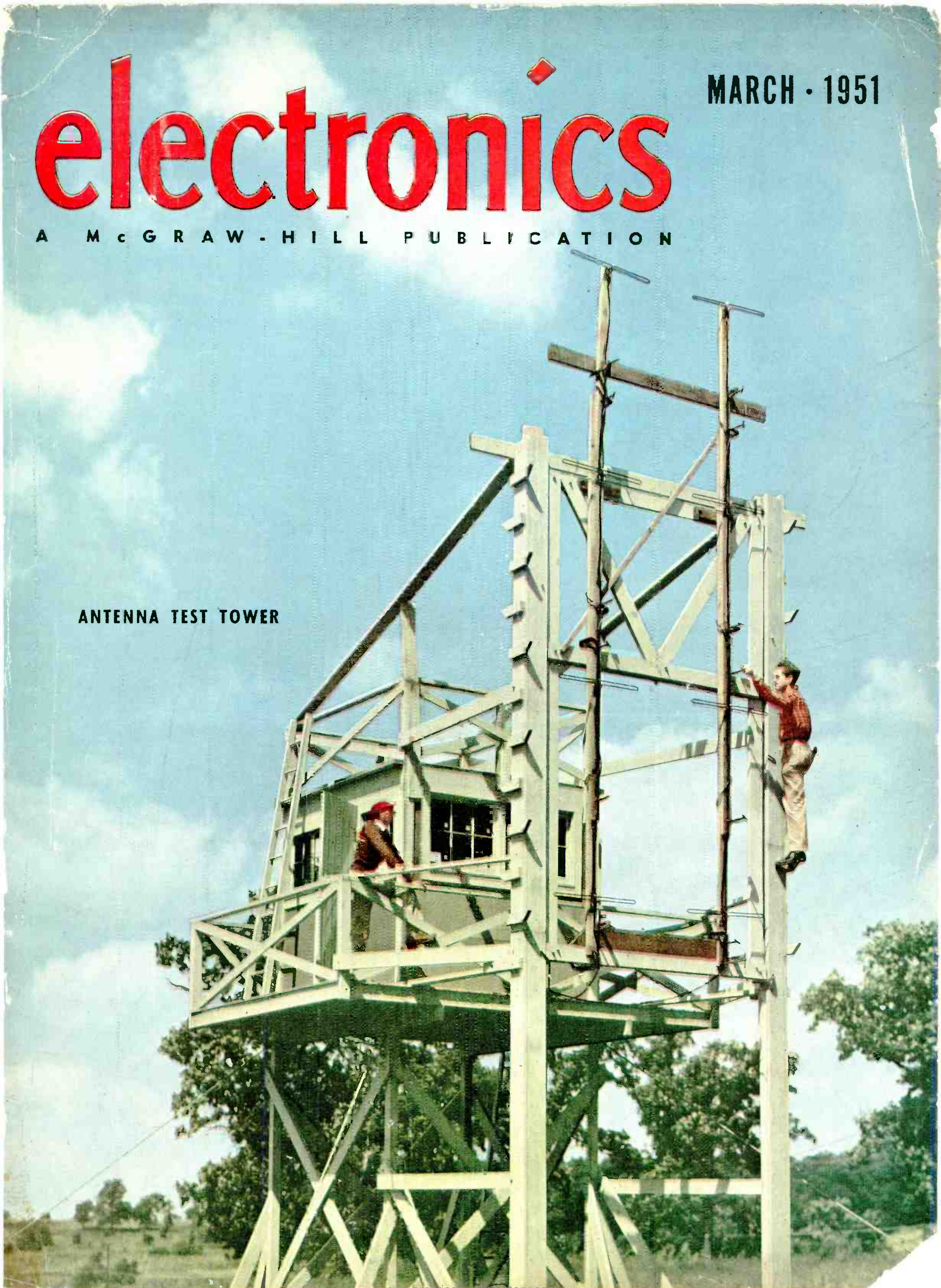
electronics

MARCH · 1951

A McGRAW-HILL PUBLICATION



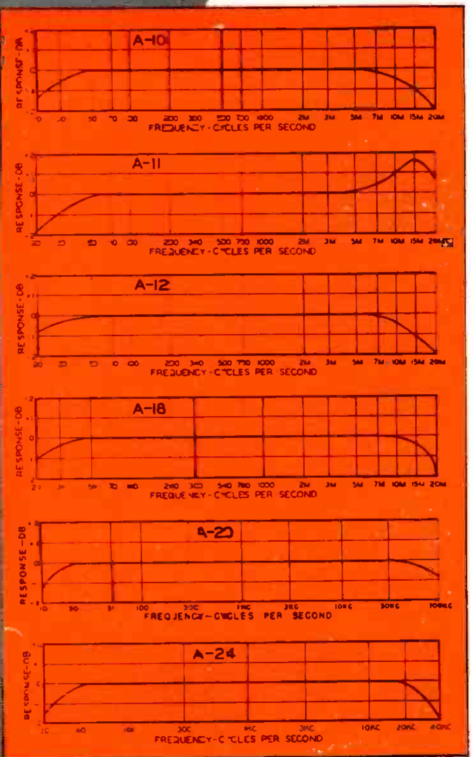
ANTENNA TEST TOWER

ULTRA COMPACT UNITS...OUNCER UNITS

HIGH FIDELITY . . . . SMALL SIZE . . . . FROM STOCK

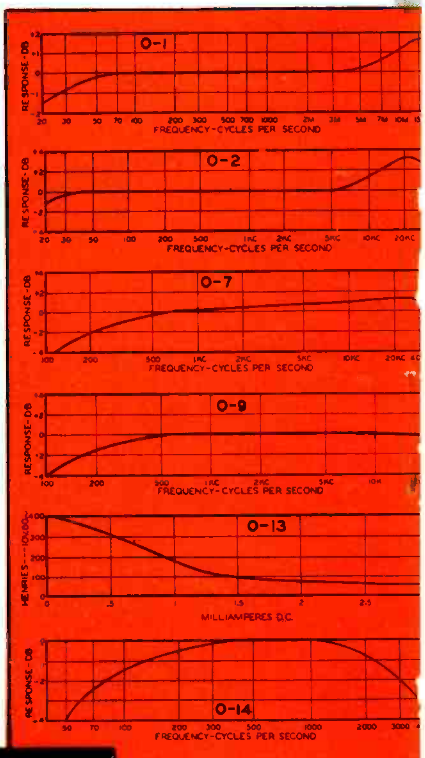
UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.



Type No.	Application	Primary Impedance	Secondary Impedance	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50 ohms	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids (multiple alloy shields for low hum pickup)	50, 200, 500	50,000 ohms	16.00
A-12	Low impedance mike, pickup, or multiple line to grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall, in two sections	15.00
A-14	Dynamic microphone to one or two grids	30 ohms	50,000 ohms overall, in two sections	14.00
A-20	Mixing, mike, pickup, or multiple line to line	50, 125/150, 200/250, 333, 500/600 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-21	mixing, low impedance mike, pickup, or line to line (multiple alloy shields for low hum pickup)	50, 200/250, 500/600	50, 200/250, 500/600	16.00
A-16	Single plate to single grid	15,000 ohms	60,000 ohms, 2:1 ratio	13.00
A-17	Single plate to single grid 8 MA unbalanced D.C.	As above	As above	15.00
A-18	Single plate to two grids. Split primary	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	14.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	18.00
A-24	Single plate to multiple line	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	14.00
A-26	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-27	Crystal microphone to multiple line	100,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-30	Audio choke, 250 henrys @ 5 MA 6000 ohms D.C., 65 henrys @ 10 MA 1500 ohms D.C.			10.00
A-32	Filter choke 60 henrys @ 15 MA 2000 ohms D.C., 15 henrys @ 30 MA 500 ohms D.C.			9.00

TYPE A CASE
1½" x 1½" x 2" high



UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ⅞" diameter... mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4,000 cycles. Maximum level 0 DB.

OUNCER CASE
⅞" Dia. x 1⅛" high

Type No.	Application	Pri. Imp.	Sec. Imp.	List Price
0-1	Mike, pickup or line to 1 grid	50, 200/250 500/600	50,000	$13.25
0-2	Mike, pickup or line to 2 grids	50, 200/250 500/600	50,000	13.25
0-3	Dynamic mike to 1 grid	7.5/30	50,000	12.00
0-4	Single plate to 1 grid	15,000	60,000	10.50
0-5	Plate to grid, D.C. in Pri.	15,000	60,000	10.50
0-6	Single plate to 2 grids	15,000	95,000	12.00
0-7	Plate to 2 grids, D.C. in Pri.	15,000	95,000	12.00
0-8	Single plate to line	15,000	50, 200/250, 500/600	13.25
0-9	Plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600	13.25
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600	13.25
0-11	Crystal mike to line	50,000	50, 200/250, 500/600	13.25
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600	12.00
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C.,		6000 ohms	9.50
0-14	50:1 mike or line to grid	200	½ megohm	13.25
0-15	10:1 single plate to grid	15,000	1 megohm	13.25

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

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MARCH • 1951

ANTENNA TEST TOWER .... COVER
Critical measurements are made at the Andrew Corporation's Orland Park, Illinois, research lab with the aid of this structure. A bulldozer skids it about the grounds and the height of arrays is readily varied by means of a sliding frame (see p 138)

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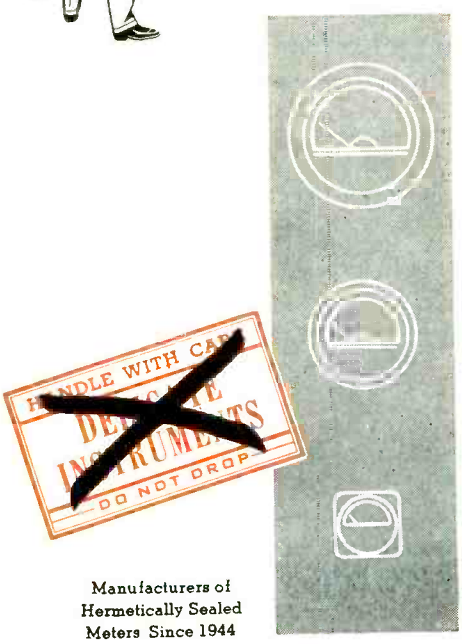
setting new standards for electrical instruments

MARION RUGGEDIZED METERS



Manufacturers of
Hermetically Sealed
Meters Since 1944

This amazing new family of Marion ruggedized electrical indicating instruments sets new standards of quality and accuracy in electrical measurement. Marion "Ruggedized" instruments give better performance in *any* application. Use them with confidence even where you never before dared use "delicate instruments." They exceed all JAN-I-6 requirements, are *hermetically sealed* and completely interchangeable with existing JAN 2½" and 3½" types.

Marion Ruggedized instruments perform perfectly under critical conditions of shock, vibration, mechanical stress and strain. Hermetic sealing makes them impervious to weather and climate.

When you want the *best* in meters for any application — from bulldozers to Geiger Counters — insist on Marion, the name that means the most in meters.

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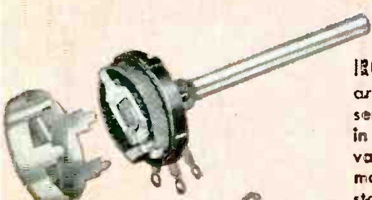
marion meters

A complete line

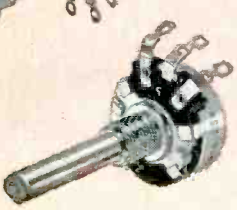
for resistors too!

Unusual *combinations of characteristics* required in today's critical electronic circuits demand a complete range of resistor types. Specializing in resistors, IRC makes the widest line in the industry. This means ease of procurement—a single dependable source of supply for *all* your resistance needs. It also means unbiased recommendations—no substitution of units "just as good". IRC's complete line of products; complete research and testing facilities; complete network of licensees for emergency production—all add up to complete satisfaction for you.

CONTROLS



IRC Type W Wire Wound Controls are designed for long, dependable service and balanced performance in every characteristic. These 2-watt variable wire wound units provide maximum adaptability to most rheostat and potentiometer applications within their power rating. Catalog Bulletin A-2.

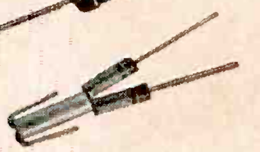


IRC New Type Q Controls feature small 15/16" size, rugged construction and superior performance. Increased arc of rotation permits same resistance ratios successful in larger IRC Controls. Catalog Bulletin A-4.

PRECISION RESISTORS

IRC Precision Wire Wounds offer a fine balance of accuracy and dependability for close-tolerance applications. Extensively used by leading instrument makers, they excel in every significant characteristic. Catalog Bulletin D-1.

IRC Deposited Carbon PRECISTORS combine accuracy and economy for close-tolerance applications, where carbon compositions are unsuitable and wire-wound precisions too expensive. Catalog Bulletin B-4.



IRC Matched Pairs provide a dependable low-cost solution to close-tolerance requirements. Both Type BT and BW Resistors are available in matched pairs. Catalog Bulletin B-3.

IRC Sealed Precision Voltmeter Multipliers are suitable and dependable for use under the most severe humidity conditions. Each consists of several IRC Precisions mounted and interconnected, encased in a glazed ceramic tube. Catalog Bulletin D-2.

is essential

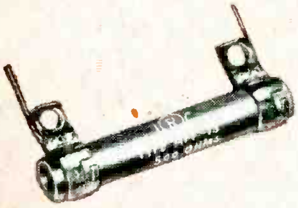
INSULATED COMPOSITION and WIRE WOUND RESISTORS

IRC Advanced Type BT Resistors meet and beat JAN-R-11 Specifications at ⅓, ½, 1 and 2 watts—combine extremely low operating temperature with excellent power dissipation. Catalog Bulletin B-1.

IRC Type BW Wire Wound Resistors are exceptionally stable, inexpensive units for low range requirements. Have excellent performance records in TV circuits, meters, analyzers, etc. Catalog Bulletin B-5.

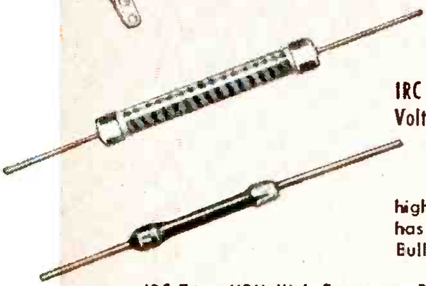
IRC Type BTAV High Voltage Resistors, developed for use as discharge resistors in fluorescent "Quick Start" ballasts, withstand momentary peak surge of 6000 volts. Also suited to TV bleeder circuits. Catalog Bulletin B-1.

HIGH FREQUENCY and HIGH POWER RESISTORS



IRC Type MP High Frequency Resistors afford stability with low inherent inductance and capacity in circuits involving steep wave fronts, high frequency measuring circuits and radar pulse equipment. Available in sizes from ¼ to 90 watts. Catalog Bulletin F-1.

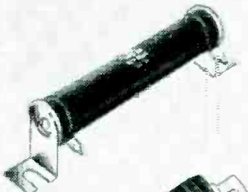
Type MV High Voltage Resistors utilize IRC's famous filament resistance coating in helical turns on a ceramic tube to provide a conducting path of long, effective length. Result: Exceptional stability even in very high resistance values. Catalog Bulletin G-1.



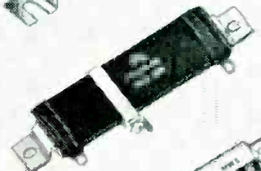
IRC Type MVX High Ohmic, High Voltage Resistors meet requirements for a small high range unit with axial leads. Engineered for high voltage applications, MVX has exceptional stability. Catalog Bulletin G-2.

IRC Type MPM High Frequency Resistors are miniature units suitable for high frequency receiver and similar applications. Stable resistors with low inherent inductance and capacity. Body only ⅜'' long. Catalog Bulletin F-1.

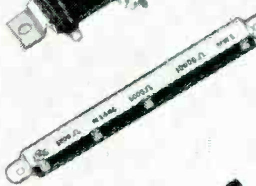
POWER RESISTORS



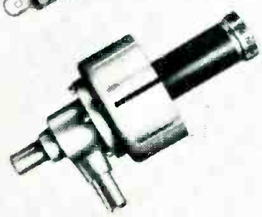
IRC Fixed and Adjustable Power Wire Wounds give balanced performance in every characteristic—are available in a full range of sizes, types and terminals for exacting, heavy-duty applications. Catalog Bulletin C-2.



IRC Type FRW Flat Wire Wound Resistors fulfill requirements of high wattage dissipation in limited space—may be mounted vertically or horizontally, singly or in stacks. Catalog Bulletin C-1.



IRC Type MW Wire Wound Resistors offer low initial cost, lower mounting cost, flexibility in providing taps, and saving in space. Completely insulated against moisture. Catalog Bulletin B-2.



IRC Type LP Water-Cooled Resistors for TV, FM and Dielectric Heating Applications. Cooled internally by high velocity stream of water; adjustable to local water pressure and power dissipation up to 5 K.W.A.C. Catalog Bulletin F-2.

Wherever the Circuit Says -\/\/\/-

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

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

Please send me Technical Data Bulletins checked below:

☐ Bulletin A-2 (W)	☐ Bulletin B-4 (DC)	☐ Bulletin F-1 (MP)
☐ Bulletin A-4 (Q)	☐ Bulletin B-5 (BW)	☐ Bulletin F-1 (MPM)
☐ Bulletin B-1 (BT)	☐ Bulletin C-1 (FRW)	☐ Bulletin F-2 (LP)
☐ Bulletin B-1 (BTAV)	☐ Bulletin C-2 (PWW)	☐ Bulletin G-1 (MV)
☐ Bulletin B-2 (MW)	☐ Bulletin D-1 (WW)	☐ Bulletin G-2 (MVX)
☐ Bulletin B-3 (M/P)	☐ Bulletin D-2 (MF)	

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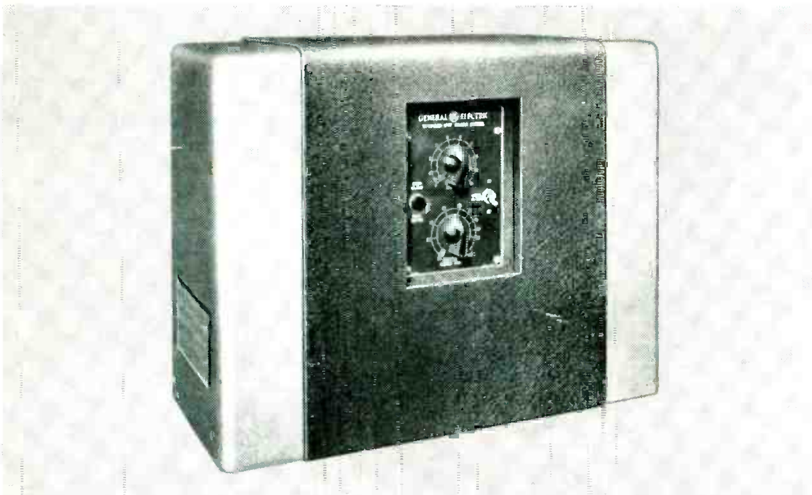
ELECTRONICS

Designers



MAKE 16 GROUND CONNECTIONS IN 1 MINUTE!

Low-resistance joints that hold at over 125°C easily made with

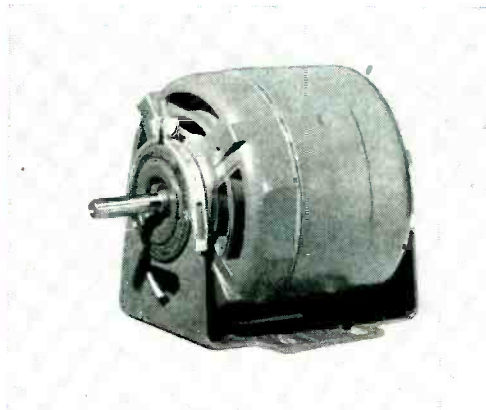
G-E PRECISION CONTROL FOR RESISTANCE WELDERS

Operators are making sixteen ground connections a minute to a television-receiver chassis with G. E.'s precision-control resistance welding method.

The compact electronic spot-welding control shown here has been specifically designed for use in conjunction with small bench welders or tongs and thus is ideally suited for many of the otherwise expensive assembly operations encountered in the manufacture of electronic equipment.

The panel provides for welding-current to control the amount of heat produced in the welds. Once set, successive welding currents remain constant to assure accurate and consistent welding of connections.

Complete data in Bulletin GEA-4175.



NEW! Unit-Bearing Motor for fans and blowers

- all angle operation
- improved appearance
- provision for 4-way mounting
- quiet operation
- requires no additional lubrication
- adjustable-speed operation available

Available in ratings from 25 millihorsepower to 1/12 horsepower to match many fan or blower sizes, this new G-E unit-bearing motor uses a new lubrication system and bearing design that permit reliable operation in any position. For extremely quiet operation, resilient cradle-base or end-ring mounting may be supplied. Suitable control is available for two-speed or adjustable-speed operation. More data in Bulletins GEA-5338 and GEC-219A.

GENERAL ELECTRIC

667-11

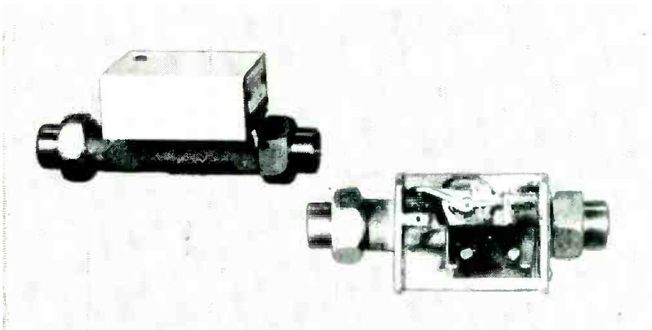
TIMELY HIGHLIGHTS ON G-E COMPONENTS

replace tubes BEFORE THEY FAIL! —record life with G-E time meters

A vacuum tube can usually be replaced *before* it fails if you have an accurate indication of operating time on the electronic device on which the tube is used.

G-E time meters, with dependable Telechron* motor drive, record operating time in hours, tenths of hours, or minutes, and are supplied for 115-, 230-, or 460-volts. The molded Textolite† case harmonizes with other G-E 3½-inch instruments mounted on the same panel. For more information, including dimensions, write for Bulletin GEC-472.

*Reg. T. M. Telechron, Inc. †Reg. T. M. General Electric Co.



sure protection against overheating!

This G-E flow interlock opens the electric circuit of your water-cooled components when water flow is lower than a preset minimum, closes it when flow is above this point.

Depending on adjustment, the interlock will actuate the electric contact for any flow between ½ and four gallons per minute. Cut-in, cut-out differential is 0.1 gpm.

Ratings: 10 amps, 120 or 240 volts a-c; maximum water-line pressure is 125 lb./sq. in. Unit is bronze with standard ½-inch fittings, is easy to install and adjust. See Bulletin GEC-411.

select 10 ranges INSTANTLY with this HIGH SENSITIVITY VTVM

CALIBRATED RANGES: .001 to 300 volts (10 cycles to 1.5 mc.); —52 to +52 db (ref. level —1 mw at 600 v.)

Just about everything you could ask for in a high-sensitivity vacuum tube voltmeter! Frequency range of this G-E Type AA-1 instrument is substantially flat from 10 cycles to one megacycle with voltage ranges of 0-.01, 0-.03, 0-0.1, 0-0.3, 0-1.0, 0-3.0, 0-10, 0-30, 0-100, 0-300, decibels from —52 to +52 in 10 ranges.

Ten-position pushbutton switch instantly selects range without passing through intermediate stages. This vacuum-tube voltmeter is stable, has high impedance input, uses full-wave rectification, and has an amplifier output of 3 volts. More in Bulletin GEC-461.

General Electric Company, Section A 667-11
Apparatus Department, Schenectady 5, N. Y.
Please send me the following bulletins:

Indicate
√ for reference only
X for planning an immediate project

- ☐ GEA-4175 Welding control
- ☐ GEA-5338 Fan motors
- ☐ GEC-219A Fan motors
- ☐ GEC-411 Flow interlock
- ☐ GEC-461 Vacuum-tube voltmeter
- ☐ GEC-472 Time meters

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Company ____________________

Address ____________________

City ____________________ State ____________

THE NEW TURNER

Aristocrat

MODEL 50D DYNAMIC
FOR TV - AM - FM
Recording • Broadcast
Public Address

The crown jewel of dynamic microphones. See it, handle it — use it on highest quality recording, public address or broadcast work. New beauty, new styling, new utility and *new performance* make the Turner *Aristocrat* the finest of the fine. Use it anywhere, indoors or out — in hand, on stand, suspended, or concealed in stage settings. The *Aristocrat* is quickly and easily detached from ball swivel coupler for hand use. Non-directional polar pattern picks up sound from any direction. Equally effective for individual or group pickups with wide range, high fidelity reproduction of voice or music. Its high output dynamic generator requires no closely associated auxiliary equipment for outstanding results. Built of finest materials with flawless workmanship, each unit is laboratory calibrated to insure specification standards. . . . Write for complete details.

SPECIFICATIONS:

FREQUENCY RESPONSE: 50 to 15,000 c.p.s. flat within ± 2½db.
OUTPUT LEVEL: 56 db below 1 volt/dyne/sq. cm.
IMPEDANCE: 15, 200, 500 ohms or high impedance.
POLAR PATTERN: Essentially non-directional in any position.
MOUNTING: Ball and swivel type, tilts in any direction. Standard ⅝" — 27 thread.
CABLE: 20 ft., high quality rubber covered, two conductor shielded cable with Cannon quick-disconnect plug.

THE TURNER COMPANY
905 17th Street N. E., • Cedar Rapids, Iowa
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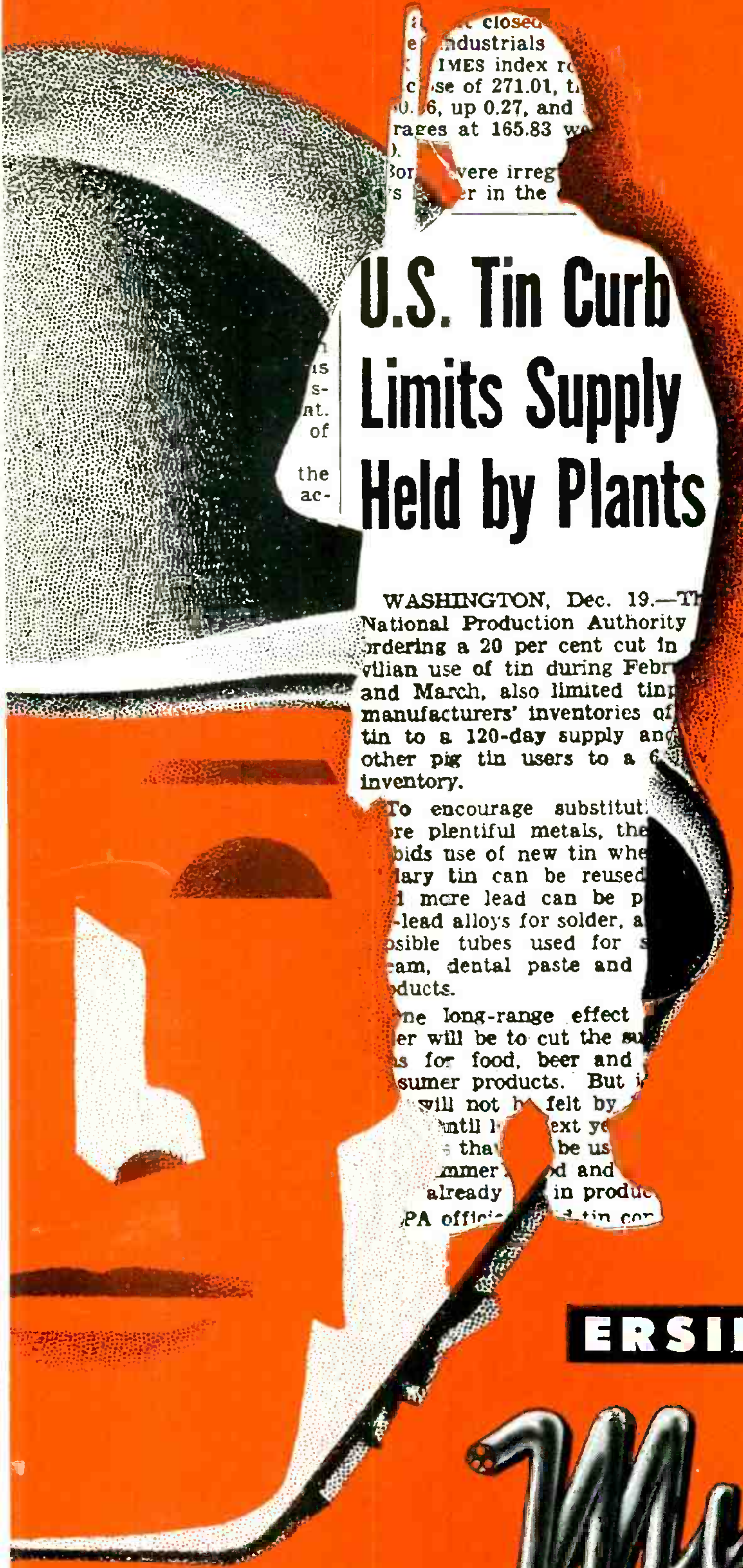
TURNER *Microphones* **BY TURNER**



1951 TIN SOLDIER...

and the question of SPEED on your assembly line

Important Now! You will be interested to know that many ERSIN MULTICORE users report higher speed and greater dependability using MULTICORE of lower tin content than other solders . . . due to extra-active, non-corrosive ERSIN FLUX and Thin-Wall Triple-Core construction.

Specify ERSIN MULTICORE to insure rapid melting, continuity of flux and perfect bonding — even on difficult metals. Maintain speed on your assembly line, yet prevent "dry" joints. ERSIN MULTICORE is the World's Finest Solder — costs less because it saves time and avoids rejects.

ERSIN Multicore

THE ORIGINAL 3 CORE SOLDER . . . THE ONLY SOLDER MADE WITH NON-CORROSIVE, EXTRA-ACTIVE ERSIN FLUX.

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Valuable booklet "Modern Solders" and testing samples available on request.

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Looking for trouble before it starts...

with an MB VIBRATION EXCITER

One of the many instruments produced by the Sperry Gyroscope Company is here undergoing a "shake test" on the MB model S-3 Vibration Exciter. Such vibration testing contributes to the dependability in service for which Sperry instruments are noted. The instrument is fastened to the shake table of the exciter, which is controlled from panel. Amplitude, velocity and acceleration are being read directly on an MB Vibration Meter.

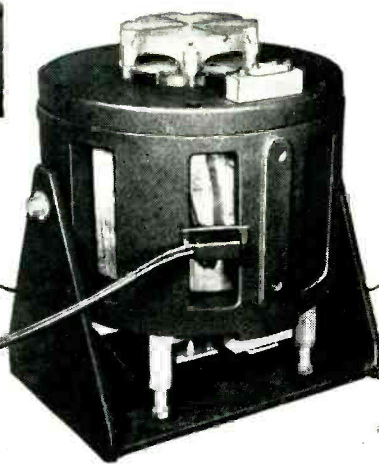
WHEN PRODUCTS GIVE unexpected trouble in service, you'll find too often that it's due to vibration.

Foresighted concerns take no chances with this enemy of equipment life. At Sperry Gyroscope Company, possible troubles due to vibration are ferreted out in the laboratory. By means of an MB Vibration Exciter, which has quick, easy adjustments for force and frequency, instruments are checked for vibratory response – for ability to resist fatigue. Result: Trouble is eliminated in the design stage, *before* it starts.

This shaker is adaptable to countless situations. You can test miniature electrical assemblies to mammoth wing structures; filaments to heavy axle shafts. In one of its jobs – fatigue testing – the shaker reproduces vibratory effect of years within hours. One company, for example, reduced the time of spot-checking bellows to 10 minutes – a job which formerly took 12 hours per unit!

Location of noise sources . . . actual observation of the motions of vibrations . . . study of damping characteristics of materials . . . these are but a few other important jobs where an MB Exciter pays off.

Models which deliver forces of 5, 25, 50, 100, 200, 300 and 2500 pounds are available – all electromagnetic. These exciters are suitable for vibration testing equipment to USAF specifications 41065-B and MIL-E-5272. Write us for details.



The Model S3 Vibration Exciter illustrated delivers peak force of 200 pounds. Operates in frequency range of 3 to 500 C.P.S. Has rotating power supply.

Write us for more detailed information on MB Vibration Exciters, and ask for **bulletin 410-M5.**

THE MB MANUFACTURING COMPANY, Inc.
1060 State Street, New Haven 11, Conn.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION . . . TO MEASURE IT . . . TO REPRODUCE IT

Announcing

WAVEGUIDE TEST EQUIPMENT

2,600 to 18,000 mc!

The revolutionary new *-hp-* waveguide test equipment shown on the following pages represents the practical, economical adaptation of a new, fresh concept of waveguide instrumentation. Emphasis throughout is on functional simplicity and low cost; instruments are offered as individual basic components. Most equipment is based on entirely new designs developed either in the *-hp-* laboratories or by Varian Associates, microwave equipment and electron tube specialists.

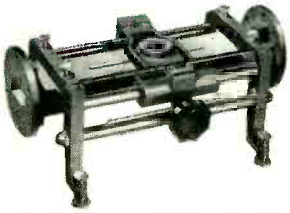
Full frequency coverage from 2,600 mc to 18,000 mc is offered in 6 waveguide sizes: 3″ x 1½″, 2″x 1″, 1½″x ¾″, 1¼″x ⅝″, 1″x ½″, .702″x .391″. Instrumentation is now available in most of these sizes. Complete instrumentation for these frequencies will be provided during the forthcoming year.

HEWLETT-PACKARD COMPANY
2178A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

Sales Representatives in all principal areas.
Export: Frazar & Hansen, Ltd., San Francisco, Los Angeles, New York City

Broad-Band Waveguide Test Equipment!

-hp- 809/810 Slotted Sections



Slotted sections are one of the most important measuring instruments in waveguide engineering. They are essential to the measurement of impedance, reflection and other transmission characteristics.

A single precision carriage (*-hp-* 809B) mounts either slotted waveguide sections or coaxial sections covering the frequency range from 4.0 to 12.4 kmc. This results in maximum flexibility and minimum cost for complete frequency coverage. The carriage travels on a new 3-point, ball-bearing suspension system; and waveguide or coaxial slotted sections may be quickly interchanged. Carriage operates in conjunction with *-hp-* 442A Broad-Band Probe and *-hp-* 440A Coaxial Detector. *-hp-* 810B Waveguide Slotted Sections are available in sizes: 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″. *-hp-* 806A Coaxial Slotted Section is available for frequency range 3.0 kmc to 12.0 kmc. *-hp-* S810A Waveguide Slotted Section, of conventional design, is available in size 3″ x 1½″ to cover the frequency range 2.6 to 3.9 kmc.

-hp- 280A, 281A Adaptors, Waveguide to Coaxial

For transition between waveguide and coaxial systems. Each adaptor covers the full waveguide range with a VSWR not exceeding 1.5. *-hp-* 280A with flexible cable, 3″ x 1½″ only. *-hp-* 281A, with Type N Jacks, sizes 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″.

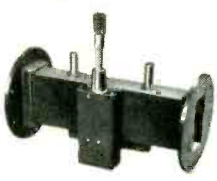
-hp- 370 Attenuators, Fixed

Fixed attenuation characteristics of 6, 10 or 20 db. For reducing power level, isolating system units and reducing reflection. Max. VSWR 1.15. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″, .702″ x .391″.

-hp- 375A Attenuators, Variable Flap

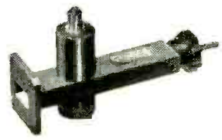
For introducing variable power differences in a waveguide, or isolating power sources and loads. Consists of slotted waveguide section in which matched plate is moved. Max. VSWR 1.15. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″, .702″ x .391″.

-hp- 380A Attenuators, Calibrated Variable



For use between 2,600 and 3,950 mc to create known attenuations or isolate sources and loads. Each instrument accurately calibrated at 3,000 mc. Max. VSWR 1.15. Sizes: 3″ x 1½″. (Other sizes to be announced.)

-hp- 485A Detector Mounts



For measurement of power between frequencies 2.6 to 18.0 kmc in conjunction with *-hp-* 430A Power Meter and Sperry 821 barretter. Also may be employed to measure relative level, or detect rf energy using a Type 1N21 crystal. Each mount is semi-tuned by means of a movable short. Additional tuning may be provided if desired by means of *-hp-* 870A Slide Screw Tuner or *-hp-* 880A E-H Tuner. Sizes: 3″ x 1½″ (for use with barretter only), 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x 1½″, .702″ x .391″.

-hp- 840A, 841A Waveguide Tees

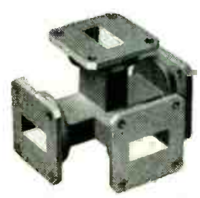
Rectangular series or shunt tees for coupling waveguide systems, as when dividing power or introducing impedances. Model 840A Series Tees branch from wide face of waveguide. Model 841A Shunt Tees branch from narrow face. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″, .702″ x .391″.

Providing a new standard of broad-band operation plus traditional *-hp-* speed, accuracy, convenience and economy, for all types of precision microwave measurements.

BOOTHS 40, 41

See this new equipment at the I.R.E. Show or write your -hp- sales representative or factory for details.

-hp- 845A Hybrid Tees



Four-arm, rectangular hybrid tee. Composed of series and shunt tee constructed at same point in waveguide. Possess many properties of bridge circuit. Used for rapid determination of VSWR; as impedance transformer; as a bridge, etc. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″, .702″ x .391″.

-hp- 920A Adjustable Shorts

Adjustable choke-type short for tuning or introducing reactance in combination with detecting sections, series, shunt or hybrid tees. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″, .702″ x .391″.

HEWLETT-PACKARD *hp* INSTRUMENTS

Simple Design, Multi-Purpose Operation!

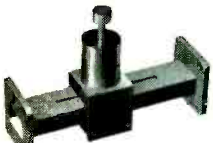
-hp- 715A Klystron Power Supply

Versatile power supply for operation of all types of low-power klystron oscillators in test-bench experiments. Beam voltage 250 to 400 v. at 50 ma. max. Reflector voltage 10 to 900 v. at 5 μamps. Internal square wave modulation, 1,000 cps; also provision for external modulation. 6.3 volt, 1.5 amp. filament supply.

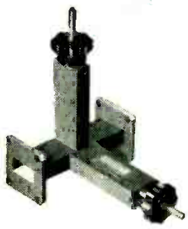
-hp- 530A Frequency Meters

General purpose reaction type frequency meter covering the entire waveguide frequency band. Consists of a high "Q" resonant cavity tuned by a plunger. Micrometer scale indicates plunger position. Accuracy ±0.10%. Ranges: 5.85 to 8.20 kmc (1½″ x ¾″) and 8.2 to 12.4 kmc (1″ x ½″). (Other sizes to be announced.)

-hp- 870A Slide Screw Tuners



For flattening waveguide systems. Consists of slotted waveguide section and adjustable probe on sliding carriage. Varying position and peneration of probe sets up VSWR which can be adjusted to cancel existing VSWR in system. VSWR values up to 20 can be tuned with an accuracy of VSWR 1.02. Sizes: 3″x 1½″, 2″x 1″, 1½″x ¾″, 1¼″x ⅝″, 1″x ½″, .702″x .391″.



-hp- 880A E-H Tuners

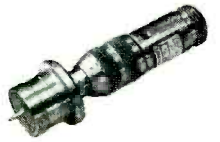
Matching section for tuning high power systems or for tuning systems where low leakage is essential. Consists of hybrid waveguide tee with moveable choke type shorts placed in shunt and series arms. Sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″x ½″, .702″x .391″.

-hp- 440A Coaxial Detector

-hp- 440A Coaxial Detector, a tunable crystal and bolometer mount, may be used as an rf detector for coaxial systems operating over the frequency range, 2.4 kmc to 12.4 kmc. A single adjustment provides rapid tuning. Equipment mates with Type N connectors and operates either with silicon crystal or bolometer.

-hp- 442A Broad-Band Probe

This probe may be combined with *-hp-* 440A to provide a highly sensitive, easily tuned detector for use with slotted sections. A micrometer depth adjustment provides quick control of rf coupling. This combination is specifically designed to operate with *-hp-* 809B and 810A/B Slotted Waveguide equipment.



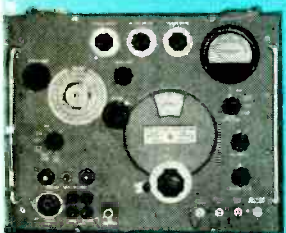
-hp- 910A Low Power Terminations

For use wherever matched load is required, as in measurement of reflection, discontinuities or where waveguide must be properly terminated. Consists of tapered piece of resistive material terminating a waveguide section in its characteristic impedance. Max. VSWR 1.06. Average power 1 watt, sizes: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″. Average power 1/2 watt, sizes: 1″ x ½″, .702″ x .391″.

-hp- 912A High Power Terminations

Used as dummy loads for high-power transmitters. Dissipate large amounts of power without undesirable reflection. VSWR less than 1.1. Forced air cooling required when operating at 50% rating or above. 250 watts average power, size: 3″ x 1½″. 100 watts average power, 1″x ½″. (Other sizes to be announced.)

In addition to waveguide equipment shown on these pages, -hp- offers the basic coaxial equipment used in major microwave research and development projects throughout America.



-hp- 616A UHF Signal Generator
1,800 to 4,000 mc. Output range 0.1 μv. to 0.223 v. (1 mw). Continuously variable, direct reading, no adjustments during operation.

-hp- 618A SHF Signal Generator
3,800 to 7,600 mc. Output range 2.23 μv. to 0.223 v. (1 mw). Continuously variable, direct reading, no adjustments during operation.

-hp- 805A/B Slotted Line
Highly stable, exclusive, parallel plane design. 500 mc to 4000 mc. Model 805A, VSWR 1.04, 50 ohms impedance for flexible cables; 805B, VSWR 1.02, 46.3 ohms impedance, for ⅞″ rigid coaxial line.

-hp- 430A Microwave Power Meter
Automatic, instantaneous power readings in db or milliwatts. No calculations, no adjustments. Use with any microwave bolometer mount.

-hp- 415A Standing Wave Indicator
High-gain amplifier operating at fixed audio frequency. Reads VSWR and db direct. 70 db calibrated range. Normal frequency 1,000 cps; others available, 300 to 2,000 cps.

HEWLETT-PACKARD hp INSTRUMENTS

A NEW Insulating Laminate...

INSURÓK* GRADE T-812

COMBINES:

- SUPERLATIVE INSULATION RESISTANCE
- LOW MOISTURE ABSORPTION
- VERY HIGH STRENGTH
- EXCELLENT PUNCHABILITY

*Reg. U. S. Pat. Off.

INSUROK T-812 is a new paper-base punching stock that laughs at heat and humidity! It has outstanding properties that have never before been combined in one insulating laminate. T-812 has excellent electrical characteristics, plus a spectacular ability to retain them through extremes of heat and humidity. Its insulation resistance after humidity conditioning is particularly noteworthy.

INSUROK T-812 retains all of the properties of the well-known INSUROK T-725 and, in addition, has lower moisture absorption and much higher insulation resistance. It punches readily into intricate shapes. Investigate INSUROK T-812 for your product. Information upon request.

T-812's *Property Combination* —Unmatched by any other material!

Thickness tested	1/16"			
Moisture Absorption (24 hours)	0.38%			
Expansion after 24 hours' immersion in water at 77°F.	Center	0.0001"	Edge	0.0002"
Tensile Strength, psi	Main Direction	19,500	Cross Direction	14,500
Flexural Strength, psi	Main Direction	23,000	Cross Direction	18,000
Dielectric Strength (perpendicular to laminations) V/Mil	Short Time	725	Step by Step	625

	Tests at Room Conditions	After 96 hrs. at 90% Rel. Hum. at 104°F.
Power Factor at 1 megacycle	0.028	0.030
Dielectric Constant at 1 megacycle	4.4	4.5
Loss Factor at 1 megacycle	0.13	0.14
Insulation Resistance, megohms		1,000,000

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

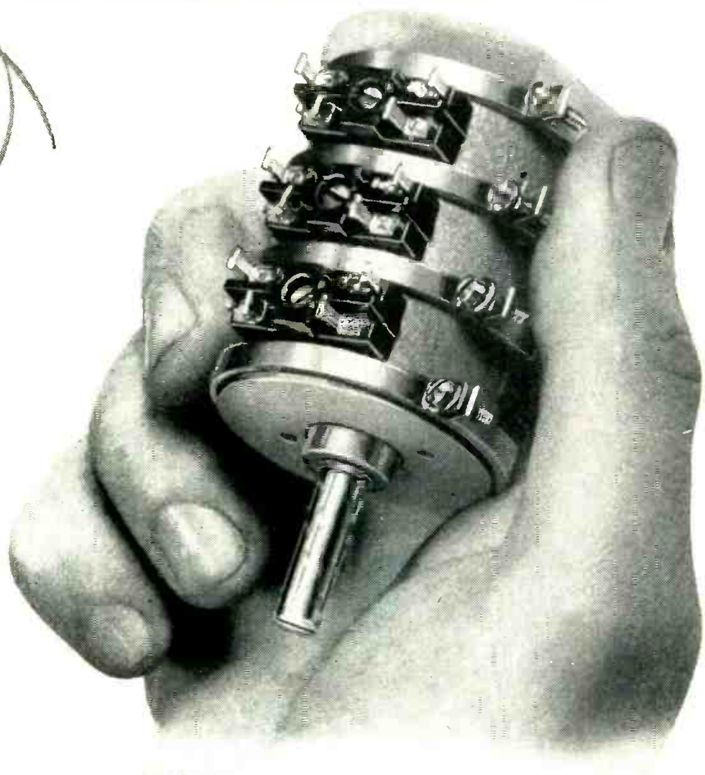
2797 Lake St., Melrose Park, Illinois (Chicago District)

SALES OFFICES: CLEVELAND • DETROIT
INDIANAPOLIS • LOCKLAND, OHIO • MILWAUKEE
NEW BRUNSWICK, (N. J.) • NEW YORK
PHILADELPHIA • ROCHESTER • ST. LOUIS

Here's Fairchild's Newest Potentiometer!

TYPE-746
PRECISION POTENTIOMETER OFFERS:

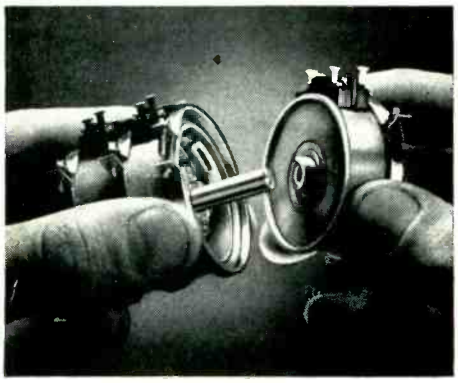
- Low Torque
- Accurate Phasing
- Quick Replacement
- Ganging up to 20 on a shaft

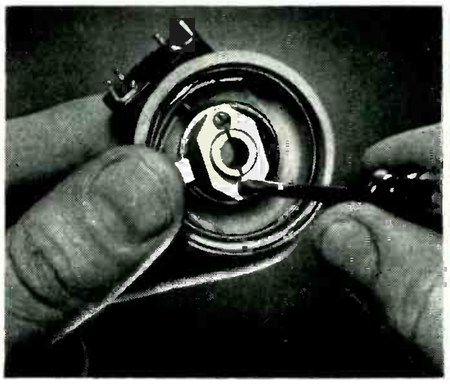


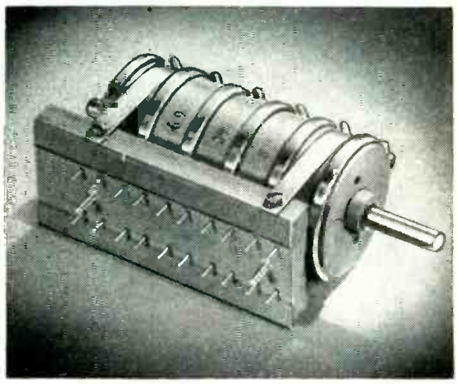
The finest we've ever built! That's our idea of the new "746". It's got lower torque, a new more accurate phasing adjustment, and a new method of ganging that makes it easy to put as many as twenty cups on a single shaft. Individual cups in a gang are easily replaced if necessary.

The new potentiometer is available with linear or non-linear windings to meet your specifications. Its attractive case is made of grey anodized aluminum.

The "746" is just one of the complete Fairchild family of precision potentiometers. What are your requirements? Write, giving details, to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.* Dept. 140-13A.







EASY REPLACEMENT

To replace a unit in a "746" gang, loosen connecting-band screws, remove "cup," slip new "cup" under bands, and tighten screws. This feature pays off in experimental work where circuit elements are changed periodically.

ACCURATE PHASING

A new type phasing adjustment is simpler and more accurate. A retainer plate clamps shaft to wiper arm. To adjust for phasing, loosen two screws, set the arm to the correct position, then tighten screws.

FLEXIBLE DESIGN

Typical of the special consideration Fairchild gives to its customers' special requirements is this plug-in version of the "746." Where fast servicing is a must, the advantages of this "quick-change" unit are quite apparent.

SPECIFICATIONS

Accuracy (overall resistance)—±.5% (linear), ±1.0% or better (non-linear)

Mechanical accuracy—
- concentricity (shaft to pilot)—.0015 in. FIR max.;
- radial play—.0009 in. FIR max.;
- shaft—centerless ground stainless steel to .2500 diam. (+.0000, —.0005 in.);
- pilot hub—machined to .5000 (+.0000, —.0005 in.)

Torque—1.5 oz-in.

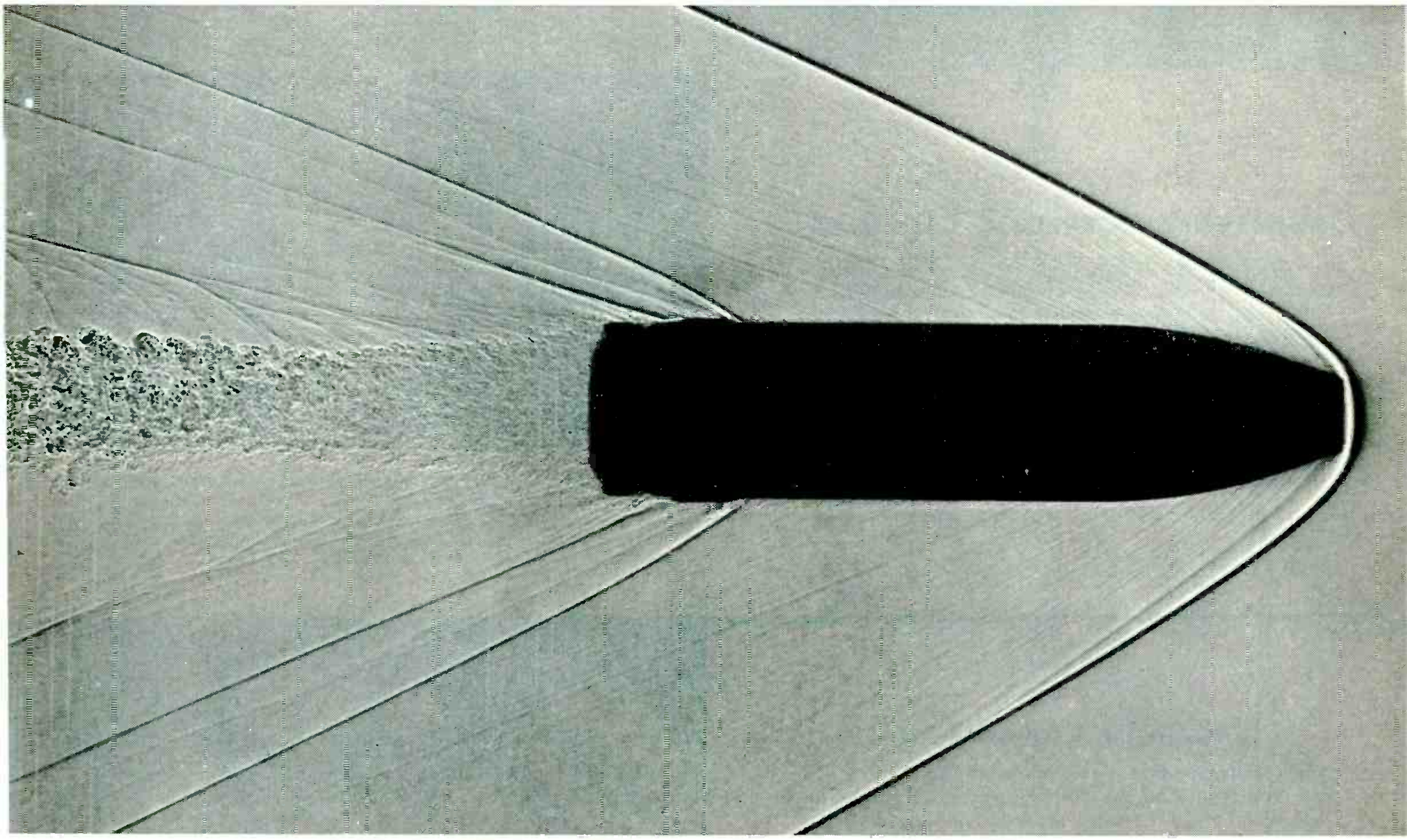
Dimensions—diameter 1.750 max.; length (1 cup) .800 in. ±.009 in.; added length per unit ganged .580 in. ±.002 in.

Case—grey anodized aluminum

FAIRCHILD
PRECISION POTENTIOMETERS

SEE THE TYPE 746 AND OTHER FAIRCHILD PRECISION POTENTIOMETERS AT THE RADIO ENGINEERING SHOW, BOOTH 238-239

TAKE A MICROSECOND LOOK AT A PROJECTILE IN FLIGHT



Velocity of projectile: Approx. 2800′ per second. Duration of spark light: 12×10^{-7} second.

How Centralab Engineers solved a problem in Electronics for Ultra-High Speed Photography

CERAMIC TUBULAR DIELECTRIC REPLACES 30′ OF STANDARD SOLID DIELECTRIC COAXIAL CABLE — LIGHT INTENSITY BETTERED 900 TIMES

Former Method

Ultra-speed photographs are taken with the light of an electric spark. Former method used 30 feet of co-axial cable transmission line — charged with 10,000 V. — and discharged across a spark gap.

To replace the bulky cable, Centralab developed a tubular ceramic condenser (2″ O.D. x 6½″ long) with silver electrodes fired to the inner and outer surfaces. The condenser is charged (to 10KV) and discharged exactly like the cable — *however with a gain in light intensity of 900 times!* Characteristics of the new Centralab ceramic condenser are:

Centralab Condenser

Dielectric Constant....6000 at 1 megacycle
Capacity ....24,000 mmf.
Velocity propagation....027 x velocity propagation in air.
Impedance....Approx. 1 Ohm
Decay time,
peak to 1/e peak....2×10^{-7} second
Rise time, O to peak....1×10^{-7} second
50% of peak limits....1.8×10^{-7} second

CENTRALAB engineers know their electronics and ceramics! This single ceramic development greatly advanced the photo-study of turbulence, ultra-sonic wave structure, and other high-speed phenomena. But this is just one of literally thousands of electronic component problems solved by Centralab. For Centralab engineers have compounded and tested over 20,000 different ceramics. So if you have a problem in electronics — in radio or radar . . . in TV, FM or X-ray — that Centralab Ceramics might solve . . . don't hesitate, call us in today!

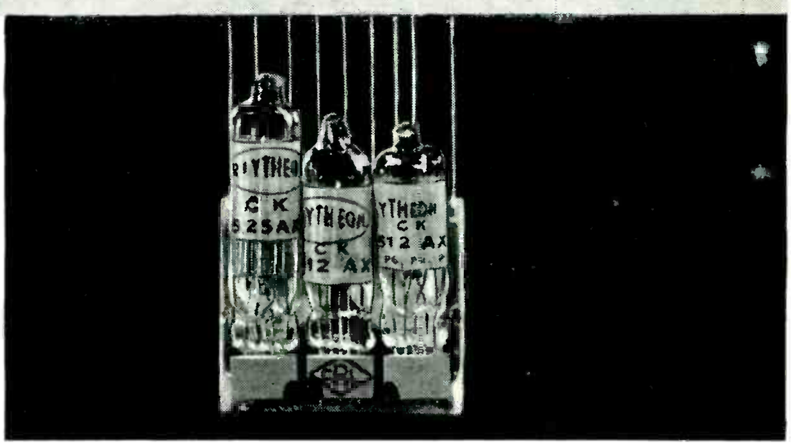
You won't regret it for Centralab is the industry's pioneer in Printed Electronic Circuits and carbon controls — the leader in the industry for the widest variety of fine quality ceramic capacitors — high voltage, by-pass coupling or temperature compensating types — in flat, tubular, disc or cylindrical shapes.

Photograph and its technical data is gratefully accredited to Dr. J. C. Hubbard, Messrs. J. A. Fitzpatrick and W. J. Thaler, Dept. of Physics, Catholic U., Washington, D.C.

For more Centralab® developments that can help you ➡

Centralab Components

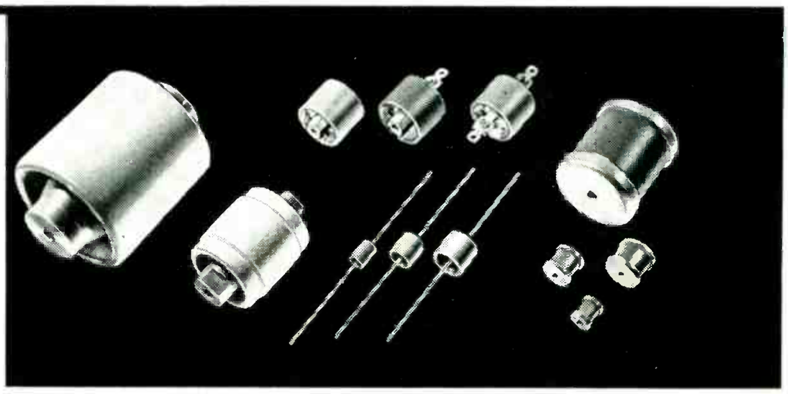
See them at the I.R.E. SHOW — Booths 232-33



Ampec is a full 3-stage, 3-tube speech amplifier. Gives you truly highly efficient reliable performance. Size: 1¼" x 1⅛" x .340" over tube sockets! Widely used in hearing aids, mike preamps and other amplifier applications where small size and outstanding performance counts. Bulletin No. 973 in coupon below.

PRINTED ELECTRONIC CIRCUITS

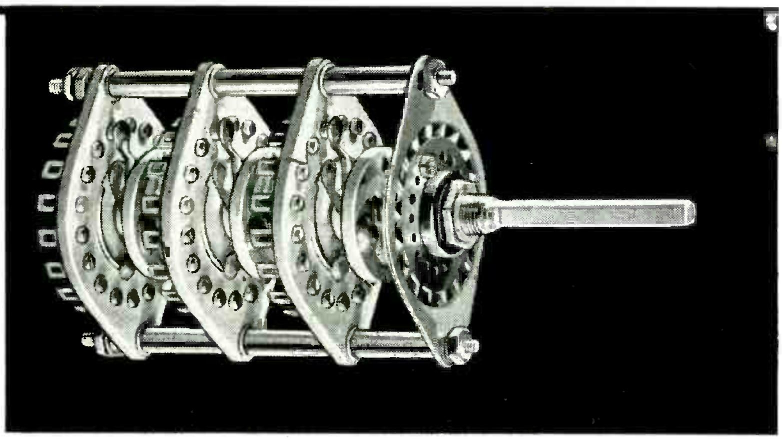
— *Are complete or partial circuits* (including all integral circuit connections) consisting of pure metallic silver and resistance materials fired to CRL's famous Steatite or Ceramic-X and brought out to convenient, permanently anchored external leads. They provide compact miniature units of widely diversified circuits — from single resistor plates to complete speech amplifiers. No other modern electronic development offers such tremendous time and cost saving advantages in low-power applications.



High voltage ceramic capacitors. Capacitance: 5 to 500 mmf., 5 KV to 40 KV D.C. working. Ideal for portable or mobile equipment. Primarily designed for high voltage, high frequency gear. For complete information, check Bulletin No. 42-102 in coupon below.

CERAMIC CAPACITORS

Centralab ceramic capacitors give you permanence never before achieved with old-fashioned paper or mica condensers. Ceramics are impervious to moisture, and have unmatched ability to withstand any temperatures normally encountered in electrical apparatus. Ceramics make possible tremendous space saving; many Centralab ceramic capacitors are ⅕th the size of ordinary capacitors. You can rely on Centralab ceramic capacitors for close tolerance, high accuracy, low power factors, and excellent temperature compensating qualities.



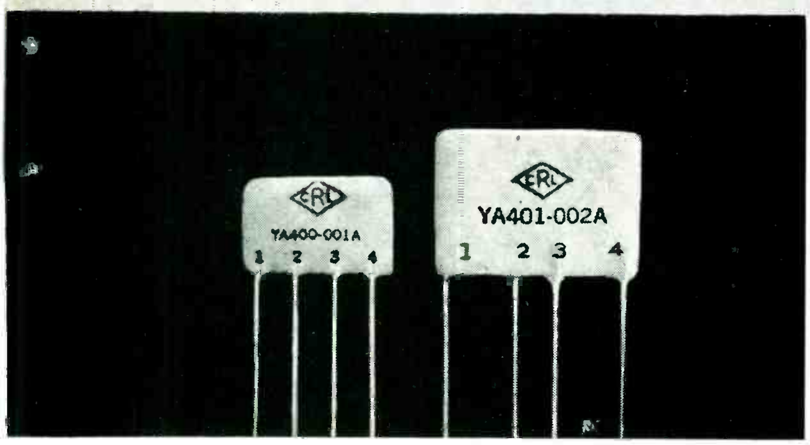
Medium Duty Power Switch for R.F. or 7½ amp. 110-115 V. application. 1, 2 or 3 poles . . . 18 contact sections . . . up to 20 sections per shaft. Contacts, collector rings coin silver mounted on Grade L5 Steatite. Cat. No. 722.

SWITCHES AND CONTROLS

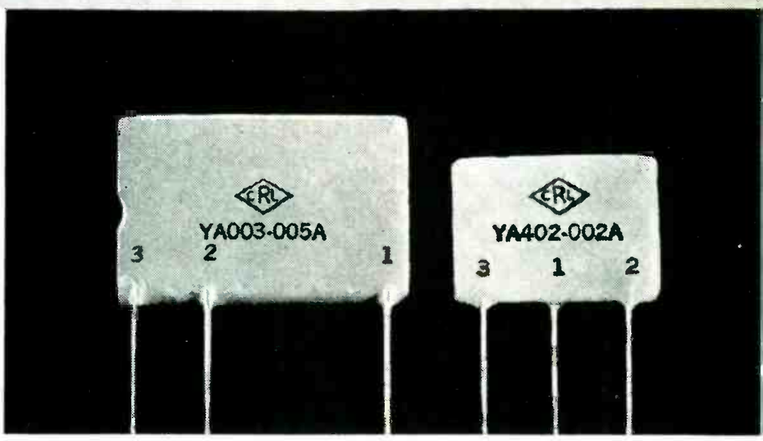
Look to Centralab for standard and special purpose switches — single or multi-section (phenolic or steatite) — single or multi-pole — rotary, slide or lever action — shorting or non-shorting contacts . . . for AM-FM-TV as well as for medium duty power applications. In controls — it's Centralab all the way . . . for Centralab introduced Carbon controls to the electronic industry 25 years ago! New Model 2 Radiohms are America's most modern controls for TV-AM-FM. Centralab Model 1 Radiohm is the outstanding truly miniature unit—the standard of the hearing aid industry.

for all Electronic Gear

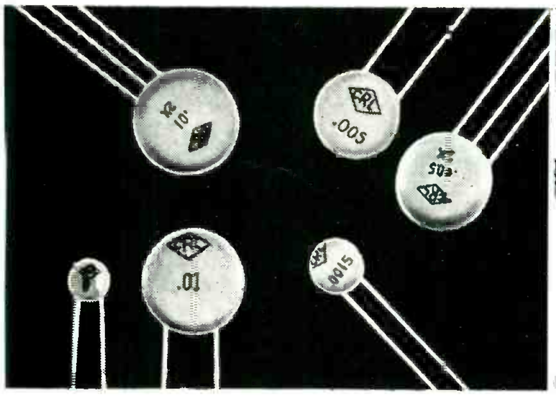
New York City, Grand Central Palace. March 19-22



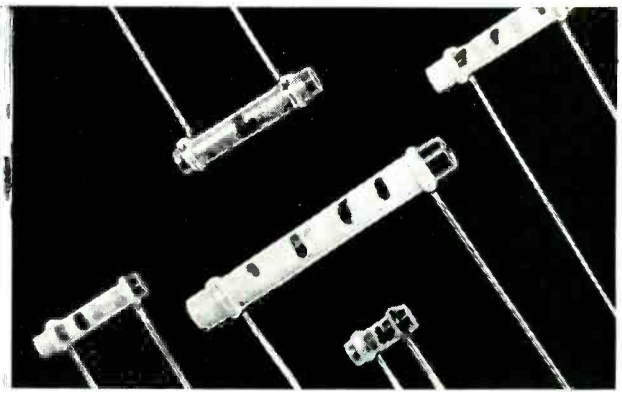
Centralab Triode Couplates save space and weight. They actually replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values. Bulletin No. 42-6 in coupon below.



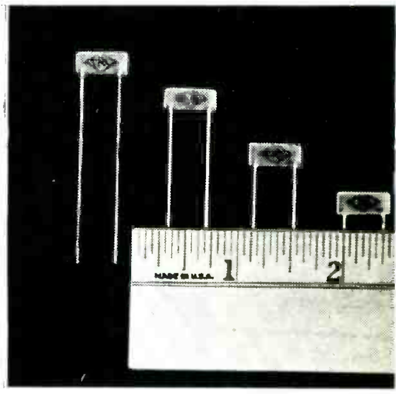
Centralab Vertical Integrators give you big savings in assembly costs, particularly in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reducing the formerly required 16 soldered connection to only 3! There's a big saving in the number of parts handled, too! Bulletin No. 42-22.



Ceramic Disc Hi-Kap Capacitors hold thickness to a minimum. Make possible very high capacity in extremely small size. Use in HF bypass and coupling. Bulletin No. 42-4R.

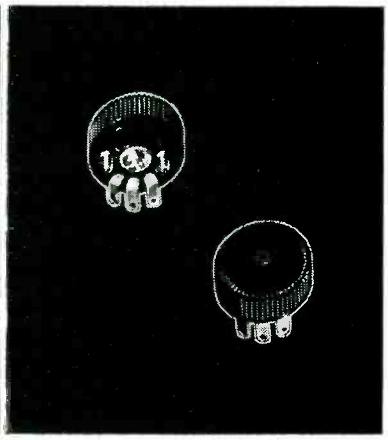


Tubular Ceramic Capacitors — Type TCZ show no capacitance change over wide range of temperature. Type TCN have special ceramic body to vary capacitance according to temperature. Bulletin No. 42-18.



Min-Kaps are very tiny capacitors used where space is at an extreme premium. Ask for Bulletin No. 42-24.

New high quality Model 2 Radiohms are designed for lower noise level, longer life. Bulletin No. 42-85.



Model "1" *Radiohm* control — 1/10 watt — plain or switch type. No larger than a dime. For miniature use. Bulletin No. 42-19.

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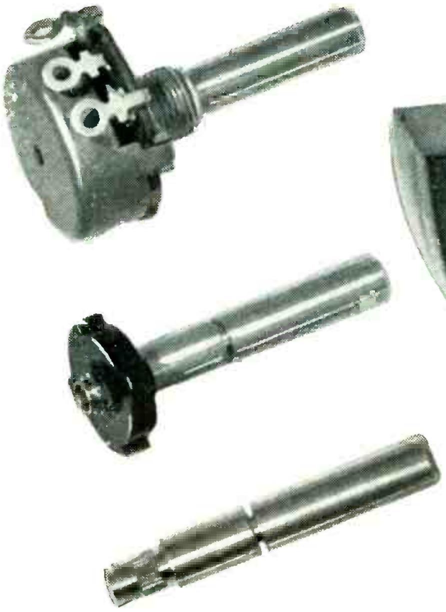
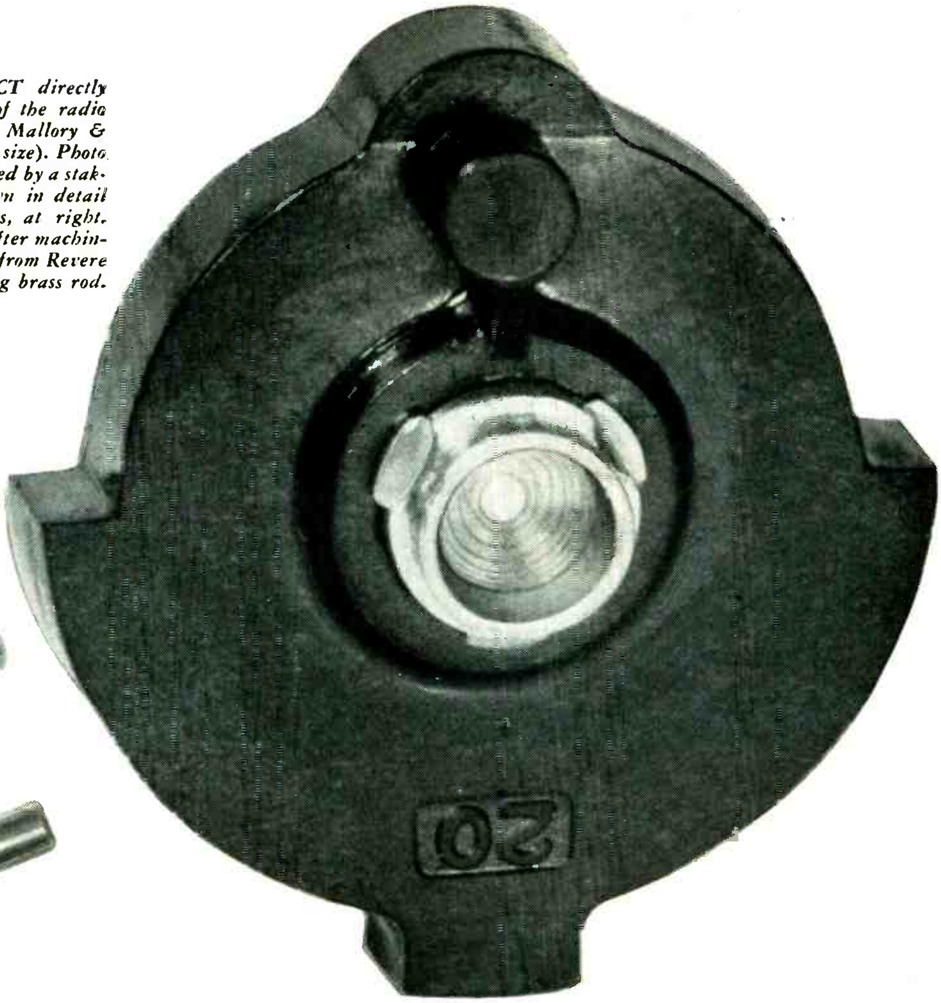
THE MUSHROOM-LIKE OBJECT directly below is the completed assembly of the radio volume control shaft made by P. R. Mallory & Co., Inc., Indianapolis, Ind., (actual size). Photo below it shows the plastic part attached by a staking operation. This staking is shown in detail in photo of part enlarged 7 times, at right. Photo at bottom shows control shaft after machining and before staking. Shaft is made from Revere Alloy 247 . . . ¼" round free cutting brass rod.





BY SWITCHING TO REVERE FREE CUTTING BRASS ROD P. R. MALLORY & CO., INC.,

SAVES ON 2 COUNTS!

Staking operation on radio volume control shaft performed without fracture . . . annealing operation eliminated.

The solution to the Mallory Company's problem was not as easy as it might appear. It was not simply a case of Revere Technical Advisory Service recommending ¼" round, free cutting brass rod. That rod had to possess the machinability to match Mallory's existing production machine set-up and at the same time be sufficiently workable so that annealing, prior to staking, could be eliminated; and that staking be accomplished without fracturing the metal.

After consulting with the Mallory Engineers, and discussing the tests which Mallory would subsequently conduct, Revere recommended a ¼" round, half hard riveting and turning rod mixture 247. Working tests made by Mallory showed this rod to possess all the necessary requirements.

As a result of those tests, P. R. Mallory & Company is now using this Revere free cutting brass rod to its complete satisfaction for the radio volume control shafts it manufactures. Not just any ¼" brass rod, but the *right* rod made it possible for them to save on 2 counts.

Perhaps Revere has a brass, a copper or some special alloy to help you in the development or improvement of your product . . . in cutting your production costs. So why not tell Revere *your* metal problems? Call the Revere Sales Office nearest you today.

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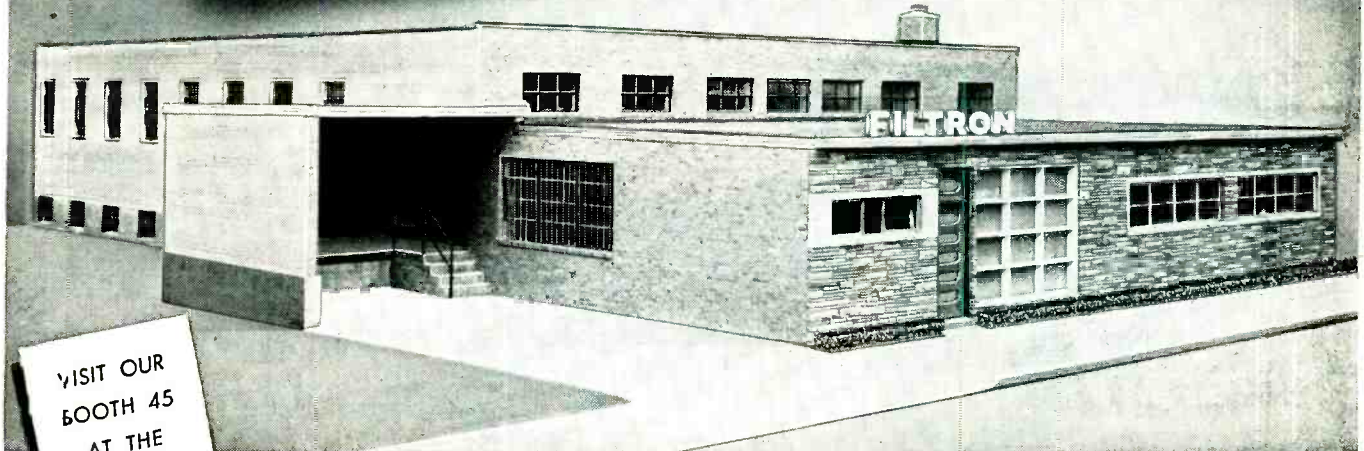

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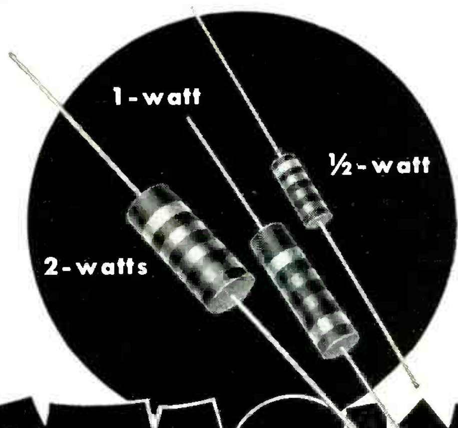
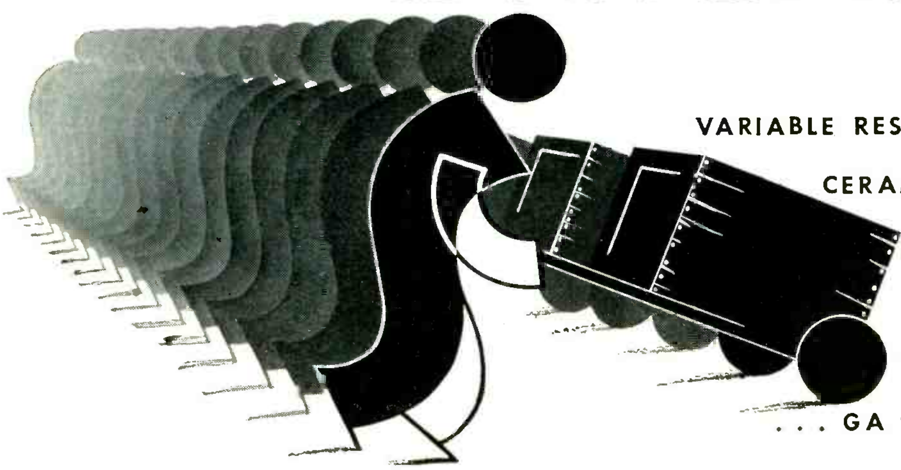


STACKPOLE



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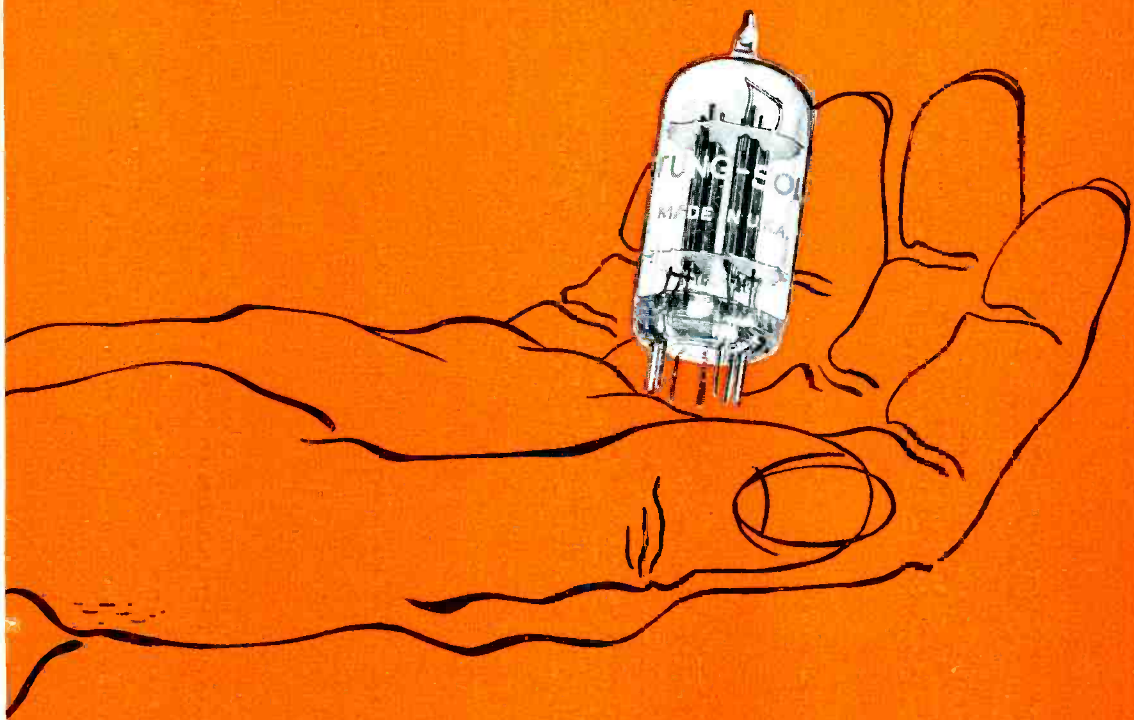


PRECISION, UNLIMITED

Ever stop to think of the precision required to engineer an electron tube to the complex requirements of modern circuits? Probably you have. Maybe you have even thought that it must be quite a job to mass-produce so exacting a unit—and by the millions, too! Frankly, it is—quite a job.

The modern electron tube, with its miniature proportions, tiny parts and microscopic tolerances, is an unbelievably critical device. Even the most minute variations in the tube assembly are sufficient to seriously alter performance characteristics.

Therefore, the degree to which those variations are held in check by the tube manufacturer determines the uniformity of their product —a factor of vital importance to set and equipment builders.

On the following pages are shown some of the tests and inspections that hold TUNG-SOL *tubes to quality standards unsurpassed in the electronic industry.*

TUNG-SOL tests and inspections are based on the most modern statistical quality control methods. The more rigid the performance specifications of a tube, the more detailed and exacting are the tests —and always in ample volume to make uniformity of performance a minimum calculated risk. New methods of maintaining ultimate precision are continually being devised so that TUNG-SOL tubes may be always abreast of industry demands.

PRECISION BUILT FOR MAXIMUM UNIFORMITY

Naturally quality is not "tested-in"—it is built-in. However, the guarantee of built-in quality is unlimited testing.

MANUFACTURING TESTS—These begin with raw materials, which are tested chemically and mechanically.

Hardly a single step of the manufacturing process is without some mechanical or visual test and inspection. There are literally more testing instruments than there are employees.

Parts such as plates and sleeves are compared and graded so that tubes of any one type will have the most uniform performance characteristics possible.

QUALITY CONTROL TESTS—Concurrently with manufacture, the Quality Control Department separately tests actuarily-determined sample lots of tubes—both in work and completed.

Quality Control is completely independent of manufacturing. It has the power to reject tubes that do not meet TUNG-SOL *standards or the specifications of a customer.*

The findings of Quality Control, collated by striking new procedures, reflect within minutes the exact quality standards being maintained on any production line. Where sub-standard work begins to show, Quality Control flashes an instantaneous "stop."

Only those lines maintaining TUNG-SOL's high level of precision, can continue to produce tubes for TUNG-SOL customers—and only after they are certified by Quality Control can TUNG-SOL tubes be shipped.

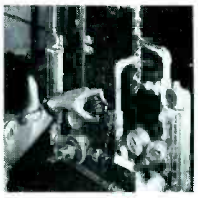
Thus, by the highest standards of manufacturing, TUNG-SOL guarantees to deliver to its customers the fullest measure of service and performance in every TUNG-SOL tube.

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

TESTS DURING MANU-FACTURE


Gas for heat-processing parts is tested for freedom from sulphur—


—and tested again for other specifications. Then refined by cracking—


—and tested still again before use on the Tung-Sol tube parts.


Cleaning salvent is rigidly tested for acidity before it is used.


Washed parts are tested for chemical as well as physical cleanliness, and—


—tested again for freedom from the slightest trace of oil film.


Cathode sleeves, like all other critical parts, are micrometer-checked—


—since dimensional uniformity is vital to electrical performance.


Few dimensions are coarse enough for mere steel-rule checking—


—most checks require micrometers reading to the thousandth-inch or finer.


The comparator tests thousandth-inch accuracy in mica specifications—


—and checks microscopic uniformity of plate details.


The tool-maker's microscope makes hair-sized holes look like circus hoops—


—and measures thickness of grid-wires down to .0001"—


—but it takes an electronic mike to check diameter of the finest wires.


Elongation specifications of wire are minutely tested on this rack.

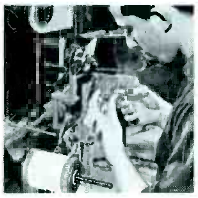

Checking the "bend value" of wire is highly important for uniformity.


Weight of filament wire is tested on a precision balance reading to .05 MG.


Carbonized nickel plates are chemically analyzed for purity and uniformity.


Chemical analysis checks cathode sleeves against any possible impurity.

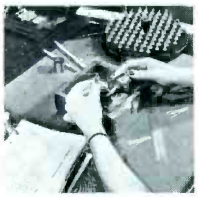

Quantitative analysis tests composition of shields, sleeves, metal parts.


Coating baked on filament wire is constantly miked for uniform thickness.


Cathode coating, too, is production-line checked for size—


—and for weight. Tolerances on this critical part are as close as .4 MG.


Finished cathodes for some tubes are micrometer-graded for uniformity.


Completed filaments are always checked before going into production.


A grid is projected giant-size for inspection.

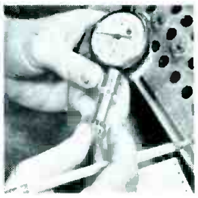

Many grid dimensions are checked to .0001".


Tube envelopes are critically inspected for sealing defects—as well as accuracy of branding.


Newly-formed stems are cold-plug checked for glass strains.


It takes a microscope to inspect the seal of lead wires in many stems—


—and a polaroscope to check the strain a stem develops in cooling.


A stem is checked for pin length with a dial micrometer.


Every stem is light-inspected after lead wires are cut and formed.


Tube envelopes are not only inspected but graded by exact size.

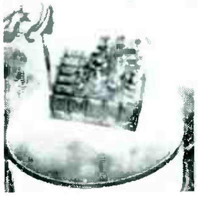

Polaroscope examination of tube envelopes checks correct strain pattern.

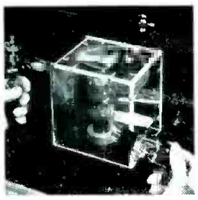

Inspection under magnification guards against minutest defects.


Precision balance checks findings of presision micrometer.


Completed mounts are literally probed during inspection—


—and are tested for shorts before sealing in envelopes.


A brute test of ruggedness; cold tubes plunged in boiling water.

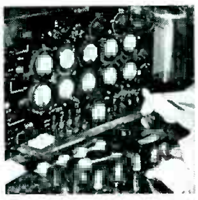

High-voltage (up to 7500V) tests new-sealed tubes.


The aging rack stabilizes characteristics, discloses latent defects.


Progressive tests check every electrical characteristic such as over-all gain—


—grid capacity and other measurables, often to very close tolerances.


Other operators check microphonics, test for hum and noise.


Special test sets check 8 or more characteristics in swift sequence.

QUALITY CONTROL TESTS

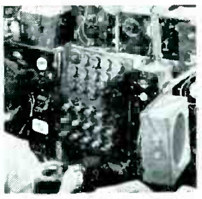

Torque test instruments check firmness of top cap assembly—

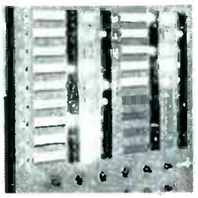

—critical inspectors check the alignment of filaments—


—over-all height must be uniform for every type of tube—


—and angular alignment of base must prove accurate, before—


—electrical characteristics, already tested in production, are rechecked—


—along with hum and noise. If defects begin showing in any—

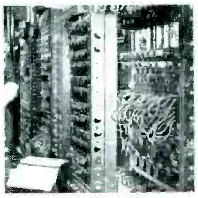

—assembly-line's product the master signal board flashes "Stop."

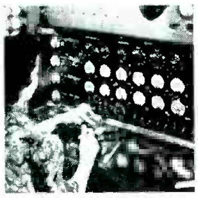

Preparing for a grueling torque test, tubes are soaked 18 hours in hot water—


—and are then wrung against heavy leverage applied to bases.

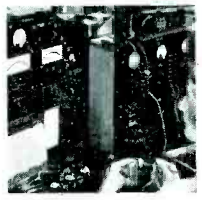

The polaroscope checks strain pattern in cold-plugged tubes.

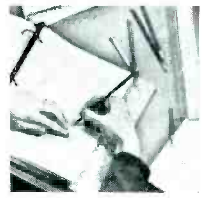

Can tubes stand continuous turning on-and-off? This test tells.

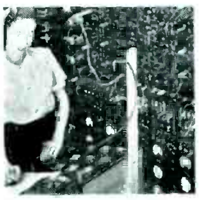

Now starts the 500-hour Life Test, applied to every type of tube.

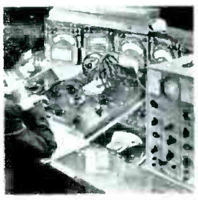

During the Life Test, tubes are removed periodically and tested for change—


—in an average of 12 electrical characteristics, after which—


—they are physically inspected and tested all over again.


Plotted curves summarize the exhaustive Life Test findings.


Grid-emission is tested—especially in mobile-set tubes.


Elaborate instruments—including oscilloscope—test design characteristics—


—while others check filament current and heater-cathode leakage.


A capacitance bridge measures direct inter-electrode capacities.


The famous vibration test, important for mobile-set tubes.


Finally, right before shipment tubes are again tested for shorts after a drop test.

You can't buy a better tube than

TUNG-SOL

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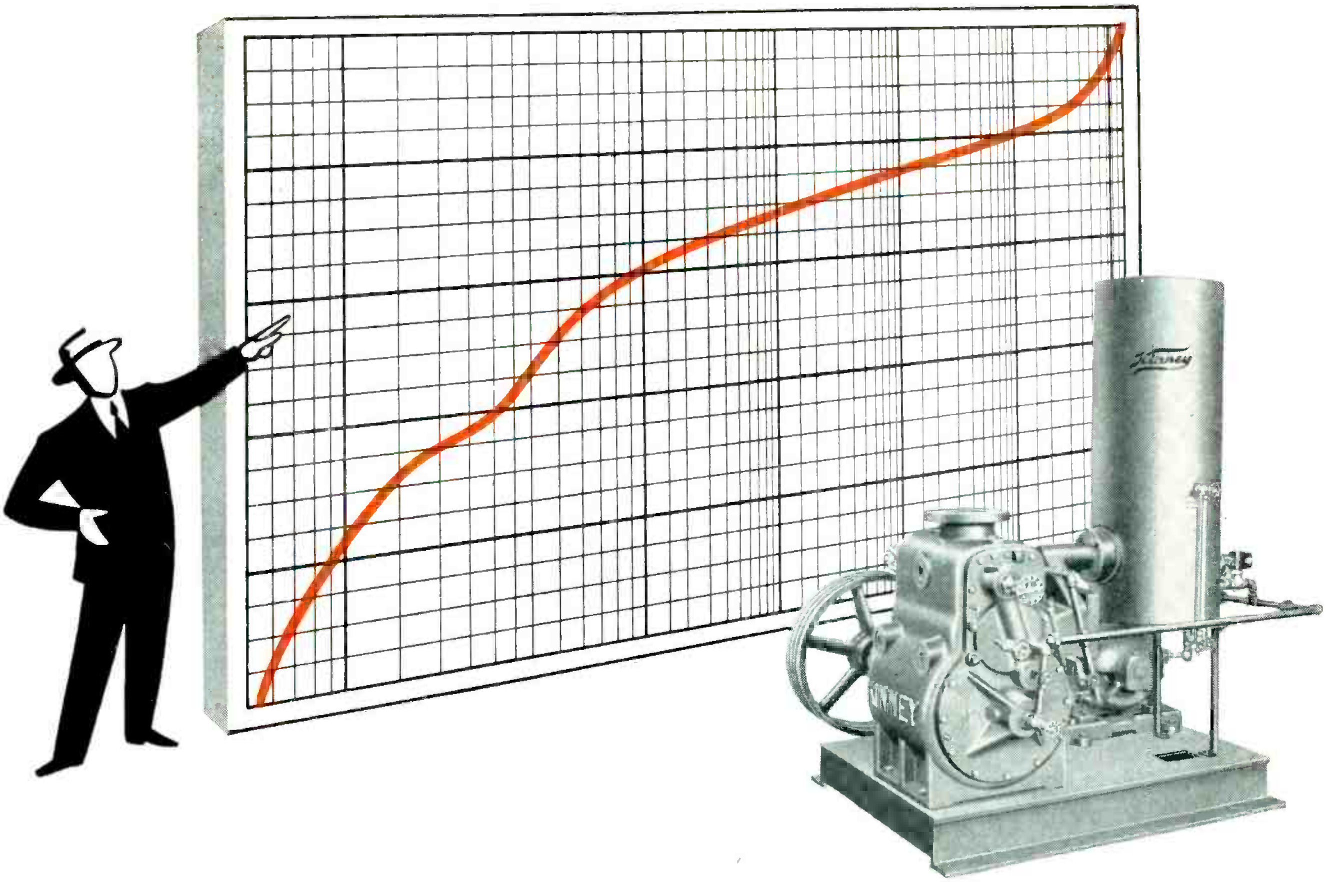

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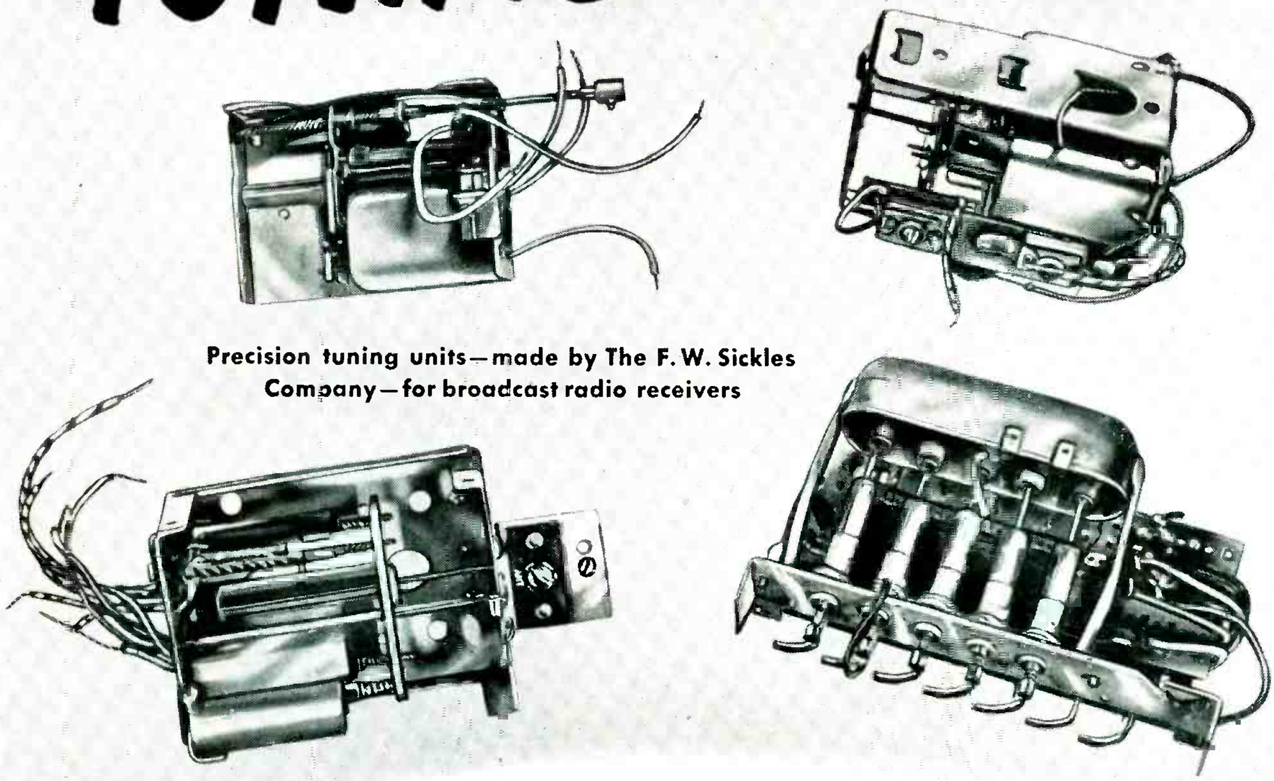

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50 to 500 Mc.

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Make three readings, plot diagram and read off impedance to ± 5%.

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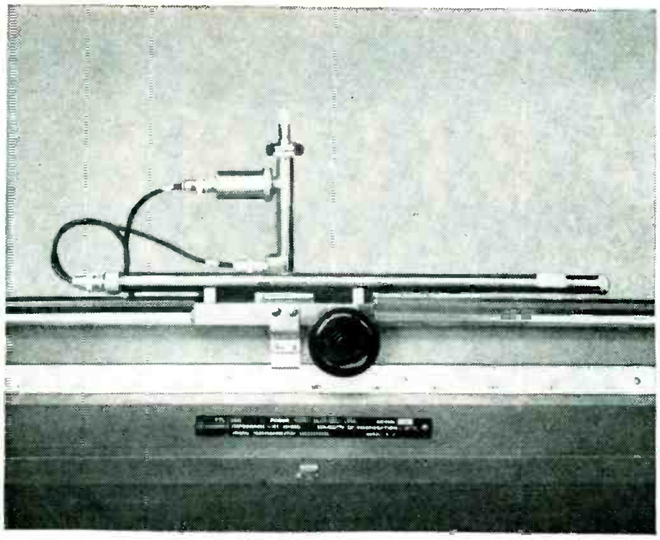

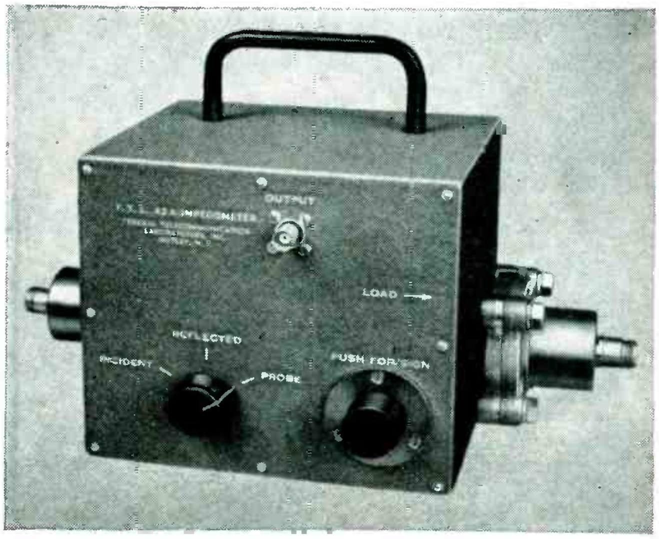

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1000 to 2000 Mc range covered with slightly reduced accuracy.

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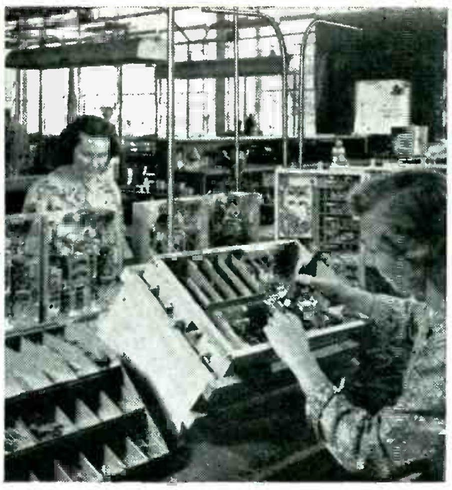

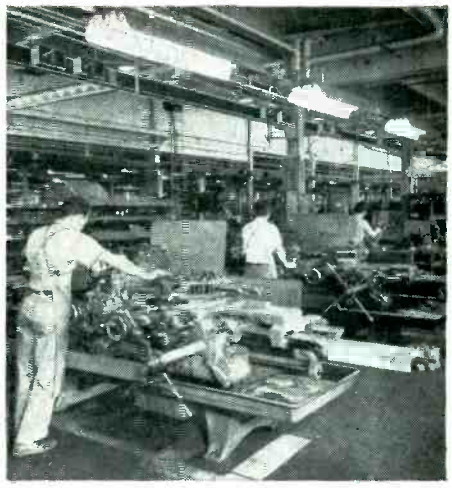

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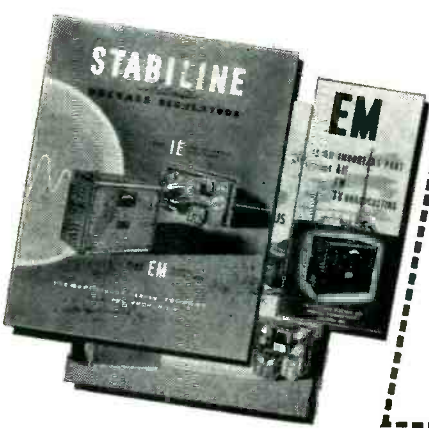

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- ☐ *Have a SECO field engineer call.*

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Official U. S. Coast Guard Photo

risky *business . . .*

Poking into uncharted inlets or up fog-shrouded channels is risky business at best, but it's been made a lot less hazardous with the new Edo-designed Contour Bottom Scanner. Known as the CBS and developed for the United States Navy, this electronic device tells the skipper not only the depth of the water below him but on both sides — gives him an actual picture of the channel's contour on a cathode ray tube, shows him where the deepest water is.

Edo has come to be recognized as a leader in the development of depth-finding equipment, such as the CBS, with which to find out more easily and clearly what's below. Edo-developed sonar devices have already made possible new accuracy in under-water detection techniques of vital importance to our Nation's defense.

OUR TWENTY SIXTH YEAR

The Edo Corporation has been engaged in design and manufacturing work for the past quarter of a century. The company is eminently staffed to undertake research and development of electronic equipment and has a plant adequately equipped to undertake quantity manufacture of intricate electronic devices.

The company's extensive background in the marine and aviation fields makes it particularly well qualified to design and manufacture electronic devices for use in aircraft or on board ship, where features of compactness and rugged design are so necessary.

You'll be interested in our booklet describing Edo's first quarter of a century of progress. Write to Department M-3, Edo Corporation, College Point, L. I., N. Y. for your copy today.

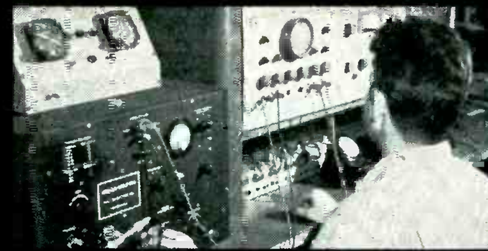
EDO CORPORATION · COLLEGE POINT, N. Y.

It's JFD for

FFD

Facilities For Defense

JFD . . . one of the world's largest producers of television antennas and accessories . . . invites orders for prime and sub-contract work. Our **Facilities For Defense** have been used, in the past, by such industry leaders as RCA, PHILCO, ADMIRAL, PILOT, MOTOROLA, BENDIX, STROMBERG-CARLSON and many others. Personnel and production machinery are geared to the standard of quality and mass production that meets your "deadlines" and lowers your costs.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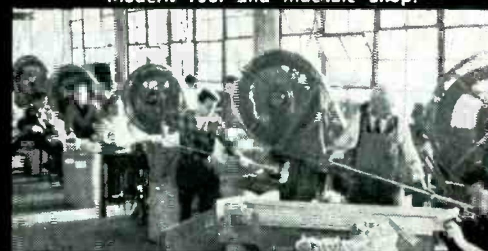
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For experience, know-how, dependability and financial responsibility—you can count on **JFD's Facilities For Defense**. Phone, wire or write direct to Mr. Albert Finkel, Vice-President.

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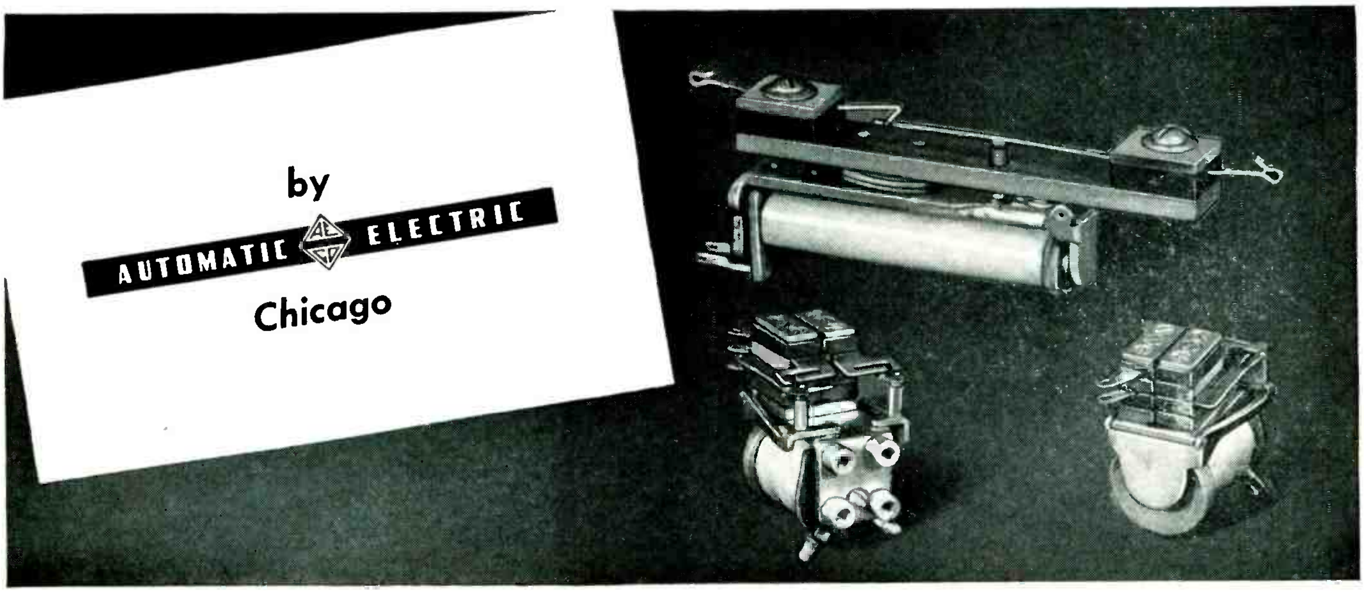
FIRST in Television Antennas and Accessories

to control high frequencies

USE LOW-CAPACITANCE RELAYS...



For smooth, chatter-free control of microwave circuits... switch them with Automatic Electric relays. Automatic Electric made its first low-capacitance relay more than ten years ago, and today offers two types, each providing exceptionally low capacitance between contact springs, and between springs and ground (frame, mounting, etc.)

In addition to these low-capacitance characteristics, Automatic Electric relays provide the dependability of "twin" contacts and the small size you need for compact mounting. The Class "C" relay (background above) is especially suitable for strip mounting; it is only 0.687″ wide and $2\frac{1}{8}''$ high and is $5\frac{15}{32}''$ in over-all length. The Class "S" relay (two views in foreground) is 1″ wide, $1\frac{3}{8}''$ high and $1\frac{19}{32}''$ long, over-all. Operating mechanisms are basically standard Automatic Electric designs, thus assuring the high operating efficiency for which Automatic Electric controls are famous,

To receive complete information, simply let us know your specific needs. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in Principal Cities.*

RELAYS SWITCHES

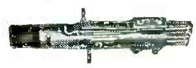
AUTOMATIC ELECTRIC

CHICAGO

OTHER AUTOMATIC ELECTRIC TELEPHONE-TYPE CONTROLS


Stepping Switches

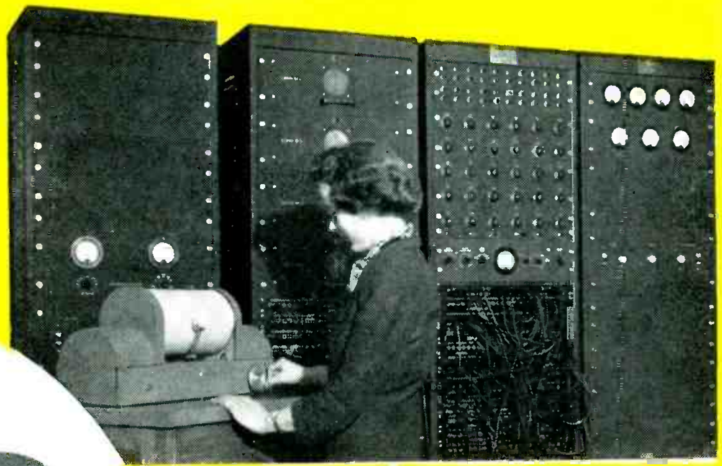

Relays


Turn Keys

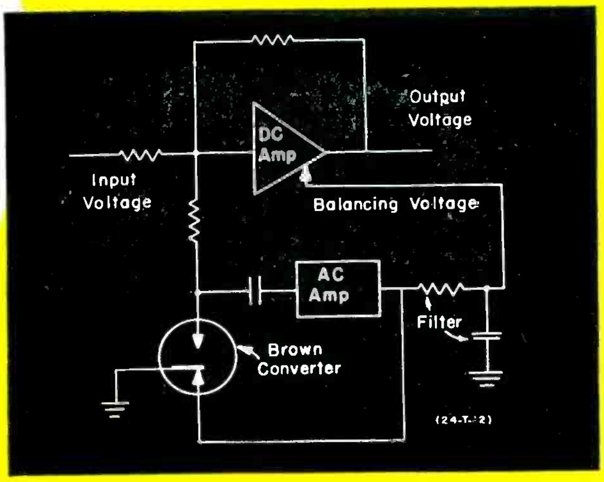

Lever Keys

Efficient, dependable Automatic Electric controls are available also for many other uses. Lever, turn and push-type keys; telephone-type dials; stepping switches; lamp jacks and caps—as well as a complete range of telephone-type relays carrying the Automatic Electric name—are now in service in hundreds of industrial applications.

BROWN INSTRUMENTS ACCELERATE RESEARCH



The REAC Computer is a product of Reeves Instrument Corporation



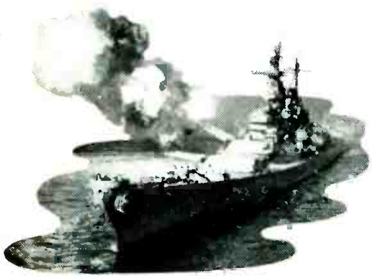
BROWN CONVERTER
meets critical requirements of
REAC COMPUTERS

BROWN CONVERTERS are precision, vibrator-type converters for use with any system requiring the conversion of low power direct voltage signals of the order of 100 microvolts to 60 or 400 cycle alternating voltages. Typical of its host of applications is in the REAC Computer, produced by the Reeves Instrument Corp. of New York. Here, it meets the requirements for a converter with extremely stable contact characteristics. In the system shown, the converter alternately connects an a-c amplifier to ground and to the d-c amplifier. Any unbalance voltage existing at the input is chopped into a 60-cycle square wave and amplified. The a-c output is then rectified by the same converter and filtered. The resultant d-c voltage is coupled into the d-c computing amplifier in such a way as to change the output voltage so as to drive the input voltage back to zero. Thus, a slight positive voltage at the input causes a drop in output voltage and oppositely for a negative voltage. This combination affords a system not susceptible to drift. Data Sheet 10.20-1 gives complete details on the converter. Write for a copy. MINNEAPOLIS-HONEYWELL REGULATOR CO., 4428 Wayne Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

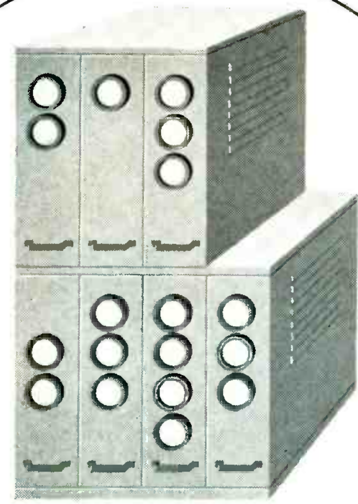
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

IN THE AIR



ON THE SEA

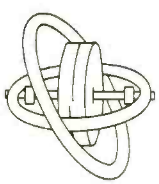


ARMA ANALOGUE COMPUTER

YES, AND EVEN UNDER THE SEA

The *Analogue Computer* has long held a high place in Arma's work in such specialized fields as automatic gun-laying and torpedo-data computing for the U.S. Navy. Its present wider application to the needs of the other Services stems largely from accelerated post-war engineering at Arma, which resulted in miniaturizing its components and at the same time making them interchangeable and more accurate.

By this Arma development, the *Analogue Computer* has reached a new level of importance as a contributing factor in the high accuracy of American arms. It is typical of many things developed by Arma engineers to aid in making America safe against those who wish to destroy it.



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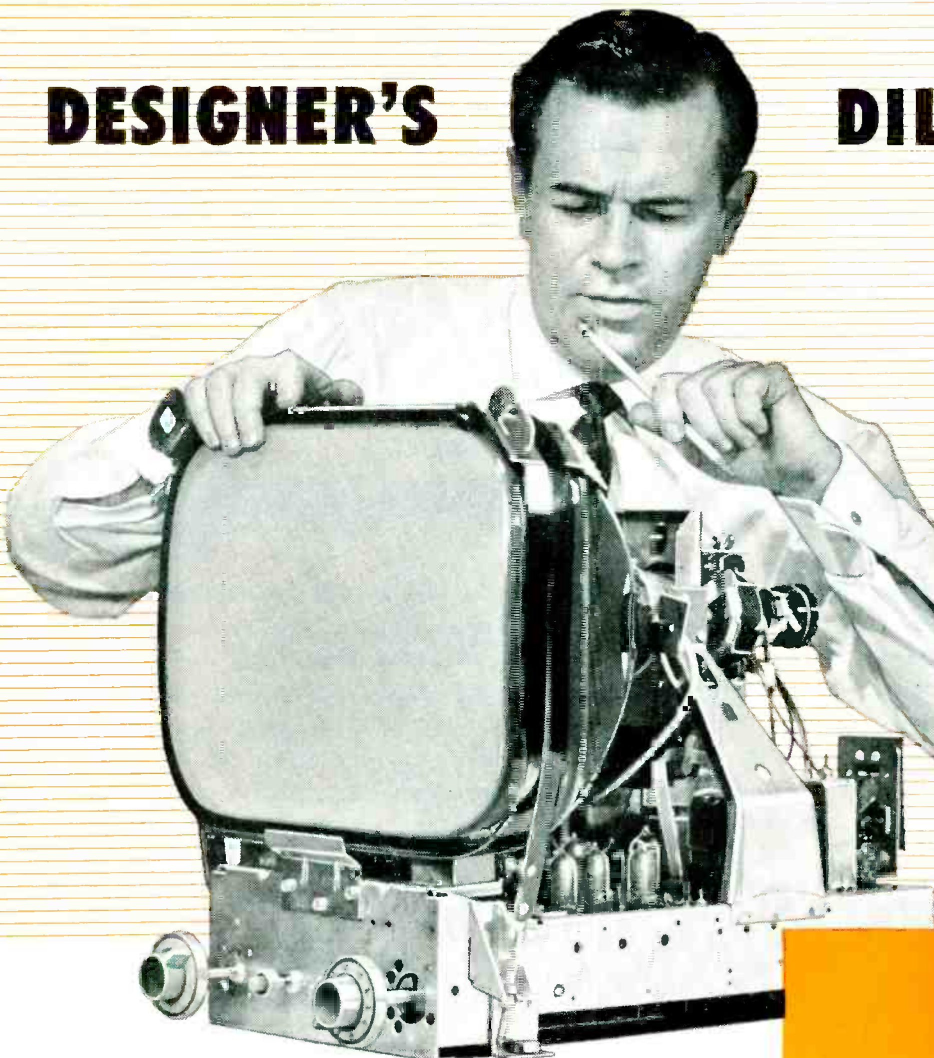


"How can I save, in order to trim the price of this set another $2.50?"

THE answer, Mr. TV-set Designer, is simple: *G.E.'s 6BN6 gated-beam tube.* It replaces three tubes and associated components, serving as a combined limiter, discriminator, and audio-amplifier.

6BN6 cost is right in line with other receiving types. You get three tubes' performance, yet you pay for only one

Ask for Bulletin ET-B28, which tells the full story of this amazing G-E *economy* tube, also charts its performance. Or if you prefer to discuss the 6BN6 in person, an experienced G-E tube engineer gladly will call on you. Wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

6BN6

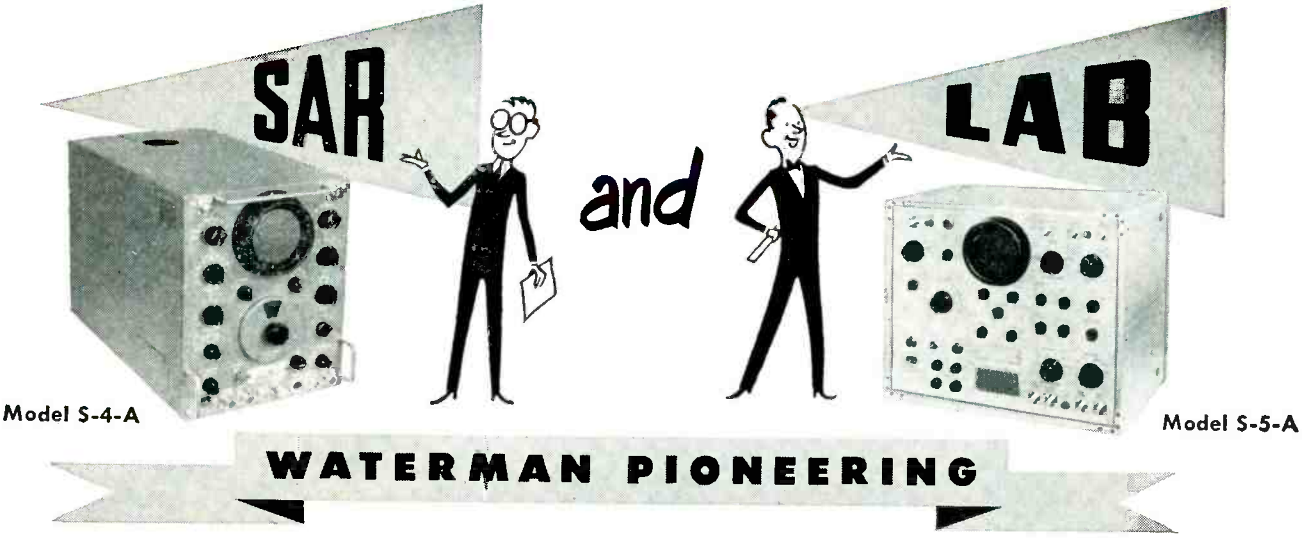
GATED-BEAM MINIATURE

Typical Operating Conditions, TV Application, 4.5 mc

Plate supply voltage	270 v
Plate load resistance	.33 megohms
Accelerator voltage	100 v
Cathode resistance	200 to 400 ohms
Min signal voltage for limiting action	1.25 v RMS
Audio output voltage	12.5 v RMS
AM rejection, with 2-v input signal	25 db

GENERAL ELECTRIC

181-K1



WATERMAN INTRODUCES

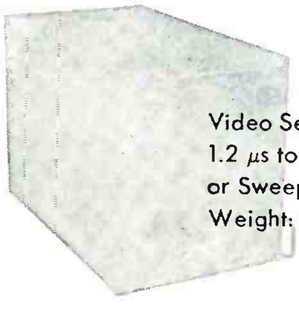
TWO NEW CATHODE RAY OSCILLOSCOPES

Compact, Portable Instruments For Precision Pulse Measurement Adaptable To All Electronic Work, Including TV . . .

The PULSESCOPE

TO PORTRAY THE ATTRIBUTES OF THE PULSE: SHAPE, AMPLITUDE, DURATION AND TIME DISPLACEMENT

Video Amplifier up to 11 MC • Video Delay 0.55 μs
Pulse Rise and Fall Time Better Than 0.07 μs



S-4-A SAR PULSESCOPE

Video Sensitivity 0.5 v p to p/in. • S Sweep 80 cycles to 800kc, either trigger or repetitive • A Sweep 1.2 μs to 12,000 μs • R Delay 3 μs to 10,000 μs, directly calibrated on precision dial • R Pedestal or Sweep 2.4 μs to 24 μs • Internal Crystal Markers 10 μs and 50 μs • Size: 9⅛ x 11¼ x 10¼ • Weight: Less than 32 pounds.

S-5-A LAB PULSESCOPE

Video Sensitivity 0.1 v p to p/in. • Sweep 1.2 μs to 120,000 μs with 10 to 1 expansion • Sweep either trigger or repetitive • Internal Markers synchronized with sweep from 0.2 μs to 500 μs • Trigger Generator and built-in precision amplitude calibrator • Completely cased • Size: 16½ x 14⅛ x 17½ • Weight: Less than 60 pounds.

See these two NEW PULSESCOPES ...at the

Radio Engineering Show
Grand Central Palace
New York City
BOOTH 29
March 19-22 1951

CABLE ADDRESS:
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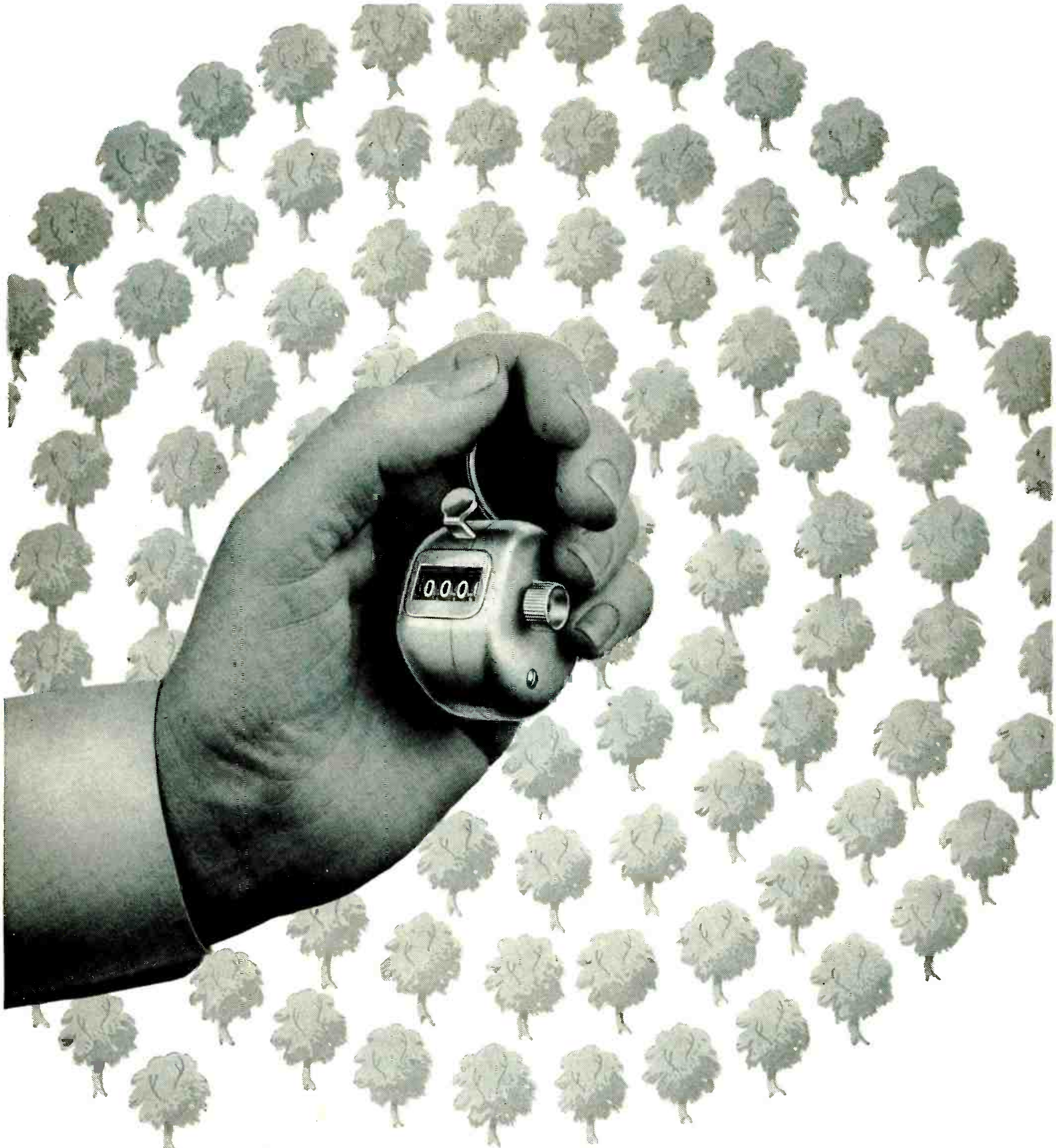
WATERMAN PRODUCTS



Like Everything Else, These Are Counted by

VEEDER-ROOT COUNTERS

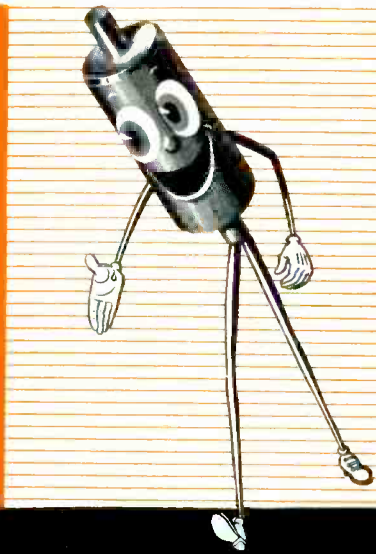
Name it and you can count it...trees, cars, people . . . and many other units that are difficult to count in any other way than with a Veeder-Root Hand Tally...on which you simply press the thumb-lever once for each count.

And in addition, there are many other Veeder-Root Counters which count mechanically and electrically in any terms or units you want. But if you want to count up to a *real* payoff, then build V-R Counters into your machine or product as original equipment. *How to do it?* Write and find out:

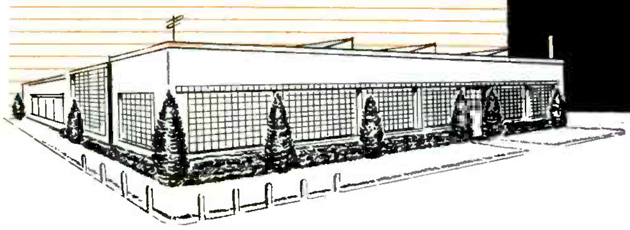
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Greenville, S. C. • Montreal, Canada • Dundee, Scotland • Offices and agents in principal cities

Welded GERMANIUM DIODES



NEW MANUFACTURING FACILITIES INCREASE PRODUCTION 200%!



New G-E diode plant at Clyde, New York

In a nutshell, here's what General Electric offers electronic equipment manufacturers:

Plant Capacity to help meet total estimated industry and mobilization requirements of germanium diodes and associated products . . .

Proved Design backed by research that is steadily increasing the use of diodes in place of vacuum tubes in many circuits . . .

Lower Costs than any other diode manufacturer offers today . . .

Application Engineering Service that will put G-E diode engineers to work on your circuit problems at your request . . .

We would like to discuss your requirements. As a start, let us send you Bulletin X57-015 covering the specifications of our diodes. Write to the *General Electric Company, Section 431, Electronics Park, Syracuse, New York.*

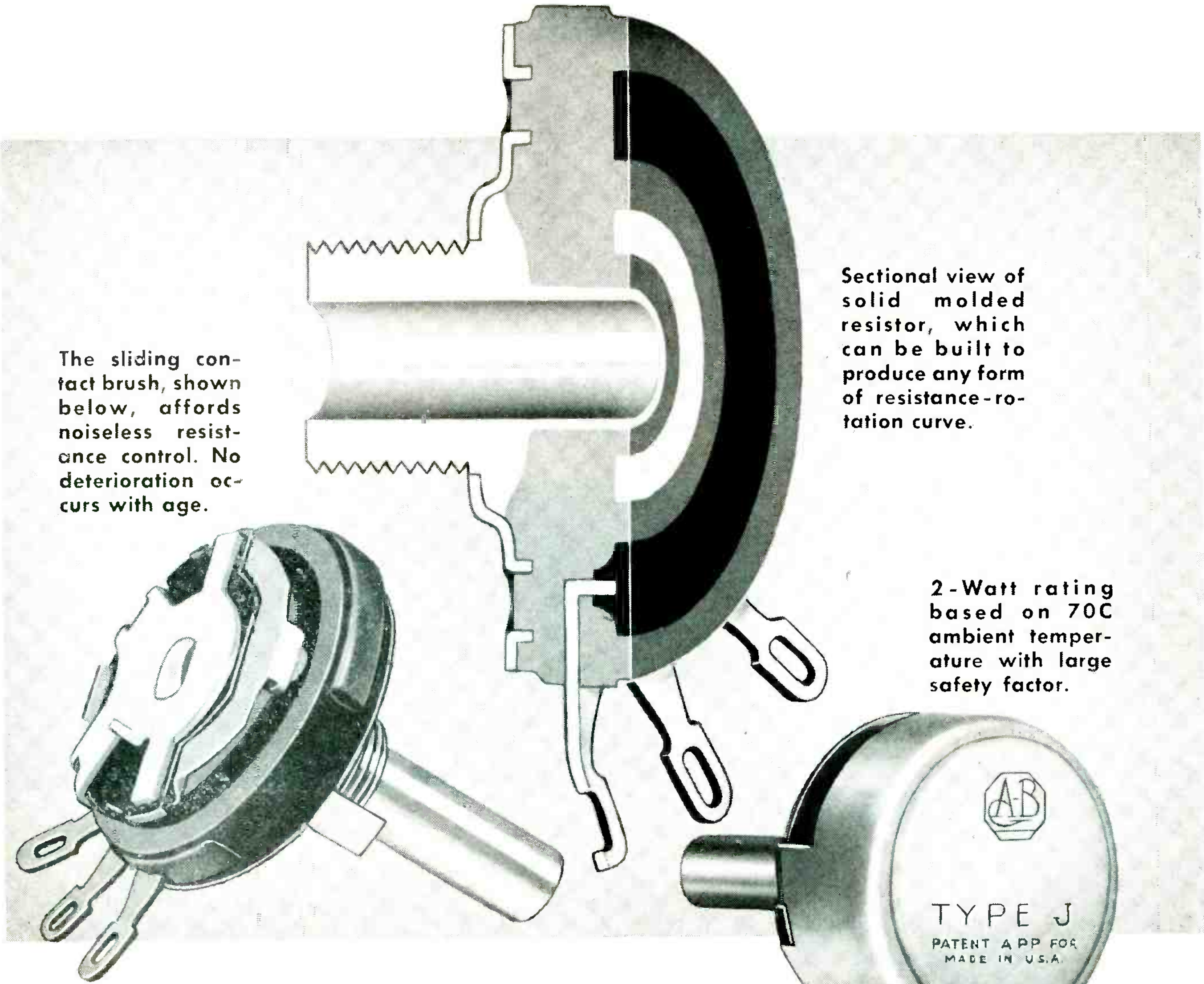
COMPLETE LINE OF GENERAL ELECTRIC WELDED GERMANIUM DIODES

General Purpose		Television	JAN	UHF	Quads	Transistors
1N48	1N63	1N64	1N69	1N72	1N73	SX-4A
1N51	1N75	1N65	1N70		1N74	Z-2
1N52						

ACTUAL SIZE

You can put your confidence in—

GENERAL ELECTRIC



PERMANENT CHARACTERISTICS are molded into the solid resistors of all Type J Bradleyometers . . .

For circuits requiring a top quality adjustable resistor that is not affected by moisture, heat, cold, or age . . . the Allen-Bradley Type J Bradleyometer is the ideal unit.

The resistor element is molded as a single piece. Insulation, terminals, faceplate, and threaded bushing are molded together into a solid, one-piece unit. There are no nuts . . . no welded or soldered connections . . . and the shaft, cover, faceplate, and other ferrous parts are made of stainless steel.

Available in single, dual, and triple unit construction. Built-in line switch is also available.

Send for dimension sheet and performance curves.

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Bradleyometers are available with any type of shaft extension to fit your requirements.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

Our hat is off

to the Electronic engineers

Engineering is a conservative and modest profession, and rare is the occasion on which electronic engineers are publicly acclaimed. Yet these men are making priceless contributions to industrial progress and national defense.

Since we serve a large number of the country's radio-electronic equipment manufacturers, we have come to know and respect their engineering personnel.

It is, in a large measure, to these men that we are indebted for helping us maintain our reputation as perfectionists in sheet metal fabrication. Their exacting demands and advanced designs keep us ever alert to match their high standards in our own performance.

Gentlemen, we doff our hat in well deserved tribute. Let us shake your hands at Booths 49-50 at the I. R. E. Show.

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Specialists in Fabricating Sheet Metal for Industry

serve your defense needs permanent magnets

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Carboloy's rigid quality tests pay off in uniform high quality Carboloy Permanent Magnets for peace-time uses like this television tube. You are assured of the same high quality for radar and other defense applications.

THROUGHOUT 1950 Carboloy Company expanded and improved its facilities for the manufacture of permanent magnets (Alnico and other types), and increased its technical organization. Today, Carboloy's extensive production facilities and its engineering consultants and technicians are available to give immediate attention to your orders for many essential magnet requirements.

