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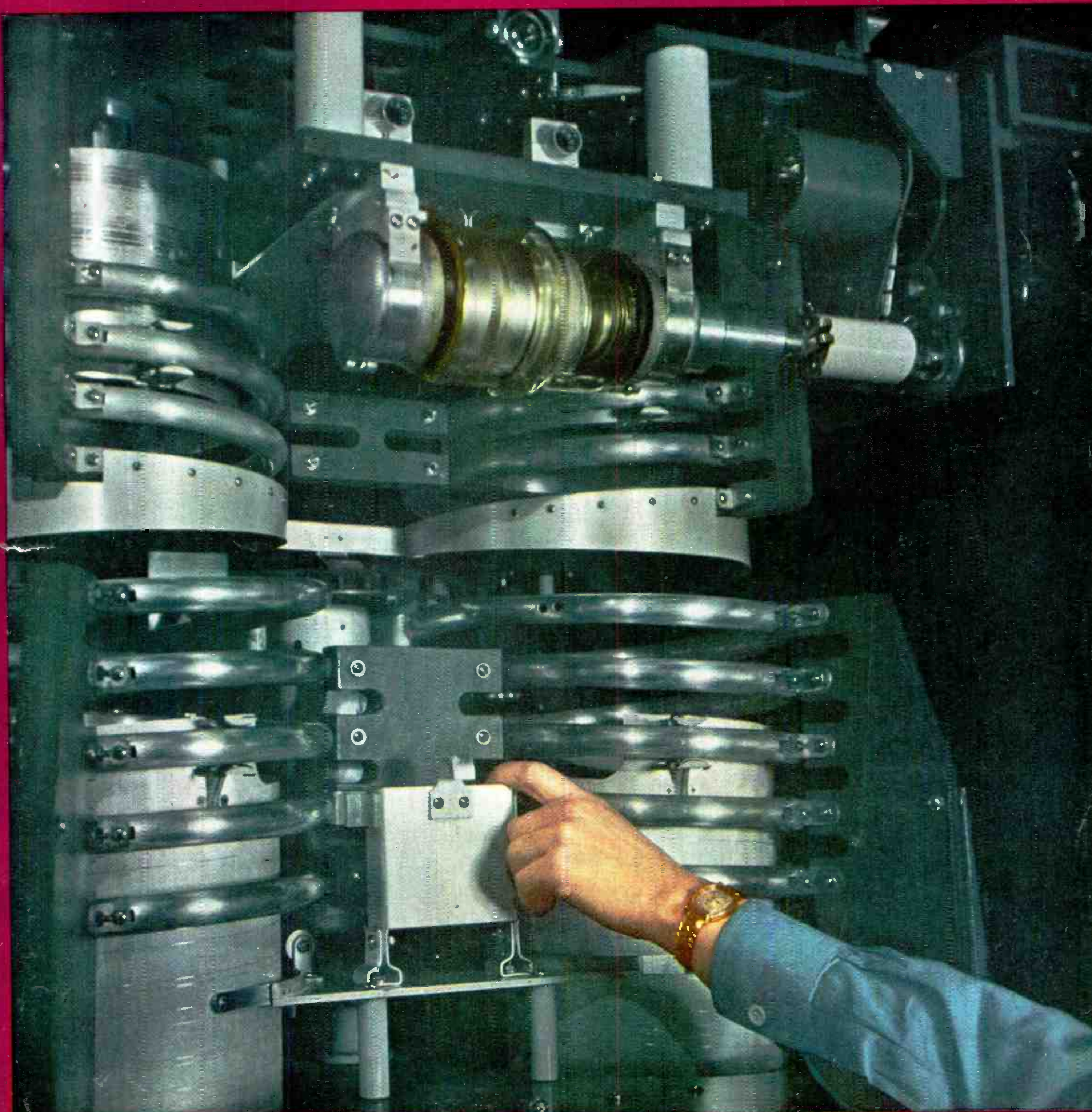

MOTOR-TUNED 50-KW AMPLIFIER

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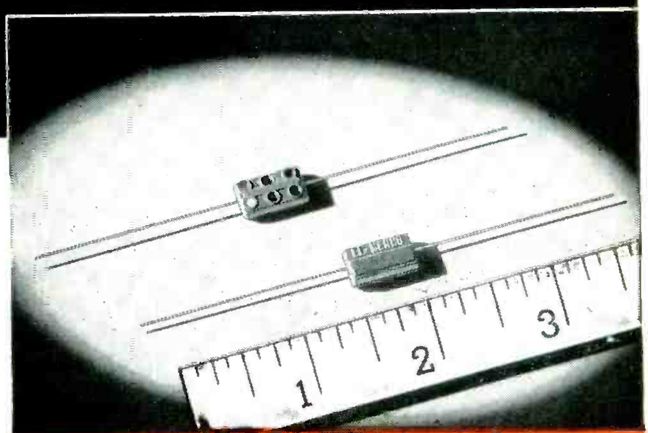

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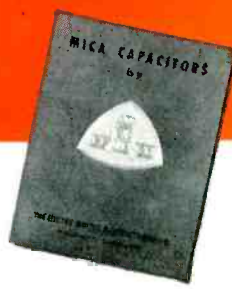

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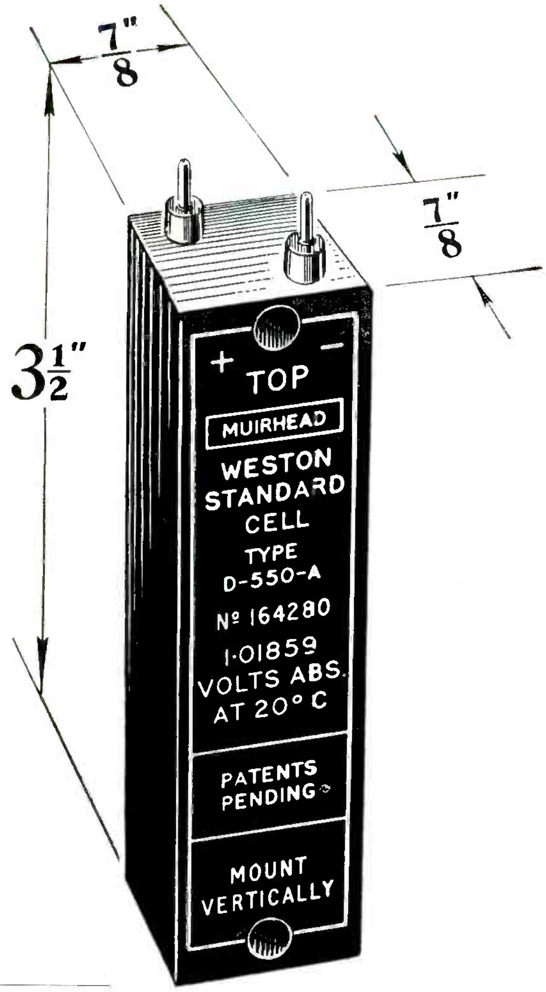

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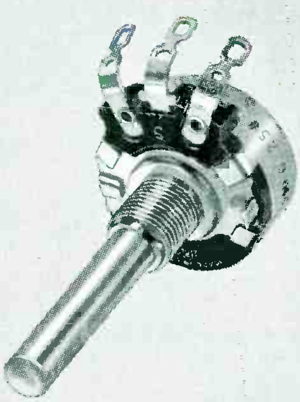

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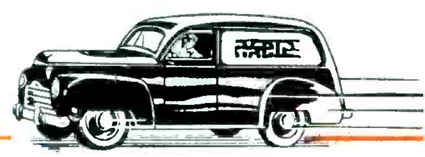

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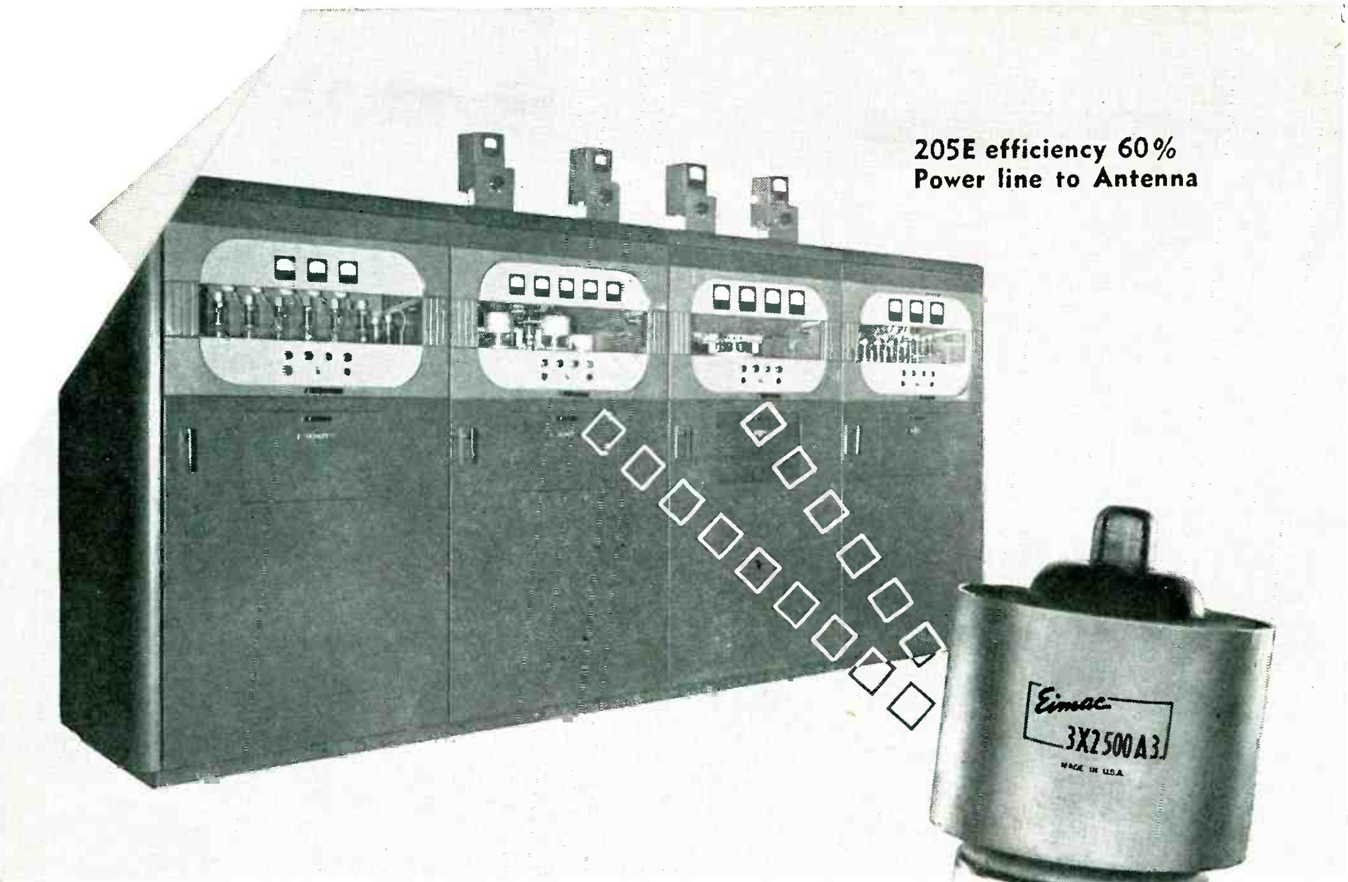

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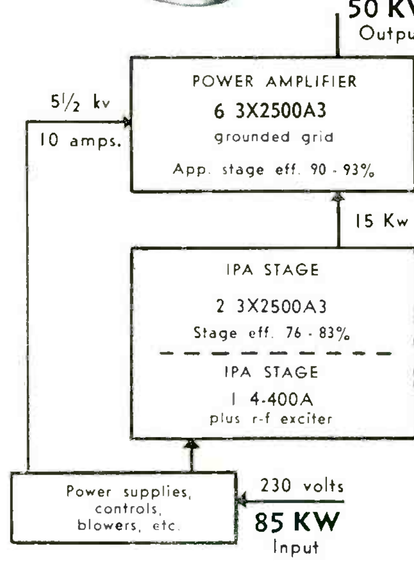

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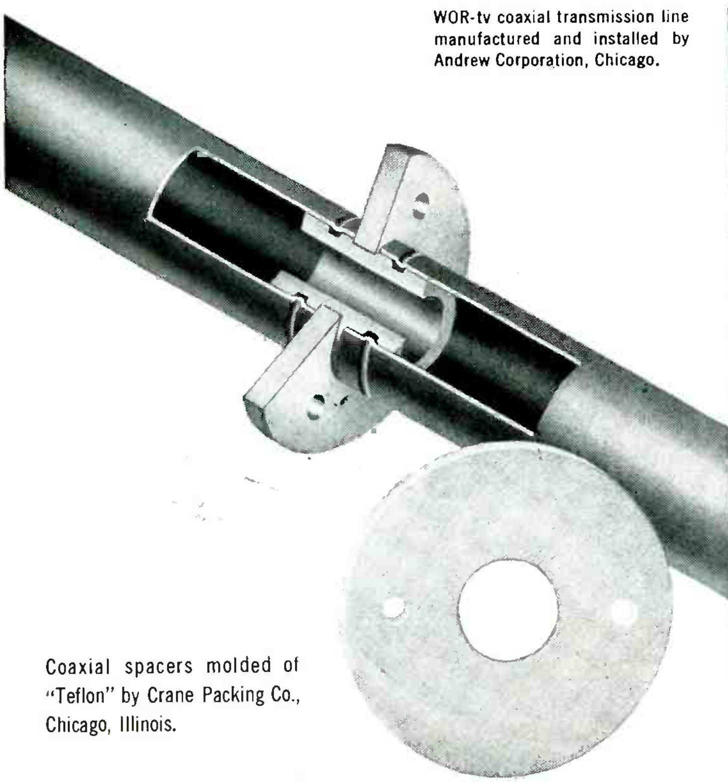
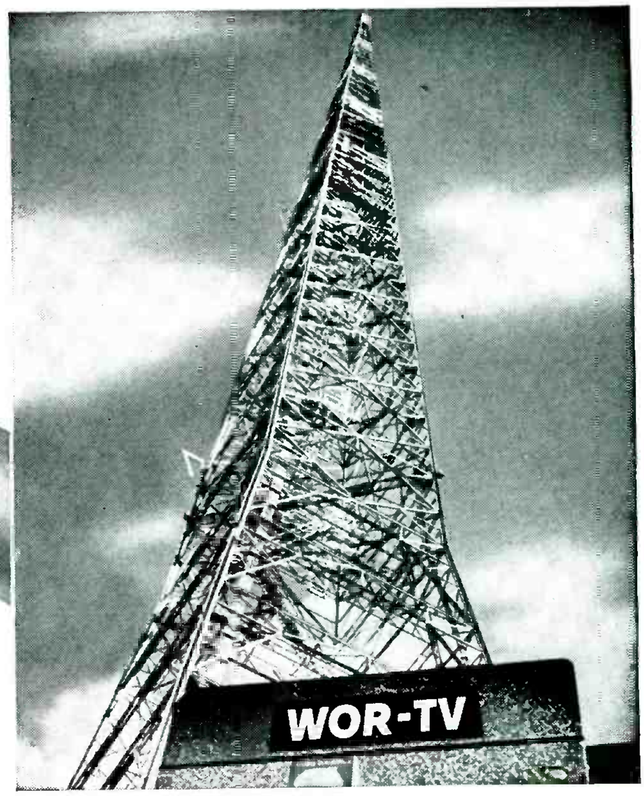


Coaxial spacers molded of "Teflon" by Crane Packing Co., Chicago, Illinois.



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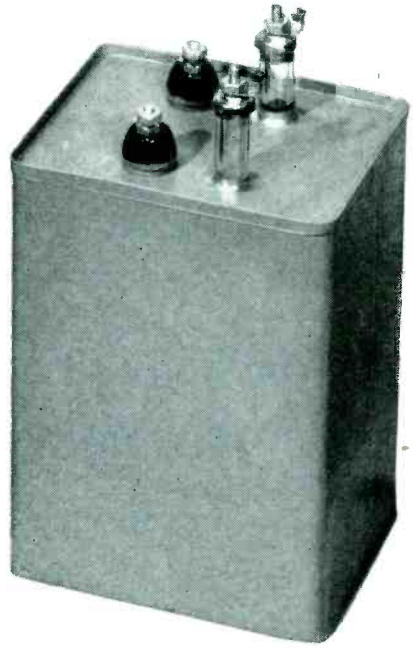

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Input frequency	:	400 cycles ± 10%
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Output ripple	:	1%
Regulation	:	80 volts per ma.
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Size	:	Small as possible
Weight	:	Light as possible
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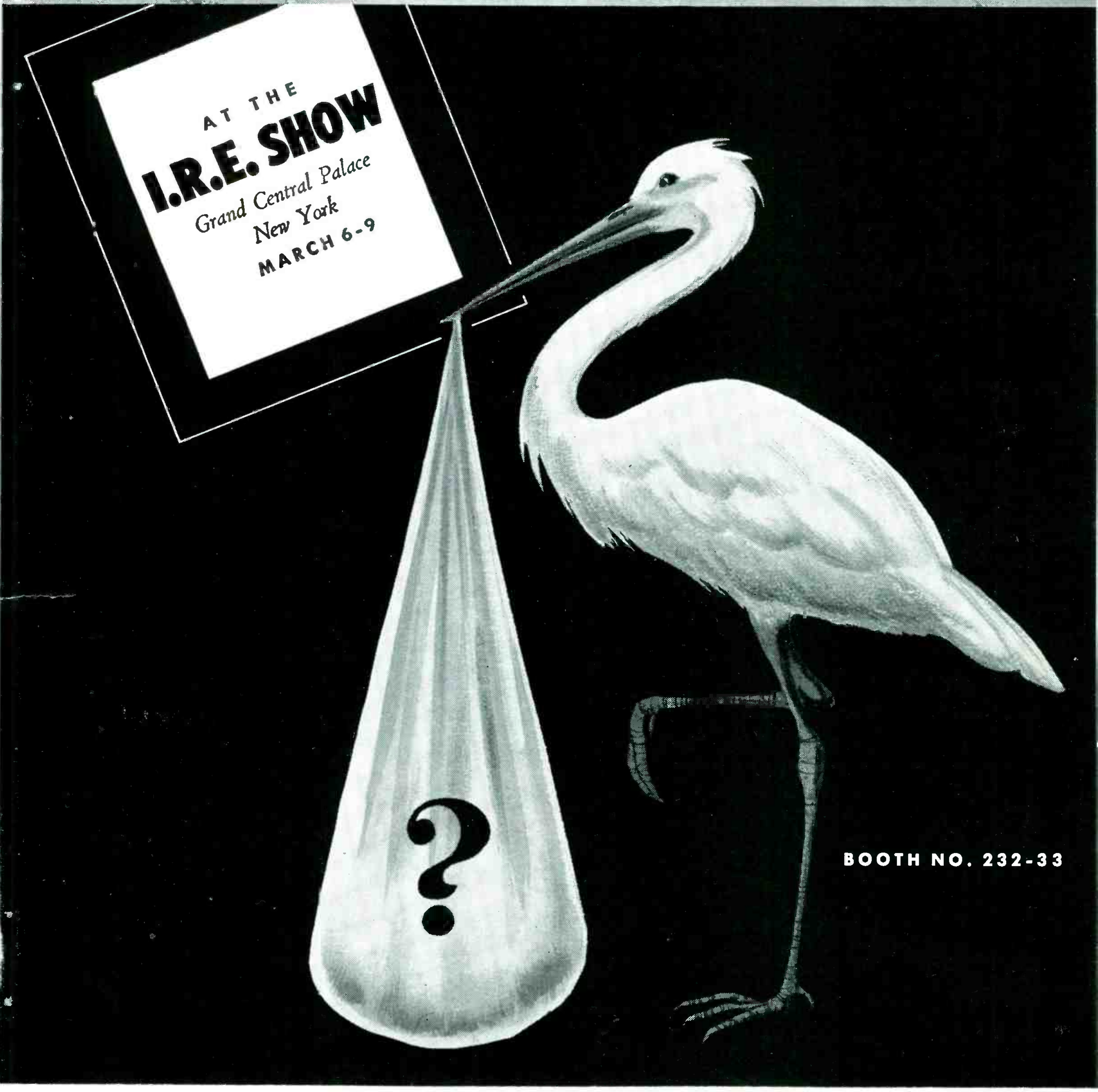

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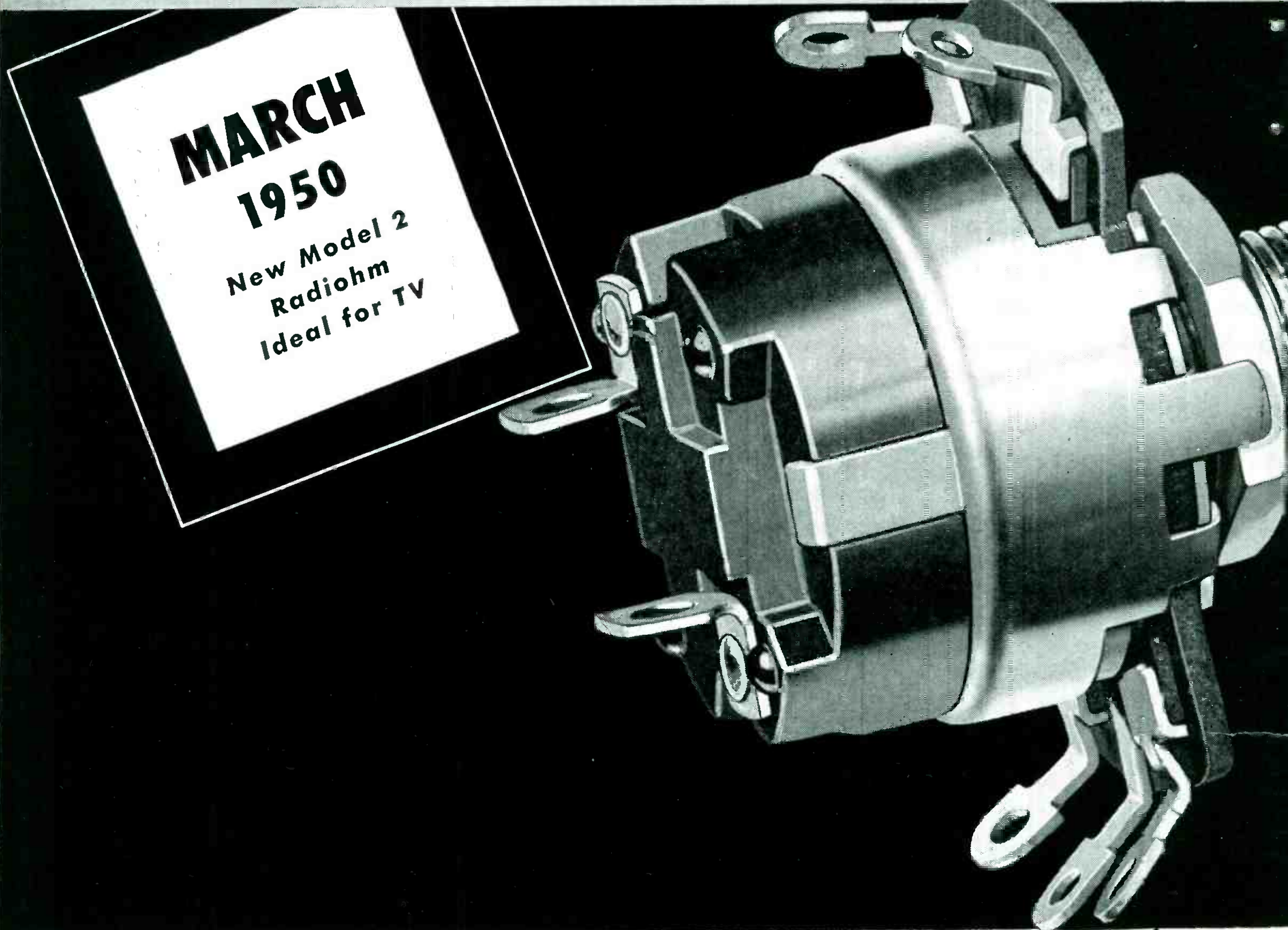

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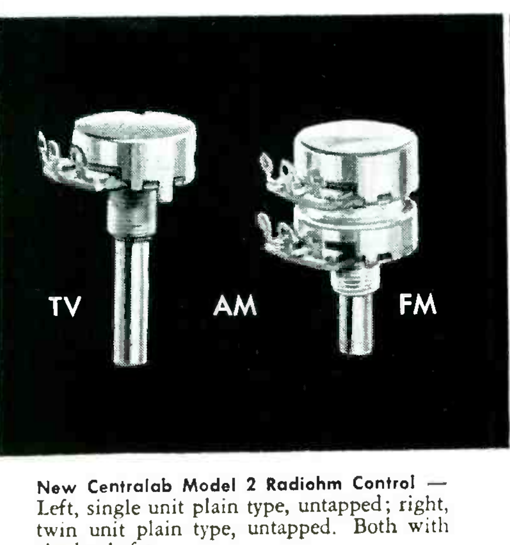
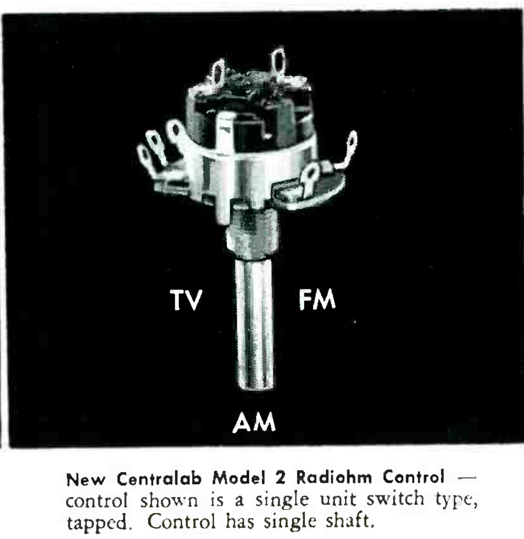


New Centralab Model 2 Radiohm Control — Left, single unit plain type, untapped; right, twin unit plain type, untapped. Both with single shafts.



New Centralab Model 2 Radiohm Control — control shown is a single unit switch type, tapped. Control has single shaft.

New Centralab Model 2 Radiohm Control — this control is a twin unit switch type, untapped. It has a single shaft.

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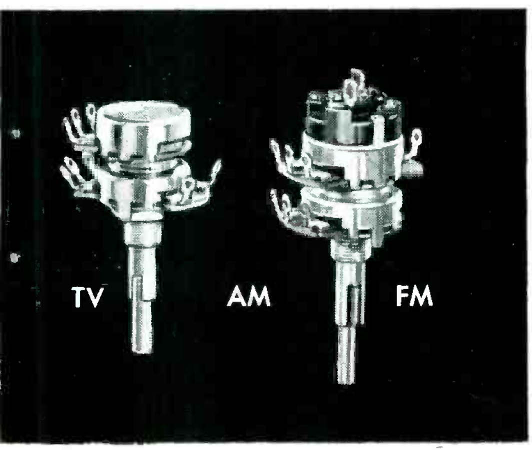
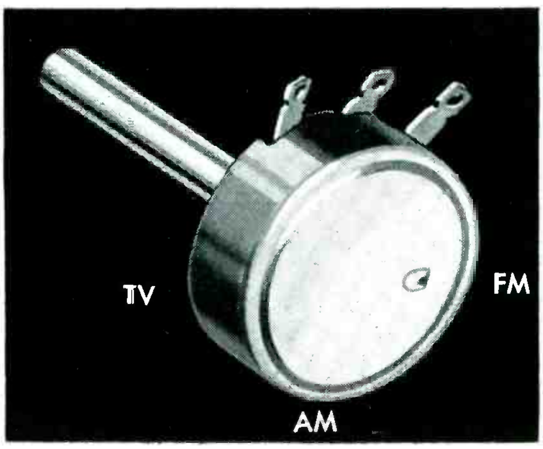


New Centralab Model 2 Radiohm Control — Left, twin unit plain type, front section tapped; right, twin unit switch type, rear section tapped. Both units have concentric shafts.



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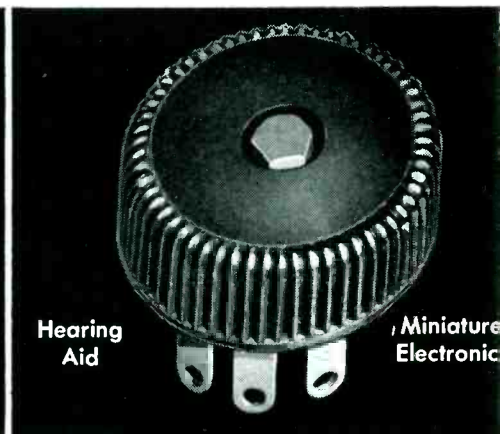

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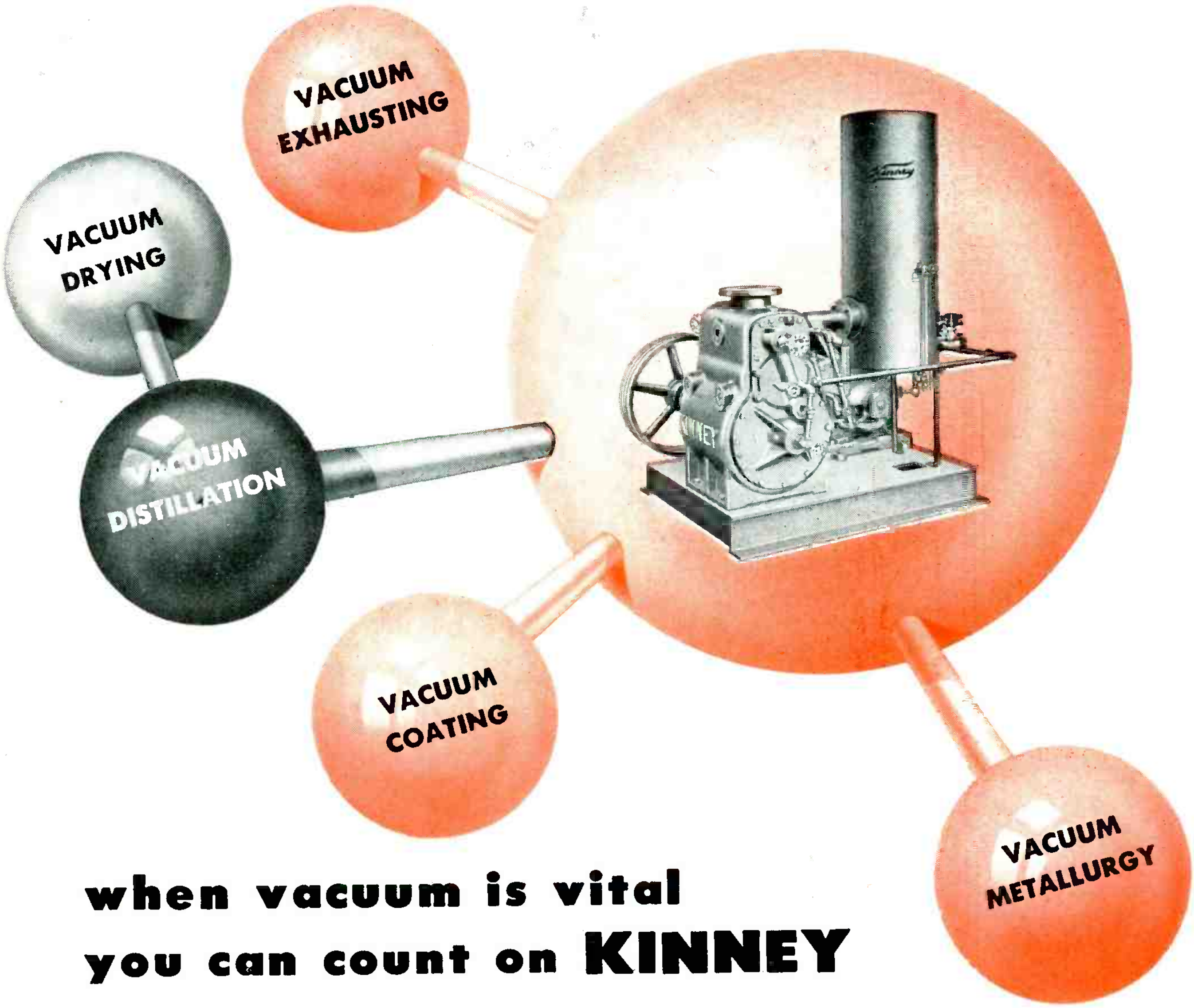

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Making old things better
Making new things possible

KINNEY Vacuum Pumps

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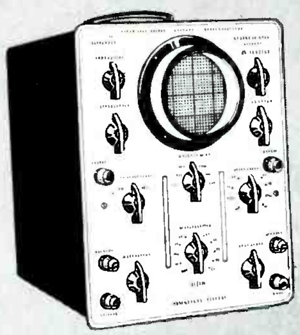
New DU MONT FEATURES

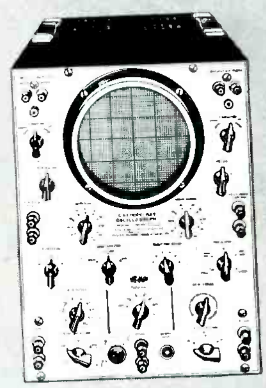
DC 10 100 1000

OSCILLOGRAPHY THROUGHOUT THE SPECTRUM Once again, DuMont paces the modern art of oscillography by extending the operation of oscillographs over the entire frequency spectrum from d-c to over 100 megacycles, for the study of new and broader fields of industry and research. In a group of new instruments covering this entire range, superior circuit design has been expertly integrated to give each instrument optimum performance in its particular category of applications.



5 CPS. TO 100,000 CPS.

DC TO 200,000 CPS.



DC TO 500,000 CPS.

Type 292—Outstanding development in portable oscillographs employing a new three-inch tube, the Du Mont Type 3RP-A. Type 292 provides, good sensitivity, balanced deflection, and other performance features usually found only in instruments employing a five-inch tube.

Type 304-H—A new standard of performance in moderately priced oscillographs. Offers such advances as many times full screen expansion of sweep and vertical signal; complete positioning; high sensitivity at 3,000 volts accelerating potential high-gain a-c and d-c amplifiers; both driven and recurrent sweeps, sync limiting.

Type 250-AH—High-voltage operation and high light output for study of transient signals. New, extremely stable sweep circuit provides good linearity over its entire range of sweep-time intervals from 5 seconds to 10 microseconds. Contains built-in voltage calibrator and a variety of input connections.

ALLEN B. DU MONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVE., CLIFTON, NEW JERSEY

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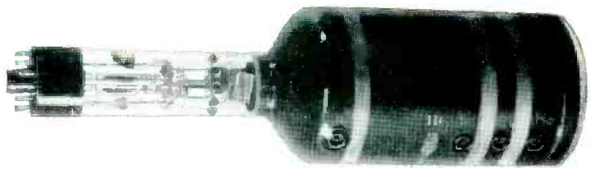
at THE I.R.E. SHOW

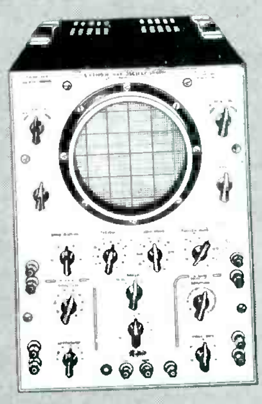
100,000 1MC 10MC 100MC

OUTSTANDING DEVELOPMENTS IN CATHODE-RAY TUBES

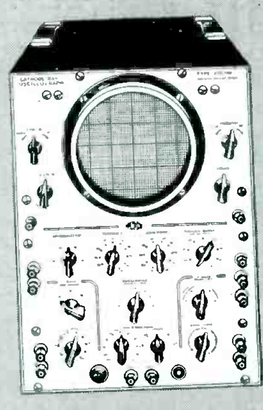


Type 5XP– Multi-band intensifier tube providing high sensitivity and high light output at operating potentials up to 29 kv. Flat face insures maximum useful screen diameter with minimum distortion of signals. Writing rates of the Type 5XP– are extended in a modification incorporating metalized screen.

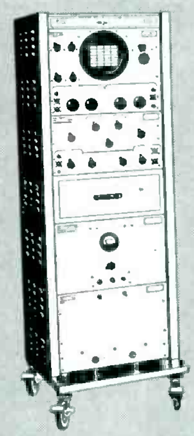
Type 3RP-A — New, flat-face three-inch tube permitting operation from balanced deflection circuits. High sensitivity is provided despite extremely short overall length of 9⅛ inches. Specially designed deflection plates minimize pattern distortions.



5 CPS. TO 10 MEGACYCLES



5 CPS. TO 15 MEGACYCLES



DC TO OVER 100 MEGACYCLES

Type 303 — This new instrument employs a five-inch cathode-ray tube operated at 3,000 volts accelerating potential and provides over three inches of undistorted deflection at a sensitivity of 0.1 volt per inch. Both sensitivity and frequency response ratings of the Y-axis amplifier include the performance of a built-in signal delay line.

Type 294 — New high-frequency oscillograph employing the sensitive Type 5XP– Cathode-ray Tube. Selection may be made at the rear panel for accelerating potential of either 7 kv. or 12 kv. Sensitivity at 12 kv. ± 0.15 rms volt per inch. Built-in signal delay line permits full display of steep wavefronts. Built-in calibrator.

Special Type — A specially constructed cathode-ray oscillograph illustrating the possible applications of a newly-developed high-gain, wide-band amplifier having a frequency response, within 3db, from d-c to over 100 megacycles. Sweep speeds as fast as 100 inches per microsecond will be observed on the Type 5XP– Cathode-ray Tube.

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DUMONT *for Oscillography*

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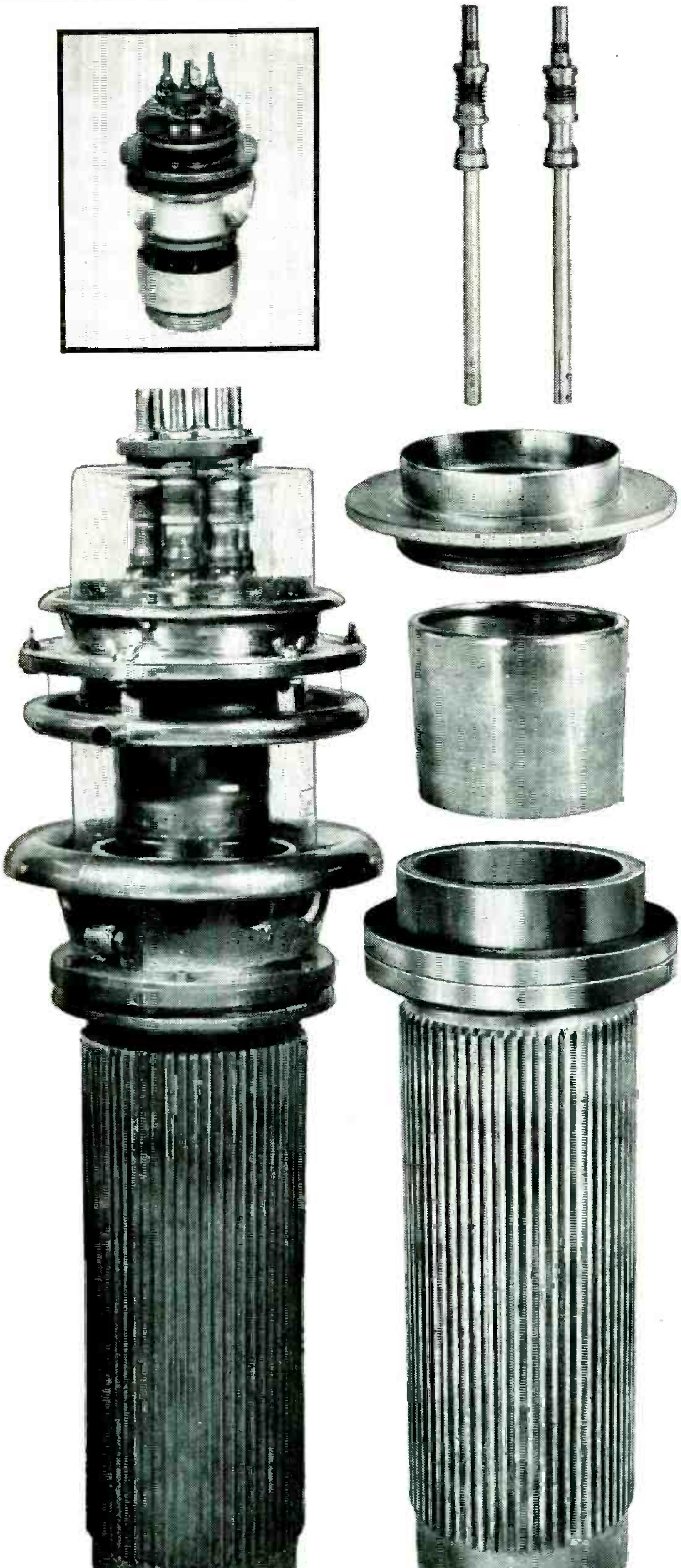

(Top left) 4½" high vacuum triode. All copper parts of Revere OFHC Copper. (Bottom left) Country's most powerful high frequency transmitting tube; 34⅝" high. (Above right) Parts of large tube that are made of Revere OFHC Copper: Anode, Anode Shield, Grid Ring with glass bead omitted from top edge, and 2 of the 6 filament terminals with which tube is equipped.

NATION'S MOST POWERFUL Transmitting Tube

made with OFHC COPPER *supplied by* REVERE

OFHC Copper also used by Federal Telephone and Radio Corporation in its 4½" Triode with maximum rating of 600 MC.

THE large tube which you see at left stands 34⅝" high and is the most powerful high frequency transmitting tube in commercial use today. Two of these tubes used in the radio station operated by the State Department make it one of the most powerful short wave transmitters in the country. That these tubes have been in constant use for more than 4 years is a tribute to the ingenuity of their makers and the quality of the materials used in their construction.

These transmitting tubes operate up to 22 MC. delivering 200 kw at that frequency. An unusual feature of construction is the water-cooled anode which is 19" long and is made from Revere 6" copper tubing with ½" wall, fluted for more efficient heat dissipation and tapered to paper thinness where it is sealed to the glass. Bottom of anode is drawn OFHC Revere Copper silver brazed to the OFHC Revere Copper tubing.

The small 4½" high vacuum triode shown in the upper left corner is used as a power amplifier or oscillator and is the only tube of its size that can handle up to 600 MC per second. It will deliver up to 750 watts. Anodes used on both these tubes are Revere Copper.

In this application, where the copper must be free from oxygen to protect the vacuum and must have the ability to expand and contract with the glass to which it is sealed as temperatures change, without altering the characteristics of the metal, only OFHC copper can be used. It is because of the importance of the purity of OFHC copper that Revere is most meticulous in segregating it in processing. Each lot and shipment is kept separate and conducted personally through the mill.

In addition to utmost care in manufacture of copper, brass and its alloys, Revere also offers you the benefits of its Technical Advisory Service. Many manufacturers of materials used in electronics have found this service useful in helping them iron the kinks out of their manufacturing difficulties, so it is entirely possible this Revere service can be of help to you. Why not call us in and see?

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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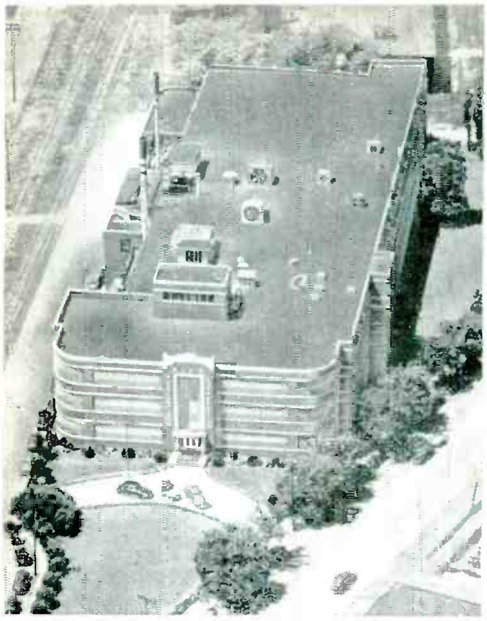
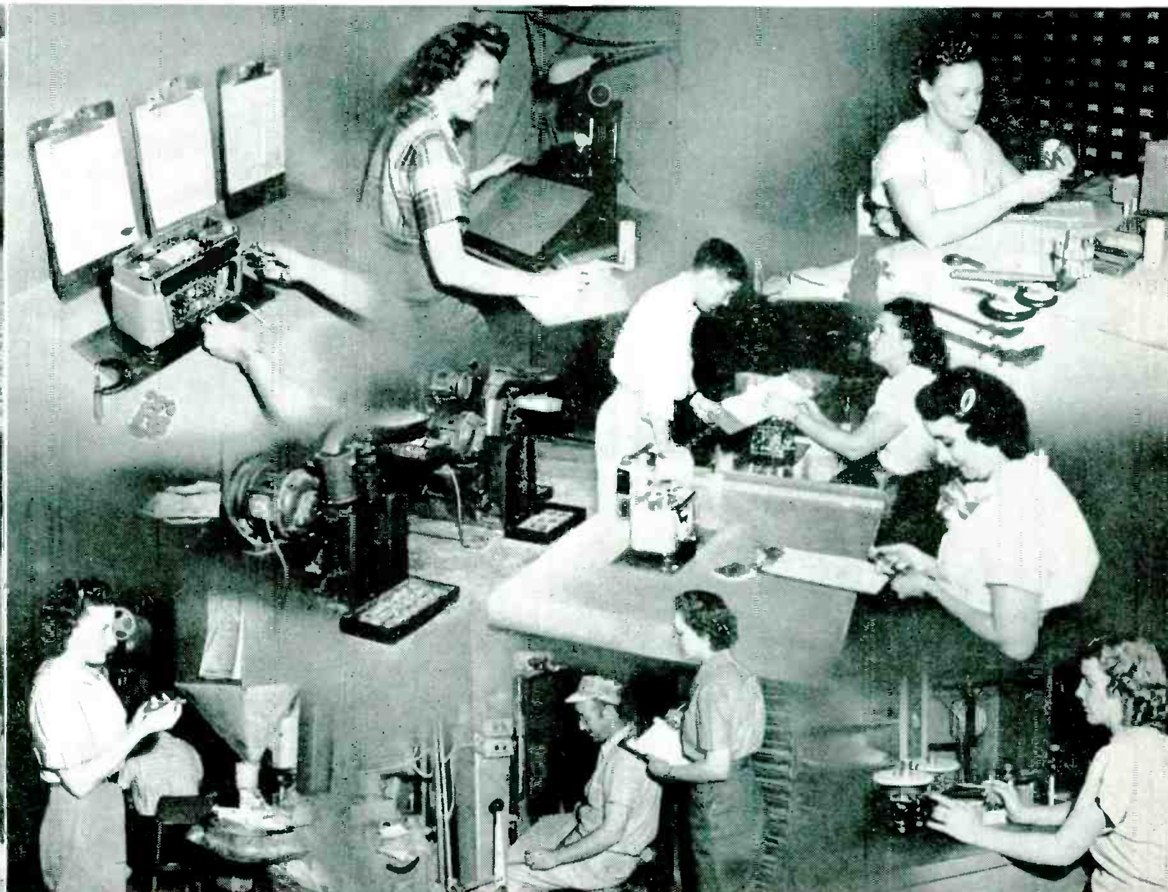
• • •

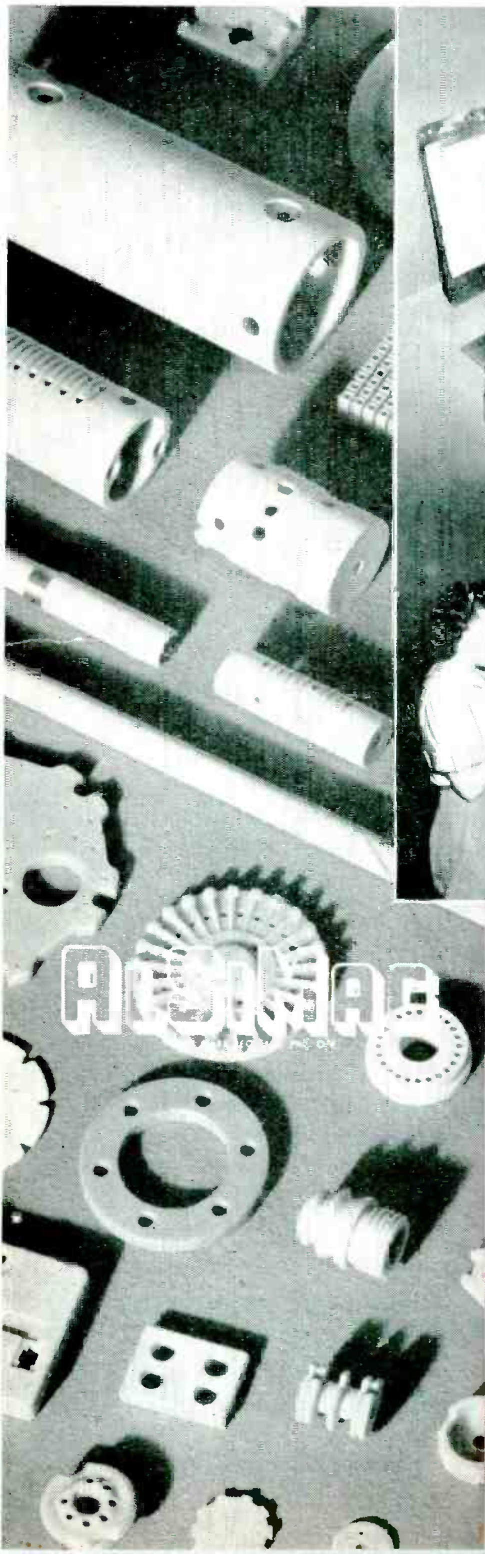
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.



quality control

At every production step, American Lava Corporation makes periodic checks to assure exact compliance with all specifications.





Savings in both time and cost result by preventing sub-standard production. Quality is maintained. Delivery schedules are adhered to more closely. Cost savings permit lower prices.

The well developed system of quality control at the American Lava Corporation is another reason why it is known as Headquarters for quality production of Custom Made Technical Ceramics.

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Announcing -hp- PRECISION EQUIPMENT

...THE BASIC TOOLS YOU

-hp- 608A VHF SIGNAL GENERATOR

SPECIFICATIONS

FREQUENCY RANGE: 10 to 500 mc in 5 bands.
ACCURACY: Calibration ±1%. Re-setability better than 1 mc, at high frequencies. Total scale length approx. 90″.

OUTPUT: 0.1 μv to 1.0 v. continuously variable. Calibrated in volts and dbm.
IMPEDANCE: 50 Ω. Maximum VSWR 1.2.
ACCURACY: ±1 db entire range.

MODULATION:
AMPLITUDE: From 0 to 90% indicated by front panel meter.
ENVELOPE DISTORTION: 1% at 30% modulation.
INTERNAL: Fixed modulation at 400 and 1,000 cps.
EXTERNAL: Any frequency 50 cps to 1 mc. 4.0 v. input.
EXTERNAL PULSE: Positive or negative, 4 v. peak. Good pulse shape. Square wave to 1 μsec length.

LEAKAGE: Less than 1 μv.

RESIDUAL FM: Not over .0025% at 90% modulation.

POWER: 115/230 v. 50/60 cps. 150 watts.

SIZE: 12″ x 14″ x 18″ deep. -*hp*- grey finish. Cabinet mounting.

PRICE: $850.00 f.o.b. Palo Alto.

Data Subject to Change Without Notice

A NEW VHF SIGNAL GENERATOR

10 to 500 mc

High power output...Constant internal impedance...Wide frequency range...Broad modulation capabilities...Master oscillator power amplifier circuit...Microsecond pulses ...Small residual FM...CW, AM or pulsed output

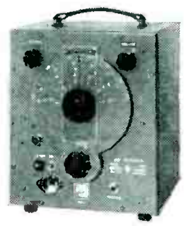
Here is a new general purpose laboratory generator of broadest application. It offers a directly calibrated output from 0.1 μv. to 1 v. for measuring gain, selectivity, sensitivity or image rejection of receivers, I-F amplifiers, broad band amplifiers and other VHF equipment. The 1 v. output (to a 50 ohm load) is available throughout the entire frequency range for driving bridges, slotted lines, antennas, filter networks, etc. The output circuit is directly calibrated in volts and dbm for fast reading. No charts are necessary.

DIRECT CALIBRATION

Frequencies from 10 to 500 mc are covered in 5 bands, and calibrated directly in mc on a drum-type dial having effective scale length of 90″. The single-dial, ball-bearing frequency control insures maximum convenience and accuracy in tuning and re-setting.

Master oscillator and power amplifier circuits are enclosed in a heavy cast aluminum shield, insuring high stability and low electrical leakage.

NEW -*hp*- 417A VHF DETECTOR



This new -*hp*- instrument is a super-regenerative (AM) receiver covering all frequencies between 10 and 500 mc. in 5 bands. It is designed for use with the -*hp*- 803A VHF Bridge. It offers 5 μv sensitivity over entire band, quick, easy operation, and a direct-reading frequency control. The instrument is thoroughly shielded, and is suitable for general laboratory use; for making approximate frequency checks, determining noise, interference, etc. Price $200.00 f.o.b. Palo Alto.

HEWLETT -hp- PACKARD

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FOR THE *10 to 500 mc* BAND!

ASKED US FOR!

A NEW VHF BRIDGE

50 to 500 mc

First commercial VHF bridge...Based on an entirely new principle...Direct impedance readings, 2 to 2,000 ohms...Wide phase angle ...Useful to 1,000 mc...Makes every kind of VHF impedance measurement

The new *-hp-* 803A VHF Bridge is the first commercial instrument built to give you fast, direct impedance readings in the 50-to-500 mc band. It can be used for any type of VHF impedance measurement. This includes characteristics of transmission lines, antennas, resistors, rf chokes and condensers; impedance of connectors, standing wave ratios; percentage of reflected power, VHF system flatness, etc.

BROAD FREQUENCY RANGE

The Model 803A operates on an entirely new principle suggested by Mr. John Byrne of the Airborne Instrument Laboratories.* It determines impedance by sampling the magnetic and electric fields of a transmission line. Phase is measured by determining the point of cancellation of these samples along a second transmission line. This method effectively overcomes the narrow frequency limitations of conventional bridges, and permits the new *-hp-* VHF bridge to make readings at frequencies up to 1,000 mc and down to 5 mc.

**A complete description of this principle and its application in the* -hp- *VHF Bridge will appear in an early issue of the* -hp- *Journal. Free copy on request.*

SEE THESE & 5 OTHER NEW -hp- INSTRUMENTS

I. R. E. SHOW — *BOOTHS 40, 41*

HEWLETT-PACKARD COMPANY

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Export: FRAZAR & HANSEN, Ltd., 301 Clay Street, San Francisco, Calif., U. S. A. **Offices:** New York, N. Y. and Los Angeles, California

***-hp-* 803A VHF BRIDGE**

SPECIFICATIONS

MEASUREMENT RANGE: Impedance magnitude, 2 to 2,000Ω. (Higher and lower values may be measured by using a known length of transmission line as an impedance transformer.)
Phase angle from −90° to +90° at 50 mc and above.

CALIBRATION: Impedance: Directly in ohms.
Phase angle: Directly in degrees at 100 mc. May be readily computed at other frequencies.
[θ (actual) = θ (read) x Frequency, mc/100.]

ACCURACY: Impedance magnitude, approx. ±5%.
Phase angle, approx. ±3 degrees (over range 50 to 500 mc).

FREQUENCY RANGE: Maximum accuracy 50 to 500 mc. Useful down to 5 mc and up to 1,000 mc. Maximum measurable phase angle at 5 mc is −9° to +9°.

EXTERNAL rf GENERATOR: Requires an AM signal source of at least 1 mw. High signal level is desirable. (*-hp-* Model 608A VHF Signal Generator is ideal for this purpose.)

rf DETECTOR: Requires a well-shielded VHF receiver of good sensitivity. (*-hp-* Model 417A VHF Detector is designed for this use.)

SIZE: 14" x 14" x 8" deep. Smooth *-hp-* grey finish.
Cabinet mounting.

PRICE: $495.00 f.o.b. Palo Alto.

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HEWLETT *hp* PACKARD

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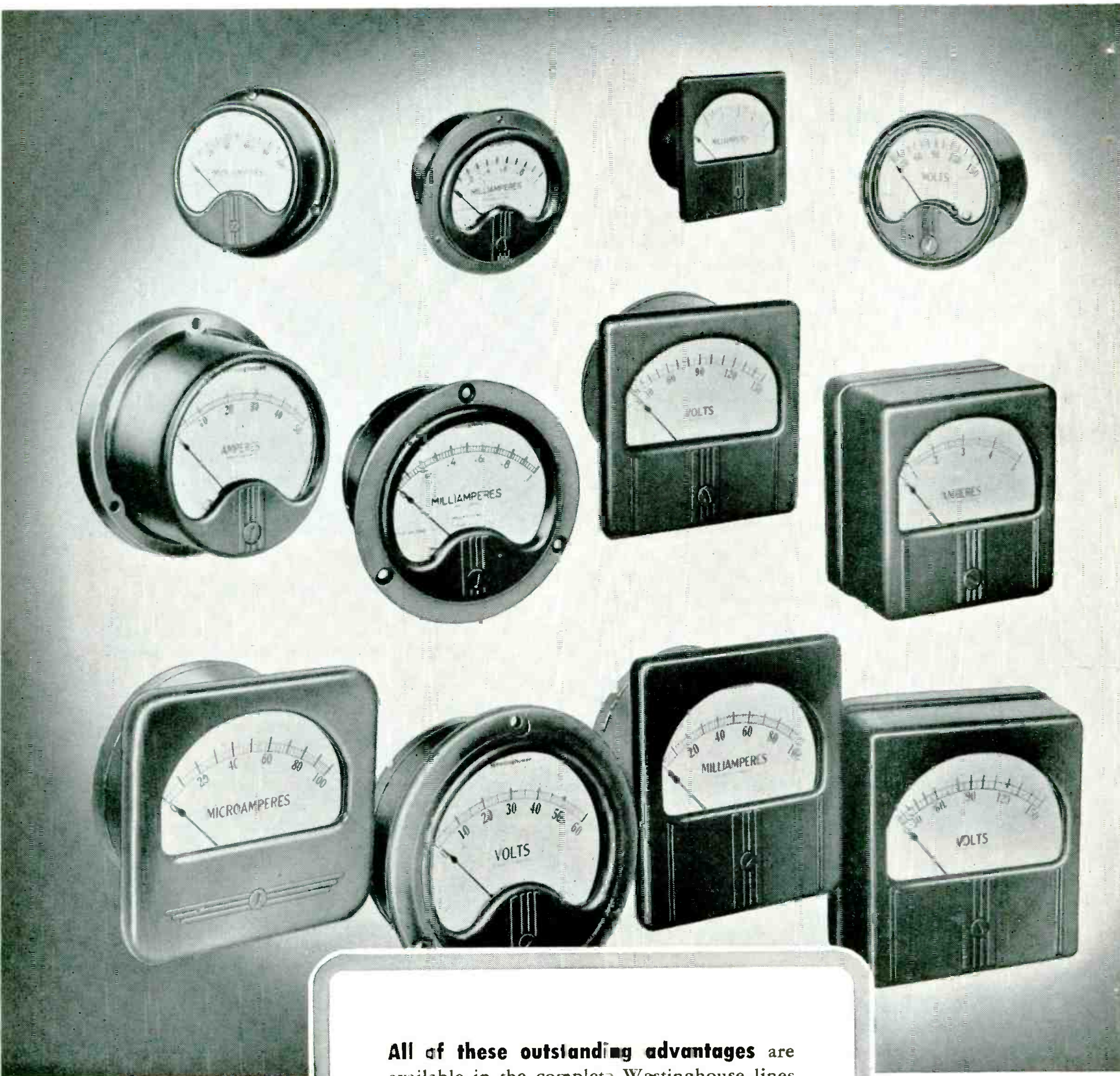
YOU CAN BE **SURE**.. IF IT'S

Westinghouse



All of these outstanding advantages are available in the complete Westinghouse lines of switchboard and portable instruments. Ask your nearest Westinghouse Representative. Write for Catalog Sections 43-200 and 43-100.

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Slash Instrument Inventory!

★ **The most complete line**

★ **Meets A.S.A. standards**

★ **Shipments in 10 days**

Cut overhead on your panel instruments. Maintain production without costly stocks.

Westinghouse now offers the most complete line of panel instruments in the industry . . . every one built to the rigid standards of "The American Standards Association". For emergencies, shipment can be made to meet every electrical requirement within ten days of receipt of order at the factory.

Westinghouse Instrument Specialists are ready to help you plan. These men have nationwide experience in solving instrument application problems of all kinds. Phone, write or wire your nearest Westinghouse Representative, ask for C.S. 43-300, for more information on panel instruments. Westinghouse Electric Corporation, 95 Orange Street, Newark, New Jersey.

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Specify Westinghouse and be SURE of all three

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Insulation Cements for Electric Heaters

ZIRCON meets these five basic requirements

1. Easy application.
2. Refractoriness.
3. Current leakage minimized at operating wattage under humid conditions or under an externally applied stress voltage.
4. Stability of insulation and structure through a 1000 hour-life test.
5. Reasonable cost.

TYPICAL CHARACTERISTICS

(The results shown apply to a particular structure for cement applied in a specific manner. Any variation may alter results.)

Type of Cement	A	A	B	C
ASSEMBLY METHOD	Dry Press Flat Iron	Strip Heaters	Mud Cast Range Element	Dry Press Flat Iron
OPERATING LEAKAGE	0.002 M.A.	0.002 M.A.	0.02 M.A.	0.02 M.A.
HUMIDIFICATION LEAKAGE	0.2 M.A.	—	<0.5 M.A.	0.03 M.A.
RETURN TO NORMAL*	15 to 30 sec.	—	10 to 15 sec.	—

*After current is turned on.

Performance of Zircon insulation cements indicates an outstanding group of compositions, both electrically and ceramically. Our trained field engineers will be glad to bring you detailed information on individual characteristics and applications. Write us. No obligation.

TAM PRODUCTS
Registered U. S. Pat. Off.

TAM is a registered trademark.

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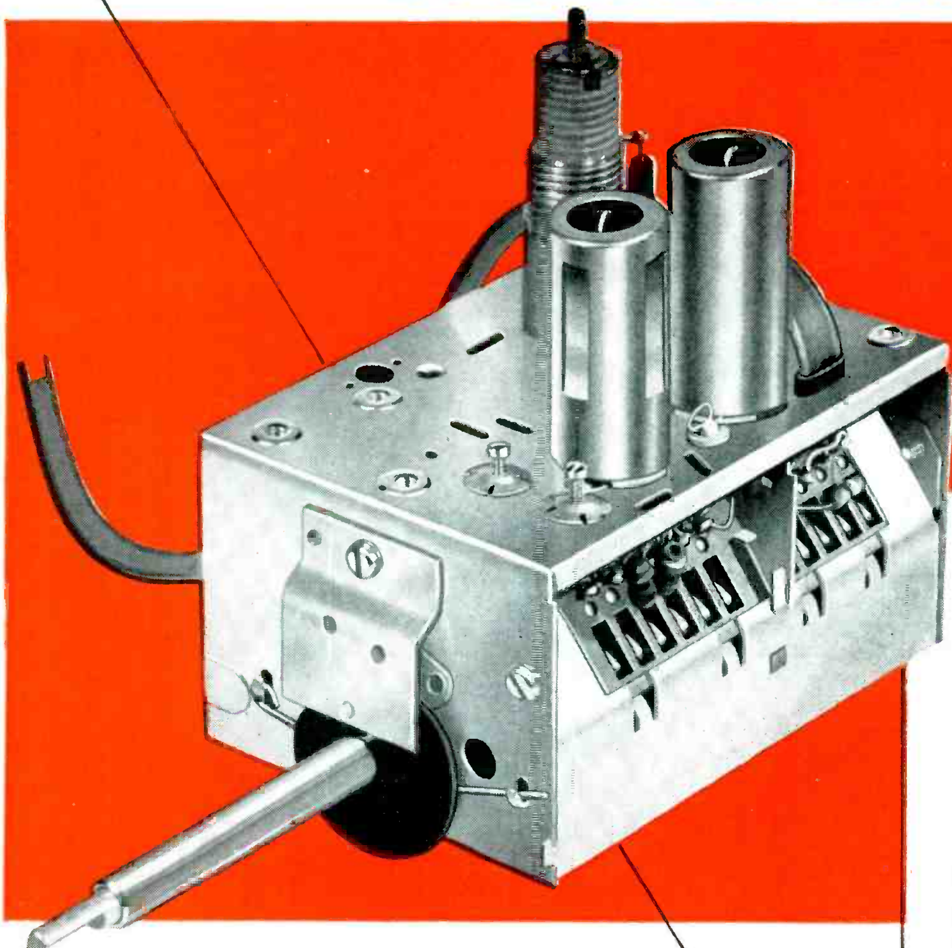
QUALITY PROVEN A MILLION TIMES



OVER **1,000,000**

STANDARD TUNERS ARE NOW OPERATING IN OVER A MILLION OUTSTANDING TV SETS

More than one million TV sets produced to date incorporate "The Standard Tuner". These are the sets the consuming public will want and buy. The Standard Tuner's superior performance brings added brilliance and sparkle to the picture. Gives your TV sets that additional sales feature.

"The Standard Tuner." The outstanding front end tuning assembly that an ever-increasing number of TV engineers are specifying. It covers all 12 channels . . . gives higher sensitivity . . . quick interchanging of channel inductors . . . adaptable to U.H.F.

GOOD NEWS FOR SERVICE MEN
"The Standard Tuner" is now available to you as a replacement unit. See your jobber for details.

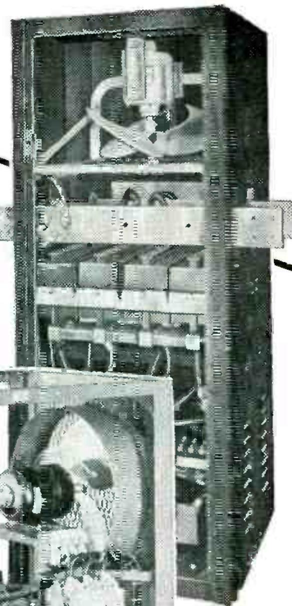
Standard COIL PRODUCTS CO., INC.
CHICAGO • LOS ANGELES • BANGOR, MICH.

They "Stack Up" For Heavy Industrial Use!

Seletron

Reg. Trade Mark

SELENIUM RECTIFIERS

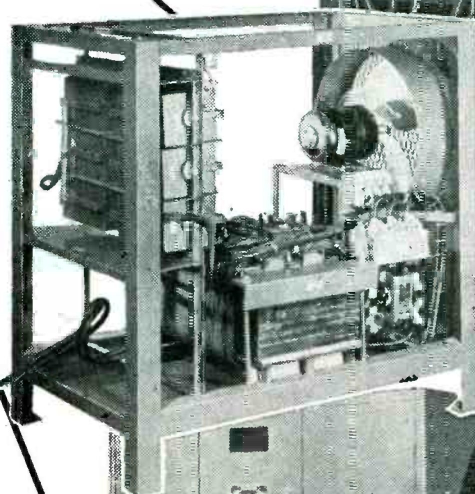


OUTPUT: 1000 Amp., 9V. Fan Cooled. 24''x24''x66''

POWER PACKS using Seletron Selenium Rectifiers range in output all the way up to 75 KW — They aren't made just in the "dainty" sizes also available for radio and television. The rugged, high powered Seletron Rectifiers are ideal for diversified industrial applications because of their flexibility and high efficiency over a wide range of load.

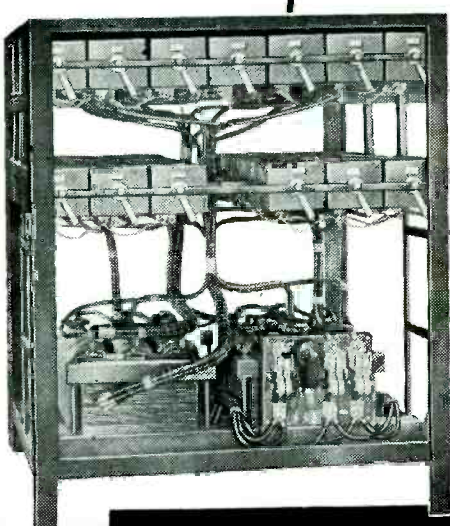
Pictured are a few applications for industry as developed by Seletron users. Clockwise from top right: Power Packs for electroplating and similar processes; for general industrial use; and elevator operation.

How about *your* rectification problems? Seletron engineers will be glad to discuss them with you. Write Dept. ES-27

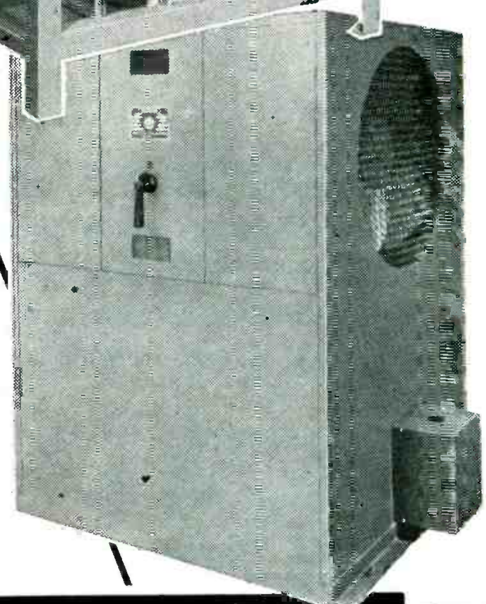


OUTPUT: 25 KW, 230V. Fan Cooled. 24''x4'x48''

OUTPUT: 45 KW, 220V. Convection Cooled. 3½'x4½'x2½'



Let us send you our bulletin. It includes interesting technical data regarding the use of selenium rectifiers.



OUTPUT: 75 KW, 230V. Fan Cooled. 6'4''x5'10''x4'7''

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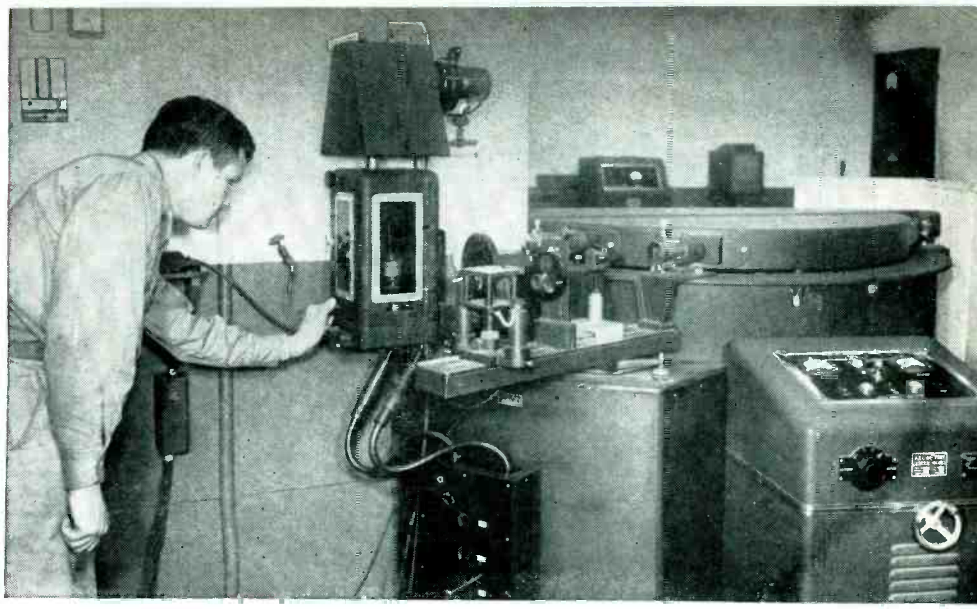
Only the **BEST** pass these tests



The spectrograph provides one of the most efficient means for precise metallurgical control. Samples taken from a heat in the Driver-Harris melting furnaces are analyzed so rapidly by means of this apparatus, that a complete analysis can be obtained before the next heat is ready for pouring. Thus any necessary adjustments can be made immediately—an outstanding advantage in controlling the constituent elements of alloys being produced to extremely close specifications. The operator is here seen adjusting the size of the analytical gap in the arc-spark stand of the Driver-Harris grating spectrograph at the start of an exposure.

The quality of any manufactured item depends upon a number of factors, but on none so much as "inspection". And here, at Driver-Harris, we give top priority to inspection.

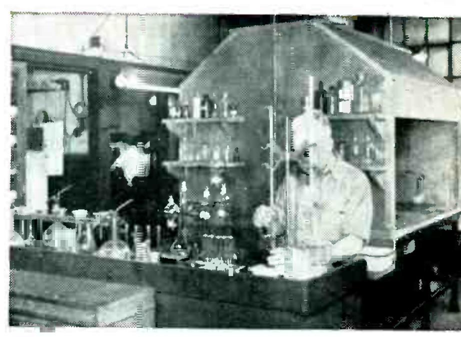
Through every stage of manufacture, precise metallurgical checks and controls are systematically applied to D-H Alloys to insure quality and uniformity that are unsurpassed—recognized the world over.

We have had 50 years' experience in continuous alloy research and manufacture. Every piece of D-H wire, ribbon or strip, and every casting embodies advantages such as only half a century of accumulated know-how can provide.

Whatever your requirements for electrical resistance and heat-resisting alloys, send us your specifications. We shall be glad to make recommendations, and supply you with the alloy best suited to your needs.

This operator is viewing the projection of a series of spectrograms, and is about to measure the intensity of specific spectral lines to determine the quantity of certain chemical elements in the samples being analyzed.

The research metallograph, the ultimate in metallurgical microscopes, is applied to both research and quality control at Driver-Harris.



A view in the Driver-Harris chemical laboratory—fully equipped for all standard types of volumetric, gravimetric and colorimetric analyses.

FIFTIETH ANNIVERSARY
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Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

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"His receiver or equipment will have a Dependable Stout Heart"

The core is the heart of the circuit — in radio, TV, short wave, FM, radar and in many forms of telephonic apparatus. The dependable, stout heart can only be built with the finest materials available.

Stackpole Carbon Company has unparalleled experience in the manufacture of quality powdered iron cores. They know — and the firms they serve know — the all-importance of minimizing fading and drifting. They know that a core made with a G A & F Carbonyl Iron Powder represents the one surest safeguard.

Stackpole Carbon Company knows — and the firms they serve know — that the *gains* thus made are all but doubled by the *savings* which also occur — automatically. If you can cut down the space and the weight in your receiver or equipment, if you can make a substantial savings in wire, why specify any core material except G A & F Carbonyl Iron Powders?

We invite you to send for the free booklet described below. We invite you to call upon our highly specialized research facilities for any help we can logically render. We also invite you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance of the equipment you manufacture. It will cost you nothing to get all the facts.

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Dept. 14.

These unique properties tell why G A & F Carbonyl Iron Powders are superior:

PROPERTY	ADVANTAGE
Spherical structure	Facilitates insulation and compacting
Concentric shell structure (some types only)	Low eddy current losses
High iron content	Exceptional permeability and compressibility
Absence of non-ferrous metals	Absence of corresponding disturbing influences
Relative absence of internal stress; regular crystal structure	Low hysteresis loss
Spheres of small size	Low eddy current losses; usable for high frequencies
Variations of sphere size	Extremely close packing

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G A & F® Carbonyl

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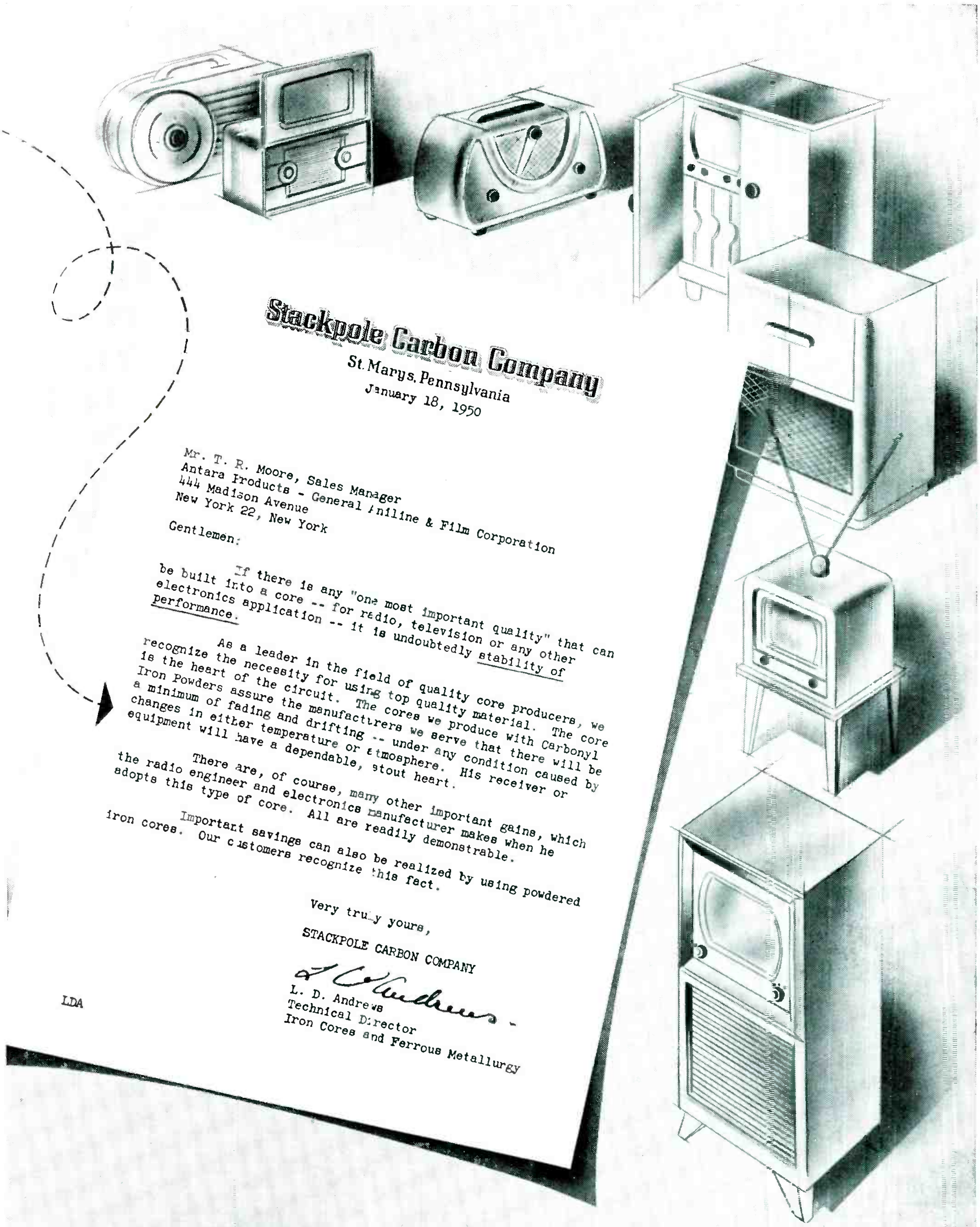

Stackpole Carbon Company
St. Marys, Pennsylvania
January 18, 1950

Mr. T. R. Moore, Sales Manager
Antara Products - General Aniline & Film Corporation
444 Madison Avenue
New York 22, New York

Gentlemen:

If there is any "one most important quality" that can be built into a core -- for radio, television or any other electronics application -- it is undoubtedly stability of performance.

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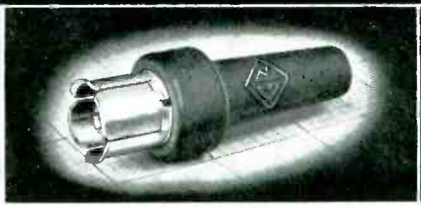
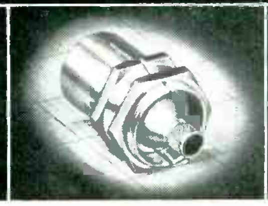
These coaxial elements, each simple in itself, can be combined easily and quickly into many different measurement set-ups. A relatively small investment in these versatile parts provides equipment for most U.H.F. measurement problems. Characteristic impedance is 50 ohms wherever possible, and the Universal **Type 874** Coaxial Connector is used throughout.

FOUNDATION ELEMENTS

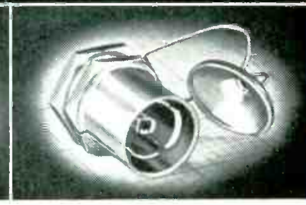
874-B BASIC CONNECTOR — $1.50
For use on rigid 50-ohm, air-dielectric coaxial lines



874-C CABLE CONNECTOR — $2.00
For use on G-R Type 874-A2 Polyethylene Cable
874-C8 CABLE CONNECTOR — $2.00. For use on Army-Navy Type RG-8/U Cable

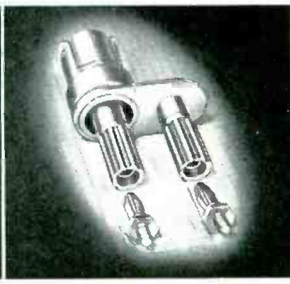


874-P PANEL CONNECTOR — $2.25. For use on panels. Rear end fits Type 874-A2 Cable
874-P8 PANEL CONNECTORS—$2.25 For use on panels. Rear end fits Army-Navy Type RG-8/U Cable

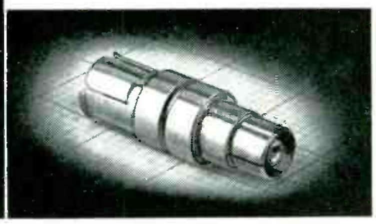


874-PC PANEL CONNECTOR WITH CAP — $2.75. For use on panels. Hinged cap shields connector when not in use. Rear end fits Type 874-A2 Cable. **874-PC8 PANEL CONNECTOR WITH CAP —** $2.75. Same as 874-PC except rear end fits Army-Navy Type RG-8/U Cable

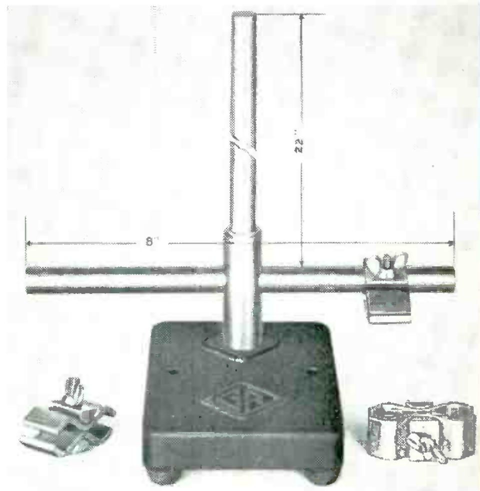
874-Q1 ADAPTER TO TYPE N — $6.00. Plugs into Army-Navy Type UG-22/U and similar jack-type connectors

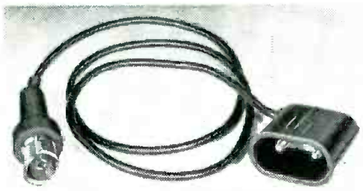


874-Q2 ADAPTER TO G-R TYPE 274 — $5.00. Makes output of a coaxial system available at pair of ¾-inch-spaced binding posts or banana plugs



874-Q7 ADAPTER TO G-R TYPE 774 — $5.00. Plugs into any G-R Type 774 Connector





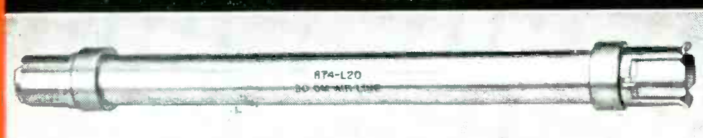
874-R20 PATCH CORD — $8.00. Three feet of Type 874-A2 Polyethylene Cable with a Type 874-C Connector on each end
874-A2 POLYETHYLENE CABLE — $0.50/ft., $27.00/100 ft. Bulk cable — characteristic impedance of 50 ohms ±5% —double-shielded — good mechanical flexibility

874-R31 PATCH CORD — $4.50. Three-foot, flexible coaxial cable terminated with Type 874 Connector and phone tips

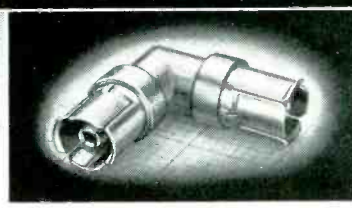
874-R32 PATCH CORD — $5.25. Similar to Type 874-R31, with a Type 274-ND Shielded Plug in place of phone tips

874-Z STAND — $12.50. To support the parts of a wide variety of coaxial systems — heavy bronze base — 22-inch vertical and 8-inch horizontal brass rods — three universal clamps — no rust or corrosion

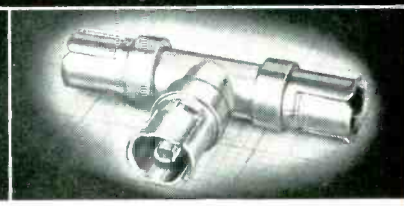
FIXED AND ADJUSTABLE LINE ELEMENTS



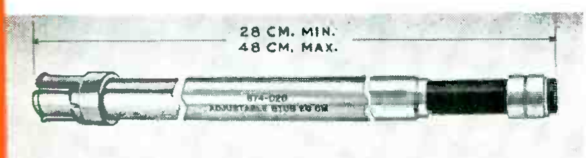
874-L10 50-OHM AIR LINE (10 CM) — $10.00
874-L20 50-OHM AIR LINE (20 CM) (*illustrated*) **— $11.00**
874-L30 50-OHM AIR LINE (30 CM) — $12.00
To space stubs or other elements of a coaxial system



874-EL 90-DEGREE ELL — $6.50

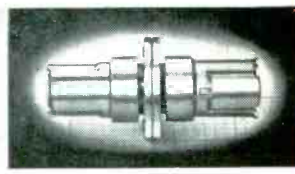


874-T TEE — $8.50



874-D20 ADJUSTABLE STUB (20 CM) — $15.00
874-D50 ADJUSTABLE STUB (50 CM) — $16.00
For matching or tuning, and use as reactive elements. Coaxial lines with sliding short circuit moved by bakelite tube. Reference marker facilitates use as wavemeter with scale

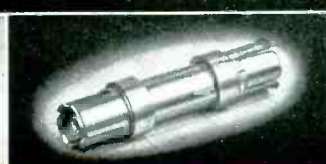
874-LA ADJUSTABLE LINE (Line Stretcher) **— $18.00**
Telescoping line — length change: 25 cm



874-JR ROTARY JOINT — $8.50

FILTERS

874-F500 500-MC LOW-PASS FILTER — $22.50
874-F1000 1000-MC LOW-PASS FILTER (*illustrated*) $22.50
Used to improve accuracy by reducing harmonics from U.H.F. generators



874-K COUPLING CAPACITOR — $12.00
Short coaxial line with 0.005 microfarad capacitor in series with inner conductor — transmits h.f., blocks d.c.

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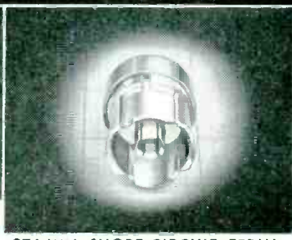
TERMINATIONS

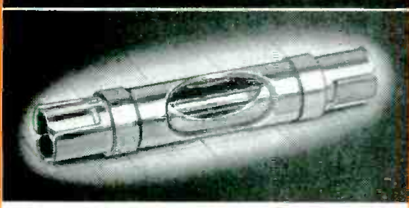
874-WM 50-OHM TERMINATION — $8.00. Provides good impedance match from D.C. to several thousand megacycles. SWR less than 0.6 db up to 2,000 Mc, 1.0 db up to 4,000 Mc



874-WN SHORT-CIRCUIT TERMINATION — $3.50. A fixed shorting strap mounted in a connector

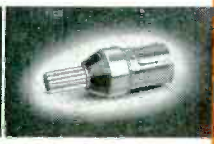
874-WO OPEN-CIRCUIT TERMINATION — $3.00. A shielding cap for open-circuited lines

COUPLING ELEMENTS



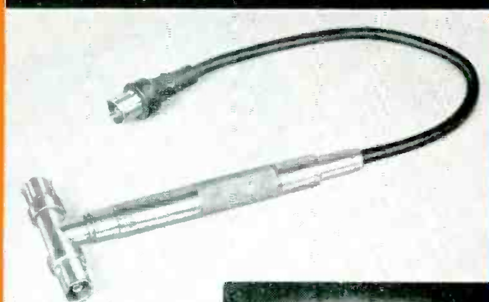
874-LR RADIATING LINE — $12.00. Short coaxial line with hole in outer conductor that can be partially or completely covered by a rotatable sleeve — for coupling to external wavemeter or heterodyne frequency meter

874-MA ADJUSTABLE COUPLING LOOP — $7.50. One-turn loop on coaxial line — collet supplied for panel mounting

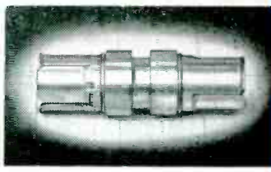


874-MB COUPLING PROBE — $5.00. Binding post, acting as a probe, mounted on connector

ATTENUATORS

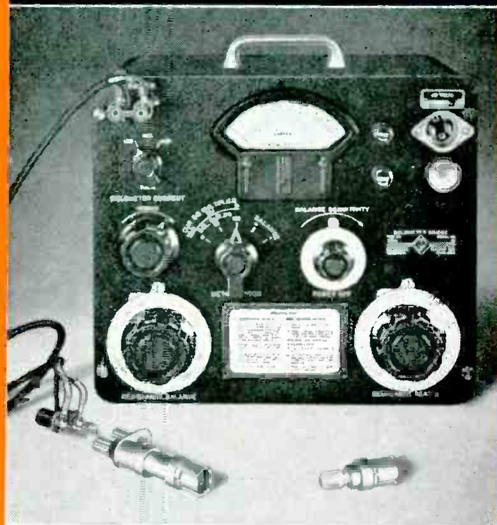


874-GA ADJUSTABLE ATTENUATOR — $55.00. Mutual-inductance (wave-guide-below-cutoff) type attenuator — attenuation is adjusted by turning sleeve — micrometer-type indication — direct reading in db



874-GF FIXED ATTENUATOR (20 DB PAD) — $18.00. Pi-type resistance attenuator for frequencies from dc to several thousand megacycles

POWER MEASURING EQUIPMENT



1651-A BOLOMETER BRIDGE. For conveniently measuring h-f power by either d-c substitution or direct-reading method with the following three bolometer units:

874-H25* THERMISTOR UNIT (25 MW) — $40.00

874-H100* THERMISTOR UNIT (100 MW) — $40.00
Thermistors in coaxial holders with by-pass condenser — useful from 5Mc to several thousand Mc

874-HF* FUSE BOLOMETER HOLDER — $34.00
Similar to thermistor units, but for fuse bolometers —fuse assortment supplied

**External appearance of all three similar — illustrated at lower left*

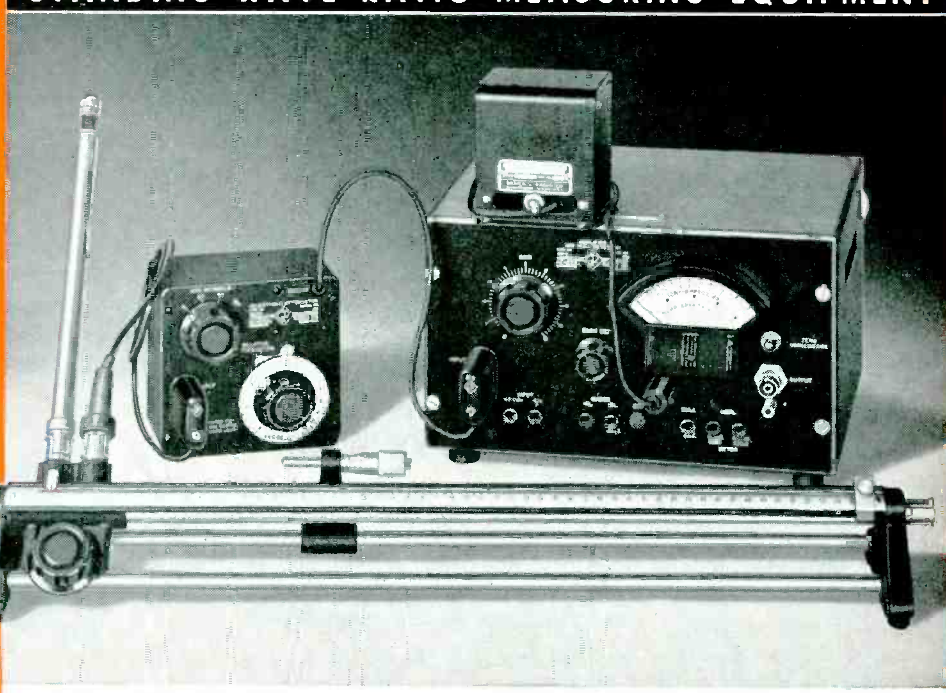
874-WL LAMP TERMINATION — $5.00. Flashlight bulb for rough power indication — 50 to 100 mw *(lower right in photo)*

VOLTAGE MEASURING EQUIPMENT

874-VR VOLTMETER RECTIFIER — $25.00. Crystal rectifier across short coaxial line — useful frequency range 15 Mc to 2,500 Mc — resistor in series with inner conductor provides 50-ohm source impedance — also useful as detector *(illustrated at bottom)*

874-VI VOLTMETER INDICATOR — $65.00. Crystal current indicator and calibrator for Type 874-VR Voltmeter Rectifier. Range: 0.1 to 2 volts — regulated 60-cycle calibration voltage

STANDING-WAVE RATIO MEASURING EQUIPMENT



874-LB SLOTTED LINE — $220. For measurements of standing-wave ratio and impedance — 300 to 5,000 Mc — variations in probe coupling along line less than ± 2½ per cent — unique simplicity of design — detector: crystal rectifier supplied, or suitable receiver — (Type 874-D20 Adjustable Stub shown in illustration plugged into slotted line tunes crystal) — slow-motion drive readily disengaged for free sliding

874-LV MICROMETER VERNIER ATTACHMENT — $30.00. For measurement of high standing-wave ratios by the "width-of-minimum" method

1231-B AMPLIFIER AND STANDING-WAVE INDICATOR — $210.00. Amplifies and indicates slotted-line crystal detector output in db

1231-P4 ADJUSTABLE ATTENUATOR — $52.50. For increasing the range and accuracy of standing-wave measurements with Type 1231-B Amplifier

1231-P2 TUNED CIRCUIT — $20.00. 400- or 1000-cycle filter; frequency selected by switch

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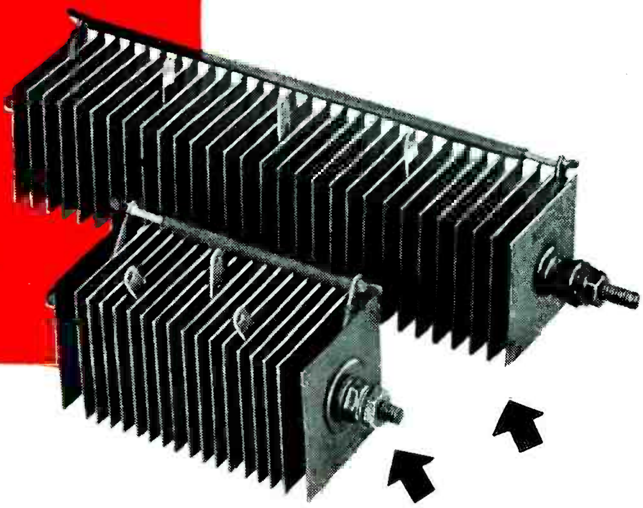

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- **SPACE SAVING**... More design freedom resulting from greatly reduced size of the rectifier unit.
- **GREATER VERSATILITY**... New fields of application are opened through the inherent advantages of lower cost, efficiency and compactness.

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1950 . . .
Our Industrial Machine Is Running Down

In his recent Economic Report to Congress President Truman chalked up a constructive advance in his economic reasoning. He pointed out that if we are going to attain the worth-while goal of a $300 billion national income in the next five years, we must equip ourselves with more and better industrial tools. Of all the dynamic forces of expansion in America, he said, one of the most important is business investment.

That is fine. It is basic common sense. We have been saying that for years and we are glad to hear the President say it too.

But having hit this new high in his economic reasoning, the President failed to draw the right conclusion. He made the mistake of accepting the false conclusion that there is no shortage of business funds to pay for more and better industrial tools. "There are immense opportunities for business investment in nearly every segment of the economy," the President said, and further, "there are in general sufficient funds available to businessmen who want to seize these opportunities."

That just is not so – and the lack is not only serious; it can well be fatal.

It is a matter of the most urgent national importance that the President's recognition of the need of more and better industrial tools should be followed by effective action. *That calls for changes in the national policies that are now blocking and, unless changed, will increasingly block business from meeting this need. If business cannot get enough new tools, the result will not be higher, but lower standards of living five years from now.*

The President should talk this matter of business investment over with Senator O'Mahoney, the Chairman of the Joint Congressional Committee on the Economic Report. Senator O'Mahoney would take to the discussion knowledge of the investment situation recently acquired through his conduct of a series of Congressional hearings.

If he told the President what he told the press during the course of these hearings, he would say, "the private capitalistic system is being seriously threatened by a lack of venture capital." That is in direct conflict with the President's conclusion that "there are in general sufficient funds available."

This serious shortage of adequate investment in new plant and equipment is brought forth so that all of us can understand it by McGraw-Hill's annual survey of American industry's plans for investment in new plant and equipment in 1950, which has just been completed.

continued on next page

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BUSINESS' PLANS FOR 1950

These are the major findings of the McGraw-Hill survey of "Business' Plans for New Plants and Equipment" in 1950. Made by the McGraw-Hill Department of Economics, the survey shows:

1. Industry—as represented by manufacturing, mining, transportation, and utilities—now plans to invest $12.4 billion in new plants and equipment this year. This is 13% less than was actually spent last year.

2. Manufacturing industries alone plan to spend $6.3 billion in 1950 for new facilities. This is also 13% less than they spent last year.

3. Manufacturers as a whole expect their 1950 sales volume to about equal 1949's.

4. Manufacturers will expand their capacity about 3% in 1950, under present plans. The largest part of their funds, 65%, will go to replace and modernize existing facilities.

5. Profits and reserves are expected to provide 92% of the 1950 investment funds of manufacturing companies. These companies count on new common stock issues to provide less than one-half of one per cent of the investment funds they will need.

6. Two out of three manufacturing companies review their investment plans monthly. Almost all companies go over them at least quarterly. The survey shows that companies changed plans rapidly during 1949 to meet changes in their prospects.

7. Other industries are also reducing their investment plans in 1950 by 13%. This coincidence arises from the fact that utility companies, notably the electric light and power companies, plan to spend only slightly less than in 1949. Railroads, on the other hand, are reducing their capital programs in 1950 by more than 40%.

A copy of a complete report on "Business' Plans for New Plants and Equipment" may be obtained by writing me at McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 18, N. Y.

The results of the survey, which are summarized above, show that American Industry—as represented by manufacturing, mining, transportation and utilities—is planning to spend 13 per cent less for new plant and equipment in 1950 than it did in 1949.

Since the rate of investment in new plant and equipment right now is apparently about 15 per cent below the rate for 1949, the present level of business investment may be relatively steady in 1950. That would relieve the fear, expressed by President Truman in his Economic Report, that "if the downward trend in business investment were to continue, our prospects for full recovery and continued expansion would be seriously endangered."

BUT, at the rate of investment planned by American manufacturing industry for 1950, it would take 40 years to modernize thoroughly our present industrial plant and equipment. That would still leave undone the job of increasing it to meet the needs of an expanding economy of the kind sketched by President Truman in his message.

In attaining even this rate of investment, the McGraw-Hill survey shows American business must rely overwhelmingly on its own profits, which have declined as the country has left the postwar boom behind it. Most American companies cannot sell new common stock except at ruinously low prices. Here is one case where government action is really needed to help business and help to keep a rising American standard of living.

In order to get enough business investment to assure the "full recovery and continued expansion" sought by the President, our country needs:

1. Lower taxes on business income so as to release more money for new plant and equipment.

2. Liberalized depreciation allowances on old plant and tools so that business can buy new equipment faster.

3. Repeal of the present double taxation of dividends which now are taxed once as corporation income and again as personal income.

It is encouraging to have the President explicitly recognize the key importance of adequate business investment in providing steadily expanding prosperity. The next and most important thing to do is to make this recognition effective by discarding national policies which are blighting an adequate volume of business investment.

James H. McGraw, Jr.

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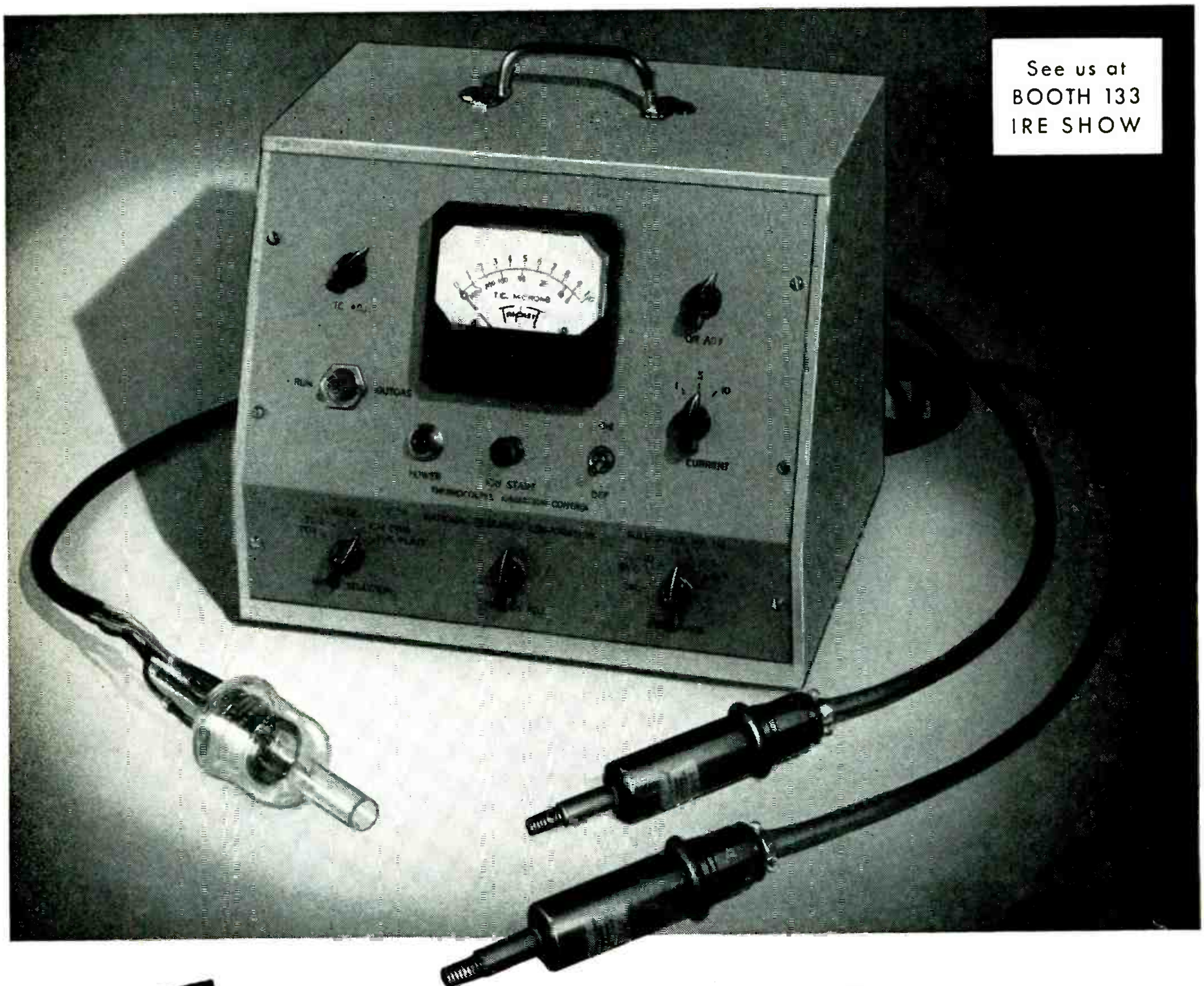

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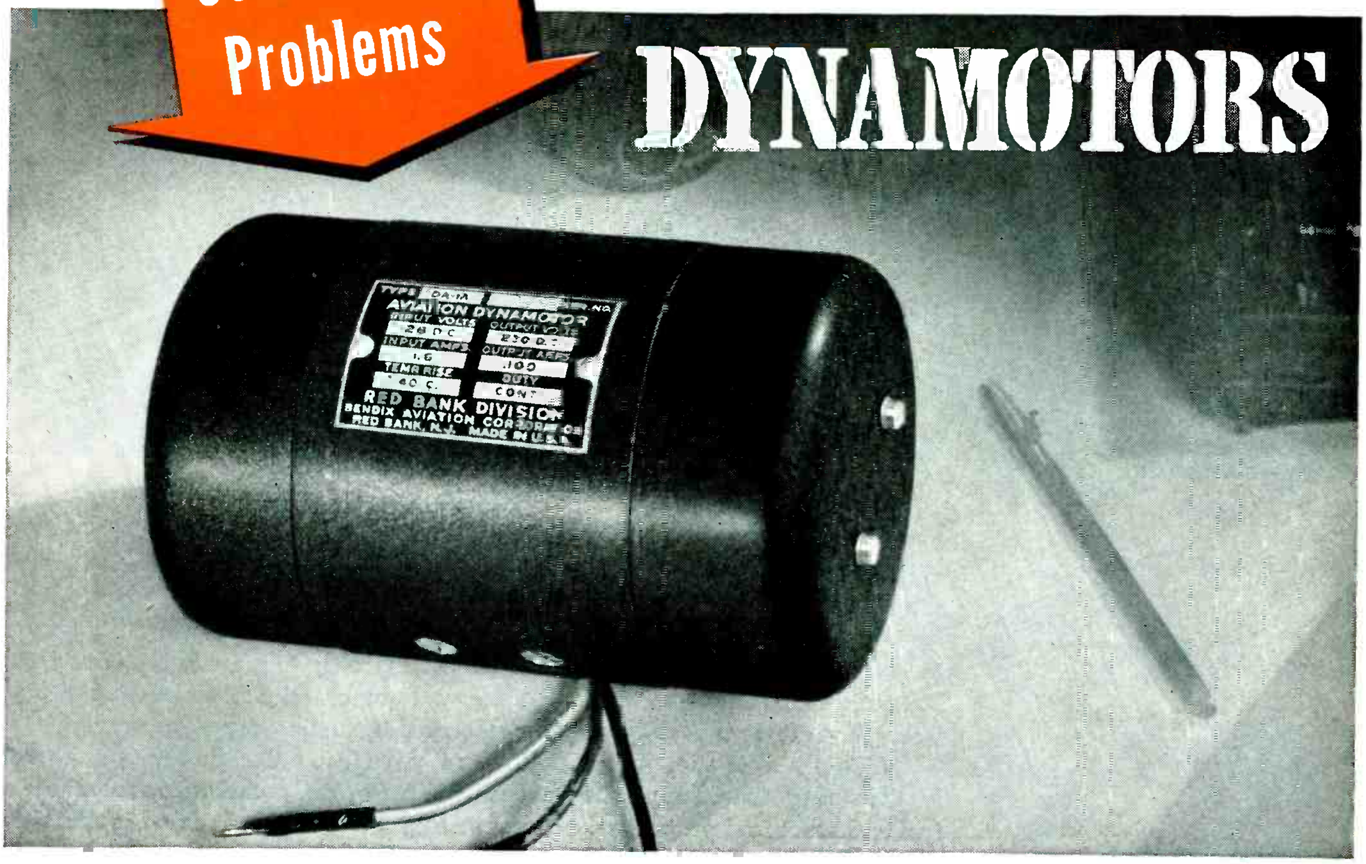

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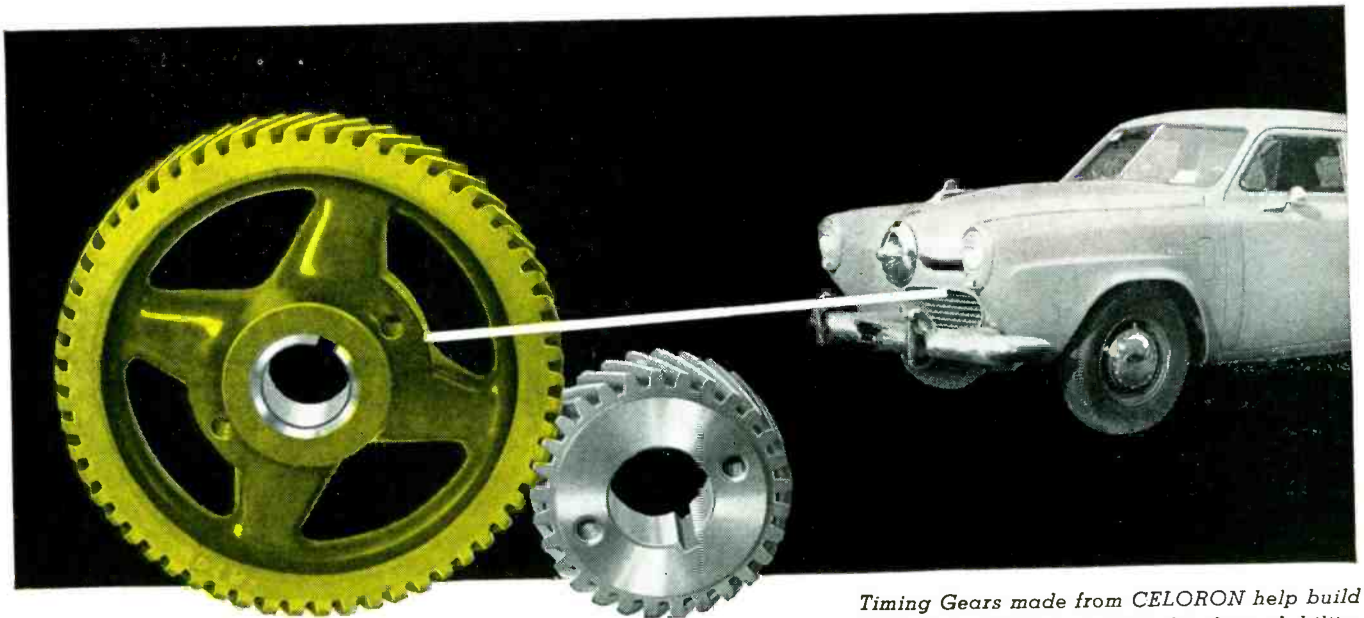
CELORON

. . . what's in it for you and your products?



Timing Gears made from CELORON help build STUDEBAKER'S reputation for dependability.

What's in CELORON for you . . . and your products? This different thermosetting plastic maintains strength and resiliency at temperatures up to 290°F. Resists oil, water and many corrosive chemicals. It is 1/6 the weight of steel—only 1/2 the weight of aluminum! Remarkably easy to machine, Continental-Diamond's CELORON gives you an unusual combination of light weight, high strength, and wear resistance *plus* electrical insulating properties.

CELORON is another example why it pays to see C-D first in your search for the right plastic. For plastics that provide *practical* combinations of mechanical and electrical properties, call your nearest C-D office. Trained technicians on hand at all times to help with your material selection problems.

CELORON—ideal for many mechanical and electrical applications

Specific Gravity	1.35	Impact Strength (Izod) (per inch of notch)	2.3 Ft. Lbs.
Tensile Strength	6,500 psi	Brinell Hardness—500 kg. load (10 mm diameter ball—30 seconds)	38
Flexural Strength	10,000 psi	Rockwell Hardness	M105
Compression Strength	25,000 psi		
Shearing Strength	8,500 psi		

your partner in producing better products

DE-1-50

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES.
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Continental-Diamond FIBRE COMPANY

Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

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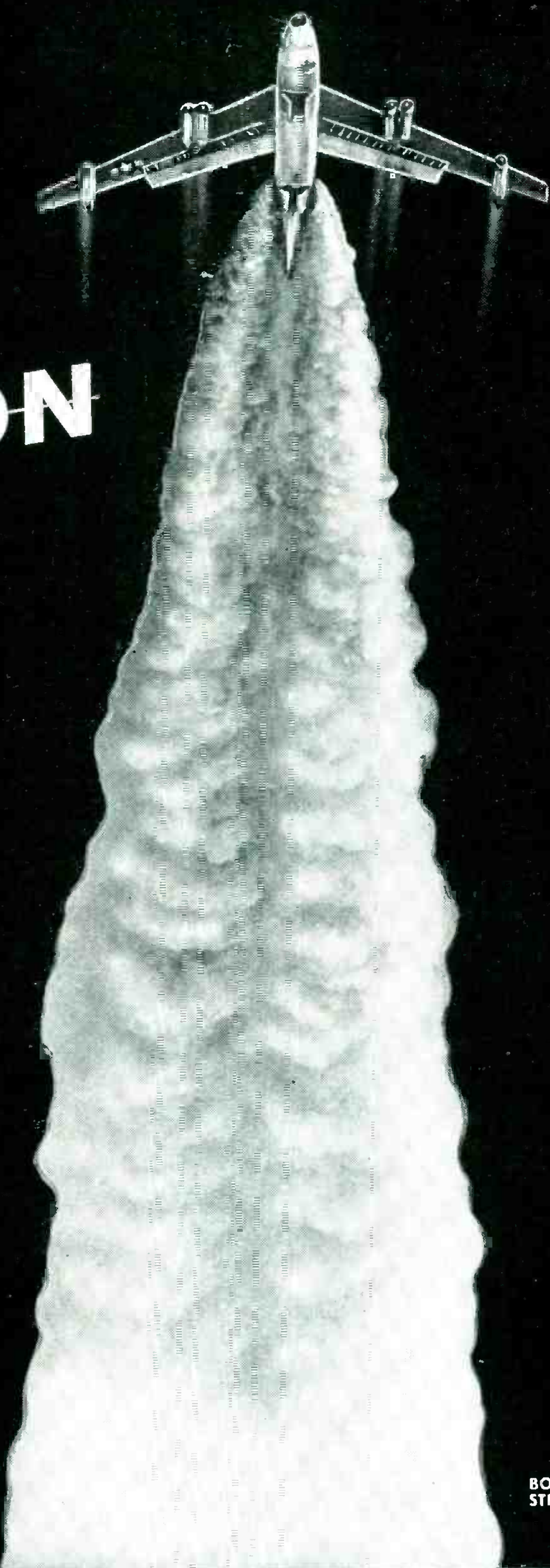
filtered by FILTRON



BOEING B-47
STRATOJET

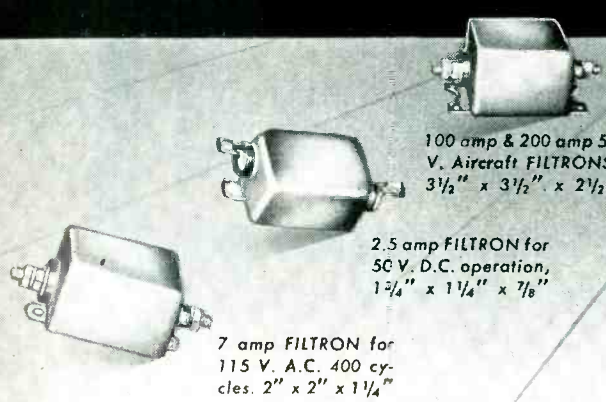
Filtered by FILTRON means Radio Interference-Free Performance

FILTRONS are suppressing RF Interference in modern Military Aircraft, Naval Equipment and Ground Signal Installations.

FILTRON will design the right filter for your circuit conditions to meet size, weight and electrical characteristics — and meet RF Interference Suppression Specifications wherever RF Interference must be eliminated.

FILTRON'S completely equipped Shielded Laboratory is available for the RF Interference Testing of your equipment.

FILTRON'S advanced engineering, due to constant research and development, together with FILTRON'S production know-how, insures quality components to meet your delivery requirements.



100 amp & 200 amp 50 V. Aircraft FILTRONS, 3½" x 3½" x 2½"

2.5 amp FILTRON for 50 V. D.C. operation, 1¾" x 1¼" x ⅞"

7 amp FILTRON for 115 V. A.C. 400 cycles. 2" x 2" x 1¼"

An inquiry on your Company letterhead will receive prompt attention

THE FILTRON CO., INC.
38-25 BELL BOULEVARD
BAYSIDE, NEW YORK, N. Y.

RADIO NOISE FILTERS FOR:

- Electronic Controls
- Electric Motors
- Electric Generators
- Electronic Equipment
- Fluorescent Lights
- Oil Burners
- Signal Systems
- Business Machines
- Electric Appliances
- Electronic Signs
- Electronic Heating Equipment

LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS

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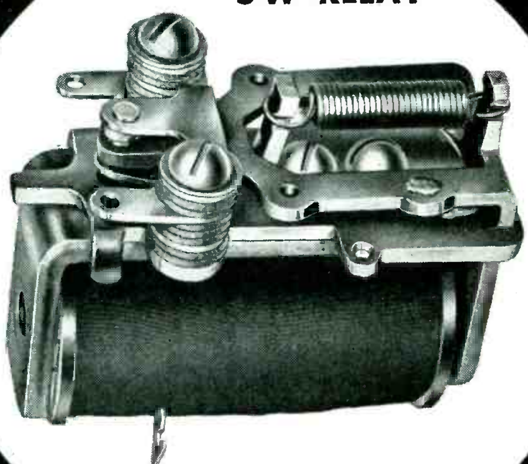
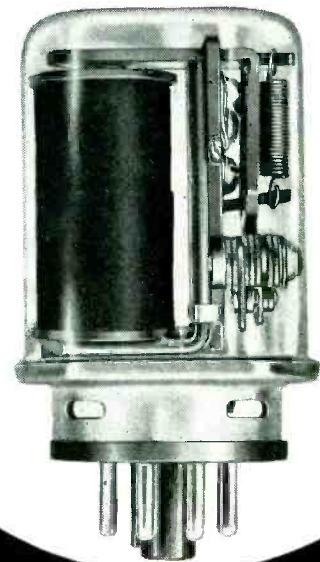
NEW SENSITIVE RELAY *built for long service*



SW RELAY



Hermetically Sealed

Supplied with OCTAL PLUG or SOLDER TERMINALS

Sensitivity Plus Dependability!

The *new* Allied SW relay offers an economical combination of both these important qualities. Here are the facts on this newest relay in the famous Allied line →

SENSITIVITY:	S.P.D.T. .012 watts d.c. / D.P.D.T. .05 watts d.c. } Can be supplied in A.C.
COIL:	Acetate insulated, bobbin or layer wound, 12,500 ohms max.
CONTACTS:	Silver, one ampere non-inductive load at 24 volts d.c. or 115 volts a.c. Armature contact at frame potential.
MOUNTING:	One hole with locating lug. Also available with dust cover or hermetically sealed, plug-in or solder terminals.
DIMENSIONS:	Open Relay—1-15/16", 1-3/16", 1-5/8" Sealed Relay—3-3/16" long, including plug, 1-13/32" wide, 1-19/32" high.
WEIGHT:	2.5 oz.
WEIGHT HERMETICALLY SEALED:	4.5 oz.
SPECIAL APPLICATIONS:	Sensitivity down to .003 watts S.P.D.T., or .012 watts D.P.D.T. Palladium or other precious metal contacts for audio or low voltage circuits, tungsten or alloy contacts for higher current or voltage circuits. Maximum input 4.0 watts at 20°C for 85° rise.

Bulletin SW gives complete details. Send for your copy today.

Be sure to visit the Allied exhibit at the I.R.E. Show, Grand Central Palace. March 6 to 9 • Booth 279

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

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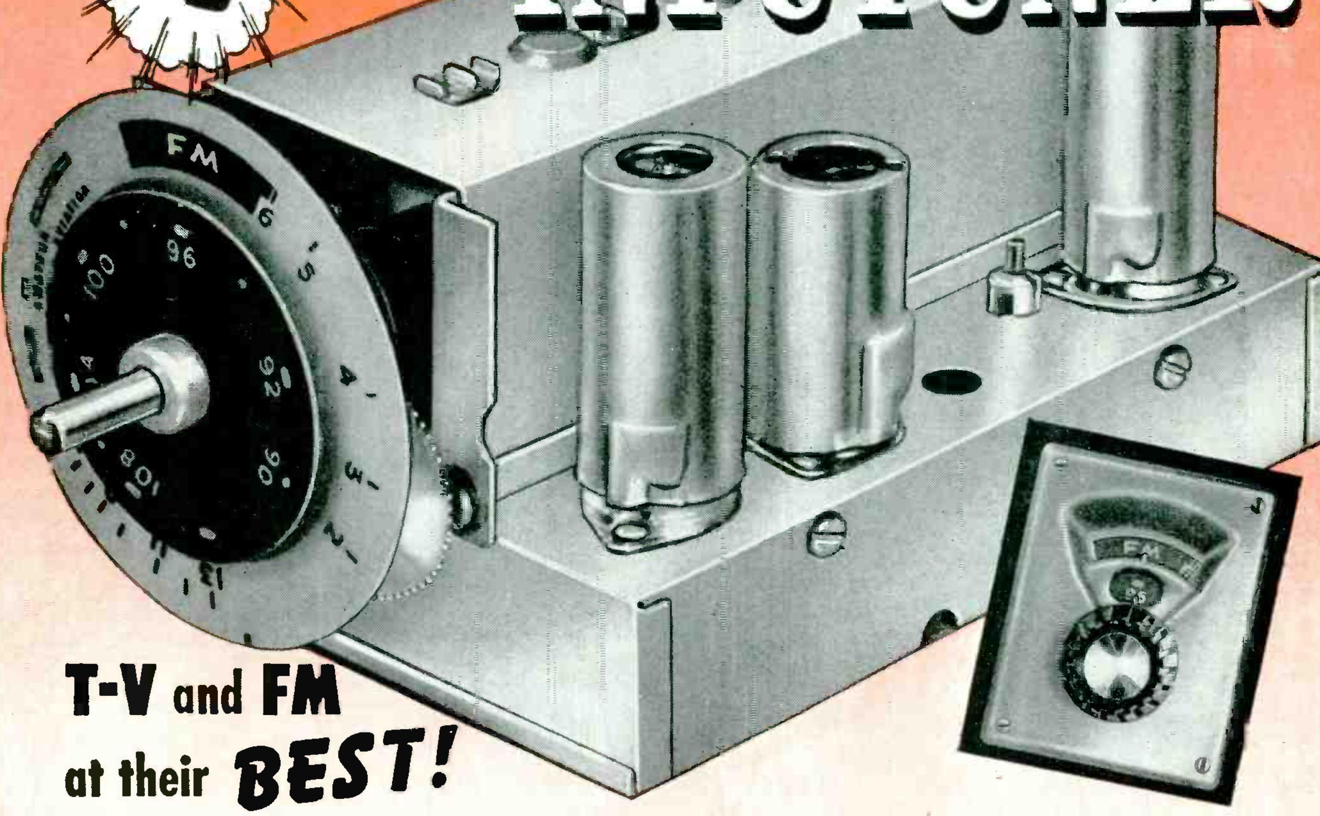
another DUMONT *first...*

4 SECTION INPUTUNER*



T-V and FM at their BEST!

- **LOWERED COST:** A 4-section Inputuner at a marked saving over previous 3-section Inputuners.
- **REDUCED SIZE:** Far more compact than previous Inputuners. Utilizes latest Mallory-Ware miniature spiral-type Inductuner.*
- **HIGHER GAIN:** Over twice the r.f. gain of previous Inputuners.
- **TV AND FM CONTINUOUS TUNING:** Provides high-quality reception from standard FM broadcasting stations, at no added cost.
- **IMPROVED SELECTIVITY:** Added tuned input plus improved circuitry permit interference-free reception.
- **UNIFORM BAND PASS CHARACTERISTICS:** Assure excellent picture and sound quality on all channels.
- **CHOICE OF INPUT IMPEDANCE:** Provides for operation with either 72-ohm or 300-ohm antenna systems.
- **COMPLETE SHIELDING:** Affords circuit stability and minimizes oscillator radiation.
- **LOW OSCILLATOR DRIFT:** Accurate temperature compensation provides freedom from necessity of retuning.
- **ATTRACTIVE DIAL AND ESCUTCHEON:** Makes tuning easy and adds eye appeal to the TV set.

Technical specifications and quotations on request.

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*Trade-mark

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FIRST WITH THE FINEST IN T-V COMPONENTS

Electronic Parts

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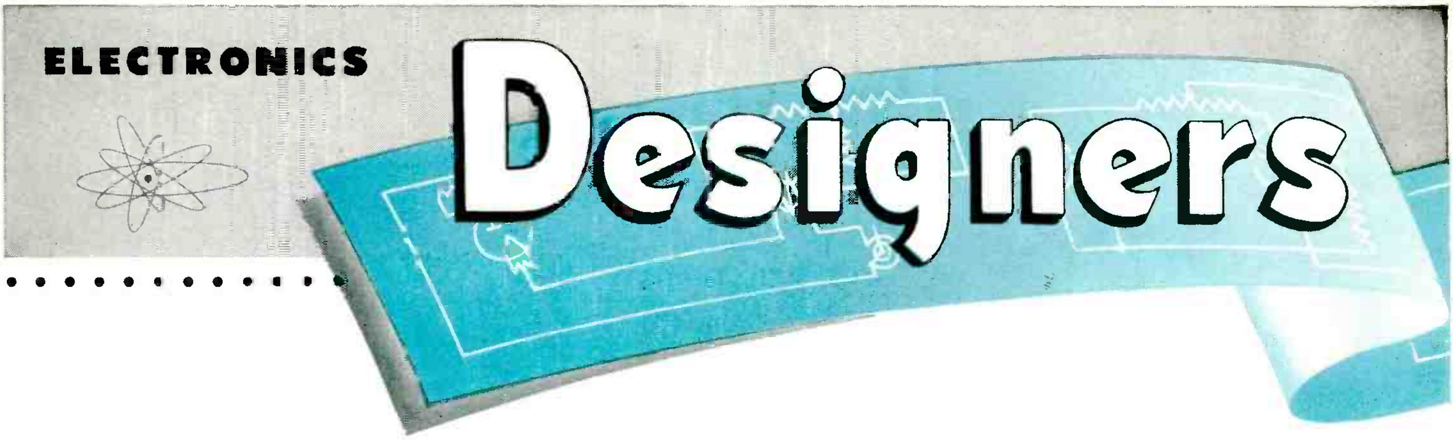
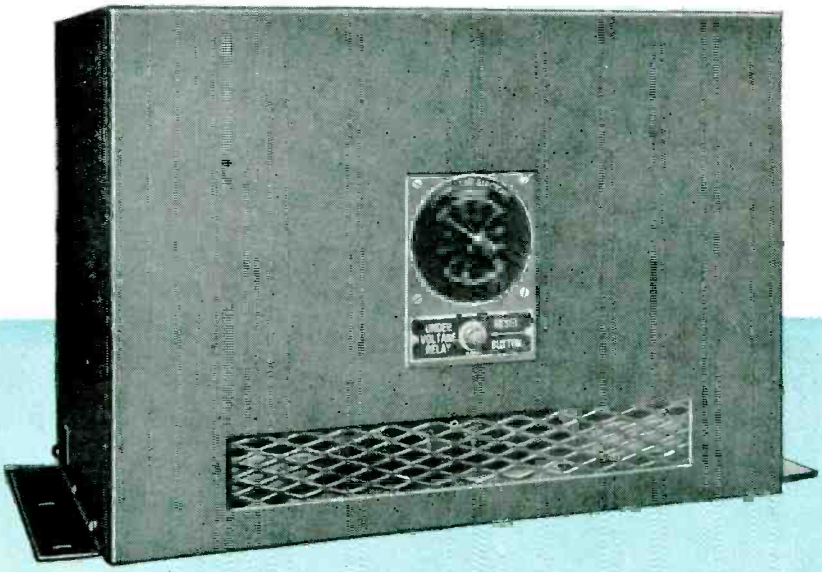


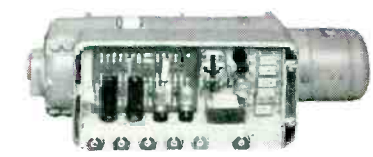


low-cost welding speeds up production

General Electric engineers have developed a new low-cost method of precision-control resistance welding for use in many expensive assembly operations in the manufacture of electronic equipment.

This new welding method makes it possible for a single operator to weld 15 grounding ribbons and one resistor lead to the chassis of a television set in two minutes.

The control panel shown above provides for welding-current adjustment to control the amount of heat produced in the welds. Once set, this control will keep successive welding currents constant to insure accurate and consistent welding of connections. Write for complete data in Bulletin GEA-4175.



one package— Amplidyne plus Amplifier

The G-E electronic amplidyne consists of a motor-amplidyne set, a high-gain d-c balanced amplifier, and a reference voltage supply. It is similar to equipments used in drive systems for radar antennas, searchlights, and ship and aircraft gun mounts. Commercially, it can be used in many kinds of motor control systems for close regulation of current, voltage and speed—to limit torque, hold tension, speed up acceleration, and position accurately.

The electronic amplifier makes the amplidyne respond quickly to sudden changes in the control signal, and gives it high sensitivity to small gradual changes. These and other features make it readily adaptable to automatic programming and closed-cycle processing control.

Applications range from power supply for ¼ to 1½ horsepower motors to field excitation for large adjustable voltage drives up to 200 horsepower. For information, see Bulletin GEA-4889.

GENERAL ELECTRIC

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Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

250 degrees of meter scale

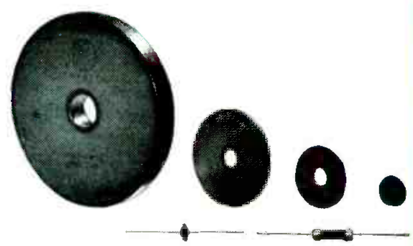
General Electric's new long-scale panel instruments are designed for applications where space is limited, but ease and accuracy of reading are required. These 3½-inch instruments have a 4.92-inch scale which covers 250 degrees.

The sturdy, attractive, molded Textolite cases (round or square) harmonize with other G-E panel instruments. The mechanism is the internal-pivot type—a reliable unit construction which permits minimum behind-the-panel depth. Accuracy is within 5% of full scale on the rectifier type, 2% on all others. For full details, write for Bulletin GEA-5425.

If you need it— ± one degree accuracy

Electronic engineers are well aware of the usefulness of selsyns. Whether used for indicating or control, they have proved themselves a reliable, accurate, and rapid means of communication.

G.E. produces a complete line of selsyns—the high-accuracy type with an accuracy of ± one degree, and the general-purpose type with a ± five-degree accuracy. All units have high operating torque and are totally enclosed with no exposed terminals. Indicators and transmitters are also available in several models. See Bulletin GEA-2176.

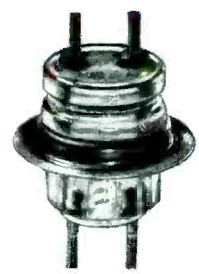


R varies inversely as E^4

Thyrite® resistance material is inorganic and has the unique electrical property of varying inversely in resistance as the fourth power (or even higher) of an applied voltage. It has stable electrical characteristics over a wide range of operating conditions and can be used with a-c, d-c, or short-duration pulses. Because of this, it has solved many problems for the electronic design engineer.

Its most widely known applications are in the limiting of voltage surges, the stabilization of rectifier output voltages, the controlling of voltage-selective circuits, and the potentiometer division of voltages.

It is usually supplied in disk form in diameters from 0.25 to 6.00 inches, with or without mounting holes. Smaller sizes are furnished with wire leads. Complete information is contained in Bulletin GEA-4138.



Cast glass bushings make possible new designs

Originally developed by General Electric for use in vital communication equipment, these unique bushings are now successfully used on such apparatus as power capacitors, transformers (filament, modulator or pulse), and rectifiers. They're made of cast glass with sealed-in nickel-steel hardware and can be readily welded, soldered or brazed directly to the apparatus. This eliminates the need for gaskets and provides a permanent hermetic seal.

Because they are small and compact, as well as vibration and weather resistant, glass bushings make possible new designs, especially where apparatus is to be airborne or where high humidity or fungus growth are special problems. Glass bushings will not puncture or shatter under excess potentials—either 60 cycle or impulse. For more data, including sizes and ratings, see Bulletin GEA-5093.

General Electric Company, Section D667-4
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

( ) GEA-2176 Selsyns
( ) GEA-4138 Thyrite Material
( ) GEA-4175 Welding Control
( ) GEA-4889 Electronic Amplidyne
( ) GEA-5093 Glass Bushings
( ) GEA-5425 Panel Instruments

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electronic voltage regulators

by sorensen

- MAXIMUM ACCURACY
- MINIMUM DISTORTION
- FREQUENCY INSENSITIVITY

Standard DC

*Output voltage	6	12	28	48	125
**Load in amperes	5-15-40-100	5-15-50	5-10-30	15	5-10
Input voltage	95-130 VAC single phase 50-60 cycles: adapter available for 230 VAC operation				
Regulation Accuracy	±0.2% from 1/10 to full load				
Ripple voltage RMS Max.	1%				
Recovery time	0.2 seconds — value includes charging time of filter circuit for the most severe change in load or input conditions				

*Adjustable +10%, —25%
**Individual models identified by indicating output voltage first then amperes. Example: E-6-5 6 VDC @ 5 amperes

Standard AC

Model in VA Capacity	150S 500S	250S 1000S	2000S 3000S	5000S 10000S 15000S
Regulation Accuracy	±0.1%	0.1%	0.1%	0.1%
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
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	O — Full load			
P.F. range	Down to 0.7 P.F.			

NOTES: Regulators can be hermetically sealed.
All models temperature compensated.

SPECIALS Your particular requirements can be met by employing the ORIGINAL SORENSEN CIRCUIT in your product or application.
SORENSEN REGULATORS can be designed to meet JAN specifications.
SORENSEN engineers are always available for consultation about unusual regulators to meet special needs not handled by *THE STANDARD SORENSEN LINE.*

Write for Complete Literature

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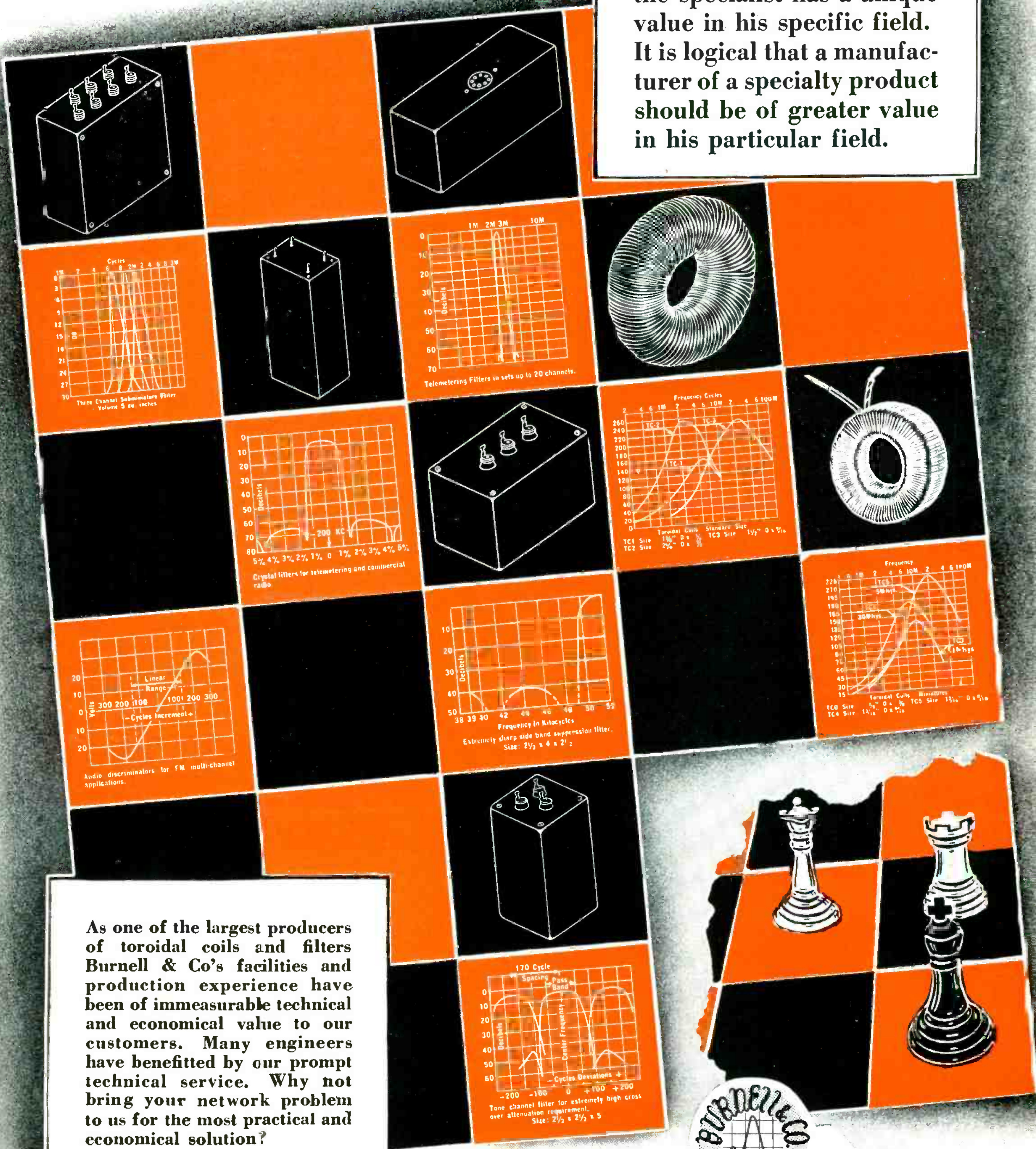
Check YOUR NETWORK PROBLEM WITH LOGIC

In any technical business the specialist has a unique value in his specific field. It is logical that a manufacturer of a specialty product should be of greater value in his particular field.



As one of the largest producers of toroidal coils and filters Burnell & Co's facilities and production experience have been of immeasurable technical and economical value to our customers. Many engineers have benefitted by our prompt technical service. Why not bring your network problem to us for the most practical and economical solution?

