to decrease the grid voltage are increased R_1 , decreased R_2 , increased E and decreased E_{N0} the plate voltage of a nonconducting tube. When the tube is conducting it is required that its grid be zero or positive and the following relation exists

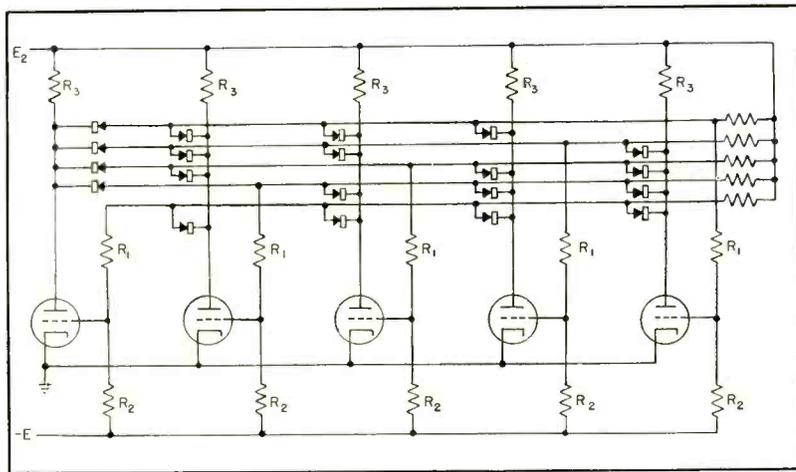


FIG. 2—Flip-flop counter uses crystal diodes in cross-coupling networks

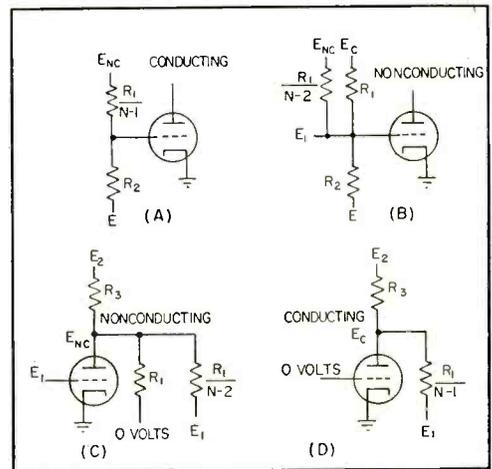


FIG. 3—Equivalent grid and plate circuits

$$(1+\sigma)E = (1-\rho)R_2 \left[\frac{E_{NC}}{(1+\rho)R_1(N-1)} \right] \quad (1)$$

When the tube is nonconducting, Fig. 3B, the negative voltage applied to the grid is E_1 . The conditions that make E_1 maximum are R_1 minimum, R_2 maximum and E minimum. The grid is connected to a low potential plate whose potential is E_0 through one grid-to-plate resistor R_1 , and to $N - 2$ high potential plates, whose potentials are E_{NC} through $(N - 2)$ (R_1) resistors. The equation for this circuit is

$$E_C = KE_{NC} - (1-\sigma)(N-1)E_1 \quad (2)$$

where

$$K = \frac{[(1-\sigma)E - (1+\sigma)E_1](1-\rho)^2(N-1)}{(1+\rho)^2(1+\sigma)E} - (N-2)$$

In the plate circuit of a nonconducting tube, Fig. 3C, conditions that decrease the grid voltage of the conducting tube are E_2 minimum, R_3 and R_1 maximum and $R_1/(N-2)$ minimum. Relationships are

$$\frac{(1-\sigma)E_2 - E_{NC}}{(1+\rho)R_3} = \frac{E_{NC}}{(1+\rho)R_1} + \frac{E_{NC} + E_1}{(1-\rho)R_1/(N-2)} \quad (3)$$

When a tube is conducting its job is to prevent all other stages from conducting. In Fig. 3D the conditions that make E_1 more positive are E_2 maximum, R_1 and R_3 minimum and r_p maximum. These relations are expressed by

$$\frac{(1+\sigma)E_2 - E_C}{(1-\rho)R_3} = i_p + \frac{E_C + (1+\sigma)E_1}{(1-\rho)R_1/(N-1)} \quad (4)$$

where r_p is the static plate resist-

ance of the tube and i_p is the plate current. Solving Eq. 3 and 4 for R_1 , then using the relationship $E_C = i_p r_p$ and solving for the maximum permissible static plate resistance r_p , gives

$$r_p = R_1 \left/ \left[\frac{e}{KE_{NC} - (1+\sigma)(N-1)E_1} - f \right] \right. \quad (5)$$

where

$$e = \left(\frac{[(1+\sigma)E_2 E_{NC} + (N-2)(1+\sigma)]}{(1+\rho)(E_{NC} + E_1)E_2/(1-\rho)} \right) - \frac{(1-\rho)[(1-\sigma)E_2 - E_{NC}]}{(N-1)(1+\sigma)E_1/(1-\rho)}$$

and

$$f = \frac{[(N-2)[E_{NC} + (1+\rho)(E_{NC} + E_1)] + (N-1)(1-\sigma)E_2}{(1-\rho)[(1-\sigma)E_2 - E_{NC}]}$$

The limits of voltages and tolerances for any value of N may be determined from Eq. 5. For r_p to be positive

$$|KE_{NC}| > |(1+\sigma)(N-1)E_1| \quad (6)$$

For K to be positive

$$\left| \frac{[(1-\sigma)E - (1+\sigma)E_1](1-\rho)^2(N-1)}{(1+\rho)^2(1+\sigma)E} \right| > |N-2| \quad (7)$$

When $N = 2$ this condition is always met. Solving Eq. 7 for E

$$E > \frac{(1+\sigma)(1-\rho)^2(N-1)E_1}{\left[\frac{(1-\sigma)(1-\rho)^2(N-1)}{-(N-2)(1+\rho)^2(1+\sigma)} \right]} \quad (8)$$

Voltage E must be positive, therefore

$$|(1-\sigma)(1-\rho)^2(N-1)| > |(N-2)(1+\rho)^2(1+\sigma)| \quad (9)$$

If $N = 2$ or the tolerances are zero, Eq. 9 will always be true. For other values of N and for practical tolerances Eq. 9 provides a means of determining the outside tolerance limits for a given value of N . With

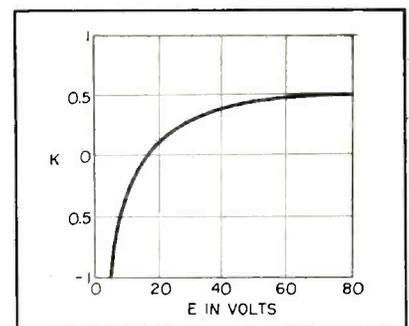


FIG. 4—Relationship of K to E for an $N = 3$ counter

this done a minimum value of E can be determined from Eq. 8.

When the conditions of Eq. 8 and 9 are met the requirement of Eq. 6 will also be met for all practical values. Equation 5 can be used to determine the maximum r_p .

For practical values the r_p of Eq. 5 changes rapidly with changes in K which depends largely upon E and E_1 . The value of E_1 is limited chiefly by tube characteristics. Therefore, the variable that may be adjusted most freely is E . Figure 4 shows the relationship between K and E for typical values of E_1 , ρ , σ and N . A logical choice for E is just above the knee of the curve.

The design procedure is easily modified to accommodate circuit variations such as the use of cathode bias resistor, catching diodes or other modifications of the basic circuit. The limitations imposed by Eq. 8 and 9 do not apply when nonlinear devices instead of resistors are used for cross coupling.

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Magnetic Tape Improves

Recorder memorizes thirteen geophone response signals resulting from seismic echoes and immediately plays them back onto pen recorder. Carrier to each recording head from 4,500-cps multivibrator is frequency-modulated $\pm 2,000$ cps by the signal from the associated geophone insuring minimum phase shift and good low frequency response

By S. J. BEGUN

*Director of Advance Development
Clevite-Brush Development Co.
Cleveland, Ohio*

MULTICHANNEL RECORDING plays an increasingly important part in geophysical exploration work. It provides a visible presentation of signals as they are picked up by a series of properly placed geophones after a dynamite charge has been exploded. By correlating the signal arrival time at the various geophones, and by inspecting the phase relationship of incoming signals, much can be deduced about the earth's crust.

Until recently, a graphic record has been the only information left for subsequent evaluation. A considerable advantage accrues if the signal derived from each geophone can be memorized as an electric signal and made available later. It is possible to re-establish an electrical signal from a graphic record, made with a predetermined filter setting but the equipment to do it would be complex.

Specifications

A few of the most important requirements for a practical recording instrument follow: recording of frequencies in the range from 20 to 500 cps within 1.5 db; time relationship between signals preserved with an accuracy better than 1 millisecond; and signal-to-noise ratio of at least 40 db.

A magnetic recording system presents a good solution for preserving and subsequently reproducing geophone signals. Since only 5 seconds of recording time are wanted, the use of an endless recording medium suggests itself. However, to make handling and storage easier, a design was adopted that employs the

endless principle without using an endless recording medium.

Two units for geophysical exploration work have therefore recently been developed. One equipment setup is designed to be carried by a truck. Its essential function is to record the information from the geophones. The other unit is a reproducing device for use in field offices. It serves mainly to recreate a facsimile of the original electrical signal and to supply it to other processing equipment.

Truck Unit

A block diagram of a truck unit is shown in Fig. 1. A number of geophones translate the soil vibrations, owing to surface transmission and due to strata reflections of the shock waves released by an explosive charge, into electrical signals. These signals are fed over cables to the input terminals of individual gain-controlled amplifier units. Each of the preamplifiers is connected to a modulator, that, in turn, energizes one of a series of magnetic heads to impress the signal-modulated carrier upon the recording medium. The recording medium is laid around the surface of a slowly rotating drum.

Also wound around the same drum adjacent to the magnetic recording medium is a strip of graphic chart paper. A single, high-speed writing pen that moves sideways after each drum revolution is sequentially connected during the playback process through a discriminator to each magnetic head. It leaves a series of traces on the chart paper, which repre-

sents a time-coordinated facsimile of the electrical signals generated by the geophones. The speed of the synchronous motor that drives the drum is controlled by a 50-cycle tuning fork.

The metal drum, supporting a plastic magnetic tape and the voltage-sensitive chart paper, is essentially hollow except for a slight offset center web. It has a diameter of 12 in. and rotates around a horizontal axis. The periphery of the drum is slightly grooved to locate the magnetic tape. This tape, which is $1\frac{3}{4}$ in. wide, comes from a supply reel and returns to the take-up reel, both in the hollow portion of the drum.

The drum rotates with a surface speed of 7.5 in. per second. A normally-open contact is actuated at each revolution of the drum and is closed at a moment when the slit in the drum wall passes under the 14-channel magnetic head. This contact initiates the dynamite explosion and makes certain that all recordings take place over the undisturbed portion of the recording medium.

Magnetic Head

Heads for all 14 channels are held in a common housing. The design of this structure is such that all the gaps are accurately aligned. This is an important requirement for preserving proper time relationship in the reproduction of signals, particularly if another playback mechanism is to be used. The center-to-center spacing between heads is 0.125 in. Each channel has a width of 0.05 in., and the physical gap

Geophysical Recordings

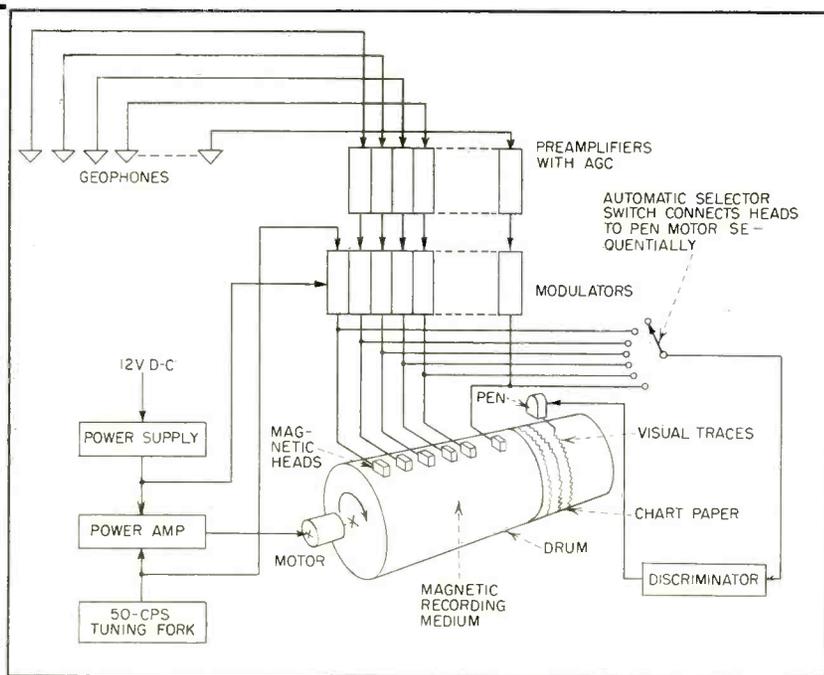


FIG. 1—Block diagram of seismic truck recording unit built to withstand rough terrain and wide variety of climatic conditions



Truck-mounted seismic recorder contains seven dual-channel modulators

length between pole pieces is 5×10^{-4} in.

To obtain minimum phase shift and good response at low frequencies, a carrier-frequency system is employed for the recording of signals. The carrier frequency of about 4,500 cycles per second is obtained from a free-running multivibrator. To frequency modulate the multivibrator by $\pm 2,000$ cycles per second, the input signal derived from the geophone develops a voltage drop in the multivibrator circuit. Thus, a corresponding change of the period of oscillation is brought about. Fourteen modulators are provided to serve the 14 heads.

However, only 13 of the heads are connected by amplifiers to geophones. One of the heads records a 50-cps timing signal. The input impedance of the modulators is approximately 50,000 ohms with $\frac{1}{2}$ -volt signal sufficient to provide full modulation.

Modulator

A more detailed description of the circuit (Fig. 2), of such a modulator is given below. A 12AT7, V_1 , whose parallel-connected grid-

input level is adjusted by potentiometer R_1 , serves as a signal-frequency amplifier. Grid bias to one section of V_1 is developed across R_2 and bypassed by C_1 while the R_{17} , C_{11} combination serves to bias the second section. Resistance R_3 and R_{18} partially neutralize current feedback developed across R_2 and R_{17} respectively.

The frequency-modulated carrier is generated by V_2 , a 12AY7 operating as a 4,500-cps free-running multivibrator with a signal frequency-modulated positive-grid bias. The principal carrier frequency-determining components of the multivibrator are the grid circuit elements R_6 , C_3 , R_9 and C_5 , while resistance R_{10} and R_7 serve as plate-coupling impedances. Signal frequency voltage is developed across resistances R_5 and R_8 which are carrier-frequency bypassed to ground by capacitors C_4 and C_{13} . The signal frequency across R_5 and R_8 varies the time of recovery of each triode half of V_2 from a condition of plate current cutoff.

Proper operating bias for the output stage is developed by the potential drop caused by the cathode current of V_3 through R_{14} , bypassed

by C_8 . Plate resistance R_{16} , in conjunction with capacitor C_{10} , serves to couple V_3 to the magnetic recording head. Resistance R_{15} , bypassed to ground by capacitor C_6 supplies the required screen-grid operating potential to V_3 . The nominal plate potential supplied to V_1 and V_3 is 225 volts. A regulated supply of 150 volts energizes the multivibrator tube V_2 through resistance R_{11} bypassed to ground by C_7 .

The magnetic cores of each head are energized with sufficient magnetizing force to generate a gap magnetic field that saturates the tape. A new recording may erase the previous one. A 4 cps square-

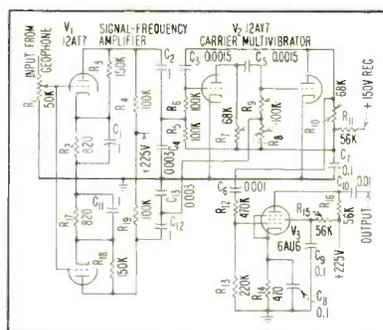
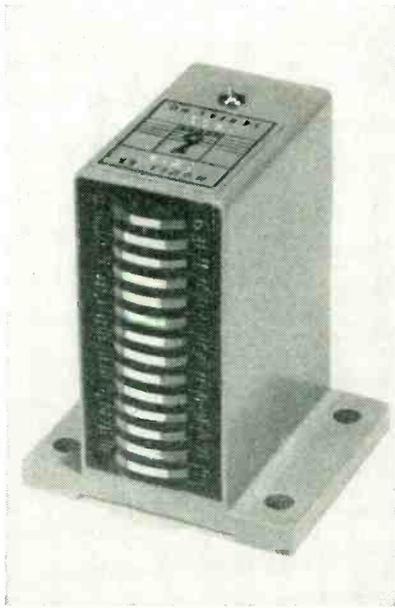


FIG. 2—Frequency-modulated multivibrator that requires only 0.5 v geophone signal for fully modulated tape record



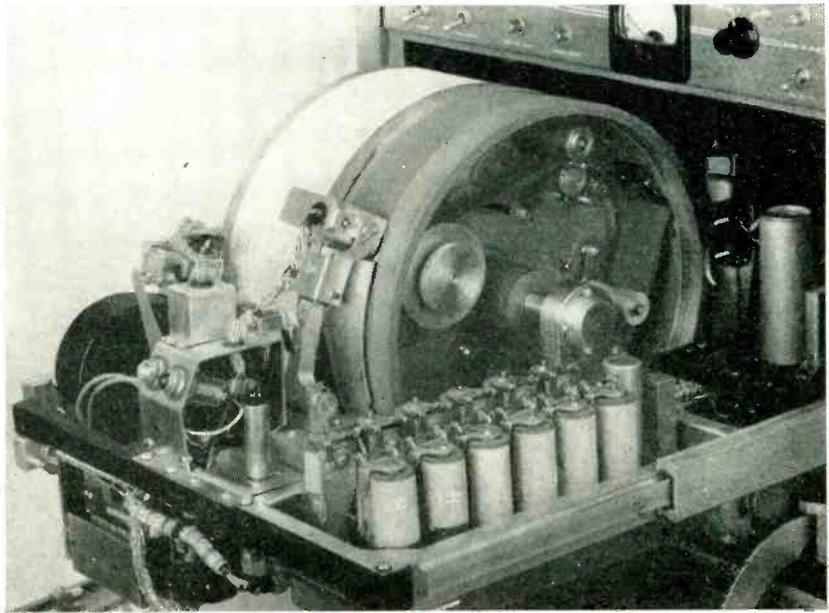
Multichannel head assembly with individual pole pieces held by a casting

wave generator provides a test signal to check the operation of the complete system.

Playback

Each of the 14 recording heads is also employed as a playback device. During the reproducing process all heads feed in sequence into one amplifier-limiter demodulator, which rejects the 2,500 to 7,000 cps band to eliminate interference from the carrier frequency. The demodulated signal is supplied to an amplifier that drives a penmotor serving as a monitor recorder.

The drum, which supports the magnetic tape on one side of its periphery, supports recording paper on the other side of its rim. The graphic record is made by one pen that is sequentially connected with all 14 channels. The penmotor first reproduces the information from the channel on the lefthand side and progresses step by step to the right. At the end of each revolution of the drum the penmotor is very quickly moved sideways $13/64$ inch under the influence of a biasing spring, which is slowly compressed during the 5-second period of a drum revolution. Therefore, it takes a total of 70 seconds to transfer the signals of all 14 channels from the magnetic tape to the chart paper. After the graphic recording period is over, the penmotor is returned to its original position.



Truck recording unit drum and drum support showing 14-channel magnetic head recording signals on the tape carried across the surface of the drum

An important feature of this device is that a simultaneous event can be resolved into sequential phenomena and can then again be presented as a simultaneous event without introducing undesirable phasing errors. This is achieved by having the magnetic recording medium and the paper on the same drum. A unique geometric relationship is maintained in the transfer process, making the outcome effectively equal whether all channels are simultaneously or sequentially reproduced.

Since the frequency response of the penmotor is limited to 100 cps, the monitor record will contain only frequencies up to this value.

The drum is friction driven by a 50-cycle synchronous motor energized from a 50-watt power amplifier. A tuning fork which might be part of either the apparatus or a part of some other device acts as a frequency standard. Since speed regulation in a frequency-modulated equipment is of greatest importance, all attempts have been made to keep speed as uniform as can easily be achieved. The use of wide sidebands is an attempt to minimize any speed-fluctuation errors.

Safety

Certain safety provisions insure that the dynamite charge is not accidentally fired and that the tape is not used for recording a second

charge which will automatically lead to erasure of previous information. As soon as the dynamite has been fired, and a recording has been made, a lever within the hollow portion of the drum is released and incapacitates all circuits which might be used for initiating a new recording operation. This lever is reset only when the magnetic tape is pulled from the supply to the take-up reel to provide a new unrecorded section for the next recording.

Testing

In actual use the operator records a square-wave signal on all channels by starting the device and pushing the square-wave selector switch. After the 5-second magnetic recording period, the unit automatically performs the signal transfer operation, making the pen draw the square wave on the chart paper for each channel to ascertain the satisfactory condition of the apparatus. Whenever the repeat button is pressed to reproduce any one of the channels a second time, the graphic recording from the second run must coincide with that obtained from the first. Should the operator wish to interrupt the recording cycle, he can do so by pushing the reset button.

Field Station Unit

In the field station unit a synchronous motor drives the drum

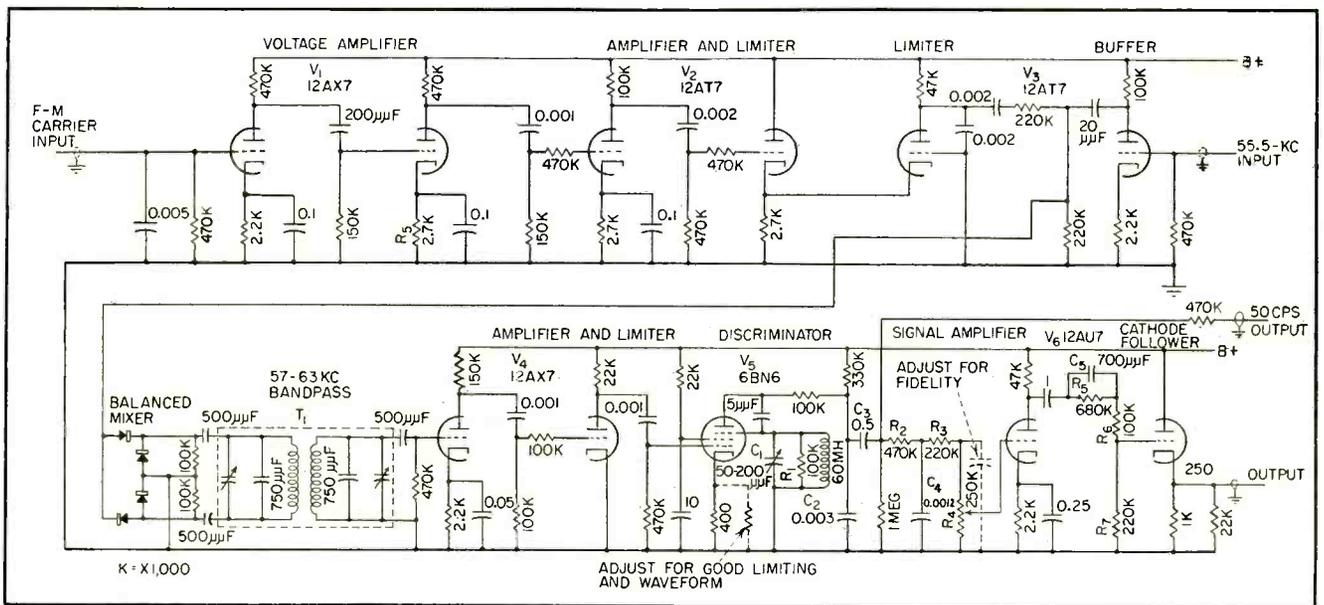


FIG. 3—Dual-channel discriminator, located in field station unit, delivers 1 volt rms into a 600-ohm load resistance to rerecord echo signals photographically. F-M carrier high-frequency components are favored by coupling capacitors in stages V_1 and V_2

which has the same diameter and angular velocity as the drum in the recording truck unit. The recording medium upon which the geophone signals have been impressed is wound around the drum.

The recorded information is picked up by magnetic heads and the reproduced data are fed to the input terminals of a series of discriminators. The original signal is recovered, amplified and then delivered to an appropriate number of galvanometers to produce a photographic record of the recorded data.

The magnetic head structure can be adjusted to assure perpendicular alignment of all gaps with respect to the recorded tracks. This is important if proper time relationship between information recorded on various tracks is to be maintained.

Demodulation of the carrier frequency in the field station unit is different from that employed in the truck unit because it is necessary to reproduce the band up to 500 cycles per second while previously only 100 cycles per second were needed for monitoring. Because of this wider band of signal frequencies, and because of the relative proximity of the modulated carrier frequency band, the following technique is employed. The modulated carrier as derived from the magnetic reproducing heads is heterodyned against a 55.5-kc frequency so that the original un-

modulated carrier of 4,500 cycles per second is raised to 60 kc. The modulated carrier varies from 58 to 62-kc, if only $(f_1 + \Delta f_1) + f_2$ terms are used and the difference terms are rejected by filters.

Discriminator

A schematic of the dual-channel discriminator circuit is shown in Fig. 3. The frequency-modulated carrier recovered from the tape is fed to the input of V_1 which functions as a conventional resistance-capacitance coupled voltage amplifier. Tube V_2 provides additional amplification and also amplitude limiting. The interstage coupling capacitors of stages V_1 and V_2 are chosen to favor the higher frequency components of the frequency-modulated carrier in order to partially neutralize the amplitude modulation that results from the head-tape frequency-response characteristic.

The output circuit of V_2 is cathode coupled to V_3 which further limits the signal. The second section operates as a conversion-oscillator buffer. The oscillator working at a frequency of 55.5 kc feeds the grid of the second half of V_3 .

The combined outputs of the limiter and buffer are fed to the input of a balanced mixer consisting of four 1N34 germanium diodes operating in conjunction with intermediate-frequency transformer

T_1 . The band-pass of T_1 is designed to pass only frequencies in the range from 57 to 63 kc. The output of T_1 is fed to V_4 which amplifies and amplitude limits the 60-kc intermediate frequency. Tube V_5 recovers the signal frequencies from the frequency-modulated carrier by virtue of electron-gating action of the quadrature grid.

The phase and magnitude of voltage impressed on the quadrature grid varies as the instantaneous carrier frequency in accordance with the frequency-response characteristics of the tank circuit consisting of inductance L_1 and capacitor C_1 . Resistor R_1 shunts the inductance for optimum linearity.

The output of V_5 is carrier-frequency filtered by capacitor C_2 and coupled by capacitor C_3 through the filter consisting of resistors R_2 , R_3 and capacitor C_4 to the input of R_4 .

Tube V_6 operates as a signal-frequency amplifier and cathode-follower output stage. The amplifier section of V_6 is capacitance coupled to the input of the cathode-follower section through a high-frequency compensating network consisting of capacitor C_5 and resistors R_5 , R_6 and R_7 . The cathode-follower section of V_6 is designed to deliver 1-volt rms into a 600-ohm load resistance.

Each demodulator has a 600-ohm output and develops approximately 1 volt at its terminals for a fully modulated carrier frequency.

Phase Meter Analyzes

By RICHARD W. HOUGHTON

Engineer
Technology Instrument Corp.
Acton, Mass.

MONOCHROME television reproduction requires that picture-sound synchronization, as well as vertical and horizontal sweep synchronization be maintained in both transmitting and receiving equipment.

Color reproduction requires, in addition, the synchronization of the individual components that make up the composite color signal. While straightforward methods of frequency-lock indication have long been known, new methods of high-frequency phase indication have been devised to fulfill the rigid requirements imposed by the color signal. These requirements are set forth in the box.

In practice, phase errors greater than 20 deg are easily detected as incorrect hues in the reproduced image. For best response, the phase error should be kept below 5 deg to insure that the corresponding hue error will be undetectable in normal viewing. A phase differential of this magnitude corresponds to a time delay error of 0.004 μ sec at the subcarrier frequency of 3.58 mc.

Sources of Phase Error

Two types of phase distortion are to be considered in a color television system. The first of these results in both the color burst and color picture information being shifted together. This type of distortion has small effect upon the resultant image, as examined by the nontechnical television viewer.

The second type of distortion causes a variation in the phase of the subcarrier as a function of its position in the amplitude range from the color burst toward the white level. This condition is the primary cause of improper color reproduction. There are at least three commonly known causes of phase shift throughout the ampli-

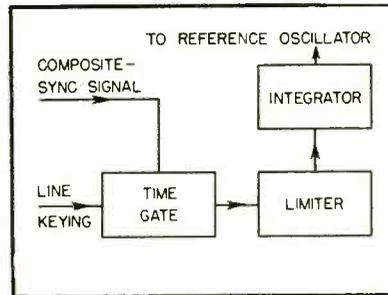


FIG. 1—Simple sync signal purifier used to control reference oscillator

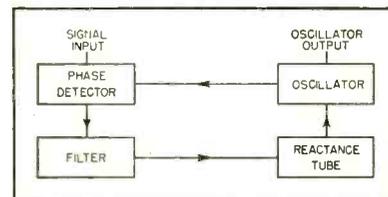


FIG. 2—Automatic phase-control system of a type used in color television

tude range. They are diagonal clipping, parallel-path phase differentials and variable load impedance.

An effect of diagonal clipping may occur as a result of overdriving the grids in television transmitter amplifier stages. Here, actual clipping may occur in the white direction, but only compression will normally occur in the sync direction. A Fourier analysis of the clipped wave shows the phase of the fundamental component to have

NTSC Phase Specifications

The NTSC color television standards approved on July 21, 1953 define basic phase tolerance in the following manner: The angles of the subcarrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75 percent of full amplitude, shall be within ± 10 degrees and their amplitudes shall be within ± 20 percent of their specified values. Closer tolerances may prove to be practicable and desirable with advance in the art

been shifted by a small amount. After bandwidth limitations have removed the harmonic components the sine wave is restored at a slightly reduced amplitude and with the phase shifted.

Parallel path phase differentials occur in almost every circuit containing active elements. The effect may result from adjacent-channel component differences, or from interchannel stray coupling. Both amplitude and phase differences can result from such effects. Frequently the phase differential varies as a function of signal amplitude and appears as a changing phase relationship between color burst and color picture information. The effect might easily occur in studio equipment, where a steady subcarrier could combine with a video signal through stray coupling.

The effect of variable load impedance is best shown by considering a generator feeding a load made up of a complex impedance. A change in either generator or load impedance can result in an apparent phase shift. A transmitting tube driven into the grid-current region by synchronizing pulses can experience a radical impedance change and resultant phase distortion.

Each of the above sources of internal phase shift may result in changes equal to, or larger than, the desired 5 deg. In each case, the angular differential must be carefully measured and in many instances appropriate compensating circuitry must be incorporated into the system.

The ability of conventional television receivers to maintain phase differentials smaller than the required 5 deg maximum angle has long been under consideration. Early in the design of color television receivers, circuits were de-

Color TV Systems

Direct readings can be made in the receiver plant or broadcast studio without ambiguity using a meter that embodies frequency reduction in both input channels and summation of resultant signals. Existing methods of phase delay leading to design are compared

vised to enable the color burst to control the reference oscillator phase in the presence of noise. This circuit is known as automatic phase control, or apc. A typical system used for signal purification is shown in the block diagram, Fig. 1.

In this system, the composite sync signal is fed into a time gate controlled by the line-deflection system. The signal is passed only during the burst period and noise occurring at other times is cut off. The separated burst is then limited to eliminate the noise amplitude variations common to its period. This burst is then integrated for control of a reference oscillator. The basic control circuit used for this purpose is shown in Fig. 2.

Here, the purified signal is fed into a phase detector, where its phase is compared with that of the oscillator. The detector output is filtered and applied to a reactance tube, which corrects the oscillator phasing. By this means, phase synchronism, falling well within the 5 deg specification, may be maintained.

Delay Measurements

The techniques of system evaluation using the concepts of phase and envelope delay have been discussed in the literature. There are three methods of evaluation possible. These are: (1) plotting phase angle as a function of signal frequency; (2) plotting phase delay ($t_p = \theta/\omega$) as a function of signal frequency; and (3) plotting envelope time delay ($t_e = d\theta/d\omega$) as a function of signal frequency.

A plot of the system phase angle versus frequency can be considered a direct approach to the problem. The information is difficult to interpret in this form, however, since small changes in slope may represent large delay increments ex-

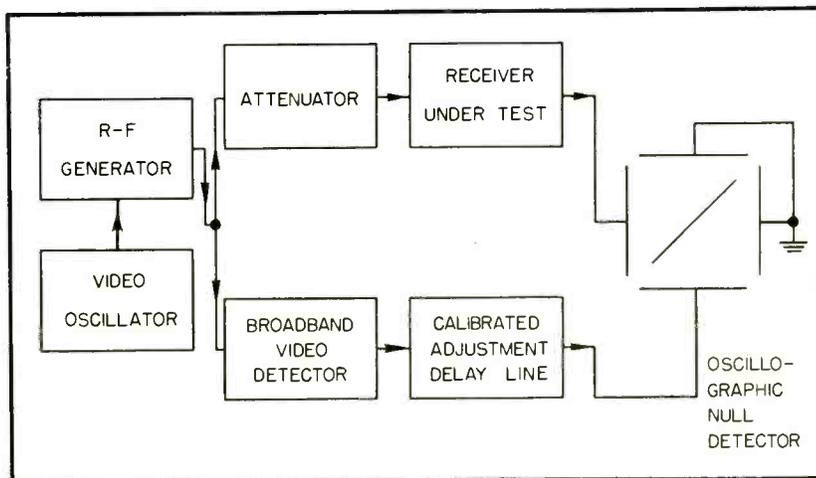


FIG. 3—Oscillographic method of measuring phase delay in tv receiver

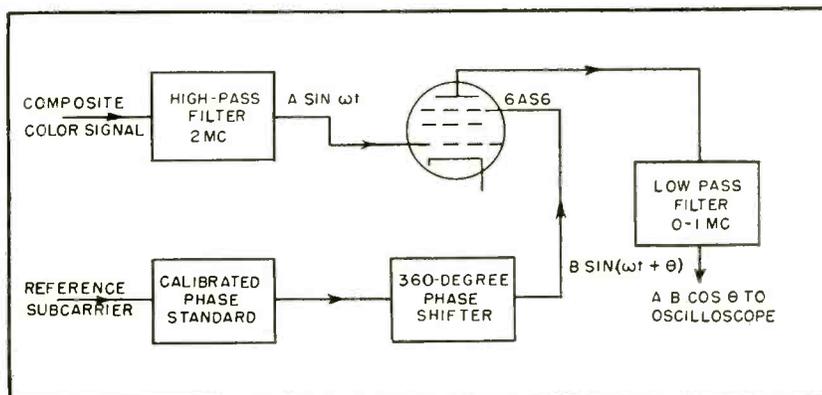


FIG. 4—Color signal analyzer described in text feeds signal to oscilloscope

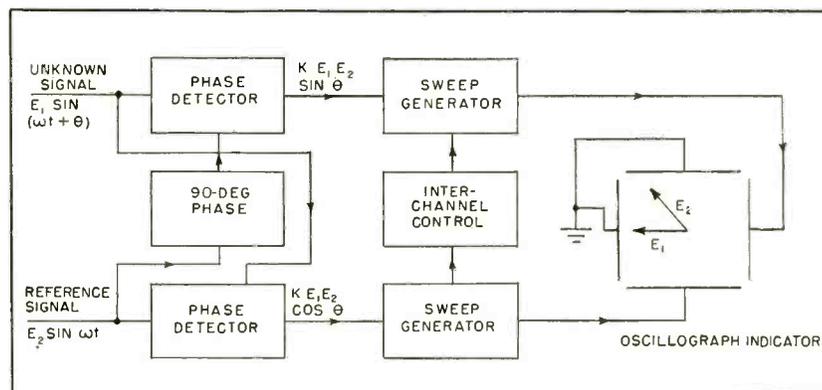


FIG. 5—Elements of vectorscope that gives cro display of phase vectors

pressed in the time domain.

A more useful characteristic is that resulting from a plot of phase delay versus frequency. Such a curve may be easily evaluated. Deviations from the average delay can be considered in terms of the rise time of the circuit under test.

The third approach is that involving the envelope delay characteristic. Such a characteristic may be plotted by taking the slope of the phase characteristic at each frequency under consideration. A more precise computation of this characteristic results from taking the sum of the phase delay and a term proportional to rate of change of phase delay with frequency. The envelope delay concept of system analysis has, as a foundation, the theory of wave-packet summations. This theory has, however, been questioned. Accordingly, it would seem that a flat envelope delay characteristic cannot be interpreted as a sufficient condition for proper receiver transient response. It has been stated by Avins, Harris and Howath that phase delay is a more useful tool than envelope delay in evaluating the transient response of television receivers.

Current Measurement

Phase delay measurements, currently undertaken, tend to follow a standard comparison approach. Typical of the methods used is that shown in Fig. 3.

In this system the radio-frequency signal source is amplitude modulated at the desired video frequency. The composite signal is then fed into the receiver under test and into a broadband video detector having known characteristics. A calibrated adjustable delay line is used as a standard of comparison in the known channel. This line may be adjusted to equalize the delays in both channels, as indicated by a narrow diagonal line upon the face of the null-indicating oscilloscope. Accuracies of $0.01 \mu\text{sec}$, (13 deg at 3.58 mc, the subcarrier frequency), are claimed for this approach.

In transmitter tests, it is frequently necessary to measure the relative phase relationships between the respective color bars carried by the subcarrier composite signal. Such measurements, using

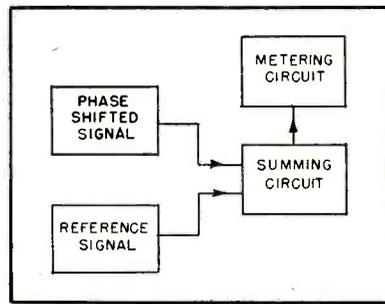


FIG. 6—Basic phase-measuring system

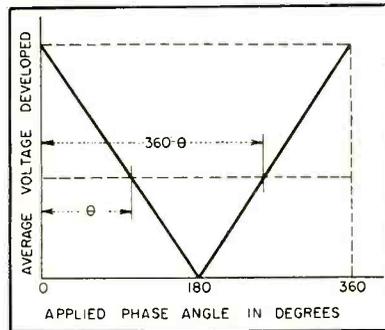


FIG. 7—System ambiguity resulting from simple summing technique

a color signal analyzer, have been described by Luther.

This device may be used for transmitter signal analysis under actual operating conditions. Its operation is comparable to that of the synchronous demodulator used in color receivers.

In brief, the chrominance portion of the color signal is separated by a high-pass filter and fed into the first grid of a 6AS6 modulator pentode, shown in Fig. 4. The suppressor grid of the 6AS6 receives a continuous-wave subcarrier reference signal, which is obtained from the color signal generating equipment or generated by a local burst-controlled oscillator. This reference may be shifted through 360 deg by the use of an uncalibrated

phase shifter, as well as by an accurately calibrated amount using a secondary phase standard.

The output of the demodulator is observed on an oscilloscope through a low-pass filter that removes all frequencies above 1 mc. Since this output is proportional to the product of the two signals multiplied by the cosine of the phase angle between them, it is possible to obtain a visual null on each color bar. For standard measurements, a reference null is established upon a known color component and the angular relationship with all other color components is determined by successive nulling operations. A measurement accuracy of ± 1 deg has been established by this approach.

Vector Phase Indication

Firestone and Richardson have recently described a dynamic approach to the color bar phase measurement problem. Using their Vectorscope device, a polar plot showing both the magnitude and angular position of color bar vectors is presented upon the face of a cathode-ray tube.

The simplified block diagram, Fig. 5, indicates the primary components used in this system.

Here, the reference and shifted signals are applied to dual phase detectors. Both signals are presented directly to the detector placed in the reference channel. The reference signal is shifted by 90 deg before detection occurs in the unknown channel. The above operations result in two output signals, one proportional to the sine of the included angle and the other pro-

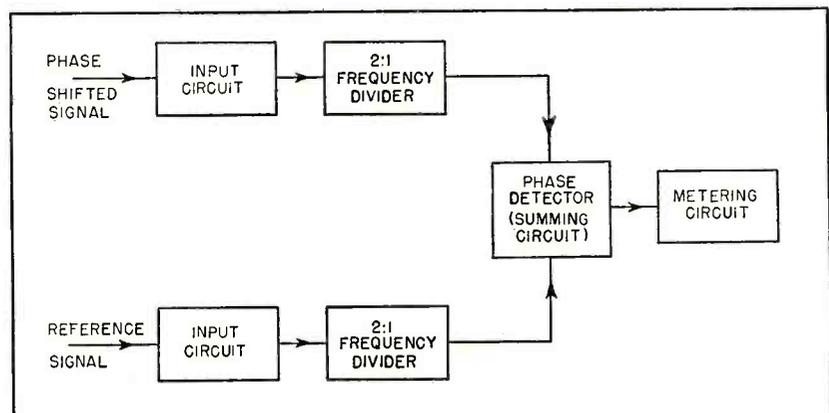


FIG. 8—Frequency division eliminates detector ambiguity in phase measurement

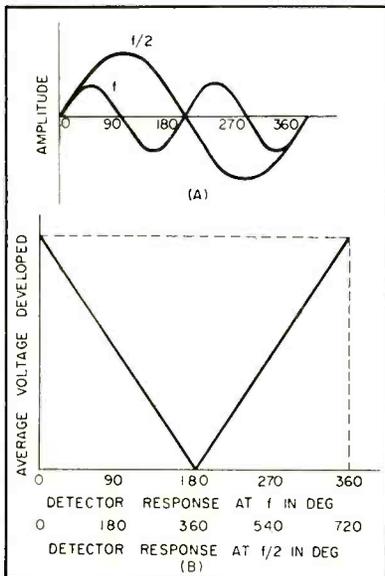


FIG. 9—Sinusoidal representation (A) and detector responses (B)

vision systems, may be considered to be representative of the current field. Others, described in the literature, may differ in detail but fundamentally they are embraced by one of the above categories.

Many of the phase measurements to be undertaken in the field of color television could be more easily accomplished by conventional means. The direct-reading instrument to be described has been designed to this end. Complete in a single package it accepts sinusoidal or complex information at the terminals of two coaxial probes and presents the resultant data upon the scales of a D'Arsonval type meter.

A study of phase detector systems currently in use indicates that conventional summing (or differ-

trated by means of the detector response characteristic in Fig. 7.

Such a phase detector will indicate the same average voltage output for two possible angles existing with a full 360 degrees of angular rotation. Such an ambiguity can be resolved by adding a known angular increment to the input system, thereby identifying the quadrant of operation from the direction of change. However, an ambiguity eliminator of this sort requires that a wide-frequency, constant-phase-shifting network be constructed for insertion in series with the incoming signal. Such a circuit was found to be complex and impractical.

A more straightforward approach involves frequency reduction in both input channels and summation of the resultant low-frequency signals, as in Fig. 8.

The theoretical advantage of this 2-to-1 frequency reduction is illustrated by the curve in Fig. 9A. When plotted upon a time axis, the high-frequency signals can be seen to pass through a change of 360 deg during the same period in which the half-frequency signals pass through 180 deg.

Average detector output plotted as a function of the phase angle between the input voltages is shown in Fig. 9B. When operated at the fundamental input frequency, this detector voltage passes through its entire range of values during every 180 deg of the applied phase angle. Since 180 deg at the half frequency corresponds to a change of 360 deg at the basic input frequency, the entire 360 deg of angular spectrum may be represented by a series of output voltage levels ranging from zero to its maximum value.

Complete System

A typical block diagram of the complete system best suited to the video-frequency phase-measurement problem is shown in Fig. 10.

In this system, input probes, similar to those used in high-frequency oscillography, are provided for direct connection to the circuit under test. The respective input signals feed from these probes through compensated attenuator networks into squaring and differentiating networks. These circuits

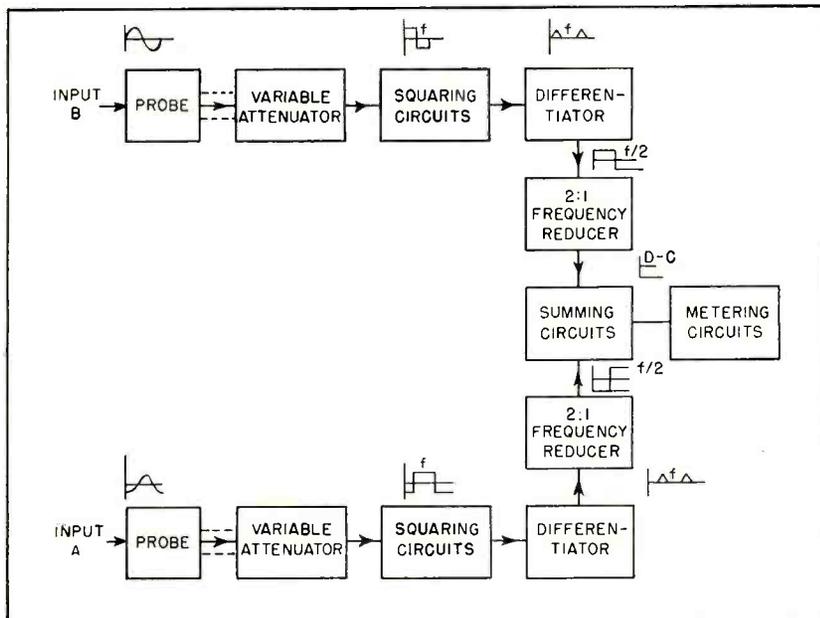


FIG. 10—Block diagram of direct-reading video phase meter

portional to the cosine of the angle.

If these signals were applied directly to the plates of a cathode-ray tube, a spot, positioned in accordance with the applied angle, would result. The use of these voltages for controlling dual sweep generators serves to convert this information into a vector presentation. Such a device may be used to display several vectors simultaneously by using sequential switching. Measurement accuracies in the order of 3 to 5 deg have been quoted for this type presentation.

The above three techniques, used for phase analysis in color tele-

encing) circuits can provide the widest frequency response. However, such detectors are ambiguous in conventional applications. Typical of this family of phase detectors is that composed of a common impedance fed by input signals having the same amplitude and an unknown phase relationship. Figure 6 shows a block diagram of this type of phase-measuring system.

An inherent weakness in this phase-measuring system, in which the phase difference is a function of a common area, is its inability to distinguish between angle θ and $360 - \theta$. This point is best illus-

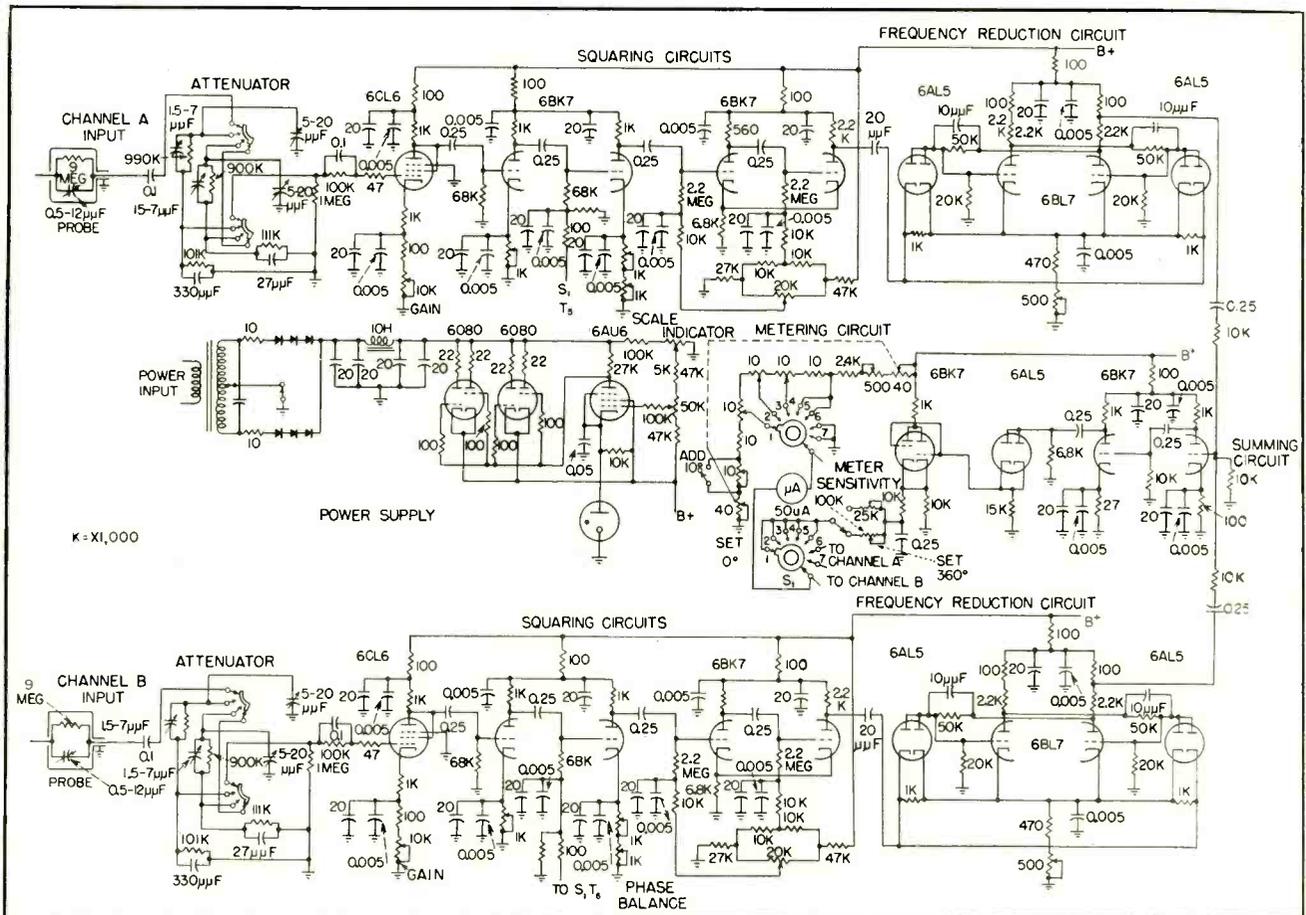


FIG. 11—Complete diagram of video phase meter used in color television

form pulses of short duration occurring at points-in-time corresponding to the positive-going zero-axis crossings of the input signals.

The pulses serve to trigger counter-type 2-to-1 frequency dividers generating the desired half-frequency signals and establishing constant detector input voltages throughout this frequency range. The signals are applied directly to the summing type phase detector and the resultant average voltage is monitored as an indication of phase change.

Metering circuits are provided to indicate the approximate magnitude of the angular difference on a 0 to 360-degree scale. Having determined this value, it is then possible to meter the proper quadrant and establish this angle within the probable accuracy of the system.

An instrument constructed in accordance with the above design considerations is shown in Fig. 11. Initial tests have shown a bandwidth of 4.5 megacycles and a phase accuracy of 2 deg. Input probe impedance could best be simulated by

a 14- μ f capacitor in parallel with a 10-megohm resistor.

The direct-reading phase analyzer finds application in many measurements common to color television. A few of the typical functions are summarized.

Direct measurement of complete receiver or transmitter phase-delay characteristics can be obtained. The data may be used for plotting composite characteristics as a function of the video modulator frequency. In addition, the device provides a direct indication of the phase relationships existent when a monochrome transmitter is to be adjusted for color signals.

Direct indication of the proper synchronization of subcarrier oscillators when controlled by incoming color burst information is possible. This usage implies those measurements necessary for proper design and adjustment of automatic phase-control circuits.

There is direct indication of properly adjusted matrices, adders and modulators in a colorplexer.

Measurement of individual cir-

cuit characteristics peculiar to both color transmitters and receivers possible include typical circuits like video amplifiers, synchronous demodulators and matrix amplifiers.

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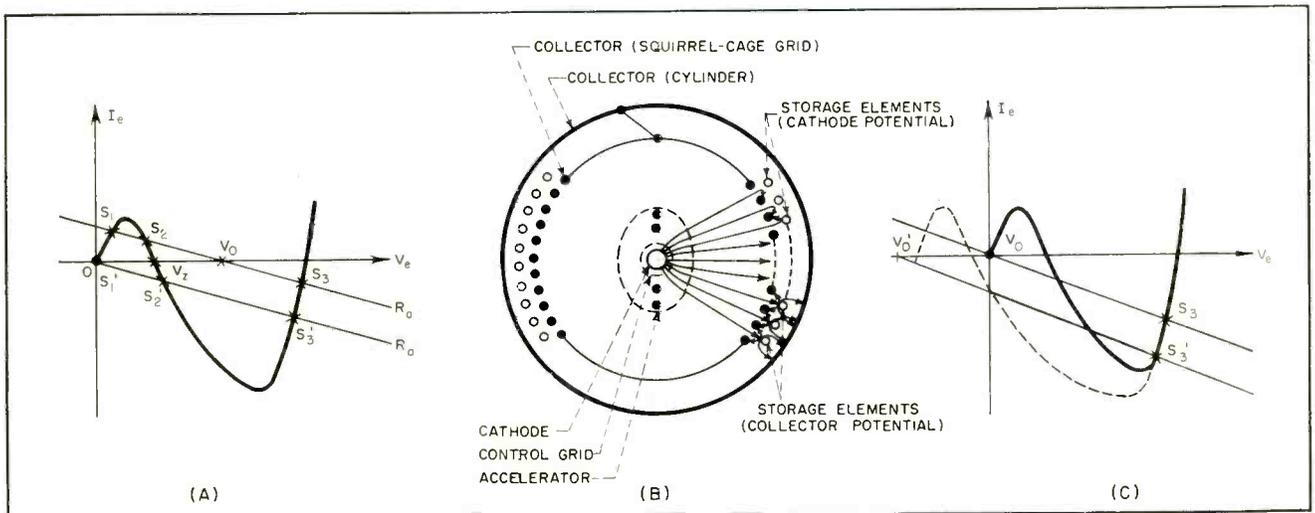


FIG. 1—Voltage-current characteristic of secondary-electron emitting surface illustrating negative slope (A), plan view of storage tube elements (B) and effect of sharply reduced cathode potential (C)

Storage Tube Employs Secondary Emission

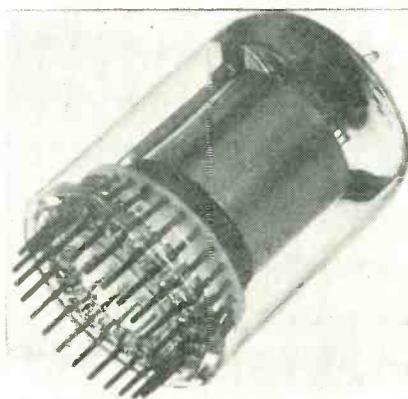
Electronic storage tube having twenty secondary-electron emitting elements between its anode elements stores binary data in all-electronic telephone system. Circuit performs cross-bar switching function. Tube can be used in pulse-position modulation systems

DURING DEVELOPMENT of an all-electronic telephone system a simple reliable storage tube was developed to meet specialized demands.

The tube makes use of the negative slope of the current-voltage characteristic of a secondary-electron emitting surface. See Fig. 1A. This surface is connected through a high resistance R_a to a positive voltage V_0 , which is so high that the resistance line of R_a intersects the characteristic of the surface in three points S_1 , S_2 and S_3 . Only points S_1 and S_3 will correspond to stable states. Thus information can be stored on the emitting surface in a binary code.

The memotron, depicted in Fig. 1B, is a modified thermionic tetrode containing twenty secondary-electron emitting elements. The pri-

By W. E. M. UHLMANN
*Research Department
 Telefonaktiebolaget L. M. Ericsson
 Stockholm, Sweden*



View of tube envelope. Note cylindrical anode and separate pins corresponding to the secondary-electron emitting storage elements

mary electron current (space current) emitted by an indirectly heated oxide cathode is controlled by a control grid and then accelerated by a second grid. The anode of the tube comprises a squirrel-cage grid and metal cylinder. These are electrically connected. The 20 storage elements are arranged in the annular space between the two anode elements. Each storage element has its own head which is brought out through the vacuum envelope as shown in the photograph. Thus all elements are separately accessible.

The resistance between elements at a potential corresponding to S_2 and the collector is low—between 10,000 and 100,000 ohms in practical tubes. The resistance between the elements at a potential corresponding to S_1 and the collector is

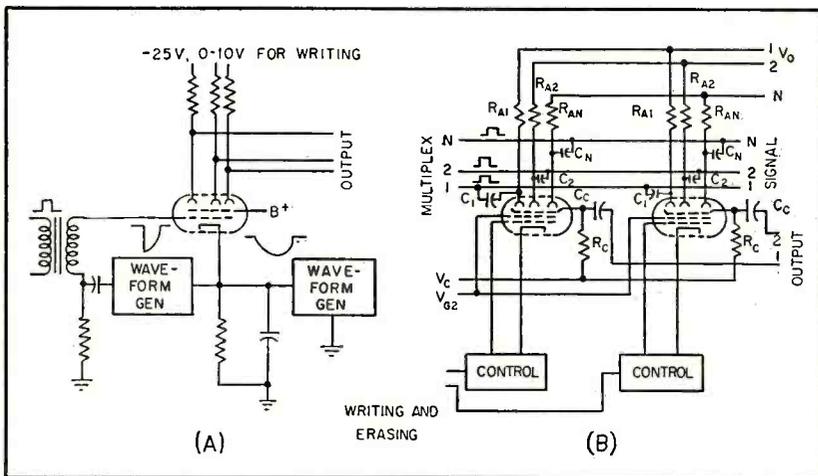


FIG. 2—Basic circuit for storing and erasing information (A) and electronic cross-bar switch (B)

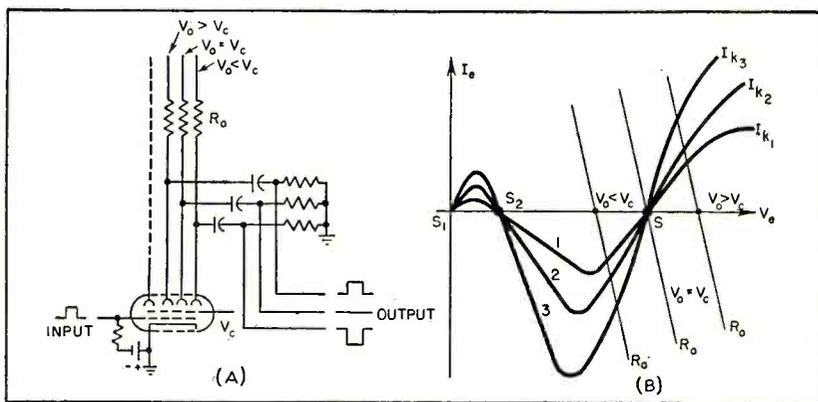


FIG. 3—Basic circuit connection (A) and emitting surface characteristics (B) illustrating how tube can be used to change polarity of input signal

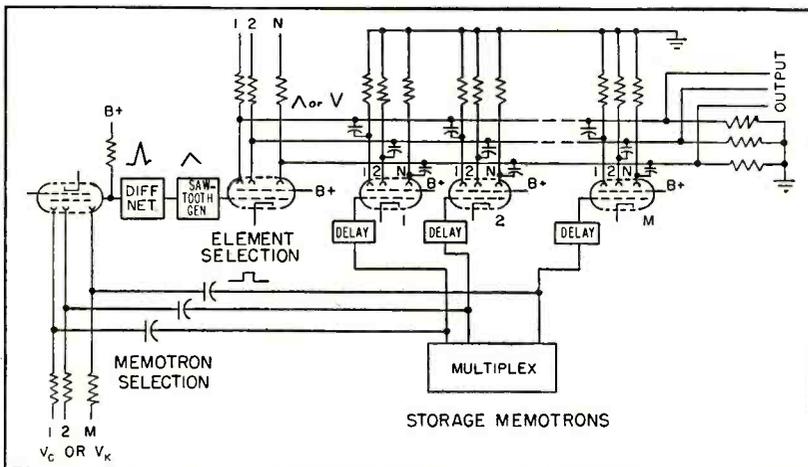


FIG. 4—Combination of circuits for introducing binary information into several secondary-emission storage tubes

elements to either cathode or collector potential.

Voltage is applied to an element through a high resistance R_o . The applied voltage is equal to V_o in Fig. 1A. If the space current is interrupted, the element will, upon resumption of current flow, assume the potential corresponding to S_3 in Fig. 1A and stay there.

If, however, a voltage lower than V_o is applied, the eventual potential of the element will approximately equal cathode potential. With the space current on, variation of applied voltage V_o within certain limits will not alter the locked states of the elements.

Modified Operation

A modification of this method as shown in Fig. 2A is especially useful when several tubes with common storage input are used in parallel with writing and erasing processes carried out independently in different tubes. The marking voltage applied to the elements is either zero or negative with reference to the normal cathode potential. However, when introducing information, the cathode potential is shifted (Fig. 1C) so far negative that the fixed element potential moves to the unstable part of the characteristic and finally to point S_3 .

A voltage corresponding to V_o' is applied to those elements that are to remain at cathode potential. The elements that were previously at point S_3 may be brought to cathode potential simply by interrupting the space current. Space current has to be cut off during part of the writing procedure.

Locking storage elements to either cathode or collector potential may also be accomplished by feeding appropriately shaped voltage pulses to the elements. In this case, it may be advantageous to pulse the space current.

Assuming that an element is initially at collector potential, a negative voltage pulse with a steep rise and a slow decay is applied to the element. The pulse begins during the interval between two space-current pulses, reaching its maximum when the space current sets in again, and decays slowly during the space-current pulse duration. The

very high. Thus a signal may pass between locked-up elements and the collector or vice versa but not between locked-down elements and the collector.

A long tube life has been attained by using pure metal elements activated by the evaporation from the oxide cathode. Some tubes life-

tested for approximately 15,000 hours have shown only relatively small variations of their characteristic which do not impair their proper functioning.

Storing Information

Information may be stored in the memotron by locking storage

amplitude of the negative voltage pulse must be so large that when the space current returns, the potential of the element corresponds to some point to the left of V_c (Fig. 1A). The returning space current will force the element to cathode potential.

The corresponding process may be carried out with an element originally at cathode potential by using an appropriate positive pulse. This procedure will work even with the space current flowing. Care has then to be taken to choose the shape and amplitude of the voltage pulses such that the displacement current through the coupling capacitor is high enough to override the holding action of the primary and secondary currents in the storage element.

Extracting Information

Any method for determining the potential of the storage element may be used to extract stored information. If for example the collector potential is modulated with pulses, the locked-up elements will follow this modulation, but the locked-down elements will not. The primary electron current may likewise be modulated.

This latter method is particularly useful when the corresponding storage elements of several memotrons are connected in parallel. If the collector voltage of one tube is modulated, a signal will appear at the locked-up elements. When the corresponding parallel-connected elements in different tubes are at collector potential, the impedance of these elements with respect to their collector will be relatively low. This will act as a shunting resistance for the output resistor of the element in question and absorb part of the output signal. If, however, the space current of the tubes is pulsed in sequence, no such effect will occur, since during the reading process current flows only in the tube from which an output signal is obtained.

Other Applications

An application of the memotron as a coupling device is shown in Fig. 2B. It makes use of the tube's gating property. This circuit may be considered as the electronic

equivalent of the crossbar switch in a telephone system. The collector electrodes correspond to the bars and the secondary-electron emitting elements to the contacts. The example shows two tubes having output terminals 1 and 2 and N input terminals corresponding to the number of elements in each tube. A pulse train is used as a signal.

The pulses of the trains applied to the N input terminals are shifted in time relative to one another. They are fed to the elements through capacitors C_1 to C_N . The d-c voltages, for locking the elements to either collector or cathode potential, are fed to the elements from the common d-c sources V_{o1} to V_{oN} through separate resistors R_{A1} to R_{AN} .

The storing and erasing of coupling-information is determined by a control circuit. The output circuit comprises resistor R_o and the capacitor C_o . In this circuit a pulse train appears, the phase of which is determined by the number of the locked-up element. If several elements are locked up, a pulse train comprising the sum of the trains applied to the locked-up elements will appear at the output terminal. It is thus possible to sort out one or more pulse positions in a time-division multiplex system.

Signal Inversion

Figure 3 illustrates how a memotron may be used for converting the input signal applied to the control grid into a signal with the opposite sign, passing it unchanged or suppressing it depending upon the voltage applied to the secondary emitting element.

If the voltage applied to the element through resistor R_a corresponds to point S_s , no signal will appear at the output terminal. If the voltage is higher than S_s , a negative signal will appear. If the applied voltage is lower than S_s , but not lower than S_c , a positive signal will appear.

Figure 4 shows a combination of circuits for introducing binary information into several memotrons. A pulse-generator pulses the control grids such that space current flows in only one tube at a time.

The memotron selection circuit

contains one memotron to select the storage memotron in which information is to be stored or in which stored information is to be changed.

The element selection circuit selects the desired storage element of the memotron selected by the memotron selection circuit and the sign of the information being introduced.

Information Storage

The storage elements of the single selection memotron are connected to the output terminals of a multiplex pulse-generator. As long as these elements are at cathode potential or at a potential negative with reference to the cathode, no signal will appear at the collector. As soon as the element is brought to collector potential, the pulse arriving from the pulse-generator will appear at the collector.

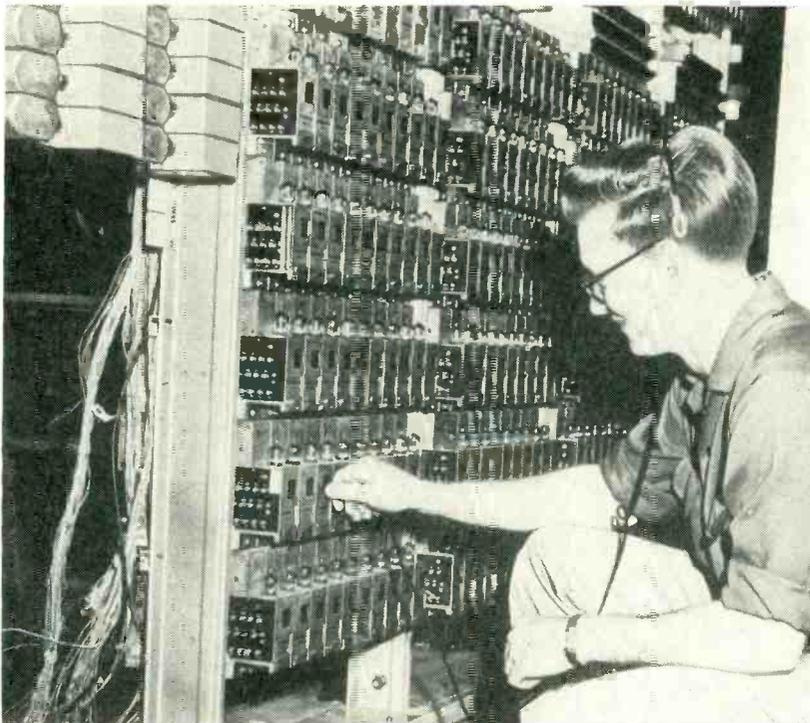
From there it will pass through a differentiator to a saw-tooth generator. When thus triggered the saw-tooth generator delivers one pulse. The pulse passes to the element selection circuit. This circuit will deliver either positive or negative saw-tooth pulses, or no pulse at all, to the storage memotrons, depending upon the bias applied to the memotron elements.

The saw-tooth pulses are fed to the elements of the storage memotrons 1- M and influence their potentials as described earlier in this article. The delay circuits insure that the space current pulses in the storage memotrons 1- M are delayed so that the rise of the pulses delivered by the multiplex device occurs in the interval between space-current pulses. This is desirable since otherwise much more power would have to be delivered by the input memotron or by an amplifier inserted between it and the storage memotrons to override the holding action of the space current. The space current may be pulsed to read out the information stored in memotrons 1- M .

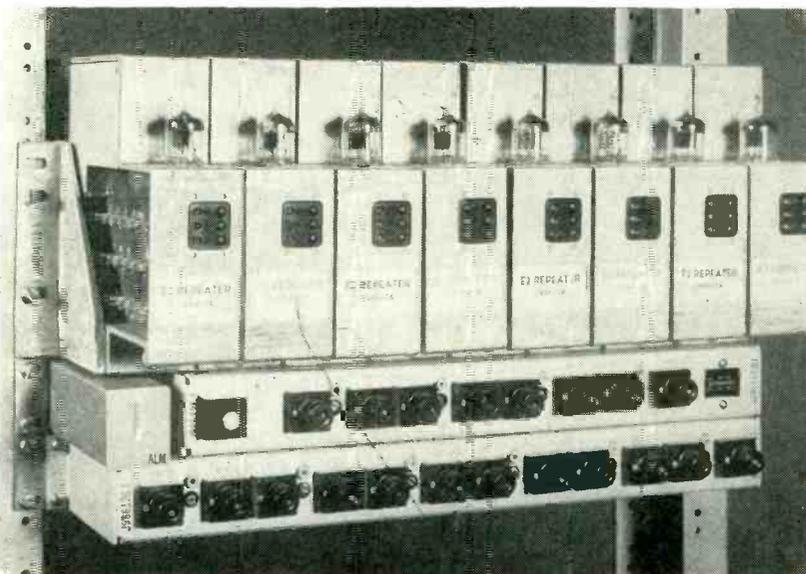
The subject matter of this paper is based on contributions by W. Jacob and O. Sternbeck. W. Jacob proposed and designed many of the electronic circuits. The author thanks C. Jacobaeus, Director of Research, for permission to publish this paper.

Repeater Amplifies in

Negative-impedance repeaters reduce overall impedance of two-wire telephone line, increasing current in line without breaking d-c continuity. Tube failure results in loss of gain without loss of service, an important consideration for broadcasting facilities



Technician tests E3 repeater installation in Oakland, California telephone exchange



Bank of E2 and E3 repeaters has power connections brought out to panels below

IN A TELEPHONE EXCHANGE speech is transmitted largely at voice frequencies over a single pair of wires, which carries both directions of conversation. Until recently, these circuits were mostly built without repeaters, adequate transmission being assured through a suitable choice of coil loading and conductor size. The need for low-cost repeaters for the exchange plant had long been recognized, but it had not been economical to use widely the conventional hybrid type of repeater with separate amplifiers for the two directions of conversation.

The negative-impedance repeater introduced in 1949 was the first device designed specifically to meet the needs of the exchange plant. A bilateral device, it provides gain in both directions of conversation without hybrid coils or line filters, but with a single transmission network.¹ This simplicity, together with the fact that it imposes little impairment on the signaling of the exchange plant, makes it well suited to introducing amplification in two-wire circuits.

Such repeaters preserve the d-c continuity of the circuits on which they are installed. This feature prevents appreciable interference with the signaling methods ordinarily used on such trunks. In the event of tube failure, the circuit still functions, but with its loss substantially increased until the defective tube is replaced.

The general effect of the introduction of the negative-impedance repeater is to shift the average cable distribution so that more small-gage cable can be economically utilized, accompanied in most

Either Line Direction

By **J. L. MERRILL, Jr., J. O. SMETHURST**

*Bell Telephone Laboratories, Inc.
New York, N. Y.*

and **A. F. ROSE**

*American Telephone and Telegraph Co.
New York, N. Y.*

cases by improved transmission.

The negative-impedance repeater operates on the principle of inserting negative resistance and, if desired, negative inductance or capacitance in series with a telephone line, thus reducing the overall impedance and increasing the current in the line. This results in transmission gain in the same sense as that resulting from a repeater of the conventional type.

Series-Type Repeater

The circuit functions of the series-type negative-impedance repeater, called the E2 repeater, can be divided into three main parts, as shown in Fig. 1. These include an input transformer, a vacuum-tube impedance converter and an adjustable impedance network. The essential element of this repeater is the impedance converter, which basically is a positive-feedback ground-grid amplifier designed to be open-circuit stable. The positive

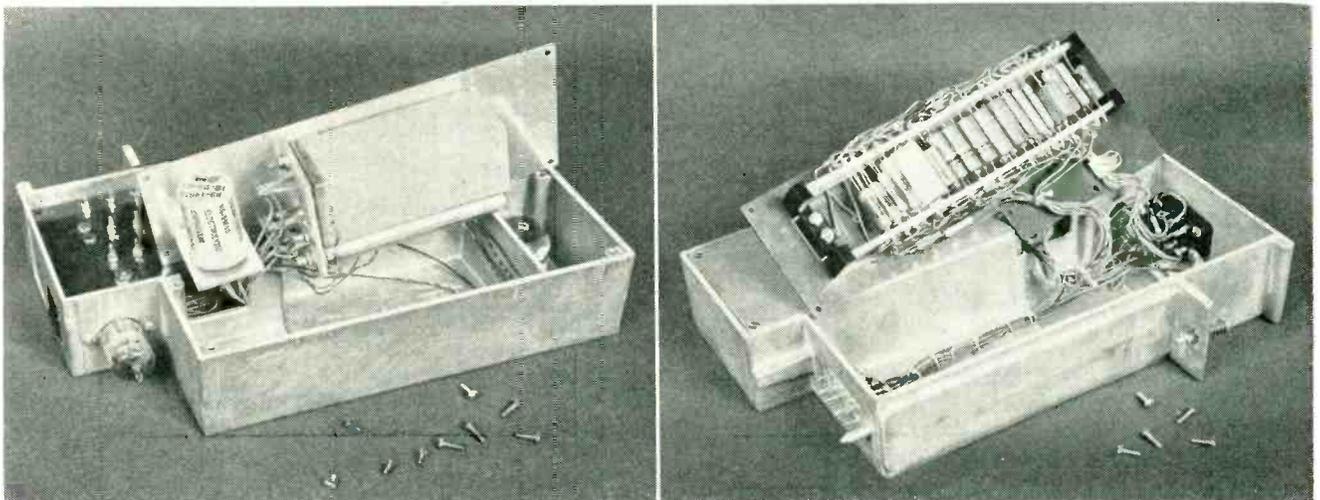
feedback is stabilized by the application of negative feedback and the proportion of positive to negative feedback is controlled by changing the magnitudes of the plate and cathode-load impedances.

The positive-feedback loop is joined by connecting the plate of each triode section through a resistance-capacitance network to the grid of the opposite section. The negative-feedback path includes the effective cathode impedance and grid circuit of each triode section. A vector addition of these two network impedances produces a stable positive-feedback condition for any practical value of cathode impedance.

Any signal voltage impressed across the cathode impedances will be applied to the grids and amplified. The increased signal amplitudes, developed across the network impedance, are coupled back to the proper grids where regenerative action causes amplified voltages to

appear across the cathode impedance in phase opposition to the applied signal. A vector addition of the two cathode voltages will occur in the transformer windings and a large reversed-signal potential will be inserted in series with the line. The induced voltage, being of the same polarity as the originating signal, will add to it and cause a larger value of signal current to flow in the line circuit. Because larger line currents are obtained by the use of a two-terminal network, the E2 repeater can be considered as having the properties of a negative impedance equal to V/I , where V is the reversed voltage across the impedance and I the current flowing through it.

The negative impedance generated by this form of converter is equal to the negative of the network impedance multiplied by a conversion factor k . To reduce the effect of variations in the tubes to negligible proportions, at the same time



Top and bottom views of disassembled E3 negative-impedance repeater for voice systems. Housing is die cast and of plug-in type

operating the tubes with load impedances that will permit optimum energy transfer from tube to connected circuit, the converter should be used with an impedance of 10,000 ohms or more between cathodes and a somewhat lower impedance between plates. To obtain an impedance of approximately 10,000 ohms, impedances Z_1 and Z_2 are stepped up to the cathodes by the input transformer.

The conversion ratio is also affected by small losses inherent to the tube and transformer circuit designs. These may be balanced out by placing a fixed compensating resistor of 2,000 ohms in the network impedance.

Bandwidth

In practice it is advantageous to limit the conversion-frequency bandwidth so that line and network impedances do not have to be controlled over an unlimited frequency range. The conversion of the E2 repeater is limited at the low frequencies by a grid-to-plate coupling network and at the high frequencies by small capacitances bridged across the grid resistors, as shown in Fig. 2.

The final negative series impedance presented to the line is equal to approximately $-0.1Z_N$ over the frequency band of 300 to 3,500 cycles. The magnitude and phase of the negative impedances are controlled by the gain-adjusting network Z_N , comprising several inductive, capacitive and resistive elements. These components may be arranged in any form to obtain the gain and frequency-shaping characteristic desired for each type of line facility. By changing the value of Z_N , the negative impedance inserted in series with the line can be varied from -100 to $-2,000$ ohms. This range of negative impedances is adequate for line facilities used.

The E2 repeater employs a 407A twin-triode of the 9-pin miniature type. When operated from a plate-battery potential of 130 volts the repeater will pass speech volumes of $+10\text{-u}$ before noticeable distortion is caused by overloading of the tube.

The 407A heater circuit can be operated from a 24 or 48-volt office battery. Heater current is 100 mil-

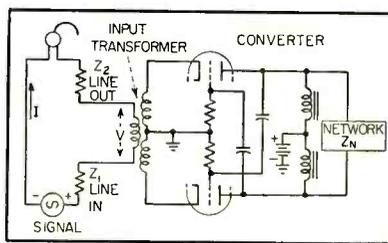


FIG. 1—Simplified circuit of series-type negative-impedance E2 repeater

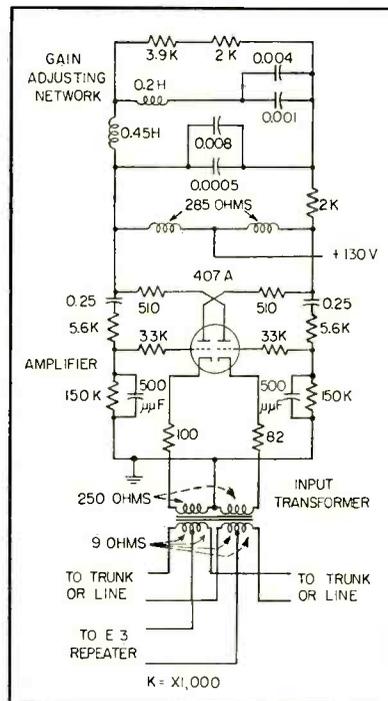


FIG. 2—Type E2 repeater has limited conversion-frequency bandwidth so that line and network impedances do not have to be controlled over an unlimited frequency range

liamperes for 20-volt operation and 50 milliamperes for 40-volt operation; the plate current is 11 milliamperes.

Shunt-Type Repeaters

The newest development in repeaters is the E3 shunt-type negative-impedance unit. This is a two-terminal device, which uses a stable positive-feedback amplifier to generate a shunt type of negative impedance. The circuit shown in Fig. 3, includes a high-impedance input circuit, impedance converter and impedance network. Of special interest is the converter circuit, which consists of a two-stage amplifier working through a Wheatstone-bridge circuit in which the telephone line and impedance network are two of the ratio arms. Two resistive components complete the

bridge. The amplifier input and output connections, being at equal potential points, are isolated by the effective balance of the bridge. The connections from the line to the amplifier input and from the amplifier output to the line are made at unequal-potential points to provide a positive-feedback connection through the bridge, amplifier and line circuits.

When the bridge circuit is unbalanced by making the impedance of the line smaller than the impedance of the network, a portion of the amplified output is coupled back to the grid as a negative-feedback voltage. As the line impedance becomes smaller and smaller, the negative feedback increases and the converter is short-circuit stable. The vector addition of the positive and negative-feedback voltages in the grid circuit can be controlled by the network impedance to produce a stable positive-feedback condition for any practical value of line impedance.

When the repeater is bridged across a telephone trunk, the signal voltage across the line side of the output bridge with the polarities shown in Fig. 3. This potential will be connected through the bridge to the input grid, amplified by both tubes and its phase rotated to produce an increased output voltage across the line, in phase with the applied voltage. The new generator, established in the plate circuit of the second-stage amplifier tube, will send current I_R through the network into the line where it divides, I_2 flowing toward Z_2 and I_3 toward Z_1 . The vector addition of I_1 , the current due to E without the repeater, and I_2 will produce a larger flow of current in the receiving load Z_2 . The repeater can be considered as having the properties of a shunt-type negative impedance equal to $V/-I$, where V is the voltage across the impedance and $-I$ is the reverse current flowing through it.

The negative impedance generated by this form of converter is equal to the network impedance Z_N divided by a negative conversion factor k . To obtain a practical design of E3 repeater for the faithful conversion of the network im-

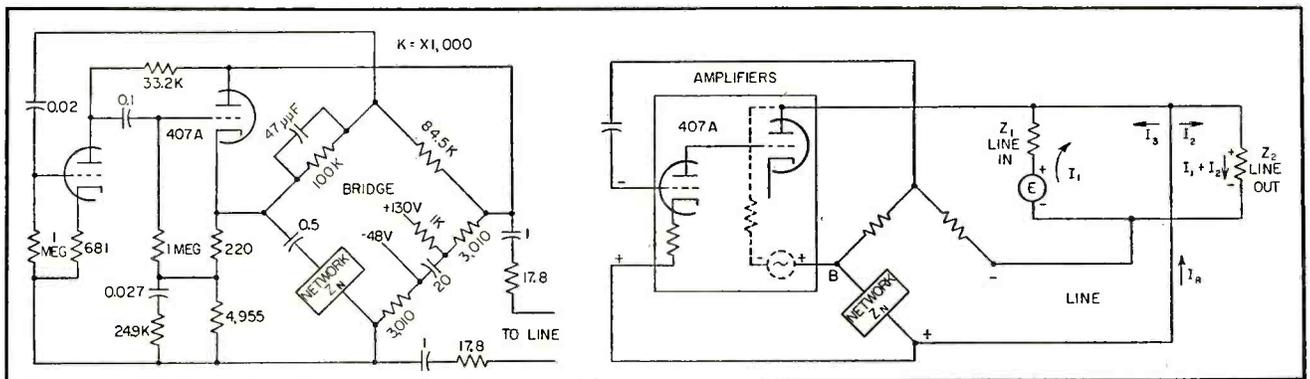


FIG. 3—Two-terminal E3 repeater, left, uses stable positive-feedback amplifier to generate shunt type of negative impedance; Simplified schematic, right, shows current relations when connected to two-wire line

pedances with a minimum of spurious components, it is necessary to balance out as nearly as possible all converted circuit elements associated with the output bridge and connections to the line. Accordingly, the two line capacitors are balanced out by a network capacitor. The battery-supply resistors, the resistor and capacitor of the plate-battery filter and the plate-load resistor of the first-amplifier stage are all balanced out in the network by placing suitable values of resistors and capacitors in the cathode circuit of the second-amplifier stage. All of these elements are combined to form an equivalent two-terminal network having fewer and smaller valued components.

Negative Impedance Limits

An ideal negative-impedance device would convert any impedance in the network over a wide frequency band, but it is advantageous to limit the negative impedance as far as practicable to the frequency bandwidth required by the particular application. This is accomplished primarily in the network associated with the converter. The conversion bandwidth of the E3 repeater shown in Fig. 4 is restricted at low frequencies by the resistive-capacitive feedback-coupling network between the output bridge and the input grid. High frequencies are attenuated by the shunt capacitance connected across one resistive arm of the bridge circuit.

The final negative impedance shunted across the line is equal to $-Z_N/0.94$, within ± 2.5 percent, over the range of 200 to 5,000 cycles. The magnitude and phase of the negative impedances are con-

trolled by the gain-adjusting network Z_N , consisting of several inductive, capacitive and resistive elements. These components may be arranged in a variety of ways to obtain the gain and frequency-shaping characteristics desired for each type of line facility. By changing the value of Z_N , the negative impedance shunted across the telephone line can be varied between -200 and $-3,000$ ohms. This range of negative impedances is adequate for the line facilities with which the repeater will be used.

The E3 repeater employs a 407A,

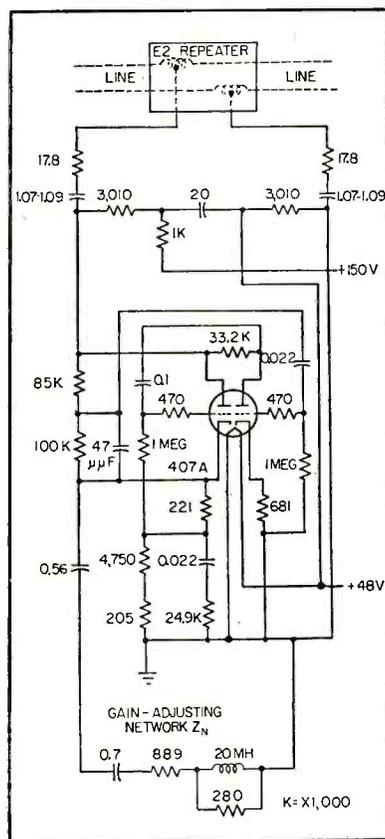


FIG. 4—Complete shunt-type E3 repeater

which when operated from a plate-battery potential of 150 volts will pass speech volumes of $+6$ v-u before distortion because of overloading in the tubes is noticeable. Plate current is 5 milliamperes.

Application

In the period from 1948 to the present time over 50,000 series-type negative impedance repeaters were manufactured and incorporated in the Bell system. These repeaters have been used largely on intra-exchange trunks and on lines extending from the exchange areas to nearby smaller towns. Such installations have been very effective in improving the transmission on short-haul calls and in many cases have also reduced trunk costs by permitting the use of smaller and cheaper conductors. They are usually operated at gains which reduce the trunk loss without repeaters by more than half.

The potential field of use for the new negative-impedance repeaters is very large and large quantities are needed to meet current demands. Before the negative-impedance repeaters became available, the hybrid-type repeater was manufactured at an average rate of less than 5,000 per year during the 20-year period from 1930 to 1949. As soon as the series negative-impedance repeater became available, the annual demand for it exceeded that of the old type by a ratio of 3 to 1. Production of the new negative-impedance shunt element has only recently started, but it is expected that the first year's requirements will exceed the average for the series repeater during the last 4 years.

Junction Transistor

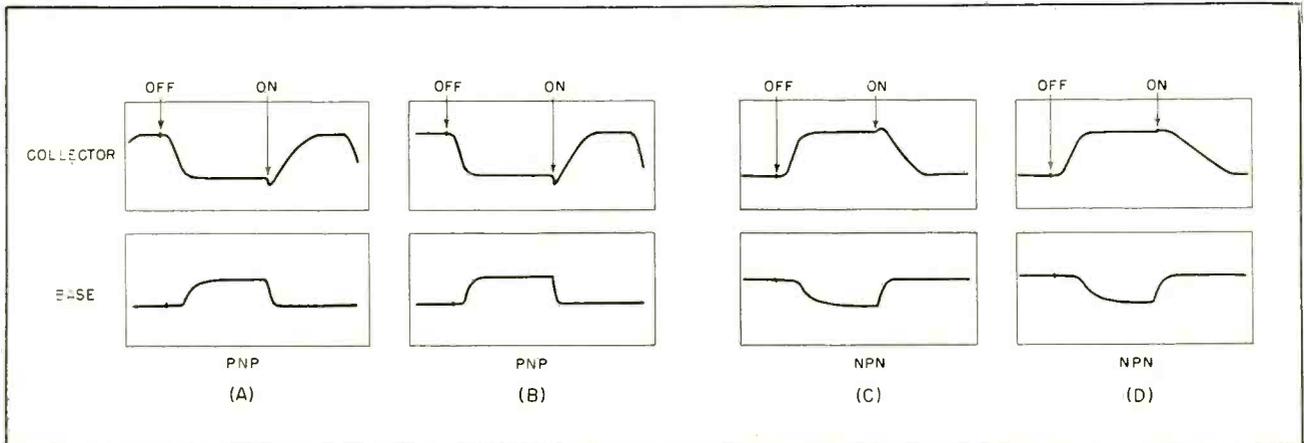


FIG. 1—Transient response curves for four junction transistors. Oscillograms for *pnp* type (A) and (B) were made at sweep speeds of 2 and 4 μ sec per cm, respectively. Sweeps for both *npn* units (C) and (D) were 1 μ sec per cm

EASE of using the negative resistance characteristic of point-contact transistors has led to their fairly wide application in switching circuits.^{1,2,3}

As yet, little effort has been devoted to the application of junction transistors to these circuits.⁴

The junction transistor has a lower cutoff current and lower voltage drop when conducting than the point-contact type. Both of these effects result in a more desirable switching device.

The grounded-emitter connection is of major interest in junction transistor switching applications. This connection has the highest power gain when coupled to following stages without the use of transformers.⁵

To determine switching times of junction transistors, a number of units were tested and turn-on and turn-off times recorded. Typical waveforms are shown in Fig. 1. The circuit used to obtain these curves is shown in Fig. 2.

The curves of Fig. 1A and 1B illustrate the transient response of two *pnp* diffused-junction transistors. For these units, cutoff delay time is one to two microseconds. Transition time, once cutoff starts, takes approximately 2 microseconds. The turn-on transition has no appreciable delay in starting but is 4 to 8 microseconds in duration. The first portion of the transition is of opposite polarity. This is pre-

sumed to be due to capacitance coupling of the base input signal to the collector.

For the *npn* grown-junction transistors shown in Fig. 1C and 1D, the same general shape of the waveform is evident but the *npn* units are approximately twice as fast as the *pnp*.

Overdriven Amplifier

The basic element of the circuits to be described is the overdriven amplifier. Assuming a collector supply voltage of 10 volts negative, a reasonable value of collector cutoff current, I_{co} , would be 10 microamperes. A collector load resistance, R_L , of 10,000 ohms would cause a 0.1-volt drop.

With the transistor in a saturated conducting condition, the collector-to-base resistance is approximately 200 ohms. Under this condition, the voltage drop across the load is 9.8

volts. The total output voltage swing is 9.7 volts (9.8 - 0.1) out of a maximum swing of 10 volts. This large output voltage relative to the collector supply voltage shows the real value of the junction transistor as a switching element.

To reduce the emitter current to zero (which turns off all collector current except I_{co}) it is necessary to feed a positive current (for *pnp*) greater than I_{co} into the base.

If the base is biased 1 to 2 volts positive from a source which can supply more than the I_{co} current, the transistor is effectively cut off. The conducting condition of the transistor requires that current be drawn from the base. In this direction, the base input impedance is low. The minimum current required is determined primarily by the b factor of the transistor and the conducting collector current (E_c/R_L). The minimum base current is the collector current divided by b . Typical values of b for present transistors range from 10 to 200, and as a result the required base current is from 100 to 5 microamperes for 1-ma collector current.

Free-Running Multivibrator

A free-running multivibrator using *pnp* transistors is shown in Fig. 3 with typical waveforms.

The R-C coupling network between stages must be designed considering the operating currents for the following stage. The resistor re-

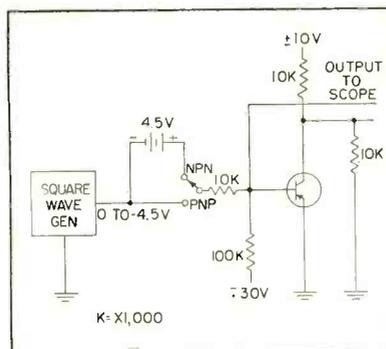


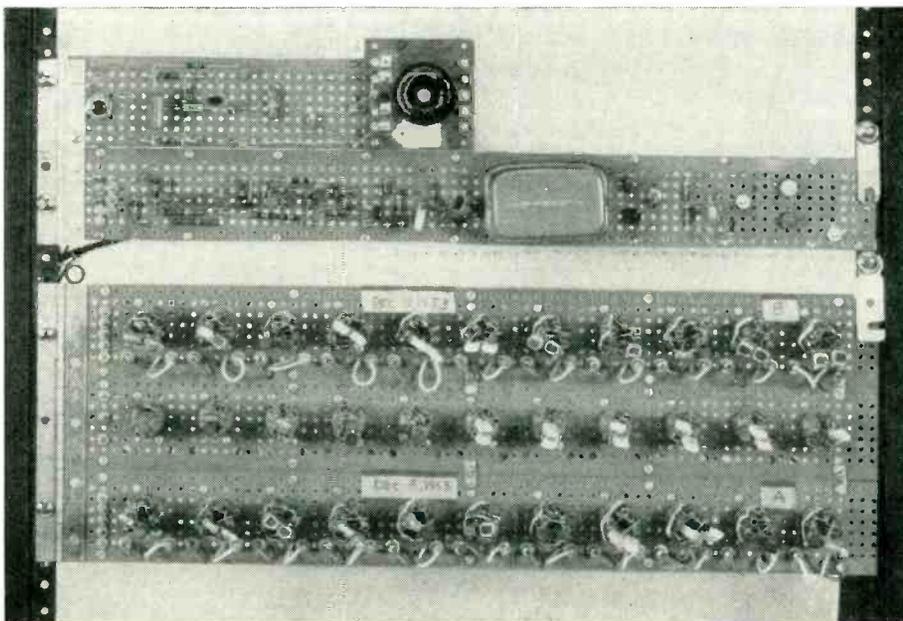
FIG. 2—Arrangement used to obtain switching-time curves

Switching Circuits

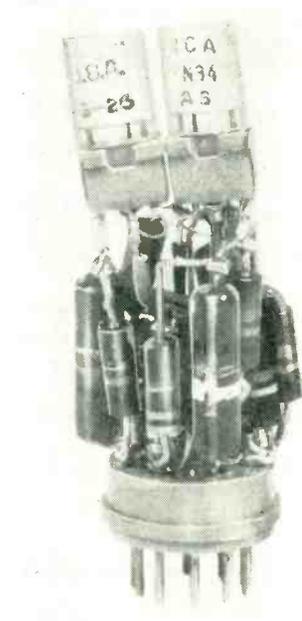
Low cutoff current and high output voltage make junction transistors superior to point-contact types for switching purposes. Blocking oscillator, multivibrator, flip-flop, gating and adding circuits are used in experimental 75-transistor switching system

By **THOMAS A. PRUGH**

*Diamond Ordnance Fuze Laboratories
Ordnance Corp., Dept. of the Army
Washington, D. C.*



Test switching system uses individual transistor circuits mounted on tube bases to allow for quick replacement of components



Flip-flop is typical of mountings used in switching-system

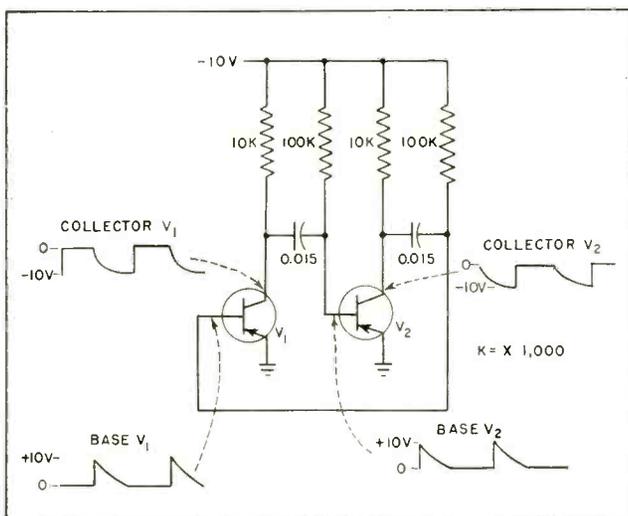


FIG. 3—Free-running multivibrator uses pnp transistors. Wave-forms are shown for various points in circuit

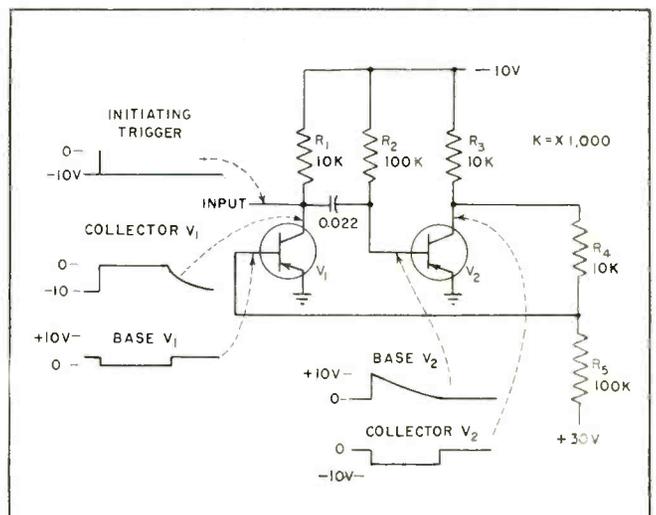


FIG. 4—Monostable multivibrator circuit is derived from free-running design shown in Fig. 3

turning from base to the -10 -volt supply must furnish sufficient current to hold the transistor in the on condition. This current may range up to 100 microamperes for low-gain transistors so that for the specific circuit shown, a 100,000-ohm resistor was chosen. The coupling capacitors are chosen to give the desired off times of the multivibrator. The off times are controlled principally by the circuit constants exclusive of transistors.