For over 22 years the name Carboloy has been a synonym for uniformity and outstanding quality with users of cemented carbides. In the present emergency the long-time Carboloy standards of continuous quality control are being applied to assure you of *uniform* Alnico permanent magnets. Write today for information: Special Metals Division, Carboloy Company, Inc., 11139 E. 8 Mile Road, Detroit 32, Michigan.

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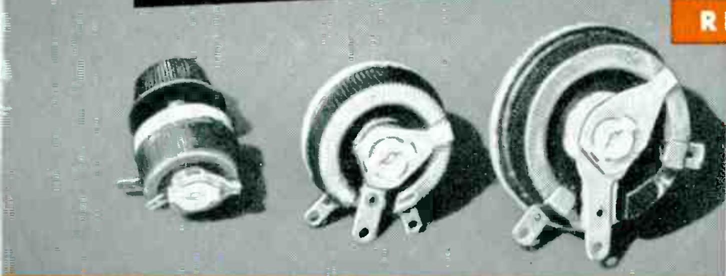
THE QUALITY BRAND

PERMANENT MAGNETS
(Alnico and other types)

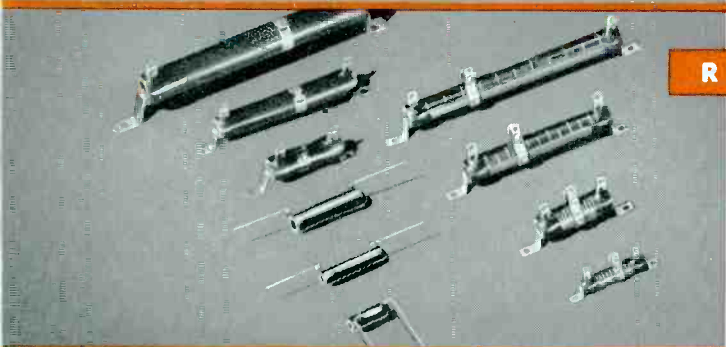
Mr. Manufacturer:

To get the best delivery on OHMITE resistance components, tailor your needs to these "standard" OHMITE items . . .



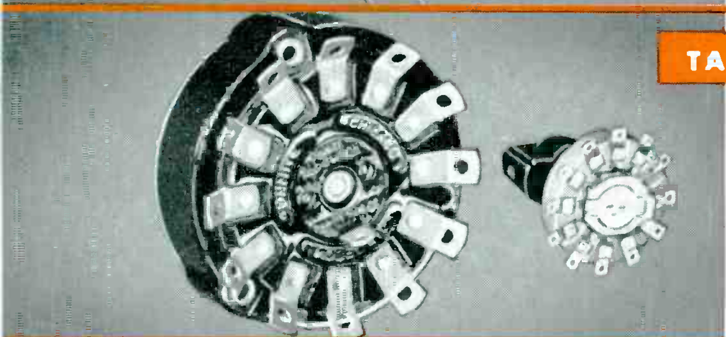
RHEOSTATS

The Ohmite series of standard, close control rheostats is the most extensive available—so it is easy to select a size to fit your application. There are ten sizes, ranging from 25 to 1000 watts, with many standard resistance values in each size. All models have the Ohmite all-ceramic construction, with winding permanently locked in vitreous enamel, and smoothly gliding metal-graphite brush.



RESISTORS

The extensive range of Ohmite types and sizes makes possible an almost endless variety of standard resistors to meet your needs. The Ohmite line includes more than 60 core sizes, in a wide range of wattage and resistance values. There are also 18 types of resistor terminals available. Included in the standard Ohmite line are fixed, adjustable, tapped, non-inductive, and precision resistors. Specially developed vitreous enamel provides years of unfailing performance.



TAP SWITCHES

Ohmite tap switches are supplied in five standard models, rated at 10, 15, 25, 50, and 100 amperes, a.c. They combine high current capacity and a large number of taps with unusual compactness. Their sturdy, one-piece ceramic bodies provide permanent non-arcing insulation. Their heavy silver-to-silver contacts have a self-cleaning action and provide continuous, dependable contact with low resistance. Ohmite tap switches are supplied in enclosed or open, shorting or non-shorting types.

OTHER PRODUCTS

Ohmite offers an extensive line of standard precision, non-inductive resistors in ½- and 1-watt sizes, in the standard type, vitreous-enameled type, or hermetically sealed in glass. They have an accuracy of ±1%. Ohmite non-inductive vitreous-enameled resistors are also available in standard 50-, 100-, and 160-watt sizes in a wide range of resistance values. In addition, Ohmite provides radio-frequency plate chokes, power line chokes, and dummy antennas.

Write ON COMPANY LETTERHEAD FOR CATALOG AND ENGINEERING MANUAL NO. 40

Be Right with

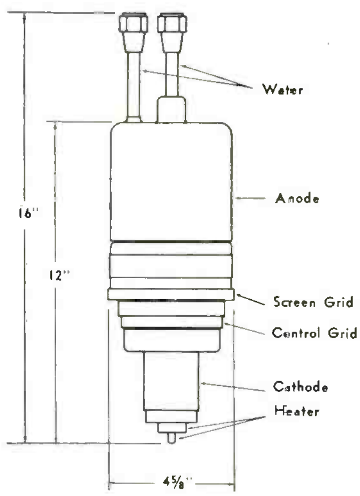
OHMITE®

OHMITE MFG. CO.,
4817 Flournoy St.,
Chicago 44, Ill.

RHEOSTATS • RESISTORS • TAP SWITCHES

TYPE 4W20000A POWER TETRODE
CLASS-B LINEAR AMPLIFIER—TELEVISION SERVICE
TYPICAL OPERATION (Per tube, 5-Mc. Bandwidth, 216 Mc.)

Peak Synchronizing Level	
Load Impedance	400 Ohms
Effective Length of Plate Line	Quarter Wave
D-C Plate Voltage	5500 Volts
D-C Plate Current	7.1 Amps
D-C Screen Voltage	1000 Volts
D-C Screen Current	600 Ma.
DC- Grid Voltage	—310 Volts
Peak R-F Grid Input Voltage (approx.)	485 Volts
Plate Power Input	39.1 Kw.
Plate Dissipation	19.0 Kw.
Plate Power Output	20.1 Kw.



For the practical approach to high-power TV through channel 13, here is the tube . . . the new Eimac 4W20000A power tetrode.

Among the features of the 4W20000A are a unipotential cathode of thoriated tungsten heated by electron bombardment, a water-cooled anode rated at 20 kw dissipation, and coaxially arranged terminals.

This new tube's potential applications are not limited to TV service. Data on typical operation in class-C telegraphy or FM telephony as well as class-B linear TV amplifier service are included in a comprehensive data sheet . . . available for the asking.

Eitel-McCullough, Inc.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Follow the Leaders to
Eimac TUBES

279

SEE THE 4W20000A
at the March IRE Show, Booth 36

specify Sorensen

AC VOLTAGE REGULATORS

Accuracy, with rugged construction, economical and trouble-free operation, reasonable cost — those are features that you expect, *and get*, when you specify Sorensen regulators!

ALL SORENSEN REGULATORS HAVE THESE ADVANTAGES:

- Wide Input Range
- Adjustable Output Voltage That Stays Set
- Regulation Accuracy of ± 0.1%
- Excellent Waveform
- Fast Recovery Time
- Insensitivity to Line Frequency Fluctuations.

MODEL NO. 500-S

STANDARD AC SPECIFICATIONS

VA capacity	150 500	250 1000	2000 3000	5000 10000 15000
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Regulation accuracy	± 0.1% against line or load			
Input voltage	95-130 VAC; also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	0 to full load			
P.F. range	Down to 0.7 P.F. All models temperature compensated			

NOTE: THREE PHASE AND 400 CYCLE REGULATORS ALSO AVAILABLE. ALL REGULATORS CAN BE HERMETICALLY SEALED.

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For regulated DC problems investigate Sorensen's line of Voltage Reference Standards, DC Supplys, and NOBATRONS

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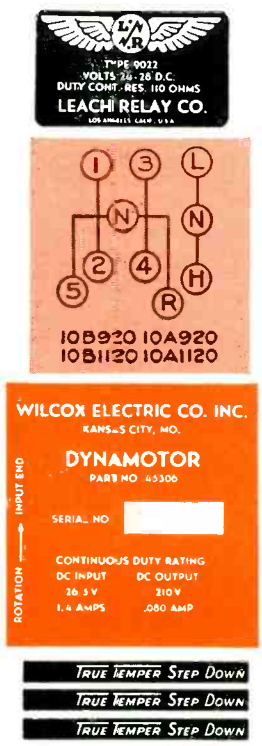
MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTERS; VOLTAGE REFERENCE STANDARDS; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

WITH

Metal-Cals*

SUPERIOR TO BOTH DECALS AND NAMEPLATES

SELF-ADHESIVE • PERMANENT



METAL-CALS consist of a .003" thickness of aluminum foil anodized and dyed, backed with high-tensile bonding material. A METAL-CAL, with your name or message etched into its surface, can be swiftly applied to any smooth, cohesive surface of metals, porcelain, bakelite, polysterene, glass, woods, paints or enamels. Once on—it *stays on,* telling your story again and again!

Only METAL-CALS offer all these advantages:

ECONOMY—No holes to drill, no screws, rivets, escutcheon pins or other fastening devices required. Labor, material costs slashed. Long life eliminates replacement cost of decals and litho-plates.

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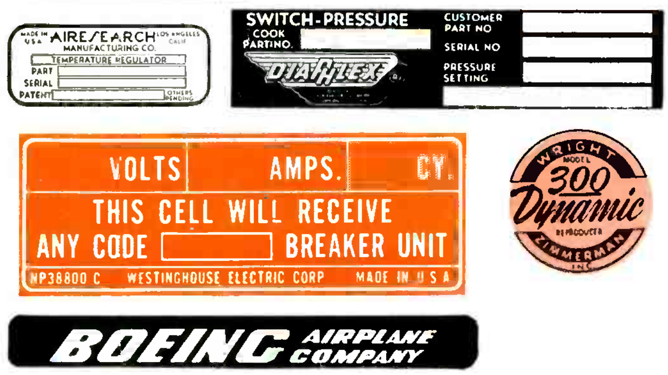
LONG LIFE—Won't chip, peel or crack. Letters, characters and colors are part of the aluminum foil itself . . . stay clear, sharp, easy-to-read.

COLOR VARIETY—Choose any one of 5 permanent, attractive colors—yellow, red, blue, black, green—plus aluminum. Available with either dull (matte) or lustrous metallic finish.

METAL-CALS have found acceptance and wide use in industries everywhere—wherever there is need for an inexpensive, permanent method of applying trade names, trade marks, insignia, numbers, specifications, diagrams, instructions, dial and gauge markings, operating or maintenance instructions, dealer service nameplates.

You've tried the rest—Now USE the Best!



For complete data, samples, technical information, write

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improve your product with — MYCALEX

THE OUTSTANDING LOW LOSS HIGH FREQUENCY INSULATION FOR OVER A QUARTER OF A CENTURY

MYCALEX is a highly developed glass-bonded mica insulation backed by a quarter-century of continued research and successful performance. Both pioneer and leader in low-loss, high frequency insulation, MYCALEX offers designers and manufacturers an economical means of attaining new efficiencies, improved performance. The unique combination of characteristics that have made MYCALEX the choice of leading electronic manufacturers are typified in the table for MYCALEX grade 410 shown below. Complete data on all grades will be sent promptly on request.

MYCALEX is efficient, adaptable, mechanically and electrically superior to more costly insulating materials

- **PRECISION MOLDS TO EXTREMELY CLOSE TOLERANCE**
- **READILY MACHINEABLE TO CLOSE TOLERANCE**
- **CAN BE TAPPED THREADED, GROUND, SLOTTED**
- **ELECTRODES, METAL INSERTS CAN BE MOLDED-IN**
- **ADAPTABLE TO PRACTICALLY ANY SIZE OR SHAPE**

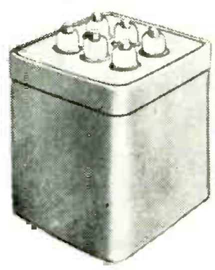
MYCALEX is available in many grades to exactly meet specific requirements

CHARACTERISTICS OF MYCALEX GRADE 410

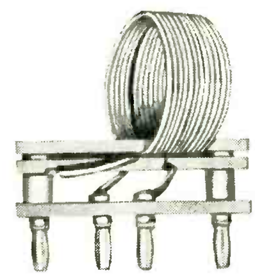
Meets all the requirements for Grade L-4A, and is fully approved as Grade L-4B under Joint Army-Navy Specification JAN-1-10

Power factor, 1 megacycle	0.0015
Dielectric constant, 1 megacycle	9.2
Loss factor, 1 megacycle	0.014
Dielectric strength, volts/mil	400
Volume resistivity, ohm-cm	1×10^{15}
Arc resistance, seconds	250
Impact strength, Izod, ft.-lb/in. of notch	0.7
Maximum safe operating temperature, °C	350
Maximum safe operating temperature, °F	650
Water absorption % in 24 hours	nil
Coefficient of linear expansion, °C	11×10^{-6}
Tensile strength, psi	6000

MYCALEX is specified by the leading manufacturers in almost every electronic category

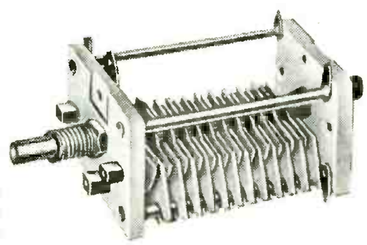


TRANSFORMER WITH MYCALEX-METAL ASSEMBLIES TO GIVE TIGHT SEAL

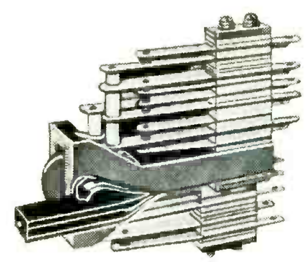


MYCALEX COIL HOLDER AND BASE

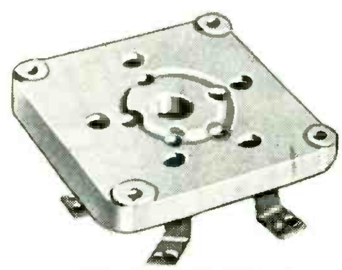
TERMINAL BASE ASSEMBLY FOR FIRE DETECTION EQUIPMENT



CONDENSER WITH MYCALEX LOW-LOSS END PLATES



MULTI-POSITION LEVER SWITCH WITH MYCALEX SPACERS



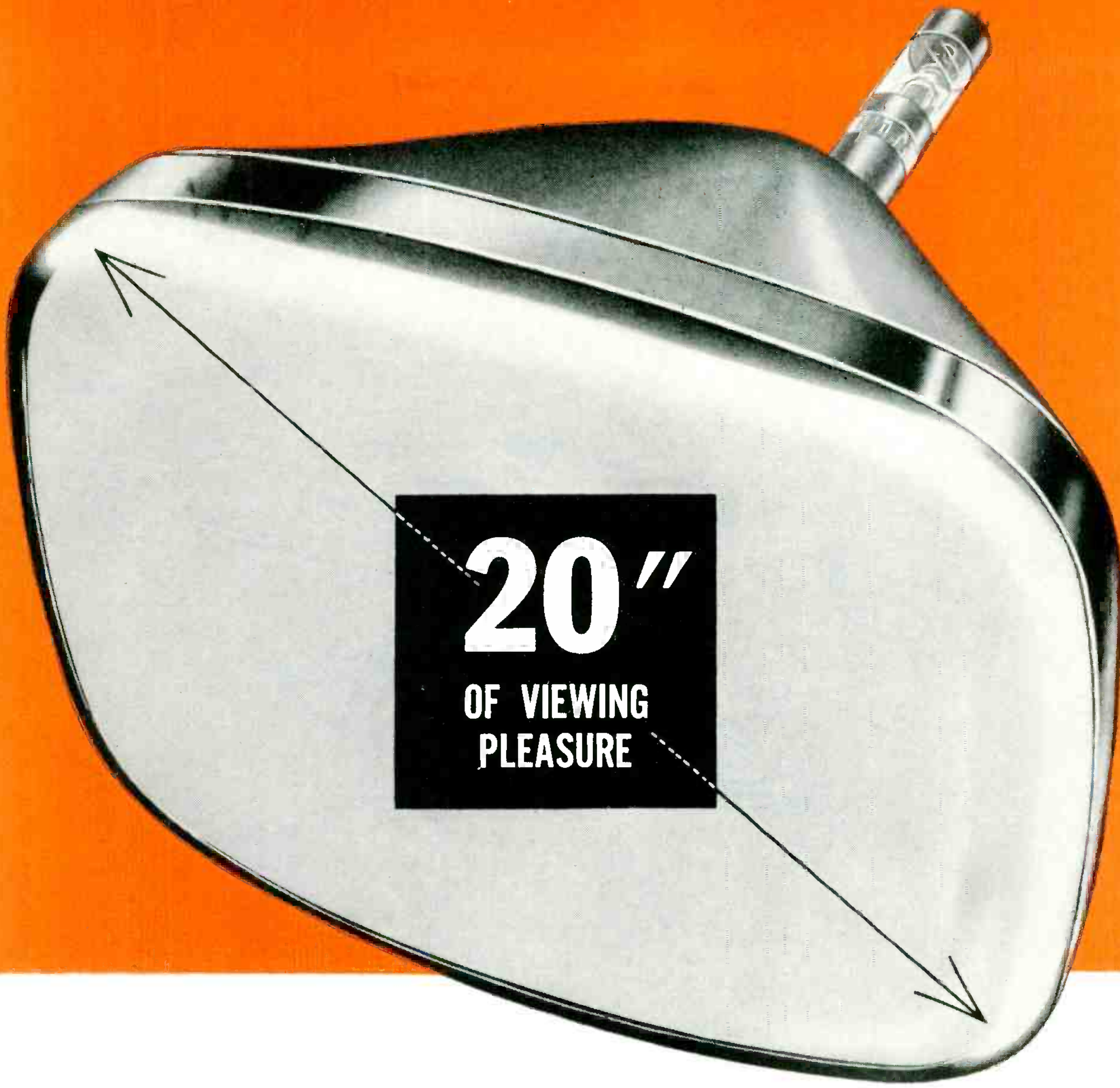
TUBE SOCKET OF MOLDED MYCALEX FOR HIGH FREQ. USE

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG US PAT. OFF.

CORPORATION OF AMERICA

Owners of 'MYCALEX' Patents and Trade-Marks

Executive Offices: 30 Rockefeller Plaza, New York 20 • Plant and General Offices: Clifton, New Jersey



the Du Mont type 20CP4

For the set that follows the "seventeen" in rectangular pictures, Du Mont supplies the "twenty" all-glass rectangular Type 20CP4.

Another in the series of Big-Picture Teletrons employing the NEW Bent-Gun for edge-to-edge sharpness that makes the difference in picture tubes of this size. The gray filter face plate improves contrast.

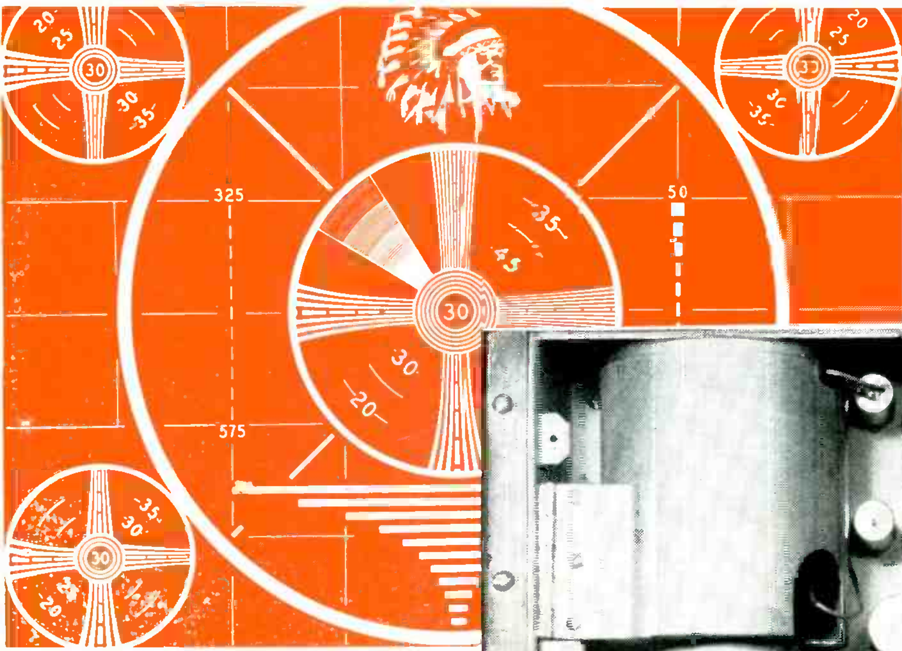
The first picture tube designed with the industry "standard" neck length of 7³⁄₁₆″.

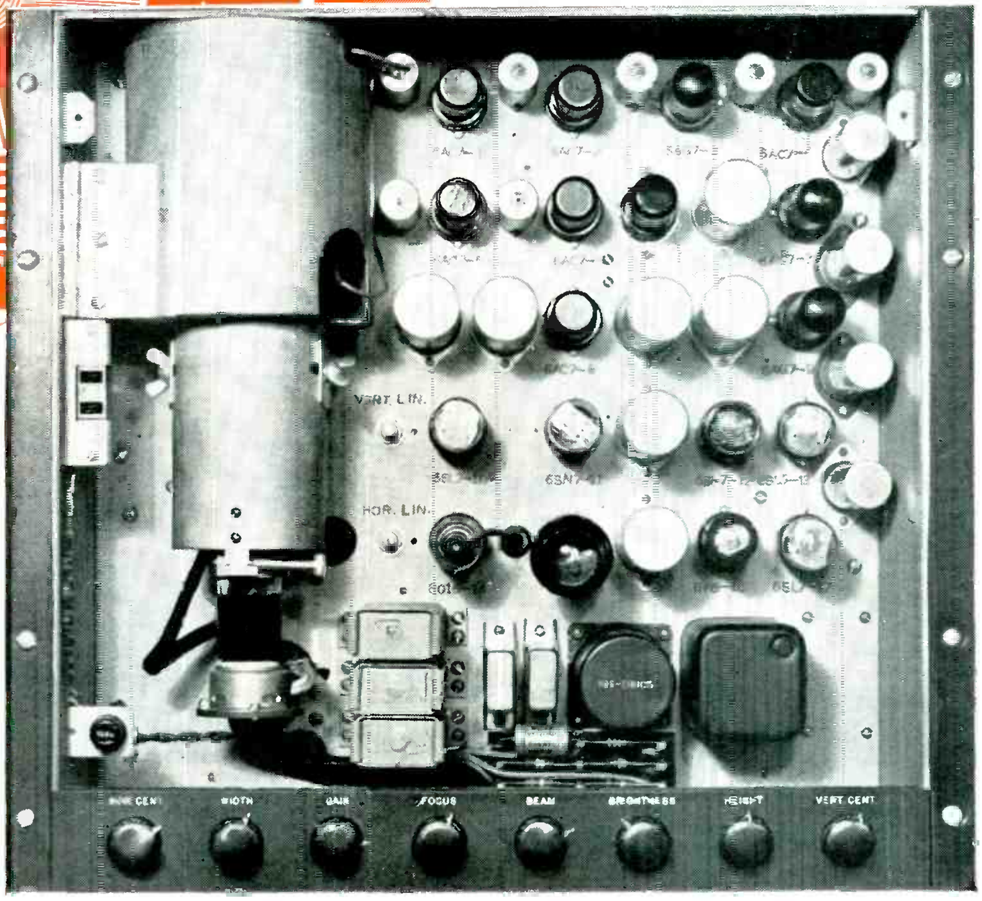
Our Commercial Engineering Department invites all design inquiries.

DUMONT Teletrons*

Allen B. Du Mont Laboratories, Inc., Cathode-Ray Tube Division, Clifton, N. J.

*Trademark





Video Monoscope Camera TK-1A

..."patternmaker" for the industry

The test pattern produced by RCA Monoscope Cameras is the standard by which picture quality has been judged since the beginning of electronic television . . . in TV stations . . . in laboratories . . . in TV receiver production.

These are the standard test-pattern cameras used by many TV receiver manufacturers. These are the standard "picture micrometers" used by TV stations to make precision measurements of video transmissions.

Deliberately designed to excel in all things, RCA Monoscope Cameras have earned the extraordinary respect of television men. Evenly lighted patterns as steady as Gibraltar. Resolution as fixed as the cut of a diamond. Operation as reliable as a ship's chronometer.

Type TK-1A pictured here is RCA's newest Monoscope Camera—built to the highest standards known. It can be delivered to you with the familiar monoscope pattern (shown above)—or with a pattern of your own choice.

Ask your RCA Television Equipment Sales Engineer for prices. Mail the coupon for data.

TELEVISION BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Radio Corporation of America
Television Broadcast Equipment Section
Dept. O-36, Camden, N. J.

Send me your technical bulletin on the RCA Type TK-1A Monoscope Camera.

Name__________

Company or station__________

Address__________

City__________ State__________

VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use

MODEL 515

B SUPPLY: 0-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
C SUPPLY: 0-150 volts, 5 Ma.
REGULATION: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.
RIPPLE: 5 millivolts.
FILAMENT SUPPLY: 6.3 volts AC, 10 Amp., CT.

This unit is available with a 300 Ma. B Supply; with or without C Supply.

MODEL 510

Model 510 features TWO COMPLETELY INDEPENDENT REGULATED POWER SUPPLIES.
OUTPUT DC FOR EACH SUPPLY: 200-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC FOR EACH SUPPLY: 6.3 volts, 6 Amp., CT.

The supplies may be connected for series, parallel, or bucking operation.

MODEL 315

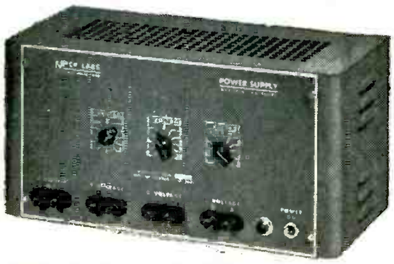
B SUPPLY: 0-300 volts, 150 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
C SUPPLY: 0-150 volts, 5 Ma.
REGULATION: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.
RIPPLE: 5 millivolts.
FILAMENT SUPPLY: 6.3 volts AC, 5 Amp., CT.

MODEL 245

OUTPUT DC: 200-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE VOLTAGE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC: 6.3 volts, 6 Amp., CT, unregulated.

MODEL 600

Model 600 features TWO INDEPENDENT REGULATED POWER SUPPLIES.
OUTPUT DC FOR EACH SUPPLY: 0-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC FOR EACH SUPPLY: 6.3 volts, 10 Amp., CT, unregulated.



MODEL 103, MULTIPLE POWER SUPPLY

TWO B SUPPLIES: 0-300 volts, 75 Ma. each, 150 Ma. when paralleled. Ripple 10 millivolts. Unregulated.
ONE C SUPPLY: Minus 50 volts to plus 50 volts, 5 Ma. Ripple 5 millivolts. Unregulated.
ONE FILAMENT SUPPLY: 6.3 volts AC, 5 Amp.

Write for specifications on our complete line of power supplies

KEPCO LABORATORIES, inc.

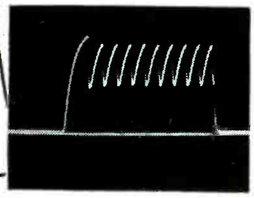
149-14—41st AVENUE (Dept. K) FLUSHING, NEW YORK

establish the signal's D-C LEVEL

...and measure its a-c and d-c components directly from the oscillograph

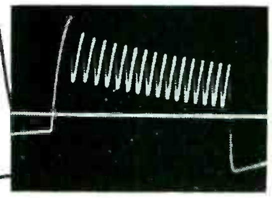
you should see...

this!



Both a-c and d-c components are displayed through the d-c amplifiers of the Type 340-H. Base line represents zero volts.

not this!



The same signal, applied through a-c amplifiers exhibits a shifted reference line and tilt of the signal which make the oscillogram difficult to interpret.

DUMONT type 304-H

...to make direct measurements

THE TYPE 264-B VOLTAGE CALIBRATOR

Simply by applying its square-wave output to the oscillograph and producing a deflection equal to that of the signal, the amplitude of the signal may be read, in volts, directly from the calibrated dial of the Type 264-B. Or the Type 264-B will calibrate your oscillograph to read directly in volts per inch.

...to obtain permanent records

THE TYPE 296 OSCILLOGRAPH-RECORD CAMERA

To complete the study of the signal, permanent records, such as those above, are obtained most efficiently with this inexpensive, single-frame, 35-mm. camera. Operation of the camera is simple and foolproof; construction is compact and rugged. A high-quality f/2.8 coated lens is used, and focus is fixed for best oscillographic results.

The "Standard of Performance" for general-purpose cathode-ray oscillographs.

To study signals containing both a-c and d-c components, direct-coupled amplifiers such as those of the Type 304-H must be used. D-C amplifiers will maintain the true d-c level of the signal and display the actual relationship between the d-c and a-c components of the signal. Then by calibration of the Type 304-H with the Du Mont Type 264-B Voltage Calibrator, these components may be measured directly from the screen of the instrument.

Features such as driven sweeps, sweep expansion, extremely slow sweep speeds, and stabilized synchronization have made the Type 304-H the outstanding general-purpose cathode-ray oscillograph. Its sensitivity of 10 rms millivolts per inch and its versatility often eliminate the need for a second instrument to perform functions not within the range of the ordinary general-purpose oscillograph.

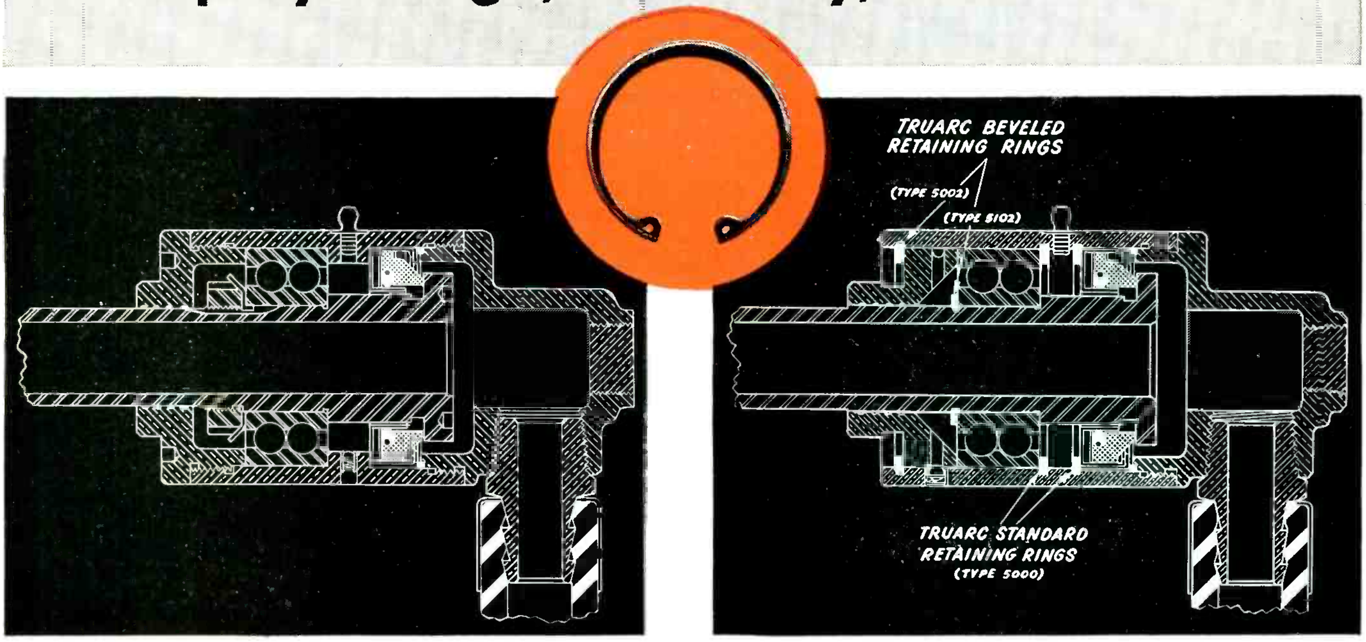
Portability contributes highly to the usefulness of the Type 304-H, especially in field work requiring good performance and in the laboratory where it serves many benches. The Type 304-H measures 13½″ high, 8⅝″ wide, 19″ deep, and weighs only 50 pounds.

Write today for catalog...

Instrument Division, Allen B. Du Mont Labs., Inc.
1000 Main Avenue, Clifton, N.J., U.S.A.

DUMONT 20th YEAR AS PIONEER in Oscillography

4 Truarc Rings save $2.41 unit cost, Simplify Design, Assembly, Maintenance



Conventional Way. This design died on the drawing boards, because the Deublin Company, Northbrook, Ill., found the simplified design, using Truarc Rings, superior and more economical.

Truarc Way. Truarc Beveled Retaining Ring holds cap in place, takes up end play, locks entire assembly. Second Beveled Ring positions ball bearing on rotor. 2 standard Truarc Rings position bearing and removable seal, eliminate shoulders, permit manufacture of housing from strong, non-porous, easily machined brass tubing. Unit can be serviced in minutes simply by removing 2 Truarc Rings.

HOW $2.41 WAS SAVED

Materials saved	
decreased wall thickness of housing	$.79
eliminated bearing lock nut and washer	.18
	.97
Machine operations eliminated	
Bore, undercut, and tap cap end of housing	.39
Locate cap on arbor, and chase threads	.28
Drill spanner wrench holes	.10
Cut thread on rotor for lock nut	.09
Mill slot in thread for tang on lock washer	.18
Drill spanner wrench holes in rotor	.10
	1.14
Assembly operations eliminated	
Install lock washer, tighten lock nut, bend lug	.20
Assemble cap into housing	.10
	.30
TOTAL SAVINGS	**$2.41**

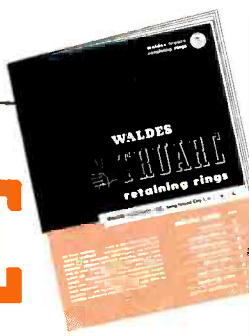
THE Deublin Union—a rotating joint for steam, air, or water—is simple, rugged, easy to service. 4 Waldes Truarc Rings hold entire unit together, permit simplified design, cut unit cost $2.41.

Improve and simplify your own product design with Truarc Rings, and you too will cut costs. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Waldes Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, 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.

Visit the Truarc Exhibit, Booth 358, at the IRE Radio Eng. Show, Grand Central Palace, N. Y., March 19-22.



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. PATENTS 2,382,948; 2,420,921; 2,411,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place
Long Island City 1, N. Y. E033

Please send the new catalog on Waldes Truarc Retaining Rings.

Name________________

Title________________

Company________________

Business Address________________

City________ Zone____ State________

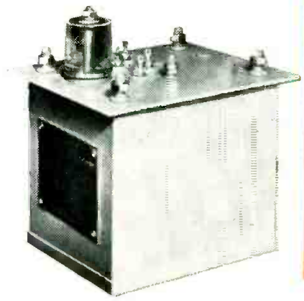
4KW

a complete line of hermetically sealed oil-filled

HIGH-VOLTAGE COMPONENTS

Rectifiers

Small, lightweight a-c to d-c power supply units for use with cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and similar jobs. Typical outputs are 7, 9 and 13 kv. Low regulation—the 7-kv unit illustrated does not exceed 3.5% regulation per 0.1 milliampere load, holds ripple on output voltage to less than 1%. Size, only 6" x 6" x 7"; weight 8 lb.

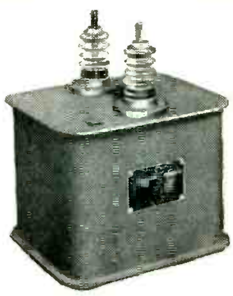


Pulse Transformers

Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications fields.

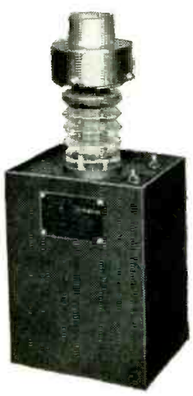
Resonant Reactors

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.



Filament Transformers

Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

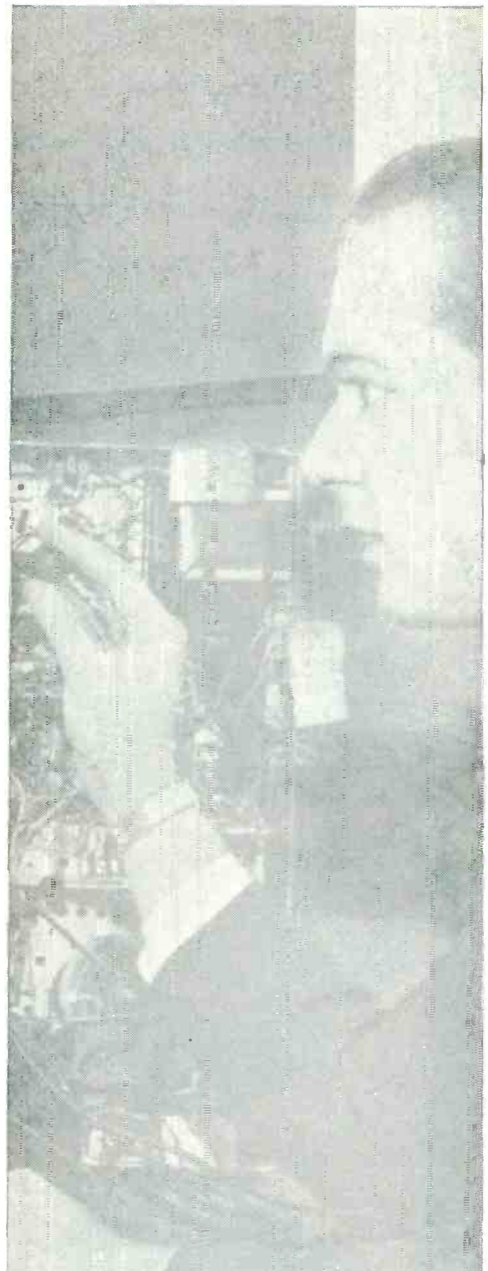


Illustrated here are typical high-voltage components manufactured by General Electric. They can be built to meet Armed Services requirements. All are oil-filled and hermetically sealed—with excellent ability to withstand mechanical shocks and to operate continuously for long periods in widely varying temperatures. Apparatus Dept., General Electric Company, Schenectady, N. Y.

Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, please include with your inquiry, functional requirements and any physical limitations. *Write to Apparatus Dept., 42-328A, General Electric Co., Pittsfield, Mass.*

GENERAL ELECTRIC

401-63



Floyd Makstein, field engineering manager at **Emerson** *recommends*

Simpson MODEL 480 GENESCOPE

FOR TV-FM SERVICING

This is what Floyd Makstein of EMERSON says about the Simpson Model 480 Genescope: . . . "The Simpson Model 480 Genescope far surpasses the standards required in the servicing and aligning of all TV-FM receivers. The wide frequency response and the 25 millivolt sensitivity of the oscilloscope, combined with the required fundamental signal sources which are provided in the AM & FM oscillator sections, simplifies the accurate aligning of all TV receivers, including those with intercarrier systems. In addition, the large, easy-to-read dials, having a 20-1 vernier control and 1000 division logging scale, cuts down on servicing time."

Mr. Makstein concludes . . . "The compactness of the complete unit will be a big factor in many of the service shops where space is at a premium. We are sure that the whole TV industry appreciated your efforts in raising the engineering standard in servicing." Emerson Service personnel *know* that modern FM and TV development and servicing demand test equipment made to the most exacting standards. They prefer the Simpson Model 480 Genescope because it is the most accurate, flexible and convenient instrument available. The Genescope will render many years of uninterrupted service and always produce accurate results.

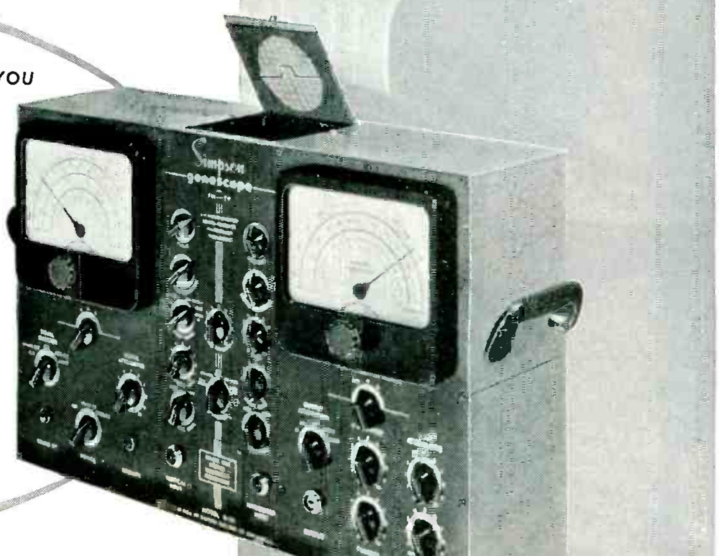
SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St. • Chicago 44, Illinois • Phone: COlumbus 1-1221
In Canada: Bach-Simpson, Ltd., London, Ont.

THESE RANGES SHOW HOW MUCH THE SIMPSON GENESCOPE CAN DO FOR YOU

FREQUENCY MODULATED OSCILLATOR
- Band A: 2-120 megacycles
- Band B: 140-260 megacycles
- Sweep width variable from zero to 15 megacycles
- Sweep rate 60 cycles per second
- Specially designed frequency sweep motor
- Continuously variable attenuator
- Crystal calibrator: 5 megacycles ± .05%
- Audio Oscillator 400 cycles
- Output Impedance 75 ohms
- Step attenuator for control of output

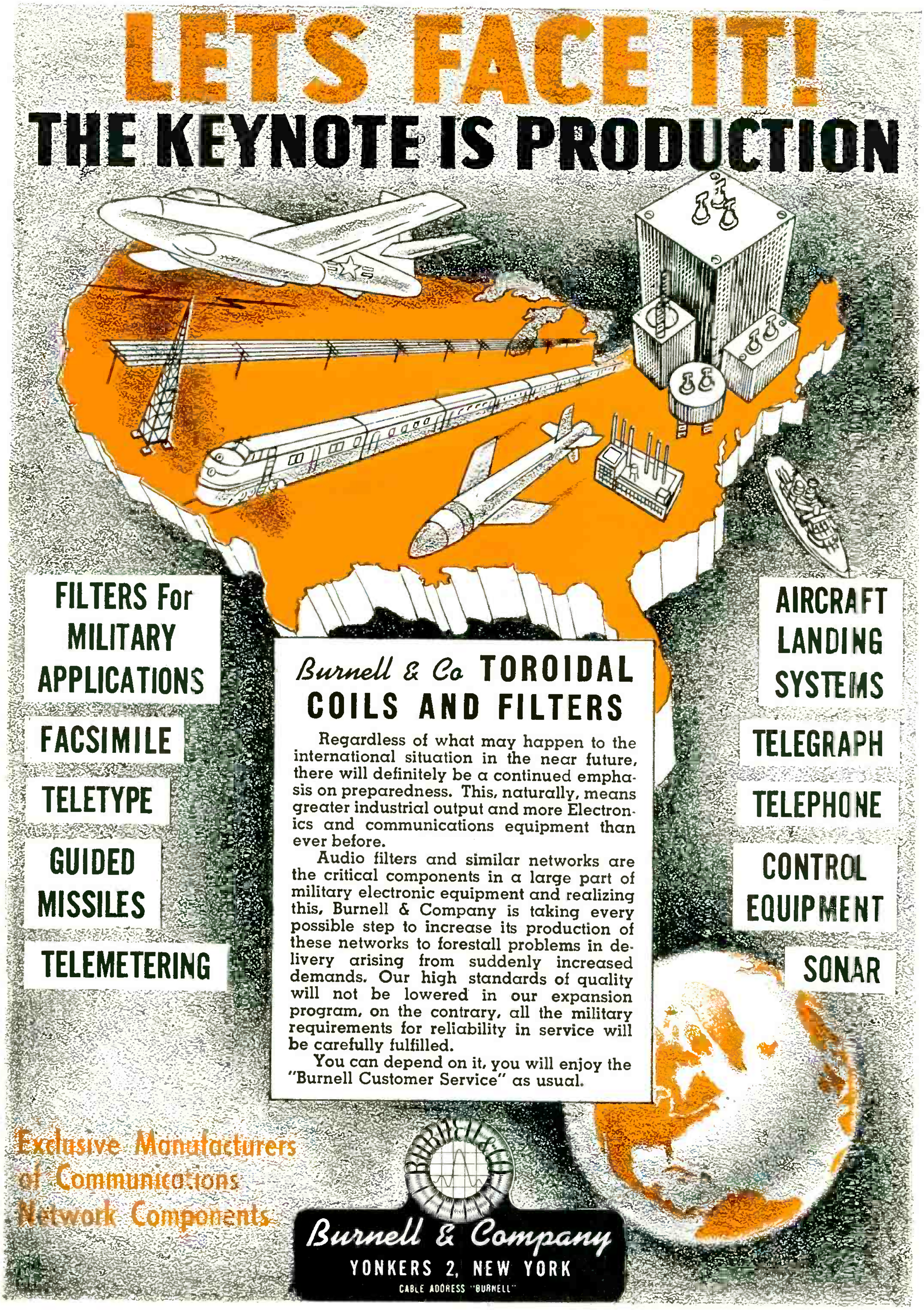
AMPLITUDE MODULATED OSCILLATOR
- Band A: 3.3-15.6 megacycles
- Band B: 15-75 megacycles
- Band C: 75-250 megacycles
- 30% modulation at 400 cycles or unmodulated
- Continuously variable attenuator
- Visual method of beat frequency indication

OSCILLOSCOPE
- Vertical sensitivity: 25 mv per inch
- Horizontal sensitivity: 70 mv per inch
- Linear sweep frequency: 2 cycles to 60 kilocycles
- 60 cycle sine sweep
- Frequency essentially flat to 200 KC. usable to over 3 megacycles

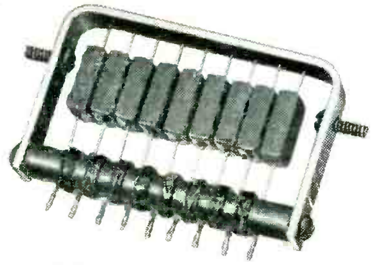


CONSERVE CRITICAL MATERIALS

Simpson Model 480 Genescope: size 22" x 14" x 7½' Weight 45 lbs. Shipping Weight 54 lbs.
DEALER'S NET PRICE complete with Test Leads and Operator's Manual, $395.00.


LETS FACE IT!
THE KEYNOTE IS PRODUCTION
FILTERS For MILITARY APPLICATIONS
FACSIMILE
TELETYPE
GUIDED MISSILES
TELEMETERING
AIRCRAFT LANDING SYSTEMS
TELEGRAPH
TELEPHONE
CONTROL EQUIPMENT
SONAR
Burnell & Co TOROIDAL COILS AND FILTERS
Regardless of what may happen to the international situation in the near future, there will definitely be a continued emphasis on preparedness. This, naturally, means greater industrial output and more Electronics and communications equipment than ever before.
Audio filters and similar networks are the critical components in a large part of military electronic equipment and realizing this, Burnell & Company is taking every possible step to increase its production of these networks to forestall problems in delivery arising from suddenly increased demands. Our high standards of quality will not be lowered in our expansion program, on the contrary, all the military requirements for reliability in service will be carefully fulfilled.
You can depend on it, you will enjoy the "Burnell Customer Service" as usual.
Exclusive Manufacturers of Communications Network Components
Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

Something New



SPECIAL DELAY LINES

Lumped delay lines "tailored" to specific applications have been announced by the Shallcross Manufacturing Co., Collingdale, Pa. A typical unit consists of eight pie-section low-loss filters having a rise time of 0.04 microseconds and a total delay of 0.3 microseconds. Maximum pulse voltage is ± 100 volts and impedance is 500 ohms. Cutoff frequency is 8.5 megacycles and the maximum operating frequency approximately 2 megacycles based on a pulse delay error of not more than 2%. The unit consists of eight universally-wound coils of 3-strand #41 Litz wire and nine low T.C. silver mica capacitors. Many other types can be supplied.

NEW SHALLCROSS WHEATSTONE-MEGOHM BRIDGE

The new Shallcross 635-A Wheatstone-Megohm Bridge is a versatile direct-reading instrument for accurate measurements between 10 ohms and 1,000,000 megohms. It can be used to measure resistance elements and insulation resistance and to determine volume resistivity of materials. The instrument is basically a Wheatstone Bridge used in conjunction with a d-c amplifier. Two built-in power supplies operating on 115 volts, 60-cycles automatically provide the correct bridge voltages for the high and low ranges. Full information is available from the Shallcross Manufacturing Co., Collingdale, Pa.

METAL-ENCASED RESISTORS

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

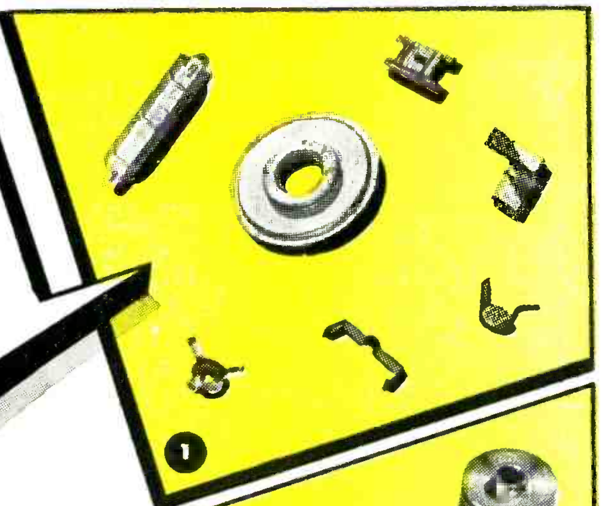
(ADV.)

ELECTRONIC

Precision METAL PARTS

by

Haydu BROTHERS



Regardless of the complexity of the parts you need, Haydu Brothers possess the design and engineering skill, the facilities, the trained operators and the down-to-earth, machine-shop "know how" necessary to fill your requirements promptly, efficiently, and economically. Whether you need precision machine parts, small metal stampings, deep-drawn and four-slide parts, screw machine made parts, or formed wire parts, Haydu Brothers will handle your entire problem from die-making through production of the finished parts to specified tolerances. Our modern, high-speed equipment in the hands of skilled personnel is your assurance of quick and dependable fabrication -- in even the most difficult metals.

Our technical staff is always available to you for design of special equipment, or for consultation on production problems. Your inquiry concerning a specific item is invited.

Some items
from current production . . .

(1) **Small metal stampings***— intricate or simple, Haydu's modern presses insure fast, accurate, volume production in monel, nickel, molybdenum, tungsten, stainless steel, copper, carbonized nickel, and other metals.

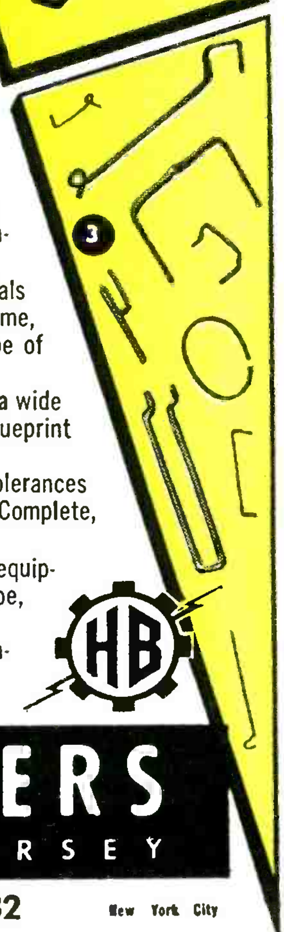
(2) **Precision machine parts***— in even the most difficult materials (molybdenum, tungsten, ambraloy, tantalum, kovar, nichrome, mishmetal, etc.) are tooling problems well within the scope of Haydu experience.

(3) **Formed wire parts***— from .004" to .080" in diameter in a wide range of materials. These are made to your exact blueprint specifications.

(4) **Drawn, four-slide parts***— perfectly produced to close tolerances on correctly designed dies for high-speed fabrication. Complete, modern facilities for deep-drawing.

(5) **Screw machine parts***— automatic and hand screw equipment give an almost unlimited range of size, shape, and finish, while maintaining closest tolerances.

*All Haydu metal parts production undergoes rigid inspection for assurance of complete accuracy.



HB

RTMA MEMBER RADIO-TELEVISION MANUFACTURERS ASSOCIATION

HAYDU BROTHERS

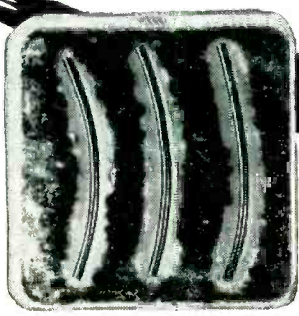
PLAINFIELD • NEW JERSEY

Radio Engineering Show
Grand Central Palace

Booth No. 82

New York City

MILDEW *Foiled...*



Shows treated Syntholvar Extruded Tubing

Shows untreated Syntholvar Extruded Tubing

NOW...

EXTRUDED VINYL TUBING that's *MILDEW RESISTANT!*

We can now supply you with a mildew resistant Syntholvar Extruded Vinyl Insulating Tubing. This will be good news to many of our customers — those who have electrical insulation problems where protection from mildew or fungus is essential.

Proof of the resistance of this new extruded tubing to fungi and bacteria is shown in the unretouched photographs of a 28-day Petri dish test. Note in the top picture how the treated tubing has completely resisted attack, whereas the untreated tubing is well covered with fungi and bacteria.

If you have a problem of this nature, we'll be glad to send you a test sample without charge.

Varflex
CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

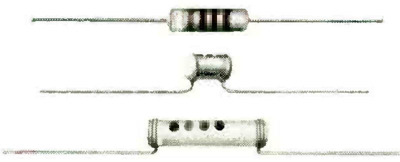
VARFLEX Corporation

308 N. Jay St. Rome, N. Y.

MEMBER OF NEMA

for easy assembly . . . dependable performance

ERIE RESISTOR COMPONENTS



Erie "GP"* Molded Insulated Ceramicons*
5 MMF—5,000 MMF

Erie "GP" Dipped Insulated Ceramicons
5 MMF—5,000 MMF

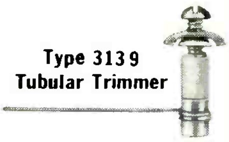
Erie "GP" Non-Insulated Ceramicons
5 MMF—5,000 MMF

Type 557 Ceramicon Trimmer
1.5-7 MMF
3-12 MMF
5-25 MMF
5-30 MMF
8-50 MMF

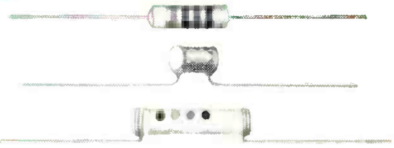
Type 535 Tubular Trimmer

Type 531 and 532 Tubular Trimmers
0.5-5 MMF
1-8 MMF

Type TS2A Ceramicon Trimmer
1.5-7 MMF 3-13 MMF 4-30 MMF
3-12 MMF 5-20 MMF 7-45 MMF



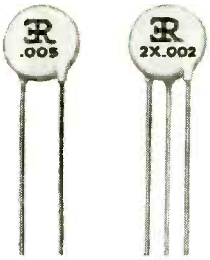
Type 3139 Tubular Trimmer



Temperature Compensating Molded Insulated Ceramicons
0.5 MMF—550 MMF

Temperature Compensating Dipped Insulated Ceramicons
0.5 MMF—1,800 MMF

Temperature Compensating Non-Insulated Ceramicons
0.5 MMF—1,800 MMF



Erie Disc Ceramicons
Up to .01 MFD

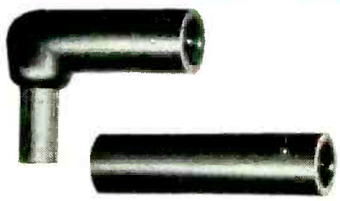
Type 720A | Types 323 and 324 Insulated | Type 2322 | Type 2336 | Type 325

Erie Stand-Off Ceramicons
5 MMF—5,000 MMF

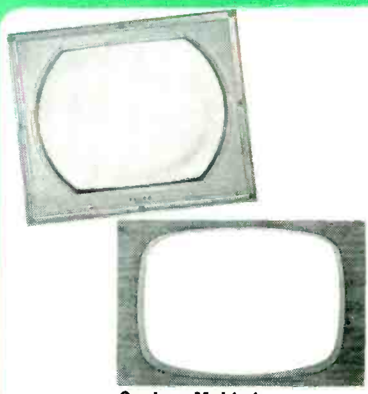
Erie Resistor Components are designed with definite objectives in mind: they must be accurate and well within the tolerances required for their application; they must be reliable for sustained satisfactory service based on time proven life tests; they must be compact and sturdy for easy installation on the assembly line and in the service shop.

Erie manufactures a complete line of Ceramic and Button Mica Capacitors for transmitter and receiver applications: Fixed Ceramic and Mica Capacitors, Variable Ceramic Capacitors, Carbon Suppressors, Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates and Coil Forms. Complete technical information on request.

*Ceramicon, Hi-K, GP, and Plexicon are registered trade names of Erie Resistor Corporation.



Types L-4, L-7, S-5 Suppressors for Spark Plugs and Distributors



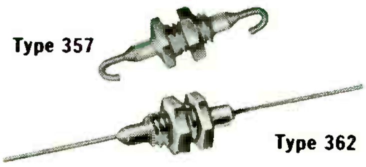
Custom Molded Plastic TV Lenses and Frames

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

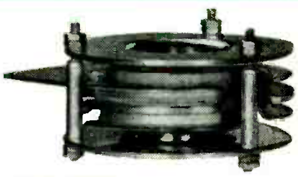
LONDON, ENGLAND • TORONTO, CANADA

Type 357



Type 362

Feed-Thru Ceramicons
5 MMF—1,000 MMF
5 MMF—1,500 MMF



Type 3688

High Voltage Ceramicons
Up to 15,000 Volts WORKING

Cinch-Erie Plexicon* Tube Sockets with built in by-pass Ceramicons 10 to 1,000 MMF

Button Mica Condensers
15 MMF—6,000 MMF

Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates, Coil Forms, etc.

If your input problem is...

- **Unstable line voltage**
- **Ambient temperature from 0C to 40C**
- **Rapid line voltage changes**
- **Simultaneously varying line and load**

If your input problem is smoothing out voltage supply fluctuations, look to 115-volt G-E stabilizers. Guarding a rated load at unity power factor, they maintain output within ±1% against line variations from 95 to 130 volts. Quiet, automatic, they provide quick recovery when subject to simultaneous line and load variations, and voltage surges. Compact, lightweight G-E stabilizers do the job for you.

HOW TO give your product low-cost voltage control within ±1%

if your product is...

If your product is composed of one of the following items that require voltage stability, it will pay you to investigate the advantages of G-E stabilizers.

- **Television and radio equipment**
- **Telephone apparatus**
- **Sound equipment**
- **Lighting circuits**
- **Photometers**
- **X-ray equipment**
- **Rectifiers (full-wave)**
- **Electrochemical apparatus**
- **Test equipment and precision processes**
- **Photographic equipment**
- **Electronic circuits**
- **Calibration devices**
- **Color comparators**

G-E Automatic Voltage Stabilizers

For equipment that requires stable a-c input, look to General Electric voltage stabilizers for precision voltage control. For stable output of 115 or 230 volts in sizes from 15 to 5000 va, standard G-E stabilizers can be used to cut costs and to save space.

Why not investigate G-E stabilizers for an answer to your problem of voltage stabilization. For a modest investment, they go a long way toward decreasing your field calls, increasing customer satisfaction.

For details on G-E stabilizers, see your G-E specialist at your local G-E office, or write for booklet GEA-3634, *Apparatus Dept., General Electric Co., Schenectady 5, N.Y.*

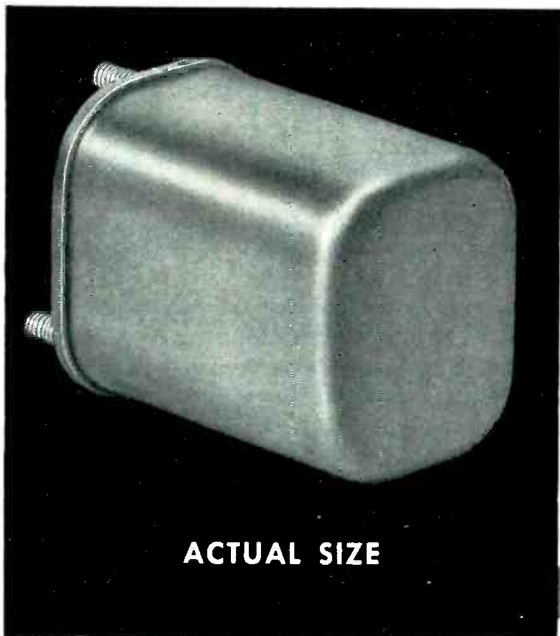
GENERAL ELECTRIC

411-83

You can use

NORTH "Midget" RELAYS

for "Man-Sized" jobs!

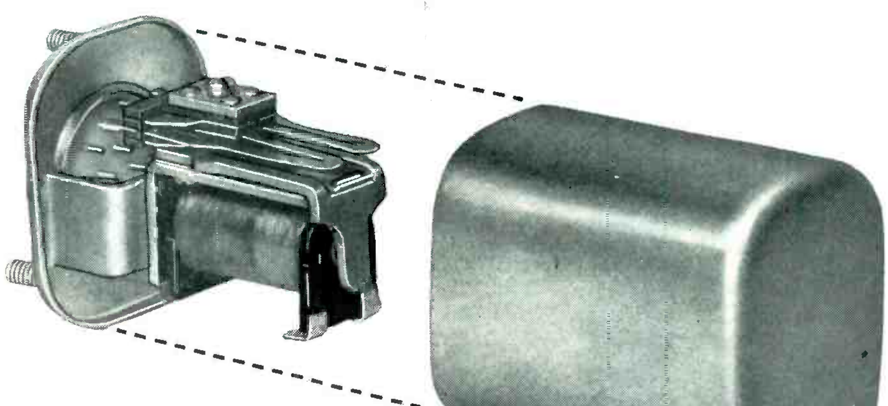


Although we've been in the business since 1884, we've never made a relay that has a broader variety of application than our new line, known as "M-type". A typical example is the enclosed relay shown at left, which will be available either hermetically sealed or with snap-off dust cover.

This "Midget" will out-perform other relays of several times its weight and current consumption. (In normal use it draws .05 watts.) It has successfully met rigid Armed Forces tests from 71° C to −53° C, survived thirty-day humidity courses, vibration tests and dielectric breakdown tests at 500 volts. Wherever there's a tough, big-time relay job to be done, specify North M-type relays. Available in more than 70 combinations of make and break contacts in stock assembly.

The new North Relay Catalog describes the vast variety of relays made by North for every conceivable use, and this company's unmatched facilities for special relay engineering.

Write for a copy today



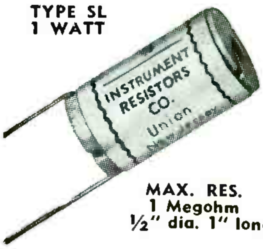
Special Relays? Let North Engineer them for you!

THE NORTH ELECTRIC MANUFACTURING COMPANY

Originators of ALL RELAY Systems of Automatic Switching

1438 T, South Market Street, Galion, Ohio, U.S.A.

TYPE SL
1 WATT



MAX. RES.
1 Megohm
½" dia. 1" long

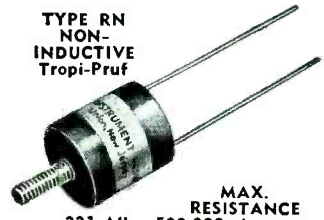
TYPE P-4
1 WATT

MAX. RES.
1.0 Megohm
9/16" dia. 1" long

TYPE P-2
½ WATT

MAX. RES.
300,000 ohms
9/16" dia. 9/16" long

TYPE RN
NON-INDUCTIVE
Tropi-Pruf



MAX. RESISTANCE
331 Alloy 500,000 ohms
Nichrome (R) 400,000 ohms
Manganin 15,000 ohms
TOLERANCE
0.5% standard to 0.1% at slightly higher cost

TYPE RX
NON-INDUCTIVE
Tropi-Pruf

MAX. RESISTANCE
331 Alloy 500,000 ohms
Nichrome (R) 350,000 ohms
Manganin 30,000 ohms
TOLERANCE
0.5% standard to 0.1% at slightly higher cost

APPLICATION-DESIGNED WIRE WOUND RESISTORS

RESISTIVE COMPONENTS FOR EVERY NEED

IN-RES-CO wire wound resistors offer the circuit designer a new opportunity to meet increasingly critical requirements. The IN-RES-CO line is complete—resistance ranges from .01 ohm to several megohms; power ratings from a fraction of a watt to 10 watts. Special units are included for counteracting high humidity, fungus, space limitations, temperature rise, etc. Units can be supplied either inductive or non-inductive, wound with Nichrome, Manganin or 331 Alloy. For complete data, send for the new IN-RES-CO catalog.

of particular importance now!

A COMPLETE LINE OF IN-RES-CO MINIATURE and SUB-MINIATURE RESISTORS

A complete line of resistors specially designed for inclusion in miniaturized equipment and component designs. Ideally suited for all applications requiring resistive units of extremely compact size and high dependability. Available in types and sizes that meet practically every application need. Available to close tolerance and in high resistance values, yet small enough to meet limited space requirements of the most compact equipment. For complete information call or write today, or consult the latest IN-RES-CO catalog.

TYPE CX
½ WATT
Non-Inductive

MAX. RESISTANCE
331 Alloy 750,000 ohms
Nichrome 500,000 ohms
Manganin 15,000 ohms
BODY SIZE
9/16" dia. ⅝" long
TOLERANCES
Standard—1%
SPECIAL—TO 1/10%

TYPE BX
1 WATT
NON-INDUCTIVE

MAX. RESISTANCE
331 Alloy 1.5 Megohm
Nichrome 1.0 Megohm
Manganin 30,000 ohms
BODY SIZE
9/16" dia. 1" long
TOLERANCES
Standard—1%
SPECIAL—TO 1/10%

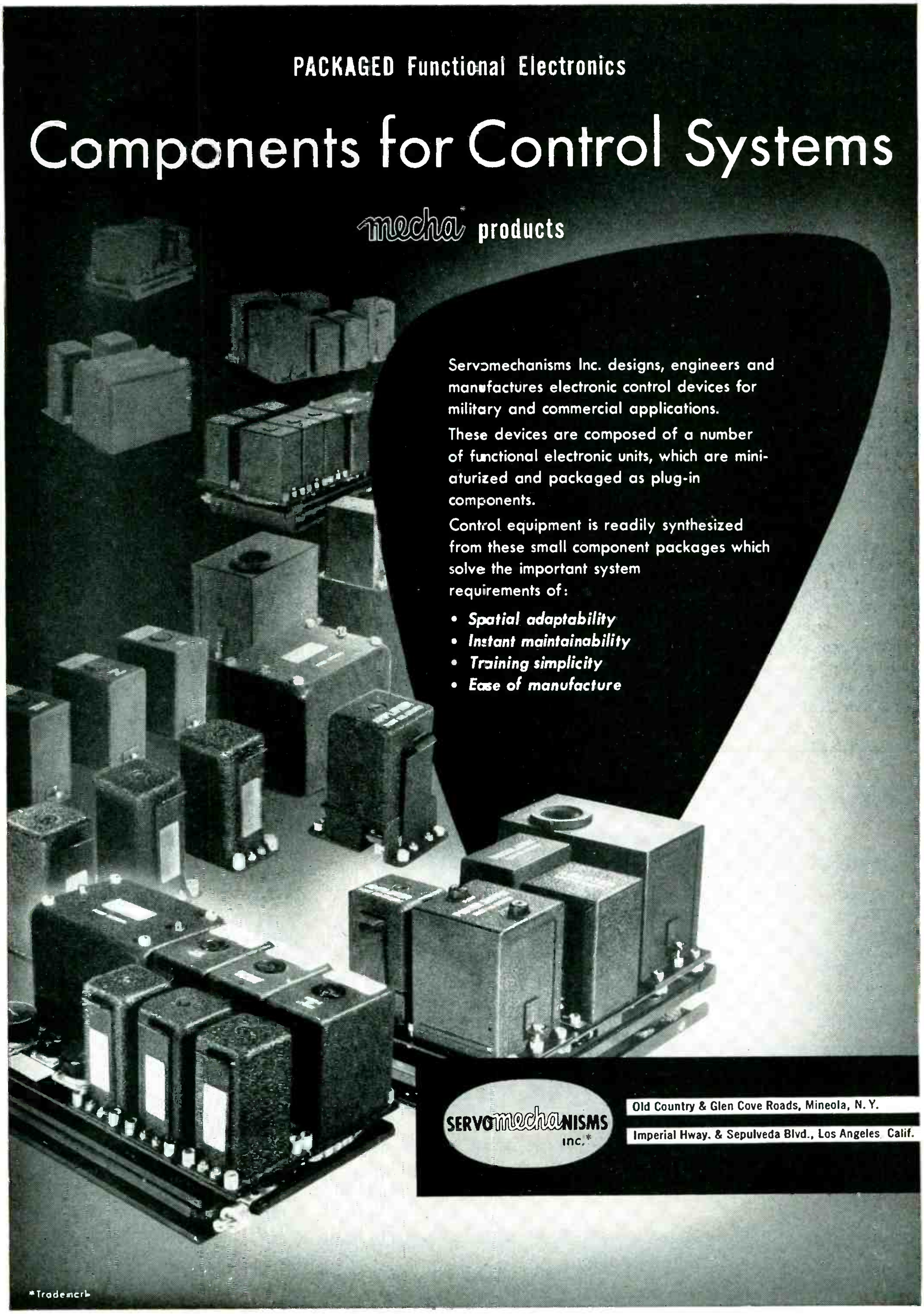
RF CHOKE COILS

INSTRUMENT RESISTORS COMPANY specializes in the manufacture of RF choke coils wound to any specified inductance and Q value. Coils in this category are precision wound on ultra-modern winding equipment that insures finest product quality at lowest cost. IN-RES-CO is equipped to supply units of these types or others, including hermetically sealed units, in large or small quantity to exact specification. For prompt quotation on your requirements, call or write outlining specifications and quantity.

INSTRUMENT RESISTORS COMPANY

1036 COMMERCE AVENUE (IN-RES-CO) UNION, NEW JERSEY

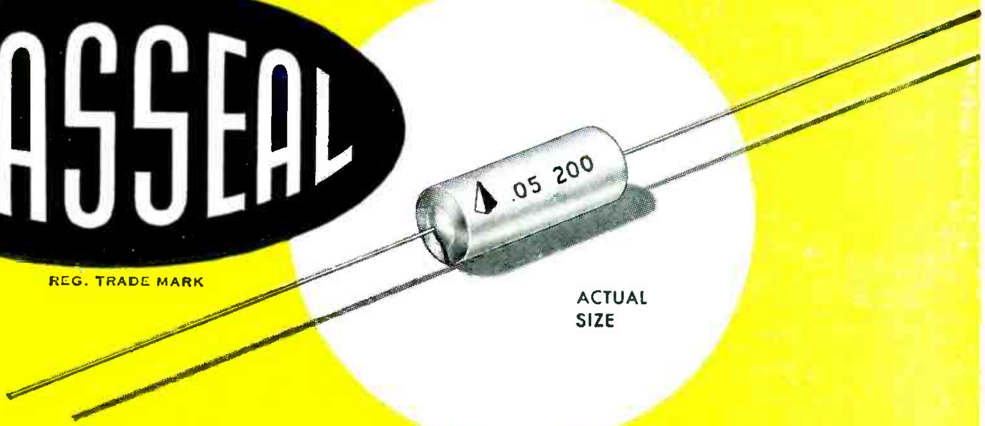
MANUFACTURERS OF WIRE WOUND RESISTORS FOR EVERY ELECTRICAL AND ELECTRONIC NEED


PACKAGED Functional Electronics
Components for Control Systems
mecha* products
Servomechanisms Inc. designs, engineers and manufactures electronic control devices for military and commercial applications.
These devices are composed of a number of functional electronic units, which are miniaturized and packaged as plug-in components.
Control equipment is readily synthesized from these small component packages which solve the important system requirements of:
• Spatial adaptability
• Instant maintainability
• Training simplicity
• Ease of manufacture
SERVOMECHANISMS inc.*
Old Country & Glen Cove Roads, Mineola, N. Y.
Imperial Hway. & Sepulveda Blvd., Los Angeles Calif.
*Trademark

Announcing

GLASSEAL

REG. TRADE MARK



ACTUAL SIZE

HERMETICALLY-SEALED *Miniature* TUBULAR PAPER CAPACITORS by PYRAMID

Pyramid Type PG "GLASSEAL" miniature paper capacitors are assembled in metal tubes with glass-metal terminals. They will fully meet the most exacting demands of high vacuum, high pressure, temperature cycling, immersion cycling and corrosion tests.

TEMPERATURE RANGES: −55° to +125°C.

CAPACITANCE RANGE: .001 mfd. to 1.0 mfd.

VOLTAGE RANGE: 100 to 600 v.d.c. operating

Your inquiries are invited

PYRAMID Electric Company

GENERAL OFFICES and PLANT NO. 1
1445 HUDSON BLVD. • NORTH BERGEN, N. J.

PLANT NO. 2
155 OXFORD ST. • PATERSON, N. J.

VISIT OUR BOOTH NO. 208 AT THE IRE CONVENTION

BUSINESS BRIEFS

By W. W. MacDONALD

"If Russia Strikes, this will be primarily an electronics war, in which type of conflict our country can show to best advantage. Science covers a multitude of fields. To single out any particular one for emphasis may seem out of place. However, in this world crisis, it is realistic to single out the field of electronics as of special importance.

"Electronics includes radar, automatic sighting for fire power, guided missiles, defense against the submarine and automatic controls of countless kinds. In World War II, electronics had a sensational start but did not get far beyond an infant industry. Numerous postwar applications came along, the best known being television. Now a great new stimulus will come from the defense program, and as a result, electronics will emerge as a mature industry. The permanent, peacetime significance for all American industry will be great.

"Statistical estimates of war orders in electronics are difficult to make. . . . The best judgment at the moment is that the value of electronic equipment per man in uniform will be at least three to four times as great as that in the last war. Quite possibly this ratio may have to be revised upward as the events of 1952 and 1953 unfold."—Economist *Lionel D. Edie*

"The Impact of rapidly increasing national defense orders has so far been felt only (largely) in the acceleration of current military production and expansion of research and development work. Volume of sales to the armed services has not yet increased (much)."

So says Charles F. Adams, Jr. of Raytheon in a statement to stockholders. Words in parentheses are ours and, with this much latitude, the statement represents a fair picture of the extent to which the mobilization program has affected most manufacturers in the field of electronics at this writing.

Late January Meeting of the Electronics Equipment Industry Advisory Committee with Munitions Board and military officials at the Pentagon highlighted problems businessmen on the one hand and government men on the other are trying to solve by mutual co-operation.

Industry spokesmen emphasized the necessity for speeding up the placement of orders to preserve engineering personnel and labor forces, suggested closer coordination by the various services, urged faster contracting procedures and the development of programs to establish more subcontracting supply sources.

Government spokesmen said every effort is being made to spread procurement over a larger number of plants, emphasized that negotiation of contracts rather than the competitive bid system could now be widely used to speed up placement of orders, said that money on hand was not enough to avoid all dislocation during the conversion from civilian to military manufacturing but soon might be.

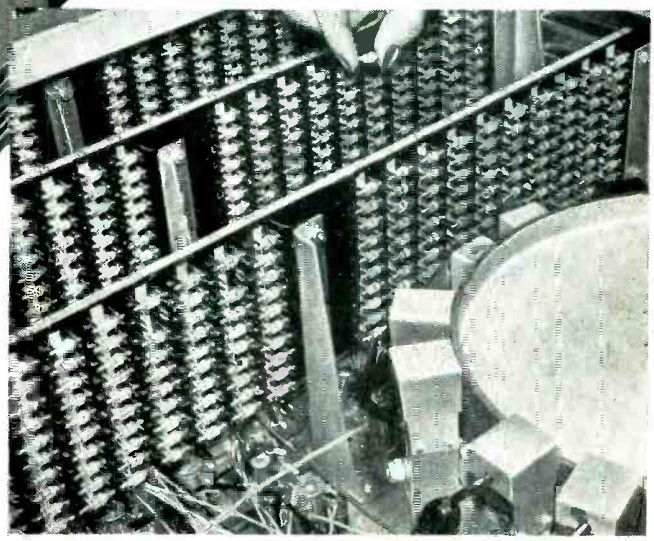
Munitions Board Electronics Equipment Industry Advisory Committee consists of the following men:

B. Abrams, *Emerson*
W. R. G. Baker, *GE*
M. F. Balcom, *Sylvania*
A. A. Berard, *Ward-Leonard*
E. W. Butler, *Federal Tel.*
R. W. Carter, *Carter Motor*
M. Cohen, *Sickles*
A. Crossley, *Electro Prod.*
R. O. Driver, *Wilbur B. Driver*
H. A. Ehle, *IRC*
R. C. Ellis, *Raytheon*
W. Evans, *Westinghouse*
F. M. Folsom, *RCA*
P. V. Galvin, *Motorola*
G. M. Gardner, *Wells-Gardner*
R. A. Graver, *Admiral*
W. J. Halligan, *Hallicrafters*
R. F. Herr, *Philco*
E. K. Foster, *Bendix*
A. P. Hirsch, *Micamold*
H. L. Hoffman, *Hoffman Radio*
J. J. Kahn, *Standard Trans.*
J. Kruesi, *American Lava*
F. R. Lack, *WE*
W. A. MacDonald, *Hazeltine*
T. Meloy, *Melpar*
H. L. Olesen, *Weston*
A. D. Plamondon, Jr., *Indiana Steel*
R. C. Sprague, *Sprague Elec.*
A. E. Thiessen, *GR*
C. A. Warden, Jr., *Superior Tube*
G. E. Wright, *Bliley*

Manpower is already critical in our highly specialized technical

This "brain" can stump a thousand experts

Hundreds of Sylvania Germanium Diodes simulate the synapses of the human brain, giving the machine the ability to compute, make comparisons and form decisions based on those comparisons.



SYLVANIA Germanium Diodes speed "thinking processes" of the new compact MADDIDA* Computer

This latest electronic computer, made by Northrop Aircraft Inc., is smaller than an average desk, yet it can surpass the efforts of a thousand expert mathematicians.

In a few seconds, the machine can solve complex problems requiring months or even years on standard desk calculating equipment.

Contributing to the amazing speed and to the compactness of this machine are several hundred Sylvania Germanium Diodes. Set snugly in short rows, these diodes actually function as ultra-high speed relays, shunting strings of numbers or instructions about among the vacuum tubes.

The small size of Sylvania diodes also permits compact packaging and worthwhile economies in design cost while assuring maximum efficiency of operation.

Let us acquaint you with some of the other important uses for Sylvania Germanium Diodes. Perhaps they can help you solve cost or design problems. For detailed data concerning the complete line of Sylvania Germanium Diodes, mail the coupon TODAY!

*The name MADDIDA is derived from "Magnetic Drum Digital Differential Analyzer."

Sylvania Electric Products Inc.
Dept. E-1003, Emporium, Pa.

Please send me your new 8 page catalog listing characteristics of all Sylvania Germanium Diodes.

Name ______________________

Street ______________________

City __________ *Zone* ____ *State* ______

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 · FIVE DECADES OF PROGRESS · 50th ANNIVERSARY

SYLVANIA ELECTRIC

FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS field. At the top of the Air Force's list of 18 types of officers most needed in the current expansion program is the word "electronics"; radar and radar maintenance heads the list of 8 needed types of airmen.

Unconfirmed but plausible is the rumor that a well-established firm in our field has offered to hire all electronic engineers in the graduating class of a western university. And that another firm, not so well established, is attempting to hire several hundred electronic engineers in the hope that if they can get engineers they can get government business.

Civilian Defense, not yet cohesive on a national, state or city basis insofar as communications is concerned, appears to wait upon assignment of radio frequencies linking at least two of the three levels of government together in the event wires go down. Action re amateurs (p 148) is just one necessary step.

A Federal Civilian Defense Administration committee says no instruments suitable for high-intensity radiation measurements immediately after an atomic attack are presently available. Low-intensity measurements can, however, be made in the weeks that follow such an attack by means of existing instruments.

Sale of 2-meter transmitters and receivers to people who are not amateurs indicates a new market for emergency communications gear. Similarly, a civilian defense market is developing for electronic megaphones.

Korean Night Attacks have renewed the interest of our military men in infrared detection apparatus such as the "sniperscopes" and "snooperscopes" employed with considerable success at Okinawa in the last war. Look for new development and production contracts in this field in the near future. And increased demand for the special batteries involved.

Along the same lines, we hear that conventional electronic hearing aids have considerable virtue in detecting the presence of infiltrating forces. Minor modification of design could greatly increase military effectiveness.

Test Equipment and maintenance procedures must be developed in step with new military electronic equipment or such equipment will be limited in its effectiveness. This is the warning of E. U. Condon of the National Bureau of Standards, who points out that in World War II many radar sets operated for extended periods at half their potential range.

Critical Materials are, we understand, conserved in a still experimental Philco television receiver design that makes wider use of selenium rectifiers, voltage doublers and new circuits, especially for synchronizing and deflection.

More detail later in, we hope, our feature pages.

Transistors, according to a report just released by the Department of Commerce, may achieve their first big-time volume in the trigger circuits of digital computers.

More Than 4,000,000 radiotelephone contacts with pilots in flight were made by CAA aircraft communicators in the first eight months of 1950, an increase of 224 percent over the similar period in 1949.

IBM, maker of business machines, has just used its 2,313,126th electron tube.

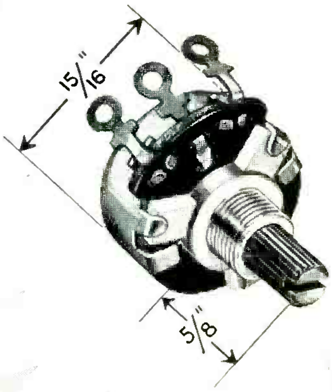
A British Subscriber has just secured an American patent covering a new type of connector which appears to be unique in that both parts are identical, facilitating interchangeability. He wants to contact interested manufacturers.

We'll be glad to provide the introduction.

TV Therapy is, according to officials of a Pennsylvania hospital, helping bring mildly psychopathic patients back to normal.

And in some cases, we hasten to add, vice versa.

Service Beyond Expectations!



New Development In Mallory Midgetrol* Minimizes TV Drift!

THE 15/16" MALLORY MIDGETROL

(Power rating ½ watt)

Electrical characteristics specially designed for critical applications in television, radio and other circuits. Insulated shafts are knurled for ease in adjustment. Current-carrying parts provide 1500 volt insulation . . . 15/16" diameter saves space. Precision-controlled carbon element provides smooth tapers, quiet operation, accurate resistance values, less drift in television applications.

*Trade Mark

The Mallory Midgetrol now embodies a new technique in variable resistor manufacture . . . providing precise control of drift under high humidity conditions. It involves a new treatment of the carbon element, assuring uniform dispersion of talcum-fine particles over a special phenolic base with an extremely low factor of moisture absorption. As a result, drift is held within very close limits...well within the requirements for TV picture stability. *This feature will obviously eliminate a troublesome source of field service problems.* It is an important addition to the desirable characteristics described at the left.

That's service beyond expectations!

Mallory's electronic component know-how is at your disposal. What Mallory has done for others can be done for you!

Television Tuners, Special Switches, Controls and Resistors

P. R. MALLORY & CO., Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

CROSS TALK

▶ **M=MMM** . . . Mobilization of our war resources involves men, materials and machines. So far as the electronics industry is concerned the recent news in these departments is, respectively, bad, good and fair. The manpower situation is bad. If we are to absorb the 5-to-10-billion-dollar annual load of military production that is now on paper, our most serious shortage is trained technical manpower. In the face of this certain fact, we find students in engineering colleges deserting their studies and enlisting in droves to escape service as foot-soldiers in favor of service as airmen or sailors. A belated promise to permit choice of service, after completion of the current college year arrested, but did not stop, this exodus. It should be stopped entirely and quickly. We need an enlightened program of student deferment (the Hershey plan makes sense to us). But we need it now, not after we lose a year's supply of young engineers.

The materials situation, as we see it, is good. Domestic production must be cut back, due to lack of materials. This is inevitable; the only danger is that it may be cut back too soon and interrupt the flow of production. This danger seems much less likely in view of the recent action by the National Production Authority in avoiding a shut-down in the RCA Harrison plant. Industry and government seem to be working well together on this aspect. Industry has to have a well-documented story, and no nonsense. But granted a little hard work in getting convincing facts together, relief can be obtained. Amen!

As to machinery, fair is the word. We have a vastly expanded plant capacity in this business of ours, based almost entirely on peacetime production of television sets. To the extent that this capacity can be used, we are in good shape. But to the extent that special items must be made for new military designs, we are in poor shape. It takes a year and a half to build a plant for making subminiature tubes, and millions of dollars on the line. If the predicted military consumption of subminiatures materializes, we'll need at least one such new plant, maybe more, before 18 months are up. But official action on new plant construction is slow. If we start now, we can meet the demand. Start we must!

▶ **SEQUENTANEOUS** . . . Looks like a new term is needed to describe color television systems. Time was when the systems were separate and distinct: CTI, CBS and RCA were sequential, by lines, fields and dots, respectively. The 1946 three-channel RCA system and the 1950 GE (Dome) system were simultaneous. But now the sharp lines are being broken down. Largely as a result of the Hazeltine work on the RCA dot-sequential system, it has been realized that the RCA system is in fact a simultaneous system, not only in the by-passed monochrome portion of the system, but also in the interspersed color signals. In fact, it appears that the difference between the GE and RCA systems lies largely in the terminal apparatus, not in the principle of spectrum utilization. It is, in fact, easy to show that the color signals in the dot-sequential system are present continuously and simultaneously and that the dot-sequential pattern is merely a form of interference between the separate carriers. Professor Everitt reminds us that the CBS system can also be considered simultaneous, in which each of the continuously-present color carriers cancels out in two fields out of three. Many think that this latter concept is stretching things, and there certainly is a difference in the manner in which the systems can be used practically. A lot of thought is needed to straighten out the concepts. Pending a definitive statement of what system does what and how, we're disposed to call the whole bunch of 'em simulquential systems.

▶ **EXAGGERATED** . . . As we shall announce in more detail in a later issue, the staff of this journal is currently engaged in a monumental indexing effort which has led us to examine critically the indexes of other periodicals. To our surprise, looking over the 1950 index of the *Proceedings of the IRE*, we came across this entry:

Obituaries: Zworykin, Vladimir K., April, p. 447. A hurried check in the April issue reassured us; Dr. Zworykin's demise had been slightly exaggerated. He had, rather, been inducted into Eta Kappa Nu.

Latest Developments

New laboratory experiments are outlined. Circuit of a practical generator is given. A short-range portable communication device using a xylene-filled tank for ultrasonic diffraction is also described

By ARTHUR R. LAUFER

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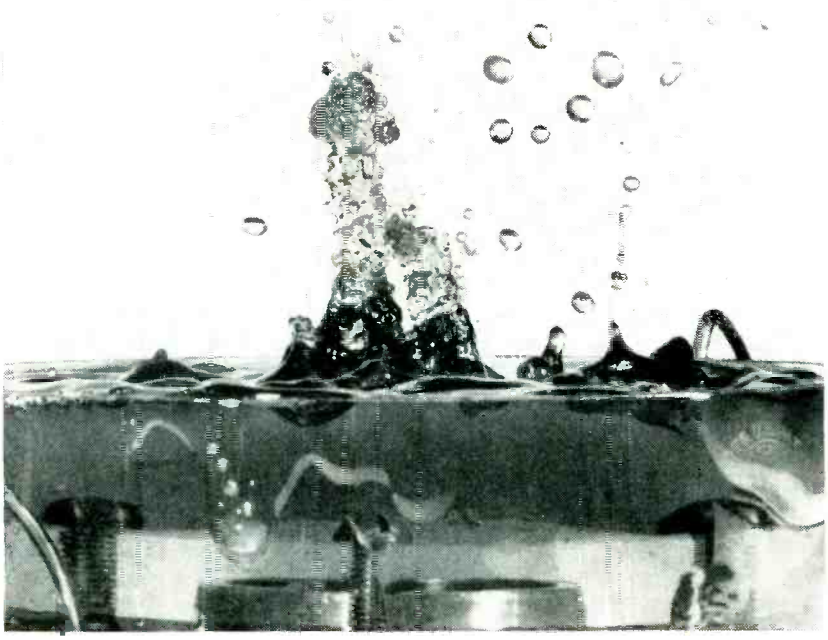
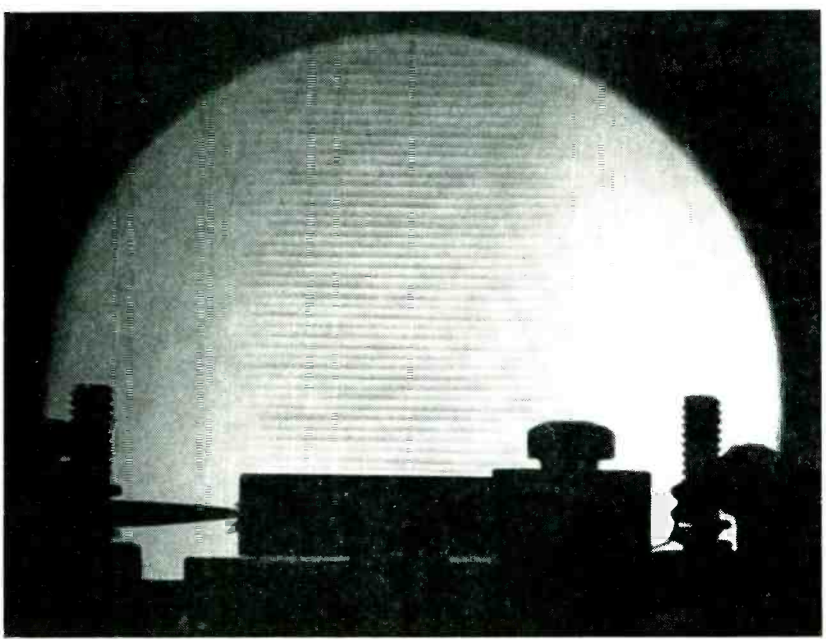


Vertical beam of ultrasonic energy radiated upward through a liquid raises a mound of liquid several inches above the surface level and shoots droplets out to greater heights



Photograph of plane-parallel regions of compression and expansion in air above a vibrating quartz crystal, taken by I. F. Zarimann

PHENOMENA associated with intense ultrasonic waves are no longer scientific curiosities and have been put to a variety of applications. Among recent patents is one for a washing machine using ultrasonic agitation to launder clothes.

Ultrasonic energy has been used to produce alloys of metals which are not ordinarily miscible. A new soldering iron uses ultrasonic vibrations to destroy refractory oxide film and permit soldering aluminum without flux. Sterilization of foods and coagulation of aerosols such as mist and smoke are subjects of ultrasonic investigation.

Waves generated by a circular piston source vibrating at audible frequencies spread out from the source in all directions and will bend around corners. At higher frequencies the waves assume directional characteristics with more of the wave energy propagated in certain directions than others and with less bending. At very high frequencies the energy is concentrated in a cone whose angle becomes smaller as the ratio of wavelength to diameter of the piston source decreases. Such short waves are propagated essentially in a given direction with negligible bending.

Concentration of ultrasonic energy into a cone makes it possible to produce beams of high intensity, defined as the energy passing through a unit area per unit time. Within the past few years ultrasonic sources have been built with outputs of 50 watts of acoustical power per square cm and beams of radiation have been focused to yield

in ULTRASONICS

LOOKING AHEAD

Ultrasonics, still in its infancy, has intrigued the imagination of many electronic engineers, as indicated by correspondence and subscriber calls. This article describes recent work which shows promise for future application in research, industry and communications

intensities of thousands of watts per square cm.

Ultrasonic Generators

In the piezoelectric-type generator the high-frequency voltage output of a vacuum-tube oscillator is applied to electrodes on opposite faces of a properly cut crystal and produces periodic changes in the thickness of the crystal. When the oscillator is tuned to the natural resonant frequency of the crystal powerful mechanical vibrations result and a beam of ultrasonic waves is radiated through the medium surrounding the crystal.

In the high-power ultrasonic generator now in use at the University of Missouri, Fig. 1, the input to the rectifiers is produced by a 7.5-kva pole transformer. The other power-supply components are housed in the black panel rack, Fig. 2. The output of this power supply, which can be continuously varied from 0 to 3,000 v, is applied to the two 304-TL tubes in parallel in the shunt-fed Hartley oscillator mounted in the grey panel rack.

The tank circuit capacitance provided by C_1, a 0 to 400 $\mu\mu$f variable air capacitor of 0.175-in. spacing, may be increased by a fixed mica capacitor, C_2, when lower resonant frequencies are desired[1]. Movable clips provide contact with coil tank, L_1, and permit variation of tank inductance and grid excitation to obtain the desired frequency range and optimum efficiency. The resonant frequency of the tank circuit can be continuously varied from about 800 kc to 5 mc.

Since the amplitude of vibration of the crystal is proportional to the voltage applied to it, coil L_2 is used as the secondary of a step-up transformer. No provision is made for tuning this secondary because a separate secondary coil is used with each crystal.

The secondary coil is mounted concentrically within the primary coil, each supported at its ends by steatite stand-off insulators equipped with corona shields. High voltage is conducted out of the panel rack by means of a large Pyrex feed-through insulator, and is applied to one face of the crystal transducer with the other face grounded. In this manner, as much as several kw of electrical power at many thousands of volts can be delivered to the crystal.

Crystals and Holders

Of the many crystals available, quartz provides the most stable source of ultrasonic energy. The resonant frequency of an X-cut quartz crystal is determined by its thickness, a greater thickness corresponding to a lower frequency

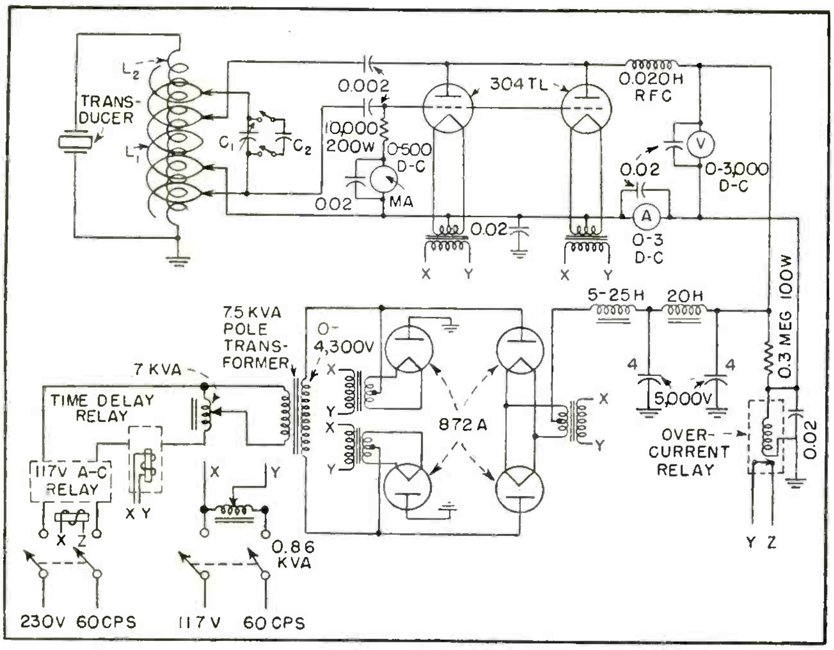


FIG. 1—University of Missouri's high-power ultrasonic generator. A bridge circuit is formed by the 872A's and the high-voltage winding of the 7.5-kva pole transformer

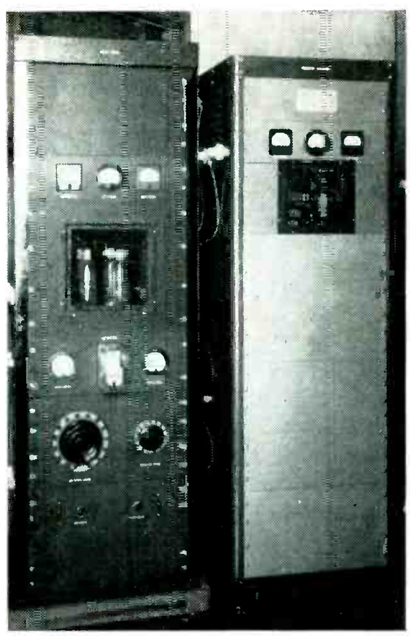


FIG. 2—3,000-v supply (left) feeds Hartley oscillator (right)

and a higher cost. Most of the manufacturers of standard radio crystals also provide ultrasonic quartzes ground to the desired frequency and plated with metal electrodes on both major surfaces.

A one megacycle circular X-cut quartz of 1½-in. diameter, such as that shown in the foreground of Fig. 3, retails for about fifteen dollars and is adequate for most of the experiments to be described. For the optical experiments a 5-mc crystal is preferable and can be purchased at even lower cost.

Two of the many possible forms of crystal holders are illustrated in Fig. 3 and 4. In the simple form of Fig. 3 the crystal rests on a brass plate serving as the lower electrode. The upper electrode, a one-mil copper foil, is supported and pressed lightly against the quartz by a wire which is itself supported by a stand-off insulator mounted on a brass plate. In order to minimize sparking between the electrodes, the transducer rests in a dish of xylene, carbon tetrachloride or some other liquid of high dielectric strength. When the high-frequency voltage is applied to the electrodes, the vibrating quartz sends a beam of ultrasonic waves vertically upward through the liquid medium.

The more advanced form of crystal holder of Fig. 4, shown in cross-section in Fig. 5, is so designed that the useful ultrasonic output of the crystal is greatly enhanced. The quartz is mounted between two hollow brass cylinders which make

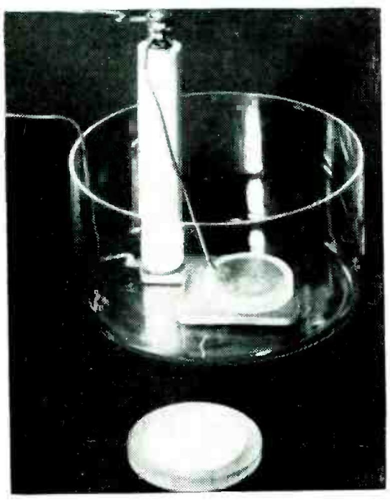


FIG. 3—Simple crystal holder, with 1-mc circular X-cut quartz crystal of 1½-in. diameter shown in foreground

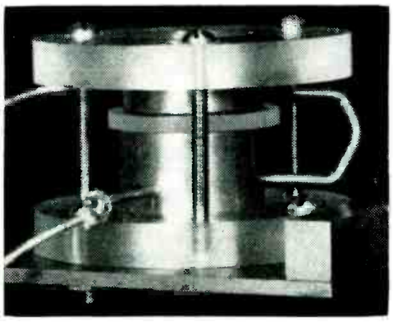


FIG. 4—Improved crystal holder which allows higher energy output because of reduced voltage gradients and air backing

electrical contact with the electrode platings on the crystal. The edges of the cylinders are rounded to reduce the large voltage gradients associated with the edges of the thin platings themselves. Higher voltages can be applied to the electrodes and the ultrasonic energy output proportional to the square of the voltage is increased. The useful energy output is also increased by the air backing for the crystal.

Energy Considerations

Little ultrasonic energy is radiated into air by the quartz as a consequence of the great difference in acoustic impedance (density × sound velocity) of the two media, whereas in the simpler form of holder an appreciable amount of energy is lost to the brass plate. Energy radiated upward into the dielectric liquid surrounding the holder and through the hole in the Plexiglas disk is thereby materially increased. A safety spark gap is employed to protect the crystal and the entire crystal holder is mounted on a brass plate.

If the crystal is excited at its resonant frequency and held in such a position that a vertical beam of ultrasonic energy is radiated upward through the liquid, the magnitude of energy in the beam can be visually demonstrated. At the liquid surface the ultrasonic beam raises a mound of liquid several inches above the level in the dish and droplets are shot out of the mound to far greater heights. Intensity of vibration in the liquid is so great that alternating pressure amplitudes as high as a thousand atmospheres and particle accelerations as high as a million times the acceleration of gravity can be achieved. This energy can be employed to produce a variety of interesting effects.

Laboratory Experiments

If the stem of a broken wine glass is held in the vibrating mound with the base of the glass upward and a fine powder such as lycopodium is sprinkled on the disk-like base, the powder will form a beautiful system of concentric circular rings delineating the nodal lines in the pattern of vibration of the base. A similar effect can be obtained by merely dusting the inner surface of a champagne glass with the powder. The ring system will appear when the base of the glass is touched to the mound.

If the closed end of a glass tube about a foot long and half an inch in diameter and coated inside with a layer of heavy oil is dipped into the mound the oil gathers itself into rings a millimeter or two apart, lining the tube from top to bottom.

A tapering glass rod, half a millimeter in diameter at the tip, with its butt immersed in the mound, transmits vibrations of such intensity that the rod will burn its way rapidly through a chip of wood. Heating is the result of friction and occurs only at the point of contact. The remainder of the rod feels quite cool to the touch but if it is squeezed, the frictional heating at points of contact with the fingers makes the rod feel too hot to hold.

For certain experiments it is necessary to conduct the ultrasonic energy from the mound into another liquid. A suitable container for the liquid can be made of a glass tube about an inch in diameter by cementing a thin disk of celluloid across one end to form the bottom of the container. If the base of this container is now held in the mound, its contents will be irradiated or "sonized" by the ultrasonic beam.

Candle wax and water are normally immiscible, but if a small amount of candle wax is melted and allowed to drip and solidify on the surface of water in a container and if the water is sonized, a rapid dispersion of the wax in the water will take place and yield a white suspension of unusual permanence. This

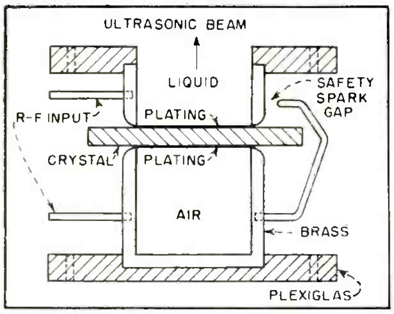


FIG. 5—Cross-sectional view of improved crystal holder, showing design details and materials used

experiment can be repeated with oil instead of wax and, similarly, the violent agitation will throw the oil down as a fine white cloud to form an emulsion of oil in water. A little mercury at the bottom of the container, with water above it, will be thrown up into suspension in the water when sonized. The water first becomes milky in appearance, then brown, and finally black.

If a volatile liquid such as benzol is sonized, another interesting effect can be observed. The ultrasonic energy throws up innumerable minute droplets to form a smoky white benzol fog with its surface in tumultuous motion, much like the cloud of fine spray projected upward by the shock wave from an underwater explosion of a depth charge.

If water containing an ice cube is sonized for a minute or two and then the cube is squeezed between thumb and fingers, it will break into small fragments, showing that internal liquefaction has taken place throughout the mass, an effect similar to the production of "rotten ice" by exposure to the sun.

Biological specimens are strongly affected by ultrasonic irradiation. Red blood corpuscles are quickly destroyed when suspended in water and sonized. The turbid mixture of blood and water becomes as clear as a solution of red aniline dye. Insects, small fish and frogs held under water and sonized are killed within a minute or two. Small forms of animal life such as Daphnia are also rapidly put to death and torn to shreds by the intense sound energy.

Low-Power Effects

Effects somewhat similar to those described can be achieved with a low-power generator if steps are taken to focus the ultrasonic beam. The low-power electronic oscillator may be built using the same circuit discussed previously with components of lower voltage and current ratings. An oscillator supplying the crystal with about twenty watts of r-f power at several hundred volts will give adequate performance. The ultrasonic beam can be focused with an ordinary watch glass. The concave surface of the watch glass, which may be about two inches in diameter, should be held in the beam so as to reflect the ultrasonic energy vertically upward toward the liquid surface. If the liquid level is adjusted to be exactly at the focus of the reflector, the liquid will be ejected from the surface in a thin stream rising high in the air and, at the same time, a dense fog will be produced.

Ultrasonic Heating

If the beam is focused on the surface of a piece of rubber or Plexiglas in the body of the liquid, the intense heating will produce small blisters on the surface and the material will have the characteristic odor of overheating when removed. Under the same circumstances a block of wax will melt in such a way as to show the conical focusing of the beam inside the block.

The low-power generator is particularly suited for demonstration of certain optical phenomena associated with ultrasonics. For the observation of these effects the crystal holder should be placed at one end of a rectangular tank, so that a horizontal beam of ultrasonic waves can be propagated along the length.

The long sides of the tank should be of plate glass and the tank should be filled with an optically transparent liquid of high dielectric strength. The end of the tank toward which the beam is directed should be covered with a pad of rubber to absorb the sound energy and therefore to prevent reflection of the beam.

Ultrasonic Diffraction

When ultrasonic waves traverse a liquid alternate regions of compression and expansion are produced parallel to the crystal surface corresponding, respectively, to regions of increased and decreased optical density. The closely spaced density variations act somewhat as the opaque and transparent regions or lines of a ruled optical-diffraction grating and serve to diffract light passing through the glass sides of the tank.

Optical arrangement for the observation of the diffraction of light by ultrasonic waves is shown in Fig. 6. A pair of condensing lenses brings the light from a lamp to a focus on a small hole in an opaque diaphragm with the illuminated hole then serving as the light source. The hole is situated at the principal focus of a large-diameter lens which renders the light parallel and sends it through the tank in a direction perpendicular to the path of the ultrasonic waves.

The beam of light is gathered by another large-diameter lens and brought to a focus, at which point

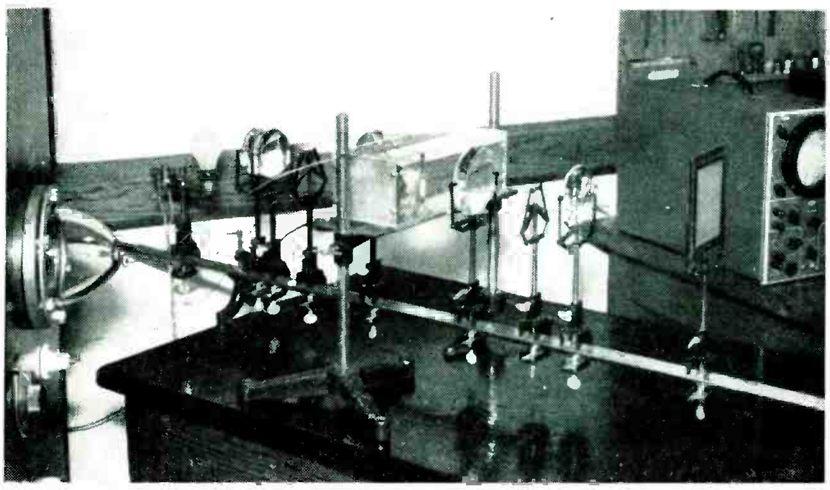


FIG. 6—Optical setup for observation of diffraction of light by ultrasonic waves

an opaque stop is inserted. The stop consists of a small spot of india ink on a strip of glass and serves to block the light beam when there are no ultrasonic waves in the tank. If voltage is applied to the crystal electrodes, however, the ultrasonic waves in the liquid diffract or bend the light out of its normal course so that it can pass around the stop and reach still another lens. This latter lens is so placed that it can produce an image of the median plane of the tank on a ground-glass screen.

This method of ultrasonic light diffraction was used by G. W. Willard of the Bell Telephone Laboratories to obtain the photographs reproduced in Fig. 7 and 8. Figure 7 (top photo) shows the beam generated by the quartz crystal at the left and absorbed in the rubber pad at the right after traversing the length of the tank. In the middle photo the beam is centered along the principal axis of a concave cylindrical brass reflector which converges the light to a sharp focus. The beam in the bottom photo is incident upon the same reflector but not along its principal axis, and the well-known effect of spherical aberration is clearly evidenced by the poor focus.

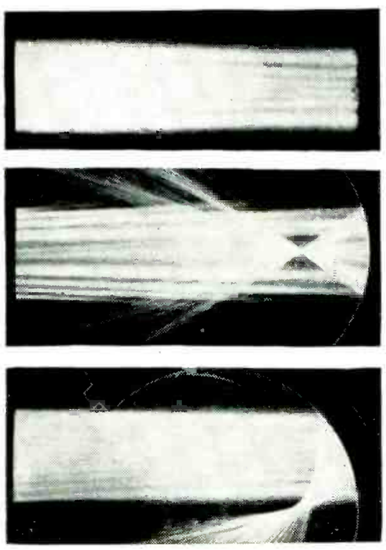


FIG. 7—Focusing of ultrasonic beams generated by crystal at left and absorbed in rubber pad at the right, as accomplished by G. W. Willard of Bell Telephone Laboratories

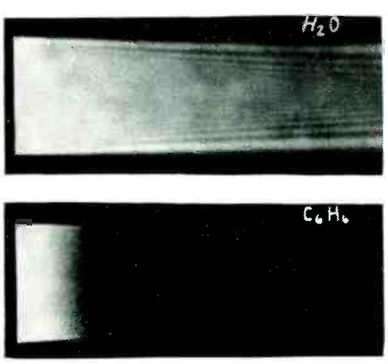


FIG. 8—Difference in attenuation of ultrasonic waves in different liquids

The great difference in absorption or attenuation of ultrasonic waves in different liquids is illustrated in Fig. 8. The upper photograph indicates that there is but slight absorption in water whereas the lower photograph shows that the ultrasonic beam is completely absorbed after traversing only a short distance in benzene.

Diffraction Applications

Not only is the diffraction of light by ultrasonics used in physical and chemical research, but it is also used in the light-modulating element in the British Scophony tv system and in a short-range communication device developed for military use.

These applications depend on the fact that the amount of light diffracted out of the zero order (undeflected) image formed by the lenses can be changed by merely changing the amplitude of the ultrasonic waves, that is, by changing the magnitude of the voltage applied to the crystal. With zero voltage applied to the crystal all the light is undiffracted and is focused by the lenses into a small spot, the zero order image. With a small voltage applied to the crystal some of the light is diffracted out of the zero order image. As the voltage is raised more light is diffracted and therefore less light remains in the zero order image. This continues until at a given voltage, about 100 volts in a typical case, little or no light remains in the zero order. The intensity of light in the zero order is therefore inversely proportional to the voltage on the crystal; hence, if the r-f voltage is amplitude modulated, the light in the zero order is likewise modulated.

The short-range communication device developed at Yale University by Humphreys, Watson and Woernley operates on this modulation principle to permit secret communication over short distances. The transmitter, the receiver, and a 6-volt vibrator pack yielding 40 watts of power, are all mounted in a single portable well-shielded unit. The ultrasonic diffraction cell of the transmitter consists of a vertical xylene-filled tank with glass sides and a 7-mc quartz crystal resting on the stainless-steel tank bottom. The upper electrode is formed by layers of copper and gold evaporated on the crystal. Electrical contact is made by means of a spring-bronze fork soldered to the gold surface with Wood's metal.

About one watt of r-f power is applied to the crystal by a conventional electron-coupled oscillator with one stage of amplification. A microphone is used with a 6V6GT tube to apply 25-percent modulation to the amplifier stage. Light from a 6-volt Mazda ribbon lamp operated at 8 volts is rendered parallel by a 6-cm diameter achromatic lens and completely fills the cell.

Light from the transmitter is beamed out toward the receiver, initial contact being aided by rifle telescopes mounted on the units. The light beam is received and brough to a focus by an 8-in. diameter lens. Situated at the principal focus of the lens, and slightly in front of an RCA-918 photocell, is a ¼-in. hole in an opaque diaphragm. The photocell is followed by three 6SJ7 stages of audio amplification which energize a set of earphones in the output circuit.

With zero voltage on the crystal, all of the light from the transmitter is focused on the receiver's photocell. Voltage on the crystal gives rise to an upward beam of ultrasonic waves which serves to diffract the light so that less of it can pass through the diaphragm hole to the photocell. The speech-modulated voltage on the crystal modulates the transmitted light which, in turn, gives rise to a-f currents in the photocell and earphones. This communication system was developed to permit satisfactory conversation at a distance of 3,000 yards in daylight and 5,000 yards at night with a Corning infrared light filter.

REFERENCE

(1) P. H. Massaut, Distributed Capacitance Chart, ELECTRONICS, p 31, March 1938.

Paratrooper's teletypewriter

Field operation of the teletypewriter after assisted jump

New Military Aids

RECENTLY RELEASED from security classifications, the two equipments illustrated are highlights of development work of the Signal Corps Engineering Lab.

An offshoot of closed-circuit television equipment used to monitor dangerous operations such as the test firing of long-range rockets, the Video-Phone provides two-way aural and visual communication.

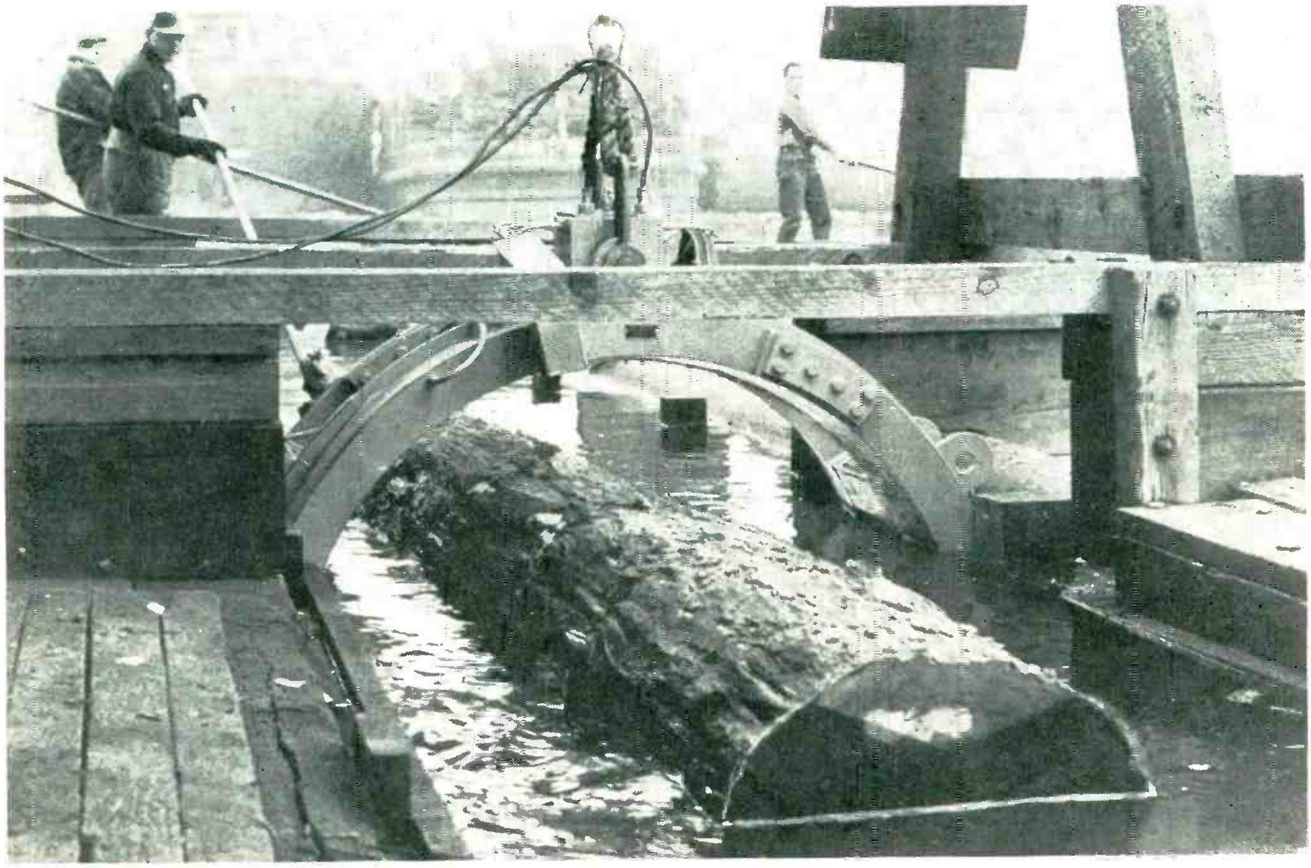
A portable teletypewriter, operating continuously at 100 words per minute from a tape, weighs but 45 pounds and is one-fourth the size of its 225-lb predecessor. A parachutist can carry it on a jump from a plane. It is capable of receiving and transmitting 66 percent faster than earlier types.

An experimental camera, "Two-Minute Minnie", employs an electrostatic, electro-photographic process in which light is recorded on a selenium-coated metal plate which has been sensitized by an electric charge. Producing a finished 4 by 5-inch picture two minutes after the shutter is snapped, its plate requires no chemicals for processing and can be used repeatedly by merely wiping off the image. The camera and other gear will be displayed at the 1951 IRE National Convention.

The U. S. Air Force will display the parabolic static characteristics of a beam-deflection square-law tube on an oscilloscope. This type of square-law tube performs squaring operations on signals ranging in frequency from d-c to 40 mc and higher. Other applications which make use of the mathematical consequences of the squaring operation performed by the tube include linear modulators of the suppressed carrier type, 4-quadrant multipliers of the quadratic type, untuned frequency doublers, instantaneous phase meters, and square-law detectors.

Video-Phone, a two-way television-telephone system

Detecting Tramp Metal



Pair of large magnetic coils, one behind the other, used with GE metal detector for detecting missiles in logs up to 56 inches in diameter floating down sea-water flume at Fort Lewis, Washington. Electronic unit is in remotely located cabinet

By C. W. CLAPP

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DETECTION AND REMOVAL of tramp metal from materials in process is a problem that is yearly increasing in importance. The greater use of automatic machinery in processing lines increases the danger of product contamination from loose or broken machine parts. At the same time, the use of more expensive and complicated processing machinery renders the line more vulnerable to damage and breakdown from the presence of large pieces of tramp. Product quality is also adversely affected in most cases.

When the tramp metal is magnetic and is easily removed from the product material, a magnetic separation method may provide the easiest solution to the problem. With the increased use of stainless steel, manganese steel, and other nonmagnetic alloys in process machinery, this simple method is frequently of little help.

When the tramp metal is nonmagnetic, or when its removal from the product is not easy, electronic detection equipment is required to detect and locate the tramp metal which may then be removed manually or by other means.

While a number of different detection principles have been invoked by different workers, in this paper we will confine our attention to the principle employing an alternating magnetic field.

Theoretical Considerations

In the method under discussion, an alternating magnetic field is generated which fills the whole volume of space that is to be inspected. Any metal particle in this space then acquires a small magnetic dipole moment, the combined result of eddy currents and magnetic polarization induced in the particle by the inspection field. The external field of the induced dipole will in turn induce a small voltage in the coil or coils used to excite the inspection field. This voltage may be detected as a small change in the impedance of the exciting coils. Alternatively, the particle may be detected by the small voltage induced in a passive secondary coil

This article is based on a paper presented at the 1950 National Electronics Conference. The Conference paper will appear in the *NEC Proceedings*.

in Logs and Iron Ore

Analysis of problem of detecting a spherical metal particle in an alternating magnetic field, and two practical applications of the solution—detecting bullets and shell fragments in logs partially submerged in sea water, and detecting broken drill bits and other tramp metal in highly magnetic taconite iron ore

Table I Maximum-Loss Conditions

Material and Assumed Conductivity in 10^6 mhos	Assumed Permeability	$\left(\frac{\gamma}{\mu}\right)_m$
Copper (0.59)	1	2.5
Brass (0.13)	1	2.5
Lead (0.048)	1	2.5
Aluminum (0.36)	1	2.5
Mild Steel (0.077)	250	0.7
18-8 Stainless (0.025)	3	1.2
Manganese Steel (0.014)	3	1.2

or coils so placed as to link the external field of the induced dipole. In any method of detection using these principles, a fundamental problem is the calculation of the strength of the dipole moment induced in the particle.

Static Alternating Field

One of the classic problems[1] in magnetostatics involves the calculation of the magnetic polarization induced in a homogeneous spherical particle when placed in a uniform magnetic field of strength H_o. In solving this problem, it is found that the field external to the particle may be considered as the linear superposition of the original uniform field H_o and the field of a magnetic dipole of strength m located at the center of the particle. The dipole strength is given by

$$\bar{m} = \frac{3(\mu - 1)}{4\pi(\mu + 2)} VH_o \qquad (1)$$

where $V = \pi d^3/6 =$ volume of spherical particle in cm^3, $d =$ diameter of sphere in cm, $\mu =$ permeability of sphere relative to free space, and a horizontal bar over a symbol is used to emphasize its vectorial nature.

The solution of this same problem for the more general case where the applied magnetic field is alternating has been worked out by H. Poritsky in a separate paper now being prepared for publication.

According to Poritsky's results, when the applied magnetic field is $H_o\,\epsilon^{j\omega t}$, the complex induced magnetic dipole moment is given by

$$\bar{m} = \frac{3}{8\pi}\left(\frac{2\mu + 1 - W}{\mu - 1 + W}\right) V \bar{H}_o \qquad (2)$$

$$W = \frac{(\gamma + j\,\gamma)^2 \tanh(\gamma + j\,\gamma)}{(\gamma + j\,\gamma) - \tanh(\gamma + j\,\gamma)} \qquad (3)$$

$$\gamma = \pi\, d\, \sqrt{\mu\, \sigma\, f \times 10^{-9}} \qquad (4)$$

where $\sigma =$ conductivity of sphere in mhos, $\mu =$ permeability of sphere relative to free space, $f = \omega/2\pi =$ frequency of field and $d =$ diameter of sphere in cm.

The depth of current penetration (δ) is commonly defined as $\delta = 1/2\pi\sqrt{\mu\ \sigma\ f \times 10^{-9}}$. The quantity γ is thus equal to the ratio of the radius of the sphere to the depth of current penetration.

Because of the assumed spherical symmetry of the particle, the direction of m is parallel to H_o.

For the discussion to follow, it will be convenient to introduce the complex quantity

$$X + j\,Y = \frac{2\mu + 1 - W}{\mu - 1 + W} \qquad (5)$$

Then Eq. 2 becomes

$$\frac{m}{VH_o} = \frac{3}{8\pi} \times \frac{(2\mu + 1 - W)}{(\mu - 1 + W)} = \frac{3}{8\pi}(X + jY) \qquad (6)$$

In Fig. 1 the complex quantity $(X + jY)$ is plotted as a function of (γ/μ) for various assigned values of μ. Four special cases are of interest.

(*a*) $\gamma \rightarrow 0$ *(Static Case)*. This case arises if f, the frequency of the applied field, approaches zero, or if the conductivity of the particle is zero. In this case W has the constant value 3, and Eq. 6 becomes equivalent to Eq. 1, the solution of the static problem. This solution is represented in Fig. 1 by the points on the real axis between 0 and 2. Since the solution in this case is a positive real number, the induced moment m is in phase with H_o.

(*b*) $\gamma \rightarrow \infty$ *(High-frequency*

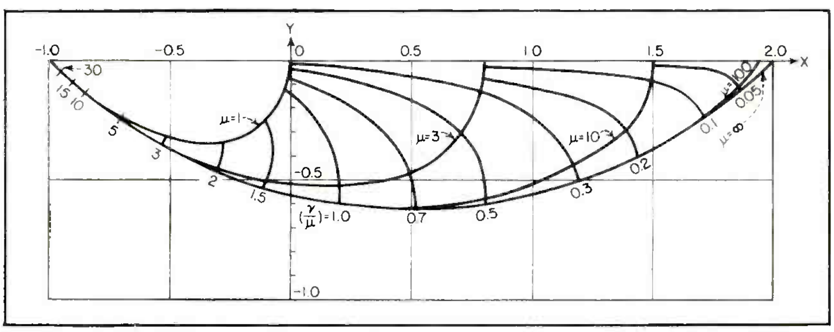


FIG. 1—Plot used in solving for the complex quantity $X + jY$ involved in finding the magnetic polarization induced in a spherical particle having various permeability values when in an alternating magnetic field

Case). This case arises if the depth of current penetration in the particle becomes very small in comparison with the radius of the particle, so that essentially no flux penetrates the sphere. In this case, the solution is represented by the single point $(-1 + j\,0)$, and the induced moment m is 180 degrees out of phase with H_o.

(*c*) $\mu = 1$ *and* γ *is small.* When $\mu = 1$, Eq. 5 becomes

$$X + jY = (3 - W)/W \qquad (7)$$

Expanding this in powers of γ for $\gamma << 1$, the asymptotic solution is

$$X + jY = -\frac{8}{315}\gamma^4 - j\frac{2}{15}\gamma^2 \qquad (8)$$

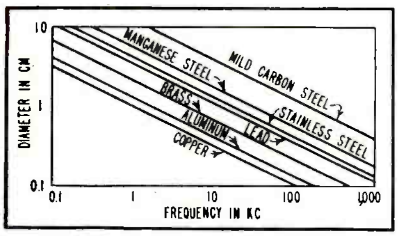


FIG. 2—Frequency for maximum loss component as a function of particle diameter

This solution is valid only for small values of γ. In this case the induced moment is derived solely from the eddy currents in the sphere. The phase angle of the moment m is essentially 90 degrees behind that of the applied field H_o. From this it may be seen that, for small values of γ, the principal effect of these eddy currents is to introduce energy losses in the system.

(*d*) *Maximum-loss condition.* It is of interest to determine the frequency of the applied field at which maximum losses occur in a particle of given diameter d. For this purpose the values of (γ/μ) corresponding to the minima of the curves of Fig. 1 have been read off for different common materials and given as $(\gamma/\mu)_m$ in Table I.

When the value of $(\gamma/\mu)_m$ for a particular material is known, the frequency required to produce maximum losses (at constant field strength H_o) in a particle of diameter d cm is given by

$$f_m = \frac{\mu\left(\frac{\gamma}{\mu}\right)_m \times 10^9}{\pi^2 d^2 \sigma} \qquad (9)$$

Values of f_m as a function of diameter d for different materials are plotted in Fig. 2.

Detection of Induced Dipole Field

So far we have considered only the interaction of the metal particle and applied field. In order to detect such a particle we must also consider the means used to generate the search field and to detect the induced field of the particle itself.

In Fig. 3 let the coil L_p be the means used to generate the search field, and let $\overline{H}_p$ be the magnetic field intensity in lines per cm² at a point P caused by a current of 1 ampere in L_p. Let the coil L_s be the means used to detect the presence of a metal particle in the field of L_p, and let $\overline{H}_s$ be the field that would have been produced at P by a current of 1 ampere flowing through L_s. Assuming the metal particle is so small that the fields $\overline{H}_p$ and $\overline{H}_s$ are essentially uniform over the volume of the particle, it may then be shown that, with unit current in L_p, the voltage in volts induced in L_s as the result of field distortion caused by a small metal sphere at P is given by

$$e_s = -j\,\omega\frac{3V}{8\pi}(X + jY)(\overline{H}_p \bullet \overline{H}_s) \times 10^{-8} \qquad (10)$$

where $(\overline{H}_p \bullet \overline{H}_s)$ is the scalar product of the two vectors $\overline{H}_p$ and $\overline{H}_s$.

It may therefore be seen that the introduction of the metal particle into the field of the two coils results in a change in their mutual impedance given in ohms by

$$\Delta Z = j\omega\frac{3V}{8\pi}(X + jY)(\overline{H}_p \bullet \overline{H}_s) \times 10^{-8} \qquad (11)$$

Single-Coil System

Let us consider now the case where L_p and L_s are superimposed, the same coil being used both to generate the search field and to detect the induced field of the particle[2,3]. In this case $\overline{H}_p = \overline{H}_s$ and the presence of the particle produces a change in the self-impedance of the coil given in ohms by

$$\Delta Z = j\omega\frac{3V}{8\pi}(X + jY)\,|H|^2 \times 10^{-8} \qquad (12)$$

where $|H|$ is the magnitude of the field produced at the position of the particle by a current of 1 ampere in the coil. If the particle is located at the center of a coil of n turns whose diameter is D cm and whose winding cross-section is small in comparison with D, then the expressions for lines per sq cm and for impedance in ohms are

$$|H| \cong \frac{4\pi n}{10D} \qquad (13)$$

$$\Delta Z = j\omega\frac{6\pi n^2 V}{D^2}(X + jY) \times 10^{-10} \qquad (14)$$

The self-inductance in henrys of such a coil in the absence of a metal particle can be approximated by

$$L_o = \pi^2 K n^2 D \times 10^{-9} \qquad (15)$$

where K is a dimensionless factor depending only on the shape and size of the cross-section of the coil in relation to the mean coil diameter D. For typical compact coils, K varies between 0.8 and 2.0. Assuming that the impedance of the coil Z_o is approximately equal to $j\omega L_o$, the fractional change in impedance of the coil due to a metal sphere of diameter d at its center is

$$\frac{\Delta Z}{Z_o} = \frac{d^3 (X + jY)}{10\,K\,D^3} \qquad (16)$$

The fractional change in impedance forms a convenient figure of merit for a metal detector problem since, in general, the size of this ratio determines the ease with which the particle may be detected. From Eq. 16 it is seen that, for a particle at the center of the coil, this ratio varies as the cube of the ratio of the particle diameter to the coil diameter. The magnitude of the metal detection problem can be appreciated by noting that to detect a particle whose diameter is one percent of the coil diameter, it is necessary to detect a change in coil inductance of the order of 1 part in 10 million.

If the particle is moved to a different point in the field, the fractional change in impedance will assume a new value proportional to $|H|^2$ at the new point. For points

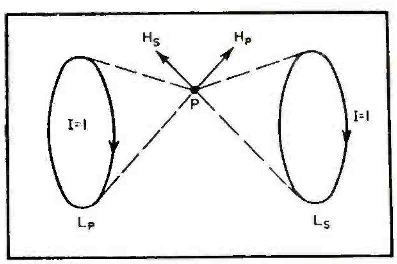


FIG. 3—Generation of metal detector field

on the axis of the coil and a distance x from its center, we find

$$\frac{\Delta Z}{Z_o} = \frac{d^3 D^3 (X + jY)}{10 K (D^2 + 4 x^2)^3} \qquad (17)$$

hence at large distances from the coil, the sensitivity falls off as the sixth power of the distance.

Figure 4 shows a set of field contours plotted to show points of equal detection sensitivity in the field of a single circular coil. The quantity d noted on the contours is proportional to the particle diameter needed to produce a given signal level in the coil. The quantity d is therefore proportional to $H^{-2/3}$.

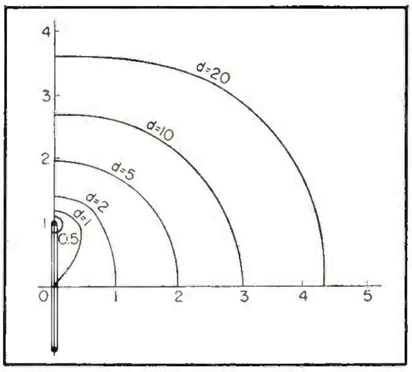


FIG. 4—Signal contours for single circular coil

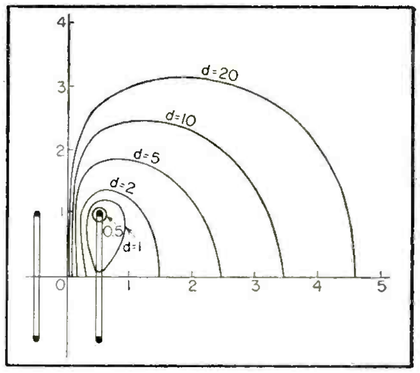


FIG. 5—Signal contours for pair of circular coils in bridge connection

Multiple-Coil Systems

While metal detectors have been built using the single-coil arrangement, it is frequently found advisable, when maximum stability is desired, to use two or more coils in a balanced bridge arrangement. By this means the effects of spurious changes in coil impedance due to such factors as ambient temperature changes may be minimized.