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

WRITE FOR TECHNICAL INFORMATION
ALL INQUIRIES WILL BE PROMPTLY HANDLED

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YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

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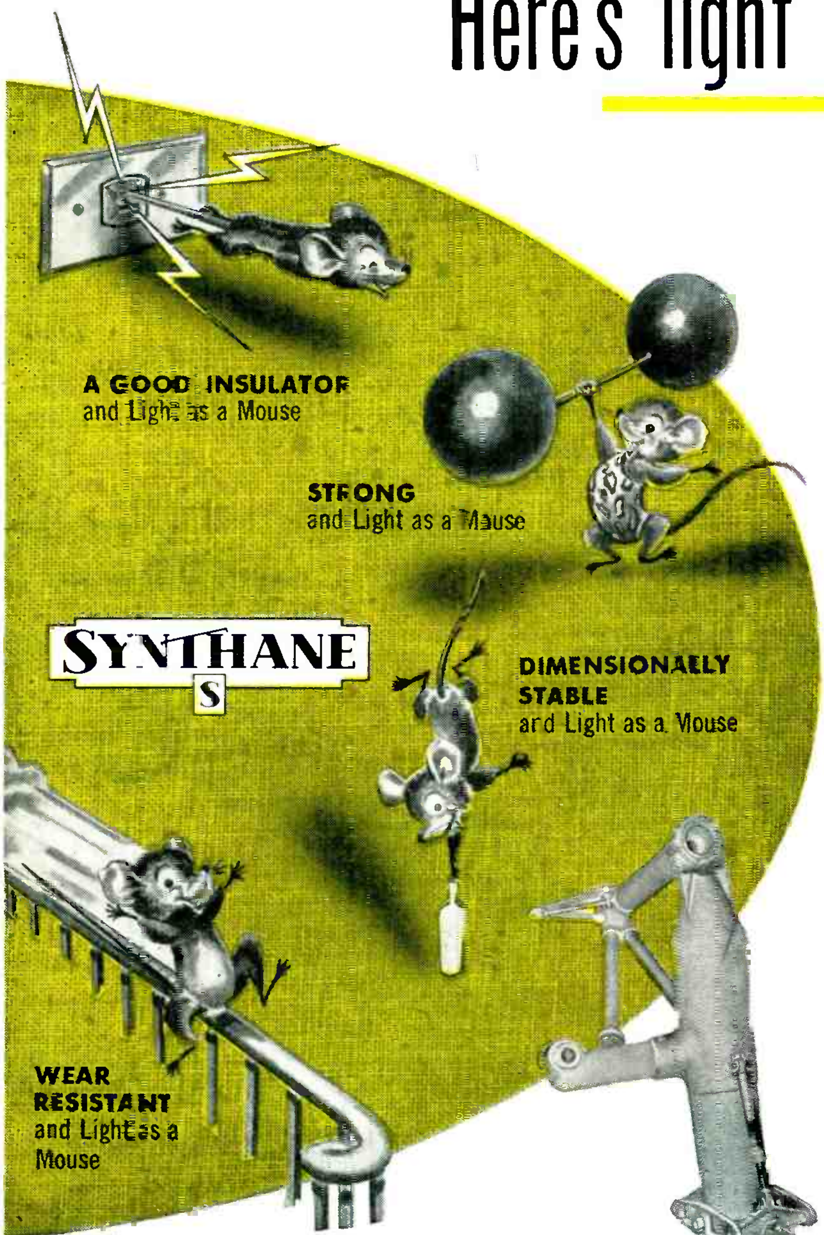
Here's light weight and much



SYNTHANE is half the weight of aluminum. Moving parts made from this type of laminated plastics start faster, require less power to start, stop and run . . . and light weight is only *one* of the Synthane properties that make it a valuable material for you.

With Synthane you get light weight, strength, resistance to wear, dimensional stability and excellent electrical insulation, plus many other desirable mechanical, electrical and chemical characteristics. This unusual *combination* of properties has led to the use of Synthane in thousands of applications in almost every industry. It may be the material you have been seeking to help make a good product better or a process less expensive.

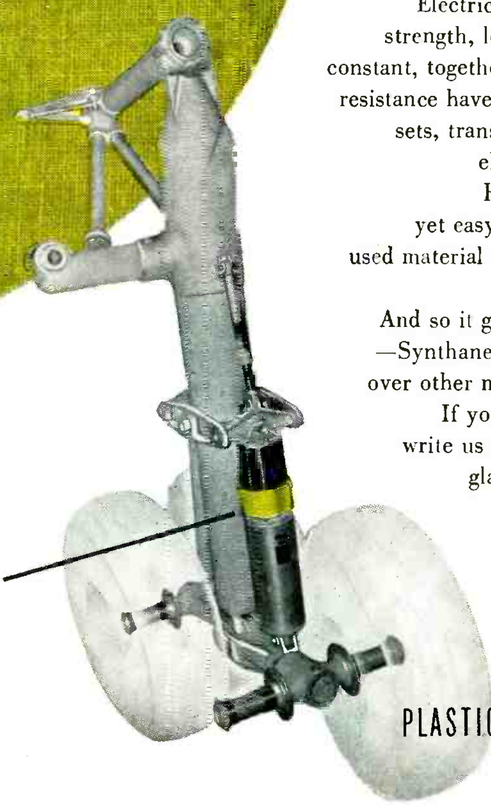
Electrical qualities such as high dielectric strength, low power factor and low dielectric constant, together with light weight and moisture resistance have helped put Synthane in television sets, transformers and many other pieces of electrical and electronic equipment.

Hard, dense and abrasion resistant, yet easy to machine, Synthane is a widely used material for long-wearing, high-speed gears, cams and rubbing blocks.

And so it goes in application after application—Synthane pays for itself in extra advantages over other materials. It may be helpful to you.

If you have a specific material problem, write us outlining the situation. We will be glad to help with material, design, or fabrication of finished parts.

Synthane Corporation,
Oaks, Pennsylvania.



SYNTHANE AT WORK IN INDUSTRY

Cleveland Pneumatic Tool Company, makers of Aerol Landing Gear Shock Strut for the U.S. Air Force Bomber, B-36, selected Synthane as the right material for the bearing shown because of light weight, wear resistance, its antifriction qualities, good compressive strength, excellent shock resistance, and the close tolerances to which it may be fabricated. Are these qualities valuable to you?

PLASTICS WHERE PLASTICS BELONG

MATERIALS • DESIGN • FABRICATION • SHEETS • RODS • TUBES

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more in a material

Here

ARE YOUR ADDED VALUES

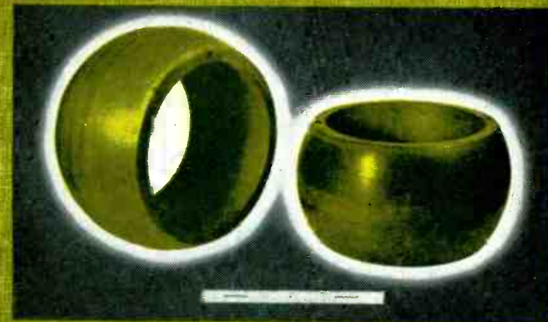
Synthane was the material selected for each of the four parts shown at the right. Each manufacturer sought one or two specific characteristics. In each application the user found that Synthane was not only a better material for the major requirement but gave him other desirable properties. This is true of almost every application, for Synthane is unusual for its *combination* of properties.

Synthane is strong, hard, light and dense. Resists abrasion, corrosion, is easily worked on standard machine tools. It is an excellent electrical insulator, has high dielectric strength, low dielectric constant and low power factor. It is a *set* plastic, dimensionally stable over a wide range of temperatures.

SYNTHANE

WHERE SYNTHANE BELONGS

MOLDED LAMINATED • MOLDED MACERATED



Knuckle Bearing for Rock Crusher. Manufacturer required good antifriction qualities. In addition, Synthane gave him excellent mechanical strength, dimensional stability, wear resistance.

Jack Panel for Radio Control Console. Insulating ability was needed. The extra values obtained were low moisture absorption, high mechanical strength, dimensional stability.

Plating Barrel. Major requirement was corrosion resistance. The manufacturer found that Synthane also gave him abrasion resistance, mechanical strength, light weight and longer life per dollar, including cost of replacement.

Bearing Retainer Rings. Production problem called for dimensional stability. Synthane delivered many extras, including mechanical strength, light weight, corrosion resistance, abrasion resistance, and low inertia.

If these few of Synthane's many desirable properties and abilities suggests its use in your product or process, clip and mail the coupon today.

SYNTHANE CORPORATION
6 River Road, Oaks, Pa

Gentlemen:

Please send me, without obligation, the complete catalog on Synthane Technical Plastics.

*Name*____________________

*Company*____________________

*Address*____________________

*City*__________ *Zone*_____ *State*_____

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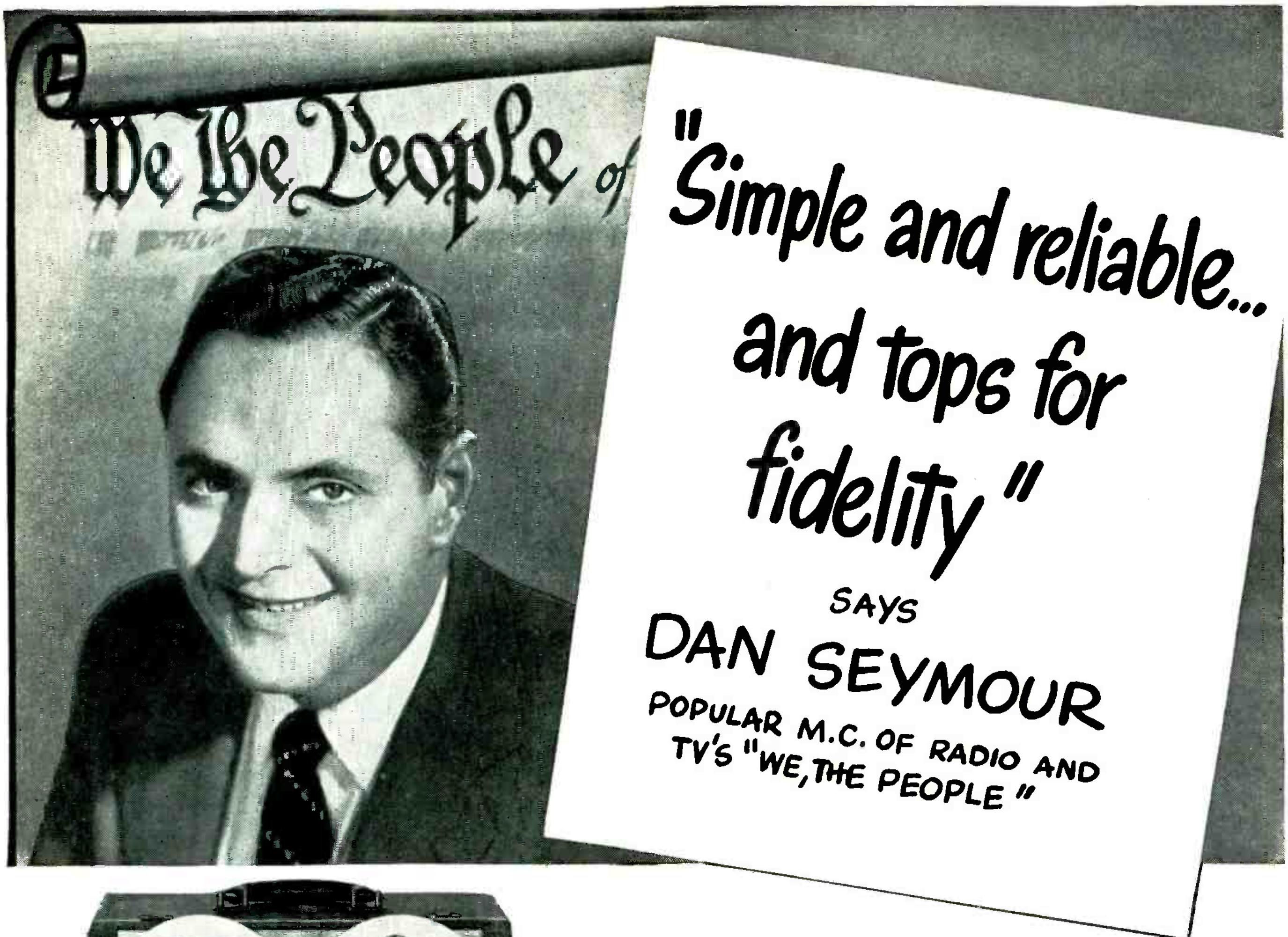

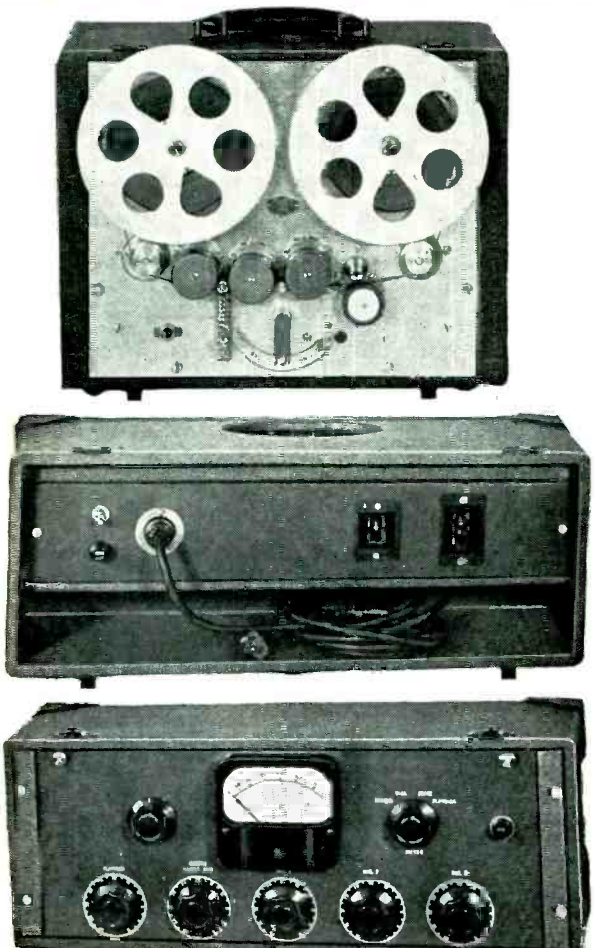

NEW PRESTO

PT-900 PORTABLE TAPE RECORDER

Here's the answer for delayed special-events broadcasts—on-the-spot recording—wherever there is a need for field recording of complete broadcast quality. Look at these outstanding engineering features:

> **Separate recording and playback heads, each with its own associated amplifier, permit monitoring direct from tape. High fidelity unit—50 to 15,000 CPS at 15" per second tape speed. 3 microphone channels with master gain control in recording amplifier. V.U. meter to indicate recording level, playback output level, bias current and erase current, and level for telephone line. 2-speed single motor drive system.**

Don't choose your tape recorder until you see the *new* Presto Portable Tape Recorder. Write for complete details today.

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***Mailing Address:* P. O. Box 500, Hackensack, N. J.**

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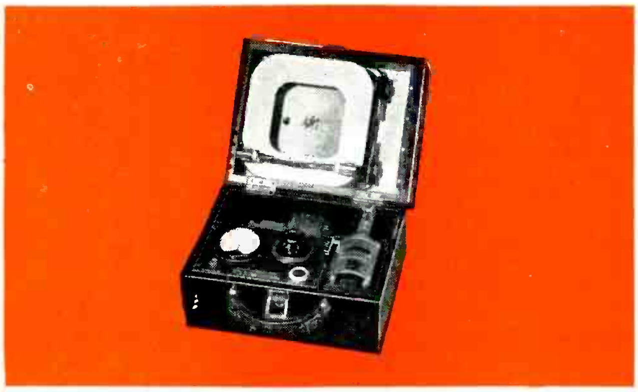
Use one of these 3 instruments ... or select from more than 300 other G-E stock instruments

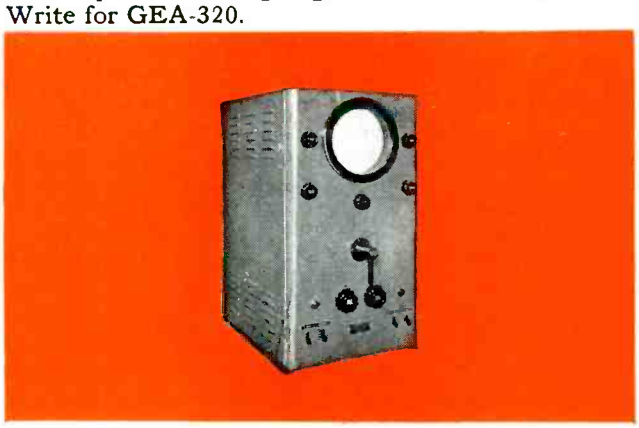


To Cut Costs of Balancing Rotors

—use the G-E portable dynamic balancer

By using the G-E portable dynamic balancer to balance rotors in their own bearings, you can drastically reduce the time and cost of balancing rotors in generators, motors, and in other machines. One operator alone can balance two-bearing machines, and he needs to make only three runs.

Ideal for factory-testing, you can use the device for installation or maintenance work, and for field service on any rotor within a speed range of 600 to 6000 rpm and weighing more than 30 pounds. Write for GEA-320.



To Detect Insulation and Winding Faults Quickly

—use the G-E winding-insulation tester

You can speed up production-line testing of motors, transformers, and generators by using the G-E winding-insulation tester. At one G-E plant, for example, more than 4000 motors a week are tested with one device.

Less than one minute is required for a complete test, which includes resistance, impedance, turn-balance, and complete high-potential tests. The operator can determine the nature of the defects by the wave shapes of the oscillograms. Write for GEC-321.

You may find that General Electric engineers can help you by recommending one of the many G-E stock devices and instruments. Your problem, especially if it is one common to industry, may even justify developing new equipment. Send the coupon today to Apparatus Department, General Electric Company, Schenectady, N. Y.

To Locate Leaks in Closed Systems

—use the G-E Type M Leak Detector

By locating even the smallest leaks while your products are on the production line, you reduce operating costs, cut service expense in the field—and safeguard the good will of your customers. Used in G-E refrigerator production for more than two years, the Type M detector uses helium as a tracer. The detector is so sensitive that it can detect one part of helium in 200,000 parts of air. Write for GEC-336.

FOR HELP on your Testing Problems . . . Mail this coupon today to:

General Electric Company
Section N 687-16
Schenectady 5, N. Y.

Please send me descriptive information on instruments that will help me to test ....

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GENERAL ELECTRIC

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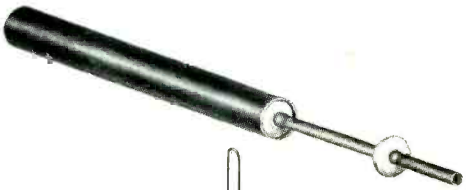
MORE *Andrew* FIXED STATION ANTENNA EQUIPMENT IS USED THAN ANY OTHER KIND!



HERE'S WHY: The topnotch engineering that only the world's largest antenna equipment specialists can give . . . the uniform dependability of Andrew equipment . . . its superior performance . . . the fact that only Andrew makes a complete line of fixed station antenna equipment.

But that's not all. An imposing parade of "firsts" maintain Andrew leadership. Some current Andrew "firsts" are 1) the exclusive Folded Unipole Antenna, 2) the new Hurricane Models, 3) the Corner Reflector Antenna, and 4) a Very High Gain Communications Antenna soon to be announced.

COAXIAL CABLE, Type 737. Significantly, there is more of this Andrew 7/8" diameter cable now in use than all similar makes combined! You get a bonus of extra miles added to your service radius because loss characteristics are exceptionally low.

FOLDED UNIPOLE ANTENNAS. Another Andrew "first" and made only by Andrew. Thousands of these popular antennas are in use at fixed stations throughout the world. More new stations are using it than any other antenna. Users acclaim 1) its quieter reception produced by the grounded radiating element, 2) the excellent impedance match, and 3) its greater transmitting coverage.

Extra! Now available in Hurricane Models to insure uninterrupted operation when you need it the most.

COAXIAL ANTENNAS. Most economical where signal-to-noise ratio is high. Above 108 MCS only.

CARDIOID ANTENNAS. If you operate along a shore or border line and want your signal to cover only a certain 180° area, this rugged antenna is made to order for you. It concentrates your signal where you want it and doesn't waste radiation where you don't want it.

CORNER REFLECTOR ANTENNAS. For narrow angle coverage or point-to-point relaying. Concentrates your signal in the exact area where you want it, using a 60° beam. Avoids interference to and from the remaining area. For the 72-76 and 148-174 MCS bands. Only Andrew makes a commercial model of this special purpose antenna—another Andrew "first."

It will pay you, too, to use Andrew fixed station equipment. Write for further information—today!

VERY HIGH GAIN
COMMUNICATIONS ANTENNA
(soon to be announced)

The highest gain antenna in mobile communications history. It actually delivers the full gain of 6.5 db as claimed—the same as increasing your power 4½ times! Think of the economy. Now, for the first time, you can cover areas you couldn't reach before! It's another pace-setting Andrew "first." Frequency range is 148-174 MCS.

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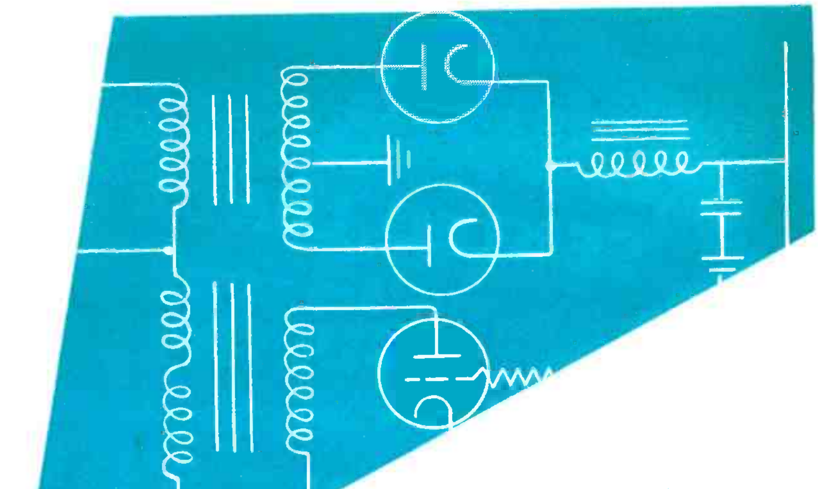

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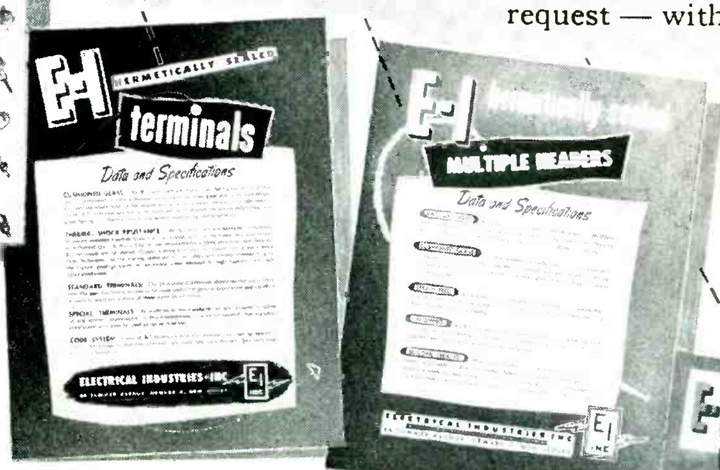

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NOW *. . . the efficient short-length tube you've needed for small test equipment!*

ULTRA-COMPACT SUPERIOR IN DESIGN LOW IN PRICE

GL-3MP1

★ 8¼" max length ★ 3 1/16" max diameter

CHARACTERISTICS

Heater voltage	6.3 v
Heater current	0.6 amp
Focusing method	electrostatic
Deflecting method	electrostatic
Screen	phosphor, P1
fluorescence	green
persistence	medium
Over-all length	8¼" max
Bulb diameter	3 1/16" max
Min useful screen diameter	2¾"
Base	small-shell duodecal 12-pin
Basing	12F

Max ratings, design-center values

Anode No. 1, voltage	1,000 v d-c
Anode No. 2, voltage	2,500 v d-c

Typical operation, for Anode-No.-2 voltages of:

		1,000 v	2,000 v
Anode No. 1, voltage		200 v to 350 v	400 v to 700 v
Grid No. 1, voltage for visual cut-off		0 v to 63 v	0 v to 126 v
Deflection factors:	D1 and D2	115 v to 145 v	230 v to 290 v d-c per inch
	D3 and D4	110 v to 140 v	220 v to 280 v d-c per inch

HERE'S a *proved* 3-inch cathode-ray tube that makes it easy for you to design test instruments truly light and compact, convenient to use. The tube may be employed either in small oscilloscopes, or as a substitute for meters in new-design equipment.

Small in size, appealing in price, the GL-3MP1 also is marked by advanced engineering. The tube has exceptionally high light output. Its brilliant spot is made possible by General Electric's special method of applying the P1 screen. The spot is held to a sharp focus through efficient tube design and quality manufacture. Moreover, deflection sensitivity is high; particularly so for a short-length tube.

Tetrode design of the GL-3MP1 includes a No. 2 grid. Because of this feature, fluctuations in first-anode voltage do not affect the beam current, which remains constant. The electron gun is a Zero-Ib_1 type, meaning that the first anode takes practically no current. This permits use of a low-current voltage-divider system as well as a very small filter capacitor in the power supply—two vital steps toward circuit simplicity and economy.

Ask, today, for price and further facts about this fine G-E cathode-ray tube—a type that opens up new areas of sales for the alert manufacturer of test and service equipment. Also, General Electric tube engineers will be glad to consult with you personally on the GL-3MP1's applications to *your* new design. Wire or write *General Electric Company, Electronics Department, Schenectady 5, New York.*

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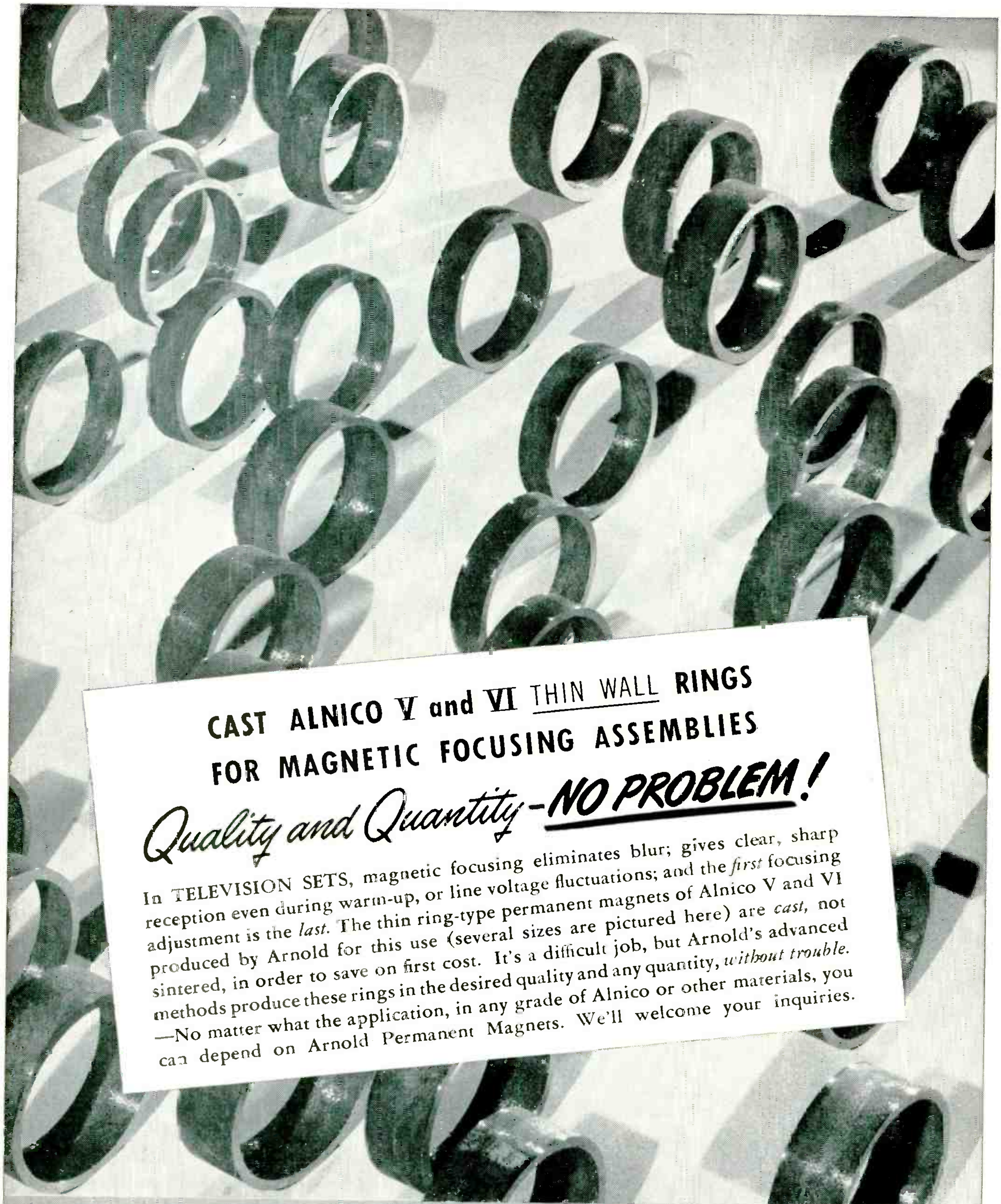

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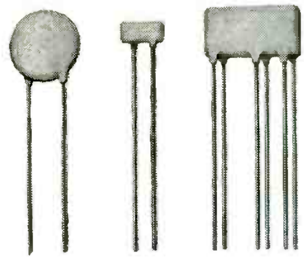
1.5-7 MMF
3-12 MMF
5-25 MMF
5-30 MMF
8-50 MMF

Type 554 Ceramicon 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



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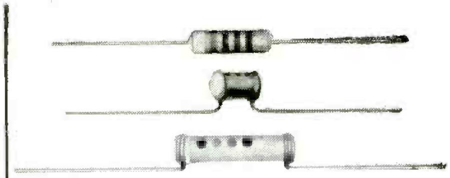
Up to .01 MFD



Temperature Compensating Molded Insulated Ceramicons*
0.5 MMF—550 MMF
Temperature Compensating Dipped Insulated Ceramicons
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Temperature Compensating Non-Insulated Ceramicons
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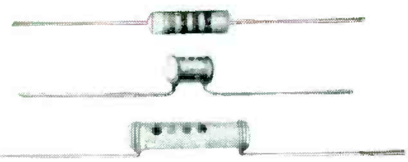

Erie "GP" Molded Insulated Ceramicons
5 MMF—5,000 MMF
Erie "GP" Dipped Insulated Ceramicons
5 MMF—10,000 MMF
Erie "GP" Non-Insulated Ceramicons
5 MMF—10,000 MMF

Button* Mica Condensers
15 MMF—6,000 MMF

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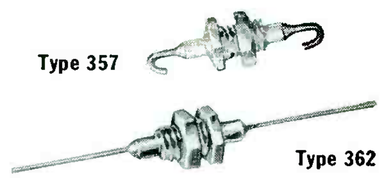
Cinch-Erie Plexicon* Tube Sockets with 1,000 MMF built in by-pass condensers



Feed-Thru Ceramicons
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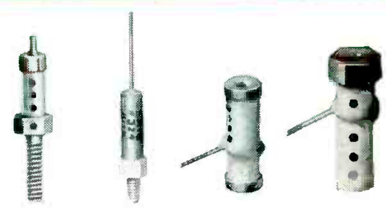
THE dependability and accuracy to close tolerances required for Television and Broadcast applications are combined in Erie Ceramicons with compact design, tubular in form, for easy installation on the assembly line.

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

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



Erie Stand-Off Ceramicons
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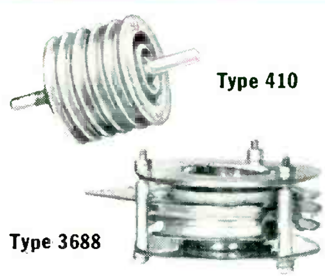

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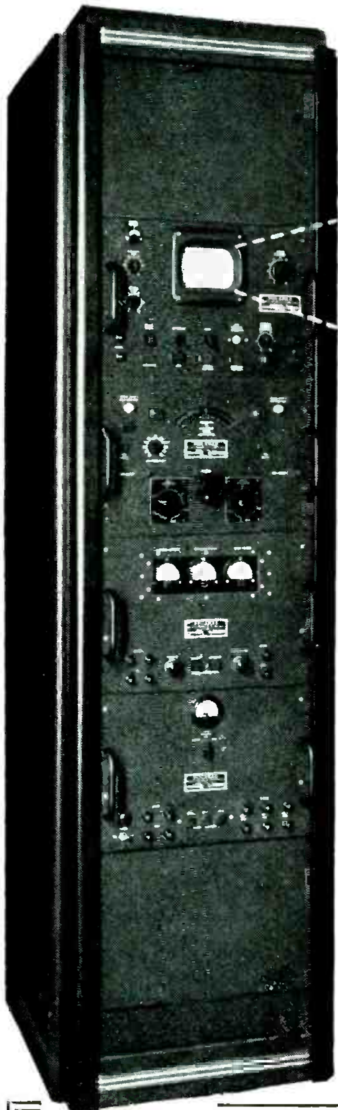
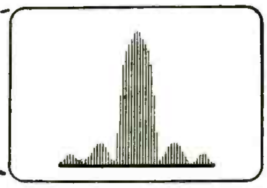
10 MCS to 16,520 MCS





Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.

Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1 per cent.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment above 1000 MCS.
- Frequency marker for measuring frequency differences 0-25 MCS.
- Only *three* tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

The equipment consists of the following units:

Model LTU-1 R. F. Tuning Unit—10 to 1000 MCS.
Model LTU-2 R. F. Tuning Unit—940 to 4500 MCS.
Model LTU-3 R. F. Tuning Unit—4460 to 16,520 MCS.
Model LDU-1 Spectrum Display Unit.
Model LKU-1 Klystron Power Unit.
Model LPU-1 Power Unit.

Where Used:

Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

Other uses are:

1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
5. Check and observe tracking of r.f. components of a radar system.
6. Check two r.f. signals differing by a small frequency separation.

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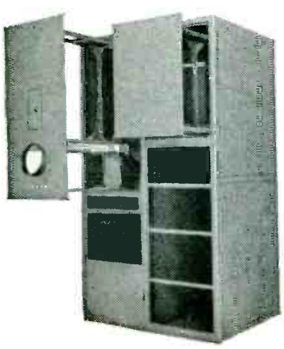
If your product requires metal cabinets, housings, chassis or enclosures, we can build them in a manner that will effect time and money savings on your assembly line. Karp craftsmanship is so accurate and thorough in detail that all units will be completely uniform. All your components will fit quickly and easily into place without forcing—without extra efforts on your part.

The resultant savings of your time and effort can help cut your costs and permit more competitive pricing, without cheapening your product in quality and value.

Let us prove that Karp's superior craftsmanship also means true economy. Pin the coupon below to your letterhead for more information.

Right: Desk panel cabinet rack

Below: Electronic control cabinet



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- Practical help with design problems, to improve product and cut cost.
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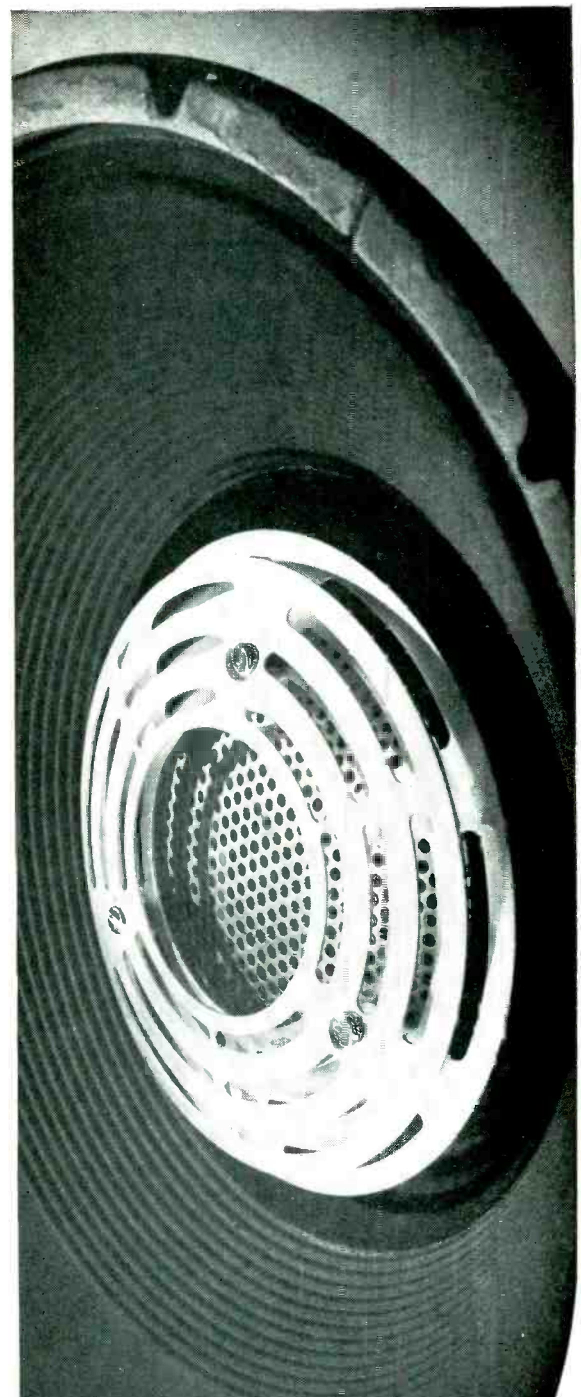
The new, wide-angle acoustic lens of the "510" is an example of Jensen leadership in loudspeaker engineering. By adapting optical principles to acoustics, this lens acts in conjunction with the h-f horn to distribute h-f radiation uniformly over a wide angle. This insures constant balance and high quality reproduction throughout the whole room.

Whether the "510" is used for broadcast monitoring, professional sound reproduction, or for home entertainment systems, the advanced Jensen electroacoustic design assures the finest performance.



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FOR COMPUTER PROBLEMS OF INDUSTRY

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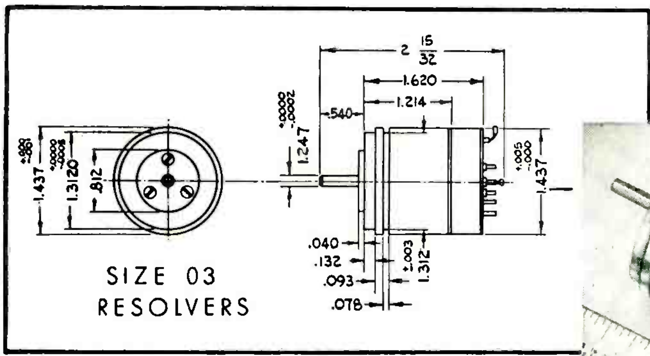
"Brain Block" instrumentation quickly describes any custom arrangement of light, small, accurate standard Arma components to make precision instruments and controls.



TYPICAL SPECIFICATIONS

SIZE	TYPE	DRAWING NUMBER	FREQ.	INPUTS	OUTPUTS	TRANSFORMATION RATIO (S/P)	PHASE SHIFT	INERTIA (oz. in²)	MAX. STATIC TORQUE (oz. in.)	WEIGHT (lbs.)	MAX. ANGULAR ERROR	MAX. AXIS MISALIGNMENT	REQUIRED TO ATTAIN TABULATED ACCURACIES			
													INPUT VOLTAGE	TEMPERATURE	AMPLIFIER DWG NO.	AMPLIFIER WEIGHT (lbs.)
03	03JJ400	786832	400 ± 0.5	2	2	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2
03	03KK400	786833	400 ± 0.5	2	1	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2
03	03LL400	786834	400 ± 0.5	1	2	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2 Note #1
03	03MM400	786835	400 ± 0.5	1	1	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2 Note #1
03	03NN400	786836	400 ± 0.5	2	2	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	03PP400	786837	400 ± 0.5	2	1	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	03QQ400	786838	400 ± 0.5	1	2	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	03RR400	786839	400 ± 0.5	1	1	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	25° C	Not Required	

Deviations shown are maximum — Average deviation is much less. Quadratures and harmonics each never exceed 0.1% of the sum of the input voltages. Characteristics shown are attainable with indicated required auxiliary equipment and good engineering practices for precision circuits. Note #1. One amplifier may be used with two resolvers of this type.

***E=Input**
†E_s=Sum of Inputs

These are the resolvers about which management men have been reading: "One of the means by which the many fast changing variables of industry can be coordinated and electrically translated is Arma's electrical resolver . . . the "brain block" that replaced a formidable aggregation of gears and slides previously used to solve the trigonometric functions. It is used in instrumentation involving computers and action-triggering circuits. And, resolvers come off Arma production lines accurate to a degree seldom equalled outside the precision model shop. They fit interchangeably into instrument assemblies."

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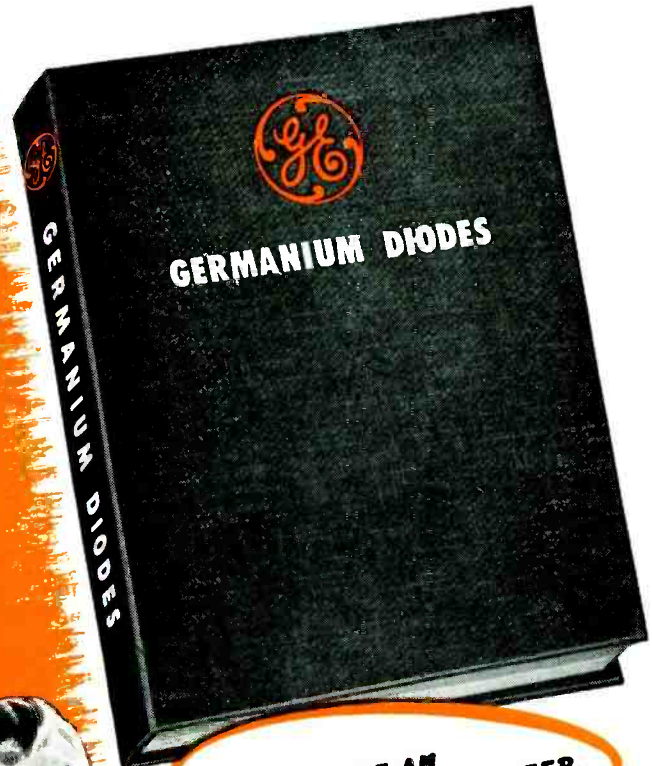
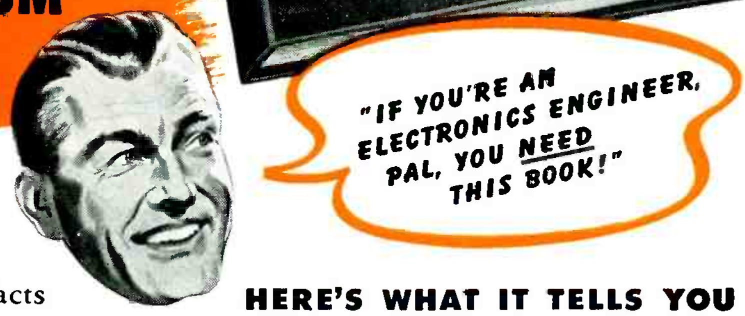
ON GENERAL ELECTRIC <u>WELDED</u> GERMANIUM DIODES





HERE'S the book that digests all the facts you should have on Germanium Diodes. Contains valuable pages of up-to-the-minute information on diodes and their applications in today's widening electronics market!

For designers and engineers who want basic facts on the development, characteristics, advantages and circuitry of diodes, this carefully prepared General Electric manual is a valuable tool. Includes specific data on diode problems, characteristics curves, electrical rating charts, circuit diagrams.

Assembled in loose leaf fashion, the book is tabbed by sections for easy reference. The $1.25 price of this leatherette bound handbook includes supplementary sheets on new diode developments which will be sent to you as they are published. Your copy is waiting. Mail the coupon today!

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GENERAL ELECTRIC

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- Design, manufacture, and specifications of G-E Welded Germanium Diodes
  - General purpose types
  - TV types
  - Quads
  - UHF diodes
- **CHARACTERISTICS CURVES**
  36 curves on resistance, current, voltage, temperature, and efficiency. Also typical distributions.
- **SERVICE NOTES**
  - How to install
  - How to check and inspect
  - Precautions
- **DIODE APPLICATIONS**
  Typical circuit applications and brief descriptions of diode characteristics as used in circuits covering AM & FM receivers, TV receivers, measuring equipment, carrier current, miscellaneous.
- Pertinent articles and public presentations on diode theory and application.

General Electric Company—Section 430
Electronics Park
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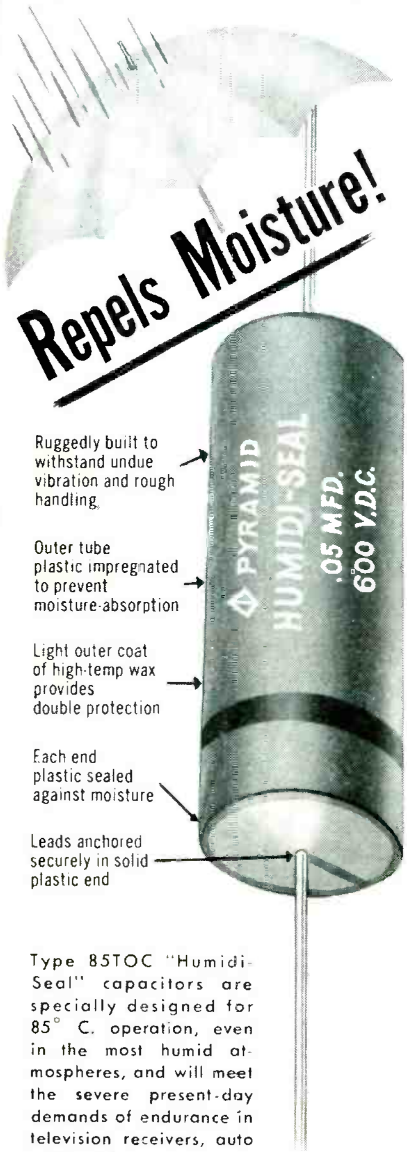
PYRAMID
"Humidi-Seal"
(TUBULAR PAPER CAPACITOR)



Type 85TOC "Humidi-Seal" capacitors are specially designed for 85° C. operation, even in the most humid atmospheres, and will meet the severe present-day demands of endurance in television receivers, auto radios, etc.

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BUSINESS BRIEFS

By W. W. MacDONALD

Field-Trip Impression: Price will be king in 1950 television. Some manufacturers think lower prices for 1949 picture sizes, or the same prices for larger pictures, can be achieved by better though simpler circuits and savings effected by improved production techniques. Others think that lowering of lists will be accomplished by just plain corner-cutting, some of it at the expense of performance.

Both schools of thought are probably right.

Another Field Impression, slightly mixed, is that the tube is at one and the same time going out and coming in.

We've seen germanium crystals, dry-disc rectifiers and magnetic amplifiers creeping into certain electronic equipment. On the other hand, we've also seen thyratrons and ignitrons substituted for relays and even for heavy-duty contactors in new gear.

All in all, we think it would be silly to sell the tube short.

Entirely Speculative, but nevertheless stimulating to some of our friends in the aviation field, is this trend of thought:

A good part of the cost of a modern airplane is in its electronic equipment, so a few extra dollars invested in electronics would not break the bank. Some of this equipment, like an automatic pilot, already moves various flight-control surfaces. This being the case, it is conceivable that similar electronic equipment could be introduced between the pilot and the control surfaces to take over part of the job of manual flying.

Several possibilities come to mind. By a combination of electronic and manual control could a small ship achieving supersonic speeds be given the "feel" of a safe-and-sane transport? Could electronic means of stabilizing flight be substituted to some extent for aerodynamic stability? Would this permit economies to be effected in the design of the airplane itself?

From here on it is your ball.

Important Trend everywhere in evidence is an engineering struggle to combine the functions of electronic measuring - telemetering - calculating - indicating - recording devices with those of the garden variety of business machine.

In fields of endeavor ranging all the way from flight research through conventional industrial laboratory and production testing to even more laborious clerical operations modern electronic equipment is gathering so much data that man cannot comfortably digest it. Thousands of people are slaving away converting oscillographic and magnetic squiggles and other hieroglyphics turned out by electronic gear into plain old-fashioned arithmetic and English such as that turned out by business machines.

What is needed is a bridge between the two devices, one that need not be monitored by human hands. Suitable component parts are already known in many cases, and the span has actually been completed in a few highly specialized robots. But the problem still lies largely ahead.

Building this bridge may very well be the next great job for engineers.

Poetry normally leaves us cold, but we do like the piece entitled:

PANORAMA WITH SIGNS AND SYMBOLS

By Harold Willard Gleason

Where brackets' jealous fingers
 About black surds entwine,
The shy mantissa lingers
 By tangents of the sine;
Binomials brood there bleakly
 In corollary trees,
As minuends munch meekly
 Cubed "x"s, "y"s, and "z"s.

There sigma curves assemble,
 Prime radii outspread,
And variants, atremble,
 By radicals are bled.
Sage scientists ecstatical
 With gleeful ease construe such;
But we, non-mathematical,
 Would rather root than view such!

Reprinted by permission and Copyright 1949 by *The New Yorker Magazine, Inc.*, this little poem comes to mind whenever we read

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FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

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SHOCK AND VIBRATION NEWS

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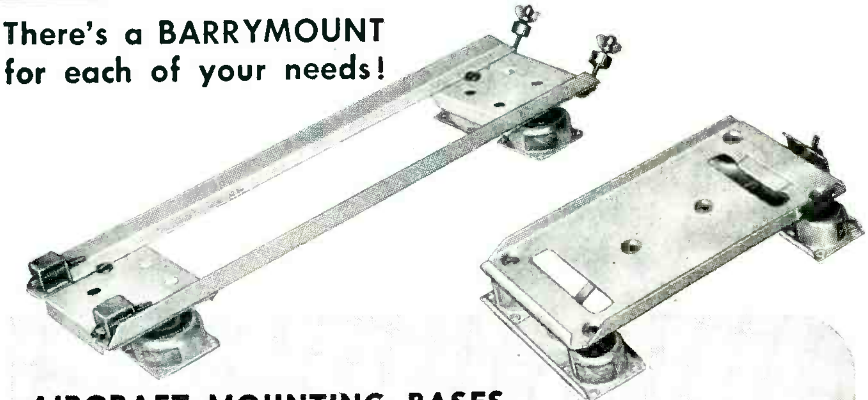

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For electronic components, tiny fractional H.P. motors, record changers, dictating machines, and other lightweight apparatus.

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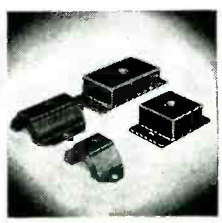

For fans, motor generator sets, transformers, presses, other heavy industrial equipment.

Free Catalogs give dimensions and load ratings of stock BARRYMOUNTS. Catalog 502 covers aircraft applications. Catalog 504 covers industrial and general-purpose mountings. WRITE TODAY to

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a technical paper with the mathematics symbolixed up.

Licensed Radio Stations totaled 152,974 as of December 31, 1949, broken down as follows:

Broadcast	
Standard (a-m)	2,234
Frequency-modulation	788
Remote pickup	649
Television	111
Television (experimental)	215
Educational	72
International	37
Facsimile	0
Other	39
Nonbroadcast	
Aeronautical	25,513
Marine	22,390
Public Safety	6,242
Industrial	5,167
Land Transportation	3,497
Amateur	84,394
Miscellaneous	1,626

Licensed operators totaled 589,706, broken down as follows:

Commercial	393,470
Special Aircraft	113,028
Amateur	83,208

We've Been Watching the new-product announcements of manufacturers who put out thousands of radios equipped with television jacks for some sign of a unit that would utilize these unused little apertures. So far we've seen nothing, and begin to grow suspicious.

Still Harping on the same string—the need for more reliable small industrial tubes—we predict that if some established tube makers refrain from designing types the customer wants much longer, for economic or any other reasons, companies that have never lighted a gas flame or pulled a vacuum will take a whirl at it.

Incidentally, just the other day we heard about a new line of tubes now in production for use in aircraft that have the following characteristics:

Solid ceramic insulation
Improved heater welds
Oversize cathodes
Eight-wire circular stems
Mica eyelets welded to side rods
Larger grid side rods
Increased electrode spacings
Increased getter capacity
Getter-splash micas
Gold-plated grid wires
Higher vacuum
Pretest burn-ins

There are ten types in all, and they have been in process of design for two years.

One Of Our Readers has just applied for a patent on a combination timer and rotary switch. Built

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into a radio, it not only turns the set on and off at desired intervals but also permits any one of several tuned circuits, and therefore stations, to be preselected.

The design seems fairly simple, and appears to lend itself to assembly by relatively unskilled workers. Printed-circuit technique could also be used. We'll be glad to pass inquiries from interested manufacturers along.

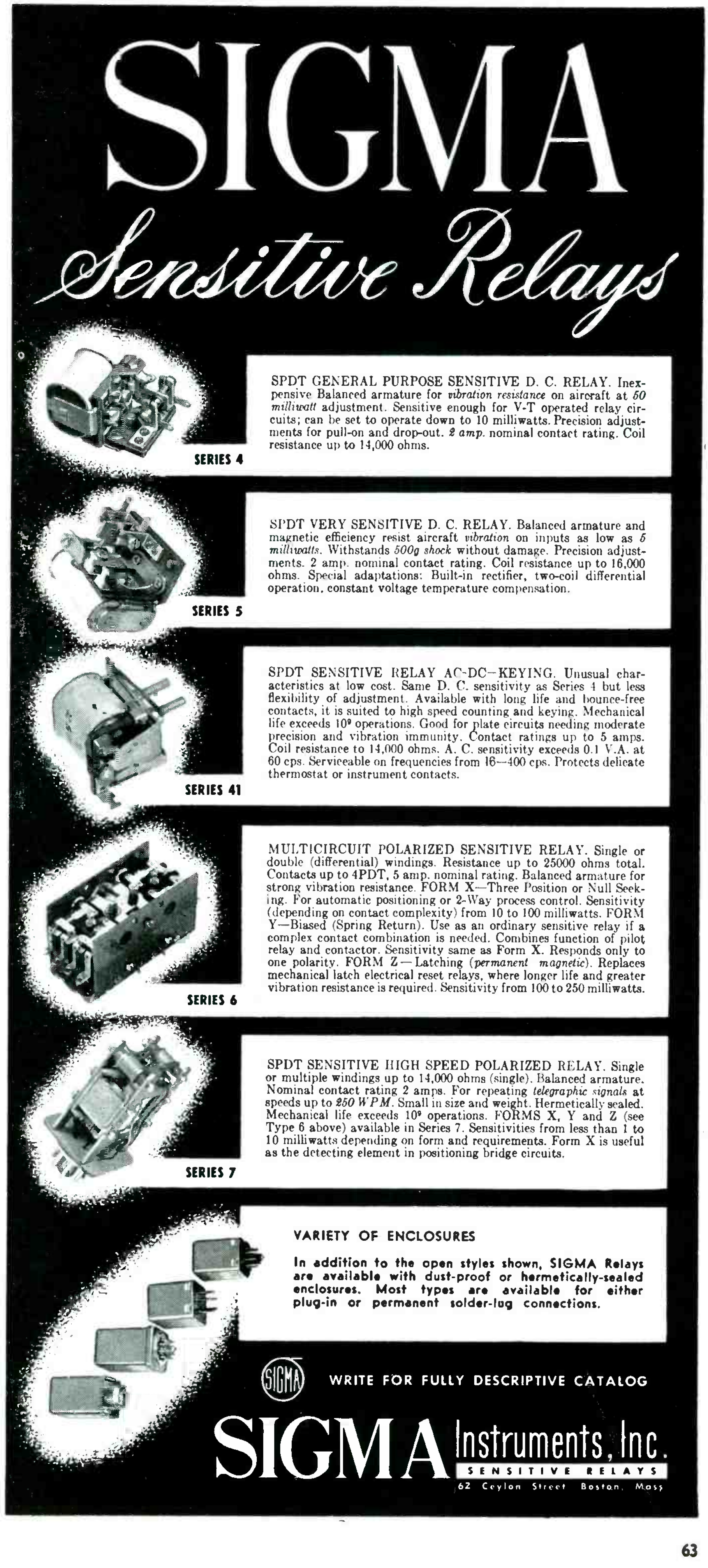
Admiral Telfair Knight of the U. S. Maritime Service says that insurance premiums covering Alaskan shipping are reduced as much as 50 percent when radar navigation equipment is installed. Scuttlebutt tells us that the average ship plying in these waters spends $11,000 per year for insurance.

Spencer-Kennedy of Boston had a rep in Europe all last Summer and reports that American laboratory electronic equipment is in very high regard indeed. Export drawback has been lack of dollars, but an ECA grant to Italy in December may be the forerunner of other similar grants.

After One Year of experience, a poll of bus and trolley drivers operating 1,000 vehicles in St. Louis indicates that 75 percent like radio programs supplied by Transit Radio through KXOK-FM, 15 percent are neutral on the subject and 10 percent object to the idea.

Magnetic Tape of the oxide-in type is specified by 78 percent of the makers of recording machines, according to C. J. LeBel of Audio Devices. Red oxide is preferred by 74 percent, black by 17, and 9 percent recommend both. Plastic-base material is specified by 69 percent, paper by 17, and either plastic or paper by 14 percent.

When Bad Engineers Die their first assignment in the hereafter is to tune up five and ten-watt marine radiophone transmitters. By the time they have learned how to adjust the four to nine interacting tank and antenna-coil taps for proper loading and resonance they know precisely what hell is.



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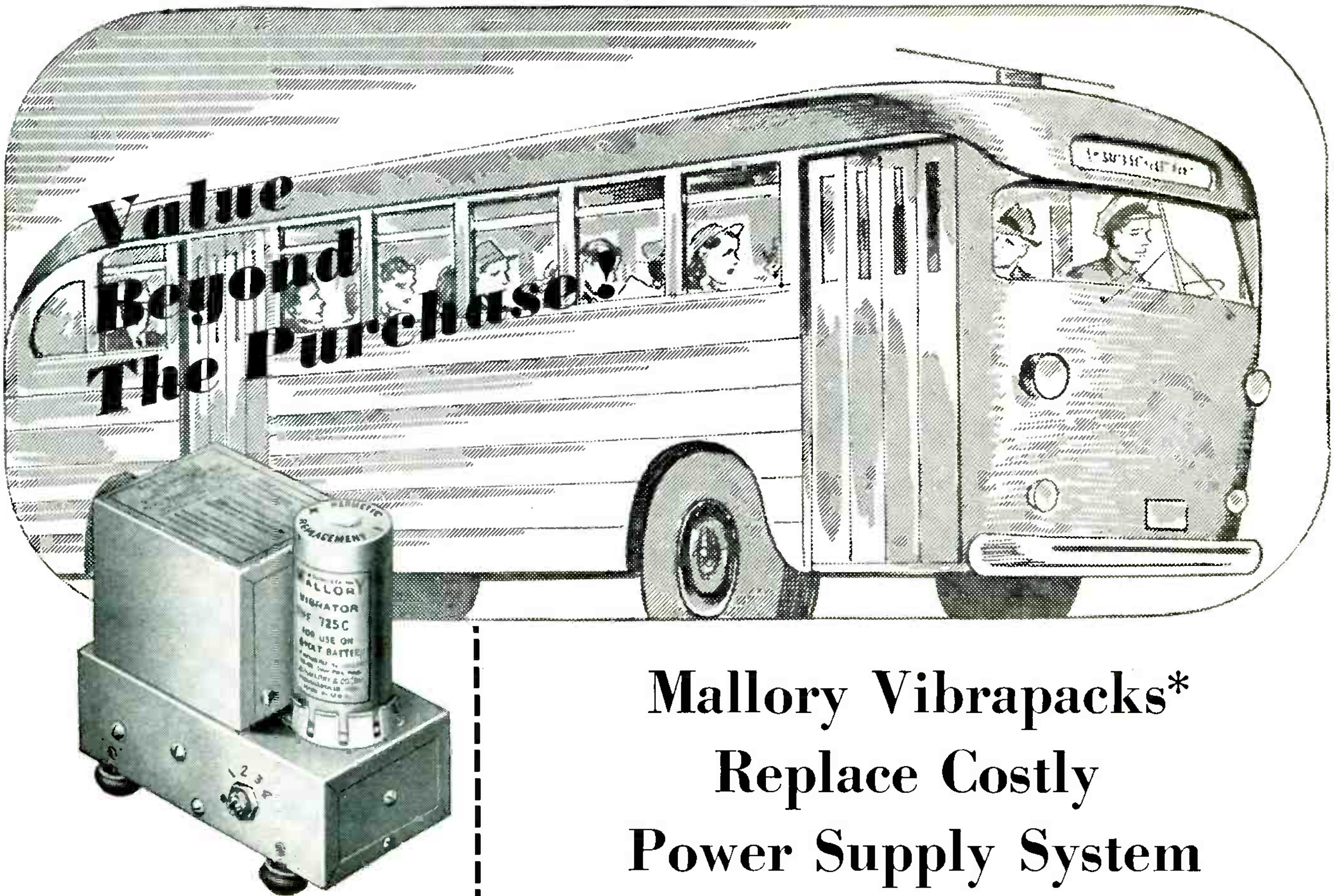

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Mallory Vibrators and Vibrapack power supplies are based on exclusive design and manufacturing methods that assure long, trouble-free service. Send the details of your application. Get Mallory's recommendation on the Vibrator or Vibrapack power supply best suited to your needs.

Mallory Vibrapacks* Replace Costly Power Supply System

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In one typical case, a simple and inexpensive circuit modification, developed by Mallory, made it possible for a manufacturer of mobile radio receivers to substitute Vibrapacks for a costly and less efficient power supply system. The conversion saved this Mallory customer $40,000 in the first year! In addition, thousands of dollars are being saved in maintenance costs. Servicing the old system required hours of labor . . . the new one requires only occasional replacement of the vibrator.

When you buy Mallory vibrator equipment you benefit by a winning combination of dependability, economical performance and creative engineering.

That's value beyond the purchase!

And whether your problem is electronic or metallurgical, what Mallory has done for others can be done for you!

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SERVING INDUSTRY WITH

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- Power Supplies
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CROSS TALK

►**WHITE ON CYBERNETICS** . . . W. C. White, having recently read Wiener's "Cybernetics", writes:

"I have been convinced for some time of two things. First, cybernetics is one of the most important, if not the most important, science of the second half of the century as regards the many detailed changes it may make in our way of life. In the second place, electronics is unquestionably the most important single factor in this science. Not only does it furnish elements and techniques for the 'brain' but even more important it furnishes the unique devices that simulate many of the human senses and thus furnishes what Wiener terms the 'impressions' or 'signals.' I refer to the microphone (ear), loudspeaker (voice), phototube (vision), each necessarily associated with electronic amplifiers and control. There are also other electronic devices that excel the human senses in response to delicacy of touch, temperature change, motion and sense of smell for certain odors.

"This whole science has crept up on us from many directions and through many channels without our fully grasping its full significance. It seems to me that Wiener's chief contribution is putting it together as a whole and naming it. Most of us, I believe, have not seen clearly that the ship's steering engine, the household thermostat with its anticipatory heat coil, as well as the memory tube, the computer and the optical contour follower control for machine tools are all parts of this newly defined science.

"I will predict that in not too many years the pages of ELECTRONICS could, if you so desired, be dominated by the electronic aspects of this new science and there would be an eager host of readers."

These words have the persuasive air of ordained prophecy. In furtherance of the program in the last paragraph, we are happy to report the receipt of a definitive manuscript on electronic correlation by Professors Wiesner and Lee of MIT. We doubt such subjects will dominate our pages, for the next few years at least, but they will surely have a prominent place.

►**QUIZ** . . . For some months we have been amazed and baffled by a series of "electrical essays" appearing in *Electrical Engineering* from the pens of Joseph Slepian, Walther Richter and others. These are impressive little problems, couched in deceptively simple language, which require a fundamental knowledge of electrical theory plus considerable ingenuity. Their purpose is partly entertainment, partly stimulation to better understanding of the art. We have had little success with them, but the answers are printed in succeeding issues, and the denoument is worth it in every case. Those unfamiliar with the essays are advised to look them up.

All of which brings up the question of whether a similar series of purely electronic problems, demanding less erudition, might not be welcomed by the readers of this magazine. We will go searching for a series of poor man's electronic essays, on the following conditions: that five readers (about 1/60th percent of the readership) will write us expressing interest in the same, and that one reader will send us an acceptable essay, and its solution, to start the thing off. After the prudent fashion of our esteemed colleagues in the AIEE, no prizes will be offered for correct solutions.

►**LAMP TVI** . . . Speaking of problems, we seek further explanation concerning a most puzzling type of television interference, first reported in ELECTRONICS in the December 1949 issue, p 132. This is produced by incandescent lamps in good working order, notably from old-type Mazda B bulbs having a single filament wire draped zig-zag fashion on a glass post. The interference appears most strongly in the 50 to 80-mc region. W. C. White wrote to say that 30-mc radiation from such lamps had been detected about 20 years ago, and the cause had been ascribed to Barkhausen-Kurz oscillations. It was found to occur only in draped-filament lamps. But other readers report the same type of interference from modern coiled-coil filament lamps. Can this be a manifestation of the worthy Drs. Barkhausen and Kurz also? In any case, what is the mechanism? Anyone in Nela Park got any ideas?

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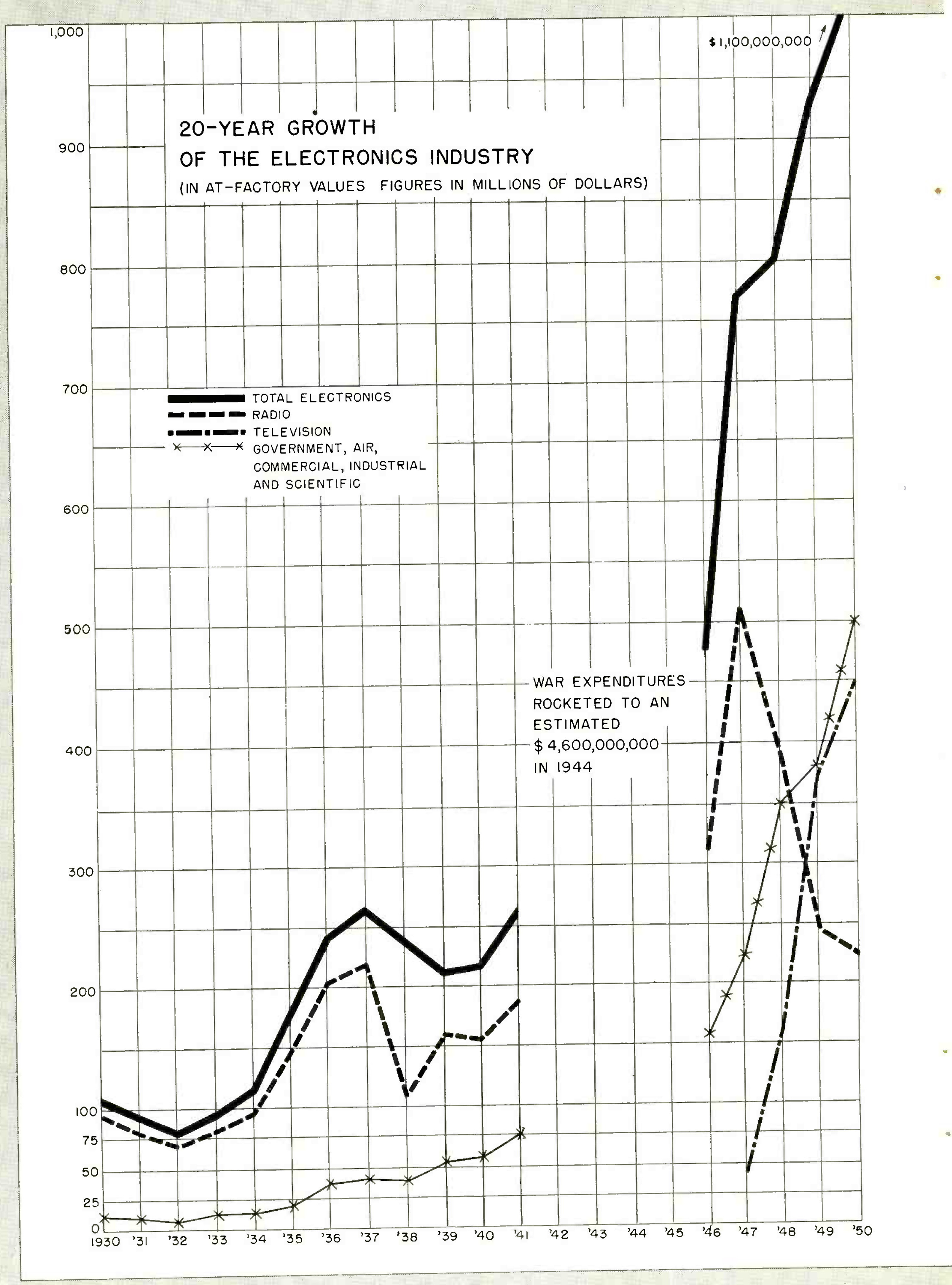

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Our Business in 1950

Until 1940, dollars revolved largely around radio. The next ten years included the war years, in which the influence of the tube made itself felt in military circles and throughout industry as well as in communications. In 1950 television may dominate, but radio production should continue to be substantial and other electronic applications will really begin carrying the ball

By **WALLACE B. BLOOD**
Manager, ELECTRONICS

FIGURES show that the electronics industry has increased ten and a half times in dollars from 1930 to the estimated volume for 1950. In round numbers this is $103,500,000 to $1,100,000,000. For the first time, peacetime electronics will cross the billion-dollar-at-factory-value mark, although it was well over four times that amount at the peak of the war.

You who are in the field today benefit by a metamorphosis unique in industrial history. The war, television, and industrial electronics have brought about tremendous growth, while radio has continued to rank in importance with other major electrical appliances. Estimated radio-receiver dollars for 1950 are two and a half times more than they were 20 years ago—a matter of $92,500,000 in 1930 against $225,000,000 in 1950. The percentage of radio-receiver manufacturing to the whole in 1930 was roughly 90 percent. The figure for 1950 is about 20 percent.

In the figures for the first decade dollars merely doubled, as the country dug out of the depression. But in the second decade, boosted vastly by the war but also in spite of it, much greater gains were made and the radio receiver has ceased to be king. Electronics is a broadly applied art, the scope of which few realize.

Readers of ELECTRONICS who were a part of the industry in 1930 when this magazine was first published (our anniversary is next month) are now fortyish and up. The average subscriber today is well below that age, so the figures herein revealed may be quite new, and certainly should be inspiring.

First Ten Years

When our April 1930 issue went into the mail, it started to serve a radio industry then about nine years old. Prior to that date, battery sets had given way to plug-ins, the speaker had been put into the cabinet and a pretty fair noise came out as the end result.

Applications of tubes to industrial uses were largely gleams in the eyes of a mere handful. There was no conception of radar, little of aerial navigation, certainly none of guided missiles. Oscillate a tube at 100 megacycles? You're crazy! It was just consoles, tabletop jobs and a trickle of phono combinations, a meager market in marine, and amateur equipment, and some playing around with this new gadget radio by police, forestry people and the like.

> **"Readers of ELECTRONICS** who were part of the industry in 1930 are now fortyish and up . . . the average subscriber today is well below that age . . . so the figures herein revealed may be quite new, and certainly should be inspiring"

The ten years prior to 1940 were not conducive to rapid expansion. With the depression and subsequent 1938 recession making things tough, manufacturers had few dollars with which to dabble in new markets. Industrial applications began to creep in, although in no great dollar volume. The cathode-ray tube permitted the timid introduction of all-electronic television. The "electric eye" began to look at more and more things industrial-wise. Welding began to be electronically controlled. High-frequency power was creeping in as a heating agent. But, at the end of that decade, electronics other than communications was of such little moment that the big companies had not even departmentalized it. A great majority of electronic developments other than communications were conceived by individuals —independent engineers and consultants—but they had a gruesome time trying to sell their brain children to industry. Electronic devices were looked upon as tricky things, unreliable, delicate and mysterious.

The industry did, however, double itself in that ten years, mostly because of radio, with its progressing needs for replacement parts. But many other industries came out of the depression with similar rapidity. December 1941 shot the starting gun of electronics as it is today.

The Next Ten

It is not for this nontechnical observer to describe the progress in electronics brought about by the necessities of war, the opening up of the usable spectrum from a narrow hallway to a path the breadth of which has not yet been measured. It is easily said that the war propelled our industry ahead ten years—twenty years. Those are just numbers. But the practical side of it is that private industry could not have gathered up the billions which went into technological research and practical applications that we had to have to win. It is paradoxical that war inevitably accelerates progress with fantastic speed, because we are able to beat the swords into plowshares.

The year 1946 presented the industry with the greatest problem it had ever faced—a quick slide-down from a war business of more than four billions. We are far enough along in history now to know that the retreat was orderly. Beset by shortages, quotas, black-markets and a carpetbagging type of conniving which tried men's souls, there were surprisingly few mortalities, and are to this day. Only a few remembered prewar company names disappeared. A few more merged. But the test of management—and that is what it was—was largely met.

The huge backlog for radio receivers was heavily cut into by colossal production in 1947. True, the sets were mostly of prewar design and were sometimes thrown together with haywire and binding twine, but the public got its clamored-for radio and didn't kick.

The year 1948 was the year of redesign. With the pressure eased for radio sets, smart management saw gruelling competition rearing its head. They redesigned with war know-how. Also, to the complete surprise of practically everyone, the infant television bounced into long pants like no prodigy ever seen before. Components, forced to quality by JAN, began to shrink in size. It was recognized with astonishment that one television set ate up three to ten times as many components as did one radio set, with only a few exceptions. Make 'em good, make 'em smaller, make everything simpler—here we go, boys, in a new entertainment field which the public wants like all-get out. Make 'em good, but get the price down for the workman with a family. The war years taught how to do it.

So, 1949 became the year of production. The quality has so far been kept up, but innovations in simplification, in production efficiency (taught, too, by the war) are bringing 1950 television sets into the homes of people whom the most enthusiastic thought could not be reached on a price basis for several years.

Dollars Versus Units

When you have scanned the accompanying graph covering twenty years of our business you will note that the electronics industry is ten and one half times greater than 20 years ago, five times greater than in 1940. It is—in dollars. But it is not in units—nor in prewar dollars.

The ELECTRONICS INDUSTRY . . .

- Will do 10½ times as much business in 1950 as it did in 1930.
- Sales, at factory prices, should top the billion-dollar mark.
- The Government is in the market for about $300,000,000 worth of gear.
- Television production is expected to reach 3,700,000 units.
- Radio should hold up above 8,000,000 sets.
- Industrial applications will achieve more substantial dollar totals.

In units there are many variables. For instance, resistor-unit totals for 1950 will probably be six times the 1940 figure. But another essential component, the speaker, will be one third less in manufacture than prewar. As Dorman Israel points out in his article in January ELECTRONICS, "In three years, tv has taken over the resistor business, but not all traditional suppliers of radio-set components have fared so well. Those on the wrong side of the ratio sign include the makers of fancy dials, who have converted to picture-masks, and the variable-capacitor people who are wrestling with head-end tuners, many of which do not even use variable capacitors. And lo! The poor loudspeaker manufacturer. Loudspeaker plants find it necessary to convert to ion traps, focus assemblies and other debased items employing permanent magnets."

Well, automobiles have shed many things, including Prestolite tanks, and now even the clutch pedal is on the way out. Yet the automobile business is still very good indeed in spite of the changes that have taken place.

We have so far stressed progress in dollars. But a 1950 dollar is not a 1940 dollar—it is 60 cents of a 1940 dollar. So, on a dollar basis, 1950 total business of $1,100,000,000 would represent a 1940 dollar business of $663,000,000. Wholesale commodity prices are up 115 percent above prewar. Radio receivers are up about 200 percent, the cost of living is up 75 percent and consumer purchasing power is up 113 percent. You figure from that hodgepodge whether we are five times bigger than prewar or only two and one half times. It's a job for an economist.

The doubling up of radio receiver costs has in it more than increases in material and labor expense. If there are 639 separate taxes in the cost of a house, 151 in a loaf of bread, and 150 in an Easter hat, it is logical to assume that a complex radio or more complex television set loaded with taxed materials made by scores of taxed manufacturers bears an extraordinarily heavy load. Certainly a good share of the excises collected at manufacturers' level must be passed on

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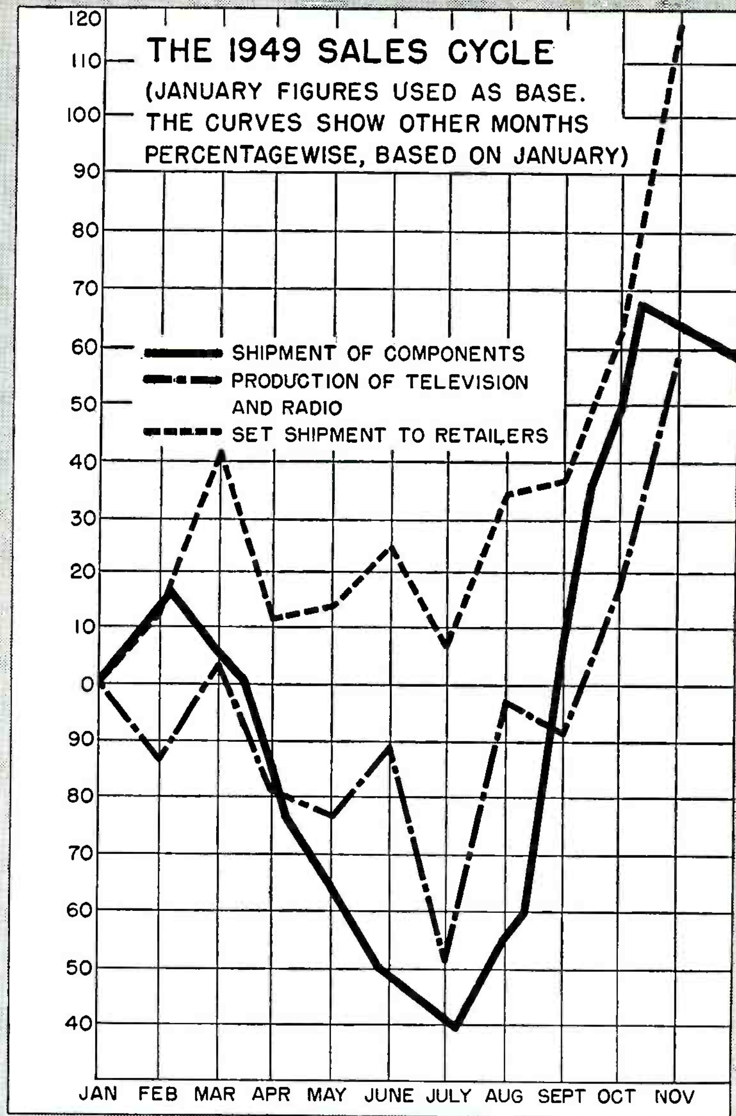
to the consumer. "So varied are the invisible taxes which impinge on the innocent taxpayer that experts are unable to determine, with any degree of exactness, how much these levies cost him over the year or what percentage of his total taxes they represent," wrote Robert S. Bird in the *New York Herald Tribune.*

Yet, with the burden of taxes comparatively nonexistent in 1930, with prices and labor costs more than doubled since then, a householder can buy a good television set with a 1950 dollar today for about what he paid for a good radio with a 1930 dollar in that period of twenty years ago. It is a great tribute to technology that such a thing can be accomplished.

Predictions for 1950

In its emergence from the war the industry has resumed a sales cycle which is not unlike that of prewar. It becomes apparent that television will be bought by the public in about the same ratio by months as has been radio. It is even possible that the spring-to-summer dip will be steeper because of the lack of "portable" appeal—though, heaven knows, we may get portable battery-type television some day soon.

Comparative curves showing shipment of components, production of television and radio, and set shipment to retailers in 1949 are shown in the second chart. This is not an entirely normal chart because few parts makers anticipated the Fall cry for television, and eased off too much in the summer months. Probably the components curve is most indicative of the normal seasonal curve.



When television goes on a buyers' market, the retail-shipment curve will surely sag deeper in May and June. However, the chart presents a study which should serve to stifle the gripe about poor business in warm months. It always has been low, always will be low, and the manufacturer who accepts such a curve and plans for it will really enjoy his golf or summer cruise.

In April 1949 we printed this: "The economists (Department of Commerce) estimate that 2,000,000 tv sets will be produced in 1949, worth $600,000,000 (retail). We get optimistic and say 2,500,000 at $750,000,000." Lately published figures (2,750,000) showed we did all right.

We also called the turn on 8,000,000 radio sets against the Commerce figure of 10,000,000, and it was a pleasure to be one of the few who about hit it. So, with no little trepidation we try again, for 1950, this time sticking to the 8,000,000 radios and going up to 3,700,000 on tv. Before us are tv predictions ranging from 3 to 5 million, and that's quite a lot of latitude.

If you predicate your business on three-seven for tv, we have a feeling you won't have to dump in the distress markets or watch your competitors grab business because of your own underproduction. If you do, you'll find us somewhere around Lake Athabaska.

Government, in 1950, is good for about $300,000,000 in electronic gear. It may go up. Depends on Joe. Radio and tv also depend on Joe and such luminaries as John L. Lewis.

Industrialwise, electronics is approaching the point where it must be used for a majority of control and measuring operations or a manufacturer will have to bow out to his competitors. It is getting that good in doing those things which cannot be as efficiently and accurately done by any other means. This control business will be the next number-one market for the electron tube.

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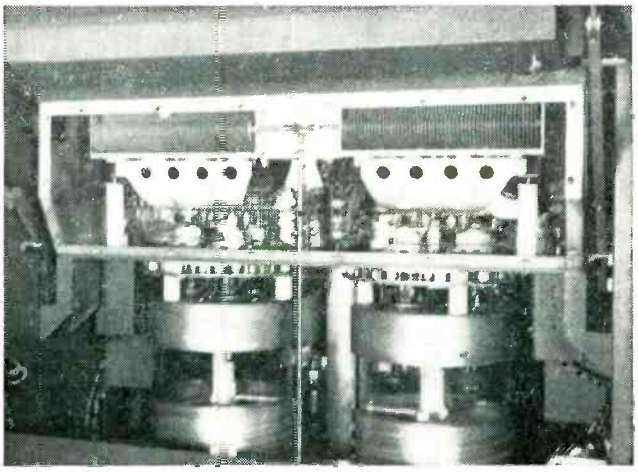
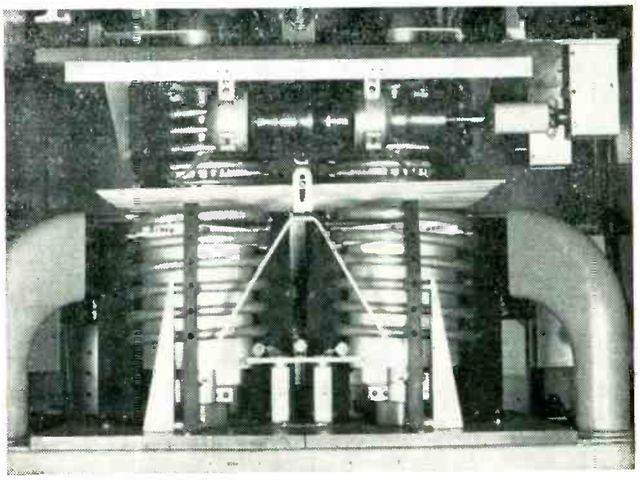
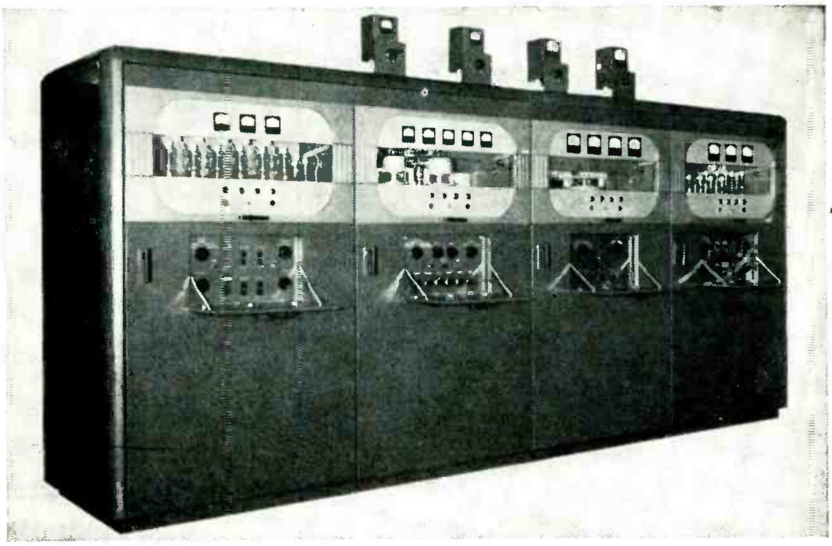


Cooling air for final amplifier tubes is brought up through two large glass cylinders. Perforated sheets form connections between tube cathodes and input tuning capacitors



Intermediate plate tank and its output coupler are separated by a Faraday shield to minimize transfer of harmonics. Funnels on either side deliver cooling air

CONTINUOUSLY-TUNED



Nine adjustments required for frequency changing are located on front of two r-f bays (center). Meters on top are r-f line meters. Two left-hand meters are only used when driver is used as independent 15-kw transmitter

By JAMES L. HOLLIS

Engineer
Collins Radio Company
Cedar Rapids, Iowa

SINCE THE OPTIMUM FREQUENCY for transmission over a given path varies annually, monthly, daily, and even hourly, and since the optimum frequency for one path length may be different from that for another, frequency changing is a big factor in high-frequency radio communications. Either several pretuned transmitters or a single easily shifted transmitter must be used for reliable high-frequency service.

Multiple transmitters unquestionably provide for the most rapid frequency shift. Initial cost and space requirements are usually prohibitive, however, especially when power outputs of 10 kw or more are required.

The transmitter to be described (Navy type AN/FRT-5 and AN/FRT-6) has been developed for use at key points in high-speed radiotelegraph circuits where dependability, versatility, and rapid frequency changeability are of great importance. It provides continuous coverage over a frequency range of 4 to 26 megacycles with an overall efficiency (output/primary power input) varying from 55 to 60 percent. Several features new to transmitters of this power and frequency range are incorporated. Paralleled medium-power tubes, servo-positioned tuning, complete air cooling, relatively low d-c anode voltage, and low-voltage rectifier tubes are among these features.

Frequency changing of this 50-kilowatt transmitter is accomplished entirely from the front panel by means of nine control knobs and a crystal selector. These controls may be set initially from individual frequency calibration charts or from a setup chart if the equipment has been previously tuned to the frequency and dial readings recorded. All circuits are motor-driven and the maximum time for travel from one frequency limit to the opposite is one minute. This means that the resonant circuits can be set quite closely to any chosen frequency within one minute. After the voltages are applied, only three of these controls need be checked to make certain that they are exactly resonant and operation can be resumed on the

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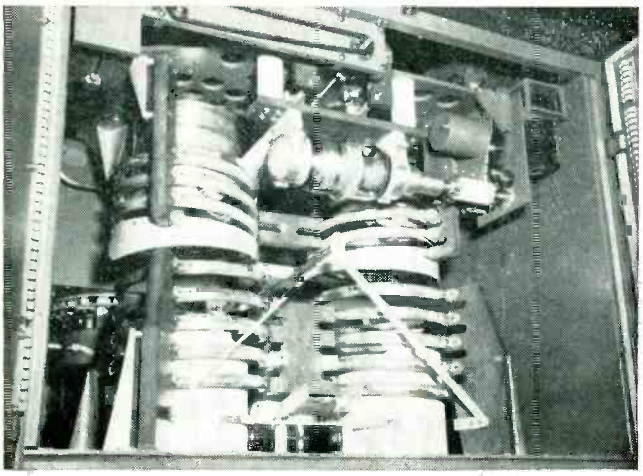


To decrease coupling to 50-kw plate tank (bottom), resonant output coupler (top) is moved forward by means of chain drive and lead-screw arrangement

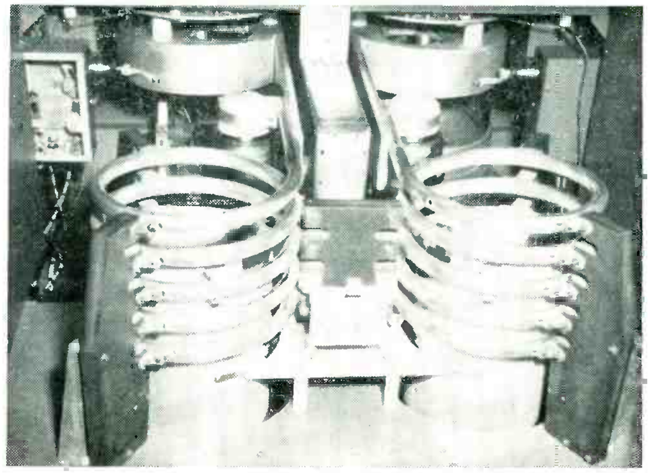


Plate tank circuit with output coupler removed to show variable vacuum capacitors and amplifier-tube anode assemblies. Sheet-metal box between plate lines distributes cooling air

50-KW TRANSMITTER

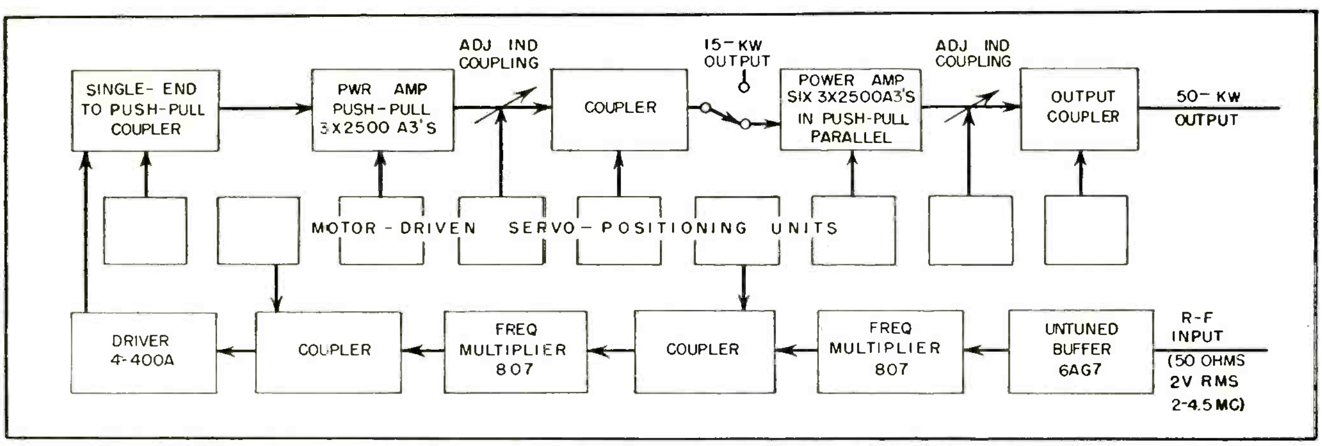
High-efficiency operation on any frequency from 4 to 26 mc is possible without tank-circuit switching. Stages are individually tuned by motor-driven servo-positioned units which may be preset for desired frequency in less than a minute

new frequency. An experienced operator can make this change in less than two minutes without hurrying.

The Transmitter

The transmitter consists of a grounded-grid power amplifier stage using six 3X2500A3 tubes in push-pull parallel driven by an intermediate power amplifier using two more 3X2500A3's in push-pull. The intermediate amplifier is driven by a single 4-400A tetrode which is preceded by a two-stage frequency multiplier and an untuned buffer. Oscillator output is fed to the buffer through a 50-ohm transmission line.

The 3X2500A3 tubes were chosen for the final and driver because of their high perveance, which insures high plate efficiency; their compact structure, which minimizes stray inductances; their low plate voltage requirement, which reduces the cost and complexity of the tank circuits as well as the power supplies; and their low filament-power requirements. All power amplifier tank and output circuits use all-copper variable vacuum capacitors with 20-to-1 capacitance ranges. A



Motor-driven servo-positioned adjustments are controlled from front panel. Seven of these adjust continuously variable resonant circuits; the other two adjust output coupling of the final and driver

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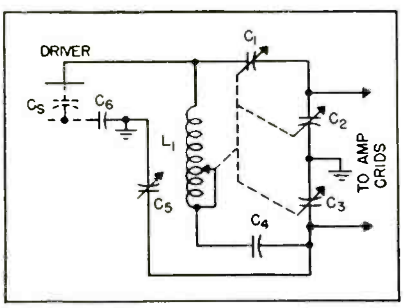
block diagram, presented on the preceding page, illustrates the functions of the nine motor-driven servo-positioned adjustments. Seven of these adjustments are continuously-variable resonant circuits. These circuits are mechanically driven by small low-inertia two-phase reversible motors geared so that approximately 2,000 revolutions of the motor will carry the circuit through its complete range. The motors are controlled by relays through a servo-positioning system to be described.

Probably the most interesting circuit and definitely the most difficult to develop, is the 50-kilowatt plate tank and output coupler.

The plate tank circuit consists of two 25 to 500-$\mu\mu$f variable vacuum capacitors (Jennings Type UXC), two oppositely wound variable inductors mounted with their axes parallel and vertical, the output capacitance of the amplifier tubes, and the connecting lead inductance. The amplifier tubes themselves are mounted in two groups of three paralleled tubes each to form a push-pull circuit. Three tubes are mounted in a common 11-inch diameter anode housing which in turn is connected to one vacuum capacitor and one inductor by a wide conductor. In order to minimize the self-inductance of this connector, and at the same time obtain reasonable mechanical spacing between components, a grounded box structure was placed between the two conductors while the conductors were made as wide as practical. The effect was to form a very low impedance transmission line section between the tubes and the inductors. By this expedient it was possible to transfer a sufficiently large portion of the required inductance at 26 mc to the tank inductors where it could serve a useful purpose for coupling to the output network. This box structure also provided a very convenient means of distributing cooling air to the tank circuit components.



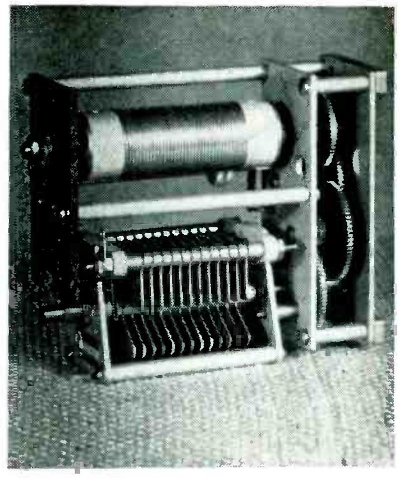
Single-ended to push-pull coupler used between driver and intermediate power amplifier uses two identical capacitors in a capacitance voltage divider

The coils remain stationary and the drum-supported contact assembly is rotated. Three sliding contacts are mounted on the top edge of the drum and arranged to match the pitch of the copper coil. These contacts have a small amount of vertical and lateral freedom and are spring-and-cam loaded so they maintain balanced downward and outward pressure with the weight of the drum providing the loading force. The drums are centerless except for the driving spline at the bottom. A second set of contacts is mounted on a cross-connecting plate to tie the drums of the contacts of the two coils together. The drums and cross-connecting plate are made as large as practical to reduce the stray inductance in the cross-connecting path.

The contacts themselves are hardened beryllium copper clips heavily chrome plated and may be easily removed for replacement. A hard contact surface was found to be necessary to prevent chattering and burning which always occurred when softer materials were used against the copper coil.

R-F Amplifiers

Since this is a grounded-grid amplifier, the input voltage is applied between cathode and ground or, because it is a balanced push-pull circuit, between the common cathode terminals of the two groups of three tubes. The input impedance is quite low being in the order of 100 ohms balanced. Effective r-f isolation of the filament terminals from ground is provided by a composite r-f choke consisting of six filament wires inside of a copper tube which in turn is formed into a helix. One such choke is used for each group of three tubes. The six filament wires provide three individual circuits so that each tube may be independently metered and protected. In each three-tube group all filament terminals are capacitively coupled to the r-f input terminal. The


Rotating coil and variable capacitor of frequency multiplier tank circuit are adjusted by gear train at right

output coupling network of the intermediate amplifier is then coupled through a short transmission line to these input terminals.

The intermediate amplifier output may be coupled directly to a 600-ohm antenna transmission line and the first two units operated as an independent 15-kw transmitter.

The intermediate amplifier plate tank and output coupling circuit is very similar to, although physically smaller than, the 50-kw amplifier plate tank. It is this output coupler which supplies the input voltage for the power amplifier. It was not practical to design this output coupler with the midpoint of its capacitance branch grounded, therefore, a pair of variable air capacitors is connected from each amplifier input terminal to ground to provide the necessary low impedance path to ground for the power amplifier plate current pulse. This variable capacitor assembly is directly connected to a front panel control and is set to produce an approximately constant shunt reactance as the frequency is varied. It is set up directly from a frequency chart and is not adjusted as part of the tuning procedure.

Very low inductance connectors are required from the variable capacitors to the common filament terminals to push the natural resonance of the circuit thus formed above 52 mc, the second harmonic of the highest operating frequency. Several other places in this coupling circuit required carefully de-

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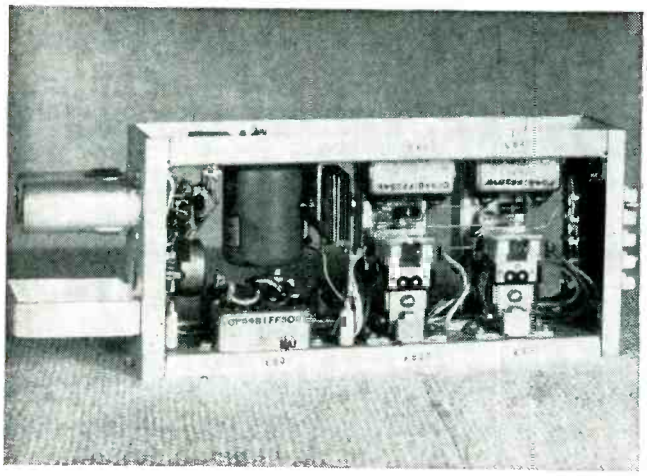
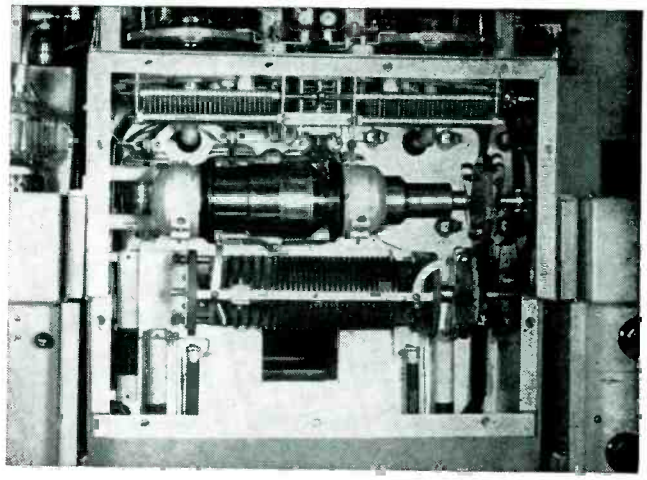


Nine of these servo control amplifiers and relay units enable operator to make all adjustments at front panel of transmitter when changing frequency



Variable inductor, two variable air capacitors and one vacuum capacitor are coupled together and driven through gear assembly visible at right

vised arrangements to prevent such resonances.

The most unique coupling circuit in this equipment is the one between the 4-400A single-ended driver and the push-pull intermediate power amplifier. This is a single circuit which simultaneously provides the single-end to push-pull conversion, a five to one impedance change, and a resonant tank for the driver stage.

The circuit of this coupler shows L_1, C_1, C_2 and C_3 to be variable elements mechanically coupled together to form a continuously-variable resonant circuit. Capacitor C_4 is a d-c blocking capacitor only. The ratio C_2/C_1 is maintained at approximately 5, which is the required ratio between driver plate voltage and amplifier grid voltage. Since C_3 is identical to C_2, the grid voltages will be 180 degrees out of phase and identical in value when C_5 is adjusted to pass all of the current that flows in C_s, the stray tube and wiring capacitance.

Servo-Positioning System

Each of the variable circuits is motor driven and controlled from the front panel through a simple servo-positioning system. The motors themselves are small, high-torque, low-inertia, two-phase units operated by two sensitive relays. The positioning system is an a-c bridge type in which the front panel control is a voltage-dividing potentiometer which constitutes two of the arms while a second identical potentiometer coupled to the driven circuit constitutes the remaining bridge arms. Identical voltages are applied across the potentiometers so that any difference in position between the manually-set front-panel control and the driven circuit results in a voltage difference between the movable arms of the potentiometers. Since this is an a-c bridge the output voltage will have a 180-degree phase difference between unbalance in one direction and unbalance in the opposite direction and thus provide a sense to the system.

This voltage could be coupled through a transformer to the grids of a pair of control tubes whose plate circuits each contain a relay —one for forward and the other for reverse operation of the motor. If these tubes are operated with a common a-c plate voltage of the same frequency and phase as the applied bridge voltage then only that tube which has a positive grid voltage swing while the plates are positive will conduct and close its relay.

In the actual equipment a voltage amplifier is inserted between the bridge output and the control tubes to increase the setting accuracy. This voltage amplifier, the control tubes, the relays and their associated components are assembled on a small chassis and arranged as a plug-in unit.

Operating efficiency and ease of tuning have been very gratifying. Overall efficiency (a-c power input to r-f power output) varies from 55 to 60 percent at 50-kw output. The apparent efficiency of the grounded-grid power amplifier measures 95 percent, at the low-frequency end, down to 89 percent at the high-frequency limit. The intermediate amplifier operating independently will deliver 16 to 18 kw at efficiencies ranging from 77 to 83 percent over this same range. The combined efficiency of the intermediate and the power amplifier varies from 74 to 71 percent over the frequency range. The efficiency figures at the low-frequency end are very nearly the calculated maximum tube efficiencies for the operating conditions. The drop off in efficiency at the high-frequency end is to a large extent the result of tank and output coupler losses. This means that these losses amount to approximately 3 kw at 26 mc.

Operation

Changing operating frequency does not involve the mad scramble to change shorting straps, plug-in capacitors, neutralizing circuits, or complete inductance assemblies so familiar to operators of this class of equipment. The control dials are simply rotated to the set-up figures corresponding to the new operating frequency, power is applied, and plate circuit resonances checked. The tune-up procedure for new uncharted frequencies is almost as simple. The control dials are set to the approximate dial reading selected from the tuning curves and a simple straightforward tuning procedure is followed.

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Versatile X-Ray Intensity

This practical device permits rapid exploratory measurements, continuous monitoring or work involving a large number of readings within a short time. Detector probe may be carried by hand for portable applications or permanently mounted for gaging thin materials during production

A DIRECT-READING x-ray intensity meter was desired that would be sufficiently sensitive to indicate the leakage radiation from lead-protected production-line "ray-proof" housings. This implies a sensitivity of the order of 0.2 roentgen (r) per hour, about 5 milliroentgens per minute, at one meter from the target of an x-ray housing.

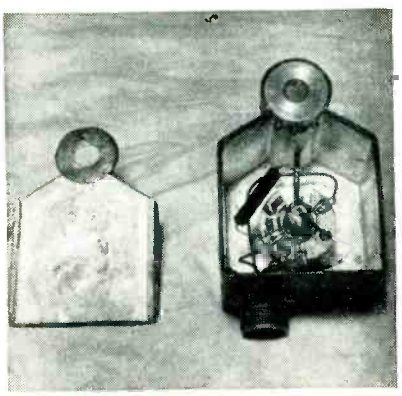
It was also desirable to measure the full r output from a beryllium window x-ray tube, previously described by Rogers[1] as a high-energy source of long-wavelength x-rays. At 10 centimeters from the tube target, the intensity of the Machlett OEG-50T tube of this type is about 58,000 r per minute. A reasonable calibration was required to be maintained over the wide range of x-rays from about 0.05 angstrom unit (260,000-volt deep-therapy tube) to about 5 angstrom units (thin beryllium window tube operating at 3,000 to 5,000 volts).

After passing through several development stages, the direct-reading r meter described herein was evolved. It consists of an electrometer tube and a triode d-c amplifier, a power supply, and a pair of ionization chambers, one for high-intensity work with direct radiation, and one for low-intensity work involving measurement of scattered or leakage radiation.

Circuit Operation

Referring to the circuit of Fig. 1, a beam of x-rays entering the ionization chamber through one of its windows partially ionizes the air in the chamber in proportion to the amount of the radiation absorbed in the air. Since a potential difference is maintained across the chamber by the B supply, a current flows through load resistor *R*, this current being proportional to the number of ion pairs produced in the chamber, assuming that all are collected. This, in turn, is proportional to the chamber volume.

The signal voltage appearing at the 959 No. 3 grid (which is its signal grid in this application) is proportional to the amount of the x-ray beam absorbed per unit volume, to the chamber volume, and to the load resistor *R*, provided that the effective resistance of the chamber while measuring the beam intensity remains high enough so that it, and not the load resistor *R*, determines the current through *R*. Since the International Roentgen Unit (r) is defined in terms of the amount of energy absorbed in one cubic centimeter of air at certain standard conditions, the chamber must be so designed (or calibrated) that its indications may be interpreted in terms of international r units.



Detector probe contains a one-cubic-centimeter ionization chamber and an acorn preamplifier

The high voltage is supplied from a conventional full-wave rectifier regulated by VR-105 tubes, and supplied from the a-c line through a Sola constant-voltage transformer. This double regulation has been found to remove all traces of line-voltage fluctuation from the B supply. The 6J4 heater is supplied from a winding of the same transformer, and is therefore also regulated. The 959 filament voltage was initially supplied from a well-filtered rectifier system but this was not found to be satisfactory in that a rapid and random fluctuation was observed. Operation of this tube on a-c is precluded by the hum voltage introduced, and so a battery supply was added for this tube alone. Provision was made for adjusting the filament voltage to a predetermined value, which may be checked as often as required on the panel meter by a push-to-calibrate button.

Electrometer Probe

The x-ray detector head consists of the ionization chamber with the electrometer stage in a lead-shielded compartment. This head is carried by hand in probing for x-ray leaks. The voltage developed by the chamber is detected by the electrometer tube and is supplied to the 6J4 d-c amplifier.

Since resistor *R* is of the order

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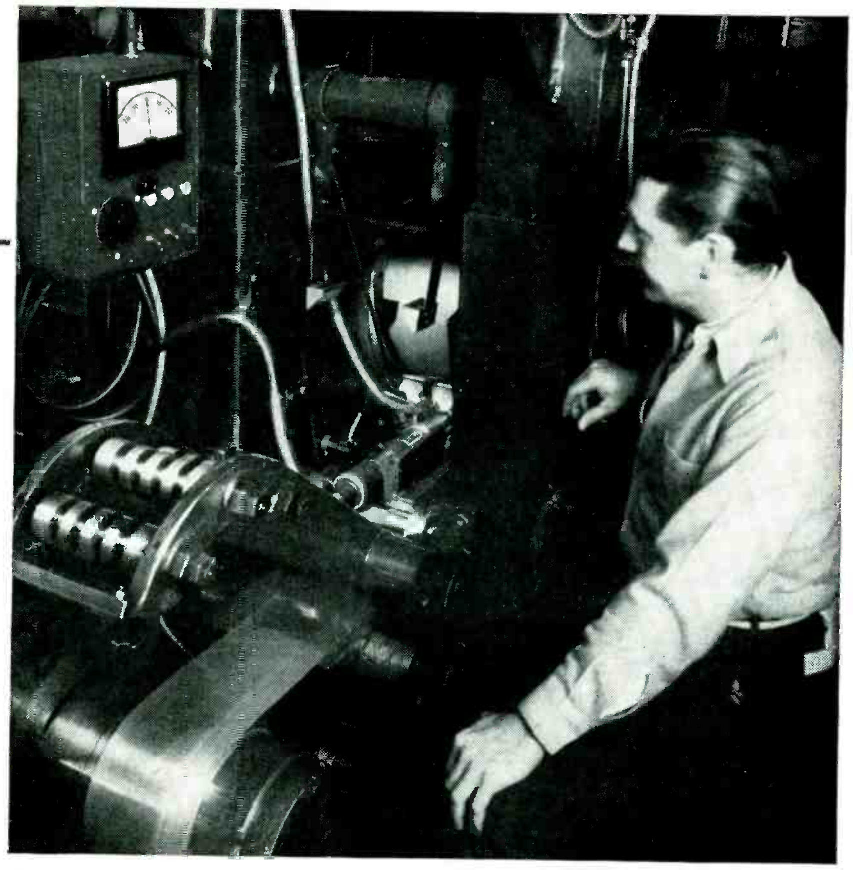
Meter

By WILLIAM B. LURIE
*Machlett Laboratories, Inc.
Springdale, Connecticut*



Typical installation of x-ray gaging equipment in a rolling mill, to measure the thickness of brass being rolled. The instrument described in the text can be used in similar applications by mounting the detector probe under the moving strip

of 10^8 to 10^{11} ohms (100 to 100,000 megohms), each chamber must be so constructed that the leakage path between electrodes provides a leakage resistance large compared with these values. Likewise, the 959 tube must be operated at electrode voltages such that its signal grid current is small compared with the 10^{-12} ampere or so of ionization current which flows. The electrometer tube is operated with about 0.7 volt across its filament, conventional control grid tied to filament (positive end), screen grid at about 7 volts positive, suppressor grid (acting as signal grid) at about 5 volts negative bias, and about 7 volts positive on the plate.

Since stock 959 tubes are used, with no special selection, different tubes must be operated at different voltages to produce the same plate current. It is necessary, in changing tubes, to keep the plate current the same in order to keep the same operating bias on the 6J4 tube.

In practice, each chamber has its own preamplifier permanently attached to it, to avoid making and breaking, even with low-leakage connectors, the very highly insulated chamber collecting electrode connection. To adjust the 959 plate current to the desired point, its filament voltage is adjusted to bring the 6J4 bias, and therefore plate current, into the range which can be handled by the zero set. This has been found to be preferable to either using the same preamplifier with all chambers, or disturbing several of the 959 and 6J4 electrode voltages by resetting them for each chamber at the time of change.

The 959 plate is returned through 3.9 megohms to ground, giving it effectively 200 volts as plate supply, since its filament is maintained at about 200 volts below ground. The change in voltage across this resistor with signal is applied directly to the 6J4 grid, this tube type having been chosen for the d-c amplifier because of its extremely high transconductance at reasonable plate voltages. The 6J4 steady-state plate current is bucked out, and its change is read on the d-c microammeter in its plate circuit as an indication of the x-ray intensity.

Indicator

The limit of sensitivity of the d-c microammeter is imposed by the stability of its needle in x-ray-free regions. The 6J4 plate current is adjusted to 10 milliamperes, at which operating point the tube has a transconductance of about 12,000 microhmos, or 12 ma per volt. A millivolt appearing at its grid, due to a sudden thermal or electrostatic change, or even random r-f pickup, produces a 12-μa displacement of the zero position of the meter.

The complete instrument has been found to be quite stable after warmup even when operated in the same room as, and from the same power line as, a 280,000-volt 15-ma constant potential x-ray generator with an exposed aerial system.

To change the full-scale sensitivity of the instrument, the microammeter may be shunted to, say, 200, 500, 1,000 and 2,000 μa full scale, provided that the chamber is not permitted to saturate (produce more ion pairs than can be collected in its volume at the operating voltage), and provided the 959 and 6J4 tubes are not operated beyond their regions of linearity. Beyond these limits, the chamber volume and voltage must be suitably adjusted.

Since the small one-cubic centimeter chamber does not saturate up to a very high x-ray intensity, the chamber load resistor may also be changed to vary the full-scale sensitivity of the instrument. Resistors of 100 megohms, 1,050, 10,-

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500, 55,000, and 185,000 megohms have been used with the chambers and amplifiers described. Thus, without changing the chamber volume or voltage, by shunting the meter and changing load resistors the full-scale sensitivity is varied over a range of 37,000 to one.

Meter Circuit

The meter shunt circuit is somewhat novel, in that its requirements are that the resistance inserted into the 6J4 plate circuit by the meter and its shunts must be the same on any range, and that the meter not be damped by plain resistance shunting. This is achieved by using a 100-μa, 360-ohm movement as a millivoltmeter. A voltage drop of 50 millivolts from the 6J4 plate to the main voltage divider will produce 100 μa of current (full scale) through the meter and its lowest series resistor, the total resistance being 500 ohms. On the next range, ($\times$2) the total resistance is still 500 ohms, with 100 μa through the meter and its multiplier resistor, totalling 1,000 ohms, or 100 millivolts drop, and 100 μa through the 1,000-ohm shunt. In this manner, no low-ohmage resistances are placed directly across the meter, and the movement remains essentially undamped.

With the 1-cc chamber used for direct radiation measurements, the full-scale sensitivities in r units per minute are as follows:

Chamber load resistor (megohms)	Microammeter range 0-100	0-200	0-500	0-2,000
100	53	106	265	1,060
1,050	5.02	10.04	25.1	100.4
10,500	0.5	1.0	2.5	10.0
55,000	0.095	0.19	0.48	1.9
185,000	0.028	0.057	0.14	0.57

The full-scale sensitivity with this size chamber is then variable between 1,000 or more r per minute and about 1/40 r per minute (1.7 r per hour) full scale. When used with a 200-cc chamber, for detection of leakage radiation, the sensitivity with the 55,000-megohm load resistor is about 30 milliroentgens per hour, and, though less stable, is still quite usable for detection and estimation of the leakage from "rayproof" housings.

Chamber Construction

Each chamber and preamplifier compartment is shielded from x-rays except where the primary x-ray beam passes through. This is accomplished by covering the entire assembly with sufficient lead to reduce the intensity in undesired places to a negligible value for the hardest (highest voltage) x-rays for which the chamber is used.

To permit simple interchangeability of load resistors, the interior of the preamplifier compartment is made accessible. The cover of the box can be taken off by removing four machine screws

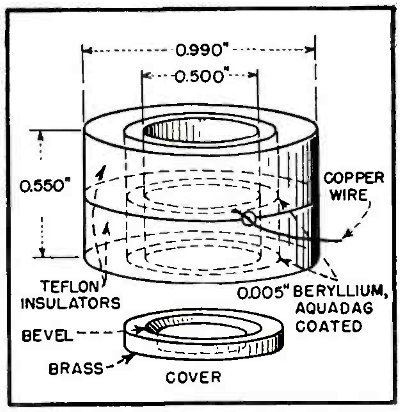

FIG. 2—Construction of ionization chamber. This assembly fits into a one-inch brass cylinder with top and bottom covers

tapped from the side so that the lead top of the box remains integral.

The chamber electrodes are beryllium disks 0.005-inch thick, beryllium being the most workable conductor of low atomic number and therefore low x-ray absorption. The center or collecting electrode is sandwiched between two annular rings of teflon, which in turn are sandwiched between the top and bottom covers of a brass pill-box, the whole assembly (other than the top and bottom) being lead covered. A hole is cut in the side of each piece of teflon, through which a lead is brought for the application of voltage to the center electrode. To this lead a brass sleeve is soldered

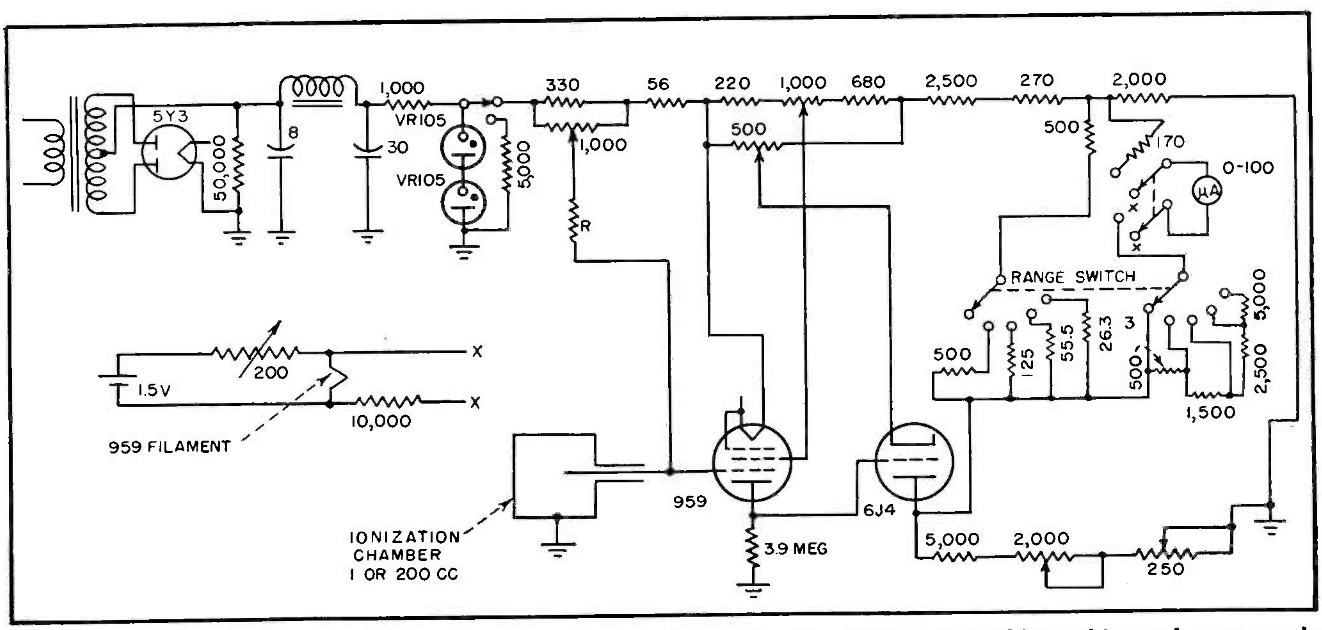

FIG. 1—Complete circuit of meter includes an ionization chamber, electrometer tube, sensitive d-c amplifier and inverted power supply

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which fits over the suppressor-grid pin of the 959 tube. The leakage path to ground from this point is over the surface of, and through, the 959 tube, over the surface of the load resistor which is soldered to the brass sleeve, and over the surface of the teflon insulators in the ionization chamber.

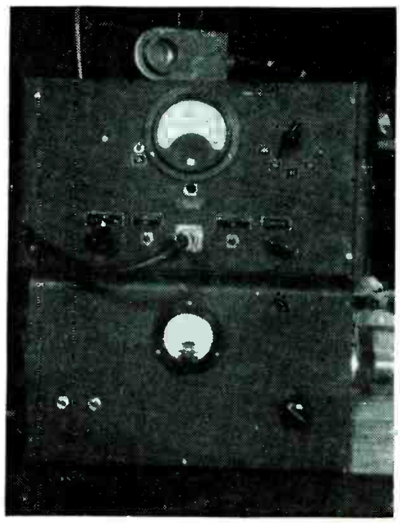
A steatite socket with the g_3 region cut off is used for the electrometer tube. This eliminates the socket as a source of leakage. The load resistor is placed inside the preamplifier compartment, so that it is shielded from hum pickup and capacitive leakage. The plate load resistor of the electrometer stage is mounted on the amplifier chassis, since at its level hum pickup and leakage are less likely; it is still shielded by the amplifier cabinet, chassis, and bottom plate.

In its present state, the equipment has been used for over a year, with no modifications or repairs other than battery replacement. During this period it has been used for a variety of tasks. The direct output of a new very-low voltage beryllium window tube for Grenz-Ray therapy was measured at only 3,000 volts anode voltage, and was found to be about 0.03 r per minute per milliampere of tube current, at a distance of 10 centimeters from the tube target. The same tube was used at 25,000 volts, at which point the total x-ray output was 1,010 r per minute per milliampere, as measured with the same ionization chamber.

Shockproof and "rayproof" housings were also tested, with the leakage radiation at 50 centimeters from the x-ray tube target known to be about 0.1 r per hour. In this case, it was of interest to probe around, to locate the regions on the housing from which the radiation was emanating, and to determine its direction of emergence. The 200-cc chamber served well for this purpose.

Since this detection method is quite sensitive to long-wavelength x-rays, which are readily absorbed by even thin layers of matter, and since compact, rugged sources of these x-rays are now available in the form of beryllium-window tubes, the combination may be used for thickness gaging of very thin sheets of material such as metal, plastics, paper and coatings.

At present, a high-voltage x-ray tube (the OEG-50) is used for continuous, non-contacting gaging of the thickness of steel plate, brass, copper, and aluminum while being rolled in a rolling mill at thousands of feet per minute. The roll pressure is continuously adjusted to maintain the plate at uniform thickness while the operator observes the thickness deviation on a large zero-center meter. The accuracy of this method of gaging has been quoted as being within one percent (within 0.0002 inch, for example, on 0.020-inch sheet brass).



Complete x-ray intensity meter with power supply at bottom and 200-cc probe unit on top of case

By using the newly developed EG-25 x-ray tube, the thickness or freedom from tears of rolled paper may be checked, or of cellophane, or of aluminum foil 0.0005-inch thick, or thinner, of plastic sheet, of paper coating or even of paint or lacquer thickness. The same or better accuracy should be obtainable with the r meter described, since even a slight variation of the thickness of the material will produce a pertinent change in the x-rays transmitted, provided the total intensity of x-rays at the detector is sufficient to be measured. The use of an x-ray tube as a source in such a gage is further advantageous in that the voltage and therefore penetrating power may be adjusted to the optimum value for the material being gaged, the tube current and therefore total intensity of radiation may be adjusted to the level necessary for the thickness of material being gaged and the intensity level is high enough for simple, stable, fast-acting detector systems.

Calibration Method

In calibrating any x-ray measuring instrument, some reference standard is necessary. In this case, the standard was a Victoreen 250-r nylon chamber, which has been calibrated by the National Bureau of Standards (Research Paper 1926) at voltages as low as 10 kilovolts. The direct-reading r meter was calibrated directly against the Victoreen r meter for voltages down to 10 kv. Below this voltage, the 10-kv calibration factor was used, with an added correction applied for absorption in the chamber window (0.005-inch beryllium) and in the center electrode of the same material. This factor becomes rather large at long wavelengths, being about 2 at 4 angstrom units and 4 at 5.3 angstroms.

No satisfactory standard exists against which to calibrate at these wavelengths, and so the exact calibration for every long wavelength is only approximate. The instrument is still usable, however, even for voltages as low as 3 kilovolts (4 angstroms and longer) for comparisons between tubes, between tube types, for thickness gaging and for filter and radiation quality determinations.

The instrument is easily carried about by one person, and maintains its calibration over long periods of time. The only apparent disadvantages it possesses are a rather long warm-up and stabilization time, for about the first quarter-hour of operation, and a rather long time constant when the 185,000-megohm and larger load resistors are used. Neither of these, however, is objectionable.

The author wishes to express his appreciation to Machlett Laboratories, Incorporated, for permission to publish this report on its engineering development.

REFERENCE

(1) T. H. Rogers, High-Intensity Source of Long Wavelength X-Rays, *Industrial Radiography*, 4, p 35, Winter 1945-6.

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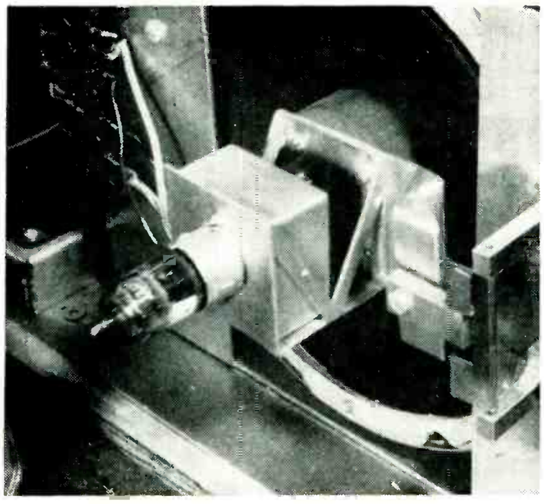

Vibration is imparted by a loudspeaker cone. Tube may be rotated ninety degrees for sidewise vibration

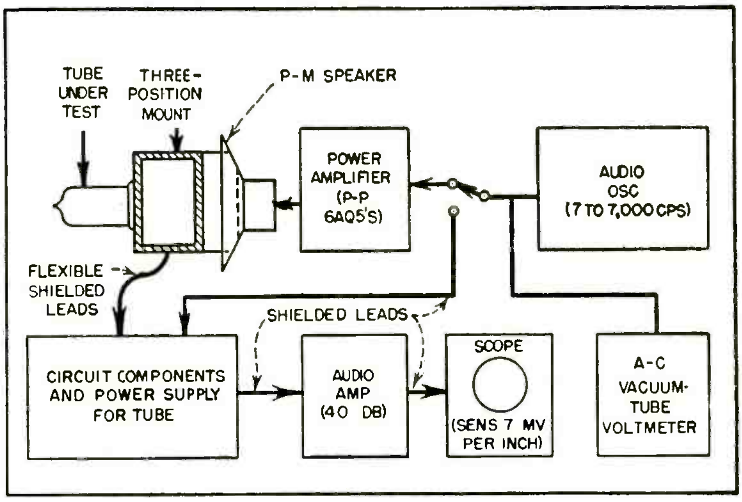

FIG. 1—Vacuum-tube voltmeter measures oscillator voltage required to match microphonic output (with no signal input) of tube under vibration

Microphonics Tester

Convenient setup for quantitative determination of the effects of varying degrees of mechanical vibration on vacuum-tube operating characteristics. Components used are practically all standard laboratory equipment. A p-m loudspeaker imparts vibration

By NORMAN ALPERT
Servo Corporation of America
New Hyde Park, N. Y.

MICROPHONICS are inherent in all types of vacuum tubes. Their existence presents a formidable problem when it is necessary to measure or detect signals which are of the order of 1 to 10 microvolts. The equipment described here was designed to obtain quantitative information about various tube types and the effects of varying degrees of mechanical vibration on their operating characteristics. The setup is made up of standard laboratory parts, with the exception of a few special, but simple, jigs and fixtures.

Figure 1 is the block diagram of the complete microphonic test apparatus. The tube under test can be vibrated sinusoidally in any plane parallel or perpendicular to its base by means of a mounting bracket which is connected to the cone of a loudspeaker. This bracket is shown in the close-up photograph of a tube being vibrated.

Procedure

The test procedure is as follows: The tube to be tested is connected to the speaker-driven bracket, and the output of the audio oscillator is fed into a push-pull 6AQ5 audio amplifier (Fig. 4) which drives the speaker. The oscillator frequency can be varied from 7 to 7,000 cps.

With no input to the tube under test, any output measured by the cathode-ray oscilloscope will be the result of microphonics caused by the vibration imparted by the speaker. The magnitude of this microphonic output is noted. The oscilloscope used has a sensitivity of 7 mv rms per inch with its associated 40-db audio amplifier.

As seen in the circuit diagram of Fig. 2, the resistive component of the grid circuit impedance of the tube under test is about 10 ohms. Johnson noise is therefore virtually eliminated in the grid cir-

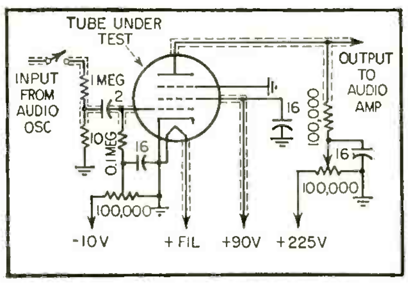

FIG. 2—Tube voltages are furnished by batteries through shielded flexible leads

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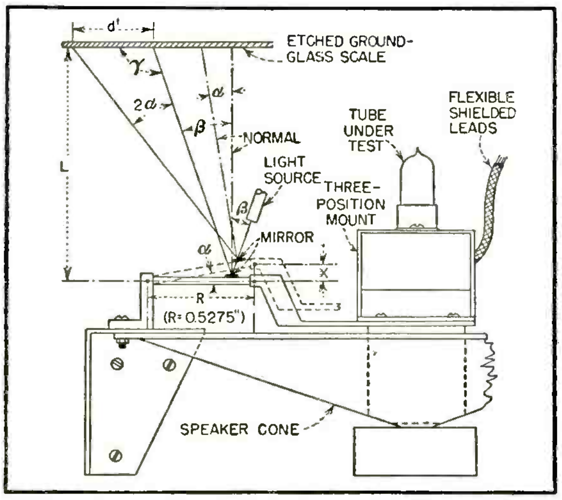
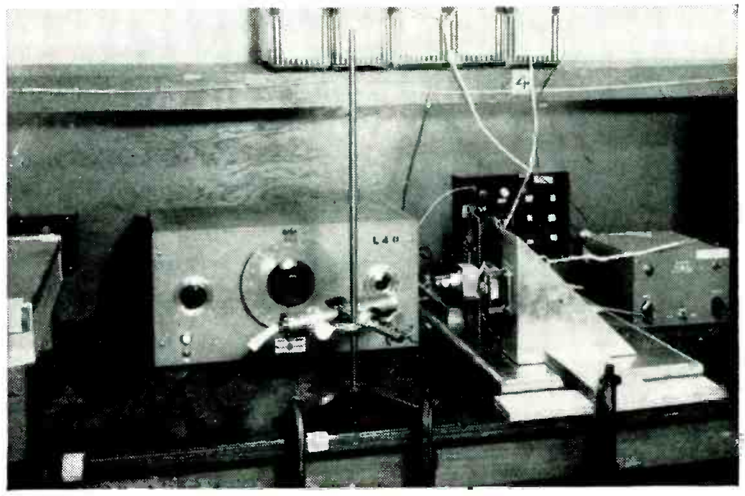


FIG. 3—Optical lever system with dimensions exaggerated for clarity. In actual test setup, *L* is four feet



Distance tube moves during vibration is determined by width of light band reflected onto etched glass scale visible at extreme left of photograph

for Vacuum Tubes

cuit. The d-c grid bias and plate voltage can be adjusted for suitable quiescent conditions.

After the amplitude of the microphonic output of the tube has been noted, the audio oscillator is removed from the speaker-driving amplifier and applied to the grid of the tube under test (attenuated 100 db). The oscillator output is adjusted to give the same output on the oscilloscope as was noted with the tube being vibrated with no signal input. The magnitude of the audio oscillator output is then measured with a vacuum-tube voltmeter and recorded as the effective microphonic noise referred to the grid.

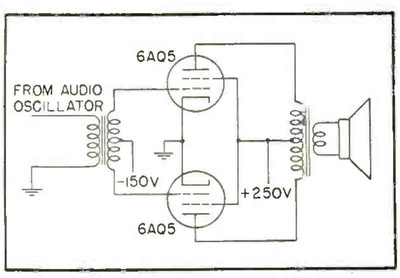


FIG. 4—The speaker is driven at various frequencies by a pair of 6AQ5's

The acceleration imparted to the tube is calculated by noting the frequency and measuring the amplitude of vibration by means of an optical lever system similar to that used with standard wall-type galvanometers. The light source is composed of a condenser and a projector lens in conjunction with a reticle which allows light to pass through a tiny 0.00625 by 0.025-inch rectangular opening. Light is focused on a small mirror which is cemented to a linkage plate that rotates when a lever arm moves in and out with the speaker cone assembly. The light is reflected from the mirror and is observed as a band of light through an etched glass scale placed four feet away.

From the expression for sinusoidal motion, the acceleration a is given by

$$a = \omega^2 x = 0.1 f^2 X$$

where a is the acceleration in G's, f the frequency of vibration in cps, and X the displacement from center or neutral position in inches.

If α, as shown in Fig. 3, is small, the rays of reflected light can be considered to emanate from the same point on the mirror. Also, with $\beta \cong 12$ deg and $L = 4$ feet, the error in assuming τ is a right angle is less than 5 percent. Hence on this assumption

$$\tan \alpha = \frac{X}{R}$$

$$\tan 2\alpha = 2 \tan \alpha = \frac{d'}{L}$$

$$X = \frac{Rd'}{2L}$$

where d is the peak-to-peak deflection on the scale in cm ($d' = d/2$), then

$$X = \frac{0.5275 \times d}{2 \times 2L \times 2.54} = \frac{0.052\, d}{L}$$

where L is the distance between scale and mirror, and X is the displacement of the tube in inches as required in the acceleration formula.

Since the amplitude of vibration for frequencies above a few hundred cycles is extremely small, the acceleration for frequencies above about 200 cps can only be roughly determined.

The optical lever system is capable of measuring displacements as small as 0.001 inch with good accuracy.

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The ELECTRON COUPLER

A Spiral-Beam UHF Modulator

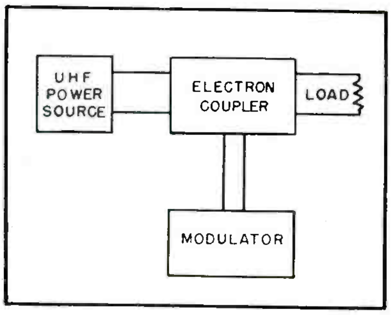

FIG. 1—Basic electron coupler circuit

By C. L. CUCCIA
and J. S. DONAL, Jr.
Research Department
RCA Laboratories
Princeton, New Jersey

THE ELECTRON COUPLER is a developmental tube which utilizes several new principles for the amplitude modulation of high power at the ultra high frequencies. These new principles arise from the use of spiral electron beams to transfer uhf power from an input system to an output system. This is a true energy transfer device since conversion from direct-current energy to alternating-current energy is not involved, only the input uhf power being available to the output system. Control factors based on the behavior of the electron beam during the power transfer may be used to control the transfer.

At low frequencies, modulation and control of power is obtained by using triodes and multigrid vacuum tubes. High power outputs are usually obtained by starting with a lower power oscillator whose frequency is carefully controlled and then building up to high power using a cascaded set of power amplifiers. Used in this manner, the tubes are unilateral control impedances in that, in addition to amplifying, they prevent variations in the output circuit from being transmitted back to the input. Such unilateral characteristics are extremely important since the primary oscillator should not be pulled in frequency during a modulation cycle as this causes distortion. In the uhf region, power is obtained in a different manner. Compact high efficiency generators, such as magnetrons, contain virtually the entire oscillator circuit within their envelopes.

Such uhf tubes are capable of working at very high power levels, and may be frequency stabilized during continuous-wave or pulse transmission by using spiral electron beams[1, 2, 3] or external stabilizing cavities for frequency control.[4] Since high power is readily available, power amplification is a factor which is not as important as control of the power. Magnetrons, for example, are difficult to amplitude modulate without attendant frequency modulation. It is for the purpose of providing a means of electronically controlling this uhf high power that the electron coupler was developed. The tube, a two-cavity device with one electron beam, has the characteristics of a nonamplifying unilateral control impedance.

Physical Characteristics

The electron coupler is a spiral-electron-beam tube consisting essentially of two adjacent cavities which are coupled by an electron beam. The input cavity is connected to the generator and the output cavity is connected to the load, as shown in Fig. 1. A basic configuration using suitable resonant cavities is pictured in Fig. 2 where the arrangement is seen to include a collector and a magnetic field parallel to the axis of the cavities. It is assumed that there is no electromagnetic coupling between the input and output cavities. Power is absorbed by the electron beam in the form of spiral or rotational energy in the first cavity. The rotational energy is in addition to the

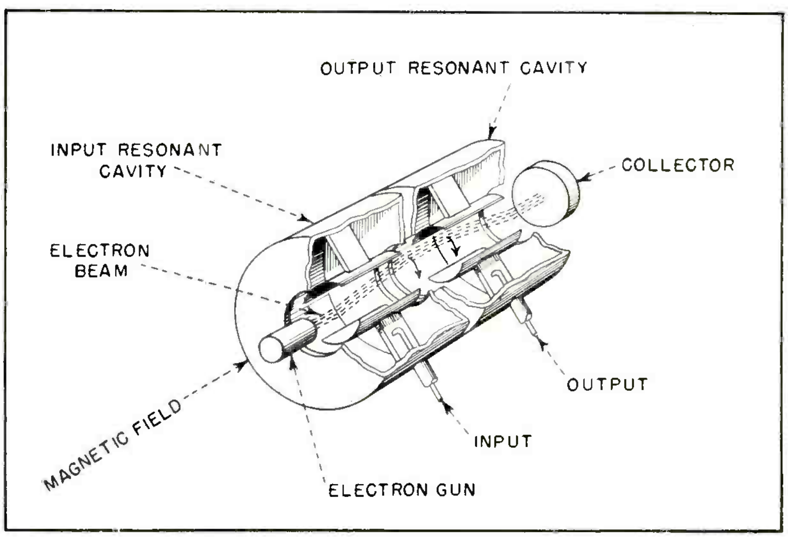

FIG. 2—Internal structure of electron coupler tube

Based on a paper presented at the 1949 National IRE Convention in New York.

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A two-cavity tube, consisting of an electron gun, two axially mounted cavities and a collector, is used to modulate uhf power. Placed between r-f generator and load, the r-f energy is imparted to the beam in the form of rotational energy with a transfer efficiency of 70 percent

energy due to a direct-current beam potential which transports the electrons through the tube and determines their transit time.

Resonance Characteristics

The resonant frequencies of the input and output cavities and the frequency of the input power are adjusted to the cyclotron frequency. This frequency is

$$f_c = 2.794H \times 10^6 \qquad (1)$$

where H is the magnetic field intensity in Gauss and f_c is the frequency in cycles per second.

The resonant cavities which are used in the electron coupler have the particular property of introducing an alternating electric field whose direction is transverse to the path of the electrons through the cavity. Each of the cavities pictured in Fig. 2 has this property and consists essentially of a pair of capacitance plates which are connected to an inductance loop. This cavity design is particularly useful because it is simple and tunable. In the electron coupler, which uses two of such cavities, complete decoupling may be achieved by rotating one cavity to a position so that transverse electric field in one cavity is in quadrature with the transverse electric field in the other. In addition, such cavities may be designed to be short compared to the wavelength of operation. This is an important practical consideration since a magnetic field must pass through the tube thereby necessitating the use of an electromagnet or a solenoid.

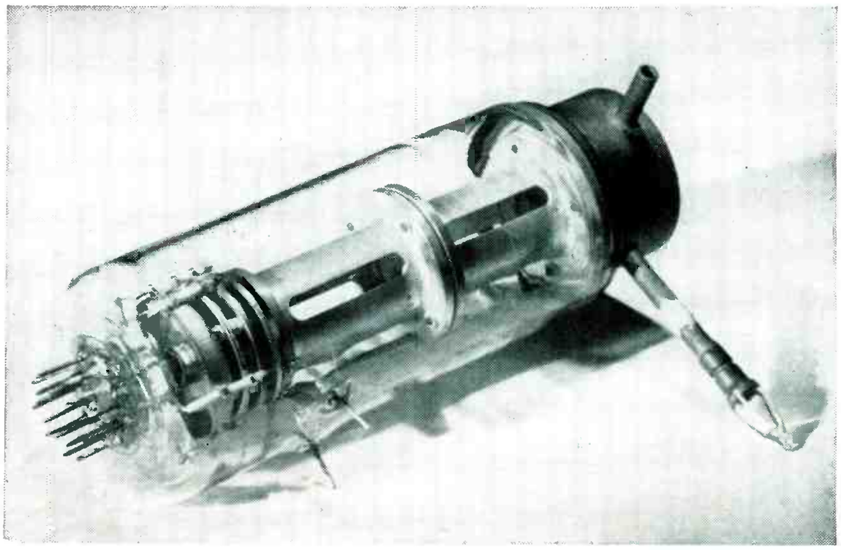

FIG. 4—Experimental tube simulating beam region of the electron coupler

Input Cavity Action

In Fig. 3A, 3B and 3C, it is seen that the electron trajectories in the input cavity are all the same. The major function of the cavity is the absorption by the electron beam of the uhf power. As the electrons pass through the input cavity, the frequency of the input power being equal to the cyclotron frequency, an absorption of energy by the beam takes place in increments of increasing magnitude as the electrons progress through the tube. Since this continued absorption can only take place if the electrons, regardless of where they may be in the cavity, see an accelerating electric field at all times, all electrons will lie on the line-directrix of a cone as shown.