The base-to-emitter and base-to-collector diodes act as a shunt across the 100,000-ohm base-bias resistor. Current flow in the resistor is always greater than 100 microamperes so the error from shunting diodes is less than 20 percent.

The half-period of a symmetrical multivibrator should be $0.7 RC$, where R is the 100,000-ohm base-bias resistance and C is the coupling capacitor.

The monostable multivibrator shown in Fig. 4 is a logical derivative of the free-running type. The

resistance network, R_1-R_5 , between V_2 and V_1 is chosen to give the necessary on and off currents to overdriven amplifier V_1 . Network $R_3-R_1-R_5$ provides 200 microamperes to turn V_1 on, and a base bias of $+2.73$ v applied through an effective resistance of 9,100 ohms to turn V_1 off.

Triggering is accomplished by coupling a positive trigger into the collector of V_1 by an additional transistor whose collector is in parallel with V_1 .

Flip-Flop

The flip-flop of Fig. 5A consists of two resistance-coupled overdriven amplifiers in series, with feedback from output of V_2 to input of V_1 . The resistive coupling networks are similar to that in the monostable multivibrator.

The flip-flop changes states upon applying a positive trigger to the base of the on stage. The diode connected to the off transistor has a larger reverse bias which pre-

vents the positive trigger from being transmitted through this diode. The steady small negative bias through divider R_1-R_2 assures that the diodes are biased in the back direction during the time between input pulses.

Reset is accomplished in about 200 microseconds by returning either R_3 or R_4 to a $+60$ -volt value.

Figure 5B shows the basic reset circuit. When the transistor is turned on, the collector circuit effectively clamps one side of the transformer to ground. The output side rises to approximately $+60$ v for the duration of the pulse on the base of the transistor. A diode across a portion of the transformer eliminates excessive transients across the windings.

The transformers use molybdenum-permalloy toroidal dust cores. A typical unit for resetting 22 counter stages has 7,500 turns of No. 40 single-Formex wire on a 1.3-inch diameter, $125\text{-}\mu$ core giving an overall inductance of 8.3 h.

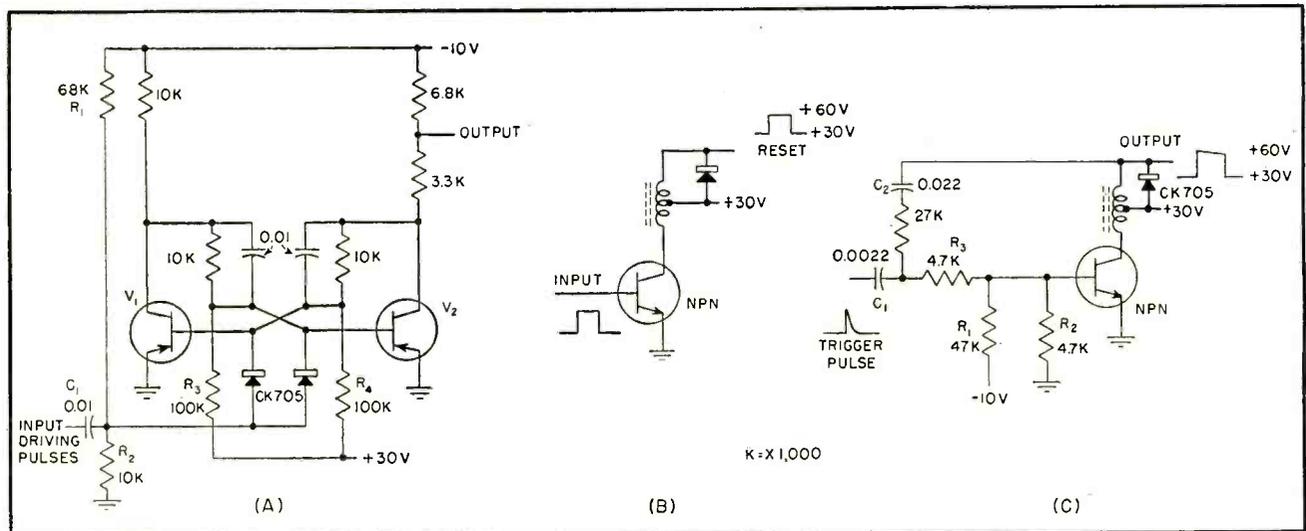


FIG. 5—Junction-transistor flip-flop (A) can be reset in about 200 μ sec by applying 60-volt signal to R_3 and R_4 through reset circuit (B). Blocking oscillator (C) uses basic reset circuit with output coupled back to input

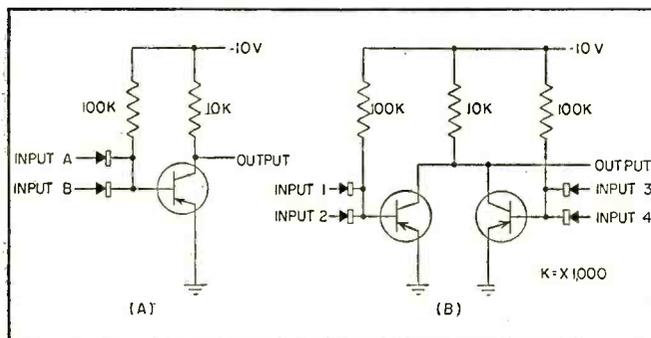


FIG. 6—Gating circuit (A) can be driven from flip-flop. Binary comparator (B) provides high-level output if inputs differ

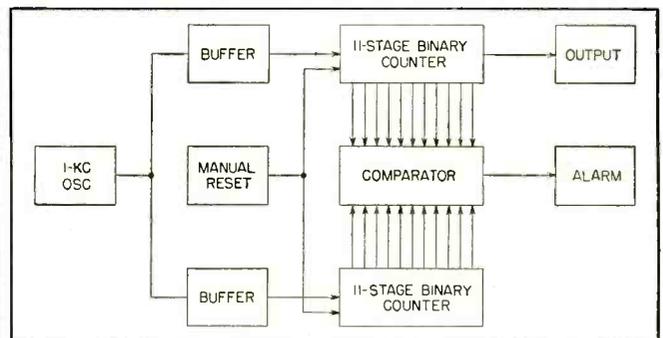


FIG. 7—Block diagram of all-transistor experimental switching system. A missed count in either counter will trigger alarm signal

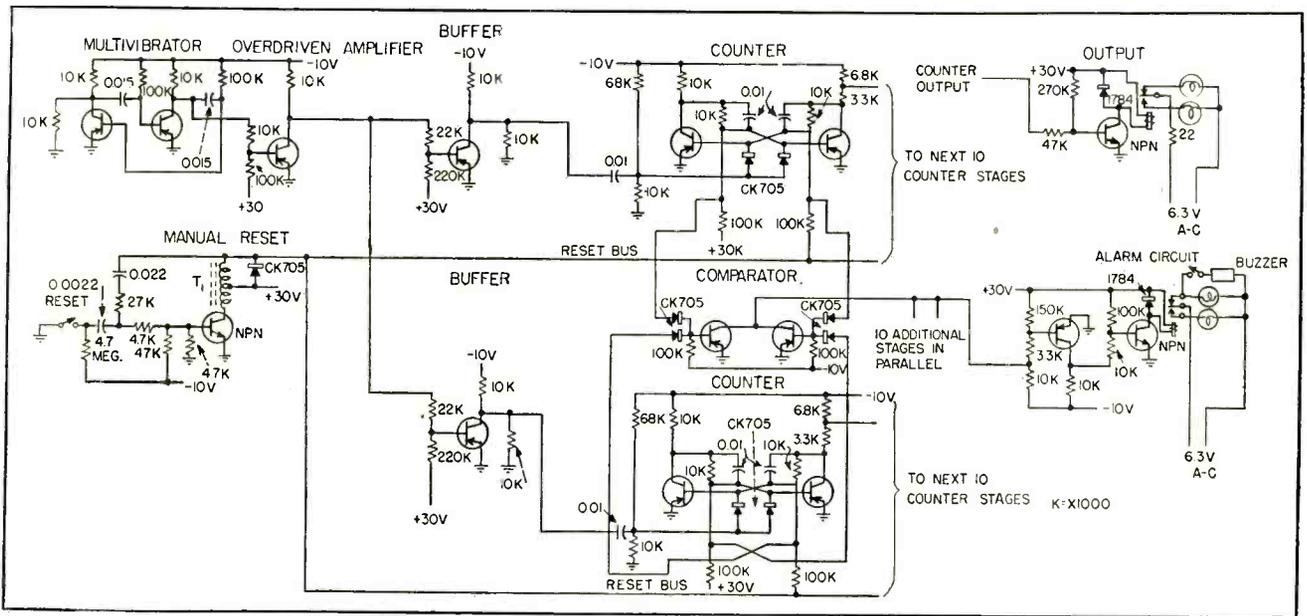


FIG. 8—Complete transistor switching system was operated for seventeen 8-hour periods without error

A blocking oscillator⁹ is shown in Fig. 5C. It makes use of the basic reset circuit. The output pulse from the transformer is coupled back and used to hold the base potential high. Resistors R_1 and R_2 provide a small negative base bias which normally keeps the transistor cut off. A positive trigger at the input is coupled through C_1 and R_3 to the base, turning the transistor on. Due to feedback the on condition is sustained until circuit conditions change sufficiently to allow the period to end.

Gate Circuits

A simple gating circuit is shown in Fig. 6A. Diodes are used for the gating function and the transistor provides gain and isolation. The circuit has the characteristic that the output is high with both inputs low; the output is low with either or both inputs high. An input voltage near zero or slightly negative is required to cut off a diode. A high input causes a diode to conduct. Sufficient current must be supplied to counteract the I_{co} of the transistor and the 100-microampere base current supplied by the 100,000-ohm resistor.

Figure 6B is a comparator for binary signals. One push-pull signal is fed to inputs 1 and 3; the other signal goes to inputs 2 and 4. If the two signals are of identical polarity the output is low as both transistors are turned off. If either signal changes polarity, one trans-

istor is turned on and the output is high.

Experimental System

The circuits described were incorporated into an experimental junction-transistor switching system.

A block diagram of the system is shown in Fig. 7.

Circuit details are shown in Fig. 8. The 1-kc oscillator is a symmetrical free-running multivibrator with an output coupling network to drive the amplifier stage.

The amplifier output drives two buffer-shaper stages, one for each 11-stage counter. Each counter has eleven identical flip-flops in series.

A comparator stage is connected to one stage of each counter and monitors the proper operation of those stages. All outputs of the comparators are connected in parallel. If two flip-flops of any one position of the counters disagree, the comparator output changes from a negative value to approximately ground potential.

The alarm circuit contains two direct-coupled transistors with a relay in the output. When the comparator output is negative both alarm-circuit transistors are on and the alarm relay is energized. If the counters get out of step or the alarm circuit transistors fail the relay is de-energized and the alarm signal is turned on.

The output circuit provides a con-

tinuous visual indication of the operation of the last stage of one counter. It consists of a single *npn* transistor used as a d-c amplifier with a relay in the collector circuit. The input is a square-wave signal from the eleventh stage of the counter which alternately turns the transistor on and off. The relay operates accordingly, causing the two lamps to light alternately.

The manual reset circuit generates a 350-microsecond pulse which is applied to the reset bus of both counters.

Test Results

The complete system operated for seventeen 7-to-8-hour periods without error. It was then operated continuously and ran 99 hours before failure of the primary power stopped the system.

Reliability of the transistors was low, as approximately 10 percent proved unusable initially or after a short period of operation.

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- (1) A. E. Anderson, Transistors in Switching Circuits, *Proc IRE*, 40, p 1,541, Nov. 1952.
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- (3) J. H. Felker, Regenerative Amplifier for Digital Computer Applications, *Proc IRE*, 40, p 1,584, Nov. 1952.
- (4) P. G. Sulzer, Junction Transistor Circuit Applications, *ELECTRONICS*, 26, p 170, Aug. 1953; also session on nonlinear applications of junction transistors, IRE-AIEE Conference on Transistor Circuits, Feb. 1954.
- (5) R. F. Shea, "Principles of Transistor Circuits", p 83, John Wiley and Sons, New York, N. Y., 1953.
- (6) J. H. Felker, "The Transistor", p 687, Bell Telephone Laboratories.

Nomographs for

Fourteen charts give directly the parameters that determine propagation characteristics of dominant waves in rectangular waveguides at a number of different operating frequencies used in design of microwave systems

By **T. S. CHEN**

*Tube Division
Radio Corporation of America
Harrison, N. J.*

IN transmission of microwave energy and development of equipment for use at microwave frequencies, it is often necessary to determine the propagation characteristics of TE_{10} waves in rectangular guides at a number of frequencies. The alignment charts given here eliminate the necessity for mathematical computation of these parameters.

1—Velocity of Propagation in

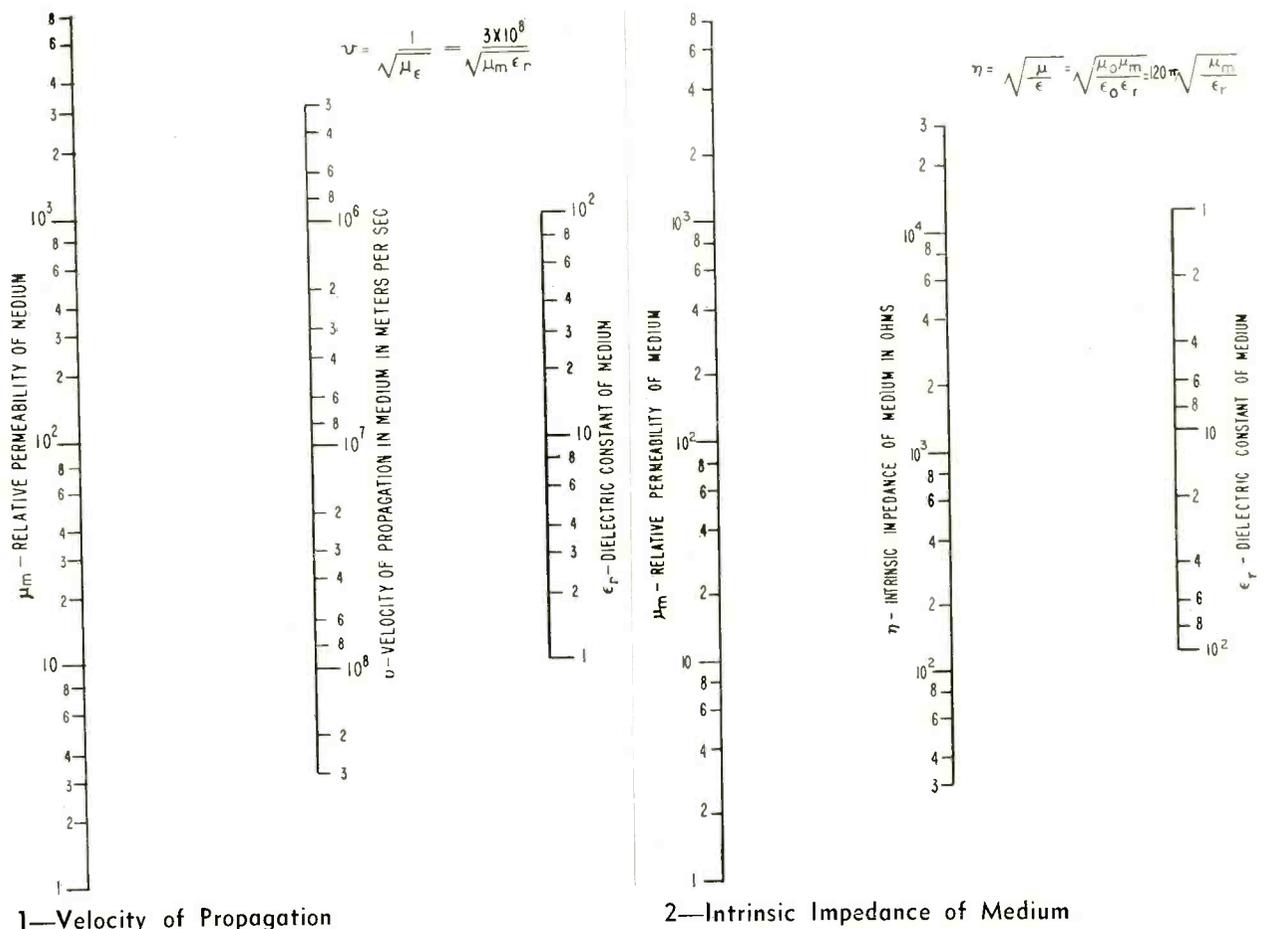
Unbounded Medium—Many of the propagation phenomena of waves in rectangular guides can be studied by means of a superposition of plane waves. In plane waves, the electric and magnetic fields are at right angles to each other and to the direction of propagation. Velocity of propagation, v , of plane waves in an unbounded medium can be obtained from the nomograph.

2—*Intrinsic Impedance of Medium*—At a fixed point in a plane-wave system propagating through a nonconducting medium, the electric field oscillates

in phase with the magnetic field. The ratio of electric to magnetic intensity is the intrinsic impedance of the medium, η .

The value of η can be determined from nomograph 2 when μ_m and ϵ_r are known. In free space the intrinsic impedance has a value of 376.6 ohms.

3—*Characteristic wave impedance*—The ratio of the transverse electric intensity to the transverse magnetic intensity of waves propagating in a guide is defined as the characteristic wave impedance, Z_0 . This impedance is analogous to the



Rectangular Waveguides

intrinsic impedance of plane waves in a medium of infinite extent. This nomograph can be used to determine the value of Z_0 when the wavelength, λ , and the cutoff wavelength, λ_c , are known, provided the medium filling the guide is air or free space.

4—*Characteristic Impedance for TE_{10} Mode on Voltage-Current Basis*—When a waveguide transmits a single wave type, all higher-order modes being suppressed, the guide resembles a transmission line in which power is carried by the principal wave. When transmission-line theory is applied to waveguides, the concept of characteristic impedance for guides is useful in experimental and analytical investigations. For the TE_{10} mode in rectangular waveguides, the characteristic impedance may be

defined as the ratio of the voltage between the top and bottom plates to the longitudinal current in one plate.

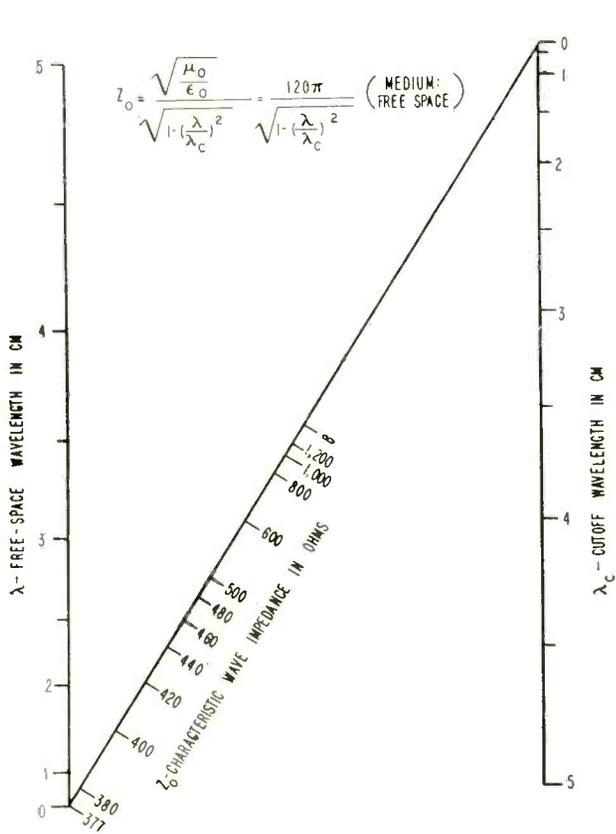
When the guide medium is free space or air, the characteristic impedances of disturbances having different wavelengths may be determined from nomograph 4 for a variety of guide dimensions. Values of $Z_{P,I}$ or $Z_{P,V}$ can also be obtained from the nomograph by multiplication of $Z_{V,I}$ by $\pi/4$ and $4/\pi$, respectively.

5—*Characteristic Impedance for TE Mode in Dielectric Medium*—For a waveguide filled with a medium having a dielectric constant equal to ϵ_r , the characteristic wave impedance of TE waves given on nomograph 3, should be modified to that shown in nomograph 5. The value of Z_0 in a dielectric medium may be

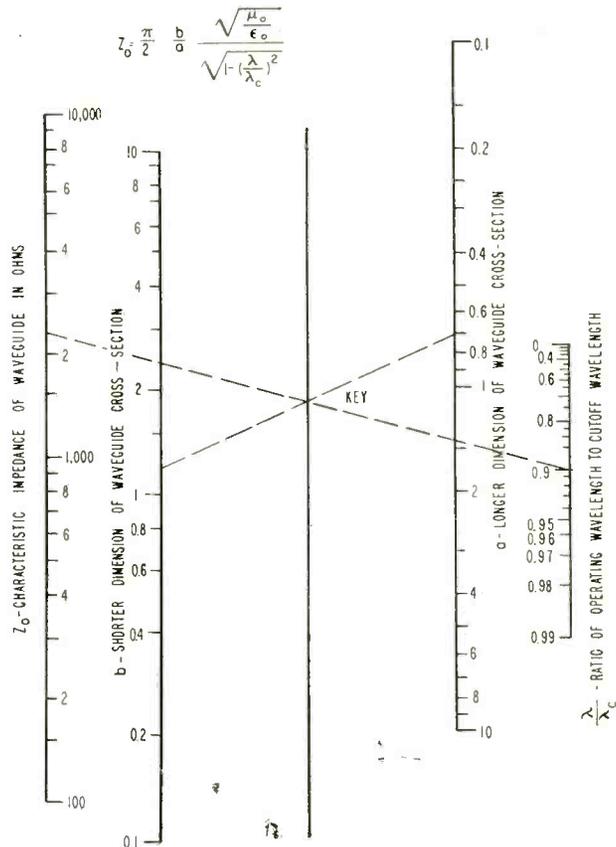
determined from nomograph 5. Permeability of the medium has been assumed to be the same as for free space.

6—*Power Flow in Waveguide for TE_{10} Mode*—If electric and magnetic field components in the guide are known, the power flow through the guide can be determined by the application of the Poynting theorem. Nomograph 6 can be used for the determination of power flow normalized with respect to the square of H_0 when the medium in the guide is free space or air. The magnetic intensity, which depends on the original excitation, cannot readily be determined directly. In practice, the power flow in a guide may be measured by means of a bolometer or water load, and H_0 estimated by the

(Text continued on page 175)



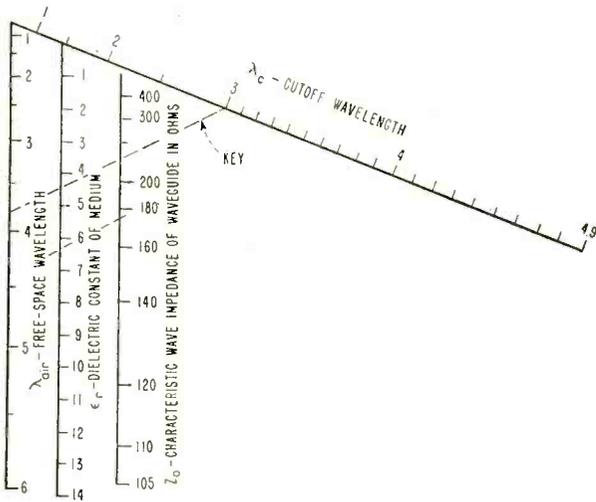
3—Characteristic Wave Impedance



4—Characteristic Impedance for TE_{10} Mode

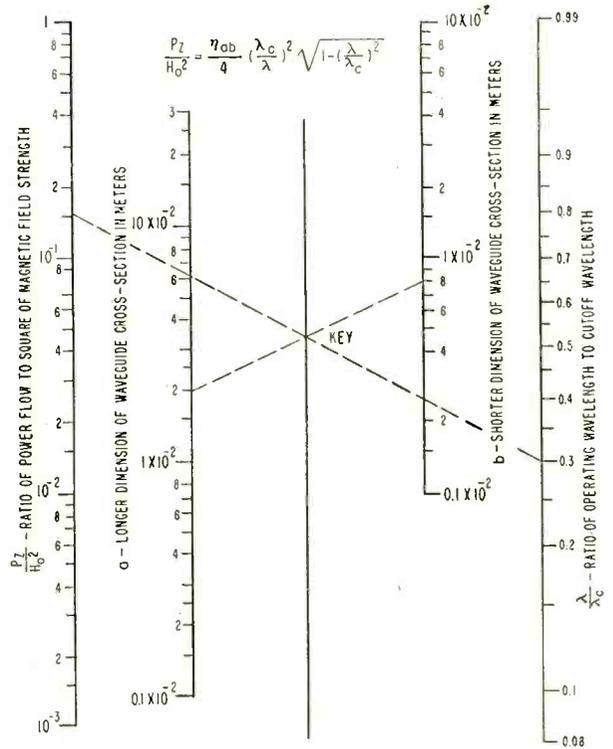
Nomographs for Rectangular Waveguides

(Continued from p 173)

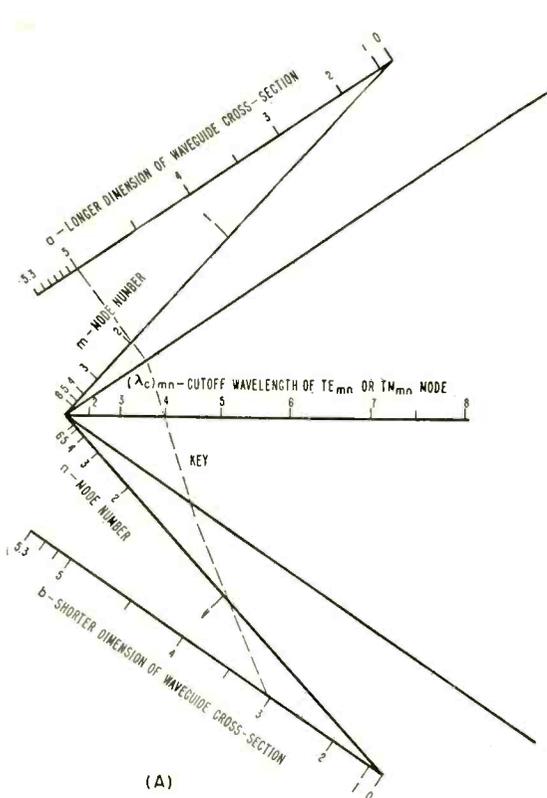


$$Z_0 = \frac{\sqrt{\frac{\mu_0}{\epsilon_0}}}{\sqrt{\epsilon_r - (\frac{\lambda_{0ir}}{\lambda_c})^2}} = \frac{120\pi}{\sqrt{\epsilon_r - (\frac{\lambda_{0ir}}{\lambda_c})^2}}$$

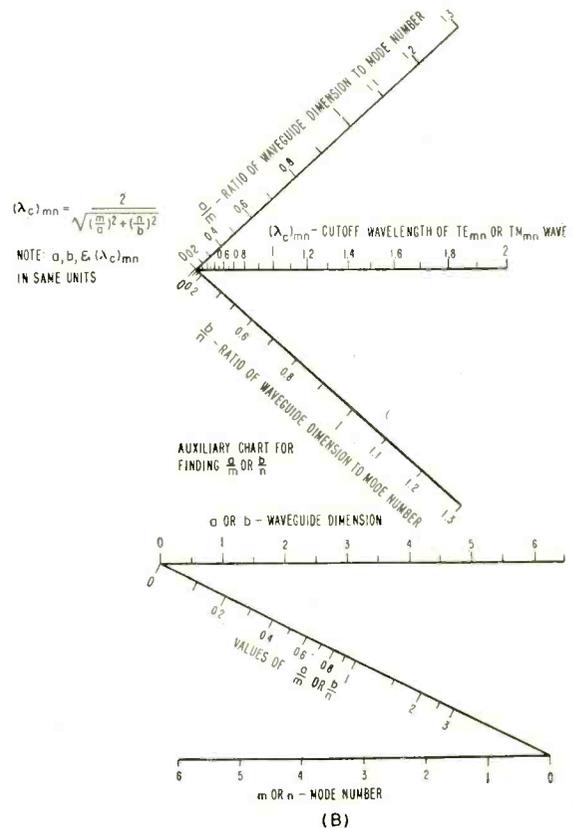
5—Characteristic Impedance in Dielectric



6—Power Flow in Waveguide for TE_{10} Mode



7—Waveguide Cutoff Wavelength for TE_{mn} or TM_{mn} Mode



(B)

use of the equation for power flow given on the nomograph.

7—Waveguide Cutoff Wavelength

—When electromagnetic waves are confined to propagate in a guide, they may exist either as transverse-electric or transverse-magnetic waves. Waves having frequencies below a critical value are attenuated rapidly enough to prevent substantial transmission down the guide. The value of the cutoff wavelength is determined by the geometry and dimensions of the guide and the mode of wave excited in it. For TE_{mn} propagation, when m and n are small integers, nomograph 7A may be used to determine the cutoff wavelength.

For cutoff at high mode numbers a more accurate value for the cutoff wavelength can be obtained from nomograph 7B. When nomograph 7B is used, the ratios a/m and b/n are determined first by the use of the auxiliary chart at the bottom,

Nomenclature

- a = longer dimension of waveguide cross-section in meters
- b = shorter dimension of waveguide cross-section in meters
- E = electric field strength in volts per meter
- f = frequency in cps
- H = magnetic field strength in ampere-turns per meter
- m = mode number along side a of guide
- n = mode number along side b of guide
- P_z = total power in watts
- v = velocity of propagation in meters per sec
- Z = impedance in ohms
- α = attenuation
- δ = skin depth
- ϵ = $\epsilon_0 \epsilon_r$ = permittivity of medium in farads per meter
- ϵ_0 = $\frac{1}{36\pi} \times 10^{-9}$ = permittivity of free space
- ϵ_r = dielectric constant of medium
- η = intrinsic impedance of medium in ohms
- λ = wavelength
- λ_c = cutoff wavelength
- μ = $\mu_0 \mu_m$ = permeability of medium in henrys per meter
- μ_m = relative permeability of medium
- μ_0 = 4×10^{-7} = permeability of free space in henrys per meter
- σ = conductivity of medium in mhos per meter

and the cutoff wavelength is found by entering these ratios in the upper nomograph.

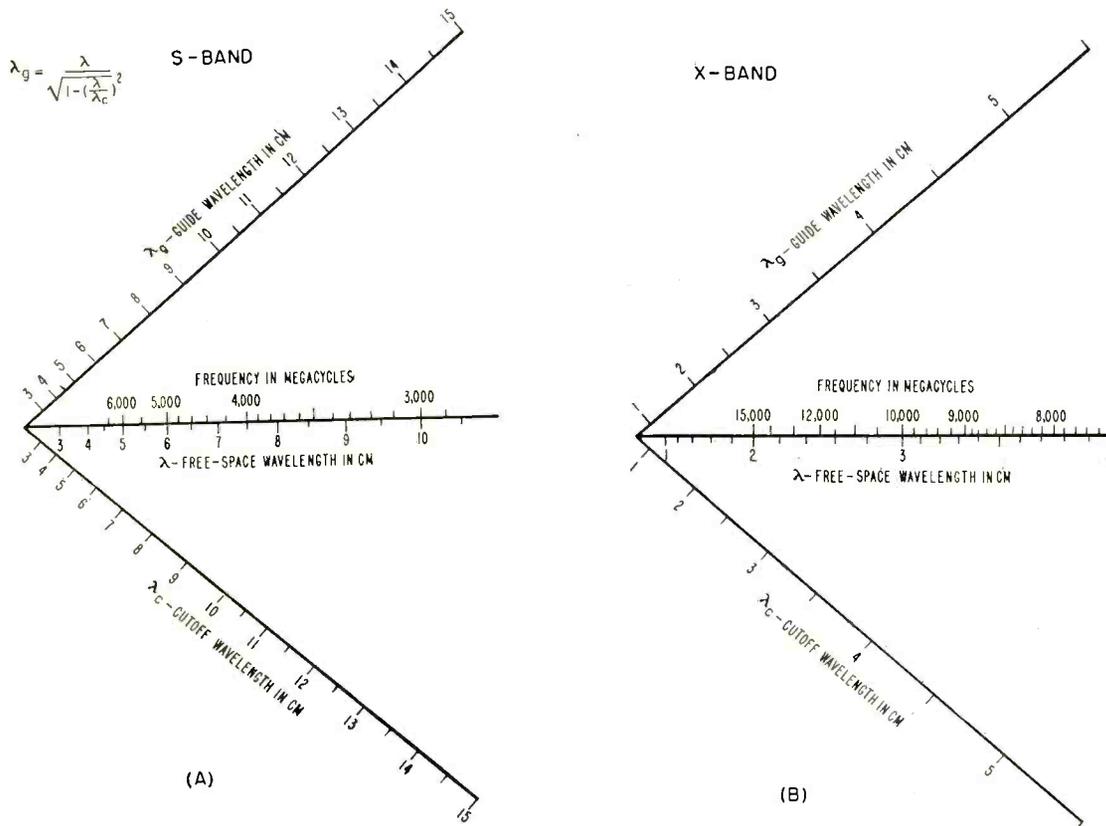
8—Guide Wavelength — The phase velocity of a wave propagating in a rectangular waveguide exceeds the velocity of a TEM wave having equal frequency in an unbounded medium of the same kind as that used in the waveguide. The guide wavelength, λ_g , therefore, is greater than the corresponding TEM wavelength, λ , and may be expressed in terms of λ and λ_c , the cutoff wavelength of the guide.

The guide wavelength for S-band applications can be determined by use of nomograph 8A; its value for X-band applications can be determined from 8B.

9—Wavelength in Medium in Terms of Free-Space Wavelength

The conversion of the free-space wavelength of an electromagnetic wave in air to the TEM wavelength of the same wave oc-

(Text continued on p 176)



8—Guide Wavelength for S-Band and X-Band Operation

Nomographs for Rectangular Waveguides

(Continued from p 175)

curing in a medium having a different dielectric constant can be made using nomograph 9.

10—Guide Wavelength in Dielectric Medium—If the waveguide is filled with a dielectric other than air or free space, equations involving λ as a variable should be modified when the wavelength in air is used for a wave to be transmitted in the guide.

The cutoff wavelength of the guide is independent of the dielectric in it and is a function of the guide dimensions only.

11—Attenuation for Wavelength Longer than Cutoff—When the wavelength of the disturbance excited in the guide is longer than the cutoff value, the wave becomes extinct within a very short distance in the direction of propagation. The attenuation due to wavelengths longer than cutoff, α , can be determined from

nomograph 11 where λ is in cm and α is in db per cm. Where the operating wavelength is longer than the cutoff wavelength, the attenuation can be determined from conversion scale.

12—Attenuation by Propagation Medium—If the material filling the guide is dissipative, the effect of its conductivity must be taken into account. When the constants of the medium and the frequency of the wave in the guide are known, the attenuation in decibels per centimeter can be determined from nomograph 12.

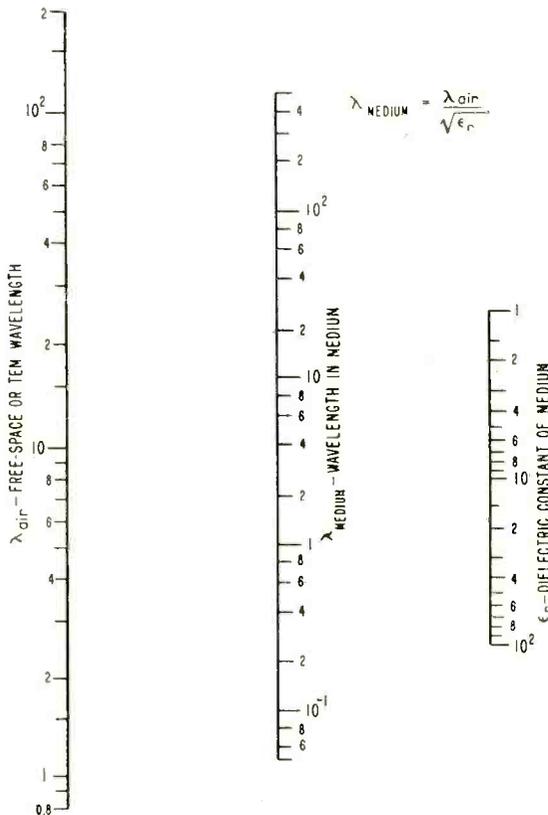
13—Skin Depth in Guide Materials—If a wave from a dielectric medium impinges on a plane conductor, the electromagnetic field penetrates into the conductor surface. The depth, δ , at which the field decays to $1/e$ of its surface value is called the skin depth of the material

and may be determined from nomograph 13.

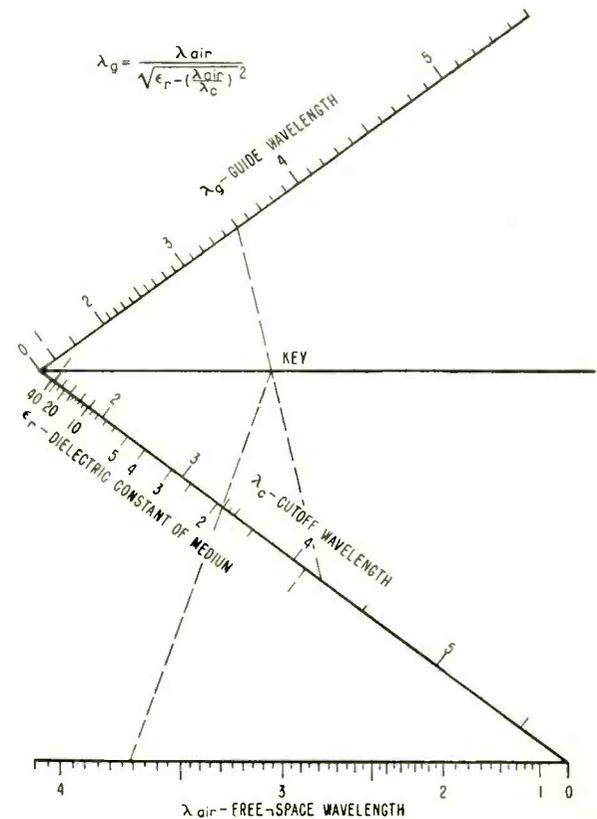
14—Skin Effect Resistance—In a good conductor, the ratio of the tangential electric field to the tangential magnetic field at the conducting surface may be expressed as an impedance per unit area, r_s . This quantity consists of a real and an imaginary part. Surface currents on the conductor are accompanied by the conversion of electrical energy into heat. From a consideration of the power dissipation, therefore, it can be determined that the real part is an equivalent surface resistance, R_s , in ohms per square meter assuming all other quantities to be expressed in mks units. The value of r_s is given in nomograph 14.

The author is indebted to B. B. Brown, H. K. Jenny and J. Paczkowski for their aid.

(Charts continued on p 178)



9—Free-Space Wavelength



10—Guide Wavelength in Dielectric Medium

2+2=4

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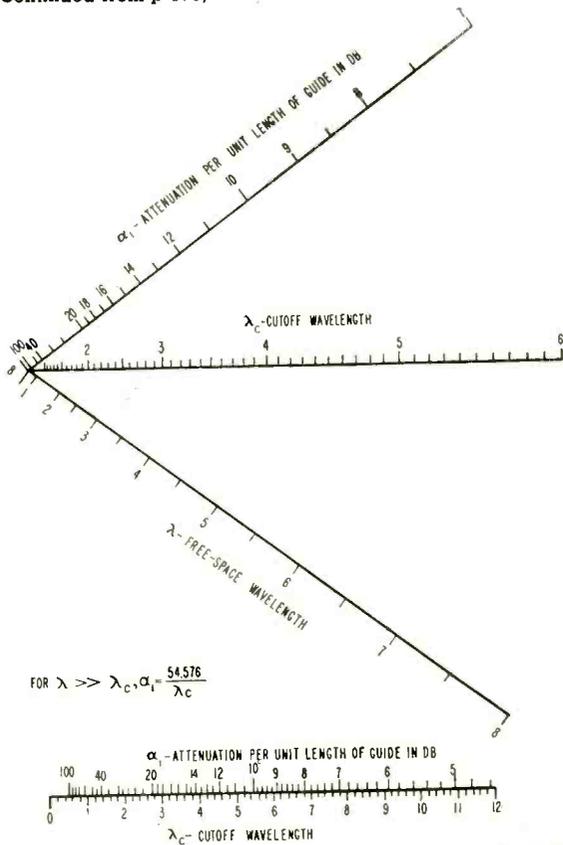


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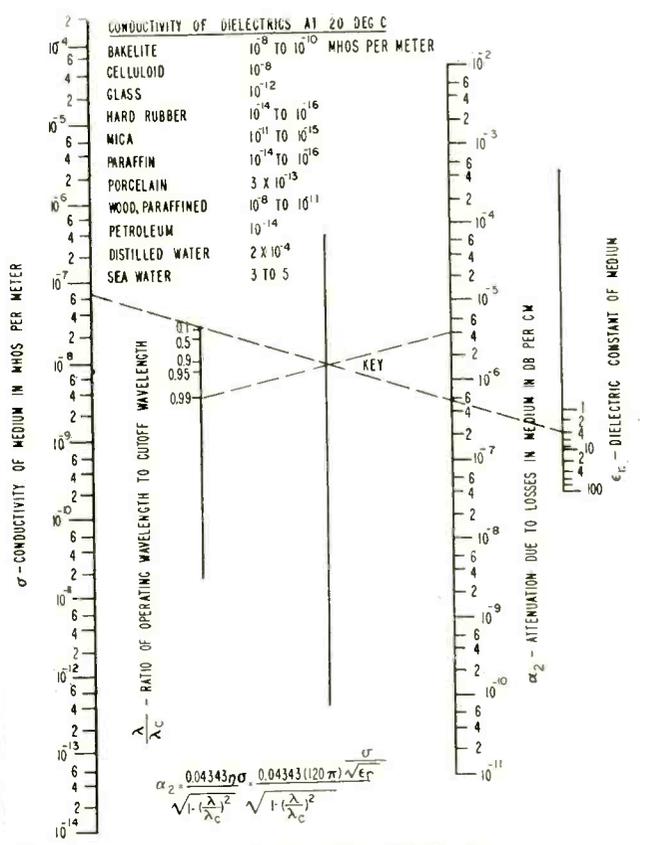
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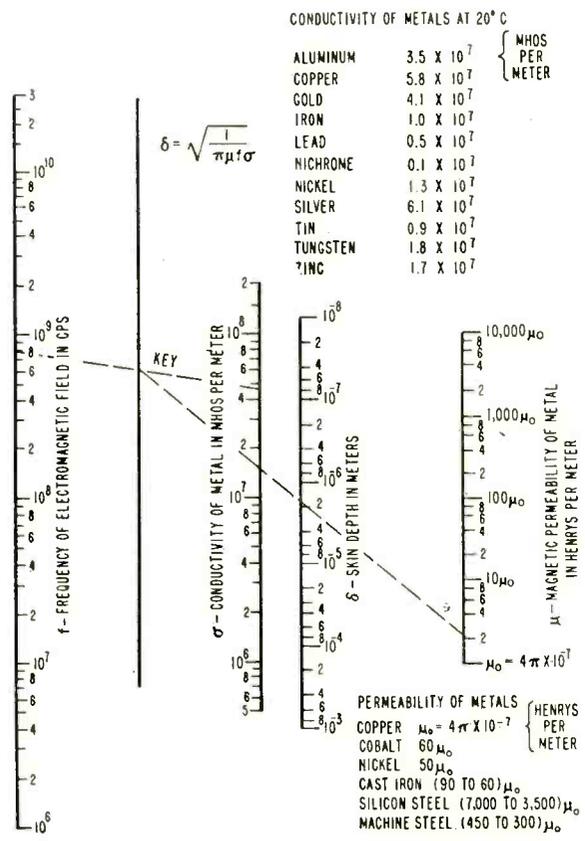
(Continued from p 176)



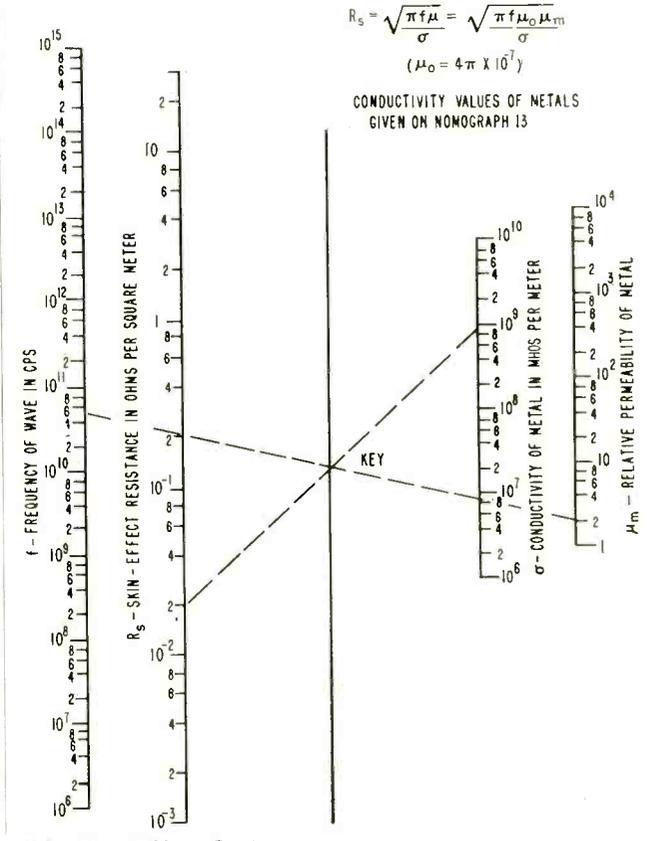
11—Attenuation for Wavelength Beyond Cutoff



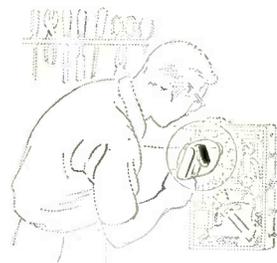
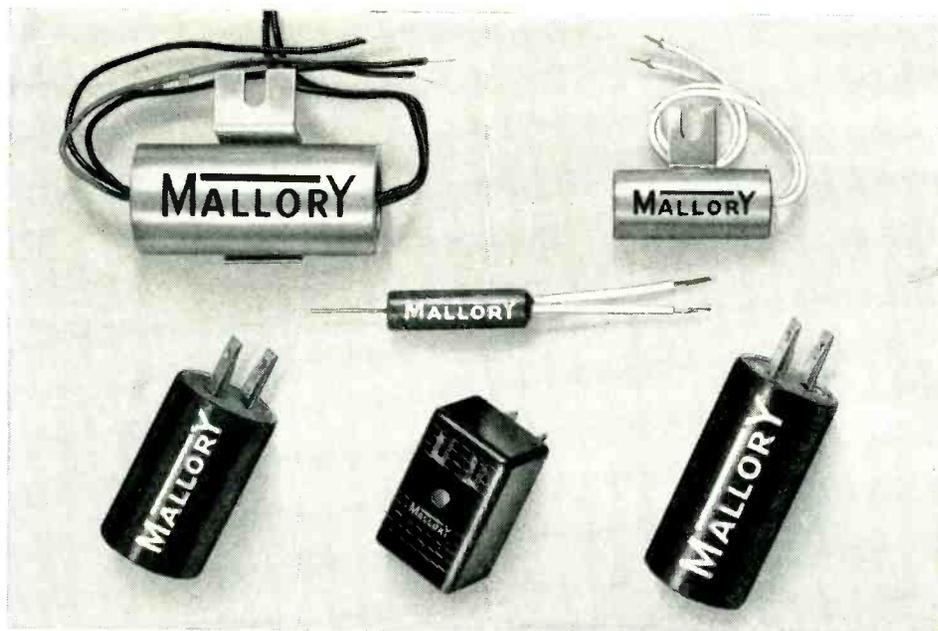
12—Attenuation by Propagation Medium



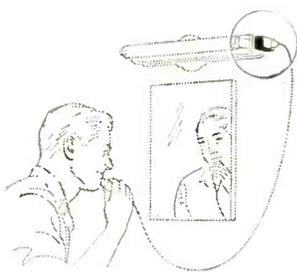
13—Skin Depth in Guide Materials



14—Skin-Effect Resistance



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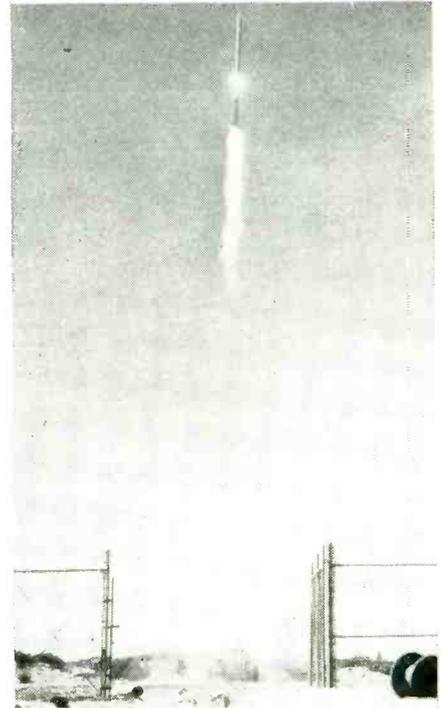
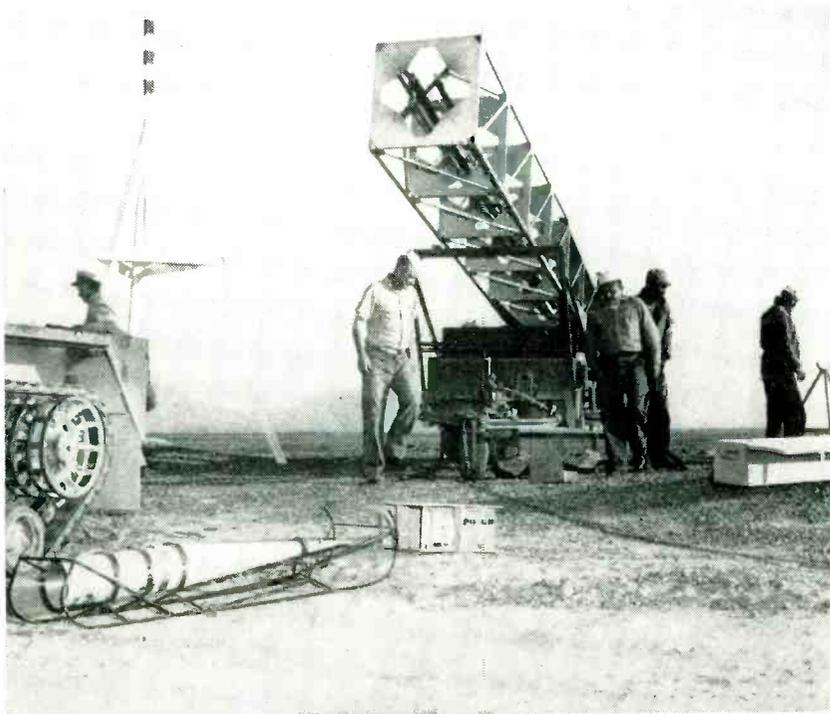
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Electrons At Work

Edited by ALEXANDER A. MCKENZIE



Pogo Parachute Replaces Drones As Missile Target

Development of a rocket-carried parachute for the Navy provides an inexpensive target for guided missiles. Drone pilotless aircraft used at lower altitudes are much more costly. The parachute, which has a diameter of 20 feet, is packed into the nose of the 13½-foot rocket. The assembly is fired vertically and the parachute

ejected by strong springs at the desired altitude. Head of the rocket (nicknamed Pogo) and portable launcher are shown in photograph at left. Airborne rocket at right. Parachute silk is coated with metallic silver to give good radar reflections. Previous expense of providing high-altitude targets has been prohibitive

Reducing Hazard of Electrical Shock in Industrial Oscillators

SAFETY CHOKE between the work coil and ground of Colpitts-type circuits used in induction heaters minimizes hazard to personnel. Equipment employing a Hartley or tuned-plate circuit should be checked to determine if the work coil is properly grounded. Panel ground straps and high-voltage sections of industrial equipment, such as the rectifier circuit, should also come under close scrutiny.

Hazard in the Colpitts oscillator arises because the high-voltage on the plate of the tube (about 2,000 volts) is isolated from the work coil by a direct-current blocking

capacitor. The work coil will expose the 2,000-volt potential if the capacitor fails. Such failure is not uncommon, owing to the high-voltage stress to which the capacitor is subjected. There is seldom any indication of such dangerous failure because the capacitor has little effect on normal operation of the equipment.

To make the circuit safe, a high-impedance inductor is connected between the end of the tank circuit and ground, as shown in Fig. 1A. Such a choke coil offers high impedance to radio-frequency currents in the tank circuit, but will act as

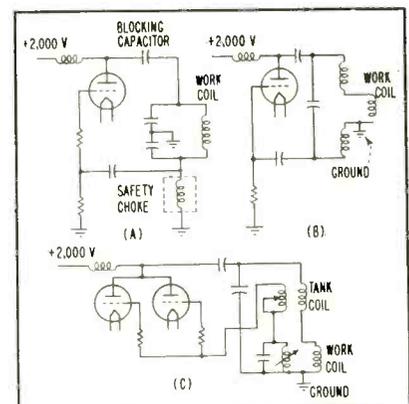


FIG. 1—Additional choke used for Colpitts oscillator (A) location of work-coil grounds on Hartley (B) and tuned-plate (C) circuits

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a direct-current short-circuit to ground if the blocking capacitor shorts out. The power-supply overload device will shut off the equipment.

Impedance of this inductor must be chosen to provide minimum r-f

leakage to ground and avoid affecting operation of the oscillator. An impedance about ten times that of the grid-circuit impedance will perform satisfactorily.

The Hartley oscillator ground (Fig. 1B) and that on the work

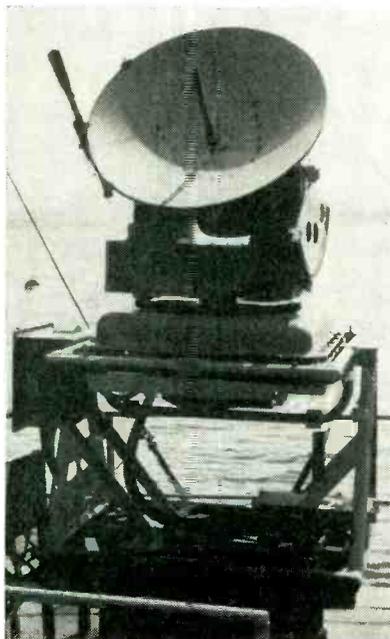
coil of the tuned-plate circuit (Fig. 1C) are shown.

This material has been abstracted from an item in the newsletter of the National Safety Council by Harold E. Vann, safety engineer of General Electric Co.

Developments in Radioastronomy Produce Navigation Aid

TWO WINDOWS exist in the earth's atmosphere, one of which is transparent to light waves and the other to radio-frequencies in the region of short wavelengths. These portions of the electromagnetic spectrum are approximately delineated in Fig. 1. Cutoff at the short-wave end of the radio-frequency window results from absorption by molecules of air. The effect of the ionosphere at the long-wave end cuts off r-f energy from outer space. Signals from earth transmitters are returned to earth by reflection from this same ionosphere.

Radio-frequency energy from outer space can be detected by suitable radio receiving equipment on the earth in the form of a rushing noise that fluctuates rapidly in an irregular manner. It has a frequency distribution similar to that



Navy sun follower built by Collins is set on stabilizer that maintains dish antenna level at all times

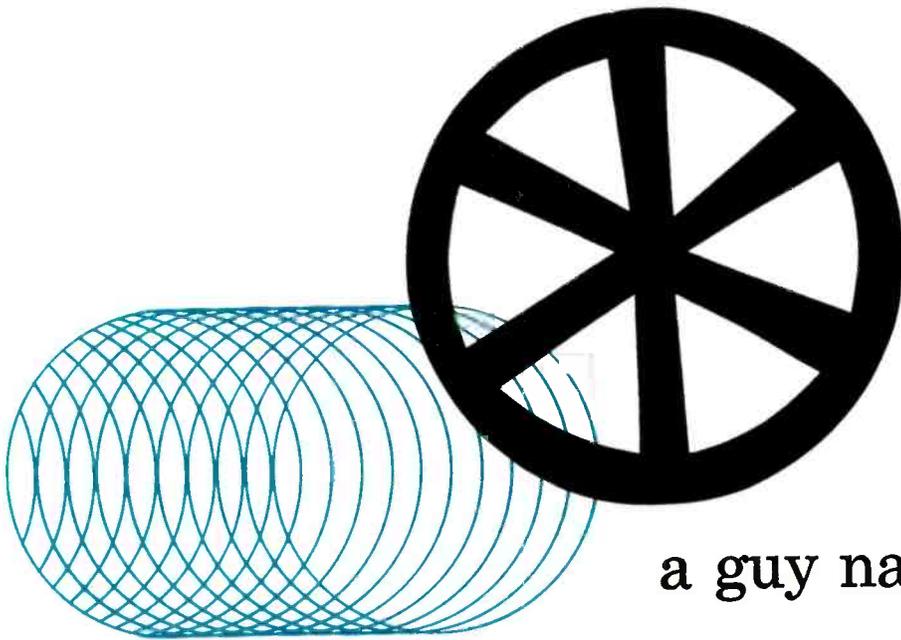
of white light. Its reception is complicated by the fact that it is like Johnson noise and shot effect found in receivers and amplifiers.

Galactic radio noise was discovered by K. G. Jansky in 1932 at about 15 meters. G. Reber in 1940, 1942 and 1944, using a narrow beamwidth at 1.85 meters, showed that this radiation is concentrated toward the galactic plane. In 1946, Hey, Phillips and Parsons in England investigating galactic noise at 4.7 meters obtained a distribution related to the structure of the Milky Way.

Although solar radio noise was not identified as such until 1942, it had been detected in 1936. During a sunspot of February 1946, Appleton, Hey and others found a high level of continuous emission associated with the sunspot. Sudden increases of 10 to 100 times in



Experimental 0.87-cm sextant (visible through doorway) at Collins Radio's Feather Ridge Observatory. Receiving equipment is in shielded room where recorders indicate results



a guy named Og

Once your name was Og. You tired of shouldering
mastodon steaks...of dragging your mate by her hair.
You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid
dance...and the Industrial Revolution was on.

Yesterday, you were a bicycle mechanic named Henry...today,
your brainchild's descendants are counted in millions.

Your name is legion. You created every linkage...
every device...every system.

You're an engineer.

You make things work better...faster...more accurately
...more economically.

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a better, faster, more accurate or more economical
means of recording...or indicating...or computing...or
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ELECTRONICS — January, 1955

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THE FRONT COVER

BUREAU OF SHIPS engineers J. R. Harter and Lt (jg) G. M. Bressner test a newly developed underwater television housing designed for use by free swimmers and divers. This type of equipment is considerably more economical than the complex hydromechanical devices heretofore necessary to operate cameras in depths beyond the reach of divers.

A special superpressure gaseous discharge lamp is attached to the front of the housing in the cover picture. This lamp is also used on an extension arm mounting in turbid waters, to reduce the scattered light reaching the camera lens. The specially developed optical system incorporated in this unit provides a total field of view in excess of 100 degrees.

power flux occurred in some cases simultaneously with onset of solar flares and occasions of sudden ionospheric disturbance (SID).

Radioastronomy can be used to explore regions where density of matter is small or beyond interstellar clouds that absorb the short visible wavelengths. Work towards this end is being carried out in the United States, England, Australia and elsewhere. Because of the difficulty of constructing antenna systems physically large enough to provide a suitably narrow beam with high resolution, particularly at longer wavelengths, spaced-antenna interferometer systems are employed.

In effect, two mirrors (antenna systems) placed several wavelengths apart act like two points on the edge of a very large lens. The resulting interference fringes can be interpreted so as to increase the effective resolving power.

A practical use of solar microwave emissions is now under advanced development in the United States in the region between 0.3 and 2 centimeters. Here, radar-like equipment has been adapted for a

solar sextant that gives sun fixes having a maximum error of 3 minutes of arc for 95 percent of daylight hours. In the frequency range used, it has been found that solar intensity level is relatively constant regardless of sunspot activity.

Energy at these wavelengths is capable of penetrating the atmosphere under most severe weather conditions.

The solar noise energy has a constant value for any radial distance from the center of the sun. A scanning system introduces a modulation of this noise energy. A standard reference signal coupled with the modulated signal produces error voltages that are used to make

the sextant track the sun automatically.

Similar equipment is under development by the Air Force. Stabilization of the airborne sun follower is complicated by high speeds and accelerations.

Material for this summary has been abstracted from a number of sources that are included in the bibliography below—A. A. MCK.

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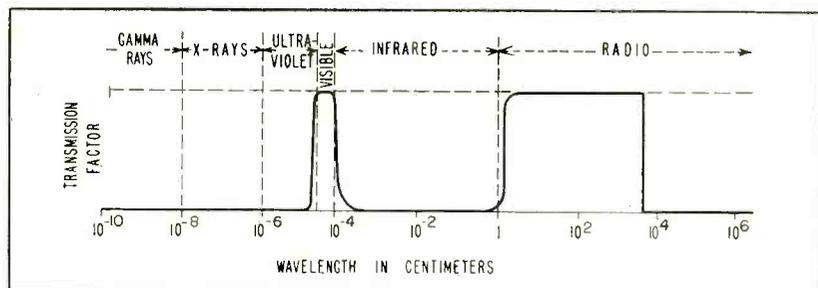


FIG. 1—Transmission coefficient of earth's atmosphere for electromagnetic waves

Radio Circuit Transmits Statistical Data from North African Base

PUNCHED CARDS carrying business data have previously been used to key wire circuits and effect their own duplication at great distances from the transmitting point. A device called a transceiver by In-

ternational Busines Machines Corp. reads the cards. Electronic circuits generate coded impulses, each series of tones representing a hole in the card.

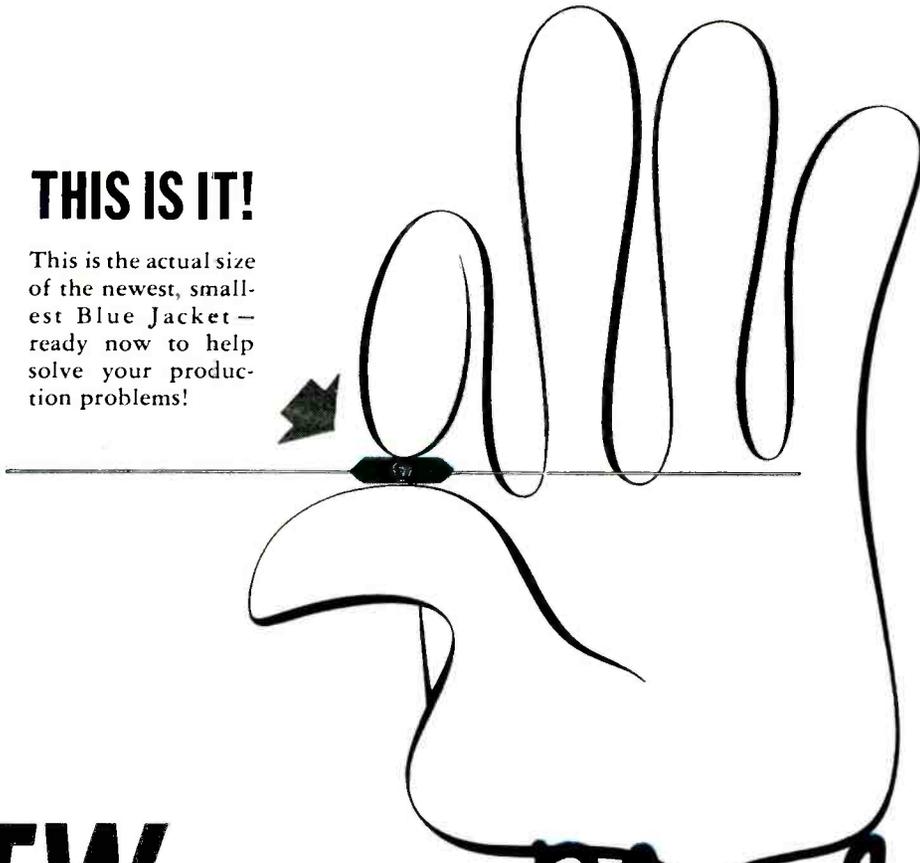
The sound signals actuate the

punching mechanism in the distant receiver, which simultaneously creates exact duplicates of the cards being transmitted. It is possible to transmit over wire lines nearly 1,000 alphabetic or numerical char-



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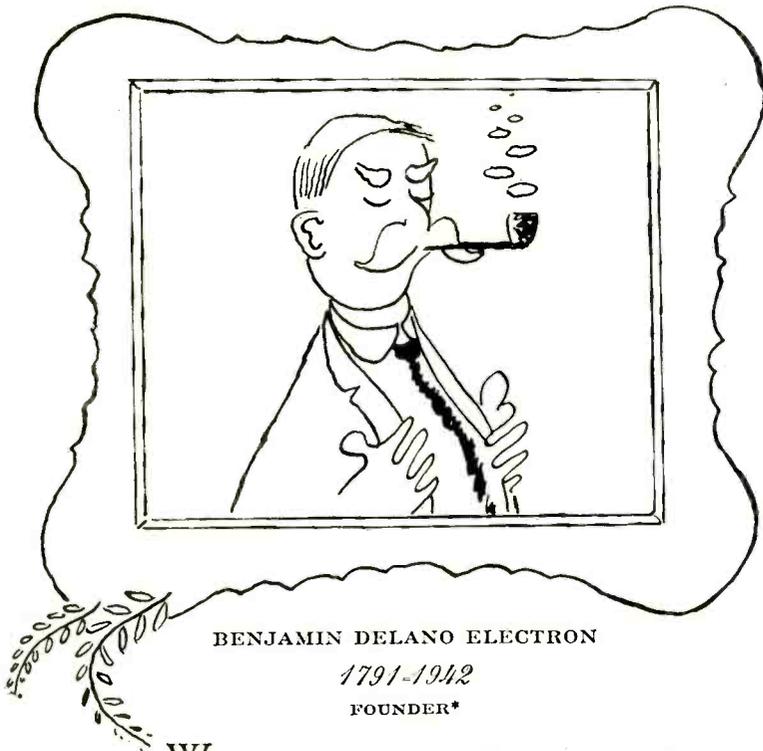
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The New Unit is equal, for obvious reasons of national pride, to the friction

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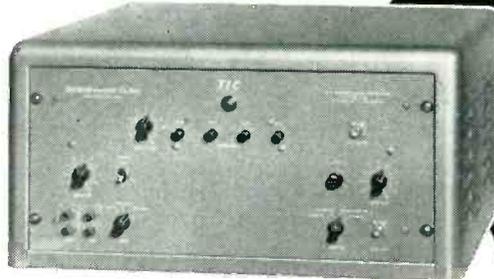
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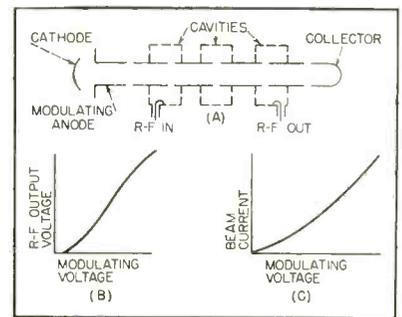


FIG. 1—Simplified construction of new tube (A) showing variation in r-f output voltage with modulation (B) and similar effect on beam current (C)

carrier efficiency of 30 percent. Without the modulating plate feature the r-f linear klystron has a carrier efficiency of less than 10 percent.

Although effective in distance measuring equipment for aircraft navigation, the new tube opens up other new operating possibilities.

Comparator for Small Phase Angles

BY P. J. NILSEN AND R. TUFTÉ

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COLOR TELEVISION has created a need for accurately measuring small phase differences incident to controlling hues of color by setting the phase of the subcarrier for color television transmission.

A variable capacitor having four separate input plates and a common output plate can be used for this purpose. A disk of dielectric material is mounted eccentrically on a shaft in such a way that as the shaft is rotated the dielectric comes successively between each input plate and the common output plate. The construction of a Variogon variable capacitor for this application is shown in the photograph.

If four quadrature voltages of equal amplitude are applied to the input plates, the voltage induced on the output plate will be a vector sum of the input voltages. The phase of the output voltage will depend on the position of the dielectric rotor, such that one mechanical degree of shaft rotation will produce one electrical degree of rota-

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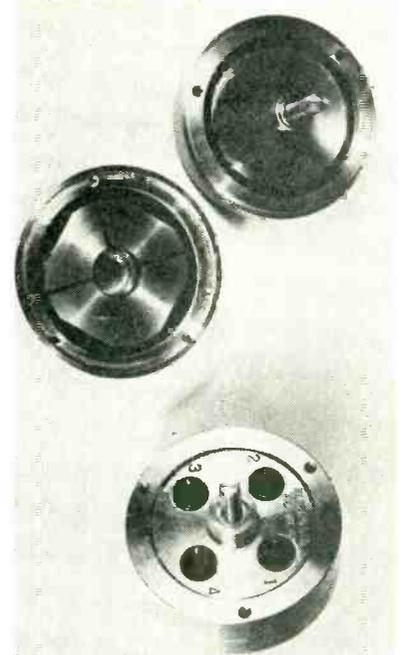


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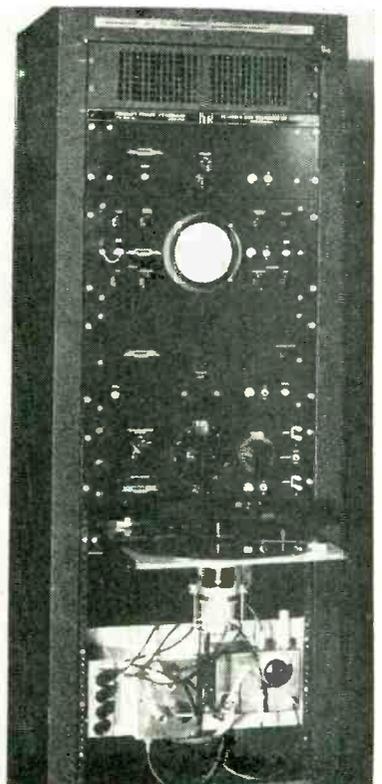


Dielectric disk between output plate (top) and input plates (center) of variable capacitor provides phase shift. Assembled unit is shown at bottom

tion of the output voltage from it.

Error in linearity between rotation of the rotor and the resulting change in output phase is below ± 0.5 degree.

However, harmonics, misalignment of network or loading of the network contribute to nonlinearity



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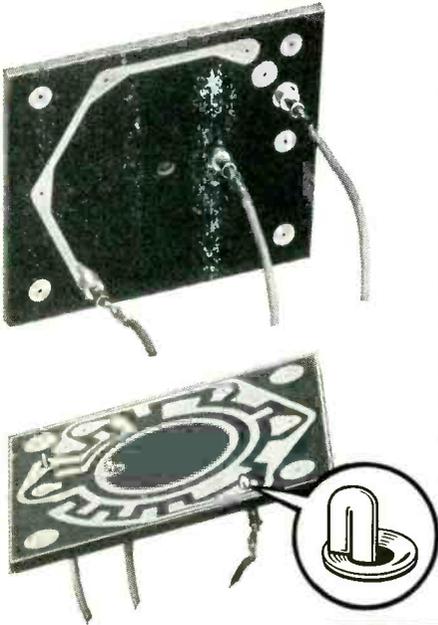
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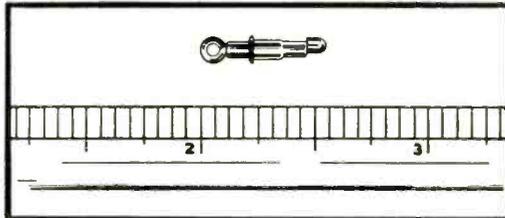
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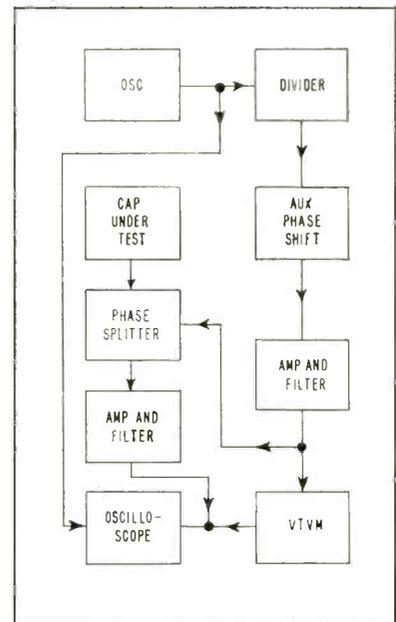


FIG. 1—Phase comparator for measuring error in phase-shifting capacitors

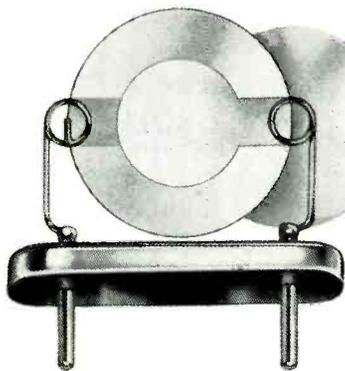
of the system. In the testing setup harmonics were held to a minimum and the capacitor was fed through a network that would not be affected by loading. Two filters and a network whose output would vary less than 0.01 deg due to variation in capacitive loading were used.

The output of the oscillator in Fig. 1 is used as a vertical sweep for a cro and the phase shifted and filtered output of the divider is used as a horizontal sweep to create either an 18 to 1 or 180 to 1 Lissajous pattern on the indicator. One or two cycles of the pattern may be observed and crossover points may be initially adjusted by the auxiliary phase shifter.

After this adjustment, rotation of the shaft by 1 deg or 10 deg will move the crossover point across to a similar position as was originally obtained. The mechanical deviation of a dial attached to the variable capacitor shaft from 10 deg or 1 deg multiples indicates the error in the variable capacitor and associated network.

Although a number of different passive network arrangements for feeding quadrature voltages to the variable capacitor are possible, the R-C phase splitter of Fig. 2 fed from the balanced secondary of a transformer was chosen for its simplicity, stability and ease of adjustment.

The capacitor output must be



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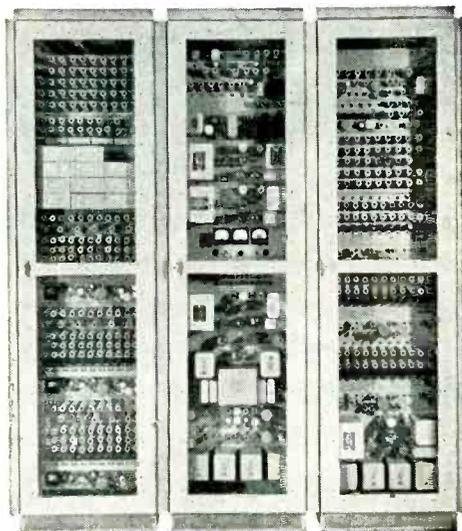
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PRINCIPLES OF OPERATION

The equipment accepts three separate dc data input voltages, encodes them into 11 digit binary codes, and decodes the received binary number to produce duplicate dc output voltages at the receiving end of the system.

In addition, six auxiliary on-off circuits are available. These auxiliary circuits may be used singly or as binary code groups. If used as six-digit binary code, 64 combinations are possible, one at a time.

TRANSMITTER

The three data and six auxiliary channels are each sampled 10 times per second.

ENCODING METHOD

A stable encoding method employs a modification of the self-balancing potentiometer principle. By means of a relay controlled summing network, 11 successive subtractions of 1/2, 1/4, 1/8 ... 1/2048 of full scale voltage are made from the input data.

OUTPUT SIGNAL

The binary codes from the input channels, the auxiliary codes, and the receiver synchronizing signals are multiplexed to permit transmission over a single communication circuit with a frequency band from 920 to 2920 cycles.

MODIFICATIONS

Many different modifications can be economically worked out because the various circuit functions are generally self-contained on separate panels.

RECEIVER

Master or frame synchronizing signals together with channel synchronizing signals are used. The multiplexed serial codes are separated and stored in transfer registers. On completion of the sample, the code numbers in the registers are transferred in parallel form to decoders.

DECODING METHOD

Resistance summing networks are used for decoding. The output from control relays in the encoder are summed by means of a chopper stabilized direct coupled amplifier.

REFERENCE VOLTAGE

Either a self-contained standard cell or external voltage can be used as the dc reference.

shielded to prevent pickup, but the capacitance to ground must be very small to prevent excessive attenuation, therefore, a triaxial cable with the outer shield grounded and the inner shield driven at cathode potential was used as shown in Fig. 3.

The network is adjusted by setting R_3 and C_1 for equal and opposite voltages on A and D with the network in place. Depending on stray capacitance and inductance in the network, voltages at capacitor plates 1 and 3 may be greater or less than those at 2 and 4. These amplitudes may be equalized by interchanging A and B with A_1 and B_1 and C and D with C_1 and D_1 and balancing with R_1 and R_5 . Phase adjustments on 2 and 4 are made with R_6 and R_9 . It is necessary to repeat balancing procedure several times due to interaction between controls.

The correct contour for the rotor to produce linearity in phase shift when used with sector-shaped input plates is a cardioid. When a circular rotor is used an inherent maximum error of about 0.7 deg is introduced. Tests of units with round rotors have shown errors of about 0.5 deg and it is believed that fringing ef-

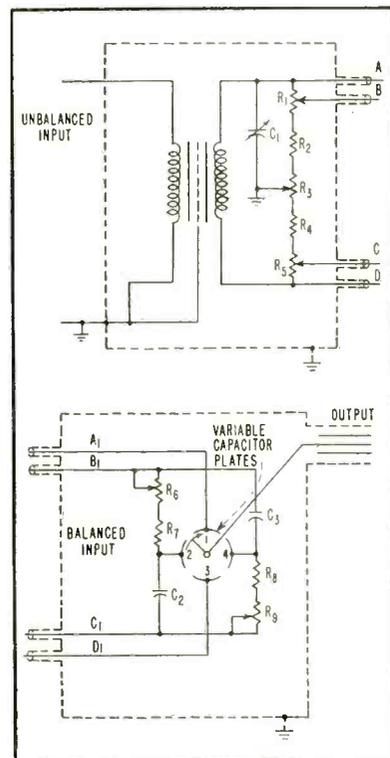


FIG. 2—Quadrature voltages for phase-shift capacitor are obtained from balanced transformer (top) and phase-shift network at capacitor plates (bottom). Transformer and capacitor mount are constructed as separate units

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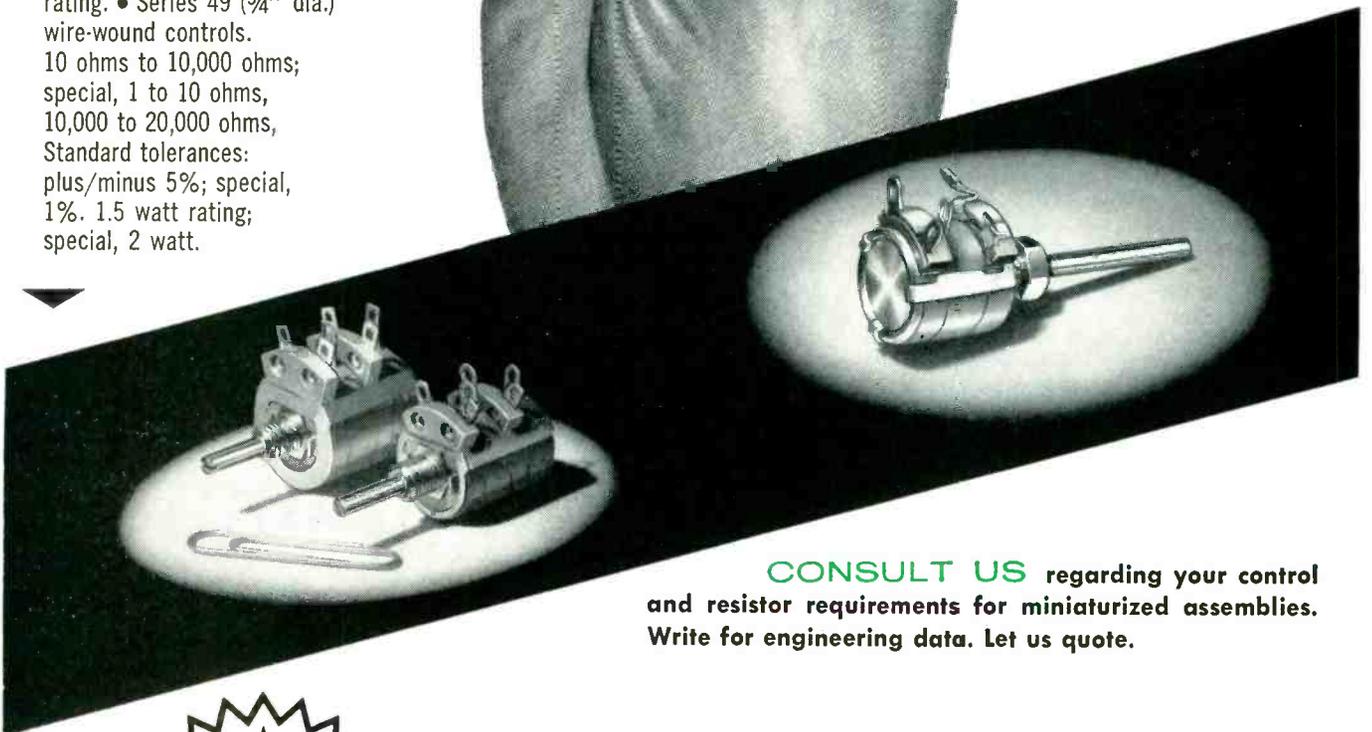
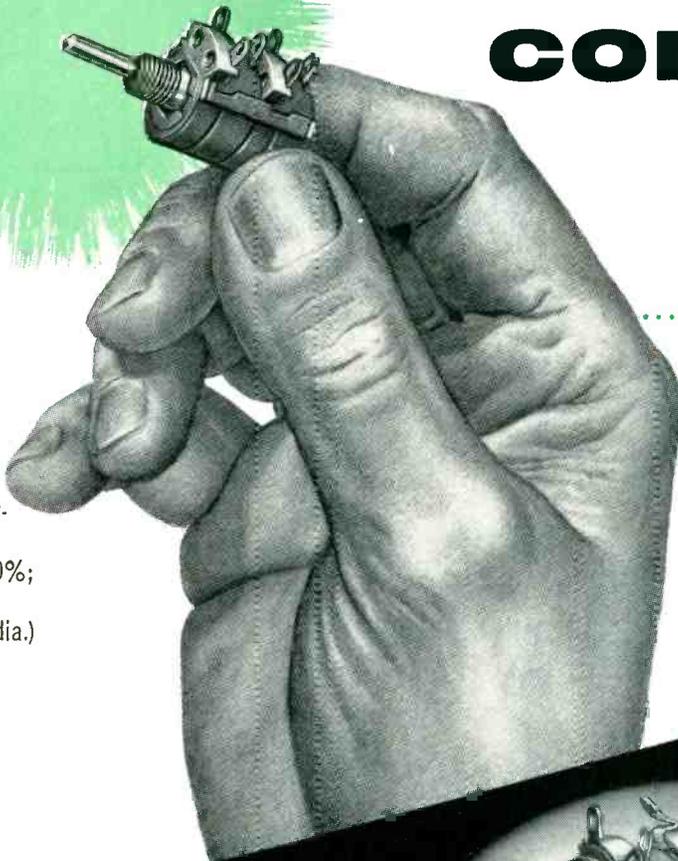
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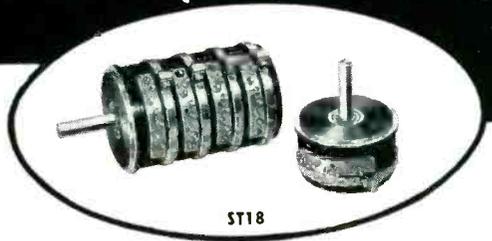
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STANDARDIZED LINE of BALL BEARING precision potentiometers

FEATURE:

- A complete range from 7/8" to 3"
- High accuracy
- Compact size
- Ball bearing for rigid, low friction support
- Servo mounting AIA proposed std. dim.
- Linear or non-linear functions



ST18

Specifications of ST18, for example, offer:

- Resistance Range: 100 ohms to 100K.
- Independent Linearity: $\pm 0.5\%$ of total resistance, standard.
 $\pm 0.2\%$ special.
- Electrical Rotation: $320^\circ \pm 2^\circ$, standard. Special angles and closer tolerance available.
- Power Rating: 3 watts @ 25°C .
- Torque: 0.5 oz. in., standard. Lower torque available.

- TIC offers: Type ST09 (7/8")
- " ST11 (1")
 - " ST15 (1 1/2")
 - " ST18 (1 3/4")
 - " ST20 (2")
 - " ST30 (3")

All in either linear or non-linear functions

Specifications of ST09

- Electrical Rotation: $320^\circ \pm 5^\circ$. Special angles and Resistance Range: 100 ohms to 50K.
- Independent Linearity: $\pm 1\%$ of total resistance standard.
 $\pm 0.3\%$ special.
- Electrical Rotation: $320^\circ \pm 5^\circ$. Special angles and closer tolerances available.
- Power Rating: 2 watts @ 25°C .
- Torque: 0.5 oz. in., standard. 0.1 oz. in., special.

The dependable precision and stability built into TIC potentiometers is inherent in the new standardized line. In keeping with the trend to miniaturization of servo drive assemblies, these compact low torque potentiometers require minimum power from the driving source. Applications in airborne electronic equipment, guided missiles and computers as well as broad industry applications in conjunction with automatic control now enjoy simplified production through standardized assemblies.

Specifications common to the entire line of standardized potentiometers:

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- Temperature coefficient resistance wire: 0.002% per degree C. Taps available.
- Rugged construction, low noise and long life plus conformity to stringent military specifications for humidity, salt spray, shock and vibration are but a few of the features of the new TIC standardized line.
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ST09

The TIC policy of setting and maintaining the highest standards of precision potentiometer manufacture assures your confidence and satisfaction. Whether for standardized potentiometers or custom design your inquiry is invited.

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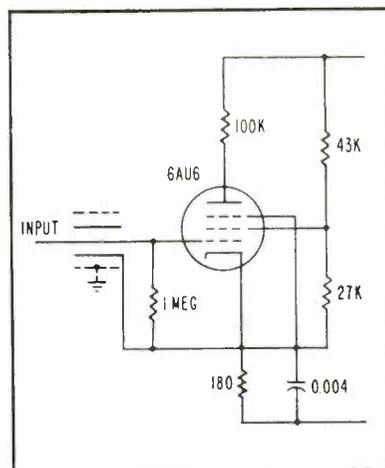


FIG. 3—Feedback amplifier input uses triaxial cable with outer shield grounded and inner shield at cathode potential

facts have a tendency to compensate partially for the inherent theoretical error. To avoid the mechanical difficulties in producing an accurate cardioid-shaped rotor, the more easily made rotor is used and the resulting error is compensated by contouring the sector plates.

Test results indicate that networks might better be incorporated within the capacitor housing and network components selected and adjusted for the particular frequency of operation to insure best results. Such combinations are being developed and tested at the present time.

The writers wish to express appreciation for the help and co-operation of D. A. Alsberg, Bell Telephone Laboratories, R. L. Frank of Sperry Gyroscope Co. and W. W. Graustein of Technology Instrument Corp.

Pressure Gage for Ship-Model Hulls

By HJALMAR CHRISTENSEN and
JENS ERIK FUNDER
*Skipsmodelltanken
Trondheim, Norway*

SHIP PROPELLER BLADES, working in a nonuniform wake, are subjected to variable loading during one revolution. This causes impulsive forces, which are transmitted to the hull through the stern frame and shaft bearings causing vertical and/or horizontal vibrations of the hull. Further, the propeller sets up vari-

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with improved **C-D-F DILECTO**® laminates

Only C-D-F, the Continental-Diamond Fibre Company, makes Dilecto laminated plastic, just as only Cadillac makes a Cadillac. Dilecto is 50 different materials with more combinations and variations in desired properties than we can tell you here.

But Dilecto has three important qualities that you should think about if you buy, design, or machine laminated plastics.

DILECTO HAS HIGH MECHANICAL STRENGTH

Mechanical strength is frequently an important determining factor in the selection of an insulating material. Insulating parts used in large electrical power equipment are frequently bulky. The high mechanical strength of Dilecto helps reduce size-dimensions of insulating parts without danger of failure. Instruments, meters and small motors frequently require very small insulating parts which must withstand comparatively large mechanical stresses. Insulation for use in high frequency circuits should have a minimum bulk factor for minimum dielectric losses. Dilecto fulfills these requirements with a combination of high mechanical strength and low loss factor, characteristic of the better C-D-F electrical grades.

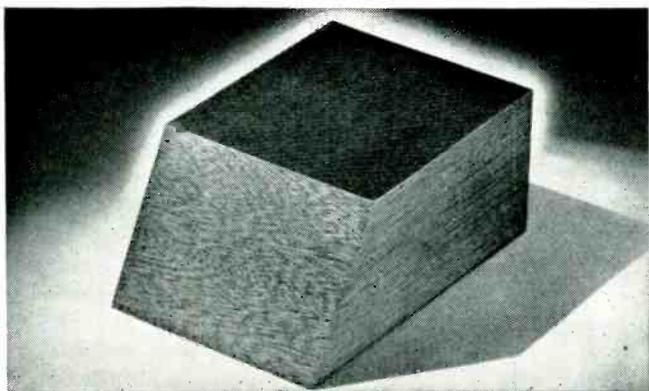
So C-D-F selects for your Dilecto insulation grade the correct, highest quality base material, paper, cotton, nylon, glass. These are used in combination with improved penetrating resins: Improved Phenolic, New Melamine, New Sili-cone, New Teflon, all synthetic, well polymerized resins.

Both the base and the resin are good insulators by themselves. But C-D-F sells them to you in an improved, practical form . . . Dilecto. Uniform sheets, tight tubes, strong rods, close tolerance machined and formed specialties, high bond strength metal clads.

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A poor laminate absorbs moisture at its edges, loses its insulating properties fast. Entrapped moisture and other volatiles within the cured structure causes inconsistent dielectric strength, with ultimate puncture and breakdown.



Punch press and bench saw operators know how much time and material is saved when the laminated plastic is *uniform and homogeneous* in nature like Dilecto.

DILECTO IS IMPROVED

Yes, C-D-F Dilecto is an improved laminated plastic, due to high standards and advances in resin and manufacturing techniques. It is watched by skilled workers in our modern plants, checked against rigid standards . . . C-D-F standards . . . by our quality control people. It is easy to machine, and the C-D-F shops are doing a booming business in specialties.

Table I—Typical Improved Phenolic Laminates

Commercial designation ^a	Resin	Filler	Improved properties	Improvement due to:
MEC-5	Phenolic	Nylon fabric	Insulation resistance; moisture resistance	Filler
XXHV-2 ^b	Phenolic	Paper	High dielectric strength parallel to laminations	Resin and manufacturing technique
CRD	Phenolic	Cotton mat	Better machining	Filler
XXXP-26 ^b	Phenolic	Paper	Insulation resistance; moisture resistance	Resin and manufacturing technique
C-92	Xylenol ^c	Cotton fabric	Alkali resistance	Resin
CF	Modified phenolic	Cotton fabric	Postforming	Resin

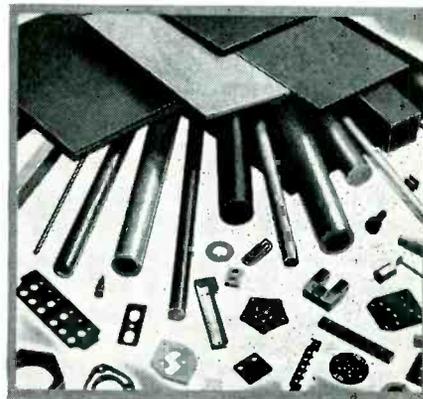
^a All grades are Continental-Diamond Fibre Company.

^b Resins have improved penetrating properties and the manufacturing techniques use these properties to provide better impregnation of the filler. Since thorough impregnation eliminates entrapped moisture and air, greater moisture resistance and better dielectric properties are attained. Manufacturing techniques also provide suitable temperature control during the curing stage to assure uniform quality and optimum property values in the finished laminate.

^c Xylenol is essentially a dimethyl phenol.

—from Electrical Manufacturing Article "Wider Design Opportunities with the NEW Phenolics", Part 11.

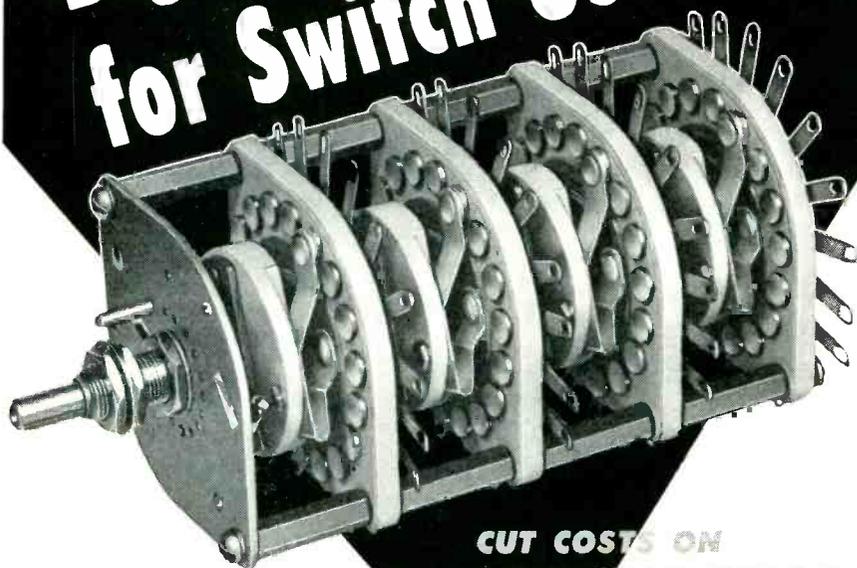
The next time you think of laminated plastics, the name to remember is C-D-F Dilecto. The improved, high strength, uniform material that makes insulation buying and using more a science, less a puzzle. New grades, new applications, new savings are just part of the Dilecto success story. Look up the facts in Sweet's Design File, or write for catalog. Send us your blueprint for quotation . . . tell us your design dream . . . C-D-F wants to work with you.



