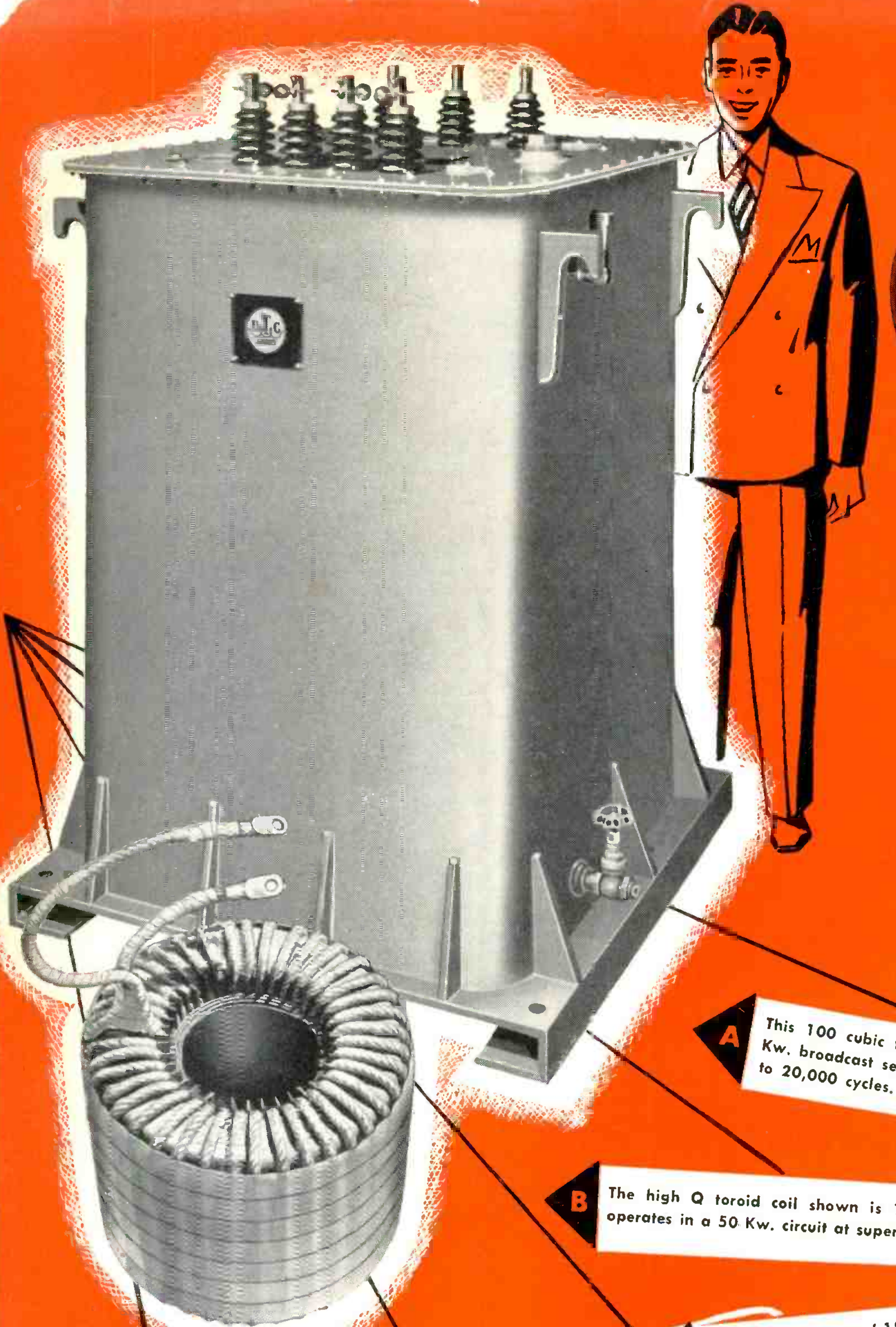
electronics

JUNE · 1951

PRICE 75 CENTS

A McGRAW-HILL PUBLICATION

DEEP-FREEZE TEST
OF NAVY RADAR



for every application

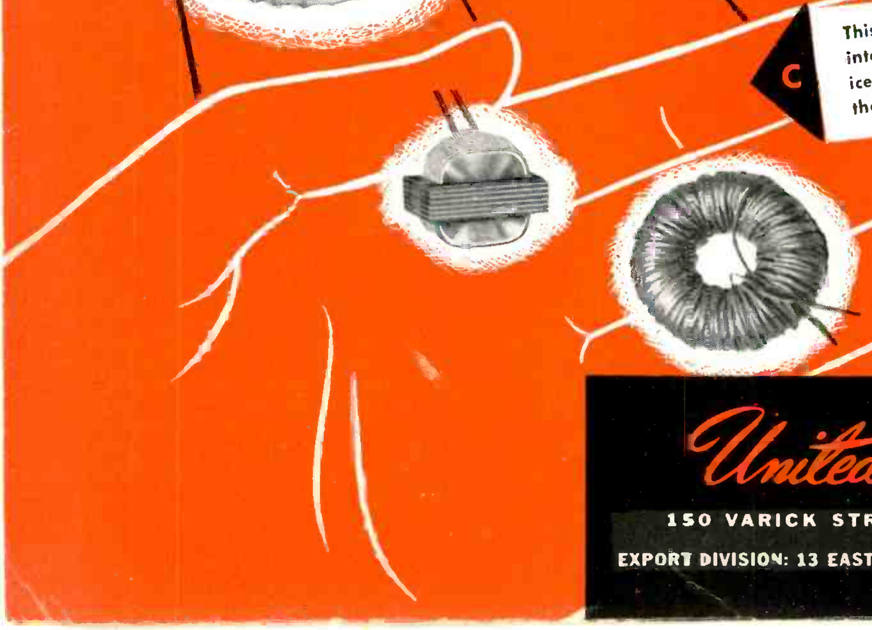
While the catalogue line of UTC components covers a wide variety of applications, many people are not familiar with the full range of products produced by UTC. It is impossible to describe the thousands of special UTC designs as they become available. The illustrations below are intended to indicate some of the range in size of these special products.

A This 100 cubic foot modulation transformer is for 50 Kw. broadcast service. Frequency response flat from 30 to 20,000 cycles.

B The high Q toroid coil shown is 12" in diameter. It operates in a 50 Kw. circuit at supersonic frequency.

C This sub-miniature (.18 cubic inch) output transformer is intended for hearing aid and other extreme compact service. While the dimensions are only 7/16" x 9/16" x 3/4", the fidelity is ample for voice frequency requirements.

D This sub-miniature (.18 cubic inch) permalloy dust core toroid is available in a wide range of inductances, and for frequencies from 1,000 cycles to 50 Kc.



United Transformer Co.

150 VARICK STREET • NEW YORK 13, N. Y.

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

electronics

A McGRAW-HILL PUBLICATION

June • 1951

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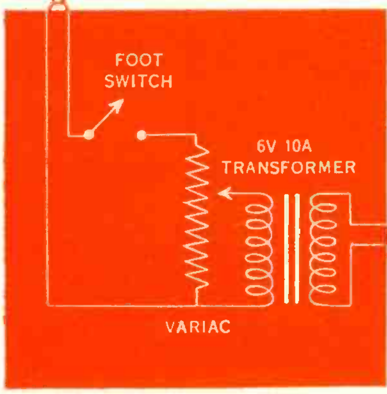
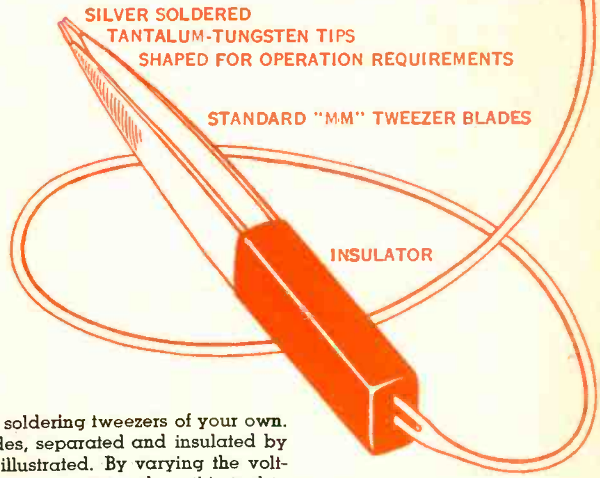
marion methods *electrify* TWEEZER SOLDERING



Electrified by Marion, these tweezers now do double duty. *They position the work and solder it at the same time. Tripled* production and finer fluxless joints result.



Help yourself to marion methods

MARION USES THIS METHOD of Tweezer Soldering for precise hairspring soldering, positioning small metal parts in thermoplastic cements, and in other fine soldering operations. Resistance heating in the work itself and conducted heat from the tips combine to give greatly increased soldering rates on pretinned components. Because the tweezers develop little heat themselves, adjacent component damage is avoided. These tweezers permit an inexperienced worker to rapidly acquire a high degree of skill. Both positioning and soldering are combined with the handling ease of a fountain pen.

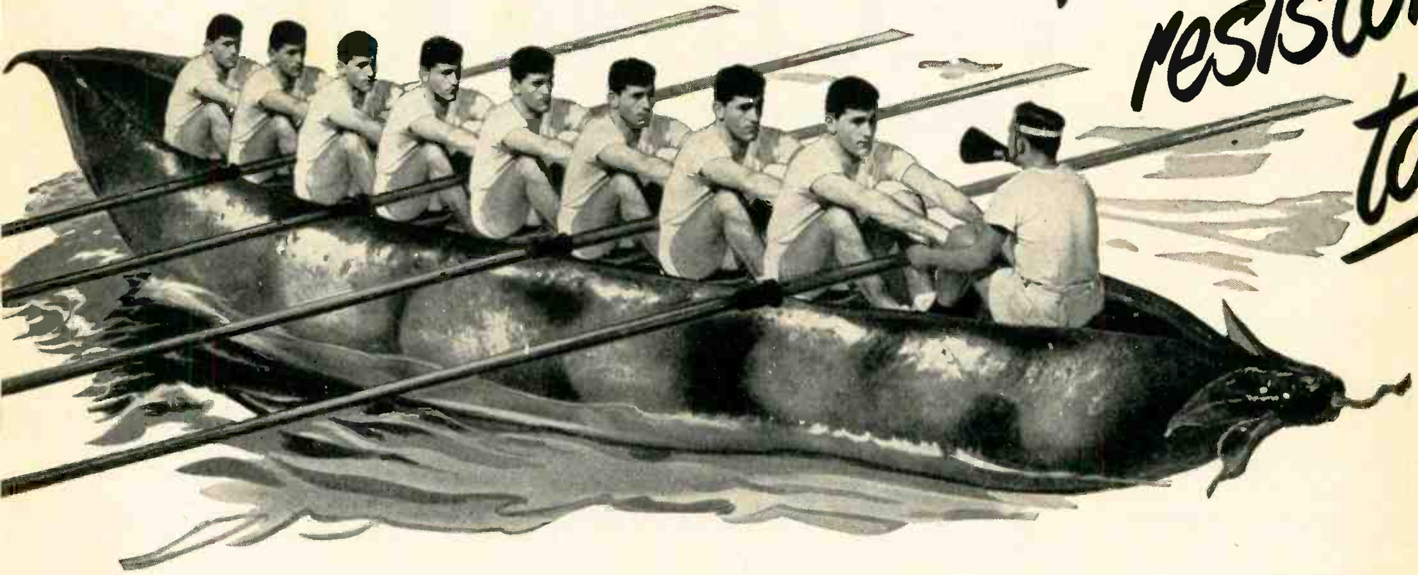
NOT FOR SALE—You can make electric soldering tweezers of your own. Those shown here have standard "MM" blades, separated and insulated by bakelite. They are assembled and wired as illustrated. By varying the voltage, the tip cross-section, and the contact area, you can adapt this tool to your specific application.

OTHER MARION METHODS—Current demands on industry by the mobilization program accentuate the importance of production methods. Electric tweezer soldering is only one of a number of methods which Marion proposes to present in the hope that some of them can help you as much as they have helped us. Marion Electrical Instrument Company, 401 Canal Street, Manchester, N. H., U. S. A.

MANUFACTURERS OF MARION RUGGEDIZED PANEL INSTRUMENTS

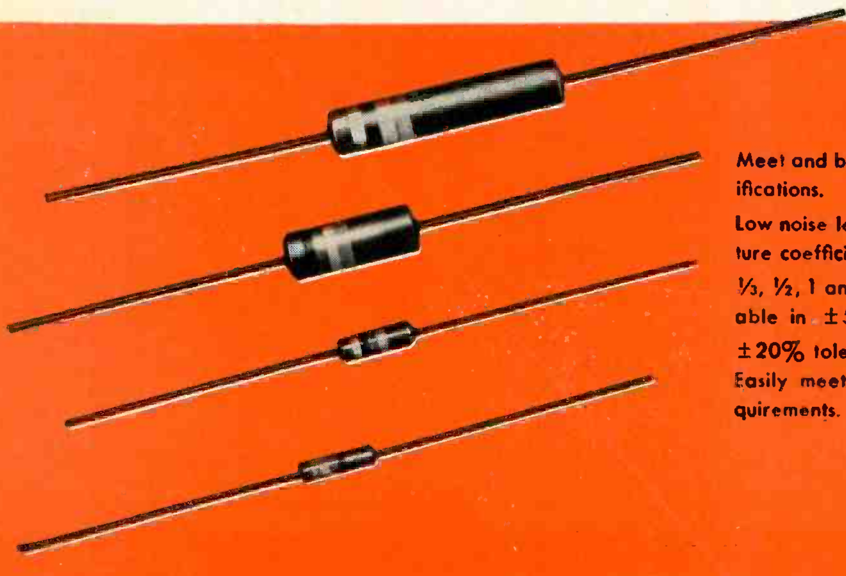
marion meters

Uniformity is *for resistors too!*



It isn't hard to make a resistor with specific characteristics. The trick is to make resistors by the million, fast and at low cost, and *still retain uniformity* in those characteristics. Specializing in resistors, IRC achieves this uniformity through mechanization of production, plus continuous inspection and rigid quality control. Result:—IRC customers are assured of identical resistance units—within prescribed limits—regardless of quantities or time of purchase.

Uniformity of IRC Advanced BT Resistors—which meet JAN-R-11 specifications—is the result of combining IRC's filament-type resistance elements with exclusive construction features. Resistance material is permanently cured and bonded to special glass. Leads extend into filament for rapid heat dissipation. Molded bakelite seals element against moisture and prevents grounding. In standard RMA Resistance Ranges, Advanced BT's possess extremely low operating temperature and excellent power dissipation at ⅓, ½, 1 and 2 watts. Full details of these compact, light-weight, fully insulated units are contained in 12-page technical data Bulletin B-1. Use coupon to send for your free copy.



Meet and beat JAN-R-11 Specifications.

Low noise level and temperature coefficient.

⅓, ½, 1 and 2 watts—Available in ±5%, ±10%, and ±20% tolerance.

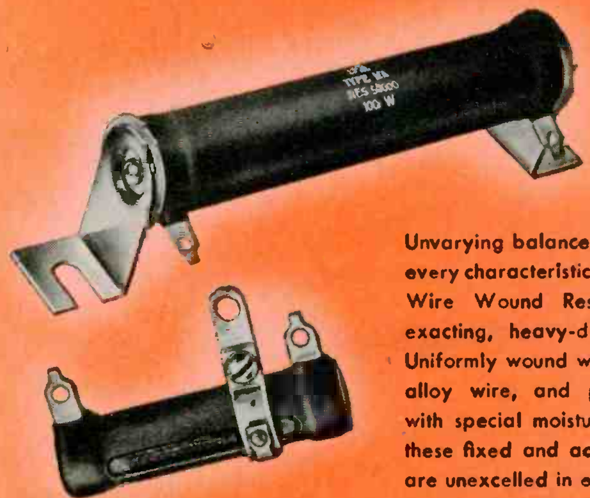
Easily meets rigorous TV requirements.

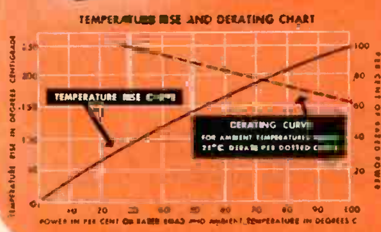
IRC

INTERNATIONAL RESISTANCE COMPANY

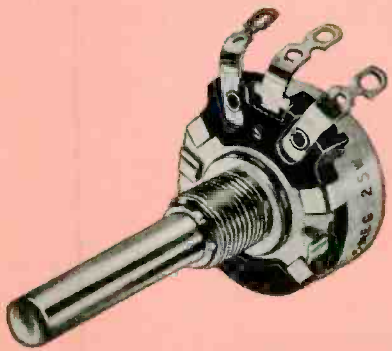
401 N. Broad Street, Philadelphia 8, Pa.

important





Unvarying balanced performance in every characteristic makes IRC Power Wire Wound Resistors ideal for exacting, heavy-duty applications. Uniformly wound with highest-grade alloy wire, and precisely coated with special moisture-proof cement, these fixed and adjustable resistors are unexcelled in essential electrical and mechanical characteristics. Leading industrial, aircraft, broadcast, maritime and commercial users have specified them for over 14 years. Catalog data Bulletin C-2 contains full details.



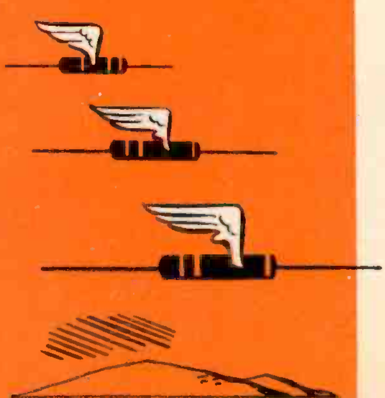
Meticulous engineering and elimination of hand manufacturing operations assures maximum uniformity in these small 15/16" Type Q Controls. Resistance element is the best IRC has ever manufactured. Increased arc of rotation permits same resistance ratios proved successful in previous larger IRC controls. Electrical rotation is the same with or without new IRC Type "76" switch. Catalog data Bulletin A-4 gives complete information.

Uniformly accurate and dependable, IRC Precision Wire Wounds excel in every significant characteristic. Leading instrument makers use them extensively for close tolerance applications. Winding forms are non-hygroscopic ceramic with high insulation qualities, high mechanical strength, low coefficient of expansion. Special humidity-proof enamelled-wire windings receive particular attention to avoid strain or breakdown in insulation. Standard 1.0% tolerance. ½, ¼ and 1/10% are available. Full details in catalog data Bulletin D-1.

Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

Wherever the Circuit Says

For prompt delivery of uniformly dependable standard resistors, in experimental or maintenance quantities, simply phone your local IRC Distributor. IRC's Industrial Service Plan keeps him fully stocked with the most wanted types and ranges—permits him to give you fast, round-the-corner delivery of small-order requirements. We'll be glad to send you his name and address.



INTERNATIONAL RESISTANCE COMPANY A

403 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me complete information on the items checked below:—

- ☐ Advanced BT Resistors (B-1)
- ☐ Type Q Control (A-4)
- ☐ Precision Wire Wounds (D-1)
- ☐ Power Wire Wounds (C-2)
- ☐ Name and Address of Nearest IRC Distributor

NAME____________________

TITLE____________________

COMPANY____________________

ADDRESS____________________

CITY__________ZONE______STATE______

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MITCHELL-RAND *announces....*

3738

DIP-COATING and POTTING COMPOUND

ANOTHER SIGNIFICANT DEVELOPMENT OF MITCHELL-RAND LABORATORY RESEARCH

3738 is a special hot-melt, black thermoplastic moisture-proofing, insulating compound with unusual low-pouring, high cold-flow characteristics. This relatively low-cost compound also has flexible toughness at room temperature and a low rate of moisture vapor transmission.

3738 *Applications*

- FLASH DIP-COATING coils and small transformers to furnish moisture resistance and electrical insulation.
- POTTING JOBS which require its distinctive properties.
- SEALING SOCKETS AND SCREW HOLES for which a filling composition with good adhesion and high cold-flow temperature are specified.

3738 *Features*

- HIGH COLD-FLOW TEMPERATURE COUPLED WITH LOW-POURING TEMPERATURE facilitates potting high operating temperature units which contain delicate parts that would be damaged by compounds poured at high temperatures. The low pouring viscosity of 3738 recommends its application to potted units in which minimum clearances of small filling holes require a free flowing composition.
  The combination of viscosity and cold-flow, in 3738, permits rapid application of dip-coatings to resist sagging and sweating at temperatures above 105°C.
- GOOD FLEXIBILITY AND ADHESION permit good moisture seals around leads and physical shock-resistance on both dip-coated and potted units.
- RAPID RATE OF SET speeds production when used for dip-coating, potting or sealing.
- NON-TACKY SURFACE reduces the possibility of accumulating surface contamination or sticking on the production line or in storage.

Methods of Application

- POTTING AND SEALING: The viscosities of 3738 differ appreciably between the upper and lower limits of the suggested pouring temperature range. To obtain higher or lower pouring viscosities, temperatures below or above this range can be employed.

Best adhesion, without surface priming, is obtained by pouring at temperatures in the upper portion of the suggested range or by preheating the unit.

Although 3738 has a low-pouring viscosity, preheating is recommended when filling close tolerance areas where a quick chill may be caused by cold parts. Preheating is suggested since 3738 sets at relatively high temperatures.

DIP-COATING: The thickness of 3738 on a single dip can be varied considerably. Generally higher bath temperatures and shorter periods of immersion will control thickness or thinness of coating.

3738 *Specifications*

Cold Flow (M-R)..248/253 F

Penetrations
- 32/200/60 1-2
- 77/100/5 7-8
- 115/50/5 10-12

Color ....Black

Softening Point (B&R) ....254/259 F

Pouring Temperature....340/390 F

Specific Gravity 1.03

Flash Point ....480 F

Write for your laboratory test samples . . . . . free upon request.

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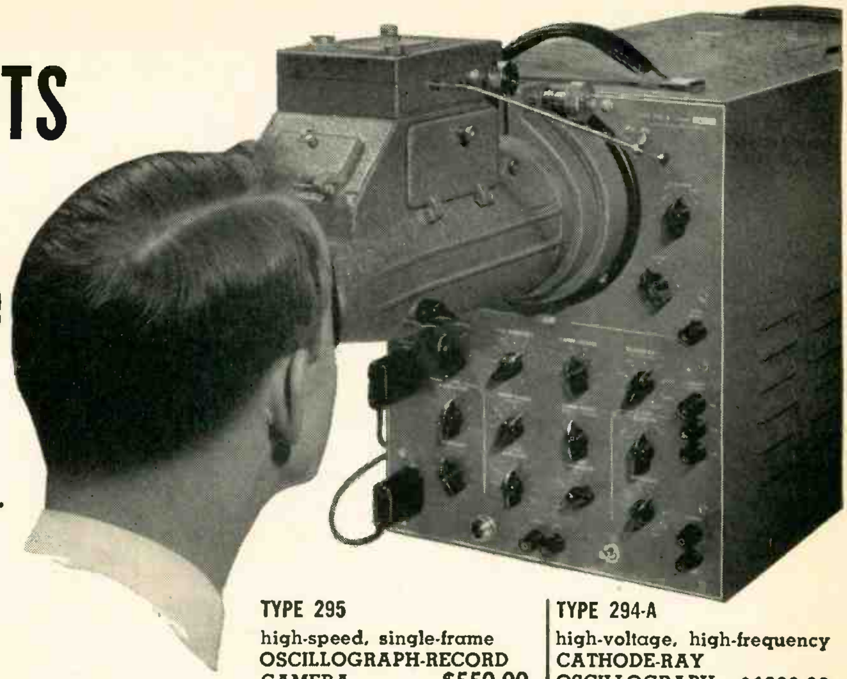
MITCHELL-RAND INSULATION CO., INC.

51 MURRAY STREET COrtlandt 7-9264 NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH · INSULATING PAPERS AND TWINES · CABLE FILLING AND POTHEAD COMPOUNDS · FRICTION TAPE AND SPLICE · TRANSFORMER COMPOUNDS · FIBERGLAS SATURATED SLEEVING · ASBESTOS SLEEVING AND TAPE · VARNISHED CAMBRIC CLOTH AND TAPE · MICA PLATE, TAPE, PAPER, CLOTH, TUBING · FIBERGLAS BRAIDED SLEEVING · COTTON TAPES, WEBBINGS AND SLEEVINGS · IMPREGNATED VARNISH TUBING · INSULATED VARNISHES OF ALL TYPES · EXTRUDED PLASTIC TUBING

A COMPLETE APPROACH TO

SINGLE TRANSIENTS and PULSES of low-repetition rate



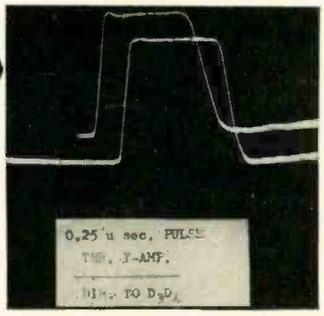
For visual observation of pulses and single transients, the Type 294-A Cathode-ray Oscillograph provides high light-output and wide-band response. For careful study and permanent reference of these signals the Type 295 Oscillograph-record Camera records writing rates as high as 35 inches per microsecond.

TYPE 295
high-speed, single-frame
OSCILLOGRAPH-RECORD CAMERA **$550.00**

TYPE 294-A
high-voltage, high-frequency
CATHODE-RAY OSCILLOGRAPH **$1320.00**

PULSE RESPONSE FREQUENCY RESPONSE SENSITIVITY

This oscillogram illustrates the double exposure technique. Binocular viewing in the Type 295 facilitates proper positioning for close comparison.



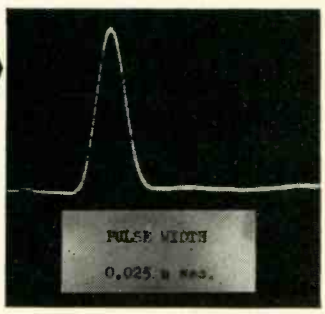
The pulses in the oscillogram at left are identical pulses of 0.25 microsecond width. The first pulse was applied through the Y-axis amplifier of the Type 294-A, and the second, directly to the vertical deflection plates. A comparison of their waveforms illustrates the excellent transient response of the Y-axis of the Type 294-A.

Response of the Y-axis amplifier to a rise time of 0.01 microsecond or less is 0.03 microseconds max. Notice that a minimum of overshoot (less than 2%) is introduced by the amplifier.

For the study of sinusoidal frequencies, the response of the Type 294-A extends from 10 cps. to 12 megacycles (down 30%). Sensitivity of the Y-axis, through the amplifier, is 0.42 peak-to-peak volts per inch.

AVAILABLE DEFLECTION LIGHT OUTPUT SIGNAL DELAY

"Time" and "Bulb" exposures may be taken with the Type 295. And provision is made so that equipment may be triggered simultaneously with shutter opening. With appropriate accelerating potentials, the Type 295 is capable of recording single transients in excess of 280 inches per microsecond.



The Type 294-A provides undistorted vertical deflection of 1.3 inches or more for both positive and negative pulses; and 2.75 inches for symmetrical signals. The high light-output of the Type 294-A increases the value of the large, vertical deflection provided by the Y-axis amplifier. This is illustrated by the high visibility of the rise and decay of the pulse shown at left. Here, the Type 5XP– Cathode-ray Tube of the Type 294-A was operated at 12 kv. However, where maximum light output is not required, the accelerating potential may be lowered to 7 kv by means of a switch. At this level of operation, of course, the available undistorted deflection is increased.

To insure the complete display of fast pulses such as those at left, the Y-axis includes a 0.25 microsecond signal-delay line.

SWEEP SPEEDS TIME CALIBRATION

The built-in illuminated data-card of the Type 295 will prove invaluable when making time measurements. A film take-up cassette is arranged so that exposed frames of film may be separated from unexposed film and taken to the darkroom for immediate developing.

Complementing the Y-axis performance of the Type 294-A, sweep durations are continuously variable from 0.1 second to 3 microseconds. By increasing the length of the sweep, speeds greater than 0.25 microsecond per inch may be obtained, thus providing more detail to facilitate the study of short-duration pulses.

Calibration of the sweeps of the Type 294-A is accomplished with vertical marks occurring at intervals of 100, 10, 1, or 0.1 microseconds. In the oscillogram at left, the 0.1 microsecond markers appear mixed with the signal on the vertical axis. Time measurements may also be made by double exposure of first, the signal, and second, the timing markers.

Send requests for information to

ALLEN B. DUMONT LABORATORIES, INC.
Instrument Division
1000 Main Avenue, Clifton, N. J.

DUMONT *for Oscillography*

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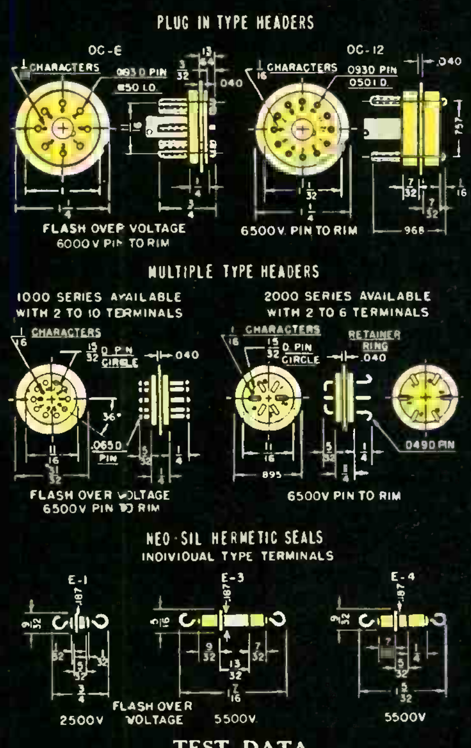


TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^6	3.5×10^{12}

Dielectric Constant and Dissipation Factor

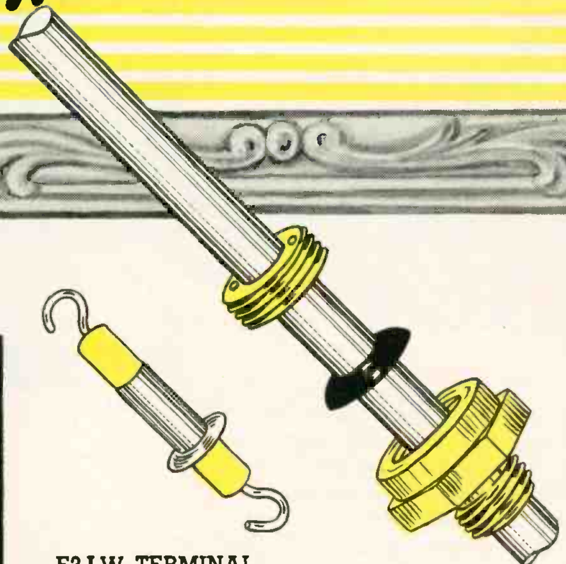
Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively — 105° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.



E3-LW TERMINAL

"E-Series terminals are applicable on MIL requirements and will withstand thermal shock, vibrations, mechanical strains, and excessive pressures with no impairment of the seal or other functional characteristics. E-3LW terminals are now being used at 1000 psi static oil pressure and undergo 5000 psi tests."

¼" SHAFT WATERSEAL BUSHING

"Rotary Waterseal Panel Assemblies, with GRAF-SIL Packing Glands, have an excellent five year customer history on gas filled pressurized components. They are available for ¼" shafts and for potentiometers and switch bushings."

"NEO-SIL's proven Hermetic sealing components will eliminate rejects resulting from breakage, strains, cracks, etc. Each NEO-SIL component is pressure checked at 25 psi — to meet military requirements and as applied to our units, NEO-SIL rubber will resist abusive temperature cycling, salt water, most acids and alkalies, and withstand high pressures and vacuums."

"In addition to the items illustrated above, NEO-SIL offers many other components, such as Hermetically Sealed Fuse Holders, Octal Type Plug In Headers, Multiple Pin Headers, Hermetically Sealed Cables, Hermetically Sealed Line Cords With Plugs For European use, Meter Gaskets, Panel Gaskets, Adapters (U.S. to Continental), Coil Forms, Crystal Contacts and other molded bakelite and NEO-SIL rubber units."

"Hermetically Sealed Fuse Holders are available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted and are applicable for use on vacuum or gas filled units."

Your special problems are solicited.

NEO-SIL CORPORATION

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PROVED

by reports of satisfied users... that you can depend on higher speed, fewer rejects, less expense on the assembly line using Ersin Multicore of even lower tin content than other solders. Specify Multicore, the original 3 core solder with extra-active, non-corrosive Ersin Flux and Thin-Wall Triple Core construction.

APPROVED

Pound by pound, Ersin Multicore meets all requirements of Federal Specification QQ-S-571-b. Made of virgin metals only — Tin: 99.75% pure Lead: 99.97% pure The World's Finest Solder!

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Mellier House, Albemarle Street • London, W. 1, England

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METALLURGISTS, PHYSICISTS and CHEMISTS

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INVESTIGATE IMMEDIATELY!

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*Right now Westinghouse is building seven new plants. These are not temporary jobs. Nearly all of the engineers and scientists who joined us in World War II are still with us, and in the past 10 years our total employment has almost doubled.

*At Westinghouse you will participate in the nation's defense effort. In 1951 a large part of all Westinghouse production will be to satisfy the nation's military needs.

THIS MAY BE YOUR OPPORTUNITY TO MOVE AHEAD IN THE CAREER OF YOUR CHOICE . . . MANY SUPERVISORY POSTS IN NEW PLANTS AND DIVISIONS WILL BE FILLED FROM OUR ENGINEERING STAFF! INVESTIGATE!

Minimum Experience Required—2 years . . . but some of these openings call for top-flight men with more experience.

Salaries—Determined individually on the basis of the experience and ability of the applicant.

Location—There are openings for engineers, metallurgists, physicists, and chemists at most of Westinghouse's 36 plants. For example: You'll find opportunities to do jet engine work at Kansas City, Missouri and South Philadelphia, Pa. . . . in Ordnance manufacturing at Sunnyvale, California and Sharon, Pa. . . . on atomic power projects in Pittsburgh, Pa. . . . in radar and electronics at Baltimore, Md. . . . in aircraft equipment and fractional horsepower motors at Lima, Ohio . . . and in commercial and airport lighting at Cleveland, Ohio . . . and in power producing equipment to speed the production lines of America. And all of these activities have a definite and established peacetime application.

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- **Opportunity to acquire Westinghouse stock at favorable prices**
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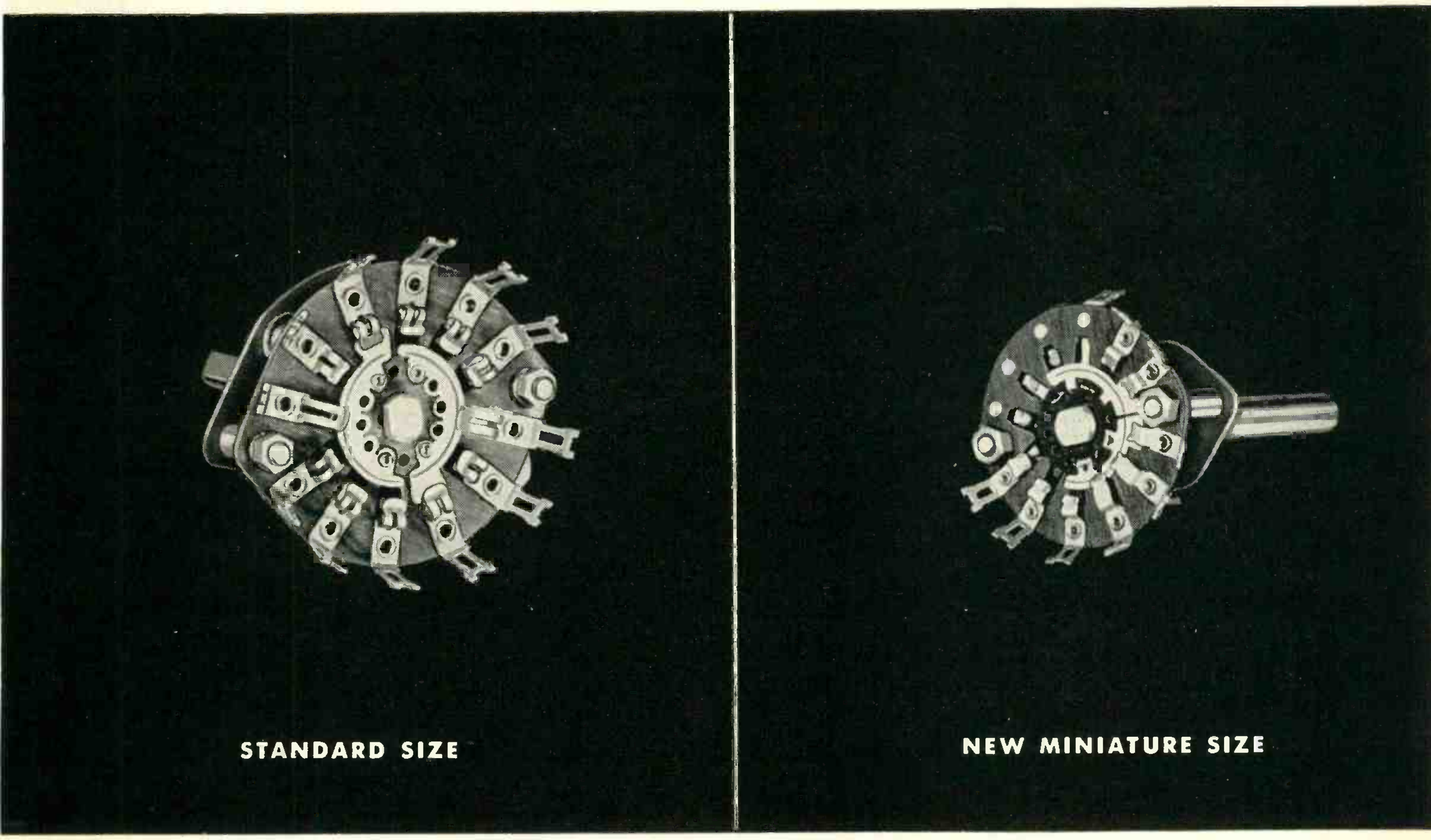
Investigate Westinghouse today . . . Write Mr. R. P. Meily, Westinghouse Electric Corporation, Box 2182 306 Fourth Ave., Pittsburgh 30, Pa.

NEW MINIATURE SWITCHES BY CENTRALAB



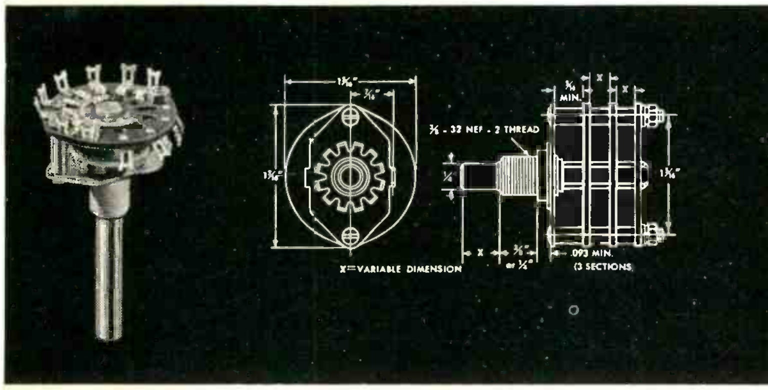
Now, Centralab, the first name in Electronic Components, offers new design possibilities in an entirely new line of truly miniature, top-quality, rotary switches for radio, TV and similar high-frequency, low-power applications.

WANT MORE INFORMATION? **SEE NEXT 2 PAGES ➡**

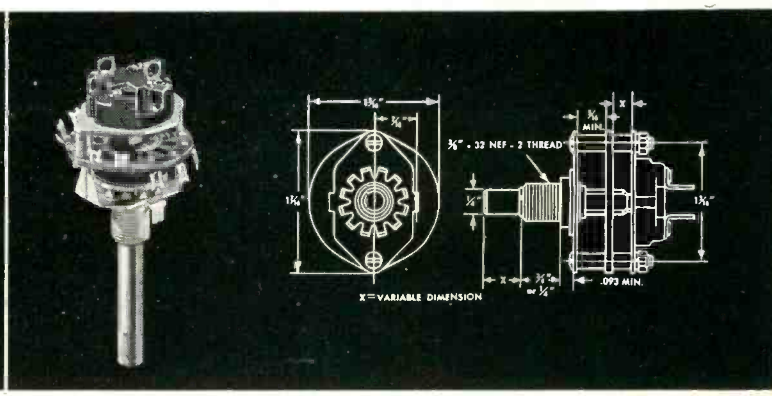
NEW LINE OF MINIATURE SWITCHES

MILITARY APPLICATIONS

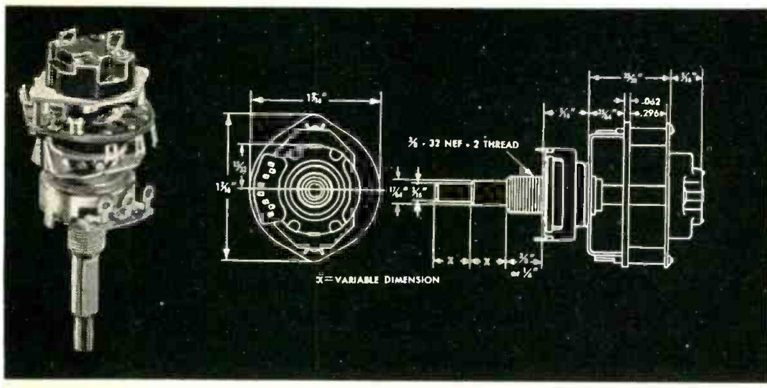
Now Centralab offers a completely new, unusually small rotary switch line — available in a variety of multi-pole, multi-position, multi-section models and in combination with line switches and variable resistors.



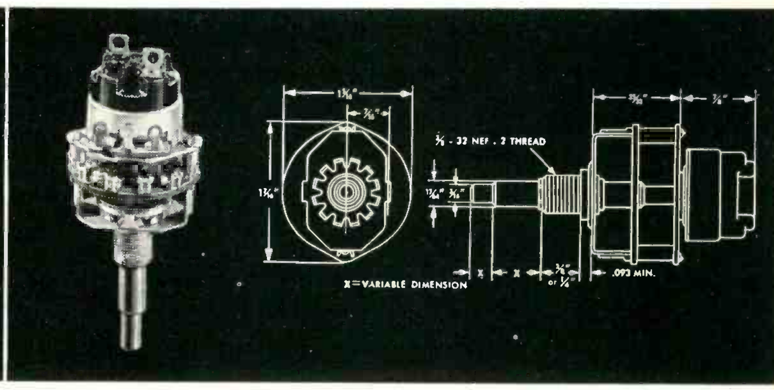
New Centralab Series 20, miniature, single section, phenolic switch. Available in 2 to 11 positions with stops, or 12 position continuous rotation — and with multiple sections.



Here's standard Series 20 miniature switch with standard shaft and phenolic section with conventional off-on switch added. Also available with multiple sections.



Combination Series 30 miniature switch unit with dual concentric shaft — permits independent operation of miniature switch including off-on switch, and Model 2 variable resistor.



Same combination Series 30 unit as shown at left, *except* that Model 2 variable resistor is mounted at rear of miniature switch. Position of resistor provides convenience of wiring.

If you need a truly small size, long-life switch, Centralab's new miniature Series 20 and Series 30 switches are the answer. They have been specifically designed to meet the modern trend toward greatly reduced size in electronic equipment for high-frequency, low-current applications. Extremely compact design and small size, plus availability of separate sections and index assemblies provide an adaptability that is invaluable to design engineers and manufacturers. For complete specification information on the new Centralab Miniature Series 20 and Series 30 Switch line, mail the coupon today. *Manufacturer's samples promptly.*

Centralab ®

Division of GLOBE-UNION INC • Milwaukee

CENTRALAB Division of Globe-Union Inc.
914 East Keefe Avenue, Milwaukee 1, Wisconsin

Please send me complete specification information on Centralab's new Series 20 and Series 30 Miniature Switch line.

Name ....

Address ....

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

Have you a Military Job for this Special Counting Mechanism?

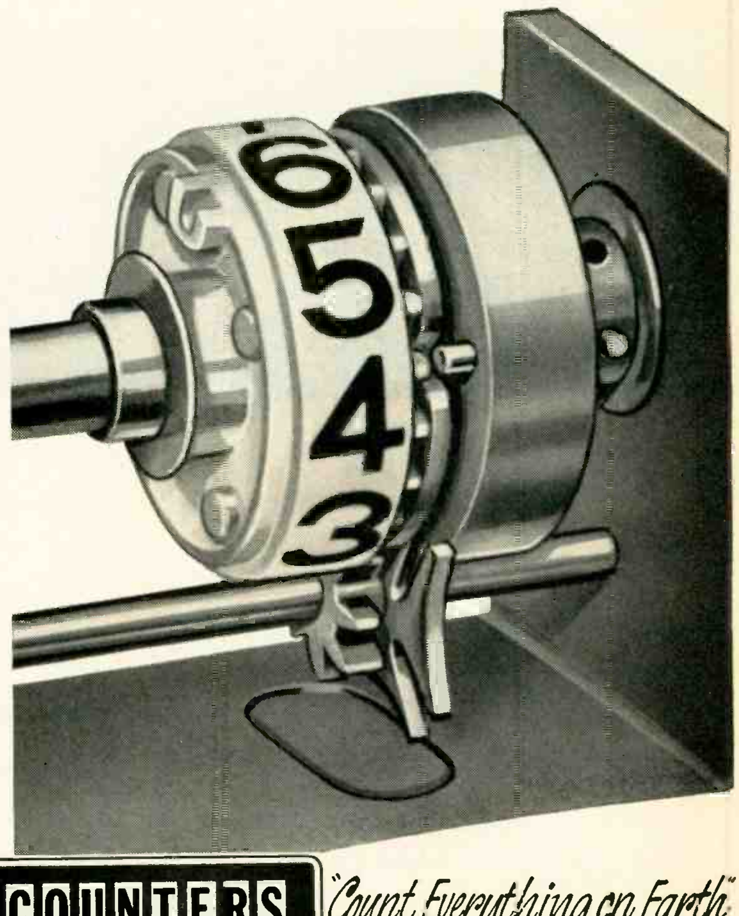
. . . then you will find out what we mean when we say . . .

Everyone Can Count on VEEDER-ROOT

You're looking at a new *and patented* development...featuring the Veeder-Root "Geneva Transfer"...designed for higher speeds and easier readability from a distance.

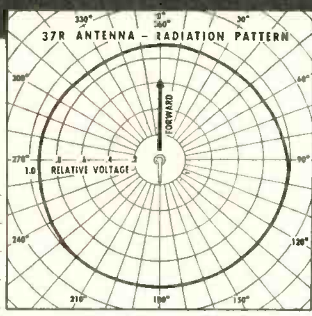
Here's another vitally important Veeder-Root "first," for use in military equipment. And within the understood limitations of the present-day rule of "first things first" . . . what can we *figure out* for you?

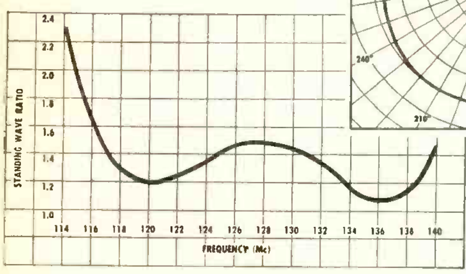
VEEDER-ROOT INC.
HARTFORD 2, CONN. • GREENVILLE, S. C.
Montreal, Canada Dundee, Scotland
Offices and agents in principal cities



VEEDER-ROOT COUNTERS *"Count Everything on Earth"*

NEW! VHF COMMUNICATIONS ANTENNA FOR AIRCRAFT

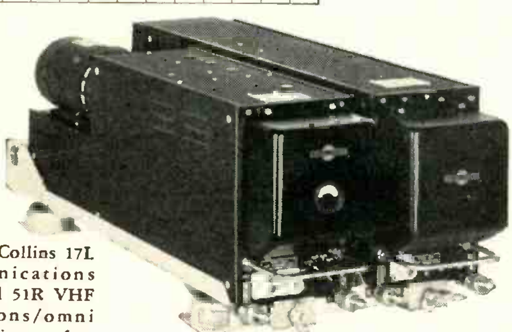




This is a portrait of the new Collins 37R-1 antenna, made expressly for use with the Collins 51R-17L two-way VHF communications system. It is designed for the most efficient radiation and reception of vertically polarized communications signals in the frequency range of 118 to 136 megacycles. Note the excellent radiation pattern and standing wave ratio graphed on this page.

The 37R-1 mounts externally on the skin of the aircraft. Its mounting base, identical with the Collins type 37J-2 omni antenna, greatly simplifies installation especially on pressurized aircraft. Only the r-f connector protrudes through the skin of the ship.

We invite inquiries and investigation of this highly specialized and effective development.



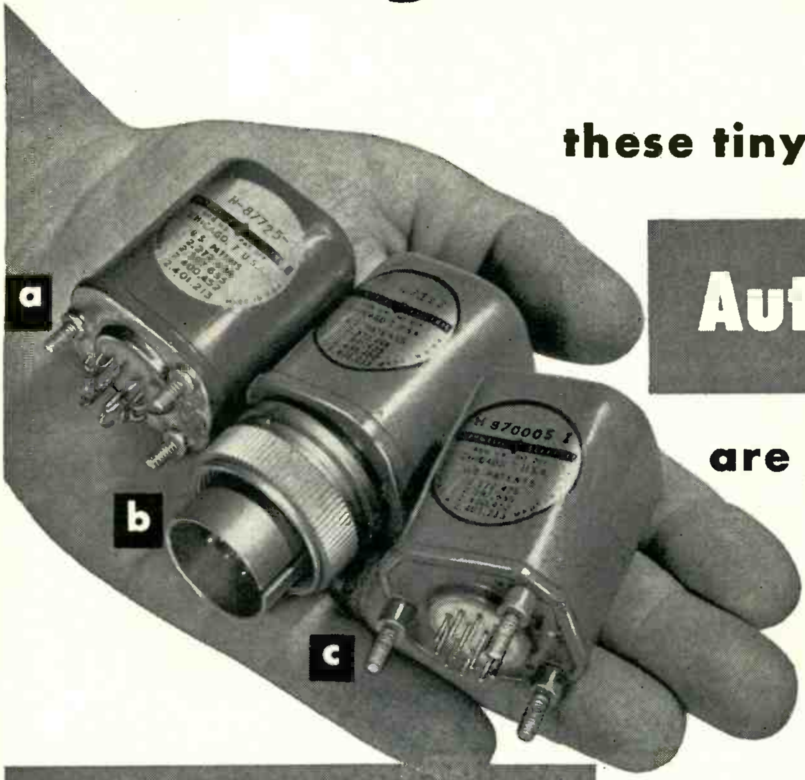
Left to right: Collins 17L VHF communications transmitter and 51R VHF communications/omni navigation receiver as furnished in specially designed dual shockmount.

In aviation communications, it's . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, NEW YORK 18 **2700 West Olive Avenue, BURBANK**

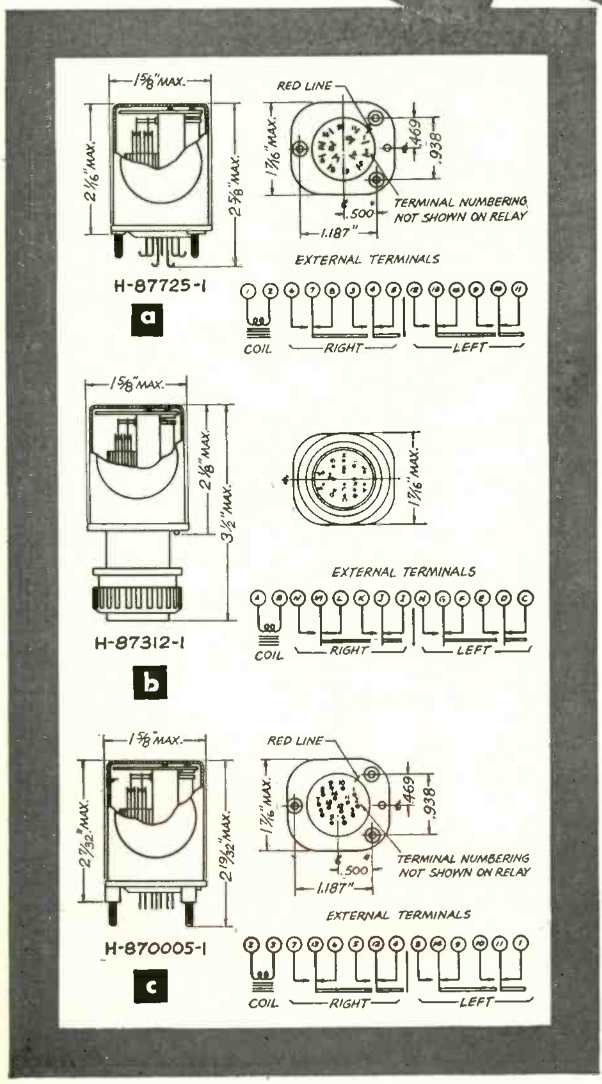
Nothing can touch them!



these tiny Class "S" Relays from

Automatic Electric

are **HERMETICALLY SEALED**



To give your product high performance standards, use relays that meet *aviation's* highest standards. These Automatic Electric Class "S" Relays meet them all!

small, light-weight—mount in any position in a restricted space...save valuable room, hold down weight.

resist shock and vibration—contact operation is dependable at vibration up to 10.5 G's.

protected from harmful conditions—operate in "ideal" atmosphere of dry nitrogen, sealed against dust, corrosion, atmospheric pressure changes and tampering.

versatile in application—as shown at left, Class "S" Relays are available with solder-or socket-type terminals...and with the contact arrangements *you* specify.

Other telephone-type relays can also be supplied, with or without hermetically sealed enclosures. Write for circulars. Address: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS **SWITCHES**

AUTOMATIC ELECTRIC

CHICAGO

Burnell NOW BIGGER THAN EVER IN THE PRODUCTION OF TOROIDS AND FILTERS

TYPICAL "Q" CHARACTERISTICS OF BURNELL TOROIDS WOUND ON MOLYBDENUM PERMALLOY CORES

Several years ago we began to specialize in the design and manufacture of toroidal coils and audio filter networks. At that time too few electronic engineers were aware of the full value of toroids (particularly those wound on molybdenum permalloy dust cores) as very little publicity had ever been devoted to a product that was fast becoming one of the most vital in the development of modern communications and control equipment.

We believe that since then through our technical service and advertising methods we have helped thousands of engineers to understand and appreciate the toroid as an essential in network applications.

The resulting popularity and industry acceptance of our toroidal coils and filters have necessitated an expansion of our production facilities to ten times what they were five years ago and we are proud to point to this growth as an expression from our customers of their satisfaction in the quality of our product and our service.

STANDARD SIZES
TC-1 = 1⅝″ O.D. x ⅝″
TC-2 = 2¼″ O.D. x ⅞″
TC-3 = 1½″ O.D. x 9/16″

MINIATURE SIZES
TC-0 = ⅞″ O.D. x ⅜″
TC-4 = 1-3/16″ O.D. x 9/16″
TC-5 = 1-3/16″ O.D. x 9/16″

MAXIMUM INDUCTANCE
TC-1 — Ind.-Up to 10 Hys.
TC-2 — Ind.-Up to 100 Hys.
TC-3 — Ind. MHY-Up to 750
TC-0 — Ind.-Up to 2 Hys.
TC-4 — Ind.-Up to 10 Hys.
TC-5 — Ind. MHY-Up to 750

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

Burnell & Company
YONKERS 2 NEW YORK
CABLE ADDRESS "BURNELL"

HOW you can produce for less...

TO SELL MORE PROFITABLY

Leading producers of electrical and electronic parts have found Plaskon Alkyd a real helper in producing better parts, faster...often for less.

Plaskon Alkyd is an ultra high-speed, thermosetting plastic molding compound with excellent electrical properties. It can be molded three to four times faster than conventional thermosetting materials... assuring greater production from molding equipment.

Loss from profit-robbing rejects is reduced because Plaskon Alkyd just doesn't require a lot of fussy, kid-glove care to mold. It's much less sensitive to variations in pressure, temperatures and time than other thermosetting materials.

And you can save some real money on tooling costs with Plaskon Alkyd. Simple, less expensive dies are required to mold it. Plaskon Alkyd's high-speed molding characteristics assure greater production from each mold cavity. And fewer cavities are needed to maintain your production schedules.

Plan to use Plaskon Alkyd to produce for less... to sell more profitably!

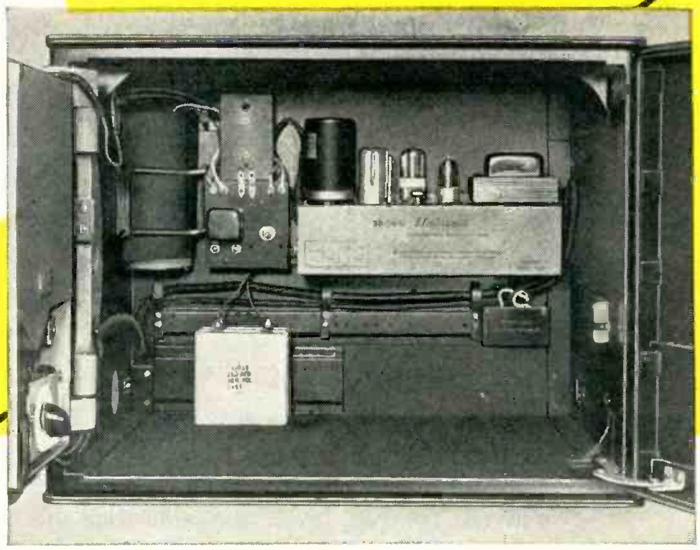
...mold it better and faster with

PLASKON® ALKYD

PLASKON DIVISION • LIBBEY • OWENS • FORD GLASS CO.
2136 Sylvan Avenue • Toledo 6, Ohio
In Canada: Canadian Industries, Ltd., Montreal, P. Q.
Branch Offices: Boston, Chicago, New York, Los Angeles, Rochester
Manufacturers of Molding Compounds, Resin Glues, Coating Resins

BROWN INSTRUMENTS ACCELERATE RESEARCH

For Accurate Records Of Rapidly Changing Variables



Internal view with chassis swung out . . . showing amplifier and damping circuit components.

. . . the *NEW* HIGH SPEED *ElectroniK* RECORDER

OPERATING CHARACTERISTICS

- **ACCURACY**—*0.25 per cent of span (spans over 12 mv.); 0.030 mv. (span under 12 mv.)*
- **DEAD ZONE**—*0.06 per cent of span (over 12 mv.); 0.007 mv. (under 12 mv.)*
- **NOMINAL SPEED**—*Full scale in one second, maximum.*
- **CHART SPEEDS**—*1, 2, 3 and 4 inches per second (change gears provided) or any standard chart speed.*
- **STANDARDIZATION**—*Push-button.*
- **POWER SUPPLY**—*115 volts, 60 cycles.*

Now you can accurately record on a *null-balance instrument* full scale signals which vary as rapidly as 20 cycles per minute. Signals with a peak to peak amplitude of 10% of scale, can be reproduced at variations up to 3 cycles per second.

The new *ElectroniK* High Speed Recorder is especially designed to measure rapidly changing variables in laboratory and test applications. The instrument develops a pen speed that traverses its *eleven* inch graduated chart in *one second!* It has chart speeds up to 4″ per second—20 feet per minute. It incorporates an adjustable damping circuit . . . and has a motor driven reroll mechanism to maintain constant tension on the chart.

Adaptable to the measurement of practically any d-c signal, the *ElectroniK* High Speed Recorder can be employed in conjunction with thermocouples, Radiamatic pyrometers, pressure and force transducers . . . plus a host of other devices capable of resolving variables to d-c signals.

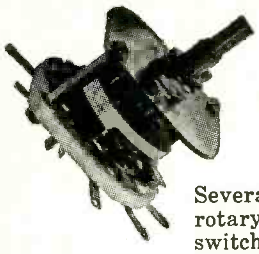
For detailed information write for Data Sheet No. 10.0-7.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* 4428 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

Something New



NEW OVAL SELECTOR SWITCHES

Several new oval rotary selector switches are described in Bulletin L13 just issued by the Shallcross Manufacturing Co., Collingdale, Pa. Six basic plates and three rotor types produce switches having from one to three poles per deck or gang and with other desired mechanical and electrical details. As many as 18, 9 or 6 positions may be obtained in single-, double-, or triple-pole types respectively. These may be single-, double, or triple-pole decks exclusively or a combination of different types.

VERTICAL STYLE PRECISION RESISTORS FOR JAN USES

Improved vertical style precision wire-wound resistors for use where mounting requirements make it desirable to have both terminals at the same end of the resistor have been introduced by the Shallcross Manufacturing Co., Collingdale, Pa. These units provide a longer leakage path from the mounting screws to the terminals. Known as Shallcross Types BX120, BX140, and BX160, they are designed to meet JAN requirements for styles RB 40 B, RB41B and RB42B respectively. For commercial uses, the resistors carry somewhat higher ratings than for JAN applications. Wire leads instead of terminals can be furnished if desired. Complete details will gladly be sent on request to the manufacturer.

FLAT, METAL-ENCASED WIRE-WOUND RESISTORS

Flat, metal-encased, Type 265A wire-wound power resistors introduced by the Shallcross Manufacturing Company, Collingdale, Penna. are space wound, have mica insulation, and are encased in aluminum for mounting flat against a metal chassis. At 175° C. continuous use they are conservatively rated for 7½ watts in still air and 15 watts when mounted on a metal chassis. Write for Bulletin 122.

ADV

EXTRA-DEPENDABLE

LONG-LIVED

WON'T SHORT

WITHSTAND HIGH HEATER-CYCLING

SHOCK-RESISTANT

G-E 5-STAR ARINC TUBES ARE 5 WAYS BETTER!

Take your design cue from airmen who praise the superiority of ARINC types!

"Records kept by our company show replacement of ARINC tubes to be only 2% as compared with an average of 49% replacement for 13 types of regular tubes over the same period."

W. W. LYNCH, *System Communications Superintendent,* Pan American World Airways System.

"Our company is using ARINC reliable tubes wherever possible. Experience has shown that equipment using these tubes seldom causes delays from tube failure."

J. H. CARMICHAEL, *President,* Capital Airlines.

"The effect of using ARINC tubes in our equipment became immediately apparent. Off-schedule removals of airborne equipment due to tube failures have been materially reduced."

J. R. CUNNINGHAM, *Director of Communications,* United Air Lines.

"During a six months' carefully controlled comparison service test, ARINC tubes required only 1/4 as many replacements as first quality standard brand tubes."

FRANK R. WAGNER, *Supervisor of Radio, Electrical and Instrument Engineering,* TWA

"We have four VHF Navigation Receivers which have been in service for more than 1,000 hours each. Of the 104 ARINC tubes used, we have not had a single failure."

J. LANE WARE, *Supervisor of Communications Engineering,* National Airlines.

A pioneer in manufacturing ARINC tubes, G.E. offers nine 5-star types which set new standards of dependability and long life. Specify these tubes in electronic circuits now on your boards, to increase safety factor . . . reduce upkeep costs . . . *build reputation* for your equipment!

G-E 5-star ARINC tubes are a joint achievement of Aeronautical Radio, Inc., and General Electric Co. Built with exacting care—individually tested—they accent the reliability of altimeters, radio compasses, h-f receivers, other apparatus that guides air passengers safely to their destinations.

Learn more about G-E 5-star tubes! Write for Bulletin ET-B29A, which tells the story of their design, manufacture, and testing . . . describes and rates the various 5-star types . . . shows how *you,* as equipment builder or designer, can profit from their superior performance! *General Electric Company, Electronics Department, Schenectady 5, New York.*

GL-5654—Sharp-cutoff r-f pentode
GL-5670—H-f twin triode
GL-5686—Power-amplifier pentode
GL-5725—Semi-remote-cutoff r-f pentode
GL-5726—Twin diode
GL-5749—Remote-cutoff r-f pentode
GL-5750—Pentagrid converter
GL-5751—High-mu twin triode
GL-5814—Medium-mu twin triode

GENERAL ELECTRIC

185-K4

YOU'LL FIND ALL 3 IN CHASE SHEET BRASS

Chase brass sheet is uniform in gauge, temper and surface. It is quality metal with accurate widths, straight, smooth edges and clean, flat surfaces. Remember, too, that the same degree of close supervision and critical inspection goes into every bit of Chase copper or bronze alloys in strips or rolls.

For information on all forms of brass and copper—sheet, rod, wire, tube—write on business letterhead for 124 page book, "Commercially Important Wrought Copper Alloys." Gives composition, forms available, uses, properties of over 50 copper alloys, weights, tolerances and other data.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	(†sales office only)
Chicago	Houston†	Newark	Rochester†	
Cincinnati	Indianapolis	New Orleans	St. Louis	

Control Room WGEM, Quincy, Illinois
Affiliated with GATES

HOW MANY ARMS should your engineer have?

If you're talking about arms in sleeves, we'll concede that the usual pair is ample — if, however, you're talking about those on turntables, well, that's a different story!

Station managers are finding it good business, indeed, to own more than the usual two turntables. There are many reasons, among them the increasing trend toward more and more transcribed commercials that must go in split second sequence without a "hitch" — often during station breaks. Engineers often find it impossible to "set up" the minimum two turntables for best results.

With an extra turntable or two, station breaks and spots are aired with precision — studio dramatic productions "live" with well timed sound effects. Extra turntables mean extra flexibility — smoother station operation.

Then, too, your salesmen will tell you it's profitable to have a turntable available for client audition, without having to make the customer wait 'til the show is "off the air"!

Actually, from the standpoint of investment, the cost of an extra turntable or two is small when proper consideration is given the many advantages they offer in better employee and customer relations, in smoother productions and in dependable "on-the-air" insurance!

The unquestioned quality of GATES transcription equipment will make it your first choice in bringing your station up to modern standards.

Write today for your copy of GATES complete Transcription Turntable Catalog.

GATES

GATES CB-10, MASTER TRANSCRIPTION TURNTABLE . . .

Provides complete transcription facilities independent of control room equipment. Incorporates GATES CB-11 Chassis for all speeds with built-in three-stage pre-amplifier, power supply and pick-up of your choice. Mixing control, broadcast-cue switch and filter control conveniently located on sloping front panel. Attractive two-tone gray cabinet.

GATES CB-14 TRANSCRIPTION TURNTABLE

Probably the most popular transcription turntable in use today. Transcription chassis is GATES CB-11, providing operation at all speeds. Variable filter is on the chassis proper and a mercury starting switch is conveniently located on the side. Available with or without self-contained pre-amplifiers. All GATES Transcription Turntables are available with the pick-up of your choice.

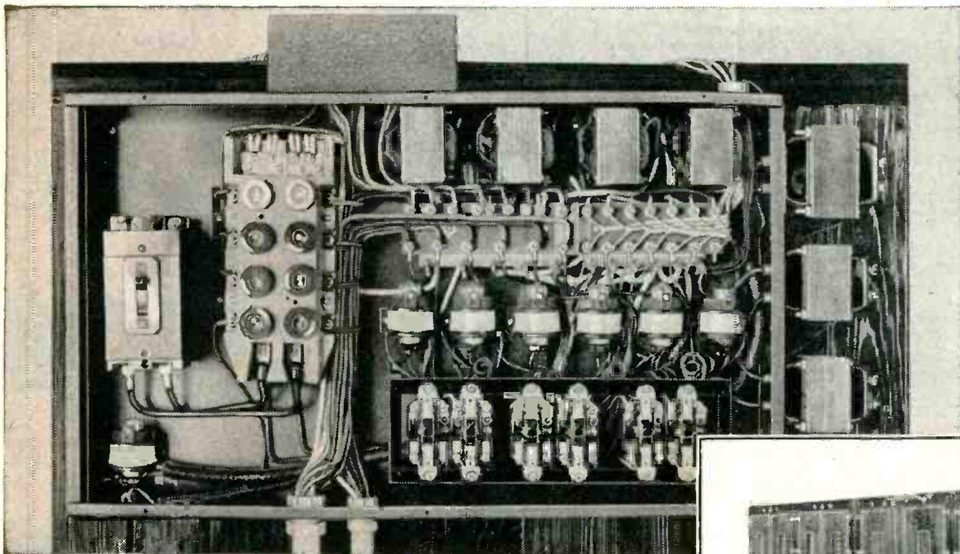
GATES RADIO COMPANY • MANUFACTURING ENGINEERS • QUINCY, ILLINOIS, U. S. A.

2700 Polk Avenue, Houston, Texas • Warner Building, Washington, D. C. • International Division, 13 E. 40th St., New York City
Canadian Marconi Company, Montreal, Quebec

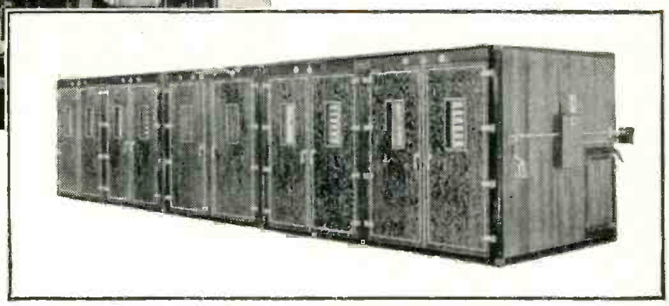
With the help of ADLAKE RELAYS—

ADLAKE RELAYS AT WORK
—One of a series of advertisements on specific ADLAKE applications.

You can count your chickens Before they hatch!



Dependable Robbins Incubators use ADLAKE RELAYS in Essential Control Circuits



The master control panel of a Robbins Incubator, showing the seven ADLAKE Relays that are an essential part of the over-all control circuit.

Control relays have a tricky job to do in incubators. As Mr. B. L. Rosenberg, Vice-President of the Robbins Incubator Company of Denver, wrote in a recent letter, "The exacting and precise control required in our specifications makes it essential that the control relays we employ be highly sensitive and dependable. The latest modifications have made ADLAKE Relays better than ever before, and we are entirely satisfied with them."

ADLAKE Relays are designed and built to meet the most exacting needs of industry. Their mercury-to-mercury contact prevents burning, pitting and sticking, and their sturdy construction armors them against outside vibration or impact.

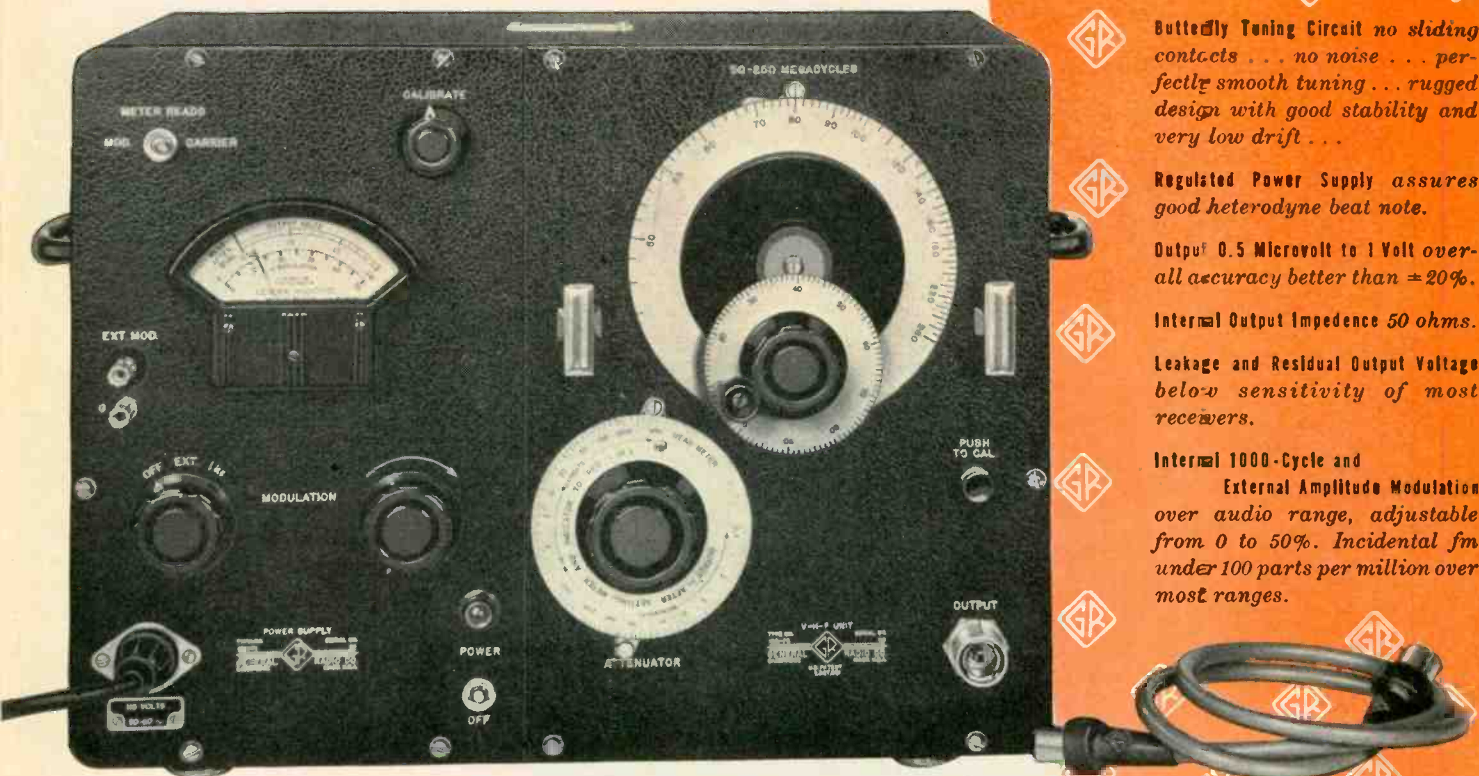
Most important of all, *they require no maintenance*, for they are hermetically sealed against dust, dirt and moisture.

For the full story on the part ADLAKE Relays can play in *your* business, just drop a card to The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every ADLAKE Relay Gives You These Advantages:
• HERMETICALLY SEALED — dust, dirt, moisture, oxidation and temperature changes can't interfere with operation. • SILENT AND CHATTERLESS • REQUIRES NO MAINTENANCE • ABSOLUTELY SAFE

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago
Manufacturers of Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits



Butterfly Tuning Circuit *no sliding contacts . . . no noise . . . perfectly smooth tuning . . . rugged design with good stability and very low drift . . .*

Regulated Power Supply *assures good heterodyne beat note.*

Output 0.5 Microvolt to 1 Volt *over-all accuracy better than ±20%.*

Internal Output Impedence *50 ohms.*

Leakage and Residual Output Voltage *below sensitivity of most receivers.*

Internal 1000-Cycle and External Amplitude Modulation *over audio range, adjustable from 0 to 50%. Incidental fm under 100 parts per million over most ranges.*

Standard Signal Generator

for Television, V-H-F Video, and U-H-F Channels

50 to 920 Mc.

The General Radio Type 1021-A Standard-Signal Generator operates at frequencies between 50 and 920 Mc with the same convenience and reliability found in other G-R generators in the broadcast frequencies.

Its main use is the determination of radio receiver and circuit characteristics. With an inexpensive diode modulator, television picture modulation can be produced for overall testing of television receivers.

It is a convenient and well-shielded source of power for measurements with bridges, impedance comparators, and slotted lines. For these uses internal modulation is provided.

With the G-R Type 874 line of Coaxial Elements, this generator provides a very complete and flexible system for measurements of voltage, power and standing-wave ratio from 50 to 920 Mc.

Two separate oscillators are available. They are mechanically and electrically interchangeable and are sold as separate units to convert the range of one standard signal generator to that of the other.

Type 1021-P1 Power Supply and 1000 cycle modulation source .	$195.00
Type 1021-P2 U-H-F Oscillator Unit only (250-920 Mc.)	$420.00
Type 1021-P3 V-H-F Oscillator Unit only (50-250 Mc.)	$400.00

To cover the complete range of 50 to 920 Mc., the following units are required: Type 1021-P1 Power Supply, Type 1021-P2 U-H-F Oscillator (250-920) Mc and Type 1021-P3 V-H-F Oscillator (50-250 Mc.) — Total Price . . . **$1015.00**

Type 1021-AV V-H-F Standard-Signal Generator (50-250 Mc) . . . $595.00

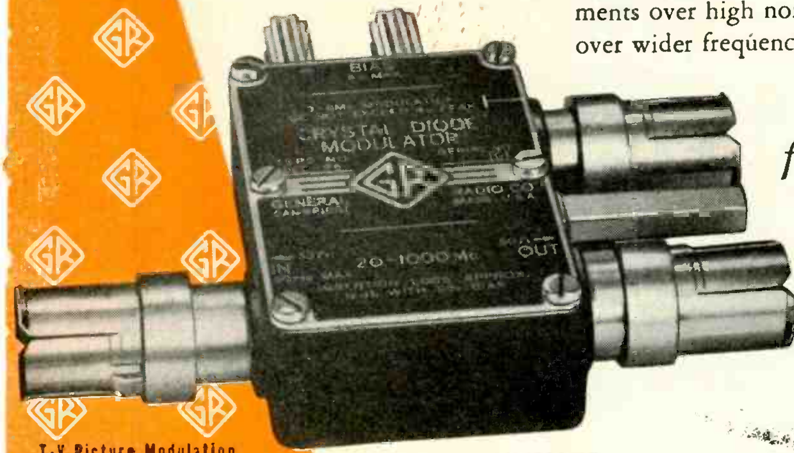
Type 1021-AU U-H-F Standard-Signal Generator (250-920 Mc) . . . $615.00

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

for Bridge and Slotted Line Measurements

High output voltage of one volt across 50 ohms makes possible measurements over high noise levels. Filter characteristics may be taken over wider frequency ranges for given noise level.



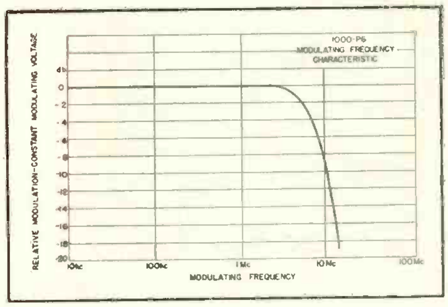
for Pulse Modulation

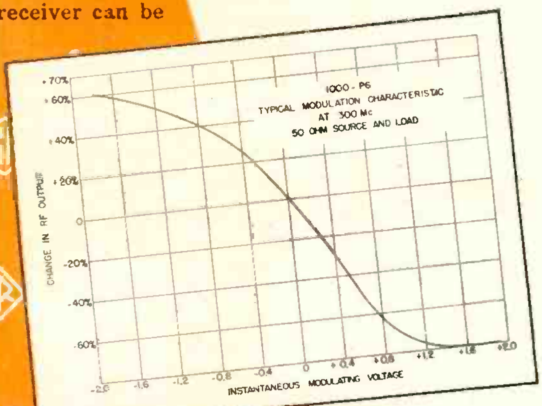
and for T-V picture modulation, the Type 1000-P6 Crystal Diode Modulator provides the means to obtain it with *no* accompanying frequency modulation. Plugs into Signal Generator output externally. Video or pulse modulation is applied from any convenient source. Note these characteristics in charts below.

T-V Picture Modulation on all Channels

Type 1000-P6 Crystal Diode Modulator — $35.00

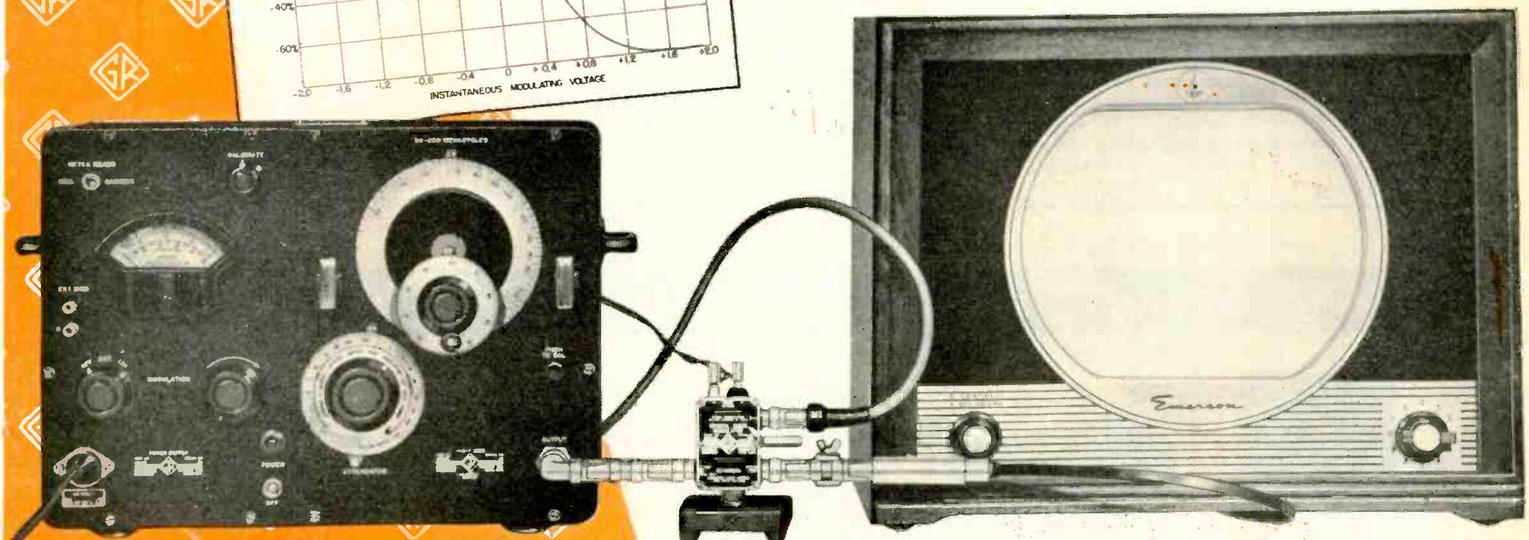
from 50 to 920 Mc with *no incidental FM,* when Type 1000-P-6 Crystal-Diode Modulator and source of video signals are used. The power requirements for modulation are so low, video output from a standard T-V receiver can be used.





above Typical Modulation Characteristic at 300 Mc. Up to 30% modulation there is no significant difference in characteristic from 20 to 1000 Mc.

at left Frequency Characteristic of Type 1000-P6 Diode Modulator.



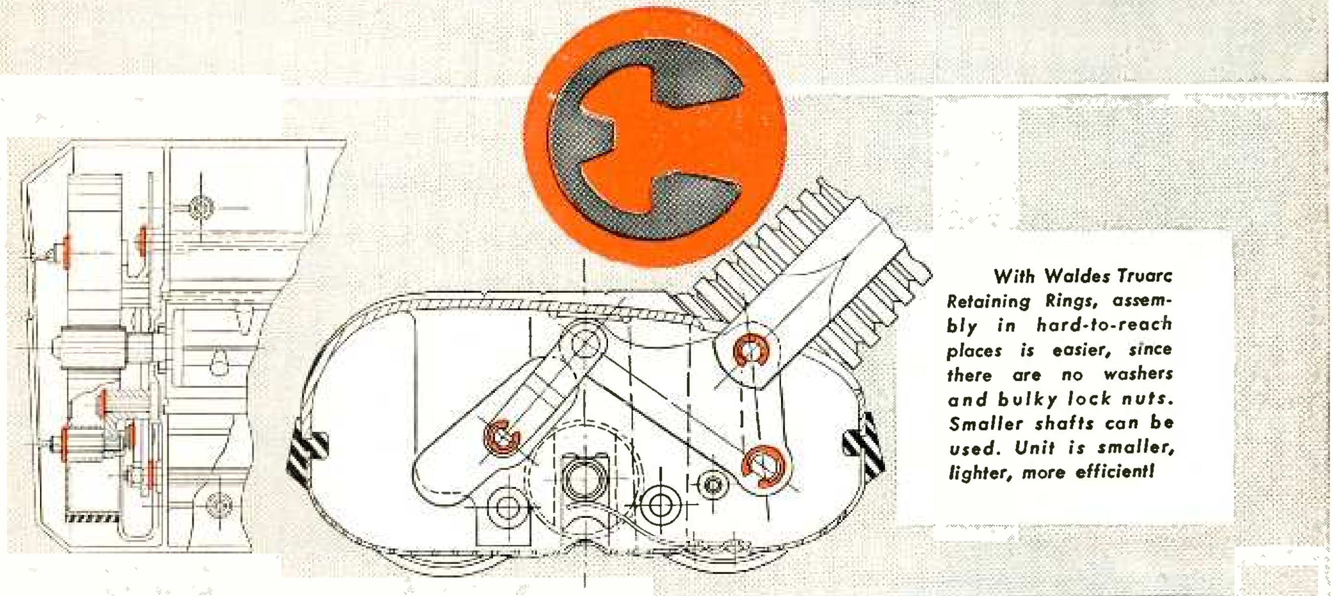
Type 1021-AV V-H-F Standard-Signal generator with Type 1000-P6 Crystal Diode Modulator, set up for tests on a television receiver.

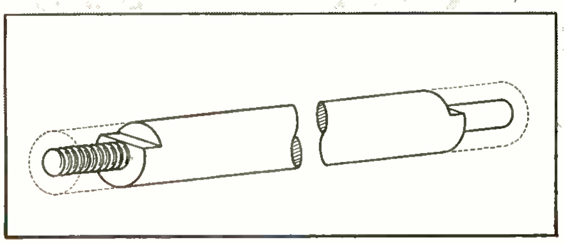
90 West Street NEW YORK
920 S. Michigan Ave. CHICAGO
1000 N. Seward St. LOS ANGELES

Since 1915 — Designers and Manufacturers of Electronic Test Equipment

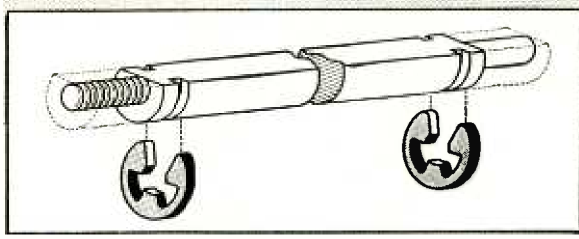
STROBOSCOPES • VARIACS • SOUND-LEVEL METERS • VIBRATION METERS IMPEDANCE BRIDGES • SIGNAL GENERATORS • OSCILLATORS • WAVE ANALYZERS • DISTORTION METERS • IMPEDANCE STANDARDS • VACUUM-TUBE VOLTMETERS • FREQUENCY STANDARDS • BROADCAST MONITORS • PARTS AND ACCESSORIES

12 TRUARC RINGS SAVE 25% MATERIAL ...50% LABOR COSTS...50% ASSEMBLY TIME





CONVENTIONAL WAY: 2 round rods were required, milled down to D-shape. 4 threading operations to accommodate lock nuts.



TRUARC WAY: Truarc Rings allowed Lewyt Corporation to use 2 stock D-shape rods. No milling . . . no threading—just 2 grooves!

Using 12 Waldes Truarc E Retaining Rings in their new "101" Vacuum Cleaner nozzle brought the Lewyt Corporation, Brooklyn, N. Y. tremendous material and labor savings...eliminated 2 milling and 12 threading operations...made possible the use of stock extruded D-shaped rods...simplified maintenance. And with Waldes Truarc Rings unit is 15% lighter...10% smaller overall!

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered... quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

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

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country

SEND FOR NEW BULLETINS

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS:
U. S. PAT. 2,382,948; 2,420,921; 2,411,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place E063
Long Island City 1, N. Y.

Please send Bulletins 6, 7 and 8—giving engineering specifications for all types of Waldes Truarc Rings.

Name__________

Title__________

Company__________

Business Address__________

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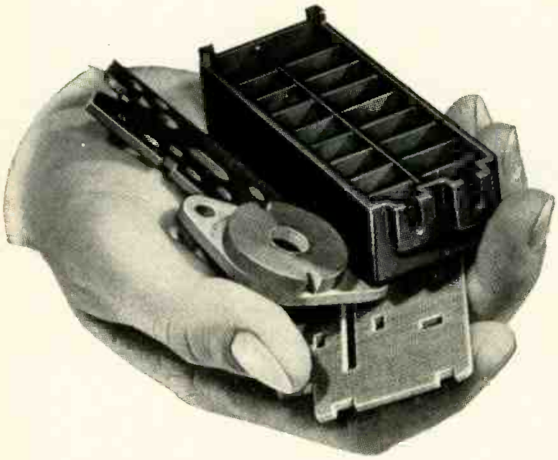
678

LOOK TO *The* RICHARDSON COMPANY FOR HELP ON PLASTICS FOR YOUR DEFENSE ORDERS



● If you have a puzzling plastics problem, consult The Richardson Company. The extensive services of its research, design, and engineering departments are offered you without cost or obligation.

Richardson engineers have a broad background in the plastics industry. For many years they have been co-operating with manufacturers in the selection or development of the correct plastics materials, choice of the proper manufacturing process, and actual production of the plastics part. Richardson's molding, laminating, and fabricating experience assure you a thorough handling of your plastics problem from beginning to end.

1 MATERIALS TO MEET GOVERNMENT REQUIREMENTS

The Richardson Company has extensive experience in the volume production of materials made to meet government requirements. In addition, Richardson develops new materials for special applications.

2 FACILITIES FOR MOLDING AND LAMINATING

Richardson is one of the few companies that have the engineering experience and production facilities to do both molding and laminating, and to produce molded laminates and post-formed laminates.

3 SIX PLANT LOCATIONS

The Richardson Company operates large, modern plants at 6 widely separated locations: Melrose Park, Ill.; Indianapolis, Ind.; Newnan, Ga.; New Brunswick, N. J.; Tyler, Tex.; and Ogden, Utah.

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

2797 Lake St., Melrose Park, Illinois (Chicago District)

INSUROK®
Laminated and Molded Plastics

SALES OFFICES: Cleveland • Detroit • Indianapolis • Lockland, Ohio • Los Angeles
Milwaukee • New Brunswick, (N. J.) • New York • Philadelphia • Rochester • St. Louis

SWIFT, SURE FREQUENCY COMPARISON

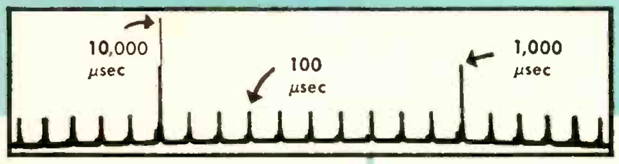


FIG. 1. Timing Comb, -hp- Model 100D

NEW (hp) SECONDARY FREQUENCY STANDARDS

MODELS 100C AND 100D

- Sine or rectangular waves
- 100 μsec time markers
- Built-in oscilloscope
- Stability 1/1,000,000
- Low output impedance
- New, improved circuits
- Audio, supersonic, rf measurements

SPECIFICATIONS

-hp- 100D Secondary Frequency Standard

Accuracy:
About 2 parts per million per week, normal room temperature.

Stability:
About 1 part per million over short intervals.

Output:
Controlled frequencies: 100 kc, 10 kc, 1 kc, 100 cps, 10 cps. Sine or rectangular waves; marker pips. Internal impedance approx. 200 ohms.

Wave Shape:
Sine wave: less than 4% distortion into 5,000 ohms or higher load.

Marker Pips:
10,000, 1,000 and 100 μsec intervals.

Oscilloscope:
Integral with circuit. Establishes 10:1 Lisajous figures to show division ratio. May be used independently of standard.

-hp- 100C Secondary Frequency Standard

Accuracy:
Within ± .001% normal room temperature.

Output:
Controlled frequencies of 100 kc, 10 kc, 1 kc, and 100 cps. Internal impedance approx. 200 ohms.

Wave Shape:
Sinusoidal only. 4% distortion into 5,000 ohm load.

Power Supply:
(100C and 100D) 115 v, 50/60 cps, regulated to minimize line voltage fluctuations. Power drawn approx. 150 watts.

Mounting:
(100C and 100D) Cabinet or relay rack. Panel 19" x 10½". 12" deep.

Data Subject to Change Without Notice

The new *-hp-* 100C and 100D Secondary Frequency Standards incorporate all the features of the time-tested *-hp-* models 100A and 100B, plus important new advantages including rectangular wave output, timing pips, and an internal oscilloscope for convenient frequency comparison. The *-hp-* 100D may be conveniently standardized against station WWV with a minimum of external equipment, and thus provide most of the advantages of an expensive primary standard.

Crystal Controlled Frequencies

The new *-hp-* Models 100D and 100C employ a crystal-controlled oscillator and divider circuits offering a new high in stability and simplicity of operation. Standard frequencies are available through a panel selector switch, and may be employed simultaneously. Internal impedance is low (about 200 ohms), so that standard frequencies can be delivered at some distance from the instrument.

The *-hp-* 100D Secondary Frequency Standard offers sine waves at 5 frequencies and rectangular waves at 4 frequencies, plus a built-in oscilloscope. The instrument also provides a timing comb with markers 100, 1,000 and 10,000 microsecond intervals. Rectangular wave output has a rise time of approximately 5 microseconds. Accuracy is 2 parts per million.

5 v. at all Frequencies

The more moderately priced *-hp-* 100C Standard offers sinusoidal frequencies at 4 crystal-controlled frequencies and, like the *-hp-* 100D, provides 5 volts of output at all frequencies. Accuracy .001%.

Both models operate from a 115 v. ac power supply, and power is regulated to minimize power line voltage fluctuations.

Get full details . . . see your -hp- representative or write direct . . . today!

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(hp) laboratory instruments
FOR SPEED AND ACCURACY

TONE ARMS—STYLI

...still available ...still tops

PRODUCT shortages? Sure. But there's *never* a letdown in the *quality* of G-E phono-accessories . . . and the items shown above are still available to manufacturers, jobbers, dealers and servicemen.

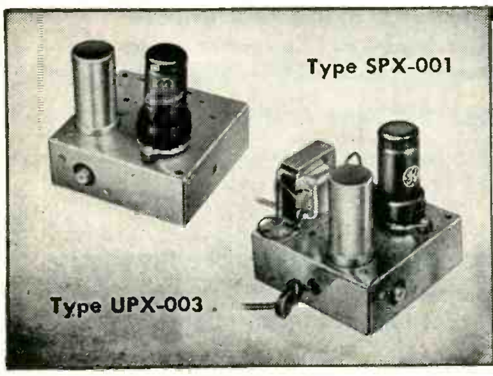
The G-E tone arm is built to accommodate the famous G-E Triple Play Cartridge (also in stock). It's equipped with ball bearings for smooth lateral movement . . . special light weight alloy keeps the arm mass to a minimum . . . stylus pressure is *constant at 6-8 grams for all three speeds* to reduce record wear. Plainly marked selector knob projects through the top of the arm—a single twist places either stylus in playing position.

General Electric's high compliance Baton Stylus with diamond or sapphire tip is unsurpassed in its field. Stock it in quantity—give your customers listening quality that lasts.

MANUFACTURERS: Your production requirements of General Electric phono-accessories can still be filled. General Electric application engineers have suggestions that will help you design a better product. Call or wire us today for details. *General Electric Company, Parts Section, Electronics Park, Syracuse, New York.*

HERE'S PLUS BUSINESS!

Use G-E phono Preamplifiers to sell *modernization* to your customers. Self-contained for easy installation, these units are ready to operate when connected to a power source. They provide sufficient amplification to enable the Variable Reluctance Cartridge to be used with any standard phonograph.



General Electric Company, Section 461
Electronics Park—Syracuse, N. Y.
Please forward information on the G-E phono accessories checked:

☐ Variable Reluctance Cartridges ☐ Replacement Styli ☐ Phono Preamplifiers ☐ Tone Arms

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MYCALEX

low loss miniature
TUBE SOCKETS

OFFER ALL THESE ADVANTAGES:

- CLOSER TOLERANCES
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- HIGH ARC RESISTANCE
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- GREAT DIMENSIONAL STABILITY
- IMMUNITY TO HUMIDITY
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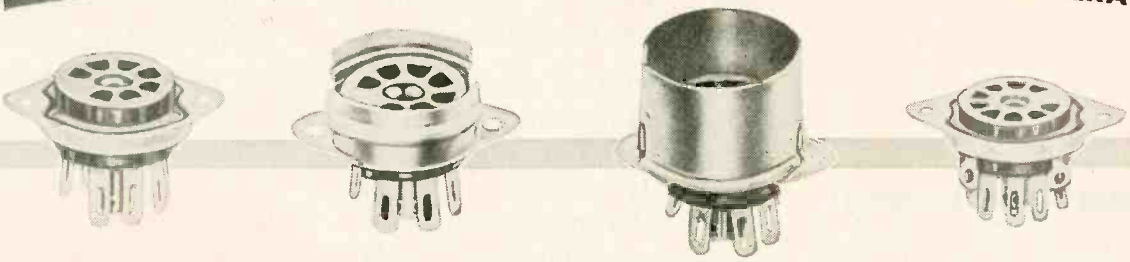

-cost no more than
PHENOLIC TYPES

These glass-bonded mica sockets are produced by an exclusive MYCALEX process that reduces their cost to the level of phenolic sockets. Electrical characteristics are far superior to phenolics while dimensional accuracy and uniformity exceed that of ceramic types.

MYCALEX miniature tube sockets, available in 7-pin and 9-pin types, are injection molded with great precision and fully meet RTMA standards. They are produced in two grades, described as follows, to meet diversified requirements.

MYCALEX 410 is priced comparable to mica-filled phenolics. Loss factor is only .015 at 1 mc., insulation resistance 10,000 megohms. Conforms fully to Grade L-4B under N.M.E.S. JAN - 1 - 10 "Insulating Materials Ceramic, Radio, Class L".

MYCALEX 410X is low in cost but insulating properties greatly exceed those of ordinary materials. Loss factor is only one-fourth that of phenolics (.083 at 1 mc.) but cost is the same. Insulation resistance 10,000 megohms.

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MYCALEX CORPORATION OF AMERICA
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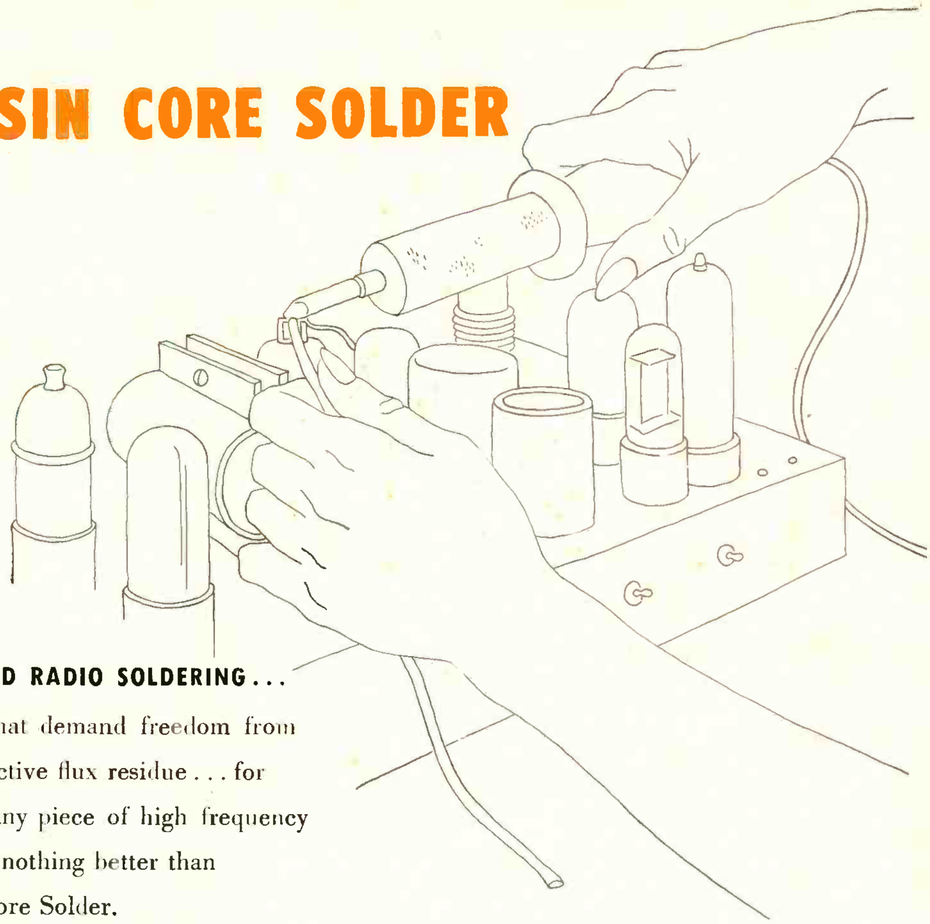

for **TELEVISION AND RADIO SOLDERING . . .**

for operations that demand freedom from corrosion and conductive flux residue . . . for soldering on any piece of high frequency equipment . . . there is nothing better than Federated Rosin Core Solder.

Each Rosin Core Solder composition is a precise alloy of tin and lead with a pure turpentine distillate flux that is effective but not corrosive. This means that current leakage at radio frequencies is prevented.

Federated Rosin Core Solder is unequalled for consistency and ease of working . . . for the permanence of the bond it produces. Look for it on the familiar orange and black metal spool. 1, 5, and 20-pound sizes.

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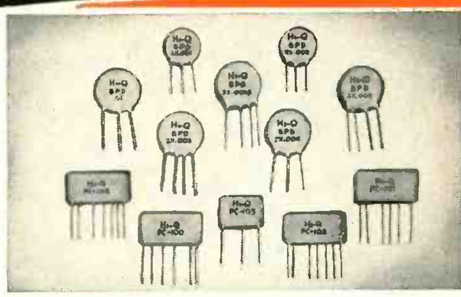
. . . and in producing better and better TV MODERN ELECTRONICS LOOK TO HI-Q*

Capacitors • Trimmers • Choke Coils • Wire Wound Resistors

The fast development of the television industry since World War II has been matched, stride for stride, by **HI-Q.** For TV producers were quick to recognize this organization as their most dependable source for the ceramic components they needed in such profusion. They quickly learned that **HI-Q** engineers were competent and resourceful in developing new components to meet new needs as they arose.

Now, though **HI-Q** output has reached several million capacitors, trimmers, choke coils and wire wound resistors each month, never once have the original precision standards or strict adherence to specifications and tolerances been shaded — or the rigid system of inspection of each individual unit at each stage of production been relaxed. The **HI-Q** engineering staff is just as ready as ever to cooperate with your engineers in the production of special components for special requirements.



HI-Q DISKS AND PLATES

High dielectric by-pass, blocking or coupling capacitors for use where their geometrical shape makes them more adaptable than tubular components. Essentially similar, other than shape, except that in multiple units, **HI-Q** Plates do NOT have to have a common ground, as is the case with the Disk type.

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- **PRECISION**
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- **DEPENDABILITY**
- **MINIATURIZATION**

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* *Trade Mark Registered, U. S. Patent Office*

HI-Q*

Electrical Reactance Corp.
OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia, Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y. Jessup, Pa., Myrtle Beach, S. C.

Where did this car come from?

Most of us think that new cars come from big auto-making cities.

But the fact is, new automobiles are assembled in these cities—but their hundreds of parts come from every state in the union!

Bringing in these parts involves plenty of expert timing. A few missing pieces can slow up production seriously. A few missing doorhandles can stop an assembly line!

But the auto makers never let that line stop. They keep their cars rolling by using the speed of planes. They bring in needed parts by Air Express!

Today, with increased production for defense, Air Express speed helps keep the tanks and planes rolling, too. Whatever your business, here are the unique advantages you can enjoy with regular use of Air Express:

IT'S FASTEST — Air Express gives the fastest, most complete door-to-door pick up and delivery service in all cities and principal towns, *at no extra cost.*

IT'S MORE CONVENIENT—One call to Air Express Division of the Railway Express Agency arranges everything.

IT'S DEPENDABLE — Air Express provides one-carrier responsibility all the way and gets a *receipt upon delivery.*

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HOOK-UP WIRES and CABLES for COMMUNICATIONS EQUIPMENT and ELECTRONIC INSTRUMENTS

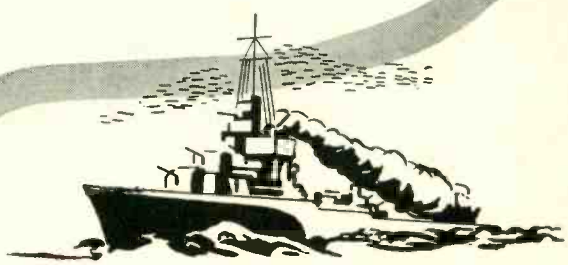
FOR almost a half century Lenz has been producing insulated Wires and Cables for the Communications Industries, wires that are engineered and designed under high quality standards.

Now, Lenz is prepared to furnish hook-up wire and cables for defense projects, conforming to Government specification JAN-C-76 TYPES WL, SRIR and SRHV.

These Thermo-Plastic Insulated Wires, with or without Lacquered Braids, and the cables constructed of same, are available for use in Communications Equipment and Electronic Instruments.

For a dependable source for your wire and cable requirements, consult Lenz.