The beam spins with angular velocity $\omega = 2\pi f_o$ and is phased with respect to the transverse electric field. When this field is a maximum

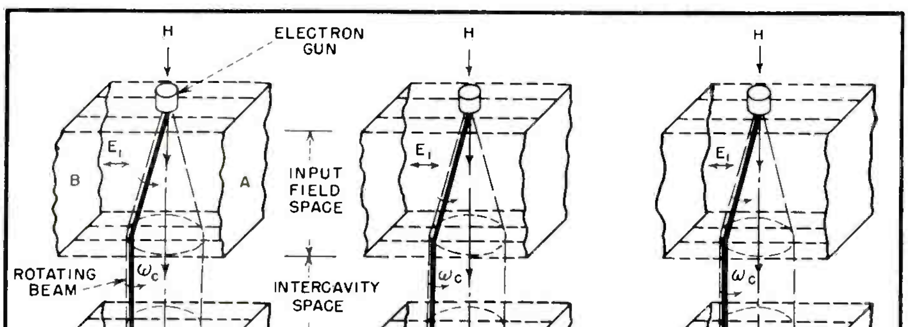

FIG. 3—Beam configuration in the tube for three different values of transit time or loading

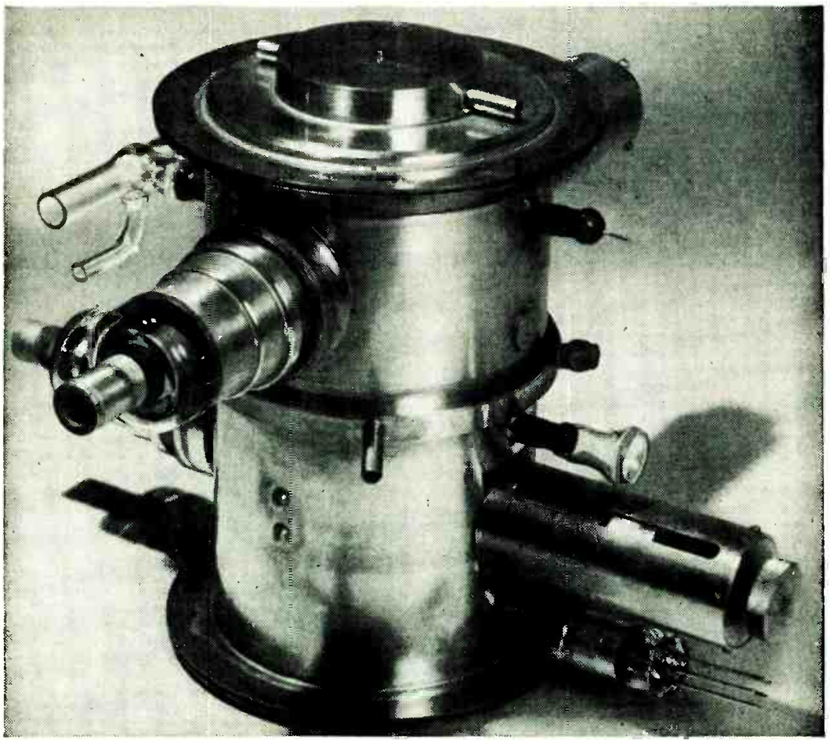

FIG. 5—Experimental electron coupler, showing both input and output sections

and when, for example, its gradient is positive from poleface A to poleface B, the electron beam will be midway between the polefaces and rotating in the direction from poleface B to poleface A. A quarter cycle later, when the transverse field amplitude is equal to zero, the electron beam is passing in closest proximity to poleface A. The electron beam continues to rotate between the polefaces with an ever widening radius. When the electrons leave the cavity, they will have attained a maximum spiral radius which will correspond to a certain amount of rotational energy.

As the electrons pass through the intercavity space after emerging from the input cavity, no energy is imparted to or extracted from the electrons since no transverse electric fields are present here (in an ideal tube). Each electron pursues a helical path through the region at a transit velocity prescribed by the beam potential and for a beam of vanishingly small cross section, all the electrons form a cylinder-directrix extension of the cone directrix beam as shown in Fig. 3. The electrons enter the output cavity with the same spiral radius which they had when they emerged from the input cavity.

Output Cavity Behavior

As the rotating electron beam passes through the output cavity, by virtue of the fact that these electrons represent an oscillating space charge with periodicity f_c between the pole faces, an induced current is produced in the load of the output system. In general, the incremental current induced between a pair of parallel-plane boundaries due to an oscillating charge, dq, between them is, for an incremental length of travel through these boundaries,

$$dIe^{j\omega ct} = \frac{dq}{d} \times v_t \qquad (2)$$

where d is the spacing between the boundaries and v_t is the transversely directed velocity. The total induced current is

$$i = \int_{\tau =}^{\tau = \tau_2} dIe^{jw_c t} \qquad (3)$$

where the integration is carried out for the total transit time, τ_2, in the output cavity. If e_1 is the voltage across the input cavity pole faces and if e_2 is the voltage across the output load, the electric field strength, E_2 in the output cavity due to the induced current flowing through R_0 is determined by[5]

$$E_2 = \frac{e_2}{d_2} = e_1 \times 2\,\frac{l_1}{d_1}\sqrt{\frac{V_{b2}}{V_{b1}}} \times \frac{d_2\, R_0\, I_0\, l_2}{[8\, V_{b2}\, d_2^2 + R_0\, I_0\, l_2^2]} \qquad (4)$$

where I_o is the beam current in amperes, R_o is the output load in ohms, V_{b1} and V_{b2} are the beam voltages in the first and second cavities respectively in volts and l_1, d_1, and l_2, d_2 are the lengths and distances between pole faces of the input and output cavities, respectively, in centimeters.

Equation 4 shows that there are two methods available for controlling the power output of the basic electron coupler[6]: beam-current variation and variation of the beam potential, V_{b2}, which will control the transit time in the output cavity. The transit time control is an important means of producing amplitude modulation since no reaction back to the input cavity is produced—the driving generator sees a constant impedance at all times.

Transit Time Characteristics

A discussion of the nature of the beam configuration in the output cavity as a function of transit time is particularly illuminating since it yields insight into the overall operation of the electron coupler. Consider the case when the transit time, τ_2, V_{b2}, and R_o are such that the voltage, e_2, across the pole faces of the output cavity is equal in magnitude but 180 deg out of phase with respect to e_1. If $l_1 = l_2$ and $d_1 = d_2$, the beam configuration in the output cavity will be an exact image of the beam configuration in the input cavity. This configuration resembles a cone whose apex is at the exit of the cavity, representing a complete extraction of rotational energy from the coupling beam by the transverse electric fields of the output cavity. This case is pictured in Fig. 3A and represents a 100-percent transfer of power to the output load—only the energy due to the beam voltage V_{b2} remains with the electrons as they reach the collector.

If the transit time τ_2 is decreased, the electrons will not remain in the output cavity long enough to give up all of their rotational energy and a truncated-cone beam, similar to

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that in Fig. 3B, will result. The rotational energy represented by the part of the cone which does not occur between the pole faces, is, of course, lost to the output cavity and goes to the collector. Since the power represented by a certain cone-directrix beam radius will be seen to be proportional to a square of the radius, see Eq. 5, a decrease in radius to one-half represents an absorption of 75 percent of the rotational power in the beam by the output cavity load—the remaining 25 percent going to the collector. For zero power into the output load, the beam radius must not change in the output cavity; all of the input power, goes to the collector. It can be shown that an increase in loading will produce the same effect on the beam configuration as the decrease in transit time.

If the transit time τ_2 is increased, the electrons will remain in the output cavity longer. The cone directrix beam will converge to zero before the end of the cavity is reached, as shown in Fig. 3C, and the electrons will start to spiral outward again, reabsorbing energy from the cavity field. This reabsorbed energy goes to the collector. However, the convergence point cannot recede into the output cavity beam space more than one-half of the length of the cavity since no more energy can be reabsorbed by the rotating beam than is made available by the entering electrons. A decrease in output cavity loading may be shown to have the same effect on the beam configuration as the increase in transit time.

Two cases based on the preceding discussion, which represent zero power into the load as a result of transit time variation become important in considerations of output modulation in which the output power or voltage is varied within certain maximum and minimum values in accordance with the rate and swing of the modulating signal. The first is that which takes place when the transit time is decreased, by raising the magnitude of V_{b2} to such an extent that the electron beam is passed through the output cavity before it can set up a transverse electric field. The other case occurs when V_{b2} is reduced to such a value that the electrons reabsorb all of the rotational energy from the output cavity field. This latter method is actually not practical because of space charge limitations which will be discussed.

Power and Grazing Consideration

The attainment of a certain spiral radius x by a cone-directrix beam in the input cavity corresponds to an absorption of power in watts which is described by the equation

$$P = 1.122 \times 10^{-2} f_c^2 I_0 x^2 \qquad (5)$$

where f_c is the frequency in megacycles, I_0 is the beam current in amperes and x is the maximum cone-directrix beam radius in centimeters. The spiral radius is related to the parameters of the first cavity by

$$x = 2.36 \frac{E_1 l_1}{V_{b_1}^{\frac{1}{2}} f_c} \qquad (6)$$

where E_1 is the peak value of the transverse electric field in volts per centimeter, l_1 is the distance which has been transversed by the electron beam in the input cavity and V_{b1} is the direct-current beam voltage in volts. For the cavity previously described, using a coupling beam of ⅜-inch diameter and 90 milliamperes at 800 megacycles, if $x = 1.25$, the value of power which can be absorbed in the input cavity of the electron coupler is

$$P = 1.122 \times 10^{-2} \times 800^2 \times 0.090 \times 1.25^2 = 1,010 \text{ watts}$$

This is not a maximum value but is one which is safely within the grazing limits. The cavity pole faces are 6 centimeters long; the beam potential necessary to yield the deflection of 1.25 cm when for example, $E_1 = 2,000$ volts per centimeter, is found from Eq. 6 to be

$$V_{b1} = \left[2.36 \times \frac{E_1 l_1}{x f_c}\right]^2 = \left[\frac{2.36 \times 2,000 \times 6}{1.25 \times 800}\right]^2 = 804 \text{ volts}$$

Space Charge Considerations

It is seen from Eq. 5, that the power which can be absorbed by the electron beam in the first cavity is proportional to the beam current. Therefore space charge limitations will have an important bearing on

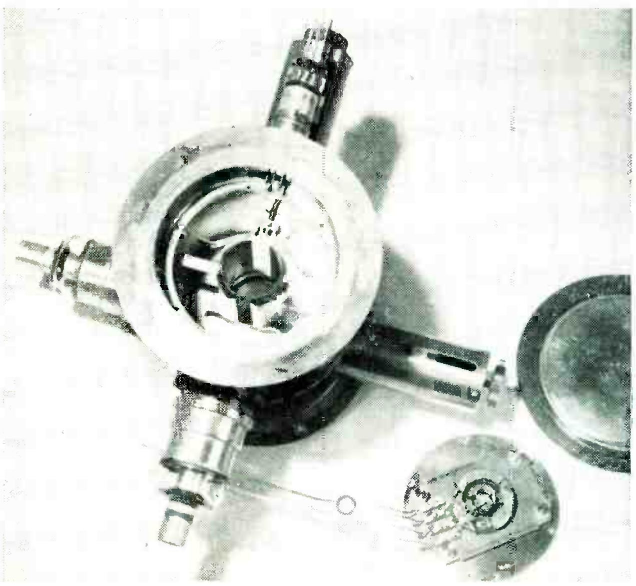

FIG. 6—Internal details of the input cavity

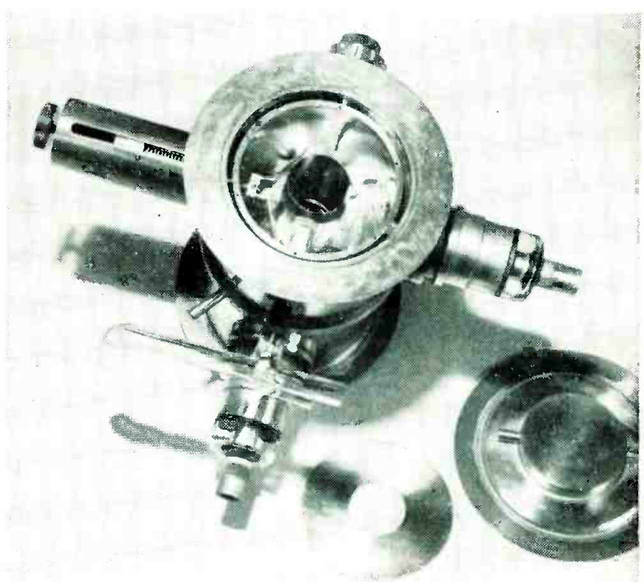

FIG. 7—Internal details of the output cavity

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the power handling capabilities of the tube.

If space charge is introduced into a region in which an electrostatic potential exists, this potential will be depressed in the region of the charge. For a particular tube geometry and potential (which is a function of the boundary voltage) there will be a corresponding maximum amount of charge which can be sustained.[6,7] Beyond this amount the potential in the vicinity of the charge will drop to zero and some of the charge will turn back, causing instability.

This maximum value of current corresponds to a particular beam voltage which governs the transit time through the tube and is connected with the power limitations arising from grazing at the pole faces. Even at a stable maximum value of beam current, considerable depression of the space potential takes place. Hence, electrons in various parts of an electron beam of the cross-section determined by the electron gun have different transit times and, because of the direct-current transverse electric field components arising from the potential depression, undergo some translation in position. Therefore, beam dispersion, which will be detrimental to the power transfer efficiency, may occur.

For a cylindrical beam, ⅜-inch diameter and concentric with respect to cylindrical boundaries of 1½-inch diameter (which are closely approximated by the arcuate pole faces in the experimental tubes), a current of 150 milliamperes could be sustained with a beam voltage of 750 volts.[7] In an experimental tube, shown in Fig. 4, which accurately simulated the region transversed by the beam in the final tube, the predicted value was confirmed; 155 milliamperes was realized before instability was encountered. In the actual operating electron coupler, an increase of beam current to about 175 milliamperes could possibly occur at the same beam voltage, because of the increased proximity of the spiralling electrons to the pole faces and some spreading of the beam.

Details of Construction

Figure 5 pictures an experimental electron coupler showing the glass press for the electron gun, the input and output load line seals, the tuners, and the water-cooled collector at the top. The top part of the tube is the output section and the lower part, the input section. The tube is made of copper with monel lids which were atomic-hydrogen welded to monel rings. These rings in turn were silver-brazed to each end of the body of the tube.

Figure 6 shows the details of the input resonant cavity, coupling loop and tuner with the top lid of the tube removed. The electron gun is shown mounted on ceramics on the lid of the input cavity.

Figure 7 shows the output section with its pole faces and a bellows-controlled capacitance tuner capable of tuning from 750 to 825 megacycles. The details of the output resonant cavity, coupling loop, and tuner are identical with those of the input cavity with the exception that the entire output cavity is mounted on ceramic supports. Thus its potential can be varied independently of the potential of the rest of the tube. The connection to vary the potential of this cavity is made by a single lead which is near the top of the tube, opposite the glass exhaust lead, see Fig. 5. The output cavity was water-cooled in subsequent tubes to prevent the continual evolution of gas from this cavity when it gets hot during actual operation.

Experimental Results

An experimental set-up in the laboratory, using an electron coupler of the design shown in Fig. 5, is pictured in Fig. 8. To the left is seen the driving magnetron which is capable of a 1-kilowatt output and which can be tuned through the tuning range of the electron coupler. A transmission line connects this magnetron to the electron coupler in the center of the picture; the output of the coupler goes to a water-cooled resistance-load system as shown. A standing-wave indicator is included in the transmission line between the magnetron and the electron coupler so that the combination of voltages and currents at which the input cavity presents a matched termination to the transmission line can be measured. This information, when used with the tube magnetron-Reike-diagram and the measured input power, is useful for making measurements on the power input to the beam.

The method for operating the magnetron—electron coupler system is relatively simple. The coupling beam voltage and current are first adjusted to arbitrary values. The driving magnetron is turned on and tuned to the predetermined resonant frequency of the input cavity of the coupler. The coupler magnetic field is then adjusted until power is indicated in the output circuit. Each parameter, including the

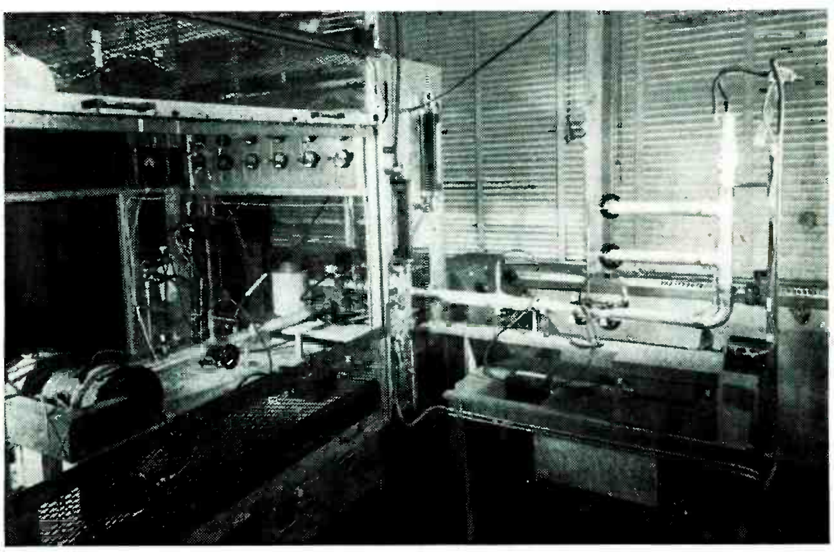

FIG. 8—The electron coupler in operation between magnetron transmission lines and load

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output cavity tuner, is then successively readjusted until the output power is maximized, assuming that the output load is properly matched to the output cavity of the electron coupler.

The power transfer efficiency of the electron coupler was measured at several power levels by using a specially designed T-network in the input circuit for a more accurate measurement of the input power. Power-transfer efficiencies up to 70 percent were obtained at output power levels of up to several hundred watts. More power output was unobtainable because of the power limitations of the driving magnetron which supplied both the coupler and another load in the T-network. This power transfer efficiency was acceptable since many factors were present which served to cause a deterioration in the power output. These were beam dispersion owing to the fringe fields at each end of the cavities, differing transit times of the electrons affected by the variations in beam potential over the cross section of the beam caused by space charge effects, and translational electric field components leading to grazing by outer electrons. This grazing, if present, takes place in the input cavity, since negligible current is measured to the output cavity which is independently maintained at a suitable voltage.

Beam-current control of the output power is the most complete type of control possible in the electron coupler since when no beam passes through the tube, no power appears in the output. However, as the beam current is reduced from some value equal to or greater than that which matches the line, the beam resistance is reduced and the driving magnetron will see a change in impedance which will be a function of the line length connecting it to the electron coupler. This impedance change may either decouple the magnetron shifting its operation to a low-efficiency portion of the Rieke diagram, or it may load the magnetron further and possibly cause spectrum failure or instability. Either effect will cause frequency and amplitude distortion during modulation if not actually causing the driving magnetron to suffer damage. The situation may be partially redeemed by adjusting the line lengths and by using a shunt load, as was done by J. S. Donal, Jr. and R. R. Bush[8], to make the frequency variation during modulation nearly negligible. Some power is lost in this shunt load however, which will reduce the overall efficiency of the system.

Transit-time control of the output power of the basic electron coupler is a useful and practical method of control since it permits the tube to function as a nonamplifying unilateral control impedance. Variations in the output are not reflected back to the input and the input impedance of the electron coupler therefore remains constant. Once the voltage of the secondary cavity is adjusted for maximum power output, the output power may be theoretically reduced by either raising or lowering the cavity voltage. Actually, the only practical direction is an increase in cavity voltage, since reducing the cavity voltage will soon cause a space-charge instability in the cavity and some of the beam current will turn back.

Figure 9 shows a representative curve of r-f output voltage across a 52-ohm load, as a function of output-cavity voltage, for a beam current of 50 milliamperes, a frequency of 775 megacycles, and an input cavity and collector voltage of 650 volts. It is seen that the r-f output voltage is variable from a maximum value at $E_b = 520$ volts to virtually zero at an output-cavity voltage of 1,700 volts. A representative sinusoidal modulating wave and its output counterpart are included in Fig. 9. The characteristic curve pictured in Fig. 9 is a function of the tube parameters and the peak-to-peak voltage necessary for 100-percent amplitude modulation may be altered by suitable changes in cavity design. Although a large peak-to-peak voltage may be necessary for the amplitude modulation of the electron coupler to a satisfactory level, it must be remembered that no electrons are collected by the secondary cavity and the impedance of the output cavity as seen by the modulator is a capacitive reactance. If very wide-band amplitude modulation is desired, then the modulator must be designed so that its output into this capacitive load is commensurate with the requirements of the modulation rate.

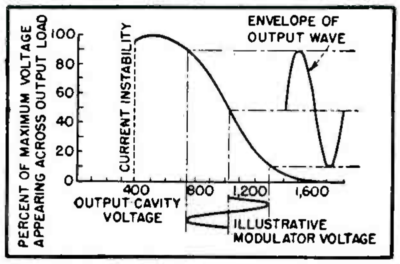

FIG. 9—Operating characteristic curve of the electron coupler with input cavity beam potential of 650 volts

Higher Frequency Operation

As the frequency of operation increases, the tube will become smaller and smaller due to the decrease in size of the resonant cavities. However, the power handling capabilities of the electron beam do not necessarily suffer from the change in tube size and may improve. As is seen in Eq. 5, the absorbed power varies as the square of both the frequency and the maximum spiral radius. An increase in frequency from 800 to 3,000 megacycles, for example, would require a spiral radius of only 0.427 centimeter and a current of 50 milliamperes for the absorption of 1,000 watts by the beam. With an interaction space in the input cavity, 2.5 centimeters long, and an r-f field strength of 1,500 volts per centimeter, the electron coupler would require, see Eq. 6, an input cavity beam voltage of 48.4 volts.

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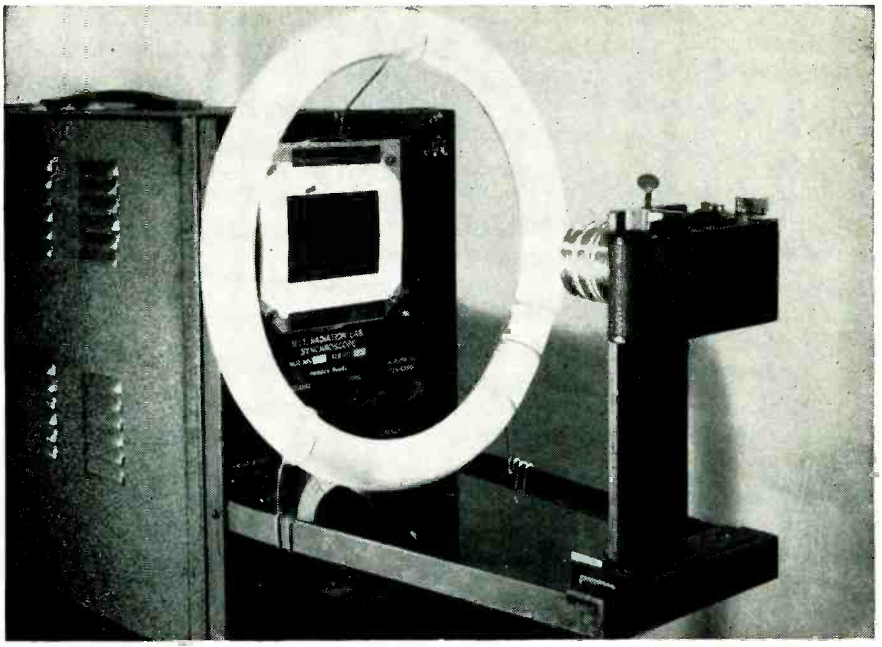
By NORMAN FULMER

*Research Department, Lamp Division
Westinghouse Electric Corporation
Bloomfield, New Jersey*



Only one photograph need be taken when calibration lines and notations are illuminated by the circular fluorescent lamp and recorded on film simultaneously with the c-r tube trace

Improved C-R Photographs

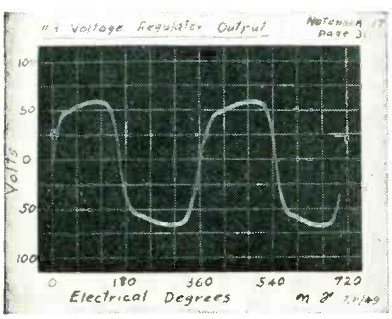
THE COMMONLY USED technique of photographically recording cathode-ray traces is to place a hood around the c-r screen and camera to exclude all external light. The resulting photographs show only the trace against a plain black background.

To keep account of each photograph, information must be kept on file concerning sweeps, calibrations and test conditions. Later, if prints are made, it is necessary to include a copy of the test information with each print.

Considerable time, effort, and chance for error can be eliminated if the required information is recorded along with the c-r trace on each photograph taken. This may be accomplished by using an external light source to illuminate the area around the tube face sufficiently for it to show in the picture. The lighting must be evenly distributed and not so bright as to interfere with the clarity of the c-r trace. The illuminated area is used for calibration data and other pertinent notations.

Calibrated Screen

Oscilloscopes are customarily equipped with a celluloid scale having dark calibration lines. With proper external illumination, these lines will show in a photograph. Normally, three shades of gray must then be recorded on the film: the light gray of the electron-beam trace, the medium gray background, and the dark gray (black) calibration lines.



Unretouched photograph of c-r tube screen and data made by the technique described

Extreme care with lighting is needed to properly balance the three shades of gray. It is difficult to obtain a picture showing clearly the light trace and dark calibration lines against the gray background. This difficulty is overcome by providing for only two shades: light-colored trace and light calibration lines against a dark background. Thus, legibility is increased since only two tones are required in the picture, white and black.

A calibrated screen having light-colored calibration lines can be made by spot welding or soldering fine, shiny wires in a criss-cross pattern on a metal frame. The external illumination reflects on the curved wire surfaces and appears on the film as white calibration lines.

A suitable screen can be made with 0.010-inch diameter tungsten wire spot-welded to a steel frame. A frame having a rectangular cut-out $2\frac{1}{2} \times 3\frac{1}{2}$ inches is suitable for a five-inch c-r tube. The frame is held by screws and bushings in front of the c-r tube face.

For a tube having a green phosphor, a green plastic filter is placed between the calibrated screen and the c-r tube face to provide a darker background by filtering out all light except the green trace. A suitable green filter can be made of $\frac{1}{8}$-inch thick DuPont Plastacele C11872.

White paper masks having rectangular cut-outs the same size as the calibration frame are provided. The mask is lightly stuck to the frame with dabs of glue and notations written on it concerning sweep speeds, trace height calibration, date, title of test or notebook reference page. If two or more

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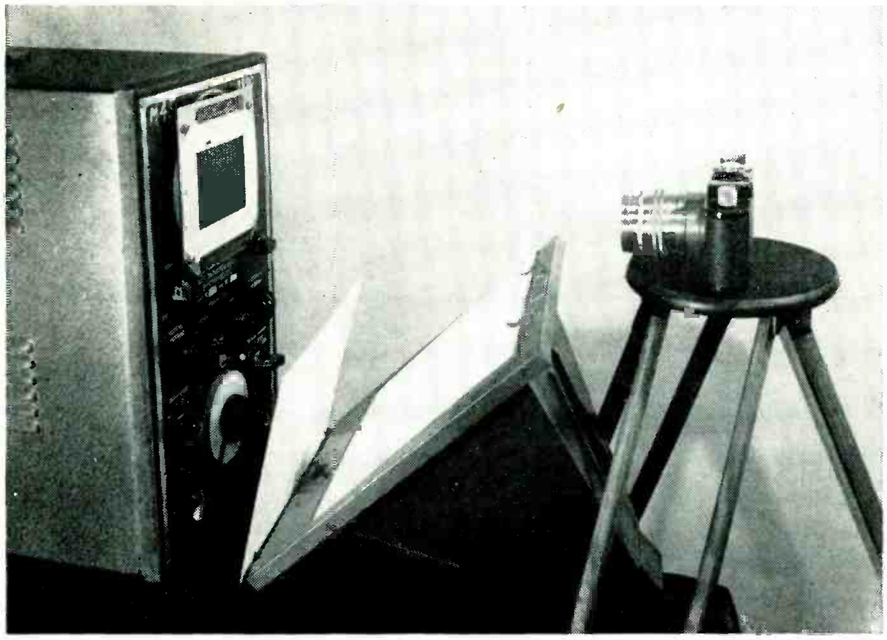

Alternative method of lighting the calibrated screen area, using a ground-glass diffused light source and baffle to distribute light evenly on the tube screen and on the surrounding area

Single picture shows clearly both the trace desired and associated data such as a calibrated screen, test conditions and other file notes. Evenly distributed light from either of two light sources provides two picture tones for high legibility of information

vertical scales are to be used frequently, it is convenient to show both scales on the mask and provide a black paper arrow that can be adjusted to indicate the scale in use.

Illumination

The best source of illumination was found to be a 32-watt circular fluorescent lamp, mounted on a frame. The lamp must be close enough to the tube screen to avoid reflections in the picture from the c-r tube glass. A spacing of four inches between lamp and screen is satisfactory.

To record both the trace and scale in a single exposure, it was found desirable to lower the illumination by operating the lamp at about 10 milliamperes from a 150-volt d-c source with about 5,000 ohms resistance in series with the lamp. Other means for reducing lamp intensity are by painting or covering the lamp with translucent material such as nail-polish, lightweight paper, or colored cellophane, or by winding a spiral of opaque tape around the bulb in a spaced toroidal manner.

An alternative device for producing even, diffused illumination is an 8×10-inch ground-glass diffuser (Eastman x-ray illuminator, model D) placed to illuminate the c-r screen at an angle. Since the amount of illumination reaching a point of the tube screen from the diffused source is approximately inversely proportional to the square of the distance of the point from the light source, means must be taken to reduce the amount of light reaching the bottom (nearer) part of the tube. A cardboard baffle was placed to distribute the light intensity so that the top and bottom of the screen receive equal illumination.

Proper lighting was obtained by operating the 50-watt incandescent lamp of the diffused light source at 80 volts.

For accurate control of illumination and to prevent reflections on the c-r-tube glass from room lights or windows, an opaque cloth is placed around the camera and oscilloscope when making exposures.

Camera Installation

When extreme detail is required in a photograph, a double-extension view camera may be used; a 4×5-inch film will record a 3 or 5-inch c-r tube almost actual size. The camera may be mounted on a tripod set on the floor, or on a support set on a table with the cro.

A 35-mm camera is convenient to use and the film cost is low. A spacing of nine inches between the camera and cro enables most cameras to cover the screen properly. A frame to support the camera and circular lamp may be fastened to the cro with machine screws. To enable the camera to focus at a distance of nine inches, a bushing must be inserted between its lens and body. A suitable bushing for a Leica camera is ½ inch thick for a lens having a focal length of five cm. This particular camera was mounted in the support frame by inserting the lens and bushing through a hole in a camera bracket. A thumb screw tightens against the bushing to hold the camera securely.

Exposure

Correct exposure for the scale when illuminated by the circular lamp operating at normal current is less than the exposure required for a typical cro trace. For example, in one instance correct exposure for the c-r trace was 0.1 second at f:3.5, and correct exposure for the illuminated scale was 0.1 second at f:11. If only a few pictures are to be taken, a single film may be exposed twice—for the trace with illumination off, then for the scale with illumination on.

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Folded Sideband Modulation

Basic principles of a proposed system of radio commmunication in which several kilocycles of information bandwidth are transmitted in sequence in a narrow band on one side of a carrier, and interfering heterodynes are eliminated by shifting them to the unused side of the carrier

AN IMPORTANT CHARACTERISTIC of any communication system is its effectiveness in the face of interference. So far the effect of interference on proposed narrowband systems has received scant attention.

Present communication systems are affected differently by interfering signals. We have, for example, heterodyne beatnote interference in a-m, capture effects experienced in f-m, and tvi in television. In wired communication where channel separation can be controlled, there is no serious problem, but in wireless communication, particularly over long distances, interference is always possible. Therefore the measure of the worth of any communication system not only should include the efficiency of modulation versus bandwidth and noise, but also the system's effectiveness in rejecting interference. Stated another way, a theoretical communication system will anticipate the factor of interference and will do something about it.

Interference Problem

The fallacy of reducing the transmitted bandwidth alone to reduce interference can be illustrated as follows. In the case of a single-sideband amplitude-modulated signal, the removal of a heterodyne beatnote caused by a carrier lying within this band can only be achieved by rejecting a portion of this band either by filters or phase-shifting networks requiring critical adjustments. In a double-sideband system, the interference can be removed more rapidly by simply rejecting the whole sideband containing the interfering carrier.[1]

In other words, greater actual selectivity or signal separating ability is achieved in the latter case by using a transmitted bandwidth twice that of the former. That the reduction of bandwidth alone is not the solution of heterodyne elimination can further be proved by c-w operation. Such a system of communication can be reduced to a bandwidth of but a few cycles. Despite this reduction in bandwidth, serious heterodyne interference prevails when an interfering carrier falls within this reduced band.

Interference will affect narrowband systems in various ways. One example is illustrated in Fig. 1. The block diagram illustrates a communication system with a bandwidth required for the r-f emissions of but 1 kc to transmit 4 kc of information. This system is essentially a simple single-sideband a-m transmitter, with suppressed carrier (replaced at the receiver by local oscillator). Sequential modulation is achieved by shifting the carrier in 1-kc steps. Such a communication system should prove useful where channel separation is effectively controlled. But its narrowband usefulness will be impaired seriously should heterodyne interference be present. If the interfering carrier is 51 kc, a beatnote of 1 kc will appear when information of 200 to 1,200 cycles is being transmitted. There would be another of 2 kc in an information band of 1,200 to 2,200 cycles, 3 kc

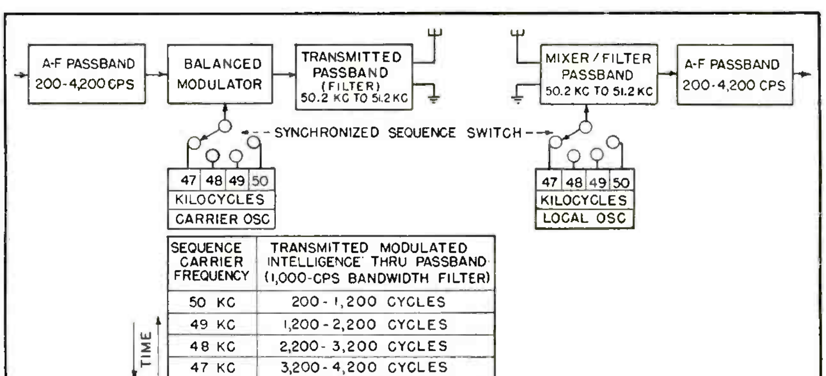

FIG. 1—Block diagram of sequence modulation. The received demodulated intelligence is the same as that transmitted for each synchronized sequence

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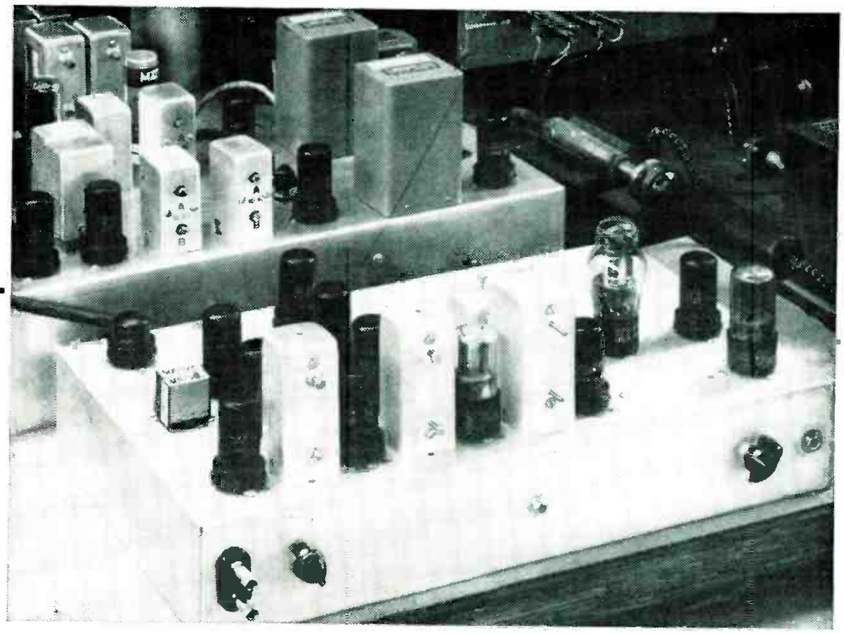
By J. L. A. McLAUGHLIN
La Jolla, California



An r-f exciter unit for folded sideband transmitter appears in the foreground and behind it is an adaptor for a receiver

in the band 2,200 to 3,200 cycles and a forth beatnote of 4 kc in the band of 3,200 to 4,200 cycles. The above illustrates simply one of the possible types of interference characteristics of narrowband systems.

Basic System

A communication system will be described with a spectrum space less than the message information and means for eliminating heterodyne beatnotes produced by carriers falling within this band. The basic principle of this new system is illustrated by a series of steps in Fig. 2.

At *A* is illustrated a conventional amplitude-modulated carrier, F_1, in the presence of a second carrier, F_2, also amplitude modulated, which causes interference in the form of a heterodyne or beatnote.

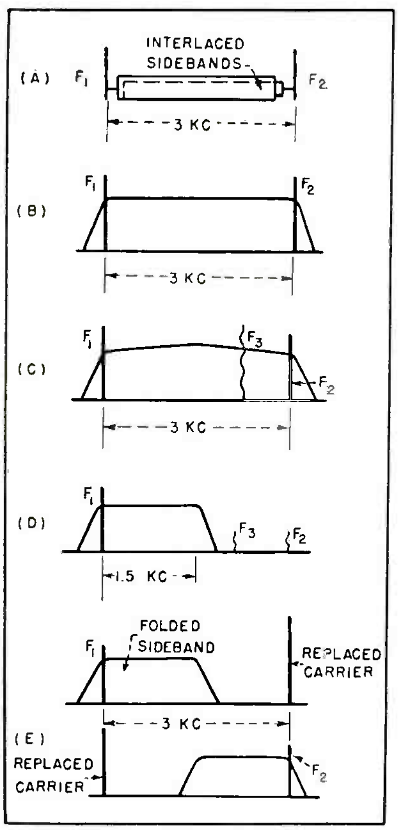


FIG. 2—Steps illustrating the basic method of eliminating two interfering carriers

The interference takes the form of a continuous whistle of 3,000 cycles since this is the frequency separation between carriers. If this heterodyne whistle is eliminated the audible interference remaining (demodulation of the desired carrier with the undesired signal's sideband) will be small. This whistle or beatnote can be reduced or eliminated by a selective circuit in the i-f or audio amplifiers.

If the two carriers are present with respect to frequency in an i-f amplifier with passband characteristics as shown in Fig. 2B, and the 3,000-cycle heterodyne whistle has been removed by one of the aforementioned schemes, both signals will be intelligible to somewhat the same extent as listening to two people talking at the same time.

The next step is to assume the modulation in the sidebands of the two transmitters to be identical. The heterodyne whistle has been eliminated and only one intelligence is now being received. The audible interference of the interlaced sidebands is present, but small, compared to the interference caused by the heterodyne whistle.

Figure 2C shows a new interfering carrier, F_3, and Fig. 2D illustrates its elimination by increasing the selectivity of the i-f passband as shown.

Folded Sideband

In eliminating the undesired carrier F_3 we have also eliminated carrier F_2. If F_2 is replaced in the detector by a local oscillator of the same frequency, demodulation of the full information band of 3,000 cycles will be recovered despite the reduced bandpass of the i-f which as shown is but 1,500 cycles. Carrier F_1 demodulates the lower half of its 3,000-cycle band (0 to 1,500 kc). The replaced carrier for F_2 demodulates the upper portion (1,500 to 3,000 kc) for F_2 sideband which falls in the same spectrum as the lower frequency half of the sideband associated with carrier F_1.

The narrowed bandpass thus contains a completely folded sideband containing all the information, one half of which belongs to carrier F_1 and the other half to F_2. Should the interfering carrier F_3 fall within the spectrum of the passband, the process can be reversed since the total transmitted spectrum of 3 kc contains two folded sidebands of information, as illustrated in Fig. 2E. If carriers F_1 and F_2 are alternately transmitted the monkey-chatter interference will automatically be removed and

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a normal-sounding signal will result.

This is a simplified explanation of FSM. The above case illustrated requires a transmitted bandwidth equal to the information, and with means at the receiver to achieve sophisticated selectivity such as to eliminate a heterodyne falling within any portion of this band since but half of the transmitted spectrum contains all the information.

Heterodyne Rejection

In a more elaborate form of the system the transmitted spectrum space can be reduced to but a few hundred cycles and still retain at the receiver the ability to reject heterodyne beatnotes, as in the above case. A system suitable for transmitting an information bandwidth of 4 kc in a spectrum space of 2 kc is illustrated in Fig. 3. Four carriers (suppressed or transmitted) are employed.

Carrier F_1 provides information from 0 to 2 kc. Carrier F_2 provides the same information in the same spectrum space but in an inverted numerical order. Carrier F_3 handles the information of from 2 kc to 4 kc. Carrier F_4 contains the same information but in inverted numerical order similar to that of the first two carriers. Carrier F_5 indicates an undesirable carrier falling within the transmitted spectrum. The shaded area of the sideband indicates the system's halfband selectivity sufficient to reject beatnotes which would be produced by F_5, the undesired carrier, beating with each of the system's carriers.

The passband of 1 kc at the receiver contains all the transmitted information, for in sequence *A* 0 to 1 kc will be demodulated, in sequence *B* 1 to 2 kc, in sequence *C* 2 to 3 kc, and in sequence *D* 3 to 4 kc. Should the interference appear in the shaded portion, instead of as shown, the system can be inverted since the other half also contains the full band of information.

Use of Filters

In order that a FSM system effectively reject interference lying close in frequency to the edge of the system's acceptance spectrum, a high degree of selectivity is required. If this selectivity is to be achieved in the i-f amplifier the required filters would be quite expensive. However, most of the system's heterodyne elimination selectivity takes place after detection, where it can be accomplished less expensively. This is illustrated in Fig. 4.

For the sake of simplicity, the system illustrated is of the two-carrier type, in this case both being transmitted alternately. The signal is converted to a low frequency i-f of say 50 kc and is split into two i-f filters with response curves as indicated. The upper i-f accepts carrier F_1 and has a bandpass of roughly 1.5 kc. The carrier F_2 and the undesired carrier F_3 will receive attenuation. At the output of this filter's detector, a lowpass filter supplies the necessary high degree of selectivity for the attenuation of beatnotes above 1,500 cycles. Since the beatnote between the system's carrier and interference is 2,500 cycles it will not be heard due to the high selectivity of the lowpass filter, plus the additional selectivity

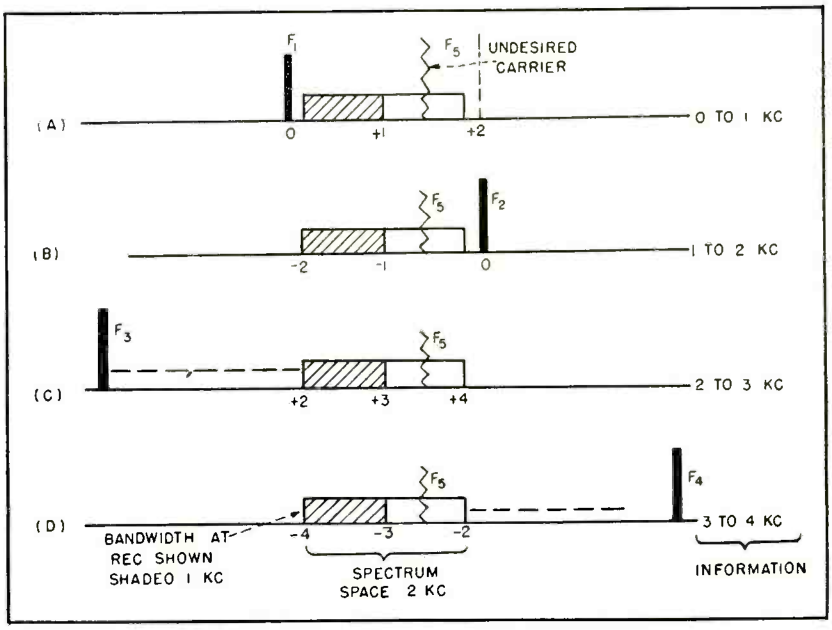

FIG. 3—Operation of four-carrier folded sideband system

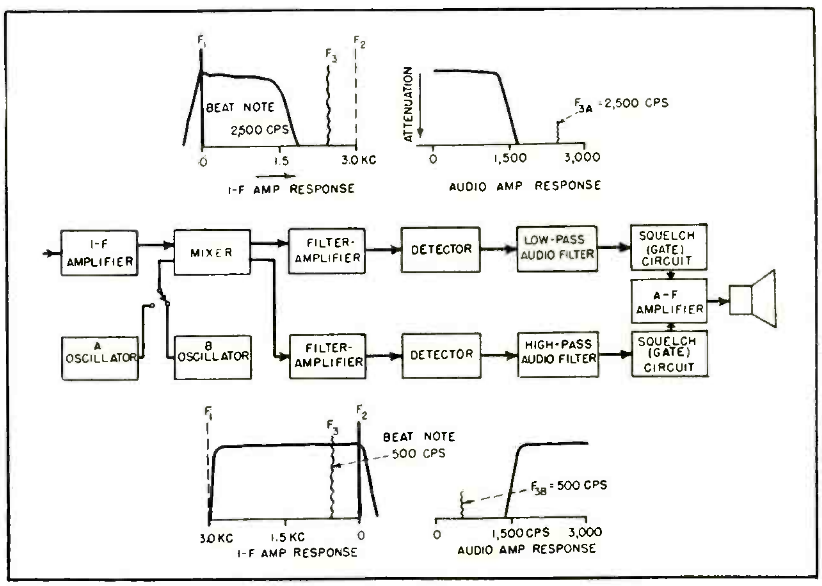

FIG. 4—Stages required in the receiver for a two-carrier system

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of the i-f filter system.

In the lower case, where carrier F_2 and its sideband information is shown, the beatnote will be 500 cycles, but at the output of this detector a highpass audio filter is used with high attenuation below 1,500 cycles, sufficient for attenuation of the beatnote and all others below the cutoff frequency.

In FSM systems employing more than two carriers, audio bandpass filters equal to the information of each sequence are used in the same manner as in the above two-carrier system.

Figure 5 illustrates more fully the transmitted spectrum with the system's two carriers at either edge of it, together with an undesired carrier falling in the unused half of the system's bandwidth. The used portion is shown shaded. The terms upper and lower sideband may cause some confusion as the system is essentially a single-sideband one. The terms refer only to the relation of the information to each carrier with respect to the numerical frequency order. The shaded area marked upper sideband for carrier F_1 transmits information from 0 to 1,500 cycles, whereas this same half spectrum in the lower case contains information from 1,500 to 3,000 cycles.

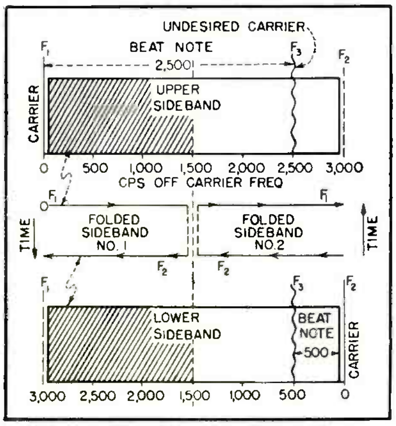

FIG. 5—Frequency spectrum handled by the receiver of Fig. 4

Frequency Inversion

In Fig. 4 two oscillators are indicated. The condition shows *B* in operation. This oscillator-mixer circuit is of the off-frequency inverter type.[1] The frequencies of the oscillators are such that in one case the oscillator's frequency is the first i-f plus the second i-f frequency. In the second case, the oscillator's frequency is the first i-f minus the second intermediate frequency. In FSM the second i-f will be the mean frequency of the system between the two carriers. Switching from one oscillator to the other inverts all frequencies around the mean. The principle of this system is illustrated in Fig. 6.

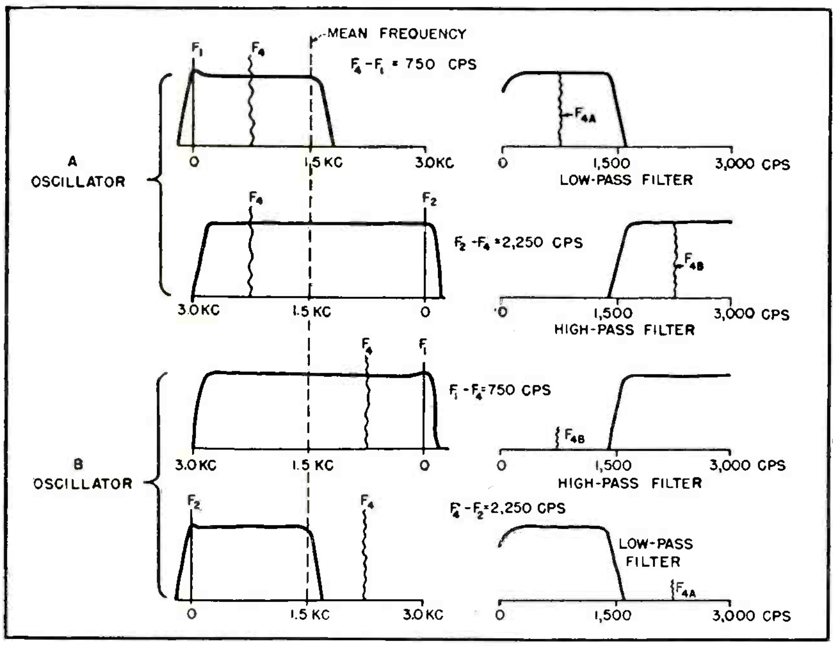

FIG. 6—Choice of oscillator provides frequency inversion to take advantage of the proper filter characteristics in eliminating heterodynes

A marked improvement in signal-to-noise ratio is achieved by the squelch or gating circuits following the audio filters (Fig. 4). Without these circuits, when the carrier handling the lower half of the sideband is on, high-frequency noise would be passed by the highpass filter. The reverse is true for the carrier handling the upper half of the sideband frequencies. These squelch circuits are normally open and are only closed by the desired carrier frequency.

The signal-to-noise ratio can be improved further by making the squelch circuits such that they remain open until the carrier is on plus a certain percentage of modulation. In other words, the gates are closed only when information sufficient for intelligibility is present, rather than alternately and cyclically in time sequence. This is an important point because many times a carrier may be on without having any information to transmit in its time sequence.

Still greater refinements along these lines can be achieved in the transmitter by information amplitude sequence time instead of cyclic time sequence. By these and other refinements the information efficiency can be raised to a greater degree than by conventional amplitude modulation means alone. Other FSM systems employ narrowband information sequence instead of carrier sequence switching. In the case of suppressed carriers this reduces synchronization problems since the reintroduced carriers at the receiver can be on at all times. One interesting FSM variation, suitable for aircraft and mobile use, permits two separate voice frequencies and one c-w signal to occupy a spectrum space of but 3 kc.

This article has been restricted to the discussion of amplitude-modulated systems suitable for speech frequencies but any band of information, modulated by more efficient pulse systems, can be converted to narrowband operation by the heterodyning principles of FSM outlined.

Reference

(1) J. L. A. McLaughlin, Heterodyne Eliminator, ELECTRONICS, p 83, March 1949.

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Simplified Multistation

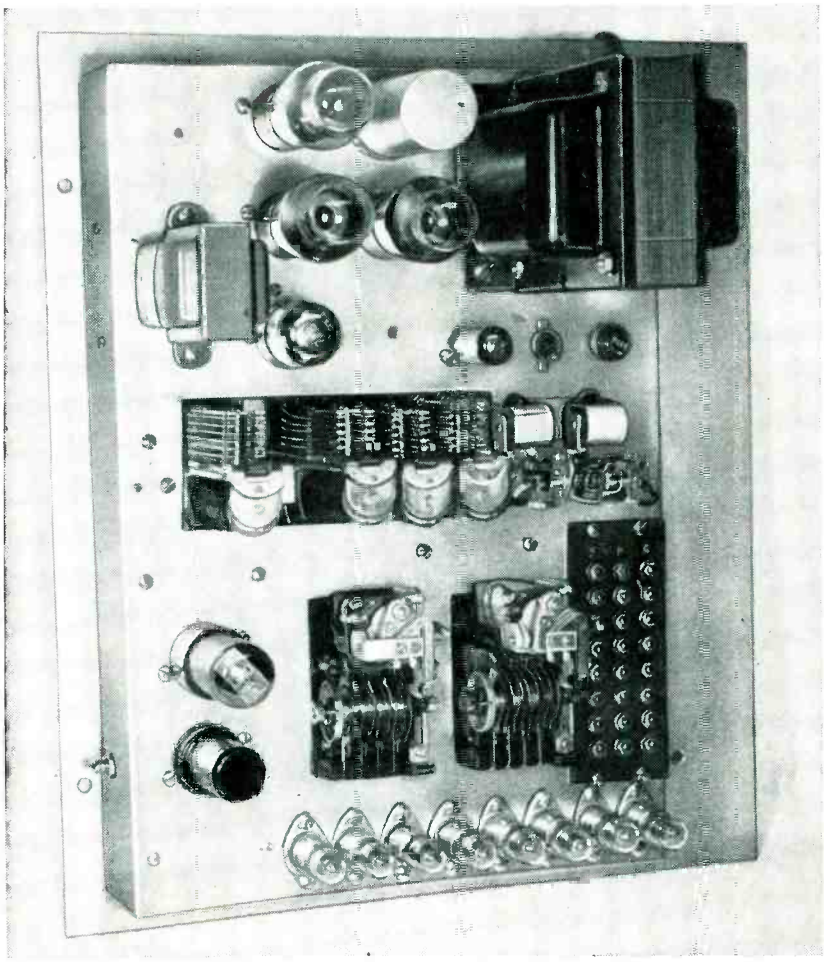
Requires only two wires and ground for complete privacy between any two stations among a maximum of eight stations. The pulse-generating system used for automatic switching can be adapted to remote control by wire, carrier or radio, when power lines are synchronized at transmitters and receivers

By ANDREW W. VINCENT
Consultant
Rochester, N. Y.

IN CONVENTIONAL intercommunication systems that do not employ centralized switching the desired talking-circuit path is set up at the calling station when a manually operated selector switch completes a direct-wire connection to the called station. An intercom employing centralized switching ordinarily requires that a circuit first be established to the switching apparatus; after this the circuit path to the desired station is remotely set up by a manual switch at the calling station.

The cost of the direct-wire system increases rapidly as the service area increases because the multiplicity of wires between stations makes installation, relocation and servicing difficult. In addition, the extensive wire network increases noise pickup. Central switching, although it eliminates individual station amplifiers and reduces the number of interconnecting wires, usually requires complex central equipment to perform the remotely controlled functions of call, talk, listen and release.

Station for automatic call selection by means of three-position switches. Extreme right switch controls talk, listen and release



Central switching unit of the intercom, showing two rotary stepping switches and neon glow lamps along lower edge of chassis

New Central System

The centralized system to be described uses a finder circuit with no line relays, a pulse system for station selection, one audio amplifier, and simple three-position switches at each station. The pulse system employs an inductor and eight different half-wave rectifier

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Intercom System

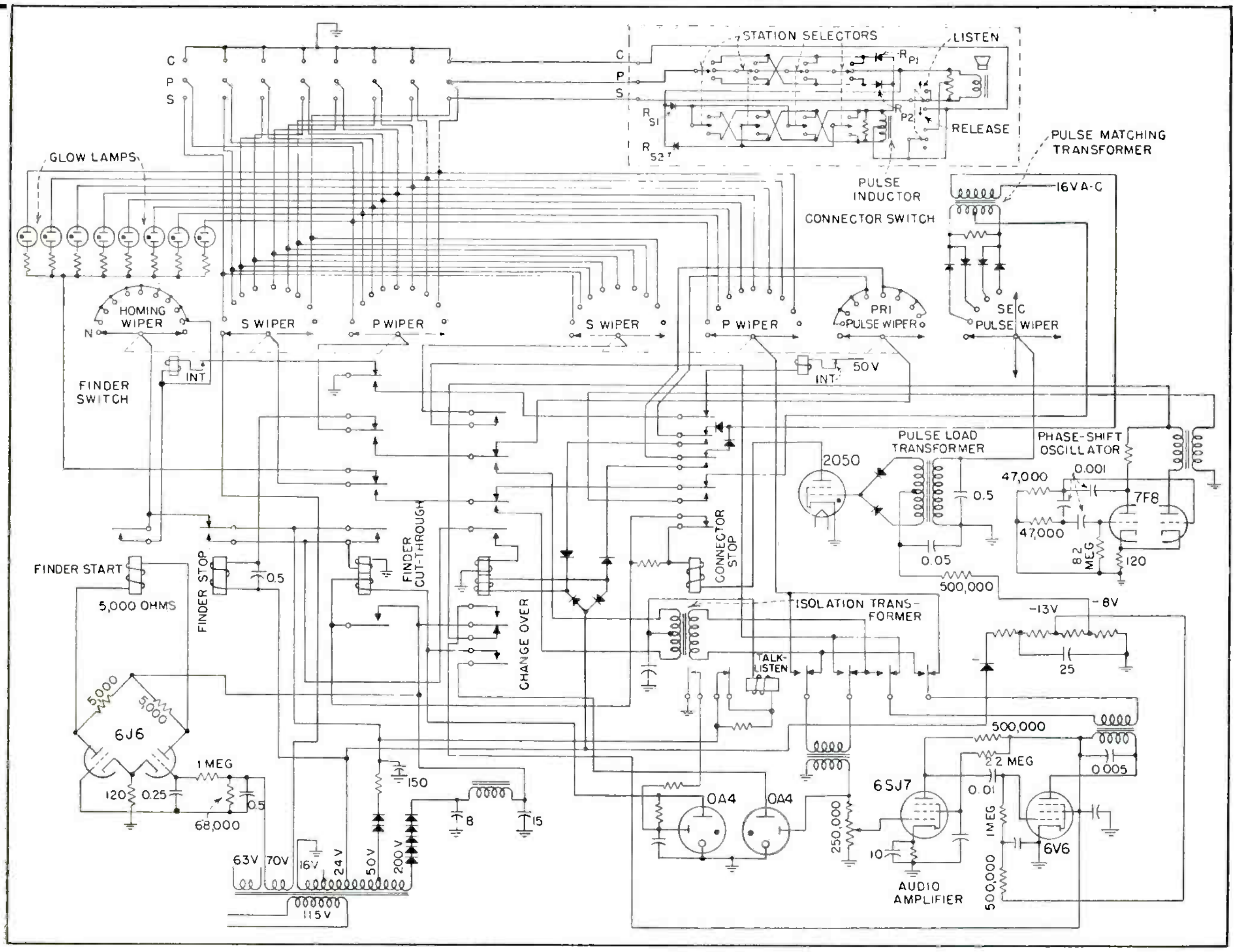

FIG. 1—Wiring diagram of the central station, with connections shown for one substation in dashed box

combinations to select eight unique positive or negative voltage impulses from a 60-cycle supply.

Up to eight stations can be used. Each station is connected directly to the central unit by three wires, a balanced talking pair and ground. The station units house a p-m speaker, small selenium rectifiers, resistors, a pulse inductor and keys that set up eight different pulse-circuit conditions for station selection and control the talk-listen and release functions. The keys are three-position lever type with spring return to center.

When a call is made the desired station-selection key is operated and held until a completion tone is heard in the speaker to indicate that the system is not in use. The switching is completed and the key may be released. The release of the station-selector key completes the connections to the amplifier and the calling station is ready to carry the message in the direction of the called station. Operation of the listen key reverses the talking direction, allowing a reply. Operation of the release key releases the system for subsequent calls.

Line Finder Circuit

The glow lamps in Fig. 1 are connected to the P wires of each of the balanced pairs extending to each of the speaker stations. The common connection to the glow lamps is in a circuit traceable to ground through the 70-volt transformer winding and the grid circuit of one of the tubes in the bridge circuit.

When the system is idle, the relay contacts complete this circuit in which the 70 volts a-c of the transformer winding is impressed upon each of the P station leads through the glow lamps. Since the glow lamp breaks down at and maintains a voltage of about 65 volts d-c, the voltage appearing across the remainder of this circuit will consist of sine-wave tops or pulses as shown in Fig. 2A having effective voltages in these peaks of about 25 volts.

When the station-selector keys are in the normal position, the station speaker voice coil is connected across the balanced pair P and S. Therefore the line capacitance of

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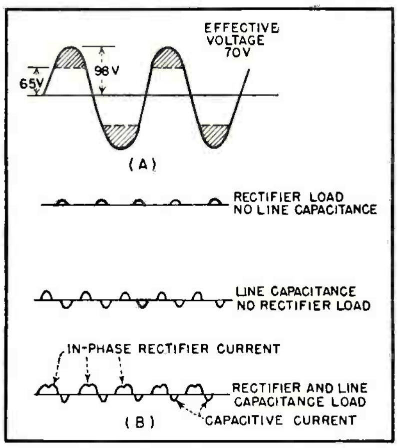

FIG. 2—Voltage and current waveforms available for switching

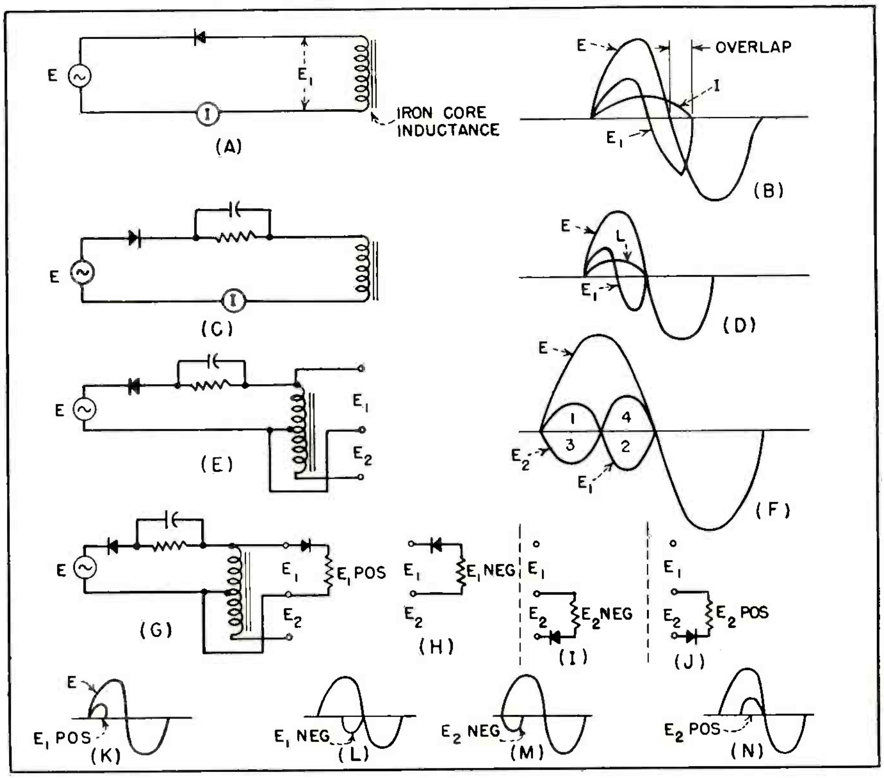

FIG. 3—Combinations of rectifier and inductance connections and their waveforms

both the P and S wires to the ground control wire is presented at each of the lines as a capacitance load between the glow lamp and ground, since the speaker impedance is small in relation to the reactance of the line capacitance.

This capacitive load causes symmetrical current pulses to flow in the load capacitor. The time constant of the R-C network in the grid circuit is purposely made long enough so that the d-c grid potential is unaffected and thereby maintains a balance within the bridge circuit.

When the station-selector key is operated at a calling station the speaker is disconnected from the P wire and the load circuit through the rectifier R_{P1} or R_{P2} and the pulse inductor to ground is presented to the glow lamp of the calling line. The effect of the rectifier load causes current pulses to flow in the direction in which the rectifier conducts. These rectified pulses cause the R-C circuit at the grid to charge either positively or negatively, thereby unbalancing the bridge circuit which operates the finder start relay and the finder switch. The finder switch, stepping on its own self-interrupting contacts, hunts over the station lines.

Because the rectifier constitutes a resistance load, the rectified current pulses are in phase with the voltage and therefore lag the capacitive current pulses. The connection of the rectifier load on the one calling line controls the bridge circuit even while being shunted by the low-shunt-reactance combination of the other seven line capacitances because the rectifier current component is displaced from the capacitive current component as shown in Fig. 2B.

The finder stop relay is connected between the P wiper of the finder switch and the 24-volt tap of the power transformer. As the finder switch hunts over the lines, the P wiper momentarily connects the finder stop relay to each of the P line wires. When connection is made to the P wire of the calling line, the rectifier load to ground operates the finder stop relay which stops the finder switch and operates the finder cut-through relay which locks up on its own contacts, thereby seizing the link.

The movement of the S wiper from the home position disconnects the 70-volt transformer winding from the glow lamps, thereby disconnecting, by the removal of a sufficient breakdown voltage, the common connection established by the glow lamps to the P line wires. This locks out the other stations from the link by preventing the operation of the finder start relay and also disconnects the unbalanced load on the P line wires, thereby bringing the lines into the balanced condition in readiness for the talking circuits.

Station Selection

The operation of the finder cut-through relay starts the connector switch and connects the P and S wires coming from the calling station, where they are connected to a pulse circuit already set up by the operation of the station-selector key, to the associated central pulse-matching circuit which will stop the connector switch on the contacts of the called line.

The principle of circuit selection utilizes an inductance and selenium rectifiers to break down the 60-cycle power supply voltage into pulses that allow 8 selections. The pulse signals are individual, thereby obviating reliance upon combinations of pulses and eliminating testing before the selection is determined.

If an alternating voltage E is fed into an iron-core inductance through a half-wave rectifier, a current I will flow and the voltage E_1 produced across the inductance is the distorted sine wave shown in Fig. 3B. Because of the effect of the inductance in the circuit, the current I and the voltage E_1 is partly carried over into the next

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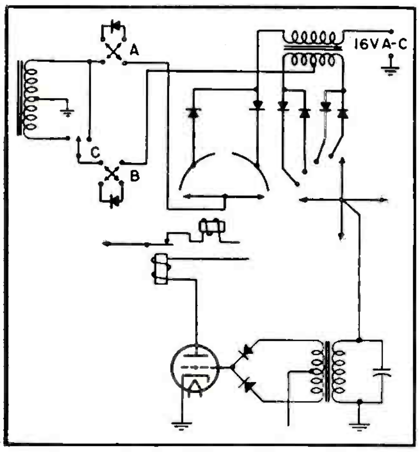

FIG. 4—Talk-listen and release switching circuits

half cycle. This overlap of current and voltage can be brought back to occupy all or any part of the first half cycle by inserting a parallel resistance and capacitance in series as shown in Fig. 3C. When current flows in the circuit, the voltage charge built up across the capacitor cancels the voltage of the inductance and causes voltage across the rectifier to reverse sooner, thereby reducing the duration of the current in relation to the applied voltage E.

If a center tapped inductance is used as in Fig. 3E it is possible to reverse the phase of the E_1 voltage, thereby producing E_2. If a secondary rectifier is added it is possible to segregate any one of the four half cycles of E_1 and E_2. These circuit combinations and their accompanying waveforms are shown in Fig. 3G through N. By reversing the polarity of the primary circuit rectifier, the current flows during the negative half of the cycle and in the same manner as described above, four more pulses can be generated, occurring during the last half-cycle of the applied voltage E. This pulse-generating circuit can be used for remote-control service over a single pair of wires or to modulate a radio or wire-carrier wave to set up eight different circuit selections, assuming that the same synchronized power source is available at both ends of the connection.

Control Circuits

In the system described, a 3-wire system is necessary for the remote control of the talk-listen and release functions. The three-wire selection circuit used, shown in Fig. 4, is a modification of the basic selection system. The a-c voltage is supplied at the central unit only, thereby making a power connection unnecessary at the speaker station. The diagram shows a simplified circuit of the station switching which, by the operation of the two rectifier reversing switches A and B and the phase-reversing switch C into their eight possible combinations, sets up the eight pulse circuit conditions. The wipers of the stepping switch set up the equivalent pulse circuits at the central unit. When the pulses are matched, current flows in the pulse-load transformer which fires the thyratron, operates the connector-stop relay, and stops the connector switch on the called line.

The operation of the connector-stop relay sets up completion tone and changeover relay circuits on the calling line. The output of the 700-cps phase-shift completion-tone oscillator is connected over the S wire to the calling station, speaker voice coil to ground through the rectifier R_{S1} or R_{S2} and the pulse inductor. The completion tone indicates that the connector switch has stopped on the calling line and that the station selector key may be released immediately.

The release of the selector key operates the changeover relay over the circuit traceable from the 24-volt power transformer winding through the rectifier bridge circuit and changeover relay winding, the primary pulse wiper of the connector switch, the P wire, the speaker voice coil, back on the S wire and through the output winding of the completion tone oscillator to ground. The bridge circuit prevents the reversal of flux in the changeover relay to allow lock-up operation and introduces into the circuit a rectifier which bucks the station rectifier and thereby prevents operation of the changeover relay before the selector key is released.

The changeover relay disconnects the plate voltage from the tone oscillator, connects it to the audio amplifier and connects the input and output of the audio amplifier to the calling and called lines respectively, thereby completing the talking circuit.

Talk-Listen Circuit

The operation of the listen key at the calling station grounds the talking pair P and S through the bridging center-tapped resistance, thereby operating the talk-listen relay which reverses the amplifier connections to allow a reply from the called station. The current interruptions to the talk-listen relay cause very little disturbance in the amplifier because of the balanced center-tapped connections at the line terminations. The isolation transformer keeps the talk-listen relay current out of the talk-listen switching contacts, thereby preventing switching transients that would be caused by the normal deviations from simultaneous contact closure in a relay with standard adjustment.

Release Circuit

The operation of the release key disconnects the S wire from the speaker voice coil and connects it to ground. The talk-listen relay circuit is completed as in the listen function but the unbalanced current in the isolation transformer causes a transient voltage surge which goes through the input transformer and fires the type OA4 cold-cathode release tube. The OA4 tube supplies current through a differential winding to knock down the cut-through relay which returns the finder switch to the home position on its homing wiper, and interrupts the holding current to the finder-stop and changeover relays, thereby releasing the system.

The R-C timing circuit fires the other OA4 release tube at a predetermined time after the finder cut-through relay operates unless the talk-listen relay is operated which discharges the capacitor and extends the timing cycle. This feature releases the system when the calling station is abandoned by the calling party without releasing the system or when there is a circuit failure following the operation of the finder cut-through relay. When a station calls its own line the system is automatically released by the amplifier feedback voltage which fires the OA4 tube.

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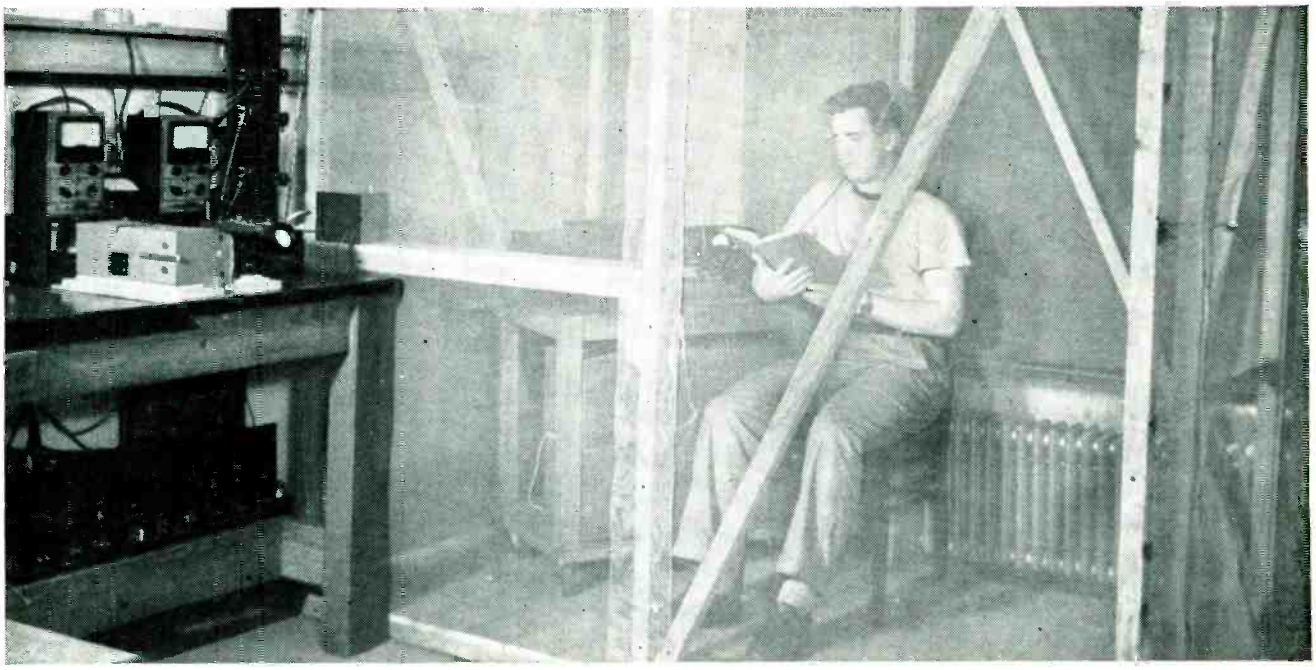

As subject reads book in shielded cage, equipment measures voltage between electrodes on temples as it varies with eye position. Resulting traces on recorder chart show variations in force exerted by extrinsic ocular muscles. These data are useful as criteria of fatigue or other cause of muscular weakness

Testing Eye Muscles

Progress of muscle-impairing disease such as poliomyelitis can be determined electronically by recording second derivative of eyeball potentials measured between electrodes on opposite temples. Technique also evaluates fatigue in physiological research

By EDWARD R. POWSNER* and KURT S. LION

Department of Biology
Massachusetts Institute of Technology
Cambridge, Mass.

THE MEASUREMENT of muscular strength is an important problem in physiological research and clinical medicine. The force of certain muscles and muscle groups varies with the progress of a disease such as poliomyelitis, with fatigue, and even depends upon psychological circumstances. Such measurements are usually made with ergometers. These instruments measure and record the output of a subject working against a load. A well known example is the bicycle ergometer which is frequently used in physical medicine and in rehabilitation service.

Certain muscles or muscle groups are not accessible to these kinds of ergometric measurements, such as the extrinsic ocular muscles, which move the eyeball left and right, and up and down. The eye has one outstanding characteristic, however, which makes it possible to measure the force of these muscles electronically. It was found by Mowrer, Ruch and Miller[1] that the eyeball is polarized. The eyeball may be represented by a sphere with a positive and a negative pole. This polarized sphere, turning in the semiconducting medium of the head, acts very much like a spherical potentiometer. Two electrodes, placed on opposite temples to record the eye potentials, serve with the intervening media to act like sliding contacts. Fenn and Hursh[2] found that the potential thus measured depends on the angular position of the eyeball in its socket. In

* Now at Yale University School of Medicine, New Haven, Connecticut.

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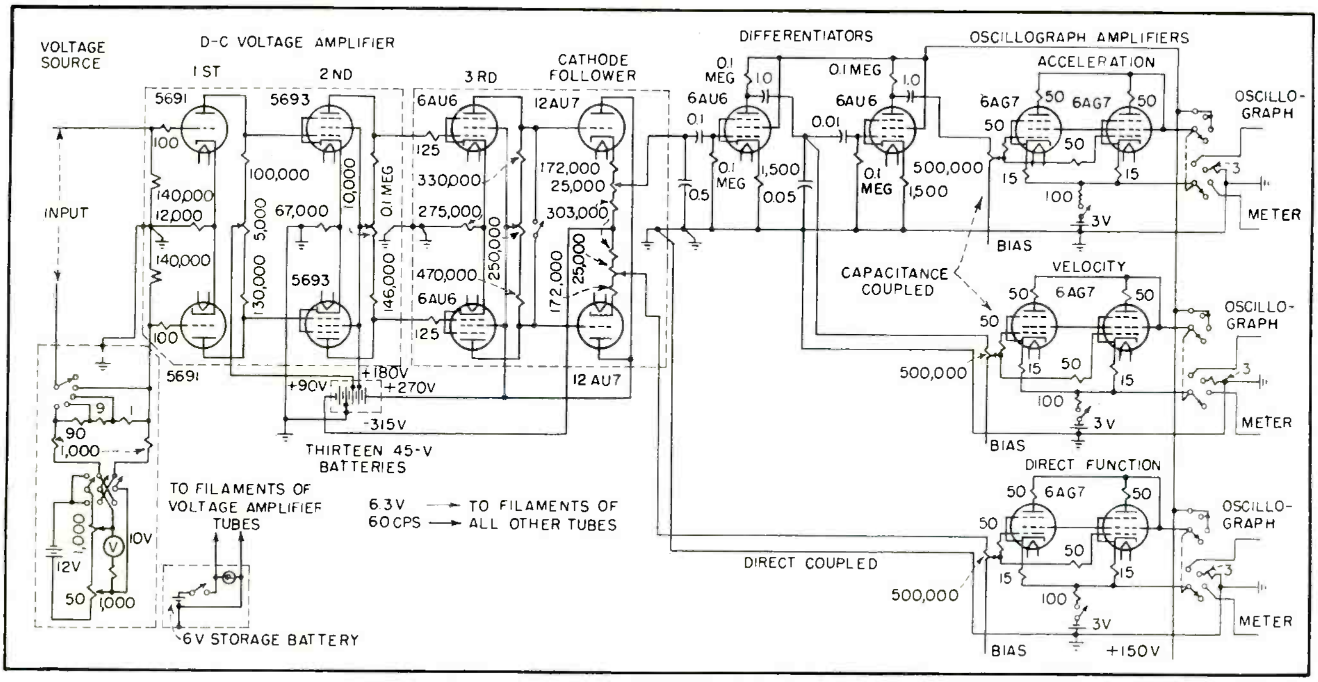
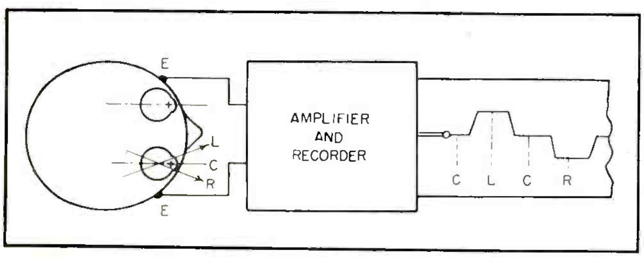
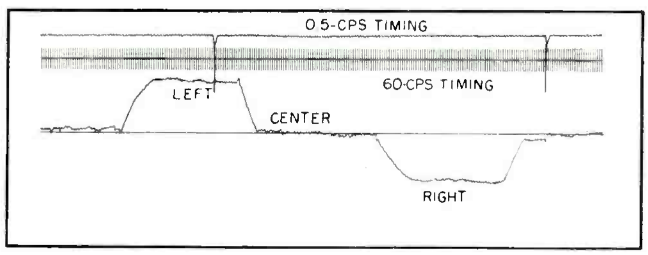


FIG. 1—Direct-coupled amplifier arrangement used to provide overall gain of 99 db, with circuit noise level of only about 3 microvolts, for recording eyeball potentials and their derivatives. Uppermost output stage handles second derivative, which is proportional to force of extrinsic ocular muscles that move eyeballs right and left and up and down



Arrangement used for recording position of eyeballs, with chart trace at right



Sample of calibration record for 45-degree eye motion left and right of center

any one subject the relation of potential to position shows little change from day to day.

This eyeball potential, if recorded, furnishes a graph which indicates the angular position of the eyeball as a function of time, $\Theta(t)$. Differentiation of this voltage therefore indicates the velocity, $\omega = d\,\Theta(t)/dt$, of the eyeball movement. A second differentiation furnishes the angular acceleration, $a = d^2\Theta(t)/dt^2$, of the eyeball.

Once the acceleration of the eyeball is known, the force causing it can be found easily from Newton's law. For translational movement, force is equal to mass times acceleration. For the rotational movement of the eye this law has to be modified into $T = aI$ where T is the torque, a is angular acceleration and I is the polar moment of inertia of the eyeball. With some simplification one can say that the torque T is the result of the muscular force f acting at a radius r from the center of rotation, so that $T = fr$. The muscular force can therefore be found from

$$f = \frac{T}{r} = \frac{a\,I}{r} = \frac{d^2\theta\,(t)}{dt^2}\,\frac{I}{r} \quad (1)$$

It can be shown[8] that the output voltage e from the subject is proportional to the angular position of the eyeball, so that

$$= k\,\frac{d^2e}{dt^2}\,\frac{I}{r} \quad (2)$$

The force of the extrinsic ocular muscles is proportional, therefore, to the second derivative of the output voltage arising between the electrodes attached to the patient's temples. In this equation k, I and r are constants; their values need not be known for comparative measurements. For absolute measurements I and r can be approximated with reasonable accuracy from anatomical data. The constant k is the overall calibration constant and includes the subject,

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the gain of the amplifiers, the constant of the differentiators and the sensitivity of the recorder, all of which can be measured.

D-C Amplifier Design

The first and most important step in the present experiments is the amplification of the eye potentials so as to permit their recording and differentiation. The smallest important signals are of the order of 25 microvolts. The slowest potential has a period of 2 seconds. At the other end of the frequency response it is desired to have the cutoff high enough to permit accurate reproduction of the most rapid rise times. Since it is desired to record the output graphically, the amplifier is designed with a slightly higher cutoff than that of the best available recording galvanometer, which is about 5,000 cps. It was felt that these requirements could best be met by a direct-coupled amplifier.

The high gain required, about 100 db, and the necessity of maintaining the drift at a fairly low level call for special techniques. Batteries are used as the power supply for all but the output stage. Tubes and other components are likewise selected for stability and low noise. Double-shock-mounted "red" tubes and wirewound resistors are used in the first two stages.

As shown in Fig. 1, the amplifier consists of three stages with a gain of 83,000 or 99 db. The stages are direct coupled. Because of the common cathode resistors, the amplifier is comparatively insensitive to equal voltage variation of the two input terminals. A Beckman Helipot in the plate circuit of the first stage permits balancing of the amplifier during operation when necessary.

The high zero-signal voltage of the third stage, which results from the direct coupling between the individual stages, is reduced to zero by the use of a cathode follower stage. There is, of course, an inherent loss of gain in this arrangement, but this is minimized by making the negative voltage large compared to the zero-signal plate voltage of the preceding stage. For the values used in this case, the gain factor is 0.63. This results in an overall amplifier voltage gain of 54,000 or 95 db.

The fact that the oscillograph galvanometers and, consequently, the oscillograph amplifiers are single-ended means that only half of the gain of the amplifier can be employed. Rather than employ an additional stage to convert the balanced output to a single-ended input, the output is simply taken from one half of the amplifier. While this solution is simpler and requires fewer tubes, it is necessary to adjust the operating points of the two tubes of the final amplifier stage so both would be capable of handling either positive or negative signals within the linear portion of their characteristic. This adjustment is made by selecting the cathode resistor to give the proper value of bias. Centering of this stage is achieved as in previous stages by adjustment of load resistors.

The basic consideration in the design of the differentiators is the time constant of the R-C network, which was arrived at experimentally. The time constant of the first differentiator is chosen at 0.01 second; that of the second, where the additional stage of gain permits, is decreased to 0.001 second.

The other important design consideration is the degree of smoothing. In general, the high-frequency components present in the noise are such that their derivative will tend to mask the derivative of the function. To avoid this difficulty, the higher-frequency components are removed from the signal to be differentiated with a shunt capacitor that acts in conjunction with the input impedance of the stage as a low-pass filter. For this purpose a 0.5-microfarad capacitor is used at the input to the first differentiator and a 0.05-microfarad capacitor is used at the input of the second differentiator. Mathematical computation, confirmed by visual comparison of the filtered and the unfiltered waveforms, has shown that the smoothing does not appreciably change the waveform, but simply removes the noise component of the signal. Both differentiators were calibrated by means of triangular waves of known rise time.

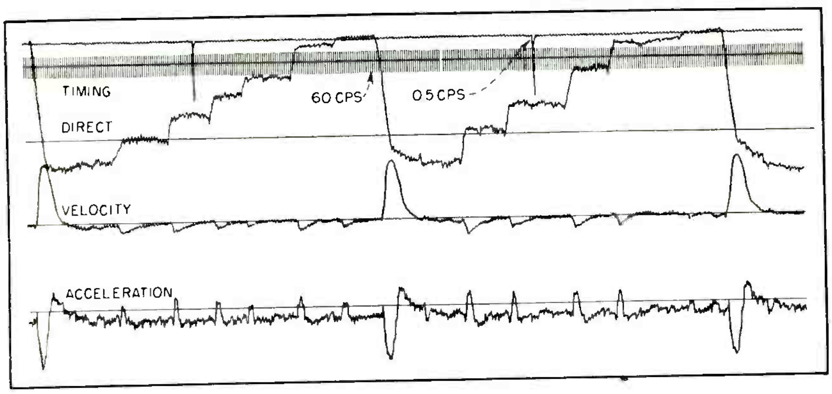

FIG. 2—Example of pattern obtained while subject reads line of print. Direct trace shows eye position during reading. Eye velocity is first derivative of eye position potential. Eye acceleration trace is second derivative, corresponding to muscular forces that move eyeballs from side to side and up and down

Oscillograph Amplifiers

The amplifier for the oscillograph galvanometer used for the recording of the function itself is direct coupled, while the amplifiers employed for the two differentiated functions are capacitance-coupled. The major requirement for this stage is high transconductance, a current rating of 100 milliamperes and a fairly low drift. The two parallel 6AG7 tubes with a small amount of cathode feedback meet these requirements. In parallel their total transconductance is 20,000 micromhos. A single-ended arrangement was chosen. A balanced stage could have been designed, but when used with galvanometers having no centertap it would have required twice the

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power supply capacity now used.

Centering was provided by the use of a variable current to oppose the tube current. This centering current was obtained from a 3-volt battery and a variable resistance. A gain control and an output selector were also provided. The latter permitted a meter or a shunt resistor to be switched into the circuit in place of the galvanometer.

Bias for the two capacitance-coupled amplifiers is provided from the power supply through the grid resistor. For the direct-coupled amplifier it is adjusted by varying the output voltage level of the cathode follower stage. The amplifier is operated with a zero-signal current of 50 milliamperes in either direction. With galvanometers of highest sensitivity (1.7 milliamperes per millimeter) this is equivalent to about 3 centimeters deflection to either side of center.

A modified General Electric miniature oscillograph PM17 is used for recording. For these experiments it is equipped with galvanometers having a frequency response of less than 1,000 cycles per second.

The electrodes were made from a head band taken from a set of earphones. Brass holders were machined to fit in place of the earphone assembly. The electrode itself consists of a cup-shaped silver button, about 3/16 inch in diameter, supported by a straight silver wire which fits through a hole in the plastic mounting. A sponge-rubber washer assures even pressure. Both the position and the pressure of the electrodes can be adjusted by use of set screws.

Whenever two electrodes are brought into contact with a human skin, a polarization voltage up to one volt may occur. Usually this voltage is not constant, and therefore introduces a slow drift. A low-impedance voltage source that is reversible in polarity and continuously variable over several ranges is used to balance out this contact polarization. A meter makes it possible to record the magnitude of the polarization if desired.

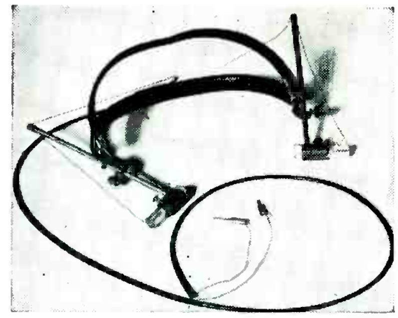
The subject is seated inside a shielded and grounded cage. The three voltage-amplifier stages and the cathode follower, all battery-operated, are placed on a small carriage. The three output terminals of the amplifier are connected to the corresponding terminals in a shielded terminal box in the side of the cage. From there connections are made to the oscillograph amplifier and to the differentiators.

Calibrating Procedure

Prior to making a test, the amplifier is allowed to warm up for 15 to 30 minutes. The subject is seated against the center of the far wall of the cage, facing a point on the near wall midway between two signal lights. The area under the electrodes is cleaned and the head piece put in place. The amplifiers and associated equipment are then adjusted and a series of calibration tests made to check the relation between the eye position and the measured eye potential. Calibration involves having the subject hold his head fixed and move his eyes to look at numbered marks on the opposite wall of the cage corresponding to a certain angular position to each side of a central point. The movement itself starts quite abruptly; preceding each movement there is a small spike of about 10 microvolts in the negative direction. This either corresponds to an eye motion through about two degrees or may represent a muscle twitch connected with the eye movement.

After the calibration test the subject is given a reading task, while the output voltage and its derivatives are recorded. As described by previous workers[4], when reading a line of print the eye does not move continuously, but in jumps (saccades). The position of the eye is fixed towards a certain group of letters or words, and then moves to a new group. Occasionally, as when the reader does not grasp the meaning of a word, regression occurs, wherein the eye jumps a step back and then continues the usual pattern.

A record of a reading pattern is shown in Fig. 2. The first derivative pattern shows that the velocity of the return sweep is considerably higher than that of the saccades. The time required for the saccades is almost the same as that needed for the much larger angular deflection of the return sweep. The



Electrode arrangement used on temples of subject to pick up eyeball potentials

muscular forces expended for the saccades as well as for the return sweeps are surprisingly constant for any one subject. The forces needed for the return sweep are from two to three times higher than the ones needed for the saccades.

The noise level in these records is of the order of five to seven microvolts. Inasmuch as the noise level of the amplifier with an equivalent resistor substituted for the human subject is about three microvolts or less, it may be assumed that the noise is biological in origin. Jaw motion, neck motion and blinking, as well as other muscular involvements, are the most important sources of this noise.

The record of the forces exercised by the extrinsic ocular muscles may be of considerable help in physiological investigations or for medical diagnosis. It is also expected to be of particular importance in the study of visual fatigue. The method is applicable, of course, to other muscles or muscle groups if their action can be converted into an equivalent voltage or current.

The authors wish to express their thanks to the Illuminating Engineering Society Research Fund for sponsoring this research.

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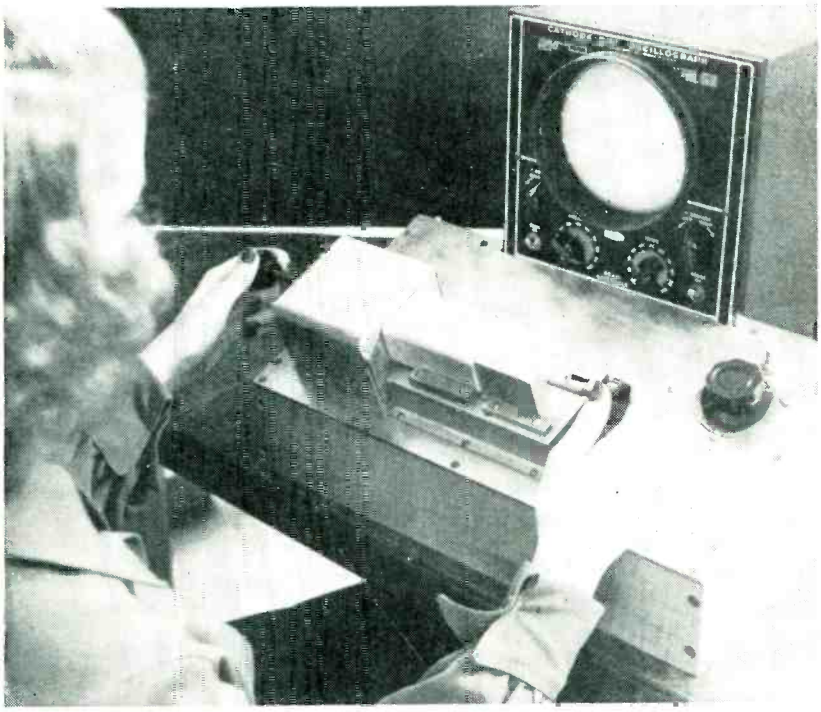
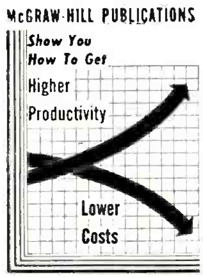
CURVE TRACER with



Unskilled operator using curve tracer can achieve higher production rates at lower test cost per unit than was previously obtainable with point-by-point production testing of band-pass filters. Resulting response curve is also smoother and more symmetrical. Operator merely adjusts captive screwdrivers to make band-pass peaks come within proper electronically produced limit lines on cathode-ray screen



By J. W. BALDE, J. C. BREGAR and K. L. CHAPMAN

Engineering Staff, Western Electric Radio Shops
Winston-Salem, North Carolina

In recent years, the cathode-ray oscilloscope and frequency-sweep generator have been adapted to display the frequency-amplitude characteristics of apparatus under test. Results of tuning or coupling adjustments are instantly shown qualitatively on the cathode-ray tube screen.

To adapt this setup for quantitative measurements, a method of calibrating the cathode-ray display is necessary. This problem has been solved in numerous ways, one of which is to have displayed on the oscilloscope not only the curve of the response of the apparatus under test, but also a high limit and low limit curve. This has been done both mechanically and electronically, the former by fastening a graph of the high and low limit curves on the face of the cathode-ray tube and the latter by electronically switching in high and low limit standards. The mechanical arrangement has proved useful but requires constant calibration due to amplifier drifts, frequency drifts and other uncontrolled variables. The electronic method eliminates errors due to these uncontrolled variables; however, if a large variety of apparatus is to be tested, the number of standards required becomes a major problem.

Recently, a program of filter production was started which required testing many different types of filters at various frequencies, for use in rural power line carrier telephone apparatus. With the high and low limit method, an excessive number of reference standards would have to be made, adjusted, carefully checked, and maintained with known recorded values for each filter. Therefore, a program was undertaken to develop a more universal type curve tracer which presents a graph-paper type of display electronically on the oscilloscope screen and requires no standard high-low limit units. In effect, what was desired was a flexible frequency scale and attenuation scale which produced a graph effect on the face of the oscilloscope. The response curve of the apparatus under test would then be read against these graph lines.

Nature of Display

The curve-tracer display obtained is shown in Fig. 1. It includes the envelope of the gain characteristic of a filter under test and three horizontal lines. Each of the lines is obtained from the same input voltage that is applied to the filter. This input voltage is either applied directly to the detector circuit, producing a zero loss-zero gain reference line, or is passed through attenuators, producing a line at any specified attenuation level. Three such lines were decided upon, although any number of lines could be displayed. Such lines spaced equally in attenuation or vertical displacement form the vertical scale of graph lines.

The horizontal frequency scale is marked by negative intensity markers. Normally, only two frequency points are indicated, each appearing as a dark vertical line cutting all curves. The frequency interval between the two marker lines is controlled by key selection of crystals

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Electronic Graph Lines

Production testing and adjustment of band-pass filters, amplifiers and discriminators is speeded up by making electron beam trace calibrated graph lines on c-r screen along with response curve. Setup can be changed for different type of product in few minutes

which generate the lines. Here again, any number of vertical frequency marker lines could be displayed at the same time if desired, forming a horizontal scale, but only two were deemed necessary for the present application. The vertical lines can be set for any frequency interval in steps determined by the crystals available. Since the marker frequencies can be changed by key selection without disturbing any adjustments, intermediate frequency points may be identified at will.

The absolute frequency through which the apparatus under test is being swept is controlled by a separate tuning control which shifts the frequency until it is set at the desired point. Once set correctly, the frequency markers are used to produce the scale of frequency differences. Such setting of frequency markers is made to indicate absolute frequency by momentarily inserting some high-Q resonant circuit of known frequency into the transmission path in place of the apparatus under test. The output frequency is then adjusted till one of the relative markers coincides with the sharp pip displayed. This effectively locates the frequency markers with respect to absolute frequency, while the difference between the markers is determined with the accuracy of the crystals generating the markers.

Technique of Use

What is needed for production testing is a display which can utilize the go-no go gage technique. Such a display should indicate the filter limits for center frequency, bandwidth and gain. Only two frequency marks are needed, with the interval between the marks set to the bandwidth limit of the filter. The filter is tuned for the desired symmetrical curve, then shifted in frequency till the curve is visually centered between the markers. Once centered by the filter tuning adjustments, the gain and bandwidth factors are ready to be measured or checked.

The gain check is performed by placing two attenuators in series with the signal from the test circuit. One attenuator, mounted on a remotely located control rack, is set to the value of nominal filter gain. The second attenuator, on the test console, is a small-range

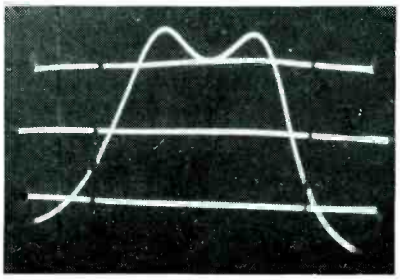

FIG. 1—Example of presentation incorporating three horizontal and two vertical graph lines along with response curve. More lines can be produced by the same electronic technique if needed, each representing a known value

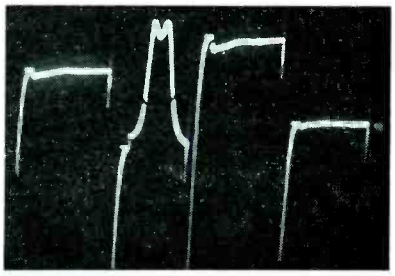

FIG. 3—Detector output waveform as applied to vertical deflection plates of c-r tube. Repeating this pattern 60 times per second with 240-cycle sawtooth sweep on horizontal deflection plates serves to superimpose the four traces

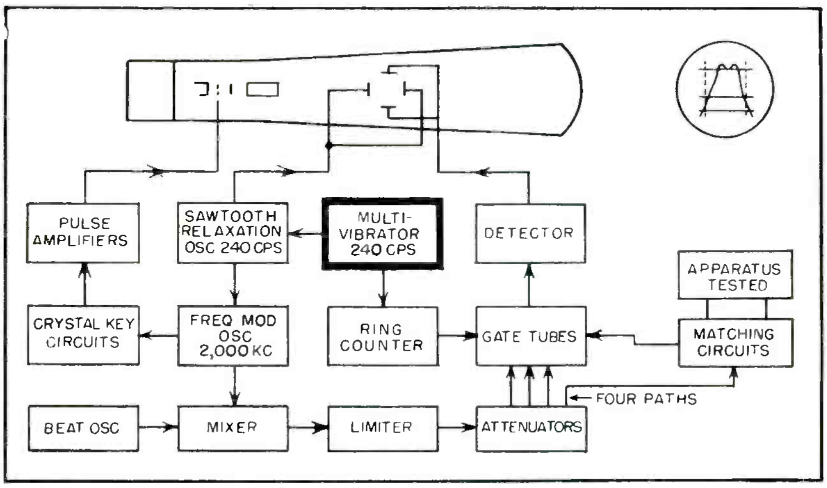

FIG. 2—A 240-cps multivibrator is the master control that makes the c-r beam trace in sequence the response curve and the horizontal graph lines, with Z-axis modulation producing the dark vertical lines

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attenuator with a locking device. This locking device is set to limit the range of this attenuator to the permissible range of deviation from nominal gain of the filters. When a filter has been tuned to center frequency this small-gain-variation attenuator is adjusted by the test operator until the voltage level of the filter characteristic curve response at center frequency coincides with a zero reference line. If such coincidence cannot be accomplished within the available variation of the small-gain attenuator, the filter is known to be outside normal gain variation limits, and is rejected.

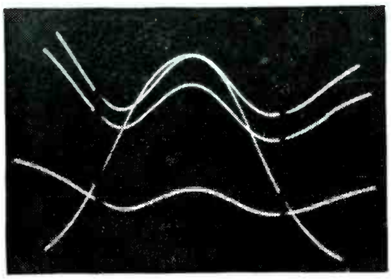


FIG. 4—Presentation obtained when input impedance of filter under test varies appreciably over range of frequencies employed. The three horizontal graph lines are now curved, but their relationship to the response curve is still a correct measure of gain or loss

With the filter centered between the frequency limits and the gain check made, the other two horizontal lines come into play. These lines are so set that they indicate the limits of filter loss at the nominal frequency bandwidth limits. The high limit line is set for 2 db, the wide limit of that filter. A filter narrower than the limit value will produce a curve which will cross the frequency marker line at a loss level greater than 2 db.

A wide filter will not have sufficient attenuation at the limit frequency (+25 kc for one particular filter) and its response curve will cross the marker line at a point above the 2-db line and be rejected.

In a similar manner, the low limit line is set for the narrow bandwidth limit (6 db) at the nominal width frequency. Excessively narrow filters having too great a loss at the specified bandwidth frequency will show on the oscilloscope as crossing below the low limit line. A satisfactory filter curve will cross the marker lines between the two limit lines.

Principle of Operation

In Fig. 2 is an overall block diagram of the complete curve tracer apparatus. The sawtooth relaxation oscillator operates at a frequency of 240 cps, driving a reactance tube which frequency-modulates an oscillator operating nominally at 2,000 kc. A beat oscillator signal is mixed with this frequency-modulated signal to shift the output frequency to the range desired for the apparatus under test. The mixer output is amplified and limited to guarantee uniform amplitude of signal over the frequency range being swept.

The frequency marker circuits are excited by a sample of the 2,000-kc frequency-modulated signal before mixing. The signal is fed to crystals in the 2,000 to 2,100-kc range serving as crystal filters. At the output side of the crystal, there is an increase in transmitted voltage at the resonant frequency of the crystal. This increase is not immediately usable to produce a marker signal because of the rounding of such increase due to the Q of the crystal.

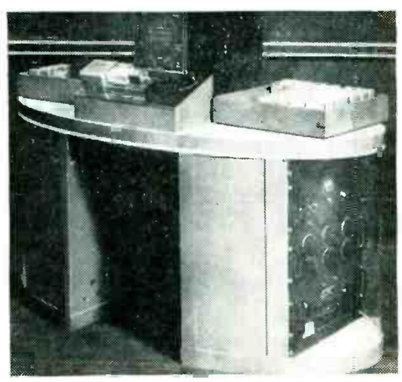
The transient effect at the frequency of the crystal is sharpened by a positive-feedback pulse amplifier circuit. The amount of feedback, the capacitance across the crystals, and the time constant of the circuits are adjusted so a sharp, clear, steady pulse is produced from the crystal disturbance.

Operation of two crystal keys produces two steep, narrow pulses which sharply intensity-modulate an oscilloscope trace. The two notches or dark spots thus produced are separated along the horizontal (frequency) scale of the oscilloscope by a value determined by the differences of the absolute frequencies of the crystals involved. The distance separation is therefore a function of the frequency bandsweep of the f-m signal. The crystals can be selected as close together as 2 kc and the markers will be usable and steady.

Such frequency markers provide a scale of relative frequency as accurate in frequency spacing as are the crystals. The frequency markers could be actuated by the output f-m frequency (after mixing), producing absolute frequency markers. The flexibility of the set with regard to changing frequency would be seriously inhibited, however, since new marker crystals would have to be provided for even the smallest change in frequency.

By actuating the markers from crystals operating at the high f-m frequency and changing the output frequency by heterodyning action with a beat oscillator, the markers become relative. Such relative markers can be located in relation to the absolute value of the output frequency by coinciding any one of the markers with the transmission output characteristic curve of any calibrated resonant circuit. The combination of relative markers and variable calibrated resonant circuit is far more flexible than absolute markers would be.

The gate tubes that serve as an electronic switch receive the frequency-modulated signal from the mixer through four separate paths, each having an attenuator. One of the paths has zero attenuation. The apparatus under test is normally inserted in another of these paths. The signal from all four paths is combined at the detector by sequence-switching the input of the detector to the signal from each of



Unified test position, with electronic circuitry and electrical matching networks for filters located under console. Operator's test jig clamps to front of scope, masking all scope controls except centering, focusing and intensity

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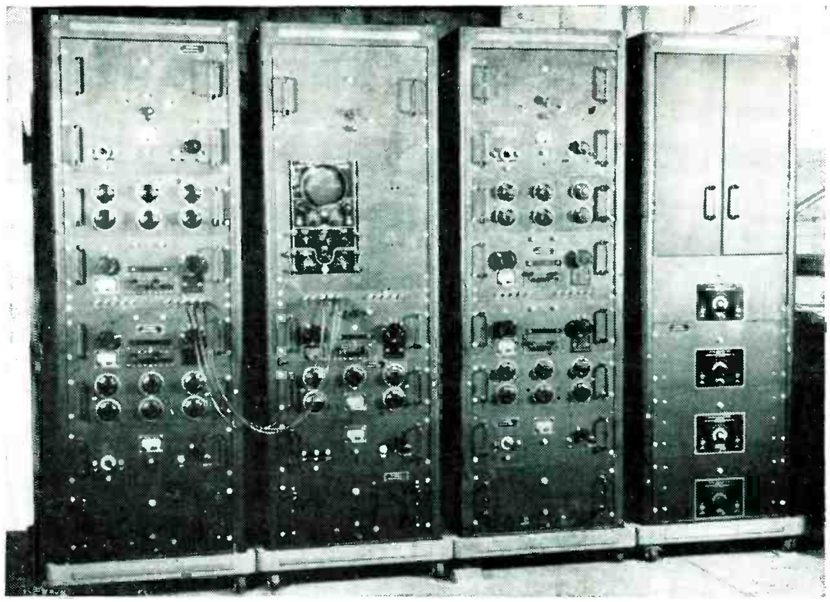
the paths in rotation. This composite detected signal is applied to the vertical input of the oscilloscope. The signal is a series of four pictures, each a frequency response of the transmission characteristics of the path involved.

A 240-cycle multivibrator synchronized with 60 cycles is used as the basic pulse generator for actuating the ring counter used to switch the gate tubes of the electronic switch and for synchronizing the saw-tooth sweep generator. Since there are four paths, the basic switching rate of 240 causes each path to be repeated 60 times per second, a value satisfactory to avoid flicker on a cathode-ray oscilloscope with a P-1 phosphor.

The waveform of the output of the detector is as shown in Fig. 3, with the four images in sequence. These four images are superimposed on the face of the oscilloscope of the curve tracer by driving the horizontal sweep of the oscilloscope with the 240-cycle sweep of the relaxation oscillator. This sweep, being the same as the frequency sweep rate, causes all paths to be displayed with the same horizontal location for equal frequencies, and persistence of vision combines them into one picture.



Rack-mounted electronic circuitry serving installation of five curve tracers. Monitor oscilloscope facilitates checking operation of test sets on production line. Locating controls remotely from operators minimizes accidental shifting of adjustments and simplifies maintenance

Production Test Procedure

The circuits connected directly to the filter under test are selected to supply the appropriate voltages and terminal impedances to the filter. The circuits may take any form necessary to provide a transmission path through the apparatus under test, terminated in the proper impedances both to the curve tracer circuits and the filter. Since the circuits will vary with the filters to be tested, little can be said here as to what form such circuits will take. They must be stable, linear elements arranged so that the transmission through the entire circuit is affected by the portion under test alone.

Connections to the filter circuits have been made low-impedance. For production line testing, it is convenient to have the test position placed right on the assembly line, especially if conveyor belt operation is planned. By connecting to the filter circuits with low-impedance cables, the rack-mounted electronic circuit items of the curve tracer proper can be located up to 40 feet away without undue pickup due to long lines. The filter circuits can be combined with the oscilloscope into a test console of small, convenient size. When there is a group of such console work positions, the curve tracer components can be located together with a monitor oscilloscope to facilitate observation of the operation of the sets.

When testing filter circuits over a range of frequencies, the effect of varying input impedance on input voltage can be eliminated by producing the horizontal attenuation lines from a sample of the input voltage to the filter. The horizontal graph lines are then pulled down along with input voltage as the filter impedance drops, and the relationship between them remains a correct measure of the transmission loss or gain of the filter. Figure 4 illustrates such a curve of a filter with input impedance variation.

When using the curve tracer with a filter whose input impedance varies, the variation in input impedance can be used as a tuning aid. The primary of the filter when tuned will produce a dip or drop in voltage at its resonant point. The filter therefore can be tuned to center frequency by observing the db reference lines only. For three or four-section filters where the output voltage is negligible till all tuning adjustments have been made, this becomes very important.

Conclusions

The curve tracer described here, while initially designed because of a particular need of one project, is essentially a flexible tool. The present model can test any apparatus with a band spread from 10 to 70 kc at center frequencies of 100 to 700 kc. Such a curve tracer could be constructed for any necessary frequency and bandwidth. The electronic graph paper method can be used to observe and test many different types of apparatus, including amplifiers, receivers and discriminators.

The design of the present curve tracer apparatus was carried on under the immediate supervision of D. K. Briggs, F. E. Burley, and D. R. Barney, department chiefs of test engineering. The authors wish at this time to express appreciation for their encouragement and assistance during the development period.

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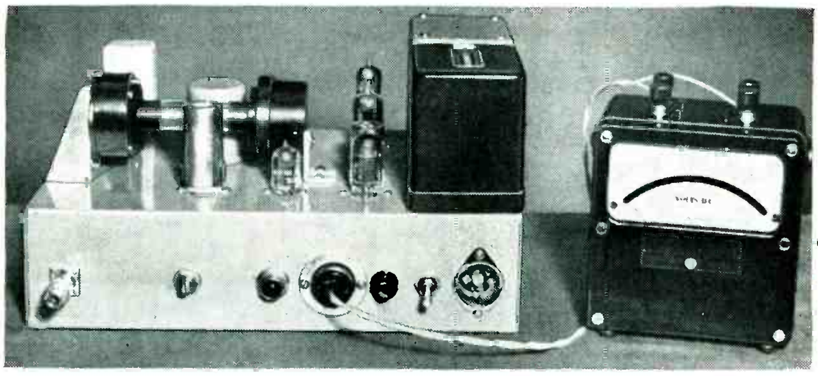
D-C AMPLIFIER Using

By **CURTISS R. SCHAFER**
Member, Technical Staff
C. G. S. Laboratories, Inc.
Stamford, Conn.



Complete amplifier is nonmicrophonic and rugged enough to withstand use in truck over rough terrain. All internal ground leads are brought to lugs under mounting screws of UG-290/U input receptacle at left. Air-coupled chopper is on top of chassis. During development, voltmeter at right was used instead of a recording galvanometer

USE of air coupling between the exciting coil and the moving contacts of this new d-c/a-c modulator, or chopper, gives two advantages over conventional choppers used for breaking up a d-c signal to permit amplification in a high-gain a-c amplifier. First, the exciting voltage for the reed is kept entirely out of the field around the contacts, so that no local noise is generated except the thermal noise due to contact friction. Second, the modulating frequency may range from 20 to 2,000 cycles per second. A high carrier frequency has definite advantages when it comes to the reduction of hum in an amplifier.

The new modulator consists of two units, shown in Fig. 1. The driver is a miniature loudspeaker of the moving-coil type, with a phenolic diaphragm which is air-coupled to the chopper diaphragm through a flexible plastic tube. This driver is excited at a frequency of 1,000 cycles per second (in the present design) by the amplified output of a stabilized Colpitts oscillator, which also supplies the reference voltage to the discriminator.

The driver unit may be mounted anywhere on the chassis, even in a region of strong magnetic fields, and the chopper may be placed right at the input stage.

The amplifier, oscillator and polarity discriminator circuits used with the air-coupled modulator to provide d-c amplification are shown in Fig. 2. One unique circuit feature here is the electronic ripple filter for the plate voltage supply.

Electronic filtering gives smoothing action equal to a standard filter section consisting of two 40-μf electrolytic capacitors and one 30-henry choke. With its use, only small values of paper capacitors are required, chiefly for bypassing.

The partially filtered voltage at the output of the choke may be assumed to have a certain value of direct current upon which there is superimposed a nonsinusoidal alternating current. During the positive peaks the grid of the 5610 is driven in a positive direction, the plate current increases, and the plate resistance of the tube is lowered so that these positive peaks are actually absorbed in the tube. The reverse action takes place during that part of the cycle when the grid is driven more negative. The 2,000-ohm variable resistor is adjusted for maximum control (or filtering), and locked. Variations in line voltage from 90 to 130 volts rms produce a change of only 0.02 percent in ripple voltage at the output of this filter, and this variation

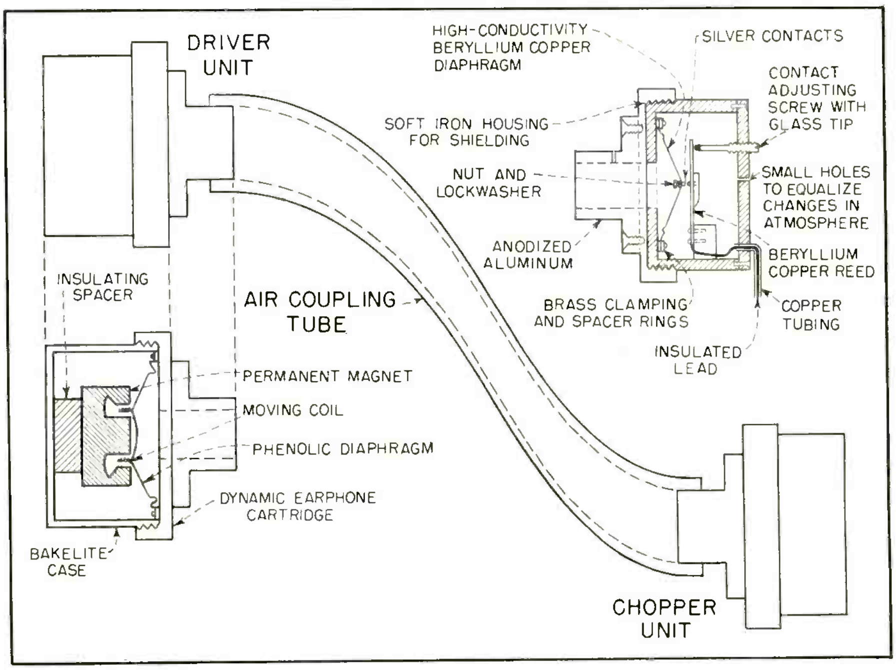


FIG. 1—Flexible plastic tubing with diaphragm at each end provides air coupling between driver and chopper that breaks up weak direct current to permit amplification in high-gain a-c stages. Locating driver remotely keeps its stray field away from chopper contacts, reducing noise

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Air-Coupled Chopper

New low-noise chopper, a-c amplifier and polarity discriminator together serve as stabilized d-c amplifier for weak currents encountered in electrical oil-well logging, prospecting, biophysical research and r-f power measurements. Circuit features include electronic ripple filter, two independent feedback loops and stabilized Colpitts oscillator

has no effect whatever on the operation of the amplifier.

Amplifier Feedback Loops

Another feature of this d-c amplifier system is the use of two independent feedback loops. Degenerative feedback is used in both, primarily to stabilize the overall gain. Two loops are used so that band-pass or high-pass filters may be inserted between the loops (between the plate circuit of the 5654 and the grid circuit of the 5687) to give almost any desired attenuation to hum or other interference.

This amplifier has been designed around the new 5600 series of miniature tubes developed by General Electric and Tung-Sol for application in the aviation services where maximum reliability and uniformity are required. Filter and bypass capacitors are Sprague and Gudeman miniature metal-based hermetically sealed units.

The polarity discriminator, using a type 5726 tube (electronically equivalent to a 6AL5), is basically a phase detector in which the signal voltage is added to or subtracted from the reference voltage. The resulting voltages are rectified, and a filter is added so that the galvanometer may be used directly in the discriminator circuit.

The reference voltage is derived from the oscillator. Both sections of a 5670 are fed from the oscillator plate; one triode drives the moving-coil transducer which is coupled to the chopper diaphragm, and the other section feeds the discriminator. Phase shifts in the d-c modulator and various amplifier stages are such that the signal voltage, when it enters the discriminator, is in phase quadrature with the reference voltage.

Overall gain of the d-c amplifier is sufficient to give an output of 200 μa for an input of 500 μv, which will drive a Piccard oil-filled recording galvanometer full-scale either side of zero center. Linearity is excellent, stability is good with regard to line-voltage variations, and total noise generated in the amplifier and modulator is less than the equivalent of 3 μv d-c input. Total drift is less than 5 percent of full scale for the first hour of operation and less than 2 percent per hour thereafter, over an ambient temperature range of −30 to +130 F. Zero input gives zero output without resort to bucking voltages.

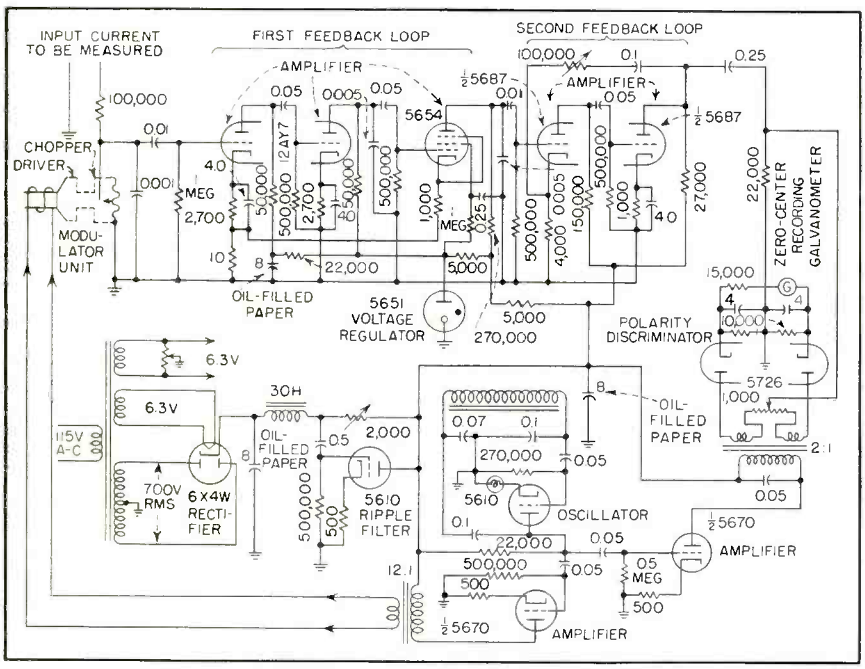


FIG. 2—Complete circuit provides stable amplification of weak direct currents and indicates polarity as well as value of current on the chart of a zero-center recording galvanometer. In test, output varied linearly from 0 to 250 microamperes when input was increased from 0 to 620 microvolts

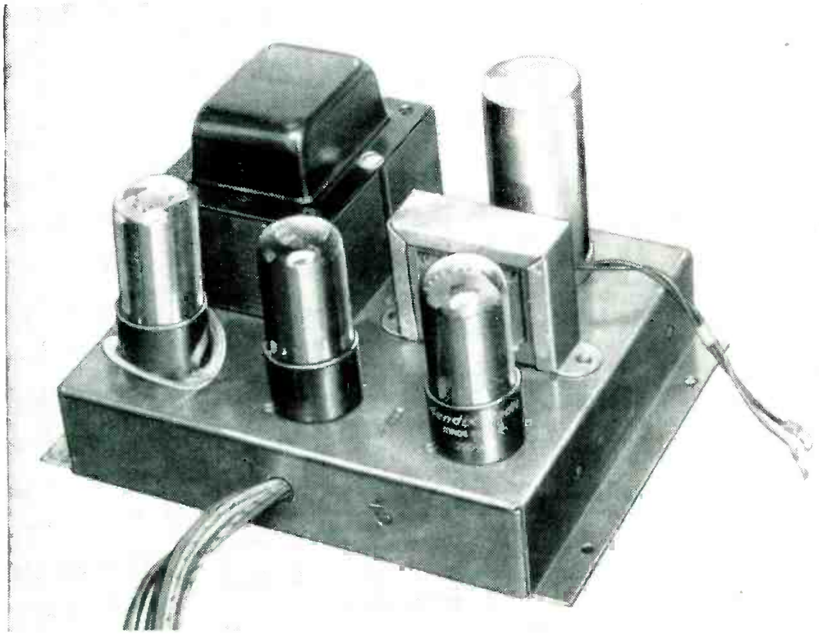
Geophysical Applications

In prospecting for oil reserves by the specific resistance method, two buried nonpolarized electrodes, usually copper sulphate, are connected to the amplifier input and pick up a small fraction of the current sent through the earth by generator electrodes. This gives a measurement of soil resistivity.

In measuring self-potential in a drill hole during electrical well-logging, the two pickup electrodes are spaced a few feet or a few yards apart in the hole. Contact with the various rock strata is obtained through the medium of mud pumped into the hole. The amplifier will satisfactorily measure local natural earth currents that produce as low as 10 μv across an input resistance of 0.5 megohm or more.

Combining Positive

By JOHN M. MILLER, Jr.
Broadcast Receiver and Television Engineering Dept.
Bendix Radio Division
Baltimore, Maryland



Experimental output-stage chassis. Unit is capable of 5 watts output with 0.5-percent harmonic distortion at 400-cps. Note small output transformer

IT HAS BEEN PROVED that the ear can detect as little as 0.5 percent of pentode distortion.[1] To achieve this low degree of distortion in typical pentode amplifiers, approximately 25 db of negative feedback is required. This sacrifice in gain, and the solution of the oscillation problem outside the passband, involve considerable added cost.

It is possible in a two-stage amplifier to approximate the results that would be obtained in a conventional amplifier with 25 db of negative feedback, by using a combination of local positive feedback in the first stage, and a moderate amount of overall negative feedback. The positive feedback has the effect of increasing the gain of the first stage. The general principle of combined feedback has been known for some time.[2]

The block diagram of a two-stage amplifier with combined feedback is shown in Fig. 1. The inherent voltage gains, with no feedback, of the first and second stages, are represented by A_1 and A_2 respectively, for very small signals; B_1 is the feedback ratio of the feedback around the first stage, and B_2 is the overall feedback ratio, for very small signals. The feedback ratio is defined as the ratio of the voltage fed back to the voltage existing at the point from which the feedback is obtained. These are all complex vector quantities, although their phase angles are likely to be very small in the vicinity of the amplifier band center. In the ideal case where there are no phase shifts, A_1 and A_2 are conventionally considered to be positive, and a feedback ratio is positive when the voltage fed back is in phase with the input.

Feedback Equations

The voltage gain is

$$A = \frac{A_1A_2}{1 - A_1B_1 - A_1A_2B_2} = \frac{A_1A_2}{N} \quad (1)$$

N is the vector quantity by which the gain without feedback, A_1A_2, is divided. If B_1 is positive (which would be the case for positive feedback), it has the effect of increasing the gain A; and B_2, if negative, tends to decrease the gain.

A term such as A_1B_1 or $A_1A_2B_2$ is known as a feedback factor. In the ideal case it will be a pure positive or negative quantity, but in the practical case, it will have a phase angle that is the sum of the phase angles of the factors involved. When there is no phase shift in the feedback network itself, the feedback ratio is considered to be a real quantity, and the phase angle of the feedback factor is equal to the sum of the phase angles of the A's involved.

The output impedance Z_2 is

$$Z_2 = Z_L \frac{(1 - A_1B_1)}{N(1 + Z_L/Z_{p2}) - (1 - A_1B_1)} \quad (2)$$

where Z_L and Z_{p2} are the load impedance and inherent output impedance of the output stage. It is seen in the above expression that when the product A_1B_1 is positive, a decrease in the output impedance can result.

The expression for distortion and gain stability is

$$D = \frac{D_1}{N} + D_2\left(\frac{1 - A_1B_1}{N}\right) + D_1D_2\left(\frac{1 - A_1B_1}{N}\right) \quad (3)$$

The inherent gain increments D_1 and D_2 in the first and second stages are caused, for example, by a change in applied static or instantaneous signal electrode voltages, or aging of the tube, and D is the resulting overall gain increment. The parameters D, D_1, and D_2 are each expressed as a fraction of A, A_1, and A_2. Equation 3 also holds if D_1, D_2, and D represent nonlinear distortion.

Regeneration and Distortion

For most purposes, optimum performance is obtained by designing so that the product A_1B_1 over the useful range of frequencies is approximately equal to unity. (If the negative feedback were temporarily removed, the first stage would be in a state of critical regeneration, with a gain approaching infinity.)

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and Negative Feedback

Development of simple two-stage audio amplifier using a combination of local positive feedback in first stage and a moderate amount of overall negative feedback to approximate the results obtainable from conventional amplifier with 25 db negative feedback

From Eq. 2, we now obtain zero output impedance, and from Eq. 3 we find that the distortion and gain variation contributed by the final stage, including the output transformer, are reduced to zero. From Eq. 1, the gain becomes $1/-B_2$. In an amplifier using negative feedback only, it would be necessary to provide an infinite amount of feedback gain reduction to obtain these results.[3] Very good results can be obtained even when A_1B_1 departs from unity by ±20 percent.

It will be seen from Eq. 3 that if A_1B_1 exceeds 2, the distortion introduced by the output stage will actually be greater than that which would be produced by omitting the positive feedback entirely. This shows the unsoundness with large feedback factors of the balanced feedback principle, in which A_1B_1 is made equal to $-A_1A_2B_2$, (N equals unity), since the distortion and gain variation are greater, though reversed in sign, than if no feedback at all were used.

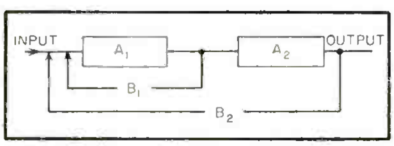

FIG. 1—Notation used for a two-stage amplifier showing two feedback paths

Oscillation

It is apparent from Eq. 1 that the quantity $(A_1B_1 + A_1A_2B_2)$ is analogous to the feedback factor AB in a conventional feedback amplifier, and may be considered to be the effective feedback factor in determining the possibility of oscillation. Thus we can use Nyquist's[4] and Bode's[5] criteria in analyzing any particular case. If, because of phase reversal in the feedback factor, a positive value of unity is assumed at some frequency, Eq. 1 gives a gain value of infinity, indicating oscillation. If the feedback factor is positive and greater than unity, oscillation will usually result, although there are exceptional cases, known as conditional stability[5], where oscillation does not result. However, in good practice it is customary to design so that the feedback factor never assumes a positive value greater than, say, 0.5.

Since the effective feedback factor $(A_1B_1 + A_1A_2B_2)$ must be held to a value less than plus unity at all frequencies to avoid oscillation, then if A_1B_1 equals plus unity, the negative feedback factor $A_1A_2B_2$ must never become zero or positive. This requirement cannot be met; in fact, the asymptotic phase shift in a loop containing a two-stage resistance-coupled amplifier and the primary and secondary of an output transformer is at least 270 degrees at very high frequencies with a resistance load. Thus it becomes necessary to cause A_1B_1 to assume a value other than unity at frequencies where $A_1A_2B_2$ is positive. A phase shift must be introduced into the feedback transmission network which, in conjunction with the phase shift in A_1, actually reverses the phase of A_1B_1 at very high and very low frequencies, so that it becomes negative feedback, although its amplitude is then very small. The local feedback factor A_1B_1 may now tend to oppose rather than aid oscillation at extreme frequencies where $A_1A_2B_2$ is positive, although A_1B_1 is still essentially positive and nearly unity

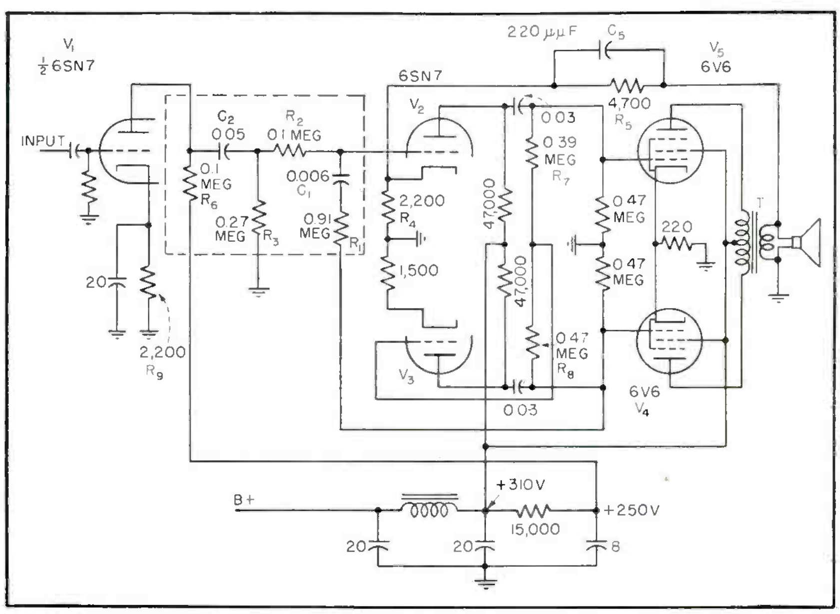

FIG. 2—Two-stage amplifier using combination feedback circuits

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Table I—Distortion Figures for Various Combinations of Operating Conditions

Harmonic Distortion — 8 watts into 3.9-ohm speaker load

Harmonic	Frequency in Cps					
	100		400		1,000	
	%	Db	%	Db	%	Db
2	0.12	58	0.2	54	0.17	55
3	0.09	61	0.24	52	0.32	50
4	0.04	68	0.045	67	0.036	69
5	0.034	69	0.017	75	0.04	68
6	0.002	94	0.003	90	0.02	74
7	<0.001	—	<0.001	—	0.006	84
8	—	—	—	—	0.006	84
9	—	—	—	—	<0.001	—
10	—	—	—	—	0.012	78
11	—	—	—	—	<0.001	—

Harmonic Distortion—3.9-ohm load

Harmonic	50 Cps, 5 watts		2 Kc, 4 watts	
	%	Db	%	Db
2	0.7	43	0.1	60
3	0.88	41	0.23	53
4	0.03	70	0.006	84
5	0.08	62	0.02	74
6	0.01	80	0.002	94
7	0.02	74	0.008	82
8	0.004	88	—	—
9	0.002	94	—	—
10	0.002	94	—	—

Percent Harmonic Distortion—8 watts into 3.9 ohms at 100 cps

Harmonic	No feedback	Negative feedback	Pos-neg feedback
2	0.6	0.07	0.12
3	6.0	2.2	0.094
4	0.15	0.01	0.04
5	0.6	0.08	0.034
6	0.2	0.08	0.002
7	0.2	0.04	<0.001

Percent Harmonic Distortion—8 watts into 3.9 ohms at 400 cps

Harmonic	No feedback	Negative feedback	Pos-neg feedback
2	1.4	0.3	0.2
3	7.0	2.4	0.24
4	0.6	0.1	0.045
5	1.2	0.08	0.017
6	0.14	0.02	<0.001
7	0.27	0.02	<0.001

Percent Intermodulation Distortion—8 watts into 3.9 ohms, 4 to 1 voltage ratio at 60 and 100 cps

Frequency	No feedback	Negative feedback	Pos-neg feedback
	60 Cps		
2 kc	—	—	1.4
7 kc	40	8.0	1.9
12 kc	—	—	2.2
	100 Cps		
2 kc	—	6.6	0.52
7 kc	—	5.8	0.84
12 kc	—	6.1	1.0

throughout the band of useful frequencies.

The amplifier of Fig. 2 incorporates positive and negative feedback. It is otherwise conventional, using self-bias throughout, and a highly degenerative self-balancing phase inverter. The output transformer is small, having a $\frac{3}{4} \times \frac{3}{4}$-inch stack. The copper efficiency is about 80 percent.

The overall negative feedback is obtained from the secondary of the output transformer T, and is fed through R_5 to the cathode of V_2. Shunt capacitor C_5 affords some feedback phase correction at very high frequencies. The feedback gain reduction is 9 db, and becomes 11 db with the positive feedback disconnected.

The positive feedback is obtained from the grid of V_4, and is fed through R_1 and C_1 to the grid of tube V_2. The positive feedback voltage is developed primarily across R_2 and C_2, since the plate resistance of V_1 is relatively small, and the input resistance of the grid of V_2 is high. The positive feedback is designed so that, with the negative feedback disconnected, V_2 will be near oscillation or oscillating weakly. Since the voltage gain of the stage V_2 is approximately 10, about one-tenth of the voltage on the grid of V_4 is fed back to the grid of V_2. The resistance of R_1 is therefore made about nine times that of R_2, and C_2 has about nine times the capacitance of C_1. Thus the phase and amplitude of the positive feedback is maintained flat over the range of audio frequencies. Because of the highly degenerative nature of the phase inverter, the balance is not appreciably affected by the additional load of the positive feedback network.

Some phase shift in the positive feedback is obtained at extreme frequencies in the stages V_2 and V_3 due to electrode and stray capacitances, and due to the blocking capacitors. The input capacitance of the grid of V_2 causes a further phase shift, so that the polarity of the product A_1B_1 reverses from positive to negative at extremely high frequencies. The input capacitance of V_2 is primarily dynamic, due to feedback through its grid-plate capacitance[6], at very high frequencies where the overall feedback is positive or small.

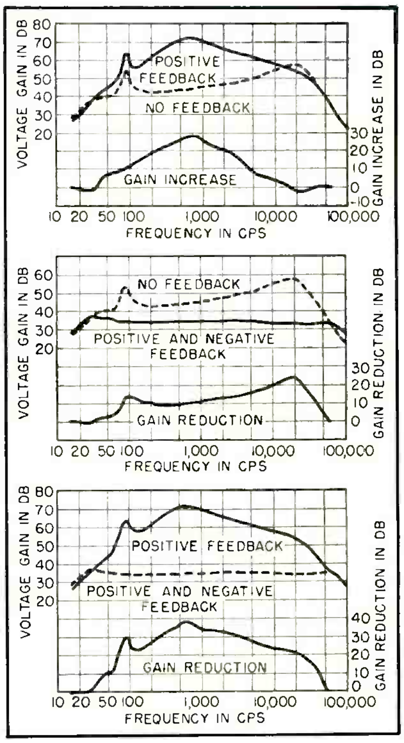

FIG. 3—Amplifier response curves for various types of feedback with 0.5-watt input to a 3.9-ohm loudspeaker load

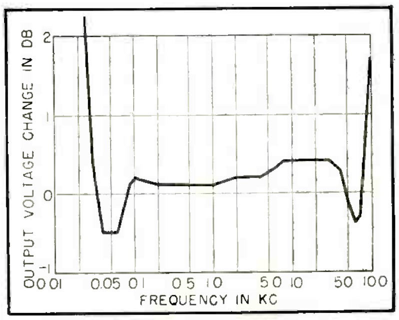

FIG. 4—Voltage regulation in db with 1-volt output into 3.9-ohm loudspeaker load

In some designs, it may be necessary to connect a small capacitor from the grid of V_2 to ground, or to use a more elaborate phase-shift network to obtain a sufficiently rapid phase turnover in the local feedback.

At extremly low frequencies most of the local feedback current flows through R_3 instead of through C_2, so that a phase shift is obtained, which together with the phase-shifting action of the 0.03-μf blocking capacitors in stages V_2 and V_3, is sufficient to cause the desired phase reversal. In practice, the phase reversal frequencies are

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placed as far outside the desired pass band as good stability permits.

Performance Measurements

Figure 3 permits the determination of the quantities $(1-A_1B_1)$, $(1-A_1B_1-A_1A_2B_2)$, or N, and ratio $(1-A_1B_1-A_1A_2B_2)/(-A_1B_1)$.

Figure 4 indicates a negligibly small output impedance, since the output voltage varies only slightly when the speaker load is disconnected. The regulation of 0.1 db at 400 cycles may be compared with the regulation of 2.7 db that is obtained with the positive feedback disconnected (11 db of negative feedback remaining) or the regulation of 19 db that is obtained with no feedback.

The distortion indicated in Table I would presumably be inaudible even with a wide-range loudspeaker. The intermodulation distortion averages three or four times as much as the harmonic distortion, as would be expected. The table shows that the positive feedback causes a great reduction in distortion.

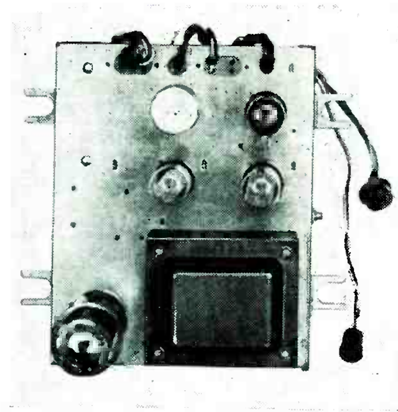
Design Improvements

The amplifier of Fig. 2 is not represented as being the ultimate in design of a positive-negative feedback amplifier, although it seems probable that most major improvements would involve cost increases.

If the negative feedback could be made uniform over a wider frequency range, the local positive feedback could also be made effective over a wider range. A wide-band output transformer would be helpful. Reducing R_1, R_2, R_3 and R_8 and R_9, and increasing C_2 and C_1, will also be helpful. The grid-plate capacitance of V_2 could be largely neutralized by shunting R_1 with a small capacitor of, say, 3 micromicrofarads. The last two measures would reduce the high-frequency phase shift in the overall feedback that is caused by the Miller effect in V_2. Also, R_7 could be shunted with a small capacitor to reduce the phase shift caused by the grid-plate capacitance of V_3. It would also be desirable to replace R_1 by a network having a rapid phase turnover at ultrasonic frequencies and a small phase shift at audio frequencies.

Low-Cost Amplifier

Figure 5 shows the circuit of an economical amplifier. Type 6K6GT output tubes are used, and the current drain is so low that a 5Y3 rectifier is used at less than its rated operating conditions, and with resistance filtering only. The hum is almost inaudible even in a quiet room, being 67 db below maximum level. In production, the output regulation rarely exceeds ± 0.2 db, and the response is flat over the useful range of frequencies. No production difficulties have arisen, although many many thousands of units have been manufactured, and no special selection of tubes or components has been made. Numerous production units selected at random for test had an average harmonic distortion at 400 cycles of 0.5 percent with 5 watts output. With a shock impulse at the amplifier input, the transient output across the loudspeaker voice coil is negligibly small after the first cycle.



Top view of complete low-cost audio amplifier. Output transformer is mounted beneath the chassis

The photograph of this amplifier shows the output transformer to be small. However, the harmonic distortion in the 60-cps output at five watts is only one percent. The 6SN7GT driver-phase inverter is not shown, as it is located on the tuner chassis of the receiver.