Let L_1 and L_2 be two similar coils connected in adjacent arms of a simple Wheatstone bridge circuit. Assuming the coils carry approximately equal bridge current, the total exciting field is given by $H_p = H_1 + H_2$ where H_1 and H_2 are the fields produced by unit bridge current in the coils L_1 and L_2 respectively. Since the output or detector current in a bridge always flows in a direction opposite to the exciting current in one of two adjacent bridge arms, the field corresponding to the detector field H_s in Fig. 3 is given by $\overline{H}_s = \overline{H}_1 - \overline{H}_2$. Inserting these values of $\overline{H}_p$ and $\overline{H}_s$, Eq. 11 becomes. . . . .

$$\Delta Z = j\omega \frac{3V}{8\pi} (X + jY) \overline{(H_1 + H_2)} (\overline{H_1 - H_2}) \times 10^{-8}$$
$$= j\omega \frac{3V}{8\pi} (X + jY) (|H_1|^2 - |H_2|^2) \times 10^{-8} \qquad (18)$$

Field contours for two such coaxial coils separated by a distance equal to their radius are shown in Fig. 5. Since the field contours are independent of the direction of the exciting current in either coil, it is usual to connect the coils in the polarity which minimizes external inductive interference.

In addition to the two simple coil arrangements discussed here, many more complicated systems have been described in the literature[4,5,6]. These systems are usually designed to produce the most uniform detection sensitivity over the volume of space to be inspected, although other problems such as ease of manufacture and mechanical stability must also be considered. Any of these coil arrangements may be analyzed for the case of a spherical metal particle by further application of the method described above.

Shape Factor

In practice, the shape of the particle to be detected frequently differs from that of the ideal sphere assumed up to this point. An elongated particle may give a signal either larger or smaller than a spherical particle of the same volume depending on the material, its orientation in the field and the frequency of the field. Lack of space prevents discussion of this important but complex phase of the metal detection problem at this time. In practice it is usual to design for a spherical particle whose size has been determined empirically for the particular detection problem at hand.

Metal Detection in Logs

As an example to illustrate the application of the principles discussed above, let us consider a problem requiring the detection of tramp metal in logs. In the particular example to be described, the logs were cut from forests that had been used for military exercises and were severely contaminated with bullets, shell fragments and some unexploded shells.

To be suitable for this application, the equipment had to be capable of detecting the equivalent of a ⅝-inch diameter steel ball anywhere in the body of a log 56 inches in diameter. For ease in handling, the logs were to be passed through the inspection area while floating in water. The inspection coils were therefore required to operate while partially submerged in sea water. The coils and detector were required to have the minimum of sensitivity to mechanical shock and to be capable of operation without frequent adjustment.

To meet the requirement of high sensitivity in combination with high stability, a balanced mutual-inductance type coil system was chosen. For best mechanical stability, and because of the shape of the material to be inspected, coaxial circular coils were used with the logs passing completely through the coils in the axial direction. A five-foot inside coil diameter was selected to permit passage of the largest log through the coil assembly. To permit operation under changing weather conditions without frequent readjustment, an automatic balancing circuit was included in the detector. This circuit, to be described in detail later, maintained the coils in the most sensitive balance condition over much wider variations in temperature than would otherwise be possible.

Since the coils were to be partially submerged in sea water, a large change in the conductivity of the space surrounding the coils was to be expected each time the end of a log approached. To reduce eddy currents in the water and thus avoid false alarms from this cause,

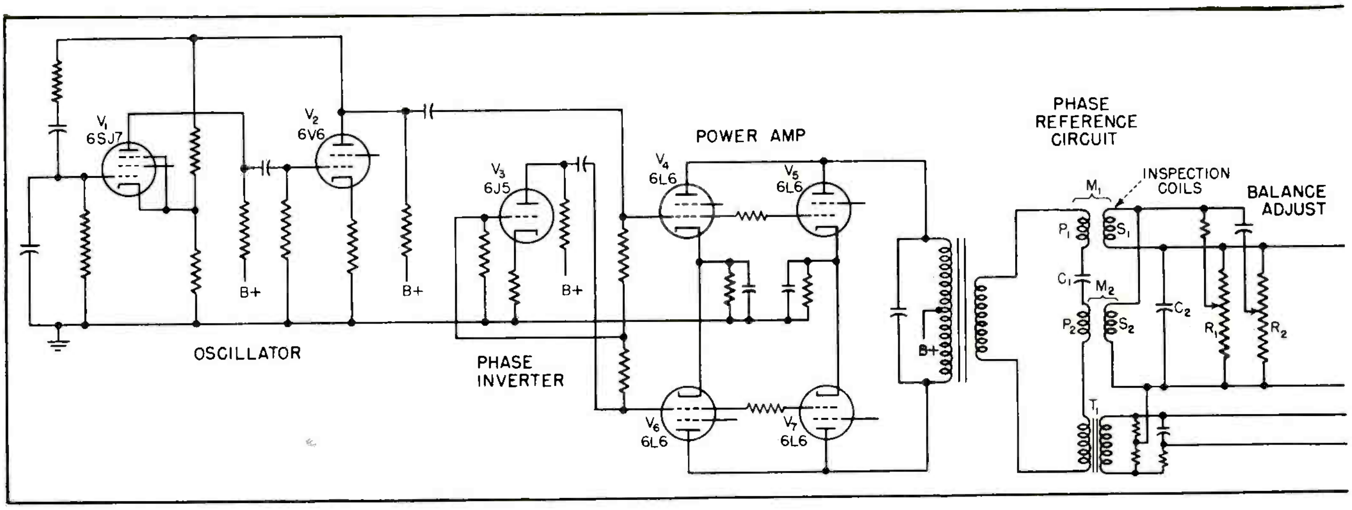


FIG. 6—Simplified circuit of metal detector developed for finding shells and other relatively large metal objects

the frequency of the coil current was made as low as practicable.

Even at the low frequency of 25 cps used in this detector, an approximate calculation using Eq. 4, 6 and 8 shows that a 36-inch sphere of sea water having a conductivity of 0.05 mho per cm could be expected to produce a signal roughly equal to that produced by a ⅜-inch sphere of iron. (An exact calculation cannot be made using these equations because the exciting field is not uniform over the volume of the water sphere.)

Additional discrimination against the sea-water signal was therefore necessary. It was secured in this instance by making use of the fact that the water signal is almost 90 degrees out of phase with the signal produced by an iron particle. To aid in discriminating between the two signals, the detector alarm was operated from a phase-sensitive rectifier adjusted to be relatively insensitive to signals having the phase of the water signal.

The circuit diagram of the detector is shown in simplified form in Fig. 6. The 25-cycle current for the detector is provided by an oscillator and power amplifier of conventional design. This current is fed to primary windings P_1 and P_2 of the coil assembly to generate the inspection field. It is also supplied, for phase reference purposes, to the detector and compensator circuits through transformer T_1.

Windings P_1 and P_2 are connected in series aiding and are tuned to resonance by C_1. Secondary windings S_1 and S_2 are connected in series opposing and are tuned to resonance by C_2. If mutual inductances M_1 and M_2 are equal, the net voltage appearing across C_2 will be zero. If a piece of metal enters the field of one of the windings, this mutual inductance balance will be upset and the resulting signal across C_2 may be used to detect its presence. Potentiometers R_{22} and R_{23} permit accurate adjustment of the balance point.

Any unbalance voltage appearing across C_2 is amplified through V_{8A}, V_{8B}, and V_{10} and applied to two phase-sensitive detectors V_{11A} and V_{11B} in parallel. These two detectors are sensitive to resistive unbalance signals and inductive unbalance signals respectively, the latter being connected to operate alarm relay tube V_{12}. In addition, each detector supplies control voltage to a compensating circuit (V_{9A}, V_{9B}). This compensating circuit cancels out the signal resulting from a slow drift in coil balance such as might be produced by unequal expansion of the coil forms but has relatively little effect on the more rapidly varying signals produced by moving a piece of metal through the coils.

This detector has been in service since January 1949 with excellent results. By its use, several unexploded shells of dangerous size were located and safely removed from logs. Sensitivity was sufficient to detect a large number of machine-gun bullets and small shell fragments of comparable size.

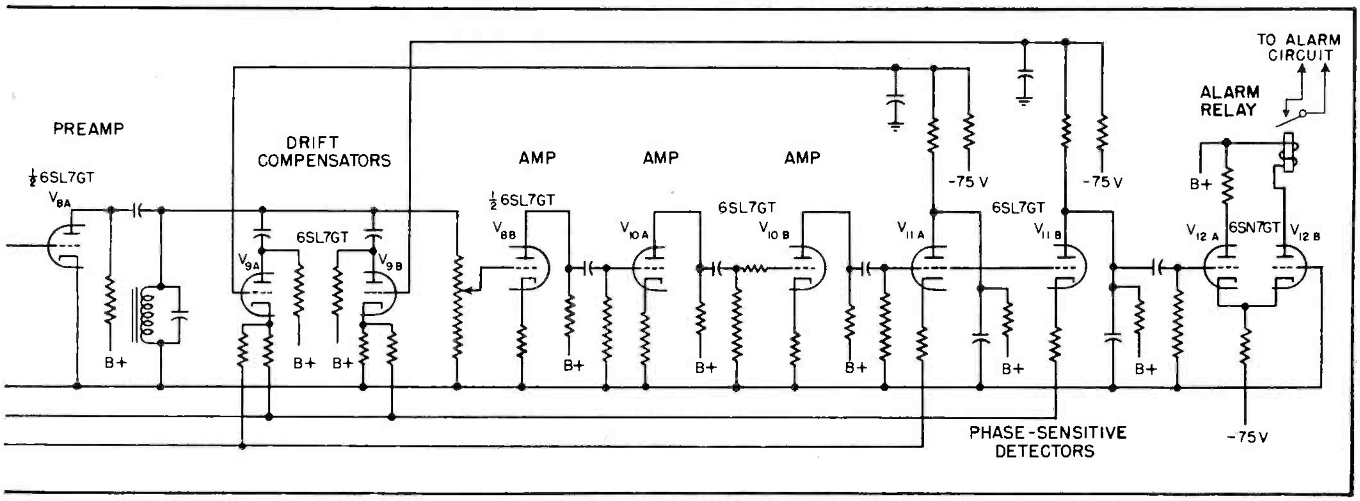
A second problem will serve to illustrate the application of these same principles in yet a different way. This problem involves the detection of both magnetic iron and nonmagnetic manganese steel in taconite iron ore. The sensitivity required in this instance is not as high since the tramp metal consists of broken shovel teeth, jack bits and similar objects large enough to damage ore-crushing machinery. The problem here resides in the fact that the ore itself is so highly magnetic that neither magnetic pulleys nor the more common types of electronic metal detectors can be used successfully.

Tests disclosed that while some streaks or filaments of high electrical conductivity are commonly found in the ore, its average conductivity is much lower than that of the tramp metal. This fact can be exploited to provide satisfactory though not perfect discrimination between ore and metal.

Detecting Metal in Ore

To provide a signal having the maximum loss component from tramp metal of the size to be detected (1¼ inch diameter, minimum) an inspection coil frequency of 4,000 cps was selected on the basis of the data given in Fig. 2. At this frequency, the signal obtained from the ore itself was found to have a very strong reactive component but a comparatively weak loss component.

Successful operation of the detector therefore depends on its ability to reject very large ore signals in quadrature with the phase of the inspection field, while



imbedded in logs floating down salt-water flume. Oscillator and amplifier at left feed energizing coils P_1 and P_2

detecting much smaller signals in phase with the inspection field. To provide this phase discrimination stably and consistently over long periods of time, the inspection coils were connected in a special bridge circuit which includes the phase-discriminating elements as part of the bridge.

A simplified circuit diagram of such a detector is shown in Fig. 7A. The 4,000-cps power supply used to furnish exciting current for the bridge consists of an oscillator and power amplifier similar to that shown in Fig. 6 and is therefore not repeated here.

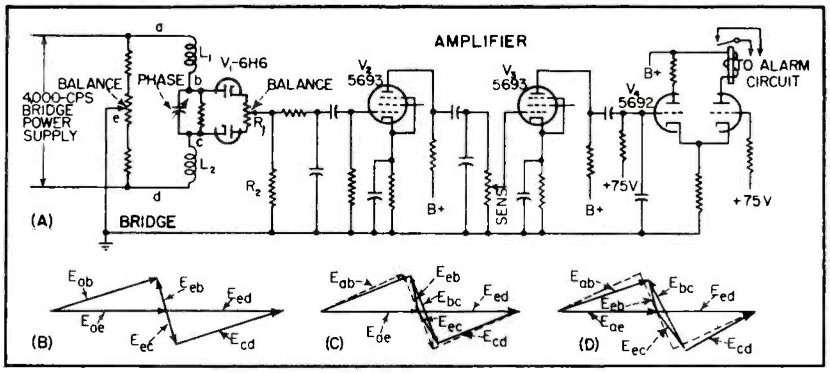


FIG. 7—Simplified circuit of metal detector as modified for detecting tramp metal in iron ore on conveyor belt

Inductances L_1 and L_2 forming the inspection coils each consist of two windings in series, one below the ore conveyor belt, the second directly above the first and spaced apart a distance sufficient to allow the ore and belt to pass between. The two sets of windings comprising L_1 and L_2 are spaced along the length of the belt so that a piece of metal carried thereon unbalances the bridge first in one direction, then in the other.

Figure 7B is a voltage vector diagram showing the bridge in balanced condition. The subscripts on the vector symbols refer to the circuit junction points. The diode rectifier connected to junction b allows a current proportional to the magnitude of E_{eb} to pass in one direction through resistors R_1 and R_2. Similarly, the rectifier connected to junction c allows a current proportional to the magnitude of E_{ec} to pass in the opposite direction through R_1 and R_2. When the bridge is in balanced condition as shown, these currents are equal and hence the net current through load resistor R_2 is zero.

Figure 7C shows the effect of a change in inductance of one arm not accompanied by a change in resistance. This would correspond to a typical ore signal. In this case the magnitudes of E_{eb} and E_{ec} remain equal and the net current through load resistor R_2 is still zero.

Figure 7D shows the effect of an inductive unbalance accompanied by a resistive unbalance such as might be produced by a piece of tramp metal in the field of one coil. In this case, vectors E_{eb} and E_{ec} are no longer equal in magnitude and a net d-c voltage appears across R_2. The transient voltage swing across R_2 resulting from temporary unbalance of the bridge by metal is amplified by V_2 and V_3. This amplified signal is then used to control the action of an alarm relay through V_4.

To reduce the ore signal to a minimum in the commercial version of this metal detector, three independent sets of inspection coils are used to cover the full width of the belt. The clearance between top and bottom sets of coils is 10 inches. This detector is now under test in a mill in northern Minnesota with very encouraging results to date.

The writer wishes to acknowledge his appreciation to Dr. H. Poritsky of this laboratory for permission to use some of his results in this paper in advance of their publication elsewhere.

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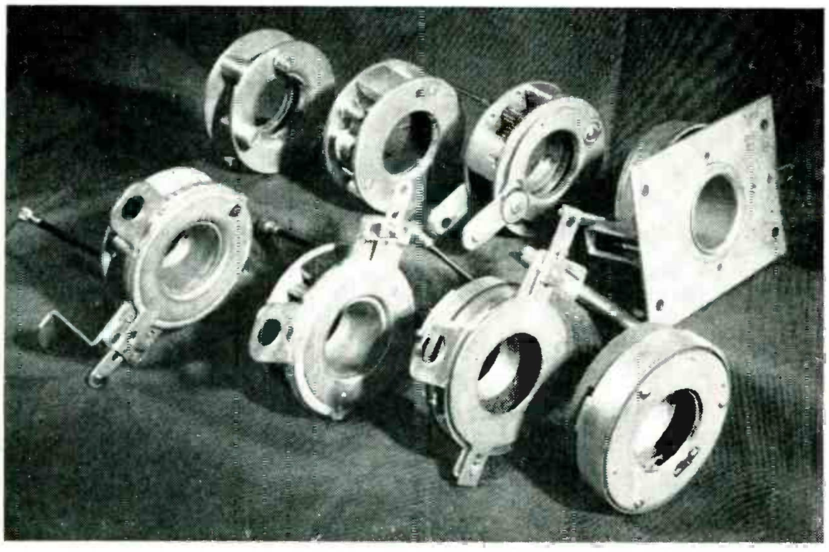
P-M FOCUS DEVICES



Various types of p-m focus units were tested, each on several different standard television receiver chassis

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THE HIGH COST of the electromagnetic focus unit and its power supply has been a serious item in the cost of all but the smallest television sets. It is largely in an attempt to reduce this cost that the cheaper permanent-magnet type focus unit has been developed.

In deciding how good a focus system must be to give satisfactory performance, it is necessary to consider the maximum spot size that may be used without causing deterioration of picture quality. Assuming about 480 active lines in each complete picture on a 16-inch tube, each picture element is about 0.025-inch square. The spot at maximum brightness should not exceed this size; it should be smaller, at least in the horizontal direction, if amplifier compensation is not used.

It is difficult to get a spot as small as this at maximum brightness because of limitations imposed by the picture tube, such as the effective grid aperture which must have a finite size. Added to this are the effects of aberrations and magnification caused by the type of focus system used. The limitations imposed by the picture tube itself are not considered in this article. We will discuss only those aberrations caused by the permanent-magnet focus unit.

Experimental Work

In examining departures from ideal conditions it was found necessary to set up a means of measuring, with some accuracy, the size of the spot produced on the screen when the picture tube is operated at a control grid-cathode voltage of zero volts and with normal anode voltage (13 kv in the case of these tests). The picture tubes used for this purpose were mounted in a commercial chassis from which all steel supports and other magnetic material near the tube had been removed.

The p-m units to be investigated were supported on the tube by a suitable thickness of adhesive paper tape wrapped around the neck of the tube. This method of mounting provides an easy and accurate method of setting the magnet coaxially with the tube neck and, therefore, nearly coaxially with the beam. The yoke was disconnected but left in position on the neck of the tube to form a stationary spot.

When running a test, the beam is held beyond cutoff and pulsed to zero volts by means of a pulse generator. The frequency of the pulse is 500 pulses per second and the pulse duration is 20 microseconds. The peak positive voltage is determined by means of a simple peak meter consisting of a diode, a capacitor and a vtvm set at the three-volt d-c range. This testing arrangement is illustrated in Fig. 1A. The pulse generator output is adjusted so that the voltmeter is just at the point of moving off zero volts, thus giving nearly zero volts on the peak grid pulses with reference to the cathode.

To examine adequately the nature of the spot produced, it was found necessary to enlarge it. This was done by setting up a 4-inch f/1.8 projection lens to give a linear magnification of 10. The image produced is projected onto a sheet of graph paper. As there is considerable loss of light by this method, it is necessary to carry out the test in a dark room.

The diameter of well-focused spots is relatively easy to ascertain. For spots with very diffused edges, it was found useful to describe their diameter in terms of (a) the diameter of a circle enclosing all points which were more than one-half as bright as the brightest part of the spot, and (b) the diameter of a circle enclosing all points more than one-tenth as bright as the brightest part of the spot.

A special light meter is used to measure the low illuminations over the small areas involved in the enlarged spot. The meter used is manufactured by Salford Electrical Industries of Ilford, London. It covers a range of 1/100 ft lambert to 10,000 ft lamberts, and can be used on an area as small as 1/100 square inch or less.

When only a qualitative estimate is required, a polka-dot generator

for PICTURE TUBES

Main disadvantage of permanent-magnet focusing devices is stray field that spreads into ion trap and deflection yoke regions. Success of p-m focus units depends on mechanical design and construction. Pole pieces must be operated well below saturation

may be used with the normal deflection system. This technique has been described in previous publications in connection with yoke design. It provides a good indication of the performance of the focus magnet alone when the area near the center of the tube is examined. This method has the advantage of showing up field distortions and rotation caused by stray focus fields penetrating the yoke. The field strengths of the p-m focus units used were measured by means of a small search coil and fluxmeter, where the flux density was of high magnitude, and by a General Electric Gaussmeter where the flux density was low.

Requirements for Good Focus

A good magnetic focus system should meet the following requirements: (1) It must provide correct magnetic strength to ensure that an image is formed on the screen. (2) It must have uniform magnetic field over the region through which the beam travels. (3) Its magnetic field must be approximately coaxial with the beam. (4) The magnetic field must be as far toward the front of the tube as possible, subject to certain considerations which will be discussed later. (5) The focus field must be restricted to the region of the tubes where the focusing action is required.

It is the aim of this paper to show causes of departures from these ideal conditions and their effect on the size of the spot produced.

The focus field forms a lens focusing the image on the screen. The strength of field required depends not only on the geometry of the system but also on the square root of the final anode voltage. The effect on the spot size due to change in high voltage is shown in Fig. 1B.

In an electromagnetic system any change of circuit conditions (such as supply voltage, aging of horizontal output tube or reduction in B supply voltage) which results in a change of high voltage, is generally accompanied by a change in focus current in the direction needed to correct the defocus produced. The correction is only approximate but is usually sufficient to take care of changes in high voltage caused by normal line-voltage variations and moderate component aging. No such correction occurs in a permanent-magnet focus system for the obvious reason that there is no focus current present.

If the focus field is not axially symmetrical over the area traversed by the beam, different parts of the beam will suffer different focusing forces and the beam will not focus properly.

If the field is not coaxial with the beam, the beam will be deflected. Use is made of this phenomenon to center the raster in its correct position on the tube by means of a plate not concentric with the polepieces. Movement of the plate distorts the field in the desired direction. With this method of centering there is always some defocus produced.

The focus coil will cause the minimum magnification of the object if it is as far from the object and as near to the image as practicable. This indicates that the focus unit should be as near to the front of the tube as possible. There are, however, certain limitations to this. Room must be found on the neck of the tube to accommodate the yoke. The stray field from the front of the focus coil must not cause excessive interference with the yoke. The beam leaving the final anode is slightly divergent. The further forward the focus field is placed, the larger the cross-section of the beam becomes at the point where it is subjected to the focus field, and the more susceptible it will be to

Table I—Measurements of Intensity and Effect of Stray Field in Ion Trap and Yoke Regions

Type of Focus Unit*	Stray Field 1 inch to Rear on Axis in Gauss	Stray Field 1 inch to Rear and off Axis in Gauss	Effect on Ion Trap Operation (Using 45-Gauss Ion Trap)		Stray Field 1 inch in Front on Axis in Gauss	Stray Field 1 inch in Front and off Axis in Gauss	Raster Rotation in Degrees
			Short-neck Tube	Long-neck Tube			
(A)	12	8	Very Slight	Negligible	25	15	5
(B)	32	40	Serious	Very Slight	35	40	20
(C)	45	60	Serious	Noticeable	38	40	21
(D)	45	50	Serious	Noticeable	38	48	23
(E)	52	68	Almost Unusable	Noticeable	31	50	24

* (A) Electromagnet. (B) P-M with ½-inch steel screw as shunt between pole faces, (C) P-M with variable-gap adjustment set to focus at 13 kv on a 16RP4, (D) and (E) P-M units with large fixed gaps and with external shunts.

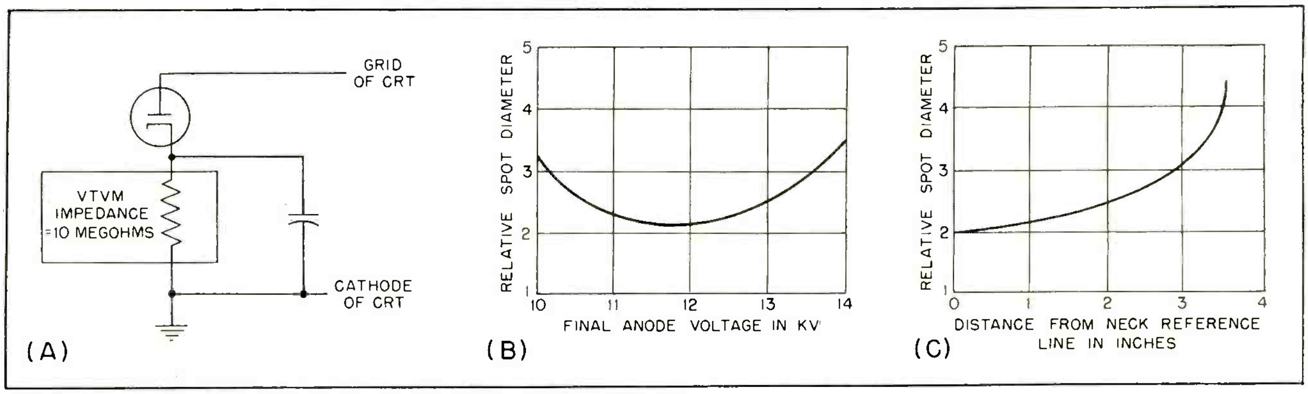

FIG. 1—Test setup is shown in *A*. Relative spot size is shown in *B* and *C* as function of final anode voltage and position of focus unit

defocus due to nonuniformity of the fields of both the focus coil and the yoke.

A good focus unit with uniform field and with limited stray field will give the smallest spot when moved as far forward as possible. Figure 1C shows the relationship between the size of the spot and the position on the tube of the focus unit.

Focus Field Spread

The most important aspect of focus design is the restriction of the magnetic field spread from the focus unit, so that it does not affect the adjacent components on the tube neck.

Penetration of the stray field into the ion trap and grid regions has three main effects:

(1) It moves the center of the electron lens back toward the object. This is usually undesirable because it increases the magnification and in turn the spot size.

(2) It may penetrate the region of low-velocity electrons, thus making good focus impossible.

(3) It may deflect the beam as it curves through the ion trap so that it no longer passes through the aperture in the final anode. This latter is the most obvious of these effects as it makes the ion trap and focus coil adjustments interdependent. This condition is particularly serious in the hands of semiskilled operators. It is well known that apparent good focus can be obtained by allowing only a small part of the beam to leave the gun. This happens when the ion trap is misadjusted so that most of the beam fails to find its way through the aperture. If this misalignment had been done by changing the focus field, it is easy to set up this position of false focus, resulting in poor illumination and the rapid destruction of the tube by gas released from the heated edge of the anode aperture. One sample focus unit was adjusted on a 16GP4 tube. The field strength was then increased by 20 percent. This caused severe ion-trap interaction which in turn produced complete spot extinction.

Penetration of the stray field into the yoke region causes a rotation of the raster. This in itself is not serious as it may be corrected by rotation of the yoke.

Severe interaction, however, is accompanied by defocusing and raster distortion, the mechanism of which was not investigated. As the amount of rotation of the raster is affected by the strength of the stray field, it may be necessary to readjust the yoke position after focusing.

Spread of the stray field to surrounding steel structures, such as the brackets supporting the magnet, chassis and yoke supports, may cause distortion as well as weakening and unbalance of the wanted focus field. This condition may be rendered less serious by using nonmagnetic brackets. However, it is preferable to eliminate the trouble at its source as far as possible by restricting the stray field to a minimum.

Focus Magnet Parts

All types of permanent-magnet focus units consist of three essential parts: (1) One or more pieces of alnico forming the permanent magnet. (2) Pole pieces to direct the field to that part of the tube where it is required. (3) A device which may or may not be part of the pole pieces, to adjust the field to its correct strength. A generalized picture of such a magnet without the field strength adjusting or focusing device is shown in Fig. 2A. This diagram shows the approximate distribution of the stray fields in such a device.

The permanent magnet may be in the form of a ring of alnico larger than the neck of the tube, or in the form of three or more pieces of alnico held between mild steel end plates or pole pieces. It is important that the field produced in the focus region be axially symmetrical. This implies that the ring be uniformly magnetized or that the magnets themselves be of equal strength and uniformly distributed around the circumference. If this is done, then there should be little need for redistribution of the flux in the pole pieces in order to produce a uniform field in the gap.

The pole piece directs the field from the permanent magnets into the correct position, and distributes the available flux so that it produces an axially symmetrical field in the gap. In order to do this the pole piece should present a reluctance very low compared with that of the gap, so that the pole piece contains the flux as far as possible and distributes it to the gap. The uniformity of gap reluctance (the accuracy with which it is made) will determine the uniformity of the field in the gap.

Two types of focusing adjustments are in general use. The variable-shunt type bridges part of the magnetic circuit, thereby reducing the flux available in the pole pieces. Such a device should operate to reduce the field uniformity

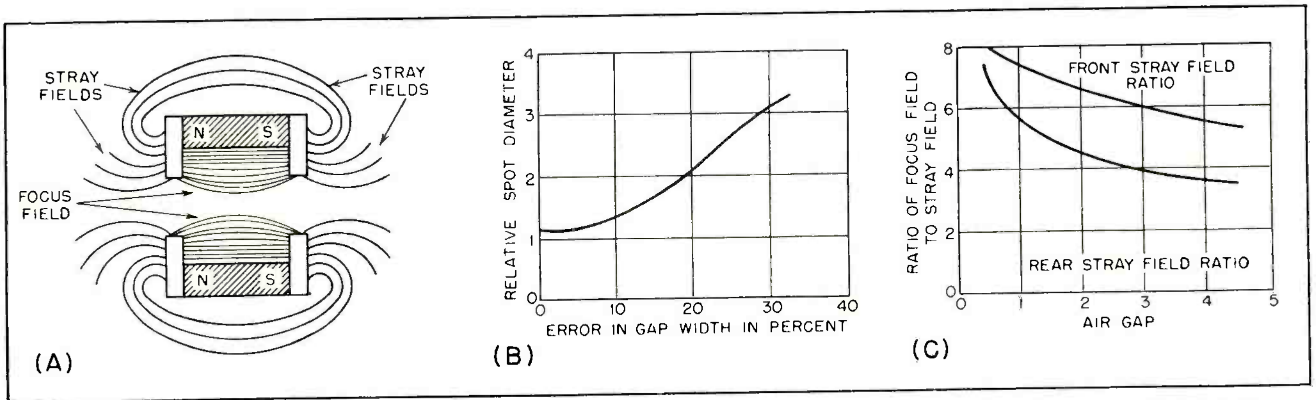

FIG. 2—Origin of stray fields is shown in drawing *A*. Dependence on gap sizes is illustrated in the curves of *B* and *C*

around the circumference in order to ensure that there is a minimum of disturbance of the distribution in the pole pieces. In the variable-gap type the reluctance of the gap, and therefore the field strength, is changed by changing the path length of the gap. These devices tend to increase the leakage field at some position of their operation.

The centering device may move one of the pole pieces in a direction perpendicular to the tube axis, or may be a small secondary movable pole piece. In either case the object is to distort the field so that its axis is no longer parallel with the axis of the beam. As far as practicable this should be done without modifying the field in any other way.

Possible Imperfections

In discussing the effect on focusing due to the various types of imperfections found in p-m focus units, it is important to consider the type of picture tube used. In general, direct-view picture tubes fall into two classes as far as focusing is concerned. These are the long-necked tubes such as the 16RP4 and the short-necked tubes such as the 16GP4. In the case of the short-necked tubes, the deflection and focus components are crowded closer together and the difficulties caused by stray field effects are greatly increased. The effects of these imperfections are as follows:

If the pole pieces are of sufficiently low reluctance and if the magnets are well distributed, the uniformity of the field will depend entirely on the accuracy with which the gap is made. Results of measurements made on a narrow-gap magnet having heavy pole pieces, one of which could be moved to give distorted gaps, are plotted in Fig. 2B.

If the magnets in a focus unit containing several pieces of magnetic material are not of equal strength, the effect on the size of the spot depends largely on the ability of the pole pieces to redistribute the flux at the pole faces. When one magnet unit out of three in a p-m focus unit was reduced in strength in each of the following types, the degree of defocus was as follows:

Type of Focus Unit	Normal Spot Size Diameter	Unbalanced Spot Size Diameter (Relative)
(a)	1.0	1.2
(b)	1.0	1.9
(c)	1.0	1.3

In the above table the p-m units used had the following construction: (a) An internal sleeve type of focus magnet with massive pole pieces operated below saturation. (b) An external sleeve type with light pole pieces operated near saturation. (c) An external sleeve type with massive pole pieces well below saturation.

Field in Trap and Yoke Regions

An effort was made to evaluate the seriousness of the effect of stray fields on the ion-trap system. These stray fields were observed on tubes set up in the chassis previously described. The strength of the stray fields was due entirely to the type of p-m focus unit used. These fields were measured at one inch from the rear face of the magnet, on the axis of the magnet, and one inch from the rear face of the magnet and one inch from the axis of the magnet. The results are listed in Table I.

Increasing the size of the gap in the system increases the path length and therefore the magnetic reluctance of the gap. This has the effect of increasing both the effective focus field and the stray field, though not at the same rate. This is particularly true when the gap is small.

Figure 2C shows the relationship between the stray and useful focus fields when measured on a variable-gap type of focus unit.

Measurements similar to those described above were made on the same focus units in the direction of the yoke. The results are also listed in Table I.

Using a unit of the type mentioned above, measurements were made to show how the magnet strength required for good focus varied with air gap. It was shown that increase of gap from 0.1 inch to 0.4 inch caused a decrease of about 40 percent in the magnet strength required; the decrease is approximately linear.

Summary of Results

Good uniformity of focus field in the gap of p-m focus units is essential for good focus. To secure this, units must be constructed solidly, must have pole pieces of good mechanical design and accurate construction and the pole pieces must operate at flux densities below saturation. The magnets forming the p-m focus unit must be well balanced.

The leakage field from the ends of permanent-magnet units is higher than that encountered in most electromagnetic units and may cause severe interference with the operation of both the ion trap and deflection yoke. This is particularly true when short-necked tubes are used.

A Modern Frequency

Riverhead equipment is prototype of a commercial service available to whole industry to fulfill legal requirements of FCC. Of particular interest are techniques giving basic accuracy of better than 2 cps from 15 kc to 26 mc. Broadcast measurements can often be made to 0.2 cps using a tape-recorder technique

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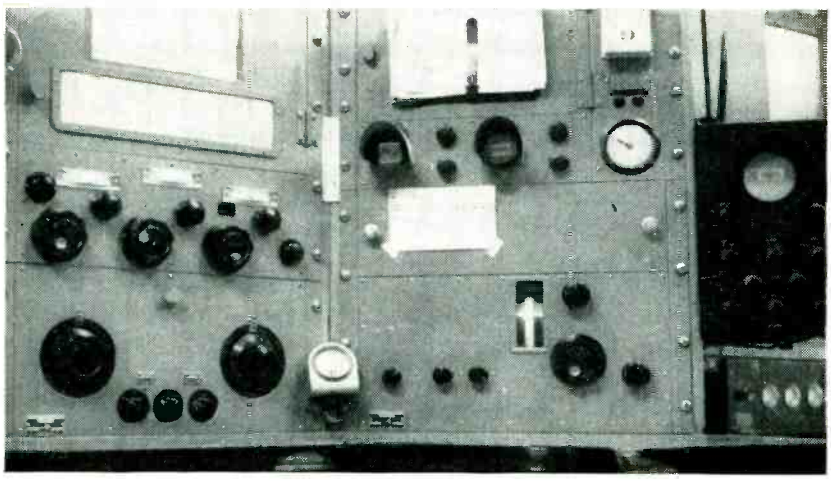
GOVERNMENT policing of radio-frequency channels extends to all users, great and small. However, many companies and individuals find it impossible or impracticable for economic reasons to establish their own frequency-measuring facilities external to normal transmitter controls. On this account, those facilities originally established by RCA Communications for monitoring its own circuits have since been expanded into a commercial frequency-measuring service.

As the art progressed, the temperature-controlled wavemeters of early days have been supplanted by modern crystal-controlled equipment. Primary receiving stations are located at Riverhead, N. Y. and Point Reyes, Calif. Equipment delivered to Manila just prior to the Japanese invasion was destroyed, but the Manila, P. I. station is once again near completion. This article describes the latest equipment and methods in use, supplementing those techniques previously described.[1]

At first the service expanded most rapidly in the broadcast field. With two frequency-measuring locations in the United States and proper time scheduling, adequate coverage could be provided for the entire country.

As additional types of radio usage were established, requests were received for equivalent frequency-measuring services with the result that measuring facilities were expanded to cover aircraft radio, police radio, short-wave broadcasting, frequency modulation, television, and many other fields.

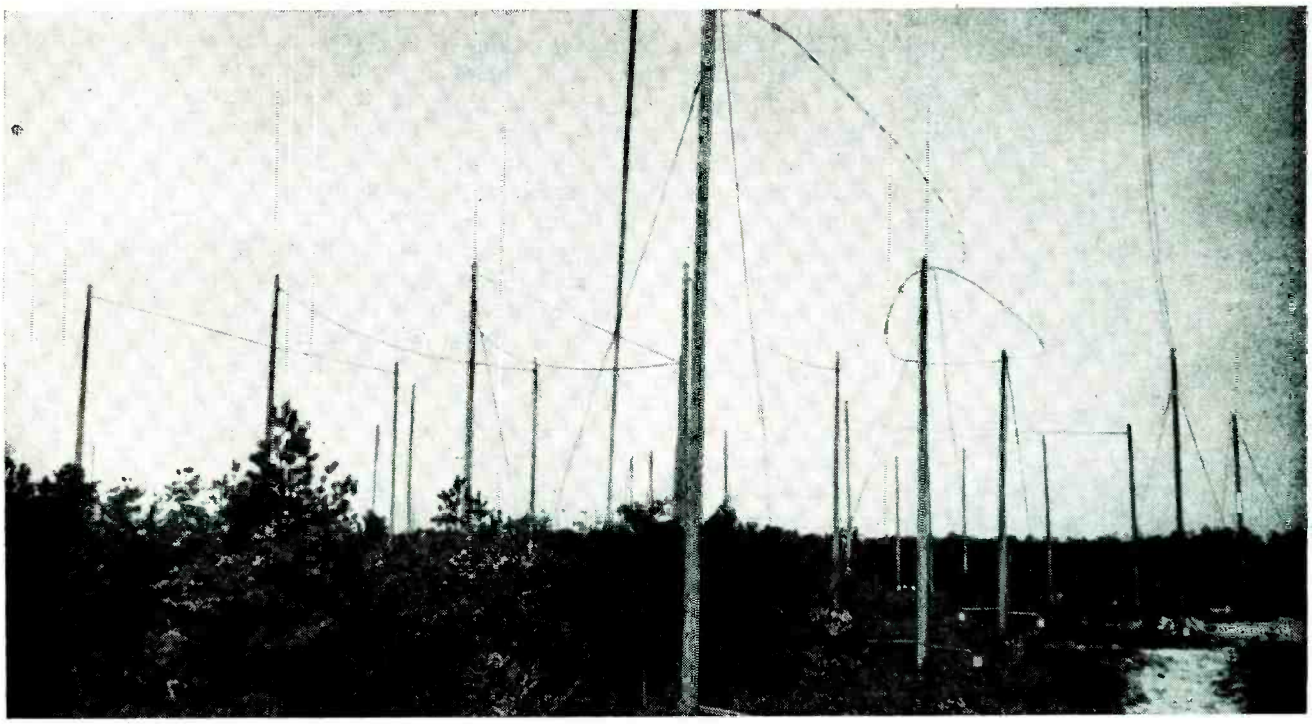


Main measuring position covers the frequency range from 100 kc to 26 mc. Other units are rack mounted above and to left

Equipment Summary

The basic equipment required for establishing a practical frequency-measuring service can be grouped in a number of separate categories. The installation must provide antennas of many types covering an extremely wide frequency range with directivity and adequate signal pickup to permit proper reception of the various frequencies being measured. The control of directive pattern is extremely important in determining the ability to receive one transmission among several that may be simultaneously active on the same or closely adjacent frequencies. After the signal has been abstracted from the air by means of proper antenna facilities, it is then necessary to provide receivers covering the frequency range required to tune in the desired signal. Within the basic receiving system, provision must be made for the comparison of the frequency being measured with a primary standard of frequency. These primary standards must have necessary auxiliary equipment, to permit their calibration and comparison with other standards. Complementing the measuring equipment, there

Measuring Installation



The frequency-measuring antenna field at Riverhead, Long Island

must be suitable monitors to permit identification of the signal being measured. In considering these items of equipment, the laboratory at Riverhead, New York will be described because that location is one of the most completely equipped and accurate frequency measuring locations available for commercial service in the world.

Antennas

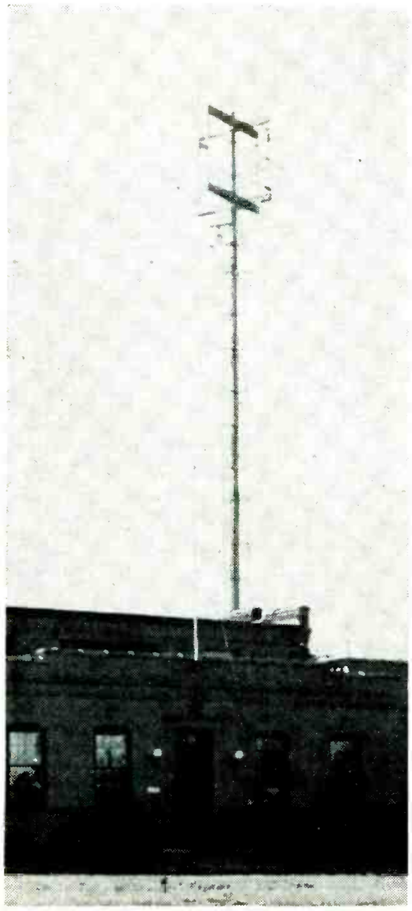
To serve the vlf and l-f classifications of emission three Beverage wave antennas are provided. These antennas range from 7 to 9 miles long and are directed roughly toward Europe. Provision is made for taking energy from either end of each antenna thus permitting unidirectional reception from either of two opposing directions. Each long wave receiver is provided with a combining unit at its input. This unit is equipped with two inputs and one output.

One input feeds directly to the output circuit after amplification, while the second input feeds through a controllable amplifier and an artificial transmission line. A continuously variable tap on the artificial line is connected to the output circuit. Thus, the second signal can be combined with the first at any amplitude, by control of its amplification, and at any phase angle by control of the tapping point on the artificial line. By combining various combinations of front-end or back-end reception of one or two Beverage antennas, a substantial amount of control over the directional pattern can be had. This control extends from simple combination in-phase to increase the gain and sharpness of the main lobe of the antenna to combinations that produce a reception null at any back or side direction desired.

This arrangement can be advantageous in several ways. Static can be balanced out to a remarkable extent during conditions when the predominant static is being received from one particular direction. Alternatively, if there is an interfering signal from some direction other than that of the desired signal, it can be almost entirely canceled out by proper control of directive pattern.

In the medium-frequency range that includes broadcast activity in this country, three Beverage wave antennas are provided. Each of these antennas is equipped with two transmission lines from which unidirectional reception is obtained from either of two directions 180 degrees apart. Because of this fact, and since the three antennas are constructed in the field on bearings that are 120 degrees apart, choice can be had of directional patterns at 60-degree intervals. Owing to this wide range of choice in directive pattern, it is possible through use of combining units similar in function to those described to cancel out undesired transmissions that are much stronger than the desired transmission and on the same frequency but from a different direction.

To cover the normal short-wave or high-frequency classification from 3,000 to 30,000 kc, several directional fishbone wave antennas are used.[2] These antennas are de-



Frequency measuring building with pole in background supporting group of vhf and uhf antennas

signed for various frequency ranges and are constructed so as to aim in various directions of principal interest. These facilities provide world-wide coverage.

In the very-high-frequency range from 30 to 300 mc and in a portion of the ultra-high-frequency range from 300 to 500 mc a variety of antennas is available. Over the lower portion for the above frequency range, some of the short-wave directional antennas are adequate. Above that point groups of wide-band dipoles are employed. Two groups of horizontal dipoles are provided for reception of horizontally-polarized waves, one for north-south directions and one for east-west directions. One group of vertical dipoles is provided to cover reception of vertically polarized waves. A directional very-high-frequency antenna is provided to cover longer distance reception from the principal metropolitan areas to the west of Riverhead. Consideration is currently being given to providing rotary directional antennas for this frequency range still further to improve the ability to make measurements at a greater distance.

Primary Standards

The primary frequency standards, with which signal frequencies are compared, originate in elaborate 100-kc quartz crystal oscillators. The basic oscillator consists of a two-tube positive feedback amplifier in whose feedback loop is placed the quartz-crystal element. The entire oscillator circuit including tubes is mounted in a temperature-controlled box. The box temperature is maintained to within a few hundredths of a degree by means of a mercury thermoregulator. The oscillator is isolated from the utilization circuits by means of buffer amplifiers. All supply voltages are regulated where necessary.

The output of whichever standard is in use drives a series of frequency dividers in such a manner that the various output frequencies are exactly related to the frequency of the primary standard. From these divider chains, output frequencies of 10 and 1 kc are available for frequency-measuring purposes. The 100 and 10-kc frequencies feed harmonic generators that provide an extremely wide band of harmonics of these frequencies throughout the main portion of the radio-frequency spectrum. These signals at 100-kc or at 10-kc intervals, as desired, serve as marker frequencies. The procedure of making a frequency measurement then consists of measuring the frequency separation between the unknown frequency and one of these marker frequencies by means to be described.

A primary frequency standard is defined as one whose frequency may be compared with standard time intervals. The 1-kc output from the divider chain drives a 1,000-cycle synchronous clock that permits a direct comparison between the number of cycles of oscillation of the primary crystal during a period of time against independent astronomical measurements of absolute time. The time of the synchronous clock is compared daily with standard time signals sent out from the Naval Observatory at Washington, D. C., by means of a recorder accurate to about 0.01 second.

Since comparison of a primary standard with standard time intervals results in evaluation of accumulated frequency drift and may not be indicative of short-term frequency variation, it is necessary to make additional comparative measurements to check the stability of the standard equipment. This is accomplished by two methods. Frequent measurements are made on the standard-frequency transmissions of the United States Bureau of Standards on radio station WWV. The Bureau certifies these transmissions as accurate to better than one part in fifty million.

In addition, arrangements are periodically made for simultaneous measurement of certain radiotelegraph transmitters (whose frequency-stability record is satisfactory and whose frequency is suitable for reception at the interested points) by the Riverhead and the Point Reyes frequency-measuring laboratories—and occasionally at one or more other frequency-measuring laboratories.

Measuring Receivers

A portion of the main measuring position, which covers a frequency range from 100 kc to 26 mc, is illustrated. Three different r-f tuners are provided, one covering the long-wave range from 100 to 550 kc, one covering the broadcast and adjacent area from 550 kc to 3 mc, and one covering the normal short-wave range from 3 to 26 mc. Any one of the three tuners can be instantly connected to the intermediate-frequency and interpolating equipment of the basic measuring position.

An extensive amount of the equipment shown consists of harmonic and subharmonic generating equipment controlled by the primary standards. These units serve to synthesize a direct frequency-calibrated source of 1,050 ± 11 kc. This adjustable signal is used in a manner to be described for determining the difference of the unknown frequency from one of the marker standard frequencies. The remaining units provide the intermediate frequency and other functions shown in Fig. 1.

In addition to this main position there are available conventional long-wave receivers covering the range from 15 to 100 kc. One of these has been equipped with a converter whose beating-oscillator frequency is obtained directly from the primary frequency standard. This arrangement permits measurement of these low frequencies at the main frequency measuring position.

Several short-wave receivers are available to cover the frequency range from 26 to 500 mc. Measurements in this range are likewise accomplished from the basic measuring position.

Basic Measuring Method

The block diagram in Fig. 1 shows the basic method used in making frequency measurements. A tuner unit (*A*) is chosen that covers the proper frequency range for the signal to be measured. The tuner is set approximately by dial calibration to the multiple of 100 kc closest to the frequency of the unknown signal. It is then connected to a harmonic generator that provides marker signals, derived from the primary standard, at 100-kc intervals. The 100-kc marker on which the tuner had

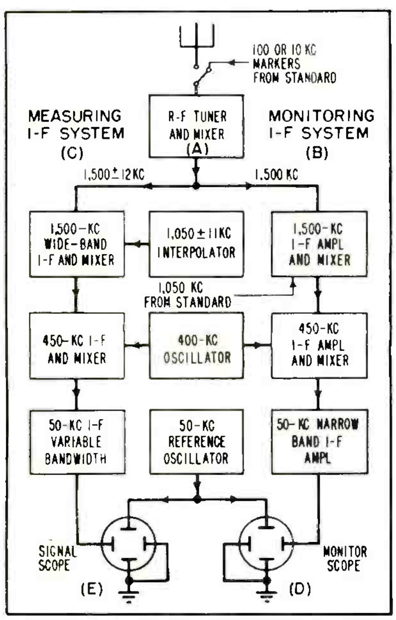


FIG. 1 — Basic frequency-measuring system in which final significant figures are obtained from directly-calibrated interpolation oscillator system

been set approximately is then tuned in. Next, the 100-kc markers are removed by the operator and a series of markers at 10-kc intervals is substituted. The tuner is then shifted toward the unknown frequency while the number of 10-kc markers passed are counted.

When the 10-kc marker nearest the unknown frequency has been reached and tuned in, the frequency of the unknown signal to the nearest 10-kc figure is known. This 10-kc marker is tuned so that its signal output from the tuner is exactly 1,500 kc. The 1,500-kc signal then goes into a monitoring i-f chain (*B*) where it is mixed with a 1,050-kc frequency generated from the primary source to produce exactly 450 kc. After further i-f amplification, the 450-kc signal is again mixed with a 400-kc frequency that is common to both the monitoring i-f system and the measuring i-f system (*C*) to produce a signal at 50 kc.

The amplification at 50-kc is provided with narrow bandwidth of about 400 cycles in order to prevent extraneous interference from confusing the oscilloscopic methods of comparison at this point. The 50-kc output is now placed on one set of deflecting plates of a monitor oscilloscope (*D*) and compared with a locally generated 50-kc reference standard. The tuner is adjusted to make the resulting signal at 50 kc exactly equal the frequency of the reference 50-kc oscillator as indicated by an elliptical pattern on the oscilloscope.

At this point the harmonics are removed from the tuner and an antenna having proper frequency characteristics and directivity is connected. In addition to feeding the monitoring i-f chain, the tuner also feeds the measuring i-f chain. In the first portion of the latter chain a frequency conversion from 1,500 kc to 450 kc occurs by means of an inserted frequency of 1,050 ± 11 kc.

This frequency is developed from the 1-kc subharmonic of the primary frequency standard and harmonics thereof combined with an extremely stable 250-kc oscillator covering a frequency range of ± 1.1 kc. The block diagram of this interpolation-frequency generator

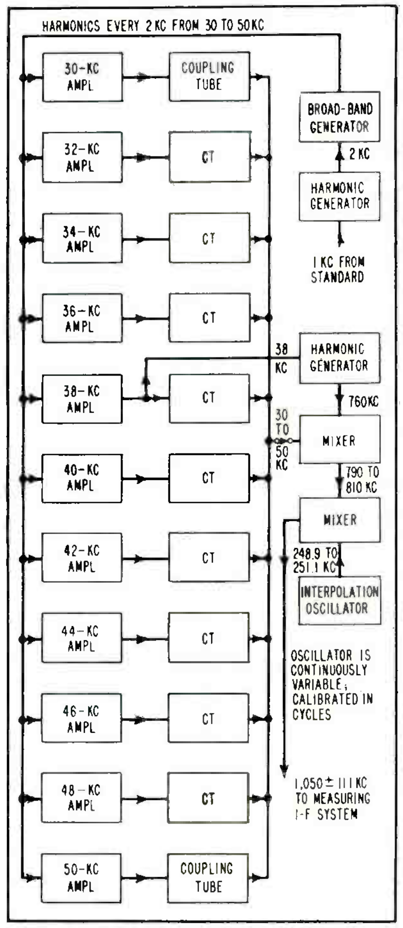
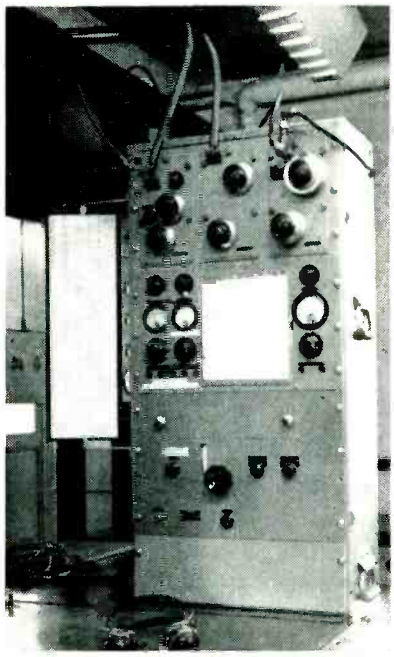


FIG. 2—Method of obtaining the interpolation frequency from the primary frequency standard and a special oscillator

is shown in Fig. 2. The 250-kc interpolation oscillator is accurately calibrated and controlled to produce a direct-reading accuracy with less than ± 2-cps error. By means of reference against the standard marker frequencies and harmonics of either a 100-cycle or 1-kc frequency derived from the primary standard, the amount of this error may be determined at frequent calibration points and taken into account in the process of measuring to produce an accuracy from this source within about 1 cycle per second throughout its range.

The frequency of the variable 1,050-kc source is now adjusted to the point where the unknown frequency output from the first portion of the measuring i-f chain is exactly 450 kc. This frequency is again converted to 50 kc following which a choice of various bandwidths may be had. The output at 50 kc is fed to another oscilloscope (*E*) whose other axis is supplied from the same 50-kc reference frequency as supplies the monitor oscilloscope. The unknown frequency is tuned to exact equality at 50 kc with the reference 50-kc oscillator as indicated by the oscilloscope pattern. The tuning is accomplished by adjustment of the 1,050 ± 11-kc frequency source. Since this frequency source is directly calibrated, the frequency difference between the signal and its nearest 10-kc marker may now be read directly from the controls of the interpolation oscillator assembly. This frequency difference then supplies the balance of the significant figures of a frequency measurement.

Owing to possibility of receiver drift during the course of a measurement, provision is made for simultaneously connecting the antenna and the standard marker frequency source to the tuner. Then both oscilloscope patterns can be observed at one time.



One of the special vhf measuring receivers with the frequency-measuring comparison oscillator below it

Extending Frequency Range

The range of the basic measuring system is extended at the low-frequency end from 100 down to 15 kc by use of a standard long-wave receiver covering that frequency range.

The output of this receiver is fed to a balanced-modulator type of heterodyne frequency converter unit whose heterodyne oscillator supply is 400 kc derived by multiplication from the standard. For this purpose, the standard 100-kc frequency is multiplied by 4. The resulting 400-kc frequency is mixed with the unknown frequency from the long wave receiver to produce a resultant frequency in the range from 415 to 500 kc. This output is fed to the basic measuring position and its frequency measured. Accordingly, the frequency of the unknown long-wave signal is that indicated by the measurement minus exactly 400.000 kc.

The extension of the frequency range of the basic measuring position from 26 to 500 mc is obtained as follows. Several uhf receivers are available to cover the added frequency range. A unit is provided that consists of a stable voltage-regulated Hartley oscillator covering a directly calibrated frequency range of 12 to 20 mc followed by a buffer stage and untuned harmonic generator of the grid-distortion type effective in producing harmonics of the oscillator over the frequency range from 24 to 600 mc.

The measuring process consists of zero beating a harmonic of the comparison oscillator with the unknown frequency to be measured in one of the uhf tuners. The fundamental frequency of the comparison oscillator is then measured by the main frequency measuring position. This measured fundamental frequency multiplied by the order of harmonic used gives the frequency of the signal being measured.

Accuracy

The average deviation of the primary standard frequency source is approximately 1 cycle in 5 million. Accordingly, a direct frequency measurement without taking account of possible correction factors can be expected to have an error from this source of approximately 2 cycles per second at 10 mc or 5 cycles per second at 25 mc. The basic accuracy of the interpolation system results in a possible error of less than 2 cycles per second at any frequency from 15 kc to 26 mc.

A special technique can be used in handling broadcast measurements and any other measurements whose assigned frequency lies in the immediate neighborhood of a 10-kc marker to eliminate the interpolation error. This method consists of simultaneously receiving the signal being measured and the nearby marker frequency. The resulting beat note between the two frequencies is recorded on a tape recorder together with standard one-second time intervals. Thus, the number of cycles of beat note per second directly gives the frequency difference. The direction of this difference from the marker standard frequency can be obtained by use of the interpolating system. This technique produces a measurement having the full accuracy of the primary standard frequency source. Accordingly, broadcast measurements can result in an overall accuracy having an error of no more than 0.2 cycle per second.

At uhf the basic error of the lower frequency measuring system is multiplied by the order of the harmonic used from the comparison oscillator. Accordingly, an overall accuracy of frequency measurements in this range would show an error of approximately 30 cycles per second at 100 mc or 150 cycles per second at 500 mc.

Service Range

At vhf and uhf the service range from each measuring location is restricted by propagation conditions to a distance of from 200 to 500 miles depending on relative antenna heights, intervening terrain and transmitted power. Every effort is made to extend the service range of these higher frequency classifications by providing the maximum practical height of receiving antennas together with extreme sensitivity of the associated tuner units.

Through the remainder of the frequency spectrum the RCA frequency-measuring stations provide essentially world-wide coverage.

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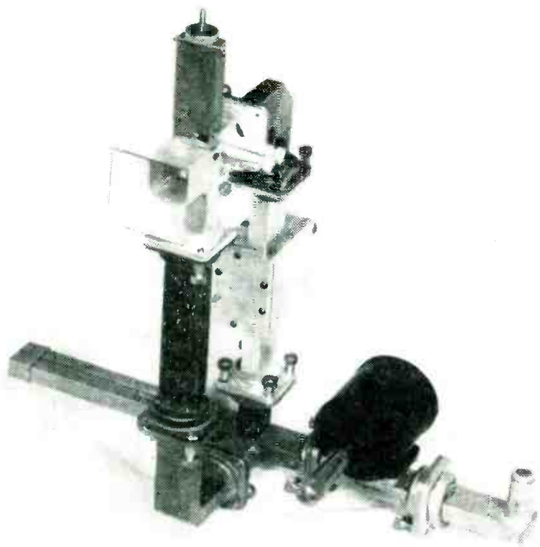
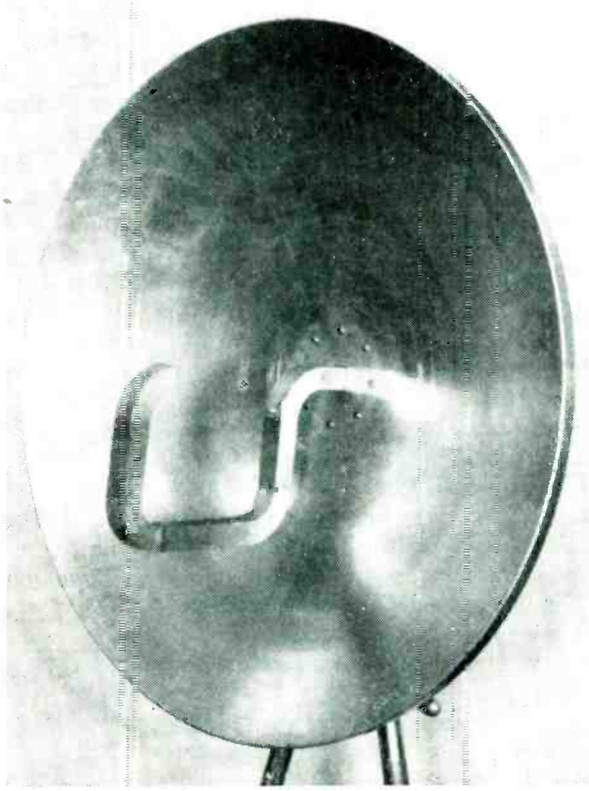

Airborne antenna circuitry for arbitrary polarization


Paraboloid used in 3.2-cm equipment. Note square waveguide

Microwave Radar Antenna

Special design permits transmission and reception of any specified polarization in search radars, including linear and circular as special cases. Antenna can receive, separately and simultaneously, both transmitted polarization and its cross-polarized component

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ELIMINATION of certain unwanted radar target reflections is made possible through the analysis of reflected radiation polarization by circular and linear components. In principle this analysis could be accomplished with a plurality of antennas designed to transmit or receive the various polarization components. In practice, however, limitations on space and equipment make it highly desirable to use a single antenna design that is capable of application over a wide range of frequencies. The antenna design described here has the property not only of receiving the transmitted polarization, but also of receiving separately and simultaneously its cross-polarized component.

Previously it has not been possible to use a circularly-polarized search radar system with a single antenna used for transmission and reception, since for most targets the reflected wave will have its sense of polarization reversed and thus will be rejected by the antenna. This present antenna design removes such a limitation and so can be used in a search radar system employing circular polarization. Another advantage in this connection is the possibility of using low power t-r and anti t-r tubes to protect the receiver since receiver and transmitter are on opposite terminals of a hybrid junction.

It is possible to design an antenna with any desired beam characteristics and with either continuously variable polarization or with some chosen fixed polarization. The proper choice of this polarization parameter at a given time may greatly increase the utility of present-day radar systems.

General Principles

Figure 1 is the block diagram of a system that establishes its polarization characteristics in the r-f transmission line rather than in the antenna proper, and is therefore capable of rather general application. On transmission the power is divided into two equal components in a hybrid junction, the phase of one component is adjusted relative to the other, and then the two components are recombined in space quadrature in the antenna feed line. Any ellipticity of polarization is achievable with this arrangement. Circular polarization requires a ±90-degree phase difference between components; linear polarization a 0 or 180-degree phase difference; other ellipticities, other phase differences. The antenna feed line may then be terminated in a variety of antenna designs.

On reception the r-f circuitry permits both the component identified with the transmitted polarization and its cross-polarized component to be received on two receivers simultaneously. The cross-polarized component is here defined with reference to the transmitted signal. These two components have the same ellipticity ratio, the major axis of their polarization ellipses orthogonal, and their instantaneous E-vectors rotating in opposite senses.

The ability of this system to transmit circular polarization of one sense and then to receive both senses of circular polarization separately and simultaneously is shown in Fig. 2. A generator, furnishing a voltage $V/\underline{0^\circ}$, is placed at the right-hand terminal of the hybrid junction (Fig. 2B), which is a magic tee. For purposes of explanation, another generator furnishing no voltage is assumed at the left-hand terminal. Therefore, equal voltages of $0.7V/\underline{0^\circ}$, in time phase with each other, will appear at equal path distances in the E- and H-plane arms of the magic tee. By adding 90 degrees of phase change to the E-plane path, and arranging the two input terminals to the square waveguide so that they are perpendicular to each other, two voltages equal in magnitude and in time and space quadrature will appear at the antenna. The signal that is radiated will therefore be right-hand circularly polarized. Similarly, a left-hand circularly polarized signal can be radiated merely by interchanging the two generators, or by adding another 180 degrees of phase change to the E-plane path.

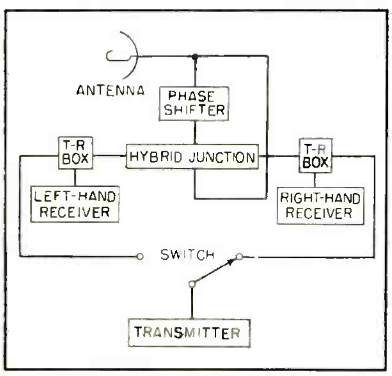

FIG. 1—Block diagram of system that establishes polarization characteristics in the r-f transmission line rather than in antenna proper

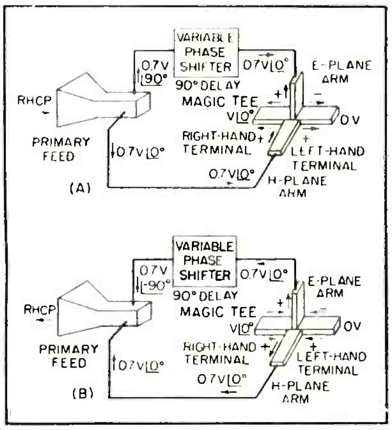

FIG. 2—Reception (A) and transmission (B) of right-hand polarization are illustrated

Reception

Upon reception, the right-hand circularly-polarized component of the incident field induces a voltage at the vertical terminal of the waveguide which is equal in magnitude to, and leads in phase by 90 degrees, the voltage induced at the horizontal terminal. Due to the phase shifter, the two voltages arrive at the E- and H-plane arms in phase and are therefore detected at the right-hand terminal of the magic tee as indicated in Fig. 2A. In like manner the left-hand circularly polarized component of the incident field is received at the left-hand terminal.

To use this same antenna to transmit and receive linear polarizations, it is necessary that a 0 or 180-degree phase shift be introduced between components. If horizontal and vertical polarizations are desired, the antenna must be so oriented that the input terminals make angles of 45 and 135 degrees with the ground as shown in Fig. 3. Any arbitrarily chosen elliptical polarization can be transmitted and received by a proper adjustment of the phase shift and rotation of the antenna feed.

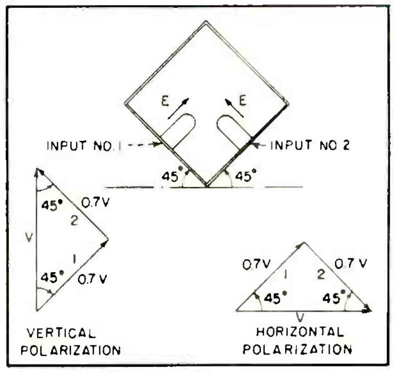

FIG. 3—Operation of antenna when used to transmit and receive linear polarization

Whatever component is generated, the component received at the generating terminal of the hybrid junction has the same polarization characteristics as the transmitted signal. For radar type of operation, assuming a single reflection of the transmitted signal from the target surface, the transmitter and receiver of a given linear component are located at the same terminal, whereas the transmitter for a circular component and the receiver for the reflected circular component are located at different terminals of the hybrid junction. It is this fact which excludes the use of circular polarization in radar systems having antennas with one terminal only.

Design Criteria

It was assumed in the previous sections that the transmitted power was divided exactly equally between the two arms and that the two path lengths differed by exactly 90 degrees or by 0 degrees or 180 degrees for circularly or linearly polarized components respectively. In practice a tolerance is put on the polarization characteristics, and it is therefore necessary that design criteria be established. Those for circular polarization are discussed here.

Let the two orthogonal linear components of an electromagnetic field be represented as

$$E_x = A \cos \omega t$$
$$E_y = B \cos (\omega t + \phi) \quad (1)$$

where A and B are the amplitudes of the components and ϕ the phase angle between them. Then the power ellipticity of polarization can be written

$$e^2 = \frac{P_{max}}{P_{min}} = \frac{A^2 + B^2 + \sqrt{(A^2 + B^2)^2 - 4\,A^2 B^2 \sin^2\phi}}{A^2 + B^2 - \sqrt{(A^2 + B^2)^2 - 4\,A^2 B^2 \sin^2\phi}} \quad (2)$$

where P_{max} and P_{min} are proportional to the squares of the major and minor axes of the polarization ellipse of this field. When A is equal to B and only ϕ is allowed to vary, Eq. 2 becomes

$$\frac{P_{max}}{P_{min}} = \cot^2 \frac{\phi}{2} \quad (3)$$

For values of ellipticity near circular it is convenient to express the power ellipticity as $P_{max}/P_{min} = \cot^2 \left(\frac{90° + \Delta\phi}{2}\right)$, thus showing the deviation of the ellipticity from unity directly in terms of the deviation of ϕ from 90 degrees. Figure 4A is a plot of this relation.

If on the other hand $\phi = \pm 90$ degrees exactly and the amplitudes of the components are allowed to vary, Eq. 2 becomes

$$\frac{P_{max}}{P_{min}} = \left(\frac{A}{B}\right)^2 \quad (4)$$

Figure 4B is a plot of Eq. 4.

Measurement of Ellipticity

It is possible to resolve any electromagnetic wave uniquely into the sum of two circularly polarized fields of opposite senses of rotation and of unequal magnitudes. Therefore, once this antenna system has been set up to receive circular polarization, it is necessary only to measure the ratio of the powers P_R and P_L present at the right- and left-hand receivers respectively (Fig. 1) in order to determine the ellipticity of polarization of an incident wave. The power ellipticity in terms of this ratio is given by

$$e^2 = \frac{P_{max}}{P_{min}} = \left[\frac{\sqrt{P_R/P_L} + 1}{\sqrt{P_R/P_L} - 1}\right]^2 \quad (5)$$

Figure 4C is a plot of P_{max}/P_{min} versus the ratio of the powers at the right- and left-hand terminals of the hybrid junction.

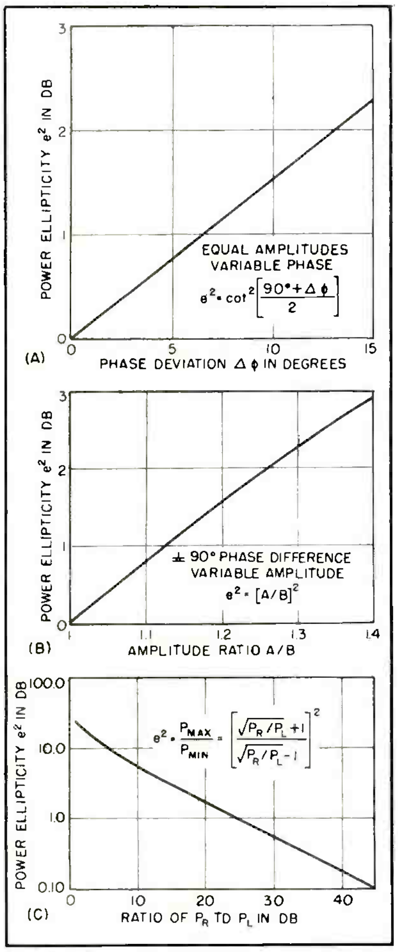

FIG. 4—Curves showing relationship between power ellipticity and other parameters

Experimental Results

This design technique is applicable to any wavelength, although the choice of circuit elements is dictated by size or weight limitations. Two such systems have been built, one operating in the 3.2-cm band, the other in the 10-cm band. The two photographs show the 3.2-cm model. The square waveguide used as the transmission line was designed to transmit two TE_{10} modes at right angles to each other but no higher modes. In other words the inner dimension a of the square waveguide satisfied the condition $\lambda/\sqrt{2} > a > \lambda/2$. Waveguides instead of probe couplings were used to reduce the crosstalk between the two input lines. The phase shifter consisted of a movable dielectric slab placed inside one of the waveguide sections and was designed to produce a maximum phase shift of 360 degrees.

It was found that these antennas could be adjusted for ellipticities of unity, the limiting factor being the accuracy of the test equipment used.

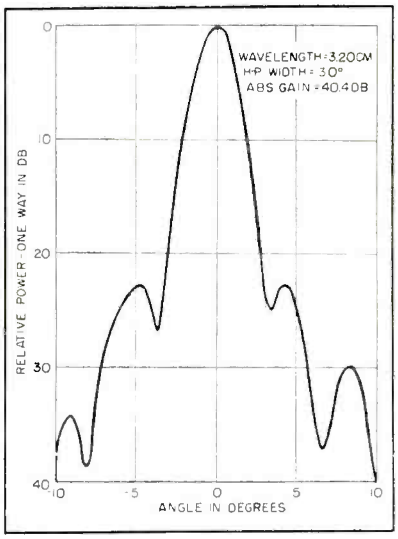

FIG. 5—Power pattern of a circularly-polarized antenna paraboloid 30 inches in diameter

The gain, beamwidth, and patterns of these antennas were consistent with theoretical predictions. For example, one cut through the main lobe of the radiation pattern of the parabolic type antenna shown was measured for many linear polarizations. It was found that the ellipticity of polarization was no greater than one decibel over the entire portion of the main lobe when the on-axis ellipticity had been adjusted to be less than 0.25 db. Figure 5 shows a typical cut.

Acknowledgment

The author is indebted to L. C. Van Atta and J. I. Bohnert of of Naval Research Laboratory and L. J. Chu of Massachusetts Institute of Technology for their continuous encouragement and stimulating consultations. The author also wishes to acknowledge preliminary work on this project done by S. Topol, formerly of Naval Research Laboratory.

THYRATRON

Seven basic methods for control of the firing angle and four primary sources of noise are analyzed, with circuit diagrams and waveforms. Analysis includes criteria for reliable circuit operation based on calculations of maximum critical grid current, interaction, transients and increasing frequency

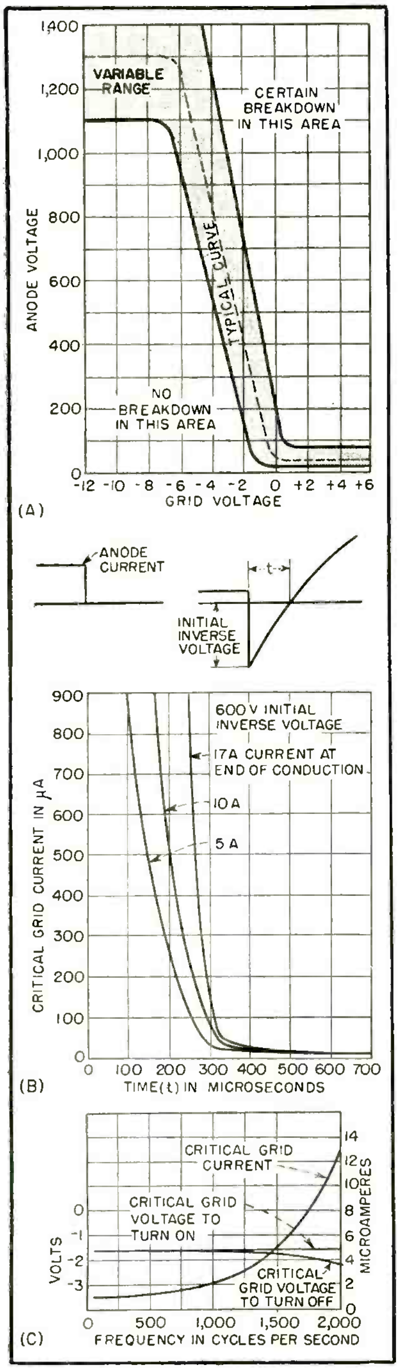

FIG. 1—Maximum range of grid voltage characteristic for type C6JA tubes (A), effect of critical grid current of one type C6M (B), and effects of frequency on critical grid voltage and current for one C1K tube (C). Critical grid-voltage curves are data for 160 v peak a-c anode voltage in a half-wave circuit with resistance load and full-rated anode current

INERT-GAS thyratron tubes are found today in increasing number and diversity of applications for automatic control systems where compact and reliable amplification is required. The degree of success of each application, industrial or military, depends vitally upon the engineering attention given to the grid circuit.

If a-c voltage is applied to the anode of a gas thyratron, the beginning of current conduction in each cycle can be accurately controlled by the voltage applied to the grid. Most tubes are designed to have a slightly negative grid characteristic to minimize grid drive and for increased stability. As the negative voltage on the grid is decreased at less than some negative value of a few volts the tube will fire and electron flow from cathode to anode will be established. This value of potential is called the critical grid voltage. To assure equipment performance independent of small variations among tubes and over tube life, the circuit designer bases his calculations on the maximum critical grid voltage range for all tubes over the entire useful life and maximum rated ambient temperature range, as shown in Fig. 1A, rather than upon typical curves.

The basic problem in grid circuit design is to convert some quantity to be controlled into an electrical signal, and to operate on the signal to cause it to shift the firing point of the tube.

Often the parameter to be controlled is available as a voltage—for instance, when regulating a generator or alternator. If position is to be controlled it can be converted into a voltage by using position to move a potentiometer, a synchro, the magnetic armature of an inductance, one plate of a capacitor, a strain gage, or a shutter in a light beam.

In nearly all circuits it is common practice to balance the quantity to be controlled or its voltage equivalent, against a reference of such magnitude that the voltage difference between it and the signal, when applied to the grids, will be large compared to changes in tube critical grid voltage, amplifying the difference if an impractical reference would otherwise be required for the desired sensitivity.

Basic Methods

The numerous schemes for control of grid firing angle can be classified as modifications of the seven methods indicated in the summary of Fig. 2.

The maximum critical grid current is the greatest value of current that flows to the negative grid just prior to firing as the grid voltage is reduced to fire the tube. This current flows in a direction to make the grid less negative, or in a sense, may be considered to make the apparent critical grid voltage correspondingly more negative than the true critical grid voltage. Since the critical grid current after cycles of

GRID CIRCUIT DESIGN

By JAMES H. BURNETT

Electrons, Inc.
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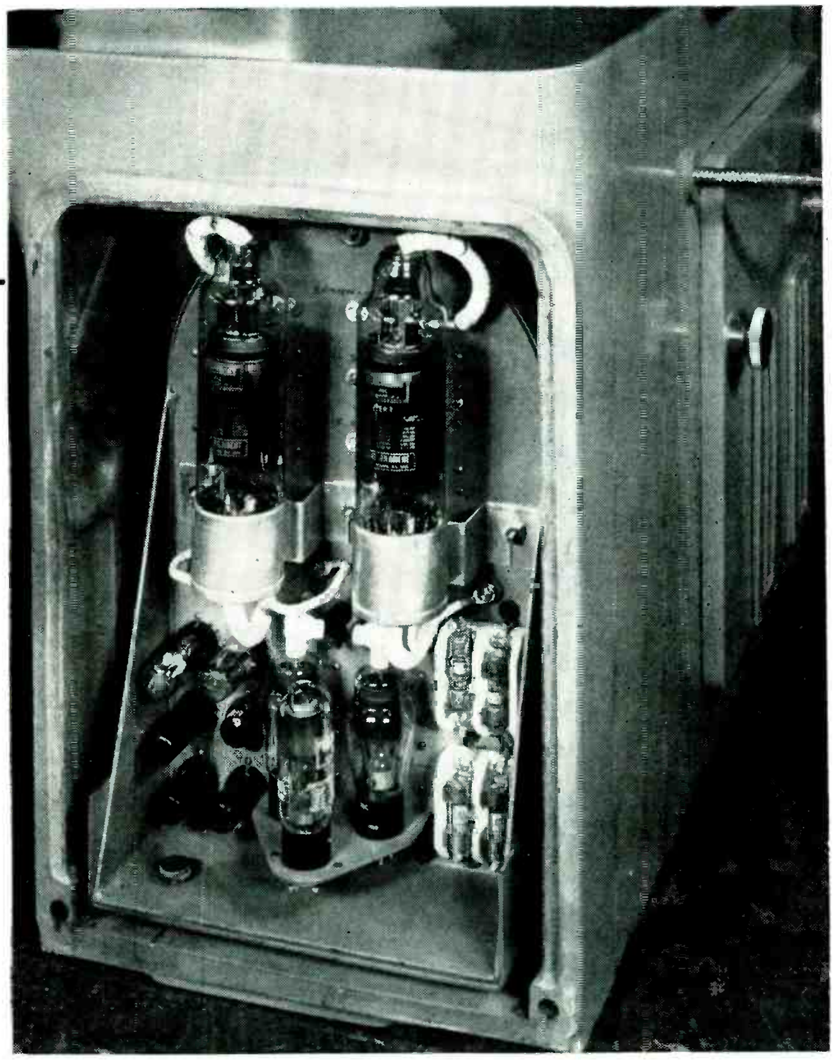

Electron-tube control unit used in Monarch screw machine assures constant speed under load and high torque at low speeds

heavy-current conduction may be greater than on the first cycle, the maximum value, not the preconduction grid current, is used in careful circuit design. Most modern tubes have so low a critical grid current at 60 cycles that circuit insulation leakage currents to be expected in usual industrial practice may be the limiting current condition.

In these methods the stability and uniformity of the thyratrons being used will usually determine the minimum practical bias voltages and hence the sensitivity.

Proper impedance matching is important. For example, in the method shown in Fig. 2A, the impedance of the phase-shift network is made low compared with the grid circuit resistance. This precaution avoids distortion and phase shift of the signal through regulation caused by loading. The upper limit of grid resistance is usually set at a value that sufficiently minimizes voltage drop with maximum critical grid current or leakage current flowing through it.

In the various methods described in which d-c bias is required, small selenium rectifiers or compact germanium crystal diodes can be used. A combination of d-c and various lagging a-c rider biases can be obtained from one grid-transformer winding as shown in Fig. 3.

Self-rectified current in the grid circuit provides a useful form of d-c bias from a small bypass capacitor across the grid resistor (Fig. 2G).

Self-rectified grid current can be used to provide a stabilizing effect when used with a variable-magnitude a-c signal. For example, in some closed-cycle systems, the overall time constant may be several cycles while the tubes respond almost instantaneously. Figure 4 shows a position servo combining a variable a-c signal with fixed lagging a-c grid bias and incorporating the self-bias scheme. With large error signal the total a-c grid voltage will be large in magnitude and nearly in phase with the anode voltage. By use of self-bias, the first cycle of full conduction results

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INDUSTRIAL GAS TUBES

Thyratrons faithfully control d-c or a-c motor speeds independent of load or line-voltage variations over a range of 500 to 1. In torch-cutter and machine-tool pattern tracers they position servomotors in quick response to the movement of delicate actuators. Performance in the order of 10 inches per minute per thousandth of an inch accuracy is possible.

Uses include shaping fragile parts, pressing automobile bodies, control of huge wind tunnels and delicate repeaters for aircraft and marine navigation equipment. Tubes are found in high-speed or synchronous switching circuits for welders, x-ray contactors, frequency changers, theater lighting and stable power supplies.

Operating in temperatures from − 60 to + 212 F, and at frequencies in excess of 1,000 cps, thyratrons are dependable when used in the proper circuits, for which the special parameters are described in this article

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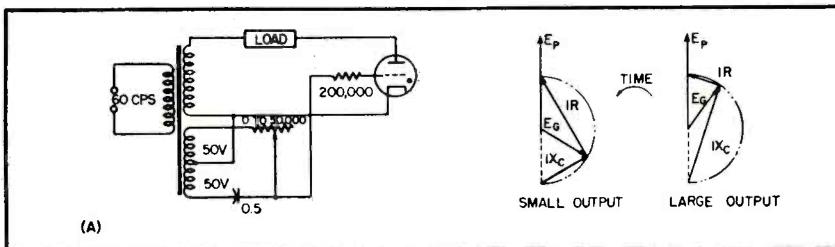
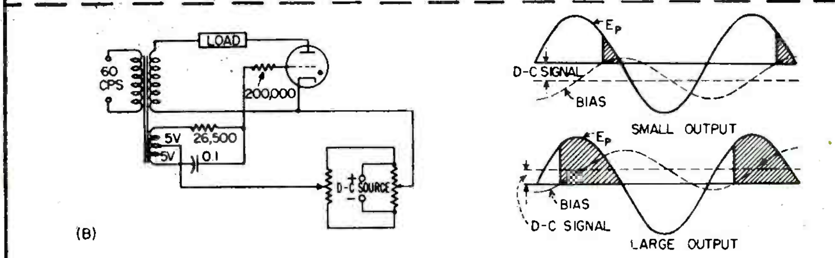
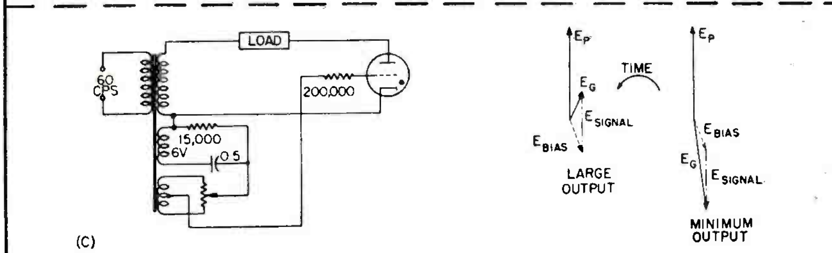


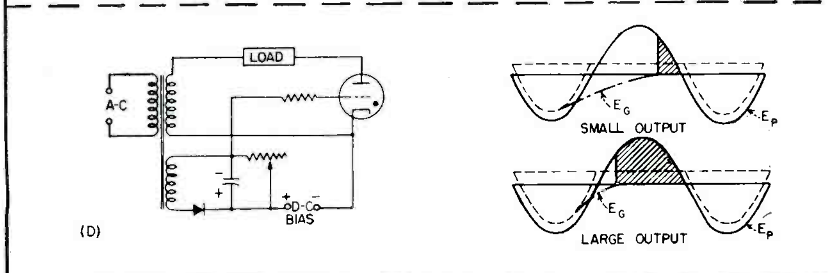
Phase shift of an a-c sinusoidal grid voltage accomplished by rotation of a synchro or by the use of bridge circuits using variable resistance, capacitance or inductance. Typical values shown for fixed capacitance and variable resistance at 60 cycles.



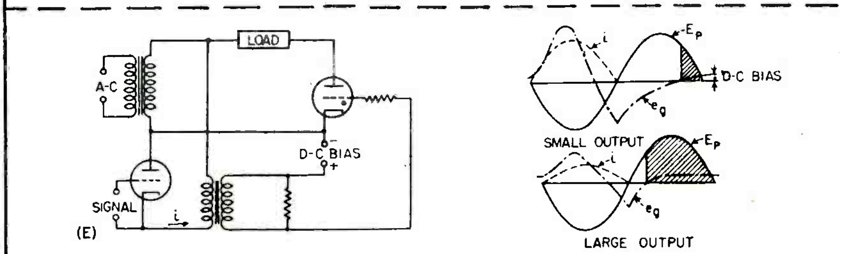
Variable-magnitude and polarity d-c signal plus a small fixed-magnitude a-c rider bias. Optimum rider bias lags anode voltage about 90 deg in half-wave and noninductive single-phase full-wave circuits; may be in phase for full-wave circuits with inductive loads.



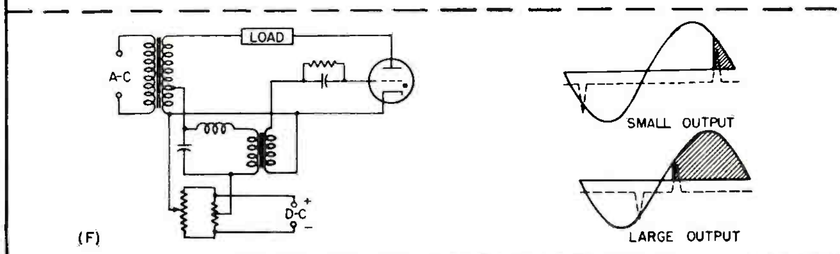
Variable-magnitude and phase-direction a-c signal plus small fixed-magnitude a-c bias. In this circuit arrangement the fixed a-c bias usually lags the anode voltage by about 160 degrees.



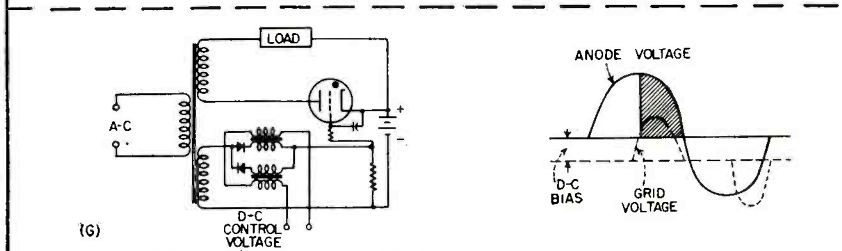
Discharge of energy in grid transformer with primary d-c pulses during negative anode half cycle. Firing angle is relatively independent of line voltage waveform. Either d-c or a-c signals may be applied to vacuum-tube grid to control the magnitude of peak negative voltage and thus the grid firing angle. Useful technique when cathodes are not common.



Discharge of energy in grid transformer with primary d-c pulses during negative anode half cycle. Firing angle is independent of line voltage waveform. Useful technique when cathodes are not common as in back-to-back or inverse-parallel connection.



Recent developments in small magnetic amplifiers make possible another means for thyratron grid control in the milliwatt power-output range. Such amplifiers have response times sufficiently fast to be useful as shown in the accompanying diagram.



Firing angle can be controlled by phase shift of a positive peaked voltage added to a negative d-c bias. Standard transformer can be operated above normal voltage with impedance in supply. Multivibrators, whose square-wave output is differentiated in R-C networks, are also used for this purpose.

FIG. 2—Seven basic methods of controlling the firing angle of thyratrons

in charging the bypass capacitor negatively. The firing angle on the succeeding cycles will be retarded more than the signal voltage indicates by an amount equal to the negative bias on the bypass capacitor. As this charge leaks off over several cycles, signal sensitivity is gradually regained. The effect is to desensitize the circuit only when signals are large and thereby avoid hunting.

For simple on-off control, the hold-off negative bias may be obtained easily by charging a capacitor between cathode and grid on the negative-anode half-cycle with a small a-c bias 180 degrees out of phase with the anode voltage as shown in Fig. 5.

Interaction

Sometimes during a conduction period the grid of the conducting tube tends to float at a potential within a few volts of cathode potential. As a result grid current usually flows through the grid circuit during this period. This current may store energy in a grid-circuit component. If the stored energy is dissipated too slowly after conduction ceases, it will appear as a fictitious signal on the following cycle. As a result, the tubes may tend to flicker instead of turn on sharply, to pass several cycles for a grid signal calling for one cycle, or to show irregularity in the control curve. Remedies are usually self-evident once the path of the troublesome current and its storage element have been established.

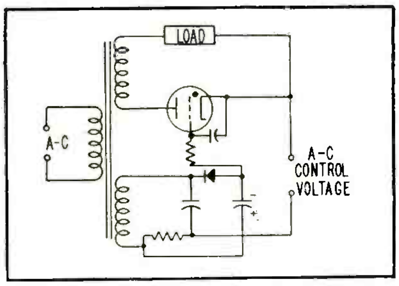


FIG. 3—Method of obtaining combination of d-c and various lagging a-c rider biases

A tube about to fire may be affected by a flow of grid current to another conducting tube through a grid-circuit impedance common to both tubes. The actual grid voltage of the first tube will be materially affected by the "float" potential of the grid of the conducting tube. This effect can occur in a full-wave rectifier circuit as well as in a reversing servo circuit.

Figure 6 shows a circuit condition in which this effect is advantageous. Self-rectified grid current through one tube and a grid circuit resistance common to the other tube in an inverter circuit produce additional negative grid bias for the second tube.

Circuit Noise

Thyratrons respond faithfully to the actual voltage on the grid whether it is signal or noise voltage. Probably the most important single consideration in successful grid circuit design is the detection of circuit noise, and its elimination. A cathode-ray oscilloscope with a d-c amplifier is practically indispensable in detecting noise. If the input impedance of the amplifier is

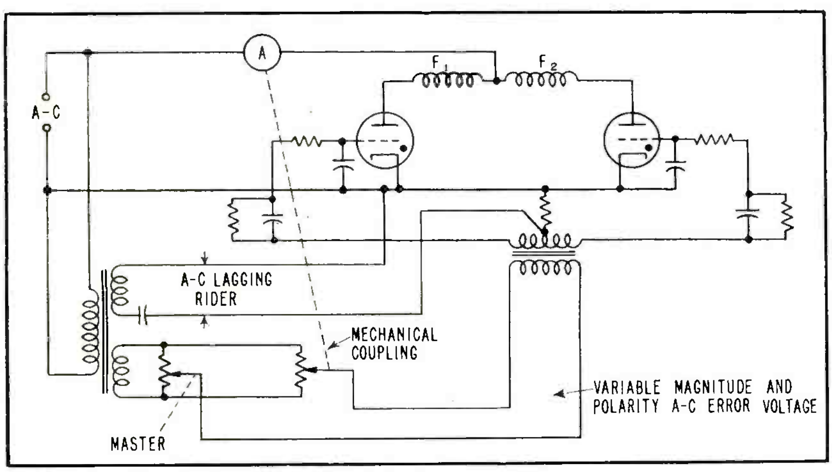


FIG. 4—Self-bias for stabilizing with variable magnitude a-c grid voltage in split-field motor positioning servo

FOUR SOURCES OF NOISE VOLTAGE

(1) A common, and often overlooked source of noise voltage is transient charging or discharging of stray capacitance between grid transformer windings, and between these windings and ground through high grid-circuit impedance. Voltages of extremely large magnitude and short duration are produced on the grid. A typical offender is the back-to-back connection in which the cathodes are exposed both to line and load potential surges. Figures 7A and 7B show thyratrons so connected for a reversing servo, x-ray or welding contactor, or for lighting control. This effect also is found in servos where the forward and reverse circuits are linked by stray capacitance across grid transformer windings as in Fig. 7C.

Consider conditions existing with a slightly inductive load at the end of conduction of one tube in Fig. 7A. Conduction continues beyond the end of the cycle for a few degrees owing to load inductance. The cathode-to-anode voltage across this tube suddenly changes from tube voltage drop of about 10 volts, to the instantaneous line voltage. A charging current then flows into the stray capacitances indicated, through part of the grid-circuit impedance of the other tube, producing a large voltage of short duration. The actual grid voltage is raised above the critical grid voltage, and the tube misfires.

Such effects can be eliminated by static shields around each grid-transformer winding connected to the respective thyratron cathode. Without shields, a small capacitor across the grid-transformer secondary, or the use of lower-impedance grid transformers, often reduce such noise.

(2) An obvious trouble, though not the most common, is the instantaneous collapse of a-c grid voltage due to commutation of anode current from one tube to another in an adjacent electronic power unit on a common supply line with poor regulation. The inrush magnetizing current when large transformers are switched on the supply line may also produce similar effects.

Correction of such difficulties usually is accomplished by low-pass filtering of the a-c grid voltage. Often the connection of a relatively small capacitor across the grid transformer is adequate and has negligible effect on phase shift of the signal voltage.

(3) Transient noise voltages are sometimes introduced on the grid through capacitive coupling of grid-circuit wiring. Short grid leads are always advisable. It is especially desirable to connect the grid resistor as close as possible to the tube. Shielded conductors connected to the respective thyratron cathodes, rather than to ground, may be necessary. Circuit noise may arise from various possible cathode-to-ground voltages on an ungrounded chassis.

(4) Transient grid voltages induced through interelectrode capacitances in the tube (Fig. 7D) may be limited to a negligible value by connecting a small padding capacitor of 0.005 μf or less directly from grid to cathode. Such a circuit results in an effective anode-to-grid/grid-to-cathode capacitance ratio of several hundred. The maximum grid voltage transients are thereby limited to a small fraction of a volt. The time constant of padding capacitor and grid resistor is limited to a fraction of a cycle, minimizing carry-over effects

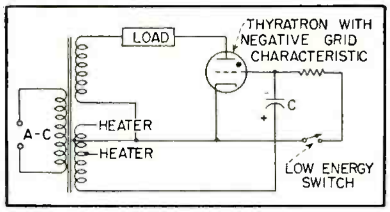


FIG. 5—Simple on-off control is normally held off by self-rectified grid-current charge on capacitor C during negative anode half-cycle

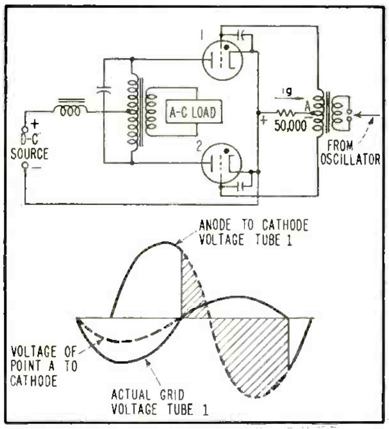


FIG. 6—Inverter circuit utilizing negative bias from common resistor in which positive grid current for another tube flows

many times higher than the grid-circuit impedance, the scope may be connected directly to the grid without upsetting the grid voltage or firing angle. An isolation transformer for the scope power supply will reduce any appreciable capacitance between it and scope ground that may otherwise distort the grid voltage if tube cathodes are ungrounded.

It is often helpful to set the scope for horizontal input sweep, and connect the grid and cathode of the thyratron to one set of plates. The anode and cathode are connected to the other set of plates to obtain a plot of actual grid voltage versus instantaneous anode voltage. Misfiring, when it occurs, is directly apparent.

Noise transients on the grids of position follow-up systems can be detected if the anode connections are opened and the scope watched with brilliance full on during the firing of the reversing tubes.

Sources of noise voltage can be conveniently grouped in four classes shown in the box.

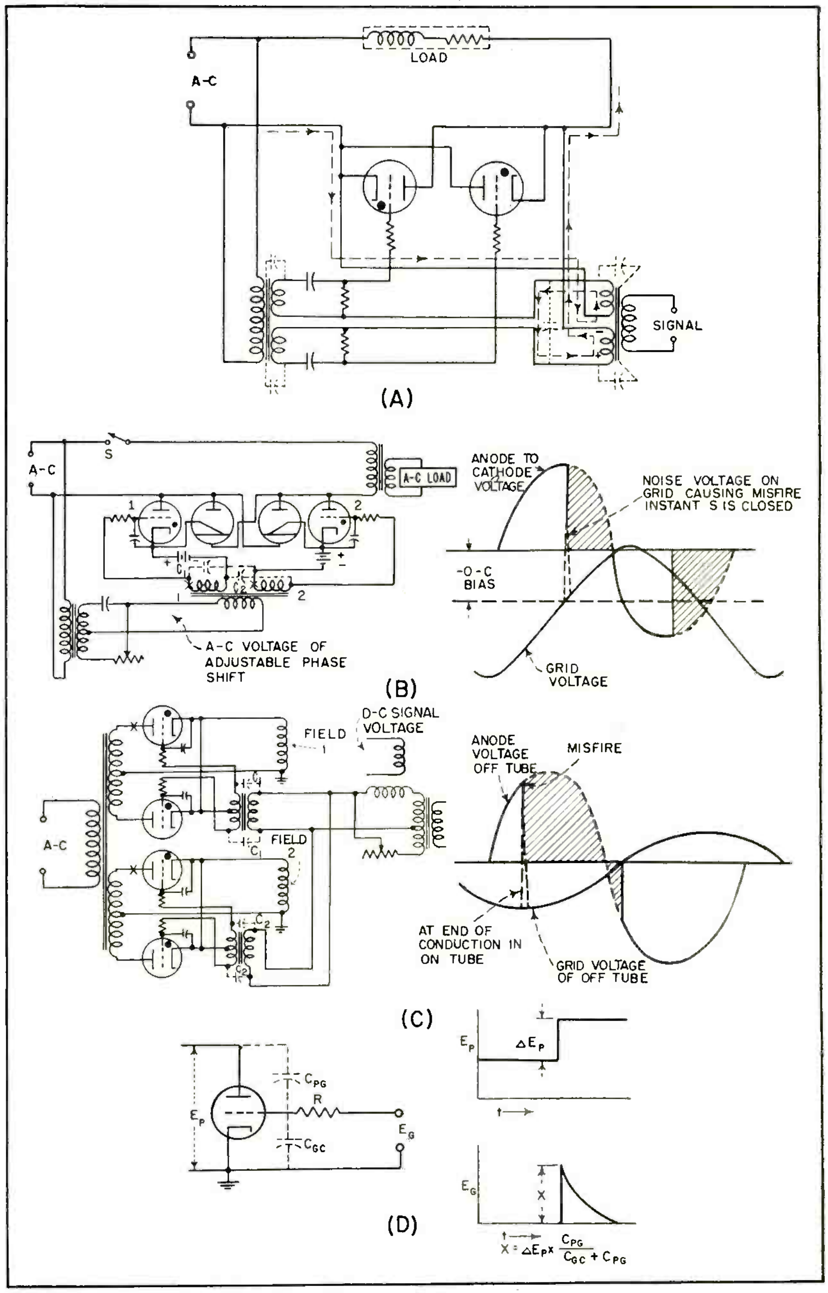


FIG. 7—Positioning servo tubes (A) connected back to back may be affected by charging of stray capacitances. One path of charging current is shown by dashed line. When S is closed (B) C_1 and C_2 charge through grid transformer secondaries 2 and 1 resulting in transients that misfire each tube for one cycle. Current flow (C) through high-impedance transformer produces noise on grids of the off tubes. Effect of interelectrode capacitance with sudden change in anode voltage (D)

There are a number of commonly encountered circuit conditions that may impose a sudden change in instantaneous anode voltage on a thyratron, with resultant undesirable change in firing angle. Rough spots in the control or hunting will result if the designer does not anticipate such circuit characteristics.

Such a condition is found in a full-wave or polyphase rectifier circuit where the load is at least partially inductive and unit operation covers the range where current in the load may change from discontinuous to continuous current. At this point, shown in Fig. 8, the peak forward voltage applied to the tubes suddenly doubles in magnitude, with resultant sudden change in critical grid voltage. In a closed-cycle control system this condition will result in inherent hunting at such an operating point, unless the designer has provided a grid-circuit voltage that minimizes the effect.

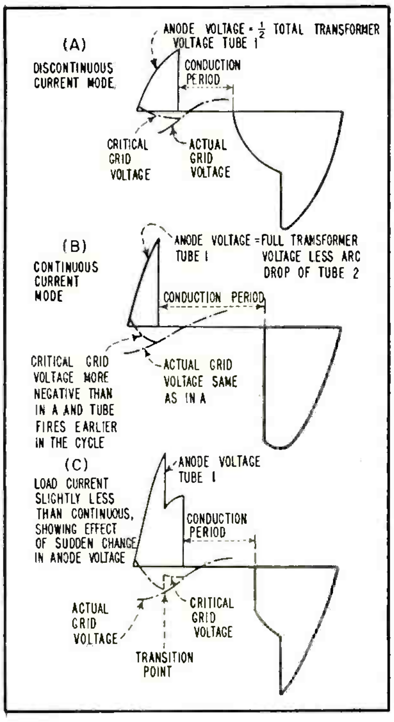


FIG. 8—Discontinuous and continuous load-current operation for full-wave thyratron circuit showing effects on anode and critical grid voltages

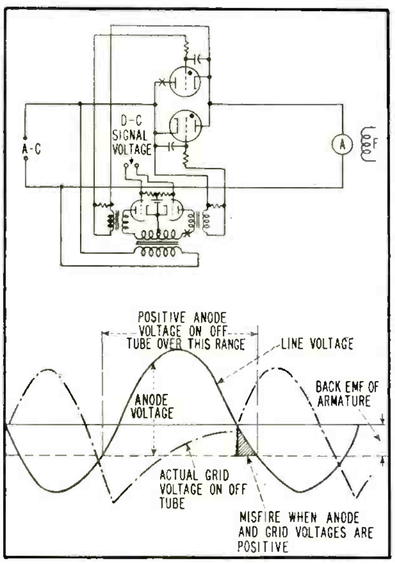


FIG. 9—Effect of voltage generated by the load added to the normal anode voltage in a positioning servo

Another circuit condition that produces a sudden change in critical grid voltage is the double three-phase rectifier circuit with interphase reactor, operating at light load. As the output current is reduced to a low value, the voltage generated in the interphase reactor no longer is great enough to sustain current conduction through each tube for as long as 120 degrees,

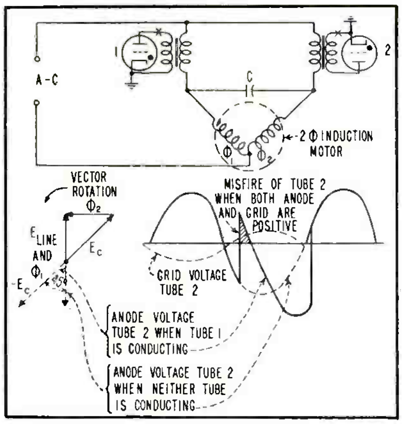


FIG. 10—Effect of phase shift of anode voltage during conduction of reversing tube in one type of a-c motor servo circuit

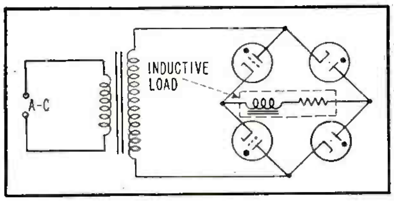


FIG. 11—Single-phase bridge with two thyratrons and two diodes cannot reduce load voltage to zero by grid phase control if load is highly inductive

and the mode of operation suddenly changes from double three-phase (120-degree tube conduction) to six-phase star (60-degree tube conduction) with a resultant sudden change in peak forward voltage and critical grid voltage on all tubes at a given firing angle.

In position follow-up servos employing either d-c armature or field-voltage reversing, the instantaneous anode voltage on the off tube or tubes is the sum of the anode transformer voltage and the voltage appearing across the load as a result of motor rotation or because of conduction of the on tubes. The effect is shown in Fig. 9. It will include any hash from the commutator. In some a-c motor-reversing circuits, the actual anode voltage of the off tube may be the voltage across the phase-splitting capacitor. It is thus of different phase angle (Fig. 10) from the line voltage. In these cases the actual anode voltage may be positive during a large part of the cycle when the anode voltage would normally be negative if the servo-signal voltage were zero. Negative d-c bias in combination with pulse firing is one prevention against misfiring. Sometimes a disabling bias derived from current flow through one set of tubes can be used to prevent simultaneous conduction in the other set and a resultant short-circuit current through both sets of tubes. At frequencies above a few hundred cycles there is a decrease in available deionization time—especially during transition from one set of tubes to another.

In certain circuits an inherent power-circuit characteristic may cause the loss of tube control which is at first erroneously attributed to faulty grid-circuit design. For example, the single-phase bridge circuit comprising two thyratrons and two gas diodes shown in Fig. 11 supplies a regulated and adjustable d-c output voltage to an inductive load over a wide range. However, the d-c voltage can not be reduced to zero by grid retardation. Analysis shows that one thyratron or the other will conduct at the instant both grids are biased off. Since the voltage generated in the load inductance permits the diodes to commutate the load current each time the supply line voltage passes through zero, the voltage on the anode of the conducting thyratron never becomes negative, and hence conduction of current through it continues. At this point the voltage suddenly jumps to about half output. If it is desired to control a d-c voltage to zero with an inductive load, a single-phase full-wave circuit using two thyratrons or a single-phase bridge using four thyratrons can be employed. A single thyratron may be used with a back rectifier connected across the load.

Increasing Frequency

As the frequency of the anode voltage is increased above a few hundred cycles, both the time required for the tube to regain control and the effect of frequency on critical grid current and critical grid voltage become important. Usually, the increased critical grid current with increase of frequency, rather than deionization time rating is the dominant factor in setting the grid circuit frequency limit. Typical values are shown for two modern tubes in Fig. 1B and 1C.

SEMICONDUCTOR DIODES

Summary of characteristics of silicon and germanium crystal diodes, with dimensions and terminal data. Since some ratings are affected by pulse shape, pulse duration and duty cycle, manufacturers should be consulted when working near rated limits in pulse circuits

Table I—Characteristics of Silicon Diodes

Type No.	Design Freq (mc)	Total Energy (ergs)	Peak Pulsed Power (watts)	Max Conversion Loss (db)	Min Fig. of Merit	Max Output Noise Ratio	I-F Impedance (ohms)	Mfr	Shape	Remarks NOTE: 1N24, 1N27, 1N29, 1N30 and 1N33 are obsolete.
1N21	3,000	0.3		8.5		4.0	200–800	Sylv	1	First detector
1N21A	3,000	0.3		7.5		3.0	200–800	Sylv	1	First detector
1N21B	3,000	2.0		6.5		2.0	200–800	Sylv	1	First detector
1N21C	3,000	2.0		5.5		1.5	200–800	Sylv	1	First detector
1N22	9,000	0.3					200–800	Sylv	1	Instruments, probes
1N23	10,000	0.3		10.0		3.0	150–600	Sylv	1	First detector
1N23A	10,000	1.0		8.0		2.7	150–600	Sylv	1	First detector
1N23B	10,000	0.3		6.5		2.7	150–600	Sylv	1	First detector
1N25	1,000		6.5	8.0		2.5	100–400	Sylv	1	First detector
1N26	25,000	0.1		8.5		2.5	300–600	Sylv	2	First detector
1N28	3,000	5.0		7.0		2.0	250	WE	1	Mixer; high burnout
1N31	10,000		0.02		55			Sylv	2	High level video detector: 500 cps-5 mc; Z = 6,000–23,000 ohms for 1N31; 5,000–20,000 for 1N32. Use 1N31 instead of 1N30.
1N32	3,000		0.36		100			Sylv	1	

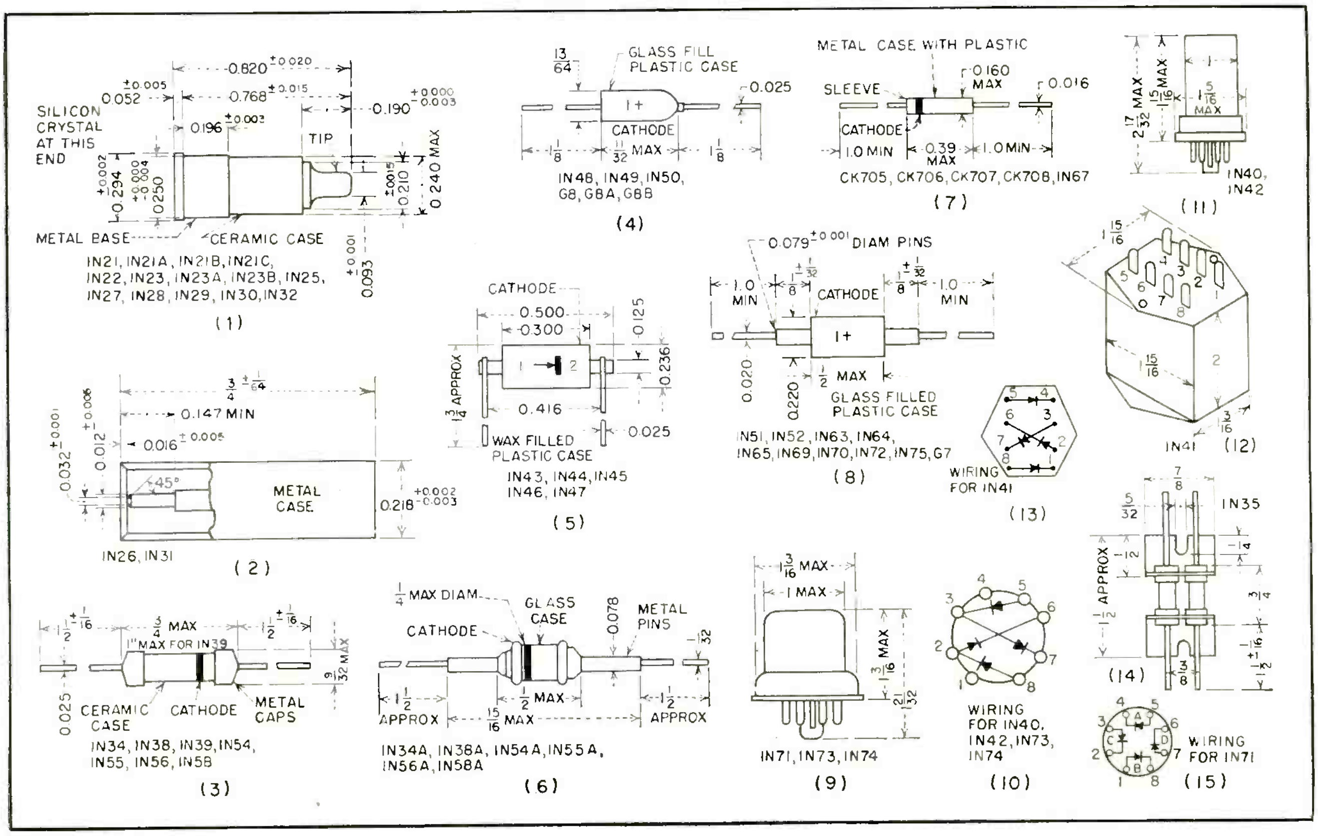
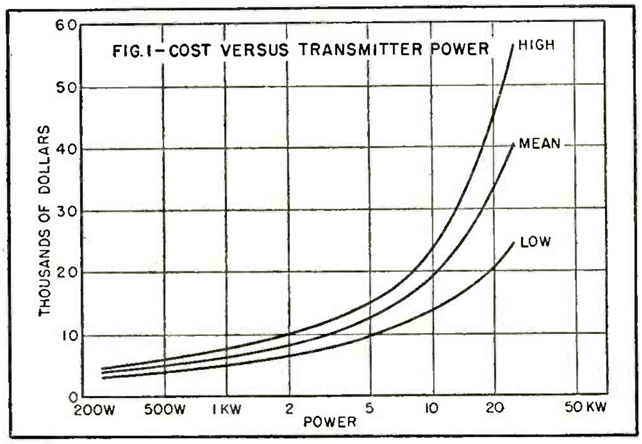


Table II—Characteristics of Germanium Diodes

Key: Sylv—Sylvania; WE—Western Electric; GE—General Electric; Rayth—Raytheon; Obs—Obsolete

Type No.	Max Reverse Working Voltage (volts)	Min Reverse Volts for Zero Dynamic Res	Min Forward Current at +1v (ma)	Average Anode Current (ma)	Max Recurrent Peak Anode I (ma)	Max Forward Surge Current (ma)	Max Reverse Current (μa)	Mfr	Shape	Remarks
1N34	60	75	5.0	50	150	500	50 at −10v 800 at −50v	Sylv	3	General-purpose diode
1N34A	60	75	5.0	50	150	500	30 at −10v 500 at −50v	Sylv	6	Glass-sealed general-purpose diode
1N35	50	75	7.5	22.5	60	100	10 at −10v	Sylv	14	Matched duo-diode. Ratings are for one diode. Currents match within 10% at forward +1v
1N38	100	120	3.0	50	150	500	6 at −3v 625 at −100v	Sylv	3	100-volt diode
1N38A	100	120	4.0	50	150	500	5 at −3v 500 at −100v	Sylv	6	100-volt diode
1N39	200	225	1.5	50	150	500	200 at −100v 800 at −200v	Sylv	3	200-volt diode
1N40	25	60	12.75 at +1.5v	22.5	60	100	40 at −10v	Sylv	10, 11	Plug-in varistors having four diodes whose resistances are balanced within 2.5% in forward direction at 1.5 volts. Forward resistances of each pair are matched within 3 ohms. Ratings are for single diodes
1N41	25	60	12.75 at +1.5v	22.5	60	100	40 at −10v	Sylv	12, 13	
1N42	50	120	12.75 at +1.5v	22.5	60	100	6 at −3v 625 at −100v	Sylv	10, 11	
1N43		60	5	40	125	500	20 at −5v 850 at −50v	WE	5	WE 400A
1N44		115	3	40	100	400	1,000 at −50v	WE	5	WE 400B
1N45		75	3	40	100	400	410 at −50v	WE	5	WE 400C
1N46		60	3	40	125	500	1,500 at −50v	WE	5	WE 400D
1N47		115	3	30	90	350	4 at −3v 410 at −50v	WE	5	Tested for min rect eff of 35% at 100 mc, 2 v rms input and 5,000-ohm, 20μμf load
1N48	85		4	50	150	500	833 at −50v	GE	4	
1N49			4		50		200 at −20v	Obs	4	
1N50			4	25	100	300	80 at −20v	Obs	4	
1N51	50		2.5	50	150	500	1,667 at −50v	GE	8	Utility grade
1N52	85		4.0	50	150	500	150 at −50v	GE	8	High grade
1N54	35	75	5.0	50	150	500	10 at −10v	Sylv	3	High-back-resistance diode
1N54A	50	75	5.0	50	150	500	7 at −10v 100 at −50v	Sylv	6	High-back-resistance diode
1N55	150	170	3.0	50	150	500	300 at −100v 800 at −150v	Sylv	3	150-volt diode
1N55A	150	170	4.0	50	150	500	500 at −150v	Sylv	6	150-volt diode
1N56	40	50	15.0	60	200	1,000	300 at −30v	Sylv	3	High-conductivity diode
1N56A	40	50	15.0	60	200	1,000	300 at −30v	Sylv	6	High-conductivity diode
1N58	100	120	4.0	50	150	500	800 at −100v	Sylv	3	100-volt diode
1N58A	100	120	5.0	50	150	500	600 at −100v	Sylv	6	Glass-sealed 100-volt diode
1N60	25	30		40	150	500	30 at −1.5v	Sylv	3	Video detector diode
1N63	125		4.0	50	150	500	50 at −50v	GE	8	High back resistance and voltage
1N64	20							GE	8	Second detector diode
1N65	85		2.5	50		150		GE	8	D-C restorer diode; 1-sec surge current = 150 ma
1N67	80	100	4	35	100	500	5 at −5v 50 at −50v	Rayth	7	50-volt d-c restorer
1N69	60		5	40	125	400	0.05 at −10v 0.85 at −50v	GE	8	Max temp 70 C. Min rect curr at 40v 60 cps with 500-ohm load is 30 ma. Min rect eff of 1N70 is 35% at 2v rms, 100 mc, 5,000-ohm load and 20μμf
1N70	100		3	30	90	350	0.01 at −10v 0.41 at −50v	GE	8	
1N71	40	50	15	60	200	1,000	300 at −30v	Sylv	9, 15	Low-imp varistor matched to pass currents equal within 1 ma at forward +1v. Ratings are for single diode
1N72	5			25	75			GE	8	UHF diode. Noise figure at 500 mc is 14 to 19 db
1N73		75	15 at 1.2–1.7v	22.5	60	100	0.05 at −10v	GE	9, 10	Plug-in varistor with four closely matched diodes
1N74		75	15 at 1.3–1.8v	22.5	60	100	0.05 at −10v	GE	9, 10	Plug-in varistor like 1N73 but wider matching tolerances
1N75	125		2.5	50	150	500	0.05 at −10v	GE	8	High back resistance and voltage. Max shunt C is 0.8 μμf
CK705	60	70	5	50	150	500	50 at −10v 800 at −50v	Rayth	7	General-purpose
CK706	40	50		35	125	300	200 at −10v	Rayth	7	Video detector. Rect eff approx. 60% at 54 mc
CK707	80	100	3.5	35	100	500	8 at −5v 100 at −50v	Rayth	7	50-volt d-c restorer
CK708	100	120	3	35	100	500	625 at −100v	Rayth	7	100-volt d-c restorer
G7								GE	8	UHF; design freq 500 mc; max op freq 3,000 mc; noise figure 14–19 db
G8								GE	4	Matched 1N48. Currents match within 10%
G8A								GE	4	Matched 1N52. Currents match within 10%
G8B								GE	4	Matched 1N63. Currents match within 10%

Typical f-m station, one of 13 operated by the Rural Radio Network of Ithaca, N. Y.



F-M and TV

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THE ENGINEER planning transmitting equipment for a new broadcast station must consider cost as well as coverage. The purpose of this article is to present a practical method of cost analysis for the case of an f-m or television station. A systematic solution is valuable because of the important common factors in these two cases, variable antenna-power gains and line-of-sight transmission.

Because of the frozen status of television applications at the present time and the resulting lack of reliable prices, f-m costs will be used in the examples which follow. However, the reader can readily revise the results when firm tv quotations are available.

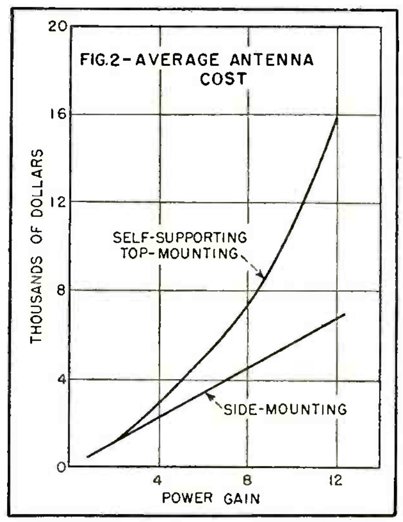
General Approach

In the example to be considered, as in most problems of engineering economics, the costs of the various major items are interrelated. This type of problem is best solved by successive approximations, as will be demonstrated. Two trials, a quick approximate solution and a careful final one, will usually give sufficient precision.

Consider this problem: *What f-m installation will result in the lowest initial cost per square mile for coverage of rural, level terrain?* Using present-day costs and the FCC's rural coverage standard (50 microvolts per meter) the answer is found to be a 5-kw transmitter, an antenna with a power gain of 12, and a 450-foot tower, giving an initial cost, exclusive of studios, of $3.80 per square mile.

The mean values of transmitter prices, as shown in Fig. 1, are first considered. The wide spread of prices reflects the present slow market for f-m transmitters.

Because of the practicality of high antenna-power gains with reasonable-sized antennas at f-m and tv frequencies, selection of the proper antenna is a very important factor in minimizing the cost of a given effective radiated power. For f-m, a side-mounting antenna is usually the best buy unless unusual circumstances indicate the desirability of the more expensive self-supporting, top-mounting type.



* Now a student in the Graduate School of Business, Stanford Univ., Stanford, Calif.

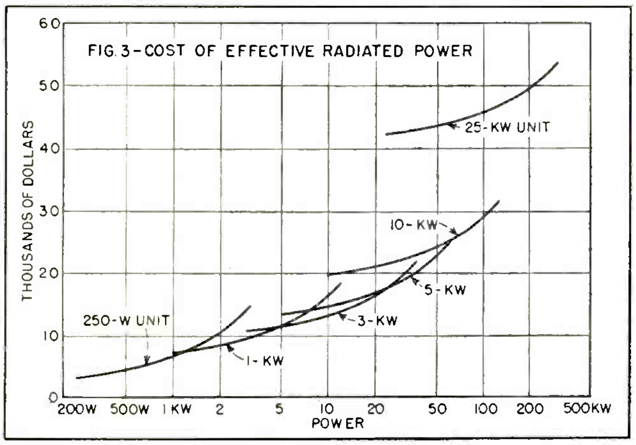


FIG. 3—COST OF EFFECTIVE RADIATED POWER

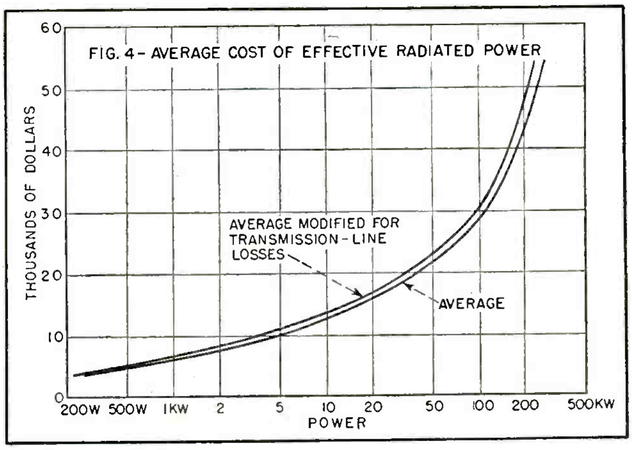


FIG. 4—AVERAGE COST OF EFFECTIVE RADIATED POWER

Station Costs

Investment in dollars, per mile of coverage, is readily estimated by the method outlined. F-M transmitter and antenna prices are used as examples but tv figures may be substituted. Cost of studio equipment is not included

Therefore, side-mounting antenna prices, as shown in Fig. 2, are used in this example. Antennas of both types are available in power gains as high as 12 at present.

Choice of the proper size of transmission line can be made by estimating the cost of the line plus the cost of the power lost in the line for each size of line available. This procedure indicates a 3⅛-inch line in the present example.

As a first approximation, the cost of obtaining a specified effective radiated power is equal to the cost of the transmitter plus that of the antenna. However, this figure must be adjusted to allow for changes in tower height necessary to maintain the required height at the center of radiation of the antenna. With a side-mounting antenna, the necessary supporting tower height will be increased by one-half the height of the antenna.

When the adjusted effective radiated power is computed using each of the commercially available transmitter unit sizes, the family of curves in Fig. 3 results. The envelope of these curves, along with a further modification to include transmission line losses, is plotted in Fig. 4.

The selection of the proper type of tower, self-supporting or guyed, is dictated primarily by the cost of land at the station location. For this example it will be assumed that moderate land costs allow the use of a guyed tower. The tower prices shown in Fig. 5 reflect the fact that towers in excess of 450 feet are usually engineered on an individual basis.

Fixed Costs

For the purposes of this example, fixed costs will be estimated as follows:

Transmitter building	$6,000
Land	2,000
Auxiliary technical equipment	2,000
Total	$10,000

The family of curves shown in Fig. 6 was constructed by selecting a particular height to the center of radiation and dividing the sum of the cost components by the area of coverage for each effective radiated power, as computed from the FCC's propagation curves. Working back from the group minimum of $3.80 per square mile at an effective ra-

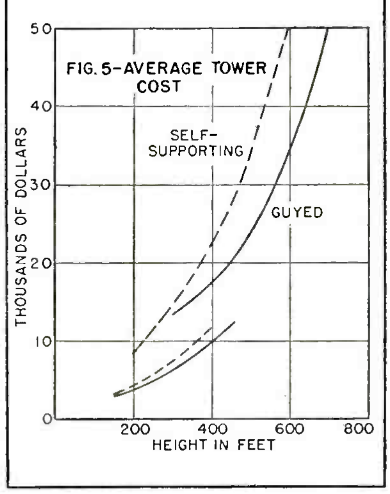


FIG. 5—AVERAGE TOWER COST

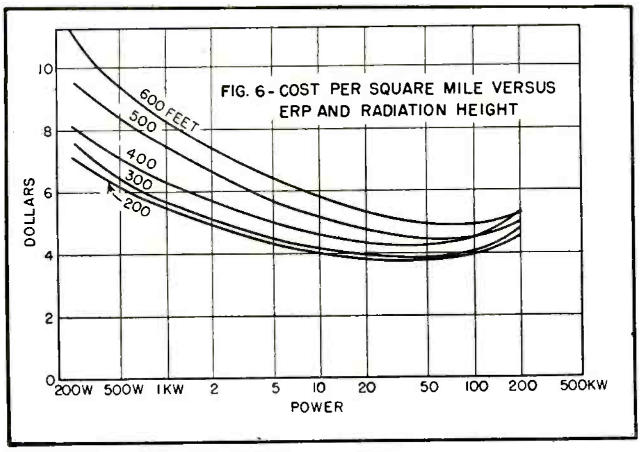


FIG. 6 - COST PER SQUARE MILE VERSUS ERP AND RADIATION HEIGHT

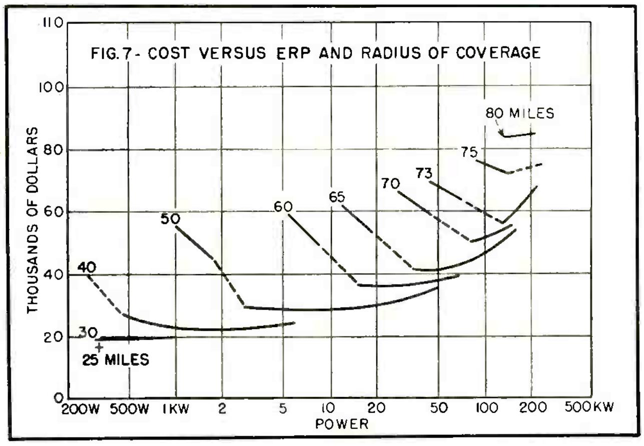


FIG. 7 - COST VERSUS ERP AND RADIUS OF COVERAGE

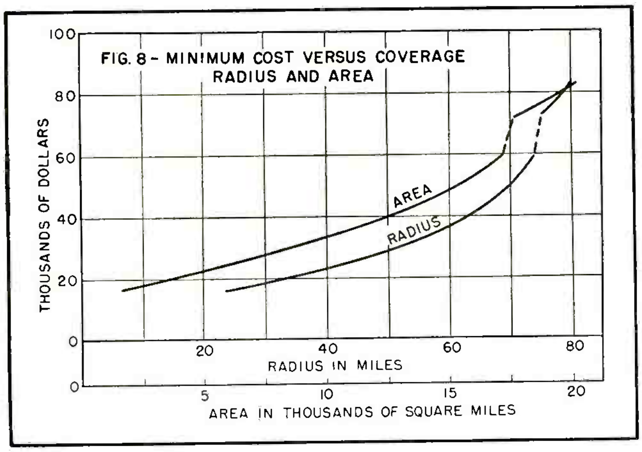


FIG. 8 - MINIMUM COST VERSUS COVERAGE RADIUS AND AREA

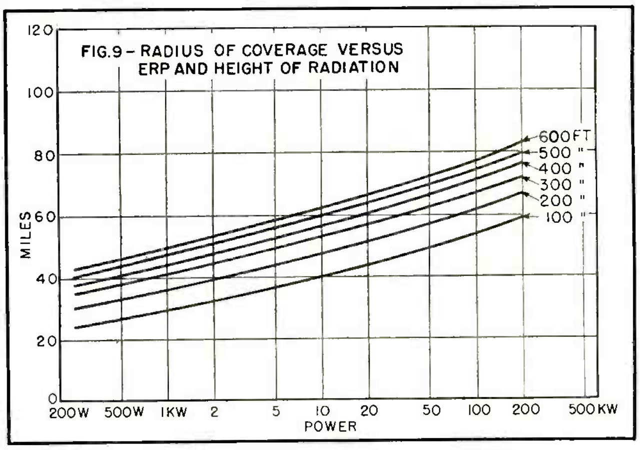


FIG. 9 - RADIUS OF COVERAGE VERSUS ERP AND HEIGHT OF RADIATION

diated power of 50 kw and a radiation height of 400 feet, it is seen that after correction for transmission line losses, 50 kw corresponds to a 5-kw transmitter and an antenna with a power gain of 12. This antenna will require a 450-foot supporting tower to maintain the radiation height at 400 feet.

Further Details

The above result would be useful if one were considering the problem of establishing a rural f-m broadcasting network and wished to know the most efficient station size. For an individual station, however, the radius of coverage or area of coverage as a function of cost is probably the most important information required by the engineer.

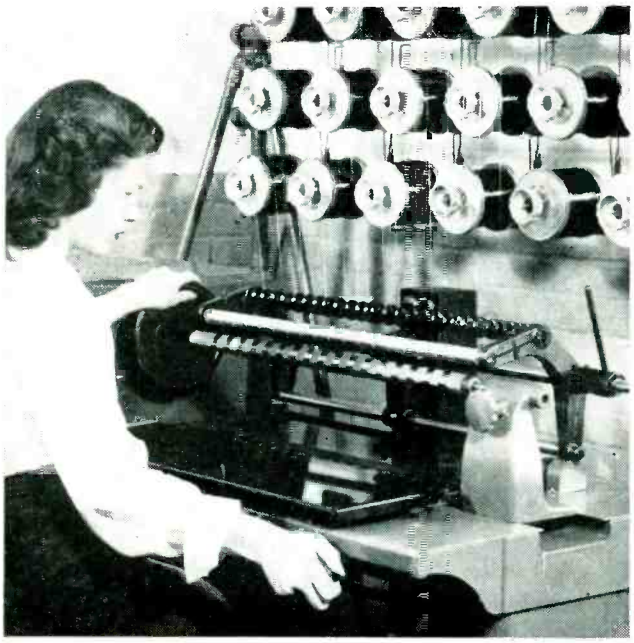
As an example of the way in which the problem of single-station coverage of level terrain might be handled, the curves in Fig. 7 and 8 have been drawn by rearranging the data from the original example and determining the radius of the 50-microvolt-per-meter contour from the FCC's curves. The curve in Fig. 8, giving the initial cost of a single station exclusive of studios, results from the minima of the curves in Fig. 7. These curves are discontinuous because of the jump in tower prices at 450 feet.

In the case of a single station, the results can readily be adjusted to include individual peculiarities of the location. If the transmitter site under consideration stands above the surrounding terrain, or if the surrounding terrain is irregular, these factors can be taken into account in estimating the coverage area. Or, if it is intended to mount an f-m or tv antenna on the top of an existing a-m tower, one variable will be eliminated.