CONFORMING TO
JAN-C-76
TYPES WL, SRIR and SRHV



ON THE SEA

ON LAND

IN THE AIR

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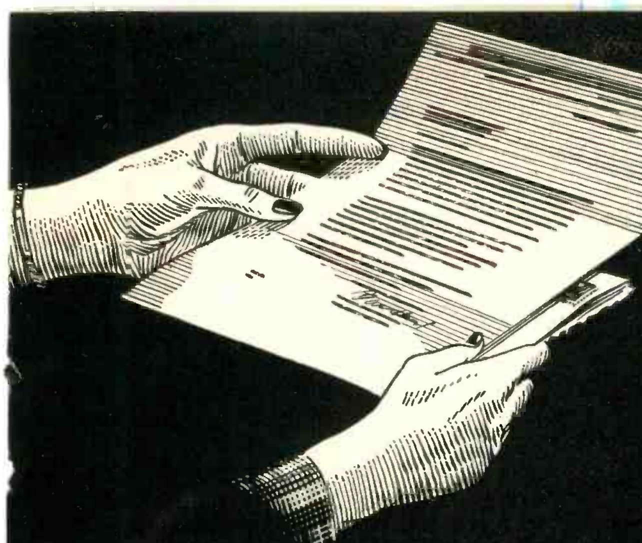

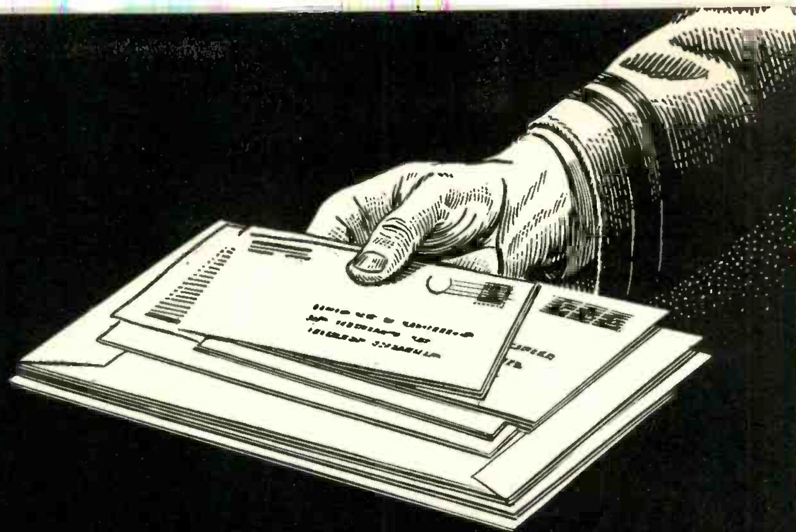

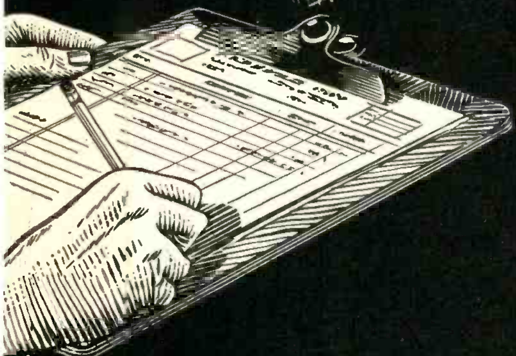

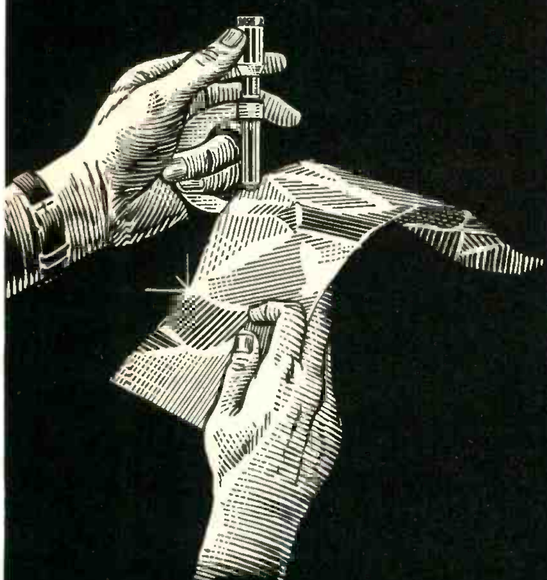

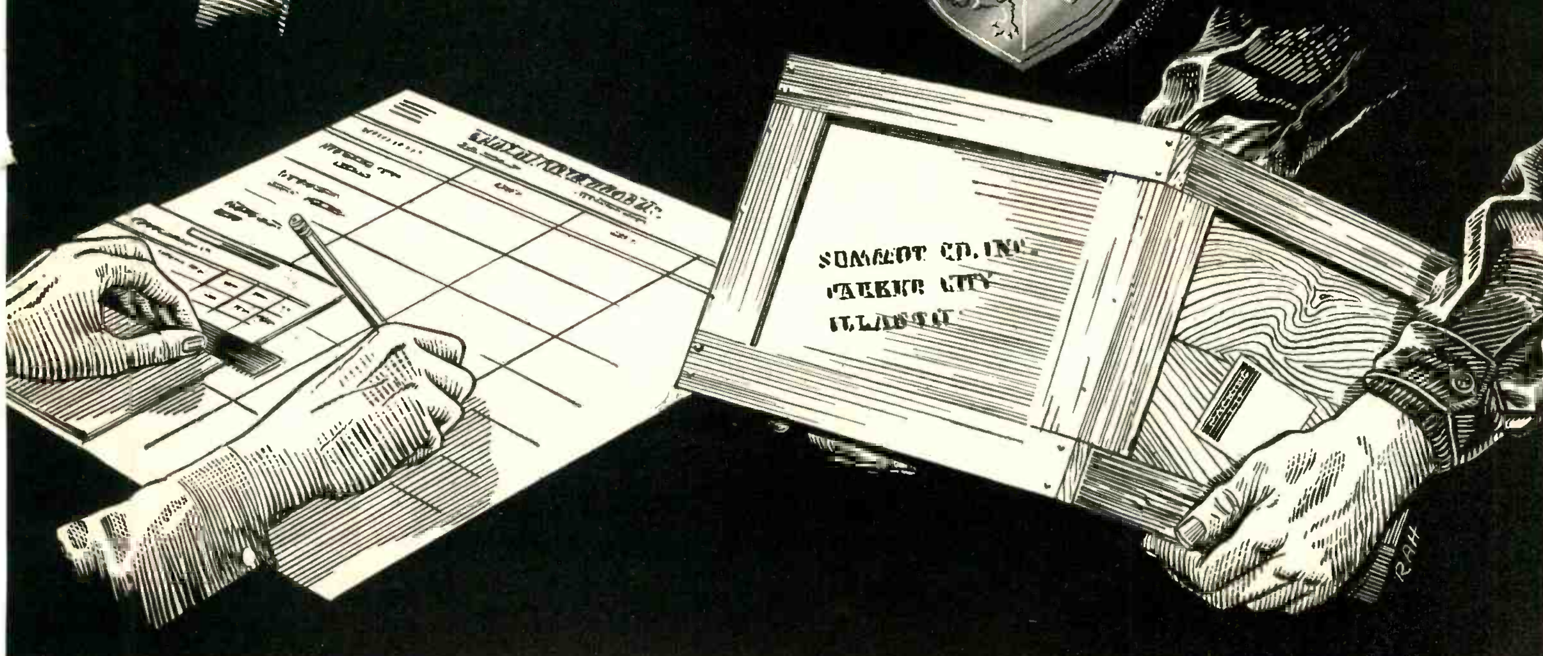

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Need permanent magnets?
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INDIANA makes nothing but permanent magnets . . .
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At INDIANA, permanent magnets get full-time attention
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Whether you want reliable "use" information
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The industry's greatest diversification
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when you call in INDIANA,
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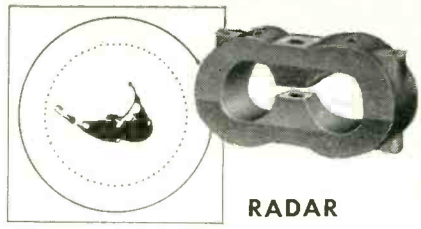
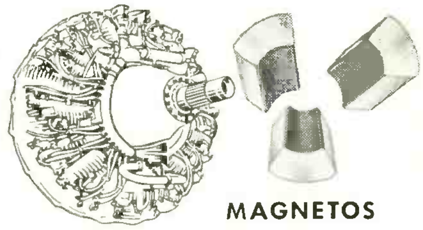
highest energy product of any magnet material.



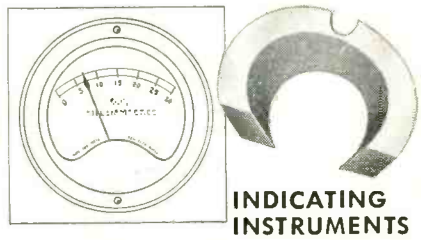
RADAR

Stability, inherent in permanent magnets, makes magnetron tubes practical.



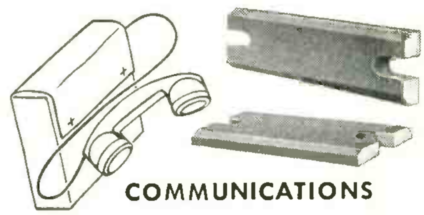
MAGNETOS

Reliability of permanent magnets makes magnetos the most dependable form of ignition.



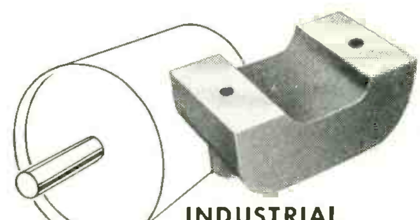
INDICATING INSTRUMENTS

Permanent magnets are essential to hundreds of types of instruments.



COMMUNICATIONS

Trouble-free permanent magnets permit unattended operation indefinitely.



INDUSTRIAL PROCESSING

Versatility of permanent magnets is continually improving processing. Illustrated: separator pulley for removing tramp iron from bulk material.

Many types and sizes of permanent magnets are available at once for your experimentations.

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is

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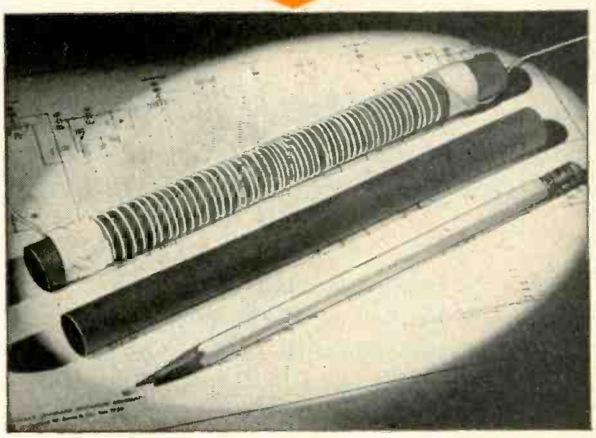
Sheer magic! This Croloy Radio Rod with suitable winding, replaces usual loop in today's advanced radios.

"Q" is of the order of 250 and up, as against 80 for average small loop mounted inside receiver. The Croloy Radio Rod fits anywhere — only 8" long by ½" diameter, or smaller. Pivoted and rotated for additional selectivity, or mounted vertically for omnidirectional reception. On the production line, the magnetic antenna can be mounted on chassis for complete assembly and test, before placement in cabinet.

Molded in widest ranges of shapes and sizes, Croloy provides other magical touches. Croloy deflection yokes expand TV-tube deflection angles without corresponding voltage increases. Croloy cores slash TV transformer bulk and cost. Croloy slug tuners and I. F. coils reduce cost and raise gain. Croloy components cut TV cabinet sizes and prices. Try Croloy: it's magic!

Let us collaborate on your TV, radio or electronic problems and needs. Samples, engineering service, and quotations.



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Pioneering POWERED-IRON and STEATITE products
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We Mobilize for Freedom

WHY Controls are Necessary

One of the encouraging characteristics of the American people is their dislike for government controls. This augurs well for the future of their economic and political freedom.

But for the next few years we must not only tolerate but also help to make effective a whole battery of emergency government controls over our economic life. If we fail to do this now the future of that freedom we cherish will be imperilled. It is the purpose of this editorial—the third in a special series—to explain in simple terms why this is so.

After our military victory in World War II, we rushed through a demobilization which cut our military strength to about one-tenth of its wartime peak. Our allies did much the same thing. But the Russians maintained much of their wartime military strength and built up that of their satellites. With prodigious speed we switched from military to civilian production and went on to enjoy a rousing postwar boom—the greatest in our history.

This boom was in vigorous progress when, on June 25 last year, the Russian-sponsored North Korean army attacked South Korea. Our industrial production was rolling along at almost twice its prewar level. We had labor shortages in many key industrial areas. Under the impact of heavy buying all along the line, prices were climbing.

When the North Koreans smashed into South Korea they smashed into our national consciousness this fact: if we want a fair chance to save our national freedom from destruction by Communist aggression, we must race to restore some of the military power we had so speedily written off after World War II. And we must do it with our resources already very fully occupied with a boom in civilian business.

Program Small Compared to World War II

Compared with our military effort in World War II, the mobilization on which we are now embarked is small. At its peak, under present schedules, it will absorb no more than one-fifth of the total national production. During World War II we reached a point when nearly half of our total production went for war-making.

Moreover, our economy now is much bigger and stronger than it was in World War II. During the last decade there has been an increase of about 15 percent in our labor force. Our workers have had the training advantage of steady employment. The capacity of our industrial establishment is two-thirds again as great as it was ten years ago. Since the war no less than $70 billion has been spent to expand and modernize it.

Given time, the industrial giant we have created could pick up in its stride the added load of production for defense that now is contemplated. But speed is of the very essence. There is little dissent from the proposition that if we are to stand off Russian aggression successfully we have, at the outside, two years in which to get ready.

Controls Needed to Prevent Chaos

These two facts – (1) the necessity for speed in our rearmament program and (2) an economy already stretched taut by a record civilian boom—create the general necessity for government controls. If we simply pile the billions of added defense expenditures authorized since last June on top of the civilian boom, and let it go at that, two destructive developments would follow. There would be a scramble for scarce materials, notably metals, which would create chaos in those markets. And prices would go through the roof.

Our situation during this mobilization is radically different from what it was when we rushed to get ready for World War II. Then we started with an economy that was coming out of a long depression. There was plenty of slack. Even in mid-1941 we still had over 6 million unemployed. Thus it was possible for us to expand war production greatly and also increase civilian living standards before the limits of our productive capacity made extensive controls necessary. But as we begin this new mobilization we find our economy already operating virtually at capacity. This fact is of key importance in understanding why this relatively small defense program so quickly requires the imposition of controls.

The selection and administration of controls thus far has been badly bungled. The threat of price controls, for example, was broadcast so vigorously and for so long that our people were virtually asked to raise prices and thereby do much to defeat the controls. Adequate taxation directed so as to attack inflation at the source and thus give direct price control a chance to operate has not yet been provided.

Indeed, we could readily assemble a long and devastating catalog of the deficiencies of the government's control program. But that would not dispose of the necessity for controls – by priority, by allocation, and, as a stop-gap, by direct prescription of selling prices – if we are to carry out our mobilization successfully. That is the only means by which a clear right of way for defense production can be cut through the highways of trade and commerce now jammed with civilian boom business.

Hope In The Wilson Plan

Since he became Director of Mobilization, Charles E. Wilson has added a new element of order and hopefulness to the mobilization program. He has laid out a plan which, if we are spared all-out war, would do three things by 1953. First, it would produce the weapons needed by our army and our allies to meet an immediate threat. Second, it would create the capacity that would enable us to move at high speed into weapons production for all-out war – if necessary. Third, it would create the additional production capacity that would restore by that date our ability to resume the climb of the American civilian standard of living.

In technical and industrial terms the Wilson Plan seems to be feasible. If it is successfully carried out, we should be able to begin getting rid of controls rapidly by 1953. But to carry out the program successfully, it must now have vigorous support from everyone. That does not mean mere agreement that it is a good plan. It means that we must conform to the controls that are necessary to make the plan work. In developing this support, the business community is in position to exercise crucially important leadership.

As has often happened in our national history, we are confronted by a paradox. We must accept emergency controls for the time being to insure survival of the freedom that they infringe. But, as we do this, we may find some comfort in the reflection that while controls from Washington are hateful, controls from Moscow would be infinitely worse.

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telegraph A1 or
telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

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

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-13.5 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to – 45° C using mercury rectifiers; 35° to – 45° C using gas filled rectifiers. Power supply, 200-250 volts, 50/60 cycles, single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

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

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

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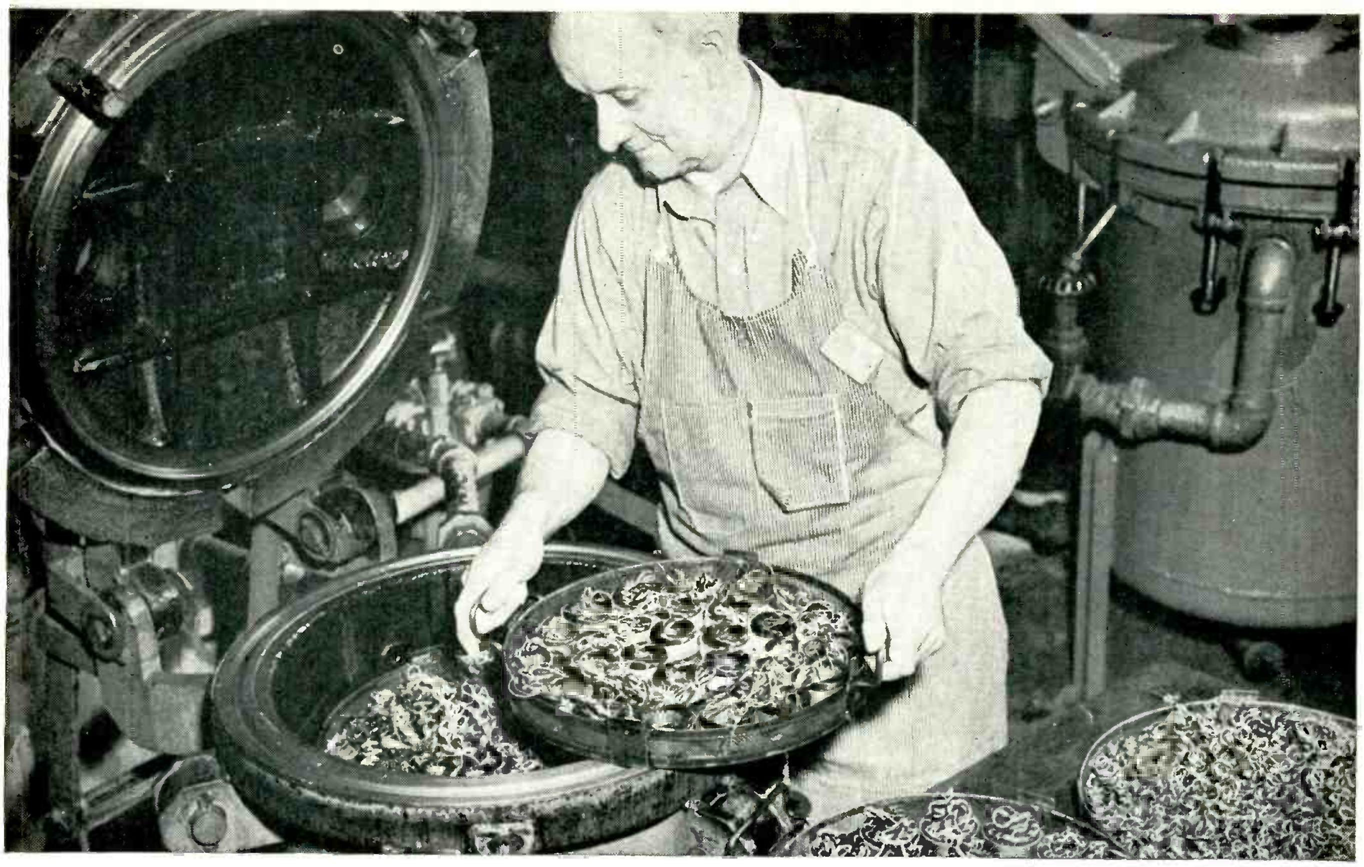
Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.



For *lasting* insulation strength, Sperry counts on HARVEL 912-C

For more than 10 years, Sperry Gyroscope Company has been insulating coils and other components with Harvel Internal Curing Varnishes, because of their excellent mechanical and electrical properties. Sperry . . . world famous for the quality and performance of its instruments . . . reports these specific advantages from the use of Harvel 912-C, electrical insulating varnish:

1. *High mechanical strength.* Conductors rigidly bonded into a compact mass. No soft, tacky varnish interiors to allow movement of conductors.
2. *High dielectric strength* . . . 2200 vpm. Electrical properties retained at high temperatures—unaffected by oil.
3. *Fast baking time.* 912-C cuts baking schedules as much as 50%—materially reduces production costs.

Sperry also turns to Irvington for Class "H" flexible insulations when space and weight are at a premium. Running safely at temperatures as high as 500°F, these insulations permit using smaller conductors, and thus open the way to lighter, more compact designs. It will pay *you* to investigate these Irvington products—mail coupon today for the full story.

Look to IRVINGTON for insulation leadership

- INSULATING VARNISHES
- VARNISHED CAMBRIC
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Please send me technical literature on:

☐ Harvel 912-C Varnish ☐ Class "H" Insulation

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Company..

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Westinghouse Switchboard Instruments are used as "standards" on this Universal Tube Test Station manufactured by Radio Corporation of America.

Westinghouse Switchboard Instruments are available in circular or conventional scale types for any switchboard application.

Where instrument accuracy is a "Must"... specify Westinghouse

The use of Westinghouse instruments as "standards" on RCA's Master Tube Test Stations demonstrates how they measure up to *your* need for accurate measurement of any electrical quantity.

In order to reliably measure the quality of all types of electronic tubes the instruments have to consistently maintain precise accuracy. Westinghouse Switchboard Instruments not only fulfill this requirement but provide important plus benefits as well: Easier readability—to simplify the operator's job . . . and co-ordinated space-saving design—to contribute to the functional compactness of the unit.

Here's further assurance of quality: all Westinghouse switchboard panel, portable and recording instruments are built to meet the rigid performance requirements of the American Standards Association. Moreover, you can select from . . .

The most complete line in the industry!

You get a wider selection for every need whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or synchrotie (position indicators). And you get . . .

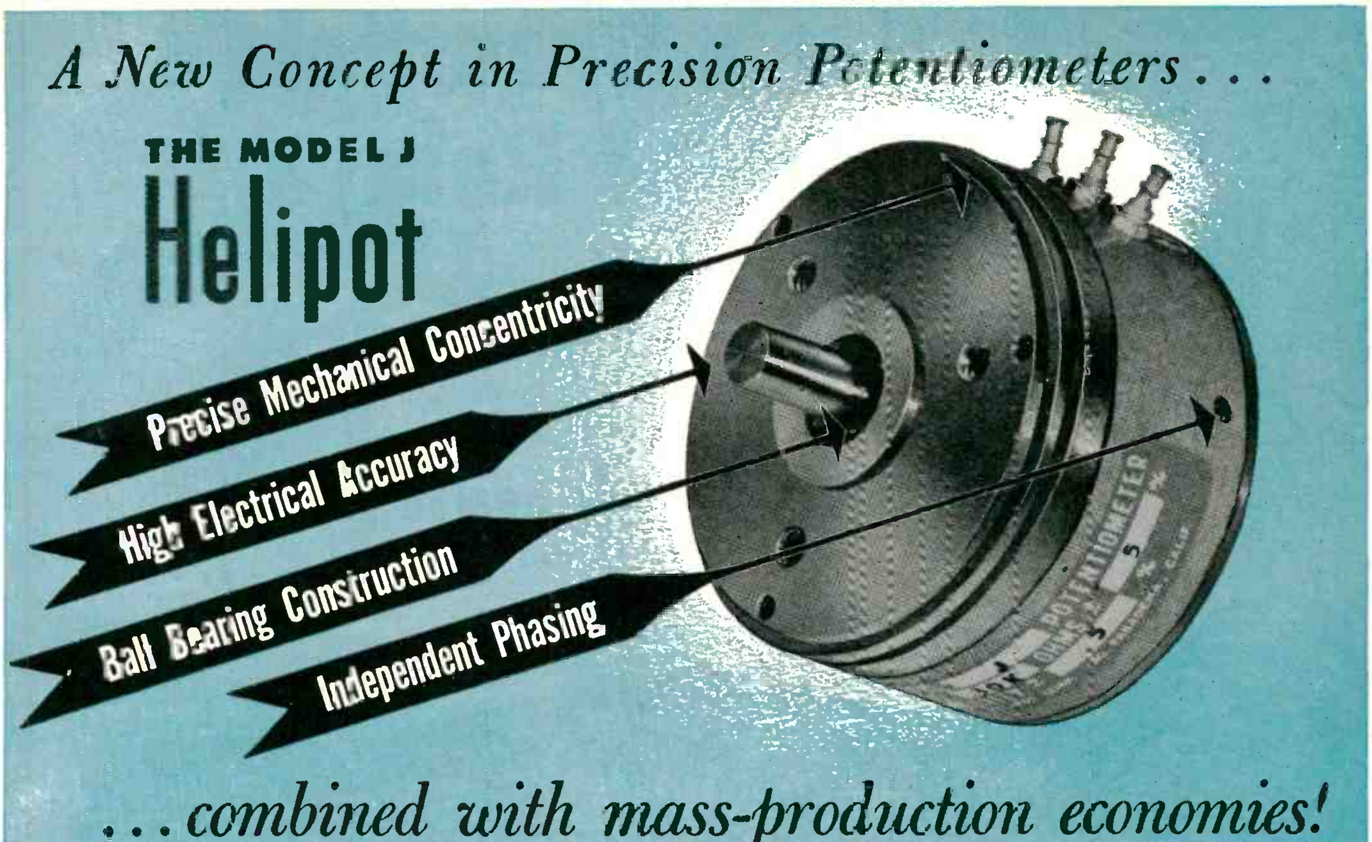
Competent application assistance!

Westinghouse Instrument Application Engineers are available to consult with and serve you in selecting and applying the proper instruments for your application. Simply call your nearest Westinghouse office.

For complete information about Westinghouse Instruments write for Booklet B-4696. Address: Westinghouse Electric Corporation, P.O. Box No. 868, Pittsburgh 30, Pennsylvania.

J-40400

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




TYPICAL 6 GANG MULTIPLE ASSEMBLY

***If it's a tough potentiometer problem, bring it to* Helipot**

—for Helipot has facilities and know-how unequalled in the industry for mass-producing precision potentiometers with advanced operating and electrical features.

This recently-developed 'Model J' Helipot, for example, combines several revolutionary advancements never before available in the potentiometer field . . .

Precise Mechanical Concentricity

Modern servo mechanisms and computer hook-ups require high mechanical precision to insure uniform accuracy when connected to servo motors through close-tolerance gears and couplings.

In the "Model J," close concentricity between mounting surface and shaft is assured by a unique mounting arrangement. The unit can be aligned on either of two wide-base flange registers and secured with three screws from the front of the panel . . . or it can be secured with adjustable clamps from the rear of the panel to permit angular phasing. Or if preferred, it can be equipped with the conventional single-hole bushing type of mounting.

In addition to accurate mounting alignment, exact rotational alignment is assured by the long-life, precision-type ball bearings upon which the shaft rotates. Precise initial alignment coupled with negligible wear mean high *sustained* accuracy.

High Electrical Accuracy

Helipot products have long been noted for their unusually high electrical accuracy and the "Model J" embodies the latest advancements of Helipot engineering in this field.

For example, tap connections are made by a new Helipot welding technique whereby the tap is connected to only ONE turn of the resistance winding. This unique process eliminates "shorted section" problems!

High linearity is also assured by Helipot's advanced production methods. Standard "Model J" linearity accuracies are guaranteed within ±0.5%. On special order, accuracies to ±0.15% (capacities of 5000 ohms and up) have been obtained.

Ball Bearing Construction

The shaft of each "Model J" is carefully mounted on precision-type ball bearings that not only assure sustained rotational accuracy, but also provide the constant low-torque operation so essential for servo and computer applications. Starting torque is only ¾ of an inch-ounce (±.25 in.-oz.)—running torque, of course, is even less.

Independent Phasing

When using the "Model J" in ganged multiple assemblies, each section can be independently phased electrically or mechanically—even after installation on the panel—by means of hidden internal clamps controlled from outside the housing. Phasing is simple, quick, accurate!

Mass-Production Economies

In addition to its many other unique features, Helipot engineers have developed unusual techniques that permit mass-production economies in manufacturing the "Model J". Actual price depends upon the number of taps required, special features, etc. . . . but with all its unique features, you will find the "Model J" very moderate in cost.*

Wide Choice of Designs

The "Model J" Helipot is available in a wide selection of standard resistance ranges—50, 100, 1,000, 5,000, 10,000, 20,000, 30,000 and 50,000 ohms . . . in single- or double-shaft designs . . . with choice of many special features to meet virtually any requirement within its operating field.

***Write for Bulletin 107 which gives complete data and price information on the versatile "Model J" Helipot!**

THE Helipot CORPORATION

South Pasadena 2, California

***Field Offices:* Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles and Fort Myers, Florida. *Export Agents:* Fratham Co., New York 18, New York.**

Potter & Brumfield's Super Midget Relays

...when Product Performance Requires:

Sensitivity

Operates on only 75 MW.

In spite of its small size this unique relay is capable of remarkable sensitivity. With maximum coil resistance of 10,000 ohms it will operate on only 2.75 ma while with minimum resistance of 0.15 ohm only 0.7 amp. is required. Relays for voltage operation are provided with ½ watt coils up to 60 volts; 1.2 watt at 115 volts. Maximum coil power permissible is 1.75 watt. Practically any combination for voltage or current operation can be provided within the limits given above. Voltage-operated relays pull in at 75% or less of nominal value; drop-out is approximately 50% of the pull-in value.

Vibration Resistance

Meets 10-G Air Force Tests

An unbelievable degree of vibration resistance has been engineered into this relay by the use of an extremely light movable element. Any type will stand 10-G test with ¼ watt in coil and the sealed relay mounted in socket with shield will pass this test with only 0.1 watt. Also meets 25-G shock test and will stand 50-G test non-operating without damage.

Compactness

½ Ounce — ½ Cubic inch

—for the unsealed relay. Sealed in drawn steel case, this relay is same size as miniature tube and fits into standard 7-pin socket. Weight of sealed relay is only ¾ ounce!

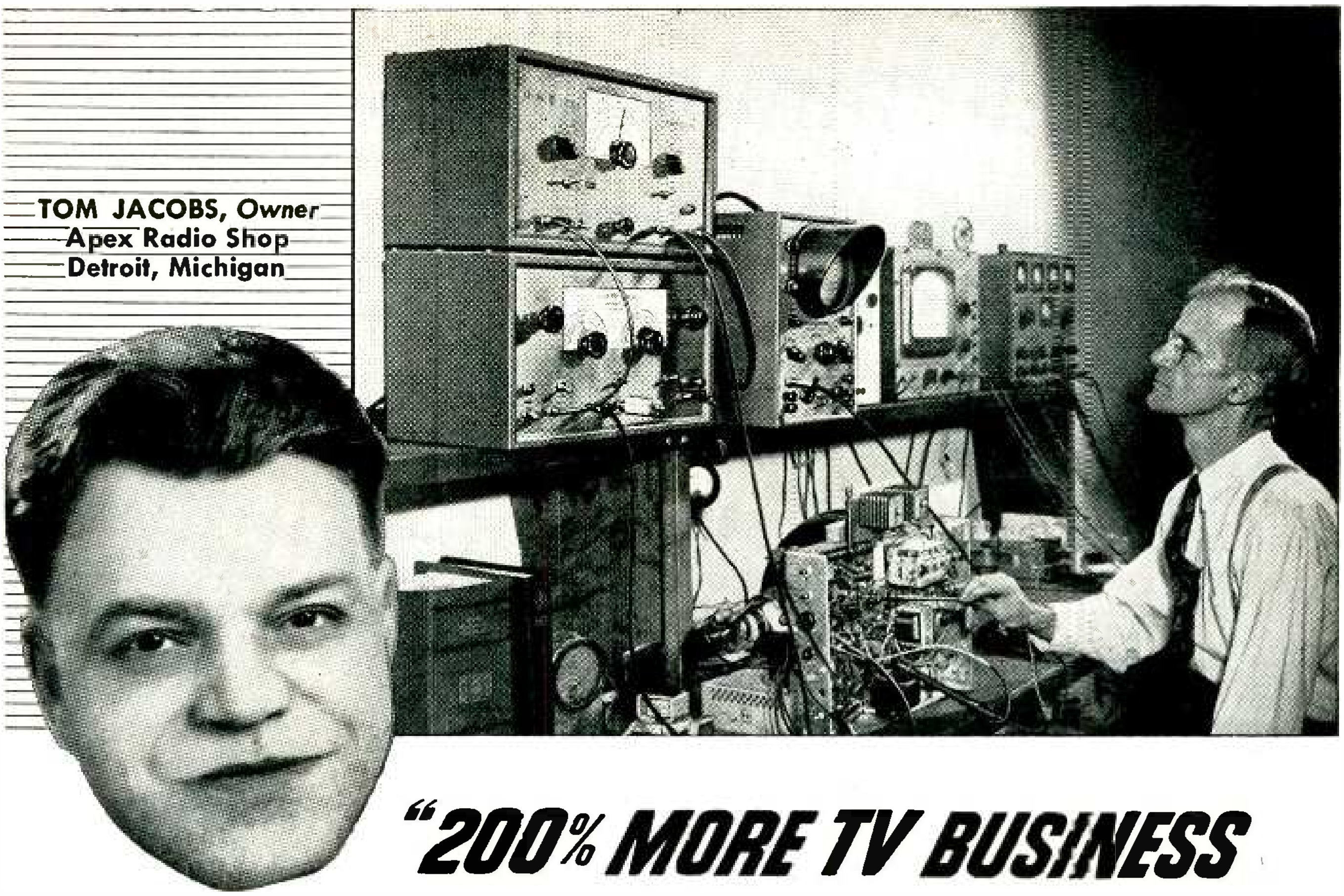
Hermetically sealed type SM relays may be used in sockets fitted with standard miniature tube shields. Such shields will provide adequate "hold-down" as required by military applications.

Potter & Brumfield

PRINCETON, INDIANA
EXPORT: 13 E. 40th St., NEW YORK, N. Y.

Your Electronic Parts Distributor Stocks Standard P&B Relays. Sales offices in principal cities.

Potter & Brumfield Super Midget relays have proven themselves in guided missile and related control applications. Numerous "tough" assignments have been successfully fulfilled by this rugged sub-miniature component under rigid government specifications. Samples and quotations will be supplied upon receipt of your specifications.



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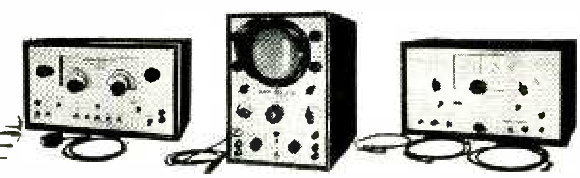
"The *Scope* is the best trouble-shooter on the market . . . it holds a steady trace —it's stable—you can overload it and it recovers instantly. The *Variable Permeability Sweep* is extremely simple to operate, and with the crystal-controlled *Marker Generator* we always get accurate and reliable results. While keeping profits up, the G-E Test Package has cut our service time in half!"

Hundreds of TV dealers and servicemen use G-E Test Equipment to turn out clean, accurate jobs that keep customers satisfied and put money in the till. Call your G-E distributor or mail coupon today for full information.



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• PORTABLE •
Instruments

Combining extreme sensitivity with high accuracy and a 6.1 inch scale, Weston Model 622 instruments are ideally suited for precise measurements of potential and current at the very low energy levels encountered in nuclear physics, electronics and electro-chemical research or in general test work. Hand calibrated, double pivoted, electrostatically and magnetically shielded.

These instruments are available as d-c voltmeters, millivoltmeters, milliammeters and microammeters; electrolysis volt-millivoltmeters and high resistance voltmeters. They are also made as thermocouple ammeters, milliammeters, and voltmeters; and as a-c rectifier type instruments. For technical data consult your Weston Representative, or write Weston Electrical Instrument Corporation, 595 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

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LAPP TUBE SUPPORTS

for mounting forced-air-cooled tubes

Now available as a standardized line, these Lapp insulated supports for mounting forced-air-cooled tubes facilitate design of transmitter and other high-power circuits. They are simple, compact and efficient. For high frequency tubes they are available either in Lapp porcelain or Lapp steatite; for standard broadcast frequencies in Lapp porcelain.

WRITE for specification sheets. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N.Y.

Lapp

ERIE STYLES 325 and 326 STAND-OFF CERAMICONS®

The Most Efficient Stand-Off Units for VHF and UHF Applications

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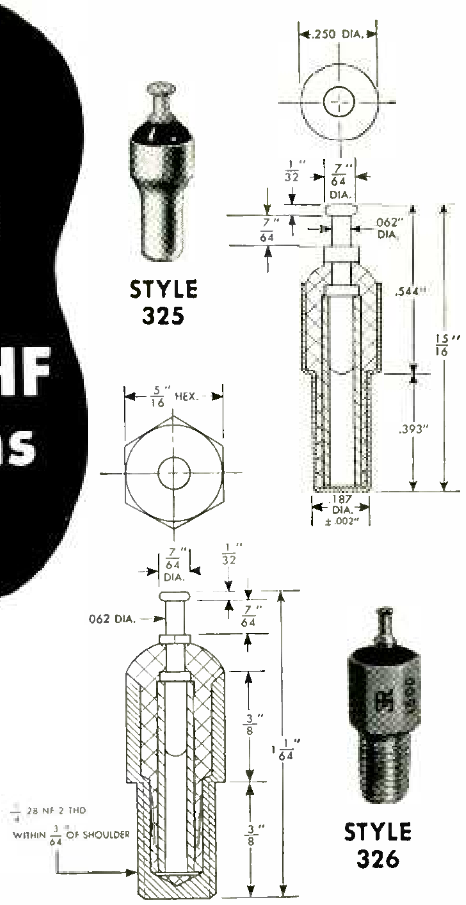

BETTER by-passing is one solution to control of regeneration in high frequency receivers. The Erie Styles 325 and 326 Stand-off Ceramicons offer outstanding features for extremely efficient by-passing. Style 325 is designed for push-on clip mounting to chassis; Style 326 is for threaded mounting installation.

This basic design provides, in a hermetically sealed case, a by-pass-to-ground through the shortest possible path. Full advantage is taken of the concentric electrode configuration in maintaining this short path by making connection to the outer electrode at the plane of the chassis. The result is an extremely low and uniform series inductance. In assembly operations both location and length of leads are accurately fixed, resulting in better mechanical uniformity. This feature has been demonstrated to be of particular importance in good VHF and UHF design.

OUTSTANDING FEATURES

1. Tubular ceramic capacitor is completely sealed.
2. Very low and uniform inductance path to ground.
3. Electrical shielding is provided by means of the grounded metal case.
4. Post terminal provides a sturdy tie point for several connections, and is made essentially to match tube socket terminal height in the interest of maintaining uniform short leads.

SPECIFICATIONS

Standard available capacitance values in MMF: 10, 33, 47, 68, 82, 100, 680, 1,000, 1,500. Voltage Rating, 500 VDC.

Electronics Division

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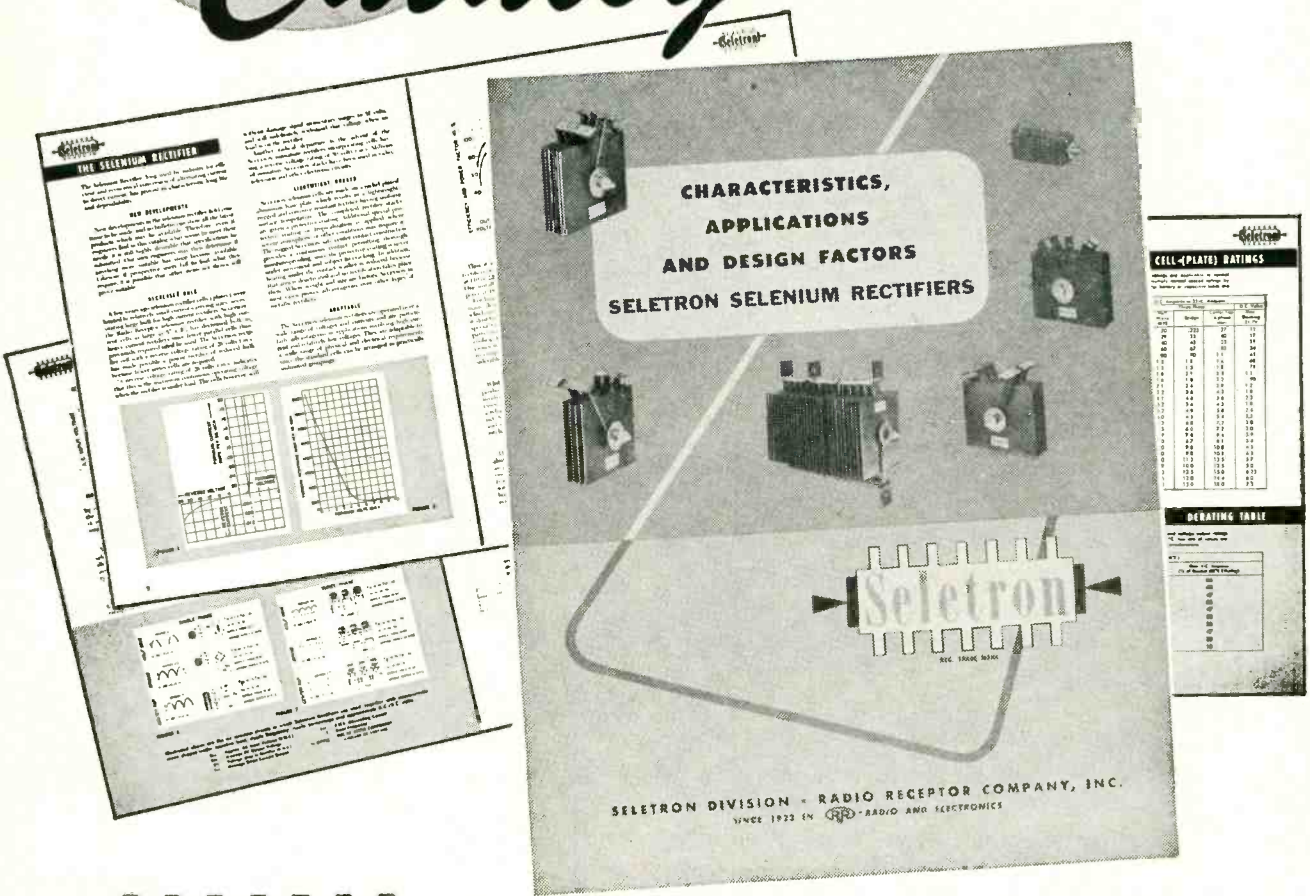
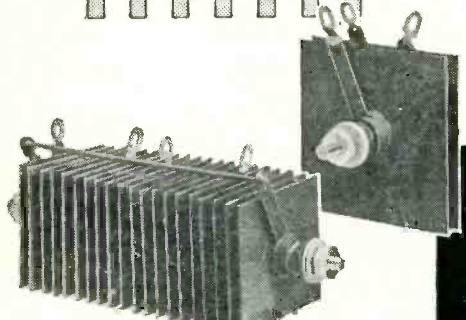


Seletron



THIS NEW two-color, fully illustrated catalog just off the press belongs on your desk for handy reference. Includes comprehensive listings of dimensions and ratings for miniature SELETRON selenium rectifiers, as well as a large selected group of power stacks. Also contains complete background material on these versatile rectifiers and illustrates many of their uses.

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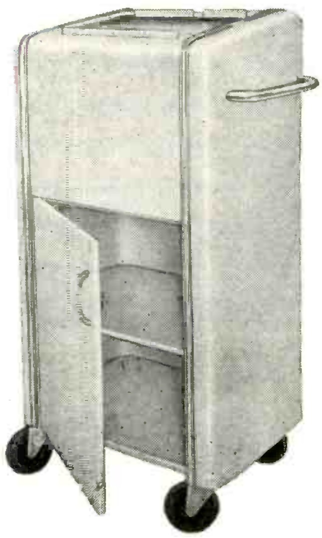

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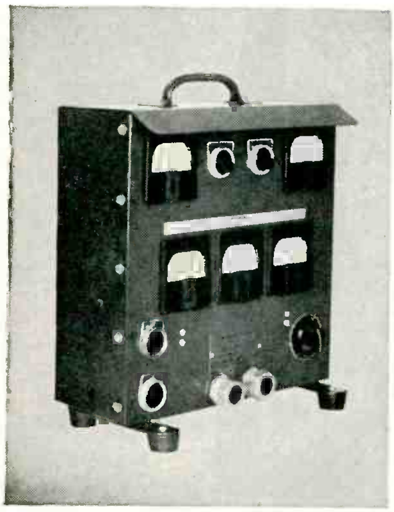
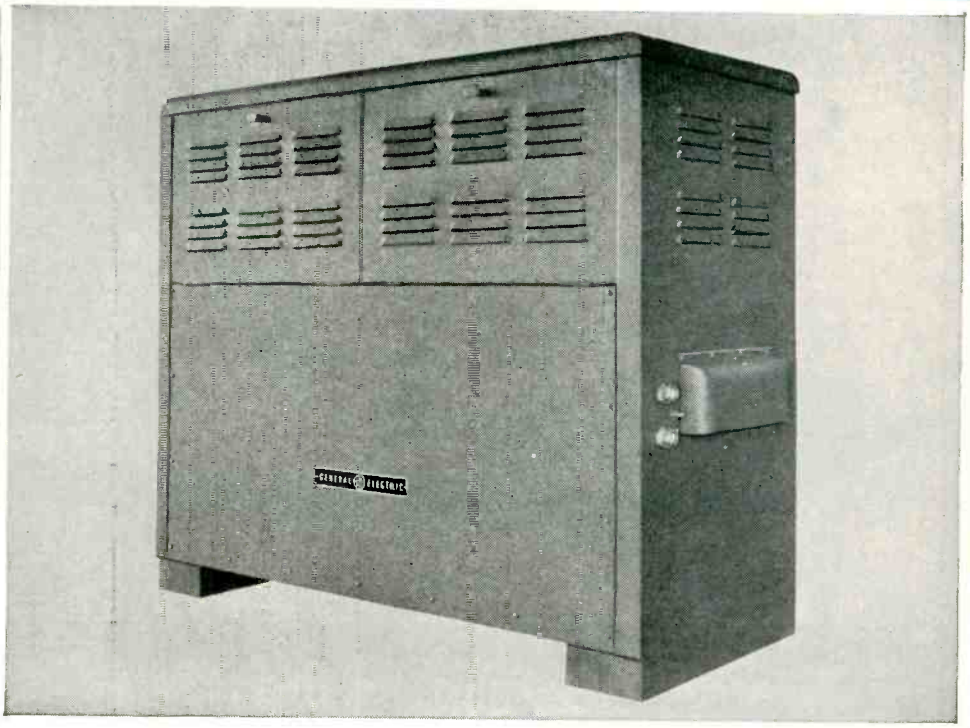


Operator's Control Unit



Motor-Generator-Type Frequency Changer

PACKAGED FREQUENCY CHANGERS

400-Cycle Ground Power Supply for Aircraft Radar Units

Here's a low-cost, high-performance, 400-cycle ground power supply with a regulated output voltage adjustable from 187 to 229 volts. It's rugged enough for permanent installation, yet compact enough to be moved on a fork truck. A 30-kva output rating is more than sufficient for virtually all radar, radio, or general load applications.

Voltage regulation: ±2 per cent variation under all conditions of balanced load, power factor, and heating, within normal operating range.

Voltage recovery: To within 5 per cent of steady-state value in 0.1 second.

Voltage adjustment: 187-229 volts in increments of 0.5 volts or less.

Wave shape: Low harmonic content.

Radio interference: Adequate suppression for most rigid applications.

Enclosure: Dripproof cabinet houses motor, generator, and controls. A separate operator's panel contains "start-stop" push buttons, adjusting potentiometer, selector switches and meters.

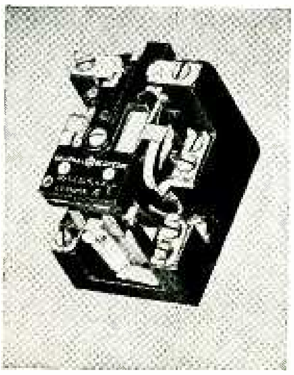
For further data on these G-E frequency changers see Bulletin GEA-5589.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

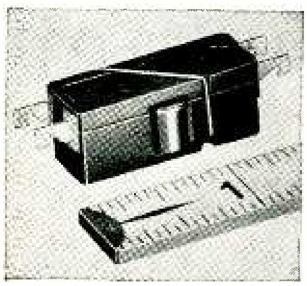
Husky Relays Mount 3 Ways Make or Break up to 45 Amps



For those heavy control-circuit applications, here's a versatile relay that can be front-connected, back-connected, or plug-in-connected, and is supplied in open or enclosed models. Circuits: spst, dpst, or dpdt.

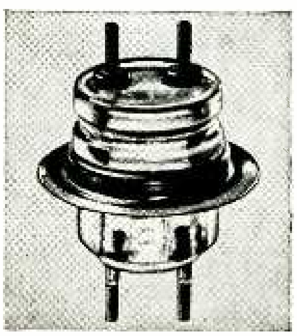
Heavy, long-lasting silver contacts carry 10 amps continuous. Normally open forms make or break 45 amps; normally closed forms make or break 20 amps. Coils are supplied for 12-, 24-, 115-, or 230-volt, 60-cycle a-c; for 6, 12, 24, 32, 125 or 250 volts d-c. Dimensions for enclosed model: 6 x 6 x 5 inches. Complete details are available in Bulletin GEC-257.

G-E Switchette Handles High Current in Crowded Quarters

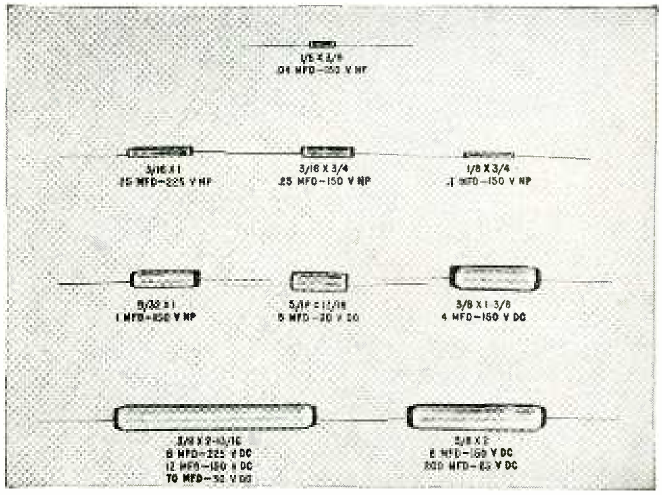


Though small and lightweight, the G-E switchette does the same work as many bulkier switches. Available in a wide variety of forms and circuits, this snap-action unit is approximately 1¼ x ½ x ½ inches, weighs only 9 grams, and operates dependably from sea level to 50,000 feet altitude. Contact arrangements available are single-circuit, normally open; single-circuit, normally closed; and two-circuit, one normally open and one normally closed. Rated ½ hp at 115 and 230 volts a-c, the switch is designed for ambient temperatures from −70F to +200F and meets the 50-hr salt-spray test for Specification AN-QQ-S-91. For full details, ask for Bulletin GEA-4888.

Cast-Glass Bushings Permit Hermetically Sealed Apparatus



Embedded nickel-steel hardware eliminates the need for gaskets and makes possible the soldering, brazing, or welding of G-E cast-glass bushings directly to apparatus. This assures gas-tight, oil-tight, or vacuum-tight construction. Extraordinary resistance to vibration and weather means the small, compact bushings are especially suited to aircraft applications or where high humidity occurs. They will not puncture or shatter under excess potentials. For full details ask for Bulletin GEA-5093A.



Tantalum + New Electrolyte = More Performance, Less Space

New G-E Tantalytic D-C Capacitors Feature

- Size and weight about the same as conventional electrolytics
- Over-all life as good as paper dielectrics
- Low-temperature properties and shock resistance better than either

By combining tantalum in foil form and a newly developed non-corrosive electrolyte, General Electric has designed a capacitor that packs superior performance into amazingly small space. Good stability, unusually low leakage currents, and hermetic sealing are additional advantages. Operating range is from −55C to +85C. Ratings presently available range from 0.02 muf to 12 muf at 150 volts d-c. Capacitors shown in illustration are representative. For additional information, furnish requirements such as temperature range, leakage resistance values, and operating voltage in writing to *Capacitor Sales Division, 42-304, General Electric Company, Pittsfield, Mass.*

General Electric Company, Section D667-15
Schenectady 5, N. Y.

Please send me the following bulletins:

(✓) Indicate for reference only

(✗) For planning an immediate project

- ☐ GEC-257A General-Purpose Relay
- ☐ GEA-4888 Size 1 Switchette
- ☐ GEA-5093 Cast-Glass Bushings
- ☐ GEA-5589 Packaged Frequency Changer

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Company________________

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. . . that's what the trademarks and brand names of American producers establish. For never has a country accumulated such wealth of designing and engineering talent, such monumental means for producing both the necessities and luxuries of the day, or such massive potential for meeting the needs of tomorrow—however vast and varied they may be.

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So if your products demand electrical resistance material of outstanding uniformity, high stability, and long life . . . or if you require radio alloys for electronic uses . . . or high heat-resistant equipment . . . *consult with us.* Our fifty years' experience is at your disposal.

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One thing is sure: Your use of a D-H product will prove a source of confidence—confidence not only in Driver-Harris products per se, but, in a wider sense, confidence in the capacity of creative America to meet any situation, *come what may.*

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Primary applications are in r.f. noise suppression work in military or commercial aircraft and for vehicular low-voltage d.c. applications. Also, for special applications such as battery or low-voltage d.c. filters, for shield room applications, and for critical equipment.

Available in seven standard types meeting a wide variety of applications. For extraordinary requirements, special filters can be developed and built to your order.

● **Write on your letterhead for latest literature. Consult AEROVOX on your noise-suppression problems, as well as capacitor requirements in general.**

Remarkably small sizes and minimized weights.

Cases and terminals based on time-and-service-proven AEROVOX hermetically-sealed containers and terminals.

Cases of non-magnetic material suitably protected to withstand military service requirements for humidity, immersion, vibration, etc.

Advanced pi type construction for highest efficiency.

Capacitor sections utilize AEROLITE* metallized-paper dielectric, assuring maximum reliability and life including "fault isolation" characteristics for protection against extreme surge voltages above rated voltages.

Filter chokes of newest design, embodying high impedance to r.f. currents and low d.c. resistance, assuring low voltage drop and minimum heating.

*trade-mark

AEROVOX INTERFERENCE FILTERS

Aerovox Type	Amps.	VDC	Size (l. x w. x h.)
IN 148	2.0	150	1¾" x 1" x ⅞"
IN 150	3.0	150	1 13/16" x 1" x 1"
IN 151	5.0	150	1 13/16" x 1¼" x 1"
IN 152	10.0	150	2 1/16" x 1¼" x 1"
IN 153	25.0	150	2" x 2" x 1 3/16"
IN 156	40.0	150	5 1/16" x 1 13/32" x 1 1/16"
IN 154	100.0	150	3 1/16" x 2⅛" x 2⅞"

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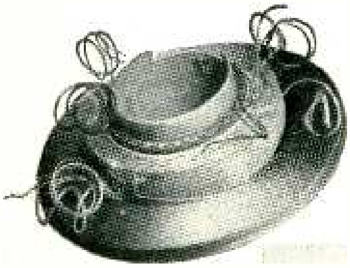
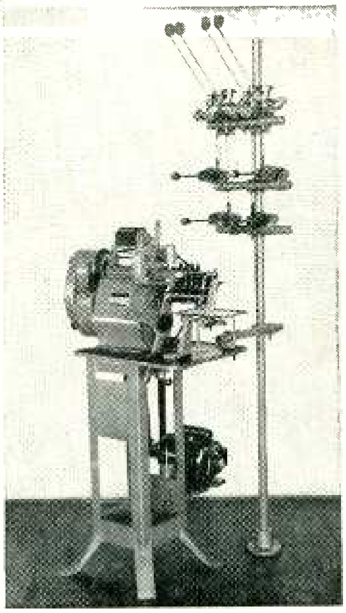


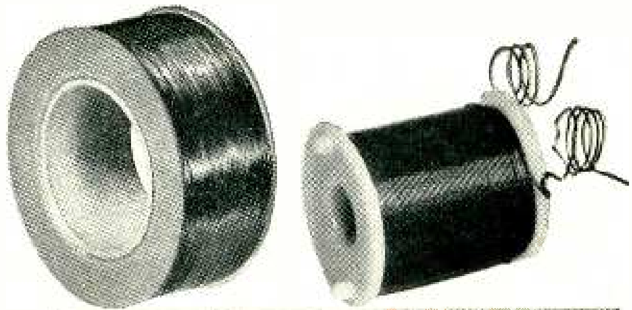


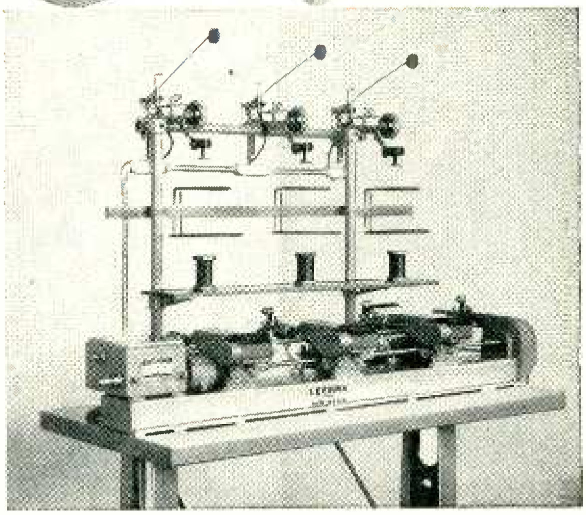
Lattice-type coils for television and radio. Wind one to four coils at once on the Universal No. 84 Coil Winder, with (in most cases) a single operator for two machines.

Speeds are from 400 to 950 rpm, and a counter control provides instant automatic stop upon completion of coil.

Quickly-adjustable "gainer" mechanism, which accurately positions wire turns, and strap-type tensions help you get accurate, uniform winding. In-built calibration facilitates change-over.

Write for Bulletin 84-LM.





Non-insulated spool-wound coils. Wind coils on several heads at once, using the new Universal 102 High Speed Coil Winder, and synchronize output on the basis of handling time per coil.

Each head is individually operated, and you can so schedule the winding that certain heads will be producing while manual operations are performed on other heads.

With a maximum speed of 5000 rpm, the High-Speed 102 is efficient for coils having up to 15,000 turns. Oil seals make the machine *oil-tight.*

Write for Bulletin 102-LM.

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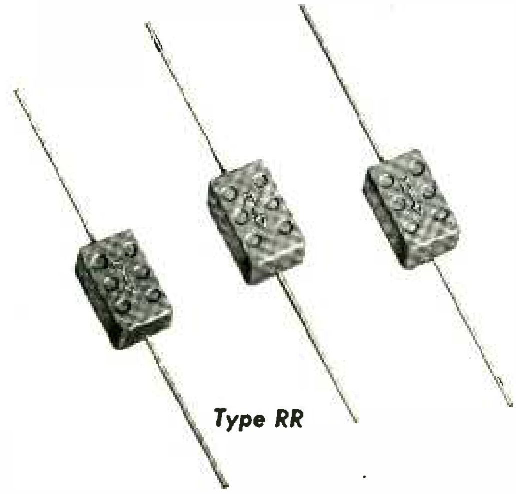
SANGAMO MINIATURE SILVERED MICA CAPACITORS



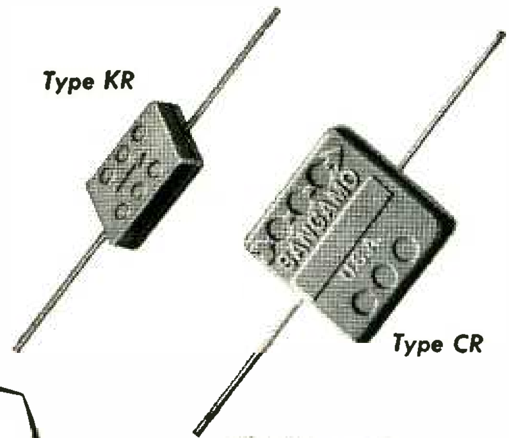
Type RR

Do a "Heap Big" job in a minimum of space

Exceptionally small, easy-to-install capacitors that can do a *big* job in *minimum* space are a helpful factor in speeding production.

Where space limitations exist, the tiny—but mighty Sangamo "Shawnee," Type RR Miniature Silvered Mica Capacitor will solve your problem without sacrificing stability or high quality. These capacitors are designed and constructed to meet the Tentative Joint Army and Navy Specification JAN-C-5A for the CM-15 case size. Whether you require Sangamo RR miniature, or standard size types KR and CR silvered mica capacitors, you can safely specify any of them for use in all types of military, or commercial radio and electronic equipment. These and many other types of Sangamo Mica Capacitors are fully described in Catalog No. 800. Write for your copy.

SANGAMO STANDARD SIZE SILVERED MICA CAPACITORS



Type KR

Type CR

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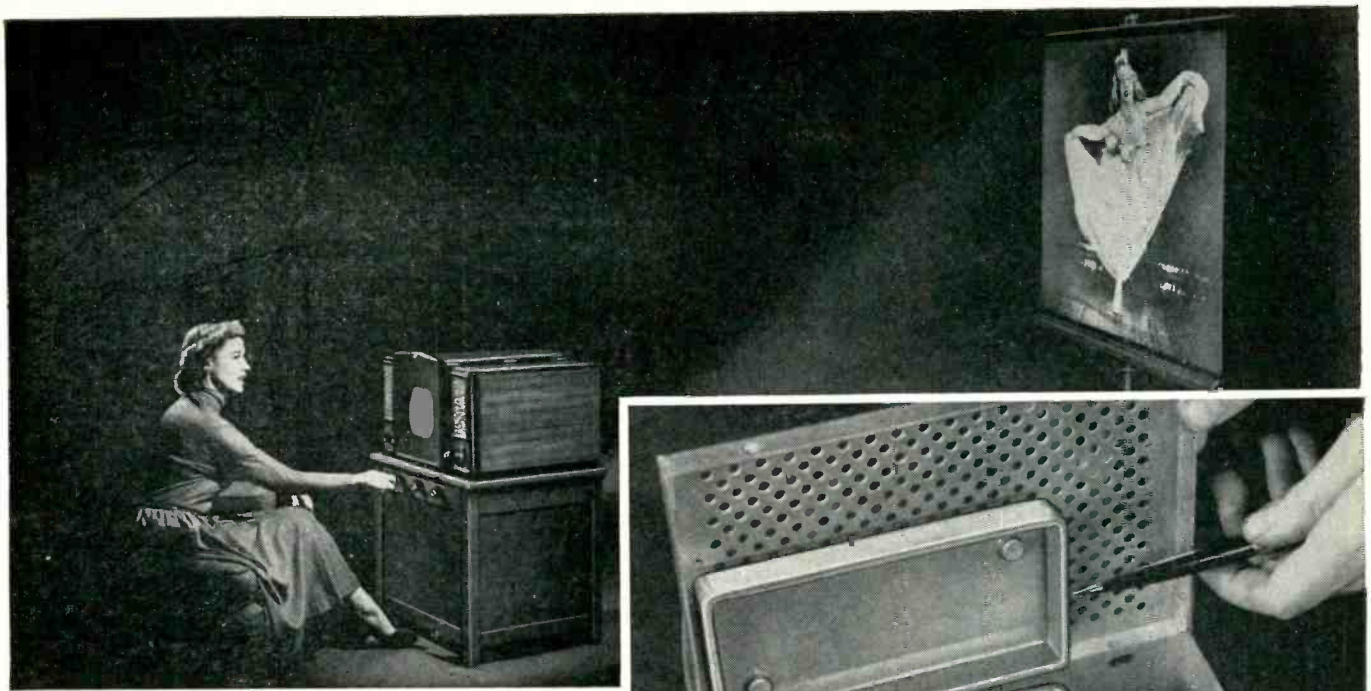

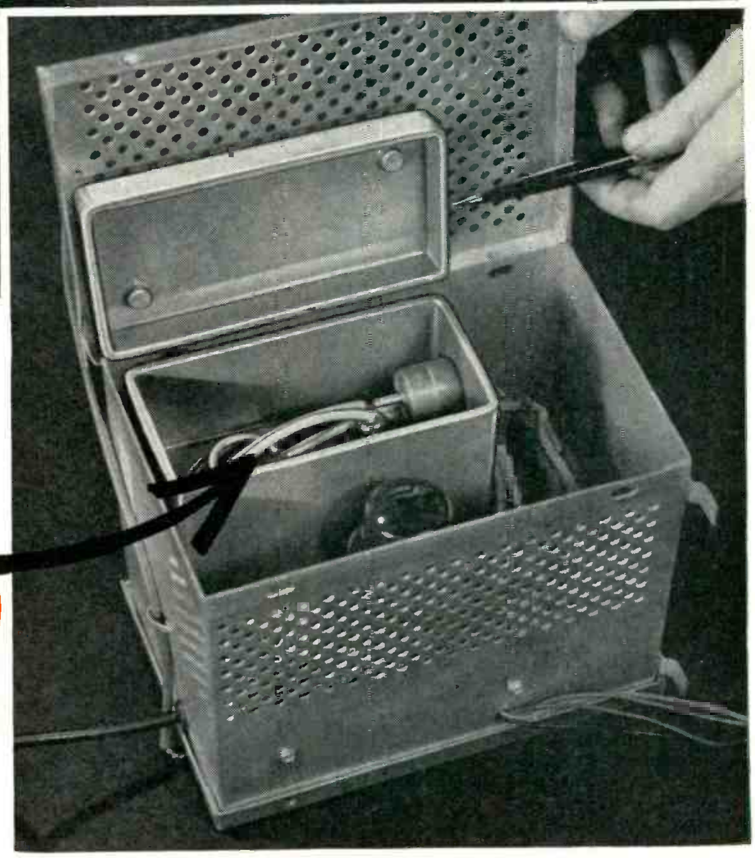

Low Cost Housing for 25,000 Volts!

Two amplifier tubes and a transformer, putting out a walloping 25,000 volts—are contained far more safely and economically in this 7¾-inch-high housing, molded from BAKELITE Low-Loss Phenolic Plastics BM-17748*. The power unit was originally designed by North American Philips Co., Inc., as part of the Norelco Protelgram projection television system, and is now being adapted to military applications where space, weight and efficiency are major design requirements.

Originally these high-voltage drivers were vacuum impregnated, oil-filled, and hermetically sealed in metal cans. Today, with the use of BAKELITE Low-Loss Phenolic Plastics, neither oil impregnation of high-voltage components nor vacuum sealing is required, because of the superior dielectric qualities of the material. Tube replacement and other services are easily handled in the field. Flammability worries are greatly reduced. Production is speeded up and simplified. Costs are pared to the bone.

BM-17748 is one of a group of BAKELITE Low-Loss Phenolic Plastics specially formulated for high-frequency electrical insulation wherever low power factor, low loss factor, high resistivity, dimensional stability, and low water absorption are required. It is available for such exacting services as capacitor casings and frames, condensers, and coil forms. It is recommended to molders and manufacturers desiring approval under MIL-P-14A.

Bakelite's engineers will be glad to consult with you, and provide detailed data on electrical, mechanical, and other properties of low-loss phenolics. Write Dept. BX-47.

*Molded by Chicago Molded Plastics Corporation

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TRADE-MARK
Phenolic PLASTICS

TRADE MARK

BAKELITE COMPANY
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30 East 42nd Street, New York 17, N.Y.

BUSINESS BRIEFS

By W. W. MacDONALD

Engineering Manpower is, as predicted (p 76, April) rapidly becoming the most critical factor in the mobilization program. Here are a few straws that show the way the wind blows:

Weston has appealed to readers of its widely mailed *Engineering Notes* for six electrical engineers, four mechanical engineers and five industrial engineers. Westinghouse has listed its detailed requirements for 563 electrical engineers, mechanical engineers, metallurgists, chemists and physicists in *Sales Record*. Philco has made a mailing for men to amateur radio station licensees.

New York's Department of Labor says firms advertising in the area for radar and other technical personnel are finding recent respondents inferior in qualifications compared with those recruited two months ago, says one company rejected 38 out of 42 men interviewed, says further that "two months from now they may regret this."

FCC field offices have been authorized to relax temporarily the requirements for a-m and f-m broadcast station operators if, after consultation with stations needing operators, it is apparent that radiotelephone-first-class operators cannot be found.

Certificates Of Necessity for fast amortization of taxes on new plant facilities have been awarded to 17 firms in the field of electronics, the dollar value of the facilities covered totalling $25,000,000 and 75 percent of the cost being written off in five years.

All industry, including electronics, has received 493 such certificates, covering $3,045,700,000 worth of facilities.

Replacement Parts Shortage will be minimized as the mobilization program progresses if television receiver makers observe the following RTMA-Better Business Bureau recommendations:

Supply present set owners with replacement parts and tubes on a quota basis related to new set production.

Expand the use of noncritical materials.

Continue to improve quality and inspection controls so as to obviate consumer complaints.

Minimize circuit changes with due consideration to availability of replacement parts.

Furnish substitution data to the trade for tubes and parts.

Develop more equitable distribution of components for repair and replacement purposes through closer cooperation within the industry.

Refrain from shipping sets without complete complements of tubes.

Increase the standardization of tubes and parts.

Continue to improve specifications for better service and longer life of component parts.

Speaking Of Parts, we've checked into a reported holdup of orders which the Signal Corps has for some time been quietly placing as part of an Industrial Preparedness Study (IPS). Washington and Philadelphia offices tell us that these pilot runs are being held in abeyance to make way for components needed immediately in military operations and that they will soon be resumed.

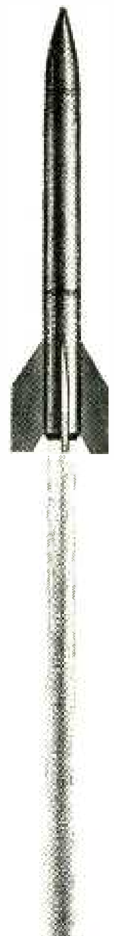
Mobilization Order attributed to Haile Selassie:

"The country is now mobilized. All men and boys able to carry a spear will report for active duty. Married men will bring their wives to do the cooking; men who are not married will bring any women they can find. The very young, the very old, and women with very young children need not report for active duty. Anybody else found at home after the issuance of this order will be hanged."

How simple war was in those days.

We're Bearing Down editorially on mobilization problems, as promised (p 81, April).

The April issue itself contained five feature articles designed to help management in these abnormal times . . . . . *Washington Report*, *Conservation of Critical Materials*,



Guided missiles...

100 MILES UP

and in the ground receiving system...

29 SYLVANIA CRYSTAL DIODES

In the Air Material Command's guided missile research at Alamagordo, N. M., transmitters in the airborne units, operating on a pulse system modulated with reference to time, send out pertinent data on temperature, air pressure, speed and structural strains. The signals are received by the ground telemetering system shown at the left.

This ground system uses a total of 29 Sylvania Crystal Diodes—25 1N34's and one 1N38 (Germanium); 3 1N21B's (Silicon). Major reasons for the selection of the Sylvania Diodes are their reliability and accuracy—outstanding advantages of these components *wherever* they are used, but *particularly* important in operation under desert conditions.

Sylvania Crystal Diodes may improve the performance standards of *your* equipment—or permit more compact designs. Get the facts!

Mail coupon for literature

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Gentlemen:

Please send literature on your Germanium and Silicon Diodes.

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ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Growing Quartz Crystals for Military Needs, Military Requirements for Subminiature Tubes and *Material-Saving Picture Tube.*

May contained three special articles . . . . . *Electronic Research in the Emergency Program, Washington Adopts Automatic C-D Warning System* and *Army Walkie-Talkie in Mass Production.*

In this current issue, June, there are four . . . . . *Government Plans Industry Support* (p 82), *Safeguarding Production of Military Equipment* (p 88), *Civilian Defense Communications* (p 94) and *How to Set Up an Instruction Manual Department* (p 100).

In the words of the late Al Jolson, "you ain't seen nothin' yet!"

Quote from a speech before NEMA by our own McGraw-Hill executive vice-president Col. Willard Chevalier:

"This time our military requirements are heavily concentrated in electronic control equipment, vehicles and airplanes—the sort of equipment calculated to multiply our limited manpower by giving it the best of modern equipment and a great deal of it.

"I am reliably informed that the electronic equipment on a medium bomber now costs as much as the entire plane cost in World War II. And, believe it or not, the same thing seems to be true of a medium tank. The electronic equipment costs as much as the whole tank did in World War II."

Television Shipments by RTMA members totalled 7,068,000 in 1950. Here's the breakdown:

Alabama	23,487
Arizona	8,823
California	658,233
Connecticut	126,453
Delaware	23,479
District of Columbia	95,756
Florida	36,332
Georgia	60,807
Illinois	508,239
Indiana	98,876
Iowa	26,227
Kansas	10,856
Kentucky	56,557
Louisiana	33,214
Maryland	131,989
Massachusetts	397,082
Michigan	352,160
Minnesota	85,264
Missouri	167,783
Nebraska	29,963
New Jersey	363,403
New Mexico	4,896
New York	1,129,801
North Carolina	26,749
Ohio	496,802
Oklahoma	25,689
Oregon	2
Pennsylvania	635,926
Rhode Island	60,426

South Carolina	1,258
Tennessee	47,095
Texas	129,421
Utah	21,195
Virginia	59,671
Washington	31,685
West Virginia	12,512
Wisconsin	83,111
Areas unlisted	1,006,778

TV Broadcasters took in $105,-800,000 during 1950, more than triple the $34,300,000 revenue of 1949, and more than half the 107 stations on the air made a profit. A-m and f-m broadcast station revenue amounted to $447,700,000, the highest on record. Thus the combined visual and aural services passed the half-billion mark for the first time.

Back in January (p 60) we published an item relative to interest in British television cameras at UN Headquarters. B. G. H. Rowley now tells us that three Marconi Wireless camera chains have been purchased, along with full ancillary equipment.

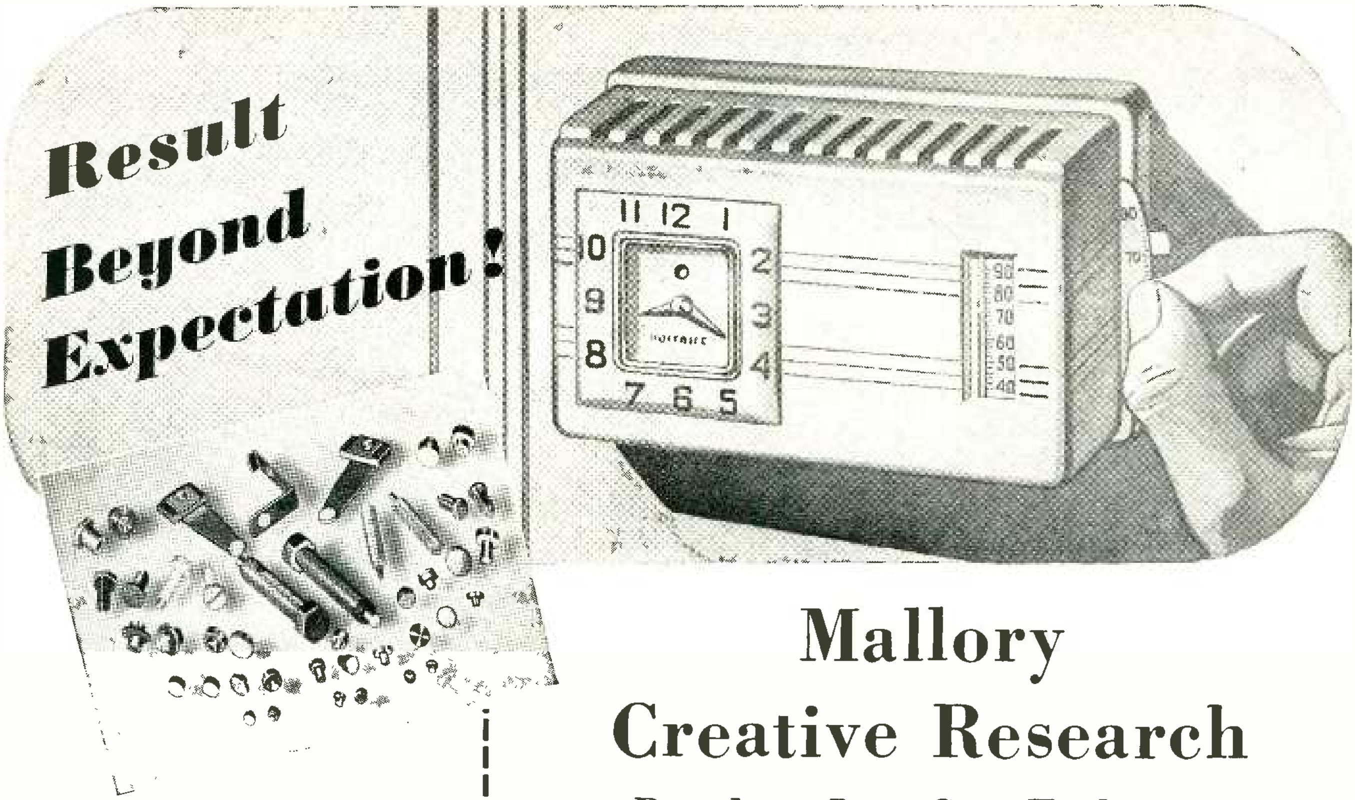
Receiving Tube Exports are reported as follows by the U. S. Department of Commerce:

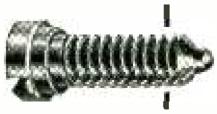
Country	*1949*	*1950*
Belgium	$307,702	$243,507
France	129,946	212,069
Germany	4,902	32,824
Greece	119,377	64,679
India	202,641	116,113
Indonesia	45,643	4,806
Iran	24,692	47,219
Ireland	19,073	5,930
Israel	37,111	24,403
Italy	106,521	164,107
Lebanon	26,030	9,166
Netherlands	60,921	9,653
Norway	51,544	11,971
Pakistan	39,190	56,235
Philippines	122,673	98,113
Portugal	25,993	21,324
Spain	36,177	17,482
Sweden	132,518	84,472
Switzerland	185,792	132,827
Tangier	45,410	67,121
Thailand	32,795	24,432
Union of South Africa	142,655	81,382
United Kingdom	37,522	26,965
	$1,936,828	$1,556,800

Export license applications for the first quarter of 1951 totalled $1,567,000, more than total shipments for the year 1950.

Secondary Supply Sources (p 83, April) are still being sought by government procurement people. To them we recommend close perusal of the 1951 ELECTRONICS *Buyers Guide,* due out about June 15.

Shot Effect is a well-known phenomenon. Not so well known is "big-shot effect," the phenomenon that causes electronic equipment not to work when first demonstrated before an admiral or a general.





Mallory Creative Research

Develops Low-Cost Technique For Platinum-Tipped Contact

New time and money saving methods for meeting customer contact specifications result from continuing research and development by Mallory.

Typical is the application of Mallory metallurgical and welding experience to the problem of attaching and forming the platinum tip on a contact screw used in home thermostats. Mallory tackled the problem of reducing the high cost involved . . . and came up with a new weldable material for the screw, a way to weld the tip in place more securely, and a method for forming the tip to proper contour. Savings on machining and waste platinum were immediately passed on to the customer.

That's result beyond expectation!

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you.

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

MALLORY PLATINUM CONTACTS

Platinum is ideal for electrical contacts where low resistance must be maintained for long periods of time. However, pure platinum lacks hardness. Mallory platinum alloys overcome this by the use of such hardening agents as iridium, ruthenium and palladium. Mallory is fully qualified to recommend the best contact material for your design. Write today.

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CROSS TALK

▶ **PIPES** • • • Fresh back from the IRE Southwestern Conference in Dallas, we are mightily impressed with the future of microwave systems for communication, control and supervision of oil and gas pipelines. The largest single order for industrial electronic equipment in history, over a million dollars worth of microwave gear, was placed last year in this field. At least five big companies are contesting for future business they estimate at 10 million dollars by the end of 1951, 100 million by the end of the next decade.

These figures are justified by the extraordinary development of pipeline transportation in recent years, but more particularly by the enormous value of the product transported in relation to the costs of controlling and supervising the pipeline system. The readiness with which the pipeline business has embraced electronic methods stands in strange contrast to the attitude of their competitors in the maritime field, down whose throats radio and radar have had to be forced at every stage.

▶ **UPGRADE** • • • If our post-convention conversations with engineering managers mean anything, and we think they do, the hottest subject at the late IRE clambake was not technical. It was the salaries being offered to young engineers in the recruiting drives of several companies, largely in the aircraft field, engaged in government cost-plus contracts. We heard repeated reports of salary offers of a straight 50 percent over the recruit's present salary. This kind of inducement is hard to resist, and as a result a great many families are now moving across the continent, and a great deal of resentment has been stirred up among the managements of old-line companies. We think this situation deserves comment and a bit of gratuitous advice.

The comment: the fact that government contracting officers will approve engineering costs in these cost-plus contracts which run 50 percent or more above the going rate is not wholly explained by expediency and the urgency of our military preparations. It is, we believe, partly explained by the fact that engineering costs in our field are low compared with many other fields, low compared with the true value of the engineering service rendered.

The gratuitous advice, to the young-man-going-west: be sure the new job offers more than mere money upgrading. If you can learn a new field, put more arrows in the quiver, fine. But if you find yourself standing still, in every respect except the bank balance, beware. To the managements of old-line companies: to hold your men against the blandishments of the pirates, how about reconsidering the true value of the services listed under engineering costs? The cost-plus boys may be closer to the proper level than you think.

▶ **INDEX** • • • We are happy to announce that a cumulative index of ELECTRONICS covering the first decade of publication, from April 1930 to December 1939, has been compiled and will be printed in the 1951 Mid-June Buyers Guide Issue. Every article published in that period, full-length feature articles as well as shorter departmental items, has been listed alphabetically by author, by title and by subject matter.

The compilation turned out to be a monumental job. It fills 36 pages of fine type, and its production took 1,200 man-hours of staff time. Indexing methods of other publications were studied, technical librarians were consulted, the bound volumes were meticulously scanned by our technical staff to collate hundreds of different subject categories into a consistent and rational listing. Every listing, whether by author, title or subject, contains the issue date and page, so no cross-checking is necessary.

We think it's one of the most complete and easiest-to-use technical jobs of its kind yet published. While hoping our readers agree, we ask for criticism which will prove helpful in our continuing effort to provide where-to-find-it information on electronic techniques. A similar index covering the second decade, 1940-1949, is in preparation and will be printed in the 1952 Buyers Guide Issue.

GOVERNMENT PLANS

Washington takes initial steps to insure that manufacturers stay healthy against emergency needs. Critical materials allotted to tube makers facing shutdown, and plant expansion permitted companies having government contracts. Controlled materials plan effective July 1 will afford further relief, may even leave adequate materials for civilian goods

By W. B. WHICHARD, JR.
McGraw-Hill Washington Bureau

THE GOVERNMENT is going to see to it that the electronics industry stays healthy so that it will be ready when the time comes to meet military needs.

Mobilization officials will see that key segments of the industry obtain sufficient materials to stay in operation, and encourage expansion of production facilities that will be needed later to meet military needs for electronic equipment.

Two basic problems have complicated such planning by both the mobilizers and the industry.

First, other defense production has steadily cut deeper into the supply of raw materials vitally needed to keep the industry in business. The shortages of such metals as cobalt, nickel, tungsten and copper are going to get worse before they ease.

Shutdown Threatened

Second, military orders for electronic equipment—which, of course, are backed by government assistance to the producer in obtaining raw materials—are not being placed in anywhere near the volume necessary to offset any major reduction in output of civilian equipment. A substantial flow of military orders to the industry is not expected before the last quarter of 1951, and will reach a peak even later. In the interim, the mobilizers have decided, something must be done to prevent other defense programs from choking off the industry's supply of critical materials.

Impact of materials shortages on the industry came in for Washington attention early in April when eight manufacturers of receiving tubes warned mobilization officials that they would be forced to halt production before June 1 unless they received relief. The National Production Authority passed the problem up to the Defense Production Administration, top policy agency for industrial phases of the mobilization program.

A check with the Armed Forces developed potent arguments for keeping the tube makers, in particular, and at least part of the industry, in general, in business.

More and more new weapons are controlled by electronic equipment. Though the arms build-up has not yet reached the phase where these devices are needed in quantity, it is nearing that stage. There will be a military demand for tubes and other components very similar to those now going into civilian products, so the services want to keep these items in production.

Even more important, some electronic controls for future weapons are still to be perfected and adopted to special uses. That will take engineering and the work of other technicians now employed by the industry. To keep these people on the job until the armed services get their orders out, there will have to be a high level of activity throughout the industry in the interim.

Finally, electronic equipment has become vital to a broad range of industrial operations that rate second only to military production in Washington planning. Among these are transportation, communications and other utility services, to name a few.

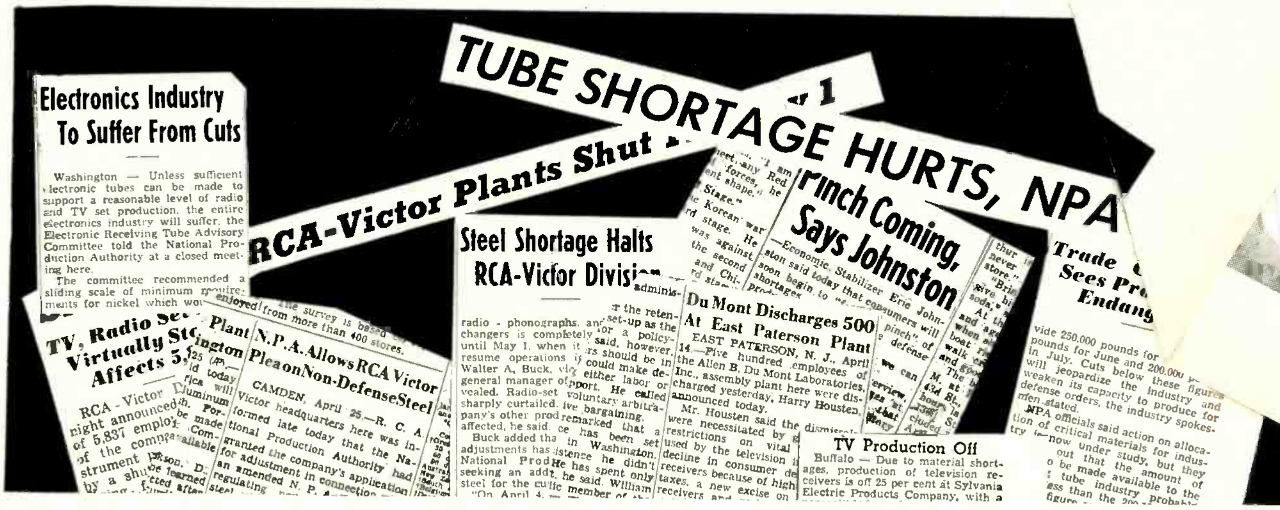
How much of the industry should be supported by assistance in obtaining materials and aid in expanding plant has not been worked out yet. Components makers will get substantial help, to prepare for anticipated military orders, and to maintain equipment already in use. Certificates of necessity for five-year tax amortization already have been issued for new plants to turn out military equipment.

Program Planning

A batch of certificates approved late in April indicates the type of plant Washington wants built. For example, Electronics Products Co. obtained certificates covering 75 to 85 percent of the $1,003,965 cost of new facilities to produce coils, tubes, and tube production equipment. Weston Electrical Instrument Corp. was certified for 80 percent of $1,500,000 in a new aircraft equipment plant. Resistance Products Co. won a certificate covering 80 percent of a new plant to turn out resistors.

Even more significant, however, was the establishment in April of an Electronics Production Board within DPA. It was set up to de-

INDUSTRY SUPPOR



termine requirements for electronic products, to steer distribution of such products into essential programs, to break production bottlenecks on vital equipment, to encourage needed expansion — in short, to make policy for mobilization operations of the industry. Material requirements and day-to-day operating problems of the industry are still assigned to the National Production Authority.

The Electronics Production Board is headed by Edmund T. Morris, Jr., on leave from Westinghouse Electric Co. Other members are Captain F. R. Furth, Director, Naval Research Laboratory; Harry A. Ehle, International Resistance Corp; John G. Daley, Chief, NPA Electronics Division; M. W. Boyer, General Manager, Atomic Energy Commission, and Don G. Mitchell, Sylvania Electric Products Inc.

Allotted Materials

First tangible result of the decision to assist the industry was an allotment of cobalt, tungsten and nickel to the tube makers faced with shutting down plants. The allotments were in the form of directives from NPA to suppliers of these materials, covering a portion of the tube manufacturers' requirements for April, May and June.

There is little question but that similar allotments will follow in July for tube production, at least. Makers of tubes, industrial communications equipment, and many other electronic devices were instructed to fill out during May NPA forms reporting their requirements during the third quarter for copper, steel and aluminum. The implication was that these producers would receive allocations of the latter metals under the controlled materials plan going into effect July 1.

Hope for '51

Manufacturers of home radio and television sets, on the other hand, were told not to fill out the forms. But this did not mean they would get no steel, copper or aluminum after July 1. There will be no allocations of metal to such producers under CMP. That is, radio and tv manufacturers will have to compete against other unallocated producers for the steel, copper and aluminum left over after military programs and other allocated production take their bite. Mobilizers were, however, guessing that as much as 60 to 70 percent of total output of steel, copper and aluminum would be unallocated under CMP this year.

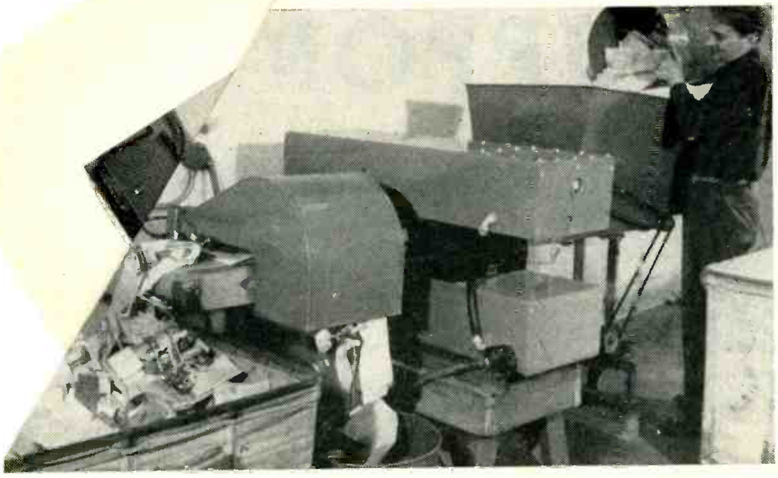
To prevent a mad scramble for unallocated metals, Washington will cut down their use in production in other than the allocated programs by conservation orders. These almost certainly will slow output of home radio and television receivers. But such production would be cut back, anyhow, by the lack of nickel, cobalt and other critically short materials.

Cutbacks will be gradual. Mobilization officials see this year's radio and tv production approaching the record levels of 1950. The limitations on use of metals will become more severe, but are likely to be eased in 1952, barring a new military crisis.

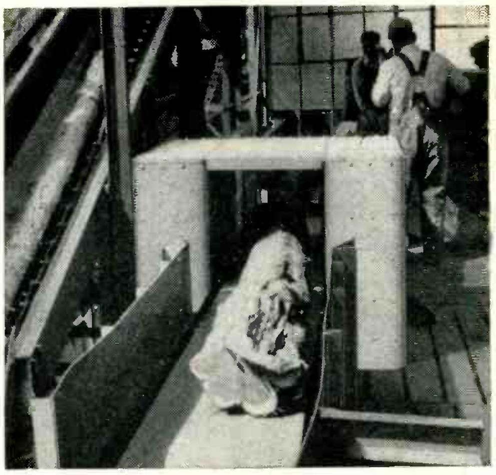
Before that time, however, there will be tough sledding for segments of the industry. Assemblers of radio and tv receivers now appear likely to be the hardest hit. Since they are not producing essential components or, in most cases, maintaining large engineering and research staffs, they can expect little help from Washington in the way of materials allotments. Their components suppliers are likely to shift from civilian to military production as fast as they can get contracts from the Armed Forces.

Some components makers are likely to be hurt, too, unless they can shift into turning out items of a military or essential-civilian nature. The mobilization agencies hope to keep some production of most civilian goods, but materials shortages already are hitting the electronics industry all along the line.

First port of call for industry people in trouble of this sort is NPA. John Daley's Electronics Division, and the Communications Equipment Division headed by Luther W. Hill, are being staffed to help with supply, production and distribution problems.



Use of RCA metal detector to inspect contents of wastebaskets for coins overlooked by mail sorters. Air jet blows coin-bearing material into can



Installation of RCA detector at The Lane Co. in Altavista, Va. for inspection of cedar logs

CHOOSING INDUSTRIAL

Practical survey analyzing factors affecting decision to buy or not buy a commercial metal detector for a particular industrial inspection application. Covers reliability, stability, effects of moisture and nearby metal, minimum detectable particle size for various coil apertures, fail-safe requirements and methods of testing performance

By
CURTISS R. SCHAFER
Ridgefield, Conn.

During the past three decades, the status of the metal detector has evolved from that of a laboratory experiment to a practical means of locating land and underwater mines, and within the last three years it has become a highly desirable way of detecting unwanted metallic fragments in many raw materials and manufactured products.

Perhaps the first industrial use of the metal detector was to warn a sawmill operator of the presence of spikes, horseshoes and unexploded artillery shells in the logs he was about to rip into boards and lath. Now, metal detectors are widely and successfully used in many fields, from detecting counterfeit Bank of England notes to finding machete blades in loads of sugar cane.

Two companies in the United States, RCA and Allis-Chalmers, are making identical models of a general-purpose detector. Eriez Manufacturing Co. has developed a metal detector which is specifically designed for conveyor belt applications. The General Electric Co., which in the past has produced tailor-made detectors for specific applications, is now developing a new version of their type YE-6, which was first made for the lumber industry.

Commercial Models

The RCA, Allis-Chalmers, and GE models are built around some form of mutual-inductance bridge employing a symmetrical coil arrangement which is fed by a suitable oscillator. The presence of a metallic particle in the a-c electromagnetic field which links the coils disturbs the original field pattern for which the bridge was balanced. The resulting bridge unbalance current is amplified and made to operate a warning or rejection device. The Felici mutual-inductance balance is ideal for this purpose, and its action is illustrated in Fig. 1. The RCA and Allis-Chalmers detectors use a slight modification which is shown in Fig. 2.

If the two pairs of coils are of identical electrical and mechanical construction, this system is inherently free from variations due to ambient temperature and humidity, line voltage (within certain limits) and oscillator frequency. Variations in temperature and humidity affect both pairs of coils alike, and hence result in no change in mutual inductance. A shift in oscillator frequency or amplitude will change the sensitivity somewhat, but will not produce an erroneous indication.

The Eriez detector, as well as one developed by Furzehill Laboratories

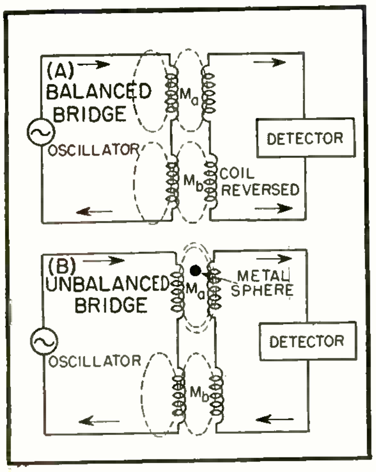


FIG. 1—Mutual-inductance bridge used in many metal detectors

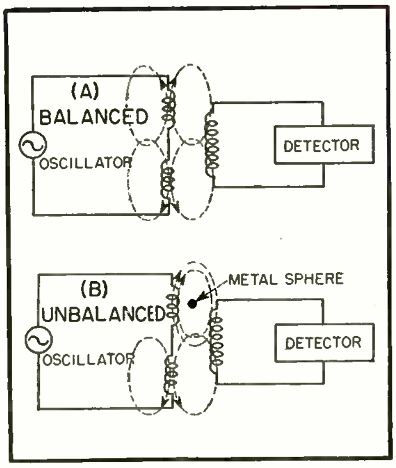


FIG. 2—Three-coil metal-detecting arrangement

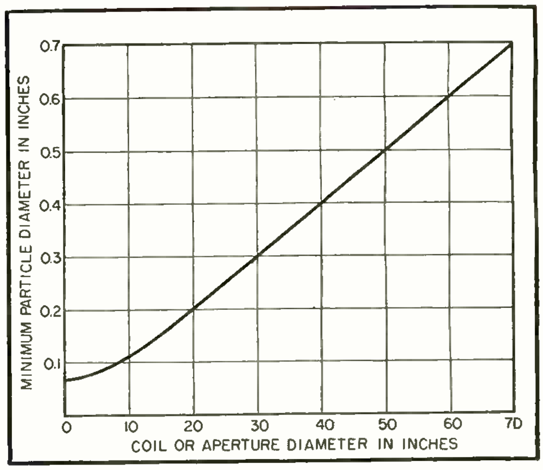


FIG. 3—Sensitivity of commercial metal detectors using mutual-inductance bridge

METAL DETECTORS

in England during the war, operate by virtue of the change in the output current of an oscillator due to hysteresis and power-factor changes in the tank circuit in the presence of metal. The sensitivity of this system can be made very high, with a corresponding loss of stability; all voltages must be very carefully regulated, as a slight change in any of the voltages applied to the oscillator tube will give a change in the output of the oscillator similar to that produced by the presence of metal.

Before-Buying Questions

The production man who is interested in the possible application of metal detector techniques to his own industry should evaluate the answers to these questions:

(1) What may be accomplished by the use of a metal detector?

(2) What advantages will an electronic metal detector have over older methods of inspection?

(3) What are the capabilities and limitations of the commercial models of electronic detectors?

(4) What shall we look for when buying a metal detector?

The proper use of a metal detector will accomplish several things. First, it will insure an uncontaminated product. This is important, for steel slivers found in flour, processed meats and candy will not only lose the goodwill of consumers of these products, but will often form a valid basis for expensive and embarrassing lawsuits. Bits of broken machinery have been found in flour; lead shot and steel slivers have been found in soups; a broken shredder blade was found in a cigarette; hairpins and pieces of bearings got into packaged cereals. To the consumer, these are logical reasons for changing to another brand.

Second, a metal detector will protect personnel and machinery. When a tooth is broken out of a circular saw by a spike which is completely embedded in a log, when a bit of metal in an explosives mill or a plastics mill strikes a spark, or when a large calender is used to process plastics which may contain metallic particles, both personnel and equipment are unnecessarily endangered.

Third, a metal detector will increase production rates. This is a direct result of protecting the machinery of production. In addition, it is a result of increasing the rate of inspection over that obtainable with visual and x-ray methods, even where such methods are possible.

Visual inspection methods are seldom feasible, for metallic particles are either imbedded in the product, as in the case of logs and candy, or are covered or mixed in with the product, as in the case of canned foods and packaged cereals.

Safety Aspects

X-ray inspection will endanger personnel exposed to these rays. This danger is particularly deceptive because the effects are cumulative and may not be evident for some time after exposure. Elaborate safety measures must be used which will not only provide shielding and space factors, but which will call for periodic exposure tests and measurements of the intensity of radiation to which the personnel is exposed. These safety measures are not required with electronic metal detection. All commercial models of electronic detectors are so constructed that the operator cannot touch any part that carries any voltage. The electromagnetic field around the coils is of such low intensity that no injurious effects are possible from exposure to this field.

Metal Detector Limitations

There are several things that an electronic metal detector will not do. It is well to know the limitations of the equipment at the start, in order to avoid later disappointment. First, the presence of much moisture, say in excess of 10 percent by weight, will reduce the normal sensitivity greatly and even render the detector useless. Most commercial models react to the presence of water just as they would to the presence of a nonferrous metal. The higher the operating frequency used, the greater the sensitivity of the equipment to moisture.

Second, the sensitivity will be impaired if large sheets or masses of metal are near the coil system of the detector, even if these masses are fixed and never moved around. This means that conveyor belts, chutes or rollers of metal cannot be run through the metal detector. Even a canvas or leather belt with metal rivets cannot be used, if normal sensitivity is required.

Third, most commercial models will not fail safe; if the oscillator stops, the presence of metal will cause no indication whatever. Various other component failures in the detector and amplifier section will likewise cause the metal detector to fail to indicate. A common cause of failure is a defective tube, for most commercial models use regular radio receiver tubes. Miniature and subminiature tubes are now readily available with a rated minimum life of 5,000 hours, and some special industrial types have been available for several years that have a rated life of 10,000 hours. These types should be used in industrial metal detectors where reliability and continuous operation are desired.

In view of the possibility of failure of the detector, its operation should be checked at least every eight hours with the special steel and brass spheres that are provided for this purpose. Most metal detectors require a slight adjustment of the balancing controls at least once a day, and this procedure is in itself a check on whether or not the detector is functioning correctly.

Fourth, no commercial model will operate satisfactorily if it is subject to much vibration, as this will cause slight dimensional changes in the coils and their relation to each other. This, in turn, will require frequent adjustment of the rebalancing control. In addition, the tubes used in most commercial models are not of the ruggedized industrial types, and hence vibration will cause shorts and intermittent operation.

Buying a Metal Detector

There are several factors which should be considered when buying a metal detector. The first of these is sensitivity; will it be adequate to detect the smallest metallic particle that may cause damage to other machinery or consumer goodwill? Particle size is directly related to coil size and aperture size, which determine the maximum dimensions of the material that may be inspected. For instance, a nail one-sixteenth inch in diameter will easily be located in a three-inch diameter log by a detector that will accommodate only a three-inch log, but it is not feasible, at this stage in the art, to locate the same size nail in a 36-inch diameter log. Table I gives the sensitivity obtainable for various metals with three different detection apertures.

Sensitivity and Stability

Sensitivity is also indirectly related to stability; the higher the required sensitivity, the more frequently the rebalancing controls will have to be adjusted.

Stability is the second feature to be considered when selecting a metal detector. Good stability is achieved by good mechanical layout and construction, a symmetrical coil system, adequate ventilation to prevent overheating of the electronic components, a mounting base (which is usually built by the user) that will effectively isolate the detector from vibration, and electrical and electronic circuit design which is inherently free from line voltage variations. This latter is most readily achieved by the use of a symmetrical mutual inductance bridge and an amplifier stabilized

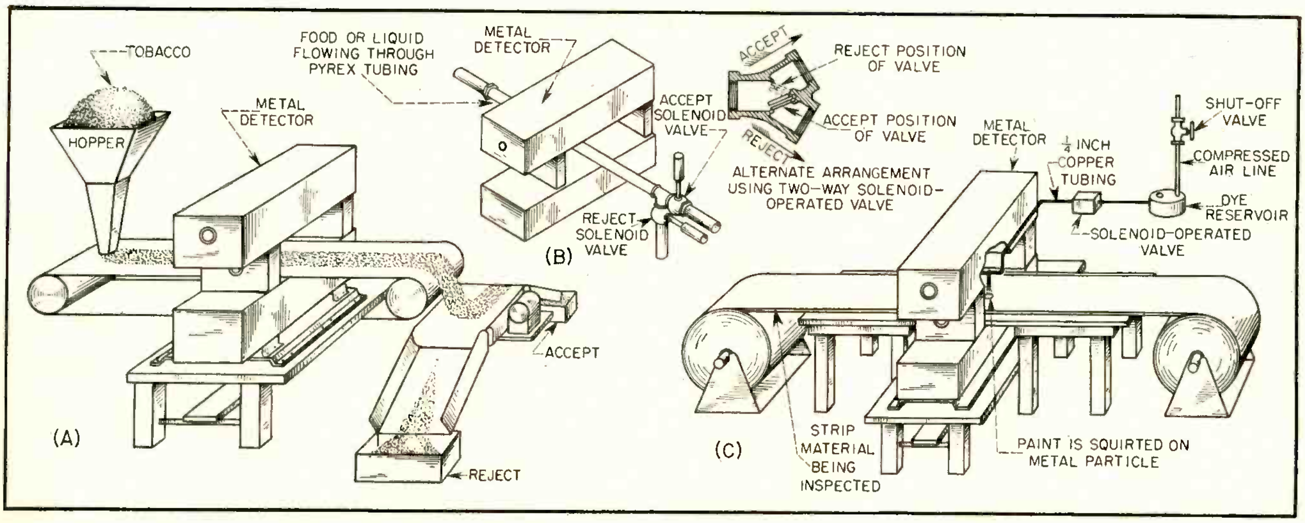


FIG. 4—Examples of metal detector applications in three different industries. Conveyor belt arrangement at (A) works well with many other granular materials besides tobacco. For any material that can be sent through a glass pipe, the arrangement at (B) is ideal. Strip material such as sheet plastic (C) can be inspected for extremely small particles because it requires minimum aperture

by a high percentage of inverse feedback. Otherwise, either line voltage regulators, plate supply regulators, or both, must be used.

The fact that voltage regulators must be used is not evidence of unsound design; it is pointed out here to emphasize that if the model selected is affected by line voltage variations, the user must be sure that voltage regulators are provided as part of the installation.

The third important buying factor is the speed of response. The electronic circuits and the necessary relays all have definite time lags, which determine the maximum speed at which the conveyor belt may be run. Most commercial models permit operation at speeds up to 600 feet per minute. Some models, particularly those using the change in the output of an oscillator, will not detect metal that moves through too slowly, so this limitation should be kept in mind where conveyor speeds are very low.

The fourth point to consider is the probable moisture content of the material to be inspected. Several metal detectors are just as sensitive to water as they are to nonferrous metals. If the materials to be inspected are not reasonably dry, the sensitivity of the detector will have to be reduced to the point where only relatively large masses of metal will give any indication at all.

Fifth, the detector should be made of materials which will not be affected by high humidity, corrosive fumes, chemicals, dust, water splash or other factors which are a part of the environment in which it will be used. If it is to be used in a grain elevator, flour mill or explosives mill, it should be adequately sealed against dust; if it will be used in a sawmill or ore crusher, the coil system should be protected from the impact of logs or large pieces of ore.

Table I—Minimum Spherical Particle Weights and Diameters Detectable With RCA Metal Detectors

Metal	4-inch aperture		7-inch aperture		12-inch aperture	
	Mass grams	Diam inches	Mass grams	Diam inches	Mass grams	Diam inches
Iron or steel	0.035	0.080	0.049	0.090	0.460	0.190
Brass	0.124	0.120	0.196	0.140	1.130	0.250
Copper	0.130	0.120	0.208	0.140	1.180	0.250
Aluminum	0.040	0.120	0.063	0.140	0.356	0.250
Lead	0.222	0.130	0.327	0.150	2.600	0.290
Magnesium	0.080	0.140	0.100	0.150	1.000	0.340
Stainless steel (non-magnetic)	0.184	0.140	0.220	0.142	3.000	0.340

Conveyor Installations

Installations generally fall into one of three groups:

(1) *Manual.* Here the material is fed or guided through the coil aperture by an operator; the detector signals the presence of metal, and the same operator removes the contaminated piece.

(2) *Semiautomatic.* The material passes through the coil aperture on a conveyor; a bell or light signals the presence of metal, and an operator removes the contaminated material.

(3) *Automatic.* The material passes through the coil aperture on a conveyor; the detector operates a solenoid which is mechanically coupled to a reject vane, an arm which pushes the package off the line, a dye-marking gun operated by compressed air, or an air valve in a compressed air line which blows the contaminated material off.

Figure 3 shows what generally may be expected in commercial detectors with regard to the smallest particle size of steel or iron that may be detected with a coil aperture of a given diameter.

Applications

A portable metal detector unit is quite convenient in a small plant. It may be moved around to inspect raw materials, to control contamination of the product during the various stages of manufacture, and for final inspection of the packaged product before it is shipped. The portable unit is also advisable in certain factories where a metal detector has not been used before, and hence where its most desirable location in a processing line is doubtful.

Applications of a metal detector to three specific industries are illustrated in Fig. 4. Figure 4A shows the automatic inspection of tobacco, which is conveyed through the detector on a continuously moving belt, and then dumped on a second conveyor which is instantaneously reversible by means of a rejection signal from the electronic circuits of the detector.

Figure 4B shows the inspection of liquids and liquid foods prior to canning. Plastic or glass piping is used to conduct the liquid through the metal detector. Two rejection methods are illustrated, both employing the same principle of operation. When metal is detected, the accept solenoid is de-energized and the reject solenoid is energized, thus diverting the flow from the canning machines. After a preset time interval, the accept solenoid is again energized (and the reject solenoid de-energized), but only if the metal detector indicates no further contamination.

Figure 4C illustrates the inspection of plastic sheeting. Operation is completely automatic, and speeds up to 600 feet per minute may be used with full sensitivity. When the electronic circuits of the detector indicate metallic contamination, a solenoid is energized which squirts a dye upon the area that is contaminated. The flow of dye continues as long as the presence of metal is indicated.

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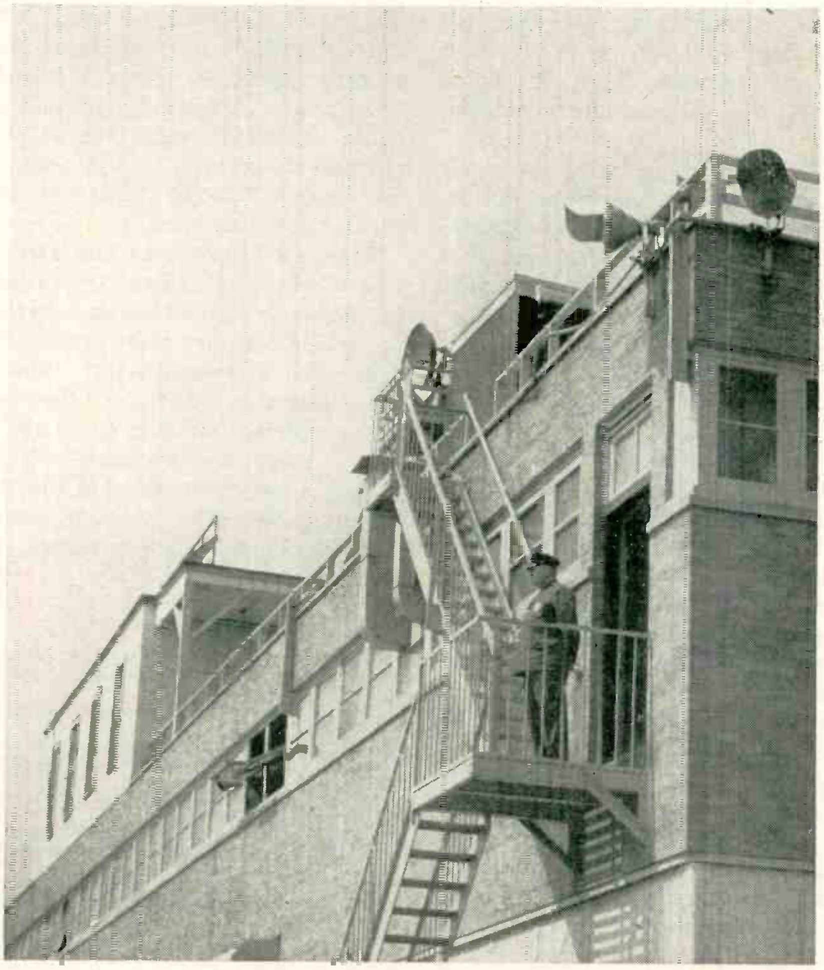
Safeguarding Production

Physical barriers of the type shown are the most effective means for preventing sabotage by keeping space between classified projects and espionage agents

Rigid enforcement of seemingly insignificant details is important



Classified equipment that must necessarily be electrically "in the clear" may be hidden from public view by tarpaper and wood structures

MILITARY strength depends on the continuous flow of essential equipment. Any interruption in production, whether premeditated or accidental, can seriously cripple striking power of a nation and its ability to ward off enemy attack.