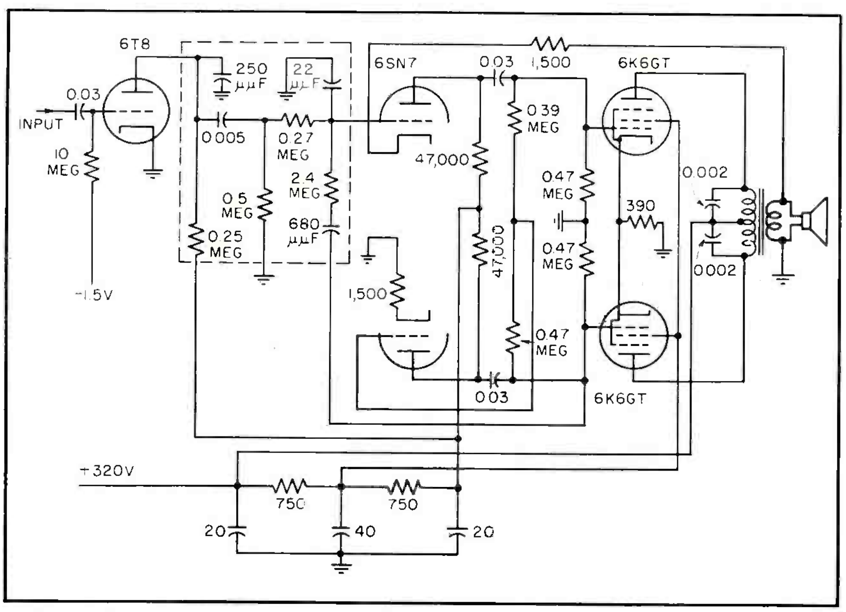


FIG. 5—Complete schematic of a low-cost audio amplifier using combination feedback

Conclusions

In conclusion, it appears that combined positive and negative feedback offers considerable possibility for improved performance in pentode audio power amplifiers, particularly where cost is an important consideration, and when conventional mass-production techniques are used.

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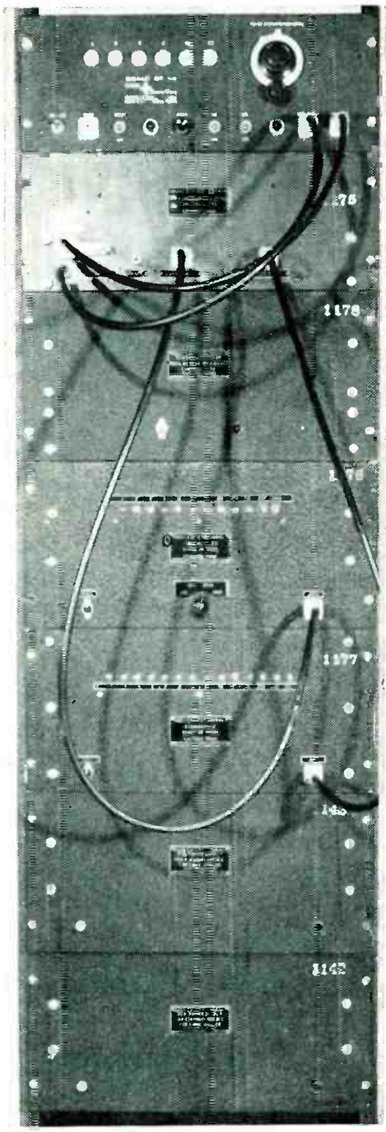

The complete frequency measuring system does not quite fill a standard rack

Measuring

By R. L. CHASE

Brookhaven National Laboratory
Associated Universities, Inc.
Upton, N. Y.

THE equipment to be described measures radio frequencies in the range between 100 kc and 5 mc to an accuracy of 0.1 percent in an interval as short as 200 microseconds. The method used is to count the number of cycles from a 5-mc standard oscillator that occur in a time interval corresponding to a selected integral number of cycles of the unknown frequency. The precision of the measurement increases linearly with the duration of this time interval.

The system is particularly useful for measuring instantaneous values of frequency from a variable-frequency source, when a measurement of short time duration is essential. The instrument was constructed in order to make precise measurements of the frequency of the r-f oscillator in a frequency-modulated particle accelerator, but circuits of this speed and precision should find many other applications. The gate and scaling circuits, for example, might be used in a high-speed counter-chronograph for the measurement of projectile velocities or for the measurement of short life times in radioactive decay schemes.

The details of operation may best be understood by reference to the block diagram, Fig. 1. The unknown frequency (sine-wave or other simple periodic wave shape) is converted by a pulse shaper into sharp pips synchronized with the unknown frequency in a definite and constant phase relationship. The pulse shaper shown in Fig. 2 is a trigger circuit of the Schmitt[1] type capable of operating at frequencies up to 5 mc. It is followed by a short differentiating time constant of 0.15 microsecond. The measurement is initiated by a starting pulse derived from an external source. This starting pulse triggers gate-control flip-flop 1 to its other stable state, opening gate 1. The gate-control flip-flops are fast-acting trigger circuits of the Eccles-Jordan type, capable of passing from one stable state to another in less than 0.05 microsecond. The gates are type 6AS6 pentodes with high suppressor-plate transconductance. The gate-control signals are impressed on the suppressor grids and the signals to be gated are impressed on the control grids as shown in Fig. 3.

When gate 1 opens, the pulses from the pulse shaper pass through the gate and associated amplifier into scaler 1. The first of these pulses triggers gate-control flip-flop 2 to its other stable state, opening gate 2 which passes a 5-mc signal from the crystal oscillator to scaler 2. The scaling circuits shown in Fig. 4 are composites of

Table I—Results of Frequency Measurements

Nominal Frequency	Scaler 1 Reading *A*	Scaler 2 Reading *B*	5 $(A-1)/B$
5 mc	528	530	4.9717 mc
	1,047	1,053	4.9668
	2,079	2,092	4.9665
	4,135	4,162	4.9664
1 mc	515	2,614	0.98317 mc
	1,028	5,223	0.98315
	2,054	10,441	0.98314
	4,103	20,861	0.98317
200 kc	513	12,804	199.938 kc
	1,025	25,606	199.950
	2,050	51,239	199.945
	4,098	102,454	199.943

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a Varying Frequency

Instantaneous measurement of slowly changing or fixed frequency between 100 kc and 5 mc is made to an accuracy of 0.1 percent in only 200 microseconds. Designed to test synchrotron controls, the circuits can be adapted to measurement of projectile velocities or short-life radioactive decay

designs by Fitch[2] and Higinbotham[3], which, in this arrangement, run reliably at pulse repetition frequencies up to 5 mc.

This cascaded-gate arrangement starts the measurement of time within less than one cycle at 5 mc (0.2 microsecond) after a pip from the pulse shaper. This 0.2-microsecond uncertainty is the controlling error of the system. It can be reduced by going to higher master oscillator frequencies, but this presents serious scaler design problems.

Provision is made to stop the timing interval in synchronism with another input pip. In this way no additional error is introduced at the end of the timing intervals. The problem is somewhat complicated by the fact that a pulse is delayed considerably in passing through the scaling circuits. For example, in the 12-stage scaler used (scale of 4,096) a signal is delayed approximately 7.8 microseconds. In addition to being rather long, this delay time is not entirely constant but varies somewhat as tubes age.

For these reasons a coincidence mechanism is used to close the gates. Scaler 1 is set to produce a trigger pulse as it records the last of a predetermined number of counts. This trigger pulse is impressed and maintained for several microseconds on the suppressor grids of the type 6AS6 coincidence trigger tubes. The control grids of these tubes are continually supplied with the shaped input pulses to scaler 1. The first of these input pulses following the initiation of the trigger pulse from scaler 1 triggers both gate-control flip-flops and turns off both gates.

Because the delay time through scaler 1 may correspond to a number of cycles of the measured frequency, this scaler, as well as scaler 2, is built with interpolating lights. These record the number of counts arriving during the total counting interval, the preset number of counts plus those which arrive in the delay interval.

As an illustration, consider the measurement of a radio frequency in the neighborhood of 2 mc. Assume that an accuracy of 0,1 per-

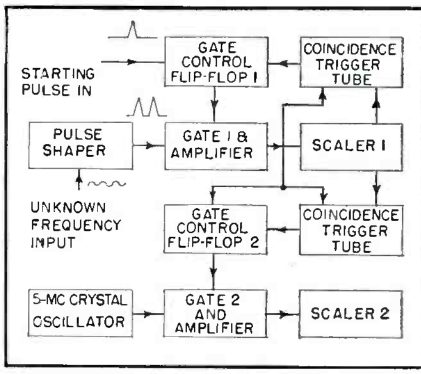

FIG. 1—Block diagram of main circuits used in the frequency measuring system

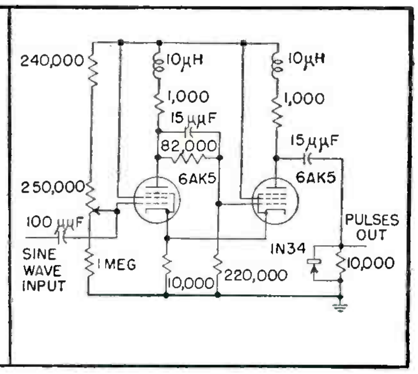

FIG. 2—Pulse shaping circuit used to change sine into triangular waves

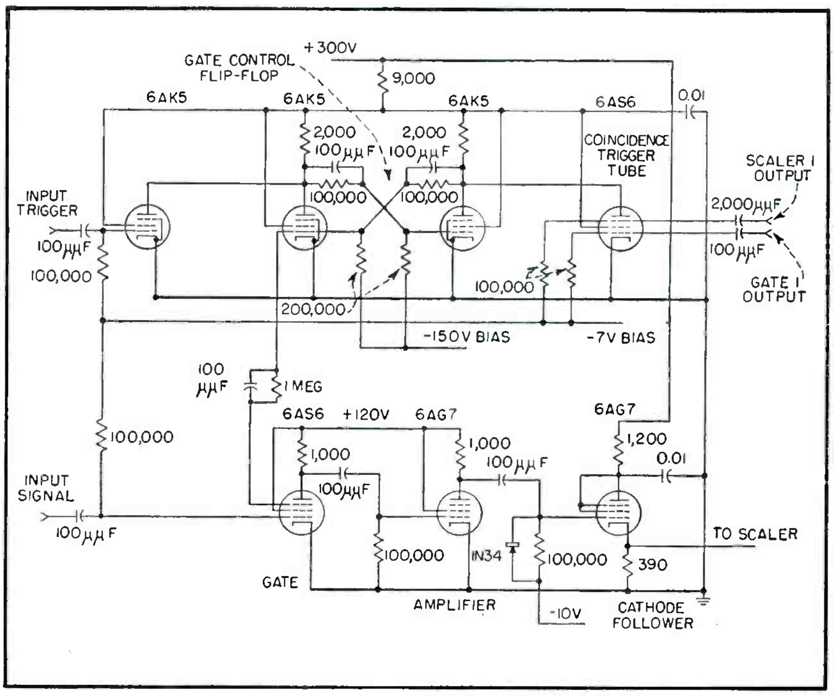

FIG. 3—Coincidence trigger, gate control, gate and amplifier circuits

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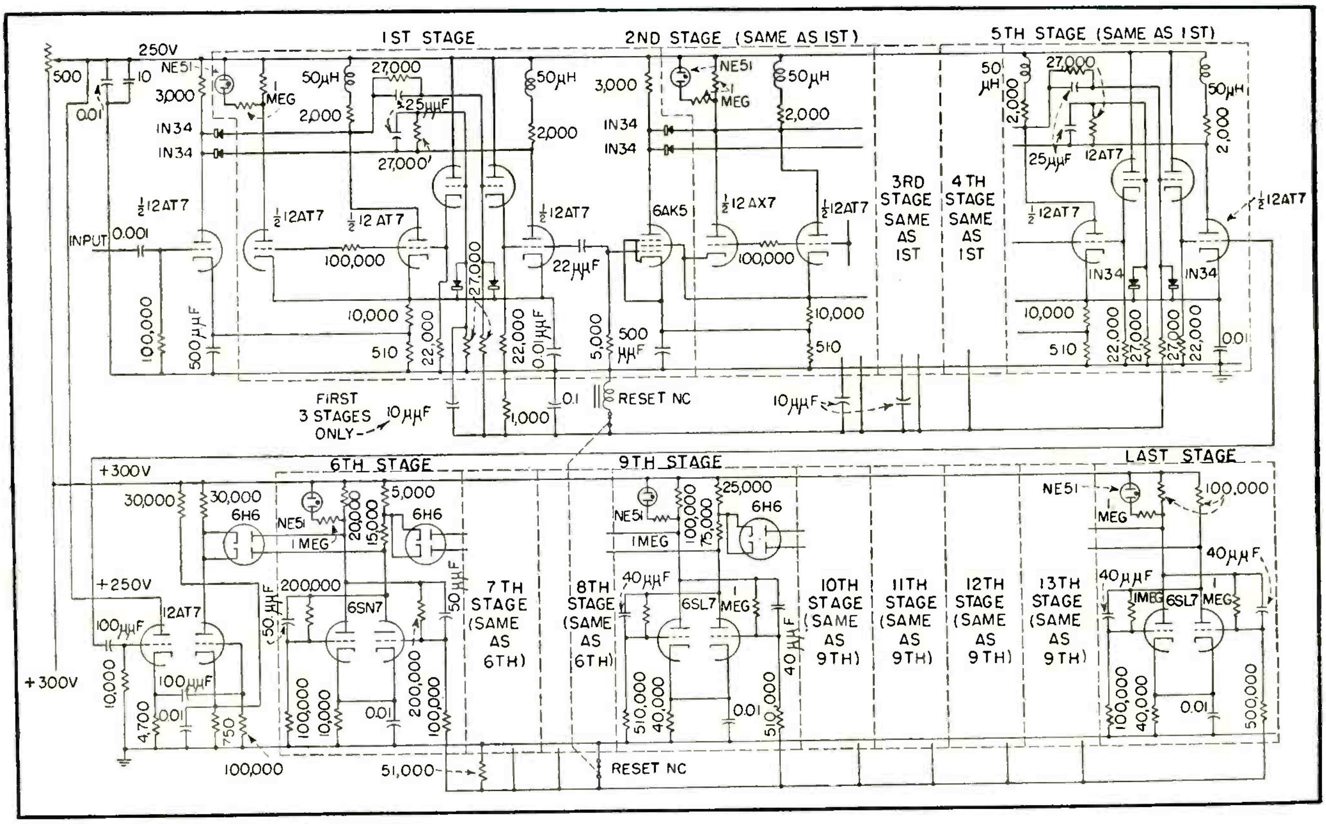

FIG. 4—Circuit diagram of the fast scaler

cent is required. This means that the counting interval must include at least 1,000 cycles of the standard 5-mc oscillator, which corresponds to approximately 400 cycles of the frequency to be measured. It is therefore necessary to preset scaler 1 to 512 cycles (the first integral power of 2 greater than 400), clear the scalers by pressing the reset buttons, and initiate the measurement with a starting pulse. After the measuring interval scaler 1 might read 517. This condition would mean that 4 additional pulses had passed through gate 1 during the time that the 512th was passing through the scaler. The next pulse (517th) turned off the gates. Gate 2 would then have been open during 517 − 1 or 516 cycles of the measured frequency, since the number of intervals bounded by n pulses is n-1. If scaler 2 had recorded 1,299 counts, then the input frequency would have been

$$5.000 \text{ mc} \times (516)/(1{,}229) = 1.9861 \pm 0.0015 \text{ mc}$$

Figure 5 shows a typical series of waveforms encountered in the measurement of a frequency in the neighborhood of 2 mc. It is seen that despite the delay in the scalers, both scalers count cycles over intervals that differ in duration by less than 0.2 microsecond.

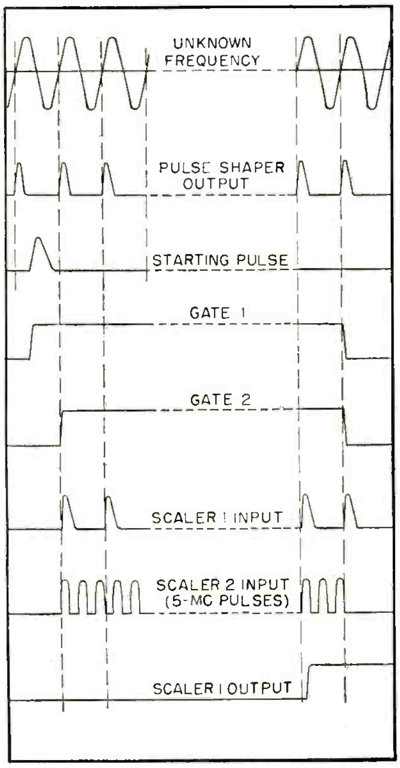

FIG. 5—Waveforms appearing at indicated circuits

Table I shows the results of some frequency measurements. Each measurement was made with four different preselected values for the count in scaler 1 in order to test the consistency of the system. At each frequency the four preselected counts were 512, 1,024, 2,048 and 4,096. Even in as short a measuring interval as 106 microseconds, the error is only slightly greater than 0.1 percent.

Synchrotron Control Problem

In the 3-billion volt proton synchrotron, the r-f master oscillator will be frequency-modulated from 200 kc to 4.2 mc in one second.

The author wishes to express his gratitude to J. B. H. Kuper and W. A. Higinbotham of the Electronics Division of the Brookhaven National Laboratory for their advice and technical assistance, and to R. V. Dvorak and L. O. Davis for their help in layout and construction. This work was done under the auspices of the Atomic Energy Commission.

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(2) Val Fitch, Columbia University Report No. CUD-35.

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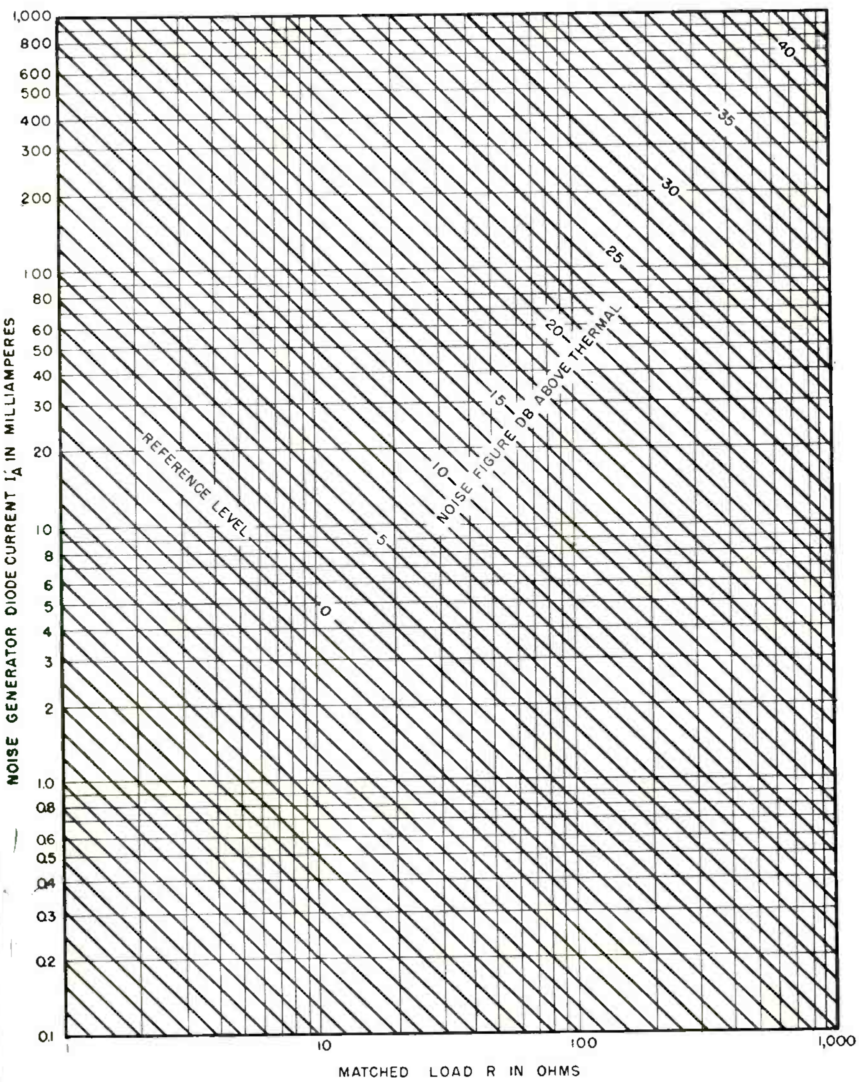
Noise Figure Chart

Gives noise figure directly in decibels from value of noise-generator diode current required to double the noise power output of an amplifier from its no-input value. The input impedance of the unit under test is the other parameter

By EUGENE D. JAREMA
Thermionics Branch
Evans Signal Laboratory
Belmar, New Jersey

THE NOISE FIGURE of a receiver or amplifier is the factor, expressed in decibels, by which the signal-to-noise ratio existing in a resistive source is degraded in passing through the receiver or amplifier, the bandwidth remaining constant. The signal-to-noise ratio is measured at 20 deg C before the source is connected to the receiver.

The most common method for determining noise figures is by using a temperature-limited diode noise generator. Such a noise generator is self-calibrating. No correction factor is necessary, providing the limiting frequencies are considerably less than the self resonance of the noise diode and the electron transit angle is less than 90 degrees. The load of the diode generator must also be matched to the input impedance R of the receiver or amplifier under test.



The accompanying chart eliminates the computations usually involved in obtaining a noise figure by the noise-generator method. The noise generator in its off position is connected to the input of the amplifier under test, and the noise power level of the amplifier is noted on an output meter. The generator is then turned on and adjusted until the amplifier noise power output reading is doubled. The noise-generator diode current I_A is then noted.

The amplifier noise figure, in decibels, will be represented on the chart by the diagonal line which crosses the intersection of the appropriate I_A and R lines. For example, let $R = 300$ ohms and $I_A = 1.0$ ma; the noise figure will be 7.8 db.

The chart is based on the fact that the noise figure is equal to $20 I_A R$, where I_A is in amperes and R in ohms.

Occasion may arise when R may be larger than 1,000 ohms or I_A may be less than 0.1 ma. For every cycle change in either R or I_A the reference level will change 10 db in the same direction.

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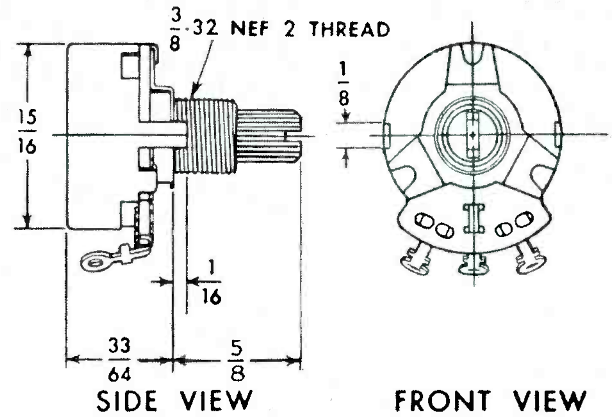

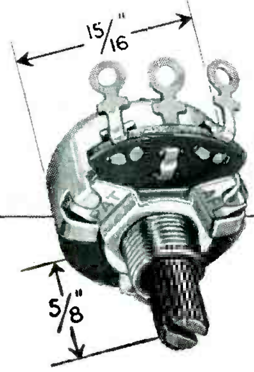

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Stable Instrument Amplifier

BY PETER G. SULZER

Engineering Experiment Station
The Pennsylvania State College
State College, Pennsylvania

IN MAKING direct-voltage measurements of high-impedance sources such as vacuum-tube circuits or electrolytic cells, it is frequently desirable to place a low-gain amplifier ahead of the indicating instrument in order to obtain high current sensitivity. Such an amplifier[1] usually requires that both terminals of the indicating instrument be above ground, a condition that is not desirable when overload protection is to be obtained with biased diodes, or when special scale characteristics are to be obtained with nonlinear circuit elements.

The circuit of Fig. 1 shows a simple amplifier which permits grounding of both the input and the output terminals; it has the additional features of low grid current, 10^{-12} ampere, low output impedance of 200 ohms and excellent linearity over the input-voltage range of $\pm$ 5 volts.

The amplifier is stabilized by the use of series-balanced bridge circuits[2]. The output stage consists of V_2, a cathode follower, connected in series with V_3, a dummy tube constituting the other arm of the bridge.

The plate circuit of V_3 presents a very high incremental impedance to the cathode circuit of V_2; consequently the cathode-follower gain is almost unity, and is practically independent of tube characteristics. This condition holds provided that the resistance of the indicating instrument is much higher than 200 ohms, which is normally true.

To correct for drift resulting from heater voltage variations, provision is made, by means of R_1, for the differential adjustment of the heater voltages of V_2 and V_3.

The first stage of the amplifier, consisting of V_{1A} and V_{1B}, also employs the series-balanced circuit. The tubes are operated with the low plate supply of 20 volts, and a heater supply of 3 volts to obtain low grid current. The use of a high cathode-bias resistor helps to maintain the grid bias at the most favorable point for low grid current.

A number of measurements have shown the amplifier characteristics to be as follows: A linearity of 2 percent is maintained over the input-voltage range of $\pm$ 5 volts. The grid current, determined by the method given by Strong[3], varies considerably over this range, it being 10^{-12} ampere at zero input, 5×10^{-12} ampere at an input of $\pm$ 0.2 volt, and 10^{-10} ampere at an input of $\pm$ 5 volts. The zero drift was found to be about 10 millivolts for a 10-percent change in heater-supply voltage.

With a stabilized heater supply, a drift of less than one millivolt per hour was noted. This measurement was made with a grid-circuit resistance of 500 megohms. The overall voltage gain of the amplifier under open-circuit conditions is approximately 0.9. Tube changes or heater-supply voltage changes of − 10 percent did not alter the gain by more than 5 percent. It should be noted that selected tubes were not used during these tests.

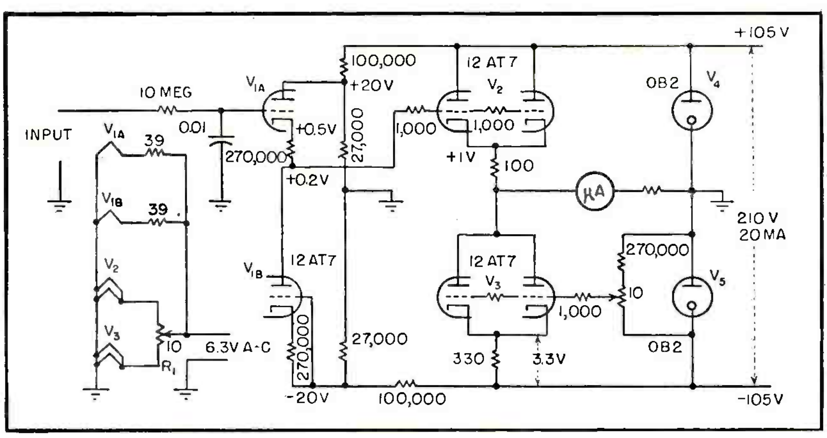

FIG. 1—Both stages of the amplifier employ series-balanced bridge circuits

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circuits. Its weight of 22 pounds compares with a 72-pound switchboard currently in use. The new board takes up four-tenths of a cubic foot as compared with two cubic feet for the older type. Three switchboards, each with a capacity of 12 lines, can be connected to provide switching for 36 circuits.

The new portable teleprinter, having a weight of 45 pounds, will eventually replace equipment weighing 225 pounds. The newly developed teleprinter is considered faster and stronger than its predecessor.

During the war, field wire used by the Army weighed 132 pounds a mile. Recent research has resulted in development of wire which weighs only 48 pounds per mile. The lighter wire has a talking range, when wet, of 12 miles, as compared with a 10-mile range of field wire currently in use.

Miniature tubes take only 15 percent of the space of older types, while subminiatures in turn are only about 10 percent the size of the miniatures. Resistors are a tenth of their wartime size, while capacitors today take less than 25 percent of the space they required in equipment used in World War II.

The Signal Corps has found 400-cycle a-c permits the use of smaller and lighter components in much of its electronics equipment. Also, 400-cycle generators themselves could be made smaller and lighter than 60-cycle equipment, for the same power output. Engineers have developed a generator weighing but 85 pounds that puts out as much power as an older piece of equipment weighing 120 pounds.

High-Resistance Measurement

By W. G. Shepard
*Physical Research Dept.
Boeing Airplane Co.
Seattle, Washington*

ACCURATE measurement of resistance below about one megohm is usually made by means of a Wheatstone bridge using a galvanometer for the null indicator. Above this value the resistance of a galvanometer is too low to properly match the high-resistance arms of the bridge and insufficient indication results. A vacuum-tube amplifier connected to the output of the bridge, however, offers a much higher impedance and is quite effective since the voltage output of a high-resistance bridge is comparatively high.

Figure 1 shows a bridge and amplifier for the purpose. The bridge consists of precision ratio arms, a variable standard, which may be a laboratory-type resistance decade, and the unknown. Since the ratio is 100 to 1, a 1-megohm decade may be used for measurements up to 100 megohms. The accuracy of laboratory decades is usually 0.1 percent or greater, and the ratio arms, if not already this accurate, may be adjusted by putting a 0.1-percent resistor across the unknown terminals of the bridge and a 0.1-percent resistor of 1/100 the value across the decade terminals and then correcting the ratio arms until the bridge balances. The meter-amplifier circuit indicates to much closer than 0.1 percent except when measuring extremely high resistances, so the

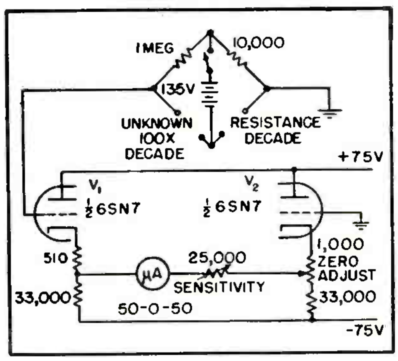


FIG. 1—Circuit of high-resistance bridge and amplifier for convenient measurements up to 100 megohms

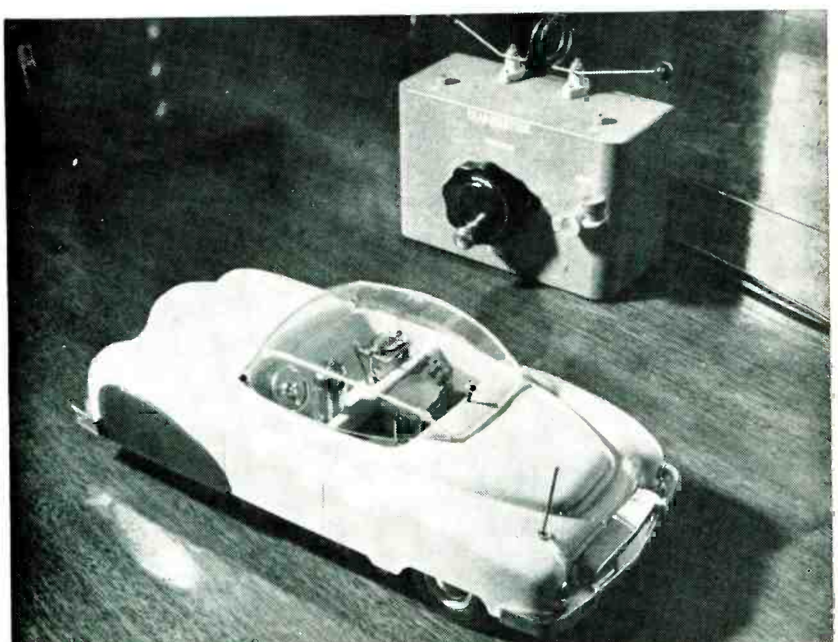
(Continued on p 132)

Radio-Controlled Toy Auto

SIMPLIFIED to just about the ultimate degree, a radio-controlled toy automobile has been invented that employs one electronic tube in the car and another in the transmitter.

As shown in the accompanying illustration, the toy consists of a plastic car powered by batteries. The tonneau contains the receiving tube and two relays. These are covered by a transparent plastic top for protection against rough treatment by the user.

The control box contains the transmitter which feeds an antenna lead that can be arranged in a circle of 50 feet in diameter. The car operates within the circle and from four to six feet beyond it. Designed by John and Andrew Yeiser of Berkeley, California, the toy will sell for 25 to 30 dollars.



Operated by radio control, this toy automobile covers a fifty-foot circle

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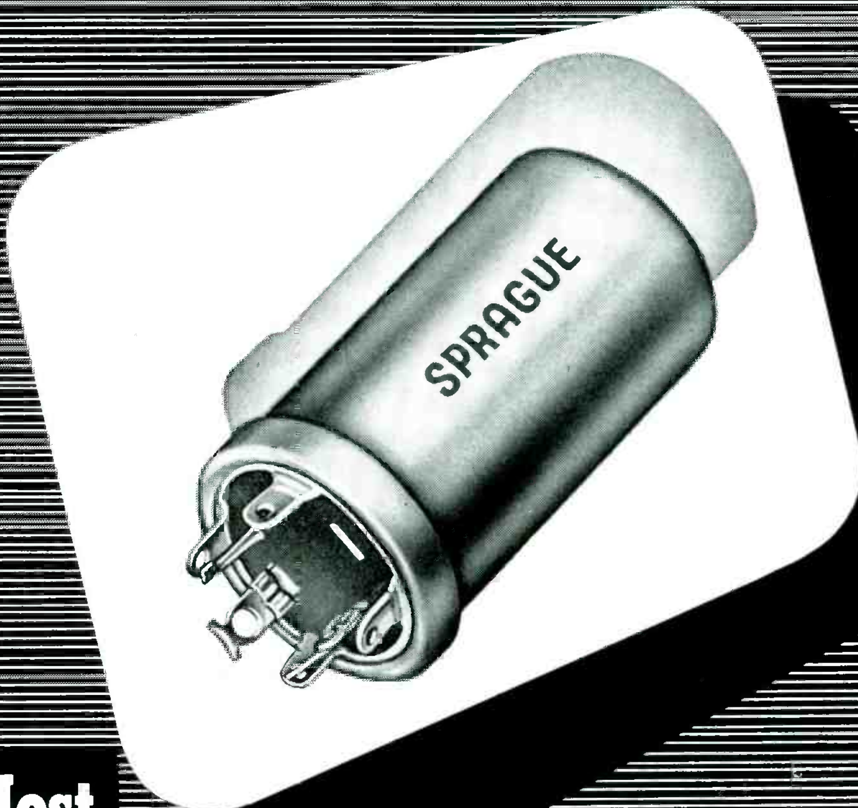

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THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Flakes of synthetic mica are examined under a binocular microscope for structural defects, such as impurities, gas bubbles, faulty orientation and incomplete crystallization

Synthetic Mica—$K_4Mg_{12}Al_3Si_{12}O_{40}F_8$

SYNTHETIC MICA has been crystallized by scientists of the National Bureau of Standards. The synthetic substance is said to have all the desirable properties of its natural version, with improved heat-resisting characteristics.

The ingredients used are similar to raw materials often used in making glass: quartz, magnesite, bauxite, and a fluorosilicate compound. The fluorosilicate is the crystallizing agent.

Process

After the initial mixing, the quartz, magnesite and bauxite are placed in a ceramic crucible and heated for more than an hour at a temperature of 1,000 C. This calcining operation drives off carbon dioxide and water which would interfere with the formation of good crystals of synthetic mica. The calcined ingredients are ground together with potassium fluorosilicate, and the resulting mixture is then packed into a platinum crucible and melted in a special electric furnace at 1,400 C. As the furnace cools, mica crystals form at the bottom of the crucible.

Ingredients for synthetic mica are melted in a special electric furnace at 1,400 C. Crystals form at bottom of platinum-lined crucible on cooling

The most satisfactory synthetic mica developed thus far has the chemical formula $K_4Mg_{12}Al_3Si_{12}O_{40}F_8$. This is equivalent to a form of natural mica in which the hydroxyl radical has been replaced by fluorine.

Impurities may occur in the synthetic mica in the form of milky films parallel to the individual layer or white patches between crystals. Crystals free of impurities are clear and transparent, and thin flakes are easily split away along the planes of natural cleavage. The synthetic form has physical properties which compare favorably with natural mica. Electrical measurements on several clear flakes, $\frac{3}{4}$ inch square by $\frac{1}{32}$ inch thick, indicate a dielectric constant of about 6.3. The largest crystals grown so far at the National Bureau of Standards have a surface area of 4 square inches.

Satisfactory mica synthesis depends to a large extent on the materials used in the crucible lining. Ceramic linings are badly corroded by a fluorine-bearing melt. Carbon and silicon carbide crucibles are somewhat better, but fluoride gases escape through the relatively porous walls, and fine carbon particles become imbedded throughout the synthesized mica. Crucibles lined with platinum foil give the best results. They do not react with the melt and are able to withstand high temperatures for long periods. Although initial cost is high, the platinum linings may be melted down and re-formed.

The shape of the crucible is also important in mica synthesis. Flat-bottomed crucibles are undesirable because they offer a large surface for the formation of many seed crystals which grow independently in different directions and thus limit the development of single large crystals. Mica has a sheet-like structure and grows faster in a direction parallel to its cleavage plane than in any other direction. Consequently, if a crucible with a cone-shaped bottom is used, the number of seed crystals is reduced and the direction of growth tends to be upward. Experiments are now in progress to find ways of predetermining crystal growth even more completely in order to grow large parallel sheets.

Television Demonstration

HOW TELEVISION WORKS can be vividly demonstrated by the experimental setup shown in the accompanying diagram. Two cathode-ray oscilloscopes, a sensitive phototube unit and a lense comprise the equipment. The oscilloscopes furnish their own sweep voltages. The internal sweep generator of the viewing oscilloscope is operated at

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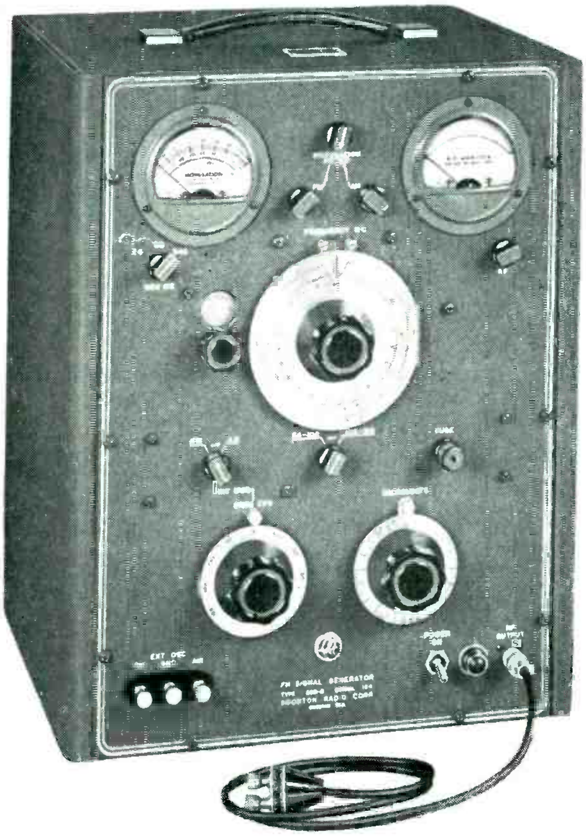
Laboratory Instruments for TELEVISION



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Additional coverage from 0.4 to 25 mc. with accessory UNIVERTER Type 203-B

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MODULATING OSCILLATOR: Eight internal modulating frequencies from 50 cycles to 15 kc. available for FM, AM.

RF OUTPUT VOLTAGE: 0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.

FM DISTORTION: Less than 2% at 75 kc. deviation.

SPURIOUS RF OUTPUT: All spurious RF voltages 30 db or more below fundamental.

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM Signal Generator and Type 203-B Univerter.

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R. F. INCREMENT DIAL: ± 250 kc. in 10 kc. increments

R. F. OUTPUT: 0.1 microvolt to 0.1 volt, ± 1 db. Also approximately 2 volts maximum (uncalibrated).

OUTPUT IMPEDANCE: Approximately 60 ohms at 0.1 volt jack, 470 ohms at 2 volt pin jack.

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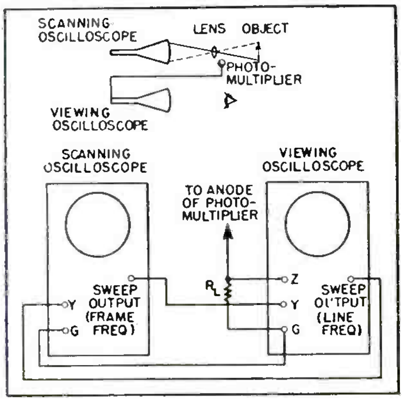


Wiring diagram for a simple but effective television demonstration using only two oscilloscopes and a photomultiplier unit

line-scanning frequency and is connected to the vertical amplifier of the scanning oscilloscope, while the internal oscillator of the scanning oscilloscope is adjusted for frame frequency and also furnishes vertical scanning for the viewing oscilloscope.

The rasters thus generated are automatically synchronized. The scanning oscilloscope raster is focused, by a lens, onto the object to be viewed. The light reflected by the object is picked up by a photomultiplier unit. The resulting photomultiplier-tube signal is used to intensity-modulate the beam of the viewing oscilloscope which reproduces the image of the scanned object.

The hook-up shown rotates the viewing raster ninety degrees on the oscilloscope screen. For erect viewing, the scanned object may be laid on its side.

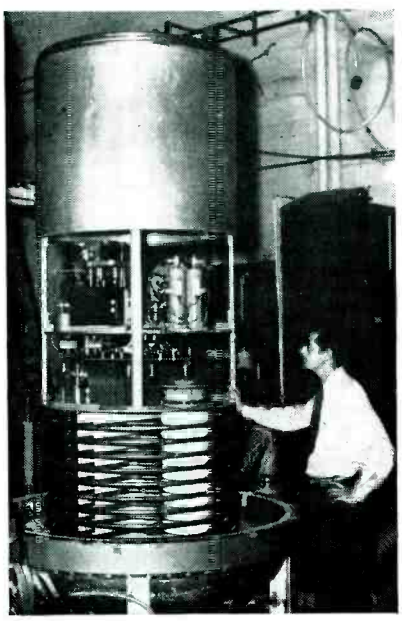
For best results, the frame frequency should be set just high enough to eliminate flicker—about 30 cps. Line frequency can be adjusted to the point where the limited resolution of the system becomes objectionable—about 3,000 cps, or 100 lines per frame. This ingenious system was presented by Robert E. Benn of the Franklin Institute Laboratories in the October, 1949 issue of the *American Journal of Physics*.

Atom-Smashing Analysis of Minute Samples

ANALYSIS of minute quantities of matter, as little as a billionth of an ounce, has been made possible by a recent Stanford Research Institute development. The new technique, which was developed for the purpose of analyzing smog particles, is capable of determining the constituents of layers of material no more than one molecule in thickness.

In operation, specimens of the substance to be analyzed are bombarded by a stream of ions which are scattered in a characteristic way when they come in contact with the substance. Ion detectors determine the nature of the scattering. By comparing the unknown's scattering characteristics with those of known elements, the elements in the unknown can be detected.

This work was described by Sylvan Rubin, staff physicist at the California Institute of Technology, in a paper presented before a national meeting of the American Physical Society at Stanford University. The photograph shows Dr. Rubin beside the half-million volt Van de Graff generator which is used to accelerate the ions that bombard the sample of the material being analyzed.



Half-million volt ion accelerator makes possible the sub-microchemical analysis of atmospherical pollutants by bombarding them with a stream of protons

Printed Iron Core Coils

BY MARTIN RUDERFER
Brooklyn, N. Y.

A METHOD of coil construction is presented here whereby the printing technique, with its adaptability to mass production and miniaturization, may be applied to iron-core coils. The basic construction shown in Fig. 1A consists of a thin insulating wafer on both sides of which are printed spiral coils, the center end *H* of each coil being automatically connected in manufacture through the wafer base. The outer ends terminate in two slightly raised contacts, one on each side. Both sides are insulated except for the contact surfaces.

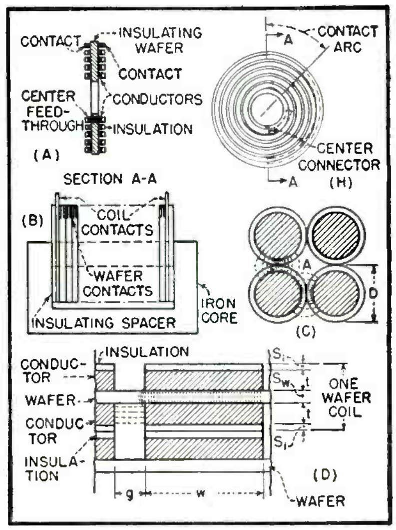


FIG. 1—Spiral coils, printed on insulating wafers, are connected in series simply by bringing two wafers together under slight pressure

A complete coil is obtained by assembling any number of wafers so that the contacts register, thereby connecting all turns in series as shown in Fig. 1B. The core is inserted through the central hole; wafer contacts, insulative spacer and a jacket (not shown) exert pressure to maintain contact between wafers. Several methods are available for printing the conductor[1,2], including electroplating or stamping for high conductivity, spraying or painting.

Space Requirements

The space occupied by the wafer base is offset by the elimination of

(Continued on p 172)

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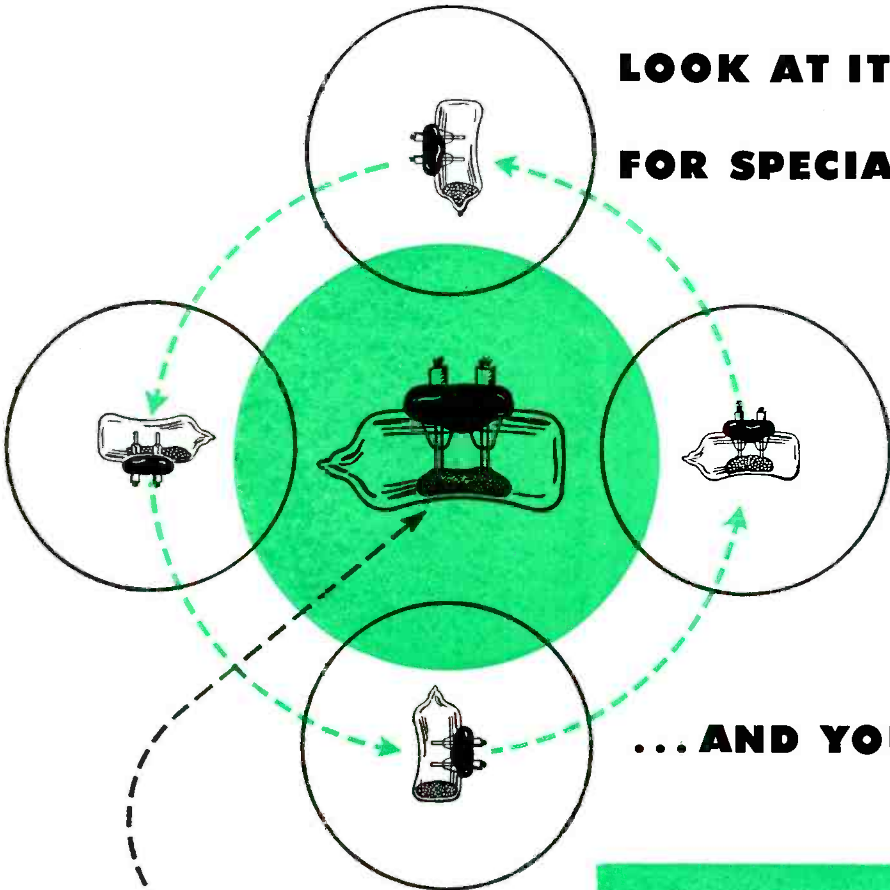

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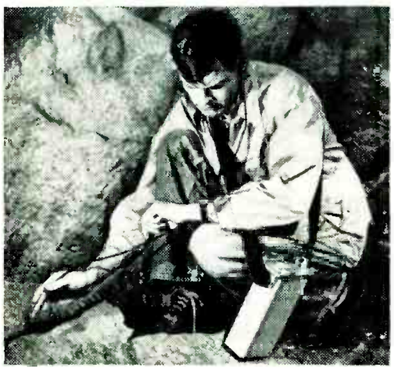
NEW PRODUCTS

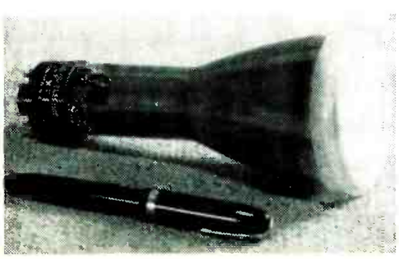
EDITED by WILLIAM P. O'BRIEN

Increased Activity in Nuclear Field Steps Up Production of Radiation Detector Equipment . . . Time and Labor Savings in Labs and Plants Augmented By New Testing Devices On The Market . . . Products of Fifty-Seven Companies Are Described



Ore Detector

TRACERLAB INC., 130 High St., Boston 10, Mass. The SU-7 detector is designed for rugged field use in prospecting for all types of radioactive ores. It is unaffected by humidity or moisture. When radiation enters the small Geiger tube contained in the probe, a clicking noise can be heard through the earphones. The small size of the probe, mounted at the end of a flexible 30-in. cable, permits exploration of crevices and small bore holes.

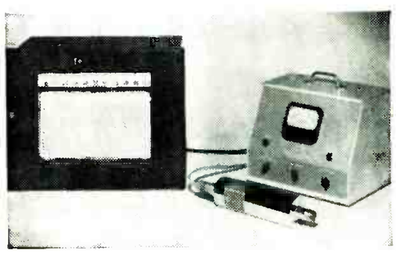


Three-Inch C-R Tube

GENERAL ELECTRIC CO., Schenectady, N. Y. The 3MP1 three-inch electrostatic c-r tube was originally designed for use in small industrial oscilloscopes. However, the new tube is expected to find numerous applications for tv servicing and for testing apparatus such as welders, amplifiers and electronic timing devices. Maximum ratings include an anode No. 1 d-c voltage of 1,000 volts and an anode No. 2 d-c voltage of 2,500 volts. Maximum negative-bias value is 200 volts d-c, and positive-bias value is 2 volts d-c.

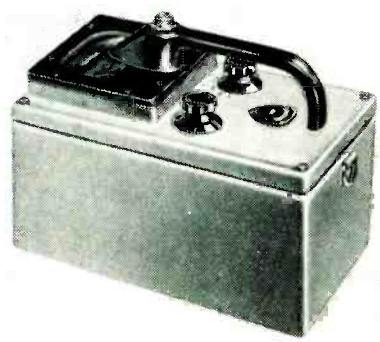
Matching Transformer

LYNMAR ENGINEERS, 1721 Delancey St., Philadelphia 3, Pa. The impedance matching transformer illustrated is designed to give improved tv reception by minimizing noise pickup and ghosts due to feed-line reflections. It is made to match a 70 to 95-ohm coaxial line to the 300-ohm input of any television receiver.



Recording Vacuum Gage

NATIONAL RESEARCH CORP., 70 Memorial Drive, Cambridge 42, Mass. The Alphatron cold-emission ionization gage connected to a recorder provides means for recording total pressure in three separate ranges from one micron to 10 mm of mercury. Control of an external circuit can be provided at option by a mercury switch on the recorder which can be set to open or close as the pressure rises above or falls below a given value, with an accuracy of ±2 percent of the full-scale value.



Gamma Survey Meter

THE KELLEY-KOETT MFG. CO., 12 E. 6th St., Covington, Ky. Model K-350 five-range ionization-chamber gamma survey meter covers the range from 0 to 5 milliroentgens per hour to 0 to 50,000 mr per hr. The instrument features a hermetically sealed ion chamber, is nonmicrophonic and has a ±10-percent accuracy over an operating range from −10 to 125 F.

Electrical Reset Register

ATOMIC INSTRUMENT CO., 160 Charles St., Boston, Mass. Model 1238 electrical reset register is designed for use with all types of nuclear and industrial equipment. Accurate counting from 1 to 999,999 at up to 12 counts per second is possible. Reliable register actu-

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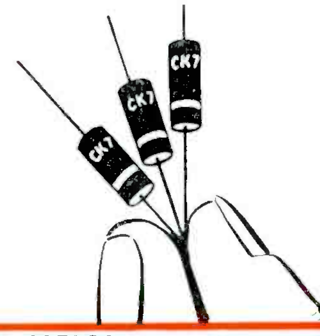
WHY THE WHOLE INDUSTRY IS TURNING TO...

RAYTHEON

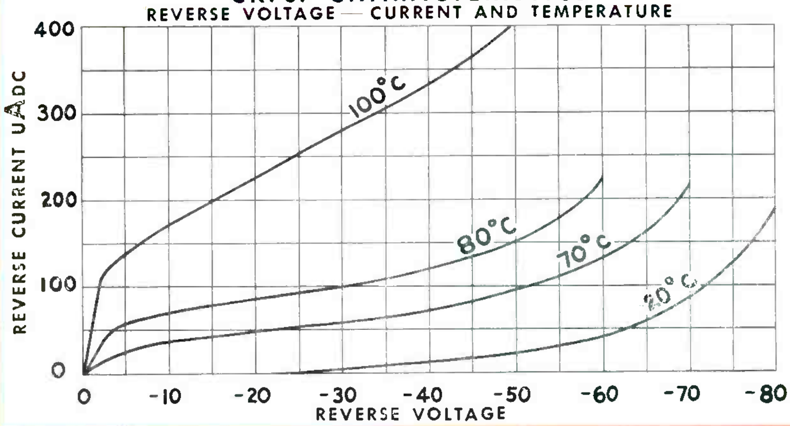


GERMANIUM CRYSTAL DIODES

CK707, for example, has high back resistance even at elevated temperatures.

CK707 CHARACTERISTICS

REVERSE VOLTAGE — CURRENT AND TEMPERATURE



Other features that mean better, more dependable performance include:

1. Superior humidity characteristics*
2. No wax or filler to affect operation even up to 100°C.
3. Extremely small change in forward resistance with temperature
4. Small size — 9/64″ diameter, 25/64″ length
5. Distinctive color coding
6. Smaller, more flexible leads for easier wiring
7. Completely insulated body for compact assembly

* Repeated eight hour temperature-humidity cycles (20°C and 70°C at 95% humidity) indicate an increase of about 10% in forward resistance. In this respect Raytheon CK707 Germanium Crystals are similar to copper oxide, selenium and other dry contact rectifiers. About 85% of the crystals show little or no change in reverse resistance characteristics after 10 of the above cycles. About 10% of the crystals decrease in reverse resistance to approximately half of the 25°C limits after 10 cycles. A small portion of the crystals become inoperative except for low impedance circuits such as video detectors, after 10 temperature-humidity cycles.

The following types are available in production quantities at Newton and Chicago, and in smaller quantities at our 310 Special Tube Distributors.

	CK705 General Purpose	CK706 Video Detector	CK707 50 Volt D.C. Restorer	CK708 100 Volt D.C. Restorer
MAXIMUM RATINGS (at 25°C.)				
DC Inverse Voltage (volts)	60	40	80	100
Average Rectified Current (ma.)	50	35	35	35
Peak Rectified Current (ma.)	150	125	100	100
Surge Current (for 1 sec.) (ma.)	500	300	500	500
Ambient Temperature for all types	−50 to +100°C			
CHARACTERISTICS (at 25°C.)				
Max. Inverse Current at −5 volts (ma.)			0.005	
Max. Inverse Current at −10 volts (ma.)	0.05	0.2		
Max. Inverse Current at −50 volts (ma.)	0.8		0.05	
Max. Inverse Current at −100 volts (ma.)				0.625
Min. Forward Current at +1 volt (ma.)	5.0		4.0	3.0
Min. DC Reverse Voltage for Zero Dynamic Resistance (volts)	70	50	100	120
Shunt Capacitance (uuf)	1.0	1.0	1.0	1.0
Rectification Efficiency at 54 mc (approx. %)		60		

Other types are available for special applications.

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SPECIAL TUBE SECTION • Newton 58, Massachusetts

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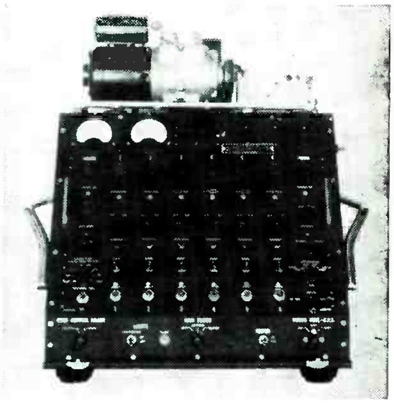
ation is obtained with as little as 10 ma at 50 v or with external contacts using the built-in d-c supply. The unit operates on 105 or 125 v, 50 or 60 cycle a-c, and draws 5 watts during normal operation, 30 watts maximum during resetting.

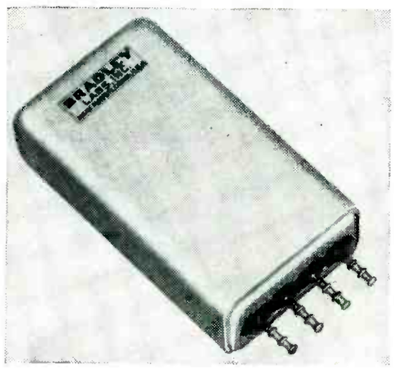


Six-Trace C-R Oscillograph

MARYLAND ELECTRONIC MFG. CORP., 5009 Calvert Rd., College Park, Md. The instrument illustrated uses eight 2-in. c-r tubes as indicating elements for recording on a moving strip of 35-mm film. Six channels are available with associated amplifiers providing an input impedance of 0.1 megohm, a frequency response flat from 0 to 40,000 cps dropping 6 db at 100,000 cps, and gain sufficient to give 1½-in. deflection for 0.01 volt rms input. The two additional c-r tubes are used for recording timing signals which are produced internally.

Radiation Meter

RADIO CORP. OF AMERICA, Camden, N. J. Type EMA-6 count-rate meter indicates the average number of pulses per unit of time produced by a G-M counter or other suitable detector in the presence of nuclear radiations. It may be used as a testing and safety device in laboratories, as an assaying device or to study the rate of decay and the decay scheme of radioactive isotopes. The meter is self-calibrating and operates from a 115-volt, 60-cycle a-c power line. The output from its h-v power supply system is a filtered d-c which can be varied over a range of 0 to 2,500 volts by means of a panel-mounted potentiometer.



Aircraft Radio Rectifier

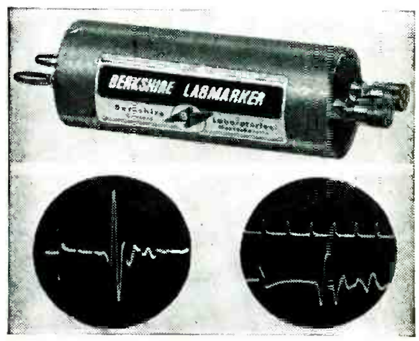
BRADLEY LABORATORIES, INC., New Haven, Conn., has developed a special hermetically sealed version of its SE-8L rectifier for use in aircraft radio receivers. Its function is to demodulate an f-m signal which provides navigation information in the new omnirange system. The unit can operate continuously within limits at 95-percent relative humidity.

Tele Picture Tube

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Type 16LP4 tube is a 16-in. glass envelope, direct-view picture tube for use in tv receivers. It employs magnetic deflection and focus and has an electron gun designed to be used with an external ion-trap magnet to prevent ion-spot blemishes. Its screen coating and practically flat face provide high-quality pictures and good contrast even under high ambient-light conditions.

Safeguard for Atomic Workers

RADIO CORP. OF AMERICA, Camden, N. J. The EMA-2B hand and foot monitor is a radiation counter for routine checking of personnel who work with radioactive substances in laboratories and plants. The unit consists of a platform, two posts containing indicator lights and a control cabinet which may be installed in any out-of-the-way space that is free from contamination and excessive vibration. It operates on a 115-volt, a-c, 50 or 60-cycle, 250-watt power supply.



Wave-Shaping Device

BERKSHIRE LABORATORIES, P. O. Box 70, Concord, Mass. The Labmarker is a wave-shaping device for producing time marks in c-r oscillography. It converts a sinusoidal input of 30 volts rms maximum into a series of sharp unidirectional pulses. The pulses may be displayed directly on the face of a c-r tube by connecting the Labmarker's output to the vertical input. Timing marks consisting of short breaks in the oscillograph trace are obtained by connecting

(Continued on p 208)

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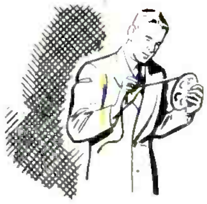

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when you buy recording tape!

THESE PHYSICAL PROPERTIES

Straight-Line Slitting that makes the tape track and wind absolutely flat

Freedom From Curl so that the tape will ride flat over the heads with minimum tension.

Smooth, Non-Absorbent Surface that permits the tape to unwind freely, without any tendency to stick layer to layer.

Uniform Dispersion of Oxide Particles, with freedom from "clumping" which causes high noise level.

Low Surface Friction which results in reduced wear of the magnetic heads.

Strong Adherence of the oxide to the base, so that the coating will not chip or peel off.

THESE MAGNETIC PROPERTIES

Maximum Signal-to-Noise Ratio, for utmost clarity of reproduction, especially on soft musical passages.

Wide Bias Range, with minimum sensitivity to possible fluctuations in amplitude of the machine bias.

Excellent High-Frequency Response, for maximum fidelity where full tonal range is desired.

Low Distortion, for more life-like reproduction of either voice or music.

Freedom From Audible Low-Frequency Modulation Noise. This avoids the rasping hum that is often blamed on the recording machine.

Uniformity of Output, within the reel and from reel to reel—without the frequently-encountered magnetic "weak spots."

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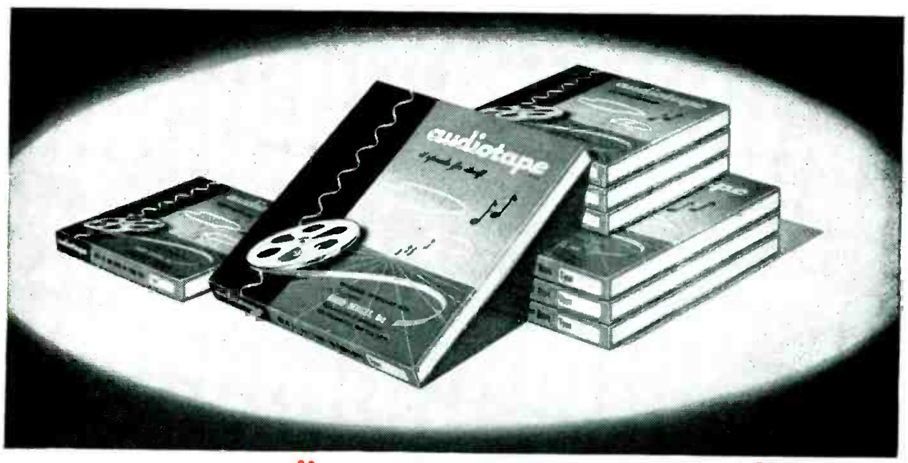

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1251	651	Red Oxide	Oxide In

PAPER-BASE audiotape*

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• The base especially developed for Audiotape, is a strong, durable, supercalendered kraft paper which provides the necessary smoothness of texture without the use of any fillers, which either tend to come out or stiffen the paper.

TYPE NO.		COATING	WOUND ON REEL WITH
1250 Foot Reel	600 Foot Reel		
1200	600	Black Oxide	Oxide Out
1201	601	Black Oxide	Oxide In
1220	620	Red Oxide	Oxide Out
1221	621	Red Oxide	Oxide In

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

First Circular Lens Antenna Used for Omnirange

A NEW precision omnirange operating on a frequency near 5,000 megacycles, developed by Sperry engineers for the Air Force, uses a circular lens antenna to reduce ground reflections. Accuracies of a half degree have been demonstrated in experiments at New York's La Guardia Airport.

Statistical studies show that delays in the handling of air traffic, both for civil and military craft, increase rapidly if the working rate becomes much greater than 70 percent of the maximum capacity. Therefore, the maximum capacity must be set as high as practicable. However, this capacity depends upon accuracy of the system. A navigation system accurate to one-tenth degree for aircraft flying at 120 mph and landing at a rate of 120 per hour would cause errors in position of 250 feet, and it could also give rise to scheduling and ground speed errors of three seconds and 2.4 miles per hour. These errors added to position error could permit aircraft, supposedly one mile apart, to fly as close as 3,000 feet from each other.

The conventional omnirange (VOR) now being installed for civil aviation operates in the frequency region between 112 and 118 mc and employs a heart-shaped beam that sweeps through 360 degrees in the manner of an airport searchlight. A basic improvement to the accuracy of the new 5,000-mc omnirange is the addition of eleven lobes or scallops to the heart-shaped pattern. When the receiving equipment is made responsive to both the large pattern and the lobes a high degree of accuracy results.

Circular lens antenna for shf consists of metal slats that direct 6-cm waves toward horizon, avoiding ground reflections. Supporting tower is 75 feet high

Technical Institute Education Award

THE JAMES H. MCGRAW AWARD in Technical Institute Education will be presented for the first time at the Seattle meeting of the American Society for Engineering Education in June on the University of Washington campus. Consisting of an annual prize of $500 in cash and an appropriately engraved certificate, the award is sponsored by the McGraw-Hill Book Co. in memory of James H. McGraw, Sr., and is given in recognition and encouragement of outstanding contributions to technical institute education in the U. S.

Thorndike Saville, dean of engineering, N. Y. U., president of the American Society for Engineering Education, has appointed the following committee to select the recipient of the 1950 award: E. E. Booher of the McGraw-Hill Book Co.; J. T. Faig of Ohio Mechanics Institute; C. J. Freund of the University of Detroit; K. L. Holderman of Pennsylvania State College; L. V. Johnson of Southern Technical Institute; C. S. Jones of the Academy of Aeronautics; and H. P. Rodes of the University of Calif., chairman.

Nomination forms, which may be obtained from any member of the committee or from A. B. Bronwell of Northwestern University, must be mailed or delivered by March 15, 1950, to H. P. Rodes, James H. McGraw Award Committee, 130 Administration Bldg., University of California, Los Angeles 24, Calif. Any persons other than members of the award committee or employees of the McGraw-Hill Book or Publishing Companies may make nominations.

IRE Awards

SIX major awards and thirty fellowships will be conferred by the IRE at its annual convention in New York, March 6 to 9. The Browder J. Thompson Memorial Prize will be awarded to Joseph F. Hull and Arthur W. Randals for their paper entitled "High-Power Interdigital Magnetrons." Winner of the Editor's Award is E. J. Barlow, for his paper "Doppler Radar." Otto H. Schade is recipient of the Morris Liebmann Memorial Prize, for outstanding contributions to the analysis, measurement technique and system development in the field of television and related optics. The Harry Diamond Memorial Award goes to Andrew

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RADIO ENGINEERS AND MANUFACTURERS

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V. Haeff, for his work in the field of h-f radio analysis, the traveling-wave tube and memory storage devices. Frederick E. Terman will receive the Medal of Honor for his many contributions to the radio and electronics industry as teacher, author, scientist and administrator.

Members raised to the rank of fellow and their citations are as follows:

A. L. Albert—"For his contribution to electronics as a teacher and writer."

R. R. Batcher—"For his pioneer work with c-r instruments and more recently for his development of precision variable-frequency standards and meters."

A. V. Bedford—"For his many contributions to sound recording and the development of many circuits of basic importance to present-day television."

R. Bennett—"For his contributions in programming, guiding and developing sonar systems for military use and his contribution to the administration of military electronics laboratories."

F. J. Bingley—"In recognition of his contributions in the field of television broadcast engineering."

K. H. Blomberg—"In recognition of his many contributions to development and engineering in the field of communications in Sweden."

J. F. Byrne—"For his development of a system of polyphase broadcasting and for effective engineering administration in connection with radar countermeasures during the war."

W. G. Dow—"For outstanding contributions to the teaching and understanding of electronics through the organization of educational material and the stimulation of students and others to critical thought."

D. E. Foster—"For his contributions and technical direction of work leading to better radio receiver design."

G. W. Gilman—"For his contributions to the communication art and for his direction of important developments in the field of radio transmission systems."

G. L. Haller—"For his work on aircraft antennas and for his diversified radio effort during the war."

A. G. Hill—"For his work in the utilization of electronics to research in physics and his contribution in the conversion of wartime development laboratories to peacetime fundamental research."

F. S. Howes—"For his contributions as a teacher in the field of communication engineering."

H. A. Iams—"For the development of electronic apparatus for converting images formed by electromagnetic waves to electrical signals, first in the television field, and later, using new principles, in the realm of short radio waves."

W. Jackson—"For his services as an educator and his many contributions to the literature in both the radio and electrical fields."

R. Kompfner—"For his research in electron tube theory and particularly for his original contributions to the concepts of the traveling-wave amplifier."

H. B. Marvin—"For his outstanding contributions to the measurements art and pioneering work in f-m, television and allied fields."

P. Mertz—"In recognition of his important contributions to the fundamental concepts of television transmission and reception."

J. H. Miller—"For his long activity and many contributions in the field of electrical metering and measuring technique."

G. Mountjoy—"For his contributions to the design of radio and television broadcast receivers."

E. R. Piore—"For his many contributions in the fields of engineering and physical sciences, and for outstanding service in enhancing the national effort in basic research."

J. R. Poppele—"For his long and continued leadership in the broadcasting field and in particular for his recent contributions to television broadcasting."

S. Ramo—"For his many contributions to the analysis of electromagnetic phenomena and for his leadership in research."

C. E. Shannon—"For his contributions to the philosophy of new pulse methods and to the basic theory of communications."

W. A. Steel—"For his contributions in Canada in advancing development of military radio, broadcasting and international communication."

J. R. Steen—"For his work in the introduction and development of statistical quality control techniques in electron tube manufacturing."

G. R. Town—"For his contributions in radio receiver engineering and research."

D. Ulrey—"For pioneering research and for administrative and technical contributions to the development of special purpose and power tubes."

R. R. Warnecke—"For his engineering and research contributions to vacuum tube theory and design in France."

H. A. Zahl—"For his guidance of the Army Signal Corps research program in the transition from war to peace and for his contribution to radar in its early development stages."

MEETINGS

FEB. 27–MARCH 3: ASTM Committee Week and Spring Meeting, Hotel William Penn, Pittsburgh, Pa.

MARCH 1–2: Cathode Committee Meeting, ASTM headquarters, 1916 Race St., Philadelphia, Pa.

MARCH 6–9: IRE Convention and Radio Engineering Show, Hotel Commodore and Grand Central Palace, New York City.

APRIL 19–22: Annual Meeting of the Electrochemical Society, Hotel Statler, Cleveland, Ohio.

APRIL 26–28: Fourth annual meeting of the Armed Forces Communications Association, Astoria, New York City, and Fort Monmouth, N. J.

MAY 3–5: 1950 Dayton IRE Technical Conference, Dayton Biltmore Hotel, Dayton, Ohio.

MAY 9–11: Conference on Improved Quality Electronic Components, 1317 F Street N W, Washington, D.C.

MAY 22–25: Parts Distributors Show, Hotel Stevens, Chicago, Ill.

JUNE 26–30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

AUG. 23–26: AIEE Pacific General Meeting, Fairmont Hotel, San Francisco, Calif.

AUG. 28–31: APCO National Conference, Hotel Hollenden, Cleveland, Ohio.

SEPT. 13–15: Sixth Annual Pacific Electronic Exhibit, Municipal Auditorium, Long Beach, Calif.

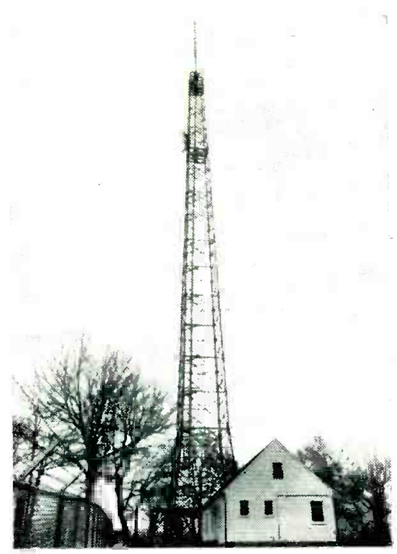
SEPT. 18–22: Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo, N. Y.

SEPT. 25–27: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

OCT. 17–21: AIEE Midwest General Meeting, Netherland Plaza Hotel, Cincinnati, Ohio.

Bridgeport UHF Television Station

IN ORDER to obtain data on the propagation characteristics of ultrahigh frequencies in the region around 530 mc, the Radio Corporation of America has established an experimental television transmitter in the town of Stratford, 2 miles from the center of Bridgeport, Conn. About 50 uhf receivers are being installed in the vicinity and mobile recording equipment is also used for measuring field strengths.



Building housing uhf equipment and tower that supports high-gain slot antenna at top and receiving dish at 160-foot level

The transmitter building and tower are located on Success Hill, 190 feet above sea level. The fabricated tower that supports the 40-foot multiple-slot transmitting antenna is 210 feet high. At the 160-foot level is located the directive receiving antenna that picks up programs from WNBT in New York City, 53 miles distant.

A modification of the type

(continued on page 246)

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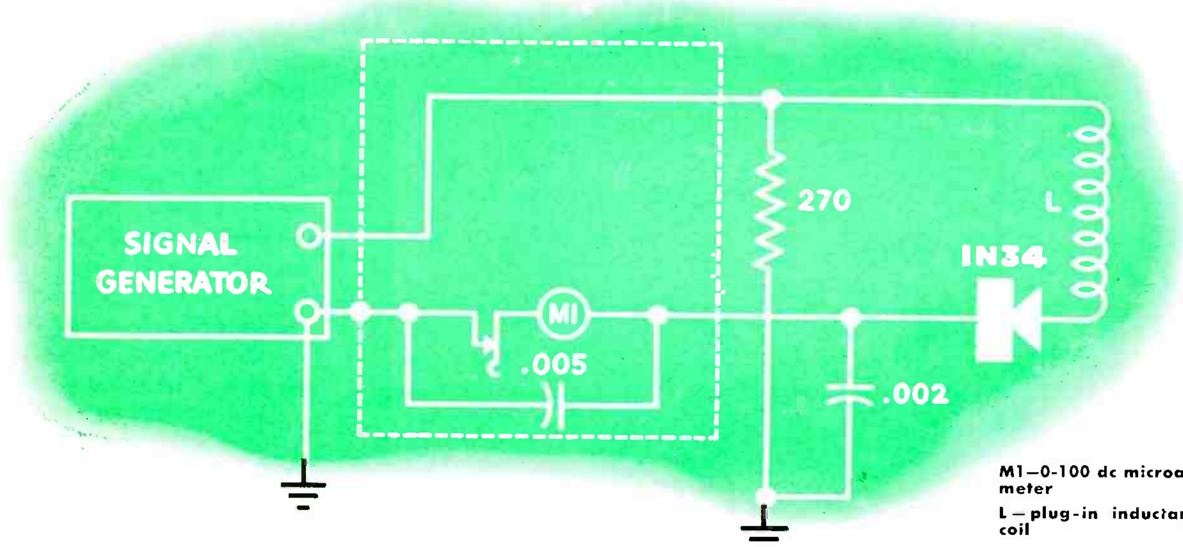
Just 3 plug-in coils cover 100-300 mc range in McMurdo Silver's "Grid Dip" adapter

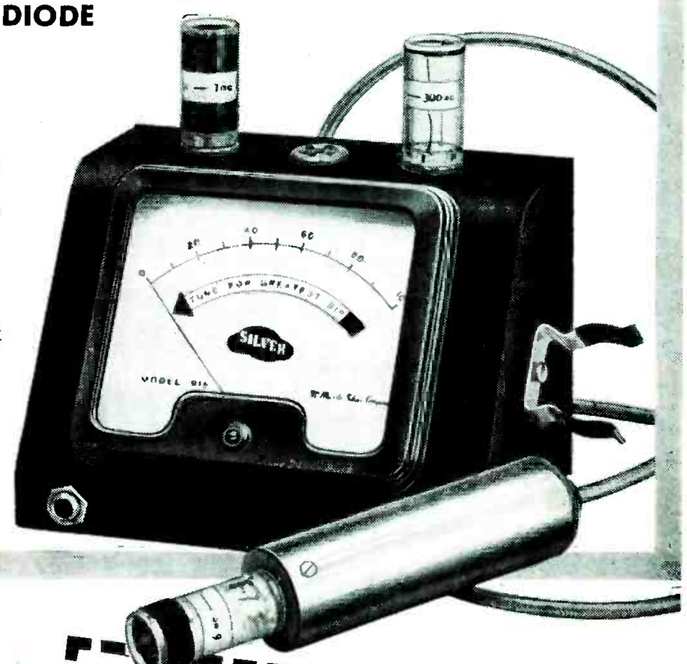


M1—0-100 dc microammeter
L—plug-in inductance coil

THE SYLVANIA 1N34 GERMANIUM DIODE MAKES THIS SIMPLIFIED CIRCUIT DESIGN POSSIBLE!

"In our Model 915 Tubeless 'Grid Dip' Adapter, the extremely low shunt capacitance of the Sylvania 1N34 Germanium Diode made possible the design of a series tuned circuit with only 3 plug-in coils to cover the range from 100 to 300 mc," reports D. H. Carpenter, Chief Engineer of McMurdo Silver Co., Inc., Hartford, Conn. "Other advantages are compact probe design, savings in production costs and assurance of a positive zero set."

Many manufacturers have found that Sylvania Germanium Diodes contribute to circuit improvement and design simplification. Have *you* investigated the possibilities of these compact, lightweight, heaterless components?



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Electronics Division, Dept. E-1003
500 Fifth Avenue, New York 18, N. Y.
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Please send me full information on your Germanium Diodes.

Name____________
Company____________
Address____________
City____________ Zone______ State______

ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS

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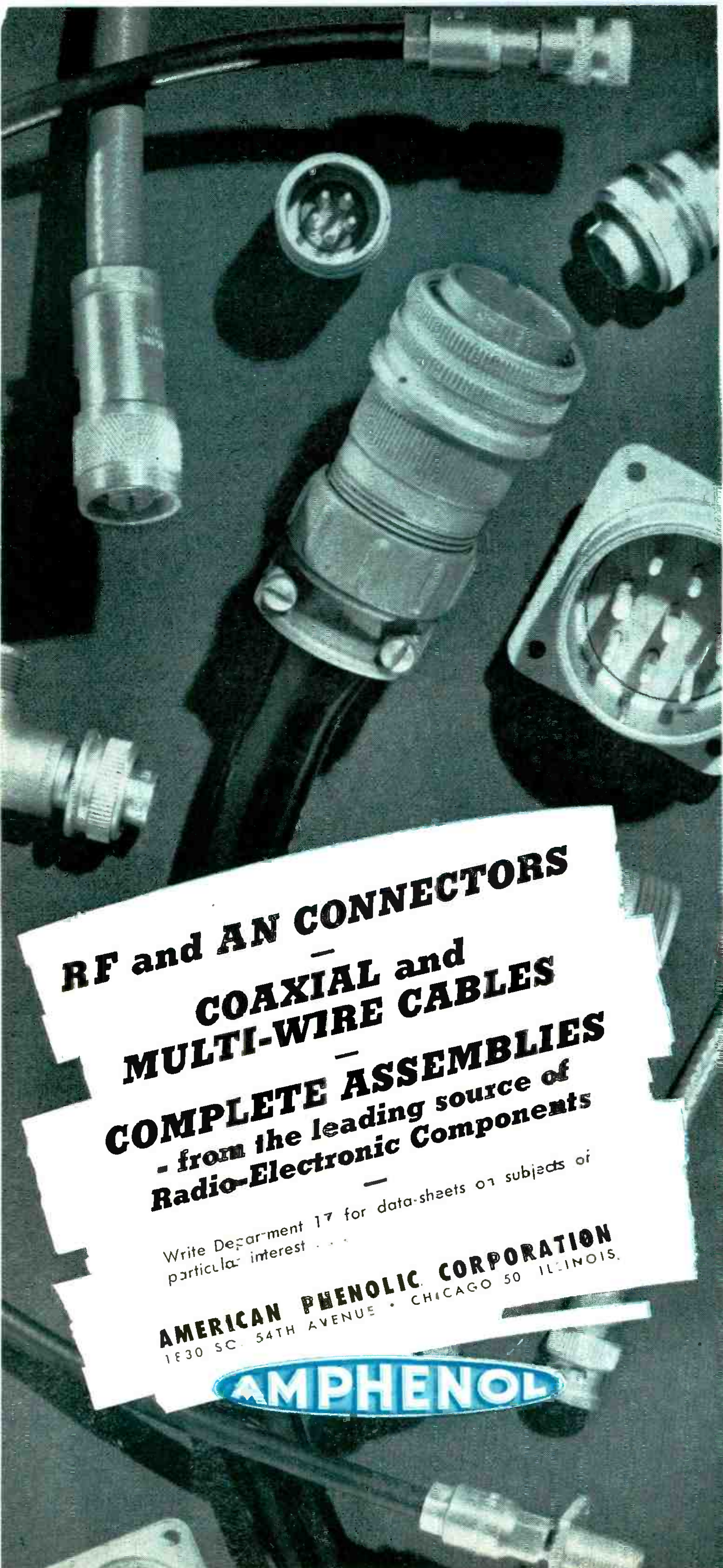

(continued from page 118)

overall accuracy is perhaps 0.2 to 0.3 percent.

Circuit

The amplifier is a conventional vtvm type in which two triodes are balanced against each other to cancel drift. Any drift that remains may cause a slight shift in the zero position of the meter, but, by using a momentary switch which must be pressed to make the measurement, the circuit is automatically placed in the zeroing position before and after every measurement and any shift in zero is immediately apparent. Since a sensitive meter is used, no voltage amplification is necessary.

Grid current flowing through the bridge causes a potential to appear at the grid of V_1, but since the circuit is arranged with the same resistance in the grid circuit in both the zeroing and measuring positions, no error is introduced. It is advisable, however, to keep the grid current at a minimum by applying proper voltages to the tubes.

Because of the high resistances involved, some points in the bridge circuit not connected to the chassis must be carefully insulated from it and from each other, as a slight leakage may cause serious errors in measurement. Although the instrument has been described as a high-resistance measuring device, it can also be used equally well for any resistance down to about 100 ohms simply by reversing the position of the decade and the unknown resistance in the bridge circuit.

Egg Processing Equipment

By S. M. MILANOWSKI
Consulting Engineer
Los Angeles, California

TO IMPROVE efficiency and to lower the cost of candling and handling eggs, Industrial Electronic Engineers of Los Angeles have developed an automatic egg processing line based on principles that could possibly be applied to other phases of the food-products industry.

The setup eliminates the need for the human handling of eggs from the time a farmer places them in crates until they are actually consumed. The components can be

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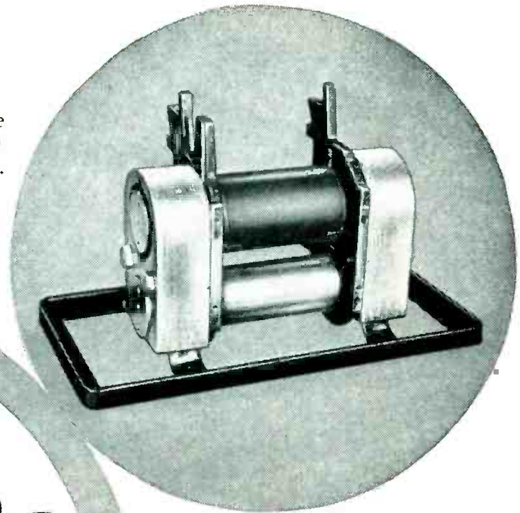
View of Magnet Assembly: Top bar Crucible Alnico; lower bar (replacing former 2nd magnet) provides return path and reinforces assembly.



Crucible cuts magnet costs in half!

TelAutograph Corporation, New York, N. Y., designs and manufactures the TelAutograph telescriber, an instrument that transmits handwritten messages over wire to one or many remotely located receivers.

Receiver operation is similar to a d-c voltmeter: the motion and position of the recording pen is determined by the force developed in a coil that is free to move in a fixed magnetic field. Originally this field was produced by current through a wound coil, but this generated heat and reduced the field strength. Permanent magnets were substituted for the coil. But here a problem arose:

Two permanent magnets were required to match the electromagnetic field. This made assembly time and unit costs excessive. Crucible Magnet Specialists were called in, and in short order developed one permanent magnet to replace the two. This resulted in a 50% magnet cost cut, improved mechanical construction and a general reduction in assembly cost . . . *plus* increased unit efficiency.

That's how TelAutograph Corporation made good use of Crucible's half-century of specialty steel experience. Your problems will be given the same careful attention. Please state your permanent magnet application when you write.

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405 LEXINGTON AVE., NEW YORK 17, N. Y.
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CRUCIBLE first name in special purpose steels

PERMANENT ALNICO MAGNETS

STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE • STEELS

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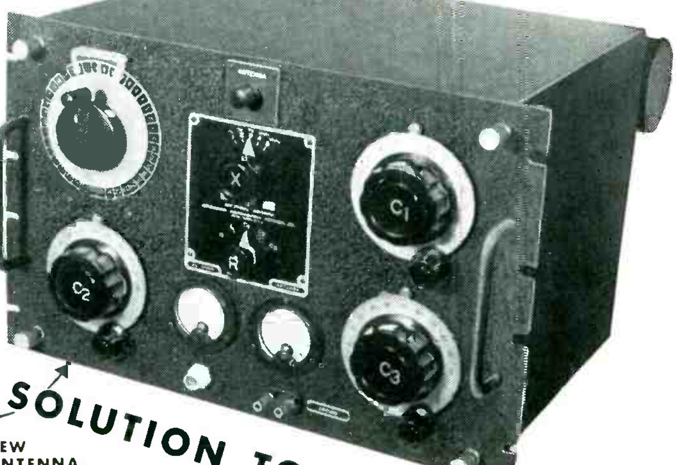

A NEW SOLUTION TO OLD PROBLEMS

AEROCOM'S NEW ARTIFICIAL ANTENNA, SIMULATING ACTUAL OPERATING CONDITIONS, SAVES TIME ON TRANSMITTER AND RECEIVER TUNING

It is no longer necessary to final tune transmitters or receivers aboard aircraft. With the new Artificial Antenna (Model DA200) you can precisely simulate, electrically, any normal aircraft antenna. All this without leaving the test bench. This equipment will accept any transmitter power up to 200 watts -- coaxial fitting provides direct 52 ohm metered load. Sturdily constructed for hard usage, can be mounted in standard rack cabinet or used on bench top.

A letter or wire from you will bring descriptive literature

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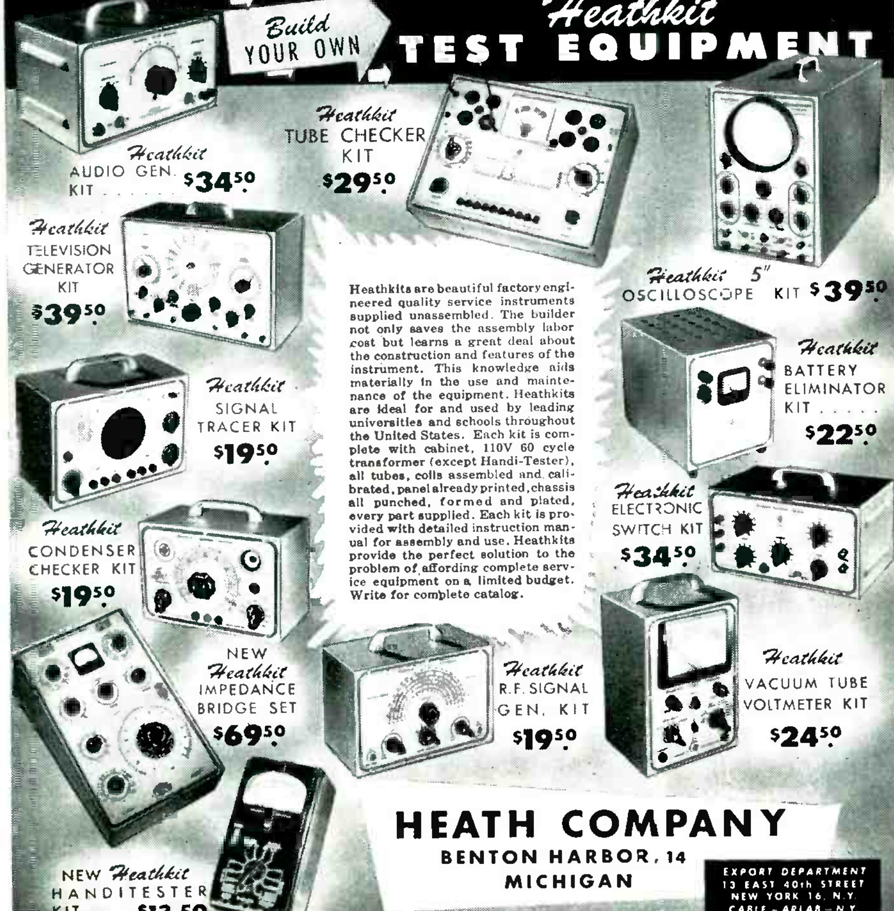

Heathkits are beautiful factory engineered quality service instruments supplied unassembled. The builder not only saves the assembly labor cost but learns a great deal about the construction and features of the instrument. This knowledge aids materially in the use and maintenance of the equipment. Heathkits are ideal for and used by leading universities and schools throughout the United States. Each kit is complete with cabinet, 110V 60 cycle transformer (except Handi-Tester), all tubes, coils assembled and calibrated, panel already printed, chassis all punched, formed and plated, every part supplied. Each kit is provided with detailed instruction manual for assembly and use. Heathkits provide the perfect solution to the problem of affording complete service equipment on a limited budget. Write for complete catalog.

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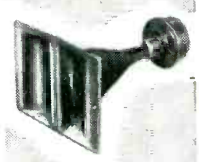
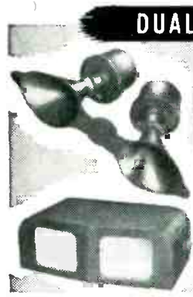


MODELS 4408, 4409—600 CYCLE TWEETERS: Recommended for highest quality reproduction systems requiring a low crossover frequency. Cobra shaped horn results in perfect wide angle distribution. Frequency response 600 to 15,000 cycles. Model 4408 handles 6 watts and 4409 25 watts.

MODEL 4407 ADAPTER MOUNTS 4401 TWEETER IN ANY 12" CONE UNIT: Converts any 12" cone speaker into a wide-range coaxial reproducer in a few minutes. Installation is extremely simple and results in a dual speaker occupying little more space than the original cone speaker. Complete with 4401 tweeter.

MODEL 4401—2000 CYCLE TWEETER: An economical 6 watt unit for converting any good 10-15" cone speaker for extended response to 15,000 cycles. Wide Angle horn, compact design and low price bring excellent high fidelity well within the popular price range.

DUAL TWEETERS



MODEL 4402, MODEL 4404: Model 4402 reproduces to 15,000 cycles. Crossover at 2000 cps. Horizontal dispersion 100°, Vertical 50°. Handles 12 watts. Compact design mounts in any radio, phono, or speaker cabinet. Model 4404 incorporates 4402 tweeter in handsome walnut cabinet complete with high-pass filter and high frequency volume control. Anyone can install.

CROSSOVER NETWORKS

MODEL 4405 HIGH PASS FILTER: An effective and economical unit for preventing lows reaching the tweeter unit. Contains high frequency control to balance highs and lows. Cutoff frequency 2000 cycles.

MODEL 4410, 4420 LC CROSSOVER NETWORK: Genuine LC frequency dividers for segregating highs and lows. Not to be confused with ordinary high-pass filters. Crossover frequencies: Model 4410 600 cycles, Model 4420 2000 cycles. Attenuator controls included and wired.

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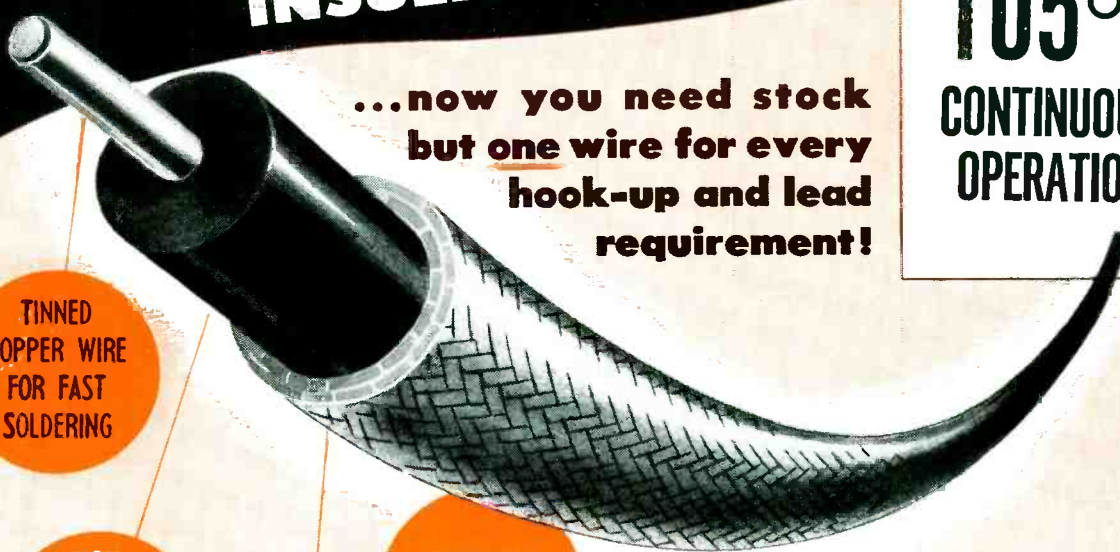
SOMETHING BRAND NEW IN HOOK-UP WIRE—

TURBOTHERM REL 16-A INSULATED WIRE

105°C CONTINUOUS OPERATION

...now you need stock but one wire for every hook-up and lead requirement!



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NON-DETERIORATING VINYL DIELECTRIC FOR PERMANENT SAFETY

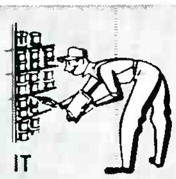
Braided Lacquered Glass Jacket 90° C with Cotton or Rayon

OPERATING RANGE —10 TO 105°C

- NON-POROUS, NON-FRAYING
- FREE STRIPPING INSULATION
- FLEXIBLE
- AVAILABLE FOR 300 AND 600 V.
- NON-DETERIORATING VINYL DIELECTRIC
- WITHSTANDS POTTING TEMPERATURES

. . . IT'S APPROVED BY UNDERWRITERS LABORATORIES

IT REDUCES WIRE INVENTORY, IT SPEEDS WIRING



. . . IT'S AVAILABLE IN ALL SIZES 12 TO 30 AWG

TURBO REL-16A Insulated Wire is the biggest news in hook-up wire to be announced in recent years. Its unusual characteristics make it possible for the first time, to stock one single type of wire for all requirements—point-to-point wiring, cabling, equipment and component leads.

REL-16A is a free stripping insulated wire composed of a tinned copper conductor, covered with a layer of non-deteriorating vinyl plastic, overlaid with a close-woven lacquered glass jacket. The combination of free stripping and the tinned conductor enormously speed production. The vinyl dielectric gives permanent electrical protection, and the lacquered glass woven outer layer insures the utmost mechanical protection.

The overall qualities of REL-16A are so thoroughly outstanding that this is the first thermoplastic wire to earn Underwriters' approval recognition for 105° C continuous operation. Check the advantages—write for free sample today.

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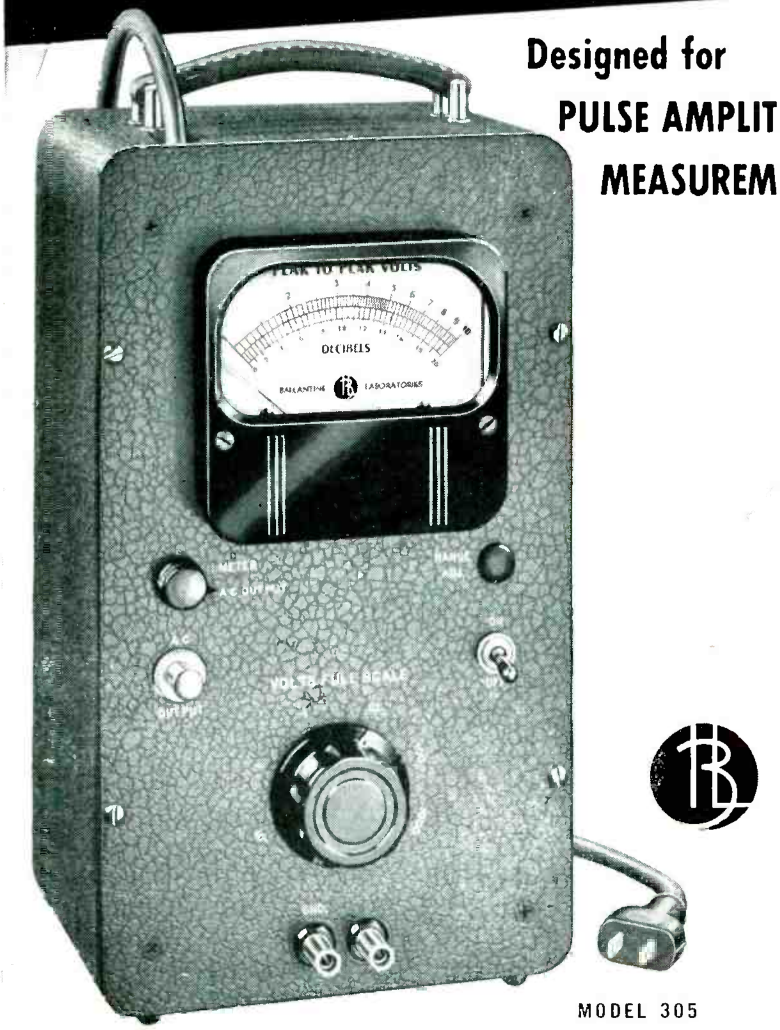
Ballantine's **PEAK to PEAK** Electronic **VOLTMETER**

Designed for PULSE AMPLITUDE MEASUREMENTS



MODEL 305

The outstanding characteristic of the Model 305 Electronic Voltmeter is its ability to provide absolute indication of transient or pulse voltages of short duration. Reliable indication of pulses a few microseconds wide repeated only 10 times per second is readily obtained with this instrument. The Voltmeter is pre-calibrated, compact, easy to operate and observe. Positive and negative peaks are registered over the range of .001 volt to 1000 volts, peak to peak. Decade ranges and a logarithmic scale output meter are characteristic features, along with a separately available high gain, wide-band amplifier.

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BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.

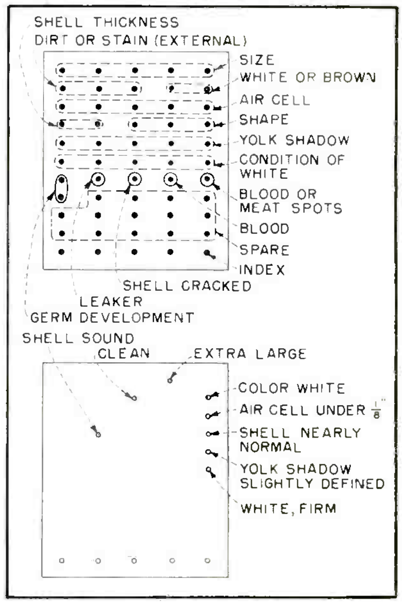

FIG. 1—Inspection data are recorded magnetically in the form of dots corresponding to each egg's characteristics. Bottom is a drawing of a typical egg card

arranged in many ways to meet different production requirements.

The automatic equipment takes over as soon as the egg crates reach the inspection station. Racks of rubber-fingered hangers reach into the crates and remove eggs a layer at a time. Between each layer an arm removes the packing pad which separates the layers of eggs. The emptied crates are moved to a storage area by another conveyor.

The rubber-fingered hangers carry the eggs to an egg-conveyor belt which consists of a series of foamed-rubber cups on which the eggs ride from one inspection operation to the next.

Magnetic Recording

As the eggs speed through their inspection stations, data describing the size and quality of each egg is magnetically recorded on a rust-proof magnetic card which is attached to each foamed-rubber conveyor cup. Details of the magnetic card are shown in Fig. 1. Each dot denotes some characteristics of the egg as determined by inspection data.

A collector unit scans the magnetic card for each egg after it leaves the final inspection station, and transmits the data on the card to a control unit which energizes various circuits in accordance with

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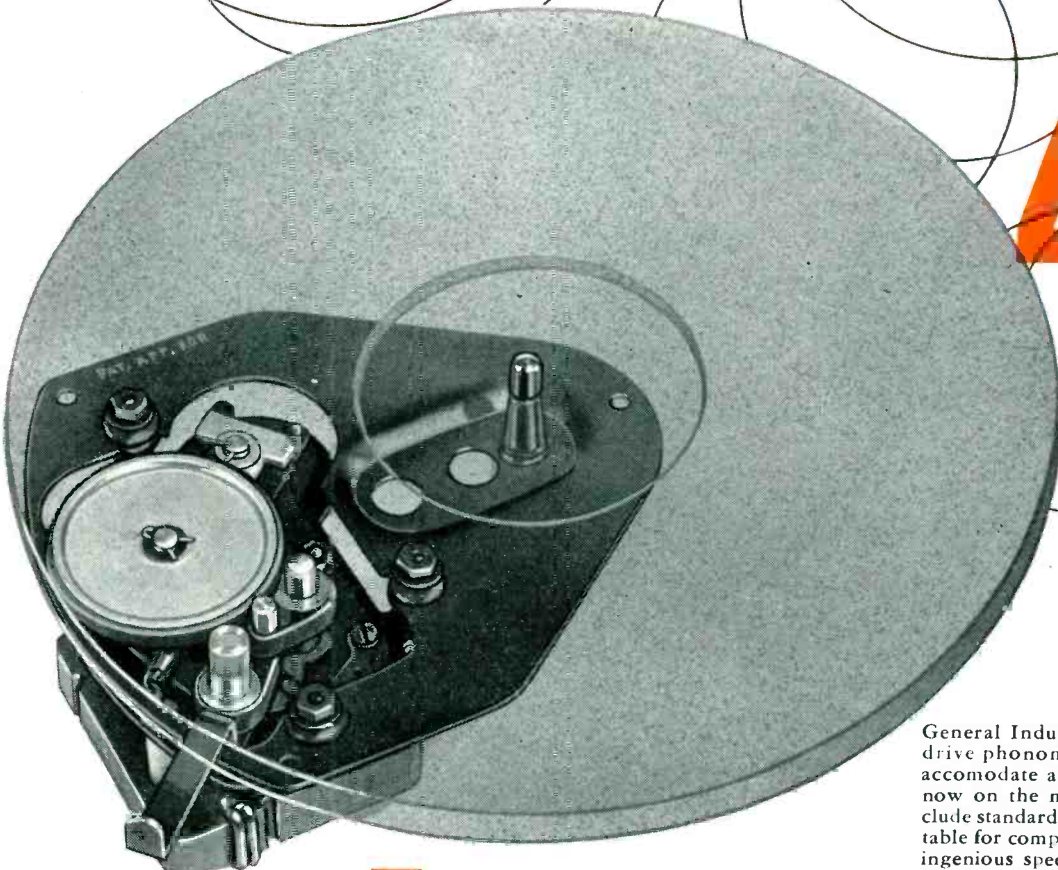
33 1/3 RPM 78 RPM 45 RPM



General Industries' newest rim-drive phonomotor, designed to accomodate all types of records now on the market. Features include standard narrow-flange turntable for compact installation, and ingenious speed-change mechanism with external shift lever.

This model for manual operation. Many variations are available to record-changer manufacturers.

MODEL TS (ALL THREE SPEEDS)

Here's the turntable that puts you right in the middle of the profitable market for consoles, table models and portable phonographs that will play all three types of records. Simple and fool-proof in operation, the Model TS incorporates all of the advanced engineering features which have long distinguished GI's *complete* line of Smooth Power phonomotors, recorders and record-changer recorders.

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Vertical and Horizontal Blocking Oscillator. Below Chassis mounting

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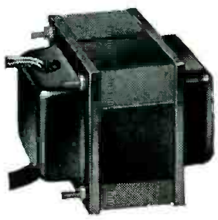
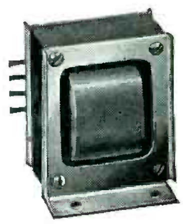
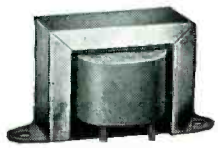


Plate and Filament Transformer with and without Magnetic Shielding



Vertical Deflection Output Transformer



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- MEASURES radiated and conducted signals
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- SENSITIVITY — Field strength using rod antennas one microvolt-per-meter to 2 volts-per-meter. Field strength using shielded loop antennas 10 microvolts-per-meter to 100 volts-per-meter.
- READS directly in microvolts and db.
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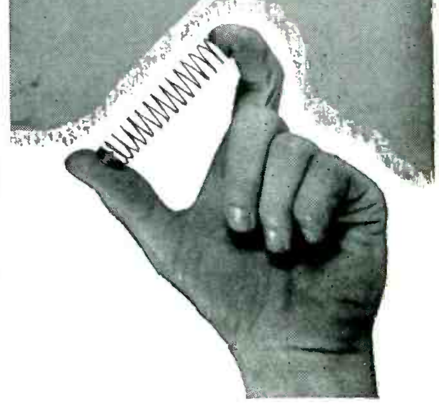

IT takes people to make springs. Ours are specialized, highly trained, long-experienced people—well qualified to give you the finest in spring craftsmanship.

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MITCHELL-RAND *announces...*

1766EX

CAPACITOR END FILLER

FOR SEALING OIL, WAX AND ELECTROLYTIC PAPER TUBE CAPACITORS

it's new • it's better • it's low cost

Once again Mitchell-Rand demonstrates the effectiveness and value of its research and development . . . produces 1766EX, a resin base thermoplastic having high cold flow, solid adhesion, inflexible oil resistance, absolute sealing and low-cost characteristics, all superior to any like product now available. 1766EX is the product long required by manufacturers of paper tube capacitors that must be guaranteed for operating temperatures to 105°C.

Yes, once again Mitchell-Rand gives point to its repute as "Headquarters for Everything in Electrical Insulation" . . .

1766EX adds another to Mitchell-Rand's more than 3500 compound and wax formulas that resist high voltage breakdown, salt spray atmosphere, humidity, cracking or flaking, acids and alkalis . . . with excellent flexibility and adhesive qualities, high cold flow and good thermal conductivity . . . waxes that penetrate fibre, floss, bakelite, paper and cloth and with low viscosity, high surface tension and good electrical characteristics . . . Mitchell-Rand has the compound or wax to meet your specific requirements and should the need arise for a special formula to meet a particular condition, then Mitchell-Rand will create the compound embodying every quality required.

SPECIFICATIONS

COLD FLOW (M-R)	250/255 F
S.P. (B&R)	255/260 F
POURING TEMPERATURE	350/400° F
COLOR	Brown
ADHESION	Good
PENETRATION 77/100/5	0
CHLORIDE CONTENT	*Negative
SPECIFIC GRAVITY	1.59
FLASH POINT	490 F
MINERAL OIL RESISTANCE	Good

*Less than 4 parts per million.

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

FEATURES

ADHESION TO WAX IMPREGNATED TUBES: In developing 1766EX every effort was made to assure good bonding properties to wax impregnated tubes without sacrificing hardness at high temperatures (100°C).

MINERAL OIL RESISTANCE: Since penetration of mineral oil from oil impregnated and oil cooled capacitor sections tend to soften end fill compositions, 1766EX was formulated to resist mineral oils.

LOW COST: In order that its adaptability be extended to almost every end sealing application, attractive low cost was included as a prime factor in the development of 1766EX . . . and without the sacrifice of any quality feature.

COLD FLOW: The high cold flow temperature of #1766EX permits its use for paper tube capacitors which are guaranteed for operating temperatures up to 105°C. Employing the standard container specified for the standard M-R Cold Flow test (2" in diameter by 1⅞" high filled to depth of 1") 1766EX will resist cold flow at 115°C for more than 24 hours.

APPLICATION CHARACTERISTICS: Sealing of capacitors with 1766-EX is facilitated by the low pouring viscosity and good bubble release which this seal exhibits. The relatively sharp melting point and special filler combination of 1766EX permit easy pinhole repair. These properties make 1766-EX particularly well suited for sealing electrolytic units.

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RED TOP
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A NEW UNIMAX DESIGN

gives new, foolproof protection for high voltage equipment . . . the "cheater-release" lets you reclose the circuit manually for test or service work . . . automatically restores protection when the door of the safety enclosure is shut . . . eliminates the hazard of a tied down, blocked, or "jumped out" circuit.

"CHEATS" FOR SAFETY

1. The leaf-spring actuator holds the circuit "ON" — until the door is opened as little as ⅛ inch.
2. The push-button-operated slide cam, mounted above the actuator, permits manual reclosing of the circuit.
3. The slide cam and interlock immediately spring back to "safety" when the door is closed on the leaf actuator.

For complete information — dimensions, performance specifications, ratings — write for Interlock Data Sheet MXM.

UNIMAX SWITCH
DIVISION OF THE W. L. MAXSON CORPORATION
460 WEST 34th ST., NEW YORK 1, N. Y.

the quality of the particular egg. The energized circuits have two functions: (1) Marking a second magnetic card on a pickup and removal hanger, so that each will be shunted off to a predetermined accumulator line; (2) Adding to the totalizers in an electronic control unit, so that the quantity and quality of eggs from each producer will be constantly and accurately indicated.

After the eggs are unloaded, the empty conveyor cups and magnetic cards are passed through a demagnetizing field, to erase the previously recorded data. The cups are then washed and dried before reuse.

Automatic book keeping is achieved through the use of markers on crates during the initial unloading process. These markers are plastic code plates that actuate a sensing switch so that the eggs in each different case will be accredited to the source from which they were purchased. The sensing switch enables a printer unit to record data with regard to quality and quantity for each producer.

Inspecting Line

In all, there are five separate inspection stations, as follows:

Station No. 1 is an egg-sizing unit, as shown in Fig. 2. It is operated on the basis of the resonant-string principle with a tungsten wire serving as the string. A temperature-compensating mounting is provided, and the wire is electro-magnetically excited to a pitch or frequency which can be amplified and fed into a discriminator which is preset to measure frequency in terms of egg sizes.

At station No. 2, the color and shape of the egg are determined. First a prism-photocell setup is used to determine shell color by means

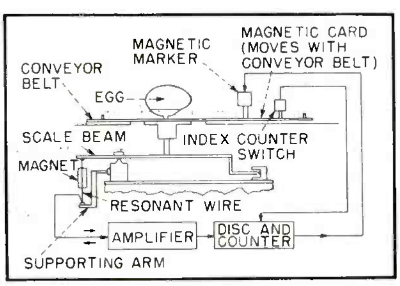


FIG. 2—Weight of egg is measured by the resonant-wire frequency-discriminator scale system shown

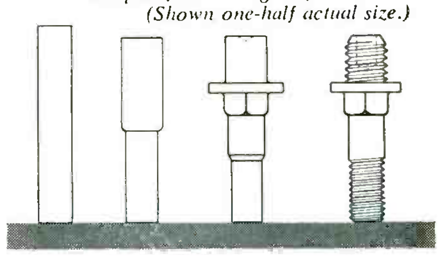
this complex shape is being made at low cost by . . .

actual size

Cold Heading

This special steel stud, used in heavy duty power transmission equipment, combines two different shapes with four diameters.

Some of the steps involved in cold heading this part from a length of steel wire. (Shown one-half actual size.)



Production of this steel part by ordinary methods would involve the use of high cost machines, plus other costly operations. Cold heading not only provides economy and speed of production, but also produces a much stronger part.

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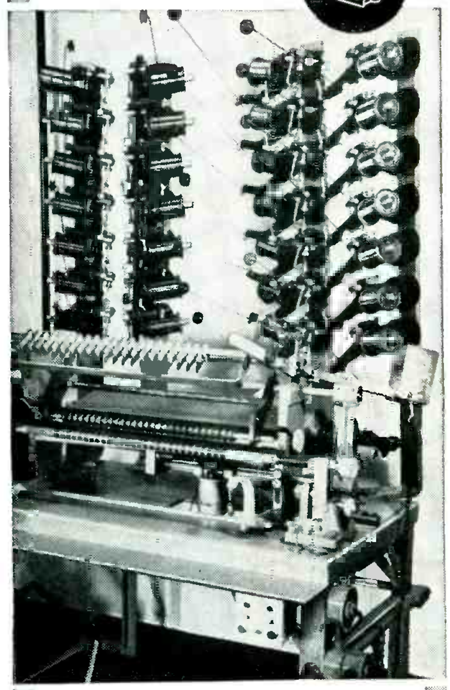

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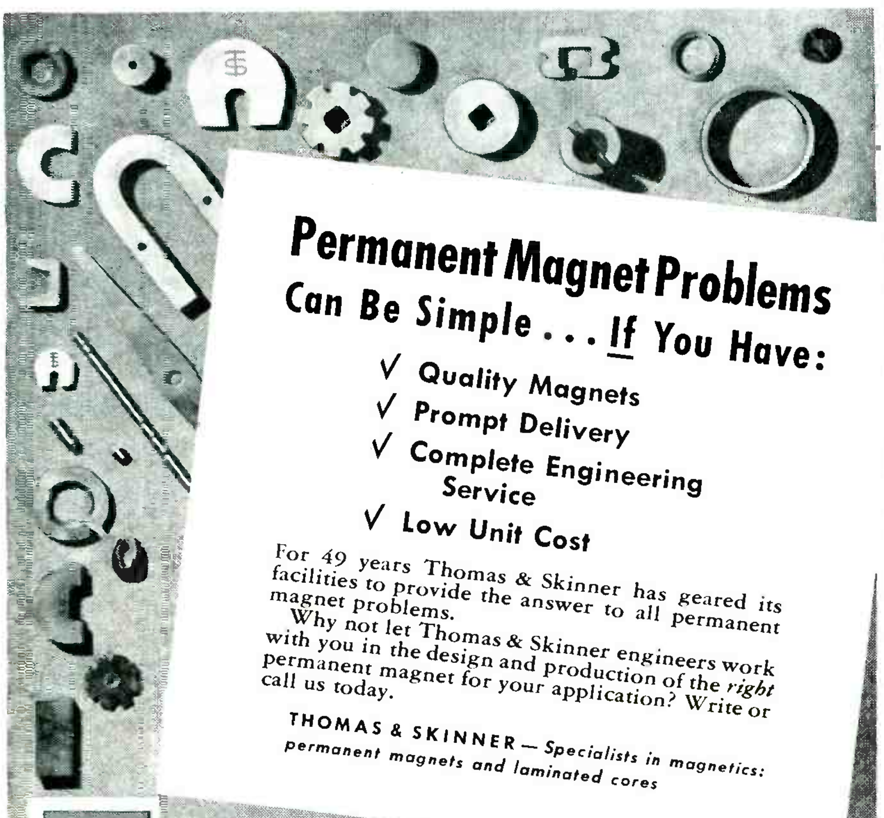

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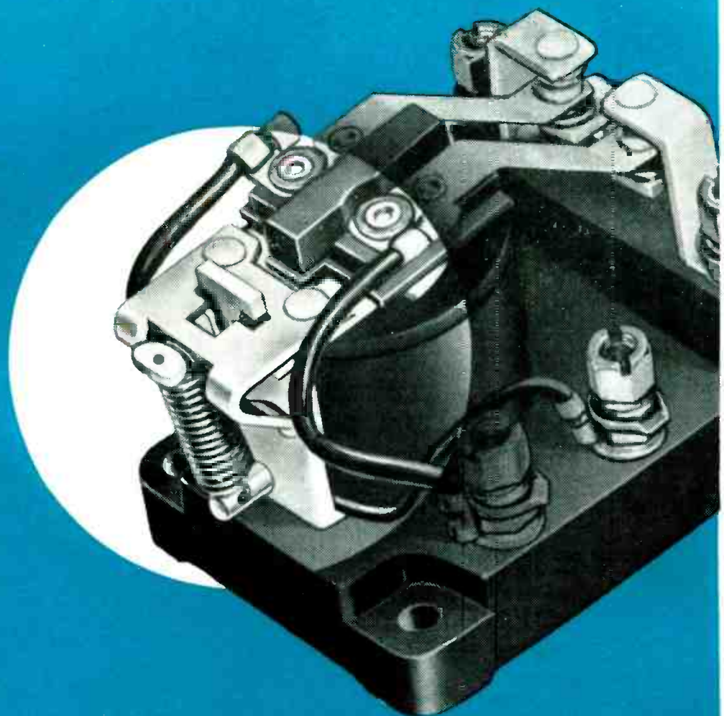

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of light reflected from each eggshell. A second photocell makes use of transmitted light to ascertain the internal color of the egg; and, a pair of flying-spot television-type scanners provide indications as to whether the shape of the egg is essentially normal, slightly abnormal, or abnormal. The scanners are respectively focused on each egg and a diagram for a perfect egg shape so that the latter indications are obtained by comparison.

Station No. 3 is a unit for measuring shell thickness, air-cell depth, and yoke centers. Thickness is checked in terms of electrical capacitance by means of a sensing head comprising a ¼-in. square block with two thin plated-metal strips which can contact a shell without damage to determine the distance from an outer shell surface to the white of each egg. Air-cell depth is measured by means of a quartz crystal which induces a very short pulse into an egg from an overhead position so as to produce wave reflections as illustrated in Fig. 3. The echo time can be computed in terms of air-cell depth (elapsed time normally being in the order of 20 microseconds). Yoke centering is determined by simultaneously applying two crystal units to an egg in the horizontal plane (with 90-deg spacing) so that three pulses will be produced and reflected for three-dimensional measurements, much the same as one pulse is used to indicate air-cell depth.

Station No. 4 is a unit for determining the condition of each eggshell with reference to cleanliness, cracks, roughness, and leaks. This involves the use of a phototube set-

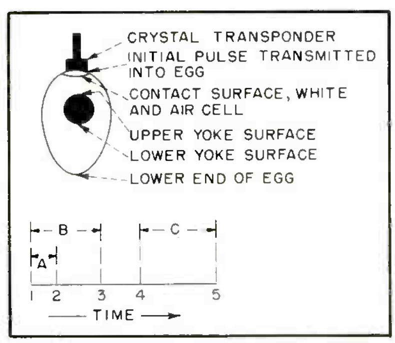

FIG. 3—Pulses shown in lower portion of diagram represent (1) initial pulse, (2) beginning of egg white (air-cell depth), (3) top of yoke, (4) bottom of yoke, and (5) bottom of egg

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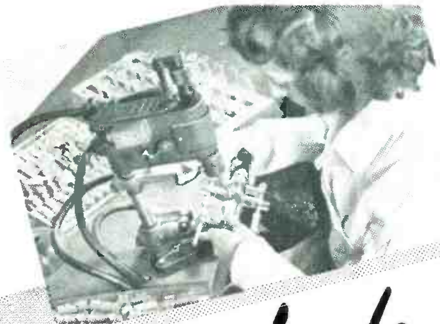

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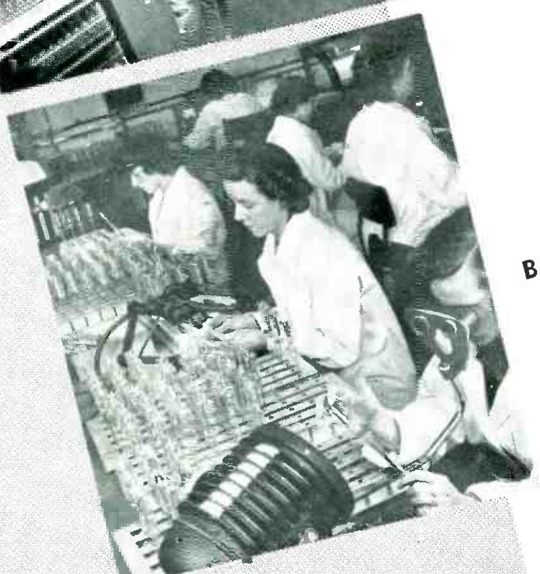

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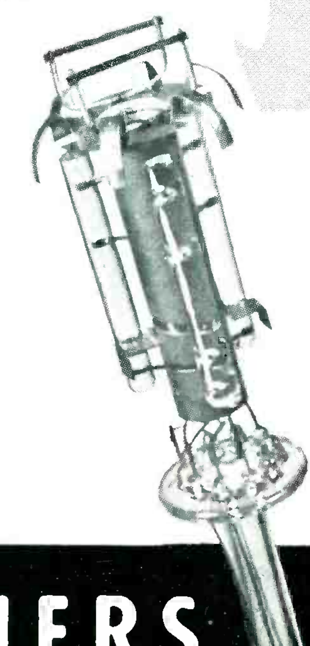

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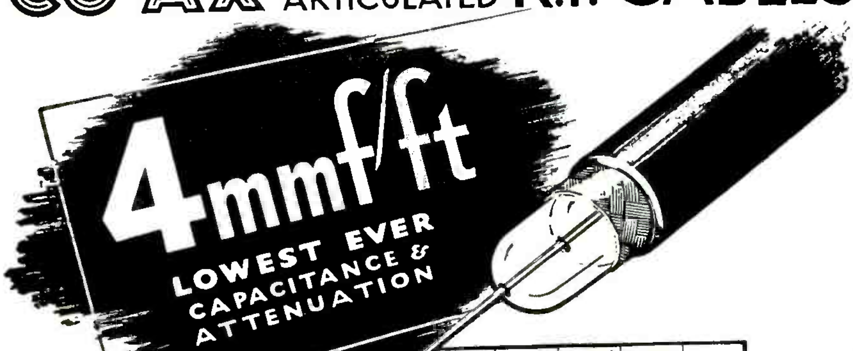

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C.11	6.3	173	3.2	0.36
C.2	6.3	171	2.15	0.44
C.22	5.5	184	2.8	0.44
C.3	5.4	197	1.9	0.64
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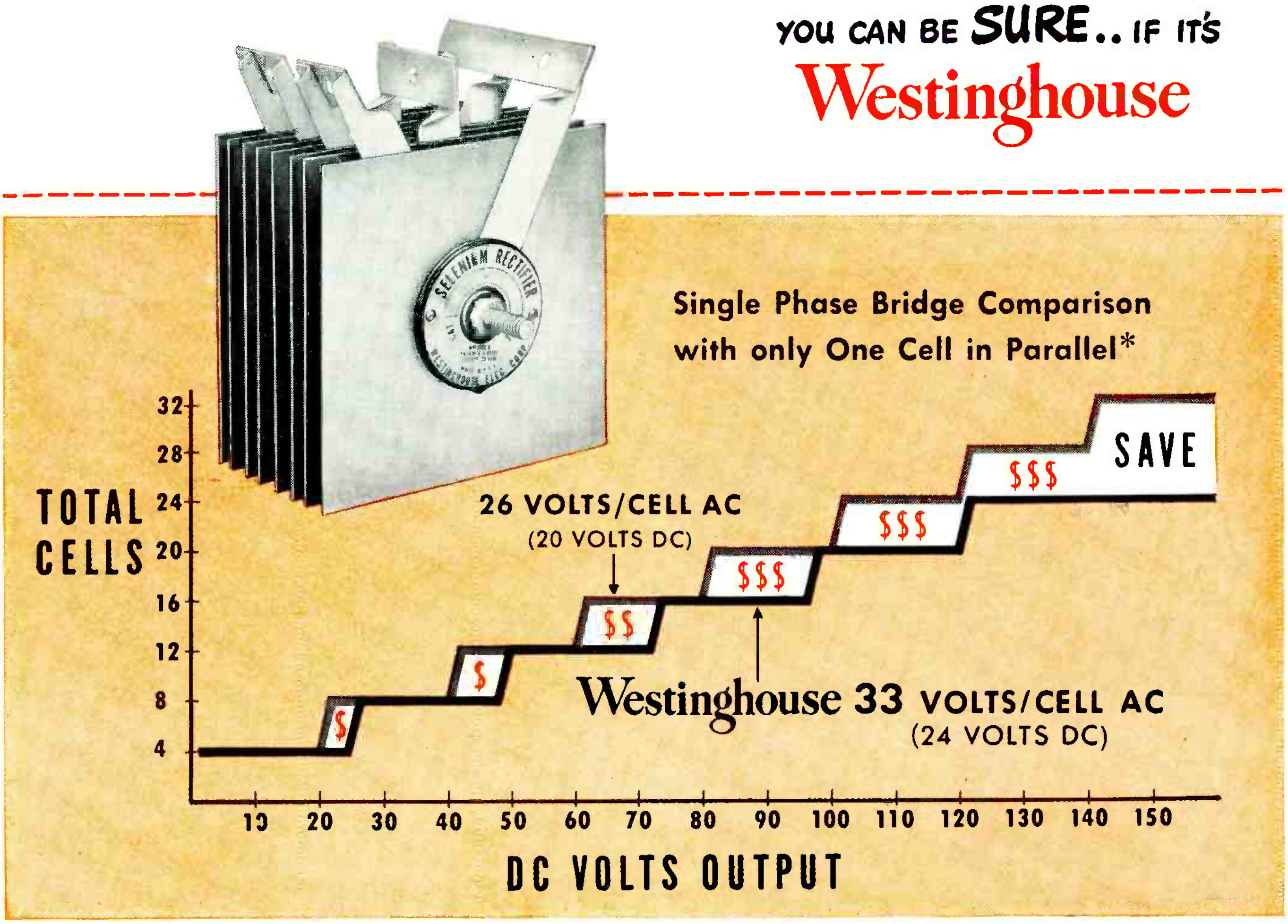

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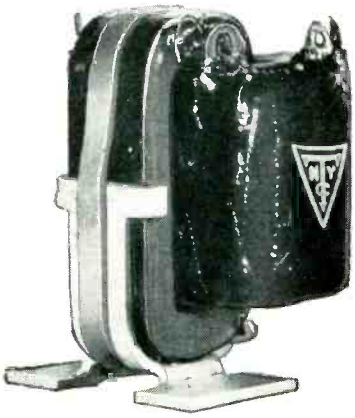

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up, similar to that at station No. 2, and a surface gage which resembles a phonograph pickup except for the fact that it generates an electrical signal which can be analyzed by comparison of the intensity of the signal in an egg with that of a specimen which is known to be in excellent condition. Two light spring feelers are attached to the surface gage to detect leakers by means of electrical conductivity.

Station No. 5 is a candling unit, employing a television-type scanning device to grade eggs according to the intensities of their yoke shadows as created by electronic signals transmitted through each egg. Shadows are classed as poorly defined, moderately defined, well defined and plainly visible.

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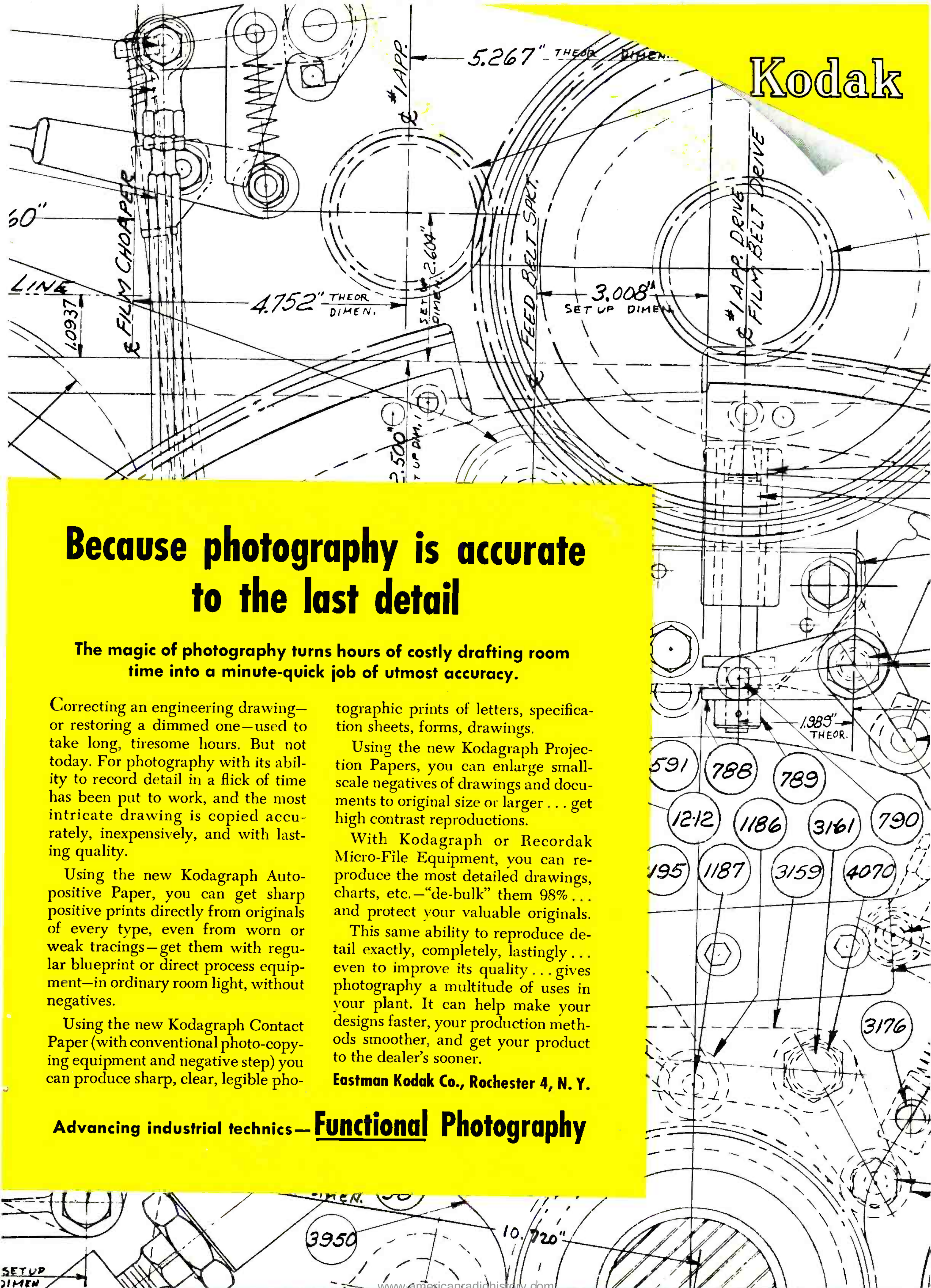

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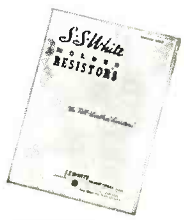
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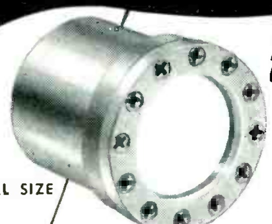

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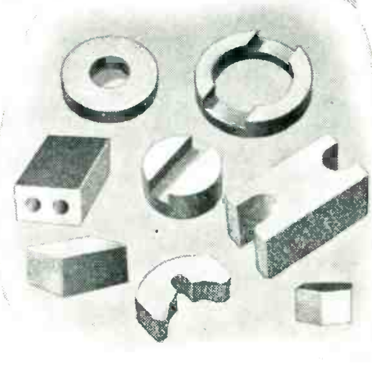

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When product listings have this symbol tied in with them, those listings are of far greater significance to the subscriber-users of the GUIDE. The symbol will indicate to them a more accurate source of supply than is possible with the unverified, non-symbolized listings. For these symbols will indicate (1) current production, (2) availability, (3) unrestricted use. This information is vital to potential buyers and will encourage far wider use of products so indicated. As a direct result, inquiries and sales of those products will show a marked increase.

HOW TO GET THIS SYMBOL WITH PRODUCT LISTINGS...

Although there is no charge for product listings or the use of this identification, it takes more than a request to obtain it. Manufacturers must first prove that the products are in actual production, or in stock, available in a reasonable time: and that there are no restrictions, governmental or other, on the use of the product. Clear indication of what proof is necessary is described in the product questionnaire which is mailed to every presently known manufacturer. Those regulations must be rigidly followed. The manufacturers should read them carefully to assure that they will have the right to the symbol.

VALUE OF SYMBOL TO USERS OF THE GUIDE...

Anyone using the GUIDE as a where-to-buy-it book will be greatly helped by the additional information this symbol identification provides. Buyers must know more than just who makes a product. They want to be sure they can get it — without unnecessary delay — and equally sure that its use, for their purpose, is unrestricted. The symbol will guide buyers directly to the products they need and prevent time wasted in a fruitless search as well as in unnecessary correspondence on the part of both buyer and manufacturer.

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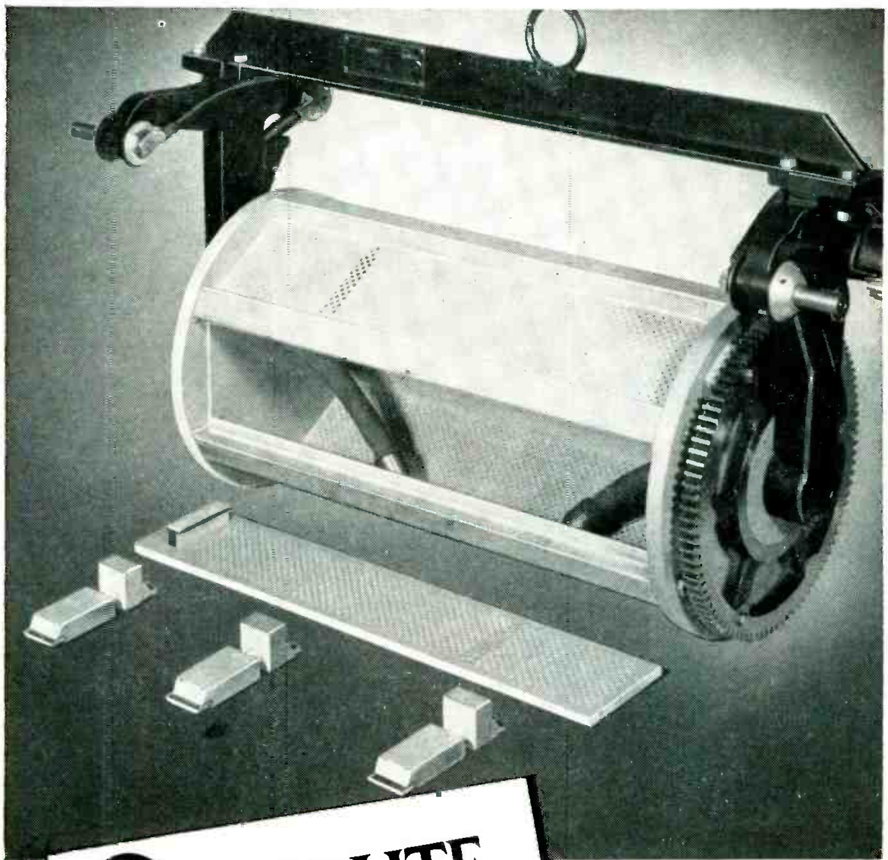

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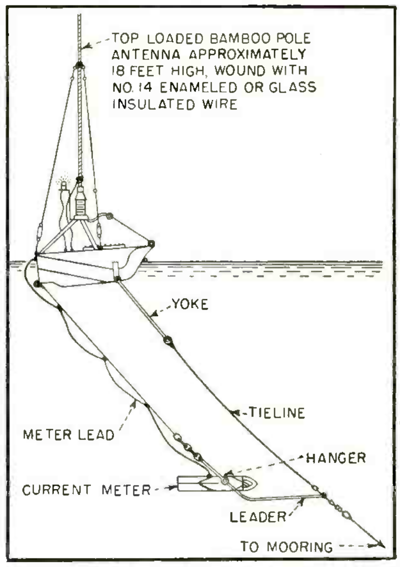

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Directional instrumentation comprises two sets of contact points, arranged for proper relationship to the vertical axis of a compass. One set is mounted on the compass for constant orientation to magnetic north. The other set is oriented in the direction imposed on the cylindrical housing by an ocean current. Comparative impulses or signals can be relayed to the transmitter by means of a revolving contactor.

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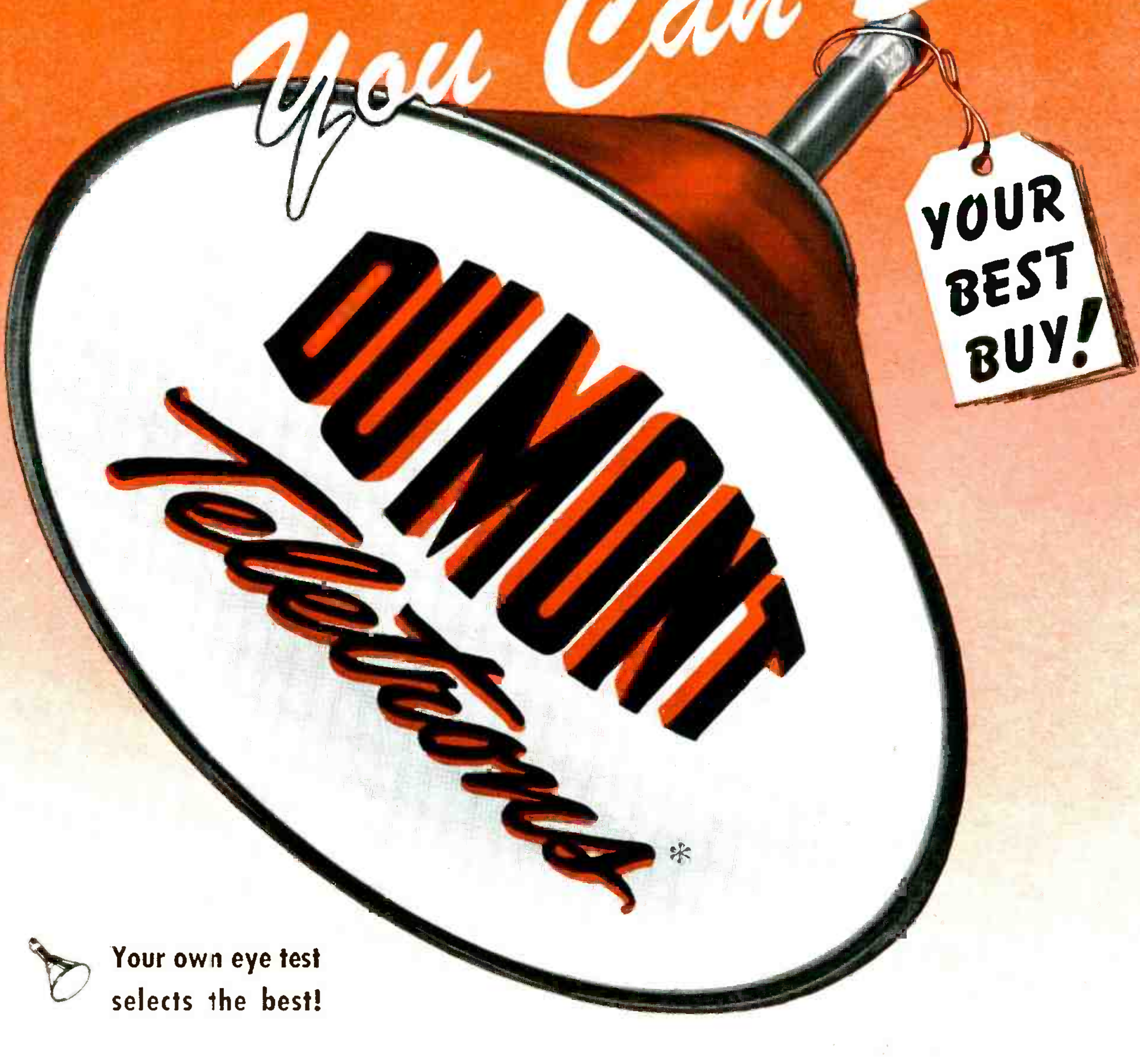

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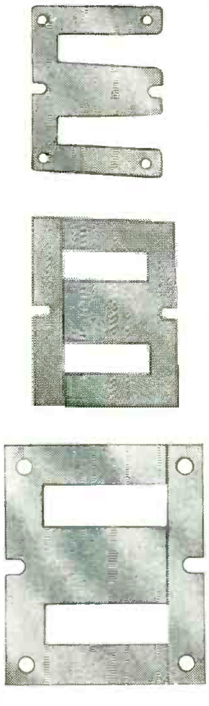

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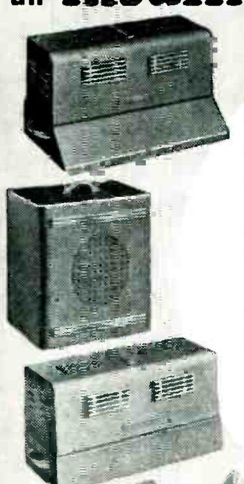

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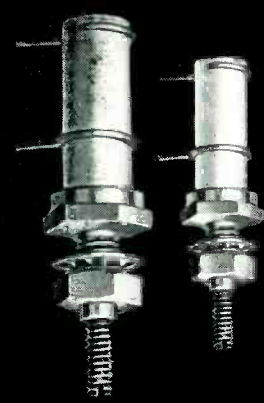

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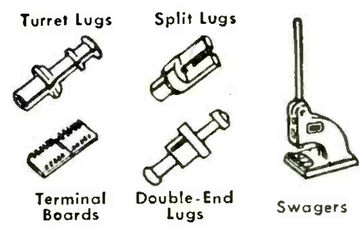

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chart at the receiving station.

