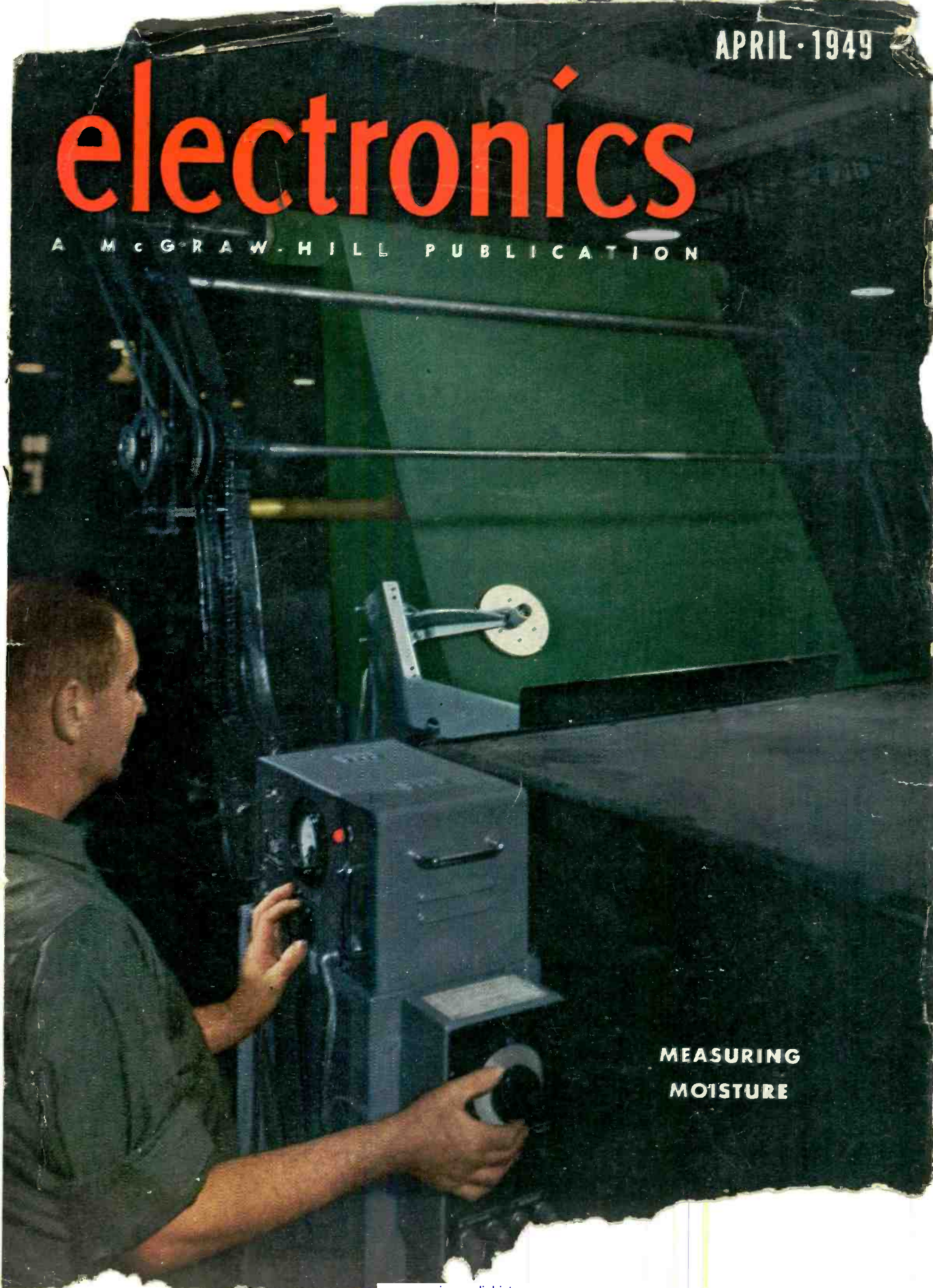
APRIL · 1949

electronics

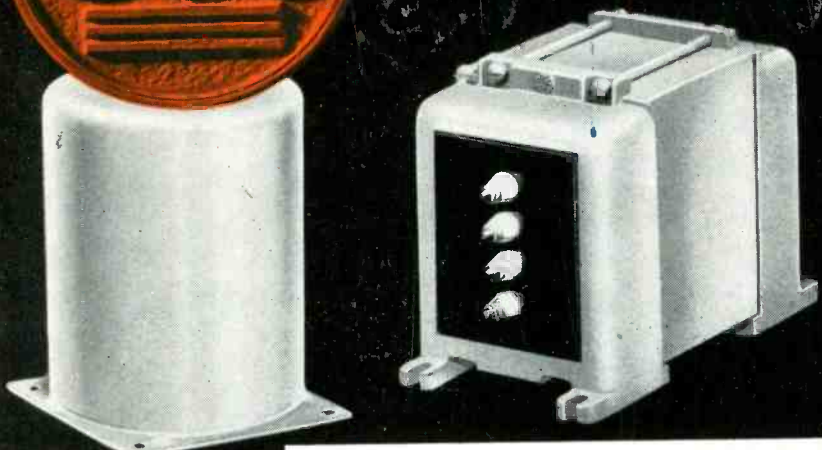
A McGRAW-HILL PUBLICATION



MEASURING MOISTURE

COMMERCIAL GRADE COMPONENTS

A wide range of units for every application



U.T.C. Commercial Grade components employ rugged, drawn steel cases for units from 1" diameter to 300 VA rating . . . vertical mounting, permanent mold, aluminum castings for power components up to 15 KVA. Units are conservatively designed . . . vacuum impregnated . . . sealed with special sealing compound to insure dependability under continuous commercial service.

A few of the large number of standard C.G. units are described below. In addition to catalogued units, special C.G. units are supplied to customer's specifications.

CG VARIMATCH OUTPUTS FOR P. A.

Universal units designed to match any tubes within the rated output power, to line or voice coil. Output impedance 500, 200, 50, 16, 8, 5, 3, 1.5 ohms. Primary impedance 3000, 5000, 6000, 7000, 8000, 10,000, 14,000 ohms.

Type No.	Audio Watts	Typical Tubes	List Price
CVP-1	12	42, 43, 45, 47, 2A3, 6A6, 6F6, 25L6	$ 9.00
CVP-2	30	42, 45, 2A3, 6L6, 6V6, 6B5	14.00
CVP-3	60	46's, 50's, 300A's, 6L6's, 801, 807	20.00
CVP-4	125	800's, 801's, 807's, 4-6L6's, 845's	29.00
CVP-5	300	211, 242A's, 203A's, 838's, 4-845's, ZB-120's	50.00

CG VARIMATCH LINE TO VOICE COIL TRANSFORMERS

The UTC VARIMATCH line to voice coil transformers will match any voice coil or group of voice coils to a 500 ohm line. More than 50 voice coil combinations can be obtained, as follows:

.2, .4, .5, .62, 1, 1.25, 1.5, 2, 2.5, 3, 3.3, 3.8, 4, 4.5, 5, 5.5, 6, 6.25, 6.6, 7, 7.5, 8, 9, 10, 11, 12, 14, 15, 16, 18, 20, 25, 28, 30, 31, 40, 47, 50, 63, 69, 75.

Type No.	Audio Watts	Primary Impedance	Secondary Impedance	List Price
CVL-1	15	500 ohms	.2 to 75 ohms	$ 8.00
CVL-2	40	500 ohms	.2 to 75 ohms	11.50
CVL-3	75	500 ohms	.2 to 75 ohms	17.50

CG VARIMATCH MODULATION UNITS

Will match any modulator tubes to any RF load.

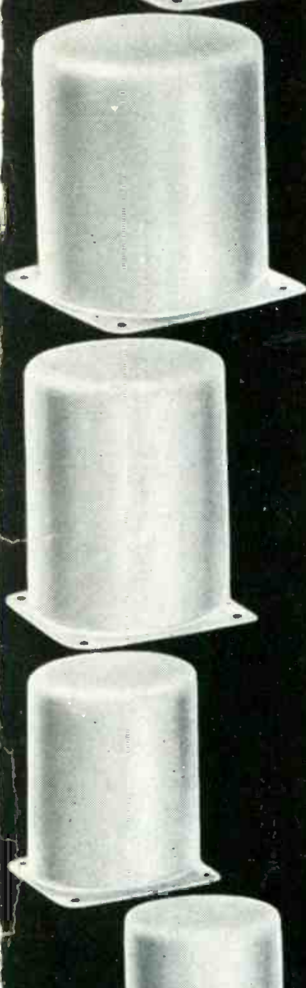
Primary impedances from 500 to 20,000 ohms
Secondary impedances from 30,000 to 300 ohms

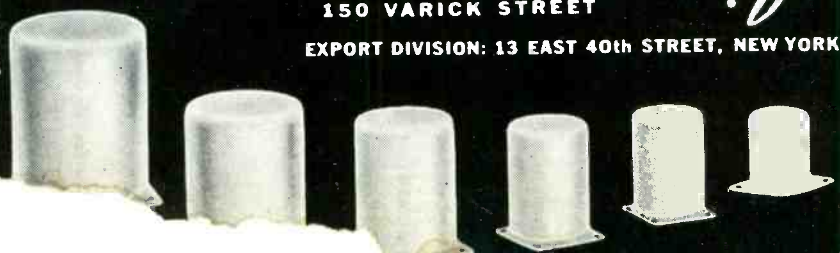
Type No.	Max. Audio Watts	Max. Class C Input	Typical Modulator Tubes	List Price
CVM-0	12	25	30, 49, 79, 6A6, 53, 2A3, 6B5	$ 8.50
CVM-1	30	60	6V6, 6B5, 2A3, 42, 46, 6L6, 210	14.00
CVM-2	60	125	801, 6L6, 809, 4-46, T-20, 1608	20.50
CVM-3	125	250	800, 807, 845, TZ-20, RK-30, 35-T	30.00
CVM-4	300	600	50-T, 203A, 805, 838, T-55, ZB-120	50.00
CVM-5	600	1200	805, HF-300, 204A, HK-354, 250TH	115.00

INPUT, INTERSTAGE, MIXING AND LOW LEVEL OUTPUT TRANSFORMERS

(200 ohm windings are balanced and can be used for 250 ohms)

CG Type No.	Application	Primary Impedance Ohms	Secondary Impedance Ohms	List Price
131	1 plate to 1 grid	15,000	135,000 3:1 ratio	$ 9.
132	1 plate to 2 grids	15,000	135,000 centertapped 3:1 ratio overall	10
133	2 plates to 2 grids	30,000 P to P	80,000 overall 1.6:1 ratio overall	12
134	Line to 1 grid hum-bucking	50, 200, 500	80,000	12
135	Line to 2 grids hum-bucking	50, 200, 500	120,000 overall	13
235	Line to 1 or 2 grids, hum-bucking; multiple alloy shielded for low hum pickup	50, 200, 500 ohms	80,000 overall	12
136	Single plate and low impedance mike or line to 1 or 2 grids Hum-bucking	15,000, 50, 200	80,000 overall	[illegible]
233	PP 6C5, 56, similar triodes to AB 45's, 2A3's, 6L6's, etc.	30,000 P to P	25,000 overall .9:1 ratio overall	[illegible]
333	PP 6C5, 56, similar triodes to fixed bias 6L6's	30,000 P to P	7,500 overall .5:1 ratio overall	[illegible]
433	PP 45, 2A3, similar tubes to fixed bias 2 or 4 6L6's	5,000 P to P	1,250 overall .5:1 ratio overall	[illegible]
137	Mixing	50, 200, 500	50, 200, 500	[illegible]
140	Triode plate to line	15,000	50, 200, 500	[illegible]
141	PP triode plates to line	15,000	50, 200, 500	[illegible]





United Transformer Co.

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

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For full details on this line, write for Catalog

electronics

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APRIL • 1949

MEASURING MOISTURE .... Cover
Installation of Fielden Drimeter on drying machine at Forstmann Woolen Co. plant in Passaic, N. J., to indicate moisture content of wool fabrics directly and continuously on a meter with accuracy of 1 percent while machine is in operation. For details see p 126. Photo by Syd Karson

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Permits measurement of voltages on high-impedance circuits with low circuit loading

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CARRIER COMMUNICATION LEVEL REGULATOR, by W.S. Chaskin 104
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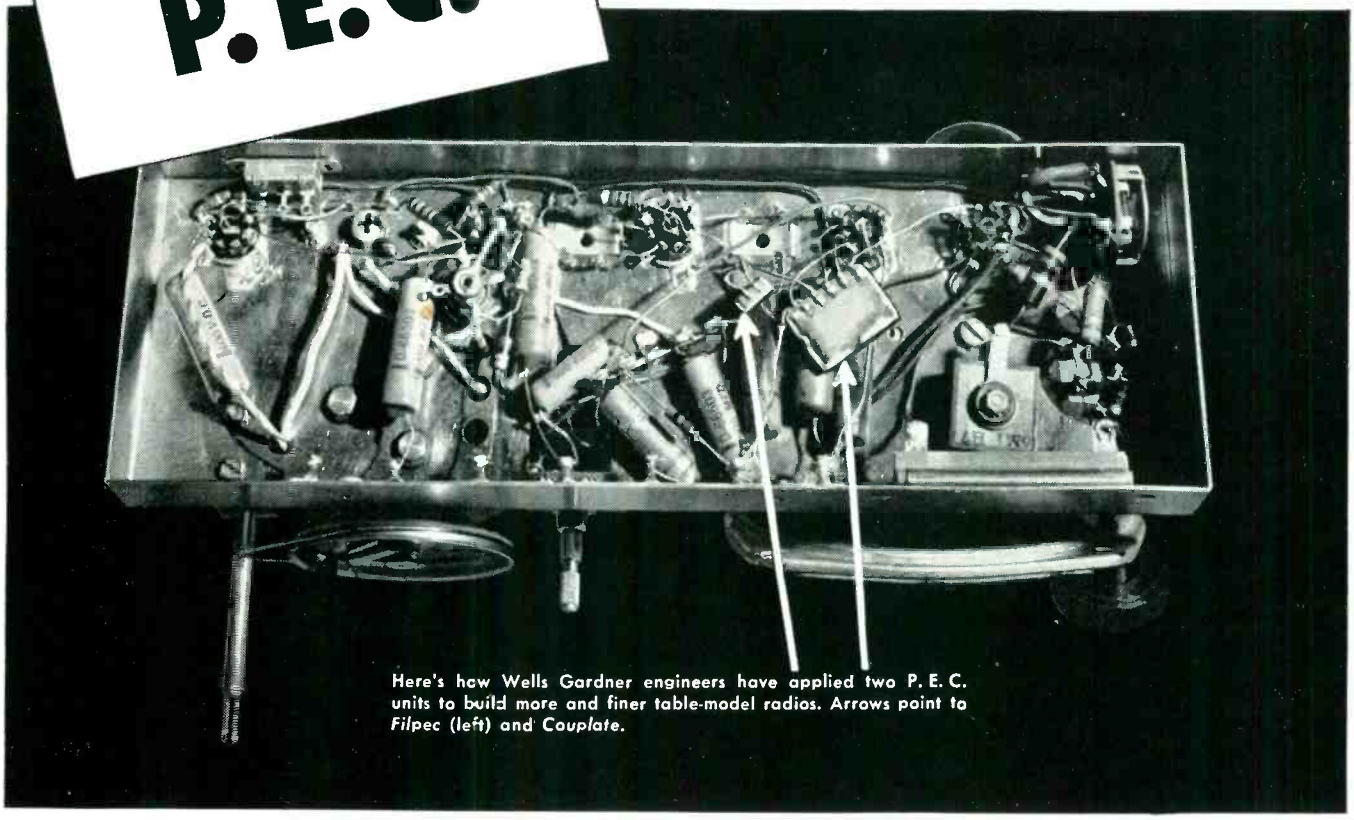
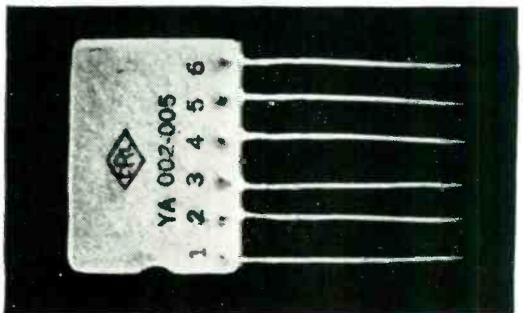
PROGRESS REPORT ON P. E. C.*

How Wells Gardner uses CRL's Pentode *Couplate* and *Filpec* to save space and speed assembly of table-model radios!

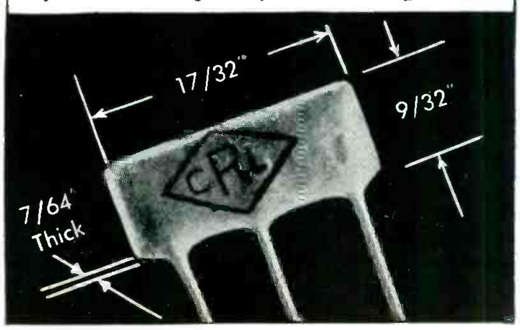


Here's how Wells Gardner engineers have applied two P. E. C. units to build more and finer table-model radios. Arrows point to *Filpec* (left) and *Couplate*.

Chassis courtesy of Wells Gardner & Company



Made with high dielectric Ceramic-X, both *Couplate* (above) and *Filpec* (below) assure long life, low internal inductance, positive resistance to humidity and vibration. All units provided with special phenolic coating.



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

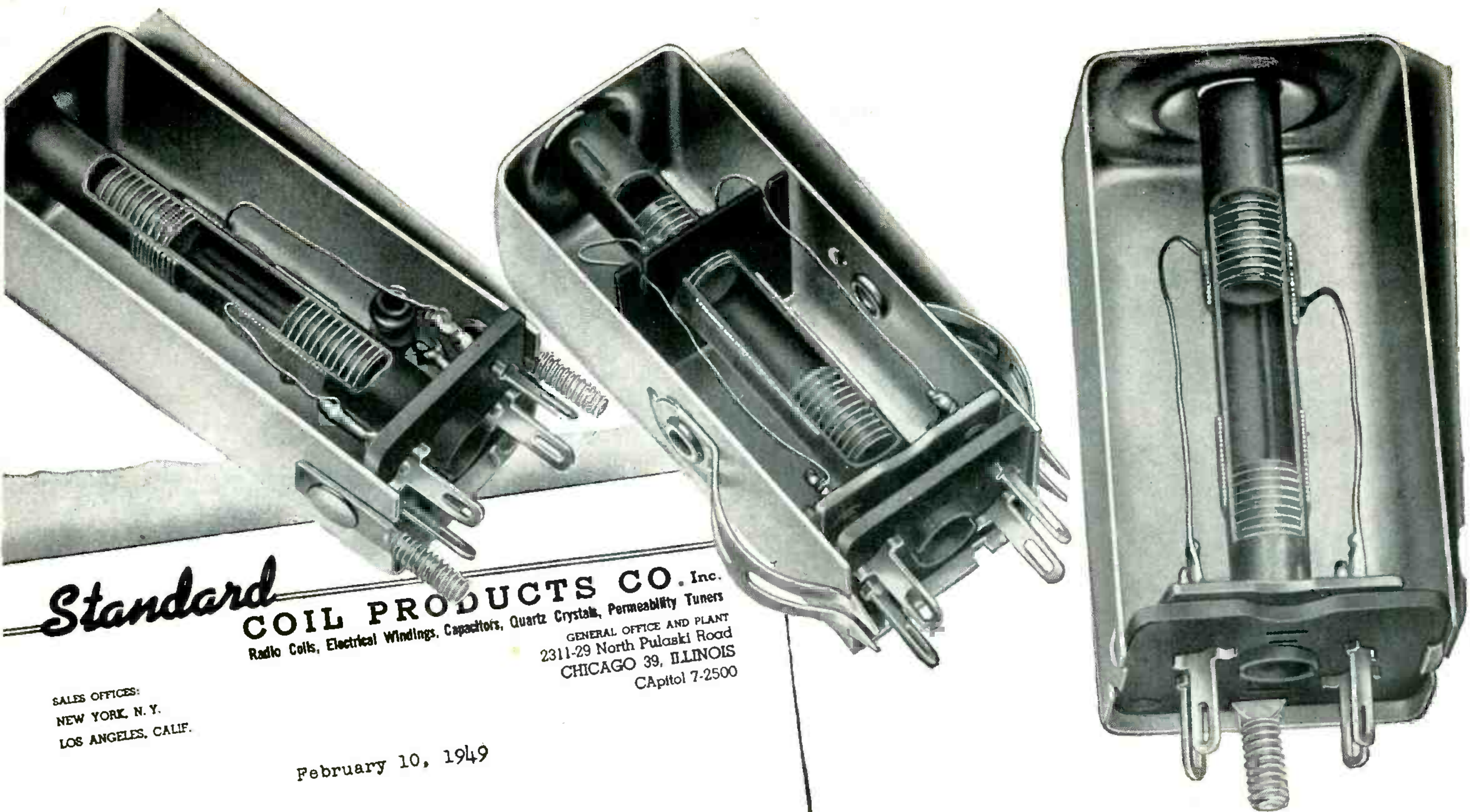
MORE and more manufacturers are turning to CRL's space-saving *Printed Electronic Circuits* to help them produce finer products, faster. That's how it is with Wells Gardner & Company, Chicago. Two Centralab P. E. C. units — *Couplate* and *Filpec* — are helping this firm cut assembling time of table-model radios by reducing the number of components needed and by eliminating many soldering operations. What's more, these same units are improving performance of Wells Gardner radios by resisting temperature and humidity . . . by practically eliminating loose or broken connections.

INTEGRAL CERAMIC CONSTRUCTION: Each *Printed Electronic Circuit* is an integral assembly of *Hi-Kap* capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate.

For complete information about *Filpec* and *Couplate* as well as other CRL *Printed Electronic Circuits,* see your nearest Centralab Representative, or write direct.

LOOK TO **Centralab** IN 1949!

Division of GLOBE-UNION INC



Standard COIL PRODUCTS CO. Inc.
Radio Coils, Electrical Windings, Capacitors, Quartz Crystals, Permeability Tuners

GENERAL OFFICE AND PLANT
2311-29 North Pulaski Road
CHICAGO 39, ILLINOIS
CApitol 7-2500

SALES OFFICES:
NEW YORK, N. Y.
LOS ANGELES, CALIF.

February 10, 1949

Thomas R. Moore, Jr.
Antara Products Division
General Aniline & Film Corp.
444 Madison Avenue
New York, New York

Dear Tom:

We feel it will be of interest to you that we have been able to use Carbonyl E powdered iron cores at frequencies up to 25 mc. without sacrifice in performance. This has been accomplished by modifications of coil structures and close cooperation with quality core manufacturers at initial stages of design. The largest production quantities have been in FM I.F. Transformers and in I.F. Coils in Television Receivers.

Very truly yours,

STANDARD COIL PRODUCTS COMPANY, INC.

Fred Edwards

F. W. Edwards
Chief Engineer

NO "SACRIFICE IN PERFORMANCE..."
IF transformers manufactured by Standard Coil Products Co., Inc., containing Carbonyl Iron "E" Powder Cores. Range—250 KC to 25 mc.

Now..low cost "E" powder for high frequencies!

ANTARA PRODUCTS
A DIVISION OF
GENERAL ANILINE & FILM CORPORATION
444 Madison Avenue
New York 22, N. Y.

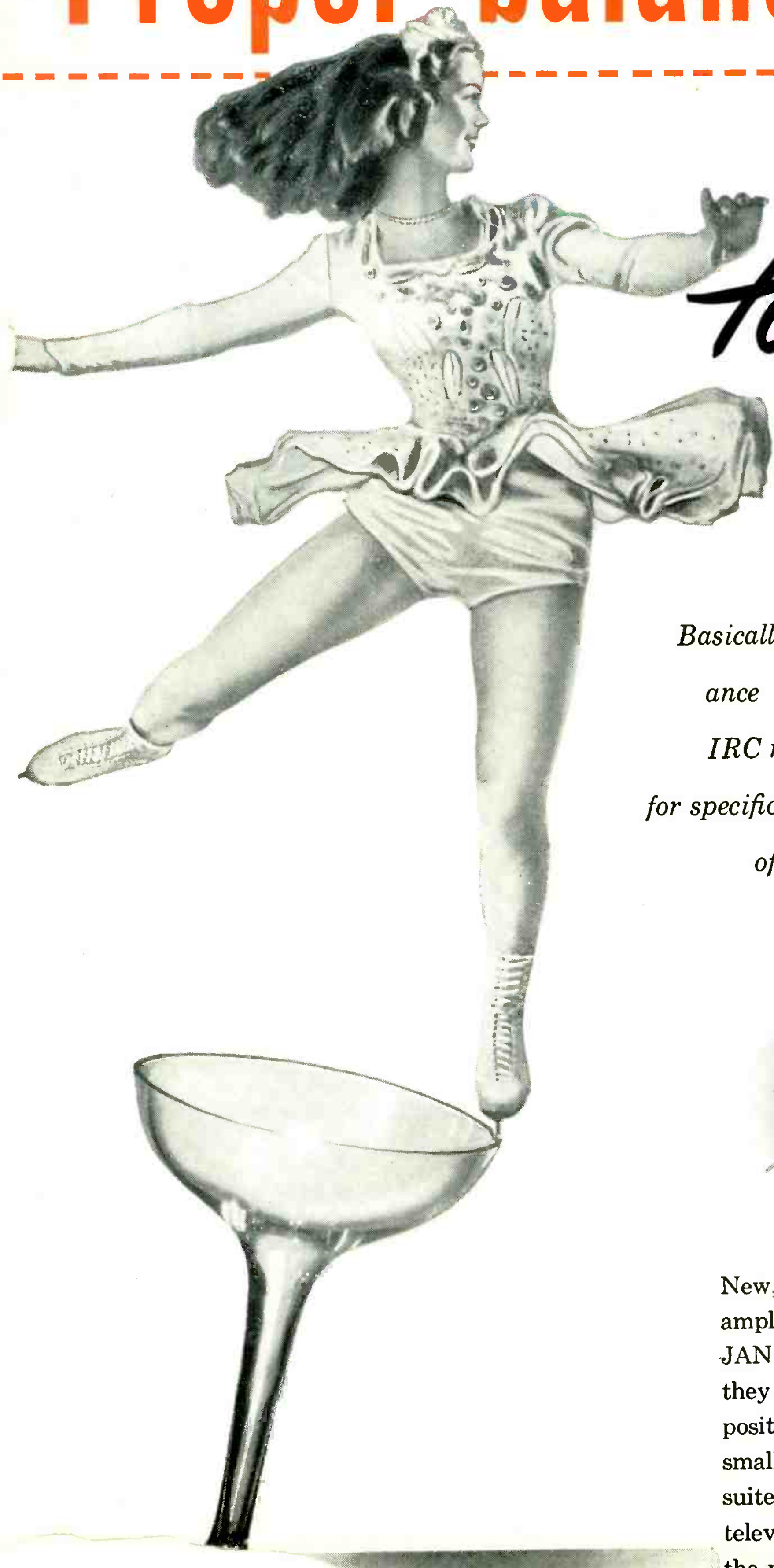
Yes! we said it was possible, and now Standard Coil Products has proved it. This outstanding manufacturer has been able to use low-cost Carbonyl Iron Powder, "E" Grade, in high frequency applications. "E" powder, lowest in cost of all grades, has heretofore been used at 455 KC. Now it has proved effective in IF transformers operating up to 25 mc.