The problems involved in protecting the electronics industry are, for the most part, similar to those necessary for safeguarding any kind of production. Electronic equipment is, however, particularly susceptible to sabotage, because of the delicacy of measuring and calibrating instruments, the dependence of over-all equipments on each of hundreds of basic components, and the extremes in speed and physical dimensions involved.

In World War II, the enemy was fairly well defined. He was a citizen of a country, rather than a member of an international party; and his activities could, for the most part, be watched. Today the problem is different, and consequently, different methods for combating sabotage must be used. The danger of mass enemy-inspired destruction timed to coincide with a surprise air attack is within the realm of possibility. Isolation is no longer a valid military advantage,

# of Military Equipment

Much of today's defense dollar goes toward the purchase of electronic equipment. The result has been an increased awareness of the industry's vulnerability to possible enemy action. Basic aspects of the problem of plant protection and internal security are discussed

because in the present state of affairs it no longer exists.

Three Dangers

Protection from the three basic dangers, attack, espionage, and sabotage, come under different responsibility headings. Naturally, a great deal of overlapping exists. Protection from enemy attack is primarily a federal and military function, but it is the function of the community and local plant management to provide means for protecting employees from such attack and for facilitating rapid return to production after an attack.

Safeguarding classified information such as circuit diagrams, parts specifications, operating frequencies, or even business-office orders, is likewise a joint problem. The development of policies, standards and procedures is the responsibility of the Munitions Board and the military department for whom the classified work is being done. It is the responsibility of the particular military department to see that adequate security measures are invoked and to take appropriate remedial action in cases involving a breach of security. Management's part is to see that directives and set procedures are complied with.

In the actual protection of plant facilities, management has the prime responsibility. The military departments furnish advice and assistance, but it is management's job to set up and maintain sufficient security measures to protect its own and the country's investment. It is relatively simple for plant managers to pin-point possible weak points, while an outside agency might have to spend countless hours finding them and recommending appropriate security measures.

In planning a program for protecting electronics plants from enemy action, a great deal of ingenuity and resourcefulness is required. The usual scheme is for the management to appoint some person who is gifted with these essentials, and then to endow him with all the authority and assistance he requires.

The success or failure of a security system is hard to measure—some steps taken during the last war now seem to have been unnecessary, but there is no way of measuring the damage that *might* have been done, had these steps not been taken. Thus planning for defense of production facilities becomes a typical engineering problem; the most severe conditions must be anticipated and generous safety factors must be employed.

Plant protection measures taken during World War II will in most cases form the nucleus for an ade-

Specific regulations have been set up for safeguarding classified information. It is management's duty to enforce these regulations

quate system for the present time. In many cases, more than adequate steps were taken, and with a very few changes, those steps can be utilized now.

One of the most effective aids, though often the most expensive, is space. It is axiomatic that, under usual circumstances, the saboteur cannot harm what he cannot reach, and the foreign agent cannot report what he cannot see. Restricted areas, along with fences, guards, photoelectric detection devices, charged wires, and so on, are all based on the principle of keeping a distance between classified equipment and information and personnel not authorized to have access to it.

The guards at the gate, and indeed the gate itself, have practically become a permanent fixture on the site of the electronics plant—with the exception of facilities engaged only in nonmilitary projects. Where the expense is justified, some plants employ electronic detection devices to prevent employees from carrying off pieces of equipment that might be essential to the smooth flow of products. Electronics also plays an important part in keeping a constant vigil on the boundaries of restricted areas—a number of plants are protected by photoelectric systems, usually operated in parallel as a safety measure, that signal the presence of intruders.

Photoelectric devices are also widely used to detect the presence of saboteurs who enter the plant under the guise of employees and conceal themselves during working hours with the idea of committing an act of sabotage when regular plant personnel have left for the night. The motivating impulse may not come from the foreign government—a disgruntled employee can cause just as much damage as an enemy agent, and a technician who conducts a servicing business on his own time can interrupt production to a great extent if he replenishes his tube supply at the cost of his employer and the taxpayer.

So the job of physical protective devices is to keep the right people in the right places and at the right times. No system is foolproof, but the nearer a system comes to fulfilling this basic requirement, the better the chances for uninterrupted production.

Safeguarding Classified Information

Requirements for safeguarding classified information are set by the federal government, and one function of the government is to see that appropriate precautions are taken so that such information does not fall into enemy hands. However, when a company receives a contract from the Army, Navy or Air Force that involves classified information, responsibility for safeguarding that information is placed squarely on the shoulders of management. The contract-issuing agency will issue security regulations that must be complied with in full.

Here again imagination and ingenuity must be applied. Persons having access to classified information must anticipate attempts to steal, copy or even see such information. And again, no system can be made perfect, but any system that makes obtaining information extremely difficult and reduces the odds of an agent's succeeding will also reduce the chances of his attempting the act in the first place.

Safe combinations and keys should be issued to a minimum number of persons. Safe combinations should be changed frequently and when employees knowing the combination leave the firm. Control of the number of copies of correspondence containing information of value must be exercised to assure that extra copies are not made and delivered to outside agents. Carbons and scrap paper may provide information and must be destroyed if of possible value to the enemy. Janitors and charwomen have an opportunity to obtain uninterrupted access to information of

GOVERNMENT PUBLICATIONS . . .

Principles of Plant Protection
Obtainable from the Munitions Board, U. S. Department of Defense, Washington, D. C.

Industrial Security Manual for Safeguarding Classified Matter
Obtainable from the Munitions Board, U. S. Department of Defense, Washington, D. C.

National Security Factors in Plant Location
A National Security Resources Board publication obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., price 15 cents.

The Effect of Atomic Weapons
Obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., $1.25.

Fire Effects of Bombing Attacks
Obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., price 15 cents.

Damage from Atomic Explosion and Design of Protective Structures
A National Security Resources Board publication obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., price 15 cents.

Survival Under Atomic Attack
Obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., price 10 cents.

Health Services and Special Defense Weapons
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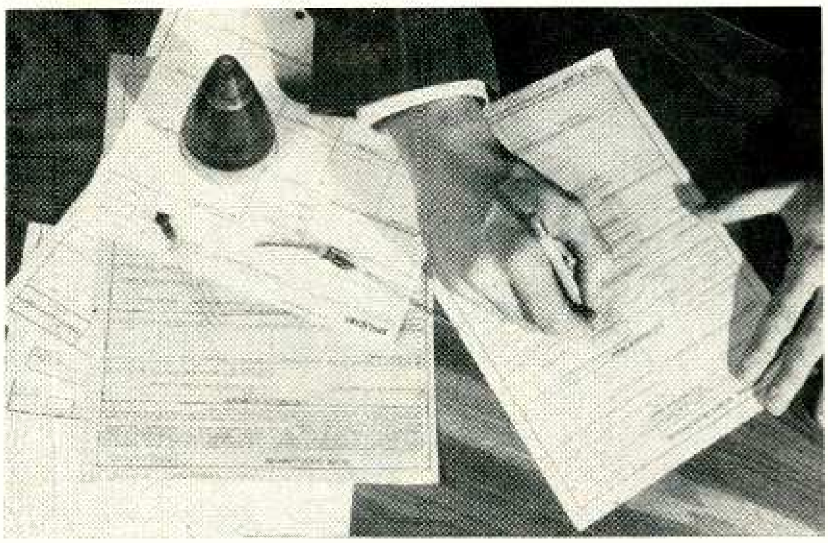
Industrial Fire Brigade Training Manual
Published by the National Fire Protection Association, Boston, price 25 cents.

general and possibly specific value.

A complete discussion of the rules and regulations governing the handling of classified information is beyond the scope of this article. Detailed treatment of the subject is contained in the second government manual listed in the accompanying editorial box.



Personnel employed for work on classified matter must be cleared through local military contracting agencies involved

Personnel

Clearance of plant personnel engaging in classified work comes under the jurisdiction of both the contract assigning agency and the plant management. The important thing is, of course, to eliminate subversive characters and to prevent their committing any act detrimental to smooth-flowing production. As before, the federal government's jurisdiction is limited, and to provide the comforting safety factor additional initiatives must be taken by the firms themselves.

The Federal Bureau of Investigation cannot look into the background and political affiliations of every person employed by a plant engaged in defense work. Where a particular employee is actually suspected of subversive activities, the FBI steps in at the request of management. But the routine screening of employees must be undertaken by management itself.

Many large cities and some states have files of people suspected or proved to be subversive. In most instances, these files are available to manufacturers. The old-fashioned fingerprint card still ranks high on the list of screening aids. These cards are available from the Superintendent of Documents at a price of $1.50 a hundred; and while it is true that a set of fingerprints is of limited value in some cases, the psychological effect cannot be overemphasized.

Security clearances of facilities and personnel are considered by the military departments only in connection with work involving classified military information. Inquiries concerning security clearances are made directly to the local procuring agency involved, and not to Washington.

Local agencies have at their disposal the Central Security Index File in Washington which saves much of the needless double checking that went on during World War II. Once a facility or a person is cleared for one classified job, a permanent file saves further investigations when the same facility or person is being considered for handling another job of similar classification.

Another recent innovation is the Security Requirements Check List, which further reduces the number of clearances necessary. These lists break complex equipments down into parts some of which are classified, and others of which are not. For example, a radio receiver may have a secret front-end that must be made by cleared personnel, while the rest of it can be subcontracted to uncleared facilities without fear of classified information falling into enemy hands.

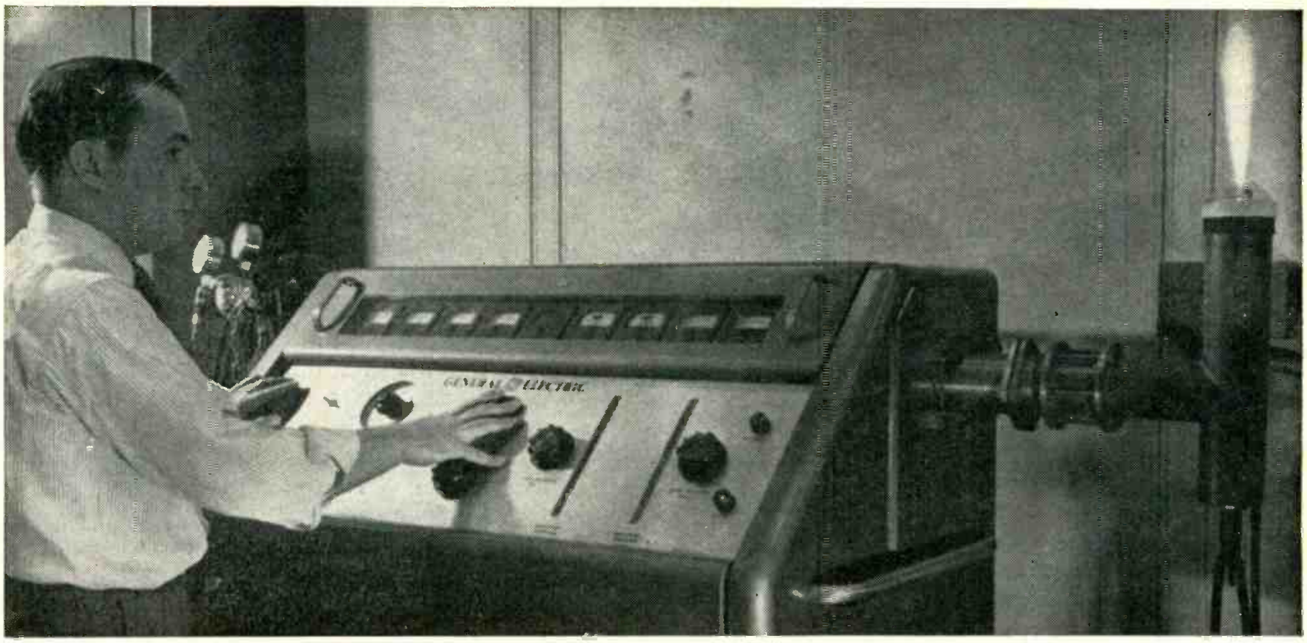
Aliens *can* be cleared to work on classified matter but the process is slightly more involved. According to the law, no aliens employed by a contractor for furnishing or constructing aircraft, aircraft parts, or aeronautical accessories for the government shall be permitted to have access to *unclassified* plans or specifications or the work under construction or to participate in the contract trials without written consent beforehand of the Secretary of the military department concerned. Special forms are available for clearing citizens and aliens. All clearing procedures start between the contracting firm and the local issuing office. In the case of subcontractors, clearance of their personnel is handled through the prime contractor.

Many special cases come up in the course of fulfilling contracts for classified matter. Oftentimes banks must be consulted for financial assistance, and the bank officers righteously insist on being informed about the contents of the contract before they will grant loans that will enable the contractor to start work on the project. In this case, the bank personnel must also be cleared through the borrowing firm, the prime contractors (if any) and the contract issuing office.

Defense Department Activities

The Department of Defense maintains an active staff of internal security experts, whose job it is to recommend and prescribe effective means for safeguarding production facilities. Among other things, these specialists make visits to selected defense plants, and from the results of their investigations, they make recommendations to assist industry in developing better security systems.

A study of the surveys made by these teams shows that industry security systems in general can stand improvement. Many plans are yet on paper, but most plants have programs under way. The general thinking, in constrast to ten years ago, is that *it can happen here.*
—J.D.F.



Electronic torch attached to output of GE magnetron electronic heater which serves as power supply

ELECTRONIC TORCH

By J. D. COBINE and D. A. WILBUR

General Electric Research Laboratory Schenectady, N. Y.

DESIGN of a torch suitable for use with a 5-kw microwave power unit at 915 mc is shown in Fig. 1.

The torch unit has a short-circuited quarter-wave section to permit the introduction of cooling water to the inner conductor. A perforated teflon washer is placed between the conductors to produce a more uniform flow of gas, which ensures a steady flame. The gas flow at the nozzle is at a velocity of from 50 to 200 feet a minute. A number of nozzles were developed, two of which are shown in Fig. 1.

The discharge is established at the tip of the inner conductor by touching the tip with an insulated carbon rod or a short piece of wire. Once started in this way, the discharge is stable when the r-f system is tuned to match its impedance. The tuning is accomplished by means of a triple-stub tuner in the power unit.

Two general types of flame are observed in the electronic torch. When polyatomic gases such as air, nitrogen, carbon dioxide and oxygen are used, the flame develops a considerable amount of heat and is capable of melting refractory materials. The other type of flame occurs when monatomic gases such as argon and helium are used, and develops little heat.

The flame usually has a bright core surrounded by a relatively dark space, which is in turn surrounded by a luminous shell of lower intensity than the core. The nitrogen flame has melted firebrick (1,800-2,000 C), and small tungsten rods (mp-3,370 C). Fernico parts have been welded together with this flame.

It seems probable that most of the heat developed at surfaces inserted in the flame is due to the heat of association of molecules dissociated by the electronic discharge. This action is comparable to the operation of the atomic-hydrogen torch described by Langmuir in 1926. The energy absorbed by the gas, both as ionized atoms and dissociated molecules, comes from the electromagnetic field through the collision processes of free electrons oscillating in the field. The central core also acts somewhat as a radiator of microwave energy which is largely lost. In many cases, the active length of the flame is about one-quarter wavelength. The buoyance of the flame in nitrogen indicates an average gas temperature of the order of 3,000 K for the polyatomic gases.

When monatomic gases are used, very little heat is developed by the flame and only a small power output can be established from the magnetron. A piece of paper could be held with this flame impinging

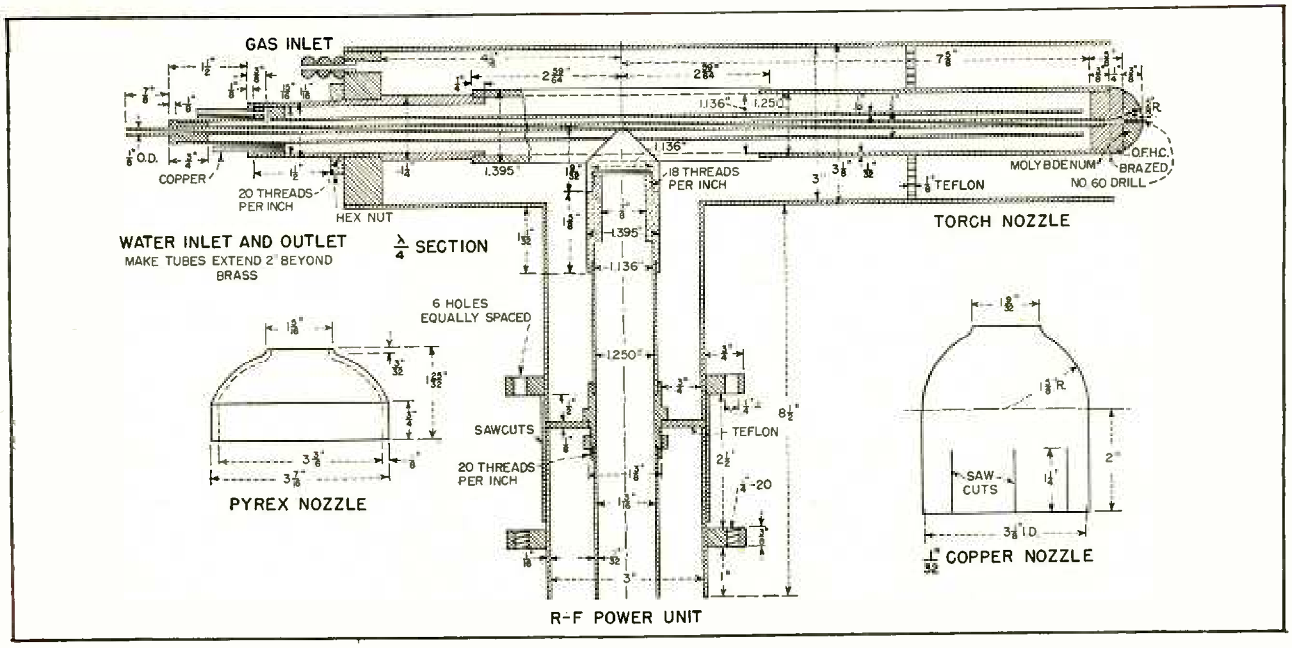


FIG. 1—Working drawings of 5-kw electronic torch capable of providing temperature well over 3,000 degrees C

High-power 915-mc discharge established at nozzle end of gas-carrying coaxial line provides steady electronic flame capable of melting tungsten rods and firebrick. Efficiency of converting microwave power to heat is good when gas is air, nitrogen or oxygen

normally to its surface without its being ignited. In the absence of dissociable impurities, the only heat reaching a surface placed in this flame appears to be directly from the recombination of positive ions and electrons on the surface, or from gas that has been mildly heated by recombinations resulting from many collisions of the ionized particles.

When welding-grade helium containing 0.3 percent hydrogen as an impurity is used in the torch, a moderate amount of heat is developed. Spectroscopic examination of this flame reveals only the lines of hydrogen. This is due to the large difference in the ionization potentials of these gases, namely 24.5 ev for helium and 13.6 ev for hydrogen. The gas having the lowest ionization potential is the one ionized.

Probe studies of the flame indicate electron temperatures of from 7.9×10^4 deg K at the tip of the flame to 13×10^4 deg K near the inner electrode. Electron temperatures of this order are not unusual in low-pressure electrodeless discharges. These temperatures correspond to mean electron energies of from 10 to 17 electron-volts, and probably account for the relatively high degree of dissociation. There is considerable uncertainty in the ion-density in the flame, but it appears to be within the limits of 10^9 to 10^{13} per cu cm. The lower limit is found in glow discharges, while the upper limit is somewhat less than usually found in atmospheric pressure arcs. The probe study reveals a d-c potential gradient along the flame of 20 volts per cm, with the tip of the flame positive relative to the inner conductor. This is probably due to the mass transport of ions by the gas stream.

The impedance of the flame was measured at 3.75 kw for the air discharge and found to be $4 - j47$ ohms.

Tungsten and molybdenum were found to make the best tips for the torch. Lower-melting-point materials are eroded by the action of the footpoint of the flame. This erosion may be largely evaporation, but some sputtering probably takes place. When considerable amounts of metal vapor are released, the heating ability of the flame is reduced and a mismatch with the magnetron occurs, resulting in unstable operation.

Applications

The electronic torch provides a source of heat that may be suitable for special heating projects where the absence of water vapor or combustible gases is especially desirable. Negligible electrode vapors are present in the flame to contaminate the work. The gas consumption is low, and when air is used a small blower is adequate to supply the necessary gas flow. Since the flame dissociates polyatomic gases at temperatures much below that of the electric arc, it may have applications in the electrochemical field.

CIVIL DEFENSE

It is hard enough to stimulate production of military gear when the immediate need overseas is limited, and still harder to prepare people on the home front for possible attack. Planning is nevertheless well along and some tangible steps have already been taken

FEDERAL civil defense communications planning is currently hampered by lack of three things . . . *money, Money* and *MONEY*.

The Federal Civil Defense Administration (FCDA) is at this writing operating on emergency funds from the President's budget. The appropriation under which it will eventually function is not yet known. The agency is nevertheless ambitiously opening 13 regional offices in

ATLANTA *(Alabama, Florida, Georgia, Mississippi, South Carolina, Tennessee)*
BOSTON *(Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)*
CHICAGO *(Illinois, Indiana, Wisconsin)*
CLEVELAND *(Kentucky, Michigan, Ohio)*
DALLAS *(Arkansas, Louisiana, Oklahoma, Texas)*
DENVER *(Colorado, New Mexico, Utah, Wyoming)*
KANSAS CITY *(Iowa, Kansas, Missouri, Nebraska)*
MINNEAPOLIS *(Minnesota, Montana, North Dakota, South Dakota)*
NEW YORK *(New York, New Jersey)*
PHILADELPHIA *(Delaware, Pennsylvania)*
RICHMOND *(Maryland, North Carolina, Virginia, West Virginia)*
SAN FRANCISCO *(Arizona, California, Nevada)*
SEATTLE *(Idaho, Oregon, Washington)*

Contact between Washington headquarters and the 13 regional offices will be maintained initially by land wire, with teletype as an important adjunct. Wire service will ultimately be backed up by a network of 13 government-owned and operated high-frequency radio transmitters. The existing Military Amateur Radio Service (MARS) network may be used to back up the government-owned network, operating at the federal level.

Three major questions currently asked by state and local civilian defense officials can be partially answered:

(1) To what extent will the federal government support the purchase of civil defense communications equipment? *FCDA is in no position to give more than moral support and advice at this time. It would like to say it with dollars but we are not too sanguine about even its future ability to do so.*

(2) What frequencies can states obtain for the operation of radio networks devoted specifically to civil defense communications? *This is still under discussion between FCDA and the Federal Communications Commission (FCC), with the military also involved. It may be some time before the question is resolved. FCC may eventually allocate a block of frequencies for such use, FCDA determining specific frequencies within this block for use by various states. Meanwhile, amateur networks can be set up on frequencies already allocated (p 148, March) for this purpose. Radio Amateur Civil Emergency Service (RACES) licenses are under consideration for use at the state and local level.*

(3) How can radio broadcast and television stations be fitted into the defense communications picture? *It now seems certain that radio stations will be so fitted in, and operators are right now studying a proposal which would permit them to function without presenting homing signals on a silver platter to potential enemy bombers. Details of the proposal are, at this writing, classified.*

The State Picture

Arizona's police communications network fits the state's civil defense plan almost to perfection. Back in 1940 the highway patrol and various county sheriffs agreed to cooperate in the building up of a network, with all base stations and mobile units operating on a common frequency. All counties, and several town and city police departments, will be covered by the end of 1951. Should any base station become inoperative, a mobile unit will be used for temporary headquarters operation and, if necessary, a number of mobile units spaced several miles apart will provide relay points between communities.

At present the highway patrol has 96 mobile units and the counties have 126. Four other state departments . . . the Department of Liquor License and Control, the State Penitentiary, the State Game and Fish Commission, and the State Highway Department . . . have 54 mobile units, including an airplane. There are, in addition, three mountain-top base and repeater stations. If present plans materialize there will eventually be a total of eight such stations, all interconnected by microwave and with a terminal station at each county seat. This will allow intercommunication without utilization of a common communications frequency.

The 276 mobile units and 25 base stations now operating on a common frequency might indicate chaos to the uninitiated. However, the state covers an area of 113,810 square miles, so there is only one base station for each 4,552 square miles and one mobile unit for each 412 square miles. Additional base stations and mobile units can still be added without difficulty.

Plans call for a secondary network of amateur stations operating on frequencies set up for the purpose, with each control center connected by direct telephone to the nearest police department, county sheriff or highway patrol station. In addition, there will be groups equipped with walkie-talkies, pack sets, mobile equipment and portable stations. Organization of the secondary setup is nearly complete.

The state of *Arkansas* has not yet made funds available for the establishment of a civil defense communications system. Until such time as money is forthcoming officials are making use of the extensive net-

COMMUNICATIONS—

CIVIL DEFENSE PERSONNEL

STATE	DIRECTOR	COMMUNICATIONS
ALABAMA	Col. James Garrett, *State Capitol, Montgomery*	——
ARIZONA	Maj. Gen. A. Tuthill, *Adjutant General, Phoenix*	G. O. Hathaway, *Arizona Highway Patrol, 1701 W. Jackson, Phoenix*
ARKANSAS	Carl C. Martin, *State House, Little Rock*	Vernon L. Kimball, *State Capitol Bldg., Little Rock*
CALIFORNIA	Maj. Gen. W. M. Robertson, *P. O. Box 110, Sacramento 1*	T. J. Kelly, *P. O. Box 110, Sacramento 1*
COLORADO	Lt. Gen. Henry L. Larsen, *300 Logan St., Denver 9*	Byron Jackson, *Mountain States Tel. & Tel. Co., Denver*
CONNECTICUT	General William Hesketh, *State Capitol, Hartford 1*	Col. Wesley L. Rogerson, *92 Farmington Ave., Hartford*
DELAWARE	D. Preston Lee, *Adjutant General's Office, Wilmington*	Lt. Samuel H. T. Standt, *State Police Station, Dover*
FLORIDA	Col. R. G. Howie, *575 Riverside Ave., Jacksonville*	M. L. Barre, *Southern Bell Tel. Co., 325 W. Adams St.*
GEORGIA	Maj. Gen. Ernest Vandiver, Jr., *410 State Office Bldg., Atlanta 3*	——
IDAHO	Col. Philip Doddridge, *State House, Boise*	——
ILLINOIS	Lenox R. Lohr, *57th & Lake Shore Drive, Chicago 37*	M. W. Casad, *57th & Lake Shore Drive, Chicago 37*
INDIANA	Arthur M. Thurston, *777 North Meridian St., Indianapolis*	Zellon Audritsh, *Indiana State Police, Stout Field, Indianapolis 21*
IOWA	Rodney Q. Selby, *Central National Bldg., Des Moines 9*	Alex M. Miller, *716 Equitable Bldg., Des Moines*
KANSAS	Standish Hall, *National Bank of Topeka Bldg., Topeka*	Col. H. F. Edwards, *Kansas Highway Patrol, Masonic Temple Bldg., Topeka*
KENTUCKY	Roscoe L. Murray, *Adjutant General, Frankfort*	Capt. E. B. Jones, *Dept. of State Police, Frankfort*
LOUISIANA	William J. Dodd, *State Capitol Bldg., Baton Rouge*	James A. Noe, *KNOE, Monroe*
MAINE	Co .Spaulding Bisbee, *State House, Augusta*	Harold L. Gerrish, *State House, Augusta*
MARYLAND	David G. McIntosh, III, *Pikesville 8*	Col. J. P. Cooper, Jr., *Chesapeake & Potomac Tel. Co., 320 St. Paul Pl., Baltimore 2*
MASSACHUSETTS	John F. Stokes, *State House, Boston*	Daniel I. Murphy, *Dept. of Public Safety, 1010 Commonwealth*
MICHIGAN	Lester J. Maitland, *Prudden Bldg., Lansing*	——
MINNESOTA	Col. E. B. Miller, *1003-4 Commerce Bldg., St. Paul*	——
MISSISSIPPI	Walter Spiva, *Executive Department, Jackson*	——
MISSOURI	Ralph W. Hammond, *401 Madison St., Jefferson City*	Charles E. Dewey, Jr., *401 Madison St., Jefferson City*
MONTANA	Col. E. K. Cheadle, *P. O. Box 1157, Helena*	Arthur Zion, *State Highway Commission, Helena*
NEBRASKA	Edward Gillette, *State House, Lincoln*	Leonard O. Arstad, *Northwestern Bell Tel. Co., 118 S. 19 St., Omaha 2*
NEVADA	Brig. Gen. James May, *Adjutant General, Carson City*	Merrill Inch, *Reno Newspapers, Inc., Gazette Bldg., Reno*
NEW HAMPSHIRE	Rear Ad. Miles R. Browning, *State Capitol, Concord*	Capt. Basil Cutting, *New Hampshire State Police, Concord*
NEW JERSEY	Leonard Dreyfuss, *State House, Trenton*	J. R. Poppele, *WOR, 1440 Broadway, New York City*
NEW MEXICO	Brig. Gen. Charles G. Sage, *Adjutant General, Santa Fe*	——
NEW YORK	Lawrence Wilkinson, *124 E. 28th St., New York 16*	Ford Bond, *Ford Bond Radio Advisors, 810 RCA Bldg. West New York 20*
NORTH CAROLINA	E. Z. Jones, *807 Capital Club Bldg., Raleigh*	Paul Dillon, *807 Capital Club Bldg., Raleigh*
NORTH DAKOTA	Brig. Gen. H. L. Edwards, *Fraine Barracks, Bismarck*	——
OHIO	Maj. Gen. Leo M. Kreber, *Adjutant General, Columbus 16*	H. G. Rice, *Fort Hayes Barracks, Columbus*
OKLAHOMA	Brig. Gen. Roy W. Kenny, *Adjutant General's Office, Oklahoma City*	——
OREGON	Louis E. Starr, *1022 S. W. 11th Ave., Portland 5*	I. B. McKinney, *1022 S. W. 11th Ave., Portland 5*
PENNSYLVANIA	Alton C. Miller, *201 South Office Bldg., Harrisburg*	Lt. Donald E. Wagner, *Pennsylvania State Police, 350 Main Capitol Bldg., Harrisburg*
RHODE ISLAND	Brig. Gen. James A. Murphy, *1051 North Main St., Providence*	Col. John B. Gegan, *234 Washington St., Providence*
SOUTH CAROLINA	Maj. Gen. James C. Dozier, *105 Wade Hampton State Off. Bldg., Columbia*	Ralph King, *State Highway Dept., 908½ South Main St., Columbia 1*
SOUTH DAKOTA	R. P. Harmon, *State Capitol, Pierre*	Sam Fantle, *Midcontinent Broadcasting Co., Sioux Falls*
TENNESSEE	Brig. Gen. Claude M. Adams, *Adjutant General, Nashville 3*	Comm. Sam K. Neal, *Department of Safety, State Office Bldg., Nashville 3*
TEXAS	William L. McGill, *Executive Department, Austin 11*	Col. Homer Garrison, Jr., *Dept. of Public Safety, Austin*
UTAH	Brig. Gen. J. Wallace West, *207 South Main, Salt Lake City*	Joseph W. Dudler, *State Highway Patrol, State Capitol, Salt Lake City*
VERMONT	Merritt A. Edson, *Dept. of Public Safety, Montpelier*	——
VIRGINIA	Joseph H. Wyse, *The Capitol, Richmond*	Guthrie S. Kennard, *C. & P. Telephone Co., 701 E. Grace St., Richmond*
WASHINGTON	Philip Batson, *Legislative Bldg., Olympia*	Capt. Richard Quantz, *Washington State Patrol, 901 Dexter Ave., Seattle*
WEST VIRGINIA	Brig. Gen. Charles R. Fox, *Adjutant General, Charleston 5*	E. L. Haines, *215 Hale St., Charleston*
WISCONSIN	Maj. Gen. Ralph J. Olson, *State Capitol, Madison*	——
WYOMING	R. L. Esmay, *Adjutant General, Cheyenne*	C. K. Faught, *P. O. Box 395, Cheyenne*

works of the Game and Fish Commission, the Forestry Service and the State Police.

In *Illinois* an ambitious program for communications and control has been proposed. It involves use of telephone, telegraph and teletype facilities, commercial radio and television stations, local, county and state police networks, amateurs, mobile highway telephone services, civil air patrol gear and private radio equipment operated by taxicab companies, transportation firms and utilities. Details of the proposal have been distributed in mimeographed form to local officials for further action at that level.

Indiana has appropriated $150,000 to support a full-time state civil defense department for two years, and set up a $350,000 contingency fund for use in the event of actual emergency. Because of the limited budget, immediate plans revolve primarily around the use of existing communications facilities such as those operated by various commercial and public mobile services and amateurs.

The state of *Maine* has set up a telephone network similar to one used during World War II. The state police network is used as an auxiliary, and the Civil Air Patrol has a considerable amount of equipment, including walkie-talkies, which can be quickly transported to disaster areas. Amateurs are organized, and have a good supply of portable equipment for use in the 80-meter band. There have been several statewide tests of the amateur network, all reported as satisfactory.

In *Maryland* plans are still under development. The air-raid warning system will utilize a wire network operating outdoor and indoor signals controlled by keys located in a Baltimore-area warning center. Communications in the event of a disaster will be by telephone where possible. As an alternate means, a fairly high-powered radio net is contemplated to interconnect seven Baltimore-zone headquarters and the headquarters of five counties surrounding the city. Use will also be made of commercial and amateur mobile services to communicate from zone headquarters to field units. Much remains to be done, in obtaining funds, organizing, and in making detailed arrangements, but tangible progress has already been made.

The civil defense communications plan of *Massachusetts* utilizes the state police radio network for the alerting of local communities. The plan calls for the installation in each community, at police headquarters, fire headquarters or other central points designated by defense directors, of radio receivers tuned to the police frequency. Emergency 500-watt, 120-volt, 60-cps gasoline-driven generators are mandatory. Selective calling attachments are optional. An auxiliary amateur radio network is also being set up.

Missouri has no definite plans for the procurement of radio equipment. Existing communications facilities such as those of the highway patrol are being utilized.

New Jersey is organizing communications in four districts, each of which contains from two to four subdivision areas. The committee roster lists men from the broadcasting field, telephone and telegraph companies, the state police and amateur radio.

In *New York* telephone lines form the primary communications network at the present time, with police radio networks contemplated as an auxiliary service and amateur equipment and personnel being enlisted as rapidly as possible for use as a third line of defense. A separate radio network for defense work has been suggested as a means of avoiding shutdowns which might occur in the event of a disaster taking out telephone lines, often used for the remote operation of police transmitters, but financing and other details have not yet been worked out.

Ohio is taking inventory of existing state communications facilities and has placed a printed bulletin outlining general communications needs in the hands of local defense officials. The state has also distributed an annex to the bulletin, listing 47 amateur radio coordinators, giving their addresses and station call letters.

At the moment, emergency work in *South Carolina* is confined to the wire services. The highway patrol's radio facilities consisting of 280 mobile units and 11 base stations have, however, been made available for auxiliary use. Means for cross-band communications with the highway patrols of North Carolina and Georgia are available. The highway patrol's message center has been designated as key state outlet. County-level notification is by telegraph.

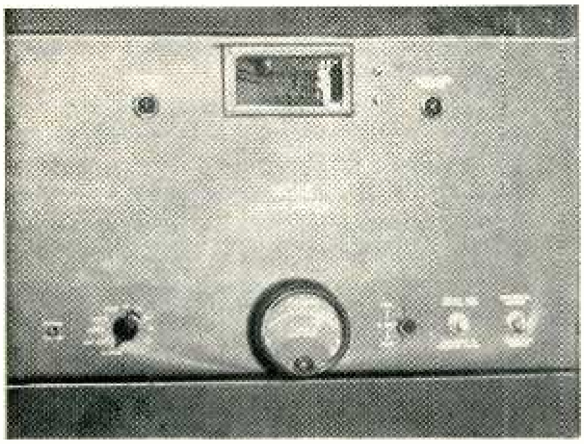
Final plans in the state of *Washington* are dependent upon what appropriations the legislature allows. Officials contemplate using telephone facilities insofar as they remain in operation and within their traffic capabilities. They would also provide each local control center and alternate centers with portable or semiportable vhf or hf stations equipped with auxiliary power units. Several large aircraft would, ideally, be equipped with transmitters and receivers. These aircraft would be strategically located throughout the state. If the situation warranted, they would be airborne and sent to an altitude sufficient to provide solid communications or relaying to any control center or area. This would make the proposed communications system entirely independent of land wire and power facilities, extremely flexible and mobile, and overtaxing of existing facilities would be avoided.

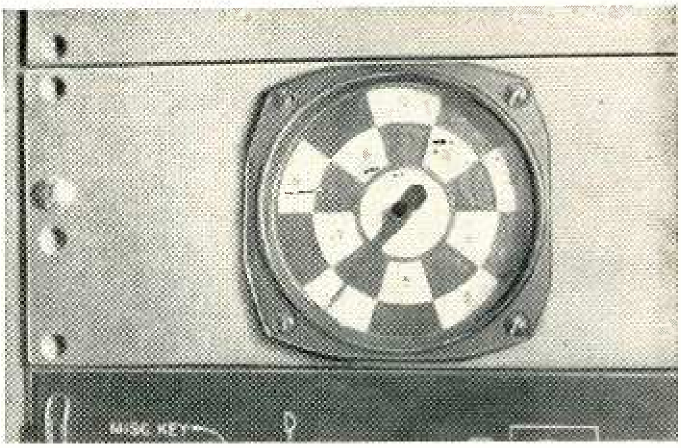
Some thought is also being given to the use of microwaves for general cross-state official communications. Should this prove feasible, several channels will be multiplexed for use by civil defense. Each control center would be equipped to feed either the microwave link or aircraft.

Typical Local Organization

Several major cities are well along with their planning for civil defense communications. Most of these have organizations set up and functioning, and some are already installing equipment.

At this writing it appears that we will be able to describe a model local setup in these columns next month, omitting only those details concerning precise control-center locations, operating schedules and frequencies which might be of value to a potential enemy.—W.MacD.





Complete rack-mounted time standard at left shows condition of system at a glance. Special 1-rps monitor clock (right) allows checking system to 0.1 sec from WWV standard time signals at any five-minute interval

ACCURATE TIME for Broadcast Studios

Inexpensive synchronous clocks keep time within 0.1 sec when driven through an audio amplifier at exactly 60-cps from a tuning-fork controlled multivibrator. They can be set when the multivibrator runs free at 55 or 70 cps

By JAMES H. GREENWOOD
Chief Engineer
WCAE, Inc.
Pittsburgh, Pa.

ACCURATE time is necessary in every broadcast studio to comply with FCC program-log requirements as well as for coordination of local and network programming. For these purposes, an accuracy of ± 1 second is adequate.

Anyone who has investigated the various means for telling time has found an almost endless variety. The exactness that may be obtained is limited only by the complexity and cost that can be tolerated. Every application has its own special requirements. The system to be described was designed to meet the needs of a radio broadcasting station in which various sizes and models of clocks were required for the different studios, control room, announce booths and recording room.

Many radio stations subscribe to a commercial time service that provides a special clock or clocks, which are corrected by a timing impulse sent out each hour. The system to be described comprises a 60-cps multivibrator controlled by a 240-cps tuning fork. Any reasonable number of inexpensive self-starting synchronous clocks can be operated from the 50-watt audio amplifier driven by the time standard. Means are provided for speeding up or slowing down the standard. The system can be checked to an accuracy of 0.1 second at any five-minute interval using the standard-time broadcasts of WWV.

Ten clocks are in use at present, although this is not the limit of the equipment. The larger clocks require about 4 volt-amperes, but less than 3 watts. Each clock has been adjusted for maximum power factor by connecting a capacitor across the motor winding, the capacitor being mounted within the clock case. The adjustment is not critical and only two values of capacitors are used, 0.5 μf for one type of clock and 0.75 μf for another. Overcorrection of some clocks is offset by undercorrection in others.

P-F Correction

Power-factor correction could also be accomplished for the system as a whole with all clocks connected. This alternative is less satisfactory because correction is not automatic with the addition or subtraction of clock units. Removal of the entire clock load from a tuned-output amplifier might result in damage to the output transformer.

Adjusting the clock's power

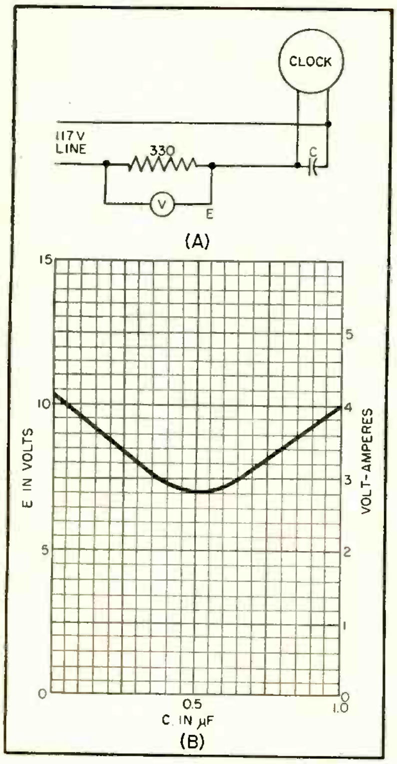


FIG. 1—Circuit (A) for determining clock power factor. Various capacitors are tried and the results plotted at (B). Correct compensation is secured with capacitance giving minimum volt-amperes

factor to unity is the same as tuning the clock to resonance. The method is simple as shown in Fig. 1. Various capacitances are tried for each type of clock used and the voltage across the resistor recorded for each value. When the parameters for a type are plotted as shown in Fig. 1B and joined by a smooth curve, the capacitance resulting in minimum voltage provides maximum power factor.

All of the available clocks were found to have backlash in the gears between the second and minute hands so that they would not track together. If adjusted to agree at 15 minutes before the hour, the minute hand would lead the second hand at 15 minutes past the hour, sometimes by ¾ minute, which would then be read as a full minute.

Drags have been installed on all clocks so that the minute hand is being pushed at all positions. The design of the drag differs for different sizes and styles of clocks, but usually consists of a thin phosphor-bronze spring pressing against the intermediate gear that transfers motion from the minute to the hour hand. It is readily accessible and a drag at this point takes up play in all the gear train ahead of it.

Counterbalances were also installed on the minute hands of the larger clocks to reduce the amount of friction required in the drag. Clocks so modified can be used indiscriminately on either 60-cycle power lines or from the time standard.

Setting the Clocks

The time standard is a type 2001–1 fork unit followed by a multivibrator that can be locked in at 60 cycles, at which the output is tuned. The entire assembly was purchased as a package from American Time Products, Inc. It is followed by a commercial audio amplifier designed to operate on about 1 milliwatt input power at high impedance. Additional amplifiers can be bridged across the same 60-cycle source if needed to operate another set of clocks. Although the nominal output power is 50 watts, only about 40 watts is available at the operating frequency.

Necessary flexibility in a clock system requires that there be a means of advancing or retarding the movement in order to set it. Although there are a number of systems possible, such as selsyns operating from a three-phase power line, there is always the danger of correcting so rapidly that the instantaneous frequency of the supply falls beyond the capacity of the clock to follow synchronously. Besides, life of a clock run at high speed (such as 120 cps) is seriously reduced. Slowing the system by simply shutting off power is not feasible because some clocks coast more than others.

A good solution is modification of the multivibrator to permit operation slightly above and below 60 cps, as shown in the circuit of Fig. 2. When switch S_1 is in the center position, normal operation occurs at 60 cps. In the upper position the clocks run fast and in the lower they run slow. Because the multivibrator output is tuned for 60 cps, operation at a higher frequency results in reduced output. Accordingly, resistor R_2 is automatically switched in to reduce the 60-cps output but is disconnected during operation at higher or lower frequencies.

Contacts on the upper portion of the switch, S_{1A}, in the cathode circuit of the 12AU7 tube, should be of the shorting type (make-before-break) so that there will be no interruption of the multivibrator as the switch is operated. The switch should disconnect the tuning-fork drive before it has changed the speed of operation of the multivibrator to either fast or slow speed. This action eliminates beat notes between the tuning fork and the detuned multivibrator and also assists in maintaining uniform output voltage. A switch having suitable characteristics can be assembled from one switch deck with non-shorting contacts (disconnecting the input) and one switch deck with shorting contacts (controlling the speed of the multivibrator).

Frequency Limits

The resistor and capacitor values shown in Fig. 2 result in setting frequencies of about 70 and 55 cps. Frequencies of 66 cps and 54 cps would be somewhat preferable since the change in each case would then be 1 second in 10, simplifying the daily setting against WWV signals.

The variable 3,000-ohm resistor R_1 in the multivibrator cathode circuit should be initially adjusted to the center of the range over which the tuning fork maintains control. An oscilloscope is handy at this time. One pair of plates is connected to the amplifier output and the other pair to the 60-cps power

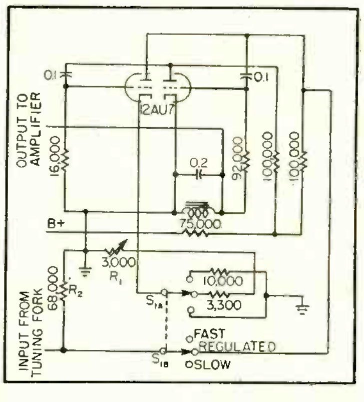


FIG. 2—Multivibrator circuit ordinarily tuned to 60 cps and driven by tuning-fork. In free-running positions of switch S_1 it can be used to speed up or slow down clock system for setting

line. If the clock-amplifier and the power-line frequencies are the same, the pattern on the scope will be stationary. When the multivibrator is detuned so far that the fork loses control, the pattern will rotate several times a second. The condition becomes immediately apparent with an oscilloscope, whereas several minutes would have to elapse before a change in the speed of the clock system could be detected. The exact speed of the fast and slow positions can be determined in the same manner if a calibrated audio oscillator is used instead of the power line on one pair of plates.

It will be noticed that the waveform of the time standard is not perfectly sinusoidal. Few commercial 50-watt amplifiers are designed for full undistorted power output at frequencies as low as 60 cps. Usually most of the distortion occurs in the output transformer. However, it is almost impossible to produce sufficient overload distortion to disturb the operation of the clocks.

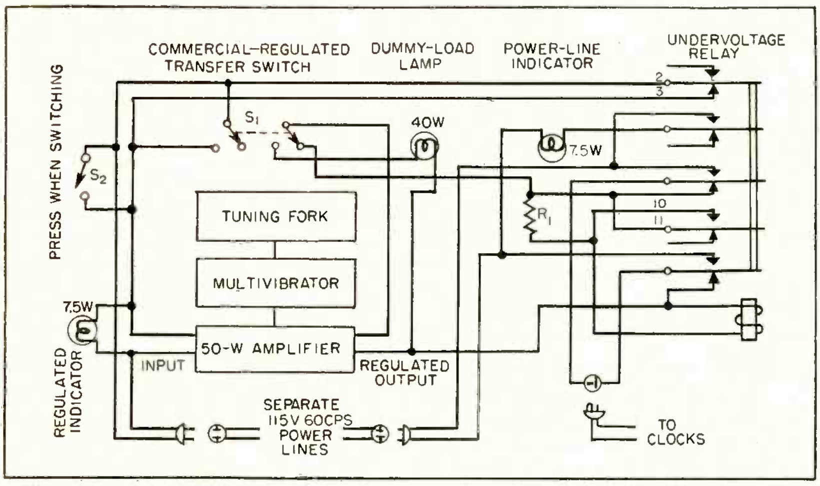


FIG. 3—Automatic switching circuits to transfer clock system from regulated 60-cps source to commercial power. Amplifier and associated circuits can be checked without interfering with clocks. Two power mains insure continuity of service

Auxiliary Power

It was not considered necessary to provide a spare amplifier or tuning fork. Instead, provision is made to switch the clock system automatically onto commercial power if the regulated supply falls below 90 volts. At the same time, power is removed from the amplifier, tuning fork and multivibrator and a warning light goes on at master control. As shown in Fig. 3, power is available from two separate trunks. Commercial power for the emergency operation of the clocks is obtained from the trunk other than that used for the amplifier. A plug-and-socket system allows rearrangement of power inputs.

The undervoltage relay used to transfer the clocks from one system to the other is a standard 5-pole double-throw type designed for 115 volts 60 cps. A resistor R_1 can be added to cause the relay to drop out with 90 volts across the coil and resistor in series. In the unoperated position of the relay, this resistor is shorted out in order that the voltage at which the relay characteristically closes will not be essentially altered by this addition. The contacts should be adjusted so that as the voltage across the relay is reduced contacts 2 and 3 open before contacts 10 and 11 close. This arrangement will prevent any tendency towards chattering in normal operation. Since the relay is connected across the amplifier output, its power factor should be compensated as was that of the clocks.

Maintenance practice demands that the amplifier system be checked periodically. This is accomplished by means of the dpdt switch S_1 in the COMMERCIAL SOURCE position. It applies power to the amplifier without disconnecting the clocks from the commercial system. A 40-watt lamp load is connected to the output of the amplifier at the same time.

After the amplifier has been adjusted for normal output, pushbutton S_2 (Fig. 3) is held down, maintaining an uninterrupted supply of power to the amplifier while the dpdt switch S_1 is returned to the REGULATED SOURCE position.

To facilitate maintenance, a plate-current metering system is used, with appropriate resistors connected in the plate or cathode circuit of each tube. A rotary triple-pole switch connects a 1-milliampere meter across the resistors in sequence. For a-c measurements on the output voltage from the amplifier and that of the power lines, a copper-oxide rectifier is switched into the circuit. The meter and selector switch are illustrated.

Clock Outlets

Special outlets are installed in the clock wiring system so that it is impossible to plug in other devices. The outlets are Hubbell 6822 or equivalent two-wire polarized. Alternatively, a standard double-T slot, single, plastic receptacle can be modified by cementing Bakelite plugs in the arms of one of the T's. Each clock is equipped with a 6918 polarized plug cap. This cap can be used in any receptacle having double-T slots, allowing the clocks to be tested on commercial power.

Standardizing the System

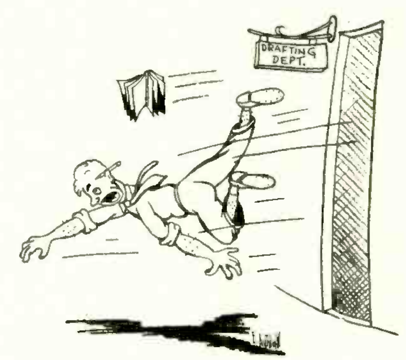
In order to compare the system with the standard time signals from WWV the special clock (illustrated) was assembled. It comprises a B3 Telechron motor operating at 1 rps, mounted with a suitable face plate, cover glass and indicating hand. The dial is divided into ten portions as shown. The hour, minute and second are determined from a standard clock, while tenths of a second are clearly indicated by the position of the hand at the start of the tick from standard-frequency station WWV.

How to set up an INSTRUCTION

Over-all analysis of the problem of producing the manuals required under practically all military electronic equipment contracts, optimum staff organization for producing manuals efficiently to meet deadlines, personnel qualifications, and breakdown of staff duties

By EUGENE ANTHONY

Product Service Manager
General Electric Supply Corp.,
New York, N. Y.



DO make certain that the technical manual writer and the supervisor of drafting can meet on equal terms.

UNCLE SAM needs a lot of electronic equipment today and many concerns are designing and building it for him. Some are new in the field; others are working with new personnel; still others are using essentially the same organization they had during World War II.

All of these groups can use help in making plans for the preparation of technical manuals. The last group particularly needs attention, for it includes many concerns whose facilities proved inadequate before. Poor planning was rather common because the technical manual was often treated as just an extra gimmick—something of secondary importance in the contract.

It is expected by the military that the manual you supply will include all needed technical data. Completeness is more than a theoretical need, as the manual may have to serve in the field in the absence of any supplementary information.

The technical manual is the only permanent link between the brains that conceived and built the equipment and the men who are called upon to put it together, use it and keep it running. Because of its importance, the technical manual demands organized and responsible planning for its preparation.

Department Manager

The block diagram (p 103) shows the operations and facilities which enter into the production of a technical manual. The block marked Mr. X shows the common force through which all others are coordinated. The force is a man—the man who is specifically charged with the responsibility of producing the manual.

What kind of a man is he? What are his qualifications?

The best bet is to get a man who is first an engineer and second a writer. He must be fully acquainted with and intensely interested in electronics. He will have to do most of the heavy writing before he is through.

Don't expect your project engineers to do the major portion of the writing. That's the tough way of doing the job and the results won't be good. A good manual is a full-time job and requires the kind of devotion your project engineers can't afford. Anyway, it's a bad idea to rely on them for the writing because they will be needed for engineering. Besides that, you may have several projects in the mill at one time and each one will represent a major educational job to get the manual idea over to new groups of engineers. In the long run, the manual department man will probably have to kick in full time to make sense out of the material initially prepared by the project engineers. It's a much better idea to start with the right man and plan on his doing the job from scratch.

Mr. X is the right man to do the heavy writing for still another reason; the manual requires literally hundreds of different kinds of information, all of which must be combined into a well-organized outline. These things can't be put together like so much patchwork. Some manuals have well over 500 printed pages. The man who does it must be a professional—he must know all of the requirements and precisely how they are to be filled.

AUTHOR

THE AUTHOR, during World War II, was in the Technical Manual Section of the General Electric Co., Electronics Department, Bridgeport, Connecticut, as one of three men specifically assigned the responsibility of producing manuals. During the war he completed approximately 20 manuals on electronic equipment ranging from small and simple units to large and complex military electronic systems

MANUAL DEPARTMENT

DO'S AND DON'TS

DO assign the responsibility for producing the manual to a single individual who has professional abilities in this work.

DO provide the writer with full-time engineering-writing assistance.

DO provide some full-time ink tracers in your drafting section exclusively for manual work.

DO impress your engineering department with the importance of manuals so that their willing cooperation is obtained.

DON'T expect project engineers to do the heavy writing.

DON'T subject your technical manual section to indirect, impersonal drafting service.

DON'T wait for the final design freeze before starting serious work on the manual.

Mr. X won't be able to do the job alone; he will require the services and assistance of many people before he is through. This leads to another very important requirement of the man. He must have the ability to supervise people properly and, of course, must be recognized as a supervisor. He must have a plan of action and be able to carry it out.

In that connection it is well to take into account the kind of philosophy Mr. X must have with respect to his approach to the task. He must not become a victim of the most common human failing which occurs in this kind of work. That failing is to take too seriously the fact that the engineering is not yet completed, that extensive changes are anticipated, and that the existing material is inadequate to prepare a final and correct manuscript. Those are the bugaboos of technical manual preparation, and they lead to hectic, heart-breaking pressure when deadlines are approached. More disturbing is the fact that this pressure occurs when the heat is on in engineering and production, with the result that there is little time or talent available for technical assistance from those departments. That's not a comfortable position for anyone.

There's not much that can be done, as a general rule, to freeze design months or even weeks before the production deadline. That's a situation Mr. X will have to live with. But there are ways of distributing the load quite evenly so that, when the pressure is on, he has enough cushion to absorb the shock. How does he do it?

He must be practical enough to accept the equipment as it exists when he starts the manual and to dismiss, temporarily, the probability of future changes. He must also keep his assistants working and thinking along those same lines.

Consider the photograph problem, as an example. Mr. X knows that his only available model is an experimental engineering sample, dirty perhaps, and with only a rough resemblance to the final product. He also knows that his best bet for his final book is the first actual production model, which will not be available until very near to deadline time. Rather than postpone all photo work until that time, however, he proceeds to take all pictures called for in the specifications. He treats them as finals, even to the extent of having the rough art work done (such as lettering and balloons).

The result of this policy is that his thinking is done early in the game. The only remaining job is to bring the photos up to date at the last possible moment. With the early pictures as guides, people with virtually no experience or talent can follow through to get new photos made up, "just like these samples only of the latest model". Similarly, the finished art work simply represents copying something already done, with a few corrections here and there that can be done with a minimum of experienced direction. Direction is much more costly than the reworking of the photos.

If Mr. X has that kind of approach to the problem he'll turn out better books quicker and with the least amount of wear and tear on personnel. When deadline time approaches he'll have the simpler problem of bringing an existing manual up to date, rather than the problem of *producing a manual.*

His Assistant

The diagram shows what Mr. X needs to get his job done in commercial time (a couple of months or in time to join the completed equipment at the end of the assembly line).

Referring again to the block diagram, note that branch 1 represents a technical person (or persons) who works directly under Mr. X. He must be good but can be a man with less experience. Generally, an engineer directly out of school is good here. We will call him the assistant technical writer. He is absolutely necessary, as he relieves Mr. X of the hundreds of detailed tasks which go into the completion of the manual, leaving him free to do the heavy writing and supply the continuity.

The assistant technical writer must gather statistical data relative to the equipment. This includes such things as weights, dimensions, test voltages and drawing references. He must follow through the preparation of stock drawings such as outline drawings, socket-voltage diagrams, tube-layout diagrams, installation drawings, panel drawings, coil data and others as required by government specification. He must gather spare-parts information if not actually make up the lists. He must supervise photography of the equipment, not only to fill government specifications but also to obtain a good comprehensive collection of reproducible photographs. He must also write some of the procedures and tables that are self-sufficient within themselves.

The assistant can also be of invaluable aid in recording drawing and photo titles and their reference numbers as they are filed away upon completion, so that they are easily gathered when needed. He is most helpful toward the end of the project when the manual work enters its final correction stages. He can withdraw the illustrations one by one, check them for validity and supervise their correction or replacement. This is frequently done while Mr. X is deeply engaged in galley proof work and is approaching the point where the final illustrations will be needed by the printer.

Office Personnel

Branch 2 in the diagram represents general office personnel directly under Mr. X. The most obvious duty here is the typing of both the rough and finished manuscripts. That, in itself, is a major operation and calls for a typist who can type rapidly and who enjoys doing it. One good typist can usually handle the work for two or three Mr. X's and their assistants.

In addition there is a good deal of stenographic work related to, but not part of, the manual. There is constant communication with the interested government agencies as well as other persons.

Some form of file system must be maintained of manuscripts, general data, blueprints, photographs and negatives of completed manuals. One manual may involve hundreds or even several thousand blueprints.

In addition to the above, it is often necessary to prepare manuals in quick stop-gap form. This requires the typing of stencils, running off the required number of copies and collation of the individual pages.

Clerical helpers also come in handy in delivering finished drawings to engineers for their on-the-spot approval, for example, after Mr. X has made those arrangements by means of a telephone call. This can save many precious hours for him near deadline, when his time is at a premium and hundreds of drawings have to be carried back and forth as they are completed. If your engineering department is on another floor or in an adjoining building you can see the advantage of this help.

Drafting

Branch 3 represents the drafting section of your organization. It is imperative that Mr. X be placed on an equal footing with the supervisor of drafting so that he can obtain top priority from that department when necessary in keeping with the importance of the associated project. It is a sorry situation when Mr. X finds himself just one among many who call upon drafting for services. The requirements of manual preparation call for so large a number of drafting services, in keeping with a strict schedule, that Mr. X cannot afford to be subject to the drafting supervisor's whims. Make certain that those two men can meet and discuss problems on equal grounds.

The drafting department is called upon to produce large numbers of ink drawings for the manual. Generally, the assistant technical writer will supervise these. The drawings do not require the most experienced draftsmen and can usually be done by inexperienced girls who have artistic talent. Government specifications call for machine lettering which is easily mastered with little practice.

A good way to handle the drawing problem is to have the assistant writer look up an existing pencil drawing which aproximates what he wants, then to mark up a print with colored pencil. He can do this in stages, requiring that just so much be done, after which he is provided with a print which he marks up further. In this way, the most experienced draftsmen are available to engineering for the greatest part of the time. Some of the more complicated drawings may require top-grade draftsmen, of course, but such drawings are the exception and are usually done only in pencil. The ink job is given to less-experienced tracers.

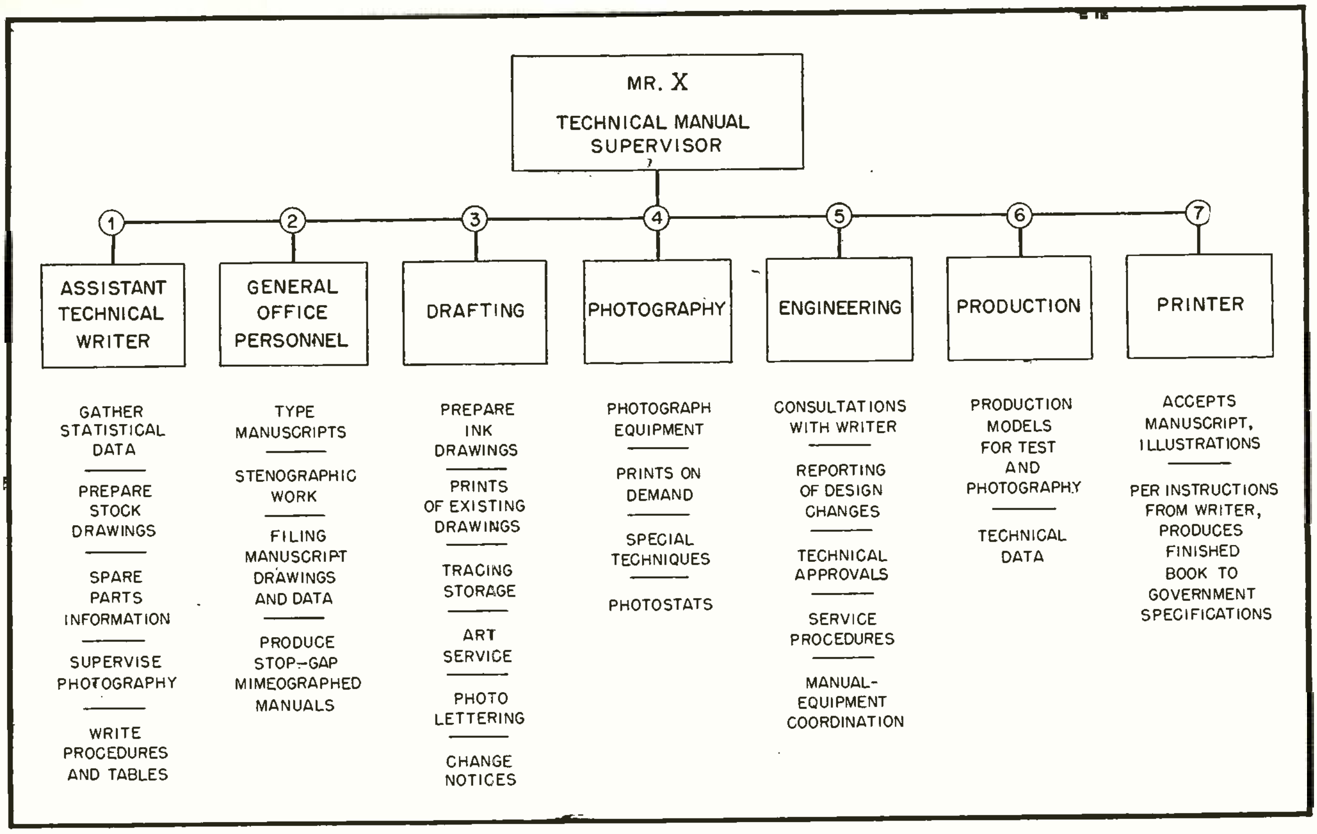
If the assistant writer has had some drafting education or experience, there are many drawings which he can produce in rough form to speed things up.

The drafting department is also called upon to provide prints of existing drawings as needed by the technical writer. These drawings usually run into the hundreds and cover such items as chassis layouts, schematics, coil data, parts lists and component specifications.

The drafting department includes storage facilities for original tracings where they can be held for safekeeping. They are surrendered upon demand to the technical manual section as they are needed. Ordinarily that section works with prints only up to the time that the manual is ready for the printer. At that time, the original tracings are needed to make the cuts or negatives.

The drafting department may also provide art service for the technical manuals. This would include technical illustrations in the form of line drawings. It may also include the addition of balloons, callouts or other types of line and lettering work on stiff-back photographs.

One remaining function of the drafting department which is im-



Block diagram of departments and operations for producing technical manuals

portant to technical manual production is the automatic daily reporting of drawing changes associated with the project. This is usually done by means of an engineering notice or drafting bulletin which is distributed through internal mail service to all interested persons. It describes drawing changes and permits these persons to keep up-to-date with a project.

The technical manual section must be kept posted on such changes, otherwise serious errors can creep into the manual. The notices also serve as an excellent check reference when final corrections are made in the drawings just prior to printing the manual. That kind of follow-through is necessary when the engineering department changes only its own pencil drawings and leaves the ink drawings to the technical manual section. In some instances, a project engineer may take it upon himself to direct the change in a technical manual drawing (in good faith), and this correction may not be considered neat enough to satisfy the requirements of the manual. The notices flag these changes, making it possible to locate and check them when convenient.

Photography

Branch 4, the photographic section, may be a formal department in your organization or it may be a group in your drafting or advertising section. It may also be specifically organized as a part of your technical manual section or it may be an outside organization which is called as needed. In any event, it will be required to take the various photographs which are needed and provide the prints on demand. A good deal of this work is special in that it may require opaqueing on the negative and special mounting and printing techniques to permit further art work. The art work is generally done by other persons. Balloons and call-outs, for example, may be done by draftsmen.

The assistant technical writer will ordinarily do the rough work on prints. In the case of parts identification, the project engineer may do the very rough work on one print after which the assistant technical writer may transfer the information in a more desirable layout on another print so that an inexperienced draftsman can then do a finished job on a mounted print.

The photography section will also be called upon to provide photostats or other "hard" copies of line drawings. A highly detailed piece of art work, for example, cannot withstand too much handling without damage; it is good practice to photograph such drawings immediately upon completion, store the original, and to do lettering on a photographic print.

In view of the preceding requirements, it is highly desirable to have Mr. X so related to the photography section that he can deal with it personally and directly.

Engineering Cooperation

Branch 5 is perhaps the most important of all. It involves the engineering section and, more specifically, the project engineers themselves.

It is most important that the engineering section appreciate fully the importance of the technical manual. They must understand in advance that a portion of their time must be spent working with Mr. X and that this is part of their expected routine. It is rather common for the engineering section to regard the manual as a nuisance, with the result that Mr. X finds himself in a difficult position to meet schedules and produce an acceptable product.

The engineering section will be called upon for the following services:

Consultation: During the early phases of a project, Mr. X will require many hours of the project engineers' time. They will have to sit down together and review the complete project. Mr. X will have to learn the general purpose of the equipment, its required functions and the manner in which it performs these functions. He will need copies of the existing specifications and he will have to know what the equipment looks like by inspection of existing models.

Progress Reporting: The engineering section should understand that any significant progress or modifications must be called to the attention of the technical manual section. It is sometimes difficult for the manual writer to recognize modifications without the interested participation of the project engineers.

Technical Approvals: As manuscript is prepared, it will have to be studied carefully by the project engineers. They should be ready to provide responsible approval together with corrections and constructive suggestions. This frequently leads to further consultation.

Service Procedures: The project engineers will be called upon to suggest specific service procedures in such a form that they will require only editing to make them suitable. As an example of this, the equipment may include a receiver of some sort, and the alignment procedure must be supplied by the project engineers.

Manual-Equipment Coordination: There are a great many requirements set forth in the specifications for the technical manual. These requirements cannot be properly filled without the active cooperation of engineering. For example, the technical manual may require drawings on which test points are clearly located and identified by symbols or numbers. The specifications may require further that those same symbols appear on the equipment itself. Mr. X cannot directly make design changes and additions to the equipment. This must be done by the project engineer.

The preceding example is a minor case. There are some which are appreciably more important and more involved. In any event, the writer of the technical manual is sometimes the only individual who recognizes the need for design changes or modifications and he must be able to pursue this point with the project engineer.

Production Cooperation: Branch 6 in the diagram represents the equipment production department. Certain requirements of the technical manual section can best be fulfilled through the production department. This relationship must be clearly established so that Mr. X has a solid contact in the production department as well as with the project design engineer.

The most common function of the production department is to make available production samples from which artists can work in preparing line drawings and for verification of test procedures. The production department can also be of great assistance in providing the technical manual section with other technical data.

Printing: Branch 7 is perhaps the most obvious of all. It represents the printing of the finished manual. Mr. X will have to work closely with the printer so that schedules can be worked out which are mutually satisfactory. The technical manual section will have to submit complete drawings and photographs and manuscript. It will have to schedule time for the galley-proof and paste-up work. When final page proof is submitted, schedules should be made with engineering for final approval by that department.

Along about this time, incidentally, Mr. X will be busy buttoning up his work. Part of that job is getting the project engineers to sign copies of the manuscript and drawings as a recorded indication of their approval. Last, and most certainly not least, will be his job of "selling" the manual to the military inspector or other officers assigned to the acceptance of the manual.

Summary

The preparation of the technical manual is a matter of prime importance to the military. It is a highly specialized endeavor and requires careful and responsible organization. Because of these factors, it requires a capable manager or supervisor, and the section should be a unit independent of engineering or production.

The assistance and services required by the technical manual section are of such magnitude that they cannot be permitted to resolve themselves through cut-and-try methods. They must be authoritatively recognized and accepted by the various department heads involved. Only in this way can the technical manual supervisor be given the opportunity to assemble the necessary data and compile a manual which fills the needs (and demands) of the military. The job is highly technical and requires a great deal of personal devotion to duty, but despite this, is frequently overlooked to some degree in overall organizational planning.

The precise size of the instruction manual department is difficult to estimate here, because of the wide variance in types of electronic equipment and numbers of types in production. A very broad approximation however, will be attempted.

One Mr. X with two assistant technical writers and one good typist-clerk can produce a manual in about 15 to 20 weeks, assuming that the equipment involved is a single rack affair of only moderate complexity. This assumes, further, that the departmental assistance mentioned above is available upon demand. In this very broad example, the drafting services of about four people for the duration of the job will probably fill the bill.

The above guess is made with some aprehension because of the variables involved. It is offered only to illustrate what proved to be true in at least one case. Once you have selected your specific Mr. X, he will be in a better position to provide a more correct estimate.

PULSE-WIDTH DISCRIMINATOR

Designed specifically for use as a channel decoder in a multiplex communications system, this discriminator handles input pulses 20 to 100 microseconds wide. Also useful for measuring width of rectangular and other waveforms

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A MAJOR PROBLEM exists in the method of multiplexing or mixing information channels together at the sending end of a telemetering system and identifying these channels at the receiving end, whether the transmission of information is accomplished by wire or radio link.

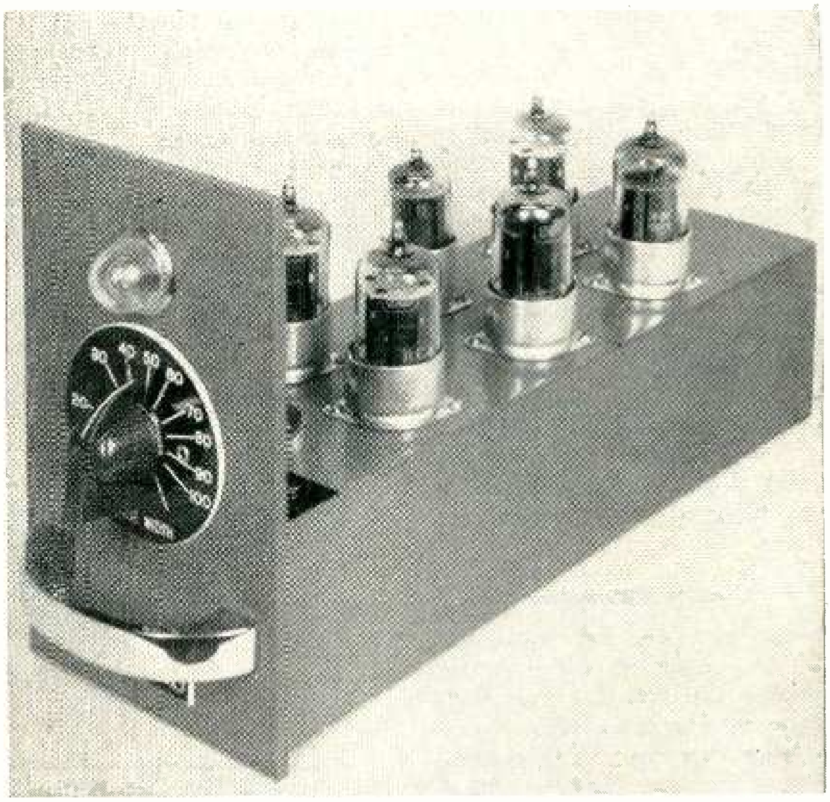
Many methods are now employed successfully in telemetering systems of varying complexity and factors involved in the choice of a particular mode of multiplexing are usually dictated by the nature of the intelligence to be transmitted and the degree of equipment complexity that is to be tolerated.

Multiplexing Methods

One widely used method is the subcarrier system where a separate carrier signal, usually in the supersonic or low r-f range of frequencies, is assigned to each information channel. The channel information is superimposed on the carrier signal by amplitude or frequency modulation and all carrier signals are transmitted through a common transmission medium to the receiving station where the individual channels are separated by means of selective band-pass filters.

Many systems of pulse-coding multiplexing have been used to good advantage such as pulse-sequence coding. Here the intelligence of each channel is embodied in the amplitude or width of a pulse and the channel is identified with the time position of the pulse. This is an electronic elaboration of the simple mechanical commutation method which is still in use.

The pulse-width discriminator to be described is employed in still another pulse-coding method of multiplexing which utilizes pulse width as a mode of channel identification. The telemetering system for which the equipment was de-



Pulse-width discriminator chassis. Predetermined pulse-width is selected by calibrated dial. Neon lamp lights when coincidence is achieved

This work was performed under contract with the United States Department of the Air Force.

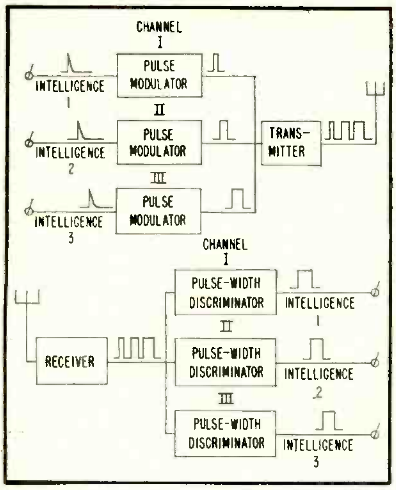


FIG. 1—Block diagram of three-channel telemetering system using pulse-width channel coding

veloped required that three channels of information be relayed by a vhf radio link and that all three channels contain information which originally appeared as pulses. The desired information would be the pulse frequency. Since the pulse-repetition rate of each channel was an independent function, pulse-position coding methods were ruled out and a pulse-width coding system was used. A block diagram of the system is shown in Fig. 1.

The function of the pulse-width discriminator in the system is to separate the information channel for which the discriminator is set from all other signals appearing at its input. Therefore, the output from each pulse-width discriminator is one channel of information. Requirements of the pulse-width discriminator are to respond to and reproduce a pulse for every input pulse of a predetermined width and to be unresponsive to pulses of all other widths. The equipment has been designed to perform properly under conditions of rather severe random noise as might be experienced in the output of a high-gain receiver.

Circuit Operation

Referring to Fig. 2 the input signals (1) are fed to a slicer which separates the spurious variations such as receiver noise from the intelligence signals. The output pulses of the slicer (2) have various widths corresponding to the information channels transmitted. This output is fed to two different circuits, one with a differentiator input stage and the other with an inverter-clipper input stage. The positive output of the differentiator (4) is used to trigger a one-shot multivibrator which provides a gating pulse of predetermined width (9) to the coincidence tube. This gating pulse is delayed for a period of time after the start of the input pulse equal to the width of the input pulse.

The output of the slicer is also inverted (3), differentiated (5) and used to initiate a delay multivibrator whose width is a controllable parameter of the discriminator unit. The output of this multivibrator (6) is differentiated and appears as a negative pip (7) at the trailing edge of the delay multivibrator used to trigger a second gate multivibrator.

The output from the second gate multivibrator (8) is delayed for a period of time after the start of the input pulse equal to the width of the delay multivibrator pulse. Outputs of the two gate multivibrators (8) and (9) are fed to a coincidence tube which conducts only during the coincidence time of the two gate pulses. The coincidence tube will therefore trigger the output multivibrator only for a given input pulse width and this width is a controllable adjustment of the dis-discriminator unit.

Figure 3 illustrates the sequence of operations on the input intelligence shown in proper time orientation. The various numbered waveforms are related to the number points in the block diagram, Fig. 2. Three different pulse inputs are shown—one to which the discriminator is set to respond, one shorter and one longer than the properly selected pulse width. Waveforms 8 and 9 of Fig. 3 illustrate the proper and improper gating conditions for coincidence.

Circuit Details

The details of the circuitry involved in accomplishing the desired objectives are illustrated in Fig. 4. Slicing of the input signals is obtained by biasing the grid of the first half of a 12AX7, V_{1A}, about 14v below cutoff. This allows for slicing of the center three volts out of a 30-v input; the rectifier action of the tube suppresses the top half of the pulse. For other input voltages the bias may also be adjusted to allow selection of the center three volts of the input pulse. The positive input pulses appear at the plate of V_{1A} inverted and cleaned of any receiver noise.

The inverted pulses are fed simultaneously to the grid of V_{1B}, inverted again and then differentiated by the 50-$\mu\mu$f capacitor and 51,000-ohm resistor. The resulting positive pip triggers the gate multivibrator consisting of both halves of V_6.

The output at the plate of V_{1B} is differentiated by the R-C network and the positive pip triggers the delay multivibrator consisting of both halves of V_2. The negative pip at the grid of V_{2A} is suppressed by a germanium crystal so as not to influence the width of the delay multivibrator pulse. The width of

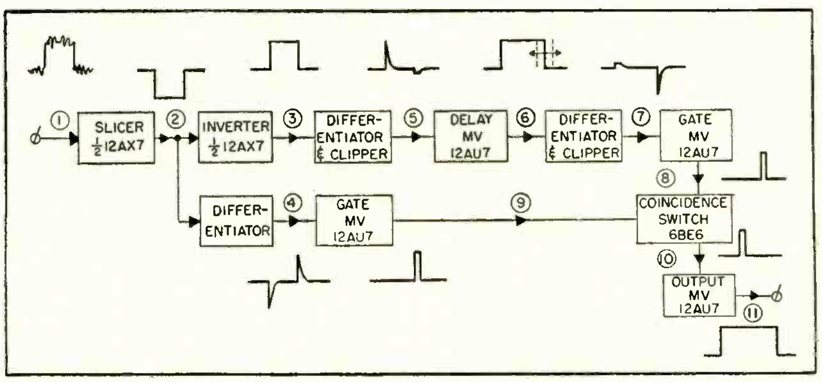


FIG. 2—Block diagram of pulse-width discriminator showing waveforms at successive stages

this delay pulse is controlled by an adjustment of the grid resistor of V_{2B} which determines the time constant of the multivibrator.

The output of V_{2B} is again differentiated through an R-C network and this time the resulting negative pip is fed to the plate of V_{3A} to trigger the gate multivibrator consisting of both sections of V_3. The positive pip at this point is suppressed by the germanium crystal connected between the plates of V_{2B} and V_{3A}. The width of this gate pulse is internally controllable in order to provide a sensitivity control for the discriminator.

The coincidence tube, V_4, is a pentagrid converter with inputs at the first and third grids. The first grid is biased at about 23v negative and the third grid is biased at about 56v negative. Either bias alone is sufficient to cut the tube off but when the outputs of the two gate multivibrators occur simultaneously at the grids of V_4 the tube conducts, supplying a trigger impulse to the output multivibrator consisting of both sections of V_5. A neon lamp is incorporated in the output circuit to indicate when coincidence at V_4 is achieved.

The power-supply requirements for the discriminator consist of a positive and a negative 150-v supply and a 6.3-v filament supply. The positive 150-v supply drain is 48 ma and the negative supply drain is 7 ma. The filament current is 1.7 amp.

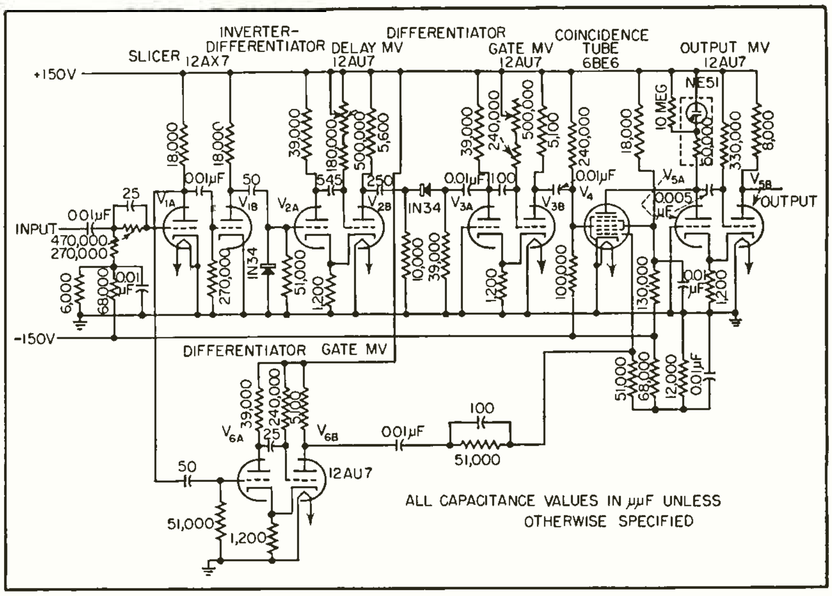


FIG. 4—Schematic diagram of the pulse-width discriminator

The circuit illustrated in Fig. 4 has been constructed and tested with both a direct video input and a modulated r-f signal which was detected by a receiver and fed to the pulse-width discriminator. In either case the circuit performed very satisfactorily and exhibited excellent stability over a prolonged period of operation.

In the circuit shown, the delay multivibrator is adjustable in width over a range of from 20 to 100 μsec by a calibrated front-panel adjustment. The width of the gating pulses may be varied by an internal adjustment over a range of from 2 to 12 μsec. For a 3-channel multiplexing system employing pulse widths of 30, 60, and 90 μsec it was found that a sensitivity range of $\pm$ five μsec was very satisfactory. This allows for instabilities due to slight pulse-width and pulse-amplitude variations and yet provides ample guard bands between channels.

The pulse-width discriminators were constructed as small compact plug-in units which may be removed and replaced in a minimum of time. Miniature tubes are employed throughout as well as turret-type sockets to make the units light and compact.

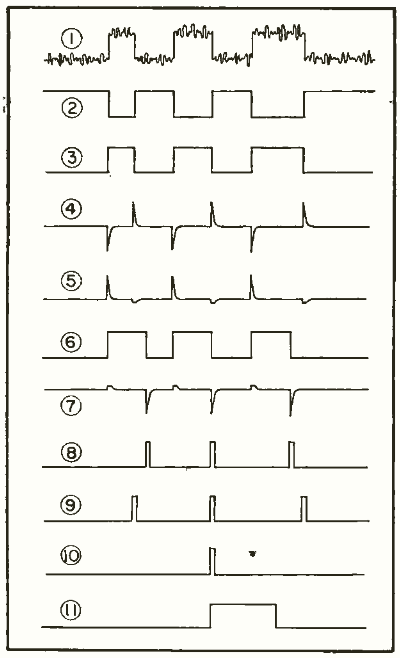


FIG. 3—Waveform relations in pulse-width discriminator. Waveforms (8) and (9) show the proper and improper gating conditions for coincidence

Conclusions

The pulse-width discriminator described exhibits both a high degree of stability and simplicity of operaton. It has the ability to discriminate the intelligence pulses from the random noise background occurring in high-gain receivers. Although the unit was designed to handle pulses in the range of 20 to 100 μsec wide, modification of the network components will allow the range to be extended.

The units discussed were intended for intelligence channel decoders in a multiplex communication system; however, their use may be extended to the field of instrumentation and measurement. The unit has been used to measure the width of rectangular pulses, and, due to the clipping action of the input circuit, it may be employed to measure the pulse width of other waveforms. This circuit has, in general, turned out to be a very useful addition to the laboratory pulse equipment used by the authors. For this measurement application it is recommended that a more accurate vernier-type control be employed in place of the simple dial arrangement shown.

Five-KW Klystron UHF

Single-ended output of five kilowatts from 475 to 890 megacycles is achieved with newly developed high-power klystron. Operating as a linear amplifier, its use avoids parallel operation of low-power tubes and other expedients suggested for these frequencies

FOR SEVERAL YEARS, government, manufacturing and operating organizations have been actively engaged in tube and circuit development, as well as propagation surveys, to determine the best means for utilizing the proposed uhf band for television.

Reports from some of the propagation investigations have been quite optimistic; others rather discouraging. Certainly much work remains to be done in this field. It is generally conceded, however, that high-power transmission is especially desirable for uhf television service. At the same time, all agree that the problems involved in generating high power at uhf are extremely difficult, in some cases seemingly impossible of solution.

A summary of this article was presented at the fifth annual NARTB Broadcast Engineering Conference, April 1951, in Chicago.

Conventional tubes and circuits usually fail to operate even at the low end of the proposed frequency band. Commercially available tubes, when used in carefully designed and very special circuits, will provide power in the order of 100 watts. By paralleled arrangement of several small tubes, outputs up to one kilowatt have been obtained.

To avoid paralleling of several small tubes, our tube and circuit development was directed toward obtaining high power of at least five kilowatts in a single-tube output stage. It was planned to build this up to an effective radiated power of 100 kw by means of a high-gain antenna system. This power level has now been successfully reached, using tubes, circuits and techniques which we believe are entirely practical for commercial television service.

In a study of conventional single or multiple-grid electron tube design for high-power uhf television, a serious conflict arises. The extremely high frequency demands a compact tube with very close spacing of elements to minimize the electron transit time and to shorten r-f circuits. At the same time, increased circuit losses due to high-frequency current and increased dissipation caused by transit time require large high-emission cathodes and large heat-dissipating surfaces. A compromise must be accepted if one is to consider any form of negative-grid tube. The

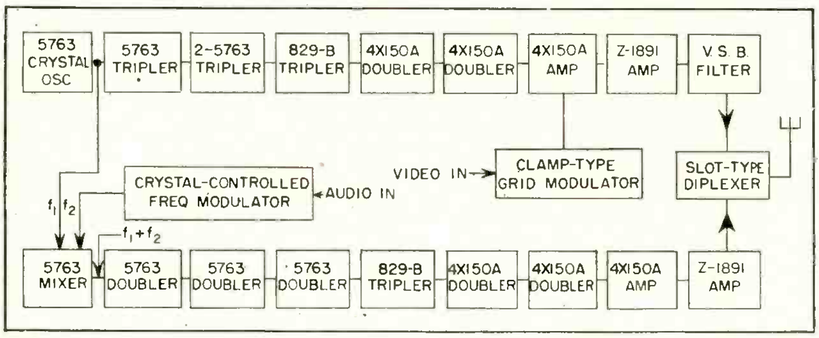


FIG. 1—Block diagram of the video and audio channels of the transmitter. For output from 475 to 890 mc, crystal frequencies from 4.4 to 8.2 kc are used

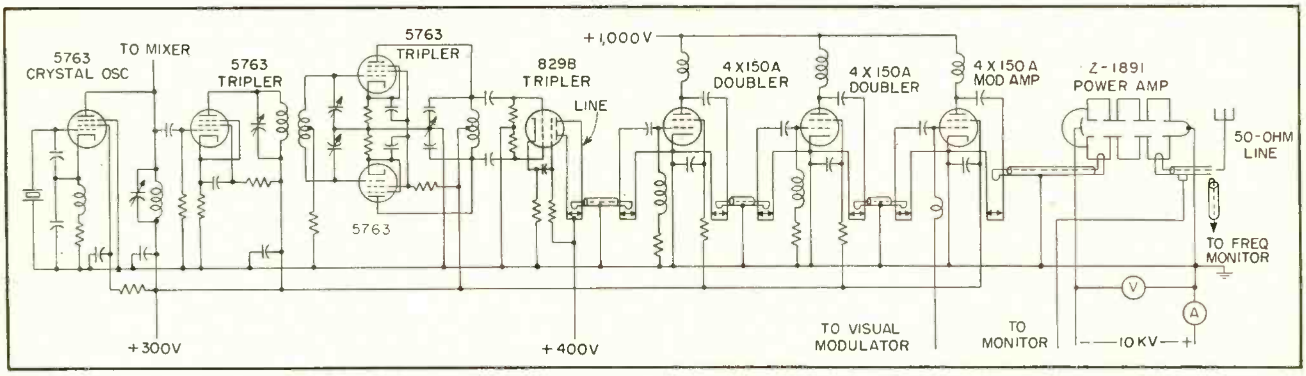


FIG. 2—Stages of the visual carrier channel. Cavities are used in the 4X150A stages and the units drawn as plate r-f chokes are not actually chokes but consist of the separation provided by the shielding between inner and outer surfaces of the cavities. The 829B tripler output tank is an open-type transmission line coupled by coaxial cable to the input cavity of the first doubler

Television Transmitter

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General Electric Company
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Adjustments are made by the author to the 5-kw klystron mounted in the cubicle of a developmental transmitter. The tube cooling system requires six gallons per minute of water and approximately 200 cu ft of air, practically at atmospheric pressure

result is almost certain to end in high initial cost, short tube life and, in most cases, failure to reach the desired power output.

High-Power Klystron

Since unavoidable transit time has such disastrous effect on the performance of the conventional high-frequency tube, it seemed logical to consider a type of tube which used such effect to advantage. General Electric did considerable development work prior to World War II on velocity-modulated tubes at outputs of a few hundred watts in the higher uhf ranges. Several types of receiver tubes and low-power transmitter tubes of this kind were employed successfully during the war.

Of the several tubes in this class, the klystron seemed to offer the most desirable characteristics. In this tube, the cathode can be placed relatively far from and outside the r-f field. Hence, the problem of designing a suitable high-emission cathode is at once simplified. The r-f circuits, which form a part of the tube, take on the dimensions of the wavelength to be used; therefore, the microscopic spacings and difficult alignments involved in conventional tube manufacture are eliminated.

Up to the time of this development, uhf klystrons providing continuous outputs as high as 5 kw had never been made, to our knowledge. Varian Associates were approached with the idea of developing for General Electric a klystron capable of at least 5-kw output and suitable for broadband amplification of uhf television signals.

The first developmental 5-kw klystron was completed and tested prior to 1950. An improved version of the tube was placed in operation during the summer of 1950. Numerous tests have been made and a great deal of operating data shows that this tube is entirely practical and reliable for high-power uhf television transmission.

Simultaneously with the high-power tube development, a uhf television exciter was being developed at General Electric, suitable for driving the klystron amplifier. In parallel with this, an extensive program was under way to develop a new type of high-gain antenna.

Line-up of Stages

The block diagram, Fig. 1, shows the tube complement and circuit functions of the complete transmitter, with power supplies omitted for clarity. The exciter-driver unit developed for use in this equipment is really a complete 100-watt television transmitter in itself. As shown in Fig. 2, the crystal-oscillator output is multiplied in the conventional manner by means of miniature tubes and normal circuits to one-fourth of the visual carrier frequency. The frequency is then doubled twice in cavity-type circuits using type 4X150A tetrodes which, in turn, excite the driver amplifier at the output frequency. Up to this point, all stages are adjusted for ordinary narrow-band operation since no modulation has taken place.

The driver amplifier, also a 4X150A tetrode in a cavity-type cir-

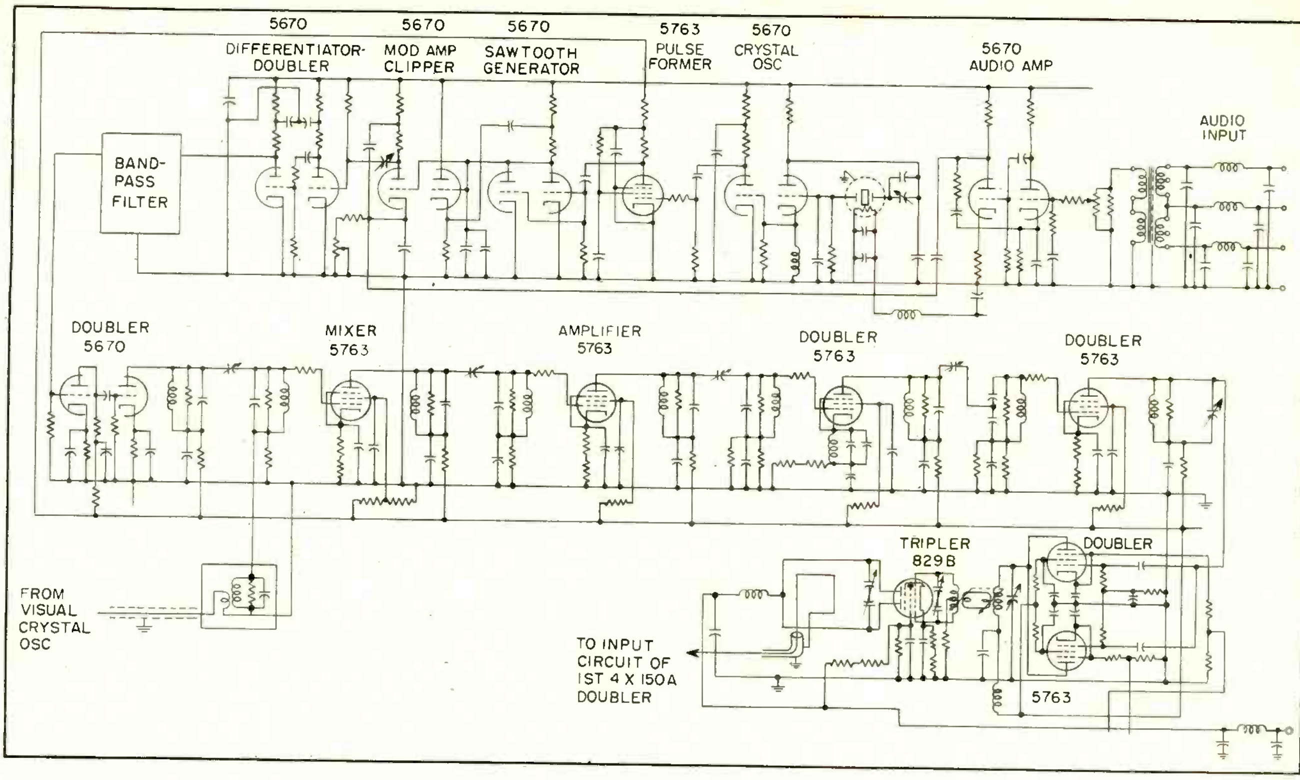

FIG. 3—Circuits of phase modulator, mixer and frequency multipliers

cuit, is grid-modulated by the visual signal through a clamp-type visual modulator. The video-modulated r-f signal from the driver is fed to the output circuit of the klystron power amplifier through a coaxial cable.

Single Crystal

The r-f frequency control of the exciter-driver unit is of novel design in that only one crystal oscillator is used to control both the visual and aural carriers. Consequently, these two carriers are essentially locked together with a fixed separation of 4.5 megacycles. Any frequency drift due to the crystal results in each of the carriers drifting in the same direction, while the two remain 4.5 megacycles apart.

The advantage of this system over the customary use of separate frequency controls for visual and aural transmitters, is obvious. It is especially desirable for receivers using the intercarrier method of aural reception. A better understanding of how this single-frequency control is achieved may be obtained by a description of the aural portion of the transmitter.

The frequency-modulated aural signal is generated by a direct crystal-controlled phase modulator employing conventional tubes and having exceptionally low noise and distortion.

The schematic diagram of Fig. 3 shows the principal circuits of the phase-modulator, mixer and conventional frequency multipliers. The plate current pulses of the crystal oscillator are transformed to narrow square-wave pulses by the pulse-former stage.

The sawtooth generator transforms these crystal-controlled square pulses into a sawtooth wave having a very linear slope. The modulating amplifier-clipper stage clips off the top of the sawtooth at varying heights depending on the instantaneous values of the audio input voltage, and produces a square wave whose trailing edge varies along the time axis in proportion to the varying slope length of the clipped sawtooth.

A differentiator stage generates from the phase modulated trailing edge a narrow pip which is then doubled in frequency and passed through a band-pass filter. The band-pass filter converts the phase-modulated narrow pip into a pure sine wave which is again amplified

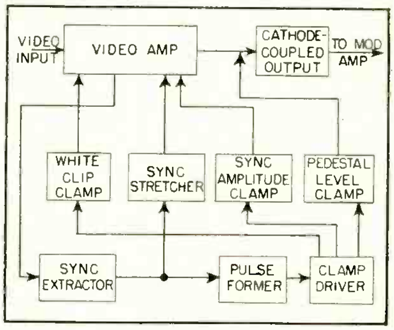

FIG. 4—Stages of the video modulator

and doubled in frequency. This frequency-modulated r-f signal, very much lower in center frequency than that of the visual channel carrier control crystal, is then added to the latter signal in a mixer stage. The resulting sum signal becomes the controlling source of the aural carrier. This frequency-modulated signal is then multiplied by conventional multiplier stages to one-fourth of the aural carrier frequency.

The signal is next doubled twice and amplified in cavity-type circuits identical to those used in the visual channel. It is then fed to the aural power amplifier through a coaxial cable. The result is a frequency-modulated aural carrier whose center frequency is 4.5 megacycles higher than the visual carrier, and essentially controlled by the visual carrier crystal.

Video Modulator

The visual modulator used in this transmitter is designed to accept a standard composite video signal, and, after processing and amplifying, to apply this signal to the grid of the r-f driver amplifier. The several functions of this modulator may be more clearly understood by reference to the block diagram of Fig. 4. The composite video signal, in passing through the video amplifier, is also applied to a sync extractor circuit, followed by a sync-stretcher which increases the percentage of synchronizing signal contained in the original composite input.

A pulse-former circuit generates a narrow pulse immediately following the trailing edge of all synchronizing signals. This narrow pulse, through the clamp driver circuit, keys the white-clip clamp, the sync-amplitude clamp and the pedestal-level clamp. These three clamp circuits then apply the clamp-type d-c insertion to the proper stages of the video amplifier to maintain the video signal at the correct pedestal level.

The white-clip clamp may be adjusted to the desired level to prevent over-modulation in the white region, thus ensuring satisfactory operation of intercarrier-type receivers. The sync amplitude clamp provides a means for maintaining the correct percentage of sync in the transmitter output signal. The pedestal level clamp may be adjusted to provide the desired pedestal power. The cathode-coupled output stage presents a low-impedance source of composite video signal to the modulated r-f driver.

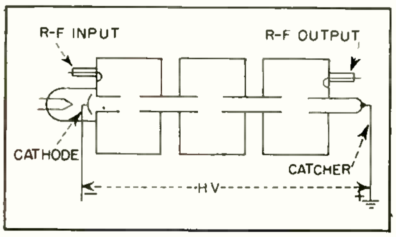

FIG. 5—Internal structure of the new klystron

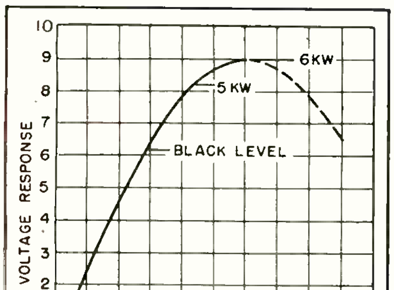

FIG. 6—Response curve of klystron power amplifier

Linear Klystron Amplifier

Possibly the most unusual and novel portions of this transmitter are the visual and aural power amplifier stages. Yet these are perhaps the least complicated parts from the standpoint of circuitry and operation. These two stages employ multi-cavity klystrons developed especially for uhf television, G. E. development type Z-1891.

Figure 5 is a schematic representation of the internal structure of the tube. The stream of electrons leaving the hot cathode flows through the drift space toward the anode or catcher because of the difference in potential. Divergence of this electron beam is prevented by an external magnetic field, thus forcing nearly all of the electrons to pass through the three cavities to the collector. When an r-f input signal excites the resonant input cavity, the electrons are bunched or velocity-modulated so that they travel in concentrations or groups. The bunches, in passing through the succeeding resonant cavities, transfer part of their energy to these circuits.

A load may be coupled to the collector cavity to extract useful power. The operating conditions are such that the power transferred to the output cavity is much greater than that used to modulate the beam at the input resonator. Therefore, the tube is an amplifier, the energy being supplied by the beam current and accelerating or collector voltage.

Pure electron coupling exists in this tube, resulting in complete isolation of input and output circuits. Consequently, very high gain can be realized with no need for neutralization. The three-cavity klystron operates like two cascaded stages, resulting in high gain in a single tube.


One of four sections of the side-fire helical antenna that provides a gain of 20 on the uhf television frequencies

Operating Characteristics

As a linear r-f amplifier, the klystron operates somewhat as a conventional tube in that output voltage across a constant load is approximately proportional to input voltage up to a certain level. Beyond this point, with a conventional tube, the output increases more slowly as excitation is increased and finally reaches a saturation point where it levels off to a constant value.

In the case of the klystron, the output current follows a Bessel function of first order and first kind. Consequently, the output voltage across the load first increases to a maximum and then reduces as excitation is increased, finally reaching zero output. Further increase in excitation causes a second rise in output. For linear amplifier operation in a television transmitter, we are interested in only the first part of the characteristic.

Figure 6 shows a typical voltage response curve of the Z-1891 klystron under operating conditions suitable for a 5-kw television transmitter. The output is quite linear up to the 3-kw or black-level point, which includes the picture portion of a television signal. The synchronizing signal occupies the remaining part of the output curve up to 5 kw. Considerable limiting of the synchronizing signal is permissible, and is standard practice in tv transmitters for reasons of economy. Sync stretching is normally provided in the video circuits of commercial transmitters to compensate for this compression.

With exception of the cathode structure and the r-f output seal, the tube is of metal construction. Cooling is accomplished by means of circulating water and forced air. The cathode structure, that part of any tube which usually limits its life, is designed for exceptionally long performance. The fact that in a klystron the cathode is removed from the r-f part of the tube permits the use of sufficiently large emissive surfaces operated at relatively low temperatures to achieve long life. It is expected that the useful life of this tube will exceed that of more conventional high-frequency tubes by several times. In addition to long-life expectancy, another unusual feature contributing to low operating cost is the type of construction whereby this tube may be easily repaired at the factory.

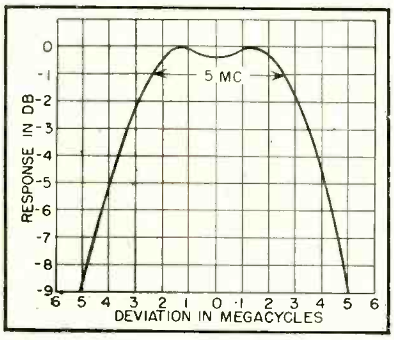

FIG. 7—Frequency response of visual power amplifier tube

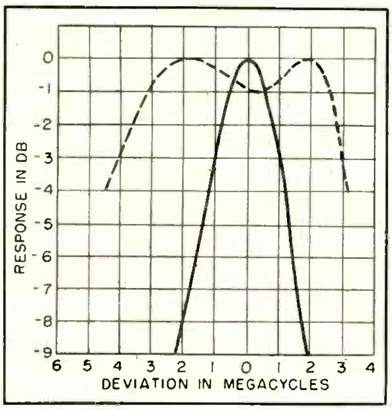

FIG. 8—Narrow-band and broad-band performance of the klystron

The klystron serving as the visual power amplifier operates as a broad-band linear stage. Power gains in excess of 50 are easily realizable in this stage when adjusted for an output response flat within 1 db over a frequency band of 5 megacycles. Noise and distortion compare favorably with that obtained from the best conventional low-frequency high-power tubes.

A typical frequency response curve taken on the visual power amplifier stage is shown in Fig. 7. Here the stage has been adjusted so as to have a total variation in response not exceeding 1 db over a range of 5 megacycles.

Narrow-Band Operation

The klystron used as the aural power amplifier is identical with that used in the visual channel, but need not be adjusted for broad-band response. Therefore, if desired, the power gain may be made extremely high. Power gains of over 5,000 times have been obtained under narrow-band operating conditions from this tube, with no evidence of instability. Figure 8 shows a typical voltage response curve for narrow-band operation, along with a broad-band response for the same tube by way of comparison.

One advantage inherent in television transmitters using low-level modulation is that considerable attenuation of the lower sideband may be accomplished in the linear amplifiers following the video-modulated stage. As a result, little additional filtering is necessary to meet the standards for vestigial sideband transmission. In this uhf transmitter some of this advantage is retained, even though only two-broad-band linear stages are used, thus making the filtering process

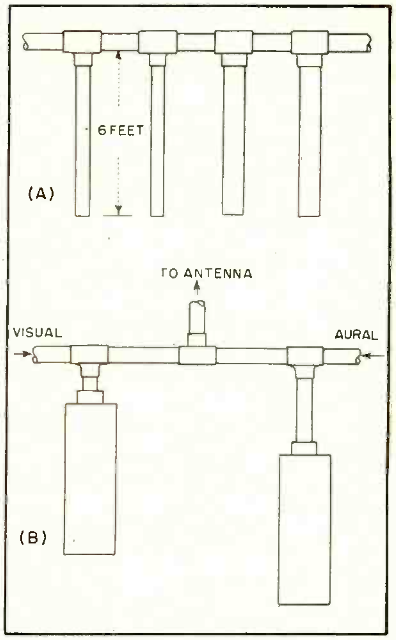

FIG. 9—The vestigial sideband filter is shown at *A* and the diplexer at *B*

somewhat easier than it might otherwise be. A vestigial sideband filter is included to completely meet the required standards. This is a reflective-type band-rejection filter consisting of four coaxial stub sections approximately six feet in length, and containing internal slope-sharpening transformer sections to provide the desired characteristics. Figure 9A illustrates the physical arrangement.

As in the case of vhf television transmitters, a diplexer is used to isolate the visual and aural outputs of this uhf transmitter. In this case, a so-called slot-type diplexer gives the necessary isolation while feeding both aural and visual outputs into a single coaxial line to the antenna. As shown in Fig. 9B, the diplexer consists of two special coaxial cavity sections connected one-quarter wave either side of the common connection to the outgoing transmission line.

A transmitter of the general type just described has been placed in operation at Electronics Park in Syracuse on an experimental basis using a newly developed antenna having a power gain of 20 times. From an effective radiated power of 100 kw, we expect to obtain some new and valuable data to supplement that already available on uhf television propagation.

Linear Discriminator For F-M Telemetering

Unbalanced trigger-circuit system provides exceptional stability and linearity and operates over a wide range of frequencies throughout audio and ultrasonic spectrum. System developed for study of experimental aircraft performance during test flights

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FLIGHT CHARACTERISTICS of developmental aircraft are usually recorded on the ground by means of frequency-division telemetering equipment. In the plane, a series of oscillators operating on different frequencies throughout the audio and ultrasonic spectrum modulate a subminiature f-m transmitter in accordance with the intelligence to be conveyed. The transmitter operates on a center frequency of either 217.55 or 219.45 mc, the two channels allocated for such telemetering services.

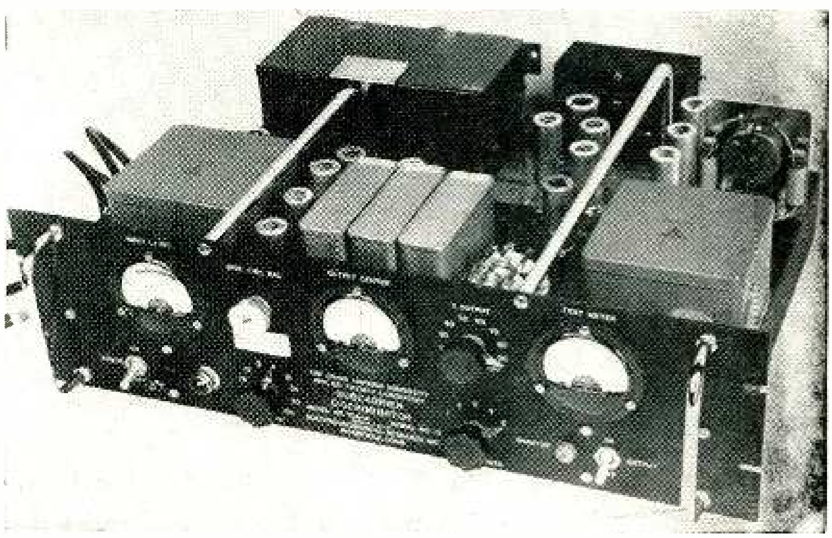
The receiving equipment consists of a series of subcarrier discriminators, low-pass filters and a magnetic oscillograph to record the intelligence. The accuracy of the system is a function of the stability and linearity of the discriminator unit. Linearity is desirable for ease of calibration, and stability is essential to maintain calibration during flight.