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SHORTING ACTION — 20° or 30° indexing

DETENT — Optional. Positive-acting star wheel type.

POLES PER DECK — 1, 2, or 3

NUMBER OF DECKS — Up to 10 decks may be ganged.

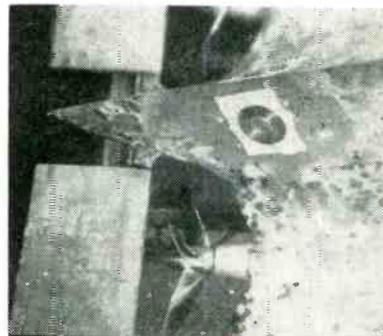
ADJUSTABLE STOP — Available on order

SHAFT — Completely isolated

CONTACT RESISTANCE — 0.0025 ohm, ± 0.0002 ohm

RATINGS — 110 v., 1a., 60 cy. — nominal.
2500 v., 60 cy. — de-rated current.
40 amps — de-rated voltage.

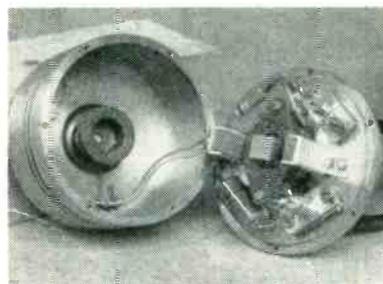
Complete specifications in
Bulletin L-32.



Pressure gage on ship model is placed flush with the hull contour



Micrometric screws on top of pressure gage assembly adjust position of balancing coil to compensate for static water pressure on hull



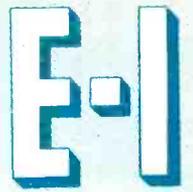
Internal structure of gage. Compensating coil is mounted in cover

able hydrodynamic pressures on the surface of the hull. These pressures, when large enough, may also cause vibrations. As excessive propeller-induced hull vibration sometimes occur in passenger ships running at high speeds, an investigation of this problem has become important.

In this article a pressure gage for measuring the varying hydrodynamic pressures acting on the surface of a self-propelled ship model will be described. High sensitivity is obtained by balancing static fluid pressure, making it possible to observe a variable pressure in the order of 0.1 inch of water, (about

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TC-1A
plain

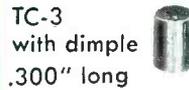


TC-1B
with hole

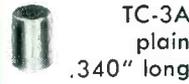


TC-1C
with hole
and dimple

CASES AVAIL-
ABLE WITH OR
WITHOUT
DIMPLE



TC-3
with dimple
.300" long



TC-3A
plain
.340" long

Where Special cases
are required, EI will
quote on your re-
quirements on re-
ceipt of your draw-
ings or speci-
fications.



TC-5
with dimple



TC-5A
plain

TC-5B
with .025" hole
All .325" long

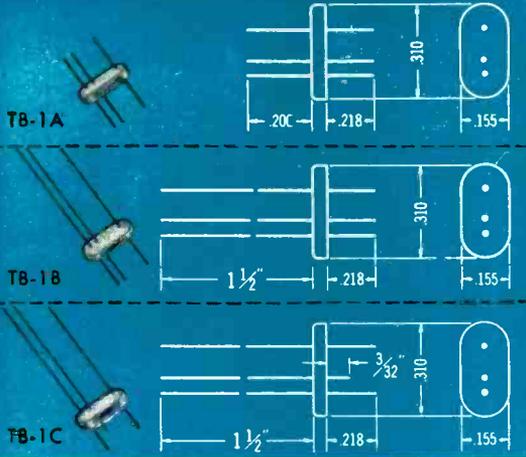
TC-5C
plain .240" long



TC-6 CLOSURE
Plain case .300"
in length.

Series No. 1 KOVAR BASES WITH NICKEL SILVER CASES

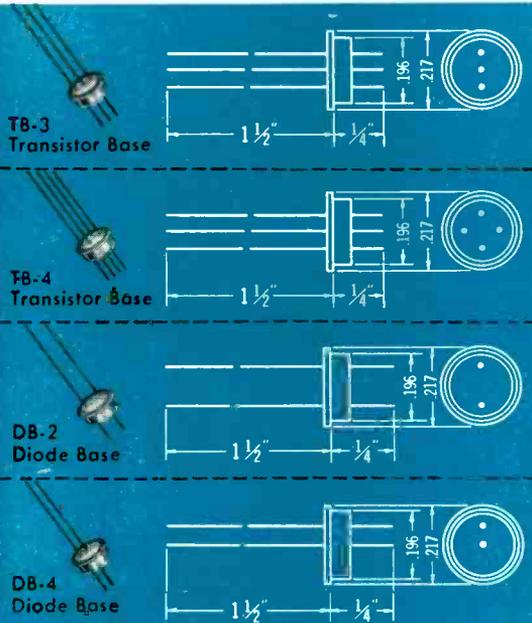
Three electrode her-
metically sealed
Kovar bases supplied
with closures. Lead
lengths and pin lay-
outs as illustrated.
Cases are available
in three types.
Closures are press-
fit to bases.



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WITH NICKEL
SILVER CASES

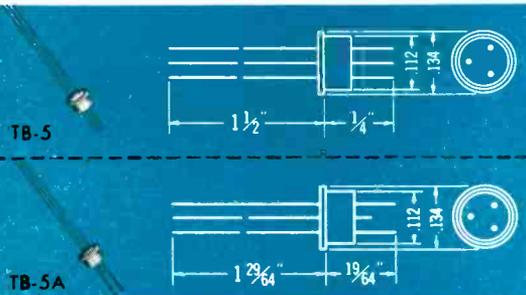
Compression type
bases available in
two, three and four
lead types. Type TC-3
or TC-3A cases, illus-
trated, can be sup-
plied. Cases are
press-fit to bases.



Series No. 5 COMPRESSION BASES

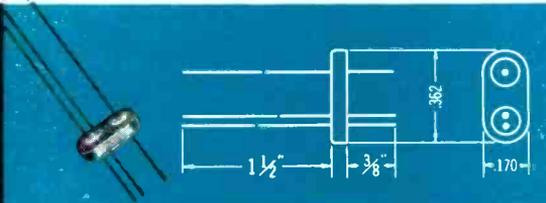
WITH NICKEL
SILVER CASES

Available as illustrat-
ed. Cases are press-
fit to bases.



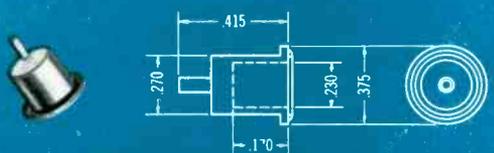
Type TB-6 TRANSISTOR BASE

AVAILABLE WITH
TC-6 CLOSURE

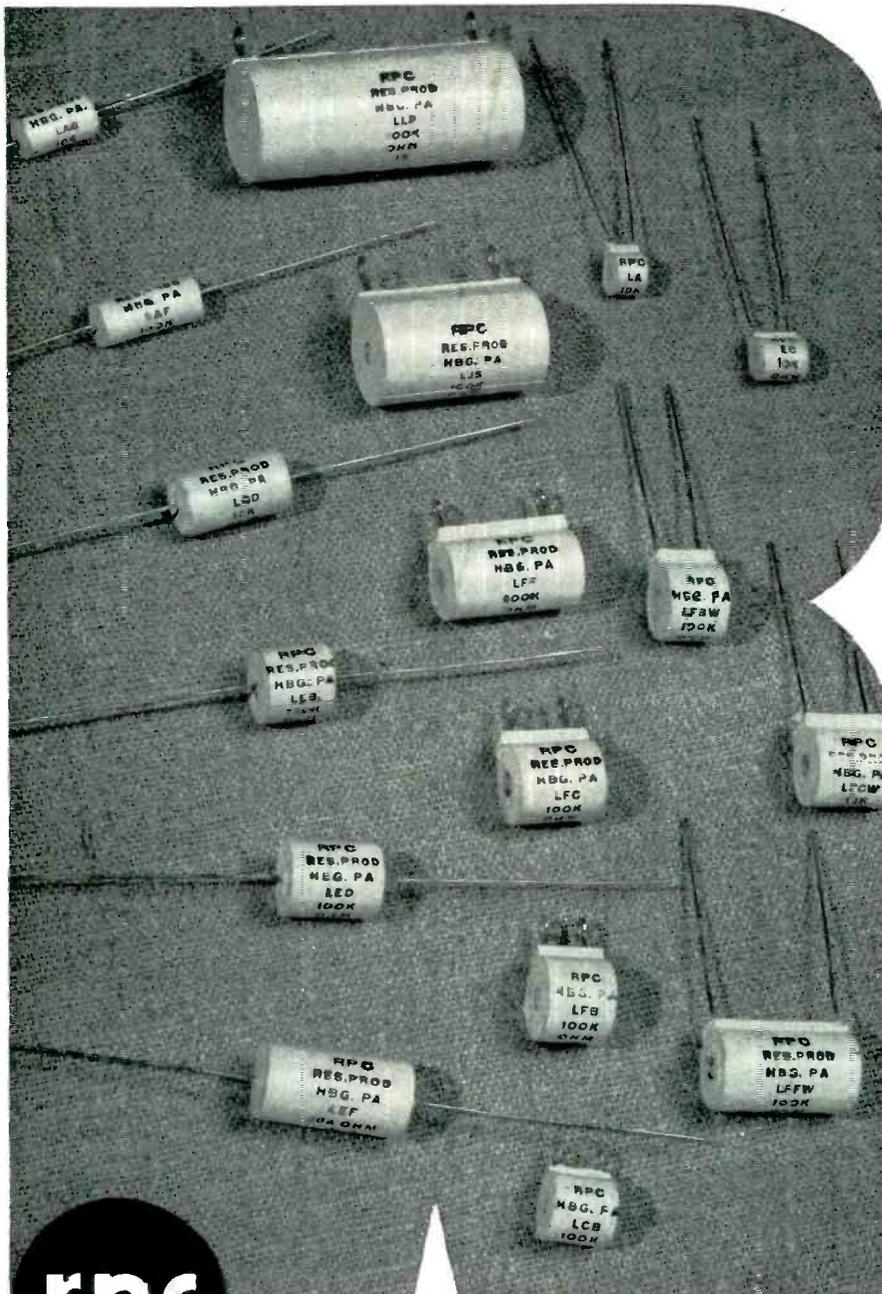


Type DC-5 GOLD PLATED

With welding projec-
tion. Available as
DC7 without welding
projection.



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RPC can supply Type L on short notice with lug type terminals or wire leads; in a *complete* line of standard, midget and sub-miniature sizes. Wide range of performance! Write for catalog or additional details.

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0.004-pound per square inch).

The gage is shown in the photographs. Other apparatus used is an amplifier with phase-sensitive detector and a pen recorder, which registers the pressure changes. Input voltage to the gage is supplied from an oscillator.

The gage works on the principle of a transformer with variable coupling between two coils. Design of the gage is shown in detail in Fig. 1. The transformer core consists of E-type Mumetal stampings

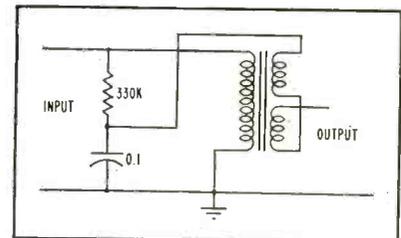


FIG. 1—Gage for pressure measurements on ship hulls has compensating coil to balance out static pressure of water

of 0.004-inch thickness. The driving coil is wound with 400 turns of 36-sw-g wire. It is supplied with 7 volts a-c at 1,000 cps from an oscillator. The voltage induced in the pick-up coil is dependent on its axial position with reference to the driving coil. The pick-up coil, wound with 100 turns of 43-sw-g wire is attached to a small diaphragm and follows its movement.

The diaphragm is made of beryllium copper. This gives high elastic strength and stability. Use of corrugations makes possible much larger deflections than would be possible with flat disks. The diameter of the diaphragm is about 1.2 inches and is 0.004-inch thick. A pressure of 0.5-inch of water gives a deflection on about 1/1,000 mm of the diaphragm. A diaphragm of smaller diameter was desirable, but this could not be combined with sufficient sensitivity.

A third coil is placed between the pick-up coil and the driving coil and connected in series-opposition to the pick-up coil. The output from the pressure gage, which is the voltage across these two coils, will thus be zero with a certain position of the compensation coil when a suitable number of turns is used. However, sufficient compensation is not obtained since there is a small



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You can use these tubes to hermetically enclose many kinds of components. Such enclosure gives the components performance characteristics they otherwise do not have.

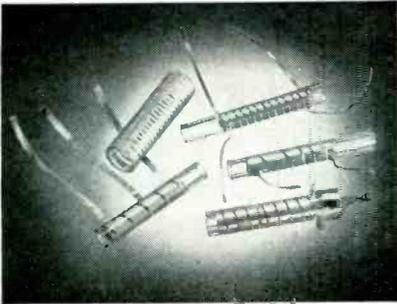
Corning's metallizing process makes possible a true hermetically sealed enclosure. Components encased in metallized glass enclosures are impervious to moisture, moulds, and atmospheric changes. Assemblies complete with end caps are capable of withstanding severe temperature changes. Glass has excellent electrical characteristics, and its transparency permits visual inspection. Bond strength for metallizing used on enclosure tubes has been measured at 1500 to 2000 pounds per square inch.

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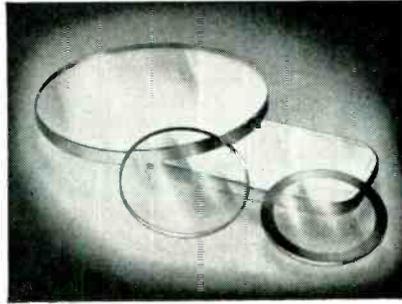


and its performance limits, or reduce servicing and minimize breakdown possibilities.

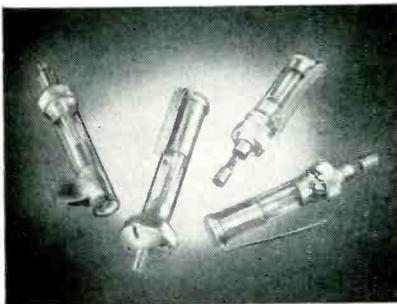
Illustrated below are other applications of Corning's metallizing process. If none of them exactly meets your needs—or, if metallized glass characteristics suggest solutions to other problems, write us your requirements. Chances are, we'll be able to help you. There is no obligation.



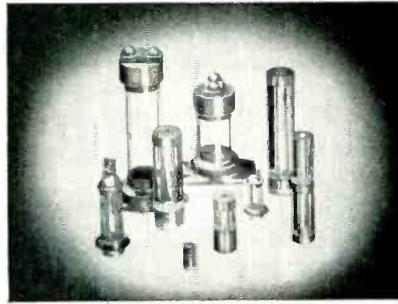
CORNING METALLIZED GLASS INDUCTANCES are made with a precision that guarantees duplication within close limits. When used in either FM or TV circuits, you can be sure that they will contribute negligible drift even under unusual temperature changes.



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phase displacement between the two coils. Thus it becomes a small residual 90 deg out-of-phase voltage of about 50 mv. An equal opposite voltage is introduced across a capacitor. With this method the output now is 1.5 mv measured with vtvm. But since it is a 90-deg phase displacement, with a phase-sensitive detector, zero-point position on the recorder is obtained.

When performing experiments with model hulls, a certain static pressure corresponding to the depth under the water surface is acting on the gage. Sensitivity requires compensation of the static pressure as this will be many times larger than the small pressure variations of interest to measure. Therefore the compensation coil is movable and can be adjusted to the desired position.

The circuit diagram of the amplifier and phase detector is indicated

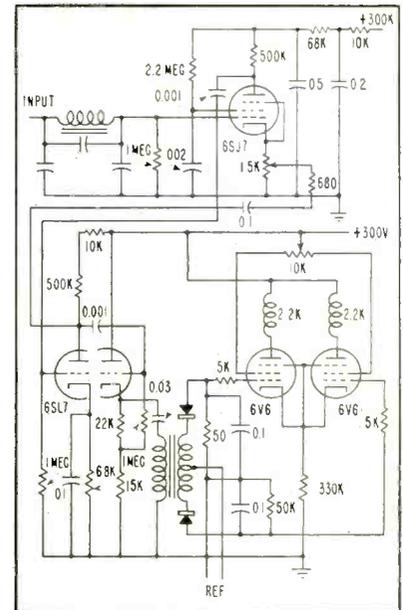


FIG. 2—Amplifier and phase-selective detector for pressure gage. Reference voltage is obtained from R-C oscillator

in Fig. 2. A low-pass filter with cutoff at 1,500 cps is connected in the input. Total amplification is about 3,000. A phase-sensitive detector of usual type has been employed. The transformer is center-tapped and has a turns ratio 1 to 2. Reference voltage is 7 volts at 1,000 cps taken from the same oscillator that supplies the driving coil. The push-pull output stage is matched to a recorder. The recorder has 4 channels and with 4 gages and am-



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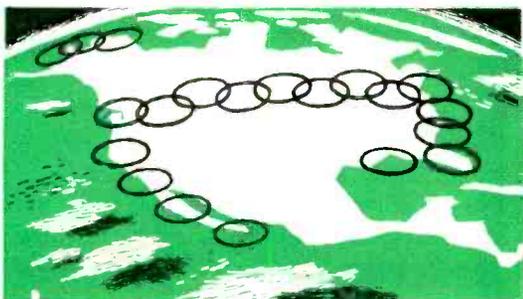
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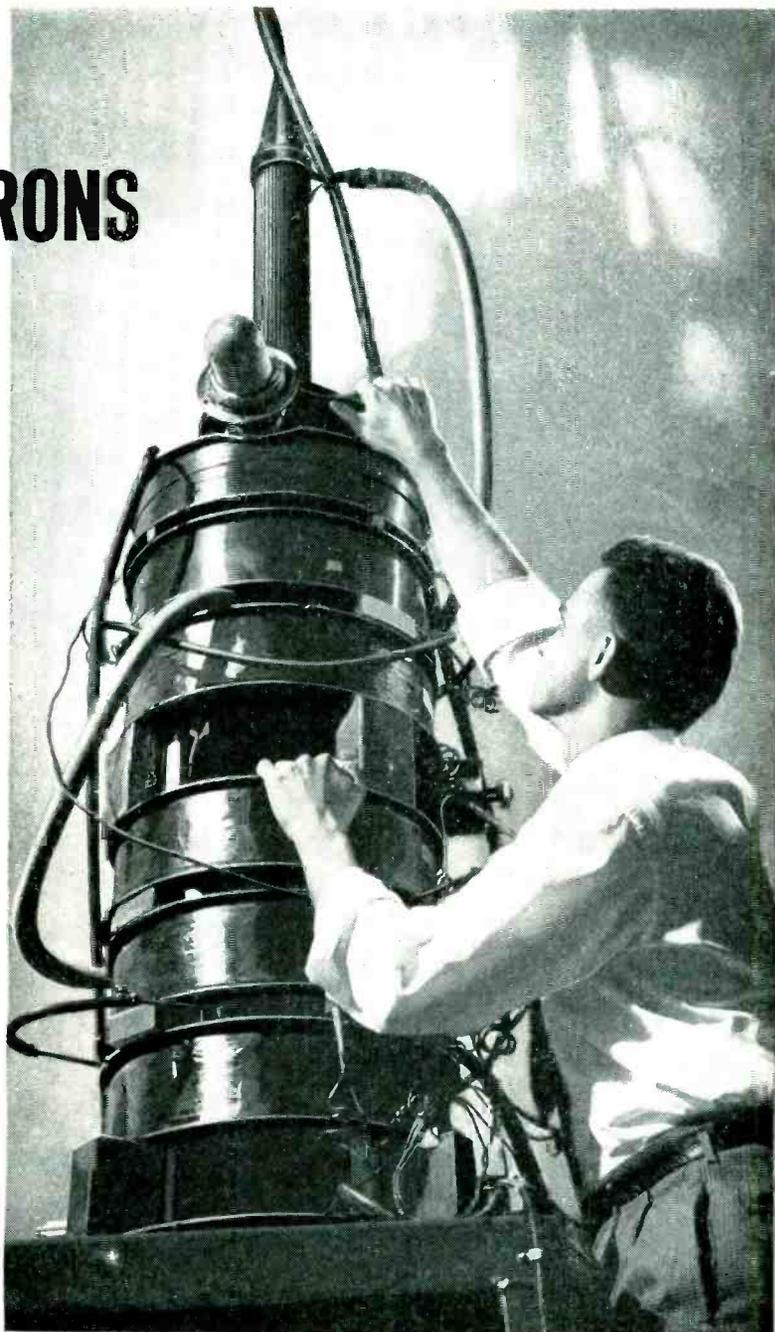
IN RADAR DEFENSE . . . Sperry's new Megawatt Klystrons have provided more than 250 times the radar power that beamed impulses to the moon and back in 1946. Such power—with a frequency held 20 to 200 times closer than the frequency limits of conventional radar or TV transmitters—permits obtaining greatly improved information from search radars.



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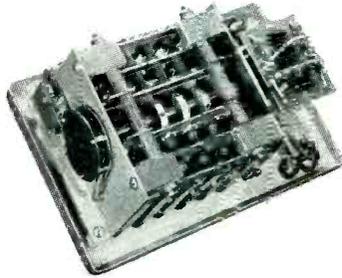
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A. W. HAYDON COMPANY

*7800 series repeat cycle timer was
custom designed for Lockheed's
wing de-icing system*

Designed to control the power for 10 de-icing circuits, carrying 3 phase 400 cycle current to the heaters in 10 wing sections, providing accurate circuit transfer from one section to the next in 10 second intervals. Each 10 second load pulse is held with a ± 25 second tolerance, with an A. W. Haydon Chromometrically Governed D. C. Timing Motor, over a voltage range of 22 to 28 volts DC and a temperature range of -65°F to $+150^{\circ}\text{F}$.

The load switches have a contact rating of 35 amps at 220 volts 400 cycle 3 phase A.C.

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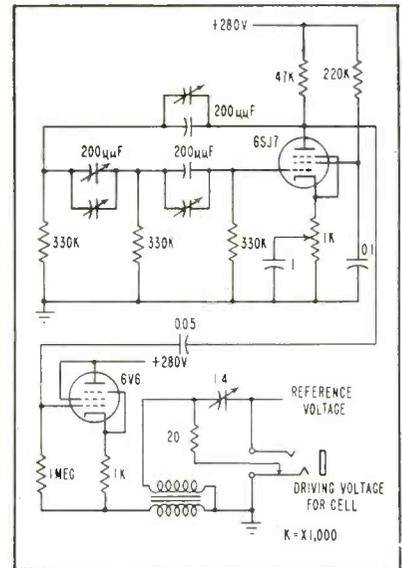


FIG. 3—Oscillator circuit with cathode-follower output provides driving and reference voltages for pressure gage

plifiers, simultaneous pressure-recordings on different spots of a model hull can be made. Tests have shown that the amplifier is linear within the actual measurement range.

The R-C oscillator at 1,000 cps with a cathode-follower output stage is shown in Fig. 3. The driving coil of the gage is tuned to the oscillator frequency by means of a capacitor in series.

The gage has been tested with a steady pressure of water up to 20 inches. Indication on the recorder is nearly proportional to the pressure. Sensitivity with maximum amplification is 3 mm per inch of water. A variation in the temperature of 3.6 F will give about 1.0-mm displacement of zero-point position on the recorder. The temperature in the water is however practically constant during the experiments and even a small displacement of zero-point position has no importance for the measured results.

Investigations have been made with a self-propelled ship model. The pressure gage was cast in the

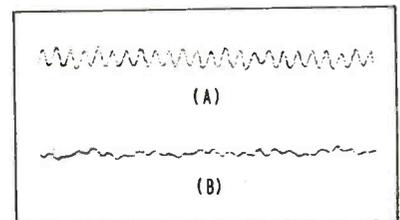
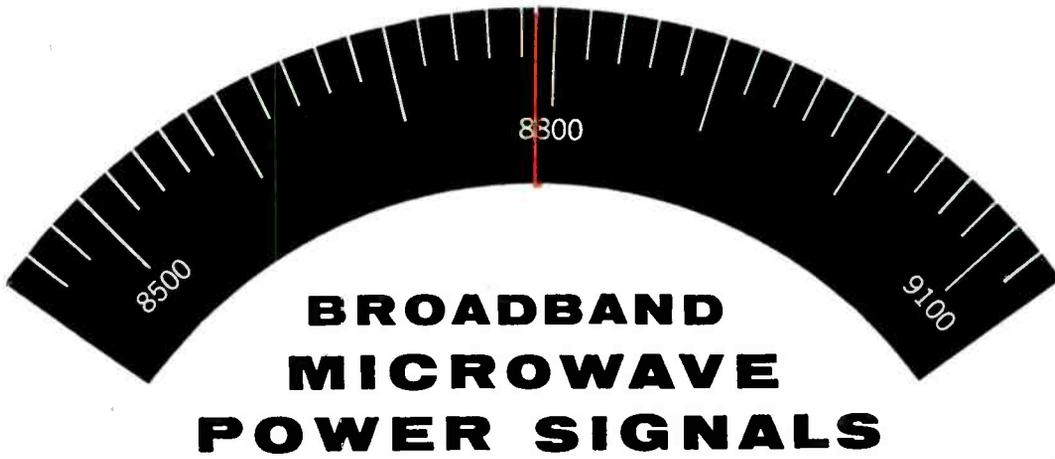
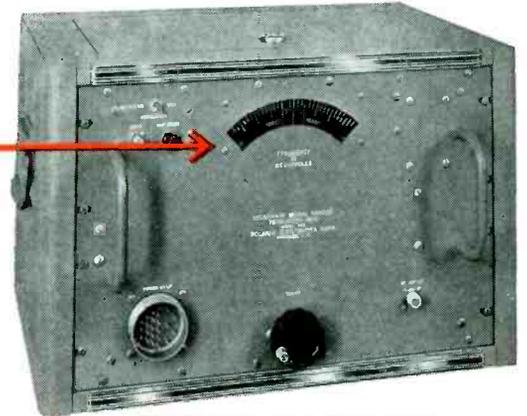


FIG. 4—Recordings of hull-pressure variations with 3-blade (A) and 4-blade propellers (B)



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MINIMUM POWER AVAILABLE (mw)	150	80	15	10	13
{ Low Range Middle Range High Range	400	150	60	70	30
	100	100	40	15	10

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afterpart of the hull so that the diaphragm followed the outer side of the hull. The arrangement is illustrated in the photograph. To obtain absolute tightness without leakage, rubber packing was applied around the brass cylinder.

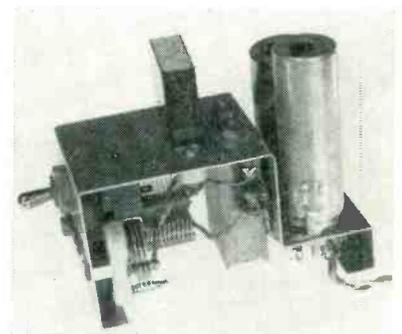
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M. J. Tucker, A Linear Transducer for the Electrical Measurement of Displacement, *Electronic Eng.*, p 420, Sept. 1952.
A. Pfeiffer, A Note on the Theory of Corrugated Diaphragms for Pressure-Measuring Instruments, *Rev. Sci. Inst.* 18, p 661, Sept. 1947.

Subharmonic Crystal Oscillator

A SUBHARMONIC crystal oscillator circuit recently constructed at the National Bureau of Standards requires a single triode tube in a blocking oscillator circuit, coupled to a quartz crystal. Each output pulse of the oscillator shock excites the crystal and the voltage generated by the crystal as it continues to vibrate or ring synchronizes the oscillator at a submultiple of the crystal frequency.

With some crystals the circuit



Single-triode blocking oscillator generates crystal-controlled signals up to 200 kc. Voltage regulator tube is mounted on the same chassis

has been operated successfully at division ratios as high as 10,000 to 1, producing harmonic-rich output at 100 cycles controlled by a 1,000 kc crystal. The present circuit is the discovery of M. C. Thompson, Jr.

In the crystal-controlled blocking oscillator used, the necessary synchronizing signal is obtained simply by coupling a quartz crystal to an ordinary blocking oscillator, by means of a third transformer winding. Alternatively, the crystal can be connected across either the

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DC Conversion Unit



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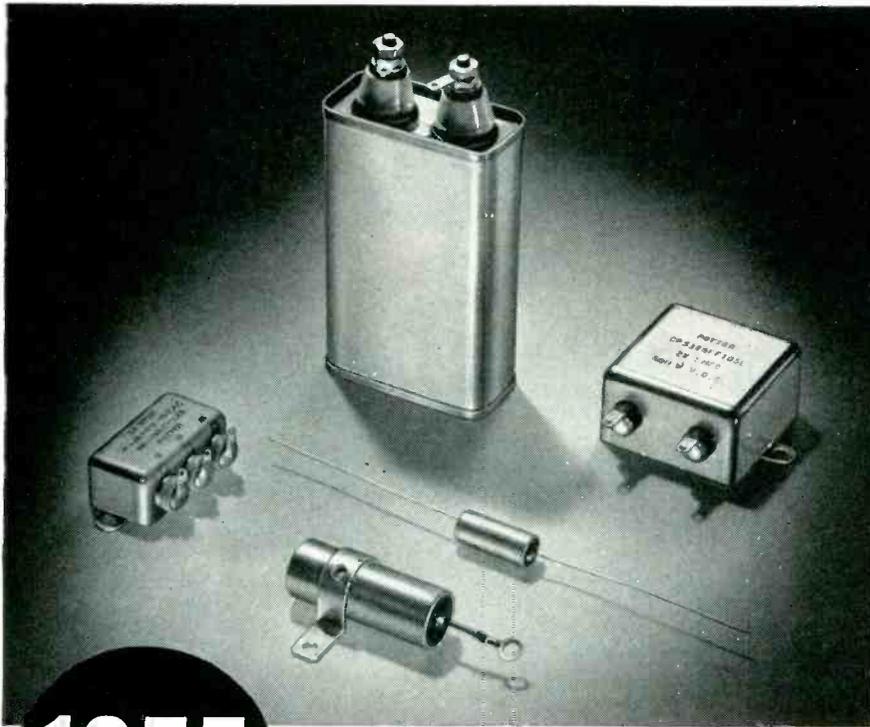
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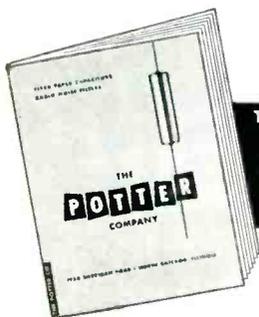
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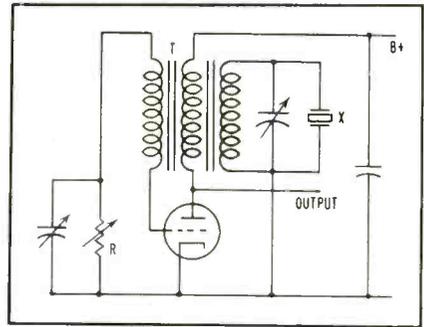


FIG. 1—Circuit of the crystal-controlled subharmonic generator

grid or plate winding of the transformer, or connected directly between grid and plate. Coupling by means of a third transformer winding is preferable, since it avoids d-c voltage on the crystal and permits grounding the rotor of a trimmer capacitor placed across the crystal.

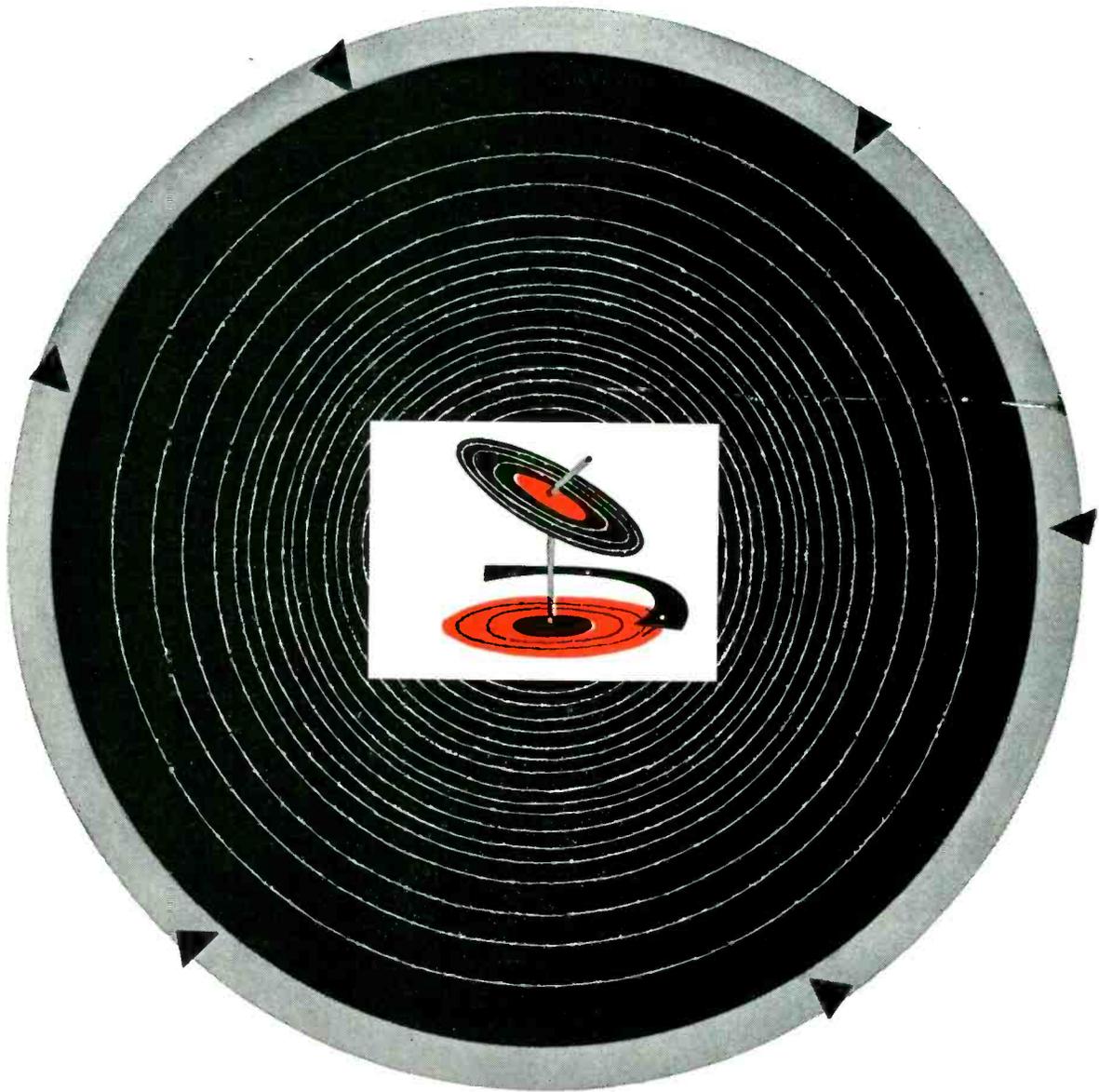
Division ratios of several hundred are readily obtained and can be maintained with high stability if supply voltages are held reasonably constant. Crystal-controlled signals can thus easily be generated at frequencies much lower than those of generally available crystals. The wide range of possible division ratios means that a desired fundamental frequency can be obtained from any of a large number of crystal frequencies.

Conversely, a single crystal can be used to give crystal-controlled output at any of a large number of fundamental frequencies. The upper limit of blocking-oscillator fundamental frequency is determined by the characteristics of the pulse transformer. This limit appears to be above 200 kilocycles with a typical transformer.

Rural Microwave

RURAL TELEPHONE service over 50-mile links may become economically feasible using packaged microwave equipment in which the antenna and electronic gear is in one unit.

Antenna beamwidth is about 5 degrees and carrier is in the 6 kmc band, with bandwidth of approximately 1 mc. The carrier is frequency modulated in one channel and by a 65-kc subcarrier in another. Transmitter uses a klystron with power output of one



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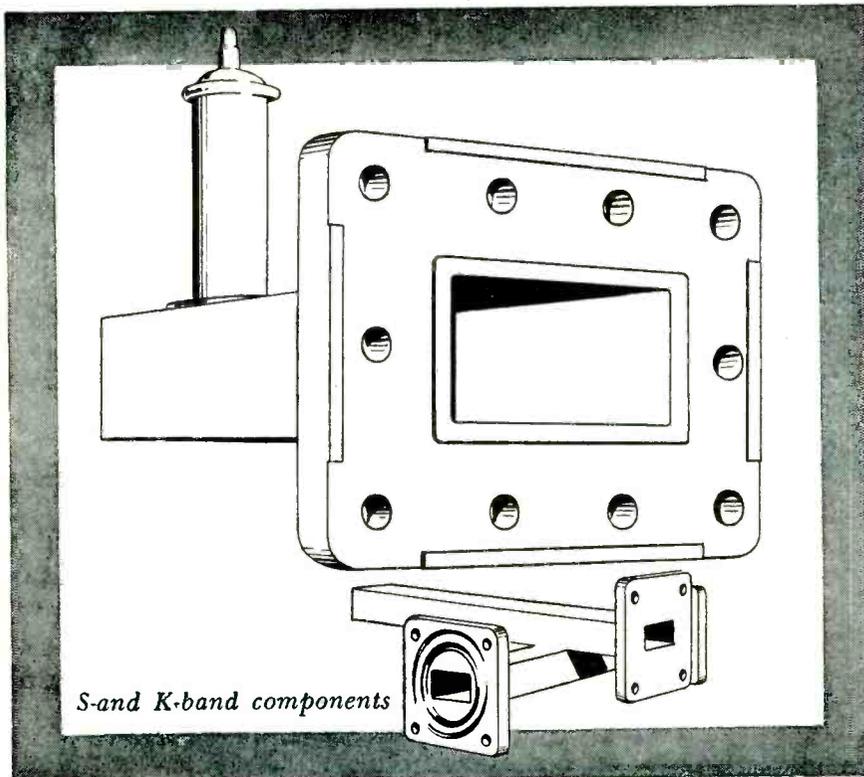
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S-and K-band components

how
small
can a
wave
guide
get?

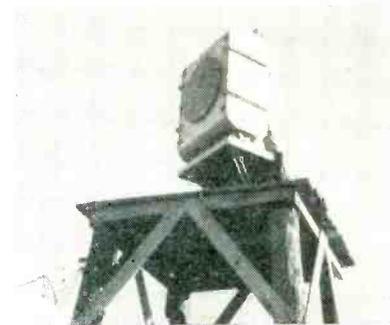
Well, alongside some of the stuff we're working with now, the radar plumbing we used during World War II gets to look like air-conditioning duct. What's more, some of our boys here seem to regard anything below S-band as practically pure D.C. Naturally, we're up to our hips as usual in work on military equipment. However, we do occasionally have some extra creative capacity available, so if you have a problem involving something special in wave guide components (real small ones, too) and like that, maybe we can help. Drop us a line.



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Intelligence bandwidth ranges from 250 to 3,500 cycles for a system with two-wire terminations having a characteristic impedance of 600 ohms. Overall circuit loss does not exceed 6 db.

Designed for use on a pole or from the ground with a passive reflector, the microwave telephone link equipment is manufactured by Raytheon Manufacturing Co.

PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

THE QUESTION sometimes arises as to where detailed information on new patents is available. For those interested, a copy of any patent reviewed in these columns may be obtained for twenty-five cents from the Commissioner of Patents, U. S. Patent Office, Washington 25, D. C.

The Patent Office, under Congressional authority, publishes weekly a listing of all patents and all trade marks issued that week, together with other information relating to patent and trade mark matters, in the *Official Gazette of the U. S. Patent Office*. Single numbers of the *Gazette* are 75 cents each. Annual subscriptions are \$30.00. The *Gazette* is issued on Tuesday of each week.

The patent listing includes a reproduction of one of the figures and

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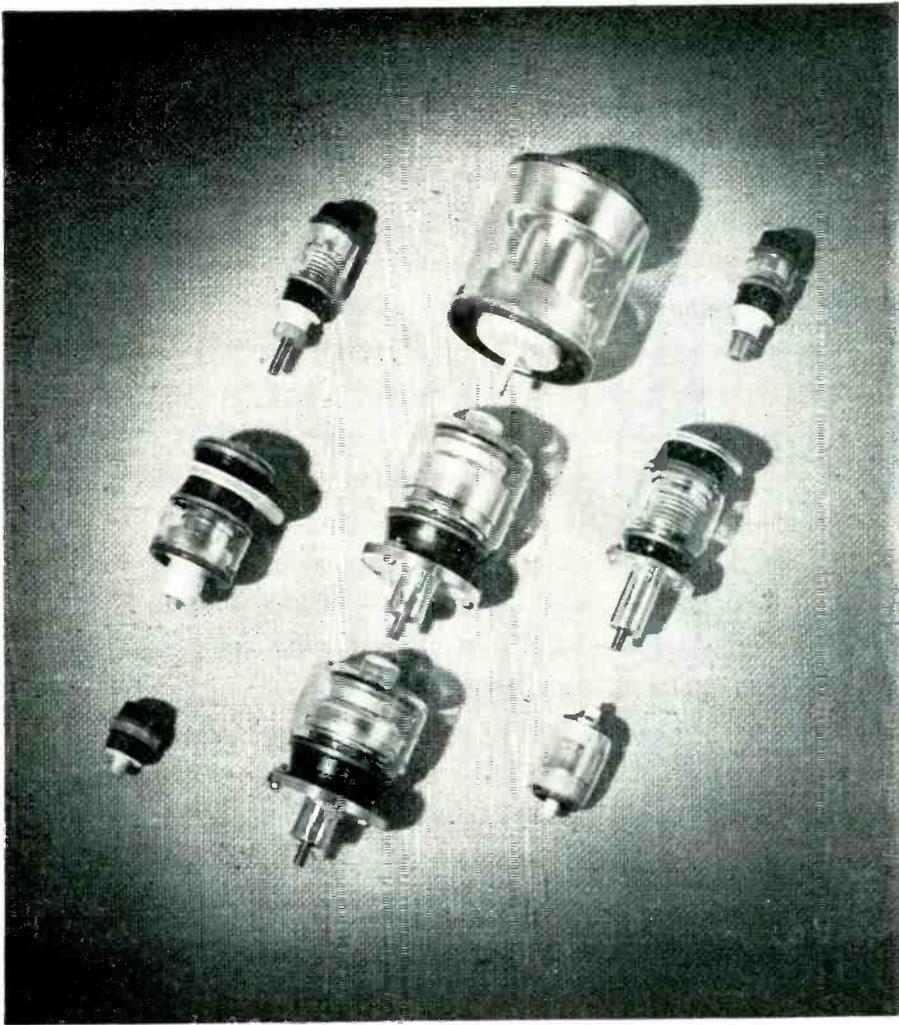


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one of the claims of each patent. All patent issue dates are on a Tuesday. This is one reason why, to the surprise of many, a patent may issue on Christmas Day, which is a legal holiday in the operation of Government offices.

Another source of electronics patent information is the RETMA *Radio-Electronics Patent Service* issued weekly by RETMA, Suite 800 Wyatt Bldg, 777-14th St. N.W., Washington 5, D. C. This service in an offset publication reproduces all patent listings from the *Gazette* in the fields such as radio, receiving, transmitting and filter circuit; radio receiving, transmitting and photoelectric tubes; television and facsimile; talking picture systems, electric pickups, parts and components; electronics; measurements; and trademarks.

Electrocardiograph

An electrocardiograph with a number of novel safety and control features is the subject of patent 2,673,559 issued to H. N. Fawcett of Briarcliff Manor, N. Y. The patent is assigned to Cambridge Instrument Company of New York.

The circuit diagram of the electrocardiograph is shown in Fig. 1. To overcome some usual problems, this instrument is provided with a pen-writing type of recorder, a stylus overload protection circuit and a patient-protecting fuse arrangement that is not subject to blowout due to momentary tran-

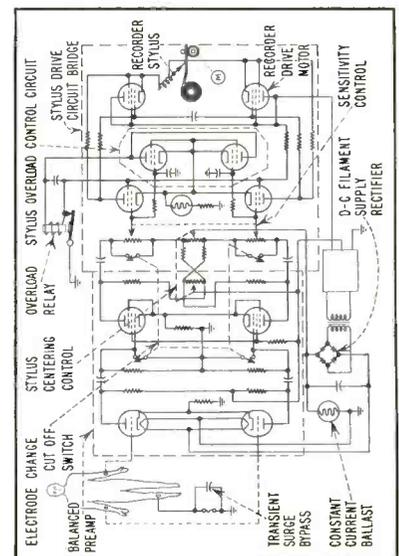


FIG. 1—Circuit of the improved electrocardiograph

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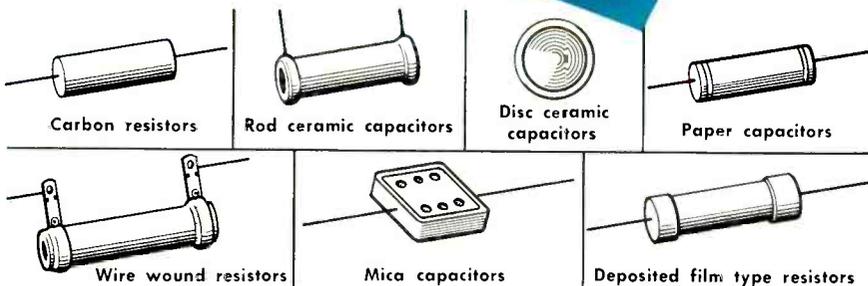
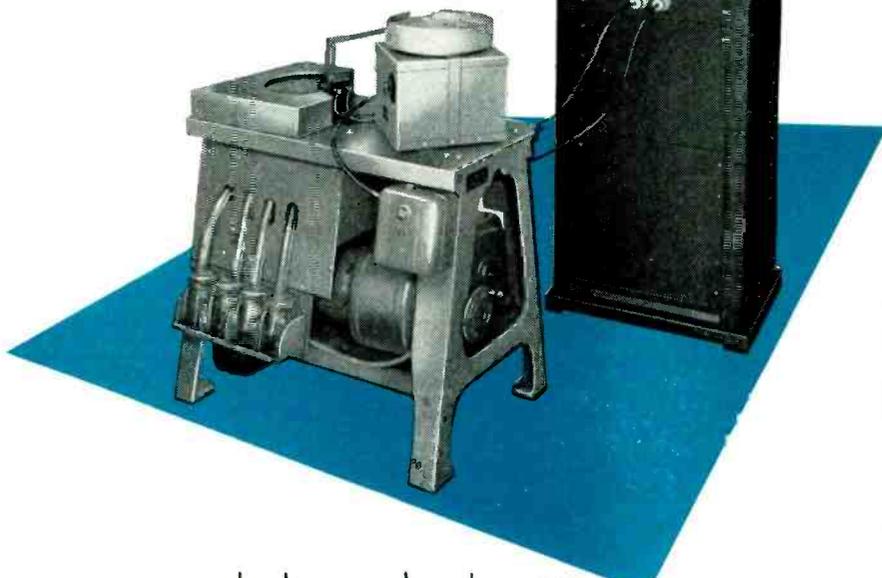
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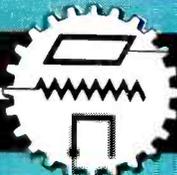
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sients at the instant of turning on the instrument.

It was the inventor's expressed intention to provide an electrocardiograph with sufficient sensitivity and power to drive an ink-stylus type recorder that was compact, safe and portable. No claims are made by the inventor as to the extreme accuracy of his instrument as compared with string galvanometer ekg equipment, but it has the advantage over such equipment that there is no delay in reading the record. The other apparatus requires that the record be photographically processed before it may be read.

The stylus overload circuit includes a thyatron in each half of the bridge driver circuit, which is triggered at some predetermined level of signal of either polarity to lower the screen voltage of the bridge-circuit tubes, substantially cutting them off for the duration of the overload.

The circuit is more or less straightforward in its other aspects. To protect the patient a fuse is usually inserted in the ground lead to the patient's leg. It was found that at certain portions of the power input cycle, if that were the instant of turn on, these fuses, which must be of low current capacity, would blow. The capacitor across the fuse eliminated this problem.

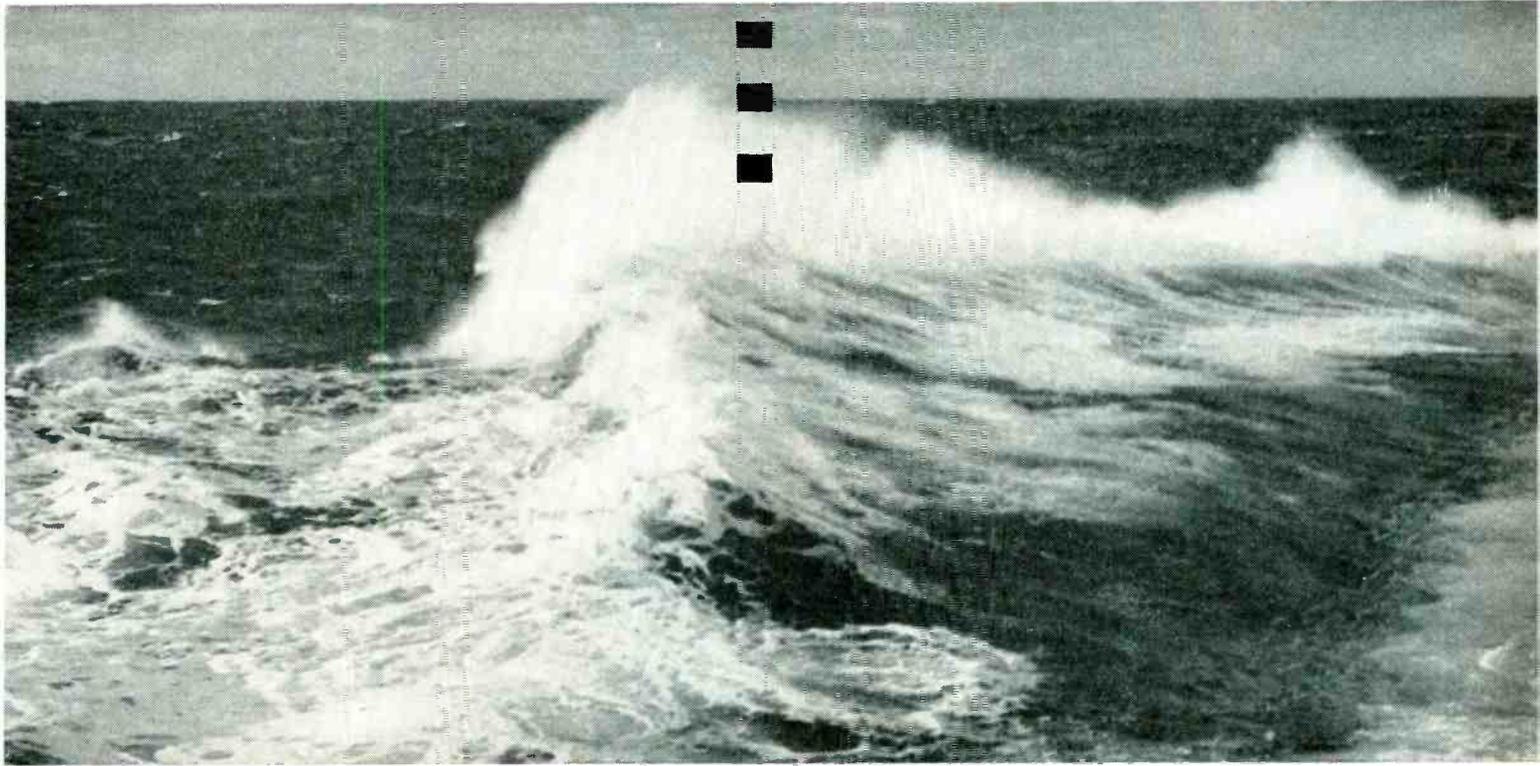
Other features noted in the circuit diagram are the d-c filament supply with a ballast constant-current control and an arrangement of switches in the input to the second stage of the balanced preamplifier and in the bridge input circuit that are provided to cut the system off when electrodes are being changed, so as not to damage the stylus.

A stylus-centering control operates by applying some of the negative d-c voltage from the filament supply in a cross-coupled arrangement between the grids of the bridge circuit while centering also the plate supply voltages to the push-pull tubes in the second stage of the preamplifier.

Hairspring Adjuster

The watchmaking industry employs several electronic devices in

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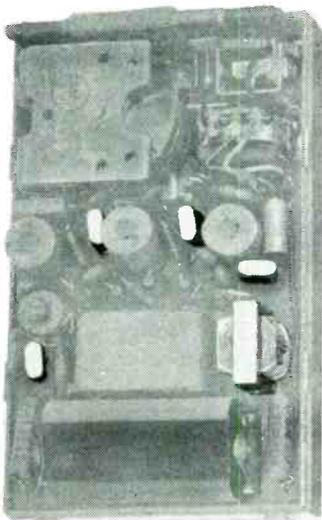
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driving apparatus the motion of the spring results in a compression pulse on a crystal microphone. The pulse is amplified to give square waves, which in turn excite a series of relays to charge a capacitor.

The capacitor discharge is employed to operate a solenoid to drive an air pump that gives a puff of air to push the balance wheel through its next cycle. Additionally the square-wave output of the amplifier charges a series of capacitors C_A and C_B to provide a d-c signal to the grid of half a differential amplifier. This signal is ripple free by virtue of a vacuum-tube regulator.

To the other grid of the differential amplifier a standard voltage is applied that is derived from the regulated plate supply.

When the current in each of the two halves of the differential amplifier is the same the hairspring then is producing the correct number of beats.

Protective rectifier limiting circuits are provided in the differential amplifier circuit to prevent overdriving the galvanometers.

In actual use, the operator obtains a record of the operation of the hairspring corresponding to its balance represented by the zero-current indication when the hairspring beats create a voltage charge in the circuit equal to the standard voltage for that number of beats.

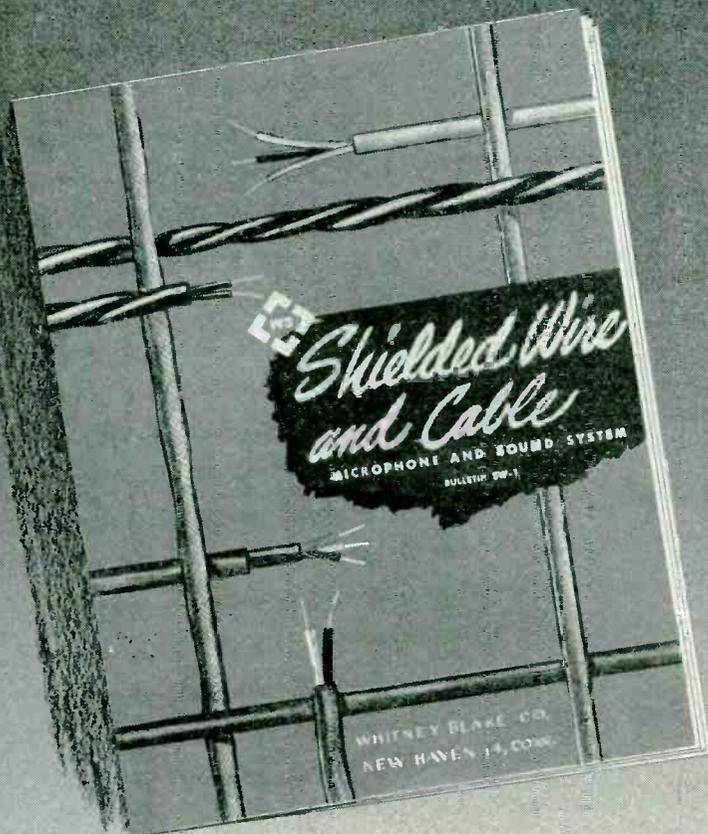
Hairsprings inserted in the machine are initially too large. When the condition of balance is reached the recording galvanometer has a mechanical link to the hairspring clamp to mark the point at which the spring is to be cut for correct operation. This may be done in two steps or more.

Electron Supply

An electron source of intense radiations and minimum power requirements is the subject matter of patent 2,640,949 awarded L. J. Cook of Berkeley, California and assigned by the inventor to the United States of America as represented by the U. S. Atomic Energy Commission.

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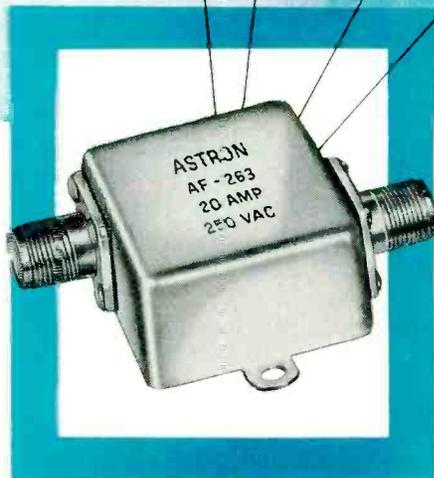
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Lockheed handed this "toughie" to Astron, recognized leader in the development and manufacturing of high quality R.F. interference filters. Astron's engineers had developed a subminiature filter with solid dependability that significantly cut maintenance and replacement cost. So successful and versatile is this Astron filter that the USAF now uses a similar hermetically sealed unit in one of its "drone" target planes, whose exact flight performance is governed by the clarity of the radio control signals received.

Efficient and economical solutions to complex interference problems like these have become commonplace over the years at Astron... whether you require a conventional unit or a unique type—rely on Astron to recommend or develop the proper design to fill your most exacting specifications. Astron "know how" gives you true filter miniaturization with an absolute minimum of size, weight and volume achieved through a highly successful combination of miniaturized elements with most modern design concepts, and construction techniques.

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Provide delays ranging from 2 to 150 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- Hermetically sealed. Not affected by altitude, moisture, or other climate changes.
- Circuits: SPST only — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from -55° to $+70^{\circ}$ C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and — inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature.

PROBLEM? Send for Bulletin No. TR-81

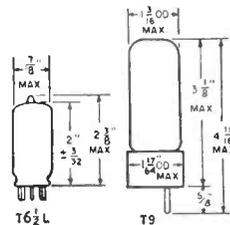
Also — a new line of Amperite Differential Relays — may be used for automatic overload, over-voltage, under-voltage or under-current protection.



T9 BULB

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- For currents of 60 ma. to 5 amps. Operates on A.C., D.C., Pulsating Current.
- Hermetically sealed, light, compact, and most inexpensive.



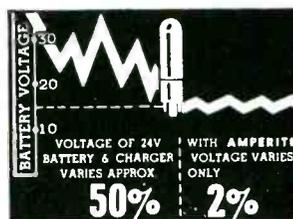
Amperite Regulators are the simplest, most effective method for obtaining **automatic regulation** of current or voltage. Hermetically sealed, they are not affected by changes in altitude, ambient temperature (-55° to $+90^{\circ}$ C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page
Technical Bulletin No. AB-51



AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

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ments that are costly.

The present invention overcomes these requirements. Figure 3A is an overall view of the electron source of this invention, with a cutaway end view at (B) and longitudinal section through the source at (C).

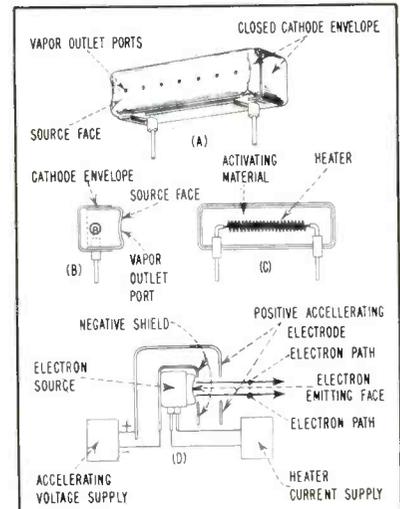


FIG. 3—Overall view of source (A) end view (B) longitudinal section (C) and use in a synchrotron (D)

Figure 3D is an illustration of an embodiment of the source in a synchrotron injector mechanism.

The electron source is encased in a cathode envelope that is the actual electron emitter and emission is accomplished by the heating of an activating material, which may be barium aluminate. The face material of the cathode envelope may be zirconium. Upon heating, the activating material vaporizes and the vapors are emitted through vapor ports in the face to combine with the face material to form a monoatomic layer of activating material. The electrons are emitted from the face surface.

Other face materials are molybdenum and titanium. The operating temperatures for the various face materials with barium aluminate are molybdenum 1,350 C, zirconium 1,200 C and titanium, 1,050 C.

The novel electron source having but one emissive surface shows less heat loss and less wasted electrons since there is but one place from which the electrons come. Other cathode structures may provide a general cloud of electrons most of which are lost. Thus efficiency and compactness (the size is about $\frac{1}{2}$ inch) are particular features of the invention.

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Hughes continues to set industry standards for quality and reliability of semiconductor devices. These **NEW** Hughes Silicon Junction Diodes now provide you with devices which will operate at high temperatures. They combine high forward conductance with extremely high back resistance. In several diode types, this resistance is in the order of 10,000 megohms! This means that, in many applications, there is essentially an open circuit in the back direction. The phenomenal back resistance of these diodes has opened up many possibilities for entirely new circuit applications, in addition to meeting requirements for higher temperature operation, which germanium cannot satisfy. Before completing design work on your next equipment, be sure to investigate the outstanding new Hughes Silicon Junction Diodes.

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- VERY SHARP BACK VOLTAGE BREAKDOWN**
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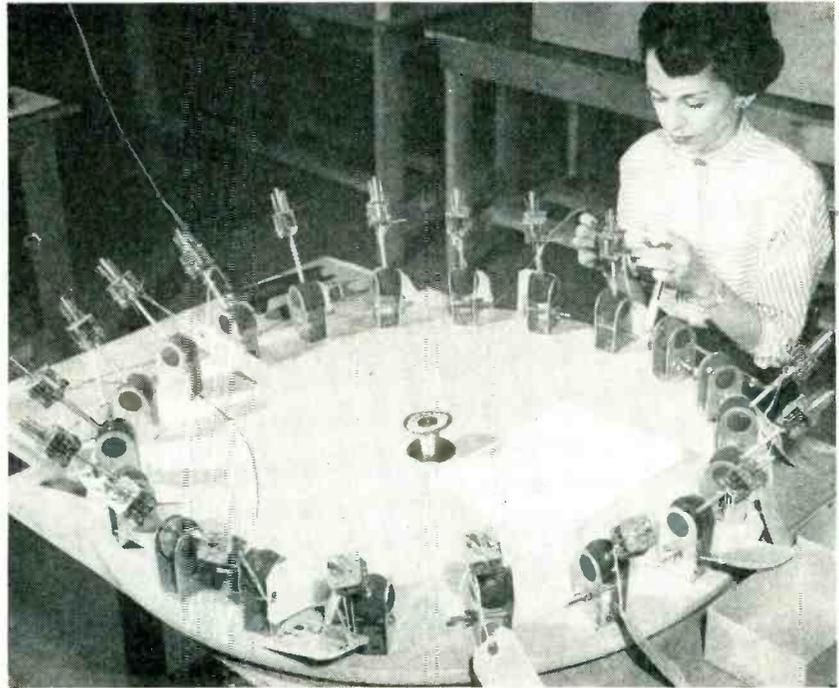
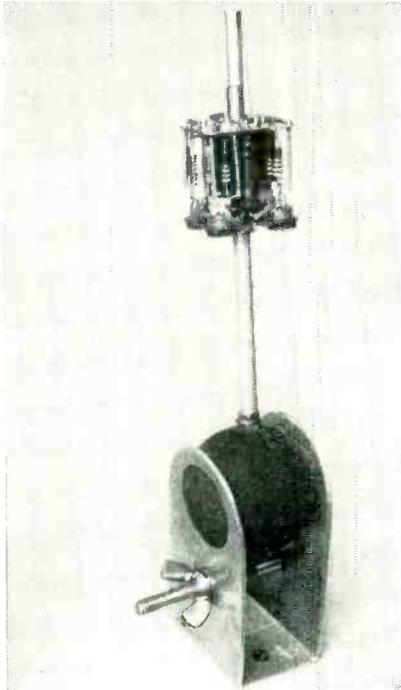
HUGHES SILICON JUNCTION DIODES ELECTRICAL CHARACTERISTICS				
Type	Saturation Voltage (E_s)	Forward Current at +1V (I_f)	Back Current	
			at 25°C	at 150°C
HD 6001	25V	15mA	.5 μA @ - 25V	.030mA @ - 25V
HD 6002	70V	5mA	.5 μA @ - 60V	.030mA @ - 60V
HD 6003	200V	1mA	.5 μA @ -175V	.030mA @ -175V
HD 6005	30V	40mA	.025 μA @ - 25V	5 μA @ - 25V
HD 6006	70V	20mA	.025 μA @ - 60V	5 μA @ - 60V
HD 6007	150V	7mA	.025 μA @ -125V	5 μA @ -125V
HD 6008	200V	3mA	.025 μA @ -175V	5 μA @ -175V
HD 6009	150V	3mA	.5 μA @ -125V	.030mA @ -125V

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COMPLICATED subassemblies for military electronic equipment are supported at optimum working angles by holding fixtures made from ordinary handballs, in the Paramus, N. J. plant of Avion Instrument Corp. The ball is sup-

ported by a U-shaped piece of metal bolted to the work turntable. A bolt and wing nut through the sides of the support permit adjustment of tension for free movement or rigid locking as required in various stages of assembly.

In one manufacturing setup, twenty of these holding fixtures are mounted on a large plywood turntable, so that the operator can put the same part in each of 20 units in turn, then repeat for the next part.

Spring Clips on Harness Board Serve as Wire-Cutting Guides



ONE-PIECE Tinnermann spring clips are used for holding the ends of wires temporarily in position on harness boards during assembly of wiring harnesses for the Matador guided missile in the Baltimore plant of The Glenn L. Martin Co.

First step in producing a new board is drawing up a cable assembly diagram. This shows the routing of wires, the location of each guide peg, the location of each terminating spring clip and identi-

Using wire-holding clips as guides for cutting wires to exactly correct lengths after assembly and tying of cable on harness board

fying nomenclature. A print is pulled from this tracing and cemented onto a sheet of quarter-inch pressed wood that is to serve as the harness board. Holes are then drilled through the print and board at each peg and clip location. The metal pegs are then easily tapped in. The clips are pushed in with the fingers, then anchored at the desired angular positions by threading a length of solid copper wire through the loops projecting through the bottom of the board.

Wires for the board are all cut slightly longer than the required length. Terminal clips are posi-

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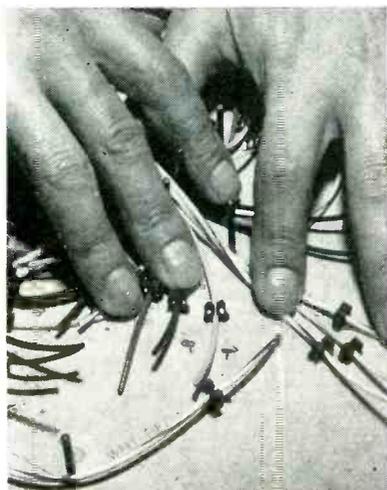
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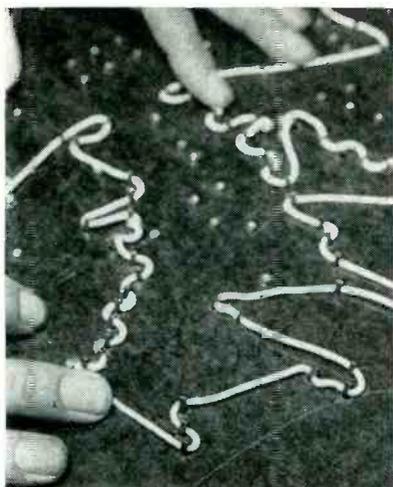
KESTER SOLDER

COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

tioned such that the wires will be exactly the correct lengths if cut off flush against the outer sides of the clips. This takes care of normal variations in the positions of wires as they are laid one over the other between the guide pegs. Wires are stripped individually with a hand-



Single-piece spring clips hold wires



Rear of harness board, showing use of heavy soft copper wire to hold spring clips at various angular positions

operated stripper after the harness is removed from the board.

Wherever possible, longer lengths are used instead of two or more short lengths, with clips again serving as accurate guides for cutting apart the long wires after the harness has been tied.

A fixture or bracket for holding the cable connector plug is usually mounted on the terminal board and wires are run to it also. This insures having exactly the correct lengths of wires going to the plug, with no bulging or strain in the cable when hooked up.

Test Pattern Checks Printed-Circuit Panels

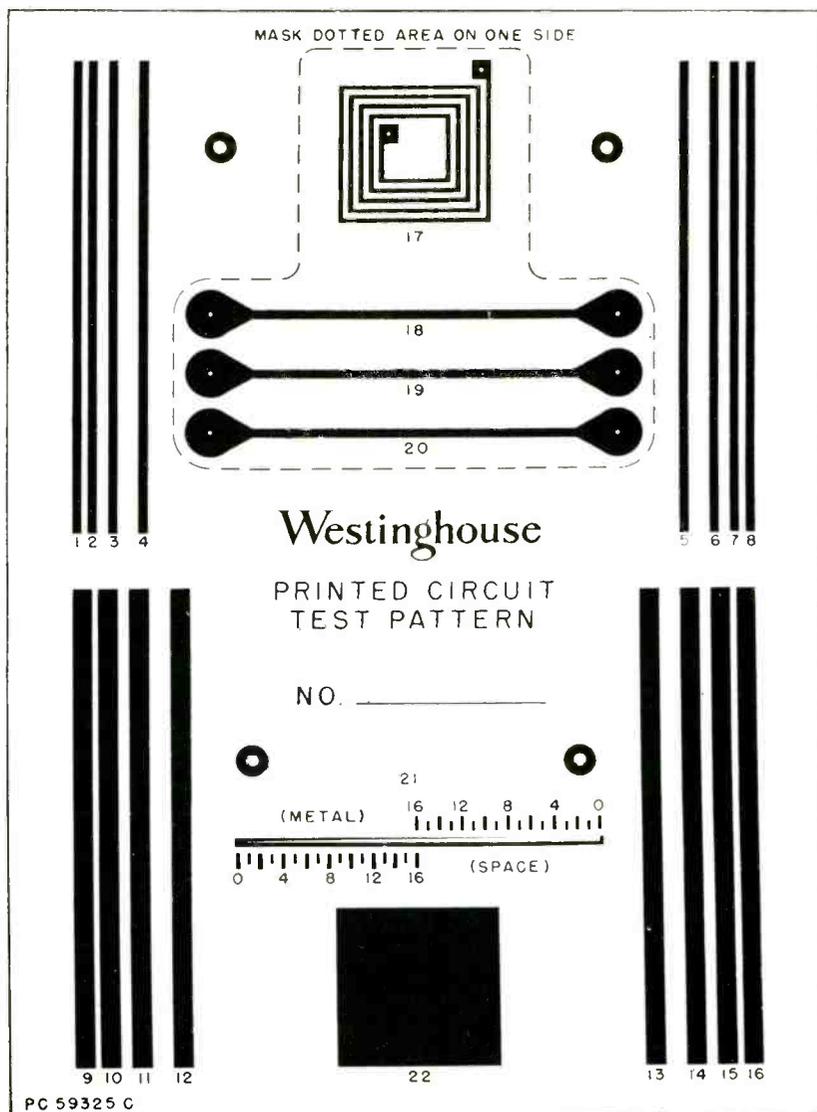
DIFFERENT CHEMICAL processes and different materials can have a marked effect on the quality of printed circuits. A measure of this effect is necessary to control processes. Environmental effects, particularly moisture, must also be determined so that their influence on sensitive electronic circuits can be judged and protective measures taken where necessary.

In order to evaluate printed circuits, a standard printed circuit test pattern was developed by the Materials and Standards Laboratory, Electronics Division, Westinghouse Electric Corporation, Baltimore. The pattern contains 22 numbered figures plus four sets of con-

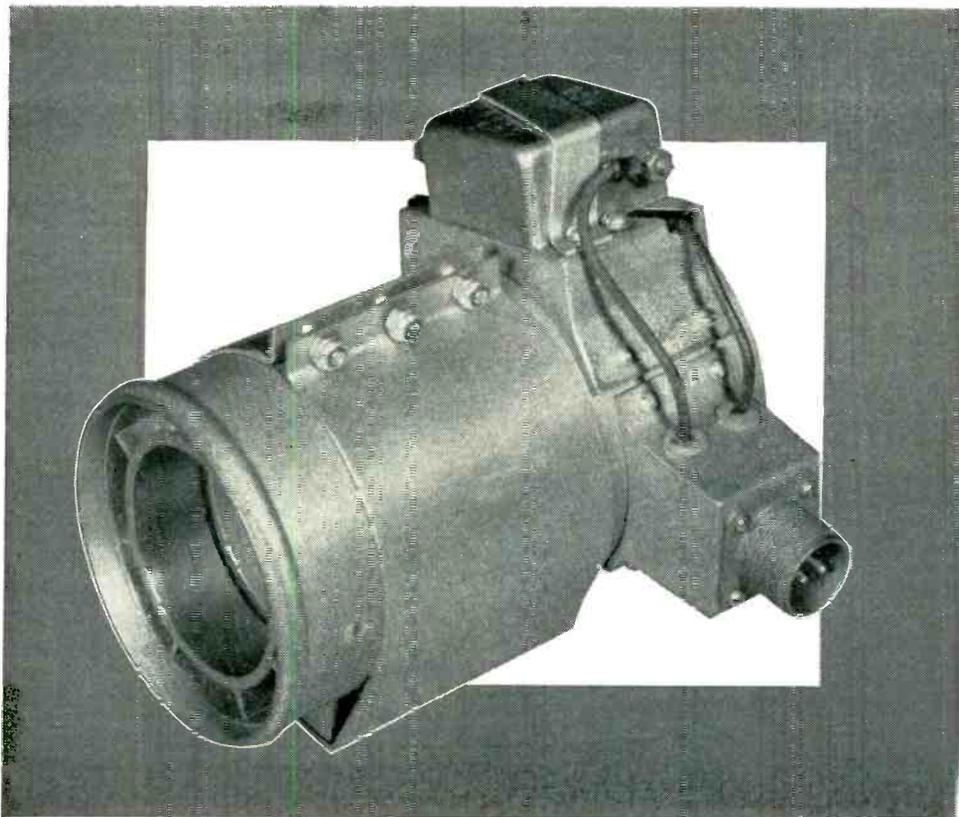
centric bull's-eyes in a 5 x 7-inch area, this being a convenient standard photographic negative size. Figures 17 through 20 are enclosed within a dotted line with the instruction to mask this dotted area on one side, and thus these four figures appear on only one side of the board. All other figures appear on both sides of the board.

Figures 1 through 8 are $\frac{1}{16}$ -inch-wide etched wiring, used to test adhesion of circuitry to board.

Figures 9 through 16 are $\frac{1}{8}$ -inch-wide etched wiring, used to check capacitance between wiring across the surface of the board, capacitance between wiring through the board, insulation resistance be-



Pattern used as production check on etched wiring processes. When border is 5 inches wide and 7 inches high as on actual pattern, scales read metal and space definition directly in thousandths of an inch



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4X150A, 4X150G
5588 and 6161

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Duty
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Motor
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cooling job at altitudes up to 50,000 feet

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tween wiring across the surface of the board and dielectric strength between wiring through the board. Figures 1 through 8 are also used for these tests.

Figure 17 is a printed inductor for which inductance, Q and distributed capacitance are checked.

Figures 18 through 20 are 1/8-inch-wide printed wiring with large terminal areas, used for measuring conductor resistance, temperature rise vs conductor current, and rupture current.

Figure 21 is a definition pattern giving definition directly in thousands of an inch for lines and for spacing between lines. It provides an overall check on the manufacturing process from the initial drawing through the manufacturing process to the finished test pattern. One part of the definition pattern consists of a metal line that is 1/8 inch wide at one end and diminishes in width until it approaches zero width at the opposite end. The other part of the pattern consists of a metal-enclosed space that is 1/8 inch wide at one end and diminishes to zero width at the opposite end. Calibration marks are so placed that space and line definition may be read directly in thousandths of an inch. In the ideal process, both readings should be zero. While this cannot be achieved in actual practice, the process which produces the lowest readings for both space and metal has the greater merit. The space reading is most critical for under-etching in the chemical process, while the metal line is most critical for over-etching.

Figure 22 serves as a capacitor for checking capacitance, dissipation factor, dielectric constant and loss factor.

The bull's-eyes serve to check registration (alignment) of circuits on opposite sides of the board. To predict the electrical characteristics that exist between components on opposite sides of the printed circuit board, it is essential that the patterns on opposite sides of the board are aligned. An alignment tolerance of 1/16 inch was established for the printed-circuit test patterns. The four bull's-eyes on each side consist of an inner and an outer circle. The outer circle has an in-

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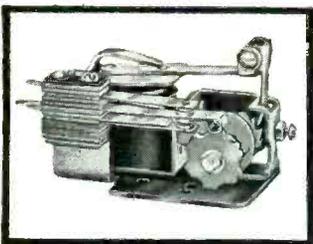
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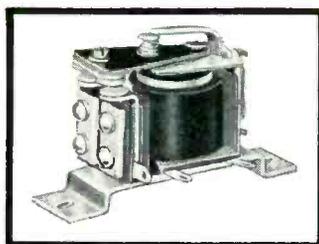
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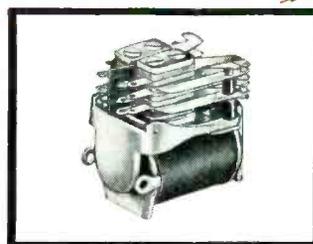
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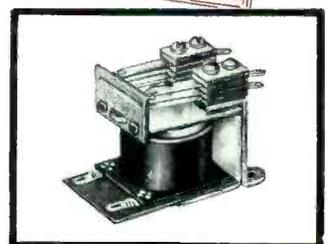
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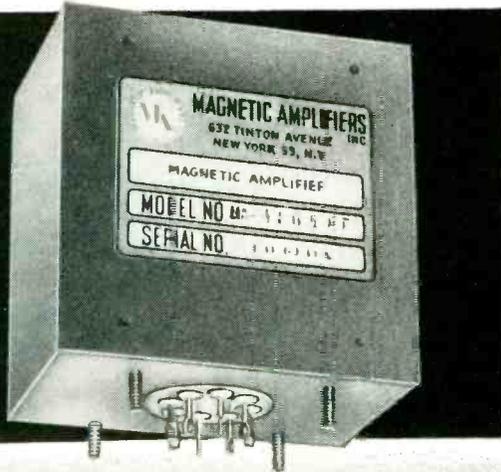
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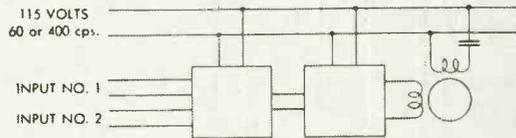
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side diameter $\frac{3}{8}$ inch greater than a $\frac{1}{8}$ -inch diameter hole. The board is printed on one side and $\frac{1}{8}$ -inch diameter holes are drilled through the inner circle of each bull's eye. The reverse side of the board is next printed so that the inner circle of each bull's eye is centered over the drilled hole. If the drilled hole does not cut the outer circle of any bull's eye on either side of the board, the registration of the test pattern is within $\frac{3}{8}$ inch of exact alignment.

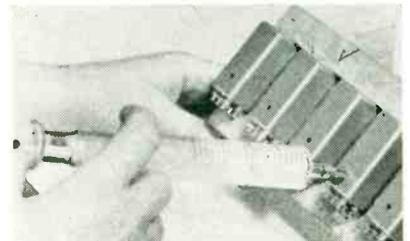
Since the adhesion test is a destructive test, it is performed after all electrical tests have been completed. Four $\frac{1}{8}$ -inch wide strips which have not been subjected to the high-potential test are used for the adhesion test.

A straight length of No. 22 solid copper wire is used to pull the test strip from the pattern board. About $\frac{1}{8}$ inch of the wire end is bent at a right angle and soldered to the middle of a $\frac{1}{8}$ -inch wide strip, centered evenly on the strip.

The pattern board is then clamped to the workbench. A spring scale is attached to the end of the pull wire about 6 inches from the board. Tension is applied to the strip through the spring scale, perpendicular to the plane of the printed strip. Care is used to prevent any side thrust on the strip. The reading at the point of rupture is recorded as the adhesion strength of the printed strip.

Potting With Hypo Syringe

AFTER COMPLETION of final soldering of header to housing for electronic units made in the Avion Instrument Corp. plant at Paramus, N. J., the units are lined up on a simple wood rack and potting compound is forced into each in turn with a large medical syringe. The needle used is just



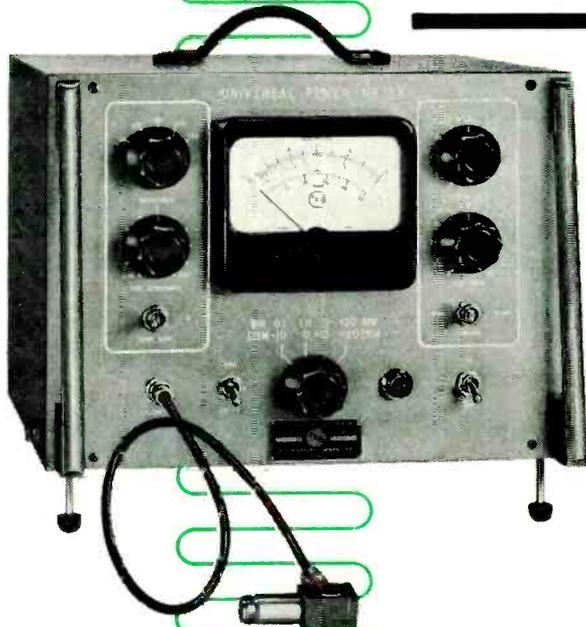
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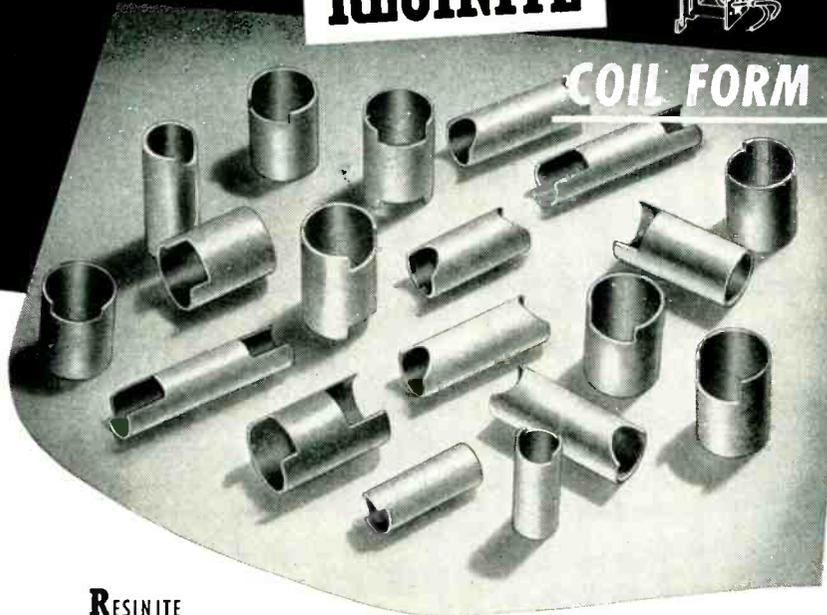
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long enough to project inside the hole provided for the purpose on one side of each housing. This technique permits precise control of the amount of compound forced into each unit, as required for such units as photoelectric choppers where only part of the housing is filled.

Potting Techniques for Cable Connectors

CABLE CONNECTORS for aircraft electronic equipment are filled with Thiokol compound after assembly to achieve waterproofing combined with improved vibration resistance and improved insulation. In most cases the connector parts themselves serve as molds for the potting operation. Sometimes the potting eliminates the need for the outer shell.

The material used is No. 1120 PC potting compound made by Minne-



Filling steel radar assembly mold for large connector in Baltimore plant of The Glenn L. Martin Co.

sota Mining and Mfg. Co., combined with their EC1031 accelerator. A one-gallon batch is mixed at a time and used to fill six air-powered dispensing cylinders. This compound keeps for 72 hours when stored at -30F in an ordinary deep freeze unit located in the potting department.

In one type of potting operation, a dispenser is connected to an air



Blinding the eyes of radar ...

This miniature transformer assembly is the heart of a potent mass radar jamming device developed for the U.S. Air Force. The unit, made up of two high-quality audio transformers and an RF choke, blankets the whole spectrum from 150-10,000 cycles with 1 volt of noise (interference) per second.

Hermetically sealed and designed for operation from -55°C . to $+105^{\circ}\text{C}$. on a 26 volt DC system, this modulation network is rigidly tested... conforms to military specification MIL-T-27. Dimensions are $3\frac{1}{4}$ " long x $1\frac{1}{16}$ " high x $1\frac{3}{8}$ " wide — total weight is less than *eight ounces!*

This is a special transformer assembly designed and manufactured by Keystone to meet a unique need. New applications—both military and commercial—are making increasing demands on components... smaller size, lighter weight, absolute dependability. Often stock transformers won't meet the specifications or insure the performance required.

Let Keystone recommend a custom unit designed to meet your specifications *exactly*. Send an outline of your requirements to Keystone's Engineering Department today—or write for information on the wide variety of transformers and magnetic amplifiers Keystone has produced for special applications.

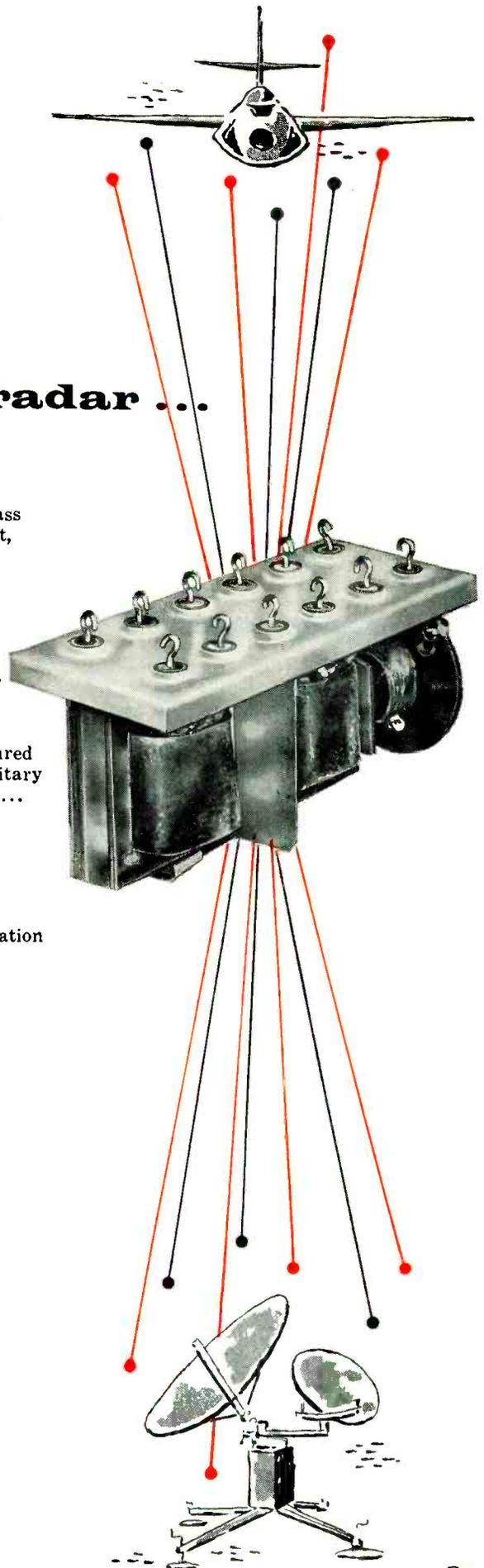
For copies of the Keystone Transformer Reply Sheet or other information on special purpose transformers, address Engineering Department.

keystone



PRODUCTS COMPANY

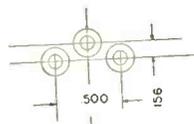
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ANOTHER PROBLEM SOLVED by *Tubular Rivet*

RE: **ELECTRONICS COMPANY**

problem Set three rivets simultaneously in small triangular pattern:



Space Between Rivet Heads
 .015 and .218 — Rivet
 Head Diameter: .281" —
 Rivet Length: $\frac{5}{8}$ " — Work:
 Stack of 13 components

solution

Our style 203 Machine with specially designed rivet cutoff and tube type delivery to special rivet positioners applied to Standard machine frame.

P.S.

Let us see what we can do with your close center problems. Drop your prints and/or samples in the mail. No obligation, naturally. Contact TUBULAR RIVET, Dept. E.

Tubular Rivet

¢ **STUD COMPANY**

WOLLASTON 70, MASSACHUSETTS

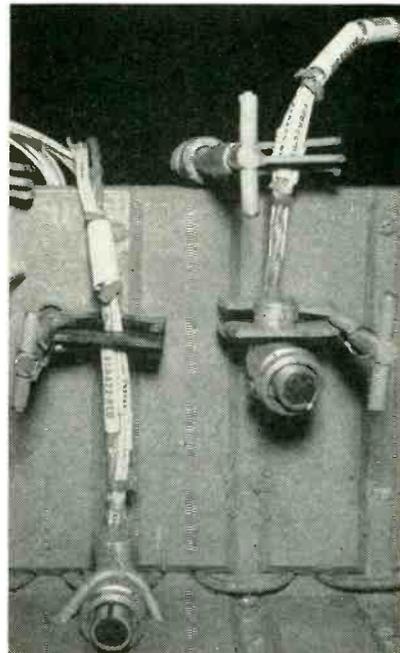
BRANCH OFFICES: Buffalo, Chicago, Detroit, Indianapolis, Dallas, Los Angeles, Nashville, New York City, Philadelphia, San Francisco, St. Louis



Filling small connector from mounted dispenser surrounded by ice

pressure hose and hand held, for filling molds that have previously been anchored to benches or racks. Pressing an air valve button admits air into the upper part of the cylinder, forcing down a floating plunger which in turn forces the highly viscous compound out through the nozzle. For other connectors, usually smaller, the dispenser is mounted vertically in a fixture, point down, and the connectors are brought up to it one by one for filling. Here the air valve is on a foot pedal, to leave both hands of the operator free.

After filling, the connectors are placed on a rack in such a way that spring clamps hold the wires cen-



Method of holding conductors in centered position in connectors while potting compound is hardening. Bungee elastic cords hold connectors down on bench, and spring-loaded clamps grip wires to hold them upright

...El Menco First Again
Announces Production of the..

the "Dur-Mica" dm15...

Smallest
Mica
Capacitor



*does more jobs — in less space — better!
the first and only miniature mica
capacitor with parallel leads*

the Dur-Mica gives you . . .

1. **SUPERIOR PERFORMANCE:** The *Dur-Mica* El Menco Capacitors range from 1 to 390 mmf. at 500vDCw. 1 to 510 mmf. at 300vDCw. Made to meet all the humidity, temperature and electrical requirements of MIL-C-5 Specifications.
2. **SUPERIOR CONSTRUCTION:** The *Dur-Mica* El Menco Capacitor is phenolic coated, durable and tough. Temperature co-efficient and stability *equal to or better than* characteristic F. Will operate efficiently at temperatures as high as 125° Centigrade.
3. **GREATER VERSATILITY:** The *Dur-Mica* El Menco Capacitor is ideally suited for all military as well as civilian electronic applications . . . Parallel leads means that the El Menco *Dur-Mica* can be used in positions heretofore impractical. Has wide application in transistor circuits and other miniature electronic equipment. The *Dur-Mica* El Menco Capacitor is ideal for use in printed wiring circuits.
4. **GREATER ECONOMY:** The *Dur-Mica* El Menco Miniature silvered mica capacitor sells at prices even lower than our famous CM-15. Provides economy of size with maximum performance and widest application.



*To solve your space problems
to fit your needs!*

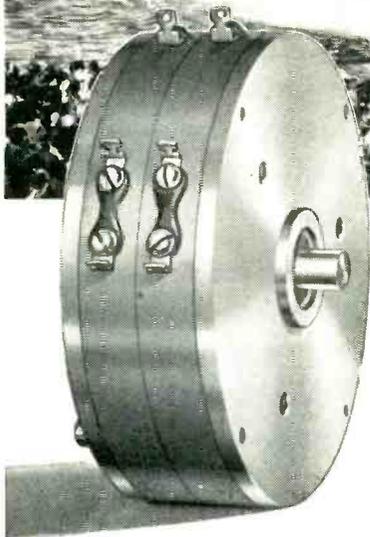
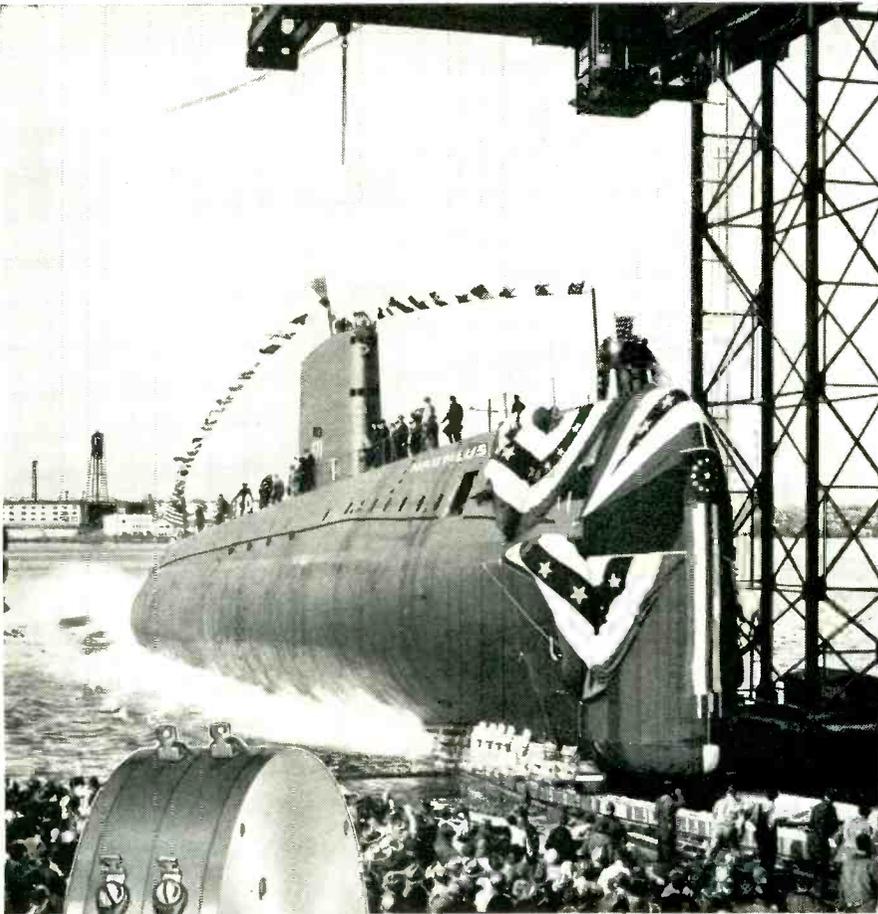
Test the El Menco Dur-Mica capacitor for yourself! Write for free samples and catalog on your firm's letterhead.