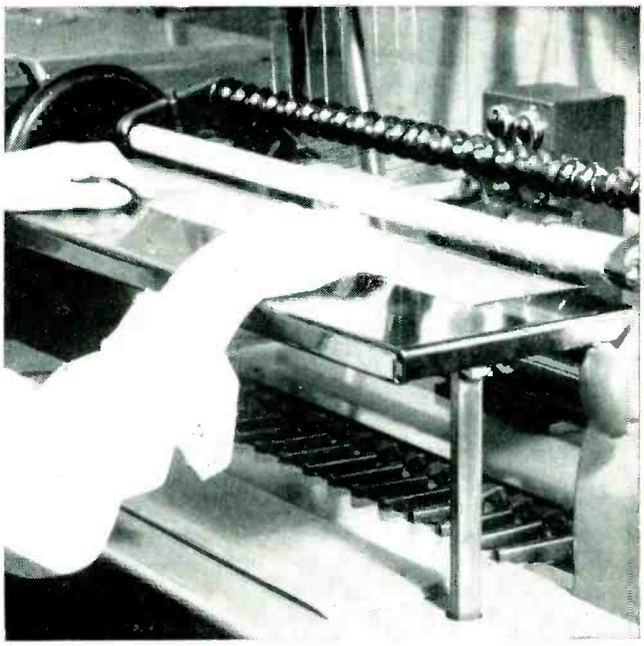
Redrawing the FCC propagation curves for the particular value of signal level of interest will speed the process of relating height of radiation and effective radiated power to coverage radius of area. For example, see the curves in Fig. 9, which were used in the preceding calculations.

Of more practical interest than the actual area of coverage of a broadcast station is the number of persons living within this area. The above results can easily be expressed in terms of cost per thousand persons in the area of coverage by relating area to population through population density maps and census data. This type of presentation, when applied to existing metropolitan stations, will in most cases confirm the often-suspected fact that power increases are seldom justified on the basis of increased potential audience. However, the same is not so likely to be true of a rural station.

Due to the wide variations in individual circumstances, the specific results presented here will probably be of value mainly for purposes of rough estimating. However, the method is general enough to allow application to most situations encountered in practice.



Operator at manual stick winder, controlling spindle speed with left hand while raising paper shelf with right hand



Feeding interleaf sheet into manual machine. Coils being wound on stick are hidden by raised shelf in this view

Planning Coil Production

Methods of winding reliable universal, interleaf and bobbin coils for electronic equipment, and instructions for constructing a nomograph that shows minimum coil-lot size at which an automatic winder becomes more economical than a manual machine

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ELECTRICAL COILS, vital parts of any radio or tv set, undergo continual redesign either to improve performance or to cut costs. The decision of the production engineer as to how coils should be wound, what machines should be used, and how the machines should be set up becomes more and more vital as military requirements call for both short and long runs of entirely new coil designs. With the pool of skilled manpower dwindling rapidly, the attractiveness of automatic coil-winding machinery increases correspondingly.

Fortunately, most of the coils used in radio, television and communication receivers use one of the following three types of construction: (1) Universal or lattice-wound coil; (2) interleaf coil; (3) bobbin coil.

The universal coil is by far the most familiar to the electronic engineer. This coil is recognized by its open, self-supporting structure and the geometric pattern of the multi-strand Litzendraht wire lay. This geometric pattern is the secret of the coil's high Q, high inductance and minimum resistance. Typical applications are for peaking coils, traps and flyback transformers in television receivers.

The interleaf coil, characterized by insulating layers of paper or acetate sheet between layers of wire, is used in power transformers, audio output transformers and filter chokes. It is generally used with a laminated iron or steel core and for these applications is square or rectangular in shape.

The bobbin coil, least used for radio and tv, is simply a single random winding in a flanged paper or plastic bobbin. Its purpose is to supply a controllable magnetic field, as in the focus coil of a tv receiver.

Winding Universal Coils

Machines for winding universal coils require accurate construction because these coils are self-supporting, depending solely on their construction for strength. The wire must be laid down in an accurate predetermined pattern that varies with the size of the wire, the diameter of the tube and the turns.

The average universal coil contains about 700 turns. As winding machines run between 700 and 1,000 rpm, winding time is seldom longer than 1 minute. On the other hand, the time required to handle or prepare the coil while on the machine is comparatively long, and each operation must be repeated for each individual coil.

To obtain maximum productivity, the largest coil multiple physically possible should be used. For universal coils, common practice is to wind four in multiple (four coils at a time). An additional advantage of a large coil multiple is that it permits a more flexible choice of speeds. Generally, after removing the completed coils from the machine the operator has a finishing operation to perform on each coil during winding of the next set.

Assuming a unit time for this operation of, say, 30 seconds, the operator would be busy for 2 minutes between sets with a four-coil multiple, but only 1 minute with a two-coil multiple. With the larger multiple, therefore, it is possible to wind at half the speed of the two-coil multiple and achieve the same productivity.

Lower speed is a definite advantage for it reduces maintenance on the machine and improves the quality of the winding by reducing vibration and improving control of wire tension. With high-turn coils, the possibility of one operator handling two machines should not be overlooked.

In a winding machine for universal coils, the cam speed is actually greater than the spindle speed, for the wire goes back and forth across the coil several times per revolution. To obtain a compact, strong coil a very fine adjustment is required so that with every revolution the crossing point of the wire is either advanced or retarded a small amount to make each turn lock the preceding turn in position. This amount is approximately equal to the size of the wire being wound. The device which controls this spacing is called a gainer. Its correct setting can be determined only by trial and error, for there are so many variables. The gainer adjustment is stepless and permits winding a coil for any degree of compactness, but there is only one setting which will give the electrical and dimensional requirements of any one specification.

Manual Interleaf Machines

In manual winding machines for interleaf coils, the interleaf paper is inserted by the operator at the completion of each layer. In automatic machines, the interleaf paper is inserted automatically by the machine without stopping the arbor. The manual machine is the more popular because it is simpler, more flexible and less expensive. However, each machine has its own merits and field of application.

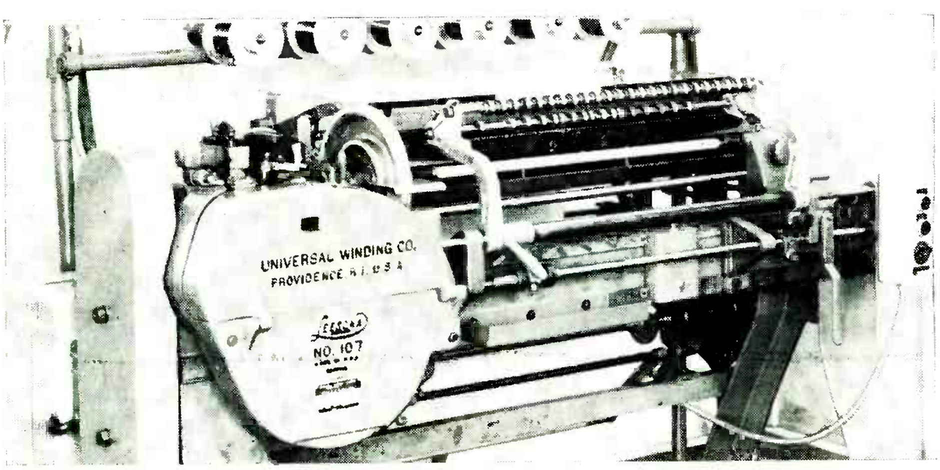
The manual machine is designed for simplicity, a minimum of adjustments and low cost. Coils are wound in multiples up to thirty on arbor-supported paper tubes 16 to 30 inches long, and wide sheets of insulating paper are inserted by the operator between each wire layer. Upon completion, the stick is marked, removed from the machine, then cut into individual coils on a band saw.

An electric motor operating through a friction clutch drives the arbor or spindle, and this in turn drives the traversing mechanism, usually a leadscrew, through a gear system. The gears are selected according to the size of the wire to be wound. Adjustable stops control reversal of the leadscrew as dictated by the length of the coil. Recent development of manual machines has concentrated on quick-change mechanisms so that a female operator can quickly change the setup of the machine to a new specification. This feature makes the manual machine especially adaptable for producing coils of few turns and in small-lot quantities.

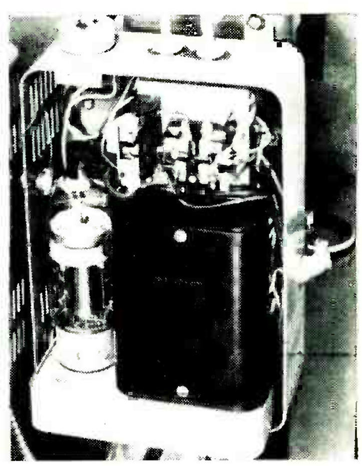
Commercial coil-winding concerns producing coils for several users, usually in small quantities, are mostly equipped with manual machines because of their extreme flexibility. Generally, however, they have a few automatic machines for high-production stock items.

Automatic Interleaf Machine

Equipment manufacturers who wind their own coils are predominantly equipped with automatic machines, as their runs are long. The automatic machine can be run at higher speeds, up to 2,500 rpm, as the paper is inserted at full speed, whereas the operator must slow down while inserting manually. Furthermore, since the entire wind-



Automatic machine for stick-winding interleaf coils. Electronic motor control box at left provides smooth acceleration from full stop to top running speed, eliminating wire breakage during starting. Paper is fed automatically to coils at high speed, with length of paper being increased as coil diameter increases



Electronic motor control unit for automatic winder. Control box with speed control knob and start-stop buttons is at other end of machine

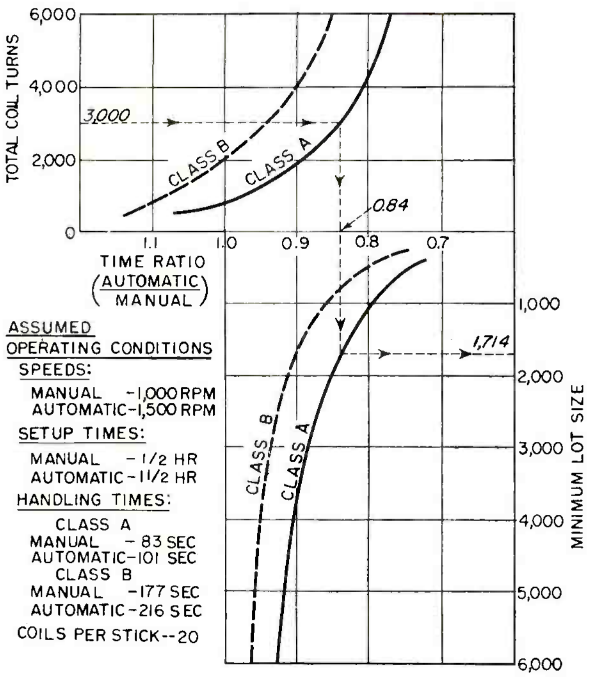


FIG. 1—Example of nomograph that can be prepared for any plant to determine whether automatic or manual winding machines are more economical for a particular job. In construction steps given below, values in parentheses are those for plant and coil used as example in nomograph

(1) Find average winding speeds for automatic (1,500 rpm) and manual (1,000 rpm) winding machines

(2) For one representative coil (3,000 turns), find handling time (total time on machine with wire not running, including taping, inserting taps and other hand work) per stick for the automatic (101 sec) and manual (83 sec) machines

(3) For same coil, find winding time (total turns divided by speed) for automatic (120 sec) and manual (180 sec)

(4) Add handling and winding times to get total time for automatic (221 sec) and manual (263 sec)

(5) Divide total time on automatic by total time on manual to get time ratio (0.84)

(6) Repeat steps 2, 3, 4 and 5 for the same type of coil having different turns, and plot resulting time ratio values against turns to get upper curve (500 turns gives 1.07 ratio; 6,000 gives 0.77)

(7) For first coil (3,000 turns) find difference in total time per stick (263 — 221 = 42 sec) as time gained on automatic per stick of 20 coils

(8) Find setup time (total time to readjust machine to new coil specification) for automatic (1½ hours) and manual (½ hour). Take difference (1 hour or 3,600 sec) and divide by time gained per stick on automatic (42 sec) to get 85.7 sticks as break-even point. Multiply by coils per stick (20) to get minimum lot size (1,714 coils) at which use of automatic machine is justified

(9) Repeat steps 7 and 8 for coils having different turns, and plot minimum lot size against time ratio values to get lower curve of nomograph (500 turns gives beyond-infinity lot size; 6,000 turns gives 705 coils minimum lot size)

ing operation is automatic, the operator can perform some finishing operation during winding.

The automatic machine is more expensive and inherently more complex than the manual. Setup time, too, is longer on automatics when changing over from one coil specification to another.

Choice of Machine

A production engineer fortunate enough to have both manual and automatic winding equipment at his disposal must always analyze each coil specification closely and decide where production would be less costly—on the hand-fed machines or on the automatics. A nomograph of the type shown in Fig. 1 can be worked up for any specific plant to aid in determining whether or not it would be economical to place a coil on an automatic machine. Handling time on the machine when the wire is not running is the variable that depends on the individual plant and the abilities of its mechanics.

The curves shown are for two different ratios of handling times, designated for convenience as class A and class B. Usually a plant will make two or even more distinct types of coils having different handling times, and here one set of curves is needed for each type on the nomograph. If desired, the curves can be designated more specifically by type names such as *Output, Type 1* or *Reactor, Type 5*, as being more descriptive of the types of work being run by the particular concern.

Once the nomograph has been drawn, its use is simple. Merely trace across from the desired value of coil turns to the appropriate upper curve, trace down from there to the corresponding lower curve, then trace across to the right-hand scale and read the minimum economical lot size for an automatic machine.

Winding Bobbin Coils

Machines for winding bobbin coils are the simplest of all in construction. Since the flanges of the bobbin support the coil, a precise lay of wire is not required and a gainer mechanism is unnecessary. A wide range of traverse speeds is required, but fine regulation is not. Generally, winders for bobbin coils are of the single-spindle variety with but one coil being wound at a time.

Sometimes two or more single-spindle units are ganged together on a machine to operate with one common traverse mechanism. The three-spindle arrangement lends itself to extremely high operator and machine efficiency, for winding speed can be so adjusted that winding time equals twice the handling time. Two spindles of the machine are always running while the operator tends the third. Just as she finishes at one spindle the next goes down and is ready to be tended. With this system, one coil is obtained for every handling time. The primary rule to follow when placing a coil on this machine is to minimize the amount of handling to be done at the machine. These machines are fitted with special motors and tensions to enable high winding speeds (5,000 rpm), and every effort should be made to take full advantage of this feature. These machines can be purchased with spindles in any multiple up to six, depending on the type of coil to be run.

This discussion has been limited to general over-all considerations pertinent in any plant, in an effort to clarify somewhat the problems facing the coil production engineer.

Locked-in Oscillator

Electronic selectivity gained with locked-in oscillator provides ability to reject an unwanted signal much greater than can be obtained with tuned circuits alone. Circuits can be used with intercarrier system or 21.25-mc i-f amplifier

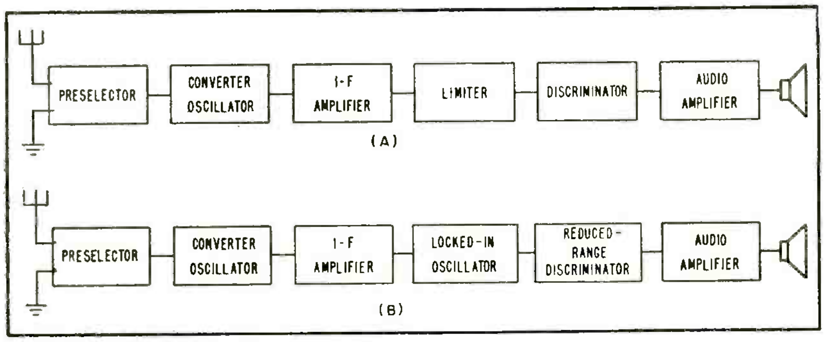


FIG. 1—Stages of receiver employing a locked-in oscillator (B) compared to a conventional receiver (A)

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DEVELOPMENT WORK on frequency-modulation receivers has shown that in order to obtain certain desirable performance characteristics it is necessary to convert frequency-modulated broadcast signals, modulated in accordance with present frequency-modulation standards, to signals having reduced swing before they are sent through the discriminator of a receiver and converted to audio-frequency signals. If the first intermediate frequency of a standard f-m receiver is 10,700 ± 75 kc, division by five gives 2,140 ± 15 kc.

The locked-in oscillator provides a simple method for dividing the instantaneous frequency by five. The incoming signal voltage is applied to the first grid of a pentagrid mixer tube, and the third grid and plate are connected in a regular feed-back oscillator circuit. The first grid serves to inject pulses of current into the plate circuit and causes the oscillator to lock in at one-fifth the frequency of the incoming signal.

This paper presents some improvements on the Beers locked-in oscillator circuit, and some circuits for use in f-m and television receivers, together with a report of field tests.

Figure 1A shows the stages of the limiter-discriminator type of f-m receiver, and Fig. 1B shows how the locked-in oscillator circuits replace the limiter and discriminator. The requirements of the preselector, converter-oscillator, i-f amplifier, and audio amplifier are essentially the same for both circuits.

There is one operating difference when receiving weak signals. The limiter-discriminator receiver can receive a signal so weak that it will not operate the limiter and yet give a usable output if there are no large variations in the amplitude of the incoming wave. These variations can be caused by multipath transmission, by common or adjacent-channel interference or by excessive i-f selectivity.

The locked-in oscillator is either locked in or it isn't; there is no intermediate condition. If the incoming signal is too weak to lock in the oscillator for the full deviation, the oscillator may break out at the ends of the swing and cause distortion. The receiver with the locked-in oscillator must have sufficient sensitivity ahead of the locked-in oscillator to assure that the input to the oscillator is enough to lock-in the oscillator for all signals to be received. The oscillator should preferably be used with high-sensitivity receivers since the distortion of a weak signal may be worse than that obtained with a limiter-discriminator or a ratio-detector receiver, when receiving weak stations with low-sensitivity receivers.

Mechanical Analogy

Figure 2 shows a simple mechanical analogy for the locked-in oscillator. The No. 1 and No. 3 grids of a pentagrid tube are represented by valves that open and close, corresponding to the swings of the grid voltages. The No. 1 valve has a variable opening, corresponding to the variation of the input voltage, and the No. 3 valve is tripped once by the flywheel in each cycle. This is similar to the way the escapement of a watch gives impulses to the balance wheel and keeps it running.

It is necessary for both valves to be open simultaneously for a drop of water (pulse of plate current) to pass. The frequency of the drops is determined by the rate at which the No. 1 valve opens and closes; and the size is determined by how wide the valves open and how long they are open.

The curves in Fig. 2 show the

for TV Sound

drop size and frequency for each grid separately and for the two together. When the drops fall on the spoon attached to the oscillating flywheel, they will lock in the flywheel with the falling drops and maintain oscillation as long as the frequency of the drops is near the resonant frequency of the flywheel, or an integral multiple of this frequency.

If the rate of the flow of drops is increased, there will be a phase shift between the two valves, so the resultant drops will not be the same size as before. There may be a big one followed by a little one. If the big drop hits the spoon when it is starting its downward motion, the drop will be in the spoon for a fairly long time and the weight can therefore do considerable work on the wheel and thus will speed up the system, keeping it locked in. Likewise if the big drop hits near the bottom of the swing of the spoon, it can do only a small amount of work and the system will slow down. It is thus evident that the drops can lock in the flywheel over a range of frequencies if the relative phase of the two valves is adjusted properly.

Locking-in Action

The theory of the locking-in process can be explained in the following manner. In the circuit of Fig 3 the oscillator is connected with feedback from the plate tank circuit to the No. 3 grid. This oscillator grid is operated with self bias through grid resistor R_3. Each time the grid voltage swings positive it draws grid current. For an intermediate frequency of 4,500 kc, the grid operates at one-fifth of this frequency or 900 kc.

The amplitude of the oscillation is determined by the curvature of the $E_g - I_p$ characteristic and is usually so great that the grid voltage swings well into the curved parts of the tube characteristic during the cycle. This means that pulses of plate current are produced having component frequencies 2ω, 3ω, 4ω, . . . where ω is the natural frequency of the tuned plate circuit L_2C_4. These harmonics are applied to the No. 3 grid through the mutual coupling. Additional harmonics are produced by the grid current pulses.

When the incoming signal at 4,500 kc is applied to the tube, the tube operates as a converter and combination frequencies will be produced equal to $\pm 5\ r\omega \pm s\omega$ when r and $s = 0, 1, 2, 3, \ldots$ Since the plate circuit is tuned to 900 kc, the only frequencies which will be amplified are those of frequency ω; the others are bypassed effectively. If $r = 1$, then $s = 4$ or 6 will give frequency ω. Then the fourth and sixth harmonics of the oscillator beat with the incoming signal to produce the frequency ω in the tank circuit.

If the incoming signal is not exactly five times that of the tank circuit, this combination beat frequency current will not be in phase with the fundamental tank circuit current but will be slightly out of phase. The reactive component of this current will cause the oscillator to work like a reactance tube, thus changing the frequency of the tank circuit just enough to lock it in. This is equivalent to the opera-

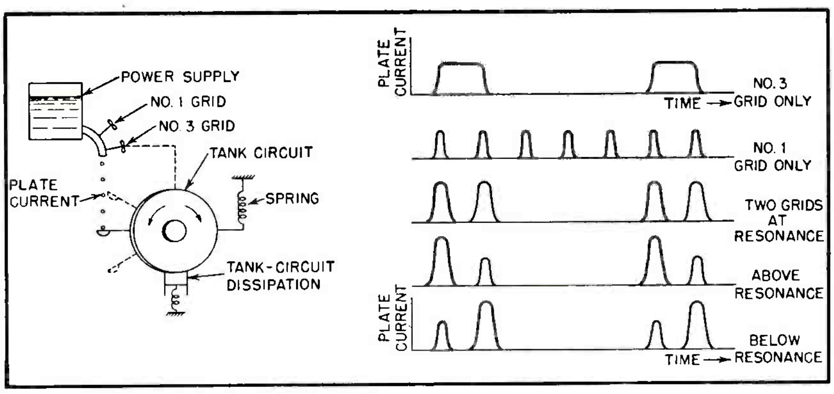

FIG. 2—Mechanical analogy for locked-in oscillator operation

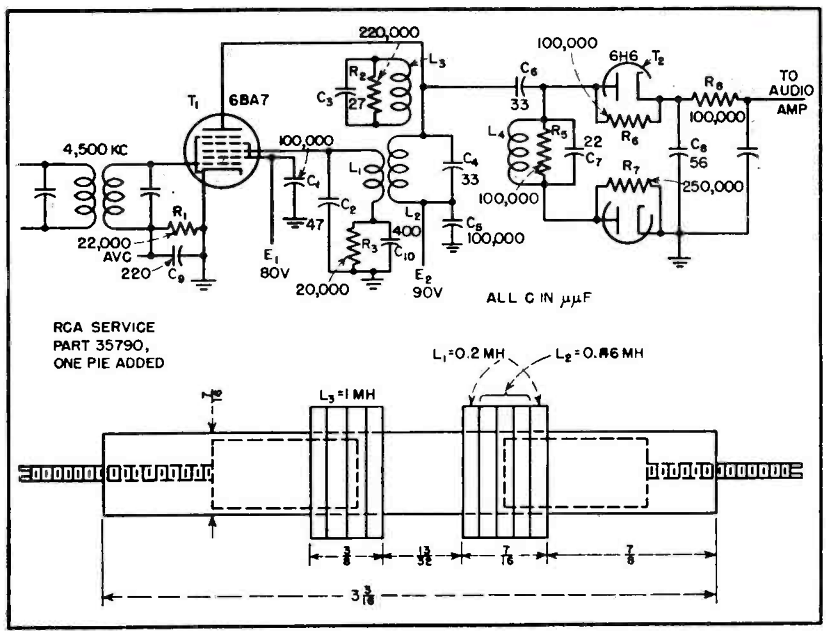

FIG. 3—Circuit and coil construction of oscillator for intercarrier sound

tion illustrated by Figure 2.

The maximum amount of reactive current is produced when all of this beat-frequency current is 90 degrees out of phase with respect to the fundamental tank circuit current. This determines the ends of the lock-in range. If the frequency of the incoming signal is outside this range, the oscillator cannot lock in, and the signal cannot be received. This accounts for the "electronic selectivity" of such a circuit; the over-all selectivity of the circuit will be considerably better than can be obtained by the tuned circuits alone.

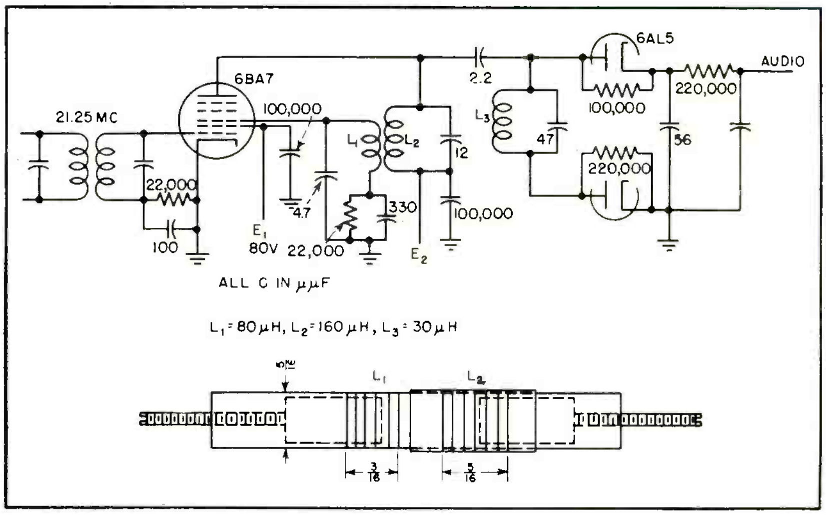

FIG. 6—Locked-in oscillator for 21.25-mc sound channel. Coils L_1 and L_2 are slightly overcoupled and mounted in a separate shield can from L_3

Extending Lock-in Range

Since the amount of fourth or sixth harmonic on the oscillator No. 3 grid determines the magnitude of the reactive current produced, the lock-in range can be extended by placing a parallel tuned circuit in series with the No. 3 grid to enhance the required harmonic. As shown by Fig. 4, this circuit is tuned to the fourth or sixth harmonic of the oscillator tank circuit frequency. This harmonic beats with the incoming signal (5th harmonic) to produce the required fundamental reactive current.

Still greater range can be obtained by detuning the tank circuit to one side and the No. 3 grid parallel circuit of Fig. 4 to the other side of the center frequency.

Another simple way to extend the range is shown by Fig. 3. The coupled circuit L_3C_3 is used to broaden out the selectivity curve of L_2C_4 and give increased lock-in range. Continuous variation of selectivity can be obtained by adjusting R_2 to change the Q of the circuit or by adjusting the mutual coupling between L_3C_3 and L_2C_4. In case of bad interference the selectivity can then be adjusted until the lock-in range is barely enough to accommodate the frequency swings of the incoming signal, thus giving the highest signal-to-noise ratio.

If the circuits of the load on the oscillator are properly designed, it is possible to increase the lock-in range. The discriminator of Fig. 3 was designed so that the input capacitance of the circuit consisting of C_6 and the discriminator fall off at just the proper rate to keep the oscillator in tune over most of the operating range. This variation is shown by Fig. 5. Care must be used to get this load just right. Other discriminators, such as the Seeley discriminator, do not have the proper input characteristic. If the decrease in capacitance of the load is too rapid, so the two curves of Fig. 5 cross over at three points, the circuit becomes unstable between the two outer points. This will be evident during alignment.

As the oscillator frequency is adjusted, it changes smoothly up to a certain frequency and then suddenly jumps to another frequency. There is a range within which it is not possible to tune the oscillator because of the instability. Usually this can be corrected by using a smaller coupling capacitor between the oscillator and discriminator, by adding a small series resistor, or by redesigning the discriminator.

Design of Discriminator

A very simple discriminator is used in this system. In Fig. 3, capacitor C_6 couples the discriminator to the oscillator. The tuned circuit L_4C_7, together with the interelectrode capacitance of the diode (in parallel with R_7), forms the discriminator. At series resonance between L_4 and the interelectrode capacitance of the lower diode, a maximum voltage appears across this diode. At parallel resonance of L_4 and C_7 a maximum of voltage appears across the upper diode. The result is a balanced discriminator, with the bandwidth determined by the difference between the series and parallel resonant frequencies.

Resistor R_6 controls the parallel Q of the circuit and R_7 controls the effective series Q. For best linearity these two values of Q should be approximately equal. But R_7 will therefore not necessarily equal R_6, since one shunts the series capacitor and the other is across the entire circuit.

Adjustment

For the circuit of Fig. 3, the auxiliary coupled circuit L_3C_3 is tuned to the same frequency as the oscillator tank circuit (900 kc) and is slightly overcoupled with respect

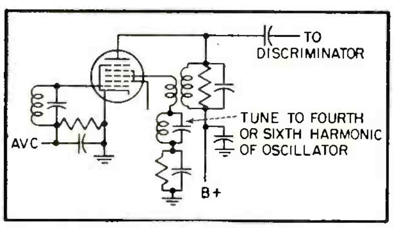

FIG. 4—Tuned circuit in series with No. 3 grid is adjusted to fourth or sixth harmonic of oscillator

FIG. 5—Frequency change with variation of input capacitance

to the circuit, L_2C_4. To adjust the circuit, tune the oscillator tank circuit until the oscillator locks in with an incoming frequency-modulated signal from a signal generator, which feeds into the i-f channel at 4,500 kc.

Remove the modulation, leaving the carrier at 4,500 kc. Adjust the discriminator to zero balance by connecting a d-c voltmeter from either end of R_8 to ground and adjusting L_4 until there is no voltage from R_8 to ground. Next adjust L_2 until the lock-in range is approximately symmetrical about the center frequency (900 kc). Then adjust L_3 to extend the lock-in range to the desired amount. A slight readjustment of L_2 may be necessary for best results.

For a practical application of the circuit, the constants shown can be used. The oscillator transformer can be made from a standard i-f transformer (RCA service part 35790) by adding one pie, increasing the coupling by moving the coils closer together and reconnecting the pies. The oscillator tank coil L_2 is composed of three pies in series aiding and L_1 is formed of two pies, one on each side of L_2, connected in series aiding. This gives fairly tight coupling without increasing the inductance of L_1 beyond the allowable limits. The cores are inserted into the coils as shown.

If the effective coupling between L_2 and L_3 is gradually increased from some low value by moving L_3 closer to L_2 the lock-in range will increase uniformly until the oscillator begins to give a distorted output in the middle of the lock-in range. Further increase in coupling will cause the oscillator to break out in the middle of the range but not at the ends. This gives a simple means for adjusting the lock-in range.

The same result can be obtained by shunting L_3 with a variable resistance, since a decrease in the Q of L_3 is equivalent to a decrease in coupling. Loading a transformer with resistors decreases the effective coupling.

In a standard television receiver with a sound i-f of 21.25 megacycles, the locked-in oscillator can be simplified to that shown by Fig. 6. Because of the limited deviation used, no circuits are needed to extend the lock-in range. This circuit requires separate shield cans for the oscillator and the discriminator. If it is preferred to use a single coil assembly and shield can, the circuit shown in Fig. 7 is satisfactory. All three coils are on the same form and can be adjusted with the two iron cores.

Performance During Interference

To test the locked-in oscillator circuit of Fig. 6 under operating conditions, it was installed in an RCA 8T241 television receiver in place of the amplifier and discriminator in the 21.25-mc sound channel. The lock-in range was approximately ± 25 kc at 0.3-volt input to the No. 1 grid of the 6BA7, ± 100 kc at 1-volt input and ± 200 kc at 5 volts input.

The complete locked-in oscillator receiver was tested by connecting two signal generators to the input antenna terminals, one to represent the desired signal and the other to represent the common-channel interfering signal. The desired signal was at 179.75 mc (channel 7) modulated with a deviation of ± 22.5 kc and an audio repetition rate of 1,000 cycles per second. The second signal had the same center frequency and deviation but an audio rate of 400 cycles per second.

The curves of Fig. 8 show how the receiver completely suppresses the undesired signal until the two are almost equal. In the first pair of curves the desired signal was 100 microvolts, and the undesired one was gradually increased until it equaled and then captured the desired signal. The amount of 400 and 1,000-cycle audio in the output was measured with a wave analyzer. For the input of 100 microvolts the locked-in oscillator barely had enough signal to work, but as the level increased the capture effect is very pronounced.

The curves show that if the undesired signal is 80 percent of the desired signal, for an input of 10,000 microvolts, the 400-cycle note is down 32 db, while with the standard receiver it is only down 8 db. The final value of the 400-cycle amplitude is slightly higher than that for 1,000 cycles because of the 1-db difference in the 75-microsecond deemphasis curve.

The practical meaning of this test is that if the receiver is capable of suppressing any undesired carrier wave unless it is at least 80 or 90 percent as strong as the desired carrier wave, compared to about 30 percent for a conventional receiver, the area in which such interference can occur is very much reduced. Many areas where intolerable distortion occurs in conventional receivers are completely free from interference with the locked-in oscillator. Since even a

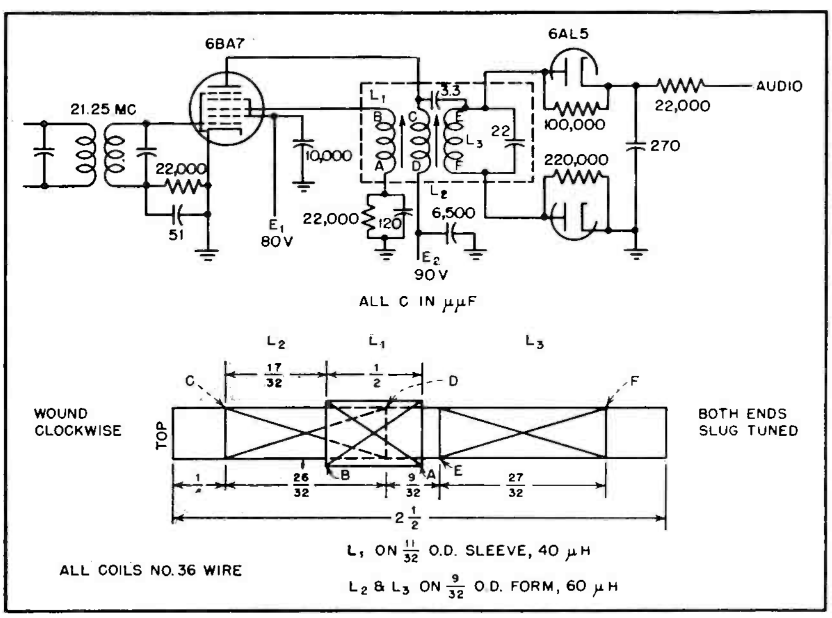

FIG. 7—Alternative circuit for 21.25 mc, with all three coils mounted on one form and installed in one shield can

slight reduction in the undesired signal will suppress it, it is often easy to use the antenna directivity for this purpose.

Comparison With Ideal Receiver

Since the solution of the problem of common-channel interference, where each carrier wave has sinusoidal frequency modulation, is known, it is interesting to see how close the performance of the locked-in oscillator can approach the mathematical limit of performance. The audio output from an ideal f-m receiver with a perfect limiter and a very wide but linear discriminator is given by the equation

$$\text{Audio output} = D_1 \cos 2\pi\mu_1 t + \sum_{r=-\infty}^{\infty} \sum_{s=-\infty}^{\infty} (r\mu_1 - s\mu_2)\, C\left(r, \frac{D_1}{\mu_1}; s, \frac{D_2}{\mu_2}; x, 0\right) \cos (r\alpha - s\beta) \quad (1)$$

where x = ratio of carrier wave amplitudes
D_1 = deviation of first carrier wave
μ_1 = audio repetition rate of first carrier wave
D_2 = deviation of second carrier wave
μ_2 = audio repetition rate of second carrier wave
$\alpha = 2\pi\mu_1 t$, $\beta = 2\pi\mu_2 t$, t = time,

and the generalized C-function is defined as follows:

$$C(k, l; m, n; x, \theta) = \sum_{s=1}^{\infty} \frac{(-x)^s}{s} J_k(sl)\, J_m(sn) \cos s\theta \quad (2)$$

To use available tables of Bessel functions, assume the following values of frequency,

D_1 = 10,000 cps $D_1/\mu_1 = 25$
D_2 = 10,000 cps $D_2/\mu_2 = 10$
μ_1 = 400 cps
μ_2 = 1,000 cps

When these values are substituted into Eq. 1, and all combination frequencies equal to $\pm$ 400 cps and $\pm$ 1,000 cps are sorted out and combined, the results are

$$\text{400-cycle distortion} = 800 \sum_{n=-\infty}^{\infty} C(10n + 1, 25; 4n, 10: x, 0) \text{ cycles per second} \quad (3)$$

and the 1,000-cycle distortion = 2,000

$$\sum_{n=-\infty}^{\infty} C(10n, 25; 4n - 1, 10: x, 0) \text{ cycles per second} \quad (4)$$

The C-functions were computed, in accord with Eq. 2, and the series summed in accord with Eq. 3 and 4.

Figure 9 shows the capture effect to be expected in an ideal f-m receiver under the assumed conditions. As the level of the 1,000-cycle interfering carrier wave is raised toward equality with the 400-cycle wave, the amount of the 1,000-cycle component in the audio output rises uniformly from a value approximately 64 db down when the ratio of carrier wave amplitudes is 0.1 to a point approximately 37 db down when the amplitudes are equal. At this point the 1,000-cycle carrier wave suddenly captures the other wave, causing full output at 1,000 cycles, and the 400-cycle component drops approximately 38 db. Beyond this point the amount of 400-cycle interference decreases smoothly.

The curves of Fig. 8 and 9 are not directly comparable because the deviation is different. However, for the higher signal levels the locked-in oscillator comes very close to the mathematical limit of performance. In a laboratory setup, working the signal generators directly into the i-f amplifier, it is possible to come so close to the ideal that a change in level as small as 5 percent will cause one signal to capture the other and almost completely suppress the accompanying distortion.

Extensive field tests have been made to compare such a locked-in oscillator with other conventional receivers such as the limiter-discriminator circuit, the intercarrier-sound system and the ratio detector. In every case the locked-in oscillator was at least as good as any of the others and whenever the interference was severe it usually was better. At times it gives a signal almost free from noise when the other systems are so distorted they are unintelligible.

Conclusions

It is often desirable to convert frequency-modulated signals having a frequency deviation up to $\pm$ 75 kc to signals of reduced carrier frequency and of reduced frequency deviation before they are sent through the discriminator of a receiver and converted to audio-frequency signals. Division of the instantaneous frequency by five reduces normal maximum frequency swings from $\pm$ 75 kc to $\pm$ 15 kc. Smaller deviations are reduced in proportion. The locked-in oscillator provides a simple and practical means for performing this division.

Since the tube operates as an oscillator with fairly large voltages on the No. 3 grid, the grid voltage swings well into the curved parts of the tube characteristic and gener-

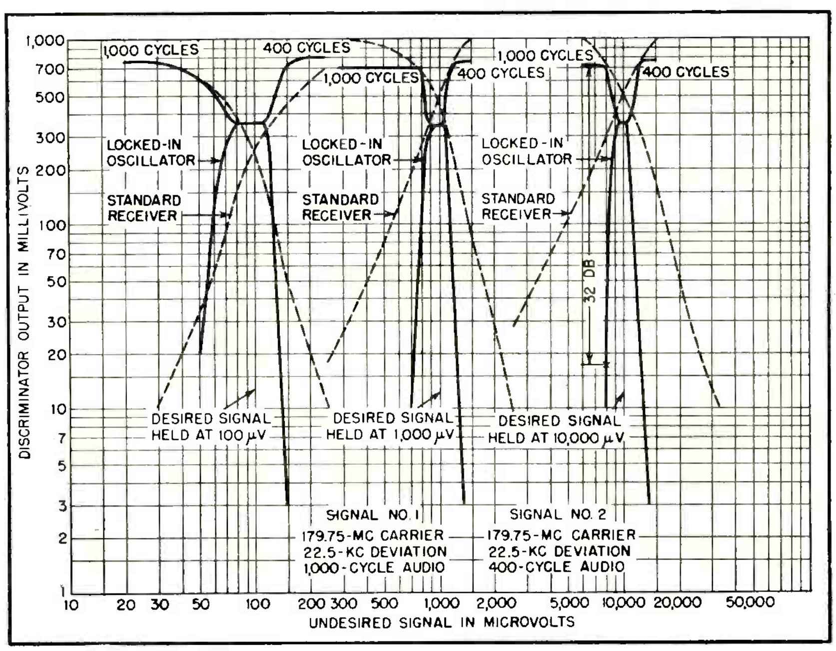

FIG. 8—Comparison of interference rejection of locked-in oscillator and RCA 8T241 receiver

ates harmonics in the No. 3 grid circuit. When the division ratio is five to one, the fourth and sixth harmonics of the oscillator beat with the incoming signal to produce a current having a difference frequency, which is just equal to the output frequency. When the incoming signal frequency is exactly five times the normal oscillator frequency, this injected current, which has the same frequency as the oscillator, is in phase with the normal plate current.

When the incoming signal frequency is increased, the injected current lags the normal plate current and cancels part of the leading current through the tank-circuit capacitor, thus effectively lowering the capacitance and raising the frequency of the circuit. This enables the oscillator to remain locked-in. The maximum amount the incoming signal frequency can be increased before the oscillator breaks out occurs when the incoming signal and likewise the injected current lag the normal plate current by 90 degrees, since this results in maximum quadrature current.

In a similar way, when the incoming signal frequency is less than five times the normal plate circuit frequency, the injected current leads the normal plate current and is thus equivalent to a larger capacitor in the tank circuit. This lowers the oscillator frequency and enables it to remain locked in. The lower end of the lock-in range is reached when the injected current leads the normal plate current by 90 degrees. The circuit thus behaves like a reactance tube since it generates a quadrature component in the plate circuit.

Self Bias

When the tube operates with self bias on the grid, the output voltage from the oscillator is substantially constant for large variations in the signal voltage. It thus eliminates the need for a limiter in f-m receivers since the incoming signal is used only to control the frequency of the locked-in oscillator and not to produce a voltage output.

It is relatively easy to design the external load on the tank circuit so the equivalent input capacitance decreases with increasing frequency at just the proper rate to keep the oscillator in tune over a wide portion of the lock-in range. This results in improved performance and an extended lock-in range. The L-C ratio of the tank circuit can be adjusted to just match the frequency discriminator for best operation.

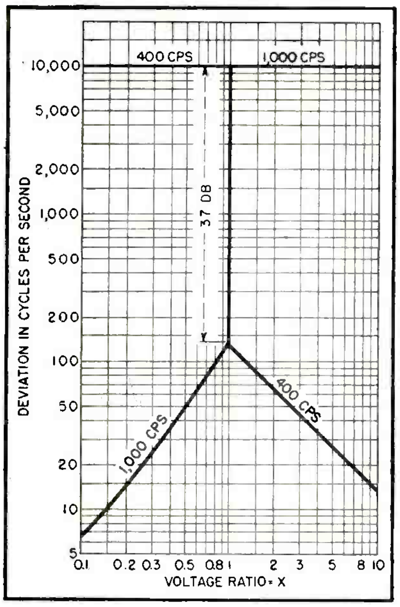

FIG. 9—Capture effect in a theoretically ideal f-m receiver

When receiving a standard f-m signal, it is important that the oscillator have a lock-in range somewhat greater than the total swing of the transmitter. If it does not, slight mistuning or oscillator drift, or overmodulation at the transmitter, will cause the oscillator to break out at the ends of the frequency swing and this results in disagreeable distortion.

It is possible to obtain an adequate lock-in range in several ways. Proper match of the discriminator to the oscillator is important, and this can be obtained by adjustment of the L-C ratio of the tank circuit, by varying the series coupling capacitor, by adjustment of the Q of the circuit in the discriminator, or by the addition of circuits which selectively control the amplitudes of the harmonics in the oscillator circuit. The last method enables very wide lock-in ranges to be obtained. With conventional tubes, the circuits should be designed to supply at least 0.5 to 1.0 volt on the input grid.

Extensive laboratory and field tests show that the performance of the locked-in oscillator comes very close to the mathematical limit for an ideal receiver. A standard television receiver with such a sound channel can suppress an interfering carrier wave less than eighty percent of the desired wave. This means that in fringe areas where there is considerable interference the locked-in oscillator is capable of reducing the area of interference considerably. If antenna directivity is also used, it will be possible to clear up most cases of interference.

A receiver with the locked-in oscillator must have sufficient sensitivity ahead of the locked-in oscillator to assure that the input to the oscillator is enough to lock-in the oscillator for all signals to be received. This means that the circuit should preferably be used with high-sensitivity receivers since the distortion of a weak signal may be worse than that obtained with a limiter-discriminator or a ratio-detector receiver, when receiving weak stations with low-sensitivity receivers.

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Direct-Coupled Amplifier

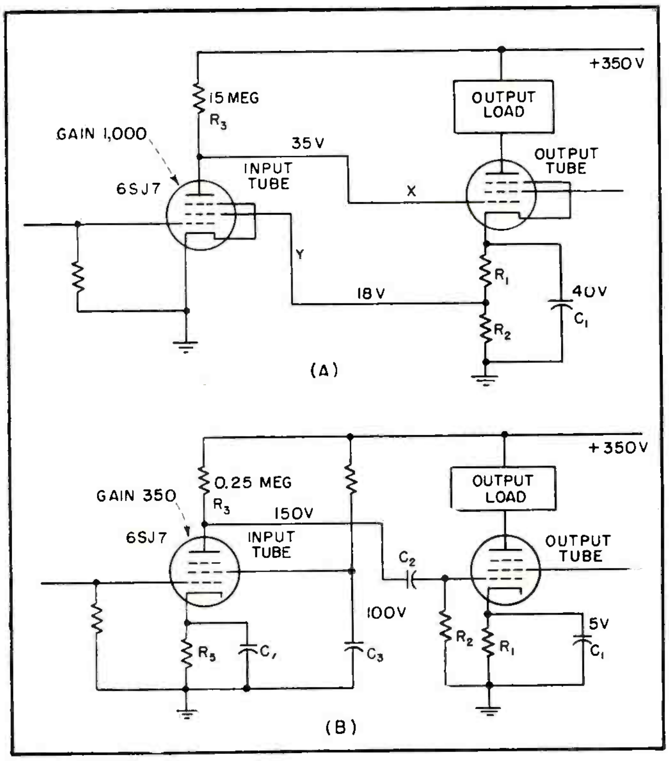

FIG. 1—Starved direct-coupled amplifier (A) and conventional R-C amplifier using two more resistors and three capacitors

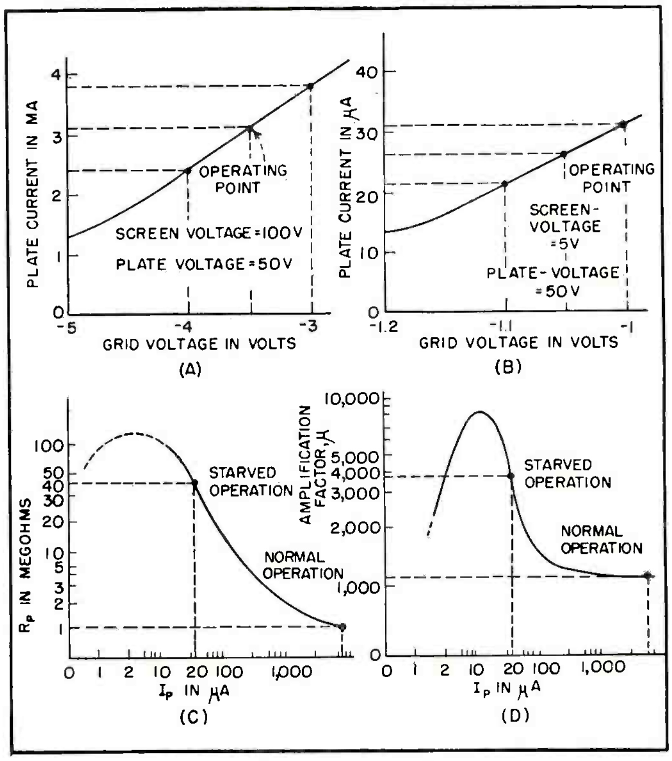

FIG. 2—Decrease of G_m, increase of R_p and increase of μ owing to use of the starvation circuit

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BY LOWERING the screen voltage of pentodes below 10 percent of their plate-supply voltage and increasing the resistance of their plate load 10 or more times beyond conventional values, the amplification factor of such "starved" tubes is greatly increased in spite of a decrease of their mutual transconductance. Stage gains as high as 2,500 have been measured in this condition, using regular 6SJ7 tubes. By incorporating the principle of starvation in a new direct-coupled amplifier two basic aims can be achieved: a drastic increase of overall gain permitting omission of amplification stages and reduction of manufacturing costs (for example, a 3-tube radio receiver requiring only 4 resistors and 4 capacitors), or trading surplus gain for minimum distortion and maximum stability.

Such starved direct-coupled amplifiers are in practical use today. They are employed in certain oscilloscope preamplifiers and vacuum-tube millivoltmeters for which circuit diagrams are shown. The circuit is also suitable for use in future domestic radio receivers. All these amplifiers have exceptionally high stage-gains in their input stage. Gains of 1,000 in a single stage are common when using ordinary plate supply voltage in the order of 350 v, and gains as high as 2,500 have been measured with higher voltages. Conventional radio tubes, such as the 6SJ7, show such high gains when starved.

Basic Circuit

The basic circuit of a starved direct-coupled two-stage amplifier is shown in Fig. 1A. It has several characteristics that distinguish it from the ordinary R-C coupled amplifier in Fig. 1B.

There are two connections (marked *X* and *Y*) between the input and the output tube in Fig. 1A. The coupling lead *X* carries the audio signal from the plate of the input tube to the grid of the output tube, and *Y*, called the self-focusing circuit, connects the screen of the input tube to a tap on the cathode resistor of the output tube. At the same time *Y* provides sufficiently low screen potential for the input tube, causing this tube to operate in a starved manner. Self-focusing is an essential feature in a d-c amplifier to prevent the average or no-signal plate current of the output tube from drifting towards the tube's upper or lower cutoff points as line or supply voltage change, resistors age or tubes are exchanged. Actually the self-focusing circuit is a high-gain negative d-c feedback circuit. In this particular case it operates as described below.

Let us assume that the output tube's plate current, for some reason, such as a change of contact potential of the input tube, begins to drift toward the upper cutoff. This effect would increase the no-signal or d-c voltage drop across

STARVATION CIRCUITS

Stage gains up to 2,500 can be obtained in direct-coupled amplifiers by using pentodes with extremely low screen voltage and high plate load resistance. Circuit requires fewer components, making possible an a-m radio receiver having only four resistors

cathode resistors R_1 and R_2 of this tube and would raise the screen potential of the input tube. That tube will therefore draw more direct current from B plus and increase the voltage drop across its plate resistor R_3. Lowering its plate voltage will also decrease the grid potential of the output tube, owing to the direct coupling. As a result of this negative d-c feedback action the output current will increase less than it would without the self-focusing circuit. In fact, in some meter amplifiers to be described, the self-focusing action of circuit *Y* has added to it a second self-focusing channel. The effect has been made so vigorous that these amplifiers can be operated over B plus voltage-fluctuation ranges between 120 percent and 35 percent of normal value without the output tube's plate current drifting appreciably from the desired value.

Starvation

The relationship between grid control voltage and plate current of a 6SJ7 tube having a screen potential of 100 volts is shown in Fig. 2A. Figure 2B shows the corresponding characteristics of the same tube operating with a screen potential of 5 volts, causing the tube to be starved. The transconductance under conditions of Fig. 2B is very much lower than for those in Fig. 2A (approximately 100 micromhos instead of 1,300). The plate resistance, shown in Fig. 2C, is increased as plate current is decreased due to starvation. Under normal operating conditions of around 2 ma it is about 1.5 megohms. In the starved condition with plate current at 20 microamperes it is somewhere near 40 megohms. Figure 2D shows how amplification factor μ, the product of transconductance and plate resistance, grows with increasing starvation from somewhere near 1,200 to over 8,000 (at 10 microamperes) and then rapidly falls off as the tube becomes overstarved.

The two main advantages of the starved direct-coupled amplifier over the R-C-coupled circuit are indicated in Fig. 1. Its gain is 1,000 instead of 350 and there is a drastic reduction in the number of circuit elements used. The R-C-coupled circuit has 6 resistors and 4 capacitors; the starved direct-coupled circuit requires only 4 resistors and 1 capacitor. The saving of parts in the direct-coupled circuit results partly from more favorable physical operating conditions. For instance, in Fig. 1A the input tube's screen, at only 18 volts when plate voltage is 35 volts, does not draw more than about 1 microampere. Since the cathode resistor of the output tube to which the screen of the input tube is attached constitutes a stiff voltage divider, no screen bypass capacitor is needed. The equivalent of C_3 in Fig. 1B is therefore saved. Starved pentodes have a tendency to develop strong negative contact potentials on their control grids. These potentials exceed even those of high-μ triodes. As a result, the cathode-bias resistor R_6 and its bypass capacitor C_4 can be left out in the direct-coupled starved circuit. Coupling capacitor C_2 between the tubes is unnecessary.

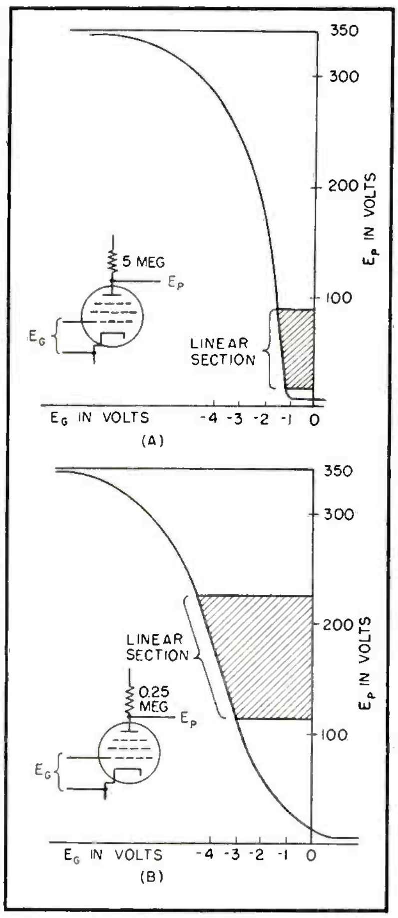


FIG. 3—Plate output voltage characteristic of starved tube (A) and that of unstarved tube (B)

Voltage Distribution

The voltage distribution in the circuit of Fig. 1A is unusual but typical of the starved direct-coupled amplifier.

The plate voltage of the input tube, sometimes called coupling voltage because it constitutes the grid potential of the output tube, is 35 v, or only 10 percent of the plate-supply voltage. In other than a starved circuit a plate voltage representing such a small percentage of the plate supply voltage would cause both low gain and distortion.

An unstarved tube, represented by Fig. 3B, shows a nearly symmetrical plate-voltage curve. It is straight near its middle between the upper and the lower cutoff points as represented by the plate-supply voltage and the zero line. When starving a pentode this curve changes its shape as shown in Fig. 3A.

The straight section is now near the lower cutoff and the former curving lower bend becomes a sharp corner. The upper bend covers nearly three quarters of the total voltage range. This method removes one of the greatest obstacles in the path of direct-coupled amplifiers — high plate-to-grid coupling voltages. The designer is otherwise forced to sacrifice a good deal of available plate-supply voltage by excessively large cathode-resistor drops in the output stage.

Prior Art

In some of his patents, S. Y. White shows circuits similar to the one above. However, he preferred to connect the load resistor of his input tube not to B plus but to the cathode of the output tube and his bypass capacitors are usually arranged in a different way. There are numerous references in the literature showing the operation of vacuum tubes with rather large load resistors and occasionally low screen voltages. The recognition of the advantages of a reduction of the transconductance in the starved condition and an increase of the plate resistance, resulting in an overall increase of the amplification factor, is considered novel.

Frequency Response

The frequency response of untuned amplifiers is limited by the shunting capacitance of the tubes and their associated circuit elements. Since the starved amplifier uses exceptionally high plate loads, frequency limitations are unusually severe. Means are available, however, for correcting the frequency response of these amplifiers.

The gain of 2,500 in a single stage, mentioned above, was obtained with a starved 6SJ7 pentode having a load resistance of 120 megohms and a plate supply voltage of 900 volts. The shunting capacitance in this case limits the frequency response to less than 1,000 cycles. This limitation rules the amplifier out for audio although it might still be useful for instrumentation.

With a plate voltage of 350 to 400 volts and load resistances of 16 megohms, gains of 1,000 and frequency limitations in the order of 2,000 cycles or so may be expected. Finally, with low-voltage supplies in the order of 100 to 130 v, as found in simple a-c/d-c radios, load resistances should be selected around 3 to 5 megohms. A frequency limit in the order of 5,000 to 8,000 cycles can be expected.

These severe frequency limitations of the starved direct-coupled amplifier can be reduced by two means at our disposal for improving the frequency response.

The first method is negative feedback, which may be used in the customary way for improvement of fidelity of reproduction. For the starved direct-coupled amplifier, negative feedback can usually be employed in a more drastic and effective manner than with R-C coupled circuits. Direct coupling eliminates to a considerable extent phase rotation and the danger of regenerative components within the degenerative feedback signal. Actual negative feedback ratios of 1,000-to-1 are employed without instability in amplifiers for instrumentation purposes.

Another successful method of raising the frequency response of starved audio amplifiers is regenerative feedback through a capacitance link between its output and its input stage. This kind of feedback creates a distortion of the audio output signal, but the size of this capacitance can be limited to such values that there is no regenerative feedback below 5,000 cycles.

Practical Applications

Figure 4 shows the circuit diagram of a television millivolt detector and oscilloscope preamplifier manufactured by Smith Industries in Ballston Spa, N. Y. It uses a starved direct-coupled 3-stage amplifier and takes full advantage of the high gain of its input tube, which is in the order of 1,000, and gives an overall gain well over 2 million. Such a high gain is actually not needed. In fact, excessive gain is plowed back into the circuit by negative feedback in what is believed an unprecedented high rate.

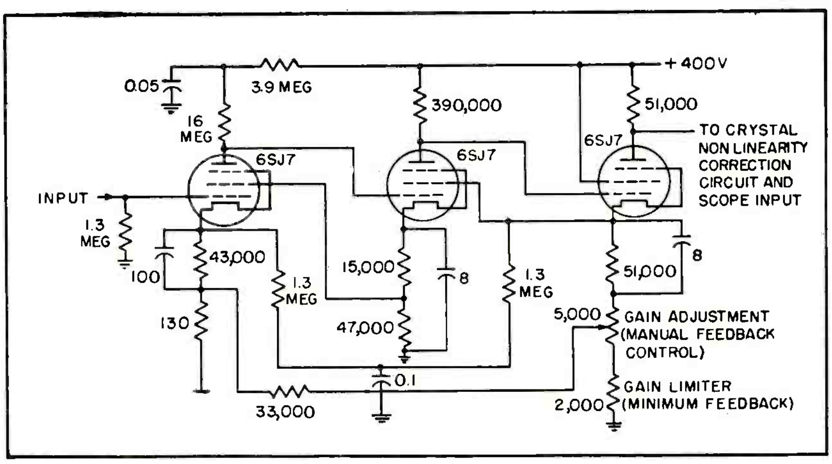


FIG. 4—Three-stage starved direct-coupled amplifier used in a commercial millivolt detector

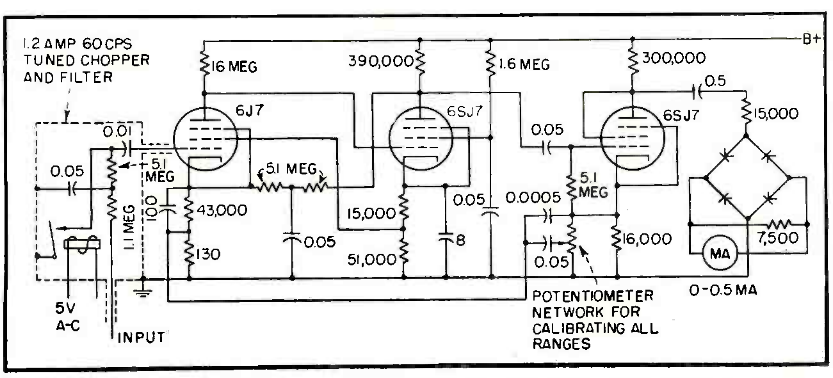


FIG. 5—Starved circuit used in wide-range vacuum-tube millivoltmeter for d-c

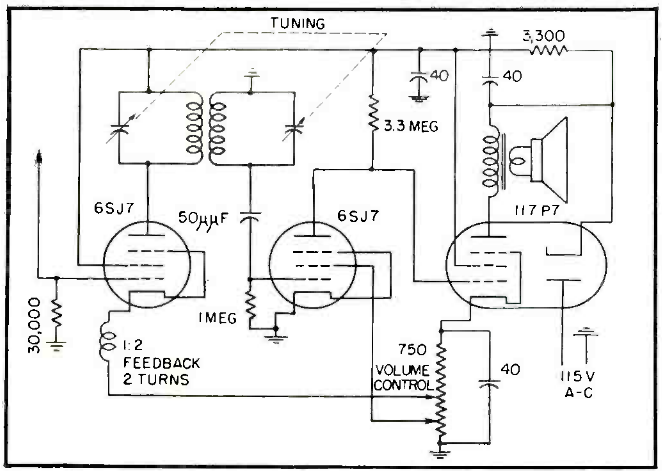


FIG. 6—Circuit of simple a-m broadcast receiver using starvation circuit

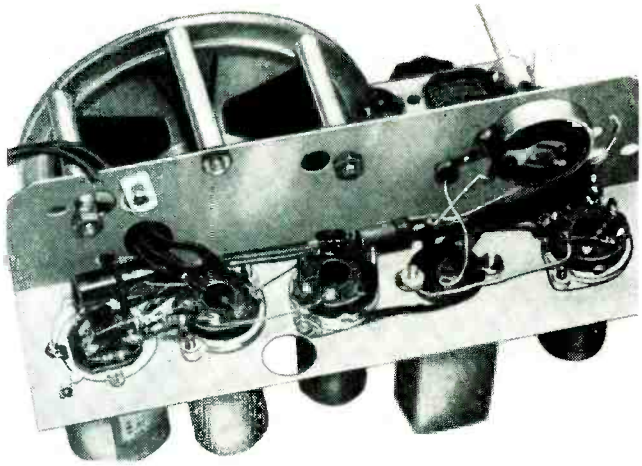


FIG. 7—Underchassis view of receiver, showing how few parts are needed

The heavy negative signal feedback in this amplifier is more than 1,000 to 1, greatly reducing hum pickup and tube noise. For this reason it is possible to build such an amplifier with less than 25 microvolts noise using 6SJ7 a-c heater tubes.

Negative feedback, with all its recognized advantages against distortion and noise, can be a two-edged weapon if applied in an ordinary R-C coupled circuit to an excessive degree. After all, negative feedback, if not completely 180 degrees out of phase with the input signal, contains a regenerative or positive feedback component. With moderate ratios of feedback, such as 3 to 1 or 10 to 1, this component does little harm. With higher ratios of feedback such as 1,000 to 1 or 2,000 to 1 this component can and often does cause oscillation. Owing to the lack of phase rotation, the starved direct-coupled amplifier will tolerate negative feedback ratios well over 5,000 to 1 without oscillating.

For more than a year the Millivac MV-17b vacuum-tube d-c millivoltmeter shown in Fig. 5 was manufactured with an R-C coupled carrier amplifier. This amplifier was then replaced by a starved direct-coupled amplifier, saving 40 percent of its capacitors and reducing the number of tubes from 7 to 4. Power consumption of the instrument decreased to such an extent that all ventilation holes could be omitted. Owing to the high ratio of feedback used in this meter its stability was greatly increased. Before the change was made, this particular instrument responded to line-voltage fluctuations by about 4 percent for full-scale reading for every 10 percent of line-voltage change. With the starved direct-coupled amplifier and high feedback, the line voltage response is less than 1 percent for 20-percent line voltage change.

Incidentally, the circuit is a good example of mixed direct-coupled and R-C-coupled operation of audio amplifiers. The voltage preamplifier has two direct-coupled stages. The input tube is starved and has a gain of 1,000 or more. The second stage is not starved and has a gain of 200, bringing the total gain of the first two stages to 200,000. The starved amplifier amplifies the carrier signal produced by a d-c modulator having less than 10 microvolts noise at 11 megohms input impedance. The negative feedback, on the most sensitive scale of this voltmeter, is roughly 100 to 1 and on the less sensitive scales, 1,000 to 1. With such high feedback rates, tube noise and hum are negligible.

Finally, a simple 3-tube domestic radio receiver is shown in Fig. 6. Its performance comes surprisingly close to the performance of regular 5- tube a-c/d-c receivers in spite of the fact that it has only four small carbon resistors and, besides its triple electrolytic capacitor, only two small paper capacitors of which one can be eliminated by providing equal intercoil capacitances.

The audio amplifier of this receiver is starved and direct-coupled. It, therefore, requires only 10 millivolts detector-output signal to drive the loudspeaker. The r-f signal fed into the detector to drive the audio amplifier is only a fraction of that normally required. Consequently, a single high-gain, double-tuned, high-Q r-f stage was chosen. This stage has both tuned circuits on its output side and uses an untuned input. In this manner parasitic oscillation through magnetic feedback between the input and the output circuit, a common weakness of trf receivers, is avoided.

A general objection against untuned r-f inputs of this type is that powerful local stations might cause cross-modulation with weaker ones. In this instance, the danger hardly exists because the output signal of the r-f stage is only approximately 1/10th of the r-f output feeding into the detector of ordinary radio receivers. Therefore, the r-f input at the antenna grid need be only 1/10th of the input required under ordinary conditions. In addition, the absence of magnetic coupling between the input and output circuits of the r-f stage and the inherent high Q of the output circuit make it possible to operate this stage with a gain of 250. The r-f input signal requirements are then so small that local stations simply cannot create signal amplitudes at the control grid large enough to cause cross-coupling. Practically, this effect is accomplished by giving the input tube a grid leak of 30,000 ohms and a short antenna wire.

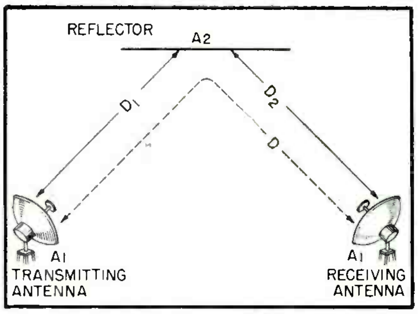
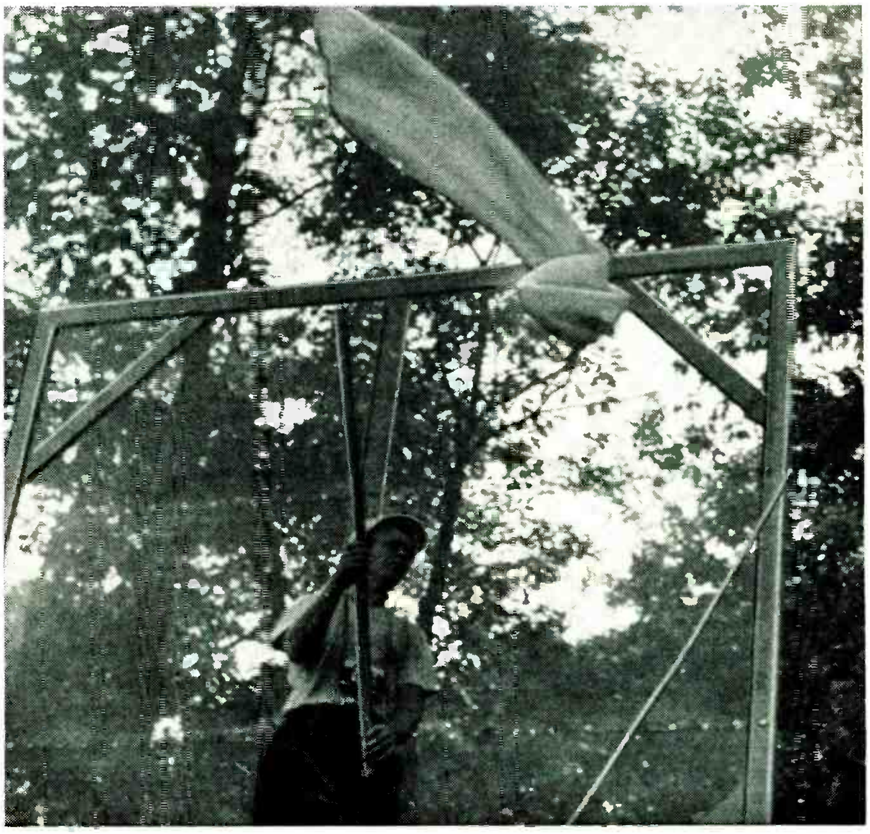


FIG. 1—Details of path using a passive repeater. Areas *A* are measured in sq ft

Table I—Normalized DB Gain vs Position of Passive Repeater

D_1/D	DB Gain
0.001	60.0
0.01	40.0
0.02	34.2
0.05	26.5
0.1	20.9
0.2	15.9
0.3	13.6
0.4	12.4
0.5	12.0



Passive reflector in process of being oriented. Reflector consists of 9 × 10-foot surface of ⅛-inch mesh galvanized screening. Screen openings are small compared to $\lambda/4$

Flat Reflector for UHF

Passive repeaters in microwave relay systems provide low-cost means for getting around line-of-sight obstacles. Data presented here are derived from experiments on commercial 960-mc power company installation

IN STUDYING conditions peculiar to the design of microwave systems for power company use, it was found that one of the problems encountered at times was that of getting a signal into or out of a deep valley. Quite often the power station, located at the foot of a dam in a deep gorge, must tie into an integrated microwave communication system with other power stations for dispatching or control circuits. For the system to compare favorably with an equivalent wire line circuit as far as economics are concerned, the number of repeater stations must be held to a minimum.

Qualitative Study

To determine whether it was feasible to use a reflector as a passive repeater, a qualitative study of the subject was made. There are undoubtedly several methods of examining repeaters—however, for the purposes of this study the line of approach outlined below was used.

Assuming the reflector to have the same effect as one antenna receiving a signal and a second antenna reradiating it, and using a formula from a paper by Friis[1], the following relationship was set up (see Fig. 1):

$$\frac{P_T}{P_R} = \frac{D_1^2\,\lambda^2}{A_1\,A_2} \times \frac{D_2^2\,\lambda^2}{A_1\,A_2} \times \frac{D^4}{D^4}$$

$$= \underset{X}{\underset{\uparrow}{\frac{D^2\,\lambda^2}{A_1^2}}} \times \underset{Y}{\underset{\uparrow}{\frac{D^2\,\lambda^2}{A_2^2}}} \times \underset{Z}{\underset{\uparrow}{\frac{D_1^2\,D_2^2}{D^4}}}$$

where P_T/P_R is the ratio of transmitted power to received power.

The total loss can be considered as consisting of three factors:

View of West hydro electric station, taken from reflector location atop Hunt's Mountain, shows clear path for reflected 960-megacycle signals transmitted at Stewart's Bridge. Path shown corresponds to ½-mile leg illustrated in plan drawing below

System

By THOMAS ROYLSTON

Microwave Engineering Department
Radio Corporation of America
RCA Victor Division
Camden, New Jersey

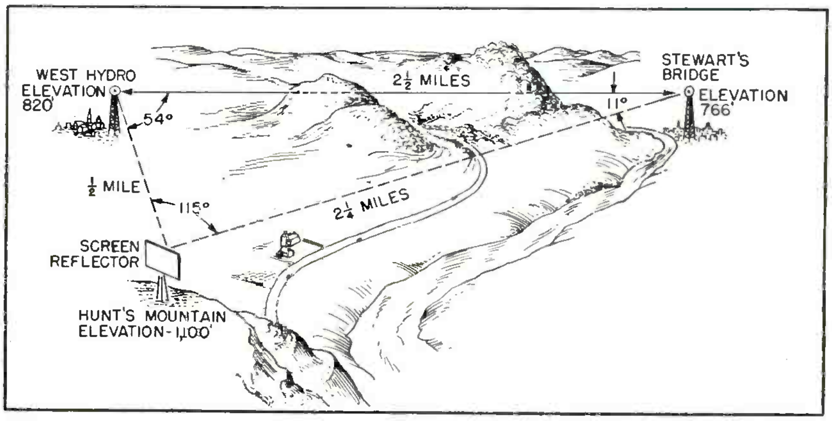


FIG. 2—Plan view of test location. Two mountain obstructions project approximately 90 and 30 feet above direct line-of-sight path

X — the loss that would exist over a direct path of distance D between the two terminal antennas of area A_1

Y — A fictitious loss over distance D using antenna area A_2

Z — A fictitious gain determined by the relative position of the passive repeater

Of these, X and Y can be readily determined from Bullington's charts[2], from the above formula directly, or from special formulas developed for a particular application, such as the following one for use at 960 megacycles:

$$\text{Loss db} = 79.7 - 40 \log d/\lambda + 20 \log D_X$$

where d/λ is the diameter in wavelengths of the parabolic reflector, and D_X is distance D_1 or D_2 in miles. Then Z can be determined from Table I which shows db gain versus the position of the passive repeater. The total circuit loss is then the algebraic sum of X, Y and Z expressed in db. It is interesting to note that Y and Z will not cancel except at extremely small values where the limit of accuracy of the basic equation is approached, or when $D_1 \geqq \frac{2A^2}{\lambda}$, A being the largest dimension of either antenna.

From Table I it is seen that if the distance from a power station to a more advantageously located spot is small compared to the distance to the next relay point, a passive repeater might be used to advantage.

Experimental Tests

To check the feasibility of using a flat reflector, a 1.3-mile circuit was set up using a commercially available 960-mc transmitter and receiver. A flat reflector approximately 6 × 8 ft was mounted on a turntable 500 feet from the transmitter and at right angles to the direct path between the units.

Measurements of received signal strength were made over the direct path, and the antennas were then visually oriented toward the reflector. Observing the received signal strength, an attempt was made to orient both antennas and the reflector for a peak signal at the receiver. However, the massive steel-work in a large bridge and a shipyard near the location of the reflector caused reflected signals of such magnitude that it was impossible to obtain useful data at this location.

To secure conclusive results a site relatively free of highly reflecting surfaces was chosen. Arrangements were made to cooperate with the New York Power and Light Company in running tests over the path shown in Fig. 2, between their Elmer J. West hydro station, near Luzerne, N. Y., and the site of a proposed power station at Stewart's Bridge, some 2½ miles away. Due to the direct path having an excess loss of approximately 35 db above free space value, it appeared that unwanted reflections would be of small magnitude, and so would not be particularly troublesome.

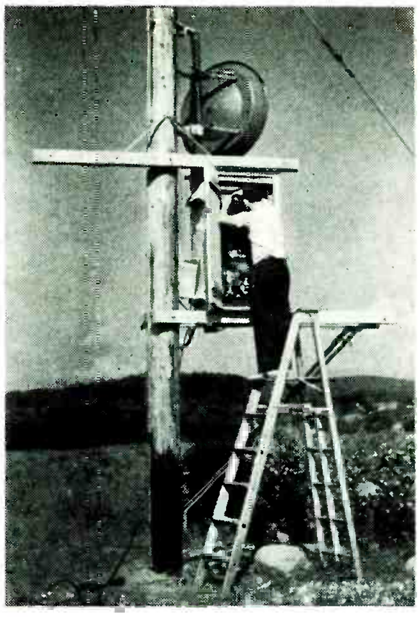
The site picked for the reflector location was on Hunt's Mountain, one-half mile from the receiver location at West Hydro and 2¼ miles from the transmitter location at Stewart's Bridge. The reflector position provided good clearance above line of sight to both locations.

The 960-megacycle transmitter was installed on a knoll at Stewart's Bridge in a special housing mounted on a 30-foot pole provided by the power company.

The transmitting dipole with its 40-inch parabolic reflector was mounted just above the transmitter housing, so that a long run of coaxial cable was not necessary.

The receiver at West hydro was connected through 50 feet of ⅞-inch air-dielectric cable to its antenna.

The 9 × 10-foot reflector was constructed of ⅛-inch mesh galvanized screening. It was located on top of Hunt's Mountain. The location was such that about 50 percent of the screen area was effective, as the angle between the direct and reflected beam was approximately 115 degrees. The screen openings were small compared to $\lambda/4$, which is about 3 inches at 960 mc, so the screen behaved as a solid sheet.



Transmitter is mounted in weatherproof box at Stewart's Bridge location to avoid high losses in a transmission line at 960 mc

Tests were first made to determine the r-f loss over the direct path from transmitter to receiver. The measured overall loss was 134 db, while calculated loss for this path was 139 db. The difference of 5 db is considered to be well within the limits of accuracy for a path of this type at these frequencies.

Due to the magnitude of this loss, it was felt that the test could be continued without having to consider multipath reflections or energy from the side lobes of the antenna, particularly since the parabola beamwidth was 20 degrees to its half-power points, and the parabolas would be aimed away from the direct path by an angle of 54 degrees at one end, and 11 degrees at the other end.

The parabolas were then aimed at Hunt's Mountain, and the net loss from transmitter to receiver over this path using the mountain itself as a reflector was 109 db. Next the reflector was raised into position and a careful orientation of both parabolas and the reflector was again made. The net loss then dropped to 106 db, indicating a reflector gain of 3 db.

From the formula developed at the first of this article, the loss using the passive repeater came out as 106.5 db. The same loss was obtained using another formula for the use of passive repeaters[3].

Conclusions

Due to the inaccessibility of the reflector position on Hunt's Mountain and the necessity of carrying out other tests, no attempt was made to use a larger reflector. The test did indicate, however, that under certain conditions the use of a reflector is justified.

Nevertheless, the use of a reflector cannot be regarded as being the solution in all likely locations, since in many cases a very large and heavy framework would be required. Also, orientation of the reflector both in azimuth and elevation was found to be quite critical. At many sites these factors would prohibit the use of a large and unwieldy reflector, not only from the standpoint of erection, orientation, and then anchoring the structure, once the correct orientation was secured, but also the problems of getting materials to the site.

The use of a passive repeater is an item to be considered in systems planning but, as in the case of all elements of a system, it must be able to justify itself economically, both in capital investment and in maintenance costs.

Acknowledgment is made to the New York Power and Light Company for its cooperation in these tests, and particularly to Wesley Baylis of that Company, who assisted directly in the test setup and accumulation of the test figures; also to B. F. Wheeler of the Engineering Products Department, RCA Victor Division, under whose supervision these tests were made.

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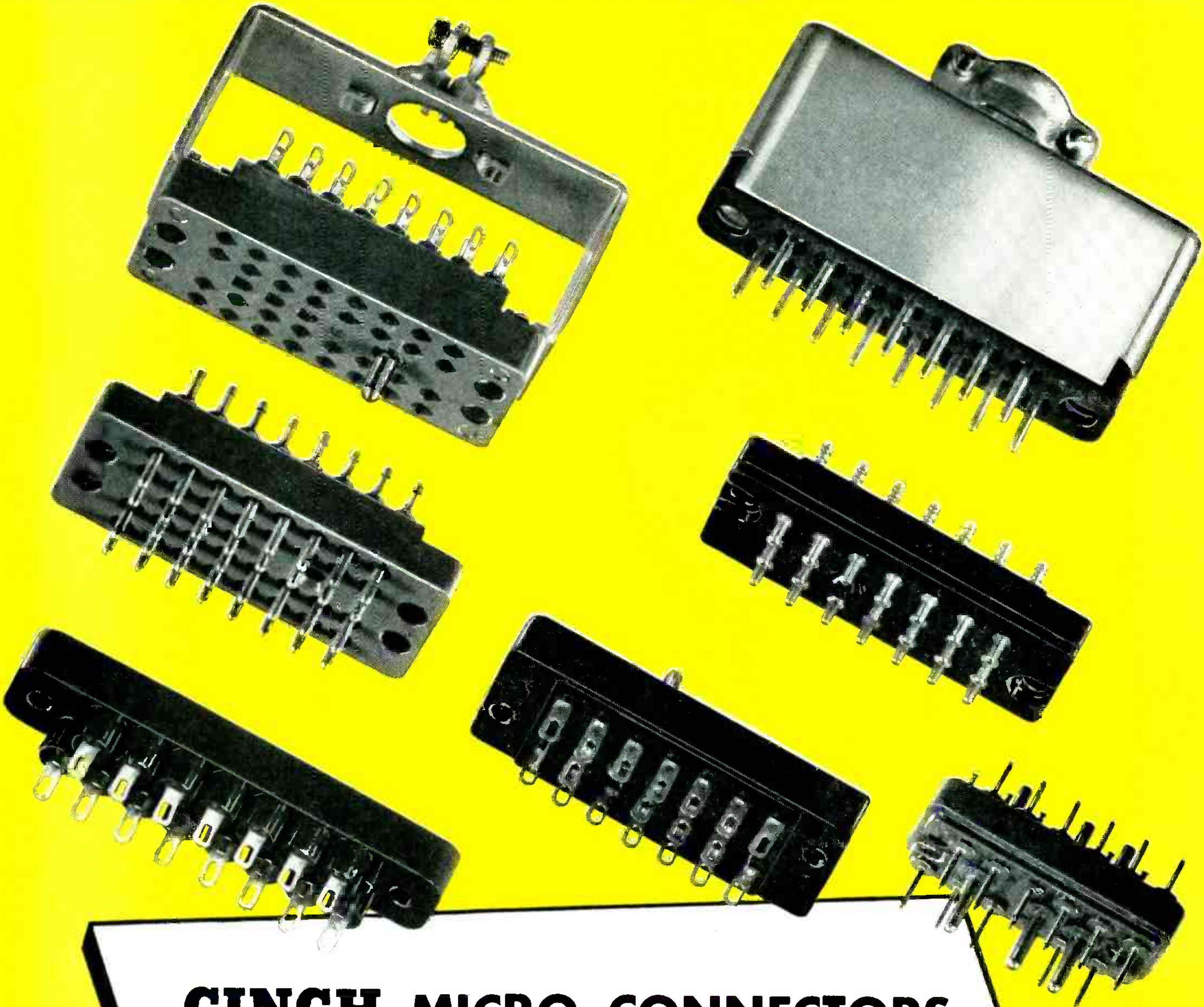
(2) K. Bullington, Radio Propagation above 30 Megacycles, *Proc. IRE*, Oct. 1947.

(3) Pattison, Reagan, Leyland and Gunter, Field Testing a Microwave Channel for Voice Communication, Relaying, Telemetering and Supervisory Control, AIEE Technical Paper 50-151.



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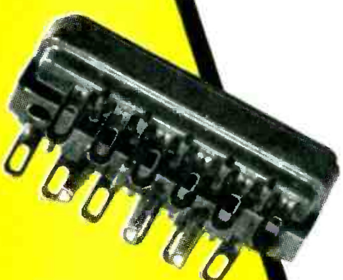

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SERVO POWER CALCULATIONS

Chart gives required shaft output power in watts for any combination of speed and torque of subfractional motors in tube-driven servo systems. Alternative slide rule method of finding power is also given

By **OSCAR E. CARLSON**
Vice-President
Servo-Tek Products Co.
Paterson, N. J.

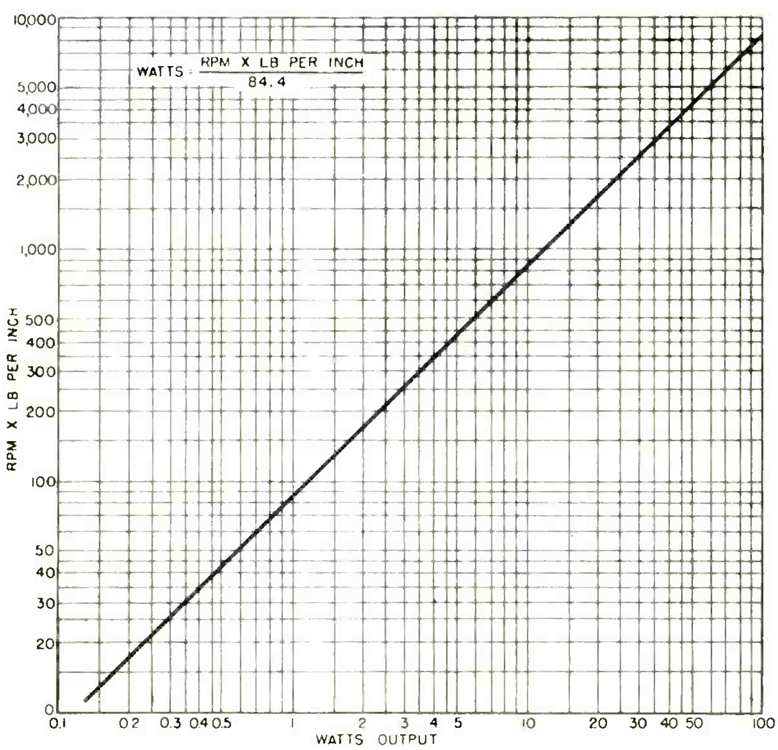
SERVO SYSTEM calculations must of necessity start with motor shaft output power to perform the specified work in a specified time. This involves the speed of shaft rotation and the torque required to perform the work. Since motors used in servo systems are usually subfractional sizes, the horsepower unit is clumsy and awkward for expressing output power. Watts of output has become a common means of expressing such power requirements.

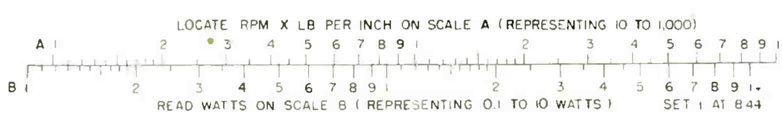
The conversion of speed and torque requirements to a wattage equivalent is a simple arithmetical computation, but its very simplicity lends itself to even more simplified computation. The equations are

$$\text{Horsepower} = \frac{\text{rpm} \times \text{lb per in.}}{63{,}000}$$

$$\text{Watts} = \frac{746 \times \text{rpm} \times \text{lb per in.}}{63{,}000}$$

$$= \frac{\text{rpm} \times \text{lb per in.}}{84.4}$$





This last equation may readily be laid out on a loglog chart so that the rpm × lb per in. factor may be translated into watts quite simply. The accompanying chart does this.

As with most loglog coordinate charts, a slide rule may be utilized for these calculations without using the slider. Set the righthand 1 of the B scale under 8.44 in the righthand log cycle of the A scale, as shown below the chart. With the A scale now representing rpm x lb per inch from 10 to 1,000, the wattage may be read directly under that product on the B scale, with that scale reading from 0.1 to 10 watts. A multiplier of 10 or 100 may of course be used to make calculations up to 1,000 watts, if so required.

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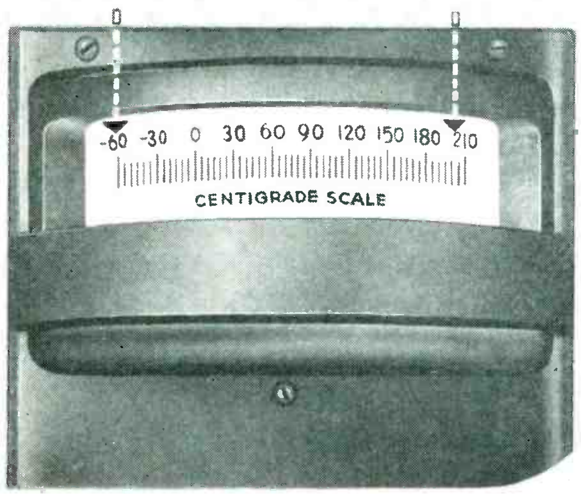

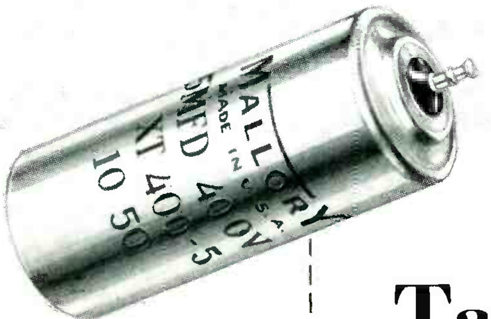

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Bolometer Amplifier for Microwave Measurements

DESIGN AND TESTING of antenna systems and various r-f networks in the microwave regions requires reliable test equipment for determining relative or absolute r-f field strengths. A modulated or pulsed r-f signal is applied to the network and measurements are usually made by using a crystal or bolometer in conjunction with a probe to yield an output voltage $e = kE^x$ where E is the absolute field intensity in the vicinity of the probe, k is a constant which depends upon the probe configurations and units in which e and E are expressed and x is a function which depends upon the crystal or bolometer and generally will differ somewhat from a constant.

Because the output voltage level of the probing devices is low, it is necessary to amplify their outputs before they are metered. The bolometer amplifier, manufactured by Pickard and Burns, Inc., of Needham, Mass., incorporates a tunable variable-bandwidth filter, an eighth power voltage ratio expander, automatic normalization of input signals and an undecaded output voltage for operating automatic recording equipments.

Operating Principle

The instrument functions on a heterodyne system in which the input voltages to both the signal and monitor input channels are converted in balanced modulators to a 50-kc i-f, see block diagram in Fig. 1. The output of the balanced modulator in the monitor channel is amplified and detected to supply bias voltage for the controlled amplifier of the signal channel which provides the automatic normaliza-

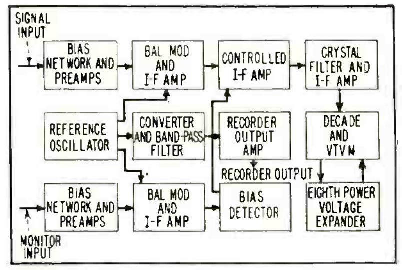


FIG. 1—Block diagram of the Pickard and Burns bolometer amplifier

tion of voltages in the signal channel.

Ouput of the balanced modulator in the signal channel is amplified in the controlled amplifier and then fed to the crystal filter and i-f amplifier. The output from the i-f amplifier is connected to the meter decade. Following the decade is the meter amplifier and logarithmic voltmeter.

By switching the input of the expander circuit into the output of the decade and the output of the expander into the input of the voltmeter amplifier, eighth power voltage ratio expansion may be obtained. To provide a recorder output voltage, the output of the i-f amplifier following the crystal filter is fed simultaneously to the meter decade and to a converter and band-

---

RADIO-CONTROLLED CADDY CART CUTS GRASS

Jim Walker of Portland, Oregon, shown with a radio-controlled caddy cart and lawn mower which he designed. In his right hand is a small unit for controlling the machines from small distances. In his left hand is a unit for operating and controlling the machines for distances up to two miles

pass filters, the output of which is then amplified and connected to the recorder output terminal.

When the bolometer amplifier is functioning with linear amplification, the decade output is amplified in the meter amplifier. The output voltage is rectified and metered on the output meter which is calibrated in a-c volts. On expand operation, the output of the decade is multiplied in the eighth power voltage ratio expander circuit to a 400-kc voltage which is then amplified in the meter amplifier, rectified and metered on the output meter.

Instrument Description

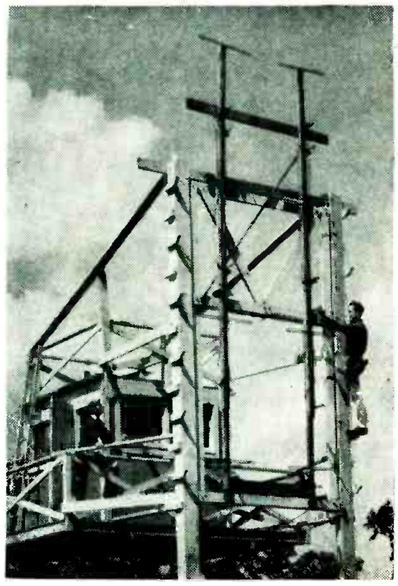
Nominal frequency range of the instrument is 400 to 5,000 cycles with the frequency dial calibrated directly in cycles. Bandwidths are selected by a switch and are 6, 12, 22, 50, 100 and 300 cycles. Input impedance is between 250 and 350 ohms for all frequencies between 400 and 5,000 cycles.

The indicating voltmeter has a logarithmic scale and is calibrated in both volts and decibels. The decade used in conjunction with the meter is calibrated in volts full scale and is adjusted in 20-db steps from 0.01 volt full scale to 100 volts full scale.

Bolometer amplifier for use in microwave field-intensity measurements

Output voltage for recording purposes is 80 db undecaded. This output is at the input frequency and is at an impedance level of approximately 50,000 ohms. Loading up to 0.01 watt maximum is permissible without causing nonlinear amplification in the output.—R.K.J.

THE FRONT COVER



CRITICAL MEASUREMENTS are made at the Andrew Corporation's 800-acre research facilities in Orland Park, Illinois, with the aid of this 35-foot testing structure.

The height of arrays is readily varied by means of a sliding frame. Antennas are tested by mounting at the top of a 40-foot high rotating mast which is inside a building not visible in the picture. Directional antennas are then placed on the testing structure. The field pattern of the inside antenna is measured by rotating the mast and exciting the directional antennas outside (for further description see article by M. W. Scheldorf on this page).

Improved Antenna Pattern Measurement Facilities

By M. W. Scheldorf
Head Research Engineer
Andrew Corporation
Orland Park, Illinois

CHARACTERISTICS OF AN ANTENNA are essentially defined by its two principal qualities, input impedance and radiation patterns. It is generally understood that electrical measurements to determine these characteristics must be made without reflections from structures in the vicinity of the antenna. This is particularly true of pattern measurements where reflected signals contribute to errors in the first order as compared with impedance measurements where these errors appear as second order effects.

Patterns are taken in two ways. In one method, a signal is applied to the antenna under test (rotatable in the plane desired) and the field is measured by a second fixed antenna, (similar to the test antenna but often only a dipole antenna or special directive antenna). In a second method, a fixed field is established by a source antenna and the test antenna is rotated in this field. Measurements are then made of the voltage received. Due to a condition of reciprocity, the results obtained are the same for both methods.

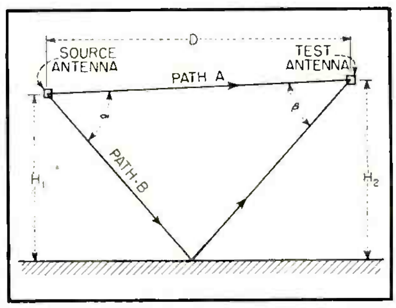
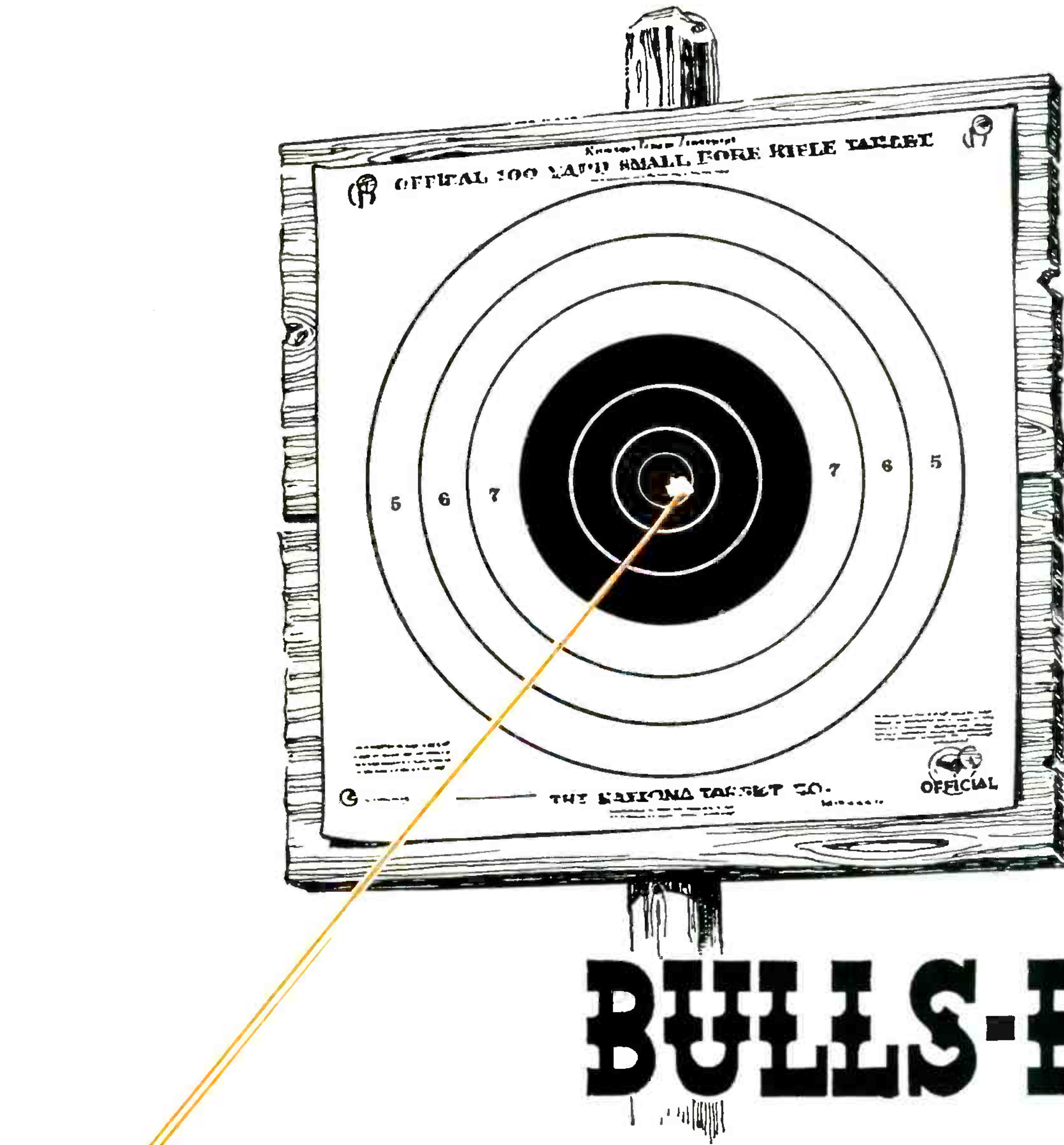


FIG. 1—Ground reflection diagram for test antenna setup

When operating at very short wavelengths it is possible to rotate the test antenna in either a vertical plane or a horizontal plane so as to obtain the commonly accepted standard patterns, but due to ground reflections, it is usually preferable to rotate it in only the horizontal plane, see Fig. 1.

In most pattern tests it is possible to avoid all reflections except the ground reflection and the conditions as indicated in this figure are met. Radiation from one antenna to the other takes place over two general paths, one directly between them, path *A*, and another by virtue of a ground reflection, path *B*. Two

(Continued on p 158)



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THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Transistor Frequency-Multiplying Circuit 140
Extending Range of Light Microscope with Television 142
Improving Loudspeaker Response with Motional Feedback 142
Voltmeter-Ammeter for Determining Characteristics of Nonlinear Devices 240
Compact Digital Differential Analyzer 244
Tuning Systems Employing Feedback Amplifiers 252

Transistor Frequency—Multiplying Circuit

By W. B. Bowers*

The W. L. Maxson Corporation
New York, N. Y.

THE FOLLOWING DESCRIBES a recently developed electrical network for direct, rapid and accurate multiplications of two voltages, which may go through zero, by utilization of special characteristics of crystal triodes, such as Western Electric Type A Transistors. The electrical network, which may be used for related mathematical operations as well as multiplication, does not contain vacuum tubes or other parts requiring periodic replacement. The network is extremely small, simple to construct, and may be expected to operate under conditions of severe vibration and shock. Operation from zero frequency to 10 megacycles is possible.

Figure 1A shows the basic circuit of a crystal-triode multiplying device. The basic circuit as shown is also that of a crystal-triode amplifier already in wide experimental use. When the circuit is applied as an amplifier, it is generally utilized as follows:

A constant potential, negative with respect to the potential of the common bus, is applied to the collector of the crystal triode through resistor, R_3. The potential applied to the collector and the ohmic value of R_3 are selected primarily for high gain. The input signal to be amplified is supplied to the emitter circuit at the junction of R_1 and R_2. The resistors in the emitter circuit, R_1 and R_2, limit the emitter bias current. The emitter bias current is adjusted as required to attain high gain and low distortion products in the output signal. When used for a-c amplification, blocking capacitors may be installed in the amplifier input and output circuits so as to prevent the d-c bias and collector voltages from producing direct currents in the external input and load circuits, as illustrated in Fig. 1C.

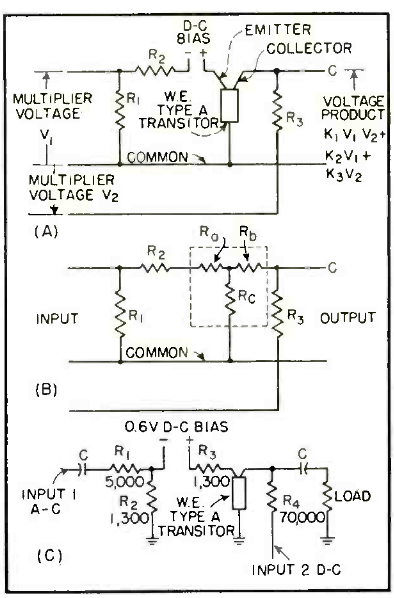


Fig. 1—Circuit and equivalent for transistor amplifier and frequency multiplier

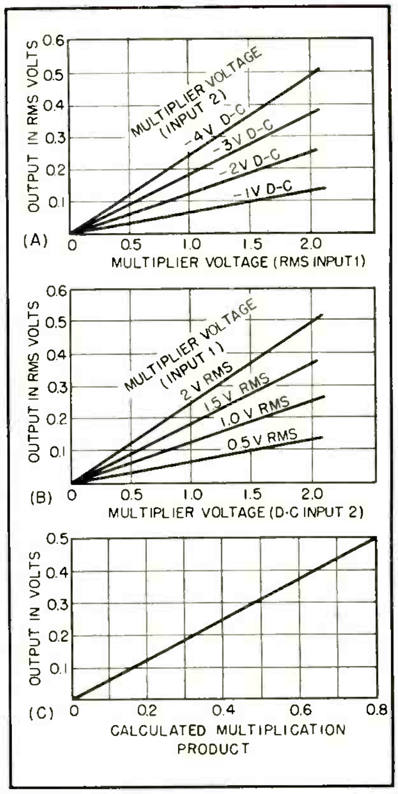


Fig. 2—Curves show characteristics of transistor used as frequency multiplier

In applying the circuit of Fig. 1A as a multiplier, the emitter bias is adjusted so as to obtain a direct proportionality between collector voltage and output voltage for a range of input voltages. Because the effective equivalent impedance of a crystal triode, such as a Western Electric Type A Transistor, at frequencies below 10 megacycles is that of a tee resistance pad (see Fig. 1B), the output voltage may be expressed mathematically in terms of the input voltages as follows:

Output voltage $= V_o = K_1V_1V_2 + K_2V_1 + K_3V_2$

where V_1 and V_2 are the multiplier voltages applied to emitter and collector circuits respectively, $K_1V_1V_2$ is the product of the multiplication, K_2V_1 and K_3V_2 are undesirable by-products which may be eliminated by balancing circuits, by blocking capacitors (in a-c multiplying circuits) or by other conventional circuit means, and K_1, K_2 and K_3 are constants.

Figure 1C shows a practical multiplying circuit. This circuit will provide accurate multiplication of

* Work done while author was with Fairchild Guided Missiles Division, Farmingdale, N. Y.

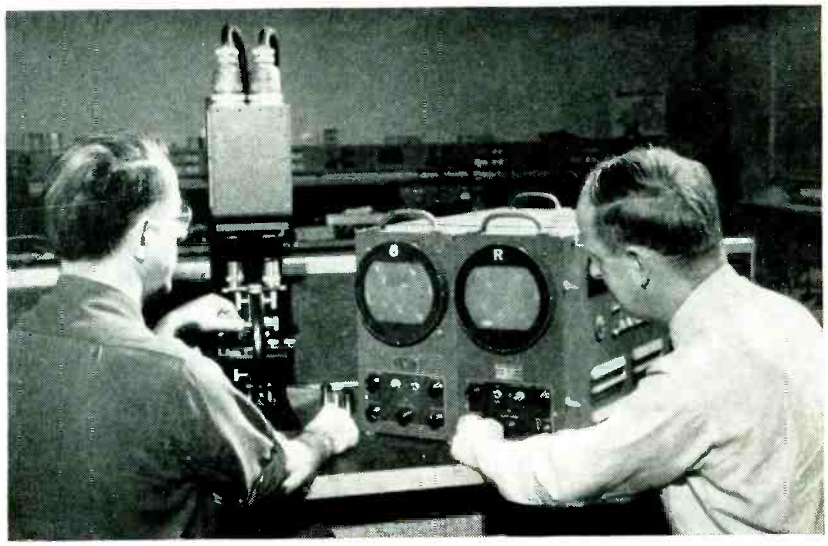
an a-c signal from zero to two volts with a d-c signal of negative polarity from zero to four volts.

For this circuit K_1 was measured as approximately 1/16. Voltage K_3V_2 was eliminated by a blocking capacitor. Constant K_2 was measured as 0.015; however, the output product K_2V_1 can be eliminated by a balancing circuit not shown. Figures 2A and 2B show output voltage products as a function of the applied multiplier voltages. Figure 2C shows measured versus computed product voltages. The measured voltages were chosen at random from the points on Fig. 2A and 2B.

Extending Range of Light Microscope With Television

SIGNIFICANT EXTENSION of the range, power and versatility of the light microscope is made possible through the use of a television link between the microscope and the human eye. The new technique of television microscopy, since it enables the interchanging of television camera tubes with sensitivities to different wavelengths of light, provides considerably sharper contrast than previously available.

The photograph shows the new system in use. According to Princeton University's A. K. Parpart, who demonstrated the RCA equipment, the television-microscope combination makes possible the study of many components of living cells normally visible only after killing and staining, and also the direct observation of motion of, and within, these cells at high magnifications.



Television link extends range and versatility of light microscope and allows studies to be made that were hitherto impossible

The system is also useful for demonstration purposes, where a group is to study a microscope image.

The binocular camera unit, shown in the photograph, employs two Vidicons, each sensitized for different wavelengths.

Improving Loudspeaker Response with Motional Feedback

By ROBERT L. TANNER
Stanford University
Stanford, California

A FACTOR OF IMPORTANCE in determining the response of loudspeakers, and one usually given insufficient consideration in design, is the effective driving source impedance. The mechanical system of a loudspeaker has the electrical analog[1] shown in Fig. 1. This equivalent circuit is based on the similarity between the differential equations of motion for the loudspeaker and the Kirchhoff circuit equations for the series resonant circuit of the figure. In the analogy the mass of the moving system (cone, voice coil, and air load) is represented by M, the compliance of the suspension by C, and the total dissipation (energy lost in flexing the suspension plus energy radiated) by R. The mechanical constants of the system relate the velocity of motion to the applied force in a manner mathematically identical to the way in

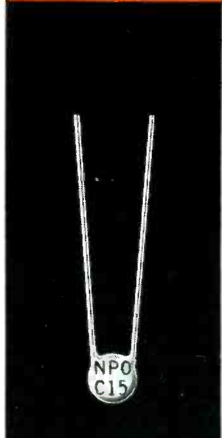
Table I—Mechanical and Magnetic Data for Adding Motional Feedback to Amplifier-Speaker Combination for Typical Loudspeakers

Speaker Type	Diameter (inches)	Magnet	Voice Coil Resistance (ohms)	Resonant Frequency (cps)	Effective Mass Including Air Load with Baffle (Grams)	Compliance of Suspension (cm per dyne)	Mechanical Q	Magnetic Conversion Factor $\frac{B^2l^2}{10^9}$
Cinaud. P8J1	8	6.8 oz Alnico V	6.5	113	9.45	2.1×10^{-7}	15	3.60×10^4
GE S810D	8	6.8 oz Alnico V	3.2	115	9.7	1.98×10^{-7}	9.6	1.38×10^4
Unknown	8	21 oz Alnico III	6.5	118	9.4	1.93×10^{-7}	18	1.82×10^4
Cinaud. P6F1	6	3.16 oz Alnico V	2.95	140	5.50	2.35×10^{-7}	17	6.65×10^3
Unknown	6	1.47 oz Alnico V	2.75	136	3.6	3.78×10^{-7}	12	2.12×10^3

(Continued on page 228)

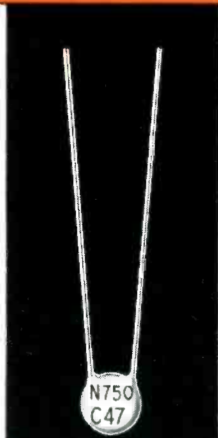
Another FIRST by RMC

Temperature Compensating and General Purpose DISCAPS



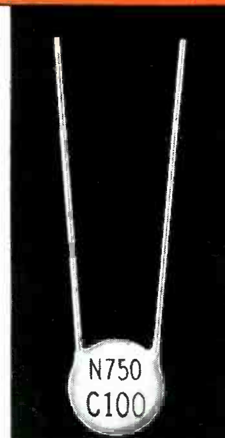
Body Size 1/4" Dia.

Available Range MMF	TC
—	—
5 to 15	NPO
5 to 15	N33
5 to 15	N75
5 to 15	N150
5 to 15	N220
5 to 15	N330
5 to 20	N470
10 to 25	N750
15 to 50	N1500
50 to 100	N2200



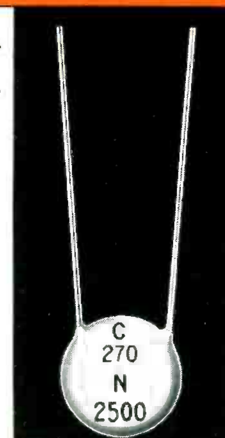
Body Size 5/16" Dia.

Available Range MMF	TC
2 to 9	P100
16 to 33	NPO
16 to 30	N33
16 to 30	N75
16 to 30	N150
16 to 30	N220
16 to 30	N330
21 to 40	N470
26 to 50	N750
51 to 80	N1500
100 to 150	N2200



Body Size 1/2" Dia.

Available Range MMF	TC
10 to 30	P100
31 to 60	NPO
31 to 60	N33
31 to 60	N75
31 to 60	N150
31 to 75	N220
31 to 75	N330
41 to 100	N470
51 to 150	N750
81 to 200	N1500
150 to 250	N2200



Body Size 5/8" Dia.

Available Range MMF	TC
—	—
61 to 75	NPO
61 to 75	N33
61 to 75	N75
61 to 75	N150
76 to 100	N220
76 to 100	N330
101 to 125	N470
151 to 200	N750
201 to 250	N1500
250 to 300	N2200

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POWER FACTOR: LESS THAN .1% AT 1 MEGACYCLE

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DIELECTRIC CONSTANT: P-100 14K N-750 88K N-2200 265K NPO 35K N1500 165K

CODING: CAPACITY, TOLERANCE AND TC STAMPED ON DISC

INSULATION: DUREZ PHENOLIC—VACUUM WAXED

MIN. LEAKAGE RESISTANCE: INITIAL 5000 MEGOHMS AFTER HUMIDITY 1000 MEGOHMS

LEADS: #22 TINNED COPPER (.026 DIA.)

LEAD LENGTH: 1/4" BODY 1", 5/16" BODY 1-1/4", 1/2" BODY 1-1/2"

TOLERANCES: ±5% ±10% ±20%

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Type C DISCAPS offer for the first time low inductance, disc type temperature compensating ceramic condensers which are ideally suited to coupling and tuned circuit applications. Because they are available in a wide range of capacities and temperature coefficients, their usefulness is practically unlimited.

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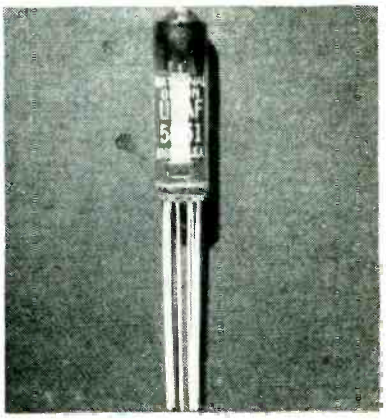
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN



Tiny Beam Pentode

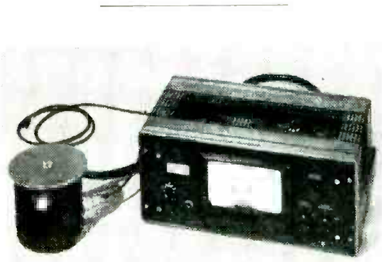
NATIONAL UNION RADIO CORP., 350 Scotland Road, Orange, N. J. Designed for use in military and other applications where subjected to excessive shock and vibration, the type 5851 subminiature tube is suitable for frequency doubler operation up to 400 mc, producing 120 mw. The filament requires 55-ma current at 2.5 v; and it may also be operated at 1.25 v at 110 ma. Plate dissipation rating is 1.5 watts. As a class-A amplifier it will deliver 650-mw audio output at 10-percent total harmonic distortion.

Precision Frequency Meter

C. G. CONN LTD., Elkhart, Ind., has announced a new industrial model 6T-4 Stroboconn, a precision frequency meter accurate to 0.05 percent. Unlike older models used in the music industry it is calibrated directly in cps. The new meter is useful in aircraft engine test work as well as in educational and industrial institutions.

Metal-Shell Rectangular

RADIO CORP. OF AMERICA, Harrison, N. J., has announced the 17CP4, a new, 17-in., metal-shell, rectangular picture tube for tv receivers. With its design-center maximum anode-voltage rating of 16 kv, it provides pictures having high brightness and good uniformity of focus over the 14⅝ x 11-in. picture area. It employs magnetic focus and magnetic deflection, has a frosted Filterglass face plate and features an improved design of funnel-to-neck section that facilitates centering of the yoke on the neck. Diagonal deflection angle is 70 deg and horizontal deflection angle, 60 deg.



Electrometer

LOUDON INSTRUMENTS, INC., 5644 Lake Park Ave., Chicago 37, Ill. Designed especially for nuclear research work, model 361–20 dynamic capacitor electrometer is suitable for general laboratory measurement of small d-c currents and voltages in high-resistance circuits. Typical applications are ionization chamber measurements of radiation, mass spectrographs, biological potentials, chemical titrations, and insulator and capacitor leakage measurements. The dynamic capacitor (located in a separate hermetically sealed inner shield) eliminates drift. Voltage ranges of the model 361–20 are 0 to 10, 0 to 100 and 0 to 1,000 mv with range selector switch.

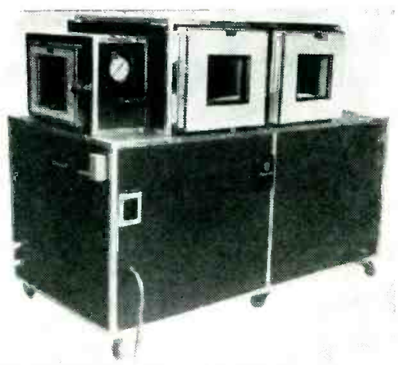
Quartz Monochromator

CAMBRIDGE THERMIONIC CORP., 437 Concord Ave., Cambridge 38, Mass. Those who require a source of monochromatic light for microscopy or other purposes can now secure it in a simple device which utilizes the rotary power of quartz. In the instrument illustrated white light from a tungsten source is passed through basal sections of optical quartz laminated to polaroid sheets. By a synchronous rotation of the quartz sections, the wavelength of transmitted light can be varied continuously through the visible spectrum. The device produces an average bandwidth of 150 Angstrom units.

Turret Switch TV Tuner

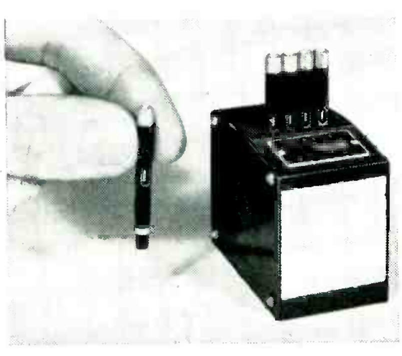
KINGSTON PRODUCTS CORPORATION, Kokomo, Indiana, presents a television tuner that combines features of the turret and the switch type. The basic design is intended to isolate the oscillator from the other

circuits to minimize radiation. On all channels the circuit is arranged to eliminate common-coupled and M-derived coils for interstage circuits, yet the interstage patterns are identical with those. The tuner is adaptable to several mounting positions and may be fitted to a number of dial drives. Coils are so arranged that individual alignment can be done on any channel without removing the tuner from the chassis.



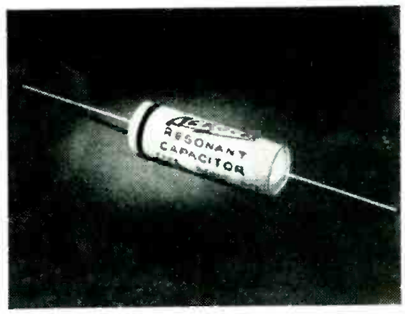
All-Weather Testing Lab

NORTHERN ZALESKI LTD., Pratt Oval, Glen Cove, N. Y. A new combined all-weather testing laboratory allows manufacturers required to test under test specifications calling for temperatures to −100 F; controlled humidities; high altitudes; and fungus conditions to purchase economically an all-in-one laboratory which combines into one unit, but in separate testing spaces, all of the required features for these tests.



Supersensitive Galvanometer

MIDWESTERN GEOPHYSICAL LABORATORY, Tulsa, Oklahoma, is manufacturing the model 106-SS galvanometer that is so sensitive it can be used in most applications directly from source without amplification. Normal balance is only 0.003 in. per G at 12-in. focal distance. It has individual circuits for both terminals of the elements. The outside diameter of the element tube is 0.187 in.; the element length, 2.062 in. Price is $200.



Resonant Paper Tubulars

AEROVOX CORP., New Bedford, Mass., has made available the type RC resonant paper tubular capacitors that are applied as bypasses to prevent i-f currents or voltages between 425 and 485 kc from circulating. Standard ratings of the new capacitors are: 0.05, 0.1 and 0.2 μf, 400 working volts d-c; measuring $1\frac{1}{8}$ in. x $\frac{1}{2}$., $1\frac{3}{8}$ in. x $\frac{1}{2}$in., and $1\frac{7}{8}$ in. x 9/16 in., respectively.

Sweep Frequency Signal Generator

EASTERN ELECTRIC CO., P. O. Box 175, Valley Stream, N. Y. Model 100 sweep frequency signal generator is an electronic, fundamentally operated tv i-f generator for production alignment in the 20-mc range. Maximum sweep width is 16 mc at a center frequency of 25 mc. Amplitude variation is 0.1 db per mc with frequency linearity within 2 percent. Swept r-f output is 0.5 v across a 100-ohm terminated cable. Three steps of 20, 20 and 10 db plus a linear vernier attenuator are available at the front panel with blanking, phasing and sweep width controls and horizontal scope source.

Linear Amplifier

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 223 West Erie St., Chicago 10, Ill. Model 1061 linear amplifier was designed to adapt G-M scalers to proportional counting. The instrument is connected between the detector and a scaler, and provides convenient sensitivity adjustment, calibrated in millivolts, with a choice of 1 or 10-mv maximum sensitivity. It has a flat frequency response of 10,000 cycles to 1.5 mc. A set of oscilloscope terminals are located in the front panel while all other connections are on the rear. The instrument is so designed that the scaler may operate independently without disconnecting it from the amplifier.

Power S[illegible] Bridge

INDUSTRIA[illegible] Wheeler St., [illegible] Uni-Bridge i[illegible]

(Continued on p[illegible] 60)

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Graduate Study in Electronics Announced

STANFORD UNIVERSITY, through its Microwave Laboratory, closely associated with the Physics Department, and its Electronics Research Laboratory of the Electrical Engineering Department, is now offering an integrated program of course work and organized research in electronics. The research work, largely staffed by graduate students on part-time employment and sponsored by industry and the government, includes an extensive activity in vacuum-tube development, including klystrons and traveling-wave tubes, a billion-volt electron linear accelerator development, microwave techniques, applications of microwaves to physical research, ionospheric propagation and upper atmosphere studies, and advanced techniques for amplifier and network synthesis.

Fellowship holders register for a full program of study. Eight awards are available, ranging from $600 to $1,200. Holders of research assistantships are assigned to the organized projects. Complete information on stipends and qualifications required is available by writing to Assistantship Committee, Electrical Engineering Dept., Stanford University, Stanford, Calif. Application forms and university bulletins will be sent. To receive full consideration applications should be submitted by March 15, 1951.

Amateur Bands for Civil Defense

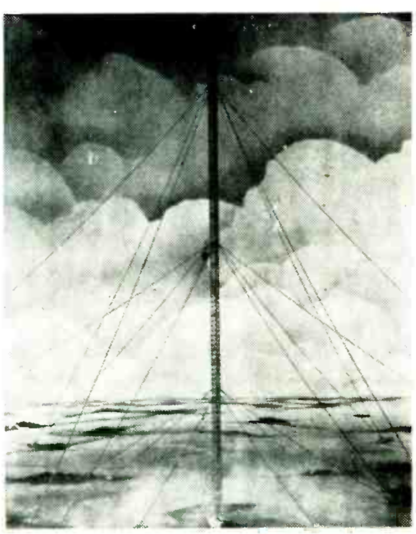
PERMANENT availability of specific frequency bands within the regularly allocated amateur bands for eventual use by amateurs in providing civil defense communication (after any suspension of normal amateur activity which may later be found to be necessary because of war or other national emergency), has been the subject of particular study by the FCC, the Civil Defense Administration and the Armed Forces of the U. S.

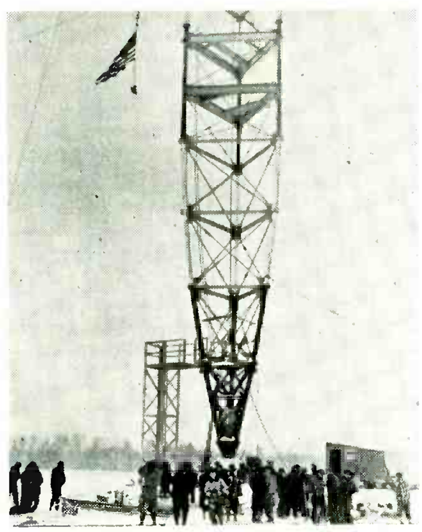
After consideration of all factors known to be involved at this time, including frequency requirements of other radio services in time of war or other national emergency, certain frequency bands already allocated to amateurs have been selected for their retention and use for the purposes described above. The extent to which these bands meet the actual requirements for amateur participation in civil defense communications may be reviewed after a sufficient number of local communities have established appropriate civil defense plans, conducted communications drills or otherwise accumulated data which will permit such a review.

The frequency bands which will remain available for civil defense use by amateurs are: 1,800 to 2,000 kc; 3,500 to 3,510 kc; 3,990 to 4,000 kc; 28.55 to 28.75 mc; 29.45 to 29.65 mc; 50.35 to 50.75 mc; 53.35 to 53.75 mc, 145.17 to 145.71 mc; 146.79 to 147.33 mc; 220 to 225 mc.

In addition to the above bands, the 1,750 to 1,800-kc band will continue to be available for use by properly qualified amateurs and others to provide a Disaster Communications Service, but it should be noted that such a service is intended as a permanent one for use in a disaster occurring at any time, to assist in handling communications within or with a disaster area, whereas the frequencies listed above are designated for amateur use for the handling of such communications as may be required in the interest of civil defense.

WORLD'S SECOND-HIGHEST MAN-MADE STRUCTURE





Recently completed giant loran tower at Forestport, N. Y., was built for experimental and development use by the Air Force Electronics Center at Griffiss AFB. Artist's conception is shown at left. Photo at right was taken during flag-raising ceremony upon completion of the steel shaft, which is stated to be in excess of 1,200 feet. More than 1,400 yards of concrete were poured and 772 tons of steel used in construction of the tower, which is supported by 18 steel guy cables. Only Empire State antenna structure is higher

IRE Convention Program

FOURTEEN professional group symposia and about 150 technical papers will be featured at the IRE annual convention to be held at the Hotel Waldorf Astoria and Grand Central Palace, New York City, from March 19 to 22.

Technical sessions are as follows:

Monday P. M., March 19

Information Theory

A Storage Tube as an Amplitude Distribution Analyser, by R. E. Nienburg and T. F. Rogers.

Cross-Correlation and the Optimum Signal-to-Noise Ratio for Periodic Systems, by M. Leifer and N. Marchand.

Detection of Repetitive Signals in Noise by Correlation, by Y. W. Lee and L. G. Kraft.

Error Reduction in the Determination of Electronic System Parameters, by L. S. Schwartz.

Coding Processes for Bandwidth Reduc-

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UHF

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VISIT US AT BOOTHS 87, 88 RADIO ENGINEERING SHOW tion in Picture Transmission, by A. E. Laemmel.

Television I—Color

Colorimetry in Color, by F. J. Bingley.

Subjective Sharpness of Additive Color, by M. W. Baldwin.

Color Multiplexing by Sine Wave Functions, by N. Marchand.

Measurement and Control of Color Characteristics of Flying Spot Color Signal Generator, by R. Moore, J. Fisher and J. Chatten.

Performance of Carrier Synchronizing Circuits for Color Television Receivers, by E. M. Creamer, Jr., and M. I. Burgett.

A Simple Pattern Generator for Color Television Signals, by R. P. Burr, W. R. Stone and R. O. Noyer.

Antennas

The Design and Use of the Automatic Antenna Pattern Recorder, by J. W. Tiley.

Stagger-Tuned Loop Antennas for Wide-Band Low-Frequency Reception, by D. K. Cheng and R. A. Galbraith.

A Theory of the Concentric-Slot Antenna, by T. Morita.

Optimum Current Distributions for Antenna Arrays with Circular Symmetry, by R. H. Du Hamel.

Directional Antenna Arrays of Elements Circularly Disposed About a Cylindrical Reflector, by R. F. Harrington and W. R. LePage.

Power Tubes I—Theory

Class-C Amplifier Calculations, by D. W. Cawood.

The Effect of Secondary Emission in Power Tubes, by H. Hsu.

Reflex Resnatron Operation and its Implication for Bandwidth, by M. Garbuny and G. E. Sheppard.

The Multi-Beam Electron Coupler—An Improved Spiral Beam Electron Tube for the Modulation and Control of Power at UHF, by C. L. Cuccia.

A New Single Cavity Resonator for a Multi-Anode Magnetron, by J. S. Needle, G. Hok, G. R. Brewer and H. W. Welch.

Frequency Control and Generation

The Generation of Single-Sideband Suppressed-Carrier Signals by a New Balancing Method, by H. M. Swarm.

Precision Frequency Generators Using Single-Sideband Suppressed-Carrier Modulators, by H. R. Holloway and H. C. Harris.

Stabilized Variable Frequency Transmitter Exciter for Military HF Equipment, by J. Bush.

Wide-Range Direct-Reading Precision Frequency Meter and Signal Source, by B. Parzen.

Crystal Control of a Four-Kilowatt 1.036-Megacycle Transmitter, by J. W. Clark, R. W. Kane and W. G. Abraham.

A Frequency Stabilization System for the Measurement of Microwave Refraction of Gases, by W. F. Gabriel.

Communication Systems

AM-FM Analogy, by H. C. Harris.

Survey of Electronic Commutation Methods, by R. S. Butts.

High-Frequency Radio Communication System Utilizing Phase Modulator Transmission and Single-Sideband Reception, by H. F. Meyer and H. Y. Littlefield.

Echo Distortion in the FM Transmission of Frequency Division Multiplex, by W. J. Albersheim and J. P. Schafer.

Management Aspects of Electronic Systems Engineering, by R. I. Cole.

Tuesday A. M., March 20

Symposium: Amplification of DC Signals

Symposium: Panel Discussion on Tube Reliability

Power Tubes II—Development

A Coaxial Power Triode for 50 KW Output up to 110 Mc, by R. H. Rheaume.

A High-Power Tetrode, by C. E. Murdock.

The Reflex Resnatron, by G. E. Sheppard, M. Garbusy and J. R. Hansen.

Transmitting Tube Suitable for UHF Television, by W. G. Abraham and M. Chodorow.

Frequency - Modulated High - Efficiency Klystron Transmitter, by M. Chodorow and S. P. Fan.

Propagation

Selective Fading of Microwaves, by A. B. Crawford and W. C. Jakes, Jr.

Propagation Studies at Microwave Frequencies by Means of Very Short Pulses, by O. E. DeLange.

Low-Frequency Ionospheric Soundings with Atmospherics, by W. J. Kessler and W. F. Zetrouer, II.

The Effect on Propagation of an Elevated Atmospheric Layer of Non-standard Refractive Index, by L. H. Doherty.

Symposium: Broadcast Transmission Systems

MEETINGS

MARCH 5–9: ASTM Spring Meeting and Committee Week, Cincinnati, Ohio.

MAR. 19–22: IRE Annual Convention, Hotel Waldorf Astoria and Grand Central Palace, New York City.

APR. 16–18: Spring Meeting of the U.S.A. National Committee of the URSI and the Professional Group on Antennas and Wave Propagation of the IRE, at the National Bureau of Standards, Connecticut and Van Ness Sts., N. W., Washington, D. C.

APR. 20–21: Southwestern IRE Conference, Southern Methodist University, Dallas, Texas.

APR. 21: Fifth Annual New England Radio Engineering Meeting, Copley Plaza Hotel, Boston, Mass.

APR. 30–MAY 4: SMPTE Spring Convention, Hotel Statler, N.Y.

MAY 21–23: 1951 Parts Distributors Show, Hotel Stevens, Chicago, Illinois.

MAY 23–24: Fifth National Convention, American Society for Quality Control, Hotel Cleveland, Cleveland, Ohio.

JUNE 18–22: ASTM Annual Meeting, Atlantic City, N. J.

JUNE 25–29: AIEE Summer General Meeting, Royal York Hotel, Toronto, Ontario, Canada.

AUG. 28–SEPT. 8: Eighteenth British National Radio Show, Earls Court, London, England.

AUG. 29–31: Seventh Annual Pacific Electronic Exhibit and West Coast Annual IRE Convention, San Francisco Civic Auditorium, San Francisco, Calif.

SEPT. 10–14: Sixth National Instrument Conference and Exhibit, sponsored by Instrument Society of America, Sam Houston Coliseum, Houston, Texas.

Tuesday P. M., March 20

Symposium: Panel Discussion on Performance of DC Amplifiers

Symposium: Matching Schools and Industry

Circuits I—Synthesis and Analysis

Network Synthesis Applied to Feedback Control, by J. G. Truxal.

Network Synthesis by Use of Potential Analogues, by R. E. Scott.

Transfer Ratio Synthesis by RC Networks, by J. T. Fleck and P. F Ordung.

Electrical - Mechanical Equivalent Network Synthesis, by A. E. Gerlach.

Linear Network Neighborhood Equivalence, by D. R. Crosby.

Constant-Resistance Varying-Parameter Networks, by L. A. Zadeh.

Electron Tubes I—Tubes Employing Electron Beams

The Rotating Beam Method for Investigating Electron Lenses, by D. E. George and M. Cooperstein.

The Design of 90-Degree Deflection Picture Tubes, by H. Grossbohlin.

A Miniature Traveling-Wave Tube for the Lower UHF Band, by R. Adler.

Beam Analyzer, by L. R. Bloom, D. F. Holshouser, H. S. Wu and W. W. Cannon.

Generation of Sidebands Due to Gain and Phase-Shift Modulations in a Traveling-Wave-Tube Amplifier, by M. Arditi, A. G. Clavier and P. Parzen.

Microwaves I—Waveguides A

Development of Waveguide Switches for Commercial and Military Applications, by T. N. Anderson.

Low-Loss Waveguide Transmission, by S. E Miller and A. C. Beck.

Dominant Wave Transmission Characteristics of Oversize Round Waveguides, by A. P. King.

Radial Probe Measurements of Mode Conversion in Large Round Waveguide with TE_{01} Mode Excitation, by M. Aronoff.

A Broad-band Microwave Quarter-Wave Plate, by A. J. Simmons.

Symposium: Panel Discussion on the "Empire State Story"

Tuesday P. M., March 20

Symposium: Color Television

Wednesday A. M., March 21

Symposium: Industrial Instrumentation

Computers I—Digital Computers

The Raytheon Selection Matrix for Computer and Switching Applications, by K. M. Weiss.

Saturable Reactors as Substitutes for Electron Tubes in High-Speed Digital Computers, by J. G. Miles.