The Foster-Seeley and cycle-counter circuits have been among the discriminator circuits used in the past for detection. These discriminators are most linear for very small frequency deviations and do not readily provide the combination of linearity with frequency stability and high output voltage to the degree required by the latest transmitting equipment. Amplitude modulation also causes occasional trouble with these types of discriminators.

Unbalanced Trigger Circuit

The unbalanced trigger circuit type of discriminator described here offers many marked advantages over former types. The specifications met by the development include: input impedance of 0.5 megohm, input level 10 mv to 10 volts, subcarrier frequency range of 400 cps to 70 kc with intelligence frequency ranges from d-c to 8 cps on lowest bands and from d-c to 7,500 cps on highest bands. Output is ±10 ma for ±7.5-percent deviation. Deviaitons as high as ±20 percent are sometimes used on the higher frequency channels. Drift is less than ±2 percent of bandwidth for temperature variations from 50 to 100 F and line changes from 105 to 125 volts.

The essential stages of the unit are shown by the block diagram of Fig. 1A. The discriminator circuit generates a rectangular pulse of constant length t_1 each time it is triggered. The center frequency f_o is the frequency produced when the square wave is symmetrical, or



Photograph showing small panel space required for subcarrier discriminator circuit

The work described in this paper was done for the United States Navy Bureau of Ordnance.

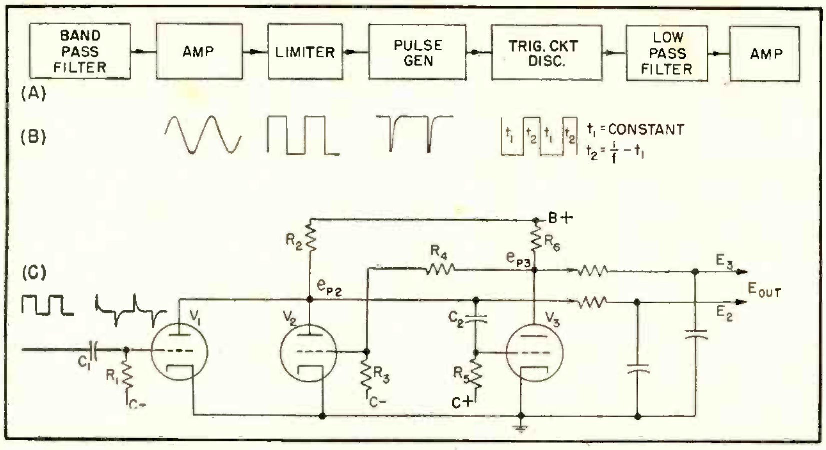


FIG. 1—Block and basic diagrams show effect of varying frequency on output waveshape

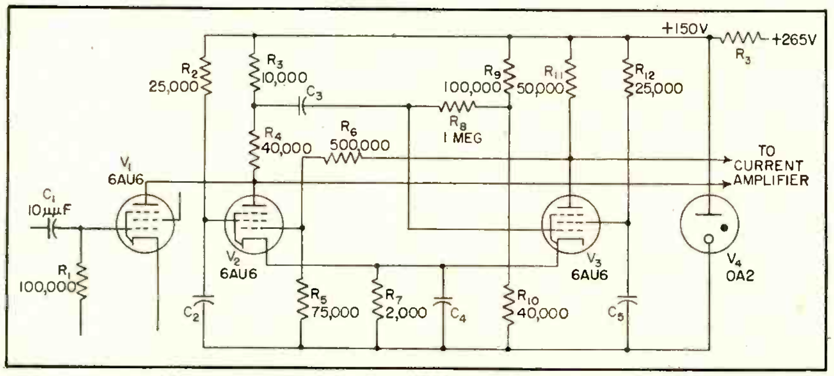


FIG. 2—Pulses from differentiated input signal trigger unstable flip-flop circuit

when t_1 is equal to t_2 as shown in Fig. 1B. When t_2 is shorter than t_1 the frequency is increased, and when t_2 is longer than t_1 the frequency is decreased. This system permits the use of d-c output in a push-pull arrangement in which the difference voltage is zero for the center frequency.

Basic Circuit

The basic circuit of Fig. 1C provides this type of operation. The subcarrier signal emerges from the limiter as a square wave which is differentiated by R_1C_1 and applied to the grid circuit of the pulse generator V_1. The grid circuit is biased beyond cutoff, so that only positive pulses cause V_1 to conduct.

In the absence of pulses from V_1, the discriminator circuit is inoperative, with V_2 cut off and V_3 conducting by virtue of their respective grid-return voltages. The discriminator passes through one cycle of operation each time the plate of V_2 is triggered by V_1. The trigger pulse also appears on the grid of V_3. With V_3 cut off, its plate voltage rises to B +, applying positive bias to the grid of V_2 through R_3 and R_4. Thus V_2 remains saturated and V_3 cut off for a specific time t_1 until C_2 discharges through R_5 sufficiently to start conduction of V_3. The circuit then returns abruptly to the initial condition, where it awaits the next pulse.

The time spent in the steady state condition (V_2 cut off) is later referred to as t_2, so that the total time between pulses is $t_1 + t_2$, and this total must equal $1/f$. During continuous operation of the discriminator, the instantaneous plate voltages of V_2 and V_3 are complimentary rectangular waves, as is true in an ordinary multivibrator circuit.

Within the limits of operation the output is a perfectly linear function of input frequency. The amplitude of the output voltage for a given frequency deviation depends on the cutoff value of plate voltage (which is essentially equal to the B + voltage) and the plate voltage while the tube is saturated. The latter value is determined by the circuit constants and the tube characteristics. To avoid excessive drift, steps must be taken to minimize the instability of certain components and the circuit constants must be so chosen as to minimize the effect of tube variations.

Linearity of Basic Circuit

The most obvious source of nonlinearity arises from the fact that t_1 cannot be maintained perfectly constant. Although t_1 depends primarily on C_2, R_5 and e_{P2} for moderate deviations from the center frequency, as f approaches $2f_0$, increasingly less time is allowed for

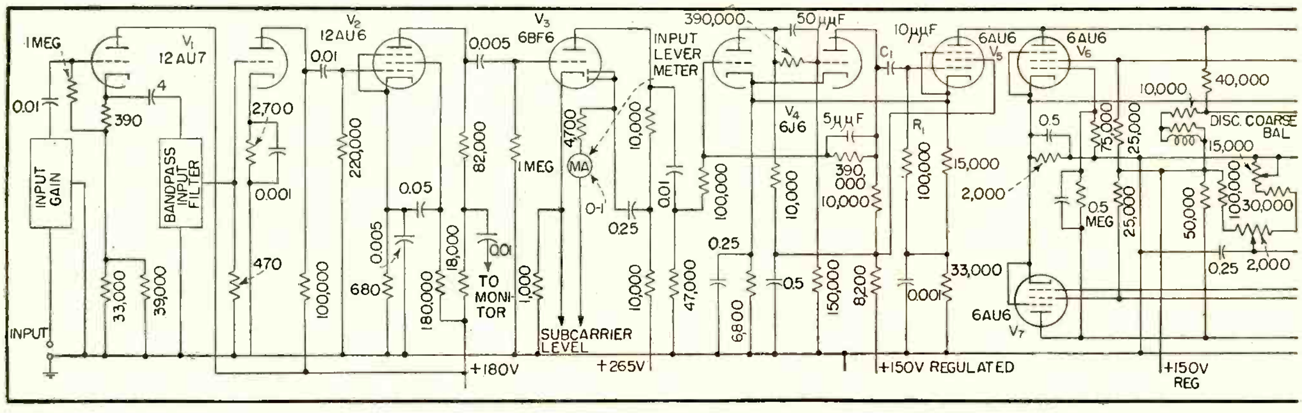


FIG. 3—Complete circuit of discriminator with input voltage amplifier and output

C_2 to charge through R_2, R_5 and the grid of V_3. The potential across C_2 at the instant the circuit is triggered will, therefore, be less. It follows that the time t_1 required after triggering for C_2 to discharge through R_5 to the point at which the circuit returns to the steady state will be correspondingly decreased. Accordingly, it becomes highly desirable to discharge C_2 through a much greater impedance than that through which it is charged.

A second source of nonlinearity becomes troublesome at higher frequencies of operation when the rise time for e_p is an appreciable portion of t_1 and t_2. Rounded leading edges may be produced by stray capacitance when operating in the high center frequencies. While such a departure from square-wave operation might be expected to introduce nonlinearity, it may be seen to be quite small until the rise time approaches t_1 and t_2 in magnitude. As the average d-c output is proportional to the area under the plate-voltage curve, if equal frequency deviations produce equal changes in area, the output is linear. Provided the top of the curve is flat, and the curve is otherwise constant in shape, this condition for linearity is satisfied. As the wave is not entirely symmetrical, when t_1 is adjusted so that $E_1 = E_2$ for the center frequency, t_1 will not be exactly equal to t_2. However, this condition reduces slightly the slope of the output-vs-frequency curve, without affecting linearity.

Practical Circuit

Sharp-cutoff pentodes are used in the trigger circuit to provide a very high plate impedance ratio for positive to negative grid swing. The circuit is shown in Fig. 2. Stability is enhanced by stabilizing the B + voltage and by the use of precision wire-wound resistors throughout. Since C_3 is in the component that determines t_1, it should also have as low a temperature coefficient as practicable. Resistor R_8 is returned to a positive voltage with respect to the cathodes, so that the circuit will restore to the steady state while C_3 is discharging rapidly, providing further stability of t_1.

The circuit is inherently linear with frequency so long as C_3 is fully charged prior to each trigger pulse. Thus, the upper limit of linearity with frequency is determined by the speed with which C_3 may be charged during the second portion of each cycle. To this end, R_3 is made small as compared to R_8 so that the charging time becomes largely a function of the grid-cathode impedance of V_3.

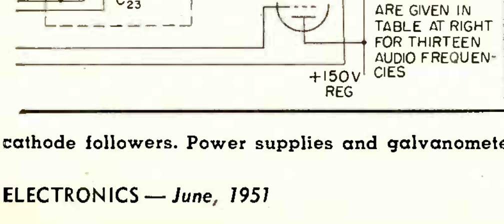
This circuit has consistently operated from 7.5 percent below to 7.5 percent above the center frequency with less than 1-percent nonlinearity, the nonlinearity occurring at the high-frequency end, as expected. Even better linearity may be obtained by operating the trigger circuit off center, so as to provide more time for C_3 to charge, but this has only been done in those channels where the frequency deviation is greater than ±7.5 percent as voltage output is otherwise sacrificed. Experience has shown that the same order of linearity may be obtained at larger frequency deviations, provided that the output is reduced to that obtained for ±7.5 percent deviation by means of off-center operation of the trigger circuit. Compensation for the slight droop at the high-frequency end may also be accomplished by introducing a closely controlled nonlinearity in the output circuit.

Complete Subcarrier Channel

The entire circuit diagram, minus power supplies and galvanometer-protecting circuits, is shown in Fig. 3. As sixteen channels may be connected to the receiver simultaneously, the input impedance must be high, and a cathode-follower circuit is employed to reduce the impedance presented to the band-pass filter. Tubes V_1, V_2 and V_3 amplify the channel signal, V_4 provides square-wave output to the pulse forming stage V_5, which then triggers the discriminator at the plate of V_6. For carrier deviations of ±7.5 percent, the output is 10 ma across a load of 330 ohms.

Considerable care must be taken to trigger the discriminator circuit in a manner which will not influence the output linearity. This condition is satisfied by providing plenty of grid drive to V_5, short pulse duration (determined by C_1 and R_1), and cathode bias somewhat above that of V_6 and V_7. The pulse duration is approximately 2 μsec. Of course, V_5 must be biased well beyond cutoff, so that the plate will have no effect on the discriminator except during positive excursions of the control grid.

All circuits past the discriminator are direct-coupled, so that d-c intelligence may be transmitted. The zero drift during normal operation has been found to be less than ±2 percent of full-scale one hour after a 15-minute warm-up.



CARRIER CPS	MODULATION CPS	C_{20}	C_{21}	$C_{22,23}$	$C_{24,25}$	$C_{26,27}$	$R_{46,47}$ MEG
560	0-8.5	6.0	0.0015	1.0	0.05	0.005	0.560
730	0-11	6.0	0.001	0.5	0.03	0.005	0.470
960	0-14.5	6.0	0.0008	0.5	0.02	0.005	0.390
1,300	0-20	6.0	0.0006	0.25	0.02	0.002	0.560
1,700	0-26	1.0	0.00045	0.25	0.016	0.002	0.470
2,300	0-35	0.5	0.00035	0.25	0.01	0.001	0.680
3,000	0-45	0.5	0.00025	0.1	0.008	0.001	0.470
3,900	0-60	0.5	0.0002	0.1	0.007	0.00043	0.680
5,400	0-81		0.00015	0.1	0.005	0.00043	0.560
7,350	0-110		0.0001	0.05	0.003	0.00043	0.390
10,500	0-160		0.00008	0.1	0.002	0.0001	0.680
12,500	0-180		0.00006	0.05	0.002	0.0001	0.560
14,500	0-220		0.00005	0.02	0.00143	0.0001	0.470

cathode followers. Power supplies and galvanometer protection circuits not shown

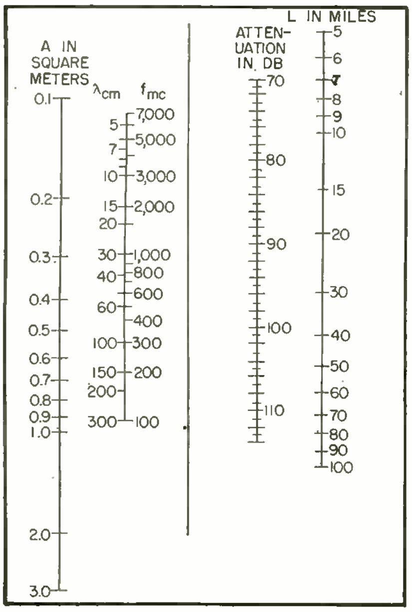


FIG. 1—Free-space attenuation between two identical antennas in terms of effective areas

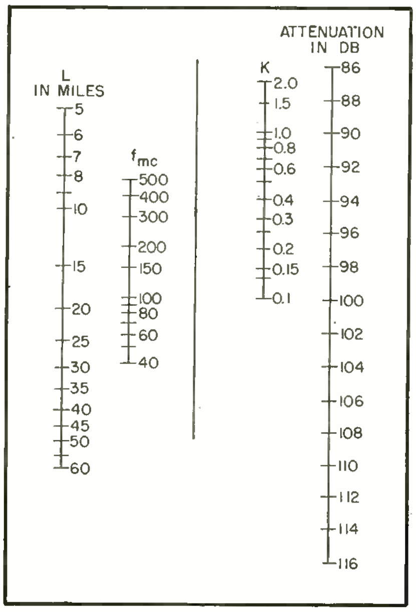


FIG. 2—Free-space attenuation in terms of effective antenna areas when the effective areas are expressed as $K\lambda^2$

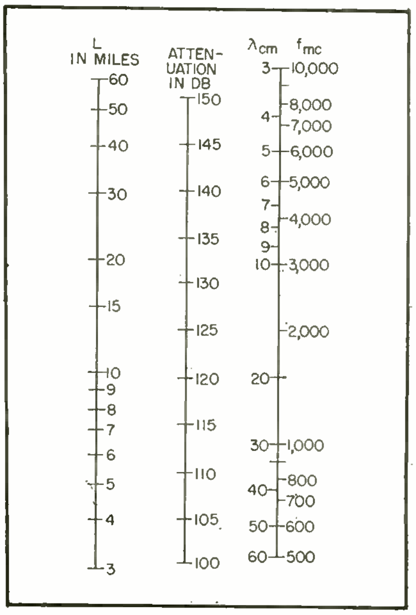


FIG. 3—Attenuation between two isotropic antennas separated by a distance of L miles

Predicting Performance

Graphic method determines suitability of a location for use as a transmitter or receiver site for uhf and shf transmissions. Takes into consideration such factors as free-space attenuation, topographic and atmospheric conditions, and absorption

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IN SELECTING transmitter sites, the propagation conditions at a proposed location must be considered. This can be done by means of mathematical formulas and nomograms. For the uhf and shf regions a number of required nomograms are contained herein, as well as the procedure to be followed in making a calculation.

Four items must be considered in determining space attenuation. These are: the attenuation that would exist in free-space, the topographical conditions, the atmospheric conditions, and absorption.

In making actual estimates for proposed sites, locations are chosen on the basis of topographical characteristics, assuming the effects of absorption to be negligible and allowing a safety margin for atmospheric changes. The following discusses the four factors that affect attenuation, with particular emphasis on the free-space and topographic factors, which are the most important.

Free-Space Factor

Free-space propagation is defined as the propagation which occurs in a homogeneous medium which is both unbounded and nondissipative. In actual practice, a criterion which determines free-space propagation is to have no objects project into the first Fresnel zone. This first zone is bounded by points for which the transmission path from the transmitter to receiver is greater than the direct path by one-half wavelength.

The attenuation that occurs in free space can be expressed in terms of different variables and, for a particular case, one formula may be more advantageous than another.

The free-space attenuation in terms of effective antenna areas between two identical antennas is:

$$10 \log \frac{P_t}{P_r} = 10 \log \frac{2.33\, L^2}{f^2 A^2} \times 10^{11} = 113.7 + 20 \log L - 20 \log fA \quad (1)$$

where f is expressed in mc, L in miles, and A in sq meters (A is the effective antenna area $K\lambda^2$). The above equation is shown solved by the nomogram in Fig. 1.

For use in Eq. 1, the effective area of the antennas must be calculated. In general, the effective

* Formerly with General Telephone Service Corporation.

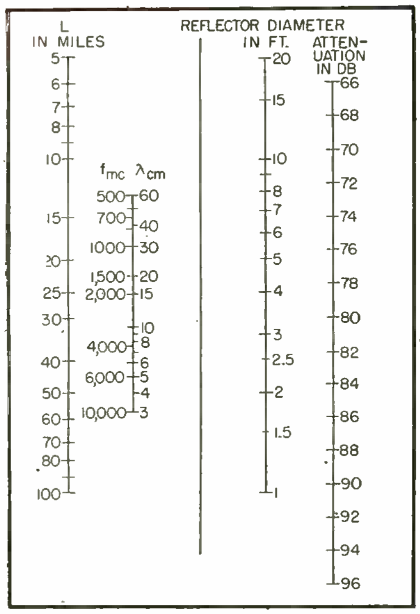


FIG. 4—Attenuation between two parabolic attennas in terms of reflector diameter in feet

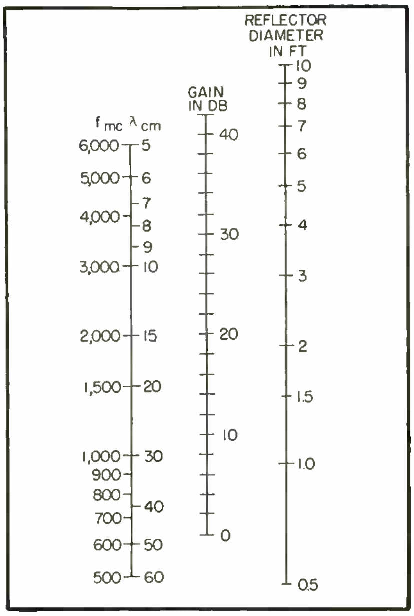


FIG. 5—Apparent power gain of a parabolic attennas in terms of reflector diameter in feet

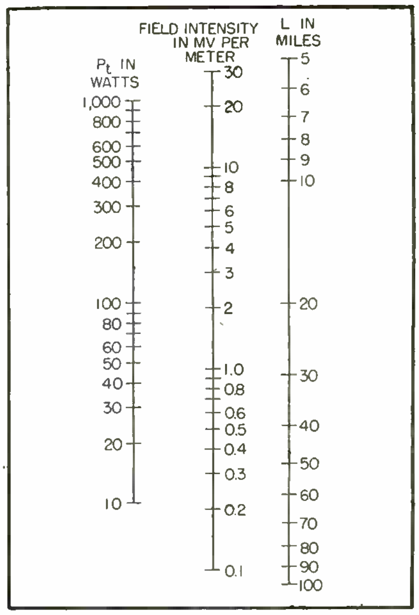


FIG. 6—Field intensity in millivolts per meter for a half-wave dipole at a distance of L miles

# of UHF and SHF Systems

area of an antenna is $1.64G\lambda^2/4\pi$ where G is the gain over a dipole radiator. Some specific examples are included in Table I.

Frequently the effective area of an antenna is expressed as $K\lambda^2$. When this is the case, the path attenuation can be expressed as:

$$10 \log \frac{P_t}{P_r} = 10 \log \frac{28.8\, L^2 f^2}{K^2}$$
$$= 14.6 + 20 \log Lf - = 20 \log K \qquad (2)$$

where L is in miles and f in mc. Figure 2 is a nomogram for the solution of Eq. 2.

The path attenuation between two isotropic antennas expressed in terms of power ratio is:

$$\frac{P_t}{P_r} = 4.55 \times 10^3 f^2 L^2$$

$$10 \log \frac{P_t}{P_r} = 36.6 + 20 \log Lf \qquad (3)$$

where L is in miles and f in mc. Figure 3 is a nomogram for the solution of Eq. 3.

In the case of actual antennas having gains of G_t and G_r, the path attenuation becomes:

$$\frac{P_t}{P_r} = \left(\frac{P_t}{P_r}\right)_{isotropic} \times G_t\, G_r \qquad (4)$$

The gains of a few typical antennas are included in Table I for use in Eq. 4.

For identical parabolas, we find that:

$$10 \log \frac{P_t}{P_r} = 20 \log 345 \frac{L\lambda}{D^2}$$
$$= 50.76 + 20 \log L\lambda - 40 \log D \qquad (5)$$

where L is in miles, D (parabola diameter) is in feet, and λ in cm. This formula is solved in the nomogram given in Fig. 4. The apparent power gain of a parabola is given by the nomogram in Fig. 5.

The maximum field intensity from a half-wave dipole in free space is given by the expression:

$$E_o = \frac{60\, \pi\, l\, I}{\lambda\, L}$$

where E_o = field intensity at a distance L in volts per meter, l = effective length of the antenna in meters, I = antenna current in amps, and λ = wavelength in meters. Any other consistent system

Table I—Approximate Gains of Various Antennas

Antenna	K	Gain in Db Referred to Isotropic	Gain in Db Referred to Half-Wave Dipole
Isotropic	0.08	—	− 2
Half-Wave Dipole	0.13	+ 2	—
2-Element Parasitic	0.40	+ 7	+ 5
3-Element Parasitic	0.88	+10	+ 8
4-Element Parasitic	1.30	+12	+10
5-Element Parasitic	1.64	+13	+11
Dipole-Fed Parabola	—	Use Fig. 5	Subtract 2 db from values obtained from Fig. 5

of units may be used also.

For a half-wave dipole, the effective length is λ/π, and the radiation resistance is 73 ohms so, when L is in miles, E_o in millivolts per meter, and P_t in watts, the field intensity is:

$$E_o = \frac{4.35 \sqrt{P_t}}{L} \qquad (6)$$

This expression is solved in the nomogram given in Fig. 6.

For a properly terminated one-half wave dipole of length d, the voltage in microvolts appearing across its terminals for a given field intensity is:

$$V = \frac{d\, E_o}{\pi} = \frac{\lambda\, E_o}{2\,\pi} \qquad (7)$$

Figure 7 is a nomogram for the solution of Eq. 7. Thus, when L is in miles and λ in cm, the free-space attenuation between two dipoles is:

$$10 \log \frac{P_t}{P_r} = 20 \log \frac{1.23\, L \times 10^6}{\lambda}$$
$$= 121.8 + 20 \log L - 20 \log \lambda \qquad (8)$$

This is solved by the nomogram given in Fig. 8.

Topographical Considerations

The free-space formula does not hold over the surface of the earth due to the fact that the earth acts as a reflector and the received energy is the vector sum of the direct and reflected energy. The direct energy travels the distance L and the reflected energy the distance S. The difference between the horizontal and vertical polarization characteristic depends upon the nature of the reflection, the earth, and the angle of incidence β. Thus the phase and magnitude of the direct and reflected energy depends upon the separation distance L, the antenna heights h_t and h_r, and the reflection coefficient of the earth.

It can be shown that the field intensity at the receiving position in the above illustration is:

$$E_1 = 0.0105 \frac{h_t h_r f \sqrt{P_t}}{L^2} \qquad (9)$$

where h_t and h_r are the antenna heights in feet, L is in miles, f in mc, and E_1 is in μvolts per meter.

From the above, we can develop a formula for direct transmission between two dipoles in terms of distance and antenna heights:

$$10 \log \frac{P_t}{P_r} = 20 \log \frac{1.7 \times 10^4\, L^2}{h_t\, h_r}$$
$$= 144.6 + 40 \log L - 20 \log h_t\, h_r \qquad (10)$$

where h_t and h_r are in feet and L in miles. Figure 9 is a nomogram for solution of Eq. 10.

In order that Eq. 9 and 10 be valid, β must be small for horizontal polarization at uhf (less than 10 degrees); for vertical polarization over earth or fresh water β must be less than 1 degree; and over sea water less than 0.15 degree. The antennas must be elevated at least $1\frac{1}{2}$ λ above the earth plane, and h_t and h_r must be the effective heights of the antennas. Effective antenna height is explained in the discussion of radio horizons. Furthermore, the phase angle arising from the path difference between the direct and reflected waves must be less than about 30 degrees. This latter condition is satisfied if $h_t h_r / L\lambda < 7$ where h_t and h_r are in feet, L in miles, and λ in cm.

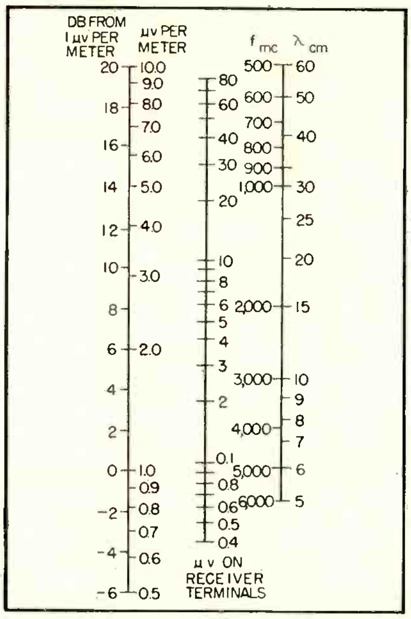


FIG. 7—Field intensity in terms of microvolts on half-wave antenna

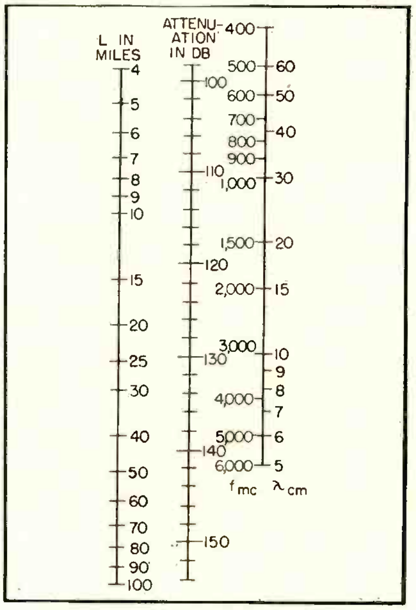


FIG. 8—Free-space attenuation between two dipoles

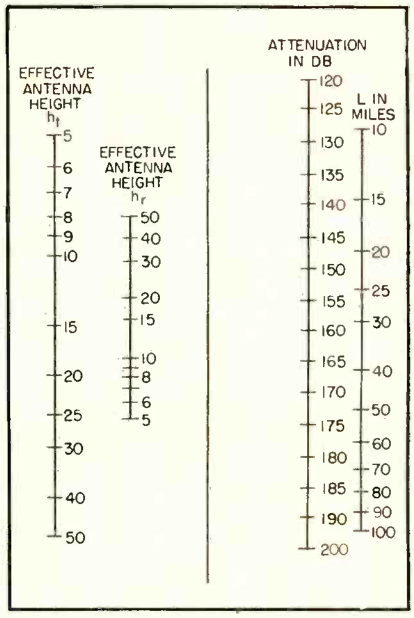


FIG. 9—Attenuation between two dipoles assuming ground reflections

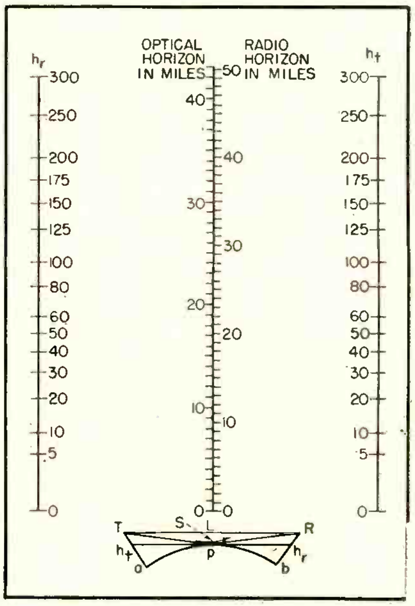


FIG. 10—Radio line-of-sight nomograph. Insert illustrates conditions

Optical and Radio Horizons

Two factors account for reception beyond the optical horizon;

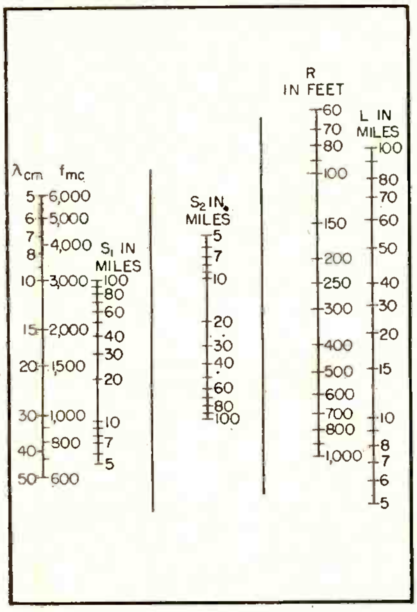


FIG. 11—Nomogram for determining Fresnel zone radius

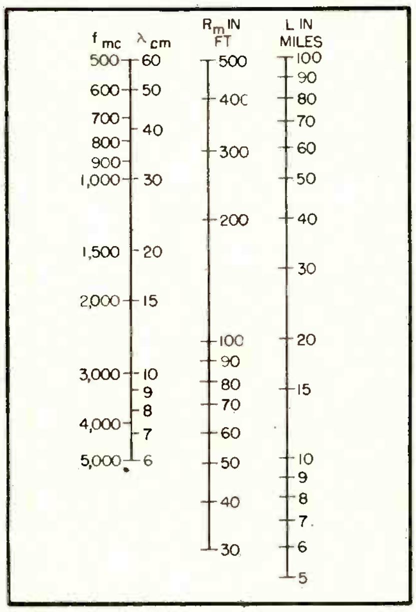


FIG. 12—Maximum radius of Fresnel zone

namely, refraction and diffraction. At uhf and shf, the effect of refraction predominates within the horizon.

For ranges just within and beyond the horizon, the effect of diffraction becomes of increasing importance. (Hence, for ranges near the horizon, somewhat inconsistent results may be obtained between Eq. 10 and 14 since the first considers only reflection or refraction while the latter equation considers mainly diffraction and average refraction.)

Refraction results in bending of the energy and is caused by the earth's atmosphere. This bending is equivalent to increasing the earth's diameter by about 33⅓ percent of average conditions. Over smooth earth a transmitter antenna at height h_t and a receiver antenna at height h_r are therefore, in radio line of sight provided the spacing in miles is less than

$$\sqrt{2h_t} + \sqrt{2h_r}\ .$$

Both optical and radio line-of-sight distances can be determined for given antenna heights from the nomogram given in Fig. 10.

Let us consider the effect of refraction on the radio horizon as used in Eq. 10, thus taking into account both the curvature of the earth and the average refraction.

The conditions that exist are shown in Fig. 10. The intersection of a tangent plane through a point P and the antenna supports determines the effective heights (h_t and h_r) of the antennas. The values of a and b can be determined by means of the line-of-sight nomogram (Fig. 10). A line is drawn on the nomogram between the total tower heights on the antenna height scales. Parallel to this line another line is drawn so as to intersect the radio line-of-sight scale, at a value equal to the actual distance L. The values of a and b are read at the points where this line intersects the antenna height scales. The value of h_t and h_r are then found by subtracting a or b from the respective total tower heights.

It is these effective antenna heights that should be used in Eq. 9 and 10.

Fresnel Zone Clearance

To have free-space propagation, the first Fresnel zone must clear all obstacles in the transmission path.

The first Fresnel zone is bound by points for which the transmission from the transmitter to the receiver is greater than the direct path by one-half wave length. These points generate an ellipsoid. The radius R of the first zone at any point in the transmission path located at distance S_1 from the transmitter and S_2 from the receiver is given by the formula: $R^2 = S_1S_2/\lambda$ where all quantities are expressed in the same units. When R is in ft; λ in cm; S_1, S_2, and L in miles:

$$R = 13.2\sqrt{\frac{\lambda S_1 S_2}{L}} \tag{11}$$

A nomogram for solution of this expression is given in Fig. 11. Radius R is a maximum when $S_1 = S_2$, and this is given by the formula

$$R_m = 1{,}140\sqrt{L/f}. \tag{12}$$

In actual use R_m is usually computed and a line is drawn a distance R_m below the direct line-of-sight path between antennas on a profile to determine if this line clears all obstacles. This method is easier than construction of an ellipse. If there is an obstacle protruding over the R_m line, it can be investigated on the basis of the first Fresnel ellipsoid using the nomogram in Fig. 11.

Shadow Losses

Equation 9 indicates that the field intensity varies directly as the frequency so that for a given distance and antenna height, as the frequency is increased, less radiated power is required for a given field intensity. Beyond the horizon this is not the case, as it has been found that the frequency varies inversely as some exponential power of the distance, the latter increasing rapidly with frequency. In fact, the exponent increases so rapidly with frequency that transmission into shadow areas in the uhf and shf regions is impractical. It has been found empirically that the following expression can be used for calculating field intensity near or beyond the horizon:

$$E_o = \frac{0.0105\sqrt{P_t}\,h_t h_r f L_H^{N-2}}{L^N} \tag{13}$$

where: E_o = field intensity in mi-

Table II—Approximate Noise Figures for Receivers

Frequency	Good Receiver 10 log F	Average Receiver 10 log F
<200 mc	5 db	10 db
200– 1,000 mc	8 db	13 db
1,000– 5,000 mc	14 db	19 db
5,000–10,000 mc	17 db	22 db

crovolts per meter, P_t = power transmitted in watts, h_t and h_r = actual antenna heights in feet, L_H = distance to the optical horizon in miles, L = total distance in miles, and f = frequency in mc.

The factor N is taken from Fig. 13. This curve takes into consideration both diffraction and average refraction. Within the horizon the exponent N is equal to two regardless of the frequency so that L_H^{N-2} equals unity. Distance L_H can be obtained from the nomogram of Fig. 10. From Eq. 13 the attenuation in this case is found to be:

$$10 \log \frac{P_t}{P_r} = 144.6 + N\,20 \log L - 20\,(N-2) \log L_H - 20 \log h_t/h_r \qquad (14)$$

Atmospheric Considerations

The normal refraction produced by the atmosphere has been previously discussed. We know that the energy under normal conditions is not refracted sufficiently to follow the curvature of the earth, but rather follows a path whose curvature is equivalent to an earth of diameter ⅓ larger than the actual earth.

The normal refraction is the refraction with which we are most concerned. However, there are some cases when the normal refractive index is exceeded and the index gradient reaches the requisite strength (5 parts in 10^8 feet) such that the energy may follow the earth's curvature. This is termed superrefraction.

The most prevalent cause of superrefraction is the presence of water vapor in the air. Over the surface of the ocean the air in near contact with the water is nearly saturated with water vapor. Frequently, this brings about a condition where the refractive index gradient becomes negative and exceeds the critical value. This forms a duct which has its top at the level where the gradient reaches the critical value. At this level the energy will just follow the curvature of the earth. It should be noted that ducts have no observable effect on the propagation of low frequencies and generally speaking, their effects are confined to frequencies in the 1,000-mc range and above.

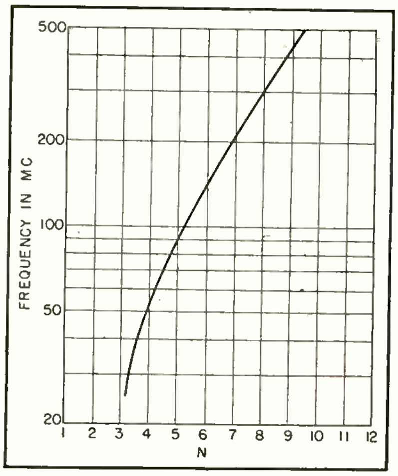


FIG. 13—Factor *N* is used in predicting field intensities near or beyond horizon

Superrefraction may occur over land. In this case it occurs during a radiation fog. The latter is caused by the cooling of land at night by radiation, causing a thin layer of cold air to be formed just above the surface of the ground, resulting in an abnormally large index of refraction in the lower layers of air.

The effect of duct formations between two microwave stations whose antennas are directed on the basis of the normal radio line-of-sight path might be to decrease slightly the signal intensity at one of the stations, but the observed effect is usually negligible.

Absorption

For all practical purposes, the absorption of energy by the atmosphere in the uhf region can be considered negligible. It does increase, however, in the shf region. The chief cause of absorption is the presence of water in some form. Curves are included in Fig. 14 to show the effect of rain and fog or clouds. It can be seen from these that the absorption increases quite rapidly with frequency, but that even a heavy rain gives little effect on any of the presently used communication frequencies.

Variations in the atmosphere result in changes in the atmospheric and absorption factors and are the chief cause of fading. Information on the amount of fading experienced under various conditions is far from complete. However, measurements made over an extended period of time at several locations indicate that for distances under 45 miles and with temperate weather conditions, fades of 20 db or greater occur only about 0.1 percent of the time on the vhf and shf frequencies. For longer distances, fades of 20 db or greater occur a larger percentage of the time. As a practical system design figure, a margin of 20 to 25 db should be allowed to provide for fading.

Overall System Calculations

The foregoing sections have developed various nomograms for predicting uhf and shf propagation. It remains to tie this data together in a form such that it may be used to predict whether or not a proposed path can be satisfactorily covered by a given uhf or shf system.

In general, the difference between the overall system gain G_s and the path attenuation α_p gives a safety margin that is used to improve the signal-to-noise ratio S/N of the output signal and to provide a safety factor S_f to protect against fading. Thus:

$$S/N + S_f = G_s - \alpha_p \qquad (15)$$

where all of the quantities are expressed in db. (The following neglects any noise improvement factor *nif* that is obtained by use of some modulation systems and hence, is somewhat pessimistic.) The overall system gain G_s

$$G_s = G_e + G_t + G_r \qquad (16)$$

where G_e is the equipment gain, G_t the gain of the transmitting antenna, and G_r the gain of the receiving antenna.

Any properly designed receiver for these frequencies should have sufficient gain to operate on signals comparable in amplitude to the receiver noise output referred to the receiver input, and it can be shown that

$$G_e = 10 \log P_t - 10 \log K\,T\,\Delta f - 10 \log f$$

Hence, the margin to provide for a desired output signal-to-noise ratio plus a safety factor to protect against fading is:

$$S/N + S_f = 10 \log P_t - 10 \log f - 10 \log K\,T\,\Delta f - (\alpha_p - G_t - G_r) \qquad (18)$$

where the various terms in this equation are all expressed in db.

From Eq. 18 the following method is obtained for determining whether or not a point-to-point path will be reliably spanned using a particular equipment:

(1) From the available transmitter output power P_t calculate 10 log P_t.

(2) Estimate the term 10 log F for the receiver noise figure using the approximate values given in Table II.

(3) Calculate $KT\Delta f$. (Since $K = 1.38 \times 10^{-23}$ joules per deg K and a normal value for T is 290 K, this becomes approximately $4 \times 10^{-21} \Delta f$ where Δf is the receiver bandwidth in cps).

(4) Determine whether or not free-space propagation conditions exist. This can be done by plotting a profile of the proposed path and checking for adequate first Fresnel zone clearance of the nearest obstacle by means of the nomograms of Figs. 12 or 13.

(5) Calculate the term $(\alpha_p - G_t - G_r)$ by one of the following methods:

Free-space propagation. If free-space propagation conditions exist, this can be calculated equally well in three different manners. These are:

(a) Use Fig. 1 to determine the attenuation. The effective antenna area required by this nomogram may be taken from the figures given in Table I.

(b) Use Fig. 3 to determine the attenuation between two isotropic antennas. Then subtract from this the gains of the antenna arrays actually used and, hence, determine $(\alpha_p - G_t - G_r)$. The gains for various arrays referred to an isotropic antenna may be obtained from Table I.

(c) Use Fig. 8 to determine the attenuation between two dipoles. Then subtract from this the gains of the antenna arrays actually used and, hence, determine $(\alpha_p - G_t - G_r)$. The gains for various antennas referred to a dipole antenna may be obtained from Table I.

Line-of-sight conditions. If free-space propagation conditions do not exist, but radio line-of-sight conditions still prevail, Fig. 9 should be used to find the attenuation between two dipoles. Then the gains of the antenna arrays actually used should be subtracted to determine $(\alpha_p - G_t - G_r)$. The gains of various arrays referred to a dipole can again be obtained from Table I.

Shadow conditions. If radio-line-of-sight conditions do not exist, Eq. 14 can be used to obtain the attenuation between two dipoles. Then the gains of the antenna arrays actually used should be subtracted to determine the value of $(\alpha_p - G_t - G_r)$. The gain of various arrays referred to a dipole are given in Table I.

Attempts to check values obtained by either Fig. 9 or Eq. 10, with values obtained from Eq. 14 for ranges close to the distance to the horizon, will lead to inconsistent results since the nomogram of Fig. 9 (or Eq. 10) considers only refraction and ground reflection while Eq. 14 mainly considers diffraction. Within the horizon Fig. 9 is to be used and beyond it Eq. 14, but in the cross-over region encompassing ranges near the horizon both effects exist and, hence, it must be left up to individual judgment as to which method applies.

(6) From the foregoing and Eq. 18 find $S/N + S_f$. From this subtract a value of S_f equal to 20 or 25 db, since this is a reasonable system design figure to use to provide for fading. The value of S/N then found gives the worst signal-to-noise ratio that should normally be obtained over a path served by this radio equipment; that is, it is the value that will exist under conditions of maximum fade. Experience will have to determine what is permissible here. Offhand, a value of 35 db should be quite satisfactory.

(7) If f-m is used, the above S/N will be improved by an amount equal to 10 log $3m^2$ where m is the deviation ratio.

The author wishes to acknowledge the assistance of Edward Daskam in the preparation of the original manuscript.

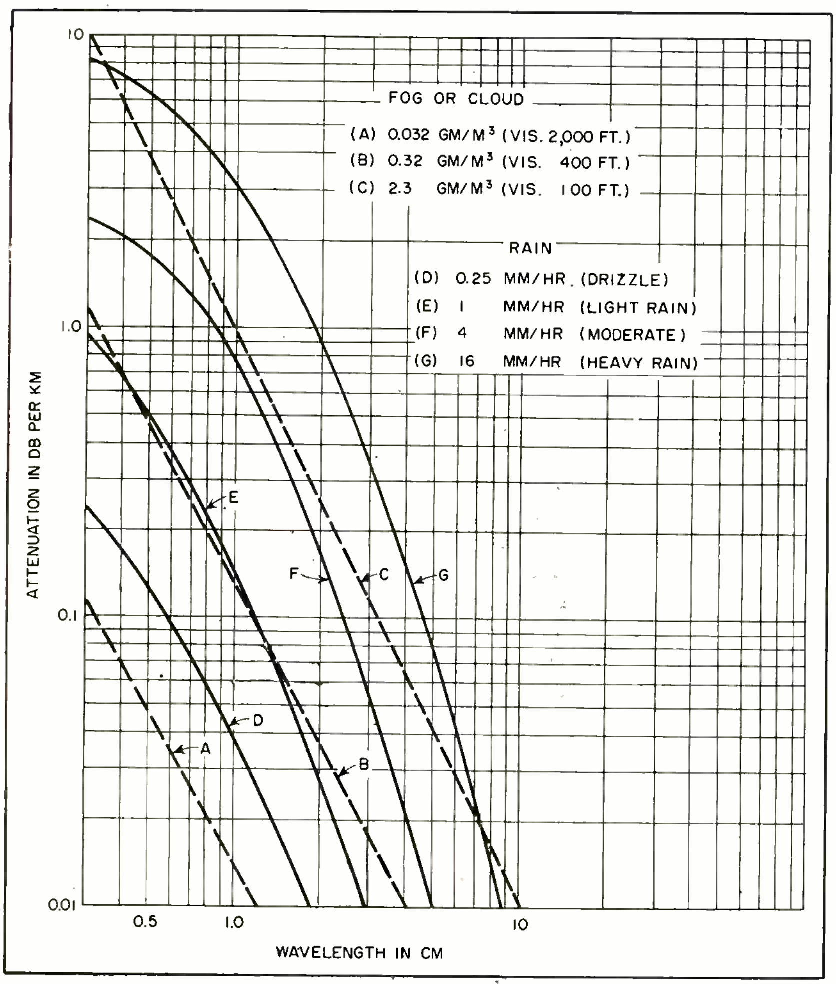
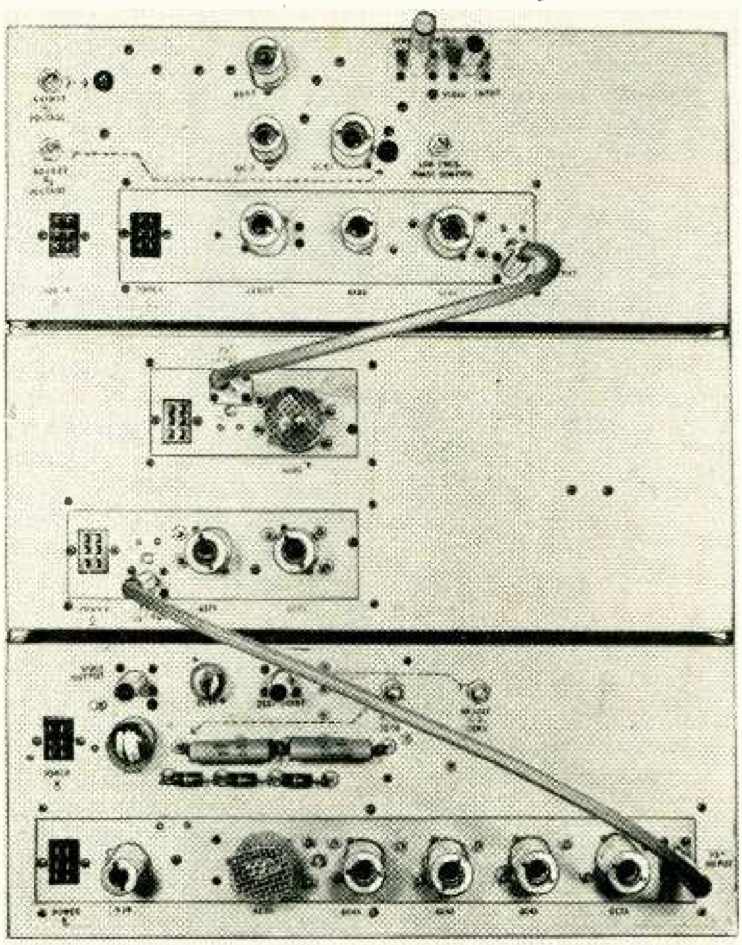


FIG. 14—Curves illustrate effect of rain and fog on shf absorption

Storing



Panel view shows the arrangement of tubes and chassis assemblies for the circuits shown in the block diagram of Fig. 1, below

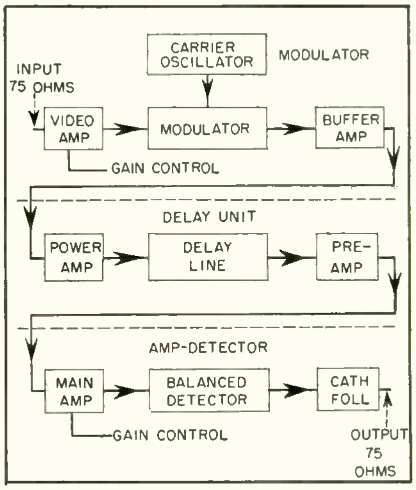


FIG. 1—Stages of the three units comprising the delay equipment

Ultrasonic solid delay lines represent a practical means for obtaining broadband delays up to several hundreds of microseconds.

This paper describes an experimental delay equipment whose over-all video characteristic is essentially flat in amplitude up to 5 megacycles and is down 3 db at 7 megacycles. The delay is 63.5 microseconds. This permits comparison of signal amplitudes along one television scanning line with those along the preceding line. For this purpose impairments due to nonlinearity, noise and band limiting must be minimized for correct evaluation of the test data. Nonlinear distortion in this equipment is about one percent when the peak-to-peak signal to rms noise ratio is 58 db.

Delay lines recently developed for wideband transmission usually employ a solid transmitting medium and operate at carrier frequencies between 15 and 60 mc.[1,2] These lines often exhibit spurious responses due to reverberations. For this application spurious responses should be no more than one percent of the main signal. To meet this requirement, H. J. McSkimin of these Laboratories designed a fused silica bar utilizing shear wave transmission. The electromechanical transducers are quartz crystals approximately 0.004 inch thick with a fundamental resonance at 18 mc. If the carrier were located at this frequency the filtering between upper video and lower sideband frequencies might prove difficult, hence the line was designed to operate at the third harmonic of the quartz crystal transducer, 54 mc.

Considered as a purely electrical circuit element, the delay line is analogous to a pentode having high input and output resistances and parallel input and output capacitances of around 30 $\mu\mu$f. To attain the desired bandwidth at 54 mc, it is therefore necessary to provide resistive loading. For high gain-bandwidth product and high signal-to-noise ratio, double-tuned circuits are used with loading concentrated at the delay-line terminals.

Load resistors of 180 ohms resulted in a bandwidth of 7.5 mc at the 3-db points. Unfortunately, the use of lower values of resistance does not increase the bandwidth in proportion. For example, halving the resistor values would increase the loss 6 db but might increase the bandwidth by only 10 percent. This is due to small electromechanical coupling in the transducers. The electrical Q looking into the crystal terminals, with mechanical loading only, is approximately 100 which corresponds to an internal

Video Information

Comparison of signal amplitudes along adjacent television scanning lines can be made by storing the video information of one line for 63.5 microseconds. Storage is done in an ultrasonic delay line employing a fused silica bar with quartz transducers

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resistance greater than 10,000 ohms.

The loss associated with the delay line may be specified in terms of the voltage ratio between input and output with the proper terminating resistor. If this resistor is 180 ohms the voltage ratio for this particular line is about 500 to 1. In computing gains at 54 mc, the line may be likened to a pentode having very low transconductance as follows:

$$\frac{\Delta E_{out}}{\Delta E_{in}} = \frac{1}{500}$$

$$g_m = \frac{\Delta I_{out}}{\Delta E_{in}} = 11.1 \text{ micromhos}$$

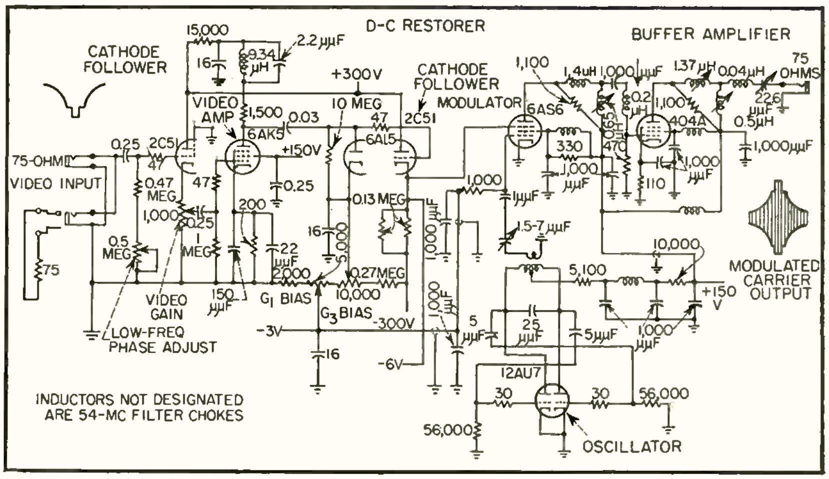
The power gain available from such a pentode with 180-ohm resistors at both input and output may be determined as follows:[3]

$$G = \frac{g_m^2 R_1 R_2}{4} = -60 \text{ db}$$

If the advantage of mismatching (removing the input resistor) is 6 db, the loss is reduced to 54 db. This is the same as 20 times the log of the voltage ratio between input and output shown above.

In practice it was found convenient to adjust the band characteristic of the transformers at either end of the line by temporarily bypassing the line with a 1,800-ohm resistance. This maintains sufficient attenuation to avoid serious interaction between the input and output circuits yet allows the delay line transmission to be effectively overridden.

The velocity of transverse waves in fused silica varies with temperature by +70 parts per million per degree centigrade. This causes the delay to decrease by 0.045 micro-



The video signal input feeds this modulator circuit

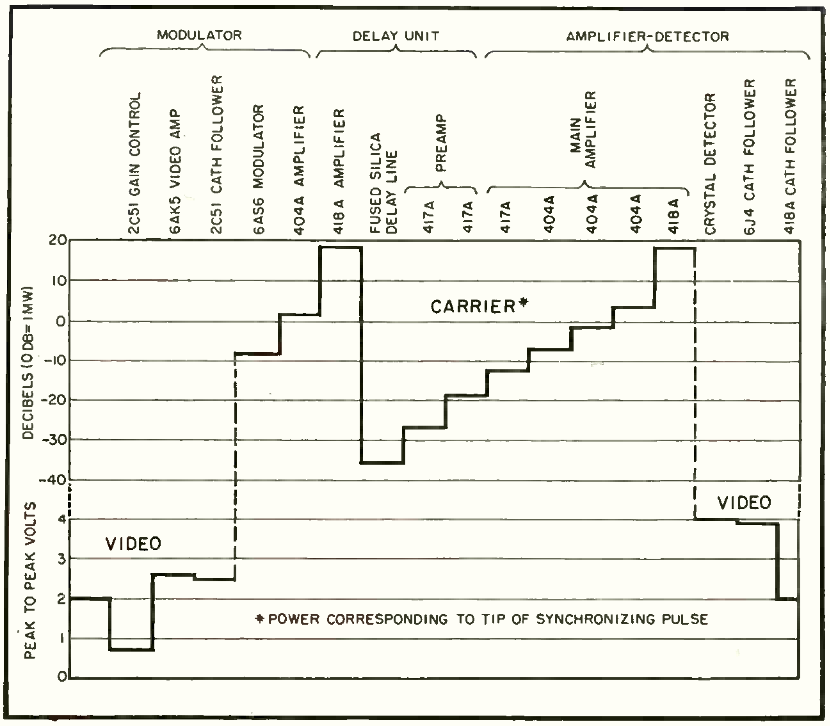
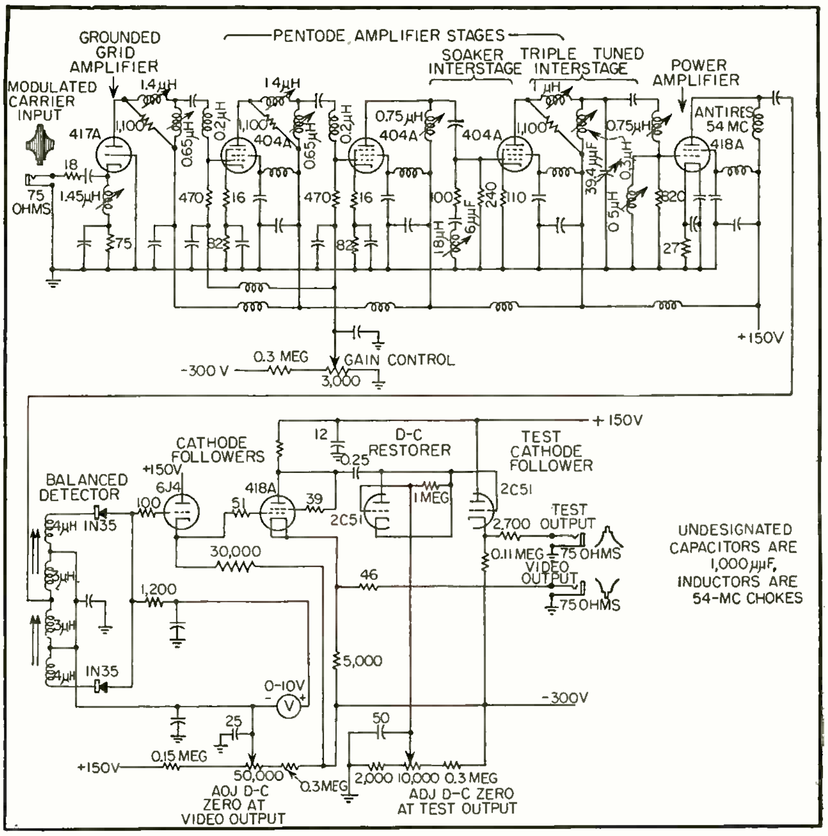


FIG. 2—Power and voltage levels throughout the three units

second when the temperature increases 10 degrees C. By locating the line inside the chassis away from the heat of the tubes, adequate stability was attained under laboratory room conditions.

For simplicity, a-m rather than f-m was chosen. The baseband signal is used to modulate a 54-mc oscillator and the carrier and both sidebands are transmitted through the delay line. Broadband amplifiers are needed to make up for the 54-db loss in the line and to equalize for its lack of bandwidth. A detector then recovers the original baseband signal. As shown in Fig. 1, the equipment is divided into three units which are normally connected by 75-ohm cables. Western Electric high figure of merit tubes (types 404A, 417A and 418A) are used for carrier amplification.

As shown by the level diagram in Fig. 2, the carrier and sidebands are amplified to a power level of approximately 0.1 watt and then applied to the delay line. After passing through the delay line a low-noise preamplifier and main amplifier restore the signal to a high level for linear detection.



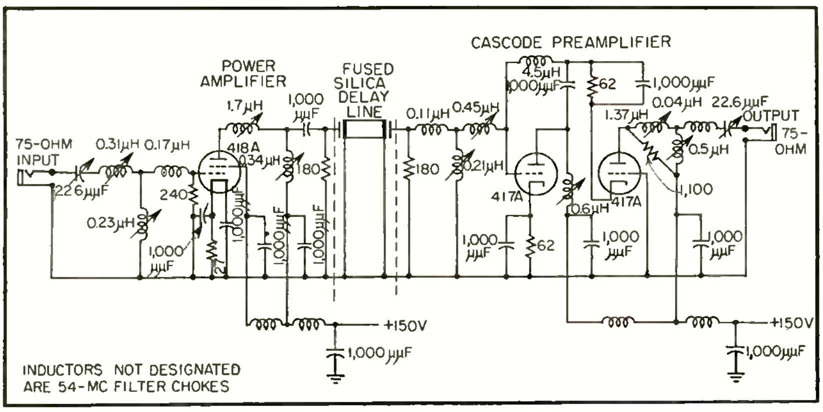
The amplifier-detector is the final unit of the equipment

Modulator and Detector

The modulator-detector combination was chosen for simplicity and lack of criticalness. Because of the many wavelengths delay in the line, carrier reinsertion seems impractical, hence the choice of an envelope detector. The modulator is a 6AS6 pentode with the carrier oscillator connected to the control grid and the video signal to the suppressor. The published characteristics show that the suppressor to plate transconductance is essentially constant while the control grid to plate transconductance is essentially linear between 800 and 1,400 micromhos, hence the percentage modulation is 27 percent. However, static tests on seven tubes showed that the best would permit around 50-percent "linear" modulation. For this particular tube the best operating conditions were found by experiment as shown by the middle plot in Fig. 3. Two other tubes allowed modulation percentages up to about 40 percent. Static measurements were checked using a 1-kc oscillator and a wave analyzer to read $2f$, $3f$, and so on. The best operating point was found by adjusting for minimum $2f$. Under these conditions $3f$ was down 46 db with 54-percent modulation, which agrees quite well with static measurements.

Amplifier-Detector

A diode detector is used instead of the infinite-impedance type because it tends to be more free of distortion. While the balanced detector is considerably more difficult to use than the single-ended type, especially with a coupling coefficient of 45 percent at 54 mc, its use also results in less distortion. To further insure a high degree of linearity, the a-c shunting and depth of modulation are kept low and the spread between carrier and video frequencies high. (This also permits simple filtering following the detector.) In addition, a large final amplifier tube is used to drive the detector. Germanium diodes are used because of their small



Output of the modulator is fed by coaxial cable to this delay unit

interelectrode capacitance and low forward resistance at high driving levels.

The detector feeds a small (6J4) cathode follower to minimize loading effects. This stage in turn feeds a large (418A) cathode follower which is capable of delivering 2 volts peak-to-peak to a 75-ohm line. The amplifier-detector linearity is shown in Fig. 4.

A detector load resistance of 1,200 ohms is high enough to give good efficiency and low enough to avoid appreciable distortion due to a-c shunting. The detector efficiency is about 33 percent; therefore, to provide 6 volts of rectified output, which is on the linear portion of Fig. 4, the power delivered to a single load resistor by the 418A tube is as follows:

$$\text{Efficiency} = \frac{E_{d-c}}{E_{peak}} \cong 0.33$$

$$\therefore\ E_{peak} = 18\text{v} \quad E_{rms} = 12.7\text{v} \quad P = 135 \text{ mw}$$

Soaker Circuit

In general, the 54-mc amplifier stages are coupled by matched double-tuned circuits for good gain and absence of criticalness.[3] Since the delay line has a single-peaked band pass characteristic as shown in Fig. 5A, a "soaker" circuit interstage is used to broaden and flatten this band. It consists of a low-Q shunt-resonant circuit in parallel with a higher-Q series-resonant circuit (see Fig. 5B). The latter circuit soaks out energy near the center of the pass band, hence the name "soaker" or "sucker" circuit.

The Q of the shunt-resonant circuit is made as low as possible consistent with the required gain. The soaker Q is then made equal to the effective Q of the delay line,

$$Q = \frac{f_m}{\Delta f} = 7.2$$

Both circuits are separately tuned to midband. After connecting them together, adjustment of the soaker circuit Q permits flattening the band as shown in Fig. 5C. Detuning the soaker circuit in either direction causes a corresponding tilting of the band characteristic.

A triple-tuned circuit is used in the interstage following the soaker circuit. The basis of this design is two double-tuned transformers in tandem to permit attaining a large step down ratio (nearly 5 to 1). The first transformer is reduced to an equivalent L and the second to an equivalent π. By combining elements, a two-mesh configuration having five adjustable elements is obtained. In practice, this facilitates the compensation of amplitude irregularities which invariably accumulate when a number of stages are cascaded.

A cascode preamplifier with W.E. 417A triodes is used to attain the best possible noise figure at 54 mc.[4] Including the main amplifier, a 3-db overall bandwidth of 24 mc is obtained with an overall noise figure of 2.1 db minimum and 2.3 db average.

For 417A triodes operating with a noise bandwidth of 25 mc in the vicinity of 60 mc, it appears that the cascode arrangement is about one db better than the grounded-grid circuit.

The measured overall video transmission characteristic is shown in Fig. 6. By careful design the overall bandwidth is greater than that of the delay line alone. On a video basis the delay line is less than 4 mc wide at the 3-db points, yet the overall is 7 mc wide.

The signal-to-noise ratio may be estimated as follows:

Power at delay line input	+20 dbm
Gain in delay line (loss)	—54 db
Input signal	—34 dbm
Noise power in 14-mc band	—102+dbm
Noise figure	2+
Input noise	—100 dbm

S/N versus percent modulation		S/N
100-percent modulation	100—34 =	66 db
50-percent modulation	66— 6 =	60 db
25-percent modulation	60— 6 =	54 db

Excellent power supplies are needed to minimize low-frequency noise and some selection of modulator and amplifier tubes may be required to minimize noise and microphonics.

The author wishes to acknowledge the assistance of J. L. Wenger who constructed and tested this apparatus.

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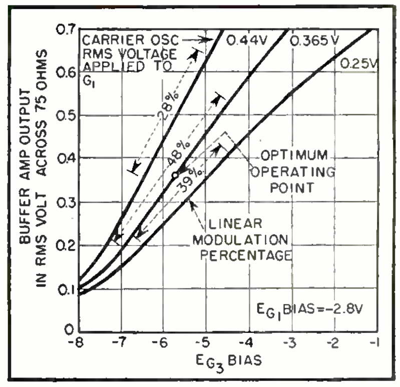

FIG. 3—Characteristics of the 6AS6 tube as modulator

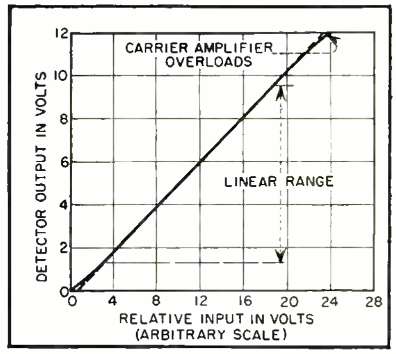

FIG. 4—Amplifier-detector linearity

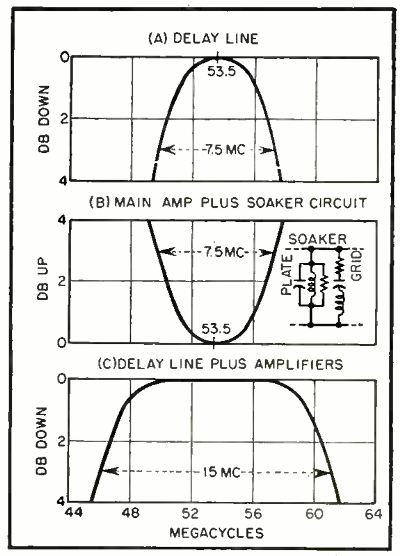

FIG. 5—Band-pass transmission characteristics

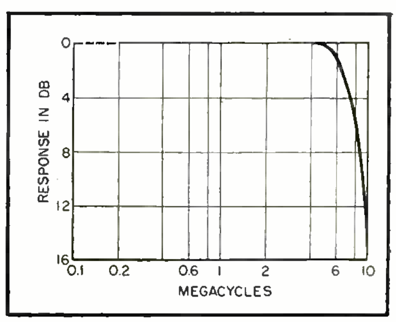

FIG. 6—Overall video transmission

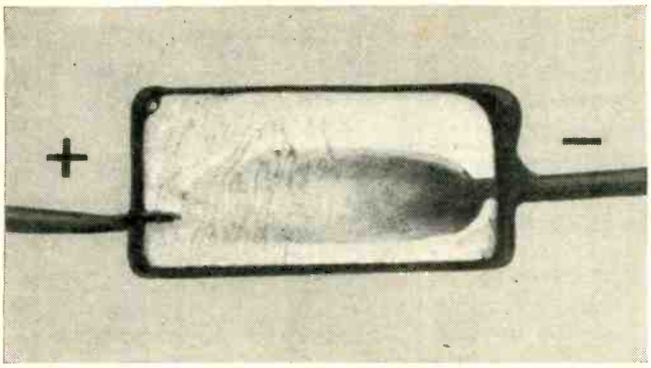

FIG. 1—First of four steps in breakdown of rock salt crystal dielectric is electron emission from cathode in clouds

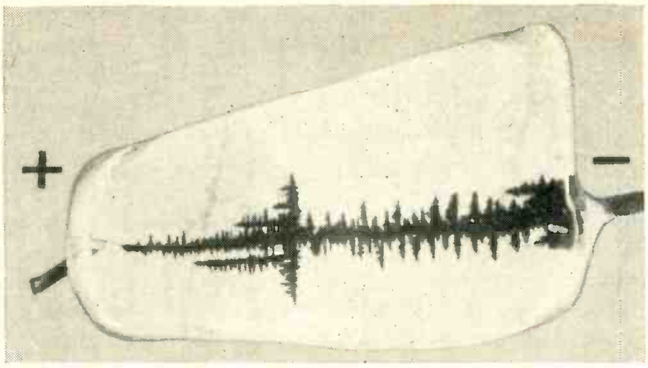

FIG. 2—Second step in breakdown is Christmas-tree growth of sodium dendrite from cathode, forming metallic bridge

DIELECTRICS

By
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THE RELATIVELY INEFFICIENT use of materials in electrical engineering today stems from the still prevailing idea that dielectrics have unalterable properties and are bestowed on us either by nature (as oil, mica and shellac) or by industry as the more or less accidental byproducts of a manufacture directed toward other goals (plastics, paper and ceramics).

These premises have to be revised. The properties of materials can be changed within wide limits, and our goal should be to tailor them to order by combining the proper atoms and molecules in the fitting patterns.

On this postulate the Laboratory for Insulation Research was founded at MIT twelve years ago. It carries on an extensive fundamental research program, now sponsored jointly by the Navy Department, the Army Signal Corps, and the Air Force under ONR Contract. It is aimed at acquiring the basic knowledge for a synthesis of materials with prescribed electric and magnetic properties.

For this type of approach, the old definition of a dielectric as a nonconductor of electricity has lost its meaning. Any material may show conduction to a varying degree, depending on the conditions and the pretreatment chosen.

A slab of rock salt, for example, may at room temperature be an excellent insulator with approximately 10^{17} ohm-cm resistivity. If used, however, at 450C in a field of about 1,000 volts per cm it will fail dramatically. For a few minutes the only indication of trouble may be a slowly climbing ammeter needle, indicating that the resistivity is falling to about 10^7 ohm-cm. Then suddenly, like an erupting volcano, the cathode begins to eject cherry-red clouds which drift rapidly through the clear crystal toward the counter-electrode (Fig. 1); the current simultaneously rises steeply. The clouds are formed by electrons issuing from the cathode and migrating to the anode. Reversal of the voltage may still pull them back and save the dielectric.

Behind this smoke screen of electron clouds, however, other events occur which damage the crystal beyond repair. From the cathode a structure like a Christmas tree begins to grow—a dendrite of sodium deposited by discharging cations, which rapidly throws a metallic bridge across the electrode gap as in Fig. 2. To replace these ions, the copper anode releases invisible copper ions into the rock salt. As the electron clouds of Fig. 1 approach this anodic region, they begin to act like a developer; each copper ion traps an electron to neutralize its charge, and a brilliant red copper colloid appears, circling the anode like a halo as in Fig. 3. Then an electric spark bursts forth from the anode in zig-zag patterns similar to lightning and, striking the dendrite, completes the destruction in the grand finale of Fig. 4.

A casual observer, not aware of these turbulent events, will notice a hole in the crystal (Fig. 5) and comment in casual complaint that the insulation broke down. Yet this outcome, like the climax in any good murder story, might have been prevented if the influences at work had been properly appraised and controlled.

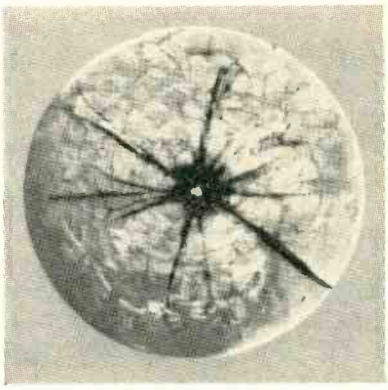


FIG. 5—Cross-section of rock salt crystal, showing breakdown hole in center due to spark discharge

We should learn how to contain the electrons in the cathode and how to release them at will; we should understand the laws of migration of electrons and ions and know how to interfere with their motions when necessary. This, then, is one of our long-range problems.

There are other problems of

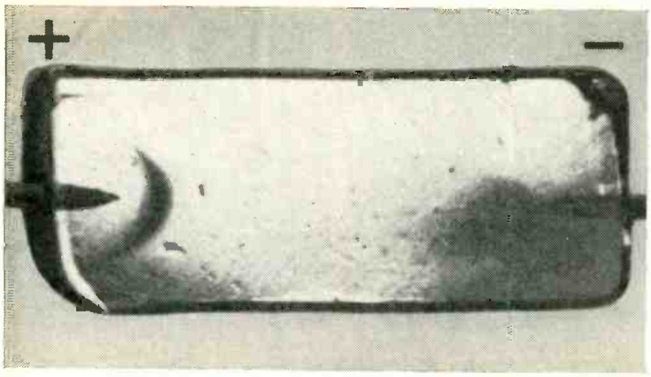


FIG. 3—Third step, occurring as electron clouds approach anodic region, is halo of brilliant red copper colloid

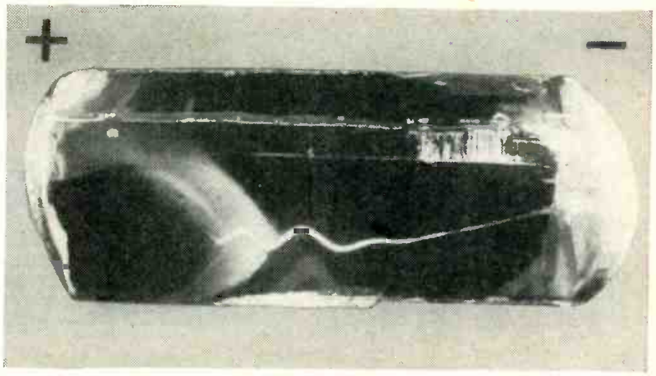


FIG. 4—Final step is destruction of dendrite and hence crystal itself by electric spark zig-zagging out of anode

MADE TO ORDER

Properties of many old and new dielectric materials can be altered at will by combining the proper atoms and molecules in particular patterns. Research into the nature of dielectric breakdown, described here, has provided clues to desirable new dielectrics

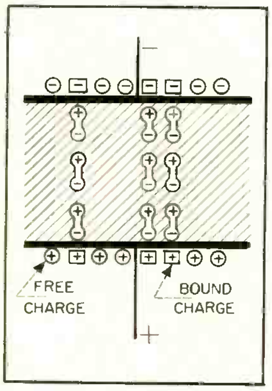


FIG. 6—Dipole chains in dielectric produce polarization in electric field

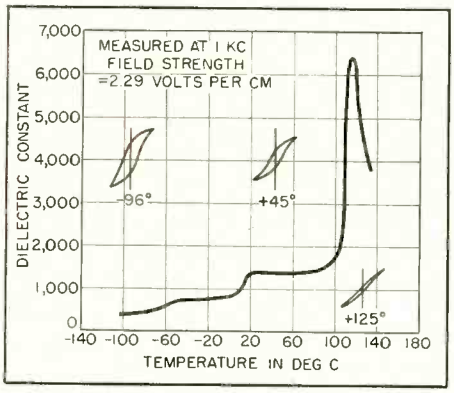


FIG. 7—Effect of temperature on dielectric constant of barium titanate ceramic, and hysteresis loops for three temperature values

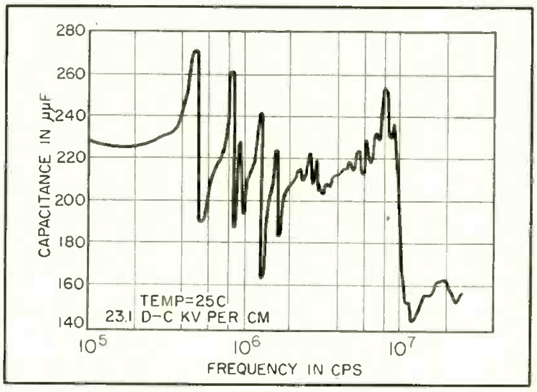


FIG. 8—Piezoelectric resonances of barium titanate ceramic. This characteristic permits use of titanates in microphones, pickups and ultrasonic generators

equal importance. Materials serve for a concentration and storage of electric and magnetic energy. It is a well-known fact that a capacitor can store more charge per unit voltage if the interspace between its internal electrodes is filled by a dielectric instead of vacuum. How much more it can store is expressed by the dielectric constant (permittivity) of the filling medium. Normally one has to be satisfied with constants ranging from 2 to 5, but recently materials have become available which may increase the storage capacity a thousand to ten-thousand-fold for special applications. These materials are called ferroelectrics, and our Laboratory has spent much research effort in developing one of the important prototypes, barium titanate.

Dipole Formation

A dielectric material increases the storage capacitance of a capacitor because it polarizes in the applied electric field. Schematically speaking, chains of electric dipoles form in the medium and the charged ends of these electric dumbbell chains bind countercharges at the electrodes as in Fig. 6. These dipoles may form under the influence of the applied voltage because the positive charges of the atoms and molecules move slightly toward the cathode and their negative counterparts toward the anode.

On the other hand, the dielectric may already contain preformed dipoles which tend to turn under the influence of an electric field like magnetic needles in the earth's magnetic field. The effect will normally be small and the dielectric constant low because the applied field is very small in comparison to the strong fields binding the atoms and molecules and tending to destroy the orientation of the permanent dipoles by thermal agitation.

In special materials, however, below a critical or Curie temperature

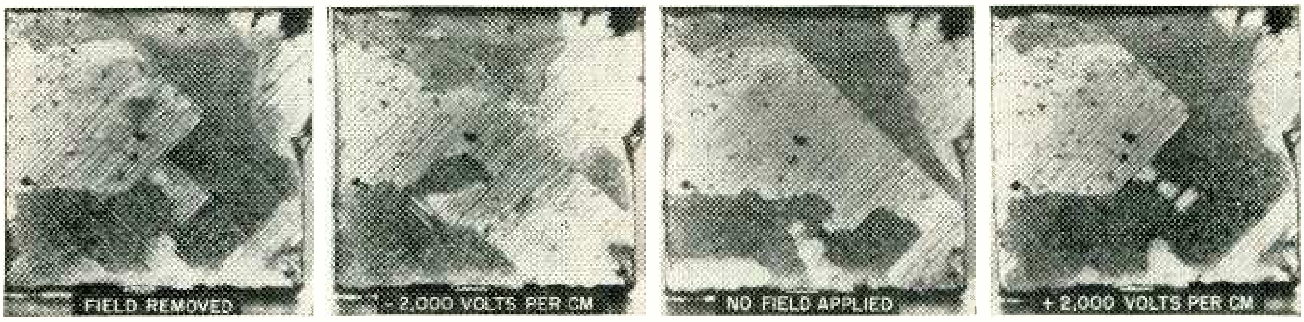


FIG. 9—Effect of high-voltage electric field on domain structure of barium titanate

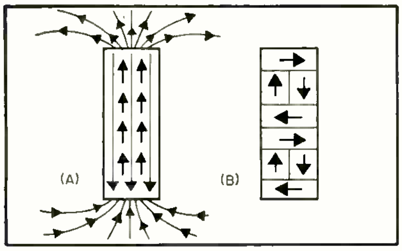


FIG. 10—Magnetic field surrounding a permanent magnet (A) and its removal (B) by domain structure involving mutual compensation of magnetic dipoles

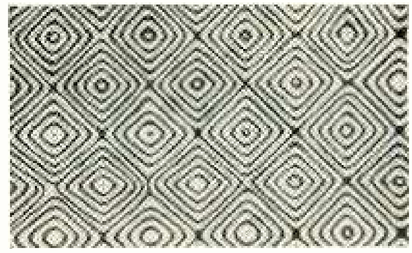


FIG. 11—Square-net domain pattern of single barium titanate crystal, visible because crystal is transparent

the dipoles sometimes align their moments spontaneously in parallel orientation by mutual interaction. If this happens to magnetic dipoles, ferromagnetism results, as in iron, nickel, or cobalt; in the case of electric dipoles, ferroelectricity is obtained—for example, in rochelle salt or barium titanate.

Figure 7 illustrates the situation for a piece of barium titanate ceramic. As the sample is cooled through the critical temperature region near 120C, the dielectric constant shoots up and traverses a peak reaching a value of about 7,000. Simultaneously it is not a constant any more but becomes a function of the applied field strength; that is, the polarization describes hysteresis loops like the magnetization in ferromagnetic metals. This makes the material not only useful for storage of energy but also as a nonlinear device in amplifiers and modulators and as tuning elements in electric circuits.

We found, furthermore, that these ceramics, once polarized, are piezoelectric resonators; they respond to electric fields by mechanical deformations (Fig. 8) and generate electric voltages under mechanical distortion. Thus ultrasonic generators, pickups, microphones, accelerometers, delay lines and many other devices can be based on these materials, a development carried forward after our findings by a number of industrial laboratories.

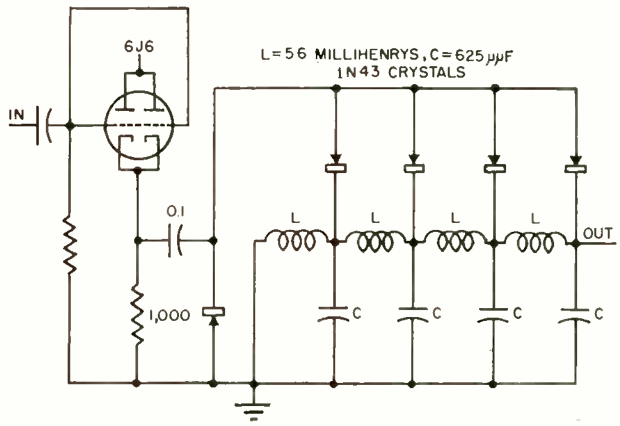
Studies on single crystals are required instead of the measurements on the multicrystalline ceramics if one wants really to understand the mechanism of ferroelectricity. We therefore learned to grow single crystals and discovered that such crystals below the critical temperature contain a variety of shaded areas (Fig. 9). In an electric field these areas were seen to expand or contract, sections of new shading suddenly emerged, and disconnecting of the voltage left a remanent state which required a countervoltage for its removal. Viewed in alternating fields under stroboscopic illumination, the whole crystal appeared in violent agitation, and in polarized light the flickering of the transmitted birefringence colors gave the impression of Broadway at night.

Magnetic Analogy

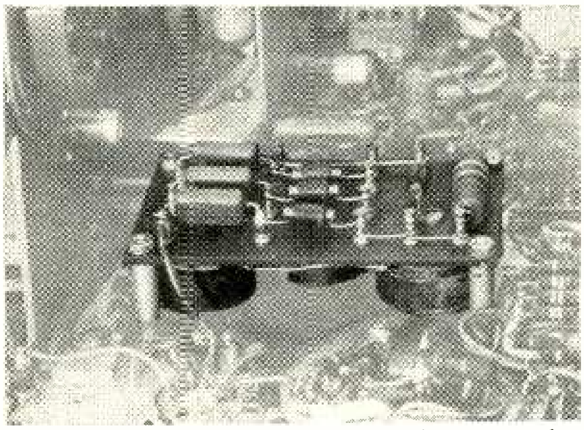
The implications of this spectacular phenomenon become clear when one turns to a ferromagnetic analog and considers the difference between a permanent magnet and a piece of soft iron. In a steel magnet a strong magnetic field originates from the free north poles of the dipole chains and terminates in the free south poles of the opposite end. A part of this field closes directly through the bar and tends to turn the dipoles in the opposite direction.

In magnetically hard materials the dipole groups are firmly clamped in place and resist this suicidal tendency, but in magnetically soft ferromagnetics the array breaks up into microblocks or domains which eliminate the external field by mutual compensation (Fig. 10). Since the metals are opaque, their domain structure can only be derived indirectly. Our ferroelectric crystals are transparent, and the domain pattern therefore lies visible before our eyes. Such patterns may have a beautiful geometrical regularity, as Fig. 11 demonstrates.

Detailed investigations have clarified the ferroelectric mechanism operating in barium titanate, and the material is beginning to play an important role in electrical engineering devices. Other studies may lead to ferromagnetic insulators or organic metals, to photocells of higher sensitivity or rectifiers of improved characteristics, and to new cables for high-voltage transmission or microwave uses. We do not know yet what will be realized, nor consider it a matter of primary concern at present. Fundamental research thrives best in a detached and unhurried atmosphere, with full freedom to follow targets of opportunity.



Circuit for increasing pulse duration from 1 to 15 μsec with no change in pulse amplitude



Complete setup of physical components of pulse stretcher in an actual circuit application

Improved Pulse Stretcher

Duration of pulses is increased as much as 25 times, with output amplitude remaining proportional to input. Flat-topped output is provided by a delay line charged by crystal rectifiers driven by a cathode follower. Sample design equations are given

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INCREASED DURATION of pulses in a series without change in their relative amplitudes is often desirable in design of pulse circuits. Pulse stretching, as distinguished from multivibrator action, retains information in the relative amplitudes of successive pulses.

One common method of stretching pulses is shown in Fig. 1A. For a positive-pulse input at terminal 1, the rectifier conducts only for the pulse duration. The capacitor charges to nearly peak pulse voltage during the pulse duration and slowly discharges through the high resistance during the interval between pulses.

In this type of stretching, the output pulse can never have a flat top because the stretched portion of the pulse is fundamentally the exponential discharge of the R-C circuit.

The exponential nature of the discharge results in a residual signal lasting much longer than the duration of the useful output. The trailing end of one pulse may overlap the beginning of the next pulse and reduce its effective amplitude. In an extreme case this phenomenon is the basis for power-supply filter operation.

A new type of stretcher is shown in Fig. 1B. Output pulses from this circuit are flat-topped with amplitudes proportional to input-pulse amplitudes. However, output-pulse duration may be as much as 25 times the original pulse length.

Pulse-Stretcher Circuit

The circuit consists of a multisection repetitive network of series inductors and shunt capacitors forming a delay line. Sections of this line are parallel charged by crystal rectifiers which permit an incoming pulse to be applied to all shunt capacitors simultaneously and charge them to nearly the amplitude of the incoming pulse. With no pulse input, the rectifiers become high resistances and the line is left with all capacitors charged equally.

When the line discharges through a short circuit at its end, a negative step of voltage (from line potential to zero) progresses down the line discharging each capacitor in turn. The output pulse, which has been at maximum since the line was charged, is terminated when the discharging action reaches the open end of the line.

Input and output waveforms are shown superimposed in Fig. 1C. The output pulse rises as rapidly as the capacitors are charged and nearly as fast as the input-pulse rise time. When the discharge step reaches the open end of the line, it tends to appear at double amplitude, shown dotted in Fig. 1C. However, the rectifiers prevent a negative excursion and the pulse ends abruptly at the base line.

The end of the pulse is more rounded than the beginning because of distortion of the step wave as it travels down the line. This distortion is usually permissible but with less distortion a line would have a wider passband and introduce less delay per section. To obtain the same delay more sections would be required. The trailing edge of the pulse may be as round as possible to save size, weight and cost of components.

Choice of Impedance Levels

Flatness of the pulse top is affected by any leakage that may discharge the capacitors before the discharge wave reaches them. Back resistance of the crystals is one source of leakage and line impedance should be limited to about one-tenth the back resistance or about 10,000 ohms for 1N43 crystals.

Another source of leakage is the output circuit fed by the line. The stretcher is usually connected directly to a vacuum-tube grid without a blocking capacitor but if such a capacitor is used, the grid resistor must be as large as possible. Low line impedance will reduce relative leakage through the grid resistor but will increase the current necessary to charge the line.

The stretcher is usually driven by a cathode follower whose cathode impedance, in series with the forward resistance of the rectifiers, varies from 50 to 200 ohms. The time constant formed by the cathode impedance and the parallel combination of line capacitors should be short enough so that the capacitors charge within the duration of the incoming pulse. The driving tube must be capable of delivering the peak current that will flow during the charging period.

These considerations are not easily subject to analytical prediction because cathode impedance and rectifier forward resistance change with current during the charging period. A good design provides for the necessary grid drive at the instant the pulse is applied to the grid, as the capacitors are then uncharged. Cathode impedance may then be assumed to be some average value and the charging time constant calculated for this value.

With stretched-pulse durations of one to twenty μsec, it is practical to use a 6J6 cathode follower with both halves in parallel and a line impedance between 5,000 and 20,000 ohms. To properly swing the crystals between low forward resistance and high back resistance it is necessary to operate with pulse amplitudes of at least two volts. Values lower than this give stretched pulses whose tops are not flat because of line discharge by the crystals.

Pulses of the order of ten volts are about the maximum that can be handled by a 6J6 cathode follower with these circuit values. Higher-amplitude pulses may have rise times rapid enough to drive the cathode follower into its grid-current region. This is permissible only if a low-impedance grid circuit or satisfactory d-c restoration is provided.

Stretching may be increased by operating several stages in cascade. However, a cathode follower is then needed between stages to provide power gain and impedance matching.

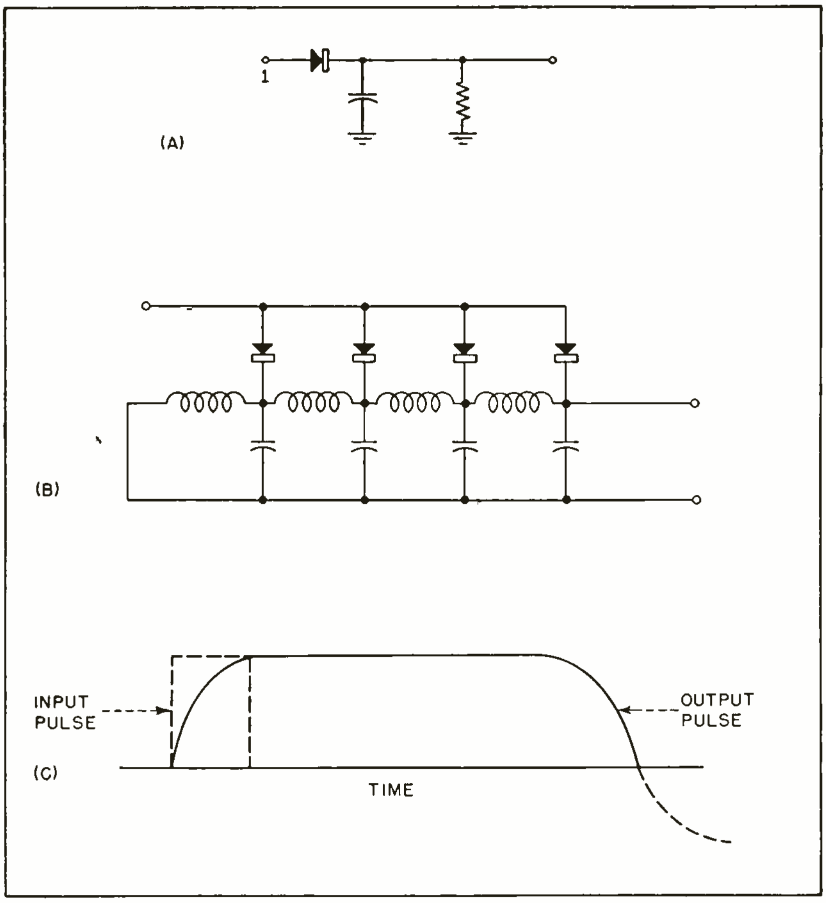

FIG. 1—Usual form of R-C pulse stretcher (A), improved type utilizing a delay line (B) and input and output waveforms for improved circuit (C) showing the sharpening of the end of the output pulse by rectifier damping

Superposition of Pulses

When a second pulse, equal in amplitude to the first pulse, is applied to the stretcher before the first pulse has completely passed through the circuit, the output amplitude will remain constant during the total stretching interval.

If the second pulse is either larger or smaller in amplitude than the first, the output amplitude will be that of the first pulse until the second is applied when it will change to the amplitude of the second and remain there for the rest of the total stretching interval. These actions are shown in Fig. 2.

Many designs for a circuit which generates pulses of special shapes are possible through the use of unequal charging voltages on successive stages and by charging the line with a series of pulses of various amplitudes.

If the input pulse is of constant amplitude and duration, series resistors may be used to vary the charging potential of various sections of the line. For varying pulse amplitude and duration, it is necessary to obtain rapid charging by the use of separate cathode followers.

When the pulse is accompanied by a background of noise, the noise pulses are stretched so that a constant d-c level is established. In most circuits this level is discarded by coupling capacitors so that the apparent signal-to-noise ratio is improved.

As the noise level approaches the signal level the signal may be degraded by short noise pulses whose amplitudes are nearly the same as the signal. These pulses may reduce crystal back resistance momentarily, permitting the capacitors to discharge. As a result, the signal is degraded into a sawtooth and becomes lost in noise. The signal-to-noise ratio at small values is not improved by the stretcher and may even be reduced slightly.

Design Equations

In the design equations of a pulse stretcher the following terms will be used: T_s, stretching interval; T_p, input pulse duration; R_k, impedance of a driven source (usually the cathode impedance of a cathode follower); L, inductance per section of network; C, capacitance per section of network; and n, number of sections of network.

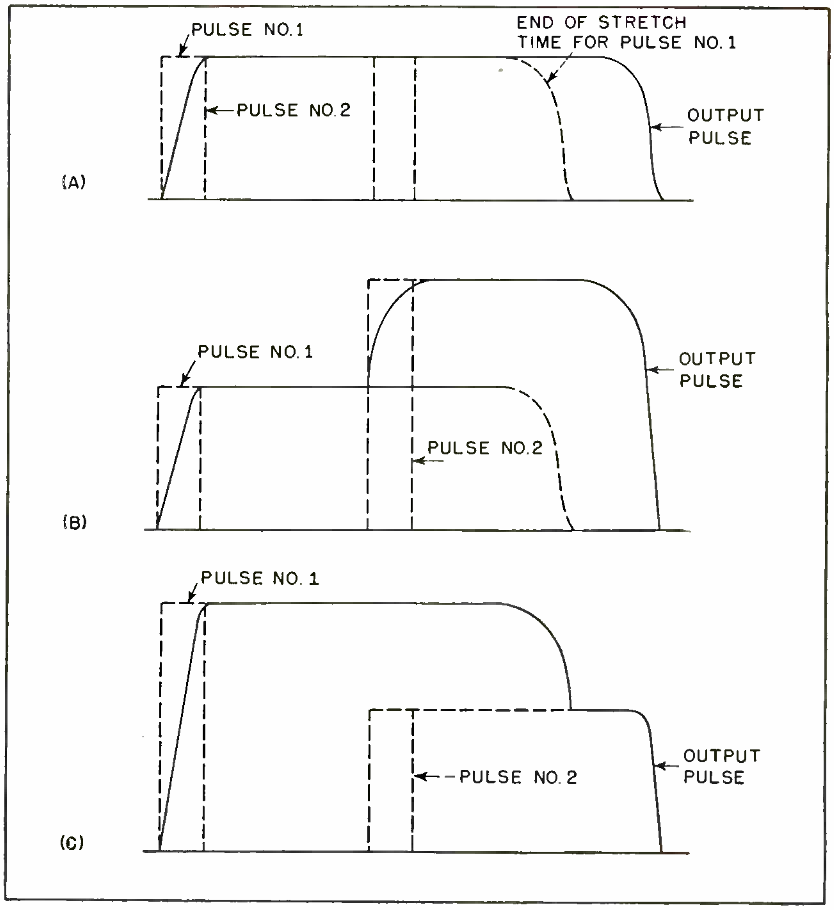

FIG. 2—Outputs for a pair of pulses spaced by less than the stretching interval. Pulses of equal amplitude (A), second pulse of greater amplitude than first (B) and second pulse of less amplitude than first (C) are shown

The input pulse duration should be at least four time constants to insure adequate charging of the capacitors

$$T_p = 4\,R_k\,n\,C$$

The stretching interval will be the delay of the network or approximately

$$T_s = n\sqrt{L\,C}$$

Solving these two equations for line constants gives

$$C = \frac{T_p}{4\,n\,R_k}$$

$$L = \frac{T_s^2}{16\,n^2\,C}$$

In practice, the number of line sections is determined by the required output-pulse squareness and in most cases about four sections have proved satisfactory. The type of driver determines the value of R_k. For both halves of a high-g_m double triode such as the 6J6 or 12AT7 the cathode impedance should be about 100 ohms.

A line impedance of about 10,000 ohms is as high as practical with germanium crystals. A practical limit to the stretching ratio then is

$$\frac{T_s}{T_p} = \frac{n\sqrt{L\,C}}{4\,n\,R_k\,C} = \frac{\sqrt{L/C}}{4\,R_k} =$$

$$\frac{Z_o}{4\,R_k} \cong \frac{10{,}000}{4 \times 100} = 25$$

Circuit constants for a pulse stretcher with a 1-μsec input pulse and 15-μsec output pulse with both halves of a 6J6 in parallel as driver can be calculated as follows

$$C = \frac{T_p}{4\,n\,R_k} = \frac{1 \times 10^{-6}}{4 \times 4 \times 100} =$$
$$625 \times 10^{-12} \text{ farads}$$

$$L = \frac{T_s^2}{4\,n^2\,C} = \frac{(15 \times 10^{-6})^2}{4 \times 4^2 \times 625 \times 10^{-12}} =$$
$$5.6 \times 10^{-3} \text{ henrys}$$

In this case, rounding of the trailing edge that accompanies a four-section line is permissible.

The final circuit uses a 0.1-μf coupling capacitor which tends to become charged by the rectifiers. However, the negative charge is drained off by an extra crystal diode connected so that a positive-going pulse may exist but a negative bias may not.

COAXIAL-STUB FILTER

Undesired signals in a coaxial transmission line can be attenuated up to 30 db by connecting two stubs to the line, one for rejection and the other to correct the line impedance. Graphs give approximate stub lengths for any interfering frequency in range from 20 to 200 mc

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Systems Engineer
Link Radio Corporation
New York, N. Y.

COAXIAL LINE stubs often can be effectively used in transmitter or receiver coaxial transmission lines to reduce or trap out specific spurious radiations or interfering signals. Stubs are well worth trying, since they are relatively inexpensive and can be depended upon to furnish up to 30-db additional attenuation to an undesired signal. Two stubs are used, one for rejection and one for correction, as shown in Fig. 1.

Receiver stubs are most easily fabricated from RG-58/U solid dielectric cable. Where stubs are to be used to suppress transmitter spurious radiations, a solid-dielectric cable should be used having the same power-handling capacity as is used between the transmitter and its antenna. The approximate length of the rejector stub for the undesired frequency can be determined from Fig. 2. A piece of cable several inches longer than that called for should be connected into the transmission line as in Fig. 1, as close as practical to the transmitter or receiver. Use a pick or other sharp-pointed instrument to short-circuit the outer shield to the inner conductor at various points, starting from the outer end of the stub and working inward. Note at which point the short-circuit produces the greatest attenuation of the undesired signal and permanently short-circuit the cable there. Cut off the excess cable. This short-circuit may be best accomplished by collapsing the outer shield around the center conductor and soldering all around.

As Fig. 3 shows, the rejection stub alone produces a certain amount of attenuation to the undesired signal. This is because it has been tuned to be a shorted half-wave section of line at the undesired frequency. As such, it presents close to zero impedance to this frequency at its point of connection to the main transmission line. However, at the desired frequency, the rejection stub will not be a shorted half-wave section of line and will therefore present either capacitive or inductive reactance to the line and thereby cause some degree of attenuation to the desired frequency. This effect can be overcome by adding a second stub called a correction stub, as shown in Fig. 1.

For various desired versus undesired frequency conditions, the length of the correction stub may vary from almost zero to one-half wavelength. The length of

(Continued on p 134)

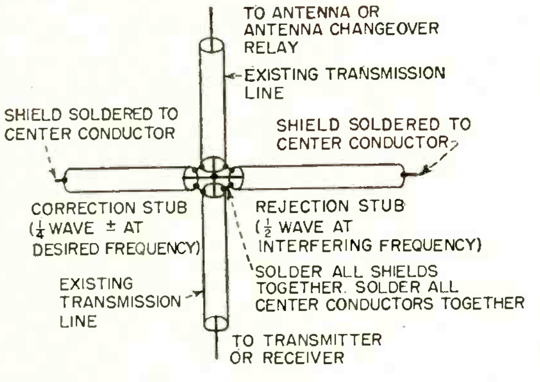

FIG. 1—Method of connecting stubs is same for both transmitting and receiving lines. Put stubs as close as possible to transmitter or receiver

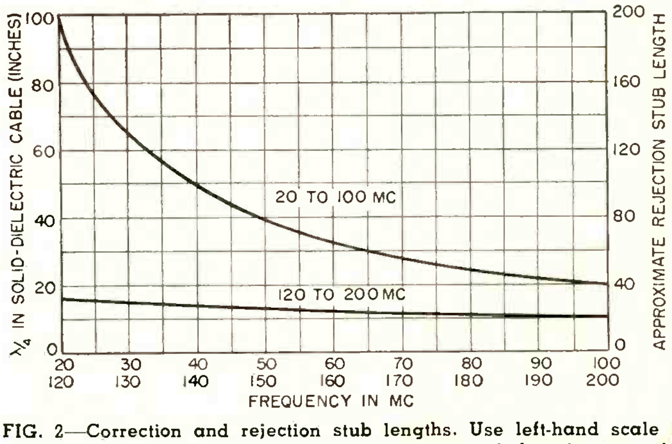

FIG. 2—Correction and rejection stub lengths. Use left-hand scale in connection with Fig. 4 to determine correction stub length, since this is longer or shorter than a quarter-wavelength at some frequencies

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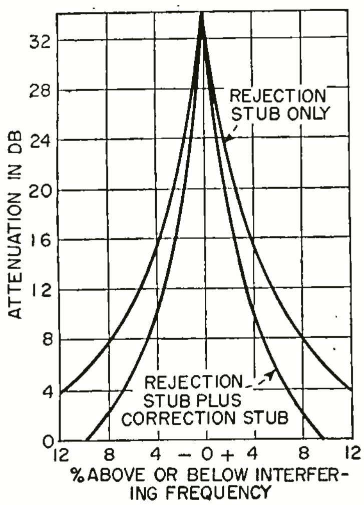

FIG. 3—Attenuation characteristics of stubs

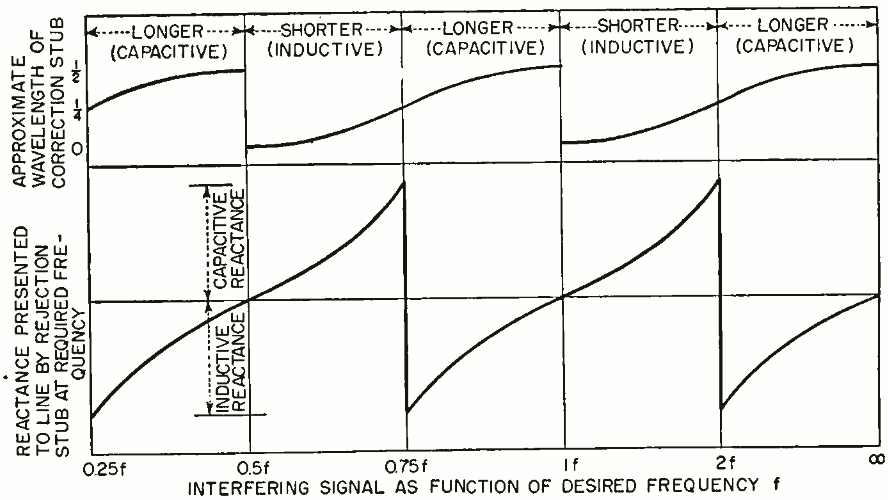

FIG. 4—Curves showing line characteristics with stubs in place, as function of ratio of interfering signal to desired signal

one-quarter wave in solid dielectric cable is also plotted in Fig. 2, to show that the correction stub will be some value between zero and a definite upper limit. In this case, the desired frequency should be used in determining the length of the correction stub. This stub is tuned and is permanently short-circuited as in the case of the rejection stub, except that the tuning is done to produce the least attenuation of the desired signal.

If the correction stub were to be made exactly one-quarter wave long at the desired frequency, it would present infinite impedance (neither capacitive or inductive) to the desired signal. While being made shorter than a quarter wave it presents progressively less inductive reactance. While being made somewhat longer than a quarter wave it presents progressively less capacitive reactance to the line.

The amount of reactance in either case depends upon how much longer or shorter than a quarter wave the correction stub is made. This length is automatically arrived at in the tuning procedure given above.

Figure 4 shows whether the correction stub will be longer or shorter than the quarter-wave-length shown in Fig. 2. To use Fig. 4, determine what relationship the interfering frequency bears to the desired frequency. As an example, if the desired frequency f is 40 mc and the interfering signal is 25 mc, the interfering frequency would be between $0.5f$ and $0.75f$. The lower curve shows that in this range the reactance presented to the line by the rejection stub is capacitive, and the upper curve shows that the correction stub should present inductive reactance and hence be shorter than a quarter wave, or shorter than the value called for on Fig. 2. The correction stub is thus utilized to balance out the reactance presented to the line by the rejection stub at the desired frequency.

Correction Stub Details

It is not necessary or desirable to show how many inches shorter or longer than a quarter wave the correction stub should be in chart form, since the precise length will be automatically arrived at as the stub is short-circuited in the tuning process. However, the upper curves in Fig. 4 do give the approximate length of the correction stub in terms of wavelength. In the example given above, these curves show that the corrector stub will be less than ⅛ wave long. In this case, it is advisable to start with a quarter-wave length of cable and short it at various points in the vicinity of an eighth wave to find the exact point.

Had Fig. 4 indicated the need for a capacitive correction stub (greater than a quarter wave and less than a half wave), it would be advisable to start with a half-wave length of cable and probe through the predicted point. Figure 4 is to be used chiefly as an aid in predicting the length of the correction stub and to help in visualizing the line conditions with the stubs in place.

A word of caution is advisable in a few specific cases. If the interfering frequency is approximately ½, ¼ or ⅛ of the desired frequency, stubs cannot be used. In these cases, the rejection stub will prove to be a full wavelength or multiple of a full wavelength at the desired frequency and will therefore present high attenuation to the desired frequency as well as to the interfering frequency. On the other hand, if the interfering frequency is exactly twice the desired frequency a correction stub will not be necessary since the one-half wave rejection stub will be an exact quarter wave at the desired frequency and will present infinite impedance to the desired frequency.

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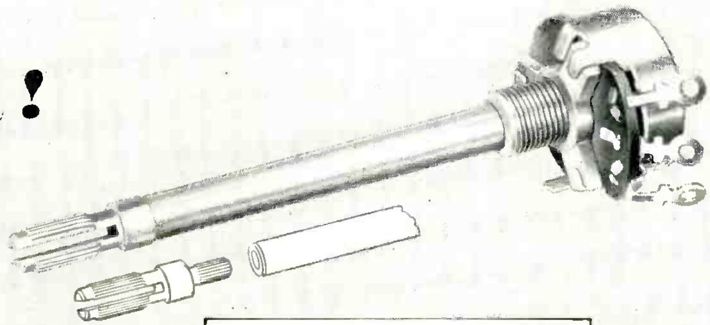

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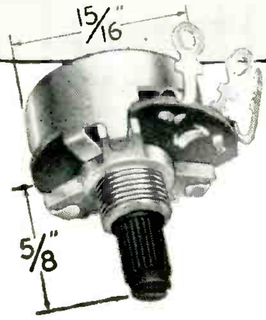

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The incorporation of a universal, tubular shaft permits easy adapting of the standard unit to the specific needs of a wide range of applications. As a result, short orders can be filled practically overnight . . . for production emergencies, for service replacement stocks. The Mallory Midgetrol is available in resistance values from 1,000 ohms up to ten megohms, for loads up to ½ watt . . . and can now be supplied with shafts to meet your specifications to fill your hurry-up orders for less than normal production quantities and at low cost.