For high Q at low cost use "E" powder in *your* cores and coils. Remember its stability and performance, its savings in space, weight, wire. Read Standard Coil Product's experience. Ask your core maker; ask your coil winder. You, too, can save with low-cost "E" powder!

See Antara Products' Carbonyl Iron Powders on exhibition at the Spring Meeting of the Metal Powder Association. Drake Hotel, Chicago, April 5 and 6.

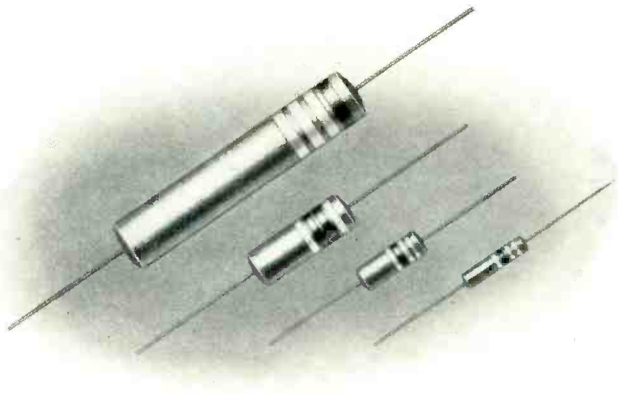
G. A. & F. Carbonyl Iron P

Proper balance can be



for resistors

Proper balance can be mighty difficult . . . but not for IRC resistors. Basically engineered for balanced *performance in every important characteristic, each IRC resistor type offers outstanding features for specific applications—without sacrifice of any significant factor.*

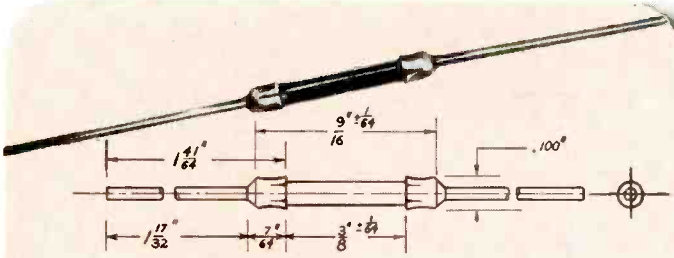


New, ADVANCED Type BT Resistors, for example, are uniformly superior in every important JAN-R-11 requirement. At ⅓, ½, 1 and 2 watts they meet JAN-R-11 specifications for fixed composition resistors. Balanced in every characteristic, small IRC ADVANCED BT's are particularly suited to high ambient temperatures and rigorous television circuits. 12-page Bulletin B-1 gives all the performance facts. Use the convenient coupon.

difficult

too!

For close tolerance requirements, IRC Precisions offer a fine balance of accuracy and dependability. Extensively used by leading instrument makers, they excel in every important characteristic. 1% accuracy is standard. Noise level is inherently low, and windings are fully protected against high humidity. Available in a wide selection of ranges and types, as described in Bulletin D-1.



Miniature MPM resistors are IRC engineered for high frequency applications. Their frequency characteristics are outstanding, but absolute balance has been maintained with all other significant electrical characteristics. Thin resistance film is permanently bonded to ceramic rods. Cupped ends of wire lead terminals are cemented to resistor bodies to form axial pigtails. Rated at ¼ watt, Type MPM's are available in resistance values from 10 ohms to 1.0 megohms. Write for Technical Data Bulletin F-1.

IRC Type W Wire Wound Controls are so carefully balanced, your customers can actually feel the difference. With center tap they are widely used as vertical and horizontal centering controls in television receivers. Design provides maximum adaptability to most rheostat and potentiometer applications within 2-watt power rating. Type W Controls have a 1¼" diameter, and 9/16" depth behind panel. Spiral Spring Connector provides positive electrical connection. Bulletin A-2 gives details. Write for your copy.

All standard IRC resistors are readily available in nominal quantities from your local distributor's well-stocked shelves. This is IRC's Industrial-Service Plan

at work, assuring you 'round-the-corner service on your small order requirements. We'll be glad to send you the name of your nearest IRC Distributor.

IRC

Wherever the Circuit Says -ᴡᴡ-

Power Resistors • Precisions • Insulated Composition Resistors • Low Wattage Wire Wounds • Rheostats • Controls • Voltmeter Multipliers • Deposited Carbon Precistors • Voltage Dividers • HF and High Voltage Resistors

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.
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INTERNATIONAL RESISTANCE COMPANY
401 N. Broad St., Philadelphia 8, Pa.
I want to know more about the IRC Resistors checked below—

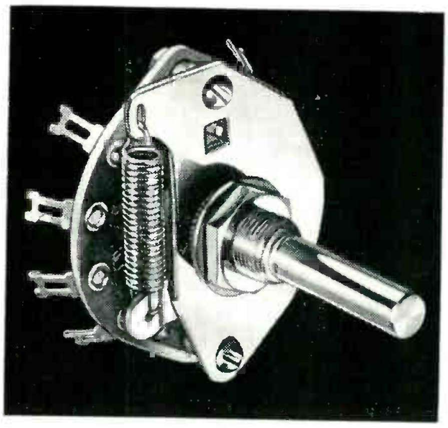
☐ Advanced Type BT's ☐ MPM High Frequency Resistors
☐ Precision Resistors ☐ Type W Controls
☐ Also send name and address of our IRC Distributor

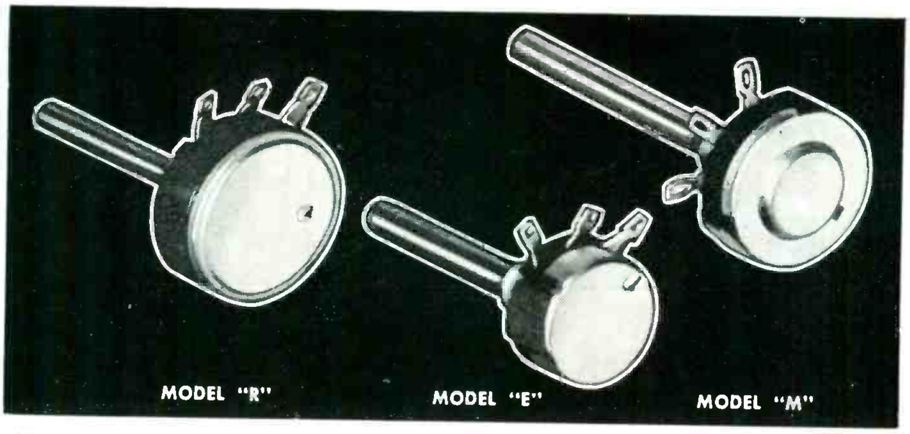
Name . . . .

Title . . . .

Company . . . .

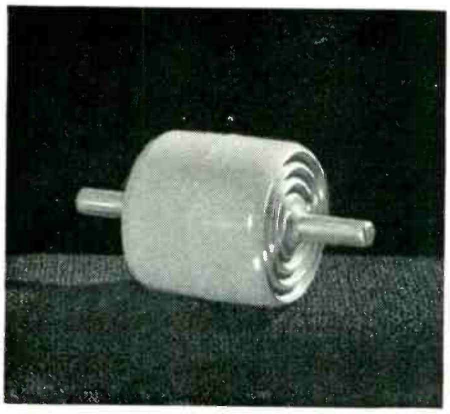
Electronic Industry

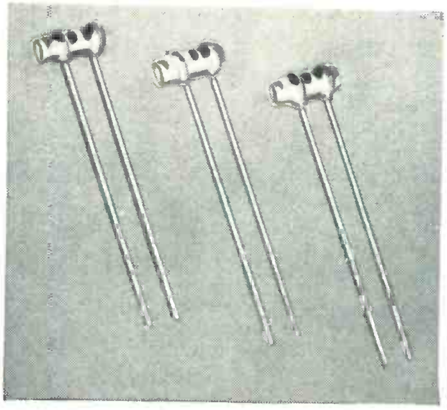


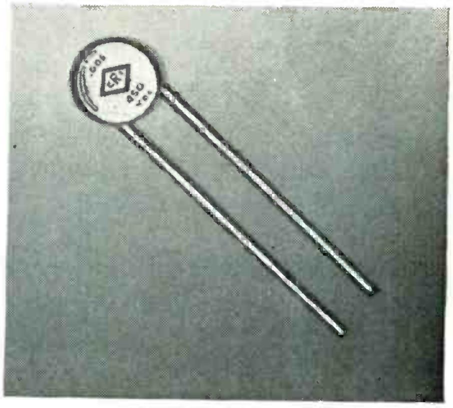


2 Great step forward in switching is CRL's New *Rotary Coil and Cam Index Switch.* Its coil spring gives you smoother action, longer life.

3 Let Centralab's complete *Radiohm* line take care of your special needs. Wide range of variations: *Model "R"* — wire wound, 3 watts; or composition type, 1 watt. *Model "E"* — composition type, 1/4 watt. Direct contact, 6 resistance tapers. *Model "M"* — composition type, 1/2 watt. For complete information, write for Bulletin 697.







4 CRL *Hi-Vo-Kaps* combine high voltage, small size for TV use. Also used as filter and by-pass capacitors in video amplifiers. 42-10.

5 Important: the recognized dependability and high quality of ceramic by-pass and coupling capacitors is now available at Centralab Distributors!

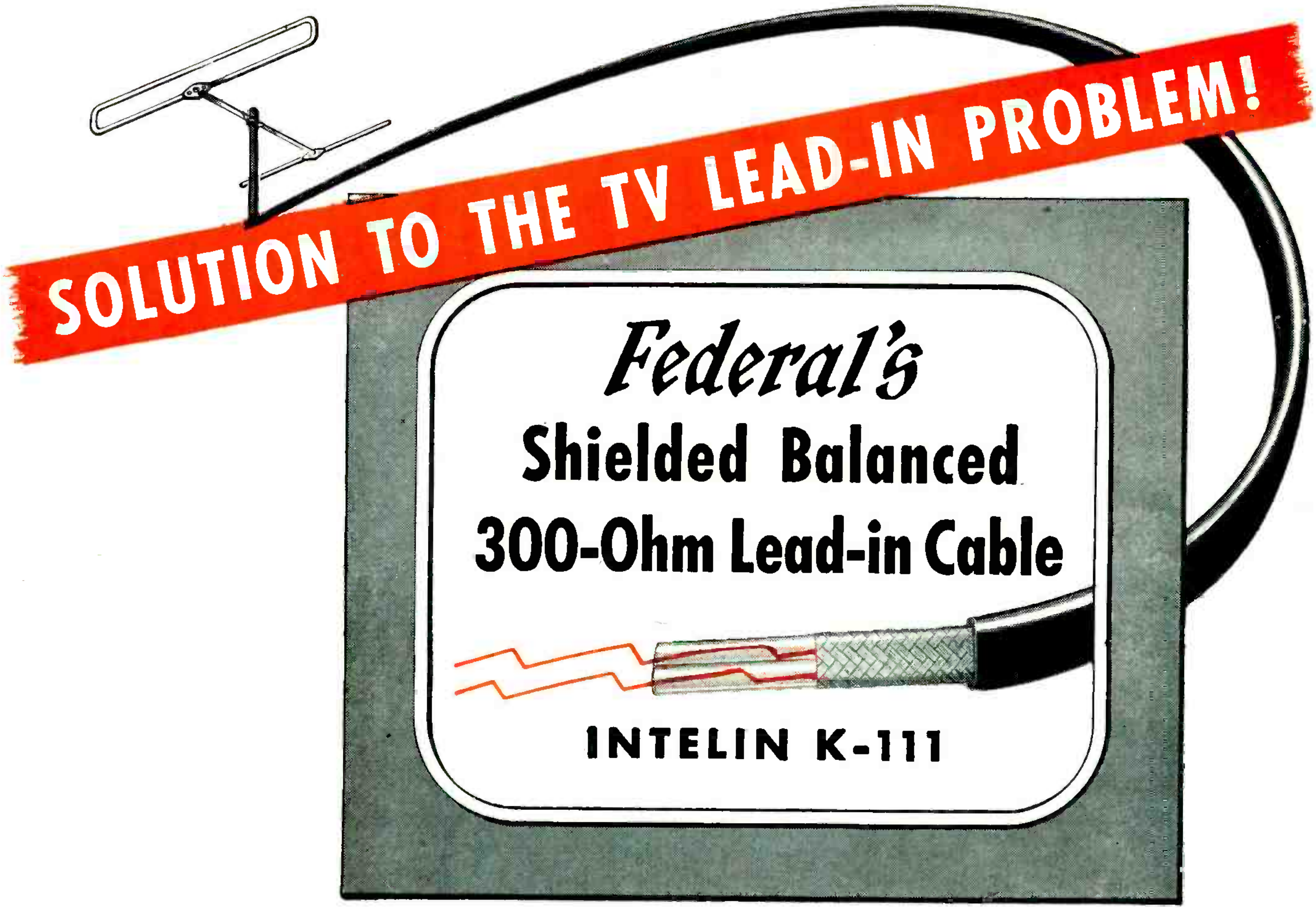
6 For by-pass or coupling applications, check CRL's original line of ceramic disc and tubular *Hi-Kaps.* For full facts, order Bulletins 42-3 and 42-4.

LOOK TO CENTRALAB IN 1949! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

Centralab

CRL ®

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.



Minimizes Noise, "Snow" and "Ghosts" Due to Transmission Line Pick-Up!

A MAJOR ADVANCE IN TELEVISION TECHNIQUE

Developed by FEDERAL
Offered Only by FEDERAL
Patent Pending

AVAILABLE IMMEDIATELY

Here is the development for which the industry has been waiting.

It is a *shielded*, balanced 300-ohm line—Intelin K-111—developed and produced by Federal—and only by Federal.

Tests have given positive proof that Intelin K-111 goes far toward solving the lead-in problem that has been a major obstacle to television progress. K-111 protects against transmission line pick-up of ignition, streetcar, fluorescent light, diathermy and practically every other type of noise, "snow" and "ghosts" which interfere with picture clarity. This new lead-in won't pick up re-radiation from nearby lead-ins in urban areas. In rural areas, where signal strength is weak, Intelin K-111 provides greatly improved reception by reducing the noise level.

Now manufacturers can obtain a lead-in that *protects* the quality performance they build into receivers of 300-ohm input impedance. Antenna kit makers can greatly improve their products. And, by changing to Intelin K-111, servicemen can call a halt to many of the customer complaints that take the profit out of service policies.

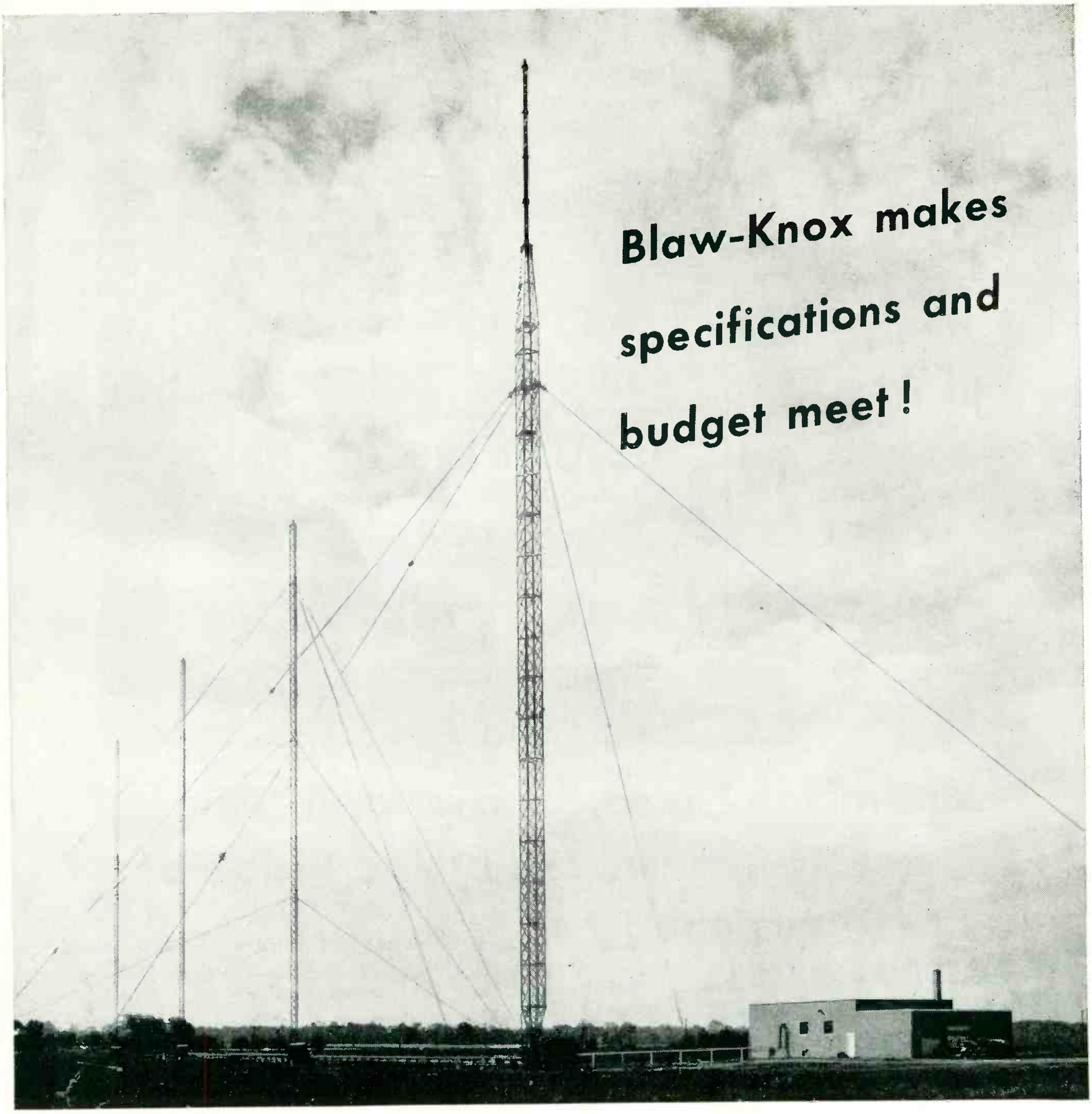
Intelin K-111 is also recommended for a pick-up-free connection between antenna post and input stage of FM and TV receivers—and for test equipment and other HF applications. For information, write to Department D-113.

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric



Station WICA, Ashtabula, Ohio

THE consulting radio engineer prescribed uniform cross section towers of maximum strength and efficiency for this directional array, but the budget demanded a minimum of expenditure. So there was only one place to take the prescription—BLAW-KNOX.

The three type LT towers illustrated, although low in cost, have the strength and high factor of safety characteristic of Blaw-Knox design and engineering. The type SGN tower completing the array has the additional strength to support the heavy-duty FM pylon and any future TV requirements.

Your tower prescription will be promptly filled at BLAW-KNOX.

Distributed by Graybar
OFFICES IN 100 PRINCIPAL CITIES

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2077 FARMERS BANK BUILDING, PITTSBURGH 22, PA.

BLAW-KNOX ANTENNA TOWERS

Facts for Manufacturers of High Frequency Equipment

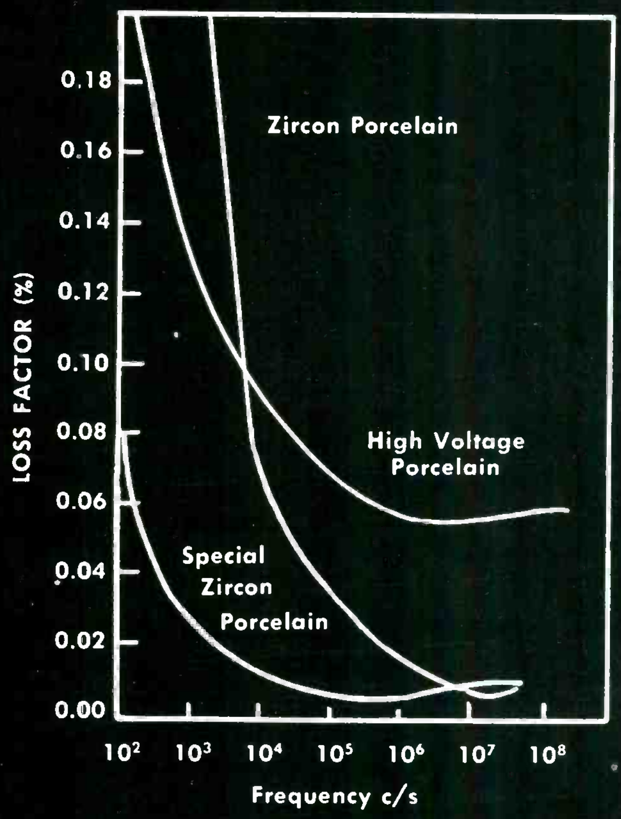
Power Loss = $55.5\varepsilon^{1} \tan\delta \times f \times V^{2} \times 10^{-6}$ Watts

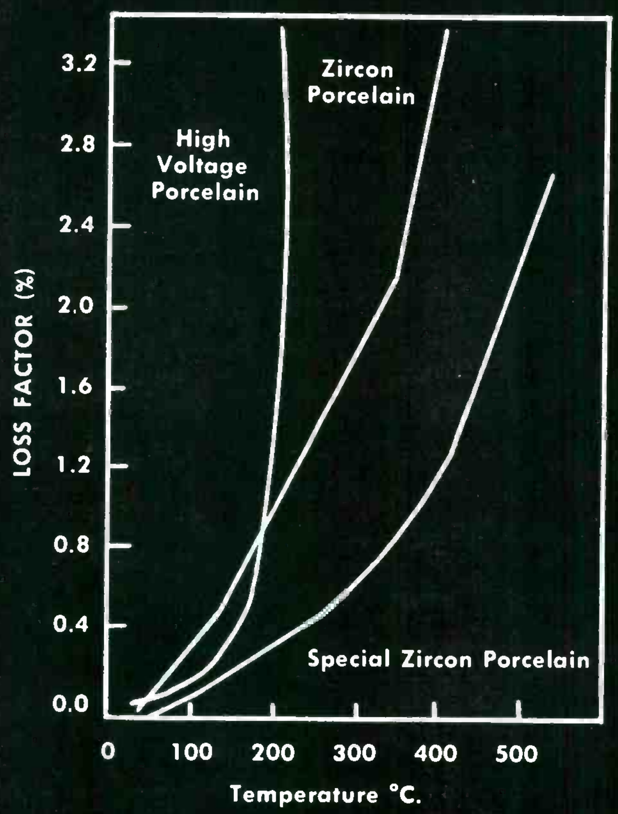
ZIRCON PORCELAIN

Because they influence efficient and effective operation, low loss characteristics of Zircon Porcelain are most desirable in the manufacture of high frequency equipment.

Meeting the requirements of the power loss formula, Zircon Porcelain retains its low loss characteristics over a wide range of temperatures and frequencies. This factor is clearly demonstrated in the charts shown.

For applications in the field of radio, radar and other equipment of this nature, it will pay to get more detailed information. Write direct or discuss the use of Zircon Porcelain with one of our qualified field staff.





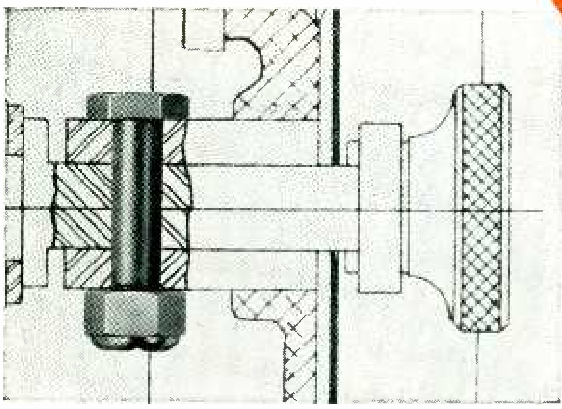
TAM

TITANIUM ALLOY MFG. DIVISION

NATIONAL LEAD COMPANY

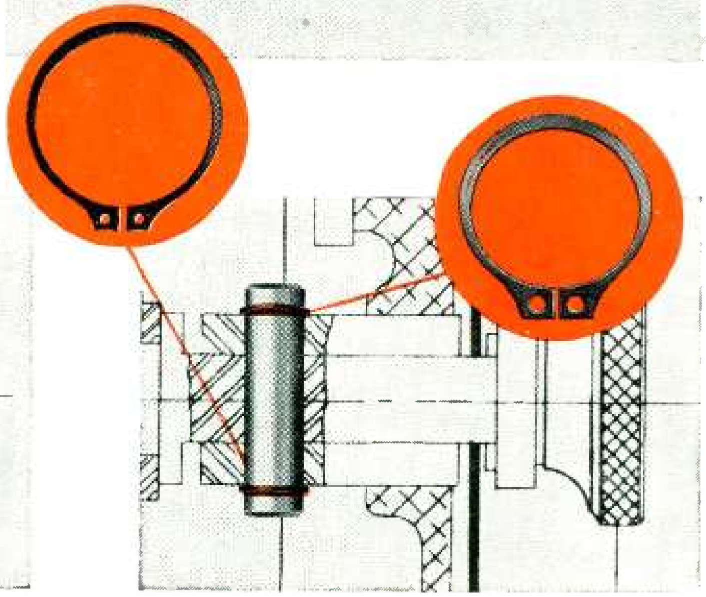
Executive and Sales Offices: 111 BROADWAY, NEW YORK, N. Y. • General Offices and Works: NIAGARA FALLS, N. Y.

Truarc saves 5 minutes, 9 cents in materials per unit without re-design of electric sanders



OLD WAY

Special ¼" cap screw and ¼-28 fibre-insert nut holds idler arm and pulley assembly on Model A3 "Take-About" Sander, Porter-Cable Machine Company.