Ferromagnetic Cores for Three-Dimensional Digital Storage Arrays, by W. N. Papian.

A Dependable Small-Scale Digital Computer, by J. Connolly.

An Asynchronous Control for a Digital Computer, by D. H. Gridley.

Circuits II—Filters

Time Domain Filters, by J. Snyder.

Pulse Repetition Filters, by D. L. Waidelich.

Optimum Nonlinear Filters, by H. E. Singleton.

Nonlinear Sampling Filters, by W. D. White.

Statistical Filter Theory for Feedback Systems Subject to Saturation, by G. C. Newton, Jr.

Electronic Filter, by H. C. Sterling.

Electron Tubes II—Special Tubes and Techniques

The Plasmatron, a Continuously Controllable Gas Tube, by E. O. Johnson and W. M. Webster.

Switching Time Limitations in Hydrogen Thyratrons, by J. B. Woodford, Jr.

A New Type Heater Cathode Tube for Portable Battery-Operated Equipment, by G. W. Baker.

New Vacuum-Tube Materials, by E. B. Fehr and A. P. Haase.

Properties of Interfaces in Metal-to-Ceramic Seals, by W. H. Christoffers and R. P. Welling.

Microwaves II—Waveguides B

The Precision Measurement of the Equivalent Circuit Parameters of Dissipative Microwave Structures, by A. A. Oliner and K. Kurss.

On the Excitation of Surface Waves, by G. Goubau.

Interaction Between Surface Wave Transmission Lines, by A. A. Meyerhoff.

Multi-Element Directional Couplers, by S. E. Miller and W. W. Mumford.

The Effect of Radiation on the Q of Resonant Sections, by R. A. Chipman, E. F. Carr, and N. A. Hoy.

Symposium: Some Systems Problems of Air Traffic Control

Wednesday P. M., March 21

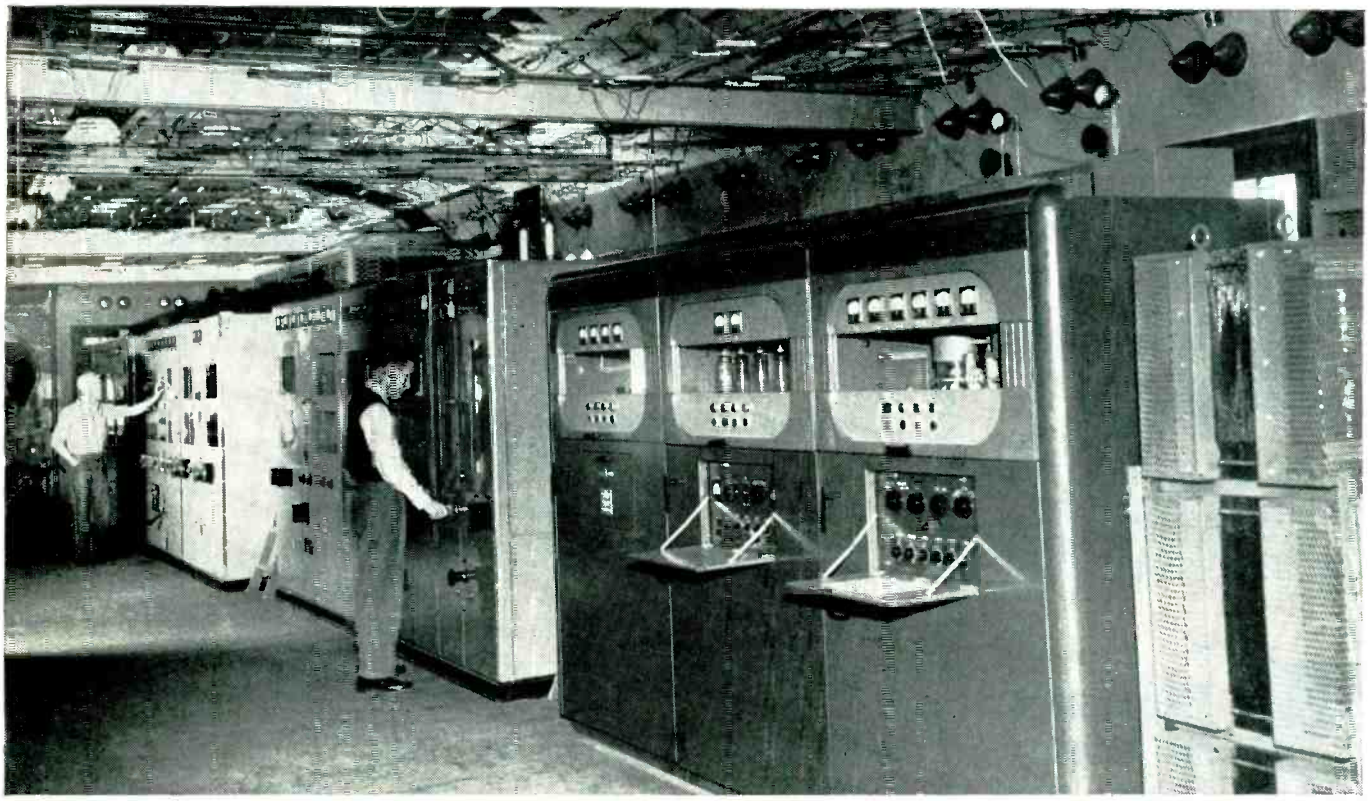
Electronic Instrumentation

Microwave Methods in Gas Analysis, by J. Weber.

X-Ray Liquid Level Gage, by J. E. Jacobs and R. F. Wilson.

Noise Figure Standards, by M. Solow.

(Continued on p 297)

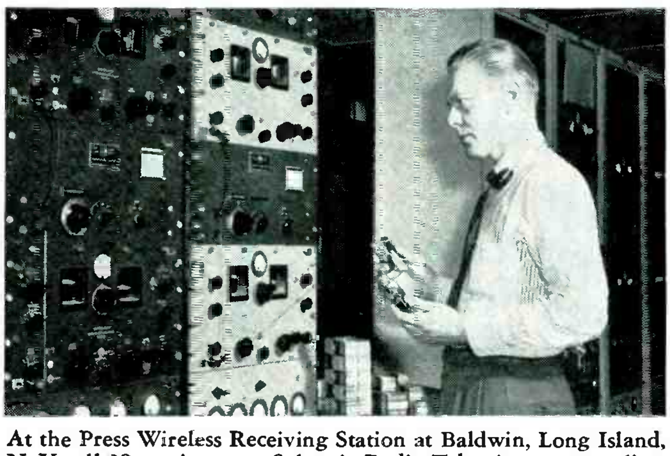


An aisle at the giant Press Wireless transmitting station at Hicksville, Long Island, N. Y., showing 3 of the 35 transmitters (from 2.5 to 50 kw output), in constant use. These transmitters beam news to North America, Central America, and South America, Europe, Africa, the Middle East, and to Iron Curtain countries, including the U.S.S.R., through the Voice of America and United Nations broadcasts. All the transmitters are keyed and controlled with equipment using Sylvania Radio Tubes.

SYLVANIA RADIO TUBES HELP PRESS WIRELESS CARRY THE NEWS TO ALL THE WORLD!

Voice of America broadcasts to Russia and the Iron Curtain countries . . . United Nations broadcasts to the world . . . news stories and pictures for the world's newspapers, magazines, and radio stations . . . this is the vital 24-hour-a-day task of the far-flung transmitters and receivers of Press Wireless, Inc. Jointly owned by leading newspapers and news services, Press Wireless is handling the biggest job of news transmission the world has ever known!

With such an urgent mission, dependability is the keynote. And naturally, to insure that dependability, Press Wireless uses Sylvania Radio Tubes by the thousands in its equipment. Like expert production and design engineers everywhere, Press Wireless' staff has found by experience that Sylvania precision, uniformity, and reliability add up to quality that can't be beat. For complete characteristics of radio tubes for every application, or for help on your special problems, write Sylvania Electric Products Inc., Dept. R-1103, Emporium, Pa.



At the Press Wireless Receiving Station at Baldwin, Long Island, N. Y., all 29 receivers use Sylvania Radio Tubes in many applications. Tuned to London, Paris, Rome, Moscow, Madrid, Buenos Aires, Mexico City, and many other news centers, they receive code and voice transmissions as well as teletype, and radio photos for dissemination to all America.

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 — 50th ANNIVERSARY — FIVE DECADES OF PROGRESS

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

NEW BOOKS

TV and Other Receiving Antennas

BY ARNOLD B. BAILEY. *John F. Rider Publications, Inc., New York,* 1950, 595 *pages,* $6.00.

AN ANTENNA is a wonderful device. It accepts energy from some source of r-f power and, in a manner not too clear to a great many well-trained engineers, creates at a remote point a disturbance which can be translated into a human communication. Some of the answers to the antenna how question will be found in this book.

The periodical literature on antennas, their theory and their design is voluminous but there are not many books on the subject. Those which do exist seem aimed at the erudite reader who is possessed of much mathematical ability. This 600-page volume, therefore, should be useful to a broad cross-section of communications engineers. Although the author is speaking mostly about tv antennas, and, therefore, about short-wave radiators, the concepts and illustrations he uses may be employed at other frequencies.

This reviewer does not have the expert knowledge to say whether the author's concepts are rigidly correct or not, but even if not, they are provocative and instructive.

After a review of definitions and terminology, a discussion of the television signal and a discussion of problems of tv reception, the author considers the electromagnetic wave, the radio path, the theory of signal interception, devotes some 85 pages to the center-fed half-wave dipole, discusses parasitic element arrange-

RELEASED THIS MONTH

Electronics: P. Parker; Longmans, Green and Co., New York; $10.00.

Introduction to Industrial Electronics; R. Ralph Benedict; Prentice Hall; $6.35.

Quartz Vibrators and Their Applications; P. Vigoureux and C. F. Booth; His Majesty's Stationery Office, London; $6.75.

HI-EFFICIENCY DICHROIC MIRRORS OR FILTERS?

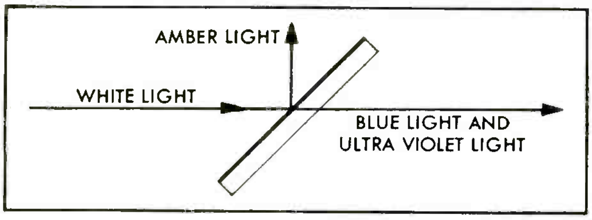


Diagram of typical 45° use of a Liberty Hi-Efficiency dichroic mirror. Such mirrors and filters frequently are used at approximately this angle.

With white light illumination the two separated beams are complementary. With gas discharge tubes or phosphor light sources the two separated beams may be utilized to isolate certain portions of the spectrum of the illumination source.

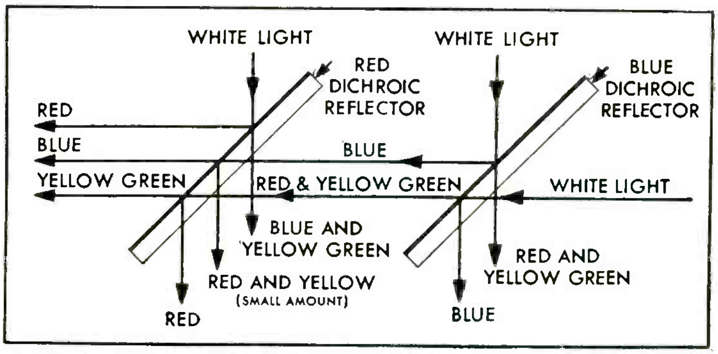
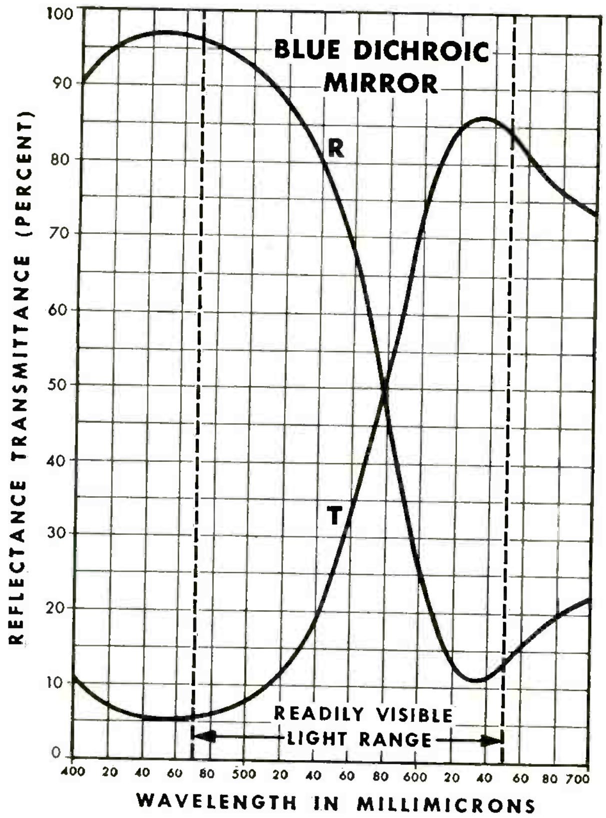


Diagram of typical result obtained by the use of two Liberty Hi-Efficiency dichroic mirrors.



At the left, is the spectrophotometric curve of a Liberty blue-reflecting dichroic mirror recorded at substantially normal incidence. Customer's specification called for peak reflection at 450 millimicrons; our designation for the resultant mirror is 90-450, indicating the approximate reflectivity at the approximate peak.

Comparison of the reflection and transmission curves shows the almost complete absence of light absorption. All Liberty Hi-Efficiency dichroic mirrors and filters possess little or no light absorption.

★ ★ ★

Liberty Hi-Efficiency dichroic filters possess rather sharp bands. However, these bands are not as sharp as the well-known "interference filters", and are not intended to replace them. Liberty Hi-Efficiency dichroic filters find application where high selective transmission is the determining requirement.

Liberty dichroic filters are made by coating commercial plate glass or optically ground and polished glass, as the use requires. Such construction has apparent advantages for certain applications, as compared with the use of colored glass filters. It completely eliminates the problems arising from defects such as are common in specially made colored glasses, particularly in large sizes. Further, such special colored glasses are not always readily available, and frequently must be made up on special order. In contrast, Liberty Hi-Efficiency dichroic filters are quickly available, with prompt delivery of uniform production lots — and color characteristics are independent of the thickness of the glass support.

Liberty Hi-Efficiency dichroic mirrors and filters are made in standard production sizes up to 20″ x 30″; larger sizes available on special order.

In making inquiry for dichroic mirrors and filters, please specify approximate reflection peak desired, as well as transmission characteristics intended, angle of use and type of light source.

If a phosphor light source is used, please give number or spectral character of the phosphor. Information as to types of sensing elements and their spectral responses also is helpful.

We invite your inquiries on orders of one of a kind — or thousands. Each will receive our early and most experienced attention.

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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.

Even More Queasy

DEAR SIRS:

IT SEEMS A SHAME to throw away Bob Wakeman's minus sign, because it makes the quiz even more queasy. I refer to the solution of the November ELECTRONICS Quiz problem, which you printed in the December, 1950 issue.

What is the input impedance across the input terminals of a ladder composed of 2-ohm series resistances and 4-ohm shunt resistances, if it is terminated by a negative resistance of −2 ohms? The value of the last shunt resistance in parallel with the negative terminating resistance would therefore be −4 ohms. The last series resistance brings the value back to −2 ohms. Similarly, the −2 ohms is reflected back indefinitely, and R = −2, no matter how many sections of positive resistance are included.

R. G. MIDDLETON
Woodside, New York

Simultaneous Systems

DEAR SIRS:

OUR ATTEMPT to describe the RCA color television system as a dot-multiplex, dot-sequential, or dot-interlace system has apparently caused a great deal of confusion. I was rather perturbed, for example, by the article published in ELECTRONICS (R. B. Dome, p 70, Sept. 1950) on the GE system of color television and the editorial comment that this was revival of the simultaneous system, as though the RCA system were not simultaneous.

Since sampling multiplies the

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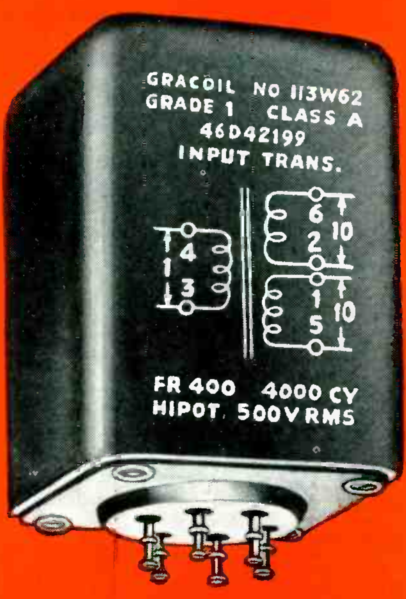
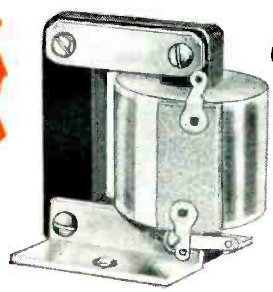


WE WILL, without cost or any obligation whatever, design a PRODUCTION SAMPLE transformer (hermetically sealed to JAN-T-27 or MIL-T-27 Government specifications), or open type construction, if unit is to be used for awarded prime or sub-contract work. Our approach stresses quality of product, efficiency in service and an alertness to techniques that discard the old for more functional methods.

James M. Blacklidge
PRESIDENT



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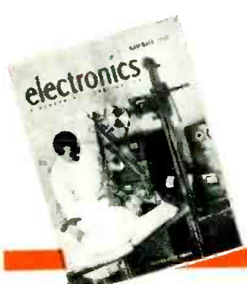
bringing Your FASTENERS to market ➧ ➧ ➧ ➧ is a full time job for . . . electronics

A big tv maker estimates that one billion, eight hundred and sixty-two million (1,862,000,000) fasteners were used in tv set assembly in 1950. That 1,862,000,000 is for fasteners used in the final assembly of tv sets only. It does not include the great quantities of fasteners used in the many tv subassemblies. Nor does it take into account the billions of fasteners used in the more than fourteen million radios produced in 1950 . . . or the fasteners used in the industrial, military, aviation, communication, broadcast, instrument and other fields of electronics. It accounts for only those screws, nuts, washers, rivets, lugs and special fasteners used in the final assembly stage of tv set manufacture. It is just an indication of the proportions the fastener market is attaining in television.

The final assembly stage exemplifies the engineering functions of fasteners in electronics and explains why they are design engineer specified and bought. Television, like many other products, is a mass production item and, wherever it is possible without affecting quality, production shortcuts and economies are *designed-in*. That is why so many special rivets and self-tapping screws, and so few standard machine screws, nuts and washers are used. It also accounts for the small number of solder lugs used in the average tv set. The metal chassis is designed by the lab with tabs to take the place of the separate solder lugs.

The reasons for designers' fastener specifications are as varied as the fasteners they design-in. The rivets used may be one kind because that kind works better in the riveting machines. The self-tapping screws may be another manufacturer's because he holds to design-specified tolerances. Other special fasteners may be designed-specified because of service or maintenance requirements, simplicity, stability, vibration or other important engineering considerations. The reasons for specific fastener specifications in electronics are varied. The specifiers are always the same — the laboratory design engineers.



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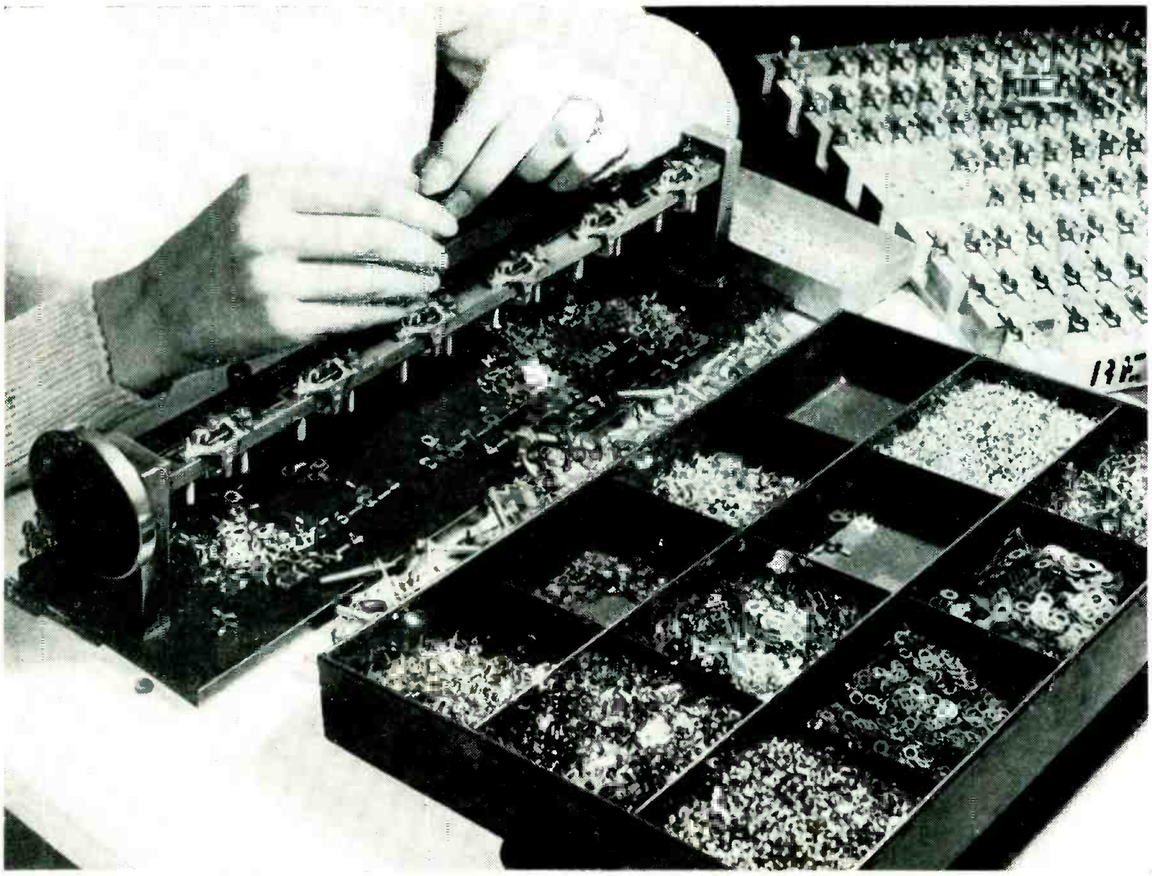


Picture above, like the 1,862,000,000 figure mentioned on the opposite page, is simply an attempt to visualize for you one small portion of the market for fasteners offered by ELECTRONICS. This is an assembly line job in which sixteen screws, washers and other special fasteners are installed on a widely used electronic instrument component.

Fasteners like every other component or material used throughout the science-art-industry of electronics are designed-in, specified and bought by engineers. You may feel that fasteners are just "hardware" and as such beneath the attention of the lofty electronists. But, "hardware" or not, and this is important because it is the key to increased fastener sales in electronics, fasteners are important, integral components designed-in, specified and bought by electronic design engineers just as carefully as any other design component.

The design engineers who direct fastener purchasing are subscribers to and readers of ELECTRONICS. Its sales pages are for them the chief source . . . sometimes the only one . . . of the information on which they base their specifying-buying. These engineer readers of ELECTRONICS constitute your market. They are the men to whom you must bring your product — the men you must reach and influence. That's where ELECTRONICS specializes — taking product stories to the important buying factors — and returning sales. That's ELECTRONICS' full time job . . . taking products to market. ELECTRONICS' subscribers are the men in all the fields of industry who design, specify *and buy fasteners*. By full use of the sales opportunities in the advertising pages of ELECTRONICS, you can take YOUR fasteners or kindred products to market.

THE DIRECT ROUTE TO — — — — — — — A $2,000,000,000 MARKET PLACE

(continued from p 138)

difficulties result: the signal received will vary anywhere from essentially nothing, due to cancellation, to about double that for path *A* alone, due to reinforcement; and the pattern as defined by the field at the test antenna, will be a complex combination of the patterns in two planes, differing in altitude by the angle β. Generally the horizontal pattern is desired, so the two antennas must be on the same level reducing H_1 and H_2 and angles α and β to the same value.

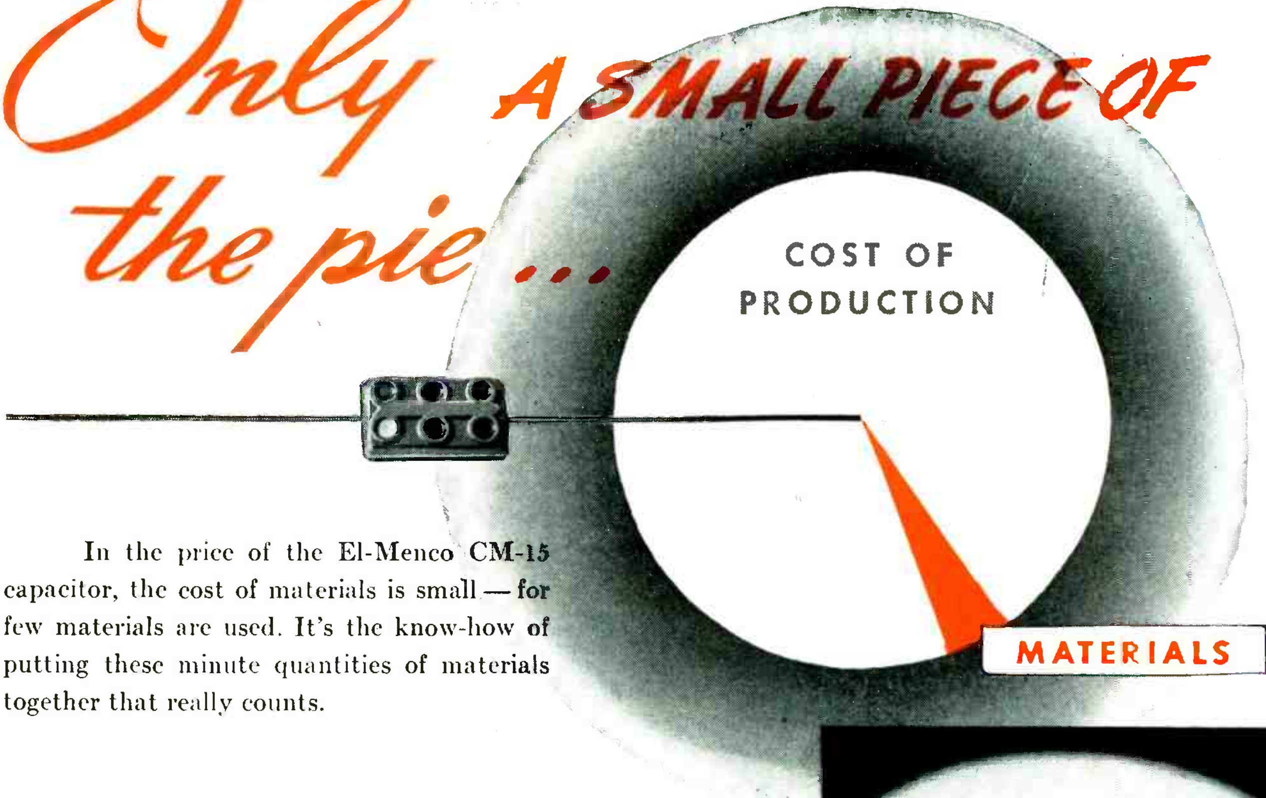
It is obvious that the only remedy for the interference is to reduce the radiation along path *B* to a satisfactory minimum. This may be accomplished in two ways. First, the antenna heights are made as large as possible compared to the separation *D*. This will reduce the field from path *B* inversely in proportion. Distance *D* is usually fixed by the frequency of operation and the size of the antennas by a commonly accepted relationship $D = Kd^2/\lambda$ where *K* is a value of unity, or greater (depending on the degree of pattern accuracy desired), *d* is the aperture of the antennas and λ is the wavelength of operation. Hence the height above ground is no longer a matter of simple arbitrary choice. Secondly, the radiation from the source antenna may be made directive in the vertical plane so that there is relatively little radiation at the angle α.

Testing Large Antennas

Testing of large antennas at low frequencies will be found to require large distances *D* and consequently large heights above ground. The cover page illustrates a tower structure designed to meet the requirements of these conditions. The tower structure is mounted on skids and is moved about to suit different distances *D* by means of a bulldozer. The source antenna is mounted on a sliding frame, which may be elevated to the desired height after the antenna has been constructed and attached to the frame at ground level.

The condition of vertical directivity is demonstrated also. The source antenna consists of two vertical rows of folded dipole antennas, four in each row, fed in phase and so spaced as to give the

Only A SMALL PIECE OF *the pie...*



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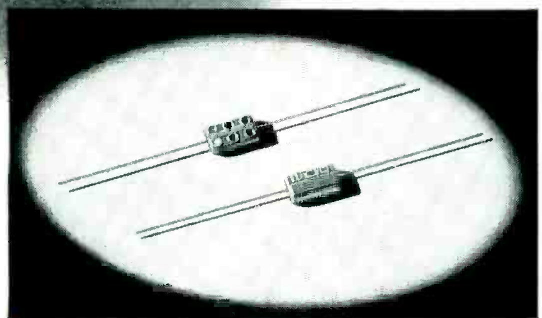

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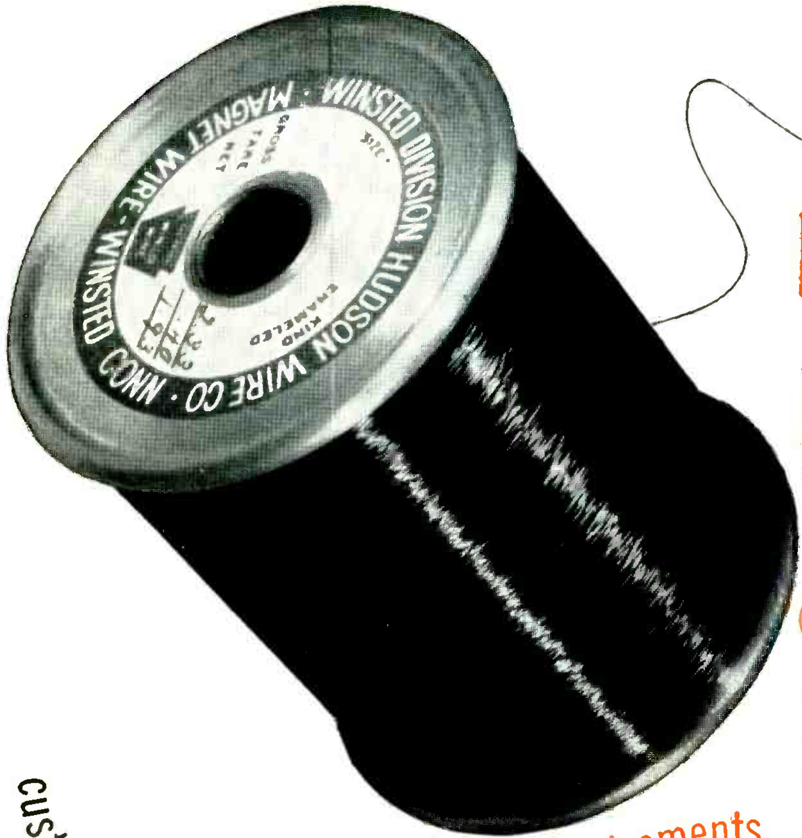

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desired horizontal and vertical radiation patterns. No attempt is made to suppress the backward radiation from this antenna, such a procedure being required only when the general space in that direction has possible reflecting surfaces or when a stronger forward field is needed. In the particular setup shown, the antenna separation was 92 feet and the height above ground 28 feet. Measurements were being made in the frequency range 152 to 162 mc.

Graphic Recorders With Fixed Styli

By R. S. Bark
Electronics Engineer
School of Medicine
University of Washington
Seattle, Washington

Many faults of moving element recorders such as fragility, instability and irremediable wear could be avoided if the tracing could be made without moving the marking device. If a stationary stylus were placed along the y axis of the chart paper and the marking function were moved along its length in accordance with the value being measured, the basic problem of avoiding moving styli would be solved.

One method might be to terminate the bar as a mismatched transmission line and to electronically control a standing wave, electrical or mechanical, along the bar so as to mark the chart paper, thus indicating the quantity being measured.

A simple method is to divide the length of the bar into discrete segments, each responding to a particular value of the quantity being measured. Recording of mechanical motion may be accomplished by a

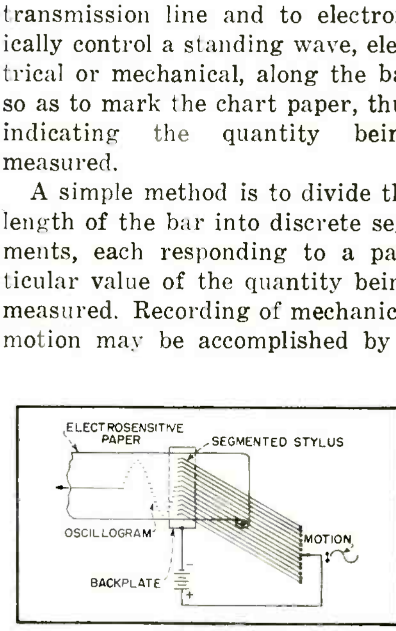
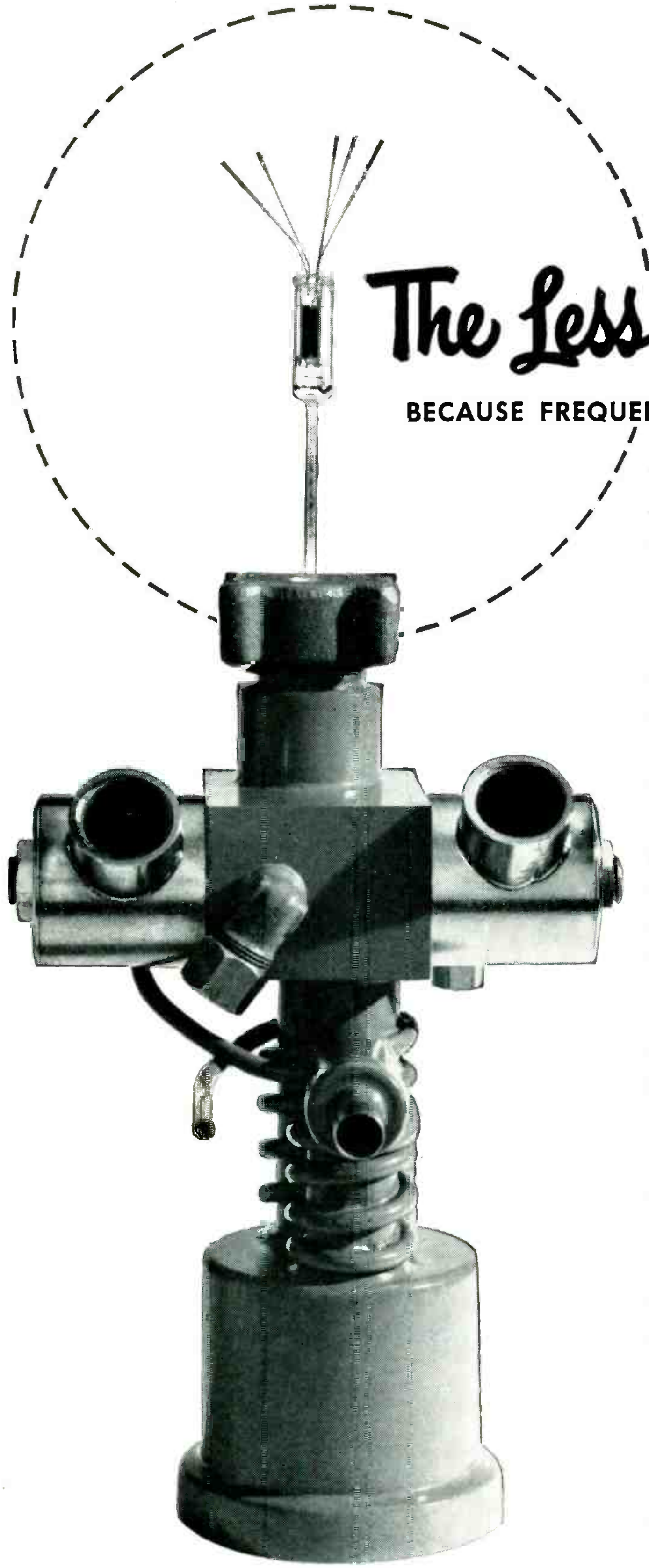


FIG. 1—Simple position-to-position fixed-stylus recorder



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If you manufacture small electronic tubes, DPi's new VMF-5 Exhaust Unit pictured here can provide a happy ending to your quest for lower, more consistent residual gas pressure.

With today's push toward ever-higher frequencies, you can't afford to ignore the effect of residual gas on the low capacitance demanded in tubes. And with the small size of today's tubes, you can't use much getter to "clean up" residual gas, because the metallic film deposited can result in serious inter-element leakage.

VMF-5 Exhaust Units quickly take pressure down to 0.1 micron Hg before the getter flash, as compared with the 10- to 100-micron pressures to which older equipment limits you. They come equipped with water-cooled ports that fit any standard tubulation or can be fitted with ports of your own design. Two a-c solenoid valves (or three if required by the design of your rotary exhaust machine) isolate the diffusion pump during roughing.

The VMF-5 is just one of a series of high vacuum pumps designed by DPi for the specific conditions of the electronics industry. They are made in a wide range of pumping speeds.

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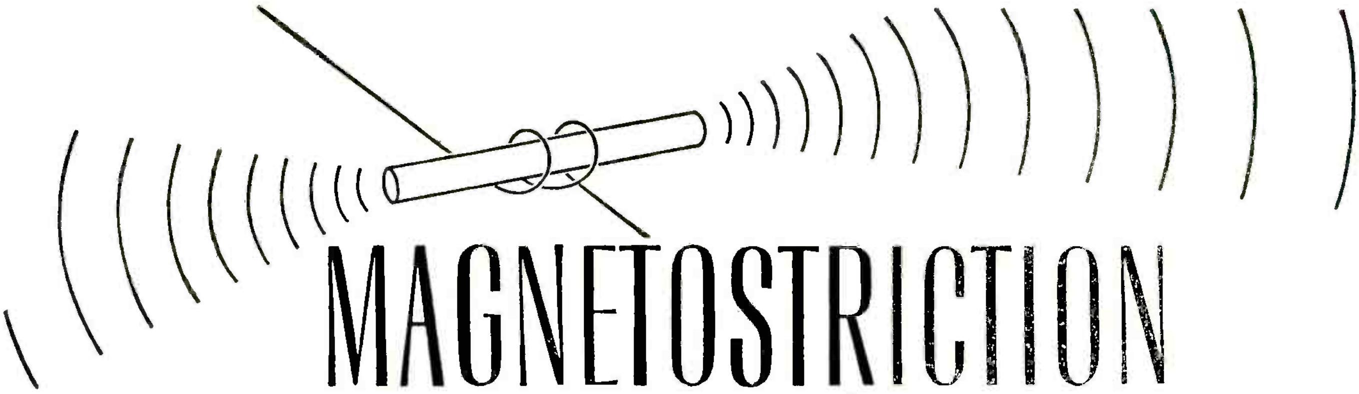

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Early experimenters noted with interest the unusual behavior of magnetized ferromagnetic materials . . . the "spontaneous" dimensional changes; and inversely, the permeability changes when dimensions were forcibly altered.

But as magnetostriction developed from laboratory demonstration to practical application, it was discovered that few materials offered sufficiently high magnetostrictive response. When the essentials of economy, workability, and availability were considered, the number of suitable materials was still more limited.

• • •

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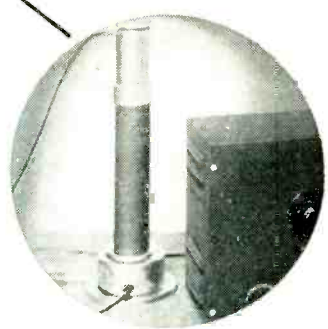
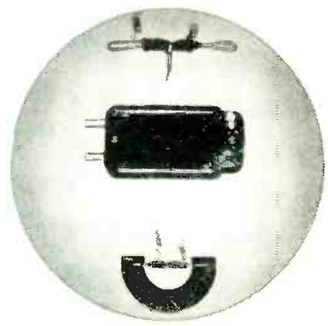
For your reference files, write for: "*Magnetostriction*", and "*66 Practical Ideas for Metal Problems in Electrical Products.*"



Bacteria Killer. A 9 Kc magnetostrictive oscillator used for sterilization in the chemical and pharmaceutical industries. The magnetostrictive material is laminated Nickel. Made by Raytheon Manufacturing Co., Waltham, Mass.



Phonograph Pick-Up: The magnetostrictive unit in this device is a 20-mil Nickel wire which is stretched between the poles of a horseshoe magnet. Variations in torsion caused by deflections of the needle produce flux variations in two pick-up coils that are wound around the stretched Nickel wire.

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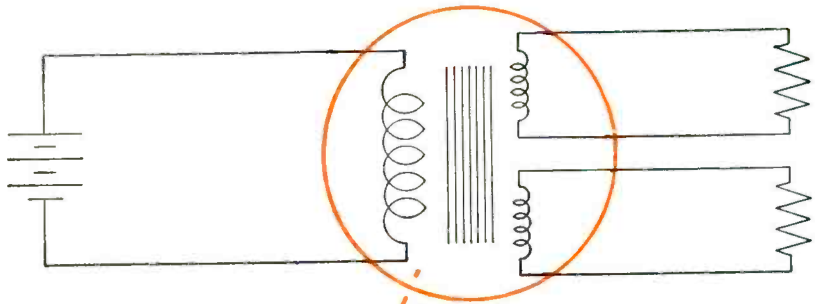

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segmented bar stylus excited from a segmented motion-pickup commutator, the two units being connected by a cable containing a number of electric wires appropriate to the number of segments, as shown in Fig. 1.

Accuracy is independent of marking voltage and calibration is permanent. Accuracy is determined by the resolution of the system, which in turn is set by the number of segments involved in the motion. One hundred segments give one percent accuracy. Frequency response is limited only by the inertia of the pickup transducer arm.

If each bar segment is a tuned reed or actuated through a tuned filter, the recorder will plot frequency. Note that it can plot several frequencies simultaneously so that it can be used as a frequency-spectrum analyzer, see Fig. 2.

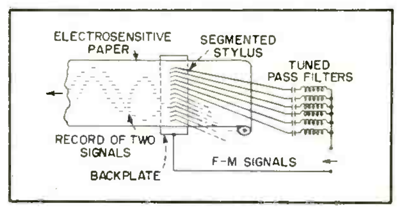
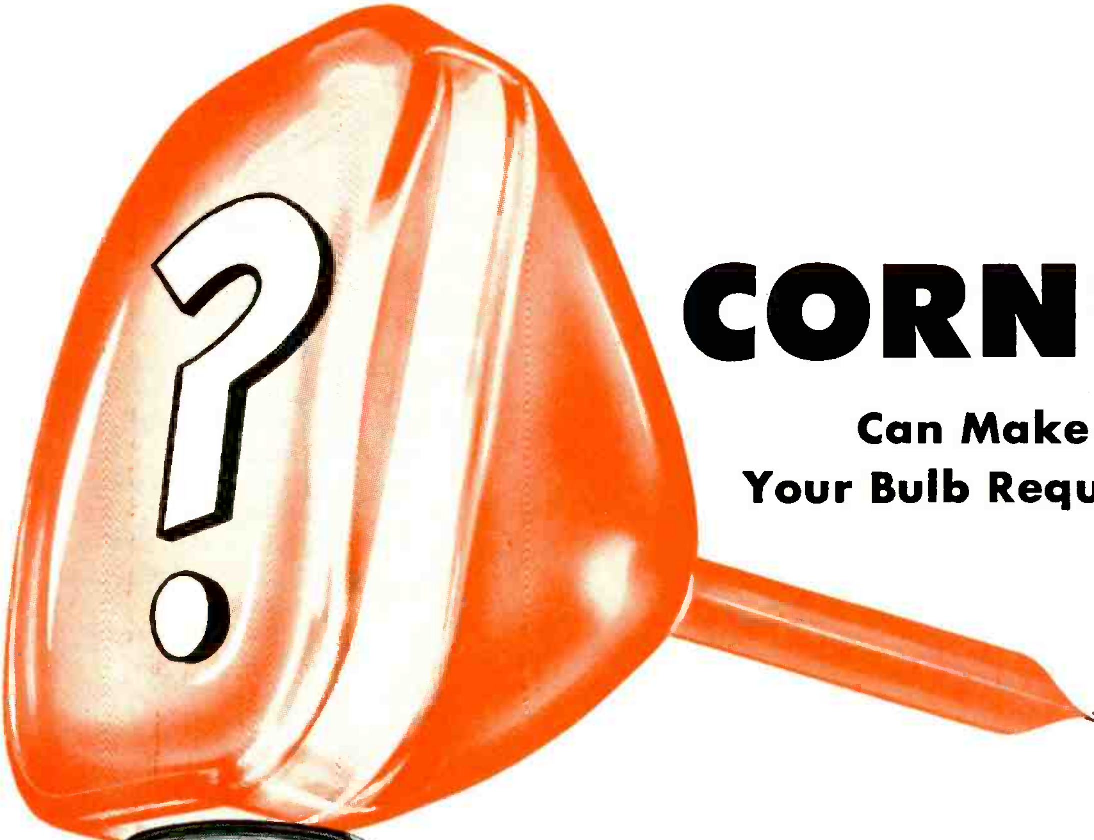


FIG. 2—Frequency-to-position system

External conversion of amplitude to frequency will make the preceding system respond to amplitude. Arrangement of the segments or filters on a logarithmic frequency scale results in a logarithmic recorder of high stability for either frequency or amplitude.

Amplitude, such as voltage, can be translated into position without going through the frequency step just described. A galvanometer may be used, either directly or in a null-balance system, to translate electric current into position by means of an electromechanical commutator. For instance, in a closed-cycle servo (mechanical inverse-feedback) null-balance potentiometer, a commutator on the potentiometer shaft can actuate a segmented bar stylus to electrically mark chart paper, thus eliminating the pen drive and also reducing the total inertia.

The frequency-response limitations of a mechanical commutator may be entirely avoided by an all-



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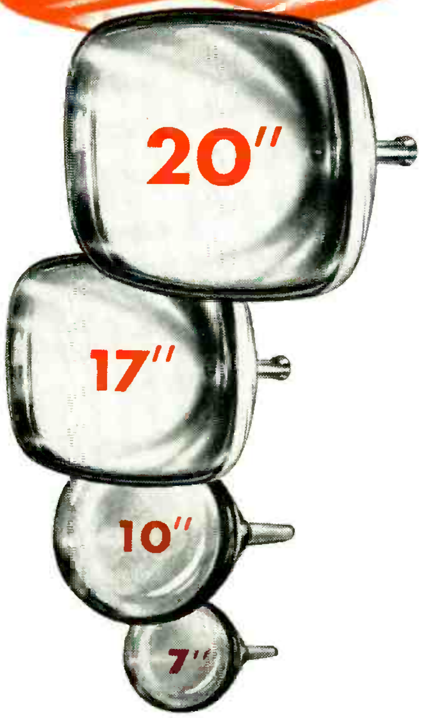

The recently announced 20" *all-glass* television bulb illustrates how tube manufacturers can always look to Corning for the latest developments. There are excellent reasons for this. The adaptability of glass in the hands of Corning technicians is one thing. For another, glass manufacturing methods are flexible. *All-glass* bulbs paced the 1950 trend to rectangular shapes and larger sizes, and continue to lead in 1951.

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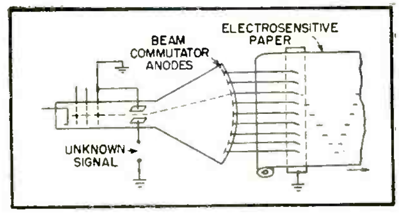

FIG. 3—High-speed beam commutator scanning system

electronic equivalent. An electron-beam commutator can be used, see Fig. 3. Here, the beam of the tube is deflected by the signal to sweep across a series of plates which form the commutator. If the beam current, a few microamperes or a milliampere at most, is insufficient to mark the electrosensitive chart paper, an ordinary triode operating as an on-off switch can be added for each stylus segment. A recorder of two percent accuracy would require 50 segments or 25 twin-triode tubes. This may be expensive, but not excessively so. Such a bank of triodes can also be applied to a mechanical pickup commutator to lessen friction due to contact burning, see Fig. 4.

A beam commutator tube may be avoided by a step-threshold system, using only the triodes, progressively biased, and the stylus segments, see Fig. 5. For any given value of input signal, some of the switching tubes will be beyond cutoff and some will be at full conduction, except one particular tube whose bias will allow it to amplify the locally generated carrier and hence mark at the appropriate stylus segment. If the electric paper had a sharp threshold of marking, any one of several systems could be applied directly to the segments without the use of switching tubes.

Sweep commutation systems, both mechanical and electronic, can be applied. Unlike closed-cycle servo null systems, sweep null systems are fast, not only because all moving parts run at a constant maxi-

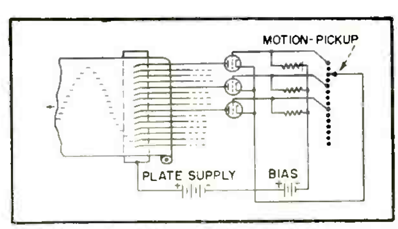

FIG. 4—Use of triodes as switches

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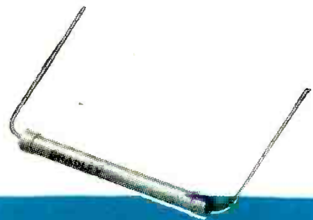

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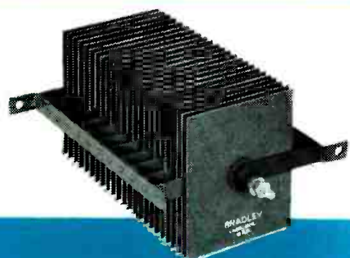

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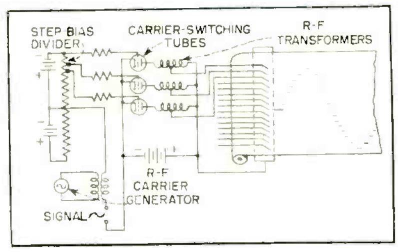

FIG. 5—Progressively biased switching system

mum speed with no time lost for stopping and starting about the point of marking, but also because no speed need be sacrificed to cure hunting instability, see Fig. 6.

In this example, a motor repeatedly sweeps a potentiometer and also a commutator on the same shaft. At the instant when the potentiometered voltage equals the unknown, a null-operated switch, electronic if fast response is desired, connects the marking current to the stylus commutator segment being swept at that instant, thus marking at the correct point on the chart paper. An all-electronic equivalent is made possible by using a beam commutator or a series of biased triodes as commutator segments and a saw-tooth sweep instead of a motor-driven sweep, see Fig. 7. The sweep rate must be high enough to take at least several samples of each signal impulse.

The accuracy or resolution of the fixed segmented stylus system is ultimately determined by the commutation accuracy, the number of segments and by the mechanical precision of the apparatus. The latter is the precision of nonmoving parts, analogous to the markings on a ruler. Hence, this system avoids many of the dynamic inaccuracies of moving styli and, rather, depends upon our more basic standard of accuracy, the static unit of length.

With a segmented bar stylus the number of segments may be great

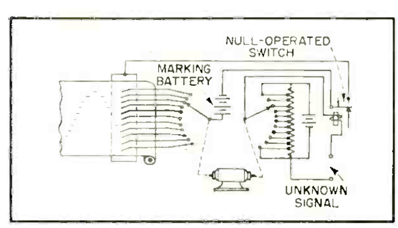

FIG. 6—Motor-driven sweeping commutator and potentiometer

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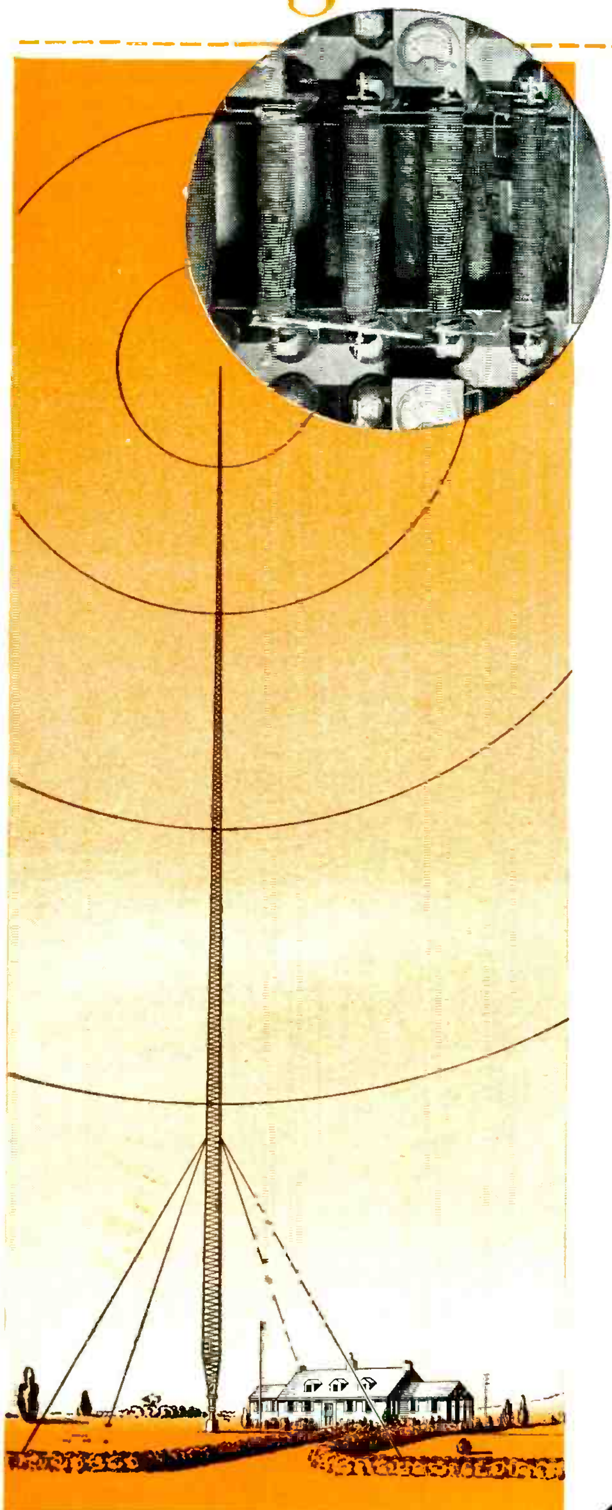

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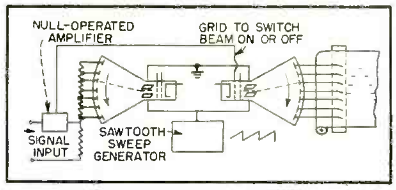

FIG. 7—Beam-commutation potentiometer

enough to give a highly accurate tracing, yet this tracing may appear broken into discrete dots such as those shown in the figures. The remedy is closer spacing or angled overlapping of the stylus segments, thus producing a continuous-line recording.

Several signals may be simultaneously recorded by one segmented stylus. If, for example, three motion-sensitive commutators are used with one stylus, the traces may be identified by having faint marking from signal No. 1, heavy marking from No. 2 and regularly interrupted marking from No. 3.

The ultimate high—frequency response of this system, aside from any commutation or sweep attachments, depends upon the time and intensity required to mark the paper. That is, transient pulses will be reproduced at full amplitude until their time duration is too short to cause marking of the chart paper. Pulse-stretching of very short transients and intensity-modulation of the stylus marking current should make possible a frequency range of several thousand cycles per second.

Conventional chart paper drives may be used for recording low-frequency phenomena. However, for high-frequency phenomena, the paper speed must be greater. To have a millisecond pulse occupy an inch of chart paper requires a paper drive of 83 fps, which may involve the waste of a large amount of chart paper in getting up to the speed required for recording. It is suggested that a short length of paper be wrapped around the periphery of a continuously revolving motor-driven drum. A pair of fast switches, electronic if necessary, can limit the oscillogram to just the one revolution, and can also be used to initiate the phenomena being measured, such as a nerve action-potential. Long, fast records can be driven by having a strip of straight, nonrolled chart paper sud-

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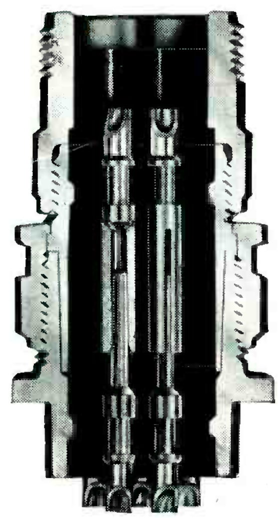

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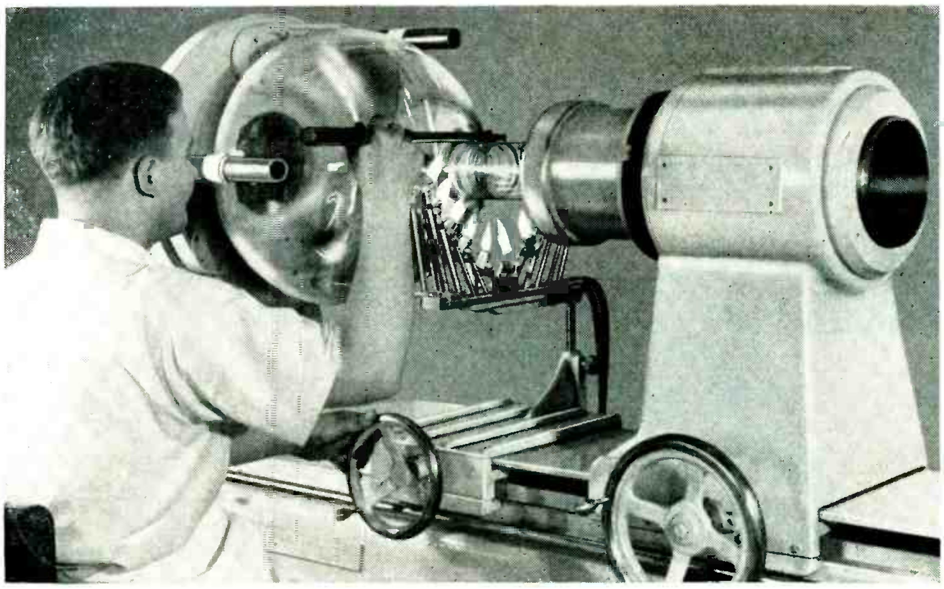
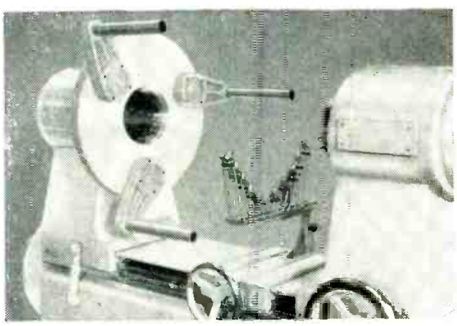
LITTON INDUSTRIES NEWS



LITTON GLASSWORKING LATHES SPEED PRECISION ASSEMBLY OF TV KINESCOPE, VACUUM TUBES

Modern vacuum tubes have extremely close alignment tolerances. Often, subassemblies must be separately aligned before junction. During sealing, both assemblies must be rotated in perfect phase to maintain this alignment.

Versatile, adaptable Litton Glassworking Lathes meet these requirements. They are built on a normalized cast iron bed, with precision ground ways and axial alignments of highest accuracy and positive phase. The lathes will chuck and hold units such as copper anodes to runouts of .001".



Close-up of spindle head, Litton Model K lathe, showing exceptionally large diameter opening of universal chuck

Air passages are arranged to avoid contamination, yet permit use of neutral gasses when sealing glass to metal. Burners provide the narrowest possible heating area commensurate with ample total heat. Continuously variable spindle speed, which makes possible much glassworking without blowing, is optional on all models. Foot pedals control the air or neutral gas supply, and the oxygen and gas volume. Convenient hand controls govern carburetion and air intake to the spindles.

Leading TV tube makers use Litton Glassworking Lathes to speed production of kinescope tubes 10" to 27" in diameter. Manufacturers find that the speed and handling ease of Litton lathes enable glassworkers to seal tube funnels to domes in minimum time—with complete control of glass distribution. Since most manufacturers align sub-assemblies on the lathe, the accurate phasing of Litton spindle heads is also an important factor.

Reliable Litton Glassworking Lathes are adaptable to the widest possible variety of glassworking jobs. Five models offer a choice of radial clearance ranging from 4" to 17½", and axial working lengths from 20¾" to 75½".

LITTON SPOTWELDERS OFFER HIGH POWER, EXTREME FLEXIBILITY FOR PRECISION JOBS

Litton Model A Precision Spotwelder offers broad applicability of use in the manufacture of vacuum tubes. It makes possible the quick altering of production setups. Rated 2 kva continuous duty, it efficiently handles average sized

or very precise jobs. Accurate alignment and absence of side play permit butt welding or parallel welding of small wires without rolling. Foot pedals and switches control top mandrel and power supply. Model A spotwelder has 6½" throat depth and extension jaws can be added.

SPOTWELDER TIMER

A new timer for the Litton Model A Spotwelder has been developed by Litton Industries and will be available for delivery soon. The timer employs two simple controls. One adjusts weld time in steps of 1, 2, 3, 5, 7, 10, 15, 25 and 60 cps. The other adjusts heat control in 6 steps. Proper adjustment of these controls makes possible precision welds up to the 2 kva rating of the welder.

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denly snatched between a pair of oppositely turning drive rollers whose speed is reinforced by flywheels or by a heavy drive motor.

Need for Improvement in Selenium Rectifiers

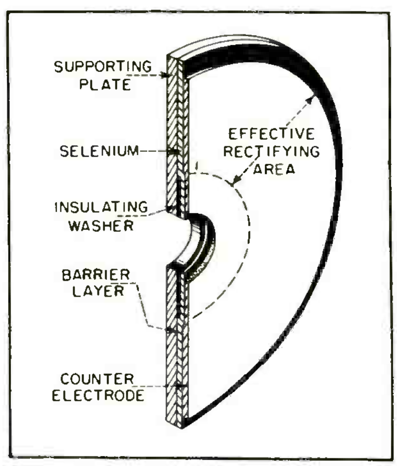
By J. T. Cataldo
Project Engineer
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

Selenium rectifiers are finding more and more widespread use in the electronics industry today. Although the unidirectional conductivity of selenium was investigated as early as 1878 by R. Sabine, it was not until 1938 that selenium rectifiers, as such, appeared commercially in this country.

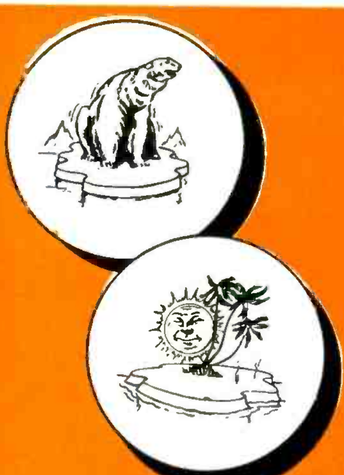
Today, because of the ever increasing requirements of light weight, compactness and economy and because of shortages in many types of tubes, selenium rectifiers have found application in almost every branch of electronics. Their most popular application has been as a rectifier to convert a-c power to d-c power for tube circuits.

Limitations

As is usually the case with new components, certain limitations to their use exist. For commercial application, the inherent limitations of selenium rectifiers do not present a difficult problem. However, because of rigid military equipment requirements, certain improvements have to be made in this field. The present major requirements for



Cross section of selenium rectifier plate. The center area around the assembly hole is coated with an insulating varnish or a thin insulating washer prior to application of the selenium



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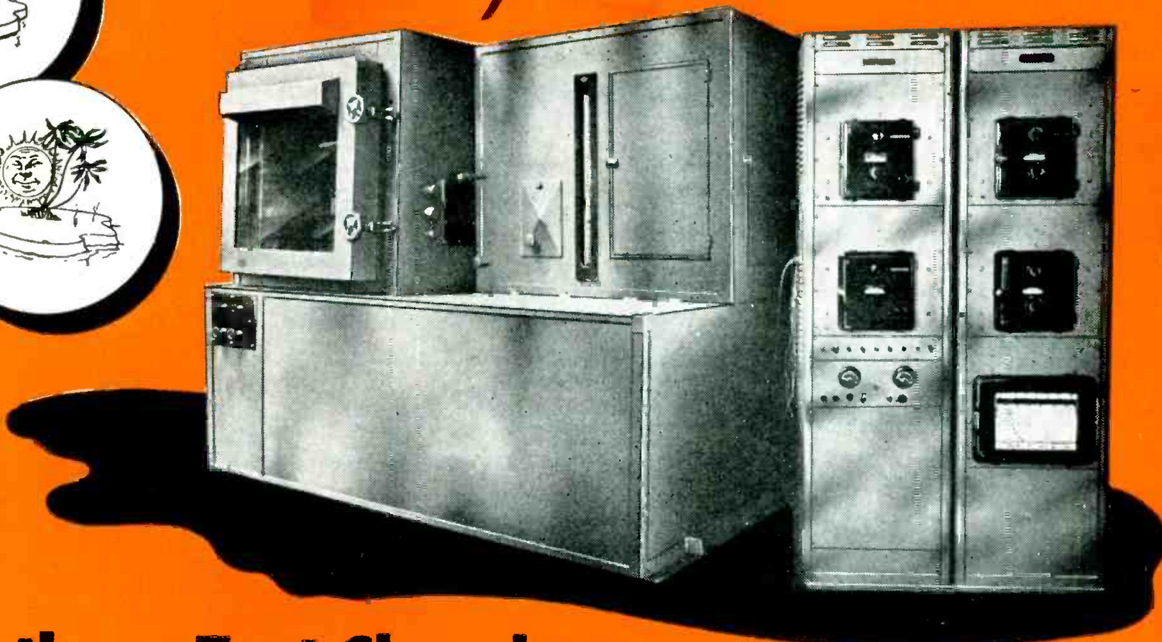

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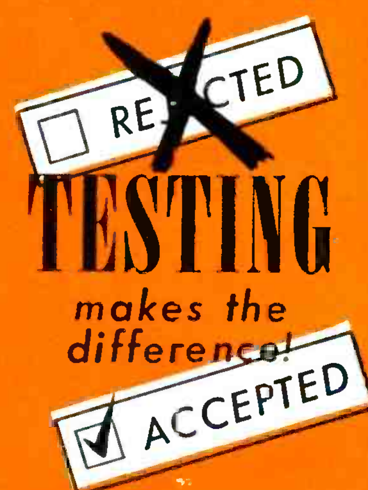

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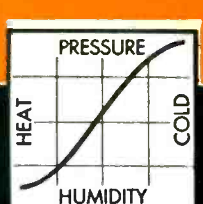

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In the free field type Model B the response is about −55db referred to 1 volt/dyne/cm². This response is flat to within ± 3db from 20 to 12,000cps and to within ± 3db from 20 to 15,000 cps with the grill removed. The overload level for this model is approximately 130db.

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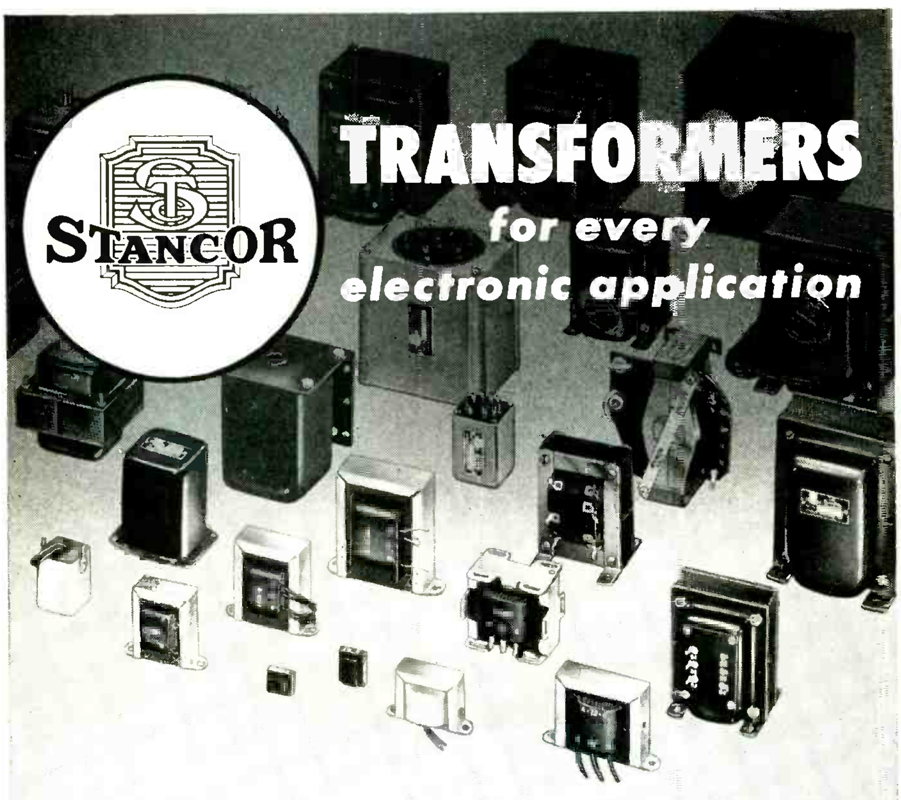

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Ratings: Ef 2.5 volts If 7.0 amps. epx 1250 volts Io 1.5 amps. ib 6.0 amps.
Atmosphere: Argon-Mercury
Type 3B28
Rectifier
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Ratings: Ef 2.5 volts If 5.0 amps. epx 10 KV Io 250 ma ib 1.0 amp.
Atmosphere: Xenon Gas
Type 393A
Thyratron
Max. Dimen.: Ht. 6-10/16" Diam. 2-1/16"
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Atmosphere: Argon-Mercury
Type 3C23
Thyratron
Max. Dimen.: Ht. 6-1/8" Diam. 2-1/16"
Ratings: Ef 2.5 volts If 7.0 amps. epx 1250 volts Io 1.5 amps. ib 6.0 amps.
Atmosphere: Argon-Mercury
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Thyratron
Max. Dimen.: Ht. 9-1/2" Diam. 3-3/16"
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Atmosphere: Argon-Mercury
Type 354A
Thyratron
Max. Dimen.: Ht. 9-1/2" Diam. 2-5/16"
Ratings: Ef 2.5 volts If 16.0 amps. epx 1500 volts Io 4.0 amps. ib 16.0 amps.
Atmosphere: Mercury Vapor
Type 575A
Rectifier
Max. Dimen.: Ht. 11-1/16" Diam. 3-1/16"
Ratings: Ef 5.0 volts If 10.0 amps. epx 15 KV Io 1.5 amps. ib 6.0 amps.
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military applications are: high ambient temperature operation, climatic protection and reduction in size.

Signal Corps equipment must meet full operational requirements at 55 C and, in addition, must be operable at 71 C after sustained storage at 74 C. Present selenium rectifier ratings are based on an ambient temperature of 35 C, which is the ambient operating temperature of most commercial equipment. For operations at temperatures above 35 C the rectifier has to be derated for voltage and/or current at 55 C. Therefore, a larger size unit must be used to prevent overheating and damage to the rectifier. Recently, an announcement was made by a manufacturer that selenium rectifier plates are being produced which can be operated at 120 C. This claim is based on the use of a higher melting point alloy for the counter electrode and a modified heat treatment process.

New Coatings

It can be readily understood that a sealed unit for operation at 55 C and high humidity is appreciably larger than a unit of the same electrical output for operation at 35 C and ambient humidity. Government Laboratories are presently investigating both the possibility of replacing oil with other fluids, to effect a reduction in size and weight, and the development of coatings to withstand severe climatic conditions.

The prime effort of industry is directed toward the development of more suitable coating materials. Development of a new coating for selenium rectifiers is a complex and time-consuming project, because of the numerous problems involved, the most important of which are: the forward resistance of the rectifier should not increase with application of coating material; the reverse resistance should not decrease with application of coating; because of the inherent characteristics of selenium rectifiers, the curing or baking temperature for the coating should be limited to below 100 C; and the coating should be chemically compatible with any approved moisture- and fungus-proofing varnishes and lacquers

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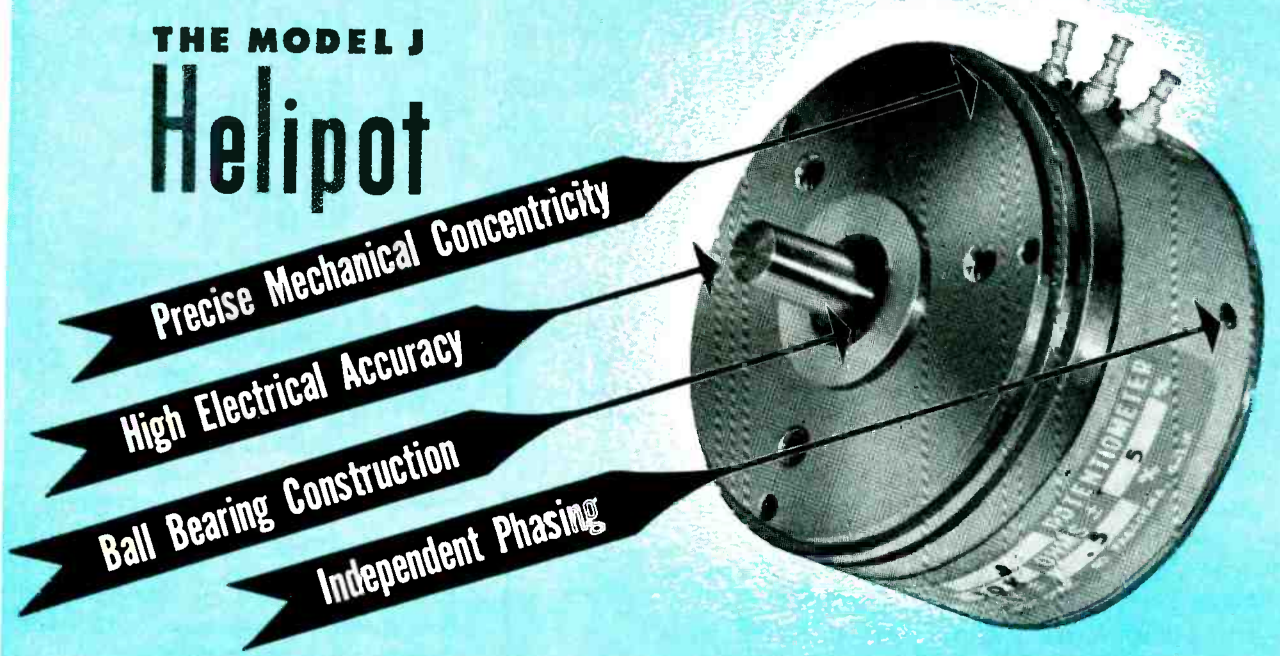
THE MODEL J

Helipot



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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.

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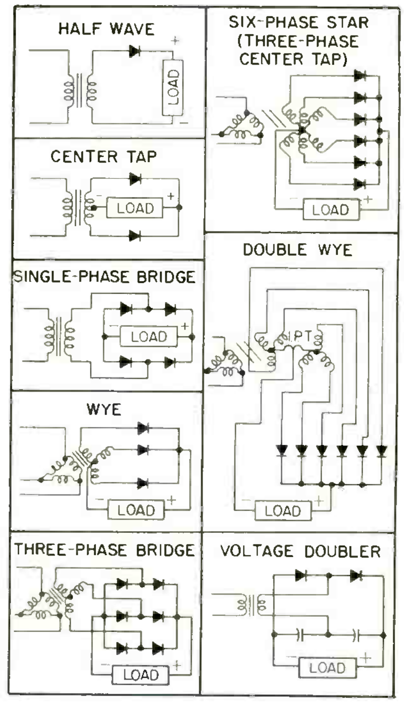

Typical selenium rectifier circuit applications

which may be applied to equipments in normal moisture- and fungus-proofing treatments.

The coating must withstand ten cycles of the Standard Moisture Resistance Test for Component Parts, and must not peel, flake, blister or show any signs of damage. Announcement has been made recently of the development of some new coatings which are currently being evaluated at the Signal Corps Engineering Laboratories.

Size Reduction

The reduction of the size of rectifiers has been limited by the voltage rating of each plate. The first selenium rectifier plates produced commercially were limited to a maximum inverse voltage rating of 14 volts. Development of better barrier layers led to a rating of 18 volts per plate. Post-war work by most of the manufacturers resulted in the development of 26-volt plates with manufacturers currently claiming development of a 33-volt and a 40-volt plate. The 26-volt plates have been evaluated by the Signal Corps Engineering Laboratories and are currently being used in the design of new equipment.

Considerable development work is being performed by industry under government laboratory contracts on selenium rectifiers leading toward

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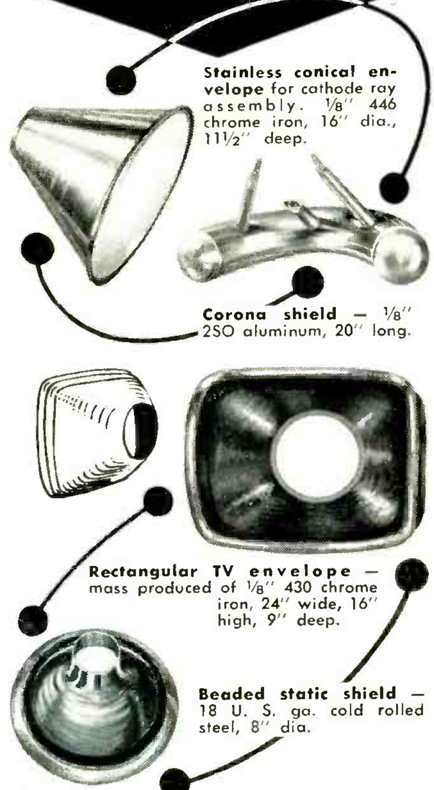

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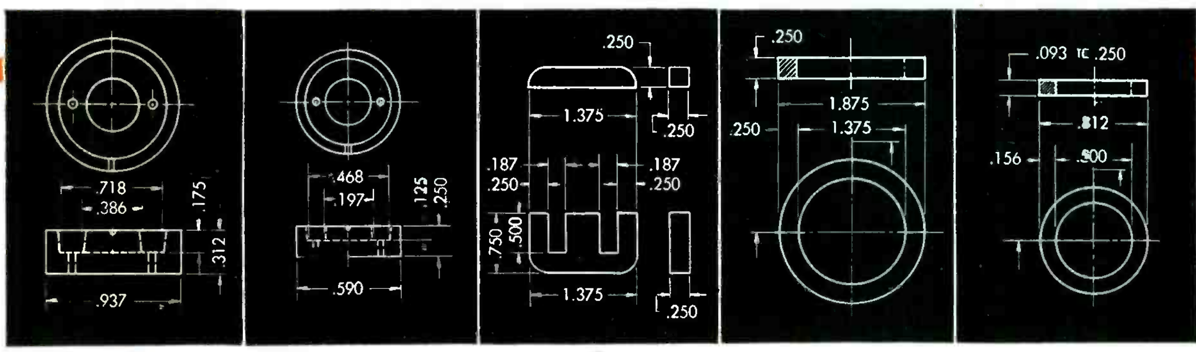
Maximum permeability	—	97	183	710	1030	1710	3300	4300	1010	750
Saturation flux density	Gauss	840	1900	3800	3100	3800	3200	3400	154[illegible]	2900
Residual magnetism	Gauss	615	830	2700	1320	1950	1050	1470	660	1600
Coercive force	Oersted	3.7	3.0	2.1	1.0	0.65	0.25	0.18	0.40	.80
Temperature coefficient of initial permeability	%/°C.	0.65	0.04	0.4	0.3	0.25	1.3	0.66	0.3	0.22
Curie point	°C.	280	260	330	165	160	160	150	70	180
Volume resistivity	Ohm-cm	1x10⁹	2x10⁵	2x10³	3x10⁷	4x10⁵	1.5x10⁸	1x10⁴	2x10⁵	—
Loss Factor: at 1 mc/sec	—	—	.00016	.00007	.00005	.00008	.00008	.00030	.0033	.000055
at 5 mc/sec	—	.0004	.0011	.0008	.0012	.002	.00075	.00155	.00[illegible]	—
at 10 mc/sec	—	.0005	—	—	—	—	.0017	.00275	—	—



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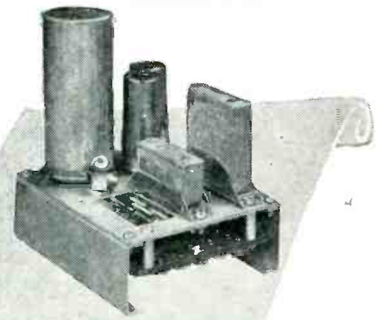

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By
Lieutenant Colonel David Talley
Signal Corps
United States Army Reserve

To provide direct person-to-person conversations between responsible personnel during emergency conditions, temporary interconnecting of wire lines to radio channels may be required until wire circuits are restored. This article describes briefly the construction and operation of a simplified four-wire radio, two-wire telephone termination set for such operation.

Circuits and apparatus described are based on standard commercial practices and design considerations. With proper audio-gain adjustments, speech levels should conform to wire-line transmission requirements providing there is no excessive interference.

Radio circuits are four-wire circuits, two wires to the transmitter input and two from the receiver output, and are essentially one-way devices. The telephone network operates on a two-wire basis and, in order that radio be used as an extension of the wire network, it is necessary to match the four-wire radio network into the two-wire telephone line.

If the radio circuit is operated on a push-to-talk or simplex basis, the connection may be made easily. Figure 1 illustrates one suggested method for a telephone line connection for simplex operation. It is desirable for transmission purposes that the radio receiver's output and the radio transmitter's in-

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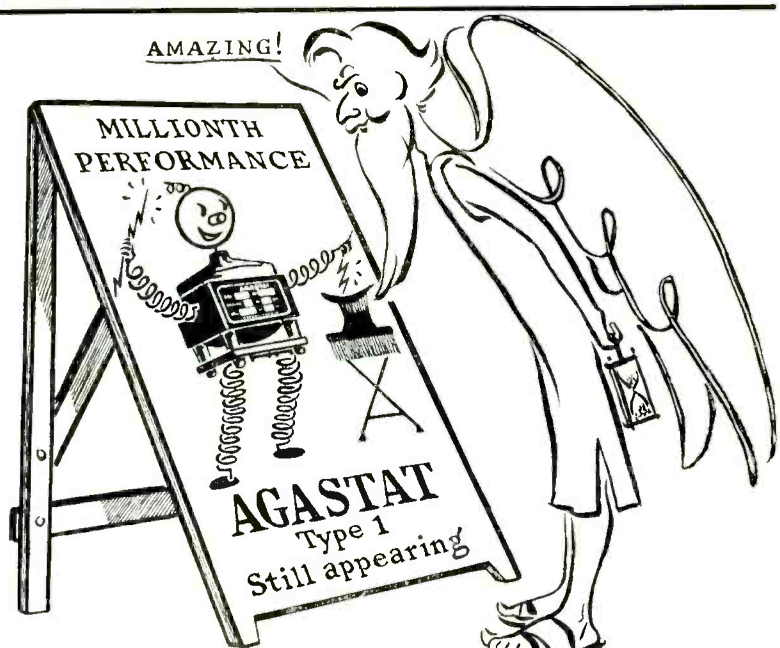

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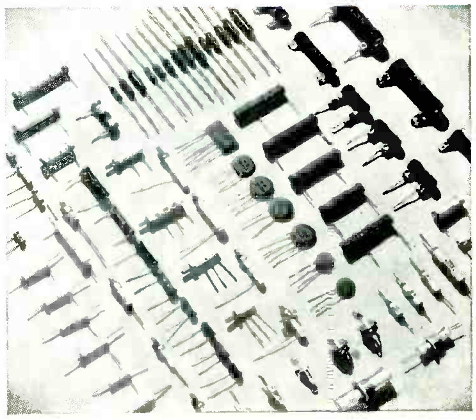

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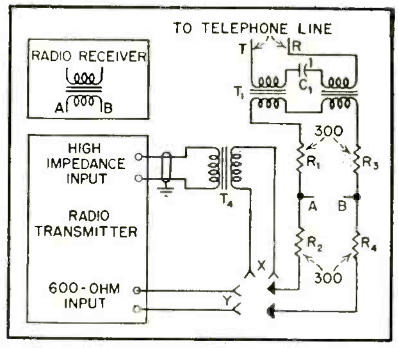

FIG. 1—Telephone line connection for simplex or push-to-talk manual switching facilities

put have terminal impedances of 500 or 600 ohms in order to match the telephone line.

In Fig. 1, the 300-ohm resistances, R_1, R_2, R_3 and R_4 form a dividing network. During reception, the audio output of the radio receiver is divided approximately equally between the input circuit of the radio transmitter and the winding of repeating coil T_1. The audio power in the transmitter's input is lost as the radio transmitter is inoperative. This audio loss is unimportant because the average communication receiver has output to provide more than enough audio to the telephone line including this 3-db loss.

When the transmitter is in operation, the input from the telephone line divides equally between the transmitter's input and the receiver's output circuit. The speech level from the telephone line should be sufficient to fully modulate the radio transmitter with normal gain adjustments. It may be necessary, however, to "ride the gain" to compensate for varying speech levels from the telephone line during the conversation period.

Full Duplex Method

Occasions may arise where the use of full duplex operations would be advantageous. This type of operation requires that the radio transmitter and receiver be connected to the telephone line in such a manner as to permit simultaneous conversations without switching the transmitter on and off. This method may be employed, for example, on the 2-and 11-meter bands where unmodulated carrier emissions are authorized. It also can be

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Volume Resistivity (D257-46), meg.-cms.	10^6-10^8
Dielectric Constant (D150-47T)	
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1,000 cycles	4.6-5.5
1,000,000 cycles	4.5-5.2
Power Factor (D150-47T)	
60 cycles	0.01-0.07
1,000 cycles	0.006-0.05
1,000,000 cycles	0.005-0.02
Loss Factor (D150-47T)	
60 cycles	0.05-0.46
1,000 cycles	0.03-0.28
1,000,000 cycles	0.02-0.10

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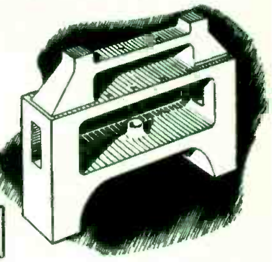

Properly molded, it is the top quality low-loss phenolic. Requires greater care in molding than other low-loss materials. Supplied on a "made to order" basis at slightly higher cost than the other materials.

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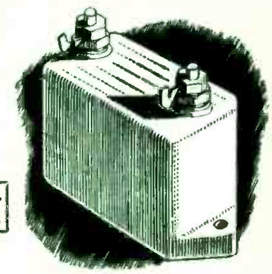
BM—16981 NATURAL "LOW LOSS" MATERIAL



Has exceptionally good electrical properties which are retained under moist service conditions. Easier to mold than BM-262, and somewhat lower in cost.

Typical uses: Electronic capacitors, resistors, and parts for radio, radar, X-ray and similar equipment.

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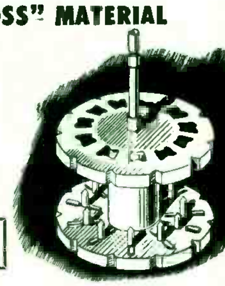
The black counterpart of this material is BM-17080.

BM—17748 NATURAL "LOW LOSS" MATERIAL



Has greater moldability than either BM-16981 or BM-262. Good electrical properties under moist service conditions. More stable dimensionally than most phenolic molding materials.

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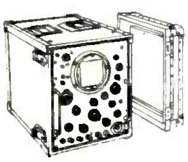
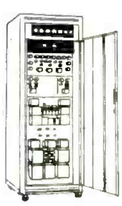


Special Test Equipment



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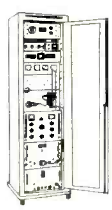

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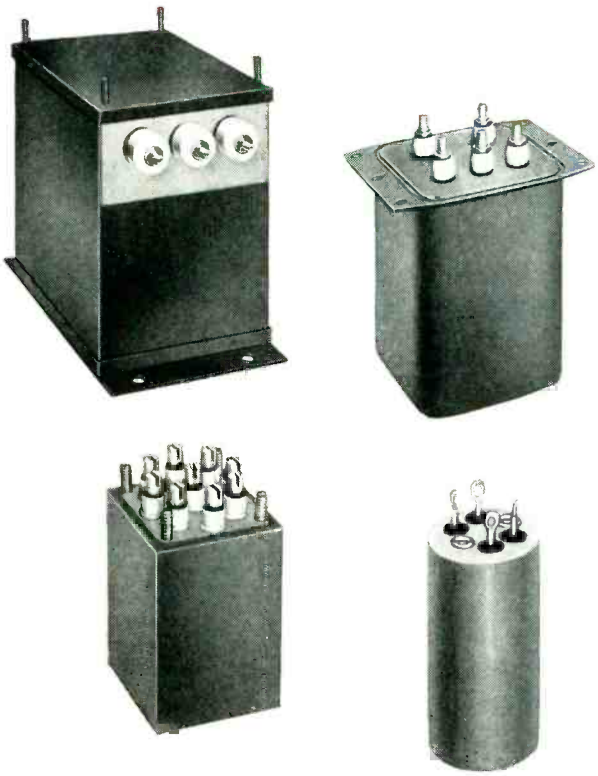

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For perfect balancing, it would be necessary to provide a special network for the particular telephone line which connects to the radio equipment. It has been found, for all practical purposes, that a compromise balance, as C_2, R_5, may be utilized to represent the average impedance of the telephone line. Sufficient audio gain values can be obtained with this balancing network for telephone operations and, at the same time, it will maintain a sufficient margin of safety below the singing point. To save space,

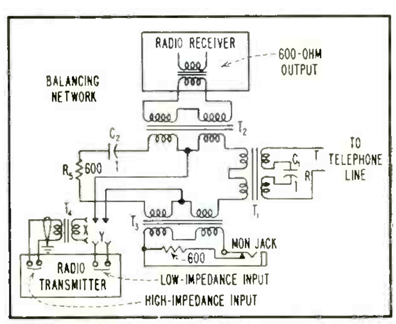
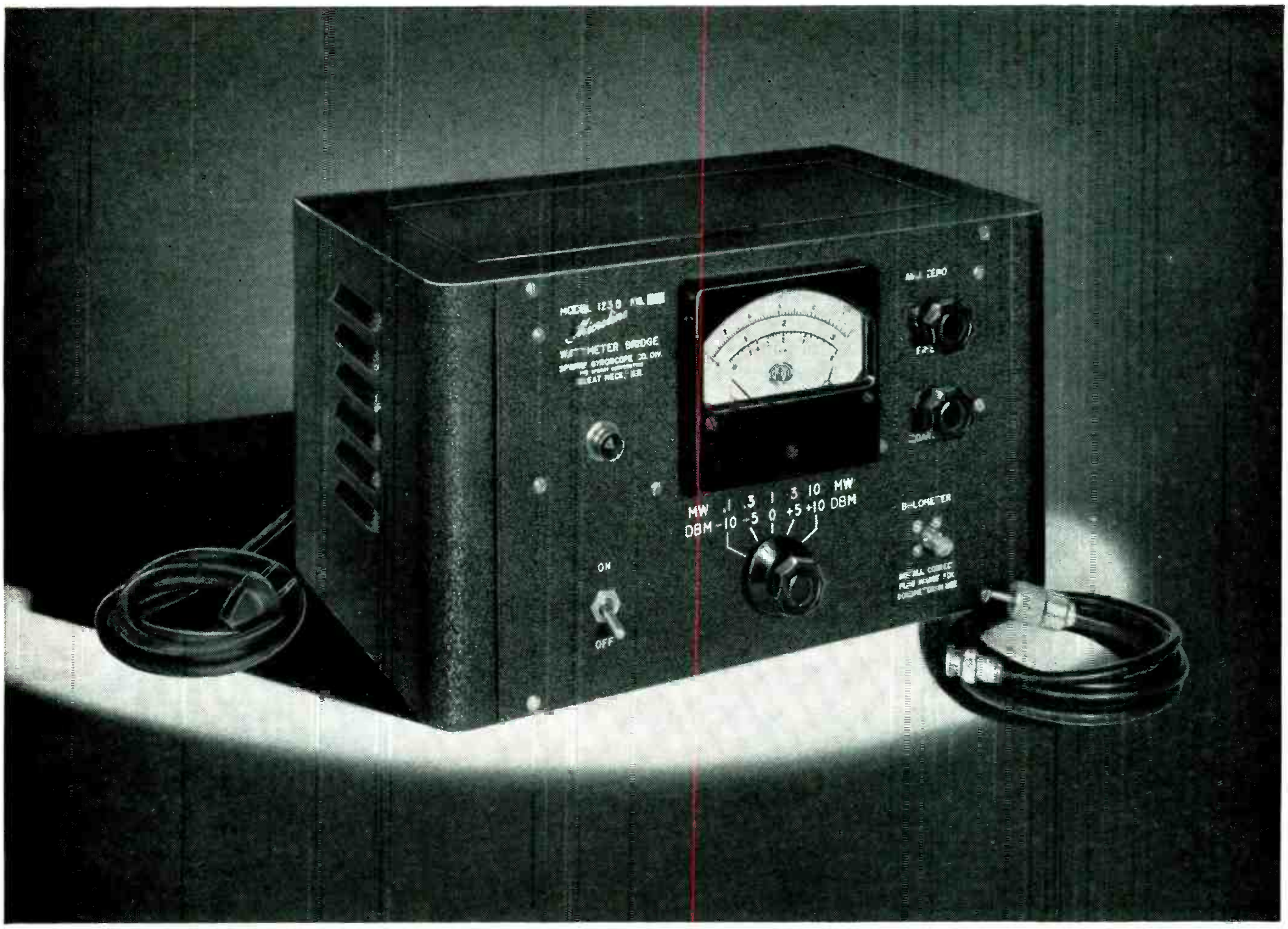


FIG. 2—Telephone line connection for full duplex operations or for initial simplex where duplex switching is planned for future use



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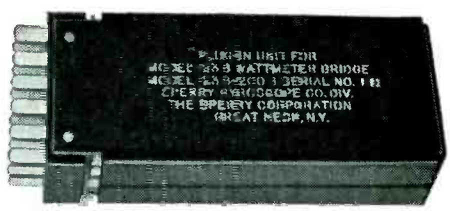

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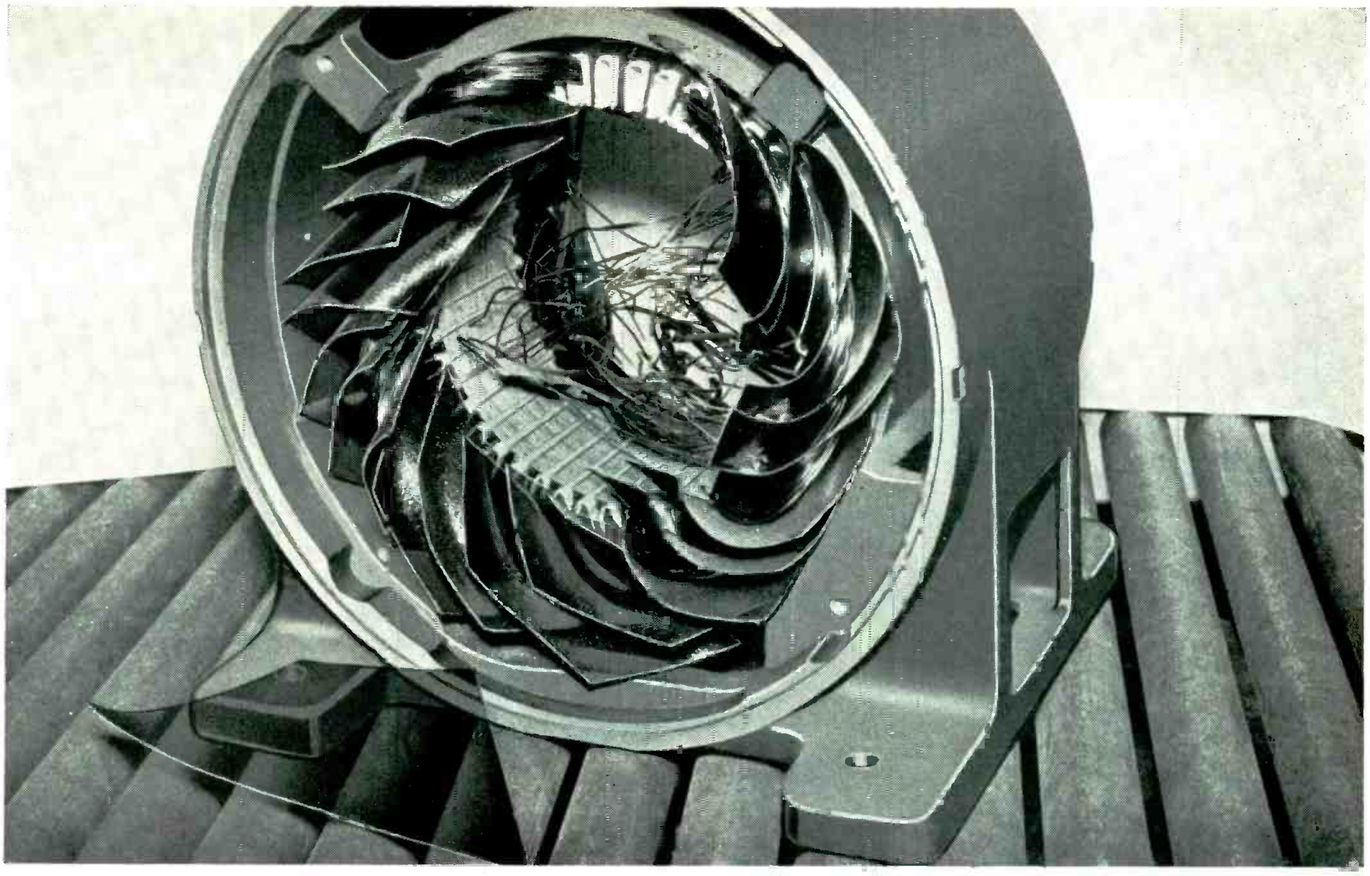

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the three transformers or repeating coils, T_1, T_2 and T_3 of Fig. 2, may be combined into one hybrid coil as shown in Fig. 3. The overall dimensions of such a hybrid coil are only about 3½ by 2 by 2 inches. The use of a single transformer of the multiwinding hybrid type makes it possible to assemble the entire four-wire—two-wire termination set on a 4 by 8-inch size panel.

Use of Monitoring Jack

The monitoring jack connected across the secondary winding of transformer T_3, Fig. 2, may be utilized for the following purposes:

(1) A pair of head-phones may be plugged into the jack to monitor the communication channel.

(2) A db meter, vtvm, or similar device may be inserted to measure the relative audio levels and to check the balance of the hybrid termination. These instruments should be terminated in 600 ohms (if not so designed) in order to obtain accurate measurements.

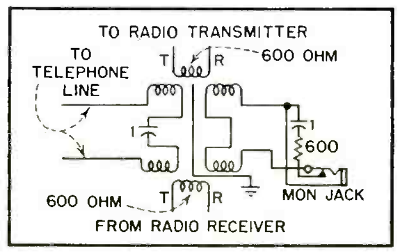

FIG. 3—Duplex switching connection with the repeating coils combined into one hybrid coil

(3) Another telephone circuit can be connected to the monitoring jack for a conference circuit.

Audio Level Adjustments

Most radiotelephone transmitters used at amateur radio stations are designed for use with high-impedance microphones of the crystal, dynamic or similar types. These microphones have a low-level output, usually in the order of −30 db to −55 db. The speech input from the ordinary telephone line ranges from about 0 db to −20 db. It is necessary, therefore, to reduce materially the gain of the speech amplifier of the radio transmitter. In this connection, the amplifier gain control should be adjusted for full modulation of the radio transmitter

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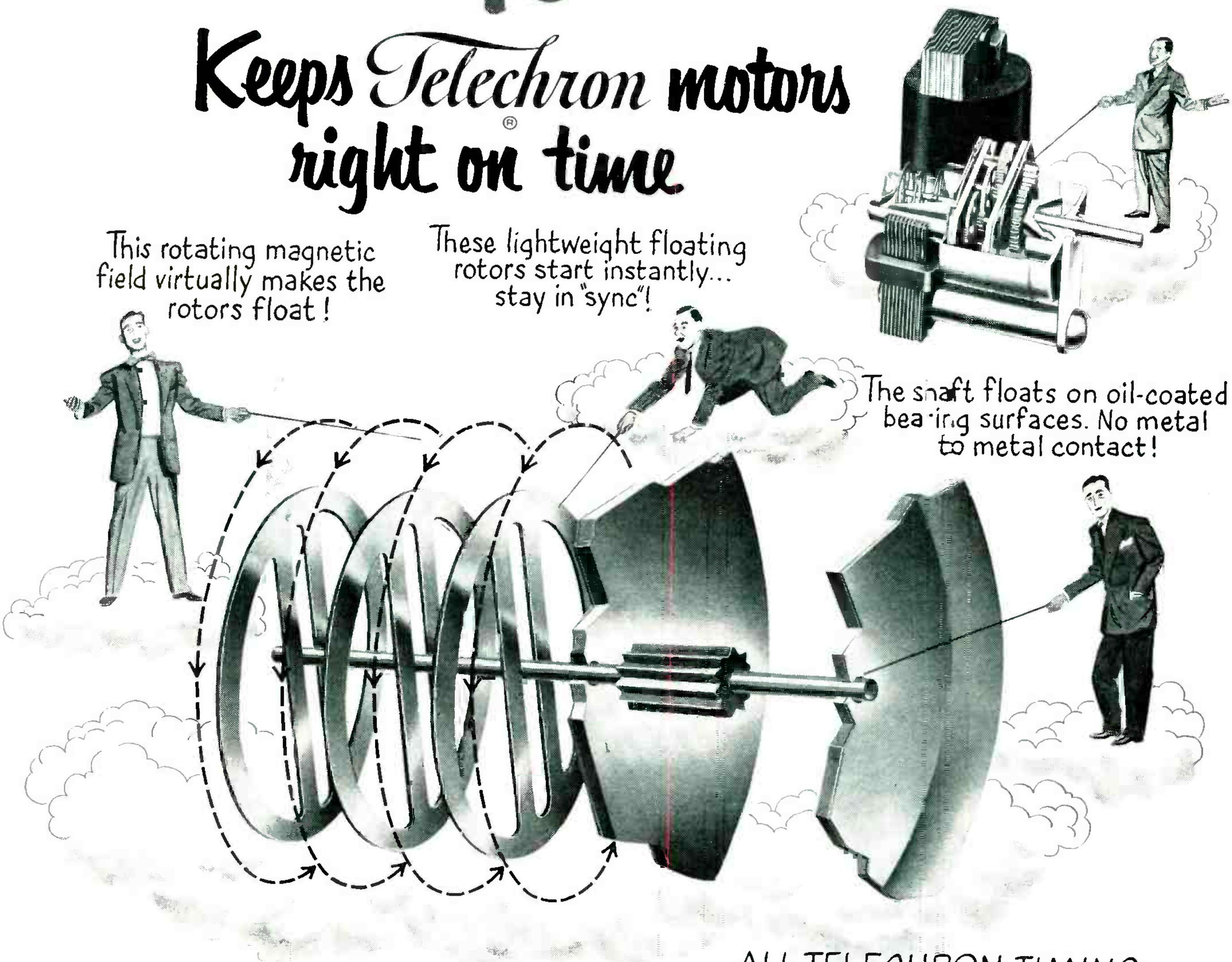

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Telechron timing motors have an outstanding record of accurate performance. The more than 50,000,000 Telechron motors used in instruments, timers, electric clocks, cost recorders, cycle controllers, etc. in the past 30 years are your assurance of perfect satisfaction. And remember, the world-wide recognition of Telechron Inc. in the timing field also adds a valuable sales feature to your product. Why not talk your timing problems over with a Telechron application engineer? In the meanwhile, write for Bulletin IS-110 for torque ratings and other up-to-the-minute data on Telechron synchronous motors and instrument movements. TELECHRON INC. A GENERAL ELECTRIC AFFILIATE.

READ ALL ABOUT FLOATING ACTION IN THIS BULLETIN

TELECHRON INC.
43 Union Street, Ashland, Massachusetts

Please send me Bulletin IS-110 which gives torque ratings, specifications and other application data on Telechron synchronous motors and instrument movements.

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Company ....

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on the incoming speech from the telephone line. This usually requires the operator to ride the gain of the transmitter on a connection to the telephone network.

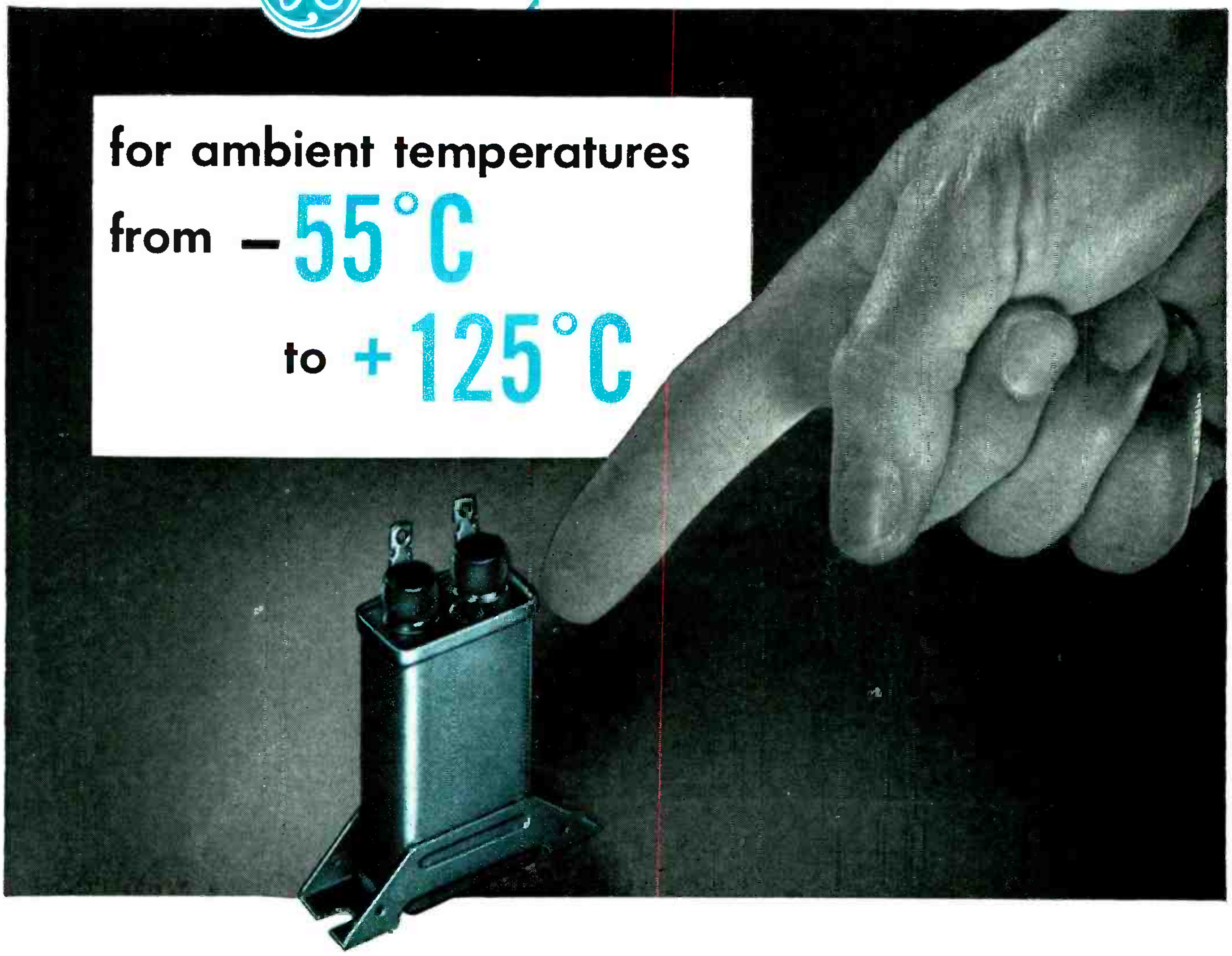
During the reception period, the volume control of the radio receiver should be adjusted to give sufficient audio level to the telephone line, corresponding to average speech conditions. Telephone companies usually require that audio inputs to their lines from amplifying devices should not be greater than about +8 db, based on 12 mw reference and care should be taken not to exceed this value. Crosstalk may be present in telephone cables at high audio levels and this condition must be avoided at all times. It is suggested that a db meter or v-u meter, terminated in 600 ohms, be bridged across the tip and ring of the telephone line to check the audio level from the radio receiver. The volume control of the receiver should be adjusted for optimum operation, exercising care not to exceed the 8-dbm level on average peaks. A vtvm or db meter also may be connected to the monitoring jack to monitor levels after the initial adjustments are made and reference values established.

Repeating Coils

The repeating coils or transformers described are standard types made by telephone manufacturing companies. It is possible to utilize Army surplus types in place of transformers T_1, T_2 and T_3, Figs. 1 and 2. The Signal Corps type coil C-161 or repeating coil C-112 may be substituted for T_2 and T_3.

If a type C-161 coil is used in place of repeating coil T_1, it is desirable to install a dpst switch to disconnect this coil from the telephone line when not in use because this type of repeating coil has no split windings for the insertion of a 1-μf d-c blocking capacitor across the telephone line. It is not advisable to insert a series blocking capacitor because of the resultant mismatch and distortion introduced in the telephone circuit.

This article was abstracted from a paper entitled "Extending Radio Circuits To Wire Line Facilities for Emergency Communications", Permafil D-C CAPACITORS



General Electric Permafil capacitors are designed for use at extremes in temperature—in high ambients—or in high altitudes where extreme cold is encountered. They are suitable for all blocking, by-pass and filtering applications.

These capacitors, while using paper dielectric, are treated with a plastic compound that retains its electrical stability at both high and low operating temperatures. Units are available in case styles CP-53, 61, 63, 65 and 70, as covered by specifications JAN-C-25—in ratings of .05 to 2.0 muf, 400 volts DC. Containers are metallic and are sealed with G-E long-life all-silicone bushings.

For full information on Permafil capacitors see your local G-E representative. Or write *Apparatus Department, General Electric Company, Schenectady 5, New York.*

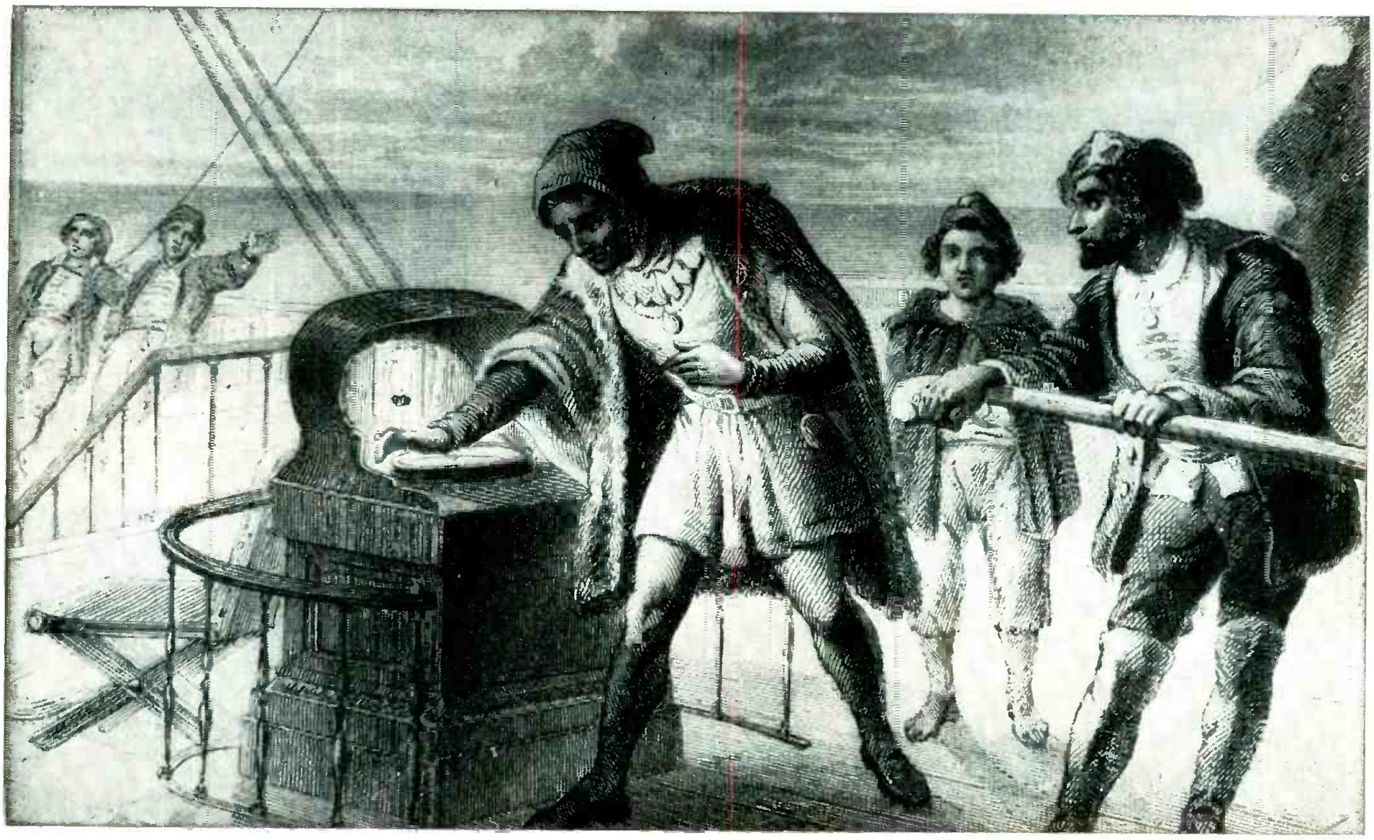
Where space or weight are especially important

Permafil capacitors will average about 1/10 the size and weight of liquid-filled capacitors when designed to operate at 125° C.

Where short-life characteristics are permissible additional savings in size and weight are possible. If you have a short-life capacitor application in mind, G-E engineers would like to discuss it with you.

GENERAL ELECTRIC

407-302



BETTMANN ARCHIVE

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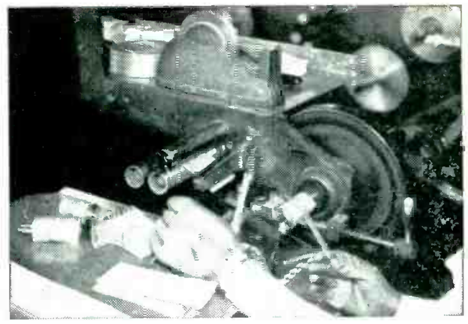
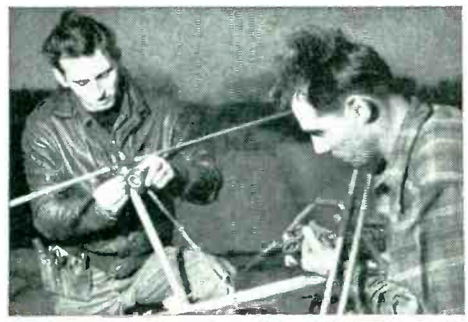
Shows you how TV manufacturers cut costs with "SCOTCH" Electrical Tapes

New booklet gives many time-saving uses of these modern, pressure-sensitive "SCOTCH" Electrical Tapes. Tells how high dielectric, mechanical strength and thin caliper equip these tapes for use in the manufacture, installation and maintenance of television sets.

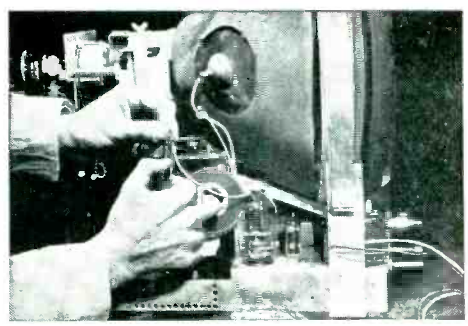
There are over 30 different tape formulations, many types of backings including plastic, acetate, cloth, treated paper. Get the details on how stick-at-a-touch "SCOTCH" Electrical Tapes are filling *every* TV taping need. Mail the coupon below to Dept. ES351.



MANUFACTURING electrolytic condensers at The Magnavox Co., Fort Wayne, Ind. New high purity "SCOTCH" Electrical Tape No. 42 cuts corrosion and breakdowns.



INSTALLING antenna lead in with "SCOTCH" Electrical Tape No. 33. Plastic-backed tape seals out moisture—prevents snow and ghosts.



MAINTAINING TV with "SCOTCH" Electrical Tape No. 33 cuts repair time as much as 50 per cent. Leads are easily spliced. Difficult soldering is eliminated.

MINNESOTA MINING & MFG. CO., DEPT. ES351
SAINT PAUL 6, MINNESOTA

Please send copy of new booklet, "Tapes for Television."

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REG. U.S. PAT. OFF.
SCOTCH
BRAND
Electrical Tapes

which appeared in the April, 1950, issue of the *Military Amateur Radio System Bulletin.*

Vibrator Power Supplies for Railroads

By L. R. THOMAS
Electronics Engineer
Atchison, Topeka and Santa Fe Railway
Chicago, Illinois

TO OPERATE communication services on rolling stock and between rolling stock and fixed locations, the Atchison, Topeka and Santa Fe Railway Co. has installed vibrator power supplies working off the starting battery of diesel engines. By this means, direct voltages of 32, 64 and 110 volts are converted to 110-v 60-cycle alternating voltage.

The heart of the vibrator-inverter circuit, Fig. 1, is a tandem heavy-duty vibrator carrying four independent power-handling circuits and duplicate independent driving circuits. A spare vibrator is also included which is switched in automatically upon failure of the operating unit.

The vibrator uses precision-ground ceramic spacers and is shock mounted within its case to permit acurate functioning of the vibrator in any position and under extreme conditions of vibration, heat and shock. The vibrator is a plug-in type and is arranged on the equipment so that it is easily accessible when replacement is necessary.

Full use of the four power-handling circuits is available. Each contact pair is permitted to operate independently of the other contacts

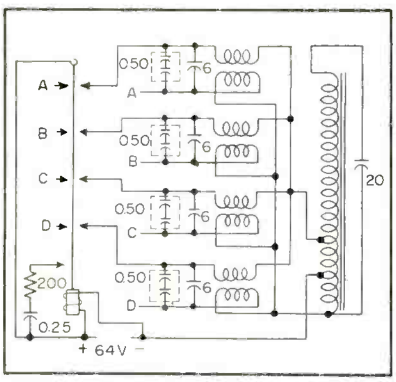

FIG. 1—Simplified schematic of the 64-v vibrator power supply showing the four independent power handling circuits. The auxiliary vibrator is connected in parallel with the one shown. Note the coupled reactors

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STAMFORD CONNECTICUT

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NOW! *A Better Frequency Standard Crystal*

THE JK G-9

- ★ Absolute Hermetic Sealing
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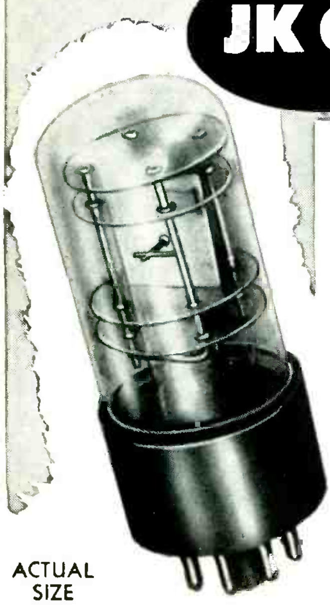
- ★ Higher Q
- ★ No Supersonic Reflections
- ★ Greater Stability



ACTUAL SIZE

JAMES KNIGHTS takes pride in presenting the JK G-9, first of a series of new crystals employing a glass envelope for absolute hermetic sealing. A dependable vacuum can be maintained, resulting in higher crystal Q and absolute freedom from the effects of supersonic reflections.

Although now available only in limited quantities and only in the 90 to 200 KC range, it is planned to use this mounting on higher frequencies.

Excellent thermal insulation is afforded by the glass and vacuum, utilizing the principle of the thermos bottle. In oven operation, for instance, a thermostat cycle of several degrees will result in a change of only a fraction of a degree at the crystal—providing stability never before possible!

LESS CRYSTAL "AGING"—Greater cleanliness is achieved in the new JK G-9 because glass is not porous and does not de-gas as does metal. Temperatures that would be destructive to the characteristics of a crystal are necessary for complete de-gassing of metal holders, whereas clean glass holders are relatively easy to de-gas. Because no fumes are emitted by the sealing operation, crystal "aging" is substantially reduced.

With minimum power dissipation, as employed in modern oscillator design, the new JK G-9 provides a new standard of stability plus years of trouble-free precision operation.

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The James Knights Company
SANDWICH, ILLINOIS

Specify JK for civilian, military or amateur use!

Boost Production

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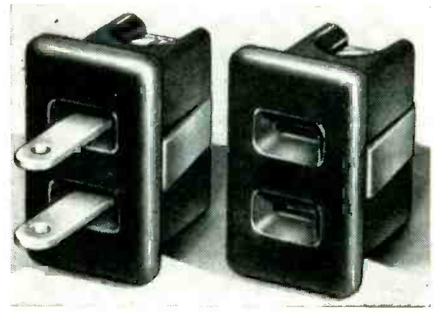
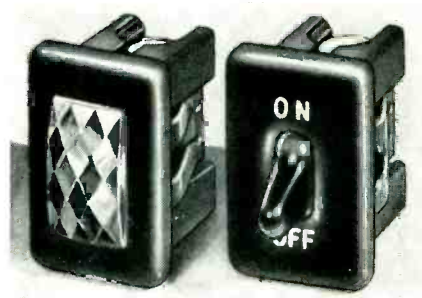


WITH

"DIAMOND H" SNAP-INS



***Save Man Hours** — toggle switches, pilot lights, convenience outlets and interconnecting load plugs just snap into their holes. Wire them up before or after. Spring clips hold them firmly and permanently. Wide flanges eliminate need for exacting tolerances in finish around installation holes.

***Get Peak Performance** — simple in design, rugged in construction, "Diamond H" Snap-Ins are built to give positive, unfailing action under demanding service conditions.

Switches, both single and double pole, have contacts held together under positive spring action in "on" position. Rated 12 and 20 A, 125 V; 10 A, 250 V., A. C., and also available with horsepower ratings. Pilots, rated 115 V or 230 V, A. C., have large faceted lenses to give greatest light output of any comparable pilots on the market. All available in black, white, brown or special color plastic.

Write today for complete details.

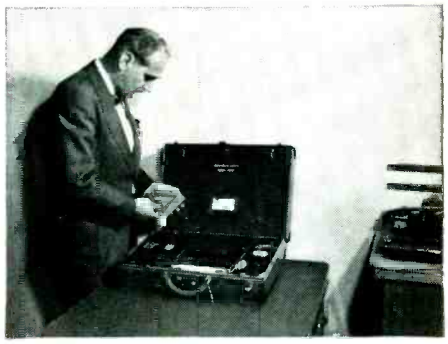
THE HART MANUFACTURING COMPANY
202 BARTHOLOMEW AVENUE
HARTFORD, CONNECTICUT

GE Instrument NEWS

VIBRATION INDICATOR PROVES VALUABLE INSPECTION TOOL

The Mutual Boiler and Machine Insurance Company of Boston, Massachusetts, established 1887, is now using the General Electric lightbeam-type vibration indicator extensively in its regular inspections of insured machinery. The company considers this easy-to-read and highly accurate (±3%) indicator to be an important instrument in the $1000 test kit used by its field personnel.

In general, every piece of rotating equipment insured by Mutual is given three inspections a year. Since excessive vibration in this type of equipment is one of the surest signs of trouble, it is a major consideration in determining whether a particular machine is a good insurance risk. Mutual's engineering department tries to maintain a vibration amplitude of not more than two mils as a standard for insured, high-speed rotating machinery.



In making vibration measurements, Mutual frequently uses a mass/weight system. But in nearly all cases, the G-E vibration indicator is used as the final authority. Mutual engineers, reporting highly satisfactory results, say that the G-E vibration indicator has proved ideal for their purposes.

G-E Magnetic Thickness Gage Aids Paint and Resin Studies

The General Electric Type B magnetic thickness gage, a portable instrument for measuring the thickness of nonmagnetic material on a magnetic surface, is now being used by the G-E Chemical Department in the development of new paints and alkyd resins for industrial finishes.

The gage is proving particularly valuable for checking and controlling the thickness of the many paint and resin samples constantly being tested. Since the tests are designed to reveal the wearing and covering characteristics of one sample in relation to the characteristics of the other samples, uniform sample thickness is essential.

With its high sensitivity, the magnetic thickness gage gives readings well within the required degree of accuracy. Because it measures magnetically, it does not in any way deface the samples. And because of its small size and light weight, it is always available for on-the-spot use.

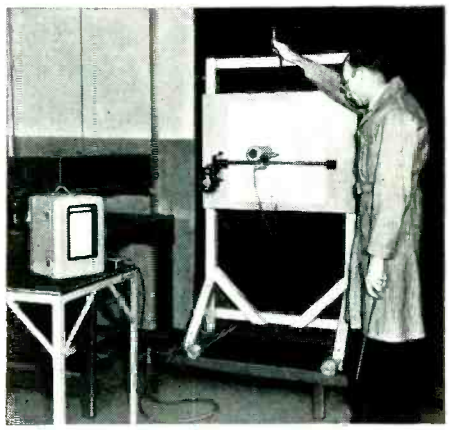
Carbon-arc Intensity Tests Made with Type C-E Recorder

In line with its policy of constantly searching for new ways to improve its products, the National Carbon Division of the Union Carbide and Carbon Corporation, New York, has for some time been using a General Electric Type CE photoelectric recorder in its carbon-arc intensity tests.

These tests, conducted at the National Carbon Research Laboratories, Cleveland, are designed to give precise indications, in microamperes, of the light intensities of various carbon arcs.

At one end of a twelve foot room, the illuminated carbon crater is placed in a test lamp directly behind a lens of 25.4:1 magnification (thus making one inch at the image equal to one millimeter at the source). At the opposite end of the room, a photocell, driven along a transverse rod by a small synchronous motor, picks up the arc light at different angles of deflection. The photocell is connected to the G-E photoelectric recorder, which writes a continuous and permanent record of light intensity.

The National Carbon Division chose the G-E recorder because of its extremely high sensitivity. In these tests, it can record intensities as low as 1 microampere and as high as 500 microamperes.



The G-E recorder weighs only 35 lbs. and is available for either portable use or semi-flush mounting. Its response can be as fast as ¼ sec. for full-scale deflection.

SECTION A602–199
APPARATUS DEPARTMENT
GENERAL ELECTRIC CO.
SCHENECTADY, N. Y.
Please send me information on the following products:

- ☐ Lightbeam-type vibration indicator (GEA-4140)
- ☐ Type CE photoelectric recorder (GEC-254)
- ☐ Type B magnetic thickness gage (GEC-319)

NAME ....
COMPANY ....
STREET ....
CITY .... ZONE .... STATE ....

GENERAL ELECTRIC

602-199

in assuming its share of the total load even though there may be an appreciable difference in exact time of closure of contact pairs which apparently are operating simultaneously. This is accomplished by each of the four side reed contacts operating through individual reactor windings which are coupled with the opposite side reed contact.

The vibrator is adjusted to provide 60-cycle operation ± one-half cycle and output regulation is within ± 5 percent with an input voltage variation of 15 percent.

Automatic transfer from the operating vibrator to the spare unit is accomplished as follows: As soon as one of the pair of vibrator contacts has worn through the tungsten contact-facing material, operation of the contacts draws an arc from the soft metal backing supporting the contact surface. The arc builds up until one of the pair of contacts is welded together, which in turn shorts out the input and blows the input fuses. The transfer circuits are then set in operation and the effective vibrator is automatically removed from the power circuit. The new vibrator takes over after a protected period of several seconds provided by a relay.

The transformers and reactors in the unit are made with class-B insulating materials which permit continuous operation to temperatures as high as 150 C. All capacitors are oil impregnated and hermetically sealed.

Vibrator Life

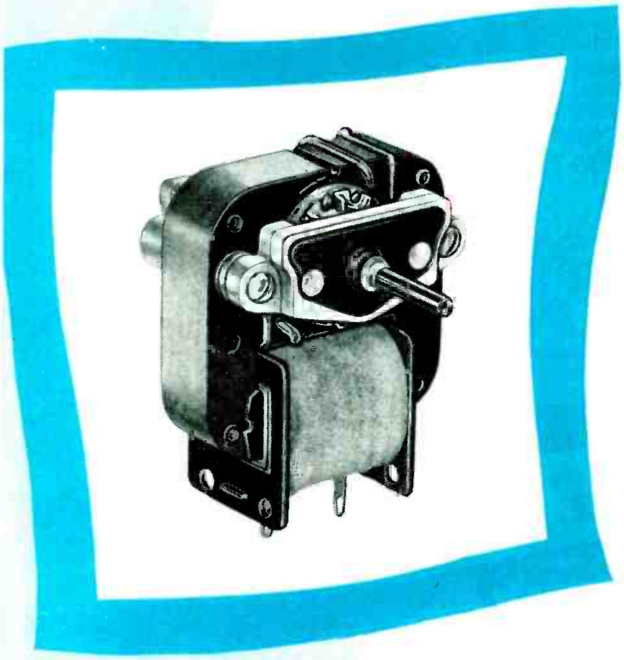
The normal life of the vibrator in service on switch engines has been between 60 and 90 days on a 24-hour 7-day-per-week basis. The life on diesel road locomotives runs approximately 90 to 120 days because the units are turned off for greater lengths of time. Life of vibrators on cabooses has been about six months or greater.

Maintenance of the vibrator equipment is much less than that of the rotary inverter. An additional advantage is obtained in that service is never completely lost with this type of equipment. If the defective vibrator is replaced after the automatic switchover has been made the interruption to radio

RAYTHEON

fractional hp motors

dependable performance

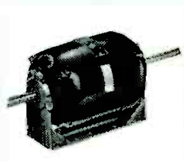


TYPE 230 Shaded 2-pole Motor. For continuous duty without fan cooling. 1/200 to 1/50 hp at 3200 rpm. Flat Speed Torque Curve and High Starting and Pull Up Torque are characteristic of all Type 230 Raytheon motors. Efficiency is almost double the value ordinarily obtained in shaded two-pole motors of this type. Write for Data Bulletin 1000.

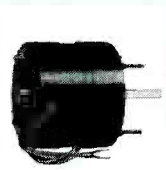
"Count on Raytheon to run it." Design engineers have learned to rely on Raytheon fractional hp motors when they want to *run* things—for example, FANS, BLOWERS and AIR CONDITIONING EQUIPMENT.

Raytheon Creative Craftsmanship assures *Dependable Performance* at the shaft—the kind of trouble-free power unit that manufacturers need in today's competitive markets.

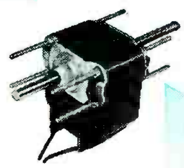
Call in your Raytheon representative for consultation on your specific application.



RAYTHEON Type 470 Shaded 6-pole, 1050 rpm Induction Motor.



RAYTHEON Type 330-S Shaded 4-pole 1/200 to 1/10 hp 1550 rpm motor.

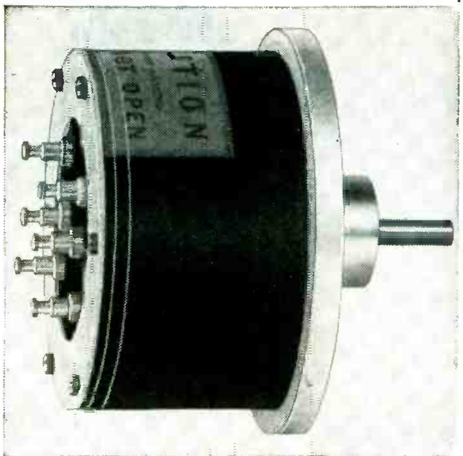


RAYTHEON Type 350 Shaded 2-pole, 1/40 to 1/6 hp at 3000 rpm motor.