Impeller bearings are carried by struts at the forward end of the subsurface cylinder, and motion is consequently provided for the revolving contactor by means of a magnetic drive. Differences in pressures within the cylinder are minimized by means of an aft expansion chamber.

Water-exposed parts of the subsurface cylinder are made from materials with low relative electrolytic potentials to reduce corrosion. Internal parts are protected with light petroleum oil seals.

The Transmitter

The transmitter circuit comprises a type 1T5 beam-power Pierce oscillator coupled to a 1Q5 beam-power amplifier by means of an untuned impedance, and the amplifier is coupled to the antenna by means of a simple pi-section network wherein coupling capacitors are the only variable elements (these being adjustable for operation in the 80-meter band frequencies). The antenna is a wire-wound bamboo pole, extending some 18 feet above the buoy.

Instantaneous value of transmitted radiations amounts to about 10 watts, which is sufficient for good reception for considerable distances over open water.

Signals are recorded at the receiving station by means of a receiver with a preselector stage, amplifier, chronograph, chronometer (with break circuit attachment to provide a time reference on the chronograph tape), and related accessories—including two independently-operated styli for the simultaneous recording of buoy signals and seconds of time.

When the flow of a current is in perfect alignment with magnetic north, directional signals are simultaneous and indistinguishable on the recording tape. However, velocities can still be computed in conformity with the time intervals between the overlapping signals.

In special circumstances, where transmitted signals were below the noise level and could not be clearly recorded, it has been found that the signals can be detected by ear (via earphones or a loudspeaker) and recorded by manually tripping the

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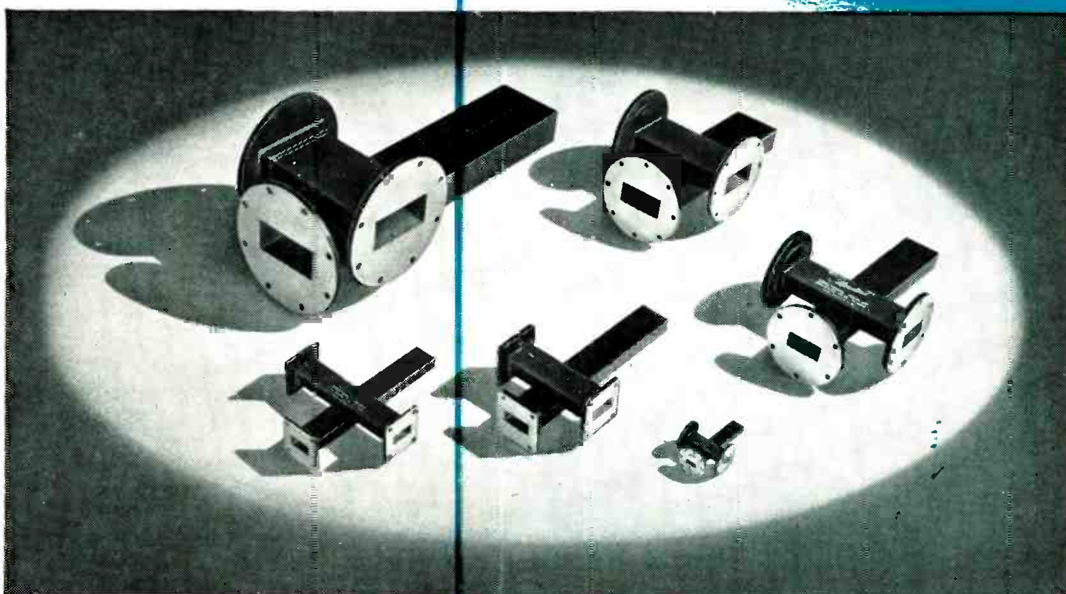

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233 321 322	4.0-6.0 4.0-6.0 4.0-6.0	24 30 40	RG-49/U	2x1x.064	UG-149A/U
209 237	5.3-8.1 5.3-8.1	24 30	RG-50/U	1½x¾x.064	UG-344/U
235 236 234	8.1-12.4 8.1-12.4 8.1-12.4	20 24 40	RG-52/U	1x½x.050	UG-39/U
388	12.4-17.0	20	RG-91/U	.702x.391x.040	UG-419/U
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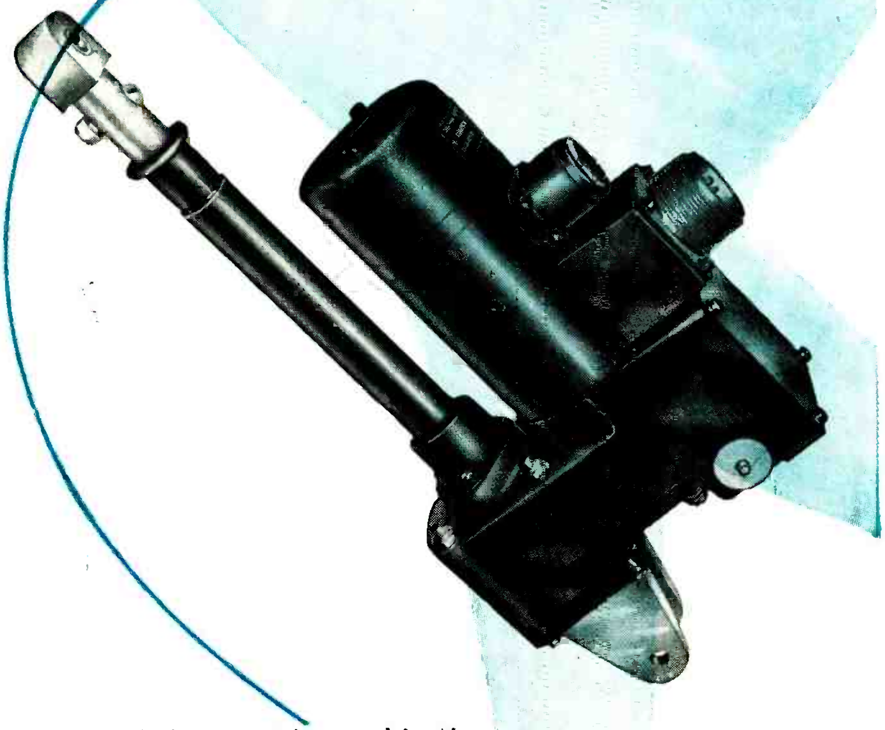

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stylus for buoy signals. Such manual records are not as accurate as fully-automatic recordings, but appear to be more than sufficient for the maintenance of safety in coastal navigation.

Horological Stroboscopes

By Ronald L. Ives
Department of Geography
Indiana University
Bloomington, Indiana

Repair of electric clocks and similar timing mechanisms by horologists, who are skilled in all mechanical phases of the work, has been inhibited by lack of a simple and inexpensive instrument for determining when the clock rotor is turning at synchronous speed.

Exact synchronism of rotor speed with line frequency is of prime importance for, assuming correct line frequency, an electric clock with its rotor making only 3,590 of the requisite 3,600 revolutions per minute loses four minutes per day, or about one hour each two weeks. This relatively minor slippage (10 rpm, or 1/360) can be detected most easily by stroboscopic methods, but the cost of a standard stroboscope is beyond the financial reach of most horologists.

Several horologists, working independently, have found that a small neon bulb (such as NE-30, 1 watt), painted so that the light from one electrode dominates the visual field, would function as a crude stroboscope[1], but the improvisation causes a great deal of eye strain, which is already a serious problem among workers with small mechanisms.

Needed, for solution of this specific problem, is a simple and inexpensive one-flash-per-cycle stroboscope which can be used and maintained by the average horologist.

Available for more than a decade is the basic circuit for such a device—the Germeshausen-Edgerton one-flash-per-circle circuit[2], using a 631-P1 Strobotron. This circuit, shown in Fig. 1, performs well under a variety of conditions.

A working model was constructed, with the rectifier and controls housed in a small utility case, and the Strobotron in a fiber tube, supported by a conventional labora-

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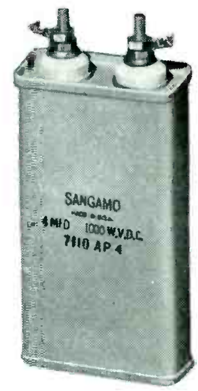

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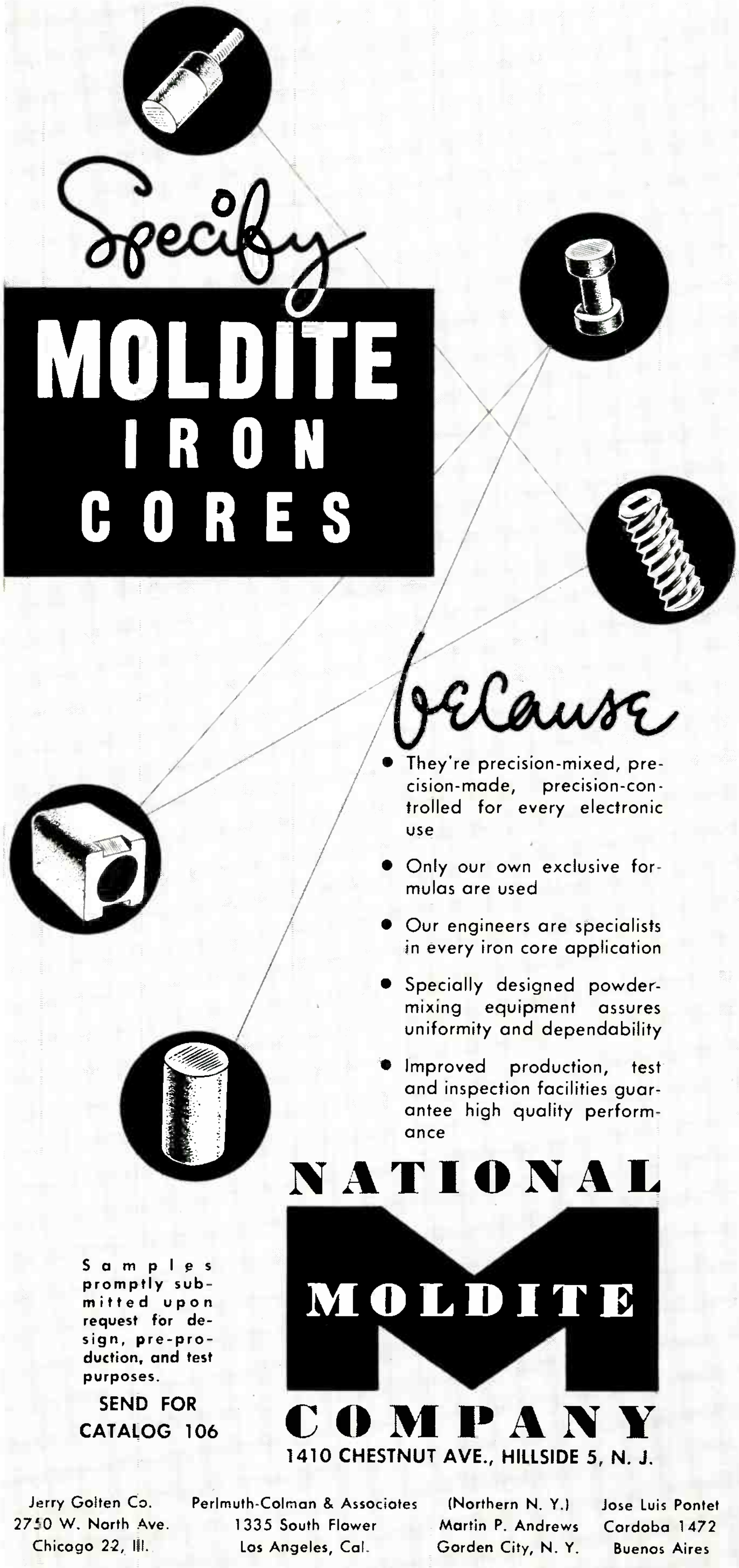

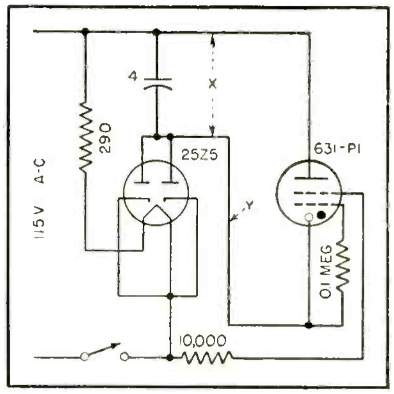

FIG. 1—Germeshausen-Edgerton one-flash-per-cycle circuit

tory stand. Power consumption is about 30 watts, component depreciation is estimated at one cent per hour, and first cost (retail) is about $20.00.

In-service tests of the unit showed that it supplies too much light for horological working distances, so that eye strain, headaches and bright green after-images result. In addition, the heat radiated by the control box, due to power dissipated in the 25Z5 filament and its dropping resistor, was found to be annoying. Reduction of the illumination was accomplished by insertion of a shunt resistor at *X* of Fig. 1 and later by a series resistor at *Y*. These resistors lowered the intensity of the ignition flash, and slowed the release of the energy stored in the capacitor.

When light intensity was reduced to about ⅓ that originally produced, the after-images disappeared, and much of the eye-strain was eliminated. Tests of illumination produced under optimum working values indicated that the Strobotron output was about equal to 2½ watts of ordinary neon illumination.

Neon Circuit

Experiments with several combinations of a rectifier and a neon bulb resulted in the circuit shown in Fig. 2, in which the intensity of the illumination can be varied by means of a series resistor, and its duration by means of a potentiometer across the line, taking advantage of the potential variations inherent in the supply cycle.

Tests showed that this is a nice

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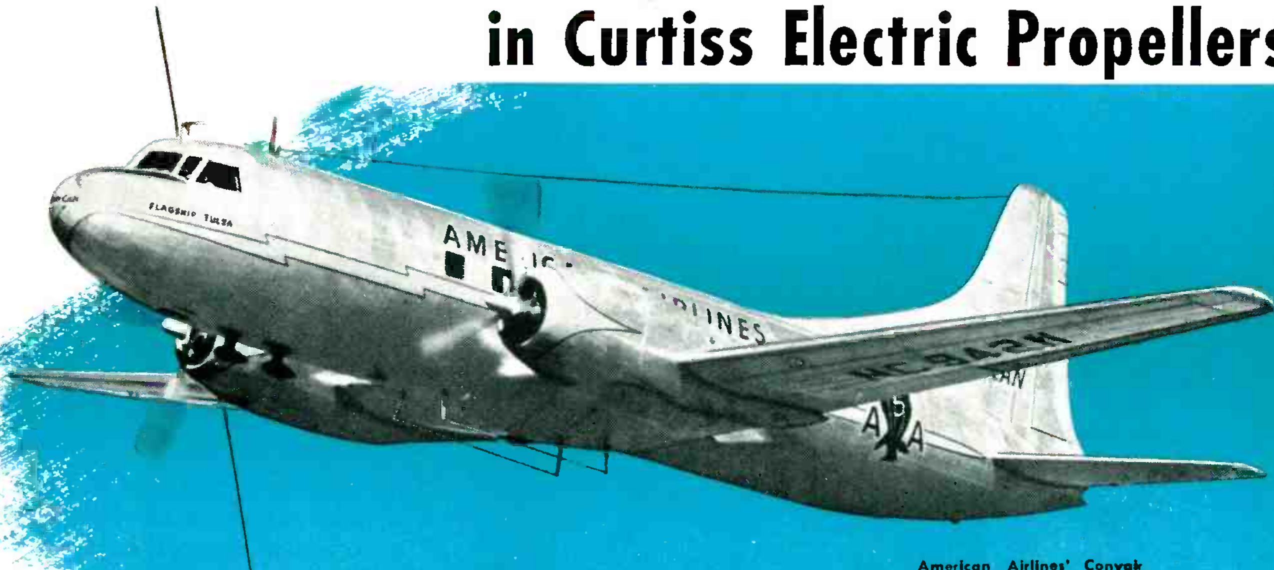

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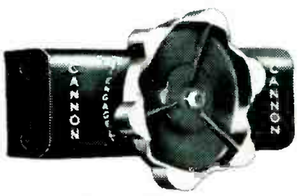

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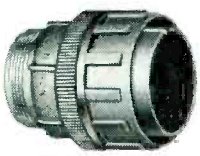

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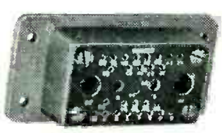

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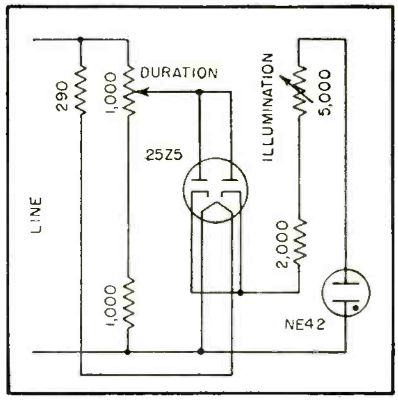

FIG. 2—Neon-tube stroboscope circuit with adjustable flash intensity and duration

laboratory instrument, ideal for classroom demonstrations, and that its optical qualities are satisfactory for testing electric clock motors for slip.

Chief objections to this neon-tube stroboscope are that it takes up about 100 square inches of bench space; that the controls require resetting; that it requires about 45 seconds to warm up for a 10-second test and that it contains about $20.00 worth of parts.

In-service tests also disclosed that as long as the duration of each individual flash was less than about 7.5 milliseconds, the rotor of an electric clock turning at synchronous speed appeared to stand still (desired appearance). Thus, it is possible to eliminate the duration control entirely, as the duration of the flash, with a reasonably sinusoidal wave form in the supply circuit, is only about 4.9 milliseconds, at 115 volts of 60-cycle a-c. Although this value will be changed by tube variations, line voltage fluctuations, and variations in wave form, the flash duration will remain below the critical value (about 7.5 milliseconds) under almost any circumstances likely to be encountered.

The circuit of the final one-flash-per-cycle neon tube stroboscope is shown in Fig. 3. Standard control components require only about three cubic inches of space, radiate a negligible amount of heat, and cost less than 5 dollars, including case and bulb.

Final Model

Because of the small bulk of this simplified stroboscope, it appeared reasonable and economical to put

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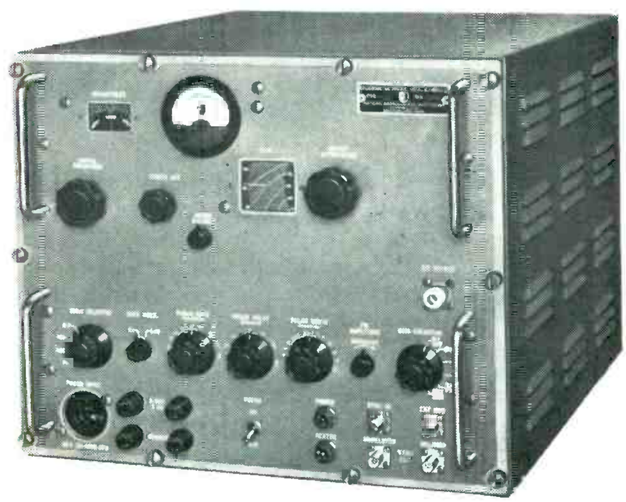

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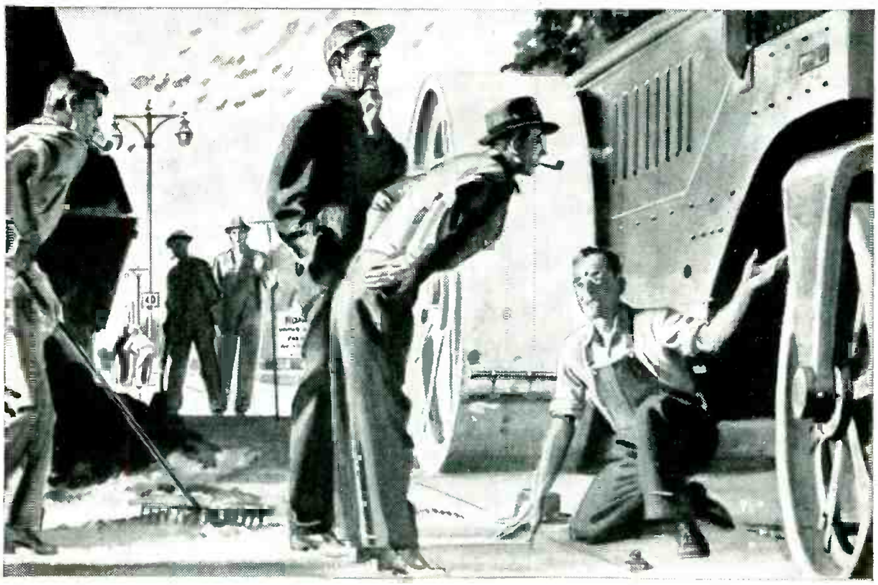

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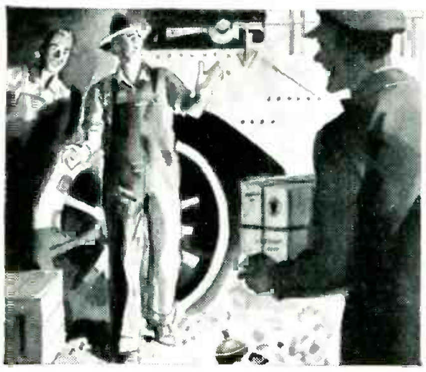

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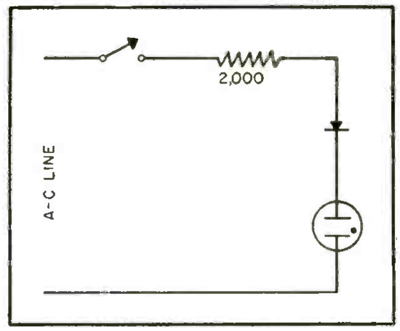


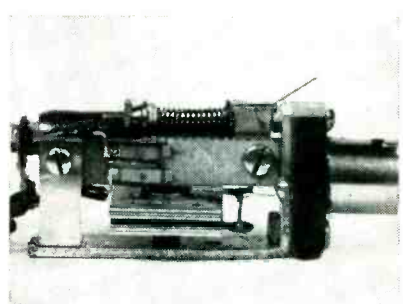
FIG. 3—Final circuit of simplified horological stroboscope

all components in a flashlight case. The original switch of the flashlight is used as the actuating lever of the internal switch. Use of the integral switch, without modification, is undesirable because of danger of shock.

All components are mounted on a metal bracket, which is firmly attached to the case by one screw. The reversed switch arm of the flashlight engages the switching mechanism of the instrument when assembled.

Bench tests of this simplified model show that it does the required job satisfactorily, conveniently, and cheaply. Power consumption is about 3 watts, depreciation is a small fraction of a cent an hour, and first cost, including construction time at $2.00 an hour, is less than $10.00.

Two minor difficulties were encountered. When a new bulb is inserted, the lower (inside) plate of the neon lamp is sometimes illuminated instead of the upper. This is corrected by taking the bulb out of the socket, rotating the base 180 degrees about the long axis, and replacing it. The second difficulty is bulb breakage due to screw-



In the final model, the reversed switch arm of the flashlight engages the switching mechanism of the instrument at arrow. Upper surface of socket base is flattened to clear switch arm

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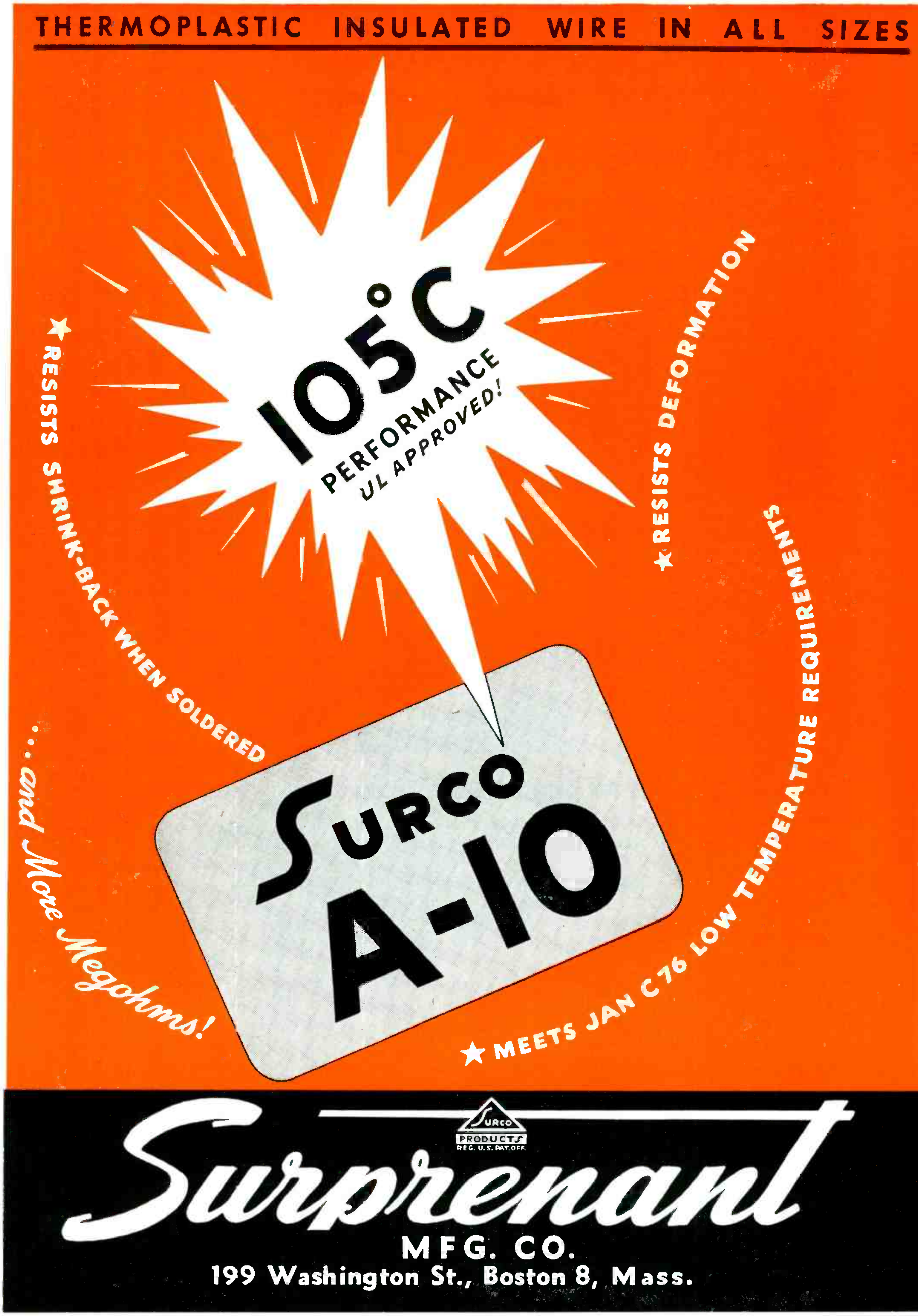
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ing down the lens retaining ring of the flashlight too tight. Surrounding the bulb with a cone of white blotting paper, which also serves as a reflector, eliminates this difficulty.

Although each instrument constructed offered a practical solution to the problem and all performed fairly well, there was an 8 to 1 variation in power need; a 4 to 1 variation in construction cost; and a 20 to 1 variation in bulk. Interestingly, the cheapest and smallest of the devices tried also performed the requisite task most satisfactorily.

REFERENCES

(1) J. E. Coleman, Clockwise and Otherwise, *Amer. Horologist and Jeweler*, p 89, Aug. 1949.

(2) E. J. Germeshausen and H. E. Edgerton, The Strobotron, ELECTRONICS, p 12, Feb. 1937; John Markus and Vin Zeluff, "Handbook of Industrial Electronic Circuits," McGraw-Hill Book Co., N. Y., 1948, p 215.

Prospecting Unit for Fluorescing Minerals

BY RONALD C. WALKER
Reading, England

MANY naturally occurring minerals show characteristic fluorescence to ultraviolet rays and a few of them exhibit phosphorescence. In most cases, the response is relatively high to long-wave ultraviolet of the 300 to 400 mμ range and feeble or nonexistent to the short-wave region below 300 mμ.

Fluorescence is known to be associated with crystal structure and is agreed to be due to the presence of minute quantities of heavy impurities such as silver, copper or manganese in the crystal lattice. In fact, the whole development of phosphors for cathode-ray tube screens has been associated with the study of activators and the enormous influence that small quantities of such substances exert on the screen characteristics. In most cases, fluorescence in mineral deposits is not universal in different samples of the same substance and appears only in those deposits which have crystallized in the presence of such activators.

Scheelite (calcium tungstate) and powellite (calcium molybdate) are apparently exceptions to the general behavior of mineral de-

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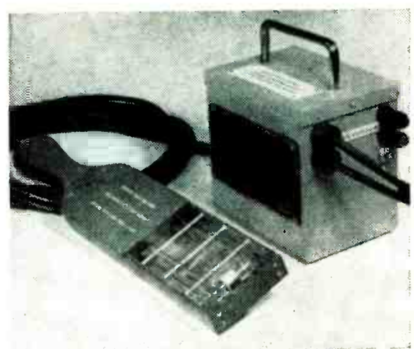
posits in that they show brilliant fluorescence in the short ultraviolet region and are invariable in this respect. Scheelite, in particular, exhibits the same blue fluorescence characteristic of synthetic calcium tungstate which, unlike so many of the synthetically prepared phosphors, requires no activator to cause fluorescence.

Tungsten and molybdenum are very valuable metals in industry, not so much for their intrinsic worth as their characteristic properties of high melting point, hardness and resistance to corrosion for which there are no adequate substitutes. As a result of their characteristic response to short ultraviolet radiation, the mercury-vapor lamp provides a reliable means of



Portable mercury-vapor discharge lamp and high-voltage power supply for examining rock faces for minerals

prospecting, particularly for scheelite which is not usually visibly distinguishable from the rocks in which it is found.

The prospecting outfit shown in the accompanying illustration incorporates a low-pressure cold-cathode mercury-vapor discharge lamp in a quartz bulb. This is fitted into a holder designed to facilitate the tube being held near vertical or horizontal rock faces, and a 15-foot high-voltage cable connects this holder to the converter, which in turn is cable-connected to a 12-volt battery as the power source.

The discharge lamp is U-shaped and requires a starting voltage of 700 with a steady running current of 35 ma at 350 volts. About 60 percent of the ultraviolet radiation is in the shortwave region around 2,537 A.

Although a good deal of visible

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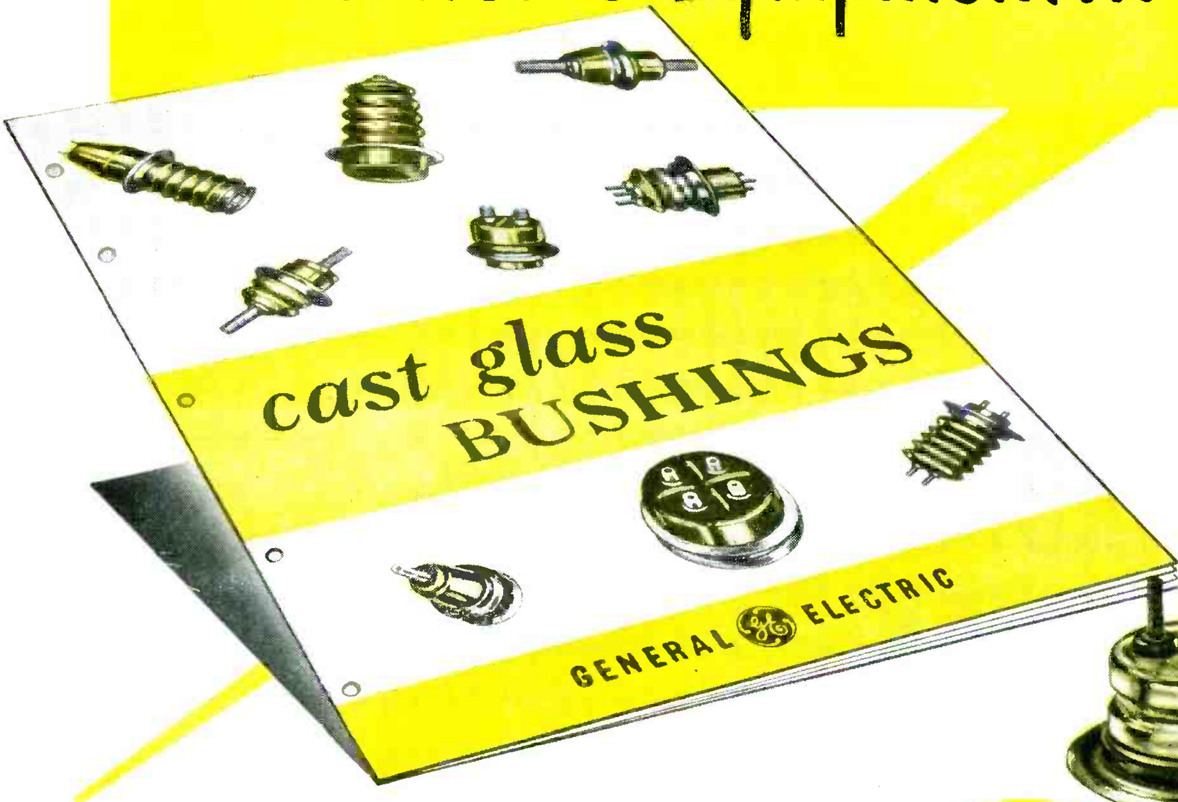

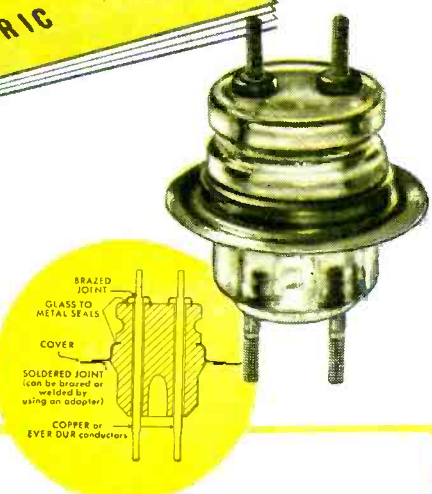

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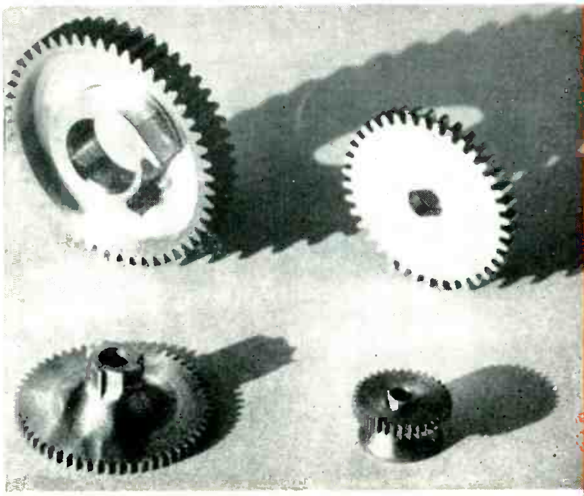

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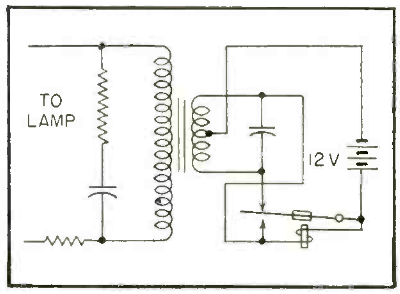

FIG. 1—Circuit of high-voltage power supply for the discharge tube

radiation is also present and can be removed by filters, no advantage is thereby secured, since there is practically no increase in contrast of the fluorescing mineral against its surroundings and some visible light is also an advantage in examining a rock face.

The circuit of the high-voltage converter is shown in Fig. 1. This is a vibrating-reed type. The high-voltage secondary is connected through a stabilizing resistance to the lamp. Spark and radio interference suppressors are included in the circuit. The total weight of the lamp and convertor is 15 pounds.

The operator must wear glass goggles with side shields since the quartz bulb of the lamp passes radiation dangerous to eyesight. It is only necessary to scrub the rock face thoroughly with water before starting an examination and the operator is soon able to judge from experience whether the fluorescence is that of a low grade ore or one of workable value suitable for a preliminary assay.

Another use for this prospecting unit is the detection of mercury ores. Mercury vapor absorbs ultraviolet radiation of 2,537 A region so that if a prepared willemite screen is excited to fluorescence by the lamp and a sample of the ore heated so that the vapor given off passes between the lamp and the screen, black shadows will be seen on the screen due to the absorption of the ultraviolet radiation by the mercury vapor.

The prospecting unit has also found some application in the examination of oil-bearing strata since crude petroleum is fluorescent to both long and short ultraviolet.

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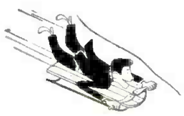

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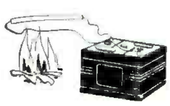

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THE ELECTRON ART

(continued from p 122)

the space lost in round wire coils (A in Fig. 1C). The relative conductor volume (RCV), defined as the ratio of volume of conductor to volume occupied, is for the printed conductor

$RCV = 1/(1 + k_t)\ (1 + k_w)$

where k_w is the ratio of gap g between turns to width w of conductor, and k_t is the ratio of half the thickness of wafer base s_w plus thickness of outer insulation s_i all divided by the conductor thickness t. RCV is plotted in Fig. 2.

For a No. 18 conductor, w and t may be 200 and 6.38 mils respectively, g 10 mils, and s 0.75 mils, so that RCV = 77.1 percent. For a No. 40 conductor, w and t may be 15.5 and 0.5 mils respectively, g 1.5 mils, and s 0.07 mils, so that RCV = 63.4 percent. Assuming a linear relationship for other wire sizes, this is plotted in Fig. 2 and compared to round wire.

The maximum internal voltage

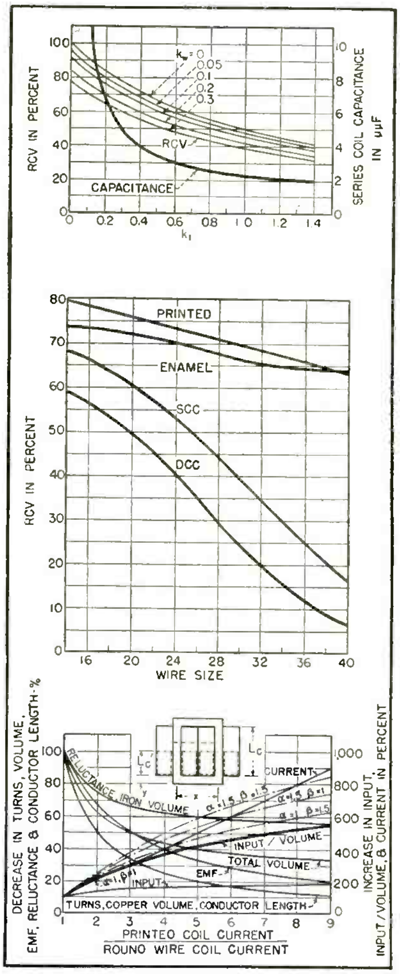

FIG. 2—Printed coil construction offers numerous advantages, as evidenced by these curves. RCV stands for Relative Conductor Volume

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between any two adjacent turns in a round wire coil compared to that in a printed coil of the same dimensions is very nearly $E_r/E_p = 1.13\sqrt{r}\,L_c/T$ where r is w/t, L_c is coil length, and T is coil thickness ($\frac{1}{2}$ difference of inner and outer diameters). The ratio L_c/T is rarely less than 1, and usually 3 or more; while r may be about 50. Thus, printed construction ordinarily results in over 20 times reduction in maximum internal potential, compared to a round wire coil of same size, same applied voltage, and same number of turns.

Properties

Thermal properties are improved by increased thermal conductivity due to elimination of space A, even distribution of thermal stress on conductor surface (compare dotted lines of Fig. 1C and 1D) and increased conductor area for a given cross-section, resulting in a cooler conductor surface.

Electrical properties are improved by even distribution of electrical stress, better current distribution, decreased eddy currents in conductor and decreased proximity effect. The combined thermal and electrical gain may be represented by an increase in current in the printed conductor. For equivalent coils of same conductor cross-section and ampere-turns, the printed coil would thus require less turns, and hence decreased coil length, iron and copper volumes, and emf, producing an increase in power input per unit volume. The latter, which determines miniaturization, turns out to be

$$\frac{P'/V'}{P/V} = \frac{(\alpha + 1)^2 (\beta + 1)\, p^2}{(\alpha + p)(\beta + \alpha\beta + \alpha + p)}$$

where P'/V' and P/V are printed and round wire input-to-volume ratios respectively, $\alpha = L_c/(x + y)$, β is ratio of copper to iron volume in round wire coil, and p is the ratio of current in printed coil to that in round wire coil. Miniaturization increases with p as shown in Fig. 2. If the advantages of the printed construction are assumed to be equivalent to double-cotton insulation, p would be 3, allowing a volume reduction of $\frac{1}{3}$, for $\alpha = \beta = 1$.

Capacitance of the printed coil is reduced in two ways: capacitance

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between spirals is in series, and turn-to-turn capacitance is decreased considerably by use of thin conductors and relatively large gap g. Assuming the conductor area on the surface of each wafer is the plate of a capacitor, total series capacitance in $\mu\mu$f becomes

$$C = \left[\frac{0.2244\ K_w\ K_o\ (1 + b)}{b\ K_w + K_o}\right] \left[\frac{A}{L_c}\right] \left[\frac{1 + k_t}{k_t}\right]$$

where K_w and K_o are the dielectric constants of wafer base and outer insulation coating respectively, $b = 2s_t/s_w$, A is the conductor area on the wafer in sq in., and L_c is coil length in inches. This is plotted in Fig. 2 against k_t for a coil having $A/L_c = 1$ in., $K_w = K_o = 5$, and $b = 0.6$.

The turn-to-turn capacitance, which is distributive, may be represented for the printed coil by

$$\frac{C_s'}{C_d'} = r\left[\frac{g}{s_w}\right]\left[\frac{b K_w + K_o}{2\ b\ K_g}\right]$$

where C_s' is total spiral-to-spiral (series) capacitance per unit conductor length, C_d' is total turn-to-turn capacitance per unit conductor length, and K_g is the dielectric constant in gap g. For a round wire coil C_s/C_d is of the order of unity. The comparison of turn-to-turn capacitance of round wire to printed conductor is then

$$\frac{C_d}{C_d'} = \frac{(C_s + C_d)\ (C_s'/C_d' + 1)}{(C_s' + C_d')\ (C_s/C_d + 1)}$$

The ratio $(C_s + C_d)/(C_s' + C_d')$ is approximately 0.1 for equal cross-sections and equivalent insulations. For $r = 50$, $g/s_w = 5$, $b = 0.6$, $K_w = K_o = K_g$, the turn-to-turn capacitance is approximately 250 times less in a printed coil compared to an equivalent round wire coil of the same size and conductor cross-section.

Disadvantage

An inherent disadvantage in the proposed construction is the large number of contacts in series. Methods for reducing this contact resistance include longitudinal pressure along the axis of contact, large contact area, plating contacts with silver, and permanently fusing contacts with suitable binder by r-f heating or equivalent tech-

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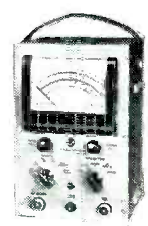
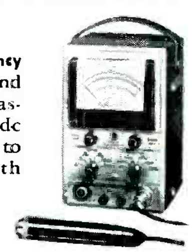
The WV-95A, 195A, and WV-75A can be used with the WG-289 accessory high-voltage probe to measure up to 50,000 dc volts.



The Standard VoltOhmyst . . . the workhorse of electronic meters. The RCA Type 195A measures ac and dc voltages to 1000 volts, resistance to 1000 megohms, in six ranges. Reads db at all audio frequencies. Has zero-center scale for discriminator alignment. Its 10-megohm dc input resistance provides accurate measurements in high-impedance circuits. WG-263 accessory crystal probe permits rf voltage measurements to 100 Mc.



The Advanced VoltOhmyst . . . for all high-frequency measurements. The WV-75A is ideal for TV and HF measurements. Reads flat to 250 Mc. Measures peak-to-peak voltages. Measures ac and dc potentials to 1000 volts. Resistance readings to 1000 megohms. Supplied complete with WG-275 diode probe.

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RADIO CORPORATION of AMERICA

TEST EQUIPMENT **HARRISON, N. J.**

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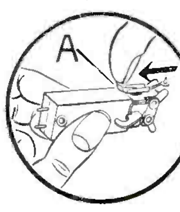
Perfection

FROM A TINY PERFORMER

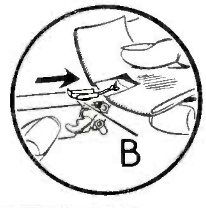
That's what you'll say when you try the new Astatic "AC" Crystal Cartridge—perfection of performance entirely unrelated to its tiny size. Weighs only five grams, is approximately 15/16" thick, 1/2" high and 1-1/2" long, not including pins. Yet, frequency response, particularly in the high frequencies, is amazingly excellent. A new low measure of inertia of the mechanical drive system is chiefly responsible for full wide range response and excellent tracking characteristics. Also assures low needle talk and long life for needle and records.

The "AC" employs Astatic's exclusive Taper-Lock Needle, easily changeable without tools. Molded Bakelite housing, with metal mounting brackets (fit standard 1/2" mounting) and needle guards. Available in four models: AC-78 with 3-mil stylus tip, precious metal or sapphire; AC, with 1-mil stylus tip, precious metal or sapphire; AC-AG with new Astatic "ALL-GROOVE" stylus; ACD turnover type, with both 1 and 3-mil point needles. Write for complete details.



Changing the Taper-Lock Needle

Placing thumbnail against stub at rear of needle (A), simply push in direction of arrow to remove. To insert, fold card, on which new needle comes, along scored line; place narrow end of needle shank in wide end of metal cartridge groove (B) and pull card in direction of arrow.



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nique. For most electronic applications this contact resistance is secondary. Other advantages include ease in providing taps, repairability, flexibility in adding and balancing secondaries, adaptability to mass production, and the possibility of using superior insulations unsuitable for wire.

REFERENCES

(1) National Bureau of Standards, *"Printed Circuit Techniques,"* Circular 468.

(2) National Bureau of Standards, *"New Advances in Printed Circuits,"* Miscellaneous Publ. M192.

Intra-Ocular Tachistoscope

By LELAND L. ANTES
Bureau of Engineering Research
The University of Texas
and
B. H. DEATHERAGE
Department of Psychology
The University of Texas
Austin, Texas

PROBLEMS have arisen in psychology for which answers cannot be derived using commercially available tachistoscopes. The commercial tachistoscope is designed to present a single image for a very brief period of time, or two or three images successively, either monocularly or binocularly. An instrument was needed which would furnish inter-ocular stimuli and continued stimulation to the eyes.

In the model built for the Department of Psychology at the Univer-

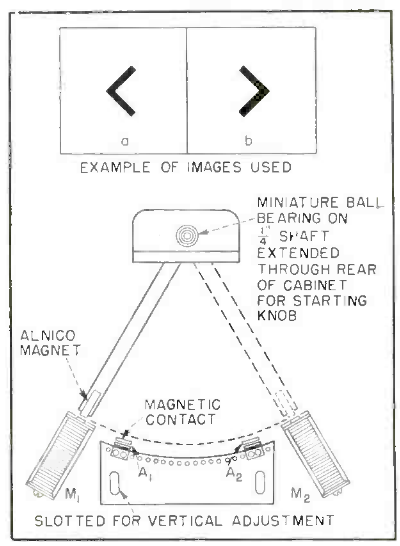

FIG. 1—Method of flashing two blue fluorescent lamps alternately to give square-wave light output, adjustable durations and flashing rates that can be adjusted by varying air gaps of armatures A_1 and A_2 and their positions along arc of pendulum

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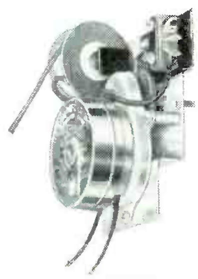

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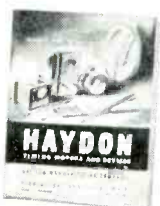

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sity of Texas, the presentation of the images continues, one image after another, for as long as desired. It will present two images, *a* and *b*, alternately to the two eyes; *a* to the left eye only, *b* to the right eye only, in the sequence *ababab* . . . for as long as desired. A pair of prisms, of six prism diopters power, serves to resolve the separate images into a single visual image in a single visual field, much as a stereoscope does. The timing of presentations may be changed rapidly and continuously from succession through optimal movement to simultaneity.

The images are made visible by consecutive square-wave flashes of illumination on the backs of two 3-inch square opal glass windows. The timing of the two flashes and the interval between them is necessarily adjustable, each flash being on the order of 0.010 second and the interval between flashes being roughly 0.060 second for optimum psychological results. Two consecutive flashes may constitute a complete operation. The order of the flashes can be reversed and the operations can be controlled remotely by means of pushbuttons. For other purposes continuous repetition of pulses can be had.

Lamps

Chief requirements for a light source are square-wave output and an economical power supply, using standard radio components. The 15-watt T-8 blue fluorescent lamp proved highly satisfactory. It has a very high flicker factor and low persistence of its cadmium sulfate phosphor. With d-c voltage applied and with one cathode heated, this

Completed tachistoscope. Fluorescent lamps are behind opal glass screens, with half of each lamp blacked out so each screen is illuminated by only one lamp. In use, hood with prisms and two eyepieces is usually attached to hinges over screens to resolve separate images into single visual image

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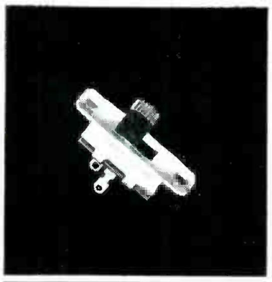
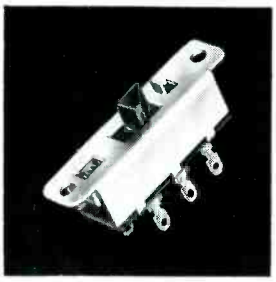
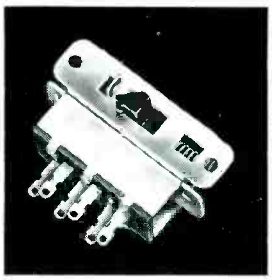
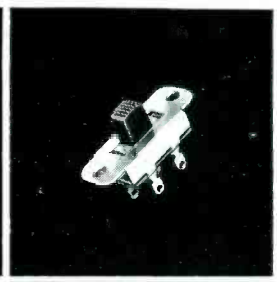
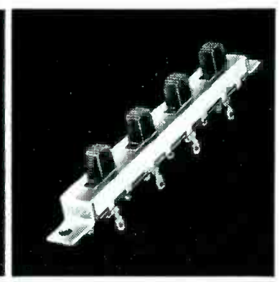
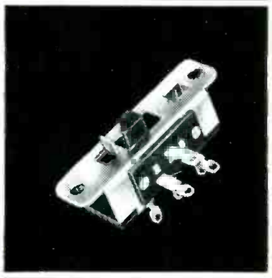
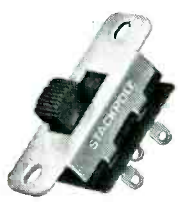








SS-26 Single-pole, single-throw



SS-26-1 Single-pole, double-throw

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Two slide sw tches rated 1 ampere at 125 volts DC 3 amperes at 125 volts AC

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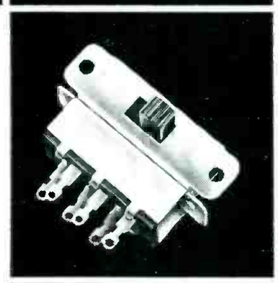
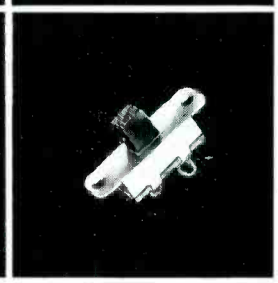

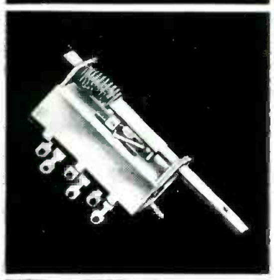

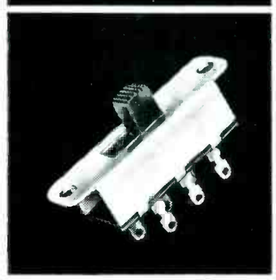
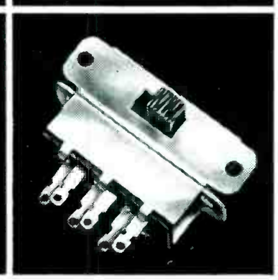

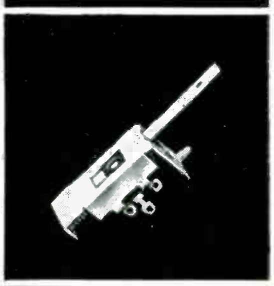
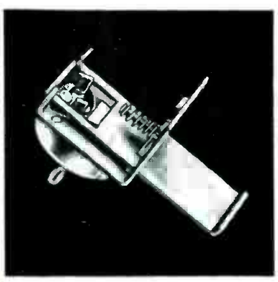
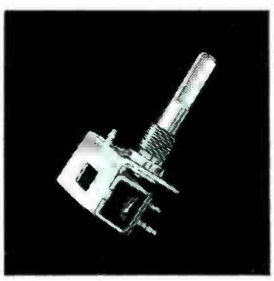
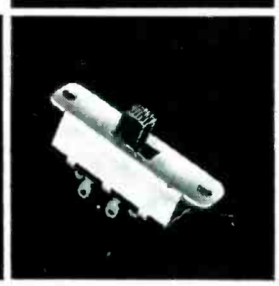
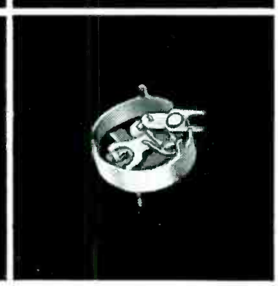

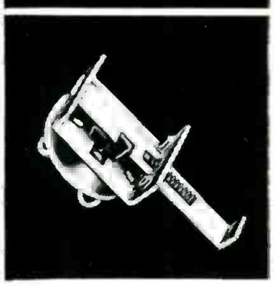

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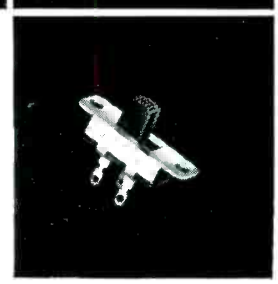

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lamp will start with a voltage of 400 to 450 at ordinary temperatures, but more than this should be applied for reliable operation. Sufficient series ballast resistance must be provided to limit the current to the desired value. Normal operating current is 254 ma, but considerably larger or smaller currents may be utilized when efficiency and lamp life are not important factors.

Vacuum tubes switch the fluorescent lamps on and off without having to break the lamp current directly. When connected in series with the lamps the 6L6 tubes give perfect control with 700 to 750 volts in the plate circuit and a grid voltage ranging from 0 to −150 volts.

Timer

Since only off-and-on control is desired, a mechanical means of grounding the grids, as shown in Fig. 1, is all that is required. The one-cycle timer is a pendulum which carries a small permanent magnet at its extremity. Electromagnet coils M_1 and M_2, mounted as in Fig. 2, maintain the swinging. The coils are connected in series with a 25,000-ohm bleeder resistance across the power supply, and are normally energized to hold the pendulum in either extreme position of its swing. Pressing control button L will short-circuit M_1 and allow the pendulum to swing across to M_2. Holding L closed during this operation

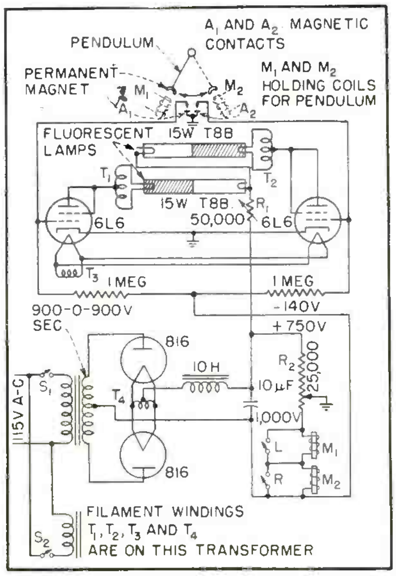
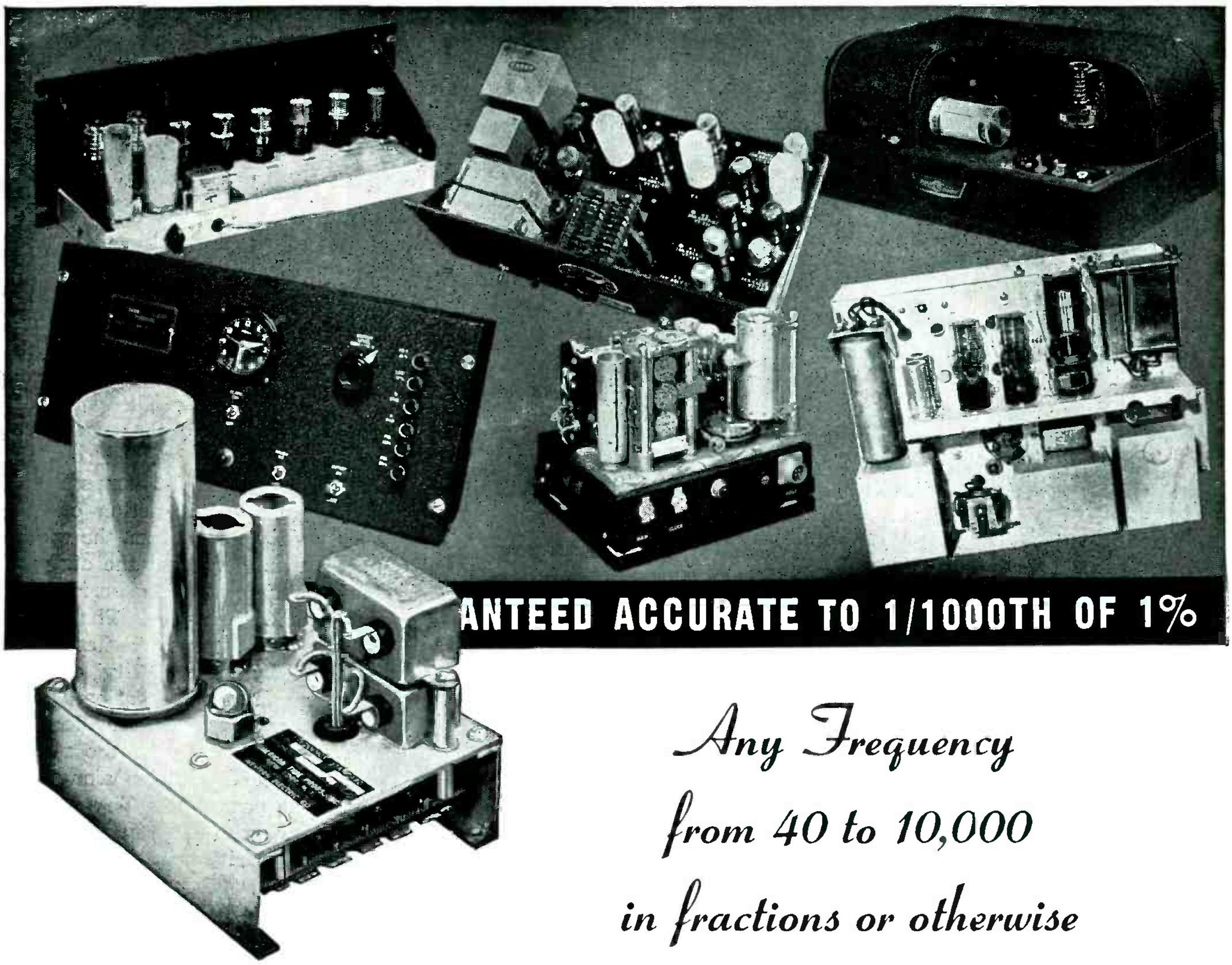


FIG. 2—Magnetically controlled pendulum used as mechanical timer in intraocular tachistoscope developed for psychological tests



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allows above-normal current to flow in M_2, giving double assurance that the pendulum will be held at the end of its swing by M_2.

Adjustments

In swinging from M_1 to M_2, the permanent magnet on the end of the pendulum passes successively above silicon steel armatures A_1 and A_2. As these armatures rise momentarily, contacts are closed which ground the grids of the control tubes in succession. The length of time during which the grids are grounded is the period during which the fluorescent lamps flash. This period is a function of the velocity of the pendulum, the width of the armatures, and the air gap distance between the permanent magnet and armatures. The interval between successive flashes is determined by the velocity of the pendulum and the separation of the armatures. Means are provided for varying the air gap of the armatures and their position along the arc of the pendulum. The magnitude of swing of the pendulum, and hence its velocity behavior, is fixed.

Circuit Details

Window illumination is varied by R_1 in series with the lamps. The cathodes of the fluorescent lamps are heated by individual 7.5-volt filament transformers. Switch S_2 should be closed first, to allow the tube cathodes to heat before the high voltage is applied by closing S_1.

Any set of external contacts actuated by the most minute stimulating forces may be caused to operate the flasher, since the control grid current of the switching tubes is almost negligible. Several types of electron tube control and amplifying circuits will suggest themselves as alternate means of controlling the flasher.

Single-Frame TV Photography

By Maurice Distel and Alan Gross

Signal Corps Engineering Laboratories Fort Monmouth, New Jersey

In endeavoring to record a remotely situated, random, short-duration visual phenomenon, an experimental closed-circuit television system was arranged to transmit

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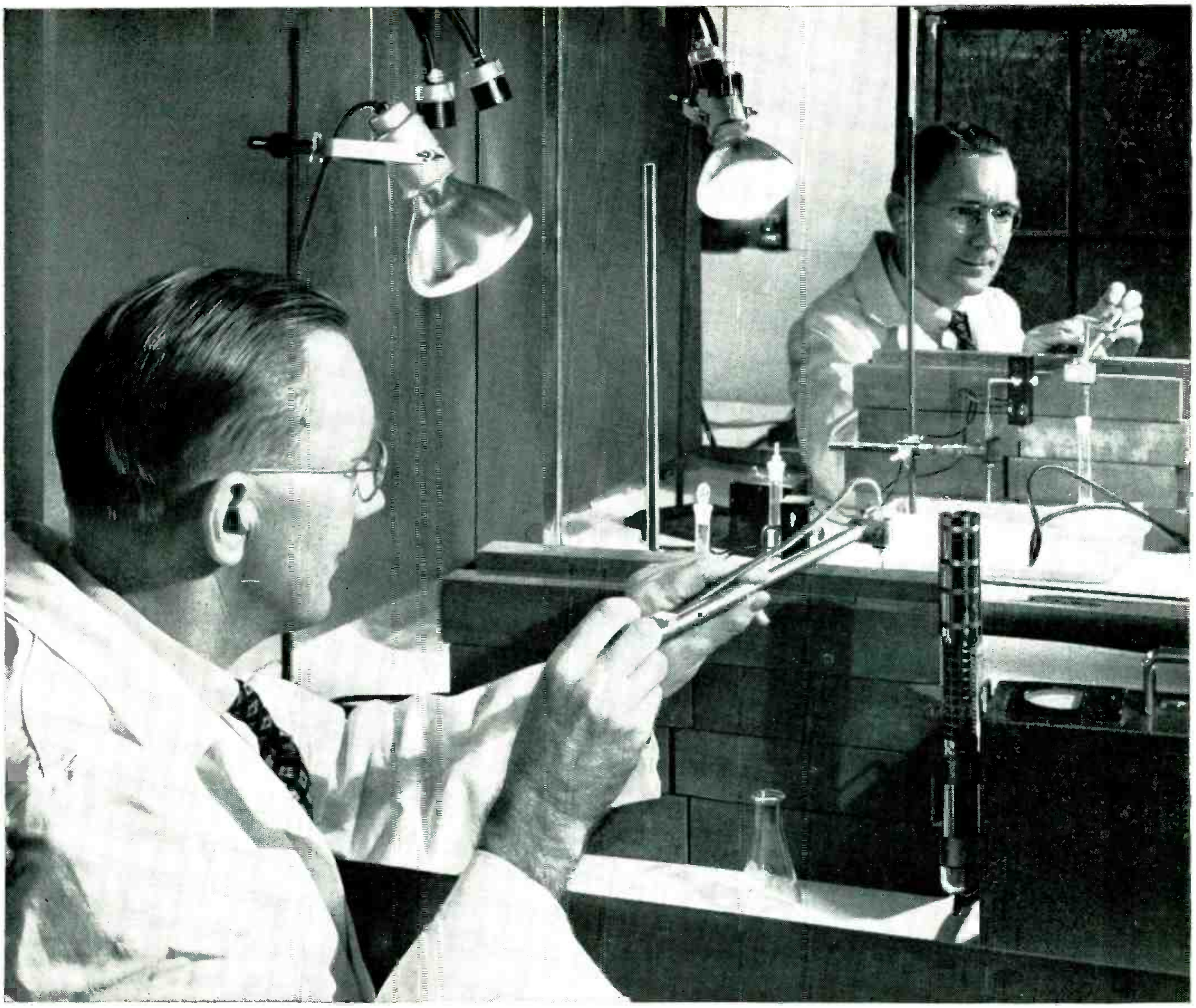

IT'S DONE WITH MIRRORS!

Protected by a wall of lead bricks and using a mirror to guide his instruments, this Bell Laboratories scientist is preparing a solution of a radioactive isotope, for use as a tracer to study materials for your telephone system.

Bombardment by neutrons turns some atoms of many chemical elements into their "radioactive isotopes"; these are unstable and give off radiation which can be detected by a Geiger counter. Chemically a "radioactive isotope" behaves exactly like the original element. Mix the two in a solution or an alloy and they will stay together; when the Geiger counter shows up an isotope, its inactive brother will be there too. Minute amounts beyond the reach of ordinary chemical methods can be detected — often as little as one part in a billion.

The method is used to study the effect of composition on the performance of newly developed germanium transistors — tiny amplifiers which may one day perform many functions which now require vacuum tubes.

It enables Bell scientists to observe the behavior of microscopic impurities which affect the emission of electrons from vacuum tube cathodes. It is of great help in observing wear on relay contacts. And it may develop into a useful tool for measuring the distribution and penetration of preservatives in wood.

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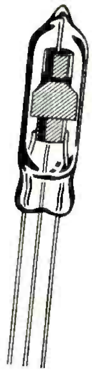
Introducing

THE NEW No. 5841
Subminiature
CORONA REGULATOR

★



CHARACTERISTICS

D.C. Starting Voltage.........(max.)	930 Volts
D.C. Regulating Voltage.............	900 ±15 Volts
Regulated Current Range............	2-50 μa
Voltage Regulation (2-50 μa)...(max.)	1.5%
Life.......................(min.)	1000 hrs.

RATINGS

Regulator Current...........................(max.)	50 μa
Relative Humidity...........................(max.)	100%
Ambient Temperatures............................	-65°C to 100°C.

The 5841 sub-miniature corona regulator now in production is another Victoreen component developed to make fine instrumentation finer. This regulator supplements other specially designed electron tubes required in radiation measurement and in the broader field of laboratory instruments.

...subminiature
ELECTRON TUBES

Tube Type	Typical Service	Volts Ec_1	Volts Ec_2	Volts Eb	μa Ib	μ	μmhos Gm	Grid current Signal grid
*5800	** Electrometer Tetrode	+3.4	***-3	+4.5	12	1	15	3×10^{-15}
*5803	Electrometer & D.C. Amp.	-1.7	----	+7.5	100	2.0	150	10^{-14}
*5828	D.C. Amp.	-1.0	----	45	250	17.5	450	10^{-9}

— — — and a complete line of counter tubes including the universally used 1B85, the 1B67 end window mica window tube, gamma ray counters, and sub-miniature counter tubes — — — not forgetting Victoreen hi-meg resistors vacuum sealed in glass, values 100—10,000,000 megohms.

Write for data sheets

THE VICTOREEN INSTRUMENT CO.
5806 HOUGH AVENUE CLEVELAND, OHIO

the scene to the picture tube where it could be photographically recorded. Since the time of occurrence of the event was not predictable, an electronic triggering scheme was tried which would enable the film camera to monitor the screen continuously. The camera shutter was opened and the screen maintained dark except when triggered to brightness by the event itself, thus capturing the image on film. The alternative to this, of course, would be the obviously less economical method of operating a motion picture camera continuously in anticipation of the event.

Trigger System

The effectiveness of the electronic triggering scheme depended upon a number of things. The camera and television receiver had to be in a light-tight enclosure to prevent fogging of the exposed film. Triggering the kinescope picture on and off had to be accomplished by sequential application of the proper bias voltages to the kinescope control grid. In trial, a single-shot multivibrator, triggered by the event by means of an auxiliary photocell in the television camera, generated a square pulse of duration equal to the average television frame period. This pulse was used to gate the cathode-ray beam.

It was found that the vertical oscillator of the 40-frame-per-second television scanning system would, over a period of days and under changing temperature conditions, vary approximately within one cycle per second about a frequency in the range 39 to 46 cycles per second. Rather than modify the television synchronization generator system to remedy this difficulty, it was decided to control the timing circuit which gates the kinescope cathode-ray beam. It

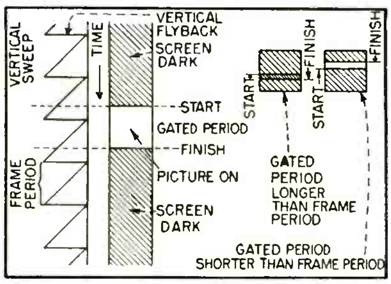


FIG. 1—Samples of banding occurring in single-frame television photography

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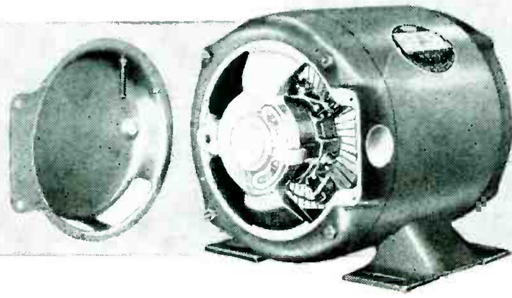
Brown-Brockmeyer solves tough insulating problem

with

ROGERS DUROID PART



Rogers ability to fabricate this complex component in one piece saved the customer the problem of redesigning the part and complicating assembly with five individual pieces of insulation.

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The problem was to find a material with the required electrical and physical characteristics and a fabricator capable of forming and shaping the part to design requirements. Rogers filled the bill on both counts. DUROID, a new Rogers material similar in electrical properties to vulcanized fibre, made the part possible. It could be drawn to the required depth — a virtual impossibility with any other fibrous sheet material. Our Fabricating Division's skill and experience met the challenge of producing this intricate piece with economy and speed.

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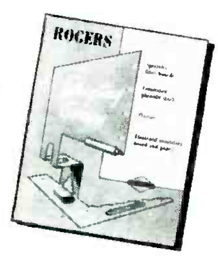

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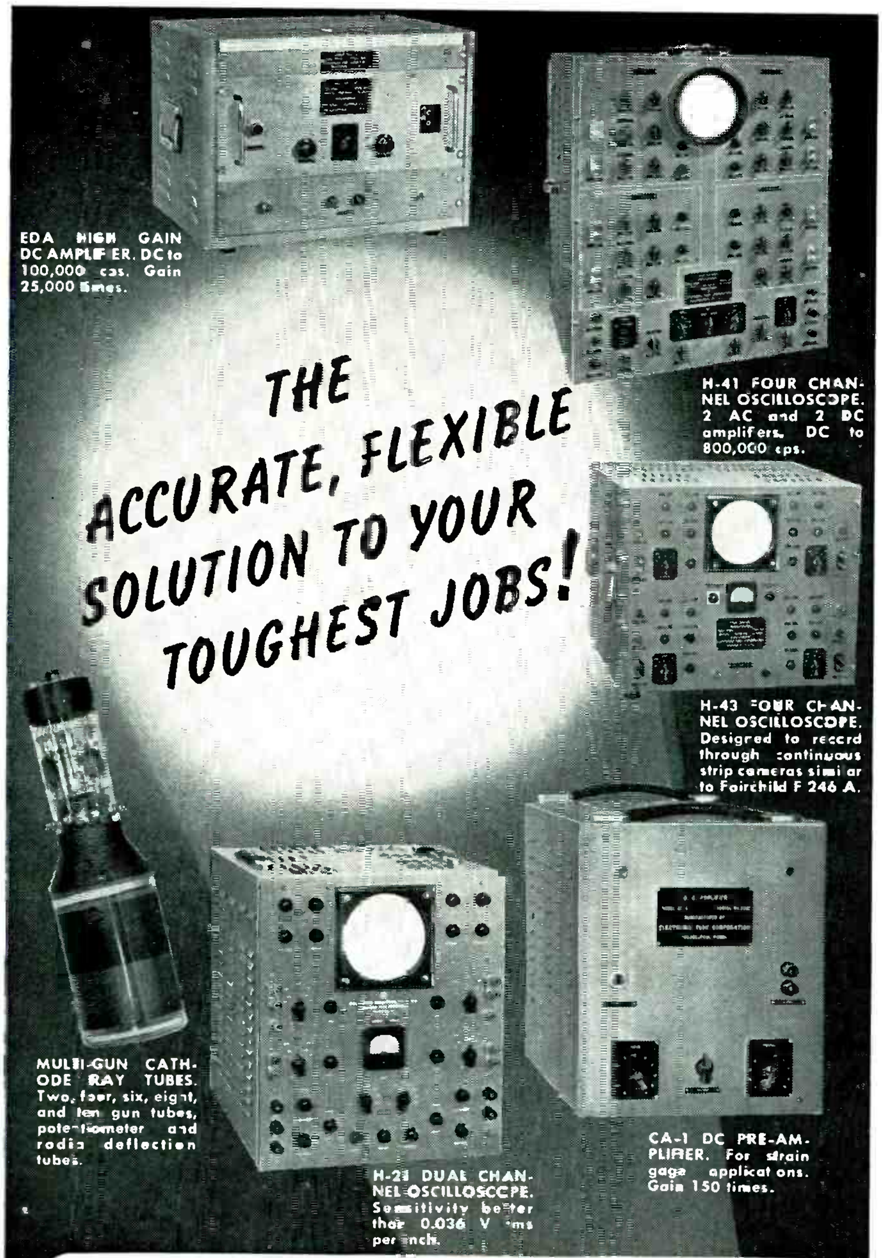

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All scopes illustrated employ five inch flat-face tubes.

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was necessary to find some solution since, within a few hours after adjustment, the photographs taken would invariably cover slightly more or slightly less than the single frame required, resulting in undesirable banding as illustrated in Fig. 1. To overcome this defect in the photograph it is necessary that the on period of the picture, initiated at any time during a given frame, extend to exactly the equivalent point in the succeeding frame.

Circuit Details

The circuit, which was evolved from various designs and selected as the simplest satisfactory solution, comprises a single-shot multivibrator whose pulse width is a function of grid bias, and an analog counter circuit whose output voltage is proportional to the input frequency, in this case the television frame frequency. Figure 2 shows a block diagram of the system.

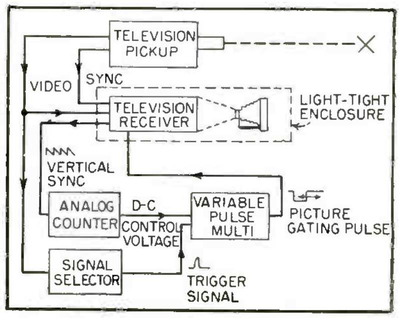

FIG. 2—System for gating one frame of a television receiver whose vertical scanning frequency is not constant

The television pickup feeds both video and sync signals to the receiver. The signal selector is used to derive a trigger pip from the event which is fed to the variable-pulse multivibrator where it initiates the picture gating pulse. The analog counter is the control circuit for the multivibrator, and makes the multivibrator pulse vary in width to compensate for the drift of the frame frequency of the television system.

Figure 3 shows the complete schematic of the multivibrator and counter. To the counter circuit is fed a portion of the output of the vertical oscillator. The counter produces a voltage proportional to the frequency of the vertical oscillator. A negative counter was used in this

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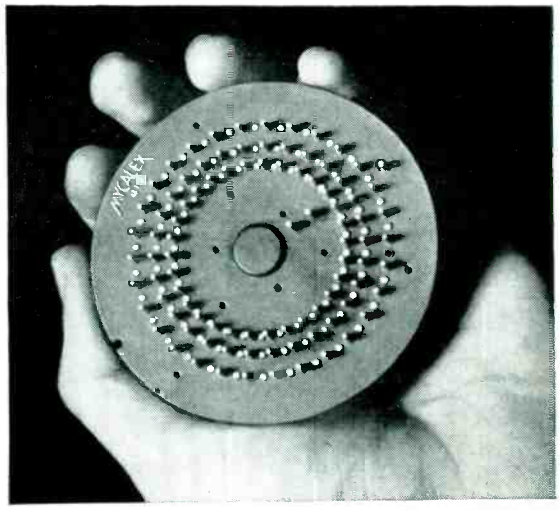

Illustrated are top and bottom views of the MYCALEX 410 molded insulation commutators manufactured to the specifications of Raymond Rosen Engineering Products, Inc., for Air Material Command, Navy telemetering projects, and other government agencies. These commutators are precision injection molded with 108 or 180 contacts and 3 slip rings all of coin silver.

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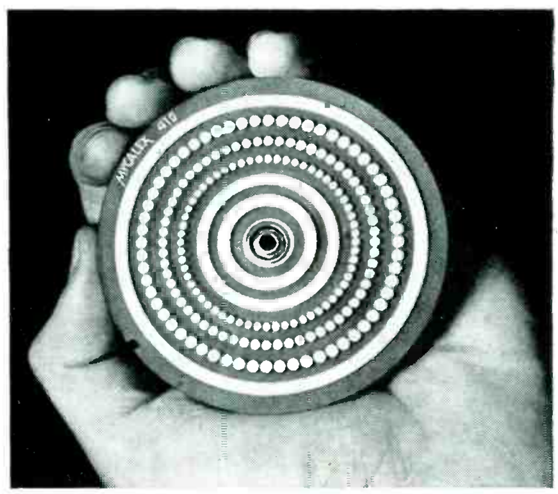
O.D. 2.996″ + .000 − .002 • Location of 3 slip rings and the 3 contact arrays from the center has a total tolerance of ± .001. • Contact spacing 6° apart ± 1 minute. • Parting line thicknesses on insulation body are + .002 − .000. • Concentricity between ball bearing bushing and O.D. .0015. • Assembly height from face of slip rings and contacts to Mycalex 410 has tolerance of + .002 − .000. • Every contact must be tested from its neighbor contact for infinity on a 500 volt megger • Plate ambient − 20° C. to + 100° C. • Plate to operate at 95% humidity must not warp, crack, change in dielectric constant or resistivity • Contacts to resist high temperatures and must not loosen when repeatedly heated by soldering • Soldering required to withstand and operate under a 50 G acceleration.



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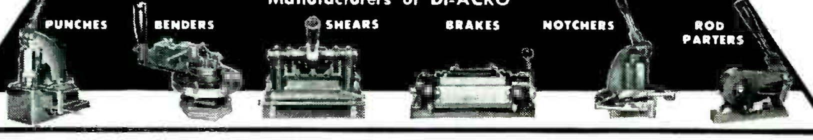

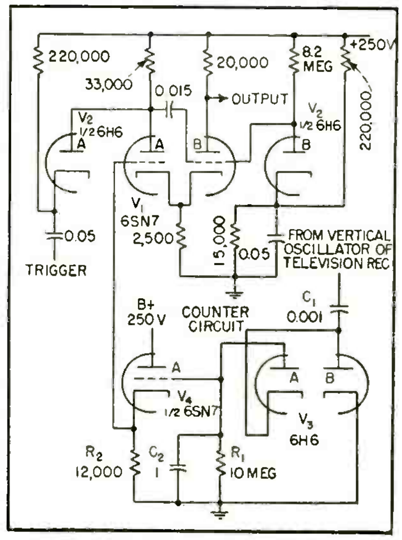

FIG. 3—Vertical scanning frequency variation from 39 to 46 cps will give a voltage change of −2.5 volts for controlling gating time

case so that an increase in frequency causes a drop in average plate current of V_4. Thus the output voltage drops with an increase in frequency. For the type of controllable multivibrator selected, this effect was necessary so that the pulse width would decrease with an increase in frequency. For cases where an increase in frequency must give a wider output pulse, a positive counter circuit may be used.

Counter Design

In the design of the counter circuit, whether positive or negative, the time constant $R_1C_2 \gg 1/f$ where f is the frequency to be measured, and $C_2 \gg C_1$ with C_1 being kept very small.

The d-c output voltage of the counter is equal to:

$$\frac{E_a f R_1C_1}{1 + f R_1C_1}\left(1 - \frac{1}{2 f R_1C_2}\right)$$

where E_a is the peak applied voltage and f the frequency, and R_1,C_1 and C_2 are as shown in the schematic of Fig. 3.

For the values shown in Fig. 3 a variation from 39 cycles per second to 46 cps will give a voltage change of 2.5 volts.

The multivibrator was so designed that for a change of −2.5 volts on the control grid the output pulse of the multivibrator decreases from 25,380 microseconds to 21,300 microseconds. This compares fairly well with the requirement of 25,640 microseconds for 39 cps, and 21,740

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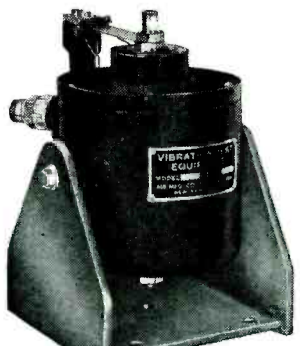

MODEL SA VIBRATION EXCITER Delivers 5 pounds force from 20 to 1,000 c.p.s., usable to 20,000 c.p.s.

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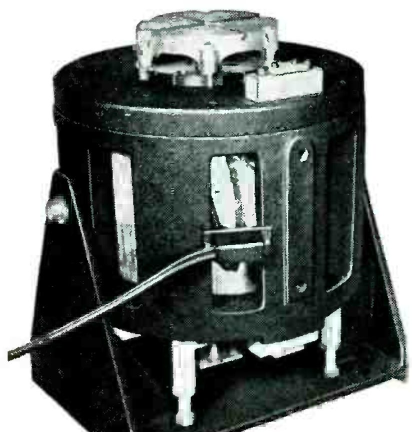
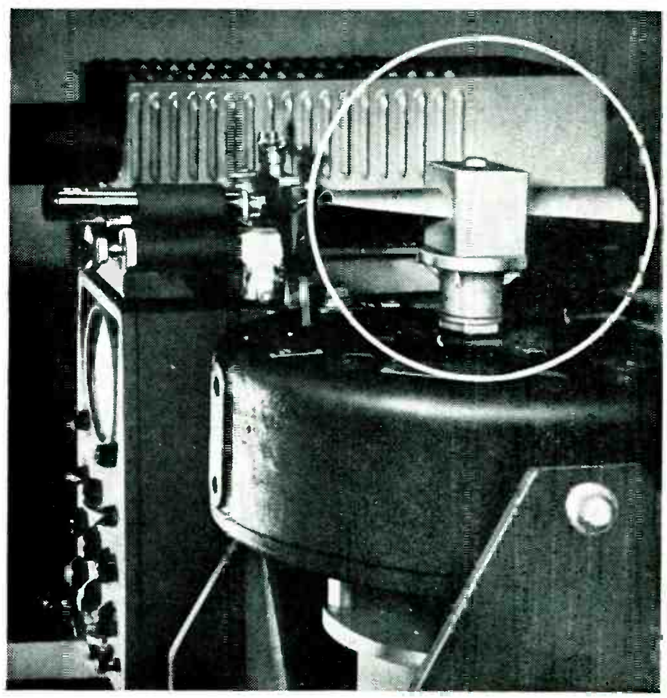
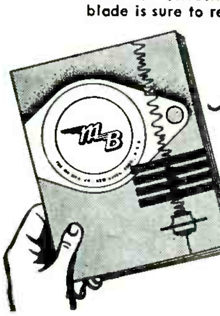


MODEL S3 VIBRATION EXCITER Delivers controlled force up to 200 pounds, in frequency range of 3 to 500 c.p.s.



Testing of small turbine blades (encircled) mounted on an MB Model C-1 Exciter which delivers 25 pounds force in range of 4 to 500 c.p.s. (and higher). Using stroboscopic lighting, resonances and deflections are studied *visually* – and any need for corrections determined quickly. A stronger, stiffer blade is sure to result.



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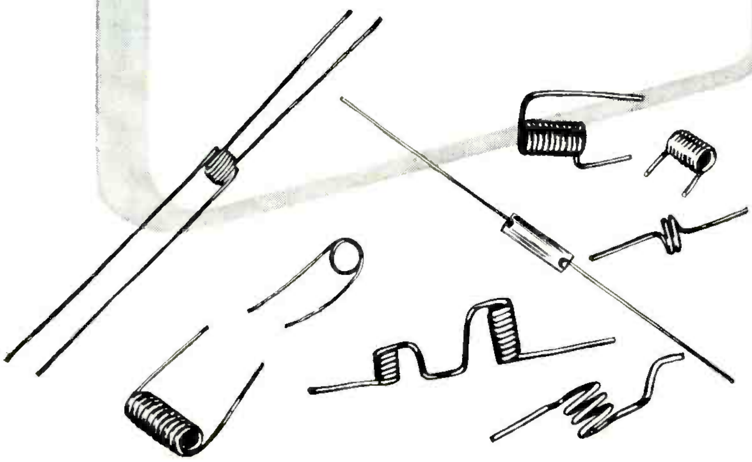

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U. S. Navy Electronics Laboratory San Diego, California

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A standard full-wave rectifier using two 5V4's with capacitor input supplies 480 volts to the four 807's in parallel that serve as the control tube. These four tubes limit the voltage obtained in the output. A single 6AC7 operated below ground serves as a d-c amplifier that is capable of swinging the grid of the control tube over the wide range required to maintain constant output voltage.

Control Tube Requirements

The amount of energy the control tube must dissipate is important in

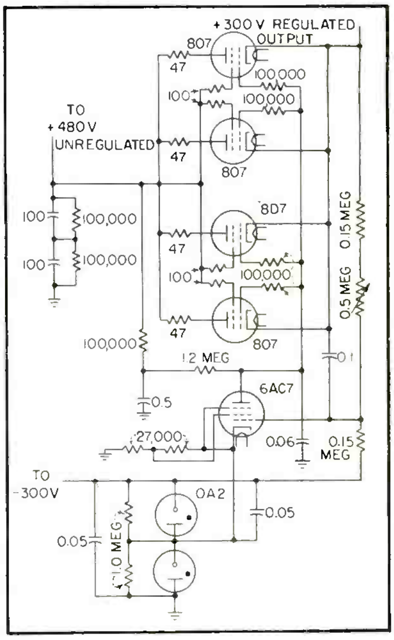

FIG. 1—Schematic diagram of voltage regulator capable of providing voltages from 3.5 to as high as 500 volts. Unregulated voltage is supplied by standard circuits, not shown

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CHATHAM 866-A RECTIFIER

A rugged half wave Mercury Vapor rectifier to withstand high peak inverse voltages. Heavy duty filament. Fil. 2.5 volts, 5.0 amp.... Peak inverse anode voltage 10,000 volts, .25 amp. average anode current.

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High voltage vacuum rectifier for Television and similar applications. Low filament power permits efficient operation from R.F. supply. Filament 1.25 volts, 200 ma. . . . Inverse peak plate voltage 30,000 volts, 2 ma. average plate current, 17 ma. maximum plate current.

CHATHAM 3B28 RECTIFIER

This rugged half wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of —75° C to +90° C Fil. 2.5 volts, 5.0 amp.... Inverse peak anode voltage 10,000 volts, .25 amp. average anode current.

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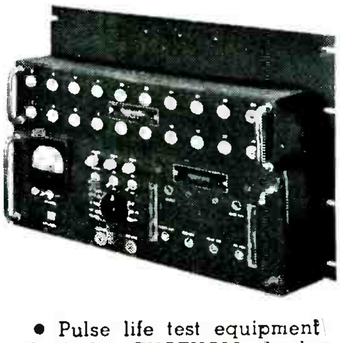
A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Fil. 1.25 volts, .265 amp. . . . Inverse peak plate voltage 15,000 volts, 2 ma. average plate current, 10 ma. peak plate current.



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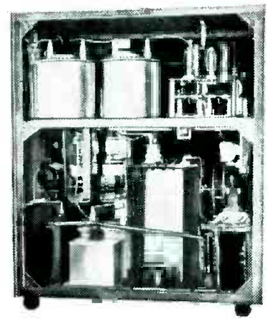

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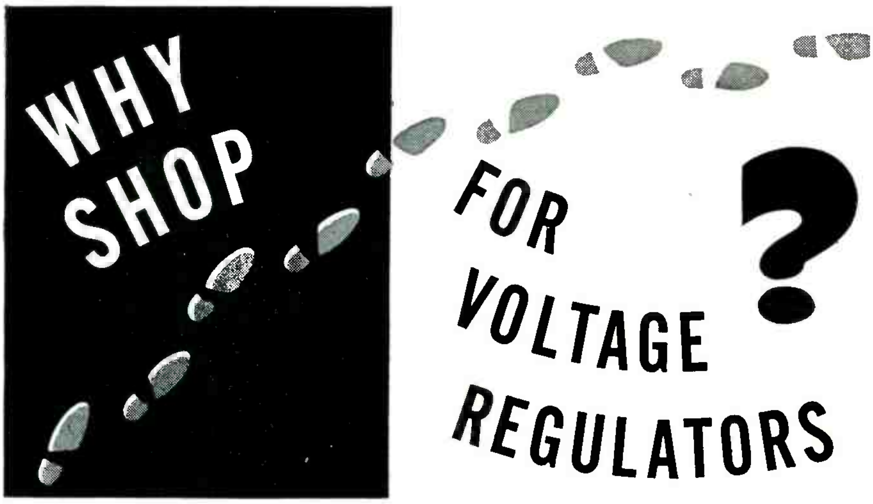

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STABILINE Type IE is instantaneous and completely electronic in action. Keeps output voltage to within ±0.1% of preset value regardless of wide line variations; to within ±0.15% regardless of load current or power factor changes. Waveform distortion *never* exceeds 3%. STABILINE Type IE is available in cabinet or rack mounting models — in numerous ratings.

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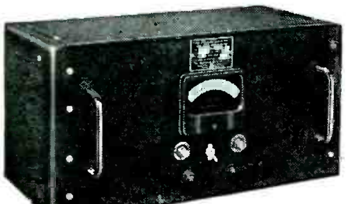

TYPE EM4102

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obtaining low-voltage, high-current operation. It is calculated by using the highest voltage drop and the largest current through the tube. In this particular supply the largest voltage drop used is about 470 volts and the greatest current is 0.3 amp. The four 807 tubes must therefore dissipate approximately 140 watts.

Since the highest output voltage occurs when the tube voltage drop is lowest, the internal resistance must be kept a minimum. The double requirements of high heat dissipation and low internal resistance are most economically met by using tubes in parallel rather than by using one large tube having sufficiently low internal resistance. The 807 tube was chosen because it will dissipate 35 watts without overheating. Four 807's in parallel will handle the required 140 watts and will have only one-fourth the resistance of a single tube.

To obtain cut-off on the control tube, the regulating tube acting as a d-c amplifier is operated somewhat below ground. A negative potential for the d-c amplifier is obtained from a power transformer and half-wave rectifier and regulated with the VR tubes. The operating voltages for the cathode and screen of the 6AC7 are taken from this bias supply, and plate voltage is obtained from the unregulated main positive supply. The control grid is made variable from −3 to −5 volts with respect to its cathode by operating on a bleeder from the regulated output voltage to the negative supply voltage. The grid potential of the 6AC7 decreases with increasing load on the power supply, thereby cutting off the plate current and raising the plate potential. Since the plate of the 6AC7 and the grids of the 807's are connected together, the 807 grids become more positive and build up the output voltage again.

High Voltage Limit

The maximum output voltage of this type of supply is the same as the safe maximum voltage that may be used on the control tubes, since at low output voltage nearly all of the potential drop in the system is across these tubes. If it is desired to obtain a higher output voltage than the 480-volt example all that

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"is tops!"

J. L. Hughes

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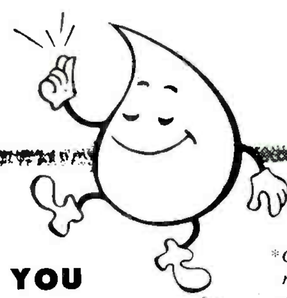
"We have found from test and practical experience that General Electric general-purpose varnish 9574 is tops for our work."

Mr. Hughes knows what he is talking about. He has been in the business of motor repair and rewinding in Columbus for thirty-three years.



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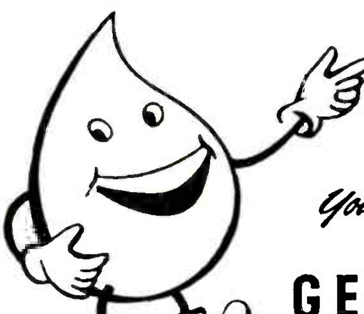
**G-E 9574 gives excellent results on all types of coils except extra-high-speed armatures. It is one of G. E.'s complete line of electrical insulating materials, including adhesives, wedges, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, permafils, tapes, tubing, varnished cloths, and varnishes.*



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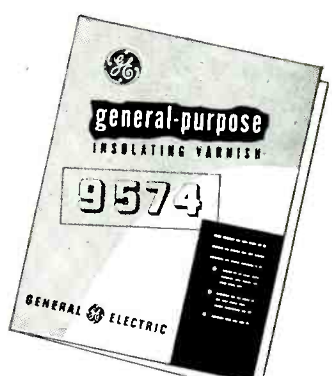

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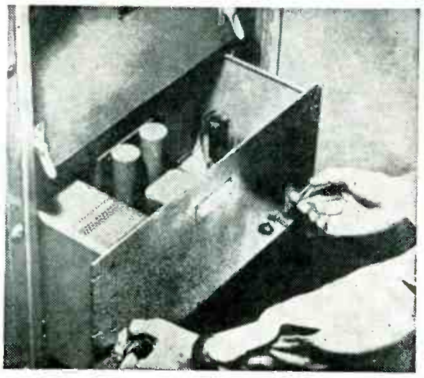
MODERN ELECTRONIC DESIGN MEANS PLUG-IN UNIT CONSTRUCTION

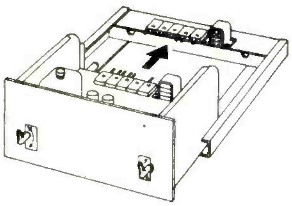
With basic elements as units—that plug-in, slide-in, lock-in, break away *easily*—so that electronic equipment is *instantly accessible*—ready for rapid checks, servicing, and unit replacement.



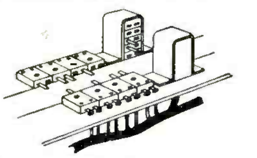
More and more engineers are finding that *plug-in unit construction* is the type of design that makes many of the new complex electronic projects feasible to operate and maintain. It's also recognized that *plug-in, unit principles* make present electronic equipment much more practical for wider general use.

Up to now there has been no one place where components *specifically designed* for *plug-in, unit construction* were available. To get this type of construction—it has been necessary for engineers to design and have parts custom made or improvise with standard components in make shift arrangements.

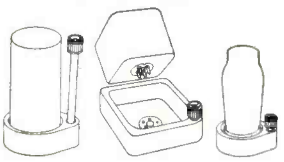
Here at Alden's we are designing and manufacturing components for *plug-in unit construction.* We are setting up to work with manufacturers on as many of these problems as possible. Very frankly, much of our work is still in the pilot run stage—but, in every instance—proven in use. If you don't see the answer to your problems here—let us work it out with you.



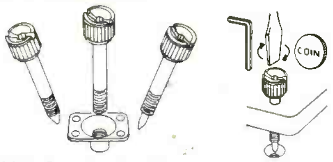
Back connected chassis — become instantly accessible. Half twist of handles brings chassis into place or ejects—no matter how heavy. Built for racks or as separate units —miniature and standard sizes.



Rugged color coded back connectors—make and break circuits — provide rapid circuit checks. Wide mating tolerances compensate for any chassis misalignment. Miniature and heavy duty sizes.

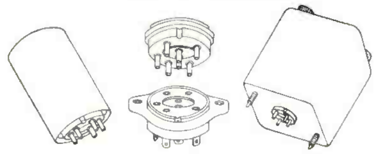


Top operated clamps for tubes and plug-in units. Take minimum of space. Can be operated in cramped locations. Free floating—orients unit to socket without straining or bending pins.



Alden Cap Captive Convenience Screws— Hold miniature chassis, heavy plug-in cans or detachable mechanical units securely. Assemble easily in production by power tools—yet any tool or coin services in field.

At last—a base specifically designed for plug-in units. No more broken bosses, bent pins, "shorted" circuits.



More and more engineers have been unitizing the basic elements of their circuits into compact, easily replaceable plug-in units. Since the conventional octal and tube socket bases have been the only component readily available, they have been constantly plagued by the broken bosses, bent pins, and "shorted" circuits caused by these bases.

This suggested an entirely new approach was necessary, so we went to work with some of these engineers. Out of this work the *Alden-Noninterchangeable plug-in base* was developed.

Pins have been made strong and stubby —for long, rugged use. The boss is eliminated entirely. Slight lead of center pins and locating rings with marker in the socket allow quick lining up of plug-in units. Further, this base is supplied with 2 to 11 contacts—in variable pin patterns —so that even where the same number of contacts are used, the pin layout may be varied so only the correct unit will mount in its proper socket. Pin patterns can even be selected to isolate critical voltages or signals.

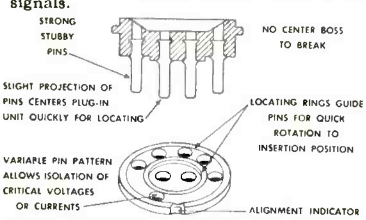


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FIG. 2—Voltage regulator chassis and remote control panel (left) showing four 807 control tubes, 6AC7 regulator tube and two miniature OA2 regulators for the negative 6AC7 supply

is required is an adequate supply transformer. If a higher current is desired, another tube may be inserted in parallel, providing the transformer and choke have the required ratings.

Under pulse conditions it is advantageous to know the internal impedance of the power supply and to determine variation in the supply voltage. This supply has a measured internal impedance of 8 ohms for loads requiring less than 300 volts at 300 ma, and reaches a maximum of 12 ohms for higher voltages and less current. This low impedance results from the use of the high-gain d-c amplifier stage.

Remote Control

To facilitate the use of the instrument, the voltage control and switches can be placed in a shielded container remote from the unit. The B+ and grid wires of the d-c amplifier that run to the control panel must be shielded to prevent pickup and amplification of signals.

Few parts are required in addition to those employed in standard regulated power supplies. Many conventional regulated power supplies can be altered without much difficulty to extend their lower limit in this way. The author wishes to acknowledge the assistance of G. A. Coates of this laboratory, who constructed the first model and whose experimentation developed optimum operating conditions for this unit.

X-Ray Microscope

X-RAY IMAGES have been magnified by 100 diameters (10 diameters by electron optics, and 10 by photographic means) in a microscope announced recently by the General Electric Company. The resulting enlargements, produced under lab-

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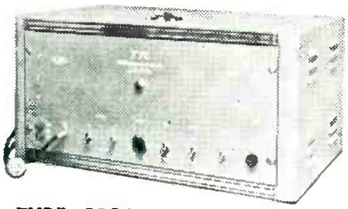


TYPE 2120
R.F. PICTURE SIGNAL GENERATOR

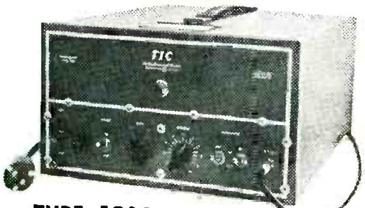
Provides picture and sound carrier. Modulated by standard R.M.A. composite picture signal. Sound carrier stability suitable for testing Inter Carrier type receivers. Internal 400 cycle FM and External audio with 75 microsecond pre-emphasis. Output max. 0.1v p-p across 75 ohm line. Available channels 2-13.

TYPE 1200
12 CHANNEL
R.F. SWEEP GENERATOR

Intended for precise adjustment of R.F. head oscillator coils and R.F. band pass circuits. Pulse type markers at picture and sound carrier frequencies extend to zero signal reference base line. Accuracy of markers 0.02% of carrier frequency. 12 to 15 MC. sweep on all channels. Max. 1.V peak output across a 75 ohm line. Provisions for balanced input receivers. Instant selection by push button.

TYPE 1900
CRYSTAL CONTROLLED
MULTI-FREQUENCY GENERATOR

A 10 frequency, 400 cps. modulated crystal controlled oscillator, ideal for production line adjustment of stagger tuned I.F. amplifiers. Available with crystals ranging from 4.5 to 40 M.C. Output frequency accurate to 0.02%. Immediate push button selection of frequency. Output attenuator range .5V to 500 microvolts. Self contained regulated power supply.



TYPE 1500
I.F. WOBBULATOR

A two band sweeping generator covering the range of 4.5 to 50 M.C. Capable of a band width of approximately ±25% on either band. Five pulse type crystal generated markers to specified frequencies available for each band. Accuracy of markers .05%. Zero signal reference base line, with markers extending to base line. I.V. output max. into 75 ohms. A saw sweep available for "X" axis of scope.

Write for Detailed Engineering Data Sheets

Tel-Instrument Co. Inc.
52 PATERSON AVENUE • EAST RUTHERFORD, N. J.

Cylinder at far right houses x-ray source for x-ray microscope capable of magnifications up to 100 diameters

oratory conditions, are clear and sharp, and no serious loss of detail has been experienced.

The device uses the electron microscope principle, but the samples under study need not be in a high vacuum, as required by the regular electron microscope. This presents the possibility of studying living materials at much higher magnifications than ever before.

Objects studied to date have been fine mesh screens. Purpose of the studies have been to test the instrument's ability to reveal small details, and the results have been excellent.

Operating Principle

The microscope operates on the principle that x-rays can be reflected from polished surfaces, as can visible light, provided they strike the surfaces at an angle less than one-half degree, after passing through the sample. The mirrors, acting like a convex lens, bend the rays in such a manner as to form a magnified x-ray image of the sample on a photographic plate.

The mirrors are platinum-plated slabs of fused quartz which are as nearly flat as surfaces can be made. They are curved by mechanical pressure which can be adjusted. This method makes it possible to change the curvature of the mirrors to effect focusing.

In passing through the entire system, the x-ray beam travels about a foot from tube to photographic plate. The setup shown in

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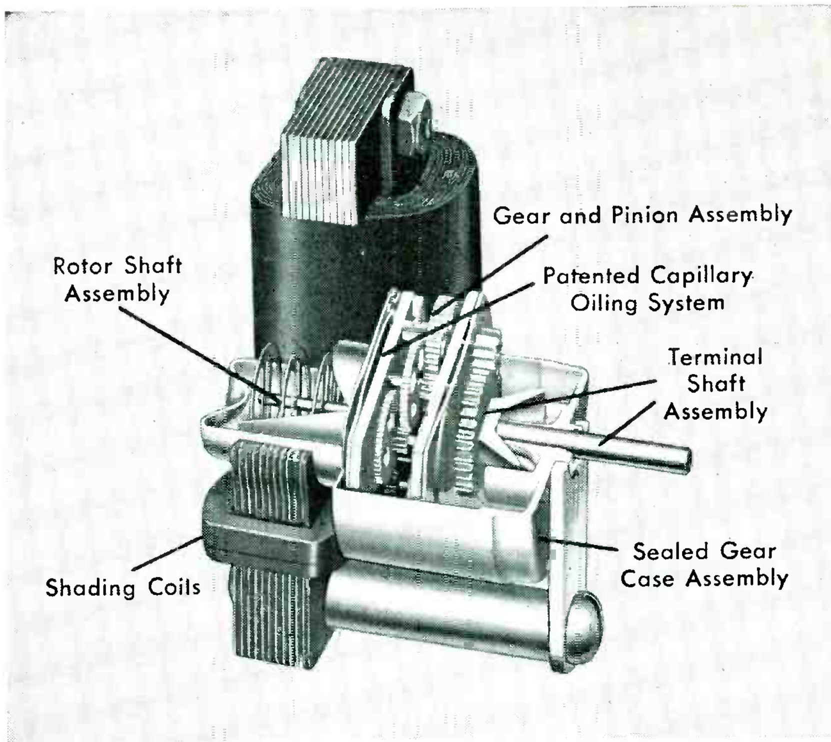
Floating Rotor Prevents Motor Lag or Slippage

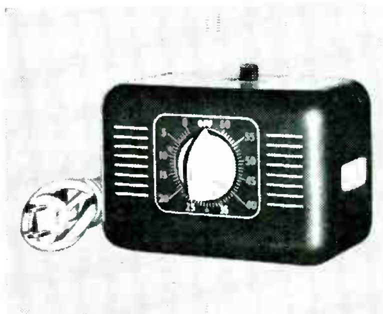
Specially designed light-weight rotor virtually floats in a rotating magnetic field. Rotor shaft rotates on a film of oil . . . no metal to metal contact with its bearing. These features, together with capillary oiling system, account for the fact that *All Telechron Timing Motors Are Instantly, Constantly Synchronous.*

That is why so many designers concerned with split-second timing or control of light-weight moving parts specify Telechron motors.

If you have such a problem, why not turn it over to a Telechron Application Engineer? Drawing on the experience that makes all electric timing possible (virtually all frequency-controlling master clocks in power stations are made by Telechron), he can probably show you how a standard Telechron motor can do your job, too. Consult him early in your planning for big savings in time and money. Use handy coupon below for complete data. TELECHRON INC. A General Electric Affiliate.



Telechron Type B Synchronous Motor. For medium duty purposes such as switches, recording-controlling mechanisms and other control equipment. Other models with lower or higher torque for light or heavy duty applications.



Typical of Telechron Type H3 light duty motor applications is this 60-minute timer, the purpose of which is to operate a switch or signal at the end of a pre-selected period.

Practically all time-stamps and recorders employ Telechron Type B motors to operate their timing mechanisms. Obviously a motor that is instantly, constantly synchronous is needed for such applications.

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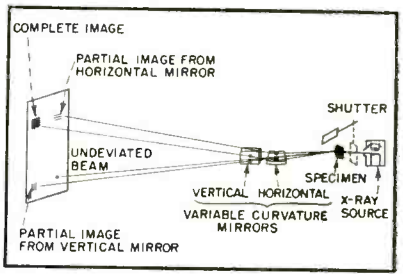

Curvature of x-ray microscope reflecting surfaces can be varied by a mechanical adjustment for focusing

the photograph is purely an experimental model with sliding mechanisms for adjustment of the distances between components of the optical system. The instrument was described by Charlys M. Lucht, shown in the photograph, at the recent Philadelphia meeting of the American Society for X-ray and Electron Diffraction.

Stanford Version

Since the General Electric announcement, Stanford University published a similar report describing the work done recently by the inventor of the x-ray microscope, Paul H. Kirkpatrick. The Stanford instrument operates on the same principle as the GE version shown in the accompanying diagram, that of bouncing electrons off optically perfect mirrored surfaces.

The Stanford laboratory model is capable of magnifications of between 50 and 100 diameters, without the aid of photographic enlargement, according to a paper delivered before the American Physical Society at Stanford.

Thyratron Thermoregulator

A SIMPLE but effective circuit for on-off temperature control has been described by D. F. Swinehart of the University of Oregon in the December, 1949, issue of *Analytical Chemistry.* The circuit is entirely a-c operated and is shown in the accompanying diagram. Current through the thermoregulator is limited to 3 or 4 microamperes, which is low enough to prevent appreciable corrosion of the mercury contacts.

The filament voltage supplies the grid signal. The connection of the

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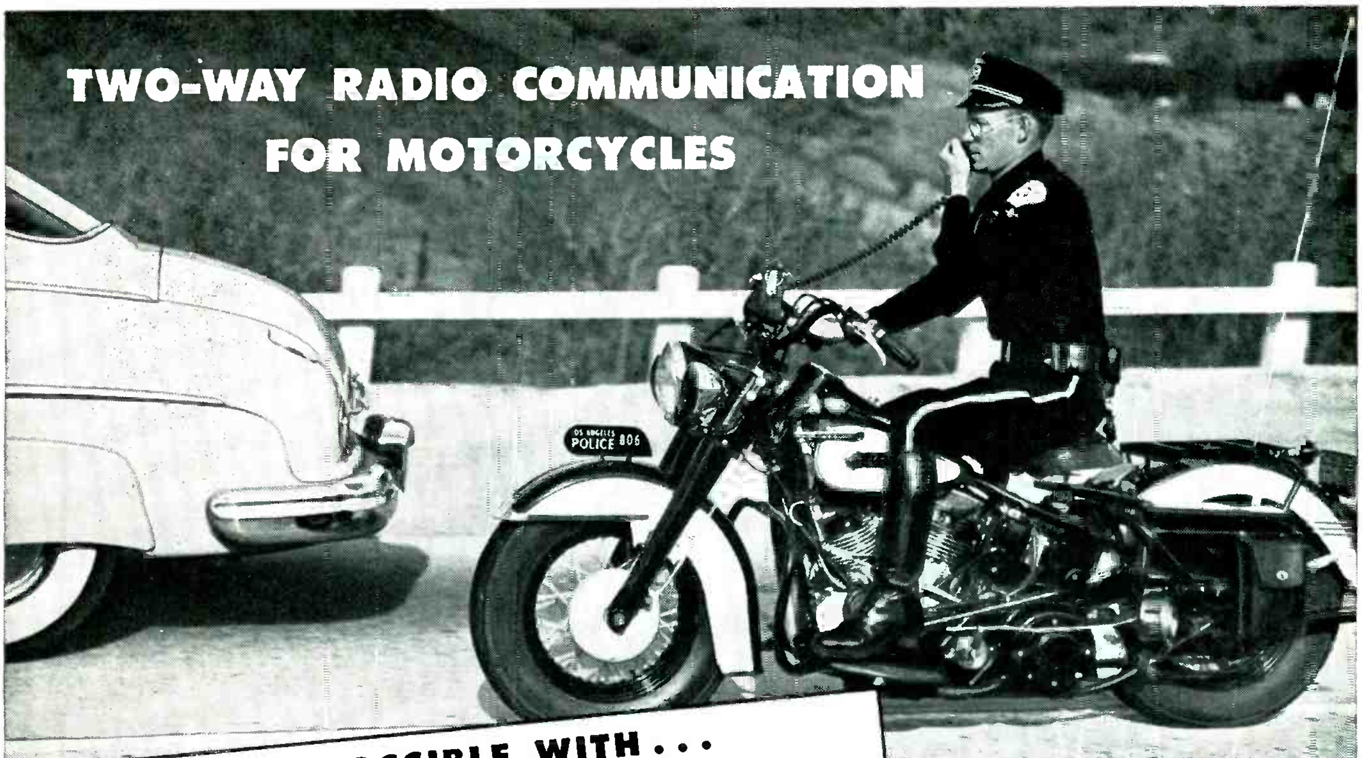

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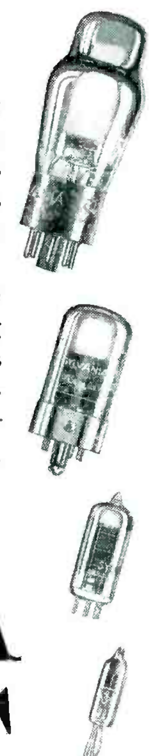
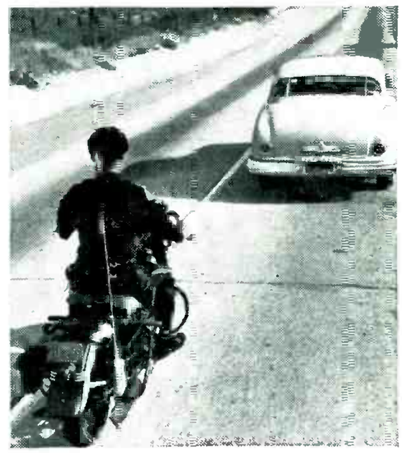


The long arm of the Law is just that much longer through the combined skill of Link-Vetric and Sylvania. In designing this compact two-way radio for the Los Angeles Motorcycle Police, one quality was paramount . . . faultless performance under the toughest conditions. Nothing must fail when the call comes through!

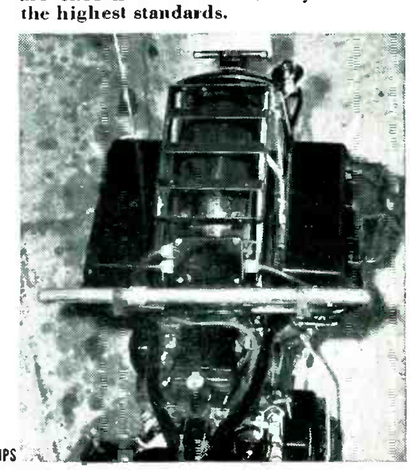
Link-Vetric uses Sylvania low-drain miniature tubes because every step in their manufacture is quality controlled, ensuring longer life under the most adverse conditions. From Regular Glass Tubes to the famous Lock-ins . . . from Miniatures to tiny Sub-Miniatures, Sylvania tubes give the perfection that can *really* take punishment. Sylvania Electric Products Inc., Emporium, Pa.



Highway bumps and rutted by-ways often have to be taken at high-speed. Sylvania tubes defy sudden shock, constant vibration. Maintenance work cut to a minimum.

• • •

Neatly installed either side of the rear fender, the two-way radio keeps patrolmen in constant touch with headquarters. All police calls are urgent calls . . . absolute reliability is essential. Sylvania tubes are chosen wherever necessity demands the highest standards.



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Write for specifications — investigate the advantages of this outstanding new instrument.

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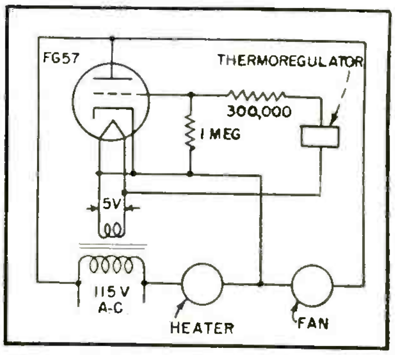
BOONTON, New Jersey



Thyratron thermoregulator circuit. If circuit fails to effect control, filament transformer connections should be reversed

grid circuit to the filament transformer secondary must be in the proper polarity for the circuit to operate.

Operation

The impedance of the fan is inherently much larger than that of the heater. When the tube is nonconducting, the fan runs by means of the current through the heater. This current is very small and produces negligible heat in the heater. When the tube fires, the fan is effectively shorted by the tube, the fan stops running, and the heater is activated.

The circuit shown has the advantage of furnishing accurate control with almost negligible current through the thermoregulator unit. It was designed for controlling (and has controlled, for over a year) two 40-gallon water thermostats. The fan is directed at the water surface of the thermostat and serves to cool it. By this means, the thermostat may be operated several degrees below room temperature.

Operating Small Thyratrons in Parallel

SUBSTANTIALLY simultaneous firing of parallel-operated thyratrons is insured by the accompanying circuit, developed by Paul G. Hansel of Servo Corp. of America for discharging a large capacitor through the primary of a high-voltage transformer to produce a high-voltage trigger for a flashing light source. When the input trigger is applied to the parallel-connected control

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● Can't guarantee that the Varflex Line will solve every insulation problem. But . . . Many's the problem—large, small, unusual—that Varflex Electrical Sleeving or Tubing has solved. The Varflex range of application is vast—chances are you'll find the solution to your Electrical insulating problem somewhere in the Varflex line.

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THE NEW SHURE "VERTICAL DRIVE"

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Big things often come in little packages . . . So it is with the superlative new Shure "Vertical Drive" Crystal Cartridges. They reproduce *all* the recorded music on the new fine-groove recordings—a reproduction that meets the strict requirements of high compliance and full fidelity. The "Vertical Drive" cartridges are requisite for the critical listener—the lover of fine music. They are especially recommended for those applications where *true fidelity* is essential.

SINGLE MODELS: W23A for standard width-groove records. W21A for fine-groove records.

TURNOVER MODELS: W22A and W22AB for both standard and fine-groove recordings.

Unusually highly compliant, these "Vertical Drive" Cartridges will faithfully track standard records with a force of only 6 grams—micro-groove records with a force of only 5 grams (an added protection for treasured recordings). Will fit standard or special mountings. Have more than adequate output for the average audio stage.

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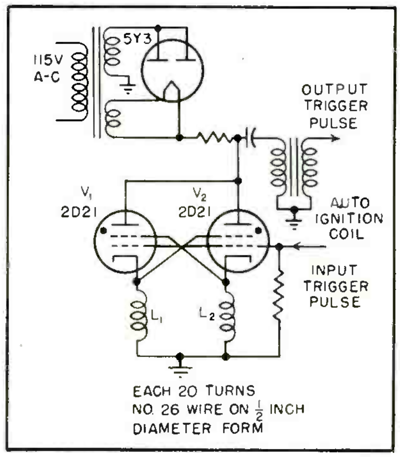


No matter which tube fires first, pulse across its cathode inductance acts on shield grid of other tube to make it fire

grids, one tube may fire first. If for example it is V_1, then the resulting surge of current through the small inductance L_1 in its cathode lead results in a positive pulse across L_1 that is applied to the shield grid of V_2, thereby causing that tube to fire. The firing delay can be made very small by proper choice of values for L_1 and L_2.

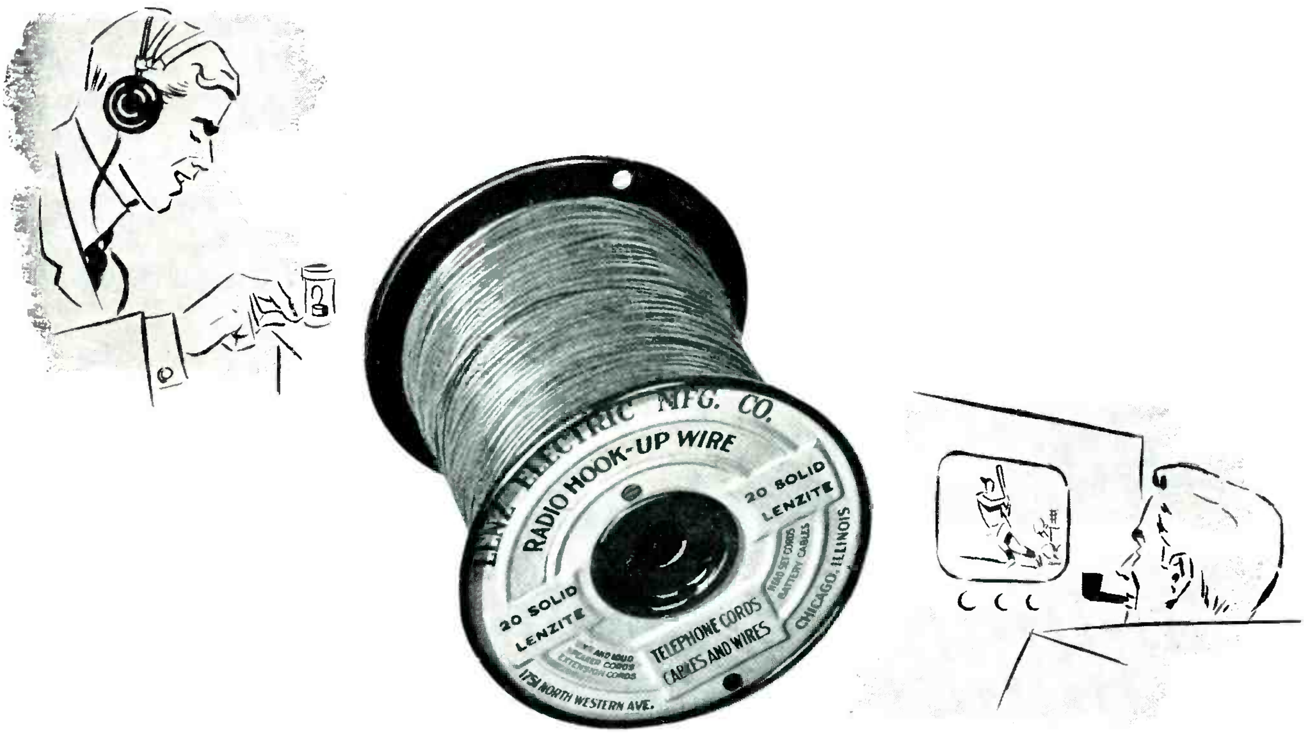
Conventional parallel operation of two thyratrons ordinarily fails to prevent overloading because of the tendency of one tube to fire first, thereby reducing the anode voltage on the second tube and preventing it from firing.

A New Ceramic Material With Unusual Properties

STUPALITH, a ceramic material which apparently defies most accepted laws by contracting when heated and expanding when cooled, is being produced by the Stupakoff Ceramic and Manufacturing Co. of Latrobe, Pennsylvania.

Engineers who are evaluating Stupalith's properties for possible use in radomes and jet and rocket engines claim that materials including the new substance can be produced with linear coefficients of thermal expansion below that of any other material known. It is believed that the material will find wide application in housing electronic instruments on airborne missiles since it will withstand a thermal shock of at least 2,000 F. Its electrical properties make it

from crystal set to television



LENZ has served the radio industry!

When the radio industry first appeared on the American scene 25 years or more ago, the Lenz Electric Manufacturing Co. was ready with the facilities required for the production of needed wires.

These facilities have grown with the industry, all through the days of the crystal set, right down to the present boom in Television equipment, Lenz Wires and Cables, have been used in the production of millions of electronic units of all kinds and their component parts.

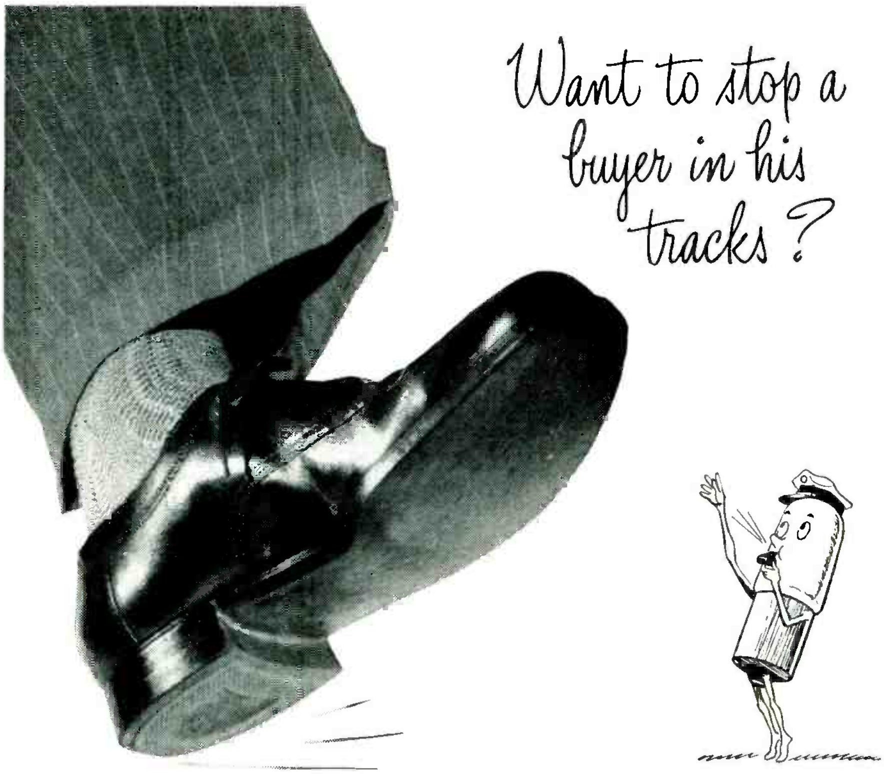
Lenz will continue to be a leading source for properly engineered underwriters approved Plastic and Textile Hook-Up, Wires, Cables, Shielded Lead-Ins, and Harnesses for all types of electronic equipment, A.M., F.M., Television and Communications. Consult Lenz, now as always your source for engineered wires and cables designed for the job.

LENZ

LENZ ELECTRIC
MANUFACTURING CO.

1751 N. Western Ave. Chicago 47, Illinois

www.americanradiohistory.com



Little lamps add extra features that win attention . . . make sales!

LIGHTS on electronic products are often the stop signs that make the passer *buy.* They flash a message of extra convenience, novelty and value!

You'll find dozens of uses for General Electric lamps—both filament and neon glow, in all types and sizes. Use them to indicate whether the current is on or off, or to check the operation of individual circuits. Let them light up instrument dials and controls. Use them to brighten your product design, add novelty and give extra appeal.

There's nothing like light to catch a customer's eye—and with General Electric lamps you know you can be sure of quality and long service.

For assistance in selecting the proper type, consult your nearest G-E lamp district office. Or write General Electric, Nela Park, Cleveland 12, Ohio.

GE LAMPS

You can put your confidence in—

GENERAL ELECTRIC

suitable for use as insulation in electronic and radio circuits.

Unlike most metals, which conduct heat rapidly and attain uniformity of temperature quickly, most currently-used ceramics are poor thermal conductors. Pronounced temperature gradients within a body result in expansion differentials which may exceed the strain point. As a result of the discovery of the new material, its producers believe that the breaking of ceramics caused by sudden exposure to high or low temperatures may soon become a thing of the past.

SURVEY OF NEW TECHNIQUES

INSTANTANEOUS PROCESSING of photofluorographic films, using techniques worked out by the Army for rapid processing of radar photographs in combat operations, is being investigated at Johns Hopkins University under supervision of R. H. Morgan. The process has potential value in rapid examination of individuals for early gastric cancer. A special optical system in the camera has ten times the efficiency of any previous photofluorographic unit, permitting sharp pictures of the relatively dim image on the screen.

X-RAY MOVIES involving exposures of 10 millionths of a second on film moving at 150 frames per second were obtained in Westinghouse Research Laboratories by using a special radar-type pulse transformer to provide power pulses exceeding five million watts for flashing an electronic tube at 150,000 volts.

LIGHT OUTPUT of a television viewing tube screen is charted accurately in 48 seconds by a recording spectroradiometer built in the Research Laboratories of Sylvania Electric. The instrument measures and records the degree of output of all visible light wavelengths progressively and automatically. Speed of operation permits prompt correction of chemical mixtures used for c-r screens, since minute changes seriously affect the actual color of the light from white screens.

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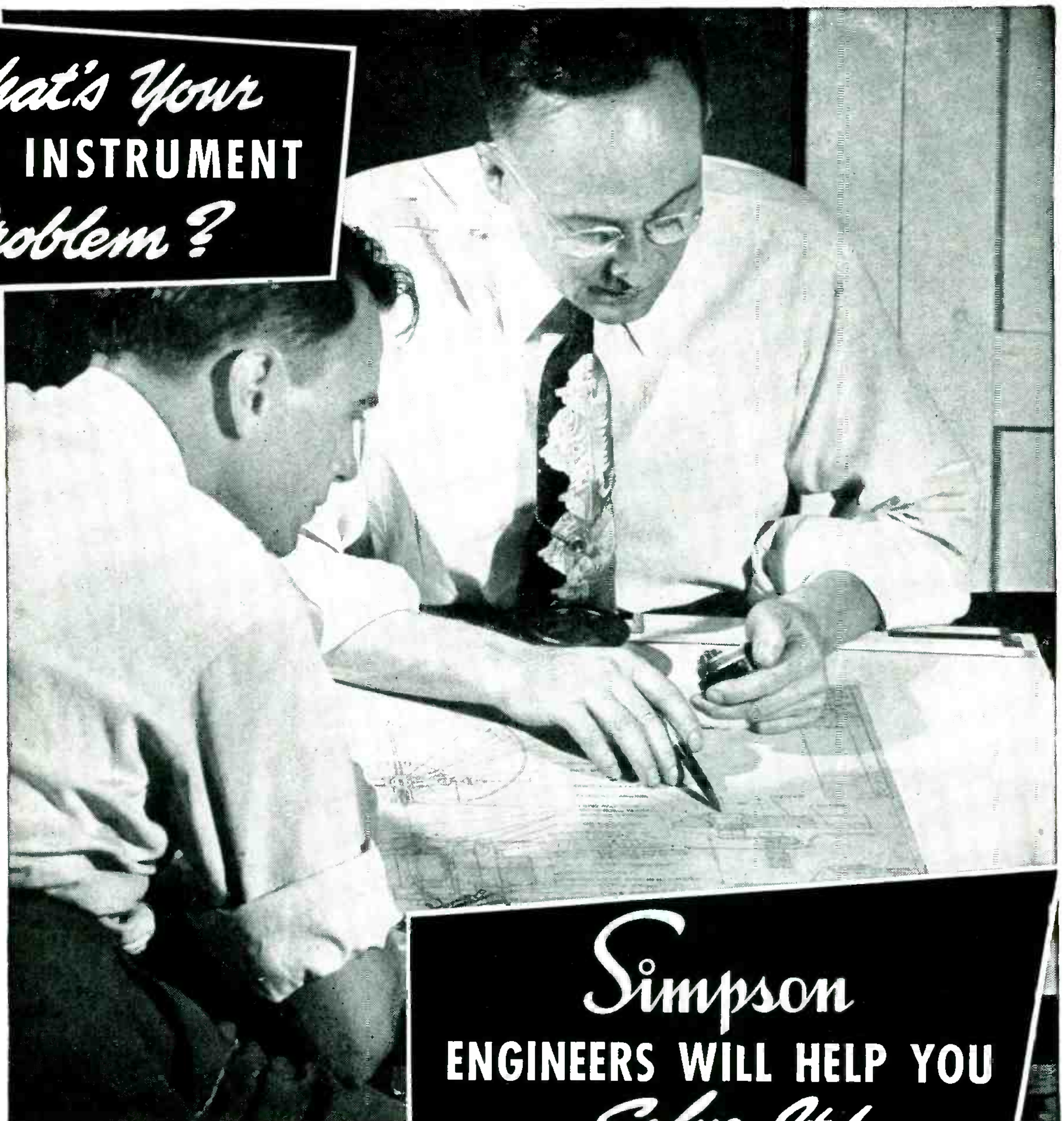
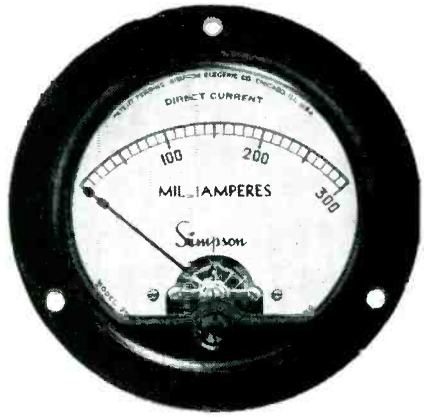
What's Your PANEL INSTRUMENT *Problem?*



Simpson ENGINEERS WILL HELP YOU *Solve It!*

No matter what your panel instrument problem is, Simpson Electric Company engineers will be glad to help you solve it. Every day they are confronted with individual design problems.



Behind every Simpson instrument is a world-wide reputation for quality. Simpson movements have greater ruggedness and accuracy, because of the full bridge-type construction and soft iron pole pieces.

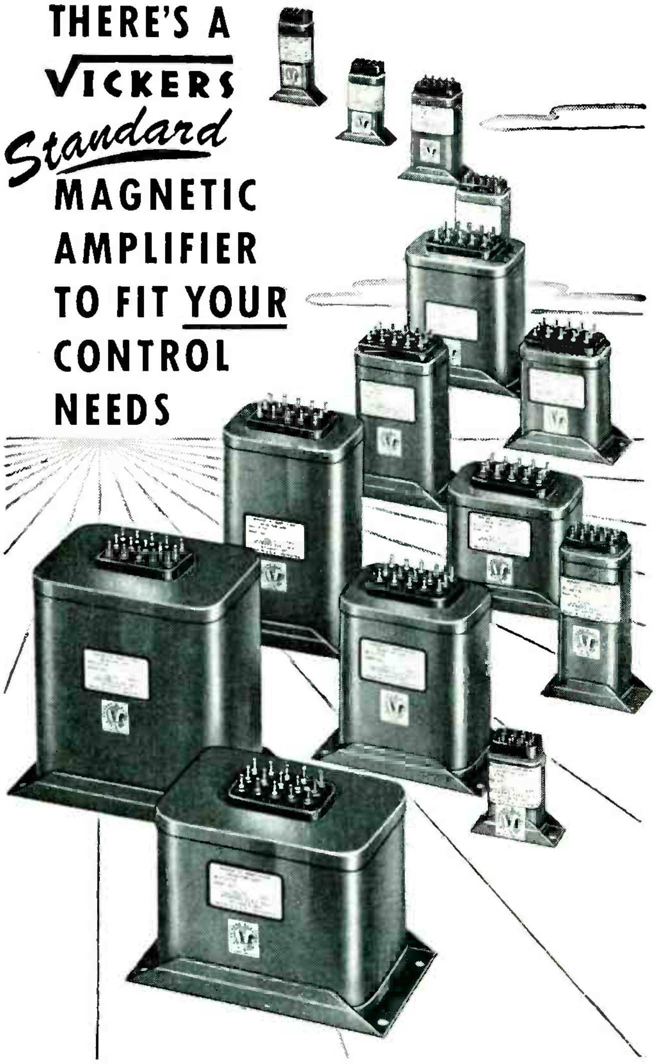
When Simpson helps you with your problem, you benefit from this world-wide reputation and the years of experience of Simpson engineers.

Let Simpson engineers help you with your next instrument problem and for your standard instrument requirements take advantage of our large stock, available for immediate delivery.

SIMPSON ELECTRIC COMPANY 5200-18 WEST KINZIE STREET, CHICAGO 44, ILLINOIS
IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO

www.americanradiohistory.com

THERE'S A VICKERS *Standard* MAGNETIC AMPLIFIER TO FIT YOUR CONTROL NEEDS



NOW —*for the first time*— you can select a standard magnetic amplifier — to serve your 60-cycle control application. Vickers supplies from stock 28 styles — pre-engineered and laboratory tested with a choice of d-c or a-c output. Power (output) levels range from milliwatt to 108 watts maximum (d-c output).

Comprehensive application data sheets are furnished to help you select the Vickers magnetic amplifier for your control needs.

A FEW OF THE MANY APPLICATIONS

• *Line-to-line Voltage Regulators* • *Hydraulic Transmission Controls* • *A-c and D-c Generator Voltage Regulators* • *Controls Relays* • *Speed and Frequency Regulators* • *Lamp and Furnace Controls* • *Temperature Regulators* • *Time Delay Devices*

READY NOW-THE VICKERS EDUCATIONAL MAGNETIC AMPLIFIER

Designed for school and industrial laboratory use, it permits study of all basic single-phase self-saturating circuits. Complete with Laboratory Experiment Manual and Magnetic Amplifier Design Handbook.

• *Write today for complete information on the Vickers Educational Magnetic Amplifier and for your copy of the Vickers Magnetic Amplifier Design Handbook which specifies characteristics and illustrates circuits. Please make request on your letterhead.*

VICKERS ELECTRIC DIVISION

VICKERS ELECTRIC DIVISION

VICKERS *Inc.*

1801 LOCUST STREET • ST. LOUIS 3, MISSOURI

NEW PRODUCTS

(continued from p 126)

the output to the Z-input terminals of the oscilloscope. Both methods are illustrated.

Utility Tester

SUPERIOR INSTRUMENTS CO., 227 Fulton St., New York, N. Y. The new pocket-size tester can measure the actual current consumption of any appliance or utility either a-c or d-c while the unit under test is in operation. The appliance is plugged into the front panel receptacle and registers a reading in amperes. A special pair of insulated clip-ends is supplied for motors. The unit measures $3\frac{1}{8}$ in. $\times$ $5\frac{7}{8}$ in. $\times$ $2\frac{1}{4}$ in.

Miniature Triode

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 6AB4 miniature triode is suitable for use as a grounded-grid r-f amplifier, frequency converter,

COPPER ALLOY BULLETIN

PRODUCT IMPROVEMENT EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Phosphor Bronze for Longer Life

Overcoming Corrosion in a Mixing Valve

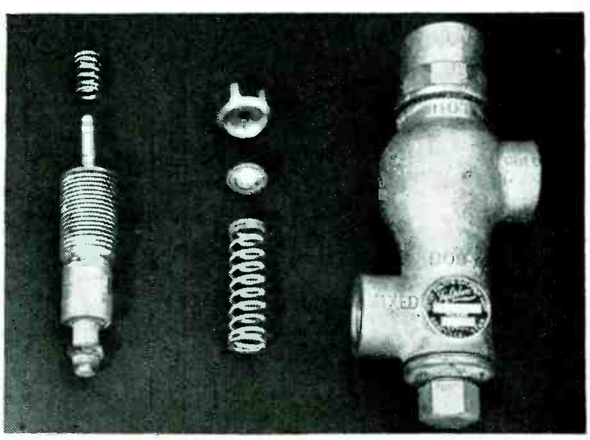
The automatic tempering valve illustrated is used to provide water at any temperature within the range of the thermostat. The mixture of hot and cold water passes over the thermal element. If the mixture is too cold, the bellows gradually contracts and partially closes the cold water port and opens the hot water port wider. If the mixture is too hot, the reverse occurs.