Jobbers and distributors write to
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El-Menco
Capacitors

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WILLIMANTIC CONNECTICUT
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Another example
of accuracy with
GAMEWELL
Precision
Potentiometers

Naturally, we can not divulge the exact operation of the Gamewell 2-gang Precision Potentiometer used in the "Nautilus". This use of Gamewell's experience in designing precision potentiometers to meet specific needs does suggest that when you have a problem, the chances are that Gamewell can help you solve it.

Send us information about your project and we will go to work with your engineers.



Drop us a note for your free copy of this booklet.

THE GAMEWELL COMPANY
Newton Upper Falls 64, Mass.



PRECISION POTENTIOMETERS

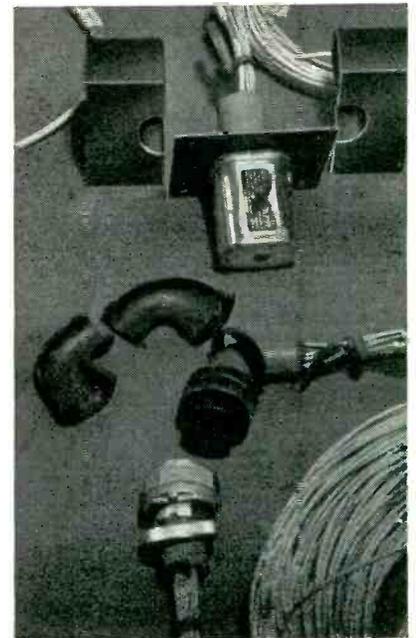
Manufacturers of Precision Electrical Equipment Since 1855



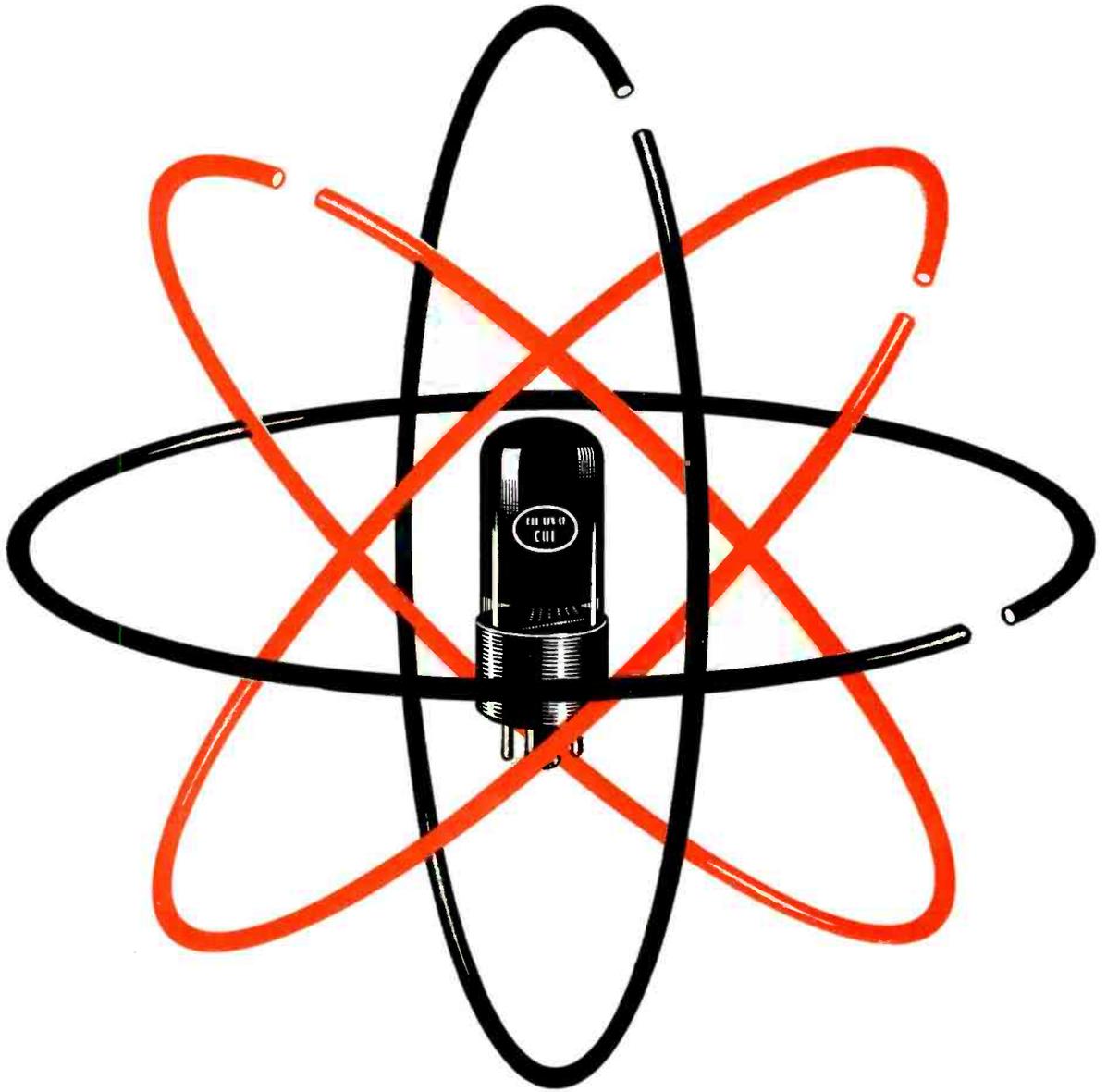
Method of storing dispensers in deep freezer. Some compound is placed in plastic bag as at left; this can be taken to an aircraft for filling plugs that are already in position. This is done by cutting off a tiny corner of the bag and then squeezing the bag to force out the compound

tered during hardening. In summer, ice is placed around the dispensing gun to keep the contents cool and thereby retard setting. Fiberglass insulation around the outside of the ice container prevents condensation from dripping down into the unit being filled.

Five types of molds are in general use in the plant. (1) The plug itself can serve as the mold, being left on



Examples of molds and potted connectors for aircraft wiring



DIELECTRIC BREAKDOWN-VALUE STAYS HIGH WITH

permanently flexible BH "649" Tubing

Reliable electronic equipment performance depends on the "life" of its insulation. High spot-temperatures in soldering, continued heat in normal use can quickly age ordinary insulation . . . but not BH "649" vinyl-coated Fiberglas. Its patented construction offers unequalled resistance to the effects of wide temperature variation. BH "649" withstands assembly abuse . . . twisting, bending, pounding . . . without cracking or reduction of insulating efficiency. It has excellent chemical and oil

resistance. Available in 11 light-stable colors, it simplifies color coding.

BH "649" is just one example of insulating tubings and sleeveings designed to meet specific electronic applications. Tell us your problem or application. We'll be glad to send samples and make recommendations for the "right" insulation.

BENTLEY, HARRIS MANUFACTURING CO.

1301 Barclay St.
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 Telephone: Conshohocken 6-0634

* BH Non-Fraying Fiberglas Sleeveings are made by exclusive Bentley, Harris processes (U.S. Patents 2393530, 2647296, 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

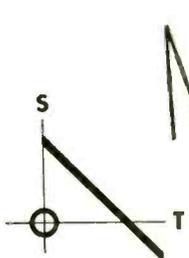
BENTLEY, HARRIS

Fiberglas
SLEEVIINGS

GEARED FOR FAST RESPONSE



Gear Reducer + Instrument Servo Motor



Now! **DIEHL** offers this Instrument Servo Motor with a Gear Reducer attractively priced for commercial applications in five different ratios. Either the motor, gear reducer or both can be quickly replaced avoiding costly down-time. The spur gear construction insures good efficiency.

GEAR REDUCTION RATIOS	SERVO MOTOR SPECIFICATION		
	Output (Watts)	1	5
191.1 } 79.6 } to 1 32.4 } 13.8 } 5.8 }	Frequency (Cycles)	60	60
	Poles	2	2
	Reference Phase (Volts)	115	115
	Control Phase (Volts)	50	115
	Reference Phase (Watts)	10	17
	Control Phase (Watts)	3.5	17
	Control Phase Impedance (Ohms)	555	575

Our engineering staff will gladly help you select the motors best suited to your specific requirements. A request on your letterhead will bring you a copy of Technical Manual No. EL-0155 describing Diehl Servo Motors and related equipment.



Other Available Components:
D.C. SERVO SETS • RESOLVERS
MINIATURE PERMANENT MAGNET D.C. MOTORS

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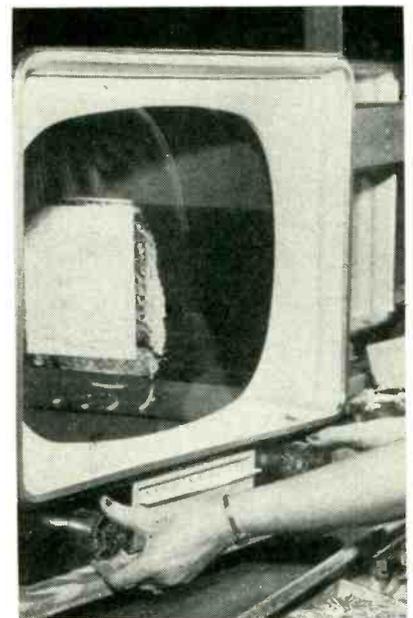
Electrical Division of THE SINGER MANUFACTURING CO.
 Finderne Plant, SOMERVILLE, N. J.

after the compound has set. (2) A length of metal tubing sawed in half can serve as the mold. The tubing sections and other two-part molds are held in position on the connector with temporary wire ties. (3) For Winchester-type plugs, the shell of an extra plug is cut off and used as the mold. (4) For some plugs a split Masonite block, appropriately contoured, serves as the mold. (5) Split elbow-type plugs serve as their own mold. Here the elbow is taken apart to inspect for air holes after potting, then reassembled.

On one radar wiring harness, a combination holding fixture and potting mold is used to seal the conductors to the plate that serves as the bulkhead fitting in an aircraft.

Chassis Centering Guides

AFTER CLEANING the inside of a table model television cabinet with an air hose, an assembler at the Westinghouse Metuchen, N. J. plant inserts two metal aligning cylinders in the control holes of the cabinet. After inserting a cylinder, the operator locks it into position by rotating an inner cam to force out two metal pieces set into the sides of the cylinder. When the chassis is inserted, the cylinders serve as



Method of locking chassis-centering guide cylinders by rotating end pieces that are fastened to inner cams. Once locked, these guides will not fall out if pushed during insertion of chassis in cabinet



SERAMELITE CAPACITORS

OPERATING TEMPERATURE -65°C to $+125^{\circ}\text{C}$



High Heat and Humidity Resistance • Low Cost



WAX FREE! Will Not Drip!

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

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

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

Easily soldered leads. Neat, clean appearance.

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

Seramelite Capacitors are available with MYLAR* or PAPER DIELECTRIC with extended foil or tab construction with various impregnants. *Dupont's name for its polyester film.

BUILT TO YOUR SPECIFICATIONS WITH CERAMIC TUBULAR CASES.

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



ELECTRIC MFG. CO. 120 FIRST ST • OGALLALA, NEBRASKA

'Diamond H' Miniature, Hermetically Sealed, Aircraft Type Relays



Shown Actual Size

HAVE A
**WIDER
RANGE**
OF
PERFORMANCE
CHARACTERISTICS

IF YOU need a relay that will operate consistently under extremely critical or downright adverse conditions, there's an excellent possibility your requirements can be readily met by one of the multitude of variations possible with the basic "Diamond H" Series R relay. Originally designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. They're adaptable to a wide variety of applications . . . guided missiles, jet aircraft, fire control and detection, radar, communications, high speed camera, geophysical and computer apparatus, for example.

TYPICAL PERFORMANCE CHARACTERISTICS

- Vibration Resistance:** 10-55 cycles at 1/16" double amplitude
55-500 cycles at 15 "G"
55-1,000 cycles at 15 "G"
55-2,000 cycles at 10 "G"
- Temperature Range:** -55° to + 85°C.
-65° to + 125°C.
-65° to + 200°C.
- Coils:** Resistances—1 ohm to 50,000 ohms
Arrangements—single coil;
two independent coils, either or both of which will operate unit
- Insulation Resistance:** 1,000 megohms at room temperature
100 megohms at 200°C.
- Dielectric Strength:** 450 to 1,250 V., RMS
- Operating Time:** 24 V. models 10 ms. or less; dropout less than 3ms.
- Contacts:** 30V., D.C.; 115V., A.C.; 2, 5, 7½ and 10A., resistive; 2 and 5A. inductive.
Minimum 100,000 cycles life.
Low interelectrode capacitance — less than 5 mmf. contacts to case; less than 2½ mmf. between contacts.
Special Ratings: to 350 V., D.C., 400 MA., or other combinations including very low voltages and amperages or amperages to 20.
- Operational Shock Resistance:** 30, 40 and 50 "G" plus
- Mechanical Shock Resistance:** up to 1,000 "G"
- Mounting:** 9 standard arrangements to meet all needs — plus ceramic plug-in socket.
- Size:** 1.6 cu. in.
- Weight:** 4 oz. or less

Call on "Diamond H" engineers to work with you in developing a variation to meet your specific requirements.

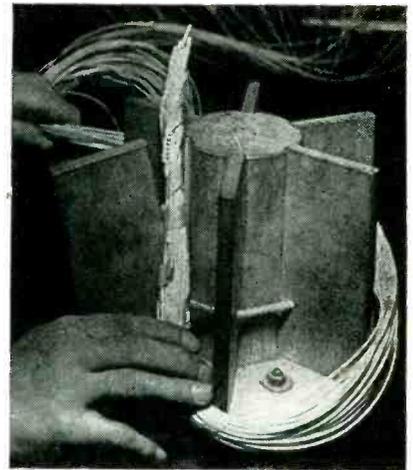
THE HART MANUFACTURING COMPANY
202 Bartholomew Avenue, Hartford, Connecticut

guides for the tuning and contrast control shafts, to insure proper centering of the control shafts when the knobs are later installed.

Pulling Cable Conductors Through Plastic Sleeve

ASSEMBLING of conductors for cables and application of a tight-fitting insulating sleeve over them is expedited through use of several unique tools and techniques developed in the Baltimore plant of The Glenn L. Martin Co. The cables are used in the P5M Martin anti-submarine aircraft.

Wires for the cable are first automatically measured and cut to length, numbered and fitted with terminals at one end, then stored horizontally on the pegs of a long



Method of anchoring end of assembled group of wires by pulling back one paddle of winding arbor. Note staggering of wire ends to give tapering; this facilitates pulling wires through sheath

rack. Each horizontal row of pegs holds wires having one particular number, with the number of wires per row corresponding to the number of cables to be made up at that time. The ends of each group of wires are brought through one hole in a vertical sheet of plywood and tucked back through a lower hole. When all wires have been cut to length and stored in this way, the operator has within easy reach every wire needed for the cable.

Assembly involves pulling one of each wire from the board and winding masking tape around the ends of the assembled group to anchor them temporarily together. The taped end is tucked behind one

high performance for low-cost tv sets with Tung-Sol

Series String tubes

2AF4 (Prototype—6AF4) Heater Current 0.6 A Heater Volts 2.35	38N6 (Prototype—68N6) Heater Current 0.6 A Heater Volts 3.15	5AQ5 (Prototype—6AQ5) Heater Current 0.6 A Heater Volts 4.7	6AX7 (Prototype—12AX7) Heater Current 0.6 A Heater Volts 3.15*	12BQ6GA (Prototype—6BQ6GA) Heater Current 0.6 A Heater Volts 12.6
3AL5 (Prototype—6AL5) Heater Current 0.6 A Heater Volts 3.15	3BY6 (Prototype—6BY6) Heater Current 0.6 A Heater Volts 3.15	5BK7A (Prototype—6BK7A) Heater Current 0.6 A Heater Volts 4.7	6S4A (Prototype—6S4) Heater Current 0.6 A Heater Volts 6.3	12BQ6GT (Prototype—6BQ6GT) Heater Current 0.6 A Heater Volts 12.6
3AU6 (Prototype—6AU6) Heater Current 0.6 A Heater Volts 3.15	3CB6 (Prototype—6CB6) Heater Current 0.6 A Heater Volts 3.15	5T8 (Prototype—6T8) Heater Current 0.6 A Heater Volts 4.7	6SN7GTB (Prototype—6SN7GTA) Heater Current 0.6 A Heater Volts 6.3	12BY7A (Prototype—12BY7) Heater Current 0.6 A Heater Volts 6.3*
3AV6 (Prototype—6AV6) Heater Current 0.6 A Heater Volts 3.15	4BQ7A (Prototype—6BQ7A) Heater Current 0.6 A Heater Volts 4.2	5U8 (Prototype—6U8) Heater Current 0.6 A Heater Volts 4.7	12AX4GTA (Prototype—12AX4GT) Heater Current 0.6 A Heater Volts 12.6	12L6GT (Prototype—25L6GT) Heater Current 0.6 A Heater Volts 12.6
3BC5 (Prototype—6BC5) Heater Current 0.6 A Heater Volts 3.15	4BZ7 (Prototype—6BZ7) Heater Current 0.6 A Heater Volts 4.2	5V6GT (Prototype—6V6GT) Heater Current 0.6 A Heater Volts 4.7	12B4A (Prototype—12B4) Heater Current 0.6 A Heater Volts 6.3*	12W6GT (Prototype—6W6GT) Heater Current 0.6 A Heater Volts 12.6
3BE6 (Prototype—6BE6) Heater Current 0.6 A Heater Volts 3.15	5AN8 (Prototype—6AN8) Heater Current 0.6 A Heater Volts 4.7	6AU7 (Prototype—12AU7) Heater Current 0.6 A Heater Volts 3.15*	12BH7A (Prototype—12BH7) Heater Current 0.6 A Heater Volts 6.3*	19AU4 (Prototype—6AU4GT) Heater Current 0.6 A Heater Volts 18.9
				25CD6GA (Prototype—25CD6G) Heater Current 0.6 A Heater Volts 25

*Using heaters connected in parallel.
Other Series String Tube Types In Development

All Tung-Sol Series String Tubes have uniform heater warm-up time to safeguard against failures from initial voltage surge.

Heater ratings are based on 600 milliamperes of current with the heater voltage adjusted for the same power as in the prototype. All other characteristics and ratings are identical to those of the prototype.

Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

If you're a TV set manufacturer with an eye on the mass volume market, Tung-Sol can provide the "series string" tube types, the quality and the service you need for a successful competitive program.

COMPLETE LINE: Tung-Sol Tube types will meet the performance requirements of circuit designs currently in use, as well as any foreseeable new circuitry. Additional tube types are in development.

DEPENDABLE QUALITY: Tung-Sol quality control standards have been adjusted to the more severe service demands of "series string" operation. You can rely on Tung-Sol "Series String" Tubes to give the same dependable performance as their prototypes.

SERVICE: Competent field engineers are immediately available for consultation beginning at the design stage to help you achieve smooth, efficient production. Tube deliveries are coordinated to your manufacturing schedules and are completely

reliable. Your design plans are received in strictest confidence.

For more information about Tung-Sol "Series String" TV Tubes, write to Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

SALES OFFICES

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

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

TUNG-SOL[®]

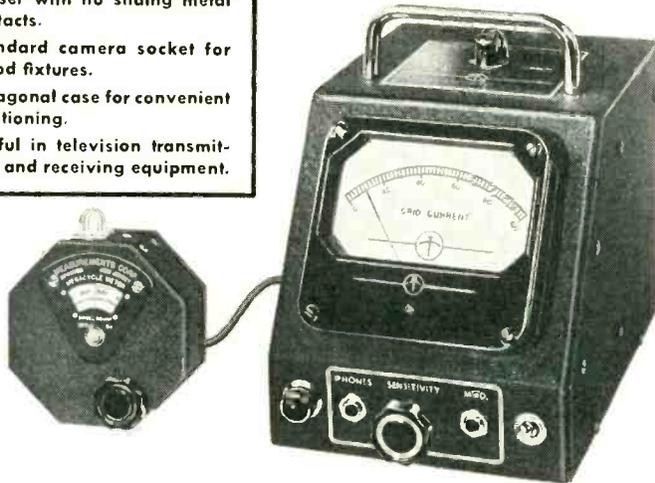
Radio and TV Tubes, Dial Lamps

NEW UHF MEGACYCLE METER

With the Widest
Frequency Coverage
in a Single Band

FEATURES

- Excellent coupling sensitivity.
- Fixed coupling point.
- Small grid current variation over band.
- Calibration point every 10 Mc.
- Uses split-stator tuning condenser with no sliding metal contacts.
- Standard camera socket for tripod fixtures.
- Octagonal case for convenient positioning.
- Useful in television transmitting and receiving equipment.



MODEL 59 UHF

The Model 59 UHF Megacycle Meter is specially designed to cover the UHF television band plus the many mobile and fixed communication services through its wide frequency coverage of 430 to 940 megacycles in a single range. It incorporates all of the quality features and the excellent performance of the popular Model 59 plus a unique design resulting in a maximum of convenience in use. It is an indispensable instrument for electronic engineers, researchers, experimenters and radio servicemen.

USES

- As a grid-dip oscillator for measuring the resonant frequency of passive circuits such as cavities, tank circuits, inductors, capacitors, chokes, transmission lines and antennas.
- As an auxiliary signal generator for alignment and tuning of UHF receivers and transmitters.
- As an oscillating or absorption marker for use with a sweep-frequency generator.
- As a wavemeter or heterodyne frequency meter.
- As a low sensitivity receiver or field-strength meter for tracing source of spurious oscillations in receivers and transmitters.
- For adjusting antenna systems, wave traps, and filters.

SPECIFICATIONS

- FREQUENCY RANGE:** 430-940 Mc in a single band
- FREQUENCY ACCURACY:** $\pm 2\%$ (Individually calibrated)
- OUTPUT:** CW or 120-cycle modulation
- POWER SUPPLY:** 117 volts, 60 cycles, 30 watts
- DIMENSIONS:** Oscillator Unit 4 $\frac{3}{4}$ " x 2 $\frac{1}{2}$ "
Power Unit 5 $\frac{1}{8}$ " wide x 6 $\frac{1}{4}$ " high x 7 $\frac{1}{2}$ " deep



Air motor under bench turns arbor slowly to wind wires for cable as they are pulled off pegs of storage rack in background through holes in vertical plywood board. When winding is completed, operator pulls taped end of cable out from behind paddle board and lifts off the coiled cable

of the six hardwood paddles on the winding arbor. These paddles are hinged at their lower ends and held in the slots of the vertical wood shaft by a loop of Bungee elastic cord going through a hole in each paddle. The operator can thus pull back the most convenient paddle for anchoring the end of the cable. She then starts an air motor which slowly rotates the winding arbor, by pressing a foot switch. When the cable has been wound, it is lifted off the arbor and transferred to an adjoining table for insertion in a tube of protective vinyl plastic. If no sheath is needed, the grouped wires go directly to the connector-assembly department.

As the first step in fishing the wires through the just-big-enough tube of Vartex plastic tubing, the operator inserts a small metal mouse in the tubing, then pushes the tubing onto a pipe going to an air supply. When the air is turned on, the mouse is forced through the tubing, pulling with it a highly flexible steel cable.

When the mouse reaches the other end it is unhooked and the steel cable is attached to a flexible woven wire cable grip into which the operator has previously pushed

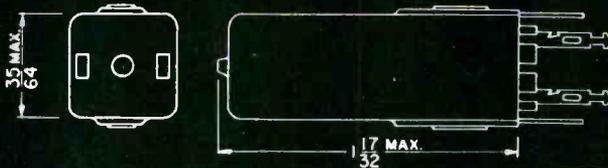
Laboratory Standards  **MEASUREMENTS CORPORATION**
BOONTON - NEW JERSEY

THE *ONLY* MINIATURE

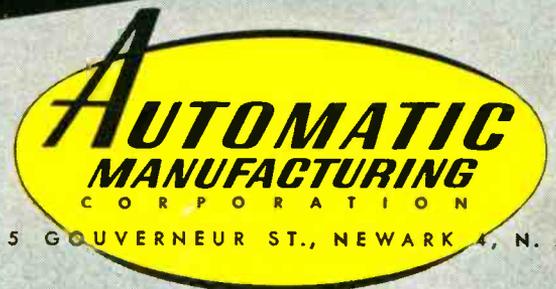
K-TRAN[®]



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MASS PRODUCERS OF
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65 GOVERNEUR ST., NEWARK 4, N. J.

**FOR PORTABLE, AUTOMOBILE
AND OTHER RADIO APPLICATIONS**

HARVEY



**AUTHORIZED
DISTRIBUTOR**

presents the

NEW RCA PORTABLE COLOR-BAR GENERATOR

TYPE WR-61A



◀ **Inherently Accurate
Color Signals**

◀ **Crystal Controlled
Oscillators Insure
Accuracy and
Stability**

***Especially suited to the
demanding requirements of the Production Line,
Research Laboratory, and Broadcast Studio.***

The advent of Color Television has opened the need for new test instruments. Accurate checking and adjustment of the phasing and matrixing circuits of color receivers require an inherently accurate color bar source. To meet this need, RCA has developed a color-bar generator that is compact, lightweight, portable, and economical.

The WR-61A COLOR-BAR GENERATOR is designed to provide a positive check on the overall operation and adjustment of color receivers and monitors and for adjusting

color phasing and matrixing. It generates signals for producing 10 bars of different colors simultaneously, without manual switching, including bars corresponding to the R-Y, B-Y, G-Y, I, and Q signals.

Crystal-controlled oscillators for color sub-carrier, picture carrier, sound carrier, bar frequency, and horizontal sync, ensure accuracy and stability. Luminance signals at bar edges for checking color "fit" or registration. Adjustable sub-carrier amplitude for checking color sync action.

Complete with tubes, shielded cable, and instructions..... **\$247⁵⁰**

Write for complete descriptive data and specifications.
Note: All prices F.O.B. N.Y.C.
Subject to change without notice.
Please add estimated shipping charges.
Excess will be refunded.

ESTABLISHED 1927

HARVEY

RADIO COMPANY, INC.

103 W. 43rd St., New York 36, N.Y. • JU 2-1500



Setup for blowing talcum powder into plastic tubing to serve as lubricant. Threaded cap with T-shaped handle is removed from cylinder for refilling

the unterminated wires of a cable group. Now, while one operator guides the wires into the sleeving, the other turns a crank that winds the steel cable back onto its drum, thereby pulling the wires through the sleeving. Air is turned on during this operation to open up the tubing and act as a lubricant for the wires.

For additional lubrication, the operator first blows odorless talcum powder into the tubing by pushing one end of the tubing over the nozzle of a powder-filled container



Inserting metal mouse in tubing to pull flexible steel cable through tubing. Valve admits air to blow mouse through. Crank on cable drum is used to pull back cable afterward

LOOK TO Amperex®

FOR CONTINUAL DEVELOPMENTS IN JAN TYPE TUBES for Military and Commercial Applications

5C22



6268
(4C35 with generator)



6229
6230



2J55
2J56

The AMPEREX history in both design and production of tubes is one that points up the strength of the AMPEREX organization in pioneering engineering advancements and improving production techniques. Year after year, AMPEREX has been in the forefront . . . introducing new types and new methods.

Many of these AMPEREX "firsts" are now standards throughout the world. This constant awareness of the fact that new designs and new applications are of the utmost importance spurs our engineering staff, which is second to none in the world, into producing the tubes of the future . . . today.

On this page we illustrate only a few of the AMPEREX JAN-TYPE MAGNETRONS and a couple of the HYDROGEN THYRATRONS. It by no means reflects the extent of these operations which encompass a complete range of frequency and power outputs for magnetrons in both packaged and non-packaged types, nor does it give any indication of the number of tubes which we make.

Naturally, all AMPEREX tubes receive strenuous life expectancy tests in field performance before any information is released. Most AMPEREX Magnetrons use new hobbled anodes, the one-piece construction technique which affords a cleaner, higher-Q resonator structure for improved performance plus longer life.

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▶ AMPEREX JAN-TYPE HYDROGEN THYRATRONS give **more than double the normal life-expectancy** . . . due to an advanced design featuring a built-in, self-regulating hydrogen generator, which requires **no outside power source** . . . providing operation with **less jitter than any other available tubes**. They are **completely interchangeable** with standard military types.

▶ AMPEREX Types 5C22 and 6268 are the only hydrogen thyratrons with this completely automatic, built-in, self-regulating generator. The 6268 is a 4C35 type tube with this added feature.

Write for list of other JAN-type AMPEREX Tubes . . .
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4J47



6507



5657



2J48



5586



4J52



4J57
4J58
4J59

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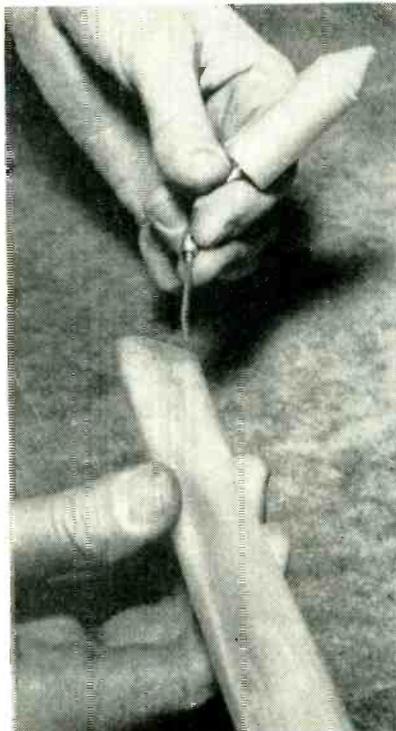
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244

PRODUCTION TECHNIQUES

(continued)



Unhooking mouse after it has been blown through tubing



Guiding cable grip and conductors into tubing as operator at other end of tubing winds up cable on drum

and applying air pressure to the container with a foot valve.

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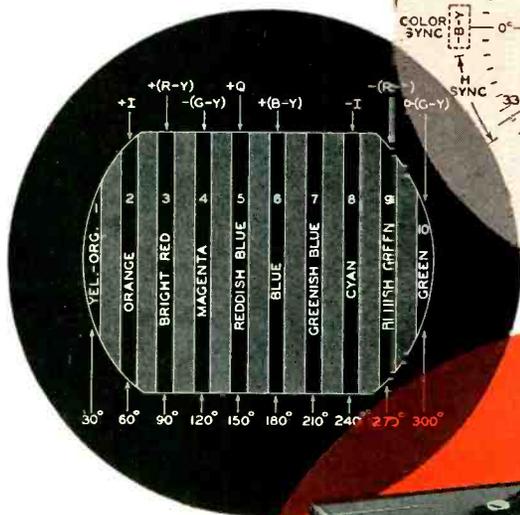
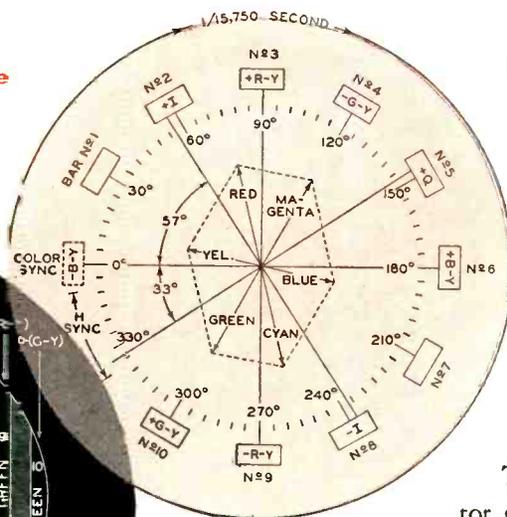
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January, 1955 — ELECTRONICS

For STABILITY...ACCURACY...PORTABILITY

...the RCA WR-61A COLOR-BAR GENERATOR

Color-vector diagram shows phase relationships of color bars produced by the WR-61A. The order in which the color bars appear on the picture tube screen is shown below.



Here is a compact, lightweight instrument designed for use in checking overall operation of color-TV sets, and for adjusting color phasing and matrixing in color receivers and monitors. Four *crystal-controlled* oscillators (color subcarrier, picture carrier, sound carrier, bar frequency and horizontal sync) assure accuracy and stability.

The RCA WR-61A Color-Bar Generator generates signals for producing 10 bars of different colors simultaneously (without manual switching), including bars corresponding to the R-Y, B-Y, G-Y, I, and Q signals. Luminance signals at bar edges are provided to check color "fit" or registration.

only \$247.50
(Suggested User Price) complete with rf- and video-output cables, and instruction booklet. Weight: 13 lbs. Size: 10" x 13½" x 7½".

See your local RCA Distributor for complete details and demonstration of the WR-61A.



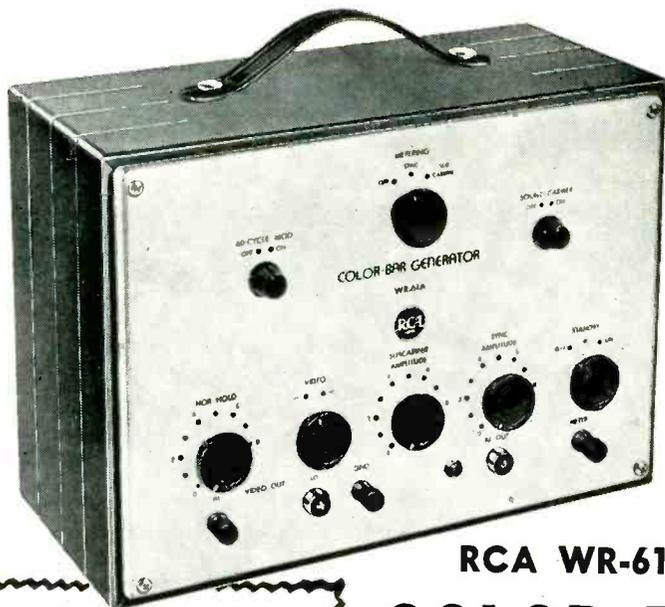
Additional features include: adjustable color subcarrier amplitude for checking color sync-lock action in receivers. Built-in metering circuit facilitates adjustment of relative amplitudes of subcarrier and horizontal sync. 300-ohm rf output. Both high- and low-impedance video output with "plus" and "minus" polarity selector.



RADIO CORPORATION of AMERICA
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HARRISON, N. J.

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RCA WR-61A

COLOR BAR GENERATOR

Generates signals for producing 10 bars of different colors simultaneously (without manual switching), including bars corresponding to the R-Y, B-Y, G-Y, I, and Q signals, for checking and adjusting phasing and matrixing in all makes of color sets. Crystal-controlled oscillators (color sub-carrier, picture carrier, sound carrier, bar frequency, and horizontal sync) ensure accuracy and stability. Luminance signals at bar edges for checking color "fit" or registration. Adjustable sub-carrier amplitude for checking color sync action.\$247.50

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that formerly had to be accomplished largely by brute force, generally with appropriate verbal comments.

Styrofoam Serves as Shipping Block

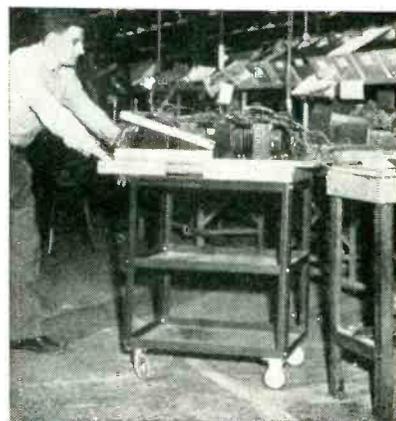


Removing special capacitor from foam plastic shipping block

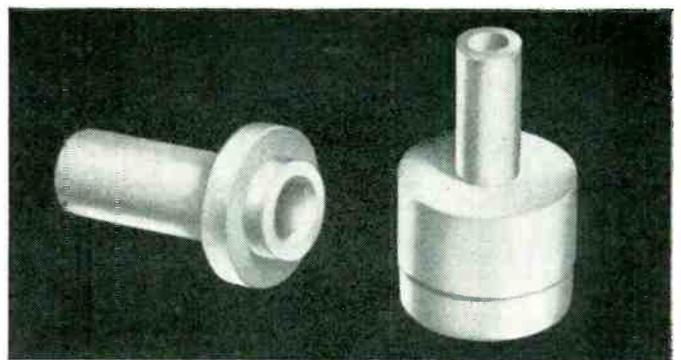
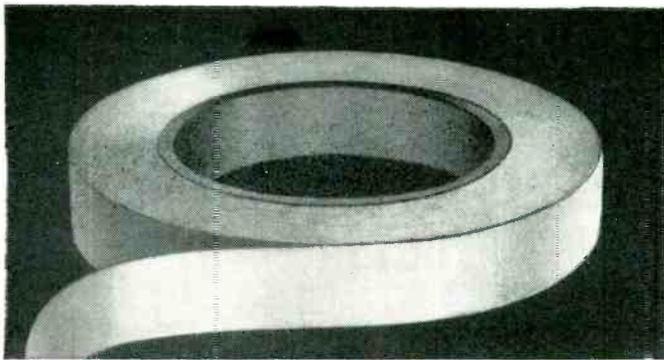
A TWO-INCH-THICK block of Styrofoam serves for protecting special silvered ceramic two-section capacitors intended for use in coaxial tuned circuits. The units remain in the blocks on the assembly bench in Motorola's Chicago plant until ready for installation in coaxial tuned circuits of two-way radio equipment.

Cart Simplifies Handling of Power Transformers

HEAVY-DUTY POWER transformers for color television receivers are brought to a subassembly line in the Westinghouse Metuchen, N. J. plant on a specially designed cart. When the loaded cart is rolled into

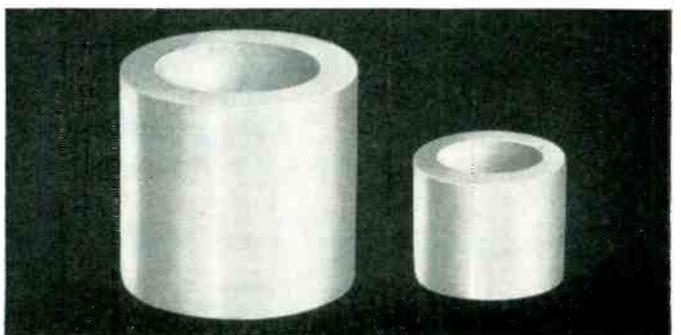
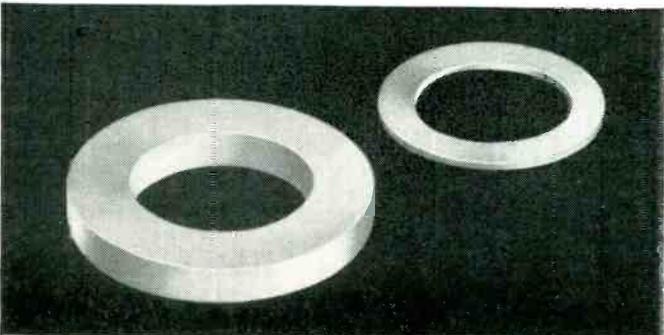
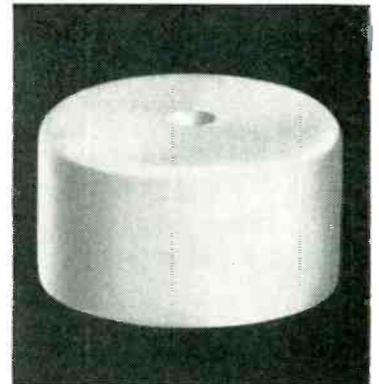


Pushing loaded transformer cart into position at start of power supply subassembly line for color television sets



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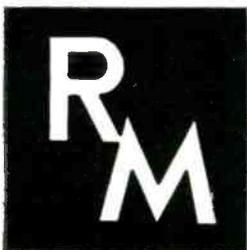
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**RCA WR-61A
COLOR-BAR GENERATOR**

Generates signals for producing 10 bars of different colors simultaneously (without manual switching), including bars corresponding to the R-Y, B, G-I, I, and Q signals for checking and adjusting phasing and matrixing in all makes of color sets. Crystal-controlled oscillators (color sub-carrier, picture carrier, sound carrier, bar frequency, and horizontal sync) ensure accuracy and stability. Luminance signals at bar edges for checking color "fit" or registration. Adjustable sub-carrier amplitude for checking color sync action. Lightweight and compact **\$247.50**

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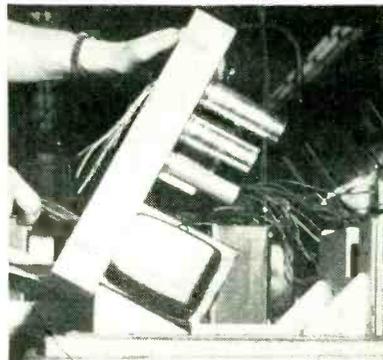
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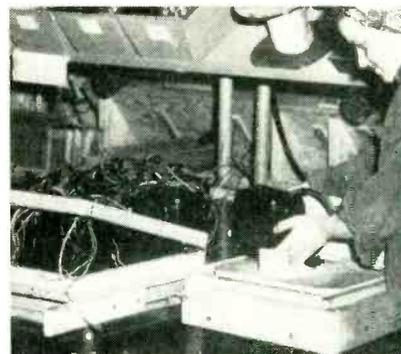
GREEN INSTRUMENT COMPANY

363 Putnam Ave.

Cambridge, Mass.



Method of tilting power supply chassis to vertical position on pallet after power transformer is mounted



Transferring power transformer from cart to pallet. Hook in foreground prevents cart from rolling away from line while transformers are being unloaded

position, a hook on the bench is pushed into a screweye on the cart. This holds the cart in position as the operator transfers the heavy units one by one to subassembly pallets.

After inserting the transformer upside down, she places over it the power supply chassis on which other large components have previously been mounted, then bolts the transformer to the chassis. The pallet is so designed that the chassis can be tilted as required for further assembly work without having to lift the power transformer.

Cutting Plastic Slewing

A SIMPLE foot-operated cutter is used in the Baltimore plant of The Glenn L. Martin Co. to produce desired lengths of Vartex plastic spaghetti slewing in small quantities for use on wire leads of electronic controls for the Matador guided missile.

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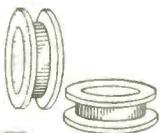
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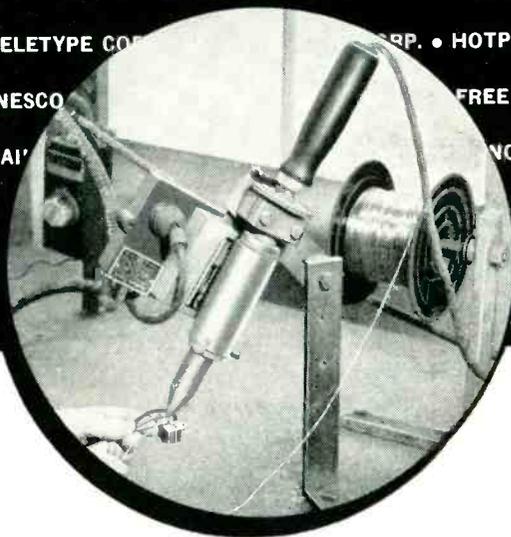
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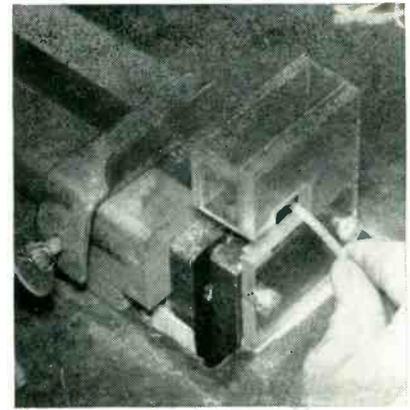
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Method of feeding sleeving into foot-operated cutter

to the desired sleeve length. The thumb nut in the front end of the stop bears against a metal plate set into the front edge of the 2x4, to insure permanence of a given setting.

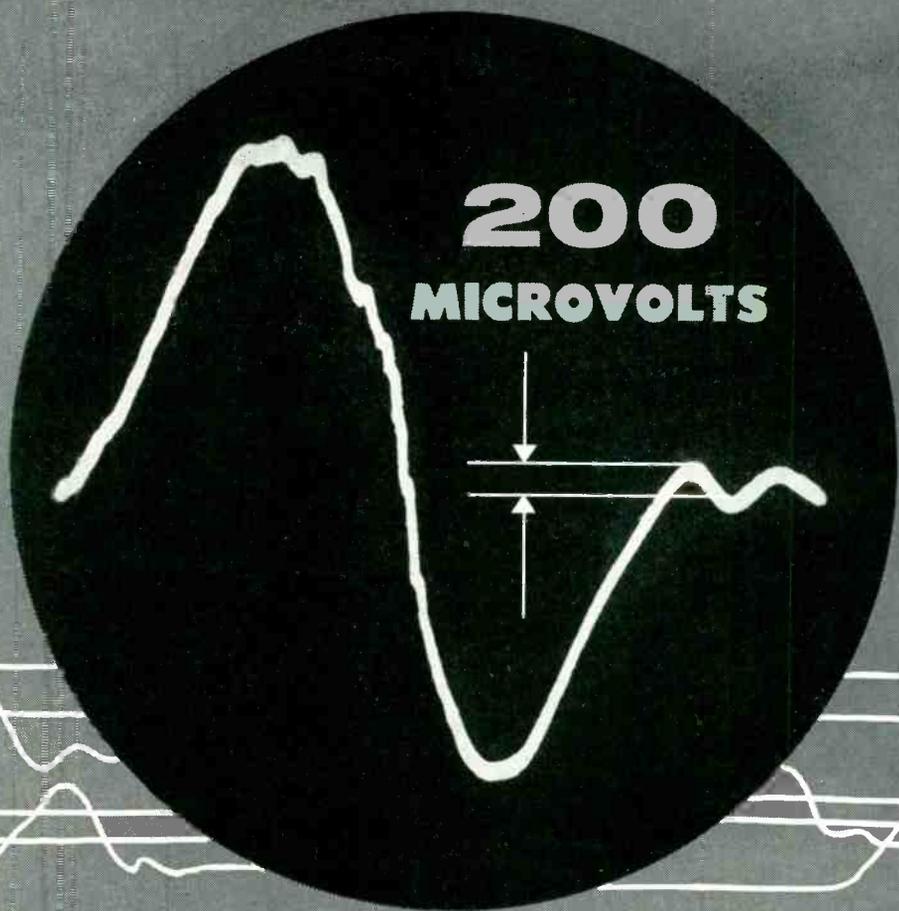
A transparent plastic guard, glued together from sheet stock, prevents fingers of the operator from getting under the cutting jaws. Spring loading is used to keep the jaws open until pulled down by a chain that runs through a hole in the bench to the foot pedal.

Light Hydraulic Presses Cut Phono Pickup Costs

By HAROLD HOLMES
*Superintendent, Machine and Tool Division
Astatic Corporation, Conneaut, Ohio*

LIGHT hydraulic presses have taken over many jobs formerly done on larger crank presses, with advantages of less costly production, greater operator safety, less operator fatigue and the maintenance of accuracy and quality in fabricated parts for phonograph pickups, recording heads and related accessories.

Typical of the operations that formerly tied up large crank presses involves stamping the tradename Astatic on half of a phonograph cartridge housing $\frac{3}{8}$ inch thick, made from 52SO aluminum. A hydraulic index table on a Denison Multipress (made by Denison Engineering Co., Columbus, Ohio) now turns out about 2,000 pieces an hour, twice as fast as formerly. Air ejection and a fixed brush assure that pieces enter a discharge chute. The cost of this setup has been paid



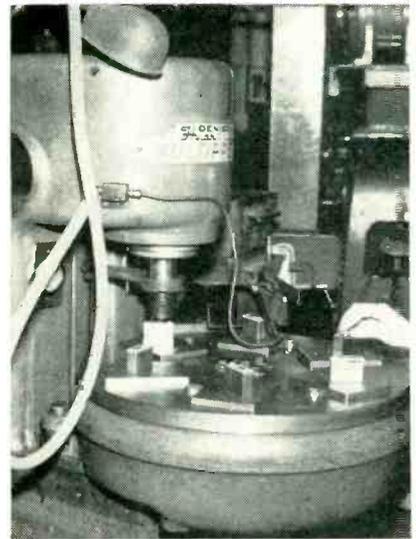
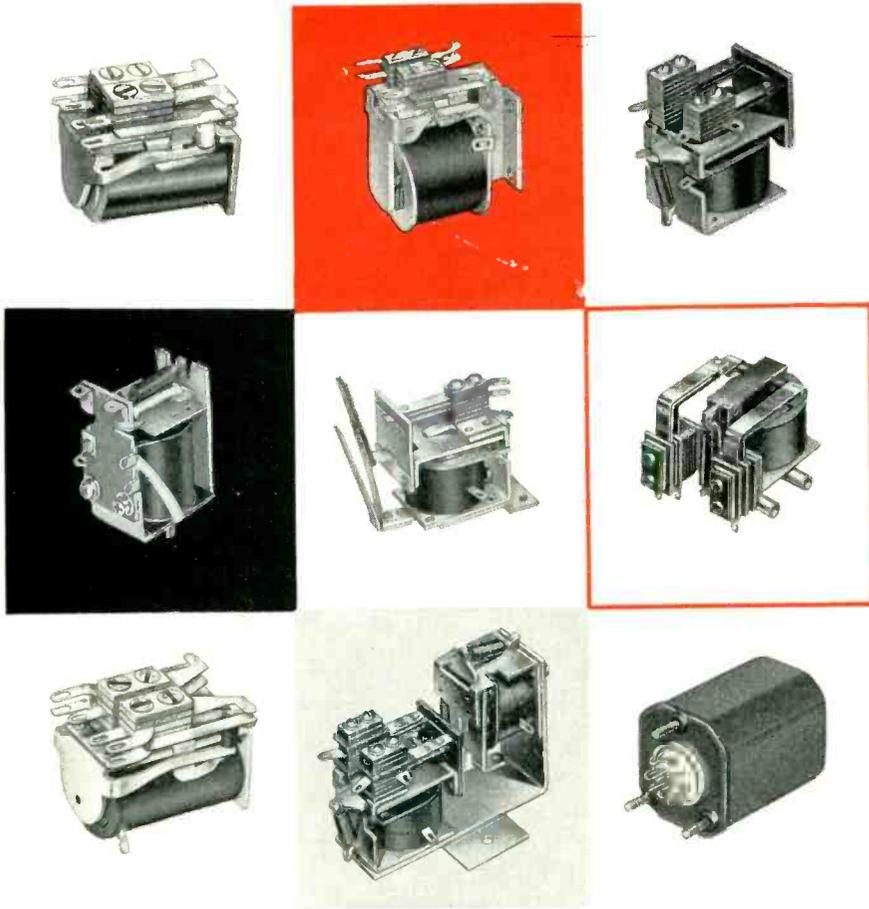
(ACTUAL SIZE PHOTO)

... and this amazing sensitivity is only one of many outstanding characteristics of the entirely new DuMont Type 324 cathode-ray oscillograph. New standards of stability, low noise and hum level assure full use of the Type 324 for d-c to 300 kc measurements even in the microvolt region. Furthermore, the Type 324 is completely calibrated to read time and amplitude directly. There are so many features incorporated in this new instrument we can't begin to give you the whole story here. Write us for complete specifications, or better still, ask for a demonstration of the

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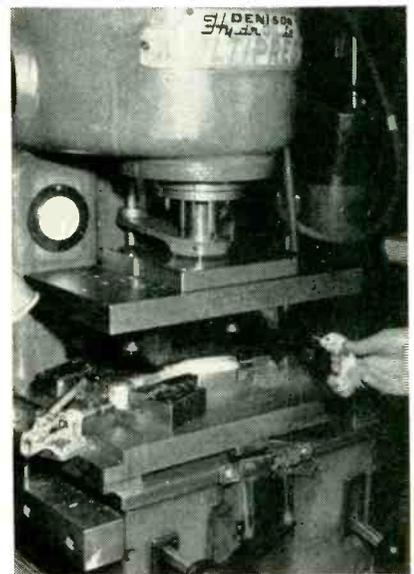


Setup for stamping tradename on housing section of pickup cartridge. Fixed brush at rear combines with air ejection pipe to remove stamped pieces as the table indexes automatically

for many times. In a year's time, some 1,500,000 pieces are stamped.

As another example, a sizeable die was tying up a big crank press needed for another job. A new die was designed to fit the light hydraulic press, to do several 0.093-inch and $\frac{3}{32}$ -inch perforations on a zinc die-cast pickup arm about 8 inches long. The arm is placed on an arbor that fits front and back, with a clamp at the back so the front punch for perforating won't dislocate the 0.093-inch pivot holes. The $\frac{3}{32}$ -inch hole is a needle screw hole.

With one steady stroke, the press



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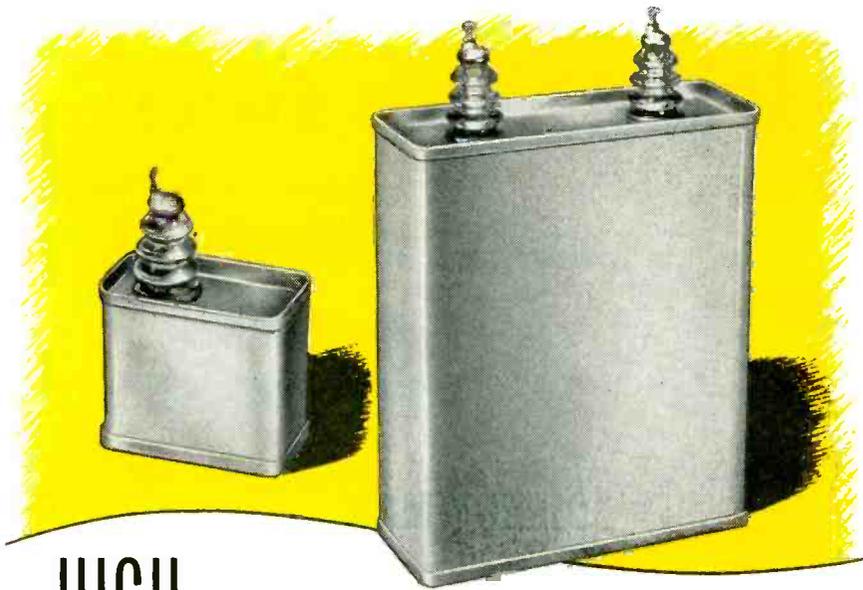
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engages a cam die, with cams engaging tapers for the perforating jobs at the two ends of the arm. There wasn't room to get bolts through to the press bolster, so blocks were fastened to the press sides to aid clamping the die. Slugs are air-blown from beneath the die occasionally.

Some of the new presses were modified by cutting a slot about 6 inches in diameter, or a semi-circle, out of the bolster plate next to the



Sheet-metal hoppers alongside press feed brass shafts and supports, for riveting together when loaded into press manually. Note semicircle cut into bolster, with chute below leading to tote box for finished pieces. Spring clips welded to hopper at right can be used to hold work cards

operator. This heads up a chute of sheet metal, down which the operator can pass pieces after press work. Materials handling is further expedited in some cases where a move-man takes tote pans from beneath these chutes and automatically moves them, when full, to the next operation.

Stop collars make it impossible for the presses to close beyond a predetermined point in the press stroke. The press can be set to decide when it meets the proper resistance on variations in commercial thicknesses of metals; in delicate press assembly work this means that the light hydraulic unit doesn't smash or distort pieces, such as might be done in a crank press hav-

ing a fixed stroke. This feature is utilized in riveting a support onto a length of brass shaft having a length tolerance of plus or minus 0.010 inch in a Multipress. A crank press would buckle the shaft, or wouldn't make the support tight enough, if the tolerances weren't met. The hydraulic press always joins the pieces correctly, be the shaft short or long.

The hydraulic presses can be modified in several ways to increase production. For instance, in the latter case, the press now trips a snap-action switch that operates a solenoid on an air cylinder, pushing a piston on a slide clamp to hold the pieces firmly as shaft and support are riveted. A manual operation of clamping is thus dispensed with, and the job goes twice as fast.

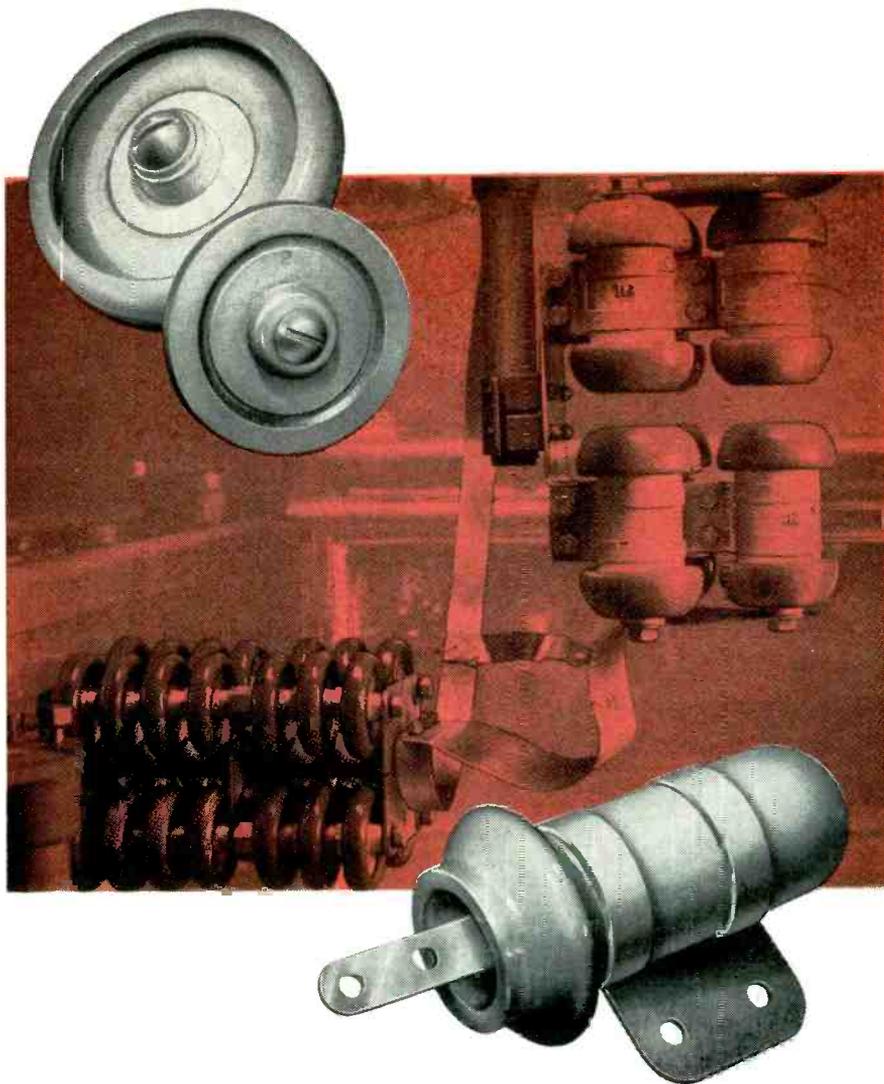
Chassis-Holding Fixture

ALL ASSEMBLY and wiring for one of the control boxes of the Matador ground-to-ground guided missile is done at a single work position in the Baltimore plant of The Glenn L. Martin Co. with the aid of a chassis-holding device that permits full 360-degree rotation of the chassis during assembly. The chassis is fastened to the fixture with four bolts and wing nuts, these being preferable to clamping devices since the chassis is changed only a few times a day.

The chassis is bolted to a pivoted square piece of 1/4-inch pressed wood having 32 equally spaced holes



Method of using chassis-holding fixture during assembly of missile control



Aerovox H-P CERAMIC POWER and Transmitting Capacitors

Take advantage of that "New Look" in your electronic power assemblies! These ceramic-dielectric capacitors serve heavy-duty functions heretofore limited to mica types. H-P Ceramic Power Capacitors are particularly suited for broadcast, radio-communication, radar and similar assemblies; for industrial high-frequency equipment; for medical appliances, etc.

In both disc ("double-saucer") and cylindrical ("tubular") ceramic-dielectric bodies. Space- and weight-saving from 50% to 90% over corresponding micas. Competitively priced.

Also: Ease of mounting; ease of wiring in series or parallel; very low inductance connections; exceptional immunity to humidity, heat, cold, atmospheric pressure; wide range of designs, sizes, capacitances, voltages.

Get the FACTS!

Let our engineer-specialists collaborate in adapting these H-P capacitors to your equipment for that "New Look." Literature on request.

HI-Q[®]
DIVISION

AEROVOX CORPORATION

OLEAN, N. Y.

AEROVOX CORPORATION
NEW BEDFORD, MASS.

ACME ELECTRONICS, INC.
MONROVIA, CALIF.

CINEMA ENGINEERING CO.
BURBANK, CALIF.

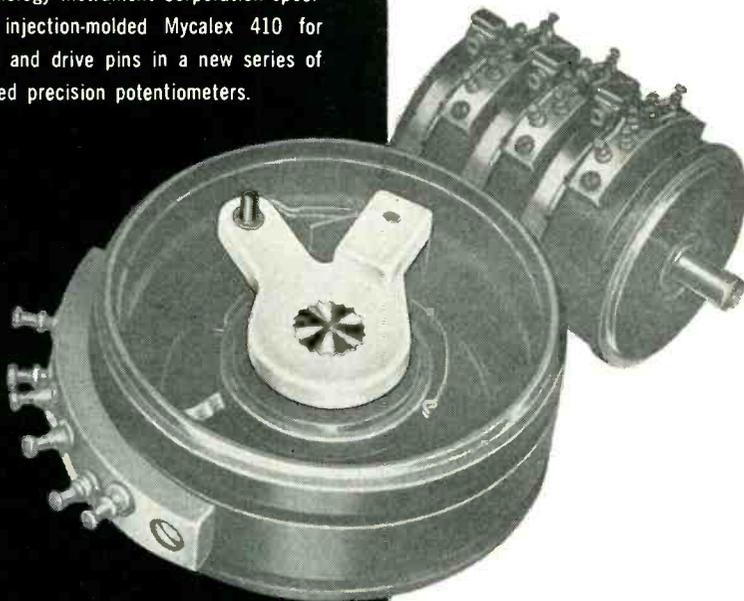
In Canada: AEROVOX CANADA LTD., Ham lton, Ont.
JOBBER ADDRESS: 740 Belleville Ave., New Bedford, Mass.

For Absolute dimensional

stability...specify

After testing numerous design materials, Technology Instrument Corporation specified injection-molded Mycalex 410 for shaft and drive pins in a new series of ganged precision potentiometers.

MYCALEX
GLASS-BONDED MICA



By permitting closer dimensional tolerances, Mycalex glass-bonded mica allows TIC to reduce the size and hold these dimensions constant under toughest environmental conditions. And dimensional stability of the Mycalex coupling arm provides precision transference of rotary shaft motion between adjacent potentiometers without backlash.

TIC designers are typical of the hundreds of electrical and electronic engineers who have discovered the outstanding qualities of Mycalex. Important Mycalex properties include:

- * **low electrical loss factors**
- * **high dielectric strength**
- * **permanent and absolute dimensional stability**
- * **impervious to water, oil and organic solvents**
- * **very high arc resistance with complete freedom from carbonization**

For more details on this exciting material and its application to your design problem, write to General Offices and Plant: Department 114 Clifton Boulevard Clifton, N. J.



**MYCALEX
CORPORATION
OF AMERICA**

World's largest manufacturer
of glass-bonded mica products

Executive offices:
30 Rockefeller Plaza
New York 20, N. Y.



Chassis can be rotated when detent pin is pulled down as shown here

drilled in a circle around the pivot. A smaller piece of pressed wood permanently fastened to the slanting vertical supports of the fixture serves as the table on which the upper piece rotates. A spring-loaded detent pin mounted on the lower piece mates with the holes in the upper piece. Pulling down the pin thus permits rotation of the chassis to the most convenient angle for a particular part of the assembly operation. Releasing the pin locks the chassis in that position.

Illuminated Magnifier Aids Inspection of Missile Controls

SOLDERED JOINTS and screw-terminal connections of control units for the Matador guided missile are carefully inspected at the Baltimore plant of The Glenn L. Martin Co. with the aid of a MagniVision



Magnification combined with intense illumination improves efficiency of inspecting screw terminals in missile black box

inspection lamp. The lamp is supported on a bench-mounted frame that permits easy adjustment to any desired angle and position. A circular fluorescent lamp provides the illumination, and the white plastic housing keeps light from the eyes of the operator. This combination of light and lamp is useful for many other types of inspection and assembly jobs in electronic plants.

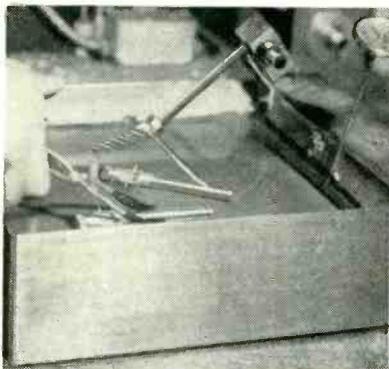
Beveling New Pliers Prevents Nicking of Wires

SOME makes of new long-nose pliers have very sharp sides and sharp peaked serrations inside the jaws. Sharp edges and points will break or nick wire strands when these pliers are used to pull, form or bend wire.

To prevent damage to wire strands, new tools should have the sharp edges cut to a fine bevel with a file or abrasive cloth. The sharp crested serrations in the jaws can be lightly dressed down with a fine-cut file.—Glenn L. Martin Co. training bulletin.

Testing Seals of Coaxial Cavities

AFTER soldering of tuning cavities for two-way radio communication equipment in Motorola's Chicago plant, the quality of the hermetic seal is checked by inserting each cavity in a liquid bath maintained at 90C by a Cenco Bimetallic Thermoregulator. Bubbles indicate a leak and pinpoint its location. The temperature of the bath is controlled and is monitored with a thermometer to maintain the desired test pressure inside the units under expansion of air with heat.



Placing finished cavities in temperature-controlled bath to check for leaks

New hf wave analyzer!



Sierra 158 High Frequency Wave Analyzer

Fast, convenient, 500 KC to 10 MC!

New Sierra 158 Analyzer is a highly selective, double superheterodyne receiver providing wave analysis data direct in dbm referred to 600 ohms impedance. The instrument uses a cathode follower input probe with two detachable capacity dividers for 20 or 40 db attenuation. It also includes a built-in attenuator adjustable in 10 db steps to a maximum of 60 db. These features, in combination with 22 db usable meter readings, provide a measurement range of 122 db, from -80 to +42 dbm. A measurement accuracy of ± 2 db is assured for levels above -70 dbm. Spurious components from analyzer circuits are at least 50 db below fundamental. An injection oscillator at 2 mc is provided for rapid voltage calibration. A phone jack is available for aural monitoring. The instrument also includes the Sierra-designed precision spiral-scale frequency dial. *Write for complete data.*

SPECIFICATIONS

Frequency Range: 0.5 to 10 megacycles.

Signal Measurement Range: -80 dbm to +42 dbm, referred to 600 ohms. (77.5 μ v to 97.5 v)

Selectivity: 3 db down at 3 kc off; 30 db down at 12 kc off.

Signal Measurement Accuracy: ± 2 db above -70 dbm.

Spurious Responses: At least 50 db down.

Input Impedance: Greater than 1 meg-ohm shunted by approximately 8 μ f.

Frequency Calibration Accuracy: Depends on stability and calibration accuracy of the 22.5 - 32 mc variable oscillator, which is maintained within 0.25%. This results in dial accuracy ranging from $\pm .056$ mc to $\pm .080$ mc.

Operating Power Requirements: 105 to 125 volts, 50/60 cps, 95 watts drain.

Cabinet Dimensions: 17 inches wide, 9 $\frac{1}{8}$ inches high, 13 $\frac{1}{2}$ inches deep.

Weight: Approximately 40 pounds.

Data Subject to Change Without Notice



Sierra Electronic Corporation
San Carlos 2, California, U. S. A.

Sales representatives in major cities
Manufacturers of Carrier Frequency Voltmeters, Wave Analyzers, Line Fault Analyzers, Directional Couplers, Wideband RF Transformers, Custom Radio Transmitters, VHF-UHF Detectors, Variable Impedance Wattmeters, Reflection Coefficient Meters.

3235

New Products

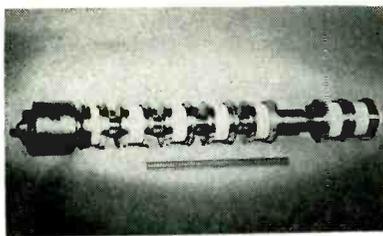
Edited by WILLIAM P. O'BRIEN

69 New Products and 65 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

KLYSTRON

extends DME effectiveness

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has announced a new klystron that will extend the effectiveness of distance measuring equipment by about 50 percent, both for measurement of distance and determination of bearing. Type X566 klystron delivers over 20 kw of peak pulse power with only 100-mw drive—a power gain of 53 db in uhf operation at 900 to 1,400 mc. It features the Eimac modulating



anode by means of which the pulsing equipment is greatly simplified. The ceramic and copper construction permits wide range tuning,

ease of adjustment of input and output coupling devices, and provides extreme ruggedness and mechanical stability. Also, it minimizes replacement costs. Of special significance is the high average power capability of 1 kw, which would allow the duty cycle to be raised to 5 percent with a 20-kw peak output, or 10 percent with a 10-kw output, and so on. The X566 and its associated circuit components, comprising a complete amplifier, have now become available.

DIGITAL VOLTMETER

measures d-c rapidly



NON-LINEAR SYSTEMS, INC., Box 728, Del Mar, Calif. Model 519

digital voltmeter is a self-balancing, digital potentiometer for measuring d-c voltages from 0.001 to 999.99 v. Maximum error is either less than 0.01 percent of the applied voltage or 0.001 v, whichever is greater. The instrument makes an average of 75 readings per minute, with automatic indication of polarity and decimal position. Input resistance

is in the order of 1,000 megohms on the low range and 11 megohms on the high range. The front panel readout presents an internally-lighted, in-line numerical display of the digital information, polarity and decimal. Accessories are available for transmitting this information to remote readouts, as well as for printing, typing or punching permanent records. All major assemblies are plugged into connectors on the chassis.

MULTICOUPLER

is a rack mounted unit

CLARKE INSTRUMENTS, Division of National Electrical Machine Shops, Inc., 919 Jesup-Blair Drive, Silver Spring, Md. A new wide frequency range receiver multicoupler has been developed to couple 8 receivers to 1 antenna with practically perfect isolation between receivers. Particular attention has been given to obtaining an extremely low noise figure. This multicoupler makes use of specially designed wide-band transformers and circuit arrange-

ments. Type AM-1 receiver multicoupler is a rack mounted unit with a frequency range of 2 to 30 mc

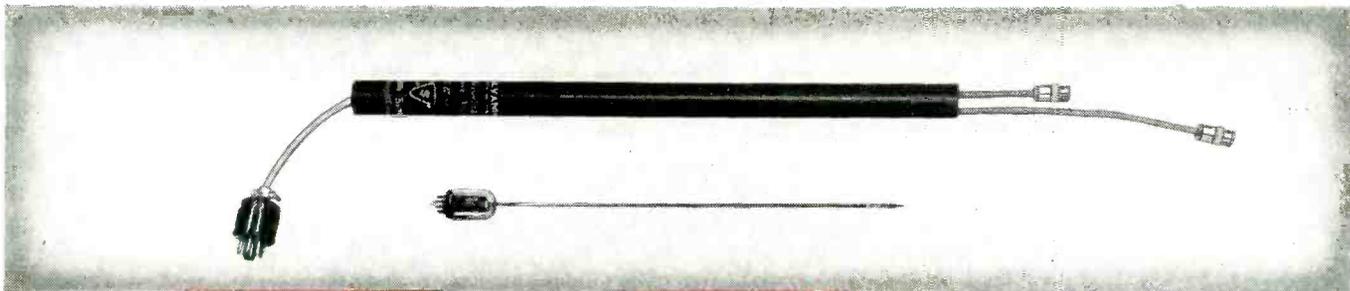


and a gain in each channel of nominally 2 db. Radiation suppression is greater than 60 db and isolation between any two receivers is greater than 55 db.

SELENIUM RECTIFIER

features long life

PYRAMID ELECTRIC Co., 1445 Hudson Blvd., North Bergen, N. J. A new design in selenium rectifiers features edge mounted plates providing full air circulation between



Type 6493—Low level 2000-4000 MC amplifier. Greater than 35 db gain with 15 MW output.

NOW

Sylvania offers

Traveling-Wave Tubes...

Sylvania offers designers

3 basic Traveling Wave Tube Types

6493 — low level amplifier

6496 — 10 to 1 voltage tunable oscillator

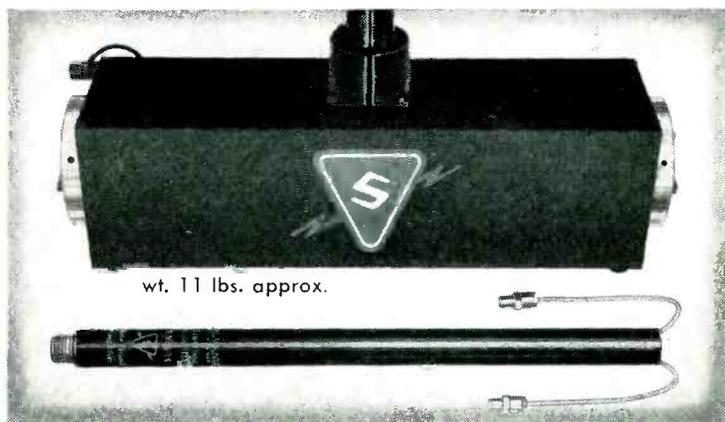
6559 — medium power amplifier

- All with 2000-4000 MC bandwidths
- Amplifiers require no tuning
- Encapsulated for ruggedness
- Aluminum foil lightweight solenoids available
- Complete technical data available on request

WRITE FOR COMPLETE TECHNICAL DATA



Type 6496—Tunable backward wave oscillator. 35 MW output, up to 1 watt. Complete 2000-4000 MC coverage.



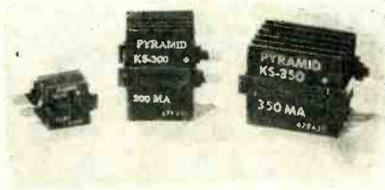
wt. 11 lbs. approx.

Type 6559—Medium power 2000-4000 MC amplifier. 1 watt output with greater than 25 db gain.

 **SYLVANIA**

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St.
Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY



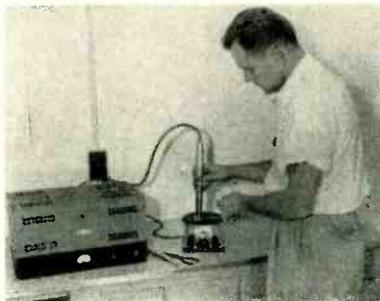
plates, light constant contact pressure which eliminates center-hot spots, rigid construction eliminating loose plates, smaller overall size per rating, and simpler mounting. Pyramid's new rectifier construction assures longer life and

minimum aging. The rectifiers can be used in all types of electronic equipment, including radio and tv circuits. They can be used as replacements for all existing standard rectifiers. Complete engineering data are available upon request.

FLUXLESS SOLDERER

for medium-sized work

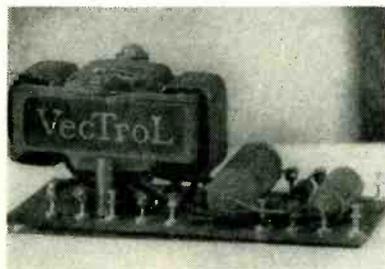
AEROPROJECTS INC., 310 E. Rosedale Ave., West Chester, Pa., has released a new model of Sonobond, ultrasonic equipment for fluxless soldering of aluminum, copper, brass, silver and magnesium. It consists of an ultrasonic generator, heating platen and a hand-operated soldering head and is designated model No. S-3-H-54-11. The unit



is particularly well adapted to hermetic sealing problems, electrical wire joints and other moderate size work. It will accommodate soldering tips varying in diameter from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. This versatile hand tool will tin aluminum in 3 to 5 seconds. A 50-watt tip heater can supply all the necessary heat for many small jobs. If the work piece is large, then the 600-watt heating platen can be used to supply additional heat.

PHASE SHIFTER

is supersensitive device



BROWNTHORN ELECTRONICS, INC., P. O. Box 1089, Stamford, Conn. The VecTrol phase shifter comprises a patented network of 4 rugged static components providing

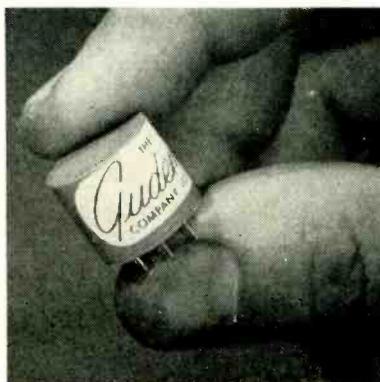
phase shift up to 360 deg. Linear proportional phase shift of 180 deg is obtainable with small change of either inductance or capacitance, as little as ± 1 percent at high frequencies, or ± 20 percent at low frequencies, with negligible time constant. Illustrated is the device using a saturable reactor as variable inductance for control of thyatron outputs up to several kw, from 0 to maximum, with d-c control signal less than 1 mw. The phase shifter with special small temperature sensing element controls thyatron

output continuously from 0 to maximum with temperature change as little as 0.5 F. The VecTrol circuit may be adapted to use existing commercial types of inductance or capacitance transducers to control thyatron output up to several kw in accordance with pressure, acceleration, temperature and so on, without further amplification. The phase shifter may be used for phase modulation or frequency modulation of radio transmitters for telemetering and the like, and provides ± 100 deg linear phase shift. This would amount to approximately four times that of conventional modulators.

PULSE TRANSFORMERS

for printed circuitry

GUDEMAN CO. OF CALIFORNIA, INC., 9200 Exposition Blvd., Los Angeles 34, Calif. Type GEM miniature plug-in pulse transformers are now available in the pulse width range from 0.05 to 2 μ sec—with 2 or 3 windings. They are epoxy resin impregnated and molded. Operating temperature range is from -70 C to 135 C, and they surpass MIL-T-27, grade 1, class A test specifications. Size is $\frac{5}{8}$ in. diameter \times $\frac{9}{16}$ in. high. Weight is approximately 5



grams. Terminals are 22 Awg copper wire (maximum length $\frac{7}{16}$ in.). High-potential test is 2,000 v rms.

COPPER FOIL

used in printed circuit work

THE PERMACEL CORP., U. S. Highway 1, New Brunswick, N. J., has introduced Permacel 195, a new adhesive coated copper foil designed for use in printed circuit work. The P195 has a heat resistance after

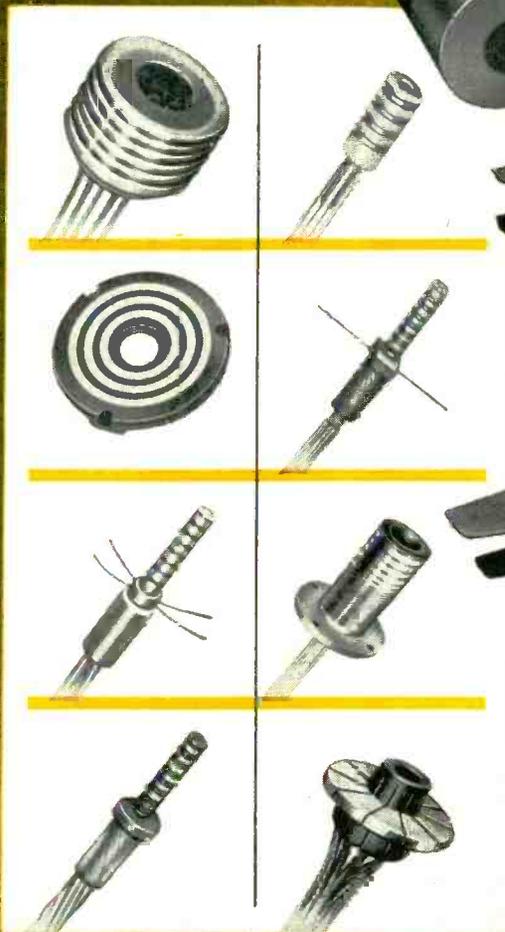
**INSTRUMENT CORPORATION
OF AMERICA**

slip ring & commutator assemblies

**One-piece construction*
assures high accuracy and
super-dependability to the
most rigid specifications.**

*Proven for
performance in
precision instruments
and equipment including
SYNCHROS, GYROS, RADAR,
FIRE CONTROL, TEST TABLES
and other CRITICAL APPLICATIONS*

Specify Instrument Corporation of America Slip Ring and Commutator Assemblies for closer tolerances, absolute uniformity and the ultimate in miniaturization. Whenever extreme dimensional precision, accurate concentricity and high dielectric qualities are required, Instrument Corporation of America assemblies are specified with confidence. One-piece, unitized construction eliminates dimensional variation due to accumulated errors, provides jewel-like finish, uniform ring hardness and reduced weight. Engineering "know-how" resulting from years of specialization and continuous collaboration with leading manufacturers all over the world is at your immediate service.



TYPICAL SPECIFICATIONS

- SIZES: .035" to 36" Diameter, Cylindrical or Flat
- CROSS-SECTIONS: Ring Thickness .005" to .060" or More
- FINISH: 4 Micro-Inches or Better
- BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
- RING HARDNESS: 70 to 95 Brinell
- SURFACE PROTECTION: Palladium and Rhodium, or Gold Prevent Tarnish, Minimize Wear & Noise

INSTRUMENT CORPORATION OF AMERICA
BLACKSBURG · VIRGINIA

* ELECTRO DEPOSITION PATENTED PROCESS AVAILABLE UNDER EXCLUSIVE LICENSE AGREEMENT WITH ELECTRO TEC CORP.

LOOK to INTERNATIONAL RECTIFIER

Cartridges

HIGH VOLTAGE TYPES
DC output voltage from 20 volts to 20,000 volts and up. DC output current, half wave from .2 MA to 195 MA. Cell diameter: 1/16" to 1". Length: from 1/2" to 12"
Write for Bulletin H-2

Selenium Rectifiers

DC POWER TYPES
Ratings to 250 KW, 50 MA to 2,300 amperes and up. 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. Ambient temperature range to 125°C with proper derating.
Write for Bulletin C-349

HERMETICALLY SEALED TYPES
Recommended for airborne equipment. Available in all types and sizes from .2 MA to 195 MA, DC current output, half wave.
Write for Bulletin H-2

TV & RADIO TYPES
Input ratings from 25 to 195 volts AC and up. DC output current from 10 to 1,000 MA. Available in half wave and voltage multiplier units. Bridge units available to 1200 MA.
Write for Bulletin ER-178A

Widest Range in the Industry

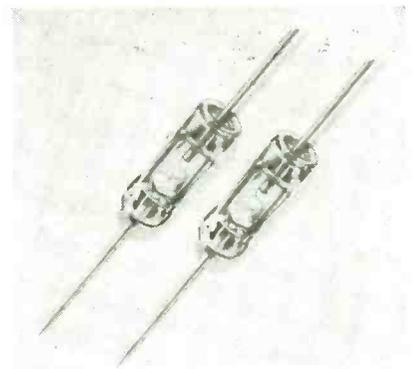
INTERNATIONAL RECTIFIER CORPORATION

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World's Largest Supplier of Quality Industrial Rectifiers

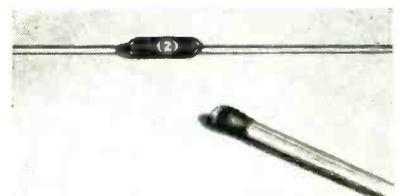
NEW YORK
CHICAGO

cure to solder of 410 F for 10 sec. This 1-oz electrolytic copper foil coated with a thermosetting adhesive in dry film form, can be laminated to materials such as steel, brass, bronze, aluminum and wood, in addition to phenolics. Used for printed circuits in such areas as radios, hearing aids, tv and numerous electrical and electronic applications, where miniaturization is desired, P195 sets at a glue line temperature of 325 to 350 F for a period of 10 to 20 minutes. Pressure required for lamination is from 100 to 2,000 psi.



GERMANIUM DIODES of subminiature glass type

TRANSITRON ELECTRONIC CORP., 403 Main St., Melrose, Mass., has available a line of subminiature glass germanium diodes with gold bonded construction. These diodes feature superior forward conductance, higher inverse resistance and greater ruggedness. An example is the type T8G, which offers over 5 megohms at 100 v inverse, and under 10 ohms at 1 v forward. Ask for bulletin TE-1319.



SMALL RESISTOR is a 3-watt unit

SPRAGUE ELECTRIC Co., 35 Marshall St., North Adams, Mass., has available a new subminiature 3-w wire-wound resistor. Developed especially

FREQUENCY STANDARD

This precision instrument is a source of highly stabilized frequencies covering the range from 10 kc to 50 mc at intervals of 10 kc, 100 kc, or 1 mc. Stability of one part in 10^7 per 24 hours has been achieved by a unique method of temperature stabilization. Frequency dividers and multivibrators develop the wide range of frequencies available.



MODEL 701

MODULATION MONITOR

The Model 252 Modulation Monitor measures the percentage of modulation of AM transmitters operating from 100-225 mc, or 225 mc-400 mc. It features: wide VHF range; over-modulation indicator; carrier level indicator; audio output monitoring; low noise and hum.

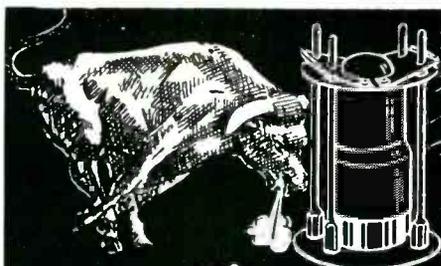


MODEL 252

Write for catalog and detailed specifications.

NEW LONDON INSTRUMENT Company

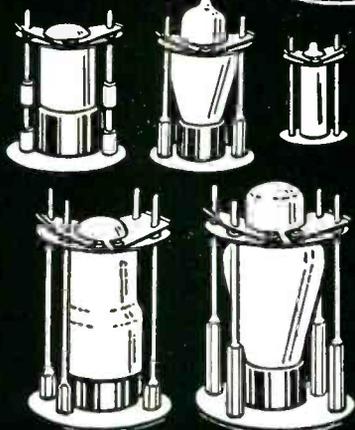
P. O. BOX 189E
NEW LONDON, CONN.



SHOCK PROOF

VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.



Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DL, ST14, S14, ST16, T5½, T6½, MT-1C, ST19, T14, ST128CT-9.

Manufacturers of
Electronic Components

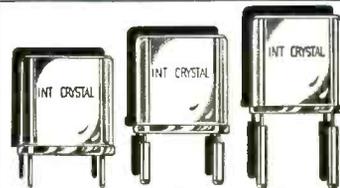
JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.



ONE DAY SERVICE ON QUARTZ CRYSTALS

throughout the range of frequencies from 1500 kilocycles to 50 megacycles. Fundamental Crystals — 1500 KC - 15000 KC. Overtone Crystals — 15 MC - 50 MC.

All orders of less than five units of any one frequency in the range 1500 KC - 50 MC - will be mailed within 24 hours from the time received.



F-605	F-609	F-612
Pin dia. .050	Pin dia. .095	Pin dia. .125
Pin length. .238	Pin length. .445	Pin length. .620

Pin spacing on each of above is .486

WHEN ORDERING SPECIFY:

- (1) Frequency
- (2) Holder Type*
- (3) Circuit Data (32 mmf load, series resonance, etc.)
- (4) End Use (Equipment type & manufacturer, development, etc.)

*Adaptors can be supplied for 3/4" pin spacing.

Calibration

All fundamental crystals are calibrated into 32 mmf unless otherwise specified. All overtone crystals are calibrated for series resonance, unless otherwise specified.

All units are calibrated to .0025% or better of their nominal frequency at 25° C.

For further information write, wire or call:

International
CRYSTAL Mfg. Co., Inc.

18 N. Lee
OKLAHOMA CITY, OKLA.
Phone FO 5-1165

Standard and Special Constructions—

"HLT 500B"
120°C WIRE

NYLON
JACKETED
WIRES



CHESTER *plasticord-plasticote* WIRES & CABLES

— FOR EVERY
ELECTRICAL
AND
ELECTRONIC
NEED!

It pays to make CHESTER quality-engineered wire and cables your standard for both commercial and military requirements. Every foot of conductor bearing the Chester label is laboratory tested and service-proven to perform as specified. Chester extra-strength plastic coatings are made super-durable for longer life and smooth pliability assures the easier working qualities that speed wiring production.

NEW CHESTER BULLETINS

Complete data and specifications on quality conductors for all electronic wires and cables will be supplied promptly. Call or write, today!

MIL-W-5086 HOOK-UP WIRE

JAN-C-76 WIRES SRIR, SRHV, SRRF, WL
Solid Colors or Spiral Marking

TV LEAD-IN WIRES

LACQUERED WIRES

SHIELDED WIRES & CABLES

INSTRUMENT WIRES

COAXIAL CABLES

SPECIAL WIRES & CABLES
TO SPECIFICATIONS

"Chester"
says —

For Dependable Wiring,
Connect It with Chester!



CHESTER CABLE CORP.
CHESTER, NEW YORK

NEW PRODUCTS

(continued)

for use in military and industrial electronic equipment, the tiny unit will find wide application in point-to-point and terminal board wiring as well as on printed wiring boards. The unit is only $\frac{1}{8}$ in. in diameter by $\frac{1}{2}$ in. in length and has a maximum resistance value of 10,000 ohms. Complete description of the new resistor is given in Engineering Bulletin 111-B, which lists standard resistance values.



MICROPHONE with transistor preamplifier

REMLER Co., 2101 Bryant St., San Francisco, Calif., has available a transistorized magnetic microphone in a new hand-held design. Transluctance model A-258 is a high quality magnetic microphone with a 2-stage built-in transistor amplifier. Its inherently low noise and h-f response yields dramatic improvement in speech intelligibility in vhf communication and audio announcing under difficult conditions. The amplifier uses 2 junction-type transistors in a circuit specially designed to afford suitable impedance matching and peak clipping. For strength and compactness, the miniature components are assembled on a tiny copper laminate base, etched to provide interconnections in the printed circuit technique. The entire unit is plastic-coated and then mounted within the microphone capsule. Frequency response of model A-258 is ± 6 db from 500 to 6,000 cps, with a 6 db per octave fall-off from 500 cps down.

H-F GENERATOR for dielectric heat sealing

INDUSTRON CORP., 50 Brooks Road, Needham Heights, Mass., announces an h-f generator for dielectric heat sealing which will operate within

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS

The accurate transmission of electrical impulses through a movable contact is dependent solely upon the properties of that contact. Illustrated at the right is a Ketay Synchro, which is the heart of many precision indicating, communicating and control devices. Ketay is noted for Synchros and Resolvers capable of extreme accuracy. Therefore, Ney Precious Metal Contacts have been selected because of their practically ideal physical and electrical properties.

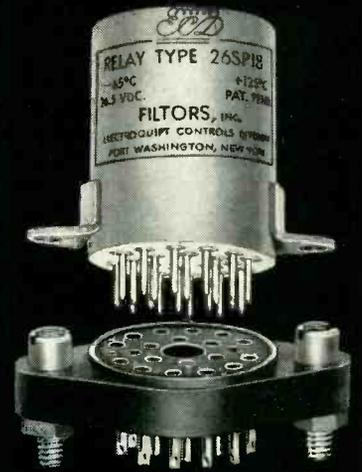
Ney Precious Metal Alloys have high resistance to tarnish, are unaffected by most industrial corrosive atmospheres, and are fabricated into slip rings, brushes, commutator segments, wipers, contacts and similar components for use in electrical instruments. Call on the Ney Engineering Department for help in selecting the right Ney Precious Metal Alloy which will improve and prolong the life and accuracy of your instruments.



THE J. M. NEY COMPANY
379 ELM STREET, HARTFORD 1, CONN.
Specialists in Precious Metal Metallurgy Since 1812

7NY54B

SUBMINIATURE RELAY-Plus!



ACTUAL SIZE

**Compact . . . Rugged . . .
Lightweight . . .
6PDT arrangement**

ALL these features are achieved by the use of an extremely efficient rotary motor, precision built, with hydrogen annealed parts.

COMPACT — One inch diameter, with 1-5/16" long enclosure

RUGGED — Withstands operational shock of 50 G's and operational vibration of 5-500 C.P.S. at 10 G's. Altitude to 80,000 feet. Ambient temperature range of -65°C to +125°C.

LIGHTWEIGHT — Only 2.6 ounces (even with mountings interchangeable with larger relays of other manufacture).

Tests of production relays, under USAF supervision, have proven that this relay meets or exceeds the requirements of MIL-R-5757B.

Based on 1,000,000 operations, contacts are rated at 3 amperes at 26.5 V.D.C. or 115 V.A.C., 60 to 400 CPS.

Coil resistance values range from 6 ohms to 14,000 ohms.

Other standard contact arrangements are 2 PDT, 3 PDT and 4 PDT. All are available with solder-type terminals.

Fill in coupon for catalog.

FILTRORS, INC.

30 Sagamore Hill Drive
Port Washington, L.I., N.Y.

Please send data sheets on your subminiature relays.

NAME

TITLE

COMPANY

CITY STATE

**SPACE SAVERS FOR
MODERN CIRCUITRY -
MONEY SAVERS FOR
PRODUCTION ECONOMICS -**



IN-RES-CO TYPE IR WIRE WOUND RESISTORS

The practical, low cost solution for circuit designers striving for the subminiature. Type IR units offer precision resistance values capable of retaining stability through long periods of continuous or intermittent service. Type IR resistors are available at prices based on mass production methods of manufacture. Wound to a tolerance of $\pm 1\%$, they are permanently accurate. Conservative ratings allow ample safety margin in all classes of service. Special Bakelite forms eliminate shrinking, swelling and temperature effects. IN-RES-CO moisture and fungus proof coating offers absolute protection against climatic extremes. Specify IR Type resistors for all applications where precision performance and limited space are important determining factors.

INSTRUMENT RESISTORS CO.

COMMERCE
AVENUE



UNION
NEW JERSEY

APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION

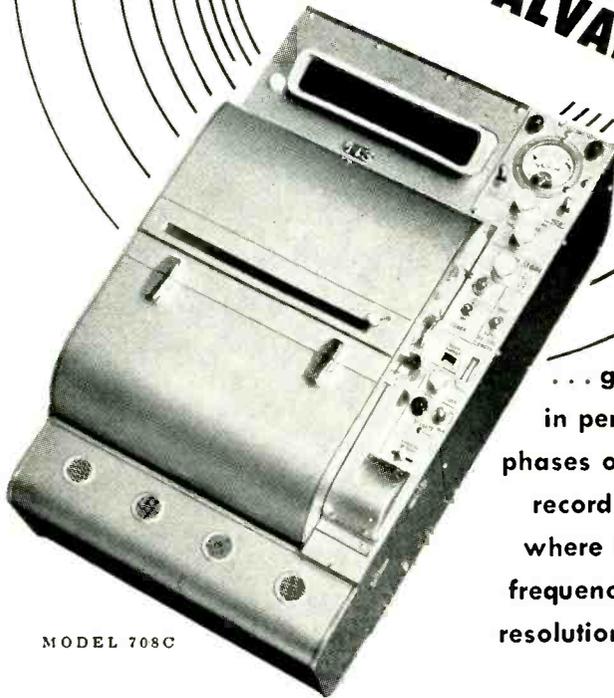
**WRITE FOR NEW RESISTOR
HANDBOOK** — Contains
complete data and recom-
mended applications
for resistors for every
purpose.