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TUBES AT WORK

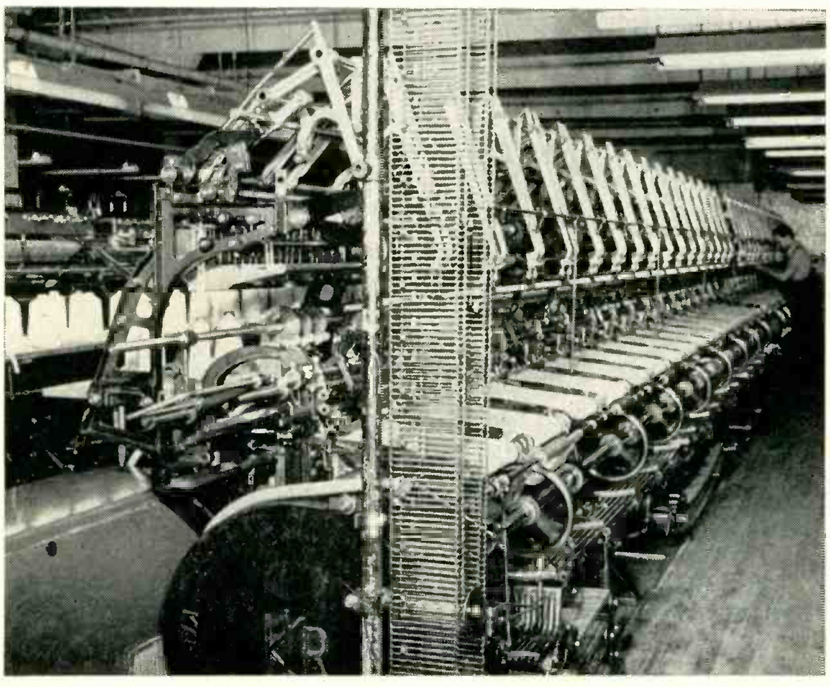
Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Electronic Knitting-Machine Drive

HIGH PRODUCTIVITY of modern machinery is to a large degree the result of the evolution of electric motor drives. Once purely a power unit to cause rotation of a drive shaft, today, the motor with its associated control is an electrical transmission that assumes the functions and duties of such mechanical transmissions as clutches, belts, gears and brakes.

Contributing heavily in this development of electrical transmissions are recently introduced electronic devices which have already proved their value in the textile and knitting industries. Full-fashioned knitting machines, such as built by Karl Lieberknecht, Inc., in Reading, Pa., are typical of modern machines in which the evolution of motor drives to electrical transmissions incorporating industrial electronics has contributed heavily in establishing new production records.



Full-fashioned knitting machine powered by an electronic drive. The control unit is partially visible at the lower left corner

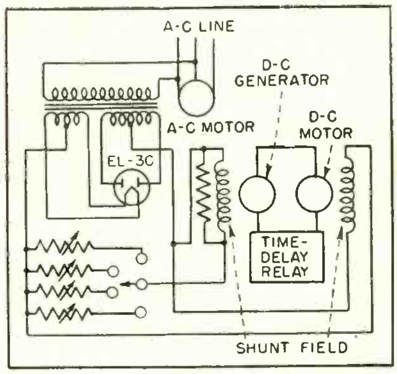


FIG. 1—Schematic diagram of the adjustable-speed control system

The Reliable V-S Drive as furnished with the machine consists of an adjustable-speed motor with shunt characteristics (the speed tends to remain constant for all loads) and a power unit with electronic excitation. The combination provides a voltage control system whereby adjustable speed is obtained from an a-c power supply. Figure 1 is a schematic diagram of the system.

The speed change on the part of the adjustable-speed motor results from varying the voltage impressed across the terminals of the motor. The generator voltage which is applied to the motor terminals is controlled by adjusting the generator field current. This current is supplied by an electronic exciter consisting of an anode transformer and a full-wave rectifier tube plus the necessary control parts and circuits.

Figure 2 is the front view of the electronic units combined with the power unit in the packaged control.

The EL-3C tube is a full-wave uncontrolled rectifier tube which furnishes unidirectional current for both the generator and motor fields. Since sufficient speed variation is obtained by varying the armature voltage, the motor field needs only a fixed, definite direct current. The motor field is connected directly to the transformer as shown in Fig. 1.

The generator field current must be varied in order to obtain variable voltage as explained previously. This variable current is obtained by inserting resistance in series with the generator field. There are four variable resistors plus a fixed resistance, any one of which may be

put into the circuit by means of switches on the machine. This permits the use of five preset, adjustable speeds by the knitting machine.

For best tube life the filament voltage of all tubes must be maintained to ± 5 percent of rated voltage. Since conventional a-c power systems vary more than this amount, the tap switch should be set to the voltage as indicated on the wiring diagrams.

Since all high-circuit rectifier tubes must have their filaments heated before the load is applied, a time-delay relay is provided. This consists of a small synchronous motor operating, through a reduction gear, an actuator arm which closes the switch after a 30-second delay. Until this time has elapsed, after closing the circuit breaker, the d-c motor or the control cannot be operated. The relay switch is held closed by the motor during all operations. When the a-c power is shut off, by tripping the circuit breaker, the spring returns the actuator arm and opens the switch, thus recycling the relay.

A pair of fuses in the rectifier plate circuits protect the tubes against short circuits or faulty operation.

For the knitting machine described, there are control stations to provide start, stop and creep operation.

The three speed-selecting switches are of the spdt type and are mounted on the upper automatic shaft of the knitting machine. The three switches are the welt-turner, splicing and narrowing switches.

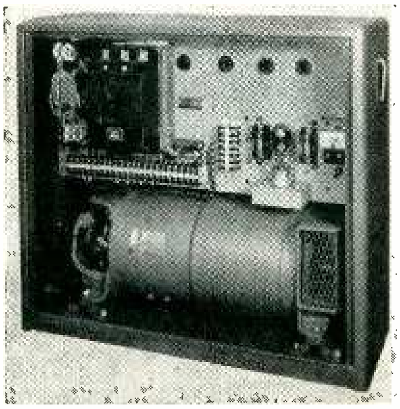
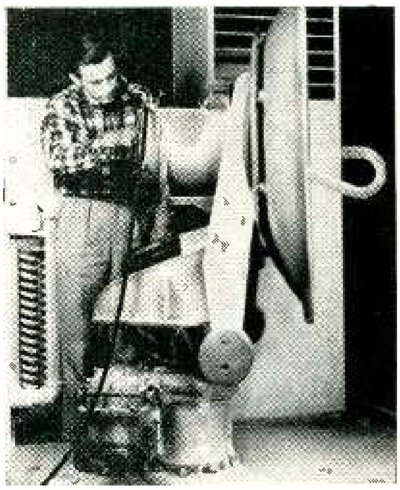


FIG. 2—Packaged control unit for the electronic drive

THE FRONT COVER



THE FOUR-FOOT parabolic reflector and pedestal shown in the cover photograph and the accompanying picture are part of a Navy SO-1 radar equipment formerly in use on a Navy PT boat.

The controlled climate chamber in which the equipment is shown being tested has a controlled temperature range of −25 C to +70 C. Relative humidity can be controlled throughout a range of 20 to 90 percent. Both temperature and humidity are controlled with an absolute accuracy of ±1.0 percent.

The equipment was adapted for tv broadcast field work by adding vertical tilt to the original mechanism so that the dish can be rotated or tilted in either the horizontal or vertical plane. The dish may be remotely controlled through use of electrical circuits and a position-indicating system employing selsyn motors.

It is possible to search for remotes in the field with the equipment by positioning the dish until maximum signal amplitude is observed. The unit was built for this purpose for use at station WABD, Du Mont station in New York City.

Increased Safety for Safes

BY ESTHER H. FORBES
New York, N. Y.

AN ELECTRONIC MECHANISM for controlling a combination lock has been designed from standard servo components of Servomechanisms, Inc. Operating the lock electronically from a remote position, the device can make any vault almost completely impregnable.

Present combination vault locks have three principal shortcomings which make them vulnerable to burglars. In the first place, the dial is manipulated manually, so that a person with sensitive fingers or sensitive ears can detect when the tumblers fall in place and thus discover the combination. With modern equipment it is also possible to rig up an electronic device to detect the combination with even greater precision.

In the second place, the dial is connected to the lock by means of a shaft which cuts through the wall of the vault. When such a mechanical connection is used, the lock is usually directly on the other side of the wall from the dial. Therefore, a burglar has a good indication of where he can drill through the wall to get at the lock mechanism.

Lastly, the person who knows the combination and can open the lock is stationed directly at the vault. This means that a hold-up man can force him to open the vault before he can register an alarm of any sort.

Substitution of electronic for mechanical operation of the lock eliminates all three hazards. This is possible with existing compon-

(continued on page 156)

THE *RIGHT* R-F NOISE FILTER FOR THE JOB

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NORTH ADAMS, MASSACHUSETTS

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Mobile Ionosphere Station

IN AN EFFORT to obtain more comprehensive data on the ionosphere, the National Bureau of Standards has incorporated a mobile ionospheric research unit into the existing chain of 60 world-wide ionosphere stations—approximately 15 of which are maintained by the Bureau. With this new unit, ionospheric soundings will be made from points midway between two permanent transmitting-receiving stations. This information will be used in studies of ionospheric effects on radio waves directly above the mobile transmitter-receiver; and it will also aid in analyzing the behavior of radio waves propagated from transmitters to distant receivers.

The equipment includes two gasoline-powered motor-generators which will provide 10 kw each. One of the trailers has been converted into living quarters for the two-man operating crew for use in regions where living accommodations cannot be obtained.

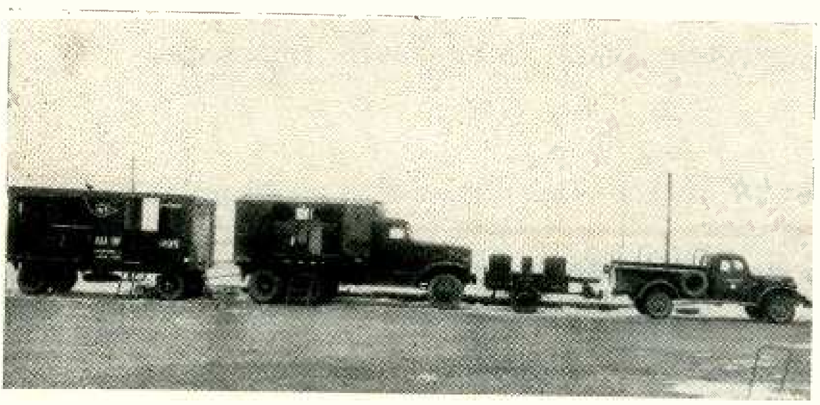
The caravan's first recording stop, 30 miles east of Cincinnati, Ohio, is a point midway between the station at Sterling, Virginia, and a leased station operated by Washington University, St. Louis, Missouri.

During the past twenty years the technique of vertical-incidence ionosphere soundings by the use of pulse transmitters scanning over a wide frequency range has been adopted internationally for recording the virtual height and degree of ionization for each of the ionosphere layers. Although vertical incidence reflection principles are basic to the understanding of radio propagation, they are rarely encountered in practical radio communication. The wave received at a distance from the transmitter impinges on the ionosphere obliquely in its journey from the transmitter to the receiver. However, theory indicates that much information about oblique incidence propagation can be inferred from data obtained at vertical incidence. Experiments with the mobile unit are designed to record simultaneously both vertical and oblique incidence data, and from an analysis of the information the relation between oblique and vertical incidence reflectors will be more exactly deduced.

In the first experiment, the Sterling and St. Louis stations will simultaneously transmit pulses of radio energy directed to strike the ionosphere obliquely. Each station will receive the other's signals. Because the pulses must pass all the way up to the ionosphere at the midpoint of the path and then be reflected down again, the travel times will be greater than if the signals traveled directly along the earth's surface. The heights of reflection will be calculated from time delays. During the transmission, the frequencies used at both ends of the paths will be slowly but simultaneously varied. At the higher frequencies the time delays will be greater because these waves travel to greater altitudes before they are reflected. Meanwhile the mobile station located at the critical point of the propagation path, will transmit signals vertically upward and receive its own echoes. By recording the heights and degree of ionization of the several layers, the heights at which, according to

(continued on page 208)

Interior of National Bureau of Standards mobile ionosphere station



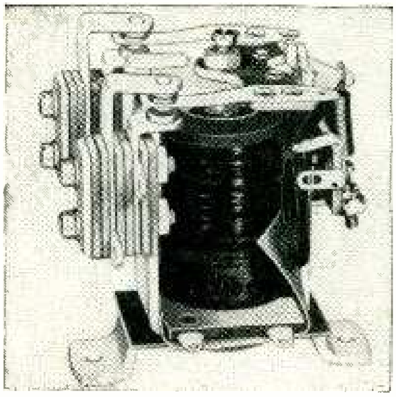
Mobile ionosphere station will permit simultaneous study of oblique and vertical incidence propagation

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Plate Circuit Relays

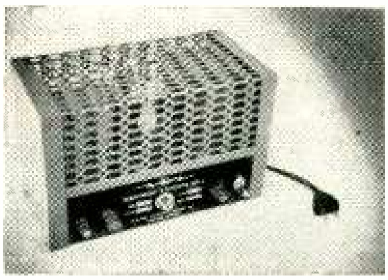
POTTER & BRUMFIELD, Princeton, Ind. The LM series relays are of the long coil construction giving a powerful magnetic circuit that with



10,000-ohm winding permits adjustment to pull in as low as 1 ma with contact pressure sufficient to carry 5 amperes. Nominal operating power is 0.1 watt. The design includes an adjustable armature return spring that allows easy adjustment when installing to meet unusual or variable current or voltage conditions. The armature is equipped with an adjustable residual screw that controls the ratio between pull-in and drop-out current. The relays are stocked in 2,500, 5,000 and 10,000-ohm windings and all contact combinations up to dpdt.

Electronic Standard Cell

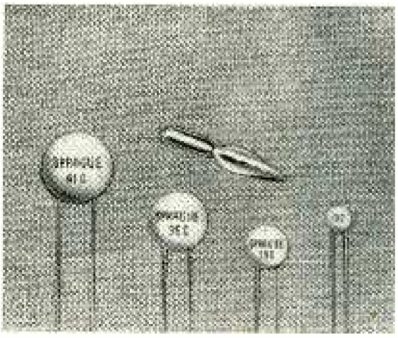
HASTINGS INSTRUMENT CO., INC., Super Highway at Pine Ave., Hampton 8, Va., has produced a new electronic standard cell for industrial and laboratory use. The unit provides a d-c reference voltage stable to 0.25 percent. Output ripple on



the low-current models is less than 0.01 percent. It contains JAN-type components, is immune to damage by momentary short circuits and is unaffected by temperature changes. The unit is for use with self-balancing potentiometers, wire strain gages, recording oscillographs, resistance thermometers and other applications that require a stable d-c source. It operates from an a-c source; 90 to 130 v, 50 to 500 cycles.

Disk Capacitors

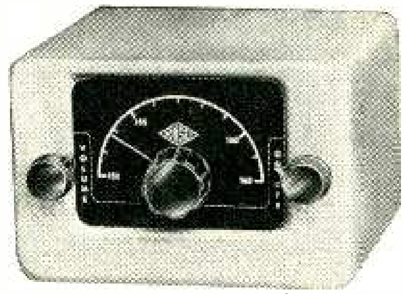
SPRAGUE ELECTRIC CO., North Adams, Mass. Cera-mite disk capacitors with voltage ratings as



high as 1,500 v are among the complete line of ceramic capacitors including temperature-compensating, general application and high-k types now available. Some 90 different standard ratings together with complete performance characteristics are included in engineering bulletin 601B, available on letterhead request.

F-M Communications Tuner

GON-SET CO., 72 E. Tujanga Ave., Burbank, Calif., has announced a new f-m communications tuner designed for uhf reception. The 5-tube tuner is ideally suited for reception of police, fire, taxicabs, aircraft, civilian defense and other



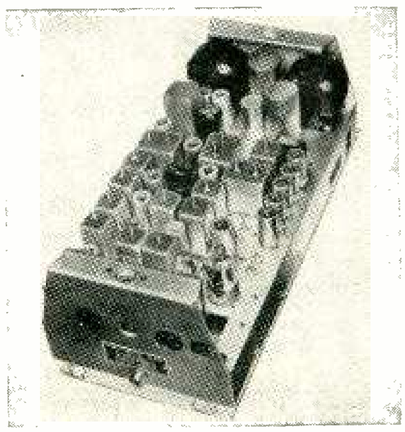
such services. Frequency ranges available are 30 to 40 mc, 40 to 50 mc, 88 to 108 mc and 152 to 162 mc. Price is $59.50 net.

Studio Picture Monitor

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model M-104 studio picture monitor is a high-impedance device and may be connected across a video transmission line without affecting the terminal impedance of the line. It features a resolution in excess of 500 lines, 16-in. kinescope, excellent vertical and horizontal linearity, light weight and minimum of maintenance. Input impedance is 470,000 ohms. Video amplifier is flat to 5.0 mc $\pm 1\frac{1}{2}$ db.

Mobile Radiotelephone

KAAR ENGINEERING CO., Middlefield Road, Palo Alto, Calif., has announced the Radiopak, a single unit transmitter-receiver for mobile communication in the 152 to 174-mc band. Power output is 10 to 12 watts, while battery drain is 6.5 amperes during standby periods and 15 amperes transmitting. The equipment will operate satisfactor-



ily from the regular 6-volt, electrical system of any vehicle. Overall measurements are: 6$\frac{3}{4}$ in. high $\times$ 8 in. wide $\times$ 18$\frac{1}{8}$ in. long; weight is 24 pounds.

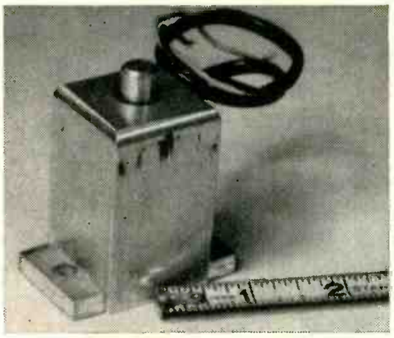
Stroboscopic Tachometer

Electronic Measurements Co., Red Bank, N. J., is producing model 351A stroboscopic tachometer that measures a wide range of speeds without physical connection to the rotating equipment. Fundamental range of flashing speed is 600 to 14,400 rpm. Accuracy is ± 1 percent of the dial reading above 900

rpm when the Strobotac is standardized in terms of a frequency controlled power line. The unit operates on 105 to 125 volts, 50 or 60 cycles, and consumes approximately 35 watts.

Synchronization Pickup

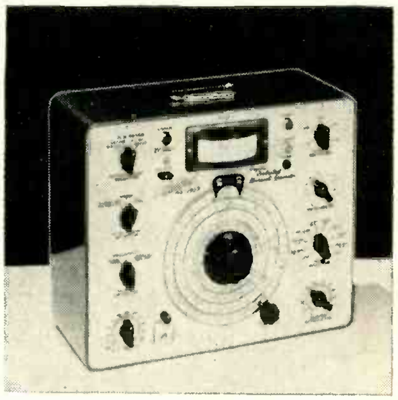
The Sterling Instruments Co., 13331 Linwood Ave., Detroit 6, Mich. The type 140 synchronization pickup was designed to be used in conjunction with the c-r oscillograph for studying pressure, stress and displacement. It consists of a 20,000-turn coil wound around a highly magnetized pole piece that protrudes a half-inch through the mounting case. A pulse to trigger the sweep of the c-r oscillograph is formed when a small piece of steel is moved past the face of the pole piece. It can trigger an oscillograph from rotary speeds of 70 rpm and up, and from linear speeds



of 15 in. per second and higher. Output pulse is double ended and symmetrical, allowing synchronization on the positive or negative polarity.

Microvolt Signal Generator

Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio. Model 292X microvolt signal generator covers a-m, f-m, tv and mobile frequencies in 7 ranges. It has a double range of 125 kc to 110 mc and 150 to 220 mc, all on fundamentals. Crystal accuracy is available to 0.0025 percent for mobile bands of 30 to 50 mc and 152 to 162 mc. The unit provides



accurately controlled modulated and unmodulated output from 0.2 to 100,000 μv through a 10 to 1 cast aluminum attenuator. It may also be externally modulated from 15 to 10,000 cps. The a-f output is 0 to 2 volts at 400 cycles.

Automatic Voltage Regulator

Thordarson-Meissner Mfg. Div., Maguire Industries, 500 West Huron St., Chicago 10, Ill., has announced the Power-Guard low-cost automatic voltage regulator designed to provide sure protection to electric motors or other electrical appliances from damage resulting from excessive fluctuations of line voltage. Rated at 750 va, the unit utilizes a power transformer with tapped windings and electrically adjusted to keep the output voltage within certain prescribed limits. One popular model adds 25 volts to

the output when line input drops to 95 volts. It also will automatically step-down 25 volts if line surge exceeds 130 volts. The relay in the Power-Guard is chatter-proof and the unit itself is filtered to prevent interference to radio or tv.

Synchronous-Motor Timer

General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass., has designed a new synchronous-motor timer for accurate control of a wide variety of timed operations. The type SY Promatic timer can be used for all time periods between $\frac{1}{2}$ second and 24 hours. It actuates five spdt load contacts independent of the timer-control circuits. There are two separate solenoids—one operates the clutch and timing mechanism, the other actuates the load

(Continued on page 236)

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Mobile Radio Unit Enters Military Service

THE MOBILE radio broadcasting company, part of the Army's Organized Reserve, which has been sponsored by the National Broadcasting Co. through the Dept. of the Army's Industrial Affiliation Program, entered active military service on May 1, 1951. Its activities heretofore had been supervised by Major General G. L. Van Deusen (Retired), president of RCA Institutes.

The unit is composed chiefly of personnel from NBC and from RCA Institutes. The bulk of the men are specialists in some phase of broadcast communications or programming.

Primary mission of the unit will be mobile radio broadcasting for psychological warfare purposes. The men in the unit will be performing essentially the same type of work they did in civilian life, which will be the operation of broadcasting studio facilities and high-power transmitters.

The NBC-sponsored group is commanded by W. B. Buschgen, Captain, Signal Corps—USAR, and was organized originally in November, 1948. The regular biweekly meetings and technical lectures have been held in NBC's Radio City studios, and other engineering facilities of the network were made available to the unit.

Initial training for the group will be given in Fort Riley, Kansas.

Research Fellowships Offered

RESEARCH fellowships in electrical engineering will be awarded by the Institute of Industrial Research, University of Denver. The stipend is $3,300 for 21 months starting Sept. 1, 1951.

Recipients will work approximately 25 hours per week in the Institute of Industrial Research on industrial research projects leading to the fulfillment of the thesis requirement, while engaged in graduate study leading to the M.S. degree in electrical engineering.

Interested applicants should send a transcript of college record, personal data, and names of three persons acquainted with their work, to the Director, Institute of Industrial Research, University of Denver, Denver 10, Colorado.

"WHAT ABOUT COLOR, MR. COMMISSIONER?"

Off-air photo of FCC Commissioner George Sterling (left), Don Fink of *Electronics* and Earl Cullum, consulting engineer, during interview over WFAA-TV, Dallas on occasion of Southwestern IRE Conference. Mr. Sterling indicated that if a new color television system is perfected, dual standards are "always a possibility"

Washington Award

E. H. ARMSTRONG, professor of electrical engineering, Columbia University, has received the Washington Award for 1951 "for outstanding inventions basic to radio tansmission and reception and notable service to his country". Administered by the Western Society of Engineers, this engineering honor was founded in 1916. There have been 28 recipients, the first being Herbert Hoover in 1919. This is the first time the award has been made in the field of radio.

E. H. Armstrong

Autoradiography Course Available

A COURSE in the theory and techniques of autoradiography will be held this summer by the Special Training Division of the Oak Ridge Institute of Nuclear Studies. George A. Boyd will direct the course, which will begin on July 2 and continue for from three to four weeks.

Subjects to be covered in lectures and laboratory sessions will in-

GU4 THREE SPEED PHONOGRAPH UNIT

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This is the G.U.4 Phonograph, incorporating the B.S.R. 'Rotocam' instantaneous speed change . . . 78, 45 and 33⅓ R.P.M. at the turn of a switch.

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clude: theory of the photographic process; reaction of ionizing particles with photographic emulsions and the interpretation of results; and techniques of making gross and microscopic autoradiograms, including special histological procedures, such as freeze-drying, carbowax embedding and smearing of cell suspensions on emulsion surfaces.

The course is intended for professional research workers who will direct research employing autoradiographic techniques. Applicants must have completed the basic radioisotope techniques course given by the Institute or possess equivalent experience in the use of radioisotopes in medical or biological research. Twenty individuals from the medical and biological sciences will be accepted for the course.

Lecturers and laboratory leaders will include: Julian Webb and John Spence of Eastman Kodak Co.; Robert Dudley of MIT; Margaret Holt of New England Deaconess Hospital; C. P. Leblond and Rita Bogorach of McGill University; L. F. Belanger of University of Ottowa; S. R. Pelc of Hammersmith Hospital, London; Agnes Williams of University of New Mexico; and Harvey Blank of University of Pennsylvania.

Registration for the course will be $25.00. Additional information and application forms will be available at a later date from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

MEETINGS

JUNE 4–7: 1951 RTMA Convention, Stevens Hotel, Chicago.

JUNE 18–22: ASTM Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City.

JUNE 20–22: IRE 7th Region Conference, U. of Washington, Seattle, Wash.

JUNE 25–29: AIEE Summer General Meeting, Royal York Hotel, Toronto, Canada.

AUG. 15–18: 1951 APCO Conference, Everglades Hotel, Miami, Florida.

AUG. 20–23: AIEE Pacific General Meeting, Multnomah Hotel, Portland, Oregon.

AUG. 22–24: Seventh Annual Pacific Electronic Exhibit and West Coast Annual IRE Convention, San Francisco Civic Auditorium, San Francisco, Calif.

AUG. 28–SEPT. 8: Eighteenth British National Radio Show, Earls Court, London, England.

SEPT 10–14: Sixth National Instrument Conference and Exhibit, sponsored by Instrument Society of America, Sam Houston Coliseum, Houston, Texas.

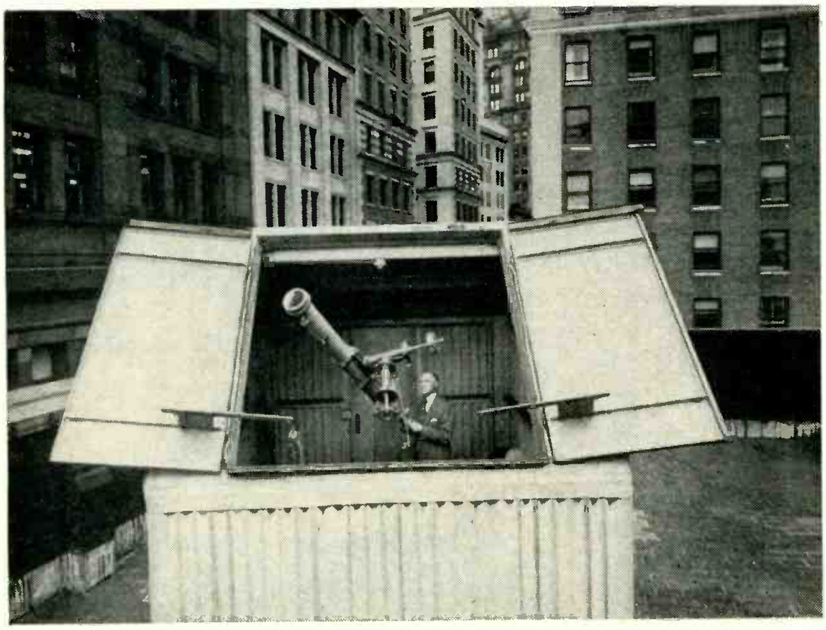
OCT. 8–10: AIEE Conference on Aircraft Equipment, Hollywood Roosevelt Hotel, Los Angeles, Calif.

OCT. 22–24: 1951 National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

OCT. 22–26: AIEE Fall General Meeting, Hotel Cleveland, Cleveland, Ohio.

NOV. 12–15: NEMA Convention, Haddon Hall, Atlantic City, N. J.

FORECASTER OF MAGNETIC STORMS



John H. Nelson, radiowave analyst of RCA Communications, Inc., has discovered evidence of a direct relationship between magnetic storms on earth and the position of planets with respect to each other and the sun. From this observatory atop an RCA building at 25 Beaver St., in the heart of New York's financial district, the scientist has applied this new approach in predicting radio weather months and years ahead

Defense Contract News

Navy:

An $8,500,000 contract for the production of radar equipment for the Navy has been awarded to the Westinghouse Electric Corp., Springfield, Mass. The contract is for search-type radar sets recently designed by Westinghouse electronics engineers at Baltimore, Md., who worked in cooperation with Navy experts.

Several hundred employees are expected to work on the project when it is fully underway, but present plans call for them to be assigned from other departments in the plant. More than half of the radar contract funds will be spent on materials and parts to be furnished by subcontractors and other suppliers.

Air Forces:

A $3,000,000 order for high-precision instruments to be used by the Air Forces has been received by the General Electric X-Ray Corp., Milwaukee, Wisc. Production of the special devices will require the hiring of 200 more employees with-

(continued on p 274)

Wherever these famous airliners fly, a trusted group of friendly guides goes with them, in the form of Sylvania Radio Tubes.

For, the dependability, long life, and splendid performance of Sylvania Tubes have won them top preference with radio and electronics engineers throughout this country, as well as abroad.

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NEW BOOKS

Micro-Wave Measurements

BY H. M. BARLOW AND A. L. CULLEN. *The Macmillan Company, New York,* 1950, 399 *pages,* $6.00.

THE material described in this volume is concerned with measurement techniques developed during the past ten years in the field of microwaves. The presentation is clear, concise, and logical, the rationalized mks system of units being used throughout.

The first two chapters are devoted to the fundamentals of guided waves and the transmission line impedance concept. Basic principles of microwave measurements are presented with a minimum of mathematical derivations and a maximum of physical reasoning. Various graphical representations are thoroughly discussed and practical examples of transmission line calculations are illustrated.

The third chapter stresses the characteristics of cylindrical cavity resonators as tuned circuits and methods for coupling into and out of such resonators.

The next six chapters are engaged in the development of various methods for the microwave measurement of impedance, wavelength, frequency, standing waves, power, attenuation, Q-factor and electrical properties of materials. These methods are suitable to coaxial, waveguide and cavity systems.

The measurement of receiver bandwidth, noise factors, modulation envelope of transmitters, and radiation patterns, gains, impedance and bandwidth of microwave antennas, are discussed in the last

(continued on page 282)

RELEASED THIS MONTH

Electromagnetic Problems of Microwave Theory; H. Motz; Wiley; $2.00.

Time Bases; O. S. Puckle; 2nd Edition; Wiley; $5.00.

Transformers; F. C. Connelly; Pitman; $7.50.

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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Bombs Away

DEAR SIRS:

I HAVE JUST come to the conclusion, after a recent visit to the Windy City (Chicago to you), that what this country needs most is an AN/DJC-(Pilotless Carrier Pigeon, Countermeasures). There is a good project for some genius to work on.

I would still like to see a good article on hi-fi amplifier construction. Surely ELECTRONICS can outdo some of the amateur mags. Most engineers that I know are classical music addicts, and I believe that an authoritative article on a good amplifier would be well received. Incidentally, the Rural Radio Network in New York state has nothing on us. We are a station in the Wisconsin State Broadcasting Service, Non-Commercial, Educational. Two 5-kw a-m stations, six 10-kw f-m stations and two more in construction are all state owned and operated, with nothing but good music and classroom lectures from the University.

F. C. HERVEY
WHKW
Chilton, Wisconsin

Rho Phi Epsilon

Mr. D. G. Fink

ELECTRONICS
330 West 42nd Street
New York 18, N. Y.

DEAR DON:

IN A GENTLY chiding way, you were so good as to call the attention of all and sundry to a regrettable sin of commission in the *Proceedings of the IRE* in relation to the fortunately nonexistent demise of

(Continued on page 290)

HOW BIG IS THE ELECTRONICS INSULATION MARKET?

The insulation manufacturers who supplied the illustrations used here answer that by saying they can't imagine an electronic component that uses none of their products and they claim that some of their products can be found in every piece of packaged electronic equipment no matter what its use.

HOW BIG IS THE MARKET IN VOLUME AND IN DOLLARS?

On those questions the same company is silent. They don't know, although they know it's big in both. They have installed electronic punch-card accounting machines to find out how big. They feel sure that the results will point directly to electronics for increased sales and increased profits. Recently they discovered that one product for which they believed the only market was the petroleum industry is going in quantity to electronic equipment manufacturers.

The important question for you, however, is how to get YOUR insulation products used in electronics. The answer is: Get them designed-in by selling the design engineers on YOUR products' advantages.

Exactly like all other components, materials and allied products used in electronics, every insulation part, material, compound and insulator is designed-in, specified and bought by the electronic design engineers who are, almost without exception, subscribers to, or readers of ELECTRONICS . . . for whom ELECTRONICS is the chief, often the only source of electronic engineering information on insulation products.

Beyond a doubt, ELECTRONICS is the best way to take your insulation products to market in electronics. Many individual advertising sales success stories attest to that. Of the 249 known manufacurers of insulation, more than one third (87) are selling insulation to the electronics market through the sales pages of ELECTRONICS.

THE DIRECT ROUTE TO — — — — — — — A $2,000,000,000 MARKET PLACE

TUBES AT WORK

(continued from page 138)

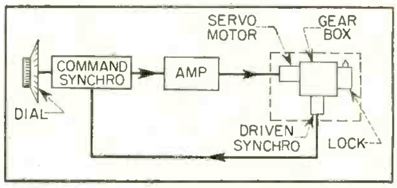

FIG. 1—Diagram of the servo loop used with the vault lock control. The command synchro dial may be remotely located from the safe itself

ents so that cost can be kept to a minimum.

In the arrangement, the shaft on the lock is not connected mechanically to a dial in any way. Instead it receives all information concerning the position of the dial electrically. A servo-type motor provides the energy to turn the shaft in the same direction and at the same rate as the dial, so that at any given time the shaft is in the same position as if it were being rotated manually.

With mechanical connections between the dial and the lock eliminated, it is impossible to sense when the tumblers fall by moving the dial. Moreover, the dial no longer need be placed in front of the vault but instead may be located remotely at any safe convenient point. When the dial is thus removed from the vault, there is no outward indication on the vault to suggest to a burglar where the lock mechanism is located.

The information concerning the position of the dial is supplied to the lock shaft by an electrical system using two synchros, see Fig. 1. The dial is coupled to one synchro, which turns once for each revolution of the dial. Similarly, the lock shaft is coupled to another synchro, also on a 1-to-1 gear ratio. The two synchros are then connected with each other electrically by three wires, so that they can act as references for each other in detecting shaft position. When the two shafts are in the same angular position, the system is in balance and the currents flowing through the connecting lines are balanced and equal. However, if one of the shafts is turned so that the rotors are no longer in alignment, the currents become unbalanced, inducing a volt-

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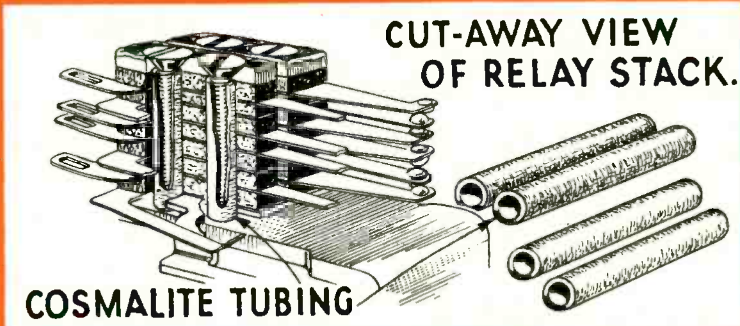

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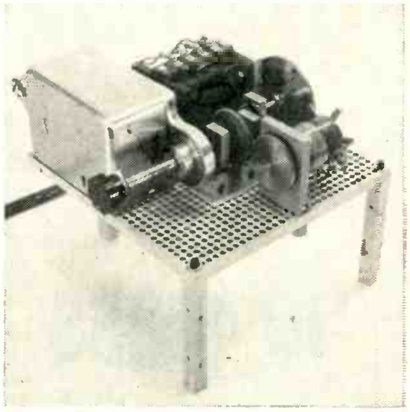
age in the rotor of one of the synchros. The polarity of the voltage indicates the direction the shaft has been turned, and the amount of voltage is in direct porportion to the difference in position between the two shafts.

A servo system provides the necessary power to turn the lock shaft. The induced voltage is amplified then used to control the motor on the vault lock, making it run in the correct direction and the correct amount to wipe out the difference between the position of the lock shaft and that of the dial shaft.

The servo system makes it possible to turn the lock shaft accurately to within a fraction of one percent by moving the dial with extremely small forces. When the last number of the combination is dialed, the servo motor provides the energy to unlock the bolt and pull it back.

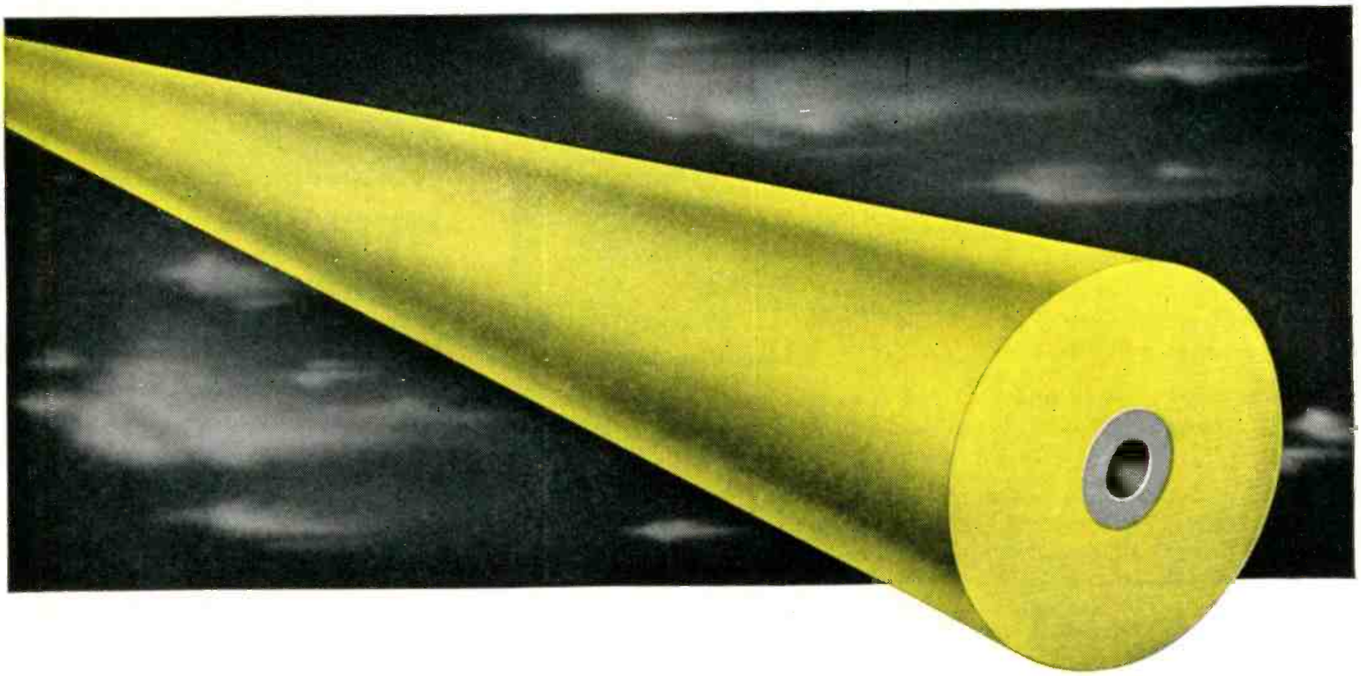


Experimental chassis for safe lock mechanism. Enclosed metal box at left is the lock mechanism. Servo motor to operate lock is at center and driven synchro is at right

The dial can be set up at almost any desired distance from the vault and be placed at any convenient inconspicuous spot. A direct telephone system can then be installed between the man controlling the dial and the person stationed at the vault entrance, and prearranged signals worked out to indicate trouble.

If the man at the vault were held up, he would be unable to open the lock himself, even at the point of a gun, and would have to ask the person in the control room to dial

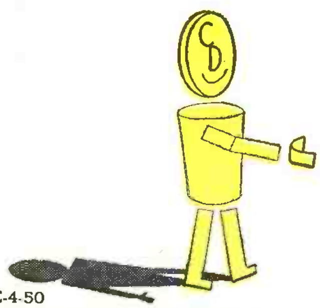
a product of imagination . . .



. . . with an ideal combination of electrical and mechanical properties

By working alongside folks like yourself—at design desks, workbenches, and in laboratories—we've acquired a good idea of the time, care, and imagination you pour into the engineering and production of your products. The thick-skinned insulation tube for an expulsion fuse shown here is a good example. The manufacturer wanted moisture resistance, high strength, weather resistance *plus* excellent arc resistance—all wrapped up in a material that was easy to machine. Working with him, and using a little imagination, C-D engineers came up with *two* different plastics: Laminated Dilecto Tubing for the wall, and Vulcanized Fibre for the core.

It's another example of how you, too, can depend upon C-D to engineer the right laminated plastic for your needs. For C-D has no "axe to grind." We can recommend from five basic plastics subdivided into a remarkably wide range of grades and combinations of grades to supply almost *any combination* of mechanical, electrical, and chemical characteristics. For *this* kind of help and imagination, call your nearest C-D office, any time.



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- 1μV - 31.6 mV and force output
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- 30% am at 1,000 cps.
- 10 mW - 1W audio power

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FM DEVIATION METER TF 934 — Direct reading monitor, 0 - 75 kc.

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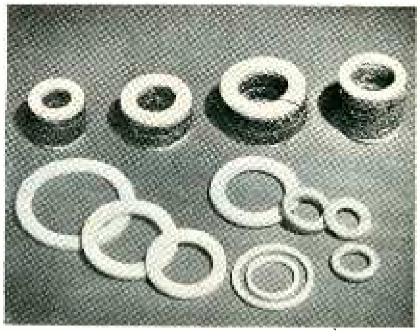

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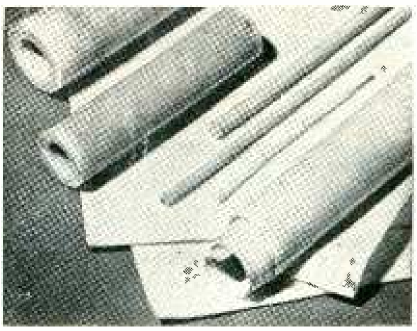
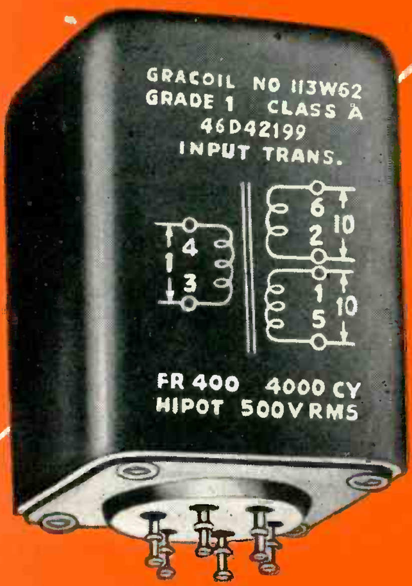


BE SURE YOU'RE RIGHT!

"His simple creed for word or deed
True as the bullet sped—
And rung the target straight:
'Be sure you're right, then go ahead.'"

James Jeffery Roche



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the combination. In making the request he could say the code word or phrase to indicate a holdup. In order to protect the man at the vault, the control man could unlock the vault but at the same time signal for the police.

A typical use of such a system might be in a bank. The dial could be secreted in the office of the president or other designated officer. From this one spot, the officer would be able to control any number of vaults either in the same building or in branch banks miles away through the use of refined telemetering techniques. Both wire and wireless telemetering are available for remote control.

On installations in which the control dial is only a few hundred feet from the vault, the problem of interconnecting the wires is simple. Precautions should be taken to protect the wiring.

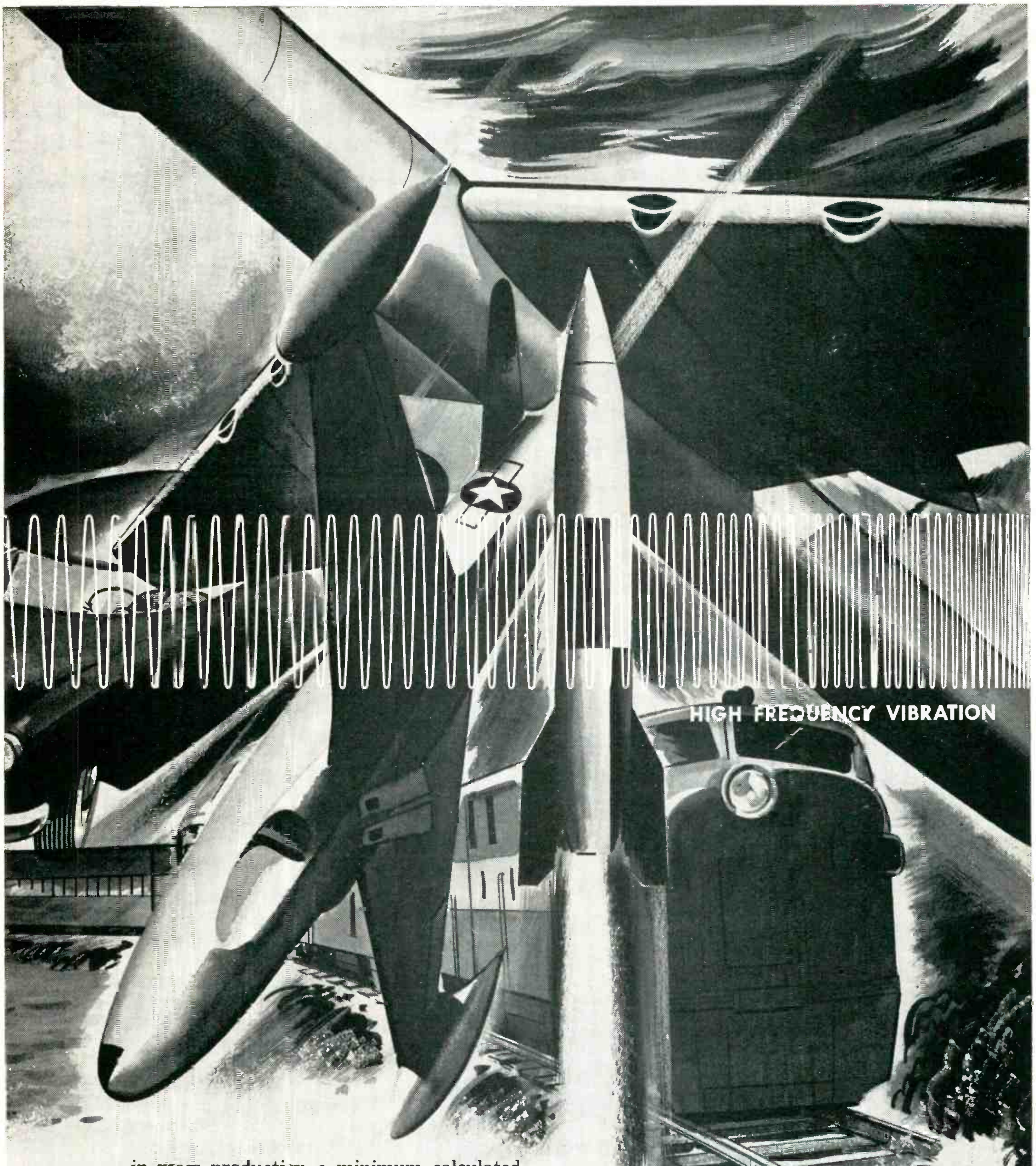
Cutting the connecting wires will not affect the operation of the lock mechanism, unlike a burglar-alarm system, which cannot work when the wires are cut. In order to profit from cutting the wires of the electronic lock control, a burglar would have to have a duplicate synchro and connect it to the three cut wires in the proper order and he would still have to know the combination of the lock and open it by remote control.

Submarine Telephone Cable With Submerged Repeaters

By J. J. Gilbert
Bell Telephone Laboratories, Inc.
New York, N. Y.

A NEW type submarine telephone cable system was installed between Key West, Florida, and Havana, Cuba, in April of 1950, comprising cables No. 5 and 6 of the Cuban-American Telephone and Telegraph Company.

Included within the armor of the new submarine cables are electron-tube repeaters designed to pass through the cable-laying machinery during normal laying procedure. The repeaters are designed so that they should not require servicing for the purpose of changing defective



in mass production a minimum calculated risk.

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FIG. 1—Submarine cable repeater being taken off cable ship after laying tests

circuit elements or electron tubes over a period of about 20 years.

The repeater appears as a bulge in the cable about three inches in diameter and tapers off in both directions to the cable diameter of a little over an inch. Total length of the expanded cable diameter is about 35 feet. The repeater was designed to be flexible enough in the cable so that it can follow the curvature of the brake drum and the sheaves in the laying gear on the cable ship. Figure 1 shows a repeater with stub cables.

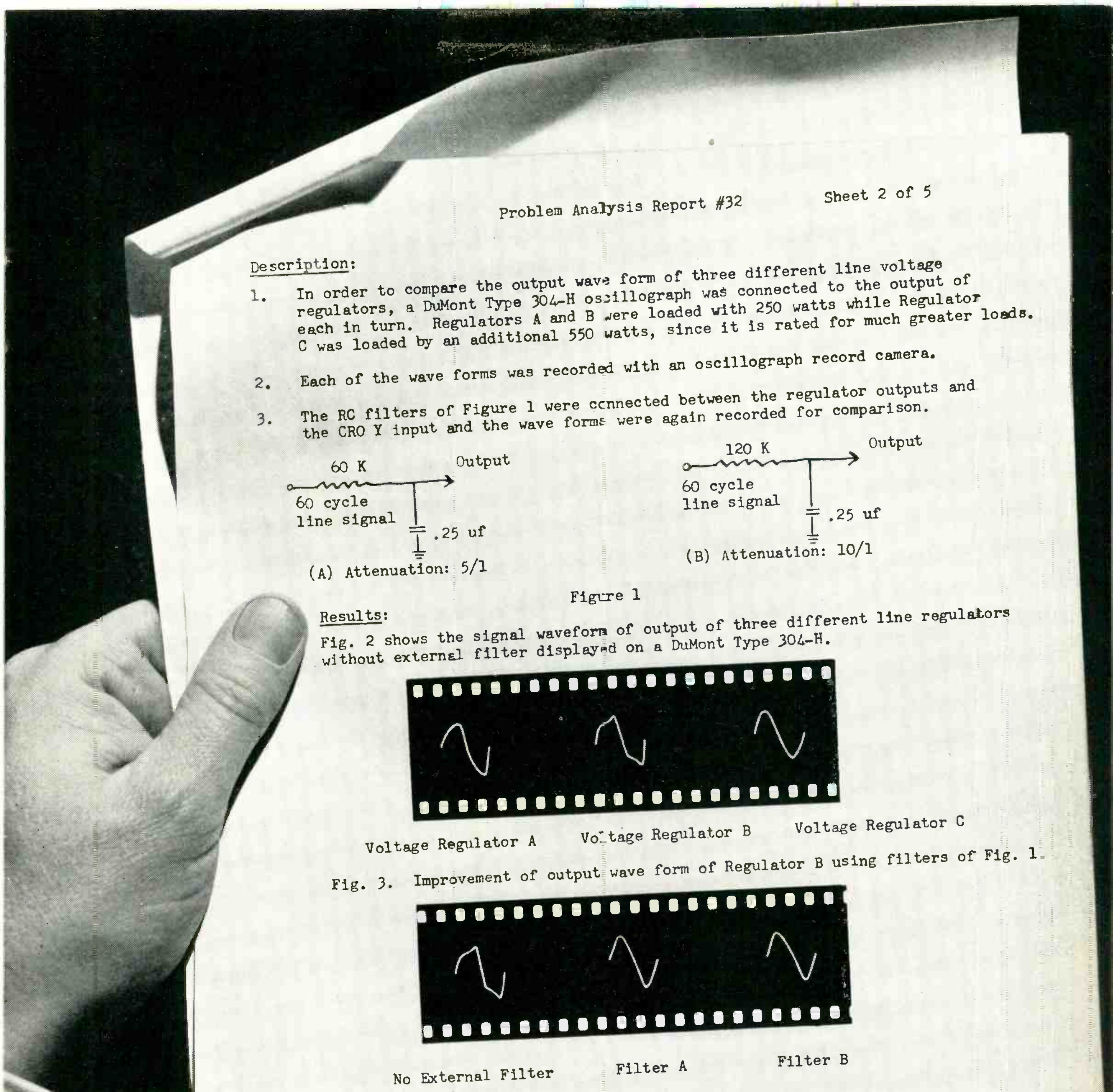
The first three submarine cables between Key West and Havana were laid in 1921[1] and, in 1930, cable No. 4 was installed[2]. After World War II, when demand for circuits to Havana continued to grow, it was decided to use the submerged repeater in cables No. 5 and 6.

Repeater Requirements

Because the stretch of water between Florida and Cuba reaches a depth of 6,000 feet in some places, the first major requirement of a submerged repeater is that it must be able to withstand the high hydrostatic pressures encountered in waters of this depth.

A second important requirement is that the operation of getting the repeater overboard from the cable ship should not slow up the functioning of the laying process. As previously mentioned, this requirement was met by making the repeater structure flexible, within practical limits, and as small as possible in diameter so that it could pass around the drum and sheaves of the laying gear like any ordinary length of cable.

From operating and commercial points of view, a third requirement



Problem Analysis Report #32 Sheet 2 of 5

Description:

1. In order to compare the output wave form of three different line voltage regulators, a DuMont Type 304-H oscillograph was connected to the output of each in turn. Regulators A and B were loaded with 250 watts while Regulator C was loaded by an additional 550 watts, since it is rated for much greater loads.

2. Each of the wave forms was recorded with an oscillograph record camera.

3. The RC filters of Figure 1 were connected between the regulator outputs and the CRO Y input and the wave forms were again recorded for comparison.

60 K Output
60 cycle line signal .25 uf
(A) Attenuation: 5/1

120 K Output
60 cycle line signal .25 uf
(B) Attenuation: 10/1

Figure 1

Results:

Fig. 2 shows the signal waveform of output of three different line regulators without external filter displayed on a DuMont Type 304-H.

Voltage Regulator A Voltage Regulator B Voltage Regulator C

Fig. 3. Improvement of output wave form of Regulator B using filters of Fig. 1.

No External Filter Filter A Filter B

Photography makes a sine wave's signature indelible

The oscillograph traces analyzed in this report leave no doubt as to results. Every detail of wave form is captured by photography for quick, accurate reference. A similar test need never be set up again because of inaccurate drawings or faulty memory.

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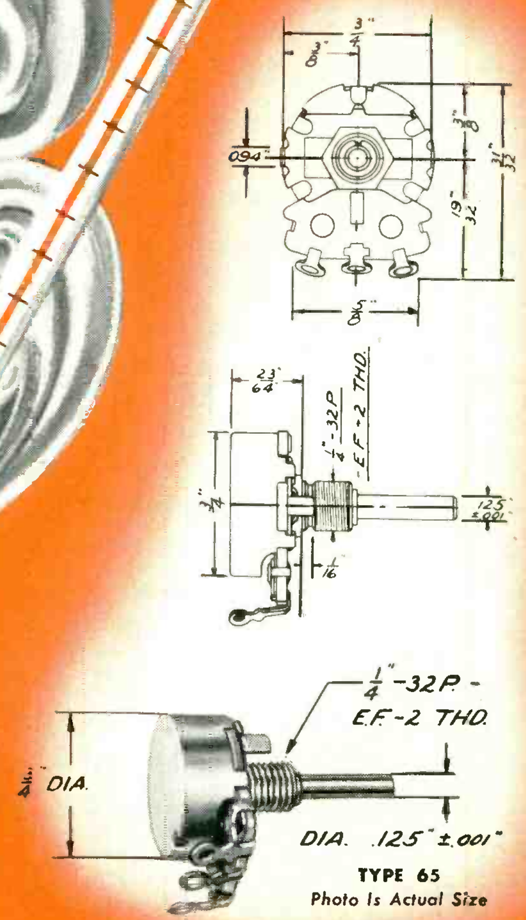
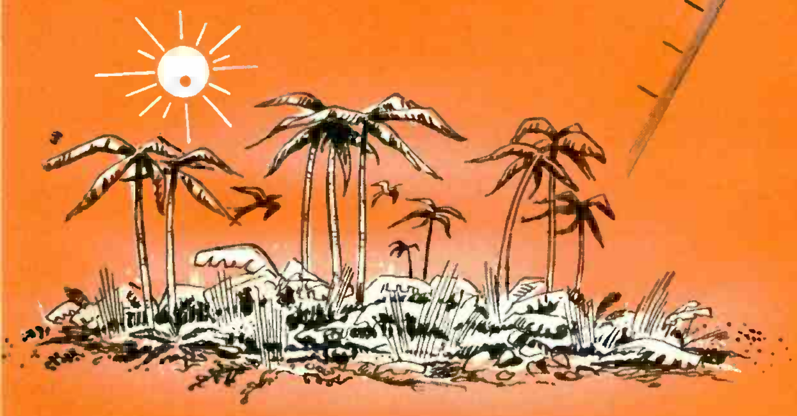


TYPE 65
Photo Is Actual Size



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RA 20B	GC-252	(with switch)	2
RA 25A	25	(without switch)	3
RA 25B	GC-25	(with switch)	3
RA 30A	25	(without switch)	4
RA 30B	GC-25	(with switch)	4

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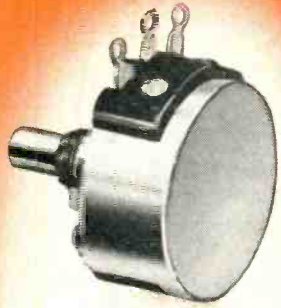

JAN Type RA 20A
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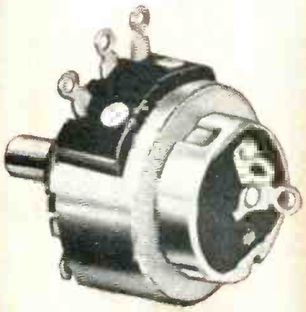

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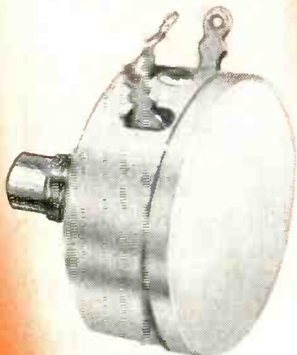

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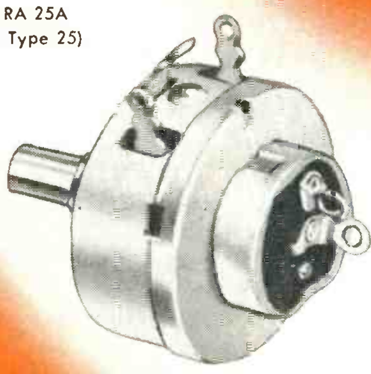
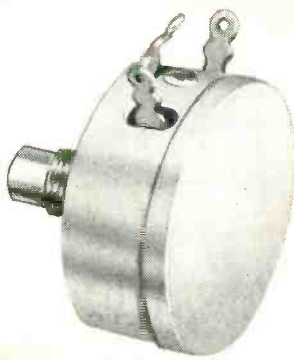
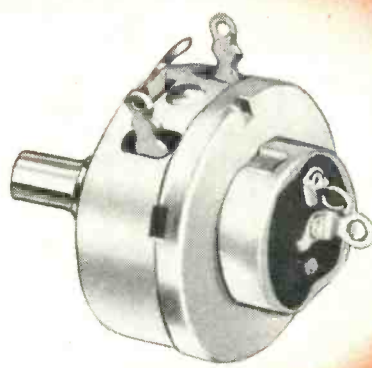


JAN Type RA 25B
3 Watt (CTS Type GC-25)



JAN Type RA 30A
4 Watt (CTS Type 25)



JAN Type RA 30B
4 Watt (CTS Type GC-25)

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A COMPLETE LINE OF VARIABLE RESISTORS (COMPOSITION AND WIRE WOUND) FOR MILITARY APPLICATIONS:

Specialists in Precision Mass Production of Variable Resistors

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is necessary, that the circuit elements of the repeater should be designed for long life under operating conditions to assure freedom from trouble or replacement of parts over a period of 20 years or more. This considerable period of trouble-free operation is desirable because of the expense of a cable-repair operation. Long life of the circuit elements presents an especially difficult problem when the space available for the elements must be minimized in order to keep the repeater diameter small.

Still another requirement relating to circuit elements is one of ruggedness. When laying cables in deep waters, the cable is often under a tension of several thousand pounds and the delicate elements of the repeater may be subjected to dangerous shocks.

Lastly, the armor unlays somewhat as a consequence of the cable tension and, as a result, twist and elongation are imposed on the interior structure, either coaxial circuit or repeater housing. The repeater housing is much more susceptible to damage from this cause than the cable circuit.

Repeater Housing

Design of the repeater housing and of the end seals, the means by which the cable enters and leaves the housing, was influenced largely by the requirements of flexibility and watertightness under ocean-bottom pressures.

The housing consists of a long tube of soft copper, 1¾ inches in diameter and 0.03 inch thick, internally supported against collapse under pressure by an assemblage of abutting steel rings, each ¾-inch wide. The housing is made rigid by means of thinner steel rings of the same width overlaying and staggered relative to the thicker rings.

The housing can be bent to a radius as small as three feet without undue distortion to the copper envelope. When sealed at the ends, the structure is capable of withstanding pressures as high as 10,000 psi.

The insulated conductor of the cable is fed into each end of the housing by means of a series of seals. The glass-metal-type inner or

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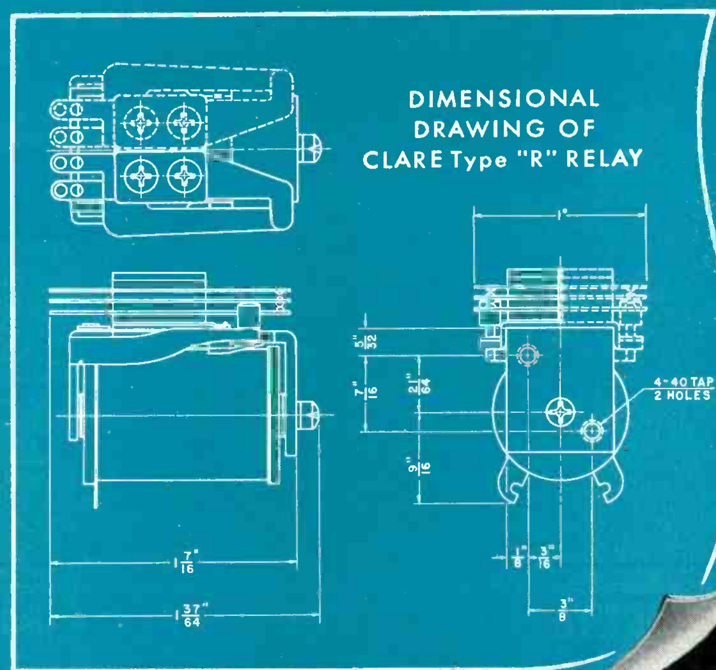
the Type "R" combines extremely small size with unusual sensitivity and long life



SPECIFICATIONS

SIZE
Length: 1⅞₁₆″—Height: 1³⁄₆₄″—Width: 1″

WEIGHT
Approximately 2 ounces

COIL
Single or double-wound

OPERATING VOLTAGE
Up to 230 volts d-c

ARMATURE
Single or double arm

CONTACT ASSEMBLY
Form A to C. Maximum of 10 springs in each pileup.

MOUNTING
Two #4-40 tapped holes in end of heelpiece

This new CLARE Type "R" d-c Relay embodies many features of the famous CLARE Type "K" Relay, which was the first to combine the advantages of a telephone-type relay with the small size, light weight and resistance to vibration required to meet the rigid demands of aircraft service.

In appearance, the Type "R" resembles the Type "K", but, through hardly noticeable structural differences, CLARE has given the new Type "R" even greater sensitivity and operating range. Both relays use the same contact springs, but the Type "R" coil is longer and of larger diameter, to provide greater winding space. Life expectancy of the new relay has been not only increased but multiplied.

The CLARE Type "R" Relay retains in an improved form the reed armature suspension which discerning engineers have come to recognize as one of the subtler reasons for the superior performance of CLARE Type "K" Relays over other relays of comparable size and somewhat similar appearance.

The Type "R" is available as either an open or hermetically sealed relay. Clare sales engineers are located in principal cities to give you firsthand information on this new relay and to cooperate with you on any complex relay problem. Call them or write to C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

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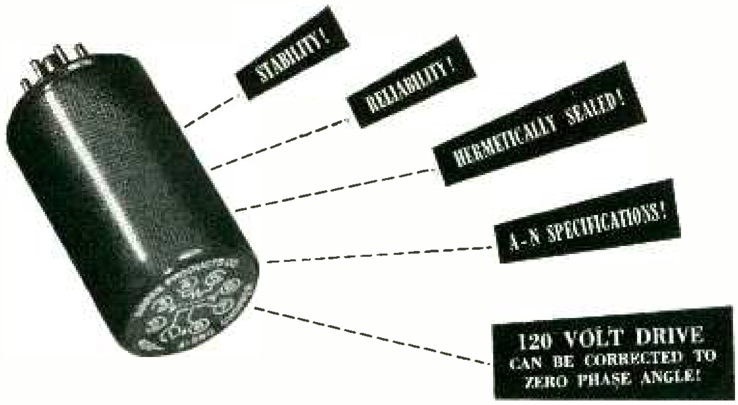

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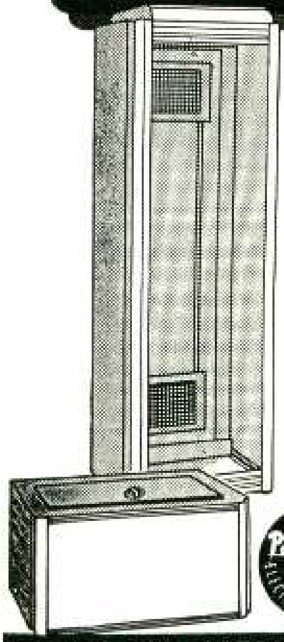

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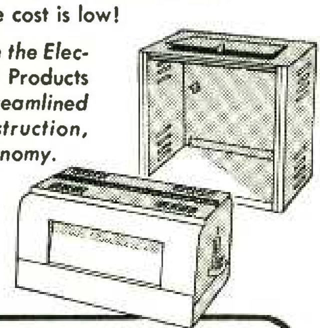

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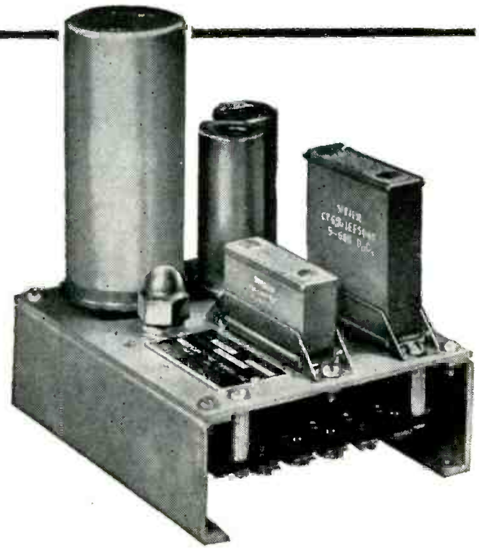

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vapor seal is capable of withstanding hydrostatic pressures. The next seal is made of a central brass tube and an external brass member, both vulcanized to rubber, which joins the insulating material of the cable.

The seals are coaxial in form with the outer member brazed to the housing or an extension of it. A close-fitting tube of copper extends over the cable insulation for a distance of about seven feet and is brazed to an extension of the copper envelope of the housing. The tube is filled with vistac and sealed at the distant end with a neoprene sleeve which joins firmly to the cable insulation and the core tube.

Corrosion protection layers and a bedding for the armor wires, built up in the form of a taper, are provided for the repeater housing and core tube. The armor consists of a continuation of the cable armor wires with additional wires interspersed because of the larger diameter of the repeater.

A second layer of wires with a direction of lay opposite to that of the main armor is employed to prevent twisting of the container due to the unlaying of the armor wires under tension. The repeater may be armored either as part of the cable or separately, with a stub on each end, and spliced into the cable.

Repeater Circuit

The main problem in designing the repeater circuit was to package the elements involved in a high-gain electron-tube amplifier in the restricted space available. The complete amplifier is made up of an assembly of composite lucite cylinders, each about five inches long, with successive units joined together by a spring assembly. Each lucite cylinder contains the related electrical elements of one particular part of the repeater circuit.

Groups of smaller elements are rigidly mounted in a lucite form which slides into an insulating envelope made up of two close-fitting lucite shells held in place by end pieces of lucite. Electrical interconnection of the various parts is made possible by eight copper tapes laid in axial slots between the shells and extending over several sections they

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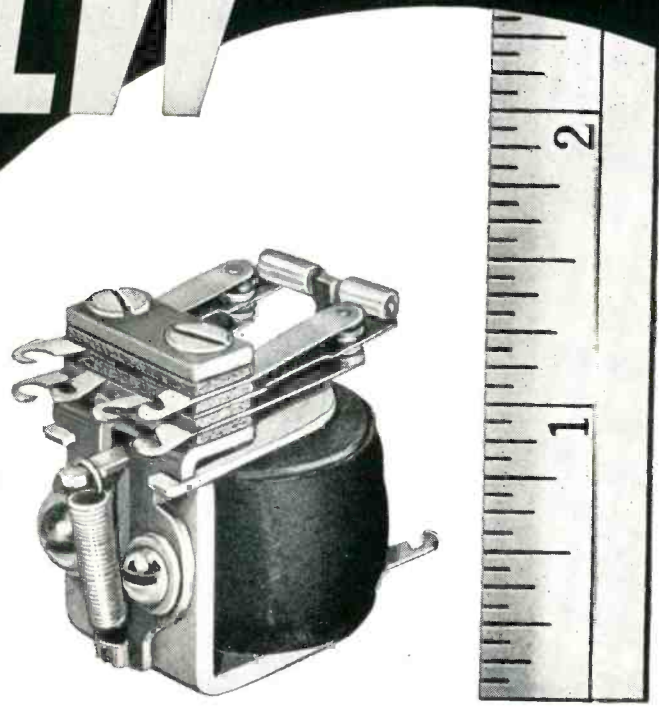

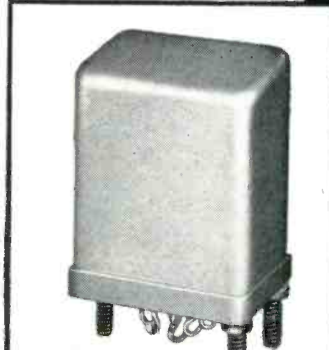

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SENSITIVITY: D.C. 0.7 watts D.P.D.T. (0.1 watt in special applications)
A.C. 3 volt-amperes (operating range: 80% to 110% of nominal voltage)

COIL: Available for A.C. or D.C.

HEAT RISE

D.C. 50°C Rise—2 watts
85°C Rise—3.5 watts

A.C. 45°C at nominal voltage
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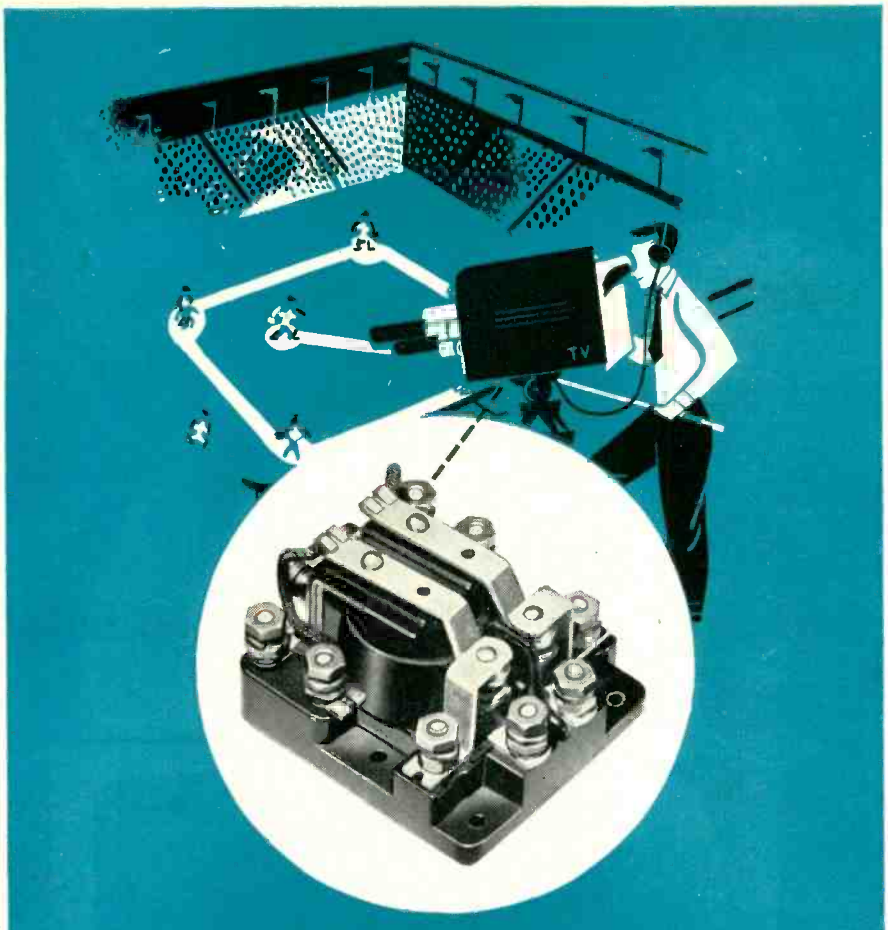

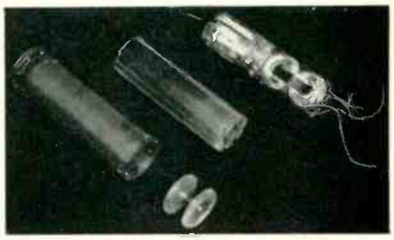

FIG. 2—One of the typical sections of the cable repeater

where necessary. A representative assembly is shown in Fig. 2. The complete assemblage is 84 inches long and contains 15 sections.

Circuit Elements

As far back as 1933, work was begun on an electron tube suitable for use in a submerged repeater. Early models of the tube, a suppressor-grid pentode with indirectly-heated cathode, had been operated on continuous life test for as long as ten years.

Spacings between electrodes in the tube are relatively large in order for the tube to be able to withstand the shocks of cable laying. Unusual care was taken in manufacture to be certain of solid welds and to avoid the presence of loose particles. Rigorous inspections were made on all tubes during the various stages of assembly.

Selection of tubes for use in the cable was based on a comprehensive examination of all details in the history of each tube as well as the group of tubes in which the individual tube was manufactured. All tubes were aged several thousand hours before the preliminary selection. Other tubes from the same production group were life tested several thousand hours more to establish the quality of the group.

It was decided at the beginning to power the repeaters by direct current fed from land over the cable conductor. Plate and grid potentials would be furnished by the tube heaters connected in series. These factors were important in setting the nominal power requirements for the tube, about $\frac{1}{4}$ amp at 20 volts for the heater supply and 40 to 60 volts for plate potentials.

Attention had to be given to life of other circuit elements, even though the electron tube is usually


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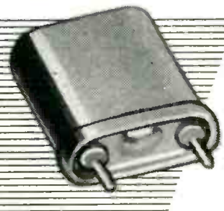
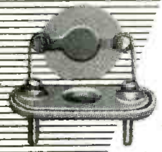


The electronic industry is progressing with seven league strides. Probably no segment of this industry has made greater progress than that accomplished in the design and manufacture of crystals.

Stabilized, metal plated and wire mounted crystals of today are far superior in stability and precision.



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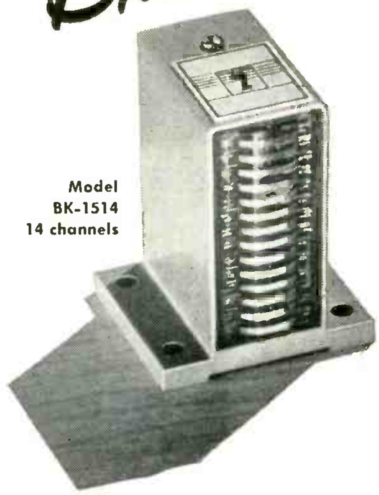

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Field Trials

Over a period of years, many simulated laying tests were conducted in the laboratory, including

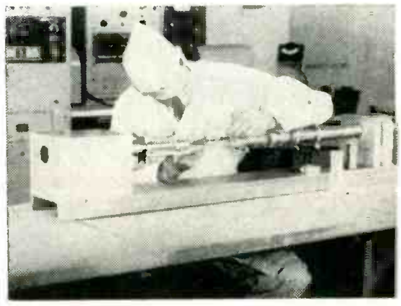

FIG. 3—Repeater assembly operation in the laboratory

as far as possible all aspects of the laying operation. Tests were made to determine the effect, if any, of the laying operation upon electrical transmission characteristics of the cable. Other tests were made to determine whether any unexpected effects would be encountered because of immersion of the cable in water.

A deep-water test of the repeater cable was made in the Bahamas in 1948 using the cable ship Lord Kelvin. Cable lengths up to 15 nautical miles with repeaters were laid in depths of water up to two nautical miles. Several repeaters were laid, measured while on the ocean bottom and then hauled back up again, involving much more severe treatment than a mere laying operation. Results indicated that the repeaters as well as the cable could

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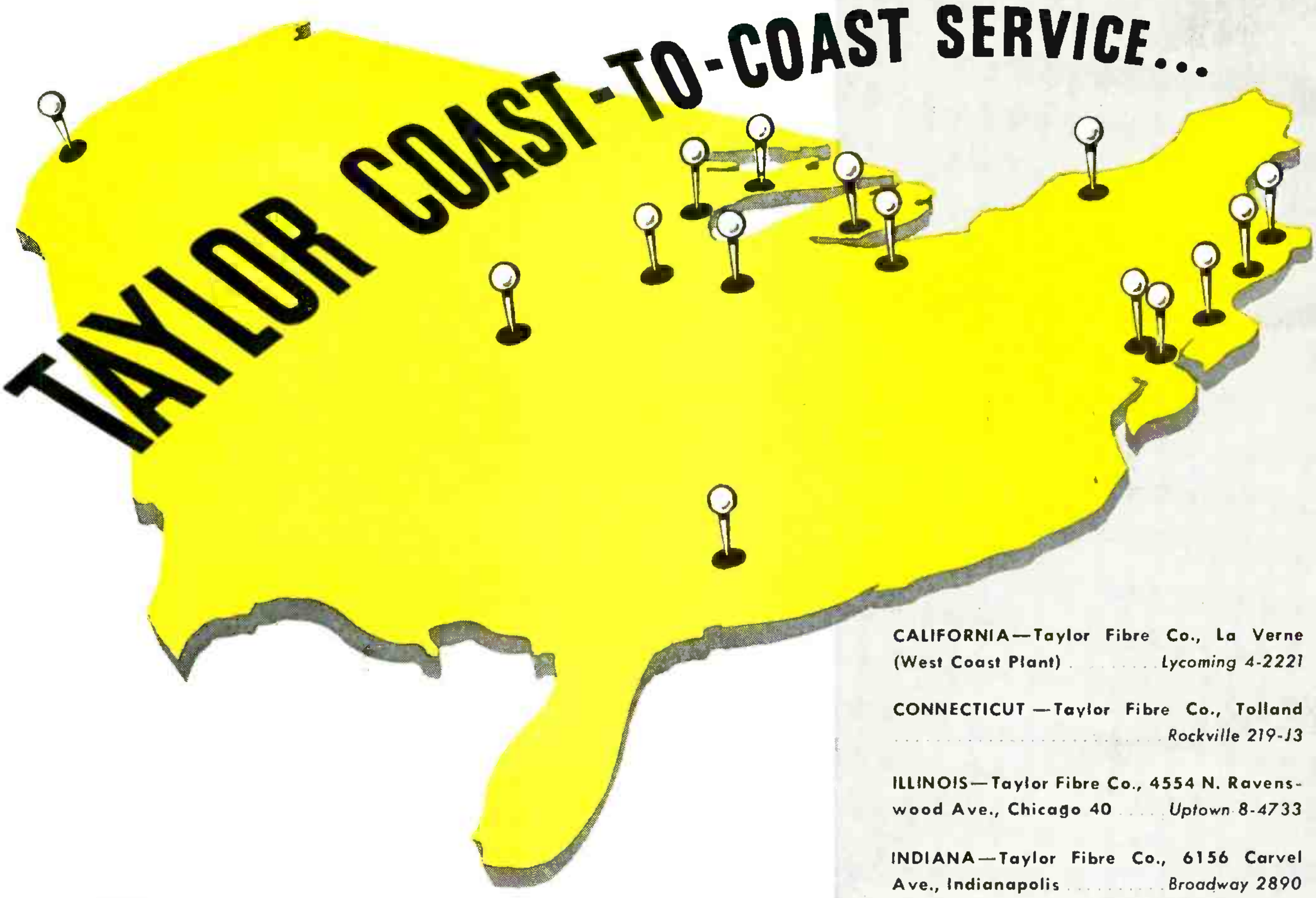

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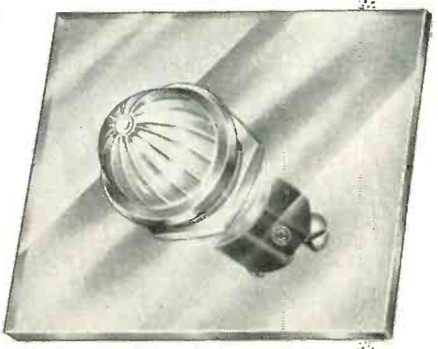

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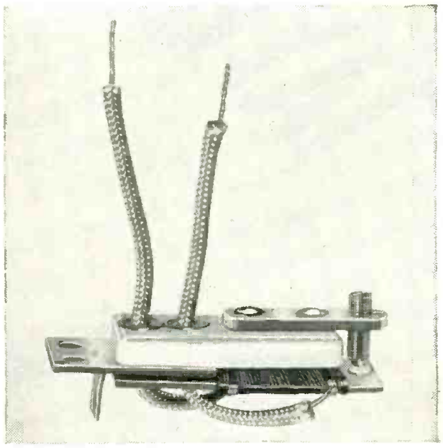

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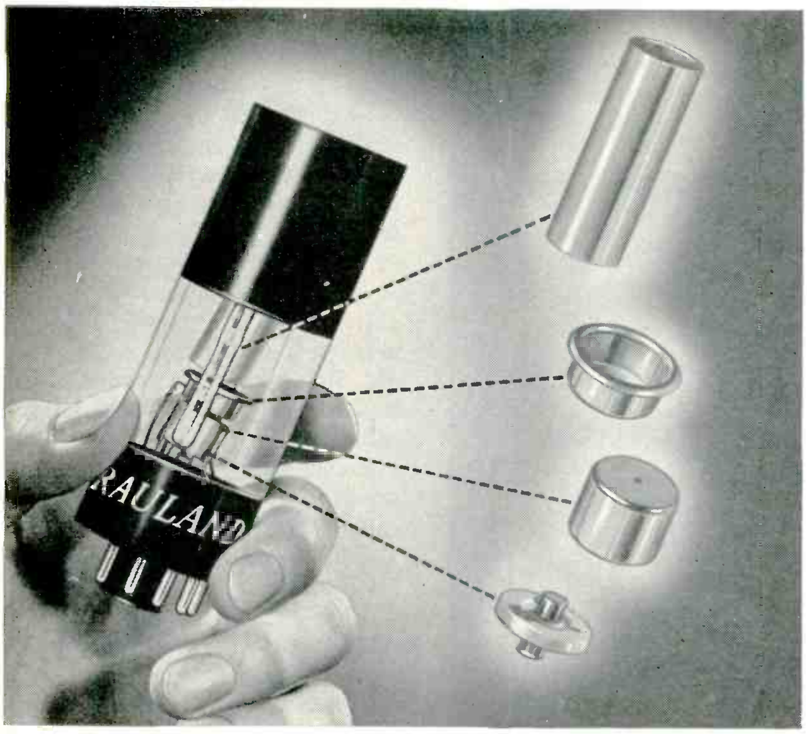

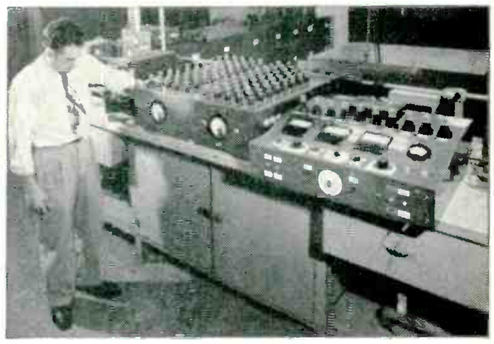

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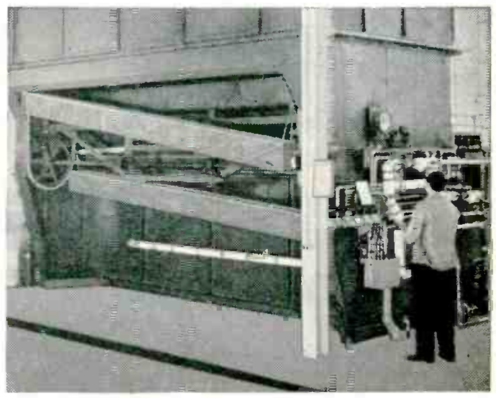

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The electrical circuit of the repeater was designed to get the most out of the long-life electron tube in the way of stability of repeater gain and low modulation while obtaining as much gain as the system would permit. Consequently a unidirectional repeater design was decided upon to obtain the most efficient use of tubes and to simplify the structure.

The circuit employed, shown in Fig. 4, has three stages with negative feedback, giving a gain-versus-frequency characteristic as shown in Fig. 5. The transmission band is from 12 to 120 kc with insertion gain at 108 kc, the top frequency employed in traffic, equal to 65 db. The repeater gain equalizes the loss in about 36 nautical miles of cable.

Each of the two cables transmits in only one direction. The No. 5 cable, which transmits south, is 114.55 nautical miles long. The No. 6 cable, which transmits north, is 124.97 nautical miles long. Each cable has three repeaters spaced about 36 nautical miles apart. Of the six repeaters, two are in a depth of about 0.35 nautical miles and

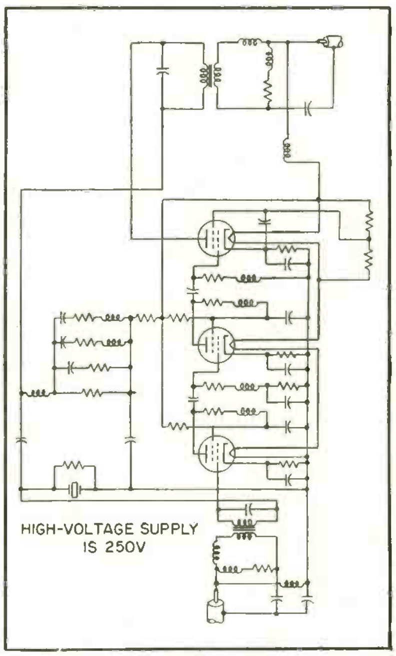
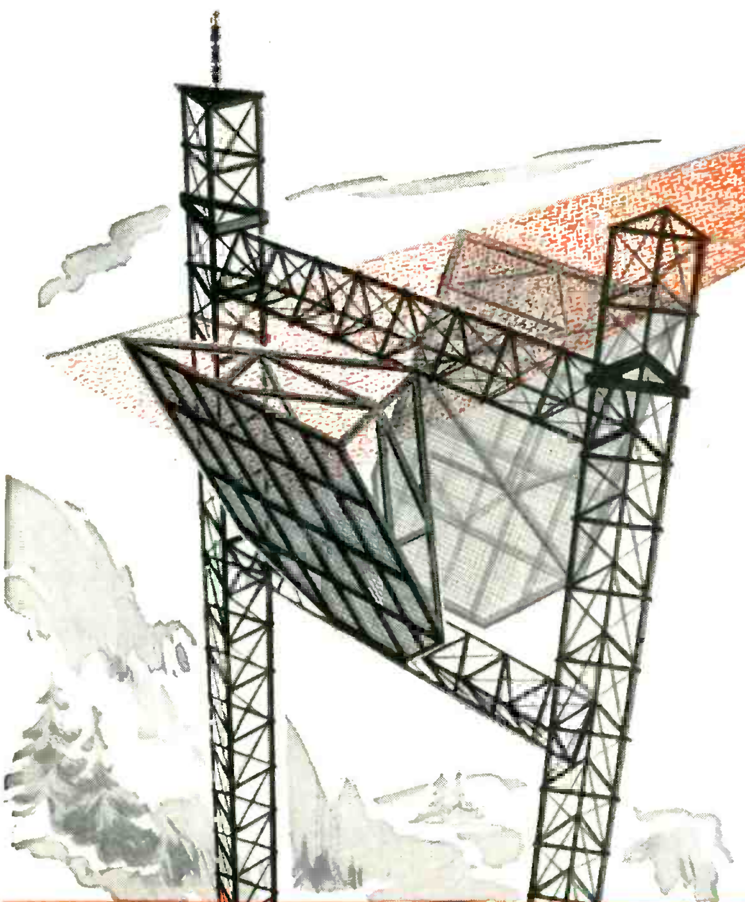


FIG. 4—Circuit diagram of the submarine cable repeater



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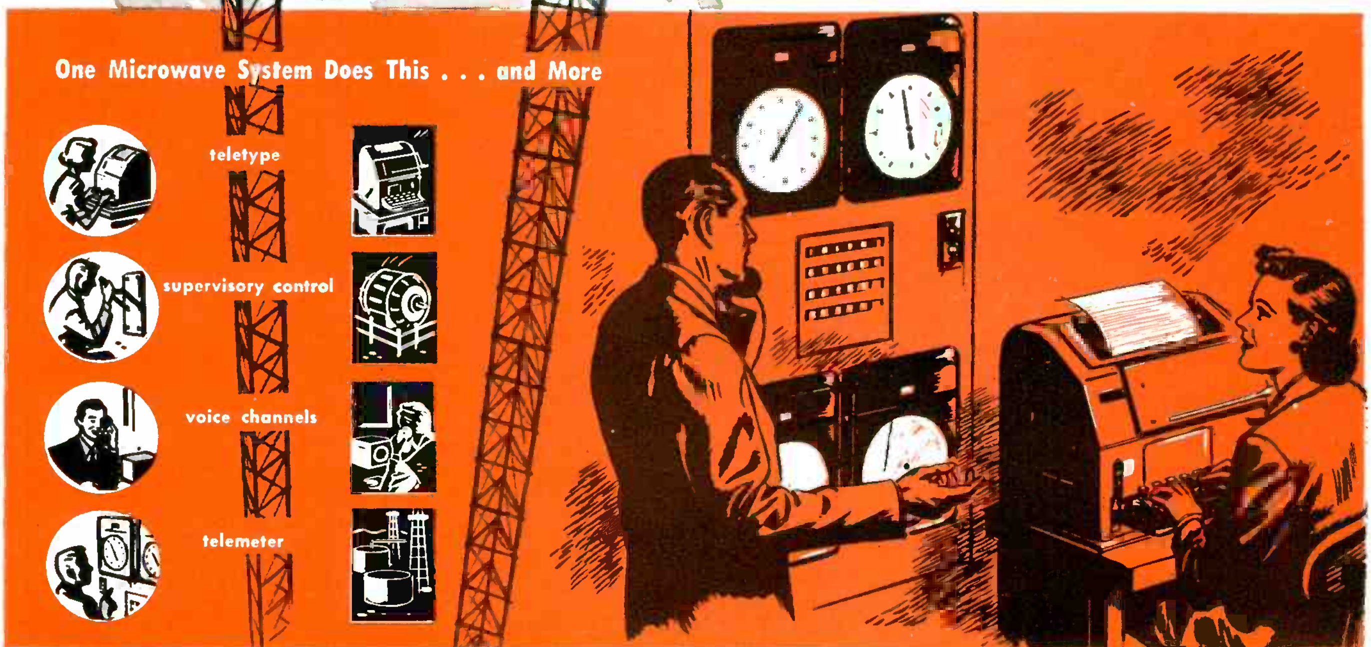

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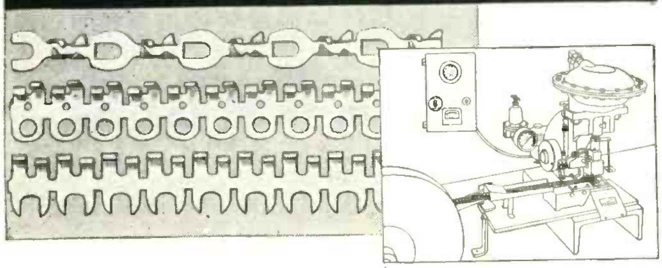

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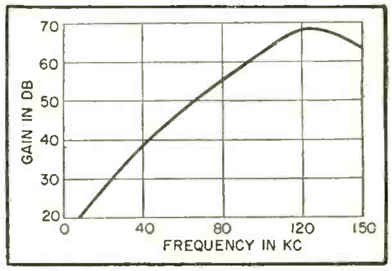

FIG. 5—Gain-frequency characteristic of repeater

two in about 0.9 nautical miles.

The final repeater in each cable is located as close to deep water as possible so that the signal will be strengthened before it enters shallow water and land sections of cable where crosstalk and static noise might be picked up.

The cables are spliced directly to underground cables at manholes near the shore at both ends. The underground cables run in ducts to the terminal equipment at the offices, a distance of one mile at Key West and three miles at Havana. The same coaxial circuit is used for the underground cables as for the submarine cables but the underground cables are provided with electrical protection of helical steel tapes, layers of paper and an overall lead sheath.

There are 24 channels in each cable, with each channel occupying a band of 4 kc. The signal-to-noise ratio for the 24 channels is about the same as for the same length of high-grade carrier frequency circuit on land.

The Cable

As in the case of earlier installations, the cable has a copper return. New features are polyethylene insulation as well as design principles that make the cable circuit less subject to change of electrical characteristics due to laying stresses. The latter feature is important in the case of submerged repeaters because after the cable has been laid it is impossible to adjust the repeater to compensate for changes in cable attenuation during laying. In ordinary cables, this compensation can be taken care of by adjusting the equipment on shore.

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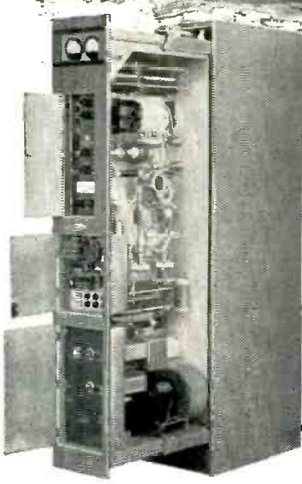

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during manufacture of the cable to avoid undesirable irregularities in transmission characteristics. Because of the wide transmission band, previous schemes used to reduce the effect of variation of impedance among the core lengths would have called for core lengths so short as to seriously increase the number of joints.

Irregularities were minimized by careful control of conductor and insulation diameters and by continuously insulated lengths of the order of 12 nautical miles. These lengths were cut only as was necessary for handling. The shorter lengths were reassembled in insulating order, as far as possible, to assure random addition of reflections due to impedance irregularities.

Structure of the deep sea, or type D, cable is shown in Fig. 6 and 7. The central conductor consists of a solid wire 0.131 inch in diameter on which are laid three copper surround tapes, each 0.0145 inch thick and 0.148 inch wide, closely conforming to the solid wire. The interstices of the conductor are filled with polyethylene.

The return conductor made up of six copper tapes is laid directly on the polythylene insulation. Each type is approximately 0.016 inch thick by 0.241 inch wide, preshaped so that when in place they conform to the surface of the insulation.

Over the return conductor is wound a teredo tape approximately 0.003 inch thick with overlap. Cutched jute, the armor and the outer jute are applied over all. Four types of armor are employed in the cable for use in various depths of water or for special shore conditions.

The cable was manufactured by the Simplex Wire and Cable Com-

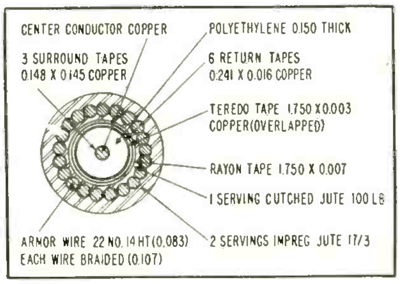

FIG. 6—Structure of the deep-sea, type D, armored cable

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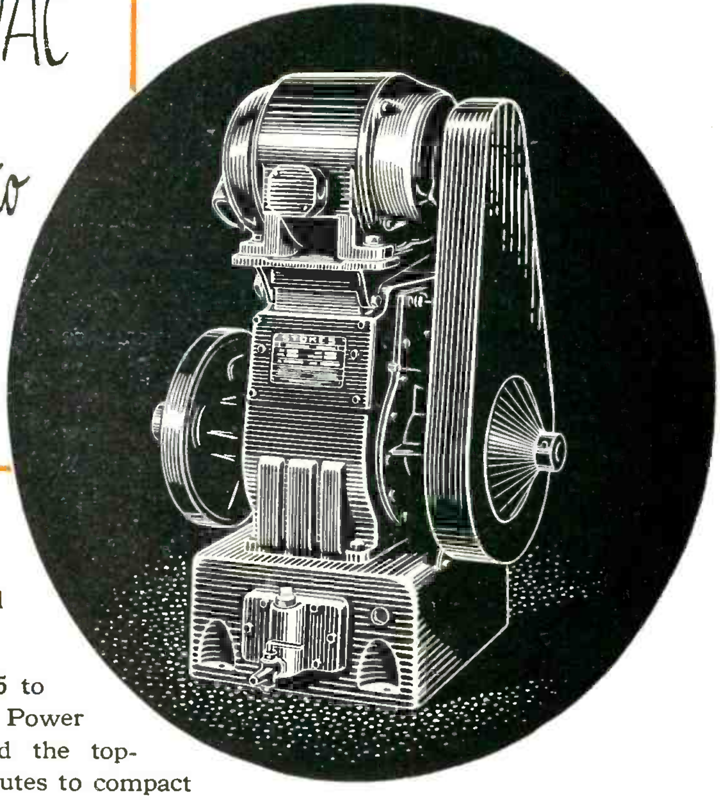

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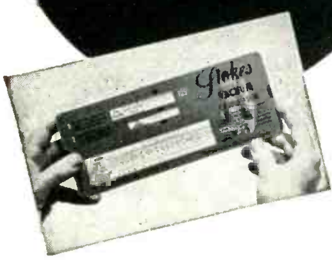

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pany of Cambridge, Mass., and incorporated the results of a cooperative development program conducted by that company and the Bell Telephone Laboratories.

Terminal Equipment

The transmission apparatus at Key West and Havana is mostly standard equipment as employed in land-line carrier systems. The operations involved in combining the 24 voice circuits into one band and then separating them again are also largely conventional.

Special equalizers, power separation filters and an auxiliary amplifier were designed and the standard transmitting amplifier used in the J system was modified to accommodate the lower frequency band.

Each repeater contains a sharply tuned circuit for increasing the gain of the repeater above normal at a distinctive frequency outside the transmission band of the repeater. The gain with reduced feedback of the individual repeaters can be measured with the aid of a loop circuit at Havana by scanning the test frequency region with an oscillator and detector at Key West. This measurement procedure gives an indication of incipient decay of gain of any repeater.

Power for the repeaters is supplied over the cable conductor from Key West. A positive potential of about 250 volts is applied to one cable and −250 volts to the other with a loop connection between the two cables at Havana to complete the d-c circuit. This neutral point is connected to ground. Current in the cable conductors is maintained at 0.23 ampere.

Laying the Cables

Laying of the cables was completed without undue incident by the cable ship Lord Kelvin after modifications were made in the cable-laying gear in order to obtain an additional margin of safety for the repeaters.

The courses laid out for the two cables kept a five-mile separation between the two cables and also a five-mile separation from the nearest of the cables comprising the

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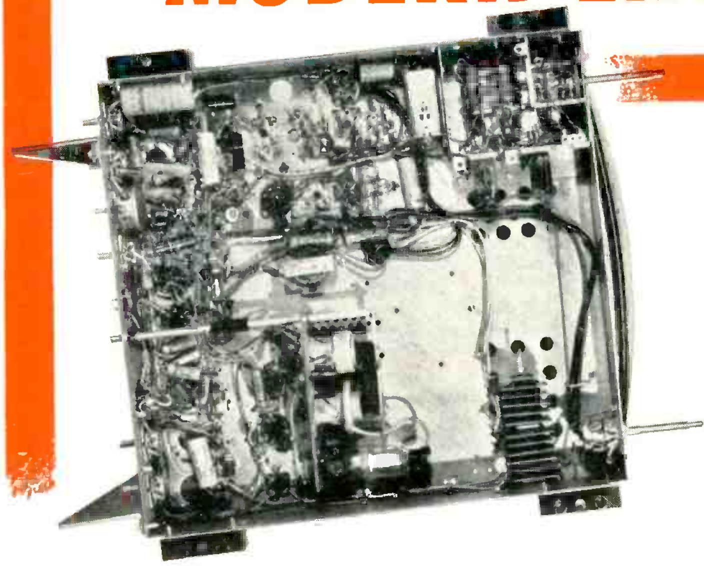

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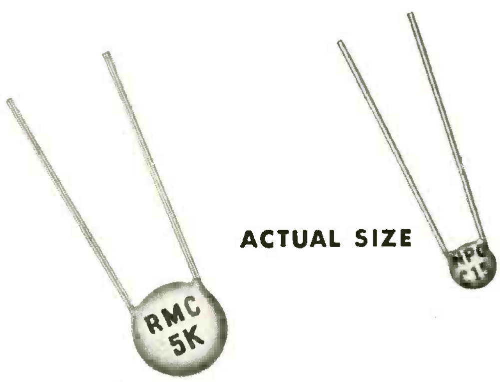

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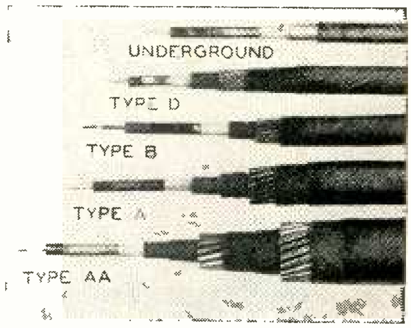

FIG. 7—Cutaway view of construction of deep-sea type cable

Key West-Havana network.

Material in this article has been abstracted from *The Bell System Technical Journal*, January, 1951, page 65.

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(1) W. H. Martin, G. A. Anderegg and B. W. Kendall, Key West-Havana Submarine Telephone Cable System, *AIEE Trans.*, 41, p 1, Feb. 1922.
(2) H. A. Affel, W. S. Gorton, and R. W. Chesnut, New Key West-Havana Carrier Telephone Cable, *BSTJ*, 11, p 197, April 1932.

Filament Protection Circuit

BY JOSEPH F. SWINGLE, JR.
Bartol Research Foundation
The Franklin Institute
Swarthmore, Pa.

THE USE of a vacuum gage tube as a vacuum indicator in a Van de Graaf electrostatic generator necessitates a protection circuit to remove the filament voltage from the tube in the event of vacuum failure. A circuit to do this is shown in Fig. 1.

A standard difference amplifier reads pressure by measuring voltage drop across the grid resistor of a 6SN7. The filament voltage should be removed when the pressure exceeds approximately 5×10^{-3} mm of mercury, corresponding roughly to a current of 50 μa or a potential of 50 v across a 1-megohm grid resistor.

It was decided to use a control circuit which would remove filament voltage at various pressures (voltages). The circuit of Fig. 1 incorporates the previously mentioned features and operates the filament cutout relay at any desired voltage from 0 to +50 v.

The setting of R_1 determines the relay triggering voltage. The total range of control voltages may be

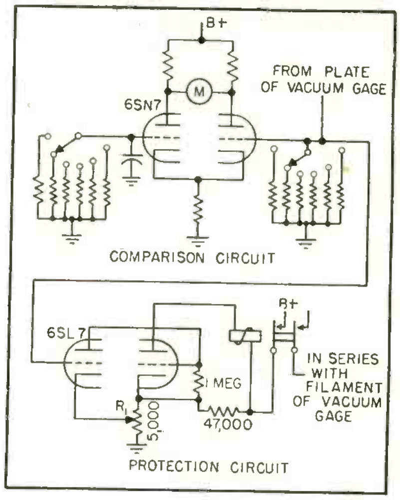


FIG. 1—Schematic diagram of filament protection circuit and comparison circuit. Plate supply may be 100 to 250 v

increased or decreased by changing the value of R_1.

The circuit should have many applications where it is desired to trigger a relay, counter or other device at predetermined input voltages using a minimum of parts.

Emergency Broadcast Pickup Head

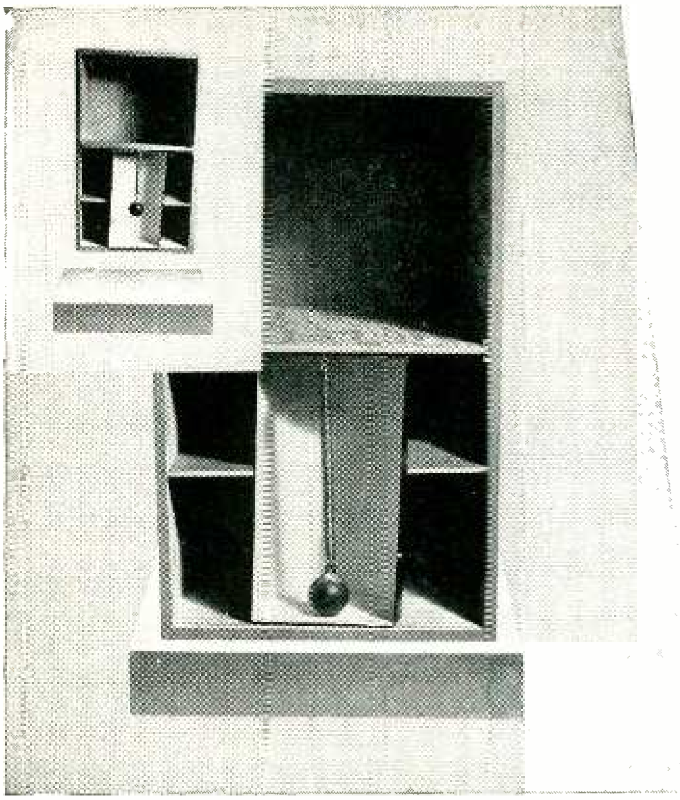
By Antonio Vaccaro
Chief Engineer, WHEB
Portsmouth, N. H.

STUDIOS of most small broadcasting stations are located at some remote point from the transmitter and the engineering staff. The situation at station WHEB is one in which the announcers or a nonlicensed man run the controls and turntables at the studio and the engineers are located out of town.

Whenever trouble occurs on any of the pickup heads, the table is out of order until one of the engineers can get to the studio and make the necessary repairs. Repairs may be delayed for an hour or more during which time the control man has only one table at his disposal.

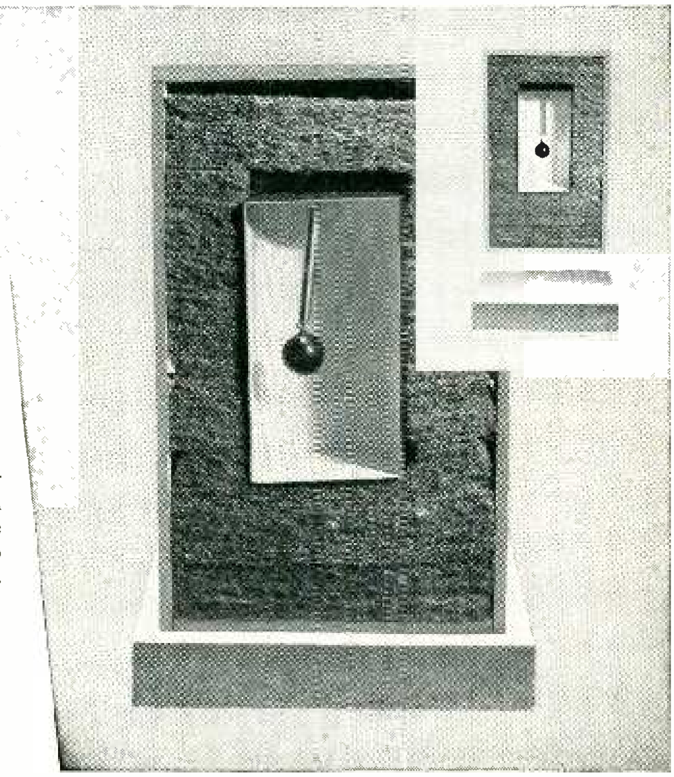
The pickup head and arm to be described can be placed into operation by the control man or announcer in a matter of seconds after trouble occurs on any pickup head.

A pickup arm was made from an old aluminum based transcription disk according to the design shown in Fig. 1. The pattern was cut out with shears, scored and then bent



g's... they ruin your product

Photograph shows how the "g's", generated by a 6 inch uncushioned drop, forced the spring suspended ball clear to the bottom of its container. It's "g's" that tear the heart out of a delicate instrument...with a bang. Inset shows position of ball just before the drop.