Obviously, the efficiency of the valve depends primarily on the reliable operation of the metal bellows. Bridgeport Phosphor Bronze, which provides an excellent combination of corrosion resistance and resilience under repeated flexing, is excellent for the manufacture of bellows of this type, which may be in constant contact with hot water and other corrosive fluids.

Excellent Corrosion Resistance

Phosphor Bronze is more corrosion resisting than most metals. Steam, hot water, sea water, and similar corrosive liquids and gases used in industrial and processing plants for heating, cooling and refrigeration come in direct, intimate contact with the parts of valves, pressure and temperature gauges and controls made from Phosphor Bronze. Long experience has shown that this metal will stand up under these conditions and give dependable service so necessary for the operation of automatic instruments and controls.

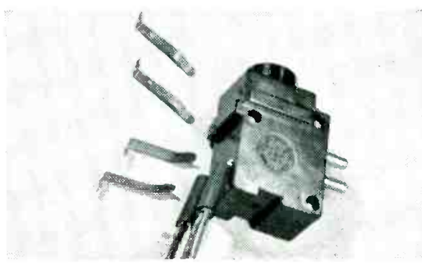
From an engineering standpoint, only the best available metals should be used since the function of the instrument or control depends upon the action of the component — bellows, diaphragms, Bourdon tubing, springs, or electrical and mechanical contacts.



Bellows for Automatic Tempering Valve made of Bridgeport Phosphor Bronze — Courtesy Fulton-Sylphon Division, Robertshaw-Fulton Controls Co., Knoxville, Tenn.

Vacuum Cleaner Switch— Wanted Reliable Spring Action

Contact springs in the vacuum cleaner motor switch illustrated are a good example of parts which are small and insignificant in appearance, but vital to the operation of the equipment. This motor switch is manufactured by Electrolux Corporation, Old Greenwich, Connecticut. The springs made from Bridgeport's Phosphor Bronze must maintain constant pressure and provide dependable contact at all times.



Motor switch connector terminals made from Bridgeport's Phosphor Bronze—Courtesy Electrolux Corporation, Old Greenwich, Connecticut.

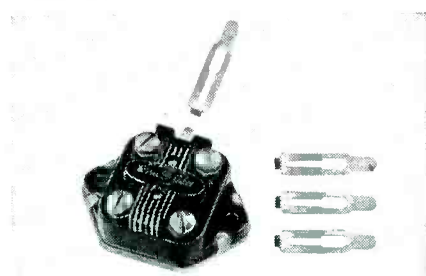
High fatigue resistance and dependable spring properties are developed in Bridgeport's Phosphor Bronze through close laboratory control of composition and careful processing in the mill with powerful modern equipment.

Thermostat Reset Lever— Dependable Spring Quality

Safety in operating electrical and mechanical equipment often depends upon the reliability of a few tiny spring parts. Thermo-O-Disc Protective Thermostat employs Phosphor Bronze for the reset lever because of fine spring properties and dependability.

Phosphor Bronze provides an excellent combination of properties for electrical and mechanical spring applications. Its resilience and high fatigue resistance mean good spring action and dependability through many thousands of flexing cycles. Its high corrosion resistance reduces failure from the attack of corrosive atmospheres. Phosphor Bronze is also unusually tough and resistant to wear and abrasion, insuring continued good mechanical and electrical contact.

The unique properties of phosphor bronze depend not only on alloy composition but also upon improved melting practise, casting techniques and processing methods.



Thermo-O-Disc Protective Thermostat employs reset lever made of Bridgeport's Improved Phosphor Bronze. Courtesy Therm-O-Disc, Inc., Mansfield, Ohio.

Other Applications

Bridgeport Phosphor Bronze offers special advantages where good spring qualities are desired—in such parts as snap switches, diaphragms, current collectors, spring contacts, and parts for radios and appliances. Because of its resistance to corrosion and wear, it is also widely used in packless valves, steam traps, lock washers.

Much information on Phosphor Bronze and other spring alloys is published in Bridgeport's 128-page Technical Handbook. This also contains the latest data on various brasses in strip, rod, wire and tubing used in the manufacture of electrical devices, appliances, and electronic instruments.

Contact the nearest Bridgeport office for technical help in selecting the alloy and temper best suited for economical fabrication.

BRASS · BRONZE · COPPER · DURONZE — STRIP · ROD · WIRE · TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA
In Canada:
Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONNECTICUT
Established 1865
"Bridgeport" *District Offices and Warehouses in Principal Cities*

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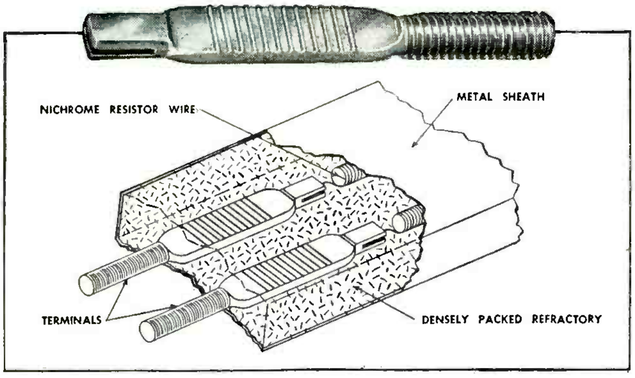
HOT ASSIGNMENT
for this PROGRESSIVE *fastener*



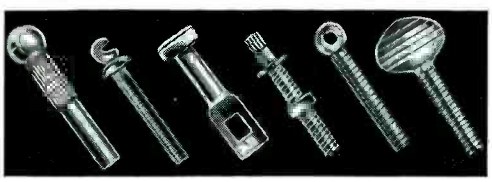
Edwin L. Wiegand Company uses this terminal pin on their versatile Chromalox seamless blade-type immersion heaters, which operate as high as 750°F. It is one of many special fasteners made by Progressive.

The design provides for electrical clearance between the pin and the metal heating blade casing — for secure fastening of the pin in the refractory — and for attaching electrical wiring connections.

Progressive is equipped to handle special fastener production with speed, precision and economy. Do what many leading manufacturers do — IF IT'S SPECIAL, see PROGRESSIVE.

WRITE FOR OUR CATALOG
IT MAY SAVE YOU MONEY

Other typical PROGRESSIVE *"Specials"*



QUALITY PROMCO BRAND

THE PROGRESSIVE MANUFACTURING COMPANY

50 NORWOOD ST., TORRINGTON, CONN.

SALES OFFICES: SAN FRANCISCO, LOS ANGELES, PORTLAND, DETROIT, PHILADELPHIA, CLEVELAND, SEATTLE, BOSTON, SYRACUSE, ST. LOUIS, CHICAGO.

or oscillator at frequencies below 300 mc. Its frequency range makes it applicable for use in currently allocated tv bands. It is supplied with a 6.3-volt, 150-ma heater.

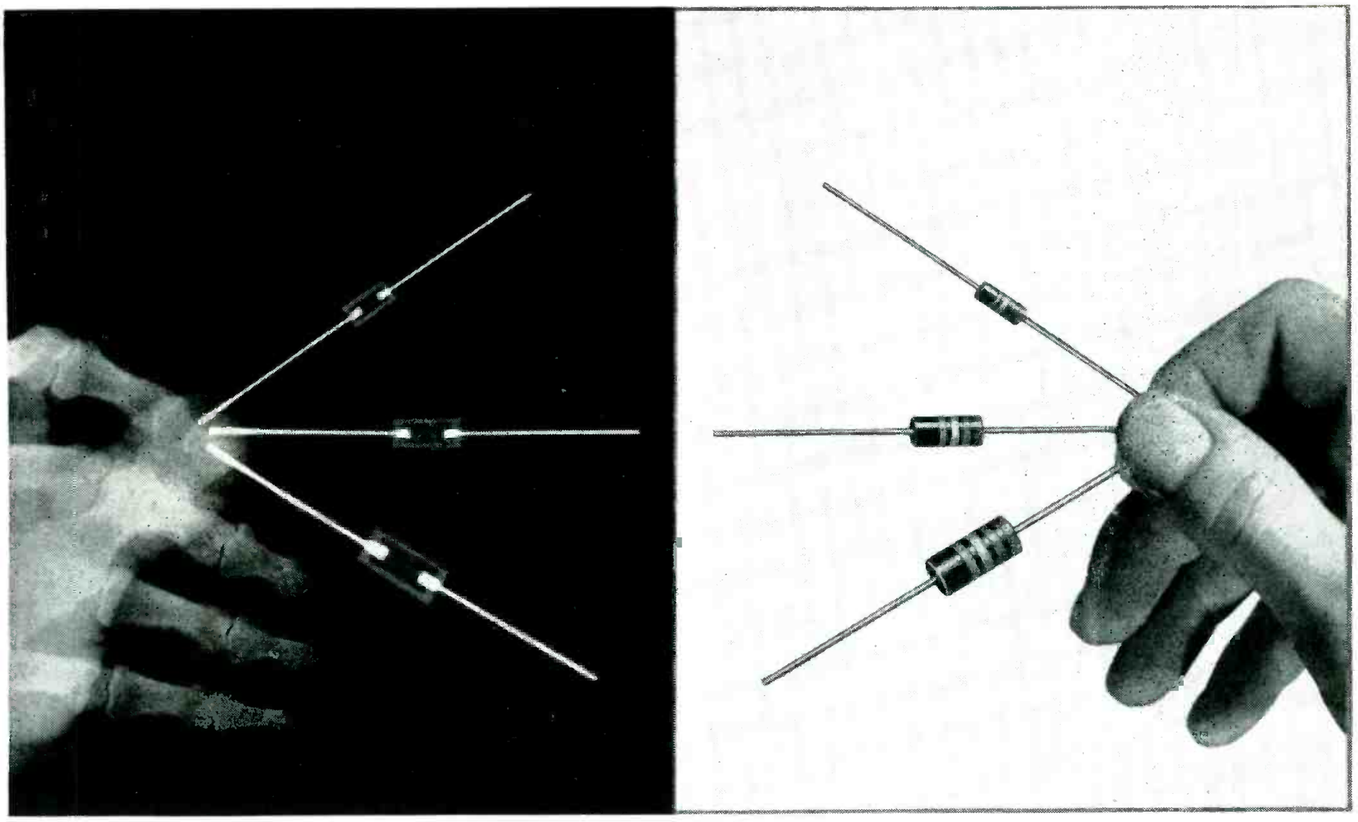
Rectifier Power Supply

P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis 6, Ind. The new portable rectifier power supply provides a dependable source of d-c power for the designing, building, testing and repairing of radio, electronic and electrical equipment for electrolytic processes and for taper charging of batteries. It will operate from either 208 to 230 or 460-volt, 3-phase input and will provide a nominal 6, 12 or 24-volt output.

Survey Meter

RADIOACTIVE PRODUCTS, INC., 3201 E. Woodbridge St., Detroit 7, Mich. Model D-1 radiation hazard survey

www.americanradiohistory.com



X-ray reveals solid molded construction of Allen-Bradley Fixed Resistors

These unusual photographs tell a convincing story . . . about Bradleyunit resistors!

Solid molded . . . through and through . . . their leads are imbedded in the densely compacted body of the resistors.

This construction assures unbeatable performance . . . stability . . . and long life. Heat, humidity, and high load do not affect Bradleyunits, which are available in all standard R.M.A. values in ½ and 2 watt ratings from 10 ohms to 22 megohms; 1 watt from 2.7 ohms to 22 megohms.

Fixed resistors are usually rated at ambient temperatures of 40 C. Bradleyunits are rated at 70 C. At this high temperature they will operate at full rating for 1000 hours with less than 5% resistance change.

Bradleyunits need no wax impregnation to pass salt water immersion tests. They have high mechanical strength. The leads are differentially tempered to prevent sharp bends near the resistor. Let us send you a complete Allen-Bradley resistor chart.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

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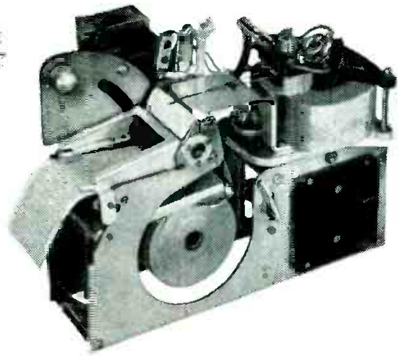
DIRECT WRITING RECORDERS



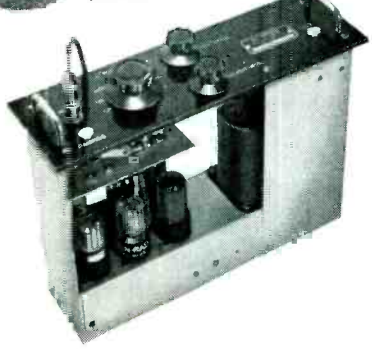
Records are produced by a heated writing stylus in contact with heat sensitive paper. The paper is pulled over a sharp edge in the paper drive mechanism (standard speed 25 mm/sec., slower available) and the stylus wipes along this edge as it swings, thus producing records in *true rectangular coordinates*. The writing arm is driven by a D'Arsonval moving coil Galvanometer with an extremely high torque movement (200,000 dyne cms per cm deflection).

This recorder assembly may be obtained in bare chassis form, as illustrated (51-600) with or without built-in timer; or, with the addition of a stylus heating transformer, temperature controls, and control panel (127); or, with the entire assembly, controls and control panel enclosed in a mahogany carrying case (127C). Complete catalog available, see below.

SINGLE CHANNEL

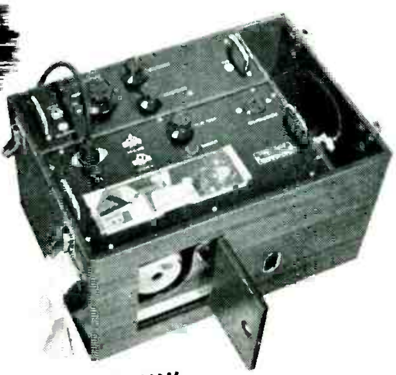
NO INK
RECTANGULAR COORDINATES
PERMANENT RECORDS

INSTRUMENT AMPLIFIERS



A general purpose, A.C. operated driver amplifier for use with model 127 Recorder, comprising three direct coupled push-pull stages. Maximum sensitivity 50 mv. per cm., minimum sensitivity 50 volts per cm., with four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

AMPLIFIER-RECORDERS



Model shown at right is a single channel unit comprising above Amplifier 126 and Recorder 127, contained in one mahogany carrying case, and designed for use in the industrial field as a direct writing vacuum tube recording voltmeter capable of reproducing any electrical phenomena from the order of a few millivolts to more than 200 volts. More complete data in catalog shown below.

At lower right is a typical "Poly-Viso" multiple channel direct writing Recorder and Amplifier in console. Numerous combinations of this recording equipment and associated amplifiers and accessories are available. The Multi-channel Recorder (Model 165) provides for the simultaneous registration of *up to four* input phenomena, using the same principles and method as for the Recorder Assembly above. In addition, the "Poly-Viso" Recorder provides a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec., and for the use of 4, 2, or 1 channel recording Permapaper. The Amplifier equipment is housed in a rack which has space for four individual driver amplifiers (electrically identical to model 126, above) and one 4-channel preamplifier.

MULTI-CHANNEL

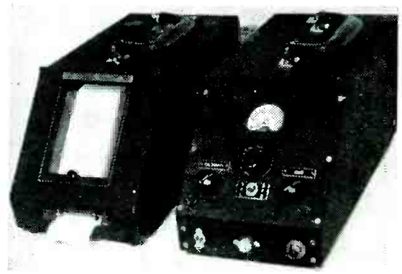
NO INK
RECTANGULAR COORDINATES
PERMANENT RECORDS

For complete catalog giving tables of constants, sizes and weights, illustrations, general description, and prices, address:

SANBORN COMPANY
Industrial Division
CAMBRIDGE 39, MASS.

Sanborn Recorders and Amplifiers have evolved from those originally designed by Sanborn Company for use in electrocardiographs, and have, by actual practice, proven to have wide applications in the industrial field as well.

meter is an ionization type battery-operated, pistol-grip instrument. The ion chamber is approximately 600 cubic cm in volume. Three radiation intensity ranges of 0 to 50, 0 to 500, and 0 to 5,000 milliroentgens per hour are provided. The instrument is calibrated against a radium gamma ray source and is accurate to within 10 percent of full scale on all scales.



Recording Oscillograph

PHOTRON INSTRUMENT CO., 6516 Detroit Ave., Cleveland 2, Ohio, offers instantaneous recording on strip chart at frequencies up to 120 cps. The complete instrument includes amplifier and single or double-channel recorder. However, amplifier or recorder may be used separately. Chart speed is variable from zero to maximum speed.

Hi-Fi Mike

ELECTRO-VOICE, INC., Buchanan, Mich. The TV655 versatile microphone has ultrawide range and high-fidelity dynamic performance

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QUALITY COIL FORMS

Ensure Satisfaction!

CLEVELAND . . .

COSMALITE* spirally laminated paper base phenolic tubes are engineered and produced for those who must have quality performance with attractive prices and quick deliveries.

The outstanding choice in the industry for coil forms in all standard broadcast receiving sets and for permeability tuners . . . Cleveland Cosmalite is backed by over 25 years experience.

Consult us about our kindred products for both new and established needs in the electronic and electrical fields. For the best . . . "Call CLEVELAND!"

*Reg. U. S. Pat. Off.

See our Exhibit No. 207
at the I.R.E.
Radio Engineering Show

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

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

REPRESENTATIVES

CANADA	WM. T. BARRON, EIGHTH LINE, RR #1, OAKVILLE, ONTARIO
METROPOLITAN NEW YORK	R. T. MURRAY, 614 CENTRAL AVE., EAST ORANGE, N.J.
NEW ENGLAND	E. P. PACK AND ASSOCIATES, 968 FARMINGTON AVE. WEST HARTFORD, CONN.

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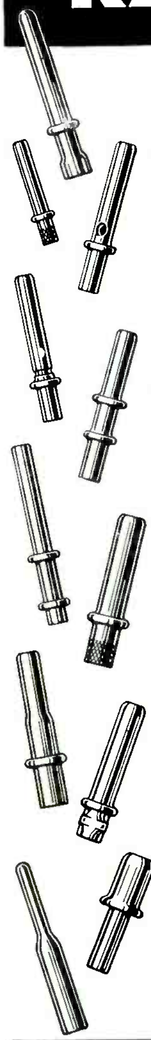
3 CLEAN-CUT ADVANTAGES OF *Seamless* [PATENTED] RADIO PINS



1 Extreme Uniformity

2 Superior Staking Qualities ...ends will roll without splitting

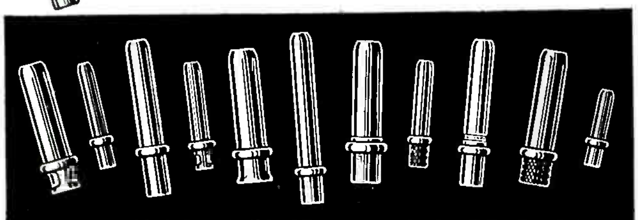
3 Better for Molded Parts ...closed end keeps compound out

If you use pins for vacuum tubes, adapters, fluorescent lamps, plugs, or electrical equipment of any kind, the chances are you'll save time, money and rejections by using these super-smooth, *seamless*, patented Radio Pins. They are available in a wide variety of styles and sizes, with staking end either closed or open. For a quotation, simply send a sketch, sample or description and state the quantity and finish you need.

SHEET METAL STAMPINGS?

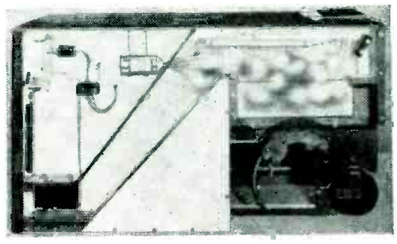
In addition to Radio Pins, we produce large quantities of top caps, base shells and adapter shells for vacuum tubes; also a wide variety of other metal products, including deep-drawn shells and cups, blanks and stampings, ferrules, grommets, washers, vents, fasteners—and, for almost every manufacturing requirement, the world's largest assortment of eyelets.

We invite your inquiry to the Waterbury Brass Goods Branch of The American Brass Company, Waterbury 20, Connecticut. 49407



FOR QUALITY BRASS GOODS— ANACONDA

and utility. It is omnidirectional and features peak-free response from 40 to 15,000 cps, plus or minus 2.5 db. Impedance is 250 ohms. The microphone without swivel is $8\frac{3}{4}$ in. long; diameter is $1\frac{1}{16}$ in.



Rat Trap

ELECTRONIC RAT TRAPS, INC., 80 W. Main St., Rochester 4, N. Y., has incorporated a new automatic insecticide device on each trap to eradicate the dreaded disease-bearing fleas and ticks from the rats' bodies while they are electrocuted in the electronic rat trap. As the electrically-charged death plate clamps down upon the rat, a single mechanism releases a jet-spray of insecticide into the corpse. Both rat and germs are dead when the body is released from the trap.

F-M Signal Generator

BOONTON RADIO CORP., Boonton, N. J. Type 202-D signal generator is designed for use with telemetering receiver equipment and in other associated applications. It covers the 175 to 250-mc range and is provided with three continuously adjustable deviation ranges: 0 to 24 kc, 0 to 80 kc and 0 to 240 kc. The internal audio oscillator provides

www.americanradiohistory.com

Nowhere does WESTON *dependability* and *value* pay bigger returns than on the panels or controls of electrical equipment. By consistently *telling the truth,* they help assure efficient performance of the equipment in users' hands . . . where *so much* depends on instrument performance. Moreover, the name WESTON on a panel instrument gains instant recognition . . . helps build buyer acceptance for the products on which they are installed. Available in types, sizes, ranges and styles for all needs. Ask your nearest WESTON representative for all the facts, or write for bulletin A-7-B. WESTON Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON
Panel Instruments

Albany • Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Jacksonville • Knoxville Little Rock • Los Angeles • Meriden • Minneapolis • Newark • New Orleans • New York • Orlando • Philadelphia • Phoenix • Pittsburgh • Rochester San Francisco • Seattle • St. Louis • Syracuse • Tulsa • Washington, D. C. • In Canada, Northern Electric Company, Ltd., Powerlite Devices, Ltd.

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KAY

SEE THESE

NEW INSTRUMENTS

at BOOTH 22, I.R.E. CONVENTION

AN ACCURATE TV RF PIX AND SOUND CARRIER MARKER

THE DUAL MEGA-MARKER SR.

New Features

- Provides both sound and picture RF markers on each TV channel (crystal controlled).
- Markers available at high level for use with TV tuners or receivers.
- Tone modulation may be switched on to sound carrier.
- 4.5 mc signal (crystal controlled) available at separate connector.
- Sound Carrier may be switched on or off.
- Attenuators available for RF and 4.5 mc signal.
- Frequency accuracy on Picture RF and 4.5 mc signal .01%. Picture and Sound Carrier Separation 4.5 mc ±500 cps.

PRICE: $350.00 F.O.B. Factory.

THE MOST ACCURATE ELECTRONIC INDICATOR OF INSTANTANEOUS SHAFT SPEED VS. TIME

THE ROTALYZER

New Features

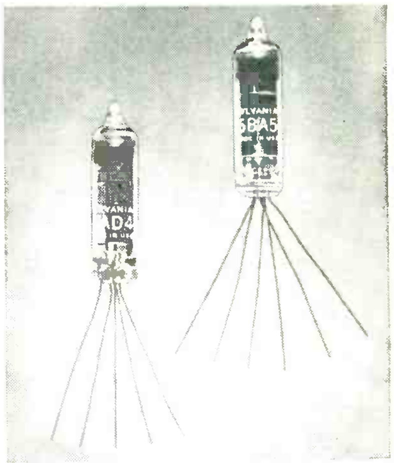
- Displays instantaneous shaft speed variations vs time on oscilloscope screen.
- Covers very wide range of shaft rpm.
- Reads average and instantaneous shaft speeds to very high accuracy.
- Indicates shaft speed variations which occur rapidly.
- Indicates very small variations in shaft speed.
- Accuracy of speed indication better than .1%. .01% at selected speeds.

PRICE: Pickup and Amplifier Analyzer $825.00 F.O.B. Factory.
Special Companion Oscilloscope $328.00 F.O.B. Factory.

Prices slightly higher outside U. S. A. and Canada.

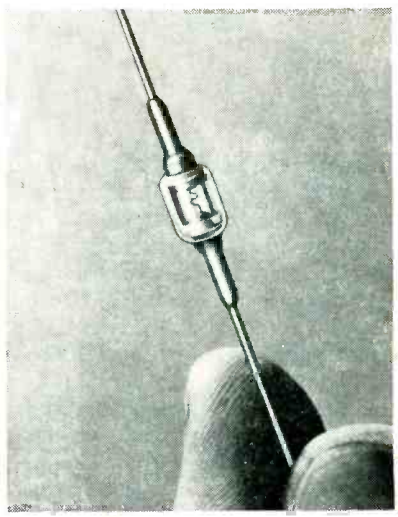
KAY ELECTRIC COMPANY
25 Maple Avenue
Pine Brook, N. J.
Phone CAldwell 6-4000

eight fixed frequencies between 50 cycles and 15 kc. Deviation sensitivity of the f-m system is within ± 0.5 db from d-c to 200 kc. The a-m system is substantially flat from 30 cycles to well above 100 kc. The instrument is designed for use on 115 volts, 60 cycles.



Subminiature Amplifier Tubes

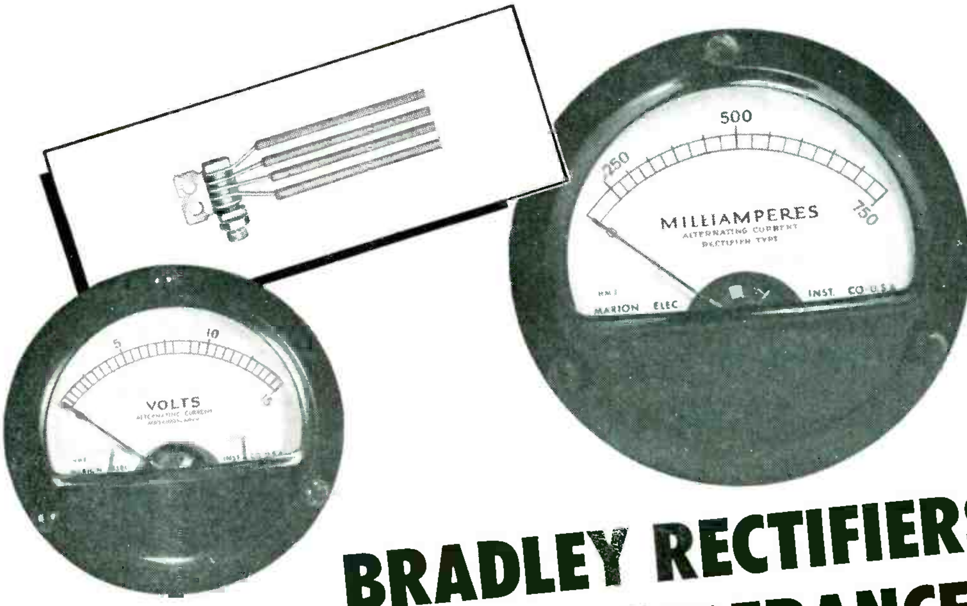
SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York, N. Y. Two new subminiature tubes have been designed for use as Class A a-f amplifiers or resistance-coupled



GLASS-SEALED CARTRIDGES for germanium diodes are proof against moisture and dust. Another wrinkle, apparent from the unit shown above, is the method of bringing out connection leads so that several units can be mounted side by side without danger of shorting. *Sylvania Electric Products Inc., 500 Fifth Ave., New York, N. Y.*

www.americanradiohistory.com

A BRADLEY CASE HISTORY



BRADLEY RECTIFIERS APPLY CORSET TO TOLERANCES

Lace a corset around something and you narrow down its digressions. Use Bradley vacuum processed rectifiers and much the same thing—in a stricter sense—happens to your power conversion requirements. Product performance improves, as it did for Marion Electrical Instrument Co. voltmeters and milliammeters.

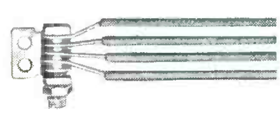
"In this particular application," reports Marion, "your rectifiers (Coprox Model CX2E4F) were of great assistance in supplying rectified type AC milliammeters which could be held, under varying temperature requirements, to much closer than normal tolerances."

That statement points up strongly the fact that the Bradley vacuum process produces rectifiers that contribute to performance. We just don't talk about uniformity in rating, predictable operating characteristics—our unique and exclusive vacuum process assures them.

For power conversion that is consistently and reliably true to rating, specify Bradley vacuum-processed selenium or copper oxide rectifiers. Our engineers are always available for consultation. Specify Bradley—your product will act better.

THE BRADLEY LINE

SELENIUM RECTIFIERS
•
COPPER OXIDE RECTIFIERS
•
SELF-GENERATING PHOTOCELLS



COPROX CX2E4F

SPECIFICATION DATA

Coprox CX2E Series — These instrument rectifiers are rated up to 4.5 volts A.C., 3 volts D.C., 5 milliamperes D.C. Available for all conventional circuits and for special current control applications. Size 7/16" x 1/4" x 3/8", 4 flexible leads. Two 7/64" diameter mounting holes.

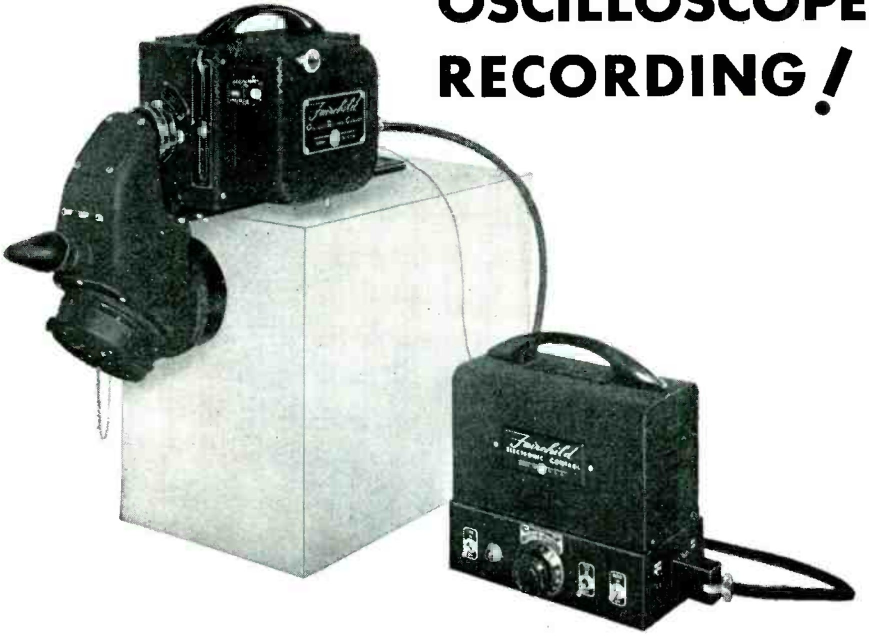
BRADLEY LABORATORIES, INC.

82 MEADOW STREET
NEW HAVEN 10, CONN.

www.americanradiohistory.com

here's your answer to problems in

OSCILLOSCOPE RECORDING!



FAIRCHILD *Oscillo-Record* CAMERA

This new engineering tool is finding more and more use in—

1. Recording of electronic circuit performance.
2. Comparison of performance after changes have been made.
3. Study of complex high-frequency signals.
4. Comparison of two or more simultaneous phenomena.
5. Telemetering.
6. Analysis of high-speed transients.
7. Monitoring of random transients.
8. Maintenance of laboratory records.

A remote control connection plus dynamic braking makes it possible to start and stop the camera automatically by the signal itself, thereby making a complete record of irregularly occurring phenomena without wasting film and without any attention on the part of the operator. Other features include:

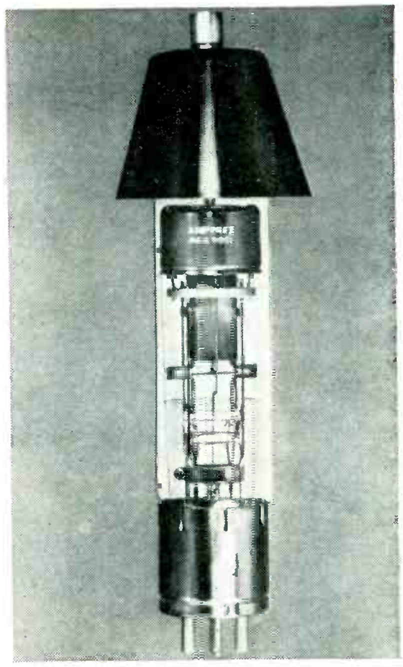
a) Sharp, clearly defined images on inexpensive 35mm film or paper; b) writing speeds up to 270 inches per microsecond; 20 seconds to 20 hours of recording on 100-ft. rolls of film, or 3⅓ minutes to 8⅓ days of recording on 1000-ft. rolls; d) no obstruction of oscilloscope controls; e) permits viewing of 'scope while photographing phenomena.

The Oscillo-Record Camera, designed by Fairchild in close cooperation with leading users and manufacturers of cathode-ray oscilloscopes, is the product of the world's foremost manufacturer of precision specialty camera equipment. It can be adapted to practically all 3-in. and 5-in. oscilloscopes.

Complete details may be obtained by writing to Dept. WS, Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

Fairchild
CAMERA AND INSTRUMENT CORPORATION

a-f amplifiers. Type 6AD4 triode has a mutual conductance of 2,700 micromhos; the 6BA5 pentode rating is 3,300 microhos. Both are enclosed in T-3 envelopes and are supplied with 6.3-v, 150-ma heaters.



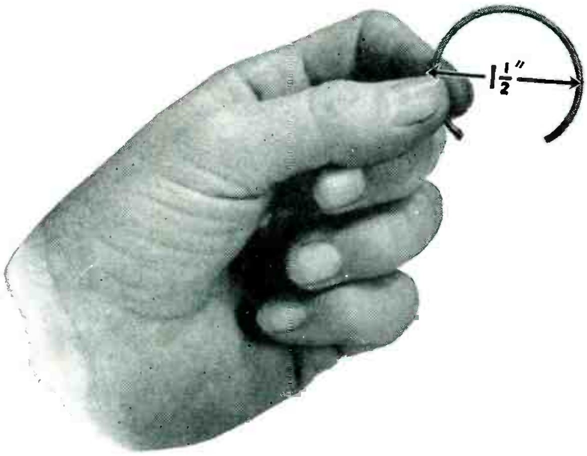
Mercury Vapor Rectifier

AMPEREX ELECTRONIC CORP., 25 Washington St., Brooklyn 1, N. Y. Type AGR-9951 grid-controlled mercury vapor rectifier tube has a maximum peak anode voltage of 21,000 volts. Filament heating time is two minutes. In a single-phase full-wave rectifier it can deliver an average current of 5 amperes.

Resistance Percentage Bridge

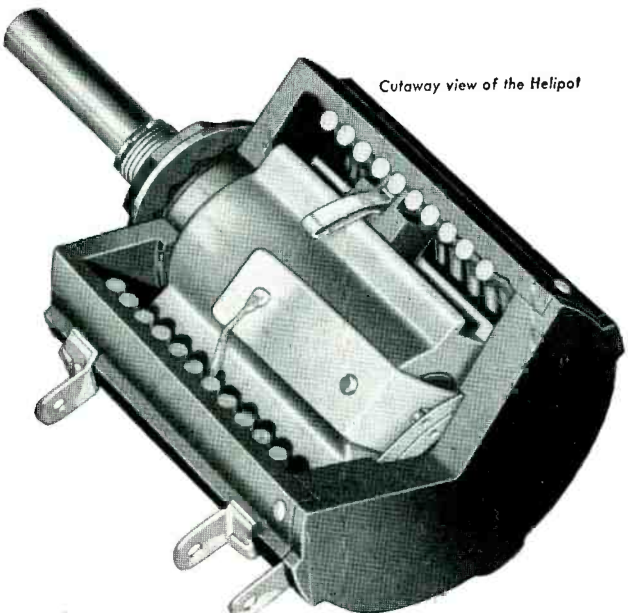
SPECIALTIES, INC., Skunks Misery Rd., Syosset, L. I., N. Y. Designed for testing and calibrating precision potentiometers, the bridge illus-

Compare! Here's the Helipot Principle that is Revolutionizing Potentiometer Control in Today's Electronic Circuits



CONVENTIONAL POTENTIOMETERS have a coil diameter of approximately 1½" and provide only 4" (about 300°) of potentiometer slide wire control.

THE BECKMAN HELIPOT has the same coil diameter, yet gives up to 46" (3600°)* of potentiometer slide wire control—nearly TWELVE times as much!



Cutaway view of the Helipot

*** HELIPOTS ARE AVAILABLE IN MANY SIZES:**

MODEL A—5 watts, incorporating 10 helical turns and a slide wire length of 46 inches, case diameter 1¾", is available with resistance values from 10 ohms to 300,000 ohms.

MODEL B—10 watts, with 15 helical turns and 140" slide wire, case diameter 3¼", is available with resistance values from 50 ohms to 500,000 ohms.

MODEL C—2 watts, with 3 helical turns and 13½" slide wire, case diameter 1¾", available in resistances from 5 ohms to 50,000 ohms.

MODEL D—15 watts, with 25 helical turns and 234" slide wire, case diameter 3¼", available in resistances from 100 ohms to 750,000 ohms.

MODEL E—20 watts, with 40 helical turns and 373" slide wire, case diameter 3¼" is available with resistance values from 200 ohms to 1,000,000 ohms.

Other types and designs of Potentiometers available.

Some of the multiple Helipot advantages

EXTENSIVELY used on precision electronic equipment during the war, the Helipot is now being widely adopted by manufacturers of quality electronic equipment to increase the accuracy, convenience and utility of their instruments. The Helipot permits much finer adjustment of circuits and greater accuracy in resistance control. It permits simplifying controls and eliminating extra knobs. Its low-torque characteristics (only one inch-ounce starting torque*, running torque even less) make the Helipot ideal for power-driven operations, Servo mechanisms, etc.

And one of the most important Helipot advantages is its unusually accurate linearity. The Helipot tolerance for deviations from true linearity is normally held to within ± 0.5%, while precision units are available with tolerances held to 0.1%, .05%, and even less—an accuracy heretofore obtainable only in costly and delicate laboratory apparatus.

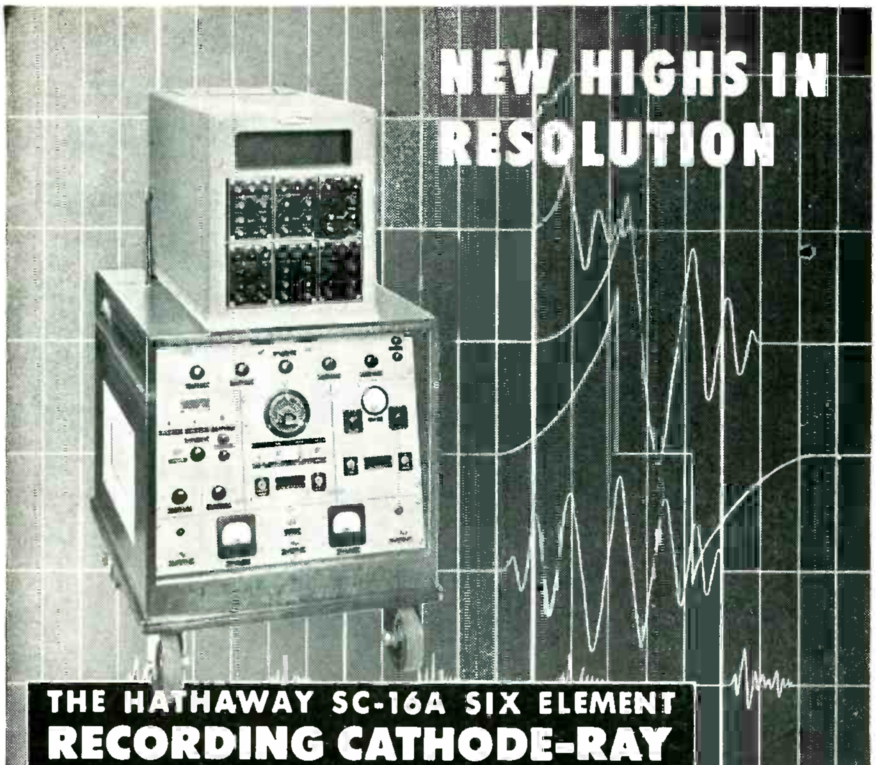
The Helipot is available in a wide range of types and resistances to meet the requirements of many applications, and its versatile design permits ready adaptation of a variety of special features, as may be called for in meeting new problems of resistance control. Let us study your potentiometer-rheostat problem and make recommendations on the application of Helipot advantages to *your* equipment. No obligation of course. Write today.

* *Data is for Model A unit*

Send for the New Helipot Booklet!

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

www.americanradiohistory.com



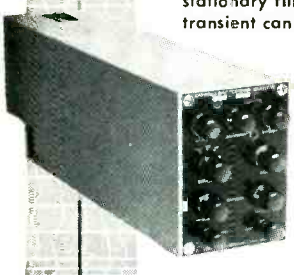
THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY
OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long as speeds up to 6000 inches per second
WRITING SPEED above 100,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
- AUTOMATIC INTENSITY CONTROL.
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.

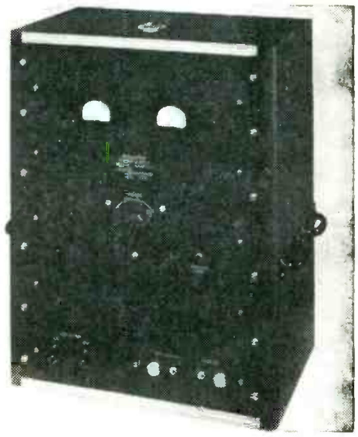


Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2 G1G

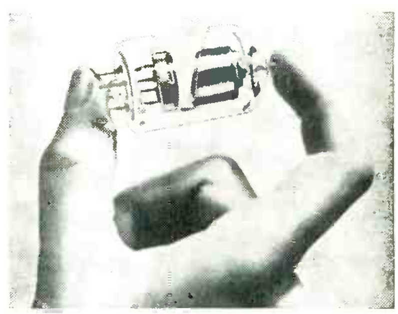
Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

trated measures the percentage of total potentiometer resistance tapped in at any mechanical setting of the potentiometer wiper arm. Accuracy is better than 0.01 percent at all settings from 0 to 100 percent of total resistance. The unit incorporates a modified Wheatstone bridge circuit and operates from 110-volt, a-c power or from a low-voltage d-c source.



Regulated Power Source

FURST ELECTRONICS, 12 S. Jefferson St., Chicago 6, Ill. Models 1110 and 1110-A power supplies were designed for laboratories, test-stations on production lines and similar applications. They produce d-c power at constant output voltages, independent of variations of power-line voltage and of currents drawn by the load. Output is 0.5 kw maximum. Power consumption is about 1,500 watts at full load from a 115-volt (nominal), 50 or 60-cycle single-phase a-c power line.



Dental Radiography Tube

AMPEREX ELECTRONIC CORP., 25 Washington St., Brooklyn 1, N. Y., has announced the Mini-X 045A

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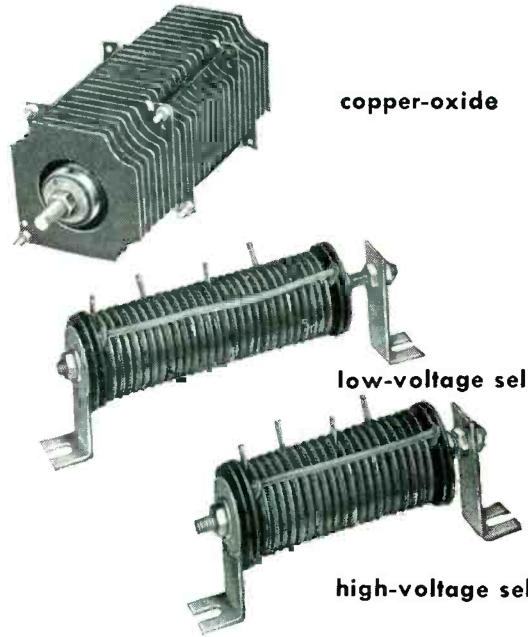
And which Metallic Rectifier Is Best?



copper-oxide

low-voltage selenium

high-voltage selenium

No one type is "best." Each type of rectifier has characteristics which make it a "natural" for a particular application. For every application there is usually one best type. The correct choice depends upon the application. Here are general recommendations!

GENERAL RECOMMENDATIONS

Where you want	*Use*	*Because*
Small size	High-Voltage Selenium	Except for 12 volts and below, fewer high-voltage selenium cells are needed.
Light Weight	High-Voltage Selenium	Selenium-on-aluminum cells are much lighter than copper-oxide.
High Power for a few seconds	Copper-Oxide	Both types will withstand high short-time *current* overloads but only copper-oxide will withstand the higher a-c voltage necessary to deliver short-time high power output.
High current with Low Voltage	Fan Cooled Copper-Oxide	While with fan cooling, selenium can operate at higher current densities than copper-oxide, efficiency will be lower. Copper-oxide aging remains stable.
High Voltage	High-Voltage Selenium	Fewer selenium cells are required.
Low Current at 6 volts or less	Copper-Oxide	Cell for cell, copper-oxide costs less than selenium. Where the minimum number of cells of either type is required, copper-oxide will be cheaper.
Long life with unchanged output	Copper-Oxide	While both types appear to have unlimited life. Characteristics of copper-oxide do not change after the first 6 to 12 months of continuous operation. Selenium continues to age—to build up internal resistance with time and particularly with high current densities.
Blocking in D-C Circuits	Copper-Oxide	Selenium tends to "unform" when used as a check valve in d-c circuits or when idle for a period of time (though it reforms quickly when reverse voltage is impressed).
Resistance to Corrosive Atmosphere	Oil-Filled Selenium	Stacks are hermetically sealed in oil, protected against fumes, dirt and dust.

Low-voltage selenium is generally recommended as a compromise between copper-oxide and high-voltage selenium. Where some of the features of both high-voltage selenium and long life copper-oxide are desired, low-voltage selenium would be a logical choice.

To fully meet your needs General Electric makes all three types. If you have a rectifier problem, bring it to us. As we make all three types, we play no "favorites." You can expect an impartial recommendation. Contact your G-E Apparatus Agent or write *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

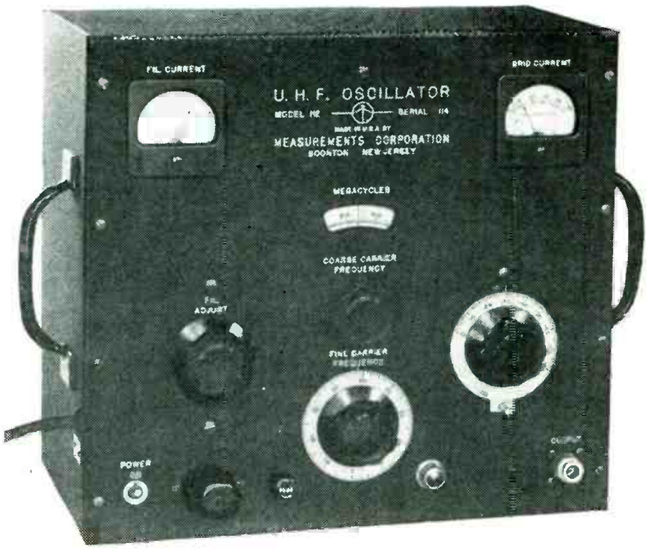
461-7

www.americanradiohistory.com

UHF OSCILLATOR

FREQUENCY RANGE:

300 Mc. to 1000 Mc.



The MODEL 112 Provides A Signal Source For The Measurement Of—

- STANDING WAVES ON TRANSMISSION LINES
- ANTENNA PATTERNS
- FILTERS
- ATTENUATORS

Also for Alignment and Tracking of UHF Receivers and for many other applications.

MODEL 112

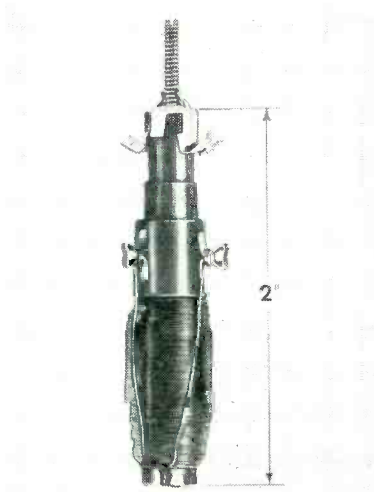
THIS oscillator was designed for the many applications in ultra-high frequency engineering that require a high degree of frequency accuracy and stability. The direct-reading frequency dial is individually calibrated to an accuracy of ±0.5%.

An output dial, calibrated in decibels, permits relative voltage measurements within a ratio of 100 to 1.

FREQUENCY RANGE: 300 to 1000 Megacycles
FREQUENCY CALIBRATION ACCURACY: ± 0.5%
OUTPUT VOLTAGE: Maximum varies with frequency between 0.3 volt and 2 volts. Adjustable over 40 db range
OUTPUT IMPEDANCE: 50 ohms
POWER SUPPLY: 117 volts; 50-60 cycles; 60 watts
DIMENSIONS: 12½" x 13½" x 8". Weight 22 lbs.

MEASUREMENTS
CORPORATION
BOONTON NEW JERSEY

tiny x-ray tube for use in dental radiography. It measures 2¼ in. in length (including the pins), has a diameter of 1⅛ in. and a focal spot of 0.8 square mm. It operates at 45 kv and 7 ma.



Horizontal Linearity Control

RADIO CORP. OF AMERICA, Harrison, N. J. Type 207R1 variable inductor is designed for adjusting horizontal linearity of the picture on 10 and 12-inch kinescopes. Utilizing a powdered-iron core, it is intended for operation with the 217T1 horizontal-deflection-output and high-voltage transformer and the 205D1 deflecting yoke. Ratings, characteristics and dimensional outline are given in a single-page bulletin.

Regulated Power Supply

OREGON ELECTRONIC MFG. CO., 206 SW Washington St., Portland 4, Oregon. Model A3 regulated power supply features flexible continuously variable d-c voltage output from 0 to 400 with 0.5-percent reg-

www.americanradiohistory.com

THIS MAN WOULDN'T NEGLECT

A MACHINE IN HIS PLANT

...yet he hasn't had a Chest X-Ray!

He checks every piece of mechanical equipment he owns for wear, lubrication, efficiency.

Yet he fails to take the simple precaution of a Chest X-Ray to make sure he does not have tuberculosis. *Not because he's opposed to the X-Ray. Simply because he is not sufficiently informed—or just hasn't taken the time and trouble, or does not realize the seriousness of the problem.*

A Chest X-Ray is the first step toward detecting tuberculosis in its early stages. And in its early stages it can be cured with the least loss of time from work.

So, if you're the man above, that one simple reason should make you get your Chest X-Ray—*today.* But listen, see how serious this really is:

Between the ages of 15 and 34, tuberculosis leads all other diseases as a cause of death—although at no age are you safe from TB. Yet, if everyone does his part by getting a Chest X-Ray periodically, and the majority of cases thus discovered are followed up, we can eliminate TB entirely as a public health hazard!

Will you do your part today? Get a Chest X-Ray. It may mean your life!

Published in the public interest by:

McGRAW-HILL PUBLICATIONS

www.americanradiohistory.com

PANORAMIC RADIO PRODUCTS, Inc.

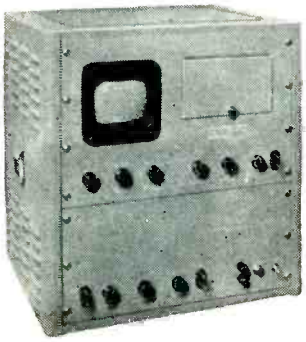
Cordially invites you to attend dynamic demonstrations of panoramic spectrum analyzers at the I.R.E. National Convention, Booth Z, March 6th-9th.

Long recognized as being unexcelled for laboratory, research and production applications requiring spectrum or waveform analysis, these instruments help collect data more quickly, simply and accurately.

Spectral components are graphically visualized on a cathode-ray tube as vertical deflections distributed horizontally in order of frequency. Deflection height directly indicates signal level.

Whether your problem is investigating the characteristics of AM, FM or pulsed signals, spurious oscillations or modulation, cross modulation, etc., or monitoring many frequency channels simultaneously, it will pay you to see these panoramic analyzers in actual operation.

AS EXHIBITED AT THE SPOTLIGHT THE NEW... RADIO ENGINEERING SHOW



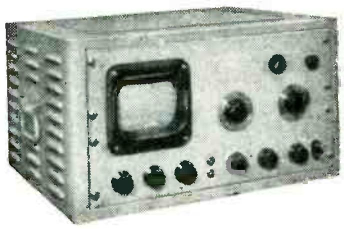
PANORAMIC SONIC ANALYZER, MODEL AP-1
Automatic Waveform Analysis in Only 1 Second

Accepted as the practical answer for truly simple high speed analysis of vibrations, noises, harmonics, intermodulation and acoustics, the AP-1 automatically separates and measures the frequency and magnitude of complex wave components.

Frequency Range:	40-20,000cps, log scale
Input Voltage Range:	500uv-500V
Voltage Scale:	Linear and two decade log
Direct Reading and	Simple operation

Can be calibrated to determine sound level of components. Presentations easily photographed or recorded.

PANORAMIC ULTRASONIC ANALYZER, MODEL SB-7
A New Direct Reading Spectrum Analyzer



An invaluable new instrument for monitoring, telemetering, and for investigating ultra audible noises and vibrations, the SB-7 allows overall observation of a 200KC wide band or highly detailed examination of selected narrow segments in the ultrasonic region.

Frequency Range:	2KC-300KC, linear scale
Scanning Width:	Continuously variable from 200KC to Zero
Amplitude Scale:	Linear and two decade log
Input Voltage Range:	Imv-50V
Scanning Rate:	6.7cps (approx.)

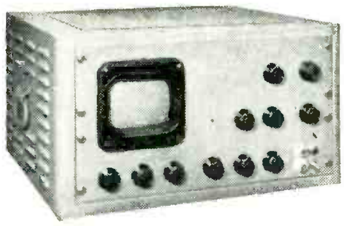
PANADAPTOR SA-3, SA-6 PANALYZOR SB-3, SB-6
For General RF Spectrum Analysis

Recognized as the fastest and simplest means of investigaing 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.

PANADAPTOR, SA-8 PANALYZOR SB-8
For RF Spectrum Analysis where Maximum Resolution is a "Must"



Available in several types with maximum scanning widths ranging from 200KC to 20MC, both the SA-8 and SB-8 feature.

- Continuously Variable Resolution from 250KC 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

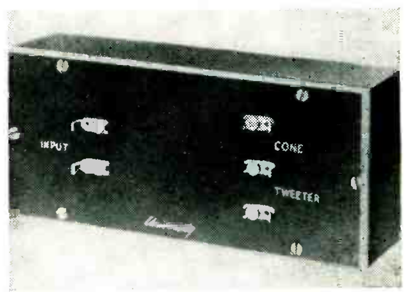
Write Dept. E3 for complete specifications and prices.

PANORAMIC RADIO PRODUCTS Inc.
10 SOUTH SECOND AVE. MOUNT VERNON, N. Y.

ulation at loads from 0 to 200 ma. Other outputs are: 400 v d-c unregulated, 0 to −150 v d-c variable and stabilized, and 6.3 v a-c at 5 amp. Output ripple voltage is less than 10 mv. A 40-μf capacitor may be switched across the regulated output to accommodate large peak-current loads.

Pencil-Type Iron

ELECTRIC SOLDERING IRON CO., INC., Deep River, Conn. The new No. 61 pencil iron is 7 in. long and weighs 2.5 ounces exclusive of cord. Handle temperature at the point where held in fingers is no higher than body temperature. A plug-type tip is held in place with a set screw. The iron is regularly wound to 25 watts at 105 to 120 volts.



Filter Network

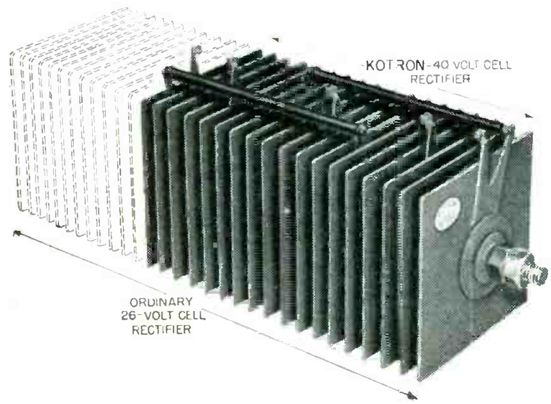
UNIVERSITY LOUDSPEAKERS, INC., 80 South Kensico Ave., White Plains, N. Y. Model 4410 filter network, for use with coaxial or duplex loudspeaker systems, provides a proper attenuation rate at a crossover of 600 cycles. It was designed primarily for use with the new h-f tweeter and is especially recom-

www.americanradiohistory.com

KOTRON

THE NAME TO REMEMBER IN SELENIUM METALLIC RECTIFIERS

KOTRON Multi-volt cells are the only industrial rectifiers blocking 40 volts rms per cell with the same current density as ordinary 26 volt cells — They save weight, size and cost and have higher efficiency.



KOTRON'S amazingly new capillary stop-gap current collector . . . perfect protection against moisture.

No center contact — no slotted petal contact.

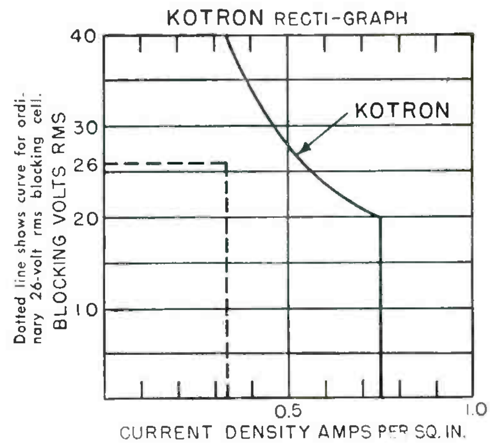
KOTRON 3-phase high voltage rectifier. 3 cells in series per arm block 120 volts rms 0.5 Amp. per sq. in. of actual rectifying area. Keyed square cells deliver 20% more current in the same space occupied by round cells.

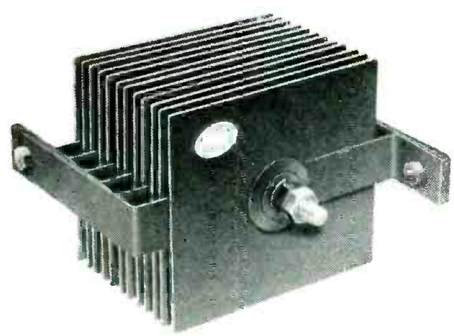
The **KOTRON** recti-graph tells the story

KOTRON blocking 40 volts rms per cell has the same current density as ordinary 26 volt cells.

KOTRON blocking 26 volts rms per cell has 1.6 times current density of ordinary 26 volt cells.

KOTRON blocking 20 volts and downward has 2.2 times the current density of ordinary 26 volt cells. High or low voltage, **KOTRON** sets new standards.





KOTRON high current selenium rectifier. 3-phase, half-wave rectifier stack. Occupies but 90 cu. in. volume. Delivers 12 volts at 500 amps fan cooled or 2.2 times the current density of ordinary 26 volt cell rectifier having 180 cu. in. volume.

Echelon terminal structure eliminates soldered, riveted or screw connections.

KOTRON specialized engineering consulting service available to help you with your rectifier problems. Details on request.

FREE — technical bulletins, data and literature available for design engineers and manufacturing executives requesting same on Company stationery.

Telephone HUmboldt 2-2400

NEMA

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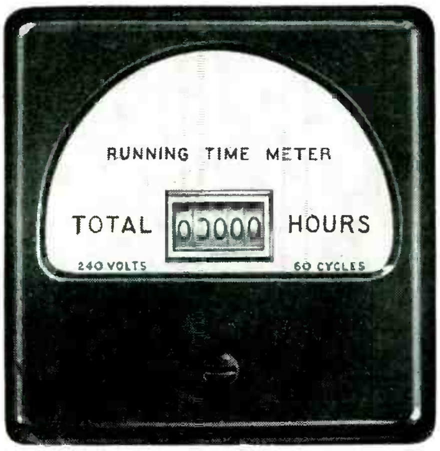

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- —55 to +55° C operating temperature

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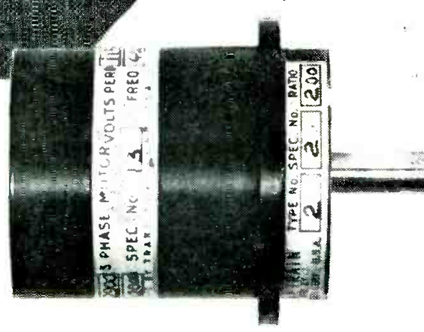

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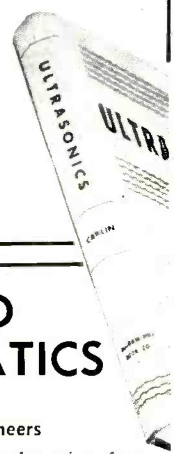

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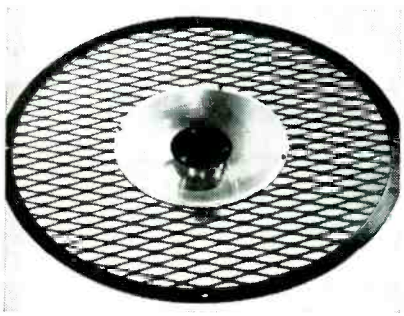

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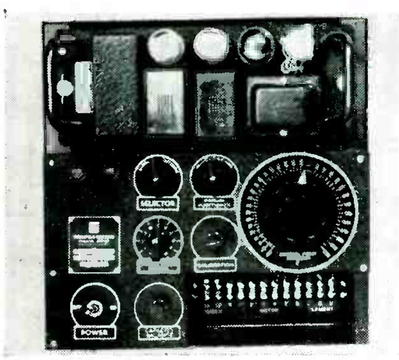

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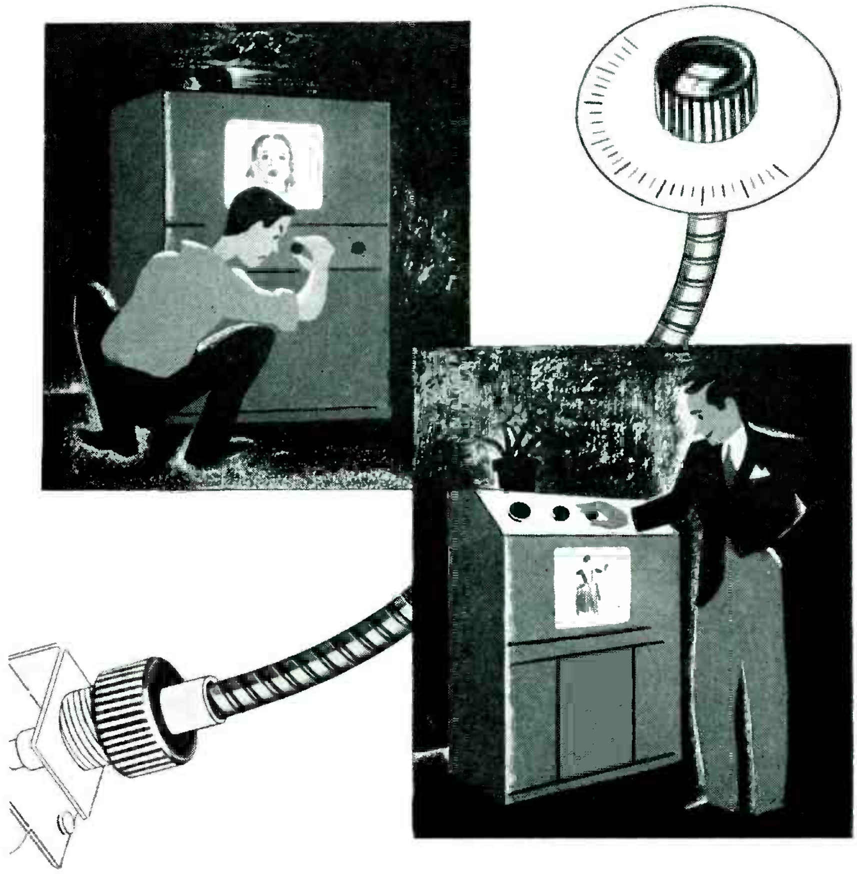

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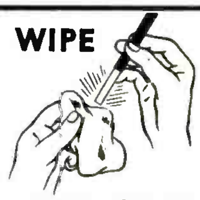

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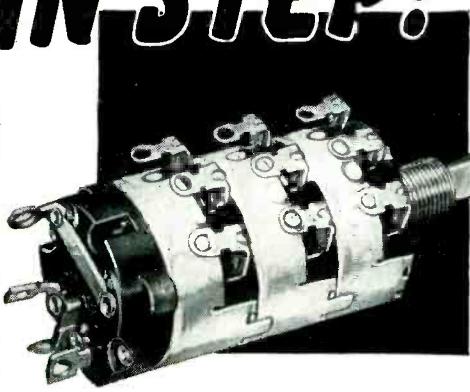

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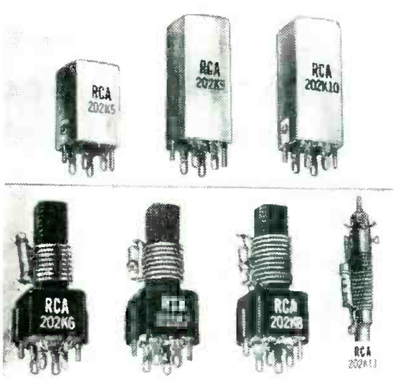

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RADIO CORP. OF AMERICA, Harrison, N. J. New picture i-f components giving improved sensitivity, selectivity and response are as follows: the 202K5 converter transformer; 202K6, 202K7, 202K8, 202K9 and 202K10 picture i-f transformers; and 202K11 cathode-circuit trap. These units, tuned by conveniently adjustable cores are designed for a sound i-f carrier of 21.25 mc and a picture i-f carrier of 25.75 mc.

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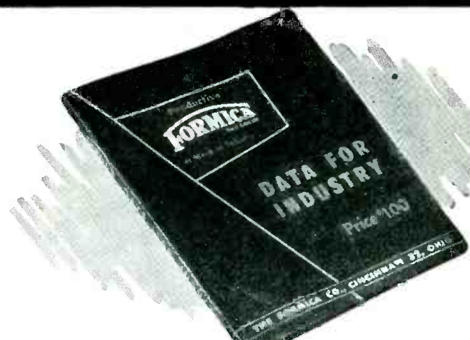

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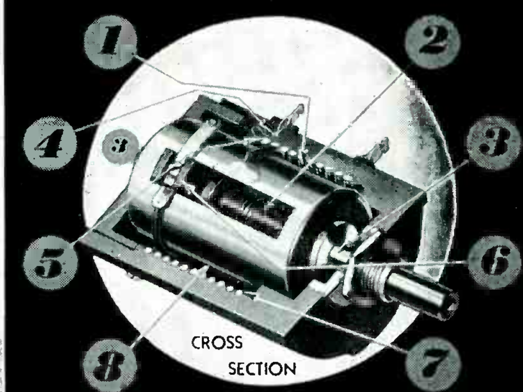

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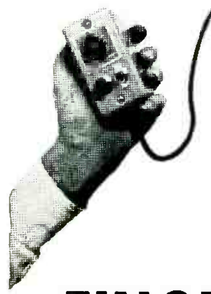

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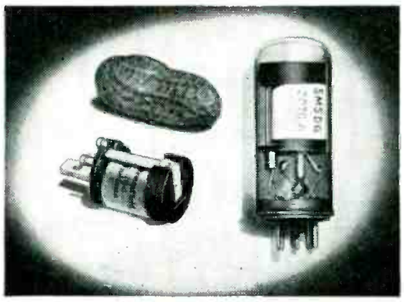

Subminiature Relay

POTTER AND BRUMFIELD, 549 W. Washington Blvd., Chicago 6, Ill. Model SM subminiature relay is available with windings as high as 8,000 ohms and adjustment for current operation to pull in as low as 3 ma, with coil consumption of 75 mw minimum. The standard model, wound for d-c voltage actuation, draws approximately 0.5 watt, but the coil size will permit a maximum dissipation of 1.75 watts at 83 deg C rise. It is available in either the open type or hermetically sealed in a miniature glass tube envelope with a 7-prong base.

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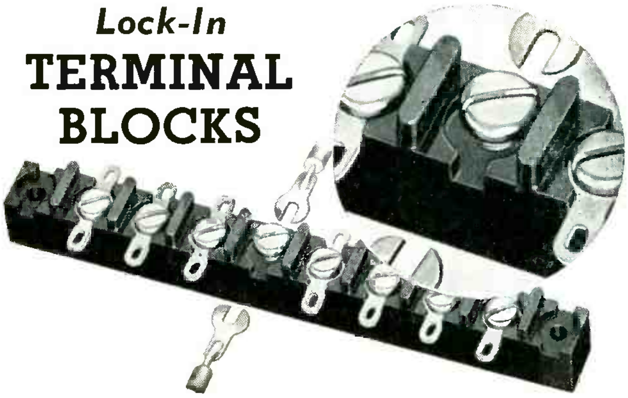

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S-38A	9000 C.T.	4-8-16	25	12.50
S-40A	2500 C.T.	4-8-16	30	12.50
S-42A	4500 C.T.	4-8-16	50	17.50
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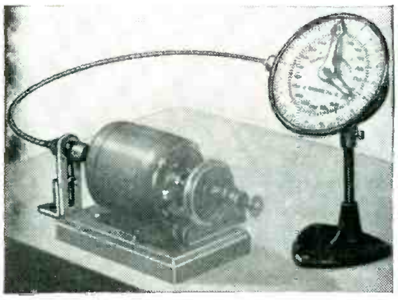

Coil Winding Counter

PRODUCTION INSTRUMENT CO., 710 W. Jackson Blvd., Chicago 6, Ill. The Clipper quarter-turn coil winding counter will count to speeds of 10,000 turns per minute. Equipped with a 6-inch dial which indicates 2,500 turns and repeats, it automatically deducts turns taken off the coil in case of overrun.

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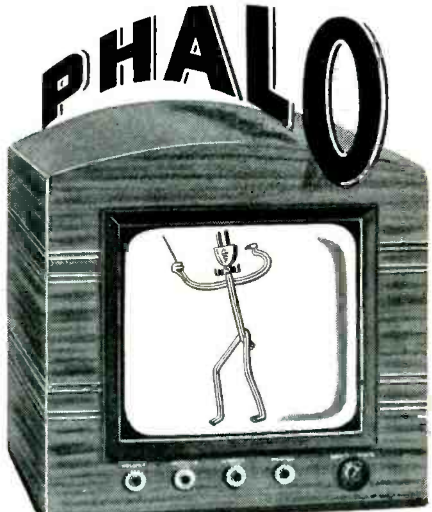

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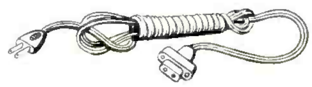

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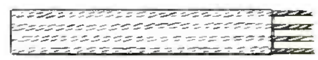

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Ultrasonic Soldering Iron

MULLARD ELECTRONIC PRODUCTS LTD., Shaftesbury Ave., London WC2, England, has developed the type E7587 ultrasonic soldering iron for soldering aluminum and other light metals and alloys. It consists essentially of a removable copper soldering bit and a magnetostriction transducer. The soldering bit, heated by means of a conventional resistance winding, is secured to a brass block held in firm contact with the nickel core of the transducer. The ultrasonic power necessary to drive the transducer is supplied by an electronic amplifier comprising the power supply unit.

Literature

Video Oscilloscope. Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J. A well-illustrated description of the FTL-32A video oscilloscope is given in a recent four-page folder. Special features of the unit treated are a vertical amplifier bandwidth of 10 cps to 50 mc, and a horizontal amplifier bandwidth of 10 cps to 10 mc. Full technical characteristics are given.

Audio Instruments. Audio Instrument Co., 1947 Broadway, New York 23, N. Y. A recent one-page bulletin illustrates and describes the following audio instruments: Model 100 bridger, model 121 logger, model 140 disc-noise meter and models 12 and 14 miniature preamplifiers for use with the 640 AA condenser microphone.

Tube Base Connections. Tung-Sol Lamp Works, Inc., 95 Eighth Ave.,

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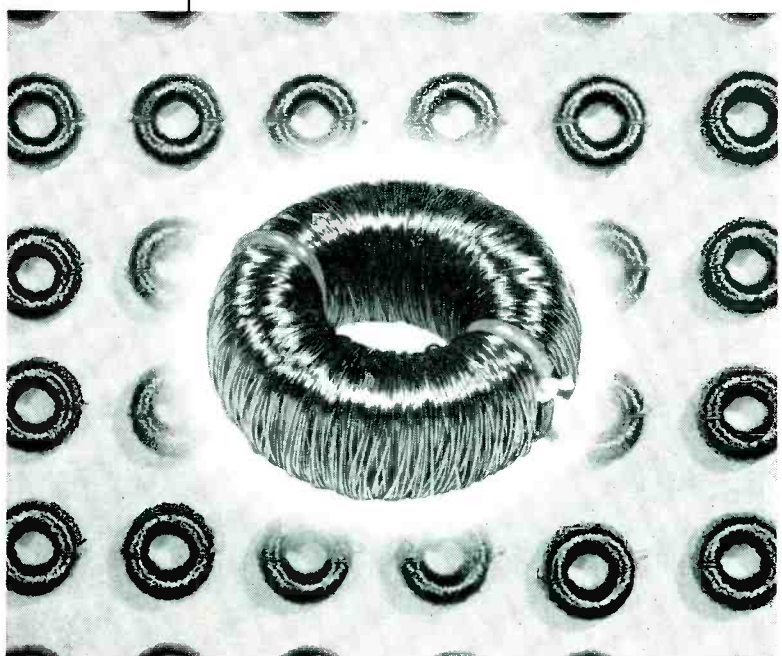

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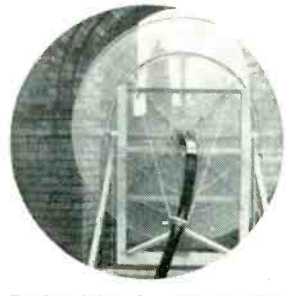

Titeflex Waveflex Waveguides used in television transmission. Assembled lengths of Waveflex over 30 feet long connect movable antenna with transmitter inside building. Antenna is directed at Empire State Bldg. faintly visible in background.

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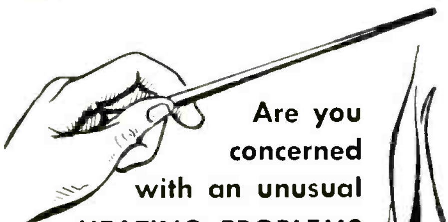

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Newark 4, N. J., has published a 3 × 3-in. book containing 301 base diagrams of nearly 800 different electron tubes. Its convenient size and form enable the radio-tv serviceman to manipulate it in the palm of one hand with the pages always lying flat. Price is 50 cents.

Self-Locking Nuts. The Palnut Co., 77 Cordier St., Irvington 11, N. J. A new four-page folder gives details of construction savings and assembly with washer-type self-locking nuts on sheet metal products and components. It outlines assembly procedures and shows many typical applications on electrical equipment, radio and television.

Multiple Power Supply. Kepco Laboratories, Inc., 149-14 41st Ave., Flushing, N. Y. A single-sheet bulletin treats of the model 103 multiple power supply. Chief features, specifications and principles of operation, as well as an illustration of the unit are given. The instrument described is particularly designed for laboratory tests and experiments.

Polystyrene. Plax Corporation Division, Hartford-Empire Co., P. O. Box 1019, Hartford 1, Conn., has published a pocket-size booklet summarizing recommended techniques for machining and working with polystyrene. It covers the use of coolants, sawing, turning, milling, drilling, threading, tapping, grinding, annealing, polishing, forming, cementing, die-cutting and checking for stresses.

Tele Relay Link. Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J. The FTL-27-A television uhf radio relay link, intended as an stl, intercity relay, or a portable remote pickup system, is fully treated in a four-page folder. Each of the parts is illustrated and technically described. The system covered operates in the 1,990 to 2,110-mc band.

Spectrophotometry. National Bureau of Standards, Washington 25, D. C. Circular 484 is a 48-page illustrated booklet written to help users of spectrophotometers to

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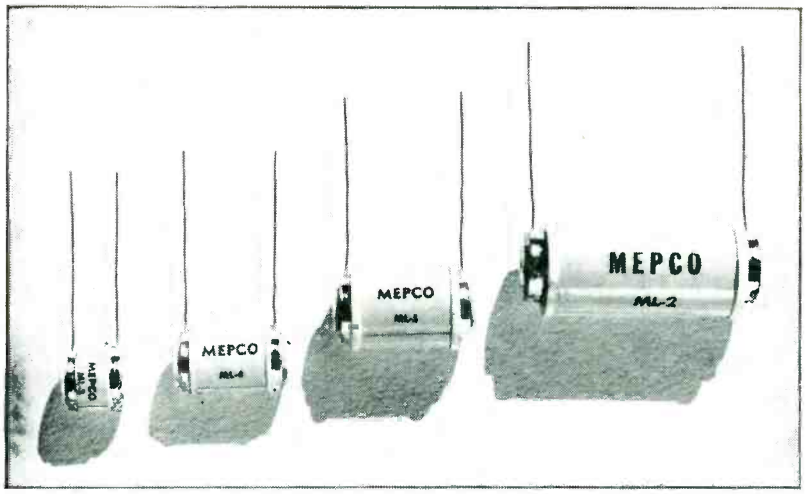

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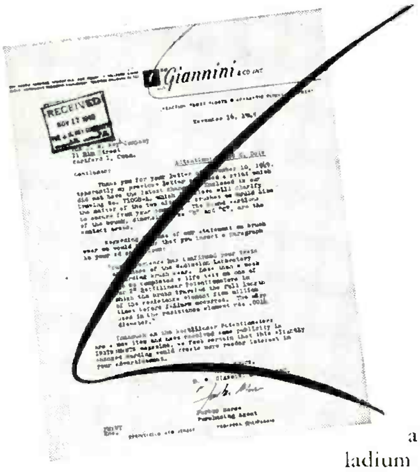

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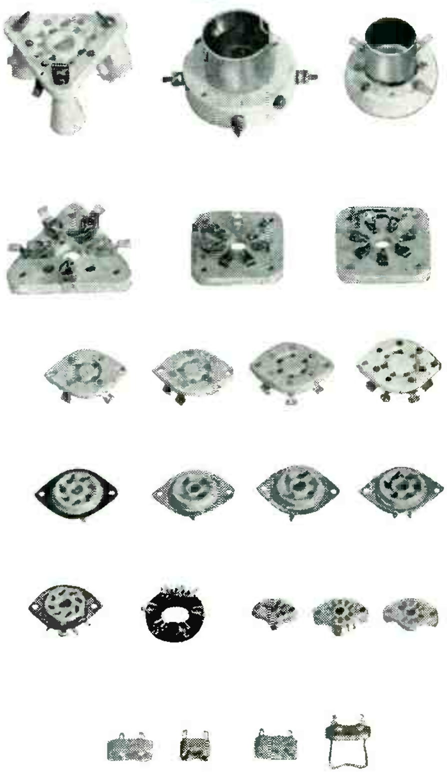

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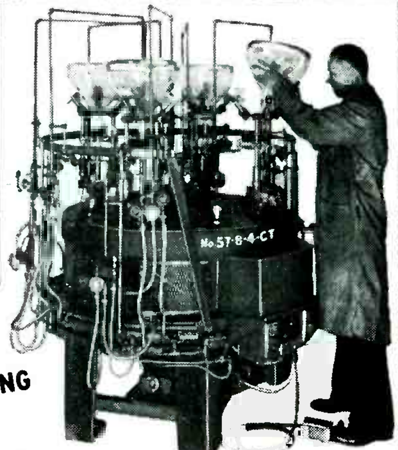

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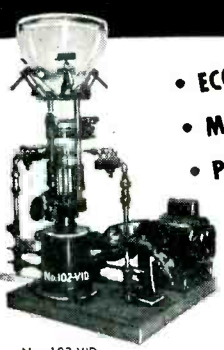

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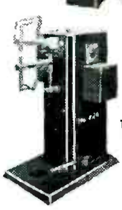

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better understand their instruments, calibrate and maintain them in the proper operating condition, and guard against the numerous errors common in such work. Instruments and methods for use in the ultraviolet, visible and near-infrared spectral regions are considered, including photographic, visual and photoelectric methods. The booklet is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 25 cents a copy (do not send stamps).

Two-Way Radios. Communications Co., Inc., Coral Gables, Miami 34, Florida. A recent folder illustrates and describes a line of vhf f-m low-drain two-way radios. Among the units covered is the small model for mounting under the dash or seat of a taxicab or other vehicle.

Transformer Catalog. Peerless Electrical Products Division, Altec Lansing Corp., 161 Sixth Ave., New York 13, N. Y. Catalog 1950-1 contains new models as well as a complete line of transformers for broadcasting and other professional applications, for amplifier constructors, audio enthusiasts, the replacement field and hams.

Filter Information. Cinema Engineering Co., 1510 West Verdugo Ave., Burbank, Calif., has issued catalog 12-E, an 8-page supplement to its general catalog 11-A. It is primarily a case study showing the use of equalizers and filters, and includes the use of fixed and variable high and low-pass filters for use in recording and reproducing lateral cut discs.

Selenium Rectifiers for Industry. Radio Receptor Co., Inc., Seletron Rectifier Division, 251 W. 19th St., New York 11, N. Y., has prepared a 4-page folder showing industrial applications of a line of selenium rectifiers in units up to 75-kw. Illustrated and described are typical installations used in theatres, electroplating and similar processes, elevator motor supplies and power packs for d-c motors.

Adjustable Speed. General Electric Co., Schenectady 5, N. Y. A 24-page, two-color booklet (GEA-

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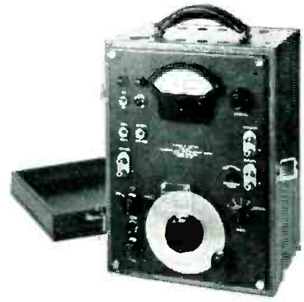

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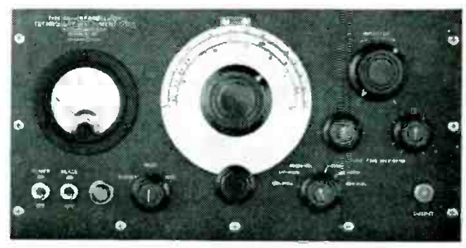

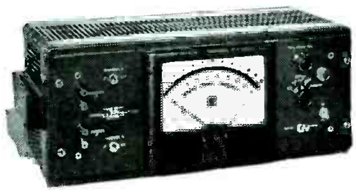

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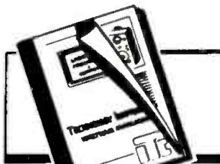

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Voltage Regulators. Sorensen and Co., Inc., 375 Fairfield Ave., Stamford, Conn. Catalog A-1049 contains complete specifications and description of the many standard voltage regulators for the control of a-c power, including new sizes and types not previously listed. Number B-1049 lists and describes the line of d-c power sources and supplies, also listing many new instruments not previously shown. Basic circuits and performance curves are included.

Instrument Transformers. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Booklet B-4319 describes construction features of a full line of instrument transformers. Methods of insulating current and potential transformers using oil, plastic, or dry-type construction are explained for all voltage classes. Illustrations show how impulse levels are coordinated and built up to provide a high degree of protection against surges.

Subcarrier Discriminator. Electro-Mechanical Research, Inc., Ridgefield, Conn., has issued a single-sheet bulletin on a discriminator which converts frequency-modulated signals to intelligence signals suitable for actuation of recording galvanometers or other devices matching the output impedance of 330 ohms. With the instrument described, by means of suitable plug-in units, any center frequency from 400 cps to 70 kc may be employed, the modulation or intelligence frequency ranging from d-c to several percent of the carrier frequency.

Pulse Transformers. Raytheon Mfg. Co., Waltham, 54, Mass., offers a chart giving complete data on a line of pulse transformers

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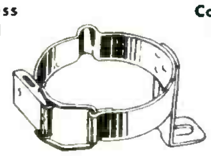

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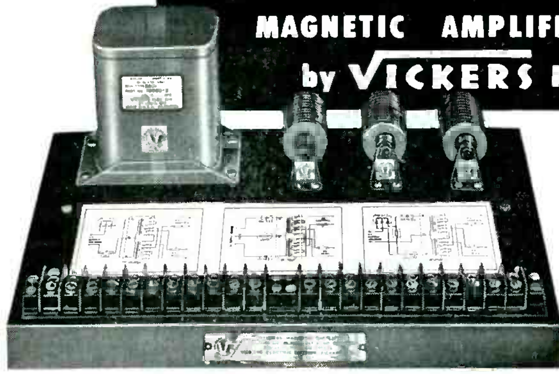

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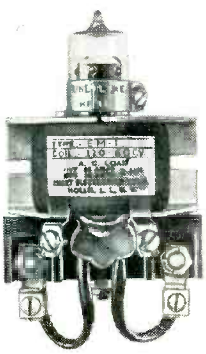

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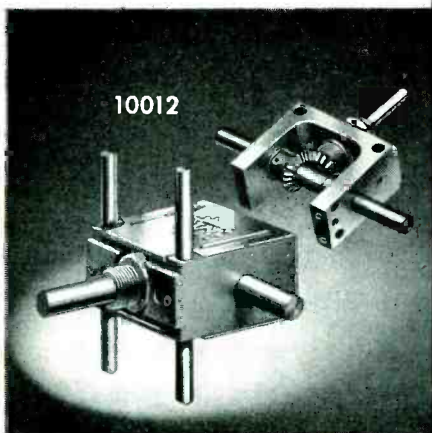

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Electro-Optical Instruments. The Perkin-Elmer Corp., Glenbrook, Conn. The first issue of a quarterly publication on modern electro-optical instruments in industry was recently released. An article in this issue on improvements in the d-c amplifier is of particular interest.

Hermetic Seals. Hermetic Seal Products Co., 29–37 S. Sixth St., Newark 7, N. J. A 16-page catalog presents information on many types of hermetic seals. It should be of interest to manufacturers or users of relays, transformers, capacitors, filters, or any components in which hermetic seals are used.

Special Transformers. Nothelfer Winding Laboratories, 111 Albemarle Ave., Trenton, N. J. An 8-page bulletin with 34 illustrations shows a wide range of special transformers from 10 volt-amperes to 300 kva, ranging from 20 to 400 cycles, and up to 60 kv. The units covered are designed for industrial, electronic and research use.

Recording Oscillographs. Consolidated Engineering Corp., 620 No. Lake Ave., Pasadena 4, Calif. Applications, operations and features of multichannel recording oscillographs are discussed in a 48-page catalog. Sample records of actual applications are presented along with detailed assembly drawings.

Geophysical Transformers. Triad Transformer Mfg. Co., 2254 Sepulveda Blvd., Los Angeles 64, Calif., has released Catalog GP-49, a four-page bulletin illustrating, describing and pricing a line of geophysical transformers. The units covered, intended for geophysical exploration equipment, are hermetically sealed and magnetically shielded.

Medium-Mu Triode. Eitel-McCullough, Inc., San Bruno, Calif. Model 450 TL medium-mu triode, intended for use as an amplifier, oscillator and modulator, is cov-

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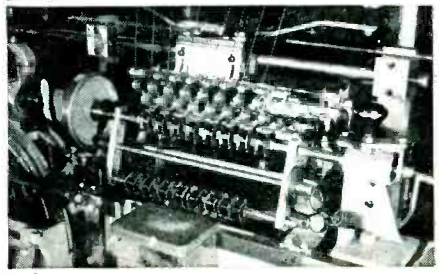

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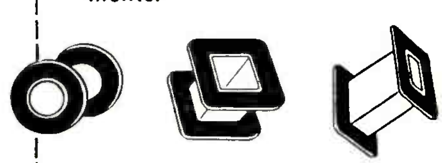

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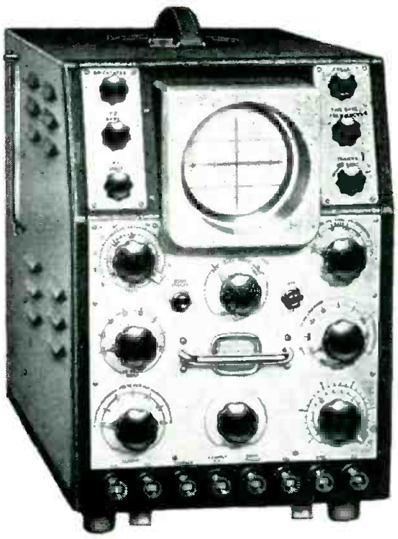

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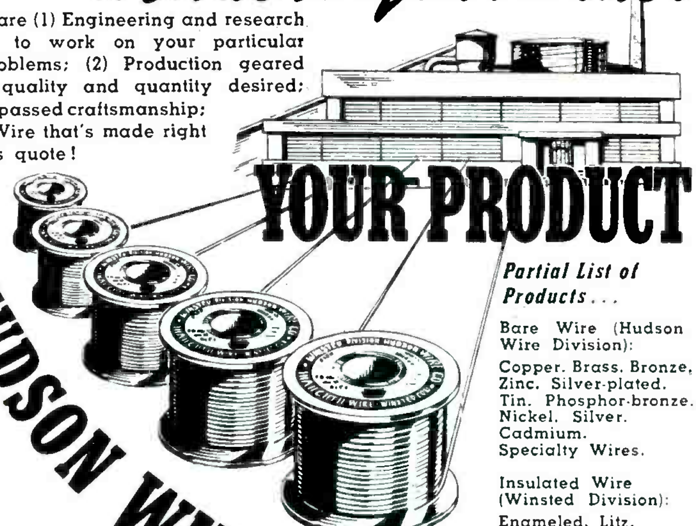

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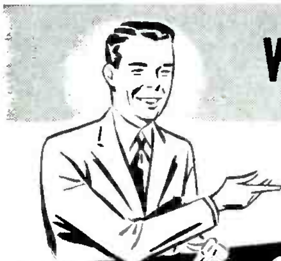

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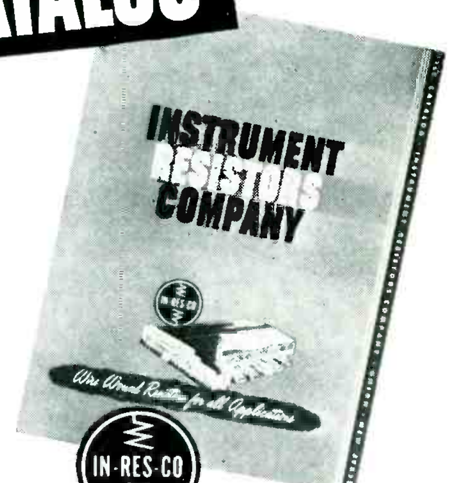

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ered in a recent folder. General characteristics, applications, dimensional drawings and several charts are given.

Machine Speed Regulation. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-5336 gives an 8-page treatment of the electronic Speed Variator, a packaged adjustable-voltage d-c drive operating from a-c power, and closely regulated by an electronic brain. Complete descriptive and application data including features, advantages, operating characteristics and ratings are given.

Leak Detector. Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif. A new 16-page two-color catalog describes the model 24-101A leak detector. Applications and leak detection methods used in both vacuum and pressure systems are discussed and examples of both probe and envelope techniques are given.

Coax Cable. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 29-A covers the type 83 coaxial cable which is $\frac{3}{8}$ in. in diameter and semi-flexible. Characteristics, a table of efficiency vs frequency and a list of accessories are included.

TV Component Replacements. Standard Transformer Corp., Elston, Kedzie and Addison Sts., Chicago 18, Ill. A 20-page booklet, form DD338C, lists replacement transformers for 215 tv receivers and chassis made by 43 manufacturers. Replacement part numbers are listed together with manufacturers' part numbers for positive identification.

Handling of Radioactive Isotopes. National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D. C. Recommendations for the safe handling of artificially-produced radioactive isotopes in the typical laboratory or small industrial operation are concisely set forth in a new handbook, "Safe Handling of Radioactive Isotopes." Designated as handbook H42, the 29-page publication is available from the Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C., at 15 cents a copy.

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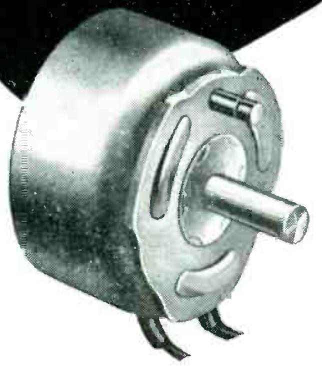

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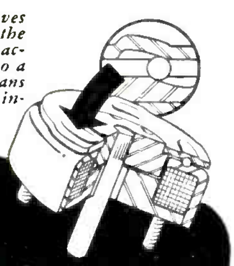
Diameter	1⅛"	1⅞"	2¼"	2¾"	3⅜"
Torque lb./inches	¼	5	10	25	50
Weight lbs.	⅛	½	1	2¼	4¼



Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.

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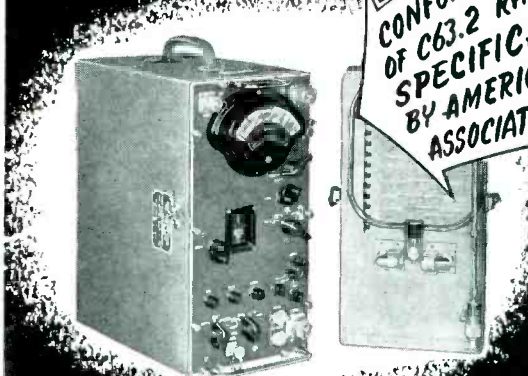

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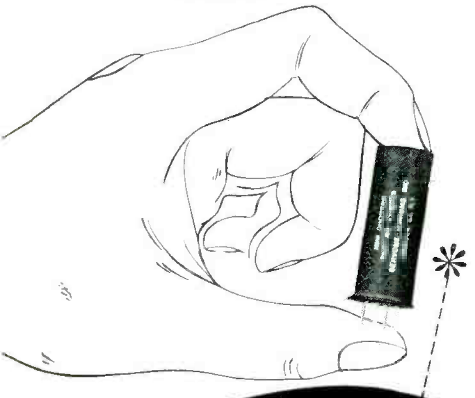

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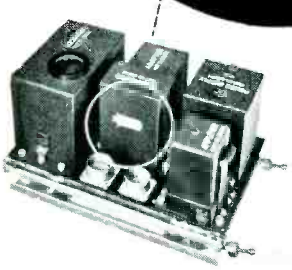

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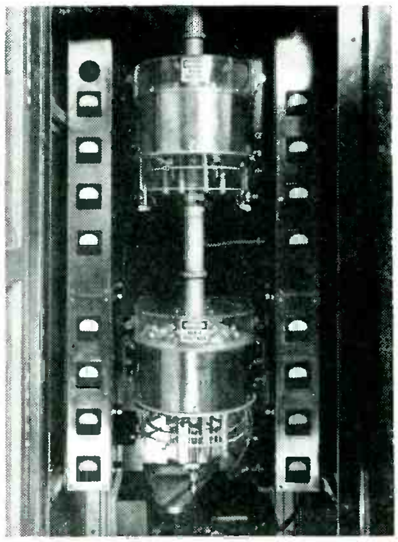
NEWS OF THE INDUSTRY

(continued from page 130)



Tripler (lower section) and power amplifier (above) of the Bridgeport uhf picture transmitter. Eight type 4X150 tubes are paralleled in each stage

TT500B transmitter, styled the type TTU1A, employs a tripler power amplifier and special cavity output stage in both the picture and sound sections to give power outputs of 1 kw (peak) and 500 watts respectively at 530.25 and 534.75 mc. Eight type 4X150A tetrodes operate in parallel in a single cavity for both tripler and final service although the arrangement of components and tuning methods differ somewhat.

Another feature of the transmitting equipment is the use of a single frequency-control unit comprising a crystal oscillator for the picture channel and another crystal reference that maintains the center frequency of the sound channel 4.5 mc above. Separation between the two carriers is thus held accurate to within 450 cycles.

The high-gain antenna is a ten-inch diameter conductor with twenty-two groups of slots. Each one is a half wavelength long with a vertical separation of an electrical half wavelength. The slots are energized by a special coaxial feed. A notch diplexer combines output from the picture and sound transmitters in the antenna feed without interaction.

A special uhf television tuner covering the range from 500 to 700 mc has been designed to feed into the i-f of any conventional television receiver. These equipments will be used on a limited basis for

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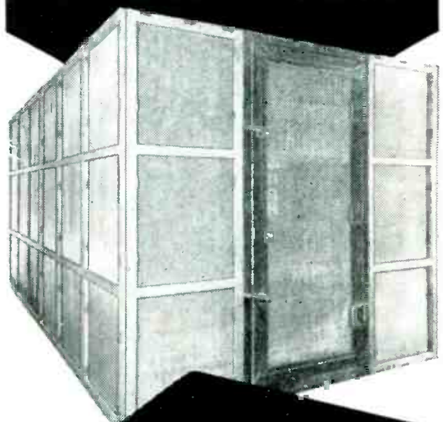

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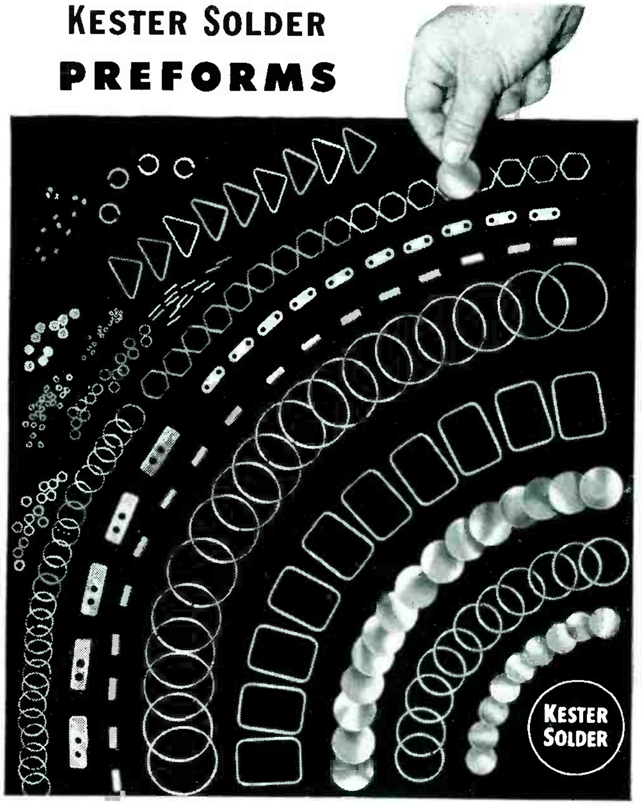

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the field tests of KC2XAK (Bridgeport station).

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Revised Technical Broadcast Services

A NEW series of technical radio broadcast services over radio stations WWV, Beltsville, Md., and WWVH, Maui, Territory of Hawaii, were inaugurated on January 1, 1950. Except in certain details, these services of the National Bureau of Standards do not differ greatly from those given in the past.

The revised services from WWV include (1) standard radio frequencies of 2.5, 5, 10, 15, 20, 25, 30, and 35 mc, (2) time announcements at 5-minute intervals by voice and International Morse Code, (3) standard time intervals of 1 second and 1, 4 and 5 minutes, (4) standard audio frequencies of 440 cycles (the standard musical pitch A above middle C) and 600 cycles, (5) radio propagation disturbance warnings by International Morse code consisting of the letters W, U or N, indicating warning, unstable conditions, or normal, respectively.

The audio frequencies are interrupted at precisely one minute before the hour and are resumed precisely on the hour and each five minutes thereafter. Code announcements are in Universal Time using the 24-hour system beginning with 0000 at midnight; voice announcements are in Eastern Standard Time. The audio frequencies are transmitted alternately. The 600-cycle tone starts precisely on the hour and every 10 minutes thereafter, continuing for 4 minutes; the 440-cycle tone starts precisely five minutes after the hour and every 10 minutes thereafter, continuing for 4 minutes. Each carrier frequency is modulated by a seconds pulse which is heard as a faint tick; the pulse at the beginning of the last second of each minute is omitted.

Further information on the tech-

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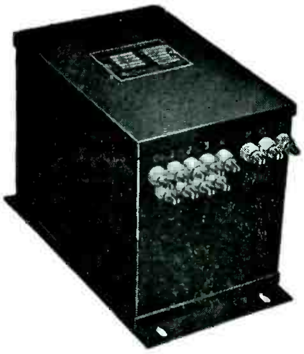

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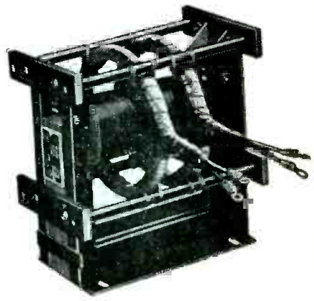

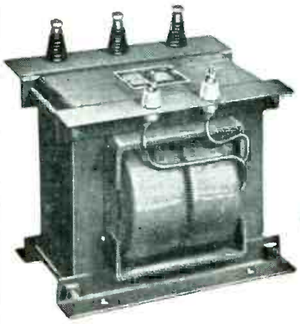

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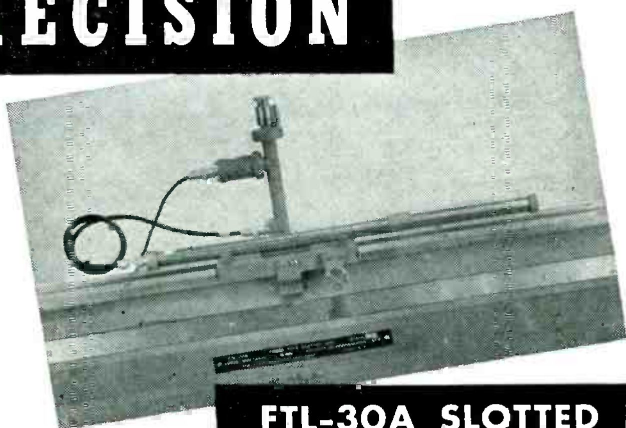

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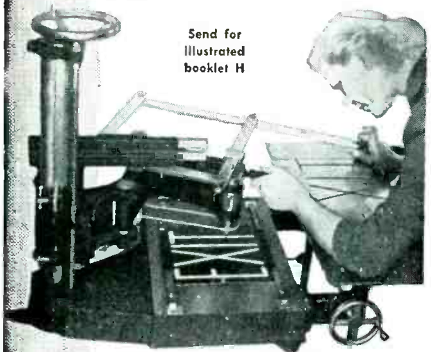

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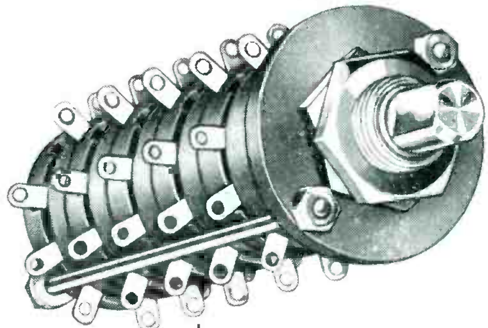

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Ask for information on Series 5000 MD

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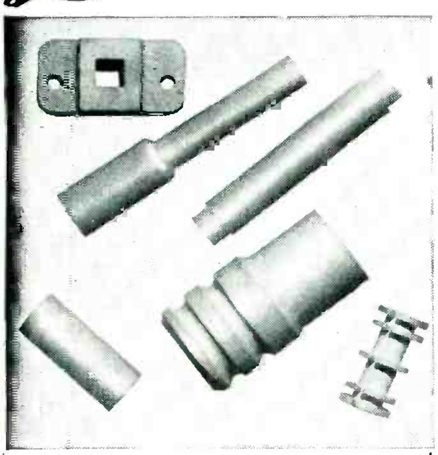

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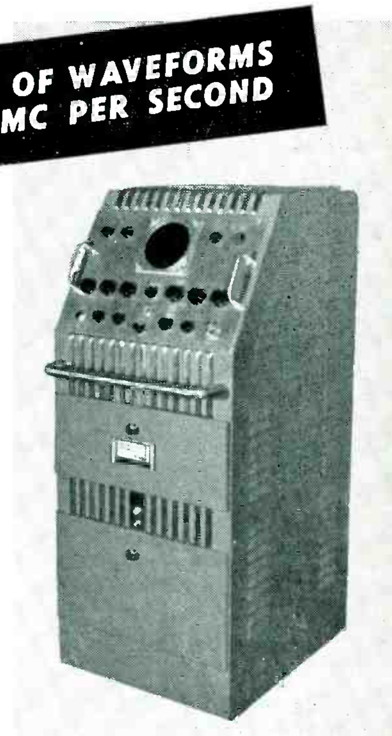

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- Vertical amplifier bandwidth of 10 cps to 50 mc.
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nical radio broadcast services may be obtained on request from the National Bureau of Standards, Washington 25, D. C. Reports on reception are welcomed; forms on which to submit such reports may also be obtained on request.

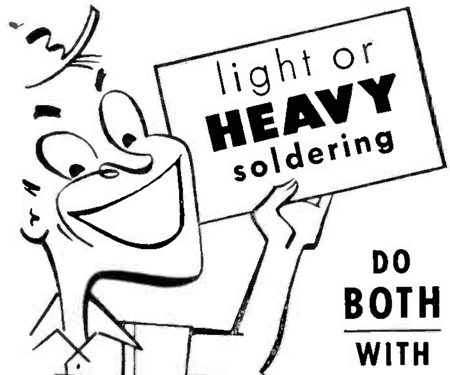
Air-Sea Rescue Radio

THE AIR MATERIEL Command's Communication and Navigation Laboratory, Electronics Subdivision, Wright Field, Dayton, Ohio, has designed and developed a new air-sea rescue transmitter-receiver. The new equipment is a miniaturized battery-operated unit which will in time become standard equipment for every USAF pilot and airman.

Up to now, men leaving a ditched or sinking airplane for a life raft have had to resort to the "Gibson Girl," a rescue set weighing about 40 pounds and operating on medium frequencies necessitating yards of antenna launched by means of a kite or balloon. The new set, known as the URC-4, is not much larger than a ration kit and can be held in one hand. Its mercury-type battery is a separate unit with a rubberized cable connection.

The entire unit is completely impervious to salt water and is designed to withstand temperature extremes ranging from 160F to – 50F. Tests at Seal Beach, Calif., have proven that a message can be picked up by a search plane rang-

J. S. Horrigan, USAF's Air Materiel Command project engineer on the URC-4, demonstrates how the battery of the midget air-sea rescue transmitter-receiver can be slipped into the pocket of an ordinary flying suit



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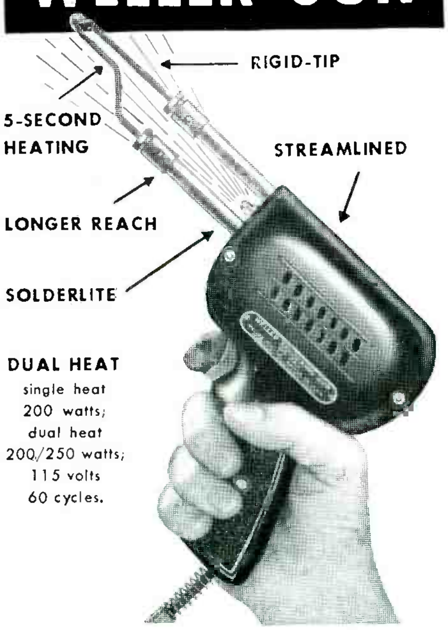
New 250-watt WELLER GUN



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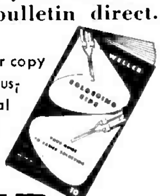

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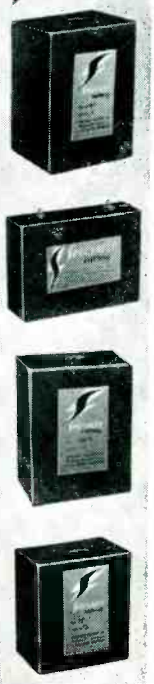

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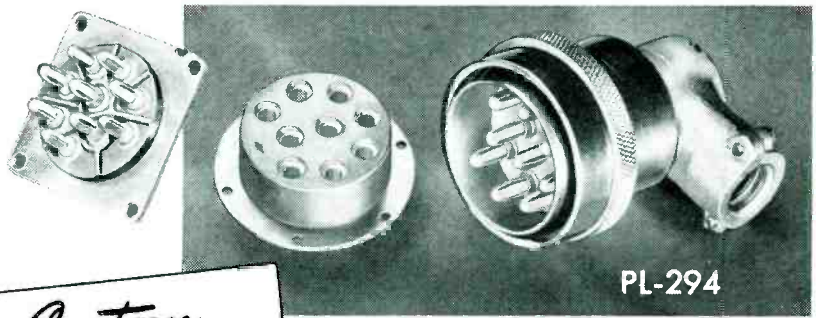

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Metal-plastic components designed and manufactured to order. Write for quotations specifying electrical and mechanical characteristics. Describe application. No obligation.

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Multi-contact connectors and mating chassis counterparts. Melamine or alkyd insulation; steel or brass nickel-plated shells. Banana springs are heat treated beryllium copper. Unexcelled low resistance contact. Highest quality . . . good for thousands of connects and disconnects.

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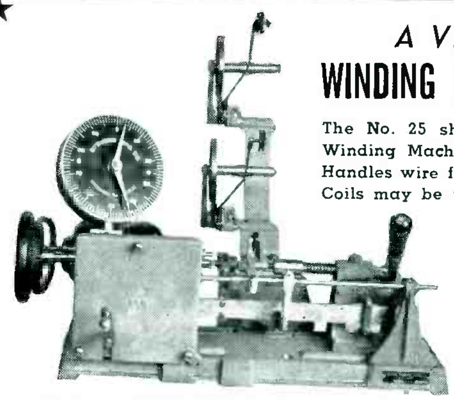

The No. 25 shown is a combination of the Universal Winding Machine and the 6" Space Winding Machine. Handles wire from 24 to 40 gauge. Progressive Universal Coils may be up to 3½ inches in length.

- Other models for winding Coils, Transformers, Resistors, and Solenoids
- Dial Counters also available separately
- We welcome the opporunity to consult with you on your needs and would like you to have our latest catalog . . . write!

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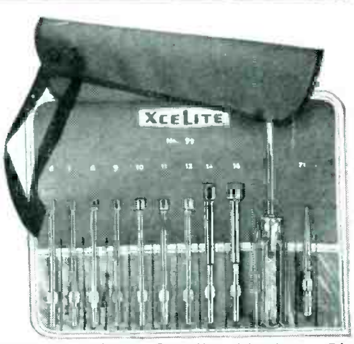
Only $9.95 for This COMPLETE
Nut Driving, Screwdriving, Reaming Kit!

The big XCELITE handle fits the detachable blades—gives you 12 QUALITY TOOLS. 9 chrome plated nut drivers, 3/16" 1/2" sizes. two screwdriver sizes. one reamer, indurable roll kit! NOW AVAILABLE—#1 and #2 Phillips points on ONE blade! Order No. 99-82 blade. List price $1.05. (P.S. We left a space for it in both 99 kits) ASK YOUR SUPPLIER OR WRITE:



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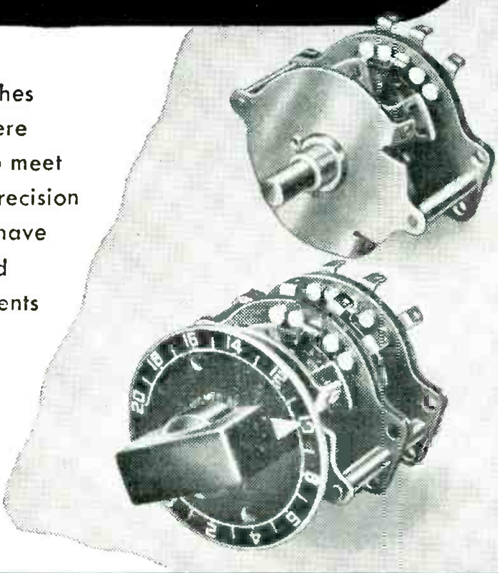

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ing as far as 80 miles from a crash survivor in life raft.

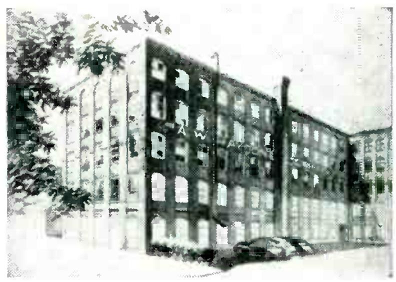
Etta Kappa Nu Awards

OUTSTANDING young electrical engineers were recognized and presented awards by Eta Kappa Nu in New York City on January 30, 1950, during the week of the Winter General Meeting of the AIEE. Robert C. Cheek of Westinghouse Electric Corp. was the winner. Recipients of honorable mentions were Lester M. Field of Stanford University and Louis G. Gitzendanner of General Electric Co.

To qualify for this annual award the 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. Final selection of candidates is made by a jury of awards composed of well known engineers from industry and educational institutions.

BUSINESS NEWS

THE A. W. HAYDON CO., manufacturer of timing motors, has moved



A. W. Haydon Co.'s new plant

to new and larger quarters at 232 North Elm St., Waterbury 20, Conn.

THE ATOMIC ENERGY COMMISSION recently transferred its radiation instruments branch from Oak Ridge, Tenn., to Washington, D. C.

STEVENS MFG. CO., INC. has transferred operations to a new plant at 69 South Walnut St., Mansfield, Ohio, to concentrate production of precision bi-metal thermostats for

The New STAVER MINI-SHIELD

TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

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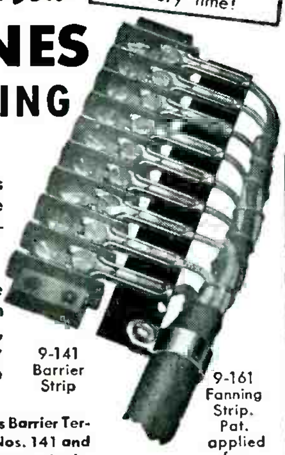
The correct wire to correct terminal every time!



Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

9-141 Barrier Strip

9-161 Fanning Strip. Pat. applied for.

Use with Jones Barrier Terminal Strips, Nos. 141 and 142, for 1 to 20 terminals.

Simplifies soldering. Insures correct connections. Saves time. Ideal for harness or cable assembly. Brass terminals, cadmium plated. Bakelite mounting. Send for complete data.

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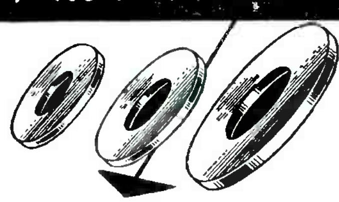

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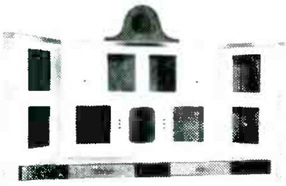

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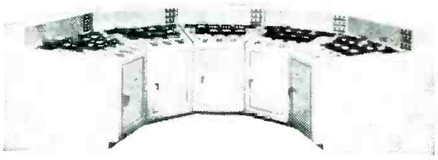

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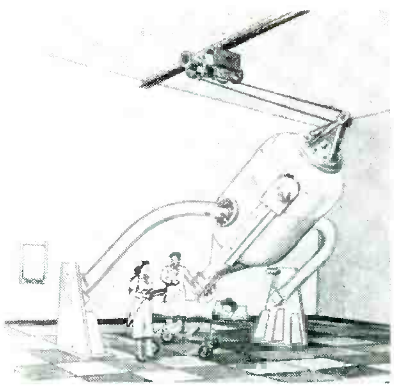
RADIO CORP. OF AMERICA AND TWENTIETH CENTURY-FOX FILM CORP. recently signed a contract for cooperative research looking toward further advancement of the applications of large-screen television in the motion picture industry.

FAIRCHILD GUIDED MISSILES DIVISION is the new name of the Pilotless Planes Division of the Fairchild Engine and Airplane Corp., Farmingdale, N. Y.

ILLINOIS INSTITUTE OF TECHNOLOGY chapter was recently given the Eta Kappa Nu Achievement Award for 1948–49. It was the second straight year this chapter has been so honored.

HYTRON RADIO & ELECTRONICS CORP. recently opened a new plant in Newburyport, Mass., for the mass production of television picture tubes.

GENERAL ELECTRIC X-RAY CORP., Milwaukee, Wisc., is constructing a two-million-volt x-ray machine for installation in New York City's new



Artist's sketch of 2,000,000-volt x-ray therapy machine recently purchased by New York City from GE X-Ray Corp. for Francis Delafield Hospital

Francis Delafield Hospital to combat cancer.

ELECTRONIC COMPUTER CORP., 265 Butler St., Brooklyn, N. Y., is a new company formed to manufac-

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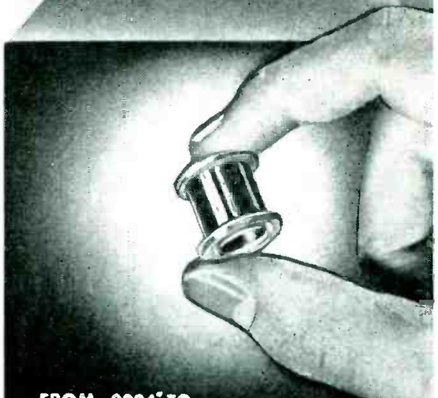
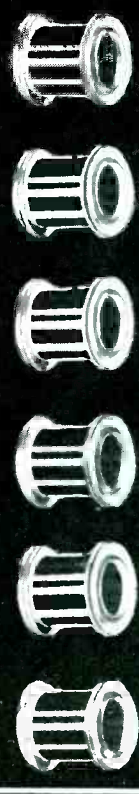


FROM .0004" TO .00015" AND EVEN SMALLER



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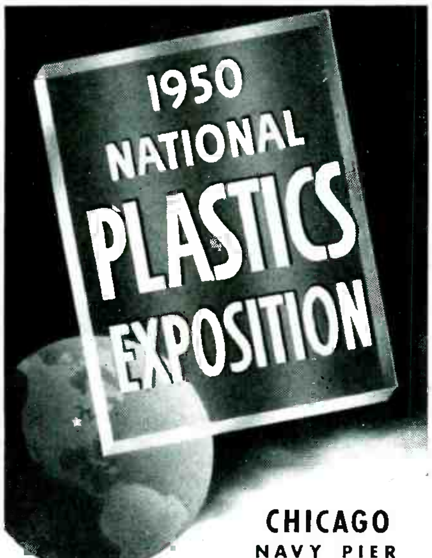

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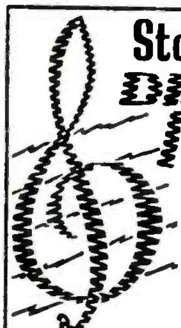

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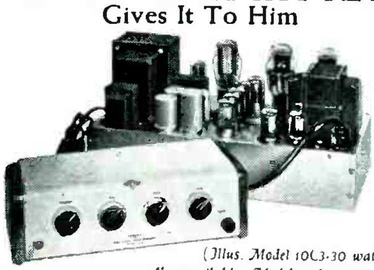

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E = Breakdown voltage
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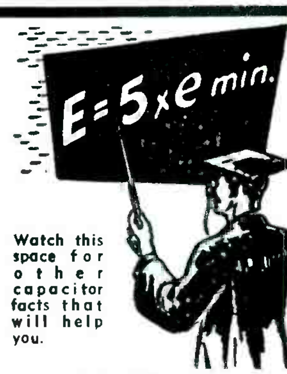

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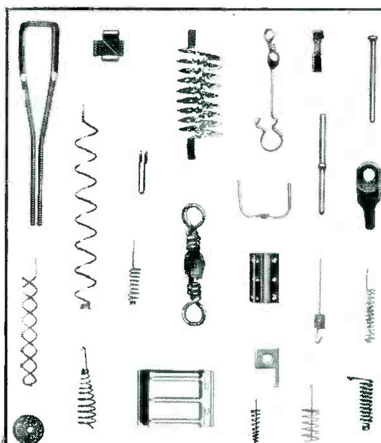

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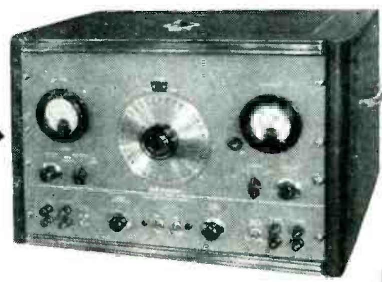

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CARRIERS accepted, 50 to 800 cps
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RAYPAR, INC., radio and television parts manufacturers, have purchased a new 59,000-sq ft factory at 7810 West Addison St., Chicago, Ill.

PERSONNEL

DELMAN E. ROWE, former head of the electronics development division of the Naval Aviation Ordnance Test Station, Chincoteague, Va., has been appointed senior test director in the guided missiles research laboratory of the National Bureau of Standards, Washington, D. C.

D. E. Rowe

N. L. Harvey

NORMAN L. HARVEY, formerly head of the Applied Research Branch of the Physics Laboratory of Sylvania Electric Products Inc., Bayside, N. Y., has been appointed director of engineering of Colonial Radio Corp., a wholly-owned subsidiary of Sylvania Electric.

VANNEVAR BUSH, president of the Carnegie Institution of Washington, has been made an honorary life member of the AIEE.

IRVIN GUTTMAN, previously associated with the U. S. Signal Corps Laboratories, is now chief electronics project engineer and sales engineer with Telrex, Inc., Asbury Park, N. J.

CLIFF GARDNER, formerly with Raytheon Mfg. Co. as engineering department head in charge of klystron development, has joined Varian Associates, San Carlos, Calif., as an engineering staff member to continue in klystron development work.

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TECHNIQUE
Saves
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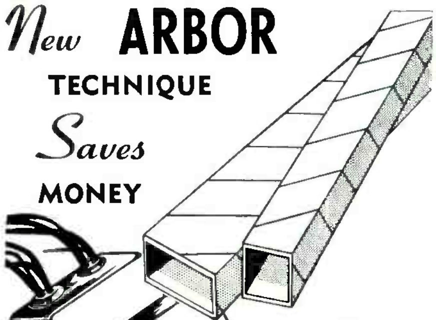

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For measurement of:

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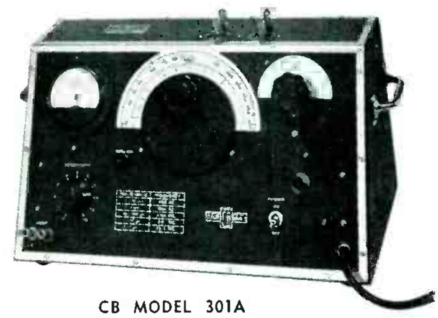
Combines an amplifier circuit, a calibrated variable capacitor with dial accuracy of 1% + IMMF, and a highly stable VTVM into a single unit. Any R.F. Oscillator may be used as an external source.



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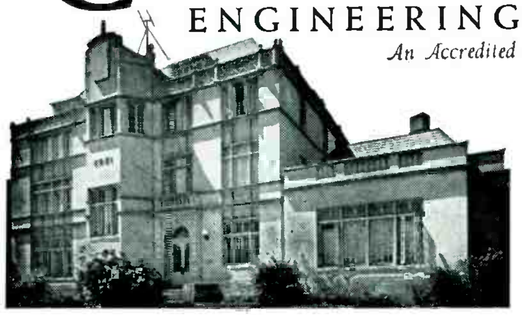

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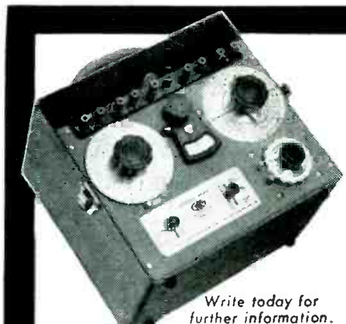

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TEN TIMES THE RANGE
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NEW BOOKS

Acoustic Measurements

BY LEO L. BERANEK. *John Wiley & Sons., Inc., New York*, 1949, 914 *pages*, $7.00.

THE NEED for this book has long been felt by engineers and physicists working with acoustical apparatus. It is written by a man who is fully equipped with the theoretical and practical knowledge required to accomplish the difficult task of correlating theory with practice.

The book, because of the nature of the subject material, takes the form of a series of essays on various acoustical subjects. It includes a brief and fact-packed history of acoustical measurements which holds enormous interest for anyone working in or around the field of sound. There is a long list of definitions of acoustical terms which seems to be quite complete, although some of the definitions are a bit terse. Then follows a discussion of liquids and gases as sound-transmitting media, the most useful part of which is a series of charts and tables which never before have been gathered together in any one place. This section is aimed primarily at the physicist, although the practising engineer can derive much benefit from it. The sections on diffraction and reflection of sound waves includes data on the effects of the human body which is of considerable practical use.

The section on absolute calibration of microphones includes a discussion on reciprocity which is most complete and understandable. It seems to be a compilation of information heretofore available only from many disconnected sources. The practical side of microphone calibration is well taken care of by detailed dimensioned drawings of test cavities, and circuits for measurement are completely detailed.

There are detailed discussions on sound sources, practical microphones (including the ear), and very excellent sections on measurements of basic quantities in acoustics, including frequency, intensity, and impedance. The section on random noise is possibly the most complete collection of usable informa-

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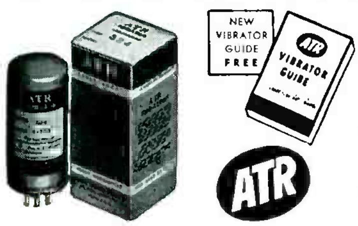

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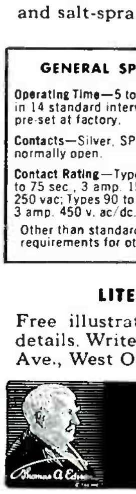

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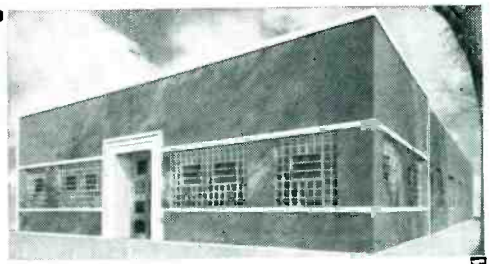

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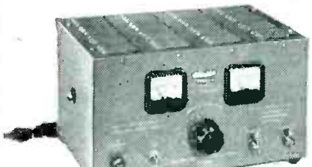

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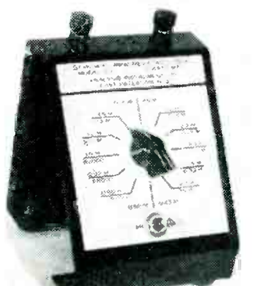

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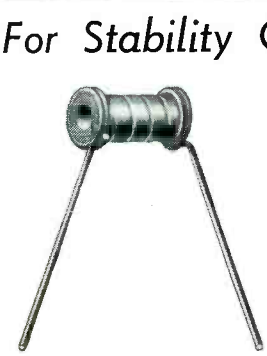

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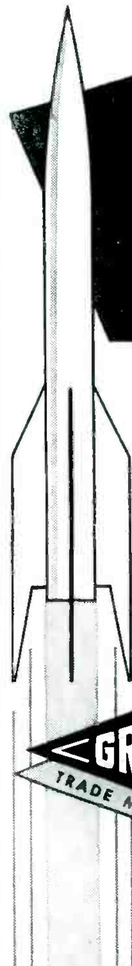

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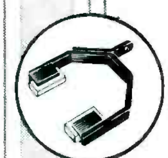

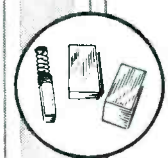

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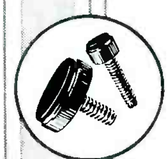

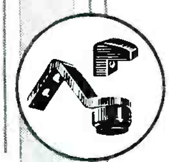

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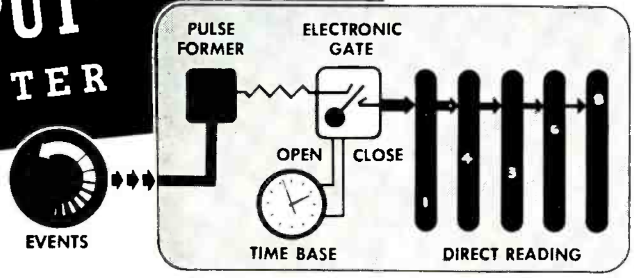

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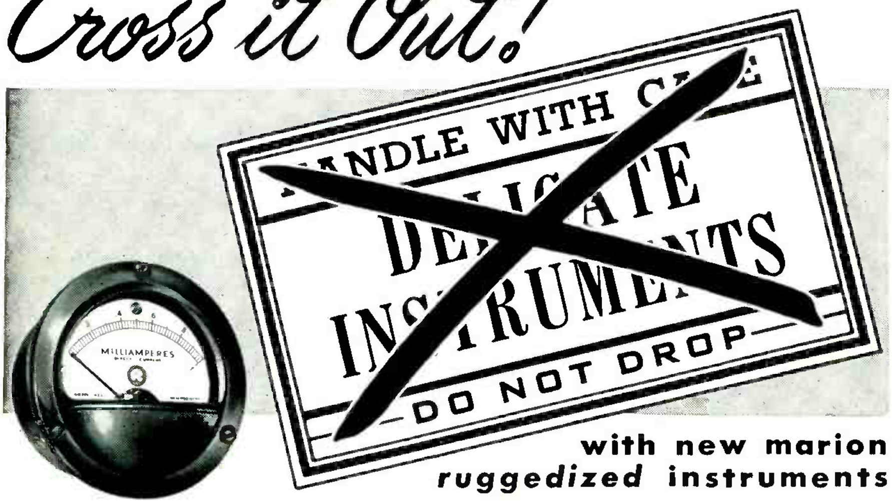

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tion on this subject which exists in the literature today. The discussions and illustrations of transient response help to fill the void which has existed because of lack of factual information on the response of acoustical systems to transient phenomena.

The section on indicating instruments should be thoroughly read and understood by anyone who encounters the problem of estimating sound power levels on audio programs. This is a problem the magnitude of which is not generally appreciated.

The test procedures outlined for loudspeakers and earphones present the problem in such a way that it becomes possible for the user of such equipment to interpret the results of measurements as they will affect actual use.

This book should become the standard reference on the subject of acoustical measurements for many years to come. It is to be hoped that college courses based on this subject matter become generally available within a short time, to help make acoustics and acoustic measurements a powerful tool for the practising engineer.—N. C. PICKERING, *Pickering & Co., Inc., Oceanside, N. Y.*

Modern Oscilloscopes and Their Uses

BY JACOB H. RUITER, JR. *Murray Hill Books, Inc., New York,* 1949, 326 *pages.* $6.00.

IT HASN'T been many years since few persons outside research and development laboratories knew what a cathode-ray oscilloscope was, or what could be done with one. Today, however, the situation is quite different. A scope is very helpful in servicing f-m receivers, and is an absolute necessity in television work. For those who must quickly learn basic oscilloscope fundamentals and operating techniques, this book is required reading.

In twenty well-written chapters, the author treats three basic phases of the subject: fundamentals, operating techniques, and practical applications. The first three

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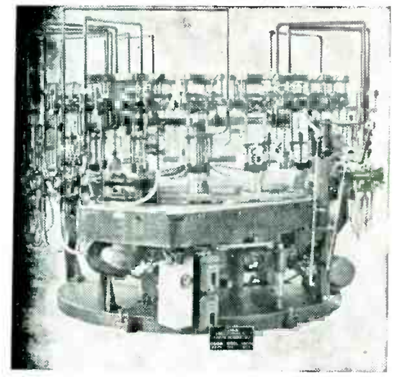

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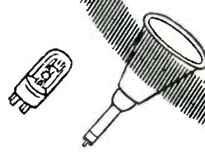

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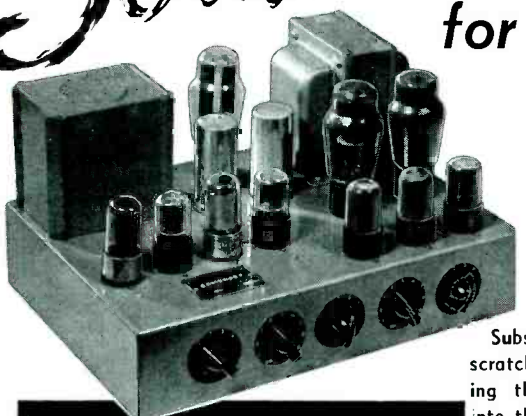

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chapters serve as a general introduction, and present a brief history of the development of the oscillograph and the cathode-ray tube. The six chapters that follow discuss the fundamental principles of cathode-ray tube operation, details of the modern cathode-ray tube, general-purpose oscilloscopes, and power-supply, amplifier, attenuator, positioning, and time-base circuits. Wherever a schematic or pictorial diagram, photograph, table or chart, or reproduction of an actual oscilloscope trace will serve to illustrate the points brought out in the text, they have been wisely chosen and generously used.

To make the sections devoted to the operation and specific applications of a scope of the greatest practical value, the author has included numerous step-by-step procedures. For continuity, the text is based on the DuMont model 208B general-purpose oscilloscope. For those who do not have access to this particular instrument, a table which gives a list of the exact names of comparable controls as they appear on the front panels of other oscilloscopes is included to extend the usefulness of the step-by-step procedures. In the chapters devoted to operating techniques, the author treats such basic procedures as adjusting and reading the frequency controls, proper display of the pattern on the screen, and interpreting the figures obtained, to name only a few.

The greater portion of the book is devoted to specific applications of the general-purpose oscilloscope, and this is as it should be in a practical textbook of this kind. Individual chapters are devoted to the use of a scope in servicing a-m, f-m, and television receivers. Also included in separate chapters are the use of a scope in audio circuits, at a radio transmitter, in teaching basic radio fundamentals, and in various industrial applications.

The book closes with a chapter on photographing cathode-ray patterns, and an eight-page glossary of terms. The illustrations are clear and appropriate throughout, and the text is sufficiently clear so that no difficulty should be experienced by the average technician. The

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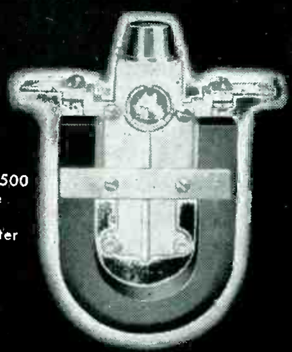

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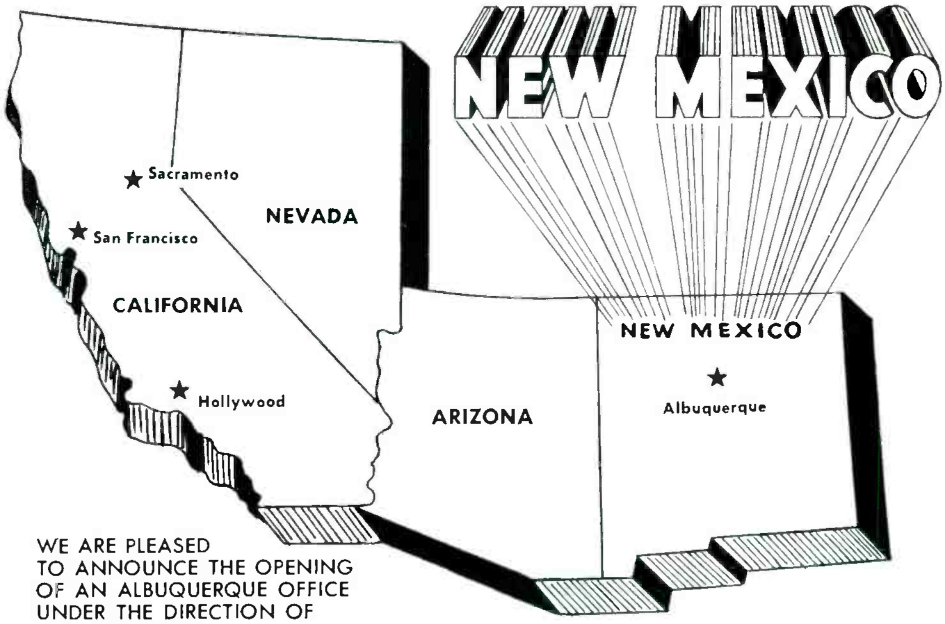

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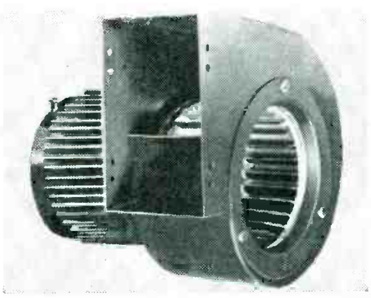

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book is a welcome and much needed addition to the how-to-do-it literature for the radio and television fields.—R. H. SCHAAF, *National Radio Institute, Washington, D. C.*

Learning Electricity and Electronics Experimentally

BY LEONARD R. CROW. *Universal Scientific Co., Inc., Vincennes, Indiana,* 1949, 525 *pages.*

IMPORTANT principles of electricity and magnetism are covered on a qualitative basis by 75 experiments requiring only simple, inexpensive material. Most of the experiments provide attention-getting action, such as by shooting aluminum rings into the air, magnetizing with a single-turn loop carrying alternating current as in soldering guns, and spinning an aluminum ball as a demonstration of phase splitting. A 300-page advanced section gives nonmathematical theory of alternating current, reactance, resonance, d-c controlled saturable-core reactors, magnetic frequency-multiplying apparatus, peaking transformers, electric arcs, dry-disc rectifiers, electronic tubes and electronic circuits along with 59 additional experiments. Specially taken photographs illustrate experimental setups and greatly increase the practical usefulness of the book. —J.M.

Isotopic Tracers and Nuclear Radiations with Applications to Biology and Medicine

BY WILLIAM S. SIRI. *McGraw-Hill Book Co., New York,* 1949, 653 *pages,* $12.50.

DESPITE the title, this book offers much to readers of ELECTRONICS. The entire 260 pages of Part I, dealing with isotopes and nuclear radiations, is applicable to the electronic physicist. The compilations of reference tables in this section alone can justify a place for this book in any fundamental research library.