MINNEAPOLIS
Honeywell

Heiland INSTRUMENTS

**RECORDING
OSCILLOGRAPHS and GALVANOMETERS**



MODEL 708C

... give the ultimate
in performance in all
phases of oscillographic
recording, particularly
where high sensitivity,
frequency response and
resolution are important.

High sensitivity consistent with extended frequency range of galvanometers is achieved through special design characteristics backed by 20 years experience in the manufacture and design of recording instruments. Better resolution is obtained through increased record travel and writing speeds. The result is high amplitude recording of static and dynamic phenomena in the 0 to 3000 cps frequency range with extremely small input signals.

*Write for complete information concerning our
oscillographs, galvanometers and
accessory bridge balance units and amplifier systems.*

Heiland

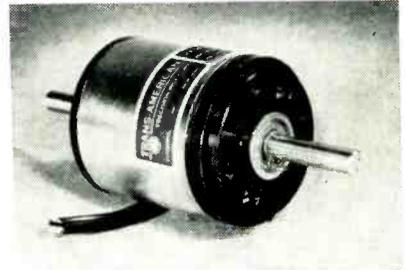


A DIVISION OF MINNEAPOLIS-
HONEYWELL
130 E. 5th Ave., Denver 3, Colo.

NEW PRODUCTS

(continued)

the FCC allocated limits of the 27-mc industrial band, eliminating the need for a shielded room. The new generator, with a single dial selector for a full range of desired sealing capacities is extremely simple in design, and an improved power source for dielectric heat sealing of thermoplastic materials. The generator, conservatively rated, is available in 1 and 2-kw models.

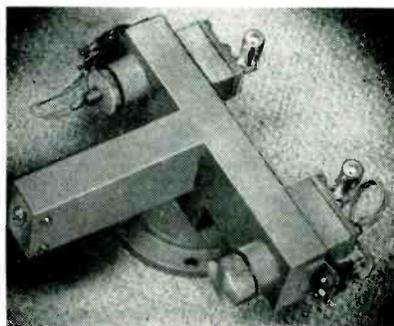


MAGNETIC CLUTCH
for use in precision devices

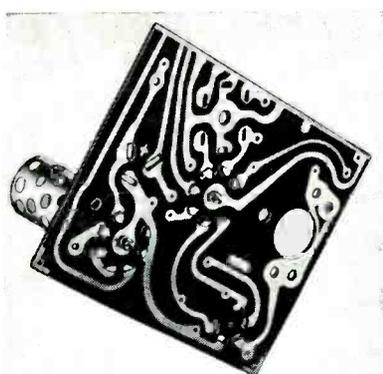
TRANS-AMERICAN PRECISION INSTRUMENT CORP., 34-17 Lawrence St., Flushing 54, N. Y. Model T500 magnetic clutch is a precision electromechanical component for use in high accuracy computers, servo systems and similar devices. Couplings are designed so that they will not induce angular displacement error into the system upon engagement. Input and output shafts are magnetically coupled when the coil is energized. Mounting is identical to Mk 8 Mod O servo motor. The case is 1.750 in diameter by 2.062 long. This size unit can cover a wide range of torque-to-current ratios. The company will also modify the shafts, provide terminals or cable to any length and supply precision gears to the customer's specifications for input and output requirements.

**MICROWAVE
ENVELOPE DETECTOR**
requires no amplifier

AIRCRAFT ARMAMENTS, INC., 4003 Seven Mile Lane, Pikesville 8, Md. Model 433 microwave envelope detector permits direct viewing of high level r-f pulse envelopes. The distortions and uncertainties caused by amplifier characteristics are



completely eliminated. Push-pull outputs are provided by two microwave diodes which terminate the collinear arms of the magic T. These output voltages can be applied directly to the vertical deflection plates of a c-r tube. With care, bandwidths of 100 mc can be attained. The pulse thus viewed on the crt is virtually distortion-free. It is available with center frequencies of 9.25 kmc (RG-52/U) and 5.65 kmc (RG-50/U).



WAFER SOCKET
for printed circuit use

METHODE MFG. Co., 2021 Churchill, Chicago, Ill., has available a newly designed laminated tube socket for printed-circuit application. Sockets utilize twin wafers supporting contacts with vertical terminals which snap into individual holes in the circuit panel. This permits the printing of jumpers on the circuit panel to connect different pin positions. Static load tests indicate that this socket, properly dip-soldered into a multiple-hole pattern in a printed wiring panel, will withstand a force ten times normal tube withdrawal force with the printed circuit base material fracturing before failure of terminal connections. Sockets are available

When size is important...



FOR SLIP RING ASSEMBLIES NO BIGGER THAN THIS CALL P M I.

Slip ring assemblies we have made measure no more than .080" diameter by .450 inches. We can make them smaller or larger, with more or fewer circuits. Many of our miniature slip ring assemblies are carried in stock and can save you development and die costs. Ask for booklet, "Miniature Slip Ring Assemblies."



ACTUAL SIZE

- 1. Coin silver rings molded in melamine.
- 2. Gold rings molded in nylon.
- 3. Plated rings in cast resin.



P M INDUSTRIES, INC.

270 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

RAYONIC CATHODE RAY TUBES

by

Waterman

TYPE 3SP

ANOTHER
EXAMPLE OF


PIONEERING


The introduction of the 3SP type Waterman RAYONIC cathode ray tube has been received with great enthusiasm. Its unique applications have more than justified enthusiasm. From a mechanical standpoint alone, this acceptance has been based upon the fact that two 3SP cathode ray tubes occupy the same space as a single 3 inch round tube—a feature which makes the tube an outstanding performer in multi-trace work. As many as ten tubes have been mounted across a standard relay rack panel without crowding. The low deflection factors of the 3SP have still further widened its use in single cathode ray tube video devices. The choice of screen is optional and available in P1, P2, P7 and P11 phosphors. The 3SP1 is available with JAN stamping. Let the 3SP type Waterman RAYONIC cathode ray tubes add their new concept of compactness to your own equipment.

TECHNICAL DATA The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table below. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.

TUBE	PHYSICAL DATA			STATIC VOLTAGE			DEFLECTION*		LIGHT OUTPUT**
	Face	Length	Base	A3	A2	A2 Max.	Vert	Hor	
3JP1	3"	10"	Med Diheptal	3000	1500	2000	111	150	352
3MP1	3"	8"	Sm Duodecal		750	2500	99	104	33
3RP1	3"	9 1/8"	Sm Duodecal		1000	2750	61	86	44
3SP1	1.5x3"	9 1/8"	Sm Duodecal		1000	2750	61	86	44
3XP1	1.5x3"	8 7/8"	Loctal		2000	2750	33	80	218

*Deflection in volts per inch.

**Light output of an element of a raster line (one mm long and not exceeding .65mm in width) in microlumens.

All heaters 6.3 V AC, .6 AMP.

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA. CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE

3JP1, 3JP7, 3SP1, 3XP1 JAN RAYONIC®

Cathode Ray Tubes

3JP—3MP—3RP—3SP—3XP RAYONIC

CATHODE RAY TUBES

Available in P1, P2, P7, and

P11 Phosphors

POCKETSCOPES® PULSCOPES®

RAKSCOPES®

And Other Associated Equipment

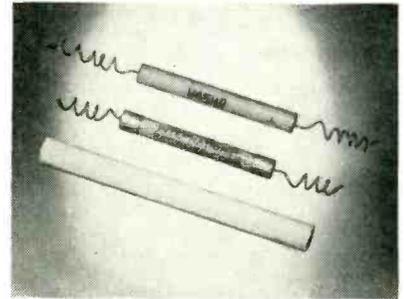
MEMO...

Write for details today!



WATERMAN PRODUCTS

in 7 and 9-pin types and to be used either with or without tube shields. They are designed primarily for use in large volume commercial receiver applications and can be furnished in most grades of sheet phenolic and polyester fiberglass insulating material.



SELENIUM RECTIFIERS

for use in Geiger counters

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Two cartridge type selenium rectifiers, types U45HP and U50-HPF, have been developed for use as h-v power supplies in Geiger counters, electrostatic deflection voltage supplies for airborne equipment, and other similar instruments. Type U45HP pictured is a half-wave unit, 2 in. long and 1/4 in. o-d, supplied with pigtail leads. It will deliver 1.5 ma maximum at 900 v d-c. Type U50-HPF, the second cartridge pictured, is a half-wave unit supplied with pigtails and ferrule terminals and delivers 1.5 ma maximum at 1,000 v d-c. This rectifier measures 1 1/8 in. in length with 1/4 in. o-d. Ratings and specifications are given in bulletin H-2.

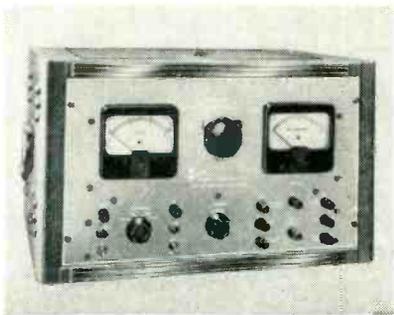


RADIO NOISE FILTER

for fuel booster pumps

THE POTTER Co., North Chicago, Ill., has developed a radio noise filter for fuel booster pump applica-

tion. It weighs only 11½ oz and measures ¾ in. × 2¾ in. o.d. with resultant volume of 4.77 cu in. Center hole design allows access to the drain plug of the booster pump. Along with meeting the environmental and vibration requirements prescribed by specification MIL-E-5272A, this new 20-ampere continuous duty filter is engineered to comply with the radio noise limits set forth in specification MIL-P-5238.



D-C POWER SUPPLY is voltage-regulated unit

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 807 voltage-regulated d-c power supply has been designed for general lab and production line use and to provide power for l-v klystrons. It features a wider than usual output range with a B-supply ranging from 0 to +600 v, 0 to 200 ma; and a C-supply from 0 to -250 v, 0 to 5 ma. It will provide klystrons with up to -600 v cathode voltage and an additional 0 to -250 v for the reflector. Higher voltages may be obtained through stacking two or more units because none of the supply voltages are grounded to the chassis. Voltage regulation is ±0.25 v change for both line fluctuations of ±10 percent and load changes from 0 to maximum, except for the variable C supply. The latter offers ±0.25-v change for line fluctuations with a constant load. Ripple is less than 4 mv.

COAX LOUDSPEAKER features improved magnet

STEPHENS MFG. CORP., 8538 Warner Drive, Culver City, Calif. The Tru-Sonic model 206AXA 15-in. coaxial

for MIL-I-7444A(1) SPECIFICATION VINYL SLEEVING



Resinite EP-93

**NOW
AVAILABLE**

IN ALL 3 SIZE RANGES

- Low Temperature Flexibility to -90° F (impact test)
- Flame resistant — all sizes self extinguishing in less than 15 sec.
- High Temperature Stability up to 260° F
- Completely fungus resistant

For use wherever Air Force Specification MIL-I-7444A, Amend. 1 applies, Resinite EP-93 Vinyl Insulation Sleeving is now available. Here is one outstanding source—one material—to meet the requirements of all 3 size ranges of this specification.

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One order will show you why more Resinite Specification Vinyl Sleeving than all others is used by the aircraft and electronics industries. Write for samples and performance data.

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RESIN INDUSTRIES, INC. SANTA BARBARA, CALIF.
SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS AND PHARMACEUTICAL FIELDS



Your source for 2K50 REFLEX KLYSTRON TUBES

The new Bendix Red Bank 2K50 is the perfect answer for those who want a thermally-tuned Reflex Klystron tube for K-band operation.

The 2K50 has two primary applications—first, as a local oscillator in small, compact, lightweight, high definition radar and, second, as an oscillator in microwave spectrometers, signal generators and spectrum analyzers.

Because of its thermal feature, the 2K50 may be tuned automatically. Thus, it is ideally suited for difficult locations . . . in aircraft, for example . . . where direct or mechanical tuning is not practical.

Perfection of the complex, ultra-precision 2K50 . . . one of the most difficult electron tubes to manufacture . . . is a tribute to the unique talents of our engineers and production men. It demonstrates why you can depend on Bendix Red Bank for the answer to *any* special-purpose electron tube problem you may have.

MAXIMUM RATINGS

Resonator Voltage.....	330 volts D.C.
Reflector Voltage.....	-150 volts D.C.
Tuner Grid Voltage.....	-50 volts D.C.
Filament Voltage.....	6.3 ± 8% volts
Gun Cathode Current.....	28 ma. D.C.
Tuner Cathode Current.....	10 ma. D.C.

ELECTRICAL CHARACTERISTICS

Heater Voltage (A.C. or D.C.).....	6.3 volts
Heater Current.....	755 amps.
Thermal Tuning Range.....	23216 to 24751 Mc/Sec.
Min. Power Output at 23504 Mc/Sec....	8.5 mW.
Min. Power Output at 23984 Mc/Sec....	10.0 mW.
Min. Power Output at 24464 Mc/Sec....	8.5 mW.
Min. Electronic Tuning at Mid-Band..	55 Mc/Sec.

PHYSICAL CHARACTERISTICS

- Dimensions: Maximum seated height 2 1/4" • Base: Small Octal 8-Pin, B8-21, Low Loss Phenolic Wafer • Coupling to Wave Guide: Direct, by means of an insulating fitting • Cooling: Convection • Mounting Position: Any • Cavity: Silver Plated Steel (integral within the bulb) • Bulb: Metal • Output Window: Low loss glass

Manufacturers of Special-Purpose Electron Tubes,
Inverters, Dynamotors, Voltage Regulators
and Fractional HP D.C. Motors.



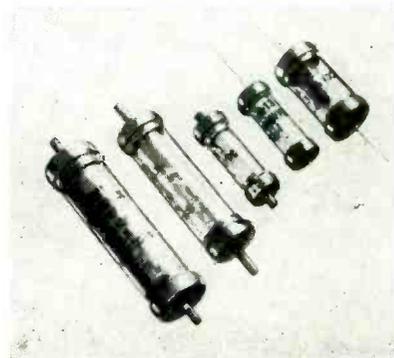
DIVISION OF



EATONTOWN, N. J.

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

loudspeaker employs a dividing network and also features a means of adapting the h-f response to the listener's individual taste as well as varying room acoustics. Also incorporated is an improved 7 1/2-lb Alnico V magnet, which operates two voice coils. The 2-in. voice coil actuates a 15-in. cone which reproduces the low frequencies down to 30 cps. A separate h-f driver with a Dural diaphragm and a 1 1/2-in. voice coil operates coaxially into a true multicellular horn for even wide-angle dispersion of the high frequencies to 18,000 cps. Impedance is 16 ohms. Power capacity is 30 w.



H-V CAPACITOR is small and light

FILM CAPACITORS, INC., 3400 Park Ave., New York, N. Y., are producing a high-voltage capacitor of extremely small size and light weight. A new high-breakdown plastic film is being employed to produce capacitors much smaller and lighter than previously available. These capacitors operate at temperatures to 125 C, with voltages from 2 to 60 kv. They are available with hermetic glass or plastic tube housings with wire leads or threaded stud mountings.

ANALOG COMPUTER features 30 amplifiers

MID-CENTURY INSTRUMATIC CORP., 611 Broadway, New York 12, N. Y. The MC-500 analog computer features 30 chopper-stabilized amplifiers, removable problem board, 54 0.1-percent scale-factor potentiometers, 16 diode limiters, 2 dpdt relays and amplifiers and extreme



accessibility. Provision for 3 servo multipliers, or 3 electronic function generators, is also incorporated. An overall accuracy of 0.1 percent of full range from -100 v to $+100 \text{ v}$ is achieved. Color coding and labeling of the 800 jacks on both patch bay and problem board are identical. Programming may be carried out directly on the machine as well as on the removable boards.



TINY RESISTOR features high resistance

THE DAVEN Co., 191 Central Ave., Newark 4, N. J., is producing a new subminiature, encapsulated resistor. The type 1273 is only $\frac{1}{8}$ in. in diameter by $\frac{1}{16}$ in. long and can be supplied with up to 400,000 ohms maximum resistance. Mounting is by radial leads and power rating is 0.1 w. This resistor is made in accordance with MIL-R-93A specifications, meets all humidity requirements and can be used from -55 C to $+125 \text{ C}$. It is available in accu-

Electro-Voice®

SPEAKS UP ON...



PHALO COM CABLES

- ✓ CONDUCTIVITY
- ✓ FLEXIBILITY
- ✓ DURABILITY

PHALO COM Scores High In ALL THREE!

Electro-Voice, Inc. of Buchanan, Michigan, pioneer producers of electro-acoustic products, have this to say about the Phalo Com cables used in famous Electro-Voice equipment — "The main advantages of the Phalo cables we use on our microphones are their excellent conductivity, flexibility and durability".

Throughout the wide field of communications, Phalo cables are very much "in the current picture to stay". Have you compared Phalo cable qualities with those of your present cables? Why not make the test NOW!

Write PHALO for cable samples — or the name of the Phalo cable man nearest you.

Complete Phalo catalog on request.

PHALO PLASTICS CORPORATION
CORNER OF COMMERCIAL STREET, WORCESTER, MASSACHUSETTS

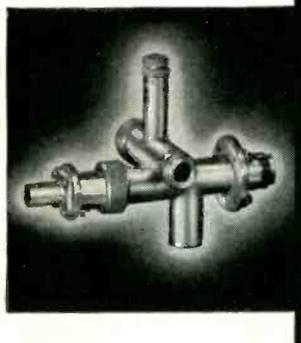
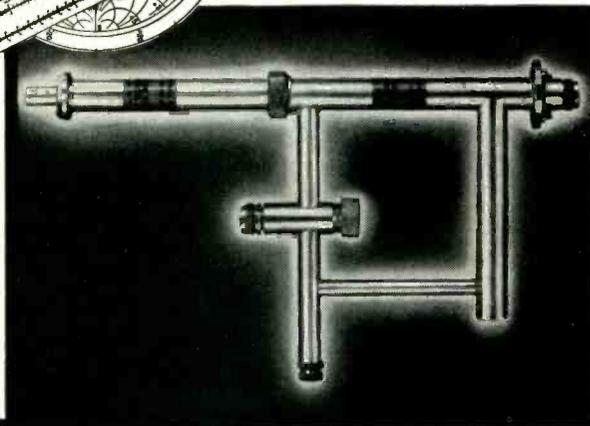
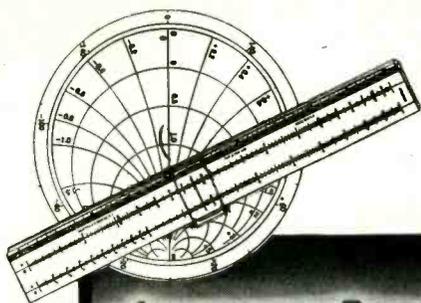
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Insulated Wire and Cables — Cord Set Assemblies



why
design
your
own

COAXIAL CRYSTAL MIXERS



...you can buy them from stock!

Save time... reduce costs... avoid design headaches. Empire Devices offers a wide variety of standard broad band, fixed tuned coaxial crystal mixers to meet your needs. Specialized manufacturing facilities and techniques result in economy, and a high degree of quality control by competent engineers assures uniformity in manufacture. Immediate delivery in many instances.

Select one of 8 models in the CM-107 Series, covering the entire frequency range from 225 to 5600 mc. Input VSWR of any crystal mixer in the line is better than 2:1, without adjustments, for all frequencies within its rated range. Local oscillator input requires 10 milliwatts, has a VSWR of 2:1 or better with any injector adjustment. A choice of input connectors is available. Standard models can be modified for special purposes!

For complete engineering data, ask for our free catalog P1

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EMPIRE DEVICES
PRODUCTS CORPORATION

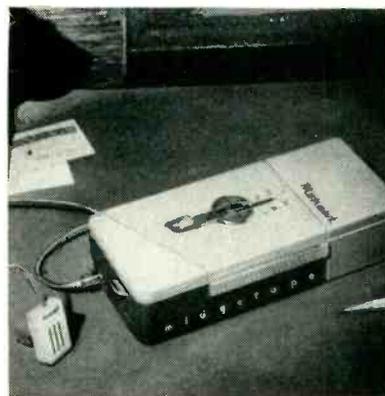
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manufacturers of

FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

NEW PRODUCTS

(continued)

racies to ± 0.05 percent and can be supplied with any type resistance wire depending upon the temperature coefficient required.



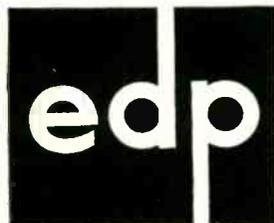
RECORDER is pocket-size tape unit

MOHAWK BUSINESS MACHINES CORP., 944 Halsey St., Brooklyn 33, N. Y. The Midgetape pocket recorder is $8\frac{1}{2}$ in. long, $1\frac{1}{8}$ in. deep, $3\frac{1}{4}$ in. wide and weighs $3\frac{1}{4}$ lb. It is priced at \$229.50 (which includes a recording cartridge, batteries, crystal microphone and earphone). The new unit is completely battery operated and cartridge loaded. The Midgetape has only three controls, records for an hour on dual track tape and simultaneously erases old material as new recordings are made. Hearing-aid type batteries, which snap-fasten into the unit, have an extended life of over 45 hours.

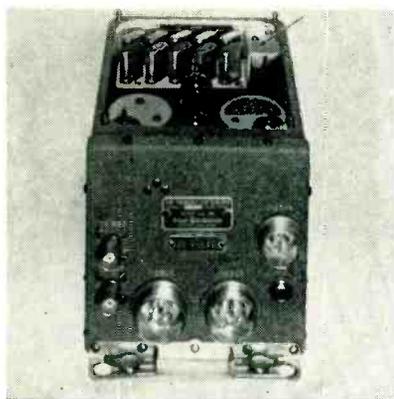


PULSE GENERATOR is a versatile unit

ELECTRO-PULSE, INC., 11811 Major St., Culver City, Calif. Model 4120A pulse generator is a low cost highly versatile unit capable of repetition rates of 30 cycles to 300 kc in 4

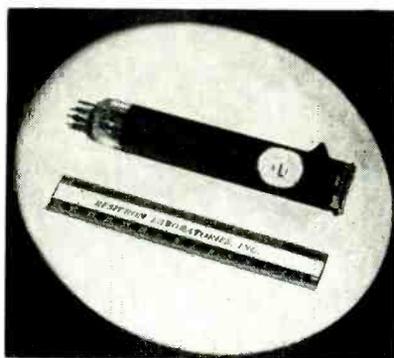


decade steps, variable pulse width from 0.2 μ sec to 100 μ sec in 2 ranges, and variable pulse delay from 1 μ sec to 100 μ sec in 2 ranges. A positive sync trigger pulse is available for reference. The main output pulse, both positive and negative, is available from low impedance in separate video connectors.



CRYSTAL ADAPTER for vhf transmitters

AIRCRAFT RADIO CORP., Boonton, N. J. The 16950 crystal adapter provides each ARC type T-11B vhf transmitter with ten communication channels instead of five. It is particularly suitable to the 4-6 place twin engine executive aircraft where frequency-flexibility is an important factor. Weight of the unit is 22 lb.



CAMERA TUBE features high sensitivity

RESITRON LABORATORIES, INC., 2025 Pontius Ave., Los Angeles 25, Calif. Type 6198 small camera tube is designed for industrial, military, tv broadcast and amateur uses. It combines high sensitivity and resolution together with long life. Di-

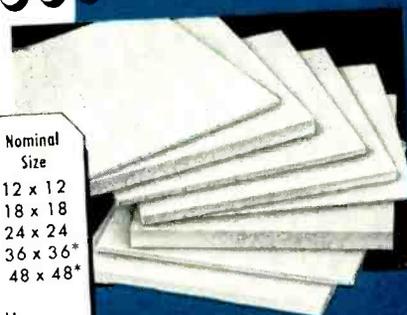
Teflon...*

Your Best Source Is



Thickness Inches	Nominal Size
1/16	12 x 12
3/32	18 x 18
1/8	24 x 24
3/16	36 x 36*
1/4	48 x 48*
3/8	
1/2 & Up	

* Can be furnished in 1/2 sheets



SHEET

HERE'S WHY: You can order in quantity and in a wide variety of sizes—and be certain of complete uniformity throughout. Our strict density control assures you thoroughly non-porous Teflon—free from any flaws which might possibly affect your end use or product. Dimensions are accurate to your most critical tolerances—no rejects, waste of material or loss of time. You get product purity—Teflon at its best in every one of its remarkable characteristics. Delivery is prompt—you get the quantity you want when you want it.

DIAMETER INCHES	
1/4	1
3/16	1 1/16
3/8	1 1/8
7/16	1 1/4
1/2	1 3/8
5/8	1 1/2
3/4	1 3/4
7/8	2
	2 1/4
	2 1/2
	3

Other diameters on specification



ROD

TYPICAL SIZES INCHES	
O. D.	I. D.
1/4	1/4
3/8	3/8
1/2	1/2
3/4	3/4
1	3/4
1 1/2	1
2 1/2	1 1/2
3	1 3/4



TUBING

Characteristics of Teflon

- CHEMICAL**
Completely inert.
- ELECTRICAL**
Very high dielectric strength. Extremely low power factor.
- THERMAL**
Temperature range -300° to +500° F.
- MECHANICAL**
Strong, flexible, weather resistant.
- LOW COEFFICIENT OF FRICTION**
Absolutely non-stick.

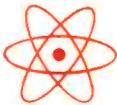
* DuPont Trademark

Request full information and ask for our bulletin, The Best in Teflon. Crane Packing Co., 1802 Cuyler Ave., Chicago 13, Ill.
In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.



Teflon. Crane Packing Co., 1809 Belle Plaine Ave., Chicago 13, Ill. • In Canada: Crane Packing Co., Ltd.,

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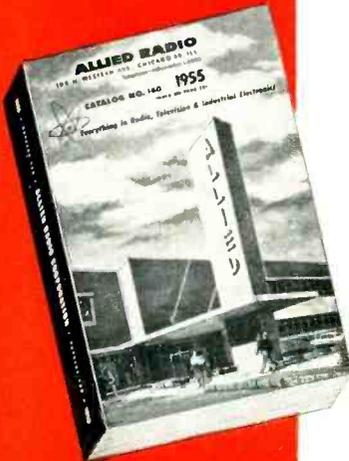
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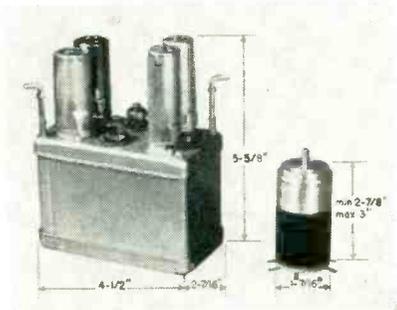
ALLIED RADIO

100 N. Western Ave., Dept. 11-A-5
 Chicago 80, Illinois

NEW PRODUCTS

(continued)

mensions are approximately 1-in. face diameter and 6½ in. high (including pins). The photoconductive spectral response approximates very closely that of the human eye. Photoconductive surfaces of different spectral responses are available upon request. This tube design is adaptable to a wide selection of commercially available lenses.



SERVO SYSTEM is completely packaged

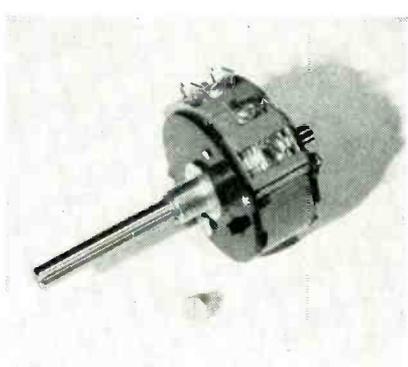
FEEDBACK CONTROLS, INC., 1332 North Henry St., Alexandria, Va., has available a new, complete packaged servo system, including amplifier, motor and gear train. The amplifier is equipped with screw-driver adjustments to peak the system to a wide variety of load conditions. Applications include: synchro data transmission systems, follow-up systems, laboratory and industrial instrumentation, simulators, computers, fire control equipment and automatic systems. Characteristics for two models of the system are given in data sheet PR-0234.



RECTIFIER KITS save engineers' time

BRADLEY LABORATORIES, INC., 168 Columbus Ave., New Haven 11, Conn., has available a series of

vacuum-processed selenium rectifier kits designed to save the development engineer time. They contain fully assembled rectifiers marked with commercial coding. The series of 7 kits will enable the engineer to have on hand the full range of commercially available selenium rectifiers, saving the usual week to 10-day delay in obtaining samples. The new series offers a complete range of sizes and rating from $\frac{1}{8}$ -in. diameter plates to 5-in. \times 6-in. plates, with ratings from 1.5 ma d-c up to 3,700 v peak inverse to types rated at 10 amperes and 222 v.

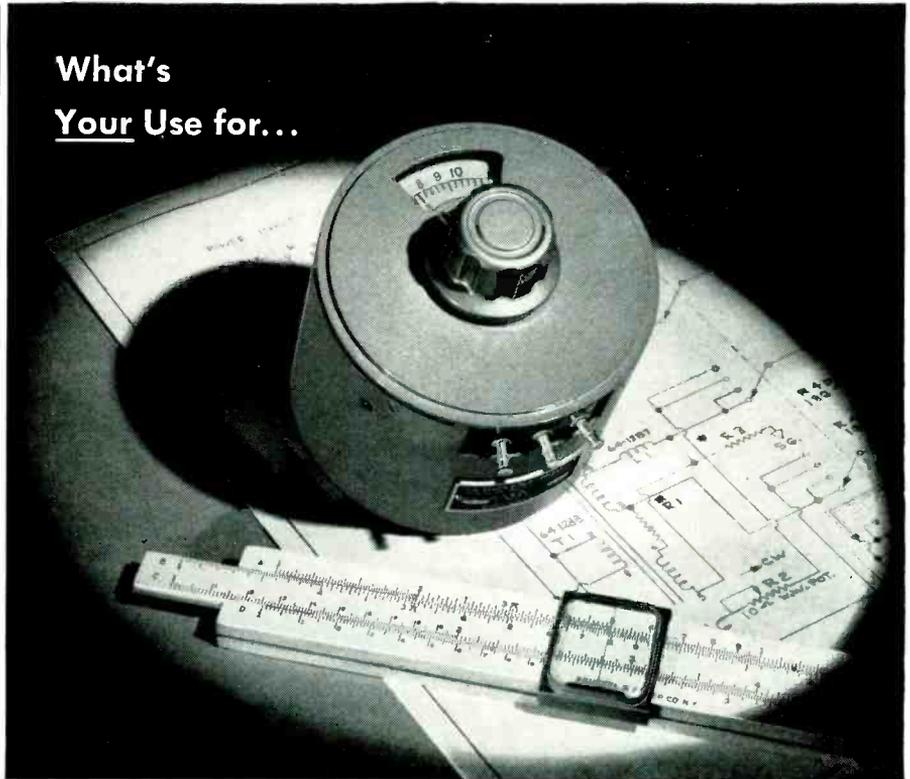


PRECISION POTS
meet needs of prototypes

CLAROSTAT MFG. CO., INC., Dover, N. H. Series 42-900 precision potentiometer has been developed to meet the needs of prototypes and laboratory testing. The new controls are based on the design of the series 42, but with such added features as: gold-plated bushings, terminals and screws; front and rear plates of anodized aluminum; limited or continuous rotation by exchanging one slotted screw only on exterior of control; and each potentiometer center-tapped. They are available in resistance range from 50 ohms to 100,000 ohms in standard increments. Power rating is 3 w. This control exceeds JAN-R-19 specifications were applicable.

SERVO AMPLIFIER
features 1-cycle response

POLYTECHNIC RESEARCH & DEVELOPMENT Co., INC., 202 Tillary St., Brooklyn 1, N. Y. The R6G16W1 magnetic servo amplifier can be



What's
Your Use for...

vernistat...The Revolutionary
New Precision Variable-Ratio Transformer

Analog Computers? Servos? Control Systems? Vernistat is a completely different type of voltage divider combining **low output impedance with an inherently high resolution and linearity** not ordinarily attainable by precision potentiometers.

The Vernistat consists of a tapped auto-transformer which provides the basic division of voltage into several discrete levels. These levels are selected and further sub-divided by a continuous interpolating potentiometer that moves between 30 transformer taps.

Because of its unique operating principles, electrical rotation is held to close tolerances eliminating the need for trim resistors. In many applications there is also no need for impedance matching amplifiers.

Specifications of the standard model Vernistat are shown below. Other versions are under development to meet specific end uses.

What are your requirements for this unique precision voltage divider? Fill in the coupon now.

vernistat division PERKIN-ELMER CORPORATION
NORWALK, CONNECTICUT

SPECIFICATIONS	
Linearity Tolerance	better than $\pm .05\%$
Resolution	better than $.01\%$
Output Impedance	130 ohms (max.)
Max. Output Current	50 ma
Frequency	50-3000 cps
Other models including a miniaturized 400 cps version will be available in the near future.	

vernistat division  PERKIN-ELMER CORPORATION
825 Main Avenue, Norwalk, Connecticut

Send me more information on the Vernistat.
The application I have in mind is as follows:.....

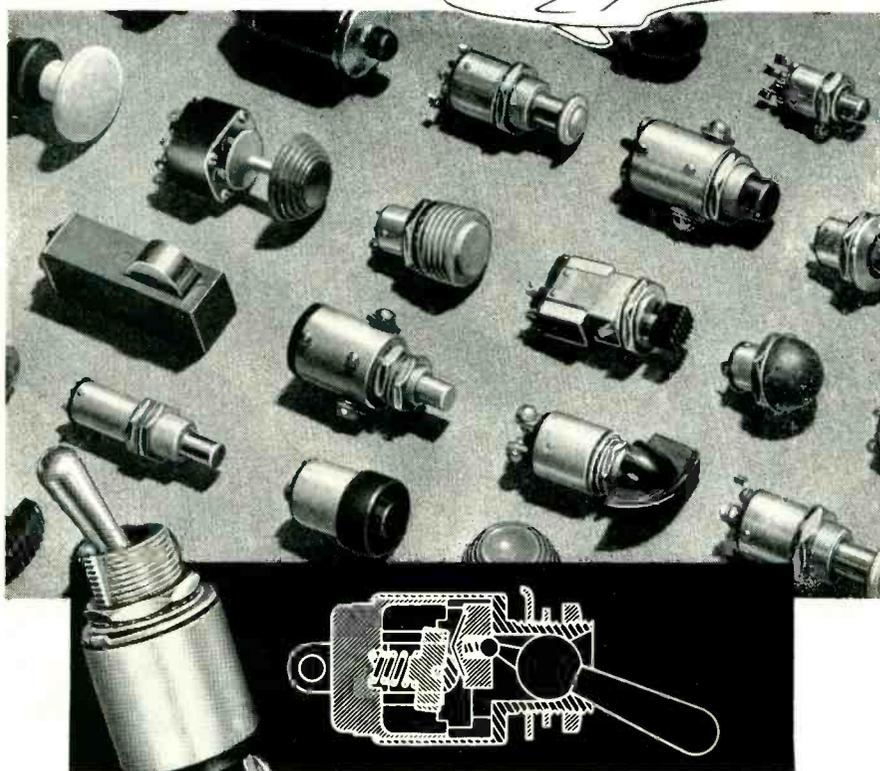
.....

NAME

TITLE

COMPANY

ADDRESS



This typical Hetherington T1000 Switch designed for MIL-S-6745 uses reduces size by 25%.

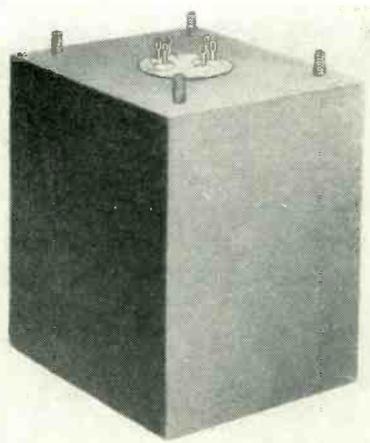
**Built to meet your
TOUGHEST
PERFORMANCE STANDARDS
...with weight and space savings
in the bargain...**

Switch Types for
Fire detection indicators
Trim tab control
Seat positioning
Auto pilot release
Tank jettison
Microphone circuits
Audible signal silencers
Equipment testing
Fire detection test
Canopy release
Seat ejectors
Bomb or rocket firing mechanisms
Auto pilots (holding coil types)
Instruments
Appliances . . .
and many others

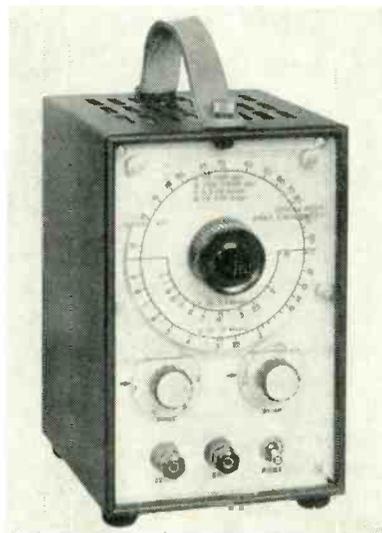
Whether for MIL or for the toughest commercial uses, Hetherington Switches and Switch-Pilot Light combinations are designed to do the job—with safety margin to spare. Unique, patented design provides positive switching (to exceed military life cycle requirements) in less space with less weight. Dozens of special aviation types in the 15-50 ampere range plus adaptations for exacting commercial jobs.

HETHERINGTON
Switches

HETHERINGTON, INC. • SHARON HILL, PA.
West Coast Division: 8568 W. Washington Blvd., Culver City, Calif.



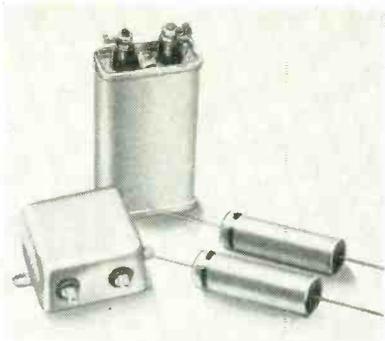
used to operate any 2-phase, 60 cps, servo motor requiring up to 16 w into the control phase. It can be supplied either as illustrated or with a built-in magnetic, transistor, or v-t preamplifier. Design for 1-cycle response assures the widest possible bandwidth consistent with the use of 60 cps as the power supply frequency and thus reduces many of the stabilization problems formerly experienced when incorporating magnetic amplifiers into servomechanisms.



AUDIO OSCILLATOR
covers from 12 cps to 1 mc

BECKMAN INSTRUMENTS, INC., Shasta Division, P. O. Box 296, Richmond, Calif. Model 301 utility audio oscillator covers the range from 12 cps to 1 mc in 6 ranges with output essentially flat over that range. Distortion is less than 0.5 percent at the lower frequencies; hum level is down -52 db from 1,000 cps to 1 mc and down

—43 db from 60 to 1,000 cps. Each model 301 oscillator is individually calibrated in conjunction with an events-per-unit-time meter and maintains an accuracy of calibration of ± 2 percent under normal operating conditions. Output is 10 v into 600 ohms on all ranges.



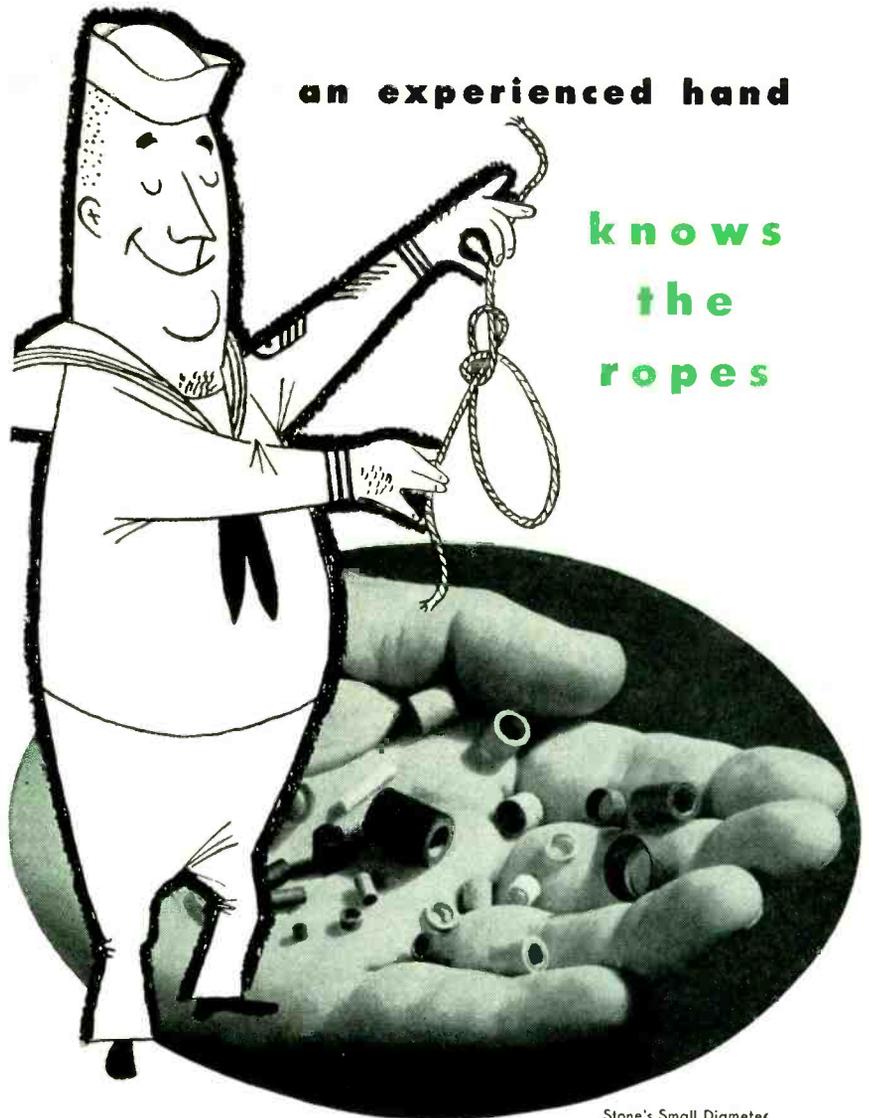
PLASTIC IMPREGNANT for capacitors and filters

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass., has developed Stycast 62, a low-loss plastic impregnant for capacitors, filters and r-f coils. The material is supplied as a low viscosity liquid, which when cured to a solid plastic has outstanding electrical properties, and a useful temperature range from -55 C to $+125$ C. Properties of the cured solid plastic are: dielectric constant 60 to 10^8 cycles, 2.6; dissipation factor 60 to 10^8 cycles, below 0.0003; dielectric strength, above 500 v per mil.



LAB AMPLIFIER is a versatile instrument

AMERICAN ELECTRONIC LABORATORIES, INC., 641 Arch St., Philadelphia 6, Pa. The 10-mc laboratory amplifier is a versatile instrument designed for application in color tv development, nuclear instrumentation, digital computer circuit development and general wide-band cir-



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the
ropes

Stone's Small Diameter
Spiral Wound Bushings

Those hundreds of manufacturers who buy small diameter paper tubes from Stone know this.

Stone led the way by inventing the spiral wound drinking straw back in the '80's. Precision production of small diameter spiral wound paper tubes has continued to be our speciality.

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Greatly expanded production facilities assure prompt deliveries.

cuit problems. Bandwidth is less than 1 cps to 10 mc (3 db) with overshoot less than 5 percent and compression maximum of 5 percent at maximum output. Tilt is less than 1 percent for 60-cps square wave input. Maximum output is 150 v peak-to-peak with gain of 40 db. The unit is supplied complete with electronically regulated power supply and packaged suitably for rack or bench use.

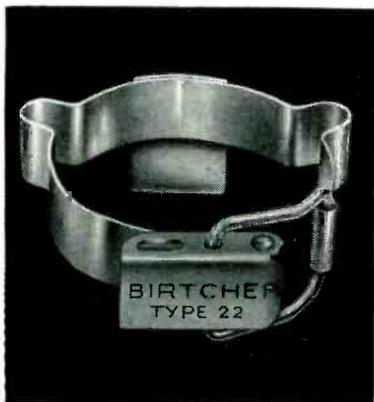


MULTIMETER includes circuit-breaker

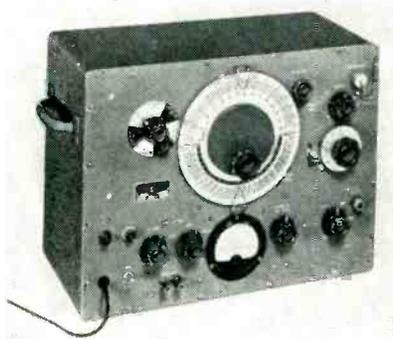
PHYSICS RESEARCH LABORATORIES, INC., 507 Hempstead Turnpike, West Hempstead, N. Y., is now offering the complete electrical instrument line of C. P. Goerz of Vienna. The Universal 1 multimeter illustrated measures both current and voltage on both a-c and d-c. Accuracy on d-c is 1.0 percent and on a-c it is 1.5 percent. The meter also measures resistance to within 1.0 percent. It has a built-in circuit-breaker which cuts the meter out when it is overloaded on any scale. The circuit-breaker can withstand overloads of ten times the scale reading. Other multimeters measure both a-c and d-c and voltage in addition to capacitance and resistance.

TUBE CLAMP is flexible in range

BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif. Made of type 302 stainless steel, the new type 22 tube clamp is specifically designed to exert a minimum 4-lb retention pressure on tube and com-



ponent bases over the entire range of the 0.040 tolerance allowed tube manufacturers under JAN specifications. The type 22, being flexible in range, exerts a minimum of 4-lb retention pressure on a minimum diameter base while never exerting so much pressure on maximum size bases as to cause breakage. This flexibility eliminates the need in assembly to match clamps to tube bases. The tube clamp is made in sizes ranging from 11 in. i-d to 6 in. i-d with several variations in location and height of the mounting bracket.



SIGNAL GENERATOR covers from 32 kc to 70 mc

THE CLOUGH-BREngle CO., 6014 Broadway, Chicago 40, Ill. The new model 552 standard r-f signal generator covers the frequency range from 32 kc to 70 mc in seven ranges. Signals from less than 1 μ v to the h-v requirements of bridge measurements may be obtained. Circuitry consists of an r-f oscillator, modulating amplifier, vtm, attenuator, 400-cycle oscillator, and power supply. The r-f carrier may be modulated from the internal oscillator or from an external source. Featured are minimum

IMPORTANT NEWS

For the Electrical and Electronic Industries

... a New HARDENABLE SILVER ALLOY



Important Properties of SILVER-MAG-NICKEL

- ✓ Oxidation Hardenable
- ✓ High Electrical Conductivity — 70%
- ✓ High Thermal Conductivity
- ✓ Hardnesses to 70 — Rockwell 30 T
- ✓ Tensile Strengths to 70,000 psi
- ✓ Corrosion Resistance Like Fine Silver
- ✓ Hardness Unaffected by Silver Brazing

SILVER-MAG-NICKEL is its name. As you receive it, it is soft and ductile, like fine silver. Fabricate your most intricate parts, then oxidation harden them and this new alloy will hold its temper permanently. This hardness is not disturbed even when subsequent elevated temperatures are encountered.

SILVER-MAG-NICKEL has excellent thermal and electrical conductivity. Its corrosion resistance is equal to that of fine silver. It is available in wire and strip in thicknesses down to .002".

Have you an application where SILVER-MAG-NICKEL can be used to advantage? See the list of properties to the left. Write giving full details of your potential application. Our engineers will be glad to discuss these properties with you.



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**March
21-24**

The
Radio-Electronic

SPECTACULAR

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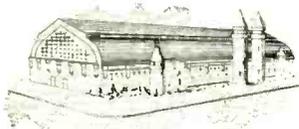
**See!
Hear!**

IRE National Convention



and

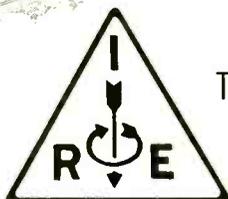
Radio Engineering Show



At both the Waldorf-Astoria (convention headquarters) and **Kingsbridge Armory**, you'll attend what actually amounts to 22 conventions fused into one. Hundreds of scientific and engineering papers will be presented during the many technical sessions, a large number of which are organized by IRE professional groups. You'll meet with the industry's leaders—enjoy the finest meeting and recreational facilities in New York.

At the Kingsbridge Armory and Kingsbridge Palace, you'll walk through a vast panorama of over 700 exhibits, displaying the latest and the newest in radio-electronics. You'll talk shop with the industry's top manufacturers—enjoy the conveniences provided for you in the world's finest exhibition halls, easily reached by subway and special bus service.

Admission by registration only. \$1.00 for IRE members, \$3.00 for non-members. Social events extra.

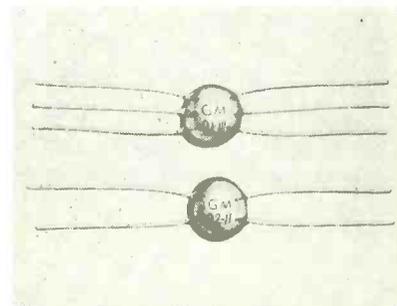


The Institute of Radio Engineers
1 East 79 Street, New York

NEW PRODUCTS

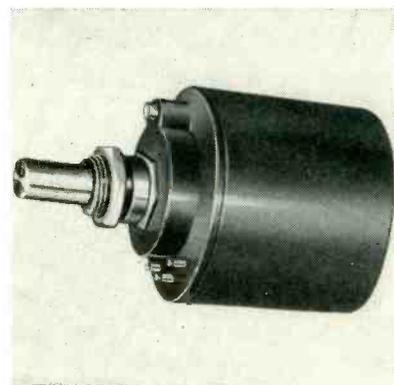
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leakage and stray fields, high reading accuracy of the frequency dial, low cable standing-wave errors, and sturdy construction combined with light weight and portability.



PULSE TRANSFORMERS of toroidal steel core

THE GUDEMAN CO., 340 W. Huron St., Chicago 10, Ill. The GM series of toroidal steel core pulse transformers produce rectangular pulses with durations, when operated in the Gudeman standard blocking oscillator circuit, of 0.05, 0.1, 0.2, 0.5, and 1 and 2 μ sec. Available with 2 or 3 windings they are epoxy resin impregnated and encapsulated—and impervious to moisture. They feature 1-to-1 turns ratio, small size ($\frac{3}{8}$ in. \times $\frac{3}{8}$ in. \times 2 $\frac{3}{8}$ in. overall), light weight, extremely fast rise time, and clear identification of leads. They are tested at 2,000 v rms and will withstand repeated thermal shock cycles from 135 C to -70 C, and they surpass MIL-T-27, grade 1, class A test specifications.



POTENTIOMETER for stepless operation

G. M. GIANNINI & Co., INC., 918 E. Green St., Pasadena 1, Calif., has

announced production of a new low-cost infinite resolution slide wire Spiralpot. This 1½-in. diameter potentiometer has standard ⅜-in. threaded bushing for panel mounting a locating pin, and can be used as a direct potentiometer replacement for applications requiring stepless potentiometer operation. Available in standard 3-turn or 10-turn models, with resistance ranges of 6 to 2,500 ohms, and linearities of ±0.1 percent and ±0.05 percent, these units feature long-life operation with low operation noise because of the true slide wire action. Additional specifications are: power rating, 5 w for a 10-turn unit; torque, 2 oz in. or less; weight, 4 oz.



UHF REFLECTION BOX
for use with a linear balun

LINEAR EQUIPMENT LABORATORIES, INC., Brightwater Place, Massapequa, L. I., N. Y., has available a vhf-uhf reflection box that greatly simplifies measurement of tuner reflection coefficient. In conjunction with a linear balun, it enables simple visual observation of the ability of a tuner to provide a proper match to a 300-ohm transmission line over the vhf and uhf tv bands, and eliminates cumbersome, unsightly transmission line installations in lab or factory.

ALPHATRON GAGE
operates on a-c

NARESCO EQUIPMENT CORP., 160 Charlemont St., Newton Highlands 61, Mass. Model 517 Alphatron vacuum gage has these features: six ranges permitting the measurement of pressures from 1,000 to 0.0001 mm Hg on a linear scale; instantaneous response for quick readings; compact construction and

PRECISION AND SKILL

IN
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DEVELOPMENT
PRODUCTION

DAYSTROM

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**ARCHBALD,
PENNSYLVANIA**

*Write
For
Facilities
Report*

Daystrom Instrument will take on the complete project . . . from design to the delivery of systems on a volume production basis. At Daystrom the development of a new product, or the improvement of an existing product can be undertaken. Experienced production engineers convert the design into modern shop practices which result in efficient production and assembly of a quality product. This ability to assume the complete job for research, design and production under one roof means worthwhile savings in time and money.

The Army, Navy and Air Force, as well as the aircraft industry have experienced Daystrom's ability to get the job done

- Radar
- Fire Control
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- Computers
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Miniaturization
Instrumentation

TANTALUM CAPACITORS...

...basic in current electronic trend..



- Premium Performance and Life
- Minimum Space per Mfd.
- Wide Temperature Limits
- Infinite Shelf Life
- Proven Reliability Since 1930

Fansteel TANTALUM CAPACITORS

Now, through the use of tantalum, new high standards of electrolytic capacitor performance are available. The tantalum oxide film is the most stable dielectric, chemically and electrically, yet discovered. As a result, Tantalum Capacitors offer advantages not found in any other electrolytic type — long life, space saving, wide temperature range excellent frequency characteristics, no shelf aging.

Tantalum Capacitors are made by Fansteel and other leading capacitor manufacturers. Ask for current information bulletins on Fansteel Tantalum Capacitors.



FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U. S. A.

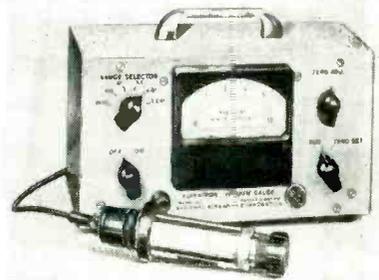
Tantalum Capacitors... Dependable Since 1930



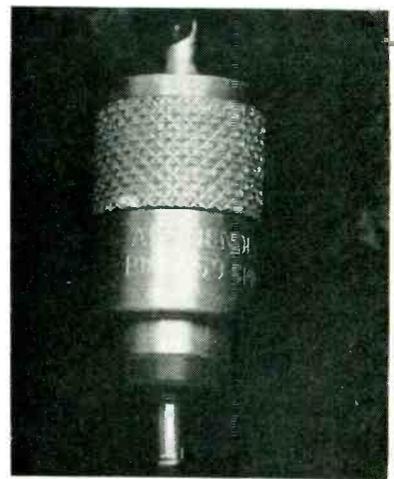
32503C

NEW PRODUCTS

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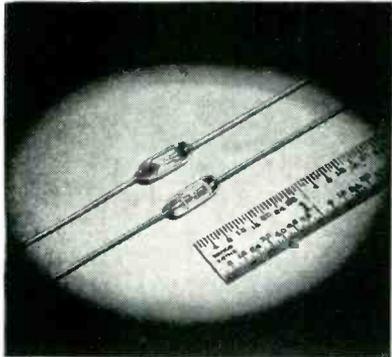
light weight; and a connection for a recorder. It utilizes a sealed radium source that emits alpha particles and produces ionized gas molecules which are collected on a plate to produce a current indicating directly the measured pressure. The gage cannot be damaged by exposure to atmospheric pressure because the ion source operates at room temperature and at zero potential. The Alphatron vacuum gages are less susceptible to contamination than are hot element vacuum gages. The gage is priced at \$425.



COAX TEST PLUG with 75-ohm resistor

HOLLAND ELECTRONICS, 572 Broome St., New York 13, N. Y., has developed a new, simplified, low-cost unit with integral test terminal which provides the comparability and high accuracy necessary in testing amplifier gain and level in color tv video systems, and also eliminates undesired reflections and temporary expedients. This coaxial termination test plug features a precision, film-type resistor and an accessible and rugged test terminal. Type No. 259-75, illustrated, includes a type PL-259 plug with 75-

ohm resistor, and is tested to 1-percent tolerance before shipment. Other tolerances, resistance values and plug types are available.



GERMANIUM DIODES
in all-glass envelope

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has added to its line of germanium diodes three new all-glass-envelope types. The 1N87G is a high quality video detector which offers high rectification efficiency coupled with low loading on resonant circuits. The OA71 is a high back resistance type designed for computer and general purpose applications. The OA73 is also a video detector having advantages similar to the 1N87G, and is intended for higher level i-f signals where its greater back resistance eliminates peak synch clipping. Its stability, and high-front-to-back ratio also makes it applicable for computer applications such as transistor clamps.



SENSITIVE RELAY
for electronic chassis use

HEDIN TEL-TECHNICAL CORP., 640 W. Mt. Pleasant Ave., Livingston, N. J., announces a new sensitive relay designed primarily for use in

extruded TEMPREX teflon* HOOK-UP WIRE

*for
reliability*



● Insulated with a smooth sheath of extruded Teflon, Hitemp's new TEMPREX hook-up wire is unaffected by commercial solvents, temperatures from -90° to $+260^{\circ}\text{C}$ (Class H or better), fungus growth, moisture, or weathering. Retains its excellent electrical properties over a wide range of frequencies, conforms to MIL-W-16878A (Navy) E and EE constructions, and to MIL Standard 104.

Furnished in 14 solid colors extruded over silver-plated, stranded copper wire, or a solid conductor. Sizes 26—10 AWG in production lengths. Delivery within 10—14 days . . . Write for complete engineering information and price list.



HITEMP WIRES INC.

26 WINDSOR AVE., MINEOLA, LONG ISLAND, N. Y.

"Specialists in high-temperature insulation"

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| TEMPRITE TEFLON MAGNET WIRE | TEMPREX TEFLON EXTRUDED HOOK-UP WIRE |
| TEMPRITE-X SPECIAL TEFLON MAGNET WIRE | TEMPCLAD TEFLON-FIBERGLAS LEAD WIRE |
| THERMALON SILICONE MAGNET WIRE | RETEP TEFLON SATURATED GLASS BRAID LEAD WIRE |
| TEMPVAR W. A. ENAMEL MAGNET WIRE | NEBROC TEFLON-FIBERGLAS LACING CORD |
| TEMPRENE TEFLON HOOK-UP WIRE | TEMPTUBE TEFLON-FIBERGLAS TUBING |

*Du Pont's Trade Name for Polytetrafluoroethylene

High Dielectric Bobbins

For High "Q" Coils

PRECISION

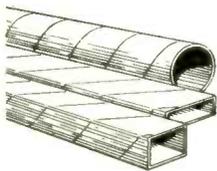
**MADE TO YOUR EXACT SPECIFICATIONS
IN ANY SIZE • SHAPE • QUANTITY**

Precision coil bobbins are fabricated from high dielectric materials and quality controlled to the most minute tolerances . . . Yet, because they are made on special high production equipment, they're available to you for prompt delivery at low unit cost.

Cores are spirally wound dielectric kraft, fish paper, acetate, phenol impregnated or combinations. Flanges are cut to any specification for all types of mountings.

Request illustrated bulletin. Send specifications for samples.

High Strength Low Cost Paper Tubes



Accurately fabricated in any size, shape, ID or OD. Spirally wound from select dielectric materials. Crush resistant, with excellent dimensional stability. Subject to rigid control and inspection for tolerance and uniformity.

Ask for samples and Arbor List of over 2000 sizes.

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Pasadena, California, Sycamore 8-3919
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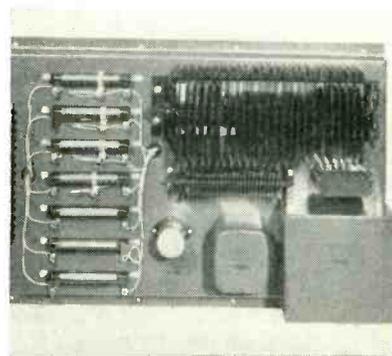
PRECISION PAPER TUBE CO.

2041 W. CHARLESTON ST. CHICAGO 47, ILL.
Plant No. 2: 79 Chapel St., Hartford, Conn.

NEW PRODUCTS

(continued)

electronic chassis which have sufficient height but little adjacent space. It also has a wide range of applications which include atomic instrumentation, transistors, germanium diodes and telephone operations. The new relay provides a hermetically-sealed dpdt combination, and has a capacity up to 3 amperes inductive load. It is equipped with a standard octal socket. Wattage consumption is 0.1 and less, depending on the contact arrangement, or less than 1 ma, depending on the voltage used. The relay shows no fatigue or deterioration after 25,000,000 operations. Coil resistances of the new relay can be furnished up to 30,000 ohms.

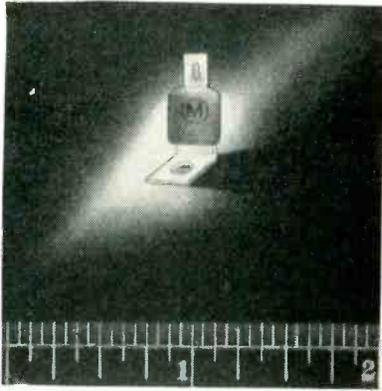


MAGNETIC AMPLIFIERS regulate control voltage

ACME ELECTRONICS, INC., 2724 South Peck Road, Monrovia, Calif., has introduced a line of magnetic amplifiers for control voltage regulation. Model S-1446 is for a 10 kva, 115 v 400 cycle, single phase alternator. Regulation is 1 percent from no load to full load, and it will withstand 150 percent overload. Recovery time is 0.3 sec. It is encapsulated and hermetically sealed, moisture and fungus resistant. Model S-1442 is designed for 115 or 208 v, 400 cycle, 3-phase alternator. It operates into high impedance field, and has 3-phase sensing.

CERAMIC CAPACITOR has rugged construction

MUCON CORP., 9 St. Francis St., Newark 5, N. J., announces the style S-3 uhf stand-off subminiature ceramic capacitor. Its sturdy con-



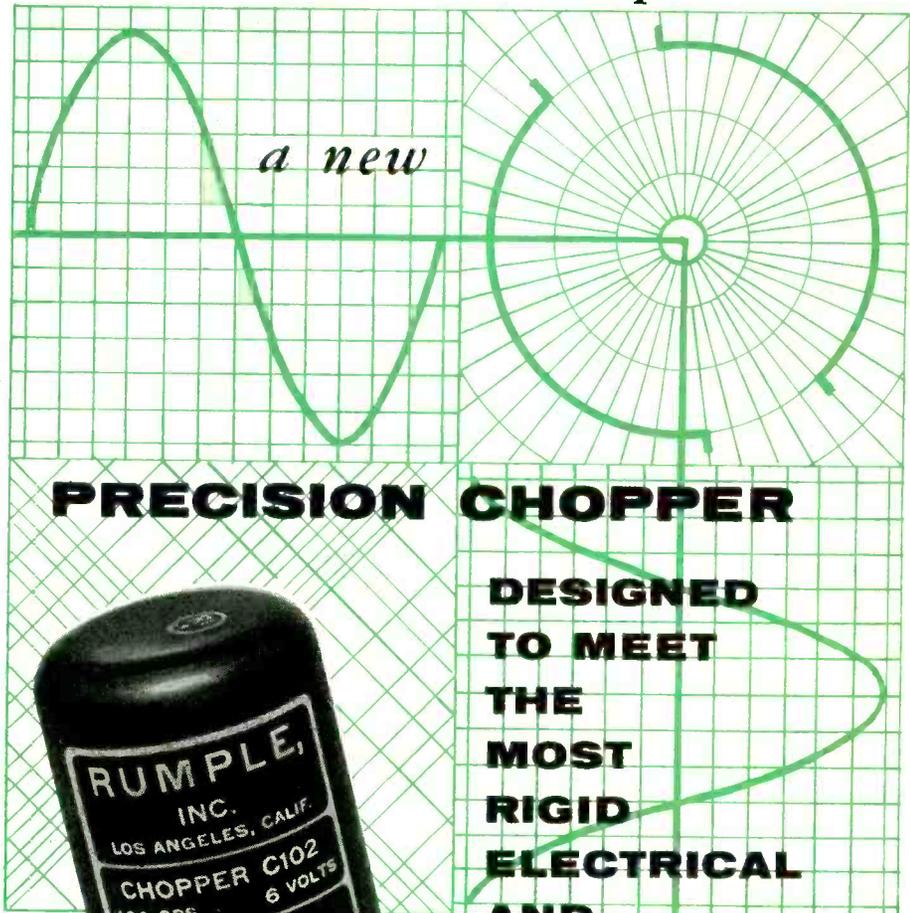
struction incorporates a tin-plated copper mounting which almost completely encloses the dielectric material, thus allowing the supporting member to take most of the stress placed upon the wiring terminal and avoiding the strain upon the ceramic body which causes failure in less rugged units. The style S-3 may be had in any one of the various types of ceramic dielectric materials, in capacitance values ranging from 2 to 3,000 μf depending on material used and working voltage rating.



COMPARATOR BRIDGE for calibrating lab units

DONNER SCIENTIFIC Co., 2829 7th St., Berkeley 10, Calif. Model 50 comparator bridge is designed for use as both a precision voltage source and a precision comparator of voltages in the range of -100 v to $+100\text{ v}$. It is especially useful as a secondary standard for calibration of laboratory instruments. A precision ten-turn potentiometer with dial allows the output voltage to be set precisely equal to an external voltage; accuracy to within 0.1 percent is readily obtainable with direct reading on the potentiometer dial. A special circuit provides sliding meter sensitivity on

RUMPLE, INC. *presents*



PRECISION CHOPPER

**DESIGNED
TO MEET
THE
MOST
RIGID
ELECTRICAL
AND
MECHANICAL
REQUIREMENTS**



CHOPPER C102

WEIGHT

Less than 6 ounces.

BASE

Standard Octal.

LENGTH

$2\frac{5}{8}$ inches.

DIAMETER

$1\frac{1}{16}$ inches.

FINISH

Black.

CASE

Hermetically sealed.

TEMPERATURE

-55°c to $+85^{\circ}\text{c}$.

VIBRATION

Withstands 10g.
(10 to 55 cps.)

SHOCK

Withstands 30g.

BREAKDOWN

280 volts D.C.

AVERAGE LIFE

1,000 hours under average operating conditions into a resistive load.

DRIVE

6.3 volts.

FREQUENCY

380 to 420 cps.

CONTACTS

SPDT — .002 amps.
100 volts.

DWELL TIME

135 degrees.
(plus or minus 20°)

PHASE LAG

65 degrees.
(plus or minus 15°)

NOISE

Less than 3 millivolts peak to peak at one megohm.

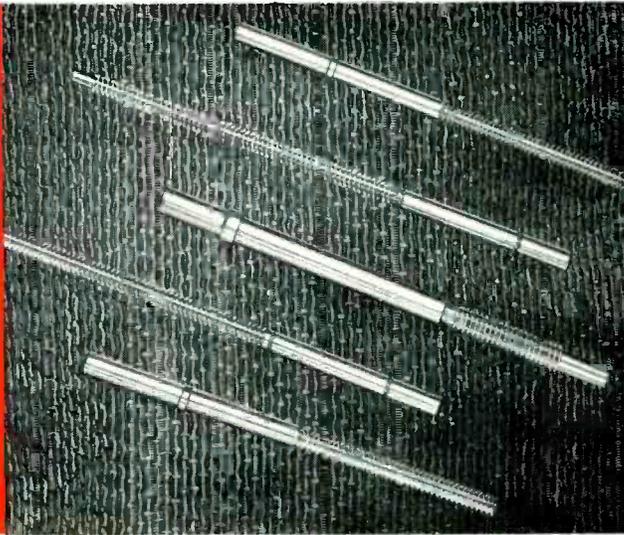
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ANOTHER

Rutherford **PRECISION
TIMING INSTRUMENT**



**MODEL (A-5)
TIME DELAY GENERATOR**



MODEL A-5

An instrument of small size which provides accurate and variable time delays from 1 μ s to 1,000 μ s in three ranges.

- low jitter (.008%)
- linear scale
- highly stabilized power supplies
- small repetition rate effects
- blocking oscillator output
- trigger type input
- separate calibration adjustments for each range.

Get complete data:
our Bulletin E-A-5

Other Rutherford precision
Time Delay Generators

Model A-2 (.8 μ s to 100,000 μ s): Bulletin E-A-2
Model A-4 (10 μ s to 10 secs): Bulletin E-A-4

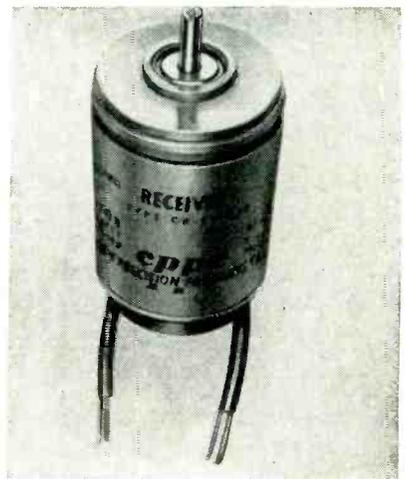
Rutherford **ELECTRONICS CO.** Telephone: TEXAS G-4362
3707 S. ROBERTSON BLVD.
CULVER CITY, CALIFORNIA

the null indicator so that a coarse-to-fine null balance may be obtained within $\pm 0.5 \mu$ a without range switching.



TESTING DEVICE
is a 2-in-1 portable unit

NATIONAL INSTRUMENT Co., Div. of General Hermetic Sealing Corp., 99 E. Hawthorne Ave., Valley Stream, N. Y., offers a 1 to 10-million range megohmmeter and a 3,000-v a-c high potential test set in one compact portable unit. It has been performing MIL and JAN tests for some time. To insure accuracy, a built-in calibrator is provided. For production line testing a high sensitivity relay-controlled leakage-indicator with a range from 20 μ a to 3 ma flashes to show excessive current. The megohmmeter operates on 200 or 500 v d-c. All testing is nondestructive.



SYNCHROS
feature high accuracies

CLIFTON PRECISION PRODUCTS Co., INC., Marple at Broadway, Clifton Heights, Pa., has developed a new

series of size 11 synchros. These instruments feature the high accuracies available previously only in larger units. Maximum diameter is 1.062 in. and maximum overall length is 1.702 in. Weight of the synchros is 3.1 oz. The size 11 synchros are available with leads, or can be specially ordered with radial or axial terminals. Cast stator and clamped bearing race construction insure lifetime alignment and accuracy. Dielectric insulation between windings and case is rated in excess of 550 v a-c. The size 11 synchros are available in the following types: signal generators, receivers, regular and high-impedance control transformers, high-output control transformers, control differentials, resolvers and sine-cosine generators.



VTVM for a-c/d-c measurements

SCIENTIFIC SPECIALTIES CORP., Snow and Union Streets, Boston 35, Mass. The VM-82 is a vacuum-tube voltmeter featuring wide range, excellent stability and high sensitivity. For d-c measurements the range is 50 mv full scale to 500 v full scale with 11 range positions. Input resistance is 50 megohms on all ranges. Power input is 115 v, 60 cycles a-c, approximately 25 w. Accuracy is 3 percent of full scale on all range positions. For a-c measurements an r-f probe using a germanium diode in a half-wave rectifier is provided. The probe is so designed as to keep a high input impedance at high frequencies. Range for a-c measurements is from 75

The New SHURE "TWIN-LEVER" CERAMIC PICKUP CARTRIDGE for High Fidelity phonographs



PC Series for 33 $\frac{1}{3}$, 45, 78 r.p.m.

AN "AB" LISTENING TEST WILL PROVE THAT THIS CARTRIDGE SURPASSES ANY OTHER HIGH QUALITY COMMERCIAL CARTRIDGE FOR EQUIPMENT MANUFACTURERS!

Here is a "Balanced-Fidelity" cartridge designed for the equipment manufacturer to give you the maximum quality possible within your cost objectives.

A new frontier for the Ceramic principle has been crossed by the development of this cartridge. Designers of high fidelity phonographs and hi-fi radio or tv phono combinations, who have been "test piloting" this new "Twin-Lever" ceramic development, report an amazing superiority in tone quality that can be easily heard before the cartridge is even measured!

This "Twin-Lever" ceramic cartridge represents the ultimate in commercial high fidelity reproduction—**without compensating preamplifiers!** Smooth, wide range response from 30 to 13,500 c.p.s. Other features which help to make this new cartridge so outstanding in performance are: high compliance that virtually eliminates tracking distortion . . . extremely low effective mass provided by new specially-designed needles and new coupling . . . tailored needles on separate needle shafts, functioning independently for best 78 rpm response, too—as well as the superior micro-groove performance.

The new unique design eliminates "turnover" of either the cartridge or the needles. Both needles are in the same plane, and an ingenious, lever-operated shift mechanism gently moves each needle in and out of position.

RADICAL NEW DESIGN FOR NEEDLE REPLACEMENT!

Needle replacement is now so simple it can be done blindfolded!! This is a feature that will be of special interest to the ultimate users of your original equipment. Anybody can replace the needle, without tools, in a few seconds—while the cartridge remains in the pickup arm!

MODELS PC4 and PC5

Output Level at 1,000 c.p.s.	.40 volts (33 $\frac{1}{3}$, 45 rpm)
Output Level at 1,000 c.p.s.	.60 volts (78 rpm)
Frequency Response	30 to 13,500 c.p.s.
Compliance	1.30 x 10 ⁻⁶ cm/dyne
Tracking Force	5 gr. min.
Net Weight	7 grams
Dimensions	1 $\frac{3}{4}$ " overall length; $\frac{3}{8}$ " wide $\frac{1}{8}$ " high

ALSO . . .

New High Output Ceramic Cartridges NO LESS OUTSTANDING IN THEIR CONTRIBUTION TO LOW COST, FINE QUALITY REPRODUCTION ARE THE HIGH-OUTPUT CARTRIDGES, MODELS PC2 and PC3.

SHURE *The Mark of Quality*

For further information on these remarkable new cartridges, write
SALES DIVISION—SHURE BROTHERS, INC., 225 W. HURON STREET, CHICAGO 10, ILL.



NEW!

NEW!

miniature solenoids

for many big jobs!

If your solenoid application involves small space plus efficiency, write us today. One of WesCo's new miniatures will probably meet or exceed your specification. If you have a special application where size and weight must be held to a minimum, our engineering service is at your disposal.

SHOWN HERE: MODEL A-205

Used in computers, memory units and in miniature electronic compensators

SPECIFICATIONS

Push or pull

9 ounces @ $\frac{1}{8}$ in. stroke

7½ ounces @ $\frac{1}{16}$ in. stroke

6 ounces @ $\frac{3}{16}$ in. stroke

5 ounces @ $\frac{1}{4}$ in. stroke

Mounting furnished to meet your requirements.

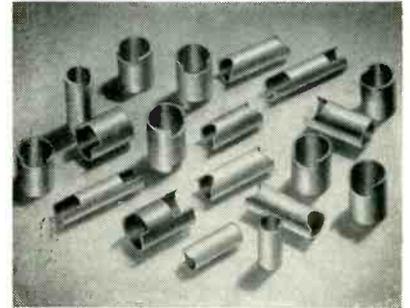


The trademark on over 5,000,000 solenoids since 1927

NOTICE

WesCo DC solenoids are used throughout the world—are famed for reliable service. The complete line is shown in WesCo's DC catalog.

Write for it today—on your company letterhead, please.



COIL FORMS for flyback transformers

RESINITE CORP., 2035 W. Charleston St., Chicago 47, Ill. Custom constructed high dielectric coil forms have been designed for improved performance in flyback transformers. Fabricated from select materials, the forms are resin-impregnated by a special process to provide very high insulation resistance. The new flyback coil forms are notched to specification. They are available in any shape or size and can be supplied in any quantity.



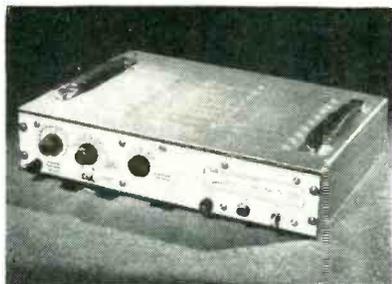
POWER SUPPLY is voltage regulated

KEPCO LABORATORIES, 131-38 Sanford Ave., Flushing, N. Y. Model 2600 voltage-regulated power supply features a continuously variable 0 to 50 v d-c, 2-ampere output. Excellent regulation, low ripple content and low output impedance distinguish this supply. In the range of 0 to 50 v the output voltage variation is less than 5 mv for line

WEST COAST ELECTRICAL MFG. CORP.

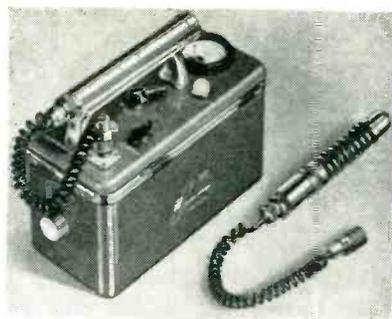
233 W. 116TH PLACE, DC DIV. 107 • LOS ANGELES 61, CALIF. • PL. 5-1138

fluctuations from 105 to 125 v and less than 5 mv for load variations of 0 to 2 amperes. Ripple voltage is less than 1 mv. Either positive or negative terminal of the supply may be grounded. There are input and output fuses on the front panel and a time-delay relay is included to prevent unregulated voltage from appearing at the output terminations.



PULSE OSCILLATOR has variable repetition rate

ELECTRO-PULSE, INC., 11811 Major St., Culver City, Calif. Model 3410A pulse oscillator is a low-cost variable repetition rate oscillator from 30 cps to 3 mc in 5 decade ranges. The output pulse, both positive and negative, is a constant width (0.1 μ sec), with variable amplitude (maximum 30 v). Its output impedance for the negative pulse is 250 ohms, and for the positive pulse is 100 ohms.



SURVEY METER for lab or field use

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill. Model 2612 is a completely redesigned portable, battery-operated G-M survey meter for measuring alpha, beta and gamma radiation. It may be used for general purpose survey work in radio-

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adjustable

POLYSTYRENE CAPACITORS

with Accuracy

in the order

of 0.1% or better

and Long Time

Stability in

the order

of 0.03%



Check these outstanding features:

- I. R. - @ 25° C - 10¹² OHMS
- Dielectric Absorption - .015%
- Dissipation Factor - .0002
- Temp. Coeff. (-20° to 140° F.) 100 P.P.M. per °C

Excellent for
Computer Integration,
Test Equipment
or Secondary Standards.

Join these other leading firms in specifying Southern Electronics' precision polystyrene capacitors for your most exacting requirements: Reeves Instrument Corp., Electronic Associates, Inc., Convair, Berkeley Scientific, M.I.T., Calif. Inst. of Tech., and many others.

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Available
from 0.1 M.F.D.
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SOUTHERN ELECTRONICS

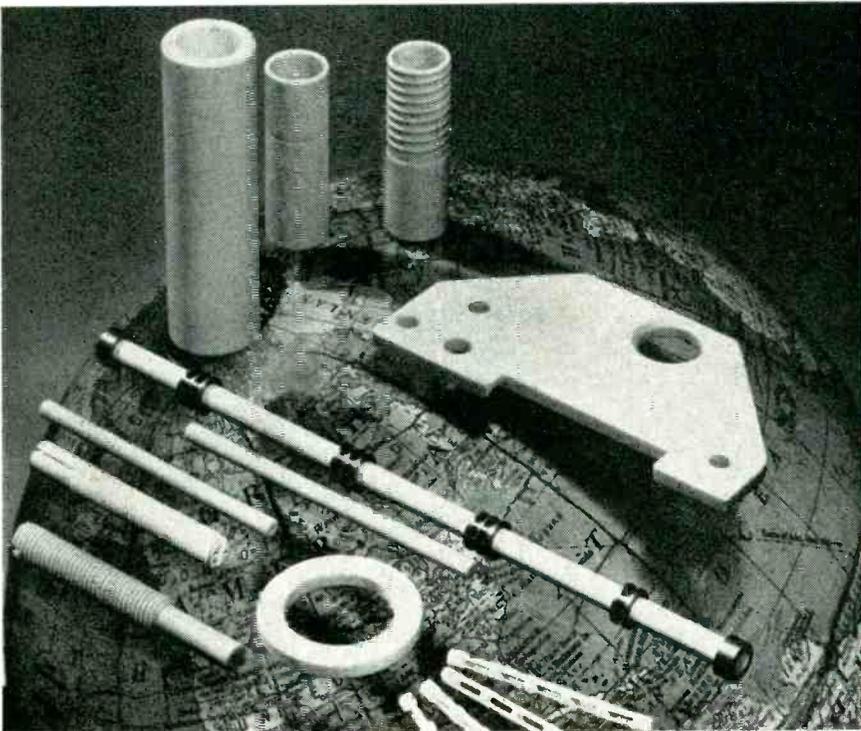


Corporation

239 West Orange Grove Ave., Burbank, Calif.

Stupakoff

PRECISION CERAMICS



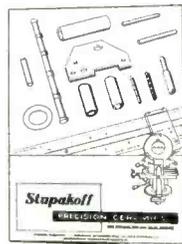
PRECISION CERAMICS can improve your products...cut your costs!

In the assembly of electrical or electronic equipment, the use of precision-made components means faster production and the correct functioning of the equipment in service.

Through the application of experience-developed engineering and technical skills and modern equipment, Stupakoff produces, in large volume, parts that meet most exacting specifications.

Stupakoff precision ceramics may be plain or metallized; and made from alumina, steatite, zircon, Stupalith or other materials.

WRITE for our new bulletin No. 155, which describes precision ceramic products, or send drawings for quotations.

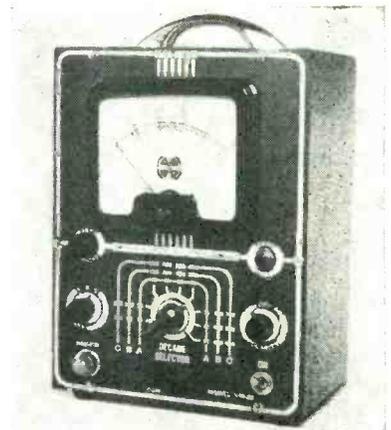


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isotope laboratories, and its rugged waterproof construction makes it an ideal field instrument for geological surveying for uranium ores. The instrument is provided with choice of probes utilizing a thin wall Geiger tube for both beta and gamma radiation of over 0.2 mev, or a thin mica end window counter for alphas, betas and gammas. A single control knob turns the instrument on and selects one of three ranges—0.2, 2 or 20 milliroentgens per hr full scale. A calibrated radiation source is mounted on the case for checking calibration at any time.



VTVM has 30 cascaded ranges

AMERICAN SCIENTIFIC DEVELOPMENT Co., 334 S. Main, Atkinson, Wis. Model VM-30 Deca-Meter has 30 ranges, cascaded one on top of another, in 10, 50 and 100 v steps. This means that in using the 10 v steps and setting the decade selector to 90 v, the range from 90 to 100 v will be spread across the entire meter scale. It features a peak-to-peak a-c rectifier calibrated in rms, good to over 5 mc. The voltage regulated unit features minimum parallex reading error and 11-meg-ohm input resistance.

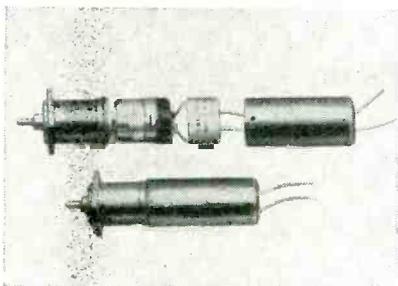
POWER SOURCES for waveguide testing

CHICAGO ELECTRONIC LABORATORIES, 1214 W. Madison St., Chicago 7, Ill., is manufacturing microwave pulsed power sources with outputs as high as 1.5 megawatts. Applications of the units include wave-

guide testing and antenna characteristic studies. The units feature adjustable pulse widths ranging from 0.1 μ sec to 5 μ sec and provide for continuously variable repetition rates. The r-f heads, consisting of magnetrons and pulse transformers, are interchangeable so that the units may be used on more than one frequency.

VHF ANTENNA for TV broadcasting

PRODELIN INC., 307 Bergen Ave., Kearny, N. J. The 16-element Tri-Loop vhf antenna for tv broadcasting provides super gains. Rated at 50 kw and with a power gain of 17 it is possible to deliver 316-kw effective radiated power with only a medium-power vhf transmitter. The Tri-Loop is obtainable with power gains from 2 to 17 with beam tilting and/or null fill-in easily accomplished with a flexible feed system thus permitting a vertical pattern most suitable for the broadcaster's optimum coverage requirements.

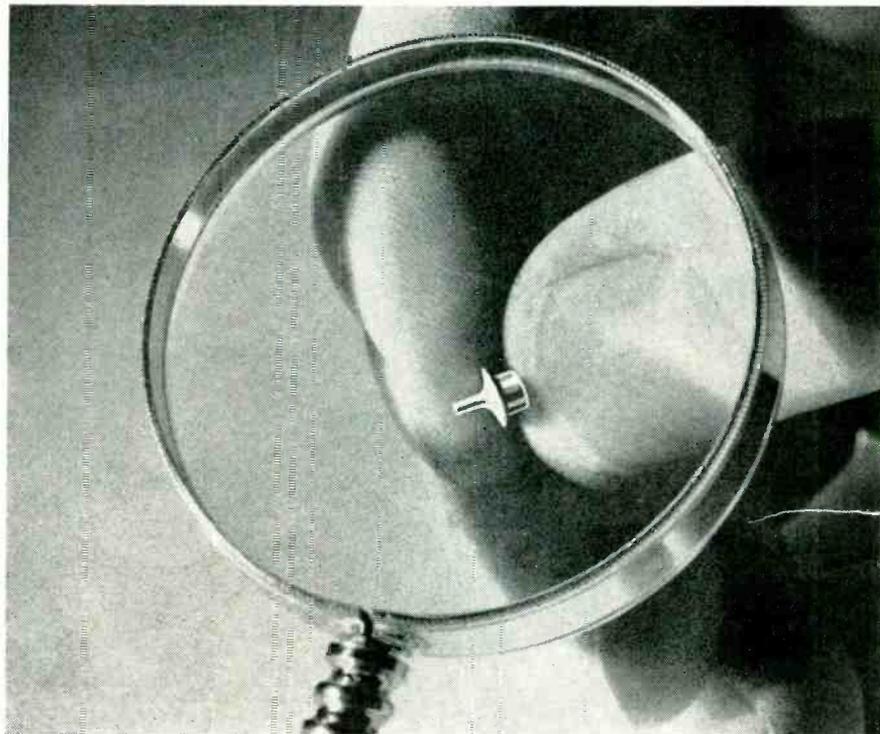


RADIO NOISE FILTER is integral with motor

THE POTTER CO., North Chicago, Ill., has produced a new miniature molded radio noise filter designed to fit a small motor and gear assembly. Measuring only 1 $\frac{1}{8}$ in. o-d \times $\frac{3}{4}$ in. long, it serves as an integral part of the motor instead of as an external accessory. Replacing a conventional assembly, it reduces overall filter length approximately 50 percent. This continuous-duty, dual-section filter features greater than 50-db attenuation over the range of 150 kc to 1,000 mc; operates satisfactorily in ambient temperatures as high as 125 C; exceeds Air Force

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Kovar **HARD GLASS** Seals



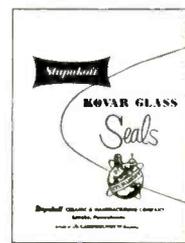
No "Leakers" in 52 million!

Over 52 million of the seals illustrated above are in use; and not a single "leaker" has been discovered!

In their manufacture, Kovar metal and *hard borosilicate glass* (Pyrex) are permanently bonded together, forming a fused-oxide seal that is vacuum- and pressure-tight, and corrosion-proof at the interfaces.

Borosilicate glass, matching perfectly the thermal expansion of Kovar, gives to Stupakoff seals thermal endurance, weather resistance, and high electrical insulating properties over the full temperature range of the glass.

Complete data of hundreds of sizes, styles and ratings of standard Stupakoff Kovar **HARD GLASS** hermetic seals is given in this catalog. Send for a free copy of Bulletin 453A.



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specification MIL-1-6181-B as applied to small motors, and meets metallized paper size with paper and foil reliability.



MAGNETIC AMPLIFIER
features 1-cycle response

POLYTECHNIC RESEARCH & DEVELOPMENT Co., INC., 202 Tillary St., Brooklyn 1, N. Y. Type R40G10W1 400-cycle magnetic servo amplifier will deliver up to 10 w reversible phase a-c output into the control phase of MK7 and MK8 servo motors for reversible phase a-c or reversible polarity d-c input. Design emphasis has been to achieve minimum size and weight compatible with operation at high temperatures in control or servo systems where 1-cycle response is mandatory. The reactor unit is only 2½ in. high and 2¼ in. in diameter. It weighs less than 12 oz. The unit is completely encased in a molded resin except for the moisture and fungus proofed rectifier which is supplied for external mounting.

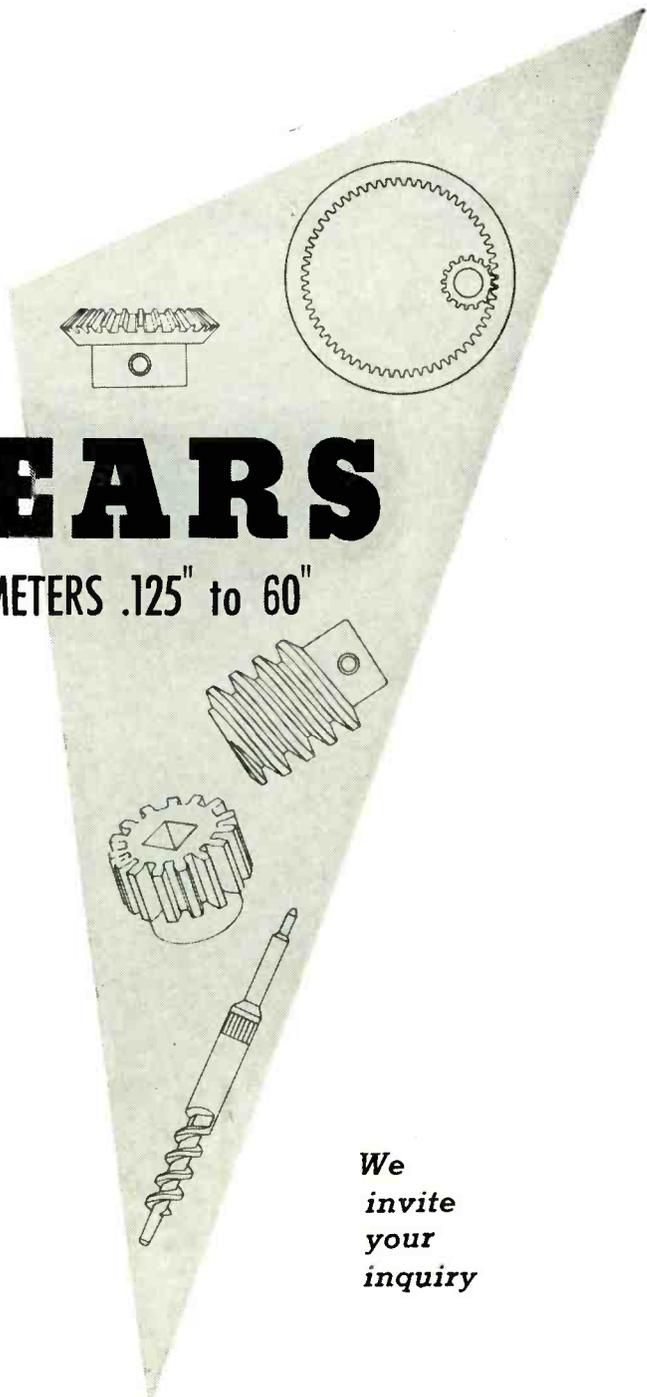


WWV RECEIVER
features high sensitivity

CONTINENTAL COMMUNICATIONS, INC., 452 W. Chicago Ave., Chicago 10, Ill. Model 110 WWV receiver's sensitivity is 2-to-1 signal-to-noise at 0.5 µv without audio filter; 16-to-1 for single tone modulated signal at 1 µv with filter. Selectivity is less than 2 kc at 65 db down. Image rejection is more than 60 db at highest operating frequency. There is a choice of any 3 frequen-

GEARS

DIAMETERS .125" to 60"

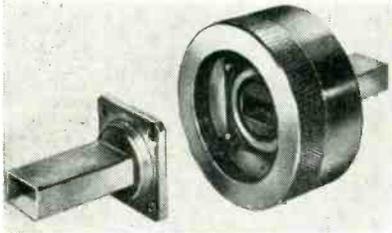


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cies, crystal controlled on 2.5, 5, 10, 15, 20 and 25 mc in stock. Also featured are a beat frequency oscillator and series noise limiter, dual audio output and an audio filter.



QUICK DISCONNECT
for waveguide users

AIRCRAFT ARMAMENTS, INC., P. O. Box 1777, Baltimore 3, Md. The waveguide quick-disconnect provides a reliable method of rapidly making and breaking waveguide connections. No tools are required. Connections are made by inserting the flange and hand-tightening the outer ring. Proper alignment is assured. The unit is also well suited for incorporation in microwave test sets as a front panel fixture. It is available to fit the standard chokes and flanges of RG-51/U, RG-52/U and RG-91/U waveguide.



BASIC STANDARD
for meter calibration

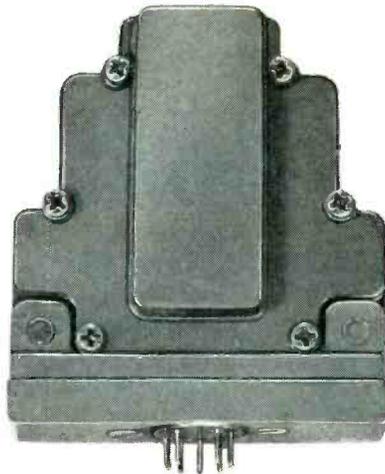
RADIO FREQUENCY LABORATORIES, INC., Boonton, N. J. Model 262 B dual potentiometer calibration standard is designed to provide a much needed medium for quickly calibrating electrical measuring instruments to a high degree of accuracy. It operates from an external power supply of 105/125 v at fre-

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James is the complete source for all vibratory products!*

THE ENGINEER'S STANDARD SINCE 1936

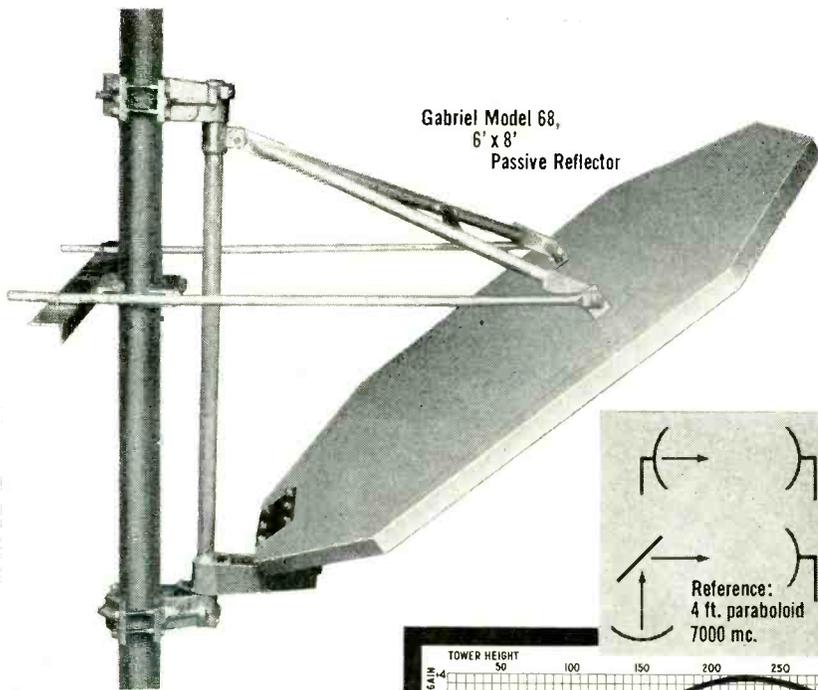
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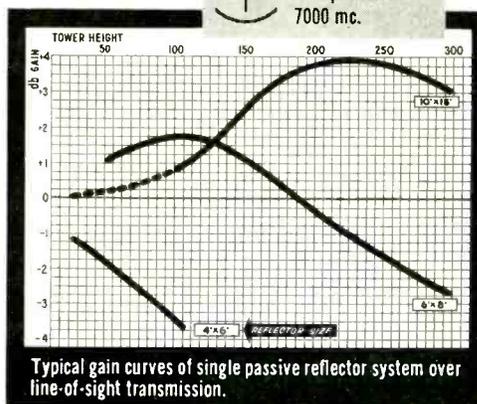
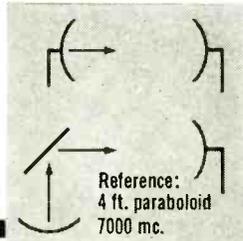
Introducing the first instrument-type double-pole, double-throw chopper featuring complete coaxial isolation of all contacts, low residual noise, 60 c.p.s., and meeting military environmental specifications for temperature, humidity, shock and vibration. The JAMES engineering department will be happy to analyze the application of this device to your specialized electronic circuitry.