Shown at right is the same container cushioned in Texlite. The "g's" of the 6 inch drop were dissipated by the gentle deceleration of Texlite. Note that there was no noticeable downward movement of the ball.

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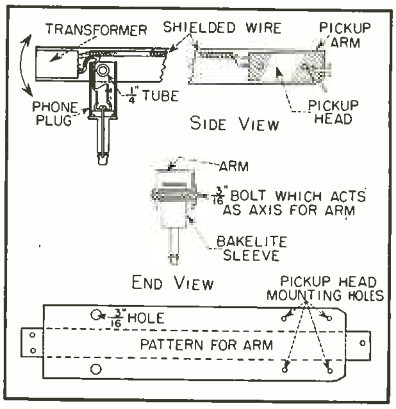


FIG. 1—Mechanical details of the emergency broadcast pickup arm

with the aid of angle irons. The arm was designed to fit around a fairly good crystal pickup head although a magnetic head could be used just as well with a few changes in design.

The only additional parts needed for construction are a UTC model 0-11 ouncer transformer, a phone plug and a jack. The transformer serves the dual purpose of matching the high impedance of the crystal head to the low impedance of the turntable input of the console and also serves as a counter weight for the pickup arm.

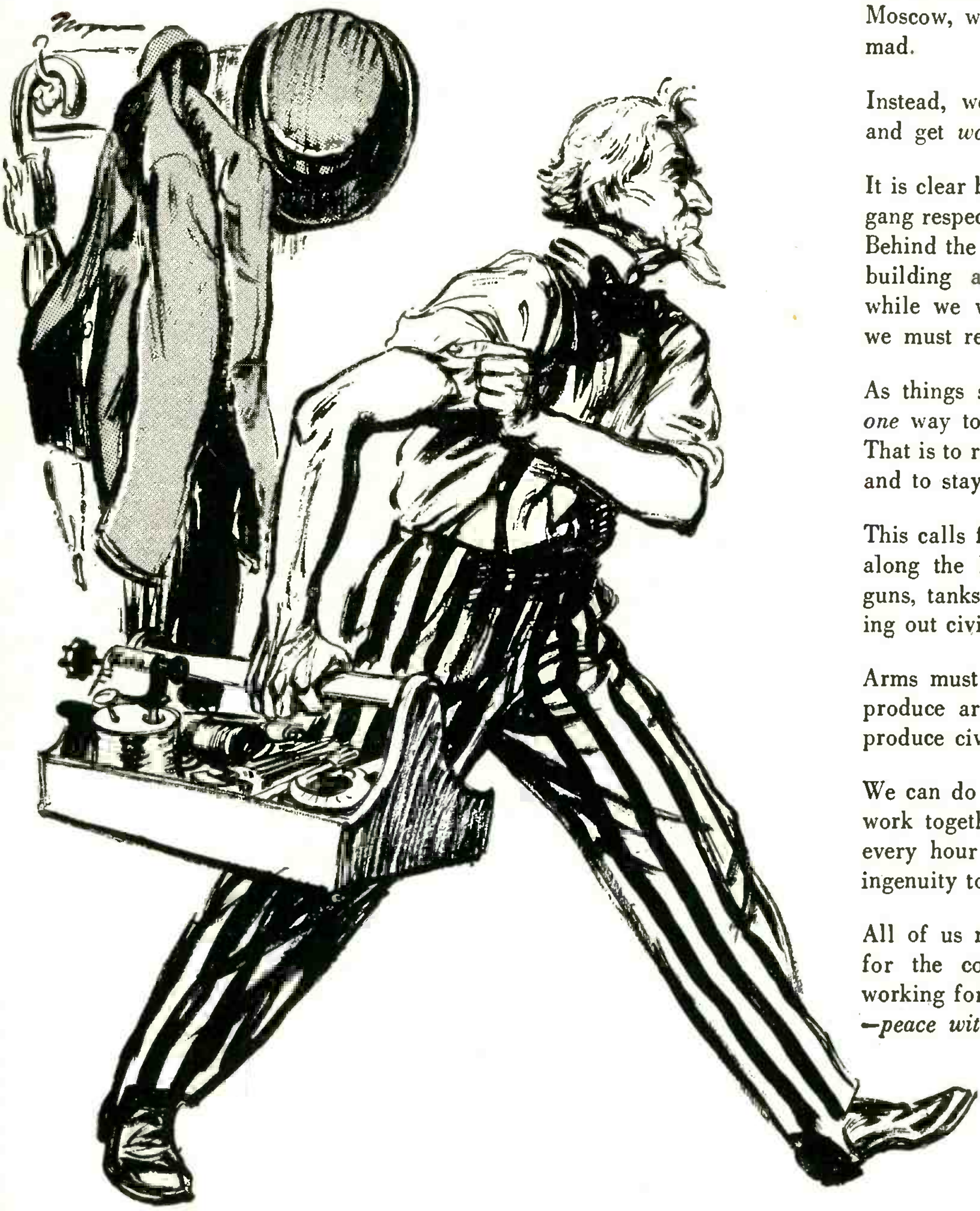
On the finished arm, the phone plug may be mounted approximately 1½ to 2 in. from the tail end of the arm depending upon how much counter weight is desired. The plug is so mounted that it serves as the supporting mount for the arm and, at the same time, allows the head to be raised from or lowered onto the recording.

The head is wired to the high-impedance primary of the transformer and the secondary is wired to the tip and sleeve of the phone plug leaving just enough slack wire to allow the head to be raised and lowered. Whenever trouble occurs with one of the pickup heads, the announcer just has to plug the emergency head into jacks on the turntable.

A closed circuit jack was used which automatically cuts out the regular head from the circuit and places the emergency head into operation. In this way, no mismatch of impedance occurs because of two heads being across the turntable input circuit at the same time.

Some of the construction details

It's time we got *working* mad!



As we listen to the latest insults from Moscow, we're likely to get fighting mad.

Instead, we'd better use our heads and get *working* mad.

It is clear by now that Stalin and his gang respect just one thing—strength. Behind the Iron Curtain they've been building a huge fighting machine while we were reducing ours. Now we must rebuild our defenses—*fast.*

As things stand today, there is just *one* way to prevent World War III. That is to re-arm—to become strong—and to stay that way!

This calls for better productivity all along the line. Not just in making guns, tanks and planes, but in turning out civilian goods, too.

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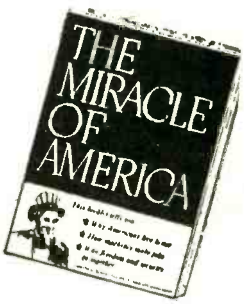

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are as follows: About $\frac{3}{8}$ in. down from the top of the Bakelite sleeve of the phone plug a $\frac{1}{4}$-in. hole is drilled and then reamed out to be just slightly larger than $\frac{1}{4}$ in. A piece of copper tubing is cut off to a length which fits snuggly between the inside surfaces of the pickup arm. The tubing is pushed through the reamed out holes which were drilled horizontally through the Bakelite sleeve of the phone plug. The tube should fit loosely enough so that the arm can be raised or lowered with ease. Next the copper tube is aligned with the 3/16-in. holes on the side of the pickup arm and a 3/16-in. bolt is passed through the entire unit and a nut is affixed tightly. The arm is then complete and the only job remaining is to mount and wire a jack on each table. The jack serves as contact for arm, support and horizontal pivot of arm.

An Improved Telephone Set

A NEW and improved common battery telephone set has been developed by the Bell System. It incorporates technical advances as well as a more functional design making the handset smaller and 25 percent lighter than the existing type. One of the new features is a manually adjustable volume control for the ringer which allows the subscriber to change the loudness over a wide range.

A schematic diagram of the new 500-set is shown in Fig. 1. The main design objective was to obtain acceptable performance over greater distances from the central office or with finer gage cable conductors and, at the same time, use

External view of the handset

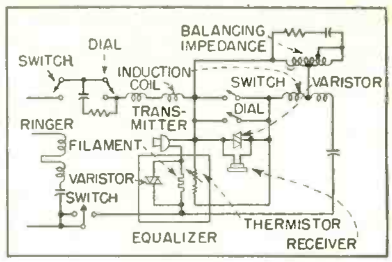


FIG. 1—Schematic diagram of the new 500-set

existing central office facilities.

A second goal was a reduction in variations in transmission between individual users and between stations with wide variations in distance from the central office.

Automatic change in performance to obtain the maximum usable increase in transmitting and receiving volume on long loops has been achieved by the use of an automatic transmission equalizer. The inserted loss characteristics of the equalizer are adjusted by the magnitude of the d-c line current through the set.

The initial design has a tungsten ballast filament in series with the transmitter so that the effect of transmitting on long loops is small. On short-loop transmission, however, with high values of d-c, the combined battery supply and a-c circuit loss inserted is about 5 db.

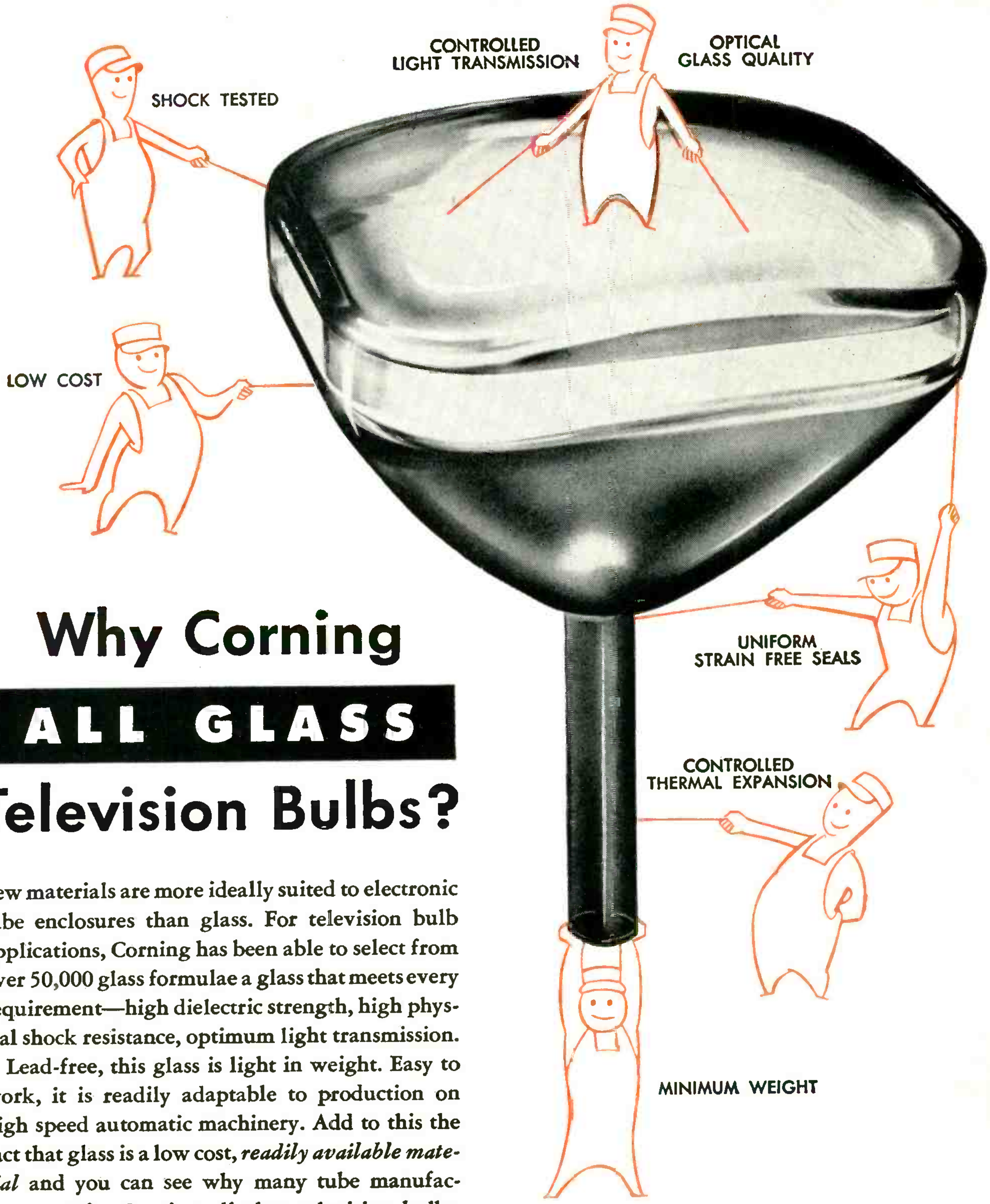
New transmitter and receiver designs were required because of the increased transmission gain. The receiver design utilizes a ring armature structure.[1] The structure is 5 db more efficient than the present model receiver and allows the upper frequency range to be extended by about 500 cycles.

In the transmitter design, modulation of the carbon was increased, smaller parts were used and the transmitter located more advantageously with respect to the mouth to increase the effective working acoustic pressures.

This material was abstracted from an article entitled "An Improved Telephone Set" by A. H. Inglis and W. L. Tuffnell which appeared on page 239 in the *Bell System Technical Journal* for April 1951.

REFERENCE

(1) E. E. Mott and R. C. Miner, The Ring Armature Telephone Receiver, *BSTJ*, 30, p 110, Jan. 1951.



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(continued from p 140)

simple theory, the oblique incidence signals should be reflected can be calculated.

All three transmitting-receiving stations will use the model C-3 automatic ionosphere recorder developed by the Bureau. Its transmitted power is 20 kw and it is capable of scanning a frequency range of 1 to 25 mc in 7.5 seconds. Signals will be transmitted, received and recorded on film strips at a 24-hour-per day-basis.

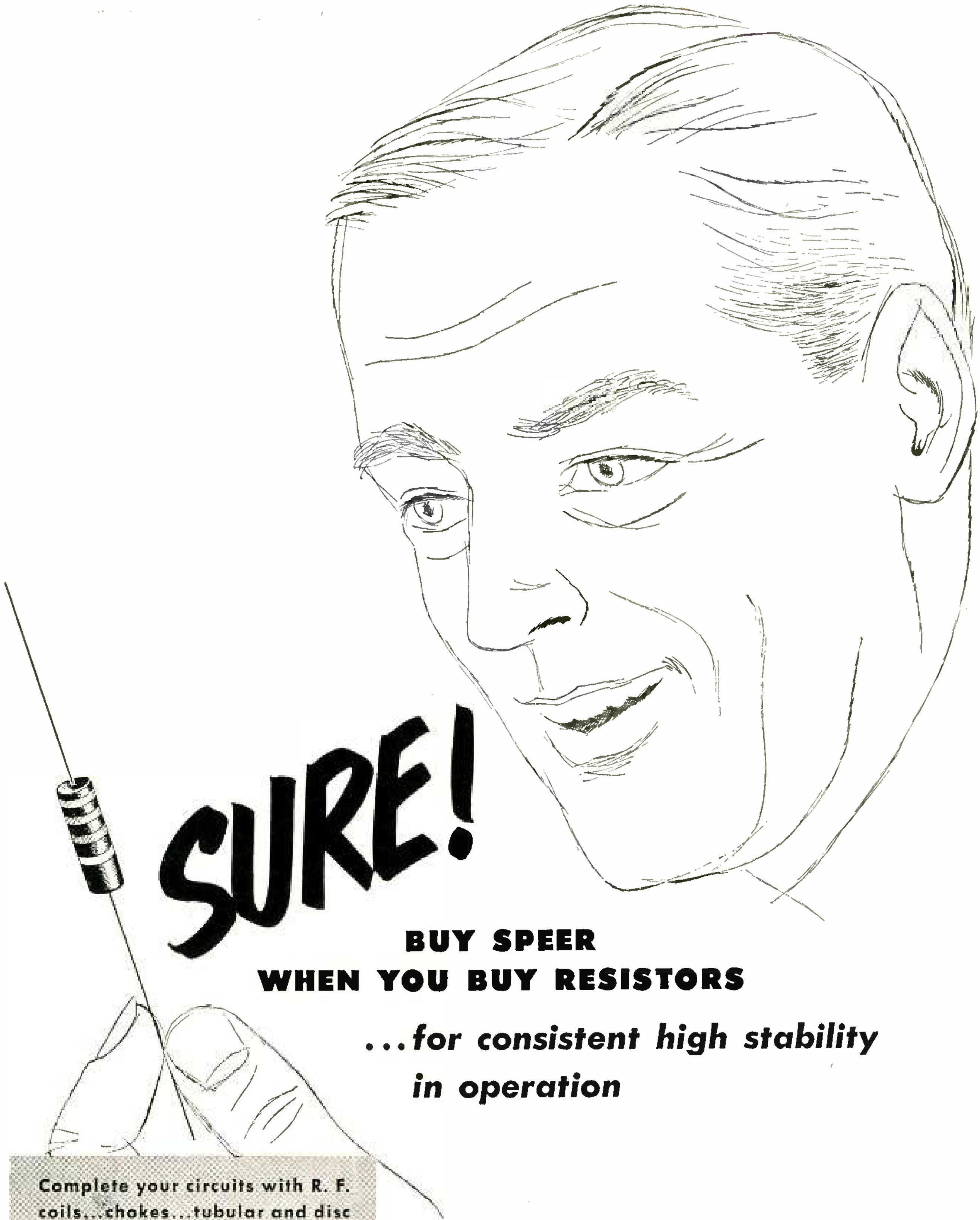
The proposed experiment involves comparatively short distances. However, it is known that the discrepancies between theory and practice increase in magnitude as the distance between transmitter and receiver becomes greater. To investigate this effect, the mobile unit will be placed at the midpoint of much more widely spaced permanent installations. The next stop may be between the Sterling station and one in the Hawaiian Islands, Alaska, San Francisco, Puerto Rico, or Panama. Before the program is completed, the mobile unit will have been placed at the midpoint of the path to most of the Bureau's ionosphere stations in the western hemisphere.

The Bureau will analyze the film-strip records from each tri-station experiment. The analysis will shed more light on the causes of fading and explain the complete loss of a signal between the transmitter and the receiver. Thus, at the end of this unusual series of experiments, the Bureau will be in a position to supply all the users of long-range communications with more accurate information for selecting the proper frequency to transmit intelligence over a certain path at any particular time of the day and year.

Modified Wallman Circuit With Voltage Feedback

BY SHIGEO SHIMIZU
Tokyo Shibaura Electric Co.
Kawasaki City, Japan

THIS is a report of a new low-noise amplifier circuit. The second stage of the Wallman circuit, which is a current-feedback amplifier, can be replaced by a voltage-feedback amplifier, to form a more convenient



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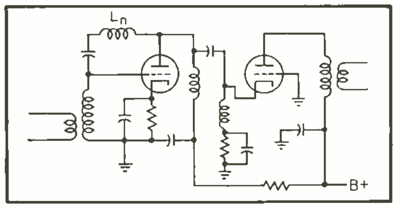

FIG. 1—Normal Wallman circuit with current feedback in second stage

circuit. This circuit was developed during a study of a low-noise i-f amplifier of a microwave receiver.

For this purpose, the Wallman circuit (Fig. 1) was generally used for its superiority in terms of noise-figure; but it has some disadvantages, such as difficulty of adjustment, and inconvenience due to the floating cathode of the second stage tube.

The operating expression of the second stage of the Wallman circuit is as follows:

$$i_{p2} = g_{m2}\,(e_{k2} + i_{p2} Z_{k2})$$
$$i_{p2}\,(1 - g_{m2} Z_{k2}) = g_{m2}\, e_{k2}$$
$$i_{p2} = \frac{g_{m2}\, e_{k2}}{1 - g_{m2} Z_{k2}} \cong \frac{e_{k2}}{Z_{k2}} = \frac{(Z_{k2}\, g_{m1}\, e_{g1}) + E_{n2}}{Z_{k2}}$$
$$\therefore e_{p2} = Z_{p2}\, i_{p2} = Z_{p2}\, g_{m1}\, e_{g1} + \frac{Z_{p2}\, E_{n2}}{Z_{k2}}$$

From these equations the facts are clear that, the second stage of the Wallman circuit is a current feedback amplifier and this stage has lower input impedance and lower noise output than a normal grounded-cathode amplifier. It was decided to try voltage feedback in the second stage to achieve the same benefits that are obtained in the Wallman circuit through the use of current feedback. The resulting circuit (Fig. 2) has the advantage of a grounded cathode in the second stage and easier adjustment due to the use of a pentode. The operating expressions are as follows:

(1) Without feedback

$$e_{p1} = Z_{p1}\, g_{m1}\, (E_s + E_{n1})$$
$$e_{p2} = Z_{p2}\, g_{m2}\, (e_{p1} + E_{n2})$$
$$= Z_{p2}\, g_{m2}\, [Z_{p1}\, g_{m1}\, (E_s + E_{n1}) + E_{n2}]$$

(2) With feedback

$$e_{p1}' = e_{p1}/Z_{p1}\, g_{m1} = (E_s + E_{n1})$$
$$e_{p2}' = e_{p2}/Z_{p1}\, g_{m1} = Z_{p2}\, g_{m2} \left[(E_s + E_{n1}) + \frac{E_{n2}}{Z_{p1}\, g_{m1}}\right]$$

where the mean square of E_{n2}

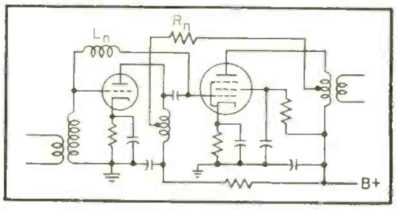

FIG. 2—Modified Wallman circuit permits grounding of second-stage cathode and offers several other advantages

$$E_{n2}^2 = 4\,k\,T\,\beta \left[R_{v2} + R_{p1} + \left(\frac{R_{p1}\,R_{g2}}{R_{p1} + R_{g2}}\right)^2 \frac{5}{R_{g2}}\right]$$

For the conditions studied—center frequency 50 mc, and a 6AK5 tube connected as pentode

$$E_{n2}^2 = 4\,k\,T\,\beta\,(4{,}300)$$

The converted value of this to the first tube grid is

$$\frac{E_{n2}^2}{(Z_{p1}\,g_{m1})^2} = 4\,k\,T\,\beta\,(43)$$

By comparison of these expressions and expressions of normal Wallman circuit, it is evident that this circuit has an equal noise figure for the case where

$$R_{p1} >> \left[R_{v2} + \left(\frac{R_{p1}\,R_{g2}}{R_{p1} + R_{g2}}\right)^2 \frac{5}{R_{g2}}\right]$$

and in addition to that, this circuit provides easier adjustment.

Result of the Experiment

In experimenting with this circuit for examination of the foregoing theory, it was found that this circuit (with a center frequency of 52 mc, bandwidth of 10 mc, and employing a 6AK5 tube) had a noise figure of 1.9, as compared to 2.04 for the normal Wallman circuit.

Electronic Analysis of Walking

THE ELIMINATION of the hazards imposed by slippery walkway surfaces—responsible each year for a large number of serious injuries and accidental deaths—is the principal objective of a research project at the National Bureau of Standards. To obtain basic quantitative data on some of the factors involved in the slipperiness of walkways, the Bureau has devised an electronic stepmeter which measures the three components of force produced between the foot and the floor in normal walking.

The electronic stepmeter consists

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Second, the large standoff insulator between the transformer case and tube socket had to be eliminated. Because the previous case was metal, a large standoff insulator had been used to keep the tube socket, mounted on top of the transformer case, 11,000 volts from ground.

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primarily of a two-foot square platform mounted on ball bearings attached to four J-shaped springs. The four sides of the platform bear against ball bearings attached to L-shaped springs which are kept under slight tension so that all will follow the horizontal motion of the platform. Electromechanical pick-ups are mounted adjacent to the appropriate springs. Deflections of the springs due to forces exerted against them produce output voltages in the pick-ups proportional to the forces in each of three directions—vertical, longitudinal, and transverse. Walkways on a level with the platform of the stepmeter are used so that walking on a level

Electronic stepmeter measures the vertical and horizontal components of the forces exerted by the leg on a walkway surface during a step

surface can be simulated. The output voltages are amplified, and are recorded with respect to time by an oscillograph.

Oscillographic recordings of the vertical and horizontal components of the force exerted by the leg on the platform of the stepmeter during a step have been analyzed for 7 men and 5 women. Curves for the vertical forces show two maxima during each step, usually greater than body weight, and a minimum, between the two maxima, usually less than body weight. The two maxima occur when the body is being accelerated upward.

Curves for the horizontal forces in the longitudinal direction frequently show a slight backward thrust when the foot first contacts the platform, indicating that the body is being accelerated forward;

this backward thrust is of very short duration and occurs at about the same time the curve for the vertical force shows a sudden deflection or reversal in direction.

The longitudinal forces reach a maximum in the forward direction shortly after the heel contacts the platform, thus retarding forward movement of the body. They reach a maximum in the backward direction as the ball of the foot prepares to leave the platform, thus accelerating the body in the direction of progression.

The transverse forces were relatively small. For the most part, their direction is outward from the body and depends upon which leg is involved. The transverse forces, however, would likely be materially increased when the direction of progress is abruptly changed.

In general, the results showed that during the retarding phase of a step, a minimum coefficient of friction of around 0.2 is essential if slipping is to be avoided. When walking is entirely automatic and subject to sudden changes in velocity and direction, a higher coefficient would likely be necessary to prevent slipping.

Instantaneous Peak Voltmeter

THE CIRCUIT shown in Fig. 1 is capable of measuring the height of an individual voltage or current pulse, regardless of the amplitude of the preceding pulse. This sort of operation is desirable in certain biological applications.

The grids of V_2 are biased so that in the absence of a pulse no current flows in that tube, regardless of the charge on capacitor C. The amplitude control potentiometer adjusts the voltage at the grid of V_1 to be less than that appearing at the grids of V_2. The latter tube acts as a switch—it conducts current in either direction during a pulse and acts as a high-impedance in the absence of a pulse.

If the height of a pulse appearing at the cathode of V_1 is greater than the voltage on C, V_{2A} will conduct, and C will charge to the new voltage with a time constant R_oC, where R_o is the series resistance of the output of cathode-follower V_1

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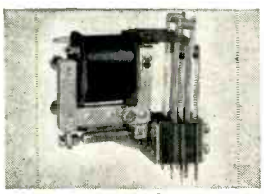

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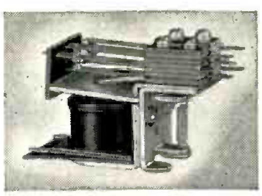

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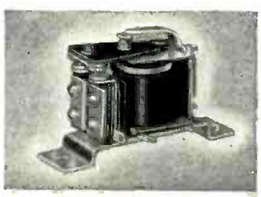

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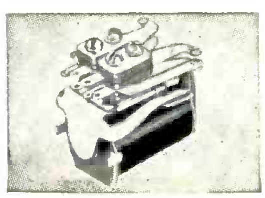

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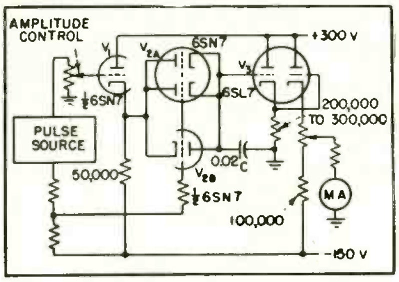


FIG. 1—Schematic diagram of instantaneous peak voltmeter

and the forward saturation resistance of V_{2A}. If the incoming pulse is less than the voltage on C, V_{2B} will conduct, and C will discharge to the new voltage with the same time constant. The trailing edge of the pulse cuts off both sections of V_2 and in the interval between pulses C discharges with time constant R_mC, where R_m is the parallel resistance of the input resistance of V_3, the parallel resistance of the two sections of V_2, and the leakage resistance of C.

With the components shown, according to Tobin, Grundfest and Schoenfeld, who describe this development in detail in the March 1951 issue of *The Review of Scientific Instruments*, a 0.1-μsec pulse of maximum amplitude and minimum frequency ($T = 5$ sec) shows a decay of less than 2 percent of the interval between pulses. At frequencies of 1 cps or higher there is no observable decay on the meter between pulses.

Additional "Trons"

BY W. C. WHITE
Research Laboratory
General Electric Co.
Schenectady, N. Y.

SINCE publication of a list of words ending in the suffix *tron* in the May, 1950, issue of ELECTRONICS, these additional words and meanings have been brought to our attention.

Additron—A Canadian special-purpose computer tube.

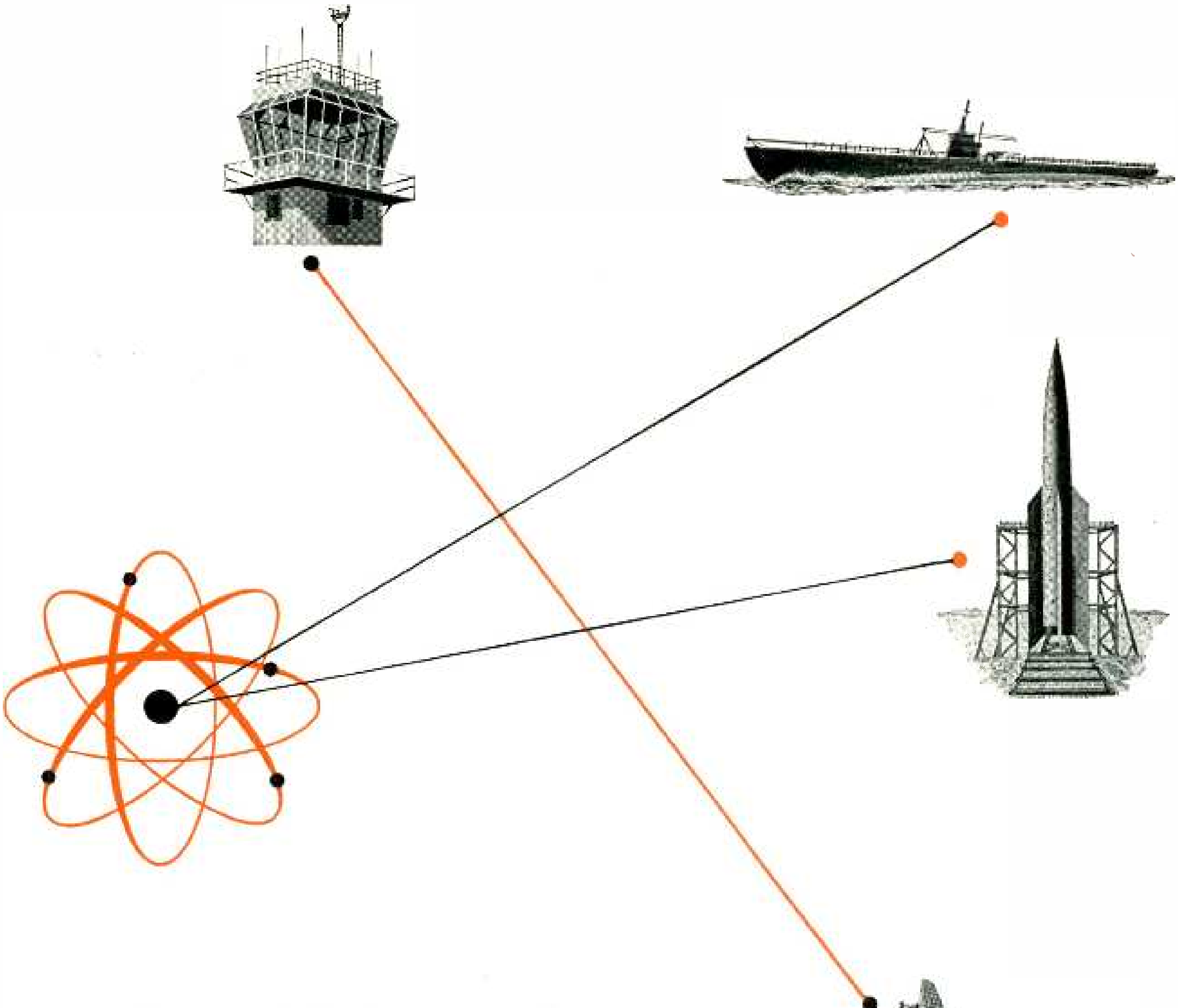
Airlectron—Name of a firm making electronic equipment.

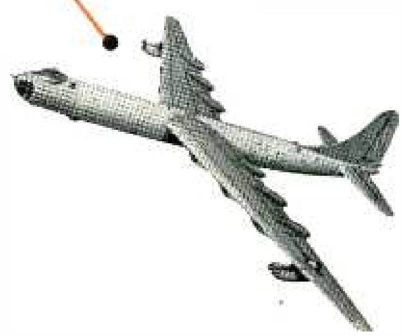
***Alphatron**—Trade name for a form of blow gun.

Anticyclotron—A form of traveling-wave tube.

Bio-tron—Trade name for a pharmaceutical product.

Circlatron—Trade name for prod-





wave spectrum analyzer.

*Videotron—Trade name for a cathode-ray tube.

*Vitron—Trade name for a glass fiber insulation.

Vocatron—Trade name of equipment for an intercommunication system.

*These names appeared also in the list published in the May, 1950, ELECTRONICS, but were applied to different devices or business firms.

Differential Analyzer Uses Plug-In Units

By C. D. Morrill
Goodyear Aircraft Corp. Akron, Ohio

GEDA (Goodyear Electronic Differential Analyzer) comprises equipment designed to analyze the performance of dynamic systems under the influence of initial and boundary conditions and driving forces by simulating the mathematical operators of the integro-differential equations which represent them. The solution of a rather wide and complex range of engineering problems with acceptable precision is thus made feasible. Such problems extend into the varied fields of aircraft design and control, vibration analysis, indus-

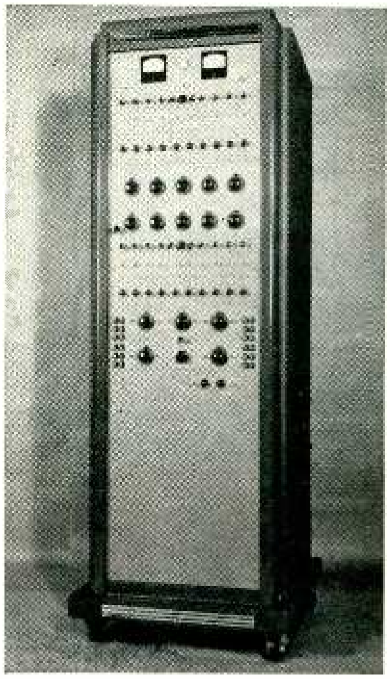


FIG. 1—GEDA linear computer

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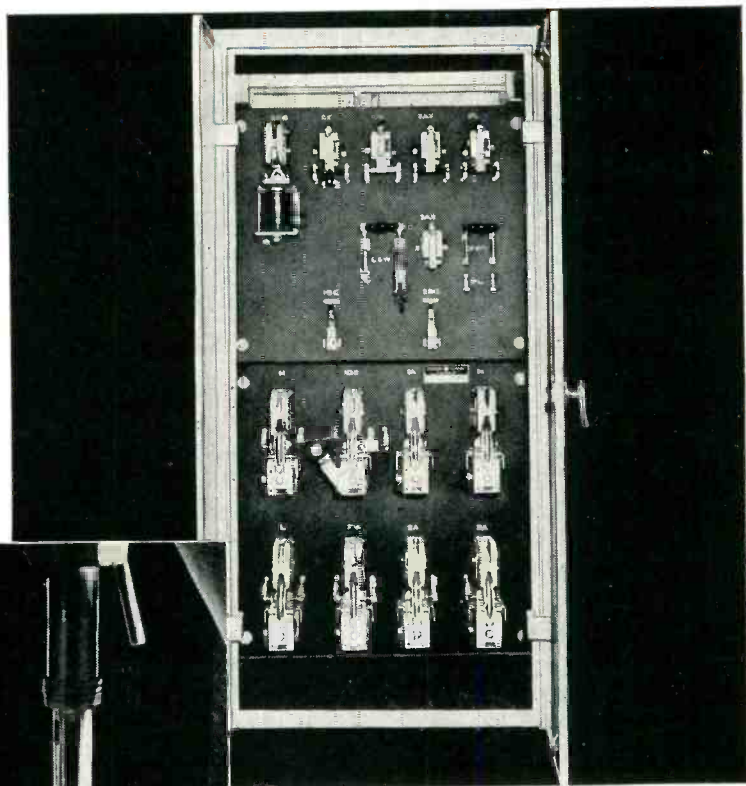

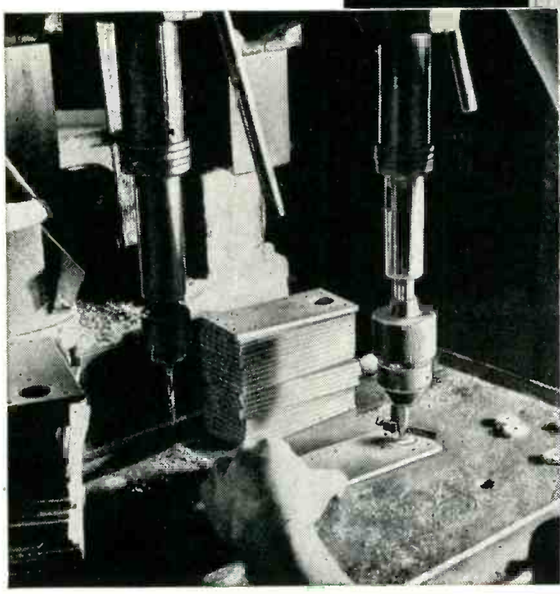

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COMPLETE LINE OF LAMINATES—General Electric produces a complete line of plastics laminates—either molded or in the forms of sheets, tubes and rods with cloth, paper, glass fabric, or special bases for a wide variety of applications.

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trial control analysis, structures, turbines and reciprocating engines and other dynamic electrical and mechanical systems.

Essentially, the GEDA equipment comprises three compact computing elements which can be combined to form an analog computing system. The first of these three elements (see Fig. 1) solves linear differential equations with constant coefficients up to the tenth order. The time scale can be varied over a wide range including actual time.

The second element (Fig. 2) extends the field of utility of the first element into the range of linear differential equations with variable coefficients and nonlinear differential equations. The third element comprises a six-channel recorder-amplifier assembly which records six of the variables appearing in the computing system as functions of time.

In the first or linear computing element of the GEDA system, simulation is accomplished by means of passive network components and direct-coupled amplifiers. Twenty plug-in d-c amplifiers comprise the operational components. These amplifiers perform complex linear operations dependent upon the combination of input and feedback impedances. Problems are set up by

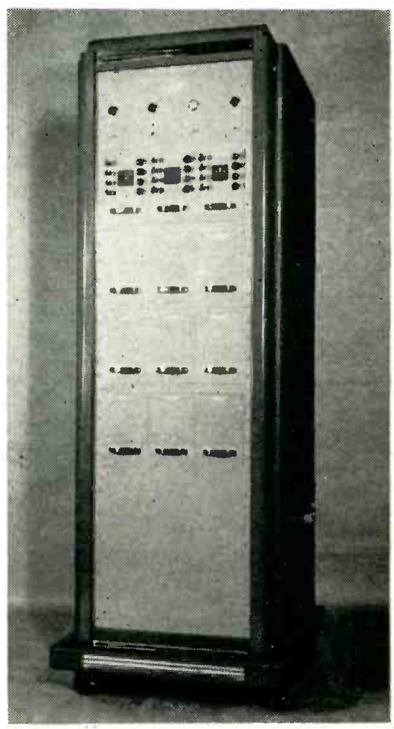


FIG. 2—GEDA nonlinear computer

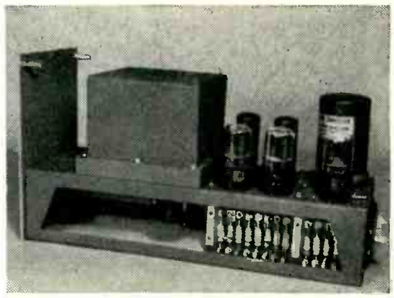


FIG. 3—Servo-multiplier unit for obtaining products

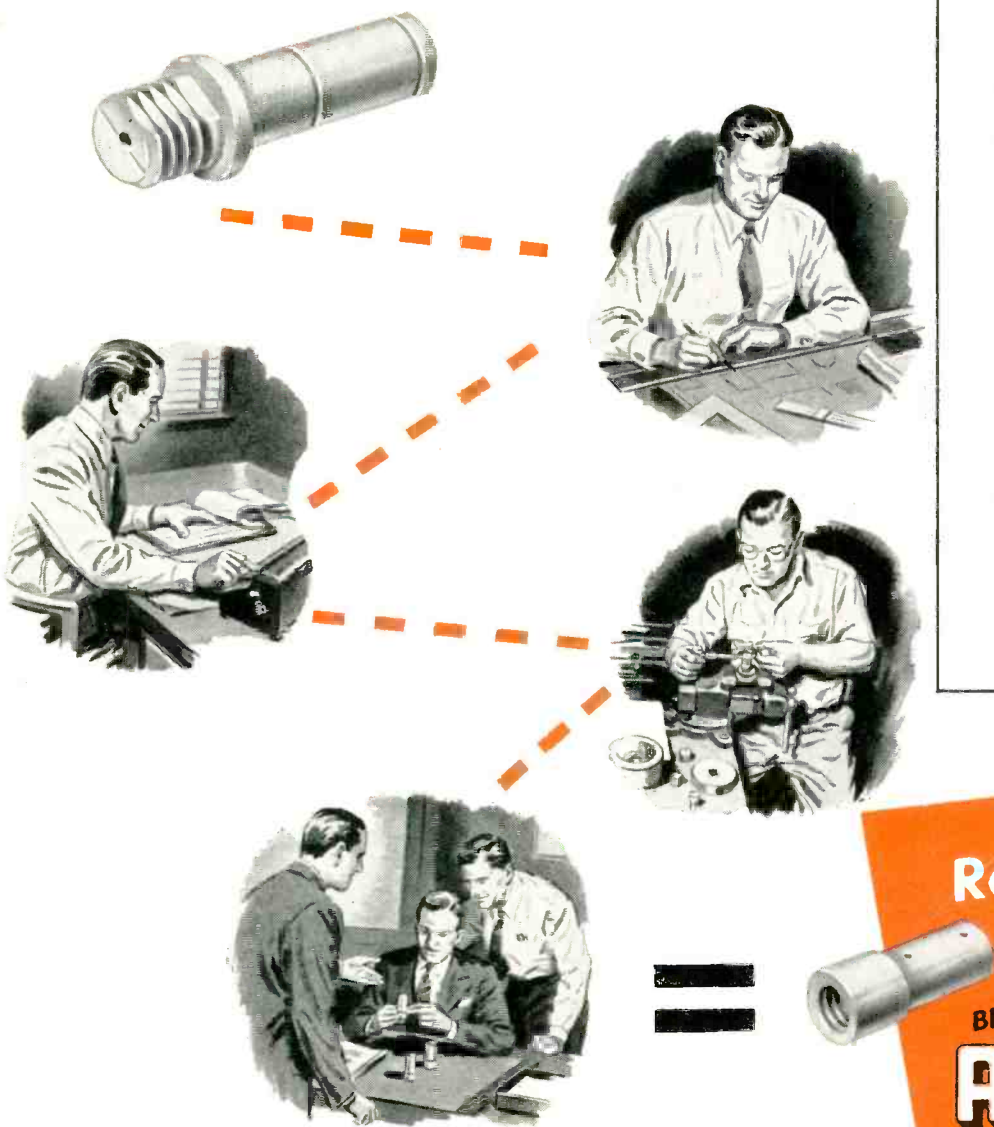
patching together the various amplifiers, resistors, capacitors, voltage sources and the like to simulate the dynamic system in question. Solutions are obtained in the form of time-varying voltages representing the different problem variables.

The second computing element, which is designed as an adjunct to the first, employs up to 12 servo-multiplier units of various types. These units permit the application of the equipment to nonlinear and transcendental integro-differential equations. Two different types of plug-in multiplier units are employed. As illustrated, one type (Fig. 3) is used to generate products only. The other (similar in size and appearance to Fig. 3) generates products and, in addition, develops certain classes of empirical or analytical functions. A third type of unit, a sign changer, makes possible the multiplication of two variables in all four quadrants.

As all of the multiplier units are of the plug-in type, it is a relatively simple matter to select an arrangement of components to meet a given set of conditions. The positive and negative voltage references required for multiplier use are supplied by a reference power supply regulator. Inter-connecting cabling permits interwiring the nonlinear element with the associated linear equipment. A jackboard for this purpose is contained in the linear computer.

Typical operation of a position servomechanism multiplier unit is shown diagrammatically in Fig. 4. Referring to the drawing, S represents the servo amplifier and actuator. The first potentiometer acts as a feedback unit and turns through an angle proportional to

It's a fact that



Very few customers object to our suggestions on redesign. For those who object, we make their designs exactly as they want them. Most customers appreciate the close co-operation given and gladly use our fifty years of specialized experience.

Here are the reasons:

1. *Makes best use of favorable ceramic characteristics, avoids misapplication.*
2. *Designs are kept within practical manufacturing limits.*
3. *Subsequent assembly operations frequently are speeded.*
4. *Several components can sometimes be combined into one.*
5. *Maximum economy.*

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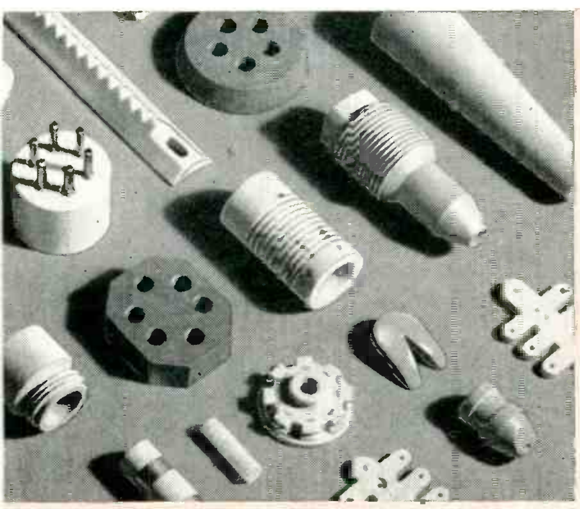

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Illustrated is a redesign which saved about 60% in original price, saved assembly time, and gave improved performance. Our engineers and production men will make recommendations on request. Send blue prints or samples with data on operating conditions and tolerance requirements. By working together we can serve you better.

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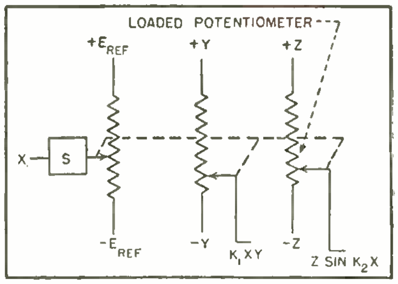


FIG. 4—Schematic diagram showing operation of multiplier unit

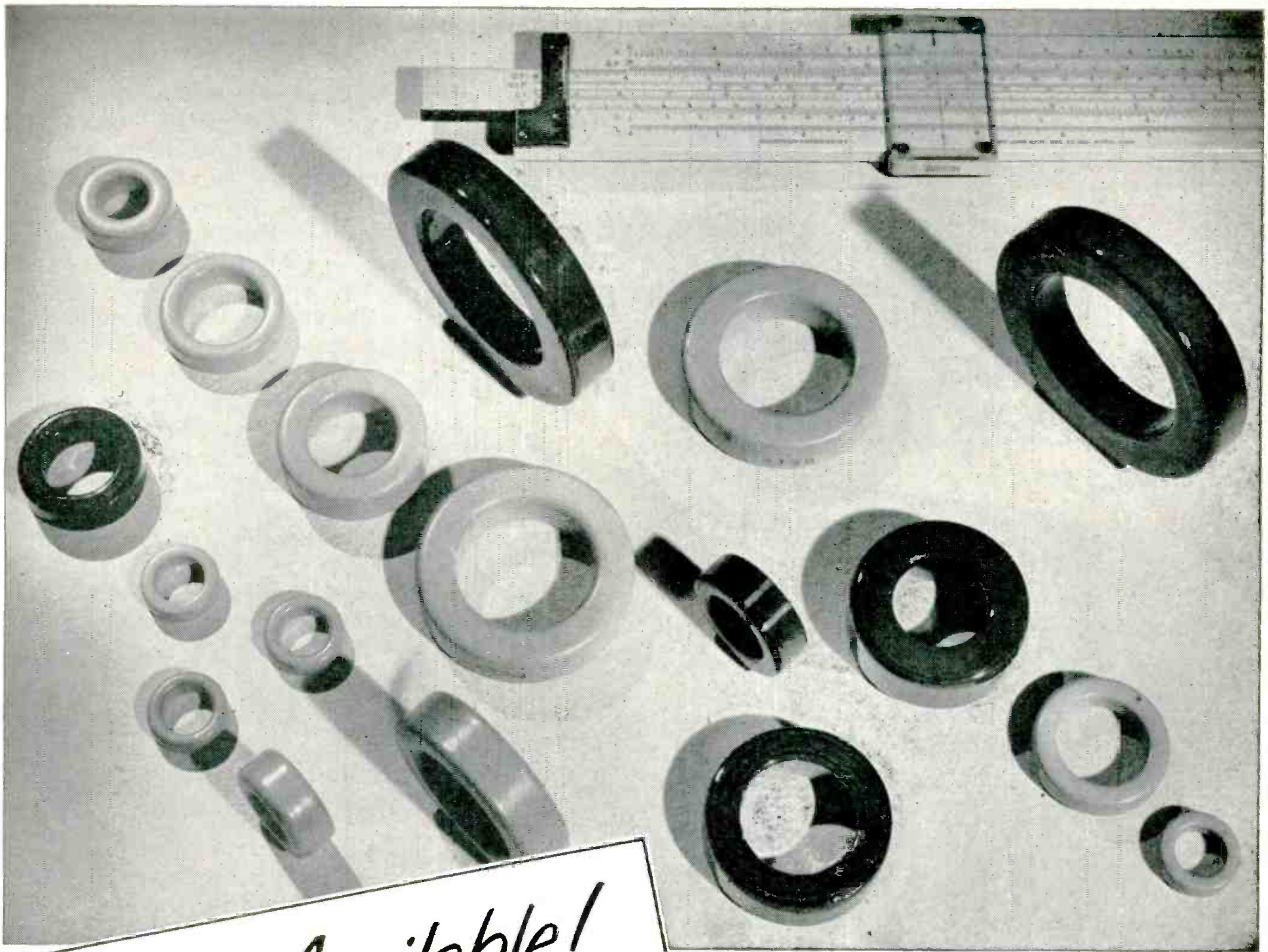
the variable input X. The second and third potentiometers are ganged to the first and must therefore turn through the same angle. As a result, the output of the second potentiometer is k_1XY volts, where k_1 is an appropriately chosen constant. The third potentiometer is shown loaded to generate sinX and its output is Z sin k_2X where k_2 has the dimensions of radians per volt. The multiplicands are Y and Z.

By means of these ganged linear potentiometers, driven by highly responsive servo actuators to produce products and/or functions, it is feasible to produce a number of linear and nonlinear mathematical results. It is possible to produce the products of functions of the independent variable—as in the coefficients of linear differential equations—or products of functions of the independent and the dependent variables—as in nonlinear differential equations. If the potentiometers be made nonlinear by suitable loading, the multiplier can be employed to generate functions of a variable.

Conversion of Error Signal

Operation of the computing potentiometers is based upon the conversion of d-c error signals in a conventional modulator circuit to a 60-cycle square wave. For this purpose, a conventional Brown 60-cycle converter is employed. Electronically, Brown converters operating as circuit components of conventional modulators, convert d-c error signals. In addition, each error signal has a plus or minus 90-degree phase relationship to the line voltage depending upon the sign or polarity of the d-c error signal.

The output of each converter is amplified sufficiently to drive an



associated servo motor. Each servo motor is mechanically coupled to the computing potentiometers incorporated in the respective multiplier units. To reduce the dependence of multiplier performance on the characteristics of the servo motor, each amplifier circuit includes an equalizing network.

A maximum of 12 servo multiplier and/or sign changing units can be accommodated. The design arrangement is such that three units can be installed on each of the four shelves. All of the units are of the plug-in type and are mechanically interchangeable. This flexibility permits the selection of component combinations best suited to the type of problems for which the computer is to be used.

Radio-Frequency Micropotentiometer

Two EXTREMELY simple devices which produce r-f voltages at a very low impedance and at a wide range of frequencies have been conceived and developed at the National Bureau of Standards. They provide accurate voltages from 1 to 10^5 microvolts without the use of attenuators at frequencies up to 300 megacycles and above. Thus, convenient standards of low voltages are made available which should greatly reduce equipment and shielding problems encountered in calibration of present-day commercial voltage generators, attenuators, voltmeters, and other radio-frequency equipment.

The micropotentiometers are especially useful in measurements of radio receiver sensitivity. The large disagreement between various

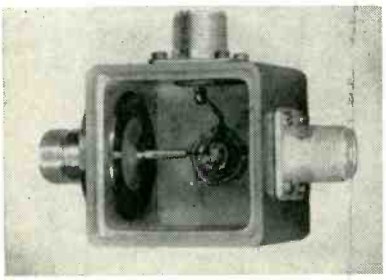


FIG. 1—Photograph shows interior of NBS r-f micropotentiometer

standard voltage generators at high frequencies and low voltage levels has been due to three major causes. First, generator output impedance and receiver input impedance are not ordinarily known as functions of changing frequencies. Second, extreme care is necessary in using precision voltage-dropping attenuators. Finally, the long-time calibration stability of vacuum-tube voltmeters is uncertain. For these reasons, manufacturers of voltage generators have been unable to guarantee the accuracy of their equipment at all frequencies. Development of the micropotentiometers now appears to have removed most of the obstacles to standardization of receiver sensitivity.

The new instruments consist essentially of appropriately housed and mounted current-carrying elements together with means for monitoring the currents they carry. Their electrical constants are simply determined by using known d-c voltages and currents. The current-carrying elements are annular membranes, either metallic or nonmetallic, of various radii, thicknesses, and electrical resistivities. Monitoring may be accomplished by means of thermocouples, thermoelements, bolometers, stable vacuum-tube voltmeters, or other devices whose indications are independent of frequency. Thermoelements have been used in measurements of 1 to 100,000 microvolts at frequencies from zero to 300 mc and also for 100,000-microvolt measurements in the region of 1,000 mc.

By means of known voltage ra-

FIG. 2—Micropotentiometer is shown in set-up for calibrating millivoltmeter

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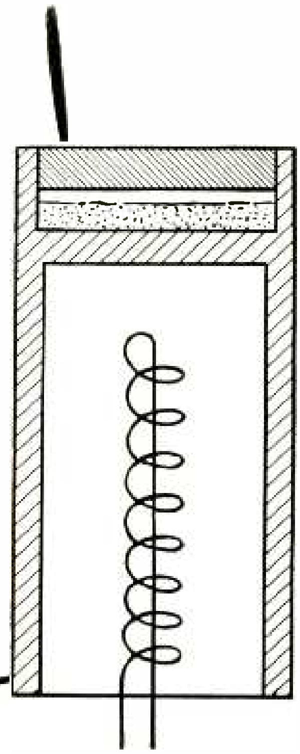

PHILIPS L-CATHODE

Illustrated above is the first basically new cathode in over 25 years—the new PHILIPS L-CATHODE. It offers these practical advantages to users of klystrons, disc seal triodes, iconoscopes, magnetrons, special cathode-ray tubes and other types where a high degree of reliability is essential:

1. *High emission current density with long life*
2. *Can be made in great variety of shapes and to close tolerances*
3. *Not damaged by high electrostatic forces*
4. *Reactivates after arcing*
5. *Can be reactivated after exposure to air*
6. *Withstands severe ionic and electronic bombardment*
7. *Maintains uniform emission characteristics during its life*

The PHILIPS L-CATHODE originated in the Philips Research Laboratories in Holland, and was further developed by Philips Laboratories, Inc., here. It was first described in the June 1950 *Philips Technical Review*. Leading electronic research laboratories have already used development types of various shapes with outstanding results.

Samples of PHILIPS L-CATHODES for experimental use can be supplied in limited quantities to those interested in producing greatly improved tubes of high emission density with longer life.

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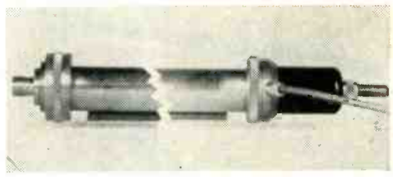

FIG. 3—Coaxial-line model of NBS r-f micropotentiometer

tios, the micropotentiometers may be used to extend the range for checking attenuators up to 120 db or higher. Simplicity of operation, trouble-free circuitry, flexibility, and absence of serious shielding problems make these instruments particularly adaptable to use by personnel of limited training.

In comparing the micropotentiometers with other sources, such as a voltage-measuring thermistor bridge[1], absolute reproducibility and agreement have been limited only by the relative complexity of the standards of comparison. Verification of the exact frequency and voltage ranges of the micropotentiometers in terms of other independent standards is still in progress at the Bureau, along with other phases of design and application. Probably the greatest single difficulty encountered in this work has been the lack of stable sensitive receivers which can indicate one microvolt (or lower voltages) at 100 mc and higher frequencies with accuracies of 10 percent or better.

Figure 1 shows one of the r-f micropotentiometers. This particular unit provides voltages in the microvolt range without the use of attenuators, at frequencies up to 1,000 mc and with source impedances of the order of milliohms. The thermoelement is shown in its housing. The cylindrical section within the right side wall of the unit incorporates silver-deposited annular membranes (the current-carrying elements of the micropotentiometer). Similar elements of different resistivities and materials may be interchanged to attain other ranges.

Figure 2 shows the unit of Fig. 1 in use as part of a setup for calibrating a millvoltmeter (left). Figure 3 shows a coaxial-line model.

Reference

(1) M. C. Selby and Lewis F. Behrent, J. Res. NBS 44, No. 1, p 15, 1950.

NEW PRODUCTS
(continued from page 144)

contacts. The timer automatically resets for each new cycle. It is available for either 115 or 230 volts a-c.

Space-Saving Oscilloscope

SIMPSON ELECTRIC CO., 5200 W. Kinzie, Chicago, Ill. Model 476 Mirroscope, designed to save space on the testing bench, has its 5-in. c-r tube mounted in a vertical position. Bench area required is only 9 in. × 8 in. The c-r image is reflected

from a mirror mounted in the adjustable cover at the top of the cabinet; thus the viewing surface is brought near the eye level when the unit is used on benches of normal height. Height is 16¼ in. and width, 9⅛ in. Weight is 24 lb; price, $179.50.

Multicircuit Electrical Connector

L. J. KAMM CO., 40 W. 96th St., New York 25, N. Y. A new multicircuit electrical connector is available in sizes from ten to several hundred conductors in a single unit. It is engineered for cable connection, plug-in chassis, subassembly mounting and connection including miniaturized assemblies. Contact ratings

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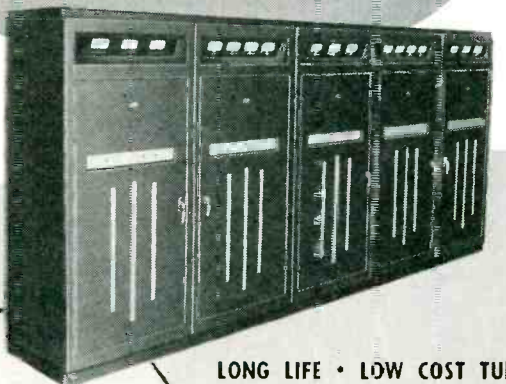
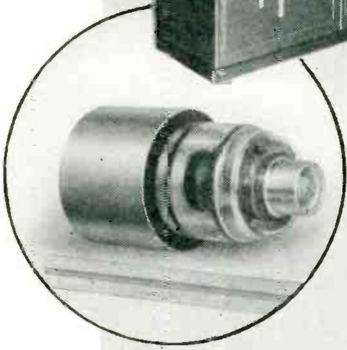


A model of efficiency and low cost. This 5 KW Oak Transmitter in commercial use for nearly two years with no final amplifier tube replacement expense. **COMPARE!**



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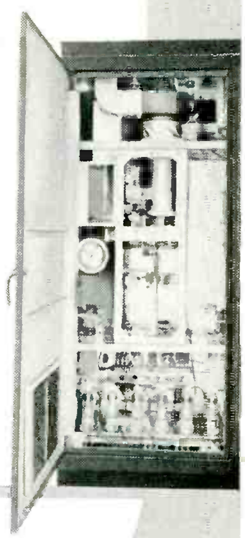

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are 5 and 25 amperes, 150, 500 and 1,000 volts. Special contacts can be had in iron, constantan or gold plated. Dustproof, pressurized or true hermetically sealed connectors are available for military, naval and air operating conditions. It is engaged with substantially zero friction and then a lever or knob is turned to apply contact pressure. For wiring, the connector disassembles into twenty point strips with easily accessible terminals.

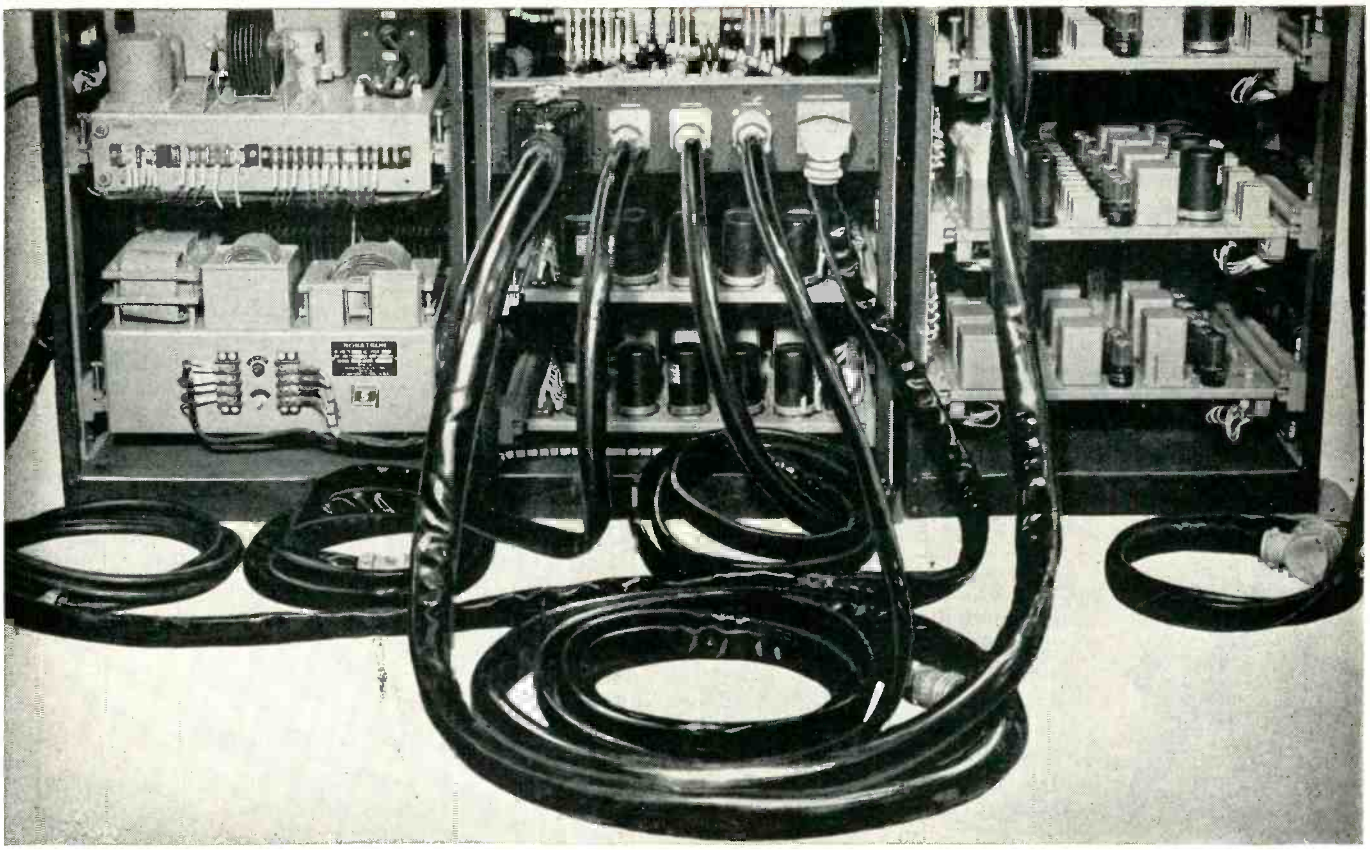
Small pH Meter and Probe

ANALYTICAL MEASUREMENTS INC., 585 Main St., Chatham, N. J., has available a pocket-size portable pH meter and companion probe unit. Total weight is 3 lb. The meter is scaled from 2 to 12 pH for easy reading, and a simple adjustment gives readings from 0 to 14. Accuracy of 0.1 pH is obtainable.

Hearing-aid type batteries provide up to 1,300 hours of operation. The electrometer tube, switch and input connector are sealed in a single unit to ensure freedom from high-humidity difficulties. The unit features one-knob control, continuous reading and a completely shielded instrument and electrode.

Servo Amplifier

SERVOMECHANISMS, INC., Old Country and Glen Cove Roads, Mineola, N. Y., is producing the SA-203 compact 60-cycle servo amplifier. It is designed as a small plug-in unit in which all the electronic elements required for one function in the control system are packaged together. Already proven in use on Government equipment, and now released for industrial use, it is available for



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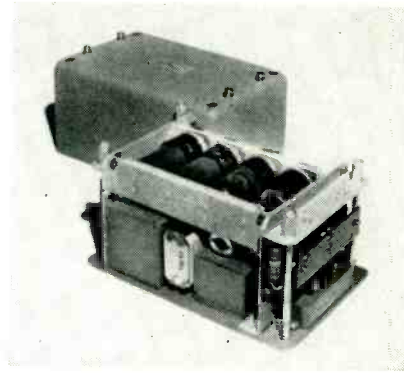


application in such equipments as analog computing devices, laboratory measuring instruments, and industrial process controls. It measures 5 in. in width × 8 in. in length × 4⅜ in. in height and weighs 5½ pounds.

V-T Electrometer

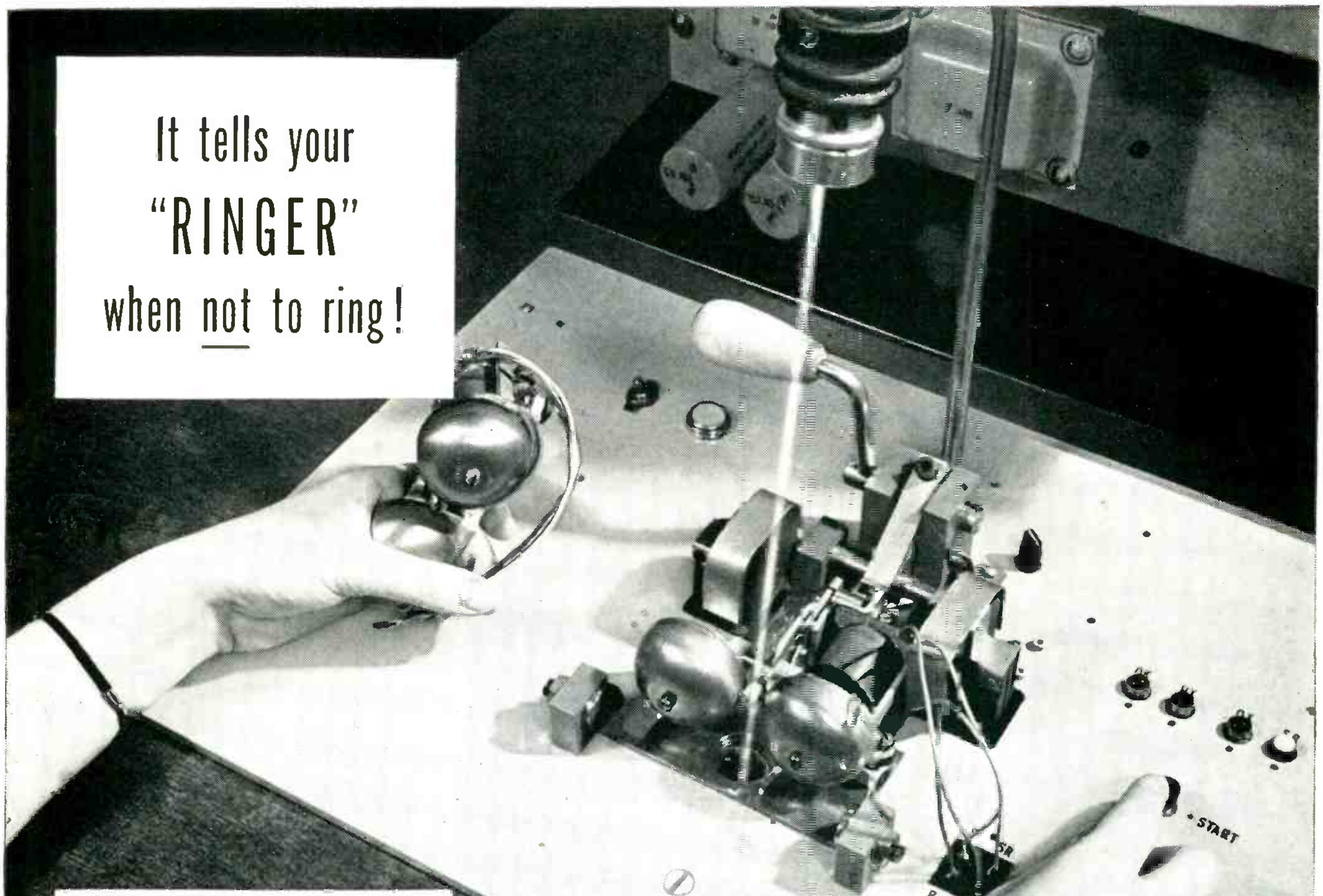
KEITHLEY INSTRUMENTS, 1507 Warrensville Center Road, Cleveland 21, Ohio. Model 200 vacuum-tube electrometer is a self-contained d-c voltmeter that has an extremely high input impedance. It measures voltages on two ranges, 2 volts and 20 volts full scale, and has an input

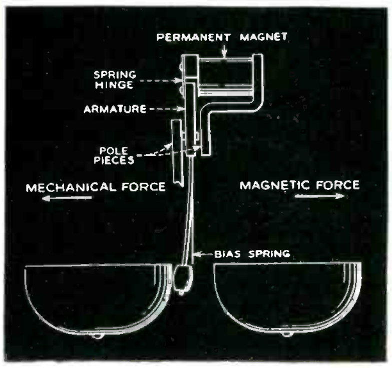
grid drift current of less than 5×10^{-14} and 5×10^{-13} ampere for the two scales respectively. Input resistance is greater than 10^{14} ohms and capacitance is approximately 6 $\mu\mu$f. Accuracy is within two percent of the full scale value.

Microphone Preamplifier

CINEMA ENGINEERING CO., 1510 W. Verdugo Ave., Burbank, Calif. The 101-BX microphone preamplifier is designed for use in the tv field or wherever extremely low micro-

It tells your "RINGER" when not to ring!





The Bell System's new automatic method of adjusting telephone ringers uses a beam of light passing between the gongs to a photoelectric cell. When test currents are applied to the ringer the machine decides whether to change the spring tension or the magnetic pull. After each change it tests again until the ringer is in perfect adjustment—and the whole procedure takes only 30 seconds.

To YOU, it's your familiar telephone bell. To telephone engineers, it's a "ringer." And it has two jobs to do. It must ring, of course, when someone calls you. And it must overlook the numerous electrical impulses which do not concern it, such as those sent out by your dial.

Ability to respond to some impulses, to ignore others, requires exact adjustment between the pull of a magnet and the tension of a spring. If they are out of balance your telephone might tinkle when it oughtn't, or keep silent when it should ring.

In the past, adjustment was made by hand, little by little until the proper setting was reached. It took time. But now Bell Laboratories engineers have developed a machine which adjusts new ringers perfectly, before they leave the Western Electric Company plants where they are made. And the operation takes just 30 seconds.

This is another example of how the Laboratories work constantly to improve every phase of telephony —keeping the costs low while the quality of service grows higher and higher.

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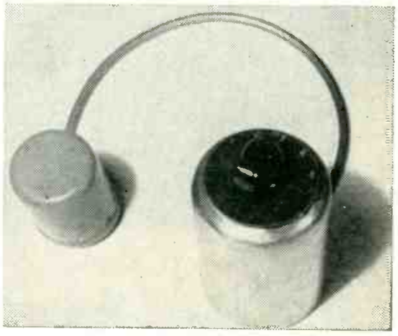
phone levels are encountered, such as when the performer is 6 to 10 feet from the microphone. It makes use of high-gain multishielded transformers, and increases the signal-to-noise ratio 10.5 db over the conventional preamplifiers. The unit uses a single 12AY7 tube, providing two stages of amplification. It is built on a plug-in chassis and weighs 4½ lb.

Adjustable Treble Filter

BERKELEY CUSTOM ELECTRONICS, 2216½ Grant St., Berkeley 3, Calif. Annoying surface noise and disagreeable distortion products in the upper-frequency ranges, commonly heard when imperfect recordings or radio programs are reproduced through wide-range reproduction systems, can now be virtually eliminated with minimum loss of use-



ful-treble frequencies, by means of the new OA-1 adjustable 5-range treble filter. The filter operates from the outputs of typical a-m/f-m tuners or phone preamplifiers and into usual amplifier or tuner input circuits. No power is required. Price is $32.50 net.

Variable Capacitors

THE JFD MFG. CO., INC., 6101 Sixteenth Ave., Brooklyn 4, N. Y., has announced a new piston-type variable trimmer capacitor. Tubular in

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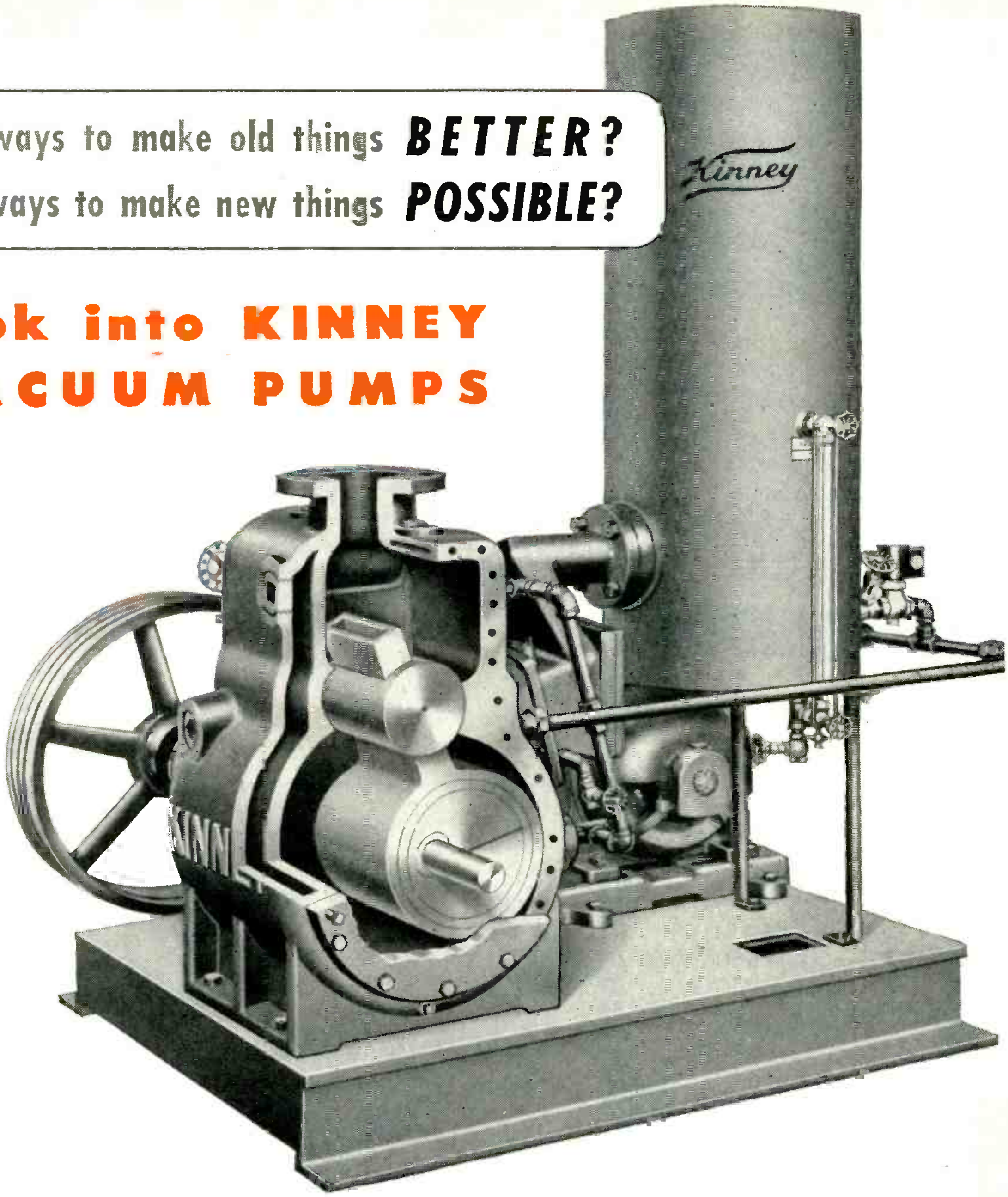

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- ☐ Vacuum distillation
- ☐ Vacuum coating
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- ☐ Vacuum dehydration

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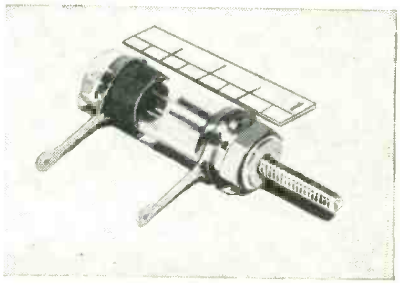
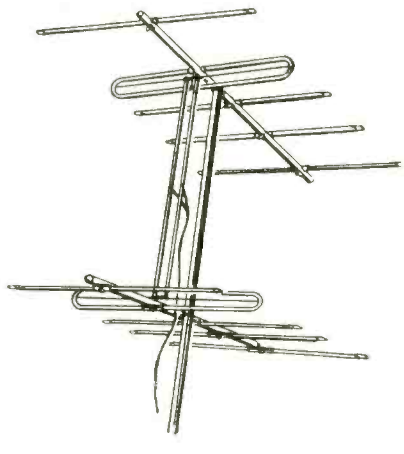


design, it delivers continually uniform change of capacitance in relation to rotation. Smooth, precise settings without backlash or disturbance from severe vibrations are made and maintained. Other features include: approximately zero temperature coefficient; Q rating of over 1,000 at 1 mc; 55 C to 100 C operating temperature; 10,000 megohmns insulation resistance. The units offer the low capacitances needed especially in the operation of commercial and government land and marine communications and microwave equipment.

TV Antennas

CHANNEL MASTER CORP., Napanoch Road, Ellenville, N. Y. A new, complete line of Yagi antennas, the 500 series, is designed to extend tv reception areas beyond present limits. Available for channels 2 through 13, the antennas combine high gain with high directivity and have an actual gain of 8 db that may be substantially increased by stacking. They have a high front-to-back ratio of 26 db to reduce rear and side pickup and match both 72 and 300-ohm line. Construction features include aluminum elements and cross-arm, high-impedance step-up dipoles of seam-



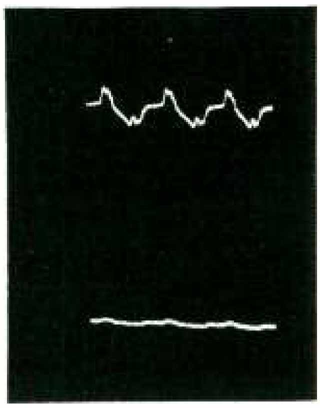
Where "Photographic Memory" *Counts!*

When you're comparing waveshapes it takes the "photographic memory" of a camera to give you the whole story in accurate, permanent form.

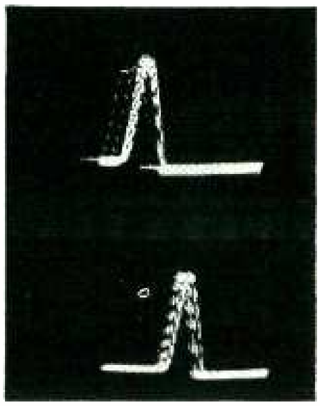
Until recently, photographic oscilloscope recording called for considerable trouble in setting up equipment and a long time period for developing the results. But today, with the Fairchild-Polaroid Oscilloscope Camera, it's an easy job to record as many traces as are needed.

Take a look at the prints below. They provided the engineer with valuable but inexpensive records for immediate evaluation. All were removed from the camera *one minute* after the final exposure was made.

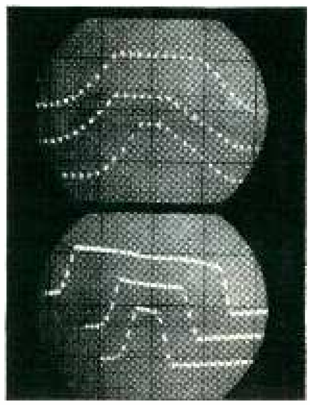
The stories of 3 "One Minute" Oscillograms



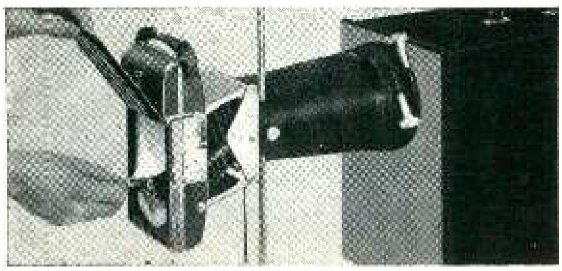
1. BEFORE AND AFTER. A visual comparison of "before and after" conditions is an easy job for the "one step" camera. Here, the upper trace shows the output of a full wave rectified power supply with insufficient filtering. The lower trace shows the effectiveness of the addition of a filtering condenser. The camera is easily adjusted to two positions (upper and lower) for two exposures; traces are exactly one half scope size.



2. SUPERIMPOSING FOR COMPARISON. The problem—determine the maximum time-interval variation between successive camera shutter openings and flash circuit closings. Instead of carefully measuring successive scope traces, the engineer superimposed several exposures for easy comparison. The length of the trace before the shutter opened is a measure of the time between the electrical contact closing and camera shutter opening.



3. MULTIPLE EXPOSURE PRE-SOLARIZATION. Here, by making 3 successive exposures on each half of the print, the engineer was able to record performance of a camera shutter at its 1/100, 1/200, 1/400 second (upper) and 1/25, 1/50, and 1/100 second settings (lower). "Pre-solarizing," the process of pre-exposing the print with the trace off the screen, made it possible to record the high writing speeds involved.



A minute after you've pulled the tab a finished print is ready for evaluation.

for still or *continuous-motion* oscilloscope recording on 35-mm film or paper

—THE FAIRCHILD OSCILLO-RECORD CAMERA

The Fairchild Oscillo-Record Camera is the first unit specifically designed for the purpose of recording cathode-ray tube images. Features: records still or continuous motion on standard 35-mm film or paper, film frontage indicator, electronic speed control — 1 to 3600 in./min., film capacity — 100, 400 or 1000 feet.

SPECIFICATIONS

Lens and Shutter—Choice of 75mm f2.8 Wollensak Oscillo-Anastigmat with #2 Alphax shutter having speeds of 1/25 sec. to 1/100 sec., "time" and "bulb"; or, 75mm f1.9 Wollensak Oscillo-Anastigmat with #3 Alphax shutter having speeds of 1 sec. to 1/100 sec., "time" and "bulb".

Picture Size—3¼ x 4¼ in. (2 or more images per print; 16 exposures per roll of film.)

Image Size—One-half reduction of scope image.

Writing Speed—With f2.8 lens, up to 1 in/μsec at only 3000V accelerating potential; higher speeds at higher voltages. With f1.9 lens these values are approximately doubled.

Dimensions—Camera, 10½ x 5¼ x 6¼ in.; hood, 11 in. length, 7½ in. dia; adapter, 2 in. width, 6⅝ in. max. dia.

Weight—Complete, 7¾ lb.

Fairchild-Polaroid Oscilloscope Camera Kits include camera, carrying case and film. Write today for complete data on the Fairchild-Polaroid and Fairchild Oscillo-Record Cameras. *Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. Dept. 120-15A.*

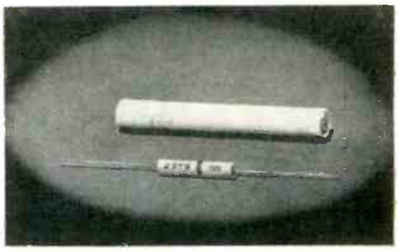
FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

less tubing, and reflectors and directors of $\frac{3}{8}$-in. butted tubing with $\frac{1}{2}$-in. external sleeves.

Miniature Paper Tubular

PYRAMID ELECTRIC CO., 1445 Hudson Boulevard, North Bergen, N. J. Type 65PTR hearing aid tubular paper capacitor is rated for 65 C, 150-v d-c applications. Designed



for continuous operation at d-c voltage rating, it will withstand a 5-second test of 300 v d-c and will meet the standard RTMA humidity test.

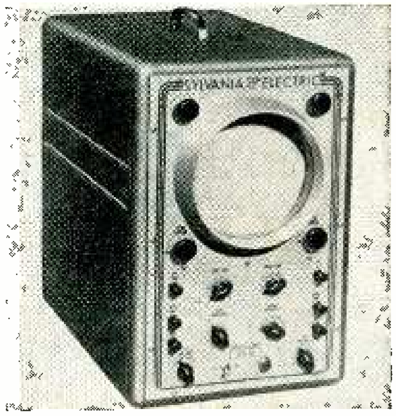
Resistors and Rheostats

OHMITE MFG. CO., 4981 Flournoy St., Chicago 44, Ill., has available 11 models of rheostats, each meeting the requirements of specification JAN-R-22. These models include both standard and enclosed types, in sizes ranging from 25 to

750 watts. Also available is a complete line of wire-wound resistors that meet all the tests prescribed in specification JAN-R-26A, including 5-hour vibration tests and air and water tests for thermal shock.

C-R Scope

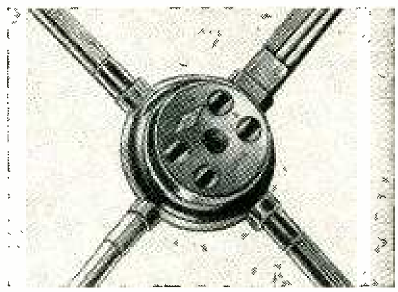
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 132Z is a 7-in. c-r oscilloscope that has been specially designed for general use in radio and tv receiver testing and in laboratory and pro-



duction applications. It incorporates a multivibrator sweep circuit for linear internal sweep from 10 to 30,000 cycles which may be synchronized to 60 cycles, an external signal or signal applied to its vertical input terminal. Balanced, non-astigmatic sweep is assured by push-pull deflection. Terminals are provided for direct connection to horizontal and vertical deflection plates and to the control grid of the c-r tube for intensity modulation.

Junction Block

CORNISH WIRE CO., Rutland, Vt., has designed and produced an all-moulded-rubber junction block to reduce wire assembly costs and to simplify and improve product and installation wiring. The unit,



which handles two cord connectors or plugs, facilitates internal wiring to any circuit arrangement or specification. The one-hole screw fastener is fully insulated and wire entrances are flexible as regards position or sizes of conductors. The unit is sealed against moisture and corrosion.

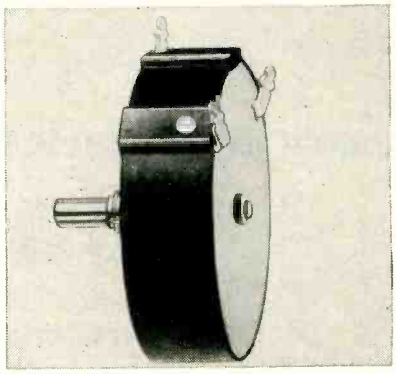
Tube Tester

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 3413-A tube tester with improved

testing flexibility permits checking any type radio receiving tube, miniature hearing-aid tubes, pilot lamps, flashlight bulbs and tv picture tubes. It has flexible 3-position lever switches for complete coverage of present and future tube connections. The RTMA pin numbering of tube element levers makes for quick reference of tube base connections. Line voltage indication on the center of the meter dial permits observation and adjustment for line fluctuations. Filament voltage is 0.63 v to 110 v in 14 steps.

H-V Electrostatic Focusing Control

CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind., has developed the type 85 high-voltage control for

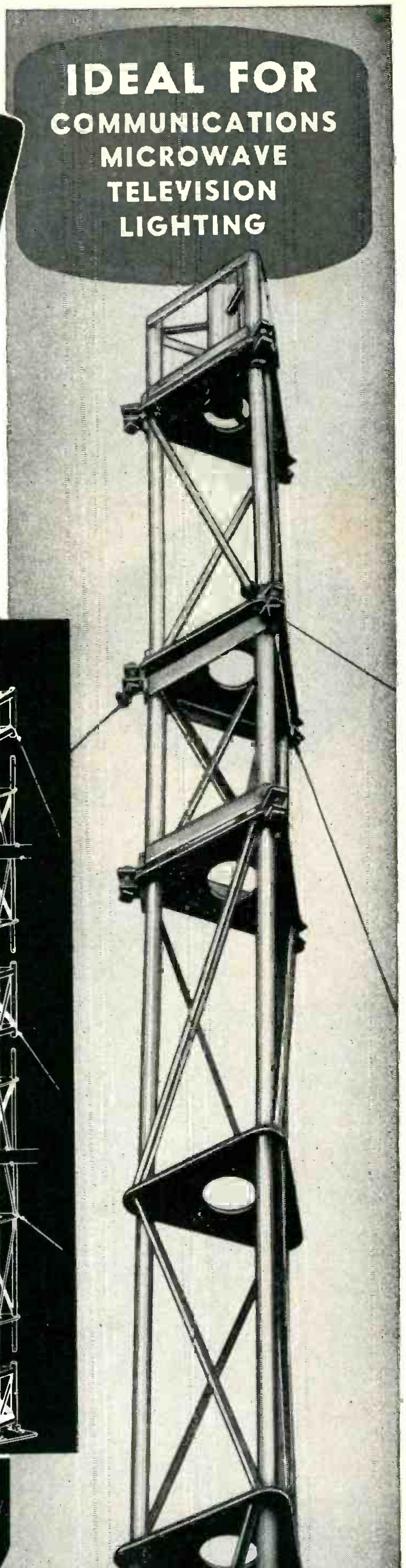


electrostatic focusing that is made chiefly of materials using a minimum amount of Alnico V magnets and copper wire.

Variable Scale

THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford 1, Conn. The variable scale illustrated is a new, unique instrument designed to be used on a multitude

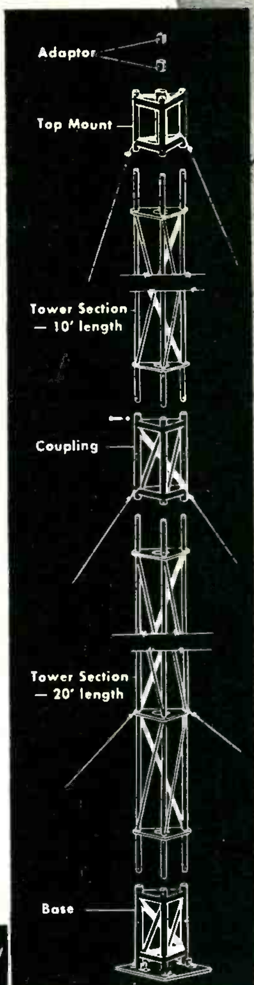
THE TOWER OF STRENGTH



Superior construction features give LOW COST Vee-D-X sectional towers the highest safety factor of any tower in its price class.

If you have an elevated installation problem, absolute permanency of your installation is assured when you use a VEE-D-X sectional tower. Strength is a major factor. Don't take chances with structural failure. Be sure with VEE-D-X!

- *Rugged, all-welded construction diagonally laced with angle iron for maximum rigidity.*
- *Can be erected on ground or on flat or peaked roof.*
- *Patented plate spaced at two foot intervals prevents twisting and affords rigidity found in no other tower.*
- *Safe and easy to climb.*
- *Completely galvanized, light weight tubular steel . . . 20 ft. section 72 lbs.*

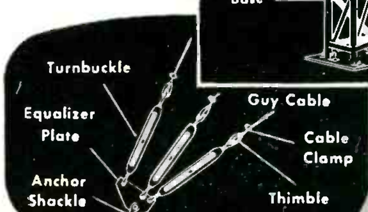


PRE-ASSEMBLED
for fast, inexpensive installation

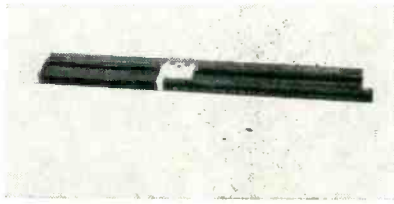
VEE-D-X towers are designed for use at any height from 10 to 140 feet. They are self-supporting up to 20 feet and, where space is limited, *semi-guyed** type installations may be used at 30, 40, and 50 foot heights. Sketch at right shows the basic parts and necessary accessories for a complete installation. Three types of top mount are available. VEE-D-X towers may be ordered in separate units or as a complete package for a specific height. (Either guyed or semi-guyed.) Write the LaPointe-Plascomold Corporation of Windsor Locks, Conn. for complete information.

*Semi-guyed towers employ one set of guy cables attached at a height of 10 ft. up the tower and anchored at a 6 ft. radius from the base.

VEE-D-X



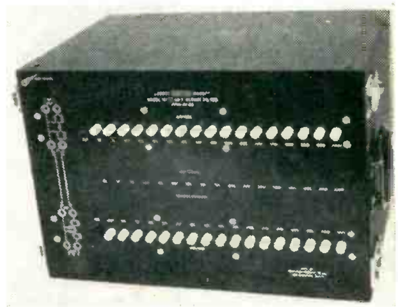
BUILDERS OF THE WORLD'S MOST POWERFUL ANTENNAS



of technical and nontechnical problems involving spacing, scaling, plotting and the like. The heart of the device is an extremely accurate calibrated triangular spring fastened at one end to the aluminum base and at the other end to a slide by means of brass end connections, screws and nuts. The slide is held in position by means of an adjustable pressure friction plug and always remains centered because of a dovetail fit between slide and base. An adjustable indicator fastened to the slide correlates the reciprocal and linear scales to the spring.

Half-Octave Filter

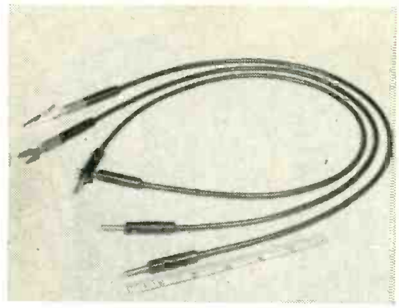
GERTSCH PRODUCTS, 11846 Mississippi Ave., Los Angeles 25, Calif. The BP-1 half-octave filter has been designed to meet a requirement where extreme attenuation outside the pass band and sharp cutoff are



required. Frequency range is from 37.5 to 13,600 cycles in half-octave steps; attenuation rate, 80 db per half-octave. Input and output are 600 ohms with one side common. Maximum input is +10 db referred to 1 mw.

Connecting Lead

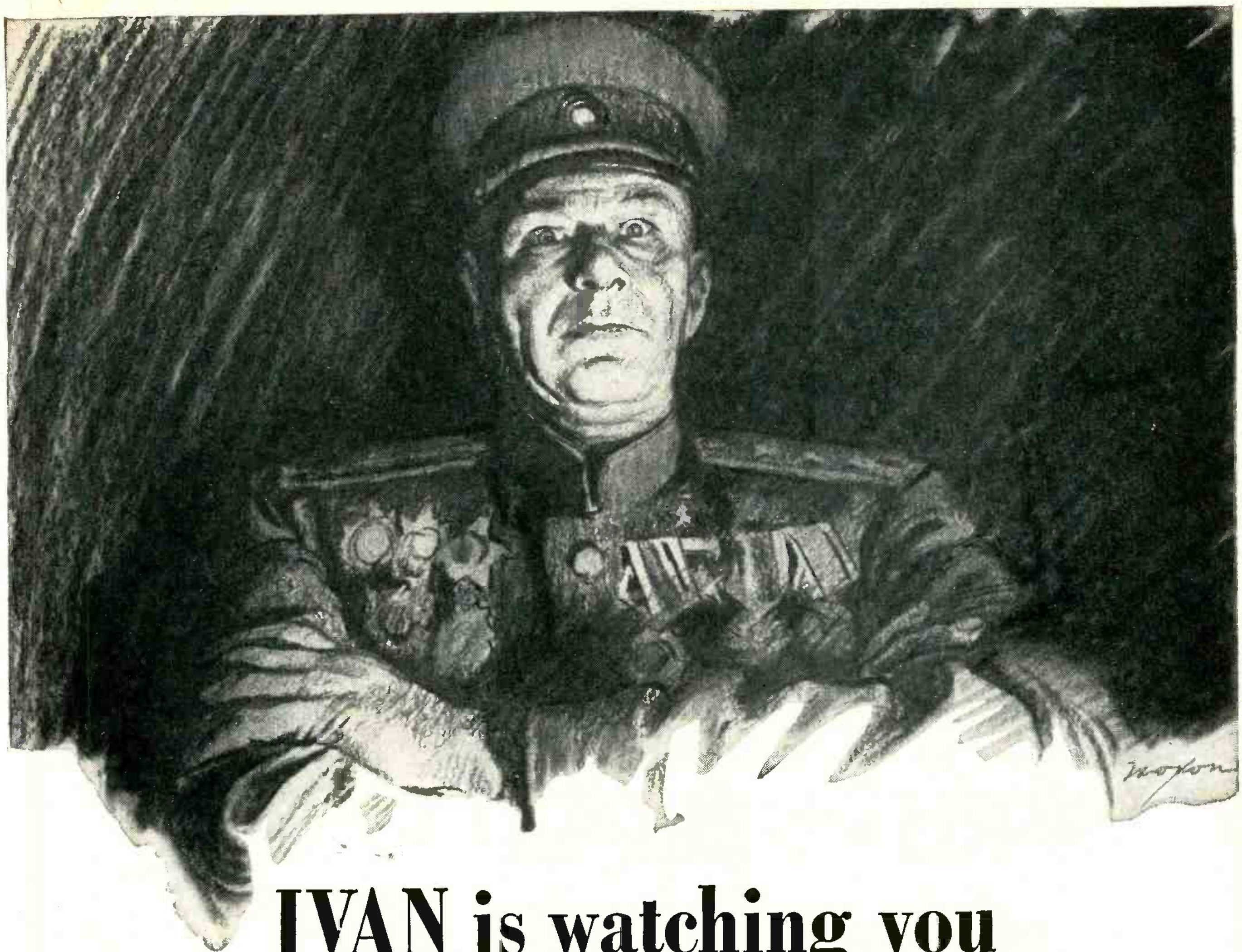
ASSOCIATED ENGINEERING CORP. OF BOSTON, 38 Euston Road, Brighton 35, Mass., has introduced the Addaplug connecting lead. Completely molded with vinyl plastic,



the lead consists of an insulated low-resistance wire, terminated by Addaplug connectors that feature a durable plug with a spring-loaded knife edge for firm low-resistance connections. The Addaplugs, which have plug holes in each for multiple connections fit into alligator clips, spade lugs and terminals of standard equipment. The lead will withstand 5,000 volts and has a current capacity of 15 amperes. Leads are available in various lengths and in red or black.

Flying-Spot C-R Tube

Radio Corp. of America, Harrison, N. J., has announced the 5ZP16, a 5-in. c-r tube for use as the flying-spot scanner in a video-signal generator. Resolution capability is better than 1,000 lines at the center of the reproduced picture. Featured is a metal-backed phosphor that has not only extremely short persistence to provide a good signal-to-noise ratio but also a stable decay characteristic for which equalization can be easily supplied. Other features include a high-resolution of the electrostatic-focus type and a 40-deg deflection angle to mini-



IVAN is watching you

IVAN is a dyed-in-the-wool Communist. There are only 6 million party members like him in all Russia, yet these Communist brass-hats enforce the iron dictatorship of the Kremlin over *200 million* Russians.

He's sold to the hilt on Red ideas. Which means he's out to get *you*. He believes it's either you or him . . . that the world is too small for both.

Ivan is working hard to beat you down. He has a big head start.

Right now he's got you in a bad spot.

Ivan is afraid of only one thing.

He fears your ability to out-produce him in guns, tanks, planes.

Frankly, he doesn't think you value your free system enough to do it . . . to make willingly the sacrifices he has squeezed out of the Russians.

But he's wrong!

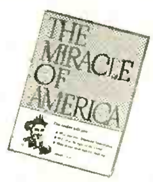
Because you and all of us have set out to build more and better weapons—to do it faster all the time.

We must use every bit of know-how and inventive skill we have to improve our machines and methods—to turn out more and more for every hour we work. Only in this way can we become militarily strong.

But we've got to supply essential civilian needs as well. We can't allow needless shortages to take prices skyrocketing and lower the value of our dollar.

Sure, that means sacrifices for everybody. But doing this double job well is the only sure way to stop Ivan in his tracks—and to save the freedoms which are ours and which he has never known.

FREE ***. . . this important booklet tells you how our American System Grew Great***



How Americans developed better machines, power and skills to build a great nation . . . Why we have been able to produce constantly more per hour . . . How this has given us the world's highest living standard.

How we can meet today's challenge—Why we must expand our productive capacity . . . supply arms and essential civilian needs, too. Read how this dynamic process works in free booklet, "The Miracle of America," endorsed by representatives of management and labor. Send for your free copy today!

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THE STRONGER WE GROW

mize deflection defocusing and provide high corner resolution.

Volt-Ohm-Mil-Ammeter

THE TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio. Model 666RL is a new handy size, compact volt-ohm-mil-ammeter that answers a need for portability and quick-testing usage. Its a-c/d-c voltage ranges from 0 to 5,000, at 1,000 ohms per volt; direct current to 10 amperes. Resistance is 0 to 3,000 to 300,000 ohms, 3 megohms. Only

one selector switch retains contact alignment permanently. Direct connections, with no cabling, eliminate chance for shorts. The unit features a precalibrated rectifier.

Tape Recording Head

SHURE BROTHERS, INC., 225 W. Huron St., Chicago 10, Ill. The tape recording head illustrated provides record and playback in one compact unit. Model TR6 series is designed for use in equipment where a separate a-c erase or a d-c erase may be involved. The structure insures production control of gap dimensions and alignment. Another feature is the fact that it em-

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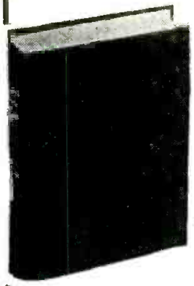

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RADIO ENGINEERING HANDBOOK

4. Provides quick answers to routine and special assignments in communications, broadcasting, aircraft radio, television, and related fields. Reflecting modern developments in the field, this handbook gives a complete coverage of every aspect of radio engineering—from inductance, power-supply systems, and electron tubes . . . to receiving systems, and code reception—all arranged in concise, quick-reference form. By Keith Henney, Editor-in-Chief. 4th Ed. 1197 pages, 1038 illus., $10.00

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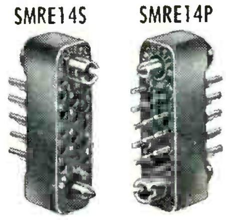
Miniature Rectangular (MRE) or Sub-Miniature Rectangular (SMRE) CIRCUIT CONNECTORS

Receptacle SMRE14S — Plug SMRE14P



Actual Size

The SMRE14 (14 contact) connector above follows the general design of the miniature rectangular (MRE) series but has been reduced to almost one-half size to meet recent requests for a smaller multi-contact connector for aircraft electronic applications.

They embody the usual high quality features that distinguish WINCHESTER ELECTRONICS connectors:

1. **MONOBLOC*** construction to reduce length of creepage paths and to eliminate dust and moisture pockets.
2. **MOLDED MELAMINE** body parts for high dielectric and mechanical strength.
3. **PRECISION MACHINED** contacts, gold plated over silver for consistent electrical conductivity, prevention of corrosion and ease in soldering.

Please write or telephone for additional information on our SMRE or other types of connectors.

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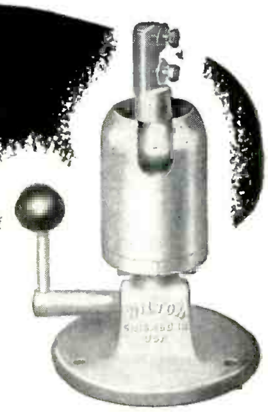
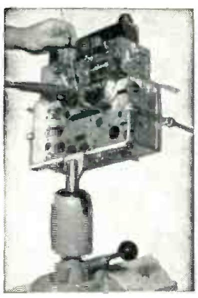


HERE'S HOW OTHERS DO IT



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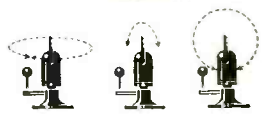

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Precision Built Bench Vises, "C" Clamps and Work Positioners

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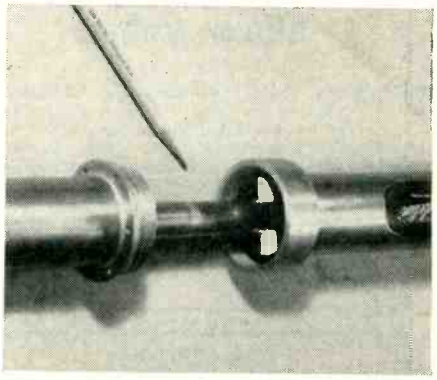
ploys an effective deep-drawn, mu-metal shield for optimum hum reduction. Record and playback coil impedance is 1,650 ohms at 1,000 cps; output level, 1 mv at 1,000 cps; and bias frequency, 25 kc.

Coaxial Line

PRODUCT DEVELOPMENT CO., INC., Arlington, N. J. Series 800 reflectionless r-f air-dielectric coaxial lines are now available in standard twenty-ft. assemblies in sizes up to $3\frac{1}{8}$-in. diameter with a unique Air-



tite coupling designed for use in broadband transmission service. A new Prodelin compensated insulator structure supports the center conductor without projecting through the surface of the outer conductor. The line has been serving in commercial and military systems handling higher powers and providing lower vswr values in applications up to 3,500 mc for tv, telephone, navigation, radar and other critical transmission systems.

Miniature Motors

SERVO-TEK PRODUCTS CO., Paterson, N. J., has begun production of a line of miniature permanent magnet field type d-c motors, measuring $1\frac{1}{8}$ in. in diameter by $1\frac{1}{2}$ in. long and weighing approximately $2\frac{1}{2}$ ounces. Motor voltage ratings from 6 to 28 volts are available for varied service applications ranging from fan or blower uses to telemetering sequence switch drives. A cylindrical, or ring type, Alnico V field magnet is used in conjunction with a 14 commutator segment armature. Long brush life and excellent commutation characteristics are

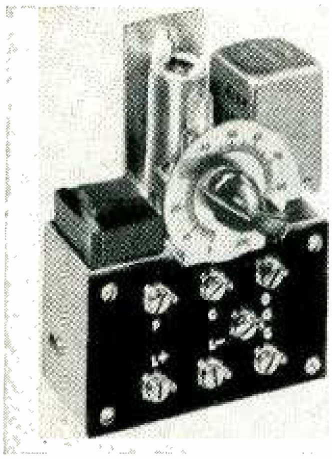
achieved. All units employ precision ball bearings and are available with high-altitude brushes for aircraft and allied services.

Wide-Range Bridge Oscillator

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1330-A bridge oscillator is a compact, stable, variable-frequency source of moderate power output. Three audio frequencies (power line, 400 and 1,000 cycles) and a wide continuous range of r-f from 5 kc to 50 mc, either modulated or unmodulated, are provided. Output voltage is of the order of 10 v, and more than one watt can be delivered into a 50-ohm load over most of the frequency range. Two levels of internal modulation at either 400 or 1,000 cycles are available over the range from 15 kc to 50 mc.

Electronic Relay

FARMER ELECTRIC CO., 21 Mossfield Rd., Waban 68, Mass. Positive operation on pulses as low as 0.5 millisecond, even with a total resistance as high as 500,000 ohms in the initiating circuit, is provided by the type CK electronic relay. The control relay operates approximately 10 milliseconds after contact, and normally remains energized for a time, adjustable by



means of a delay potentiometer, between 0.25 and 1.5 seconds. The relay is adaptable to use as an on-off timer for life-testing and laboratory applications. The spdt relay contacts are rated at 2 amperes, 115 v a-c, noninductive.