Part II, dealing with methods and instruments, gives 240 pages of engineering descriptions for the electronic engineer in design and pro-

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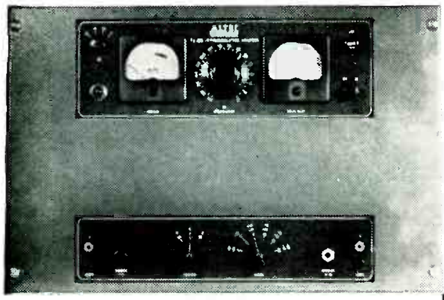

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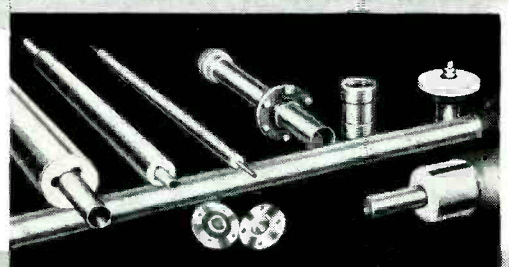

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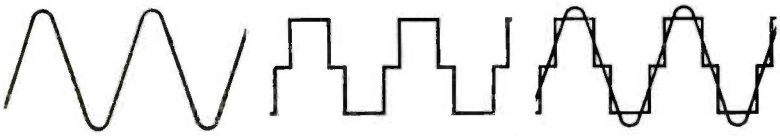

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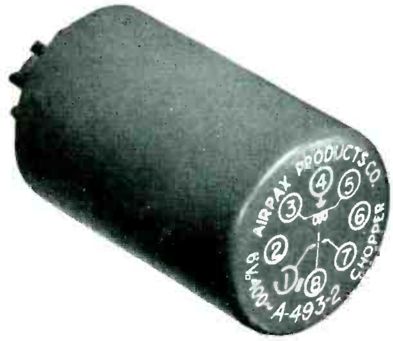

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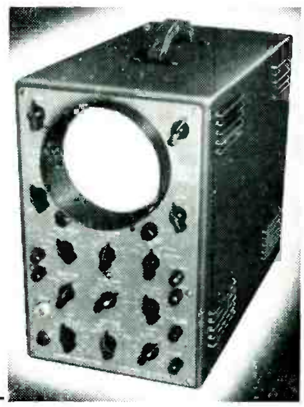

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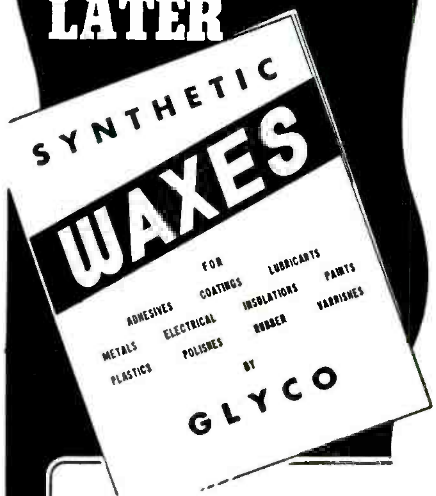

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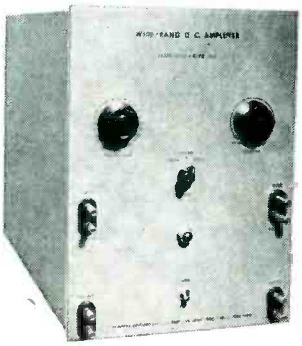

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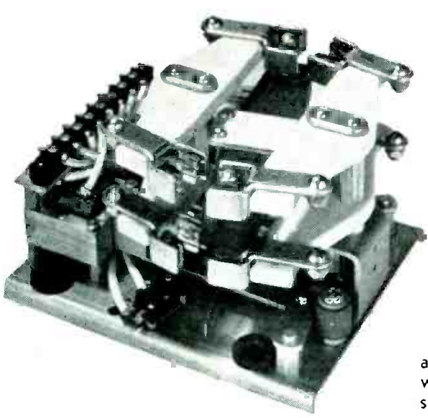

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duction fields. Subjects covered here include: Mass Spectrographs; Geiger-Muller Counters; Proportional Counters; Ionization Chambers; Standardization of Radioactive Samples; Radioautograph; Tracer Methods; Safety Precautions; Electrostatic Generator; Cyclotron; Betatron; Synchrotron.

Only the 50-page concluding section on biological and medical applications of isotopes is really pertinent to the title of the book and hence of little interest electronics-wise. The 90-page bibliography in the concluding chapter is universally useful to all who deal with radiations and related subjects—J.M.

Microwaves and Radar Electronics

By Ernest C. Pollard and Julian M. Sturtevant. *John Wiley & Sons, Inc., New York*, 1949, 426 *pages*, $5.00.

THIS BOOK could be called the pocket edition of the 27-volume Radiation Laboratory Series. It is a well-written introduction to the multitude of subjects that are covered by the title. The authors, a physicist and a chemist, have presented this book in the hope that the information and knowledge gained during and after the war on microwaves and associated circuits will be useful in the various fields of science. To those who have not been associated with microwaves or radar, this introduction to the art should provide them with many new tools for their work.

A short introductory chapter outlines the special knowledge of electromagnetic fields that is necessary to an understanding of microwaves. In general, an understanding of the book requires no special knowledge not present in the usual student background of physics or electrical engineering. References are included to direct the reader to detailed information.

The three major sections into which the book is divided are microwaves, radar circuits, and radar systems together with an analysis of microwaves being used in physical research. The first four chapters deal with microwaves. This group starts with a detailed description

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and review of electromagnetic fields from which the actions of coaxial lines, waveguides, and cavities are explained. A discussion on the production of microwaves, using both klystrons and magnetrons, is followed by a discussion of methods of measurement and detection. A short section deals with impedance measurement and the various components necessary to deal with microwaves including waveguide, rotating joint, antenna, T-R box and magic T.

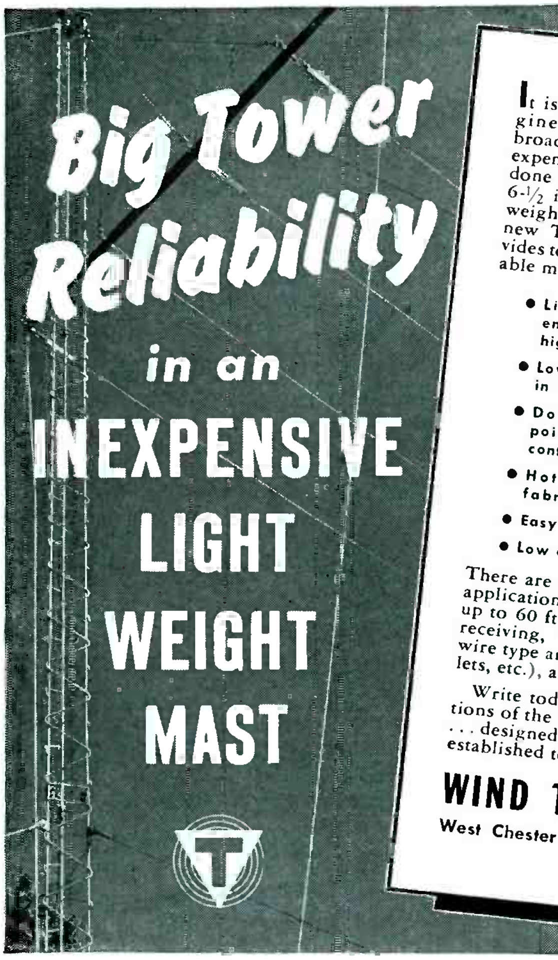
The elements of various radar circuits are covered in the second section consisting of the next seven chapters. Included here are discussions on various pulsing techniques such as generating, delay and timing circuits. Separate chapters are devoted to cathode-ray tubes and their associated sweep and indicator circuits, amplifiers, amplification of very weak signals, servomechanisms and computers, and miscellaneous circuits including regulated power supplies, cathode followers, multivibrators, clamping and counting circuits.

The last three chapters deal with a brief discussion of the overall properties of several typical radar sets now in use. Four different fields of physical research are described in the concluding chapter and thus serve to remind us that the purpose of this book is to help in furthering the use of this knowledge gained in the development of radar.—JAMES A. KENNY, *Airborne Instruments Laboratory, Inc., Mineola, N. Y.*

Pulse Generators

Volume 5 of the MIT Radiation Laboratory Series. EDITED BY G. N. GLASOE AND J. V. LEBACQZ. *McGraw-Hill Book Company, New York*, 1948, 741 *pages*, $9.00.

TECHNIQUES for pulse generation developed during the war at the Radiation Laboratory are treated in this volume. Although these techniques were developed for radar applications, the material in the book will interest engineers and physicists who are concerned with the general problem of pulse generation. The treatment is alternately theoretical and descriptive;



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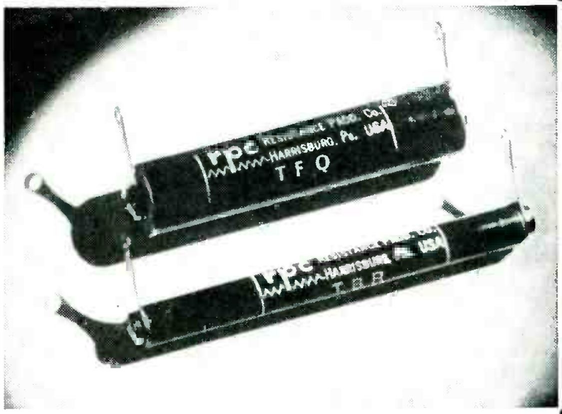

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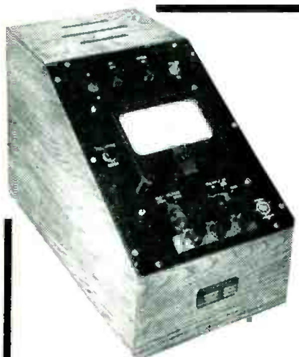

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rather complete descriptions of several specific systems are included. A knowledge of the Laplace-transform method of circuit analysis is assumed.

Necessary terms are defined in the introduction, and the various types of pulse generator are briefly described and compared. The remainder of the book is divided into three parts. Part I deals with hard-tube pulsers, in which the pulse is formed in a lumped-constant network and a vacuum tube is used as a switch. Consideration is given to charging and discharging circuits, impedance matching, and required tube characteristics.

Part II is a treatment of line-type pulsers, in which the pulse is formed in a transmission line or equivalent network, and the switch may be a spark gap or hydrogen thyratron. Charging from both a-c and d-c sources is discussed. Pulse transformers are covered in detail in Part III, attention being given to design, construction and performance. An appendix describes oscillographic and metering techniques, and discusses the equivalence of various pulse shapes.

A commendable feature of the book is the large number of oscillographs and illustrations of actual equipment. Some readers may be disappointed by the emphasis on power pulse generators, with the resultant concentration on low impedance and magnetron loads.—T. M. STOUT, *Department of Electrical Engineering, University of Washington.*

Physical Aspects of Color

BY DR. P. J. BOUMA, *Philips Research Laboratories, Eindhoven. Published by N. V. Philips Gloeilampenfabrieken, Eindhoven, The Netherlands,* 1949, 312 *pages.*

THE CLOSER color television comes to being a commercial reality, the more electronic engineers become interested in color. This book, like W. D. Wright's "The Perception of Light" (Blackie & Sons, London, 1938), provides a bridge between physics and physiology.

A resume of the contents of the book will indicate its nature and scope. The introductory chapter sets the stage. The five following

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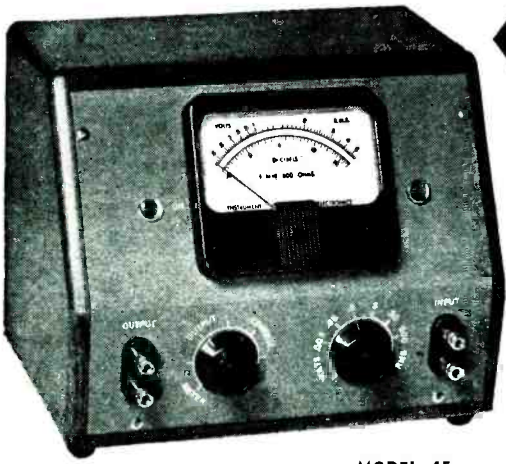

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MICROWAVE ELECTRONICS

By John C. Slater, Ph.D., Sc.D.
Head of the Department of Physics, Massachusetts Institute of Technology

In this broad treatment of microwave theory, both wartime and post-war developments are included. Based upon Dr. Slater's extensive work at Bell Telephone Laboratories and M.I.T. Radiation Laboratory on magnetron research and the general theory of microwaves, this comprehensive account also treats the theory of the linear accelerator, the cyclotron and the syncrotron.

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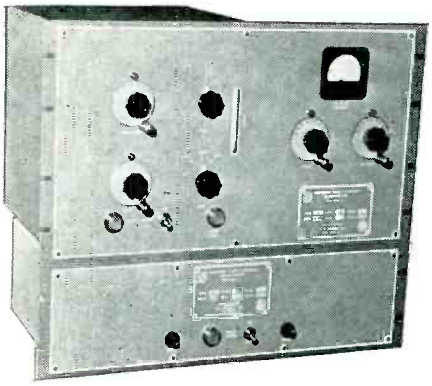

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chapters present the scientific background of the subject: brightness, the color triangle, the representation of color in space, the CIE coordinates, and calculations based on the CIE system. Three chapters are devoted to colorimetry. They deal with light sources, objective measurements, and subjective methods. Four following chapters present the biological aspects of color, defective color visions, the development of the science (which chapter constitutes a convenient introduction for those making a first acquaintance with this subject), color discrimination, and the chromatic adaptation of the eye. The concluding chapter reviews the practical applications of color phenomena. The book contains an appendix with an extensive bibliography.

As the author states in his preface to the Dutch edition, the reader is assumed to be acquainted with mathematics and physics as taught in secondary schools "and to possess a certain amount of zeal!" W. de Groot translated the book into English in the expectation that the author's " clear exposition and his simple style" would prove useful to the English-speaking reader.—F. H. ROCKETT, JR., *Airborne Instruments Laboratory, Inc., Mineola, N. Y.*

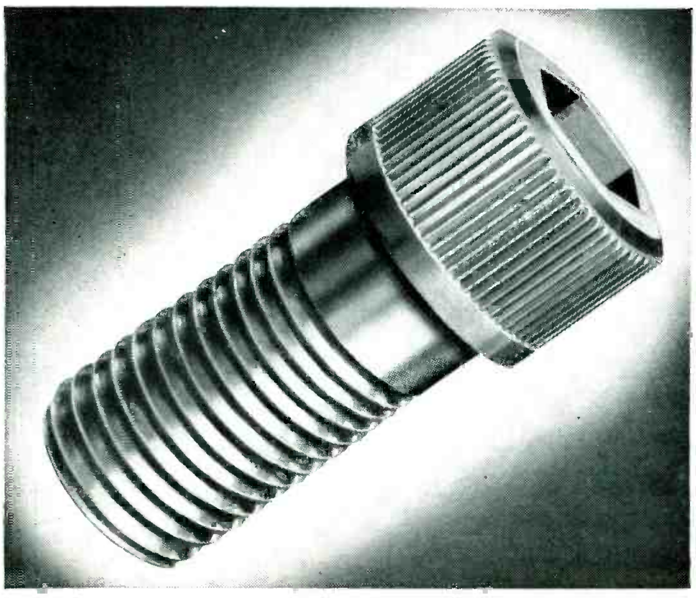
• • •

Books Received for Review

TELEVISION PICT-O-GUIDE, Vol. II. By John Meagher. RCA Tube Department; available only from RCA tube distributors. Loose-leaf booklet containing 84 photos taken from face of kinescope to show effects of various operating troubles on the image, for quick isolation of the defective stage in a television receiver. Each picture is accompanied by troubleshooting suggestions.

ENGINEERS' DICTIONARY—Spanish-English and English-Spanish. By Louis A. Robb. John Wiley & Sons, Inc., New York. Second Edition, 664 pages, $12.50. Enlargement of 450-page first edition to cover electrical and mechanical engineering more thoroughly. Important radio and television terms are now included, along with those of other new engineering fields. Definitions are not included, except in default of a satisfactory equivalent or to avoid ambiguity. English trade names have been translated into Spanish whenever they are in good technical usage.

THE OSCILLOGRAPH IN MODERN AM, FM AND TV SERVICE. By Walter Weiss. The Hickock Electrical Instrument Co., Cleveland, Ohio, 47 pages, paper-covered, $1.00. Consists chiefly of diagrams of wave shapes normally encountered at various points in each stage in an a-m superheterodyne radio receiver, plus chapters on f-m and television receiver alignment with a scope.



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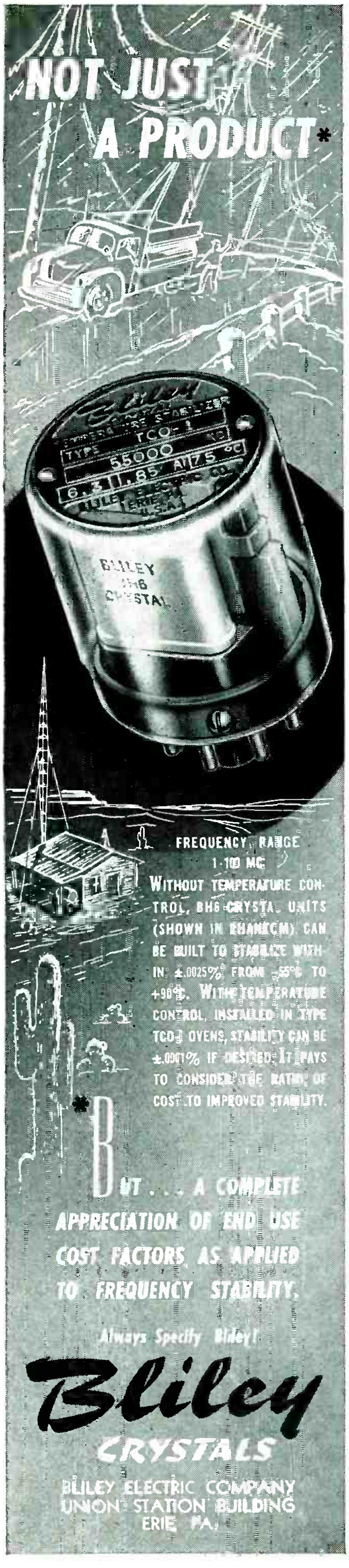

Backtalk

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.

Mice and Men

DEAR SIR:

HAVING BEEN A LOYAL SUBSCRIBER and also contributor to ELECTRONICS for quite a few years, I know you will not take amiss this suggestion for the improvement of your otherwise excellent publication.

My copies of ELECTRONICS are filed in a bookcase in my office along with *Proceedings of the IRE*. Recently I have noted that the glued edge of ELECTRONICS which contains the Vol., No. and date seemed to be missing from quite a few issues. Subsequent investigation proved that mice were responsible. Since not a single issue of the *Proceedings* has been so treated I can only surmise one of two things:

(1) ELECTRONICS is more readily digested and assimilated than the *Proceedings*, or

(2) The glue used in ELECTRONICS is more palatable to mice than that used in the *Proceedings*.

After considerable thought and deliberation I am forced to the conclusion that, although the first of these surmises is undoubtedly as true as the second, the best procedure would be to change the glue.

I trust this suggestion will receive the consideration it merits.

FRED SCHUMANN
Professor of Electrical Engineering
Box 115, Vanderbilt University
Nashville, Tennessee

Why Not Covat?

DEAR SIR:

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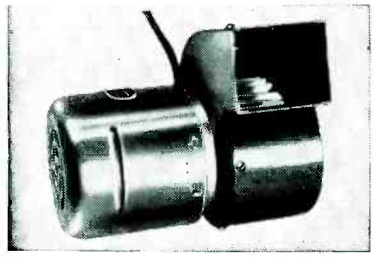

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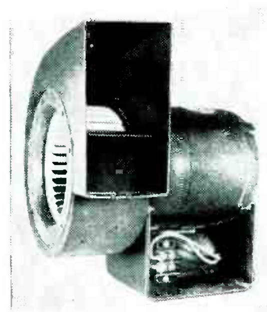

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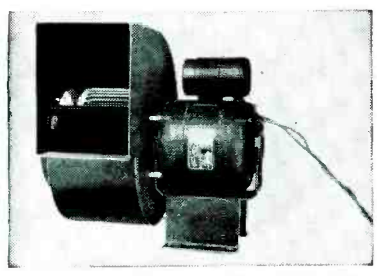

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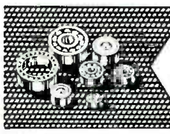

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ogy relevant to electronics. May we inquire as to whether any serious consideration has been given to the nomenclature with regard to continuously adjustable auto-transformers? Our organization manufactures variable-output d-c power supplies. We are finding it occasionally embarrassing to call the voltage control units "variacs" or "power-stats." These names, as you know, are both trade names. On occasion, we have even had to use "transstat."

In our instruction manuals and on our circuit diagrams, and also on the nameplates that are used on the control panels, we occasionally have to inscribe "variac" or "powerstat." We, naturally, prefer to have a single term to reduce costs of name plates. Also, the single term would be preferred where we have to use both of the manufacturers' products in one power supply, in order to achieve the optimum design and minimum cost.

If such a suggestion has never been made, would it be feasible for us to introduce the term "Covat" or something similar as a contraction of *CO*ntinuously *V*ariable *A*uto *T*ransformer? If this term is adopted throughout the electrical industry, we can eliminate the use of the terms "variac" and "powerstat", which will not only prove convenient but will eliminate embarrassment.

VICTOR WOUK
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Same System

DEAR SIRS:

I NOTE WITH INTEREST the timer described by Sidney Wald in the August, 1948, issue of ELECTRONICS, in which the timing action is independent of the supply voltage.

During the war, I employed the same principle to make an artificial bottom for use in an echo sounder. A servo system kept this artificial bottom equal to the real bottom and so gave a sounding record that was independent of the excessively variable marine power supplies.

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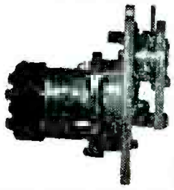

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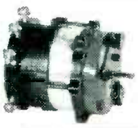

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Holtzer Cabot MG-149H—Similar to MG-149F but draws 44 amps DC at 28 v. Output ratings are at 0.90 P.F. Equipped with high altitude brushes. Stock #SA-4. **Price $34.50 each**

General Electric 5D21NJ3A — Input 28 volts DC at 35 amps. Output 110 volts 400 cycles. 485 V.A. at 0.90 P.F. Weight 15 lbs. Stock #SA-41. **Price $9.95 each**

General Electric 5AS131NJ3 — Input 26 volts DC at 100 amps. Output 115 volts 400 cycles. 1500 V.A. 0.8 PF. Stock #SA-286. **Price $19.50 each**

DC SERVO MOTORS

C-1 Autopilot Servo Unit—28 v. d-c Shunt motor. 2250 rpm. 2 magnetic clutches, reduction gear, differential and 2 magnetic brakes. Output shaft 15 rpm. Torque 225 in/lbs.
Stock #SA-180 **Price $19.50 each**

Elinco B-64 DC Servo Unit — armature voltage, 80 v d-c max. 27.5 v. field 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.
Stock #SA-211 **Price $12.50 each**

John Oster A-21E-12R — Split field series reversible motor. W.E. KS-5996-LO-4. 28 v. d-c at 0.4 amps. 2 watts output. 1½" diam. x 2½" lg. Ideal for relay or thyratron servos. Stock #SA-282. **Price $6.75 each.**

G.E. 5PS56HC18 — Split field series reversible motor. 60 v. d-c at 1.4 amperes. 5500 rpm. 3" diam. x 5" lg. Ideal for servo applications. Stock #SA-273. **Price $8.75 each.**

SAWTOOTH POTENTIOMETER

W.E. KS-15138

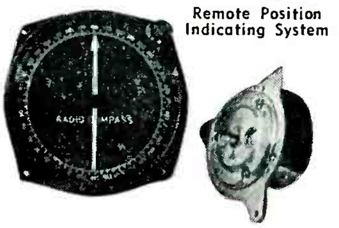
Type RL-B-R. 100 ohm element. Non linear ring gives linear output with CRT deflection coil load. Cont. rotation. 2 brushes 180 degrees opposed, 2 taps 180 degrees opposed. Stock #SA-288. **Price $5.50 each.**

LP-21-LM Compass Loops

Motor driven loop enclosed in graphited zeppelin housing includes Autosyn transmitter.

New **$9.50 each**

Remote Position Indicating System

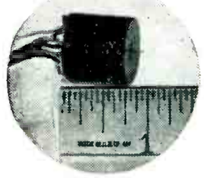


6-12 v. 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

AC Motor Special
Eastern Air Devices J-33
115 V. 400 cy. 3 phase synchronous. 8000 RPM. Stock #SA-59.
Price $8.00 each

Autosyn 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

MINIATURE DC SELSYN INDICATOR



Miniature indicator, 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-248. **Price $6.75 each.**

G.E. POSITION TRANSMITTER

Type 8TJ9—continuously rotatable 360 wound potentiometer. Taps every 120 degrees. Two 180° opposed sliders. 24 v. d-c operation with indicator described above. Stock #SA-13. **Price $4.75 each.**

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

D.C. MOTORS

Universal Electric DC

W.E. KS-5603-1-02, 28 v. d-c 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233. **Price $2.95 ea. plus 15¢ p.p.**

OSTER PM MOTOR

Alinco Field

27.5 v. D-C 10,000 RPM. Can also be used as rate or tachometer generator. Stock #SA-281.
$3.75 each

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5 v d-c 3600 rpm. Cont. duty. 2½" diam. x 5½" lg, ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75**

Delco 5069625 Constant Speed DC Motor, 27 v. d-c 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.**

General Electric 2 RPM Motor. Type 5BA10FJ228, 27 v. d-c @ 0.6 amps. 10 lb/in torque at 2 rpm. Shunt wound. L-C noise filter. Stock #SA-274. **Price $6.75 each.**

AC DC GENERATOR

Homelite 18A120D28-1

Self ecxited. Output 115 v. 400 cycles single phase at 39 amperes and second output 28 v. d-c at 17.9 amps. Required speed 4000 rpm. **SPECIAL PRICE $175.00.**

Prices F.O.B. Paterson
Phone ARmory 4-3366
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R. F. COMPONENTS – MICROWAVE – TEST EQUIPMENT

10 cm. horn and rotating joint assembly, gold pated .... $65.00 ea.
ROTARY JOINT choke to choke $17.50
ROTARY JOINT choke to choke with deck mounting $17.50

BC 987A PPI. 12" Indicator Console w/additional A Scope BC 986B Compl/w all Pwr Sply Osc. Control Unit, desk shelf $350.00
12 GPT Tubes for above $14.95

TR-ATR Section for above with 724 ATR Cavity $8.50
TR-ATR Section, APS 15, for 1B24, with 724 ATR Cavity with 1B24 and 724 tubes. Complete. $21.00
TR CAVITY for 724 A Tube $3.50

RADAR BEACONS

CPN-3 10 cm. Used $1500.00
CPN-8 10 cm. Used 1500.00
CXBR (3 cm) CPN-6 Prototype 1500.00

APS-31 mixer section for mounting two 2K25's. Beacon reference cavity 1B24 TR tube. New and complete with attenuating slugs .... $42.50 ea.
DUPLEXER SECT. for 1B24 $10.00

AIRBORNE RADAR

APS-4 3 cm Compl. Write
APS-15 All Major Components $500.00
APS-3 New & Complete $750.00

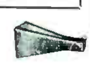
3 cm 180° bend with pressurizing nipple $6.00 ea.
3 cm. 90 bend, 14" long 90° twist with pressurizing nipple .... $6.00 ea.

THERMISTOR BRIDGE: Power meter 1-203-A, 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case. $72.50

12" SECTION 45 deg twist 90 deg bend $6.00
15 DEG BEND 10" choke to cover $4.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 144 KW (12 KV at 12 amp.). Duty Ratio: .001 max. Pulse duration: .5, 1.0 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715-B, 1-829-B, 3-72's, 1-73 New $110.00



AT-48 Horn Silver Plate. "N" Inpt. New $6.50
AT-68 Horn, Sperry. "N" Inpt. New $6.50
TS-235 UP. Dummy Load. New $87.50

I.F.F. KW Pulsed output Pkg. Tunable 154-186 mc. adj. modulating pulses 4-10 micro sec. comp. 115v 60 cy ac pwr. supply. Video output receiver. New w/tubes $350.00
Wavemeter for above $75.00
Dipole Array for above $85.00

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00

10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10 CM Directional Coupler $350.00

TRANSITION 1 x ½ to 1¼ x ⅝, 14 in. $8.00
723 A/B Klystron mixer section with crystal mount, choke flange and Iris flange output $22.50
3 cm. right angle bends. "E" plane 18" long cover to cover .... $6.50 each

APS 4 AIRBORNE RADAR

Complete sets and various components available.

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER. CHOKE FLANGE. SILVER PLATED BROAD BAND $37.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50

SCR 584 SPARE PARTS AVAILABLE

Magnetron Cplg. ⅞ rigid coax, ⅜ I. C. $7.50
⅞" rigid coaxial tuning stubs with vernier stub adjustment. Gold Plated $17.50

WRITE FOR FLYERS OF DEMORNAY BUDD PLUMBING. WE PURCHASED 80% OF THE N. Y. INVENTORY TO BE SOLD AT SURPLUS PRICES

3 CENTIMETER

Choke Flanges UG40/U .... $ .85
Cover Flanges UG39/U .... $ .65
Uni-Directional Couplers CU105 APS-31, Type "N" Terminated 25DB $10.00
Uni-Directional Couplers Cover Flange Terminated 20 DB $9.50
"E" Plane Bends 2½" Radius CH. to CUR. .. $10.00
12" Straight Sections Square CH. to CUR S. P. $3.00
"H" Plane Bends 2½" Radius CH. to CUR. .. $10.00
Crystal Mount $9.00
B- Directional Coupler Type "N" Teminated .. $15.00
Bi-Directional Coupler Type "N" Terminated. Broad Band $15.00
E9-176/AP Dir. Coupler 20DB Nominal "N" Terminated $15.00
Xa Band Mitred Elbows $9.00
Bulthead Feed-Thru $10.00
Press Test Sections Ch to CUR W/15 lb. gauge $9.00
Mitred Elbows $8.00
Adapter UG39 U to UG40/U $3.50

"K" BAND

90 Deg Bend Sq. CH. to CUR. .... $ 5.00
90 Deg Bend Sq. CH. to CH. 5.00
90 Deg Bend Sq. CUR. to CUR. 5.00
Bi-Directional Couplers 20DB P/O APS-34 .. 49.50
Uni-Directional Couplers 39.50
Rotary Joints P/O APS 34 .... 49.50
Straight Sections CH. to CUR. 6" 3.00

"C" BAND

RT Angle Bends Circ CH to CIRC CUR Unplated $3.50
CIRC CHOKE FLANGES (2) Mitred Elbows CIRC CH. to CIRC CUR $16.50

TEST EQUIPMENT

"L" Band Slotted Line with Probe and Carriage and "N" Terminated Directional Coupler $300.00
"C" Band Flap Attenuator. Gold Plated $90.00
⅞ Rigid Coax ⅜" Bullet Directional Couplers 20DB $17.50
⅞ Rigid Coax ⅜" Bullet To Type "N" Adapter $10.00
10 CM Horn P/O APS-20 .... $100.00
C9176 AP Dir Cplr 20 DB Nominal $15.00

WILCOX CS390 CONTROL EQUIPMENT

FOR AIRPORT CONTROL GROUND STATION — Standard relay rack housing, monitor loudspeaker, dual channel receiver amplifier. Type 109 A control panel, microphone speech amplifier, etc., spare parts, new and complete .... $750.00 each

HV. Rect. Full Wave Sin. Phase Rect. utilizing 2-705A tubes. Input 115v 60 cy AC. Output 1800v 45 ma. at xfmr secondary. 12000v DC at output term. New $125.00 w/tubes.

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MARK IV RADAR CONSOLE

Compl. "L" band pkg. Operating fr. 115 v 60 cy. c/o Pulser, Rec. 700A Mag. Osc. Pwr. Sply. w/most tubes $750.00
Individ. Chassis avail. separately

3 cm. wavemeter. Ordnance type micrometer head. New: Absorption type $85.00
9000-9500 MCS X Missn type .. $92.50

H.V. PWR. SUPPLY

15000v 30 ma. DC Bridge Rect. Pwr Sply. Oper. FM. 115v 60 cy $115.00

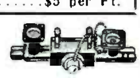
3 cm 90° twist 6" ch. to cover $8.00

DEHYDRATOR UNIT. CPD 10137 Automatic Cycling. Compressor to 50 lbs. Compl for Radar XSMN. Line. New $425.00

SWR MEAS. SECTION, with 2 type "N" output probes MTD full wave apart. Bell sizes guide. Silver plated $10.00

200 MC COAXIAL PLUMBING

Right Angle Bend $35.00
T Section $55.00
T Section with Adapter to ⅞" in rigid coax .. $65.00
Running Ftg. .... $5 per Ft.



Rotating joint, with deck mounting $15.00
RIGID COAX slotted section CU 60/AP $5.00

AN/APS-15A "X" Band compl. RF head and mod. 725-A magnetron two 723A/B 1B24, TR, revr-ampl. duplexer. HV supply, blower, Peak-Pwr Out: 45 KW apx. Input: 115, 400 cy. Mod. pulse dur. .5 to 2 micro-sec. apx. 13 KV Pk Pulse. Compl. with all tubes incl. 715-B, 829B, RKR 73, two 72's. New $210.00

10 cm Wavemeter. WE type B 435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial. Gold Plated W/Calib. Chart. P/o Freq. Meter X66404A. New $99.50

SURFACE SEARCH RADAR

S.E. 10 cm 115 VDC New $1200.00
SQ-1 10 cm. 115 VDC Used $1200.00
SF-1 10 cm. 115 VDC New w/spares $2800.00

TR/ATR SECTION choke to cover $4.00
MITRED ELBOW and S sections choke to cover $4.50

UG 65/U 10CM flanges .... $6.75 each
UG 53/U Cover .... 4.00 each
UG 54/U Choke .... 4.50 each

"K" BAND FEEDBACK TO PARABOLA HORN, with pressurized window $30.00
MITRED-ELBOW cover to cover $4.00
FLEXIBLE SECTION 1" choke to coke $5.00
WAVEGUIDE ½ x ¼ per ft. $1.00

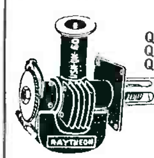
AS14A/AP—10cm Pick up Dipole with "N" Cables $4.50

TWIST 45 deg., 6" long $8.00
90 degree twist. 6 inches long $8.00
TWIST 90 deg. 5" choke to Cover w/press nipple $6.50

RL 26. Gas driven reversible engine, for laying & pick up field tel. wire $125.00
WIRE PIKES $1.50

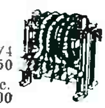
ADAPTER, rd. cover to sq. cover $5.00

APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser, 714 Magnetron 417A Mixer all ⅞" rigid coax, incl. revr, front end $210.00



MAGNETRONS

QK 61 2975-3200 mc $65.00
QK 60 2800-3025 mc $65.00
QK 62 3150-3375 mc $65.00
QK 59 2675-2900 mc $65.00



FILAMENT TRANSFORMER

for above 115V/60 cy Pri: four 6.3V/4 Sec. 5000VT $27.50
Magnetron Kit of four QK's 2675-3375 inc. w/trans special $250.00

BRAND NEW ORIG. PACKED GUARANTEED GOOD

2J31	2J38	3J31	WRITE FOR QUANTITY & PRICE
2J21-A	2J39	5J30	
2J22	2J40	714AY.A	
2J26	2J49	718DY	
2J27	2J61	720BY	
2J32	QK915	720CY	
2J34		725-A	
2J37		730-A	

728-AY, BY, CY, DY, EY, FY, GY
700-A, B, C, D
706-AY, BY, DY, EY, FY, GY
Klystrons: 723A/B 707B W/Cavity 417A 2K41

Electromagnets for magnetrons 700A $24.50 ea.
GE Magnet type M7765115. Gl distance between pole face variable from 2 1/16" (19.0 gauge to 1½" (2200 gauge). Pole dia. 1⅛ P/o SCR 586. New $34.50

RT32/APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR. 723 A/B local osc and beacon MT. Preamp. Used but exc. cond. $97.50

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	3/4 in.	5/8 in.	$12.50
4200	21/32 in.	3/4 in.	$15.50
1300	1 5/8 in.	1 5/16 in.	$12.50
1860	1 5/8 in.	1 1/2 in.	$14.50

TS 89/AP Voltage Divider. Ranges 100: ½ for 2000 to 20000v. 10:1 for 200 to 2000v. Input Z 2000 ohms. Output Z 4 meg ohms flat response 150 cy to 5 meg cy $42.50

All merchandise guaranteed. Mail orders promptly filled. All prices, F.O.B. New York City. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

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CHOKES
INVERTERS

TRANSFORMERS

THERMISTORS
VARISTORS

Power Transformers—115V/50-60 cps input

Volts Out	Am p	Filaments	Each
770V	.0025	2.5V/3A	$1.98
550VCT	.050	6.3V/.5, 2.5VCT/1.75	2.49
2 x 110VCT	.01	6.3V/10, 2.5VCT/7	2.75
2 v 110V	.010	6.3/2.5, 2 x 2.5VCT/7	3.45
550VCT	.100	6.3V/1.8, 6.3/.6	2.29
580VCT	.040	5VCT/3A	2.49
100VCT	.017	5VCT/3A	2.25
2300V	.004	2.5/2A	7.49
100VCT, 65V	.100	6.3VCT/10, 40V/.1, 18VCT/.1, 18-6/.1 6.3/.1	3.49
1500V	.160	2.5VCT/12, 30V/.01	6.95
1100V, 400V	.250	6.3V/6A	6.95
78V	.300	6.3V/2A	1.79
800VCT	.150	5V/3A, 2.5V/2	3.98
2 x 300V	.042	55V/.125, 45/3.5	3.95
585	.086	5V/3, 6.3V/6	3.95
1080VCT	.055	6.3V/1.2, 6.3/1.2	5.95
600VCT	.155	6.3VCT/5, 5VCT/3	3.95
1120V	.600	2 x 5VCT/6-2A, 6.3VCT/3, 6.3/.300	14.95

Plate Transformers—115V/50-60 cps input

Volts Out	Amp.	Each	Volts Out	Amp.	Each
65V	.500	1.49	70V	1	$1.95
500VCT	.150	3.00	100V	3	1.95
650VCT..	.015		121V	1.5	
2 x 150V	2 x .940	4.25	126.5V	1.5	2.25
600VCT	.0165	2.49	132V	1.5	
250VCT	.077		690V	.450	4.95
			1470VCT	1.2	24.00

Filament Transformers—115V/50-60 cps input

Rating	Each	Rating	Each
2.5V/5A, HV Ins.	$1.79	30VCT/.330, 34VCT/.380	$1.95
6.3V/2A, 78/300	1.79		
36V/1.11	1.49	6.3V/2.5, 2 x 2.5/7	3.25
5VCT/20A	5.49	2 x 2.5VCT/6.5A	3.25
4V/16A, 2.5V/1.75 HV ins	4.75	2.5V/1.75, 5V/3A, 6.5/8A, 6.5V/.6A	3.85
5V/115A	12.95		
7.2V7, 6.4/10, 6.4/2, 2 x 26.2/2.5, 16V/1	5.95	10VCT/13A, 10VCT/3.25	6.95
		5CVT/13.5, 2 x 5VCT/6.75	6.95
6.3VCT/20, 6.3V/1.8, 6.3V/.6	5.25	1.3V/.0091Kva	2.95
6.3VCT/1, 6.3VCT/7	2.75	6.3VCT/.6A, 5V/2A	1.85
6.3/5m 6.3/1A	2.25	6.3VCT/2A, 5.3VCT/2A	2.45
6.3VCT/3.2, 6.3VCT/1	2.25	6.3V/1A, 6.3V/1A	1.95
5V/6A	2.25	6.3 2.5/7A, 2.5V/7A	3.25
6.3VCT/1A, 5V/2A	1.65		
6V/3A	1.10		

SPECIAL TYPES

Input	Output	Each
6, 12, 24 or 115VDC, or 230VAC	420VCT/85Ma, 6.3V/1.9, Univ Vibrator Xfmr	$2.39
230V 60 cy	230V/.05A	1.10
115V 60 cy	115V/78V-410A/.600MA	1.59
110/115/120/125	13.5V/1.11A	1.49
210/220/230	2.5VCT/4A	1.49
230V 60 cy	2.5V/6.5A	1.95
230V 60 cy	200V/20A, 4 x 6.3/.900A	2.95
220/440V	286VCT/290MA	2.95
220V 60 cy	260V.03, 100/1.6.3/4.2	2.95
200V 60 cy	700VCT/.75, 40VCT/.1A 15/10/15V/1A	2.39
45/78/90	Tapped 1V to 10V	2.95
.220V 60 cy	2 x 40V/.05, 2 x 5V/6A, 12.6V/1A	2.95
220V 60 cy	24V/6A, 5V/3, 2 x 6.3/1A	2.29
43/78/90/115/180/230	2.5V/6.5A, 2.5/6.5, 6.3/4A	3.95
110/115/120/125	6/12/18/24/75/100/115V/150A	2.49
230V 60 cy	5V/9A MV INS	4.25
200V 60 cy	700VCT/.08A, 110VCT/.08A 24V/.08, 6.3V/.3, 6.3VCT/1.5V/3A, 5V/5A, 2.7V/5A	4.25
230V 60 cy	400V/.03, 190V/.03A, 5/2.5, 5V/2.5A, W/2-866 Sockets	4.25
50V 60 cy	2 x 750V/.901A	1.95
6V & 12V	84V.009, 51V/.003, 1.4V/500 Vivrator Transformer	1.95
230V 60 cy	250V/.1A, 5V/2A, 5V/9A	4.95
220-440	3 x 2.5V/5A, 2.5V/15A	5.95
230V-115V	5VCT/7 5, 5V/7.5, 5VCT/15A	10.95
440V/60 cy 3PH	220V 30W 3 phase or 220V & 6V 1 phase 60 cy	5.95
230V 60 cy	110V200, 33V/200, 5V/10A, 2.5-1.4/10A, 1500V/.160	7.95
95-130V 60 cy	115V/3.6A, 40.9V/3/3A	10.95
220/440V	115V/6.52A	12.95
220-440V	115V/110/105/-7A	13.95

PRECISION CAPACITORS

D-163707: 0.4 mfd @ 1500 vdc. —50 to plus 85 deg C $4.50
D-163035: 0.1 mfd @ 600 vdc, 0 to plus 65 deg C $2.00
D-170908: 0.152 mfd, 300 v, 400 cy, —50 to plus 85 deg C $2.50
D-164960: 2.04 mfd @ 200 vdc, 0 to plus 55 deg C $2.50
D-168344: 2.16 mfd @ 200 vdc, 0 to plus 55 deg C $3.00
D-161555: .5 mfd @ 400 vdc, —50 to plus 85 deg C $3.00
D-161270: 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg C $12.50

INVERTERS

PE 218-E: Input: 25 28 vdc. 92 amp. Output: 115 v, 350-500 cy 1500 volt-amperes. Dim: 17"x6½"x10" New (as shown) $29.50

PE 218-H: Same as above except size: 16½" x 6" x 10". New $29.50

PE 218H, used, good cond $22.00

PE 208: Input: 28 vdc, 38 amps. Output: 80 v, 800 cy, 500 volt-amps. Dim: 13" x 5½" x 10½". New $12.50

GE 5D21NJ3A: Input: 28 vdc, 35 amp. Output: 115 v, 400 cy, 485 volt-amps. Dim: 9" x 4½" diam. New $49.95

MOTOR GENERATOR SETS

GE Generator 5BC76AB109 Type BC. KW.75 DC 12.5A 1725 RPM AC motor Type AM, 3 HP 440V-250V 60 Cy 3 PH 3.6A DC. 1725 RPM. Used Good.... $250.00

Marconi Motor Generator. 1KW Type #CB232A 125V 500 Cy Crocker Wheeler Generator 120V/14A, 250V/10A 2000 RPM 1.7 HP. Used $75.00

Cont Elect Motor Generator for TBL Equip.. Gen. 1.4 KW 2000V .7 Amp 1780 RPM. Motor 3.5 HP 115V 27A 1780 RPM. $300.00

Marathon Elect. Motor Gen. 115VDC 1 HP 3600 RPM. Type DP Gen. 115VAC .5KVA 60 Cy 4.54A Model DE 753 .... $98.00

Elect Spec BFS54. AC Motor 440V 3 Phase 60 Cy 5.8A 1750 RPM. DC Gen. 97517 Type F42. 120-75V 1.7—7 Amp. DC Gen. BFSR55 1500-600V 1-.15A. 1750 RPM $375.00

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RG 9/U. 52 ohms .... $.24/Ft.
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RG 23/U. twin coax. 125 ohm imp. armored. . $.50/Ft.
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Many other Cables & Wire in stock. Write.

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MARCH 6 TO 9th INCL.

POWER EQUIPMENT

- Fil. Trans. 110v 60 cy in., 5vct/30A out $8.95
- In 110v 60 cy out 6.3vct/20A, 6.3v/1.8A, 6.3v/600MA $4.95
- In 110v 60 cy out 2x5vct 6.75A, 5vct/13.5A, 3500 Test $6.95
- In 110v 60 cy out 10 vct/13A, 10vct/6.5A, 6.3vct/2A $7.95
- In 115v 60 cy out 760vct/500MA, 800vct/40MA $10.95
- In 110v 60 cy out 690vct/400MA $6.95
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- In 110v 60 cy out 4v/16A, 2.5v/.75A $4.75
- In 110v 60 cy out 17000v/144MA, w/choke 26" x 29" x 13" oil immersed $65.00
- In 115v 60 cy out 2x5v/5.5A 29kv ins........ $24.50

115V 60 Cy to 10800 V or 21000 V Dblr. PRICE. . $19.95

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5HY 40 MA. 3 for..$ .99	20 HY 50 MA ...... $ .79
30 HY 25 MA ...... .79	11.5 HY 90 MA 1.39
25 HY .065A 1.00	6 HY 150 MA .99
8.5 HY 125 MA 1.49	25 HY 75 MA 1.25
1.75 HY 100 MA .... .59	.030 HY 2A 1.39
30 HY 24 MA ...... .98	5 HY 150 MA 1.45
15 HY 100 MA 1.39	Dual 7 HY 75 MA, 11 HY 60 MA 1.39
.2 HY 600 MA 1.95	
Swing: 1.0-3.0 HY .225-.02A.	75 HY 225 MA ... 2.25
Dual: 22 HY 600 MA; 44	HY 400 MA 1.75
Dual: 1.52 HY .167A 1.95	.100 HY 1.4A 1.95
Dual: 120 HY 17 MA 2.49	.333 HY 1.12A 2.29
Dual: 10 Hy 200 MA3.50	1 HY 1 Amp. 3.95
3.5 HY 500 MA 4.95	20 HY 300 MA 7.95
10 HY 500 MA 12.95	10 HY 450 MA 12.95
Swing: 9:26 HY .525/.075	MA 14.95
6 HY 175 MA 1.50	2.5 HY 130 MA 1.25
.116 HY 150 MA 4.25	.01 HY 2.5A 1.45
.35 HY 350 MA 7.25	5 Hy 200 MA 1.45

RADIO PARTS DIV. ATT. MR. ROSEN

400 CYCLE TRANSFORMERS

Input	Ratings	Price Each
115V	6.3V/1.8A P/O APG2	$1.49
57/5V	2x57.5V/.0001 A. P/o APG2	1.95
115V	2x145V/.000145A.	1.49
115V	780V, 27V/4.3, 6.3V/2.9, 1.25V/.20A.	3.95
115V	6.4V/11 Amp. P/o APQ7	2.25
115V	2x63V/1.25a, P/o APQ13	1.95
80v	6.3V/1A, 2.5V/2A P/o PE172A.	3.95
115V	15.35VCT/1A	1.95
115V	59.2V/.118, 63V/8.1, 5V/2A, P/o APQ13	3.95
118V	6.3/.9, 6/3V/.6.5V/6, 640/200 MA.	4.95
115V	2x14CV/00014A, 12QV/.00012a, P/o APG2	1.95
115V	3460V/400 Ma. P/o APT 4	7.95
115V	23.5V Tapped 22V/47 MA.	1.95
115V	600VCT/36 Ma	1.95
115V	408VCT/.11a, 120VCT/.250a, 6.3V/6.15, 5V/2A 45V Tapped 28V/.8 and .3a	4.95
115-80V	6.4V/2.5, 400VCT/35Ma, 6.4/.150a.	3.95
115V	6.4V/7.5, 6.4/3.8, 6.4/2.5a	3.49
115V	780V/-, 27V/4.7, 6.3/2.9, 1.25/.2a	2.49
115V	6.4V/8a, 6.4V/1A	1.95
115V	6.3V/9.1A. 6.3VCT/6.5a 2x2.5/3.5a	2.49
115V	5V/2a, 6.3V 2a, 5V/2a, 6.3/.5a	2.99
80-115V	5V/15A, 5000V Ins.	3.95
115V	6.3/2.7, 6.3/.66 6.3VCT/21A	5.95
118V	760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A	
110V	220V	
110V	3V	
55V	20V/20V	1.49
115V	6.4/7.5, 6.4/3.8 6.4/2.5	2.95
115V	592V/118Ma, 6.3/8.1a, 5V/2 W.E.	4.95
115V	6.3V/9.1, 6.3VCT/.65a 2x2.5V/3.5A	2.95
115V	6VCT .00006 KVA	.98
115V	6.4/8a, 6.4V/1a	1.49
115V	1034 VCT/.111a, 6.9V/10, 2x6.3V/1, 5V/2, 6.3/2, 63/1	6.49
115-80V	526VCT/.50a, 6.3VCT/2a. 5VCT/29	3.49
80-15V	400VCT/35Ma, 6.4/2.5, 6.4/15a	3.25
115V	2300VCT Large Qty	2.25
115-V	600VCT/36Ma.	1.49
80-115V	2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5/2a. For SCR729.	3.95
115V	640V/500Ma, 2.5V/1.75a P/o APS 15B	2.95
80-115V	360VCT/20Ma, 1500V/1Ma, 2.5V, 6.3/2.5 6.3V/.6a. P/o 729A.	3.95
115V	2x2.5V/5A, 2.5V/10A. P/o APT 4	4.95
118V	2x2.5V/2.5a, 6.3V/2.25a 1200V Tap 1000V-750V P/o AN/APS-15.	4.95
115V	742.5V/50 MA, 709V 47 MA, 671V/45MA	2.95
115V	600VCT/36 MA, 2 3/4x2 1/4 x3 1/4	
115V	1150–1150. 2 3/4x2 1/4x3 1/4.	
115V	640 VCT/250 MA, 6.3V/.9. 6.3V/.6, 5V/6A.	3.95
115V	6.3V/9.1a 2.5V/3.5a 6.3VCT/.65a 2.5V/3.5a	3.25
115V	9800V or 8600V/32MA.	12.50
115V	592 VCT/120 MA, 6.3V/ 8a, 5V/2a.	3.50
115V	4540VCT/250 MA.	7.50
115V	5V/3a, 6.3V 2a.	1.75
115V	70 to 111V @ 247–622VA.	1.35
115V	5000V/290 MA, 5V/10A.	12.50
115V	2200V/350	5.45
115V	2.5V/5, 5200V/2 MA.	14.95
115V	13.5 KV/3.5 MA	11.50
115V	734 VCT/.177a, 1710VCT/.177a.	6.95
115V	6.3V/9A, 7.7V/.365A	2.79
100/110 120/130	2.5/20A.	4.85
115V	6.3V/12a, 6.3V/2a, 6.3V/1a P/o AN/APQ-5	5.85
115V	6.4VCT/7.5, 6.4VCT/3.8, 6.4VCT/2.5a	4.35
115V	6.3V/2.7, 6.3V/.66A, 6.3VCT/21A.	2.95
115V	6.5V/12A, 250V/100 MA, 5V/2a P/o AN/APS-15.	3.50
115V	400VCT/35 MA, 6.4V/.15a, 6.4V/2.5a.	2.25
80-115V	650VCT/50 MA, 6.3VCT/2A, 5VCT/2a P/o R58/ARQ8	2.45
115V	2400CT/.5MA, 640V/.5MA, 2.5V/1.75A	3.85

THERMISTORS

D-167332 (tube) .... $.95
D-170396 (bead) .... $.95
D-67613 (button) ... $.95
D-104690 for MTG in "X" band Guide $2.50
D-167618 (tube) .... $.95

VARISTORS

D-170225 .... $1.25
D-167176 .... $.95
D-168087 .... $.95
D-171812 .... $.95
D-171528 .... $.95
D-168549 .... $.95
D-168442 .... $3.00
D-163293 .... $1.25
D-98428 .... $2.00
D-16187A $2.85
D-171121 .... $.95
SA (12-43) $1.50
D-167620 .... $3.00
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RADAR TELEVISION ELECTRONICS

CABLE ADDRESS: COMSUPO
PHONE DIGBY 9, 4124
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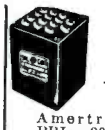
FM MICROWAVE RADIO SONAR

C.E.C. MONEY BACK GUARANTEE, $3 MIN. ORDER. F.O.B. N.Y.C. SEND MONEY ORDER OR CHECK, ONLY SHIPPING CHARGES SENT C.O.D.

SHOCK MOUNTS

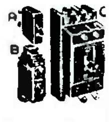
No. 1 Square
No. 2 Square & Diamond
No. 4 Square & Diamond
No. 6 Square
No. 8 Square & Holder
No. 12 Square & Holder
No. 15 Square & Holder
No. 20 Square & Holder
No. 33 Square
No. 35 Square & Holder
No. 10 Square & Holder
No. 25 Square & Holder
No. 45 Holder
No. 55 Holder
Write for More Data



Universal Output Transformer

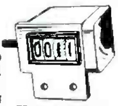
Amertran Silcor. PRI: 20,000/16,000/5000/4000 ohms. Sect. 500/15/7.5/5/3.75/1.25 ohms. 30 db. contin. Flat to 17,000 CY. w/Diag. & Inst. for 6 watt amplifier $4.75

LOOK at these BIG VALUES!



Heineman Ckt. Bkrs. for AC-DC Operation Amperes .010, 3, 7, 10, 50, 80, 100, 150, Ea. $1.10
Klixon 25A 75c
Dual 8 & 25 Amp...$2.25

VEEDER Counter



Counts to 9999 and repeats. Many uses ½" shaft, Front meas. 1" x 1¼" 98c

VFD 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

BC-223 TRANSMITTER

30 Watt Transmitter with crystal oscillator control on four preselected channels — also master oscillator. Frequency coverage 2000 KC. to 5250 KC. by use of three plug in coils. Five tube operation, 801 oscillator, 801 power amplifier, two 46 modulators and one 46 speed amplifier. Price with TU18 Tuning Unit 3000-4500 KC $19.95

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
7	800	1.20
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
10	1K	1.95
15	1K	2.20
.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	30.95
.015	16K	6.95
.25	20K	16.95
.5	25K	36.95
1	25K	83.95
4	50	.29
1	100	.15
2.5	100	.23
200VDC		
2x.1	2ST	.15
2x.1	3TT	.15
2x1	4ST	.16
2	2ST	.20
.5	2TT	.15
.5	2ST	.15
400VDC		
2x.25	3ST	.21
2x.1	3ST	.21
2x.1	2TT	.20
3x.1	3ST	.25
.1	2TT	.19
.5	1TT	.19
1	2ST	.23
2	2ST	.26
600VDC		
.1	2BT	.20
.1	2ST	.21
2x.1	3ST	.27
2x.1	3BT	.25
2x.1	2ST	.26
3x.1	ST	.25
2x.25	3ST	.23
.25	2TT	.20
1	2ST	.30
2x1	3ST	.35
2	2ST	.40
2	2BT	.39
2	2BT	.39
1000VDC		
1	2ST	.45

BT—Bot. Term.
ST—Side Term.
TT—Top Term.
MANY OTHERS

MICA CONDSRS

1000VDC Test	
.0015	.36
.0175	.45
.00005	.59
.00137	.98
.000075	.59
1200VDC Test	
.00027	.59
2000VDC Test	
.00003	.98
.01	1.64
2500VDC Test	
.00025	.36
.006	1.38
.005	1.00
.000047	.39
.005	.79
.00051	.39
.00005	.54
3000VDC Test	
.00007	1.59
.0004	1.25
.002	1.60
5000VDC Test	
.0035	.98
.006	1.65
.00015	2.70
.0043	.98
.0002	2.70
.0008	2.70
.0004	2.70
.00075	2.70
.005	2.50

T.V. Transformer, 7" or 9" scope, 3000v/5MA, 720vct/200MA, 6.4/8.7A, 6.4/6A, 5/3A, 1.25/3A, 115 V 60 cy input. Price $3.95

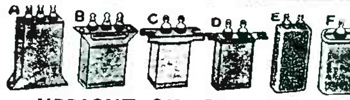
INSULATORS

STAND OFFS

w/alum base 1 1/4x8"	$1.25
w/alum base 1"x6"	98¢
w/alum base 1 1/4x5"	98¢
w/alum base 1x4"	70¢
w/alum base 1 3/4x3 3/8.	1.69
w/alum base 1 5/8x3"	1.00
IN84,xS1, 2 1/4"	10¢
IN81 feed support 1 1/2".	8¢
IN82 feed suport 3"	16¢
Stand off 3"x1"d	20¢
Stand off 6 3/4x1"d	40¢
Spreader 2 1/8x5/8 Sq.	8¢
Spreader 2 11/16x7/16"d.	10¢
Thru panel 1 1/4x3/4d	15¢
Bowl thru x53, 6 3/4x3"d	1.10
Antenna IN86	15¢

Send your requirements for all types of Rotary Switches.

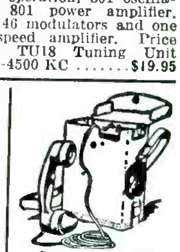
Mossman Type 4PDT $1.79



UPRIGHT OIL CAPACITORS
STANDARD BRANDS

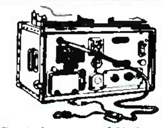
Fig.	Mfd.	Voltage	Terminals	Price
B	1	600VDC	2	35¢
E	.25	400VDC	2	39¢
E	.5	600VDC	2	35¢
E	1	600VDC	2	35¢
D	2 x .5	600VDC	3	49¢
B	3 x .1	600VDC	3	55¢
B	.25	400VDC	2	39¢
D	.5	600VDC	2	39¢
B	.5	600VDC	2	35¢
E	1	400VDC	2	35¢
B	.1	400VDC	2	40¢
B	.4	600VDC	2	39¢
D	.1	600VDC	2	45¢
B	2 x .1	600VDC	2	50¢
E	1.75	400VDC	2	35¢
D	3 x .1	600VDC	3	55¢
A	2 x .5	600VDC	3	49¢
B	.1	600VDC	2	45¢
B	.1	600VDC	2	45¢
D	.1	500VDC	2	45¢
A	.1	500VDC	2	45¢
B	.1	600VDC	2	45¢

Private Telephone for Home or Off. Consists of Hangar, Buzzer, Pushbutton, Mount. Handset, 50 Ft. Wire, Batteries. Complete set of two phones wired ready to operate. $14.95



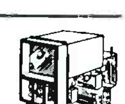
Sound Power FIELD PHONES

EE - 108. Talking range 9 to 12 miles without batteries or current. Has crank and generator for signaling. In fine leather case. Weighs 9½ lbs. Brand New. A wonderful buy. 2 units as fig. above $37.50



AN-GSC-T1 (Code Training Set

Operates on 6V - 12V - 24V - 115 V DC 115V-230V AC with 10 keys. Contains a blinker system and frequency adjustment. A real buy for Boy Scouts and students. Enclosed in trunk. Brand New. Complete $23.95
TG5 Telegraph Set includes Key, Buzzer, Ringer Bell in compact metal or wooden box. To learn code $2.95



BC-605 Interphone Amplifier

Easily converted to an ideal intercommunications set for office-home-or factory. Original. New $4.75

Birtcher Tube Clamps

926C
926–16
926–B1
926–B2
926–B8
926–C15
926–C–13
926B
926C–19 926–B31
926B–16 926C–23
926A–14
926A
926C1
926A11
Each 15¢
10 $1.40
100 $12.00

Ceramicons

Mmt	
1	25
3	27
3.1	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	1000
200	
100 for	$7.50

Button	Feed Thru	
40	100	50
180	200	500
175	500	470
185		
100 for	$9.50	

EE65E Telephone Test Set

To locate any kind of trouble on Tel. lines, can be used as telephone. Includes ringing circuit etc. A valuable unit $19.95

EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/3Q5 tube. Phone supplied (Featherweight) $9.75

Loading Coil C114

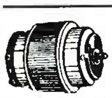
Same as WE No. 632 but in waterproof case to counter balance cap. in line gives clearer signal. Army used W/W110 & W130 wire. 85¢ ea.

WING LIGHT

for planes aqua blue. Mfg. Grimes NAF-1021-12 ea. 40¢

Large quantity of Aircraft hardware and components. Write your requirements

SELSYN MOTORS



115 V.A.C. 60 cycle #C-78248. Can be used to turn small antennas or as indicators. Size 3½" x 5½". Price per pair........$6.95

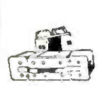
Soldering Iron 200W

121-130V Iron ⅝" removable copper tip. Heats in a minute. Complete with cord & plug. New with stand ...$3.95

ANTENNA MAST

Are you in a dead spot. If you can't get a good T. V. Picture. Here is a Sig. Corp. Ant. mast 30' high of rugged plywood construction to solve your problem. It telescopes into 3 ten ft. sect. for easy stowage. Easy to Mnt. Comp. with stakes & rods. Ea. $19.95.

SCR 183 REC. TUNING UNITS



D—Range 850-1330 Kc
E—Range 1330-2040 Kc
F—Range 2.04-3 Mc
G—Range 3-4-5 Mc
H—Range—4-6 Mc
K—Range 9.05-13.5 Mc
Dual Range 400-600 Kc 6-9 Mc
$1.95 EACH

SCR 183 TRANS TUNING UNITS

1-1.2 Mc	$1.49	5-6.2 Mc	1.49
1.2-1.5 Mc	1.49	4-5 Mc w/4495Kc XTAL	2.95
3.2-4 Mc	1.49		

Many Others

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Digby 9-4124
ATT. MR. C. ROSEN

4,000,000 Micas
300,000 Sil. Micas
100,000 Oil Cond.
4,000,000 Resistors
400,000 Electrolytics
400,000 H.V. Micas
5,000 K.V. Cond.
150,000 Prec. Resis.
500,000 Tube Clamps
1,000,000 An. Connectors
50,000 Dynamotors
20,000 Power Xfrmrs
20,000 Chokes
100,000 Antennas
50,000 Audio Xfrmrs
100,000 400 CyXfrmrs
100,000 Shock Mts.
25,000 Magnetrons
5,000 Magnets
50,000 Pulse Xfmrs
50,000 Control Boxes
500,000 Tubes
300,000 Relays
500,000 Pots.
35,000 Vibrators
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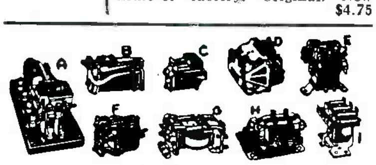

RELAYS

Contacts	Rating	Coil Ohms	Mfg.	Price
DPDT (8A)	24–28V vdc	170	GECR2791B 100F3	75¢
SPDT	28vdc	175	GECR2791B	75¢
3PDT	24–28 vdc	175	GECR2791B	75¢
4PST	24 vdc	180	GECR2791G	75¢
DPDT, SPST	12 vdc	44	Leach 1067-490	1.25
DPDT	22–28 vdc	160	Leach	1.25
SPST	28 vdc	250	Allied BO48	75¢
DPST	14 vdc	85	Price X20-A	65¢
3PDT	24–28 vdc	280	Allied DOX-3	1.50
SPST	24–28 vdc	2400	GM 12917-1	75¢
DPDT	24 vdc	280	Allied BO635	1.00
3PDT (10A)	26 vdc	280	Allied KS 5910	1.10
DPDT	28 vdc	280	Allied BO 6D35	1.00
SPST (NC)	75MA	60	Allied KS 5862	85¢
DPDT	20–30 vdc		Ounce 50XB	1.00
DPDT	10–14 vdc		Ounce 100AB	1.00
DPDT	24–28 vdc		PB21C057-A	1.00
3PDT	24–28 vdc		GECR2791	1.50
SPDT	24–28 vdc		GECR2791	1.00
DPDT	12 vdc		Ounce	1.49
SPDT	10–12v	125	Ounce	1.49
DPDT	27 5 vdc	400	Allied	1.10
DPDT	9–14 vdc		Allied	1.10
DPDT	24v60cy	50	Allied	1.40

ARC 3 MINIATURE RELAYS

Can SPDT 5 Prong.			GECR2791C104	1.95
SPDT, 6 PST	28 vdc	300	RBM55342	35¢
	22–28 vdc	300	RBM55528	35¢
SPST	22–28 vdc	300	RPM55251	35¢
DPDT, DPST	22–28 vdc	300	RBM55531	35¢
SPDT, SPDT	22–28 vdc	300	RBM55526	35¢

Time delay Relay W.E. KS10163 DPST 115V DC 3.00 with 6VDC Interchange Coil $3.95

Solenoid Aircraft Relay, 4PST High Amp Cutler Hammer 24VDC..$3.95

Solenoid Aircraft Relay SPST High Amp double break 24 volt Leach 7220-24.

Many Others

ROTARY BEAM COUPLER

RF Coupler 360° rotation 1 turn coupling link. Easily adpt 200 to 300 Mc. Plastic case mount on side. Price $2.95

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/ARC6
FT-225A
FT-229A
FT-232A
FT-234A

RF CHOKES

1Mhy/125MA	.23
1.9-2Mchy	.10
2.5Mhy/500Ma	.89
3.2Mchy	.10
3.3Mchy	.10
3.6Mchy	.10
5.2Mhy/200Ma	.39
5.5Mhy/500Ma	.98
6.4Mchy	.10
10Mhy/350Ma	.39
20Mchy	.18
94Mhy	.10
100Mchy	.10
115Mhy/150Ma	.39
185Mchy	.10
220Mchy	.18

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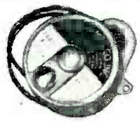
A.C. MOTORS

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.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake **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 $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 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 gear. **Price $3.30 ea. 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.**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2, Pioneer, 2 phase, 400 cycle. **Price $4.25 each net.**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-49-6 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, .3 amps., 10 watt, output. **Price $34.50 each net.**

FPE-25-16 Diehl Low Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., .85 amps. **Price $10.00 ea. net.**

FP 25-3 Diehl, Low Inertia, 20 V., 60 cycle, 2 phase, .50 amps., 3200 r.p.m. **Price $10.00 each net.**

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 Cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $8.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

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 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $10.00 ea. net.

Schwein Free & Rate Gyro, type 46800. Same as above except later design.
Price $15.00 each net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase. **Price $17.50 each net.**

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 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 $10.00 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.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Norden Type M7 Servo Motor. 26 V., D.C. **Price $20.00 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.**

COMPLETE LINE OF AIRCRAFT THERMOCOUPLES

D.C. MOTORS

5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $3.90 each net.**

A-7155, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Shunt Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $3.75 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.**

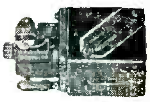
General Electric Type 5BA10AJ52C, 27 V. D. C., 0.65 amps., 14 oz. in. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V. D. C., .5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

D.C. ALNICO FIELD MOTORS

5067043 Delco 12 volts, 10,000 rpm. **Price $5.50 each net.**

5069600, Delco, 27 V., 250 r.p.m. **Price $5.00 each net.**



5069466, Delco, 27 V., 10,000 r.p.m.
Price $3.50 each net.

5069370, Delco, 27 V., 10,000 r.p.m. **Price $5.00 each net.**

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

Sampsel Time Control Inc. Alnico Field Motor, 27 V. D.C. Overall length 3 5/16" by 1⅜". Shaft ⅝" long by 3/16", 10,000 r.p.m. **Price $4.50 each net**

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked—10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

RELAYS

Type B4 28 volts D.C., 200 amps. continuous duty. Electric Auto-Lite Co. Part no. WSN4001. **Price $2.50 each net.**

Type B5B, 28 volts D.C., 50 amps., continuous duty Hart Mfg. Co. Part no. 692R[illegible] **Price $1.85 each net.**

Type B8, 28 volts D. C., 250 amps., intermittent duty Cutler-Hammer. Part no. 6041H139A **Price $2.50 each net.**

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Wincharger Corp. Dynamotor Unit. PE-101-C. Input 13, V.D.C. or 26 V.D.C. D.C. AT, 12.6 or 6.3 amps. Output 400 V.D.C. AT. .135 amps., 800 V.D.C. AT. .02 amps., 9 V.A.C. 80 cycle at 1.12 amps.
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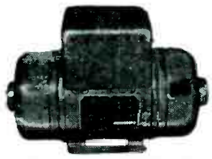

153F, Haltzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter.
Price $115.00 each net.

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 $40.00 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 $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A.
Price $22.50 each net.

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A.
Price $20.00 each net.

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts.
Price $100 each net.

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $12.00 each net.**

PE218, 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.**

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-D120, 120-0-120 amps. D. C.
Price $4.50 each net.

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement.
Price $15.00 each net.

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Rauland Corp. vibrator non-synchros type Stock No. 3H6694-11; 6, 12 or 24 V.D.C., Input. Frequency 200 cycle.
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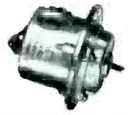
Sperry Phase Adapter. Part No. 661102. Used for operating three-phase equipment from a single phase source. 115 volts 400 cycle. Maximum load 50 watts. **Price $15.00 each net.**

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle.
Price $5.50 each net.

AY14D, 26 V., 400 cycle, new with calibration curve.
Price $15.00 each net.

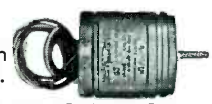
AY20, 26 V., 400 cycle.
Price $7.50 each net.



AY31, 26 V., 400 cycle. Shaft extends from both ends.
Price $10.00 ea. net.

AY38, 26 V., 400 cycle. Shaft extends from both ends. **Price $10.00 each net.**

PIONEER PRECISION AUTOSYNS



AY101D, new with calibration curve.

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AY131D, new with calibration curve.
Price $35.00 each net.

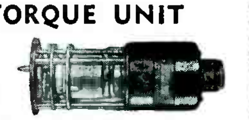
AY130D, new. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $15.50 each net.

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $30.00 each net.

PIONEER TORQUE UNIT



Type 12602-1-A.
Price $40.00 each net.

Type 12604-3-A.
Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.

Type 12627-1-A. Price $80.00 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 $8.50 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 MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 67000 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

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 $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase.
Price $14.00 each net.

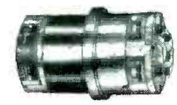
Weston Tachometer Generator (aircraft type) model 752-J4 single phase. A.C. output. **Price $17.50 each net.**

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.

7G Generator, 115 V., 60 cycle.
Price $30.00 each net.

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 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 $4.50 each net.

5G Generator 115 volts, 60 cycle.
Price $50.00 each net.

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 each net.**

5SF Repeater, 115/90 V., 400 cycle.
Price $19.00 each net.

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer. 90/55 volts, 60 cycle. **Price $40.00 each net.**

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575A	11.95	872A	1.12
816	.99	RX21	2.39
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PENTODES

307A/RK75	$3.69	837	$1.19
713A	.79	1613	.49
717A	.49	1619	.15
803	2.95	1851	.69
804	7.95	EF50	.39
807	1.09	HY115/145	.59

UHF TRIODES

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2C43	7.95	708A	3.59
2C44	.98	826	.39
2C46	6.95	8012	.89
3C24/24G	.35	GL434A	2.69
388A	.47	HY615	.19
527	5.95	VT127A/100TS	1.95

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3C23	2.19	C0J	3.65
3C31/C1B	.169	FG17	2.69
3C45	12.95	FG27A	6.95
884	1.19	FG81A	3.29
885	1.19	FG105	8.95
2050	1.19	FG172	13.95

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955	.25	959	.35
956	.25	9004	.24
957	.22	9005	1.39

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2C22/7193	$ .15	811	$ 1.98
2C26A	.15	812	2.45
3C22	39.50	814	1.98
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30 spec	.19	841	.29
45 spec	.19	843	.29
75TL	3.89	845	3.85
100TH	10.49	851	12.95
211	.25	1626	.25
250TH	18.75	8005	4.75
304TH	3.49	8011/WL538	.25
304TL	1.29	8014	22.50
316A	.29	8025	3.69
450TH	16.95	F123A	7.95
710A	.25	F127A	15.95
800	1.49	F128A	69.50
801A	.19	F862A	397.50
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808	.99	ML101/GL605	49.50
809/3C30	1.89	WL530	12.95
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3B24	$1.49	8013	$ 1.39
3B26	1.49	F660/WL562	49.50
15R	.49	RK72	.59
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GL451	.89	VU111	.49
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371A	.39	WL616	37.50
371B	.49	KC4	37.50
705A	.69	ML100	37.50
1616	.49	F606	37.50

MINIATURES

9001	$ .32	9003	$ .33
9002	.25	9006	.15

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2AP1	$3.89	5CP1	$1.29
3AP1	4.59	5CP7	2.95
3BP1	2.39	5FP7	1.19
3CP1	1.39	5GP1	2.98
3DP1	1.79	5JP1	29.95
3DP1-S2A	2.79	5JP2	8.95
3FP7	.97	5LP1	12.95
3GP1	5.95	7BP7	3.49
4AP10	2.98	9LP7	1.98
5AP1	2.95	902	3.39
5AP4	2.95	905	2.49
5BP1	1.85	908/3AP1	4.95

CRYSTAL RECTIFIERS

1N21	$ .49	1N23A	$ .79
1N21A	.89	1N23B	1.89
1N21B	.89	1N27	.89
1N23	.59	1N34	.82

KLYSTRONS

2K25/723AB	$22.50	723A/B	$12.95
2K28	24.95	726A	6.75
417A	3.95	726B	29.50
707B	14.95	726C	49.50

TWIN PENTODES

3E29	$8.95	829UHF	$7.45
815HF	1.59	832A	4.89

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3D21A	$ .98	715A	$ 5.49
4-65A	14.21	715B	6.59
4-125A	26.05	715C	19.95
4-250A	36.25	813	6.85
4E27	12.45	860	14.95
257B	12.45	861	9.49
5D21	24.45	865	.79
350B	1.39	1614	1.35

GAS SWITCHING TUBES

1B24 TR	$4.59	532A	$1.89
1B26 TR	2.79	1B36 anti TR	3.95
1B27 TR	7.95	721A anti TR	1.98
1B29	.79	724B anti TR	2.49
1B32	1.89	1960/S836 diode	.89

PHOTOTUBES

1P24	$ .59	930	$ .98
1P36	2.98	931A	2.39

TWIN TRIODES

2C21/RK33	$ .24	2C34/RK34	$ .22
1642	.24	RK59	1.69

MAGNETRONS

2J21A	$ 7.95	2J48	$12.75
2J22	7.95	2J54B	22.50
2J26	6.95	5J29	11.95
2J27	12.75	5J30	47.50
2J31	8.49	714AY	3.59
2J32	12.95	725A	6.45

DUO-DIODE GAS RECTIFIERS

3B22/EL1C	$1.98	CK1005	$ .09
4B24/EL3C	1.98	CK1006	.85

SPECIALS

23D4 ballast	$ .29	1625 beam amp	$ .19
28D7 beam amp	.29	1629 tuning eye	.19
559 UHF diode	.98	1631 beam amp	.98
876 ballast	.29	1636 beam amp	.98
1624 beam amp	.67	REL21 spark gap	.98

1630 orbital beam hexode....... $ .49
RK60/1641 duodiode vac rect.... .42

RECEIVING TUBES

OA2	$1.29	6B8G	$.69	12AT7	$.79
OA4G	.89	6BA6	.55	12AU6	.57
OB2	1.67	6BE6	.52	12AU7	.67
OZ4	.57	6BF6	.57	12AV6	.54
O1A	.39	6BG6G	1.47	12BA6	.55
1A3	.44	6BH6	.59	12BE6	.49
1A4	1.09	6BJ6	.57	12C8	.34
1A4P	.97	6C4	.19	12F5GT	.58
1A5GT	.49	6C5	.47	12H6	.27
1A6	.79	6C6	.57	12J5GT	.34
1A7GT	.67	6C8G	.69	12J7GT	.67
1AB5	.59	6D6	.44	12K7GT	.52
1B3/8016	1.15	6D8G	.79	12K8	.59
1B4	1.19	6E5	.69	12Q7	.49
1B5/25S	.89	6F5	.47	12SA7	.57
1C5GT	.59	6F6	.57	12SC7	.54
1C6	.89	6F6GT	.57	12SF5	.59
1C7G	.89	6F7	.69	12SF7	.54
1D5GP	.97	6F8G	.87	12SG7	.52
1D7G	.89	6G6G	.69	12SH7	.35
1D8GT	.95	6H6	.39	12SJ7	.47
1F4	.75	6H6GT	.37	12SK7	.57
1F5G	.75	6J5	.47	12SL7	.59
1G4GT	.69	6J5GT	.39	12SN7	.52
1G6GT	.65	6J6	.77	12SQ7	.49
1E7G	1.15	6J7	.67	12SR7	.49
1H4G	.55	6J7GT	.65	12Z3	.69
1H5GT	.54	6K5GT	.79	14A4	.79
1H6GT	.87	6K6GT	.44	14A7	.52
1J6G	.75	6K7	.49	14B6	.67
1L4	.48	6K8	.79	14F7	.69
1LA4	.79	6L5GT	.79	14F8	.79
1LA6	.89	6L6	1.05	14H7	.59
1LB4	.89	6L6G	.99	14J7	.87
1LC5	.69	6L6GA	.85	14N7	.85
1LC6	.79	6L7	.79	14Q7	.53
1LD5	.79	6L7G	.87	14R7	.67
1LE3	.69	6N7	.75	19	.69
1L5	.79	6Q7	.64	24A	.49
1LH4	.79	6R7	.79	25L6GT	.53
1LN5	.67	6S7G	.79	25Z5	.44
1N5GT	.59	6S8GT	.77	25Z6GT	.43
1P5GT	.67	6SA7	.44	26	.49
1Q5GT	.67	6SC7	.59	27	.42
1R4	.59	6SD7GT	.44	28D7	.35
1R5	.69	6SF5	.49	30	.37
1S4	.59	6SF7	.59	31	.59
1S5	.49	6SG7	.59	32	.85
1T4	.53	6SH7	.37	32L7GT	.89
1T5GT	.69	6SJ7	.47	33	.69
1U4	.59	6SK7GT	.44	34	.37
1V	.57	6SL7GT	.59	35/51	.57
2A3	.87	6SN6GT	.97	35A5	.63
2A4G	1.07	6SN7GT	.54	35B5	.55
2A5	.69	6SO7	.45	35C5	.59
2A6	.79	6SR7GT	.52	35L6	.52
2A7	.79	6SS7	.49	35W4	.39
2V3G	.69	6ST7	.72	35Y4	.49
2X2	.37	6SU7GTY	1.25	35Z3	.57
2X2A	.65	6SV7	.79	35Z4	.44
3A4	.34	6T7G	.89	35Z5	.39
3A5	.79	6U5G	.65	36	.67
3A8	1.59	6U6GT	.63	37	.35
3B7/1291	.29	6U7G	.49	38	.37
3D6/1299	.29	6V6	.89	39/44	.27
3LF4	.79	6V6GT	.57	41	.49
3Q4	.47	6W4	.63	42	.49
3Q5GT	.67	6W7G	.77	43	.49
3S4	.57	6X4	.57	45	.52
3V4	.67	6X5GT	.47	45Z3	.57
5R4GY	1.09	6Y6G	.67	45Z5	.55
5T4	.87	6C7G	.98	46	.62
5U4G	.49	6ZY5G	.59	47	.69
5V4G	.87	7A4/XXL	.49	49	.85
5W4	.67	7A6	.59	50	1.39
5X4G	.57	7A7	.53	50A5	.69
5Y3GT	.39	7AG7	.72	50B5	.53
5Y4G	.49	7B4	.53	50L6GT	.52
5Z3	.52	7B5	.67	50Y6	.57
5Z4	.77	7B6	.56	53	.87
6A3	.92	7B7	.59	56	.45
6A4LA	1.09	7C4	.34	57	.45
6A6	.79	7C5	.48	58	.49
6A7	.69	7C7	.59	59	.89
6A8	.75	7E5	.67	70L7	.99
6AB7	.79	7E6	.54	71A	.59
6AC7	.74	7E7	.62	75	.53
6AD7G	1.09	7F7	.59	76	.44
6AF6G	.79	7H7	.59	77	.43
6AG5	.69	7K7	.89	78	.44
6AG7	.98	7L7	.69	80	.37
6AH6	1.29	7N7	.67	81	1.25
6AJ5	.79	7Q7	.59	82	.84
6AK5	.85	7R7	.69	83	.75
6AK6	.79	7V7	.87	83V	.89
6AL5	.59	7W7	.79	84/6Z4	.56
6AQ5	.49	7X7	.79	85	.69
6AQ6	.59	7Y4	.47	89Y	.35
6AR5	.52	7Z4	.57	117L7/M7	1.19
6AT6	.44	12A	.57		
6AU6	.59	12A6	.17	117N7	1.19
6AV6	.47	12A7	.89	117P7	1.19
6B4G	.89	12A8GT	.49		
6B6G	.79	12AH7GT	.80	117Z3	.49
6B7	.87	12AT6	.44	117Z6	.65

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OIL CONDENSERS—DC RATINGS

3x.1	mfd	600v	$.49	15	mfd	2000v	$4.95
.25	mfd	600v	.25	.1	mfd	2500v	1.09
.5	mfd	600v	.25	.25	mfd	2500v	1.19
1	mfd	600v	.28	.5	mfd	2500v	1.29
2	mfd	600v	.28	2	mfd	2500v	1.98
2x2	mfd	600v	.57	.01	mfd	3000v	1.07
4	mfd	600v	.57	.05	mfd	3000v	1.19
6	mfd	600v	.97	.1	mfd	3000v	1.39
8	mfd	600v	1.05	.25	mfd	3000v	1.49
10	mfd	600v	1.15	.5	mfd	3000v	1.69
3x.1	mfd	1000v	.59	1	mfd	3000v	2.19
.25	mfd	1000v	.29	2	mfd	3000v	3.47
.5	mfd	1000v	.39	4	mfd	3000v	4.45
1	mfd	1000v	.49	12	mfd	3000v	6.95
2	mfd	1000v	.69	1	mfd	3600v	2.39
4	mfd	1000v	1.29	.25	mfd	4000v	1.98
8	mfd	1000v	1.89	.5	mfd	4000v	2.49
10	mfd	1000v	2.07	1	mfd	4000v	2.79
20	mfd	1000v	3.29	2	mfd	4000v	3.10
.5	mfd	1500v	.77	3	mfd	4000v	4.95
1	mfd	1500v	.97	.1	mfd	5000v	1.98
2	mfd	1500v	1.19	.25	mfd	5000v	2.29
4	mfd	1500v	1.98	1	mfd	5000v	2.98
24	mfd	1500v	4.98	.1	mfd	7000v	1.49
.1	mfd	2000v	.69	.01	mfd	7500v	1.79
.25	mfd	2000v	.89	.02	mfd	7500v	1.79
.5	mfd	2000v	.97	.03	mfd	7500v	1.79
1	mfd	2000v	1.29	.05	mfd	7500v	1.79
2	mfd	2000v	1.98	.1	mfd	7500v	1.79
4	mfd	2000v	3.89	2x.1	mfd	7500v	4.95
8	mfd	2000v	4.95	.02	mfd	12000v	9.95

HIGH CAPACITY CONDENSERS

2x3500	mfd	25v	$3.47	100	mfd	50v	.45
2500	mfd	3v	.35	4000	mfd	18v	1.95
3000	mfd	25v	2.45	4000	mfd	30v	3.25
650	mfd	80v	1.29	2350	mfd	24v	2.25
1000	mfd	15v	.98	10000	mfd	25v	4.57
200	mfd	35v	$.57				

1000KC crystal BT cut $3.95
3" scope shield $1.29
2 sp. dial dr. for ¼" shaft ratios 5 to 1-1 to 1 .. $ .49

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input: 0–18v AC — Output: 0–14.5v DC

Type #	Max. DC Current	Price
18D1	1.2	$2.59
18E1	2.4	3.49
18F1	6.4	4.95
18K1	13.0	8.95
18J1	17.5	11.95
18K2	26.0	17.95
18K3	39.0	24.95
18K4	52.0	29.95
18K5	65.0	35.95

Input: 0–40v AC — Output: 0–34v DC

Type #	Current	Price
40D1	0.6	$2.95
40E1	1.2	3.89
40F1	3.2	5.79
40K1	6.0	9.95
40J1	9.0	12.95
40K2	12.0	18.95
40J2	18.0	22.45
40K4	24.0	32.50
40K5	30.0	37.95
40J4	36.0	42.50

Input: 0–120v AC — Output: 0–100v DC

Type #	Max. DC Current	Price
40D1	.6	$7.85
40E1	1.2	10.76
40F1	3.2	16.65
40K1	6.0	27.47
40J1	9.0	34.35

SINGLE PHASE FULL WAVE—Center Tapped

Input: 10–0–10v AC — Output 8v DC

Type #	Max. DC Current	Price
20D1	1.2	$1.89
20E1	2.4	2.25
20F1	6.4	3.87
20K1	12.0	4.95
20J1	16.0	7.95
20K2	24.0	11.95
20K3	36.0	14.95
20K4	48.0	17.95
20K5	60.0	22.49
20K6	72.0	25.57
20K7	84.0	27.95
20J6	96.0	32.50
20K10	120.0	36.50

THREE PHASE FULL WAVE—Bridge Rectifiers

Input: 120v AC — Output: 150v DC

Type #	Max. DC Current	Price
40D31	.9	$16.52
40E31	1.8	19.87
40F31	4.75	27.95
40K31	9.0	32.50
40J31	12.0	54.69

Input: 240v DC — Output: 0–300v DC

Type #	Max. DC Current	Price
40D61	.9	27.45
40E61	1.8	33.65
40F61	4.75	49.95
40K61	9.0	92.76
40J61	12.0	98.75

Current ratings can be increased 2 to 2½ times by fan cooling

TRANSFORMERS—115v 60 cyc

HS—Herm. Sealed **FS—Full Shell**
OF—Open Frame **FE—Fully Enclosed**

	SECONDARIES:	Wgt	Ht	W	D	Price
HS	6350v @ .025 arms (16KV ins)	33½	8	7¾	6	$11.95
OF	6250v or 3850v or 2600v @ .056 arms	37	12	8	5¾	13.95
HS	2500v @ 15 ma	13¼	5½	4¾	4½	3.49
HS	1600v @ 4 ma; 350–0–350v @ 150 ma; 6.3v @ 9A	9¾	5½	4	3¾	4.45
HS	1540v @ 5 ma; 340–0–340v @ 300 ma	16	5¼	5½	4¾	4.35
FS	1120–0–1120v @ 500 ma; 12v CT @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32v @ 25 ma 115/230 pri	45	7¼	10	7¼	27.00
HS	925v @ 10 ma; 525–0–525v @ 60 ma; 2x5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	14¾	5½	4¾	4½	5.55
FE	700–0–700v @ 300 ma	34	5½	11½	4¼	7.55
FE	500–0–500v @ 175 ma	16½	5½	5¾	4¾	4.55
FS	430–0–430v @ 340 ma; 6.3v CT @ 6.3A; 5v @ 6A	14	5½	4¾	4¼	4.85
HS	425–0–425v @ 75 ma; 6.3v @ 1.5A; 5v @ 3A	8½	5¼	3¼	3¼	3.65
FE	415–0–415v @ 60 ma; 5v CT @ 2A 115/230 dual pri	7½	5	5	3¾	4.97
FS	405–0–405v @ 150 ma; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	7½	4¾	3¾	3¾	4.35
HS	400–315–0–100–315v @ 200 ma; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	12¾	5¼	4¾	4¼	5.35
HS	500–385–0–385v @ 200 ma; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A	18	6¾	4½	4¼	4.75
FE	325–0–325v @ 12 ma; 255–0–255v @ 240 ma	15½	5¾	4½	3¾	4.25
HS	300–0–300v @ 65 ma; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	6¾	3½	3¼	3¾	3.25
HS	120–0–120v @ 50 ma	3¼	4¼	2½	2½	.95
HS	80–0–80v @ 225 ma; 5v @ 2A; 5v @ 4A	6½	4½	3½	3¼	2.97
FE	0–17.4/21.6/25.8v @ 400 ma; 6.4v @ 5A; 2.6v CT @ 2.5A pri 115/230	7	5	5	3¾	3.85

	SECONDARIES	Wgt	Ht	W	D	Price
OF	18 or 36v @ 15A	16	6¼	6	3¾	$8.75
FS	13.5v CT @ 3.25A	5½	4¼	3½	3	2.17
FS	12.6v CT @ 10A; 11v CT @ 6.5A	12½	6¼	5½	3¾	6.35
FE	3x10.3v CT @ 7A	17½	4½	7	5¾	6.95
HS	6.5v @ 12A; 6.3v @ 2A; 115v @ 1A	9¾	5¼	4½	3½	3.50
HS	6.4v @ 10A; .6.3v @.6A	7½	5¼	4½	2¼	2.77
OF	6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	9	4¾	4¼	3¾	4.17

	SECONDARIES	Wgt	Ht	W	D	Price
HS	6.3v @ 1A; 2.5v @ A	8	5¼	4¼	3½	$2.29
OF	6.3v @ 1A	½	1¼	2	1½	.77
FE	6.3v CT @ 3.5A; 2x2.5v CT @ 3A	7	3¾	3½	3	2.97
FE	5v CT @ 20A; 10 KV ins	22	7¼	7½	4¼	8.95
HS	4–0–4v @ 1A	1½	2¾	2½	2	.87
HS	.6v @ 15A rms	3½	3¼	3½	2¼	1.47

TRANSFORMERS—220v 60 CYC

		Wgt	Ht	W	D	Price
FE	512.5–0–512.5 @ 427 ma	24½	6¾	6½	4½	5.35
FE	3x5v @ 6A; 4v @ .25A	10	5¼	4	4	2.95
FE	3x6.3 CT @ 3A; 6.3v CT @ 1.6A	9½	5¼	4	3¼	2.95
FE	10v CT @ 6.5A; 6.3v CT @2.5A: 6.3v CT @1.8A 220/440 pri	13	5½	5½	4½	3.95
FE	Step up/down 110/220 500 watt	25	6	11	5	$10.95
FE	Step up/down 110/220, 220/440 600 watt	39	5½	7¼	7	14.95

FILTER CHOKES—HI V INS

		Wgt	Ht	W	D	Price
HS	600 hy @ 1 ma/5000 ohms	1	2¾	2	Dia	$3.15
HS	325 hy @ 2 ma/4500 ohms	1	2¼	2½	1¾	3.37
HS	200 hy @ 10 ma/5260 ohms	1½	3¼	2½	Dia	3.37
FE	30 hy @ 60 ma/240 ohms	6	4	4½	3	1.57
HS	30 hy @ 25 ma/870 ohms	1½	2¾	2	2	.97
HS	15 hy @ 70 ma/500 ohms	3	3¼	2¾	2¼	1.15
FS	10 hy @ 200 ma/85 ohms	3½	3¾	3	8	2.17
FS	3/30 hy @ 250 ma/70 ohms	6½	4½	3¾	Dia	3.65
FS	10/20 hy @ 85 ma/2000 ohms	2½	3	2½	2½	1.55
FE	14/3.5 hy @ 40/400 ma	17	4½	6¼	6¼	$6.95
FE	3 hy @ 50 ma/300 ohms	½	1½	1¼	Dia	.33
HS	2 hy @ 175 ma/60 ohms	1½	2½	1¾	1¾	1.49
FE	5 hy @ 70 ma/100 ohms .2 hy @ 350 ma/6 ohms dual	5	3¾	4½	3	2.39
HS	.1 hy @ 5A	12	6¼	4½	3½	6.97
FE	.065 hy @ 2.5A	9	4	4¾	3¼	2.49
HS	.05 hy @ 15A	11	6	4¼	3¼	7.97

COMPONENTS

50 mmfd ceramic condensers	$ .29
50 mmfd button condensers	.07
55 mmfd ceramicon feed thru	.08
4-30 mmfd ceramicon trimmers	.29
25, 50 mmfd air trimmers screwdriver	.29
100, 140 mmfd air trimmers screwdriver	.39
50 mmfd 5KV GE vacuum condenser	1.49
1 mfd 600v donut condenser (152 in box) per box	1.98
TMC-300 national variable 300 mmf	1.29
Single gang variable 33-435 mmf	.69
Five gang variable 11.5-30 mmf per section	.98
Three megacycle IF coil double slug	.29
Thirty megacycle IF coil	.19
80 meter osc. coil for ARC5	.29
80 meter PA final coil for ARC5	.29
0-1 MA meter Weston 506	2.95
—10+5 decibel meter Weston 301	9.95
2v, 6v, 12v vibrators	.98
Circuit breaker 15 amp	.98
J37 key	.69
200 watt power supply kit, complete	17.95
400 watt modulation xformer 803, 813, 100th	19.95
Output xformer UTC pri: 8500 ohms, sec: 0-8-125-500	.69
500 watt 12.5 ohm Rheostat	3.49
Driver unit WE 35 watt	4.95
Horn throat for above	.39
Rotary switch GE Mycalex, 2 deck SP3T	.49
Plate caps ceramic, 2x2, 807, etc	.19
Plate caps ceramic, 866A, 813, etc	.19
Couplings ceramic ¼" to ¼"	.29
Couplings ceramic ¼" to ⅜"	.29
Couplings ceramic ⅜" to ⅜"	.29
Crystal socket ceramic 2 prong 5/32"	.14

SOCKETS

Angle octal	$.19
Magnal	.59
Dihepta1	.59
Safety recessed for 2x2	.39
Mycalex for 813	.59
Ceramic for 5D21, 705A	$.89
Ceramic for 832, 826, 829	.69
Mycalex for VT127A	.59
Ceramic acorn	.29
Ceramic for 866A	.59

EQUIPMENT

APN-1 altimeter transceiver	New	$7.95
ATR inverter 12v DC in 110v AC 100w out	New	16.95
AN/CRW-2 UHF receiver	New	5.95
BC 1016 tape recorder	New	139.50
BC 950A-121 xmitter 100-156 mc, modulated	New	49.50
BC 778 Gibson Girl	Shelfworn	3.95
BC375E xmitter, 7 tuning units, dynamotor	Like New	69.50
BC-AL229 receiver	Used	2.95
BC 733 receiver	New	6.95
BC 433 receiver	Used	24.95
BC 456 modulator	New	1.98
BC 434A control box/SCR269	Used	2.45
BC 996T1 interphone amplifier	Like New	6.95
BC 602A control box/SCR522	Used	.49
BK-22 relay for SCR269	New	2.95
BK-22 relay for SCR269	Used	1.95
CF1 Navy unit w/200 KC crystal	New	14.95
Constant Voltage transformer, sola 190/260-60c in 115v-1.7A out	New	16.95
DM19 dynamotor 12v DC in 200 ma cont out	Good	5.95
EE8 foundation unit	Good	4.95
I-135E test set for handy talkie	Good	7.95
KS12013 wire recorder GE, complete	Good	97.50
LM7 or 10 frequency meter	Good	37.50
MN26C compass receiver	Good	24.95
M110 dynamic chest mike	New	4.95
MT28 mounting rack ARN5	New	.98
PE94 dynamotor/SCR522	Good	1.98
PE97A vibrator power supply	New	4.95
R89/ARN5 receiver	New	7.95
SCR518 altimeter, complete	New	29.95
T17B carbon mike	Good	.98
T21B field microphone radiosonde	Good	19.95
TU25 tuning unit/BC223	New	1.79

PHONE DIGBY 9-0347

Write for quantity prices

Prices subject to change without notice

All Merchandise Guaranteed

F.O.B. N.Y.C. Minimum Order $10.

20% Deposit Required

RADIO HAM SHACK Inc.
189 GREENWICH STREET . NEW YORK, N. Y.

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SPECIAL SURPLUS BROADCAST OF OUR SUPER SPECIALS!!!

Amertran "TRANSTATS" Voltage Regulator

11.5 KVA 50/60 cy. Commutator range 0-115 V. Max. Amps 100. Reconnection diagram available for 230 V. 50 A operation. BRAND NEW. Factory Cases $100.00

TRANSTAT VOLTAGE REGULATOR

Amertran type RH. Input: 115 V. 400 cy. 0.5 KVA. 5.5 max. amps. Output: 92-115V. 5½x4½x3¼. $1.95

• • •

.25 KVA Fixed winding 115/1/60. Commutator range 103-126 V. 2.17 Max. Amps....................$9.45

DECK ENTRANCE INSULATORS (Bowl and Flange Type)

Mfd. by Ohio Brass Co. heavy galv. metal flange 10½" D., porc. bowl set in rubber gaskets. Top bell 7½" D. brass feed thru rod 10½" L. Insul. dist. between top bell and flange 6½"...$3.50

DYNAMOTOR GENERATOR

Model 3975-1. Electric Sprayit Co., p/of "Gibson Girl". Input 28 VDC @ .175 amps. Output 300 VDC @ .040 amps. 5" L. 3¼" D. ....$1.00 ea.

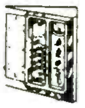
SELECTOR SWITCHES

Heavy duty. U. S. N. Control any type of multi-circuit devices. Removable contacts enabling any comb. of closed and open circuit. The following available: 5 section-10 pole or 10 section-20 pole. $1.50 ea. Case lots of (8) $8.00 or (5) cases, special....$32.50

MINE DETECTOR SCR 625

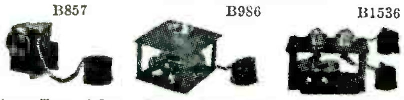
Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book, $65.00. Used but like new....................$45.00

B. C. 604 F. M. TRANSMITTER



Wide or narrow band FM. 30 watt power output. Excellent possibility for ten or eleven meter exciter. Freq. 20-27.9 MC. Working space permits modification. W/tubes but less power supply and xtls. LN $11.50. Complete with Crystal, $25.00

NEW SWITCH INTERLOCKS



Cory Type B857. Single Key Oper. Interlocking of doors, vaults, reactor or resistor-enclosures, oil circuit breakers, etc. $1.98
Cory Type B936. Single Key Oper. SPST SW w/Yale Cyl Lock 60A tumbler lock......................$2.49
Cory Type B1536, Supervisory Oper. 2 key type..$2.95

DELCO CONSTANT SPEED MOTOR

Type A-7155, 27 VDC, 2.4 A 1/30 HP. 3600 RPM. 2½" Diam. x 5½ L. ⅞" Sh. Ext. Cont. Duty. Base mounted ....$4.25 ea.

VIBRATOR POWER SUPPLY (PE 204A)

Used with Telephone Repeater EE-99A. Input 12 VDC. Output 2 windings @ 4.3 VDC @ 50 MA; 2 @ 45 VDC @ .5 MA; 2 @ 85 VDC @ 5 MA. Loaded with parts. New $1.95

YJ RADIO EQUIPMENT. Two Channel, automatic responding Radar Beacon or Racon. Designed for shore installation. Automatically transmits coded signals in reply to interrogating signals from craft equipped with radar or IFF equipment. Replies to interrogating signals in the (A) Band 176 MC, (B) Bank, 515 MC. Rectifier power unit; A and B Band transpondors, transmitter and receiver complete with 30 tubes, 115/1/60 36" L. 18" H. 17" W. Wgt. 270 lbs. LN. Price $80.00

CATHODE RAY TUBES 5BP1 @ $3.00; 5 BP4 @ $4.95; 5 CP1 @ $3.50; 3 EP1 @ $2.95.

HOT SPECIALS—CONDENSERS—Standard Brands
2x50 MFD @ 150 WVDC TUBULAR............@ 50c
40 MFD. @ 200 WDC TUBULAR ....@ 35c
16 MFD. @ 150 WVDC TUBULAR............@ 20c
.1 MFD. @ 600 WVDC TUBULAR.........@ ea. 15c
.25 MFD. @ 600 WVDC OIL IMPREG TUBULAR CAW 481074 17c ea.; 10 for....................$1.50
Same as above but 400 volt 15c ea.; 10 for......$1.35
.01 MFD @ WVDC PAPER TUBULAR HERM. SEALED, 10c ea.; 10 for.........................$1.50

RAYTHEON DEFLECTION COILS. #US820 for 5FP7. CRT. Metal Cased.......................$1.85

COMMAND SET EQUIVALENT—BC 430. Excellent VFO using 2 Type 45's and 2 Type 10 tubes, 40 WATTS CW with one coil. (COIL RANGES: 2 - 2.5, 2.5 - 3.2, 3 - 3.6, 3.6 - 4.5, 4 - 4.8, 6 - 7.3, and 7.3 - 9 MC. Your choice of coil.............................$6.95

COMMAND TRANSMITTERS 2 - 3 MC. LN $7.95. 3-4 MC LN $12.95. 4 - 5.3MC LN $7.95. 5.3 - 7 MC LN $7.95.

SCR 178—TRANSMITTER RECEIVER. 2400-3700 KCS 10 W OUTPUT w/spare parts PHONE, AND CW opt. $45.00

RL-42B ANTENNA REEL—w/MOTOR AND GEAR BOX Perfect Beam rotators. Wt. 4 lbs. magnetic clutch. Reversible with SPDT switch.............$3.95

"BEAM INDICATOR" SELSYNS GE model 2JIG1. Operates from 57.5/57.5 V. 400 cy w/wiring diagram for 110 V 60 CY oper. $2.50 pair. Also available GE Model 2JIF1 115/57.5 V 400 CY..............pair $3.00

SELSYNS—Diehl/BENDIX SYNCHRO TRANSMITTERS. 115 V 60 cy. 3" Dia. ea. $4.35..........Pr. $7.95

ANTENNA CHANGE OVER SWITCH SPDT, knife operated. Heavy duty. Isolantite insulation......25c

HEAVY DUTY AIR COOLED RESISTORS. .52 ohms or 10 ohms 1000W. Your choice..................$1.00

REMOTE CONTROLS. RM29A Telephone Units, no ext. power nec. Good up to 30 miles, self contained Magneto ....pair $12.95

CALROID HEATERS GE. #5A760 115V 200W..$1.50
GE. 5A699 65W 57.5V.............................75

G.E. FUSE HOLDERS TYPE EL-1. Neon lamp indicating Midget size #6328725G1, 15A............ 49c
G. E. 6227889G1, 60A 69c

TRANSMITTER AND RELAY RACK CABINETS—Chrome decorated hinged door on top and back with catch Amateur or W.E. notched. Black crackled 28½" H., 18" D Panel space 26½" LN $15 ea.; 2 for $27.00

WESTERN ELECTRIC PRECISION CRYSTALS—40 Meter Band 7270 KC 95c ea. 2 for..............$1.75

25' EXTENSION LIGHT heavy duty cord. Switch on handle. Metal bulb protector.....................$1.95

HEINEMAN CIRCUIT BREAKERS—24 VDC @ .229 A., SPST 95c ea.; 0311 M-10, 24 VDC @ 10 A. SPST $1.45. 0322M-10-24 VDC @ 15 A. DPDT.........$2.25

GUYWIRE—1/16" Dia. Galv Perf Steel. Excellent elasticity. Rust proof. Ideal for TV antenna installations. 1000 ft. rolls...........................$3.00/M

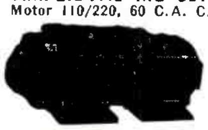
FRACTIONAL HORSE POWER MOTORS OSTER 27.5 VDC 1/20 HP 3600 RPM SHUNT Wound..$7.55
UNIVERSAL ELECTRIC 115 VDC. .12 AMPS .003 HP 5000 RPM $4.50
OSTER 6 VDC 1.8 AMPS 5000 RPM, 6 oz./in. torque W/BLOWER Size 1½ AND IMPELLER.........$4.50
EMC 110 VAC 60 cy. 1/40 HP 1725 RPM, LN...$4.50
OSTER 27.5 VDC1/100 HP. Series 7000 RPM....$2.50
UNIVERSAL ELECTRIC 28 VDC. 0.6 AMPS 5000 RPM. 1/100 HP.................................$2.50
EMERSON 24 VDC 24 AMPS. Series wound. 100 RPM 160 OZ/FT torque..........................$7.95
GE. 27VDC. 5 AMPS 250 RPM 8 OZ/IN LN....$2.50

PHONO MOTORS—GENERAL IND 115 V 60 cy; .5 A., 80 RPM Minus turntable.......................$2.50

CHOKES—2.5 H @ 700 MILS, 14 OHMS.......$5.95
20 HENRIES @ 45 MILS, 500 OHMS.............60c
40 HENRIES @ 20 MILS.............................80c
150 HENRIES @ 1 MIL 7,000 OHMS...............45c

TRANSFORMERS—Pri: 115 V 60 Cy.
THORDARSON (70R62) 350-0-350
145 MILS; 5 V @ 3 A; 6.3 VCT @ 4.5A.........$4.25
JEFFERSON FIL—20 Volts @ 10 A.............$3.95
OPEN CORE POWER, 18 V @ 6 A...............$2.95

AMPLIDYNE MG SET
Motor 110/220, 60 C.A. C.



Mfd. by G.E. Generator Type V-5875677, motor 73AB58; Navy type CG21ABU, Generator delivers 250 VDC 375 w. Motor 115/230v., 1 ph., 60 cy. ¾ HP RPM-1725. PRICE, EACH—NEW..............$58.00

VDC SERVO MOTORS

White Rodgers Elec. Co. (6905X-46). 24 VDC @ .65 Amps Torque 50 in/lbs. ½ RPM reversible, comp. w/limit switch, relays and selenium rectifiers on top of motor, to keep AC out of motor 5x5x4 ....$8.95
690-4X-27, 24 VDC @ 1 Amp., 150 in/lbs. torque, 2½" RPM reversible. Complete w/limit switch, relays and selenium rectifiers same as above............$9.95

DICTOGRAPH INTER-COMMUNICATION SETS

Designed to bring to homes and offices the conv. of two-way, convers. w/o the use of telephone, household elec. current, or radio. Efficient to 800 ft off flashlight batteries. New. Pair.......$9.95

DAVEN SOUND ATTENUATORS

Type 350-A. Network, ladder, linear imped. 30/30 ohms. 2DB attenuation. 10 W dissipation. Brand new............$3.95

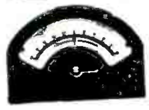
Standard Brand RHEOSTATS

High shock rheostats, four 13" plates, 100 ohms 8-2A, 175-345 V connected in series. Assembled for back of board mtg. or by reversing the supporting brackets for floor or table oper. New..............$19.75

RETARD CHOKE COILS

Amertran. Disc Type Line voltage 15,000; ripple freq. 120. Oil-filled; .020A DC @ 200H @ 48% ripple. 52A DC @ 25H @ 48% ripple. 17"x17"x22" w/term. 10" above base. 40°C temp. rise...................$34.00

MILLIAMMETERS



150-0-150 MA DC. Accuracy ½ of 1%. Scale length 4⅛". Wt. 3½ lbs. 6" x 2½" x 4⅛". Like New $2.50

SPERRY A-5 VERTICAL GYRO UNIT

#644841. 115 V. 400 CY 3 phase. Contains gyro assembly, erection motor, erection relay assembly, pick-off assembly, elevator and aileron limit switches, and roll axes. 15 x 12 x 9 New $27.50

New Submarine Signal QBE-1 Underwater Sound Equipment

Type CBM 55681 Indicator Unit—Ranges 0-1000 yds. and 0-5000 yds., Visual & Audio Indication Synchronous motor driven, input 115/1/60. 20 x 16 x 8½ $25.00

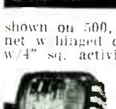
BATTERY CHARGER

Ideal for your car, for the serviceman and ham. Selenium—transformer type, 7½ x 4½ x 4¾. Portable metal container. Input 115, VAC output 6.5 V. @ 2 amps.......$7.25

FITCH CRYSTAL DUPLICATOR

Calibrates crystal plate of unknown freq. against standard plate of desired freq. Consists of standard and test oscillators whose outputs are mixed to produce an amplified beat note; the freq. is shown on 500, 5000, 50,000 cycle meter. Metal cabinet w hinged cover. 9" H. x 13" W. x 19" L. Comp. w/4" sq. activity and frequency meter.........$29.50

DIEHL MOTORS



Normally 110V. 60 cy. 3 ph. units. Will operate satisfactorily on 110V, 60 cy. 1 Ph. by addition of capacitors across one of the other phases. 1/10 HP, cont. duty, 3450 RPM. 1¾" x ⅝" D shaft. Motor dimensions: 4" H x 5"W x 5"D. Wgt. 10 lbs..........$5.50

AMERTRAN HEAVY DUTY TRANSFORMERS

Pri 115/230 VAC 60 cy. Sec. 4730/2365. KVA 1.66 RMS 12 KV. Wgt. 150# 11" x 11" x 9" Brand New $37.50

ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FROM RATED CONCERNS ON OPEN ACCOUNTS NET 30 DAYS. MINIMUM ORDER $3.00

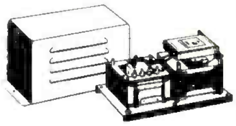
ESCO ELECTRO Sales Co.

399-405 ATLANTIC AVENUE Dept. E-3 BOSTON 10, MASSACHUSETTS LIBERTY 2-7890

www.americanradiohistory.com

LINE VOLTAGE STABILIZERS

RAYTHEON—Navy Type, CRP-301407 Input: 92-138V, 57/63 CPS., 1 PH. Output: 115V, 0.82 KVA., 1% Reg., 0.96 PF. Weight 385 lbs. Overall size—36" high x 20" wide x 12¼" deep. Enclosed in Navy Grey Ventilated Cabinet for Wall Mounting.
Brand New **$97.50**



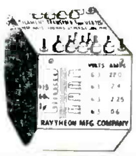
RAYTHEON Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.
Special **$12.50**

TRANSFORMERS

1. 5 KVA Stepdown

General Electric Cat. No. 76G173. Input: 115 or 230 Volts, 60 cycles. Output: 23 or 11.5 volts at 1.5KVA. Either high voltage connection may be used with either low voltage connection. Weight 50 lbs.
Brand new **$23.95**

FILAMENT TRANSFORMER

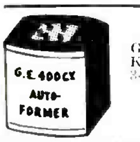


Raytheon Hypersil core. Primary: 115V., 60 cycles. Sec: 6.3 at 22A., 6.3 @ 2.4A., 6.3 @ 2.25A., 6.3 at 0.6A., 1700V. INS.
Brand New **$3.95**

For type B66 tubes

Input: 115 volts. Output: 2.5 volts center tapped, at 10 amps. Glazed porcelain standoff insulated for high voltage breakdown. Mfgd. by Kenyon.
Brand New **$3.95**

AUTO TRANSFORMER



G.E. 400 cy. Cat. No. 80G184 K.V.A. .9458—.520P Volts 460/345/230/115 New......... **$4.50**

FILAMENT TRANS.
400/2600 cy.

Input: 0/75/80/85/105/115/125V. Output: 5V3A, 5V3A, 5V3A, 5V3A, 5V6A, 5V6A, 6.3V6A, 6.3V5A **$3.95**

THYRATRON POWER TRANS.

Raytheon UX8876. 400/1600 cy. PRI: 115V, 1 PH SEC: 50-050V at 0.5A, 6.3V 1.2A Test r.m.s. 1780 **$2.75**

Pulse, Input Trigger Inverting

Westinghouse #145 EWP Fosterized...... **$4.95**

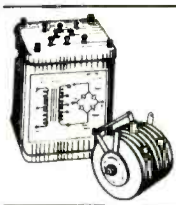
PULSE

Utah No. 9350.............. **$1.25**

BLOCKING, OSC

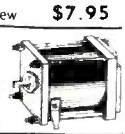
Westinghouse #132 AWP Fosterized **$4.95**

12 and 24 Volt POWER KIT



Consists of Power Trans. and full wave bridge selenium rectifier. Input: 115/230 A.C. Output: 12/24V D.C. at 1.1 amps. Fine for operating relays, small motors, dynamotors, or for low voltage D.C. source in laboratories, etc.
Brand New **$7.95**

SWEEP GENERATOR CAPACITOR



High speed ball bearings. Split stator silver plated coaxial type. 5/10 mmfd. Brand new. **$1.00**

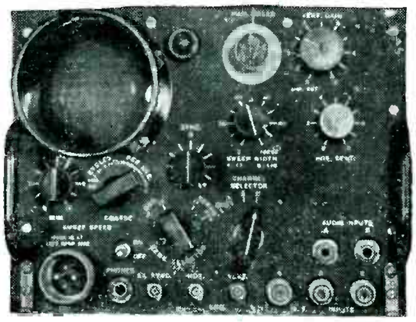
FULL WAVE BRIDGE TYPE SELENIUM RECTIFIER

Input up to 36V A.C.
Output up to 28V D.C., Fed. Tel. & Tel. Co. 1.1 amps. 8 plates 2½" diameter.
Brand New.......................... **$2.75**

MICROWAVE RECEIVERS

APR-1, APR-4, APR-5A.
Tuning Units for APR-1 or APR-4. TN-16 (38-95 mc). TN-17 (74-320 mc.) TN-18 (300-1000mc.) These front ends may be used with any 30 mc.IF amplifier or as converters into receivers tuned to 30 mc.)

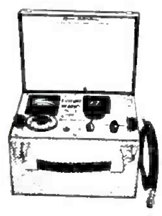
MODEL AN/APA 10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscillosocopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc, 5.2mc. or 30mc.
With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
Includes 80 page T. M **$195.00**

Micro-Wave Lavoie Freq. Meter
375 to 725 MCS



Full data on request.

$69.50

Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 MIN. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries

PARABOLOIDS

Spun Magnesium dishes 17½" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center for dipole. **Brand new per pair**................ **$8.75**

Synchro Differential

90/90 volts, 400 cycles. Brand new in sealed containers. Ford Inst. type 5SDG. Brand new. **$12.50**

MOTOR GENERATORS

Allis Chalmers 115V. D.C. to 120V. 60 cy. 1 Ph. 1.25 K.V.A., P.F. .80 Centrifugal starter. Fully enclosed.
New **$97.50**

Same as above but for 230V. D.C. input **$125.00**

Spare Parts Kit for either machine.......$15.00

Diehl 120V. D.C. to 120V. A.C., 60 cy., 1 Ph., 2.5 K.V.A., P.F. .4. Complete with magnetic controller, 2 field rheostats and full set of spare parts including spare armatures for generator and motor.
New **$185.00**

O'Keefe and Merritt, 115V. D.C. to 120V. A.C. 50 cycles, 2 K.V.A., Pf. .9 Idles as a 3 phase synchronous motor on 208V. 50 cy.
New **$165.00**

Electrolux dynamotor 105/130V. D.C. at 6 amps. to 26 or 13V. D.C. at 20 amps or 40 amps. respectively. Fully filtered for radio use and complete with Square "D" lineswitch. Navy type CAJO-211444.
New **$74.50**

MERCURY CONTACT VACUUM RELAYS
WE Type D-168479

Glass sealed, mercury-wetted contact switches surrounded by operating coils encased in metal housings on octal tube base. S.P.D.T. contacts. 2 coils, 700 and 3300 ohms. Operating current coils seriesed 6.6 MA releasing at 5.2MA. Operating life 1000 hrs. at 60 operations per sec. Use for • High speed keying • tabulating • sorting and computing machines • Relay amplifiers • Vibrator supplies • Servo Mechanisms, etc.
Send for 4 page data sheet
$4.75 ea.
Brand New

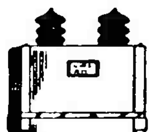
THERMOSTATIC TIME DELAY RELAY

Amperite type 115 No. 45 Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V-3A., A.C. (or 440V., A.C. 2A) max. voltage on contacts—1000 max voltage bet. contacts and heater—1500. Size 3 9/32 x 1¼" overall. Made for U. S. Navy.......... **$1.10**

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil. Brand new **$1.00**

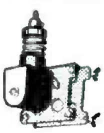
High Voltage Capacitors
Oil Filled



.25 MFD.. 20KV **$15.75**
.5 MFD.. 25KV **$23.50**
1 MFD.. 15KV **$16.50**
1MFD.. 7.5KV **$5.95**

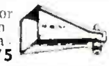
All brand new. Made by prominent manufacturers.

MP22 Mast Base Insulator



Ideal for marine, mobile vertical whip antennas. Complete, new with mounting plate and hardware.... **$2.75**

3CM Antenna Horn For receiving or transmittin Type AT-48/UP with coa. recept. Brand new **$4.75**



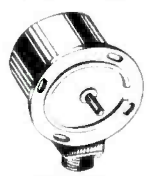
LINE FILTER

Elimostat 20 amp. 115 volts A.C. or 600 D.C. Brand new **$1.75**

PILOT LAMP

Aircraft "grain of wheat" 3V Mazda G.E. 323. Brand New ... **10c ea.**

LINEAR SAWTOOTH POTENTIOMETER
No. KS 15138



$5.75
Brand New

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O, Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable **$19.50**

Automatic Elec. Co. No. GL843A0. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable. **$19.50**

SYNCHRO GENERATORS

Brand new—Gov't. sealed and inspected—Packed in overseas cans. Synchro Transmitters 115V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't. $90.00 each. Wgt. 5 lbs. Dimensions: 4½"L x 3¼".
Brand New Per Pair **$14.75**

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT
INC.
5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.
All Prices Subject to Change Without Notice

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SELENIUM RECTIFIERS — and — ELECTRONIC COMPONENTS

THREE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0–234VAC — Output 0–250*VDC

Type	Current	Price
3B13-1	1 AMP.	$22.00
3B13-2	2 AMP.	32.00
3B13-4	4 AMP.	56.00
3B13-6	6 AMP.	81.50
3B13-10	10 AMP.	105.00
3B13-15	15 AMP.	120.00

CENTER TAPPED RECTIFIERS SINGLE PHASE FULL WAVE

Input 10–0–10VAC — Output 0–8*VDC

Type #	Current	Price
C1-10	10 AMP.	$6.95
C1-20	20 AMP.	10.95
C1-30	30 AMP.	14.95
C1-40	40 AMP.	17.95
C1-50	50 AMP.	20.95

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1............$ .35 per set
For Types B13............ .70 per set
For Types 3B............ 1.05 per set

SINGLE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0–18VAC — Output 0–12*VDC

Type #	Current	Price
B1-250	250 MA.	$ .98
B1-1	1 AMP.	2.49
B1-1X5	1.5 AMP.	2.95
B1-3X5	3.5 AMP.	4.50
B1-5	5 AMP.	5.95
B1-10	10 AMP.	9.95
B1-20	20 AMP.	15.95
B1-30	30 AMP.	24.95
B1-40	40 AMP.	27.95
B1-50	50 AMP.	32.95

Input 0–36VAC — Output 0–26*VDC

Type	Current	Price
B2-150	150 MA.	$ .98
B2-250	250 MA.	1.25
B2-300	300 MA.	1.50
B2-2	2 AMP.	4.95
B2-3X5	3.5 AMP.	6.95
B2-5	5 AMP.	9.95
B2-10	10 AMP.	15.95
B2-20	20 AMP.	27.95
B2-30	30 AMP.	36.95
B2-40	40 AMP.	44.95

Input 0–115VAC — Output 0–90*VDC

Type #	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 AMP.	24.95
B6-10	10 AMP.	36.95
B6-15	15 AMP.	54.95

CUSTOM DC POWER SUPPLIES
Built to your specifications
We will be pleased to quote on your requirements. Kindly send for our specification form.

RECTIFIER CAPACITORS

CF-14	3000 MFD	12VDC	$1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-2	2000 MFD	15VDC	1.69
CF-20	2500 MFD	15VDC	1.95
CF-3	1000 MFD	25VDC	1.25
CF-4	2X3500 MFD	25VDC	3.45
CF-5	1500 MFD	30VDC	2.49
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF-19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-21	1200 MFD	90VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	200VDC	3.25
CF-12	125 MFD	350VDC	2.49

Mounting clamps for above capacitors..15¢ each

RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50/60 Cycles

Type #	Volts	Amps	Shpg. Wt.	Price
XF15-12	15	12	7 lbs	$3.95
TXF36-2	36	2	6	3.95
TXF36-5	36	5	8	4.95
TXF36-10	36	10	12	7.95
TXF36-15	36	15	20	11.95
TXF36-20	36	20	30	17.95
XFC18-14	18 VCT	14	10	5.95

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.	D.C. Res.	Price
HY5	.02	5	.25	$3.25
HY5A	.028	5	.20	3.95
HY10	.02	10	.30	9.95
HY10A	.014	10	.04	7.95
HY15	.015	15	.30	13.95
HY20A	.007	20	.02	12.95

Type "A" low resistance chokes are specially suited to circuits requiring excellent voltage regulation.

ADDITIONAL SELENIUM RECTIFIER TYPES AND GENERAL INFORMATION MAY BE FOUND IN OUR CATALOG No. 719

VACUUM CAPACITORS

Standard Brands

50 Mmfd.	20 Kv	$4.95
50 Mmfd.	32Kv	5.95

Overall length: 6½". Diam: 2-3/16". Terminal Diam: ¾". Shpg Wt 2 lbs.

EDISON THERMO TIME DELAY RELAY

Heater voltage 115 V. Norm. open SPST contacts, 15-30 sec. delay. Contact rating 115 V. 3A., 440 V. 2A. Size 3¾" x 1⅛" diam. Standard 4 prong tube base .... **98c ea.**

OIL CONDENSERS

2X.1 Mfd 600VDC Bathtub......... .39
6 Mfd 600VDC w/mtg. Clamp .... .79
8 Mfd 660VAC/2000VDC w/Brkts. 3.50
.15-.15 Mfd 8000VDC Voltage Doubler Type 26F381 w/Brkts 3.95

KLIXON 40 SECOND DELAY SWITCH

Heater operates on 115 VAC or DC. Contacts SPST—rated at 30 A., 115V. or 20 A. 220 V. plus auxiliary contacts for lighter loads. Each..............$2.49

PILOT LIGHT ASSEMBLIES

Aircraft type, panel mounting, amber jewel only. Knurled rim, controls "Dim-Bright." Bakelite and aluminum construction. Bulb replaceable from front panel. For single contact bayonet bulbs. T-3¼ or G-3½ size. Dimensions: 2¼" overall length, 3¼" diameter, ⅝" panel mtg. hole. IMMEDIATE DELIVERY — 500 to carton, nested, $50.00 per carton. Prices on larger quantities on request.

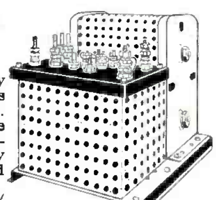
SILVER CERAMIC TRIMMERS

820-Z 5-20 Mmfd Zero Temp......24¢
822-N 5-20 Mmfd Neg. 300........24¢
822-AZ 4.5-25 Mmfd Zero Temp.....24¢
823-AN 20-125 Mmfd Neg. 650.......33¢

ATTENTION!!!

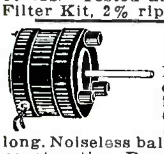
Bulletin #713, listing various government and commercial surplus items, is now available upon request.

DC POWER SUPPLY



Limited quantity — Gov't Surplus Ready to operate. Full wave bridge copper-oxide rectifier, heavy duty multi-tapped transformer. Input: 85/95/105/115/VAC50/60cps Output: 2.5/24/28/32/36 VDC at 5 amperes, unfiltered For wall or bench mounting. Overall dimen. 9" x 8¼" x 8½" high. Shpg. wt. 30 lbs. Tested and guaranteed...$36.00
Filter Kit, 2% ripple............ 6.65

DIEHL MOTOR



Fan duty, brushless induction type (no TV interference). For 115 VAC 60 cycles 46 watts, 1800 RPM. Shaft ¼" diam. 1" long. Noiseless ball-bearings—heavy cast construction. Brand new $4.50

RECTIFIER KIT #612-10

6 and 12 VDC at 10 Amps

This unit will deliver unfiltered direct current for operation of motors, dynamotors, solenoids, electroplating, battery charging and similar equipment.
The two output voltages may be used simultaneously, and varied above and below their nominal ranges.
Complete with schematic diagrams and instructions, shpg. wt., 12 lbs. **$15.95**

Filter Kits For #612-10

1 Section choke input, 10% ripple..$9.64
2 Section choke input, 2% ripple..19.28

D-C PANEL METERS

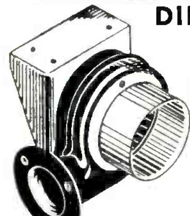
Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%.
0-6 Amperes D-C
0-12 Amperes D-C
0-15 Volts D-C
Any range **$2.49** each

Minimum order $3.00. No C.O.D.'s. Add 10% for Prepaid Parcel Post and Handling. Terms: Net 10 days in the presence of approved credit.
All prices subject to change without notice. *Prices and Delivery F.O.B. our NYC Warehouse. All merchandise subject to prior sale.*

WESTERN ELECTRIC BLOWER

#KS5881 — Brand New — Heavy Duty Sirocco type blower, capacitor start, 1/40 H.P. 3400 RPM 115 VAC 60 cycles. Displaces 84 C.F.M. Extremely quiet operation. Opening 2¾", overall size 7½" long, 6" diam. Moisture and fungus resistant. With capacitor. Shpg. Wt. 15 lbs. Quantity limited.$13.95

DIEHL BLOWER



Sirocco type, displaces 100 C.F.M. 115 VAC 60 cps. Moisture and fungus resistant. Flange diameter 4". Overall size 7½" x 6½". Removed from equipment. Tested and guaranteed
$9.95

Adjustable right angle aluminum extension tube to fit flange ....$.98

WESTINGHOUSE AIRCRAFT MOTOR

Brand new—24 VDC or AC, reversible on both. 1/50 H.P. 4800 RPM continuous duty. Length of leads 18". Dimensions 3½" x 2¼" shaft ¼" diam. by ⅝" long.
Price $2.95
Reversing switch with "off" position
Each ....79¢

OPAD-GREEN COMPANY
71 Warren St.
New York 7, N. Y.
Phone: BEekman 3-7385-6

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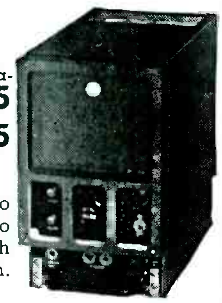
ORDER from ARROW!

BC-605 INTERPHONE AMPLIFIER

Easily converted to an ideal intercommunication set for office—home—or factory
Original—New $4.95
Like New 3.95
(With schematic)



All necessary parts and instructions to convert the above to AC operation with one remote station. $8.25 additional.

Miscellaneous SPECIALS

	Used	New
ID 6/APN 4 Scope. Excellent	29.50	——
ID 57/APQ 7 Scope	9.95	——
ID 2/APS-5FP7 Assembly	——	6.95
R 7/APS 2 Receiver-Indicator	——	79.50
R 78/APS-15 Receiver-Indicator	34.50	——
BC 1287 A Scope	75.00	——
ASB 7 Indicator Scope	12.95	——
ARB Receiver, 200 to 9000 KC	19.95	——
SCR 522 Transceiver 100 to 150 MC	34.95	75.00
BC 1206 Receiver, 200 to 400 KC	3.95	5.95
MN 26 C or Y Receiver	17.50	24.95
RA 10 DA Receiver	17.50	24.95
T 85/APT 5 Transmitter	——	69.50
T 39/APQ 9 Transmitter	7.95	——
T 26/APT 2 Transmitter	8.95	——
BC 457 Transmitter—as is—fair condition—as they come, some with, some less tubes and Xtal	1.95	——
BC 458 Transmitter—as is—fair condition—as they come, some with, some less tubes and Xtal	1.95	——
R 89 Receiver chassis less tubes and side covers	1.95	——
RT 7/APN 1 Transceiver	7.95	9.95
APN 1 Complete	——	34.50
BD 71 6 Pos. Switchboard	9.95	12.95
EE 8 Field Phones	7.95	——
BC 347 Interphone Amplifier	——	2.95
I-70 Tuning Meter	——	.89
AM 61 Indicator Amplifier	——	9.50
SCR 625 Mine Detector	——	39.50
PE 237 Power Supply	——	12.95
BC 461 Veeder Root Counter	——	.59
BC 442 Less Condenser	1.49	1.95
BC 306 Antenna TU for BC 375	——	1.50
A 27 Phantom Antenna	——	.98
APS 13 UHF Antenna, Pair	——	.98
Manual for BC 312 & 342 J	——	1.00
Manual for SCR 269 G	——	2.50
FL 8 Filter	——	2.95
I-97 Bias Meter	2.95	3.95
RM 29 Remote Telephone Control	7.95	9.95
BC 602 Control Box	——	.98

B C 639 Receiver with RA 42 Rectifier
RTA 1B Transceiver
TA 2J24 Transmitter and MP 10G Power Pack
SCR 269 Compass Installation
R 5/ARN 7 Compass Installation
MN 26 Compass Installation
I.L.S. Installation (R 89-BC 733)
SCR 584 Components

Information and prices on request

HERMETICALLY SEALED CHOKES

10 H. 100 M.A. .... 59¢
59 H. 100 M.A. .... 95¢
3.7 H. 145 M.A. .... 59¢
10 H. 20 M.A. .... 39¢

RECEIVER

Easily Converted for Use in Citizens Band

Crystal Controlled Local Oscillator. Broad Band Pass—20.7 MC I.F.'s. Complete with 7-6AJ5, 1—12SR7, 2—12SN7, 1—28D7, relays, crystals.
Schematic furnished .... Used $7.95

CONDENSERS

	Each
2 mfd. 4000 VDC Oil-Filled	$2.95
	4 for $10.00
2 mfd. 5000 VDC Oil-Filled	3.95
	3 for 10.00
1 mfd. 6000 VDC	1.98
.25 mfd. 15000 VDC	4.95
.00025 mfd. 25000 VDC	2.95
.4 mfd. 1500 VDC	.29
	10 for 2.49

TUBES

All Brand New

Drastically Reduced from 10 to 50%

Nationally Advertised Brands

Type	Net Price	Type	Net Price	Type	Net Price
1A4P	$0.24	6R7	$0.34	39/44	$0.24
1A6	.19	6SF5GT	.34	49	.39
1B5/25S	.24	6S8GT	.59	50	.39
1B22	1.49	6SF7	.39	56	.24
1B26	2.29	6SJ7	.69	57	.24
1B29	.39	6T7G	.39	76	.24
1B32-532A	2.29	6U7G	.29	77	.24
1C6	.19	6Z7G	.39	211/Vt4L	.29
1C7G	.19	6ZY5G	.29	316A	.34
1D5GP	.24	7C4/1203A	.24	371B	.34
1D7G	.19	7E5/1201	.39	703A	1.49
1F4	.24	10YVT25A	.19	705A	.79
1F5G	.24	12A6	.34	714AY	5.95
1H4G	.24	12A6GT	.34	724B	4.95
1J6G	.24	12A7	.34	801A	.39
1J6GT	.24	12A8GT	.19	836	.95
1N5GT	.24	12C8Y	.29	837	1.49
1P5GT	.24	12F5GT	.29	841	.29
1V	.24	12H6	.29	864	.29
2A6	.39	12J5GT	.24	872A	.98
2A7	.24	12J7GT	.24	954	.19
2C26A	.19	12K8GT	.24	955	.34
2V3G	.49	12Q7GT	.24	957	.34
2X2/379	.25	12SF5	.24	1625	.19
3FP7	.98	12SF5GT	.24	1626	.24
4AP10	.98	12SF7	.24	1629	.24
5BP1	1.95	12SH7	.24	1630	.29
5BP4	2.95	12SR7	.24	1636	2.95
5CP1	2.95	12SR7GT	.29	1638	.69
5D21	9.95	12Z3	.29	1642	.29
5J23	5.95	15R	.19	2050	.89
5T4	.49	19	.59	2051	.49
5W4	.49	2J22	.24	7193	.19
5Z4	.49	28D7	.34	9002	.35
6B8	.59	30SPEC		9003	.39
6C4	.29	(Vt67)	.59	9006	.29
6D8G	.59	30	.24	GL4A21	.29
6F5GT	.39	32L7GT	.39	Amperite	
6H6	.29	33	.24	10T1	.29
6J6	.89	34	.24	Jan CRP72	.98
6J7GT	.39	35/51	.24	WE331A	.89
6K6G	.59	36	.24	REL36	.69
6L5G	.39	37	.24	VR150	.39
6L7G	.39	38	.24	VR105	.69

WRITE FOR QUANTITY PRICES

BEAM INDICATORS

I 82—5" .... New $4.95
Transmitter selsyn for above 2.45
both for 7.00
I 81—3" .... New 3.45
Transmitter Selsyn for above 2.45
both for 5.25
I 81 .... Used 2.45

SURPRISE PACKAGE

20 lbs. Ass't radio parts. A $25.00 value for only $1.95

PP 12A/APS-3 RECTIFIER POWER SUPPLY

110 VAC—800 to 2400 CPS input. Used to supply many voltages for APS 3 equipment. Contains four VR105; Three 5U4G; 2x2; 6AC7; 6Y6-G; VR 150; 6X5GT-G condensers, chokes, etc. Parts alone worth more than $6.95

OUTPUT TRANSFORMER

Hi-Fi used in Scott Manufactured Navy receiver. Fully potted. Pri. 5000 ohms; output secondary 600 ohms C.T.—Inverse feedback secondary CT-60 ohms.
New $1.45

NEW CATALOG

listing many surplus values, write for your FREE copy TODAY.