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Gabriel Model 68,
6' x 8'
Passive Reflector



Typical gain curves of single passive reflector system over line-of-sight transmission.

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"PEAK"
 performance at lower cost
 with
GABRIEL passive reflectors

Fast . . . accurate . . . easy adjustment permits peaking Gabriel Passive Reflectors in microwave relay links to gain maximum point-to-point transmission at lower overall cost. Gabriel's new design offers increased system efficiency that can out-perform line-of-sight transmission.



Adjusting elevation done
by one man on tower.

- Two lead-screw systems permit continuous, stepless adjustment in azimuth and elevation by one man on the tower with only a hand wrench.
- Mounting on the tower can be done usually by a two-man crew, with total man-hours cut as much as 50%.
- Increased gain over line-of-sight transmission is obtainable with optimum size reflector for various tower heights.

Ask for Gabriel recommendations for your system.

Write for Bulletin PR-11 for complete mechanical and electrical systems data.

Gabriel Electronics Division

THE GABRIEL COMPANY, Endicott Street, Norwood, Mass.



quencies ranging from 50 to 1,600 cps and consumes 350 w. Accuracy on all ranges is 0.1 percent at full scale with voltages ranging from 1 mv to 1,500 v and current ranging from 1 μ a to 150 amperes. An accuracy of 0.05 percent may be obtained when using calibration charts supplied. Price of the unit is \$14,800. Demonstrations can be arranged and inquiries are welcomed.



TUBELESS SUPPLY for high-current uses

ELECTRONIC RESEARCH ASSOCIATES, INC., P.O. Box 29, Caldwell, N. J. Model 30 tubeless supply is a portable, variable low voltage, high current d-c/a-c power supply designed especially for high amperage applications. It is ideally suited for high power transistor amplifiers, regulated a-c or d-c filament supply, solenoid and magnetic clutch operation, a-c motor control and all types of high current a-c or d-c laboratory and factory applications. Input voltage is 105-125 v a-c, 60 cycles. Output is 0-30 v d-c or 0-130 v line regulated a-c. Maximum load current is 1.5 amperes maximum, 30 v-a capacity. Ripple for the d-c output is less than 1 percent. Line regulation is better than ± 1 percent change in output for the full range of input line variation.

TEST TAPE SAMPLER measures recorder accuracy

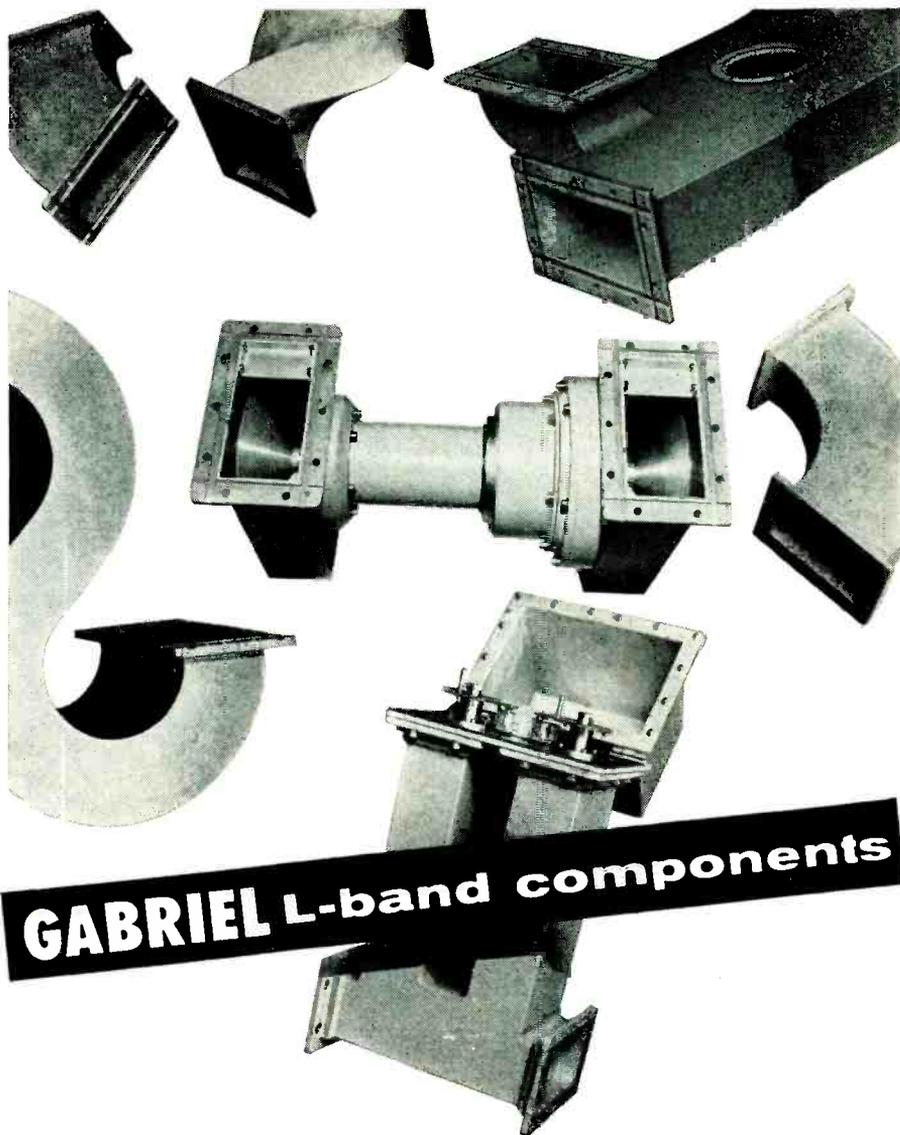
THE DUBBINGS SALES CORP., 41-10 45th St., Long Island City 4, N. Y. The D-210 is a 3-in. reel of Reeves Soundcraft Plus 50 mylar tape with

test signals and music recorded on it at 7½ ips by Dubbings. The recording is full track and thus may be used on either full-track machines. The D-210 offers the means of measuring the timing accuracy of any machine. This is provided by 2 timing beeps, which will be heard exactly 7 minutes apart when tape speed is 7½ ips. It also offers the means to align a playhead in an exactly vertical position to insure maximum output and frequency response of any machine; the opportunity to observe the performance of extended play mylar tape in action; and the opportunity to evaluate and enjoy the quality of beautiful music on prerecorded tape. A recently available instruction sheet tells how to use D-210 tests. It gives information on timing and alignment.



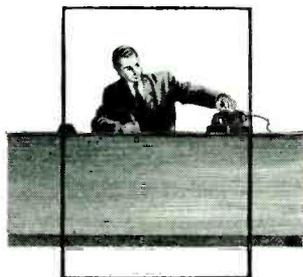
TUBELESS SUPPLY for airborne applications

ENGINEERED MAGNETICS, 11812 Teale St., Culver City, Calif. Very low ripple and precise regulation characterize the EM-28-1B tubeless magnetic-amplifier regulated d-c power supply. Developed for airborne applications, it is equally adapted to bench use in the lab to operate strain gages and scientific instruments requiring precise regulation and low ripple. The small size, 12×7×9 in., was designed to fit the supply into the same space occupied by the battery it replaces. Performance tests have proved the design which calls for long, maintenance-free life while delivering continuously 0 to 1.5 amperes. Voltage is easily adjusted within the range of 28 to 32 v, d-c, while the single-phase input fluctuates be-



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Now, a complete line of large-size microwave components is available from the Gabriel Laboratories. Whatever L-Band components you need . . . stub tuners, power dividers, waveguide components, rotary joints, hybrid junctions, adjustable phase shifters . . . Gabriel can supply them. If you have a special problem, our staff of designers and engineers is ready to meet your most exacting specifications. Extensive testing equipment and complete production facilities operated by highly-skilled personnel insure exceptional electrical performance and mechanical strength.

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The Gabriel Laboratories

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Where fine audio quality is essential, for private, commercial or military equipment, you can depend on CHICAGO high fidelity transformers for distortionless sound reproduction.



CHICAGO ULTRA-LINEAR HIGH FIDELITY Output Transformer BO-13

This "super-range" transformer, specifically designed for ultra-linear Williamson amplifier circuits, is typical of the many high fidelity transformers available from CHICAGO.

Amplifier frequency response, with the BO-13, is flat from 20 to 60,000 cycles at 20 watts output. At a 1 watt listening level, the BO-13 is flat from less than 10 cycles to beyond 200,000 cycles.

Intermodulation distortion, measured at 60 and 7000 cycles, 4:1 ratio, is less than 3% at 21 watts. Total harmonic distortion is below 0.1%, measured at 1000 cycles, up to 21 watts.

The BO-13 is housed in a compact, seamless steel case measuring $3\frac{5}{16}$ " x $3\frac{1}{16}$ " x $4\frac{1}{16}$ " high. CHICAGO'S famous "sealed-in-steel" construction provides maximum shielding and full humidity protection.

CHICAGO Bulletin 33 lists performance curves and other useful information on the BO-13. Write for your FREE copy, or get it from your CHICAGO distributor.



CHICAGO STANDARD TRANSFORMER CORP.

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**CHICAGO CATALOG
CT-554,**

listing complete electrical and physical specifications on over 500 CHICAGO transformers. Available from your CHICAGO distributor or from Chicago Standard Transformer Corporation.

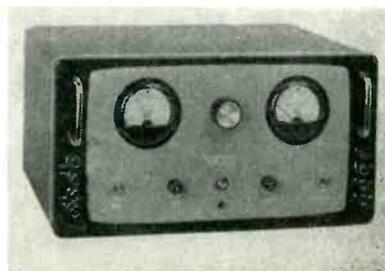
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tween 105 to 125 v and 380 to 420 cps, a-c. Regulation is held to better than 0.2 percent with 5 mv rms ripple throughout a temperature range of -30 F to ± 120 F and at altitudes up to 70,000 ft. Recovery time is better than 0.2 sec under worst conditions.



PLUG-IN UNITS for electronic circuits

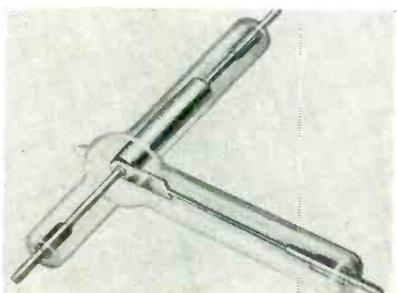
VECTOR ELECTRONIC Co., 3352 San Fernando Rd., Los Angeles 65, Calif. New compact plug-in mounting packages may be quickly wired for a variety of electronic circuits. Single or multitube units are easily assembled in new Lip-Loc cases with snap-open side panels, locks, choice of plugs and finishes. All internal modular structures furnishable are discussed in a recent bulletin now available.



POWER SUPPLY Has ultrahigh regulation

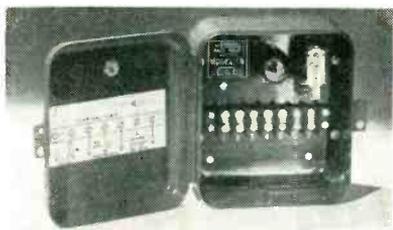
KROHN-HITE INSTRUMENT Co., 580 Massachusetts Ave., Cambridge 39, Mass. Model UHR-245 ultrahigh regulation power supply furnishes continuously variable voltage from 150 to 500 v and delivers up to 0.5 ampere of d-c with 0.002-percent load regulation and less than 100 μ v of ripple over the entire operating range. Internal impedance is 0.01 ohm for d-c and low frequencies

and is less than 0.05 ohm for frequencies as high as 50 kc (at higher frequencies the impedance is equivalent to 0.05 ohm in series with 4 inches of wire). Full rated maximum current can be drawn with 100-percent duty cycle at any output voltage and at any line voltage from 105 to 125 v with a substantial safety factor. Drift is kept very low by the use of drift-cancelling differential amplifiers, a new high-stability reference tube and low temperature-coefficient wire-wound resistors.



H-V SWITCH used in d-c pulse systems

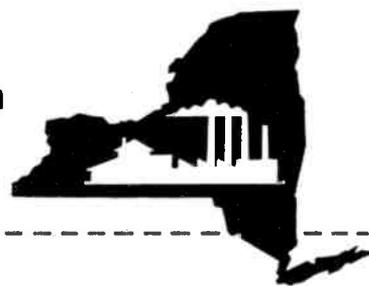
NAER CORP., 2301 S. Purdue Ave., West Los Angeles 64, Calif. This recently developed vacuum switch is externally operated by a d-c solenoid and it is ideally suited for switching purposes in d-c pulse systems, especially in radar installations. Part No. NVS-300 is a normally closed spdt high-voltage device. For pulse application, switching is done under no-load conditions. Breakdown test voltage between open contacts shall be 20 kv d-c.



PILOT RELAY has unusual sensitivity

INDUSTRIAL ELECTRONIC CONTROLS Co., 2271 E. 14th St., Brooklyn 29, N. Y. Model EB electronic pilot relay is able to control large values of current and power with a current

plant-location news



Need facts on buildings or sites?

Here's some plain talk on a rather tricky subject—industrial real estate. Our Industrial Location Service doesn't sell property, but we can help you with many of the problems involved in locating the right plant, or plant site, for your company. What we do is supply confidential data to suit your needs on available sites or buildings anywhere in New York State. This comprehensive information is free of charge and, even more important, it's free of "boosterism"!

We never try to unload real estate just because it's available. Businessmen simply don't go for that kind of promotion. Besides, the aim of New York State's ILS is to find only the *best* locations for industry. We want companies who'll stay here for years to come. They'll do that only if the location *is* the best. That's why we supply unbiased data right from the beginning.

We aim to please: with facts

That's the kind of thinking behind the ILS information service. The way we look at it, real property is only one of many considerations. ILS experts never recommend a site without sifting and analyzing all location factors in the light of your particular requirements. And they'll never withhold unfavorable information.

Find what you want here

Let's get down to cases, and see what kind of detailed information

ILS offers on buildings and sites:

For suitable buildings, we'll give information on price and financing, describe the type and condition of the structure and explain the heating or cooling systems. You'll also learn about electric installations, sprinklers, floor-load capacities, and facilities for handling sewage and other waste. Water sources, rail sidings, loading docks—any detail you wish, plus photos and plans, can be supplied in these reports. The same data is available for sites.

If no suitable building exists, we'll help you arrange to have one built to your specifications. At the same time we'll help you secure financing at an annual cost you can afford.

You'll like the way we collect this information. It's put together without divulging your identity, so there's never the danger of prices being jacked up before you're ready to make a final choice.

Other free plant-site services

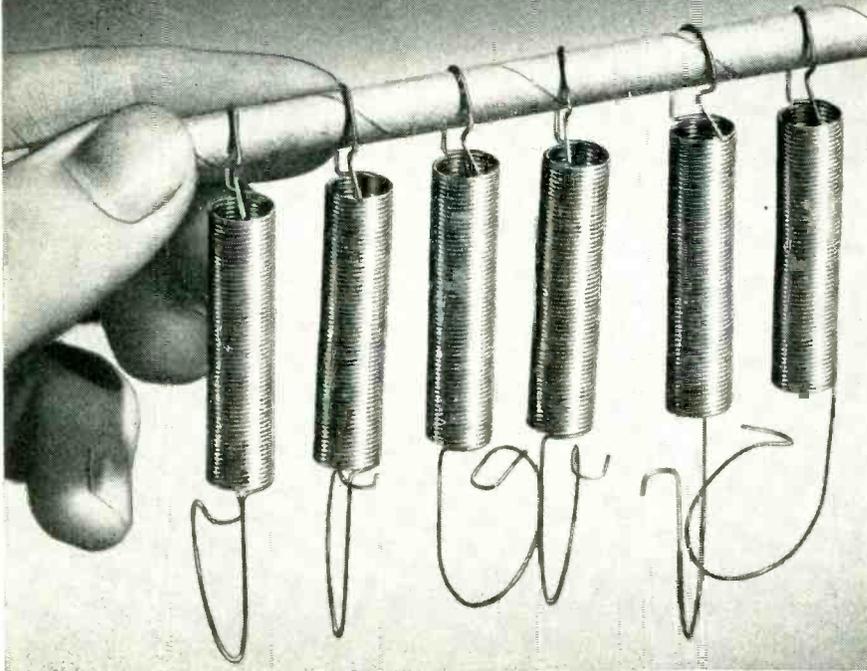
Buildings or sites won't be your only concern when you're looking for a new plant location. But no matter what factors are involved, ILS can be of help. Free reports are available on transportation, markets, raw materials, labor, water, and local laws and regulations—to mention just a few.

Our booklet called "Industrial Location Services" shows how you can put this valuable plant-location data to work. To get your free copy, just drop me a card, care of the New York State Department of Commerce, Room 877, 112 State Street, Albany 7, New York.

Ronald B. Peterson

Director, Industrial Location Service

We'll Help You Put More "Automatic" In Your Automation!



● There is an "extra" Lewis Service many spring users don't know about... it might be called: "packing for production" or "arranged for automation." It's simply the way in which Lewis Springs and Wireforms may be shipped to reach the production line ready for quick, time-saving handling and the most efficient assembly operation... by hand or automatic equipment.

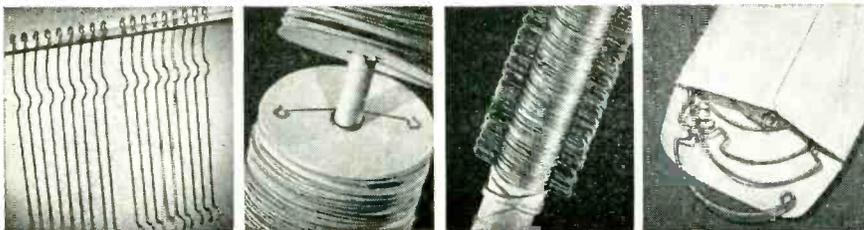
Working with customer's production men, Lewis Engineers devise the packing method best suited to the job: Perhaps threaded on a rod... on special holders... in envelopes... tied or grouped in bundles... and in many other different ways.

If you use springs and wireforms, and have plans to further "automate" production we'd like to help you with our "extras" in Lewis Service. And, of course, top quality springs and wireforms are our business. Send us your problem.

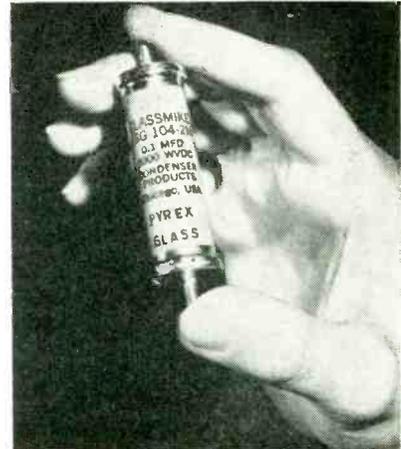
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The Finest Light Springs and Wireforms of Every Type and Material



flow of 2 millionths of an ampere. Sensitive to high speed impulses it operates with an actuating pilot circuit resistivity from 0 ohm to 10 megohms. A catalog sheet giving specifications, dimensional sketches and circuit data is available.



CAPACITORS in Pyrex glass case

CONDENSER PRODUCTS Co., division of New Haven Clock and Watch Co., New Haven, Conn., is now using tempered Pyrex brand glass as the tubing case for its glass capacitors. The Pyrex case will give glass capacitors greater resistance to thermal shock and a higher voltage breakdown resistance. The tempered Pyrex will improve production procedures, which will ultimately result in reduced costs of the capacitors. The unit illustrated is the Glassmike ASG104-2M, rated at 0.1 μ f at 2,000 v d-c.

Literature

Closed Circuit Television. Radio Corp. of America, Camden 2, N. J., has published a 4-page folder, How To Read A Blueprint at 500 Feet, telling how closed circuit tv is applied to achieve effective work coordination and two-way visual communication between widely separated buildings. The folder describes the simplicity and functions of TV Eye, a low-cost closed circuit

tv equipment. Several applications for closed circuit tv are outlined. Accessory equipment required for special applications is briefly described and illustrated. Request Form 3R2436.

Selenium Rectifiers and Diodes. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin SR-1A deals with Microstak selenium rectifiers and selenium diodes. The 8-page bulletin contains comprehensive data on construction, applications, types, ratings, reference curves, specifications and d-c characteristics. Charts and graphs are included.

Electronic Test Instruments. Shasta Division, Beckman Instruments, Inc., 1432 Nevin Ave., Richmond, Calif., announces availability of a brochure describing its new line of electronic test instrumentation including vacuum-tube voltmeters, oscillators, square wave generators resistance bridges, power supplies, wide-band amplifiers and various accessories.

Transistor Soldering Tool. Television Accessories Co., Box 6001, Arlington 6, Va., has available a catalog sheet dealing with the new ORYX-6 transistor soldering tool. The soldering iron discussed weighs only ¼ oz, is but 6 in. long, and features a ⅛ in. chisel tip. It is particularly recommended for fine soldering of transistors, germanium diodes, hair-spring movements and all delicate assemblies.

Decimal Counters. Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J. A recent bulletin illustrates and describes types 100A and 100B decimal counters. The units discussed feature direct reading in digits, plug-in construction, counting rate up to 100,000 per sec and immediate reset without missing a count. Complete specifications are listed.

Crossbar Switch. James Cunningham, Son & Co., Inc., 13 Canal St., Rochester 8, N. Y. A single-sheet bulletin contains an illustrated description of a new h-f crossbar switch. Included are a dimensional drawing, chief features and

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throughout the East Coast and
found this sector the most suitable
from every aspect for his company.

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AND it might well be yours! For if you are now buying the components for servo systems from several manufacturers, you are probably wasting time, labor, machinery, and material, modifying the various units for better coordination. And you still end up with only the inferior performance that such a hodge-podge delivers.

Transicoil experience proves that you can save the time and trouble of secondary operations and end up with a better system by merely using assemblies made up of matched Transicoil components. The units comprising these assemblies are designed and constructed to work with each other for optimum efficiency, top performance, and actually cost less when assembled than the total purchase price of individual components acquired from several sources.

If you are now purchasing servo components from several manufacturers, a serious talk with Transicoil will pay you dividends in lower costs and a better system. But if you require only one component, you can be sure of optimum performance from the Transicoil units you specify.

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Miniature Control Motors Motor and Gear Train Assemblies Motor, Generator, and Gear Train Combinations Servo Amplifiers Plug-In Assemblies

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Bell Telephone System

STANDARD CONTROL KNOBS

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70 Series Round



90 Series Skirted Round



90 Series Pointer



90 Series Skirted Pointer



125 Series Dial Skirted Round



175 Series Crank

The quality of fine electric and electronic equipment is obvious at every look and touch when you use Raytheon standard control knobs.

These injection molded knobs add the appeal of custom styling at standard cost. They are available in an integrated family of 54 items — in a choice of *six* basic types and *five* widely used sizes.

Made of tough, durable "Tenite II" (cellulose acetate butyrate) with anodized aluminum inserts and dual setscrews. All types and sizes available in black with gleaming *mirror finish* or with non-reflecting *matte finish*, for government equipments. Also available in color or with knob parts assembled in striking color combinations.

Write for complete information. Address Department 6120-A, Raytheon Manufacturing Company, Equipment Sales Division, Waltham 54, Massachusetts.

DRESS UP YOUR PRODUCT



information on application, function, operation and construction of the unit.

Fluctuating-Pressure Transducer. Electronic Engineering Associates, Ltd., 961 Brittan Ave., San Carlos, Calif. A new leaflet, form PT654, describes a miniature flush-diaphragm strain-gage transducer recommended for applications requiring small size and light weight as well as arrangement where the sensing diaphragm can be located directly in the surface under pressure to eliminate phase and amplitude errors in fluctuating-pressure measurements. The leaflet illustrates and describes the transducer; provides dimensional and construction information in mechanical drawings and gives electrical circuitry. Operating parameters are tabulated for the standard pressure ranges of the $\frac{1}{2}$ -in. diameter transducers.

Shielded Room. The Office of Aviation Information, CAA, Washington 25, D. C. Information on construction of a shielded room is contained in Aviation Safety Release No. 391, entitled "The Use of Shielded Rooms in Aircraft Radio Maintenance," now available without charge. The shielding described keeps out radio interference which makes electrical measurements difficult and prevents accurate frequency adjustments. The shielding also prevents illegal and undesirable radiations from going outside the room.

Receiver Recorder. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio. A recent 12-page brochure explains in detail a receiver recorder for pneumatic and electric transmission systems. It includes liberal illustrations, application, operation, engineering and ordering specifications. Write for Product Specification E12-5.

Potentiometer Linearities. Clarostat Mfg. Co., Inc., Dover, N. H. To aid in the selection of the type of linearity which the application of a potentiometer demands, while remaining consistent with economic considerations, the company's engineering department has come up with definitions of 4 different types of linearities—*independent, zero-*

based, terminal and index-point. The bulletin is illustrated with the pictorial output of each type of linearity. Ask for bulletin Form No. 753813.

Interference Filters. Tobe Deutschmann Corp., Norwood, Mass. The new 2-page engineering bulletin No. F-102, "Guide to Specification of Interference Filters," presents 27 electrical environmental and mechanical check points when designing, selecting or specifying electronic noise filters. The reverse side of the bulletin has a handy decibel conversion chart.

Insulated Terminals and Splices. Burndy Engineering Co., Inc., Norwalk, Conn. The Insulug Bulletin YAE54 has recently been released, providing latest information on the tin-plated copper, nylon-insulated, compression-installed Insulugs and Insulinks. The bulletin contains all straight and right-angle Insulugs and Insulinks for copper aircraft and flexible cable sizes No. 26 through 2/0. A convenient tool index provides tool information for installing the entire range of Insulugs and Insulinks.

Converter Data. Gothard Mfg. Co., 2110 Clear Lake Ave., Springfield, Ill. Bulletin 420, a new condensed catalog, has just been issued on the series K rotary converter. The new literature describes the company's line of heavy-duty, industrial-type, 3,600-rpm converters. It offers a wealth of information, including characteristics and capacities.

Step Variable Delay Lines. Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J. A recent bulletin covers types 601, 602 and 603 step variable delay lines that feature equal input and output impedance, 11 different steps and excellent transient response. Included are an illustrated description and a table of specifications.

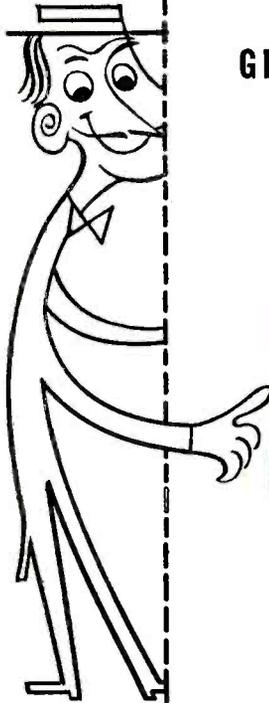
Waveguide Equipment. NARDA Microwave Test Equipment & Bolometers, 66 Main St., Mineola, N. Y. A recent bulletin contains illustrated descriptions of types N-333 and N-334 thermistors, types N-610B and N-821B bolometers. Also included are specification data on K_a-band, X-band and broadband

NEW

improved lightweight model!

CANOGA Wobbulator

SWEPT FREQUENCY SIGNAL GENERATOR with OSCILLOSCOPE



Here is a new improved functional design of the well-known Canoga Model 705 Wobbulator Signal Generator. Smaller in size and lighter in weight, it features a wider bandwidth, a greater frequency range, and an all-electronic sweep circuit. It is ideal for use in manufacturing, servicing, or testing receiving equipment such as video, RF, IF, and distributed amplifiers.

As an example of the Wobbulator's new functional design, the housing is an aerated structure with tapered sides allowing ample passage of cooling air throughout the unit, even when placed alongside other equipment.

These, and other features of the new Wobbulator, are positive proof of Canoga Corporation's superior electronic engineering and design.

FREQUENCY RANGE . . . 2.0 to 1000 mcs. Continuous single knob tuning with calibrated dial.

FREQUENCY SWEEP . . . Any bandwidth of 100 mcs. or smaller.

AMPLITUDE VARIATION . . . Less than 0.01 db/mc.

OUTPUT VOLTAGE . . . 0.1 volts across 50 ohm resistive load.

ATTENUATOR . . . The output level is continuously adjustable by means of a wave guide beyond cut-off attenuator calibrated in 1 db divisions.

DISPLAY . . . 5" CRT

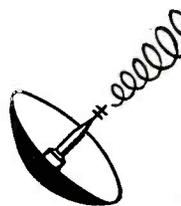
SENSITIVITY . . . Detector for built-in amplifier and CRT presentation has a sensitivity approx. 60 db below 0.1 volt; gain and bandwidth measurements can be accomplished on circuits having a loss as great as 60 db.

POWER SUPPLY . . . Self-contained, all DC voltages regulated. Input 105-125 volts, 50-400 cps, approx. 100 watts.

SIZE . . . 12" x 13" x 17".

WEIGHT . . . Approx. 50 lbs.

PRICE . . . \$1500.00



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• **RADIO INTERFERENCE**
• **and FIELD INTENSITY***
• **measuring equipment**

• **Stoddart NM-50A • 375mc to 1000mc**

• Commercial Equivalent of AN/URM-17

ULTRA-HIGH FREQUENCY OPERATION... Frequencies covered include UHF and color television assignments and Citizen's Band. Used by TV transmitter engineers for plotting antenna patterns, adjusting transmitters and measuring spurious radiation.

RECEIVING APPLICATIONS... Excellent for measuring local oscillator radiation, interference location, field intensity measurements for fringe reception conditions and antenna adjustment and design.

SLIDE-BACK CIRCUIT... This circuit enables the meter to measure the effect of the peak value of an interfering pulse, taking into account the shaping due to bandwidth.

QUASI-PEAK FUNCTION... An aid in measuring pulse-type interference, the Quasi-Peak function is just one of the many features of this specially designed, rugged unit, representing the ultimate in UHF radio interference-field intensity equipment.

ACCURATE CALIBRATION... Competent engineers "hand calibrate" each NM-50A unit. This data is presented in simplified chart form for easy reference.

SENSITIVITY... Published sensitivity figures are based on the use of the NM-50A with a simple dipole antenna or RF probe. However, the sensitivity of this fine instrument is limited only by the antenna used. The sensitivity of the NM-50A is better than ten microvolts across the 50 ohm input.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of
AN/URM-6B. Very low frequen-
cies.

HF NM-20B, 150kc to 25mc
Commercial Equivalent of
AN/PRM-1A. Self-contained
batteries. A.C. supply optional.
Includes standard broadcast
band, radio range, WWV, and
communications frequencies.
Has BFO.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of
AN/URM-47. Frequency range
includes FM and TV bands.

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

frequency meters. Also given is illustrated information on directional couplers and terminations.

Casting Compounds Bulletin. Thio-kol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J. Starting formulations and resultant properties of the company's liquid polymer/epoxy resin casting compounds are described in a new 12-page booklet. The compounds described display a high degree of resilience and impact resistance throughout a broad temperature range, will withstand severe temperature cycling and have good resistance to water vapor transmission. Good strength and electrical properties and excellent resistance to organic and inorganic liquid are obtained with the casting compounds discussed.

Wafer Capacitors. Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa., has available a catalog on a new line of Capitron wafer capacitors ranging from 25 to 100,000 μf with a tolerance of ± 5 percent. The catalog gives complete descriptions, special design factors, voltages, dissipation factors, leakage resistance, temperature vs voltage derating factor, absorption and capacitance variation vs frequency and temperature of capacitors.

Analytical and Control Instruments. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Bulletin CEC-1302A is entitled "Analytical and Control Instruments." The graphically-illustrated general catalog contains information on the company's analytical, isotope-ratio, dual-purpose and process-monitoring mass spectrometers; high-vacuum leak detectors; Titrilog sulfur recorders and Spectro-SADICs (high-speed analog-to-digital converters). Detailed information is also given on the operation of the company's Analytical Services section which serves research and industrial organizations.

VHF Communications Receiver. Collins Radio Co., Cedar Rapids, Iowa. An 8-page folder covers the 51X-1 vhf communications receiver. Included are photographic

illustrations, outstanding features and specifications, a block diagram and an outline drawing. Illustrated information on associated equipment is also given.

Direct-Writing Oscillograph. Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill., has available an 8-page illustrated booklet describing a new direct-writing oscillograph, the type M Dynograph recorder. This booklet details the construction, specifications and operating principles of the Dynograph. Schematic diagrams show the wide variety of sensing units that can be used with the chopper-type d-c amplifier.

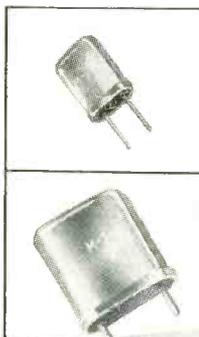
Meter Catalog. Empire Devices Products Corp., 38-15 Bell Blvd., Bayside 61, N. Y. A 6-page folder illustrates and describes models NF-105 and NF-114 noise and field intensity meters; models AT-100 and AT-101 step attenuators; models AT-50 and AT-60 uhf attenuators; model CM-107 broadband crystal mixer; models IG-102 and IG-115 uhf impulse generators; and model ND-110 noise and distortion analyzer. Complete engineering data for all instruments are included.

Plug-In Units. EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif. A new 32-page illustrated bulletin 81554 presents circuit drawings and specifications on 29 different plug-in units. A number of typical applications are also presented to illustrate the use of the company's plug-in units. Prices are included.

High-Altitude Nomograms. Rotron Mfg. Co., 7-9 Schoonmaker Lane, Woodstock, N. Y., offers the design engineer a novel and practical short-cut to calculating volumes and weights of cooling air required for electronic equipment in diverse airborne applications. ENG-DATA sheet No. 20201-1 covers 8 pages of graphs and nomograms with a short text giving examples pertaining to typical practical cases. These examples are split into the 2 categories for laminar and turbulent flow. Some of the nomograms are the result of considerable mathematical work, and derivations of the form-

McCoy Precision Quartz Crystals
 deliver the SAME FINE PERFORMANCE

You can expect the same precision performance from both the McCoy M-1 and the M-20 "McMite," although the "McMite" is only 1/5th as big. Both crystals are produced up to 110 mc on the 5th overtone. The fact that these two crystals perform equally well in meeting widely varied job specs illustrates the versatility of McCoy design and production facilities. Whatever you need in quartz crystals, McCoy either makes them or can develop them for you. Send for free catalog today on the McCoy line of high quality, precision-made quartz crystals.



M-20 "McMite" is a sub-miniature hermetically sealed unit, adaptable to multi-channel design for communications and frequency control equipment. Can be wired into a sub-miniature selector switch assembly or soldered to a printed circuit terminal board.

M-1 is an hermetically sealed, plated crystal preferred when fundamentals below 5 mc are desired. Easily interchangeable, it plugs into a standard socket. Meets government specification MIL-C-3098A and CAA-R-916; also ARINC No. 401.

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During the coming months you'll be seeing top-level Martin developments in the news—developments which spell out the message above.

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ulas used are made available by the company to those interested. They will be sent free to design engineers upon application by letterhead.

Solenoid Contactor Bulletin. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill., has available a completely new solenoid contactor bulletin. Featuring a wide range of enclosed and sealed models with power ranges up to 250 amperes, the bulletin is fully illustrated, shows dimensional drawings and gives complete technical data. Included are military specification numbers, type numbers and specific approval information. Write for bulletin SC-9.

Printed Circuitry Techniques. National Vulcanized Fibre Co., Wilmington 99, Delaware. Advantages of printed circuitry are thoroughly covered in a new 12-page bulletin entitled "Mechanize Your Wiring . . . With Copper-Clad Phenolite." The bulletin highlights the numerous potentials printed circuitry offers design engineers and manufacturers. Of particular interest is a discussion of the economics of printed circuit design and construction as compared with conventional handwiring methods. The fully-illustrated bulletin covers basic technical facts and design data related to applied printed circuitry. Methods of producing printed circuits and design and construction considerations are treated in detail. Also presented are complete specifications on, and properties of, copper-clad Phenolite.

Electronic Counters. Electronic Products Division, Post Machinery Co., Beverly, Mass. Catalog A is a 14-page booklet giving operating instructions for the company's Decitron electronic counters. Included are specifications, general description, installation instructions and data on photo heads and kickers. Information on maintenance and service as well as a parts list are included.

Extruded Plastics. Anchor Plastics Co., Inc., 36-36 36th St., Long Island City 6, N. Y. A new 4-page brochure illustrates over 50 different cross sections typical of the almost limitless variety of

shapes, rods, strips and tubes which can be custom extruded from thermoplastics. General specifications of the various types of extrusions are given. In addition, the brochure describes and illustrates fabricated components which can be made from extrusions and also explains how plastics can be extruded over other core materials. Also included is a guide to the comparison and selection of ten thermoplastic materials used for extrusions.

Pulse Transformers. Berkshire Laboratories, Lincoln, Mass. A single-page bulletin covers 3 types of pulse transformers, listing their uses and advantages. Diagrammatic specifications, characteristics and prices are included.

Magnetic Tape Data Recording. The Davies Laboratories Inc., 4705 Queensbury Rd., Riverdale, Md. Bulletin 54-D covers magnetic tape data recording equipment. Information included consists of data on compensation, recording and playback heads, portable recorders, laboratory recording-reproducing equipment, tape transports, f-m discriminators, playback amplifiers and speed control servo. A table shows characteristics of portable recorders.

Environmental Test Equipment. The American Research Corp., 11 Brook St., Bristol, Conn., has published a 6-page catalog, No. 55, covering developments in and additions to a complete line of environmental test equipment. In addition to regular equipment for testing under conditions of temperature, altitude, humidity and sand and dust at various extremes, in various combinations, the publication covers their recently developed explosion chamber, rain and sunshine chamber, altitude and temperature equipment for occasional and visible testing, and a calibration test stand for sensitive calibration of temperature measurement and control devices.

Electronic Hardware. U.S. Engineering Co., 521 Commercial St., Glendale 3, Calif. The company's terminals, terminal boards, and etched and printed circuits are described and illustrated in a new

WANT TO CUT INSPECTION COSTS ELIMINATE CIRCUIT DEFECTS



Automatic quality control with the **CTI Supertester**

Here is the answer to the problem of maintaining high standards of inspection and reliability with the ever-increasing complexity of modern equipment.

The CTI Supertester is an automatic precision instrument for production testing, fault analysis, and preventive maintenance. It checks electronic and electrical products more completely and in a fraction of the time required by present methods.

Profit three ways by reduced labor costs, higher efficiency, and improved customer relations.

Here are a few widely varied applications. Others will suggest themselves immediately. Completely automatic checking for:

electronic and electrical assemblies
aircraft-engine nacelles
equipment in routine maintenance
guided missile pre-flight tests
computers
cable harnesses

The CTI Supertester automatically programs any combination or sequence of these measurements:

Impedance
Resistance
A-C Voltage
D-C Voltage
Leakage
Continuity

COLOR TELEVISION INCORPORATED



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**FOR
EFFICIENT COOLING
OF HIGH-POWER
TUBES**



WATER-COOLED

● For carrying cooling water which must undergo a change in potential, use of Lapp porcelain eliminates troubles arising from water contamination and conductivity, sludging and electrolytic attack of fittings. Lapp porcelain Water Coils or Lapp Porcelain Pipe assure permanent cleanness and high resistance of cooling water—for positive cooling and long tube life.



AIR-COOLED

● Now available as a standardized line, Lapp insulating supports for mounting forced-air-cooled tubes facilitate design . . . make for economical production, easy interchangeability, availability of replacement parts. Sizes for all standard high-power tubes.

Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 233 Sumner St., Le Roy, N. Y.

Lapp

8-page bulletin. The bulletin also illustrates production methods and details quality control.

Resistor Bulletins. Cinema Engineering Division of Aerovox Corp., 1100 Chestnut St., Burbank, Calif., has issued two new catalog sheets. One is on the company's hermetically sealed resistor networks with description, illustrations and customer application design detail data. The networks exceed the requirements of MIL-STD-202, methods 102 and 104; resistors within the assemblies exceed the requirements of MIL-R-93A specification. The second bulletin is on PW resistors for automation and printed wiring. These resistors, encapsulated in cast epoxy, exceed the requirements of MIL-R-93A where applicable.

Industrial Tube Characteristics. Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass., has announced availability of its new industrial tube characteristics booklet. It is composed of over 450 industrial types comprising 17 distinct tube classes ranging from reliable sub-miniature and miniature tubes to transistors. This largest and most comprehensive of the company's booklets now contains over 20 pages of technical data and basing information. The transistor line covered now consists of 9 types, including 3 hermetically sealed units.

Electronic Frequency Counter. The Detectron Corp., 5420 Vineland Ave., North Hollywood, Calif., has available a single-sheet bulletin illustrating and describing the DS-6100 electronic frequency counter. The unit discussed will count and display any electrical or mechanical event that can be converted to electrical impulses, from 10 to 100,000 events per sec. The bulletin outlines features, applications and specifications. Price is included.

Regulated D-C Power Supplies. Vickers Electric Div., Vickers, Inc., 1815 Locust St., St. Louis 3, Mo., has available a bulletin containing complete information on the new magnetic amplifier-selenium rectifier regulated d-c power supplies. Included are photographs of the equipment; a description of its design, operation and application; and

complete electrical and dimensional data on all models, in a range of ratings from 5 to 50 kw.

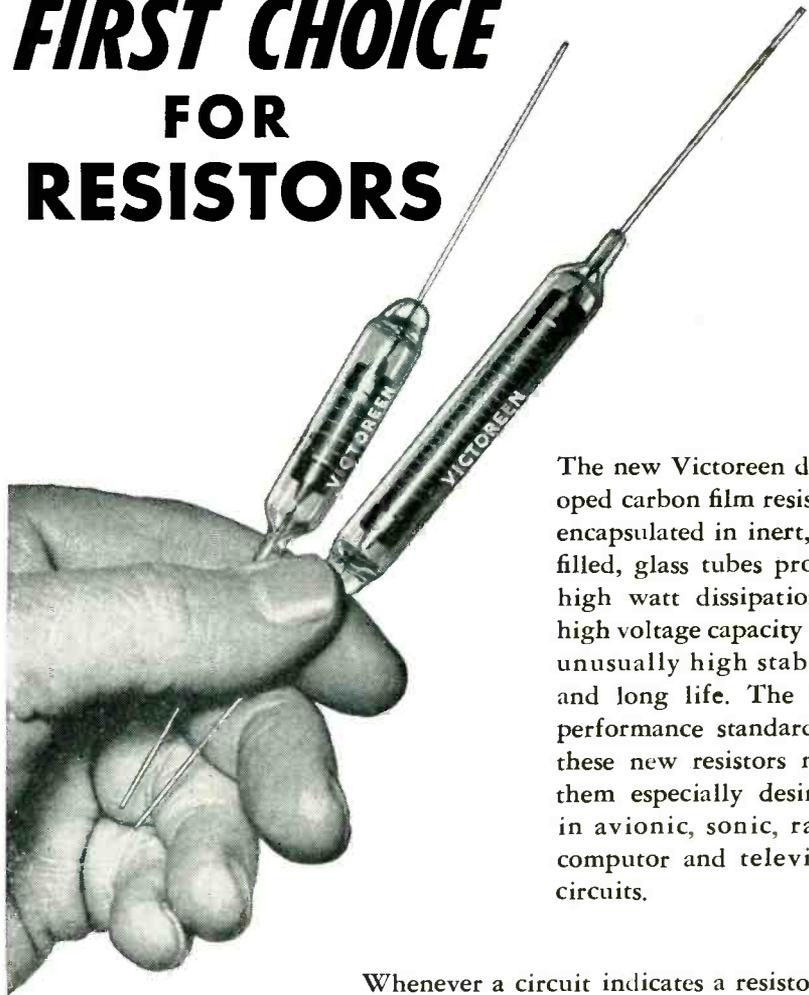
Precision Variable-Ratio Transformer. Vernistat Division, The Perkin-Elmer Corp., Norwalk, Conn. A new 6-page, 2-color brochure fully explains the construction and operation of the Vernistat, a new type of precision variable-ratio transformer. The Vernistat described combines the resolution and linearity associated with multi-turn potentiometers with the low output impedance characteristic of variable autotransformers. Included in the brochure are performance curves, application schematics in computer and servo systems, specifications of the 60 and 400-cps types, and step-by-step drawings illustrating the combination autotransformer and potentiometer mode of operation of the Vernistat.

Deflection Yoke Winder. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill., has issued a catalog page illustrating and describing the new model YW series deflection yoke winder. Complete technical data are given on unique oscillating winding motion, types of coils wound, tension equipment, winding speeds, set-up time, motor equipment, instant resetting predetermining counter, positive stopping magnetic brake, mounting, multiple winding and other features. Illustrated are the machine, a color yoke, 70-deg yoke and two 90-deg yokes.

Subminiature Relay. General Electric Co., Schenectady 5, N. Y. A hermetically-sealed subminiature relay for electronic applications in aircraft, aboard ship and on portable units is described in a new bulletin now available. The new publication, listed as GEA-6211, gives information on the tiny relay's performance features, construction and operation. Size of the relay is illustrated with photographs and dimensional drawings.

Portable Power Supply. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y. Model 71 portable power supply is illustrated and described in a recent 4-page folder. Included are special

VICTOREEN SHOULD BE YOUR FIRST CHOICE FOR RESISTORS



The new Victoreen developed carbon film resistors, encapsulated in inert, gas-filled, glass tubes provide high watt dissipation or high voltage capacity with unusually high stability and long life. The high performance standards of these new resistors make them especially desirable in avionic, sonic, radar, computer and television circuits.

FOR YOUR REFERENCE FILE

The Victoreen catalog providing reference data on Vibrator Power Supplies, Vibrators, Hi-Meg Resistors, Voltage Regulator Tubes, Electrometer and DC Amplifier Tubes, Special Tubes, Current Regulator Tubes and Counter Tubes is available on request.

Whenever a circuit indicates a resistor for extraordinary high performance standards, specify Victoreen as your first choice for stability and long-life. From engineering, thru all manufacturing processes these resistors are made to the highest possible quality. To many manufacturers, the use of Victoreen resistors has meant the elimination of costly field failures.

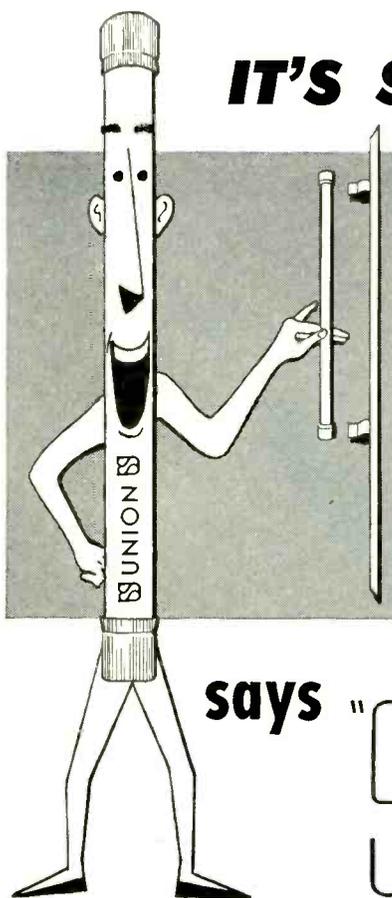
VICTOREEN HI-MEG RESISTORS

Resistor elements are vacuum sealed in glass tubes, which have been processed to maintain stability under high humidity conditions and artificially aged to maintain their characteristics. Such processing assures the accuracy needed in circuit applications of very high impedance levels.



The Victoreen Instrument Co.

COMPONENTS DIVISION: 3810 Perkins Ave. • Cleveland 14, O.



IT'S SO SIMPLE

Just snap us into your circuits and we'll trim your costs

says "Selenium Slim"

Now you can get *highest quality, trouble-free*, tubular selenium rectifiers at prices that will compete with power-hungry vacuum tubes.

A superior production method has been perfected by Union Switch & Signal engineers, the original developers of copper-oxide rectifiers more than 30 years ago. Better selenium cells are now being produced with greater precision and at lower costs than ever before.

You can snap these tubular rectifiers into standard fuse clips. Maximum peak inverse voltage ratings vary from 36 to 9360 with condenser input filter. Maximum DC current rating is 2.5 ma., though other current ratings can be supplied on special order. Stacks may be combined in series, as full-wave bridge circuits, or as voltage doublers.

These new UNION Selenium Rectifiers will reduce the cost, the weight and the power consumption of any high-voltage, low-current circuit. What's more, they give you the major advantage of long life and trouble-free operation. Call our representatives listed below or write us for complete information.

Union Tubular Selenium Rectifiers

BETTER QUALITY AT LOWER COST

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JJefferson 5-7300

LOS ANGELES
CLinton 6-2255

features, specifications, and a check list of 35 power supplies. Prices and specifications are given.

Hysteresis Synchronous Motors. Technical Development Corp., 4060 Ince Blvd., Culver City, Calif. Nineteen models of hysteresis synchronous motors for high-fidelity recording and reproducing equipment are described in the 4-page catalog, No. 403-2. Motors discussed feature a flywheel rotor with a capstan shaft and provide direct-drive magnetic tape speeds of $1\frac{1}{2}$, $3\frac{1}{2}$, $7\frac{1}{2}$, 15 or 30 ips. Complete specifications, wiring diagrams and mounting details are included.

Data Processing Instruments. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Bulletin CEC-1301, a 12-page general catalog entitled "Data Processing Instruments", furnishes information on the company's complete line, ranging from miniature transducers to entire instrumentation systems. Photographs, technical specifications and descriptive functional diagrams lend reader interest to descriptions of the instruments playing vital roles in flight-test, field, production-line and laboratory use. Recording oscillographs, galvanometers, amplifiers, power supplies, matching networks, velocity and pressure pickups, vibration meters, oscillogram processors and analog-to-digital converters are among subjects included in the profusely illustrated booklet.

Magnet Wire. Garfield Wire Division of The Overlakes Corp., 142 Monroe St., Garfield, N. J. A six-page folder contains a step-by-step illustrated description of the company's methods of production of magnet wire. Included are 3 pages of magnet wire specifications. Also available is a complete price list for the various types.

Hermetically-Sealed Miniature Relay. General Electric Co., Schenectady 5, N. Y. The hermetically-sealed miniature relay, primarily applied in military and civilian aircraft, is described in a new bulletin. The publication, listed as GEA-6213, explains the features, per-

formance and specifications of the small relay. In addition to aircraft application, the relay is described as widely used in shipboard and land-based electronic equipment.

Constant-Speed Motor. Dalmotor Co., 1329 Clay St., Santa Clara, Calif. Form SC-23 gives details of a unit recommended for those continuous-duty applications calling for constant speed under varying voltage, load and ambient conditions throughout a wide range of temperature, pressure and humidity variations. The unit illustrated is described as suitable for radar antenna spin drives, as well as similar applications. Performance curves are included in the leaflet giving data on output watts, rpm, efficiency and input amperes plotted against torque output.

Voltage Stabilizers. Raytheon Mfg. Co., Waltham 54, Mass. A 16-page catalog describes the company's voltage stabilizers, their performance characteristics and their importance to industry. Factual in content, it discusses applications for voltage stabilizers, and shows why voltage stabilizers are of value to manufacturers using or producing electronic equipment. Catalog 4-260 points out that many equipments require a high degree of voltage stability if they are to give satisfactory performance.

Shock and Vibration Isolation. The Barry Corp., 1,000 Pleasant St., Watertown, Mass. A 4-page illustrated brochure shows all the company's standard isolators, including miniature mounts for electronic gear in aircraft, shock mounts for mobile and shipboard packaging, and the leveling Barrymounts. The brochure also lists technical articles on various aspects of shock and vibration.

Modulating Anode Klystrons. Eitel-McCullough, Inc., San Bruno, Calif. A single-page bulletin gives an illustrated description of the company's new modulating anode klystrons which employ an insulated anode placed between the cathode and drift tube section. The modulating anode discussed permits a klystron to be pulse modulated easily with low pulsing power; to be amplitude modulated with low

Save Time, Reduce Errors... Determine and Record Data Automatically with These Two Versatile Berkeley Instruments



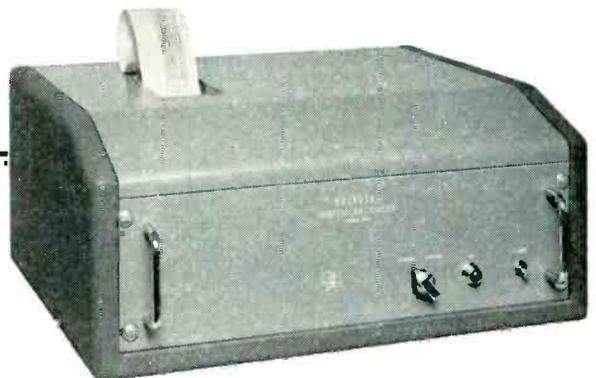
Model 5510 Universal Counter and Timer offers direct-reading digital display of count, frequency or microsecond time interval. Time bases from 1 mc. to 1 cps; gate times from .00001 to 10 sec. Accuracy ± 1 count, \pm crystal stability (1 part in 10^6). Price \$1,100.00 f.o.b. factory.

1. UNIVERSAL COUNTER AND TIMER, Model 5510, combines the functions of four instruments in one single, compact unit. It will:

- a. Count at speeds to 1 million per second.
- b. Count events occurring during a selectable, precise time interval.
- c. Measure time intervals in 1 microsecond increments, from 3 microseconds to 1 million seconds.
- d. Determine frequencies or frequency ratios from 0 cps to 1 megacycle.
- e. Operate directly the BERKELEY printer (below), BERKELEY digital-to-analog converter, or BERKELEY data processor to drive IBM card punches, typewriters or teletype systems.

2. BERKELEY DIGITAL RECORDER, Model 1452, combines scanner and high speed printer in a single unit; prints up to 10 digits on standard adding machine tape. Can be modified to print "Time" or "Code" information simultaneously with count data on same tape.

Model 1452 prints 6 digits (8 or 10 on special order) on standard adding machine tape. Is only 19" wide x 10 1/2" high x 14" deep, weighs 60 lbs. Price, \$750.00 f.o.b. factory.



Write for complete specifications and data; please address Dept. G-1

M-43

Berkeley

division

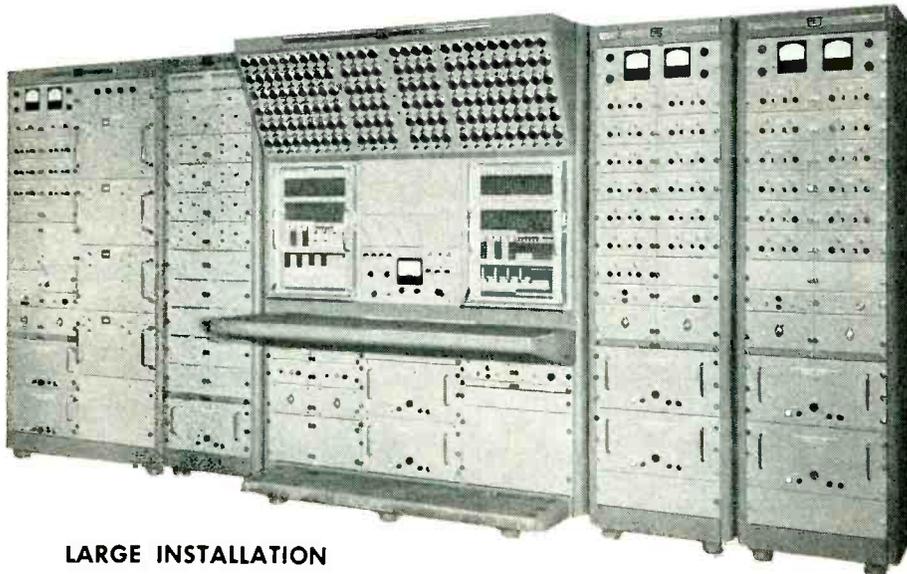
BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVE., RICHMOND, CALIF.

INDUSTRIAL INSTRUMENTATION AND CONTROL SYSTEMS • COMPUTERS • COUNTERS • TEST INSTRUMENTS • NUCLEAR SCALERS

MODERN Problems Demand... MODERN SOLUTIONS

NEW PRODUCTS

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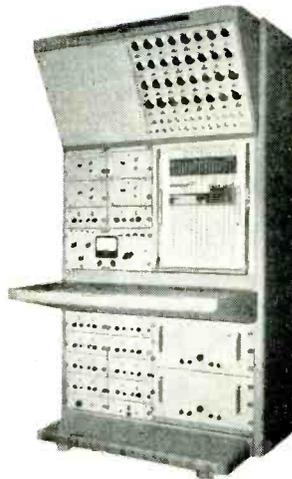


LARGE INSTALLATION

This large computer is used for the rapid solution of aero-dynamic problems. It consists of 50 operational amplifiers, 10 servo multiplying channels, 4 resolving channels, and a control console with two pre-patch bays, 156 attenuators, two voltmeters, and all necessary operational controls.

SINGLE PACKAGE COMPUTER

Our Type 16-31R Computer is a single package computer capable of solving differential equations with many simultaneous elements which are often encountered in the simulation of dynamic systems. It contains 20 operational amplifiers, 4 servo multipliers, thirty-two attenuators, all-metal removable problem board, and complete control panel.



PLOTTING EQUIPMENT

For presentation of problem solutions, the Variplotter Plotting Boards provide an accurate inked record. Typical uses include the automatic plotting of: Analog Computer output; guided missile data; engine performance characteristics; and control of manufacturing processes. With accessory equipment the range of applications can be greatly extended.

modulating power; and to operate as a modulated r-f amplifier and deliver a carrier capable of 100-percent modulation, with carrier efficiency of 30 percent.

Magnetic Tape. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. A discussion on the characteristics and application for Scotch brand No. 190 "Extra Play" magnetic tape is the subject of Sound Talk bulletin No. 30. The 3-page bulletin covers the physical and magnetic specifications of the new tape and is illustrated by 2 charts showing comparative frequency response curves and layer-to-layer signal transfer. The new No. 190 tape discussed, employing a high-remanence oxide coated on a thinner acetate backing, boosts recording time on any machine by 50 percent.

Relay Amplifier. The Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif., has available an 8-page folder dealing with a relay amplifier for guided missiles, aircraft, ships, industry, telemetering and radio command. Application, typical coupling circuits, block diagram and specifications are included.

Measuring and Testing Equipment. Federal Telephone and Radio Co., a Division of International Telephone and Telegraph Corp., 100 Kingsland Road, Clifton, N. J., has issued a catalog on the company's measuring and testing equipment. Included are illustrations, features, applications and specifications. This condensed catalog gives a brief technical description of a representative cross section of the instruments offered by the company.

Glass Products for Electronic Industry. Corning Glass Works, Corning, N. Y., announces the publication of a new catalog of glass products for the electronics industry. It includes descriptive and application information for fixed glass dielectric and trimmer capacitors; accurate grade, high temperature, power, and h-f resistors; and other components made of glass. Also included in the new publication is descriptive material covering new compositions and production methods in glass such as glass-to-metal seals, soldering metal to glass,

Write Dept. EL-1



ELECTRONIC ASSOCIATES INC

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NEW JERSEY

photosensitive glass, and fused silica. The information in the catalog will be of value to all those concerned with the design and construction of electronic equipment. Ask for catalog NP-54.

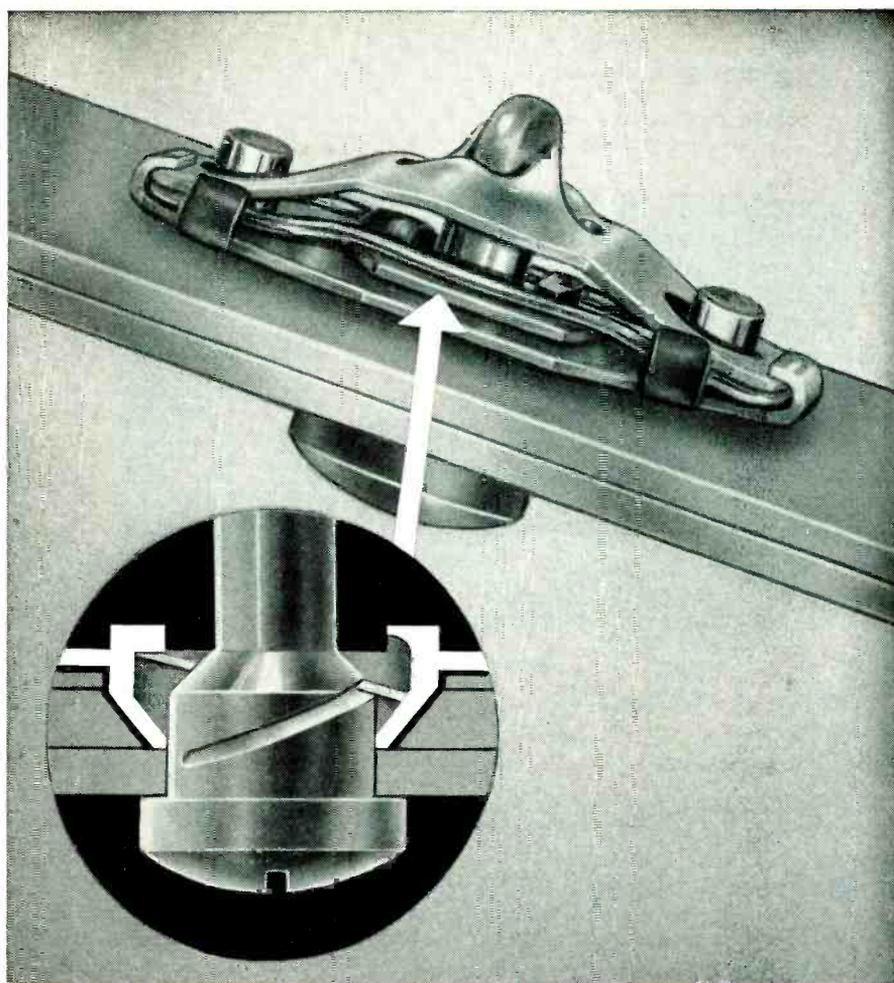
Power Supplies. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 60, N. Y., has available a new catalog of regulated and unregulated power supplies for industrial and laboratory use. It contains specifications for 35 models, of which more than a dozen are new this year. Among these is the company's model 71 portable power supply.

Speaker Catalog. Oxford Electric Corp., 3931 South Michigan Ave., Chicago, Ill. A new, multicolored catalog illustrates a complete line of speakers for original equipment and replacement uses. Complete data on each type of speakers are included. Copies are available for the writing.

PNP Power Junction Transistor. Transistor Products, Inc., 241 Crescent St., Waltham 54, Mass. Tentative data sheet No. TDS-54-5 deals with the experimental type X-78 *pn*p power junction transistor. The sheet describes application, mechanical specifications and electrical data, and also includes a chart showing typical operating conditions.

Time Delay Relay. AGA Division, Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J. Bulletin SR-6 describes a time delay relay with a double-throw auxiliary switch which will allow pushbutton operation, or instant or delayed contacts after de-energization. The 2-page, 2-color bulletin describes 2 types of the model NEH Agastat time delay relay. Type 1 begins its time delay upon energization of the coil; type 2, upon de-energization. The bulletin gives dimensions, mounting arrangements, terminal arrangements and wiring diagrams for each type.

Capacitor Catalog. Arco Electronics Inc., 103 Lafayette St., New York 13, N. Y. The 21st edition of the Elmenco capacitor catalog, in three colors, contains complete listings of the entire capacitor line,



New Lion "Hi-Strength" fastener completely assembled. Cutaway shows the beveled counter sink. Beveling substantially increases the area over which stress is distributed.

NOW! Shear strength twice that of any other fastener!

New Lion "Hi-Strength" design fills every need for parts that must be fastened, taken apart, buttoned tight quickly

Here's a new and better answer to your problem of metal-to-metal fastening where high shear stress and vibration are factors.

It's the Lion "Hi-Strength" fastener, combining speedy quarter-turn opening and closing with a shear strength of 4750 lbs!

This "Hi-Strength" fastener is remarkably strong because shear load is distributed evenly over the area of the fastened parts. The secret lies in the *beveled* counter sink in the sheet and the nut. It's the same high shear prin-

ciple used for years by the automotive industry for wheel lugs.

In addition to high shear strength, its tensile strength is 3000 lbs. Sheet separation is zero up to 4750 lbs. Misalignment is as much as .125 with high shear qualities. Regardless of the number of times it's opened or closed, there is no wear. It cannot be overtorqued (up to 3750 lbs.). It cannot be fastened incorrectly. It is no larger than a standard No. 5!

To test it yourself, write for a free mounted working sample. Just drop us a line on your company letterhead.


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FASTENER, INC.
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MEECO
Instruments



SWEEPMASTER Sweep Frequency Generators give you these outstanding advantages . . .

- Frequency Marker with an accuracy independent of Sweep Width. Inserted after external detection, it eliminates erroneous interpretation—eliminates possibility of undesirable transient distortion or limiting actions. The Marker is adjustable in amplitude and after adjustment remains independent of other controls.
- An attenuator whose performance is free of Frequency, assuring you that the Output Envelope is the same as that indicated by the Internal Monitor.
- A simple switching operation to permit examination of either Envelope of the Swept Frequency Signal.
- Durable, compact, lightweight Output and Detector Probes, either of which can be detached easily and replaced by cables having standard connectors.

SPECIFICATIONS

MODEL	CENTER FREQUENCY	RF OUTPUT 50 ohm * TERMINATION	SWEEPWIDTH CONTINUOUS ADJUSTMENT	FREQUENCY MARKER
SM I	100 KC to 11 MC	1 volt RMS	150 KC to 14 MC	100 KC to 11 MC
SM I	500 KC to 50 MC	0.2 volt RMS	150 KC to 20 MC	500 KC to 50 MC
SM III	500 KC to 75 MC	0.1 volt RMS	150 KC to 20 MC	500 KC to 75 MC

FLATNESS: LESS than 1 DB variation over maximum sweepwidth range.

FREQUENCY MARKER: Engraved calibration accurate to $\pm 2\%$.

* 75 ohm available when specified

HORIZONTAL DEFLECTION: A 60 cps sine wave for application to horizontal input of oscilloscope is supplied. continuously or blanked out for $\frac{1}{2}$ of each 60 cycle period.

BLANKING: The RF signal may be operated

EXTERNAL DETECTOR: Blocking capacitor of 400 volt breakdown capacity.

Write for complete information

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
15 Sunset Lane • Hatboro, Pa.

including molded mica, steatite paper tubulars, mica trimmers and padders, fixed and variable ceramics. With publication, the company presents 4 new products: the Duramike dipped mica capacitors, CM42 molded mica capacitor, and types 40 and 42 trimmers.

Modulator Circuit Structures. Vector Electronic Co., 3352 San Fernando Rd., Los Angeles 65, Calif. Bulletin 54A covers the company's strip turret system that provides new ultra-compact deck type mounting units for circuitry with unique clip-in terminals and stitched wiring, all with dip-soldering and automation possibilities. Included are data covering the new Lip-Loc cases that provide novel plug-in enclosures with snap-open side panels.

Picture Tube Comparison Chart. Sylvania Electric Products Inc., Seneca Falls, N. Y. In addition to new listings of aluminized types, the new tv picture tube chart gives characteristics of approximately 200 picture tubes. Listed are data on types, face, body, focus, deflection, basing, ion trap magnet and length in inches.

Power Supplies. Power Designs Inc., 119-22 Atlantic Ave., Richmond Hill 19, N. Y. A 4-page folder illustrates and describes a line of electronically stabilized power supplies. Features and electrical and mechanical specifications are given. Tabular data give technical information on 11 models. A price list is also available.

Tiny Sealed Capacitors. Hopkins Engineering Co., 2082 Lincoln, Altadena, Calif., has released catalog C-6 pertaining to Hy-Therm subminiature, hermetically sealed capacitors, that have been designed to meet or exceed the requirements of MIL-C-25A. The Hy-Therm capacitors described are being used for all applications requiring exceptionally high insulation resistance and unusual stability at high temperature. The new catalog shows complete performance in detail together with size availabilities.

Toroid Coils. Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif. Bulletin STP supplies com-

plete technical data including general characteristics, specification charts and standard case styles for Hycor toroid coils which are available in three forms: uncased, cased and type "p" plastic encapsulated.

Push-About Conveyor-Oven. The Miskella Infra-Red Co., East 73rd and Grand Ave., Cleveland 4, Ohio, has published a bulletin illustrating and describing its push-about conveyor-oven for tv and radio coils, deflection yokes, flybacks and miscellaneous assemblies. Applications, specifications and prices are included.

VHF Transmitter. Collins Radio Co., Cedar Rapids, Iowa. An 8-page folder fully illustrates and describes the 17L-4 vhf transmitter for aircraft communication. Included are specifications, block diagram and outline drawing. Illustrated descriptions of associated equipment are also included.

Tiny Relays. Union Switch & Signal, Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa., has published a 4-page folder dealing with miniature relays for airborne electronics and other vital applications. The hermetically-sealed miniature relays described meet the specifications of MIL-R-5757A & B, and, under severe test, will not malfunction in the energized or de-energized position when subject to vibration up to 1,00 cycles at 15 g's and shock in excess of 40 g's for 10 milliseconds.

Turbo Products Catalog. The William Brand and Co., Inc., Willimantic, Conn., has published a new Turbo Products Catalog that combines easy-to-use features with helpful information with respect to wire and tubing, an appendix which defines technical terms, and tables of insulation resistance temperature coefficients and temperature conversion. The product index includes 44 pages full of specific information concerning wires and cables, plastic tubing, coated tubing and sleeving, and identification markers which carry the Turbo brand. It contains a wealth of general information on wire and tubing problems. Complete ordering information is included.

No. 2
in a
series

design progress through
inter-company co-operation

... coordinated by *Airtron* inc.



NEW...
DOUBLE-RIDGE WAVEGUIDE
for both X-band and C-band operation!

Recently, Airtron was confronted with a difficult problem—how to develop a waveguide that would perform satisfactorily for both "X" and "C"-Band operation.

Due to differences of opinion concerning the optimum frequency for airborne weather radar systems, equipment manufacturers have selected two different operating frequencies for their designs . . . 5.6 cm ("C"-band) and 3.2 cm ("X"-band). As a result, two different waveguide sizes were required. This meant that should it become advisable to switch from one frequency band to the other it would necessitate the installation of an entirely new waveguide system . . . as well as the replacement of the radar equipment.

This was highly impractical and, accordingly, a coordinated effort was set up among the airlines technical advisory organization (ARINC), leading manufacturers of radar equipment, and the engineering staff of Airtron.

Working as a team the theoretical and practical difficulties were overcome and the solution evolved in a new double ridge waveguide. The new design not only permits handling of both bands, but also results in a considerable reduction in size and weight for "C"-band and improved electrical properties for "X"-band.

This is just another concrete example of how Airtron's creative engineering . . . and their close association with leading manufacturers in all phases of electronics . . . can be of assistance to you . . . whether the components you need are new in design or so-called "standard" plumbing.

FREE CATALOG on Ridge Waveguide for Airborne Weather Radar . . . contains a complete description of the new ridge waveguide series. Write on your letterhead c/o Dept. J for your copy today!

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Designers & Manufacturers of Rigid and Flexible Waveguide Components and Aircraft Accessories

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Plants and People

Edited by WILLIAM G. ARNOLD

Technical societies honor engineers and elect officers for 1955 . . . Electronics manufacturers announce plant acquisitions and expansions . . . Engineers move to new job positions in the industry . . .

Engineers Honor Lee De Forest

RADIO AND TELEVISION SCIENTISTS, members of the De Forest Pioneers, gathered in New York City to honor Lee De Forest (left), for his development of the radio vacuum tube. Allen B. Du Mont, president of Du Mont Laboratories, who worked with Dr. De Forest 25 years ago in developing radio and other electronic equipment, surprised the radio inventor by showing him one of the first audion tubes made by Dr. De Forest. The tube was thought to have been lost many years ago.



Sylvania To Buy National Union Picture Tube Plant

STOCKHOLDERS OF NATIONAL UNION ELECTRIC CORP. have approved plans for the sale of the firm's television picture tube manufacturing facilities at Hatboro, Pa., to Sylvania Electric Products.

National Union's proposal that Sylvania purchase the Hatboro facilities has been approved by the board of directors of each company.

National Union will continue in

the electronics field with its transistor division and with its research laboratory at Orange, N. J. Proxy material mailed to stockholders indicated that National Union may acquire another business.

The Hatboro plant includes nearly 76,000 sq ft of manufacturing space and now employs about 500 persons. Sylvania would purchase it as part of its picture tube division.

According to present plans, Sylvania will produce aluminized black-and-white tubes at the former National Union plant, thus freeing part of its facilities elsewhere for its color picture tube operations.

Sylvania also announced that Bennett S. Ellefson has been appointed technical director of the firm. Ellefson has been director of research for Sylvania since 1946.

Radio Engineers Elect Officers For 1955

JOHN D. RYDER, dean of Michigan State College School of Engineering, was elected president of the Institute of Radio Engineers for 1955. He succeeds William R. Hewlett, vice-president of Hewlett-Packard Co., as head of the international society of 40,000 radio engineers and scientists.

Franz Tank, professor at the Swiss Institute of Technology, Zurich, will succeed Maurice J. H. Ponte, director of Compagnie Generale de Telegraphie Sans Fil, as IRE vice-president in recognition of

the Institute's international scope.

Elected as directors for the 1955-1957 term are John F. Byrne, director of engineering for the Communications and Electronics Division of Motorola and Ernst Weber, director of the Microwave Research Institute and head of the electrical engineering department at Polytechnic Institute of Brooklyn.

Regional directors elected for 1955-1956 are as follows: Region 2 (North Central Atlantic), John N. Dyer, vice-president of Airborne Instruments Laboratory in Mineola,



John D. Ryder

NORMAL OUTPUT Marka-Sweep MODEL VIDEO TTV

RETRACE BLANKING

SWEEP TIME $\frac{1}{60}$ SEC.

OUTPUT SAME MODEL Marka-Sweep WITH Keydsweep, SYNC AND BLANKING PULSES INTERNALLY GENERATED

RETRACE BLANKING

15750 SEC.

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

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

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

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"Keydsweep"

Eliminates Spot Frequency Checking

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NOW—in another important advancement from Kay Electric—circuits may be completely evaluated with *spot frequency checking wholly eliminated*. The new Kay KEYDSWEEP provides in-

ternal sync pulses, and will operate with an external source of sync and blanking pulses giving pedestals and spacings in accordance with the source characteristics.

SPECIFICATIONS AND PRICES — KAY ELECTRIC VIDEO SWEEP GENERATORS

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



Model Video *Marka-Sweep*

KAY Electric Company

14 Maple Ave., Pine Brook, N. J.



Model Video TTV *Marka-Sweep*

Write for Technical Data Sheets and copy of Kay 1954-56 Catalog

L. I., N. Y.; Region 4 (East Central), E. M. Boone, professor of electrical engineering at Ohio State University in Columbus, Ohio; Region 6 (Southern), Durward J. Tucker, managing director of radio station WRR in Dallas, Tex.; Region 8 (Canadian), John T. Henderson, principal research officer of the National Research Council in Ottawa, Ont., Canada.

Dr. Ryder was associated with GE in Cleveland, Ohio, from 1929 to 1931. He then joined the research laboratory of the Bailey Meter Company in Cleveland as supervisor of the electrical and electronic section.

In 1941, D. Ryder was appointed assistant professor of electrical engineering at Iowa State College, professor in 1944 and in 1946 he was in acting charge of the electrical engineering department. He became assistant director of the Iowa Engineering Experiment Station in 1947 and in 1949 was named head of the department of electrical engineering at the University of Illinois.

On July 1 of this year he became dean of the School of Engineering at Michigan State College, East Lansing, Michigan.

Navy Seeks To Simplify Provisioning



INDUSTRIAL REPRESENTATIVES conferred with Naval personnel at the Electronic Supply Office, Great Lakes, in an effort to simplify the method used to provision Navy electronic equipments.

Left to right are: L. T. Bard, chairman of the spare parts committee of the Radio Electronics Television Manufacturers Association; G. F. Wickham of Navy's Bureau of Supplies and Accounts; F. S. LeRoy of RETMA; M. D. Cohen of

ESO; W. C. Tayloe of the Bureau of Ships; Commander R. L. Watson, Supply Corps, USN, Bureau of Ships; Captain E. F. Metzger, Supply Corps, USN, Commanding Officer of the Electronic Supply Office; Commander R. C. Sergeant, USN, ESO; H. H. Haber, Bureau of Ships; Lieutenant J. L. Midgett, USN, ESO; C. O. Granzin, ESO; L. F. Schropp and H. G. Beauregard of the Radio Electronics Television Manufacturers Assn.

Ramo-Wooldridge Signs Pact, Appoints Engineers

RAMO-WOOLDRIDGE CORP. of Los Angeles, a subsidiary of Thompson Products, has set a development pact with Westinghouse and has made seven new personnel appointments.

Completely automatic flight and tactical operation of high-speed military aircraft and guided missiles is foreseen under the new working agreement reached by the company and Westinghouse.

Under the \$1-million program, Ramo-Wooldridge engineers and scientists will develop for the two companies an airborne miniaturized version of computers used by business and industry.

Ramo-Wooldridge also expanded in personnel. Lt. Gen. Harold L. George, USAF, (ret) has been elected senior vice-president of the firm. Gen. George is a member of the board of directors of the company. He was formerly vice-president and general manager of



Left to right, Lt. Gen. Harold L. George, new senior vice-president of Ramo-Wooldridge, Dean E. Wooldridge, president, Simon Rama, executive vice-president and J. D. Wright, president of Thompson Products

Hughes Aircraft Co., in Culver City, Calif. Herbert C. Corben and Wendall A. Horning have joined the firm as physicists in the guided

missile division. Millard V. Barton joined the division as engineer and Frank W. Lehan was named electronics research engineer. George

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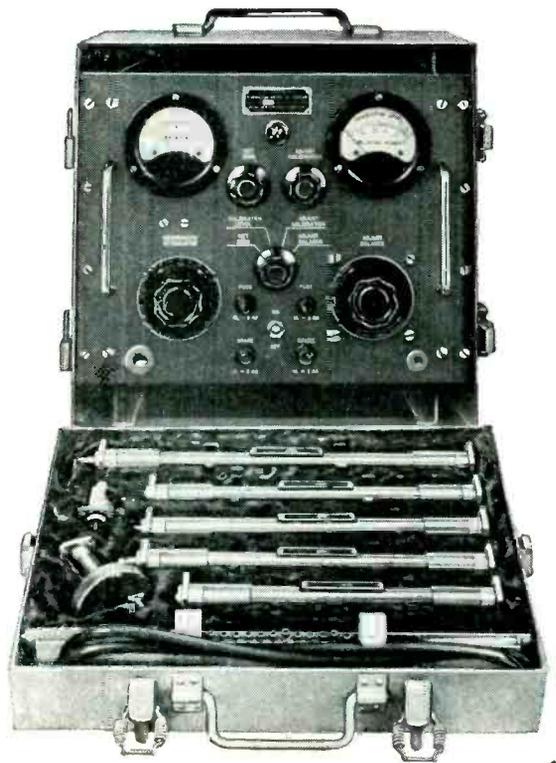
TYPICAL APPLICATIONS

Microwave Links . . . Television . . . Communications . . .
Radar . . . Telemetry . . . Signal Generators . . .
Laboratory Standards.

Write for descriptive literature to Department E-1

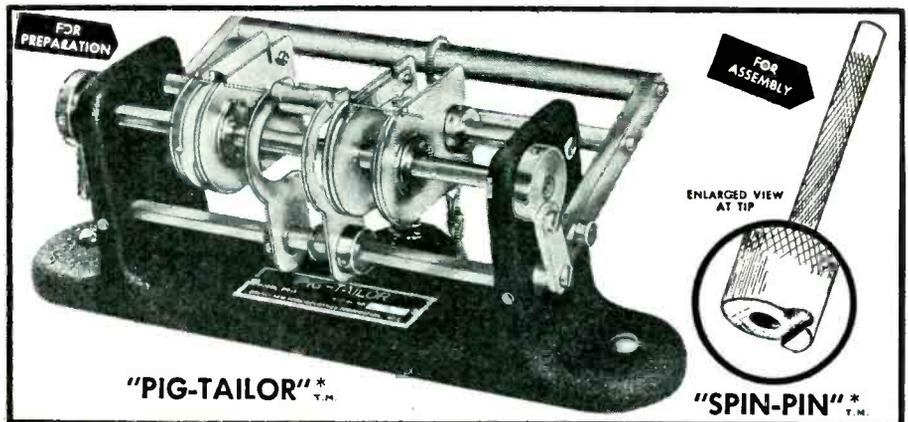
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Fastest **PREPARATION** and
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"SPIN-PIN" *
T.M.

The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends,
Ejects and Assembles both leads simultaneously to individual lengths and
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training time.

PIG-TAILORING provides:

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|-------------------------------------|-------------------------------------|
| 1. Uniform component position. | 6. Individual cut and bend lengths. |
| 2. Uniform marking exposure. | 7. Better time/rate analysis. |
| 3. Miniaturization spacing control. | 8. Closer cost control. |
| 4. "S" leads for terminals. | 9. Invaluable labor saving. |
| 5. "U" leads for printed circuits | 10. Immediate cost recovery. |

PIG-TAILORING eliminates:

- | | |
|--------------------------------|-----------------------------------|
| 1. Diagonal cutters. | 6. Broken leads. |
| 2. Long-nose pliers. | 7. Short circuits from clippings. |
| 3. Operator judgment. | 8. 65% chassis handling. |
| 4. 90% operator training time. | 9. Excessive lead tautness. |
| 5. Broken components. | 10. Haphazard assembly methods. |

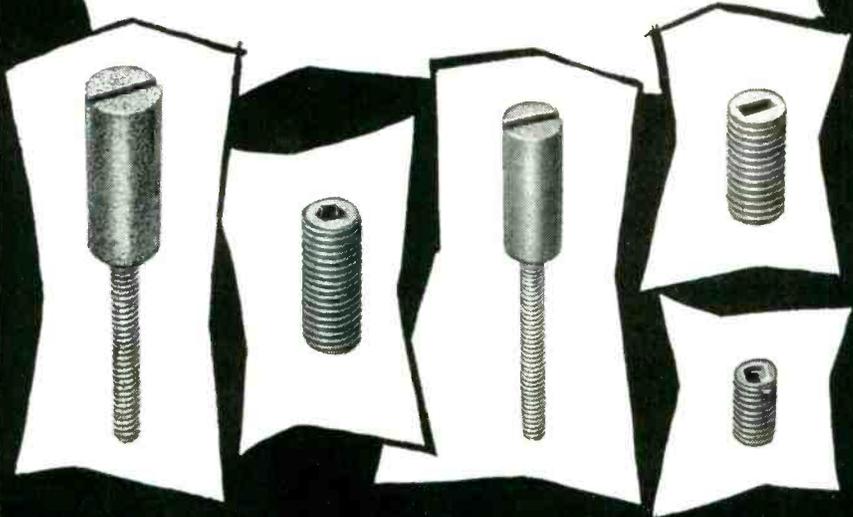
* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. E-1

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Now . . . we have added six new Engineered Economy Iron Cores to expand our line to fourteen, covering most insert and threaded applications.

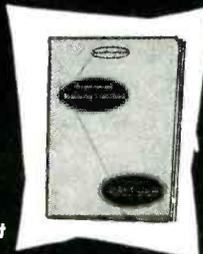
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M. Ewing joined the staff as mathematician and physicist and Bernard Rasof was appointed mathematician and aeronautical engineer in the division.

Dr. Corben served on the staff of the Carnegie Institute of Technology for six years as professor of physics. Dr. Horning was a theoretical physicist in neutron physics and reactor theory with GE for six years. Dr. Barton was for 12 years chairman and professor of the engineering mechanics department and research engineer of the defense research laboratory at the University of Texas. Lehan has been with the Jet Propulsion Lab of the California Institute of Technology for ten years. Dr. Ewing was professor of mathematics at the University of Missouri for 24 years. Dr. Rasof has been with U. S. Naval Ordnance, North American Aviation and California Institute of Technology.

Engineering Heads Named By Bendix

A. P. FONTAINE has been appointed director of engineering and A. C. Hall, general manager of the research laboratories of the Bendix Aviation Corp.

Fontaine, who will also have jurisdiction over the laboratories of the corporation, will supervise an engineering program which, during the past year, expended \$70,000,000 and used the services of a staff of more than 7,000 persons.

He has been associated with the



A. P. Fontaine

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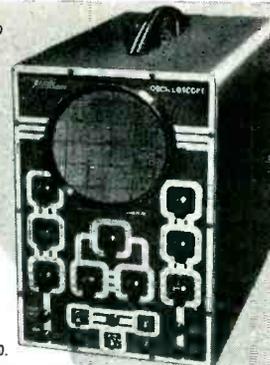
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Kit \$34.95. Wired \$49.95



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625K Tube Tester
Kit \$34.95
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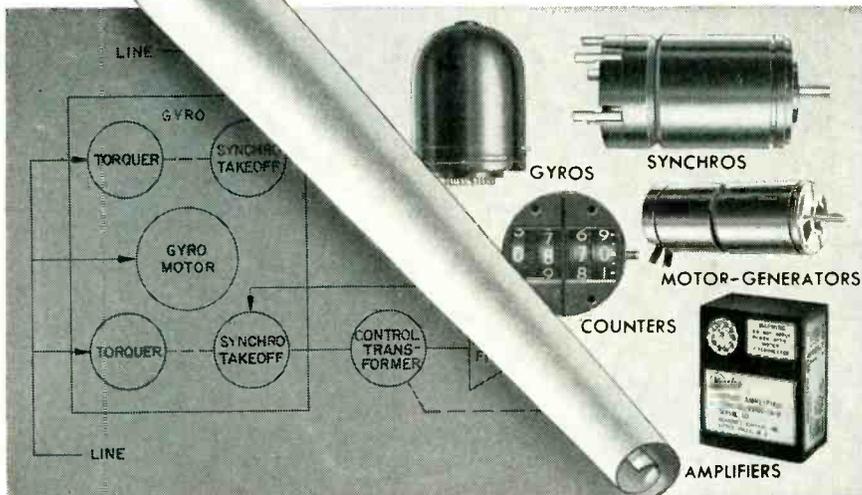
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Laboratory Precision at lowest cost

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A. C. Hall

aviation industry for 24 years. Prior to his present appointment he helped direct expanded operations in aircraft control, navigation and instrument equipment, electron tubes, ignition systems, meteorological instruments, precision electrical units and other products at six of the 24 manufacturing divisions of Bendix.

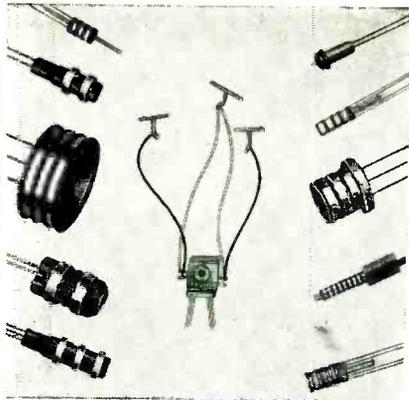
Dr. Hall joined the staff of the electrical engineering department of MIT in 1937 and served progressively in the capacities of assistant, instructor, assistant professor and associate professor until 1950.

In 1950, he left MIT to become associate director of the research laboratories of Bendix. In 1952, he became technical director of that laboratory. Since he has been at Bendix, Dr. Hall has directed development work in guidance systems for missiles, of hydraulic control components, of digital and analog computers, of automatically controlled machine tools and of special instruments for process controls.

Motorola Opens California Lab

MOTOROLA has opened a new \$500,000 research laboratory in Riverside, California for its Communications and Electronics Division. The 22,000 sq ft building will be used for work in dynamic systems analysis in military ordnance and guided missiles.

General manager of the Riverside laboratory, John F. Byrne, heads a staff that includes 40 senior scientists formerly with a guided missile research facility of the National



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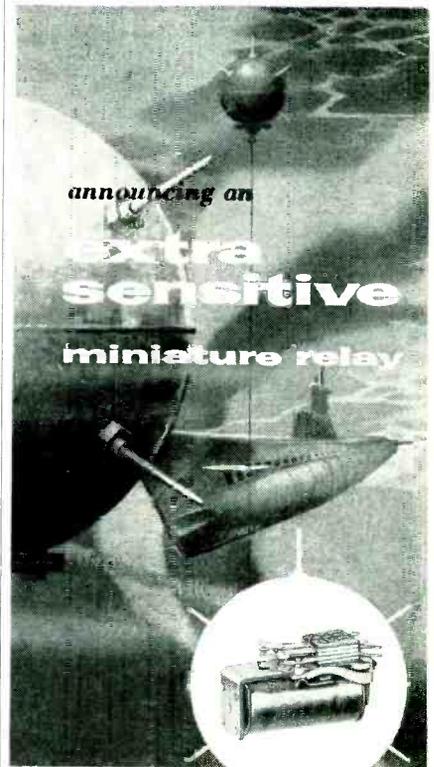
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It's the new ADVANCE SQ — a telephone type that hits a new high in ruggedness and efficiency!

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oscilloscope kit
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Check the outstanding engineering design features of this modern **printed circuit** Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles. **5 times** the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail—retrace blanking amplifier—voltage regulated power supply—3 step frequency compensated vertical input—low capacity nylon bushings on panel terminals—plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!



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\$69.50 Shpg. Wt. 27 lbs.

Heathkit TV
sweep generator kit
 ELECTRONIC SWEEP SYSTEM

A new Heathkit sweep generator covering all frequencies encountered in TV service work (color or monochrome). FM frequencies too! 4 Mc—220 Mc on fundamentals, harmonics up to 880 Mc. Smoothly controllable all electronic sweep system. Nothing mechanical to vibrate or wear out. Crystal controlled 4.5 Mc fixed marker and separate variable marker 19-60 Mc on fundamentals and 57-180 Mc on calibrated harmonics. Plug-in crystal included. Blanking and phasing controls—automatic amplitude constant output circuit—efficient attenuation—maximum RF output well over 1 volt—vastly improved linearity. Easily your best buy in sweep generators.



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Sustained efficiency keynotes SQ operation. The use of a beryllium copper armature retaining spring insures positive contact between armature and pivot points at all times. Cross-bar palladium contacts are always properly aligned. A wide variety of coil resistances is feasible. Instead of organic insulation, the unit employs Silicone glass, Kel-F, or Teflon tubing. Life expectancy for 5-amp, non-inductive loads is 150,000 cycles... for 1-amp, non-inductive load: 1,000,000 cycles.

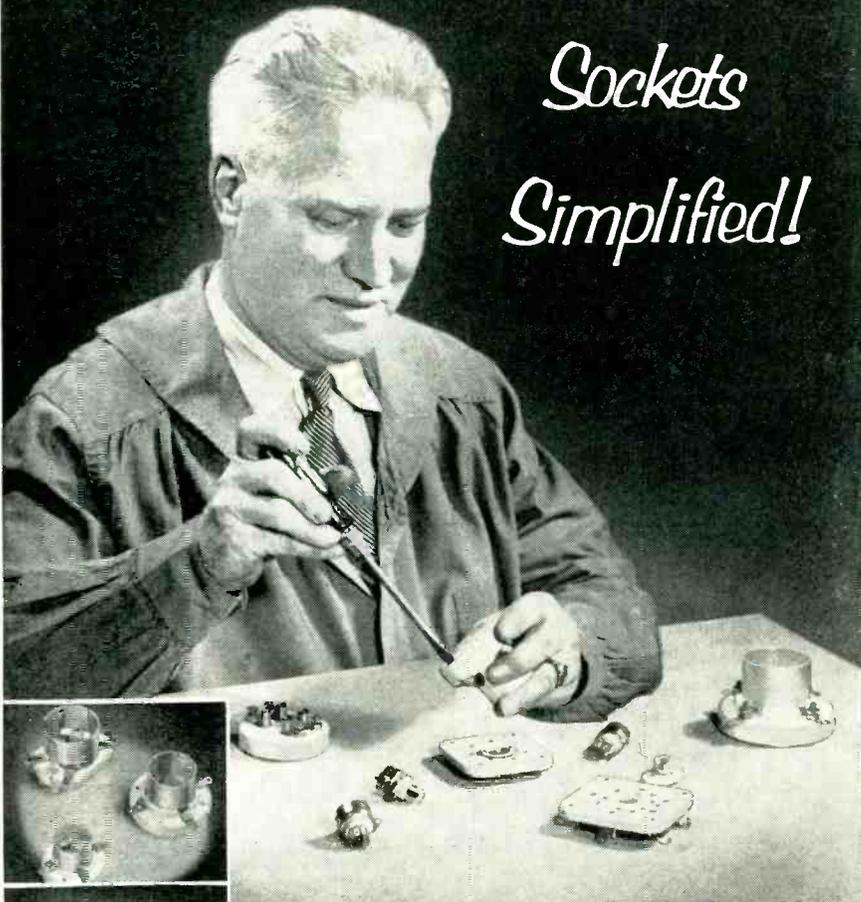
Open type dimensions are 1" x ¾" x 1½". DPDT units are supplied in a sealed container measuring 1" x 1" x 2". Write for literature on the SQ series.



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Standard: Commercial grade for general requirements. Bases, glazed porcelain or L4 steatite. Cushion washers, fungus resistant glass base melamine.

Industrial: Higher quality with glazed steatite bases, DC200 treated, phosphor bronze or beryllium copper contacts .0005 silver plated. Aluminum retaining shells or shields are Iridite #14 treated. Glass base melamine cushion washers, fungus resistant.

Military: Top quality to meet all military requirements. Bases L4 or better glazed steatite, DC200 treated. Phosphor bronze or beryllium copper contacts, heavy silver plated. Fungus resistant glass base melamine cushion washers. Solder terminal ends hot tin dipped. Retaining shell brass .0003 nickel plated. Aluminum shields or shield bases Iridite #14 treated. Threaded hardware .0002 nickel plated, unthreaded hardware .0003 nickel plated. Entire socket protected for 200 hour salt spray.