QUALITY
PRECISION

RUSSELL ELECTRIC COMPANY
SUBSIDIARY OF RAYTHEON MANUFACTURING CO.
4501 So. Western Boulevard Dept. C-24 Chicago 9, Illinois

PRECISION POTENTIOMETERS



Various types of potentiometers custom wound to specifications are available. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life.

All types will operate within specified limits of performance at temperatures —55° C. to +55° C., 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and specifications.

A minor modification of the standard sinusoidal potentiometer type RL-11-C (as illustrated) permits operation up to 1800 RPM. After a test of 28 million cycles at 1800 RPM, one of these units showed negligible wear.

Write for Bulletin F-68.

THE GAMEWELL COMPANY

Newton Upper Falls 64, Massachusetts

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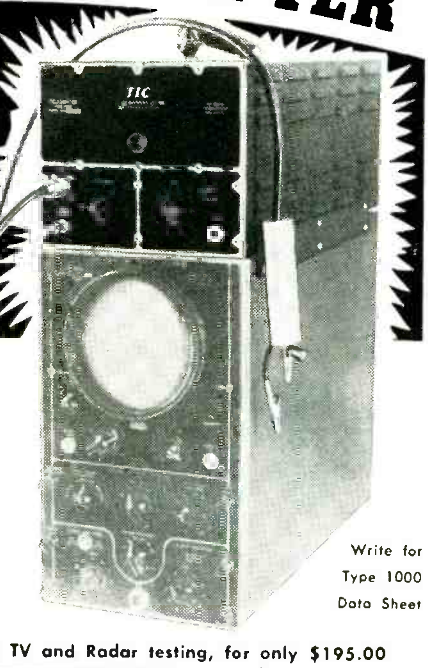
- **TELEVISION WAVE FORM OBSERVATION**
- **RADAR PULSE**

LOW PRICED AT $195 F.O.B. PLANT



- Converts a DuMont 208 or 304 Scope for use with TV and Radar pulse type signals. Response 3 db down at 5 M.C.
- Completely self-contained including power supply. No modifications to the 208 or 304 Scope required.
- Size matches both Type 208 and 304 scopes and tie plates are furnished to fasten both instruments together.

Write for Type 1000 Data Sheet

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HOLTITE screws are made in all types, sizes, metals (especially stainless steel) and finishes required in electronic equipment. Special fasteners are made, on order, exact to specifications, samples or prints.

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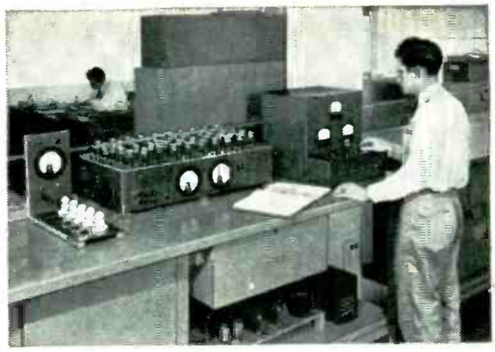
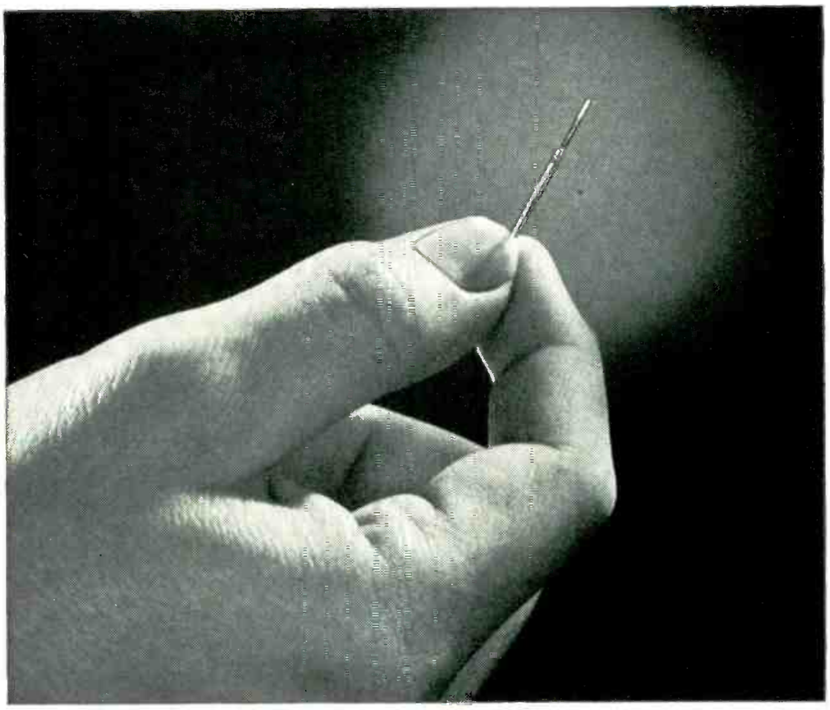
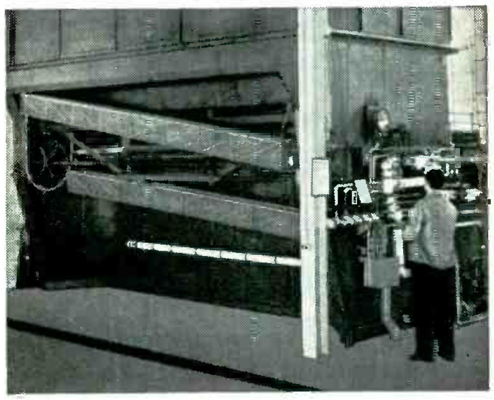
New Bedford, Mass. U.S.A.

Trim Assembly Time with the Tube with the Tab

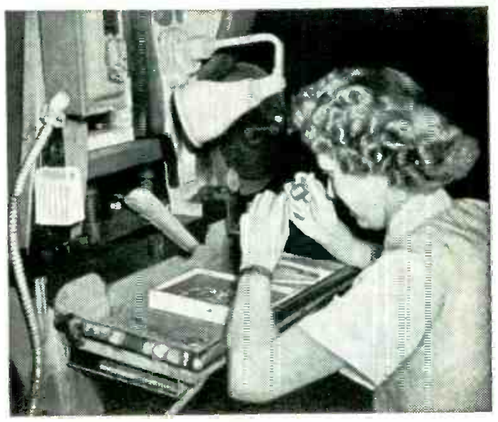


Electronic Engineering — Life test rack and emission test set. Checking Superior assembled standard diodes under simulated customer conditions to determine if material meets minimum requirements.





To guard against contamination by processing lubricants, Superior tubing is thoroughly degreased before each annealing operation.



Part of inspection procedure on Lockseam Nickel Cathodes as they come off the production machine. Each cathode must undergo many rigid tests before being approved.

● Superior's pioneering in tubing technology is constantly at work to bring electronic manufacturers new developments—to help them produce better equipment, faster, at lower costs. Newest of these improvements is the integral tabbed round Lockseam* cathode. It is designed to eliminate a welding operation, cut assembly time, and provide superior performance.

These integral tabbed round Lockseam* cathodes may be valuable to you . . . but whether they are or not one thing is sure. If you use Seamless or Lockseam* cathodes in your product a Superior tube is available to do a Superior job. Our research and engineering facilities are ready at all times to help solve your tubing problems.

For more information about Superior Tubing and its possible place in your operation write to Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

Which Is The Better For Your Product . . .

SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010″ to .121″ O.D. inclusive, with wall thicknesses of .0015″ to .005″. Cathodes with larger diameters and heavier walls will be produced to customer specification.

Or LOCKSEAM* . . . ? Produced directly from thin nickel alloy strip stock, .040″ to .100″ O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.

Certain analyses (.035″ max. wall) Up to 1⅛″ O.D.

**Mfd. under U. S. Pats.—SUPERIOR TUBE COMPANY • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey.*

service is a matter of approximately one to two minutes for each vibrator failure.

Facsimile Reproduction for AEC Library Service

FULL REFERENCE library service will be provided to outlying atomic research laboratories as a result of a new high-speed long-distance facsimile system recently installed at the Oak Ridge National Laboratories of the Atomic Energy Commission.

The new system, developed by the Radio Corporation of America Laboratories, incorporates several innovations in the field of facsimile reproduction. The reader-transmitter, Fig. 1, will scan printed copy or drawings on flat surfaces such as book pages and will make direct enlargements of material in small type by any ratio up to 4 to 1.

The copy bed can handle individual sheets or books up to three-inches thick. The signal is transmitted over an ordinary telephone line and the recorder will reproduce clear and legible black-on-white copy at a speed of 15 linear or 128 square inches per minute.

The new system promises to cut down expensive outlay for new books and will also prevent possible contamination of books and journals

FIG. 1—Reader-transmitter of the test model of the new RCA facsimile system being prepared for operation by Roger Olden, research engineer. Operation of the transmitter is monitored by the oscilloscope on the right panel

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MEETS THE MOST EXACTING SPECIFICATIONS!

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Why Pay More?

ALSO USED WIDELY BY MANUFACTURERS OF ELECTRICAL EQUIPMENT . . . FOR ITS HIGH DIELECTRIC STRENGTH . . . LOW MOISTURE ABSORPTION . . . STRENGTH, LOW LOSS AND GOOD MACHINEABILITY.

AVAILABLE IN DIAMETERS, WALL THICKNESSES AND LENGTHS TO MEET ENDLESS SPECIAL OR NEW ADAPTATIONS.

INQUIRIES ARE GIVEN IMMEDIATE ATTENTION.

ASK FOR SAMPLES.

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Grade E. . . . . .Improved post cure fabrication and stapling.
Grade EX. . . . . .Special grade for TV deflection yoke sleeve.
Grade EE. . . . . .Improved general purpose.
Grade EEX. . . . . .Superior electrical and moisture absorption properties.
Grade EEE. . . . . .Critical electrical and high voltage applications.
Grade XAX. . . . . . . .Special grade for government phenolic specifications.

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Grade SP. . . . . .Post cure fabrication and stapling.
Grade SS. . . . . .General purpose.
Grade SSP. . . . . .General purpose—punching grade.
Grade SLF. . . . . .Thin wall tubing—high dielectric and compression strength.

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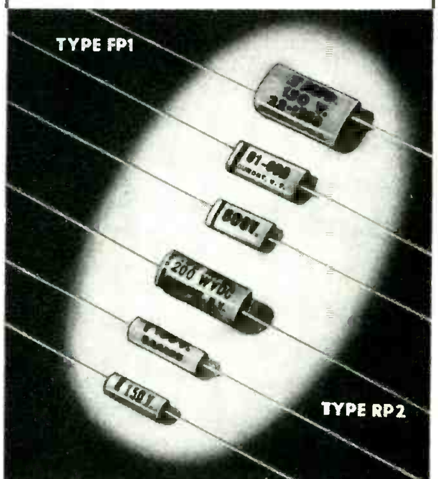

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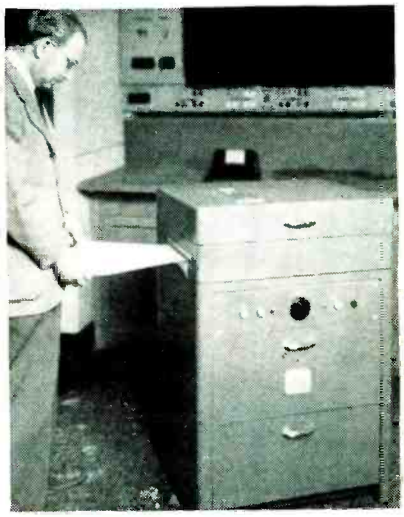

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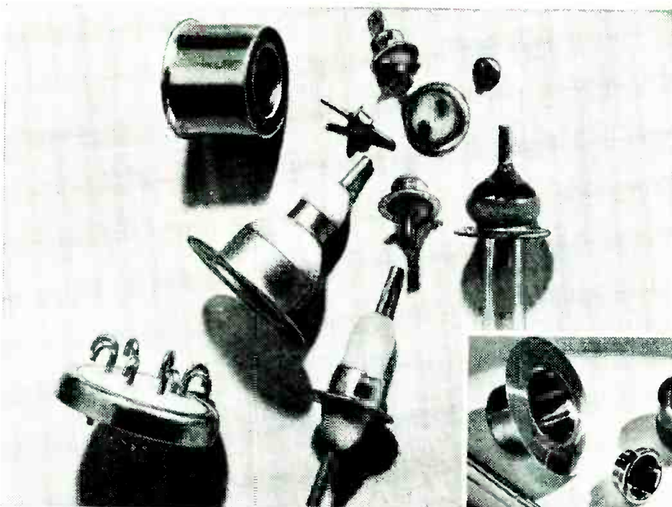

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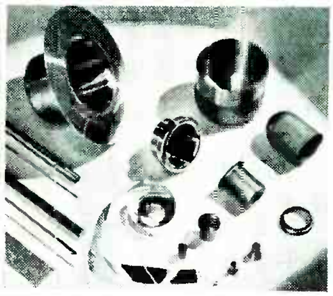

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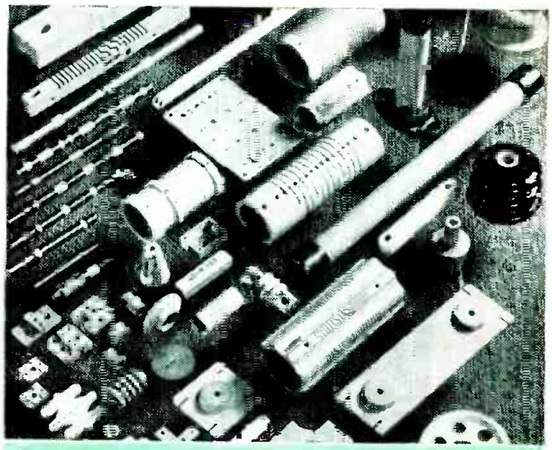

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(continued from p 142)

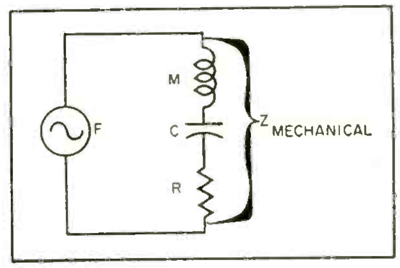


FIG. 1—Electrical analog of loudspeaker

which electrical circuit constants relate the current to the applied voltage. It is therefore possible to write the equation.

$$F = Z_{MECH}\, v$$

where F is applied force, v is velocity, and Z_{MECH} is the mechanical impedance, given in this particuler case by

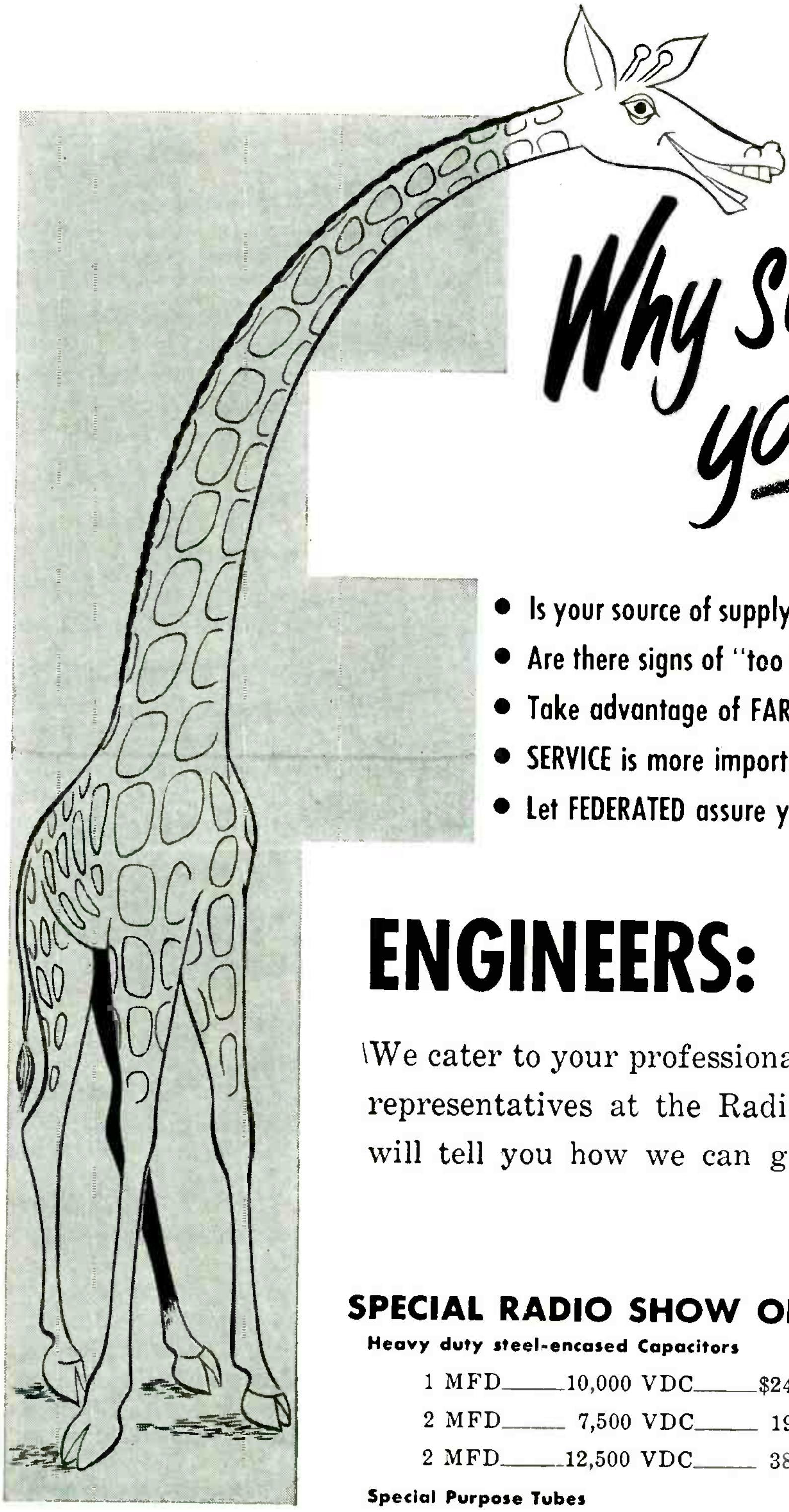
$$Z_{MECH} = R + j\left(\omega M - \frac{1}{\omega C}\right)$$

The force acting on the mechanical system is produced by the flow of current in the voice coil. On the other hand, motion of the voice coil in the magnetic field produces a counter emf in the electrical circuit which can be represented as a voltage drop across a fictitious impedance Z_{MOT} called the motional impedance.

From the electrical point of view it is therefore possible to draw an equivalent circuit as shown in Fig. 2. In this figure the amplifier is represented by an equivalent generator E in series with the effective internal impedance Z_i. The loudspeaker is represented by the electrical impedance of the voice coil Z_{vc} in series with the motional impedance. As will be shown, Z_{MOT} is proportional to $\frac{1}{Z_{MECH}}$ and therefore has the characteristics of a parallel resonant circuit. It is convenient to lump Z_i and Z_{vc} into an equivalent driving source impedance Z_e. In general Z_e includes some reactance, but for the frequency range of particular interest the reactance is negligible compared to the resistance and can be ignored.

A more precise understanding of the effects of the electro-mechanical

[1] For a demonstration of this and an excellent discussion of electro-mechanical analogues see M. F. Gardner and J. L. Barnes, "Transients in Linear Systems", John Wiley and Sons, New York, 1942, Chapter II.



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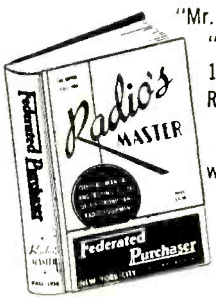

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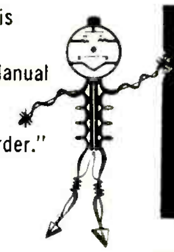

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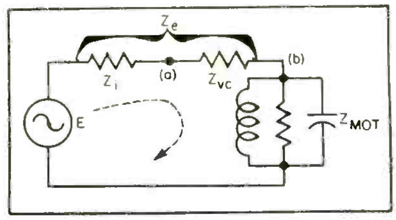

FIG. 2—Equivalent circuit of loudspeaker and driving amplifier

coupling between the mechanical system of the speaker and the electrical circuit of the amplifier and voice coil can be gained by considering the following equations.

$$Z_e i + \frac{Bl\,v}{10^8} = E \quad (1)$$

$$Z_{MECH}\, v = \frac{Bl}{10}\, i \quad (2)$$

Equation 1 is the voltage equation in the electrical circuit. The term $\frac{Bl\,v}{10^B}$ is the counter emf produced by the motion of the voice coil of length 1 cm in a magnetic field of strength B gauss with velocity v cm per sec. Equation 2 is the force equation of the mechanical system; the term $\frac{Bl}{10} i$ is the force in dynes exerted by the voice coil carrying i amperes. By solving for v in Eq. 2 and substituting in Eq. 1 we have

$$Z_e i + \frac{B^2 l^2}{10^9 Z_{MECH}}\, i = E \quad (3)$$

Equation (3) is the basis of the equivalent electrical circuit of Fig. 2. The second term on the left shows that $Z_{MOT} = \frac{B^2 l^2}{10^9 Z_{MECH}}$, and confirms our earlier statement concerning the nature of Z_{MOT}.

Although the effects of the driving source impedance Z_e can be analyzed from the electrical point of view shown in Fig. 3, it is more profitable to make the analysis from an equivalent mechanical point of view. If Eq. 1 is solved for i and the result substituted in Eq. 2 we obtain, after rearranging

$$Z_{MECH}\, v + \frac{B^2 l^2}{10^9 Z_e}\, v = \frac{Bl}{10 Z_e} E \quad (4)$$

This equation serves as the basis of the mechanical equivalent circuit of Fig. 3, in which the driving amplifier is represented as a force source of magnitude $\frac{Bl\,E}{10 Z_e}$ in series with an effective internal impedance $Z_s = \frac{B^2 l^2}{10^9 Z_e}$.

There are several reasons for

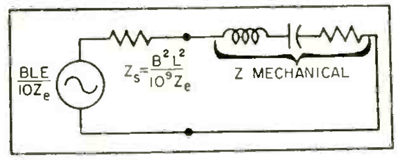

FIG. 3—Equivalent mechanical circuit of loudspeaker and driving amplifier

considering the speaker system from the mechanical rather than the electrical point of view. These are first, that speakers of comparable size all have approximately the same mechanical characteristics; second, that the magnetic gap strength and effective driving source impedance are conveniently accounted for because they effect only the element Z_s; and third, that the effects of baffles are most simply considered from the mechanical point of view. For example, a simple enclosure merely increases the effective stiffness and can be considered as a series capacitor in the mechanical circuit.

In calculating the response of a loudspeaker by means of the circuit of Fig. 3 it must be remembered that the radiation resistance of a speaker in an infinite baffle or enclosure increases as the square of the frequency over the range of frequencies for which the speaker diameter is small compared to the wavelength. Most loudspeakers operate in this region for a range of several octaves in the vicinity of the resonant frequency. The low frequency response of a loudspeaker in an infinite baffle has been calculated for several different values of the impedance Z_s, and plotted in the curves of Fig. 4. The curves, which can also be applied to a speaker in a simple enclosure, give response as a function of the frequency relative to the resonant frequency. The magnitude of Z_s is given in terms of X_R, the reactance at resonance of the reactive elements in Fig. 3.

The curves of Fig. 4 indicate how important the impedance Z_s is in determining the response of loudspeakers. Curve *A* corresponds to a very small value of Z_s, and a mechanical Q of 10 for the speaker. The small value of Z_s might be the result of either a small value for *Bl* or a large value of Z_e. It is the type of response encountered, for example, when pentode tubes are

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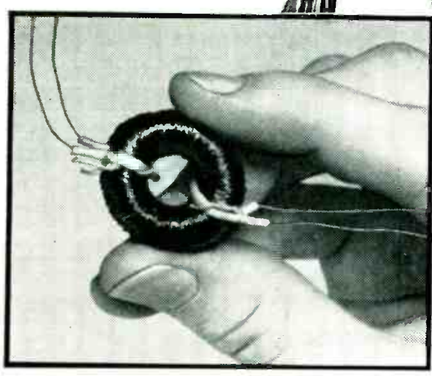

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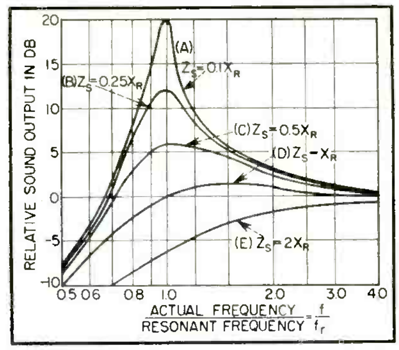

FIG. 4—Relative response of loudspeaker for different values of driving source impedance

used in the driving amplifier and no inverse feedback is employed to reduce the effective internal impedance. The pronounced peak in the response curve is responsible for the poor reproduction of transients which is sometimes described as poor speaker damping. The curves make it obvious that for uniform response and clean reproduction of transients the impedance Z_s should be quite high. This makes it imperative that Z_e be low. Triode tubes, when used in the output stage, provide a source of relatively low impedance, and this is one reason for the traditional preference for triodes. When using triodes the load is usually matched to the tubes in such a manner that the impedance looking back into the amplifier from the speaker is approximately equal to the voice coil resistance. Thus the impedance Z_e is equal to twice the voice coil resistance. By using pentode or beam tetrodes with sufficient negative voltage feedback it is possible to make the effective output impedance of the amplifier small compared to voice coil resistance. Thus Z_e can be made approximately equal to Z_{vc}. In other words, the speaker damping of pentodes with sufficient feedback is twice as good as that of triodes without feedback.

Since ordinary methods never permit the impedance Z_e to be reduced below the value of the voice coil resistance, the maximum value which can be achieved for Z_s is limited by the value of Bl. For speakers with small magnetic strucures this maximum value is still too low to result in appreciable improvement in the response obtained with a very high value of Z_e. Even

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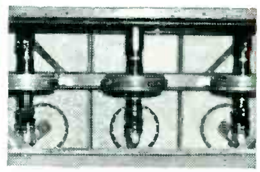

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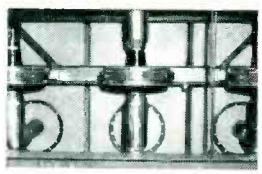

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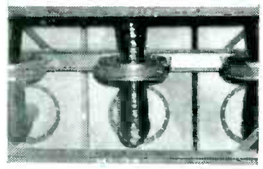

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with speakers having the largest magnetic structures supplied in the standard lines, the maximum value of Z_s which can be obtained is still considerably below the optimum value for the speaker in an infinite baffle. Thus, curve *B* corresponds closely to the response in an infinite baffle of an eight-inch speaker with a 6.8-oz. Alnico V magnet and a 3.2-ohm voice coil when driven by an amplifier with triodes in the output. It is apparent that optimum response, if achieved by conventional methods, requires the use of an amplifier having sufficient negative voltage feedback to reduce the internal impedance to a negligible value, and in addition, the use of a larger magnet than is obtainable in speakers of moderate cost. Investigation has also revealed that optimum values of Z_s for other baffles require larger magnetic structures than can be obtained in even the more expensive speakers.

The foregoing discussion indicates that a method for increasing the value of Z_s which does not require the use of excessively large and expensive magnetic structures would be of considerable value. The remaining portion of this paper outlines such a method.

Motional Feedback

Optimum response requires that for most speakers Z_e be made smaller than the voice coil resistance. Inspection of Fig. 2 makes it obvious that negative voltage feedback, applied in the customary fashion, cannot reduce Z_e below Z_{vc}. In conventional feedback amplifiers the feedback voltage is taken from point *a* in Fig. 2 and acts to reduce Z_i only. If a feedback voltage could be taken, instead, from point *b*, or from directly across the motional impedance, then Z_{vc} would be included in the feedback loop along with Z_i, and Z_e could then be reduced to any desired value. In other words, the feedback voltage must be a motional voltage.

The author has accomplished the result mentioned above in a very simple manner by winding a separate feedback coil of very fine wire over the existing voice coil in a conventional speaker. The voltage

induced in this coil by the motion of the voice coil is a pure motional voltage at most frequencies. This voltage, used as a feedback voltage, permits reducing Z_s below Z_{vc}. The method has the additional advantage of including nonlinearities of the cone suspension in the feedback loop and reducing distortion from this cause. Also, by proper design of the feedback coil, nonlinearities due to fringing of the magnetic field are included in the feedback loop and the accompanying distortion reduced with no loss in magnetic efficiency of the speaker.

At very high audio frequencies some difficulty is caused by the mutual inductance between the driving voice coil and the pickup coil. The mutual inductance produces in the feedback voltage a component which is dependent on the induction between the coils rather than on the motion alone. This voltage of induction is very small at most frequencies but becomes quite large at the higher frequencies, and, unless compensated for, results in attenuation of high frequencies. This difficulty is overcome by placing additional mutual inductance of opposite sign between the voice coil and feedback circuits at a point external to the magnetic field. Voltages of induction which are equal and of opposite sign are thus produced in the feedback circuit and cancel, leaving a pure motional voltage as the feedback voltage. It is therefore possible to design as a unit an amplifier-speaker combination, such as the one shown in Fig. 5, of superior performance. Table I, which is included for reference, lists for five typical speakers mechanical and magnetic data necessary to such a design.

In summary, the method presented furnishes a means of achieving excellent performance

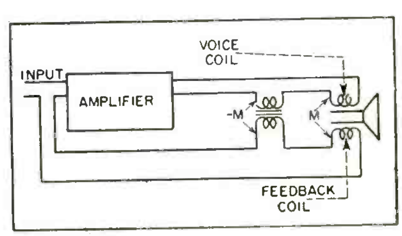

FIG. 5—Block diagram of amplifier-speaker combination with motional feedback compensating mutual inductance

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from speakers of low cost. The addition of the pickup coil to the voice coil structure at the time of manufacture should add very little to the cost, and result in negligible change in the mechanical characteristics of the speaker.

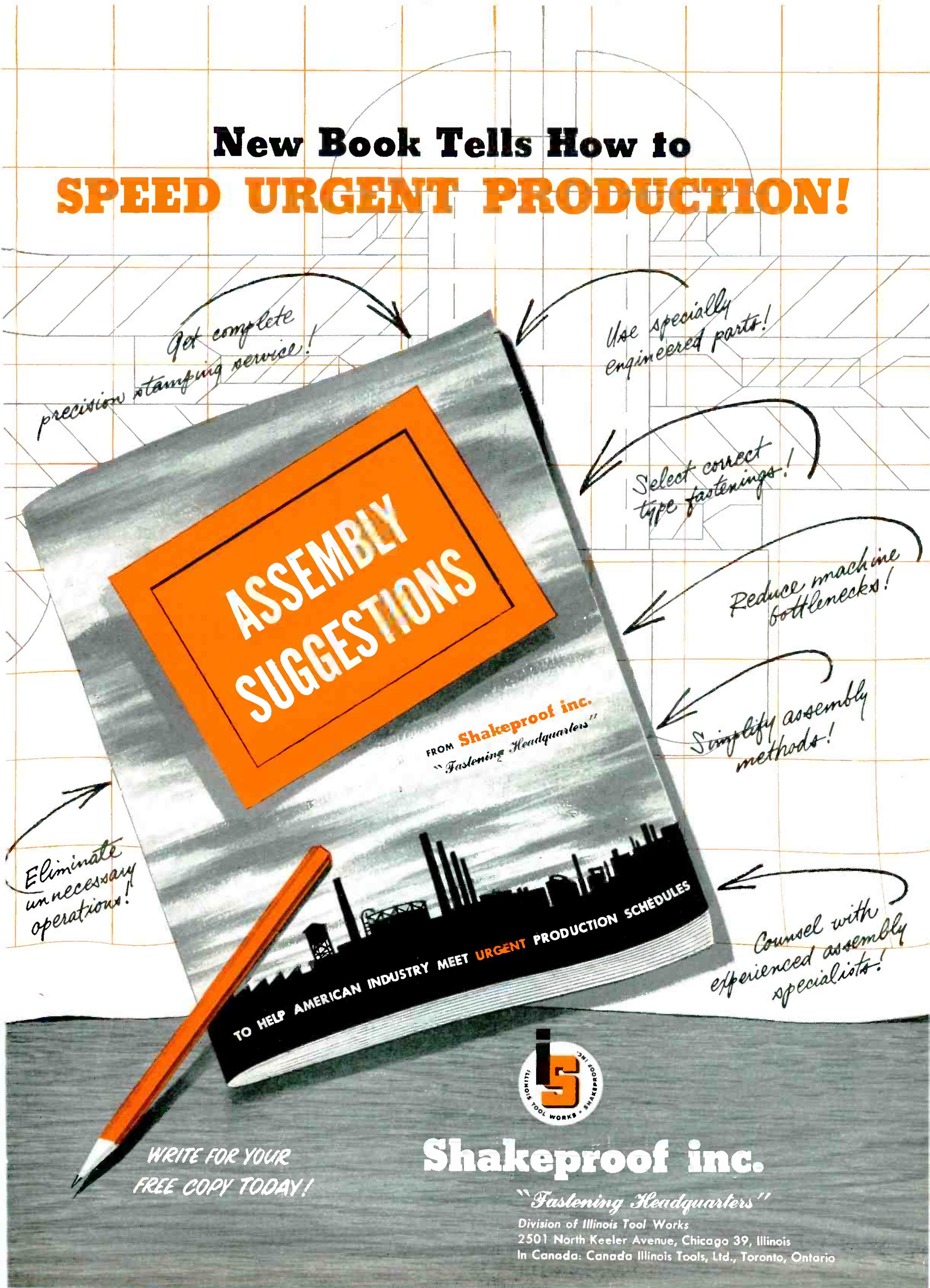
Voltmeter-Ammeter for Determining Characteristics of Nonlinear Devices

By Fred J. Lingel
Commercial Equipment Division
General Electric Company
Electronics Park
Syracuse, New York

Nonlinear devices, such as germanium diodes and varistors, can not be evaluated by resistance measurements made by a simple ohmmeter or resistance bridge, because the resistance of the element depends on the current flowing during the test. A voltmeter-ammeter resistance measuring setup is thus indicated.

With the voltmeter across the unknown resistance in the usual setup, the current indicated includes that taken by the voltmeter. In order to reduce this current it has been common practice to use a vacuum-tube voltmeter. This method s satisfactory for rough measurements but it is not readily adapted to precision measurements because of the inherent instability of the vacuum-tube voltmeter, the effects of line voltage, and the relatively short scale. These difficulties are especially noticeable in attempting to evaluate diode performance and drift in terms of small changes re-

Photograph of author using precision resistance-measuring equipment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sulting from temperature and humidity.

Connecting the voltmeter across both the milliammeter and the unit under test is not satisfactory either because it is then necessary to subtract the milliammeter resistance from each measurement.

The equipment described in this article was developed to eliminate all of the above difficulties. Resistance is obtained directly from the voltmeter and milliammeter readings using the proper scale multiplying factors. A laboratory standard d-c voltmeter, GE Type DP-2, is connected directly across the diode under test. The current taken by this voltmeter is balanced from the current indicating meter by means of a special bridge circuit. With this method it is possible to work directly from 0.1 percent, laboratory standard type meters, using a long scale for high reading accuracy along with a knife edge type mirror scale. The value of each range resistor is determined by substitution using precision laboratory resistance boxes. After all values are established, resistors of the proper value are obtained and wired into the circuit. The complete unit should be checked with standard resistors in the unknown position, and minor resistance adjustments made as necessary.

The basic circuit of the instrument is shown in Fig. 1.

The ratio of current through the unknown resistor X to that in the galvanometer circuit is a constant and is independent of the unknown resistance. The direction of the current flow for the polarities chosen may be neglected at this point. The current through the

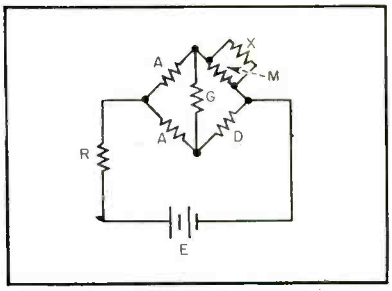
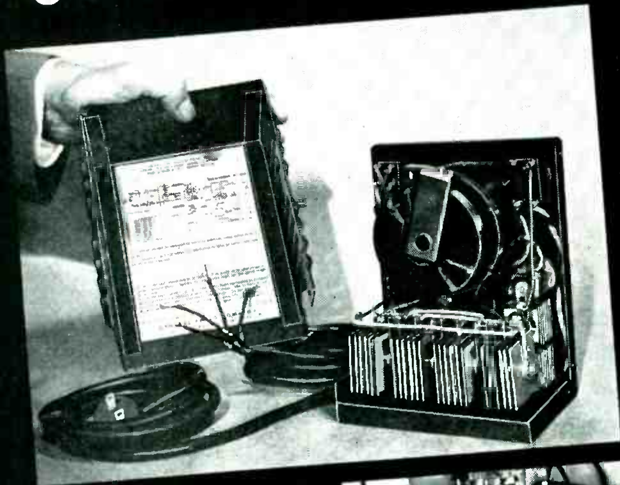
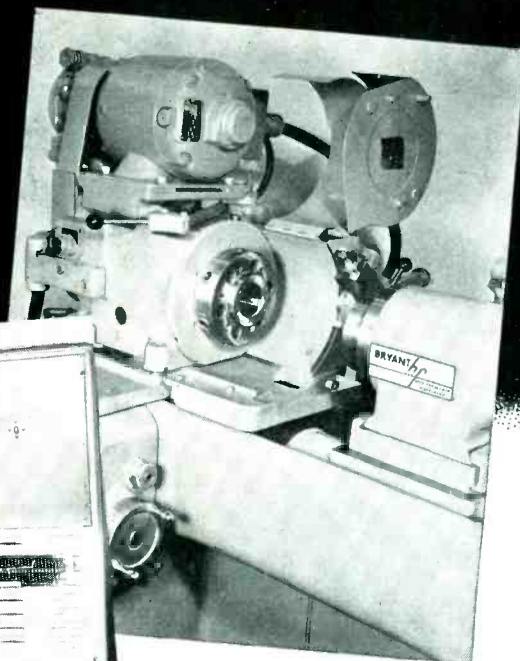


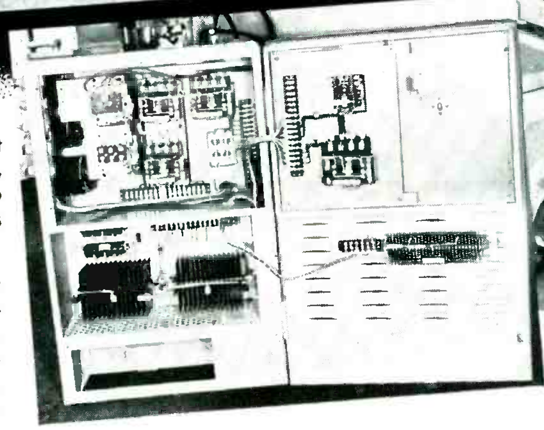
FIG. 1—Basic circuit of precision voltmeter-ammeter for determining characteristics of nonlinear devices under various operating conditions

YOU ARE IN GOOD COMPANY...

when SELETRON selenium rectifiers are "at the controls" for variable speed D.C. motor operation







ABOVE: Compact speed control built by General Radio Co., Cambridge, Mass. for applications requiring up to approx. 1/15 H.P. output. Employs Seletron miniatures.

RIGHT: Internal grinder produced by Bryant Chucking Grinder Co., Springfield, Vt., equipped with ¾ H.P. D.C. motor. Seletron power stacks, suitable for operation on standard A.C. current are incorporated into design of machine.

Seletron makes them ALL . . . *Large, Medium and Small!*

ABOVE: Elevator rectification — 3 bank power supply and regenerative braking equipment employing Seletron, built for Clinton Realty Co., Chicago, by Ther Electric & Machine Works.

There is a dependable SELETRON selenium rectifier for economical conversion of alternating current to D.C. for *all* requirements. SELETRON rectifiers have proved their efficiency and adaptability through the years in a wide range of industrial applications and electronic circuits.

Let SELETRON engineers help solve your rectification problems as they have for so many other ranking companies. Write now! Make sure to request a copy of our comprehensive bulletin No. ES-37.

Seletron

SELETRON DIVISION

RADIO RECEPTOR COMPANY, INC.

RR *Since 1922 in Radio and Electronics* RR

Sales Dept: 251 West 19th St., New York 11, N.Y. Factory: 84 North 9th St., Brooklyn 11, N.Y.

See us in our Booth N-16 at the IRE Show

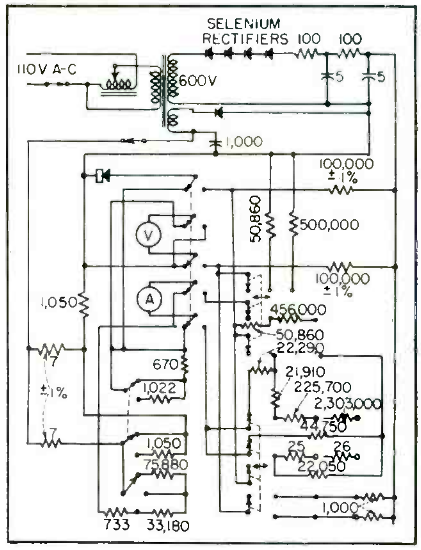


FIG. 2—Complete circuit of precision wide-range resistance measuring device

galvanometer can be determined by the following equation:

$$I_G = \frac{I_x}{2 + \frac{G(A+M)}{A\,M}}$$

where M is the resistance of the voltmeter.

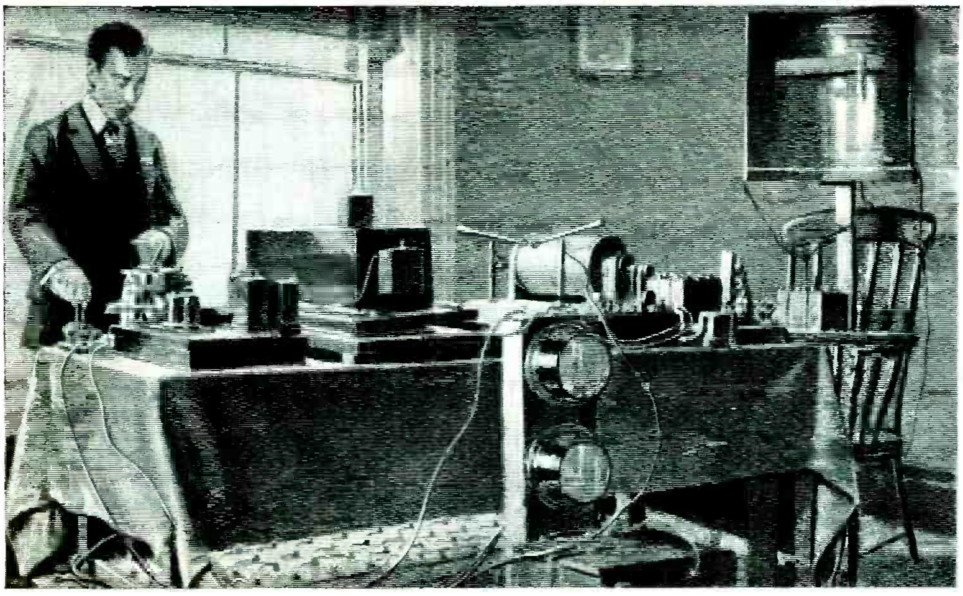
This shows that the minimum full scale current obtainable is twice the normal full scale rating of the milliammeter. It is approached when the milliammeter resistance G is low and both the arm resistance A and the meter resistance M are large.

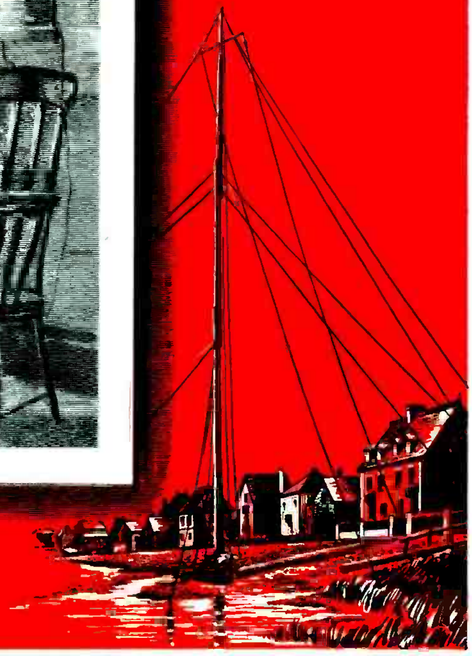
The complete circuit diagram of the instrument, with appropriate switching and power supplies is shown in Fig. 2. Two units of this type have been constructed for use in our laboratory. The first of these has been in constant service since November 1949 with very satisfactory results. One of the most important features of this equipment is the ability to measure trends in diode behavior in a relatively short time. This helped a great deal in aging and humidity cycling studies.

Considerable help in working out the mathematical proof of the validity of this method was given by N. De Wolf of this section.

Compact Digital Differential Analyzer

ENGINEERS at Northrop Aircraft, Inc., have developed an office-furniture-sized magnetic-drum digital differential analyzer for the solution





Above: Wireless telegraphy apparatus employed by Guglielmo Marconi in 1899. Right: 150-ft aerial mast at his Boulogne, France, experimental station.

Rendezvous With MASTERY

1899—and a young man, near Boulogne, France, presses the key of a transmitter. Instantly, his message clicks out on a receiver in Dover, England—32 miles distant. The way has been opened to mastery of instantaneous, world-wide communication.

1899—and a Board of Directors of an infant firm, convening for its initial meeting in Newark, N. J., hears the Treasurer state that $1,400 is at the disposal of Driver-Harris Company with which to commence business. The way has been opened to mastery of new facts and techniques which will provide industry with quality metal products never before available.

"Wireless" has been developed with phenomenal speed since the day Marconi's message was successfully transmitted from Boulogne. Within fifty years—as radio, television, and radar—it has been made to circle and serve the world.

And Driver-Harris, expanding within the same fifty years until represented on all five continents, has produced many of the alloys required. For example: Gridnic* for electron tube grid wire, alloys for radio cathode sleeves and glass seal metals, Karma* and D-H Manganin for resistors, and universally famous Nichrome* and Nichrome V for resistors, plates and other components.

Today, Driver-Harris' specialized knowledge and extensive facilities are employed in supplying superior alloys for a host of applications in numerous fields. The name "Driver-Harris", indeed, has become so widely accepted as a synonym for quality that the demand for D-H products is engaging the resources of the firm to an unprecedented extent. Driver-Harris can only say it is utilizing all the mastery at its command to meet this exceptional demand as fully as possible.

SPECIAL PURPOSE ALLOYS SINCE 1899 — D/H — TRADE MARK REG. U. S. PAT. OFF.

Makers of Nichrome and over 80 other alloys for the electrical, electronic, and heat-treating fields.

Driver-Harris Company

HARRISON, NEW JERSEY

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

In Canada: The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. REG. U. S. PAT. OFF.

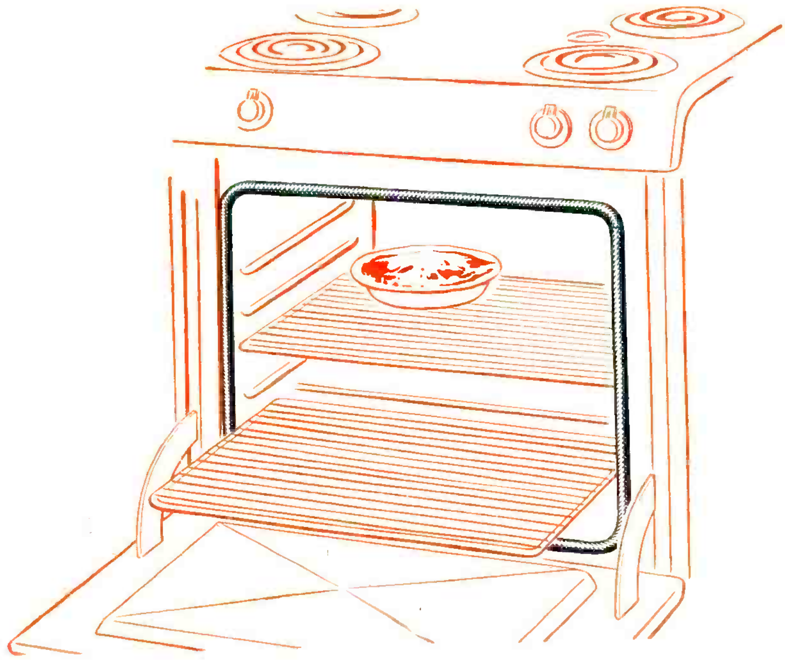
New techniques have enabled Northrop engineers to design this desk-side 400-pound computer. The computer can read 12 printed graphs or tables simultaneously, and plot six graphs or type out on 12 printers simultaneously as it operates

of problems in the aircraft and other industries. According to the designers, the computer combines large mathematical capacity, phenomenal acuracy, extreme ruggedness and reliability with amazingly small size and compactness—and low cost. The device will furnish solutions to ordinary differential equations or sets thereof, either linear of nonlinear, with accuracies in excess of any differential analyzers now existing.

Applications suggested for the computer, which is referred to as MADDIDA, include use as a general-purpose tool in engineering departments of large industrial firms for computation of design problems, such as stresses in large structures, vibration and windload calculations, heat transfer problems and so on. It lends itself particularly to analysis of new theories reducible to differential and integral equations.

MADDIDA is also capable of solving complex aerodynamic problems such as flight trajectories of missiles; aeroelastic problems of wing and body design; flutter and vibration problems; control problems; jet, rocket, or other propulsive device problems and again structural analyses. It can also be arranged to solve industrial control problems and to regulate or control chemical or physical processes and general research conditions such as heat or fluid flow.

In addition to being able to solve any ordinary differential equa-



The heat is "sealed in" when this door closes

See how the door of this electric oven closes on a strip of BH "750" Fiberglas Sleeving . . . closes and seals in the heat.

BH "750" is braided Fiberglas, tubular in shape, 3/8" inside diameter, with these properties:

(1) Oven heat won't impair it—no baking out or drying out even when subjected to prolonged high temperatures, nothing to melt or fuse.

(2) Easy to work with—speeds assembly because of its remarkable flexibility. Non-fraying—without use of hardening varnish or lacquer.

(3) Abrasion resistant—durability proved in service, no splitting or cracking under mechanical vibration.

BH "750" has merchandising possibilities, too. The oven door, illustrated, has the quiet closing of a Cadillac door—the tubular braid is "springy" in action, no porcelain-to-porcelain contact. Roasts do not dry out because moisture is sealed in the oven. Reduces staining of porcelain surfaces by minimizing leakage of heat or vapors from the oven.

BH "750" is a branch of the BH Insulation Family. There are many others. Whether you are interested in heat-resistant properties, dielectric properties, or a combination of both, BH Fiberglas Sleevings may be the answer to your problem. Write us today.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH *Fiberglas** SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

—USE COUPON NOW—

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I am interested in BH "750" Fiberglas Sleeving. Send samples for production testing.

My heat sealing problem is ____________________

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NAME ____________________ COMPANY ____________________

ADDRESS ____________________

Send sample and price on BH Electrical Insulating Sleevings:

- ☐ BH 649 Fiberglas Tubing, Grade A-1
- ☐ BH 649 Fiberglas Tubing, Grade B-1
- ☐ BH 649 Fiberglas Sleeving, Grade C-1
- ☐ BH Extra Flexible Fiberglas Sleeving
- ☐ BH Special Treated Fiberglas Sleeving

tion of any order or degree, linear or nonlinear, or any simultaneous set of such equations, it will also solve integral equations, transcendental algebraic equations and simultaneous sets of such equations. Some partial differential equations can be handled with special techniques.

Differential equations need not first be reduced to difference equations as has been necessary with previous computers of this type.

Information is transmitted between integrators in the form of incremental changes in variables.

Metal-drum memory device is capable of storing about 10,000 numbers which may be referred to by the computer during operation

Each integrator has a *dx* input through which it receives incremental changes in an independent variable *x*; a *dy* input through which it receives changes in a dependent variable *y*; and a *dz* output through which it delivers incremental changes in a new variable *z*, which bears the relation:

$z = \int y\, dx$

The source of *dx* may be the output of any one of 42 other integrators, or its own output, or any one of 12 empirical input channels. The source of *dy* may consist of the algebraic sum of from one to seven of the above sources in any combination. The *dy* input may also be omitted when using the integrator as a constant multiplier. In cases where the equation is such that *dx* must also consist of the sum of several channels, an additional in-

The sleeper that took the 12 noon plane

Would you have been caught napping in a situation like this?

Suppose you were in the fashion business. You have just created a line of women's nightgowns that are going to be given an unexpected publicity break in some top national magazines. This will mean more sales all over the country. But you must get more merchandise to the stores in a hurry — or forever lose your golden chance to get sales.

What would *YOU* do?

This happened to one company recently—but the problem caused them to lose no sleep. Faced with this situation at 10:30 A.M. they were able to start goods flowing to the stores on planes that left at noon.

The answer was Air Express!

But you don't have to be in the fashion business to profit from the regular use of Air Express. Here are its unique advantages which any business can enjoy:

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.*

IT'S PROFITABLE—Air Express expands profit-making opportunities in distribution and merchandising.

For more facts call Air Express division of Railway Express Agency.

AIR EXPRESS

GETS THERE FIRST

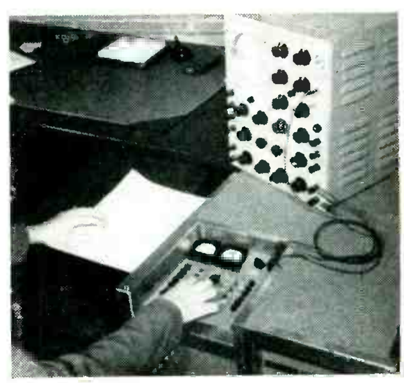
tegrator is used, coded as a simple adder.

Computation within the computer is done in the binary number system, since this leads to more compact and reliable circuitry. Initial conditions are typed into the computer as binary or octal numbers; however, output devices are available which will tabulate the results of MADDIDA computations directly in the decimal system.

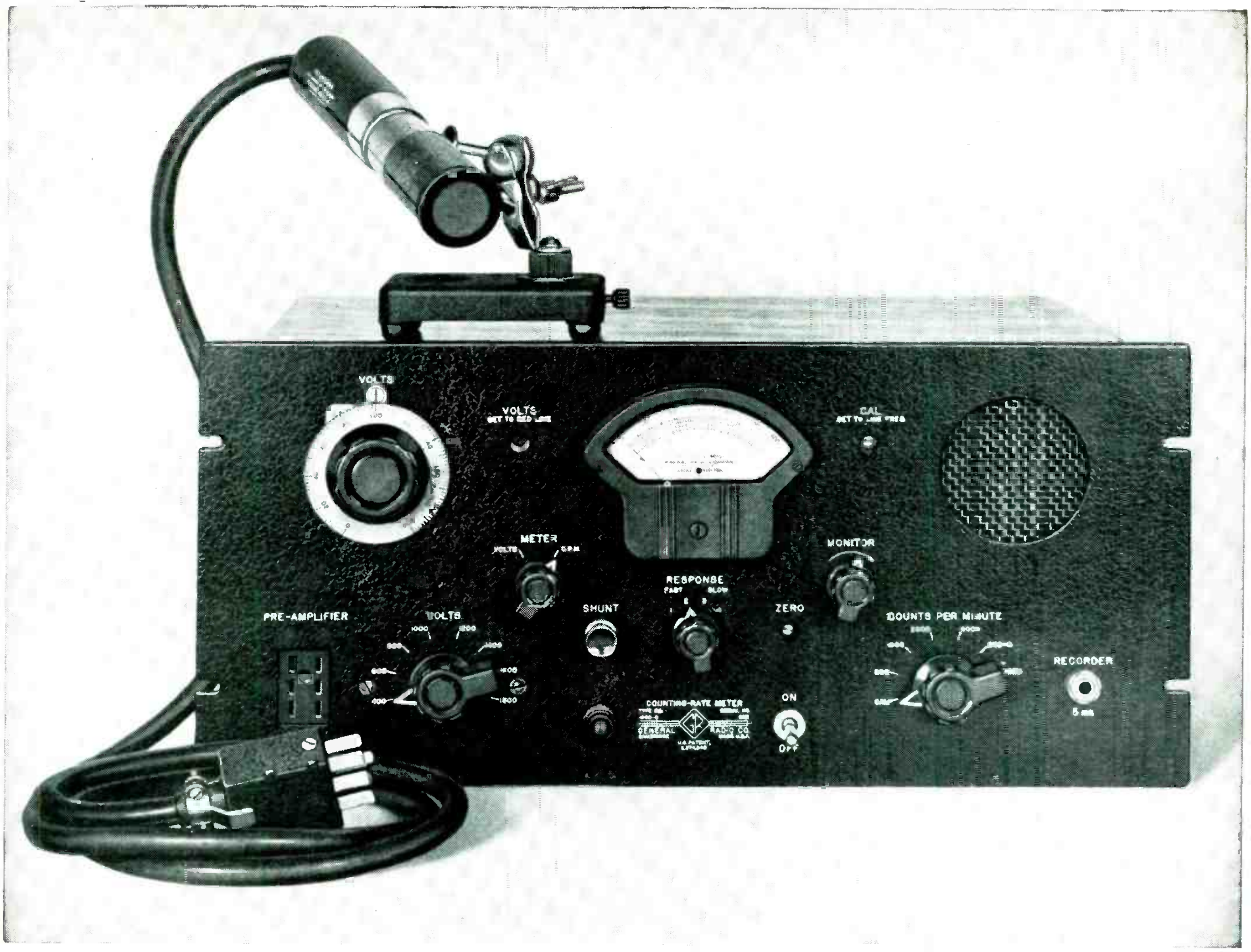
The problem of scaling (positioning the decimal point) is much the same as that for an analog differential analyzer, and straight-forward systems have already been developed. Control of the scale is provided through the ability to arbitrarily designate the number of significant digits to be carried in any individual integrator. In most problems scaling can be conveniently handled in powers of two, making it unnecessary to use constant multipliers to change the scale.

In addition to the operations of integration and addition already mentioned, an integrator may be coded as a servo. This is useful in inverting operations and it is sometimes necessary to achieve proper scaling. Such a digital servo may be set up either as a proportional device with a predictable lag or it may be coded to operate as a tight, on-off servo where the servo error can be kept down to less than one part in a million.

Integrators may also be coded to exercise decision; for example, one might be set to stop all computation when a variable passes through zero or exceeds certain limits, or it



Problems are fed into the desk-side computer on a simple binary typewriter keyboard. The oscilloscope on top of the computer enables the operator to monitor and check his input figures



IMPROVED COUNTING RATE METER FOR CONTINUOUSLY MONITORING RADIO-ACTIVE MATERIALS

● **RESPONSE CONTROL:** 4-position switch gives equilibrium time from 2 or 3 minutes to one second

● **NEWLY DESIGNED PRE-AMPLIFIER:** in small cylindrical anodized aluminum case; easy decontamination; long cable may be used; case equipped with tripod-type mounting thread **(bench-top mount in photo is accessory sold separately)**

● **NEW QUENCHING CIRCUIT** operates with self-quenching or non-self-quenching counter tubes

● **GREATLY INCREASED SENSITIVITY:** counting rate meter sensitivity increased four-fold; now responds to ¼-volt pulses

● **PANEL JACK TERMINALS** for 5 ma pen recorder providing continuous picture of what happens while radio-active material is being monitored; in absence of operator will show variations in the activity of materials being measured

● **AURAL MONITOR:** small, built-in loudspeaker, with volume control for aural monitoring

● **ADJUSTABLE VOLTAGE ON COUNTER CIRCUIT,** continuously variable from 400 to 2,000 volts (also available at terminals at rear of panel), with accurate voltage indication

● **VERY WIDE RANGE:** 5 to 20,000 counts per minute, full-scale values of 200, 600, 2000, 6000 and 20000; meter direct-reading in counts per minute on *all* scales

● **GOOD ACCURACY:** $\pm 3\%$ of full scale on all ranges

● **COUNTER TUBES** not supplied with instrument; beta- and gamma-ray tubes available; tubes plug into probe cylinder

TYPE 1500-B COUNTING RATE METER . . . $540.00

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

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might be set to add or drop terms from an equation when one variable exceeds another.

The desired interconnections between integrators are easily expressed as a binary code, and this code is typed into the computer along with initial conditions. The actual interconnection of integrators is done fully automatically in the machine's electronic circuits.

While many functions can be generated within the computer by solving auxiliary differential equations, it is at times convenient to insert purely arbitrary or empirical data into the computation. For this reason 12 empirical input channels are provided in the machine. These input channels may be fed from various input devices. One such arrangement is now being made available as a graph follower with which graphical data is semi-automatically placed on perforated tape. A number of tapes may then be simultaneously fed into the computer through these input channels while computation proceeds. The independent variable (or speed of tape advance) is under control of the computer. Step functions may also be inserted at pre-set intervals with such apparatus.

Also provided in MADDIDA are 12 output channels. Read-out equipment operated from these channels, now available is: A tabulating printer which will accumulate and print results decimally, and an automatic plotter to present results graphically.

These input and output channels facilitate the use of MADDIDA as a control device. For example, the input channels might take information directly from instruments, and the output channels might directly operate switches, valves, or motors.

Tuning Systems Employing Feedback Amplifiers

By PETER G. SULZER

National Bureau of Standards Washington, D. C.

IT IS possible to alter the effective value of an inductance or a capacitance by means of a feedback amplifier. The method is applicable

where large variations are required, and is particularly useful where an L-C resonant circuit is to be tuned over a wide frequency range.

Consider an amplifier of voltage gain A having an infinite input impedance and a zero output impedance. An impedance Z is connected between its input and output terminals. With Z_e defined as shown in Fig. 1, it is found that

$$Z_e = \frac{Z}{1 - A}$$

Four conditions can be considered.

$$-\infty < A < 0 \qquad Z_e/Z < 1$$
$$0 < A < 1 \qquad Z_e/Z > 1$$
$$A = 1 \qquad Z_e/Z = \infty$$
$$1 < A < \infty \qquad Z_e/Z < -\infty$$

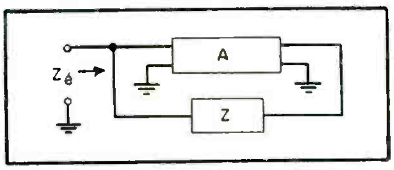


Fig. 1—Feedback amplifier connected for impedance multiplication or division

If L_e and C_e are the equivalent values of L and C when either one is inserted for Z,

$$L_e = \frac{L}{1 - A} \text{ and } C_e = (1-A)\,C$$

With the first condition, L is effectively decreased, while C is increased (Miller effect[1]). With the second, L is effectively increased, while C is decreased. The third condition is trivial in this application, while the fourth may produce instablity, and will not be considered here.

It is worth noting that the variations in the equivalent values of the components can be obtained without a serious loss of Q or selectivity. This requires only that the output impedance of the amplifier be kept low, and that its input impedance be high.

The required variation of amplifier gain can be obtained by employing an attenuator or potentiometer or, if desired, by electronic means. Thus it has been possible to tune an L-C circuit over a 30-to-1 frequency range by means of a potentiometer;

the same frequency ratio was obtained by changing the grid bias of one of the amplifier tubes. Since a potentiometer is a more stable circuit element than a variable-μ tube, better frequency stability will be obtained when using potentiometer tuning. However, electronic tuning is to be preferred when

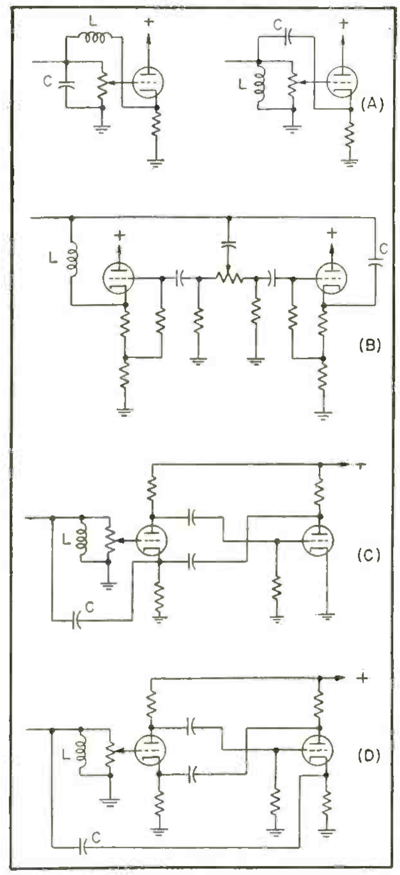


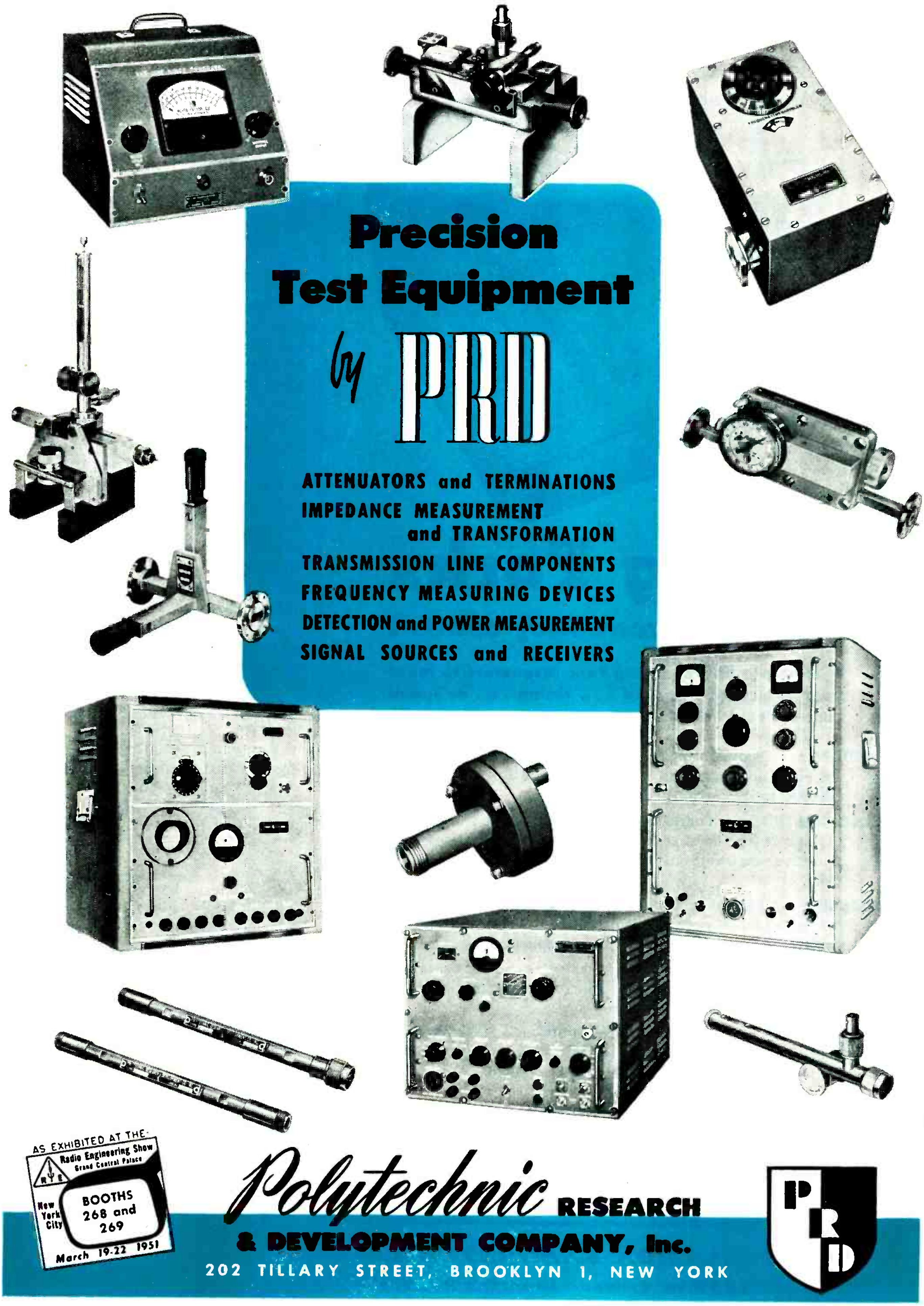
Fig. 2—Simple cathode-follower tuners, A; dual cathode-follower tuner, B; two-stage tuners providing large frequency ratios with good stability C and D

rapid or remote frequency variation is required.

Practical Circuits

Many circuits can be devised using the scheme presented here. Figure 2 contains a few that have been investigated by the writer.

The simple cathode-follower circuits of Fig. 2A produced a frequency ratio of 5 when using a parallel-connected 12AT7. The equivalent resistance inserted in series with the tuned circuit is approximately 100 ohms, which re-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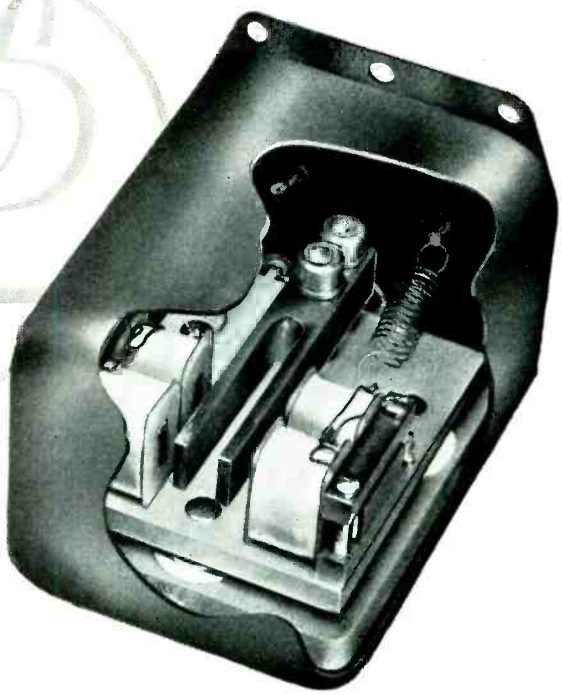


quires that a high L/C ratio be employed to avoid excessive degradation of Q. The dual cathode follower of Fig. 2B provided a frequency ratio of 25. The equivalent resistance is 400 ohms, which may be undesirable in some applications, particularly at radio frequencies.

Cathode Follower

These three circuits do not employ a large feedback factor to stabilize A; hence relatively poor frequency stability will be obtained when large frequency ratios are used.

The completely degenerative amplifier[2] of Fig. 2C is superior in this respect. In addition, the output impedance may be less than 1 ohm, while the voltage gain may be as high as 0.999, resulting in a frequency ratio of approximately 30. When using a pentode-triode amplifier to tune an oscillator with a frequency ratio of 10, the frequency was constant within 1 percent for plate-supply-voltage variations of ±50 percent.

The circuit of Fig. 2D differs from the previous ones in that A is negative. A frequency ratio of 10 was obtained using a pentode driving a triode. Larger ratios can be obtained by employing more stages, but instability becomes a serious problem.

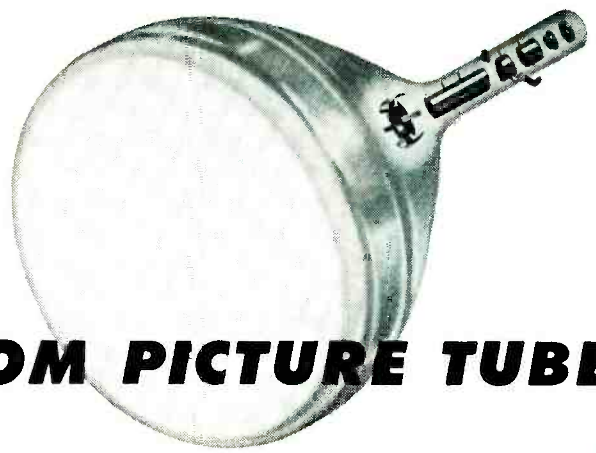
Conclusions

The simple cathode-follower circuits are most useful for obtaining wide-deviation frequency modulation at radio frequencies. They should also be useful for tuning radio receivers, although tube noise will be contributed by the amplifier. The two-stage circuits, which are limited to audio or video-frequency applications because of the coupling networks used between stages, have been employed in wide-range, resistance-tuned audio oscillators.

REFERENCES

(1) J. M. Miller, "Dependence of the Input Impedance of a Three-Electrode Vacuum Tube upon the Load in the Plate Circuit," Bureau of Standards Scientific Paper 351.

(2) Calvin T. Hammack, "Cathode Follower," Report 469, Radiation Lab., MIT, Cambridge, Mass.; also see ELECTRONICS, p 206, Nov. 1946.



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...TO CATHODE RAY

AND SUBMINIATURES

What we have done for industry

In 1950 Volkert produced over 260,000,000 precision stampings and became the leading independent supplier of metal parts for electron guns.

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Volkert has wide experience in designing and building high-production dies and producing parts for cathode ray tubes and radar. Volkert is again ready to help American industry turn out the parts for electronic equipment which is vital to the Armed Forces.

Volkert can help you in your defense production. Write today for our brochure, "3-Way Facilities for Precision Stampings." It shows how Volkert successfully combines—under one roof—integrated facilities for design engineering, tooling and production...to produce millions of small, intricate stampings yearly.

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JOHN VOLKERT METAL STAMPINGS, INC.
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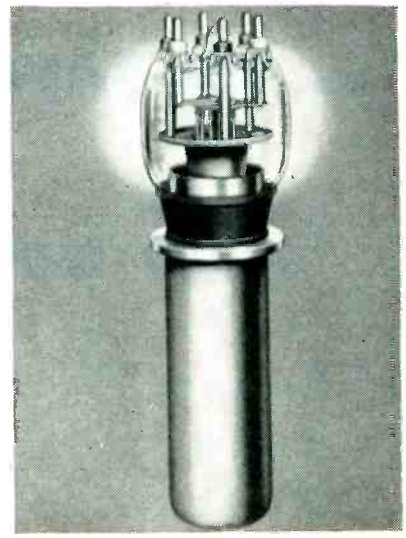
NEW PRODUCTS

(continued from page 146)

supply and bridge control unit designed for use with transducers employing resistance elements. A scope jack and chopper are provided in order to observe steady as well as vibratory phenomena on c-r oscilloscopes without preamplification. The unit contains a d-c power source of 100 v at 100 ma with an a-c ripple of less than 1 mv. A 10-turn helipot permits precise bridge balancing.



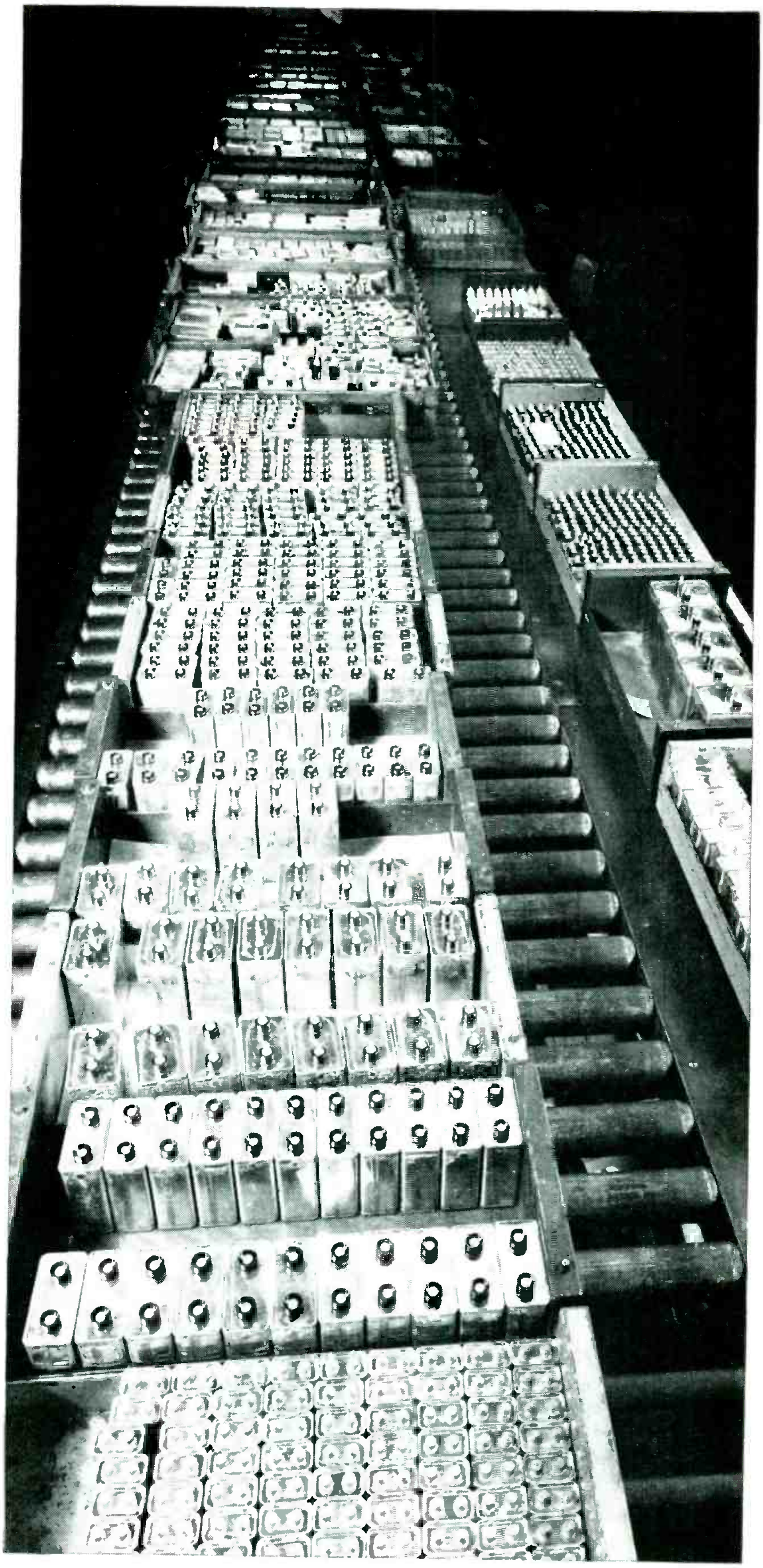
High-Powered Triode

FEDERAL TELEPHONE AND RADIO CORP., 100 Kingsland Road, Clifton, N. J., has developed the F-5918 200-kw triode to meet the increasing demand for higher power in the broadcast and shortwave bands. The three-electrode tube is suitable for use as a radio-frequency amplifier, oscillator, or class B modulator. The heavy-wall, high conductivity copper anode is water-cooled and is capable of dissipating 60 kw in continuous commercial service. It weighs approximately 25 pounds. Maximum ratings to 22 mc can be achieved.

Selenium Rectifier Cartridges

INTERNATIONAL RECTIFIER CORP., 6809 So. Victoria Ave., Los Angeles

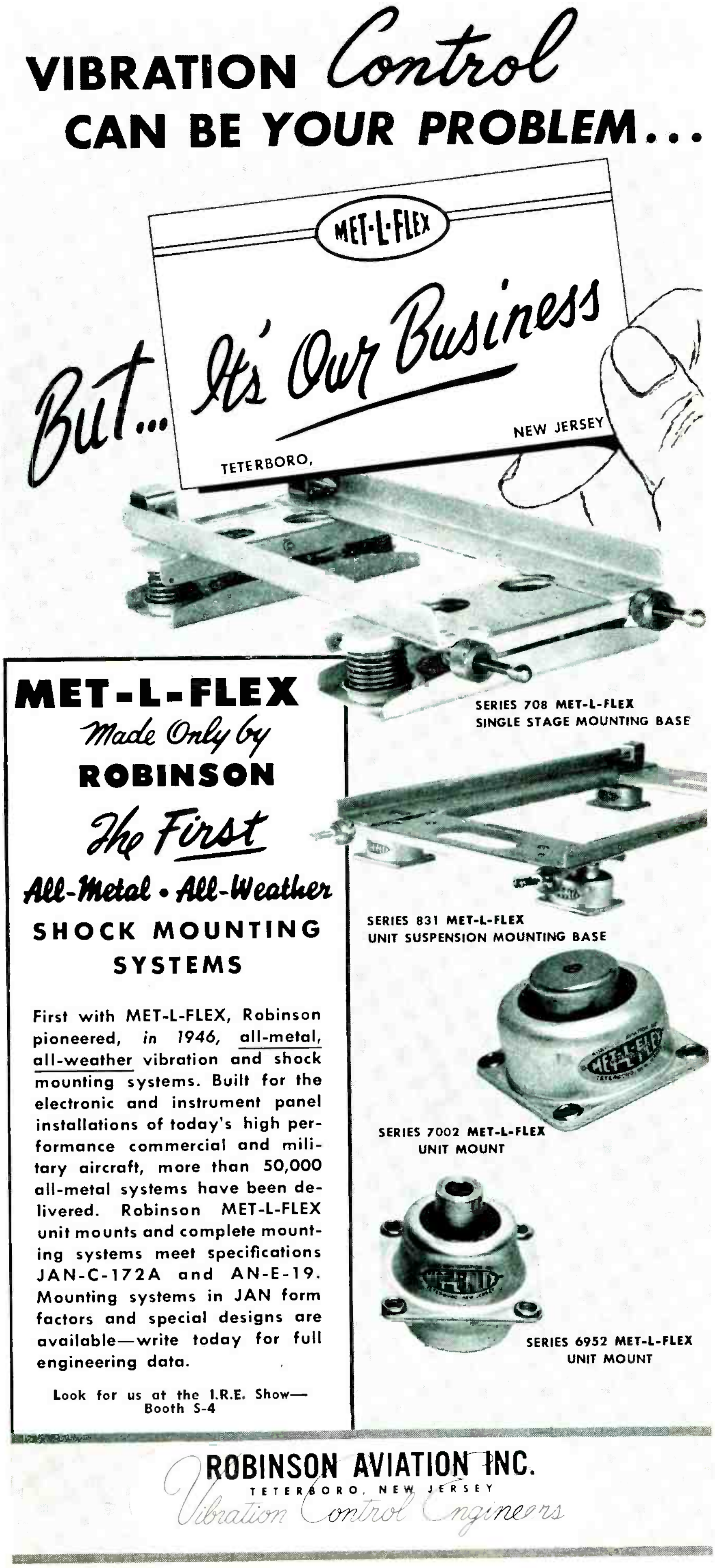
General Electric can build and test JAN-C-25 CAPACITORS in mass production quantities



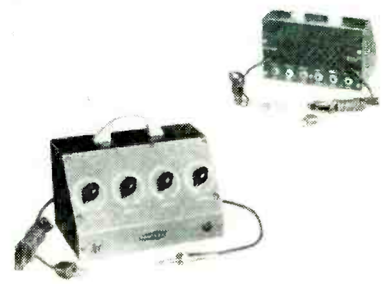
Apparatus Department,
General Electric Company,
Schenectady 5, New York

GENERAL ELECTRIC

407-3

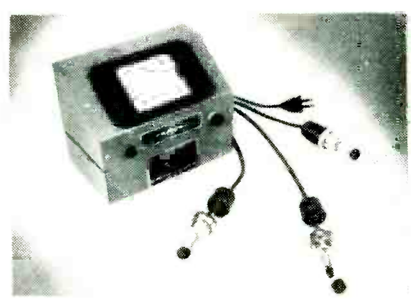


43, Calif., has developed a line of h-v selenium rectifier cartridges with voltage ratings up to 25,000 v per cartridge and current ratings up to 75 ma. They utilize five different selenium cell sizes varying from 1/8 in. in diameter up to 1 in. in diameter, with corresponding current ratings varying from 1.5 ma up to 75 ma; and can be operated over the temperature range of −55 C to 100 C. Type W248HS (illustrated) is rated at 4,960 v d-c output at 75 ma, and its over-all length is 13 in. with an outside diameter of 1¼ in.



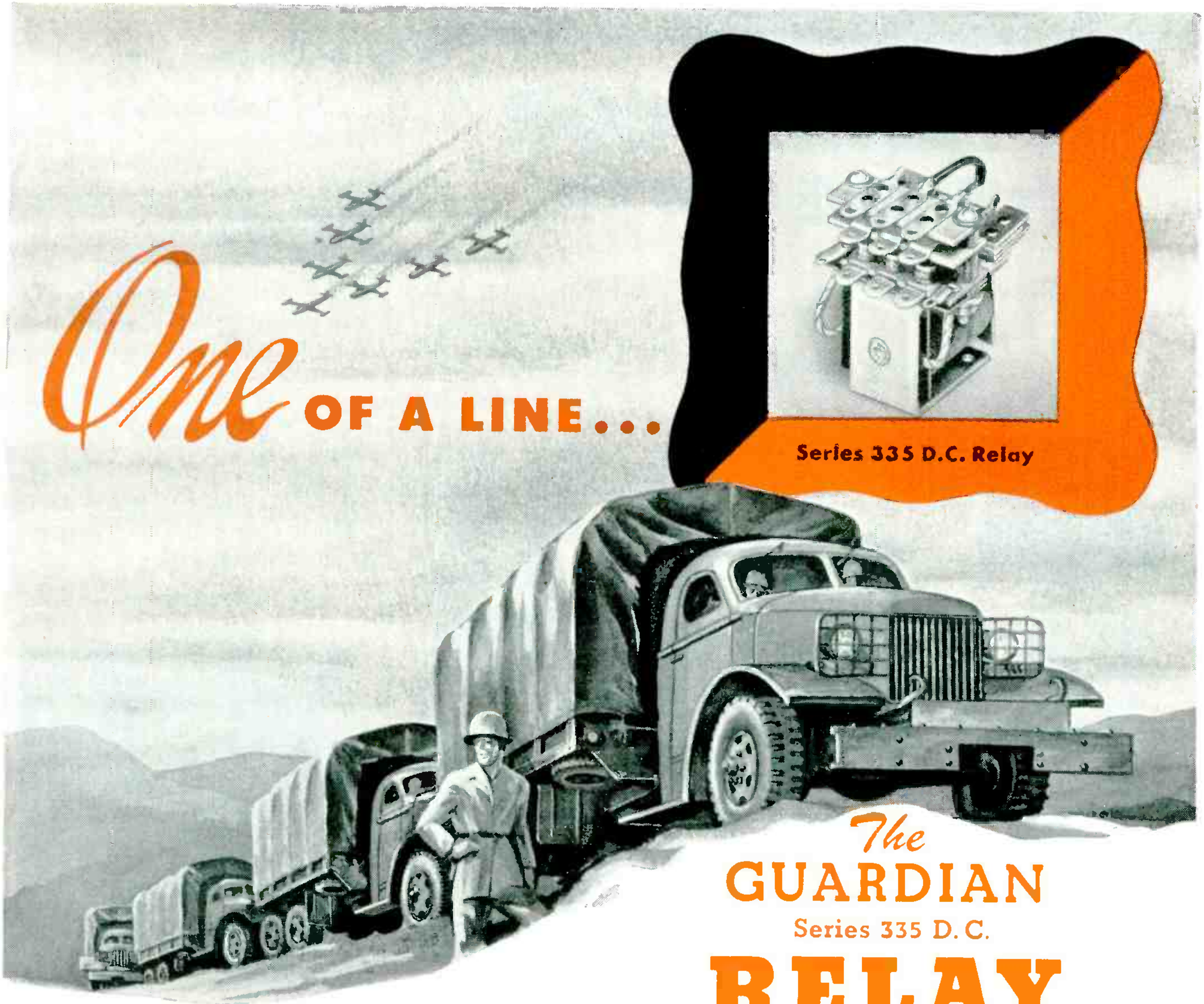
Audio Mixer

THE PENTRON CORP., 221 E. Cullerton St., Chicago 16, Ill. Audio-Mix, an electronic mixer for all audio systems, has four individual controls that permit a wide range of audio blending applications on each of its four channels simultaneously. It features six high-impedance inputs, four microphone and two phonograph. Microphone gain is 8 db; phonograph gain, −22 db. Frequency response is 20 to 20,000 cycles; power consumption, 8 watts. List price is $59.50.



Vacuum Gage

HASTINGS INSTRUMENT CO., INC., Super Highway at Pine Ave., Hampton 10, Va., has announced a new direct-reading vacuum gage

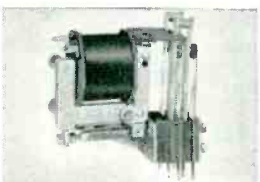


The GUARDIAN
Series 335 D.C.
RELAY

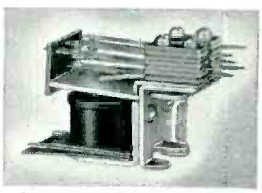
The A.N. CONNECTOR TYPE *mounting is approved by the Army and Navy as standard hermetic seal termination equipment. This type of mounting is particularly adaptable where shielded or cabled circuits are a necessity. Vibration-proof mounting with quick connect and disconnect is insured.*

Approved—distinguished by spectacular performance in truck train communications and thousands of flying echelons—The Guardian Series 335 D.C. Relay! Hermetically sealed or with conventional open and special mountings, unit offers a wide variety of applications. Series 335 D.C., built to rigorous aviation standards, meets the 10-G Vibration Test and the Mil-R-6106. Generous coil winding area permits single windings up to 15,000 ohms. Parallel and double windings available.

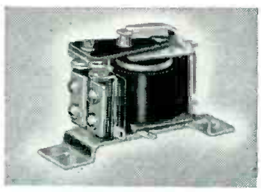
Maximum voltage: 220 V.D.C. Power requirement: Normal, 3½ watts. Max.-resistance standard unit: 12,000 ohms. Applicable to time delay attract up to .06 second and release up to .01 second. Contact rating: ¼″ dia. silver, 12 amps. at 24 V.D.C. inductive load. Combinations up to 3 P.D.T. with 12 amp. contacts. Bakelite insulated, tested at 1500 V.—60 C.



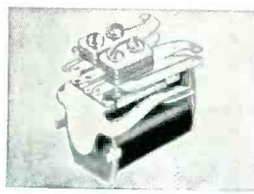
Series 30 A.C.



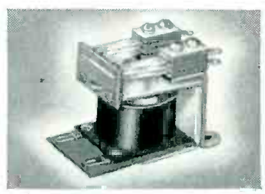
Series 210 A.C.—215 D.C.



Series 220 A.C.



Series 595 D.C.



Series 610 A.C.—615 D.C.

WRITE OR WIRE... FREE CATALOG, SPECIFIC RECOMMENDATIONS, NO OBLIGATION.

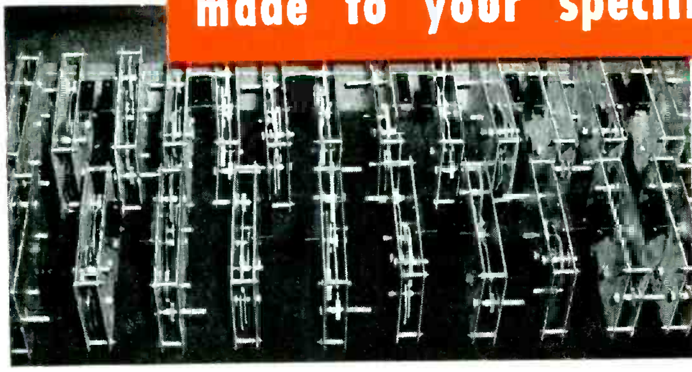
GUARDIAN G ELECTRIC

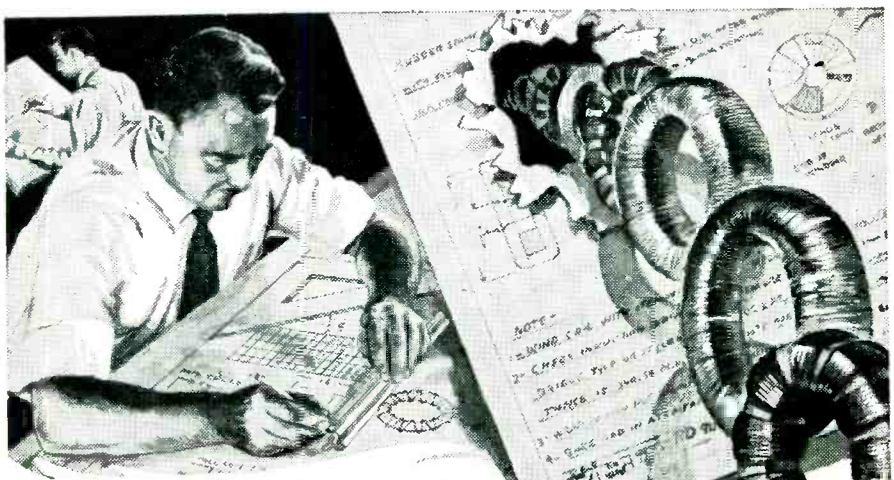
1625-C W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY with a five-position switching attachment. It gives rapid response (less than ½ sec) for laboratory or production instrumentation, and its unique design includes such features as noble metal thermopiles and nickel-plated pickup tubes. The nickel-plated pickup tubes afford freedom from outgassing, system contamination and corrosion. The unit can measure absolute pressures of from 0 to 1,000 microns of mercury. Its rugged gage tube connects to the vacuum system by means of a standard ⅛-in. male pipe thread. Length of the cable from the indicator to the pickup tube does not affect calibration so extensions for remote indications may be added if desired.

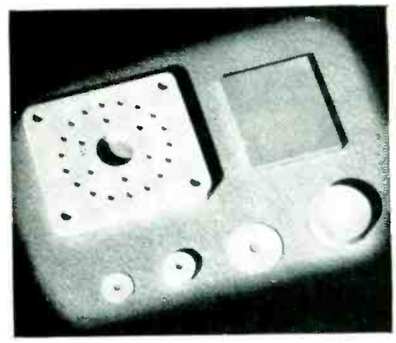
Proportioning Input Controllers

Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa. Series 4700 Atcotronic input controllers answer the demands of the industrial electric furnace users for accurate, automatic control of temperatures. Based on the rate of charge and discharge of a capacitor, this proven circuit enables the user to line-out without incurring undue overshoot. The ability to operate with a very narrow proportional band (2 percent in many cases) eliminates set point shift with varied load changes. Type 4702-A incorporates a snap-acting precision switch, independently wired. It is load-rated 10 amperes at 115 v, 5 amperes at 230 v a-c, noninductive, 25, 50 or 60 cycles. Type 4702-B uses a mercury switch relay. It is load-rated 30 amperes at 115 v,





20 amperes at 230 v, a-c noninductive, 25, 50 or 60 cycles.



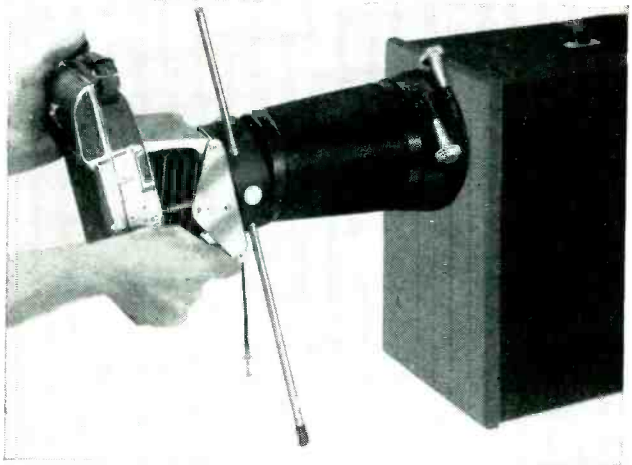
Technical Ceramics

AMERICAN LAVA CORP., Chattanooga 5, Tenn., has available a line of optically flat discs and plates of Al Si Mag technical ceramics that are custom made in any size up to 9 in. in diameter. They are very hard, totally and permanently rigid, resistant to heat shock and can be used at elevated temperatures. The material is resistant to all alkalies and acids except hydrofluoric acid. Dimensional accuracy can be maintained within almost any limits specified. The three larger pieces shown above are flat within one to two light bands (0.0000116 in. to 0.0000232 in.). Test samples can be produced to specifications.

Vibration Control Mountings

LORD MFG. CO., Erie, Pa. The Temproof (temperature-proof) vibration control mounting is designed specifically to meet the requirements of base-mounted airborne electronic equipment and functions efficiently throughout the entire range of operational temper-

How to make Oscillograms FAST!



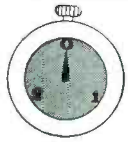
—SET UP THE CAMERA
—SNAP THE SHUTTER
—SEE THE PRINT

ALL IN 3 MINUTES—or even less
with the Fairchild-Polaroid® Oscilloscope Camera

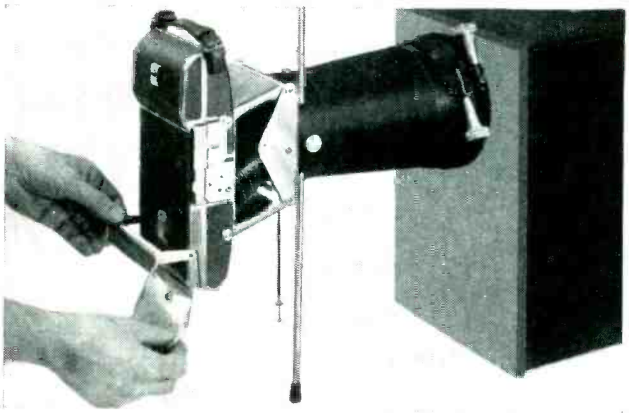
The easiest way is the fastest way when you're photographing oscilloscope images with the Fairchild-Polaroid® Oscilloscope Camera.

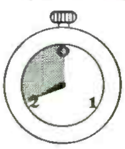
No more darkroom processing! With this new camera it takes only two minutes (less if you're fast) to set up and snap the picture, one minute to finish a print. Each 3¼ x 4¼ print records traces exactly one-half life size to make comparisons easy.

Write for complete data and prices on F-284 Oscilloscope Camera Kit including camera, carrying case, and film. *Fairchild Camera and Instrument Corporation. 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.* Dept. 120–14A.

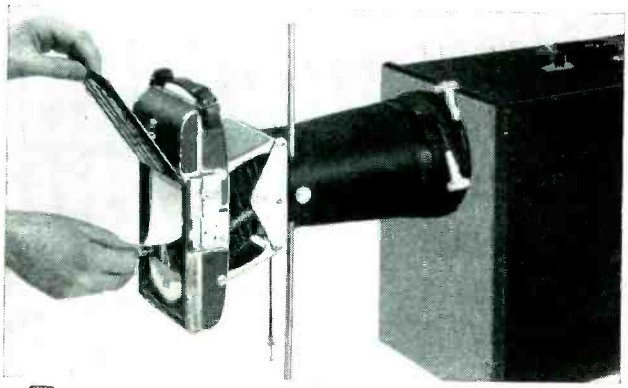


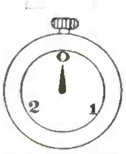
Set up the camera. The Fairchild-Polaroid camera consists of three units: adapter ring, hood, and camera body. To set it up, you place the handy adapter ring over the oscilloscope bezel, slip the hood into the ring, then snap the camera into the bayonet lock on the hood. That supporting rod is a safety feature that protects both camera and oscilloscope.





Pull the tab to finish exposed print. After a snap of the shutter, the exposure is made and you're ready to finish the print. If you want two exposures, it's easy to move the camera body down and make a second exposure. To finish the print, you merely pull tab at back of camera.





Remove the finished print. A minute after you've pulled the tab, the finished print is ready for evaluation. Just open the camera back and there it is. An easy job, but you have a photographically accurate record of the trace in less time than you could sketch it from memory.

SPECIFICATIONS

LENS—Special 75 mm. f/2.8 Wollensak Oscillo-anastigmat.

SHUTTER—Wollensak Alphax; speeds 1/25 sec. to 1/100 sec., "time," and "bulb."

FOCUS—Fixed (approx. 8 in.)

PICTURE SIZE—3¼ x 4¼ in. (2 or more images per print; 16 exposures per roll of film.)

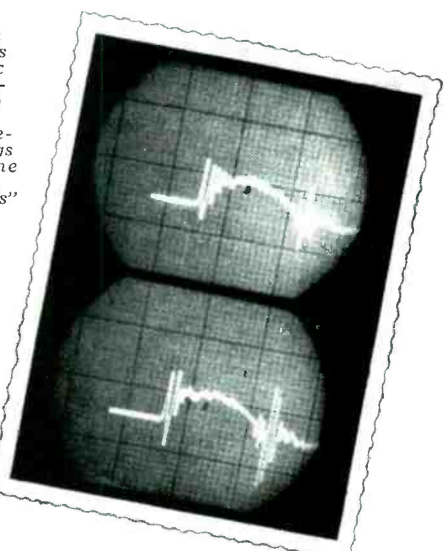
IMAGE SIZE—One-half reduction of scope image.

WRITING SPEED—to 1 in/μsec at only 3000V accelerating potential; higher speeds at higher voltages.

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.

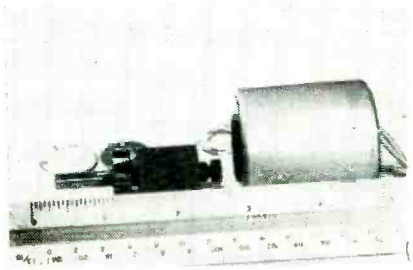
Typical of the work being done with this camera is this 3¼ x 4¼ print of 35-millisecond single-sweep transient—one of a series of accelerometer-output recordings that made possible the completion of nine recorded "drop-tests" in 40 minutes.



FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS

See the Fairchild-Polaroid Oscilloscope Camera and the Fairchild Oscillo-Record Camera at the Radio Engineering Show, Booth 238-239.

atures from −80 F to +250 F. It is designed for use with Government Specification JAN-C-172A equipment. Friction dampers are designed in to prevent excessive equipment motion at resonant frequencies. Although intended primarily for use with airborne electronic equipment the new mounting will fill an additional need in the industrial field for applications in areas subject to temperatures above and below the range in which rubber mountings are ordinarily used.



Miniature Induction Motor

EASTERN AIR DEVICES, INC., 585 Dean St., Brooklyn 17, N. Y. Type J49D-16 miniature induction motor was primarily developed for use by manufacturers of aviation and portable military equipment. It operates from a 3-phase, 200-volt, 400-cycle source and is rated as follows: 1/50th h-p, 0.25 ampere, 10,000 rpm. This reversible motor is totally enclosed, weighs 10 ounces, is 1¾ in. in diameter and 1⅞ in. long.

Preamplifier-Equalizer

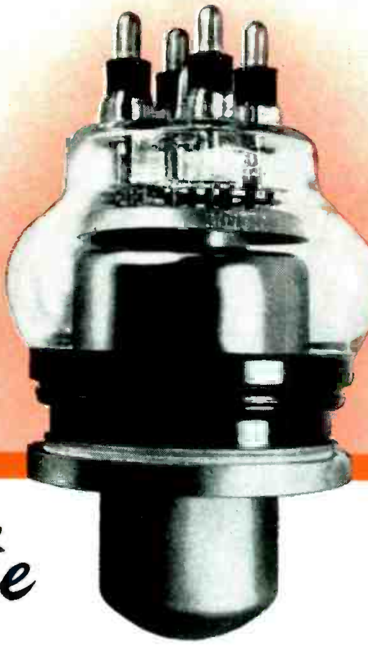
BROCINER ELECTRONICS LABORATORY 1546 Second Ave., New York 28, N. Y. Model A100P preamplifier-equalizer is a flexible, compact, high-quality equalized preamplifier for use with constant velocity (magnetic or dynamic) pickups

If you use the 880 you will get

BETTER PERFORMANCE

LOWER OPERATING COSTS

and LONGER LIFE . . .



. . . with the ML-5658

THE ML-5658 is an improved and directly interchangeable version of the widely used 880. Designed originally as a better, more rugged tube for electronic heating equipment, it has since found extensive use in the high power broadcast field and in such exacting applications as cyclotron and synchrotron oscillators.

The ML-5658 incorporates in its design many of the outstanding features developed by Machlett Laboratories for all its industrial tubes. Typical of these design and process improvements which have given broadcast and industry better, more dependable tubes are:

1. **Kovar-to-glass seals. The elimination of the inherently weak feather-edged copper seal —increasing seal strength and providing greater stability of the internal electrode structure.**

2. **An improved, stress-free, self-supporting filament structure which substantially eliminates filament distortion, provides uniform filament emission throughout tube life and reduces the complexity and the hazards of the older spring-supported filament construction.**

3. **A unique pre-exhaust treatment of all parts and the thorough, high voltage exhaust of each tube on Machlett's special high voltage, high temperature exhaust system.***

These, and many other improvements in tube design and processing, provide for every installation which uses or contemplates the use of an 880 type tube, a far more rugged longer lived tube in the ML-5658. It will directly replace the 880 with *no* electrical or mechanical changes and will provide better performance, longer tube life and more economical operation.

The ML-5658, like other Machlett industrial tubes, is available with the Machlett automatic seal water jacket.† This new jacket eliminates the use of tools and the hazard of tube breakage and water leakage. The jacket cannot be opened unless the water pressure is off, nor closed unless the tube is properly installed.

Complete technical data on both tube types is available upon request. Write direct to Machlett Laboratories, Inc., Springdale, Connecticut.

* Patent No. 2,324,559. † Patent applied for.

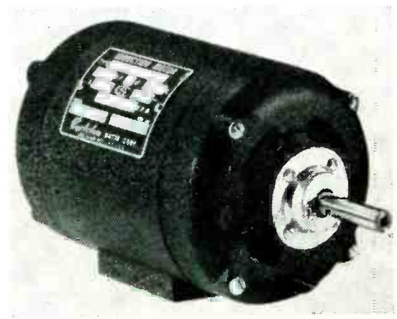
Westrex Export Distributor

Distributed by Graybar

Machlett Industrial and Broadcast Tubes will be exhibited at the 1951 I.R.E. Show Booth 96-97

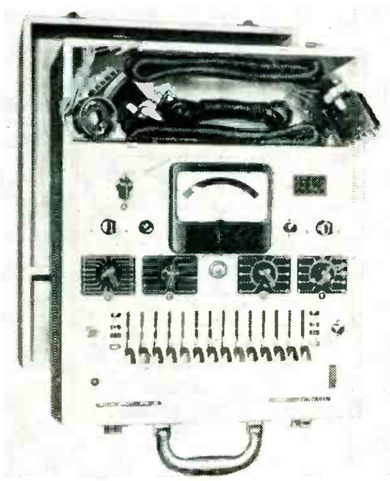
OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE — MACHLETT

having outputs as low as 10 mv. It affords exact compensation for widely varying recording characteristics. It has a 39-db voltage gain and a 20,000-ohm output impedance. The device uses a 12AY7 low-hum nonmicrophonic dual triode for initial stages; and a 6C4 for output stage. Price is $83.33 F.O.B. factory.



Induction Motor

HOWARD INDUSTRIES, INC., Racine, Wisc., Model 2900 fractional h-p motor is a two-speed hysteresis motor for use in tape-recording applications. It is also available as nonsynchronous capacitor motor and torque motor with high resistance rotor. The unit is rated 1/100 to 1/15 h-p. Among its uses are the powering of blowers for electronic equipment, in telegraph switching equipment and in tape pullers for automatic code equipment.



C-R Tube Tester

PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst, L. I., N. Y., announces the

Wherever SELENIUM RECTIFIERS can be used . . . be sure to specify

Federal

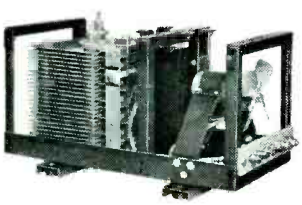
—to meet requirements of military end-use equipment

Requirements for military end-use equipment are rigid and exacting. To meet them fully and efficiently you need the quality that is backed by America's *oldest* and *largest* manufacturer of Selenium Rectifiers...the "know-how" that has pioneered every major advancement in their design and construction since they were first produced in the U.S. by Federal, in 1938.

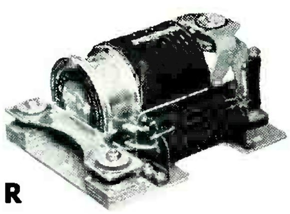
Federal's unmatched experience in building Selenium Rectifiers to meet an almost unlimited range of specifications is more valuable now than it was in World War II, when tremendous quantities were produced to power equipment used by the nation's fighting forces.

This *same* experience is yours for the asking... ready to assist you in determining or developing the Selenium Rectifier that will do the job demanded by government specifications.

2 Important Examples of Engineering to Meet Government Specifications



FTR 3146-BS AIRCRAFT POWER SUPPLY



FTR 3141-CS-03 CLIP-IN VOLTAGE REGULATOR

—to save component items and critical materials

Today in many industries, commercial production is finding Federal Selenium Rectifiers of enormous value in keeping assembly lines on the move...through the replacing or supplanting of component items... through the saving of critical materials.

These versatile power conversion units are rapidly taking the place of rectifier tubes... television and radio transformers... rotating machinery for supplying DC for electroplating, battery charging, welding and numerous other applications... larger and more complicated equipment used in magnetic amplifiers.

When you specify Federal Selenium Rectifiers to save space and weight...to obtain increased efficiency, dependability and economy... you can be sure of the best obtainable. And you can be sure that Federal engineers will give you the full benefit of their more than a decade of experience in Selenium Rectifier design.

"Federal"—First Name in Rectifiers for the "Front Line of Design"

Millions of Federal Selenium Rectifiers are now successfully performing hundreds of power conversion jobs in vital applications... from aircraft to submarines... in both industrial and commercial products... in sizes ranging from subminiature special equipment to heavy duty power supplies.

Whatever your AC to DC power conversion requirements, get in touch with a Federal engineer today. He has complete information on the Selenium Rectifier that *you* need. Write to Dept. F-313.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

SELENIUM and INTELIN DIVISION, 100 Kingsland Road, Clifton, New Jersey

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

model CR-30 cathode-ray tube tester, a complete, self-contained instrument that will test all tv picture tubes (electrostatic as well as electromagnetic), scope tubes and industrial c-r tubes. It performs such tests without removing the tube from a tv set or tube carton. Designed to eliminate guesswork in determining tube quality, the unit has test parameters based on true beam current (proportionate picture brightness) principles. A voltage-regulated, bridge-type vtvm provides c-r tube quality indications. With test circuits at high-sensitivity position, a beam current change of only 0.1 μa will create a change in meter indication of approximately five divisions on the 120-division scale.

D-C Microvolt Meter

MILLIVAC INSTRUMENT CORP., Box 3027, New Haven, Conn. The MV-15A d-c microvolt meter has a full scale sensitivity of 10 μv with an input impedance of 1,000 ohms. It incorporates a new modulator that not only increases the sensitivity of d-c carrier-type amplifiers, but, in addition, eliminates to a considerable extent contact hazards commonly found in ordinary chopper circuits. Among the meter's more important applications are delicate temperature measurements, geophysics, meteorology, medical research, slowly changing strains and stresses, null detection in extremely sensitive bridges, chemical research and nuclear research as well as measurement of the output

HOW ALDEN CAN HELP YOU IN THE DAYS AHEAD

Now, more than ever, it is tremendously important that *each component on your line fall into place with maximum ease and speed,* using a minimum of highly skilled labor. *Don't eat up thousands of precious man-hours* with bulky, awkward parts that slow down and often stop an entire assembly line. . . . *Don't get stuck with an impossible design* that needlessly taxes the patience and skill of assemblers, and which, when finally assembled, presents further problems of check and service.

It is extremely necessary in the critical days ahead to *hurdle production pitfalls* and produce the best and fastest way possible. Using components of ALDEN Design will help you to avoid *stumbling blocks and bottlenecks* of bulky, poorly engineered components and enable you to manufacture equipment with *maximum ease and efficiency.*

To get real production design, one has to *know and appreciate* the production problems—For over 15 years we have been engineering and manufacturing electrical and electronic components that have become standard for many applications because of both *good engineering principles and practical working production design.* We use these components in many of our own designs; therefore we actually anticipate and take into consideration the end use. We *test and judge* each new component by how it will *save* you time, material, and money; how it will *add* to the performance of your product; and how it will *fall* into standard production assembly techniques.

ALDENS is set up with *extremely flexible production facilities* and has readily available many techniques not generally found under one roof. The diversity of skills and combined technical and practical knowledge of engineering and manufacturing enables us to supply you with a *whole series of components* production designed to *prevent headaches* and *save valuable man-hours* of engineering, planning, purchasing, and manufacturing departments.

Save time, save money, eliminate waste—Know ALDEN design.

Send for descriptive folder, "What's New at Alden's" . . . .

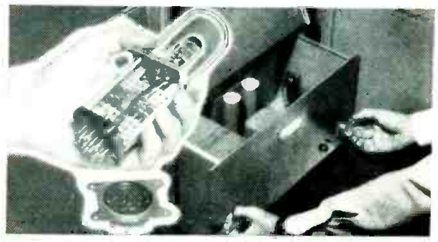
See us at Booth N-3 The I.R.E. Show

NA-ALD

ALDEN PRODUCTS COMPANY

117 N. Main St., Brockton 64E, Mass.

PLUG-IN COMPONENTS

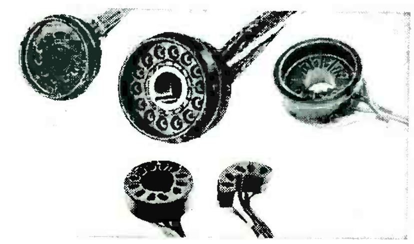


ALDEN is pioneering a whole series of components for plug-in unit construction . . . *Accessible,* back connected, slide-in lock-in chassis, rugged color-coded back connectors for slide-in plug-in chassis, dress up housing and rugged bases for plug-in units, and quick acting, *easily operable* fastenings and locks for plug-in units. ALDEN design is tremendously popular and is fast becoming the *standard* for plug-in construction.

Sturdy plug-in chassis design gives you quick and positive insertion and removal. ALDEN *color-coded* back connectors make and break electrical connections smoothly and efficiently—rapid check, service and changeover of chassis unit is completed with ease.

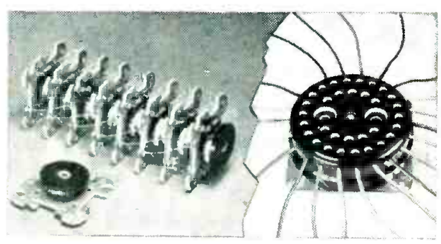
Extremely flexible plug-in kits allow you to design circuits and mount components as *ultra-compact* plug-in units . . . *on a production assembly basis.*

TOP CONNECTED CONTACT CONNECTORS



Here are connectors that you can't afford not to be acquainted with. From single wire to multi-wire connectors you get these *exclusive* performance design features. ALDEN famous *top connected contacts* which allow *ultra compact connector design requiring less space, less material*—lead is attached directly to forward end of the contact; No metal is wasted; No bulky housing is necessary. *100% molded insulation around each clip and lead*—no danger of insulation pull-back and no need of insulating tubing around wiring. *Individual strain relief on each lead*—lead held without the use of cable clamps or Underwriters' knot. Wire is crimped firmly to contact at solder joint and capillary action gives *perfect connections without danger of cold solder joint.*

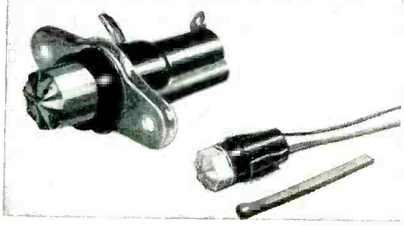
COMPUTER COMPONENTS



Imagination and *ingenuity—skill* and *production facilities* are combined at ALDENS to manufacture computer components that are standard production items. ALDENS is working with laboratories and other manufacturers developing computer components—taking them from the idea stage, designing them into components embodying *working* production design principles and getting into volume manufacture.

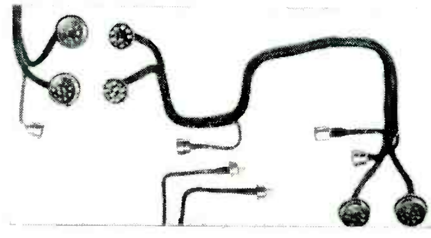
Recent developments include a multiple connection socket for the RCA SB256 Memory Tube and a new storage and pulse handling component, the Static Magnetic Memory, designed and manufactured in conjunction with the Harvard Computation Laboratory. ALDEN'S skill and ingenuity at setting up assembly line techniques greatly *reduces* costs and makes available *practical* components that permit the profitable application of many new ideas in the computer field.

MINIATURIZED COMPONENTS



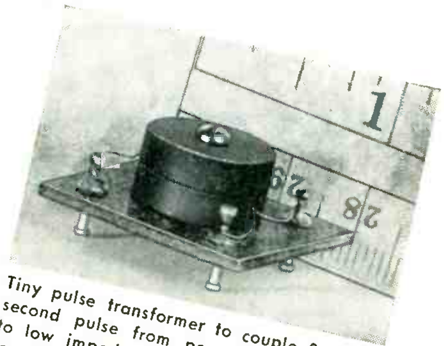
Squeeze without sacrificing efficiency or performance—ALDENS has long anticipated the trend to miniaturization and has been conducting extensive work for both government and commercial applications—already has a wide line of components developed which can become standard to help meet many of your limited space requirement needs. Connectors, indicator lights, fuseholders, terminals, plugs and sockets all take a minimum of space, and yet, good *practical engineering design* has eliminated possible assembly *bottlenecks.* Carefully designed ALDEN components *readily* fit into your production techniques using standard production tools.

UNIT CABLING

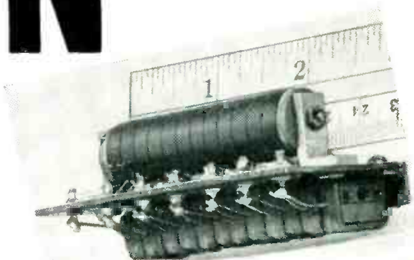


ALDEN *performance proven* unit cabling is designed *specifically* for the job it is to be used on . . . . . Here is what ALDEN engineers do for you—take your prototype model, engineer to *your specific requirements* cables which incorporate years of technical design and development of connectors and wire services. You get cables that are economic and efficient units which allow instant continuity checks and rapid replacement in the field. ALDEN unit cabling *solves* the problems of malfunctions, time delays, excessive production costs and high service cost in the field caused by cables designed as an *afterthought.*

DESIGN AND PRODUCTION FACILITIES ...NOW AVAILABLE



Tiny pulse transformer to couple 2 microsecond pulse from power amplifier tube to low impedance load. We can produce low power pulse transformers to reproduce pulses of widths ranging from a fraction of a microsecond to several milliseconds.



Lumped delay line with phase correction: 1750 ohm; 20 microsecond delay; cut-off frequency of 200 kc; ½ db power loss. We are prepared to make delay lines covering the audio and radio frequency spectrums.

Low-loss inductor: inductance = 1 henry; Q = 400 at 30 kc. Extremely low-loss inductors and high-fidelity transformers are obtainable over a wide range of values and frequencies, using similar structures in various physical sizes.

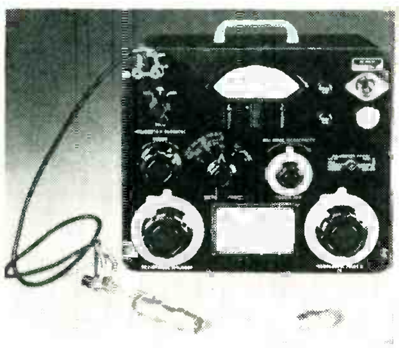
In the course of a current assignment, these components were developed. We invite inquiries regarding similar requirements where an unusual approach and exceptional engineering ability and material know-how are requisites.

NETWORKS • FILTERS • TRANSFORMERS • REACTORS

ELECTRONIC COMPUTER Corp.

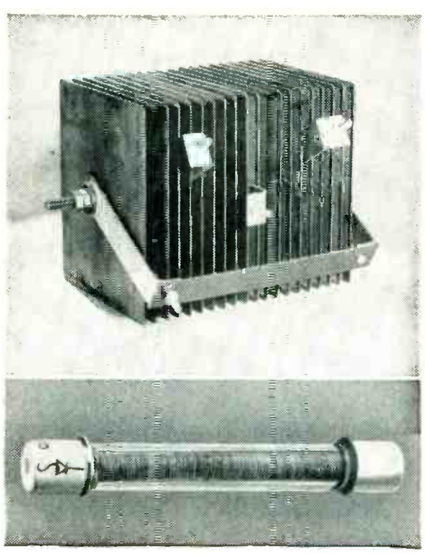
265 BUTLER STREET, BROOKLYN 17, N. Y. TRiangle 5-2324

of h-f vacuum thermocouples, bolometers and crystal diodes.



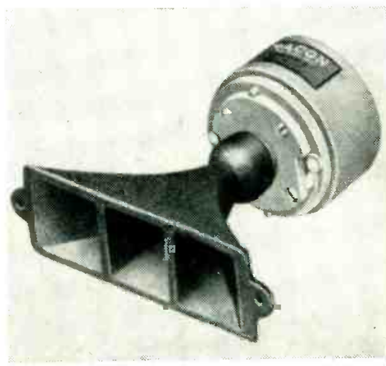
General Purpose Bolometer Bridge

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1651-A bolometer bridge has been designed for maximum flexibility in application, so that it can be easily adapted to a variety of power measurement problems. It can be used with any bolometer having a resistance between 25 and 400 ohms. Measurements can be made either by a direct-reading or a substitution method. Current range is 0 to 100 ma; power range, 0 to 500 mw. It operates from the 60-cycle line and is priced at $325.00 exclusive of bolometers.



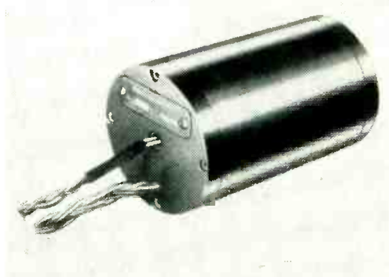
Power & H-V Selenium Rectifiers

Sarkes Tarzian Inc., 415 North College Ave., Bloomington, Ind. Centre-Kooled power rectifiers are available in 10 basic cell sizes and by employing series-parallel connections and combinations, any practical current and voltage range is attainable. Applications include battery charging, electroplating, railway signaling, aviation, elevator control and power supply, cathodic protection and wherever d-c is either required or desirable. High-voltage selenium rectifiers are available in two cell sizes with inverse voltage ratings to 5,000 v and d-c current ratings of 5 and 25 ma in half-wave circuits and 10 and 50 ma in full-wave circuits.



Wide-Range Tweeter

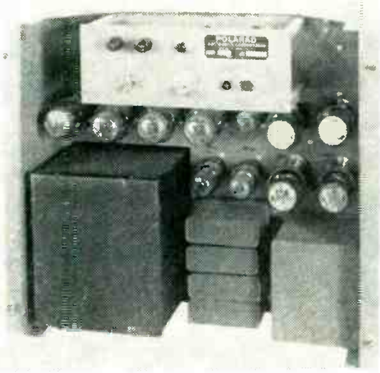
RACON ELECTRIC CO., INC., 52 East 19th St., New York 3, N. Y. Specially designed for high-quality wide-range audio systems, model CHU-5 tweeter provides clean and uniform response to 12,000 cycles, with excellent usable output to beyond 15,000 cycles. When used with a 12 to 15-in. cone speaker and proper network, it handles 25 to 30 watts of program material. Impedance is 15 ohms. List price is $30.50.



Phase Converter

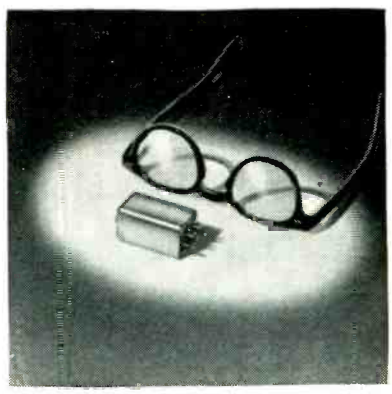
FORD INSTRUMENT CO., DIVISION OF THE SPERRY CORP., Long Island City 1, N. Y., is producing a new, com-

pact phase converter which converts a primary 4-phase supply for multiphase telemetering equipment. It is a nonrotating unit with movable primary for initial setting. Weighing 30 ounces, with an over-all length of 3.5 in. and a diameter of 2.25 in., it replaces bulkier transformers, with resultant space and weight saving. The outside shell is anodized to insure corrosion protection.



Regulated Power Supply

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., announces the model PT-112 regulated power supply. The unit is designed to provide high current drain at precisely regulated voltages to meet the need of the television industry. It is adjustable from 250 to 300 volts and delivers in excess of 800 ma. Ripple is held to the extremely low levels required of tv applications. Regulation is better than 0.02 percent. Output impedance is less than 1½ ohms.



Sensitive D-P Relay

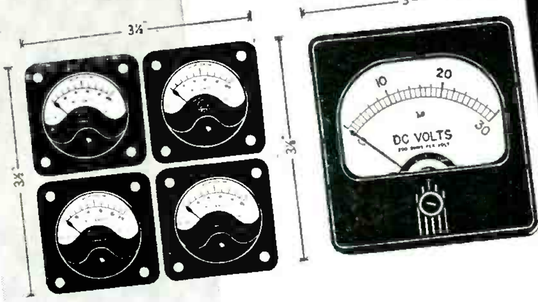
SIGMA INSTRUMENTS, INC., Boston 21, Mass. The hermetically-sealed

DeJUR makes great little meters . . .

Panel Meters

- Miniature 1 1/2″ square
- Waterproof sealed
- Obtainable with Lucite scales and Magnetic Shielding

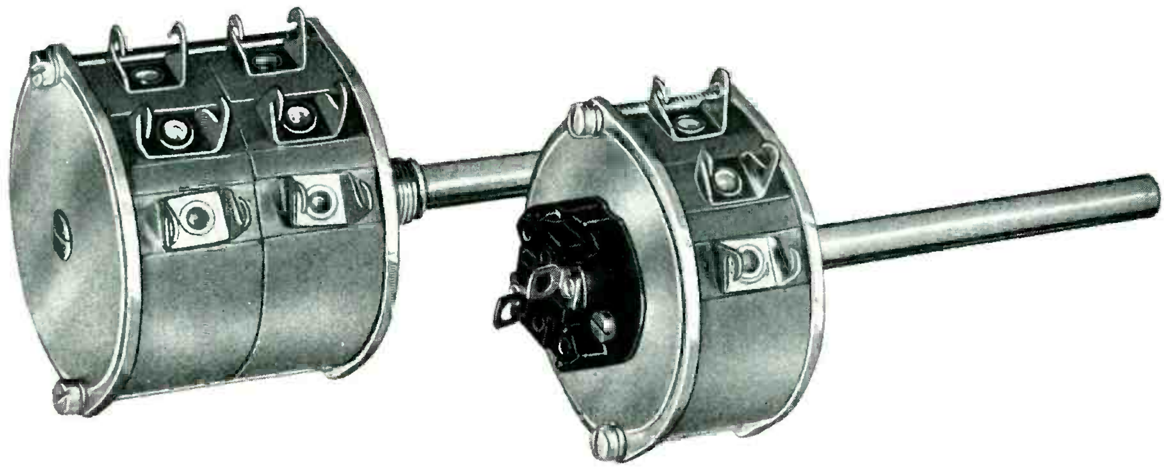
Larger sizes available
2 1/2″ round
2 1/2″ square
3 1/2″ round
3 1/2″ square
4″ square
JAN-1-6 and A.S.A. specifications



Built to Conform to Forthcoming JAN Spec. for 1 1/2″ Meters

PRECISION *Potentiometers*

BRAND-NEW MODEL L-400



FEATURES

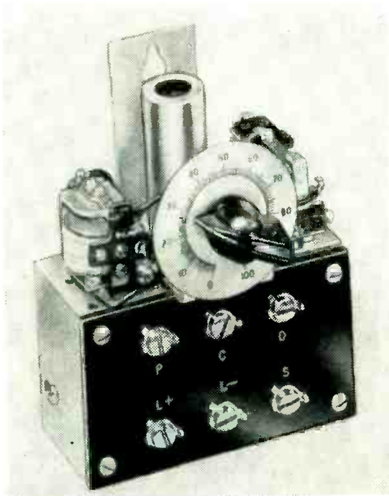
- 1 5/8″ diameter
- 3 watts
- Fully Enclosed
- Linearity Accuracy-Standard 0.5% (0.3% on order)
- Available with or without switch
- Designed for easy ganging
- Double end shaft available
- Will meet JAN-R-19 Specs

Drop in to see us at our factory.
We're just across the bridge. Take IND subway to 46th Street, Long Island City.

DeJUR USA

DeJUR AMSCO CORPORATION
45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.
MANUFACTURERS OF SCIENTIFIC PRECISION EQUIPMENT FOR OVER A QUARTER OF A CENTURY

d-p relay illustrated measures 1 in. square by 1¾ in. high, exclusive of the terminals. Sensitivity is approximately 40 mw. Such relays withstand better than 10 g vibration at frequencies in excess of 60 cps. When 2 to 1 margins for OPERATE and RELEASE current are provided the new miniature relay can be used under conditions of sustained acceleration as high as 50 g.



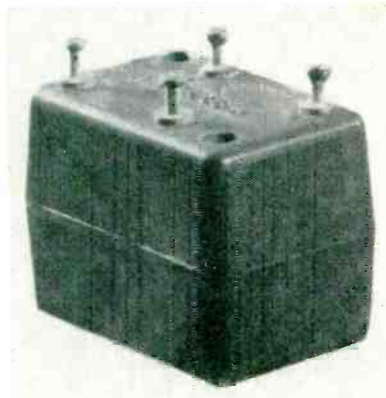
Electronic Timer

FARMER ELECTRIC Co., 21 Mossfield Rd., Waban 68, Mass. Model CK electronic timer overcomes the need for frequent tube replacement by use of the type 5823 cold-cathode tube. A further advantage is the ability to recycle the timer immediately. Four time ranges are available: 1.5, 3, 6 or 12 seconds; and a dial with 100 graduations allows the unit to be set for any desired percentage of the total range. The timer operates directly from 10 to 125 volts, 60 cycles. Its load control relay handles 8 amperes noninductive load at 125 volts a-c, in a spdt circuit with no intermediate OFF.

Resistance-Wire Strain Gage

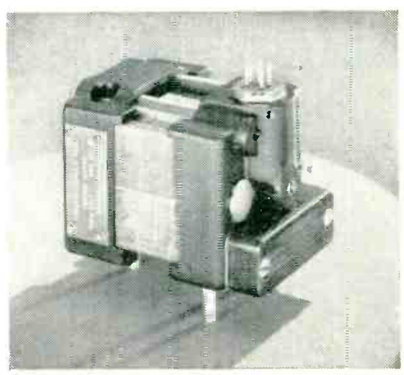
BALDWIN LOCOMOTIVE WORKS, Philadelphia 42, Pa. Type SR-4R bonded resistance wire strain gage is self-compensated for temperature variation. Its principal advantage is elimination of a second strain gage to compensate for tem-

perature changes, thus saving application time and wiring. Basically, the new gage is similar to standard Bakelite gages with cupronickel wire and its application is by means of the same methods and phenol-resin cement. Gages for two temperature ranges are offered: 50 to 300 F and −50 to 300 F. Single-element gages for Dural or steel are available in four lengths: $\frac{1}{4}$ in., $\frac{3}{8}$ in., $\frac{13}{16}$ in. and $\frac{7}{8}$ in.