NEW WAY

Simple ¼" C.R. shaft, grooved in automatic screw machine, equipped with Waldes Truarc Retaining Rings. Bowed external ring (#5101-25) at top exerts resilient pressure taken up by Standard external ring (#5100-25) at bottom. Assembly is secure against vibration, can be easily taken apart and re-installed many times with same Truarc rings.

Every sander through the production lines costs 9 cents less for materials, requires 5 minutes less labor—with just the simple change from cap screw and nut to Waldes Truarc rings by Porter-Cable Machine Company, Syracuse, New York. The change to Truarc required no new design, no alterations in castings, but just the reappraisal of old methods.

Truarc can help you cut costs and increase production, too. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc Retaining Rings are precision engineered, remain always circular to give a never-failing grip.

Send us your drawings. Waldes Truarc engineers will be glad to show how Truarc can help you.

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-10 Austel Place E-4
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

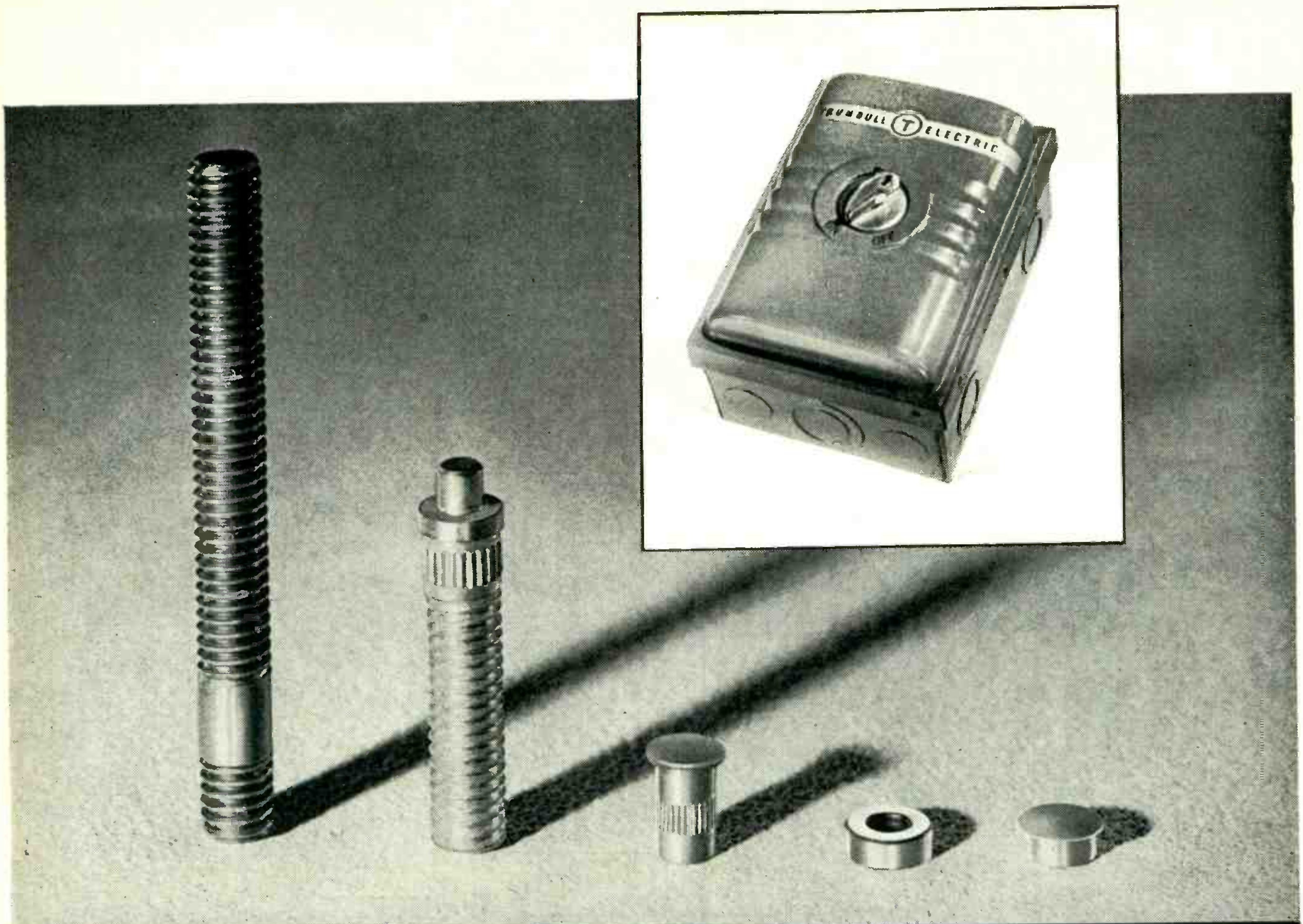
Name____________________

Title____________________

Company____________________

Business Address____________________

City__________ Zone____ State______



IF YOU MACHINE COPPER—

THIS REVERE METAL WILL SAVE YOU MONEY

REVERE makes Free-Cutting Copper Rod, and if you are making electronic devices requiring machined copper parts of high conductivity, it will pay you to investigate the savings made possible by this metal. We would suggest that you make trial runs to prove what it will do under your own shop conditions. That was the procedure followed by The Trumbull Electric Mfg. Co., Plainville, Conn., with these results:

Part #18107 and 18108, contacts for the Type D switch illustrated, were designed around this alloy. Trumbull states: "On both these parts we found we could make them in one operation instead of two. That is, due to the smooth free cutting of the metal, it was unnecessary to perform a facing operation . . . Our Screw machine foreman advises that, in his opinion, both these parts could be made four times as fast as out of ordinary electrolytic copper rod."

#3731, 60 amp. post stud.—5,760 pieces run in 19.6 hours with no machine down-time; 10,425 pieces of ordinary copper rod run in 66.6 hours with 11.8 hours machine down-time. In addition to the extra time required, three sets of dies were used for the regular rod. "The savings of the free-cutting material over ordinary copper were figured at $1.81 per thousand, including in these costs both material and direct labor."

#16552, space washer. "Savings per thousand over electrolytic copper were 77¢. This figure included the material difference and direct labor. In addition, there was an 18% saving in machine down-time."

#K-60-1A, 70-200 amp. stud. "The use of Free-Cutting Copper Rod on this part very definitely increased production and practically voided machine down-time.

In a letter to Revere, Trumbull added: "In general, at least for most of the parts we have used, we find that there is at least a 25% saving in machine time of free-cutting over regular copper. In addition, the workers are enthusiastic about this material, particularly when running studs, because of the fact that it is no longer necessary for them to keep a constant close watch on the machine to see that the turnings do not become tangled up with the moving parts of the machine."

The Trumbull experience is being duplicated in other machine shops. If you have not tried this Revere Metal, we suggest you get in touch with your nearest Revere Sales Office.

REVERE

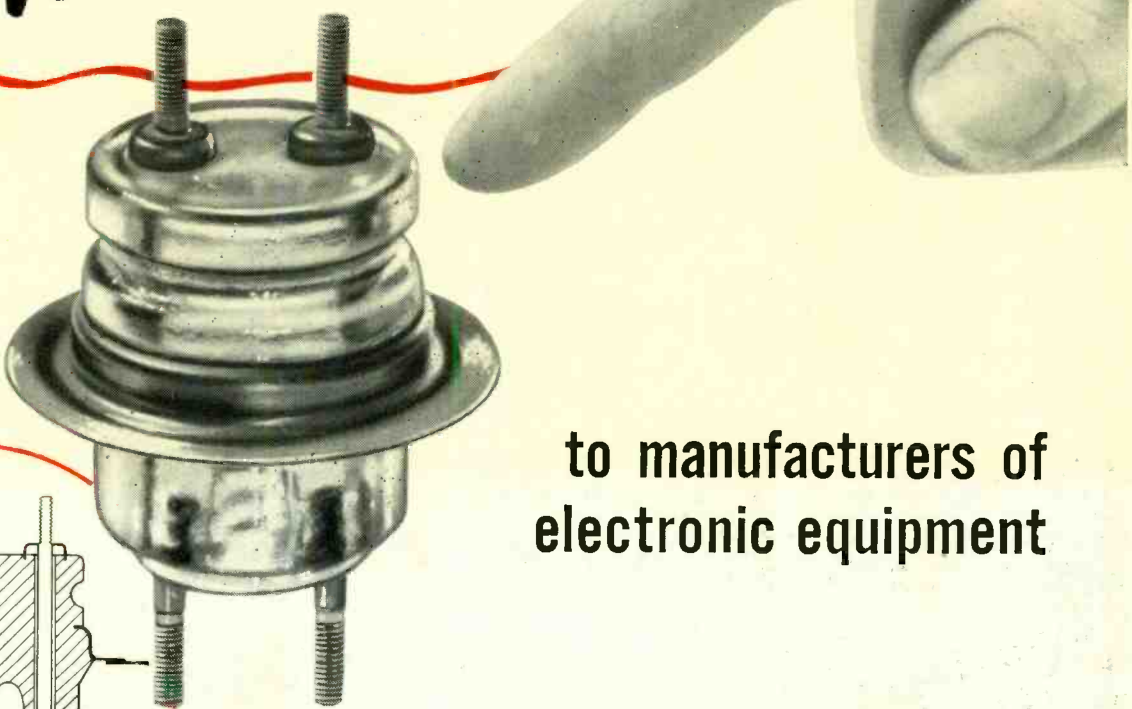
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

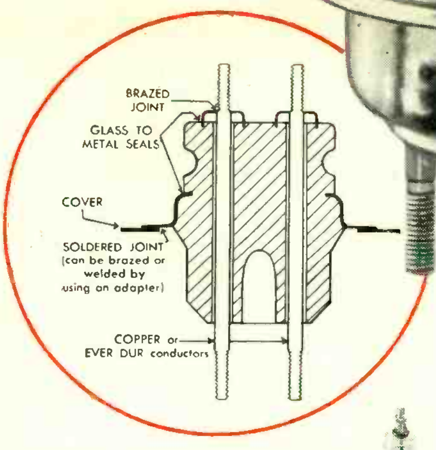
230 Park Avenue, New York 17, New York

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

Glass bushings Now Available



to manufacturers of electronic equipment



Can be welded, brazed, or soldered to case, forming a strong, permanent, hermetic seal that eliminates moisture problems and often permits more compact, light-weight design.

General Electric now offers to other manufacturers the glass bushings that it has used so successfully on capacitors, rectifiers, modulator and instrument transformers, and other electrical equipment. These bushings are cast of an exceptionally stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings are attached directly to the apparatus without gaskets—by soldering, welding or brazing the metal bushing flange to the metal case.

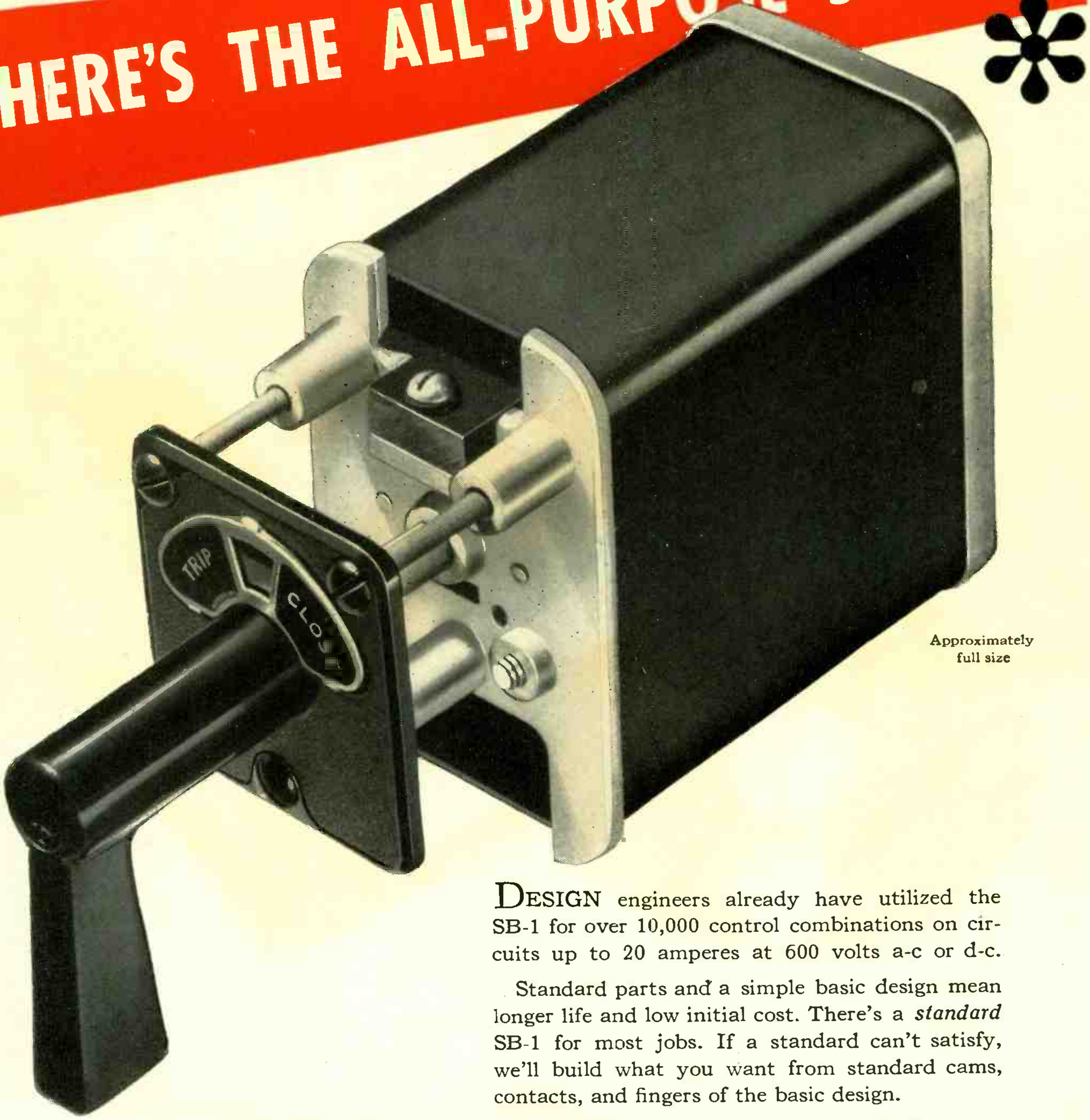
The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, fungus growth or severe changes in temperature. These glass bushings are available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from $1\frac{5}{8}$ to $3\frac{3}{8}$ inches and weights from $2\frac{1}{2}$ oz. to 4 lb.

The best way to evaluate these glass bushings for capacitors, modulator transformers, and other electronic equipment, is to see them. If you will send us a sketch and ratings of bushings you are now using, we will furnish you with samples of one or more of our standard glass bushings. Bulletin GEA-5093 contains complete listings of our standard designs, allowing you to select the particular bushing you require. ***Power Transformer Sales Division, General Electric Company, 16-215 Pittsfield, Mass.***

WRITE TODAY FOR BULLETIN GEA-5093

GENERAL ELECTRIC

HERE'S THE ALL-PURPOSE SWITCH *



Approximately full size

DESIGN engineers already have utilized the SB-1 for over 10,000 control combinations on circuits up to 20 amperes at 600 volts a-c or d-c.

Standard parts and a simple basic design mean longer life and low initial cost. There's a *standard* SB-1 for most jobs. If a standard can't satisfy, we'll build what you want from standard cams, contacts, and fingers of the basic design.

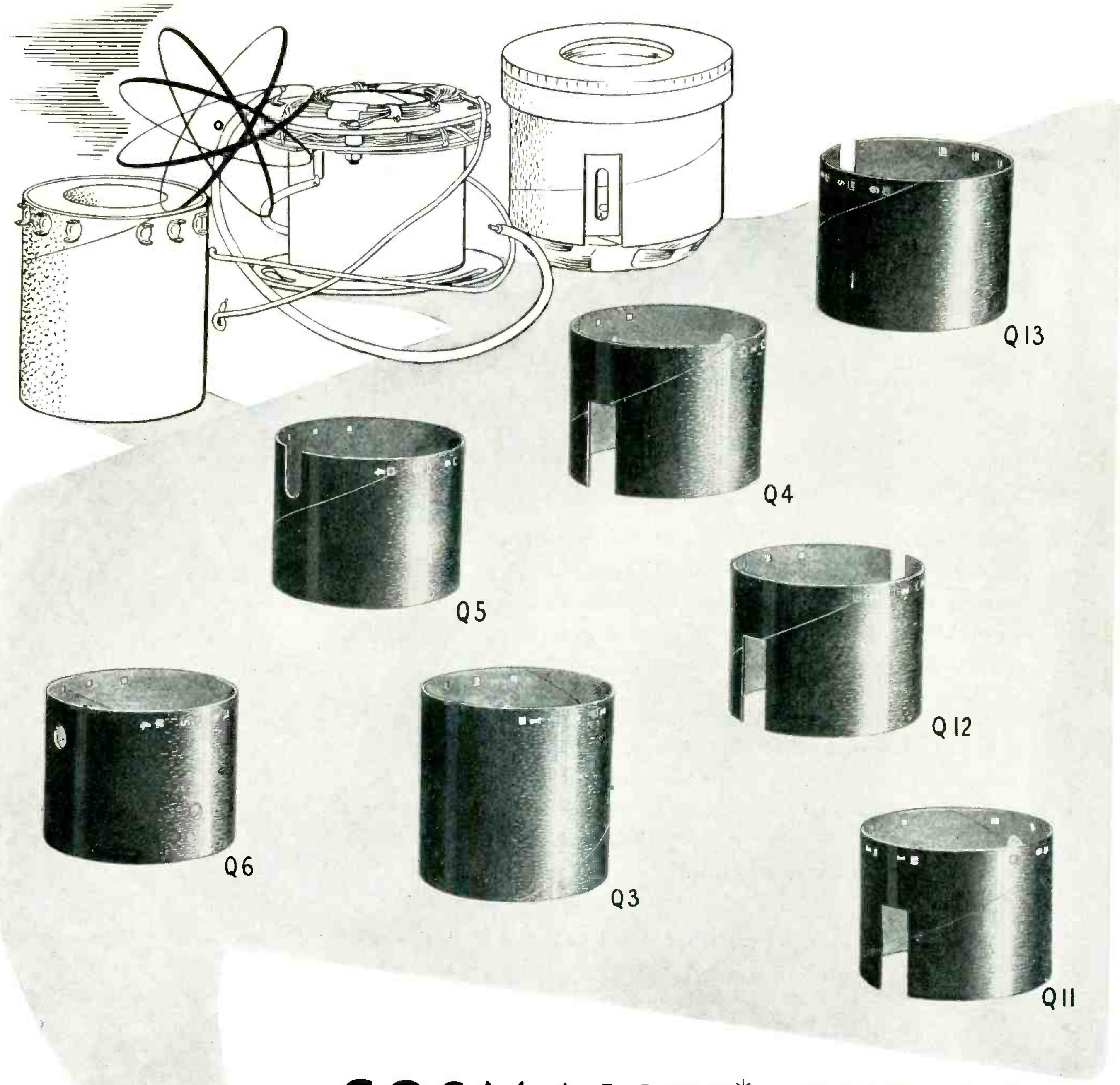
A variety of attractive switch handles, and water-tight, dust-tight, oil-immersed, fabricated-metal, or explosion-proof housings are available to fit your particular installation problems.

Your nearest G-E sales representative will be glad to assist you in the selection of an SB-1. Also, ask him for a copy of GEA-4746 which gives additional information about the SB-1, or write to *Apparatus Department, Section 856-6, General Electric Company, Schenectady 5, New York.*

SB-1

* it's the.... **CONTROL AND TRANSFER SWITCH**

GENERAL ELECTRIC



COSMALITE* SHELLS

for Television deflection yokes are made to meet your individual needs.

Keep in mind that we have tools available without charge for all Shells shown above. And . . . we can quickly make tools for other punching and notching as may be required. COSMALITE is known as a quality product. It meets the most exacting requirements.

Inquiries given specialized attention

DEFLECTION YOKE SHELLS with black exterior finish, as illustrated above, have 3" inside diameter and 3.093 outside diameter.

Q-3 is 2 31/32" long. The others, Q-4, Q-5, Q-6, Q-11, Q-12, Q-13 are 2 11/32" long.

* Reg. U.S. Pat. Off.

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.

MITCHELL-RAND

WEDGES

all sizes . . . all styles

HARD WOOD MAPLE • FIBRE AND FISH PAPER

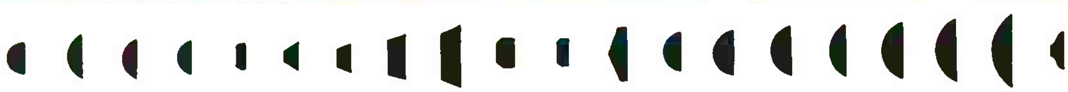
MITCHELL-RAND HARD WOOD MAPLE WEDGES are fine grain, hard, accurately sized and shaped and wax processed to resist humidity and moisture. They are available in lengths of 30 inches and in any of 20 styles and sizes.

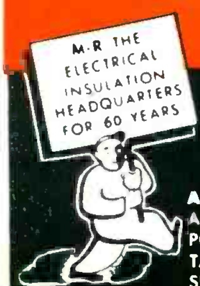
MITCHELL-RAND MOLDED and FORMED WEDGES are of FIBRE and FISH PAPER. They are flexible, easy to handle, have great bending strength with high dielectric and tensile resistance . . . available in lengths of 40 inches and in almost any shape and form.

For WEDGES as for all other ELECTRICAL INSULATIONS you can depend upon —

MITCHELL-RAND

THE ELECTRICAL INSULATION HEADQUARTERS SINCE 1889.





MITCHELL-RAND INSULATION CO. Inc.

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

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

ANNOUNCING...
"Three-Sixty" Hypex PROJECTORS

MODEL VR-11 "THREE-SIXTY" HYPEX ***(above)*** *15 WATTS; 280 CPS CUT-OFF.*

MODEL VR-241 "THREE-SIXTY" HYPEX ***(at right)*** *25 WATTS; 140 CPS CUT-OFF.*

TWO *new* Hypex* Projectors—designed for 360-degree sound dispersal—are now available. With sound distributed horizontally in all directions, these new models are intended for installations where coverage of relatively large areas and suspension from the ceiling are desired. Like all Hypex Projectors, these radial units incorporate the famous Hypex formula† which results in improved acoustic performance.

By the addition of the two radials to the four previously announced Hypex units illustrated below, the Hypex line now includes a model for every "sound" need, indoors or outdoors.

Jensen Hypex

**Trade Mark Registered* *†Patent 2,338,262*

Write for Data Sheet 143

JENSEN MANUFACTURING COMPANY
Division of the Muter Company
6607 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS *In Canada:* COPPER WIRE PRODUCTS, LTD., 351 CARLAW AVENUE, TORONTO

MODEL VH-24 HYPEX
25 WATTS; 110 CPS CUT-OFF

MODEL VH-20 HYPEX
25 WATTS; 140 CPS CUT-OFF

MODEL VH-15 HYPEX
15 WATTS; 180 CPS CUT-OFF

MODEL VH-91 HYPEX
15 WATTS; 300 CPS CUT-OFF

A NEW SOLUTION TO OLD PROBLEMS

Keeping Your Radio Beacon Signal "On The Air" Is Simple With Aerocom's Automatic Transfer

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.

The problem of transmitter failure in radio beacons is very serious. The safety of crew and passengers depends on the continuous operation of this navigational aid.

Aerocom's Automatic Transfer provides the means of placing your standby transmitter "On the Air" should the main transmitter fail for any reason except loss of powerline voltage. It can be set to function either on abnormally low carrier power or abnormally low level of keyed tone identification signals.

A letter or wire from you will bring descriptive literature

CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT.

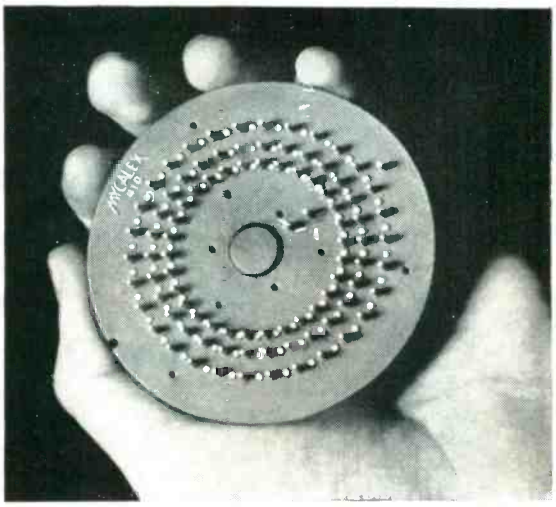
AER -O- COM
Reg. U. S. Pat. Off.

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DEALERS: Equipeletro Ltda., Caixa Postal 1925, Rio de Janeiro, Brasil ★ Henry Newman Jr., Apartado Aereo 138, Barranquilla, Colombia ★ Radelec, Reconquista 46, Buenos Aires, Argentina

MYCALEX 410 MAKES HISTORY

Sets astonishing high operational record for telemetering commutator used on aeronautical research projects . . . MYCALEX 410 only insulation to fill exacting requirements.

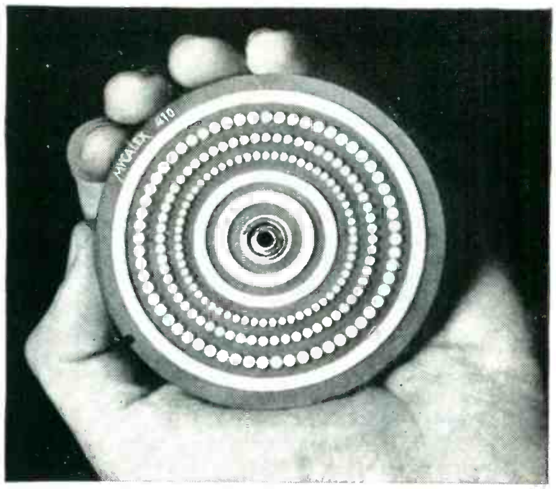


Illustrated are top and bottom views of the MYCALEX 410 molded insulation commutators manufactured to the specifications of Raymond Rosen Engineering Products, Inc., for Air Material Command and Navy telemetering projects. This commutator, with 180 contacts and 3 slip rings of coin silver, samples sixty channels of information such as air speed, altitude, angle-of-attack, temperature, pressure, voltage and other variables; and provides thirty synchronizing pulses.

To February 7, 1949, more than 200 hours of maintenance free, high speed, clean signal telemetering commutator performance has been logged on MYCALEX 410 Units. . . . Experience indicated four hours was optimistic . . . specifications hoped for ten hours . . . and the challenging problem was solved by MYCALEX 410 molded insulation.