TV Signal Booster

I.D.E.A., 55 North New Jersey, Indianapolis, Ind. Model DB410 Regency tv signal booster has contra-wound bifilar coils with push-pull triode to give a balanced circuit. Internal impedance matching

an input and output accommodates either 300-ohm parallel-line or 73-ohm coaxial cable. The wide bandwidth assures satisfactory video-audio reception on all twelve channels.

Literature

Flexible Shafts. Kupfrian Mfg. Co., 218 Prospect Ave., Binghamton, N. Y. Bulletin 5194 describes

various typical flexible shafts and their properties, illustrates a number of standard fittings and also describes various casings that may be employed. Applications of the shafts treated are found in electronic and other instruments, servo devices, radio transmitters and receivers and remote controls for aircraft.

Preformed Contact Finger Stock. Eitel-McCullough, Inc., San Bruno, Calif., has available a catalog sheet giving an illustrated description of its preformed contact finger stock that is especially suitable for making connections to coaxially constructed tubes and those of external-anode design. The sheet also points out that the strip is an excellent means of providing good circuit continuity through adjustable components or to moving parts such as long-line and cavity-type circuits and also is very useful in acting as an electrical weatherstrip around access doors of equipment cabinets.

Antenna Data. Technical Appliance Corp., Sherburne, N. Y. Bulletin No. 65 covers the application of the special twin-driven Yagi antenna in overcoming the problem of cochannel interference. Complete technical information as to gain and directivity is given in curves and graphs, while other electrical characteristics are written up in the accompanying copy.

Selenium Rectifiers. Seletron Division of Radio Receptor Co., Inc., 251 West 19th St., New York 11, N. Y., has prepared a comprehensive new 16-page catalog on selenium rectifiers. In two colors and fully illustrated, it includes listings of dimensions and ratings for all miniature selenium rectifiers, as well as a large selected group of power stacks. It also contains complete background material on the versatile rectifiers and illustrates many of their uses.

Wire-Wound Resistors. Wirt Co. 5221-27 Greene St., Germantown, Philadelphia 44, Pa. Complete information and specifications on an extensive line of standard wire-wound resistors available in fixed,

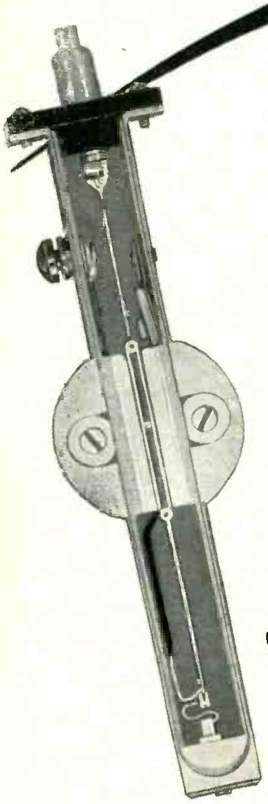
ferrule and adjustable styles are found in bulletin 176. Arranged for easy reference, a specification table lists catalog number and core dimensions with maximum wattages and resistances for Phenocoted units which are rated for maximum rise of 130 C above ambient temperatures; vitreous enamel and Infernocoted units for a maximum rise of 250 C.

Civilian Defense Pamphlet. Tracerlab, Inc., 130 High St., Boston 10, Mass. A new pamphlet entitled "How Safe," contains a discussion of the dangers of the radiation resulting from an atomic explosion and recommendations for instruments to be used for the protection of all personnel. The publication is of interest to all industrial safety directors and state, municipal and local civilian defense officials.

Booster Data. Industrial Television, Inc., 359 Lexington Ave., Clifton, N. J., has announced publication of application notes for its Autobooster and Multibooster. The notes described detailed methods of increasing gain by means of peaking, impedance matching and cascade operation. Also described are methods of eliminating several kinds of interference.

Tube Catalog. Eitel-McCullough, Inc., San Bruno, Calif. A new comprehensive catalog summarizes the basic characteristics of all the vacuum tubes manufactured by the company. In addition to data on vacuum tubes the publication contains pertinent information on other products presently being manufactured.

TV Transmitting Equipment. Allen B. DuMont Laboratories, Inc., Television Transmitter Div., 1000 Main Ave., Clifton, N. J. Several new equipment bulletins are available to anyone interested in telecasting operations or plans. They describe in detail the latest products of the division, including operational features, engineering data, illustrations and diagrams of interest to the station manager, engineer and planning personnel. Among the topics covered are: the universal color scanner, master



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HEILAND GALVANOMETERS

of high current and voltage sensitivity are the heart of Heiland recorders.

Heiland galvanometers are available in natural frequencies ranging from 32 cycles per second to 4700 cycles per second. All galvanometers are electromagnetically damped with exception of those having natural frequencies above 450 cycles per second; these are fluid damped. Permanent magnet assemblies are available for mounting 2, 6, and 12 Heiland galvanometers.

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Heiland DENVER

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ICA is the leading manufacturer of metal goods. Our line consists of hundreds of styles and sizes for relay racks, transmitters, amplifiers, speakers, meters, etc. . . . many with decorative chrome trim.

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THE MOST

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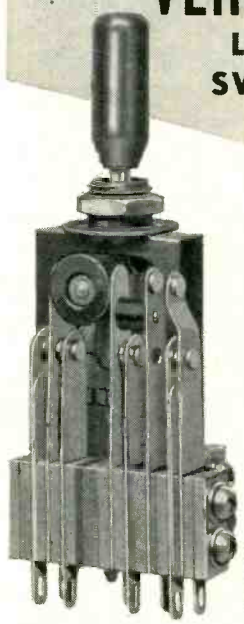
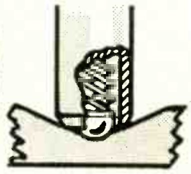
LEVER SWITCH

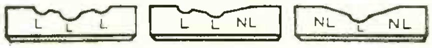


solves complex switching problems



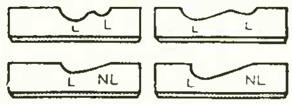
This simple mechanism gives positive control of these seven useful lever actions.

3-POSITION



2-POSITION

HALF-THROW FULL-THROW



THESE FEATURES

are the key to the exceptional versatility of the Type MCM lever switch.

Interchangeable stainless-steel camtracks as shown above are shaped to give your choice of seven different lever actions.

Lever arm can have full throw in non-lock as well as in locking action.

Detachable mounting block, carrying all contact assemblies, is held to frame with a single bolt; easily dismounted to speed wiring.

Alternate actuating methods include waterproof handle for marine use, rotary knob actuator, and lever arm for use with switch mounted parallel to panel.

Single-hole mounting; available with positioning pin if specified.

Compact design — switch extends only 2¾ inches back of panel and weighs but 3½ ounces complete with 12 springs.

High load rating — contacts will handle 10 amperes at 115 VAC, depending on load characteristics; insulation-tested at 2500 VAC to ground.

Ask for Catalog Sheet and B/P 351510 giving details of contact arrangements, lever actions, dimensions and prices.

GENERAL CONTROL COMPANY

1202 SOLDIERS FIELD ROAD
BOSTON 34, MASSACHUSETTS

control switch unit and master control mixer amplifier, universal console and linearity bar generator.

Electronic Student Aids. Sylvania Electric Products Inc., Emporium, Pa. A profusely illustrated bulletin listing: wall charts; notebook-size lesson folders; technical tube manuals; color code cards; radio symbol charts; tv servicing booklets; tube complement and characteristics bulletins for tv picture, radio receiving, radio transmitting and subminiature electron tubes; and eight precision instruments for school and college electronics laboratories, was recently published.

Transmitter Accessories and Parts. Gates Radio Co., Quincy, Ill., has available a new transmitter accessories and parts catalog. The publication covers open wire transmission line equipment, meter switches, relays, sockets, meters, remote metering equipment, coaxial cable, radio frequency inductors, sampling loops, isolation coils and power lighting chokes. Much application information is illustrated and described.

Positive-Ion Accelerators. High Voltage Engineering Corp., 7 University Road, Cambridge, 38, Mass. Bulletin H deals with Van de Graaff electrostatic accelerators for positive ions. The 5.5-million-volt unit that makes available a new energy range for precision research is described in addition to the 4-million-volt horizontal apparatus and the compact, 2-million-volt unit. Photographs giving external and internal views of the accelerators, and drawings that show the manner of installing the apparatus are included.

Precision Stampings. John Volkert Metal Stampings, Inc., 222-34 96th Ave., Queens Village 8, New York, N. Y., has published a 16-page word and picture tour of a precision stamping plant that serves the electronics, television and radio industries. A typical engineering-tooling-stamping problem of a radio tube manufacturer is described in detail. Another interesting feature of the booklet is the series of photographs of five progressive dies for producing complex stampings in high-production quantities.

Atomic Energy Development. The Kellex Corp., 233 Broadway, New York 7, N. Y. An 18-page booklet, "Engineering New Fields," contains information on the company's staff, facilities and present program. It includes a general story on the status of the U. S. atomic energy development and outlines the company's work for the AEC and the Armed Services.

Electronic Air Cleaner. Westinghouse Electric Corp., 200 Readville St., Hyde Park, Boston 36, Mass. Booklet SA-6691 describes in nontechnical language the Precipitron air cleaner for factories, stores and offices. The 8-page leaflet explains how it operates, why it cleans air so efficiently, where it can be used to advantage, how it is constructed and the kind of unit to select for a given job of air cleaning.

Marine Radio Service. Radiomarine Corp. of America, 75 Varick St., New York 13, N. Y. Details concerning world-wide marine radio and electronic service facilities are described in a 12-page illustrated reference booklet. The booklet shows the various types of systematic service plans available and illustrates the varied assignments covered by the company's technicians. The assignments referred to range from refinishing chassis and repairing broadcast receivers to overhauling shipboard radar sets and surveying damage claims, and include free consultation service on FCC regulatory matters.

Antenna Bulletin. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 64 covers a line of bidirectional and cardioid antennas. Radiation patterns, specifications, transmission line requirements and illustrations are included.

Germanium Diode Applications. Sylvania Electric Products Inc., Emporium, Pa. A new booklet describes 24 applications of germanium crystal diodes. It contains circuits for an interval timer; polarity checker; polarity reversal

alarm; spark quenchers; charger for small dry batteries; low current relay circuit; door chime "pepper"; photoelectric relay; crystal radio receiver; wired radio control transmitter and receiver; and other applications. Price is 25 cents a copy, postpaid.

Q Control. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Comprehensive data on characteristics and specifications of a new type Q control are found in catalog bulletin A-4. Advanced performance standards are completely given for Q control with "76" switch, insulated shaft, split bushing, Q control plain dual, concentric dual, plain triple and with taps. Detailed charts and graphs are shown.

Nonfiring Paints. Micro-Circuits Co., New Buffalo, Mich. A recent data sheet describes the SCT-series of silver Micropaints that have considerably higher conductivity, high-temperature durability and adhesion than has been obtained so far in similar preparations. A few uses of the paints described are in conductors, tube shields, circuit shielding and printed-circuit wiring.

Connector Bulletin. Waltham Horological Corp., 899 Main St., Waltham 54, Mass. A recent 6-page bulletin covers a line of r-f connectors and adapters, pulse connectors, telephone plugs and terminal boards. Tabular data, illustrations and dimensional diagrams are included.

Vibration-Isolating Mounts. The Barry Corp., 700 Pleasant St., Watertown, Mass. Assurance of accuracy and portability of machine tools, flexibility of plant operation, as well as reduction of building and machinery maintenance costs are described in bulletin 607. Included is a convenient table from which the proper Barrymount can be quickly selected in terms of machine-weight and strokes-per-minute.

Strain and Vibration Study. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. Bulletin 331 gives a 2-page description of the H-42A

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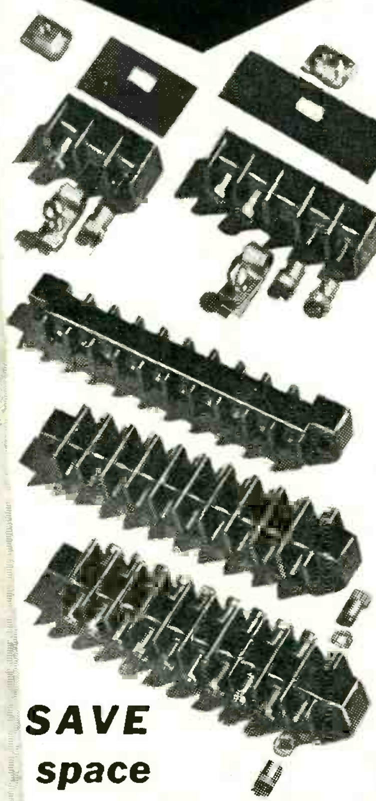
now available for industrial use...



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Shaw developed these terminals to highest standards for the Navy. They're designed to eliminate non-functional material and take advantage of minimum space. Their maximum strength, high voltage insulation, and quick easy installation make them ideally suited for industry. Send for complete information today.

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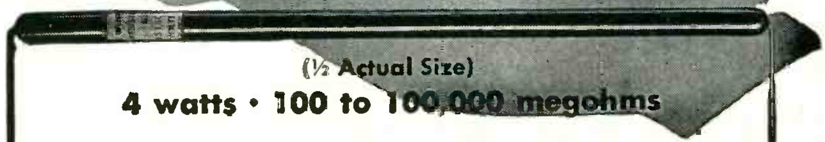
QUALITY MARK ON MOLDED PLASTICS

The new S.S.WHITE 80X HIGH VOLTAGE RESISTOR



(½ Actual Size)

4 watts • 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage cofficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture - resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

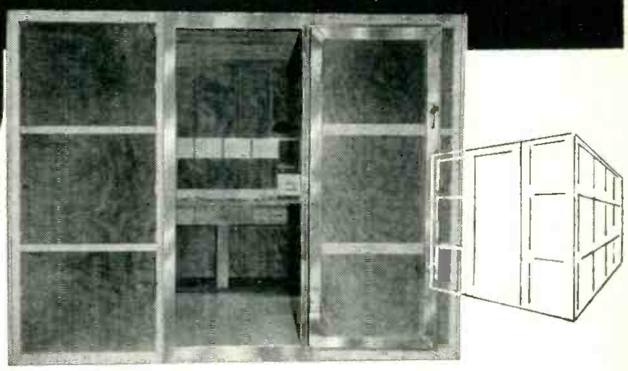
WRITE FOR BULLETIN 4906

It gives complete information on S.S.White resistors. A free copy and price list will be sent on request.

THE S.S.White DENTAL MFG. CO. INDUSTRIAL DIVISION
Dept. R, 10 East 40th St.
NEW YORK 16, N. Y.

SHIELDED ACE ROOMS PHILA., PA.

...for MAXIMUM RADIO INTERFERENCE SUPPRESSION



- ✓ "Cell-type" panel construction
- ✓ Ready built
- ✓ Ready to assemble
- ✓ Easy to disassemble and relocate
- ✓ Easy to enlarge
- ✓ Many standard sizes
- ✓ Special filter entry
- ✓ Unique door construction
- ✓ Built to last

Attenuation of 100 db. from 0.15 to 10,000 mc. obtainable

(HIGHER ATTENUATION WITH SPECIAL DESIGN)

Scientifically designed and constructed for maximum radio interference suppression, ACE pre-built screen rooms assure real accuracy for:

Radio inspection and quality control... R-F calibration, susceptibility, spurious radiation and other tests.

and complete, low-cost shielding for:

Medical instruments sensitive to minute voltages, diathermy, induction heating and similar equipment that must meet FCC interference regulations,

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Telephone: REgent 9-1019

Strainalyzer, an instrument used in conjunction with SR-4 resistance wire strain gages and designed for dynamic strain and vibration studies from 0 to 50,000 cps. Possibility of simultaneous observation and recording of four strains is shown.

Adjacent Channel Interference. Westinghouse Electric Corp., 2519 Wilkins Ave., Baltimore 3, Md. A new 10-page railroad radio booklet (SA-6736) presents a relatively simple graphical method of evaluating the adaptability of f-m radio equipment for adjacent channel use. The graphical method described uses a plot of receiver attenuation vs frequency off-resonance for both type FE railroad radio equipment and a hypothetical receiver, both meeting AAR specification points, and both with their squelch circuits adjusted to open on an assigned channel signal of 0.5 μv.

Function Plotter. Minneapolis-Honeywell Regulator Co., 4428 Wayne Ave., Philadelphia 44, Pa. Outstanding advantages, applications and detailed information on the ElectroniK function plotter are found in data sheet 10.0–5. With the instrument described it is possible to record automatically a precise and continuous curve representing the relation of any two variables that can be reduced to a d-c voltage.

Equipment Catalog. Milo Radio & Electronics Corp., 200 Greenwich St., New York 7, N. Y., is offering free to industrial purchasing agents a copy of its gigantic 1,053-page catalog. The lavishly illustrated book lists the products of the major radio-electronic equipment manufacturers, complete with prices and discounts, and will serve as a valuable ready-reference buying guide.

General Export List. Hellesens Enke & V. Ludvigsen Ltd., Copenhagen, Denmark, has available a booklet made up of catalog sheets covering a line of electrolytic capacitors, paper capacitors and high-frequency iron dust cores. Complete descriptions and a full export price list are included.

NEWS OF THE INDUSTRY

(continued from page 148)

in the next few months.

Together with a number of other military orders received earlier this year, the new order brings the company's war contract total over the $5,000,000 mark.

No specific information concerning the product to be manufactured could be revealed except that it is mechanical-electrical in nature and requires close tolerances and high-quality manufacturing processes. The military orders will not curtail civilian operation.

Air Force Aids Radio Reception Studies

OFFICIALS at Air Materiel Command, Wright-Patterson AFB, Dayton, Ohio, recently announced a three-way cooperative venture, involving the Air Force, State Department and the Crosley Broadcasting company. The plan is expected to assure the continuance of undistorted radio reception in a radius of 150 to 200 miles from Cincinnati.

Because new antennas being installed for the Voice of America broadcasts may interfere with the radio waves from station WLW and thus modify its coverage characteristics and cause distortion in receiving sets, studies are being made of the existing intensity patterns of the standard broadcast station with a view toward determining the extent of reradiation of waves from the new antennas and the seriousness of the possible interference.

An Air Force helicopter, equipped with standard field intensity measuring equipment and two types of antennas mounted on a pole extending from the front of the aircraft, flies for several hours a day over check points around WLW's transmitting tower. Intensity readings are taken at various altitudes up to 5,000 feet and in eight directions from the tower. When all readings have been taken, engineers will analyze their findings and will augment them with similar readings taken after the new antenna system is constructed, six months to a year from now.

An analysis of the readings is expected to show that the reradiation of the new antenna system will

be so low that it will not interfere with the standard broadcast. Should its intensity be high enough to cause distortion, however, the engineers can either detune the new antennas or trap the interfering signals. Either or both methods are expected to eliminate reradiation by the antennas.

NPA Appoints NEDA Members

THE Industry Advisory Committees of NPA have appointed six members of National Electronic Distributors Association to serve as members of the Electronic Parts and Components Distributors Industry Advisory Committee.

Those named to serve on the committee are Arthur C. Stallman of Ithaca, N. Y.; Dahl W. Mack of Scranton, Pa.; W. D. Jenkins of Richmond, Va.; George Wedemeyer of Ann Arbor, Mich.; Hoyt C. Crabtree of Dallas, Texas; and Lealis L. Hale of Monroe, La.

The first meeting of the committee was held on March 5, 1951 in Washington, D. C. Agenda include critical materials, supply situation, inventory problems, conservation, repair parts program and equitable distribution.

BUSINESS NEWS

WESTINGHOUSE ELECTRIC CORP. will construct a new manufacturing plant on a 70-acre site in Bath, N. Y., to produce electronic tubes for the Armed Services and for essential industries.

LONG ISLAND RADIO CO., formerly of Flushing, N. Y., has moved to a new address at P. O. Box 474, Montrose, Pa.

PHILCO CORP., Philadelphia, Pa., has established a separate Government and Industrial Operating Division with full divisional status, to handle increased output of government and industrial products.

GLOBE-UNION INC. has purchased a 650-ft building at 3410-3450 W. Hopkins St., Milwaukee, Wisc., to be used by the company's Centralab electronics division. Facilities in

Here it is! The

NEOMATIC

A TRULY RUGGED

SUBMINIATURIZED

Anti-vibration

Anti-acceleration

RELAY

High and Medium Sensitivity

Actual Size

Small in size! Big in performance!

The latest development in subminiaturized relays! NEOMATIC Relays are extra small, feather-light, yet are rated higher than much larger conventional relays. NEOMATICS are extremely rugged, yet are exceptionally sensitive. Special anti-vibration, anti-acceleration design assures positive functioning under severe operating conditions. Ideal where space is strictly limited.

Over 500,000 current interruptions with no evidence of wear! NEOMATICS are solving daily the really tough relay problems in aircraft, guided missiles, rockets, radar, radio and telemetering devices. For fast solution to your subminiature relay problems—call on NEOMATIC engineers. They are always glad to help.

RAPID DELIVERY

SPECIFICATIONS — Model 5500 — Standard

Vibration Resistance	20 g's
Acceleration Resistance	Over 50 g's
Contacts	SPDT, 1 amp (non-ind.)
Coil Voltages	3-72 V. D. C.
Coil Resistances	8-5000 ohms
Coil Power Consumption	1 watt
Weight	0.462 oz.
Size	less than 0.5 cubic inch

Other models also available

Hermetically sealed No. 5610, special alloy contact No. 5530 for heavy loads, and dual SPDT No. 5580 for motor control.

NEOMATIC, INC.

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Square Wave Generator

MODEL 71

MANUFACTURERS OF

- Standard Signal Generators
- Pulse Generators
- FM Signal Generators
- Square Wave Generators
- Vacuum Tube Voltmeters
- UHF Radio Noise & Field Strength Meters
- Capacity Bridges
- Megohm Meters
- Phase Sequence Indicators
- Television and FM Test Equipment

SPECIFICATIONS

FREQUENCY RANGE: 5 to 100,000 cycles.

WAVE SHAPE: Rise time less than 0.2 microseconds with negligible overshoot.

OUTPUT VOLTAGE: Step attenuator giving 75, 50, 25, 15, 10, 5 peak volts fixed and 0 to 2.5 volts continuously variable.

SYNCHRONIZING OUTPUT: 25 volts peak.

R. F. MODULATOR: 5 volts maximum carrier input. Translation gain is approximately unity—Output impedance is 600 ohms.

POWER SUPPLY: 117 volts, 50-60 cycles.

DIMENSIONS: 7" high x 15" wide x 7½" deep, overall.

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

Ideal for

ANTENNA CONNECTIONS
PHOTO-CELL WORK
MICROPHONE CONNECTIONS

JONES

SHIELDED TYPE

PLUGS & SOCKETS

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS. SUPPLIED IN 1 AND 2 CONTACT TYPES:

P-101-¼

S-101

101 Series can be furnished with ¼", .290", 5/16", ⅜" or ½" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation and sockets have bakelite. Quality construction. Fine finish. Assembly meets Navy specifications.

For full details and engineering data ask for Jones Catalog No. CS-18.

JONES MEANS Proven QUALITY

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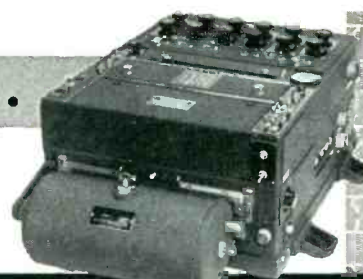

for complete oscillographic recording

The S-8 Oscillograph, long the standard of oscillographic recording, has been improved to meet the expanding demands of modern research. The NEW Type S-8 Oscillograph has *all* the inherent capabilities you need to record rapidly changing phenomena such as vibration and dynamic strain.

A few of the newest features are:

QUICK-CHANGE TRANSMISSION—16 record speeds over range of 120:1

FULL RESILIENT MOUNTING makes possible use of super-sensitive galvanometers

CHART TRAVEL INDICATOR provides continuous indication of chart motion

NEW GALVANOMETER STAGE takes all Hathaway galvanometers for recording milliamperes, microamperes, and watts.

NEW RECORD-LENGTH CONTROL and NUMBERING SYSTEM for long, trouble-free service

All the other valuable features characteristic of the S-8 are retained. Investigate the NEW Type S-8 and its 170 types of galvanometers.

Write for Technical Bulletin 2B-1A-G.

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

the 158,000 sq ft of space will be devoted entirely to production of a defense item in the classified category.

REX RHEOSTAT CO., Baldwin, L. I., N. Y., has sold to P. R. Mallory & Co., Inc., Indianapolis, Ind., its equipment for manufacturing vitreous-enamelled, round power rheostats for 50 to 500 watts. In addition, the Mallory Co. has acquired the exclusive patent and manufacturing rights.

I.D.E.A., INC., Indianapolis, Ind., tv signal booster manufacturer, has expanded its production facilities by the addition of 25,000 sq ft of floor space.

BERGEN-PASSAIC ELECTRONICS, INC., Bogota, N. J. is broadening its activities to include consulting engineering on electronic equipment maintenance and service problems, with emphasis on consultation in early design stages to minimize need for special test equipment and simplify servicing requirements.

ACME ELECTRONICS, INC., has moved from Los Angeles to larger quarters at 300 N. Lake Ave., Pasadena, Calif. The company designs and manufactures precision wave filters, sonar and radar delay lines, coils and similar devices.

PERSONNEL

ANDREW KALITINSKY, former chief engineer of the Nuclear Energy for Propulsion of Aircraft Project, has been appointed manager of the M. W. Kellogg Co. Special Projects Department.

JOHN S. BOYERS, formerly chief engineer and assistant treasurer of the corporation since 1946, has been elected president of Magnecord, Inc., manufacturer of high-fidelity magnetic tape recorders for the broadcast, industrial and educational markets.

MARTIN V. KIEBERT, JR., formerly with Raymond Rosen Engineering products, Inc., as manager and director of research of the company's telemetering division, was recently

appointed business manager of the Research Laboratories of Bendix Aviation Corp., Baltimore, Md.

EDWARD G. HALL, for several years general transmission engineer for the Indiana Associated Telephone Corp., Lafayette, Ind., had been appointed engineering representative for the sales and engineering service department of The Lenkurt Electric Co., San Carlos, Calif.

E. G. Hall

H. S. Bamford

HENRY S. BAMFORD, vice-president and chief engineer of the company since 1942, was recently elected president of Electronic Tube Corp., Philadelphia, Pa., manufacturers of electronic instruments and c-r tubes.

WALTER J. BONAZZA, formerly associated with Hazeltine Electronics Corp., is now chief engineer of Aerocoil Inc., Union City, N. J.

WALKIE-SEEIE DEMONSTRATED

Jack Dilley and model demonstrate 53-pound newly developed portable television transmitter before IRE in New York City last March. Trial model, developed under direction of Vladimir K. Zworykin at RCA Laboratories, Princeton, N. J., sends both voice and video signals for a distance of a mile

NEW BOOKS

(Continued from page 150)

three chapters of the book.

The text is ideally suited for personnel with formal training in microwave theory. It is an excellent companion to Professor Barlow's book, "Micro-Waves and Wave Guides," published by Dover. This book should prove to be most valuable as a reference manual for graduate courses in microwave laboratory techniques even though details of equipment design and methods for determining equivalent circuits of multiterminal structures are not elaborated upon. Each chapter is documented with an adequate bibliography, which is in the main British.—ANTHONY B. GIORDANO, *Polytechnic Institute of Brooklyn*

Short Wave Wireless Communication

BY A. W. LADNER AND C. R. STONE, *both former affiliates of Marconi's Wireless Telegraph Co. Ltd., of London. John Wiley and Sons Inc., New York*, 1950, *5th edition*, 716 *pages*, $8.00.

A COMMON complaint about books on the subject of communications is that they are usually too technical and too theoretical. As an example, in most books the chapters on tuned circuits are of limited value when one is actually confronted with the problem of choosing a wire size for winding a coil for a specific purpose.

This new fifth edition of a widely-accepted British book comes just about as close as possible to tying theory and practice together in an understandable way. For instance the effects of different values of Q in power amplifiers are fairly well known among practical engineers, but most of us can remember what a mystic thing this Q was when we first came across it in college. To orient the reader on this subject, the authors of Short Wave Wireless Communication have listed the various effects of low Q and high Q. The reader finishes the chapter on power amplifiers with a complete picture.

The illustrations are plentiful, but somewhat inferior in quality. By American standards, they are oldfashioned—indeed, some of the photographs appear to have aged

with the book since its first publication in 1932. The writing is definitely British, but since circuits and theory explanations are of a general nature and not confined to specific tube types, this fact should not detract from the book's value to American readers. Practical examples and problems are included.

The book is recommended as supplemental reading for anyone engaged in studying communications who feels that the gap between the textbook formulas and the breadboard or chassis is too great. Some would resent the absence of mathematical treatment, but many will appreciate this omission.—J.D.F.

Television Receiving Equipment

BY W. T. COCKING. *Published for Wireless World by Iliffe and Sons Ltd., Dorset House, Stamford St., London, S.E. 1, England,* 1950, 375 *pages,* 19 *shillings plus* 8d. *postage.*

AS GLOBAL distances become more and more insignificant, technical differences in ways and means of different countries become more and more evident. The engineers of various countries seem to consider their pet technical systems just as sacred as their flags and standards.

In this book, W. T. Cocking presents the British side of television reception. The material presented, however, should be of value to both British and American engineers. To the British, it represents a well-organized compilation of current circuits and techniques in which they find themselves involved from day to day. To American engineers it fulfills the need for a to-the-point synopsis of what the other guy is doing.

The book assumes a fairly complete previous knowledge of radio, but the coverage of television is complete and thorough. The material has been carefully organized, reflecting the editor's experience in both the technical side of his subject and journalism. Although two chapters are devoted to servicing and finding and remedying faults, the book is not recommended as an aid to the serviceman, as such. It will of course furnish background

for the serviceman, but the actual discussion of dollars-and-cents troubleshooting is very limited and somewhat sketchy.—J.D.F.

The Electronic Musical Instrument Manual

BY ALAN DOUGLAS. *Pitman Pub. Corp., 2 West 45, New York, 1949, 142 pages, $3.50.*

This British-authored book discloses design details of American as well as British commercial instruments, including many circuit diagrams on which values of component parts are commendably indicated as an aid to understanding circuit operation. Four opening chapters on underlying theory deal with the nature of sound, the nature of music and noise produced by strings and by wind instruments, the construction of conventional pianos and organs, and the production and mixing of electrical oscillations. Next comes a highly practical chapter on the amplifiers, tone controls and loudspeakers required with all electronic musical instruments, and the remainder of the book deals with the instruments themselves.

Apparently U. S. firms are well advanced in this particular field, because well over ninety percent of the book deals with or is applicable to their products. The book is well written, and highly recommended both for background reading and for engineering reference by anyone interested in the music of vacuum tubes, electromechanical tone generators and photoelectric tone generators.—J.M.

THUMBNAIL REVIEWS

RADIO AND TV INDUSTRY RED BOOK. Howard W. Sams & Co., Inc., Indianapolis, Ind., 2nd Edition, 1950, 623 pages, $3.95. New edition contains 8 sections: I—component replacement listings for 1938-1948 radios and amplifiers, including correct replacement data for tubes, dial lights, electrolytic capacitors, transformers, chokes, phono cartridges, i-f coils, speakers and controls; II—same for 1948-1950 sets; III—postwar television receiver replacement listings, covering tubes, dial lights, electrolytics, iron-core transformers, phono cartridges, coils, speakers and controls; IV—vibrator replacements for 1938-1950 sets; V—battery replacements for 1938-1950 sets; VI—selenium rectifier re-

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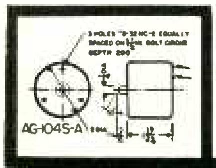

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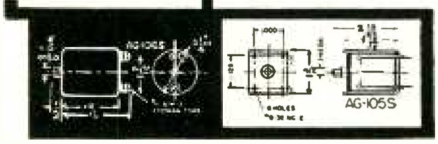

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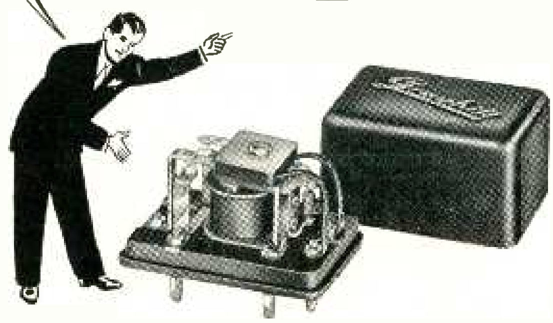

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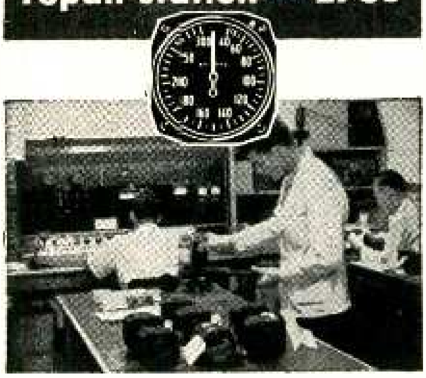

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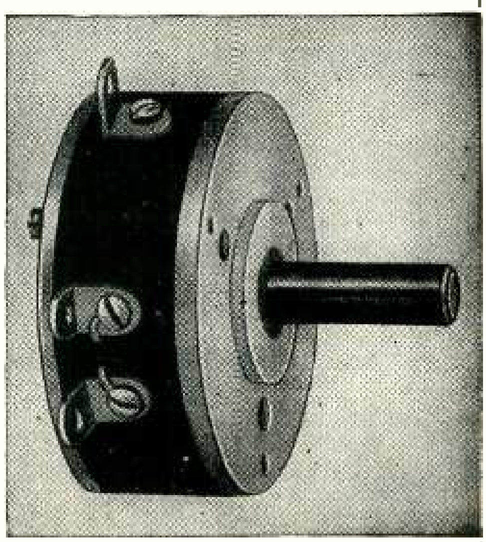

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placements for postwar equipment; VII—volume control replacement data for very popular 1931-1938 radios; VIII—installation notes.

HANDBOOK OF HUMAN ENGINEERING DATA FOR DESIGN ENGINEERS. Tufts College Institute for Applied Experimental Psychology, Technical Report No. SDC 199-1-1, produced under contract with Special Devices Center of ONR; approximately 350 pages loose-leaf, $5.00 from Tufts College Bookstore, Medford, Mass. Report on investigation into all aspects of increasing the effectiveness of a man-machine system, with emphasis on data pertaining specifically to fighting machines. Essentially a condensed compilation of literature on the subject, organized for convenient reference. Subjects covered include minimum and maximum space requirements for functional use of human body, factors affecting visual acuity, light sensitivity, depth perception and color vision; factors affecting efficiency of hearing; human response to various cues; effect of amount of sleep, temperature, humidity, ventilation, drugs, alcohol, tobacco, caffeine and benzedrine on higher mental processes, motor processes, sensory processes and physiological functions.

AUTOMATIC RECORD CHANGER SERVICE MANUAL. Volume 3 (1949-1950). Howard W. Sams & Co., Inc., Indianapolis, Ind., 286 pages, $3.00. Servicing information and exploded views of mechanisms of 30 record changers, wire recorders and tape recorders, based on analysis of actual equipment, with cumulative index covering models in first two volumes as well.

MODEL CONTROL BY RADIO. By Edward L. Safford, Jr.; No. 43 of the Gernsback Library, published by Radcraft Publications, Inc., 25 West Broadway, New York, paper cover, 112 pages, $1.00. The author, who is instructor in Guided Missile Electronics at Fort Bliss, Texas, has carefully selected portions of the literature that are of value to the person applying radio control to model ships, airplanes and cars. The book presents complete systems, separate sections on fundamentals of receiver and transmitter design, and discussions of various types of tubes, batteries, controls, servos, antennas, coders and decoders and power circuits. All component values for circuit diagrams are given, even coil dimensions.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS, 1949 Supplement, American Society for Testing Materials, Philadelphia, 28 pages, paper-covered, $0.75.

APPLIED ELECTRONICS ANNUAL 1951. British-Continental Trade Press Ltd., 222, Strand, London, W.C. 2. 264 pages, $8.00. Available also from J. D. Griffiths, 2 Clarke Court, Rutherford, N. J. Collection of articles on various aspects of broacasting, communication, radar, radioactivity an dindustrial electronics; addresses and officers of electronic associations throughout the world; addresses of electronic manufacturers throughout the world, arranged by countries; buyers' guide listing firms making various electronic components and equipments.

INDUSTRIAL RESEARCH LABORATORIES OF THE UNITED STATES. Published by National Research Council, National Academy of Sciences, Washington, D. C., Ninth Edition, 1950, 444 pages. For each of 2,845 different research laboratories, gives address of lab, names of executives, size of research staff, nature of research activities, whether consulting services are available, and size of library. Appendices give similar data for government labs and for universities and colleges offering research services to industry. One index gives geographical distribution of laboratories, and the other is a subject index to research activities. For electronics, 189 labs are listed; for microwave equipment 13; antennas 16; radar 22; radio 69; television 43.

BACKTALK

(continued from page 152)

our eminent and revered friend, Dr. V. K. Zworykin (ELECTRONICS, March, 1951, page 81).

However, there are also sins of editorial omission, often quite as serious as those of commission. May I accordingly welcome you also to Rho Phi Epsilon, the fraternity of Red-Faced Editors. Please consider yourself elected, "tapped," initiated, and a member in as good standing as the rest of us.

I refer particularly to a beautiful but mangled composition which appeared in the March, 1951 issue of ELECTRONICS, namely, Dr. A. C. Schroeder's letter on "Simultaneous Systems". His letter started sedately, and with promise, on page 154 of your journal, under the general heading of "Backtalk". It ended after about one paragraph without any indication of the page on which it would resume its thoughtful way. In other words, the reader could only guess how far "back" the "talk" would be continued. Still sadder, the final sentence on page 154 was both cryptic and challenging, namely, "Since sampling multiplies the". This left the reader dangling, supported by an uncomfortable noose. What was multiplied by sampling, he asks himself. Could it be trouble, joy, dot visibility, circuit components, or something else?

On the following page 155, the reader finds only a pleasing advertisement. Pages 156 and 157 bring him no more than the startling news that 1,862,000,000 fasteners were used in television set assembly in 1950—and ELECTRONICS helped get them there. Surely these billions of fasteners could not have been multiplied by sampling. Page 158 brings another advertisement and also a continuation, stated to be from page 138, of "Tubes at Work". Hopefully the reader scans the first few phrases. But they do not fit into the *"Backtalk"* jigsaw puzzle.

Rather desperately the reader continues on his way, grimly determined to find what sampling multiplies. Like fluttering calendar sheets in a movie, the individually and carefully scanned pages fly past; 162, 170, 180, 200, 220, 240, 260, 280 and 300. Pausing for

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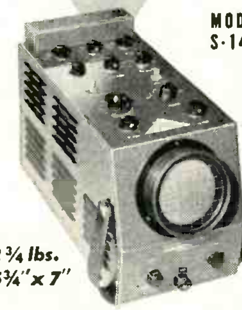

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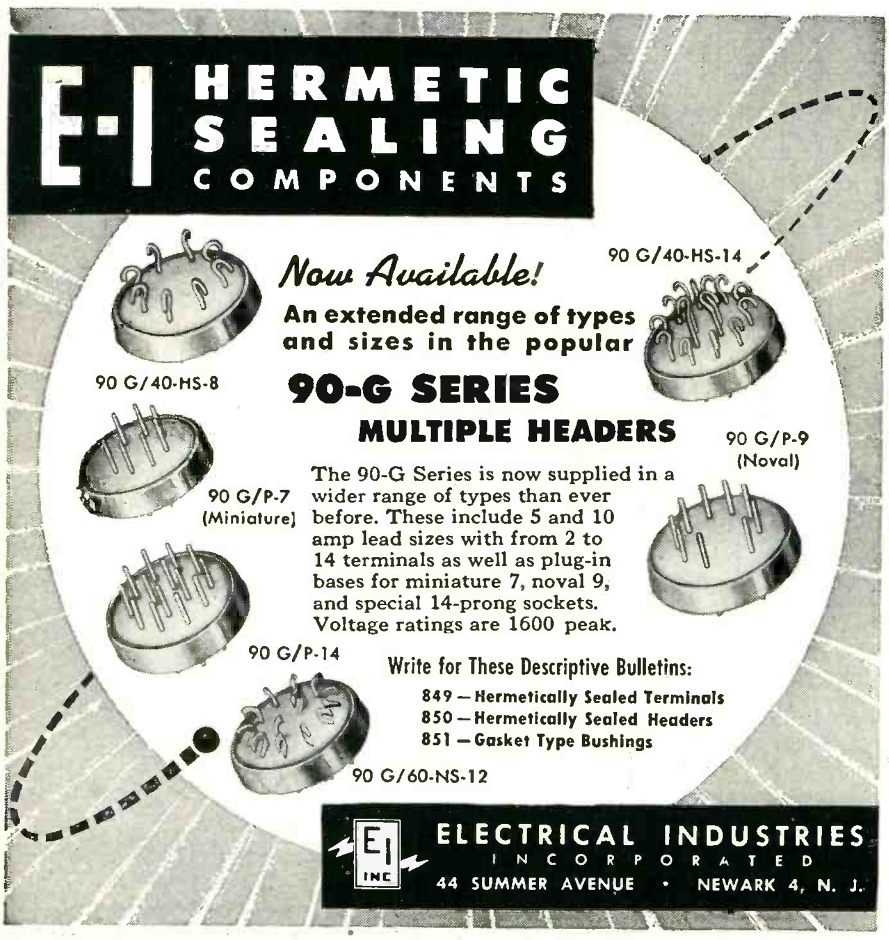

breath and renewed vigor, the reader decides to fight out this battle even if it takes all summer. After all, eventually the Editor of ELECTRONICS will have to break down and tell what sampling multiplies. So he plods on, somewhat like Kipling's "boots" over Africa.

And then, Eureka! On page 318, and without any indication of authorship by Dr. Schroeder or the page from which it stems, Dr. Schroeder's letter is resumed. It is a bit of an anti-climax to find that what is multiplied by sampling is a mathematical function. But why quibble after so great a triumph as finding an unannounced continuation of an important analysis only 164 pages further on.

From this point, the sailing is comparatively smooth. Sandwiched here and there, a paragraph or two to a page, the reader picks his way through the letter on pages 320, 322, 324, and 326. Thus he triumphantly finds the remainder of Schroeder's "Unfinished Symphony".

Evidently our editorial slips are showing. And as one not without sin I have not hesitated to throw the second stone.

With sincere regards,

Whimsically yours,

ALFRED N. GOLDSMITH
Editor
Proceedings of the Institute of Radio Engineers

Editor's Note: Doctor Goldsmith's observations are, unfortunately, quite correct. We were, however, somewhat relieved to find that our distinguished critic's careful eye overlooked a similar omission in the *New Books* department for the same month. We should have had continued lines routing book review readers to page 306. We hope our standing in Rho Phi Epsilon will not be jeopardized if we promise it will never happen again.

Electronics Quiz

THIS month's quiz puzzler was furnished by A. T. Colbeck of Talgarth, Brecs, Wales. For his contribution, Colbeck will receive our check for five dollars, as will all

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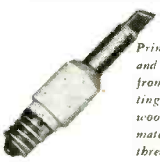

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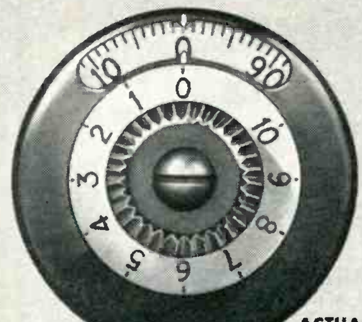

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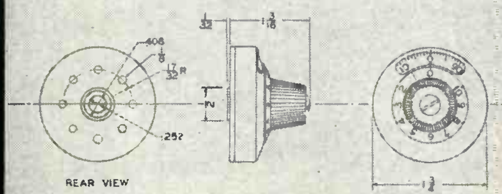

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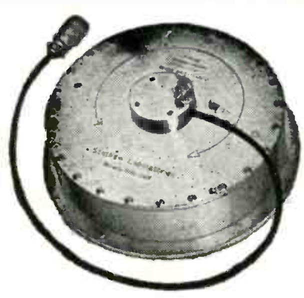

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of the other contributors whose problems are published in this department.

This Month's Problem

A bridge of resistors is formed as follows: C to A = 100,000 ohms; A to D = 200,000 ohms; D to B = 50,000 ohms; and B to C = 100,000 ohms. Points C and D are connected across a zero-impedance source of 300 volts d-c, and a 10-μf capacitor is placed between points A and B.

What will be the initial current flowing into the capacitor at the instant the voltage is applied? Also, what is the time constant of the circuit? (By time constant is meant the time taken for the potential difference across the capacitor to rise to $(1 - 1/\epsilon)$ of its final value.)

The answer to this problem will be published in this column next month.

Last Month's Problem

Last month's problem was as follows:

Assume a superheterodyne receiver with a signal input to the converter of frequency f, and a local oscillator input of frequency (5/4)f. Then, in accordance with established principles of converter action, its output will contain the two input frequencies f and (5/4) f, and the sum and difference frequencies (9/4)f and ¼f. The intermediate frequency amplifier is, as usual, tuned to pass only the difference frequency.

Now suppose that, instead of the local oscillator, we substitute a modulator. This modulator accepts the signal input of frequency f and modulates it with a voltage of frequency ¼f, taken from a point at or near the output of the intermediate frequency amplifier. In accordance with principles of modulator action, its output will contain the two input frequencies f and ¼f, two side-band frequencies (¾)f and (5/4)f,

and higher harmonics which may be bypassed and neglected. Note that the side-band frequency (5/4)f is the same as the local oscillator frequency in the original receiver. The other side-band frequency (¾)f. entering the converter would produce beat frequencies with the signal frequency, of which only the difference frequency ¼f would be accepted by the intermediate frequency amplifier.

General Case

Extending the reasoning now to the general case for any ratio n of signal frequency to intermediate frequency, the output of the modulator contains the frequencies

$$f + \frac{f}{n} \text{ and } f - \frac{f}{n}$$

Considering the first of these two terms in the converter action, we obtain the following expressions for the sum and difference frequencies in its output:

$$(1) \quad \left(f + \frac{f}{n}\right) + f = 2f + \frac{f}{n}$$

(rejected by i-f amplifier)

$$(2) \quad \left(f + \frac{f}{n}\right) - f = \frac{f}{n}$$

(passed by i-f amplifier)

Considering the other modulator output frequency, we obtain for the sum and difference frequencies in the converter output:

$$(3) \quad f + \left(f - \frac{f}{n}\right) = 2f - \frac{f}{n}$$

(rejected by i-f amplifier)

$$(4) \quad f - \left(f - \frac{f}{n}\right) = \frac{f}{n}$$

(passed by i-f amplifier)

Thus it would appear that we can construct a superheterodyne receiver with a modulator operating as described instead of a local oscillator. The modulator would automatically provide the correct relationship of frequencies to make best use of the intermediate frequency amplifier characteristic and thereby do away with the tracking

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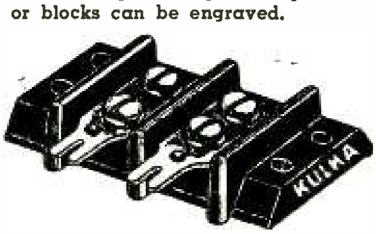

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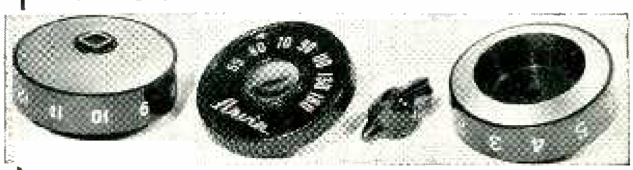

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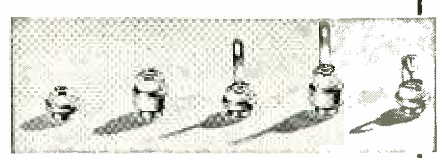

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problems inherent in the tuning of an adjustable type of local oscillator.

What is the fallacy in this reasoning?

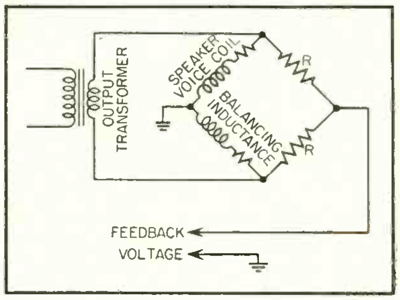
Answer: The reasoning is not fallacious per se. It is actually possible to construct a receiver operating on this principle, although the feedback involved makes stabilization of the circuits extremely difficult. Furthermore, the circuit would accept all signal frequencies equally well, and hence such a receiver would have no better selectivity than that of the preselector ahead of the converter.

Feedback

DEAR SIRS:

ROBERT TANNER of Stanford, California (Stanford University) did an excellent detailed theoretical analysis of a loudspeaker coupled to an amplifier in his article entitled "Improving Loudspeaker Response with Motional Feedback" in *Electron Art*, March, 1951.

I am enclosing letters to show that I had the same idea; in fact, with my good friend Russell Warren I made a stab at getting a patent on the idea in 1939. We conducted laboratory experiments on both RCA and Jensen speakers by winding an



extra coil on the voice coil form for feedback. The results were very pleasing.

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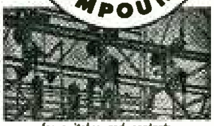

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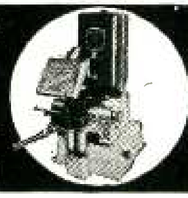

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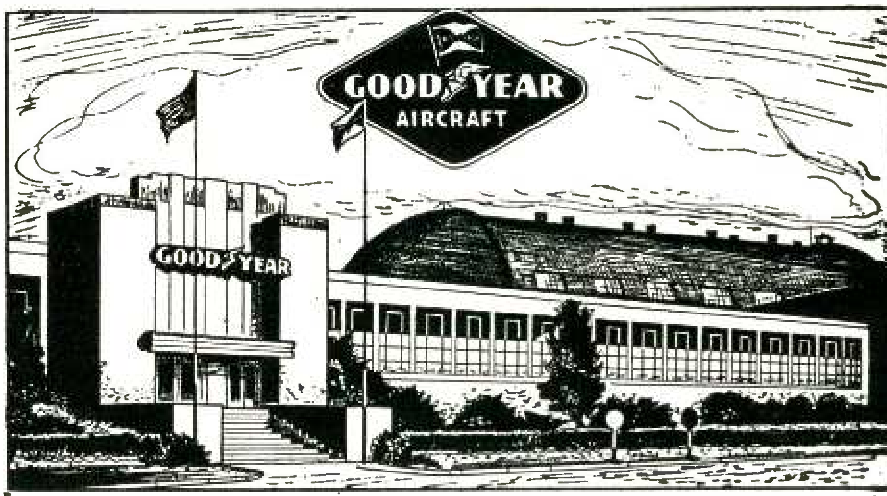

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1LA6	1.35
1LB4	1.30
1LC5	1.10
1LC6	1.18
1LD5	1.30
1LE3	1.18
1LG5	1.15
1LH4	1.75
1LN5	1.30
1N5GT	1.05
1P5GT	1.05
1Q5GT	1.18
1R4	1.05
1R5	1.39
1S4	1.50
1S5	1.50
1T4	1.50
1T5GT	1.18
1U4	1.30
1V	.89
1X2	1.60
2A3	1.65
2A4G	1.40
2A5	1.05
2A6	.98
2A7	.98
2B7	1.20
2V3G	.98
2X2	.65
2X2A	1.95
3A4	.69
3A5	1.95
3B7/1291	.69
3D6/1299	.69
3LF4	1.10
3Q4	.95
3Q5GT	1.25
3S4	1.10
3V4	1.25
5R4GY	3.75
5T4	1.95
5U4G	.98
5V4G	2.40
5W4	1.10
5X4G	1.28
5Y3GT	.89
5Y4G	.98
5Z3	1.05
5Z4	$1.40
6A3	1.35
6A4LA	1.45
6A6	1.25
6A7	1.10
6A8	1.25
6AB7	1.49
6AC5GT	1.40
6AC7	1.65
6AD7GT	1.45
6AE6G	1.05
6AF6G	1.45
6AG5	1.35
6AG7	1.65
6AH6	2.10
6AJ5	2.65
6AK5	2.25
6AK6	1.85
6AL5	.98
6AQ5	1.20
6AQ6	1.20
6AR5	1.25
6AT6	1.05
6AU5	2.35
6AU6	1.10
6AV6	1.05
6B6G	1.25
6B7	1.25
6B8G	.85
6BA6	1.05
6BC5	1.25
6BE6	1.15
6BF6	1.05
6BG6G	2.45
6BH6	1.20
6BJ6	1.48
6BQ6	2.50
6G4	1.40
6C5	.85
6C6	1.10
6C8G	1.10
6CB6	1.45
6D6	1.10
6D8	1.15
6F5	1.15
6F6	1.25
6F7	1.05
6F8G	1.35
6G6G	1.35
6H6	1.25
6H6GT	1.15
6J5	.89
6J5GT	.79
6J6	1.75
6J7	1.40
6K5GT	1.35
6K6GT	1.30
6K7	.98
6K8	1.35
6L5G	1.25
6L6	3.00
6L6G	2.65
6L6GA	2.65
6L7	1.25
6L7G	1.25
6N7	1.40
6Q7	1.45
6R7	1.20
6S7G	1.59
6S8GT	1.35
6SA7	1.15
6SC7	1.75
6SD7GT	1.50
6SF5	1.10
6SF5GT	1.20
6SF7	1.25
6SG7	1.50
6SH7	1.10
6SJ7	1.30
6SK7	1.50
6SL7GT	1.50
6SN7GT	$1.60
6SQ7	1.15
6SR7GT	1.10
6SS7	1.50
6ST7	1.45
6SU7GTY	2.25
6SV7	1.45
6T7G	1.65
6T8	1.65
6U5G	1.25
6U6GT	1.25
6U7G	1.05
6V6	2.00
6V6GT	1.50
6W4	1.15
6W7G	1.30
6X4	1.05
6X5GT	1.05
6Y6G	1.48
6Y7G	1.55
6ZY5G	1.20
7A4/XXL	1.10
7A5	1.10
7A6	1.10
7A7	1.10
7A8	1.80
7AG7	1.65
7B4	1.10
7B5	1.10
7B6	1.10
7B7	1.10
7C4	.79
7C5	1.10
7C6	1.25
7C7	1.20
7E5	.89
7E6	.89
7E7	1.05
7F7	1.10
7H7	1.10
7K7	1.49
7L7	1.10
7N7	1.65
7Q7	1.10
7R7	1.15
7S7	1.35
7V7	1.35
7W7	1.45
7X7	1.69
7Y4	.98
7Z4	.98
12A	.79
12A6	.75
12A7	1.25
12A8GT	1.05
12AH7GT	1.85
12AL5	1.35
12AT6	1.05
12AT7	2.25
12AU6	1.35
12AU7	1.45
12AV6	1.10
12BA6	1.25
12BE6	1.25
12C8	1.05
12F5GT	.98
12H6	.98
12J5GT	.79
12J7GT	1.05
12K7GT	1.05
12K8	1.05
12Q7	.98
12SA7GT	1.15
12SC7	1.45
12SF5	1.20
12SF7	1.05
12SG7	1.05
12SH7	1.05
12SJ7	1.15
12SK7	1.50
12SL7	$1.10
12SN7	1.35
12SQ7	1.25
12SR7	.98
12Z3	1.10
14A4	1.20
14A7	1.15
14B6	1.15
14F7	1.15
14F8	1.30
14H7	1.20
14J7	1.25
14N7	1.30
14Q7	1.15
14R7	1.20
19	1.30
24A	1.20
25L6GT	1.10
25Z5	1.05
25Z6GT	1.05
26	.98
27	.95
28D7	.98
30	.89
31	.89
32	1.05
32L7GT	1.15
33	1.05
34	.98
35/51	.98
35A5	1.10
35B5	1.10
35C5	1.25
35L6GT	1.30
35W4	1.25
35Y4	1.05
35Z3	1.05
35Z4	1.05
35Z5	1.05
36	1.05
37	.89
38	.98
39/44	.68
41	.98
42	.98
43	.98
45	1.10
45Z3	1.05
45Z5	1.05
46	1.10
47	1.10
48	2.15
49	1.10
50A5	1.10
50B5	1.25
50C5	1.25
50L6GT	1.15
50Y6	1.25
53	1.35
56	.98
57	1.05
58	1.05
59	1.25
70L7	1.30
71A	1.25
75	1.25
76	.89
77	.89
78	1.10
80	1.20
82	1.20
83	1.35
83V	1.35
84/6Z4	1.10
85	1.10
89Y	.89
117L7/M7	1.75
117N7	1.75
117P7	1.75
117Z3	1.05
117Z6	1.25

FULL-WAVE SELENIUM RECTIFIER STACKS

Max. A.C. Input Volts RMS	Max. D.C. Volts Output	Cell Size in Inches		Max. D.C. Amps. Output Continuous	Order by This Number	Price
SINGLE PHASE BRIDGE						
0-18	0-14.5	1¾″	x1¾″	1.3	18B4D1S1	$ 3.95
"	"	2-3/16″	x2-3/16″	2.4	18B4E1S1	4.95
"	"	3⅜″	x3⅜″	6.6	18B4F1S1	7.95
"	"	4½″	x5″	13.0	18B4K1S1	12.95
"	"	5″	x6″	17.5	18B4J1S1	15.45
"	"	4½″	x5″	26.0	18B4K1S2	22.50
"	"	4½″	x5″	39.0	18B4K1S3	37.50
"	"	4½″	x5″	52.0	18B4J1S3	47.50
"	"	4½″	x5″	70.0	18B4J1S4	54.50
0-40	0-34	1¾″	x1¾″	0.60	40B4D1S1	4.95
"	"	2-3/16″	x2-3/16″	1.2	40B4EW1S1	6.95
"	"	3⅜″	x3⅜″	3.2	40B4FW1S1	9.75
"	"	4½″	x5″	6.0	40B4K1S1	14.95
"	"	5″	x6″	9.0	40B4JW1S1	17.50
"	"	4½″	x5″	12.0	40B4K1S2	28.75
"	"	5″	x6″	18.0	40B4JW1S2	34.50
"	"	4½″	x5″	25.0	40B4J1S3	42.50
"	"	4½″	x5″	34.0	40B4J1S4	54.25
"	"	5″	x6″	36.0	40B4JW1S4	62.25
0-120	0-100	1¾″	x1¾″	0.60	40B4D3S1	12.45
"	"	2-3/16″	x2-3/16″	1.2	40B4EW3S1	14.95
"	"	3⅜″	x3⅜″	3.2	40B4FW3S1	24.50
"	"	4½″	x5″	6.0	40B4K3S1	32.50
"	"	5″	x6″	9.0	40B4JW3S1	42.50
CENTER-TAP						
10-0-10	0-8	1¾″	x1¾″	1.2	20C2D1S1	2.35
"	"	2-3/16″	x2-3/16″	2.4	20C2EW1S1	3.10
"	"	3⅜″	x3⅜″	6.4	20C2FW1S1	4.25
"	"	4½″	x5″	12.0	20C2K1S1	6.95
"	"	5″	x6″	16.0	20C2J1S1	8.95
"	"	4½″	x5″	24.0	20C2K1S2	14.75
"	"	4½″	x5″	36.0	20C2K1S3	19.65
"	"	4½″	x5″	48.0	20C2J1S3	27.50
"	"	4½″	x5″	64.0	20C2J1S4	34.50
"	"	4½″	x5″	80.0	20C2J1S5	42.50
"	"	4½″	x5″	84.0	20C2KW1S7	49.50
"	"	5″	x6″	96.0	20C2J1S6	55.50
"	"	4½″	x5″	128.0	20C2J1S8	67.50
3 PHASE BRIDGE						
0-120	0-150	1¾″	x1¾″	0.90	40B6D3S1	24.50
"	"	2-3/16″	x2-3/16″	1.8	40B6EW3S1	29.50
"	"	3⅜″	x3⅜″	4.75	40B6FW3S1	42.50
"	"	4½″	x5″	9.0	40B6K3S1	79.50
"	"	5″	x6″	12.5	40B6J3S1	86.75

SPECIAL RECTIFIERS ON REQUEST

TRANSFORMERS—115V 60 CY
HI-VOLTAGE INSULATION

2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A	$ 4.45
2500v @ 15 MA	3.49
1540v @ 5 MA; 340-0-340 @ 300 MA	4.35
925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Dual Pri	4.25
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	5.35
500-385-0-385v @ 200 MA; 3x6.3v @ 6A; 5v @ 3A; 2.5v @ 2A	4.75
375-0-375 @ 175 MA, 5v @ 3A, 6.3v @ 5A, 78 v @ 1A	3.79
325-0-325v @ 12 MA; 255-0-255v @ 240 MA.	4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	3.25
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230	3.85
12.6v CT @ 10A; 11v CT @ 6.5A	6.35
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A	3.50
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	4.17
6.3v @ 1A; 2.5v @ 2A..$2.29 4-0-4v @ 1A	.87
5v CT @ 20A; 10 KV INS	8.95
.6v @ 15A RMS	1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA	$ 5.35
3x5v @ 6A; 4v @ .25A	2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A	2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri	3.95
Step Up/Down 110/220, 500 watt	10.95

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$ 1.98
2 HY @ 175 MA	1.49
3 HY @ 50 MA.	.39
5 HY @ 70 MA/.2 HY 350 MA DUAL	2.39
10 HY @ 700 MA	11.95
10 HY @ 55 MA	.89
10 HY @ 100 MA	1.49
10 HY @ 250 MA	$3.15
10/20 HY @ 85 MA	1.49
13 HY @ 130 MA	1.55
15 HY @ 25 MA.	.59
200 HY @ 10 MA	2.95
325 HY @ 2 MA.	2.95
600 HY @ 1 MA.	2.95
9/60 HY @ 50/-400 MA	9.95

OIL CONDENSERS—DC RATINGS

3X.1	MFD	600v	$ .59	.1	MFD	2500v	$1.15
.25	"	"	.35	.25	"	"	1.25
.5	"	"	.45	.5	"	"	1.35
1	"	"	.69	2	"	"	3.45
2	"	"	.85	.01	"	3000v	1.25
2X2	"	"	1.15	.05	"	"	1.30
4	"	"	1.29	.1	"	"	1.35
6	"	"	.98	.25	"	"	2.75
8	"	"	1.85	.5	"	"	2.85
10	"	"	2.25	1	"	"	2.95
3X.1	"	1000v	.85	2	"	"	4.25
.5	"	"	.89	4	"	"	6.95
1	"	"	.67	12	"	"	9.95
2	"	"	1.75	1	"	3600v	3.98
4	"	"	1.85	.25	"	4000v	3.49
8	"	"	2.45	.5	"	"	3.75
10	"	"	3.19	1	"	"	3.95
20	"	"	4.25	2	"	"	5.75
.5	"	1500v	1.02	3	"	"	5.89
1	"	"	1.19	.1	"	5000v	2.75
2	"	"	1.69	.25	"	"	2.95
4	"	"	2.69	1	"	"	3.10
.1	"	2000v	1.75	.1	"	7000v	3.75
.25	"	"	1.92	.01	"	7500v	2.25
.5	"	"	1.95	.02	"	"	2.25
1	"	"	2.09	.03	"	"	2.35
2	"	"	2.85	.05	"	"	2.35
4	"	"	4.45	.1	"	"	4.95
8	"	"	4.95	2X.1	"	"	7.95
15	"	"	6.95	.02	"	12000v	12.95

HIGH CAPACITY CONDENSERS

2X3500	MFD	25v	$3.47	200	MFD	35v	$ .57
2500	"	3v	.35	100	"	50v	.45
3000	"	25v	2.45	4000	"	30v	3.25
650	"	80v	1.29	2350	"	24v	2.25
2000	"	15v	1.69	10000	"	25v	4.57

RADIO HAM SHACK Inc.
189 GREENWICH STREET . NEW YORK, N. Y.

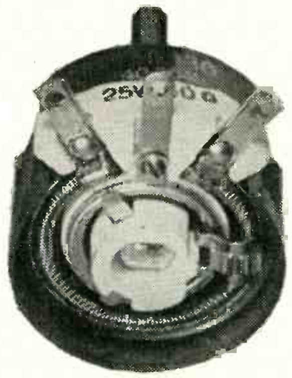
PHONE DIGBY 9-0347
WRITE FOR QUANTITY PRICES
Prices subject to change without notice. F.O.B. NYC, minimum order $10.00. 20% deposit required. All merchandise guaranteed.

WE'VE GOT THE STUFF!

SEND A WIRE, AIR EXPRESS EVERY DAY

POWER POTENTIOMETERS

Ohm	Watt	Bushing	Shaft	Cat. No.	Price
2	25	5/8S	1/8SD	O-H	$1.04
3-3	25	1/2	1/2	I	$1.04
15	25	3/8	1"	C	
15	25	3/8	1 1/8	D-245	
15	25	1/2	1 1/4	D—I	
20	25	1/2	1/2F	D-245	
25	25	1/2	1/2F	C	
25	25	3/8	1"	D-245	
25	25	1/2	3/8S	I	
30	25	3/8	1"	C	
50	25	3/8	1 1/8	D-245	
50	25	5/8	1/8SD	O-H	
75	25	1/2	7/16	O-H	
100	25	3/8	1"	D-245	
100	25	1/2	1/2	H	
350	25	3/8	1 1/8	O-H	
500	25	3/8	11/16	D-245	
800	50	3/8	7/16F	O-J	1.24
1K	25	1/2	1/2	O-H	1.17
3K	25	3/8	1 3/16	D-245	1.20
5K	25	1/2	1/8SD	I	1.24
5K	25	3/8	7/8FS	D-245	1.24
20K	25	1/2	1/8SD	D-245	1.40



PRECISION POTENTIOMETERS

Ohm	Watt	Cat. No.	Price
10	6	D-292	$1.20
12	6	301AS	1.20
2K	6	314A	1.70
5K	6	M-314A	1.70
10K	12	371A	1.70
20K	6	D-5083-G2	1.70
20K	6	D-260	1.70
20K	6	M-314A	1.70
100K	25	433A	6.50

TOGGLE SWITCHES

Molded Bakelite — 7/16" Bushing
N.P. Bat Handle

Contact	Current	Stock #	Price
SPST	6A	110B	$.39
SPDT	3A	112	.44
DPST	3A	216	.60
DPDT	3A	316	.66
DPDT Center Off	1A	138	.60

On All Items Write For

QUANTITY PRICES!

COMPUTER POTENTIOMETERS $22.50

Cat.	Resistance	Taps	Function
D170547	20,368 (#1)	4	Sine-
	13,980 (#2)	4	Cosine
D170561	26,000	1	Non-Lin.
D170692	4,000 (#1)	1	Linear
	866 (#2)	1	Linear

TURRET LUGS

Add letter for corresponding board thickness; A—1/32" B—1/16", C—3/32", D—1/8"

Our Number	Other Number	Price for 100
1200	x1548	$1.38
1210		1.70
1220	x1143	2.76
1230		3.31
1250		3.05
1260		2.34
1280	X1558	1.38
1290	X1463	1.68
1300	X1724	1.38
1310		2.05
1320	X1579	2.90
1330	X1798	2.02
1340	X1457	1.30
1350	X1245	2.00
1360	1081	3.13
1391	X1578	2.40
2000	X1785	2.90
2010		1.78
2020		3.15
2030		1.95
2040		3.46
2050		3.39
2060	X1604	1.65
POT. LOCK #1510		$ .23

TIE POINTS

Our Number	Other	Price
1400B	X1581B	$ .13
1410B	X1580B	.13
1417		.19
1418		.19
1419		.19
1421		.24
1422		.24

HIGH VOLTAGE GLASS-METAL SEAL

10¢ each. $7.50 per 100. $65 per 1000

JONES CONNECTORS

P302CCT	$.29	S318CCT	$.87
P304AB	.18	S321AB	.74
P306AB	.22	S324AB	.84
P308CCT	.42	S327AB	1.01
P310FHT	.39	S330AB	1.16
P312AB	.32	S330SB	1.46
P315AB	.42	P404AB	.39
P318AB	.53	P406AB	.46
P321CCT	.95	P406CCT	.70
P324EB	.80	P408AB	.53
P324CCT	1.11	P408SB	.70
P330CCT	1.46	P410AB	.60
P330SB	1.40	P410SB	.80
S302AB	.14	P412FHE	.87
S303CCT	.32	P412SB	.91
S304AB	.19	S404CCT	.68
S306AB	.23	S408CCT	.95
S308AB	.29	S408CCTL1	.17
S310AB	.34	S410AB	.77
S310CCT	.52	S410CCE	1.09
S310FHT	.44	S410CCT	1.09
S312AB	.40	S412AB	.87
S315AB	.49	S412SB	1.11

BLACK LIGHT BULBS
4 Watt &T5 .... $ .35
8" lg. #TF6 .... $ .69

4 WATT POT.
5K or 10K mica filled body, wire-wound .... $ .45

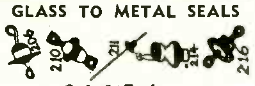
10 AMPERE FILTER
60 db att. .15 to 30 Mcs. permalloy core. D170738 .... $3.00

SERVO MOTOR
400 cy 2 phase, 40:1 gear train, low inertia 10047-2A $12.50

POWER SUPPLY, PE204A, Radiart to operate from 12 volts DC to supply plate & screen & DC filament volts to telephone repeater EE99 & TY14. Sealed in original packing cases with spare vibrator, cable, schematic, etc. Approx. 50 MA $5.95

ANTENNA AN80-A, SC ZA-275 w/ MC299 connector for BC 645 ..... $ .98

GLASS TO METAL SEALS

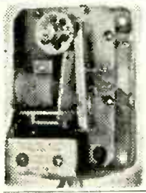


Only 5¢ Each

Stock No.	Color	Stock No.	Color
199	White	207	green
200	white	208	yellow
202	blue	210	clear
203	green	211	clear
205	brown	214	clear
206	red	215	clear
		216	clear

CONNECTORS 69¢ SPECIALS

31511	PLQ 74
AP-60A-2	RFK-59A-2
AP-FD2-23-3/4"	RNK-M8-22C-7/8
BN	RNK-M8-31SL
AP-4-14	RNK-12-22C-7/8
AP-4-CG-11	RNK-27-31-SL
AP-6-14	RWK-C3-22C-5/8
AP-6-CG-11	SK-S2-21C-1/2"
ARC 6967	SK-C16-32S
CLT 49043	SK 4397
CLT 49171	SK 4408
CQA 49547	SO-40
CUF 49042	SO-56
D-163326	SO-239
E-1002-1-20	UG 9/U
E-1002-4-40	UG 10/U
E-1002-13-20	UG 12/U
F 68552-5	UG 13/U
FK 10-32 S	UG 21/U
GK-N2-21-3/4B	UG 25/U
GK-C4-21C-7/16"	UG 27/U
GK-C4-21-3/4B	UG 58/U
GK-M5-23 1/2AC	UG 85/U
GK-C8-23 1/2"B	UG 87/U
GK-9-32S	UG 167/U
GK-12-21C-5/8	UG 342/U
GK-12-32S	UG 203/U
J201	WK-1-23-3/8B
LK-R24C-22-7/8T	WK-1-23S
M 359	WK-M2-23-3/8B
NAF 47908-1	WK-C3-21C-3/8B
NAF 68925-1	WK-C3-21C-5/8"
NAF 68925-2	WK-C3-23
NAF 68925-3	WK-C3-23C-1/2"
NK-M8-21C-7/8"	RWK-C3-31-SL
NK-12-21C-5/8"	WK-4-21-1/2"
NK-12-21C-7/8"	AC & AN
NK-12-22C-5/8"	WK-4-21-1/2B
NK-12-31SL	WK-4-21C-3/4
NK-12-32SL	WK-6-21C-3/8"B
NK-M16-32S	WK-6-23-3/8B
P3-GP 6/7	PS-6 ZA 2415
PL-56	PL-75429C
PL-258	ZA-2816; PM-12
PL-259	ZA/US10630 & 31
PL-P56	ZA/US10631;
PLP 60	ZA/US10630
PLQ 62	



EAGLE ADJUSTABLE TIME DELAY RELAY. 110 volt 60 cy with double throw Micro Switch. Can be set from 1½ to 58 minutes. Includes attractive 3¼ x 4½ x 2¾ black cover. Made to sell for $26. SALE PRICE $6.95

DELAY LINE 15-E4-91-400-50P, Sprague #S92-5245, H623, 4x5x7 inch oil filled with 3½ inch insulators. 0.91 Microsecond, 15KV $9.90

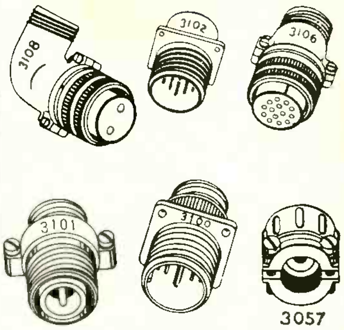
PULSE FORMING LINE, Millen flexible type, 23½ inches long, form 2 microsecond pulses, Zo-1000 ohm. our #388 .... $3.75

PULSE TRANSFORMERS

7P26, Westinghouse $4.50
69178. Dinion. 3⅝" x 5¾" x 5⅝ .. 7.50
901756-501, RCA. 15/16 dia. x 1⅝" high, 165 turns on primary, 330 turns secondary, core is ¼" stack of .007 inch "F" laminations, Magnetic Metals Co. Audio 58, used to form 7.3 microsecond pulses, 1744 in stock $1.50
901756-502, RCA, same core & can as 501, 100 to 200 turns, used to form 2.2 microsecond pulses. 870 pieces in stock $1.50
A117012, Bendix, 1 ⅞ x 1 7/16 x 1 13/16" can, nine terminals, Hypersil core $1.50
C12A-1318, Jefferson. 50 millihenry & 10 millihenry, 2¾ x 3 x 3½ $1.95
D161310, WE frequency response 50Kc to 4 Mc, Video input, 120 to 2350 ohm, Perm. core $1.50
K2468B, GE Magnetron pulsing bifilar 250KVA peak power at ¼ microsecond pulse, 1000/1' duty cycle, 3.85KV into 50 ohm pulse cable socket gives 17.3 KV to built-in Mag. socket. Only 31 in stock. Cost $223. SALE PRICE $18.00
L406825, Wenco. Pulse Inversion. 25 turns ea. winding 200 volts to 200 volts at 3 ampere, 0.93 ohms DC, 3¼" dia. x 4½" high $1.50

CONVERTER, Electronic Labs Model 1485. 26 VDC input, 115 volts, 60 cy., 50 watts output, complete with NSB 1341 vibrator $9.95

CHOKE, conservatively rated 165 MA, 5 Henries, 160 ohm dc, 2 Inch High, 3 ⅜" Mtg. Ctr. Worth $3. **SALE PRICE** 89 cents. #1A-158.

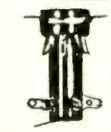


AN CONNECTORS

COMPLETE LIST NEXT PAGE →

AN	Price	AN	Price
3050-4	$.05	3057-10-5/16-2	.35
3050-6	.05	3057-10-1/2-2	.35
3050-8	.05	3057-10-6	.35
3050-10	.06	3057-10-6	.35
3050-16	.08	3057-12	.38
3050-20	.10	3057-12-6	.38
3051-4	.05	3057-12-1/2-2	.38
3051-8	.05	3057-16	.40
3051-10	.06	3057-16-11/16-2	.40
3051-20	.13	3057-20	.75
3052-16	.12	3057-24	.80
3054-8	.08	3057-28	.88
3054-10	.11	3057-32	.95
3054-16	.15	3057-40	.95
3055-8	.40	3060-6	.33
3055-10-3	.43	3061-4	.50
3055-14-4	.60	3062-6	.40
3055-14-6	.60	3062-12	.55
3055-16-8	.80	3063-3	.50
3055-18-6	.90	3063-16	.60
3055-18-8	.90	3066-6	.05
3055-22-8	1.00	9760-10	.50
3055-28-12	1.10	9760-14G	.50
3055-28-16	1.10	9760-14	.50
3055-40-20	1.40	9760-16	.50
3055-44-24	1.50	9760-20	.55
3057-3	.30	9760-22	.60
3057-4	.30	9760-28P	.65
3057-6	.30	9769-6	.05
3057-8	.35	9769-8	.05
3057-6-5/16-2	.30	9769-12	.07
3057-10	.35		

TURRET SOCKETS



SAVE TIME

BETTER CIRCUIT

Socket	Height	Stock #	Price
Octal	2 1/2"	10-0-9T	$ .59
Octal	2	8-0-9T	.57
Octal	1 1/2	6-0-9T	.54
Min.	3"	12-MB-12	.73
Min.	2"	8-M-9T	.63
Min.	1 1/2	6-M-6T	.60
Min.	1"	4-M-6T	.59
Noval	3"	12-NB-12	.78
Noval	2"	8-N-9T	.66
Noval	1 1/2	6-N-6T	.65
Noval	1	4-N-6T	.63

PLUG-IN UNITS

D.C. AMPLIFIERS
MULTIVIBRATORS

A—No Can, B—1 3/8" sq. can, C—2" sq. can

Socket	Length	Stock #	Price
Octal	2"	A8-0	$ .95
Octal	2	B8-0	1.43
Octal	2	C8-0	1.75
Octal	2 1/2	A10-0	.97
Octal	2 1/2	B10-0	1.45
Octal	2 1/2	C10-0	1.78
Octal	3	A12-0	1.00
Octal	3	B12-0	1.47
Octal	3	C12-0	1.81
Min.	2	A8-M	.99
Min.	2	B8-M	1.52
Min.	2	C8-M	1.84
Min.	2 1/2	A10-M	1.01
Min.	2 1/2	B10-M	1.55
Min.	2 1/2	C10-M	1.86
Min.	3	A12-M	1.03
Min.	3	B12-M	1.57
Min.	3	C12-M	1.90
Noval	2	A8-N	.97
Noval	2	B8-N	1.57
Noval	2	C8-N	1.87
Noval	2 1/2	A10-N	1.00
Noval	2 1/2	B10-N	1.60
Noval	2 1/2	C10-N	1.90
Noval	3	A12-N	1.02
Noval	3	B12-N	1.62
Noval	3	C12-N	1.95

Also Dual Socket Units.

Widely Known for Fair Dealing and Good Service

HAROLD H. POWELL
632 Arch Street Philadelphia 6, Pa.
MArket 7-5650

AN CONNECTORS—DISCOUNT: 50% PHENOLIC, 40% MELAMINE

Insert	Shell and 1947 List Price 3100	3101	3102	3106	3108
8S-1S	$1.59	1.63	1.19	1.59	2.61
8S-1P	1.53	1.59	1.19	1.59	2.67
10S-2S	1.48	1.53	1.08	1.39	2.47
10S-2P	1.43	1.48	1.08	1.48	2.52
10S-3S				1.73	2.67
10S-3P	1.73	1.77	1.43		
10S-4S				1.53	2.76
10S-4P	1.59	1.63	1.19		
12S-1S	1.63	1.73	1.19	1.97	2.72
12S-1P	1.68	1.68	1.24	1.97	2.87
12S-2S	1.63	1.73	1.19	1.97	2.72
12S-2P	1.68	1.68	1.24	1.97	2.87
12S-3S	1.63	1.73	1.19	1.97	2.72
12S-3P	1.68	1.68	1.24	1.97	2.87
12S-4S	1.39	1.53	1.04	1.59	2.72
12S-4P	1.39	1.53	1.04	1.59	2.72
12-5S	1.59	1.92	1.39	1.97	3.01
12-5P	1.53	1.73	1.24	1.92	2.81
12S-6S	2.37	2.37	1.84	2.67	3.73
12S-6P	3.14	3.49	2.61	3.79	4.56
14S-1S	1.77	2.03	1.33	2.37	3.16
14S-1P	1.77	2.03	1.33	2.32	3.16
14S-2S	1.88	1.97	1.43	2.41	3.25
14S-2P	2.08	2.17	1.63	2.37	3.50
14-3S	2.03	2.08	1.43	2.17	4.15
14-3P	2.08	2.12	1.43	2.57	3.95
14S-4S	1.70	1.70	1.43	2.27	3.16
14S-4P	1.39	1.48	1.08	1.97	2.81
14S-5S	2.12	2.32	1.57	2.47	3.71
14S-5P	2.12	2.37	1.59	2.81	3.71
14S-6S	2.57	2.47	2.17	3.07	4.20
14S-6P	2.61	2.61	2.08	2.96	4.09
14S-7S	2.23	2.23	1.63	2.76	3.76
14S-7P	1.97	1.97	1.43	2.27	3.16
14S-9S	2.08	2.08	1.53	2.37	3.56
14S-9P	1.97	1.92	1.43	2.23	3.36
14S-10S	2.17	2.17	1.63	2.52	3.65
14S-10P	2.52	2.37	1.83	2.72	4.29
14S-11S	2.17	2.17	1.63	2.52	3.65
14S-11P	2.37	2.37	1.83	2.72	3.85
14S-12S	2.08	2.08	1.53	2.37	3.56
14S-12P	2.08	2.08	1.53	2.37	3.56
14S-13S	2.08	2.08	1.53	2.37	3.56
14S-13P	2.08	2.08	1.53	2.37	3.56
14S-14S	2.17	2.17	1.63	2.52	3.65
14S-14P	2.37	2.37	1.83	2.72	3.85
16S-1S	2.61	2.87	2.23	3.21	3.85
16S-1P	2.87	2.87	1.88	3.21	4.40
16-2S	2.27	2.32	1.68	2.72	3.56
16-2P	2.08	2.12	1.48	2.47	3.56
16S-3S	1.83	1.92	1.24	2.23	3.41
16S-3P	1.83	1.92	1.24	2.23	3.41
16S-4S	1.92	2.03	1.39	2.37	2.92
16S-4P	1.92	2.03	1.39	2.32	3.56
16S-5S	2.17	2.37	1.73	2.76	3.56
16S-5P	2.17	2.23	1.59	2.57	3.76
16S-6S	2.17	2.37	1.53	2.67	3.91
16S-6P	2.12	2.17	1.53	2.52	3.71
16-7S	2.67	2.72	2.08	2.61	4.15
16-7P	2.37	2.52	2.32	2.81	3.91
16S-8S	2.37	2.72	2.08	3.07	3.65
16S-8P	2.61	2.47	1.92	2.87	3.71
16-9S	2.72	2.87	2.12	3.25	4.29
16-9P	2.57	2.67	2.03	3.01	4.05
16-10S	2.61	2.76	2.12	3.11	4.09
16-10P	2.27	2.37	1.73	2.72	3.85
16-11S	2.37	2.52	1.83	2.47	3.91
16-11P	2.27	2.37	1.59	2.72	3.80
16-12S	2.67	2.72	2.08	3.07	4.15
16-12P	2.37	2.47	1.77	2.76	3.85
16-13S	2.96	3.02	2.19	3.02	4.74
16-13P	4.21	4.32	3.50	4.69	5.92
16S-15S	2.03	2.08	1.43	2.37	3.60
16S-15P	1.97	2.08	1.39	2.37	3.60
16S-16S	2.03	2.08	1.53	2.37	3.60
16S-16P	1.97	2.08	1.37	2.37	3.60
16S-17S	2.37	2.47	1.77	2.81	3.95
16S-17P	2.12	2.17	1.53	2.57	3.71
18-1S	3.65	3.80	2.87	3.91	5.19
18-1P	4.00	4.15	3.16	4.49	5.72
18-2S	3.51	3.16	2.08	3.71	4.69
18-2P	2.61	2.72	1.63	3.80	4.25
18-3S	2.76	2.52	1.63	3.65	4.44
18-3P	2.72	2.76	1.68	2.96	4.00
18-4S	2.87	2.92	1.83	3.11	3.95
18-4P	3.07	2.96	2.03	3.16	4.55
18-5S	2.76	2.76	1.83	3.16	4.44
18-5P	2.96	2.67	1.68	2.96	4.44
18-6S	2.87	2.92	1.83	3.31	4.40
18-6P	2.72	2.81	1.73	2.96	4.25
18-7S	3.36	3.11	2.03	3.60	4.64
18-7P	2.87	2.68	2.08	3.16	4.55
18-8S	3.71	4.00	2.96	4.00	4.99
18-8P	3.60	3.65	2.61	3.71	4.93
18-9S	4.00	3.56	3.41	4.89	4.40
18-9P	4.09	4.20	2.92	4.35	5.19
18-10S	4.00	3.71	2.37	4.84	5.24
18-10P	3.56	3.25	2.17	3.41	4.75
18-11S	3.60	3.36	2.47	4.35	5.39
18-11P	3.21	2.96	2.32	3.95	4.93
18-12S	3.11	3.24	2.52	3.36	4.64
18-12P	3.71	3.16	2.23	3.36	4.99
18-13S	4.64	4.40	3.41	5.43	6.03
18-13P	3.45	3.16	2.23	3.95	4.84
18-14S	3.85	3.60	2.52	4.09	5.09
18-14P	3.36	3.16	2.32	3.60	4.99
18-15S	4.98	4.56	3.26	5.33	6.99
18-15P	7.94	7.58	6.34	8.90	9.36
18-16S	3.07	2.67	1.73	3.25	4.35
18-16P	2.87	2.61	1.68	3.11	4.25
18-17S	4.00	3.71	2.61	4.49	5.28
18-17P	4.09	4.09	3.01	4.35	5.59
18-18S	2.91	3.71	2.61	4.89	5.19
18-18P	4.09	4.09	3.01	4.35	5.59
18-20S	2.96	3.11	2.08	3.21	4.49
18-20P	3.31	2.92	2.12	3.76	4.99
18-22S	3.51	3.16	2.08	3.71	4.69
18-22P	2.61	2.72	1.63	3.80	4.25
18-23S	3.65	3.80	2.87	3.91	5.19
18-23P	4.59	4.75	3.65	4.35	6.12
18-24S	3.65	3.80	2.87	3.91	5.19
18-24P	4.59	4.75	3.65	4.84	6.13

Insert	Shell and 1947 List Price 3100	3101	3102	3106	3108
18-25S	$3.21	2.87	1.73	3.65	3.65
18-25P	2.72	2.76	1.68	2.96	4.00
18-26S	3.21	2.87	1.73	3.65	4.40
18-26P	2.72	2.76	1.68	2.96	4.00
18-27S	3.25	2.92	1.83	3.80	4.44
18-27P	2.96	3.07	2.03	3.21	4.44
18-28S	3.25	2.92	1.83	3.80	4.44
18-28P	2.96	3.07	2.03	3.21	4.44
18-29S	3.60	3.25	2.17	4.40	4.79
18-29P	3.80	3.45	2.37	4.59	4.99
18-30S	2.96	3.11	2.08	3.21	4.49
18-30P	3.31	2.92	2.12	3.76	4.99
18-31S	2.96	3.11	2.08	3.21	4.49
18-31P	3.31	2.92	2.12	3.76	4.99
20-1S	4.44	4.69	3.60	4.75	4.84
20-1P	5.63	6.32	3.91	5.92	5.97
20-2S	3.25	3.36	1.92	4.05	4.25
20-2P	3.11	3.31	1.83	3.45	4.20
20-3S	3.71	3.76	2.23	4.25	4.69
20-3P	3.41	3.56	1.97	3.80	4.84
20-4S	3.36	3.36	2.08	3.76	4.93
20-4P	3.16	3.20	1.92	3.71	4.84
20-5S	3.07	3.16	1.68	3.45	4.40
20-5P	2.87	2.92	1.43	3.56	4.20
20-6S	3.25	3.45	2.08	3.60	4.40
20-6P	3.25	3.31	1.83	3.60	4.20
20-7S	3.51	4.15	2.87	3.80	5.09
20-7P	4.35	4.69	3.25	4.64	5.59
20-8S	4.40	4.44	3.01	5.33	5.33
20-8P	4.20	4.29	2.81	4.89	5.09
20-9S	4.29	4.40	2.92	4.79	5.28
20-9P	4.15	4.20	2.76	4.64	5.09
20-10S	3.36	3.36	2.08	3.76	4.93
20-10P	3.16	3.20	1.92	3.71	4.84
20-11S	4.44	5.04	3.60	4.75	5.92
20-11P	5.63	6.03	4.59	5.92	6.92
20-12S	3.56	3.60	2.17	4.44	4.49
20-12P	3.36	3.45	2.03	3.80	4.35
20-13S	3.65	4.75	2.27	4.84	4.59
20-13P	3.11	3.76	2.27	3.45	4.59
20-14S	4.40	4.44	3.11	5.59	5.39
20-14P	3.91	4.44	2.92	4.15	5.28
20-15S	4.55	4.69	3.21	5.19	5.53
20-15P	3.75	4.07	2.61	4.89	4.93
20-16S	4.55	4.79	3.31	4.89	5.63
20-16P	4.44	4.49	3.11	4.89	5.43
20-17S	4.44	4.55	3.11	5.63	5.43
20-17P	4.20	4.29	2.81	4.59	5.19
20-18S	4.84	4.93	3.41	5.83	5.83
20-18P	4.25	4.29	2.81	5.43	5.24
20-19S	4.20	4.25	2.81	5.39	5.19
20-19P	3.91	4.15	2.72	4.21	5.04
20-20S	4.25	4.29	2.81	4.40	5.24
20-20P	3.80	3.91	2.41	4.40	4.79
20-21S	4.59	4.75	3.25	4.93	5.63
20-21P	4.44	4.44	3.11	5.43	5.43
20-22S	4.44	4.55	3.11	5.43	5.43
20-22P	4.25	4.35	2.87	4.55	5.24
20-23S	3.71	3.80	2.32	4.64	4.69
20-23P	3.36	3.45	2.03	3.80	4.35
20-24S	3.91	4.00	2.57	5.04	4.89
20-24P	3.71	3.80	2.32	4.35	4.69
20-25S	4.44	5.04	3.60	4.75	5.92
20-25P	5.63	6.03	4.59	5.92	6.92
20-26S	3.85	3.91	2.47	5.04	4.87
20-26P	3.45	3.71	2.23	3.80	4.55
20-27S	4.44	5.04	3.60	4.75	5.92
20-27P	5.63	6.03	4.59	5.92	6.92
20-28S	4.44	5.04	3.60	4.75	5.63
20-28P	5.63	5.97	4.49	5.92	6.57
20-29S	4.94	5.54	4.10	5.25	6.42
20-29P	6.13	6.53	5.09	6.42	7.42
20-30S	4.44	5.04	3.60	4.75	5.92
20-30P	5.63	6.03	4.59	5.92	6.92
22-1S	3.71	3.71	2.03	4.25	5.04
22-1P	3.41	3.45	1.88	4.00	4.79
22-2S	4.29	4.35	2.87	5.24	5.63
22-2P	3.95	4.00	2.57	4.40	5.33
22-3S	3.71	3.76	2.32	4.79	5.04
22-3P	3.36	3.36	1.97	3.95	4.75
22-4S	4.00	4.09	2.52	4.55	4.89
22-4P	3.71	3.91	2.37	4.09	5.04
22-5S	3.95	3.95	2.57	4.15	5.33
22-5P	3.71	3.71	2.27	3.91	5.09
22-6S	3.80	3.85	2.37	5.04	5.19
22-6P	3.56	3.56	2.12	4.29	3.56
22-7S	3.85	3.85	2.47	4.75	5.24
22-7P	3.41	3.41	2.03	4.00	4.79
22-8S	3.71	3.91	2.52	4.15	5.24
22-8P	2.96	3.11	1.68	3.41	4.44
22-9S	3.71	3.76	2.27	4.93	5.04
22-9P	3.21	3.25	1.92	4.00	4.15
22-10S	3.16	3.76	2.17	3.56	4.84
22-10P	3.41	3.45	2.03	3.91	4.79
22-11S	3.45	3.56	2.12	4.09	4.84
22-11P	2.87	3.36	1.97	3.25	4.49
22-12S	4.20	4.29	2.76	4.79	5.53
22-12P	3.85	3.91	2.47	4.59	5.24
22-13S	4.29	4.29	2.87	5.33	5.63
22-13P	3.60	4.00	2.57	4.05	5.28
22-14S	5.19	5.97	4.64	5.59	6.81
22-14P	5.88	5.88	4.44	7.06	7.21
22-15S	5.19	5.24	3.76	6.37	6.52
22-15P	3.95	4.09	2.67	4.35	5.39
22-16S	4.93	4.99	3.51	6.08	6.32
22-16P	4.35	4.40	3.01	5.59	5.73
22-17S	4.25	4.79	3.31	4.64	5.88
22-17P	4.44	4.49	3.07	5.09	5.83
22-18S	4.09	4.35	2.87	4.55	5.63
22-18P	3.91	3.91	3.52	5.09	5.28
22-19S	4.49	5.24	4.00	4.89	6.17
22-19P	4.89	4.93	3.45	6.07	6.27
22-20S	3.85	4.44	3.07	4.25	5.48
22-20P	4.09	4.15	2.67	4.35	5.19
22-21S	4.55	4.79	3.56	5.04	6.32
22-21P	4.09	4.20	2.72	4.55	5.48
22-22S	4.35	4.40	2.92	5.24	5.68
22-22P	4.20	4.20	2.76	4.79	5.48
22-23S	4.99	5.04	3.60	6.17	5.83
22-23P	4.40	4.40	3.01	5.33	5.77

Insert	Shell and 1947 List Price 3100	3101	3102	3106	3108
22-24S	$4.15	4.09	2.72	4.20	5.48
22-24P	3.65	3.71	2.23	3.95	4.99
22-25S	4.15	4.20	2.72	5.24	5.48
22-25P	3.80	3.80	2.37	4.40	5.19
22-26S	4.49	4.49	3.11	4.79	5.83
22-26P	4.20	4.25	2.81	4.75	5.53
22-27S	4.89	5.09	3.71	5.33	6.43
22-27P	4.29	4.84	3.31	4.75	5.92
22-28S	4.55	4.55	3.16	5.77	5.92
22-28P	3.80	3.85	2.37	4.98	5.19
22-29S	4.79	4.84	3.41	5.39	6.12
22-29P	4.49	4.49	3.11	5.43	5.83
22-30S	5.19	5.91	4.64	5.59	6.81
22-30P	5.88	5.92	4.49	7.10	7.21
22-32S	3.95	4.00	2.61	4.69	5.33
22-32P	3.76	3.76	2.32	4.35	5.04
22-33S	3.95	4.20	3.11	4.40	5.77
22-33P	4.20	4.25	2.81	5.13	5.53
22-34S	4.15	4.20	2.72	4.89	5.48
22-34P	3.80	3.95	2.52	4.29	5.28
22-35S	4.35	4.35	2.92	5.53	5.63
22-35P	4.00	4.00	2.61	5.24	5.43
22-36S	5.24	5.29	3.85	6.42	6.08
22-36P	4.65	4.65	3.26	5.58	6.02
22-37S	4.35	4.29	2.92	5.48	5.63
22-37P	4.00	4.00	2.92	5.24	5.43
24-1S	4.44	4.35	2.67	5.28	5.59
24-1P	3.71	4.00	2.57	4.55	5.48
24-2S	4.89	4.79	3.07	5.63	5.97
24-2P	4.09	4.29	2.57	4.49	5.48
24-3S	4.29	4.69	3.01	5.04	5.88
24-3P	3.80	3.80	2.61	4.49	5.53
24-4S	4.64	4.79	3.07	5.63	5.97
24-4P	4.05	4.25	2.57	4.84	5.48
24-5S	4.69	5.43	4.70	5.39	6.57
24-5P	5.19	5.63	3.91	5.13	6.86
24-6S	5.09	4.99	3.31	5.88	6.17
24-6P	4.35	4.35	2.67	5.04	5.59
24-7S	5.48	6.37	4.69	6.23	7.45
24-7P	5.28	6.03	3.76	6.03	7.21
24-9S	4.93	5.24	4.00	5.77	6.96
24-9P	3.85	4.09	2.47	4.64	5.39
24-10S	5.53	5.48	3.76	6.37	6.86
24-10P	5.43	5.39	3.65	6.27	6.57
24-11S	6.03	5.92	4.25	6.81	7.16
24-11P	4.89	5.28	3.56	5.68	6.47
24-12S	5.04	5.83	4.75	5.77	7.01
24-12P	4.64	4.79	3.07	5.43	5.97
24-14S	4.99	4.93	3.21	5.83	6.12
24-14P	4.00	4.25	2.72	4.79	5.63
24-15S	4.69	5.43	4.40	5.39	6.67
24-15P	5.77	5.63	3.95	6.57	6.92
24-16S	5.28	5.19	3.45	4.69	5.92
24-16P	4.20	4.55	2.81	4.20	5.04
24-17S	5.73	5.63	3.16	5.68	6.86
24-17P	3.80	4.05	2.52	4.59	5.43
24-18S	4.49	4.44	2.72	5.33	5.63
24-18P	3.45	3.71	2.17	4.25	5.13
24-19S	5.59	5.53	3.80	5.48	6.72
24-19P	4.55	5.04	3.31	5.33	6.27
24-20S	5.63	5.63	3.80	5.92	6.47
24-20P	6.12	6.08	4.44	6.61	7.06
24-21S	4.84	4.84	3.65	5.68	5.73
24-21P	4.59	4.55	3.11	5.04	6.37
24-22S	5.73	5.63	3.16	5.68	6.86
24-22P	3.80	4.05	2.52	4.59	5.43
24-24S	4.69	5.43	4.40	5.39	6.67
24-24P	6.23	5.63	3.95	6.57	6.92
24-25S	5.09	5.04	3.31	5.92	6.27
24-25P	4.35	4.40	2.72	5.04	5.59
24-26S	5.09	5.04	3.31	5.92	6.27
24-26P	4.35	4.40	2.72	5.04	5.59
24-28S	7.30	7.25	5.63	8.09	8.25
24-28P	9.28	9.18	7.56	9.48	10.22
24-691S	5.28	5.19	3.45	4.69	5.92
24-691P	4.20	4.55	2.81	4.20	5.04
24-835S	9.09	9.04	7.25	9.88	10.22
24-835P	5.04	4.98	3.25	5.88	6.17
28-1S	5.77	6.61	4.25	6.57	7.45
28-1P	5.13	5.83	3.56	5.68	6.76
28-2S	5.59	6.43	4.09	6.17	7.65
28-2P	5.24	5.88	3.56	5.88	7.10
28-3S	5.53	5.73	3.41	6.57	6.96
28-3P	4.35	4.64	2.52	5.39	6.03
28-4S	5.09	5.83	3.56	5.88	6.72
28-4P	4.59	5.24	2.92	5.33	6.23
28-5S	5.88	5.88	3.60	6.81	7.16
28-5P	4.89	5.13	2.92	5.88	6.52
28-6S	6.03	6.03	3.76	6.96	7.36
28-6P	4.75	5.04	3.07	5.43	6.57
28-7S	5.33	5.33	3.01	6.17	6.57
28-7P	4.25	4.49	2.57	5.24	6.12
28-8S	5.48	6.32	4.00	6.37	7.60
28-8P	5.13	5.88	3.65	6.08	7.21
28-9S	6.32	7.25	5.43	7.21	8.64
28-9P	5.39	5.97	3.71	6.27	7.21
28-10S	6.47	6.47	4.20	7.41	7.76
28-10P	5.97	6.08	3.80	6.96	7.36
28-11S	7.41	8.09	5.83	6.76	9.33
28-11P	7.01	7.21	4.93	7.06	8.49
28-12S	6.52	7.50	5.92	7.45	8.84
28-12P	7.10	7.76	5.48	7.56	9.04
28-13S	6.52	7.50	5.92	7.45	8.84
28-13P	7.80	7.80	5.48	8.69	9.09
28-14S	5.04	5.28	4.35	6.03	7.60
28-14P	5.77	5.77	3.45	6.67	7.06
28-15S	8.54	8.78	7.76	9.53	10.76
28-15P	9.28	9.28	7.01	10.22	10.61
28-16S	5.77	6.61	5.13	6.67	8.05
28-16P	6.86	6.86	6.23	7.76	8.09
28-17S	5.09	5.88	4.44	5.97	7.41
28-17P	5.43	6.17	3.91	6.17	6.17
28-18S	6.12	6.37	4.55	7.10	8.14
28-18P	5.59	5.83	3.71	6.57	7.21
28-19S	5.33	6.12	3.85	6.12	7.06
28-19P	4.64	5.39	3.11	5.59	6.61
28-20S	6.32	7.25	4.99	7.10	8.00
28-20P	5.48	6.32	4.00	6.27	7.56
28-21S	10.86	10.86	7.45	11.80	12.14
28-21P	9.58	9.58	7.16	8.89	10.81

Insert	Shell and 1947 List Price 3100	3101	3102	3106	310
28-22S	$6.81	6.81	4.49	7.65	8.05
28-22P	6.37	5.97	3.76	6.96	7.25
32-1S	6.67	6.86	4.40	7.90	8.34
32-1P	5.82	6.32	3.91	6.72	7.76
32-2S	7.65	7.90	5.53	8.64	9.42
32-2P	6.08	6.32	3.95	7.06	7.90
32-3S	7.25	7.41	4.93	7.25	8.89
32-3P	6.57	6.81	4.44	7.45	8.34
32-4S	7.30	7.56	5.92	8.29	9.42
32-4P	6.92	7.01	4.64	8.05	8.54
32-5S	6.32	7.25	4.25	6.67	8.20
32-5P	5.09	5.77	3.36	6.03	7.01
32-6S	10.76	10.86	8.44	11.90	12.40
32-6P	9.33	9.42	7.06	9.62	10.96
32-7S	10.61	10.72	8.29	11.76	12.29
32-7P	9.73	9.82	7.16	9.43	11.41
32-8S	9.73	9.88	7.45	10.86	11.41
32-8P	8.98	9.13	5.83	10.12	10.66
32-9S	8.40	8.64	6.61	9.38	10.46
32-9P	7.45	7.56	5.09	8.54	9.09
32-10S	7.80	8.14	5.73	8.69	9.68
32-10P	6.23	6.72	4.35	7.10	8.09
32-12S	7.76	7.90	5.48	8.89	9.38
32-12P	6.86	7.01	4.55	8.05	8.54
32-13S	10.61	10.72	8.29	11.76	12.29
32-13P	9.73	9.82	7.16	9.42	11.41
32-14S	7.80	8.14	5.73	8.69	9.68
32-14P	6.23	6.72	4.35	7.10	8.09
32-15S	10.16	10.86	8.44	11.90	12.40
32-15P	9.33	9.42	7.06	9.62	10.96
32-16S	10.76	10.86	8.49	11.90	12.44
32-16P	9.38	9.53	7.10	10.52	11.01
32-17S	7.65	7.90	5.53	8.64	9.42
32-17P	6.08	6.32	3.95	7.06	7.90
32-18S	7.30	7.56	5.92	8.29	9.42
32-18P	6.96	7.06	4.64	8.09	8.58
32-19S	7.41	8.00	5.59	8.34	9.33
32-19P	5.83	6.37	3.95	6.72	7.76
32-20S	9.93	10.86	8.49	11.80	12.44
32-20P	9.38	9.42	7.10	9.62	11.01
36-1S	8.84	9.28	6.99	9.13	10.96
36-1P	8.20	8.34	5.28	8.64	10.08
36-2S	7.60	8.29	6.12	9.04	9.97
36-2P	7.25	7.56	5.33	8.34	9.28
36-3S	8.44	8.58	6.43	9.77	10.02
36-3P	7.59	7.80	5.53	8.58	9.42
36-4S	8.00	8.09	5.92	9.24	9.73
36-4P	6.72	7.01	4.99	7.80	9.09
36-5S	7.94	8.09	5.92	9.28	9.77
36-5P	6.96	7.10	4.84	8.29	8.78
36-6S	9.42	9.62	7.60	10.76	11.30
36-6P	8.34	8.58	6.37	9.38	10.17
36-7S	12.89	10.04	10.81	12.34	14.72
36-7P	10.26	11.90	8.64	13.09	13.58
36-8S	10.92	12.40	9.97	11.90	14.22
36-8P	11.50	11.70	8.78	12.89	13.48
36-9S	12.60	12.78	10.52	13.97	14.46
36-9P	9.48	11.01	8.44	12.14	12.49
36-10S	12.89	10.04	10.81	12.34	14.72
36-10P	10.26	11.90	8.64	13.09	13.58
36-11S	12.89	10.04	10.81	12.34	14.72
36-11P	10.26	11.90	8.64	13.09	13.58
36-12S	12.89	10.04	10.81	12.34	14.72
36-12P	10.26	11.90	8.64	13.09	13.58
36-13S	8.58	8.74	6.12	9.93	10.42
36-13P	7.60	7.76	5.09	8.89	7.01
36-15S	8.89	10.17	8.00	9.88	11.06
36-15P	10.12	10.26	7.65	11.16	11.94
36-16S	12.93	13.09	10.42	12.34	14.72
36-16P	10.26	11.94	8.64	13.38	13.62
36-17S	12.93	13.09	10.42	12.34	14.72
36-17P	10.26	11.94	8.64	13.38	13.62
36-18S	12.64	12.84	10.17	14.02	14.52
36-18P	10.92	11.01	8.49	12.29	12.64
36-19S	11.89	9.04	9.81	11.34	13.72
36-19P	9.26	10.90	7.64	12.09	12.58
36-20S	11.89	9.04	9.81	11.34	13.72
36-20P	9.26	10.90	7.64	12.09	12.58
36-21S	12.64	12.84	10.17	14.02	14.52
36-21P	10.92	11.01	8.49	12.29	12.64
40-1S	12.29	12.49	9.04	13.73	12.93
40-1P	10.81	11.01	6.57	11.10	11.57
40-2S	10.32	10.57	7.50	10.86	11.80
40-2P	9.73	9.88	6.37	11.70	12.29
40-3S	11.85	12.05	8.29	13.62	14.61
40-3P	10.61	10.81	7.06	11.80	12.78
40-4S	12.69	12.93	9.33	14.72	15.30
40-4P	11.70	11.85	8.14	13.58	14.22
40-5S	13.88	14.08	10.32	15.80	16.40
40-5P	12.09	12.34	8.58	13.33	14.32
40-6S	12.09	12.34	8.78	12.64	13.58
40-6P	11.21	9.77	7.65	13.13	13.73
40-9S	17.24	17.44	13.68	19.21	19.85
40-9P	14.76	15.01	11.26	16.78	17.38
40-11S	13.04	14.66	10.61	16.44	17.04
40-11P	11.86	12.05	8.34	13.82	14.42
40-13S	10.32	10.57	7.41	10.86	11.80
40-13P	9.73	9.93	6.17	11.76	12.34
44-1S	14.72	16.54	10.86	15.16	16.54
44-1P	15.06	15.30	9.09	15.06	13.73
44-2S	18.37	16.44	10.46	17.18	16.93
44-2P	13.88	14.42	8.44	14.12	15.65
44-3S	15.90	12.34	10.17	15.90	8.64
44-3P	14.52	14.72	8.74	14.52	15.26
44-4S	18.86	18.37	13.13	18.02	18.81
44-4P	16.40	16.60	10.46	16.34	17.82
44-5S	14.72	16.54	10.92	18.16	16.54
44-5P	15.10	15.30	9.38	16.44	15.85
44-6S	14.72	16.54	10.92	15.16	16.54
44-6P	15.10	15.30	9.33	15.06	15.85
48-1S	15.94	16.29	9.58	19.85	18.46
48-1P	13.97	14.22	8.20	15.36	16.93
48-2S	15.94	16.29	9.58	19.85	18.46
48-2P	13.97	14.22	8.20	15.36	16.93
48-3S	15.94	16.29	9.58	19.85	18.46
48-3P	13.97	14.22	8.20	15.36	16.93
48-4S	15.94	16.29	9.58	19.85	18.46
48-4P	13.97	14.22	8.20	15.36	16.93
48-5S	15.94	16.29	9.58	19.85	18.46
48-5P	13.97	14.22	8.20	15.36	16.93

METERS

3 MA DC 2½" R—Simpson black scale.........$3.35
500 Microamps. DC—2½" round—Sun.......... 4.30
1 ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R—General Electric........ 2.95
2 amp. RF 2½" Sq.—Simpson................ 3.15
5 amp. AC 4½ R.—JBT...................... 4.11
50 VAC 3½" R.—General Electric............ 2.95
10 amp. RF 3½" R.—Simpson................ 4.95
50 amp. AC 3½" R.—General Electric......... 4.11
3 amp. RF 3½" R.—Weston.................. 6.00

MAGNETRONS

2J21A	2J36	2J61	706CY
2J22	2J37	5J23	706FY
2J26	2J38	5J29	706GY
2J27	2J39	700B	714AY
2J31	2J40	700C	718AY
2J32	2J41	700D	720B/C/DY
2J33	2J48	706AY	725A
2J34	2J49	706BY	730A

KLYSTRONS

2K23	2K33	707A	726A
2K25	2K54	707B	726B
2K26	2K55	723A	5611
2K29	417A	723A/B	

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G.E. Cat. 8248886G-1 and 9001934G-1 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D.........................$77.50

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KOLLSMAN Type 936-0240—85/68V 100 cy 5 watts 2650 RPM—new $12.95
DIEHL, Type FPE-25-11 75V 60cy 4 watts—new $34.50

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MFD	VDC	Price	MFD	VDC	Price
2	600	$ .45	.1	2500	.49
4	600	1.25	1-1	2500	3.85
4	600 (R'd)	1.25	32	2500	15.80
6	600	1.65	3x.2	4000	2.95
8	600 (R'd)	1.39	1	5000	4.88
10	600 (R'd)	1.52	.01-.03	6000	1.65
8-8	600	1.49	.1	7000	1.79
1	1000	.62	2	12500	28.95
2	1000	.89	.045	16KV	4.70
4	1000	1.65	.05	16KV	4.95
8	1000	2.45	.075	16KV	8.95
1	1500	.89	.25	20KV	18.95
4	1500	2.95	50	220VAC	3.95
.1-.5	2000	.87	7	660VAC	4.25
1	2000	1.50	8	660VAC	4.50

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy
Sec. 6250V 80 MA—12.5 KV Ins.............$18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins..............................$18.50
Raytheon—Pri. 115V 60 cy Sec. 8500/6450V CT 43 MA Hermetically sealed......................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	3.75	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

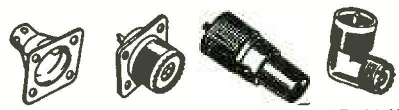
AT-38A/APT (70 to 400MC)...................$13.70
AT-49/APR-4 (300 to 3300MC)................. 13.70
DZ-2 Loop antenna with pedestal.............. 14.50
AN-74B (125 to 150MC)....................... 1.65
AN-65A (P/O SCR-521......................... .95
AN-66A (P/O SCR-521)........................ 1.15
AIA—3CM conical scan........................125.00
ASB Yagi—5 element 450 to 560MC............ 7.00
ASB Yagi—Double stacked 6 element........... 12.70
ASA Yagi—Double stacked 370 to 430MC..... 29.40

WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.
$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$.45	83-22AP	$1.10
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.45	83-22SP	1.15
83-1H	.10	83-1SPN	.45	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF		N	BN	BNC	
UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-83	UG-106	MX-195	UG-264
UG-21	UG-29	UG-85	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-86	UG-109	UG-201	UG-275
UG-22	UG-34	UG-87	UG-167	UG-206	UG-290
UG-22B		UG-88	UG-171	UG-236	UG-291
					UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201
93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

$1.25 each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	1/2"
60	9/16"	5K	3/8"	100K	SS
100	SS	5K	1/2"	100K	5/16"
100	1/4"	10K	SS	100K	3/8"
200	SS	10K	3/8"	100K	1/2"
250	1/8"	10K	1/2"	150K	1/2"
500	5/16"	15K	SS	200K	3/8"
500	1/2"	15K	1/2"	250K	SS
500	5/8"	20K	SS	250K	3/4"
650	1/2"	25K	SS	250K	3/8"
1K	SS	25K	1/4"	500K	SS
2K	3/8"	30K	1 1/8"	500K	1/4"
2500	SS	40K	SS	500K	7/16"
4K	SS	50K	SS	1 Meg	SS
5K	SS	50K	1/4"	2.5 Meg	SS
		50K	3/8"	5 Meg	SS

DUAL "JJ" POTENTIOMETERS—$1.95 each

50	SS	500	SS	1 Meg	SS
100	SS	1K	SS	2.5 Meg	SS
250	SS	2500	SS	5 Meg	SS
330	SS	10K	SS	1K/25K	3/8"

Triple "JJJ" Potentiometers..............$1.95 each.
100K/100K/100K—⅝" 20K/150K/15K—⅝"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets.......................$8.92 ea.