For further information on Johnson Tube Sockets, write for the new Johnson General Products Catalog #975.



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Bureau of Standards in Corona, California. Ultimately, personnel will be expanded to 200. Byrne has been a director of engineering in Motorola's Communications and Electronics Division since 1950.

Projects researched at the Riverside location will be developed at Motorola's Phoenix, Arizona plant.



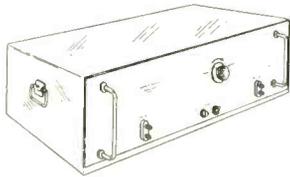
Hyland Joins Hughes As General Manager

LAWRENCE A. HYLAND was appointed vice-president and general manager of Hughes Aircraft Co. following his resignation as vice-president in charge of engineering of Bendix Aviation Corp.

A founder of Radio Research Company in 1932, he was president until its purchase by Bendix in 1937 when he became manager of that company's radio division. In 1943 he became an executive engineer and in 1950, vice-president in charge of research. He was appointed to his position at Bendix in 1953.

This year, Hyland was appointed to the Aeronautics Steering Committee of the Department of Defense, working on guided missiles. He has served on the Advisory

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Board, Air Force Arnold Engineering Development Center; Advisory Board, Argonne National Laboratory for Atomic Energy and the Guided Missiles Committee of the Research and Development Board.

Ketay And Norden Plan Merger

KETAY INSTRUMENT CORPORATION plans to offer to the common stockholders of Norden Laboratories the right to exchange their shares of stock on the basis of one share of Ketay for four shares of Norden.

Plans are to change the name of the present Ketay Instrument Corp. to the Norden-Ketay Corp. and to continue both the Ketay Instrument operations and the Norden Laboratories operations as subsidiary companies with no major changes in personnel. Morris Ketay, president of Ketay, will be president of the new corporation and Paul Adams, president of Norden, will be chairman of the executive committee and executive vice-president.

Norden's research and development laboratories employ approximately 350 engineers and technicians. The company's two manufacturing plants employ approximately 600 people.

Ketay employs a total of approximately 1,200 people in plants in New York, Los Angeles and Long Island.

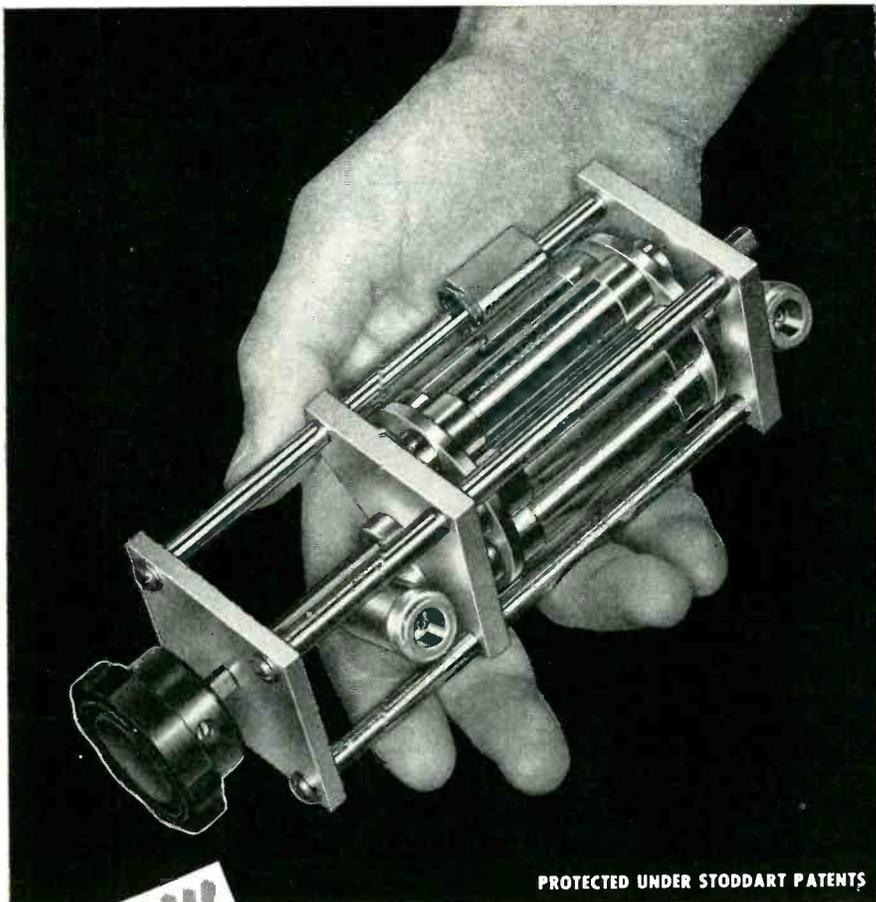
A Ketay subsidiary, Nuclear Science and Engineering Corporation, is engaged in research and other engineering services for industry in the atomic energy field. Norden has recently undertaken a program involving instrumentation and controls for commercial application of atomic energy.

It is believed that the combined volume of the two companies should be in excess of \$20,000,000 annually.

Westinghouse Promotes Tube Engineers

ERNEST A. LEDERER has been promoted to the newly created position of chief engineer for the Westinghouse tube division in Elmira, N. Y.

Carmen E. Ramich has been named manager of engineering, the post formerly held by Dr. Lederer, and Dewey D. Knowles has been ap-



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ATTENUATOR PADS
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FREQUENCY RANGE:
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CHARACTERISTIC IMPEDANCE:
50 ohms

CONNECTORS:
Type "N" Coaxial female fittings each end

AVAILABLE ATTENUATION:
Any value from .1 db to 60 db

VSWR:
<1.2, dc to 3000 mc., for all values from 10 to 60 db
<1.5, dc to 3000 mc., for values from .1 to 9 db

ACCURACY:
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POWER RATING:
One watt sine wave power dissipation

*Send for free bulletin entitled
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*Inquiries invited concerning pads or
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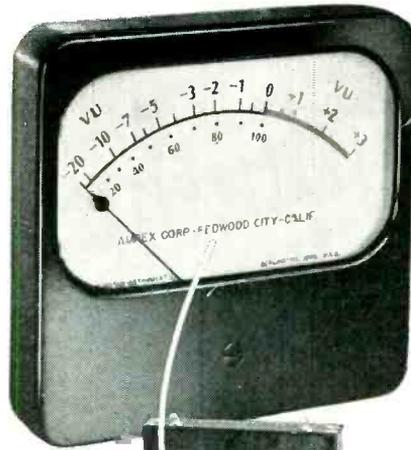
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ounces... inch pounds
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should have
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equipment in communication
and power circuits.
U. S. C. heavy duty multi-con-
tact connectors offer

- Maximum number of heavy
current contacts
- Mechanical and electrical de-
pendability of operation in a
minimum of space.
- available 7 to 34 contacts

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U. S. C. Printed Card Recep-
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- Channel Strength and Snap-
in Contacts
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Over 1000 types available

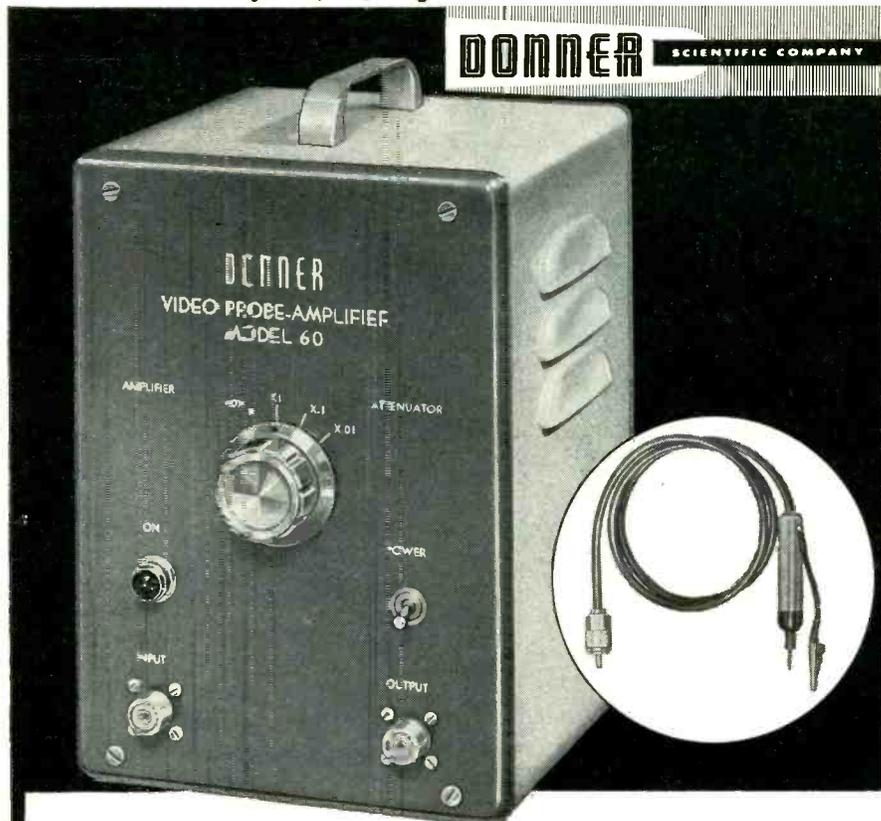
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MODEL 60 with probe as illustrated

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\$150

The Model 60 enables any oscilloscope to be used to its full capabilities with negligible circuit loading effects. Its useful range extends throughout the frequency spectrum from sub-audio to the microsecond pulses of television and radar. Used with the hand probe, the Model 60 presents an input capacitance of 2 micromicrofarads and an overall range of signal gain between unity and 0.01. The instrument is also a versatile video amplifier with a gain of 40 when used without the probe.

Specifications

Bandwidth: 5 cps to 112 mcps \pm 3db.
Input impedance: 4.5 megohms shunted by 2 mmf.
Gain: X1, X0.1, X0.01 with probe, 40 without probe.
Maximum undistorted output: 12 volts peak-to-peak.
Hum and noise: 2.5 millivolts RMS output.
Dimensions: Panel 7 $\frac{3}{8}$ " x 10 $\frac{3}{8}$ ", depth 8 $\frac{1}{8}$ ".
Weight: Approximately 20 lbs.
Accessories: Clip-on high impedance probe with 3' RG/62U with connector. Output cable 4' RG/62U with connector. Amplifier input cable 4' RG/62U with connector.

Typical Applications

Video Amplifiers: measurements without addition of significant stray capacitance . . . **Color TV:** alignment and measurement in high frequency circuits with negligible effect on critical phase relationships . . . **Black-and-white TV:** adjustment of video peaking circuits and examination of waveforms without test equipment loading . . . **Radar:** measurements of pulse rise time and pulse width with negligible changes in circuit performance . . . **High frequency tuned circuits:** examination without appreciable detuning . . . **High impedance circuits:** measurements without significant loading.

Write for Technical Bulletin No. 601

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pointed manager of product administration.

In his new position as chief engineer, Dr. Lederer will maintain liaison within the industry on technical matters and will assist on matters relating to technical policy. In addition, his duties encompass complete responsibility for all advanced development of product engineering.

Dr. Lederer served in research and engineering capacities for the Westinghouse Lamp Division, Bloomfield, N. J., then became chief engineer for the National Union Radio Corp. From 1934 to 1950 he was manager of chemistry and physics laboratories for RCA at Harrison, N. J., then returned to Westinghouse as manager of engineering for the new electronic tube division.

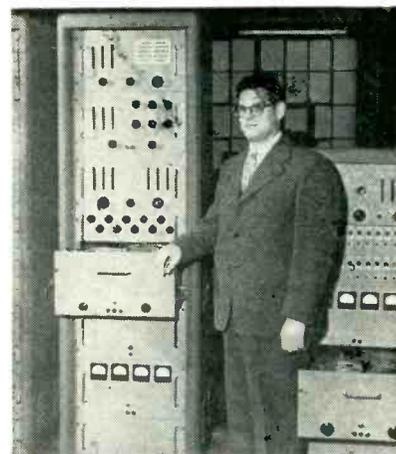
Ramich joined Westinghouse in 1948. In 1951 he was assigned to England as a Westinghouse technical representative for special electronic equipment. In 1952 he returned to Elmira as an engineering staff assistant for the electronic tube division.

Knowles joined Westinghouse in 1923.

He served at the research laboratories until 1937, when he left Westinghouse to become director of research and development for Raytheon. He re-joined Westinghouse in 1939 and was transferred to the electronic tube division in 1952.

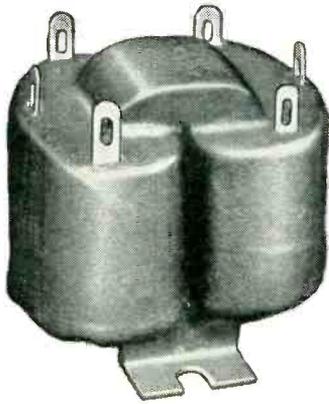
Victor Adding Machine Names Robert Howard

ROBERT HOWARD has been appointed manager of the Vic-Dar division of the Victor Adding Machine Co. The



Robert Howard and Vic-Dar

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To meet the need for transformers finished in any one of several tested plastic formulations, Acme Electric have complete production facilities as well as experienced personnel and supervisory engineers to produce this class of equipment.

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F-C-1 Type D capacitors are furnished in glass tubes with hermetically sealed end caps and either wire leads or threaded studs.

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Power Factor	0.3% @ 1 KC
Dielectric Absorption	0.1%
Voltage Derating at 85° C.	30%
Voltage Derating at 125° C.	66%
Temperature Coefficient	+500 PPM/° C.
I.R. at Room Temperature	10 ⁸ megohms/MF
Capacitance Stability	0.5%

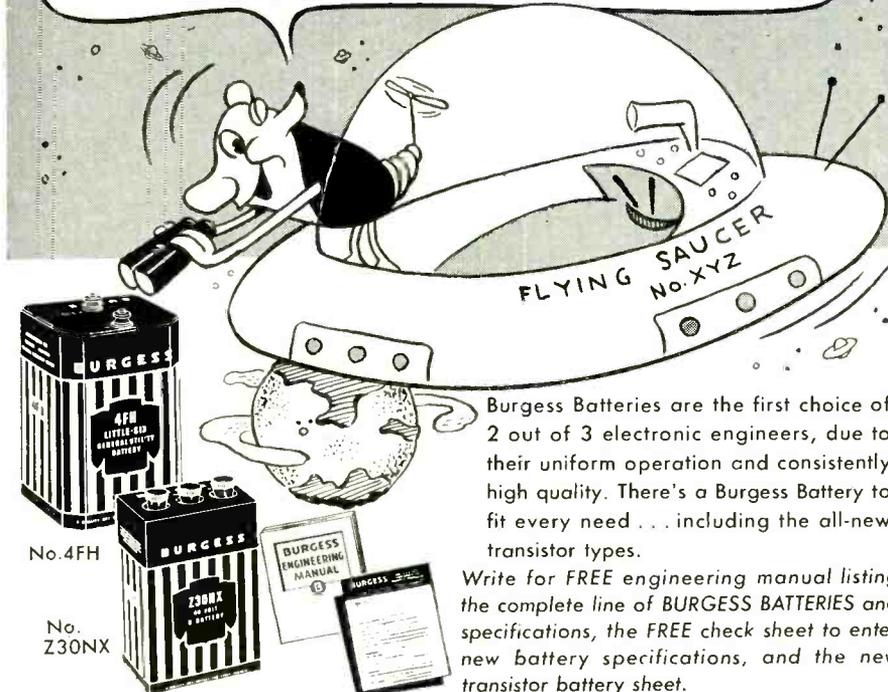
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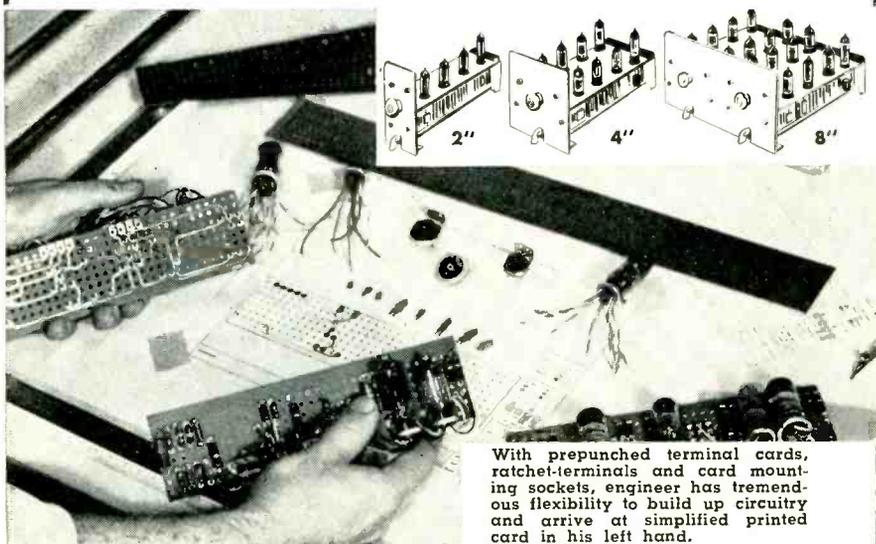


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Write for **FREE** engineering manual listing the complete line of **BURGESS BATTERIES** and specifications, the **FREE** check sheet to enter new battery specifications, and the new transistor battery sheet.

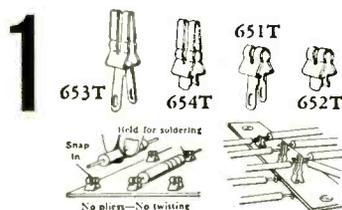
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With prepunched terminal cards, ratchet-terminals and card mounting sockets, engineer has tremendous flexibility to build up circuitry and arrive at simplified printed card in his left hand.

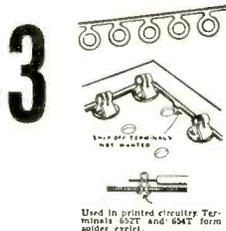
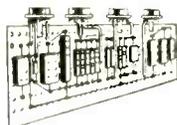
ALDEN COMPONENTS MAKE IT AS SIMPLE AS THIS—



1 Move your circuitry into compact vertical planes by staking Alden Ratchet-Slot terminals onto Alden Prepunched Terminal Mounting Cards in any desired pattern. Four styles of Terminals hold any type component provide for wiring on both sides.



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3 As you move from wire stage to printed circuitry, use Alden Stamped Jumper Strip you can lay out in any pattern you eventually want to print.

From here it's a simple step to fully automatized printed circuitry—with the option of retaining Ratchet Terminals to form solder cups where heat sensitive components prevent dip soldering.

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Send for Kits today!

ALDEN PRODUCTS CO. 3127 N. Main St. Brockton 64, Mass.

company is manufacturing a new electronic data accumulation and reduction system called Vic-Dar. Howard has had engineering and production administration experience with RCA and was manager of the government division of Webster-Chicago Corp.



Beckman Opens New Plant

BECKMAN INSTRUMENTS officially opened its new \$2-million plant in Fullerton, Calif.

The 200,000-sq ft plant is corporate headquarters for the company and manufacturing facility for its main division. Some 800 engineering, production and sales personnel are housed at the plant, representing a total annual payroll of about \$3.5 million. Future manpower needs will top 2,000 as the plant expands to possibly triple size on the same 40-acre site, the company predicted.

The four divisions of the company have exceeded \$18.6 million in sales this year.

Raytheon Constructs Electronics Laboratory

A LARGE ELECTRONICS LABORATORY for engineering and research, to cost nearly \$1,500,000, is being built for Raytheon in Wayland, Mass.

The building will have approximately 150,000 sq ft of floor area. Raytheon has more than 1,500

a complete
line of relays



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SUB-MINIATURE
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Air-System Sockets



Eimac air-system sockets are custom designed to provide adequate cooling with the most economical blower requirements for several Eimac radial-beam power tetrodes.

4-400A/4000 air-system socket is employed with Eimac tube type 4-400A. Air enters through the bottom of the socket and is guided by a pyrex glass chimney, assuring efficient cooling of the various seals. If desired, this socket may also be used with Eimac 4-125A and 4-250A.

4-1000A/4000 air-system socket is designed for use with Eimac tube type 4-1000A. Air entering the bottom of the socket is guided by a pyrex glass chimney toward the plate seal, assuring correct cooling even during maximum rating operation of the tube.

4X150A/4000 air-system socket provides adequate air cooling and high frequency circuit arrangement for Eimac 4X150A and 4X150D. Air enters the socket through the bottom and is guided by a ceramic chimney.

4X150A/4010 socket is identical to the 4X150A/4000 except that this socket is complete with grounded cathode connecting tabs.

Eimac air-system sockets and chimneys are also available as separate units.

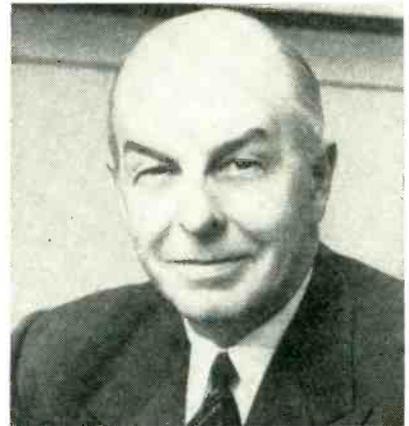
For further information contact our
Technical Services Department.



EITEL-McCULLOUGH, INC. SAN BRUNO CALIFORNIA
The world's largest manufacturer of transmitting tubes

professional engineers among its approximately 18,000 employees, it was pointed out. The new laboratory will provide office and laboratory space for the largest single group of engineers within the company.

Raytheon also announced that Hubert Sear, M.D., has joined the company as an engineer in the medical products laboratory. He will assist in the application and promotion of the firm's diathermy and room air cleaner equipment and in designing new products for the medical field. He has a background of experience in both medicine and electronics.



Richards Cotton Joins National

RICHARDS W. COTTON was appointed assistant to Joseph H. Quick, president of National Co. He was previously assistant to the president of Philco. He was also vice-president of Philco International, a director of Philco Overseas in London and managing director of British Philco in London.

In his new post, Cotton will assist the president of National in the executive administration of the firm's program of development and expansion in the field of electronics.

He has also served since 1953 as a consultant to the Secretary of Defense, the Office of Defense Mobilization and the Electronics Division of the Department of Commerce. He represented the United States at the NATO Conference and was sent to Japan on a special government assignment during last year. In 1952, he was appointed a director of the



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ELECTRIC SOLDERING IRON CO., INC.
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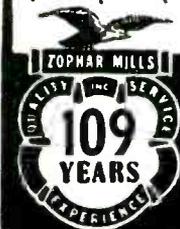
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Other models available for frequencies up to 4000 mc and power levels up to 120 kilowatts.



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MODEL 263 Laboratory type complete coupler and indicator. Coupler equipped with N connectors. Indicator provided with 3 scales calibrated in watts, 0-10, 100, 1000. . . . \$85.00

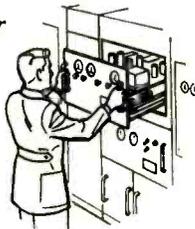
MODEL 261 Coupler (only) similar to Model 263 coupler but with 83-1R Connectors, complete instructions to build #262 Indicator included. \$22.50

MODEL 262 Indicator (only), provides relative power measurements when used with #261 coupler. . . . \$14.50

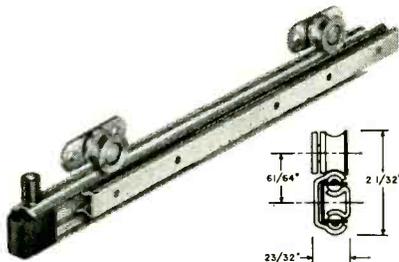
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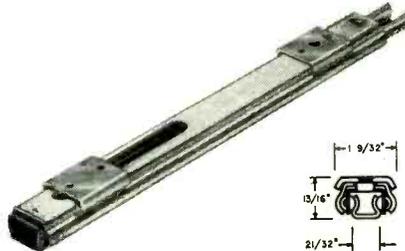


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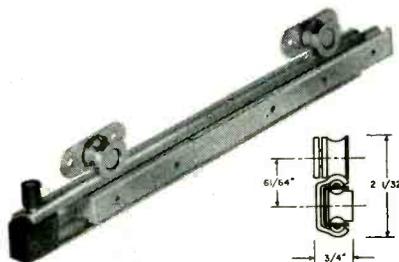
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Two-section slide with rollers for moving unit. Ball bearing action. Full travel possible. Load capacity: 50 lbs. per pair mounted vertically.



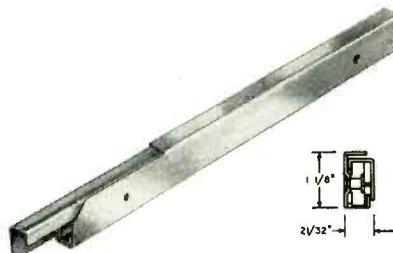
No. 308 Slide

Two-section underneath mounting slide. Ball bearing action. Glide brackets permit full travel, easy chassis removal. Load; 30 lbs. per pr.



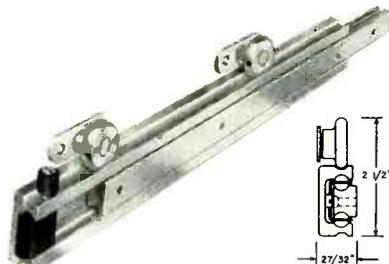
No. 313R Slide

Same as No. 306, but with solid center track of steel or aluminum. Load capacity: 75 lbs. per pair mounted vertically; 45 lbs. mounted horizontally.



No. 330 Slide

Very inexpensive roller type slide for quantity installation. Has some slide play. Travel 4" less than slide length. Load capacity: 50 lbs. per pair.



No. 575R Slide

Same features as No. 306, but heavier sections for greater loads. Load capacity: 100 lbs. per pair mounted vertically; 60 lbs. mounted horizontally.

Grant Industrial Slides

Grant Pulley & Hardware Corporation
Flushing, N. Y. Los Angeles, Cal.

Electronic Division of the National Production Authority and as Chairman of the Electronic Production Board. Prior to this, he served as consultant to the munitions board for the Department of Defense in 1950.

Prior to joining Philco, Cotton was managing director and chairman of the board of British Rola and concurrently a director of various other electronic companies during the 12 years he spent abroad.

RCA Forms Transistor Group, Names Engineers

RCA ESTABLISHED a separate semi-conductor operations department, devoted exclusively to the engineering and manufacturing of transistors and other semi-conductor electron devices.

Alan M. Glover, associated with RCA for over 18 years, has been appointed manager of the new department, which will have its headquarters at the firm's Harrison, N. J., tube plant. For the past year, Glover has been manager of controls and standards for the cathode ray and power tube operations department.

Also named to executive posts in the new department are Norval H. Green as manager of semi-conductor manufacturing; Robert E. Higgs as manager of planning and scheduling and Lewis Malter as manager of engineering.

RCA also announced that Edmund A. Laport, chief engineer of the RCA International Division, has joined the research and engineering staff of RCA as administrative engineer of communications. Raymond F. Guy has been appointed director of radio frequency engineering for NBC.

The research and engineering staff which Laport joins was created recently to have broad responsibility for all research and engineering activities of the corporation.

Laport started with RCA in 1936 as engineer in charge of the high power transmitter section. Two years later, he was named chief engineer of RCA Victor of Canada and in 1944 he joined the RCA International Division as chief engineer.

Guy was formerly manager of

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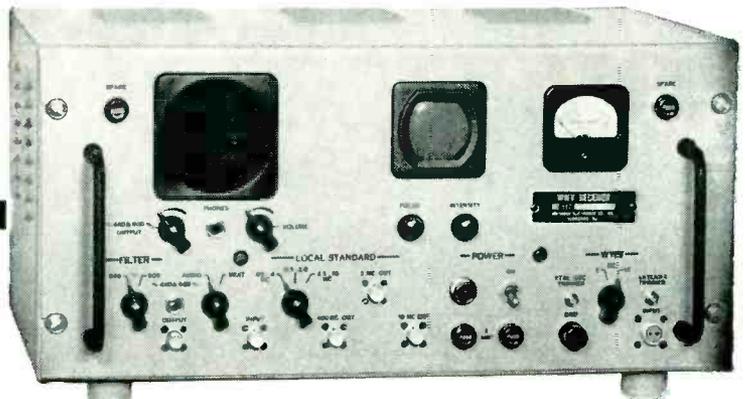
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By using the new Matawan WWV receiver, this frequency standard, with all its information (standard audio frequencies, time signals, propagation notices) is now available to your laboratory. The WWV carrier, after elimination of its modulation, by means of a narrow band pass crystal filter, monitors your local HF standard. The rotative pattern on the screen of the cathode ray tube gives sense and amount of the frequency deviation.

Either the 5MC WWV or the 15MC WWV may be received. The receiver will accommodate any local frequency in the range from 50kC to 10MC equal to a subharmonic of 10MC, 2 MC or 400 kC. A second channel receives the audio modulation and time signals of the WWV-Standard.

Four Models Available.

Fully descriptive, illustrated spec. brochure available on request.

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	5.0 MC	5 and 15.0 MC
Audio Modulation on Speaker Phone Jacks	Model ME-117A \$865	Model ME-117C \$910
Additional Filter for 440/600 CPS	Model ME-117B \$940	Model ME-117D \$985

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*Reads Directly... WATTS FORWARD
WATTS REFLECTED... In 50 Ohm Coaxial Lines*

Measures POWER into the antenna in the actual operating circuit. Continuous monitoring if desired.

Measures reflected power, direct reading. In antenna matching work, results show directly in lower reflected power. Ideal for mobile equipment.

Tests 50 ohm r-f lines, antenna connectors, filters—quickly. **ACCURATE** because of high directivity and small frequency error.

DIRECT READING—no calibration charts, no full scale meter adjustments needed. Meter scale reads directly for all ranges and is expanded for better down-scale reading.

CONVENIENT—does not require reversal of r-f connections. No auxiliary power required.

Negligible power loss and insertion VSWR.

Full scale power range and frequency range are determined by the selection of plug-in elements from the following list.

Frequency Range—25-1000 megacycles in five ranges vis. 25-60 (A), 50-125 (B), 100-250 (C), 200-500 (D), 400-1000 (E).

Power Range—10, 25, 50, 100, 250, and 500 watts full scale. Available in most frequency ranges.

Accuracy—5% of full scale.

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Model 43 with front element in operating position. Dimensions: 7" x 4" x 3" Weight, 4 pounds. \$O239 jacks for PL259 plugs available.



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radio and allocation engineering for NBC.

He will continue to direct the activities of the engineering allocations group and will be responsible for all radio frequency engineering problems within the company.

He will also act as liaison on radio frequency engineering and allocations matters between NBC's engineering department, RCA divisions and government and industry organizations.

French Elected EPRA Head

LIEUTENANT COLONEL HERBERT H. FRENCH, U. S. Air Force, was elected director of the Electronics Productions Resources Agency of the Defense Department.



Kessler Heads Du Mont Communication Products

ROBERT E. KESSLER has been appointed manager of the communication products division of A. B. Du Mont Laboratories. Kessler, who has been assistant manager of the division since 1948, replaces Herbert E. Taylor, Jr., who has resigned.

Irving G. Rosenburg, vice-president of Du Mont, has administrative responsibility for the division.

Kessler has been employed by Du Mont continuously since 1936 and was the ninth full-time employee to be hired by Dr. Allen Du Mont in the early years of the electronics company.

Throughout Du Mont's experimental and development work in television transmitting equipment,

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20 G UP TO 2000 CPS**



ACTUAL SIZE

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Martin Malador, courtesy The Glenn L. Martin Company

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$1\frac{15}{32}$ " diam. x $1\frac{3}{4}$ " long

WEIGHT:

less than 1 oz.

OPERATING POWER:

100 MW Max.

CONTACTS:

spdt—2 amp. at 24 V DC
Resistive load

VIBRATION RESISTANCE:

20 G up to 2000 CPS
(cycles per sec.)

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Augat clamps are precision produced and made of 18% nickel silver for greater fatigue value, increased tensile strength and for utmost durability. They have withstood a two hundred-hour salt spray test with no adverse effect.

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 Capacitance: $\pm 0.25\%$
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Resistance: 1 milliohm to 11 megohms
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Featuring **esi** DEKADIAL

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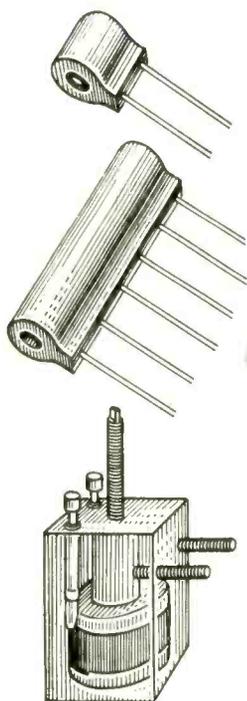


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radar, cathode-ray tubes, television receivers, and cathode-ray instruments, Kessler has actively participated in engineering, operations and production. Following World War II he was made responsible for the product design and specifications of all equipment to be manufactured by Du Mont as it entered competitive commercial operations. With the establishment of a television transmitter division in 1947, he was placed in charge of manufacturing and engineering for the division. He was responsible for the design and manufacture of the complete Du Mont line of television broadcasting equipment, including cameras, control equipment, and transmitters. In 1948 he was named assistant division manager and he continued with this title in 1954 when the division was renamed the communication products division following its entry into the mobile radio equipment field.

**Fairchild Appoints
Engineering Director**

ARTHUR E. HARRISON has been appointed director of engineering for the Fairchild Guided Missiles Division.

Harrison has been vice-president in charge of engineering for the Wilcox Electric Company of Kansas City for the past two years.

Previous to 1952, he was chief engineer of Air Associates of Teterboro, N. J. In this position, he was responsible for the development of uhf airborne radio equipment and fire control systems. For a number of years, he was a member of the technical staff of the Bell Telephone



Arthur E. Harrison

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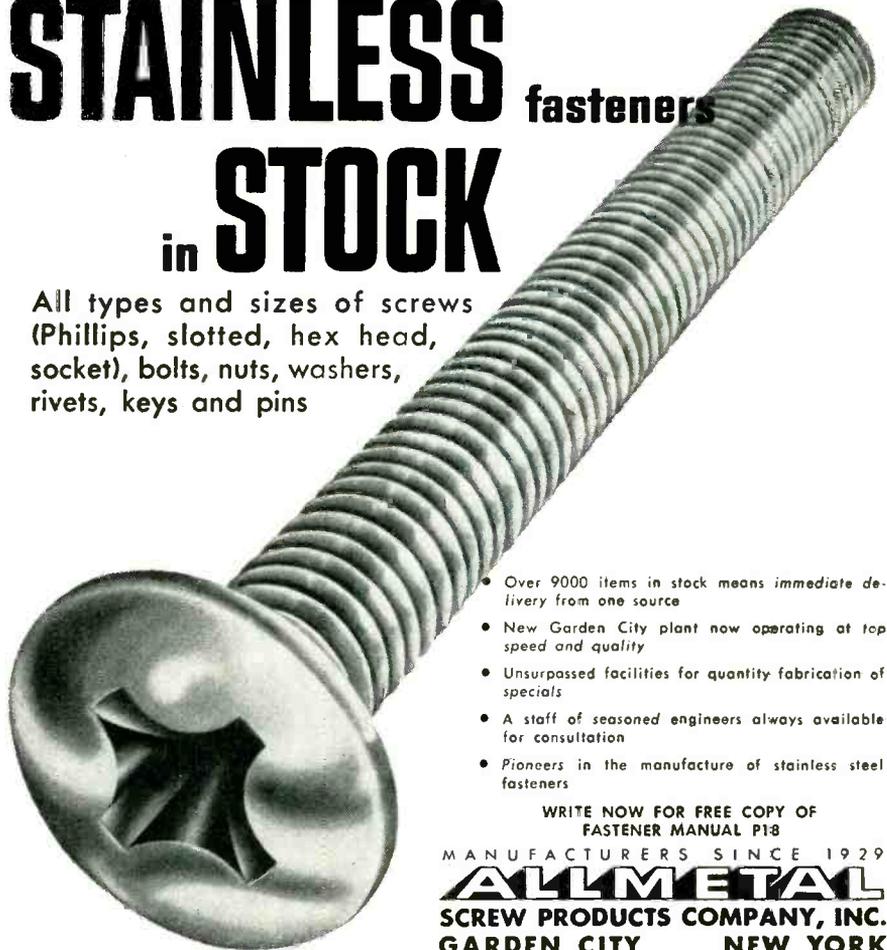
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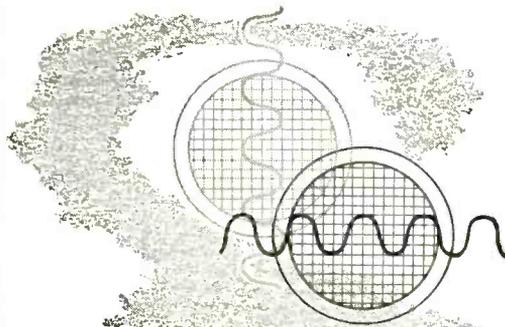
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Precision measurement of phase shift is practically distortion free in the

CROSBY Wideband Oscilloscope, Model 320. Identical horizontal and vertical amplifiers allow phase shift indication for frequencies up to 5 megacycles.

A deflection sensitivity of 35 millivolts RMS per inch, on both amplifiers, makes the Model 320 ideally suited for use in laboratories requiring accurate phase shift evaluation.

A general purpose, high-gain instrument particularly adapted to color television measurements. An Oscilloscope designed by engineers for use by engineers.

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Laboratories where he developed vhf and uhf airborne radio communication equipments. Previous to this association, Harrison was a consultant for the U. S. Navy on the Joint Radio Board of the Joint Aircraft Committee, Washington, D. C.

**Clarostat Acquires
Resistor Company**

CLAROSTAT MFG. Co. has completed arrangements for the purchase of Campbell Industries of Chattanooga, Tenn. Campbell manufactures carbon resistance products. George S. Campbell will continue in active management of this company in the capacity of general manager.

For the present there are no plans by Clarostat to discontinue any department at its Dover, N. H. plant. Plans are to increase facilities and output, as well as necessary labor requirements at the Chattanooga location.

**NBS Selects
Boulder Lab Chiefs**

DIVISION CHIEFS have been named for the four scientific divisions of the National Bureau of Standard's Boulder Laboratories in Colorado. They are Russell B. Scott, Cryogenic Engineering; Ralph J. Slutz, Radio Propagation Physics; Kenneth A. Norton, Radio Propagation Engineering and Harold A. Thomas, Radio Standards. In addition, Harold Lyons has been designated assistant chief for research of the Radio Standards Division. He will also serve as chief of the Microwave Standards Branch. Director of the Boulder Laboratories is Frederick W. Brown.

**Daystrom To Buy
American Gyro**

DAYSTROM plans to purchase the American Gyro Corp. of Santa Monica, California, manufacturers of gyroscopes for guided missiles, radar and aircraft.

The current sales volume of American Gyro is at the rate of about 2½-million dollars annually,



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... WHEN YOU DESIGN METEX ELECTRONIC WEATHERSTRIPPING INTO YOUR EQUIPMENT YOU GET ITS POSITIVE SHIELDING EFFECTIVENESS — AT MAXIMUM OVERALL ECONOMY

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ELECTRONICS — January, 1955

PLANTS AND PEOPLE

(continued)

mostly in their new flotation type gyroscopes. The backlog of new orders is reported to be about 2½ million dollars.

Daystrom said the West Coast plant would continue to be American Gyro's main manufacturing headquarters. Expansion of this company's work will be handled in cooperation with Daystrom's electronics plants in the future.

GE Names Meyers As Capacitor Head

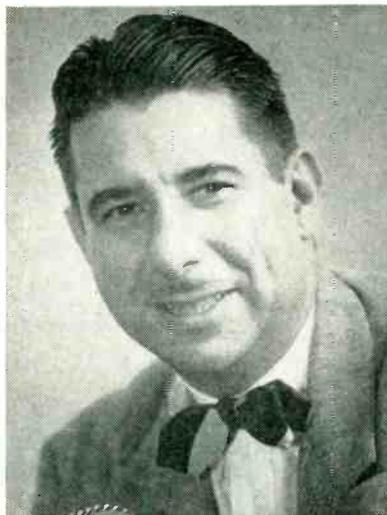
RUSSELL E. MEYERS has been appointed manager of manufacturing facilities and engineering for the GE capacitor department in Hudson Falls, N. Y.

He joined the company in 1935 and has been at the company's Pittsfield, Mass., works until his present appointment.

In 1951 Meyers was named superintendent of underwater antenna manufacturing in the GE Naval Ordnance department and for the past year and a half has been manager of manufacturing engineering in the same department.

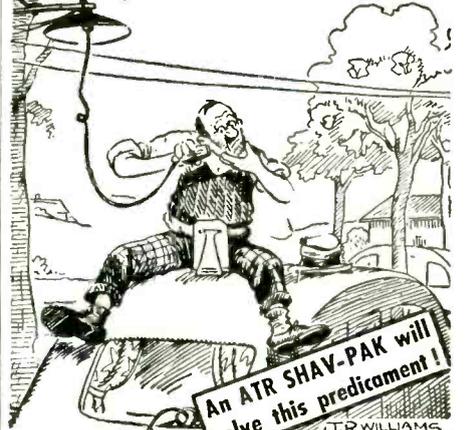
Michigan Appoints Smith and Beighley

NEWBERN SMITH, research engineer at the University of Michigan's Engineering Research Institute, has been named supervisor of Project Michigan, the institute's university-wide research program sponsored



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TYPE	INPUT D.C. VOLTS	A.C. OUTPUT 60 CYCLES	OUTPUT WATTAGE	LIST PRICE
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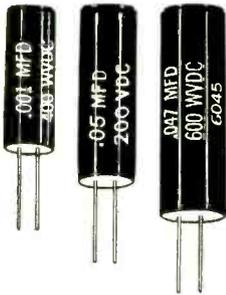
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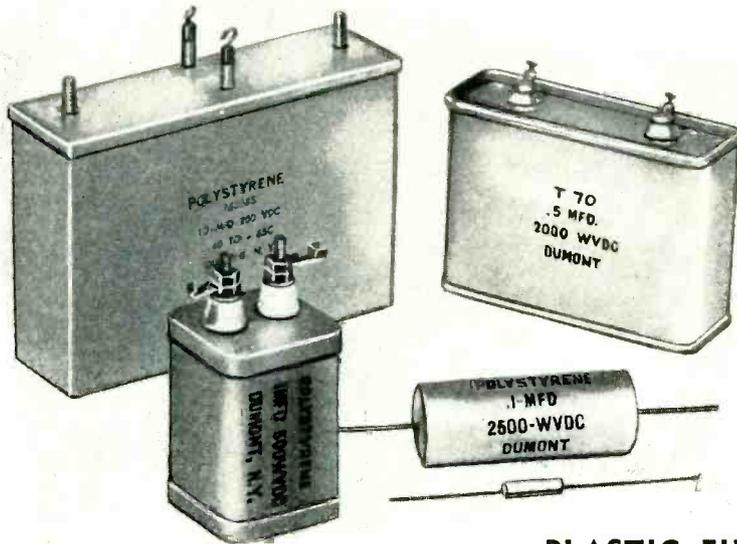
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by the military. Clair M. Beighley, formerly of Bell Aircraft, has been appointed associate research engineer in charge of ERI's Rocket Propulsion Laboratory.

As supervisor of Project Michigan, Smith will head a broad program of study set up last year for the development of methods for gathering accurate, up-to-date combat intelligence through radar, television and other devices.

Smith came to the institute in February from the National Bureau of Standards where he was chief of the central radio propagation laboratory. He joined the bureau in 1935.

With Bell Aircraft since 1952, Beighley served there most recently as acting head of the rocket research group. He succeeds Leland G. Cole at the propulsion laboratory.

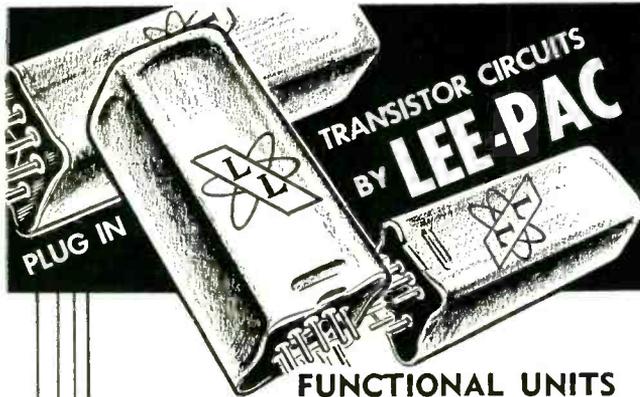


Admiral Gingrich Joins IT&T

ADMIRAL JOHN E. GINGRICH, U.S.N. (Retired) has been elected a vice-president of IT&T and has joined its administrative staff. In his last Naval post he was Deputy Chief of Naval Operations (Administration). In this position his duties were to determine the procurement and production policies and methods to be followed by the Naval Service.

Dahlberg Appoints Chief Field Engineer

HERBERT E. WEYRAUCH has been named chief field engineer for The Dahlberg Company of Minneapolis, Minnesota. Weyrauch will direct



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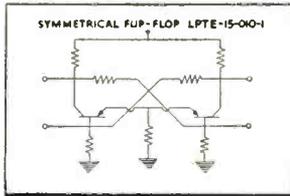
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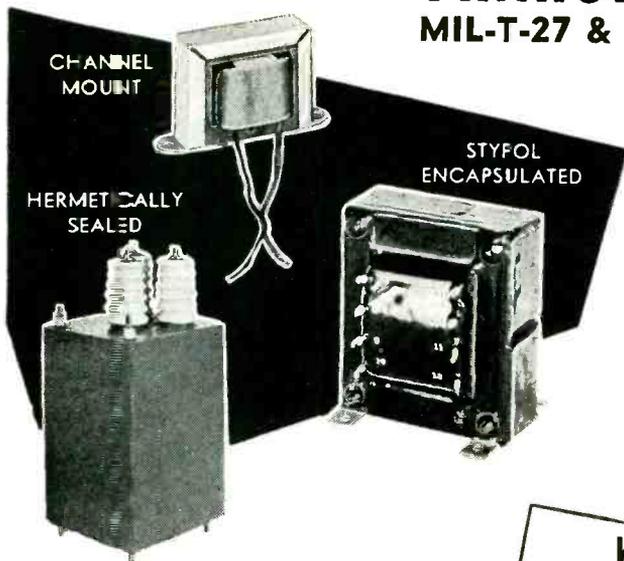


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Write for Catalogues L-151, L-153, and L-154

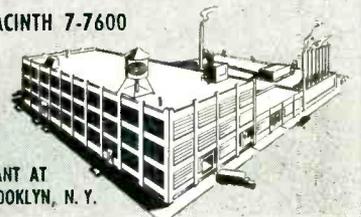


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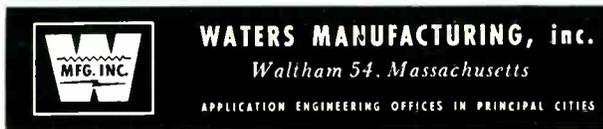


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CABLE ADDRESS: MANSOL

the installation of the firm's radio and tv equipment and work on special miniaturized electronic component development projects.

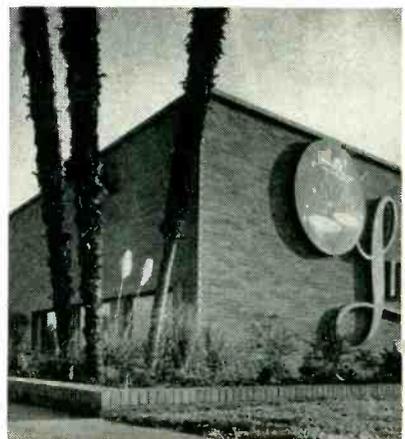
Since 1941, Weyrauch has been on active duty with the Navy. He was commanding officer of the U. S. Naval Computing Machine Laboratory in St. Paul and did work on research, design, development and construction of digital computers and sonar systems.

Univox Selects Engineering Head

UNIVOX CORP. of New York and Los Angeles has appointed Mox Meukel as West Coast director of engineering and research. He formerly was a special consultant to Univox.

Texas Instruments Buys Land

TEXAS INSTRUMENTS purchased 6 acres of land in Houston, Texas and plans are now being considered for construction on the land of a new plant and general headquarters for Houston Technical Laboratories, a wholly owned subsidiary of the firm. Houston Technical Laboratories manufactures gravity meters, geophysical instruments and optical components for the petroleum industry.



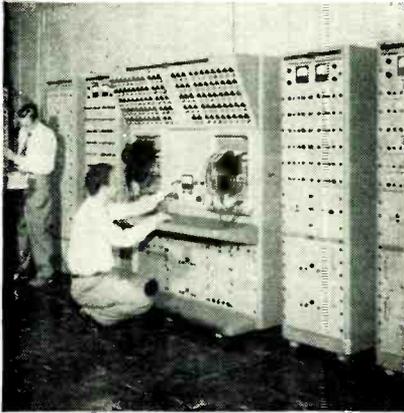
Librascope Opens Plant, Names Manager

LIBRASCOPE opened its new 55,000 sq ft plant in Glendale, Calif. With the opening of the new building the computer manufacturer has 160,000

sq ft of plant space and a combined staff of over 1,000 persons.

In another action, the company appointed Richard E. Hastings as general manager of its subsidiary, The Minnesota Electronics Corporation of St. Paul.

Minnesota Electronics makes building-block type components for military and industrial computers and controls.



Rea Expands Computer Center

AN ANALOG COMPUTATION CENTER for the Los Angeles area was opened by the J. B. Rea Co. in Santa Monica. For the past year the firm has also had a digital computer service available for industrial and military customers.

Anaconda Advances Di Lustro And Randall

VICTOR DI LUSTRO has been appointed general manager of all mills of Anaconda Wire & Cable and C. F. Randall has been named manager of production planning. Di Lustro had been assistant general manager of mills and Randall, formerly, was assistant-secretary and assistant-treasurer. Di Lustro has been in the wire business since 1922 and joined Anaconda in 1929. Randall joined Anaconda in 1924.

Pyramid Builds Plant Addition

THE CONSTRUCTION of a new plant on the firm's present site, has been announced by Pyramid Electric Co.,

Aerohm Precision Potentiometers

A Complete Line of
Micro-miniature
and Miniature Wire-wound

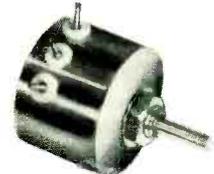
"LO-TORK" POT



Designed for minimum-torque uses. Minimum torque is 0.01 inch-ounce. Dissipates one watt at 80° C. Resistances — 100 to 100,000 ohms. Weight is only 1/2 ounce. Ganging to 6 decks, internal clamps hold 7/8 in. diameter.

These potentiometers have standard linearity of .5%, special order .25%; precision toroidal winding allows winding angles to 360°, standard 354°.

"HOT-POT"



Designed for high-temperature use. Dissipates one watt at 200° C. Dissipates five watts at 80° C. Resistances 1,000 to 25,000 ohms. Stainless steel case, one inch dia. by 1 1/16 in. depth behind panel. Teflon-insulated terminals.

Micro-miniature Series AP 1/2



Two watts continuous at 80° C. Resistances from 10 to 20,000 ohms; 5% tolerance standard. Diameter is 1/2 in., depth is 1/2 in. Weight is only 1/4 ounce. Sealed well enough for potting.

Miniature Series RT/RTS 7/8



Precision wire-wound construction. Three watts continuous at 80° C. Resistances 10 to 50,000 ohms. Diameter 7/8 in., depth is 3/8 in. Weight is only 1/2 ounce. Independent linearity 3% standard.

Ganged Units



The Series AP 1/2, AP 1-1/8 and the RT 7/8 are easily ganged together with potentiometers of the same series to permit control of the unit by a single shaft.

Miniature Series AP 1 1/8



Four watts continuous at 80° C. Resistances 10 to 100,000 ohms. Diameter 1-1/8 in., depth 1/2 in. Weight is less than 3/4 ounce.

These potentiometers are precision machined, with bodies of anodized aluminum, line-reamed phosphor bronze bushings, centerless-ground stainless steel shafts, and gold-plated fork-type terminals. Units are fully sealed, and treated with Service-approved moisture-proofing and fungicidal materials. On special order these potentiometers can be processed for operation up to 125° C.

AEROHM potentiometers are individually checked in a quality-control system that guarantees full performance from every unit. Write for information and prices.



WATERS MANUFACTURING, inc.

Waltham 54, Massachusetts

APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

BE Sure with **CORNISH**
Electronic **WIRES and CABLES**

MICROPHONE CABLES 
Designed for low capacitance, high insulation resistance, low attenuation—in plastic or rubber insulation to stand severe service

T-V LEAD-IN CABLES 
Furnished only in pure virgin polyethylene to insure best electrical properties and long life under severe operating conditions

T-V LEAD-IN CABLES 
Made hollow, of pure virgin polyethylene, for maximum efficiency in receiving Ultra High Frequency signals

INTERCOMMUNICATION CABLES 
These quality cables are made in various constructions, utilizing plastic insulation for both conductors and jacket

SHIELDED INTERCOMMUNICATION 
When installation conditions dictate, shielded cables are recommended. Made with internal or external shield—2 and 3 conductors

“MADE BY ENGINEERS FOR ENGINEERS”

CORNISH WIRE COMPANY, INC.
50 Church Street New York 7, N. Y.

of North Bergen, N. J.

The new building will house the executive and general offices, engineering and research laboratories, jobber division warehouse and shipping department. The space now occupied by these functions will be converted to additional manufacturing space.

Gudeman Buys Capacitor Firm

THE GUDEMAN COMPANY, electronic components manufacturer, has purchased Dilectron of Monrovia, Calif., manufacturer of ceramic capacitors. The 12,000 sq ft Dilectron plant becomes Gudeman's fifth plant and will be known as the Dilectron Division of the Gudeman Company. There will be no personnel changes in the new division. F. T. Reischel is vice-president and general manager, George Wiesinger is sales manager and purchasing agent and Steve Taylor is chief engineer.

Electronics Engineering Plans New Plant

ELECTRONICS ENGINEERING COMPANY of California plans a 50,000 sq ft laboratory and plant to be built in Santa Ana, Calif. at an estimated cost of \$500,000. Buildings will house EECO's 500 engineering and administrative personnel.

Honeywell Opens Denver Research Center

A NEW RESEARCH and product development center has been opened in Denver, Colo. by Micro Switch, a division of Minneapolis-Honeywell Regulator Co.

The center will supplement research activities conducted at the division's main office and factory in Freeport, Ill. Wilbert Martin, assistant director of product research and development, will be in charge of the new facility. About ten engineers and technicians will be employed.

The new research office becomes Honeywell's second major facility in Denver. The Minneapolis firm

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NULL DETECTORS

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IMPEDANCE COMPARATORS

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Other Electronic Test Equipment



MODEL 200 A

PRICE \$349.50
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- HIGH ACCURACY
- MEASURES FROM 0 TO 360 DEGREES
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- PHASE SHIFTS OF THE ORDER OF .01° CAN BE MEASURED EMPLOYING SPECIAL CIRCUIT TECHNIQUES
- MEASURES IN-PHASE AND QUADRATURE COMPONENTS SEPARATELY

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G. G. WILLISON CO., 1821 W. Alabama, Houston 6, Texas
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THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers — and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

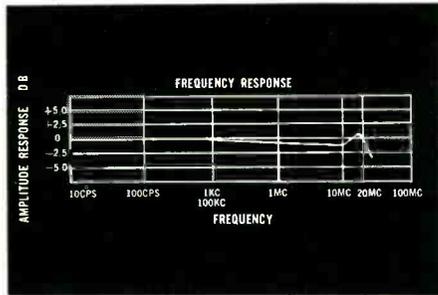


McGRAW-HILL PUBLICATIONS

WIDE BAND VIDEO AMPLIFIER

10 cps to 20 mc

An oscilloscope deflection amplifier for measuring and analyzing pulses! Extremely wide band with extended low frequency response down to 10 cps. Will accurately analyze television signals. Excellent to increase the amplitude range of your vacuum tube voltmeters and signal generators.



The Polarad Wide Band Video Amplifier offers an extremely wide band coverage: flat within $\pm 1\frac{1}{2}$ db from 10 cycles to 20 megacycles per second. It has a time delay of 0.02 microseconds and assures extreme stability because of its associated electronically regulated unit. A low capacity input probe is provided.

See other Polarad equipment advertised on pages 77, 205, 355, 362



**ELECTRONICS
CORPORATION**

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Representatives in all principal cities.

Want more information? Use post card on last page.

346

PLANTS AND PEOPLE

(continued)

purchased the Heiland Research Corporation, manufacturer of scientific instruments and photographic flash equipment.

High Voltage Engineering Adds Kelliher

MAURICE G. KELLIHER of England has joined the staff of High Voltage Engineering Corp.

Kelliher will assist J. C. Nygard, associate chief engineer, in the direction of High Voltage's activities in the linear accelerator field.

Kelliher has for the last seven years been with the Mullard Research Laboratories at Surrey, England. His first two years there were spent on vacuum tube application research in the television and higher communication frequency ranges. Later he shifted to linear accelerator research and development.

Lenkurt Electric Promotes Nolan

EDWARD E. NOLAN has been appointed an engineering representative for Lenkurt Electric in San Carlos, Calif.

Before joining Lenkurt in 1952 as an applications engineer, he had been with Western Electric more than 10 years in various supervisory and engineering positions.



Admiral Clark Joins Radio Receptor

ADMIRAL J. J. CLARK, U. S. N. (retired), has been appointed a vice-president of the Radio Receptor Co.

Admiral Clark became Assistant

Digital Communication Engineers

with
experience
in
the
fields
of

Systems
Engineering
Miniaturization
Circuit
Development
Electromechanical
Development
Digital
Techniques

Long-Range Information Transmission

New advancements in the field of long-range information transmission are being made at Hughes with digital techniques.

Areas of Work

To further expand work in this area, Hughes Research and Development Laboratories are interested in people with experience in airborne communication systems, digital storage, low frequency measurements, modulation systems, miniaturized packaging, audio, IF and RF circuitry in the HF range, analog to digital—and other data conversion methods.

Scientific and Engineering Staff

Hughes

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AND DEVELOPMENT
LABORATORIES

CULVER
CITY,
LOS
ANGELES
COUNTY,
CALIFORNIA

Relocation of applicant must not cause disruption of an urgent military project.

January, 1955 — ELECTRONICS

Chief of Naval Operations for Air in 1946, and since November 1948 has had duty afloat in command of Carrier Division Four and Carrier Division Three.

During the Korean War he transferred to command of the Seventh Fleet.



Brady Named Plant Head of Automatic Mfg.

AUTOMATIC MANUFACTURING CORP. of Newark, N. J., has appointed Patrick J. Brady as plant manager.

Brady's experience includes 8 years with RCA at Camden, N. J. His most recent position was operations manager for Sylvania where he directed manufacturing, engineering and sales of automobile and home radio and test equipment. His duties included direction of Sylvania's plants in Buffalo and Arcadia, N. Y. and in Williamsport, Pa. During 7 years with Sylvania, he held successively the posts of chief industrial engineer for the radio and television division and plant manager of the Williamsport plant, prior to his post as operations manager.

Sprague Builds New Coast Headquarters

THE SPRAGUE ELECTRIC Co. has started construction of a 13,000 sq ft, one-story building in the Venice section of Los Angeles, Calif. to house all of its Southern California operations.

The building is expected to be completed in the spring of 1955.

It will house the concern's South-



★ ULTRA LOW capacitance & attenuation

TYPE	μF/ft	IMPED.Ω	O.D.
C1	7.3	150	.36'
C11	6.3	173	.36'
C2	6.3	171	.44'
C22	5.5	184	.44'
C3	5.4	197	.64'
C33	4.8	220	.64'
C4	4.6	229	1.03'
C44	4.1	252	1.03'

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SPOT DELIVERIES FOR U.S.
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 Constant 50Ω-63Ω-70Ω impedances

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ERA

MAGNETIC STORAGE DRUMS

ADAPTABLE ... operate at any speed between 4500 and 15,000 rpm.

FAST ACCESS ... average access time as short as 2½ milliseconds.

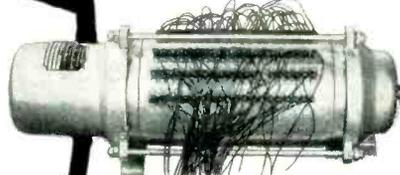
APPROPRIATE SIZE ... proper capacities for many computer applications.

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MINIATURE FERRITE READ-WRITE MAGNETIC HEADS ... one per track on regular orders. On special orders several heads can be installed on each track.

PLUS ALL THE USUAL ADVANTAGES OF ERA DRUMS ... highest reliability, selective alterability, non-volatility, long life.



ERA 1119 ... Rotor 4¾ by 8 inches. Stores 100,000 bits of information.



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Remington Rand's Engineering Research Associates Division, pioneer designer and builder of magnetic storage drums, has placed models 1119 and 1120 on the market for all system builders to buy and use. Featuring advanced design based on ERA's most thorough know-how in the field, these drums can be depended upon to give utmost satisfaction in the data-handling systems that you are designing. Other outstanding ERA drums of many sizes and types are also available.

To receive full particulars, please write on your business letterhead to:

Remington Rand
ENGINEERING RESEARCH ASSOCIATES DIVISION
 1902 W. Minnehaha Ave., St. Paul W4, Minn.

ern California sales offices, the radio interference filter laboratories and production facilities.

The new Sprague building is situated on a two acre plot of land and has been designed so that an additional 10,000 sq ft of floor space can be readily added.

Minnesota Mining Advances Thurnauer

HANS THURNAUER has been appointed technical consultant on ceramics and electrical insulations by Minnesota Mining & Manufacturing Co.

He will conduct development studies and long-range basic research in ceramics to further enlarge 3M's activities in this field. In addition to this new position, he will continue as vice-president of American Lava Corp., a 3M subsidiary which manufactures technical ceramics in Chattanooga, Tenn.

He became associated with American Lava in 1935 as technical director.

Fairchild Recording Appoints Engineers

FRANK G. MULLINS, JR. has joined Fairchild Recording as manager of engineering and special counsel. Robert J. Marshall has been promoted from chief engineer to head of new product development. Mullins was formerly with the electronic division of Westinghouse in Baltimore. He is a member of the Maryland Bar. Marshall as head of



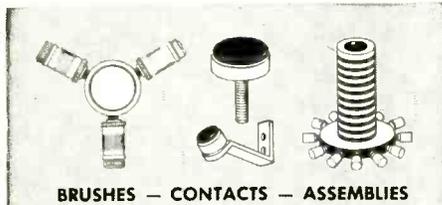
Robert J. Marshall



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SLIP RINGS

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EXTENSIVELY USED IN:

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Wide range of grades available for standard and special applications.

Other Graphalloy Products



Oil-free, self-lubricating Bushings and Bearings (applicable —100° to +200° F.; with expansion coefficient half that of steel will not seize shaft at low temperature); oil-free Piston Rings, Seal Rings, Thrust and Friction Washers, Pump Vanes.

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EECO

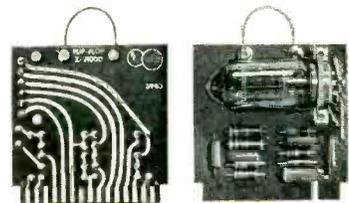
PLUG-IN UNITS

FOR COMMERCIAL AND MILITARY APPLICATIONS



FLIP-FLOP PLUG-IN TYPE Z-90048 (0 to 1 Megacycle)

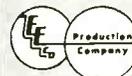
EECO plug-in circuitry reduces engineering — design and production time... cuts costs and performs with the highest degree of reliability. The Z-90048 flip-flop (shown above) is a typical high speed bi-stable multivibrator designed for counting and frequency division applications. Binary operation ranges from 0 to above 1 megacycle. The 11 pin base increases flexibility, so that binary counting, counting employing feedback, and re-setting may be readily accomplished. Output of one Z-90048 will drive a similar following unit without amplification.



EECO ETCHED CIRCUITRY FLIP-FLOP PLUG-IN UNIT Z-91000

Here is another reliable EECO plug-in unit... the Z-91000 Flip-Flop utilizing etched circuitry.

This is a medium speed bi-stable multivibrator circuit for applications in counting, frequency division, switching and time selection. Units are wired for linear binary or feedback counting applications.



Write for other Technical Data on Complete Line of EECO Standard Plug-in Units and Custom Engineered Circuitry

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January, 1955 — ELECTRONICS



BRANSON THERMAL TIME DELAY

Hermetically sealed— $\frac{3}{4}$ " dia. x $1\frac{1}{8}$ " long—
—for use in military applications.

Type TRH for delays between 1 second
and 1 minute with long term repeatability
and accuracy.

Ambient compensated from -65°C to
 100°C . Special units available for use up
to 125°C . Timing does not vary during
thermal shocks and transients.

Not affected by near-by heat sources.

Withstands military shock and vibration
tests.

For use on standard voltage supplies.

Various contact ratings available de-
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Short recycle and recovery times.



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UNIVERSAL meets exacting DESIGN REQUIREMENTS *in* TOROIDAL COILS

Our specially designed machines now wind
Toroidal Coils quicker and with more accuracy than
other standard methods. Universal Toroidal Coils
in any size wire to your specifications—are economical
in materials and possess the smallest external
leakage field of all other shapes.

Universal Toroids wound to Mil-T-27 specs.

Wire sizes #42 (.00249 mils) to #10 (.1019 mils).

Excellent Delivery in small or large quantity.

Engineering Service Available.

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**HIGHEST ELECTRICAL
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New
JONES

SERIES 2400- PLUGS & SOCKETS

- Improved Socket
Contacts—4 individ-
ual flexing surfaces.
Positive contact over
practically their entire
length.

- Cadmium plated Plug
and Socket, Contacts
mounted in recessed
pockets, greatly in-
creasing leakage dis-
tance, INCREAS-
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RATING.

- Interchangeable
with 400 Series.



P-2406-CCT



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Send for complete Catalog No. 20. Plugs,
Sockets, Terminal Strips.

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SUBSIDIARY OF UNITED-CARB FASTENER CORP.

16/1 SIGNAL-TO-NOISE AT 1 MICROVOLT



MODEL 110
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WWV
RECEIVER

- Sensitivity: 2/1 signal-to-noise at 1.2 microvolts without audio filter. 16/1 for single tone modulated signal at 1 microvolt with filter.
- Selectivity: Less than 20 kc at 65 db down.
- Image Rejection: More than 60 db at highest operating frequency.
- Frequency: Choice of any three frequencies, crystal controlled on 2.5, 5, 10, 15, 20, and 25 mc in stock. Any frequencies between 2 and 25 mc at slight additional cost.

30-day delivery

- Beat frequency oscillator and series noise limiter.
- Dual Audio Output: Speaker on panel and 600 ohm line terminated at rear.
- Audio Filter: Electronic rejection or selection of any frequency in audio range with adjustable selectivity.
- Size: Standard panel mounting, $5\frac{1}{4}$ x 19 x $8\frac{1}{2}$ inches behind panel.

Literature Available

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Fabric-covering problems vary with the size and shape and function of the carrying case. Here's the cue for APEX specialists! For fast-colored, durable fabrics to make your units SELL faster and LAST longer... ask men who KNOW.



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SOUND and PROJECTION EQUIPMENT · PORTABLE TV SETS · TEST INSTRUMENTS

the recently established new product development group will be responsible for analyzing and making recommendations for a wide variety of new products under consideration for manufacture and sales. He has had a varied background in both audio and motion picture work and holds a number of patents in these fields.



Carbonara Named Director of Standard Coil

VICTOR E. CARBONARA, president of Kollsman Instrument Corp., has been appointed a director of Standard Coil Products, filling the vacancy created by the retirement of Robert E. Peterson.

Kollsman was purchased by Standard Coil in 1950 from Square D Co.

Carbonara joined Kollsman in 1934 as executive engineer and production manager. He became general manager in 1940 and was named president at the time of the company's acquisition by Standard Coil.



COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION

You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

Our engineering staff is at your service for all small bearing problems.

Over 40 years of serving industry with Quality jewel bearings

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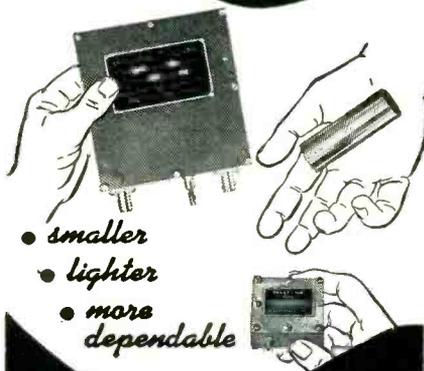
Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire styli

1 Spruce Street, Waltham 54, Mass.

Magnetic Research Moves, Ups Wolfram

MAGNETIC RESEARCH CORP. of El Segundo, California, recently moved to a larger location in the city. The new plant has four times the area of the previous facility. Additional equipment for test and manufacturing has been installed. Bodo M. Wolfram has been appointed chief engineer of the company. He was previously associated as a research specialist in the electronics depart-

Andersen offers
**SOLID
 ULTRA-SONIC
 DELAY LINES**
to meet your
CRITICAL spec.

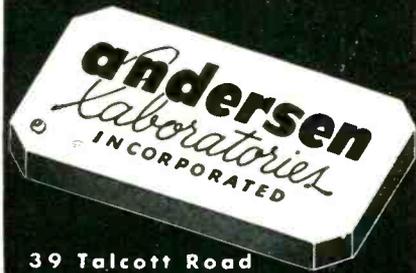


- smaller
- lighter
- more dependable

for RADAR and COMPUTERS

Delay Time	From 1 to 3500 microseconds.
Delay Tolerance	\pm 0.01 microsecond.
Carrier Frequency	From 5 to above 65 megacycles, transducer fundamental for moderate delays.
Bandwidth	Up to 60% of carrier frequency.
Attenuation	Zero to 60 decibels (depending on termination).
Dynamic Range	Up to 60 decibels.
Line Terminations	50 to 2500 ohms (depending on bandwidths and attenuation requirements).
Temperature Range	Dimensionally and functionally stable from -60 to +100 degrees Centigrade. (Temperature controlled cases available).

Whatever your vital requirement in ultrasonic delay lines, Andersen Laboratories, specialists in the research, design, and manufacture of fused quartz lines, can provide you better performance characteristics at lower cost. Write for general bulletin #54 or send details of application for advisory service.



39 Talcott Road
 West Hartford 10, Conn.

Want more information? Use post card on last page.
 ELECTRONICS — January, 1955

ment of North American Aviation, working primarily on magnetic amplifiers.

**Armour Research
 Plans New Lab**

A \$1-MILLION-DOLLAR LABORATORY building will be constructed during the coming year for Armour Research Foundation of Illinois Institute of Technology in Chicago.

The structure will house the Foundation's electrical engineering research facilities and proposed nuclear reactor.

Contracts for the building will be let toward the end of the year. Construction will get under way about March 15, 1955, with completion scheduled for Oct. 1.

The cost of the building will include the reactor and accompanying installations.

Construction of the reactor area of the building will depend on approval of Foundation plans submitted to the Atomic Energy Commission.

The one-story building will be located on the Illinois Tech campus. It will provide 39,744 sq ft of space.

**Universal Metal
 Builds New Plant**

WORK HAS STARTED on a \$160,000 plant in Bassett, Calif. for Universal Metal Products. Expected to be complete by early 1955, the 40,500 sq ft building will employ 200 for manufacture of electronic, hydraulic and mechanical aircraft accessories.

**Admiral Laidlaw
 Joins Hycon**

REAR ADMIRAL J. S. LAIDLAW, U. S. Navy (retired), has joined Hycon Manufacturing of Pasadena, Calif., electronic and photographic instruments firm, as staff assistant to president Alden E. Acker.

Laidlaw has been director of the production division of the Bureau of Ordnance and deputy director for atomic energy. Prior to joining Hycon, he was supervising inspector of naval material in the Los Angeles District.

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 PRINTED
 CIRCUITS**

PRINTED CIRCUITRY

FLUXES

**3 NON-ACTIVATED
 AND
 4 ACTIVATED
 FLUXES**

A TRUSTED NAME IN

ALPHA

ELECTRONIC INDUSTRY

PRINTED CIRCUITRY

SOLDERS

**5 BAR SOLDERS
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NEW BOOKS

Magnetic-Amplifier Circuits

BY W. A. GEYGER. *McGraw-Hill Book Co., New York, 1954, 277 p., \$6.00.*

THE WIDENING scope of magnetic-amplifier uses has prompted investigations of many and varied circuits. The results of these investigations have been reported mainly in technical papers, though more recently in several books, of which this is one.

It would be expected that the original independent treatments would be unified, or at least digested to their essentials, before presenting them in book form. This book is noteworthy where this has been accomplished, and somewhat lacking where this has failed. This apparent lack of an orderly process of distillation, next of organization, and then of generalization prevents this from being a suitable textbook for beginners in the field. (A book more suitable for beginners is George M. Ettinger's "Magnetic Amplifiers" in the Methuen Physical Series.)

Presentation of basic principles is sketchy, even though the subtitle indicates the inclusion of "Basic Principles, Characteristics, and Applications". The second chapter, titled "Magnetic-amplifier Elements", illustrates this point. It contains little that is elemental about the circuits, even though it does discuss some practical factors common to most of the circuits.

Circuit Data Is Exceptional

The latter two parts of the subtitle are well fulfilled. The presentation is opened by an interesting chapter on the historical development of magnetic-amplifier circuits. In chapters three and on are discussed circuits classified as "Non-feedback, Internal-feedback, and Second-harmonic-type". The coverage of each circuit type is primarily from the experimental point of view, with little theory given. Many practical details of each circuit are usually included. The circuit diagrams used with explanations of circuit operation are exceptional,

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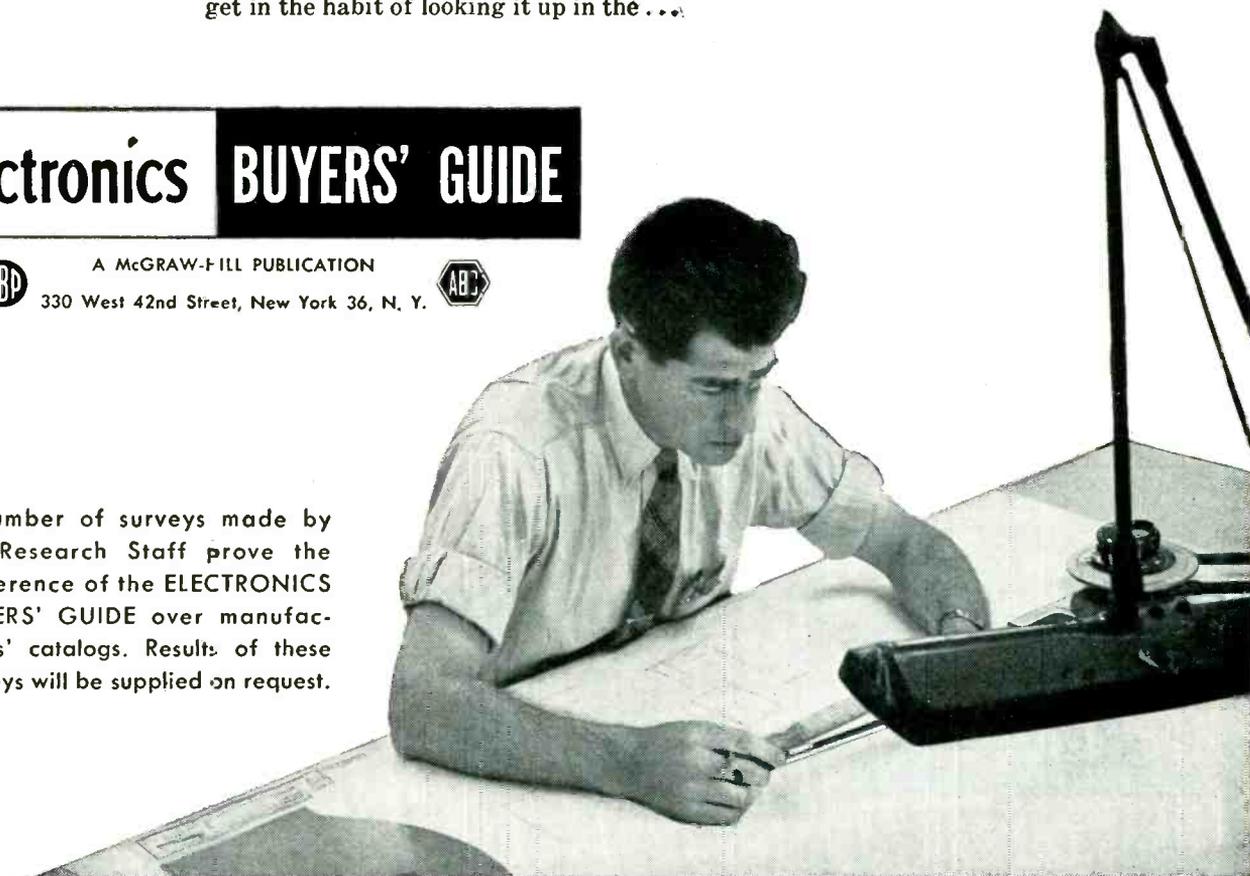


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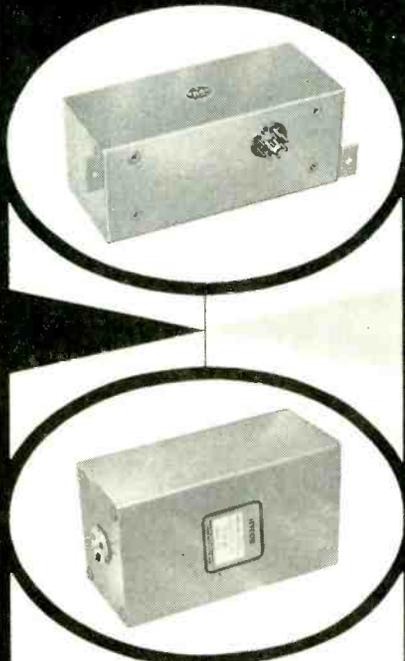
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particularly with regard to distinguishing positive and negative half cycles.

Quotations Are Confusing

In places, the statements or explanations of the original investigator are employed. These may be helpful, though at times confusing. An example occurs in Chapter 10 on "Single Core Internal Feedback Circuits". The statement is made that in using sharp-loop core material, the amplitude of control current determines the amount of flux reset. Actually, in practical cases, the reset is volt-second determined, and the control current fixed by the dynamic magnetizing current. A few other delusive statements were noted, though for this type book it is not serious. Still, it does make reading more difficult.

One could probably choose a circuit type from this book to meet his particular needs. From the many references listed at the end of each chapter he could find additional information that might be necessary for a detailed design. These references add considerably to the book's value, particularly since they include much of the work that has been done in Europe.

Omissions

Little or no mention is made of ferroresonant amplifier circuits and of other circuits closely related to magnetic amplifiers, such as magnetic pulsers. On the other hand, the circuits in more widespread use are adequately covered. These discussions include various types of servo amplifier circuits, and particularly detailed explanations for the field in which the author is an authority, namely instrumentation circuitry.—ROBERT A. MATHIAS, Associate Engineer, Carnegie Institute of Technology, Pittsburgh, Pa.

Introduction to Ultra-High-Frequency Radio Engineering

By STEPHEN A. KNIGHT. Pittman Publishing Corp., New York, 1954, 256 p., \$4.50.

THE AUTHOR of this small volume describes it as a basic book aimed at an audience whose previous aca-

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NEW BOOKS

(continued)

demetic preparation is midway between that of the serviceman who knows little or nothing about the theoretical aspects of radio and the graduate engineer well grounded in electromagnetic theory. He describes such an audience as including general engineers (radio?), radio amateurs and military radar technicians. The required background for understanding the material is said to be a knowledge of "ordinary radio techniques and their elementary mathematics". The content is not intended to treat any specific application such as television or radar but rather the new techniques of ultrahigh-frequency electronics. Incidentally, the author's definition of ultrahigh frequency embraces all frequencies from 30 to 30,000 mc, a considerably wider band than is commonly accepted as uhf in this country.

Contents

After defining the scope of his subject and pointing out its potential significance to radio engineers, the author launches into a discussion of transmission lines and gives impedance formulas for lines with open, short-circuit and general terminations. Basic formulas for capacitance, inductance, characteristic impedance, power and voltage-standing-wave ratio are introduced. A few elementary problems are worked out.

In chapter 3, some waveguide formulas are given, although not the field equations. The various modes of wave propagation are illustrated and waveguide components such as flanges, irises, probes, bends, horns and radiators discussed. Chapter 4 deals with cavities. The various shapes are sketched and a few basic formulas given. Subsequent chapters discuss uhf oscillators: negative and positive grid triodes, magnetrons and klystrons.

Chapter 6 deals with measurement of frequency, power and impedance at uhf as well as dielectric constant measurements and spectrum analyses. The final two chapters concern radio wave propagation and antennas respectively.

Time Aspects of Book

Basically, this book could have been written at any time since early

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in World War II. Its discursive material is similar to that found in several excellent training manuals written between 1941 and 1946. The formulas given are apparently culled from the standard graduate courses in microwave electronics. Understandably they are introduced without derivation but in some cases the quantities involved in the formulas are inadequately defined and the reader senses a certain amount of discontinuity.

It is unfortunate that the book does not include material on the several very useful impedance charts and calculators that have appeared since World War II. This material together with some vicarious problems might go very well at the end of chapter 1.

Omissions

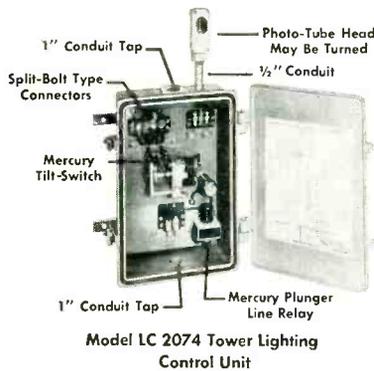
The author might also have included material on automatic frequency control circuits and uhf receivers as these are common to nearly all uhf systems. Noise figure measurements of uhf receivers in particular are receiving much attention today. Devices such as magic tees, hybrid rings and directional couplers could very well have been introduced in chapter 1 or 2, or even in the chapter on uhf measurements.

After noting several omissions such as those mentioned above, it seems indeed surprising that the author has included 12 pages on ground wave and ionospheric propagation—neither of which are particularly important at uhf.

In the portion of the chapter on propagation that does deal with uhf phenomena the author stresses the signal cancellation difficulties arising from passing aircraft but neglects the serious multipath problems arising from topographical features. In this connection mention also has been made of the Fresnel-zone clearance necessary in laying out point-to-point uhf systems. Again, the book would have been strengthened by including a few of the nomographs currently used by many uhf system engineers in siting their stations.

In the final chapter on antennas, the author makes a statement to the effect that grounded half-wave vertical radiators are not used at

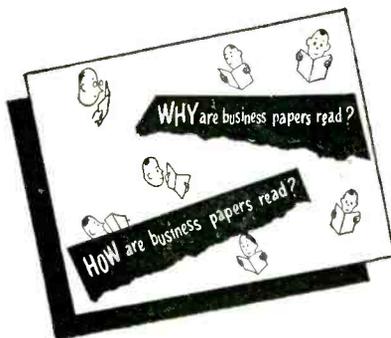
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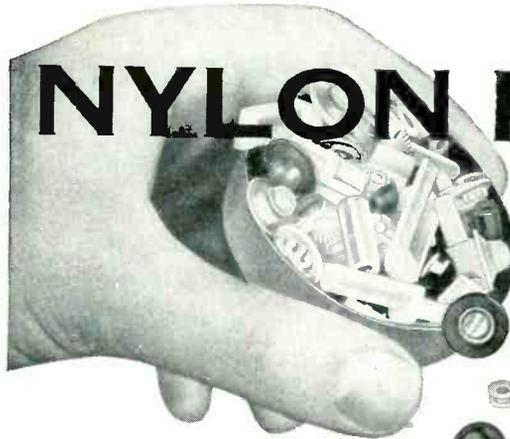
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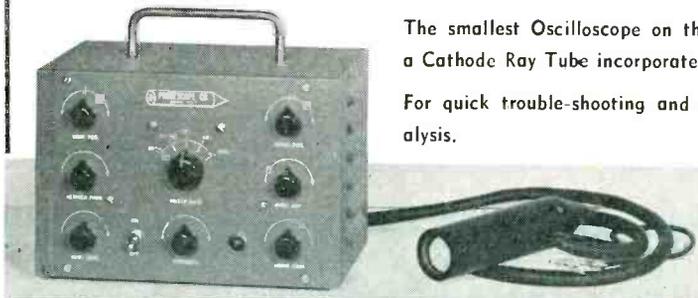
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uhf. Bearing in mind that he is concerned with all frequencies above 30 mc, the author should not have forgotten the very common use of a quarter-wave vertical radiator mounted on counterpoises. —J.M.C.

THUMBNAIL REVIEWS

Table of Gamma Function for Complex Arguments. National Bureau of Standards, Applied Mathematics Series 34, 105 pages, 1954, \$2.00, Government Printing Office, Washington, D. C. Useful in pure and applied mathematics and of special value in the fields of atomic and nuclear research.

Electronic Measuring Instruments. By E. H. W. Banner, Chapman & Hall, Ltd, London, 1954, 395 pages, 45s. Survey of practices cited in the literature as late as 1952.

Experiments in Electronics and Communication Engineering. By E. H. Schulz, L. T. Anderson and R. M. Leger. Second Edition, 1954, Harper & Brothers, New York, N. Y., 342 pages, \$6.00. New edition aimed solely at college level students.

Operations Research in Business and Industry. Midwest Research Institute, Kansas City, Mo., 1954, 185 pages, \$5.00, paperbound. Proceedings of symposium on the subject held in Kansas City April 1954. Analysis and history of operations research, tools required, computational technique, case histories.

Techniques of Plant Maintenance & Engineering—1954. Clapp & Poliak, Inc., New York, N. Y., 291 pages, 1954, \$7.50. Texts of paper by 24 authors, summary of 20 roundtable discussions and direct answers to more than 1,300 questions on current factory maintenance problems.

Effective Radio Ground-Conductivity Measurements in the United States. By R. S. Kirby, J. C. Harman, F. M. Capps, and R. N. Jones, NBS Circular 546, 87 pages, 1954, 65¢; Government Printing Office, Washington 25, D.C. Maps with over 7,000 radials, with provisions for entering new data.

Color TV Dictionary. Rider Publications, New York, N. Y., 70 pages, 1954, \$1.25. Terms originated in NTSC; 263 names and terms and 45 illustrations.

Human Engineering Guide for Equipment Engineers. By Wesley E. Woodson. University of California Press, 1954, 260 pages, large format, paperbound, \$3.50. Information prepared for Bureau of Ships involving design of equipment and workspace and giving the human factors of vision, audition, body measurements and the other factors which enable man and machine to work as a unit. A well-illustrated and most useful book on a subject now recognized as having considerable importance.

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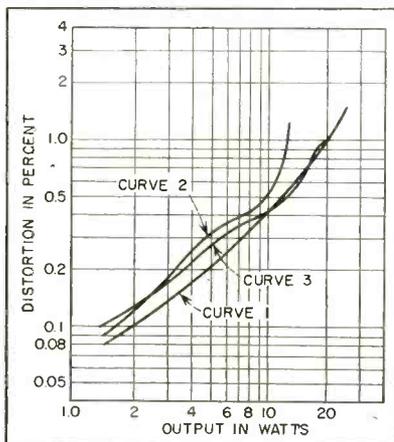
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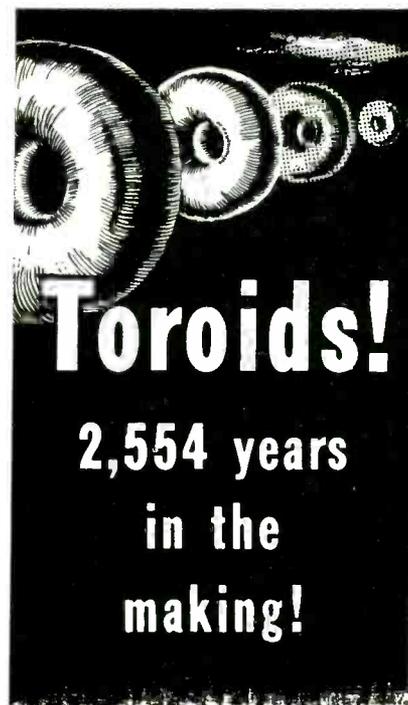
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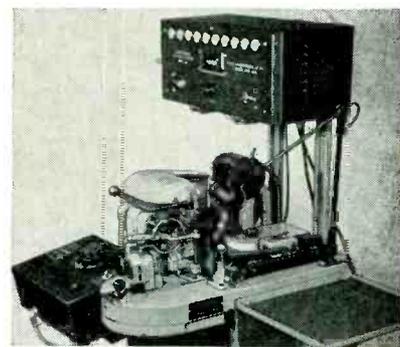
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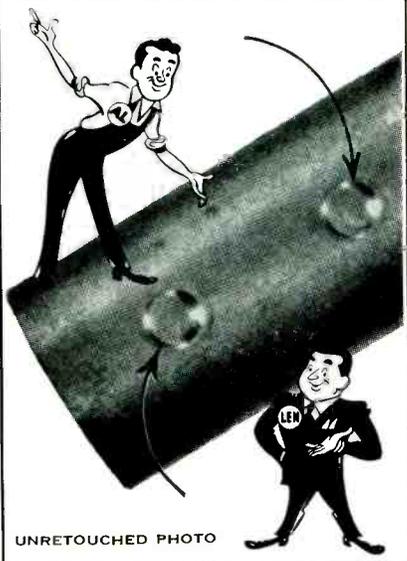
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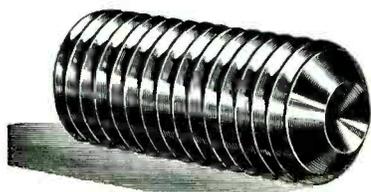
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distortion, and idp when it refers to the percentage.

Medical Electronics and Custom Construction

DEAR SIRS: THE PURPOSE of this "clinical note" is not necessarily intended to discourage one planning to enter this undeveloped field, but to describe a few of the diseases encountered, to list associated symptoms, and, when possible, to suggest a cure . . .

The greatest source of trouble in medical electronics is ignorance. This consists, on the part of the medical man, of the most utter and abysmal ignorance imaginable about devices electronic. Even cook-book directions leave most completely at sea if they involve twisting more than one knob.

Few doctors have even the rudimentary knowledge intelligently to describe what is required of a gadget, and fewer know the meaning of significant figures in describing necessary limits of accuracy or performance.

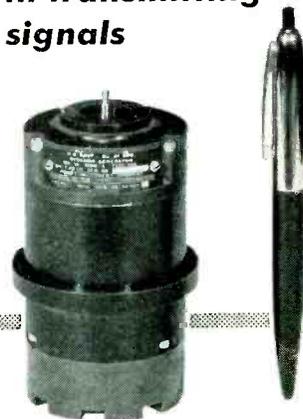
Ignorance on the part of the electronic engineer abides largely in the field of biological phenomena. This includes the important and often ignored fact that seldom does the man who orders the device operate it. He delegates this task to a laboratory technician (medical type), thus leading to second-order ignorance effects and, to the designer, apparently unimportant or illogical complaints about weight, stiff or loose detents and a host of others of similar nature.

A designer-constructor in this field is faced with problems covering frequency ranges from d-c to the cm wavelengths of diathermy, broad-band and selective amplification, computer and pulse techniques and those of measurement of radioactivity from fractions of a microcurie to curie quantities. Add that these instruments must always fail-safe to protect the patient in spite of misuse by untrained personnel and the self-limiting market . . .

Of some problems encountered . . . excellent examples are in electrocardiography. This field began with a string galvanometer attached by

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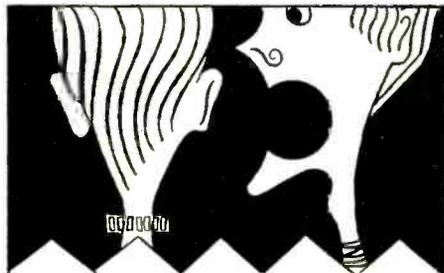
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BACK TALK

(continued)

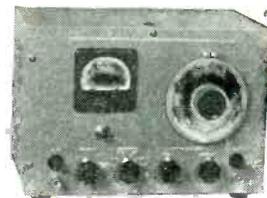
Einthoven to various portions of a patient's anatomy. Currents produced coincidentally with contraction and relaxation of heart muscle were recorded on moving photographic film as deflections of the string. The patterns thus produced were found to be relatively constant in healthy individuals and varied in certain diseases.

One rapidly finds too many exceptions. Fifteen years ago we used only four standard connections or leads. Cardiologists found that in the absence of clinical data they arrived at a correct diagnosis in about 50 percent of cases. Flipping a coin served about as well. So the number of leads has gradually increased to 18 or 22 with others, such as one which is swallowed by the patient, on special order. (If the patient has a healthy gag reflex, use of the esophageal lead may aggravate the heart disease, on rare occasions to the point where the diagnosis is made by the pathologist at autopsy.) The increased number of leads and other factors have raised absolute accuracy to about 70 percent in well-controlled studies.

Engineering-wise there are several problems. Most pressing is the lack of an exact analytical explanation of the observed phenomena. Until this is forthcoming clinical electrocardiography must remain an empirical art. The string galvanometer is cumbersome and the record must be developed in a dark room with all its clutter and bother. This undoubtedly led to the development of the electrical amplifier, direct-writer instrument, producing troubles overlooked by many design engineers.

For instance, the manner of mounting the 'gram on the patient's chart must be changed. Photographic traces are efficiently mounted with dry-mounting paper and a hot iron. No method as satisfactory is available for heat-sensitive direct-writer paper. Amplifiers, to record accurately the low-frequency components of the cardiogram (5-10 cps) must have long time constants, which in the R-C coupled type leads to blocking by switching and other transients. This may be so annoying to the operator as to make an otherwise excellent instrument useless. Direct-

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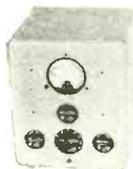
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BACK TALK

(continued)

coupled amplifiers would eliminate this, but substitute the problem of drift.

Adequate critical damping of the galvanometer is simply accomplished by changing string tension. This is not so simple with the more massive heated stylus and is relatively poorly accomplished in most or all of the presently available instruments. No one has tried, to my knowledge, the device long since used by engineers in making phonograph records . . . a second coil on the recording stylus to furnish a damping inverse feedback.

Other imperfections include poor high-frequency response resulting in loss of one diagnostic portion of the trace; leads too short conveniently to attach to a patient in bed; accessibility for repair is usually miserable; and weight is far greater than necessary. Why one such instrument must use nine pounds of alnico magnet when four will do if the coil current is increased slightly remains something of a mystery to me.

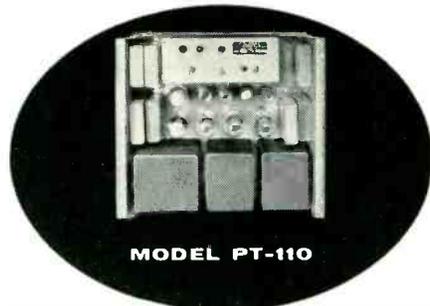
Ballistocardiography . . . defined rather crudely as the study of recoil force imparted to the body by the beating heart, is a particularly poor field for the designer of electromedical apparatus because the meaning of every variable is a subject of contention among medical authorities. It has been demonstrated that the periodicity of the building in which the instrument is located as well as street rumbles may cause ambiguous records.