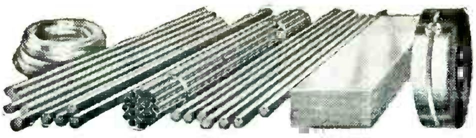
Pulse Transformers

ENGINEERING RESEARCH ASSOCIATES, INC., 1902 W. Minnehaha Ave., St. Paul W4, Minn., is manufacturing a line of pulse transformers designed especially for circuits requiring low power applications. General applications include triggering and counting circuits and blocking oscillators. More specific uses are for d-c isolation, inversion, pulse shaping and pulse transmission circuits. Specifications for the entire line may be found in brochure PX29394.



Torque Motor

TRANS-SONICS, INC., Bedford Airport, Bedford, Mass. Type 35–1



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Selling to Department of Defense —Army, Navy and Air Force

The information contained on this page relative to selling to the Military Departments of the Department of Defense was obtained from the Munitions Board Small Business Office.

Manufacturers, faced with material shortages and curtailment of civilian goods, are of necessity seeking defense orders to keep their plants operating. These do not come without effort on the part of the manufacturer.

However, a manufacturer may waste time seeking war orders through trips to Washington. Information, and eventually orders, can be obtained more quickly and easily by writing.

The Department of Defense, under which falls the Army, Navy and Air Force, has assigned to individual military departments responsibility to procure certain supplies and services for all three units.

At the same time the Army, Navy and Air Force have offices which buy for their individual needs.

Get on "Bidders Lists" for Prime Contract Work

All of these offices have what is known as "bidders lists". The manufacturer should be on these lists to receive a chance to bid on a formally advertised contract or to be approached for a negotiated contract.

Wherever possible, the advertised method is used. However, negotiated contracts are permitted under the recently declared national emergency.

The Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., has available three booklets. These publications list the purchasing offices of the Army, Navy and Air Force, and give a brief descriptive list of the items each purchases. The method of getting on "bidders lists" and the necessary steps in seeking contracts are also explained:

1. "How to Sell the U. S. Army" (30 cents).
2. "Purchasing Items and Purchasing Locations of the Department of the Navy" (20 cents).
3. "A Guide for Selling to the U. S. Air Force" (15 cents).

IT'S YOUR JOB!

There is no easy way to do business with the Government. You must exercise just as much initiative, enterprise and salesmanship as you would in doing business with private industry.

Another service is available to manufacturers for information as to the purchasing office to write to for a specific product or products. A letter listing products you are making or can make should be addressed to:

The Military Procurement
Information Office
Munitions Board
The Pentagon
Washington 25, D. C.

Information as to specific offices to contact for getting on bidders lists will be sent to you. This office will also answer questions pertaining to defense orders.

When you have obtained the name and address of the office, or offices, interested in procuring your goods, a simple letter, illustrated on this page, will either put your company's name on the bidders list or bring application blanks.

Daily Listing

As an aid to businessmen in obtaining current information as to what the Government is purchasing, and an opportunity to bid, the U.S. Department of Commerce publishes daily a "Consolidated Synopsis of U.S. Government Procurement Information." It lists the purchasing office making the procurement, the item contemplated and the amount, the invitation for bid number, and the bid opening date. A firm may bid on any item listed by writing to the office doing the buying, giving the IFB number, and requesting a bidding set.

Sub-contract Work

Up to this point only prime contracts have been discussed. There are, however, many concerns who can handle, or desire, only sub-contract work such as screw machine, press, tool shops, etc.

To facilitate small business in obtaining the names of the firms awarded unclassified Department of Defense contracts in amounts over $25,000, the Department of Commerce publishes weekly the "Consolidated Synopsis of Contract Award Information." This gives the name and address of the successful bidder, the commodity purchased, the quantity, and the value.

Both contract award and procurement information synopsis may be reviewed at your local Chamber of Commerce or nearest field office of the U. S. Department of Commerce. If you wish to receive these regularly write to:

U. S. Department of Commerce
Division of Printing Services
Washington 25, D. C.

Suggested Letter Seeking Bids

(Company Letterhead)

Commanding Officer
(Purchasing Office)
(City, State)

Dear Sir:

Our firm is desirous of supplying items centrally procured through your office, as outlined in pamphlet "How to Sell to the United States Army" and/or "Purchasing Items and Purchasing Locations of the Department of the Navy", and/or "A Guide for Selling to the U. S. Air Force".

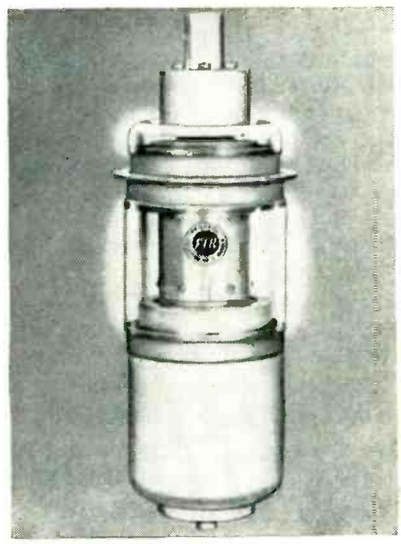
Attached hereto is a list in duplicate of items which we desire to furnish. Where known, we have also indicated the applicable Government specification.

As we have never before bid on business through your office, we are attaching a copy of our most recent balance sheet, and profit and loss statement.

It is recognized that your office is extremely busy under the impact of procurement necessitated by the present emergency. No formal reply is requested, however, we would like the duplicate list returned to us in the enclosed self-addressed stamped envelope. Please mark any items that are not procured by your office, and if possible indicate the appropriate purchasing office.

Yours truly,

torque motor is an electromechanical device that uses an electrical current to produce a backlash-free translational motion, such as is suitable for displacing the piston on a hydraulic amplifier. By utilizing this torque motor design, electrohydraulic servomechanisms with natural frequencies as high as 100 cps have been constructed. The unit provides a linear motion of ±0.004 in. and will move approximately 0.001 in. per ma of signal current. The locked rotor force output is 4 pounds for a differential current of 5 ma. The input may be connected directly to the plate circuit of a push-pull amplifier, and a pair of subminiature vacuum tubes are sufficient to provide full output from the motor.



Power Triode

FEDERAL TELEPHONE AND RADIO CORP., 100 Kingsland Road, Clifton, N. J. The F-5512 power triode is designed for use in high-powered tv and f-m broadcasting, cyclotron or synchrotron oscillators, and industrial h-f heating equipment. It operates in the 88 to 108-mc range. The anode is fabricated from oxygen-free, high-conductivity, heavy-wall copper, which allows a more uniform heat distribution and higher dissipation than a thin-wall anode. High mutual conductance makes it possible to obtain 25-kw output at 7.5 kv, eliminating the high cost of 10 or 15-kv rectifiers usually associated with high-power

SPEED UP

You'll collect data more quickly, simply, objectively . . . with the help of Panoramic instruments. Unexcelled for laboratory, research and production applications requiring spectrum or waveform analysis.

Spectral components are seen graphically on a cathode-ray tube as sharp vertical deflections distributed horizontally in order of frequency. Deflection height directly indicates component or signal level.

Whatever your problem—analyzing waveform distortions, noises, characteristics of AM, FM or pulsed signals, vibrations, spurious oscillations or modulation, response characteristics of filters or transmission lines or monitoring many frequency channels simultaneously — you'll find a Panoramic analyzer to answer your needs.

● Complete Display of these and other Panoramic instruments in operation at the

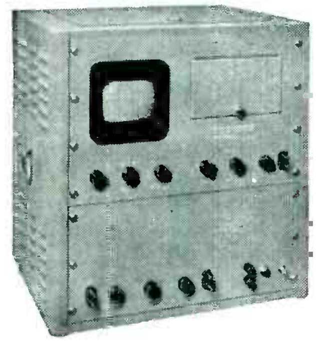
IRE SHOW
BOOTH #N-6

SPECTRUM ANALYSIS FROM AF TO UHF
with easier-to-use
PANORAMIC INSTRUMENTS

PANORAMIC SONIC RESPONSE INDICATOR G-2
for More Accurate Frequency Response Measurement

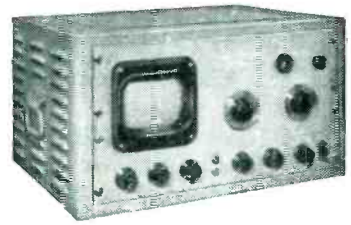
Used with Model AP-1, the G-2 allows visual inspection of the amplitude vs. frequency characteristic of systems in the range between 40 and 20,000 cps. May be used for research, development or production line testing of the frequency response characteristic of amplifiers, speakers, filters, transmission lines, receivers.
The G-2 is advantageous for study of systems in which the presence of noise or non-fundamental components obscure or distort the output at the exploring frequency.
Calibrated log frequency scale
Linear or log (60 db range) amplitude scale.
Slow, 1 cps sweep rate
10-step attenuator with 100 db range selects
output voltages between 50 microvolts and 5 volts.
3 selectable output impedences; 100 ohms; 500 ohms; 3000 ohms

PANORAMIC SONIC ANALYZER, MODEL AP-1
Automatic Waveform Analysis in Only 1 Second



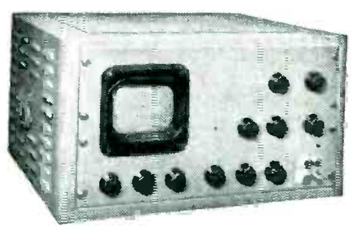
Here is your answer for truly simple high speed analysis of vibrations, harmonics, noises, acoustics and intermodulation under static or dynamic conditions. AP-1 automatically separates and measures frequency and magnitude of complex audio wave components.
Frequency Range..........40-20,000 cps, log scale
Imput Voltage Range..................500uV-500V
Voltage Scale...........Linear and two decade Log
Resolution.....Optimum throughout frequency range
Presentations easily photographed or recorded. Can be calibrated for determining level of individual sound or vibrational components.

PANORAMIC ULTRASONIC ANALYZER, MODEL SB-7
A New Direct Reading Spectrum Analyzer



An invaluable instrument for channel monitoring, telemetering, medical studies, and for investigating ultrasonic waveform content and ultra audible noises and vibrations, the SB-7 allows overall observation of a 200 KC wide band or highly detailed examination of selected narrow bands.
Frequency Range: 2KC-300KC, linear scale
Scanning Width: Continuously variable, 200KC to zero
Amplitude Scale: Linear and two decade Log.
Imput Voltage Range: lmV-50V
Resolution: Continuously variable from 2KC to better than 500 CPS.

PANADAPTOR, SA-8 PANALYZOR SB-8
For RF Spectrum Analysis where Maximum Resolution is a "Must"



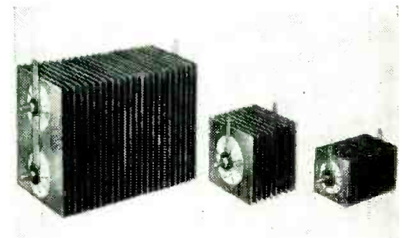
Available in several types with maxium scanning widths ranging from 200 KC to 10MC, both the SA-8 and SB-8 feature . . .
- Continuously Variable Resolution from 100KC to 100cps
- Synchronous and Non-synchronous Scanning
- Long Persistence Displays plus Intensity Grid Modulation for Analysis of Pulsed RF Signals
- Continuously Variable Scanning Width from Maximum to Zero

PANADAPTOR SA-3, SA-6 PANALYZOR SB-3, SB-6
For General RF Spectrum Analysis

Recognized as the fastest and simplest means of investigating and solving such RF problems as frequency stability, modulation characteristics, oscillations, parasitics and monitoring under static or dynamic conditions, these models are available in over a dozen different types, designed to meet your particular application.
Panadaptor units operate with superheterodyne receivers which tune in the spectrum segment to be observed.
Panalyzors use an external signal generator for this purpose and have a flat response for determining relative levels of signals.

PANORAMIC
RADIO PRODUCTS INC.
10 SOUTH SECOND AVENUE, MOUNT VERNON, N. Y

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND PRICES tubes. Filament current is 435 amperes at 6.2 v.



Selenium Rectifiers

SYNTRON CO., Box 220, Homer City, Pa., is producing a line of selenium rectifiers made by a vacuum process that insures a smooth uniform selenium film, free from flaws, and permits thicker deposits of selenium and the production of larger cells than have been practical heretofore. Cells are available in 16 standard sizes. Rectifier stacks are arranged in various circuits depending on the d-c voltage and current requirements and the a-c supply voltage.

Ionizing Flash Lamp

KEMLITE LABORATORIES, 1819 W. Grand Ave., Chicago 22, Ill., has developed a new low-voltage electronic ionizing flash lamp for use with units in the repeating photoflash and stroboscopic fields. Of the gaseous ionizing type, it achieves intense light output by temporary electronic disturbance of inert gas molecules rather than by the filament burning process common to incandescent lamps. This so-called cold light is gained without material loss or destruction and, consequently, useful life is extreme and virtually constant in effect.

Precision Regulator

WESTINGHOUSE ELECTRIC CORP., 306 Fourth Ave., Pittsburgh 30, Pa. The Microsyn precision regulator can perform the following operations: (a) produce a voltage proportional to turning a rotor over a range of ±10 deg. with a sensitivity of 20 seconds; (b) produce a torque that is linear with the square of a signal current; and (c) act as an elastic restraint generator, producing a torque proportional to the product of the square of a current and the angular displacement. The magnetic structure is of Hipernik specially processed to give a hysteresis loop of small area, and a permeability of 100,000 with 0.03-oersted coercive force.

Variable Capacitors

JFD MFG. CO., INC., 6101 Sixteenth Ave., Brooklyn 4, N. Y. The new piston-type variable trimmer capacitors are tubular in design and deliver continually uniform change of capacitance in relation to rotation. Only 1 in. in length, they offer maximum space economy with ease of mounting. Other features include: approximately zero temperature coefficient; Q rating of over 1,000 at 1 mc; 55C to −100C operating temperature; 10,000 megohms insulation resistance. The capacitors offer engineers, experimenters, technicians and designers the unusually low capacities needed especially in the operation of commercial and government land and marine communications and microwave equipment.

Literature

V-T Electrometer. Keithley Instruments, 1507 Warrensville Cen-

HERE'S WHY

you may have to wait for AEROCOM Equipment...

On June 27, 1950, Aerocom was humming along — smoothly geared to the needs of its customers...filling orders as rapidly as required. After Korea, volume of orders rapidly increased to a level far beyond normal.

As this is written, it takes up to six months to fill DO rated orders for high-quality Aerocom equipment. Aerocom suggests that you anticipate your needs as far ahead as possible, so that you may continue to be served by the best in communications, electronic, and meteorological equipment.

CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT

AER-O-COM Reg. U. S. Pat. Off.

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DANDUX

Canvas & Leather Products

BAGS and CASES
BG BAGS
CW BAGS
RADIO EQUIPMENT
ELECTRONIC EQUIPMENT
RADAR EQUIPMENT
TOOL ROLLS

C. R. DANIELS, INC.
75 West St., New York 6, N. Y.
549 W. Randolph St., Chicago 6, Ill.

ASTRON

ELECTROLYTIC CAPACITORS

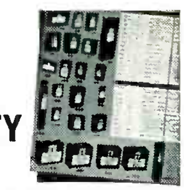
Consecrated to Quality Output and Golden Rule Service

Because of LONGER LIFE on the job . . . because of compactness, easy mountability and perfect compliance with today's set-engineering requirements . . . these dependable Electrolytic Capacitors are rapidly becoming a MUST with leading radio and television manufacturers. We believe they belong in YOUR plans for 1951. Get acquainted with them, and the rest of the extensive ASTRON line.

WRITE FOR CATALOG **AC-2**

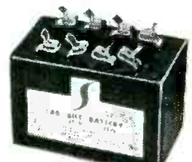
ASTRON CORPORATION 255 Grant Ave., East Newark, N. J.
Manufacturers
HIGH QUALITY FIXED CAPACITORS AND FILTERS

SPECIALTY



LAB-BILT DRY BATTERIES

INDUSTRY



LABORATORY

RADIO AND IGNITION

Write for New FREE CATALOG

Here are complete descriptions of 78 Lab-Bilt Batteries of industrial and hard-to-get types. Specification Sheet enables you to order batteries especially designed to your own requirements. No order is too small. Specialty makes and ships FRESH Lab-Bilt Batteries without delay. Get this new catalog today.

SPECIALTY BATTERY COMPANY
Ray-O-Vac RAY-O-VAC Subsidiary
MADISON 10, WISCONSIN

ter Road, Cleveland 21, Ohio. A recent 4-page folder covers the model 200 vacuum-tube electrometer, a self-contained d-c voltmeter that has an extremely high input impedance. The unit described measures voltages on two ranges. 2 v and 20 v 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; its input resistance being greater than 10^{14} ohms, and the capacitance approximately 6 $\mu\mu$f.

Electromagnet. Arthur D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass., has published a 4-page folder dealing with its versatile electromagnet, a new research tool for producing high flux density magnetic fields. Illustrations, typical characteristics, outstanding features and research applications of the laboratory unit are shown.

Subminiature F-M Transmitter. Telemetering Associates, P. O. Box 6, Silver Springs, Md. A single-page bulletin describes the model T-1 subminiature f-m transmitter designed primarily for exacting telemetering applications. The unit treated consists of a triode oscillator, pentode reactance-tube modulator and a triode amplifier. Specifications and typical operation details are included.

Sound Level Meter. Dawe Instruments Ltd., 130 Uxbridge Road, Hanwell, London W7, England. Type 1400 sound level meter, a self-contained portable instrument giving a direct measurement of sound level over the full audible range, is illustrated and described in a recent single-sheet bulletin. Technical specifications are given and accessory equipment is described.

Electrometer. Loudon Instruments, Inc., 5644 Lake Park Ave., Chicago 37, Ill. A recent bulletin gives a very complete description, with specifications, of the model 361-20 electrometer, an instrument designed for measurement of small direct currents and voltages in high resistance circuits. Features making the unit described important for general laboratory appli-

cations are its fast response, independence of calibration, simplicity of operation and versatility.

High-Potential Testers. Associated Research, Inc., 3758 West Belmont Ave., Chicago 18, Ill. Bulletin 4A deals with the Hypot Juniors, a line designed for high-potential testing for leakage, breakdown or shorts in a single instrument. Illustrations, complete description, details on simple operation and technical specifications are included.

Hook-Up Wire. Rome Cable Corp., 330 Ridge St., Rome, N. Y. Bulletin TR-901 gives complete information on a new high-temperature, space-saving radio and tv hook-up wire with an 8-mil wall. The wire described is insulated with Synthinol 901, a thermoplastic compound, plus nylon sheath or lacquered braid and is fully approved by Underwriters' Laboratories, Inc. for continuous operation at 90 C above or below the chassis in approved applications. Diameters available for the wire discussed range from 0.051 in. to 0.1 in.

Servo Unit. Avion Instrument Corp., 121 East 24th St., New York 10, N. Y. A single-sheet bulletin treats of the type 60-A servo unit designed for use in computer circuitry and for remote positioning devices requiring low torque. Photographs, description of operation, typical specifications and dimensional diagrams are included.

Bimetal Strip Thermostats. Stevens Mfg. Co., Inc., 69 South Walnut St., Mansfield, Ohio. Bulletin F-2008 describes the type C bimetal strip thermostats for use in communications equipment, electronic and avionic devices, and other types of electrical apparatus. It is illustrated with photographs of standard and hermetically sealed models, dimensions, a schematic diagram showing operating principle and a typical thermostat response curve.

VHF Crystal Probes. United Technical Laboratories, Morristown,

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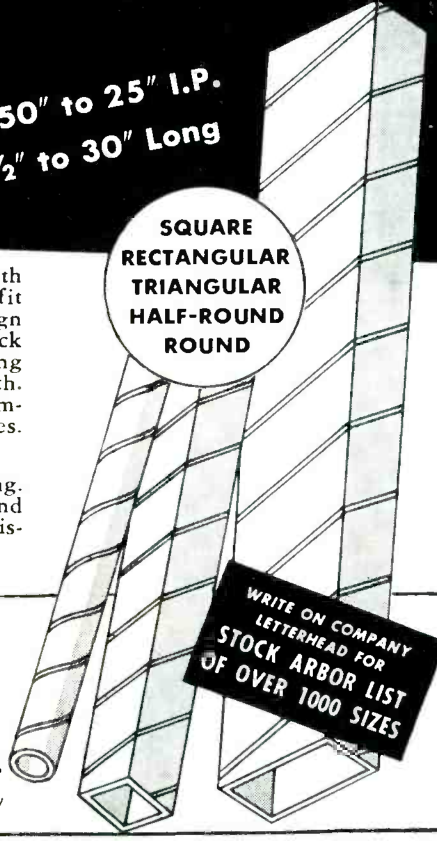

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SPECIFICATIONS:

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2. **SINE WAVE AMPLITUDE:** Varies less than ± 0.25 db (3%) over the entire frequency range.
3. **DISTORTION & HUM:** Less than 0.25% over the entire frequency range.

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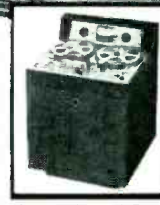

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N. J. A four-page folder illustrates and describes the Klipzon types V and C vhf germanium crystal probes designed to add versatility and speed to laboratory and service equipment. The probes discussed feature unique self-holding test points and complete shielding, and the price of each is $6.95.

Substitution Tubes. Sylvania Electric Products Inc., Emporium, Pa., has announced a new 40-page tube substitution manual for quick reference for substitute types of radio and tv tubes. The manual is arranged in nine sections providing informative text and charts on general tube classification; circuit modifications in which additional resistors are needed; substitute battery-type tubes; substitute 150-ma types; substitute 300-ma types; substitute transformer and auto tube types; substitute tv receiving tubes; substitute tv picture tube types; and frequently needed changeover diagrams.

TV Products. Brach Mfg. Corp., 200 Central Ave., Newark, N. J., is distributing a catalog describing all its new and current products. It is divided into two sections: one describing tv antennas and accessories, and the other, the components of the Mul-Tel system. Actual pictures are used to describe the individual units, except for minor accessories where drawings are employed.

Electron Tubes. Radio Corp. of America, Harrison, N. J. Designed for users in industrial, broadcast, experimental, and similar fields, the new CRPS-102-A booklet provides detailed technical data on more than 150 electron tubes. Technical information, arranged in tabular form, includes descriptions, rating, operating conditions, dimensions, base and envelope connection diagrams and applications of a line of phototubes, cathode-ray and special tubes.

Replacement Control Chart. Centralab Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisconsin, has available a new,

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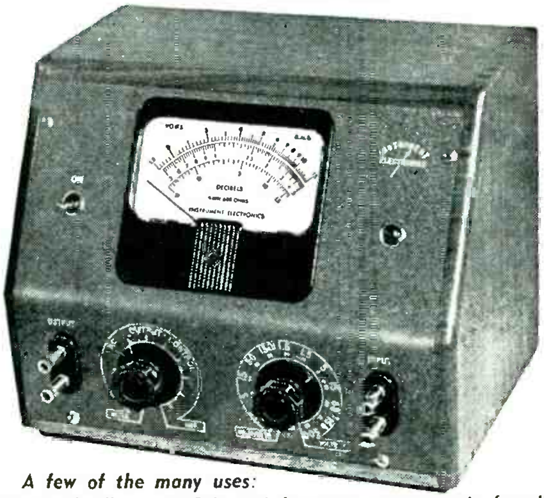

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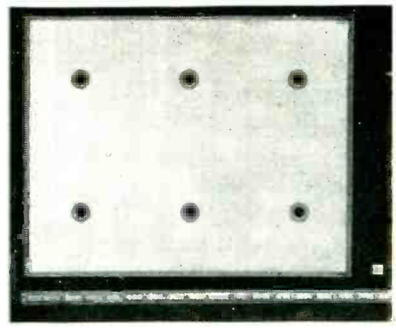

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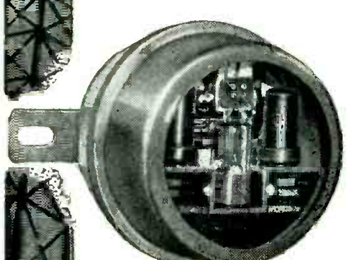

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Oscilloscope Camera. Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y., has issued a 20-page booklet containing the transcript of an address on the model F-284 Polaroid-Land camera for oscilloscope recording. The booklet is fully illustrated, gives a complete description of the unit, and contains a section of pertinent questions and answers.

Capacitor Catalog. Illinois Condenser Co., 1616 North Throop St., Chicago, Ill. A 12-page catalog describes and illustrates a line of six types of capacitors. Data shown for each are the part numbers, with their individual capacitance in $\mu\mu$f, d-c working voltage, diameter, length and list price.

Control Relays & Switches. Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill., has issued an 88-page catalog and technical guide covering its line of relays and switches for industrial control. Shown and described are telephone-type relays, stepping switches and mounting facilities. Featured are class B general-purpose relays and two new high-speed rotary stepping switches—types 44 and 45. Complete technical data are included as a guide for selection of components to meet any desired application, as well as data on hermetic sealing for all relay types.

Phase Sequence Indicator. Associated Research Inc., 3758 West Belmont Ave., Chicago 18, Ill. Bulletin 7A covers the model 40 phase sequence indicator for 115, 220 or 440-volt circuits. Illustration, mode of operation, chief features and price are given. The unit described, which weighs less than a pound, measures only 3 in. x 5½ in. x 2 in. and features instant reading.

NEWS OF THE INDUSTRY

(continued from page 150)

I. W. Hammer and P. H. Haas.

Spark-Over of Air at Radio Frequencies, by W. Caywood, Jr.

New Limits for Low-Level RF Energy Measurements, by W. K. Volkers.

Computers II—Analog Computers

A Sampling Analog Computer, by J. Broomall and L. Riebman.

A Time-Division Multiplier for a General Purpose Electronic Differential Analyzer, by R. V. Baum and C. D. Morrill.

A High-Speed Product Integrator, by A. B. Macnee.

Plug-In Units for Digital Computation, by G. Glinski and S. Lazecki.

A Five-Digit Parallel Coder Tube, by J. V. Harrington, K. N. Wulfsberg and G. R. Spencer.

Circuits III—General

A Linear Operational Calculus of Empirical Functions, by R. G. Piety.

Pulse Transformer Considered as a Wide-Band Network, by E. G. Rudenburg.

Single-Tapped Coil Delay Line, by S. G. Lutz.

Nickel Acoustic Delay Line, by T. F. Rogers and S. J. Johnson.

Amplifier Synthesis on Equal-Ripple Basis, by D. L. Trautman and J. A. Aseltine.

Broadcast and TV Receivers

90-Degree Deflection Yoke Design—The Design of Wide-Angle Deflection Yokes, by H. Thomas.

Semi-Automatic Fabrication of Audio and Video Equipment, by W. H. Hannahs, R. Bahr, and J. Caffiaux.

UHF Converter, by B. F. Tyson.

Power Supplies for Television Receivers, by A. M. Levine and S. Moskowitz.

Radio Receiver Subminiaturization Techniques, by G. Shapiro.

Microwaves III—Antennas and Artificial Dielectrics A

The Study of Artificial Dielectrics of the Obstacle Type, by C. Susskind.

Isotropic Artificial Dielectric, by R. W. Corkum.

A Virtual Source in Microwave Optics, by K. S. Kelleher.

Experimental Prototype of the Rinehart-Luneberg Lens, by E. C. Fine.

Propagation of Microwaves Between Parallel Conducting Surfaces, by K. S. Kuns.

Phase Shift of Microwaves in Passage Through Parallel-Plate Arrays, by D. J. Epstein.

Radar and Navigation

On the Measurement of the Radar Echoing Areas of Conducting Bodies, by J. R. Mentzer.

Polarization Properties of Target Reflections, by E. M. Kennaugh.

The Use of Circular Polarization as a Means of Reducing Radar Precipitation Return, by W. D. White.

An ICW System for Distance Measurements, by J. Lyman, G. Litchford and C. Grunsky.

Effects of Vertical Radiation Pattern on Omnirange Beacon Characteristics, by S. Pickles.

Thursday A. M., March 22
Nuclear Science

A Delayed Coincidence Scintillation Spectrometer, by F. K. McGowan.

Timing Unit and Pulse Deflector Generator for 145-Inch Synchrocyclotron, by E. M. Williams, C. H. Grace and L. W. Johnson.

Design and Construction of a Billion-Volt Linear Electron Accelerator, by M. Chodorow, E. L. Ginzton, J. Jasberg, R. Kyhl, R. Neal and P. Pearson.

Precise Measurement and Regulation of Magnetic Fields with RF Techniques Using Nuclear Resonance, by H. A. Thomas.

A High-Precision Magnetic Field Measuring Instrument, by E. C. Levinthal.

Television II

Parallel Operation of Vacuum Tubes at UHF to Obtain High Transmitter Power, by W. H. Sayer, Jr., and E. Mehrbach.

An Ultra-Portable Television Pickup Equipment, by L. E. Flory, W. S. Pike and J. E. Dilley.

The Technique of Dot-Arresting for Television Transmission Using Dot Interlace, by K. Schlesinger.

A Sweep Method for Measuring the Transmission Amplitude Characteristic of a Television Transmitter, by J. Ruston.

Circuits IV—Amplifiers

RF Amplifier Design for Low Noise Figure, by R. Guenther.

HF Amplifiers with Direct Coupling, by D. R. Crosby and K. F. Umpleby.

Distributed Amplification: Additional

Considerations, by J. Weber.
Distributed Amplification for Pulses, by R. B. White.
Cathode-Coupled Clipper Response, by P. F. Ordung and H. L. Krauss.

Audio

A Single-Ended Push-Pull Audio Amplifier, by A. Peterson and D. B. Sinclair.
The Application of Damping to Phonograph Reproducer Arms, by W. S. Bachman.
Transient Testing of Loudspeakers, by O. K. Mawardi.
A Practical Speech-Silencer for Radio Receivers, by R. C. Jones.

Microwaves IV—Antennas and Artificial Dielectrics B

The Half-Space as a Spherical Transmission Line, by L. Felson and N. Marcuvitz.
The Calculation of Progressive-Phase-Shaped-Beam Antennas, by A. S. Dunbar.
Physical Limitations on Minimum Side Lobes in Broadside Arrays, by J. Ruze.
The Behavior of Microwaves in Focal Regions, by F. J. Zucker.
A Microwave Schmidt System, by H. N. Chait.

Symposium: Telemetering Systems

Thursday P. M., March 22

Symposium: Nuclear Reactors

Television III—Receivers

Synchroflection: A Horizontal Deflection System Possessing Inherent Noise Immunity, by K. R. Wendt and W. K. Squires.
Internal Television Receiver Interference, by B. Amos and W. Heiser.
An RF Amplifier for the UHF Television Bands, by B. F. Tyson and J. G. Wiessman.
Television Line Selector with Automatic Identifier, by J. Fisher.
Development of a High-Stability UHF Television Tuner, by M. W. Slate, J. P. Van Duyne and E. G. Mannerberg.

Circuits V—Oscillators

Oscillator Frequency Indeterminancy, by L. Riebman.
Simultaneous Oscillations in Oscillators, by H. Schaffner.
Amplitude Stabilization of Oscillators by Nonlinear Networks, by L. Rosenthal.
Stability of Oscillations in a Nonlinear System, by N. R. Scott.
Tuned Coupled Circuit for Oscillator Application, by R. A. Martin and R. D. Teasdale.

Symposium: Loudspeakers

Microwaves V—Generators and Amplifiers

Low - Distortion Frequency - Modulation Modulators, by A. R. Vallarino.
1,700- to 2,400-Megacycle Triode Amplifier, by E. M. Ostlund and H. G. Miller.
A K-Band Amplifier Klystron, by W. G. Abraham and J. W. Clark.
Mode Interactions in Magnetron Oscillators, by R. Moats.
Guiding Principles in the Production of Submillimeter Waves, by H. M. Von Foerster and H. Schaffner.

Symposium: Simulation As An Aid to Design of Remote Control Systems

Eta Kappa Nu Awards

THE OUTSTANDING young electrical engineers of the U. S. were recognized and presented awards by the Eta Kappa Nu Association in New York during the week of the Winter General Meeting of the AIEE. To qualify for the award a candidate must be not older than 35 years nor be out of college for more than 10 years by May 1 of the year for which he is cited. After qualifying on these two counts the candidate is judged on the basis of accomplishment in professional, social and cultural fields.

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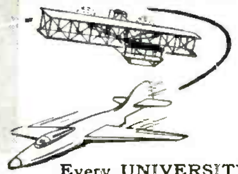

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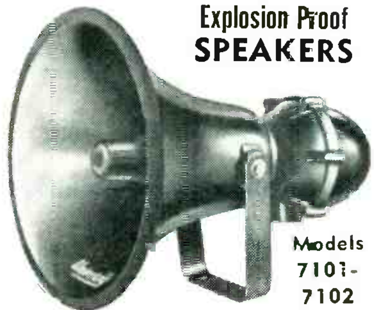

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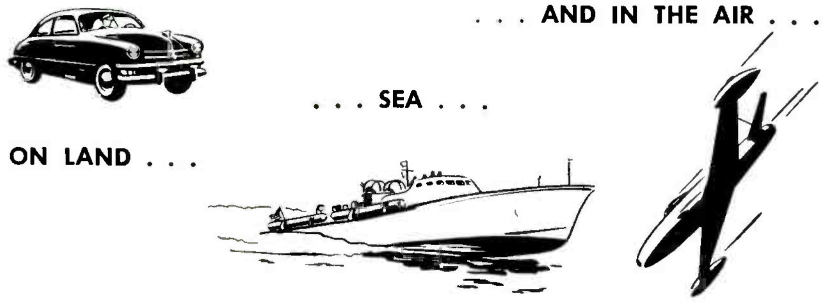

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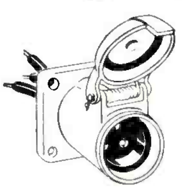

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EXPORT DIV., Dept. E-351

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Applicants should complete Standard Form 57, the application for Federal employment (available at any post office), and report for an interview at the Civilian Personnel Office.

BUSINESS NEWS

THE HENDERSON-SPALDING CO. of England has appointed the British Overseas Mart, Inc., 300 Fourth Ave., New York City, as sole American agent for the licensing of its patented Technograph process of printed circuit production.

KINGS MICROWAVE CO., INC. recently moved from New York City to 50 Marbledale Rd., Tuckahoe, N. Y.

ALTEC LANSING CORP. has opened a new plant in Beverly Hills, Calif. Over 30,000 sq ft are devoted to the assembly and testing of loudspeakers and amplifiers and to the complete fabrication of microphones.

THE SHELDON ELECTRIC CO. plant of Allied Electric Products Inc. has built a two-story addition to its main building in Irvington, N. J., to increase facilities for tube manufacturing.

PRECISION METAL PRODUCTS CO., manufacturer of electronic components, recently moved from Malden to Stoneham, Mass., to increase its manufacturing area.

LANSDALE TUBE CO., a subsidiary of Philco Corp., has purchased a site at Frederick, Md., for a new plant to manufacture electronic tubes for the Armed Forces and essential civilian requirements.

WESTINGHOUSE ELECTRIC CORP. has opened negotiations for a tract of land near the Baltimore, Md., Friendship Airport for a new plant to meet expanding military demand for products of the company's electronics and x-ray division.

MINNEAPOLIS-HONEYWELL REGULATOR CO., Brown Industrial Division, has expanded its output facilities by the purchase of the Thomas M. Royal plant and 60,000 sq ft of property adjacent to it in Philadelphia, Pa.

FIDELITY TUBE CORP. of East Newark, N. J., producers of tv c-r tubes, have announced plans for the manufacture of miniature receiving tubes and radar tubes for use by the armed forces.

LYSCO MANUFACTURING CO., INC., is the new corporate name of Lysco Laboratories, Hoboken, N. J. George R. Scott, formerly with Mackay Radio, has joined Lysco as president and chief engineer.

PERSONNEL

E. W. RITTER, with Westinghouse Electric Corp. since last April as a consultant, has been appointed manager of the company's newly formed electronic tube division. He will retain his headquarters in Bloomfield, N. J., for an indefinite period.

JOSEPH P. SPAULDING, formerly associated with the Naval Research Laboratory as a section head in the investigation and development of electronic devices, was recently appointed to the staff of the National Bureau of Standards, where he will

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OVER ONE MILLION AT WORK

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5 MILLIAMPERES DC

Circuit-Half-Wave. In 9/16″ OD Phenolic Tube with ferrule at each end for insertion in Fuse Clips. Overall length varies to 9″ depending on the DC output voltage rating.

PARTIAL LIST OF TYPE V-HF SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
40	V2HF	800	V40HF
80	V4HF	1500	V75HF
200	V10HF	2500	V125HF
600	V30HF	4000	V200HF

TYPE Y-HP SERIES

11 MILLIAMPERES DC

Circuit-Half-Wave. In 9/16″ phenolic tube with pigtail leads. The overall length of rectifiers in this series varies up to 9″, depending on the DC output voltage rating.

PARTIAL LIST OF Y-HP SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
20	Y1HP	1000	Y50HP
60	Y3HP	2000	Y100HP
100	Y5HP	3000	Y150HP
400	Y20HP	4000	Y200HP

TYPE V-HM SERIES

5 MILLIAMPERES DC

Circuit-Half-Wave. In 3/8″ metallic case with pigtail leads, the negative lead being grounded to the case. Overall length varies to 0.890″, depending on the DC output voltage rating. Also available in hermetically sealed units.

PARTIAL LIST OF TYPE V-HM SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
20	V1HM	160	V8HM
60	V3HM	200	V10HM
80	V4HM	220	V11HM
120	V6HM	240	V12HM

STANDARD SELENIUM CELL SIZES

Cell Type No.	U	V	Y	Z	W
Cell Diam. (In.)	⅛	¼	⅜	½	1
Current Rating (ma.)	1.5	5	11	20	75

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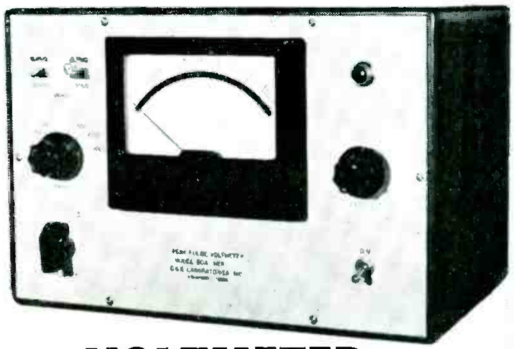

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do electronic research in the Bureau's ordnance development division.

VANNEVAR BUSH, president of the Carnegie Institution of Washington, D. C., was awarded the John Fritz Medal at the AIEE Winter General Meeting, for outstanding scientific contributions to his country and to his fellow-men.

J. B. LINDSAY, previously associated with RCA Victor, has joined the engineering staff of Thomas Electronics, Inc., Passaic, N. J., manufacturers of tv picture tubes.

WILLIAM J. FLEMING, formerly vice-president in charge of engineering at the Trumbull Electric Mfg. Co., Plainville, Conn., has been transferred to the General Electric X-Ray Corp., Milwaukee, Wisc., as vice-president in charge of engineering and manufacturing.

W. J. Fleming

H. C. Tittle

HULBERT C. TITTLE, formerly engineering service manager, has been appointed assistant chief engineer for the radio and television division of Sylvania Electric Products Inc., Buffalo, N. Y.

ROBERT HARRIS, formerly a sales representative on tv products for Brach Mfg. Co., Newark, N. J., has been brought into the company's engineering department.

GUIDO FERRARA, assistant professor of electrical engineering at the University of Detroit, has been named acting director of the department of electrical engineering.

KURT APPERT, vice-president and chief engineer of Lenkurt Electric Co., San Carlos, Calif., since its founding in 1934, has become director of engineering there. The company manufactures wire-line and radio carrier equipment for telephone, telegraphy, telemetering and control.

ments and then covers polarized antennas.

Offhand, one would not think it possible to write 600 pages on tv and other receiving antennas, but once you get into the subject it is evident that there is much to be said!—K.H.

Static and Dynamic Electricity

By W. R. Smythe. *McGraw-Hill Book Co., New York*, 1950, *Second Edition*, 616 *pages*, $8.50.

This second edition is a considerably revised and enlarged version of Professor Smythe's well-known textbook. The book is intended for a graduate course in electricity and magnetism and as such, has found wide use both as a text and as a collateral reference.

The average electrical engineering student will perhaps find this book somewhat on the difficult side for a first course in electromagnetic theory and will want to supplement it with a more elementary introduction to the subject. For those who have some background in the subject, the book will prove to be a mine of information on the methods and techniques of solving field problems. A large number of problems are worked out in some detail in the body of the text. In addition, the end of each chapter has an extensive collection of problems. Many of the results of the problems are listed in the unusually complete index, further enhancing the value of this book as a reference.

The material in the first three-quarters of the book follows the general pattern of the classic texts on "Electricity and Magnetism" written by Maxwell and by Jeans. The treatment is thoroughly modern and uses vector notation throughout. One very welcome change in the second edition is the use of rationalized MKS units.

The last quarter of the book contains chapters on electromagnetic waves, radiation, waveguides and resonators, and a brief treatment of special relativity. It is in this section of the book that the greatest changes will be found. The chapters on radiation and on waveguides are entirely new. One now finds a

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treatment of such topics as biconical antennas, radiation from apertures, modes in waveguides and resonators, discontinuities in waveguides, coupling to guides and cavities, and numerous other boundary-value problems that are encountered in microwave work.

On the whole, the book treats its material in a thorough and up-to-date manner. The only part of the book which might be considered out of date by the electrical engineer are the chapters on Transient Phenomena and on Alternating Currents. These two chapters appear out of place in a text which deals mainly with field theory. In addition, since they were originally written for the first edition, use of the methods of the Laplace transform and of function theory have become relatively commonplace and any treatment of transients and of networks would not be doing justice to the subject without the use of these powerful mathematical tools. Because an adequate treatment of these two subjects would require several volumes, the reviewer feels that these two chapters might better have been omitted and the space used for further topics in the microwave field.

Aside from this minor comment, the book is highly recommended to those engineers and physicists who have any occasion to work with field problems. The unusual number of applications worked out makes it useful as a handbook of boundary value problems. If an analytic solution to a field problem exists, the chances are reasonably good that it will be found in this book.—HENRY JASIK, *Airborne Instruments Laboratory.*

Fundamentals of Acoustics

BY LAWRENCE E. KINSLER AND AUSTIN R. FREY, *both of the United States Naval Postgraduate School, Annapolis, Maryland. John Wiley and Sons, Inc., New York,* 1950, 516 *pages,* $6.00.

THIS BOOK is a lucid and concise presentation of the fundamentals of acoustics. There are chapters devoted to simple harmonic motion, the vibrations of strings and bars, plane and spherical acoustic waves, transmission phenomena in fluids

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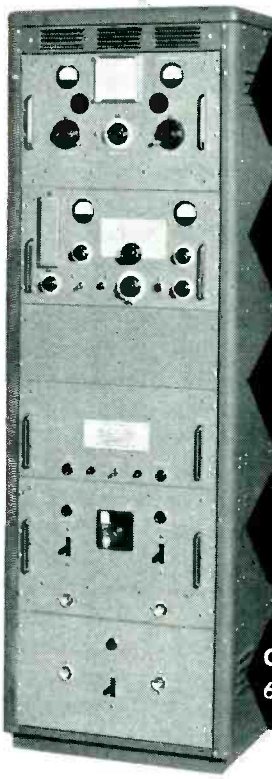

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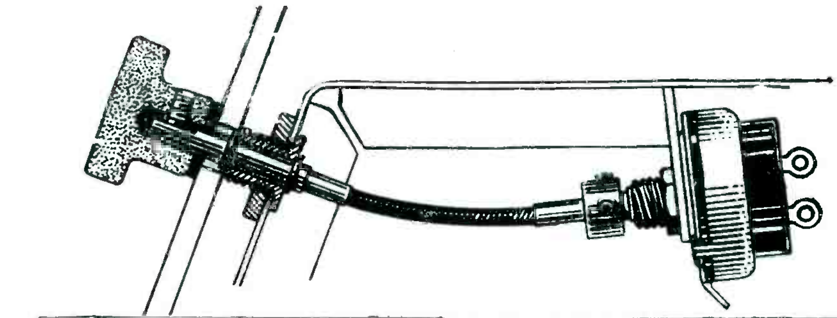

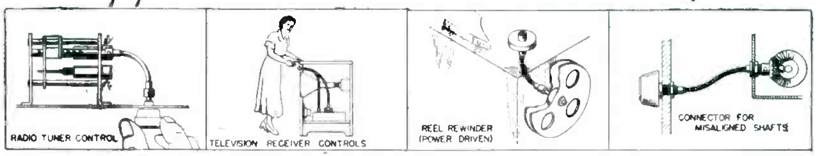

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and gases, resonators and filters, absorption phenomena, electromechanical transducers, the psychology of hearing, architectural acoustics, underwater sound and the inevitable final chapter on ultrasonics.

The first nine chapters are intended to be the basis for a one-semester course in the theory of acoustics. For this, the student should have a good knowledge of the fundamentals of mechanics, electricity and calculus, including partial derivatives. The last seven chapters are intended for the second semester's work, and illustrate the mathematical techniques developed in the earlier chapters. There are comprehensive sets of problems for each chapter. However, this book is definitely not for home study or self-instruction. The extreme conciseness of many chapters, together with a paucity of bibliographical references, make the services of a teacher quite necessary. The book is intended for advanced undergraduate or graduate students, and it will also serve admirably as a refresher course for those who have had previous education in acoustics.

Many acoustical problems, particularly those relating to resonators and filters, are treated by means of electromechanical analogies.

The authors are members of the Acoustical Society of America, and their writing evinces a genuine interest in this field.—CURTISS R. SCHAFER, *Ridgefield, Conn.*

Electronic Equipment Construction

Published at Stanford University, and available from Office of Technical Services, Department of Commerce, Washington, D. C., about 300 *pages,* $7.00.

THE EVER-INCREASING amount of electronic equipment carried by military vehicles today has brought about the need for new materials and techniques. This book is a survey of new developments resulting from a program of maintenance minimization established at the Stanford Research Institute by the Office of Naval Research. Included are latest details on high-reliability

vacuum tubes, tantalum electrolytic capacitors, cracked carbon resistors and stable inductor elements printed on ceramics. Sections are also devoted to operational experience with printed circuits and hermetically-sealed subassemblies.

Different components are treated separately and in logical order. For instance, in the section on resistors, each type is discussed with respect to historical background, production techniques, voltage and temperature coefficients, available wattage ratings, physical configurations, life expectancy, operation under unusual circumstances and names of manufacturers. The presentation is not in the form of tabular material, listing each manufacturers list, but rather in almost story form with the most important characteristics emphasized to attract the attention of the reader.

The greater portion of the book is devoted to the description of various production techniques developed by various companies and government agencies in recent years. Abundant illustrations add substantially to the value of the book as a reference. Also included are brief summaries of the facilities available at the larger companies, government agencies and educational institutions connected with the electronics industry.

The book should find many uses for small and large companies engaged in the development or production of military electronics equipment. It represents a quick and interesting resumé for keeping abreast of the changing industry.—J.D.F.

Radio Communication at Ultra High Frequency

BY J. THOMSON. *John Wiley & Sons, Inc., New York*, 1950, 203 *pages*, $4.50.

AN AUTHORITATIVE treatment of radio communication at ultra high frequency. Mathematical analyses of circuits and of circuit components are clear and concise. While the book covers both theory and practice, the emphasis is largely on theory. One could wish that more space had been devoted to fundamental electromagnetic wave theory and that some of the illustrations

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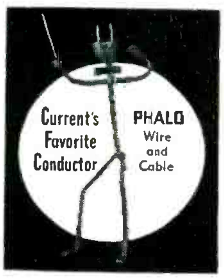

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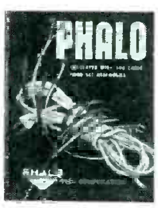

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- INSERTION LOSS . 0 db
- NOISE LEVEL 70 db below 1 volt
- FREQUENCY RESPONSE 2 cps to 2 MC

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were not quite so sketchy but, aside from this, the author has done a remarkably good job of explaining a very difficult subject. The section devoted to waveguides and resonators is an outstanding example of this.—OSCAR E. PIERSON, *Western Union Laboratory, Water Mill, N. Y.*

Electronic Valves

Philips Technical Library. Book I—Fundamentals of Radio Valve Technique, by J. Deketh, 547 *pages* $5.00. *Book II—Data and Circuits of Receiver and Amplifier Valves,* 1933-1939, 406 *pages,* $2.75. *Book III—Data and Circuits of Modern Receiver and Amplifier Valves (First Supplement,* 1940–1941), 213 *pages,* $1.90. *Book IV—Application of the Electronic Valve in Radio Receivers and Amplifiers, by B. G. Dammers, J. Haantjes, J. Otte, and H. Van Suchtelen,* 416 *pages,* $5.00. *Distributed in U. S. by Elsevier Publishing Company,* 215 *Fourth Avenue, New York* 3, *N. Y.*

THESE BOOKS are the first four of a series of seven to be published by members of the staff of the Philips Gloelampenfabrieken (Netherlands). Books I and IV are in the nature of technical texts, while Books II and III are essentially tube handbooks. These books have all been written in Dutch and have been translated and published in French, German and English, and Book I, in addition, in Swedish, Italian, Spanish and Finnish.

The tube handbooks (II and III, and one yet to be published, III A) are, of course, of restricted use in this country because of the limited use of the Philips tubes. There are several interesting features of them, however, which our own handbook publishers could well duplicate. In addition to the essential characteristics for each tube, there are discussions, with circuits shown, for special applications for which the tubes are particularly suited. In expanded form, these application notes are available from some of the manufacturers in this country, but the particular form of presentation in these books seems quite effective. The use of semi-log scales for showing the plate current-grid voltage characteristics is something which is highly desirable.

Books I and IV are technical texts which again will be of rather

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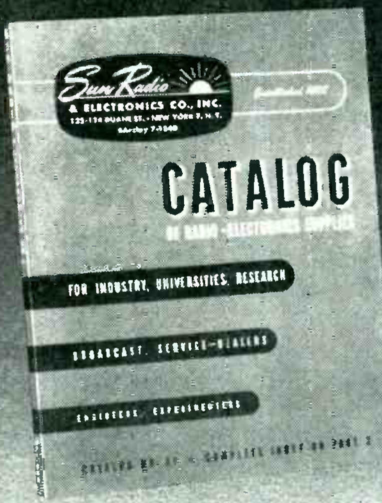

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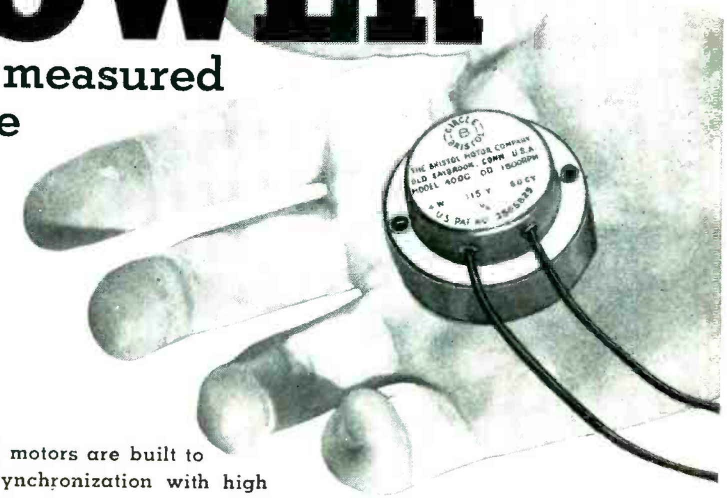

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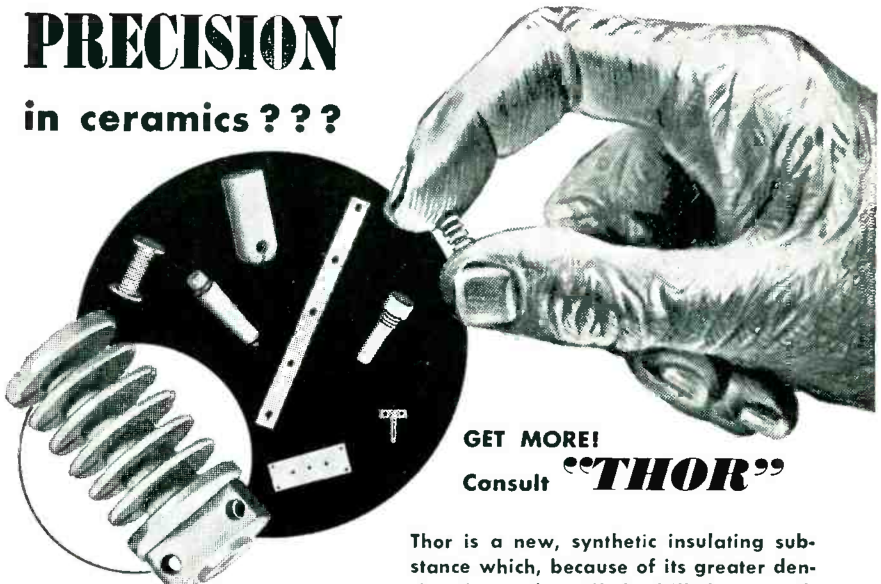

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restricted use. Book I is not, as its title implies, a text on design and construction of tubes, but is more in the nature of a book on tube characteristics and their relation to the attached circuits. It is almost completely concerned with low-frequency, narrow-band applications and for these purposes, goes into great detail. Book IV is also concerned with narrow-band applications, particularly broadcast receivers, with sections on r-f and i-f amplification, frequency-changing, interferences and distortion, and detection. It is quite similar, in many ways, to Sturley's "Radio Receivers".

The translation is fairly good, although it is surprising that it is not better. Philips has available, in its many subsidiaries in English-speaking countries, many excellent engineers who could have eliminated much of the unevenness of some sections of the text. The books are well printed and, for present day standards, quite inexpensive.—MATT LEBENBAUM, *Airborne Instruments Laboratory.*

THUMBNAIL REVIEWS

APPARATUS NOISE MEASUREMENT. ASA publication Z24.7-1950. American Standards Association, 70 E. 45, New York, 12 pages, 50 cents. Presents standardized methods of conducting and recording sound-level tests on radio, air conditioning, refrigeration and other equipment. Covers measurement of direct air-borne noise, reflected sound, ambient sound, apparatus mounting, location of microphone and standing waves.

TAX ASPECTS OF PATENTS, COPYRIGHTS AND TRADE-MARKS. By P. Gitlin and W. R. Woodward. Practising Law Institute, 57 William St., New York, 1950, 79 pages, $2.00. Methods of reporting gains and losses; permissible income tax deductions for research on inventions and research prior to writing technical books; legal means of mitigating tax burden when income is concentrated in one year or when rights are sold; option of treating creative work as capital asset; treatment of litigation, advertising, promotion and other business expense; deductions for depreciation and obsolescence; tax problems raised by death of owner of patent or copyright.

MOVIES FOR TV. By John H. Battison. The Macmillan Co., New York, 1950, 376 pages, $4.25. Principles and operation of television transmission equipment used for film; kinescope recording; program production techniques; getting releases from people showing on film programs.

ECONOMIC ASPECTS OF ATOMIC POWER. By S. H. Schurr and J. Marschak. Princeton University Press, Princeton, N. J., 1950, 289 pages, $6.00. Compilation of chapters by various authors, analyzing the practicality and economics of atomic power in selected industries and the overall relation to national economy.

function to be sampled by $1 + 2\cos(\omega_s t + \theta)$ (if we neglect the higher-order terms which are not transmitted anyway), the sampled red low frequencies for example will be $aR_L + 2aR_L \cos(\omega_s t + \theta_R)$; then, if we let $aR_H + bG_H + cB_H$ equal the mixed highs, then the total signal as transmitted is $aR_H + bG_H + cB_H + aR_L + bG_L + cB_L + 2a^1R_L \cos(\omega_s t + \theta_R) + 2b^1G_L \cos(\omega_s t + \theta_G) + 2c^1B_L \cos(\omega_s + \theta_B)$. It is obvious that the first part of this expression is a normal black and white signal containing the lows and highs. The second part is a phase and amplitude modulated subcarrier of angular frequency ω_s which constitutes the color information. In the RCA system as originally proposed, the a, b, and c and the a^1, b^1, and c^1 are all equal and equal to 1/3, and θ_R, θ_G, θ_B are 0 deg, 120 deg and 240 deg. In the Hazeltine modification using asymmetrical sampling, a, b and c are in such a proportion as to give a black and white signal with a brightness characteristic corresponding to that of the eye and a^1, b^1 and c^1 and θ_R, θ_G and θ_B are so chosen as to have the desired transmission characteristic. This includes, among other things, that for a white signal the amplitude of the subcarrier should be zero, for instance.

The subcarrier frequency is so chosen as to cause the least amount of interference to the black and white part of the signal and from the black and white signal into the signal carried by the subcarrier. If we choose this frequency by looking at a kinescope and observing the dots caused by the carrier on the face of the tube we would choose the frequency so that these dots interlaced and call it dot-interlaced. If, on the other hand, we examined the frequency spectrum and interlaced the side bands, we would call it frequency-interlaced. However, the two are identical because every possible frequency-interlaced frequency will be dot-interlaced and vice versa.

Since the subcarrier in the RCA system is phase and amplitude modulated, we can say that we have two subcarriers one of which is phase modulated and the other amplitude

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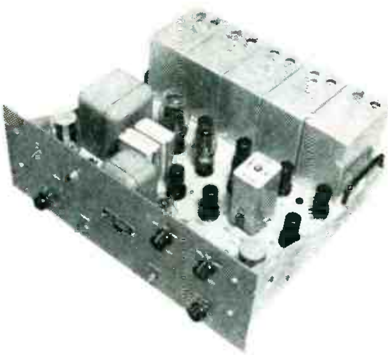

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modulated. The reason that we phase-modulate one is because we find that the two subcarriers must be the same frequency and this is the only way to separate the two modulations. The reason that they must be the same frequency is that if we have two frequencies both of which are interlaced frequencies, they will not be interlaced with respect to each other. (If one is $(M + \frac{1}{2})$ times line frequency and the other is $(N + \frac{1}{2})$ times line frequency, then the difference will be $(M - N)$ times line frequency.) This difference frequency will show up on any black and white receiver, due to the detecting action of the non-linearity of the kinescope, as a series of coarse, stationary, vertical lines. (We were made very conscious of this effect during our cable tests where we had two modulated signals of different frequencies running in adjacent rooms, when we had to go quite great lengths to keep one from interfering with the other).

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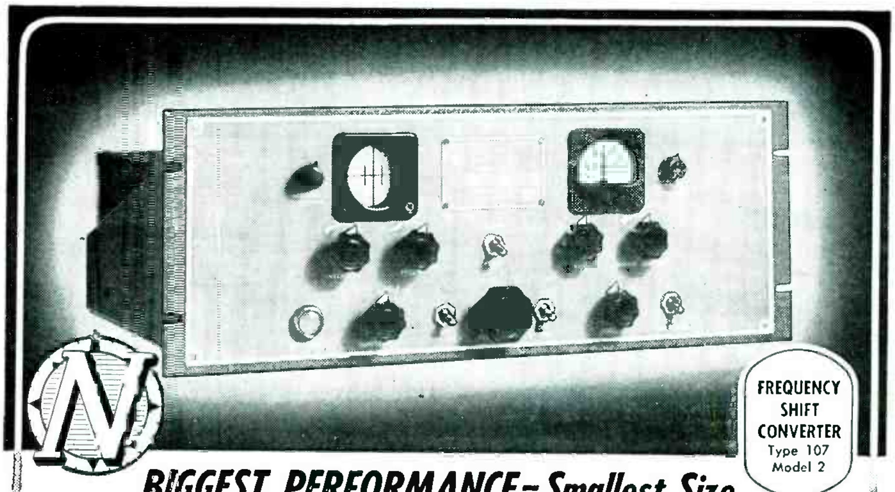

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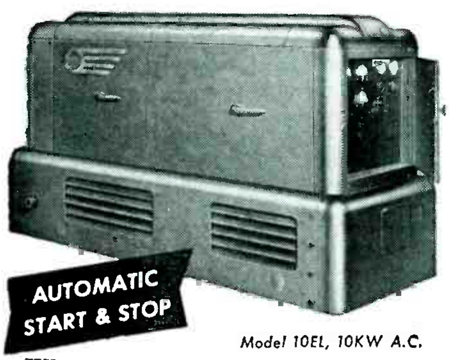

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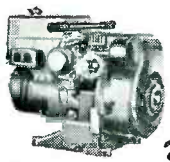

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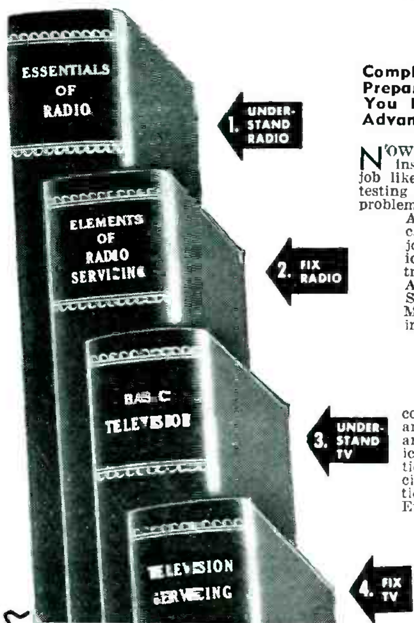

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could of course carry any three signals from which a color picture can be derived. They might, for instance, carry the red, blue and green signals, or they might carry the brightness and the red and blue signals, or the brightness and x and y. In the RCA system they are the brightness, chroma and hue where the chroma is the amplitude and the hue is the phase of the subcarrier. We may make a polar plot of phase angle versus dominant wavelength and get a locus of points similar to the color triangle.

It will be seen then that in the transmission we no longer have a tri-color signal, and this is perhaps what you meant, but it is still simultaneous; that is, the three components exist together simultaneously.

It doesn't matter how the signal is obtained so long as it gives this relation between phase and dominant wavelength. It can be obtained, as we obtain it at present, by modulating three sine waves of appropriate phase by the red, blue and green signals, or by modulating two (sine and cosine) with the

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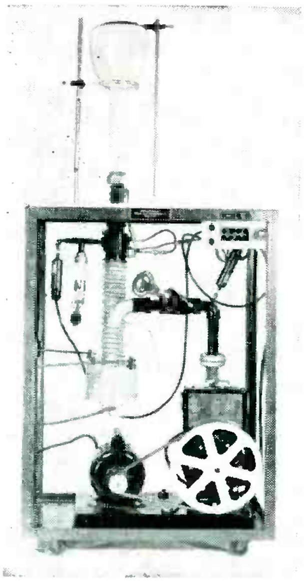

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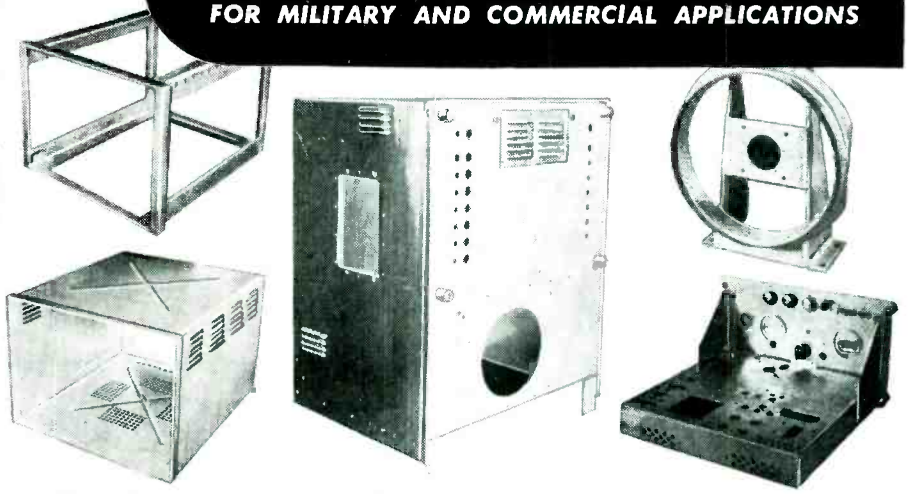

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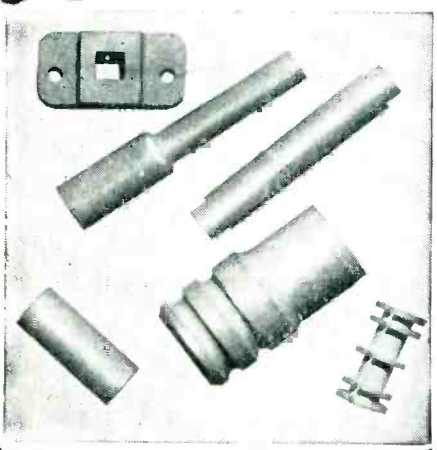

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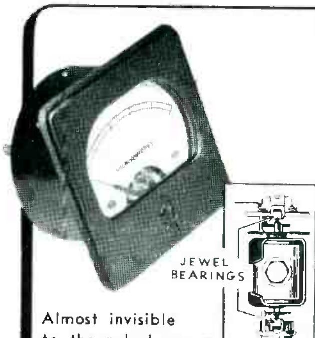

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proper two signals derived from the three, or by modulating with any three signals from an infinite number of primaries which by linear transformation can give the desired primaries so long as the angles and amplitudes into the three modulators are correctly chosen. One very useful such combination is that in which one of the signals is derived from a tube having the eye characteristic, so that this same signal can be used as the brightness signal.

At the receiver, likewise, the exact primaries do not matter because the proper signal for any set of primaries can be derived from the received signal, even, for instance, if the receiver had a reproducing system using subtractive primaries. The three signals are derived by simple combination of the brightness signal and the output of three properly phased modulators; or again, by a combination of the brightness signal and the output of two (sine and cosine) modulators.

It will be noticed again that the signals that are applied to the three

guns of the kinescope at the receiver are continuous simultaneous signals which have color information up to half the subcarrier frequency.

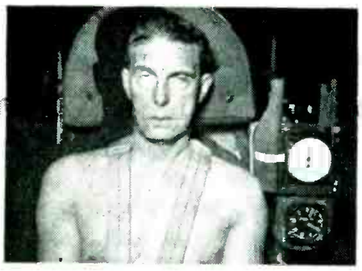
ALFRED C. SCHROEDER
Huntington Valley
Pennsylvania

Photoelectric Neon Diodes

DEAR SIRS:

I HAVE READ with interest the article by Irving Gottlieb entitled "Novel Application for Neon Diodes" in the January, 1951, issue of ELECTRONICS.

The photoelectric action of neon bulbs was pointed out in my article in the August 1948 issue of *Radio Electronics* (page 52). Since then many such articles have appeared along the same lines which leads one to suspect that commercial application may be expected in the near future. I do not believe that my observations of this effect were the first although they may have been as far as the neon bulb is concerned. The famous experiment



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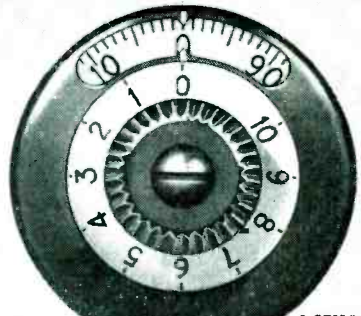
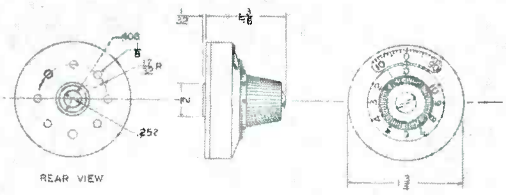


ACTUAL SIZE



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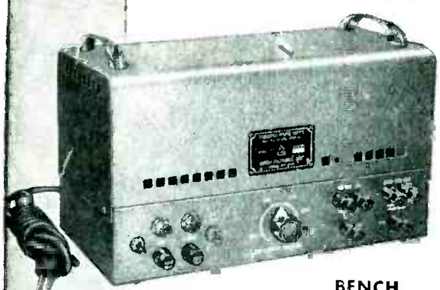

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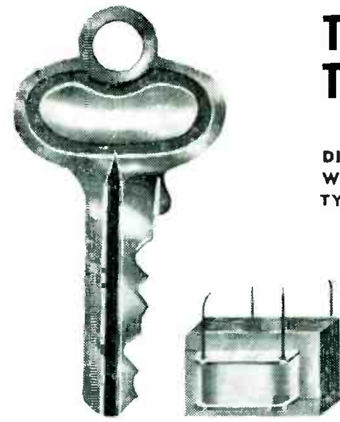

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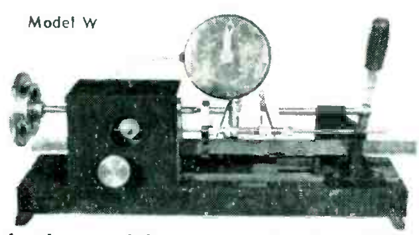

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by Prof. Hertz showing the photo-electric action of ultra violet light on spark gaps is perhaps the original.

You may be interested in some experiments made in 1945 on using the gaseous filled lamps as d-c generators. Many lamps were tested, but the best of any was an ordinary fluorescent lamp. This lamp was energized by the output of a radar set (about 100 kw pulse). The voltage developed across the two filaments being of low current was measured on a 20,000 ohms per volt meter. Readings as high as 60 volts d-c were obtained in this manner.

It is hoped that this small contribution of added information on this subject will be of interest to some of your readers.

HAROLD PALLATZ
Precise Measurements Co.
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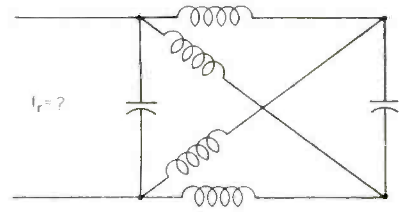
Electronic Quiz

THIS MONTH'S puzzler is submitted by Ken Maxwell, Chief Engineer,

KLTI and KLTI-FM in Longview, Texas. Readers are encouraged to submit quiz problems (with correct solutions) for use in this department. For each problem that is accepted for publication, the contributor will receive our check for $5.00.

This month's problem.

What is the resonant frequency of the circuit shown?



All inductances are 50 mh, and both capacitors have values of 0.01 μf.

Answer will appear next month.

Last Month's Solution

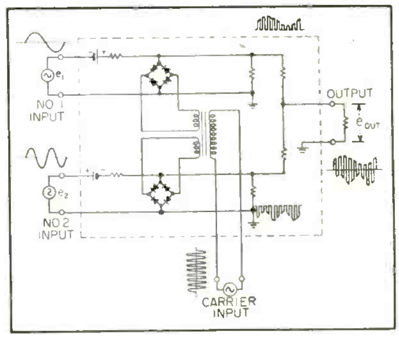
THE PROBLEM published last month was as follows:

Several years ago a circuit

was needed that would modulate the positive peaks of a carrier wave with one pulse or recurrent wave and at the same time modulate the negative peaks of the same carrier wave with a second and unrelated pulse or recurrent wave . . . and each modulation envelope had to be independent of the other. No vacuum tubes or moving parts were to be used. Design an appropriate "black box" to accomplish the desired purpose.

Solution. The circuit shown was submitted by the author of the original question, William H. Fritz of Mamaroneck, N. Y. He substantiates his claims with oscillograms and equations. It should be noted, in studying the circuit, that the two carrier transformer secondary voltages have a phase difference of 180 degrees. The waveforms at various points in the circuit are indicated.

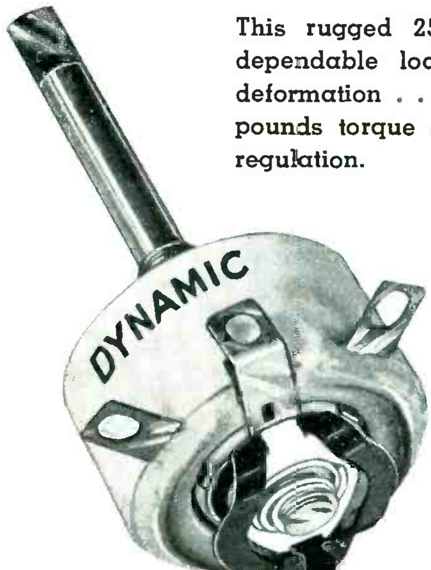
The result is accomplished by the use of two copper-oxide varistors,



a transformer, six resistors and two bias batteries. It is apparent that the output wave is obtained by adding two nonsymmetrical modulated waves that are displaced by a phase difference 180°. The phase difference is established by the polarity of the carrier transformer.

The mathematical expression for the output waveform precludes the possibility of using such a system to transmit two messages over a single radio carrier. Examination of the expression for e_{OUT} includes the following components: (a) positive peak modulating frequency f_1,

COMPACT-RUGGED



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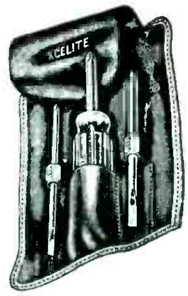

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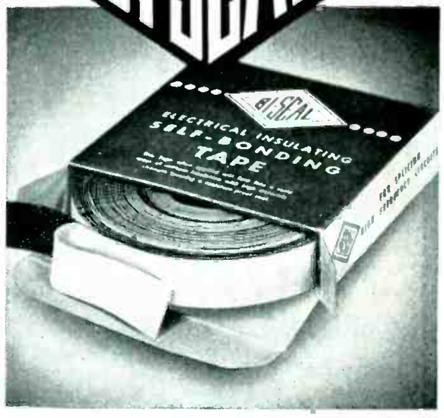

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Erratum Color Fundamentals for TV Engineers

IN "Color Fundamentals for TV Engineers, Part I" (December 1950, p 88) Fig. 8 gives the color mixture data for the I.C.I real primaries in watts per watt. These curves indicate the color match that would be found using a device,

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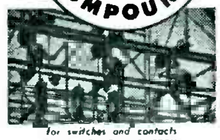
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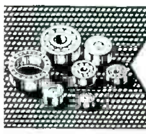

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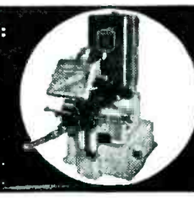

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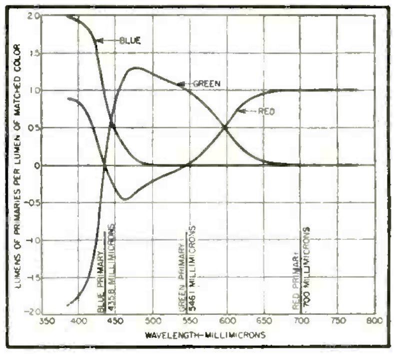
This CONTACTS Section

supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.



I.C.I. primary mixture data plotted in lumens per lumen

such as a radiometer, receptive to the radiated power, in watts, of the primaries and the matched color. Since the text describes the color matching process in terms of visual observation, using the eye and a colorimeter, the units shown should be visual ones, that is, lumens per lumen. The curves of Fig. 8, redrawn in terms of the latter quantities are shown above.

In Part II of the same series, (January 1950, third column p 83), illuminants *B* and *C* were incorrectly defined. Illuminant *B* is representative of noon sunlight and illuminant *C* of average daylight.

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Equipment Wanted Advertising—pages 339, 362, 369 & 372

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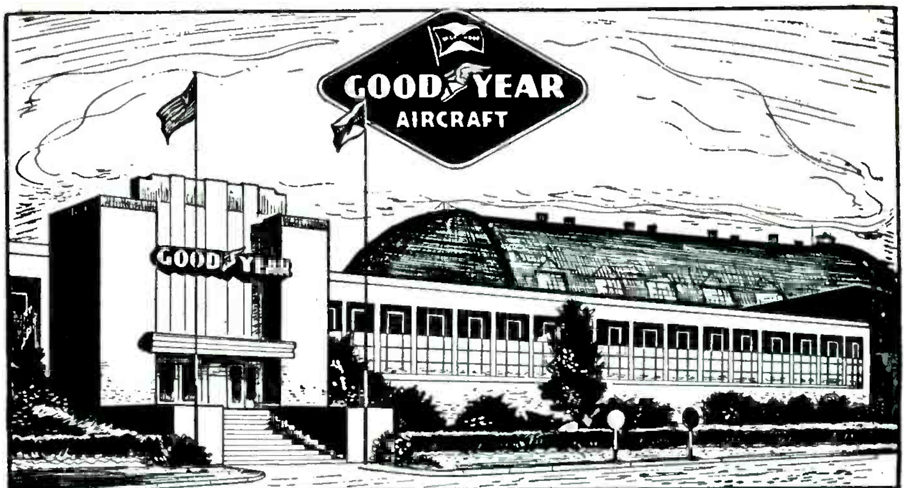

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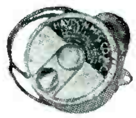
A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**



36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m. **Price $3.00 ea. net.**

Telechron Synchronous Motor, type BC, 110V, 60 cycle, 60 RPM, 6 W. **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Calman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $14.00 each net**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $10.00 each net**

FPE-25-16 Diehl Low-Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps. **Price $10.00 each net.**

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $15.50 each net.**

MINNEAPOLIS-HONEYWELL TYPE 8 Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $10.00 each net.**

Kollsman Type 776-01 400 cycle 2 phase drag-cup type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.

Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 46800. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".

Price $15.00 ea. net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.

Price $20.00 each net.

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $15.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Sperry A5 Autopilot Indicator: contains Pioneer AY20 Autosyn 26 V., 400 cycle. **Price $9.50 ea. net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $15.00 each net.**

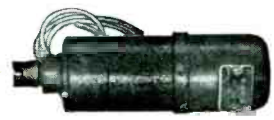
Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

Type C1 auto-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

GOVERNMENT approved instrument repair station No. 3564.

D.C. MOTORS



5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $7.50 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $4.50 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D.C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $6.50 each net.**

General Electric Type 5BA10AJ37C, 27 V.D.C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. torque. **Price $6.50 ea. net.**

D.C. ALNICO FIELD MOTORS

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $6.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $6.50 each net.**

5069466 Delco 27.5 V. 10,000 R.P.M. **Price $10.00 ea. net**

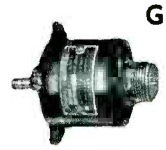
706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower assembly. **Price $15.00 ea. net.**

5069370 Delco 27.5 V., 10,000 R.P.M. **Price $15.00 each net.**

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear. **Price $10.00 ea. net.**

GENERAL ELECTRIC D. C. SELSYNS



8TJ9-PA8 Transmitter, 24 V. **Price $4.00 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked —10° to +65°. **Price $6.00 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $25.00 ea. net, with tubes.**

G. E. Servo Amplifier Type 2CV2A1, 115 V. 400 cycle. **Price $10.00 ea. net.**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

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IMMEDIATE DELIVERY

INVERTERS

Wincharger Corp. Inverter PU/16 type MG 750, Input 24 V.D.C., 60 amps. Output 115 V, 400 cycle, 1 phase, 6.5 amps. **Price $60.00 each net.**

Leland type 10285, Input 28 V. D.C. at 60 amps. Output 115 V. 3 phase at 750 V.A., 26 V., 400 cycle, single phase at 50 V.A. **Price $100.00 each net**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $50.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $50.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $30.00 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $25.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $25.00 each net.**

PE 218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

ACTUATORS

White Rodgers Electric Co. type 6905, number 3, 12 V., D.C., 1.3 amps., 1½ RPM, torque 75" in lbs., contains adjustable limit switches. **Price $10.50 each net**

METERS

Weston Frequency Meter, Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0 100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net. With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D-120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Westinghouse Ammeter, type E1, part No. 1162965, range 0-300 amps. D.C. **Price $7.50 each net.**

Weston Voltammeter, type 201-P, Mod. 606, range 0-30 volts D.C. and 0-30 amps. with shunt. **Price $12.50 each net.**

CARBON PILE VOLTAGE REGULATOR

Leland Electric Co., type B, Philco Spec. 451-1288, input 21 to 30 Volts D.C., regulated voltage 18.25 at 5 amps. **Price $6.50 each net.**

Western Electric Transtat Voltage Regulator, W.E.Co Spec V-122855, load K.V.A. 0.5, input 115 volts, 400 cycles, V.A. 126, max amps 5.5, output adjustable 92-115 volts, Western Electric No KS 5945L01 **Price $10.50 each net.**

RECTIFIER POWER SUPPLY

General Electric, Input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F. Size: Height 46", width 28", depth 17½". **Price $225.00 each net.** New

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle. **Price $7.50 each net.**

AY14G., 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**

AY5, 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net.**

AY54D, 26 V., 400 cycle, with pointer for I 81 & I 82 Indicator. **Price $10.50 each net**

PRECISION AUTOSYNS

AY131D, new with calibration curve. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $20.00 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. **Price $12.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes.**

BLOWER ASSEMBLY

John Oster, MX-215/APG 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $8.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $7.50 each net.**

RATE GENERATORS

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $12.50 each net**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. **Price $14.00 each net.**

PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C. **Price $14.00 ea. net.**

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net.**

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage. **Price $15.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $10.00 each net.**

1G Generator 115 V., 60 cycle. **Price $40.00 each net**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net.**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $15.00 each net.**

1CT Control Transformer, 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

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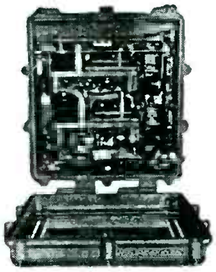
BROWN TELEPLOTTER RECEIVER



Model 791X1R

115 volt 60 cycles

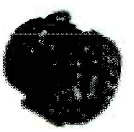
Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00

Aircraft Generator Eclipse NEA-3

Output 115 VAC; 10.4 amps 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $39.50 each.**

400 Cycle Generator



G. E. 5ASB31JJ3. 400 cycles out at 115 volts 7.2 amps. Ideal for lab. 6" lg. x 6" diam. 8000 rpm. Stock #SA-292. **Price $79.50 ea.**

A-5 Autopilot Indicator

Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. **Price $12.50 each.**

Pioneer Servo Motor

Type 10047-2A. 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

SYNCHROS

Navy Types

1G, 1CT, 5G, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 7G, etc.

Prices on Request

Compass Indicator

I-82F Compass Indicator. 0-360°-5 in. dial. 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $2.75 each**

ALSO IN STOCK

C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

400 CYCLE AC BLOWERS

E. A. D. J-151—115 v. 400 cy. 22 c.f.m.
Westinghouse Type FL—115 v. 400 cy. 17 c.f.m.

DC MOTORS

Haydon-0666, ½ rpm. 29 v. d-c, 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—½ hp. 27 v. field. Arm. v. 60, Amplidyne controlled.
Delco-A-7155—1/30 hp. 3600 rpm. Gov. cont.
W. E. KS-5603-LO2—1/100 hp. 4 lead shunt.
National Mineral—90600. 1 hp. Int. duty. Fan cooled.
Diehl FDE-53-5—3600 rpm. Gov. cont. 1/30 hp.
G. E. 5BA25MJ409—24 v. 7500 rpm. Cont. duty.
Airsearch—Actuator—25800-24. 2" travel.
Barber Colman — Actuator — YLc-2066-2. 200 in/lb. 135 degrees in 45 seconds.
Airsearch—Actuator (Manual Flap) 25080.
Airsearch — Actuator—(Automatic Flap) 25040.
Holtzer Cabot—RBD-2220—½ hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor).
Elinco B-64—1/165 hp. 3100 rpm. 27 v. f. 80 v. armature. (Thyratron control).
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5PS56HC18 — Split field series rev. 60 v. 1.4 A. 5500 rpm.

AC SERVO MOTORS

Kollsman—776-01—400 cy. 2 ϕ drag cup type.
Diehl FP-25-3—2 ϕ 60 cy. 20 v. 2.5 watts out.
Pioneer CK-2 — 2 ϕ 400 cy. 1.05 in/oz. stall.
Pioneer CK-17—2 ϕ 400 cy.
Minneapolis Honeywell G303AY2CA1. Built in gear reduction. 2 ϕ 400 cy.

AUTOSYNS (Pioneer)

B-9A—Dual Oil Pressure Indicator (6007-4F-7A).
B-9A—Oil Pressure Transmitter, (4150-3B3).
Pioneer Types—AY-1, AY-14, AY-54, 2320, etc.
C-14A—Fuel Pressure Transmitter.
Pioneer I-81A and I-82A Compass Indicators.

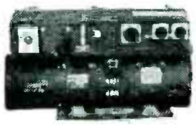
Subfractional Horsepower AC Motors

Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
E. A. D. J-33—115 v. 3ϕ 400 cy. Int.' duty.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60 cy. 1 rpm.
Haydon 36228—115 v. 60 cy. 1 rpm.

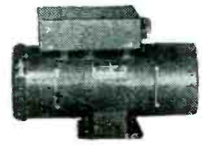
MAGNESYNS

Pioneer Type CL-3, 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.

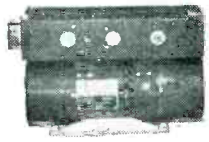
INVERTERS



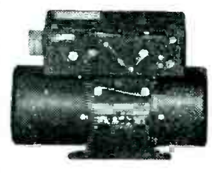
Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $89.50 each.**



G. E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $29.50 ea.**

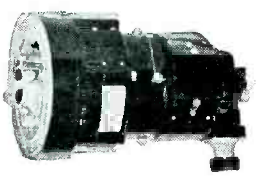


PE-218E Inverters Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9 Stock #SA-112A. **Price $49.50 each.**



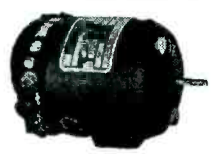
Pioneer 12130-4-B Input 28 VDC at 14 amps. Output 120 v. 400 cy. Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each**

JACK AND HEINTZ STARTER



Dwg.6-950-R Aircraft engine starter 28 VDC. Stock #SA-305. **Price $19.50 each**

DC SERVO MOTOR



Elinco Type B-64. 1/65 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control. Stock #SA-211. **Price $12.50 each.**

MAGNETIC AMPLIFIER ASSEMBLY

Sperry 661824. Saturable reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. Price $6.75 each.

FORD INS'T SERVO MOTOR

115 volt 60 cycles two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

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SERVO-TEK PRODUCTS CO.

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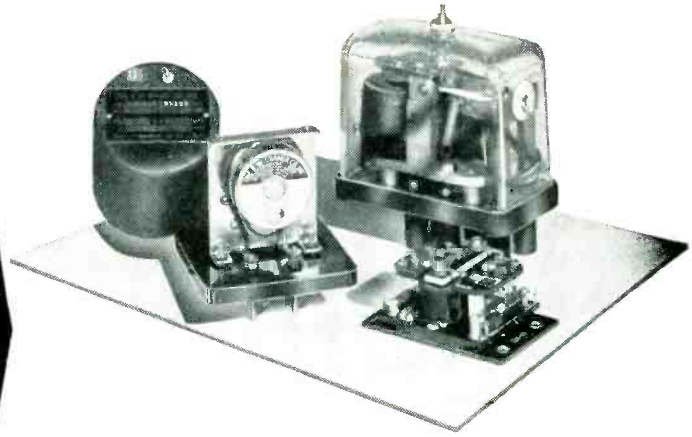
Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.



This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

STOCK NO.	VOLTAGE	OHMAGE	CONTACTS	MANUFACTURER & NUMBER	PRICE
R-503	12/32 VDC.	100	3A, 2C	G.E. Ant. Keying 500W 2C6530-653AR1	$ 2.25
R-749	600 VDC.	...	Max. 28 Amps.	Allen Bradley 810 Dashpot	5.95
R-804	550 VAC.	...	1B/38 Amps.	Culter Hammer C-261173A34 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	...	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.25
R-686	115 VAC.	...	2C	Leach 1157T-5/20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
R-246A	115 VAC.	...	1A	Cramer 2 Min. Adj. Time Delay	8.95
R-611	24 VAC.	...	1A/30 Amps.	Durakool BF-63	4.25
R-283	12 VDC.	125	AC/10 Amps.	Onan Rev. Current 3H4512/R24	1.00
R-614	18/24 VDC.	60	1A/15 Amps.	Rev. Current Cutout 3H2339A/E1	3.50
R-262	....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
R-245	12 VDC.	25	4 In. Micalex Lever	....	.95
R-527	6/12 VDC.	50/50	In Series	2Z7668 For Scr-274N	.95
R-544	12/24 VDC.	60/60	1C	G.E. Push Button Remote Relay #CR2791-R-106C8	1.65
R-255	....	...	1A	G.E. Pressure Switch #2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	3/8" Stroke	Cannon Plunger Relay #13672	.95
R-651	24 VDC.	100	Solenoid Valve	....	2.50
R-295	12 VDC.	275	Annuncitar Drop	....	2.15
R-230	5/8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Wafer	Ratchet Relay From Scr-522	4.25
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A/5 Amps.	BK-13	1.45
R-620	6/12 VDC.	35	2C, 1A	Guardian BK-16	1.05
R-629	9/14 VDC.	40	1C/10 Amps.	Guardian BK-17A	1.25
R-778	8 VDC.	4500	1C/5 Amps.	Kurman BK-24	2.10
R-720	24 VDC.	50	2C, Ceramic	45A High Power	1.35
R-500	12 VDC.	10/10	2C 6 Amps.	Str. Dunn. Latch & Reset	2.85
R-816	12 VDC.	10/15	2C 6 Amps.	Guardian Latch & Reset	2.85
R-811	48 VDC.	8000	1C	Sigma 4R	1.65
R-524	24 VAC/DC.	...	....	Edwards Alarm Bell	.95
R-838	90/120 VDC.	925	2A	Allen Bradley-Bulletin #702 Motor Control	4.50
R-839	100/125 VDC.	1200	3A	Allen Bradley-Bulletin #200E Motor Control	4.50
R-840	115 VDC.	1200	2A	Allen Bradley-Bulletin #209 Size 1 Motor Control W/Type "N" Thermals	5.50
R-841	115 VDC.	1200	4A	Allen Bradley-Bulletin #709 Size 2 Motor Control W/Type "N" Thermals	25.00
R-842	115 VDC.	925	3A	Allen Bradley Bulletin #709 Motor Control W/Type "N" Thermals	5.50
R-843	115 VDC.	1200	3A	Allen Bradley-Bulletin #200 Motor Control	4.50
R-844	115 VDC.	1200	3A, 1B	Allen Bradley-Bulletin #202 Motor Control	4.50
R-845	220 VAC.	Intermit.	3A	Allen Bradley-Bulletin #704 Motor Control	4.50
R-831	7.5/29 VDC.	6.5	1A/250A, 1000A Surge	Leach B-8	3.50
R-837	110 VAC.	...	2A/30 Amps.	Leach 6104	2.75
R-835	24 VDC.	2800	1A Dble. Brk./10 Amps.	Wheelock Signal, B1/39	1.95
R-836	220 VAC.	...	2A Ddle. Brk./10 Amps.	Wheelock Signal, A7/37	3.45
R-566	115 VAC.	(Coil-only, Not a complete relay)		Leach #6104	.75
R-710	....	150-Ohms. Coil Only		Guardian #38187	.50

Wide Selection of Electronic Components at WELLS

- Tubes
- Resistors
- Condensers
- Wire & Cable
- Volume Controls
- Co-ax Connectors
- Relays
- Rectifiers
- Transformers and Chokes
- Micro Switches and Toggles
- Antennas and Accessories
- Electronic Assemblies
- Dial Light Assemblies

NOTICE!

Although our offices and showrooms were recently destroyed by fire, we are conducting business as usual from our new address.

Write For New Wells Catalog

Each relay is new, individually boxed, and unconditionally guaranteed by Wells

WELLS SALES, INC.

TELEPHONE: SEeley 8-4143

833 W. CHICAGO AVE., Dept. SL, CHICAGO 22, ILL.

SYNCHROS

G.E. 2J1F1	C-56701	C-78410
G.E. 2J1G1	C-69405-2	C-78411
G.E. 2J1H1	C-69406-1	C-78415
Connecting caps	C-78248	C-79331
C-4460A-2	C-78249	

Size 3, 5, 6, 7 synchro generators, motors, differentials, control transformers in stock.

KOLLSMAN INSTRUMENT
LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles
2 Phase—5 Watts—2650 RPM
Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—

$12.95 EACH—Our Price

COAXIAL CONNECTORS

83-1AC	.42	83-1J	.80	83-1T	1.12
83-1AP	.30	83-1R	.40	83-22AP	1.10
83-1F	1.30	83-1SP	.45	83-22R	.48
83-1H	.10	83-1SPN	.45	83-22SP	.85

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UG-7	UG-23	UG-37	UG-102	UG-175	UG-236
UG-12	UG-24	UG-57	UG-103	UG-176	UG-254
UG-18	UG-27	UG-58	UG-104	UG-181A	UG-255
UG-19	UG-27A	UG-83	UG-106	UG-185	UG-264
UG-21	UG-29	UG-85	UG-108	MX-195	UG-274
UG-21B	UG-30	UG-86	UG-109	UG-197	UG-275
UG-22	UG-33	UG-87	UG-167	UG-201	UG-290
UG-22B	UG-34	UG-88	UG-171	UG-206	UG-306

M-358	MC-277	PL-259A	SO-239
M-359	MC-320	PL-274	SO-264
MC-359A	PL-258	PL-284	TM-201
M-360	PL-259	PL-293	

49120	D-163950	ES-685696-5
49121A	D-166132	FS-689172-1

WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

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 — Original Packing $38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing....$9.50

STANDARD BRANDS ONLY — TUBE SPECIALS — BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES. QUOTATIONS UPON REQUEST

PULSE TRANSFORMERS

Utah 9262	AN/APN-4 Block. Osc.
Utah 9340	Philco 352-7149
Utah 9278	Philco 352-7150
G.E. 68G828	Philco 352-7071
G.E. 68G-627	Philco 352-7178
G.E. K-2469A	Raytheon UX-7350
AN/APN-9 (901756-501)	W.E. D-161310
AN/APN-9 (901756-502)	W.E. D-163247
AN/APN-9 (352-7250)	W.E. D-163325
AN/APN-9 (352-7251)	W.E. D-164661

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

MISCELLANEOUS EQUIPMENT

- 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
- T-47/ART-13 Transmitter 165.00
- 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—Orig. Cartons 19.95
- Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used).................. 22.65
- G.E. Inverter—28VDC to 120VAC 800 cy 750VA 1 ϕ (new) 39.50
- Navy SD-3 Radar complete................$1200.00
- Navy DP-14 complete $385.00

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BAO

U. S. NAVY TYPE M HEAD AND CHEST SETS
These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE ....$14.88 ea., $28.00 per pair.
TS-10 HANDSETS ....$8.92 each

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

MAGNETRONS

2J21A	$9.95	2J39	24.50	700C	18.90
2J22	8.95	2J40	24.50	700D	18.90
2J26	7.80	2J41	132.50	706AY	45.00
2J27	13.70	2J48	14.95	706BY	45.00
2J31	19.90	2J49	39.50	706CY	26.95
2J32	19.90	2J61	45.20	706FY	45.00
2J33	19.90	4J50	197.00	706GY	45.00
2J34	19.90	4J52	197.00	714AY	6.95
2J36	85.00	5J23	14.20	720B/C/DY	75.00
2J37	13.70	5J29	14.20	725A	8.95
2J38	12.70	700B	18.90	730A	10.95

KLYSTRONS

2K23	$37.50	2K33	295.00	707B	17.50
2K25	27.50	2K54	135.00	723A	6.95
		2K55	135.00	723A/B	14.95
2K28	27.50	417A	10.65	726A	8.50
2K29	29.95	707A	7.22	726B	29.50
				5611	135.00

TYPE "J" POTENTIOMETERS
$1.25 each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS"	10K	SS	50K	SS
200	SS"	15K	½"	100K	5/16"
500	½"	15K	SS	100K	⅜"
650	½"	20K	SS	100K	7/16"
6500	SS"	25K	1½"	100K	SS"
10K	⅜"	25K	SS	150K	½"
10K	½"	30K	1⅛"	1 MEG	SS

Dual "JJ" Potentiometers.................$1.60 each
50-50 Ω SS   100-100 Ω SS   250-250 Ω SS
Triple 100K "JJJ" Potentiometers—⅛" shaft..$1.95
All shaft lengths beyond bushing—SS (screw slot)

TEST EQUIPMENT

- 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
- TS-146/AP X-Band Test Set............$595.00
- TS-184/AP $60.00
- CPR-60AAJ and CPR-60AAK—IFF Test Sets, (pair) $16.95
- AN/APA-23 Recorder $147.50
- 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
- Gen. Radio 670-F Decade..............* $38.00
- I-130 A Signal Generator..............* $70.00
- TS-6/AP Frequency Meter..............* $42.00
- L & N KS-9470 Null Volt Test Set......* $60.00
- Measurements 79B Pulse Generator......$200.00
- MIT TTX-10RH 3 cm FM Test Set......* $325.00

All Items New Except Where Noted * (Exc. Used Condition)

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

CONSTANT VOLT. TRANSFORMERS

- Federal Constant Voltage Transformer Input 95-135V 60cy Output 115V 210W..................$34.00
- Sola Constant Voltage Transformer Input 95-125V 60cy-Output 15.8V 285VA..................$24.70
- Sola Constant Voltage Transformer Input 105-125V 60cy-Output 115V 80VA..................$15.95

SELENIUM RECTIFIER STACKS
FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		MAXIMUM RATINGS AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.2 Amps	$2.90	0.6 Amps	$3.30
2.4	3.38	1.2	3.78
6.4	4.50	3.2	5.66
13.0	8.44	6.0	10.25
17.5	9.56	9.0	11.05
26	16.86	12	20.50
39	25.30	18	22.13
52	33.74	24	39.56
65	42.26	36	45.36

W. E. MERCURY CONTACT RELAYS

Glass sealed mercury wetted SPDT contact assemblies. Magnetically operated. Used in Western Electric D-168479 high speed plug in relays. Supply your own coil ....$2.00 each

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	600	$ .45	2	2000	$2.70
4	600	1.05	4	2000	3.95
4	600 R'd)	1.05	.1	2500	.49
8	600 (R'd)	1.39	1-1	2500	3.85
10	600	1.95	32	2500	15.80
10	600 R'd)	1.52	1	5000	4.88
8-8	600	1.49	.01-.03	6000	1.65
1	1000	.62	.1	7000	1.79
2	1000	.89	2	12500	28.95
3.5-.5	1000	1.39	.045	16KV	4.70
1	1500	.89	.05	16KV	4.95
4	1500	2.95	.075	16KV	8.95
.1-.5	2000	.87	.25	20KV	18.95
.5	2000	.95	50	220VAC	3.95
1	2000	1.50	60	330VAC	5.75
			7	660VAC	3.35

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

COMPONENT SPECIALS

FUSES	4AG	10 Amp.	$3.00/c
	4AG	20 Amp.	$3.00/c

MOLDED PAPER CONDENSERS—

.02 MFD	200 VDC	$4.50 per 100
.05	200	4.50
.1	200	5.00
.1	400	9.00
.005	600	4.50
.01	600	8.00
.05	600	9.00

CRYSTAL DIODES—

1N21	1.19	1N23	1.49	1N34	.79
1N21A	1.69	1N23A	2.55	1N45	.94
1N21B	3.25	1N23B	5.25	1N52	1.05
1N22	1.09	1N27	1.79	1N63	1.39

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.

LECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA.
Telephones - MARKET 7-6590 and 6591

Reliance Specials

WIRE WOUND PRECISION RESISTORS 1% OR BETTER

¼ WATT—30c

6.68Ω	12.32Ω	16.37Ω	125Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	59,148
11.74	14.98	123.8	366.6	100,000

½ WATT—30c

.250Ω	1.53Ω	75Ω	260Ω	4,000Ω	8,500Ω
.334	2.04	90	270	4,451	14,825
.444	11.1	97.8	298.3	5,000	15,000
.502	13.15	100	400	5,900	15,750
.557	18.75	125	723.1	6,500	17,000
.627	46	180	2,500	7,000	30,000
.76	52	210	2,850	7,500	37,000
1.01	55.1	235	3,427	8,000	79,012
					100,000

1 WATT—35c

1.01Ω	3.39Ω	270Ω	7,000Ω	55,000Ω
2.58	5.21	3,300	9,000	65,000

1 WATT—45c

100,000Ω	128,000Ω	320,000Ω	600,000Ω
120,000	130,000	522,000	700,000

1 Megohm—1 Watt 1%—65-; 5%—45c

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
MRC .205R	63/64"	2 3/64"	19/32"	1.10
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
TIMKEN	4 5/16"	6 1/4"	29/32"	4.25

NEEDLE BEARINGS

B108 1/2" wide 5/8" 13/16" 30¢

ALLEN SET SCREWS

4-40 x 1/8 8-32 x 1/8 8-32 x 5/16
4-40 x 3/16 8-32 x 3/8
ALL SIZES $1.50 per 100

VERNIER DIAL or DRUM (From BC-221)

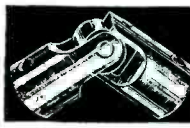
DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks ....either, 85¢

BLOWER & MOTOR

Blower #1½, motor 27½ V.D.C., 1/100 H.P., 8,500 R.P.M. Continuous duty. Has mounting brackets. Navy Inspected $3.50

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenters dream! ....Only $6.50



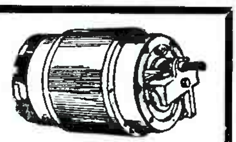
UNIVERSAL JOINT

3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

2J1G1 SELSYNS

BRAND NEW
400 Cycle
Can be used on 60 cycle
$1.95

DIFFERENTIAL



115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅝" long
$3.95 ea.

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted) $4.50

Mounting Brackets — (Bakelite) for selsyns, and differentials shown above ....35¢ pair

FILAMENT TRANSFORMERS

Pri., 115V., 60 Cyc.—Secondary: 6 V. @ 35 A. / 12 V. @ 18 A. / 24 V. @ 9 A. **$6.50**

PULSE TRANSFORMERS

D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms.... **$1.75**

KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S.......... **$3.50**

D106173, W.E. Freq. resp. 10KC to 2 MC.. **$9.80**

800 KVA, G.E. #2731, 28,000 Volt peak output: Bifilar: one microsecond pulse width.... **$37.50**

WATER TIGHT JUNCTION BOX

14 gauge steel. 17"x25"x6½", hinged lid, 2 access panels. Approx. wt. 50 lb....$3.50

VARIAC—General Radio. 100 watts. Removed from equipment $10.00

PLUG IN CAPACITOR

8-8 MFD, 6,000 V.D.C.—Oil Filled. Plugs into standard 4 prong socket....$2.25

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	43	100	250	580	.0013	.006
10	47	110	300	600	.00136	.0062
15	50	120	330	620	.0015	.0065
20	51	125	350	680	.001625	.0068
22	56	130	370	800	.002	.007
24	60	150	390	820	.0026	.0075
25	62	160	400	910	.0027	.008
26	75	175	430	MFD	.003	.0082
30	82	180	470	.001	.0033	.01
35	85	200	500	.0011	.0047	
39	90	220	510	.0012		
40		240	560			

Price Schedule
8.2 MMF to .001 MFD....5¢
.0011 MFD to .002 MFD....7¢
.0026 MFD to .0082 MFD....12¢
.01 MFD....22¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	51	120	270	470	815	.00282
18	60	125	325	488	820	.002826
22	62	150	330	500	875	.003
23	66	180	360	510	MFD	.0033
24	68	200	370	525	.001	.0039
30	75	208	390	560	.001625	.005
39	82	225	400	660	.0022	.0051
40	100	240	410	700	.0023	.0056
50	110	260	430	750	.0024	.006
	115		466		.0028	.0082

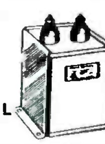
Price Schedule
10MMF to .001MFD....10¢
.001625MFD to .0024MFD....20¢
.00282MFD to .0082 MFD....50¢

OIL FILLED

MFD	V. D. C.	Price
.25	20,000	$16.75
.03	16,000	1.95
.375@ / .75 @	16,000 and 8,000	5.95
.1	7,500	1.69
.1-.1	7,000	1.69
.01	6,000	.95
.03-.03	6,000	1.25
.02-.02	7,000	1.25
1	6,000	5.25
2	5,000	4.50
2	4,000	3.95
2	3,000	2.15
.25	3,000	1.10
.2	750 AC	.49
8	2,000	3.95
4	2,000	3.65
2	2,500	1.95
1	2,000	.95

MFD	V. D. C.	Price
4	1,000	$1.39
3	1,000	.80
2	1,000	.65
1	800	.39
10	600	1.95
8	600	1.60
4	600	.98
2	600	.45

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$3.95



CERAMICONS

2 MMF	30 MMF
5.6	35
12	45
15	62
20	82
22	110
	150
	200

$6.50 per hundred

500 VOLT CERAMIC CONDENSERS

MMF	MMF	MMF	MMF
2	18	56	150
3.44	22	62	180
4.7	27	68	200
8	30	82	220
12	33	91	270
13	40	100	300
15	47	140	1000
16			

$5.00 per hundred

SOUND POWERED HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. ....$17.60 pr.

Sound Powered
Chest Set
RCA—With 24 Ft. Cord
$17.60 per pair

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully cased • ONLY $6.50

PRECISION CONTROLS

6 WATT				4 WATT			
20,000Ω	Muter	314A	$1.70	5K	De jur	296	$1.50
6,000	De jur	260	1.70	500Ω	Centralab	48-501	1.00
6,000	Muter	314A	1.70	200Ω	GR	301	1.25
5,000	Muter	314A	2.50	50	De jur	292	1.00
2,000	De jur	260	1.70	12	GR	301	1.10
12 WATT				12	De jur	292	1.00
10,000Ω	De jur	271T	$2.00	2	GR	301	1.25
10,000	Muter	471A	2.00				
5,000	De jur	271T	2.00				

PRECISION CAPACITOR—W.E.

D-161270, 1 mfd @ 200 VDC; −40° to +65°C......$8.50

SELENIUM RECTIFIERS

Full Wave—200 ma., 115 V....$1.79
Half Wave—100 ma., 115 V.... .79

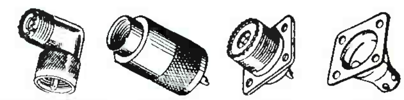
COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-6/U	76	$150	RG-29/U*	53.5	$50
RG-7/U*	97.5	65	RG-34/U	71	175
RG-15/U	76	160	RG-35/U	71	450
RG-21/U	53	100	RG-37/U	55	40
RG-22/U*	95	110	RG-39/U	72.5	180
RG-24-U	125	240	RG-41/U	67.5	550
RG-25/U	48	575	RG-54/U	58	65
RG-26/U	48	75	RG-55/U	53.5	65
RG-27/U	48	290	RG-57/U*	95	100
			RG-58/U*	53.5	60
			RG-77/U*	48	100
			RG-78/U	48	80

*No minimum order—others 250' minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



Angle Adapter	Plug	Socket	Hood
30¢	45¢	40¢	9¢
M-359	PL-259	SO-239	83-1H
83-1AP	83-1SP	83-1R	

Adapter for PL-259 A for use on small coax.
12¢ each ....$10.00 per 100

83-1AC	$0.42	UG-19/U	.73	UG-85/U	.88
83-1F	1.30	UG-21/U	.67	UG-87/U	.79
83-1J	.80	UG-22/U	1.10	UG-103/U	.48
83-1SP	.45	UG-23/U	.85	UG-104/U	.85
83-1SPN	.50	UG-24/U	.67	UG-167/U	2.00
83-1T	1.12	UG-25/U	.60	UG-171/U	1.33
83-22AP	1.10	UG-27/U	.68	UG-175/U	.15
83-22R	.48	UG-29/U	.83	UG-176/U	.15
83-168	.15	UG-33/U	14.80	UG-197/U	1.33
83-185	.15	UG-34/U	16.00	UG-206/U	.63
UG-7/AP	2.14	UG-36/U	12.80	UC-255/U	1.22
UG-12/U	.63	UG-37/U	12.80	UG-264/U	1.74
UG-13/U	.63	UG-58/U	.63	UG-281/U	.60
UG-18/U	.63				

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	5-141	.26	17-141Y	1.17
3-140¾W	.19	5-141¾W	.37	3-142	.21
5-140	.21	5-141Y	.37	3-142Y	.29
6-140	.25	7-141	.36	5-142¾W	.46
10-140¾W	.53	7-141¾W	.49	11-142Y	.95
2-141	.13	8-141¾W	.58	2-150	.39
3-141¾W	.24	9-141¾W	.64	2-150¾W	.47
3-141W	.24	9-141Y	.64	3-150	.54
4-141W	.30	10-141Y	.71	4-150	.70
4-141¾W	.30	13-141¾W	.89		

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay....
T 114—Approx. 2.2 micro. sec. delay....
T 115—Similar to T 114 with tap brought out
} 95¢ each

CHOKES

30 Henry 80 ma....$1.29
6 Henry 80 ma.... .79

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	¾	$4.00	6	$3.00
¼	4.00	1½	3.00	10	3.00
¾	4.00	2	3.00	15	3.00
½	4.00	5	3.00	20	3.00

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss)...25¢

4AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
1/8	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	25	2.50
1	2.00	5	2.00		

Fuse Holder—For 4AG Fuse. (Littlefuse)....25¢

Brand New METERS—Guaranteed

0-1 Amp, R.F. 2½"....$3.29
0-300 V.D.C. 2½".... 3.50
0-80 Amp. D.C. 2½".... 2.25
0-7.5 V. A. C. 3½".... 3.46

AN CONNECTORS

IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

BC 348—H, J, L, O, P, Q, S—write for prices

POSTAGE STAMP MICA ASST.—100 pcs. including some silver micas....$3.29

CARBON MIKE—T-17, slightly used, guaranteed. Has 5 foot cord and PL68....89¢

THROAT MIKE—MT 81-A—2 mikes in leather zipper case with 56" cord & PL68—Brand New....59¢

SPAGHETTI SLEEVING—assortment—99 feet.....$1.00

Minimum Orders $3......All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

1000 KC crystal BT cut	$3.95
3″ scope shield	1.29
2 speed dial drive for ¼″ shaft ratios 5:1 1 to 1	.39
ATC 100 mmfd air trimmer screwdriver shaft	.29
Sigma Sens. Relay 8000 ohms	1.98
Centralab 850 S 50MMF 5KV BUTTON COND.	.39
500 watt 12.5 ohm power rheostat	3.49

R·H·S

SPECIALS · OF THE MONTH

50 mmfd 5 KV vacuum condenser	$1.49
6v, 12v vibrators any type	.98
Rotary switch Mycalex, 2 deck SP3T	.39
1 mfd 5000v oil condenser	2.98
2 mfd 3000v oil condenser	3.25
3 mfd 4000v oil condenser	3.95
24 mfd 1500v DC 3KV flash. Excellent for speed lamp	3.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

OA3/VR75	$1.29
OB3/VR90	1.29
OC3/VR105	1.49
OD3/VR150	1.29
1B22	3.45
1B23	12.50
1B24	6.95
1B26	3.95
1B27	24.50
1B29	2.75
1B32	8.95
1B36	24.96
1B38	32.50
1N21 Xtal	1.25
1N21A Xtal	2.25
1N21B Xtal	3.25
1N22 Xtal.	1.35
1N23 Xtal.	2.25
1N23A Xtal	3.25
1N23B Xtal	4.95
1N27	1.69
1N34	1.05
1N34A	1.05
1P23	3.95
1P24	1.79
1P36	2.95
1S21	6.95
2AP1	8.95
2AP5	6.95
2C21/RK33	.69
2C22/7193	.49
2C26A	.49
2C34/RK34	.89
2C39	24.50
2C40	4.95
2C43	14.95
2C44	1.49
2C46	7.50
2C51	5.75
2D21	1.79
2E22	1.95
2E24	4.89
2E26	3.69
2E30	2.29
2J21A	9.95
2J22	8.45
2J26	29.50
2J27	29.50
2J30	39.50
2J31	39.50
2J32	39.50
2J33	39.50
2J34	39.50
2J36	97.50
2J37	12.75
2J38	12.75
2J39	39.50
2J40	39.50
2J46	39.50
2J48	29.50
2J49	39.50
2J50	22.50
2J54B	39.50
2J55	97.50
2J61	49.50
2J62	49.50
2K25/723AB.	24.95
2K28	39.50
2K29	24.50
3AP1	9.95
3B22/ELIC	2.95
3B23/RK22	4.85
3B24	5.95
3B24W	7.95
3B25	4.65
3B26	3.95
3B27	3.95
3B28	8.95
3BP1	8.95
3C22	64.50

3C23	$9.95
3C24/24G	2.25
3C30	2.95
3C31/C1B	3.49
3C45	12.75
3CP1	2.25
3CP1-S1	2.95
3DP1	4.95
3DP1A	6.95
3DP1-S2A.	8.95
3D21A	1.98
3E29	14.95
3EP1	5.95
3FP7	3.95
3GP1	4.75
3HP7	3.95
4-65A	14.21
4-125A	26.95
4-250A	29.95
4AP10	4.95
4B22/EL5B	9.95
4B24/EL3C	7.95
4B25/6GF	8.95
4B26/2000	8.95
4B28	4.95
4B32	9.95
4C27/CV92	49.50
4C35	29.50
4D22	12.95
4D32	14.95
4E27/257B	17.95
5AP1	3.69
5AP4	3.69
5BP1	5.95
5BP4	5.95
5CP1	4.95
5CP7	4.95
5C22	49.55
5D21	24.50
5FP7	1.95
5GP1	4.95
5JP1	24.45
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5J32	99.50
5LP1	13.95
5NP1	5.95
6AS6	3.69
6C21	22.50
6F4	5.95
6J4	5.95
7BP7	8.95
9GP7	14.95
9JP1	14.95
9LP1	19.95
9LP7	14.95
10BP4	18.95
7DP4	17.95
10	.49
12DP7	16.95
12GP7	16.95
12HP7	16.95
12LP4	22.50
15E	1.19
15R	.89
16AP4	42.50
16CP4	42.50
19T8	1.29
23D4	.45
28D7	.98
30 Special	
35TG	4.95
45 Special	.39
53A	5.95
75TL	6.95
100R	.89
100TH	9.95
121A	2.98
203A	8.95

204A	$69.50
211	.69
212E	49.50
215A	.19
217C	8.95
227A/5C27	5.95
249C	3.95
250R	12.95
250TH	21.50
250TL	21.50
274A	5.50
274B	2.65
276A	9.95
293A	2.98
294A	5.75
300B	9.95
304TH	27.50
304TL	29.95
305A	34.95
307A/RK75	5.95
310A	8.95
316A	.65
323A/B	24.50
327A/5C37	4.95
328A	13.95
331A	12.95
350A	8.95
350B	2.95
368AS	7.95
371A	1.49
371B	.98
388A	2.75
393A	6.95
394A	4.95
417A	12.95
434A	4.95
446A	4.95
446B	1.79
450TH	47.50
450TL	44.50
527	12.75
559	1.39
562	97.50
575A	13.95
701A	5.95
702A	3.95
703A	7.95
704A	1.05
705A	.89
706BY	39.50
706CY	39.50
706FY	42.50
706GY	42.50
707B	17.95
708A	4.95
709A	3.95
710A/8011	1.75
713A	1.45
714AY	6.95
715A	7.95
715B	12.95
715C	24.50
717A	1.69
721A	2.59
722A	2.95
723A	9.95
723A/B	14.95
724B	3.89
725A	7.95
726A	6.95
726B	29.50
726C	49.50
730A	12.95
750TL	79.50
800	1.95
801A	.49
802	4.49
803	4.49
804	9.95
805	4.49
806	29.95
807	1.98
808	4.49

809	$2.45
810	9.95
811	2.95
812	2.95
812H	6.90
813	8.95
814	3.95
815	2.95
816	1.19
826	.98
828	12.75
829	12.95
829B	14.95
830B	3.95
832	5.95
832A	8.95
833A	37.50
836A	3.95
837	1.69
838	2.95
841	.45
843	.39
845	4.95
849	29.50
851	69.50
852	29.50
860	6.95
861	29.50
864	.39
865	1.45
866A	1.39
866JR	1.29
869B	39.50
872A	2.49
874	1.49
876	.59
878	2.25
884	1.49
885	1.49
902	8.95
905	3.59
908	7.95
918	1.69
919	2.79
922	.98
923	1.05
927	1.59
930	1.05
931A	4.95
954	.39
955	.45
956	.45
957	.45
958	.45
959	.65
991/NE16	.39
1603	3.25
1613	1.25
1614	1.95
1616	.98
1619	.29
1622	1.98
1624	1.98
1625	.45
1626	.35
1629	.25
1630	.98
1631	1.29
1632	.79
1633	.75
1634	.75
1636	3.25
1638	.65
1644	.98
1654	2.39
1665	1.45
1851	1.89
1960	.79
1961	4.99
2050	1.25
2051	.65
8005	5.95
8011	1.75

8012	$3.95
8013	2.95
8014	29.95
8020	1.29
8025	5.95
9001	2.25
9002	1.49
9003	1.49
9004	.45
9005	2.35
9006	.29
C1JA	9.95
C5B	9.95
C6A	7.95
C6J	6.95
C100D	1.49
CK502AX	2.95
CK503AX	2.95
CK505AX	2.25
CK506AX	2.25
CK507AX	2.25
CK512AX	2.25
CK517AX	8.45
CK1005	.89
CK1006	.95
E1148	.35
EF50	.69
F123A	8.75
F127A	22.50
F128A	89.50
F606	37.60
F660	79.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	14.95
FG81A	3.95
FG105	8.95
FG172	29.50
FG146	8.95
FG434A	4.95
FG451	.89
FG502A	1.85
GL562	97.50
GL592	14.95
HF125	14.95
HF300	19.95
HY114B	.79
HY115	.79
HY615	.29
KC4	37.50
KU610	6.95
ML101	69.50
REL21	3.25
RK20	9.95
RK25	4.49
RK33	.69
RK34	.89
RK48A	4.49
RK59	1.49
RK60/1641	.98
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.95
RX120	8.95
V70D	6.95
VR78	.69
VR91	1.49
VR92	.98
VT127A	3.95
VT158	14.95
VU29	2.95
VU111	1.49
WL468	12.95
WL530	12.75
WL531	12.75
WL532	2.95
WL578	1.29
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50

OA2, OA4G, OB2, OZ4, O1A, 1A3, 1A4P, 1A5GT, 1A6, 1A7GT, 1AB5, 1B3/8016, 1B4, 1B5/25S, 1B7GT, 1C5GT, 1C6, 1C7G, 1D5GP, 1D7G, 1D8GT, 1E5GT, 1E7G, 1F4, 1F5G, 1G4GT, 1G6GT, 1H4G, 1H5GT, 1H6GT, 1J6GT, 1L4, 1LA4, 1LA6, 1LB4, 1LC5, 1LC6, 1LD5, 1LE3, 1LG5, 1LH4, 1LN5, 1N5GT, 1P5GT, 1Q5GT, 1R4, 1R5, 1S4, 1S5, 1T4, 1T5GT, 1U4, 1V, 2A3, 2A4G, 2A5, 2A6, 2A7, 2B7, 2V3G, 2X2, 2X2A, 3A4, 3A5, 3A8, 3B7/1291, 3D6/1299, 3LF4, 3Q4, 3Q5GT, 3S4, 3V4, 5R4GY, 5T4, 5U4G, 5V4G, 5W4, 5X4G, 5Y3GT, 5Y4G, 5Z3

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUOTE ON LARGE OR SMALL QUANTITIES.

5Z4, 6A3, 6A4LA, 6A6, 6A7, 6A8, 6AB7, 6AC5GT, 6AC7, 6AD7G, 6AE6G, 6AF6G, 6AG5, 6AG7, 6AH6, 6AJ5, 6AK5, 6AK6, 6AL5, 6AQ5, 6AQ6, 6AR5, 6AT6, 6AU6, 6AV6, 6B4G, 6B6G, 6B7, 6B8G, 6BA6, 6BE6, 6BF6, 6BG6G, 6BH6, 6BJ6, 6C4, 6C5, 6C6, 6C8G, 6D6, 6D8G, 6E5, 6F5, 6F6, 6F6GT, 6F7, 6F8G, 6G6G, 6H6, 6H6GT, 6J5, 6J5GT, 6J6, 6J7, 6J7GT, 6K5GT, 6K6GT, 6K7, 6K8, 6L5G, 6L6, 6L6G, 6L6GA, 6L7, 6L7G, 6N7, 6Q7, 6R7, 6S7G, 6S8GT, 6SA7, 6SC7, 6SD7GT, 6SF5, 6SF5GT, 6SF7, 6SG7, 6SH7, 6SJ7, 6SK7, 6SL7GT

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUOTE ON LARGE OR SMALL QUANTITIES.

6SN7GT, 6SQ7, 6SR7GT, 6SS7, 6ST7, 6SU7GTY, 6SV7, 6T7G, 6T8, 6U5G, 6U6GT, 6U7G, 6V6, 6V6GT, 6W4, 6W7G, 6X4, 6X5GT, 6Y6G, 6Y7G, 6Z7G, 6ZY5G, 7A4/XXL, 7A5, 7A6, 7A7, 7A8, 7AG7, 7B4, 7B5, 7B6, 7B7, 7C4, 7C5, 7C6, 7C7, 7E5, 7E6, 7E7, 7F7, 7H7, 7K7, 7L7, 7N7, 7Q7, 7R7, 7S7, 7V7, 7W7, 7X7, 7Y4, 7Z4, 12A, 12A6, 12A7, 12A8GT, 12AH7GT, 12AL5, 12AT6, 12AT7, 12AU6, 12AU7, 12AV6, 12BA6, 12BE6, 12C8, 12F5GT, 12H6, 12J5GT, 12J7GT, 12K7GT, 12K8, 12Q7, 12SA7GT, 12SC7, 12SF5, 12SF7, 12SG7, 12SH7

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUCTE ON LARGE OR SMALL QUANTITIES.

12SJ7, 12SK7, 12SL7, 12SN7, 12SQ7, 12SR7, 12Z3, 14A4, 14A7, 14B6, 14F7, 14F8, 14H7, 14J7, 14N7, 14Q7, 14R7, 19, 24A, 25L6GT, 25Z5, 25Z6GT, 26, 27, 28D7, 30, 31, 32, 32L7GT, 33, 34, 35/51, 35A5, 35B5, 35C5, 35L6GT, 35W4, 35Y4, 35Z3, 35Z4, 35Z5, 36, 37, 38, 39/44, 41, 42, 43, 45, 45Z3, 45Z5, 46, 47, 48, 49, 50A5, 50B5, 50C5, 50L6GT, 50Y6, 53, 56, 57, 58, 59, 70L7, 71A, 75, 76, 77, 78, 80, 82, 83, 83V, 84/6Z4, 85, 89Y, 117L7/M7, 117N7, 117P7, 117Z3, 117Z6

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUOTE ON LARGE OR SMALL QUANTITIES.

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-18V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps.	$ 2.49
20E1	2.4 Amps.	3.49
20F1	6.4 Amps.	4.95
20K1	13.0 Amps.	8.95
20J1	17.5 Amps.	11.95
20K2	26.0 Amps.	17.95
20K3	39.0 Amps.	24.95
20K4	52.0 Amps.	29.95
20K5	65.0 Amps.	35.95
0-40v AC	**Current**	**0-34v DC**
40D1	.6 Amps.	$ 2.95
40E1	1.2 Amps.	3.89
40F1	3.2 Amps.	5.25
40K1	6.0 Amps.	9.95
40J1	9.0 Amps.	12.95
40K2	12.0 Amps.	18.95
40J2	18.0 Amps.	22.45
40K4	24.0 Amps.	32.50
40K5	30.0 Amps.	34.95
40J4	36.0 Amps.	39.50
0-120v AC	**Current**	**0-100v DC**
40D1A	.6 Amps.	$ 7.85
40E1A	1.2 Amps.	10.76
40F1A	3.2 Amps.	16.65
40K1A	6.0 Amps.	24.75
40J1A	9.0 Amps.	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps.	$ 1.89
10E1	2.4 Amps.	2.25
10F1	6.4 Amps.	3.87
10K1	12.0 Amps.	4.95
10J1	16.0 Amps.	7.95
10K2	24.0 Amps.	10.75
10K3	36.0 Amps.	14.75
10K4	48.0 Amps.	17.75
10K5	60.0 Amps.	19.95
10K6	72.0 Amps.	25.57
10K7	84.0 Amps.	27.95
10J6	96.0 Amps.	32.50
10K10	120.0 Amps.	42.50

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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; 340-0-340v @ 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
500-0-500v @ 175 MA	4.55
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
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	4.35
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
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A	2.97
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230	3.85
13.5v CT @ 3.25A	2.17
12.6v CT @ 10A; 11v CT @ 6.5A	6.35
3x10.3v CT @ 7A. $6.95 6.3v @ 1A	.98
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
6.3v CT @ 3.5A; 2x2.5v CT @ 3A	2.97
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

EQUIPMENT SPECIALS

ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	$14.95
AN/CRW-2 UHF Receiver Less Tubes	New	5.95
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC459 Transmitter	Good	10.95
BC778 Gibson Girl	Good	3.95
BC950A-121 Xmitter 100-156 MC	New	69.50
BC1016 Tape Recorder	New	459.50
BC1206B Beacon Receiver, Less Tubes	Good	3.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Output	Good	6.95
MN26C Compass Receiver	Good	24.95
M110 Dynamic Chest Mike	New	3.95
PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE103 Dynamotor	Like New	29.95
R89/ARN5 Receiver Less Tubes, Covers	Good	14.95
SCR518 Altimeter Complete	New	97.50
T17 Carbon Mike	Used	1.59

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$1.98
.05 HY @ 15A	7.95
.065 HY @ 2.5A	2.49
.1 HY @ 15A	6.95
2 HY @ 175 MA.	1.49
3 HY @ 50 MA.	.39
5 HY @ 1A	13.95
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
14/3.5 HY @ 40/400 MA	6.95
15 HY @ 25 MA	.59
200 HY @ 10 MA.	2.95
325 HY @ 2 MA	2.95
600 HY @ 1 MA	2.95

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3 SQ.	Supreme	542	Multimeter	$3.75
3 SQ.	RCP	446	Multimeter	3.75
3 SQ	Hichcock	0–200	Microamps	6.50
3 RD.	Asst'd	0–200	Microamps	6.50
3 RD.	Triplett	0–500	Microamps	6.25
3 RD.	Weston	0–100	Thermo-Galvanometer	10.00
3 RD.	Weston	0–120	Galvanometer	9.80
3 RD.	Asst'd	0–1	MA.	4.95
3 RD.	Asst'd	0–100	MA.	3.95
3 RD.	Weston	0–150	MA.	3.95
3 SQ.	Asst'd	0–150	MA.	3.95
3 RD.	Asst'd	0–300	MA	3.95
3 RD.	G. E.	0–500	MA.	3.95
3 RD.	Weston	0–8	A. C. Volts	3.75
3 RD.	G. E.	0–10	A. C. Volts	3.75
3 SQ.	West'hse	0–10	A. C. Volts	3.85
2 RD.	West'hse	0–15	A. C. Volts (600 cy.)	2.49
3 RD.	West'hse	0–150	A. C. V.	3.95
3 SQ.	Marion	0–150	D. C. V.	3.95
3 RD.	G. E.	0–350	D. C. V.	3.95
3 RD.	Asst'd	0–500	D. C. V.	3.95
3 SQ.	Simpson	0–1000	D. C. V.	3.95
3 RD.	Asst'd	0–1.5	D. C. K. V.	3.49
3 RD.	West'hse	0–3.5	D. C. K. V	3.49
3 RD.	F. E.	0–30	D. C. K. V.	3.49

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CAP.	D. C Volts	No.	Net Each
.005	15,000	14F322	$7.95
.005-.005-.01	10,000	26FH16g2	10.50
.035	10,000	AX1U36	7.50
.02	15,000	14F321	21.95
.01	6,000	143-806	
.15	2,500	26F345	1.10
.2	5,000	C8B2784	2.98
.25	4,000	P9717	3.10
.25	10,000	14F192	19.50
.6	2,500	72041-503	1.25
1	440 AC	KG4010	.59
1	2,500	482616-10	2.55
1	3,000	A1089	2.75
1	3,600	C8B3062	2.95
1	5,000	23F49-G2	3.15
1	6,000	60010GA	4.35
1	12,000	26F628	9.50
2	440 AC	67 x 21	.79
2	600	A14109-2	.85
2	1,000	23F11	1.10
2	2,000	324-138	2.20
2	3,000	2538-16	4.50
2	5,000	C-8B2784	6.50
2.5-2.5-5	600	C8B1256	1.95
4	330 AC	KG3040	.85
4	400	25F785	.95
4	600	B8B1253-1	1.10
4	1,000	10365	1.75
5	1,000	13765	1.85
6	330 AC	67 x 7A	.89
6	44 AC	K64060	.95
6	600	P971S	1.75
8	1,000	143-117	2.50
8	2,000	TJU20080G	4.95
10	400	7DB1AE1D	1.25
10	600	10373	1.85
15	1,000	23F19G2	3.95

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Popular Split Stator Variables at unbelievable low Prices! Well Built, low loss ceramic mounted with bushings at both rotor ends. Ideal for V. F. O., low powered rig and exciter units, receivers, etc. All with ¼" Shafts.

CAPACITY	LIST PRICE	YOUR COST
15-15	$3.80	$1.14
20-35	3.95	1.19
27-27	4.10	1.23
35-35	4.30	1.39
75-75	4.80	1.44

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Ferris 18c Sig. Gen. L.N.	$499.95
Bendix Ta-12c Exc.	39.95
BC733D Vy Good	14.95
ATA-CBY-52232 2.1-3 Xmtr—New	14.95
BC-652A 2-6 Mc Rcvr. New	39.95
DM40A 12 V. Dyn. for Above. New	4.95
DM42A Xmtr Dyn. Oversea Crated. New	19.95
Sig. Gen. I-126. Vy. Gd.	125.00
RS25-3 Rcvr. Vy. Gd.	29.95
BC-605D Amplifier—New	5.95
AVT-23 Transmitter—New	34.95
ID-93/APG-13A Scope. New	39.95
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PE-103. Exc.	24.95
PE-103 Connecting Cables	4.95
ART-13. Exc.	175.00
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ATD Xmtr. New	49.95
Dyn. for Above	24.95
ATD Spare Parts Kit	19.95
BC 906c Freq. Mtr.	32.50
GYRO FLUX GATE Comp. Amplif. New	14.95
BC 439 Freq. Meter	19.95

SMASHING VALUES IN BLOWERS

(A):—**DUAL BLOWER,** approximately 100 cu. ft., per min., per section. Constant duty 110 V. A. C. 60 cycle, 3400 RPM motor made by HEINZE. 2½" intake, 2" outlet. Measures 6" high x 6½" deep x 10¾" long. NEW—BOXED. **$14.95**

(B):—**SINGLE SECTION BLOWER.** Approximately 100 cu. ft., per min. Constant duty 110 V. A. C. 25 and 60 cy., 3200 RPM HEINZE MOTOR. 2½" intake, 2" outlet measures 6" high x 6½" deep x 6" long. NEW—BOXED. **$9.95**

(C):—**SINGLE SECTION BLOWER.** Approximately 50 cu ft., per min. Air cooled 110 V. A. C. 60 cycle F. A. SMITH MOTOR. 2" intake, 1¼" outlet. Measures 5" high, 4" deep, 5" long. NEW—BOXED. **$6.95**

(D):—**SINGLE SECTION BLOWER.** Approximately 50 cu. ft., per min. Constant duty 24 V. D. C. 6000RPM A. G. REDMOND CO., MOTOR. 2" intake by 1" outlet. Measures 3¼" high, 3" deep, 5" long. NEW SURPLUS SPECIAL. **$3.95**

AIRCRAFT TYPE

Vibrator power supply delivering 300 V. D. C. at 80 Ma. Filter Built-in, fully wired, tested and guaranteed new **$5.95**

TRANSFORMER BARGAINS!