SPECIFICATIONS TO BE MET IN PRODUCING MYCALEX 410 MOLDED INSULATION COMMUTATORS FOR TELEMETERING

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 meter • 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.



SPECIFY MYCALEX 410 for Low Dielectric loss. . . . High Dielectric strength. . . . High Arc Resistance. . . . Stability over wide Humidity and Temperature Changes. . . . Resistance to High Temperatures. . . . Mechanical Precision. . . . Mechanical Strength. . . . Metal Inserts Molded in Place. . . . Minimum Service Expense. . . . Cooperation of MYCALEX Engineering Staff.

MYCALEX 410 molded insulation is designed to meet the most exacting requirements of all types of high frequency circuits. Difficult, involved and less complicated insulation problems are being solved by MYCALEX 410 molded insulation . . . the exclusive formulation of MYCALEX CORP. OF AMERICA . . . our engineering staff is at your service.

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

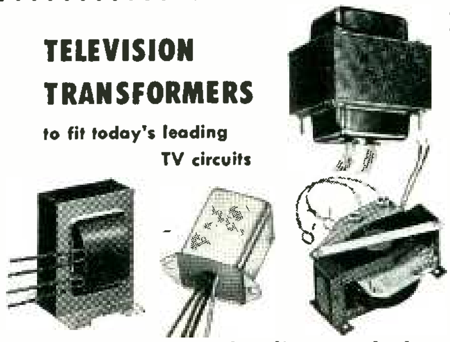
Plant and General Offices, CLIFTON, N. J. *Executive Offices,* 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

CHICAGO

The Name that Makes NEWS in TRANSFORMERS

TELEVISION TRANSFORMERS

to fit today's leading TV circuits



A complete catalog line, made by CHICAGO—the largest single manufacturer of original equipment TV transformers. Included are power, vertical blocking oscillator, and both vertical and horizontal scanning output transformers in a range of designs that are exact duplicates of units used in the leading TV sets.

POWER TRANSFORMERS

A Complete Line in 2 alternate "Sealed in Steel" Mountings

Exclusive features like these make this the "Engineer's Line": Plate and filament voltages to fit today's most-used tubes; in two mountings —with solder lugs or 10″ leads; one series for condenser input, another for reactor input use; exactly matching reactor for each power transformer. Get complete catalog now.

HIGH Q CHOKES

for Dynamic Noise Suppression Circuits

Two efficient filter reactors, inductance values .8 and 2.4 henrys respectively, are designed for noise suppression circuits, but can be used in any tuned circuit requiring the given inductances. Inductance values are accurate within ±5% with up to 15 ma. d-c. Minimum Q of 20. Mounted in identical drawn steel cases 1 11/16″ x 2 3/8″ x 1 7/16″. Write for descriptive sheet including diagram of simplified dynamic circuit.

FULL FREQUENCY RANGE AUDIO TRANSFORMERS

within ± ½ db. typical response 30 to 15,000 cycles

For uniformly low distortion, for response curves that are truly flat over the full frequency range, use these CHICAGO input and output units. Get the facts on the BO-6 (P-P 6L6's to 6/8 or 16/20-ohm speaker), the BO-7 (600/150-ohm line to 6/8 or 16/20-ohm speaker), and other CHICAGO full frequency units—they're tops in transformers.

ISOLATION TRANSFORMERS

for safer, more efficient servicing

For isolating chassis ground from line ground and eliminating the shock hazard (important on "hot" TV sets). Dual purpose: where line is under/over voltage, sec. supplies 115 v.; with 115-volt line, sec. supplies 125/115/105 volts (high/low volts help find doubtful tube, etc.). Three sizes: 50, 150, or 250-VA. to cover full range of servicing needs.

MODULATION TRANSFORMER

for Ham and Commercial Transmitters

A Modulation Transformer ideally suited for use in ham and commercial speech transmitters. Will deliver 250 watts of Class B audio power from P-P 203A's, 211's, 805's, 75TL's, etc. to a Class C load with response variations not exceeding ±1 db. over the speech range, 200-3,500 cycles. Primary impedances, 9000/6700 ohms; secondary impedances, 8000/6000/4000 ohms. A matching driver transformer is available.

REPLACEMENT TRANSFORMERS

Premium Quality Yet They Cost No More

The new CHICAGO Replacement Line provides servicemen with a wide range of standard ratings that fit the most frequent power and audio transformer requirements. These units, backed by CHICAGO'S 20 years of manufacturing experience represent the finest quality attainable through engineering ingenuity and precision manufacture—yet they *cost no more.*

See the Complete CHICAGO Line at
THE RADIO PARTS SHOW
BOOTH **160** CHICAGO, MAY 18 to 20

in the meantime...
SEE YOUR JOBBER

Write for complete **CHICAGO** *Transformer Catalogs*

CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET • CHICAGO 18, ILLINOIS

CHICAGO TRANSFORMER — TRADE MARK REG.

Federated ROSIN CORE SOLDER

Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

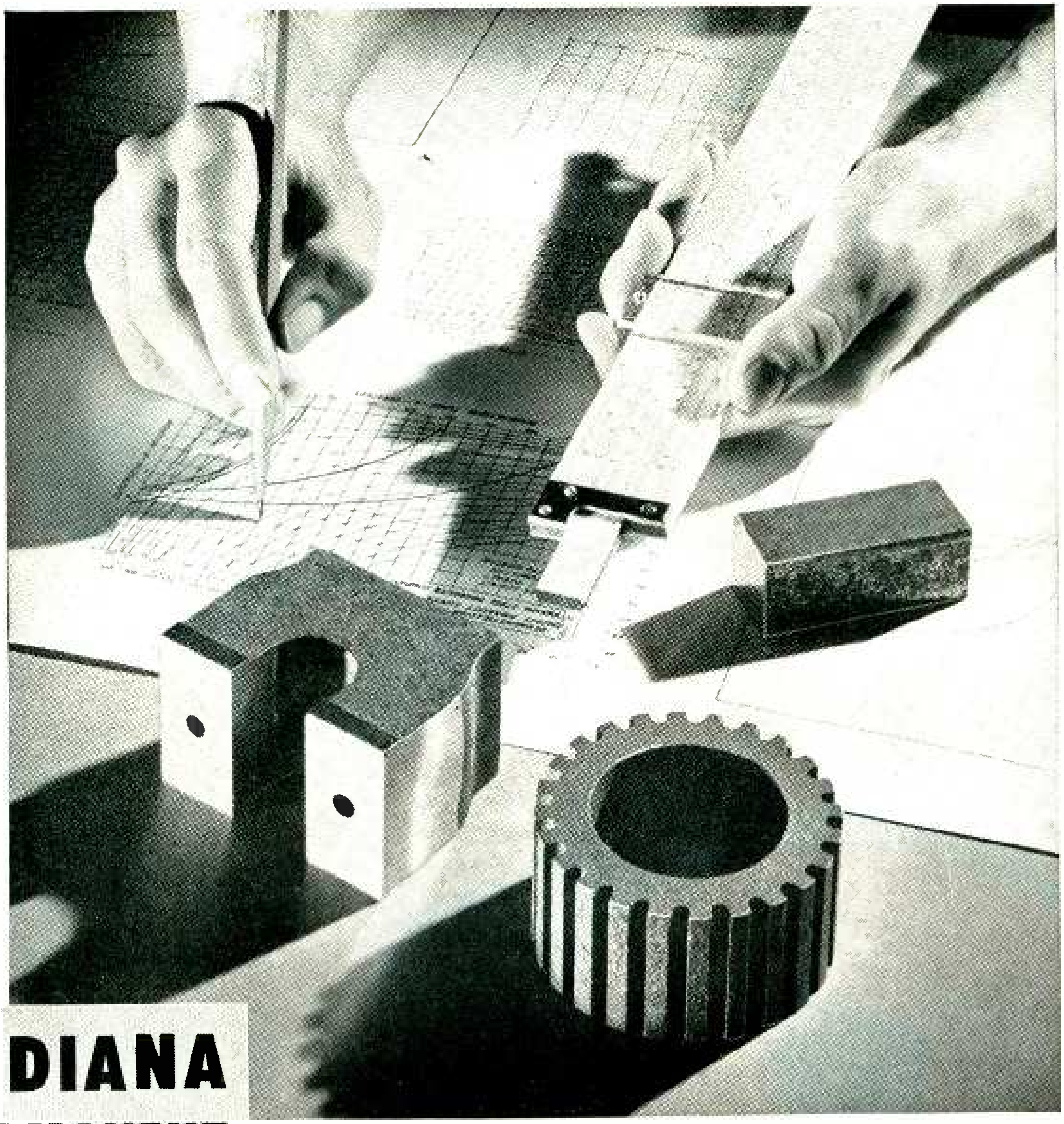
The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes *every* commercial solder . . . Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world's leading supplier of solder.

Federated first in the non ferrous field FMD

Federated METALS

Division of AMERICAN SMELTING AND REFINING COMPANY
120 Broadway, New York 5, N. Y.
OFFICES IN PRINCIPAL CITIES ACROSS THE NATION



INDIANA PERMANENT MAGNETS may be your answer, too...

"Packaged Energy" Saves Size, Weight, and Cost

Every day, *Indiana* permanent magnets are opening new fields, bringing new opportunities to science and industry. From magnetic can openers to cosmic ray research, these permanent magnets—of new designs and increased efficiency—enable equipment to do *a better job.* They add new functions . . . step up performance . . . *cut costs.* These magnet developments can mean extra profits for *you*—for "packaged energy" may have direct application to *your own* methods and products.

Our specialists have a complete range of magnetic alloys for casting, sintering, or forming permanent magnets as large or as small as you need. Strict supervision of *every step* in production assures magnets of *exact* characteristics, both magnetic and mechanical. The experience and know-how of more than 25,000 different applications are at your service. Let us help you with *your* magnetic problems, too. Write today.

● *Indiana*—world's largest exclusive producer of permanent magnets—is the *only* manufacturer furnishing *all* commercial grades of permanent magnet alloys. The most commonly used are:

CAST:
Alnico I, II, III, IV, V, VI, and XII; Indalloy; Cunico; Cobalt.

SINTERED:
Alnico II, IV, V; Indalloy; Vectolite.

DUCTILE:
Cunico; Cunife I and II; Silmanal.

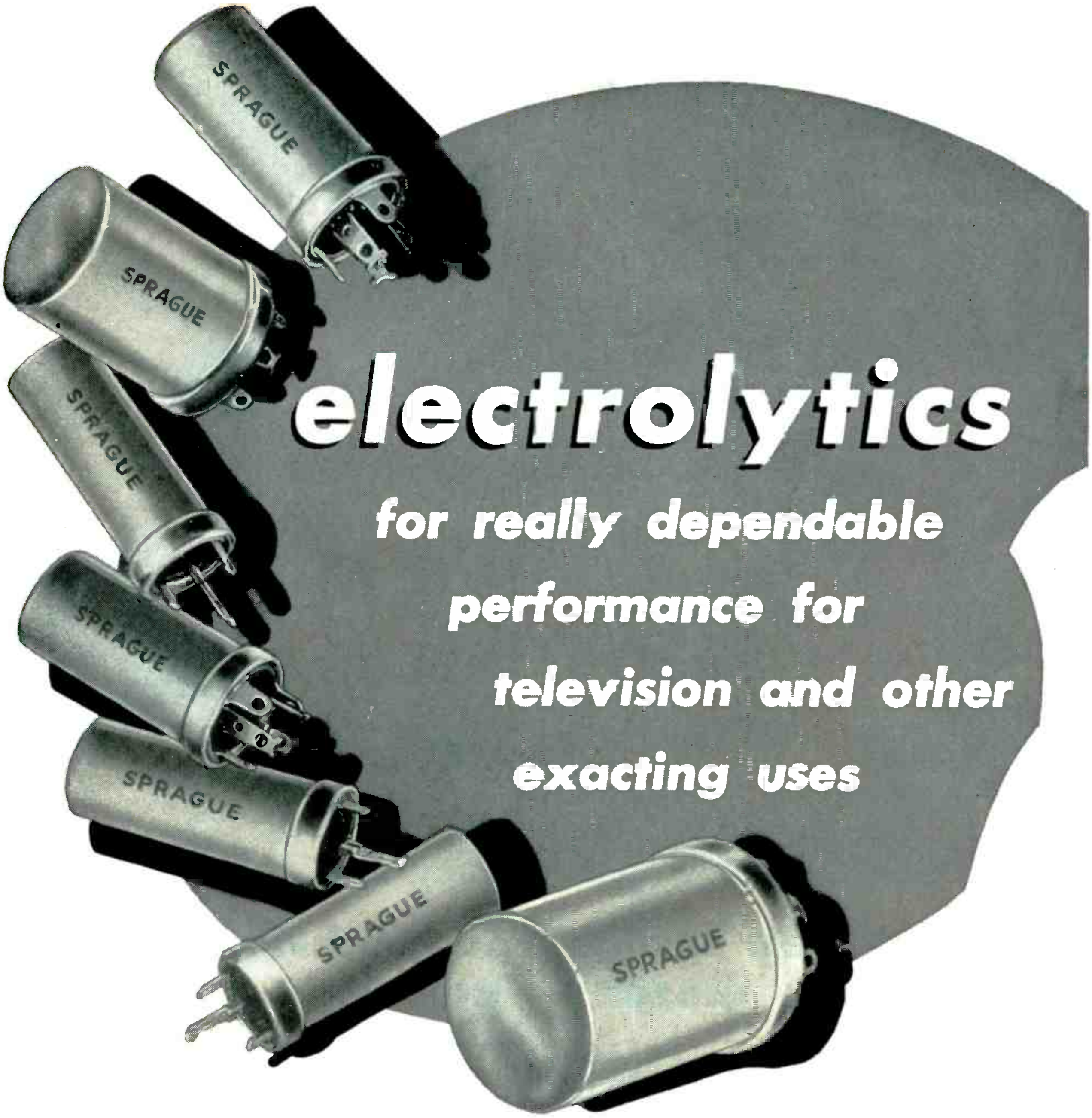
FORMED:
Chrome; Cobalt; Tungsten.

Ask for free Book No. 4-E4 — our new permanent magnet reference manual. A note on your company letterhead will bring a copy to your desk.

THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1908
PLANTS: VALPARAISO, INDIANA; CHAUNCEY, N. Y.


SPRAGUE
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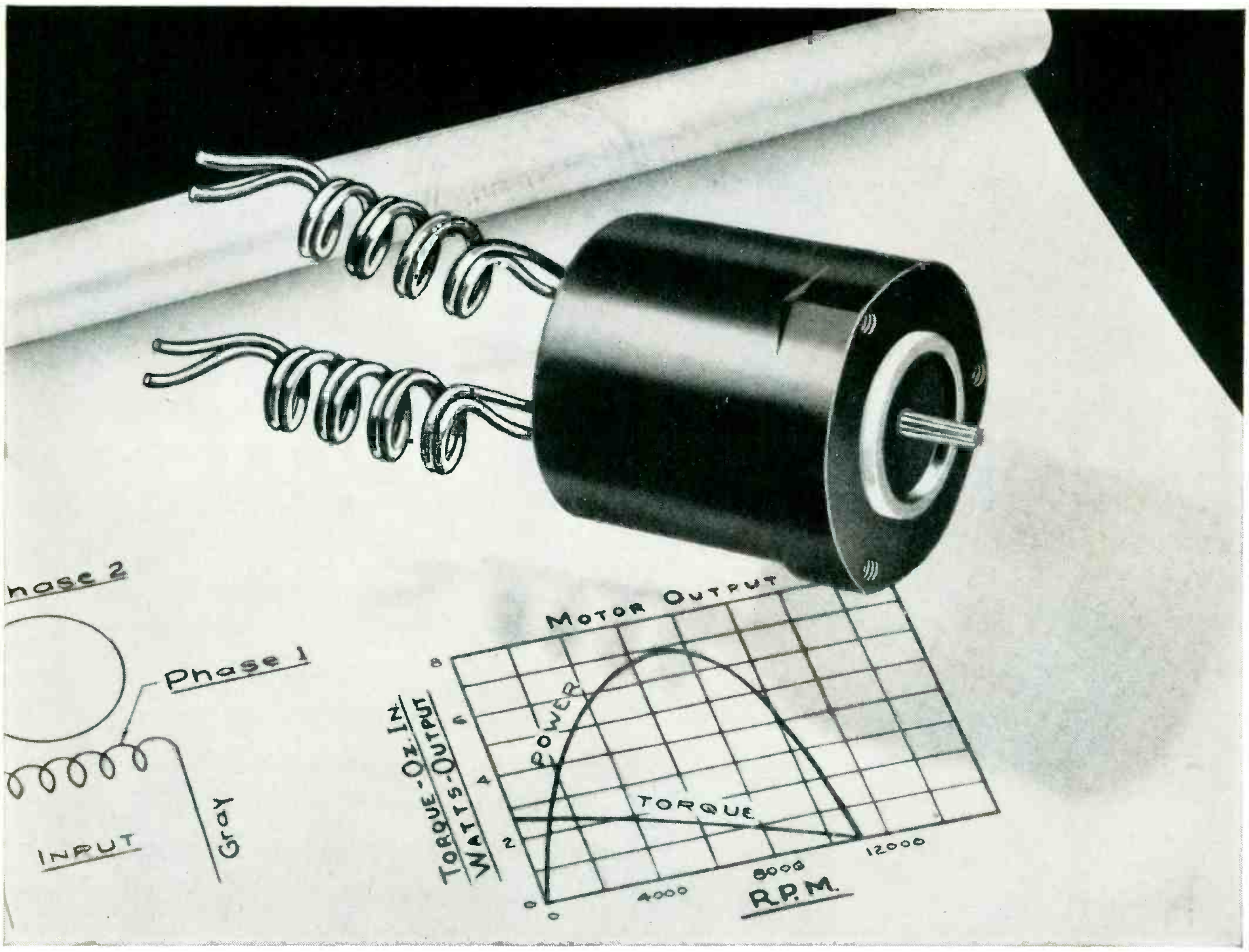
electrolytics
for really dependable performance for television and other exacting uses



A new low-inertia, high-torque motor by KOLLSMAN

This newest addition to the Kollsman line of special-purpose motors is a two-phase, low-inertia induction unit. It is designed for use in 400-cycle servo (null follow-up) systems which require a small motor with an unusually high torque/inertia ratio.

The Model 1318-0460 delivers maximum torque at stall, has a low moment of inertia and will not run single phase. Its frame is fully enclosed. Units with either plain or pinion shaft are available.

The Model 1318-0460 is but one of a complete line of special-purpose motors developed by Kollsman for remote indication and control applications. Complete information concerning any or all of these units is available by addressing: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

Characteristics

Frequency (c.p.s.)	400
Phases	2
Speed (r.p.m. — no load)	11,500
Torque (oz./in. — stalled)	2.5
Torque/inertia ratio (radians/sec./sec.)	26,340
Torque/inertia ratio (in. — oz./oz.—in.^{2})	68
Size (dia. x length)	1¾" x 1-47/64"
Weight (ounces)	6.1

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

Actual Size

The Disc Cathode, product of the Electronics Division of Superior Tube Company, is designed primarily for television and other cathode ray gun structures. The Disc Cathode is manufactured to Superior Print ED1-1, a copy of which is available upon request.

for Television

DISC CATHODE ASSEMBLIES

The Disc Cathode manufactured by the Superior Tube Company has been proved in service. It consists of a tubular nickel shank, a ceramic insulator, and an emitting cap welded to the shank. Its use relieves you of a delicate assembly operation. Through the use of integral beads (embosses) on the tubing, the ceramic is firmly held in place, so that it does not move during processing.

Close control of tolerances, material and cleanliness is maintained, with the result that the cut-off characteristics of your television tube are more uniform. In addition to the plain ceramic insulators (Print ED2-3) illustrated above, a grooved type (Print ED2-3A), is also available in regular production.

For television, other tubular products of the Electronics Division include—

- Stainless Steel Anode and Grid Cylinders, available with rolled ends, straight and angle cut, etc.
- Seamless and Lockseam† Nickel Cathodes.
- Aluminum Wave Guide Tubing in cut or random lengths for the "X" and "K" bands.
- Tubing for glass to metal seals.

You are invited to contact Superior's Electronics Division for complete information.

†Reg. U. S. Patent.

Superior

THE BIG NAME IN SMALL TUBING

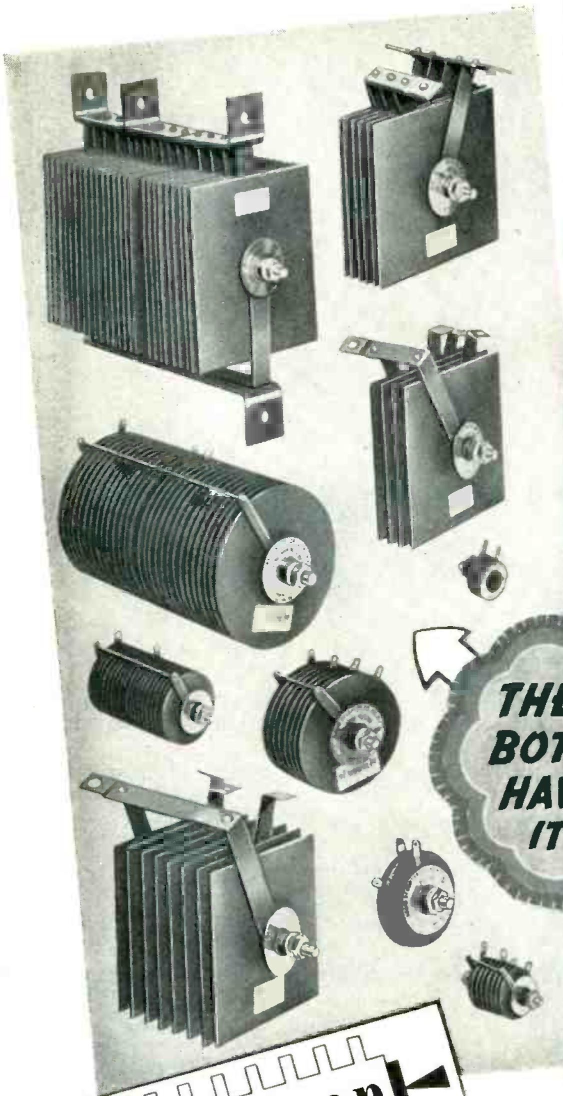
SUPERIOR TUBE COMPANY

ELECTRONICS DIVISION

2500 Germantown Avenue **Norristown, Pa.**

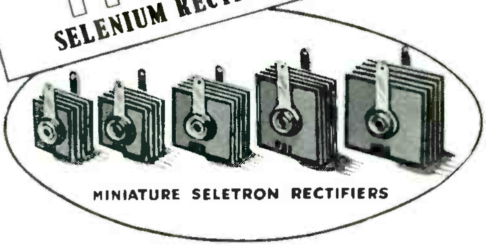
For Electronic products for export, contact Driver-Harris Company, Harrison, New Jersey. Harrison 6-4800

BUILT ON ALUMINUM



The "EXTRA SOMETHING" that spells TOP PERFORMANCE

Seletron
SELENIUM RECTIFIERS



NO "primrose path" guides the fancy skater to the championship spotlight. The amazing feats that thrill her audiences were made possible only through tireless practice and tenacity of purpose—the "Extra Something" that spells Top Performance.

In the manufacture of Seletron Selenium Rectifiers we have labored with similar tenacity of purpose to impart to our product the "Extra Something" that spells Top Performance—extra quality in materials, extra care in maintaining the highest precision standards, extra testing and inspection from start to finish of the production line.

Where such an exacting formula is followed the result must be a product of dependable performance and long life.

For assured dependable service in all Electronic and Radio applications specify Seletron Miniatures.

CODE NUMBER	5L1	5M1	5P1	5R1	5Q1
Current Rating	75 ma.	100 ma.	150 ma.	200 ma.	250 ma.
Plate Height	1"	1"	1 3/16"	1½"	1"
Plate Width	⅞"	1"	1 3/16"	1¼"	1"

Write today for catalog. Address Dept. ES-16

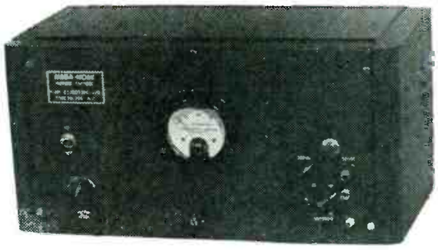
1949 IS TV YEAR

SELETRON DIVISION
RADIO RECEPTOR COMPANY, INC.
Since 1922 in Radio and Electronics
251 WEST 19TH STREET, NEW YORK 11, N. Y.

KAY ELECTRIC COMPANY

FOUR NEW KAY INSTRUMENTS
INTRODUCED AT I.R.E. SHOW . . .

For High Frequency Laboratory Work and TV Receiver Development and Service.



THE MEGA-NODE (NOise dioDE) HELPS OVERCOME RF FRONT END PROBLEMS

- A Calibrated Random Noise Source
- Read the Noise Figure of Your Receiver Directly from a Panel Meter in db—
- Selection of Various Output Impedances by Panel Switch.

SPECIFICATIONS

Frequency Range: 1 to 220 mc
Output impedances: 50, 75, 100, 150, 300 ohms and infinity controlled by panel switch. Balanced or Unbalanced.
Noise Figure Range: 0 to 17 db at 50 ohms
0 to 23 db at 300 ohms
Filament Voltage: Regulated d.c. used on filament of noise generating tube.
Power Supply: 117 Volts plus or minus 8 volts 60 cps
Dimensions: 8" x 16" x 8"

Price $295.00 F. O. B. Factory

THE MEGALYZER JR. A SENSITIVE VISUAL VOLTMETER AND SPECTRUM ANALYZER ATTACHMENT

- Used in Combination with Mega-Sweep and Standard Oscilloscope as a High Frequency Spectrum Analyzer.
- With Same Combination plus Calibrated Signal Generator, Voltage Measurements over Wide Frequency Range can be Made.

SPECIFICATIONS

Frequency Range: 30 to 500 mc Usefull to 1000 mc.
Frequency Sweep on Display: Up to 30 mc
Frequency Resolution: 100 KC
Sensitivity: 100 to 10,000 microvolts. Range can be extended upward by external pads.

Price $250.00 F. O. B. Factory

THE MEGALIGNER PROVIDES TUNABLE C W TYPE "BIRDIE" MARKER OR TUNABLE PIP MARKER

- A Television Marker Generator
- Covers All Present and Proposed Television IF Frequency Bands
- Pip Type Marker Does Not Go Through Receiver. Does Not Overload Receiver in Pass Band Nor Disappear in Traps.
- Accuracy .5% of Full Scale.