F.W. BRIDGE SELENIUM RECTIFIERS

AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.3 Amps......	$2.90	0.6 Amps.......	$3.30
2.4............	3.85	1.2............	4.40
6.6............	5.45	3.2............	'6.55
13.0...........	9.80	6.0............	11.70
17.5...........	12.50	9.0............	13.75
26.............	18.80	12.............	21.50
39.............	25.30	18.............	25.50
52.............	33.74	24.............	39.56
70.............	42.26	36.............	45.36

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy. 1 ϕ; DC 30 Volts 60 Amps. Brand New.......................$38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing..$15.50

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
3C31	FG-105	KU-628	2050
4C35	FG-166	KU-634	2051
C5B	FG-172	WL-652	5550
C6J	FG-178	WL-672	5551
FG-17	RX-233A	WL-677	5552
FG-33	FG-235A	WL-681	5557
			5560

TEST EQUIPMENT

- I-222A Signal Generator................* $79.50
- I-72K Signal Generator.....................$48.50
- Vibrotest Mod. 218 Megger...............* $45.00
- TS-263/TPS-10—3CM FM Test Set.....* $325.00
- TN-1B/APR-1 Tuning Unit...................$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ....* $9.00
- TS-127/U Freq. Meter w/spares.........$69.50
- TS-143/CPN Oscilloscope ....* $95.00
- Dumont 175A Oscilloscope ....* $225.00
- LM-20 Frequency Meter ....* $49.50
- Gen. Radio 757-P1 Power Supply........* $27.00
- I-130 A Signal Generator...............* $70.00
- TS-6/AP Frequency Meter...............* $42.00
- L & N KS-7470 Null Volt Test Set......* $60.00
- A.W. Barber Labs. VM-25 VTVM......* $86.00
- TS-10A/APN Delay Line Test Set.........$45.00
- TS-19/APQ-5 Calibrator $75.00
- REL W-1158 Frequency Meter 160-220 Mc.$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC...............................$11.75

3 CM. Pickup Horn Antenna.......................$9.95
All Items New Except Where Noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter...............$ 9.87
Powerstat 1226—115/230V input—0-270V out @ 9 amp. 37.00
G.E. 2CV2A1 Servo Amplifier.................. 6.95
Sperry A-3 Hydraulic Servos.................. 3.95
EIMAC 35 TG Ionization Gauge............ 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W.. 19.95
ID-6/APN-4 Indicator 29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
SCR-522 Transceiver 36.95
RT-7/APN-1 Transceiver—less tubes......... 6.95
FL-8 1020 cycle filter.......................... 1.37
RM-29 remote control unit.................... 8.95
RM-14 remote control unit.................... 8.95
RTA-1B 12/24 V dynamotor.................... 40.00
BC-1206-CM2 Receiver 7.95
CY-230/MPG-1 Radar Console..............575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete.............. 69.75
AN/APS-13 less tubes......................... 12.95
T-9/APQ-2 less tubes 16.50
BC-645A complete 18.95
RCA AVR-15 Beacon Recvr.................... 15.50
TBY Trans-Recvr 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used).................... 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 ϕ.................................... 39.50
Navy SD-3 Radar complete....................$1200.00
Navy DP-14 Direction Finder complete......$385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G828	AN/APN-4 Block Osc.
G.E. 68G-627	Philco 352-7149
G.E. K-2469A	Philco 352-7150
AN/APN-9 (901756-501)	Philco 352-7071
AN/APN-9 (901756-502)	Philco 352-7178
AN/APN-9 (352-7250)	Raytheon UX-7350
AN/APN-9 (352-7251)	W.E. D-161310
Westinghouse 132-AW	W.E. D-163247
Westinghouse 232-AW2	W.E. D-163325
Westinghouse 232-BW2	W.E. D-164661

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN/APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV. "E" Circuit 1 Microsec. 200 PPS, 67 ohms Imped. 3 sections.......$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms Imped. 3 sections.......$6.75
7.5 E4-16-60-67P, 7.5 KV "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms imped.......$8.25
15 E4-.91-400-50P, 15KV "E" circuit .91 microsec. 400 PPS, 50 ohms imped, 4 sections......$12.00
15-A-1-400-50P, 15KV, "A" Circuit, 1 microsec, 400 PPS, 50 ohms imped................$37.50
15 E7-2-200-50P, 15KV "E" Circuit, 2 microsec, 200 PPS, 50 ohms Imped., 7 sections......$42.00

SYNCHROS

Size 1, 3, 5, 6, 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

1F	6DG	X	C-78248
5B	6G	2J1F1	C-78249
5CT	7DG	2J1G1	C-78410
5D	7G	2J1H1	C-78411
5DG	A	C-44968-6	C-78415
5F	B	C-56701	C-79331
5G	M	C-69405-2	C-78254
5N	N	C-69406-1	C-78670

SEND FOR COMPLETE LISTING

LECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA.
Telephones - MARKET 7-6590 and 6591

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG Set. Diehl Elec. Co. 120V D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New $285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers. 230 DC To 120 AC, 60 cy. 1 Ph. Fully enclosed, Splashproof Ball Bearings, centrifugal starter. New, complete with kit of Spare Parts....$150.00

MG Set. Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy. 1 Ph. Output 115, 480 cy. 1 Ph. 1200W and 26V DC at 4 amps. New......$295.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy. 3 Ph. 1500 VA to 875 DC and 300V DV. New $69.50

DYNAMOTOR. Navy-Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New. $69.50

DYNAMOTOR. Elcor. 64V DC to 110V AC. 60 cy. 1 Ph, 2.04 Amps. New.................$24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New..................$17.50

DYNAMOTOR — Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig Corps. U. S. Army MG-27-B. New....................$26.50

AMPLIDYNE—Edison type 5AM31NJ18A. Input: 27 volts 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New.................$22.50

INVERTER—G.E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy. 485 Va. New...$24.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output, 80V., 800 cy. 485 VA. New $17.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115, 400 cycles at 1.5 KVA...$24.50

GENEMOTOR—Carter 6V DC to 400 V DC at 375 mils. New $39.50

D.C. MOTOR—G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A. Field 6V D.C. at 2.3A. RPM 4000. H.P. 0.5. New $22.50

MOTOR GENERATOR M.G. 164. Holtzer-Cabot Motor: 440V, 3PH, 60 cy., .90A, 1/3HP, 1750 RPM. Generator: 70V, 3Ph, 146 Cy., .140KVA Exciter: 115DC, 1A. New.................$67.50

BC-348 RECEIVER PARTS

Dial Mechanism assemblies. 1st, 2nd, 3rd, 4th I.F. transformers. C.W. osc. and xtal filter trans. with xtals. All R.F. coils. Front panels. Shock mounts. Large quantity misc. hardware sub assemblies, etc. Write your requirements.

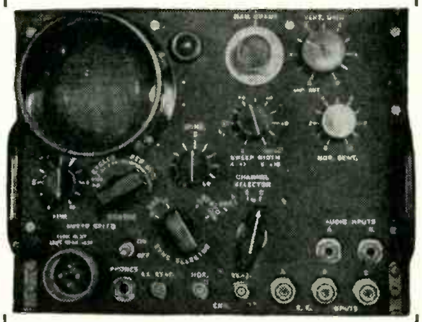
MISCELLANEOUS EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47APR Test Set—40 to 500 MC.
213-A DuMont C.R. Modulation Monitor.
BC1203B APN-4 Test Set.
6255A H.P. Interpolation Osc.
TS-23/APN Test Set.
TS-487/U Peak to Peak VTVM.
BC-221AE Freq. Meter.
LM-13 Freq. Meter.

MICROWAVE RECEIVERS

AN/APR-1 Receivers and tuning units TN-1 (38 to 95 MC) TN-2 (76-300 MC) TN-3 (300-1000 MC).
AN/APR-4 Receivers and tuning units TN- 16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000 MC).
AN/APR-5A Receivers. 1000 to 6000 MC Range.

MODEL AN/APA-10 PANORAMIC ADAPTER



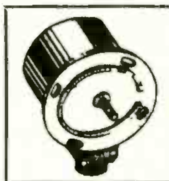
Provides 4 Types of Presentations:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I. F. of 455kc. 5.2mc, or 30mc.

SUMMARY OF CHARACTERISTICS:

SENSITIVITY: "A" channel, 400 microvolts or less per ¼" beam deflection. "B" channel, 400 microvolts or less per ¼" beam deflection. "C" channel, 1 volt or less per ¼" beam deflection.
RESOLUTION: 12 kilocycles at 3 db down from peak, sweep control at maximum, using CW signal.
PRESENTATION: Panoramic ("A" & "B" channels): Oscillographic, "C" channel.
SWEEP WIDTH: Channel A, ± 50 kc (100 kc overall) Channel B, ± 500 kc (1 Mc overall) Channel C, ± 1 Mc (2 Mc overall).
CATHODE RAY SWEEP: Oscillatory or non-oscillatory (Servo) Variable Sawtooth Generator. 35 to 40,000 cycles per second.
AUDIO OUTPUT: 50 milliwatts into 600 or 8000 ohm load.
VERTICAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc or higher. Amplifier out position permits direct connection to one vertical plate through coupling capacitor.
HORIZONTAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc. No provision for direct connection to deflection plates.
CATHODE RAY TUBE VOLTAGE: Cathode to accelerating anode; 1200V DC for 115V A.C. input.
SENSITIVITY OF CATHODE RAY OSCILLOSCOPE: Maximum through Amplifier. Horizontal: 10 volts peak to peak per inch. Vertical: 1.5 volts peak to peak per inch.
DIRECT TO VERTICAL PLATE: 150 volts peak to peak per inch.
NOISE: No disturbance in excess of 25,000 microvolts between 200kc to 200Mc generated by equipment.
Overall Dimensions: 19-9/16" x 10¼" x 7⅝".
Weight: 40 lbs.
Power Requirements: 115V. A.C. 60 cycles, 1 phase. With 21 tubes including 3" scope tube, for operation on 115 V. 60 cycle source. PRICE..........$245.00

AN/APA-10 80 Page Tech Manual..............$2.75



LINEAR SAWTOOTH POTENTIOMETER

W.E KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.
Brand New $5.50

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier, 115 volts—400 cycles. Dual channel. Employs 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. New $22.50

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No 80G184. KVA .945S—520P. Volts 460/345/230/115. New. $4.95

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $2.95

THYRATHRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115. Sec: 50-0-50V at 1.5A. 6.3V at 1.2A. Test r.m.s. 1780. New..$2.75

PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New..................$2.95

Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new.............$49.50

SCOPE PL. & FIL. WECO 9556. 400/2400 cy Pri: 115. HV Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75

FILAMENT. 400/2400 cps. WECO KS9558. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New $1.95

PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec: #1=1200VDC at 1.5MA. Sec. #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A. (ins. 1500V)/5V2A/5V2A $4.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $5.95

High Rectance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New $89.50

High Voltage Trans. Westinghouse Pri: 115, 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up $24.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps.$5.00

PULSE. WECO KS-161310. 50 KC to 4 KC—4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New $1.95

RAYTHEON VOLTAGE REGULATOR

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special.........$14.75

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$16.50
.25 MFD., 15KV	12.50
1 MFD., 7.5V	6.25

SOUND POWERED PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. Brand new including 20 ft. of rubber covered cable.......$17.50

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable $10.00

U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new............$13.50

W. E. type TS-10M Handset. New........$16.50

PARABOLOIDS

Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new, per pair..........................$8.75

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.........$2.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR. Available in quantity—following frequencies—fundamentals.
5910—6350—6370—6470—6510—6610—6670—6690—6940—7270—7350—7380—7390—7480—7580—9720—Kilocycles.

$1.25 each

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT
INC.
27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

CRYSTALS Low Freq.

FT241-A. Holder ½" Pin spacing, for ham and general use, Xtal controlled. Signal Generators, marked in army Mc harmonic frequencies—Derections for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370	396	420	446	487	514	447
372	397	422	458	488	515	448
374	398	423	459	490	516	450
375	400	424	461	491	518	451
376	401	425	462	492	519	453
377	402	427	468	493	520	454
379	403	429	469	494	522	455
380	404	430	470	495	523	456
381	405	431	472	496	525	457
383	406	433	473	497	526	463
384	407	434	474	502	527	465
385	408	435	475	503	529	498
386	409	436	476	504	530	500
387	411	437	477	505	531	501
388	412	438	479	506	533	538
390	413	440	480	507	534	540
391	414	441	481	508	536	
392	415	442	483	509	537	each
393	416	443	484	511	each	
394	418	444	485	512		
395	419	445	486	513	69c	$1.49

BATHTUB CAPACITORS

MFD	Volt	Type	Price Each	10 for
.5	400	2BT	$0.23	$2.20
.5	600	2TT	.25	2.40
3x.1	600	3TT	.45	4.35
3x.1	600	3ST	.45	4.35
2x.1	400	3ST	.26	2.50
2x.1	600	3ST	.28	2.65
2x.1	600	3BT	.28	2.65
2x.1	400	2TT	.26	2.50
2x.1	200	2ST	.23	2.20
2x.1	600	2BT	.26	2.50
2x.1	600	3TT	.26	2.50
.1-.1-.025	400	3ST	.28	2.65
.1	600	2BT	.22	2.10
.1	600	1ST	.22	2.10
.1	600	2TT	.22	2.10
.1	600	2ST	.22	2.10
.13	600	2ST	.25	2.40
2x.25	600	3ST	.30	2.85
.05	600	2TT	.21	2.00
1	100	2TT	.23	2.20
20	50	2ST	.26	2.50

TEST EQUIPMENT

Frequency Modulated Generator, Type 155A Frequency 38 MC—50 MC. Range 1 MC—10 MC. Boonton Radio.
Solar Exameter Capacitor Analyzer.
Tube Tester Model 7050. Philco 110/120. AC 60 Cy.
3" scope No. 155A C.R. Oscillograph R.C.A.
Test Set I-180A, Hickok Model 540 Test Equipment Tube checker.
Sweep Signal Generator Model 909.
McMurdo (Silver), Range 2-226 MC. Output 0-.5 V Max. 105/125V 50/60 Cy. 35W.
Frequency Meter BC221N 125-20000 KC.
Precision Series E-400, Sweep Generator FM-TV-AM.
Signal Generator Model 702, Radio City Products.
Standard Signal Generator Model 78B. Boonton (Measurements Corp.)
Television Calibrator WR-39A. R.C.A.
Microvolter Model 20-B Ferris Instrument Boonton.
Signal Generator I-216 15-26 MC CKE 115V/60 Cy. 180-235 MC.
Model LU-1, Radar Test Equipment. Frequency meter & Test Oscillator.
Industrial Instrument Bridge. LB2-DR1. 10 Watt 115V 60 Cy.
Industrial Instrument Bridge RN-1.
Hunter charging control analyzer Model 372K2.
Hickok Thermo Ammeter Model 14T #1-4270.
Weston DC Milliameter Model #155.
Leeds & North Type S Test Set #5300 #5410.
RCA Voltmeter Ohmyst.
Leeds North Galvanometer #2420A.
GR Output Meter #783A.
Boonton Q Meter Type 160A & 170A.
Industrial Bridge LBID.

Write or Phone for Price

TOP TRANSFORMER BUYS

These XFRMRS are Army Spec.

All Underrated.

Comb. Transformers—115V/50-60 cps input

Item	H.V.	Amp.	Filaments	Price
CT-861	2100VCT	.175	7.5VCT/4A, 2.5V/10A	$10.95
CT-142	645VCT	.060	5V/2A, 6.3V/1.2A	4.25
CT-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-076	600V	.100	2 x 12.6V/1	1.95
CT-626	1500V	.160	2.5/12, 30/100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8 3 lbs	2.95
CT-071	110V	.200	33/200, 5V/10, 2.5/10	4.95
CT-378	2300V	4 MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A, 2.5VCT/7A	3.25
CT-91A	726V	.100	5V/3A, 6.3/3.5	3.25
CT-441	50V	.200	5V/2.4, 5V/1.2	2.29
CT-408	350VCT	.026MA	5V/3A	2.75
CT-931	585VCT	.086	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A	2.75
CT-102	1080VCT	.055	25V/3A, 6.3V/1.8A, 6.3V/1.2A	5.95
CT-866	330V	.065	6.3V/1.2, 6.3V/600MA	1.75
CT-319	330VCT	.085	5V/2, 6.3/7.5, 6.3/3	3.25

Filament Transformers—115V/50-60 cps input

Item	Rating	Each
FT-029	13.5V/1.11A	.79
FT-346	5VCT/13/5, 5VCT/6.75, 5VCT/6.75	5.95
FT-781	866 Trans. 2 x 2.5/5A	2.25
FTG-31	2.5V/2.5, 7V/7A (Tape@ 2.5V/2.5A), 16 lbs	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-391	6.4V/3A	1.10
FT-736	2 x 6.3VCT/3.2-1.2A	1.49
FT-899	2 x 5V/5.5A 29000 Rms	22.95
FT-418	6.3VCT/1A, 6.3VCT/7A	1.95
FT-735	6.3VCT/5A, 6.3VCT/1A	1.79
FT-101	6V/.25A	.79
FT-738	6.3VCT/1A, 5V/2A	1.69

Plate Transformers—115V/50-60 cps input

Item	Rating	Each
PT-976	Auto: 120VCT/10MA	$0.69
PT-31A	2x300V/5 MA	.79
PT-46A	4080VCT N. L. 3% to 1 8" H x 6" W x 7" L 20 lbs	29.95
PT-033	4150V/400 MA 11½ x 9¼ W x 9" D 70 lbs	49.95
PT-75-2	3780/3446/3112VCT/77 MA	10.95
PT-28-1	4600VCT/.077	12.95
PT-403	Auto: 70V/1A	2.29
PT-160	1120VCT/770 MA, 590VCT/82 MA, 25 lbs	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT-139	42V/46V/50V/55V/15.2A 7⅞ x 7" W x 6¾" H	10.95
PT-31A	2 x 300V/5 MA	.79
PT-976	120VCT/10 MA	.79
PT-67-1	62V/3.5A	2.95
PT-12A	280VCT/1.2A	2.95

SELSYN TESTER

Magnesyn Instrument Field Tester AAF 43G23330 Spec. 40772. To test individual mag. Ind. & Xmitters, for isolating Faults in magnesyn systems. Brand new $99.00

AN-GSC-T1 CODE TRAINING SET

Complete with 10 keys. Consists of a variable pitch audio oscillator powered by universal power supply. DC, 6-12-24-115V. AC, 115-230 V. Voltage selectable by switch. Has loudspeaker and volume control. Contained in carrying case 17 x 10¼ x 13". Ideal for code training groups, clubs, schools, etc. NEW original boxes. Were **$49.50,** now ea. **$24.95.**

TUNING UNITS for BC 375

TU7 4500— 6200KC.......
TU8 6200— 7700KC.......
TU9 7700— 1000KC.......
TU26 200— 500KC.......

Price $2.49 ea.

MOBILES

CAP CD

6 V. Trans. Dyn. Supply Ratings

Input	Output
Volts 6	450
Amps 45	.350
Or	
Volts 6	450
Amps 22	.200

Originally Designed For Use With 14 V Input, But Mobiles Report Ex. Service at 6 V. Complete With Mtg. Plate, Filter Box, Starting Relay **New $12.95**
Set of 2 Plugs (Sold with Dyn. Only) $1.00

HEADSETS & MIKES

HS23 Used Good 8000 Imp..$2.49
HS33 Used Good 600 Imp..$2.49
HS30B Replace Elements .60c ea.
Rubber Earplugs for HS30...... 10 for 25c
Matching XFRMR C410 Less Cords 59c
T45 Lip Mikes.. 98c
T30 Throat Mike 39c
CD508T30 Ext. Cords w/Switch Sw141. Complete $1.25
Gas Mask Mike Elements ...49c
Cords 3 Cond. Color coded approx. 42#. 15c ea.
Hdband HBI. 25c
HdbandHB30. 25c

AUDIO TRANSFORMERS

ITEM		
AT666	Input 6 ohms: 250K ohms	$0.79
AT SUB	Multimatch Subouncer 200 ohms 15K ohms C. T.: 100K ohms/20K ohms	.69
AT070	Input to Grid 250 ohms: 60K ohms HI FI	1.19
AT566	Input to Grid, 500/200 ohms: 50K ohms	.95
AT227	Output to line, 7500K 5pp ohms CT 200—5 kcy	1.45
AT353	Output PP 6L6 to 300/20/12/16 ohms 25 Watt	2.95
AT871	UNIV. Output, HI FI, Pri 20K ohms nec. 15/7.5/5/3.75/1.25/500 ohms	2.79
AT554	Interstage, 10K ohms: 250K ohms 15db Level	1.95
AT765	Input 600 ohms to 50K ohms	.79
AT707	Interstage ouncer 10K ohms: 125/125K ohms	.79
AT449	Driver 5K ohm to 4K ohm PP6L6 to PP805 Class B	3.89
AT21	Dual XFRMR 300 ohms: 300 ohms and 600 ohms: 250K ohms	1.35
AT383	Output 8500 ohms: 19 ohms 25W	1.79
AT415	Output 18K ohms CT to Line 125 ohms 175W	2.95
AT649	Input. Line 500 ohms T Grid, 75K ohms	.79

Many Others

INSULATORS

Feeder Support IN81-IN82 Porc. Standoff 1-1/2 H x 1-3/16 D 10¢ ea., 10 for 75¢
Feed Thru IN84-XS1. Complete w/ Hdwre ....15¢ ea., 10 for $1.25
Feed Thru Lapp Bowl Sim to XS3 for 2¾" hole. 6¾ L x 3" dia. $1.25 ea.
ANT Insulators, IN86 3⅝ L x 1 x 1 18¢ ea., 10 for $1.50
Feeder Spreaders 2-11/16 x 7/16". 2" C to C Holes........Price 10¢
Feeder Spreaders 2⅛" L x ⅝" Sq. 1⅜ C to C Holes.....Price 8¢ ea.
Locke Suspension Ins Cat # CAL 61249. 18" L x 2" D...Price $19.95
Telephone Knob Insulator Whiteall Tatum #4. Heavy Glass Price $2.29

Many Others—Write

ANTENNA MAST

Are you in a dead spot? If you can't get a good T. V. Picture, Here is a Sig. Corp. Ant. mast 30' high of rugged plywood construction to solve your problem. It telescopes into 3 ten ft. sect. for easy storage. Easy to Mnt. Comp. with stakes & rods. **Ea. $19.95.**

MICA CAPACITORS SOLAR XMB TAPPED POLES

Mfd.	Price
2500 V Test	
.00001	$0.35
.000025	.35
.00003	.35
.00005	.35
.000075	.35
.0001	.35
.00015	.35
.00025	.35
.0003	.35
.0004	.35
.0005	.40
.00075	.40
.00085	.40
.001	.50
.0015	.50
.0016	.50
.0017	.55
.002	.65
.0023	.65
.003	.75
.004	.95
.005	.95
.006	.98
.0063	.98
.0069	.98
.007	.98
.0075	.98
.0076	.98
.008	1.05
.01	1.25
.015	1.25
.02	1.30
.025	1.30
.027	1.35
.03	1.45
5000 V Test	
.0015	1.75
.002	2.00
Solar XQ Solder Lugs 2500 V Test	
.01	1.25
.015	1.30
.02	1.50
.04	1.75
.001	.60
.0015	.60
.002	.75
.0022	.75
.0023	.75
.0024	.75
.0025	.75
.0027	.80
.003	.80
.004	.85
.005	.90
.0056	.95
.006	.95
.0063	.95
.0075	1.00
.0076	1.00
.008	1.05
.0085	1.20
.0005	.60
.00085	.70
.00015	.60

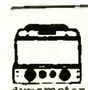
OIL CONDENSORS

Mfd.	Volt.	Price
5	50	$0.45
650	80	1.95
5	150 AC	1.45
15	220 AC	2.20
1	500	.40
7	600	1.25
20	600	2.10
0.5	750 AC	1.59
0.5	1000	.69
2 x 0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
4	1000	1.75
3 x .01	1200	1.35
0.0016	1500	1.25
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
2 x 0.1	2000	1.10
1	2000	1.45
2	2000	2.25
3	2200	2.45
0.5	2500	1.35
1.5	2500	1.35
0.15	4000	1.20
2 x 0.1	4800	1.20
0.1	6000	1.20
2 x 0.1	7000	1.25
0.1	7500	1.25
2 x 0.15	8000	4.75

Many Others

932 PHOTO TUBE

Gas Phototube having SI response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data. Price........ **75¢**



ARC 5 MODULATOR

MD7 ARC5 Plate Modulator w/ dynamotor complete w/Tubes 1—12J5, 2—1625, 1—VR50. Good cond. Price....$6.95
BC456 Screen Mod. $2.25

Heineman Ckt Bkrs for AC-DC operation.

AM1510M	7 Amp
1614	80 Amp
1614	50 Amp
U90	100 Amp

Price ea......$1.10
P-0322 Dual 10 Amp. Price ea......$2.25

DYNAMOTORS

Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DY-2/ARR-2	28	1.1	250	.060	ARC-5
DM36	28	1.4	320	.080	SCR 508
DM25	12	2.3	250	.050	BC 367
	28	1.25	575	.070	BC 348
DM31A	28	7	540	.250	BC 456
DM42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
35CO458	28	1.2	250	.060	
ZA-085	12/24	4/2	500	.050	
ZA-056	12/24	8/4	12/275	3/110	
B-19 pack	12	9.4	275	.110	Mark II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
DM21	14	3.3	235	.090	BC 312
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
BD 77KM	14	40	1000	.350	MG 191
PE94	28	10	300	.200	SCR
			150	.010	522
			14.5	.5	

PE 86 DM 32A DY 22 ARC 3 DAG 33A

Screen Mod. XFRMR for pair of 807's PP—PP or Parll Sidetone Wndg. 95¢

T. U. for BCAR230 or 430
3.2—4MC
5—6.2MC
1.2—1.5MC
1—1.2MC
Price 95¢ ea.
4—5MC w/ 4495KC XTAL $1.69 ea.

NEW—BC—906 FREQ. METER—NEW

Range 15-22.5 MC — Bat. operation with precision velvet vernier dial, tuning charts, 0-500 D.C. microammeter, diode - Triode and plug-in antenna. Contained in black aluminum carrying case 12½ x 8¾ x 6½. Price $15.95

1% PRECISION RESISTORS

.6	128	10,000
1.01	250	12,000
5	300	12,000
5.05	430	17,000
10.1	463	17,300
18	800	20,000
43.5	920	25,000
50	1100	30,000
75	4300	33,000
82	5000	40,000
120	7500	55,000
125	8500	57,000
128	10,000	75,000
150	10,000	84,000

30c ea. 10 for $2.50

100,000	150,000
120,000	220K
120,000	250K

40c ea. 10 for $3.50
1 Meg. 75c ea.

HIGH CURRENT CERAMIC MICAS

.0012	20000	$32.50
.0001	20000	32.95
.001	6000	4.95
.002	6000	4.95
.01	4000	3.95

AMPS—RF

0-4 Amp RF GE Type DW52, 2% Accuracy, Expanded Scale, 2.19" dia. Int. Thermocouple. List Price $19.75. Our Price.....$2.95

EE 894 TELEPHONE REPEATER

Used to extend range of field telephones, teleg. & 20 cyc. ringing possible over lines complete w/305 tube & phone. Featherweight. Price $9.95

CERAMICON CAPACITORS

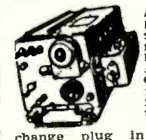
Mmf.	Mmf.	Mmf.
3	35	82
3.1	47	125
4	50	200
11	51	220
13	60	240
14	62	250
15	65	345
20	70	350
25		500
		1000

$7 per 100

SILVER MICA BUTTONS

Mmf.	Mmf.	Mmf.
40	175	500
50	180	2000
100	185	

$7.50 per 100



Aircraft Rec. #429 for Mobile or Aircraft Covers from 201 Kc up by interchange plug in tuning units includes one Dual Tuning Unit: 200 KC. 400 KC. & 2.5 Mc-4.7 Mc. less tubes. Rec. Only a few left.......$3.95 ea.

All merch. guar. Mail orders promptly filled. All prices F.O.B. N. Y. C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E6 Chas. Rosen Phone: Digby 9-4124

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS Sweeptime: 100 to 2,500 microsec. in 4 steps, fixed mod. pulse, suppression pulse, sliding modulating voltage, marker pulse, sweep voltages, calibrations, voltages, fil voltages. Operates 115 vac. 60-60 cy. Provides various types of voltage pulse outputs for the modulation of a single generator such as General Radio #894B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New $125.00

BC 758A Pulse modulator....................$395.00

APS-10 Low voltage power supply less tubes........$18.50

725A magnetron pulse transformers..............$18.50 ea.

PULSE NETWORKS

Ray-WX4298F $39.50

GE-K6824736 ....$50.00

GE-K9216945 ....$50.00

15A—1-400-50: 15 KV. "A" CKT. 1 microsec 400 PPS. 50 ohms imp. $42.50

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS, 50 ohms impedance.......$6.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 sections, .84 Microsec. 810 PPS, 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp. $6.50

7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec 200 PPS, 67 ohms impedance, 3 sections $7.50

7.5E4-16-60.67P. 7.5 KV. "E" circuit, 4 sections 16 microsec. 60 PPS, 67 ohms impedance...........$15.00

7.5E33-200-6PT. 7.5 KV. "E" Circuit, 3 microsec 200 PPS, 67 ohms imp. 3 sections....................$12.50

PULSE TRANSFORMERS

G.E.K.-2745 ....$39.50

G.E.K.-2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1/ microsec. @ 600 PPS....................$39.50

W.E. #166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms, Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil.......$36.00

W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00

W.E. #D169271 Hi Volt input pulse Transformer....$27.50

G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G. E. $34.50

G.E. #K2748A. Pulse Input line to magnetron......$36.00

400 CYCLE TRANSFORMERS
115-V 400 CYCLE INPUT

Ratings	Price Each
6.3V/1.8A P/O APG2	$1.49
6.4V/2.5, 400VCT/35Ma, 6.4/.150a	3.95
6.4V/7.5, 6.4/3.8, 6.4/2.5a	3.49
780V/27v/4.7, 6.3/2.9, 1.25/.2a	2.49
6.4V/8a, 6.4V/1A	1.95
6.3V, 9.1A, 6.3VCT/6.5a, 2 x 2.5/3.5a	2.49
5V/2a, 6.3V/2a, 5V/2a, 6.3/.5a	2.99
5V/15A, 5000V Ins.	3.95
6.3/2.7, 6.3/.66, 6.3VCT/21A	5.95
760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A 6.4/7.5, 6.4/3.8, 6.4/2.5	2.95
592V/118Ma, 6.3/8,1a, 5V/2 W.E.	4.95
6.3V/9.1, 6.3VCT/.65a, 2 x 2.5V/3.5A	2.95
6VCT/.00006 KVA	.98
6.4V/8a. 6.4V/1a	1.49
1034VCT/.111a, 6.9V/10, 2 x 6.3V/1, 5V2, 6.3/2, 63/1	6.49
526VCT/.50a, 6.3VCT/2a, 5VCT/29	3.49
400VCT/35Ma, 6.4/2.5, 6.4/15a	3.25
2300VCT Large Qty	2.25
600VCT/36Ma	1.49
2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5/2 . For SCR729	3.95
640V/500Ma, 2.5V/1.75a P/o APS/15B	2.95
360VCT/20Ma, 1500V/1Ma, 2.5V, 6.3/2.5, 6.3V/.6a, P/o 729A	3.95
2 x 2.5V/5A, 2.5V/10A, P/O APT 4	4.95
2 x 2.5V/2.5a, 6.3V/2.25a, 1200V Tap 1000V–750V P/o AN/APS-15	4.95
742.5V/50MA, 709V, 47MA, 671V/45Ma	2.95
600VCT/36MA, 2 3/4 x 2 1/4 x 3 1/4	
1150–1150, 2 3/4 x 2 1/4 x 3 1/4	
640VCT/250MA, 6.3V/.9, 6.3V/.6, 5V/6A	3.95
6.3V/9.1a, 2.5V/3.5a, 6.3VCT/65a, 2.5V/3.5a	3.25
9800V or 8600V/32MA	12.50
4540VCT/250MA	7.50
5V/3a, 6.3V/2a	1.75
5000V/290MA, 5V/10A	12.50
2200V/350	5.45
2.5V/5, 5200V/2MA	14.95
13.5KV/3.5MA	11.50
734VCT/.177a, 1710VCT/177a	6.95
6.3V/9A, 7.7V/.365A	2.79
2.5/20A	4.85
6.3V/12a, 6.3V/2a, 6.3V/1a, P/o AN/APQ–5	5.85
6.4VCT/7.5, 6.4VCT/3.8, 6.4VCT/2.5a	4.35
6.3V/2.7, 6.3V/.66A, 6.3VCT/21A	2.95
6.5V/12A, 250V/100MA, 5V/2a, P/o AN/APS-15	3.50
400VCT/35MA, 6.4/.15a, 6.4V/2.5a	2.25
650VCT/50MA, 6.3VCT/2A, 5VCT/2A, P/o R58/ARQ8	2.45
2400CT/5MA, 640V/.5MA, 2.5V/1.75A	3.85
15.35VCT/1A	1.95
6.3/.9, 6/3V/.6.5V/6, 640/200MA	4.95
2 x 14CV/00014A, 12QV/00012a, P/o APG2	1.95
3640V/400Ma, P/o APT4	7.95
23.5V Tapped 22V/47MA	1.95
600VCT/36Ma	1.95
780V, 27V/4.3, 6.3V/2.9, 1.25V/20A	3.95
6.4V/11 Amp. P/o APQ7	2.25
2 x 6.3V/1.25a, P/o APQ13	1.95

VARISTORS

D-167176 ....$ .95
D-172155 ....$2.25
D-172307 ....$1.75
D-167208E $1.85
D-172175 ....$1.65
D-168687 ....$ .95
D-171812 ....$ .95
D-171528 ....$ .95
D-165593 ....$1.25
D-162356(308A) $1.50

THERMISTORS

D-166288 ....$1.50
D-168392 ....$1.75
D-167332 (tube) $1.50
D-170396 (bead) $1.50
D-167613 (button) ..$1.50
D-164699 for MTG in "X" band Guide..$2.50

RADAR

RADAR

RADAR

RADAR

RADAR

APS-2. 10 cm. airborne radar set designed for navigation and high altitude bombing. The antenna rotates through 360 degrees. Presentation is PPI and A Scope. The following units of the set are supplied: Antenna, transmitter-receiver, modulator, indicator, 24VDC input power unit. New with all tubes, incl. 714AY magnetron, 417A klystron.

APS-3. 3 cm. airborne radar set designed for intercept of enemy aircraft and nominal navigation. Antenna is sector scan. Remote as well as master indicator is supplied. 725A magnetron operates the set at 45kw. Complete sets available with all tubes incl. magnetron and 723AB klystrons. Both new and used condition.

APS-4. 3 cm. airborne radar set designed for sector scan surface search, mapping and navigation, weather forecasting, intercepting of enemy aircraft. Entirely enclosed in a streamlined housing for optional mounting on aircraft bomb rack, or on nose of large bombers. Complete sets with indicator equipment, and power unit ready for installation.

APS-6. 3 cm Night Fighter radar with pencil beam antenna. Transmitter-receiver packages and antennas available in equal to new condition.

APS-6A. 3 cm airborne radar RF package, 45kw, using 725A magnetron, IF strip using 6AK5's 723AB beacon and local oscillator.

ASP-10. 3 cm airborne radar using 2J42 magnetron. Modulator decks and low voltage power supply, only, available, less tubes. Beacon-local oscillator klystron mounts are available.

APQ-13. 3 cm airborne radar complete RF package in excellent condition including all tubes.

APS-15. 3 cm airborne radar designed for high altitude bombing, navigation, intercept of enemy aircraft weather forecasting. Antenna rotates 360 degrees. Presentation is PPI and A scope. The following units are supplied: Antenna, transmitter-receiver, modulator, indicator, slant-range computer, 24VDC input power unit. New with all tubes including 45kw 725A magnetron, 723AB local oscillator-beacon.

CPN-8. 10cm Navigation Beacon ground station. Complete and partial installations available. High power beacon of long range capability. Complete power, frequency, operation analyzer (5" scope) included.

CXBR. 10cm MIT navigation beacon equipment. Complete, in excellent condition.

FD & Mark IV. 800 mc gunlaying radar mfg and designed by Western Electric for battleships. Complete consoles available with all tubes including 700A magnetron and modulator thyratron.

Mark 10. 10cm gunlaying radar, complete, for automatic firing of guns as antenna tracks target. 250 KW.

SA. 200mc Air Search radar especially designed for shipboard or mobile installation. Ideal for ground intercept and control of aircraft. PPI 7" indicator. Long range.

SD. 200mc radar similar to SA but designed for installation on submarines. New.

SE. 10cm shipboard Surface Search radar, using thyratron modulator. Complete installation available including spare parts. "A" scope presentation. 250 KW.

SF-1. 10cm shipboard Surface Search radar with PPI and A scope. Used for navigation and target range information on naval vessels. 250 KW.

SG. 10cm shipboard Surface Search radar with PPI and A scope. Heavy, rugged equipment designed for large naval and merchant vessels. 250 KW.

SJ-1. 10cm radar designed for installation on Submarines. Equipped with PPI and A scope. Complete installations.

SL. 10cm radar designed for Surface search on shipboard. PPI indicator console.

SN. 10cm portable radar. Lightweight, easily transportable complete radar installation using lighthouse tubes with a 25 mile maximum range. 115 VAC operation.

SO-1. 10cm shipboard radar for navigation on all types of vessels. 4, 20, and 80 mile range. PPI indicator. Large antenna. 115 VDC input.

SO-8. same as SO-1 but with a lightweight antenna.

SO-13. same as SO-1 but with lightweight antenna, 28VDC input. Designed for PT Boat installation.

SCR 518. Radar altimeter using pulse-echo-time principle, 400mc. 28 VDC input, CR tube altitude indication.

SCR 520. Airborne radar RF package, 10cm, complete with pulser, hard tube, 714AY magnetron.

SCR 533. IFF/Air Search trailer, complete, 500mc operation, A scope.

SCR 663. Sperry searchlight training, aircraft tracking ground installation. Used condition.

SQ. 10cm portable radar designed for use on landing barges and beachheads. PPI, B, A indication on 3" scope. 115 VAC operation.

TPS-2. 1000mc Portable Early Warning System. Bedspring antenna. Complete with portable gasoline generator.

RT73/UPN-2. 10cm Portable Beacon Equipment.

RADIO SYSTEMS

White Radio Telephone Model #WRM55. Ship to Ship—Shore to Ship—Small Airports—Mines—Plantations—Inter Island—Ranches. 10 channel Fix Tuned Receiver & Transmitter XMTR Pwr Output in excess of 100W unmodulated into antenna of 18Ω & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 Cy or 220V 60 or 25 Cy. Meas. 24" H x 19" W x 14" D. 125 lbs. Write or phone for data.

TAJ. 500 Watt Low Frequency Transmitter, 150-550 KC. C.W.. M.C.W.

TBK. 500 Watt High Frequency Transmitter 2 to 18 MC, A1, A2, A3. Emission. Mfg. by RCA.

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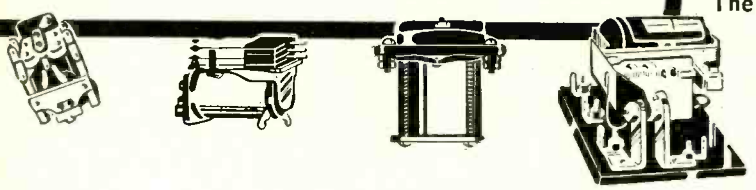
The following list represents only a tiny portion of our relay stock. Write or wire us for information on types not shown.



Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-714	9/14 VDC.	65	2C/5 Amps.	$1.55
R-653	12 VDC.	14	2C	1.55
R-721	18/21 VDC.	290	2C/5 Amps.	1.55
R-773	24 VDC.	280	3C/10 Amps.	1.60
R-694	24 VDC.	300	1A/5 Amps.	1.50
R-704	2/6 VDC.	.25	2B/5 Amps.	1.35
R-297	115 VAC.	...	2C	2.80
R-173	2/6 VDC.	2	1A	1.55
R-280	6/8 VDC.	77	1A Double Break	2.45
R-647	6/12 VDC.	15	1B/20 Amps.	1.45
R-273	20 VDC.	160	2A/15 Amps. D. Break	3.55
R-169	24 VDC.	200	1A	2.45
R-570	24 VDC.	230	1B Double Break	2.70
R-171	24 VDC.	230	2C/10 Amps.	2.70
R-529	24/48 VDC.	1020	2C	3.10
R-715	24 VAC.	...	2C Ceramic	3.70
R-584	6 VDC.	20	1A Double Break	1.30
R-192	12 VDC.	44	3C/10 Amps.	1.70
R-204	12 VDC.	66	2A	1.45
R-224	12 VDC.	85	1A	1.45
R-221	18/24 VDC.	5000	1A	1.45
R-205	24 VDC.	260	2C	1.55
R-536	27 VDC.	230	2C	1.55
R-220	75 VDC.	5000	1C	1.50
R-627	115 VAC.	...	1A Double Break	3.10
R-698	12 VDC.	75	1C	1.20
R-734	24 VDC.	150	3C/10 Amps.	1.30
R-598	28 VDC.	185	2C	1.30
R-622	20/30 VDC.	200	3A & 2C/10 Amps.	1.45
R-274	24 VAC.	...	2A	1.55
R-270	24 VAC.	...	1A	1.55
R-269	24 VAC.	...	1A/15 Amps.	1.55
R-277	12 VDC.	30	2C D. Break. Cera.	2.20
R-594	12 VDC.	50	2C	2.00
R-668	12 VDC.	50	1C/10 Amps.	1.30
R-613	12 VDC.	50	1C	1.30
R-772	12 VDC.	70	1A/15 Amps.	1.45
R-293	12 VDC.	150	1C Double Break	3.10
R-697	12/24 VDC.	100	1A/10 Amps.	1.45
R-580	12/24 VDC.	150	1C Double Break	2.45
R-276	24 VDC.	100	2C D. Break. Mica.	3.10
R-752	24 VDC.	150	2C/3 Amps.	1.45
R-768	24 VDC.	175	2A/5 Amps.	1.45
R-699	24 VDC.	200	3C/5 Amps.	1.55
R-700	24 VDC.	200	2C/8 Amps.	1.55
R-282	24 VDC.	325	1A Double Break	1.25
R-286	115 VAC.	950	2C	2.80
R-612	2/6 VDC.	1	1A	1.55
R-815	2/6 VDC.	1.5	1A/10 Amps.	1.55
R-263	6 VDC.	12	2C/15 Amps.	1.55
R-279	14 VDC.	250	1A/15 Amps. D. Break	1.55
R-278	18/24 VDC.	260	2C, 1A, 1B	1.55
R-706	24 VDC.	150	4C/10 Amps.	2.45
R-177	24 VDC.	250	4C	2.05
R-609	250 VDC.	5000	1A Double Break	2.45
R-779	12 VAC.	...	1B/10 Amps.	1.70
R-272	24 VAC.	...	1A, 1B/5 Amps.	1.55
R-271	24 VAC.	...	2A, 1B/3 Amps.	1.55
R-685	115 VAC.	600	1A/6 Amps.	2.50
R-663	12 VDC.	40	2C/10 Amps.	1.30
R-757	12 VDC.	44	2C, 1A, Ceramic	1.45
R-152	12 VDC.	50	2C, 1B, Ceramic	1.35
R-624	12 VDC.	50	1C	1.45
R-268	12/24 VDC.	260	3A, 1B	1.55
R-805	18 VDC.	200	1A/10 Amps.	1.30
R-644	18/24 VDC.	275	1A/25 Amps. & 1A/5A	1.45
R-687	26.5 VDC.	125	2C/15 Amps. & 3A/10A	2.45
R-674	24 VDC.	250	1C/5 Amps.	1.45
R-593	28 VDC.	125	2C/10 Amps.	1.45
R-191	28 VDC.	125	2C/10 Amps. Ceramic	1.50
R-248	28 VDC.	150	1A/20 Amps.	1.30
R-615	32/40 VAC.	...	3A/15 Amps.	1.55

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-582	120 VAC.	...	1A	2.45
R-812	115 VAC.	...	1A-D. Break. 15A	2.45
R-260	115 VAC.	500	3A/15 Amps.	2.80
R-249	100/135 VAC.	600	2A Ceramic	2.80
R-665	115 VAC.	500	2B/10 Amps.	2.80
R-693	2/6 VDC.	125	1C/3 Amps.	1.10
R-597	4/12 VDC.	16	1A/25 Amps.	2.45
R-193	5/8 VDC.	11	2C, 1A/10 Amps.	1.30
R-595	5/8 VDC.	18.5	3C	1.30
R-692	6/24 VDC.	1280	1C/3 Amps.	1.35
R-793	12 VDC.	42	2C/10 Amps.	1.55
R-599	12 VDC.	67	3A/15 Amps.	1.45
R-559	24 VDC.	95	1A/10Amps.&1A/20A's.	1.30
R-560	24 VDC.	160	1A	2.80
R-795	24 VDC.	160	2A/10 Amps.	1.55
R-796	24 VDC.	160	2A/15 Amps.	2.80
R-562	24 VDC.	160	4A/10 Amps.	1.60
R-797	24 VDC.	160	8A/8 Amps.	2.80
R-549	24 VDC.	160	1C/10 Amps.	1.55
R-758	24 VDC.	160	2C/10 Amps.	1.55
R-242	24 VDC.	170	1C/20 Amps.	1.55
R-675	24 VDC.	180	2A/10 Amps.	1.50
R-649	24 VDC.	265	1A	1.30
R-744	24 VDC.	265	1A/20 Amps.	1.50
R-530	24 VDC.	265	2A/10 Amps.	1.45
R-574	24 VDC.	265	2B	1.30
R-791	24 VDC.	375	2C/10 Amps.	1.55
R-775	28 VDC.	180	2C Ceramic	1.55
R-776	28 VDC.	265	2A	1.55
R-701	22/28 VDC.	425	2B/10 Amps.	1.70
R-802	24 VDC.	160	3A D. Break. 15 Amps.	2.80
R-792	24 VDC.	200	1A/15 Amps.	1.30
R-798	24 VDC.	500	1C/5 Amps.	2.40
R-695	12 VDC.	70	2C/3 Amps.	1.30
R-288	18/24 VDC.	175	2A Ceramic	2.20
R-558	24 VDC.	280	2C/3 Amps.	1.55
R-299	6 VDC.	24	2A	1.55
R-267	12 VDC.	65	2C/5 Amps.	1.55
R-206	24 VDC.	150	5C	1.50
R-207	24 VDC.	210	4C	1.35
R-219	50 VDC.	1500	2A/15 Amps.	1.55
R-531	12/24 VDC.	83	2A/10 Amps.	1.50
R-506	24 VDC.	300	2A/6 Amps.	1.20
R-581	24 VDC.	4500	1A/5 Amps.	1.20
R-825	115 VAC.	...	1A/6 Amps.	2.45
R-819	115 VAC.	...	2A/6 Amps.	2.45
R-652	115 VAC.	...	1A D. Break/20 Amps.	2.80
R-217	115 VAC.	...	1C	2.80
R-824	2 VDC.	.75	1C	1.55
R-600	8/12 VDC.	5000	1C	2.80
R-820	10 VDC.	20	1B D. Break/6 Amps.	1.30
R-821	18 VDC.	2000	1A, 1B/2 Amps.	2.45
R-587	24 VDC.	160	2C/10 Amps.	1.55
R-739	24 VDC.	200	1A	1.35
R-724	75 VDC.	2000	2B/3 Amps.	2.40
R-823	110 VDC.	5000	1B	2.45
R-617	12 VDC.	600	1C Double Break	1.30
R-729	12 VDC.	80	1A/10 Amps.	1.25
R-722	24 VDC.	300	1A/10 Amps.	1.30
R-577	48 VDC.	220	2C	2.45
			MIDGET RELAYS	
R-572	24 VDC.	256	1C	$1.25
R-291	6 VDC.	5	1A	1.25
R-738	12 VDC.	60	3A	1.20
R-144	12 VDC.	228	1A	1.45
R-145	18/24 VDC.	250	2A Ceramic	1.45
R-586	21 VDC.	300	1A	1.25
R-298	21 VDC.	300	1A	1.25
R-296	21 VDC.	300	1A & 1C	1.25
R-586	21 VDC.	300	1A & 1C	1.25

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-137	24 VDC.	300	1C	1.45
R-142	24 VDC.	400	2C	1.50
R-785	24 VDC.	200	2C/10 Amps.	2.00
R-607	24 VAC.	...	1A	1.20
R-606	24 VAC.	...	1A & 1B	1.20
R-605	25 VAC.	...	3A	1.20
R-728	6 VDC.	30	1A	1.25
R-807	6 VDC.	30	2C	1.25
R-625	6 VDC.	45	1C/3 Amps.	1.35
R-732	12 VDC.	120	1A	1.45
R-733	12 VDC.	120	2C	1.50
R-281	12 VDC.	126	2A	1.25
R-818	18/24 VDC.	300	1B	1.25
R-139	24 VDC.	200	4C	1.45
R-135	24 VDC.	250	1B	1.45
R-133	24 VDC.	300	None	.75
R-138	24 VDC.	300	4A	1.45
R-132	24 VDC.	300	2C	1.50
R-731	24 VDC.	300	2C	1.55
R-730	24 VDC.	300	2C & 1A	1.55
R-292	24 VDC.	350	1C	1.25
R-626	24 VDC.	400	1A/5 Amps.	1.55
R-786	60 VDC.	1300	2C	2.00
R-588	90/125 VDC.	6500	4C	2.70
R-755	24 VDC.	300	1A	1.45
R-150	6 VDC.	30	1A	1.20
R-640	24 VDC.	330	1C/3 Amps.	1.50
R-148	12 VDC.	100	2C & 1B	1.35
R-285	12 VDC.	75	3A	1.35
R-222	12 VDC.	100	2A	1.20
R-639	6 VDC.	20	3C/3 Amps.	1.45
R-696	24 VDC.	230	1A/8 Amps.	2.00
R-143	24 VDC.	280	1A	1.45
R-141	24 VDC.	280	3A	1.45
R-140	24 VDC.	280	1C	1.45
R-590	24 VDC.	300	2B	1.25
R-540	24/32 VDC.	300	2C	1.50
R-543	24/32 VDC.	300	4C	1.50
R-743	110 VDC.	5000	3B & 1A	2.05
R-783	100 VDC.	6500	1C Micalex.	2.40
R-782	100 VDC.	6500	4C & 1A	2.45
			SPECIAL RELAYS	
R-503	12/32 VDC.	100	3A, 2C	2.80
R-749	600 VDC.	...	Max. 28 Amps.	7.45
R-804	550 VAC.	...	1B/38 Amps.	4.35
R-250	115 VAC.	...	Adj. Clr. Br.-.04-.16A	17.50
R-579	220 VAC.	...	1B	8.70
R-294	27.5 VDC.	200	1B	5.35
R-686	115 VAC.	...	2C	6.10
R-246	115 VAC.	...	1B	11.20
R-246A	115 VAC.	...	1A	11.20
R-611	24 VAC.	...	1A/30 Amps.	5.35
R-283	12 VDC.	125	1C/10 Amps.	1.25
R-614	18/24 VDC.	60	1A/15 Amps.	4.35
R-262	....	200	1C	1.70
R-245	12 VDC.	25	6" Micalex Lever	1.20
R-527	6/12 VDC.	50/50	In Series	1.20
R-544	12/24 VDC.	60/60	1C	2.05
R-255	....	...	1A	1.20
R-669	75 VAC.	400 Cy.	1B, 1A	1.20
R-660	6 VDC.	...	38" Stroke	1.20
R-651	24 VDC.	100	Solenoid Valve	3.10
R-295	12 VDC.	275	Annunciator Drop	2.70
R-230	5/8 VDC.	2	2A, 1C	2.70
R-813	12 VDC.	12	Water	5.35
R-275	12 VDC.	750	1A, 1B, 1C	3.45
R-716	24 VDC.	70	2A/5 Amps.	1.60
R-620	6/12 VDC.	35	2C, 1A	1.30
R-629	9/14 VDC.	40	1C/10 Amps.	1.55
R-720	24 VDC.	50	2C Ceramic	1.70
R-500	12 VDC.	10/10	2C/6 Amps.	3.55
R-816	12 VDC.	10/15	2C/6 Amps.	3.55
R-524	24 VAC/DC.			1.20
R-566	115 VAC.	Coil only		1.00
R-710		150 Coil only		.75
R-811	48 VDC.	8000	1C	2.05

BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION

Form A—"Make" (Single Throw, Normally Open) | Form B—"Break" (Single-Throw, Normally Closed) | Form C—"Break-Make" (Double-Throw) | Form D—"Make-Before-Break" | Form E—"Break-Make-Before-Break"

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Pieces	Part No.	Insert
53	AN3100-8S-1P	M
10	-8S-1S	M
15	-10SL-3P	B
81	-12S-3S	B
650	-12-5P	B
2098	-12-5S	B
586	-14S-1S	B
69	-14S4P	B
141	-14S-6P	M
73	-14S-6S	M
65	-14S-7S	B
96	-14S-7S	
328	-16S-4S	B
41	-18-4S	B
99	-18-8S	B
448	-18-12S	B
314	-18-12S	
28	-18-15S	
70	-18-22P	M
50	-20-21S	M
92	-22-2S	M
698	-22-5S	B
16	-22-14P	M
32	-22-21P	M
15	-24-2S	M
14	-24-5P	M
65	-24-5P	M
37	-32-6P	B
45	-32-7P	B
98	-PR32-7P	M
314	-32-7S	M
281	-32-14P	B
132	-32-14S	B
26	-36-7P	M
358	-36-19P	B
77	AN3102-8S-1P	M
440	-10S-2S	B
828	-10S-2S	M
31	-10S-8S	M
577	-12S-3P	M
70	-12S-3S	B
172	-12S-3S	M
34	-16S-1P	
330	-16S-5P	B
32	-16S-8S	M
10	-16-11S	B
734	-16-13P	B
1428	-18-4S	B
1607	-18-5S	B
38	-18-12S	M
25	-18-22P	M
1122	-20-3P	B
17	-20-5P	B
16	-20-14P	M
207	-22-1S	B
227	-22-5S	B
349	AN3102-24-1S	B
82	-PR28-1P	M
20	-28-11P	
34	-28-11S	B
70	-32-1P	B
154	-32-1S	B
66	-32-6P	M
20	-32-6S	M

M—Melamine
B—Bakelite

Pieces	Part No.	Insert
38	-32-7P	M
62	-32-15P	M
34	AN3106-8S-1P	M
61	-8S-1P	B
12	-8S-1S	M
116	-8S-1S	B
809	-10S-2P	M
275	-10S-2P	B
177	-10S-2S	B
50	-10S-2S	M
466	-10S-2S	B
500	-10SL-3S	B
2737	-10SL4S	B
248	-12S3S	
373	-12S-4P	B
351	-12S-4P	M
13	-12-4S	B
22	-12S-4S	B
250	-12S-4S	M
191	-12-5S	B
10	-14S-4P	M
68	-14S-7S	B
138	-16-2S	B
12	-16S-4P	B
62	-16S-4S	B
200	-16S4P	M
45	-16-13S	M
200	-18-1S	B
269	-18-5P	B
32	-18-5S	M
4711	-18-6S	B
278	-18-10S	M
20	-20-5P	B
828	-20-12S	
12	-20-23S	B
49	-20-25S	M
56	-20-27S	B
20	-22-3P	B
12	-22-5P	M
510	-22-19P	B
72	-22-27S	B
14	-24-2P	B
78	-24-3P	B
38	-28-12P	B
22	-32-7P	M
173	-32-7S	
155	-32-14S	B
43	-32-16S	M
25	-36-10S	M
68	-44-1P	B
146	AN3108-8S-1S	B
324	-8S-1S	M
1013	-10S-2S	M
815	-10S-2S	B
36	-12S-3S	B
72	-12-5P	B
13	-12-5S	M
102	-14S-2P	M
1062	-14S-2S	B
12	-14S-7S	M
14	-14S-10P	M
438	-16S-1S	B
411	-16S-4P	B
1759	-16S-4P	M

M—Melamine
B—Bakelite

Pieces	Part No.	Insert
32	-16S-4S	B
450	-16S-5P	B
65	-16S-5S	M
152	-16-11S	M
137	-16-11S	B
2947	-18-4P	B
12	-18-4S	B
147	-18-4S	M
1437	-18-5P	B
11	-18-5S	B
404	-18-6S	B
233	-18-9P	B
97	-18-11S	M
35	-18-20P	M
38	-22-14S	B
556	-22-19P	B
30	-24-2S	B
19	-24-9S	B
15	-24-10P	M
25	-24-10S	B
42	-28-1S	M
26	-28-2P	M
235	-28-12S	
106	-28-16P	B
169	-28-17S	M
20	-32-1S	M
24	-32-6P	M
70	-32-7S	B
54	-32-13S	M
40	-32-13P	M
152	-32-14S	B
30	-36-6P	B

M—Melamine
B—Bakelite

UNUSED

ELECTRONIC COMPONENTS

Pieces	Part No.	Description
35	RA-10-DB	Receiver
20	TA12B	Transmitter
150	DA-1F	Dynamotor
162	3611-B	Amplifier
35	MR-9B	Control Box
7	AS27A/ARN-5	Antenna
9000	45	Bulb
11000	1667	Bulb
1000	987	Bulb
300	AN3135-1	Bulb
87	MR16D	Filter
97	FT213	Mount
54	FT293	Mount
80	BX42-7	Dynamotor

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— THE BEST IN ELECTRONIC SURPLUS —

SF-1 Radar Eqpts. 10 Centimeter, Brand NEW with complete spares to insure over 10 years of continuous operation. Includes motor-generator set in each, all wave-guide plumbing, instruction books, etc. 19 cases per set, export packing.
PRICE, EACH $2,500.00

Beachmaster, 250 watt Portable Sound Amplifier Systems, with nine speaker rack, tubes, mike, cables, and spares. Operation from 110 volts, one phase, 60 cycles AC. Excellent and New condition units.
PRICE, EACH $485.00
Case of spares for above. **PRICE** $100.00

Western Electric Model HLAS, 500 watt Sound Amplifier Systems, consisting of 40 watt Pre-Amplifier; 500 watt Power Amplifier with built-in power supply, expander-compressor circuit, internal blower-ventilation. 30 kc erasing oscillator circuit for magnetic-tape recording, volume and meter controls; two speaker racks, each with 6-60 watt dynamic horn units. Operation from 115/230-3-60 AC. New. Unused. Complete with tubes, cables, connectors and instruction manual. **EACH** $895.00

Wilcox 36A Rectifiers, single cabinet unit containing 4 separate transformer rectifier power supplies, capable of supplying DC voltage to one or more 96C transmitters and one or more Wilcox 50A Modulators (which are designed to modulate a 96C 3 KW RF Output Transmitter). Has terminal connections for 5 96C Transmitters, and for local or remote operation. Measures: 72" high, 29½" wide, and 24½" deep. Operates from 220/3/60 AC. NEW eqpt., complete with control relays, tubes, power transformer (removed for shpmt), instruction manual. **WRITE FOR PRICE.**

RMCA, Model 8010 I.F. Ship Main Radio Transmitter, 325 to 500 KC, types CA & E. Excellent condition. Less motor generators.
PRICE, EACH $475.00

RMCA, Model 8019A/H.F. Ship Transmitter, complement to 8010 above, for H.F. transmission A1 and A2, 200 watts output. Excellent Condition, less tubes and MG (mg with 8010 powers this unit.)
PRICE, EACH $400.00

RMCA, 8003 Emergency Transmitter, 500 KC. 50 watts output with 12/115 V. DC. motor generator set, and battery charging unit. Excellent Condition. Complete with tubes. **PRICE, EACH** $275.00

RMCA, 8707 Direction Finder. (Int. Freq.) consisting of receiver, loop, shaft, rotating wheel. Excellent Condition except shaft housing not available (can be easily improvised). With tubes. **PRICE** .. $750.00

Mackay, Model 150-AY, I.F. Ship Transmitter. 325 to 500 KC. A1 and A2 emission. Excellent Condition. **PRICE** with MG. 115 V. DC. **EACH** .. $350.00
PRICE without MG. **EACH** $275.00

RC-163 Radio Beacon Eqpt. 20-40 MC. Converts SCR-508/528/608/628 to directional transmitters and receivers. Ideal for airports or for homing application. NEW and complete equipt. Export packed.
EACH $90.00

SCR-511 "Pogo Stick" Walky-Talky. Portable low power AM radiotelephone for 2 to 6 mc operation. with 13 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Transmitter-receiver BC-745 of this SCR-511 includes telescopic antenna and "Press-Talk" Switch as well as all cables. Range 5 miles, plus. With PE-157 Vibrator Power Supply 2-volt battery (less electrolyte). T-17 mike, ready for immediate operation. **PRICE, EACH** $95.00

RMCA, 8600X Auto Alarm Receivers, 500 KC Automatic SOS (4-second dash actuated) Alarm Unit. Complete with Relay, Control Box and warning light. For 110 V. DC operation. Excellent Condition, with tubes. **PRICE, EACH** $250.00

TBK-10, 500 watt, 2-18.1 MC. CW Telegraph Transmitter designed for ship installation. Almost new condition, complete with tubes, less MG set and accessories. **PRICE, EACH** $350.00

Link FM Transmitter-Receiver, 70-100 mc. 50 watts output. Model 1498 DC. Wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim.: 34" x 21" x 11". New Condition. Complete with tubes, crystals, special telescopic antenna, instruction book.
PRICE, EACH $500.00

AN/CRT-1A Sonobuoy Transmitters, for mine and submarine detection. With parachute, tubes, etc., ready for operation (except standard types dry batteries). Operates at 67.7 mc. Excellent to New condition. **PRICE EACH** .... $55.00 **and up.**

R-2/ARR-3 Receivers, FM, 67 to 72 mc, for use with Sonobuoy Transmitters described above. 24 V. DC operation (less dynamotors). Excellent condition. With tubes. **EACH** $125.00

BC-319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes.
PRICE, EACH $300.00

Wilcox, 90-200A, 2-KW RF section 115 to 525 KC. Large cabinet with complete RF end containing two VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance. Less tubes.
PRICE $300.00

TDE-2, Ship Transmitter. HF and IF bands, for 230V, DC operation. With internal mg supply, and all tubes. NEW, unused condition.
PRICE $600.00

TCS, Ship Radio Transmitter-Receivers, for 12/24/115/230 V., D.C., and 115 V. AC Power Supplies, all available. Also TCS spares, new, export wrapped. Radio telephone and radiotelegraph at 20 & 40 watt. 1.5 to 14.0 mc. Complete with all accessories. Excellent condition. **EACH** .... $500.00 **up.**

RCA Models ET-4332-B, and ET-4336 Radiotelephone Transmitters, 250 Watts output. Freq. 2.0 to 20.0 mc, front-panel band switching—no plug-in coils, crystal or VFO. Uses 4—866, 2—805, 2—813, and 1—807. Dim: 57"x17"x24" deep. Excellent Condition units. Separate Speech Amplifiers, to match, also available. Transmitter, **EACH** $485.00

TS-47/APR

Signal Generator. 40 to 115 mc and 115 to 500 megacycles, butterfly condenser tuning with direct precision calibration. Solid construction and shielding, with built-in power supply which operates from 80 to 220 volts AC, 50 to 2600 CPS. Complete with instruction sheets, tubes, and connectors. NEW and like new units. EACH $140.00

BC-348 Receivers, like NEW condition, complete with tubes and dynamotor. EACH $140.00

BC-221 Frequency Meters. Excellent to LIKE NEW condition, with calibrated charts, tubes and crystal. EACH $85.00

RADIOSONDE AN/AMQ-1, meteorological transmitter with sensitive instruments for measuring pressure, temperature, and humidity and means for modulating transmitter so that this information is transmitted while unit is in flight suspended from a balloon (not supplied). Standard battery powered, NEW, complete in cardboard casing, packed, ready for immediate use after installing batteries. Large Quantity Available. WRITE FOR PRICES.

Sound-powered Head/Chest Sets, RCA Type MI-2454-B, Complete. NEW, packed for export.
EACH $8.75

Model ATD Aircraft Transmitter, mfd. by Bendix, 50 Watts A1 & A2, 40 Watts A3, 4-Channel motor tuning 1500 to 9,050 KC. Complete, with tubes, 24 V. Dynamotor, remote control, connectors, spare parts in box, all NEW Equipment. Export Packed.
Per Set $175.00

Teletype Co. Wheatstone Perforator, For automatic high-speed transmissions of Int. Morse Telegraph signals on perforated tape, when used with Boehme **Keying Head** with Keying Head Drive for controlling radio transmitter. Both units available, excellent condition. The Boehme unit includes Pilot Lamp and Transmitting Speed Recorder from 15 to 570 w.p.m.
PRICE, both units $490.00

TEST EQUIPMENT

Model 62 VTVM, Measurement Corp.
Model 78-E Standard Signal Generator, Measurement Corp.
Model 65-B Standard Signal Generator, Pre-set Push-Button Control for Frequency, Motor-Driven Tuning, Measurement Corp.
Type 160-A "Q" Meter, with Type 560 L/C Dial Conversion Kit and 141-B Coupling Transformer, Measurement Corp.
Model 200-C Hewlett Packard Audio Oscillator
Model 205-AG Hewlett Packard Audio Signal Generator
Model 330-B Hewlett Packard Distortion Analyzer
Model 154 RCA Beat Frequency Audio Oscillator
CRO-3A. G. E. Oscilloscope
General Radio 814-AM VTVM Amplifier
Dumont Type 208-B 5" C-R Oscillograph
RCA 160-B Oscilloscope

All Excellent Condition Test Equipment.
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Infra-Red Image Converter Tube (British) to make "Snooperscopes," "Sniperscopes," and other devices that see in the dark. Has many useful industrial applications. Operates with invisible infra-red rays, without scanning or amplifiers. Supplied with technical data and diagrams. Every tube **guaranteed!**
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6 for $30.00

BAUSCH & LOMB Front-End Lens Assembly, for best images. F2.1, 3.5 in. EF. **EACH** $10.00

MOUNTED LENS UNIT, also for front-end, results as good as B & L unit. Speed F1.9 f. 1. 91.44 mm. outside dia. at one end 60 mm. length of mount 64 mm. **PRICE, EACH** $7.00

20-40 MC FIELD STRENGTH AND WAVEMETER

Uses a 0-100 Micro-ammeter with a 1S4 Pentode, to receive signals in the 20-40 mc range. 1.5 volts battery required. Tuning dial has dial lock, for fixing position, and telescopic Antenna permits adjusting for strong or weak signals. Calibration must be self-performed. With instruction sheet and diagram NEW, unused eqpts. Dim: 6½" x 4¼" x 5½".
PRICE, EACH $14.95

YJ-1 I.F.F. Eqpt. Consists of dual transmitters and dual receivers, each working in "A" and "B" bands, 176 and 515 mcs respectively. Includes power supply (115-230 volts, 60 cycles AC) and tubes, all in one metal cased unit. UNUSED eqpt.
PRICE, EACH $165.00

32 Volt DC to AC Rotary Converter, mfd. by Kato. For yachts, workboats, or farm installation. Output 110 V., 60 cycles AC, rated 225 watt but good to 300 watts. All NEW Units.
PRICE, EACH $39.95

Deck Entrance Insulators, bowl and flange type 8⅞" dia. with heavy galvanized metal flange and bell. Top bell 6¼" dia. x 11"; brass feed thru. Very high voltage insulation. Individually packed in cartons, all NEW. **12 FOR** $24.00

Generator Electric Amplidyne M. G. Set, general type #V5875677, motor type #73AB58, Navy #CG 21ABU, 115/230 V., 60 cycles, motor rated at ¾-HP., generator output 250 V. DC at 375 watts. NEW. **PRICE, EACH** $75.00

T9/APQ2 Radio Transmitters. Noise-modulated Jamming Transmitter, using Electron-Multiplier Photocell. For Jamming certain types radar eqpt. New unused transmitters only, with Electron-Multiplier tube, less other tubes. **EACH** $32.50

SB-23/GTA-2 & SB-14/GY Switchboards & Power Supply, for operation from 110V, 60 cycles AC (and storage batteries). Each in individual metal cabinet. NEW. **Price, Each Set** $450.00

TS-11 Handsets, for SCR 194 & 195. NEW.
EACH $6.95

TS-48AP Echo Boxes. UNUSED. **EACH** $20.00

SCR-584 Sector Scan Units. Unused. **EACH** .. $9.00

QBE-3 Control Rectifiers, Type CBM-20223. Unused.
EACH $27.50

BC-689A Radio Transmitters. Unused. Less tubes.
EACH $22.50

580-765 MC SUPERHET RECEIVER WITH WAVEMETER

Easily modified for Citizen's Band reception, or for experimental use on VHF Television. Uses a 955 Autodyne detector-oscillator into 3-stage resistance-coupled IF amplifier. Output is for headphones. Includes VR-150 voltage regulator tube, 6E5 tuning-eye, and 5Y3 rectifier. For 115 volts, 50/60 cycles AC. Calibrated Wavemeter mounted as separate portion, with variable tuning rod and hand-plotted calibration curve for each, permits checking frequency of incoming signal. NEW unused surplus. With instruction sheets and diagram, plus calibration curve, and tubes. **PRICE, EACH** $75.00

RADAR TRAINING SET—MARK V

For Student, Schools, Labs, or actual radar application. Operates in the 580 to 765 mc region, designed especially to illustrate how radar eqpt. functions, and permits making numerous experiments to put over radar fundamentals. Uses above described receiver; separate transmitter using 8025 triode with 1.5 watts at antenna, with 400 KC internal modulator using two 811 tubes; External modulator, generating audio frequencies of 16,000, 4,000, and 1,000 cycles, and RF at 750, 350, and 175 KC, with selection switch for modulation frequency and wave form control, using 3 tubes, 807, 6N7, and 6J5; set of Antenna Dipole rods. Supplied with full instruction sheets, diagrams, calibration curves, tubes, NEW unused surplus. **PRICE, Per Set** $175.00

DZ-2 DIRECTION-FINDING EQUIPMENT, with loop assembly, 28 V. DC operation, 15-70 & 100-1750 Kcs. NEW. **PRICE, EACH** $150.00

SCR-509/510 and 609/610 Equipments. Vehicular Transmitter-Receiver, FM, 20 to 40 MC, New and Excellent Condition units, with PE-97, or PE-117, or PE-120. 6-12-24 volt Power Supplies available. **WRITE FOR QUANTITY PRICES.**

SUPREME ship-to-shore transmitter receiver, 110W output, 9 channel, 2-3 mcs., crystal controlled for 110V, 60c, A.C. Condition N-2. Complete with tubes and microphone. **EACH** $500.00

MASTER POWER METER PANEL, for measuring voltage, current, and frequency of 2 to 4 50 KW power units of 240 v. 3-phase-3 wire or 3-phase-4 wire, 60 cycles AC. Measures each phase lead. Measures current 0-300 or 0-600 amps., through selection of current transformers. Dim: 22"x34"x20". Has many industrial applications. NEW condition.
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TUBE SPECIALS

2J27	$24.50	100TH	$ 9.00
707B	$24.50	250TH or TL	$19.50
527	$19.50	450TL	$40.00
721A	$ 2.85	861	$22.75

LIMITED QUANTITIES Following: R-89/ARN-5A Receivers, new; APN-4 Indicators; TBY 2 Portable 28-80 mc Transceivers; TA-12B Transmitters; Model NAA Underwater Ultrasonic Beacon Transmitters; Model ZB-3 Aircraft Homing Adapter Equipment; Portable Test Oscillators for ZB Eqpt.: RT-3/ARN-1 Altimeter Transmitter-Receivers; Receivers for DP-12 or 13 D.F. Receiving Eqpt; Radio Receivers BC-733-D; Model ATD Aircraft Transmitters; BD-72 Switchboards; 500 Watt. 110 DC to 110 AC. 60 cps motor-generators. Also, BC-603 Receivers, BC-604 and BC-684 Transmitters, BC-620 and BC-659 FM Transceivers, PE-97, 117, and 120 Power Supplies; Ship-to-Shore Radio Telephone for 32 V. & 110 V.D.C. operation. Large quantities of transformers, power and audio, filter chokes, Radar fittings and accessories.

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LELAND-MURRAY MG SET. Motor: 5 H.P. 220/440 Volts 3 phase, 60 Cy. directly connected to Alternator: 3 KVA. 120/208 Volts, Wye connected. 400 c.p.s. Price $525.00

HOLTZER-CABOT MG149F. Input: 24 VDC, 36 amp. Output; 26 Volts, 400 cycles, 250 VA. Also secondary output of 115 Volts, 400 cycles, 500 VA. Completely rebuilt and guaranteed. Price....$25.50

Brand New Units, Price....$49.50

GE MG UNITS. Motor: 110 Volts, D.C. 31.5 Amperes, in a single compact unit with output of 120 Volts, 20.8 Amp. single ph. 500 cycles. Like New. Price...$95.00

500 CYCLE MG SETS. British made motor generator. 8 KW, 2 bearing unit, input 180-240 VDC, output 180 volts, 1ϕ weight app. 1000 lbs. Price....$425.00

ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cy. 3600 RPM. Output: 250 Volts, 20 Amp. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE $160.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3ϕ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA, 115 Volts, single ph. 800 CPS. and secondary output of 500 Watts, 28.5 VDC 17.5 amperes. PRICE....$289.00

INVERTER UNIT PE206A. Input: 27.5 VDC. 38-amp. Output: 80 Volts, single ph. 800 CPS. 500 VA. Price $19.00

G. E. HIGH FREQUENCY MG UNITS. Motor operative at 115 Volts, DC. Generator: 2.5 KW. 24/32 Volts, 78 Amp. D.C. Alternator: 120 VAC, 20.8 amp. .9 PF, single ph. 720 cycles. All three components in a single compact housing. Price....$200.00

800 CYCLE UNIT. Operate at 440 V. 3ϕ, 60 cy. directly connected to self-ex. alternator with output of 120 Volts, single phase, 6.6 amp. .8 K.W. 800 Cycles. Price $119.75

CROCKER-WHEELER 500 CYCLE MG SET. Compact 2 bearing Unit. Operative at 120 VDC, 7.3 amps. Output: 250 Volts, 5 amp. 500 cycles. Rebuilt. Price $88.88

HOLTZER-CABOT HIGH FREQUENCY MG Sets. Compact 2 bearing units with input of 120 VDC, 7 amps. Output: 120 Volts. 3ϕ 320 Cycles. Has shaft extension permitting use as dual generator. Price $112.90

WESTINGHOUSE HIGH FREQUENCY UNITS. Operate with input of 115 VDC to deliver 17 VAC, 1050 to 1650 cycles. An excellent value....$25.50

ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC, 10 amperes. Delivers 70 Volts at 120 Cycles or 200 Volts at 720 Cycles. Price....$95.00

ESCO 500 CYCLE UNITS. Operate at 100 VDC and deliver 110 VAC 1.38 amp. 150 VA. 500 C.P.S. Price $25.00

WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3000 R.P.M. Separately excited at 110 VDC. Price..$44.00

Also available with built-in exciter. Price....$78.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operating at 440-3-60 .75 amp. Output. 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 amperes. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $34.50

GE HIGH FREQUENCY MG SETS. Motor: 250 VDC. 4 amp. Alternator: 600 watts, 125 single ph. 4.8 amp. 500 cycles. Brand new. Price....$90.00

BENDIX-ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC, 75 amps. Output: 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon. Price $22.50

CROCKER-WHEELER 500 CYCLE SET. Operate at 110 Volts, D.C. 29.6 Amps. Output: 120 Volts, single ph. 500 cycles 2.5 KW. Price....$146.95

WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 2.7 Amps. Output: 14.4 Volts. .139 Amp. 450-2550 Cycles. Frequency variation is obtained with built-in controller on end of unit. Price $48.50

GE DUAL OUTPUT MG SETS. Consist of Motor rated 3 H.P. 220-440 V. 3ϕ, 60 Cy. directly coupled to 2 generators. Output: .5 K.W. 220 Volts, 2.27 Amp. 525 Cycles. Also .5 K.W. 110 Volts, D.C. 4.55 Amp. 3 separate units mounted on common bed plate. Price $150.00

ONAN 2 BEARING MG UNITS. Motor: 115/230 Volts, single phase, 60 cy. Generator: .6 KVA 115 Volts, 5.3 Amps, 480 C.P.S. Price....$165.00

ESCO HV-HF UNITS. Operative at 11.5 VDC 28 Amp. Output: 575 VDC. .25 Amp. also 55 VAC. .91 Amp. 1ϕ, 500 Cycles. Price....$39.75

ONAN 800 CYCLE ALTERNATORS. Brand New. Mounted on base with guard for V Belts. Alternator is self-excited, rated at 1.5 KVA. 115 Volts, single ph 800 Cyc. 2666 RPM. Also output of 28.5 VDC 17.5 Amp. 500 Watts. Price....$199.00

GENERAL ELECTRIC 400 CYCLE UNITS. Operate at 27 VDC 100 Amp Output: 115 VAC 1ϕ, 400 CPS. 1500 V.A. With filter system built-in. Price...$29.50

HOLTZER-CABOT 500 CYCLE MG SET. Motor: 110 VDC. GENERATOR: 5 KVA. 230 VAC, 1ϕ, 500 Cyc. Rebuilt. Price $271.50

MARCONI MG UNITS. Operative at 110 VDC to deliver 500 VAC, 6 Amp. 3 K.W. 240 CYCLES. Extending shaft permits driving complete unit to obtain dual self-excited generator. Price....$99.00

LOUIS ALLIS FREQUENCY CHANGER SETS. We have 3 sizes in stock, all brand new. (1) Pri: 220/440-3-60; Sec: 30 K.W. 306 Volts, 2 Ph. 500 Cyc. .8 P.F. Units are belted on common bed plate. Price $1250.00

(2) Pri: 25 H.P. 220/440-3-60; Sec. 15/10.8 K.W. 3300/2200 RPM. 306/220 Volts 35/35 Amps. 2 ph. 500/360 C.P.S. Price $1050.00

(3) Pri: 1 H.P. 220/440-3-60; Sec: 7.5 K.W. 440/220 V. 17/8.5 Amp. 3000/1200 RPM. 360/180 Cycles, 2 ph. Price $750.00

We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

ECLIPSE 800 CYCLE GENERATORS. Flange mounting with spline shaft. Output is 115 VAC 10.4 Amp. 90% P.F. 800 Cycles, 1200 V.A. with secondary output of 28.5 VDC. 60 Amperes. Self excited. Price $39.00

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts. 3 PH.—50 Cycles, XX-Alternator: 5 K.W. 180 Volts. 27.8 Amp. 500 Cycles, Excitation—110 VDC When used at 60 Cycle current. Output is 600 cycles 220 Volts. Price $353.00

WINCHARGER PU-7/AP; Input: 28 VDC, 160 Amps. Output: 115 VAC, single ph. 2500 V.A. 400 C.P.S. Frequency and Voltage regulation built-in. Price $87.00

HOMELITE 400 CYCLE POWER PLANTS. PU-6/tps-1 Single cylinder engine, air-cooled governed to operate at 4000 RPM. Generator rated at 1400 Watts, 120 Volts 400 Cycles also secondary output of 27 VDC, 400 watts. Brand new in original cases with instruction book, and complete spare parts. An exceptional unit to procure 400 cycle current or to be used as a lighting plant. Price $150.00

HERE IS EXCEPTIONAL VALUE

Robins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 32/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

CENTURY MOTOR GENERATOR SETS

7.5 KVA: 230 Volts, DC to 115 Volts, AC, single phase, 60 Cycles. Complete with automatic controller and push button station $445.00

ALLIS-CHALMERS MOTOR GENERATOR

Input: 115 VDC at 14 amp. 3600 RPM. Ball Bearings. Output: 1.25 KVA; 80% PF 120 Volts, AC, 1 Ph. 60 cyc. 10.4 amp. Centrifugal automatic controller permits line start operation. Fully enclosed. Brand New $99.95. Also available for 230 VDC operation at the same price.

GENERAL ELECTRIC DC/AC MG SETS

Four Bearing Marine Units: 25 HP 230 Volts, DC coupled to alternator 18.75 KVA; 80% PF; 1800 RPM Output: 115 Volts, AC. Single Ph. 60 cycles. Ball Bearings. 4 bearing set; marine duty. Brand New. $545.00

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Output: 115 V.A.C. 1ϕ, 60 Cyc. 460 V.A. Brand New......$120.00

JANETTE ROTARY CONVERTERS

110 VA. Input: 110 VDC; Output: 110 VAC, single phase, 60 cycles; 3600 speed. With filter for elimination of radio interference. Reliably rebuilt. Special Price $19.95

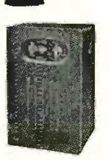
INDUCTION VOLTAGE REGULATOR

Type IRT, form M. 1.64 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 33 x 17" x 14"........$90.00

G. E. MOTOR CONTROLLED VOLTAGE REGULATOR

Cat. #837625, Type 'Tirs', Form — .568 KVA, cont. duty, 60 cy., Primary volts 115. Load Amps 16.2 Indoor service. Voltage controlled by mtr. 120/1/60/1/40 HP..............$39.50

Send for list of other sizes in stock.



Westinghouse Transformer Controller contains 300 watts 120-220 volt transformer with multi-taps. The transformer with tap switch alone is worth more than the special price......$7.50

GEN. ELECTRIC AMPLIDYNES

Model 5AM73AB89; Input: 115 VAC, 1ϕ, 60 cyc. 9 amp. Output: 375 K. W. 250 VDC. 1.5 amp $86.00

Model 5AM65FB2A; Input: 115 VAC, 3ϕ, 60 cyc. 5 amp. Output: 500 watts, 250 Volts, 2 Amp......$144.00

Model 5AM73AB62; Input: 115/230 VAC 6.2/3.1 Amp. 60 cyc. Output: 250 watts, 125 volts, 2 amp......$65.00

Model 5AM78AB10; Input 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 Watts $190.00

PINCOR ROTARY CONVERTERS

300 VA; Filtered; Brand New. Input: 115 VDC, 4.2 Amp. Output: 220 VAC, 1.36 Amp. **SPECIAL PRICE** $38.00

IDEAL AC/DC M-G UNIT. 110 V. 1ϕ, 60 cy. input. 110 VDC 2.28 amp. .25 KW output. 2 bearing unit thoroughly rebuilt and guaranteed. With rheostat. Price $55.00

GE DC Generators. Consists of three separate generators in one unit. 3600 RPM. Delivers: 1200 V., 450 V. .25 a. and 115 V. 1.3 amp. Price....$24.90

British Alternators. 1.5 KVA., 230 Volts, 1ϕ, 400 CPS. sep. exc. Price $115.00

Crompton-Parkinson Alternators. 3 KVA. .7 PF. 110 VAC, 1ϕ, 60 cy. 1800 RPM. sep. exc. Price....$170.00

British made DC/AC MG Sets. Operative at 110 VDC to deliver 220 VAC, 50 cyc. 200 watts. Can be used with rheostat to deliver 60 cyc. BB. Price......$36.75

Normand High Freq. Units. Operative at 220 VDC 8.8 amp. 2 HP. delivers 1200 watts, 1400 to 2800 cycles. Exc. 24 Volts. Price....$70.00

Westinghouse Amplidyne Type Units. Consists of Motor rated 1.5 HP operative at 220-3-60 with shunt wound generator having output of 250 VDC, 2 amp. sep. exc. 35 V. and control shunt wound gen. with output of .35 KW., 125 VDC., 2.8 amp. Fields have center tap permitting 'amplidyne'' operation. Price.......$183.00

DC Manual Controllers. mfg. by Marconi Co. of England. Enc. type. For starting duty of 24 VDC Motors. rated at .7 HP. A really hard-to-get unit at a give-away price. SPECIAL $4.90

Selenium Rectifiers. Full wave bridge type. Input: 15 VAC. Output; 12 VDC, 4 amp. Consists of 4 plates about 4" dia. Price....$4.00

GE DC Generators. Type SD. Sh. wdg. .5 KW. 18 VDC, 27.8 amp. 1725 RPM. Price....$30.00

Watthour Meters, 110/110 Volt DC operation. Used but in A1 condition. 5 amp......3.75 10 amp......$4.35 15 amp ......$5.00 25 amp $6.00

G. E. Motor Starting Reactors Type 11K2840G2; Rated at 440V. 3 Ph. 60 Cy. 16.8 Amp. Only a 3 Pole Double Throw Switch is necessary with this unit to make a 15-20 HP compensator starter. Useful for any purpose requiring three phase choke. **SPECIAL PRICE** $16.00

Esco AC Motors; built-in magnetic brake for quick reversing. Double shaft, ball bearings. Rated: 2½ HP—30 minutes, marine duty: 440-3-60. Brand new in original cases. **SPECIAL PRICE** $34.00

ESCO DC/DC MG SET

Operate at 220 Volts, DC to deliver 110 Volts, 3.5 amperes. Two of these units can be used on 220 VDC to obtain 110-0-110 Volts DC. **Special Price** $17.50

General Electric Synchronous Motor or Alternator; excitation 2 Volts: operating at or delivering 110 volts, 3 phase, 60 cycles at 1800 speed; no name plate, but lab tests determined specs as above....$9.95

ESCO CONVERTERS

Rebuilt like new. Input: 86 VDC 2.85 amp. 3600 R.P.M. Output: 115 VAC, 2.18 amp. .50 P.F. Ball Bearings. Base for table or side mounting. Special $9.80

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC, IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922

WILLIAM I. HORLICK COMPANY

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BOSTON 10, MASSACHUSETTS

TEST EQUIPMENT!

Complete Line!

DUMONT 224-A OSCILLOSCOPE

TS-36/AP	TS-102A/AP
TS-108	TS-184A/AP

1-77 HICKOK TUBE CHECKER

UPM-1 COMPLETE TS-250/APN

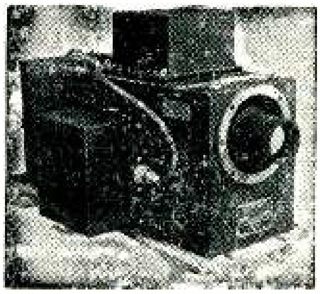
BC-221 FREQUENCY METER

RPC MODEL 644 MULTIMETER

FERRIS MICROVOLTER MOD. 188

TS-111/CP	I-212
TS-117/GP	TS-5/AP
TS-3/AP	TS-19/APQ-5
TS-100/AP	TS-61/AP
TS-170/ARN-5	TS-10B/APN
	TS-375 U
TS-182/UP	TS-15A/AP
TS-127/U	TS-268/U

TELEVISION CAMERA



3350 line resolution. Easily converted to present RMA standards. Circuits available with camera. Complete, like new.

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5 W. MARINE RADIOTELEPHONE

RC-184 IFF EQUIPMENT
BRAND NEW, COMPLETE
SCR-584 PARTS

APS-4 RADAR COMPLETE

APS-6 RADAR COMPLETE
MARK 16 RADAR COMPLETE

MG19A NEW U/16/U PLUGS

MK20A/UP, NEW, INDIVIDUALLY BOXED

BC-1100-A TRANSMITTER
WITH REMOTE CONTROL. 125 W.
115 VDC OR AC.

WE WANT THIS EQUIPMENT:

BC-348	ART-13
BC-611	ARC-1
RTA-1B	ARC-3
BC-1000	R5A/ARN7

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N. HOLLYWOOD, CALIF.

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BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.98	225	50	2.53
.5	50	2.81	250	25	2.23
.5	150	5.93	250	50	2.53
1	50	2.81	300	50	2.53
2	50	2.81	300	100	4.27
2	100	4.68	350	25	1.98
2	225	6.59	350	100	4.26
2	300	8.42	370	25	1.98
3	100	4.67	378	150	6.59
3	225	6.58	400	25	1.98
3x3	300	29.95	400	75	3.90
4	225	6.60	500	25	1.98
5	25	1.97	500	75	3.95
5	100	4.68	500	50	2.53
6	25	2.23	500	100	4.39
6	75	3.90	500	150	4.68
7	25	1.98	585	150	6.60
8	50	2.53	750	25	2.23
10	25	2.23	750	150	5.95
10	100	4.27	1000	25	1.98
12	25	2.23	1000	150	5.93
12	50	2.53	1200	225	7.20
15	25	1.98	1250	50	2.66
15	75	3.90	1250	150	6.59
15	100	4.38	1500	25	2.53
20	50	2.53	1500	50	2.65
25	25	2.23	1800	150	6.24
50	25	1.98	2000	25	2.23
50	50	2.53	2000	50	2.53
60	25	1.98	2250	150	6.24
75	25	1.98	2500	150	6.24
75	75	3.90	2500	25	2.23
75	100	4.39	2500	50	2.53
80	50	2.53	2500	100	4.68
80	500	12.46	3000	25	2.39
100	25	1.98	3000	100	4.68
100	50	2.53	5000	25	2.53
100	100	4.39	5000	50	2.85
125	25	2.53	5000	100	4.98
125	500	12.47	7500	50	2.85
150	50	2.53	7500	100	5.31
175	25	2.53	10000	50	3.12
185	25	1.98	10000	100	5.51
200	25	1.98	15000	25	3.29
200	100	4.27	20000	150	8.43

Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	Bak-n/shtg	.89
2	2	1	Cer-shtg	.50
2	6	2	bak-n/shtg	.60
2	11	2	bak-shtg	.75
3	4	2	bak-n/shtg	.58
5	8	2	Cer-n/shtg	.98
6	11	6	bak-n/shtg	1.95
10	5	5	cer-shtg	2.25
16	2	4	bak-n/shtg	1.35

(Many other types in stock)

"AN" CONNECTORS

Large Variety Available At Great Savings

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A
#926-A1
#926-A14
#926-B
#926-B1
#926-B7

35c.

#926-B22
#926-C
#926-C1
#926-C5
#926-C10
#926-C24

MICROSWITCHES

A-#Y2-RS13 SPST "S" plunger, metal housing norm. op. .... .59
B-#B-RS10 SPDT type "S" plunger, 2-circuits: one op and one cl .59
#WZ-RL8 (not illus.) SPST leaf actuator, norm. cl. .... .59
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed .... .59
C.G.E. SWITCHETTE 10a/115voltsAC
#CR1070-C103A3 SPST closed .. .59
#CR1070-C103E3 SPST open .... .59
#CR1070-C103R3 SPST closed .. .59
#CR1070-C123C3 DPST op/cl ... .59
(Many other types in stock)

OIL CONDENSERS

Mfd.	Voltages Avail.
.1	3-6-20K
.25	2-3-3½-4-5K
.5	600-1½-3K
1	600-1-1½-2-5-6
2	400-600-1-1½-2-3-4K
4	600-700-1-1½K
6	400-600-1½-2K
8	600
10	600-2½K
15	600-1K
30	90-vac. 3-ph
100	230-vac. 3-ph
3x4	500
3x8	600
4x3	600
4x8	600
3x10	90-vac

Special Prices on Request

BATHTUBS

Mfd.	Voltages Avail.
.033	400
.05	2-4-600
.1	4-6-1K
.15	600
.25	2-4-600
.35	400
.5	4-6-1K
.75	600
1	1-2-4-6-1K
2	4-600
4	50-100
8	500
25	25-50-75
40	25
50	25
100	15
200	12
300	6
2x.01	2-400
2x.02	6-1500
2x.045	600
.046x.055	600
.2x.05	6-1500
.1x.05	200
.1x.5	400x50
2x.1	4-600
2x.16	600
2x.2	600
2x.25	4-600
.3x.5	500
2x.5	4-600
1.x.05	500
1.x.1	300
1.x.5	200
2x1	600
2x10	25
2x200	9
3x.001	600
3x.05	600
3x.1	4-600
3x.25	4-600
3x.5	100-600
.015x.03x.045x.06x.12/	600

Also available CHANNEL Types. Special Prices on request.

SHOCKMOUNTS

100P-1.....	1 lb.	.15
100P2.....	2 lb.	.15
100PR-2...	2 lb.	.15
100P-3.....	3 lb.	.15
100P-6.....	6 lb.	.20
150P-4.....	4 lb.	.20
150PH-8...	8 lb.	.45
150PH-15..	15 lb.	.49
156P-6.....	6 lb.	.35
200PD-15..	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112...	112 lb.	.98

TERMINAL BOARDS

5 terminal ...... .98
8 terminal 1.67
12 terminal 2.49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.50			TYPE "JJ" $2.50	
ohms	ohms	ohms	ohms	ohms
50*	2500*	100K*	500-500*†	130 K-130K*
65*†	4000†	100 K†	600-600†	150 K-150K†
200†	5000†	125 K*	1500-1500†	250 K-250K†
300†	10 K*†	200 K*	2000-2000*†	350K-5K†
400*†	15 K*†	250 K*	2000-50K*	350K-25K†
500†	20 K*†	250 K†	2200-24K†	300K-300K†
600*†	25 K*†	500k*†	20K-2000†	350K-350K*
750†	30 K*†	1meg*	25K-10K†	800K-75K*
1000*†	50K*†	1meg†	35K-5000†	2meg-2meg†
1500*†	80K†	2meg*	50K-50K*	4meg-4meg†
2000*†		2meg†	100K-100K*	5meg-5meg†

TYPE "JJJ" $4.95

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* ⅛" screwdriver slotted shaft.
† Knob type shaft.

TRANSMITTING MICAS

mfd.	wv	type	ea.	mfd.	wv	type	ea.
.00001	600	4	.36	.0015	600	4	.36
.00003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

(Many other sizes in stock)

"UG" and "UHF" CONNECTORS

UG-9/U	UG-25/U	83-1AP
UG-10/U	UG-27/U	83-1RTY
UG-12/U	UG-27/AU	83-1SP
UG-14/U	UG-57/U	83-1R
UG-15/U	UG-58/U	83-1D
UG-16/U	UG-88/U	83-1SPN
UG-18/U	UG-123/U	83-22R
UG-19/U	UG-185/U	83-22SP
UG-20/U	UG-260/U	83-2R
UG-21/U	UG-290/U	83-2SP
UG-21B/U	83-1AC	
UG-22/U	83-1F	
UG-24/U	83-1J	

PRICES QUOTED ON REQUEST!

Jones Connectors

P-101-¼	.25
P-101-⅜	.30
S-101-D-MOD ...	.33
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.58
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
S-2412-CCE	.87
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52

Jones BARRIER STRIPS

2-140-Y	.13
6-140-Y	.33
10-140-¾W	.53
10-240	.38
18-240	.66
4-141-W	.30
4-141-¾W	.30
7-141-Y	.49
12-141-Y	.82
13-141-Y	.89
15-141-Y	1.02
2-142-Y	.20
4-142-Y	.38
8-142	.48
3-150	.53
4-150-Y	.83
4-151	1.30
5-151	1.60
4-152	1.89
2002	.04
2008	.07
8-54	.22
8-6	.18

Many other types in stock

MALLORY PUSH SWITCH

#2001	S.P., make cont., non-L..........	.45
#2003	S.P.D.T., non-lock	.48
#2003L	S.P.D.T., lock	.48
#2004	D.P., make 2 non-L	.55
#2004L	D.P., make 2 lock	.55
#2006	D.P.D.T., non-lock	.65

HUNDREDS OF OTHER ITEMS AVAILABLE

Open a/c to Rated Concerns. Prices net FOB our whse NYS *and subject to change without notice*

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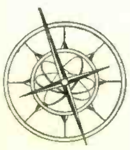

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Special Lots of Equipment

100—Sets—mobile ground station, **model SCR-284**
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125—Switchboards, portable, 6-line, **model BD-71**
100—Receiver, direction finder, complete, **model MN-26**
12—Shipboard Transmitters, 115 and 230 V dc, **model TDE—$675.00 ea.**

TRANSMITTING STATIONS

1 KW—200-500 KCS, complete with 440 volt, 3 ph, 50-60c. power supply **Price $2500.00**

800W—(400 watts phone) Western Electric, 10-channel, automatic dial selection, 2.0 20.0 mcs, with 220 volt, 1 ph, **50-60c**, power supply. SAME TRANSMITTER AS USED ON S.S. "QUEEN MARY"—brand new

1 KW—FM Broadcast station, complete with monitor, all tubes, antenna and waveguide, Mfr. G. E. **$1,500.00**—at location, N. Y. C.

RADAR—SA, SO, SN, SQ, SJ, SF, SL, SK, etc.
ASB, APS-2, 3, and 4, APN-9, etc.
AN/CPN-6, AN/CPN-8.

SONAR—QCD, QBE, QCJ, QBG, WEA, NAA, etc.

Marine Transmitters—TBK, TAJ, TBL, TBM, TDE, TAQ, and TCS sets for 12, 24, 110 volts dc and 110 volts ac.

MAGNETRONS & KLYSTRONS

2J21A	2J61	714AY
2J22	4J32	725A
2J26	4J33	718AY
2J27	4J42	718DY
2J28	4J50	730A
2J31	5J23	721A
2J32	5J29	723A/B
2J33	700B	2K28
2J34	700C	2K41
2J36	700D	726A
2J39	706A-GY	726B
2J50	707B	

THOUSANDS OF
DYNAMOTORS, INVERTORS, CONVERTORS and MOTOR-GENERATORS IN STOCK
6, 12, 24, 28, 32, 115 and 230 dc. input

This months specials:
12/24 input, 265/540 at 120/26 ma output
Brand new—$8.00

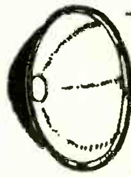
All material guaranteed, offered subject to prior sale.

½ hr. timer ½ min. grads. rings buzzer at end of time interval — Telechron Motor & Micro Switch constr. 115V. AC, 10 Amp. Cap. 10⅝" L., 5¼" H., 3⅞" W.... **$7.50 ea.**

AMMETER, 150/300 dual range Triplet 341A 3½" rectangular flush bakelite 5 amp Movement @ $4.95 with external current transformer for 150 amp. **Only $7.50**

DELCO BLOWER — sirocco type D.C. Flange diameter 3½" blade 3-3/16" RPM @ 12 volts 3400 RPM @ 6 volts 1600 .... **$3.95**

G. E. Model 6RS 5FB3 full wave 3 plate bridge (12 plates) maximum A.C. input 54 volts maximum D.C. output 40 volt D.C. current 0.150 .... **$1.15 ea.**



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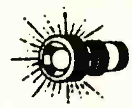

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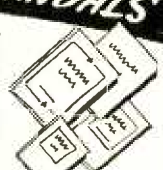

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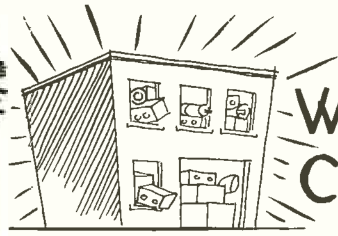

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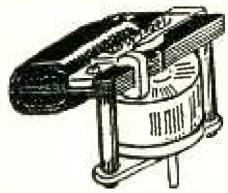

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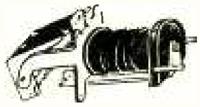

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TS-33	TS-118	BC-221	LM-8	RECVRS.
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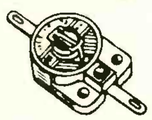

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4 —30 MMFD	.60
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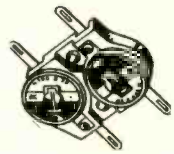

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6B8G	1.39
6BA4	1.08

6SL7GT	1.25
6SN7GT	1.08
6SN7WGT	1.90
6SQ7GT	.98
6SR7	1.08
6SS7	1.08
6ST7	1.33
6SU7GTY	3.37
6SZ7	1.05
6T7G	.98
6T8	2.45
6U4GT	.95
6U5/6G5	.98
6U6GT	1.05
6U7G	.79
6V6	2.25
6V6GT	.98
6V6GTY	1.65
6V7G	1.18
6W4GT	.98
6W4WGT	1.70
6W5GT	.98
6W6GT	1.35
6W7G	1.33
6X4	.69
6X5GT	.75
6Y5	1.85
6Y6G	1.25
6Y7G	.89
6Z5/12Z5	1.18

12Q7GT	.90
12S8GT	.98
12SA7GT	1.05
12SC7	1.39
12SF5GT	.75
12SF7GT	.69
12SG7	.89
12SH7	1.10
12SJ7GT	.89
12SK7	1.25
12SL7GT	1.07
12SN7GT	1.22
12SQ7GT	.91
12SR7	.98
12X3	.90
12Z3	.98
14A4	1.19
14A7/12B7	1.08
14AF7/XXD	1.18
14B6	1.08
14B8	.98
14C5	1.19
14C7	1.09
14E6	1.10
14E7	1.33
14F7	1.10
14F8	1.19
14H7	1.09
14J7	1.23

RK48A	14.85
49	.83
50	1.19
EF50	.98
50A5	1.22
50B5	1.11
50C5	1.03
50C6	1.49
50L6GT	.81
50X6	1.10
50Y6GT	.90
50Y7GT	.99
52	.99
53	.78
55	1.06
56	.85
57	.89
58	.89
RK59	1.45
59	1.78
HY69	2.75
70A7	1.59
70L7GT	1.95
71A	.98
72	.95
CRP72	1.37
73	1.67
NR74	.29
75	.83
HY75A	4.59

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955	.49
956	.39
957	.39
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CK1089	3.98
CK1090	2.69
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HY1269	5.39
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6BG6G	1.85
6BH6	1.35
6BJ6	1.35
6BL7GT	2.75
6BQ6GT	1.78
6C4	.91
6C5GT	.83
6C6	.89
6C7	1.26
6C8G	.98
6C21	42.50
6CB6	1.11
6CD6G	2.98
6D4	2.85
6D6	.89
6D7G	.89
6D8	.98
6E5	1.54
6E6	1.39
6E7	1.39
6F5	.83
6F6	1.04
6F6GT	.85
6F7	1.39
6F8G	1.49
6G6G	1.48
6H4GT	.98
6H6	.91
C6J	6.95
6J4	6.98
6J5GT	.93
6J6	1.98
6J7	1.11
6J8G	1.29
6K4	3.49
6K5GT	1.16

6Z7G	.89
6ZY5G	.89
7A4/XXL	.98
7A5	1.10
7A6	.85
7A7	1.45
7A8	.90
7AD7	1.56
7AF7	.87
7AG7	1.98
7AH7	1.15
7B4	.83
7B5	1.23
7B6	1.00
7B7	.90
7B8	.90
7C4/1203A	.79
7C5	1.00
7C6	1.00
7C7	1.49
7C23	72.00
7E5/1201	1.25
7E6	.98
7E7	.98
7F7	1.15
7F8	2.25
7G7/1232	1.33
7H7	1.11
7J7	1.23
7K7	1.33
7L7	1.23
7N7	1.22
7Q7	.95
7R7	1.07
7S7	1.23
7T7	1.03
7V7	1.33
7W7	1.23
7X7XFM	1.23
7Y4	.90
7Z4	.87
10Y	.45
12A	.89

14N7	1.35
14Q7	1.10
14R7	1.19
14S7	1.33
14W7	1.23
14X7	1.23
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27	.75
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76	.83
77	.75
78	.83
79	.89
80	.74
81	1.75
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83	1.89
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805	4.98
807	1.98
808	2.39
809	2.45
810	11.96
811	2.90
812	2.90
813	11.75
814	3.85

1621	1.29
1622	2.26
1625	.49
1626	.49
1629	.39
1631	1.25
1632	.77
1633	.75
1634	1.80
1635	1.49
1641/RK60	1.98
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5516	7.75
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5618	3.29
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9JP1	14.85
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313/28V	.15
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Sylvania S6/6W/120V	.15
Wstghs C7/7W/120V	.15
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1N27	3.50
1N29	3.50
1N32	18.00
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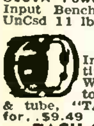

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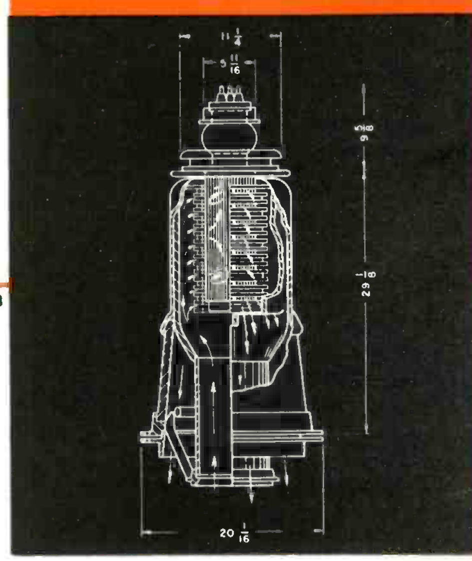

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Filament		Thoriated Tungsten
Voltage		18 v.
Current		196 a.
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Grid — Plate		36. mmfd.
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