Whether one should have the patient completely, critically or undamped with reference to the recording device has not been settled, nor have all agreed upon using amplitude changes or acceleration or an integrated combination as a standard vector for recording . . .

Electroencephalography . . . medical users cannot agree on what constitutes an ideal instrument. The exceedingly high-gain, low-frequency amplifiers not too infrequently leave the user uncertain whether the leads were connected when the trace was made. At one time a curious series of traces produced by such an instrument was investigated. Strangely, the device would not produce similar traces for an engineer, but the technician

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Power Input	105-125V 50/400 cps	105-125V 50/400 cps



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	Model PT-111D	Model PT-112
	Dual power unit, each side provides:	
Output Voltage	250-300 V DC	250-300 V DC
Output Current	100-400 ma	150-800 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 8 mv rms	Less than 8 mv rms
Line Voltage	105-125V, 50/400 cps	105-125V 50/400 cps
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was sure all leads were properly connected and the patient correctly grounded. Eventually the trouble was traced to an improper ground and the opening of a new broadcast station near the hospital. The moving-coil writers acted as dynamic loudspeakers, reproducing the program with only slight distortion. When taxed with this observation the operator admitted hearing the broadcast but was understandably reluctant to report that she was hearing voices in the psychiatric ward.

Similar troubles beset the custom designer, with the added feature of inability easily to make even minor changes in design without severe financial loss. A device recently installed in one hospital was required to enable twenty or thirty students simultaneously to listen to a patient's heart-beat. The instructor gave that statement alone for his specification, later adding that there must be no audible inherent noise in the device.

This seemed simple: any audio amplifier, plus a microphone coupled to a stethoscope bell should do. A trial model quickly revealed: headphones with ear-pieces like stethoscopes had to be substituted for those selected to give the apparently necessary illusion of reality; even the best commercial amplifier had to have pads between it and the headphones to drop hum to inaudibility; the only available stethoscope-like headphones had plastic tubing—very noisy when rubbed (which they were, often); flat frequency response was exceedingly undesirable—an ordinary stethoscope cuts off at 2,500 cps; frequencies as low as 5 cycles had to be reproduced since they can be felt if not heard by the ear and constitute an important component of some heart sounds; some method for the instructor to talk as well as listen had to be provided. Even after the other difficulties were surmounted it took three months to teach two instructors to use the device with even moderate success partly because volume controls were labeled "Attenuators", tone controls were labeled "Equalizers", and neither had ever heard of Fletcher and Munson.

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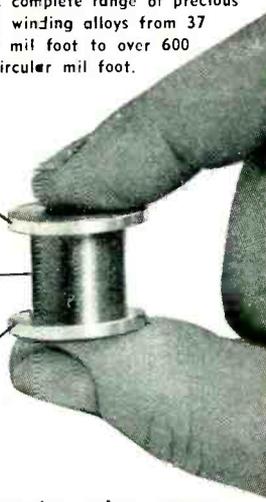
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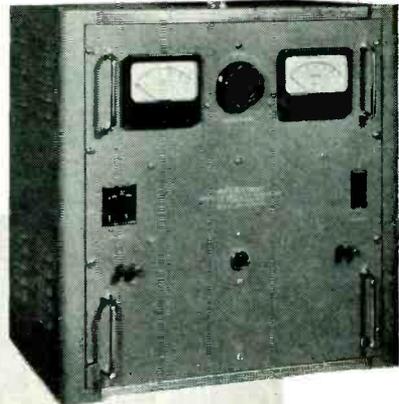
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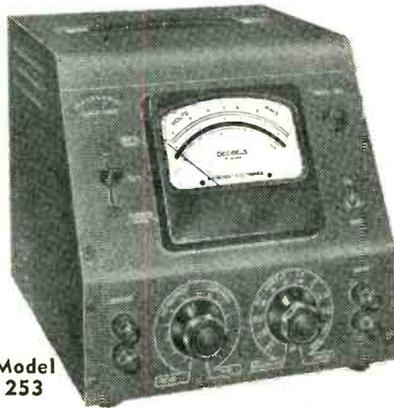
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247 B	.00005-15	10	30%	10C- 50KC	50 Megohms 15 MMF	30000
253	.00015-500	12	30%	5C-300KC	7 Megohms 15 MMF	10000
255	.0005-500	6	10%	10C-1MC	7 Megohms 15 MMF	3000

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the exposed brain at surgery, the neurosurgeon wanted a square-wave generator since he had read that this waveform was the most efficient for his application. Frequency and amplitude were not specified. A brief look at previous work indicated that 60 cps would do and the device was so constructed. Happily it was tried on animals, and worked like magic, except for the fact that aside from stimulation it had the same effect as a soldering iron applied to the brain. So we returned to the more conventional triangle generator of somewhat higher frequency which seems to lack the hot-iron effect.

A polio patient upon whom an electrophrenic respirator was being used complained bitterly of being burned by the electrodes . . . no one had told the floor nurses to use contact paste and to keep it moist with salt solution.

If one must design or manufacture electrical gadgets to be used by doctors he may expect absolute failure of his enterprise if he overlooks the following factors. Even careful attention does not assure success.

Medical personnel not only seldom have any idea how electrical devices (even one so simple as a fluorescent light) work, seldom care, but often are actually afraid of them.

The medical man seldom knows enough to describe a special electrical gadget he wants which makes it rather difficult to design. Furthermore limitations inherent in such instruments are likely to be completely incomprehensible to the ultimate operator.

The more knobs on the panel the less likely will the user be able to make even the best instrument work.

Portable usually means fifteen pounds or less, even if weight reduction adds expense.

All electromedical gear must fail safe.

Be careful that a device contemplated for mass production is not one demanded because of a fad whose popularity is waning.

Medical men never agree on everything and seldom agree on anything.

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VC 12	10 to 20	approx. zero	Quartz	Invar	-55°C to +200°C
VC 1G	.5 to 8	+50 ± 100	Glass	Invar	-55°C to +125°C
VC 3G	.7 to 8	+600 ± 100	Glass	Brass	-55°C to +125°C
VC 4G	1 to 18	+600 ± 100	Glass	Brass	-55°C to +125°C
VC 11G	.7 to 12	+100 ± 50	Glass	Invar	-55°C to +125°C
VC 11GRB	.7 to 10	+750 ± 100	Glass	Brass	-55°C to +125°C
VC 11GRC	.7 to 10	+275 ± 100	Glass	Invar Brass Screw	-55°C to +125°C
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(Continued on opposite page)

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SEMI-CONDUCTORS —Transistors—Circuitry—Advanced Development	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
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AVIATION ELECTRONICS —Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization			M			M			M			
RADAR —Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control			M			M			M			
COMPUTERS (ANALOG AND DIGITAL) —Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms			M			M			M			
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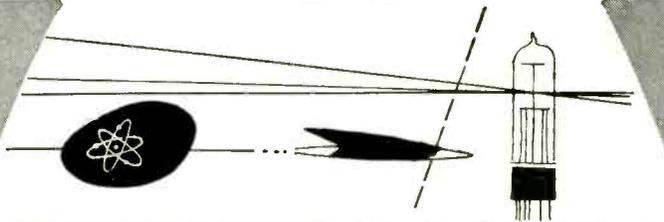
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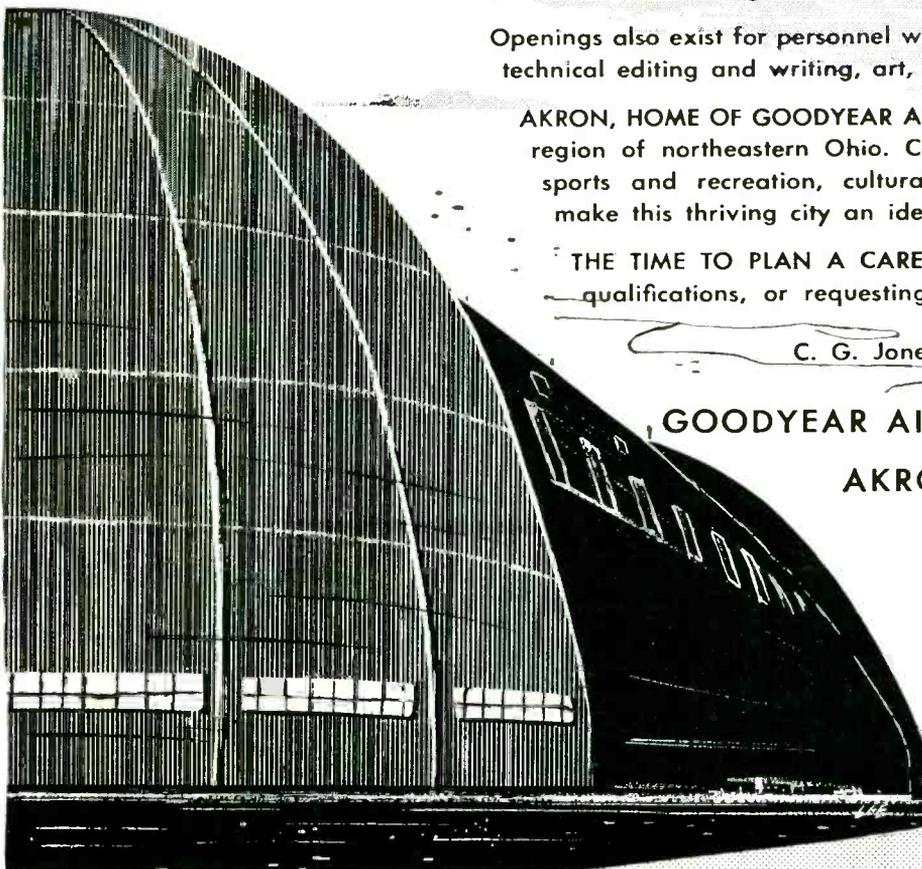
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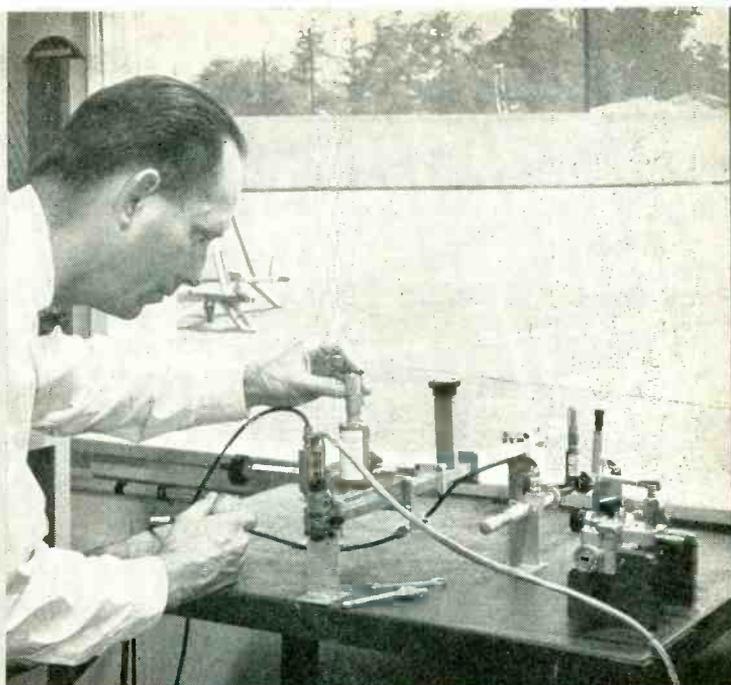
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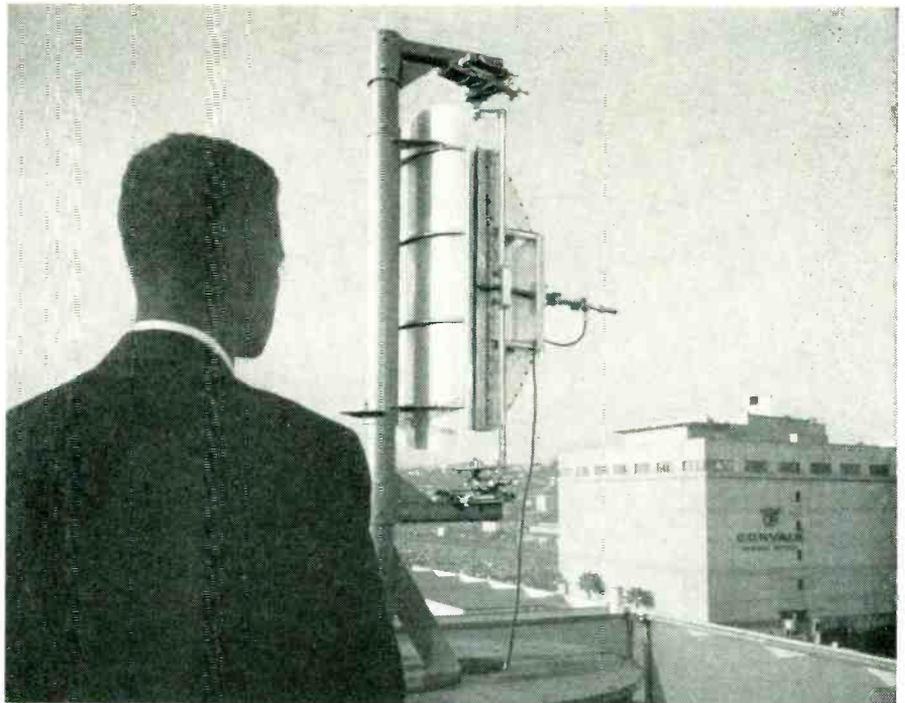
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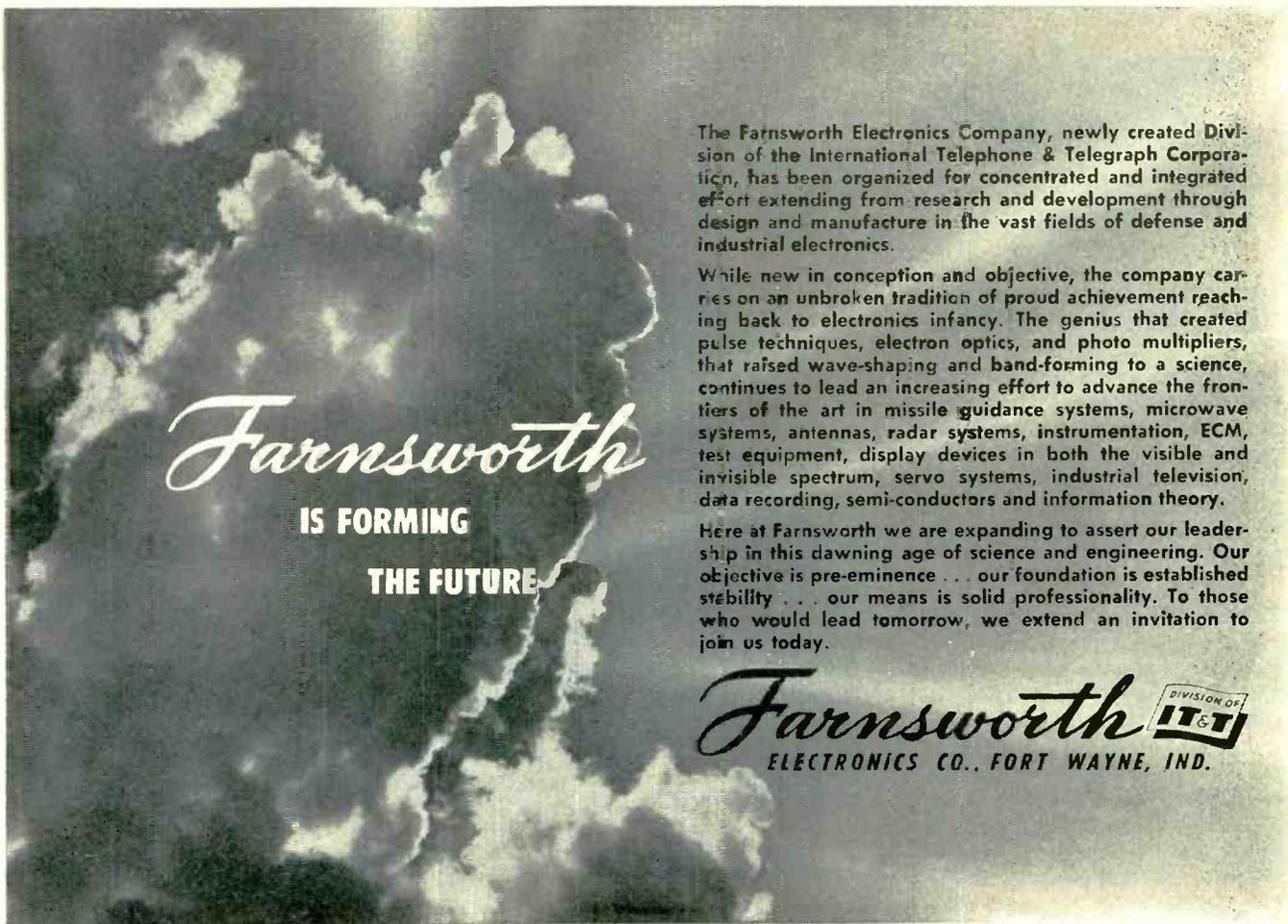
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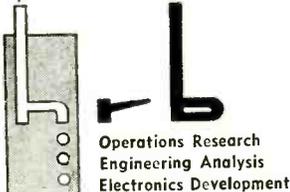
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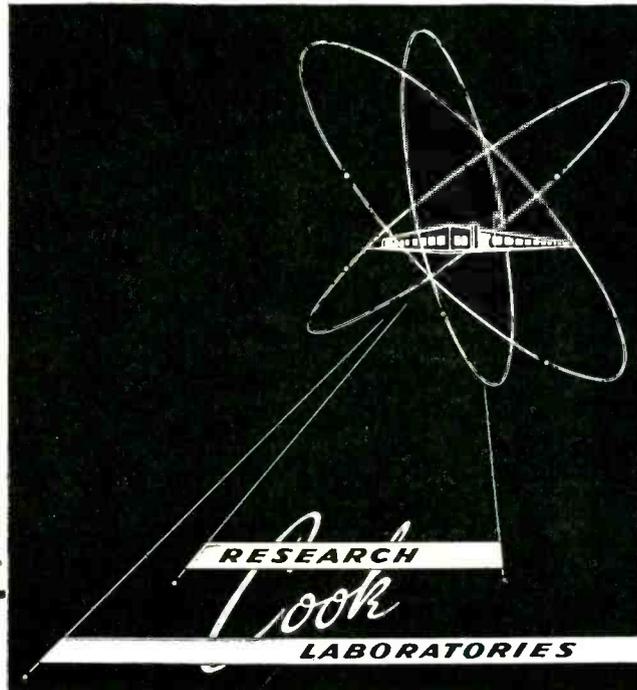
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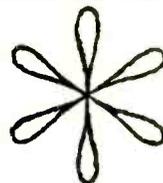
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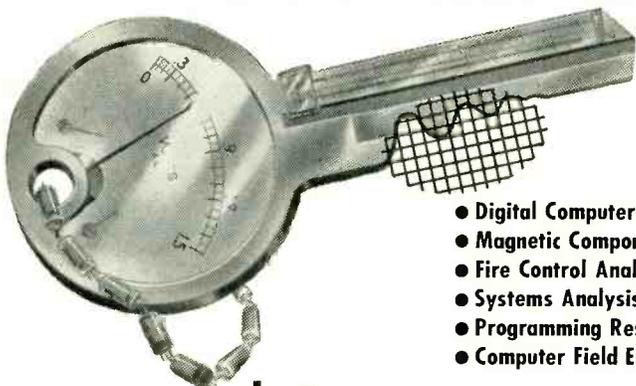
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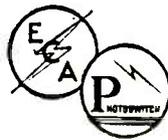
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WESTINGHOUSE

you can be SURE . . .

Of Excellent Living Conditions . . . Of Professional Progress

DESIGNERS: Micro-wave, TV pickup, and receiving tubes; solid state devices and traveling-wave tubes.

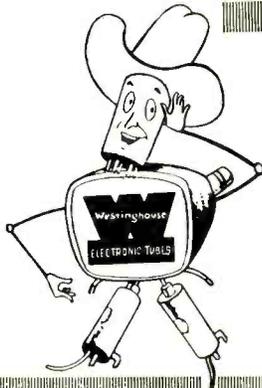
APPLICATION ENGRS: Circuit experience helpful in radio, TV, VHF, and semi-conductors.

PRODUCT ENGRS: Knowledge and/or exp. in cathode design and fabrication of magnetrons and klystrons.

Recent graduates in Electrical, Chemical and Mechanical Engineering, Physics, Chemistry & Metallurgy are also urged to apply. Expenses paid if invited to Elmira for interview. Send Resume:

WESTINGHOUSE ELECTRONIC TUBE DIVISION

P. O. Box 284, Elmira, New York



TUBE ENGINEERS

Research Or
Development For
SYLVANIA

2 TO 5 YEARS—

Experience in tube development. Minimum BS Degree in Physics or EC—PhD in Electronics-Physics acceptable in lieu of experience.

Many engineers are needed for Sylvania's expanding tube research and development program in the laboratories at either Key Gardens or Bayside, Long Island. Knowledge of electromagnetic theory and electron dynamics essential. Experience in microwave phenomena especially desirable.

Relocation expenses will be paid by Sylvania.

Please forward resume to:
E. W. DOTY
MANAGER OF PERSONNEL

RESEARCH LABORATORIES
SYLVANIA
ELECTRIC PRODUCTS, INC.
Bayside, Long Island

ALL INQUIRIES WILL BE
ANSWERED WITHIN 2 WEEKS

ELECTRONIC ENGINEERS

Technical Operations, Inc., is looking for an electronic engineer with three to five years of experience, capable of supplying original ideas in the fields of transistor circuitry and operations research instrumentation. Join an expanding research and development organization located in suburban Boston. Please send complete resume and requirements to:

R. R. SMYTH

Technical Operations, Inc.

6 Schouler Court

Arlington 74, Mass.

AUTOMATIC TEST EQUIPMENT ENGINEERS

Graduate electronic engineers with two to four years experience to supervise design of electronic test equipment for TV receivers and government electronic equipment. Emphasis on automatic testing techniques. Openings at Stromberg-Carlson provide solid growth opportunities for capable engineers interested in this expanding field. Substantial employee benefits. Community noted for fine schools, cultural and recreational facilities.

Send resumes to: **H. P. Field**
Manager of Test Equipment Engineering Department
Radio-Television Division
Stromberg-Carlson Company
Rochester 3, New York

ENGINEERS & PHYSICISTS

LAYOUT SYSTEM DESIGN
FIELD INVESTIGATIONS
ORDNANCE SYSTEMS
EVALUATION
SYSTEMS & CIRCUIT
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Permanent positions in the Vitro Laboratories for career-minded men providing challenging assignments in missiles, radar, sonar, fire control and ordnance systems.

This modern laboratory provides a professional environment in a quiet residential community accessible to metropolitan New York City. Please submit resumes to Personnel Dept.

VITRO LABORATORIES

Division of Vitro Corporation of America
200 Pleasant Valley Way, West Orange, N. J.

ENGINEERS

Countermeasures
Systems
• Radar Servo

BACKGROUND: Responsible positions open for top level development and project engineers with practical and research experience in:

Advanced Electronic Circuits
and Systems
Microwave Radar
Microwave Receivers
and Transmitters



Requirements emphasize advanced analytical and/or management experience on highly complex electronic and electro-mechanical systems.

Kindly send resume and salary requirements to

The W.L. MAXSON CORP.
460 W. 34th ST., NEW YORK 1, N.Y.

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Unique opportunity to get in on ground floor of young successful company applying atomic energy to industrial uses (non-government).

Graduate engineers are needed in two major functions: sales and applications engineering, and development and design engineering. Rapid expansion of company offers promotion opportunities found in few organizations. Only men with top academic and work records who desire and are capable of hard work and rapid promotion will be considered.

INDUSTRIAL NUCLEONICS CORP.
1205 Chesapeake Ave., Columbus 12, Ohio

A leader in Nuclear Instrumentation and Automation Equipment.

AMPLIFIER UNIT MAGNETIC

Mfr. Pioneer Instrument Type
12071-1-A;
110 volts;
400 cycles;
26 volts;
400 cycles;
4 tube
(12AH7-GT);
take-off for four
autosyns . . .



\$29.95 ea.

TELEGON OSCILLATOR

Input: 115 volts, 60 cycle
Output: 26.5 volts, 400 cycle
3-watts @ 250 ohm load
Ideal for
laboratory use
. . . approx.
10" x 7" x 8",
wt. 16 lbs. . .



\$29.95

PIONEER TORQUE UNITS

Type 12602-1-A. Includes CK 5 Servo motor coupled to output shaft thru
125:1 gear reduction train.
Output shaft coupled to
autosyn follow-up (AY-43).
Ratio of output shaft to
follow-up autosyn is 30:1.
Includes base mounting
type cover for motor and
gear train . . .



\$34.95 ea.

TRANSTAT 100 AMP

Voltage Regulator

Prim: 115 VAC; 60 cycle;
11.5 KVA; Sec: 0-115
VAC; 60 cycle;
100 amp.
Max. MFD.
Amerron.



Only \$125.00

TELECHRON SYNCHRONOUS MOTOR

Type BC; 110 Volt; 60 Cycle; 60 RPM;
with
mounting
bracket . . .



\$3.95 ea.

AUTOSYN MOTORS

Mfr. Bendix Type 851; 32 volts AC;
60 cycle; single phase; Size: 3/4"
1. x 2 3/8" dia. 1/8" shaft . . .



\$19.95 pr.

MINIATURIZED SELSYN

Mfr. Henschel Corp.; 115 volts;
60 cycle; .22 amp. Type "N"
Indicator Motor with dampener.
Bras encased. Approx. size: 2 1/4"
dia. x 3 1/2" length . . .



\$19.95 pr.



INVERTERS

PIONEER 12126-2-A
Output: 26 volts; 3 phase; 400 cycle;
10 VA; .6 PF Input: 27.5 volts DC;
1.25 amps . . . \$24.50

DMF2506M
CONTINENTAL ELECTRIC
23-30 volts input; 5.5-4.5 amps; cont.
duty. Output: 115 volts; 44 amps; 400
cyc; 1 phase; PF 1.0; 50 watts \$39.50

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-phase.
115 VA; 75 PF. Input: 28.5 VDC; 12
amps. . . \$39.50

PIONEER 12117
Output: 26 volts; 400 cycles, 6 volt
amperes, 1 phase. Input: 24 VDC; 1
amp. . . \$19.95

ALTERNATOR, CARTER
Mfd. Carter Motor Co.; Output: 7
VAC; 9.7 amp; 650 cycles, and 295
VDC; 200 amps. Input: 26.5 VDC; 10.5
amps. 6500 rpm. . . \$29.50

PE 218 LELAND ELECTRIC
Output: 115 VAC; Single Phase PF
90; 380/500 cycle; 1500 VA. Input:
25-28 VDC; 92 amps; 8000 rpm; Exc.
Volts 27.5 BRAND NEW . . . \$39.95

PE 109 LELAND ELECTRIC
Output: 115 VAC; 400 cyc; single
phase; 1.53 amp; 8000 rpm; Input:
13.5 VDC; 29 amp. . . \$65.00

MG153 HOLTZER-CABOT
Input: 24 VDC; 52 amps. Output: 115
volts—400 cycles, 3-phase, 750 VA and
26 volt—400 cycle, 250 VA. Voltage
and frequency regulated. . . \$95.00

PIONEER 12130-3B
Output: 125.5 VAC; 1.5 amps, 400
cycles single phase. 141 VA. Input: 20-
30 VDC; 18-12 amps. Voltage and fre-
quency regulated. . . \$69.50

12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single
phase; 45 amp. Input: 24 VDC, 5 amp.
\$39.95

10285 LELAND ELECTRIC
Output: 115 volts AC, 750 VA, 3 phase,
400 cycle, .90 PF and 26 volts, 50 VA,
single phase, 400 cycle, .40 PF. Input:
27.5 VDC, 60 amps, cont. duty, 6000
rpm. Voltage and frequency regulated.
\$59.50

10486 LELAND ELECTRIC
Output: 115 VAC; 400 cycles; 3-phase;
175 VA; .80 PF. Input: 27.5 DC; 12.5
amps; cont. duty. . . \$90.60

PIONEER 10042-1-A
DC input 14 volts; output: 115 volts;
400 cycle, 1-phase; 50 watt . . . \$39.50

10339 LELAND ELECTRIC
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



SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, ap-
proximately 4" dia. x 6" long. Mfd. by
Diehl and Bendix

QUANTITIES AVAILABLE
REPEATERS . . . \$20.00 ea.
TRANSMITTERS . . . \$20.00 ea.

SYNCHROS

GENERAL ELECTRIC MOD. 2J15M1;
115-57.5 volts, 400 cycle. . . \$22.50
KOLLSMAN AUTOSYN MTR. TYPE-
403; 32 VAC; 60 cycle; single phase. . . \$9.95

BENDIX AUTOSYN MTR. TYPE-801;
32 VAC; 60 cycle, single phase. . . \$9.95
MICROSYN UNIT TYPE IC-000-A.
\$15.00

IF SPECIAL REPEATER; 115 volt-
400 cycle . . . \$13.00
21F3 GENERATOR; 115 volt-400
cycle . . . \$10.60

5C7 CONTROL TRANSFORMER; 90-
50 volt; 60 cycle . . . \$45.00
5F MOTOR; 115-90 volt; 60 cycle
\$45.00

5SDG DIFFERENTIAL GENER-
ATOR; 90-94 volts; 400 cycle. . . \$30.00
BENDIX TRANSMITTER TYPE C-
78248; 115 volt; 60 cycle. . . \$22.50

DIFFERENTIAL TYPE C-78249; 115
volt; 60 cycle. . . \$5.00
BENDIX REPEATER TYPE C-78410;
115 volt; 60 cycle. . . \$37.50

REPEATER, AC SYNCHRONOUS;
115 volt; 60 cycle. . . \$9.95
DIEHL REPEATER TYPE FJE 22-2;
115 volt; 400 cycle; secondary 90 volt.
\$27.50

5G GENERATOR; 115/90 volt; 60
cycle . . . \$45.00
7G SYNCHRO GENERATOR; 115/90
volt; 60 cycle. . . \$75.00
6G SYNCHRO GENERATOR; 115/90
volt; 60 cycle. . . \$60.00

60G SYNCHRO DIFFERENTIAL
GENERATOR; 90/90 volt; 60 cycle.
\$50.00
2J5FI SELSYN CONTROL TRANS-
FORMER; 105/55 volts; 60 cycle
\$22.50

2J5SHAI SELSYN GENERATOR;
115/105 volts; 60 cycle. . . \$50.00
2J1FI GENERATOR; 115/57.5 volts;
400 cycle . . . \$12.00

2J1HI DIFFERENTIAL GENER-
ATOR; 57.5/37.5 volt; 400 cycle \$12.50
2J1G1 CONTROL TRANSFORMER;
57.5/57.5 volts; 400 cycle . . . \$7.50
2J5HI SELSYN GENERATOR; Mfr.
G.E.; 115/105 volts, 60 cycle. . . \$27.50

KOLLSMAN TYPE NO. 999-0411

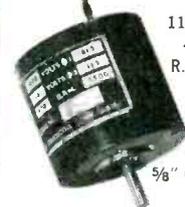


2-phase, 26 volt, 400
cycle. Size: 1 3/4" dia.,
2-5/32" long.
Shaft size: 1/8"
dia., 7/16"
long. 1" O.D.
index ring.

\$22.50 ea.

TRANSICOIL CORP. TYPE 2900

115 volt, single phase
400 cycle.
115 volt, 2-phase,
400 cycle, 5500
R.P.M. Size: 1 1/2"
dia., 2" long.
Shaft size:
1/8" dia.,
9/16" long.
5/8" O.D. index ring.



\$22.50 ea.

INDUCTION MOTOR, KOLLSMAN

TYPE 1515B-0410
26 volt, 400 cycle, 2-phase.
Size: 1-1/64" long;
15/16" dia.
Shaft size: 1/8" dia.



\$25.00 ea.

TELETORQUE AUTOSYN, MFG. KOLLSMAN TYPE 1377-0410

26 volt, 400 cycles.
Size: 1-31/32" long,
1-7/16" dia. Shaft
size: 1/8" dia.,
9/32" long;
1/2" O.D.
index ring.



\$15.00 ea.

PIONEER INSTRUMENT TYPE 10047-2-A

26 volts, 2-phase, 400 cycle.



\$17.50 ea.

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MATION ON OUR COMPLETE
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Type	Price	Type	Price	Type	Price	Type	Price
1A7GT	.42	1LD5	.50	6B8G	.29	6F8G	.38
1H5GT	.38	1S4	.38	6C6	.38	6G6G	.45
1G6GT	.45	6AC7	.68	6C8G	.38	6H6	.38
1D8GT	.55	6AK5	.63	6D6	.45	6J5GT	.35
1LA6	.55	6B7	.69	6F5	.28		

This is just a sample. We have thousands of other types of Receiving, Transmitting, Magnetrons, Klystrons and Rectifiers. Come to us for any kind, whether standard or special, made by Western Electric, RCA, Sylvania, General Electric, Hytron, Raytheon, and others. We also carry Micro Wave Test Equipment for S, X, and K bands.

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER



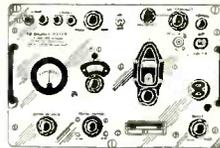
Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles. Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

NEW UNUSED SURPLUS TS 259 K BAND 23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW

TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

Hard-to-get X-Band Now Available



Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube.

\$990

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TS1K1/SE	TS34/AP	TS100	TS270	SURPLUS EQUIP. APA10 APA39 APS 3 APS 4 APR4 APR5A APT2-APTS
TS3A/AP	TS35/AP	TS102A/AP	TS171/AP	
RF4/AP	TS36/AP	TS105	TS175/AP	
TS12/AP	I-96A	TS110/AP	TS225	
TS13/AP	TS45	TS125/AP	TS239A-TS239C	
TS14/AP	TS47/APR	TS126/AP	TF890/1	
TS33/AP	TS69/AP	TS147	834	

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K21 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

You Can Reach Us on
TWXNY1-3235

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80
Large quantity of Polystyrene beaded coaxial cable.

Minimum Order 25 Dollars



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Cables: TELSERUP

New Sola Const. Volt. Transformers

Input 95-125VAC, output 115VAC 60 cycle
165VA, \$24.95, 225VA \$32.95, 310VA \$42.50,
500VA (115V out) \$47.50, Raytheon 120VA (115V
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Primary, 240/220/200 VAC 60 cycles 1 Phase secondary
131OVCT@850 Ma. \$19.95.

Filament Transformer

Primary, 115VAC 60 cycles 1 Phase, dual secondary
2.2V@18 amps each, \$3.95.

1% Wire Wound Precision Resistors

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Kirby 1285

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0-5 MA DC Gruen G.W. 508	\$3.50 ea
0-80 MA DC Marion MR25W 80 DC MA	3.50
0-300 MA DC G.E. DW 55	4.95
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0-300 Volts DC Sun 2 AP 380	4.95
0-150 Volts AC Hickok MR 26150 ACV	4.95
0-300 VAC Triplett Metal Case 232	4.95

3 1/2" ROUND PANEL METERS

0-10 VDC G.E. 100 ohms/Volt DO 41	5.95
0-50 MA DC Weston 301	6.50
0-150 MA DC Weston 301	6.50
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0-3 Amp AC Weston 476	7.50
0-5 Amp Simpson 57 3" sq	5.00

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WOrth 4-8216-7

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LEACH



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MIN. AIRCRAFT

RELAYS



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WESTON TYPE 705 SENSITROL



Operation is as follows: The stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact. This contact then draws movable contact and holds it firmly. Perfect contact is assured and chattering is eliminated. Contacts remain closed until reset. Accuracy in general may be considered as within 5% of the range. Operates directly from a photocell or a group of thermocouples. Net weight 14 oz.

#R561
Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts: "Twin-tacts", Capacity 100 ma at 110 volts; Nickel plated, Brass cover; Weston Model 705 Type 6 #R56018.75
10 for \$170.00

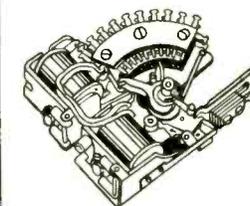
Same as #R560 but with glass face; Weston Model 705 Type 6 #R56119.75
10 for \$180.00

Single contact (Normally Open), Solenoid Reset; Sensitivity: 10 Microamperes; Reset coil: 6-24 V DC or 24 V AC; Contact: "Twin-tact"; capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R52317.75
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Same as #R523 with Brass Cover Weston Model 705 Type 4 #R523N16.75
10 for \$150.00

Production Quantities Available.
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STEPPING SWITCHES



Mfg by Western Electric, Automatic Electric Sales
Minor Switch
10 steps and off
Single Level;
Contacts: Gold plated brass;
Bridging Wiper;
Operating Voltage: 6.0 to 12.0 V. DC

Resistance:
Oper. Coil 6 ohm; Reset Coil 9 ohm; Net Weight: 1 lb.; W.E. Type SS5 #R96011.95
10 for \$100.00



Mfg. by Western Electric Co., Automatic Electric Sales; 22 step; 5 levels; Bridging Wipers; Contacts: Gold plated brass; Operating Voltage: 5.5 to 12 V. DC; Coil Resistance: 4.0 ohm; Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz. SS6 #R92614.75
10 for \$120.00

Mfg by Western Electric Co., Automatic Electric Sales; 44 step; 2 levels; Bridging Wipers; Contacts: Gold plated brass; Operating Voltage: 5.5 to 12 V. DC; Coil Resistance: 4.4 ohm; Interrupter Switch: 1 Break-Make; Net Weight: 1 lb. 14 oz. SS7 #R92714.75
10 for \$120.00

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Universal general corp.

COMMUNICATIONS EQUIPMENT CO.



MT 36/TA2J
Low frequency antenna loading unit for TA-24 transmitter. May be used with any medium-band xmtr. Contains 24 VDC. band-change motor, antenna relay, R.F. ammeter 0-3A, variable coils, Hi-current mica capacitors, 250V. An ideal antenna tuner. Brand new. **\$32.50**

SPECIALS

Hydrophone, MODEL MI-2. A lattice of 3 crystals in a disk-like structure; 17-37 Kc. High imp. \$27.50
AN/CRW-3A Remote control receiver, for operating target planes, etc. New, with soundproof mtg. box. \$34.50
TEL. REPEATER, EE 89, complete with tubes and test manual. \$17.50
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F.T.&R. 101-A, Two-wire applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems. \$47.50
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RA-74 Power Supply for Super Pro. 69.50
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J-22/ARC-5 Junction Box 3.49
Blasting Galvanometer with silver chloride cells in portable leather case. New \$27.90
T-21 Artillery Microphone complete with preamp. tube, Condenser type. \$24.50

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Stock	Description	Price
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CH-113	2.5H/700 MA, 2.5 KV Test.	5.75
CH-044	8.5H/350 MA, 3.5 KV Test.	6.35
CH-291	0.14/42 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-119	8.5H/125 MA	2.79
CH-69-1	Dual 120H/17 MA	2.35
CH-8-35	2.5H/380 MA/25 Ohms	1.79
CH-76	1.2H/130 MA/75 Ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15 MA—850 ohms DCR	1.75
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 KV INS.	29.95

PE 204 VIBROPACK



input 12VDC/0.58 Amp. Out: 2X4.3V/50MA, 2X45 VDC/0.5MA, 2X85VDC/5 MA. New. Complete with Spare Vibrator. Well Shielded and Portable. Shown with cover removed. **\$475**

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical, 300-3300 MC. Type N Feed \$8.95
 Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4 1/2" x 3". New. \$100.00
 Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector. \$14.50
AS14A/AP, 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors. \$4.50
AS46A/APG-4 Yagi Antenna, 5 element array. \$22.50
30" Parabolic Reflector Spun Aluminum dish. \$4.85
AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit \$37.50
TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable. \$125.00
AN-154-3 vertical dipoles working against a rectangular mesh approx. 3"x4". Freq. 140-200 mc. with latching switch (115v, 60 cy) and portable statted crate. Extremely rugged. \$27.95
LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc. \$32.50

DYNAMOTORS

TYPE	INPUT		OUTPUT		Price
	VOLTS	AMPS	VOLTS	AMPS	
35X-059	19	3.8	405	.095	54.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM 33A	28	7	540	.250	3.95
B-19	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
DA-3A*	28	10	500	.050	6.95
			300	.260	
			14.5	.010	
PE 73 CM	28	19	1000	.350	22.50
BD 69†	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

† Used, Excellent. * Replacement for PE 94.
 PE 94-C, Brand New 6.95

D.C. RELAYS*



CR2792B116A3
SPST—50 Amp Contacts. Operates from 22-30 VDC. Coil Res. 200 Ohms. Completely enclosed in transparent plastic case, which may be removed for adjustments. **\$1.59**

GE #CR2791B116W3
Same as above, except additional terminal brought out from contact arm. **\$1.74**

GE #CR2791-F100D3
Differential; DPST, Norm. open. Dual coil, 1500 ohms per coil — 25 Ma. Operating Current. Contacts: 20 Amp. **\$2.25**

GE#CR2791F100G3
Same as above, except has extra I/A contact. Rated 5 Amp. **\$2.35**

GE#CR2791-D101F3
All Ceramic Insulation, DPDT, Coil — 12VDC, 100 Ohms DCR. Contacts designed for fast operation. Rated at 5 Amps. **\$1.25**

GE#CR2791B106J3
SPDT, 5 Amp contacts. Coil rated 22-30VDC. 150 Ohms DCR. Contacts are designed for fast operation, and enclosed by clear plastic cover. **\$1.35**

GE#CR2791B106C3
SPDT, Dual Contacts will handle 20 Amps. Coil: 18-28VDC 125 Ohms DCR. **\$1.25**

*THESE RELAYS AVAILABLE IN MFRS. QUANTITIES

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent. \$18.75
 PE-218H: Input: 25/28 vdc, 92 amp. Output 115V 350/500 cy 1500 Volt-ampere. NEW. \$37.50
 PE206: input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amp. Dim. 13 x 5 1/2 x 10 1/2. New. \$22.50
 EICOR—ML 3011-5, Input: 13.75V/18.4A. Output: 115 V/400 , 3φ, 0.95 PF. New. \$85
 PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400 , 1φ, 2500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. \$69.50

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc center frequency. Bandwidth 2.5 Mc. gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector. A.F.C. Strip Included. Input impedance: 50 Ohms. Less tubes. \$27.50
 Model APS-4: Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95db at Bandwidth of 2.7 Mc. New, less tubes. \$27.50

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms # 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC. \$2.50
 D-167332 Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC. \$1.35
 D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F. P.M. 2.5%, 1 Watt. \$1.35
 D-166228 Disk Type 7120 Ohms @ 60° F. 4220 Ohms @ 80° F. 2590 Ohms @ 100° F., 1640 Ohms @ 120° F. \$1.35

H. V. Transformer



PRI: 115V/60 ~ 1φ. SEC: 4500V / .005A, 650 VCT/175A, 5V/3.8A, 5V/3.8A, 6.3V/10A, 2.5V/3A (9500V, RMS TEST) Size: 7"x7"x 5 1/4" D. **\$7.45**

POWER TRANSFORMERS

COMBINATION—115V/60 ~ INPUT

CT-133	150-0-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	17.79
CT-312	290-0-290V/90MA, 5VCT/3A, 6.3VCT/2.5A	3.25
CT-127	900V/25MA PK, 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/0.18V, 2.5V/5A/17,800 V. Test.	29.50
CT-013	450-0-450V @ 200MA, 10V/1.5A, 2.5, 3.5A 5V/3A	4.35
CT-403	650VCT/0.26A 5V/3A	2.75
CT-931	885VCT 086A 5V/3A, 6.3V/6A	4.25
CT-929	4200V/0.01A, 2.5V/2A, 6.3VCT/6A	5.35

PLATE—115V/60 ~ INPUT

PT 034	125V/45MA (For Preamp)	\$1.15
PT 157	660-0-660VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC.	8.70
PT 159	900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC.	10.00
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300 MADC.	25.50
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC.	33.00
PT 371	210V-0-210V AT 2 1/2 Amp.	9.45
PT 333	3140V/1570V, 2.36KVA	105.00
PT 801	22,000V/234 MA, 5.35 KVA.	135.00
PT 521	7500V/.06A, Half-Wave	85.00
PT 913	2500V/12 MA H'SLD	4.95
PT 12A	280VCT/1.2A	3.95
PT-38-2	37.5V/40V AT 750 MA.	2.15

FILAMENT—115V/60 ~ INPUT

FT-140	5VCT @ 10A 25KV Test.	\$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP.	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

MAGNETRONS

Type	Peak Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345-9405	50		\$8.75
2J22	3267-3333	265		7.50
2J26	2992-3019	275	.002	7.49
2J27	2965-2992	275	.002	13.50
2J29	2914-2939	275	.002	44.95
2J31	2820-2860	285	.002	21.50
2J32	2780-2820	285	.002	21.50
2J38*	3249-3263	5		8.50
2J39	3267-3333	5		8.50
2J48	9310-9320	50	8.7	24.50
2J49	9000-9160	50	.001	54.50
2J56*	9215-9275	50	.001	132.50
2J62†	2914-3010	35	.002	32.50
J31	24-27KMC	50	.001	85.00
4J34	2740-2780	900	.001	87.50
4J38	3550-3600	750	.001	125.00
4J42†	670 730	30	.003	169.50
5J23	1044-1056	475	.001	49.50
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
QK259†	2700-2900	800	.001	249.50
QK60†	2840-3005	.100	CW	65.00
QK61†	2975-3170	.100	CW	65.00
QK62†	3135-3350	.100	CW	85.00

†—Packaged with magnet.
 †—Tunable over indicated range.



CORY INTERLOCKS

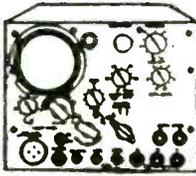
Type B986, Safety Type, with Lock and Key (as shown) Contacts rated 20 Amp. Dspst. Play Safe at the **\$2.85**
 Type #C1—Same as Above, but with Double Lock and 2 Keys. Both Locks must be Operated Before Switch Operates. **\$3.95**

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulsar delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of .001. Input requires 115V, 400-2400 Cycles, 1 phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Rect'd. Brand New. Complete with schematic and all tubes. \$375.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P.O.

131 Liberty St., New York 7, N. Y. Dept. E-1 Chas. Rosen Phone: Dlgby 9-4124



PANADAPTER and SCOPE AN/APA-10

A combined Panoramic Adapter and Oscilloscope. Has 3 coax input connectors for feeding in from receivers having I.F. of 455kc., 5.2 mc or 30mc. Designed also to be used as regular oscilloscope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc.

Complete with 21 tubes including 3" CRT scope tube. For operation on 115V. 400 Cy. Price.....\$99.50 For operation on 115V. 60 Cy. Price.....\$145.00

SPECIAL OFFER!

AN/APA-10 TECH. MANUAL, 80 pages. Postpaid in U.S.A. Price \$2.75

TS-47/APR Test Oscillator



Covers 40-500 Mc in 2 ranges. Harmonics above 2000 Mc. A calibrated (dial accuracy ± 0.7%) I.F. source for testing receiving Output 3MW or more to 400 Mc, less on harmonics. C.W., mod. pulse or sine wave output. 115/230 60 Cy. or batteries. New with inst. book.

SPECIAL \$149.50

FLUXMETER



Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1 1/4". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12 1/2 x 9 x 6 in. Ideal for lab and school use. New.

Special..... **\$17.95**

NEW REPAIR PARTS

For BC 348

MODELS H, K, L, R, ONLY

- Main Tuning Capacitor..... \$ 2.00
- 1st I-F Transformer Assembly..... 2.00
- 2nd I-F Transformer Assembly..... 2.00
- 3rd I-F Transformer Assembly..... 2.00
- 4th I-F Transformer Assembly..... 2.00
- Crystal Filter Assembly..... 6.50
- C. W. Oscillator Assembly..... 2.00
- 915 kc Crystal mounted..... 2.75
- Antenna Unit Assembly..... 12.50
- R. F. Unit Assembly..... 12.50
- Resistor: Volume Control..... 2.75
- Knob for Main Tuning Condenser..... .50
- Band #1 Coils—per set of 6..... 3.00
- Band #2 Coils—per set of 4..... 2.00
- Band #3 Coils—per set of 4..... 2.00
- Band #4 Coils—per set of 4..... 2.00
- Band #5 Coils—per set of 4..... 2.00
- Band #6 Coils—per set of 4..... 2.00
- Complete dial assembly..... \$16.50

RADAR ANTENNAS

- SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New..... \$279.50
- SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases..... \$149.50
- SO-13 (10CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New..... \$89.50

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in this ad. New less tubes..... \$29.50

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts	Price
.001	50 KV	\$22.50
.01	5 KV	1.29
.021	8 KV	2.65
.021H	20 KV	9.75
.025	50 KV	26.50
.05-.05	3 KV	95
.1	4.5 KV	3.50
.135	7.5 KV	6.95
.2	50 KV	39.50
.25	15 KV	15.50
.25	20 KV	17.50
.25	50 KV	44.50
1.	7.5 KV	6.95
1.	15 KV	39.75
2.	5.5 KV	9.50
2.	6 KV	12.50



SPECIAL \$6.95

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26 V DC at 4 amps. New..... \$295.00
 Onan MG-0-75. Navy type PU/11. Input 115/230, 60 cy., 1 Ph., Output: 115, 480 cy., 1 Ph., 5.3 amps, and 26 VDC @ 3.8 Amps. New..... \$225.00
 Leland Elec. Co. 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., 1.5KVA. New..... \$32.50
 G.E. 5AS131J11A. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New..... \$89.50

DYNAMOTORS

Navy type CA10-21444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps, or 13VDC at 40 amps. Radio filtered and complete with line switch. New..... \$89.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60VDC at 8.3 Amps. Field 27.5VDC 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
 Dumore Co. type ELBG. 24 VDC, 40-1 gear ratio. For type B-4 Intervalometer. New..... \$2.75

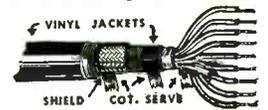
AMPLIDYNES

5AM21J17. 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

RA38 RECTIFIER

Variable output 0-15000 V DC @ 500 MA. Input 115V 60 cy., 1 ph. Size 63 x 53 x 56 in. Write for detailed information.

9 CONDUCTOR CABLE



Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels. Price \$.10 ft. Sample 100 ft Coil. \$10.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

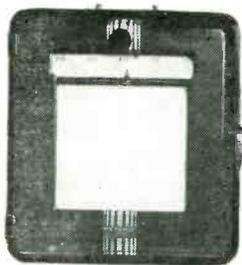
PHONE: DEERFIELD 7-0044

ELECTRONICRAFT INC.

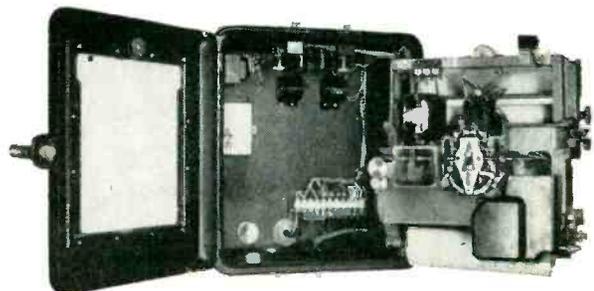
Cable Address: Electcraft, N.Y.

27 MILBURN ST. BRONXVILLE 8, N. Y.

SURPLUS—SAVE! SAVE! MICROMAX RECORDERS



For fast and sensitive recording or controlling one or more points throughout a wide variety of processes. Used originally for temp. ranges of 350-550 Degrees cent. but may be changed for other applications by suitable control units. Control units not incl. with instrument. Used but guaranteed to satisfy or money back.



Price - - \$89.50

BAILEY METER RECORDER, as pictured, used and guaranteed \$65.00

All mdse. guaranteed to satisfy or money back if returned prepaid.

ESSE RADIO COMPANY

42 W. South Street

Indianapolis 25, Ind.

SPECIAL PURPOSE TUBES

OA2..... .75	3B24W..... 5.75	9LP7..... .1.75	FG-258A/ 5553..... 132.50	715A..... .2.00	956..... .35
OA3/VR75 .75	3B25..... .2.50	9MP7..... .7.50	264C..... .3.00	715B..... .5.00	957..... .35
OA5..... .3.50	3B26..... .3.25	10Y..... .25	267B..... .6.00	715C..... 12.50	958A..... .50
OB2..... .75	3B28..... .3.00	12A6..... .25	271A..... .7.50	717A..... .75	959..... 1.25
OB3/VR90 .75	3C23..... .4.00	12GP7..... 15.00	272A..... .5.00	719A..... 10.00	991/NE-16. 35
OC3/VR105 .75	3C24/24G. 1.50	12J5WGT. 2.50	274A..... .4.75	721A..... .1.00	CK-1005... 25
OD3/VR150 .50	3C45..... .6.00	12L8GT... .50	274B..... .75	722A..... .1.50	CK-1006... 1.00
C1B..... .2.00	3D21A..... 6.00	LM-15.... 250.00	275A..... .5.00	723A/B... 10.00	R-1100.... 5.00
1B22..... .1.00	3D22..... 9.75	15E..... .1.50	276A..... .3.75	724B..... .75	R1130B/ 1B59.... 10.00
1B23..... .3.75	3DP1A..... 7.50	15R..... .25	282A..... .5.00	725A..... .7.50	1500T.... 75.00
1B24..... .4.50	3E29..... .9.00	FG-17/5557 3.00	283A..... .3.50	726A..... 10.00	1603..... 4.00
1B27..... .8.75	3EP1..... .1.50	RK-19..... .1.50	286A..... .6.00	726B..... 30.00	1611..... 2.50
1B32..... .1.00	3FP7A..... 5.00	RK-20A... 12.50	304TH..... 6.00	726C..... 30.00	1612..... 1.50
1B35..... .4.75	3GP1..... .2.50	RK-21..... .1.00	304TL..... 5.00	728AY-GY 10.00	1613..... .75
1B42..... .6.00	3HP7..... .3.00	RX-21..... .5.75	305A..... .3.50	730A..... 10.00	1614..... 1.50
1C21..... .1.50	3KP1..... .7.25	PJ-22..... .1.75	307A/ RK-75... 1.00	801A..... .25	1616..... .50
1P23..... .1.50	4-65A... 12.50	RK-23..... .3.00	310A..... .2.75	802..... .3.00	1619..... .25
1P24..... .1.50	4AP10... 3.75	HK-24..... 3.50	311A..... .5.00	803..... .1.50	1622..... 1.50
1P30..... .2.75	4B21..... 6.50	FG-27A... 4.50	313C..... .2.00	804..... 12.50	805..... 2.75
1P36..... .2.50	4B26..... 3.50	28D7..... .75	316A..... .50	806..... 15.00	807..... 1.00
1V5..... .1.50	4B27..... 3.50	28D7W... 2.00	323A..... 10.00	808..... 1.00	809..... 2.75
1Z2..... .2.00	4B31..... 25.00	TWIN 30... 10.00	323B..... .5.00	810..... 10.00	811..... 2.50
VG-2..... 10.00	4C22/ HF-100... 7.50	FG-32/5558 7.25	327A..... .3.50	811A..... 3.50	812..... 2.50
2AP1..... .5.00	4C27/CV-92 5.00	FG-33/ 5720... 11.50	328A..... .3.75	813..... 10.00	814..... 2.00
2C21/1642. 50	4C35..... 15.00	GL-34..... .2.00	329A..... .7.50	815..... 1.00	822..... 15.00
2C22/7193. 25	4E27..... 12.00	35TG..... .5.75	348A..... .4.50	826..... .50	828..... 8.75
2C26A..... .50	4J34..... 25.00	VC-50..... .5.00	349A..... .7.50	829..... 5.75	829B... 9.00
2C33/ RX-233A 1.25	4J35..... 75.00	FP-54/ 5740... 44.00	350A..... .3.50	832..... 4.00	832A... 6.00
2C34/RK-34 .25	4J42..... 35.00	HK-54..... 3.50	350B..... .3.50	833A... 35.00	834..... 7.50
2C39A..... .9.00	5AP1..... 2.50	RK-60/1641 1.75	352A..... 15.00	835..... 15.00	836..... 3.00
2C40..... .6.50	5B21..... 4.75	RK-62..... 1.75	353A..... .5.00	837..... .75	838..... 1.50
2C43..... 12.00	5BP1..... .2.00	RK-65/ 5D23... 7.50	354A..... 15.00	842..... 2.50	843..... .25
2C44..... .50	5BP2A... 5.00	FG-67/ 5728... 10.00	355A..... 15.00	845..... 7.50	845W... 10.00
2D21..... .1.00	5BP4..... .2.00	RK-73..... .75	368AS... 4.00	846..... 125.00	849..... 10.00
2E22..... .1.50	5C22..... 30.00	75T..... .5.00	371A..... .75	850..... 10.00	851..... 25.00
2E24..... .2.25	5C30/C5B. 1.75	75TL..... .6.00	F-375A... 15.00	860..... 3.00	861..... 10.00
2E26..... .3.25	5CP1..... 3.75	FG-81A... 9.00	388A..... .1.00	866A... 1.00	868/PJ-23 2.00
2J21A..... 3.50	5D21..... 7.50	FG-95/ 5560... 14.00	393A..... .7.00	869B... 25.00	872A... 1.00
2J22..... .3.00	5FP7..... .1.00	C-100D... 2.00	394A..... .2.00	874..... .75	876..... 1.00
2J26..... .4.75	5FP14... 5.00	100TH... 5.75	WL-417A. 5.00	884..... 1.00	885..... 1.35
2J27..... .6.00	5GP1..... 5.00	FG-105... 17.50	GL-434A. 5.00	902P1... 5.00	917..... 2.25
2J29..... 25.00	5J23..... 25.00	RX-120... 15.00	446A..... .75	918..... 1.75	920..... 2.50
2J30..... 50.00	5J29..... 7.50	VT-127A. 2.50	446B... 3.25	922..... 1.00	923..... 1.00
2J31..... 20.00	5J30..... 15.00	F-128A... 50.00	450TL... 45.00	925..... 1.75	927..... 1.50
2J32..... 15.00	5J32..... 25.00	HK-154... 3.00	WL-460... 10.00	931A... 3.00	954..... .25
2J33..... 15.00	5JP1... 12.50	VT-158... 15.00	464A... 3.00	955..... .35	
2J34..... 15.00	5JP2... 7.50	FG-172... 20.00	WL-468... 15.00		
2J36..... 50.00	5JP4... 7.50	FG-190... 3.50	SS-501... 7.25		
2J37..... 9.00	5JP5A... 7.50	HF-200... 9.50	CK-510AX 1.25		
2J38..... 8.00	5LP1... 9.75	C-202... 10.00	527..... 15.00		
2J39..... 6.00	5R4GY... 1.00	2 3Z..... 5.00	WL-530... 10.00		
2J40..... 25.00	C6A..... 10.00	204A..... 5.00	WL-531... 4.50		
2J50..... 35.00	C6F..... 10.00	205B..... .50	559..... .75		
2J55..... 50.00	C6J..... 5.00	207..... 40.00	575A... 15.00		
2J56..... 75.00	C6L/5528. 7.50	211..... .75	WL-579B 12.50		
2J61..... 20.00	6AC7W... 1.75	212E... 25.00	KU-610... 10.00		
2J62..... 10.00	6AJ5..... 1.00	217A... 2.00	HY-615... .50		
2J-B51... 2.00	6AJ6... 2.50	WL-218... 25.00	WL-632A 15.00		
2K25... 12.50	6AN5... 2.50	220C... 182.50	WL-670A 8.75		
2K33A... 60.00	6AR6... 3.00	221A... 75	686... 25.00		
2K41... 90.00	6BM6... 35.00	225R... 50.00	701A... 2.00		
2K54... 25.00	6C21... 15.00	249B... 3.00	702A-B... 1.00		
2K55... 15.00	6G4/ X-102B... 2.50	250R... 5.00	703A... 1.75		
2P21 (Image Orthon) 250.00	6J4..... 4.00	250T... 17.50	704A... .75		
	6L6GAY... 1.50	250TL... 15.00	705A... .75		
2X2/879... .25	6Q5G... 3.25	251A... 35.00	706AY-GY 20.00		
2X2A... 1.00	6SB7Y... 1.00	252A... 15.00	707A... 3.50		
3A4..... .50	6SC7GT... 2.00	253A... 3.50	707B... 4.75		
3A5..... .50	6SK7Y... .50	257A... 2.00	708A... 1.00		
3AP1... 5.00	7BP7... 1.00		709A... 1.50		
3B22... 1.50	7C29... 65.00		713A... .50		
3BP1... 2.00	7CP1... 15.00		714AY... 17.50		
3B24... 2.00	9GP7... 3.75				

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1B26	1.50	5J32	16.00	471A	2.00	5646	7.00	5851	6.00	1N34	.80
1B35	7.50	5R4WGY	3.75	532	3.25	5647	7.00	5879	1.40	1N34A	.75
1B35A	7.50	CSB	2.35	700A/B/C/D	7.50	5651	1.70	5881	2.95	1N35	2.30
1B42	1.50	5L1WA	1.50	701A	3.75	5651WA	5.50	5886	4.00	1N38	1.75
1B63A	35.00	6AQ5W	2.00	702A	1.50	5652	6.00	5902	8.00	1N38A	.95
1P28	7.50	6AL5W	1.10	705A	1.00	5653	1.10	5910	.75	1N44	1.10

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1Z2	2.75	6A56W	2.35	CK722	4.40	5696	1.75	5937	33.50	1N48	.65
2C33	1.95	6A57G	3.25	222A	1.25	5702	3.50	5967	1.20	1N51	.50
2C39A	17.00	6D	2.15	800	3.00	5702WA	5.00	5964	1.35	1N52	1.30
2C40	9.50	6F4	3.25	832A	3.00	5703WA	5.25	5985	4.00	1N54	.75
2C46	15.00	6L6WGA	8.50	837	.90	5704	1.90	5986	2.50	1N55	1.45
2C51	3.95	9C24	400.00	865	.75	5718	3.55	6007	2.00	1N55A	4.30
2C53	13.25	9P7	.25	CK1030	75.00	5719	2.50	6021	6.00	1N58A	1.10
2D21W	2.00	24C	.95	1620	4.20	5726	1.75	6074	3.75	1N58A	1.80
2E24	1.50	25T	6.50	1654	4.00	5744WA	5.00	6080WA	5.00	1N63	1.80
2E30	1.50	25A7GT	3.50	2050	1.00	5749	1.50	6082	3.25	1N64	.65
2J21	3.50	FG27A	11.00	2907	.90	5750	2.50	6095	1.50	1N69	.80
2J21A	3.50	29D7	.90	5628	26.00	5751	2.00	6097	1.90	1N70	2.40
2J22	3.50	35T	8.00	5629	21.00	5763	1.10	6098	1.90	1N75	.85
2J26	5.75	35T	8.00	5639	5.00	5784WA	7.50	6101	1.50	1N75	2.50
2J37	11.00	35TG	4.50	5639	5.50	5784WA	7.50	6110	11.00	1N81	1.95
2J40	25.00	100R	15.00	5641	3.00	5814	1.75	6111	7.50	1N81	1.50
2J51	250.00	F123A	6.25	5638	7.50	5814A	1.75	6112	7.50	1N82	2.50
2J62	15.00	211	.75	5641	7.50	5814A	1.75	6113	1.25	1N93	3.50
2K25	17.50	215A	2.25	5643	8.00	5823	1.00	6136	2.00	1N110	1.05
2K28	25.00	249C	7.00	5644	11.50	5829	2.20	6146	6.55	1N113	2.40
2K33A	47.50	250YL	17.50					6201	3.75	1N112	1.90
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CP68B5FF503V .05MFD-.05MFD 600 WVDC	.35	WVDC	.30		
CP26A1E504M .5MFD 600 WVDC	.20	CM70B472J 4700MFD-3000	.30		
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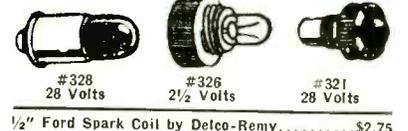
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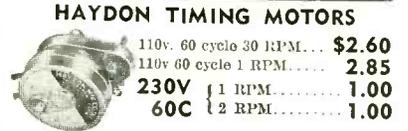
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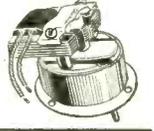


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3J30.....99.50
3K23.....149.50
3K27.....175.00
3K30.....199.50
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282B.....3.00

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Complete with all five Tuning Units, covering the range 38 to 4,000 Mc.; wideband discosc and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.
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Self-contained automatic unit reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code practice signals to one or more persons at speeds from 5 to 25 W.P.M. **BRAND NEW** in original carton. **\$18.95**



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Low Prices!

Type	Input	Output	Used	BRAND NEW
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DM-42A	14V 46A	515/1030/2/8 MA 215/260	12.95	16.95
DM-42A	28V 23A	515/1030/2/8 MA 215/260	29.50
DM-32A	28V 1.1A	250V .05A	2.95	7.50
DM-34D	12V 2.8A	220V .080A	11.95	.....
DM-35D	12.5V 18.7A	625V .225A	9.95	.....
DM-36	28V 1.4A	220V .080A	9.95	.....
DM-37	25.5V 9.2A	625V .225A	12.95	.....
DM-28	28V	224V .07A	1.95	4.95
DM-53A	28V 1.4A	220V .080A	2.95	6.95
DM-33A	28V 5A	575V .16A	.....	3.95
	28V 7A	540V .25A	1.95	3.95
PE-73C	28V 20A	1000V .350A	9.50	12.50
PE-101C	13V 12.6A	400V .135A	.....	3.75
	26V 6.3A	9VAC 1.12A	3.75	4.85
PE-94A	28V 10A	300V .200A	.....	3.95
		150V .101A	3.95	7.50
PE-94C	26V 10A	300V .200A	.....	7.95
		150V .101A	7.95	12.75
PE-103	6V	500V .160A	.....	24.50
	12V	500V .160A	24.50	39.50
PE-98	14V 21A	300V .200A	.....	32.50
		150V .101A	22.50	32.50
PE-36	28V 1.25A	250V .060A	2.95	5.24
PE-135AX with filter	24V 12A	500V .200A	24.95
BD-77	12V	1000V .350A	16.50	22.50

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PE-206 Inverter. Leland. Input: 28V DC @ 38A. Output: 500V 800cyc. 80VA. 1ph. **BRAND NEW** \$11.50

PE-204A Sig. Corp Power Supply. Made by Radiart. **BRAND NEW** \$3.24

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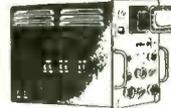


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FINE QUALITY
NAVIGATIONAL
EQUIPMENT

Determine exact geographic position of your boat or plane! Complete, BRAND NEW installation consists of: 1D-6B/APN-4 Indicator; R-9B/APN-4 Receiver; PE-206 Inverter; Set of Plugs; Visor for Indicator; Operation manual; Brand New, Export packed. **COMPLETE \$129.50**

R-65/APN-9 LORAN Receiver-Indicator



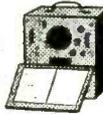
Furnishes position data at greater distances from transmitting stations than is possible by any other methods. Accurate to within 1% of distance from ground transmitters. Operates entirely by radio. Complete in one case. **BRAND NEW** export packed. **\$295.00**

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Model	Description	Excellent Used	BRAND NEW
T-17	Carbon hand mike	\$5.45	\$7.95
T-30	Carbon Throat Mike	.33	.69
T-45	Navy Lip Mike	1.95	5.95
RS-38		.....	1.25
T-24	Carbon mike	.....	3.95

BC-221 FREQ. METER

Limited quantity, first come first served! Range 125 to 20,000Kc with crystal check points in all ranges. Complete with tubes, crystal, calibration charts. Excellent condition. **\$129.50**



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Model	Description	Excellent Used	BRAND NEW
HS-23	high impedance	\$2.25	\$4.35
HS-33	low impedance	1.79	4.65
HS-30	low imp. (featherfoot)	1.49	1.85
H-16/U	high imp. (2 units)	2.75	7.95
CD-307A	cards. PL35 plus and JK26 Jack83

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0-15 Amps 3 1/4" scale. 75 divisions. Plastic case 4 1/2" x 5 1/4" x 2 1/4". Test clip leads plus black metal carrying case with cover. **Brand new. \$3.99**
Value \$25



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Shpg. wt. 25 lbs.

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Cond.



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Type	Excellent Cond.	BRAND NEW	Type	Excellent Cond.	BRAND NEW
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15 Amp. Hour Rating Navy Standard Black Rubber Case, **BRAND NEW** **\$5.95**



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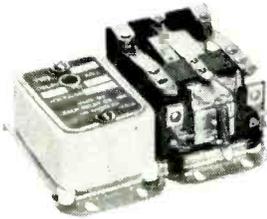
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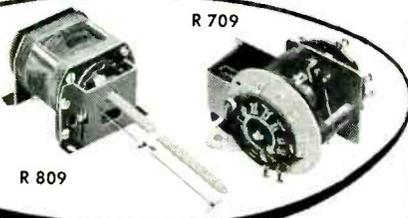
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Lab. precision pots 2 3/4" dia. W.W. 20K	1.25
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AN/CPN-6, 17 RADAR BEACONS
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AN/TRC-1
 70-100 mc point to point VHF radiotelephone equip. This is a frequency modulated 50 watts point to point radio trans. and receiver set to be used as a communication channel in mountain country where a land wire is impractical, or where temporary operation is desired such as a construction project. The range is approx. 60 miles line of sight. The set is completely portable and operates from 110v 60 cyc. POR.

AN/TRC-7
 100-156 mc. portable crystal controlled 2 channel walkie-talkie battery operated. POR.

AN/ARN-6 RADIO COMPASS
 This is a very compact light weight automatic radio compass covering 100 KC to 1750 KC in 4 bands. All components are miniaturized including the loop for use in high speed aircraft. Complete sets and components are available. Input 110 Volts 400 cyc. and 28 Volts DC. POR.

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RC-115B 75 MC BEACON
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 Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

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SCR-682 A RADAR
 10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225KW, pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

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 Multiple echo equipment. This set will pick up signals from a ground search radar and re-transmit them making the plane carrying it look like an entire fleet of planes on the ground radarPOR

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- TS-101/AP
- TS-125/AP
- TS-173/UR
- TS-278
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SN—RADAR—10 cm—Compact, light and portable, ranges of 5 and 20 miles. Uses 5CPI scope. Operation is from 115 volts, 60 cycle, but we can supply converter for dc operation. . . . \$750.00 ea

ANTENNA ASSEMBLY—10 cm RADAR—Reflector is a lightweight parabolic cylinder, Ass'y has both manual and motor drive. Ideal unit for labs, classroom demonstration, small craft, etc. \$99.50 ea

MAG—10 cm. remarkable link radar, portable, operated from 6 volt battery, uses folding antenna and tripod. A pair at \$1,750.00

APS-3—3 cm—Airborne radar for search and homing, 5-in scope. 10 brand new sets at . . \$700.00 ea

APQ-13—Very late model airborne radar set, complete and new. One only at \$2,950.00

SCR-545—Complete radar set, less vehicle, antenna and power plant, pretty fair condition. sold as-is at \$1,375.00

TEST SETS

TS-35A/AP—(Late Model) X-Band Signal Generator and Power Meter—Input 115/1/50-1200 CPS. Generates and measures RF power. Produces (CW or pulsed, int. or ext. synchronized) signal of known frequency and power. Generates FM signal for trouble shooting radar. NEW. . . . \$375.00

TS-69/AP Frequency Meter, Range 340-1,000 mcs. Uses 0-200 microammeter; Excellent. . . . \$75.00

TS-100/AP Test Scope with type A, R, J and X Indications. Gated and ungated sweeps, int. or ext. triggering \$125.00

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 Details on Any
 Particular
 Item in Which
 You are
 Interested

393 Greenwich St., New York 13, N. Y.
 BEEKMAN 3-6510 Cable: COMPRADIO, N. Y.

Wholesale, Industrial and Institutional Sales Only

These are partial listings only of our stock. Please write for other types.

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- ARB
- ARC-1
- ARC-3
- ARC-4
- ARC-5
- AR-88
- CR-91
- SLR
- RAK
- RAL
- RAO
- RBB
- RBO
- RBG
- RBL
- RBA
- RBM
- RCH
- BC-224
- BC-312
- BC-314
- BC-344
- BC-348

AND SPARE PARTS

FIELD EQUIPMENT

- SCR-274
- 300
- 399
- 536
- 808
- 828
- BC-191
- 654
- 603
- 604
- 610E
- 683
- 684
- 923
- 924
- 1000
- 1306

AND SPARE PARTS

FOR SALE

2 Each, UHF Radio Noise and Field Strength Meter, Measurements Corp. Model 58 with Accessories.

1 Each, Field Intensity Meter with Accessories RCA Type 308A.

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 L & M Micromax Recorders.

INSTRUMENT SERVICE CO.

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When you WANT or OFFER

- EMPLOYMENT
- EQUIPMENT
(Used or Surplus New)
- PRODUCTS
to manufacture
- CAPITAL
- INDUSTRIAL PROPERTY

USE THE SEARCHLIGHT SECTION

● RATES:

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UNDISPLAYED RATE: \$1.80 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

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BOX NUMBERS if used count as one additional line.

Searchlight Section closes January 3, 1955 for February issue

"SEARCHLIGHT" IS LOW-COST NATIONAL CLASSIFIED ADVERTISING

"TAB" THAT'S A BUY

CIRCUIT BREAKERS

Hamamann Magn. Hkrs. Amps:
 1228 5, 7, 9, 12, 30, 40, 80, 180
 1500 5, 7, 9, 12, 30, 40, 80, 180
 2000 5, 7, 9, 12, 30, 40, 80, 180
 3000 5, 7, 9, 12, 30, 40, 80, 180
 4000 5, 7, 9, 12, 30, 40, 80, 180
 5000 5, 7, 9, 12, 30, 40, 80, 180
 6000 5, 7, 9, 12, 30, 40, 80, 180
 7000 5, 7, 9, 12, 30, 40, 80, 180
 8000 5, 7, 9, 12, 30, 40, 80, 180
 9000 5, 7, 9, 12, 30, 40, 80, 180
 10000 5, 7, 9, 12, 30, 40, 80, 180

TRANSFORMERS

ALL 115V 60 CYC INPUT
 2800V/20MA, 3.3V, 6A, 2.5V/17.5A
 4/BC412 Recept. Replmt. 2 for \$7.98
 1600VCT/5MA, 6.3VCT/3A, 0.3
 CVT/10A 3.0VCT/5A, \$7.95
 900V/35MA, 2X2.5V/2A, Xelnt
 1800V PBLR T/W 0.2X2 P/L
 WNDGS \$1.98
 776V/200MA, 5V/3A, 8.3VCT/5A
 THORDA/BSON \$4.88; 2 for \$9; 5 for \$24
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 FILTER PARTS 4 scope, \$3.69; 2 for \$6.00
 700VCT/10MA, 5VCT/1A, 6.3VCT/2A, \$3.25
 600V/50MA, 6V/3A, 6V/1.5A, 5V/1A HALF
 BEELIE \$2.43; 2 for \$4.50; 10 for \$20.00
 550VCT/30MA, 5V/2A, 8.3VCT/2.5A, 12.8V/1
 3.5A CSD RKA \$4.50; 2 for \$8.00
 420VCT/30MA, 6.3V/1.5A, W/INPUTS 6, 12, 24
 54.15VDC, 4.1A & 28.5VDC, 1.5A \$1.45
 2X330VCT/10MA, 1/2CH WNDG \$1.39
 42V/1 Amp, 6.3V/6A \$2.98 @ 2 for \$5

OIL CONDENSER BUY

4 MFD \$1.65 ea.
 lots of 3
 Case Dimension: Not incl. Insulators,
 3 1/2" H, 1 1/2" W, 5/16" D. \$1.79 ea.
 10MFD/600VDC Spec. \$1.98

MERCURY THERMO REGULATOR

DUAL CKT, 105° F & 32° F. Extremely sensitive
 & accurate for Research, Fire Prev., Freeze
 Pt Control, Brand New w/data & ckt.
 En. 98c; 12 for \$10.00

MICA CONDENSERS

File	MFD	WVDC	Price
B	.01	500	55c; 100/\$53
B	.01	1000	40c; 100/\$36
B	.002	1200	25c; 100/\$25
A	.002	2500	30c; 100/\$36
A	.001	1200	20c; 100/\$18
C	.0001	8100	\$1.39; 100/\$125

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV .79 10 for \$5.00
 2.5 MEG "MVT" 5W 7.5KV .89 10 for 7.00
 7 MEG "MVP" 1W 10KV .135 10 for 12.00
 12 MEG "MVP" 1W 10KV .135 10 for 15.00
 50 MEG "MVP" 25W 40KV 2.75 10 for 25.00
 100 MEG "MVP" 10W 10KV 2.25 10 for 20.00

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Image Converter Tube Hi-Sensitivity
 Image amplified 100x dia. 1/2" dia.
 Williams screen—Resolution up
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 1800VDC/35MA, Using Doublers
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 Rotary Switches, Ass'd 12 @ 95% .6 ea .85
 * All Popular Values and Sizes

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Tremendous Bargain Prices
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 \$1.89 Free 240 cy. \$3.98; 3 for \$10
 R10S1 S'Dunn SPST/115VAC/6-30
 ACT \$1.49
 R11AC2 Allied BJ DPDT/115VDC/5A CTS \$1.39
 R12AC3 Allied BJ DPDT/6VDC/5A CTS \$1.49
 R14AU1 J.P.D.T. & P.N.O./10VDC/10A CTS \$2.25
 R18LE2 Lensw/DPST/70VDC/10A CTS \$1.49

NEW IMPORTED AC-DC VOM

MODEL 12C
 \$9.35 ea
 Lots of 3
 Sold Singly \$9.89
 (Plus 40c ea. Ship in USA)

Hi-Accuracy Precision Pocket VOM, 1000 Ohms per V, Read 1/4" D. 4 1/4" W. Test Leads 4' 250 MA, AO & DC Volts: 0 to 25, 250 & 1000V DCMA; 0 to 1, 10, 100 MA Ohms: 0 to 10K & 100K Size 1 1/4" D. 4 1/4" W. Test Leads 4' 250 MA, MODEL T5 52 Small Precision Built Pocket VOM, 1000 Ohms per V, Ranges AC & DC Volts: 0-10, 250 & 500V, DCMA: 0-1 & 250 MA, Ohms: 0-100k Measures only 2 1/2" D. 4 1/4" W. Test Leads Singly \$6.89 (plus 40c ship in USA)

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 2X0.31MFD/2800V \$2.49; 6 for \$12.50
 2X0.44MFD/2800V \$2.49; 6 for \$12.50
 2X0.76MFD/2400V \$2.96; 6 for \$18.00
 2X0.85MFD/2000V \$2.96; 6 for \$18.00
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ENGINEERED FOR INDUSTRIAL USE
 "TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN Specs. Write for catalog.
 * FULL WAVE BRIDGE

Wtr	18VAC	36VAC	72VAC	130VAC	144VAC	264VAC	Ctr Tap	3 Phase Bridge
Amp	14VDC	28VDC	56VDC	100VDC	118VDC	217VDC	AC/DC	740VAC
1	5.15	5.25	5.40	5.70	5.12	5.22	5.10	\$14.90
2	2.00	2.75	6.00	9.25	15.75	28.85	0	15.90
3	2.25	4.15	7.80	12.90	20.00	36.95	0	18.90
4	3.50	6.50	14.50	22.00	26.75	38.85	2.95	18.90
6	4.10	8.00	17.50	29.95	34.75	54.85	7.25	20.90
8	5.95	11.50	25.00	41.50	44.75	84.85	4.75	36.90
12	7.50	14.50	30.00	44.50	54.75	99.85	5.95	41.90
20	12.00	23.00	43.00	72.00	82.75	160.85	7.95	50.90
24	14.50	28.00	52.00	81.50	94.75	180.85	9.95	59.90
30	18.00	34.50	72.00	110.00	128.75	235.85	0	117.90
36	22.00	42.50	88.00	135.00	165.75	295.85	14.95	134.90
50	29.75	54.50	110.00	175.00	195.75	405.85	22.95	179.90

NEW HIGH CURRENT POWER SUPPLIES

Variable 0-28V DC. Completely Built. Ready to Go Full Wave Selenium Rectifier. Transformer, Variac, Volt & Amp Meters, Switch, Terminal & Fuse. In Heavy Duty Steel Cabinet Std 115V/60Hz 110 & 230V/2 9 phase.

Stock Continuous With Meters

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T28V10A	5 Amp (1% Ripple)	60.00
T28V20A	0-28 VDC @ 12 Amp	99.00
T28V12AC	12 Amp (1% Ripple)	139.00
T28V24AC	0-28 VDC at 24 Amp	135.00
T28V24ACC	24 Amp (1% Ripple)	135.00
T28V50A	0-28 VDC at 50 Amp	260.00
T28V50ACC	50 Amp (1% Ripple)	370.00
T28V100A	0-28 VDC at 100 Amp	650.00
T28V100ACC	100 Amp (1% Ripple)	650.00

NEW RECTIFIER CHOKES

CH07/4 Amp/0.1 Ohm/1.5 Ohm/12 Lbs. \$7.95
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 CH004/24 Amp/0.04 Ohm/1.05 Ohm/20 Lbs. \$29.95
 CH001/50 Amp/0.01 Ohm/1.05 Ohm/20 Lbs. \$54.95
 CH003/70 Amp/0.03 Ohm/1.05 Ohm \$66.00

New Rectifier & Transformer Combo

Sel/Bridge 115 v 60 cyc Input
 up to 14VDC at 12 amps Cont. Duty \$19.98
 up to 28VDC at 4 amps Cont. Duty \$29.98
 up to 28VDC at 12 amps Cont. Duty \$29.98
 up to 28VDC at 24 amps Cont. Duty \$59.98
 up to 28VDC at 50 amps Cont. Duty \$199.00
 *TRANSFORMER HAS DUAL INPT 115 & 230V

TUBES

0A2	50.88	4J31	59.51	6S7	50.58
0C3/VR75	1.04	4J5	2.98	6X4GT	50.58
0B2	1.37	4PR50A	42.50	6SL7GT	59.98
0B3/VR90	0.96	EL38BD	15.99	6SN7GT	50.58
0C3/VR50	0.92	5C2	65.95	6X4GT	50.58
0B3/VR150	0.92	5C2	38.95	6SR7	50.58
8X3/8016	8.00	5D21	14.98	6T8	50.58
1B2	1.32	5Y4	1.82	6X4	50.58
1B23	8.98	5R4GY	1.75	6V8	50.58
1B24	8.98	5Y4	1.48	6V6	50.58
1B25	2.24	6AR5	8.95	6X4GT	50.58
1B27	11.98	5V4G	9.55	6W4GT	50.58
1B28	2.48	5Z3	9.99	6X4	50.58
1B28/532A	9.15	6AT	1.25	6X4GT	50.58
1B37	14.87	6AR7	9.00	6Y6GT	50.58
1B42	17.48	6AC7	8.00	7A8	50.58
1B43	1.98	6AC5	9.95	7B7GT	50.58
1B63	45.00	6AR7	1.14	7F7	50.58
1L4	4.88	6AH6	1.21	7F8	50.58
1L6	1.35	6AJ5	1.44	7X7	50.58
1L7	0.98	6AK5	8.97	7N7	50.58
1L8	0.98	6AK5	2.79	7Y7	50.58
1L9	5.24	6AL5	4.48	8A1	50.58
1L10	5.48	6AL5	4.48	8A2L5	50.58
1V2	7.00	6AL7GT	9.88	8AT6	50.58
1K2A	27.98	6AN5	5.25	8AT7	50.58
2C30	27.00	6AR7	5.25	8A7GT	50.58
2C33A	26.98	6AQ5	2.78	12AU7	50.58
2C40	1.98	6AR5	1.29	12AV6	50.58
2C43	12.70	6AUG	1.29	12AX7	50.58
2C44	1.15	6AR6	3.22	12AV6W	50.58
2C51	3.88	6AS5	2.49	12AX7	50.58
2C52	1.18	6AS6	2.48	12B7	50.58
2E43	1.49	6AS7G	3.28	12BA6	50.58
2J31	29.40	6AT6	5.48	12BA7	50.58
2J32	29.40	6AUGT	1.29	12BE6	50.58
2J33	27.00	6AUG	5.68	12BE6	50.58
2J34	24.90	6AV5GT	9.88	12BF6	50.58
2J42	14.98	6BA6	5.48	12BH7	50.58
2J38	69.98	6BA7	1.18	12SA7GT	50.58
2J39	6.98	6BR6	6.00	12SC7	50.58
2J40	23.88	6BA6	5.48	12SF6GT	50.58
2J48	24.45	6BA7	1.09	12SFG7GT	50.58
2J49	84.00	6BC5	6.33	12S7GT	50.58
2K23	145.00	6BQ7	1.65	12SL6GT	50.58
2K21	23.88	6BD6	8.33	12SJ7GT	50.58
2K22	23.88	6BE6	5.48	12SK7	50.58
2K23	11.48	6BH6	6.33	12SQ7GT	50.58
2K25	28.48	6BQ6	6.99	12SR7	50.58
2K25/723AB	23.88	6BK7	1.58	SR12	349.00
2K28	27.48	6BL6	58.00	SRX16	149.00
2K29	134.98	6BN7	1.19	GT1	3.90
2K39	134.98	6BN7	2.69	24G/3C24	1.32
2K41	126.00	6BQ6GT	1.20	25B06GT	98.72
2K42	72.50	6C6	5.25	25C6	67.81
2K48	99.48	6C21	24.50	25Z6GT	58.80
2K53	298.00	6C6P	1.69	35T	1.69
2K7	2.48	6D4	2.70	35L6	67.80
3B22	4.70	6F5	6.20	45Y4	8.95
3B24	3.70	6F7	7.98	45Z3	8.95
3B26	7.90	6C4	2.85	45Z3	8.95
3B28	85.00	6C4	6.66	50C5	62.85
3C23	8.67	6J5	5.40	50L6GT	62.85
3C31	3.45	6J6	58.88	RK61/XF3	14.88
3C33	9.88	6KGT	5.78	HV69	4.98
3C45	9.88	6K7	1.08	7A	4.98
6K7/299	8.98	6K8	1.08	7A	4.98
3C48	9.88	6K8	1.08	7A	4.98
3C52	13.97	6L6G	1.08	81	1.42
3C53	14.48	6L6GY	1.08	81	1.42
3K23	349.00	65A7GT	6.63	80	4.48
3K27	149.00	65C7	90.84	6Z4	1.26
4E21	21.45	6F5	9.98	8A	1.25
4D21	18.93	6F7	7.3	G104	2.98
4E27	22.49	65GT	6.4	F105	2.59
4J27	129.51	65H7	61	VXR130	4.50

NEW RECTIFIERS 6FMRS

PRIMARY 115V 60CYC
 SEC 18-15-9-0-9-15-18 Volts
 4 amp \$8.65; 2 for \$15.75
 12 amp \$16.65; 2 for \$29.95
 24 amp \$35.75; 2 for \$65.95

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13-0-13V (CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Replacement 6 Volt Booster Charger. Model CR16 \$10.00 3 for \$27
 15-0-15V (CT) Fan Cooled For 12V/60AMP and 6V/100 AMP Booster Chargers. Model CR30 \$11.00 3 for \$30

DC POWER-SUPPLY

Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60 cy Output 6.3V or 12.6V 2 Amp
 Model 510F (2 amp) \$12.98
 Model 510CF (5 amp) \$22.98
 5DFC A/C 5 amp 1% Ripple \$32

230 TO 115V AUTOFORMERS

For 230-240V/50-60Hz Input To 110-120V or Step-up with Cord Plug & Receptacle
 TPA250/50W \$22.55; TPA205/75W \$3.65
 TPA100/100W 4.00; TPA200/200W 5.75
 TPA300/250W 6.75; TPA300/300W 7.25
 TPA500/500W 8.25; TPA750/750W 16.95
 TPA1000/1000W 22.50; TPA1500/1500W 28.95
 Model TPA3000/3000W 49.95

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PRICES SUBJECT TO CHANGE WRITE FOR COMPLETE TUBE LISTING

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50.58	6X4	59.98	1614	1.95
50.5				

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40 cps - 200,000 cps

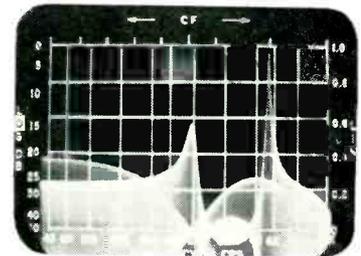


PANORAMIC SWEEP GENERATOR

MODEL **SG-1**

Assures Convenient Accurate Analysis of Frequency Responses between 40-200,000 cps because of these Unique Advanced Engineering Features

DIRECT READING SCREENS: Frequency and amplitude calibrated for slave scopes.
FREQUENCY RANGE: Log 40-20,000 cps or 400-200,000 cps, true decade, selectable. Linear same as above. Two selectable linear sweep-widths calibrated and continuously variable from 20 kc to 100 cps, and 200 kc to 1 kc. Sweep-width remains constant as calibrated center frequency control is varied anywhere between 0 to 200 kc.
AMPLITUDE SCALES: Linear or 2 decade log.
OUTPUT VOLTAGE: 2 volts into matched 600 ohm load, flat to within 5%. 75 db attenuation in 5 db steps.
RETURN SIGNAL AMPLIFIER and ATTENUATOR: Covering range of 40 millivolts to 200 volts.
DISTORTION: At least 40 db below maximum output.
SCAN RATES: 1 cps internal or 0.04 to 60 cps with Model TW-1 Triangular Wave Generator.
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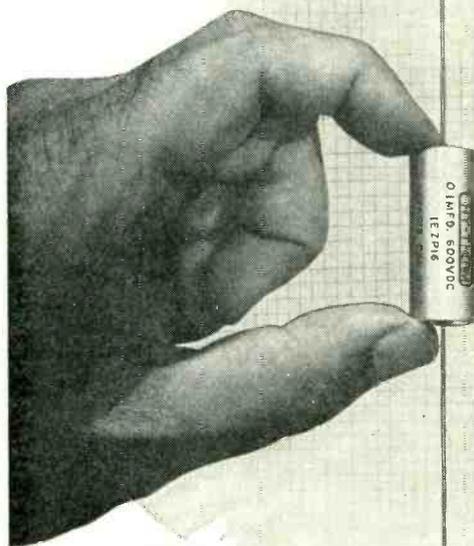
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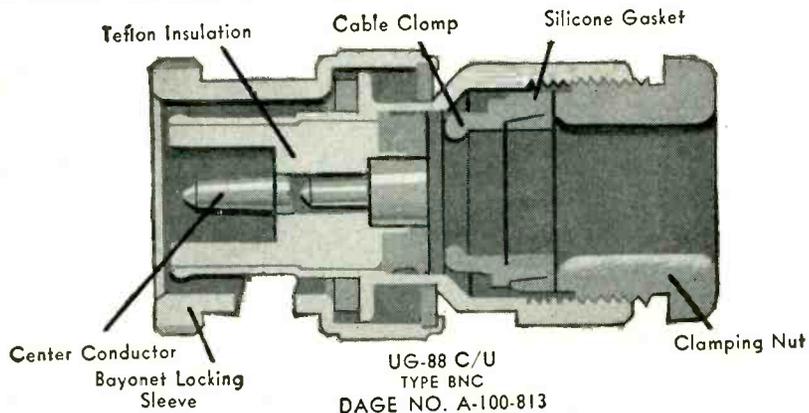
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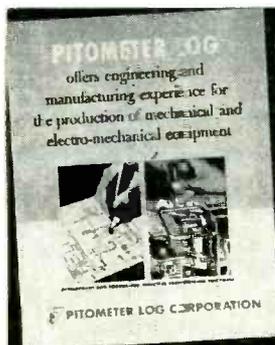
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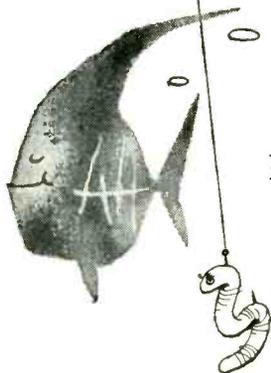
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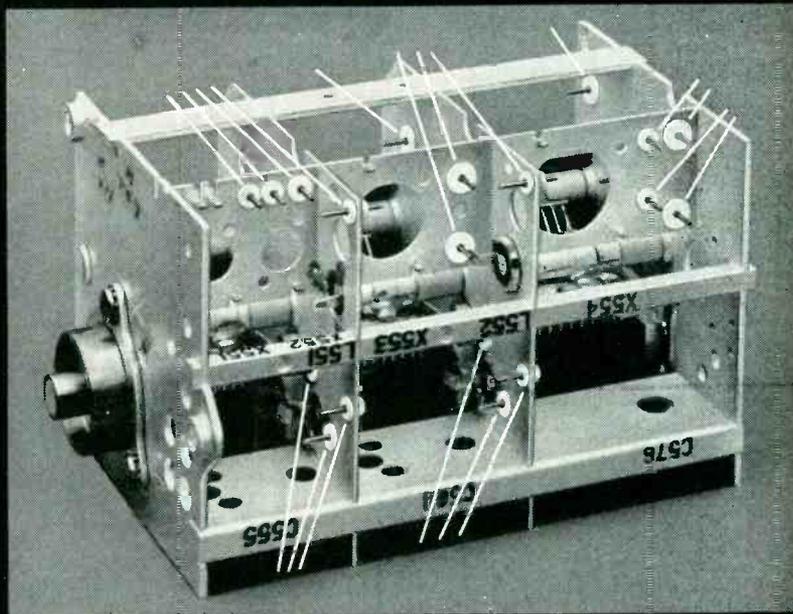
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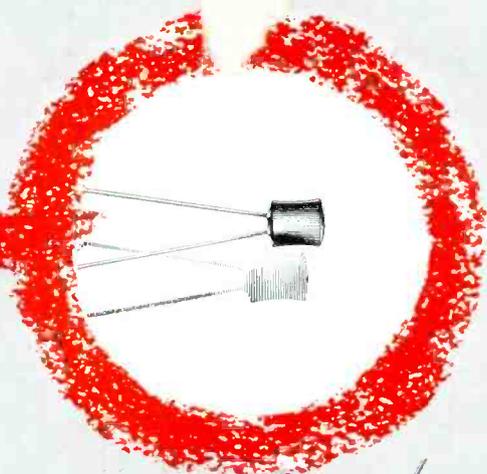


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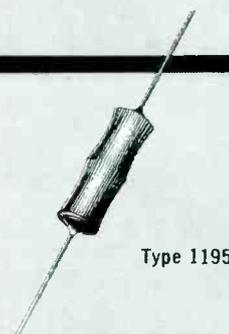
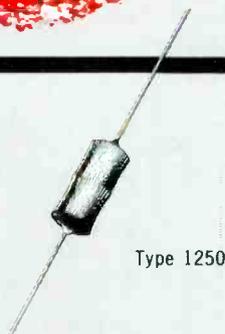
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