SPECIFICATIONS

Frequency Range: Two Bands 19 to 30 mc; 30 to 49 mc
Marker Outputs: CW "Birdie" or "Pip" Type
Power Supply: Self Contained
Amplitude Control: Both Outputs Adjustable by Panel Controls
Accuracy: .5% Full Scale
Mixing System: Self Contained Mixer System for Use with Sweeping Oscillator to Obtain "Pip"

Price $150.00 F. O. B. Factory

THE MICROWAVE-MEGA-MATCH DISPLAYS REFLECTED ENERGY IN X-BAND

- Displays Amount of Reflected Energy Over a Wide Frequency Range
- Sweep Frequency Width on Display up to 30 mc
- Rapid Adjustment of Microwave Antennas and Matching Sections is possible.
- Indications of Reflection Coefficient Change Down to .02.
- Approximately 75 feet 1" x ½" Waveguide Occupying Space 8 feet by 1 foot Supplied as Delay Waveguide.

SPECIFICATIONS

Frequency Range: 8500 to 9700 mc (X-Band)
Frequency Sweep on Display: Up to 30 mc
Frequency Measurement: Calibrated Microwave Wave meter
Sensitivity: Reflection Coefficient Changes Indicated Down to .02.
Equipment Includes Power Supply and Control Box, Approximately 75 Ft. 1" x ½" Delay Waveguide in 8' by 1' space

Price $895.00 F. O. B. Factory

INSTRUMENTS

FOR FURTHER DETAILS WRITE

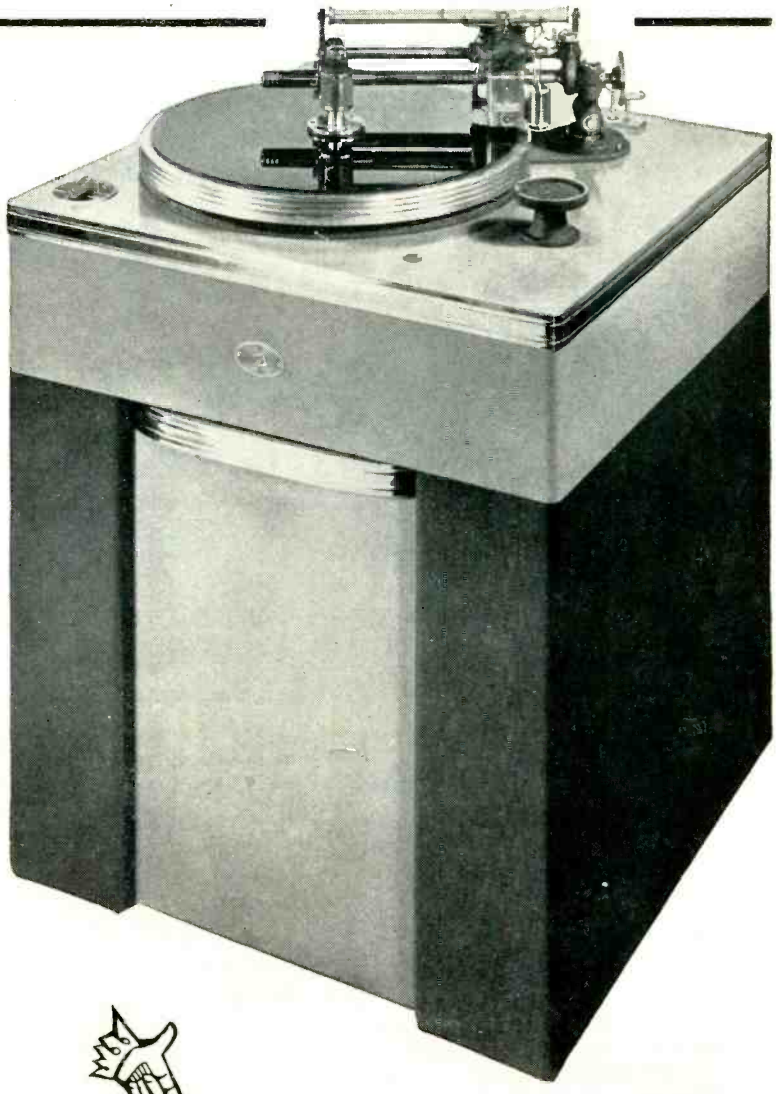
KAY ELECTRIC CO., 25 MAPLE AVE., PINE BROOK, N. J.

Tel Caldwell 6-4000

Manufacturers of: Mega-Sweep, Mega-Marker, Mega-Pipper, Mega-MarkerSr., Mega-Match, Mega-Pulser, Megalyzer, Micro-Pulser, Kay Sound Spectrograph.

66-G

Here's the Recorder You asked for!



The best features of Presto's dual motor gear drive *with* the overhead mechanism and turntable of the famous Presto 6-N.

YES, engineers have often asked us for a compact, economical yet high-quality recorder. Now you may have it in the Presto 66-G for standard and microgroove recording.

Here is a unit ideally suited and priced for the typical broadcast station or large transcription manufacturer. List price, Standard Model, *$996!* ($70 additional for microgroove.)

Here's perfection in total speed regulation and very low mechanical disturbance, thanks to the standard Presto dual motor gear drive. Here's high-quality recording, too, for the 66-G, of course, includes the Presto 1-D cutting head.

You'll find 66-G equal to the most exacting recording tasks when used with suitable amplifiers such as Presto 92-A recording amplifier and 41-A limiter amplifier.

FOR HIGHEST FIDELITY . . . IT'S PRESTO DISCS

Microgroove, even more than standard recording, demands a perfect disc. The answer is Presto. For, sixteen years ago, Presto made the *first* lacquer-coated discs . . . and today Presto discs are *first* in quality.

PRESTO

RECORDING CORPORATION

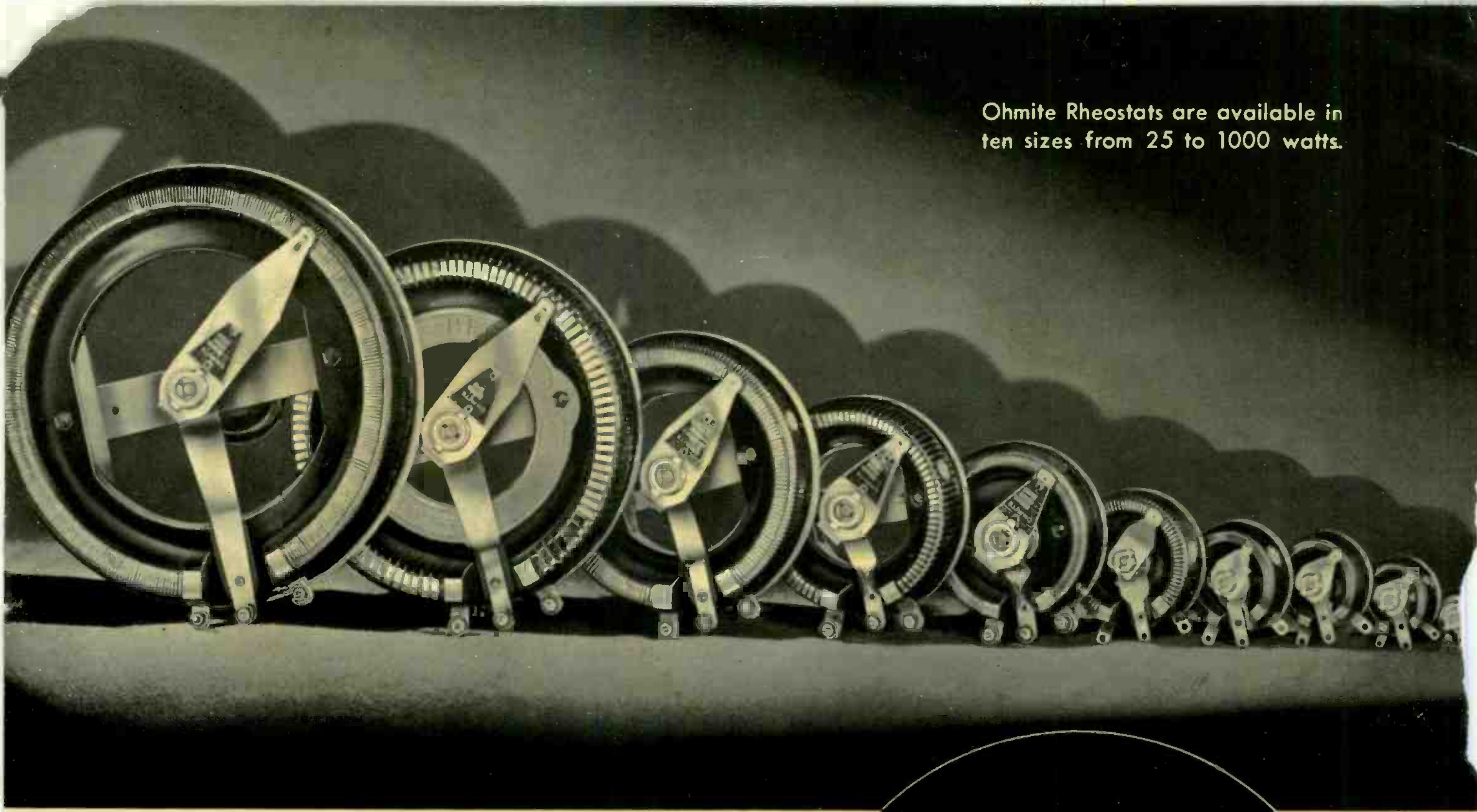
Paramus, New Jersey

READY NOW: Magnetic Tape Recorder

You probably saw Presto's new superquality magnetic tape recorder at the I.R.E. Show. If not, be sure to see it in Presto's room at the N.A.B. Convention in Chicago.

Mailing Address: P. O. Box 500, Hackensack, N. J.
In Canada: WALTER P. DOWNS, LTD., Dominion Sq. Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

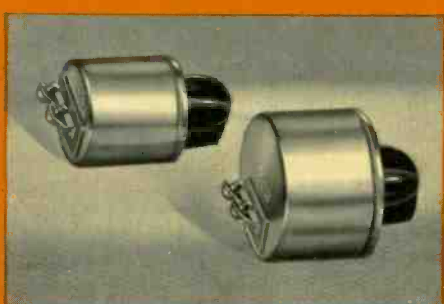


OHMITE RHEOSTATS

MEET REQUIREMENTS OF

JOINT ARMY-NAVY SPECIFICATION

JAN-R-22



Models H (enclosed) and J (enclosed)
Also AN 3155 (AN-R-14a)

TYPE	OHMITE MODEL	WATT RATING
RP10	H	25
RP11	H enclosed	12.5
RP15	J	50
RP16	J enclosed	25
RP20	G	75
RP25	K	100
RP30	L	150
RP35	P	225
RP40	N	300
RP45	R	500
RP50	T	750
RP55	U	1000

OHMITE RHEOSTATS MEET THESE RIGID TESTS:

★ 5-Hour Vibration Test
★ 100-Hour Salt-Spray Corrosion Test
★ 150-Hour 95% Humidity Electrolysis Test

and other tests as prescribed in Specification JAN-R-22.

By meeting these severe Joint Army-Navy requirements, Ohmite Rheostats have proved what industry has long accepted as true—that they can be depended upon for unfailing performance under the toughest operating conditions. All-ceramic construction . . . a smoothly gliding metal-graphite brush . . . uniform windings locked in place by vitreous enamel . . . insure close control throughout years of trouble-free service. It will pay you to standardize on Ohmite Rheostats for your product.

Be Right with

OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

See Nex

OHMITE JAN TYPE WIRE-WOUND RESISTORS

MEET REQUIREMENTS OF JOINT ARMY-NAVY SPECIFICATION JAN-R-26

STYLES AND SIZES

TAB-TERMINAL TYPE

Style	Overall length	Diameter	*Watts
RW-30	1"	19/32"	8
RW-31	1½"	19/32"	10
RW-32	2"	19/32"	12
RW-33	3"	19/32"	18
RW-34	3"	29/32"	30
RW-35	4"	29/32"	38
RW-36	4"	1-5/16"	60
RW-37	6"	1-5/16"	78
RW-38	8"	1-5/16"	110
RW-39	12"	1-5/16"	166

TAB-TERMINAL TYPE with terminal hole to clear No. 8 screw

Style	Overall length	Diameter	*Watts
RW-40	3"	29/32"	24
RW-41	4"	29/32"	32
RW-42	4"	1-5/16"	49
RW-43	6"	1-5/16"	74
RW-44	8"	1-5/16"	100
RW-45	12"	[illegible]5/16"	160

FERRULE-TERMINAL TYPE

Style	Overall length	Diameter	*Watts
RW-10	11-7/16"	1-5/16"	140
RW-11	9-5/8"	1-5/16"	116
RW-12	7-7/16"	1-5/16"	86
RW-13	5-1/8"	1-1/16"	50
RW-14	4-7/16"	1-1/16"	40
RW-15	2-15/16"	3/4"	20
RW-16	2-3/8"	3/4"	14

[illegible] free air, JAN Characteristic "F"

To qualify for approval under Joint Army-Navy characteristics, resistors are required to withstand in excess of nine cycles of immersion in saltwater baths of 100°C and 0°C; to withstand a severe vibration test for five hours; and, in addition, are subjected to all other tests as specified in JAN-R-26. Ohmite Resistors designed for JAN-R-26 are specially vitreous enameled and have a textured gray finish. Available in the types and sizes listed.

Write on Letterhead for Bulletin No. 139

OHMITE MFG. COMPANY
4917 Flournoy St., Chicago 44, Ill.

Be Right with...

OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

two **great names**

Faradon

CORNELL-DUBILIER CAPACITORS

Reg. U.S. Pat. Off.

Important Announcement To Our Many Friends

In The Broadcasting And Specialty Electronics Fields

CORNELL-DUBILIER ELECTRIC CORPORATION
333 HAMILTON BOULEVARD

Faradon — SO. PLAINFIELD, N.J.

To Our Customers:

We take pleasure in announcing the purchase of the Faradon Capacitor Division of the Radio Corporation of America.

Cornell-Dubilier acquired by the purchase the good will and trademark of "Faradon", the inventory, tools, dies, molds, equipment, instruments, designs, processes, and patent licenses. We have moved the Faradon equipment to our plants and are presently manufacturing the complete line of Faradon capacitors previously manufactured by the Radio Corporation of America.

Cornell-Dubilier transmitting capacitors and Faradon capacitors will be sold as separate lines, as Faradon capacitors are not always interchangeable with those of Cornell-Dubilier. Orders for Faradon capacitors, using the Faradon part numbers, may be mailed to our Sales Office at South Plainfield, New Jersey.

The high quality for which both Faradon and Cornell-Dubilier have been known for the last four decades will be meticulously maintained. The addition of the Faradon line will greatly improve our services, particularly to the broadcast stations and for those engaged in the specialty electronic fields.

The continued confidence of our customers in our product has made possible the acquisition of this additional outstanding line.

Sincerely yours,

CORNELL-DUBILIER ELECTRIC CORPORATION

Octave Blake
President

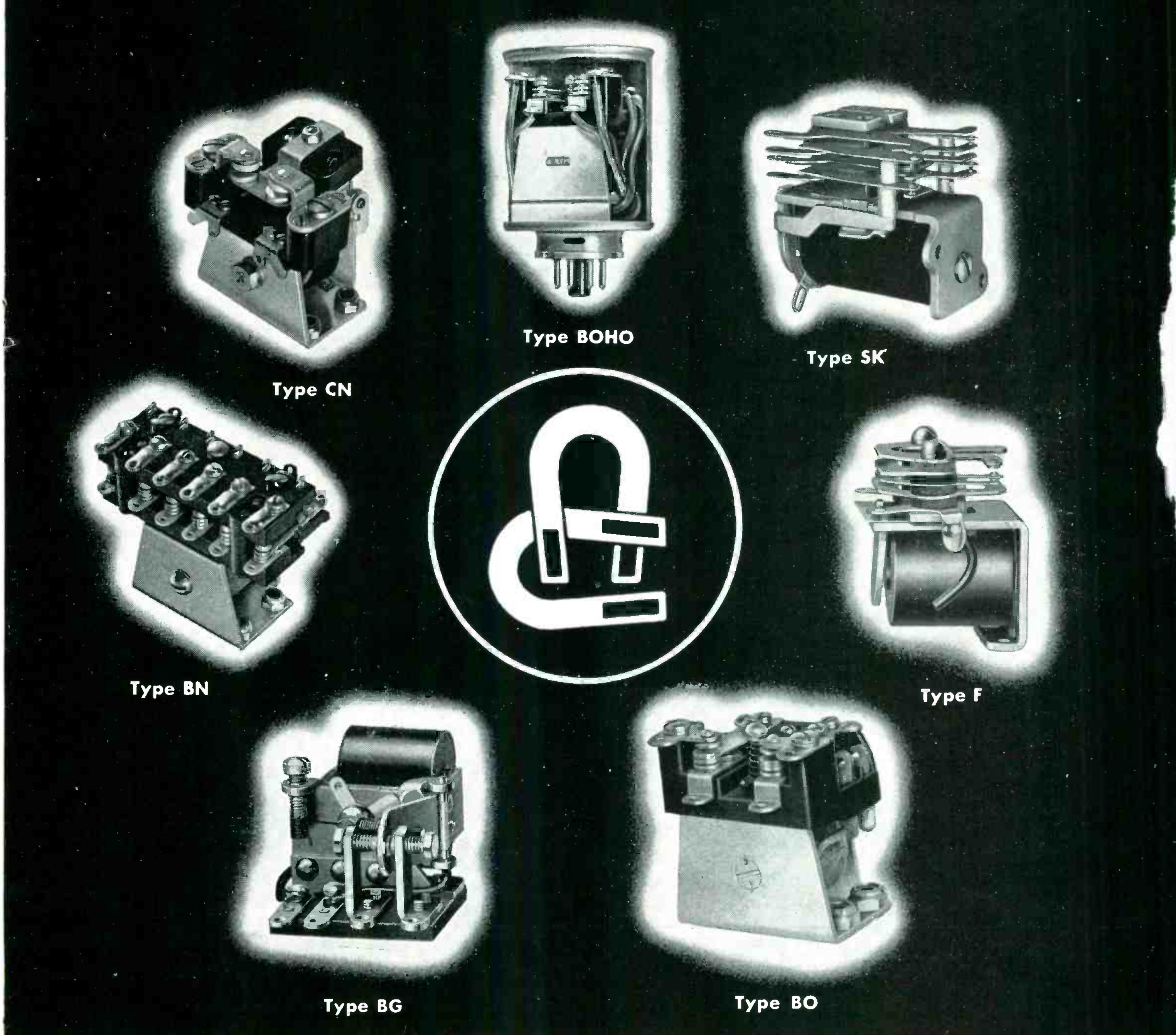
OB:K

PLANTS LOCATED IN U. S. A.
AT SOUTH PLAINFIELD, N. J., PROVIDENCE, R. I., INDIANAPOLIS, IND., NEW BEDFORD, MASS., WORCESTER, MASS., AND BROOKLINE, MASS.

CORNELL DUBILIER ELECTRIC CORPORATION

CAPACITORS . AUTO VIBRATORS . TV AND FM ANTENNAS . POWER CONVERTERS

RELAYS OF ADAPTABILITY



Thousands of specifications are filled by the complete line of Allied Relays—seven of which are grouped around the Allied emblem of engineering leadership.

Allied Control engineers pioneered the design of relays from signal circuits to 75 ampere contacts, coils from 12 milliwatts to 3½ watts to give the smallest mounting area and accessible wiring facilities.

**Type "BOHO"* is D.P.D.T. relay sealed with standard octal plug. Contact rating of 5 to 10 amperes and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

**Type "CN"* is S.P.S.T. double break relay with 50 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts and 220 volts; 60 cycles at 10.5 volt-amperes.

**Type "BN"* is 6 P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts (not available in A.C.).

**Type "BG"* is S.P.D.T. relay with 2 ampere contacts and coil capacity of 25 v. D.C. at 50 milliwatts (not available in A.C.)

**Type "BO"* is D.P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

**Type "F"* is S.P.D.T. with 2 ampere contacts and coil capacity of 85 v. D. C. at 1.5 watts (not available in A.C.).

**Type "SK"* from S.P.S.T. up to 4 P.D.T. with 1 ampere contacts and coil capacity of 60 v. D.C. at 750 milliwatts (for 4 P.D.T. relay) not available in A.C.

Allied Control representatives are located throughout the United States. A short note to our home office will give you the name of our nearest representative.

AL-119

ALLIED CONTROL CO., INC. 2 EAST END AVENUE, NEW Y

Vibration Control

Columbian Humming Birds, one of the famous drawings from nature by John James Audubon.

Wing vibration, nimbly controlled, keeps the humming bird in flight, enables it to feed without alighting.

Electric vibration is the essence of telephone transmission. Voice, music, pictures, teletype — no matter what type of signal — the story is told by the frequency and strength of not one, but many vibrations.

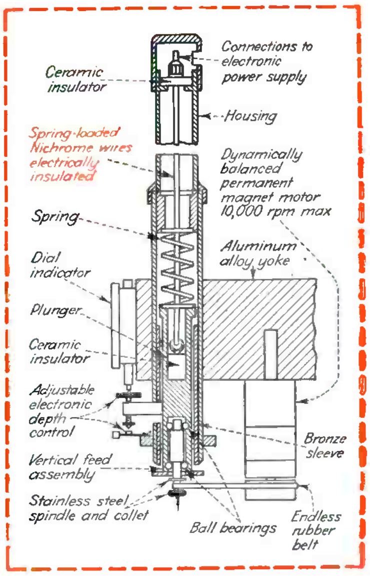
Learning how to control electric vibrations to pin-point accuracy has been one of the basic jobs of Bell Laboratories scientists in their development of the "carrier" art which enables the sending of many more conversations over existing wires. Among their inventions have been oscillators, modulators, filters, coaxials, wave-guides, and radio lenses.

Constantly Bell Laboratories scientists discover new and better ways to control and adapt electric vibrations by wire or radio to the needs of the telephone user. Their pioneer work in this field is one important reason behind today's clear, dependable and economical telephone service.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

a Revolutionary method of drilling microscopic holes that depends on NICHROME*



High coefficient of linear expansion of Nichrome V permits maximum vertical movement of spindle with shortest possible length of wire.

High tensile strength of Nichrome V permits use of a spring large enough to furnish sufficient force to drive spindle down.

High heat-resistance of Nichrome V permits heating wire to 1700°F. without permanent elongation—affording substantial drill feed range.

High specific resistance of Nichrome V minimizes heating current required.

Until now, precision drilling of extremely small diameter holes (such as .0016″ dia.) has been manually controlled. Even with highly skilled operators, however, drill breakage has been frequent—resulting in waste of time and effort, and damage to work and equipment.

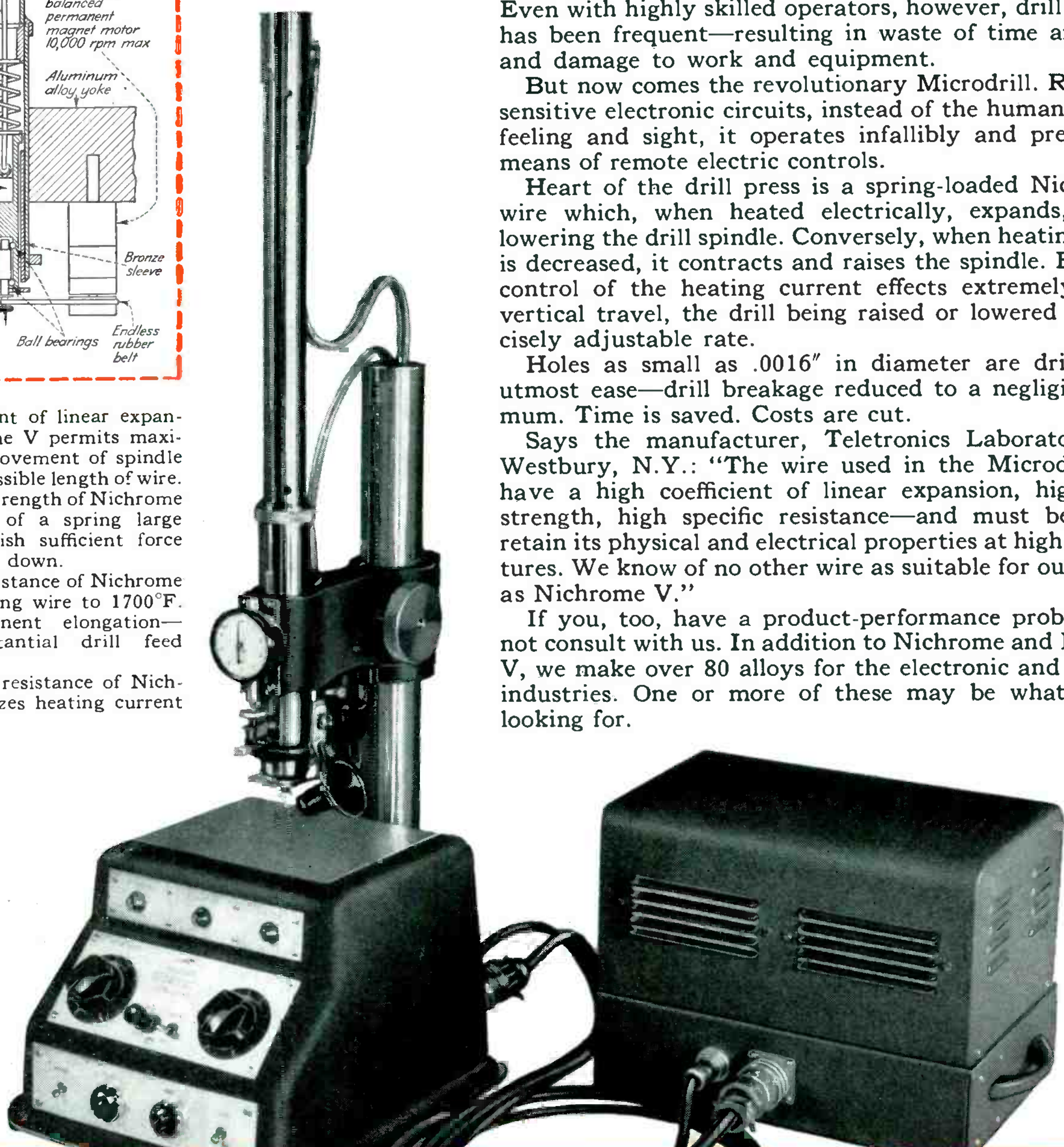
But now comes the revolutionary Microdrill. Relying on sensitive electronic circuits, instead of the human senses of feeling and sight, it operates infallibly and precisely by means of remote electric controls.