All shipments FOB Chicago. 20% Deposit required on all orders. Minimum order accepted —$5.00. Illinois residents, please add regular sales tax to your remittance

ARROW SALES, Inc.
Dept. ES
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

BC-604 TRANSMITTER FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition .. $12.95
Crystals—Set of 80 .... 14.95

COMMAND (SCR 274 N) EQUIPMENT

	Used	New
BC-453	$12.95	——
BC-454	4.95	$6.95
BC-455	7.95	——
BC-456	1.95	2.95
BC-457	5.95	——
BC-458	5.95	7.95
BC-459 (or T22)	9.95	——
BC-696 (or T19)	14.95	24.95
ARC5 Transm 2.1-3MC	9.95	——
BC-450—3 Receiver Remote Control	.89	1.95
BC-442		2.95
3 Receiver Rack	1.95	——
2 Transmitter Rack	1.50	——

Complete Command set as removed from air-craft — 3 receivers — 2 transmitters — Relay unit—control boxes—mounting racks—plugs — modulator and dynamotors — crated. Set $34.50

DYNAMOTORS

DM-28—For BC-348 with Mount and Filter .... New $6.95
Used 3.95
DY-12—For ART-13 less filter and base .... New 6.95
DM-36 .... Used .95
New 1.95
BD-77 .... New 5.95
PE-206 .... New 6.95
Used 2.75
PE-101 .... New 2.75
PE-73 .... New 3.95
DM-53 .... New 3.95
Used .95 (3 for $2.00)
DM-32 .... New 1.95
Used .95 (3 for $2.00)

MIKES—HEADSETS

HS-23 Hi Imp. .... New $2.95
HS-33 Lo Imp. .... New 2.95
HS-30 Hi Imp. .... New 1.50
Used .79
T-17D Carbon Mike .... New 2.75
T-24 Hi Imp. Carbon Mike .... New 1.19
T-30 Throat Mike .... New .98
T-45 (or Navy) Lip Mike .... New .98
CD-307 Extension Cord for Headsets .... New .59

BC 620

Receiver-Transmitter — 2 crystal channels — 20 to 27.8 MC FM—13 tubes. Metered, Plate and Filament .... New $14.95
Used 9.95

PE 97 Power Supply for above 6-12 volt vibrator type.
Used—complete $6.95
Used less tubes, vib. & cond. 2.95

FT 250 Mount for both BC 620 and PE 97 New $1.50

BC 223

Brand new Transmitter with all three tuning units, two tuning unit cases, spare tube carrying case, shock Mount and brace; but less tubes at new low price of $19.95
Tuning units are available separately at Ea. $2.50
Cases at .... Ea. .95
PE 125—12-volt Vibrator Pack .... New $12.95
Used 8.95

www.americanradiohistory.com

GUARANTEED BRAND NEW

LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

RECEIVING TUBES

Tube	Price
OZ4	.59
OZ4G	.59
1A3	.45
1A5GT	.54
1A7GT	.69
1AB5	.73
1B3GT/8016	1.18
1B4P	1.15
1B5/25S	1.16
1C5GT	.69
1C6	.94
1D5GP	1.04
1D8GT	1.04
1E5GP	1.16
1E7G	.66
1G4GT	.79
1G6GT	.79
1H4G	.69
1H5GT	.59
1J6G	1.04
1L4	.66
1LA4	.94
1LB4	.94
1LC5	.73
1LC6	.94
1LD5	.94
1LE3	.73
1LH4	.94
1LN5	.88
1N5GT	.69
1N6G	.72
1P5GT	.59
1Q5GT	.94
1R4	.29
1R5	.69
1S4	.86
1S5	.64
1T4	.64
1T5GT	.94
1U4	.72
1V	.69
2A3	.89
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2/879	.49
2X2A	.79
3A4	.61
3A5	.96
3A8GT	1.76
3B7/1291	.29
3C6(XXB)	1.15
3D6/1299	.29
3Q4	.69
3Q5GT	.79
3S4	.61
3V4	.72
5AZ4	.48
5R4GY	1.05
5T4	.89
5U4G	.59
5V4G	.84
5W4	.76
5X4G	.59
5Y3GT	.38
5Y4G	.46
5Z3	.65
5Z4	.79
6A6	.87
6A7	.72
6A8GT	.72
6AB7/1853	.99
6AC5GT	.94
6AC7/1852	.79
6AC7W	1.45
6AD6G	.79
6AD7G	1.13
6AE6G	.72
6AF6G	.96
6AG5	.89
6AG7	1.19
6AJ5	.89
6AK5	.89
WE-6AK5	1.35
6AK6	.82
6AL5	.69
6AQ5	.72
6AQ6	.65
6AT6	.54
6AU6	.72
6AV6	.55
6B4G	.94
6B8	.79
6B8G	.79
6BA6	.65
6BA7	.86
6BE6	.65
6BG6G	1.72
6BH6	.72
6BJ6	.72
6C4	.21
6C5	.60
6C6	.69
6C8G	.89
6D6	.59
6D8G	.87
6E5	.79
6F5	.60
6F5GT	.60
6F6	.69
6F7	.72
6F8G	.89
6G6G	.88
6H6	.49
6H6GT	.48
6J5	.49
6J5G	.48
6J5GT	.48
6J6	.89
6J7	.72
6J7GT	.71
6J8G	.96
6K5GT	.86
6K6GT	.52
6K7	.54
6K7G	.54
6K8	.83
6K8GT	.79
6L6	1.22
6L6G	1.11
6L6GA	.87
6L7	.87
6N7	.87
6N7GT	.87
6P7G	1.28
6Q7	.69
6R7	.89
6S7	.94
6S7G	1.02
6S8GT	.95
6SA7GT	.52
6SB7Y	.79
6SC7	.66
6SC7GT	.61
6SD7GT	.79
6SF5	.59
6SF5GT	.59
6SF7	.72
6SG7	.69
6SG7GT	.68
6SH7	.44
6SH7GT	.43
6SJ7	.59
6SJ7GT	.59
6SK7	.59
6SL7GT	.69
6SN7GT	.64
6SN7W	1.45
6SQ7	.53
6SQ7GT	.53
6SR7	.59
6SS7	.65
6ST7	.79
6T7G	1.15
6T8	1.04
6U5/6G5	.72
6U7G	.65
6V6	1.07
6V6G	.59
6V6GT	.59
6W4GT	.65
6W7G	.79
6X4	.59
6X5GT	.59
6Y6G	.88
6Z7G	1.09
6ZY5G	.79
7A4 XXL	.65
7A6	.65
7A7	.65
7AD7	.95
7AG7	.79
7A8	.65
7B4	.65
7B6	.64
7C4	.19
7C5	.64
7C7	.65
7E5	.29
7E6	.64
7F7	.79
7F8	.92
7H7	.72
7K7	.95
7L7	.79
7N7	.79
7Q7	.65
7S7	.96
7V7	.96
7W7	.96
7Y4	.65
7Z4	.65
10Y	.19
12A6	.24
12A7	1.16
12A8GT	.72
12AH7GT	.87
12AT6	.59
12AT7	.99
12AU6	.72
12AU7	.86
12AX7	.86
12BA6	.64
12BA7	.86
12BE6	.64
12C8	.59
12F5GT	.65
12H6	.39
12J5GT	.49
12K8	.69
12Q7GT	.59
12SA7GT	.59
12SC7	.69
12SF5	.65
12SF7	.69
12SG7	.69
12SH7	.49
12SJ7	.49
12SJ7GT	.49
12SK7	.59
12SK7GT	.59
12SL7GT	.69
12SN7GT	.79
12SQ7GT	.59
12SR7	.69
12X3	.88
14A4	.88
14A7/12B7	.79
14B6	.79
14B8	.79
14C5	.79
14H7	.79
14J7	.89
14N7	.89
14W7	.96
14X7	.96
19	1.16
19T8	1.04
22	1.16
24A	.66
25L6GT	.59
25Z5	.55
25Z6GT	.49
26	.59
27	.49
28D7	.61
30 Spec.	.48
31	.62
32	.99
33	.99
34	.99
35/51	.72
35A5	.65
35L6GT	.59
35W4	.45
35Y4	.65
35Z3	.65
35Z5GT	.44
36	.69
37	.59
38	.69
39/44	.49
41	.59
42	.59
43	.59
45	.59
45Z5GT	.65
46	.84
47	.86
50	1.41
50A5	.97
50B5	.69
50L6GT	.57
53	.95
55	.79
L55B	.18
56	.59
57	.72
58	.72
59	1.24
70L7GT	1.24
75	.59
76	.59
77	.59
78	.59
79	.77
80	.45
81	1.41
82	.94
83	.95
83V	1.15
84/6Z4	.65
89Y	.55
117L7GT	1.24
117N7GT	1.24
117P7GT	1.24
117Z3	.54
117Z6GT	.87
UV199	.52
FM-1000	.97

Cathode Ray Tubes

Tube	Price
2AP1	3.65
2AP5	5.95
3AP1	4.63
3AP4/906P4	5.94
3BP1	2.59
3CP1	1.87
3DP1A	5.75
3EP1	2.92
3HP7	4.91
4AP10	5.35
5AP1	3.75
5AP4	4.75
5BP1	2.40
5CP1	2.87
5CP7	3.76
5FP7	.57
5HP4	3.35
5JP4	9.55
5LP1	13.95
5MP1	10.65
5MP5	10.65
7BP1	12.87
7BP7	4.95
7BP14	14.95
9GP7	9.85
9LP7	3.88
10BP4	24.66
10FP4	28.88
12DP7	12.85
12GP7	12.85
905	4.47
913	4.90

Photo Cells

Tube	Price
CE-1C/918	.88
1P24	.29
923	.97
927	1.67
931A	3.22
1645	1.67

Thyratrons

Tube	Price
OA4G	.95
EL-C1A	3.35
2A4G	1.15
2D21	1.09
3C23	3.20
3C31/EL-C1B	3.35
4C35	19.77
EL-C5B	8.95
C6J	4.44
FG-17	2.89
FG-33	11.95
FG-67/1904	8.85
FG-81A	4.95
FG-105	9.95
FG-172	14.50
WE355A	14.15
394A	3.77
KU-610	6.35
KU-634	17.20
WL-652/657	38.00
884	1.35
885	.88
1665	.97
1904	8.85
2050	.83
2051	.49

Transmitting & Special Purpose Tubes

Tube	Price
OA2	1.32
1B22	3.87
1B23	8.95
1B24	4.90
1B26	4.50
1B27	4.50
1B29	2.90
1B32	3.15
1B36	4.50
1B42	9.80
1H20	.58
2B22	1.41
2C22	.22
2C26	.27
2C34/RK-34	.28
2C44	.79
2E22	1.25
2J21A	8.95
2J22	8.95
2J26	7.80
2J27	13.70
2J31	9.60
2J32	14.45
2J33	19.90
2J34	19.90
2J37	13.70
2J38	12.70
2J48	14.95
2J61	36.20
2K23	23.95
2X2/879	.49
2X2A	.79
3B22/EL-1C	1.12
3B24	1.25
3B27	1.29
3C24	.44
3E29	6.20
3J31	39.25
SN-4/631-P1	3.77
4A1	.58
4B22/EL-5B	5.20
4B24/EL-3C	2.44
4B25/EL-6CF	8.70
4C28	8.85
4E27	12.75
5D21	26.50
5J23	14.20
5J29	14.20
5R4GY	1.05
6C21	19.88
6J4	5.20
10T1	.58
10Y	.19
15R	.75
REL-21	3.25
24G	.44
RK-25	2.11
FG-32	4.25
RK-34	.28
REL-36	.78
RK-47	4.92
EF-50	.45
VT-52	.36
53A	3.82
RK-59	2.44
RK-60/1641	.59
RK-72	.92
RK-73	.92
VR-75	.98
VR-78	.34
VR-90/OB3	.81
VT-98 (BR)	29.90
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
VR-105/OC3	.72
WE-113A	1.32
WE-120A	1.47
WE-121A	1.97
WE-124A	3.80
VT-127A	2.40
VR-150/OD3	.65
203A	6.40
203B	4.33
204A	27.90
WE-205B	1.70
WE-205F	2.85
CE-206	3.15
211	.62
WE-215A	.24
221A	1.95
WE-231D	1.25
WE-245A	1.35
WE-249C	1.88
WE-257A	2.77
WE-259A	4.22
WE-271A	6.75
WE-274B	1.06
WE-283A	1.27
WE-293A	3.36
304TH	3.86
304TL	1.25
WE-310A	7.50
316A	.66
350A	2.80
350B	1.95
354C	19.50
WE-356B	4.45
361A	4.75
371B	.82
388A	2.95
417A	10.65
434A	3.65
446A	.79
450TH	19.70
471A	2.75
503AX	1.47
506AX	1.47
507AX	1.47
527	9.75
530	17.20
531	17.80
532A	3.15
559	1.41
561	1.45
579B	5.85
HY615	.29
631-P1	3.77
WL-670A	8.70
700B	16.90
700C	16.90
700D	16.90
701A	3.67
702A	2.95
702B	3.87
703A	3.90
704A	2.75
705A	1.17
707A	5.22
707B	6.95
708A	4.85
710A	2.25
713A	1.45
714AY	6.95
715A	6.75
715B	9.95
717A	.97
721A	3.93
723A/B	16.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
730A	10.95
731A	2.45
WL787	9.80
800	1.88
801A	.48
802	4.25
803	4.87
804	8.95
805	4.75
807	1.15
808	2.19
810	7.25
811	1.91
813	6.95
814	3.79
815	1.72
816	.97
826	.57
829	4.91
829B	6.20
830B	3.35
832	3.95
832A	4.91
836	.89
837	1.38
838	2.93
841	.49
843	.59
851	27.50
852	6.40
860	4.50
861	17.70
864	.19
866A	.95
869B	27.00
872A	1.88
874	1.65
876	.39
878	1.85
954	.39
955	.39
956	.49
957	.49
958A	.49
991	.29
1005	.24
1201A/7E5	.29
1203/7C4	.19
1294/1R4	.29
1299/3D6	.29
1602	.68
1613	.61
1616	.87
1619	.19
1624	.69
1625	.19
1626	.29
1629	.29
1630	3.11
1631	1.38
1636	3.77
1638	.70
1641/RK-60	.59
1642	.39
1644	1.17
1960	1.21
UX-6653	.65
7193	.22
8011	.87
8012	1.45
8012A	1.91
8013	.92
8013A	1.42
8016	1.18
8020	1.39
8025	3.17
9001	.42
9002	.39
9003	.39
9004	.39
9006	.29

WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$11.50 EACH

$10.00 ea. Lots of 10

KOLLSMAN INSTRUMENT LOW INERTIA SERVO MOTOR

Freq. Cycles	100
Volts—Phase 1	85
Volts—Phase 2	68
Current—Phase 1—110MA	
Current—Phase 2—40MA	
Res.—Phase 1	306 Ω
Res.—Phase 2	776 Ω
No. of Poles	4
Speed—RPM	2650
Weight—Oz.	6.5
Input Watts—No Load 2650 RPM CW	5.8
Input Watts—Stalled	5.0
Torque Stalled—(Oz. In.)	.80
Temp. Rise (°C)—2650 RPM—No Load	54
Temp. Rise (°C)—Stalled	54
Reversing Time—(Seconds)	0.1
Moment of Inertia (G. CM.^{2})	6.7

Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

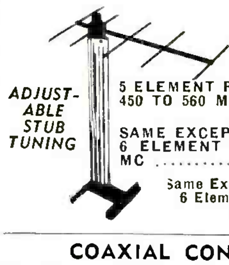
$7.50 EACH—Lots of 10

AMERTRAN HIGH CURRENT TRANSFORMER

Suitable for Welding Use — Pri— 115 Volt, 60 cy. Sec—5 Volt—190 Amp. 35 KV. Insul. **$19.50**

All material brand new and fully guaranteed. Terms 20% cash w/ order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna.

ASB YAGI ANTENNA



ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC
$29.40

COAXIAL CONNECTORS

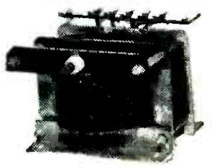
83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.09	UG-21/U	.67	UG-87/U	.68
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.63	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.28	UG-27/U	.68	UG-180A/U	3.82
83-1RTY	.45	UG-29/U	.83	UG-191/AP	.57
83-1SP	.28	UG-30/U	.94	MX-195/U	.41
83-1SPN	.28	UG-33/U	14.80	UG-197/U	1.33
83-1T	1.12	UG-34/U	12.80	UG-206/U	.58
83-22AP	.85	UG-36/U	12.80	UG-254/U	.88
83-22F	.88	UG-37/U	12.80	UG-255/U	.82
83-22R	.48	UG-58/U	.57	UG-264/U	1.74
83-22SP	.48	UG-85/U	.62	MX-367/U	.15

Full Line of JAN Approved Coaxial Connectors In Stock. Send us your inquiries.

RAYTHEON SUB-MINIATURE PENTODE OUTPUT TUBES

CK-503AX	ANY TYPE	$1.47 EA.
CK-506AX	Lots of 10	$1.30 EA.
CK-507AX	Lots of 100	$1.00 EA.

RCA HI-VOLTAGE TRANSFORMER



Pri—115/230V. 60Cy
Sec—6000V—80 MA

$11.80

Insulated for Voltage Doubler Use

Antennas for AN/APR-4 Receivers

AT-38A/APT—(70 to 400 MC) $13.70
AT-49/APR-4—(300 to 3300 MC) $13.70

GENERAL ELECTRIC AMPLIDYNE Motor-Generator

Consists of G.E. 1HP 115V 1 ph 60 cy 11.5A 3450 RPM continuous duty motor coupled to G.E. model 5AM65FB31 250V DC 2A 0.5KW 3450 RPM Amplidyne generator.

Brand New $97.50

RADIATION COUNTER TUBES

1B98 GAMMA COUNTER $9.87
AMPEREX 75N & 75NB (Beta & Gamma) $9.90
Full Line of Amperex Radiation Counters in Stock

AT-48/UP 3 CM HORN ANT.

$3.95

$3.50 each (Lots of 10) Type N Plug to connect to probe ....67¢

GENERAL ELECTRIC FG-32 TUBES

$4.25

$3.75 Ea. - Lots of 10
Brand New
Original Cartons

LECTRONIC RESEARCH LABORATORIES

1021-23 CALLOWHILL ST. PHILA. 23, PA.

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WELCOME I.R.E.ers

• RESISTORS
EB½, GB1 and HB2

LIFE OFFERS THE MOST COMPLETE INVENTORY OF ½, 1 and 2 WATT RESISTORS IN 5% and 10% TOLERANCES IN THE COUNTRY

PRICE SCHEDULE

	Wattage	Tol.	Quantity per Type 1–49	50–499	500 or over
EB½	½ Watt	10%	.06	.04	.025
EB½	½ Watt	5%	.12	.08	.05
GB1	1 Watt	10%	.09	.06	.045
GB1	1 Watt	5%	.18	.12	.09
HB2	2 Watt	10%	.15	.10	.075
HB2	2 Watt	5%	.30	.20	.15

Prices shown are per size. Resistors may not be assorted for quantity price.

THE FOLLOWING VALUES ARE AVAILABLE IN 10% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	100	1000	10000	.1	1.0	10.0
12	120	1200	12000	.12	1.2	12.0
15	150	1500	15000	.15	1.5	15.0
18	180	1800	18000	.18	1.8	18.0
22	220	2200	22000	.22	2.2	22.0
27	270	2700	27000	.27	2.7	
33	330	3300	33000	.33	3.3	
39	390	3900	39000	.39	3.9	
47	470	4700	47000	.47	4.7	
56	560	5600	56000	.56	5.6	
68	680	6800	68000	.68	6.8	
82	820	8200	82000	.82	8.2	

THE FOLLOWING VALUES ARE AVAILABLE IN 5% TOLERANCES:

Ohms	Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	68	470	3300	22000	0.15	1.0	6.8
11	75	510	3600	24000	0.16	1.1	7.5
12	82	560	3900	27000	0.18	1.2	8.2
13	91	620	4300	30000	0.20	1.3	9.1
15	100	680	4700	33000	0.22	1.5	10.0
16	110	750	5100	36000	0.24	1.8	11.0
18	120	820	5600	39000	0.27	2.0	12.0
20	130	910	6200	43000	0.30	2.2	13.0
22	150	1000	6800	47000	0.33	2.2	15.0
24	100	1100	7500	51000	0.36	2.4	16.0
27	180	1200	8200	56000	0.39	2.7	18.0
30	200	1300	9100	62000	0.43	3.0	20.0
33	220	1500	10000	68000	0.47	3.3	22.0
36	240	1600	11000	75000	0.51	3.6	
39	270	1800	12000	82000	0.56	3.9	
43	300	2000	13000	91000	0.62	4.3	
47	330	2200	15000	0.1	0.68	4.7	
51	360	2400	15000	0.11	0.75	5.1	
56	390	2700	18000	0.12	0.82	5.6	
62	430	3000	20000	0.13	0.91	6.2	

TYPE "J" POTENTIOMETERS

Available in screw-driver and regular shafts locking and non-locking type bushings.
When ordering locking type bushing potentiometers, locking nuts are available at $.05 each.
Specify whether regular or screw-driver shaft is required.

PRICE SCHEDULE

Single Pots	$.50
Dual Pots	1.50
Triple Pots	2.50

SINGLE POTENTIOMETERS TYPE "J" AND "JL"

Ohms	Ohms	Ohms	Ohms
50	1300	20,000	200 000
60	1500	25,000	250,000
150	2000	30,000	500,000
200	2500	35,000	600,000
250	3000	50,000	750,000
400	5000	60,000	1.0Meg
500	6500	75,000	2.0Meg
			2.5Meg
600	10,000	100,000	3.0Meg
1,000	15,000	150,000	4.0Meg

DUAL POTENTIOMETERS TYPE "JJ"

Ohms	Ohms
60/60	10,000/25,000
100/100	20,000/35,000
500/500	20,000/700,000
600/600	25,000/25,000
1800/1800	50,000/50,000
2500/2500	75,000/75.000
3000/3000	100,000/100,000
5000/5000	200,000/200,000
7500/7500	500,000/500,000
10.000/	1 Meg/1 Meg
10.000	5 Meg/5 Meg

TRIPLE POTENTIOMETERS TYPE "JJJ"

Ohms
150,000/150,000/150,000
500,000/500,000/500,000

Send for Free A.B. Bulletin

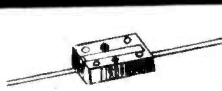
SILICON DIODES

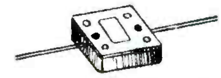
Type	Design Freq. (mc)	Price each
IN21	3,000	$.50
IN21B	3,000	1.00
IN23	10,000	1.25
IN23A	10,000	1.50
IN23B	10,000	2.00

GERMANIUM DIODES

Type	Price each
IN34	$.85
IN35	2.00

MICA CAPACITORS
Regular and Silvered





Capacity MMFD	Regular Mica	Silvered Mica	Capacity MMFD	Regular Mica	Silvered Mica	Capacity MMFD	Regular Mica	Silvered Mica
5	$.07	$.12	120	$.06	$.14	1100	$.12	$.33
10	.07	.12	130	.06	.14	1200	.12	.36
12	.07	.12	150	.06	.14	1300	.12	.42
15	.07	.12	160	.06	.14	1500	.12	.45
18	.07	.12	180	.06	.14	1600	.15	.48
20	.07	.12	200	.06	.14	1800	.15	.51
22	.07	.12	220	.07	.14	2000	.15	.54
24	.07	.12	240	.07	.16	2200	.15	.54
27	.07	.12	250	.07	.16	2400	.15	.54
30	.07	.12	270	.07	.16	2700	.15	.60
33	.06	.12	300	.07	.16	3000	.15	.60
36	.06	.12	330	.07	.16	3300	.15	.63
39	.06	.12	360	.07	.16	3600	.15	.63
43	.06	.12	390	.07	.19	3900	.17	.63
47	.06	.12	430	.07	.19	4300	.17	.63
50	.06	.12	470	.07	.21	4700	.17	.63
51	.06	.12	500	.07	.21	5000	.18	.66
56	.06	.12	510	.07	.21	5100	.18	.66
62	.06	.12	560	.07	.23	5600	.18	.75
68	.06	.12	620	.09	.25	6200	.20	.81
75	.06	.12	680	.09	.25	6800	.22	.90
82	.06	.12	750	.09	.27	7500	.24	.96
91	.06	.12	820	.09	.27	8200	.30	1.05
100	.06	.12	910	.10	.30	9100	.30	1.12
110	.06	.14	1000	.10	.30	10000	.36	1.20
						15000	.51	1.50

"UHF" COAXIAL CABLE CONNECTORS

83-1T 83-1SP 83-1SPN 83-1R

No.	AN No.	Description	1–99	100–499	500 or over
83-1SP	PL259	Plug	.35	.28	.24
83-168	UG176U	Adapter	.15	.12	.11
83-185	UG175U	Adapter	.15	.13	.12
83-1SPN	PL259A	Plug	.35	.28	.24
83-776	UG203U	Plug	.61	.55	.53
83-1R	SO239	Receptacle	.35	.28	.24
83-1RTY	....	Receptacle	.50	.45	.40
83-1H	UG106U	Hood	.12	.10	.09
83-1HP	....	Hood	.27	.24	.21
83-765	UG177U	Hood	.31	.25	.22
83-1AC	....	Cap and chain	.61	.50	.45
83-1BC	....	Cap and chain	.38	.34	.31
83-1T	M358	"T" connector	1.12	.98	.90
83-1AP	M359A	Angle adapter	.35	.28	.24
83-1J	PL258	Junction	.85	.70	.65
83-1F	PL274	Feed thru	1.12	.98	.90
83-22SP	UG102U	Twin plug	.75	.68	.62
83-22R	UG103U	Twin recept	.50	.40	.36
83-22AP	UG104U	Twin ang. adapt.	.98	.80	.72
83-22J	UG105U	Twin junction	1.25	1.12	1.05
83-22T	UG196U	Twin "T"	1.65	1.50	1.35
83-22F	PL275	Twin feed thru	1.50	1.35	1.25
83-2SP	PL295	L'ge twin plug	1.94	1.75	1.55
83-2R	SO265	L'ge twin recept.	1.44	1.30	1.18
83-2H	M365	L'ge Hood	.24	.22	.20
83-2AC	....	L'ge CAP and chain	.61	.55	.50
83-2AP	PL325	L'ge Twin angle adpt.	2.08	1.88	1.68
83-2J	PL305	L'ge twin junction	1.45	1.30	1.18

COAXIAL CABLES

BRAND NEW! ! !
JAN APPROVED! ! !

RG No.	Impedance	Price per Thousand Ft.
RG5U	52.5 ohms	$70.00
RG6U	76.0 ohms	150.00
RG7U	97.5 ohms	70.00
RG8U	52.0 ohms	60.00
RG9U	51.0 ohms	135.00
RG9AU	51.0 ohms	125.00
RG10U	52.0 ohms	125.00
RG11U	75.0 ohms	100.00
RG12U	75.0 ohms	190.00
RG13U	75.0 ohms	125.00
RG18U	52.0 ohms	450.00
RG19U	52.0 ohms	350.00
RG20U	52.0 ohms	450.00
RG22U	95.0 ohms	120.00
RG24U	125.0 ohms	240.00
RG25U	48.0 ohms	575.00
RG27U	48.0 ohms	290.00
RG29U	53.5 ohms	50.00
RG34U	71.0 ohms	175.00
RG38U	52.5 ohms	400.00
RG39U	72.5 ohms	180.00
RG41U	67.5 ohms	575.00
RG54U	58.0 ohms	65.00
RG54AU	58.0 ohms	75.00
RG57U	95.0 ohms	100.00
RG58U	53.5 ohms	50.00
RG59U	73.0 ohms	40.00
RG62U	93.0 ohms	50.00
RG65U	950.0 ohms	250.00
RG71U	93.0 ohms	175.00
RR74U	52.0 ohms	250.00
RG78U	48.0 ohms	80.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50% to prices shown.

BRAND NEW!! UG TYPE CONNECTORS JAN APPROVED!!

UG 30/U UG 88/U UG 290/U UG 306/U UG 352/U

AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.
UG9/U...	$.95	UG23BU...	1.29	UG88/U...	1.17	UG146/U...	2.25	UG235/U...	28.50
UG10/U...	1.56	UG27AU...	2.25	UG89/U...	.95	UG155/U...	.40	UG236/U...	11.75
UG11/U...	1,45	UG28/U...	2.34	UG90/U...	1.05	UG154/U...	5.35	UG241/U...	2.20
UG12/U...	.95	UG29/U...	1.22	UG91/U...	1.25	UG156/U...	4.25	UG242/U...	2.50
UG13/U...	1.56	UG29AU...	1.36	UG91AU...	1.05	UG157/U...	4.25	UG243/U...	2.75
UG14/U...	1.45	UG30/U...	1.75	UG92/U...	1.10	UG160/U...	1.90	UG244/U...	2.50
UG15/U...	.95	UG33/U...	1.75	UG92AU...	1.35	UG160AU...	1.55	UG245/U...	1.25
UG16/U...	1.56	UG32/U...	20.00	UG93/U...	1.25	UG167/U...	3.00	UG246/U...	1.45
UG17/U...	1.45	UG33/U...	20.00	UG93AU...	1.45	UG173/U...	.30	UG252/U...	4.50
UG18/U...	.99	UG34/U...	17.50	UG94/U...	1.25	UG174/U...	16.00	UG254/U...	1.82
UG18/AU...	1.05	UG35AU...	16.00	UG94AU...	1.05	UG188/U...	.95	UG255/U...	1.85
UG19BU...	1.09	UG36/U...	16.00	UG95/U...	1.10	UG195/....	.75	UG259/U...	4.10
UG19/U...	1.28	UG37/U...	16.00	UG95AU...	1.35	UG197/U...	5.00	UG260/U...	.99
UG19AU...	1.38	UG37AU...	16.00	UG96/U...	1.25	UG201/U...	1.83	UG261/U...	.95
UG19BU...	1.45	UG57/U...	.99	UG96AU...	1.45	UG202/U...	2.75	UG262/U...	1.05
UG20/U...	1.17	UG58/U...	.65	UG97/U...	3.50	UG204/U...	2.25	UG269/U...	2.60
UG20AU...	1.26	UG59/U...	2.75	UG98/U...	1.55	UG206/U...	1.02	UG270/U...	6.50
UG20BU...	1.41	UG59AU...	1.70	UG100/U...	2.34	UG208/U...	28.00	UG273/U...	1.50
UG21/U...	.99	UG60/U...	1.90	UG101/U...	2.95	UG212/U...	4.50	UG274/U...	1.98
UG21AU...	1.05	UG60AU...	1.30	UG107/U...	2.25	UG213/U...	4.50	UG279/U...	2.40
UG21BU...	1.09	UG61/U...	2.05	UG108/U...	1.75	UG215/U...	3.35	UG287/U...	5.25
UG22/U...	1.08	UG61AU...	1.80	UG109/U...	1.75	UG216/U...	8.70	UG290/U...	.85
UG22AU...	1.38	UG62/U...	28.00	UG114/U...	1.50	UG217/U...	3.10	UG291/U...	1.05
UG22BU...	1.34	UG83/U...	1.50	UG115/U...	1.33	UG218/U...	6.50	UG306/U...	2.03
UG23/U...	.99	UG85/U...	1.65	UG123/U...	.45	UG222/U...	35.00	UG333/U...	4.70
G23AU.....	1.26	UG86/U...	1.69	UG131/U...	6.00	UG231/U...	2.00	UG334/U...	5.75
		UG87/U...	1.40					UG352/U...	6.00

LIFE ELECTRONIC SALES • 91 GOLD STREET • NEW YORK 7, N. Y. • DIGBY 9-4154

www.americanradiohistory.com

Reliance Specials

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MFD
8.2	60	250	600	.0015
10	62	300	620	.002
15	70	350	650	.0026
20	75	370	680	.0027
22	82	390	750	.003
24	90	400	820	.0033
25	100	430	910	.0039
39	110	470	MFD	.004
40	150	500	.001	.005
47	160	510	.0012	.0068
50	220	560	.0013	.0075
51	240	580	.00136	.0082
56				.01

Price Schedule
8.2 MMF to .001 MFD... 5¢
.012 MFD to .002 MFD... 7¢
.0026 MFD to .0082 MFD...12¢
.01 MFD.................18¢

SILVER MICA

MMF	MMF	MMF	MMF	MFD
10	100	360	680	.0027
24	110	370	700	.003
25	120	390	820	.0033
30	125	400		.0039
40	150	430	MFD	.004
47	180	466	.001	.0047
60	200	488	.0013	.005
62	208	500	.0015	.0051
66	240	510	.002	.006
68	250	560	.0022	.0082
75	300	600	.0024	.01

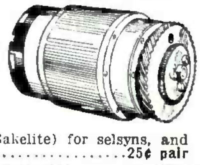
Price Schedule
10 MMF to .001 MFD...10¢
.0012 MFD to .0027 MFD...20¢
.003 MFD to .0082 MFD...50¢
.01 MFD.................65¢

OIL FILLED

MFD	V.D.C.	Price
.375@	16,000 and	
.75@	8,000 (dual)	$6.95
5	7,500	23.95
.1	7,500	1.55
.1-.1	7,000	1.55
.02-.02	7,000	1.50
1	6,000	8.50
.1	6,000	1.45
2	4,000	4.50
.25	3,000	1.95
1	2,000	.95
4	1,000	.90
3	1,000	.80
2	1,000	.65
10	600	1.00
4	600	.69
2	600	.39

SELSYNS

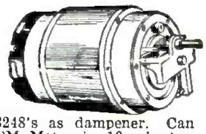
115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅝" long
$7.95 pair



Mounting Brackets — (Bakelite) for selsyns, and differentials shown above ....25¢ pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅝" long
$2.25 ea.



Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied.

WW PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
11.74	14.98	105.8	366.6	59,148

½ WATT—25c

.250Ω	11.1Ω	210Ω	3,427Ω	8,500Ω
.334	13.15	235	4,000	14,825
.502	46	260	4,451	15,000
.557	52	270	5,000	15,750
.627	55.1	298.3	5,900	17,000
.76	75	400	6,500	30,000
1.01	97.8	723.1	7,000	100,000
1.53	125	2,500	7,500	150,000
2.04	180	2,850	8,000	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	55,000
3.39	10.9	7,000	50,000	70,000
5.05	270			

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	522,000Ω
120,000	130,000	320,000	600,000
125,000	160,000	470,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c
100 pieces—10% off; 1,000 pieces—20% off.

UNIVERSAL JOINT

3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

TOGGLE SWITCHES

Bat Handle, S.P.S.T. 6A., 125 V, Off-On plate.......20¢
Ball Handle, S.P.D.T. 6A, 125 V......................24¢
Bat Handle D. P. S. T. 6A, 125V......................29¢

DRY DISK RECTIFIER

117 V.A.C. in, 110 V.D.C. out @ 100 Ma.............72¢

ALLEN SET SCREWS

4-40 x ⅛	8-32 x ⅛	8-32 x 5/16
4-40 x 3/16	8-32 x 3/16	8-32 x 3/8

ALL SIZES (Cup Point)...................**$1.50 per 100**

GLYPTAL CEMENT 1 qt.........75¢ 1 gal. $2.50

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	.25
N.D. 38	5/16"	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

SOUND POWERED HANDSET

Brand New! TS-10

Includes 6 ft. cord & spring clips
$8.92 ea. — $17.60 pr.

WALL HANGER — Navy type, for Sound Powered Phones (Shown above).......................$1.00 each

HAYDON TIMING MOTORS

2/3 R.P.M., 115V., 60 Cyc. Two motors connected on one shaft to make unit reversible. Only..........$1.95
4 R.P.M., 115V., 60 Cycle 1.79

POWER RHEOSTATS

STANDARD BRANDS

25 WATT

Resist.	Shaft	
10Ω	7/16"	49¢
15	7/16"	59
25	⅛"	59
145	½"	49
	with switch	
200	7/16"	59
250	7/16"	59
370	½"	59

25 WATT

3,000Ω	7/16"	69¢
3,500	7/16"	69
5,000	S.D.*	69
90Ω	½"	79¢
123	½"	79
1,250	½"	89
2,000	½"	89
3,500	⅛"	89

50 WATT

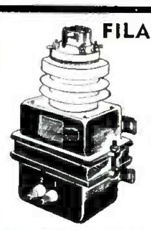
2Ω	7/16"	79¢
8	S.D.*	79
12	7/16"	79
20	7/16"	79

150 WATT

8Ω	½"	$1.99
75	7/16"	1.99

*S.D. Screw Driver Slot

FILAMENT TRANSFORMER



Amertran Type WS

For High Voltage Rectifiers.
PRI. 115V., 50/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube (See our tube list).

NEW OVERSEAS PACKED **$10.95**

RANGE UNIT

From AN/APS-15. Contains 11 Utah X 124-T2 (9262) Pulse Transformers. 12 Prec. Resistors. 28 V.D.C. Blower, metal cabinet and other useful parts **SPECIAL** $10.95

PRECISION CONTROLS

6 WATT

20,000	Muter	314A	$1.70
20,000Ω	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70

25 WATT

100K	GR	433A	$4.95

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
12	GR	301	1.10

12 WATT

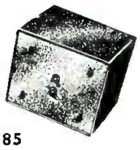
10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00

0-15A DC AMMETER

BASIC MOVE
12 Ma.
5" x 4"
METAL CASE
MIRROR SCALE

Lots of 10—$34
$3.85 ea.

CHOKE



400 MA
12 Hy.
90 OHM
6,000 V. D. C. TEST
$3.85
10 for $34.00

METERS

0-7.5 V.A.C. 3½" Westinghouse.....................$3.49
0-15 V.A.C. 3½" Westinghouse...................... 3.49
0.8 Amps. R.F. 3½" Weston......................... 3.29
60-0-60 Amps. D.C. 2" Westinghouse................ 1.29

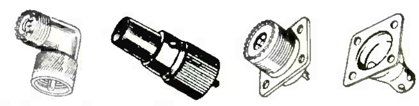
RG 8/U 52 OHM

$50.00 per 1,000 feet

OTHER COAXIAL CABLE

RG 7/U	97 OHM	per 1,000 ft.	$60.00
RG 9/U	51 OHM	per 1,000 ft.	125.00
RG 22/U	95 OHM (2 cond.)	per 1,000 ft.	100.00
RG 58/U	53 OHM	per 1,000 ft.	50.00
RG 59/U	73 OHM	per 1,000 ft.	40.00
RG 62/U	93 OHM	per 1,000 ft.	50.00

COAXIAL CABLE CONNECTORS



Angle-Adapter	Plug	Socket	Hood
15c	28c	28c	9c
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax.
12¢ each ....$10.00 for 100

83-1SP	$.28	83-22SP	.48	UG 27/U	.60
83-1J	.80	83-2J	1.50	UG 59/U	.60
83-1T	1.12	UG 13/U	.60	UG 61/U	.60
83-1F	1.12	UG 21/U	.60	UG 85/U	.60
83-22AP	.85	UG 22/U	.60	UG 87/U	.50
83-22J	.85	UG 24/U	.60	UG 167/U	2.00
83-22R	.48	UG 25/U	.60	UG 281/U	.60

CARBON RESISTOR ASSORTMENT

Color coded, insulated....................100 only $1.19

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262 or 9280, small gray case. Ratio 1:1:1. hypersil core $1.50
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms $1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.00
D166638 W.E. Permalloy core. Semi-toridal windings $1.25
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
300 KVA GE K 2468B, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out (250 KVA @ ¼ microsecond) $13.75
800 KVA G.E K2731., 28000 Volt pk. output; Bifilar; one-microsecond pulse width $14.50

TUBE SPECIAL—New—Guaranteed

2J26	$8.29	6AL5	$.72	6X5 GT	$.57
2X2/879	.44	6SJ7	.59	6Y6	.84
3C24	.49	6SN7 GT	.65	872A	1.88
6AC7	.79	6SQ7 GT	.47	C5B	6.98
6AK5	.84	6V6 GT	.59		

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay.....................85¢
T 114—Approx. 2.2 micro sec. delay.....................85¢
T 115—Similar to T 114 with tap brought out............85¢

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec.

- 115 V. 60 Cycle
- Adj. 50-70 Seconds
- 2½ seconds recycling time. spring return
- Micro Switch Contact, 10A
- Holds On as long as power is applied. Fully Cased

ONLY.......................................$6.50

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	4-141¾W	$.22	9-141¾W	$.47
2-140¾W	.10	4-141Y	.22	9-141Y	.47
3-140¾W	.13	5-141	.20	10-141¾W	.52
4-140	.13	5-141Y	.27	12-141	.44
8-140	.23	5-141¾W	.27	17-141Y	.87
8-140W	.33	6-141	.23	3-142	.15
10-140¾W	.40	7-141	.27	5-142	.24
13-140	.37	7-141¾W	.37	6-142	.28
3-141¾W	.17	7-141Y	.37	9-142	.41
3-141W	.17	8-141	.30	10-142¾W	.64
3-141Y	.17	8-141¾W	.42	2-150	.28
4-141W	.22			4-150	.52

7 Terminal Bakelite Tie Point..................35 for $1.00

VERNIER DIAL

(From BC-221)

2 ⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock ....85¢

HARDWARE ASSORTMENT (mostly brass — screws, nuts, washers, rivets) ....3 lbs., $1.00

Gear Assortment..............................$6.50
Experimenters dream, 100 pieces, many stainless steel.

FUSES

3AG			3AG		
⅛ Amp	$4.00 per	100	2 Amp	$2.50 per 100	
¼	4.00	100	3	2.50	
¾	4.00	100	4	2.75	
1	2.50	100	10	3.00	
1½	2.50	100	15	3.00	

Fuse Holder—Littlefuse for 4AG fuse...............18¢

Minimum Orders $3 ...... All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

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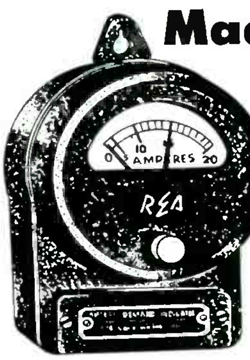
A ONCE-IN-A-LIFETIME SURPLUS SALE

EXCLUSIVE! AMPERE DEMAND INDICATOR

Made by STEWART-WARNER, ONLY $2.49!



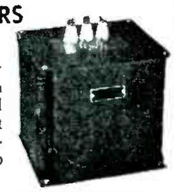
SPECIAL PRICE IS 5-10 TIMES LOWER THAN REPLACEMENT COST!

THERMALLY OPERATED — 2 WIRE — 20 AMP RANGE — 600 V OR LESS

CUT current costs, INCREASE equipment life with 20 amp range Stewart-Warner Model 748A (Type RD) demand indicators for 600 volts or less. These 2-wire instruments are a "must" for Electrical Contractors, production lines, labs, colleges, electric sub stations. Accurately check transformer loading, load distribution! Determine proper current distribution! Meter consumes only 6 watts at full indication. Red pointer indicates demand at time of reading; black pointer shows maximum registered demand; front panel knob zeros pointers. Weather-proof gray crackle-finish metal case 4½" W, 5½" H, 2¾" D. Provision for wall mounting. Weight 1½ lbs. Brand NEW! Individually packed in original carton, with complete technical data. Only $2.49 each!

New! Not War Surplus! Heavy Duty POWER TRANSFORMERS

SEE THE LIST PRICE ON EACH!



Brand new power transformers in battleship gray enamelled potted metal cases, with porcelain high voltage terminals. Conservatively rated — will handle much larger than stated capacities. Mount upright or inverted. Excellent for ham rig, experimenters, broadcast stations. Available in two ranges, both with input of 115/1/60:

2650-0-2650 AC at 550 ma (ICAS) — size 7¾x7¾x8½". Weight 50 lbs. LIST Price $150. OUR PRICE ONLY $29.95

1750-0-1750 AC at 550 ma (ICAS) — size 6¾x8x7½". Weight 37 lbs. LIST Price $100. OUR PRICE ONLY $18.95

NOTE: add 50c ea. for wooden crating of above transformers.

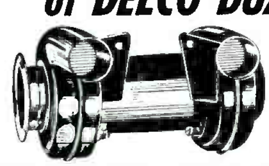
$48 PRICE CUT ON RCA VOLTOHMYST! NOW $39.50

WAS $87.50

ONLY A LIMITED QUANTITY REMAINS of this sensational battery-operated V.T.V.M. at a price LESS THAN HALF of RCA's original net price! WV-65A is a fully self-contained portable vacuum tube voltmeter-ammeter-ohmmeter requiring no external power. Among its many features are: zero grid current, controlled inverse feedback, 1 meg shielded signal-tracing probe, polarity reversing switch. Has scores of TV, FM, shop, lab and field uses. RANGES: 0-3/10/30/100/300/1000 volts DC, constant input resistance 11 meg all ranges; 0-10/30/100/300/1000 volts AC at 1000 ohms/volt; 0-1000/10,000/100,000/1 meg/10 megs/1000 megs; 0-3/10/30/100/300 milliamps DC; 0-10 amps DC. Gray metal case 9½ x 6½ x 5½". **Only $39.50. Battery kit $2.52 extra.**

BRAND NEW! MADE BY GENERAL MOTORS!

HUGE SURPLUS SALE of DELCO DUAL BLOWERS!



ONLY

$14.85 Ea. lots of 1-9
$13.95 Ea. lots of 10-49
$12.75 Ea. lots of 50-99

New and in original shipping cartons! Way, way, way below regular price! Built by Delco division of General Motors. Million household, commercial and marine uses: photo darkrooms, cooling xmtr tubes, furnace draft boosting, machinery suction unit, humidifiers, hair dryers, kitchen ventilation, etc. No brushes to cause radio interference. Quiet, continuous duty 115 V 60 cycle Delco shaded-pole motor with skewed squirrel-cage type rotor. Two multi-blade squirrel-cage type fans and pressed-steel welded 2-piece snail type housing. Die cast alloy case and housings. Operates at 2800 rpm; 2750 fpm velocity, 120 cfm free volume air delivery. 62 watts input. Black lacquer finish. Weight 11 lbs. Over-all 10 21/32" by 5 27/32" by 6 7/32", with universal mounting brackets. It's the blower-buy of all time!

MANUFACTURERS! EXPORTERS!

Write for discount on lots exceeding 100 blowers.

1¢ TUBE SALE

minimum order $2

BUY ONE TUBE at our regular low price . . . get ANOTHER FOR ONLY 1c. EXTRA!

THE RADIO SHACK again honors the forgotten penny and the penny-wise gentleman who uses tubes! LIMIT is two tubes per type. Penny-sale ENDS March 24. All tubes brand new, standard makes. Tubes will be shipped by Railway Express only, for your protection. Inspected for mechanical breakage by us before shipping.

TYPE	EACH	SALE PRICE
1A3	.39	2 for .40
2X2	.40	2 for .41
2E22	1.50	2 for 1.51
3A4	.39	2 for .40
3FP7	2.25	2 for 2.25
6AK6	.89	2 for .90
7C4	.35	2 for .36
7E5	.75	2 for .76
12A6	.23	2 for .24
125F7	.69	2 for .70
15R	.98	2 for .99
227A	3.50	2 for 3.51
304TH	4.50	2 for 4.51
724B	1.70	2 for 1.71
805	4.25	2 for 4.26
814	2.95	2 for 2.96
815	1.95	2 for 1.96
826	.49	2 for .50
830B	3.50	2 for 3.51

TYPE	EACH	SALE PRICE
838	2.95	2 for 2.96
872A	1.15	2 for 1.16
957	.25	2 for .26
1616	.60	2 for .61
1626	.37	2 for .38
9001	.40	2 for .41
9004	.30	2 for .31
9006	.42	2 for .43
FG27A	5.45	2 for 5.46
RK72	.75	2 for .76
VR150	.60	2 for .61

MORE PENNY BUYS!

TRANSFORMER — 115VAC 60 cy. Sec. 9V at 1A, Order No. R-0132. Each 75c . . . . . **2 for 76c**

2-GANG SELECTOR SWITCH — SP/7POS, 2PDT. Each 25c . . . . . **2 for 26c**

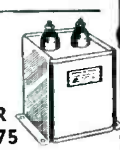
10 MFD 600V OIL CONDENSER — 2 x 5 mfd, rect., Tobe. Each 75c . . . . . **2 for $1.11**

HURRY!

EVEREADY 600 AMP STORAGE BATTERY REG. $9.50, ONLY $1.95

Eveready T-1600 "Aircell", 1.25 volts at 600 amp-hour capacity at maximum drain. Perfect for telephone, railroad, industrial and other applications where current drain is of utmost importance. Bakelite cased. Shipped dry. 10" x 5" x 6½". BRAND NEW, individually packed. Order No. R-734A. **Only $1.95 each, 3 for $5.50**

REDUCED!



650 MFD AT 80 VDC RECTIFIER CONDENSER REG. $6.50, ONLY $1.75

Ideal for heavy duty low-voltage supplies! C.D. type 48952. Isolantite pillar terminals, base mounted through angle brackets. 6 x 6 x 3". Unused! Order No. R-379. **Only $1.75.**

ORDERS FILLED PROMPTLY

TERMS - cash or 20% deposit, balance C.O.D.

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Field Strength-Frequency Meter. 1-95BM 100 to 155 Mc. Cavity Type-Battery Operated. Now being used by CAA and Airlines. Complete in case—New.....**$21.50**

Wave Meter-BC906D. 160 to 220 Mc. Absorption type consisting of coaxial wave meter, diode rectifier, amplifier and individual calibration charts. Complete in black crackle case with antenna....**$29.50**

Lavoie Frequency Meter. 375 to 725 Mc. Model 105SM. 0.1% accuracy. Covers new citizen band, Aircraft, Amateur, New Television band, Government bands. Precision Equipment. Individually calibrated. Complete with instruction manual and cable. New, $59.50. Case scratched but otherwise perfect **$49.50**

Resonance Cavity "S" Band Wavemeter Manf. by Western Electric. Type B435, 490 Transmission type ca ity. Coaxial input and output loops. Rotary calibrated indicator and calibration charts....**$49.95**

MAGNETRONS

Magnetron—2J32, 2780 to 2820 Mc. Fil. Voltage—6.3V at 1.5 Amps. Pulse Voltage—18-22 Kilovolts. Average Ma. 12.5-25. Average Power Out—285 Watts. Peak Power Out—285 KW. Band Width—2.5 Mc. Duty Cycle 1000/1. New JAN boxed Crystal Diodes..............**$19.95**

CRYSTAL DIODES

1N21..**$.75** 1N23A..**$1.25** 1N22..**$1.00**
New—Jan Inspected—Boxed

BAND PASS FILTER
1000 CPS

Band Pass at 3 db: ± 150 cycles. Center Frequency adjustable: ± 10 cycles. Input 23,000 — Output 225,000—Triple allow. Shielded. Mfd. by UTC. Size 1½x1½x2" each **$3.95**

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10 Hy. 75 Ma.-260 Ohms Herm. sealed in 100 lots	$ .47
single unit	.70
4/20 Hy. 100 Ma.-120 Ohms Herm. sealed	1.10
10 Hy. 100 Ma.-260 Ohms	1.10
5 Hy. 130 Ma.-100 Ohms Herm. sealed	1.20
10/14 Hy.-145-200 Ma. 100 Ohms	1.95
5 Hy. 200 Ma.-70 Ohm	1.95
3-3 Hy. 200 Ma.-60 Ohms Herm. sealed	2.50
16 Hy.-450 Ma.-112 Ohms. Herm. sealed	9.95
8 Hy.-500 Ma. 80 Ohms	8.50
5/20 Hy. 500 Ma. 80 Ohms	8.50
8 Hy. 700 Ma. 60 Ohms	12.75
5/20 Hy. 700 Ma. 60 Ohms	12.75
4 Hy. 900 Ma. 28 Ohms. Herm. sealed	15.50

OIL CAPACITORS

2 MFD 600 volts	$ .35
4 MFD 600 volts	.60
6 MFD 600 volts	.80
7 MFD 600 volts	.80
10 MFD 600 volts	1.20
2 MFD 1000 volts	.80
4 MFD 1000 volts	1.10
10 MFD 1000 volts	2.25
1 MFD 3600 volts	3.50
.25 MFD 4000 volts	3.50
1 MFD 5000 volts	4.95
2 MFD 5500 volts	6.95
1 MFD 7500 volts	5.95
.02 MFD 20,000 volts	7.95

All made by prominent manufacturers.

RELAYS-CONTACTORS

Type	Coil Contacts	Price
CH Contactor	115V AC 4PST-30 Amps	$7.95
West gl. encl	115V AC 4PST-20 Amps	$7.50
Allied Bo.	6 V DC DPDT-10 Amps	$1.00
G. E. PJC Adj. overload	4-12A ac/dc	$12.50
G. E. PJC Adj. overload	2-8A ac/dc	$12.50
G. E. PJC Adj. overload	0.5-1.5A ac/dc	$12.50
AB Solinoid	115V AC DPST 20 Amps	$3.95

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GRID DIP OSCILLATOR. See August Issue Electronics Pg. 176, "New Products". An all around Laboratory instrument for measurement of resonant frequency, Circuits Q, RF, voltages, antenna and many other purposes. 3 MC. to 250 Mc. or other extended ranges. Compact and complete in kit form. Instruction book and application book sent free on request. Complete Kit..........**$21.50**

BIRD WATTMETER. 5 to 500 watts of R.F. Measures MF, HF, VHF and UHF. Write for full description. Only one used unit left........**$75.00 each**

DAVEN ATTENUATION BOX Model HA-740 110 DB attenuation in 1 Db steps 600/600 ohm input and output. New. Three left.........**$59.00 each**

TELRAD FREQUENCY STANDARD. Self contained, dual 100/1000 Kc XTL, Multivibrator and Harmonic Amp. Calibrate with WWV or Broadcast for high accuracy. 100 to 45,000 KC check points every 100/1000 KC. **Now** **$29.50**

MULTI CONDUCTOR CABLE
MILLION FEET AVAILABLE

9 CONDUCTOR—#20 str. plastic, 2 vinyl jacket. Shield ½" G.E. Reel Lengths **.09/ft. 100 ft. .14/ft.**

10 CONDUCTOR—#20 Solid, Plastic vinyl jacket. ½" dia. On steel reels. Reel lengths **.08/ft.** 100 ft. **.10/ft.**

28 CONDUCTOR—#20 stranded plastic vinyl jacket ⅞" dia. Reel lengths. **20/ft. 100 ft. .24/ft.**

4 CONDUCTOR. Each cond. ¼" dia. Double plastic Ins. Heavy Duty Power Cable—Extremely flexible. 1-¼" Dia. Reel lengths Approximately 250 ft. **.26/ft.**

3 CONDUCTOR—#18. Shield Jacket. **.05/ft.**

2 CONDUCTOR—#20 Shield Jacket. **.04/ft.**

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Underwriters Laboratory Approved Wire—Ideal for Television—8 colors—Plastic Insulation—Solid #22 Voltage Insulation **3000 Volts**

5000' reel lengths—$5.75 per 1000'
1000' lengths ....**$6.00 per M**

#20 HV str. White plastic...**$4.95/M**
#20 str. white, red and green plastic **$3.95/M**

3/16 "magnet DCCrect. Reel lengths **.35/lb.**

#30 SSE magnet. Reel lengths **.60/lb.**

MICA CONDENSERS

Largest stock in the country at 90% Discount.

Types—Fil, XR, etc.

Cap.	Wk.Vo.	Pr	Cap.	Wk.Vo.	Pr.
750	5,000	.75	200	3,000	.70
560	5,000	.75	100	3,000	.55
375	5,000	.75	90	3,000	.50
.001	4,500	1.10	50	3,000	.50
.002	3,500	.95	.025	2,500	1.10
.003	3,000	.95	.006	2,500	.75
700	3,000	.60	30	2,000	.40
500	3,000	.70	.015	1,500	.75
400	3,000	.55	.12	500	1.15

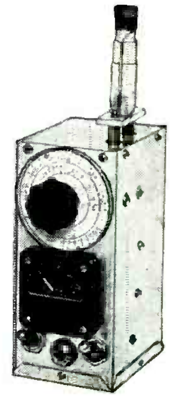
Type H-A2

Cap.	Wk.Vo.	Pr.	Cap.	Wk.Vo.	Pr.
.002	3500#9	.60	350	2500#9	.35
.005	2500#4	.45	.002	1000#4	.25
400	2500#4	.30			

Also complete stock of ceramicons-2.2 to 300 MMFD Button capacitors 40 to 2400 MMFD—500 to 1250 Volts

VOLTAGE REGULATOR

Manf. guaranteed 1% regulation. Primary 92-138V 57-63 cycles. 1 Phase Secondary 115V 1% regulation 96 PF Navy Gray Cabinet. Shipping wt. 250 lb. Size 36x20x12. Limited quantity..........**$97.50**



STEPDOWN TRANSFORMERS

440 to 220 to 110-5 KVA. Complete encased G.E. Explo. Proof. Can be used as 4/1 or 2/ratio step-up or down, 60 cps. Size 20x11x10. Weight 225 lbs. Navy gray finish, integral junction box and mounting frame **$75.00**

440 to 220 to 110-2 KVA. Same specifications as above except 2 KVA. Size 12x11x10. Wt. 93 lbs. Only 5 units left..**$35.50**

BROADCAST MODULATION TRANSFORMER

R.C.A. 833'As to pair 833'As, as used in R.C.A. Commercial 1 K.W. Broadcast Transmitters. Transformer being used in U.S. Broadcast stations. New fully guaranteed. Primary 15,000 ohms Secondary 5,030 ohms. .86 KVA Audio. Size 12x10x13. Wt—uncrated 153 lbs. Limited Qty. available **$75.00**

POWER TRANSFORMER

440/220 3 Phase. A husky brute for induction heating. Primary 440/220 3 phase. Secondary. Each phase 1365V at .67 Amps. Manf. by Raytheon. This transformer and a pair of 304's will give 2.5 KW output at a total cost of less than $50.00. Special—while they last—Only.....**$42.50**

POWER TRANSFORMER

440 or 220 1 phase Filament transformer 440/220 Pri. Secondary 5.0 at 30 Amp 1500 volt insulation. Herm. Sealed Navy Specs. **$7.95**

Plate Transformer. 200/220/240 Pri. Secondary 1400V Ct. at 350 ma. Gray Hermetically sealed **$6.70**

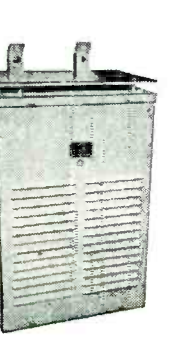
Filament Transformer 200/220/240 Pri. Secondary 6.3V at 2.7 Aps. Matched unit for above **$2.45**

POWER TRANSFORMERS
115V A.C. 60 cycles Primary

110 volts A.C. 60 cycles Primary
3700-0-3700 at 500 Ma. (Delivers 3000 volts D.C. full load) **$59.00**
2500-0-2500 at 700 Ma. (Delivers 2000 volts D.C. full load) **$45.00**
2500-0-2500 at 500 Ma. (Delivers 2000 volts D.C. full load) **$39.50**
1800-0-1800 at 350 Ma. (Delivers 1500 volts D.C. full load) **$19.50**
1500-0-1500 at 350 Ma. (Delivers 1250 volts D.C. full load) **$17.50**
575-0-575 at 220 Ma. (Delivers 500 volts D.C. full load) **$7.95**

The above transformers not Surplus but made by a large transformer manufacturer especially for ELDICO

740-0-740 at 1.2 Amps..............**$17.50**
430-0-430 at 325 Ma. **$4.95**
400-0-400 at 300 Ma. and filaments **$5.95**

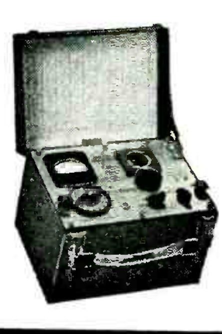


SCOPE & TELEVISION TRANSFORMERS
115 Volts A.C. Primary

4500 Volts at 4.5 Ma. 5 V at 3 Amps.	$7.95
3750 Volts at 2 Ma.	4.50
1100 Volts at 10 Ma. & Filaments	2.75

FILAMENT TRANSFORMERS
115V A.C. 60 cycles Primary

36 Volts at 10 Amps	5.95
24 Volts at 10 Amps	4.95
12.6 Volts at 7 Amps	3.95
11.5 Volts at 11.5 Amps. (10 Volts at 20 Amps.)	4.95
10 Volts at 6 Amps	3.50
10 Volts at 6 Amps. 6.3V at 11A. 5.0V at 3A	5.50
6.3 Volts at 10 Amps	2.95
5 Volts at 10 Amps. 15KV Ins (For 872A's)	$5.75
2.5 Volts at 10 Amps. 10KV Ins. (For 866A's)	3.75



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SPECIAL METERS

SENSITROL RELAY. 0-50 microampere sensitivity, Weston 705 type 5, Single fixed contact with 110 volt A.C. solenoid reset and adjustable index to indicate operating point. Has two scales, one for setting index, the other for reading pointer position. Contact closes on decreasing value and has a capacity of 5 Watts at 110 volts.
List Price $68.50 Your Cost ONLY $27.50

FREQUENCY METER. JBT 30-F, Dual Range covers Co. type MF-11 Frahm vibrating reed type, 11 reeds, 100 to 150 volt operation, 3½" round flush bakelite case $7.50

FREQUENCY METER. JBT 30-F, Dual Range covers frequency ranges from 48-52 cycles and 58-62 cycles: Dual element, vibrating reed type 115 volt, 3½" rd flush metal case $5.95

DECIBEL METER. Weston 301 type 61, minus 10 to plus 6 DB, 3½" rd fl bake case, 6 MW 600 ohms. High speed type, with 3 external wire wound multipliers to extend range $11.50

AIRCRAFT METERS

All aircraft meters listed are 2½" type with black scales unless noted otherwise.
0-30 Volt, Westinghouse AX-33 ....$4.50
0-30 Ampere, Westinghouse AX (USN C-30) ...$5.00
0-240 Ampere, Westinghouse AX 33 W/ext shunt $6.50
0-300 Ampere, Westinghouse, E-1, 3½" $7.50
30 Volt 60 Amp. G.E. W/ext shunt, AN Conn. type $5.50
30 Volt 120 Amp. General Electric W/ext shunt, AN Conn. type $5.50
30 Volt 240 Amp. Westinghouse AX-33 W/ext shunt $7.50

A.C. VOLTMETERS

0-15 G.E. AO-22, 3" R-B bl sc. MR35BO15ACVV $3.00
0-40 W.H. NA-33, 2" R-B bl sc, Cal for 60 cycle $3.95
0-40 W.H. NA-33, 2" R-B 400 cycles....$3.50
0-75 Weston 517, 2" R-M ring mtd....$2.95
0-150 Weston 517, 2" R-B, MR24W150ACVV..$4.50
0-150 G.E. AO-25, 3" S-B....$5.50
0-150 Triplett 331-JP, 3" R-B....$4.50
0-150 Triplett 331-JP, 3" R-B W/resistor for 300 volts $5.50
0-300 Triplett 232-C, 2" R-M....$6.00

A.C. AMMETERS

0-10 G.E. AO-25, 3" S-B, expanded between 4 & 7 Amps. Scale calibrated 0-100 Amps for Direct Reading divide scale reading by 10....$4.95
0-30 Triplett 331-JP, 3" R-B....$4.00
0-60/120 Burl 32XC, 3" R-B W/ext Transformer $7.50
0-150 G.E. AO-22, 3" R-B, 5 Amp mvt, W/ext trans. $7.50

R.F. AMMETERS

0-500 M.A. R.F. Weston 425, 3" R-B W/ext thermocouple $12.50
0-1 G.E. DW-44, 2" R-B bl sc....$2.95
0-1 G.E. DO-44, 3" R-B....$11.00
0-1 Weston 425, 3" R-B....$11.00
0-1.5 Weston 425, 3" R-B....$8.25
0-2 Simpson 135, 2" R-B....$3.50
0-2.5 Simpson 35, 3" R-B....$4.95
0-2.5 Weston 425, 3" R-B....$8.50
0-3 Weston 507, 2" R-B bl sc....$3.95
0-3 Weston 425, 3" R-B W/Ext couple....$9.50
0-5 G.E. DO-44, 3" R-B....$7.50
0-8 Weston 424, 3" R-B....$10.50
0-30 Triplett 0347-A, 3" S-B W/ext couple....$8.00

D.C. MICROAMMETERS

0-100, Weston 506, 2" R-M, Bl. Sc. cal 300 Volts & 30 M.A....$3.95
0-200, W.H. NX-35, 3" R-B MR35W200DCUA $8.50
0-200, Superior 4" x 4⅝" F-B....$7.50
0-400, Triumph 4" x 4⅝" F-B....$5.50
0-500, DeJur Amsco 210, 2" R-B....$3.00

D.C. MILLIAMMETERS

0-1 G.E. DO-41, 3" R-B sc cal 0-50 M.A....$4.50
0-1 W.H. NX-35, 3" R-B MR35W001DCMA....$7.50
0-2 W.H. NX-35, 3" R-B MR35W002DCMA....$5.50
0-5 Westinghouse RX-33, 2" S-B red mark for 3 Volts $3.50
5-0-5 Western Electric 3" R-B, concentric style $3.00
0-15 Simpson 26, 3" R-B MR25W015DCMA...$4.95
0-20 W.H. NX-35, 3" R-B MR350020DCMA....$4.95
0-50 G.E. DO-41, 3" R-B....$4.00
0-80 G.E. DO-41, 3" R-B....$3.75
0-150 Gruen 508, 2" R-B....$3.00
0-200 Gruen GW-511, 2" R-B MR25W200DCMA $3.00
0-200 G.E. DO-41, 3" R-B....$4.50
0-200 Simpson 26, 3" R-B MR35W200DCMA...$4.95
300-0-300 G.E. DO-40, 3" R-B, ring mtd non-flanged case $3.00
0-500 W.H. NX-33, 2" R-B....$3.95
0-500 DeJur 312, 3" S-B....$4.50

PORTABLE TACHOMETERS

0-20,000 RPM Range Jaeger #43 A-6 Chronometric type $24.50
300-1200, 1000-4000, 3000-12000 RPM. Jones Motorola Co., Multiple Range, Continuous Indicating $24.50
300-1500, 1000-5000, 3000-15000 RPM, Jones Motorola Co., Multiple Range, Continuous Indicating $25.50

CURRENT TRANSFORMER, Weston 461-4 5 Amp Secondary. Primary 50/100/200/250/500/1000 Amps., 15 V. A. Capacity.
List Price $98.00 Your Cost Only $35.00

D.C. VOLTMETERS

0-5 W.H. NX-33, 3" R-B 200 r/v....$3.50
0-10 Sun 2AP458, 2" R-B 100 r/v....$2.50
0-30 DeJur Amsco 210, 2" R-B....$2.50
0-40 Sun 3AP597, 3" R-B, 100 r/v....$4.95
0-150 Weston 301, 3" R-B surf mtd 200 r-v....$4.50

D.C. KILOVOLTMETERS

0-1.5 W.H. NX-35, 3" R-B W ext resistor....$7.50
0-3 Weston 301, 3" S-B W ext resistor....$10.50
0-3.5 W.H. NX-35, 3" R-B 1 MA W/ext resistor $9.00
0-5 W.H. NX-35, 3" R-B, 1 MA mvt. W/ext resistor $11.00
0-7.5 Weston 301, 3" S-B, 1 MA mvt W/ext resistor $14.50
0-15 W.H. NX-35, 3" R-B 1 MA mvt, less resistor $4.95
0-20 G.E. DO-41, 3" R-B, 1 MA mvt W/ext resistor $19.50
0-35 W.H. NX-35, 3" R-B, 1 MA mvt less resistor $4.95

Weston 433 PORTABLE A.C. VOLTMETER

FREQUENCY RANGE 25 to 2400 CYCLES 0-150 Volts, Weston 433, Accuracy within ¾ of 1% on A.C. from 25 to 1000 Cycles and within 1¼% up to 2400 Cycles. Knife edge pointer; hand calibrated mirror scale; shielded moving iron vane movement; Resistance approximately 2800 Ohms. Scale length 4.04", in case 5" x 6" x 3½". Similar to illustration.
Your Cost Only $35.00

SOCKET SELECTOR SET WESTON 666 TYPE 1C

Designed for purpose of taking readings of currents, voltages and resistance and other electrical measurements in a vacuum tube circuit. It can be used with many Western Analyzers or other make multirange volt-ohm-milliammeters. To test a tube circuit the tube is plugged into the appropriate adapter and the test plug inserted in the tube socket. This brings all currents and voltages out through a cable where they may be measured with an analyzer.

Complete with Tube Base Data Connections and Chart, 15 Adapters, pin leads and test block.
List Price $30.00....**Your Cost $9.50**

COMBINATION OFFER

150 VOLT A.C. METER	30 AMP A.C. METER
Triplett 331-JP, 3½" Rd flush case	Triplett 331-JP, 3½" Rd flush case

Both meters for $7.95

CURRENT TRANSFORMER, Weston 461-4 5 Amp Secondary. Primary 50/100/200/250/500/1000 Amps., 15 V. A. Capacity.
List Price $98.00 Your Cost Only $35.00

POTENTIAL TRANSFORMER, Weston 311 Potential ratio of 1500 & 750 to 150 volts. 15 VA Capacity.
List Price $247.50 Your Cost Only $90.00

GASOLINE HEATER—MOTOROLA MODEL GN-3-24

An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volts 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.

Approximately 12" long x 9⅛" high x 9½" wide. Complete with technical manual and parts list. Made by Galvin (Motorola) Mfg. Co.
Your Cost Only $22.50

MINIATURE MILLIAMMETERS

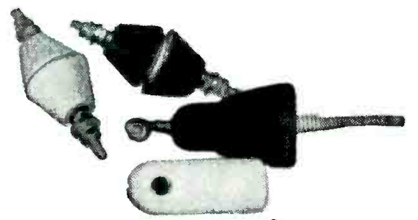
BULOVA WATCH CO., type G-1, 1.25 M.A. 500 M.V. movement, 1 ¾" square flush bakelite case, 1 7/16" barrel diameter, 1 3/16" overall depth behind flange $4.50

ROLLER-SMITH, Type G-1

1.25 MA., 500 M.V. movement, 1 ¾" Square flush Bakelite case, 1½" Barrel Diameter, 1 ⅝" overall @ $4.50

TERMINAL BOARDS

Barrier type, 6 pairs, 12 connections, General Electric # 16 EBINB 2 4½" L x 2" W x 1¾" H. Minimum order 10 pieces....@ $ .60



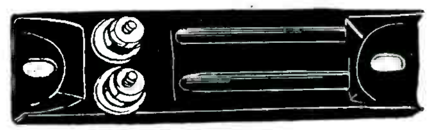
INSULATORS

32,200—Glazed, white, 2 cones, 1⅛" L x 1¾" base diameter with stud. Signal Corps # 3G584.
5,000—Same as above except brown.
31,800—Stand-off type, 3" long, glazed with mtg. Signal Corps # 3G582. (pigtail type not available ....**LOT PRICE $800.00**

INSULATORS

5,100—Stand off type, Navy stock & CBO-61174B. Over all height 3", brass base and cap, brown glazed porcelain, (some with hardware). Individually cartoned. ....**LOT PRICE $600.00**

STRIP HEATERS



50 Watt, 115 Volt, 250 Ohms, 1½" x ½" x 6" G.E. Catalog No. 2A301, Minimum order 10 pieces at 60¢ each.

PORTABLE TACHOMETER

Multiple Range Continuous Indicating

This unit is of the centrifugal mechanical type and is designed to show INSTANTANEOUSLY and CONTINUOUSLY the speed or change in speed of any revolving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M. and three in F.P.M. Low Range 300-1,200 (Each division equals 10 R.P.M.)
  Medium Range 1,000-4,000 (Each division equals 10 R.P.M.)
  High Range 3,000-12,000 (Each division equals 100 R.P.M.)
- Large open dial 4" diameter.
- Ruggedly constructed for heavy duty service.
- Ball bearing and oilless bearings—require no lubrication whatsoever.
- Readily portable—Fits neatly into hand.
- Gear shift for selecting low, med., high ranges.

Made by Jones Motorola, Stamford, Connecticut. Comes complete in blue velvet lined carrying case: 7⅛"-L x 4"H x 5"W. Your cost $24.50

PORTABLE (CHRONOMETRIC) TACHOMETER

Jaeger Watch Co. Model #43A-6

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for lineal speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators, turbines, centrifugals, fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequalled Readability 2" Open face dial—each division on large dial equals 10 R.P.M.; each division on small dial equals 1,000 R.P.M.
- Greatest Accuracy—meets Navy specifications—guaranteed to be within ½ of 1%.
- Results of test reading remain on dial until next test taken.
- Push button for automatic resetting.
- Complete with the following accessories.
  1—Large pointed rubber tip
  1—Large hollow rubber tip
  1—6" circumference Wheel tip
  1—Operating instructions
  1—Temperature Correction chart.

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. of shafts or the lineal speeds of surfaces without any accessories or timing of any kind. Each unit comes complete in a red velvet lined carrying case 5"x3½"x1½". Net List Price....$70.00
Your Cost $24.50

ALL ITEMS ARE BRAND NEW-SURPLUS-GUARANTEED UNLESS SPECIFIED OTHERWISE. All materials shipped from stock same day as order received, subject to prior sale. 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.

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NEW YORK, 13, N. Y.
Worth 4-8217

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EACH METER TESTED BEFORE SHIPMENT. CALIBRATIONS ARE FOR NON-MAGNETIC PANELS. IF METERS ARE FOR USE ON MAGNETIC PANELS SPECIFY PANEL THICKNESS AND WE WILL CALIBRATE ACCORDINGLY AT NO EXTRA CHARGE. All meters have white scale and are flush mounted unless specified otherwise.

S—Square	M—Metal	sc—scale
R—Round	r/x—Ohms per volt	surf—surface mounted
B—Bakelite	bl—Black	

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TEST EQUIPMENT

APR-1 or APR-4 RADAR SEARCH RECEIVER, 30 mc I. F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):

TN-19, range 1000 to 2000 mc..........$150.00

TN-54, range 2000 to 4000 mc..........$150.00

30 MC I. F. STRIP AND 110 VOLT 60 cps POWER SUPPLY, bandwidth 10 mc, complete, new (part of APR-5 Receiver) $65.00

TS-45A/APM-3 SIGNAL GENERATOR, 9200-9600 mc, 110 V, 60-800 cps

TS-155B/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cy., NEW

TS-155A/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cy., NEW

TS-56/AP SLOTTED LINE, slot length 16", tuned probe and meter $100.00

TS-35/AP X BAND SIGNAL GENERATOR, pulsed, calibrated power meter, frequency meter, 8700-9500 mc

TS-13/AP X BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cycles

TS-120/AP X BAND SIGNAL GENERATOR, pulsed, calibrated output

WAVEMETER CAVITY, 8500-9600 mc, Transmission Type $35.00

TPS-51PB/20 S BAND 20 db PAD..........$20.00

X BAND PICK-UP HORN.................$10.00

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case, NEW. UNITS I AND II are available separately or together as a test set.

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 $8.00

X BAND TEST LOAD TS-108/AP, 150 watts, accessories $35.00

250 WATT X BAND TEST LOAD, VSWR less than 1.15 between 7 and 10 KMC............$150.00

LAE-2 SIGNAL GENERATOR, 520-1400 mc, CW & pulse modulation, calibrated output 110 V, 60 cps, used, good condition

LAF-1 SIGNAL GENERATOR, 100-600 mc, CW & pulse modulation, calibrated output, good condition, 110 v, 60 cps operation

GENERAL RADIO SIGNAL GENERATOR MODEL 522, 250-1000 mc, good operating condition.

GENERAL RADIO POWER OUTPUT METER MODEL 583-A $45.00

GENERAL RADIO VACUUM TUBE VOLTMETER MODEL 726, good working order.........$120.00

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories & carrying case NEW...$175.00

GENERAL RADIO SIGNAL GENERATOR 605-B, good working order....................$300.00

GENERAL RADIO VACUUM TUBE BRIDGE, Model 561D $275.00

GENERAL RADIO FREQUENCY METER AND CALIBRATOR, Model 620AM, 300 kc to 300 mc $340.00

FEDERAL RADIO 605-CS, 9 kc to 50 mc SIGNAL GENERATOR (JAN version of G. R. 605 $350.00

HEWLETT-PACKARD AUDIO SIGNAL GENERATOR 205A $230.00

HEWLETT-PACKARD DISTORTION ANALYZER MODEL 325B $200.00

OBU-2 S BAND ECHO BOX..............$100.00

TBN-3EV THERMISTOR BRIDGE

S BAND THERMISTOR BRIDGE CU-60 ABU, Part of LZ Radar........................$60.00

RADIO RECEIVER BC-967T2, 18-160 mc, 3 bands, FM/AM, 110 V, 60 cps..................$200.00

RADIO RECEIVER BC-969B, 15-150 kc....$150.00

MEASUREMENTS 78E, 50-75 mc, calibrated output $100.00

FERRIS MODEL 22A SIGNAL GENERATOR, 85 kc to 25 mc. Output .2 microvolts to 1 volt, modulation variable, good working order $175.00

FERRIS MODEL 10B SIGNAL GENERATOR, 85 kc to 25 mc, calibrated output, good working order $100.00

FERRIS 18 C SIGNAL GENERATOR, 5-175 mc, calibrated output, good working order....$250.00

STANDARD SIGNAL GENERATOR MEASUREMENTS 65B, 100 kc to 30 mc, 1-2,000,000 microvolts, good working order................$400.00

LABORATORY RECTIFIER, SYLVANIA 541-A, 3500 volts at 2 amperes DC output.

LB-3 LIMIT BRIDGE, Industrial Products $60.00

P-4 SYNCHROSCOPES, made by Sylvania or Browning Lab. $175.00

SIGNAL GENERATOR 1-72-K, 100 kc to 32 mc, output not calibrated, 110 V, 60 cps........$35.00

AUDIO OSCILLATOR, HICKOK 198, RC tuned, 20-20000 cps $45.00

TEST SET TS-278/AP FOR AN/APS-13, synchronized, delayed pulse signal generator, 400-430 mc, calibrated waveguide below cutoff attenuator, synchronized marker generator, 115 V, 60 cps. NEW, COMPLETE.................$160.00

RCA SCOPE 5" MODEL 160B, NEW, export packed $125.00

CLOUGH BRENGLE RESISTANCE CAPACITY BRIDGE, model 230A, new..............$50.00

FIXED ATTENUATOR PADS, 20 db + 0 — 2 db, DC-1200 mc, 50 ohms, VSWP 1.3 or less, 2 watts average power $30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, calibrated 20-120 db. frequency range 300-2000 mc.........$32.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, similar to above except upper frequency limit is 3300 mc $32.00

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

CERAMIC FEED-THRU CAPACITORS:
300 mmf ....10 for $2.00
55 mmf ....10 for $1.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms $3.00

PULSE TRANSFORMER, UTAH 9280.......$1.50

PULSE TRANSFORMER, 132-AWP.........$6.00

PULSE TRANSFORMER, GE 68G, 828G-1...$5.00

TS-10/AP CALIBRATED DELAY FOR APN-1, $25.00

TS-203/AP CALIBRATED SELSYN........$10.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

U.H.F. RIGHT ANGLE ADAPTER 83-1AP 10 for $2.50; 1000 for $125.00

SD-3 SHIPBOARD RADAR, New and complete with test equipment...................$1050.00

SQ RADAR, used but in good working order, complete with antenna, control unit........$650.00

SN RADAR, used, good working order, complete $550.00

NYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032..............$3.00

PULSE FORMING NETWORK, 20 kv, .92 microsecond, 50 ohms, 800 p.p.s..............$40.00

ANCHOR SCREWS from AB26CR Mast Equipment ....$2.00 each

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TRANSMITTERS—PHONE

BC-610	HF	450 Watts
WE-34A	HF	350 Watts
BC-365	LF	350 Watts
BC-325	HF	400 W. CW
TDE	LF/HF	125 Watts
TCE	LF/HF	125 Watts
ET-8019	HF	300 W. CW

RECEIVER-TRANSMITTERS

Mobile, Field, Aircraft,, Marine

JT-350A	HF	75 Watts
SCR-508	VHF	35 Watts
SCR-528	VHF	35 Watts
SCR-608	VHF	35 Watts
SCR-628	VHF	35 Watts
SCR-298	VHF	35 Watts
TCS	HF	20/40 W.
AVT/R/A	MF	6/10 W.

JT-52 Ship - to - Shore radiotelephone, for 6 volts DC BRAND NEW & COMPLETE. Large stock available.

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Made for US NAVY, it incorporates built in pulse analyzer. Has a PRR of 50 to 8000 cps, 110 V.AC power supply (60-2600 cycles), Amplifier, Detector, 2 Antennas, Tubes, Cables, Spares, Manuals & Test Oscillator.

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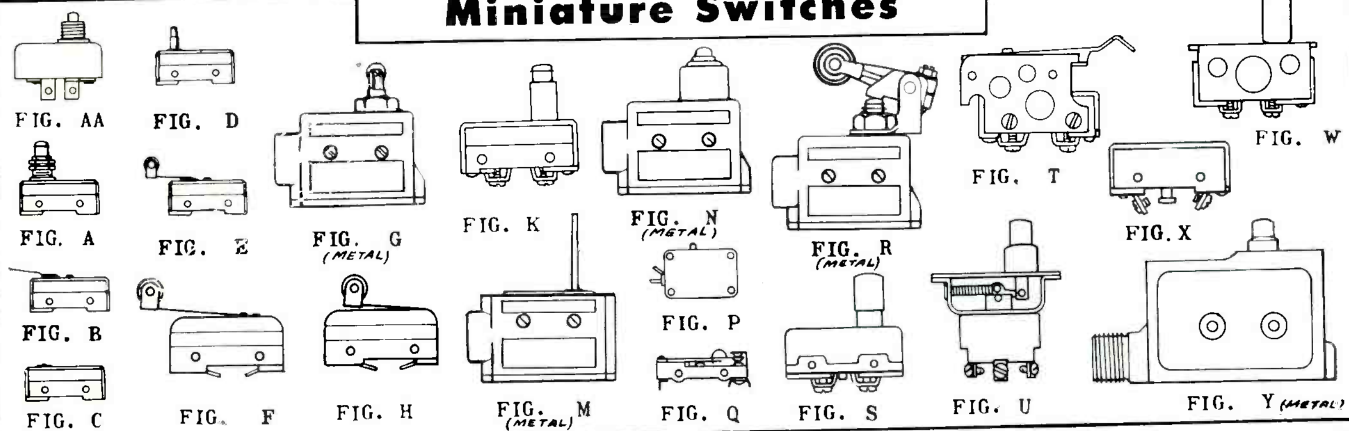
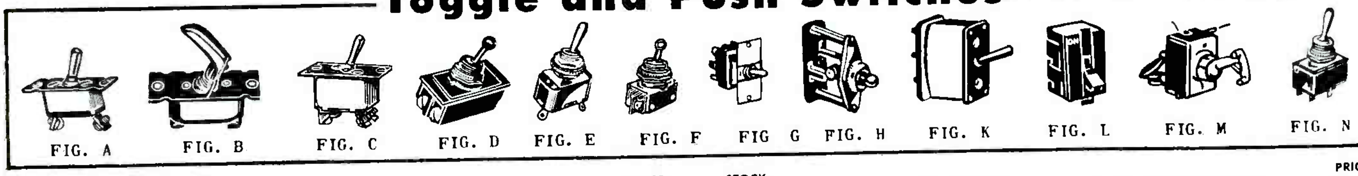
SAVE on Miniature and Toggle Switches at WELLS

Miniature Switches



STOCK NUMBER	MANUFACTURER	MFR. TYPE NO.	CONTACTS	ILLUSTRATION	PRICE EACH
305-10	Microswitch	WP3M5	N.C.	FIG. AA	$0.40
305-160	Microswitch	WP-5M3	N.C.	FIG. AA	.40
307-210	Microswitch	YP3A	N.O.	FIG. AA	.50
L309-75	Microswitch	YZ-RQ1	N.O.	FIG. A	.92
303-67	Microswitch	YZ7RA6	N.O.	FIG A	.71
PH-100	Acro	RO1P2T	N.O.	FIG. A	.71
301-46	MU-Switch	MLB-321	SPDT	FIG. B	.85
301-93	Microswitch	YZ-2YLTC1	SPDT	FIG. B	1.01
301-30	MU-Switch	RO2M	SPDT	FIG. B	.95
301-78	MU-Switch	Green Dot	SPDT	FIG. B	.75
303-79	Microswitch	BZ-RL32	SPDT	FIG. B	.75
303-85	MU-Switch	MLB329	SPDT	FIG. B	.67
305-154	Acro	XD4-5L	SPDT	FIG. B	.78
311-130	Acro	— —	SPOT	FIG. B	.70
PH-101	Microswitch	BRL18	SPDT	FIG. B	.78
PH-102	Microswitch	YZRL812	N.O.	FIG. B	.65
PH-103	MU-Switch	Blue Dot	SPDT	FIG. B	.68
PH-104	Microswitch	YZ3RLTC2	N.O.	FIG. B	.64
PH-105	Microswitch	YZR31	N.O.	FIG. C	.53
PH-106	Microswitch	R-R36	N.C.	FIG. C	.50
PH-107	Microswitch	G-R36	N.C.	FIG. C	.53
PH-108	Microswitch	WZ-2RT	N.C.	FIG. C	.50
305-161	Microswitch	YZ3R3	N.D.	FIG. C	.71
311-115	Microswitch	WZR31	N.C.	FIG. C	.71
311-123	Microswitch	WZ-7R	N.C.	FIG. C	.60
311-126	Acro	HRRC7.1A	N.C.	FIG. C	.50
311-125	Acro	HRR07.1A	N.O.	FIG. C	.53
311-121	Microswitch	WZ7RTC	N.C.	FIG. C	.50
311-128B	Microswitch	YZ	N.O.	FIG. C	.53
370-6	Microswitch	X757	N.C.	FIG. C	.45
PH-109	Microswitch	RRS13	N.C.	FIG. D	.45
PH-110	Microswitch	BRS36	SPDT	FIG. D	.53
PH-111	Microswitch	GRS	N.O.	FIG. D	.49
311-116	Microswitch	SWO186	N.C.	FIG. D	.63
303-49	Microswitch	YZ2YST	SPDT	FIG. D	.68
309-93	Microswitch	BRS36	SPDT	FIG. D	.68
370-17	MU-Switch	QRS	SPDT	FIG. D	.75
PH-112	MU-Switch	MBW	SPDT	FIG. E	.72
305-64	Microswitch	WZR12	N.C.	FIG. E	.65
311-25	MU-Switch	CUN24155	N.C.	FIG. E	.85
370-10	Acro	RO2M12T	N.O.	FIG. E	.70
303-32	Microswitch	YZ-3RW2T	N.O.	FIG. F	.65
306-10	Microswitch	BZE-2RQ9TM1	SPDT	FIG. G	2.48
309-101	Microswitch	BZ-2FW221	SPDT	FIG. H	.95
PH-113	Microswitch	RZBQT	SPDT	FIG. K	.58
L306-1010	Acro	RD7-8586	N.O.	FIG. K	.55
370-18	Acro	HRO71P2TSF1	N.O.	FIG. K	.60
370-19	Microswitch	YZRQ41	N.O.	FIG. K	.65
370-40	Cutler Hammer	— —	N.O.	FIG. K	.75
370-8	Microswitch	RN-11-HO3	SPDT	FIG. M	1.50
309-157	MU-Switch	— —	N.C.	FIG. N	1.15
370-15	MU-Switch	AHB203	SPDT	FIG. N	1.25
370-7	Microswitch	WZE-7RQTN	N.C.	FIG. N	1.35
305-11	Acro	2M031A	N.O.	FIG. P	.37
305-71	Acro	2MD41A	SPDT	FIG. P	.37
305-50	Microswitch	Open Type	SPDT	FIG. Q	.35
370-28	Microswitch	YZE-RQ22	N.O.	FIG. R	2.75
303-84	Acro	HR07-4PST	N.O.	FIG. S	.50
303-83	Microswitch	YZ-RQ4	N.O.	FIG. S	.50
PH-114	Microswitch	WZR-31	N.C.	FIG. T	.65
PH-115	Cutler Hammer	8905K564	DPDT	FIG. U	.65
PH-116	Microswitch	WZRQ41	N.O.	FIG. W	.60
PH-118	Microswitch	BZRQ41	SPDT	FIG. W	.60
311-128A	Microswitch	YZ-RTX1	N.O.	FIG. X	.90
PH-117	MU-Switch	Z	N.C.	FIG. Y	1.35

Toggle and Push Switches



STOCK NUMBER	FIG.	CONTACT ARRANGEMENT	MANUFACTURER & NUMBER	PRICE EACH
PH-500	A	SPDT	B1B	.35
PH-501	A	SPDT	AN3022-3B	.35
PH-502	A	SPST MOMENTARY	B10	.30
PH-503	A	SPDT CENTER OFF MOM EACH SIDE	B11	.32
PH-504	A	SPDT CENTER OFF	B14	.35
PH-505	A	SPDT MOMENTARY	B21	.30
PH-505	A	SPST	AN-3022-2B	.30
PH-506	A	SPDT CENTER OFF	AN-3022-1	.35
PH-507	A	SPDT CENTER OFF MOM EACH SIDE	AN-3022-7B	.32
PH-508	A	SPST MOMENTARY	AN-3022-8	.28
PH-513	A	SPDT CENTER OFF	CH AN-3022-1B	.38
PH-514	A	SPST	CH B-5 A	.35
LT-104	A	SPDT 1 SIDE MOMENTARY	CH 8905K568	.35
309-168	A	SPST	168553	.30
309-171	A	SPDT CENTER OFF MDM 1 SIDE	CH 8209K5	.35
370-1	A	SPST MOMENTARY	CH AN-3022-8B	.25
370-4	A	SPDT CENTER OFF	CH B-9A	.35
370-14	A	SPOT CENTER OFF 1 SIDE MOM.	CH B-7A	.30
370-25	A	SPST MOMENTARY	CH B-6B	.25
305-171	A	SPDT CENTER OFF MOM 1 SIDE	8209K5	.32
309-169	B	SPST MOMENTARY	CH B-19	.35
PH-509	C	DPST	AN-3023-2B	.45
PH-510	C	DPDT MOMENTARY	CH 8715K2	.50
PH-511	C	DPDT MOMENTARY	CH 8715K3	.50
PH-512	C	DPST CENTER OFF	CH 8720K1	.55
303-65	C	DPST	CH AN-3023-2	.45
305-174	C	DPDT CENTER OFF MOM 1 SIDE	AN-3023-5	.50
305-177	C	DPDT CENTER OFF MOM EACH SIDE	C-3	.50
305-176	C	DPDT CENTER OFF MDM EACH SIDE	AN-3023-7	.50
305-173	C	DPDT	8710K3	.55
305-175	C	DPDT CENTER OFF MOM EACH SIOE	3712K3	.50
305-179	C	DPDT CENTER OFF MOM EACH SIDE	8732-K2	.50
309-163	C	DPDT CENTER OFF MOMENTARY	CH C-11	.55
309-162	C	DPST	CH C-1	.45
309-164	C	DPST MOMENTARY	CH 8711K3	.40
370-31	C	DPDT	CH C-1B	.55
305-87	D	1 SIDE DPST MOM 1 SIDE SPST	AH & H	.95
305-111	E	SPST MOMENTARY	CH 8817K2	.28
305-153	E	SPDT CENTER OFF	CH AN-3021-1B	.35
LT-100	F	SPST	CH	.22
LT-101	F	SPST MOMENTARY	AH & H w/LEADS	.20
301-51	G	4PDT MOMENTARY	CH 8905K12	.75
305-140	H	DT NO MAKE EACH SIDE	OPEN FRAME	.25
309-161	K	SPST	CH 8781K3	1.95
305-76	L	DPST	AH & H OPEN FRAME	.75
311-77	L	DPST	AH & H	1.25
301-12	M	DPST	AH & H SPECIAL FOR HANDY	.40
LT-107	N	DPST	AH & H TALKIE	.25

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115 v., 60 cy. 1 phase input, output 0-15,000 v. d-c @ 500 ma. Write for detailed information.

ASD RADAR TRANSMITTER & MODULATOR

3 centimeter: complete with 725A magnetron. cavtiy. two 723A/B Klystrons, one RKR73, four 72's, one 715B, one 829B, two 724B's, two 6AC7's, one 1N23 crystal diode, high voltage supply, two cooling blowers, etc. Input: 115 v. 400 c. N-2 condition $39.50

Preamp assembly: includes plumbing (2) 723 A/B's, (2) 6AC7's, (2) 724B's, 1N23, etc ... **$17.50**

931A PHOTOMULTIPLIER TUBE, new R.C.A., original cartons. **$2.00 each, 10 for $15.00.**

TRANSTAT, 115/220 v. 50/60 c., 0-260 v. 2½ amp. cont., 5 amp. max. output. New. Original packing. **List $43.00. $17.50 each, 2 for $30.00.**

TUBES:

1B22	$4.25
1N23	.50
2J62	37.50
3B22	2.50
3C23	2.25
4B28	2.75
15E	1.25
127A	2.25
250TL	19.50
304TL	.95
316A	.35
388A	2.75
700A	9.75
701A	3.50
702A	2.75
703A	2.75
704A	1.00
706BY	12.50
706EY	12.50
707A	12.50
707B	7.00
708A	2.75
713A	.75
714AY	3.75
715A	7.50
715B	6.50
719A	9.50
721A	2.75
722A	7.50
723A/B	8.50
724B	2.50
725A	8.50
730A	10.50
750TL	45.00
829B	3.50
846	47.50
872A	1.75
C5B	7.75
C6A	8.25
C6J	4.75
FG81A	3.75
WE-203A	8.75
VT98 (Br)	12.50

Filament Transformer

HIGH VOLTAGE FILAMENT TRANSFORMERS: Amertran Type W.S. .050 KVA, 50/60 c., 1 phase; 35 KV test, 12 KV d-c operating; sec. 5 v c-t @ 10 amps. Has socket that takes 872A, 250T, 371, 5563 etc., rectifiers. Net Wt. 16 lbs. **$12.50 each, 2 for $22.50, 4 for $40.00.**

METER, 3" Roller-Smith, 1 ma. f.s., calibrated 0-4 KV d-c; and 4 Weston precision 1 meg. meter multipliers. **$3.75 each, 3 for $10.00.**

CAPACITOR, 4 mfd. 1000 wv d-c, new, original boxes. **$.60 each, 4 for $2.00.**

SELENIUM RECTIFIER, 6.5 v. a-c., FWCT, 2.2 v d-c @ 3 amps., new, original boxes. **$.75 each, 4 for $2.00.**

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1527 E. SEVENTH ST.
Los Angeles 21, Calif.

2 x 5 MFD. 400-600V. OIL CAPACITORS — 57¢ EACH

Famous make 2x5 mfd. oil capacitor, packed 24 to a carton weighing 42 lbs., offered at fraction of cost. New Glyptal sprayed units measuring 3 5/16 x 2 x 3 25/32 overall with 4 #13 mtg. holes spaced 3¾ x 1 7/16 on centers. Capacity tolerance +14 −6%, tested 1800VDC. Good at 600V up to 40° C, at 400V up to 72° C. Sample forwarded for $1.00 postpaid. Discounts for larger quantities.

WESTON LABORATORIES, Weston, Massachusetts

GRAIN OF WHEAT LAMPS

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

Mazda G.E. 323 3V. .19.A doz. **$1.50**

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE.... **$3.90**

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Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices. Shipping Weight 5 lbs. Other sizes and 220-110 in stock. **$1.95**

Kilowatt Demand Meter Totalizer containing heavy-duty TELECHRON B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs. 5 for $10.00 **$2.50**

RADAR MAGNETS .... $5.00 to $17.50
Write for Sizes and Weights.

RCA 930 PHOTO TUBE **$1.25**
5 for $5.00.

HOLTZER-CABOT MOTOR 110V A.C. 50 R.P.M. Inst. Revers. $17.50

SMALL 12V. DC 40 OHM RELAY..... 5 for $1.00
Sample 50¢

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ALLIANCE OR RUSSELL 110V AC MOTOR. $1.85; 3 for $5.00

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820 Volts CT at 775 MA. Pri. 110/220 Volts 60 Cycles. Wt. 36 lbs. Fully Cased..........$5.95

HIGH VOLTAGE VACUUM CONDENSERS

50 MMF 32 Kilovolts.................... 5.50 ea.

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MMF: 10, 47, 50, 60, 240, 750, 780, 1000, any type .... .06 ea.

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Steatite Insulation

15 MMF (HF 15)	.39
Dual 15 MMF (HF 15 D)	.69
250 MMF (MC 250 S)	.69
325 MMF	.79

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831AP-UG12U, UG-14U-831, R831SP....... .35 ea.

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for..............$1.90

Thermal Time Delay Relay. 15 to 30 seconds, plugs into 4 Prong Tube Socket Glass Enclosed. 250 V. .95 ea.

Mallory Vibropack Kit. 6 Volt Input. Output 300 Volts at 100 MA. Transformer & Vibrator. $5.95 for both

30 WATT WIRE WOUND RESISTORS

Ohms: 100-150-2500-3k-4k-4500-5k-5300-10k-15k-18k .... .15 ea. 8 for .99

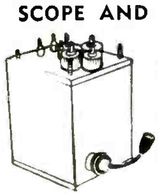
ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms	.25
50 Watt: 500 Ohms	.35
75 Watt: 40, 100, 150, 200 Ohms	.39
100 Watt: 20, 75, 120, 180 Ohms	.49
150 Watt: 50, 100 Ohms	.59

WIRE WOUND RESISTORS

5 Watt type AA, 20-25-50-200-470-2500-4000 ohms .... $.09 ea.
10 watt type AB, 25-40-84-400-470-1325-1000-2000-4000 ohms .... .15 ea.
20 watt type DG, 50-70-100-150-300-750-1000-1500-2500-2700-5000-7500-10000-16000-20000-30000 ohms .... .20 ea.

SCOPE AND FIL. TRANSFORMER



Pri. 115 volts, 60 cycles. Sec. 4400 volts RMS 4.5 MA., 5 volts CT 3 amps.. Fil. Ins. 15 KV RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon. 4½ x 5 x 5½ ....Only $4.95

5 for 22.50

SCOPE TRANSFORMERS

Pri 110V 60CY — Hermetically Sealed
2500 V @ 12MA $2.95
1050V @ 20MA, 20V 4.5A, 2.5V 5A 4.75

50 megohm 35 watt Resistor with mount....$1.49 each; 10 for $9.90
10 Meg 10 Watts.... .49; 2 Meg 5 Watt.......... .35

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps±1 DB. GREAT VALUE..........................ea. $2.75

MISCELLANEOUS BARGAINS

.02 400 volt dc tubulars	15 for .99
G.E. 2mfd 250 volts ac oil cond	6 for .99
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Heineman 15 amp 110 volt ac ckt breaker	.99
Heineman 25 amp 110 volt ac ckt breaker	1.19
Ceramicon .0005 mfd	20 for .99
.01 600 volt dc pigtail micas	10 for .99
.001 600 volt dc pigtail micas	15 for .99
.006 600 volt, pigtail micas	12 for .99
Butterfly cond. 2 to 11 mmf ball brngs	3 for .99
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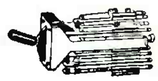
CRL 10,000 ohm potentiometers	6 for .99
.5 meg potentiometers	5 for .99
Trimm "Commercial" Headphones	3.75 ea.
CD 16 mfd 450 volt electrolytic (EB9160)	3 for .99
Hammarlund cond. 150 mmf .07 spacing	2 for .99
Variable ceramicon 20 to 125mmf type 823	5 for .99
Western Electric silver variable .5 to 2.5 mmf	8 for .99
G.E. weatherproof switch DPDT 20amp 120vac	.99 ea.
CRL steatite switch 3 section—2 pole 5 positions per section, model 2524 centralab	2 for .99



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4 Pole Single Throw..... 1.10
3 PDT. plus 6 PST...... 1.75

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250 ohms imp. Can be used for sound power Telephones, etc. Type HS 30............ .69 ea.
10 For 4.99
Hi Imp Transf. for above... .45

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Ideal for Bias, Filament, Isolation, Stepdown, etc. 2 isolated 110V Pri. Sec. 110V at 900 ma plus 6.3 @ 2 amps. Fully cased................Now $1.49 ea.

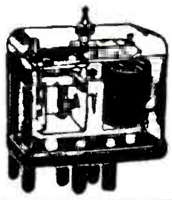
1% PRECISION RESISTOS W. W.

2000-2500-5000-8500 ohms .... ea. 25
50000-95000 ohms 750,000.................. ea. .29
1 meg .... ea. .69

GENERAL ELECTRIC SELENIUM RECTIFIER 32 Volts input, 28 Volts Output at 2 Amps. Full Wave 3.75

WESTINGHOUSE

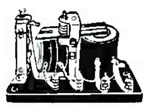
OVERCURRENT RELAY



Type MN Overcurrent Relay. Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $5.95

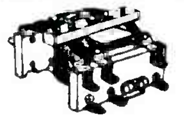
GENERAL ELECTRIC Type PBC Instantaneous Overcurrent Relay. Adjustable from 100 to 200 MA. Electrical and Manual Reset. 4 PDT. Reset 110 Volts 60 Cycles 7.95

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle



Breaks at 640 Milliamps but easily adjustable for other currents. Terrific value at only.......... 2.95

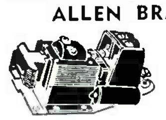
10 for 25.00



ADVANCE D.P.D.T. ANTENNA RELAY

110 V. 60 cycle coil Steatite Insulation. Only $1.95 each.

ALLEN BRADLEY SOLENOID



115 Volt 60 Cycle Coil D.P.S.T. 25 Amp Contacts. Model 702 3.75

3 for 9.90

FILAMENT TRANSFORMERS

110 V 60 CY Pri. Fully Cased.

5 Volt 15 Amp	$2.75
6.3 Volt 12 Amp	1.69
2.5 Volt 10 amp	3.49
2.5 Volt CT 21 Amp	4.75
5¼V CT 21A, 7.5V 6A, 7.5V 6A	4.95
5 Volt 4A, 6.3V, 3A	2.45
2.5V CT 20A, 2.5V CT 20A	6.95

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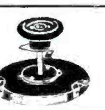
6 Henry 50 ma 300 ohms	3 for $0.99
6 Henry 80 ma 220 ohms	2 for .99
8 Henry 160 ma 140 ohms	.99
1.5 Henry 250 ma 72 ohms	.59
6 Henry 300 ma 65 ohms	3.75
Swing 1.6/12 Henry 1 Amp/100 ma 15 ohm	19.95

W. W. POWER RHEOSTATS

100 Ohms 100 Watt	.89
150 Ohms 50 Watt	.59
250 Ohms 50 Watt	.59
300 Ohms 50 Watt	.59
Dual 200 Ohms 50 Watt	.79



STANDARD BRAND RHEOSTATS

25 Ohms, 675 Watts Max. with Knob and Hardware.... 3.95
10 for 29.50

PANEL METERS—BRAND NEW

2" WESTON 0-1 Ma DC 26 ohms res	$3.50
2" G.E. 0-1 Ma DC (volt scale)	2.95
2" G.E. 0-5 Ma DC (amp scale)	1.95
2" G.E. 0-30 Volts DC 1000 ohm/v	2.50
2" G.E. 0-30 Amps DC	2.45
2" G.E. 0-1 Amp RF (Internal Thermo)	2.45
3" WESTINGHOUSE 0-2 Ma DC	3.95
3" WESTERN ELECTRIC 0-80 Ma DC	2.95
3" DEJUR 0-100 Ma DC	2.95
3" GE 0-200 Ma DC	3.95
3" WESTON 0-50 Amps AC	4.95
3" TRIPLETT 75 Amps AC	2.95
3" WESTINGHOUSE 0-20 Ma DC	3.95
2" TRIPLETT 0-300 VAC	2.95
3" WESTON 0-200 Micro Amp. Mod 301	8.75

SENSITIVE RELAY

TYPE G2

S.P.D.T., Breaks at 3 Milliamps. Beautifully Constructed, Delicately Pivoted and Balanced. Approx. 2000 ohms resistance. Sealed in aluminum container. Plugs into standard 5 prong socket....Only $1.50 ea.

PLUG IN CAPACITOR

8 x 8 Mfd 600 volts DC. Oil filled. Plugs into standard 4 prong socket. 3¾ h x 3 ⅛ w x 1⅞ d....$1.39

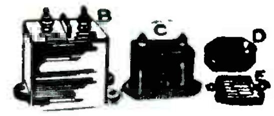
Heavy Duty Tap Switch, Ohmite Model 412

Single Pole 6 Positions. Non-Shorting. 50 amp. contacts. Vitreous Enamel case ....Only $2.95

CERAMICONS

MMF: 1.5, 2, 3, 8, 10, 20, any type .... .05 ea.

BAKELITE CASED MICA



MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	D .005	3 KV	$ .70
E .01	600	.26	C .005	3 KV	1.24
D .02	600	.26	C .006	3 KV	1.50
E .027	600	.26	D .002	3 KV	.70
C .01	1 KV	.45	C .0001	5 KV	.70
C .056	1 KV	.50	C .0005	5 KV	.85
C .07	1 KV	.55	C .0015	5 KV	1.60
C .024	1500	.65	C .003	5 KV	1.90
C .033	1500	.75	C .005	5 KV	2.50
C .015	2 KV	.80	B .007	5 KV	2.75
C .02	2 KV	.90	B .003	6 KV	3.75
D .002	2500	.45	B .006	6 KV	4.25
E .005	2500	.55	B .0005	8 KV	2.90
C .025	2500	1.25	B .0012	8 KV	3.25
C .001	3KV	.90	B .004	8 KV	5.59
C .002	3 KV	.95			

HIGH CURRENT MICAS

Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better

CAP MFD	Amps 1 Mc	Amps 300 Kc	KV DC	Price Each
.08	60	42	4	$27.50
.1	70	50	4	29.50
.05	60	42	5	24.50
.037	45	35	6	26.50
.02	40	30	9	29.50
.02	55	38	10	31.50
.0117	40	27	14	24.50
.0075	39	27	15	24.50
.009	40	25	15	29.50
.00978	40	25	15	29.50
.01	43	28	15	31.50
.0025	23	15	20	29.50
.00315	26	18	20	30.50
.004	30	20	22	33.50
.0033	25	16	25	35.50
.00082	14	8	30	27.50
.00153	21	13	30	33.50
TYPE G3 4" High 5" DIAMETER				
0013	15	9	15	14.50
TYPE G2				
.00057	8	5	10	7.95
G1 2½" High 2-1/16 DIAMETER				
.004	16	11	6	4.95
.00024	4	2	6	3.95

OIL CONDENSERS

1 mfd 600 vdc— .29	10 mfd 2000 vdc—6.95
2 mfd 600 vdc— .39	2 mfd 4000 vdc—4.95
4 mfd 600 vdc— .59	1 mfd 5000 vdc—4.50
6 mfd 600 vdc— .79	.1/.1 mfd 7000 vdc—2.25
3/3 mfd 600 vdc— .79	.1 mfd 7500 vdc—1.95
10 mfd 600 vdc— .89	1 mfd 7500 vdc—9.25
20 mfd 600 vdc—1.99	.02/.01 mfd 12 kv dc—5.75
4 mfd 1000 vdc— .95	
6 mfd 1000 vdc—1.19	.005/.01 mfd 12 kv dc— 5.50
5 mfd 1000 vdc—1.09	
2 mfd 1500 vdc—1.25	65 mfd 12,500 vdc—12.95
4 mfd 1500 vdc—2.25	
6 mfd 1500 vdc—2.95	.75/.35mfd8/16kv—7.95
1 mfd 2000 vdc—1.45	2 mfd 18 kv dc—49.55
2 mfd 2000 vdc—2.25	1 mfd 15 kv dc—15.95
8 mfd 2000 vdc—5.95	

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TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA4G	$.72	4C35	19.95	249C	3.75	720BY	45.00	879	.55
C1B	3.95	4J31	95.00	250TH	19.25	720DY	45.00	884	1.70
1A3	.29	4J32	95.00	250TL	15.00	721A	2.40	885	1.25
1B22	2.95	4J35	195.00	250R	5.95	722A	3.95	931A	3.95
1B23	8.95	4J38	95.00	HK253	6.95	723A	6.95	954	.45
1B24	4.95	4J40	195.00	274B	1.75	723A/B	10.95	955	.45
1B26	2.95	4J44	195.00	287A	3.95	724A	2.95	956	.45
1B38	32.50	4J52	350.00	CE303	3.95	724B	3.95	957	.25
1N21	.85	5BP1	2.75	304TH	3.95	725A	12.95	958A	.55
1N21A	.95	5BP4	3.95	304TL	1.25	726A	9.95	959	.75
1N21B	1.50	5C30	9.95	307A	4.25	726B	19.95	975A	12.50
1N23	.85	5CP1	1.95	310A	4.50	726C	36.00	991	.25
1N23A	.95	5D21	24.95	316A	.69	728AY	45.00	CK1005	.35
1S21	3.75	C5B	9.95	350A	2.40	801A	.69	CK1006	.95
2AP1	3.50	5FP7	1.95	350B	1.80	802	4.50	1280	.99
2C23	.75	5JP1	45.00	368AS	2.40	803	4.50	WE1378X	2.95
2C33	1.95	5JP2	10.95	371B	.89	804	10.95	1602	.59
2C34	.59	5JP4	25.00	388A	1.80	805	4.95	1611	1.50
2C39	18.00	C6A	7.95	393A	4.95	807	1.35	1613	.75
2C40	5.75	6AC7	.90	394A	4.95	808	2.75	1616	1.10
2C43	12.50	6AC7W	1.75	417A	12.95	809	2.75	1619	.50
2C44	1.25	6AK5 (JHN)	1.16	434A	3.50	810	7.50	1624	.99
2C51	7.50	6C21	19.95	450TH	17.50	811	2.11	1625	.45
2D21	1.08	6F4	5.95	450TL	37.50	812	2.50	1626	.45
2J21	9.95	6J4	4.95	446A	.90	813	7.95	1629	.45
2J22	9.95	6-8	.95	446B	1.80	814	2.95	1635	1.35
2J26	8.75	6Q5G	1.75	WL468	5.95	815	2.50	1641	1.00
2J27	9.75	6SU7GTY	1.25	WL469	2.75	826	.59	1851	1.10
2J31	9.75	7BP7	4.95	WL525	2.75	827R	90.00	1852	.99
2J32	12.95	7DP4	12.50	527	7.95	829B	7.50	1853	.90
2J36	105.00	10Y	.59	WL530	12.95	832	3.95	1984	2.75
2J38	7.95	15E	1.25	WL531	7.95	832A	4.50	2050	.99
2J40	25.00	15R	1.00	WL532	2.95	834	7.50	2051	.55
2J42	150.00	RX21	2.50	533	39.95	836	1.10	8011	1.25
2J49	24.50	5C22	45.00	WL535	7.75	837	1.95	8012A	3.95
2J50	24.50	CV35	35.00	WL538	1.25	838	3.75	8013A	2.75
2J55	55.00	CK72	.95	GL570	1.25	845	4.50	8014A	25.00
2J61	45.00	CK73	.95	575A	12.50	849	19.95	8016	1.25
2J62	45.00	OK77	249.00	579B	5.95	851	19.95	8019	1.75
2K25	19.95	QK47	55.00	653B	.45	852	9.95	8020	2.95
2K28	19.95	QK61	49.50	700A to B	19.50	860	3.75	8021	1.75
2K29	24.95	RK39	2.25	701A	3.95	861	19.95	8022	1.00
2X2A	.69	RK49	2.40	703A	2.40	866A	1.15	8025	3.75
2V3G	.99	VK59	.45	705A	.75	869B	29.95	9001	.55
3A4	.75	NR74	.45	707A	6.95	872A	2.75	9002	.35
3A5	.95	VR90	.79	707B	9.95	874	1.95	9003	.55
3AP1	4.95	VR95	.45	710A	1.25	876	.75	9004	.45
3BP1	3.95	100TH	10.95	714AY	4.95	878	2.25	9006	.25
3B24	1.50	VR105	.79	715A	6.95				
3C23	3.95	F123A	8.95	715B	9.95				
3C24	.95	VR150	.63	715C	24.95				
3C31	3.95	VT90	1.25	717A	.95				
3C45	13.95	VT98	39.95	720AY	45.00				
3DP1A	3.25	X99	.75						
3E29	6.75	203A	3.95						
3J31	59.95	211	.75						
4A1	.95	217C	6.95						
4B30	1.75	CE220	.95						
4C21	1.25	RX232	.95						
4C27	29.95	RX233	1.95						
4C30	1.25	242C	7.50						

350A is a long life WE807
350B is a long life WE6L6G
WE701A can he used for a Super 813

$10 Minimum Order

LIST OF TEST EQUIPMENT

Micro-Wave Test Equipment

X Band TS148/UP X Band Spectr Analyzer
X Band Signal Generator Type TS-146/UP 115 V. 50-1200 Cycle TAA 16 Twin T Amplifier
X Band Sig Gen Type TS263A TP/10 115 V. 50-1200 Cy
TS 12/AP Unit I SWVR meter
TS 12/AP Unit 2 Plumbing for unit I
TV N7 Pulse Gen for microwave sig gen (Browning Labs Inc.)
TBN-3EV High Freq Thermistor Meter Radiation Labs MIT
SVWR Meter TAA-11BL Browning Labs
High Power Klystron Sig Gen S Band, Polarad Mod PE 102
BC 1287A Scope for Radar, up to 1,000,000 cycles, CW-60ABP made by Western Electric
BC 1277A/60ABQ-1 Signal Generator and Freq. Meter 2700-3400 MC S Band Western Electric
TS3A/AP Freq and Power meter 2400-3400 MC WE
1017-1 Pulse and Sweep Gen by Hazeltine Corp.
I-203A Power Meter
X-Band Magic T
X-Band Precision Calibrated Load
X-Band Tunable Crystal Mounts
X-Band TS 13 Signal Generator
X-Band TS 35 Signal Generator
X-Band TS 45 Signal Generator
TS 34 Oscilloscope

Standard Broadcast and Short Wave Equipment

Model 20B Ferris Microvolter
Rider Chanalist 162C
Rider Chanalist Short Wave Adapteur
Hewlett Packard Model 2000
RCA Audio Chanalist
65 B Signal Generator
160 A Q Meter

Meters

TS 15/AP Gauss Meter
General Radio Tube Voltmeter Type 728A to 3000 volt
Airradio Millivolter 0-2 Millivolt
Model 617-F Shallcross, Percent Limit Bridge
Model 40 Pyrometer, Elematic Equipment Co.
Light Spot Galvanometers, General Scientific Co.
Microammeter Rollers 0-10 Micramp.

Radar Sets

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WHIP ANTENNA EQUIPMENT

MAST BASES—INSULATED:

MP-132—1" heavy coil spring, 2" insulator. Overall length: 11½". Weight: 2¾ lbs. Price........$3.95
MP-22 Spring action direction of bracket. 4" x 6" mounting. Price $2.95
MP-57—2" heavy coil spring, 5" insulator......$3.95
MP-48—2" heavy coil spring, 3" insulator......$2.95
MP-37—2" heavy coil spring, 8" insulator......$3.95
MP-47—2" heavy coil spring, 9" insulator......$5.95

MAST SECTIONS FOR ABOVE BASES:

Tubular steel, copper coated, painted, 3 foot sections, screw-in type. MS-53 can be used to make any length, with MS-52-51-50-49 for taper. Price, per section .... 50¢
BAG BG-56 for carrying above 5 mast sections. 50¢ ea.

DYNAMOTORS:

Input	Output	Stock No.	Price
12 V. DC	680 V. 210 MA.		
@ 6 V. DC	300 V. 150 MA.	DM-680	$7.95
9 V. DC	450 V. 60 MA.	DM-9450	
@ 6 V. DC	275 V. 50 MA.	w/Blower	3.95
12/24 V. DC	440 V. 200 MA.		
	220 V. 100 MA.	D-104	9.95
18 V. DC	450 V. 60 MA.	DM-175	2.95
12 V. DC	600 V. 300 MA.	BD-86	7.95

PERMANENT MAGNET FILLED DYNAMOTORS:

12/24 V. DC	275 V. 110 MA.	USA/0516	3.95
12/24 V. DC	500 V. 50 MA.	USA/0515	2.95

PM FIELD DYNAMOTOR POWER SUPPLY—Completely filtered. Has two PM Dynamotors as listed directly above $5.00

WRITE TODAY FOR QUOTATION ON OTHER DYNAMOTOR OR INVERTER NEEDS!

ALNICO FIELD MOTOR—24 VDC. 3¼" x 1⅝". Shaft ¾" x 3/16" w/10,000 RPM. Design No. 63662C. Price: $3.75
ALNICO MIDGET DC VOLTAGE GENERATOR—Type PM-2 Electric Indicator Co. .0175 V. per RPM. 3¼" x 2½". Shaft ½" x 5/32". Price: $6.95
ALNICO FIELD MOTOR—24 VDC. 3-5/16" x 2". Shaft 9/16" x ¼" knurled. 10,000 RPM. Type P-11212. Price: $3.75

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5 GANG—with vernier tuning 25 MMFD to 450 MMFD each section. Size: 7½" x 3½" x 3½". Price: $2.95

3 GANG—25 MMFD to 450 MMFD each section. Size: 6" x 3¼" x 3". Price $1.95

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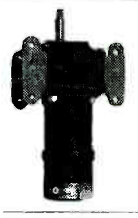
115/200 V. Three Phase 400 Cycle input:
TYPE 143 w/Transformer & VR 100 amp.....$89.50
TYPE 3FS-5 w/Trans., VR, & Blower 200 amp. $99.50
TYPE 52A-11 Rectifier only, Cased 200 amp...$49.50
TYPE AI Rectifier only, Cased 300 amp.......$59.50
TYPE RE-60 Rectifier only, Cased 400 amp.....$69.50

GEARED MOTOR



Ideal reversible motor for rotating antennas, displays, etc. (Similar to illustration) Weight: 4 lbs. Overall size: 7" long, less shaft. Gear Box size: 3¼" x 3¼". Motor size 4" x 2½". Shaft size: ⅜" x 1½" threaded. Operates from 24 volt DC, 2.9 A., 9 RPM or 36 volt AC at 75 lbs. torque per inch. Price $5.95
36 Volt Transformer $2.95

SYNCHRONOUS MOTOR—26 V. 60 cycle 60 RPM. Size: 1½" x 2¼". Shaft 1" x 1/16". Type 1147, with 26 V. Transformer $2.95

AUTOMATIC CODER-TIMER complete with 110 Volt 60 cycle motor, 7.2 Watts at 4 RPM. Micro switch and adjusting discs................$12.95

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TS-23/APN	I-126
TS-33/AP	I-145
TS-34/AP	I-152C IND.
TS-35/AP	I-196B
TS-36/AP	I-222
TS-61/AP	BC-376-H
TS-62/AP	BC-689A
TS-74/UPM	BC-754A
TS-92/AP	BC-906D
TS-110/AP	BC-929A
TS-118/AP	BC-949A
TS-126/AP	BC-1061A
TS-131/AP	BC-1066B
TS-143/CPM-1	BC-1155A
TS-192/CPM-4	BC-1203A
TS-204/AP	BC-1255A
TS-BE-67	
T9-APQ2	SN7A/APQ-13
T28-APT-1	R78-APS-15A
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BRAND NEW IN ORIGINAL CARTONS

*(Except as specified with *)*

1B24	$4.75	RKR-73	$0.95	954	$0.39
2C44	1.75	304TH	3.95	955	.39
2D21	1.19	304TL	1.95	956	.49
2J38	14.95	417A	19.95	957	.39
2J48	14.95	705A	1.95	958A	.39
2K28	24.95	715B	9.95	959	.39
2X2A	0.89	715C	24.95	991/NE16	.29
3D21A	1.95	723A/B	14.95	2050	.79
5R4GY	1.09	724B	4.75	8013	1.49
6AC7*	.79	725A	7.50	9001	.39
6AG7	1.19	805	3.95	9002	.39
6AK5	1.09	811	1.95	9003	.39
6AL5	.75	814	3.95	9004	.39
6J6	.95	815	1.95	9006	.39
6SL7GT	.69	829B	4.75		
6SU7GT/Y	1.29	872A	1.69	OB3/VR90	.89
6Y6G	.88	902A	3.95	OC3/VR105	.89
72/3B24	.95	931A*	3.95	OD3/VR150	.69

Specify JAN tubes when ordering.
• *Manufacturers bulk pack JAN.*

Wide Range Butterfly Wavemeter & Oscillator Elements

Precision wide range butterfly circuit elements. Sturdily constructed. Mounted in ball bearings. Suitable for motor drive. Ideal for use as wavemeters and oscillators (See description below.)

Stock No.	Freq. (mc.)	Notes *	Unit Price
TN-20	105–330	1.3	$4.95
TN2A	75–300	1.4	4.95
TN-30	135–485	2.3	5.95
TN3A	300–1000	2.5	6.95

Brand, new, in original packing.

• NOTES: 1) Aluminum construction
2) Silver-plated brass
3) Designed as oscillator element (955 acorn triode)
4) Has diode socket mounted on unit (955 as diode)
5) Has crystal diode mount for 1N21 crystal

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1N21B	1.25	804	12.95	5R4GY	1.25
1N23	1.25	805	5.95	5U4G	.79
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1N23B	2.49	811	2.49	5Y3GT	.55
1N23C	37.50	813	8.95	5Z3	.69
1N34	.85	814	3.95	6C4	.25
1N35	2.05	816	.95	80	.49
1N48	1.35	829B	7.95	83	.79
2J36	115.00	830B	5.25	2050	1.10
2J21A	12.95	832A	4.95	2051	.95
2K25	24.50	836A	1.75	OA2	1.55
715B	9.95	837	2.50	OB2	1.75
715C	24.95	845W	4.85	VR75	.89
723AB	9.95	866A	1.15	VR105	.89
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0–1 MA DC S scale	3.95	0–75 AMP AC TRIP	5.95
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0–5 MA Spec Scale	3.45	**2" METERS**	
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0–1000 MA DC DEJ	3.95	0–1 AMP RF GE	3.50
0–2 AMP DC SIMP	5.95	0–9 AMP RF WH	3.50
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8 HY 50 MA 90 ohm	$0.39	6 HY 250 MA 90 ohm	2.95
10 HY 80 MA 240 ohm	.75	5 HY 300 MA 75 ohm	3.50
10 HY 150 MA 140 ohm	1.10	200 HY 6 MA 620 ohm	.99

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2 MF 600V	.69	2 MF 1500V	1.75
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10 MFD, 330 v. A.C., 1,000 v. D.C. Standard Brand.
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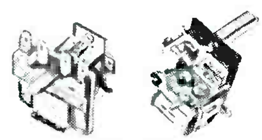

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50 MMFD each section. ⅝" slotted shaft. Length 2", width 1", height 1⅜". Bakelite insulation.
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Each ....95¢
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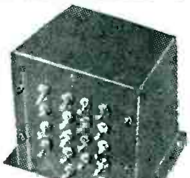

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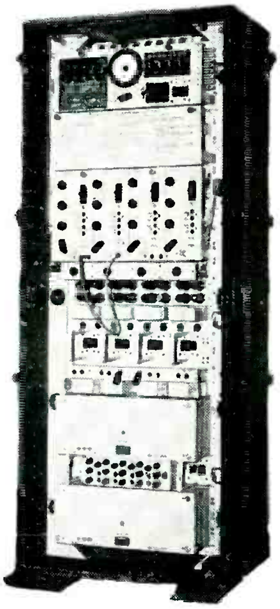
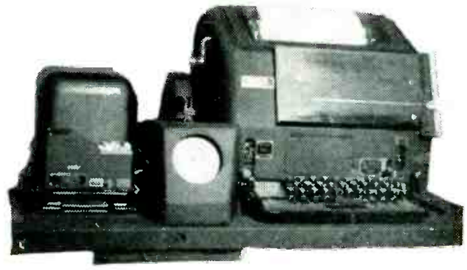
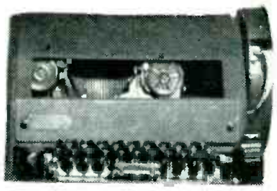


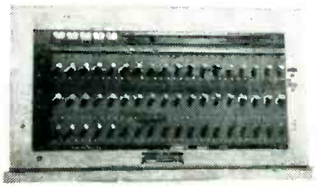
W. E. Co. type CF-2B; 4 Channel V. F. Telegraph Carrier Terminal.

Teletype Model 19—Page—Sending—Receiving & Tape Perforating Set.





Teletype Model 14—Sending—Receiving Typing Reperforator Set.



W. E. Co. Type 506B Cordless Monitor Telephone Switchboard.

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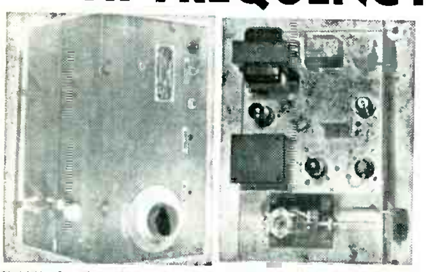
SQUARE WAVE AUDIO OSC. & HI FREQUENCY SIGNAL GEN.



BC423 Radio Mod. (tweeter) MFG. W.E. consists of 2 important parts, an A-F OSC and R-F Hi Frequency osc with a self contained 15 Volt AC 60 cycle power supply. The A-F oscillator is an unusually stable oscillator known as a transition oscillator and operates at a freq. of 4100 cycles square wave, the output passes through 2 A-F distortion amplifier stages and is then used to mod. the R-F oscillator. the freq. approx. 125 to 210 megacycles this covers channels 7 to 13 in television, and radiates a test pattern for these channels with the audio of 4100 cycles square wave for the audio section of the tel. set.

This makes an ideal test unit for lining and Etc. no changes are needed to use this unit for the above purpose. you can however put a tapped switch with several values of capacity across the audio tank circuit coil 167 D for any audio freq. desired for example .18 MFD equals 440 cycles .1 equals 555 cycles and etc.

If you want to use this unit for a reg. sine wave can be done by changing the value of cap. 29 or use a gain control in the first audio stage this gives a sine wave instead of a square wave in the output stage, as the unit is the first stage is overdriven this gives square wave output.

The output transformer is an Amertran J871 30 DB gain response flat to 17000 cycles universal tapped Pri. 20 M 16 M 5 M 1 M Sec. 500 15 7½ 3.75 1.25 ohms has Thordarson power trans. and choke W.E. audio circuit National Venier Velvet Dial on the R-F oscillator. Once you calibrate this national dial you have a stable variable osc. for approx. 125 to 210 megs. and an audio osc. with a square or sine wave 4100 cycles or tapped at various frequencies.

These units also make perfect speech amplifiers transmitters and receivers a unit you do not want to miss. the original print is with each unit we furnish other info plus a print of the taps on the output modulation trans.

These Units Sold Only on a Money Back Guarantee a Fraction of original Cost New $16.95

RECEIVERS

BC406 and BC406A 190 to 210 megacycles with self contained 115 VAC 60 cycle 150 mil supply with 4 section filtering 150 mil choke and 8-8 mic cond. in ea. section. has 2 R-F and 4 I-F stages 15 tubes as follows: 5-954 1-955 4-6SK7 2-6SJ7 2-6N7 1-5T4. This receiver is ideal (for converting to the 420 meg. band and perfect for 2-6-10 meters. we furnish a print and instructions for converting to 2 meters, this receiver will also make a television picture receiver only difference in the 406 and 406A is the 406A is a latter model and has a 115 VAC motor for var. tuning this motor has 75 ounce inches of torque speed. .65 RPM, Super Het circuit.

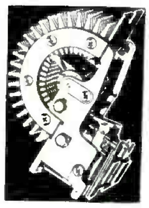
MADE BY WESTERN ELECTRIC; COST GOVT. $292.95 EA.

BC406 $14.95
BC406A-$17.95

Converts to 2-6-10 meters and 420 meg. band. We give conversions for 2 meters and the 6 page CQ FEB. '46 10 meter conversion free. All perfect—like new.

McCONNELL'S 3834 Germantown Ave., Phila., Penna. RA5-6033 **XTALS 500KC** standards 2 pin holder CR-2B/U brand new $1.50

CLARE STEPPING SWITCHES



Type SD-14, 20 steps, 6 levels. Coil 12V, DC. Lists at $40.26; our low price $13.00. Brand new in original boxes—not war surplus. Quantities of four or more, $12.25 each. Satisfaction guaranteed or money refunded.

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NEW BENDIX PLATE TRANSFORMERS

A limited supply of original packed high quality plate transformers are offered for sale. Operating from 200/220/240 — 1Φ 50-60 cycle lines, these fine units deliver 2900VCT • 4KVA. Insulation tested at 9000v and weighing 220 lbs. each, they represent a $500.00 list value. Specially priced at $94.00 each FOB.

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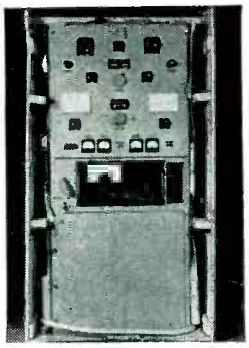
WESTON 93, MASS.

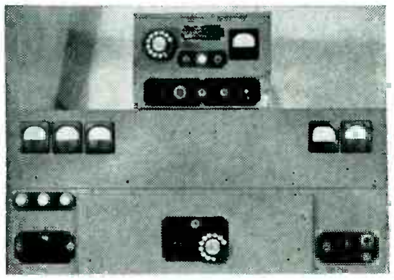
Columbia Electronics, Ltd.

MODEL ET-8023-D1 TRANSMITTER



High frequency radio telegraph transmitter. Continuous frequency range of 2 to 24 Mcs., with A1 or A2 emission. Xmitter can be converted to A3 by slight modification of audio amplifier. 225-watts output. Input power 115-VDC. Has center section for Receiver housing. Xtal or M.O. control, with or without Receiver.

$325.00 Less Receiver



1100-A
FOUR TRANSMITTERS IN ONE

Can be present on 4 bands. Has BFO or xtal on each from 1.5 to 10 mcs. Oscillators are all between 1.5 and 5 mcs. 6L6 osc. VR-150 regulator, buffer or doubler is a 6L6 into 3-807's in parallel. 125 watts on phone and 125 watts on cw, modulator has 4-6L6's in push-pull parallel. Rig has telephone dial on front for selecting any one of 4 transmitters, selecting phone, CW, turning heaters on, plate current, or turning everything off. Also has remote control unit for remote operation. Used, but in excellent condition.

$225.00 With Remote

RA-38 RECTIFIER

115 V. 60 cycles, single phase input, output 0-15,000 VDC at 500 ma.

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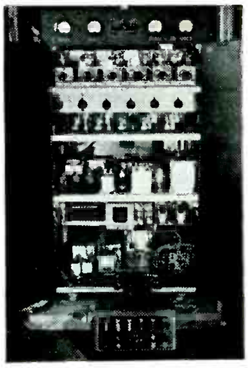

TCR TRANSMITTER

w / remote control, 6-channel, pre-set frequencies in 2 to Mc. 125-Watts output with A2 or A3 emission. Input 105 to 125, or 210 to 250 volts at 60-cycle (50-60 cy)

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Supply current at a constant voltage and supplies current to a storage battery, providing an automatic AC-DC power system; No moving parts; No adjustments; Life of the battery increases as much as 40%; Eliminates voltage variations. 11/12 cells, 22-24 volts at 3 amp. output; Input 95-130 volts, 60 cycles; Weight 180 pounds. **$45.00**

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PU-7 INVERTERS: New. $27.50.
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SCR-528 FM RECEIVER & TRANSMITTER: complete with 80 xtals for operation in the 20 to 27.9 Mc. Powered by 12 or 24 VDC. A light, portable set for mobile or fixed operation.
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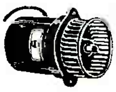
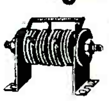
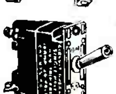


DELCO BLOWER — sirocco type D.C. Flange diameter 3½" blade 3-3/16" RPM @ 12 volts 3400 RPM @ 6 volts 1600 .... **$3.95**



SELENIUM RECTIFIERS — G.E. model 6RS 5FB3 maximum A.C. volts 56 D.C. amps. 0.150 ..... **$1.35**



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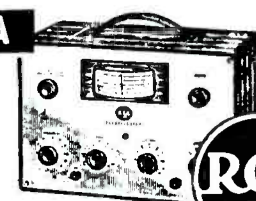
TEST OSCILLATOR WR-67A



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Band A: 100-260 kc; Band B: 260-650 kc; Band C: 635-1600 kc; Band D: 1.6-4.7 Mc; Band E: 4.4-12.8 Mc; Band F: 10.5-30 Mc
Scale Accuracy, ±2%
Fixed Frequencies: 455, 600, 1500 kc
Output Voltage (RMS): Continuously variable, 5 μv to 1 volt
Internal Modulation: 400 cps; adjustable from 0% to 50%
External Modulation: 2 RMS volts req. for 30% mod.
Audio Output: 25 max. RMS volts across 100,000 ohms
RF Output Impedance: 10-1000 ohms
(Varies with attenuator setting)
Dimensions: 10" x 13½" x 7½"

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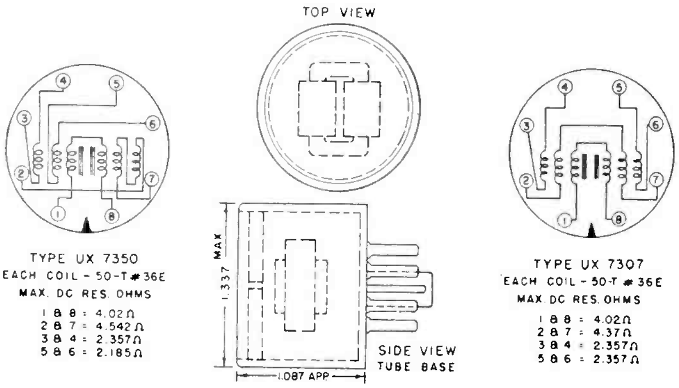

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- ★—Convenient to use—merely plug into an octal socket—simplifies production.
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- ★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

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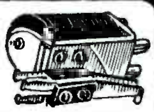

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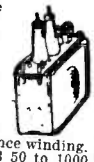

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3	100	2.90	200	25	.98
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5	50	1.24	250	25	.98
5	100	2.90	350	25	.98
5	150	3.50	350	100	2.70
6	25	.98	378	150	3.50
6	50	1.24	400	25	.98
7	25	.98	500	25	.98
8	50	1.24	500	75	2.49
10	25	.98	585	150	3.50
10	100	2.70	750	25	.98
12	25	.98	750	150	3.50
15	25	.98	1000	25	.98
16	50	1.24	1200	225	4.95
22	50	1.24	1250	50	1.24
25	25	.98	1250	150	3.50
32	300	5.25	1500	50	1.24
50	25	.98	2000	25	.98
50	50	1.24	2000	50	1.24
50	750	17.95	2500	100	2.90
60	25	.98	3000	25	.98
75	150	3.50	3000	100	2.90
80	50	1.24	3500	50	1.24
80	500	7.60	5000	25	.98
100	25	.98	5000	50	1.49
100	50	1.24	7500	50	1.63
100	225	2.70	7500	100	3.30
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Pole	Pos	Deck	Type	Ea.
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1	6	1	bakelite	.31
1	12	1	ceramic	.55
1	21	3	bakelite	.69
2	2	1	ceramic	.39
2	6	2	bakelite	.49
2	8	2	bakelite	.54
2	11	2	bakelite	.60
4	4	2	ceramic	.54
5	3	2	ceramic	.56
6	11	6	bakelite	1.98
10	5	5	ceramic	1.49
12	2	3	bakelite	.75
16	2	4	bakelite	.98
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Mfd.	Volt.	Each
.1	3000	$0.75
.25	2000	.95
.25	3000	1.10
.25	3500	1.35
1	500	.28
1	600	.35
1	2000	1.95
2	400	.35
2	600	.39
4	600	.69
6	400	.75
6	600	.79
10	600	.98
14	600	1.75
15	600	1.98
15	1000	3.25
2x.1	7000	3.95
3x4	400 Plug-In	1.49

BATHTUBS

mfd	vdcw	each
.033	400	.17
.05	200	.17
.05	400	.19
.05	600	.21
.1	400	.20
.1	600	.22
.1	1000	.32
.15	600	.22
.25	200	.19
.25	600	.23
.35	400	.22
.5	400	.23
.5	600	.25
.5	1000	.35
1	200	.29
1	600	.35
2	400	.44
2	600	.49
4	50	.25
8	500	.59
25	50	.28
25	75	.30
40	25	.27
50	25	.28
200	12	.35
300	6	.39
.05-.05	600	.29
.05-.05	1500	.45
.1-.05	200	.25
.1-.1	400	.26
.1-.1	600	.28
.16-.16	600	.28
.2-.2	600	.29
.25-.25	600	.30
.5-.5	600	.35
1.0-.1	300	.29
200-200	9	.49
3 x .05	600	.40
3 x .1	400	.42
3 x .1	600	.45
3 x .25	600	.50
3 x 1.0	100	.40

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UG-27/U 1.75
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100	1/8"*	1/2"†	10K	3/8"	3/8"
150	1/8"*	3/8"	11K	1/4"	1/4"
300	3/8"	1/4"	12K	3/8"	3/8"
400	1/8"*	1/2"†	15K	1/8"*	1/4"
500	3/8"	1/4"	15K	1-1/8	3/8"
500	1/2"	1/2"†	16K	1/4"	1/4"
600	1/2"	1/2"	20K	1/8"*	1/2"†
1000	1/8"*	1/2"†	20K	3/8"	3/8"
1000	5/8"	1/2"†	25K	1/8"*	1/2"†
1200	1/4"*	1/4"	25K	1-1/8	1/2"†
1400	1-1/8	1/4"	30K	1/4"	3/8"
1500	1/8"*	1/2"†	50K	1/8"*	1/2"†
1500	1/2"*	1/4"	50K	3/8"	3/8"
2000	1/8"*	3/8"	75K	5/16"	7/16"
2000	1/2"	1/2"	80K	1/2"	1/4"
2100	1/8"*	1/2"†	100K	1/8"*	1/2"†
2200	1/8"*	3/8"	100K	9/16"	3/8"
2200	1-1/8	3/8"	200K	1/8"*	1/2"†
4000	1-1/8	3/8"	200K	3/8"	3/8"
4700	3/8"*	1/2"	250K	7/16"	1/2"
5000	1/8"*	1/2"†	300K	1/8"*	1/2"†
5000	1/2"	1/4"	1meg	1/8"*	1/2"†
5000	5/8"	1/2"†	1meg	3/8"	1/4"

TYPE "JJ" $1.25 ea.

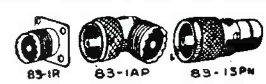
ohms	shaft	ohms	shaft
100/100	1/8"*	100K/100K	1/8"*
200/200	1/2"	100K/100K	1/2"
500/500	1/8"*	130K/130K	1/4"*
500/500	2-1/8	150K/150K	3/8"
600/600	1-1/2	200K/200K	3/8"
1500/1500	2-1/8	250K/250K	1/2"
2000/2000	1/8"*	300K/300K	1/2"
2000/2000	2-1/8	350K/5000	3/8"
5000/5000	2-1/8	350K/25K	5/16"
10K/10K	3/8"	500K/500K	2-1/8
20K/2000	3/8"	800K/75K	1/2"
25K/10K	2-3/4	1meg/1meg	3/8"
35K/5000	3/8"	4meg/4meg	3/8"
50K/50K	1-1/4	5meg/5meg	1/2"

TYPE "JJJ" $2.25 ea.

ohms	shaft
20K/200K/20K	3/8"
45K/27K/2500	1/4"
700K/700K/700K	3/4"
750K/750K/750K	1-3/8
800K/800K/800K	1-3/8
1 meg/1 meg/1 meg	3/4"

*Screwdriver slot. † Locking bushing

"UHF" Coax Cable Connectors



Cat. No.	Army No.	Type	Ea.	Per/C
83-1AP	M-359	Plug	.35	.28
83-1D	PL-271	Adap	1.25	1.00
83-1F	PL-274	Feed	1.10	.90
83-1R	SO-239	Rec.	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-22R	SO-264	Rec.	.50	.40
83-22SP	UG-102/U	Plug	.45	.40

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42-108 MC, F.M.—2 bands

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- Complete with shunts
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- Spare parts.

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50 watt tube socket 872, 211 .19

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5–0–5	MA DC	Weston with 50 MA shunt	3½"	4.25
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0–100	Amps DC	Hoyt	3"	3.00
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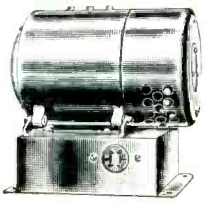

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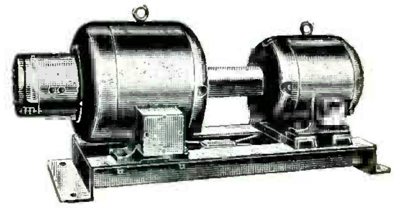

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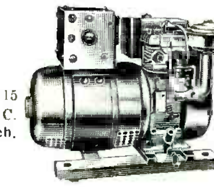

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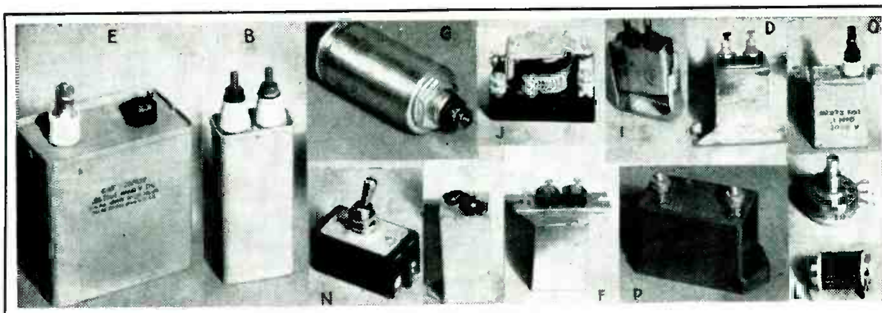

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2x.025 mfd.	600	ST	.12
2x.04 mfd.	600	ST	.12
.05 mfd.	600	ST	.15
.05 mfd.	600	TT	.15
.05 mfd.	1000	TT	.18
.05 mfd.	1400	ST	.25
2x.05 mfd.	600	ST	.12
2x.08 mfd.	600	ST	.12
.1 mfd.	400	ST	.12
.1 mfd.	1000	ST	.17
.1 mfd.	1200	ST	.19
2x.1 mfd.	400	ST	.16
2x.1 mfd.	400	TT	.10
2x.1 mfd.	400	BT	.10
2x.1 mfd.	600	TT	.19
2x.1 mfd.	600	BT	.19
2x.1 mfd.	600	ST	.22
2x.1 mfd.	1000	ST	.24
3x.1 mfd.	400	ST	.19
3x.1 mfd.	600	ST	.24
3x.1 mfd.	600	TT	.23
3x.1 mfd.	600	BT	.23
.25 mfd.	300	ST	.10
.25 mfd.	600	ST	.20
.25 mfd.	600	TT	.19
.25 mfd.	600	Matchbox	.12
.25 mfd.	1000	ST	.22
2x.25 mfd.	400	ST	.18
2x.25 mfd.	600	ST	.20
2x.25 mfd.	1000	ST	.24
.3 mfd.	400	ST	.12
.5 mfd.	400	ST	.15
.5 mfd.	400	TT	.15
.5 mfd.	600	ST	.22
.5 mfd.	600	TT	.21
.5 mfd.	1000	ST	.24
2x.5 mfd.	400	ST	.21
2x.5 mfd.	600	ST	.24
1 mfd.	100	ST	.10
1 mfd.	300	ST	.15
1 mfd.	400	ST	.20
1 mfd.	600	ST	.25
1 mfd.	600	BT	.25
1 mfd.	600	TT	.25
1 mfd.	1000	ST	.40
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2x1 mfd.	600	ST	.39
2 mfd.	200	ST	.14
2 mfd.	600	ST	.39
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"D"	.5 mfd	— 400vdc	.12
"B"	.5 mfd	—2000vdc	.75
"B"	.5 mfd	—3000vdc	1.10
"D"	1 mfd	— 500vdc	.16
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"B"	4 mfd	— 600vdc	.59
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Neut. Cond. Bud NC-890 (For 6L6)........ .25
Coax. Connector 83-1 SP........................ .28
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"L" Prec Res WW-5 1 Meg. 1 W. @ 1%.... .49
"L" Prec Res WW-4 5000 ohms 1 W @ 1%.. .25
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Ceramicon, 100 mmfd $5.00 per "C"
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"P" Trans. Mica. .0005— mfd 5000 wvdc 1.50
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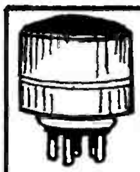

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