Plate

1025-0-1025—500 MA	$17.95
2500 V.—4 MA	3.95

Filament

2.5V.10A cased	4.95
5 V.C.T.-3A	3.95
5 V.C.T.-10.5A	3.95
6.3 V.C.T.-3.5A	3.95
5V-10A	1.85
5 V.C.T.-15A	5.95
6.4V-8A	2.05
7.5V-5A	2.49

Power

275-0-275—70 MA.—5V-5A, 2.5V-10.5A	3.00
325-0-325—40 MA.—5 V.C.T.-2A, 2.5 V.C.T.-4A	2.25
325-0-325—70 MA.—6.3V-1.2A, 5V-3A	2.95
350-0-350—100 MA.—6.3V-6A, 6.3V-2A	3.25

Modulation

807 to P.P. 6L6	$2.49
P.P. 807 to single 6L6, 4D32 (2400 ohms)	3.49
From 200, 500 ohms to 5, 6, 7, 8, 9, 10K ohms at 150 MA.	4.49

Driver Xfmrs.

200, 10,000 ohm P. to single G.	$ .79
10,000 ohm P. to single G.	.80
P.P. 45, 2A3, etc. to P.P. 210, 801, etc.	1.95
P.P. 6L6, 2A3, etc. to P.P. grids	1.65

Output

6V6 to 2, 4, 8 ohms	.69
P.P. par 6N7 Class "B" to 8000 ohms	1.49

Input

600 ohm C.T. to 300 ohm mike	$1.49

Mike to Line

From and to 50, 125, 200, 330, 500 Ohms	$2.49
30 ohm mike to 600 ohm C.T. Bal. line	1.65

Chokes

.875	HY.	2.5 Amps	8.95
2.5	HY.	4 Amps	9.95
2.5	HY.	130 MA.	1.10
4	HY.	40 MA.	.25
8	HY.	200 MA.	2.35
10	HY.	180 MA.	3.49
40	HY.	90 MA.	3.49
10	HY.	200 MA.	2.49
12	HY.	150 MA.	1.75
15	HY.	125 MA.	1.60
15	HY.	200 MA.	2.65
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15 Volts, Westinghouse NA-35, 3½" Round flush bakelite (JAN type MR 35W015ACVV) @ $5.50
15 Volts, General Electric AW-41, 2½ Round flush bake. bl. scale with markings & calib. at 0, 10 & 15 only. Signal Corps Stock 1S-122..@ $3.00
15 Volts, General Electric AW-41, 2½" Round flush bake. black scale, red mark at 10 Volts, calib. for 800 cycle @ $3.00
40 Volts, Westinghouse NA-33, 2½" Round flush metal case, black scale lum. markings, calib. for 400 cycles @ $3.50
40 Volts, Westinghouse NA-33, 2½" Round flush metal case, black sc. lum. markings. (These were originally calib. for 400 cycle use but have been adj. for 60 cycle) @ $3.95
40 Volts, Weston 517, 2½" Round flush metal case, black scale lum. markings, calib. for 400 cycles @ $3.50
75 Volts, Weston 517, 2" Round flush metal case, ring-clamp type mtg. non-flanged @ $2.95
150/300 Volts, Dual Range, Triplett 331-JP, 3½" Round fl. bakelite case with external series res. for 300 volts, sc. calib. 150 double scale indications for 300 volt use @ $6.00

R. F. AMMETERS

120 MA Simpson 125, 3½" Round flush bakelite, arbitrary linear scale calib. 0-10 with caption Output Units, external thermocouple...@ $7.50
1 Amp. G.E. DW-52, 2½" Round fl. metal @ $4.50
1 Amp. G.E. DO-44, 3½" Round fl. bake. @ $11.00
1.5 Amp, Weston 507, 2½" Round flush metal, black scale @ $4.50
1.5 Amp, General Electric DW-52, 2½" Round flush metal, black scale @ $3.50
2 Amps, Simpson 137, 2" Square flush bakelite case @ $4.50
2 Amps, Weston 425, 3½" Round flush bakelite @ $8.50
2.5 Amps, Simpson 35, 3½" Round flush bakelite @ $5.50
2.5 Amps, Westinghouse NT-35, 3½" Round flush bakelite Signal Corps 1S-111 @ $6.00
2.5 Amps, McClintock MD 3001, 3½" Round flush bakelite, Signal Corps Stock 1S-111 @ $4.50
2.5 Amps, Weston 425, 3½" Round flush bakelite @ $8.50
3 Amps, Weston 507, 2½" Round flush bakelite, black scale @ $4.50
3 Amps, Weston 425, 3½" Round flush bakelite, with external thermocouple @ 09.50
3 Amps, Westinghouse NT-35, 3½" Round flush bakelie (JAN type MR35W003RFAA3..@ $6.00
5 Amps, G.E. DO-44, 3½" Round fl. bake. @ $7.50
5 Amps, General Electric DO-44, 3½" Round bakelite with external thermocouple @ $8.50
6 Amps, General Electric DW-44, 2½" Round flush bakelite, black scale @ $3.50
8 Amps, West. RT-35, 3" Square fl. bake. @ $7.50
8 Amps, Weston 425, 3" Square flush bakelite case @ $10.50
10 Amps, Weston 425, 3½" Round flush bakelite @ $8.50
10 Amps, Weston 425, 3½" Round flush bakelite MR35W010RFAA @ $9.50
1 Amp, Westinghouse NX-35, 3½" Round flush bake. case, (JAN type MR34W001DCAA) @ $6.00
1 Amp, General Electric DO-41, 3½" Round flush bakelite CG-22000 @ $5.50
2 Amps, General Electric DO-40, 3" Round flush ring-mounted non-flanged bakelite case @ $4.95
5 Amps, General Electric DO-40, 3" Round, non-flanged, ring-mounted fl. bakelite case @ $4.95
10 Amps, General Electric DO-40, 3" Round non-flanged, ring-mounted fl. bakelite case @ $4.95
15 Amps, Triplett 0321-T, 3½" Round flush bakelite case @ $4.50
30 Amps, General Electric DW-51, 2½" Round flush bake. case (JAN type MR24W030DCAA) @ $4.50
30-0-30 Amps, Beede, 2½" Round flush metal Case @ $3.00
30-0-30 Amps, General Electric DW-51, 2½" Round flush metal @ $3.50
50-0-50 Amps, General Electric DO-41, 3½" Round flush bake. black scale with luminous markings @ $5.50
100 Amps, Westinghouse OX-33, 2½" Round flush bakelite case 50 M.V. movement, with leads but without shunt @ $2.95
150 Amps, Simpson 125, 2½" Round flush metal case, complete external 50 M.V. shunt @ $5.50
200 Amps, Weston 506, 2½" Round flush bakelite case, 50 M.V. movement with external shunt, (JAN type MR24W200DCAA) @ $7.50
200 Amps, General Electric DO-41, 3½" Round flush bakelite, complete with external 50 M.V. shunt @ $9.50
200-0-200 Amps, Weston 506, 2½" Round flush bakelite case, complete with external 50 M.V. shunt @ $7.50
300 Amps, General Electric DW-51, 2½" Round flush bakelite 50 M.V. movement, requires external shunt (JAN type MR24W300DCAA) @ $4.50
500 Amps, General Electric DW-51, 2½" Round flush bakelite case, 50 M.V. movement, without shunt @ $3.95
600 Amps, General Electric DO-47, special 3 color scale without calibration, 50 M.V. movement, 3½" Rd. flush metal case @ $4.00

D. C. MICROAMMETERS

500 Microamps, General Electric DO-53, 3" Square flush bakelite scale calib. 0-15 Kilovolts D.C. @ $5.95
500 Microamps, General Electric DW-40, 2" Round flush ring-clamp mounted (non-flanged) bakelite case, 100 M.V. sc. calib. 0-1 Milliampere, approx. 200 ohms resistance @ $3.50
500 Microamps, General Electric DO-41, 3½" Round flush bake. sc. calib. 0-20 Kilovolts D.C., approx. 250 ohms resistance @ $5.95

D. C. MILLIAMMETERS

1 MA, General Electric DW-41, 2½" Round flush bakelite case, special sc. calib. 140 volts and 500 MA @ $3.95
1 MA, Westinghouse, NX-33, 2½" Round flush bakelite case, black scale calib. 140 volts, 500 MA @ $3.95
1 MA, Westinghouse NX-35, 3½" Round flush bakelite (JAN type MR 35W001DCMA), approx. 53.7 ohms resistance @ $7.50
2 Milliamps, Westinghouse NX-35, 3½" Round flush bakelite case (JAN type MR35W002DCMA) @ $5.50
3 Milliamps, Gruen GW-587, 2½" Round flush bakelite case, scale calib. 30 and 450 MA and 3000 volts @ $3.50
3 Milliamps, Simpson 126, 2½" Round flush bakelite case, (JAN type MR25W003DCMA) @ $4.50
15 Milliamps, Simpson 26, 3½" Round flush bakelite case, (Jan type MR25W015DCMA)..@ $6.00
20 Milliamps, General Electric DO-53, 3" Square flush bake. @ $5.50
50 Milliamps, General Electric DO-41, 4½" Round flush bake. @ $4.95
150 Milliamps, Electrical #350, 3½" Round flush bakelite case, made by Elec. Division of US Time Corp. @ $4.00
150 Milliamps, Weston 506, 2½" Round flush bakelite case @ $4.50
150 Milliamps, General Electric DO-53, 3" Square flush bake. @ $5.50
150 Milliamps, Triplett, 2" Square flush bakelite, black sc. @ $3.95
150 Milliamps, Gruen 508, 2½" Round flush bakelite case @ $3.95
200 Milliamps, Marion, 3½" Round flush bakelite case, knife edge pointer @ $4.00
200 Milliamps, General Electric DO-41, 3½" Round flush bake. @ $5.50
200 Milliamps, Simpson 26, 3½" Round flush bakelite (JAN type MR35W200 DMCA) @ $5.95
300 Milliamps, General Electric DO-53, 3" Square flush bake. @ $5.50
500 Milliamps, General Electric DW-41, 2½" Round flush bake. case, black scale (Signal Corps Stock # IS-22) @ $3.95
500 Milliamps, General Electric DO-53, 3" Square flush bakelite @ $5.50
500 Milliamps, General Electric DW-51, 2½" Round flush bake. @ $4.50
500 Milliamps, Dejur Amsco 312, 3" Square flush bakelite @ $5.00
800 Milliamps, Dejur Amsco # 310, 3" Round flush bakelite case Signal Corp Stock # 3F980 @ $4.50
800 Milliamps, Weston 301, 3½" Round flush bakelite @ $5.95
800 Milliamps, General Electric DO-41, 3½" Round fl. bake. @ $4.95
1000 Milliamps, Weston 301, 3" Square flush bakelite case @ $6.50
1000 Milliamps, Western Electric type D-55049, 3½" Round fl. bakelite, concentric style movement, with 190° scale length @ $4.00
1000 Milliamps, Electel 350, 3½" Round flush bakelite case, (JAN type MR35W100DCMA) sc. calib. 0-100, caption "DC Milliamperes x 10" Mfg. by Electrical Division of U.S. Time Corp. @ $4.50

D. C. VOLTMETERS

5/125 Volts, Dual Range, Weston 506, 2" Round flush metal, ring clamp mounted (non-flanged) approx. 135 ohms per volt, plus button for high range @ $4.00
20 Volts, McClintock MD2001, 2½" Round flush bakelite case, 1000 ohms per volt MR25W020 DCVV @ $4.50
30 Volts, General Electric DO-41, 3½" Round flush bakelite case, 100 ohms per volt @ $6.00
30 Volts, General Electric DO-40, 3" Round non-flanged, ring mounted flush bakelite case, 100 ohms per volt @ $4.95
35 Volts, Simpson 125, 2½" Round flush metal case, approx. 110 ohms per volt, made for Homelite Corp. @ $4.00
40 Volts, Sun 3AP593, 3½" Round flush bakelite case, 100 ohms per Volt, made for Mallory Co. @ $5.95
75 Volts, General Electric DO-40, 3" Round non-flanged ring mounted flush bakelite case, 100 ohms per V. @ $4.95
150 Volts, Roller Smith type FDS, 3 ¾" x 3 ⅞" surface mounted bakelite case, 100 ohms per volt @ $12.00
300 Volts, Sun 2AP380, 2½" Round flush bakelite case, 1000 ohms per volt (JAN type MR25 W300DCVV) @ $6.00
50/500 Volts, Weston 506, 2½" Round flush bakelite case, Dual range 1000 ohms per volt, black scale with luminous markings @ $5.50
750 Volts, Westinghouse RX-35, 3" Square flush bakelite case, 1 MA movement, complete with external resistor @ $8.95

D. C. KILOVOLTMETERS

2 Kilovolts, General Electric DO-53, 3" Square flush bakelite, 1 MA movement complete with 1000 ohms per volt precision ferrule-type multiplier @ $10.95
4 Kilovolts, Dejur Amsco # 310, 3½" Round flush bakelite case, 1 MA movement @ $4.50
15 Kilovolts, General Electric DO-41, 3½" Round flush bakelite case, L MA movement (JAN MR34W015DCKV) @ $6.50
20 Kilovolts, General Electric DO-41, 3½" Round flush bakelite, 1 MA with multiplier @ $27.95

A. C. AMMETERS

150 Milliamps, General Electric AO-22, 3½" Round flush bakelite @ $4.95
30 Amps, Triplett 332-JP, 3½" Round flush metal case @ $4.00
50 Amps, Westinghouse NA-35, 3½" Round flush bakelite 500 cycles @ $5.50
60/120 Amps, Dual Range Burlington 32 x C, 3½" Round flush bakelite, 5 Amp. movement with external current transformer @ $7.50
75 Amps, Burlington 32 C, 3½" Round flush bakelite @ $4.95
150 Amps, Multirange, Westinghouse NA-35, 3½" Round flush bakelite with Current Transformer @ $7.95

D. C. AMMETERS SPECIAL METERS

Suppressed Zero Micrommeter, Hickok 56 C, 2½" Round flush bakelite case, Suppressed zero type, 600 Microamper D.C. Approx. 150 Microamp ½ Scale, approx. 1000 ohms resistance, Special "Battery Volts" scale @ $3.50
Rectifier Milliammeter, McClintock, 2" Round flush metal non-flanged ring mounted case, 1 MAAC, 700 uadc with ½ wave rectifier black scale, calib. 0-10. Signal Corps Stock 3F891-2 S.C. Inspection @ $3.95
Rectifier Milliammeter Weston 545 type 81, 270° concentric style F.S. 1 MAAC, 940 uadc 70 ohms, with rectifier, black scale calib. 0-270°..@ $6.50
S Meter, Simpson 25, 3½" Round flush bakelite case, 5 Ma zero right movement. Caption D B Avove 1 Microvolt with translucent scale & internal illuminating feature @ $4.50
Frequency Meter 350-450 cycles, Weston 637, 4" Square, 4 hole mtg., 115 Volt, Electrodynamometer type @ $7.50
Decibel Meter, High Speed type Multirange, Weston 301 type 61, 10 to ± DB, 6 Mw in 600 ohms; ODB equals 1.9 volt 5000 ohms resistance. High speed type .20 to .35 seconds to find reading. Only 2-6% overthrow, 16-50 Damping factor. Complete with 3 external wires wound, resistors @ $11.50
Weston 545, type 81, Rectifier type milliammeter, 270° movement 4" Aircraft type case, full sc. is 1.1 M.A.A.C. @ $6.50
Zero Center D.C. Milliammeter 1-0-1 DCMA MV Weston Model 502, 6" Square flush metal, black scale calib. 900-0-900 R.P.M. @ $18.00

AIRCRAFT METERS

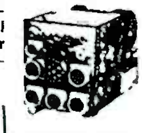
.5-0-.5 D.C. MA, General Electric DW-53, 10 sc. div. no numbering Caption "Bottomside" with illum. feature 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $3.50
30 Volts 30 Amps D.C. Dual Meter, Weston 606, complete with external 50 M.V. shunt, normally indicates amps, with push button for volts, 2½" Square flush type, 4 hole mtg. with black scale & luminous markings @ $6.00
30 Volts 60 Amps D.C. Dual Meter, General Electric, AN connector type, complete with external 50 M.V. shunt & connector, normally indicates amps, with push button for volts, 2½" Square flush type, 4 hole mtg. with luminous markings @ $5.50
30 Volts 240 Amps D.C. Westinghouse AX-33, Complete with external 50 M.V. shunt, normally indicates amps, with push button for volts, 2½" Square flush type 4 hole mtg. with black scale & luminous markings @ $7.50
0-30 Volts, Westinghouse AX-33, 2½" Square, case, black sc. @ $4.50
0-30 Volts D.C. Weston 606, 2½" Square flush type, 4 hole mtg. with black sc. & luminous markings @ $4.50
0-30 Volts D.C. General Electric DW-53, 2½" Square flush type, 4 hole mtg., black scale @ $4.50
0-30 Amps D.C. Westinghouse AX-33, USN-C30 in. shunt, 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $5.00
30-0-30 Amps D.C. Weston 606, with internal shunt, 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $5.00
60 Amps D.C. Westinghouse AX-33, 2½" Square flush type, 4 hole mounting @ $5.50
60 Amps, D.C. General Electric, complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $5.50
60-0-60 Amps D.C. Weston 606, complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $5.50
20-0-100 Amp D.C. Hickok, 2½ Round flush metal case, black scale, requires external shunt @ $4.50
20-0-100 Amps D.C. Weston 506, 2½" Round flush metal case, complete with external 50 M.V. shunt, black scale @ $6.50
120 Amps D.C. Westinghouse AX-33, complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale & luminous markings @ $5.50
120-0-120 Amps D.C. Westinghouse AX-33, complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale & luminous markings @ $5.50
150Amps D.C. Westinghouse F-1 (NX-33) 2½" Round flush metal case, black scale luminous markings, 50 M.V. movement with external shunt..@ $6.50
240 Amps D.C. Sutton-Horsley Br. Complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale and luminous markings @ $5.50
240 Amps D.C. Westinghouse AX-33, complete with external 50 M.V. shunt, 2½" Square flush type with black scale and luminous markings @ $6.50
240-0-240 Amps D.C. General Electric DW-53, complete with external 50 M.V. shunt, 2½" Square flush type, 4 hole mtg. with black scale & luminous markings @ $6.50

We specialize in electrical Instruments. Over 75,000 meters in stock. Send for our latest circular showing our complete line of Surplus-New-Guaranteed meters.

MARITIME SWITCHBOARD
INSTRUMENTS—ACCESSORIES
338 Canal St., N. Y. 13, N. Y.
Worth 4-8217

Orders accepted from rated concerns, public institutions and agencies on open account, others please send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

Complete stock of Relays available for immediate shipment. All sold at surplus prices. Write for Latest Relay List. Now Available.

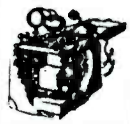


UPRIGHTS

Mfd.	Volt	Type	Cat. No.	Price
.0025	1500	2TT	D164209	30¢
.03	1600	2ST	RO3	25¢
2x.0515	600	2TT		45¢
.05	400	2BT	616M	25¢
.05	600	2BT	C51481918–20	28¢
.05	600	2BT	7700BR	28¢
3x.05	300	3BT	NJOCA195	30¢
3x.05	300	3BT	CA195	30¢
.125–.05	400	2TT	CMR481380–10	25¢
.1	600	2BT	616M–14842	35¢
.1	600	2BT	R11–616MB	35¢
.1	400	2BT	418CB	30¢
.1	600	2BT	7701BR	35¢
.1	600	2BT	CP69B1AF104K	35¢
.1	400	2BT	XMRBW4–.1	30¢
.1	600	2BT	C69B1AF104	35¢
2x.1	600	2BT	P9711	39¢
3x.1	400	3BT	CA255	39¢
3x.1	400	3TT	ROBC	39¢
3x.1	400	3BT		39¢
3x.1	600	3TT	C168B5EF104V	42¢
3x.1	600	3BT	7710BR	42¢
3x.1	600	3BT	CD516	42¢
2x.125	400	2TT		
.25	800	2WTT		69¢
.4	600	2BT	M–7725BR	30¢
.25	600	2BT	C168B1EF254K	30¢
.5	600	2BT	SO1	32¢
.5	600	2BT	PO8	32¢
.5	400	2TT	416T	30¢
.5	600	2BT	616MB	32¢
2x.5	250	2TT	A–8B515	30¢
2x.5	400	3BT	418MCB	35¢
2x.875	400	2BT	CWS-P-72076-503	39¢
1	400	2TT	305–1605S	35¢
1	600	2BT	616MCB	38¢
1	600	2BT	YAB6100	38¢
1	250	2TT	CBV48553–15	30¢
1	100	1BT	104M59	25¢
1	600	2BT	616MCB	38¢
1	400	2BT	418MCB	35¢
1.75	50	2TT	CRV48661	45¢

BC-733D SUPERHET RECEIVER

w/10 Tubes, 6 Selector - Relays operate on Xtal Controlled freq. 108.3-110.3 M C. Can easily be converted to 2 Mtr. ham bands.



EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/ 305 tube. Phone supplied. (Feath-rweight) $9.59

COLLINS ART-13 FREQ. MULT. UNIT

2-18 Mc for two 1625 Tubes. Comp. Assy less Tubes & Coils w/ ckt dia Price.. **$8.95**

CRYSTALS Low Freq.

FT-241. A holder ½" pin spacing, for ham and general use, Xtal controlled Signal Generators, marked in army Mc harmonic frequencies—Directions for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370, 372, 374, 375, 376, 377, 379, 380, 381, 383, 384, 385, 386, 387, 388 each **39c**

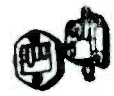
412, 413, 414, 415, 416, 418, 419, 420, 422, 423, 424, 425, 426, 427, 429, 430, 431, 433, 434, 435, 436, 437, 438, 440, 441, 442, 443, 444, 445, 446, 457, 458, 459, 461, 462, 463, 466, 468, 469, 470, 472, 473, 474, 475, 476, 477, 479, 480, 481, 483, 484, 485, 486, 487, 488, 490, 491, 492, 493, 494, 495, 496, 497, 501, 502, 503, 504, 505, 506, 507, 508, 509, 511, 512, 513, 514, 515, 516, 518, 519, 520, 522, 523, 525, 526, 527, 529, 530, 531, 533, 534, 536, 537, 538, 540 each **49c** 10 for $4.50

390, 391, 392, 393, 394, 395, 396, 397, 398, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 411 each **79c**

RL9 or RL7

Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Comp. w/ 12A6. 12SL7, 2 Choker 1 XRFRMR, DYN. for 24 operation, eto $2.29

CAPACITORS



XMTG. Micas Tapped Holes

Mfd.	Price
2500 V Test	
.00001	$0.29
.000025	.29
.00003	.29
.00005	.29
.000075	.29
.0001	.29
.00015	.29
.00025	.29
.0003	.29
.0004	.29
.0005	.35
.00075	.35
.00085	.35
.001	.35
.0015	.35
.0016	.35
.0017	.35
.002	.50
.0023	.50
.003	.50
.004	1.79
.005	1.79
.006	1.79
.0063	1.79
.0069	1.79
.007	1.79
.0075	1.79
.0076	1.79
.008	1.79
.01	1.10
.015	1.10
.02	1.10
.015	1.10
.027	1.10
.03	1.10
5000 V Test	
.0015	1.75
.002	2.00

XQ Solder Lugs 2500 V Test

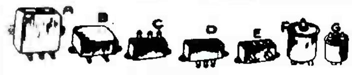
.01	.85
.015	.85
.02	.85
.04	.85
.001	.60
.0015	.60
.002	.60
.0022	.60
.0023	.60
.0024	.60
.0025	.60
.0027	.60
.003	.60
.004	.60
.005	.60
.0056	.60
.006	.60
.0063	.60
.0075	.80
.0076	.80
.008	.80
.0085	.80
.0005	.60
.0005	.60
.00015	.60

Oil Condensers Famous Makes Brand New

Mfd.	Volt	Price
15	220AC	$2.00
.5.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.05
6	1.5K	2.25
1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.1	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	70.00
.015	16K	6.95
.25	20K	16.95
.5	25K	75.00
1	25K	125.00
4	50	.29
1	100	.15
2.5	100	.23

AMPLIFIER

AM-32/PRSI less batt w/carry case for Mine Detector AN/PRSI. Price ea. $7.95



BATHTUBS

Mfd.	Volt	Type	Cat No.	Price
.01	600	2ST		25¢
.02	600			
.1	400	2ST	HC 3755	30¢
.02	1600	2ST	BA31227–E	45¢
.03	1000	2ST	W3-94	45¢
.06–.1	1500	2TTins	305-1526S	50¢
3x.05	600	3ST	CP50BSOFSO3V	30¢
.05	600	2TT	CSF–481391–10	30¢
.05	600	2ST	DYR 6005	30¢
2x.05	600	3ST	CGF48315B–10	40¢
2x.05	600	3ST	DYR 60055	40¢
.1	600	2ST	A–8B–373	25¢
.1	600	2TT	630T	25¢
.10	600	1ST	NDN	25¢
.1	1000	2ST	CAW48197–B10	30¢
2x.1	400	2BT	1574	25¢
2x.1	400	2TT	1572	25¢
2x.1	600	3ST		30¢
2x.1	400	2TT	CBY48678	25¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	2BT	CSF48680–A20	30¢
2x.1	200	2ST	CP-204D P11	20¢
2x.1	600	3ST	CQU48313–B10	30¢
2x.1	600	2ST	CGF48712B–10	30¢
2x.1	600	3ST	DYR6011	30¢
2x.1	600	2ST	CQU–48712–B10	30¢
2x.1	600	3BT	305–1133	30¢
2x.1	600	3ST	2XDMRW6–1	30¢
2x.1	600	3ST	CP50B4EF104UX	30¢
2x.1	600	3BT	305–1133	30¢
2x.1	600	3BT	305–1133	30¢
3x.1	600	3TT	7890481–P1	35¢
3x.1	600	3ST	CQU48713–B10	35¢
3x.1	600	3TT	305–1683S	35¢
3x.1	600	3BT	22F462	35¢
3x.1	600	3TT	3XDRTMW6–.1	35¢
3x.1	400	3BT	CAW48709	30¢
3x.1	600	3ST	A–18933–1	35¢
.13	600	2TT	630MT	25¢
.25	400	2TT	430T	30¢
2x.25	400	2ST	7253775	40¢
2x.25	100	2TT	K–7101880	25¢
3x.25	400	3BT	CAW–481372	35¢
.5	120	2TT	C226806–2	20¢
.5	600	2TT	305–1154	25¢
.5	400	1TT		23¢
.5	200	2ST	XDMR2–.5	20¢
.5	600	2ST	DYR6050G	25¢
.5	400	2ST	14862	23¢
.5	600	2BT	CSF48704–A20	25¢
.5	400	2TT	RO5	23¢
.5	400	2ST	48205A	23¢
.5	200	2ST	8A31231–C2	20¢
.5	400	2TT	1573	23¢
3x.5	100	3ST	B–215563–5	25¢
2x.5	250	2TT	A8B–515	25¢
2x.5	400	2ST	Z1065A	30¢
2x.5	300	3TT	541B	25¢
2x.5	400	2BT	1575	30¢
3x.5	400	3BT	CBY48703	30¢
.7	200	1TT	7157	30¢
1	200	1ST	55907	25¢
1	600	2ST		35¢
1	600	2BT	305–1391	35¢
1	400	2ST	A–8B–361	33¢
1	600	2TT	305–1507SNDO	35¢
1	600	Test 2ST	NDPS	30¢
1	400	2ST	A–8B–1104	30¢
1	600	2ST	W5–13	35¢
2x1	200	4ST	W226671–1	35¢
2x1	200	4ST	W–226671–2	35¢
2.5	100	2ST	K7101881–P1	30¢
4	50	2ST	678687–5	25¢
8	500	2ST	55844	79¢
30	150	2ST	D11206	1.15
25		2BT		
5–20		3TT	5417	
.025	600	2ST	NCN	35¢
2x1	400	3TT	P8887	25¢
2x.1	600	3TT	CP51B4EF104V	30¢
2x.1	600	3BT	CP52B4EF104V	30¢
2x.1	400	3ST	NKPS	25¢
3x.1	600	3TT	CMR–48849–A	35¢
3x.1	400	3ST	CP50BSEE104V	30¢
3x.1	400	3ST	CP505BEE104X	30¢
3x.1	600	3BT	CSF48709–A20	35¢
.1	400	2TT	CD–1066–11V	23¢
.1	600	2BT	NKP	25¢
.5	600	1TT	7283	30¢
6	400	2TT	CE64B060Q	1.00

ARC/5 BATHTUBS

3x.05	300	3TT	5414	08¢
.05–.01–.05	300	3TT	5415	08¢
3	300	1TT	7582	05¢
3x.22	300	3TT	692643 NAO	20¢

Model 542 Supreme Sensitivity. 5,000 Ohms/v 3" square meter, Reads: D.C. volts, 6-150-300-1,500; AC Volts 6-30-150-600; D C ma., 0.3-6-30-150; Ohms, 2,000 - 20,000 - 200,000, 2 megs; db. —6 to +50; Output, 6-30-150-600 volts. Bakelite case, 5-7/8 x 3 1/16 x 2-1/8" Shpg. wt. 2 lbs. ....$8.95 ea.
Model 442 Rad City. Same as above..........$8.95 ea.
Model 666—SC 56J Triplet VDC 3/30/300/600/1500 VDC ohms 1000/10000/100000/1 meg. Price ....$7.95 ea.
Model Same as above Chicago. Price $7.95
All above meters are sold as is. No refund minor repairs required.

Photo Material Ethyl Phthalate (East Kod) Aprx. 1 Qt. Bottle $3.95

Detonit Surface Cleaning Solution Photomat lithomat Apx. 1 Qt. $3.95

Transparente #146ForTransparentizing Drawings & Tracings Apx. 1 Qt. $3.95

MOUNTINGS

MT-5/ARR2
MT-7/ARR2
MT-171A/U
FT-265A
FT-340
MT-167/U
FT-308A
FT-282A
MT-80/ARC5
FT-141
MT-85/ARC5
MT-78/ARC5
MT-62/ARC5
FT-225A
FT-229A
FT-232A
FT-234A

SHOCK MOUNTS

No. 1 Square
No. 2 Square & Diamond
No. 4 Square & Diamond
No. 6 Square
No. 8 Square & Holder
No. 12 Square & Holder
No. 15 Square & Holder
No. 20 Square & Holder
No. 33 Square
No. 35 Square & Holder
No. 10 Square & Holder
No. 25 Square & Holder
No. 45 Holder
No. 55 Holder
Write for More Data

0-30V DC Meter Westing. Type AX Aircraft type. Price $2.49

Weston 3½" Rnd. Bake 0-500 Ma. RF Thermocouple Model 425 Res.—1.3 ohms....$9.95
IS-110 Double range 0.3 & 0-75 V Internal Res...$4.75
Triplett Model 221 2½" rnd. 0-500 Ma. $3.95
2½" rnd. Bake G. E. Model ADF—10 type DW 51 0-500 Ma. $3.95
McClintock 3½" Rnd. Tuning ind. for S-37 FM Tune, etc. DB over S9..........$5.95
2½" rnd. 0-5 ARF Weston 507 ....$3.95
3½" rnd. Bake 0-1V Marked 0-100 and 0-250 Ma. General Electric model VY 412.$4.95
IN1909 3½" rnd. Bake, 0-3AAC basic. Marked 0-120 A. A. C. Western Electric type NA 35 ....$6.49

0-1MA 3½" Rd. DeJure Mod S-310. Price ea. $4.75
0-1MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP259. Price ea. $3.95
0-10MA 3½" Rd. DeJure Mod S-310. Price ea. $4.65
0-10MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP236. Price ea. $3.95

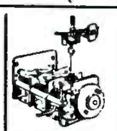
Multimeter Mvmt. 0-100 Meg. 0-600/50/14VDC (0-5 Ma Basic) 3" Rd Metal Sim to Sipson #23 ......$3.95

METERS

0.5Ma SQ 2" Metal Case or 0-10 volt movement readrite meter 98c

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



VFO Capacitor

High grade unit consists of 3 gang cap. 420 MMF per sect. ceramic ins. low drift; w/worm reduction gear 120:1 w/ext. shaft and 4 digit Veeder counter $3.95

XMTR COILS AIR WOUND

Regular Both Boxed
80 MTR
160 MTR
40 MTR
80 MTR
160 MTR
500 watt
500 watt
150 watt
150 watt
150 watt
$1.49 each

GIBSON GIRL

The Emergency Radio Transmitter. Sends S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand - driven generator, tubes, wire. New. It's only $4.25

PHOTO PRINT-DRYERS

Consists of microme element insulated from open frame 9¾"x10" 110V 60 cy.................75c

FUSES

Amp.	Volt	Type	Size	Price
1	250V	F2–9	2"x½"	12¢
10	250V	GN50	2"x½"	15¢
3	250V	Indicator GX–31	2"x½"	22¢
30	250V	1130NC44	2"x½"	15¢
1	1000V		3"x⅜"	15¢
1	250V	1110	2"x½"	15¢
5	250V	Indicator GX–32	2"x½"	22¢
¼	1000V	Cartridge	3"x⅜"	15¢
1½	2500V	Cart	4½"x⅜"	18¢
1½	2500V	HVP	4½"x⅜"	18¢
2	3000V	HVC	5½"x⅜"	20¢
¾	1000V	Cart	3"x⅜"	15¢
1	1000V	Cart	3"x⅜"	15¢
1.1	2500V	SP111	4½"x⅜"	18¢
.5	1000V	Cart	3"x⅜"	15¢
1	3000V	2114	5½"x⅜"	20¢
¼	2500V	Cart	4½"x⅜"	18¢
1	250V	F29	2"x½"	15¢
2	250V	FK-65 Indicator	2"x½"	22¢
1	1000V	HVA	3"x⅜"	15¢
6	250V	Indicator HV76	2"x½"	22¢
4	250V	Indicator FK67	2"x½"	22¢
1½	1000V	Cart	3"x⅜"	15¢
¾	3000V	Cart	5½"x⅜"	20¢
1¼	2500V	Cart	4½"x⅜"	18¢
¾	2500V	Cart	4½"x⅜"	18¢
1	1000V	HVA1	3"x⅜"	15¢
1	1000V	78X481	3"x⅜"	15¢
150	250V	Clamptype HBO	1¾"x¾"	35¢
70	125V	Clamp type ACK	2½"x1"	30¢
90	250V	Knife Blade NEC	3½"x1"	less blade 40¢
1	250V	4AB	1¼"x¼"	7 for 25¢

T. U. for BCAR230 or 430
3.2—4MC
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MD7/ARC5 w/ dynamotor complete w/Tubes 1-12J5, 2-1625, 1-UR50. Good cond.
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Screen Mod. XFRMR for pair of 807's PP — PP or Parll Sidetone Wndg. 95c

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TU 7— 4500 to 6200 KC
TU 8— 6200 to 7700 KC
TU 9— 7700 to 10000 KC
TU 26— 200 to 500 KC
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TUNING UNITS FOR BC 223 XMITTR

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TU18 3000-4500Kc. 2.25
TU25 3500-5200Kc 2.25

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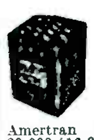

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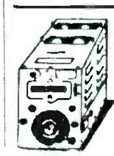

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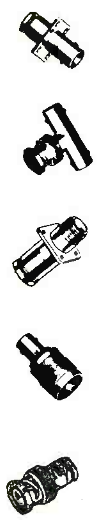

AN No.	Price Each	AN No.	Price Each	AN No.	Price Each	AN No.	Price Each	AN No.	Price Each		Price Each
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UG10/U	1.95	UG36/U	20.00	UG97A/U	4.25	UG175/U	.18	UG246/U	3.10	UG352A/U	7.95
UG11/U	1.80	UG37/U	20.00	UG98/U	1.95	UG176/U	.18	UG249/U	16.20	UG406/U	6.75
UG12/U	1.25	UG37A/U	20.00	UG98A/U	2.30	UG180/U	6.95	UG250/U	16.20	UG407/U	5.25
UG13/U	1.95	UG38A/U	25.00	UG100/U	2.95	UG181A/U	6.95	UG251/U	16.20	MT412/U	.95
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UG19/U	1.60	UG58A/U	.90	UG107A/U	2.80	UG203/U	.85	UG260/U	1.25	UG475/U	25.00
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UG20/U	1.45	UG60/U	2.40	UG108A/U	2.80	UG206/U	2.50	UG269/U	3.75	UG483/U	4.30
UG20A/U	1.60	UG60A/U	1.75	UG109/U	2.30	UG207/U	22.50	UG270/U	8.50	UG484/U	5.95
UG20B/U	1.75	UG61/U	2.55	UG109A/U	2.25	UG208/U	22.50	UG271/U	8.50	UG486/U	2.50
UG21/U	1.25	UG61A/U	2.25	UG110/U	12.50	UG212/U	5.60	UG272/U	20.00	UG487/U	6.95
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UG21B/U	1.45	UG83/U	1.90	UG115/U	1.95	UG213/U	4.20	UG274/U	2.50	UG492/U	5.00
UG21C/U	1.50	UG85/U	2.05	UG119/UP	7.50	UG213A/U	3.75	UG275/U	5.95	UG493/U	7.25
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UG22B/U	1.75	UG88/U	1.25	UG146/U	2.55	UG217/U	5.50	UG287/U	6.90	UG496/U	3.26
UG23/U	1.25	UG89/U	1.25	UG154/U	8.50	UG218/U	8.10	UG290/U	1.15	UG498/U	1.35
UG23A/U	1.60	UG90/U	1.35	CW155/U	.63	UG219/U	5.60	UG291/U	1.30	UG499/U	1.25
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UG28A/U	3.15	UG93/U	1.75	UG159A/U	1.95	UG233/U	16.20	UG332/U	2.00	UG532/U	5.75
UG29A/U	1.55	UG93A/U	1.75	UG160/U	2.40	UG234/U	16.20	UG333/U	6.50	UG533/U	5.50
UG29/U	1.95	UG94/U	1.75	UG160A/U	2.40	UG235/U	35.60	UG334/U	7.30	UG534/U	16.50
UG29/B	2.35	UG94A/U	1.50	UG160B/U	2.25	UG236/U	9.40	UG335/U	3.75	UG535/U	4.95
UG30/U	2.50	UG95/U	1.75	UG166/U	47.50	UG237/U	16.20	UG342/U	2.25	UG536/U	2.45
UG32/U	20.00	UG95A/U	1.75	UG167/U	4.50	UG241/U	3.45	UG334/U	3.50	MX554/U	2.25
UG33/U	20.00	UG96/U	1.60	UG167A/U	5.30	UG242/U	4.10	UG348/U	1.25	MX564/U	.55
UG34/U	21.75	UG96A/U	1.75	UG173/U	.38	UG243/U	4.50	UG349/U	2.95	MX913/U	.65
						UG244/U	4.40				

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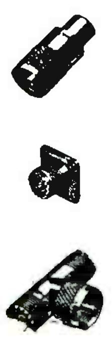
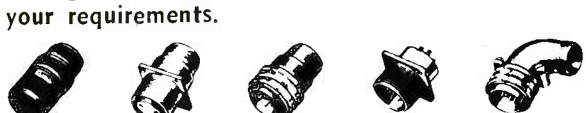


No.	Jan. No.	Description	1–99	100 or more
83-1SP	PL259	Plug	$.55	$.50
83-168	UG176U	Adapter	.18	.17
83-185	UG175U	Adapter	.18	.17
83-1SPN	PL259A	Plug	.60	.55
83-776	UG203U	Plug	.85	.75
83-1R	SO239	Receptacle	.55	.50
83-1RTY	....	Receptacle	.75	.65
83-1H	UG106U	Hood	.12	.10
83-1HP	....	Hood	.27	.24
83-765	UG177U	Hood	.31	.25
83-1AC	....	Cap and chain	.61	.50
83-1BC	....	Cap and chain	.35	.31
83-1T	M358	"T" connector	1.50	1.40
83-1AP	M359A	Angle adapter	.55	.50
83-1J	PL258	Junction	1.00	.90
83-1F	PL274	Feed thru	1.50	1.40
83-22SP	UG102U	Twin plug	.90	.80
83-22R	UG103U	Twin receptacle	.90	.80
83-22AP	UG104U	Twin ang. adapter	1.40	1.25
83-22J	UG105U	Twin junction	1.50	1.40
83-22T	UG196U	Twin "T"	1.65	1.50
83-22F	PL275	Twin feed thru	2.00	1.80
83-2SP	PL295	Large twin plug	1.94	1.75
83-2R	SO265	Large twin recept.	1.44	1.30

"AN" CONNECTORS

We have over 300,000 assorted "AN" connectors having the 5 basic shell types illustrated. Send us your requirements.



AN 3101 AN 3100 AN 3106 AN 3102 AN 3108

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RG. No.	Impedance	Price Per Thousand Ft.
RG5U	52.5 ohms	$100.00
RG6U	76.0 ohms	160.00
RG7U	97.5 ohms	120.00
RG8U	52.0 ohms	135.00
RG9U	51.0 ohms	247.00
RG9AU	51.0 ohms	247.00
RG10U	52.0 ohms	245.00
RG11U	75.0 ohms	175.00
RG12U	75.0 ohms	245.00
RG13U	74.0 ohms	225.00
RG14U	52.0 ohms	300.00
RG17U	52.0 ohms	650.00
RG18U	52.0 ohms	950.00
RG19U	52.0 ohms	1250.00
RG20U	52.0 ohms	1550.00
RG21U	53.0 ohms	195.00
RG22U	95.0 ohms	150.00
RG24U	125.00 ohms	450.00

RG. No.	Impedance	Price Per Thousand Ft.
RG25U	48.00 ohms	$495.00
RG27U	48.0 ohms	450.00
RG29U	53.5 ohms	50.00
RG34U	71.0 ohms	250.00
RG39U	72.5 ohms	180.00
RG41U	67.5 ohms	400.00
RG54U	58.0 ohms	75.00
RG54AU	58.0 ohms	60.00
RG55U	53.5 ohms	110.00
RG57U	95.0 ohms	125.00
RG58U	53.5 ohms	70.00
RG59U	73.0 ohms	70.00
RG62U	93.0 ohms	75.00
RG63U	93.0 ohms	75.00
RG63U	125.0 ohms	175.00
RG65U	950.0 ohms	650.00
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726C	69.00
728AY	27.00
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807	1.69
808	3.95
809	2.45
810	11.00
813	7.95
814	3.95
815	3.25
827R	27.50
829	9.95
829A	11.95
829B	14.95
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832A	9.95
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8025	5.95
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9004	.75
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TS 36 X Band Power Meter
TS 45 X Band Signal Generator
TS 146 X Band Signal Generator
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TS 108
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S Band

TS3A/AP S Band Power and Frequency Meter
RF 4 Electrically Tuned S Band Echo Box
BC 1277/60ABQ S Band Pulsed Signal Generator
PE 102 High Power S Band Signal Generator

L Band

Hazeltine 1030 Signal Generator 145 to 235 Megacycles
Measurements Corp. type 84 Standard Signal Generator
TS 47, 40 to 400 MC Signal Generator

Broadcast Wave Bands

162C Rider Chanalyst
Short Wave Adapter for 162C
TS 174 Signal

Oscilloscopes

BC 1287A used in LZ sets
TS 34 Oscilloscopes WE
Supreme 564

Audio Frequencies

RCA Audio Chanalyst

Other Test Equipment and Meters

TS 15/A Magnet Flux Meter
General Radio V T Voltmeter 728A
Calibrator WE I-147
General Radio 1000 cycles type 213
Limit Bridges
Boonton Standard Inductances
Weston Meters types 430, 429, 741
Model 40 Pyrometer
Rawson, meters 0-10 Microampere 0-2 Millivolt

RADAR Sets & Parts

APS 3—APS 4—SCR 284
R-111/APR5A Receivers

LIBERTY ELECTRONICS, INC.

PHONE WORTH 4-8262 135 LIBERTY ST., NEW YORK 6, N.Y.

WANTED:

RESISTORS and POTENTIOMETERS

MADE BY

ALLEN BRADLEY COMPANY

all types and values

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also

CARBON RESISTORS

other makes Domestic and Foreign

all types and values

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WE PAY HIGHEST PRICES

LEGRIS COMPANY

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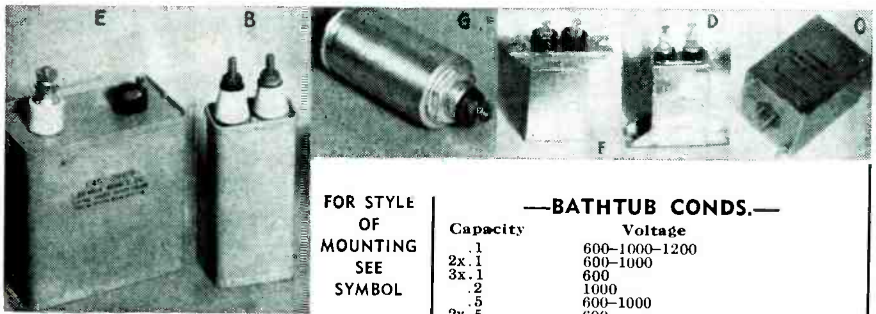
NEW YORK 25, N. Y.
Phone: ACademy 2-0018

CONDENSERS

OIL–PAPER
CERAMICONS
MICA–SILVER

IN COMMERCIAL QUANTITIES – IMMEDIATE DELIVERY



FOR STYLE OF MOUNTING SEE SYMBOL

OIL CONDENSERS—NEW

Symbol	Capacity	Voltage	Type	Price
B	.005–.005–.01	10KV	#26F344	3.50
	.012	25KV		14.50
	.02	20KV		11.50
E	.03	10KV	#26F380	8.75
B	.05–.05	2000YAC		1.10
B	2x.075	7500V		11.75
B	.08	12.2KV		12.75
B	.1	1500V		.49
F	.1	2000V	1 Term	.32
F	.1	2500V		.59
G	.1	7000V		1.25
E	.1	7500V	#25F475	1.25
B	.1	7500V	#25F469	1.59
B	2x.1	7500V		2.35
B	.1	10KV	#23F644	7.95
B	.1	15KV	#25F572	12.50
B	2x.1	3000V		1.75
B	.2	10KV	#25F433	8.95
B	.25	3000V	Round Can	1.50
E	.25	6000V	#23F350	1.50
E	.25	6000V	25F659	1.75
B	.25	18KV		17.50
B	.25	20KV		21.95
B	.25	32.5KV		31.95
B	.4	10KV		9.95
B	.5	750VAC	(2000 VDC)	.75
B	.5	2000 V	(Small)	1.65
B	.5	3000 V	CP70	2.35
B	.5	25KV		29.95
F	.5–.1	2000V	3 Terms	.89
B	1	1000V		.59
B	1	1500V		.98
B	1	2000V		1.75
B	1	2500V		2.25
B	1	3000V		2.75
B	1	5000V		3.25
B	1	6000V		4.50
B	1	15KV		19.95
B	1	20KV	#14F35	39.95
B	1	25KV		48.95
B	2	600V		.45
B	2	600V	#26F407	.50
G	2	600V	TLAD	.59
B	2	1000V		.79–1.25
G	2	1000V	TLA	1.25
B	2	1500V		1.75
B	2	2500V	Brackets	2.75
B	2	4000V		4.95
B	2	5000V		10.95
B	2	10KV		17.50
B	2–2(Vit. "Q")	600V	4 Terms	.89
B	3	600V	Rd Can	.42
B	3	2000V		3.95
B	3	4000V		5.25
B	2x3	150V		
B	4	440VAC		.75
B	4	400V		.65
B	4	600V		.95–1.35
G	4	600V	TLA	1.25
B	4	1000V		1.69
B	4	1500V		2.75
B	3x4	600V	4 Terms	1.30
B	5	600V		.90
B	5	330VAC	Pyranol	1.05
F	5–5	600V		.98
B	6	600V		1.15
B	6	1500V		2.95
B	6	2000V		3.35
B	7	600V	Brackets	1.25
B	7	800V	Brackets	1.45
F	8	500V		1.20
B	8	600V	Brackets	1.45
O	8–8	600V		1.39
B	8	1000V		1.95
F	10	600V		.98
B	10	600V	Brackets	1.85–2.35
B	10	330VAC	Pyranol	1.80
B	10	1000V		3.05
B	12	1000V		3.50
B	15	1000V	Brackets	4.25

—BATHTUB CONDS.—

Capacity	Voltage
.1	600–1000–1200
2x.1	600–1000
3x.1	600
.2	1000
.5	600–1000
2x.5	600
1	600–1000 Boxed
2	400–600

SPECIAL—.2 mfd—1000 V. ST $.19

SPECIAL BATHTUB KIT 15 @ $1.00

Quotations submitted. Other types available

CHANNEL CONDENSERS—NEW

Capacity	Style	Voltage	Price
2x.05	BT	600	.28
.1	BT	500 Pyranol	.34
.1	BT	600	.34
.1	BT	2500	.59
2x.1	BT	600	.38
3x.1	BT	400	.38
.25	BT	400	.26
.25	BT	600	.31
.25	BT	1000 Pyranol	.42
.4	BT	600	.28
.5	BT	400	.21
.5	TT	400	.19
.5	TT	500 Pyranol	.35
.5	BT	600	.39
.5–.1	BT	600	.39
.5–.5	BT	400	.34
1	BT	400 Pyranol	.30
1	TT	500 Pyranol	.35
1	BT	500 Pyranol	.35
1	BT	600	.39

SPECIAL
.5 mfd—400 V CT 63, TT $.19

—NEW MICA CONDS.—

6	140	500	3900
8	150	510	4000
10	185	600	4700
15	200	650	5000
25	230	750	6500
34	240	1000	7960
39	250	1500	9100
50	300	2000	10,000
70	350	2400	
75	390	3000	
100	400	3700	

.6 mmfd to 750 mmfd .045
1000 mmfd to 7960 mmfd .05
9100 mmfd to 10,000 mmfd .18

SPECIAL MICA KIT—100 @ $2.95

—SILVER MICA CONDS.—

15	300	1500
20	330	2000
25	390	2900
50		
60	400	4000
75	450	4900
95	500	5000
120	510	
150	950	
240	1000	
250	1400	
270	1450	

15 mmfd to 510 mmfd .08
950 mmfd to 5000 mmfd .09

SPECIAL MICA KIT—100 @ $5.95

SPECIAL $1.75
Type "JJ" Pots

Ohms	Shaft
1500	¼
1 Meg.	½

TYPE "J" POTS. $.75—$1.15

Ohms	Shaft	Ohms	Shaft
50	1/8 S	15,000	1/8 S
300	3/8 R	20,000	1/8 LS
400	1/8 LS	20,000	1 1/4 R
500	3/8 S	20,000	3/8 S
1000	1/8 LS	25,000	1/8 LS
2000	1/8 LS	25,000	1/8 SR
2500	1/2 R	50,000	1/8 LS
3000	1/8 LS	50,000	1/8 S
5000	1/8 LS	50,000	1/4 S
10,000	3/8 R	100,000	3/8 R
10,000	1/8 LS	100,000	1/8 LS
		150,000	2 1/8 R
		200,000	1/8 LS
Other types Available		250,000	1/8 S
		250,000 Knurled	1/4 R
		1 Meg	1/8 S

Symbols:— LS—Locking Shaft S—Screwdriver R—Round

BAKELITE TOGGLE SWITCHES

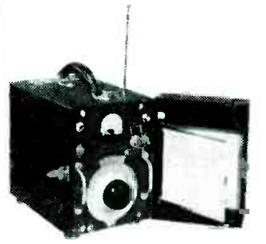
SPST 3A. 250V. ⅜" Bushing ⅛" SD Shaft....$ .15
SPDT C-H 8800 K4, 7/16" Bushing, Bat Handle (on-off on)................$ .39
DPST 3A. 250 V. 7/16" Bushing, Bat Handle..$ .38
DPST C-H 8823 K4, 7/16" Bushing, Bat handle.$ .48
DPDT C-H 8824 K4, 7/16" Bushing, Bat Handle ....$ .52

—COAX CONNECTORS—

83-1AP	$.19	83-1SPN	.39	83-1J	.64
83-1SP	.39				

SPECIAL — Coax Assembly RG-59/U length 6", connected with 83-1SPN, 83-1J and Amphenol type 80-M connector $.79. Less 83-1J $.23

NEW—BC—906
FREQ. METER—NEW



Range 150-225 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.

MONMOUTH RADIO LABORATORIES

BOX 159 • **OAKHURST, N. J.**

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

TEST EQUIPMENT

X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.

K Band Test Load, low power.....$20.00

X Band Test Load, 50 watts, average power ½" x 1" waveguide. Sand load TS 108..................$35.00

HI POWER X BAND TEST LOAD, dissipates 350 watts of average power for ⅝" x 1¼" waveguide, VSWR less than 1.15 between 7 and 10 KMC $150.00

Dummy Load, DA-21/U, X Band, High Power Load, VSWR less than 1.15. 7 to 10 KMC. Dissipates 280 watts average power.

Dummy Load, TS-338/U2, S Band, High Power Load, 2500 to 3700 mc. Dissipates 600 watts average power. For 1½"x3" waveguide.

X Band VSWR TEST SET, TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven travelling probe, matched termination and various adapters, with carrying case.

X Band Pick-up Horn, AT-48/UP with coaxial fitting $10.00

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide.........$55.00

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-45A-APM-3 Signal Generator, 8700-9500 mc., 110 V. 60-800 cps.

TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of SPR-2 Receiver.

AMPLIFIER STRIP AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps. Send for schematic $65.00 less tubes.

S Band Signal Generator Cavity With Cut-Off Attenuator, 2300-2950 mc., 2C40 tube, with modulator chassis $30.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc. and below; used for receivers above 1000 mc...............$12.00

UPN-1 S Band Beacon Receiver-Transmitter $75.00

S Band Test Load TPS-55P/BT, 50 ohms $12.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc................$12.00

TS-125 CALIBRATED S BAND POWER METER with attenuator.

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

S Band Mixer, tunable by means of slider, type N connector for the R. F. and local oscillator input, U.H.F. connector for the I.F. output, variable oscillator injection $30.00

TS-110 S Band Echo Box 2400-2700 mc, portable $110.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide. Range 2500 to 3700 MC.

X Band Thermistor Mounts, VSWR less than 1.4 8500-9600 MC Fixed triple tuned, ½"x1" waveguide......$40.00
Fixed triple tuned ⅝"x1¼" waveguide $50.00

Frequency Meter, 8500-9600, variable, absorption type for either ½"x1" or ⅝" x1¼" waveguide, with calibration, ± 4 MC, precision ground thread.$150.00

X Band Crystal Mount, ½"x1" waveguide $25.00

X Band Attenuator, double van type, VSWR less than 1.4, 8500-9600 MC 0-30db, calibrated for 1¼"x⅝" waveguide $80.00
½"x1" to ⅝"x1¼" adapter, UG80/U $5.00

TS-203/AP CALIBRATED SELSYN..$10.00

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc. 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case NEW....$175.00

HEWLETT - PACKARD - AUDIO SIGNAL GENERATOR 205A............$230.00

ESTERLINE Angus recording Milliameter 60 cycles, 110V. AC. 1 ma full scale. $150.00

TS-89 Voltage Divider for measuring high video pulses, ratios 1:10 and 1:100 transmission flat within 2 db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope.

Waveguide Below Cut-off Attenuator L 101-A U.H.F. Connectors at each end calibration 30-100 db..........$15.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR same as above except input is matched in range of 2200-3300 mc. VSWR less than 1.2...........$54.00

PULSE TRANSFORMER 132-AWP...$8.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L 422-32....$3.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc., WE-D161310, impedance ratio 120 to 2350 ohms..$3.00

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LABORATORY

62 White Street   Red Bank 6-0404   Red Bank, N. J.

RADAR EQUIPMENT

Search Radars

APS-2; APS-3; APS-4; APS-15;
SCR-717B; SCR-720; APQ-13;
APR-1 Receiver & Tuning Units
APR-4 Receiver & Tuning Units
APR-5 Receivers
TPX-1 IFF Transmitters—Receivers
R-69/APN-9 Loran Receivers
CPN-6 3cm Radar Beacon
AN/APG-13 Complete New
SO-9 10cm Search Radar
APG-8 Units; AS-168/AP Antenna;
BC1153 Indicators; BC 1157A Control Boxes;
CA-4 Turbo Amplifiers; CN-21 APA-15A;
MD-12A/APQ13 Modulators;
RA-10DB Receivers;
RF-4A/AP Antenna Boxes; RT-39/APG Recvr-Trans.;
RT-48A/TPX-1 Recvr.-Trans.

TEST EQUIPMENT

TS-3/AP; TS-14/AP
TS-15/AP; TS-16/APN
TS-19/APQ; TS-23/APN; TS-24/APR-Z
TS-26/TSM; TS-27/TSM; TS-33/AP
TS-35/AP; TS-36/AP; TS-45
TS-47/APR; TS-59
TS-61/AP; TS-62/AP; TS-74/VPM
TS-76/APM-3; TS-91; TS-98
TS-100/AP; TS-102; TS-111/CP
TS-118/AP; TS-125/AP; TS-126/AP
TS-127/V; TS-131/AP; TS-159/TPX-1
TS-146; TS-155/VP; TS-218/AP
TS-203A/P; TS-206/AP; TS-226/AP
TS-268/VB; BC-376H
BC-905; BC-906; BC-978
BC-1277; BC-1236A; APA-11
LS-1 Frequency Meter
LM-15 Frequency Meter
804 Measurement Corpor. Signal Generator
Test Equipment and Signal Generators for 10 and 3 cm
1-208 FM Signal Generator
All types of Magnetrons

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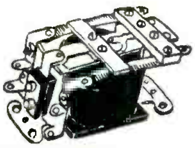
Over 200,000 RELAYS in our Vast Stock—Guaranteed—*HERE'S A FEW*

MINIATURE RELAYS

AUTOMATIC ZH77628-14 12VDC. Make one, Break two, 640 ohms Dual Telephone Contacts #R244 ....$ .85 ea
GUARDIAN 24VDC, SPST n.o. 300 ohm #R106........ .59 ea
G.E. 7472679 3VDC SPST n.o. 30 ohm #R59A........ .59 ea
COOK 55526 24VDC Makes 2, Breaks 1, 300 ohm Ceramic Insulation #R107 .... .95 ea
ALLIED 55837 24VDC Double Make, 250 ohm #R108 .... 1.50 ea
G.E. 55837 Same as &R108 #R108G........ 1.00 ea
RBM 55837 Same as #R108 #R108R........ 1.25 ea
RBM 55589 24VDC DPST n.o. 250 ohm #R245 1.25 ea
CLARE A13415 12VDC DPST n.o. 120 ohm #R246 .... 1.25 ea

ANTENNA SWITCHING RELAYS



G.E. 37843 12VDC DPDT & SPST n.c. Ceramic Insulation 50 ohms 10A contacts #R57 ..$1.95 ea
ADVANCE 4001B 75VDC DPDT & SPST n.o. Ceramic Insulation 2500 ohms 15A Contacts #R227 3.95 ea
LEACH 1054B 24VDC DPST n.o. 265 ohms 10A Contacts #R110 .... 1.25 ea
LEACH 1027BF 24VDC DPDT 250 ohms 10A Contacts #R228 .... 1.95 ea
LEACH .1421-174 24VDC Double Make 200 ohms 10A contacts Hi Voltage Ceramic Insulation #R07 .... 1.95 ea
G.E. CR2791D107F3 24VDC DPDT Ceramic Insulation 100 ohms 5A Contacts #R229 11.95 ea

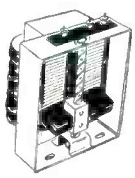
A. C. RELAYS

GUARDIAN 24VAC Make 2, Break 1 5A Contacts #R273 ....$1.10 ea
GUARDIAN 24VAC SPST n.o. 5A Contacts #R274 .... .98 ea
ALLIED B06A35 55VAC DPDT 10A Contacts #R211 .... 1.69 ea
12VAC DPST n.o., 5A Contacts, #R275 .98 ea
COOK 319318-60 110VAC Make 2, Break 1, 1A Contacts Octal Plug-in Base #R272.... 2.65 ea

G.E. 1500V C.T. 150 MA

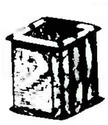
2 x 6.3V at 2.5A 5V at 3A. Excellent for Arc-5; 274N; 807 or 1625 Power Supply. Shipping Wt. 12 lbs. No. T85.......................$5.29 ea.

W. E. TRANSTAT



W.E. D122855 400 cy. Voltage Regulator, Input: 115VAC, Output: 92-115VAC, 5.5A #T281 .....$6.75 ea 10 for....$60.00

SERVO OUTPUT XFMRS



PP6L6 to Servo mechanism with 10% feed-back winding. MU metal core $3.50 ea
DUAL unit PP6L6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism. Both in 1 can....................$3.95 ea

SINE — COSINE — SQUARE WAVE POTENTIOMETER W. E. CO# D169100 for very low freq. sweep circuits ..$9.95 ea.

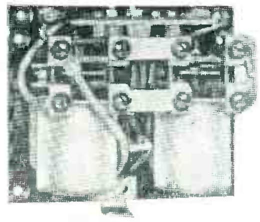
SILVER MICAS

MMF	TOL	EA	MMF	TOL	EA
8.5	±10%	.09	250	±10%	.09
25	± 5%	.12	1500	± 1%	.35
125*	± 1%	.10	1700	±10%	.15
			2500	±10%	.15
			5600	±10%	.20

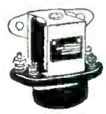
* on mounting block

SAVE 50% AT U.g.

SOLENOIDS



GUARDIAN 34585 Dual latching 24VDC each section: double make—one, double break—one & alternate double make—one, break—one 100A 24 ohms #R223 ..$8.75 ea
ALLEN BRADLEY B5A 24VDC SPST 50A 100 ohms #R105 ....$1.95 ea
G.E. CR9533K 100A2 24VDC 2 Switchettes DPST n.c. & SPST n.o.; extra long throw #R132...... 9.95 ea
HART M569A Cat #694R19 24VDC SPST 200A 75 ohms #R127A .... 2.95 ea
AUTOLITE B8 SPEC #32424A 24VDC SPST 200A 6 ohms #R128 .... 2.75 ea
CUTLER-HAMMER B8 6041H139A 24VDC SPST 200A 10 ohms #R130.......................... 3.95 ea
SQUARE 0 B5A 24VDC SPST 50A 150 ohms #R25 .... 2.25 ea
G.E. CR2792D116W2 12VDC SPST 100A 30 ohms Plastic Enclosed #R23B .... 5.50 ea
EPCO S47D 12VDC SPST 25A 35 ohms #R122 .... 2.95 ea
ECLIPSE D1EA53538 24VDC 200A 6 ohms #R126 .... 2.95 ea
RBM BN5 24VDC 50A 200 ohms #R224 .... 1.95 ea
WARD LEONARD N83 110V 60 Cyc. 5 double make contacts 3 at 50A, 2 at 30A #R233............ 10.95 ea



ALLIED TYPE BO RELAYS

B06A35 55VAC (or 12VDC) DPDT #R211..$1.69 ea
B06D35 24VDC DPDT 240 ohms #R04..... 1.75 ea
B0635 24VDC DPDT 240 ohms #R04B..... 1.69 ea
B013D35 24VDC SPST Double Make 240 ohms #R06 .... 1.25 ea
D09D28 6VDC 3PDT 14 ohms #R225...... 2.25 ea
BJX-42 12 or 24VDC SP Dble Break 240 ohms C.T. #R226 .... .89 ea
55837 24VDC Double Make 250 ohms #R108 1.50 ea
B01535 24VDC Double Make & Break 240 ohms #R238 .... 1.30 ea
BJ-36 24VDC DPDT 210 ohms #R239..... 1.25 ea

FERRULE RESISTORS

Over 200,000 in stock—all sizes—all wattages.

H-F TIE POST

Low-Loss Bakelite Insulation, pictured actual size (4-40 Thread) $7.50/C $60.00/M

S.S.WHITE DENTAL LAB RESISTORS

1K, 4K, 60K, 100K, 500K. All 1 watt $10.00/C

9006 Jan Tubes—Bulk. .$.35 each

LARGE STOCKS OF

AN Connectors	Controls	Relays
APC's	Crystals	Resistors
Binding Posts	Filters	Servo Xfmrs.
Cable	Fuses	Shock-Mounts
Capacitors	Hardware	Sockets
Ceramicons	Iron Core Slugs	Spaghetti
Ceramics	Knobs	Switches
Chokes	Potentiometers (sine-cosine)	Transformers
Circuit Breakers		Tubes
Coils	Pulse Xfmrs.	And Others

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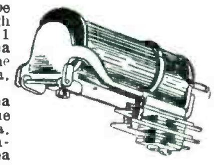
TELEPHONE RELAYS



CLARE Telephone type 6500 ohm, 2 ma, High Speed Keying, 5 Make 1 Break #R104F ..$5.98 ea
AUTOMATIC Telephone type, 1300 ohm 9 ma, SPST, n. o. #R103 1.25 ea
KURMAN, Telephone type, 3300 ohm, 7 ma. Make 3, Break 1, 5A contacts #R243 .... 2.95 ea

SENSITIVE PLATE CIRCUIT

DUMONT 5000 ohm 5 ma SPST n.o. 10A Contacts #R230 ....$ .98 ea
POTTER & BRUMFIELD SPS46 5000 ohm 9 ma Double break, 10A contacts................ .38 ea
G.E. CR2791B109P36 10,000 ohm, 9 ma. double Make & Break 5A Contacts #R231......... .98 ea
WESTERN ELECTRIC D168479. Mercury Contact. Hermetically sealed, 2 Coils: 700 & 3300 ohms. With coils in series makes at 6.6 ma, breaks at 5.2 ma, SPDT, High current capacity, High speed #R232 11.95 ea

MISCELLANEOUS RELAYS

WESTINGHOUSE MN Overcurrent: Current Coil 100 to 400 ma DC. Reset Coil: 230 V AC or DC, also external push button reset. Glass enclosed; Individual Calibration #R234 ....$9.95 ea
WESTINGHOUSE MN Same as R234 but 0.5 to 2A #R235 .... 9.95 ea
STRUTHERS DUNN CX1535A 12VDC SPST n.o. 240 ohms 20A contacts #R236 .... 1.50 ea
G.E. CR2791B106J3 12VDC 3PDT 180 ohms 3A contacts #R237 .... 1.25 ea
G.M. 12792-1 18-24VDC 3PDT 100 ohms 10A contacts #R240 .... 1.75 ea
LEACH 2069 (G.E. M7472260) 12-24VDC 3PDT 130 ohms 15A contacts #R241................ 1.50 ea
PRICE 501A 12VDC DPDT 60 ohms #R242 .95 ea
RBM Voltage Regulator 6V SPDT Adjustable Contacts & Arm #R247 .... 1.49 ea
AMPERITE TIME DELAY 24N02 24V AC or DC SPST n.o. 5A Contacts 2 sec. delay at 24V; can operate from 110V with 1250 ohm resistor or larger for longer delay. #R316.................... .98 ea

PULSE XFMRS

T151 is a 3 winding Pulse input xfmr with hypersil core. 1000-ohm windings carefully balanced for operation in series with filament. Pulse modulation fed to low impedance winding.
W. E. type KS9565 40 to 1000 to 1000 W. V. 7.5 KV #T151 ....$3.25 ea.
DONGAN TR 1043-A461 Ratio 1:1 high power pulse modulation driver xfmr for final. Ea. winding approx. 8 ohms d-c; 200mh; 260T #30 wire #T152 ....$3.25 ea.
W.E. (coreless type) A quasi-differentiating xfmr. Pri. when tuned with a .01 mfd resonates at 5630 cps. Split wound secondary terminates into 10000 ohms Army SC# 2C2270/T2 ....$2.25 ea.
W.E.—KS9562 3 windings Blocking Osc. xfmr. ....$1.75 ea.
W.E. KS9564 1:1 ratio—high repetition rate ....$1.19 ea.
FREED #12524 2:1 ratio—high repetition rate ....$1.49 ea.
HORIZONTAL blocking osc. xfmr....69¢ ea.
VERTICAL blocking osc. xfmr........69¢ ea.
UTAH—X146-T1—2 winding $2.95

HI CURRENT MICAS BAKELITE CASED

MFD	WV	EA.	MFD	WV	EA.
0.000051	3KV	$ .50	0.025	2.5KV	1.10
0.00005	3KV	.50	0.03	2KV	.75
0.0001	3KV	.50	0.035	1.5KV	.75
0.00055	5KV	1.10	0.05	1.5KV	.80
0.001	5KV	1.50	0.05	500	.70
0.002	3KV	.60	0.062	1KV	1.00
0.003	3KV	.60	0.12	500	1.25
0.01	2KV	.60	0.15	500	1.35
0.02	2KV	.80	0.25	250	1.25

Large Stock of Type 4 and 9 Transmitting Micas

WIRE • WRITE • PHONE • CABLE • COME IN

STOCK UP NOW AT THESE LOW PRICES!

ACORN

Serves Schools, Labs, Industrials
Top Values—Same Day Service

FILTER CHOKES

Hy.	@ Ma.	Ohms D. C.		Mounting	Price
10	55	350	D. C.	Channel	$ .69
10	60	400	D. C.	Hermetically Sealed	.69
15	70	420	D. C.	Hermetically Sealed	.79
10	75	200	D. C.	Channel	.79
10	85	200	D. C.	Channel	.89
20	100	350	D. C.	Hermetically Sealed	1.89
10	100	460	D. C.	Hermetically Sealed	1.79
15	110	400	D. C.	Upright	1.39
8	150	130	D. C.	Channel	1.19
10	150	200	D. C.	Cased Channel	1.39
3½	150	65	D. C.	Channel	1.29
8	150	90	D. C.	Cased	1.39
10	200	60	D. C.	Upright	2.29
2.5	200	60	D. C.	Channel	1.29
15	250	65	D. C.	Upright	2.95
8	250	95	D. C.	Channel	2.39
12	500	95	D. C.	Cased	9.95

STEP-DOWN TRANSFORMERS

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—117 V. @ 8 amp.
#2—5 V. C. T. @ 10 amp.
Open Frame Fed. Tel. & Tel.— **$10.95**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—25 V. C. T. @ 10 amp.
#2—25 V. C. T. @ 10 amp.
#3—6.3 V. C. T. @ 5.5 amp.
#4—6.3 V. C. T. @ .3 amp.
Open Frame Fed. Tel. & Tel.— **$6.95**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—115 V. @ 8 amp.
Open Frame Fed. Tel. & Tel.— **$8.95**

PLATE TRANSFORMER

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—556-0-56 @ 220 ma.—
Open Frame Fed. Tel. & Tel.— **$5.95**

POWER TRANSFORMERS

Pri. 115 V.—50-60 cy.
Sec. #1—775 V. C. T. @ 175 ma.
#2—6.3 V. @ 6 amp.
#3—5 V. @ 3 amp.
#4—5 V. @ 2 amp.
Half Shell Mount— **$4.79**

Pri. 115 V.—50-60 cy.
Sec. #1—700 V. @ 250 ma. C. T.
#2—10 V. @ 6.3 @ 5 amp. tapped
#3—5 V. @ 3 amp.
Half Shell Mount— **$4.79**

Pri. 115 V.—50-60 cy.
Sec. #1—600 V. C. T. @ 100 ma.
#2—6.3 V. @ 3 amp.
#3—5 V. @ 3 amp.
Half Shell Mount— **$2.95**

Pri. 115 V.—50-60 cy.
Sec. #1—450 V. C. T. @ 100 ma.
#2—6.3 V. @ 5 amp.
#3—5 V. @ 3 amp.
Half Shell Mount— **$2.95**

Pri. 115 V.—50-60 cy.
Sec. #1—600 V. C. T. @ 150 ma.
#2—6.3 V. @ 4 amp.
#3—5 V. @ 3 amp.
Cased— **$3.95**

Pri. 115 V.—50-60 cy.
Sec. #1—750 V. C. T. @ 225 ma.
#2—6.3 V. @ 8 amp.
#3—6.3 V. @ 1.2 amp.
#4—5 V. @ 3 amp.
RCA Half Shell Mount— **$6.95**

Pri. 115 V.—50-60 cy.
Sec. #1—650 V. C. T. @ 150 ma.
#2—6.3 V. @ 4.5 amp.
#3—6.3 V. @ .3 amp.
#4—5 V. @ 3 amp.
Half Shell Mount— **$3.95**

Pri. 115 V.—50-60 cy.
Sec. #1 800 V. C. T. @ 240 ma.
#2—6.3 V. @ 8 amp.
#3—6.3 V. @ 2 amp.
#4—5 V. @ 3 amp.
Half Shell Mount— **$7.95**

Pri. 115 V.—50-60 cy.
Sec. #1—600 V. C. T. @ 40 ma.
#2—5 V. @ 2 amp.
#3—2.5 V. @ 4.5 amp.
Upright Mount— **$1.49**

FILAMENT TRANSFORMERS

Pri. 105-115 V.—50-60 cy.
Sec. #1—6.3 V. C. T. @ 5 amp.—
Thord. C. H. T. case **$2.79**

Pri. 105-115-125 V.—50-60 cy.
Sec. #1—6.3 V. @ 4.5 amp.
#2—6.3 V. @ .6 amp.
#3—6.3 V. @ .6 amp.
Cased— **$2.95**

Pri. 115 V.—60 cy.
Sec. #1—2.5 V. @ 10 amp.
#2—2.5 V. @ 6 amp.
10,000 V. insulation—
Cased— **$4.95**

Pri. 115 V.—50-60 cy.
Sec. #1—6.3 V. @ 1.2 amp.
Channel Mount— **.89**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—2.5 V. @ 20 amp. C. T.
Insulated for 10 KV—
Open Frame Fed. Tel. & Tel.— **$5.95**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—6.3 V. C. T. @ 6 amp.
Open Frame Fed. Tel. & Tel.— **$4.95**

Pri. 220-210-220-230-240 V.—50-60 cy.
Sec. #1—5 V. @ 4 amp. C. T.
Open Frame Fed. Tel. & Tel.— **$3.95**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—9 V. @ 28 amp. C. T.—
Open Frame Fed. Tel. & Tel.— **$10.95**

LOW VOLTAGE STEP-DOWN TRANSFORMERS

Pri. 115 V.—50-60 cy.
Sec. #1—15 V. @ 12 amp. G. E.— **$4.95**

Pri. 115 V.—50-60 cy.
Sec. #1—10 V. @ 12 amp. G. E.— **$4.95**

Pri. 115 V.—50-60 cy.
Sec. #1—16 V. @ 5 amp.—U. T. C.— **$2.79**

Pri. 110-147-220 V.
Sec. #1—13 V. @ 8 amp.—U. T. C.— **$3.49**

Pri. 115 V.—50-60 cy.
Sec. #1—24 V. @ 2 amp.—Ferranti— **$1.49**

KENYON FILAMENT TRANSFORMER

Pri. 0-105-110-115 V.—50-60 cy.
Sec. #1—11 V. @ 10 amp. C. T.
#2—7 V. @ 1 amp. C. T.
#3—7 V. @ 1 amp. C. T.
Cased— **$4.95**

OUTPUT TRANSFORMERS

6V6 Push Pull—8000 Ohm Pri.
Plate to plate—12 W. output
Univ. Sec. 4-8-15-250-500 ohm voice coil—
Shielded U. M.— **$1.99**

6L6 Push Pull—6000 ohm. Pri.
Plate to plate—25 W. output
Univ. Sec. 4-8-15-250-500 ohm voice coil—
Half Shell Mounting Shielded— **$2.95**

VIBRATOR TRANSFORMER

Pri. 6 V.
Sec. 600 V. C. T. @ 90 ma.—
Upright Mount— **$1.99**

220 V. INPUT TRANSFORMERS

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—5 V. @ 14. 5 amp. C. T.
#2—5 V. @ 14.5 amp. C. T.
Open Frame Fed. Tel. & Tel.— **$6.95**

Pri. 200-210-220-230-240 V.—50-60 cy.
Sec. #1—367-0-367 V. @ 500 ma.
Open Frame Fed. Tel. & Tel.— **$5.95**

HEAVY DUTY POWER TRANSFORMER

Pri. 110-220 V.—50-60 cy.
Sec. #1—820 V. C. T. @ 400 ma.
#2—6.3 V. @ 3 amp.
#3—6.9 V. @ 13.5 amp.
#4—5 V. @ 3 amp.—
Open Frame— (3 for $21. **$7.49**

RCA HIGH FIDELITY OUTPUT TRANSFORMER

6L6 Push Pull 9000 ohm. Pri.
Plate to Plate
Sec. 8 ohms—25 W. output—
Chicago Trans. Cased— **$4.95**

6V6 HIGH FIDELITY OUTPUT TRANSFORMER

Pri. 5000 ohms
Sec. 4-8-15-ohm—Frequency response 60-10,000 Cy. ± ½ D. B.—
Hermetically Sealed— **.98**

6L6 SINGLE OUTPUT TRANSFORMERS

Pri. 2500 ohms
Sec. 6-8 ohms—
Channel Mount— **.98**

6V6 SINGLE OUTPUT TRANSFORMER

Pri. 5000 ohms
Sec. 6-8 ohms—
Channel Mount— **.89**

ALL MERCHANDISE SUBJECT TO PRIOR SALE

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ACORN ELECTRONICS CORP.

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Terms: 20% cash with order, balance C.O.D. If rated, terms 1% net 10 days. All prices F.O.B. our warehouse in N.Y.C. Minimum order $5. NOTE: Due to conditions beyond our control, prices are subject to change.

FOR IMMEDIATE DELIVERY

SPECIAL! 300 ohm **TWIN LEAD TV LINE**, per 100 ft. **$3.89**

DYNAMOTOR SALE!

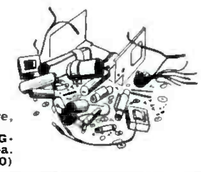
RD77—Brand New **$8.95**
PE94—Used, excellent **4.95**
PE73—Used, excellent **4.95**

CORDS

CD478—5 ft. long with Alligator Clips, can be used as test leads .... **19c pair**
CD307A with PL55 and JK26 .... **69c each**
PL68 .... **20c each**
PL55 .... **39c each**
PL54 .... **17c each**

FILTER UNIT

This unit is an excellent buy for the parts alone. Some parts are worth more than we're asking for the whole unit.



1—40 MFD @ 450V
1—1600 MFD @ 12V
1—.5 MFD @ 400V
2—.5 MFD @ 50V
1—.01 MFD @ 400V
2—20 watt Resistors
2—Filter Chokes
2—RF Chokes
1DPST Toggle Switch
Miscellaneous Hardware, wire, etc.
BRAND NEW. ORIGINAL PACKING. 89c ea. (10 for $7.50)

SLEEVING—various colors and sizes—3 ft. lengths.
10 lengths for **25c**
100 lengths for **$2.00**

SOLDERING PASTE—8 oz. cans — U.S.N. Specification

51-FLB .... **29c ea. (10 for $2.50)**

KIT SALE!

Kit of 50 assorted **KNOBS** **$1.19**
Kit of 25 **TRIMMERS**—single, dual and triple sections **79c**
Kit of 10 assorted **VOLUME CONTROLS** .. **$2.79**
Kit of 100 assorted **MICA and CERAMICON CONDENSERS** **4.75**
Kit of 100 assorted **PAPER TUBULAR CONDENSERS**—from 200 to 800 V.......... **5.75**

BATHTUB CONDENSERS

20 MFD @ 350 VDC
2 x .25 MFD @ 600 VDC
.5—.5 MFD @ 100 VDC
3 x 1 MFD @ 400 VDC
} **14c each $12.50 per hundred**

TERRIFIC TUBE SALE

Brand New—Standard Brands—Immediate Delivery
3C24/24G **59c**
1626 .... **39c**
10Y **39c**
872A .... **$1.75 each**

THERMAL RELAY Type ER, 110 volts 30 amps. **BRAND NEW .....ONLY $1.29 each**

RCA MICAS

470 MMFD. 1200 MMFD. 1500 MMFD. . .**6c ea. ($50.00 per thousand)**

TRANSMITTING MICAS

.0001 @ 5000 V, .00025 @ 5000 V
F2L Type .... **59c each**

RESISTORS

5 ohm— 10 watt **14c**
85 ohm— 10 watt **14c**
2500 ohm— 25 watt **17c**
2500 ohm— 33 watt **20c**
250 ohm— 50 watt, lamp base **24c**
105 ohm—100 watt, 4 taps **48c**
50 ohm Muter Resistor .... **8c ea. ($6.00 per hundred)**

HEAVY DUTY LINE CORD with molded plugs, 3 ft. long .... **9c each**
6 ft. **RUBBER LINE CORDS** with molded rubber plugs .... **$15.75 per 100 cords**

3 GANG TRF VARIABLE CONDENSER—365 per section with push buttons. . .**89c ea. (10 for $7.25)**
2 GANG FM-AM VARIABLE .... **89c ea. (10 for $7.25)**

MINIMUM ORDER — $2.00. Send 25% deposit with order, balance C.O.D. Shipped F.O.B., N.Y.C. (N.Y.C. residents add 2% sales tax.)

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Bausch & Lombe Binocular Research Microscope Optics. Mid-40's vintage, uncoated. Some slightly used, most unused. Five apochromat objectives—10x Dry, 47.5x Dry Adjustable, 67x Dry, 61x Oil, 78x Glycerine. Pair 5x compensating eyepieces. Three condensers—achromat, cardioid & paraboloid on slide mounts. Also miscellaneous incidentials—$590.

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Ted Powell, Great Neck 4-4129 (Long Island) after 6:30 P.M.

Desirable
Select Surplus
ELECTRONIC EQUIPMENT

	Price
• BC-375-E Aircraft transmitters complete, new, with all turning units, 24 volt dynamotor, tubes, plugs, etc.	$125.00
• BC-191 same as above for 12 volt operation	$125.00
• TDE Navy model radio transmitters with 230 volts, D.C. power supply, complete with tubes, ready for operation. New	$675.00
• SCR-522 Aircraft radio transmitters-receivers complete with dynamotor, control box, plugs, jackbox, microphone adapter, microphone, headset, extension cord. Newly overhauled, inspected and tested	$130.00
• SF Ships' radar units complete with all components	$500.00
• TCS, Collins type Navy and mobile type transmitters-receivers complete with remote control, antenna coil, cables, key, microphone, for 110 volt A.C. operation including set of parts. New in original cases	$1,275.00
• TCS Collins type, transmitters-receivers, same as above but without spare parts. Refinished, checked-out and guaranteed for operation on 12 or 24 volts D.C.	$575.00
• ET-8023-D1 Radiomarine Corporation telegraph transmitters	$375.00
• BC-348 Receivers, unconverted 24 volt operation	$150.00
• MN-26 Bendix radio compass receivers	$45.00
• BC-221 A.K. Frequency meters with modulation	$125.00
• BC-221 Frequency meters without modulation	$100.00
• LM-15 Frequency meters (Navy version of BC-221 A.K.) with modulation and A.C. power supply	$150.00
• I-100A Test sets for SCR-269	$750.00
• IE-19A Test set for SCR-522	$350.00
• ARP-5 high-frequency oscillators	Price on Application
• JWG-458 Gasoline-engine driven electric generating plants, 5000 watts, Onan, 100-120 or 220-240 volts, rebuilt-factory reconditioned	$590.00
• Telephone or power line insulators, glass Hemingray No. 40, heavy duty	.10
• W-110 B Army field telephone wire	$7.50
• RC-58-B Army Tape Facsimile transmitters-receivers	$250.00
• Link radio transmitters-receivers 1498 including remote control and antenna reconditioned.	Price on Application
• Link-50 UFS receivers, transmitters including remote control and antenna. New	Price on Application

ALL ITEMS ARE OFFERED F.O.B. OUH WARE-HOUSE, AND ARE SUBJECT TO PRIOR SALE. ALL ITEMS ARE NEW, UNUSED SURPLUS UNLESS OTHERWISE INDICATED.

FRENCH-VAN BREEMS, Inc.
405 Lexington Avenue New York 17, N. Y.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.24	150	50	2.10
.5	50	2.34	175	25	1.87
.5	150	4.45	185	25	1.24
1	50	2.34	200	25	1.24
2	50	2.34	200	100	3.29
2	100	3.51	225	50	2.10
2	225	9.60	250	25	1.86
2	300	6.32	250	50	1.49
3	100	3.51	300	50	2.11
3	225	9.60	300	100	3.29
4	225	9.60	350	25	1.24
5	25	1.24	350	100	3.28
5	100	3.51	370	25	1.24
6	25	1.86	378	150	4.95
6	50	2.10	400	25	1.24
6	75	4.80	400	75	4.80
7	25	1.24	500	25	1.24
8	50	1.49	500	75	4.80
10	25	1.86	500	50	1.49
10	100	3.28	500	100	3.29
12	25	1.86	585	150	3.51
12	50	1.49	750	25	1.86
15	25	1.24	750	150	4.45
15	75	4.80	1000	25	1.24
15	100	3.29	1000	150	4.45
22	50	2.10	1200	225	9.60
25	25	1.86	1250	50	2.22
25	100	3.29	1250	150	4.45
25	150	4.21	1500	25	2.11
32	300	6.42	1500	50	2.22
50	25	1.24	1800	150	4.68
50	50	1.49	2000	25	2.10
60	750	21.30	2000	50	1.49
60	25	1.24	2500	25	2.11
75	25	1.24	2500	50	2.22
75	75	4.80	2500	100	3.51
75	100	3.29	3000	25	1.24
75	150	4.21	3000	100	3.51
80	50	2.10	5000	25	2.22
80	500	9.13	5000	50	2.34
100	25	1.24	7500	50	2.34
100	50	1.49	7500	100	3.98
100	100	3.29	10000	50	2.34
100	225	9.60	10000	100	4.21
125	25	1.86	15000	25	2.67
125	500	9.13	20000	150	6.32

Specify whether shaft required is for knob or screwdriver adjust.

OIL CONDENSERS

Mfd	VDCW
.1	3000
.1	6000
.1	20,000
.25	3000
.5	1500
1	600
1	2000
2	400
2	600
2	1000
4	600
6	400
6	600
10	600
14	600
15	600
15	1000
2 x .1	7000
2 x .5	9000

SPECIAL PRICES QUOTED ON REQUEST

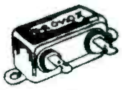
TYPE "J" POTENTIOMETERS

TYPE "J" $1.50			TYPE "JJ" $2.50	
ohms	ohms	ohms	ohms	ohms
50*	2500*	100 K*	500–500*†	100 K–100K*
65*†	4000†	100 K†	600–600†	130 K-130 K*
200†	5000†	125 K*	1500–1500†	150 K-150 K†
300†	10 K*†	200 K*	2000–2000*†	250 K-250 K†
400*†	15 K*†	250 K*	2000–50 K*	350 K-25 K†
500†	20 K*†	250 K†	2200–24 K†	350 K-350 K*
600*†	25 K*†	500k*†	20 K–2000†	500K-8000†
750†	30 K*†	1meg*†	25 K–10 K†	800 K-75 K*
1000*†	50 K*†	1meg†	35 K–5000†	2meg-2meg†
1500*†	80 K†	2meg*	50 K–50 K*	5meg-5meg†
2000*†		2meg†		

TYPE "JJJ" $4.95	
ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* 1/8" screwdriver slotted shaft.
† Knob type shaft.

BATHTUBS



mfd	vdcw
.033	400
.05	200
.05	400
.05	600
.1	400
.1	600
.1	1000
.15	600
.25	200
.25	600
.35	400
.5	400
.5	600
.5	1000
1	200
1	600
2	400
2	600
4	50
8	500
25	50
25	75
40	25
50	25
200	12
300	6
.05-.05	600
.05-.05	1500
.1-.1	400
.1-.1	600
.2-.2	600
.25-.25	600
.5-.5	600
200-200	9
3 x .05	600
3 x .1	400
3 x .1	600
3 x .25	600
3 x 1.0	100

SPECIAL PRICES QUOTED ON REQUEST

TRANS-MITTING MICAS

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.0051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

(Many other types in stock)

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	1	bak-n/shtg	.53
5	3	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)

"UHF" CONNECTORS

Cat. No.	Army No.
83-1AC	
83-1AP	M-359
83-1D	PL-271
83-1F	PL-274
83-1R	SO-239
83-1SPN	PL-259A
83-22R	SO-264

PRICES QUOTED ON REQUEST

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS
Send your specs and let us quote

"UG" Connectors

UG-12/U	$1.10
UG-13/U	1.49
UG-18/U	1.15
UG-19/U	1.18
UG-21/U	.98
UG-22/U	1.05
UG-24/U	1.10
UG-25/U	1.15
UG-27/U	1.75
UG-57/U	.89
UG-58/U	.63
UG-123/U	.40

Connectors / BARRIER STRIPS


Connectors		Barrier Strips	
S-302-AB	.13	2-140-Y	.13
S-304-CCT	.25	5-140-Y	.28
P-306-AB	.18	6-140-Y	.33
P-306-CCT-L	.33	9-140	.34
S-306-FHT	.24	10-140-Y	.53
S-308-AB	.21	10-140-3/4W	.53
P-312-AB	.24	10-240	.38
P-312-CCT-L	.42	13-140	.48
P-315-FHT	.40	4-141-W	.30
P-315-EB	.30	4-141-3/4W	.30
P-315-CCE	.40	5-141	.26
S-315-AB	.36	7-141-Y	.49
S-318-AB	.43	11-141-Y	.76
P-324-FHT	.74	12-141	.58
P-324-EB	.58	12-141-Y	.82
S-330-AB	.84	13-141	.62
S-404-AB	.33	13-141-Y	.89
P-406-AB	.33	15-141-Y	1.02
S-406-CCT	.58	2-142-Y	.20
S-408-CCT	.69	4-142-Y	.36
S-2408-SB	.53	8-142	.48
P-2412-SB	.61	10-142-3/4W	.85
P-502-CE	1.10	11-142	.65
S-502-DB	.97	3-150	.53
P-508-CE	2.55	4-150-Y	.83
P-510-CE	3.04	4-151	1.30
S-510-SB	2.64	5-151	1.60
P-512-CE	3.52	4-152	1.89

Many other types in stock

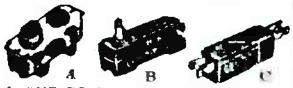
BIRTCHER TUBE CLAMPS

#926-A	**35c.**	#926-B22
#926-A1		#926-C
#926-A11		#926-C1
#926-B		#926-C5
#926-B1		#926-C10
#926-B7		#926-C24

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
100P-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

MICROSWITCHES



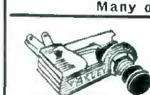
A-#YZ-RS13 SPST "S" plunger, metal housing norm. op.	.49
B-#B-RS10 SPDT type "S" plunger, 2-circuits: one op and one cl.	.49
#WZ-RL8 (not illus.) SPST leaf actuator, norm. cl.	.49
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed	.49
C-G.E. SWITCHETTE 10a/115voltsAC	
#CR1070-C103A3 SPST closed	.49
#CR1070-C103E3 SPST open	.49
#CR1070-C103R3 SPST closed	.49
#CR1070-C123C3 DPST op/cl	.49

(Many other types in stock)

TERMINAL BOARDS

5 terminal	.98
8 terminal	1.67
12 terminal	2.49

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

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AN CONNECTORS

FAST SERVICE - LOW COST

REFER to Page 279 Jan. Electronics for COMPLETE LISTING

CONNECTORS

PJ-055B-New high temperature version of old PL55 ....$.60
XL-3-11, fine three circuit, 15A.... .45
Solderless RG59U connectors, C-51.... .48
Chassis mtg jack C-51, C-61.... .51
Junction fit two C-51, C-81.... .60
Winchester 5KV on three circuits and 500 volts on each of twelve circuits, #201 & #202, pairs with shells, regularly $26 without shells, our price ONLY $9.50
COAXIAL: PL259 $.45, PL258 $.70, PL274 $1.20, UG9U, UG10U, UG12U, UG13U, UG21U, UG22U, UG25U, UG27U, UG58U, UG85U, UG87U, J-201, UG342U, UG203, CQA 49547, 8880073-501 (WE type jack) ....**ONLY** $.60
SPECIAL-M359, 83-1AP, 49192....$.15
Lundquist 8 contact, 49170 & 49043 pr....$.25
USECO tiny pairs of plugs & jacks for swaging in Bake. board, #1600, pr....$.17
Jones P302CCT $.27, P304AB $.16, P306AB $.20, P308CCT $.38, P310FHT $.35, P312AB $.29, P315AB $.38, P318AB $.48, P321CCT $.86, P324EB $.73, P324CCT $1.01, P330CCT $1.33, P330SB $1.27, S302AB $.13, S303CCT $.29, S304AB $.17, S306AB $.21, S308AB $.26, S310AB $.31, S310CCT $.47, S310FHT $.40, S312AB $.36, S315AB $.45, S318 CCT $.79, S321AB $.67, S324AB $.76, S330SB $1.33, P406CCT $.64, P408AB $.48, P410AB $.54, P412SB $.83, S404CCT $.62, S408CCT $.86, S410AB $.70, S410CCT $.99, S412AB $.79.

25 WATT WIRE WOUND POTENTIOMETERS

Refer to Jan. Electronics for description. 2, 3-3, 15, 20, 25, 30, 50, 75, 100, 350, 500, 800 ohm—reg. $3.12. SALE PRICE....$1.04
1K, 3K, 5K....$1.20, 20K....$1.40

PRECISION POTENTIOMETERS

Leading Manufacture, Wire Wound 10, 12 ohm #301 ....$1.20
1.5K ct, 2K, 5K, 20K-8 watt.... 1.70
100K 25 watt.... 6.50

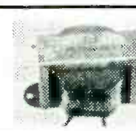
CTS Wirewound POTENTIOMETER

These excellent controls were made to sell for $2 each. They are the finest ww potentiometers made in the two and four watt size. The four watt has a 1-9/16" dia. x 11/16" metal body. The two watt has a 1-1/4" x 9/16" bakelite body. Both use DUAL wipers for extra quiet action. SPECIAL PRICE ....$.45
Four watt: 6, 30, 50, 100, 750, 1K, 1.5K, 2K, 3K, 4K, 7.5K, 10K, 15K, 20K ohm.
Two watt: 20, 75, 200, 255, 300, 350, 500, 750, 1000, 2K, 5K, 10K ohm
Four Watt Tf also fine control with mica filled bakelite body: 2K, 5K, 10K, 20K, (Over 2000 each 5K in stock) ....$.45

J Composition Pots: 75, 200, 1K, 1.5K, 2K, 2.5K, 5K, 10K, 15K, 25K, 30K, 50K, 100K, 250K, 300K, 1 Meg, 2 Meg....$1.25
GLASS to METAL HEADER, eight different color seals in 1x1x5/16" metal cap. Fusite #267535 our stock # 345, 1400 in stock....$ .22

Special High Voltage Glass to Metal Seal for 3/16" hole 1 1/8" overall. #356 ...... **$ .10**
Reg. $.25

CHOKE, Conservatively rated 165 MA, 5 Henries, 160 ohm dc, 2 Inch High. 3 5/8" Mtg. Ctr. Worth $3.
SALE PRICE
89 cents
#1A-158, 2000 pieces in stock.



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TURRET LUGS, complete stocks including new miniature molded melamine tie point only 1/8" diameter by 3/8" high w 2-56 thread, #1426.....$ .18

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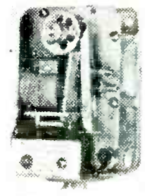

EAGLE ADJUSTABLE TIME DELAY RELAY. 110 volt 60 cy with double throw Micro Switch. Can be set from 1½ to 58 minutes. Includes attractive 3¼ x 4½ x 2¾ black cover. 265 pieces in stock. Made to sell for $26. SALE PRICE $6.95

DELAY LINE 15-E4-.91-400-50P, Sprague #S92-5245, H623, 4x5x7inch 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

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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
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L406825, Wemco, 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 NSB1341 vibrator....$14.95

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....$9.95

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RELAY, 24 Volt, Tiny CP Clare operates on 86 milliampere, 4 pole DT & make-break, 1 x 1 5/8 x 1 7/16 overall, 1000 in stock....$ .90

RELAY, 24 Volt, Struthers Dunn 10XBX102, mkd. 24 VDC, but has shaded pole, good for 60 cycle operation, DPDT, 7 amp contact....$ .90

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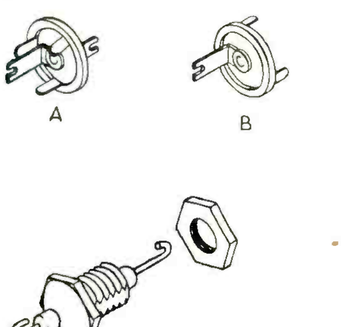

A B C

Type A—300 mmf—100 for $20.00
Type B—300 mmf—100 for $20.00
Type C— 55 mmf—100 for $10.00

ELECTRO IMPULSE LABORATORY
62 White St. Red Bank, N. J.

"AN" "K"

3108	WK
3106	GK
3102	SK
3100	NK

Connectors

FOR IMMEDIATE DELIVERY

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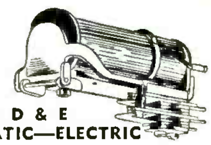
BA-7-4862

TELEPHONE RELAYS



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COOKE, AUTOMATIC—ELECTRIC
ALL TYPES of COILS and PILE-UPS
Send Us Your Specifications For Our Quote

MONTHLY SPECIALS

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1) 6500 ohm coil, SPST, N.O. 3ma..$1.65 ea.
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3) 1300 ohm coil, 3 make 1 break $1.25 ea.

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All Values and Voltage Ratings
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Navy surplus units. All are in perfect operating condition. Sales will be made for experimental, research or production work only. Write for prices and details.

COLONIAL PULSE GENERATOR

Model 700-A. Generates variable width and PRF pluses from .4 to 120 microseconds, metered output to 20 volts, unmetered to 100 volts. Built in sweep circuits. 115 volt 60 cycle. LIKE NEW 400 dollars

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Full Wave Bridge

Input: 0-18 VAC Output: 0-12 VDC

Type No.	Current	Price
B1-250	250 Ma.	$ .98
B1-1	1.0 Amp.	2.49
B1-1X5	1.5 Amp.	2.95
B1-3X5	3.5 Amp.	4.50
B1-5	5.0 Amp.	5.95
B1-10	10.0 Amp.	9.95
B1-20	20.0 Amp.	15.95
B1-30	30.0 Amp.	24.95
B1-40	40.0 Amp.	27.95
B1-50	50.0 Amp.	32.95

Input: 0-36 VAC Output: 0-26 VDC

Type No.	Current	Price
B2-150	150 Ma.	$ .98
B2-250	250 Ma.	1.25
B2-300	300 Ma.	1.50
B2-2	2.0 Amp.	4.95
B2-3X5	3.5 Amp.	6.95
B2-5	5.0 Amp.	9.95
B2-10	10.0 Amp.	15.95
B2-20	20.0 Amp.	27.95
B2-30	30.0 Amp.	36.95
B2-40	40.0 Amp.	44.95

Input: 0-115 VAC Output: 0-90 VDC

Type No.	Current	Price
B6-250	250 Ma.	$ 2.95
B6-600	600 Ma.	5.95
B6-750	750 Ma.	6.95
B6-1X5	1.5 Amp.	10.95
B6-3X5	3.5 Amp.	18.95
B6-5	5.0 Amp.	24.95
B6-10	10.0 Amp.	36.95
B6-15	15.0 Amp.	44.95

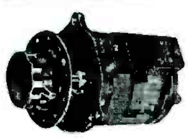
THREE PHASE
Full Wave Bridge

Input: 0-234 VAC Output: 0-250 VDC

Type No.	Current	Price
3B13-1	1.0 Amp.	$ 22.00
3B13-2	2.0 Amp.	32.00
3B13-4	4.0 Amp.	56.00
3B13-6	6.0 Amp.	81.50
3B13-10	10.0 Amp.	105.00
3B13-151	15.0 Amp.	120.00

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1 .... $.35 per set
For Types 3B .... 1.05 per set



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Smooth, efficient voltage control 0 to 135V. output, from 115V. AC line. Type 20. 3 Amps....$12.50

Type 116U (illustrated) 7.5 amps.................. $18.00
Type 1126 15 Amps........ 46.00
Type 1156 45 Amps........ 118.00
Also available for 230volt input. Write for descriptive literature.

Minimum Order $5.

All prices FOB our NYC warehouse. Send check or money order. We will ship transportation charges collect. Rated concerns send P.O., Terms Net 10 days.

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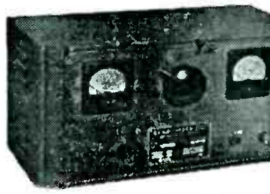

GENERAL PURPOSE Low voltage DC power supplies, with variable outputs. Rugged — Dependable — precision control.

Features

- √ Long life Full Wave Selenium Rectifiers
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- √ Instant Power—No Warm-Up Period
- √ Assembled and Ready to Operate
- √ For 115 VAC 60 Cycles
- √ Dimensions 9″ x 9″ x 17½″

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CF-1	1000 MFD	15 DVC	$ .98
CF-2	2000 MFD	15 VDC	1.69
CF-7	3000 MFD	35 VDC	3.25
CF-19	500 MFD	50 VDC	1.95
CF-16	2000 MFD	50 VDC	3.25
CF-21	1200 MFD	90 VDC	3.25
CF-10	500 MFD	200 VDC	3.25

Mounting clamps for above capacitors..15c ea.

RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50/60 Cyc es

Type No.	Volts	Amps.	Shpg. wt.	Price
TXF36-2	36	2	6 lbs.	$ 4.95
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TXF36-10	36	10	12 lbs.	9.95
TXF36-20	36	20	25 lbs.	17.95
XFC18-14	18 VCT	14	10 lbs.	6.95
XFC18-50	18 VCT	50 amp	17 lbs.	18.95

All TXF Types are Tapped to Deliver 32, 34, 36 volts. XFC Type is Tapped to Deliver 16, 17, 18 Volts Center-tapped.

RECTIFIER CHOKES

Type No.	Hy.	Amps.	DC Res.	Price
HY5A	.028	5	.20	$ 5.25
HY10A	.014	10	.04	9.95
HY20A	.007	20	.02	13.95

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94-29 MERRICK BOULEVARD JAMACIA, N.Y.- REpublic 9-4651

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No. M-652 Jackson Audio Oscillator...used $30.00
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Others as Low as.......................... 49.50
IE 36 Test Set for SCR522 less meter..New 19.95

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I-114 P/O RC-68	TS16/APN
I-135 P/O IE-17	TS19/APQ5
I-167 Weston Anal. #772	TS27/TSM-1
	TS36/AP
I-183 Freq. Meter	TS47/AP
I-185 Oscillator	TS59/APN-1
I-187 Synchronizer	TS62/AP
I-189 Calibrator	TS102A/AP
IE-19	TS126/AP
TS3/AP	TS-251 Less Xtal

TUBE SPECIALS!

211	$ .59	805	3.29
307A	4.95	807	1.89
703A	1.89	813	6.95
723A/B	12.95	837	1.19
724B	1.89	860	4.95
803	2.89	5D21	9.95

ID6/APN4 Scope unit, complete with 5CP1 cathode ray tube and shield and all parts except smaller tubes and crystal. Used $9.95 ea.

SCR 625 Mine Detector—Brand New—Price and information on request.

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	Used	New
RA 10 DA Receiver	$17.50	$24.95
RT7/APN1 Transceiver	6.95	9.95
APN 1 Complete	——	24.50
BC 347 Interphone Amplifier	——	2.95
I-70 Tuning Meter	——	.89
APS 13 UHF Antenna, Pair	——	.98
FL 8 Filter	——	2.95
I-97 Bias Meter	3.95	4.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
TS 10—Sound powered phones	6.50	——

BC 1066 B—150 to 225 MC Portable Receiver adaptable to many amateur uses. In Canvass Carrying Bag. Used........................$5.95
BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery.................. New $3.95
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A-81-2 Transmitter Selsyn for 182 indicator..$2.45
(Both 182F & Trans. Selsyn for $7.00)

AS-138/ARN—10 INCH STREAMLINE LOOP as used with direction finding receivers. Fixed position, it is ideal for planes, boats, automobiles ....New **$1.95**

CONDENSERS

	Each
1 mfd 6000 VDC, OIL FILLED	$1.98
.00025 mfd, 25000 VDC OIL FILLED	2.95
50 mmfd—5KV—5 Amp. Vacuum Cond	1.19

SCR 508 RADIO SET—Complete installation includes:

BC 603 Receiver
BC 604 Transmitter
BC 605 Interphone Amplifier
BC 606 Control Box
DM 34—12 volt Dynamotor (Receiver)
DM 35—12 volt Dynamotor (Transmitter)
Set of 80 Crystals
MP 48 Mast Base
3 Mast sections
FT 237 Mounting Rack
Complete, only $100.00

COMPASS RECEIVER MN-26

Remote control commercial type navigational receiver. Indicates direction of any desired transmitting station. 3 bands—frequency range: 150 Kc to 1500 Kc; has 12-6 V. type tubes. Brand New $39.95

Accessories for Above:
Loop MN-20.......$9.95
MN-28 Control Box $10.00
MN-52 Loop Control Unit $4.45
Loop Transmission cable—168″ long $9.95
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Set of 3 plugs..$4.60

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BC-610 Transmitters with BC-614 Speech Amplifier. 4 Plug-in coils and Exciter Units for 10, 20, 40, and 80 meter operation. Output 400 watts A1, 300 watts A3. Operates from 110/1/50-60 cycles AC. Used in SCR-299,399,499 eqpt. Spares available at extra cost. Condition Excellent to like new. Export Packed. **PRICE EACH** $900.00

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

TCS, Collins Ship Transmitter-Receivers, for 12 V. DC operation, radio telephone and radiotelegraph at 20 & 40 watts, 1.5 to 12.0 mc. Complete with all accessories. Excellent, like new condition. **EACH** $300.00

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

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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 115/3/60 AC. New, Unused. Complete with tubes, cables, connectors and instruction manual. **EACH** $895.00

Wilcox 36A Rectifiers, single cabinet unit containing a 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.**

Wilcox 4-Channel CW3 Dual-Diversity Receiving Eqpt. Enclosed rack-panel arrangement, with 8 CW-3 receivers and 4 Diversity receiving units to provide 4 channels of dual-diversity simultaneous reception. Range 1.9 to 24.0 mc, frequency determined by plug-in coils and crystals, in shield cans. Includes BFO, sensitivity, and audio output controls on each receiver. Operates from 110/1/50-60 AC. NEW EQPT., with essential spares available. **WRITE FOR PRICE.**

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

T-34/ART-7 Jamming Transmitter, uses 2-Eimac 35TG tubes in push-pull oscillator, with motor-driven condenser to provide complete frequency sweep of intended spectrum. Frequency approx. 60-80 mc. For 28 V. DC. operation. NEW, metal-cased transmitters only (less power supply), with 2 35TG tubes, export-packed. **PRICE, EACH** $22.50

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

T-9/APQ-2 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 (with storage batteries). Each in individual metal cabinet. NEW. **Price, Each Set** $450.00

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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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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

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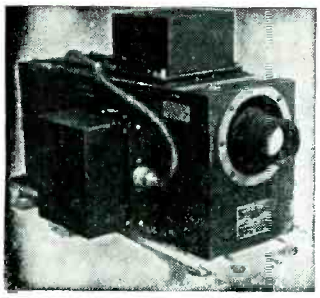

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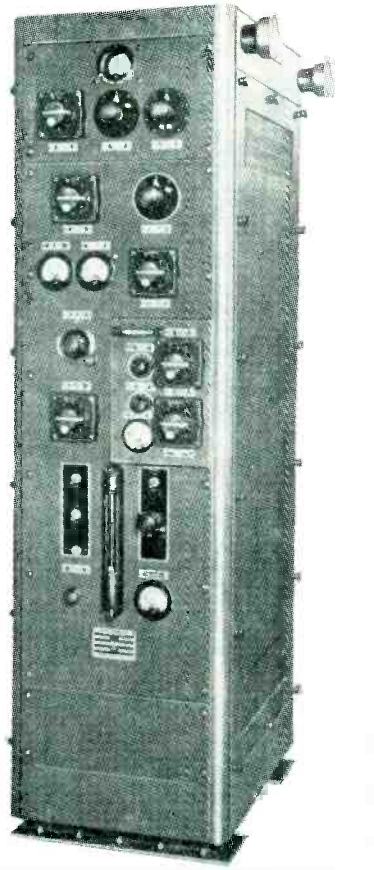
RCA Model MI-8167



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Output: 350 Watts C. W.
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OC3/VR105	.99	2X2A	1.43	10	.35	530	12.50	803	3.95	869B	39.50	8014A	24.95	3FP7	1.95
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1A3	.95	3B7/1291	.49	24G	1.95	559	3.95	805	3.95	874	1.49	8021	2.89	5AP1	3.49
1B22	3.25	3B22/EL1C	2.75	39/44	.49	700A	17.50	807	1.69	876	.59	8025	4.95	5CP1	3.95
1B23	8.50	3C24/24G	1.95	45 Spec.	.35	701A	4.95	810	10.95	879	1.43	8025A	7.95	5CP1A	4.95
1B24	6.75	3C28	4.95	100TH	8.75	702A	3.49	811	2.95	931A	4.50	9003	1.75	5CP7	3.95
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1B27	19.95	3D21A	1.98	203A	8.75	704A	1.00	813	8.49	955	.45	9005	1.90	7BP5	18.95
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2C26	.39	6AJ5	2.25	286A	14.95	715A	6.95	833A	43.95	1616	.95	FG104	19.95	16RP4	37.00
2C34 (RK34)	.29	6B8	.98	304TH	18.95	715B	12.75	836	2.95	1622	2.29	HY65	2.50	17BP4A	37.00
2C40	4.95	6C8	.88	310A	6.95	715C	24.50	837	1.65	1624	1.25	HY114B	.75	19AP4A	62.00
2C44	1.49	6C24	27.50	316A	1.50	721A	2.25	838	2.95	1625	.45	HY615	.29	19AP4B	62.00
2J22	7.95	6F4	5.75	329A	8.95	722A	2.49	843	.75	1626	.45	RK25	3.95	20CP4	68.50
2J26	24.50	6J4	5.95	331A	14.95	723A/B	14.95	846	49.95	1629	.38	RK34	.29		
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2J62	48.75	7C4	.49	388A	1.50	730A	8.95	861	24.50	1665	1.25	VT90	.98		
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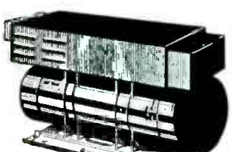
INVERTER UNIT PE 218



Output: 115 VAC; Single phase; PF 90; 380/500 cycle; 1500 V.A. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. volts 27.5; Leland Electric mfg.

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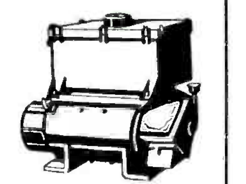

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Primary 125 volts tapped at 105 and 115 volts, 50 to 425 cycles. Secondaries: 5.1 V. at 3.0 amps; 325-0-325 V. at 0.175 amps; 5.4 V. at 8 amps; 6.4 V. at 10.3 amps; 2.5 V. at 3.0 amps; 4500 V. at .005 amps; 2.5 V. and 4500 V. windings insulated for 6000 Volts. All other windings insulated for 1500 Volts. Cost gov't more than $42.00 . . . a real bargain at (removed from new equipment)

$4.95 ea.

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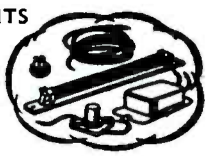
Ultra-Violet Fluorescence



Now . . . build your own black light lab equipment at a new low cost with these easy - to - assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.

4-Watt Kit—5½" tube) $3.00
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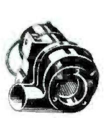

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New $9.95

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300 OHM—good TV line per ft. 05
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B.C. 221N FREQ. METER—new condition. 125.00
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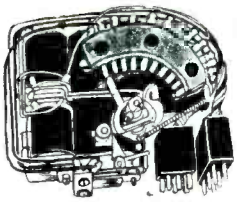

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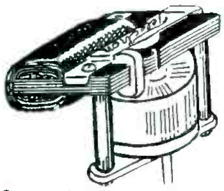

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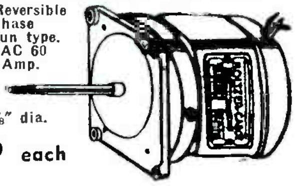

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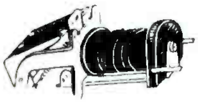

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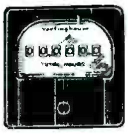

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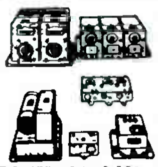

SCR-27N COMMAND and ARC-5 EQUIPMENT

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BC-453—190 to 550 KC	$12.95	
BC-454—3 to 6 MC	6.95	
BC-455—6 to 9 MC..............	6.95	
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ADDITIONAL EQUIPMENT

	USED	NEW
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BC-450 Control Box (3 Receiver)...	.98	1.95
BC-451 Control Box (Transmitter)..	.89	1.49
BC-442 Relay Unit (ANT)..........	1.95	2.95
Plugs: PL-147, 148, 151, 152, 153, 154, 156—EACH	.75	
Flexible Shafting with gear to fit Receivers		1.69
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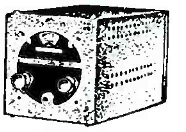
2 Transmitter Rack	1.69	

BEACON RECEIVER BC-1206-C
Manufactured by Setchell-Carlson



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0.607	220.4	740	1926	6495	24600	160000
0.7	225	750	1960	6500	25000	165000
1.03	230	800	1980	6840	25200	166750
1.3	235	806	2000	6990	25400	167000
1.75	240	850	2045	7000	25833	169200
2.5	245	854	2080	7320	26000	175000
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5	271	917	2145	7900	27500	186600
5.025	275	946	2150	7930	28000	190000
6.25	280	978	2160	7950	28430	198000
6.5	286	1000	2180	8000	28500	200000
7	289	1030	2187	8094	29000	201000
7.8	299	1056	2195	8250	29500	205000
7.9	300	1059	2200	8500	29990	210000
8	310	1067	2250	8700	30000	215000
10.38	311.5	1100	2300	8770	31000	220000
11.25	320	1110	2400	9000	31500	225000
12	325	1150	2450	9100	32000	229000
13.52	330	1155	2463	9445	33000	230000
14.2	340	1162	2485	9500	35000	235500
14.25	350	1200	2490	9710	37000	238000
14.5	360	1225	2500	9800	38140	240000
15	366.6	1250	2525	9900	38500	245000
16	370	1260	2600	9902	39000	250000
17	375	1300	2625	10000	39500	265000
19	380	1350	2635	10430	40000	268000
19.2	389	1355	2700	10500	42000	270000
20	390	1400	2750	10600	43000	275000
22	400	1488	2850	10900	45000	294000
23	410	1495	2860	10936	47000	300000
24	414.3	1500	2870	11000	47500	307500
25	418.8	1510	2900	11400	48000	311000
26	425	1518	3000	11500	48660	314000
28	426.9	1600	3100	11690	49000	316000
30	427	1640	3163	12000	50000	325000
31.5	440	1646	3259	12500	52000	330000
37	450	1650	3290	12600	55000	330000
48	452	1670	3333	13000	56000	333500
49	460	1680	3384	13100	57065	350000
50	470	1710	3500	13500	58333	353500
51.78	475	1712	3509	13550	60000	375000
55	478	1740	3700	13600	61430	380000
56.7	480	1770	3730	14000	62000	400000
60	487	1800	3760	14250	64000	402000
63	500	1818	4000	14400	65000	420000
68	520	1830	4030	14500	66600	422000
74	525	1865	4200	14550	66650	425000
75	540	1892	4220	14600	67500	450000
80	550	1894	4280	15000	68000	458000
81.4	575	1895	4300	16000	70000	478000
88	580	1896	4314	16500	72000	500000
89.8	588	1897	4440	16800	73500	520000
95	600	1898	4444	17000	75000	521000
100	612	1899	4500	17500	80000	525000
101	625	1900	4720	17977	82000	543000
105	633	1901	4750	18000	84000	550000
105.7	640	1902	4850	18300	85000	570000
107	641	1903	4885	18380	85750	575000
120	645	1904	4900	18500	88000	600000
121.2	649	1905	5000	18800	90000	620000
125	650	1906	5100	19000	91000	650000
130	657	1907	5210	19500	93300	654000
135	665	1908	5235	20000	95000	660000
147.5	668	1909	5270	20441	100000	690000
150	670	1910	5300	20500	110000	700000
160	673	1911	5500	21000	115000	750000
165	675	1912	5600	21500	116667	761300
170	680	1913	5730	22000	120000	800000
175	681	1914	5770	22500	130000	813000
179	684	1915	5910	22990	135000	850000
182	689	1916	6000	23000	140000	900000
182.4	697	1917	6100	23150	141000	930000
200	699	1918	6125	23325	145000	950000

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Megs-1.	1.5	2.11	3	4.25	7
1.1	1.57	2.2	3.3	4.5	7.5
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5Z3	1.15
5Z4	1.35
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6A4	1.60
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6A6	1.33
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6AD7	1.60	6SB7Y*	1.20	12AV7*	2.90	FG33	8.90	242C	7.20	832A	12.98		
6AE5	.99	6SC7*	1.45	12AW6*	2.40	33	.69	244A	4.15	833A	39.98		
6AE6G	.79	6SD7GT	1.29	12AX7*	2.40	34	1.60	247A	9.95	836	3.98		
6AF5G	.89	6SF5	.98	12BA6*	1.80	35/51	1.00	249B	3.75	837	1.39		
6AF6G	1.33	6SF7	.98	12BA7	2.40	35A5	.95	249C	1.95	838	3.98		
6AG5*	2.65	6SG7*	2.00	12BD6*	2.00	35B5*	2.00	250TH	21.29	842	2.75		
6AG7*	2.88	6SH7GT*	1.07	12BE6*	1.80	35C5*	2.00	250TL	21.29	843	.39		
6AH5G	1.49	6SJ7*	1.65	12BF6	.85	35D5*	2.00	HK254	15.49	845	5.95		
6AH6*	3.90	6SK7GT*	1.80	12BH7*	2.40	35L6GT*	1.65	262A	3.98	851	29.98		
6AJ5	1.49	6SL7GT*	1.25	12C8	1.39	35W4*	1.25	262B	3.98	860	12.98		
6AK5*	3.90	6SN7GT*	2.20	12F5	.90	35Y4*	.90	271A	6.65	861	29.95		
6AK5Jr		6SN7WGT*	2.90	12H6*	1.80	35Z3	.90	274B/5R4	1.98	864	.38		
6AK6*	2.40	6SQ7GT*	1.50	12J5GT*	.73	35Z4GT	.75	282B	8.49	865	1.39		
6AL5*	2.00	6SR7*	1.80	12J7GT	1.00	35Z5GT*	1.50	300	27.50	866A	1.35		
6AL7GT*	2.65	6SS7	.90	12K7GT	.98	REL36/6J4	.50	304TH	24.98	869	25.98		
6AN5*	6.00	6ST7	1.33	12K8	1.07	36	.69	304TL	24.98	872A	2.45		
6AQ5*	2.00	6SU7GTY	3.37	12Q7GT	.90	37	.69	307A/RK75	6.45	GE872A	4.98		
6AQ6*	1.80	6SZ7	1.05	12S8GT	.98	38	.69	310A	6.98	873	15.98		
6AQ7GT	1.23	6T7G	1.29	12SA7GT*	1.05	39/44	.69	316A	2.98	874	1.49		
6AR5*	1.65	6T8*	2.90	12SC7	1.39	CRC40	.54	323B	12.25	878	1.95		
6AR6	5.49	6U4GT*	.88	12SF5GT	.79	41	.79	327A	2.50	884/6Q5G	1.80		
6AS5*	2.00	6U5/6G5*	.98	12SF7GT	.79	42	.79	350A	8.95	885	1.80		
						43	.85	350B	3.50	893A	250.00		
						45	.98	354A	24.98	922	.98		
						45S/VT52	.69	355A	14.15	923	1.75		
						45Z3	.89	HK357C	39.49	927/CE25	1.00		
						45Z5	.90	367A	3.98	929	1.33		
						46	.99	371B	.98	930	1.05		
						47	.89	380A	.79	931A	4.98		
						48	3.90	388A	2.69	HK953E	78.00		
						RK48A	14.85			954	.25		

2E36	1.49
2E42	1.39
2E43	1.39
CK501AX	1.26
CK502AX	1.79
CK505AX	1.79
CK509AX	1.26
CK512AX	1.79
CK522AX	1.79
CK525AX	1.79
CK526AX	1.98
CK528AX	1.79
CK529AX	1.98
CK531DX	.98
CK532DX	.98
CK533AX	1.39
CK534AX	.89
CK536AX	.89
CK537AX	4.98
CK538DX	.89
CK539DX	.98
CK541DX	1.98
CK542DX	.98
CK543DX	.98
CK544DX	.98
CK546DX	1.98
CK547DX	1.98
CK548DX	1.98
CK551AXA	1.69
JRP5676	1.49
CK5678	2.48
CK5697	5.98
CK5702	5.98
JRP5704	5.79
CK5744	2.98
CK5784	5.98
5829	5.98
5875	1.98

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6AS6	3.59	6U6GT*	1.05	12SG7	.89	49	.89	393A	4.98	955	.49
6AS7G*	6.75	6U7G	.90	12SH7	1.10	50	1.95	394A	4.98	956	.39
6AT6*	1.50	6V6*	2.25	12SJ7GT	.89	50A5	1.35	X400	14.98	957	.39
6AU5GT*	2.65	6V6GT*	2.00	12SK7*	1.80	50B5*	1.80	WL414	63.95	958A	.69
6AU6*	2.00	6V6GTY*	2.45	12SL7GT	1.07	50C5	1.03	417A	9.49	SD968	.98
6AV5GT*	2.65	6V7G	1.18	12SN7GT*	2.20	50C6*	1.49	GL434	14.98	991	.40
6AV6*	1.50	6W4GT*	1.80	12SQ7GT*	1.50	50L6GT*	1.65	446A/2C40	1.19	FM1000	1.50
6AW6*	2.65	6W4WGT*	2.50	12SR7	.98	50X6	1.10	446B	1.75	1000T	85.00
6AX5GT*	1.65	6W5GT	.98	12X3	.90	50Y6GT	.90	450TH	45.00	CK1005	.49
6B4G	1.98	6W6*	2.00	12Z3	.98	50Y7GT	.99	450TL	42.50	CK1006	.64
6B6G	.98	6W7G	1.33	14A4	1.29	52	.99	GL451	.89	CK1007	.89
6B7	1.39	6X4*	1.50	14A7/12B7	1.08	53	1.33	460/HF200	15.95	HK1054	130.00
6B8G	1.39	6X5GT*	1.50	14AF7/XXD	1.18	55	1.06	WL468	8.95	CK1089	3.98
6BA4	1.08	6Y5	1.85	14B6	1.08	56	.85	RH507	9.98	CK1090	2.69
6BA5	1.98	6Y6G*	1.25	14B8	1.10	57	.89	527	35.00	R1100	5.00
6BA6*	1.80	6Y7G	.98	14C5	1.29	58	.89	GL530	49.69	R1130B	12.00
6BA7*	1.20	6Z5/12Z5	1.18	14C7	1.20	59	1.78	WL531	3.75	HY1231Z	5.39
6BC5*	2.00	6Z7G	.98	14E6	1.10	RK65	24.95	WL532A	3.89	HY1269	5.39
6BD6*	2.00	6ZY5G	.98	14E7	1.33	HY69	2.75	544	4.98	1273	1.15
6BE6*	1.80	7A4/XXL*	.98	14F7	1.10	Hy75A	4.59	GL546	1.69	1603	3.0[illegible]
6BF6*	1.49	7A5*	1.10	14F8*	1.29	70A7	1.59	550P1	19.95	1609	5.98
6BG6G*	2.25	7A6*	.90	14H7*	1.17	70L7GT	1.95	575A/975	12.65	1613/6F6X	1.25
6BH6*	2.00	7A7*	1.62	14J7	1.33	71	1.00	601B	.19	1614	2.05
6BJ6*	2.00	7A8	.90	14N7	1.35	72	.95	HY615	.18	1616	1.98
6BQ6GT*	3.20	7AD7*	1.56	14Q7	1.10	CRP72	1.37	WL619	18.90	1619	.29
6C4*	1.65	7AF7*	.87	14R7	1.29	73	1.67	WL632A	8.98	1620	4.95
6C5GT	.83	7AG7*	1.15	14S7	1.33	NR74	.29	702A/702B	2.65	1621	1.29
6C6	.89	7AH7*	1.16	14W7	1.33	75	.83	703A	3.98	1622	2.26
6C7	1.26	7B4*	.87	14X7	1.33	76	.83	704A	1.05	1625	.49
6C8G	.98	7B5*	1.80			77	.83				

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6CD6G*	6.00	7B8	.90	15E	1.17	80	1.19	707B	24.98	1631	1.25
6D6	.89	7C4/1203A	.89	15R	.89	81	1.95	710/8011	1.98	1632	.77
6D7G	.89	7C5*	.89	FG17	3.98	FG81A	3.75	710A/8011	1.75	1633	.75
6D8	.98	7C6*	1.62	RK18	.98	82	1.29	713A	1.00	1634	1.80
6E5	1.10	7C7	.95	18	.98	82V	1.39	715A	6.98	1635	1.49
6E6	1.39	7C23	72.00	19	.69	83	1.29	715B	9.98	1641/RK60	.75
6E7	1.39	7E5/1201	1.25	19BG6G*	2.98	83V	1.54	715C	24.35	2050	1.80
6F5	.83	7E6	1.10	19J6*	3.20	84/6Z4	.95	716A	2.75	2051	1.80
6F6*	1.04	7E7	1.10	19T8*	2.90	85	1.10	717A	1.59	R4340	36.00
6F6GT*	.85	7F7*	1.15	20	1.17	89	.79	719A	22.75	5514	4.85
6F7	1.39	7F8*	2.65	RK20A	9.90	VR92	.25	720CY	45.00	5516	7.75
6F8G*	1.49	7G7/1232	1.33	RX21	2.50	DR100	11.49	721A	5.98	5618	3.29
6G6G	.98	7H7*	2.00	PJ22/CE1C	1.49	100TH	8.89	722A/287	2.75	5656	9.98
6H6*	1.15	7J7	1.33	22	.99	FG104	17.45	723A	9.75	5670	5.98
C6J	6.49	7K7	1.33	HY24	1.39	FG105	12.95	723A/B	18.98	5686	4.23
6J4*	6.98	7L7	1.33	24	.89	VU111	.45	724A/B	2.89	5687	5.75
6J5GT*	1.50	7N7*	2.65	24A	1.10	HY114B	.79	725A	7.75	5812	2.99
6J6*	2.90	7Q7*	.95	24G/3C24	.69	HY115/145	.75	726A	7.98	5881	2.89
6J7*	1.20	7R7*	1.07	25A6	1.20	117L7	1.95	726B	24.98	HK5944	16.49
6J8G	1.39	7S7	1.33	25A7	3.27	117N7GT	1.95	726C	69.98	HK5990	11.50
6K4	3.49	7T7	1.03	25AC5GT	1.95	117P7GT	1.95	730A	9.89	HK5991	18.00
6K5GT	1.16	7V7	1.33	25B5	1.39	117Z3	.79	801	.89	8002R	99.50
6K6GT*	1.50	7W7*	2.65	25BQ6GT*	3.20	117Z4GT	1.45	803	3.00	UX6653	.69
6K7	.85	7X7/XXFM	1.33	25C6	1.18	117Z6GT	1.20	804	8.45	8012A	1.25
6K8	1.07			25L6GT	.87	117Z7GT	1.49	805	4.98	8013A	5.98
6L5G	.98	7Y4*	.90	25N6	1.69	F127A	15.89	807	1.98	8020	1.98
6L6*	2.85	7Z4	.87	25W4GT*	2.00	CV148	4.98	808	2.39	9001	1.98
6L6G*	1.98	10Y	.79	25Y5	1.45	150T	14.50	809	2.45	9002	1.65
6L6GA*	1.98	12A	.89	25Z5	.87	155	.98	810	11.96	9003	1.98
6L7	1.15	12A5	1.39	25Z6GT*	1.50	FG166	49.00	811	2.92	9004	.79
6N4	2.39	12A6*	.98	26	.79	FG172	42.50	812	2.92	9005/RC4B	1.95
6N6G	1.95			27	.75	182B	1.20	813	11.75	9006	.27
6N7GT	1.26	12A7	1.49	FG27A	8.70	FG190	12.80	814	4.25	SubMiniatures	
6P5GT*	1.17	12A8GT	1.00	RK28A	3.85	200	22.98	815	2.98		
6Q7	.98	12AH7GT	1.33	28D7	1.39	205B/VT2	1.69	816/866Jr	1.29	2E31	1.39

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3HP7	3.85
3HP14	14.98
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3JP7	7.95
3JP12	19.95
3JP14	16.95
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5BP1	6.98
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5CP1	4.85
5FP7	1.85
5FP14	18.98
5HP1	9.75
5HP4	9.75
5JP2	24.75
5LP7	19.98
5MP1	9.75
5NP1	5.85
7BP1	4.95
7BP7	8.85
7CP1	12.95
9GP7	14.89
9JP1	14.85
9LP7	14.85
10BP4	19.49
10BP4A	27.48
10FP4	24.50
12DP7	12.45
12GP1	49.98
12JP4	27.00
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16LP4A	36.98
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25–32	18.75
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PM8	.98
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10-4B	.49
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20-4	.49
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K55B	.36
M55B	.36
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K80B	.36
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311/28V	.15
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1N27	3.50
1N29	3.50
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1N35	1.95
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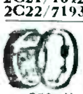

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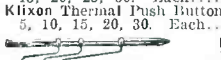

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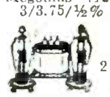

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of unexcelled accuracy and reliability

have many applications

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Impedance Range: 2.5 ohms to 20,000 ohms. Remains essentially resistive over frequency range of 30 to 10,000 cps. Accuracy ±5%.

Power Range: 0.1 mw. to 5 watts in steps of 0.1 mw.

Indicating Meter: Calibrated from 0 to 50 milliwatts and from 0 to 17 db. —Zero level: 1mw.

Meter Multiplier: Will change reading of indicating meter by ratios of 0.1:1, 1:1, 10:1, 100:1, or decibel reading by —10, 0, +10, +20.

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2. **Effects of Load Variation on a Signal System.**
3. **Transmission Line Equalization Measurements.**
4. **Measurement of Insertion Loss in Multi-channel Mixer and other complex circuits.**
5. **Filter and Transformer Measurements.**
6. **Radio Receiver Measurements.**

The equipment shown on this page is built to DAVEN'S well-known standards of precision. Please write for more detailed data. Let our engineering department help you on specific problems.

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Characteristics similar to OP-961, except that it can measure up to 100 watts.

Impedance Range: 40 selected impedances between 2.5 and 20,000 ohms. Accuracy ±2% over frequency range 30 to 10,000 cycles.

Power Range: 0.1 mw to 100 watts in 0.1 mw steps. Range may be extended below 0.1 mw by use of external amplifier.

Indicating Meter: Calibrated from .01 watt to 1 watt and from —10 to +10 db. Zero level: 1mw.

Meter Multiplier: Extends range of meter from 0.01 to 100 times scale reading.

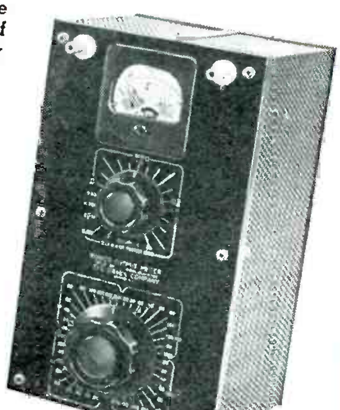
TYPE OP-961

Impedance Range: 2.5 ohms to 20,000 ohms. Remains essentially resistive over frequency range of 30 to 10,000 cps. Accuracy ±2%.

Power Range: 0.1 milliwatts to 50 watts in steps of 0.1 milliwatts.

Indicating Meter: Calibrated from 1 to 50 milliwatts and 0 to 17 decibels. Zero level: 1mw.

Meter Multiplier: Extends the power reading of the indicating meter from 0.1x to 1,000x scale value, or the db. reading from —10 to +30 db. in steps of 2 db.



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