Heart of the drill press is a spring-loaded Nichrome V wire which, when heated electrically, expands, thereby lowering the drill spindle. Conversely, when heating current is decreased, it contracts and raises the spindle. Electronic control of the heating current effects extremely smooth vertical travel, the drill being raised or lowered at a precisely adjustable rate.

Holes as small as .0016″ in diameter are drilled with utmost ease—drill breakage reduced to a negligible minimum. Time is saved. Costs are cut.

Says the manufacturer, Teletronics Laboratory, Inc., Westbury, N.Y.: "The wire used in the Microdrill must have a high coefficient of linear expansion, high tensile strength, high specific resistance—and must be able to retain its physical and electrical properties at high temperatures. We know of no other wire as suitable for our purpose as Nichrome V."

If you, too, have a product-performance problem, why not consult with us. In addition to Nichrome and Nichrome V, we make over 80 alloys for the electronic and electrical industries. One or more of these may be what you are looking for.



50TH YEAR · SPECIAL PURPOSE ALLOYS SINCE 1899 · D H · TRADE MARK REG. U. S. PAT. OFF. · 1899 - 1949

*Nichrome is manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

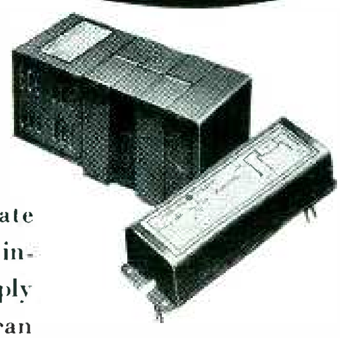
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle

Manufactured and sold in Canada by

The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

Variable Voltage giving you trouble?

G-E Automatic Voltage Stabilizers provide a steady 115 volts



Where precision equipment fails to operate satisfactorily because of ups and downs of input voltage, General Electric stabilizers supply an economical remedy. Small in size, they can easily be built into your equipment to supply automatically a constant 115 volts while line voltage varies from 95 to 130 volts.

These stabilizers have no moving parts, hence present no maintenance problem. They are available in standard ratings from 15 va to 5000 va. Stabilization is instantaneous (less than three cycles) and within ±1 per cent for fixed, unity-power-factor loads.

Contact your local G-E office for a call by one of our engineers. Or let us evaluate your problem by sending data and description of the circuit and load. Inquiries invited about special units. For general information, ask for Bulletin GEA-3634B. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

DO YOU MAKE—OR USE—ANY OF THESE?

Here are just a few of the applications where you may find a G-E automatic voltage stabilizer valuable:

Radio transmitters and radar equipment

Laboratory testing equipment and precision processes

Motion-picture projectors and sound equipment

Telephone apparatus

Precision photographic equipment and photometers

Phototube equipment

Calibration of electric devices

Color comparators

Electron-tube apparatus

Electro-chemical analysis

Rectifiers (full-wave)

Lighting circuits

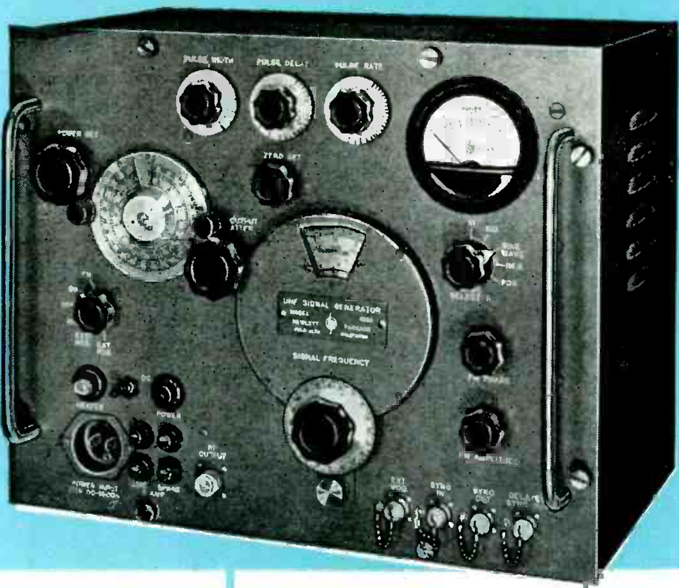
GENERAL ELECTRIC

NEW hp SIGNAL GENERATOR

FAST DIRECT READINGS

800 mc to 2100 mc

NO CHARTS OR INTERPOLATIONS



-hp- 614A UHF Signal Generator

Direct reading output, accuracy ±1 db...Constant internal impedance, SWR 3 db...Direct frequency control...External modulation 0.5 microseconds pulses to square waves...CW, FM, pulsed output.

This new *-hp-* signal generator will save you hours of time and work in making UHF measurements between 800 and 2100 mc. Its many different modulation and pulsing capabilities mean these man-hour economies can be applied to a wide variety of measurements—receiver sensitivity and alignment, signal-to-noise ratio, conversion gain, standing wave ratios, antenna gain and transmission line characteristics, to name but a few.

Carrier frequency in mc can be set and read directly on the large central tuning dial. R-f output from the klystron oscillator is also directly set and read in microvolts or db. No calibration charts or tedious interpolation are necessary. And thanks to the unique *-hp-* automatic tracking mechanism, no voltage adjustments are needed during operation.

R-f output ranges from 0.1 volt to 0.1 microvolt. Output may be continuous, pulsed, or frequency modulated at power supply frequency. The instrument may be modulated either externally or internally and may be synchronized with positive or negative pulses or sine waves.

Because of its wide range, high stability and versatile usefulness, this new *-hp-* signal generator is adaptable to almost any uhf measuring need. The instrument is available for early delivery. Contact your *-hp-* field representative or write direct to factory for complete details and technical specifications.

HEWLETT-PACKARD CO.
1874-A Page Mill Road, Palo Alto, California
Export Agents: Frazar & Hansen, Ltd.
301 Clay Street • San Francisco, Calif., U.S.A.

SPECIFICATIONS

FREQUENCY RANGE:
800 to 2100 mc. Selection is made by means of a single directly-calibrated control covering entire range. No charts are necessary.

FREQUENCY CALIBRATION ACCURACY:
±1%.

OUTPUT RANGE:
1 milliwatt or .223 volts to 0.1 microvolt (0 dbm to −127 dbm). Directly calibrated in microvolts and db; continuously monitored.

ATTENUATOR ACCURACY:
Within ±1 db without correction charts. A correction chart is provided when greater accuracy is desired.

OUTPUT IMPEDENCE:
50 ohms. SWR 3 db (VSWR 1.4).

EXTERNAL MODULATION:
By external pulses, positive or negative, peak amplitude 40 to 70v., 0.5 microseconds to square wave.

FM MODULATION:
Oscillator frequency sweeps at power line frequency. Phasing and sweep range controls provided. Maximum deviation approximately ±5 mc.

INTERNAL MODULATION:
Pulse repetition rate variable from 40 to 4000 per second; pulse length variable from 1 to 10 microseconds. Pulse rise and decay approximately 0.1 microseconds.

TRIGGER PULSES OUT:
1. Simultaneous with r-f pulse.
2. In advance of r-f pulse, variable 3 to 300 microseconds.

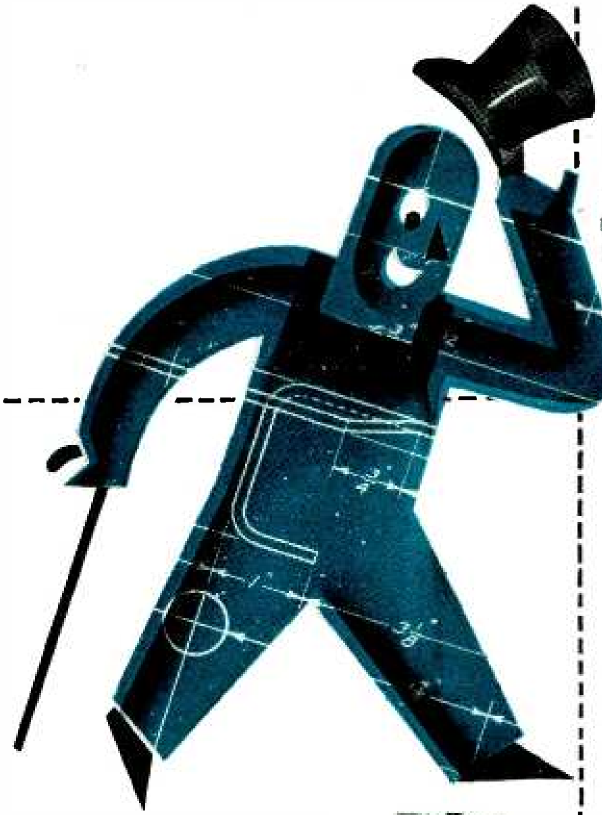
(Both approximately 1 microsecond rise time, height 10 to 40 volts.)

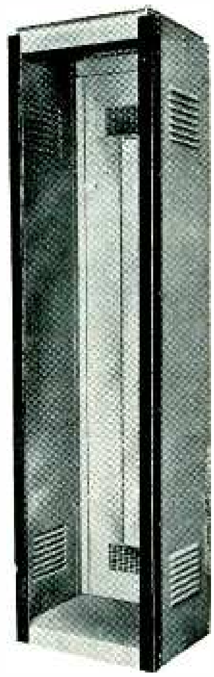
EXTERNAL SYNC PULSE REQUIRED:
Amplitude from 10 to 50 volts of either positive or negative polarity and 1 to 20 microseconds width. May also be synchronized with sine waves.

Data subject to change without notice.

hp laboratory instruments
FOR SPEED AND ACCURACY

Simple Jobs...
Intricate Jobs...





We Give Them All "High Hat" Quality

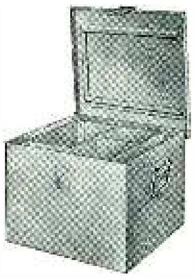
Whether you come to us for simple stamped-out chassis, ordinary metal boxes or the most intricate electronic apparatus housing, your job will receive the same Karp quality treatment, plus every possible economy.

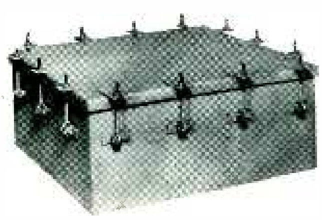
The same long-experienced principals of our staff will give you intimate, personalized service, from planning and design to delivery. Your work will be done by highly skilled specialists, in a plant which is without an equal in its field for up-to-date machinery and modern facilities. Welding, when needed, will be done under precise timing controls . . . painting and finishing with the most modern equipment and conditions.

In most cases, our vast variety of dies will save you the cost of special dies and jigs. We will give your work accuracy and uniformity that will make your final assembly easy, time-saving and hence economical.

Try us for the plain or the precise . . . the everyday or the elaborate and de luxe . . . in modest or substantial quantity. Whatever your needs in sheet metal fabrication, it pays to get our estimate.

WRITE FOR NEW CATALOG

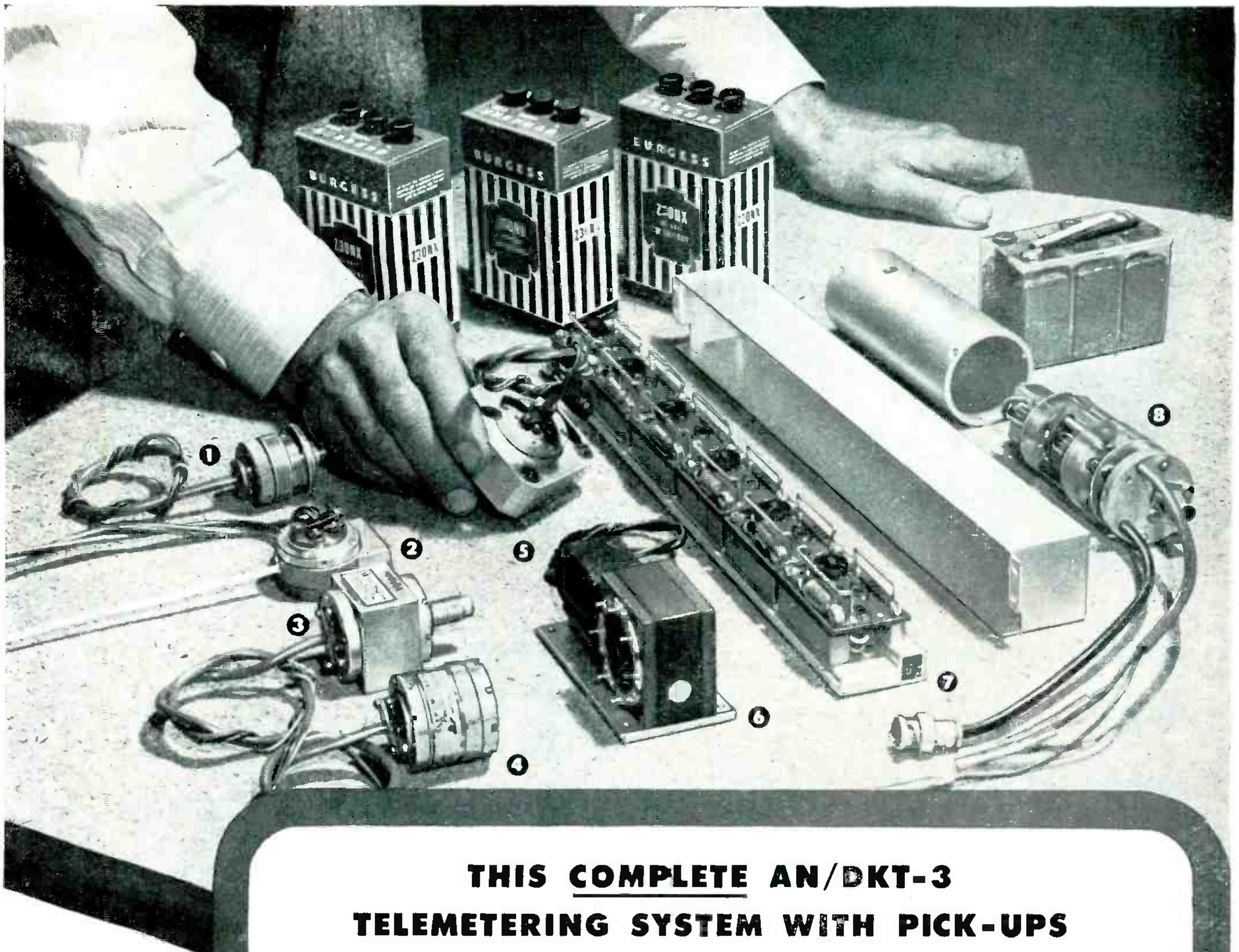




KARP METAL PRODUCTS CO., INC.

215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal



1. *Motion Pick-up*
2. *Pressure Pick-up*
3. *High Pressure Pick-up*
4. *Accelerometer*
5. *Altimeter Gage*
6. *Commutator*
7. *Telemetering Case With Sub-Carrier Oscillators*
8. *Transmitter (217 mc)*

THIS COMPLETE AN/DKT-3 TELEMETERING SYSTEM WITH PICK-UPS WEIGHS

LESS THAN 12½ POUNDS

The time-tested Bendix-Pacific basic sub-miniature system illustrated above, now approved as AN/DKT-3, offers outstanding advantages for precise remote instrumentation on guided missiles, aircraft and for industrial use where conventional means of measurement are impractical because of inaccessibility.

The entire system as shown, including pick-ups and batteries for 30 minutes operation, takes up only 130 cu. in. and weighs less than 12½ pounds. The basic system provides six channels of information and with the addition of a TSC type commutator and associated equipment up to 48 channels are available. The system operates on 210-220 mc (also available on 80-84 mc).

Bendix-Pacific facilities include installation and application engineering, field operation, data reduction and engineering consultation. Complete ground station facilities, including antenna also may be purchased. Information is available upon request.

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

PRODUCT OF Bendix AVIATION CORPORATION

TO MEASURE . . . TO INDICATE . . . TO WARN . . . AT A DISTANCE

EAST COAST ENGINEERING OFFICE: 475 FIFTH AVENUE, NEW YORK 17, N. Y.

For Your TV Designs

Low Capacity .25 to 4.7 MMF
Close Tolerance ±0.1 to 0.25 MMF

Insulated Ceramicons

Temperature Coefficient
NPO ±250

Capacity	Tolerance
0.25*	±0.1 MMF
0.5	±0.1 MMF
0.75	±0.1 MMF
1.0	±0.1 MMF
1.2	±0.1 MMF

Temperature Coefficient
N750 ±250

Capacity	Tolerance
0.75	±0.1 MMF
1.0	±0.1 MMF
2.2	±0.1 MMF

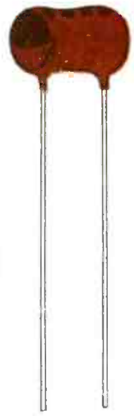
Temperature Coefficient
N1400 ±250

Capacity	Tolerance
3.3	±.25 MMF
4.7	±.25 MMF

*Style K molded insulated; all others are Style 331 dipped phenolic insulated.

ERIE CERAMICONS*

at an economical price



STYLE 331

Here are accurate, quality, low capacity close tolerance ceramic condensers that will go far in improving performance of front ends and other oscillator circuits.

Because of special processing methods, many popular values with capacity tolerances as close as ±0.1 MMF are available at prices comparable to wider tolerance condensers. The values and temperature coefficients of these Erie Ceramicons are listed at the left.

If you have an application for these units, we will be glad to send you samples of the capacities you select.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • TORONTO, CANADA

*Ceramicon is the registered trade name of silvered ceramic condensers made by Erie Resistor Corporation.

Little lamps can help your product win top billing!

WANT extra features to put your product in the limelight and to win applause from customers? It's easy with General Electric miniature lamps!

Little lamps can simplify operation, add extra convenience and safety in dozens of electronic applications. Use them as warnings to tell whether the current is on or off. Install them as "tell-tales" to check the operation of individual circuits. Apply them in novel design features that pay off in added attraction and sales value.

Whatever miniature lamps you need, General Electric makes 'em all—more than 1,000 different types and sizes. All voltages and wattages. Filament or neon glow. And every General Electric miniature lamp is made to the same high standards of quality as its bigger brothers.

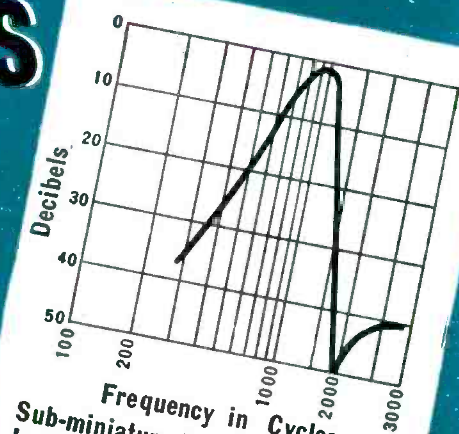
For assistance in selecting the proper type for your particular applications, consult your nearest G-E lamp district office. Or write General Electric, Nela Park, Cleveland 12, Ohio.

G·E LAMPS

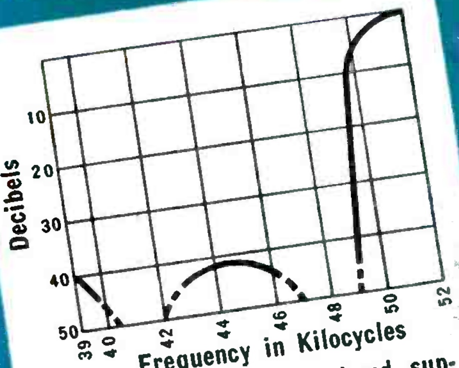
GENERAL ELECTRIC

Exclusive Manufacturers of Communications Network Components

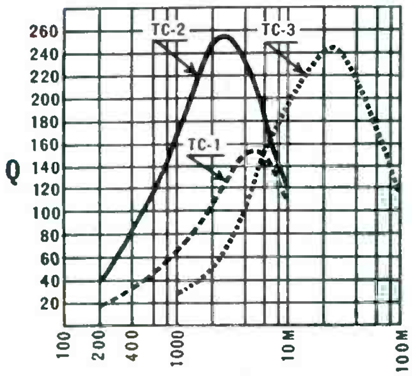
TOROIDAL COIL FILTERS AND TOROIDAL COILS DESIGNED FOR CRITICAL APPLICATIONS



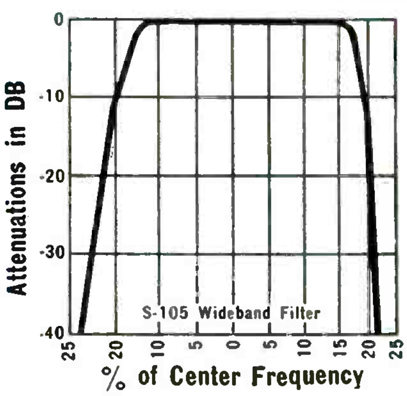
Sub-miniature band pass. Includes 3 coils and 4 condensers. Volume—4½ cubic inches.



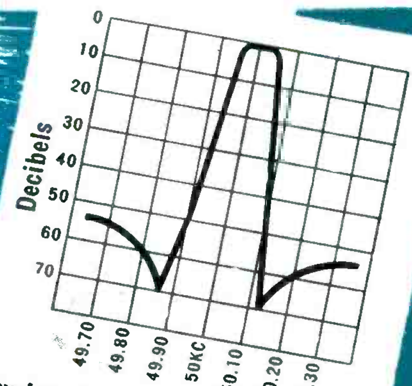
Extremely sharp side band suppression filter. Available in either low or high pass. Size: 2½ x 4 x 2½.



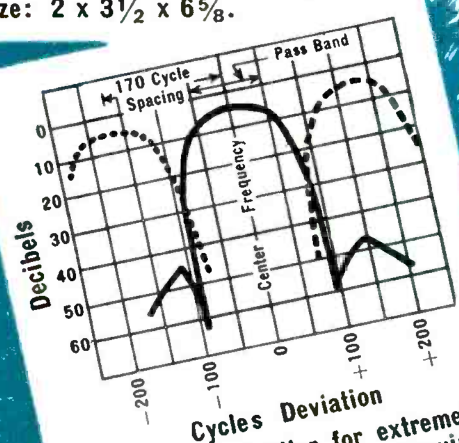
The big three out of 30 types of toroidal coils we are supplying.
TC-1 any ind. up to 10 hys.
TC-2 any ind. up to 30 hys.
TC-3 any ind. up to .750 hys.



Wide band sharp cutoff band pass. Size: 2 x 3½ x 6⅝.



Crystal filter for narrow band pass applications too critical even for toroidal coils.



Tone channel filter for extremely high crossover attenuation requirement. Size: 2½ x 2½ x 5.

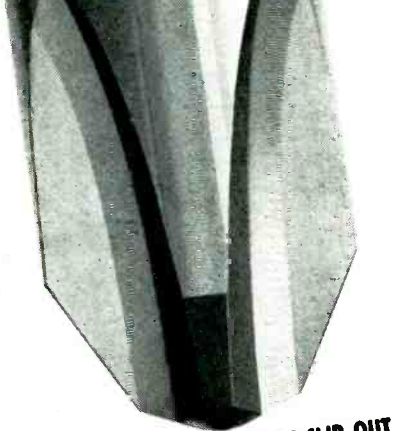
Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

ALL INQUIRIES WILL BE PROMPTLY HANDLED WRITE FOR TE...

Motor-Makers Know that

AMERICAN PHILLIPS SCREWS

put up a "Good Show"



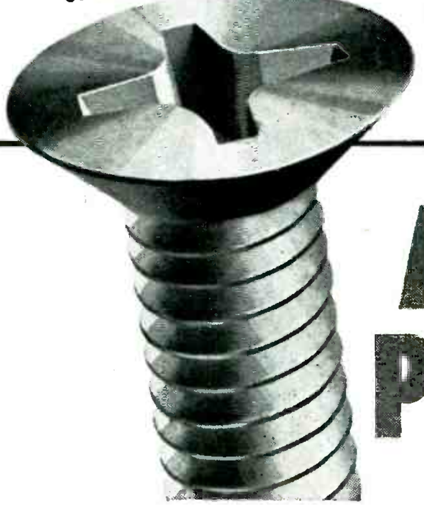
4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

On the Production Floor . . . and Sales Floor, too!

GOOD SHOW IN PRODUCTION: Assembly rolls along smoothly in high gear, with fastenings made by American Phillips Screws that turn up straight and tight *every time* . . . with never a slip or a slash to spoil costly enameled surfaces. Workers do more and better work, far more easily, than they ever did with out-of-date slotted screws. *And time savings run as high as 50%.* That's why so many million American Phillips Screws are used in automotive plants *every month.*

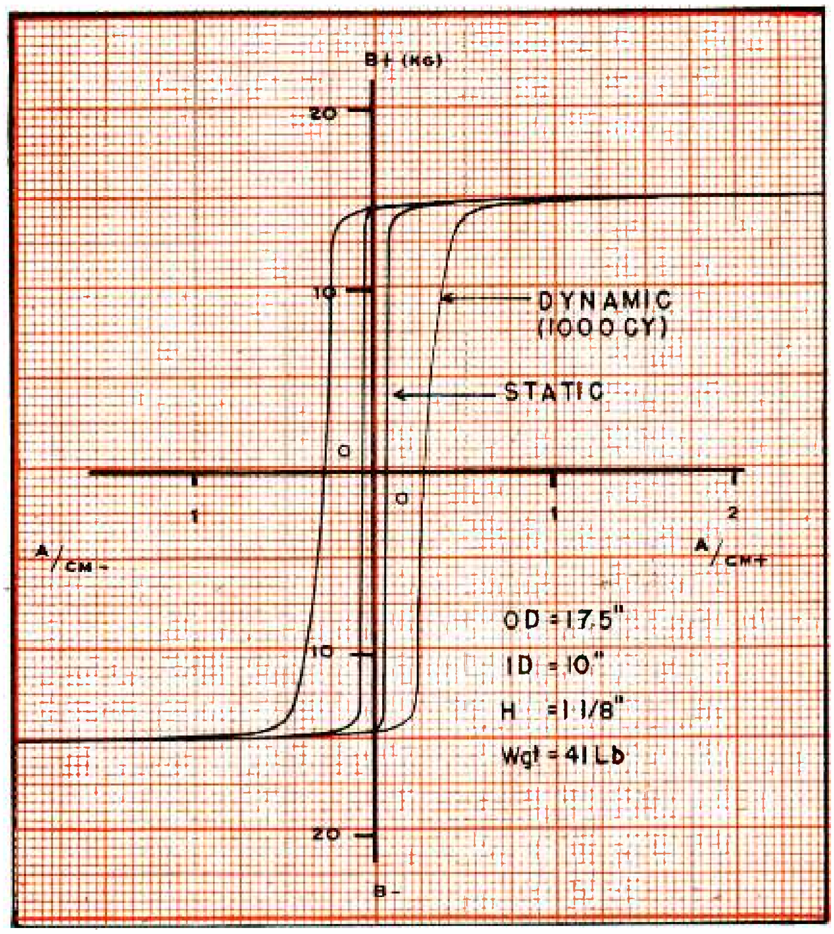
GOOD SHOW IN SALES: The modern mark of American Phillips' cornerless, crossed recess is one of the quality insignia of top cars and trucks . . . a feature looked for and recognized by customers. It means no unsightly burred heads to mar sales appeal or snag clothes and hands. And it means extra vibration-resistance to keep bodies tight and squeak-free. Does *your* product have this double-feature of production-economy and sales promotion? Then write:

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building



AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)



One Look TELLS THE STORY

. . . *of new and better products* made possible. These curves show the static and dynamic (1000 cycle) magnetization characteristics of "Permanite". This new magnetic alloy has the extremely useful property of reaching magnetic saturation with a very slight change in magnetizing current.

Utilization of this property in a core and coil assembly results in a magnetic amplifier of extreme reliability for many applications.

Permanite cores are available now. I-T-E can deliver spiral wound permanite cores of any size, all having identical magnetization characteristics. This will enable designers to predict equipment performance accurately and positively.

One look at the curve tells the story of "Permanite". But Permanite is only part of the continuing story of I-T-E research and development to bring you better equipment and better designs — first.

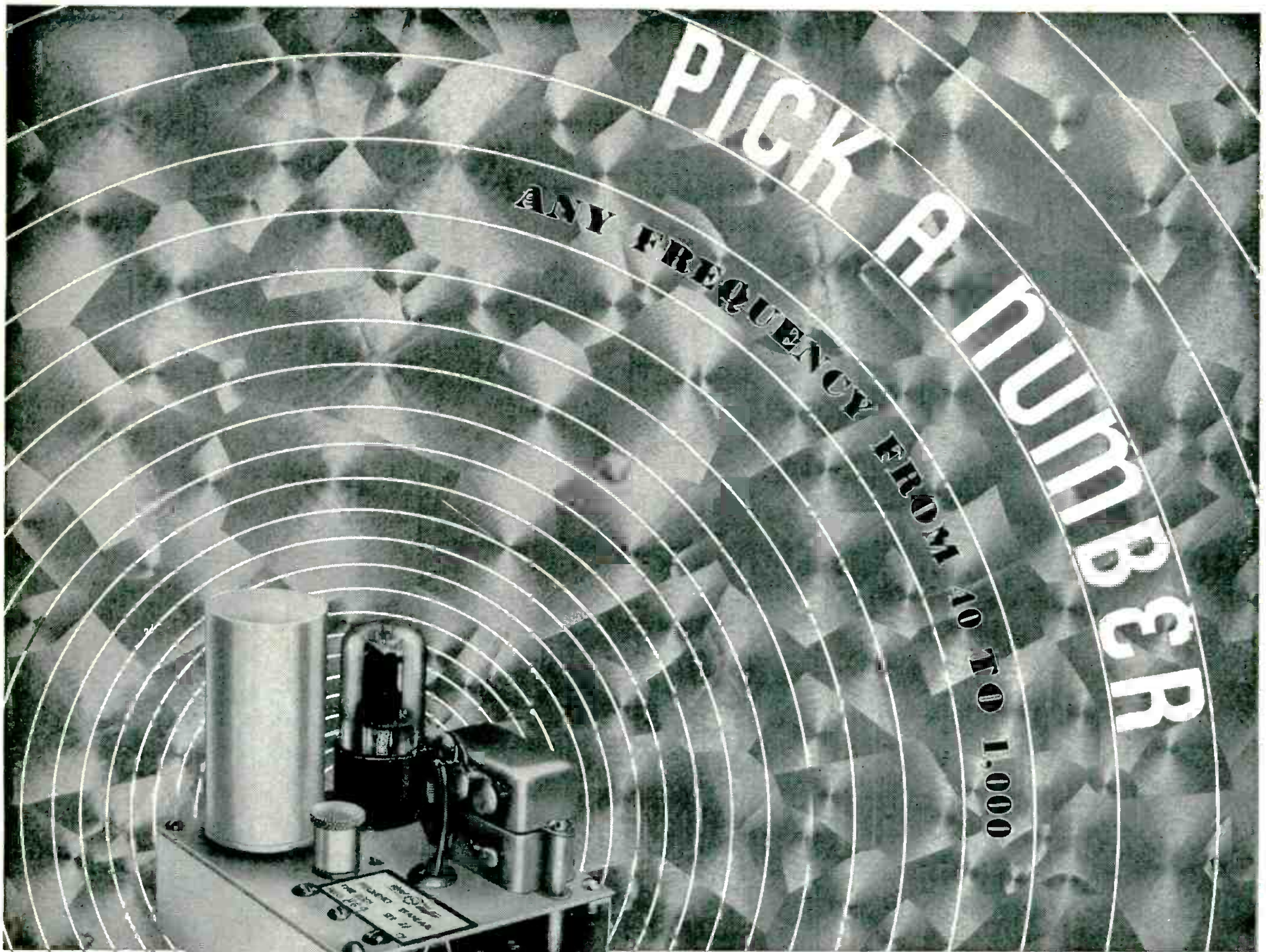
For additional information write — Rectifier division I-T-E or consult your local I-T-E representative

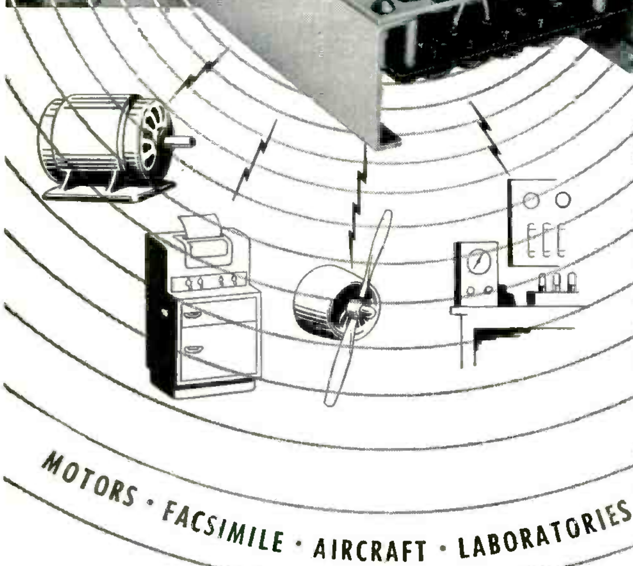
THE LEADER IN TECHNICAL EXCELLENCE

I-T-E CIRCUIT BREAKER CO., 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

31 OFFICES IN THE UNITED STATES. In Canada, Eastern Power Devices, Ltd., Toronto

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • RESISTORS • SPECIAL PRODUCTS





Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

American Time Products, Inc.

580 Fifth Avenue *New York 19, N. Y.*

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY


UNEQUALLED
STRENGTH
THE NEW
Harvel 1012C
Insulating Varnish
The big news in insulation is HARVEL 1012C . . . an outstanding development by IRVINGTON which provides an insulating varnish with far greater bonding and cementing qualities than the numerous thermo-setting varnishes tested. It's a very fast curing resin . . . absolutely oil-proof, and with excellent resistance to moisture and high temperatures. Unequalled for windings operating at high peripheral speeds as well as those subject to great stresses and strains.
Full information and generous test samples of HARVEL 1012C will be furnished on request. Write today.
IRVINGTON Varnish & Insulator Company
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Authorized distributors in Baltimore; Berkeley; Bluefield, W. Va.; Boston; Charlotte; Chicago; Cleveland; Dallas; Denver; Los Angeles; Milwaukee; Minneapolis; New Hartford, N. Y.; New Orleans; New York; Philadelphia; Pittsburgh; Portland, Ore.; St. Louis; Seattle; Hamilton, Ontario, Canada

Big Game Hunter is Wild about...

Frank Luck says, "I needed strong bars for my lion traps . . . so I got TEXTOLITE."

G-E TEXTOLITE*
Laminated Plastics

*REG. U. S. PAT. OFF.

Lions have little chance of escaping from this tough General Electric Textolite lion trap. Textolite blends with the jungle surroundings . . . completely camouflages the trap. Lions walk in —never escape.

● Of course this story of Frank Luck and his G-E Textolite lion trap is fictitious, but it does get over an important fact. . . . *General Electric Textolite is versatile.*

If you have an application that requires a non-metallic material with excellent electrical, mechanical, chemical, and thermal properties, it will be to your advantage to investigate Textolite. Reduced costs and product improvement may result.

G-E Textolite offers you a choice. It is produced in many grades—over fifty. And each of these grades has an *individual combination* of properties. None are alike. With this wide selection you can be assured of getting a laminated plastics with the *correct* properties for your application. Plastics Division, Chemical Dept., General Electric Co., Pittsfield, Mass.

G-E LAMINATED TEXTOLITE IS SUPPLIED IN:

LOW-PRESSURE MOLDED PARTS

MOLDED-LAMINATED PARTS

FABRICATED PARTS

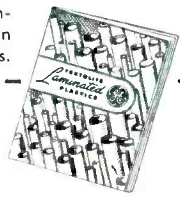
SHEETS, TUBES RODS

GENERAL ELECTRIC

CD49-J1

SEND FOR THIS HELPFUL BULLETIN TODAY— IT'S FREE

Write for your copy of "G-E Textolite Laminated Plastics." It lists grades, properties, fabricating instructions, and detailed information about Textolite industrial laminates.



General Electric Company
Chemical Department (9-4)
One Plastics Ave.,
Pittsfield, Mass.

Please send me the new G-E Textolite laminated plastics bulletin

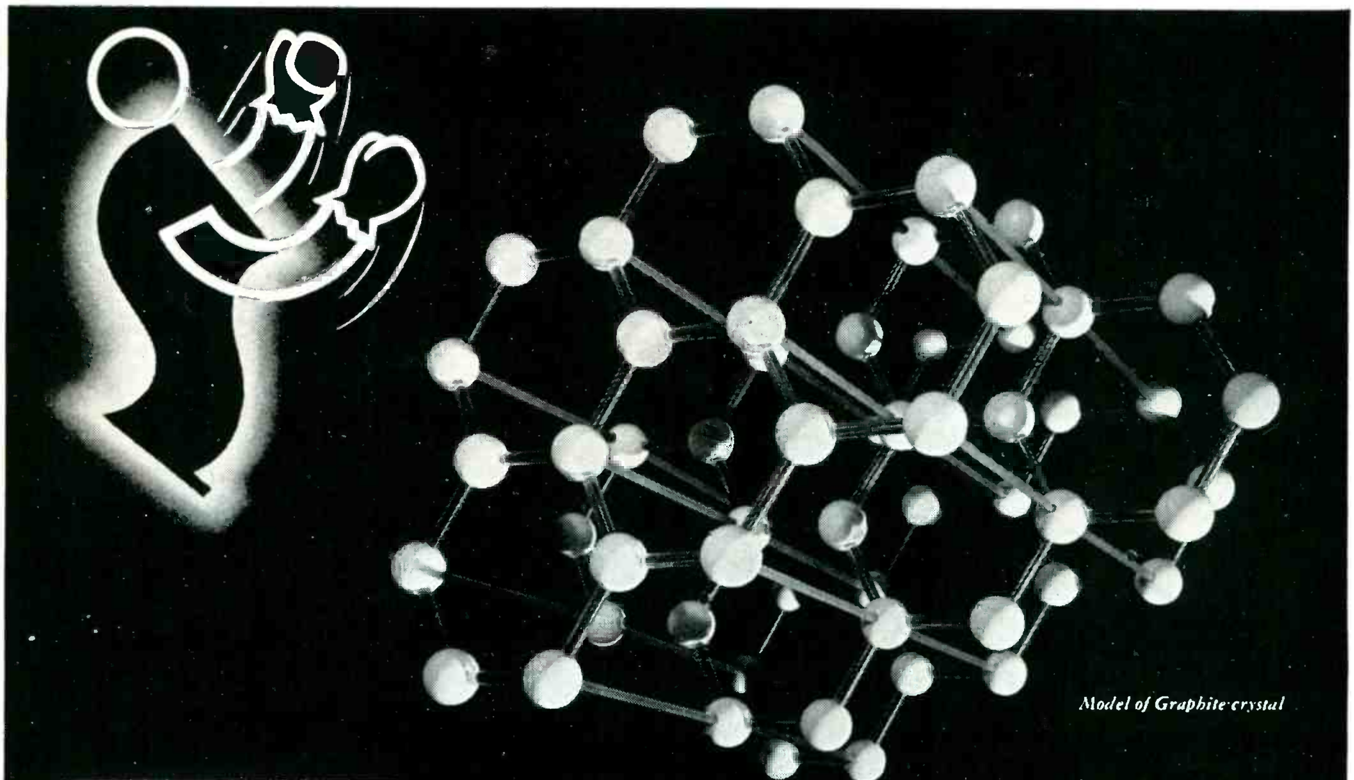
Name ....

Firm ....

Address ....

City .... State ....

LICKED! FRICTION...TEMPERATURE CORROSION...SHAFT SEALING AND ARC PROBLEMS...



Model of Graphite crystal

OTHER STACKPOLE PRODUCTS

- ELECTRICAL CONTACTS
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on 1001 applications

What is YOUR application problem? Need a material that can be heated to 4000° F. and thrown into cold water without cracking . . . that will resist atmospheric surface action while retaining constant contact resistance . . . that will have low friction (graphite) or high friction (carbon) or any intermediate frictional value?

Stackpole Carbon and Graphite components handle all of these assignments—and many more. Chemically, electrically, and mechanically, Carbon and Graphite offer far flung engineering advantages—and, for almost a quarter of a century, Stackpole design and production service has paced the trend in progress along many important lines.

WRITE FOR THIS BIG CARBON GRAPHITE BOOK!

In addition to a wealth of informative data, the new Stackpole Carbon-Graphite Specialties Catalog #40 describes hundreds of items regularly produced. More particularly, it contains interesting evidence of the ability of Carbon and Graphite to solve a broad range of design, engineering and production problems—and of Stackpole's facilities for producing what is needed.

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

STACKPOLE

"EVERYTHING IN CARBON BUT DIAMONDS"

NEW C-D Silicone Dilecto withstands an inferno of heat and electricity

to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

DE-2-49

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Continental-Diamond FIBRE COMPANY

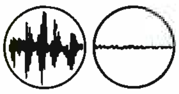
Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

TWO ways you benefit from MB Isomode* Vibration-Isolators

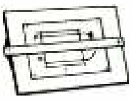
1. IMPROVED VIBRATION CONTROL!

2. EASIER ENGINEERING!

Experiences of two well-known manufacturers demonstrate this double benefit:



Always on the alert to improve their product, a truck maker comprehensively tested Isomode mounts. Their adoption followed quickly. Because, instead of previous, typical truck characteristics, motors mounted on *Isomode* units displayed passenger-car performance! *Vibration was really isolated,* even though the units were not at optimum locations, but placed at standard points to allow interchangeability with earlier models.



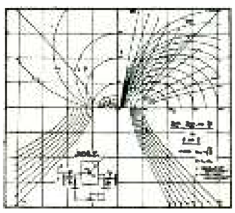
Another company, with a tough vibration control problem because they use various makes and types of engines in their own product, discovered *engineering and production simplicity* through Isomode units. Vibration was controlled by units placed at the regular mounting points. This accomplishment is all the more remarkable when you consider that the vibration varies with each type of engine!

There you have actual demonstrations of the value of Isomode units' outstanding advantage—"equal spring rates in all directions". The same benefits apply to *many* products—engines to electronic assemblies. And you not only isolate them more easily, but also gain a mounting that *withstands severe shocks!*

THE ADVANTAGES OF designing with ISOMODE MOUNTS

- ✓ *They absorb vibration in all directions* equally well—vertical, as well as troublesome horizontal and rocking motions.
- ✓ *Non-directional*—can be mounted at any angle, in any direction, simplifying design problems.
- ✓ *High load capacity* in compact size—saving space, weight, costs.
- ✓ *Large rubber volume* for softness—yet perfectly stable and self snubbing.

**Trade Mark Reg. U.S. Pat. Off.*



SEND FOR YOUR FREE COPY

This Isomode design chart saves you hours and effort—locates best points on your product at which to place standard mountings. For bulletin which contains chart and helpful information on vibration control, write Dept. F-5

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

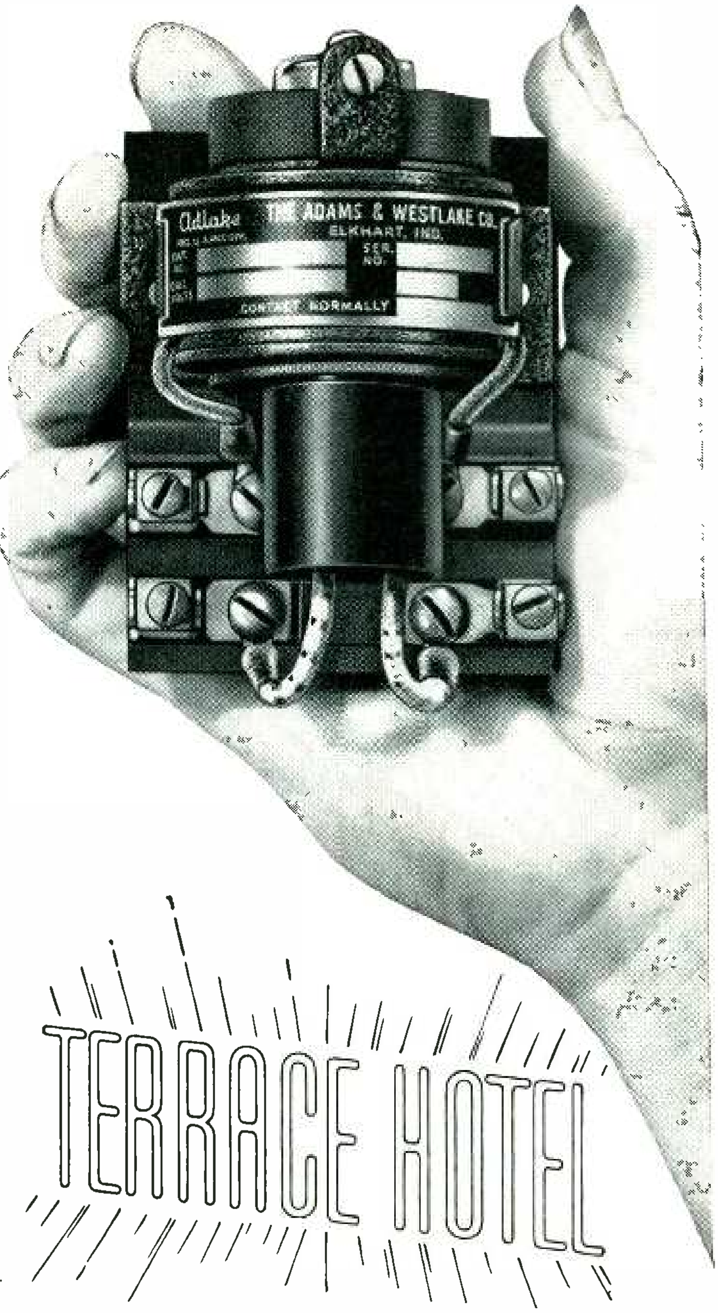
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

THE ADLAKE MIGHTY MIDGET RELAY (No. 1110)

IS IDEAL FOR

Flasher Service



IT IS DEPENDABLE— REQUIRES NO MAINTENANCE

The Adlake No. 1110 Relay is small enough to fit in one hand, yet it makes and breaks 30 amps. easily, and with low operating current.

Like all Adlake Relays, No. 1110 is hermetically sealed against dust, dirt, moisture and oxidation; mercury-to-mercury contact prevents burning, pitting and sticking. It's absolutely safe, *requires no maintenance*, and is cushioned against impact and vibration.

These qualities make the Adlake "Mighty Midget" ideal for use with flasher installations—as well as in power circuits, motor and heater controls, traffic signals and a host of other uses.

WRITE TODAY for FREE illustrated catalog, with details on No. 1110 and other new Adlake Relays. The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana.

The Adlake Mighty Midget Relay gives you long, trouble-free service on outdoor installations. It's weatherproof, shockproof and absolutely dependable! Silent and chatterless! Equipped with compression-type terminals to simplify installations.

Adlake TRADE MARK

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

WINDING HORIZONTAL SWEEP COILS FOR TELEVISION RECEIVERS

FOUR COILS WOUND AT ONCE ON UNIVERSAL NO. 84 MACHINE

The tremendous interest in television all over the country has created a large and attractive market for producers of component parts for TV receiving sets.

For complete assurance of high quality and production in coils for television sets, manufacturers are using Universal Coil Winders.

One of the most difficult coils to wind is the so-called horizontal sweep or fly-back transformer coil (Fig. 1). This can best be wound on the No. 84 Universal Coil Winder (Fig. 2), which makes it possible to wind one to four coils at once for each of the three sections.

The following technical data was prepared by our engineers and is intended as basic information when producing the horizontal sweep coil on the No. 84 machine.

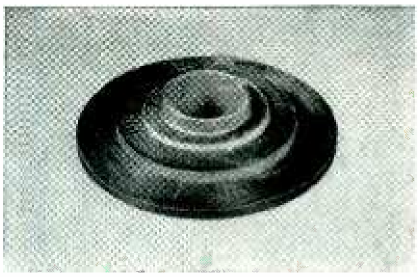


Fig. 1. Horizontal Sweep Coil.

Another component coil for television is the focus coil, which is wound on the No. 102 machine.

Detailed information on recommended winding practice for both these coils is contained in *Getting the Most from Coil Winding* — copies of which we will be glad to send you. Ask for GMCW-L.

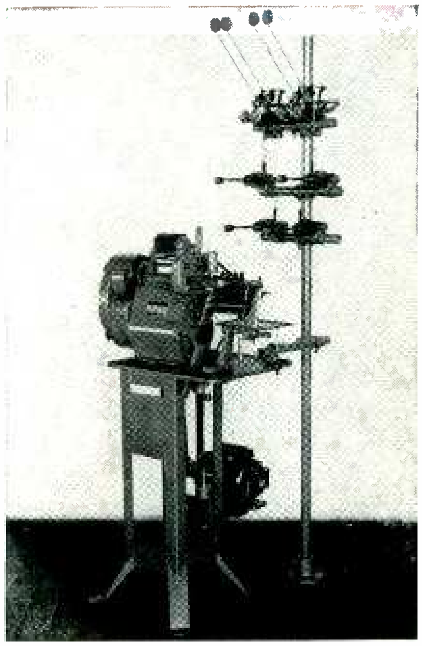


Fig. 2. No. 84 Coil Winder.

NO. 84 MACHINE SET-UP FOR TELEVISION HORIZONTAL SWEEP TRANSFORMERS

FIRST SECTION

Wire 375 turns of No. 28 single nylon and enamel covered wire (.0156 in. O.D.)

Cam 5/8 in. single throw.

Winding speed 750 rpm.

Wind 1½, using gearing 48 or 72 with any intermediate gear to mesh.

Wire guides .018 in. center slot.

Tension medium spring in fourth hole from top.

Pressure two weights on traverse frame cord.

Wind four coils at a time.

SECOND SECTION

Wire 1,000 turns No. 33 single nylon and enamel covered wire (.0099 in. O.D.)

Cam ½ in. single throw.

Winding Speed 750 rpm.

Wind 2/3, using gearing 119-80 with any intermediate gear to mesh.

Guides .018 in. center slot.

Tension sixth hole from top.

Pressure two weights on traverse frame cord.

Wind four coils at a time.

THIRD SECTION

Wire 1,000 turns No. 38 single silk and enamel covered wire (.0065 in. O.D.)

Cam 3/32 in. single throw.

Winding speed 400 rpm.

Wind 1/7th using gears 120-40-88-38. (With this compound gearing, use any small gear on the spindle shaft on the inside of the 120-tooth gear. The second and third gears will go on the intermediate stud with the 40-tooth gear on the outside and the 88-tooth gear on the inside. The 38-tooth gear will be on the clutch shaft, and should mesh with the 88-tooth gear.)

Wire guides .008 in. center slot.

Tensions light spring in about the third hole from the top.

Pressure one pressure weight on the traverse frame cord.

Wind one to four coils at a time.

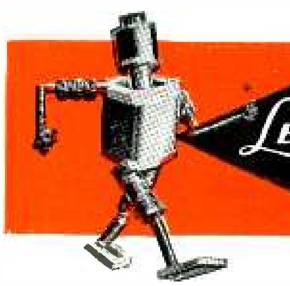
COIL WINDING DEMONSTRATION ROOM

We have in our coil winding demonstration room the following complete line of coil winding machines: 84, 96, 98, 102, 103, 104 and 105.

We invite anyone who is interested to visit our demonstration room and view these machines in operation.

UNIVERSAL WINDING COMPANY

P. O. Box 1605 Providence 1, R. I.



LEESONA*

* REG. U. S. PAT. OFF.

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

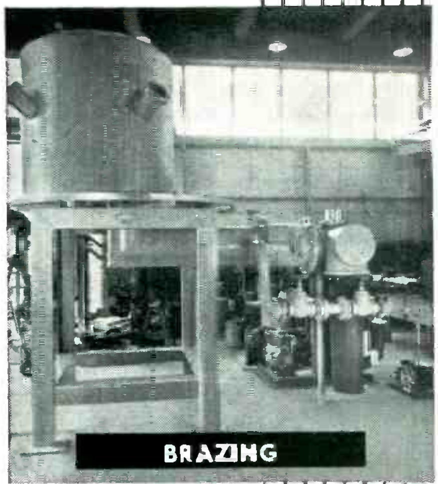
SPECIAL HIGH VACUUM EQUIPMENT

BUILT TO MEET YOUR PROCESS REQUIREMENTS

We design, engineer, fabricate and install special High Vacuum process equipment.

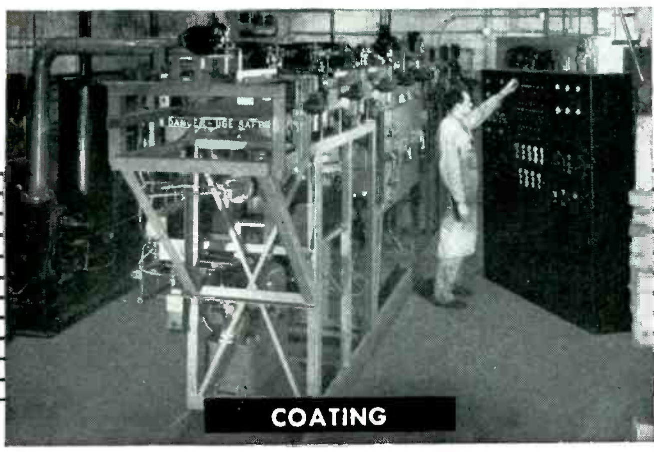
In the High Vacuum field National Research Corporation offers you unified, under-one-roof control and responsibility. We not only build equipment, but also undertake development work for others in fields where the unique experience and ability of our own Research Division can be used to your advantage.

If you plan to profit from your own High Vacuum process developments—if you require assistance in developing your processes—you should become acquainted with the National Research Corporation, 70 Memorial Drive, Cambridge 42, Massachusetts.

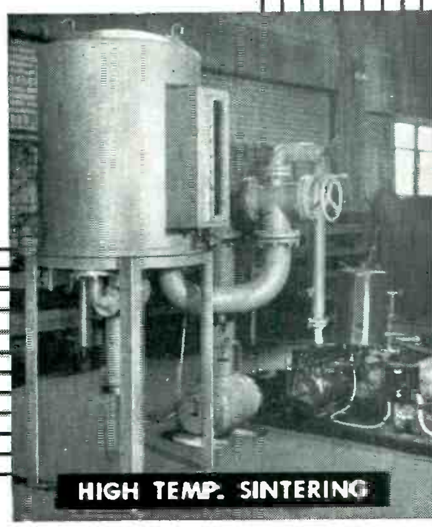


BRAZING

MELTING AND CASTING



COATING

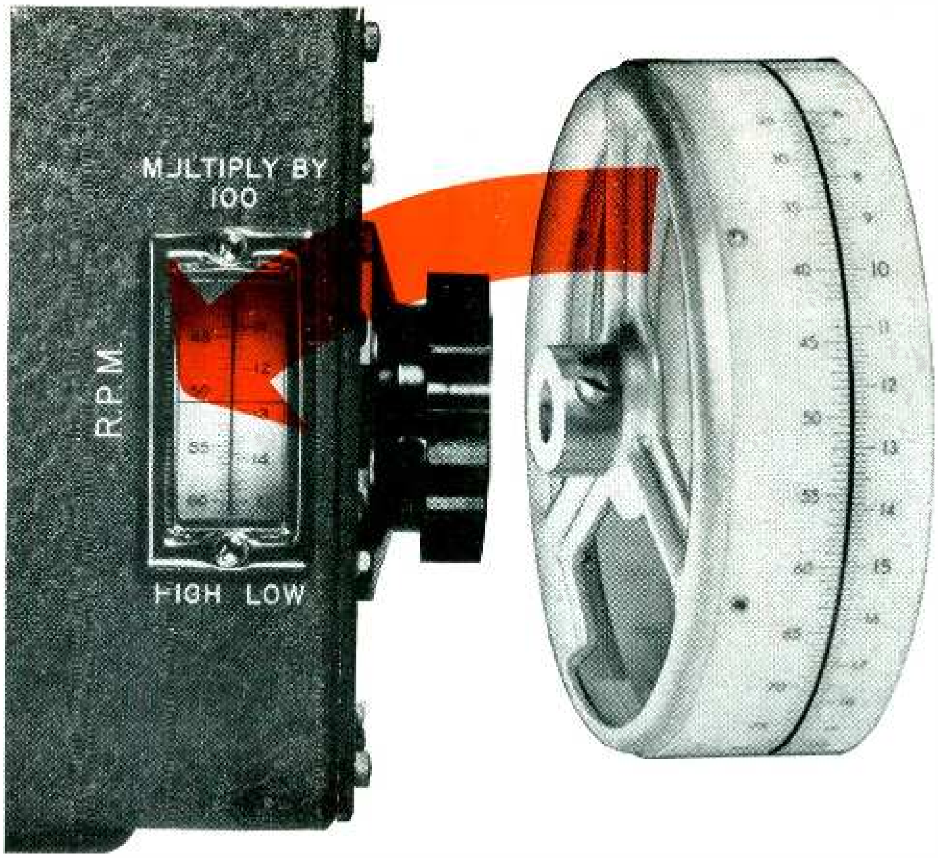


HIGH TEMP. SINTERING

HIGH VACUUM FOR INDUSTRY

NATIONAL RESEARCH CORPORATION

Vacuum ENGINEERING DIVISION



GENERAL RADIO COMPANY, Cambridge, Mass., uses flexible Translucent Lamicoid for the rear-illuminated dial of the Strobotac, a small, portable stroboscope.

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You, as designer or user of radio-TV transmitter equipment, can have the protection of G-E custom-miniature dependability *now*—starting with Type GL-5654 (electrically the same as the 6AK5), and Type GL-5670 (similar to the 2C51 except for improved heater design and a somewhat higher heater current). Other types are being added.

These tubes are carefully manufactured one by one, from individually gaged and inspected heaters, cathodes, grids, and plates. Each gets not less than 50 hours' operation—ample assurance that when plugged in, tube performance will be in line with ratings consistently. Ask your G-E electronics office for further facts. Or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-5654
7-pin miniature
h-f pentode

FIRST OF AN *Outstanding* NEW SERIES

Characteristics

TYPE GL-5654

Heater voltage, a-c or d-c	6.3 v
Heater current	0.175 amp
Max ratings, design center values:	
plate voltage	180 v
Grid No. 2 voltage	140 v
plate dissipation	1.7 w
Grid No. 2 dissipation	0.5 w
Typical operation:	
plate voltage	180 v
Grid No. 2 voltage	120 v
cathode-bias resistor*	200 ohms
plate resistance (approx)	0.69 megohms
transconductance	5,100 micromhos
plate current	7.7 ma
Grid No. 2 current	2.4 ma

(*Fixed-bias operation not recommended)

TYPE GL-5670

Heater voltage, a-c or d-c	6.3 v
Heater current	0.350 amp
Max ratings, design center values, each triode section:	
plate voltage	300 v
plate dissipation	1.5 w
Typical operation, Class A1:	
plate voltage	150 v
cathode resistor, per section	240 ohms
plate current, per section	8.2 ma
transconductance, per section	5,550 micromhos
amplification factor	35
cut-off grid voltage, Ib equals 75 mu a (approx)	—10 v
Typical operation, Class AB1:	
plate voltage	300 v
cathode resistor	800 ohms
A-F grid-to-grid voltage, RMS	14 v
zero-signal plate current, per section	4.9 ma
max-signal plate current, per section	6.3 ma
load impedance, plate-to-plate	27,000 ohms
total harmonic distortion	10 per cent
max-signal power output	1.0 w

GL-5670
9-pin miniature
h-f twin triode

GENERAL ELECTRIC

180-H3

FIRST AND GREATEST NAME IN ELECTRONICS

"Give us the tools . . ."

Now is the time to *FIGHT SOCIALISM* in Washington

Do we want to follow Britain down the economic skids?

We Americans face that question today. For we are being advised by Administration economists in Washington to take the course which destroyed Britain industrially. It is the temporarily easy course of cutting down expenditures for tools in order to have more things to consume right away.

The President's Council of Economic Advisers tells us we are spending too large a part of our national income on new tools and equipment. A larger share, they say, should go for goods and services used directly by consumers.

Before we take that advice, let us look at Britain. When the British once allowed their industrial plants and equipment to run down – they started down a dreary road to industrial stagnation and decay.

British industry once ruled the world. Low production costs enabled it to undersell all competitors. Efficiency gave British workers the highest living standards anywhere.

Now all that Britain has between it and economic disaster is pluck and American aid through the Marshall Plan.

The British people are living poorly – still on rations and in austerity. With practically everyone working, and working longer hours than we do in the United States, they cannot produce enough to pay for the raw materials and food they must import.

How did Britain get in this fix?

The story is complicated. British sacrifices in two wars play a tragic part in it. But another fact also stands out:

Britain began to go downhill even before World War I – when British industries allowed their plants and equipment to grow obsolete.

Once that process started, it grew steadily worse. By 1929 the share of Britain's national income being plowed back into capital investment had shrunk to less than two-thirds of what it had been twenty years earlier. We were putting twice as big a share of our national income into capital goods at this same time.

Skimping on capital equipment – on new plants and new tools – put the skids under industrial Britain.

World War II only speeded up a process already well under way.

continued on next page

British industry today shows the results of its failure to keep up to date. Here are three examples found by Dr. Laci Rostas, Britain's leading authority on measuring workers' productivity:

An American produces *four* times as much pig iron as his British counterpart.

He produces *more than four times* as many tires.

In all industry, on the average, an American produces almost three times as much.

The real reason is the American's better tools. The British are struggling with equipment that is, on the average, forty years old.

Britain once had a big head start in industrial equipment. But she let it slip away. And as it went, Britain's industrial and political leadership slipped with it.

How could British leaders have slept while all this happened?

This, too, is a complicated story. But parts of it stand out clearly:

1. *British business men put in more time perfecting cartels to avoid competition than they did in improving their plants and equipment to meet it.*

2. *British labor leaders concentrated on sharing the work and sharing the wealth—rather than doing the job necessary to have enough wealth to make the sharing worthwhile.*

3. *British governments taxed away the means to buy new equipment. By steadily increasing personal taxes, they undercut the* ability *of individuals to invest in new equipment. Finally, they took away the* incentive *to get new equipment by progressively taxing away any returns on it.*

4. *Farseeing socialists smiled all the while, knowing that as private industry more and more lacked the tools to do a progressive job, they would have their chance to run the country.*

Now, with Britain's fate in their hands, the socialists are trying desperately to stem the nation's economic decline by rebuilding its industrial plants and equipment.

They are making a little headway, but not enough. There are several reasons. One is that Britain must export most of the new equipment she can make. *Another major reason—increasingly important for her future—is that money needed to renovate Britain's run-down industry is taxed away to support welfare programs.* The (London) *Economist* grimly puts it this way:

"The importance of the function of saving has only been discovered now that the means of saving have largely been destroyed."

Our own Federal and State governments, too, have dangerously whittled away incentives. They have more than tripled tax rates on personal and corporation incomes in the last twenty years. Now, the President proposes to do more whittling.

If the United States is not to go Britain's way, we must preserve our incentives to save and to invest in industry.

If the United States is to progress, we must continue to build up our industries.

The President's Economic Advisers say we can slow down. But the McGraw-Hill survey of "Business' Needs for New Plants and Equipment," reported in the previous editorial in this series, produced facts to the contrary. It showed that industry *now* plans—*if it can get the money*—to spend $55 billion in the next five years for new plants and new tools. Moreover, it showed *industry's needs* for new facilities are large.

By cutting down the incentives to save, by giving soothing advice that we do not need to save so much, Washington is pushing us toward Britain's way—the route via industrial stagnation to socialization.

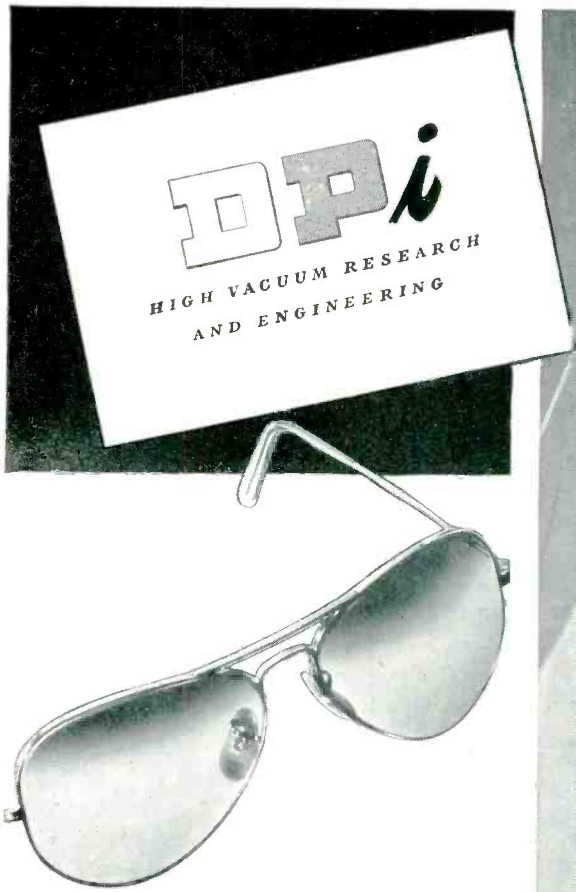
Before we skid too far, we should pull up short and ask ourselves: Do we want to go Britain's socialistic way?

There still is time to say, "No."

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

A complete report on our national survey, "Business' Needs for New Plants and Equipment," may be obtained by writing McGraw-Hill Publishing Co., 330 West 42nd St., New York 18, N. Y. This is the fifth editorial of a special series on industry's needs for new plants and equipment.



Sunglasses plated with stainless steel—a recent commercial application of high vacuum. Used by Bausch & Lomb Optical Co. for RAY-BAN Gradient Density sunglasses, it works wonders in killing glare, relieving eye strain and fatigue, and improving vision.

Easy on the Eyes with High Vacuum

During the war, planes jockeyed to attack out of the sun — battleships maneuvered to get the sun at their backs. The sun glare impairing vision, and accuracy of optical instruments made them a poor target for the enemy.

Counter strategy developed telescopic sights, range finders, and aerial cameras whose lenses were coated under high vacuum with transparent fluoride salts. Thus treated lens surfaces were less reflective, more light was admitted, instruments could work better against the sun.

Improving aviators' sunglasses presented a different problem. Here the same high-vacuum process was used, but the coating must serve to *cut down* passage of light through the lens. Experiments disclosed stainless steel as the ideal material.

The process has been adopted for commercial use. At Bausch & Lomb, in the chamber of a DPI high-vacuum coater, metallic vapor of stainless steel is deposited in a scientifically controlled "gradient" pattern of density and area. These stainless steel coated sunglasses are now available at optometrists.

This is but one of many applications of high vacuum in science and industry to make improved products at lower cost.

Do you know what high-vacuum distillation, dehydration or fusion may do to improve your products—to decrease processing costs, or to salvage waste materials into valuable commodities? DPI research men and engineers may be able to tell you. Write

DISTILLATION PRODUCTS, INC.

727 RIDGE ROAD WEST, ROCHESTER 13, N. Y.

Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry; Manufacturers of High-Vacuum Equipment

BUSINESS BRIEFS

By W. W. MacDONALD

Parts For Tubes are being sold to quite a few people not ordinarily considered tube manufacturers. Investigation of several such cases indicates that the need for tubes having very long life is the usual reason.

Computer manufacturers, in particular, appear interested in building their own tubes. Many thousands are used in some calculating machines operating many hours a day. By virtue of the number employed alone, failures must be kept to the very minimum. So, while tube manufacturers wonder whether it would or would not pay to produce types having particularly long-lived cathodes for such specialized applications the manufacturers of the machines roll their own.

Communications Equipment Sales should increase in 1949 to $23,500,000, thinks GE's Ernie Vogel. Market analysis indicates the following breakdown: Police purchases up 16 percent to $6,000,000, taxicab business up 25 percent to $5,000,000, utilities up 30 percent to $4,000,000, petroleum industry up 75 percent to $3,500,000, forestry conservation up 25 percent, forestry industries up 160, fire departments up 50 and highway-maintenance installations up 160.

Our Washington Office thinks there is only a 50–50 chance of upsetting local laws concerning the operation of sound trucks, with Supreme Court decisions likely to go either way in individual cases. Everything, apparently, depends upon how the local law is worded.

Last Time We Mentioned mobilization planning (p 68, January) we said that a government-industry stalemate appeared likely. Latest we've heard is that one government agency recently wrote a press release giving the details of the first contingent contract but that another government agency, whose approval of the release was necessary, refused to approve it.

By the time this item sees the light of day the contract will probably be signed, but it may not be publicized.

RMA Members produced 866,832 television receivers, 1,590,046 f-m/a-m receivers and 11,675,747 a-m receivers in 1948, a total of 14,132,625 sets of all kinds. Production breakdown by months was as follows:

	TV	F-M/A-M	A-M
Jan	30,001	136,015	1,173,240
Feb	35,889	140,629	1,203,087
Mar	52,137	161,185	1,420,113
Apr	46,339	90,635	1,045,499
May	50,177	76,435	970,168
Jun	64,353	90,414	959,103
Jul	56,089	74,988	552,361
Aug	64,953	110,879	759,165
Sep	88,195	171,753	1,020,498
Oct	95,216	170,086	869,076
Nov	122,304	166,701	827,122
Dec	161,179	200,326	876,315

Receiving-Tube Sales by RMA members totalled 204,720,378 in 1948, five million more than in 1947. New equipment took 146,162,214 receiver-type tubes, replacements 47,056,521, export 10,686,769 and government agencies 814,874.

Ten Times As Much Tin goes into the average television receiver as into the average radio set. And the Department of Commerce plans to cut down the allocation of tin to our industry because of the shortage of this metal. Therefore, it seems that conservation, substitution and allocation within the industry itself are in order for 1949.

From What We Have Read about Gulf Oil's *Gulfstream* and the Coast Guard's *Eastwind* it seems to us that the latter has earned the unique distinction of having participated in what appears to be the first radar-assisted collision.

High-Tension Coils are being placed closer to the distributor in most new automobiles, according

Though it would seem a strange place to look for a precious stone, each Eimac 3X2500A3 triode, and modifications of this tube type, contains three sapphires . . . making this Eimac triode a better vacuum tube . . . better able to do a superior job in communication, research, and industrial applications.

It became evident in the early stages of 3X2500A3 development that the structure which provided filament tension posed a problem. The source of tension was easy . . . by using a conventional pusher-spring at the cool end of the center-rod, transferring the pressure to the top of the rod, and then out to the filaments.

But . . . somewhere in the structure, between the filaments and the center-rod there must be a non-conducting material with the ability to remain inert under high temperatures (1500 degrees to 1600 degrees C). It must be unaffected by electron bombardment and it must be physically strong.

The imaginative foresight of Eimac engineers, after exhausting the possible use of conventional materials, brought synthetic jewels under consideration . . . the rest of the story is vacuum tube history.

As in the past, when better vacuum tubes are made they will first bear the trademark "Eimac" . . . the result of engineering foresight . . . skill . . . imagination . . . and research.

EITEL-McCULLOUGH INC.,

728 San Mateo Ave., San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California to General Motors' Charles F. Kettering. This reduces radiation of noise, with some benefit to users of television receivers.

Scarcely A Month Passes but what some manufacturer asks us for a new product idea, and the quota has increased since we published Paul Weiller's "Finding New Products" in March. So suggestions from readers are very welcome indeed. We're glad to serve as a clearing house concerning things needed in our field and not made, items that can be made better and/or cheaper.

Suggestions should meet at least one acid test before we are told about them. If you had the money to manufacture the item in question but would have to gamble the whole roll would you make it?

Concerning New Products, it seems to us that what the consumer wants and what he is willing to pay for it are frequently poles apart. Obviously one cannot produce custom-made precision equipment at home-radio-receiver prices.

Dynamotor Market-Softening reported by several manufacturers appears to be due largely to increasing competition from inherently cheaper vibrator-type power supplies. Some day, off in the still-distant future, vibrators will probably face similar pressure from all-electronic types.

Norbert Wiener's Story opening the January issue of ELECTRONICS proved stimulating to at least one reader. An ad in the Personal column of *The Saturday Review's* February 5 issue read as follows: CYBERNETIC SECRETARY, efficient as electronic equipment and twice as beautiful, yearns for intriguing job, preferably abroad.

Two-Way Radiophone licenses have been issued in Australia to 57 motor-servicing organizations, 12 taxicab companies, two express carriers, bus services, many radio and electrical-equipment servicing organizations, newspapers and manufacturing concerns. The total number of licenses in the commercial category is 158. In addition, there are 1,561 licenses in the names of the police, harbor authorities, public works, electrical supply authorities and other government instrumentalities.

Australia is experiencing the boom in portable radio sales we went through a year or so ago. Manufacturers are at present advertising 31 brands, and 48 models.

A Friend Of Ours who manufactures a bulky piece of production-testing equipment is toying with the idea of installing it in a trailer, driving the thing right into the plants of prospective customers so that its effectiveness can be demonstrated on a regular run.

Program Hours teletranscribed each week by WABD, key outlet of the Du Mont network, total between 14,000 and 20,000 feet of 16-mm film. This, according to Lawrence Phillips, is roughly twice the weekly output of all Hollywood feature films.

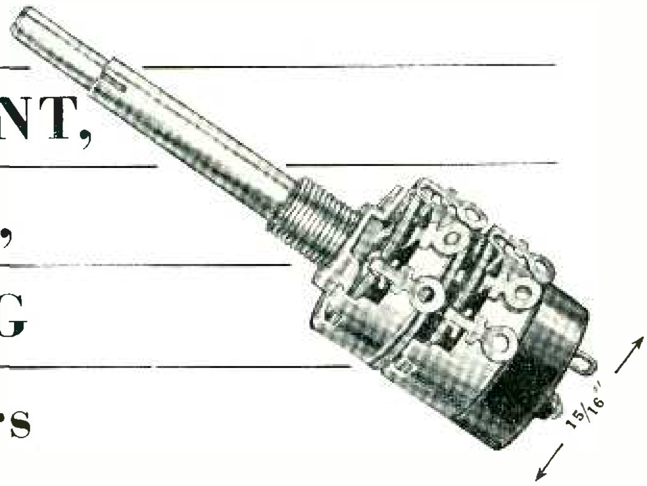
Direct Approach: Listening to an f-m station the other night we were somewhat startled when the announcer said . . . . "Planning a movie evening? Why not stay home and see a movie on your television set instead."

Thus writes the moving finger.

LP Record-Player Sales totalled 600,000, and 2,000,000 of the long-playing disks had been marketed by mid-February, according to Columbia's Edward Wallerstein.

Greatest Need of business today, according to one of the biggest wheels in the electronic component parts game, with whom we recently talked, is men for top management who have (1) common sense, (2) courage, (3) imagination and, (4) experience . . . men who lead rather than drive; men who make the right decision, at the right time, in the right way.

A New Glass for television picture tubes contains no lead and will therefore be lighter and cheaper to produce. Corning, it might be said, is shaking the lead out of its glass.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CROSS TALK

► **BANDWIDTH, AGAIN** . . . Since the announcement last year that information can be sent over a communication channel whose bandwidth is narrower than the spectrum occupied by the information itself, provided only that the signal-noise ratio is kept high enough, there has raged a great controversy in the classrooms and laboratories. Few venture to doubt the theory; those who can understand it say it's sound. But the practical man wants to see it done. Rumors are afloat that it has been done, or is about to be. But the official word is that the systems and apparatus men are busy catching up with the theoreticians.

Good news it is, then, that W. P. Boothroyd and E. M. Creamer, Jr. of the Philco research organization have devised a time-division pulse-multiplex system, suitable for telephonic communications, which exhausts the classical theory of Hartley. That is, this multiplex system uses a channel bandwidth which is, within narrow tolerances, *equal to* the spectrum of the modulating intelligence. In the new system the successive pulses, equally spaced in time, are crowded together so that their oscillatory overshoots overlap. The heights of the pulses are then read by a sampling circuit, synchronized with the transmitter, which sensitizes the indicator only when the sum of the superimposed overshoot amplitudes is zero. Thus the main pulse amplitudes are indicated, and the overshoots are dispensed with, permitting the band of the channel to be narrowed to the Hartley limit.

While not easy to describe in three sentences, as the above try clearly shows, the system is not overly complicated and it does work. That leaves the Wiener-Shannon-Tuller-Sullivan territory directly ahead. The advance scouts are already over the border.

► **F-M FOR VIDEO** . . . The recent suggestion, originating with the technical staff of the FCC, that frequency modulation might be employed for the picture channel on the ultrahigh frequencies has created something of a stir in Washington circles. The FCC laboratory experiments indicate a substantial advantage in reduction of co-channel interference when narrow-band f-m is used. But the testimony, at the time of writing, is rather meager on another aspect, namely what happens when multipath transmission occurs.

There is plenty of evidence, dating from the tests made by Philco and NBC in 1940–41, and witnessed by panel members of the National Television System Committee, that distortion of the picture signal due to multipath propagation is a very serious matter. In the Philco alternate-carrier tests (f-m for sync pulses only) multipath effects often reversed the polarity of the sync pulses, or eradicated them altogether. Thus the reduction of co-channel interference must be balanced against possible loss of sync and other effects of multipath distortion. No final conclusions can be drawn before an adequate field demonstration, in a city providing typical multipath conditions. is held.

► **LENSES** . . . We are always gratified when the new science of electronics gives a helping hand to an old and established art. A recent noteworthy example is the work of Otto Schade in testing optical systems, particularly lenses and photographic films, using a television system as the testing medium. Optics is one of the oldest applications of science. Yet, in over a century of work, no objective means of rating the ability of lenses to show pictorial detail had been devised. Mr. Schade, who has extended the performance of television systems further than any other engineer known to us, passes a magnified image, formed by the lens under test, into a television camera and analyzes the video waveform thus produced. A neat trick, applicable to electron lenses in camera and picture tubes no less than to glass optics. Such techniques, carefully applied, can assist materially in the progress of photography and television.

Airline Test Techniques

Facilities of American Airlines at La Guardia Field permit complete overhaul of electronic gear used in 205 commercial planes and ground stations. Accessory circuits simulating those used in planes constitute an important part of the equipment

By JOSEPH ALBIN
New York, N. Y.

Line crew removing a typical piece of Collins equipment from a ship for overhaul

THE RADIO OVERHAUL WORKSHOP of American Airlines at LaGuardia Field, New York, handles the bulk of the aircraft and ground radio work for the entire airline system, as well as engineering changes and modifications to equipment. In addition to scheduled overhaul, the shop is prepared to aid the engineering branch of the communications department in the development of new models. A separate manufacturing section of the shop is equipped with hand-operated and power tools for fabricating accessory parts in reworking operations. A pioneer in the use of vhf for communication between ground and aircraft, the airline was interrupted in its installations of such equipment in planes by the war. Resuming in 1945, the addition of vhf gear to the entire system has been facilitated by the equipment to be described.

Test equipment has been designed to include circuits which simulate actual conditions found in a specific plane installation or at a ground station. Largely through use of adapters, a single piece of equipment has sufficient flexibility to handle a wide range of types. An employee suggestion system has been helpful in utilizing the talents of the radio overhaul crew in recognizing the need for special equipment when it arises.

ADF Receiver Test

Figure 1 shows the arrangement of American-Airlines-built equipment designed for alignment of a Bendix MN62A adf receiver. The

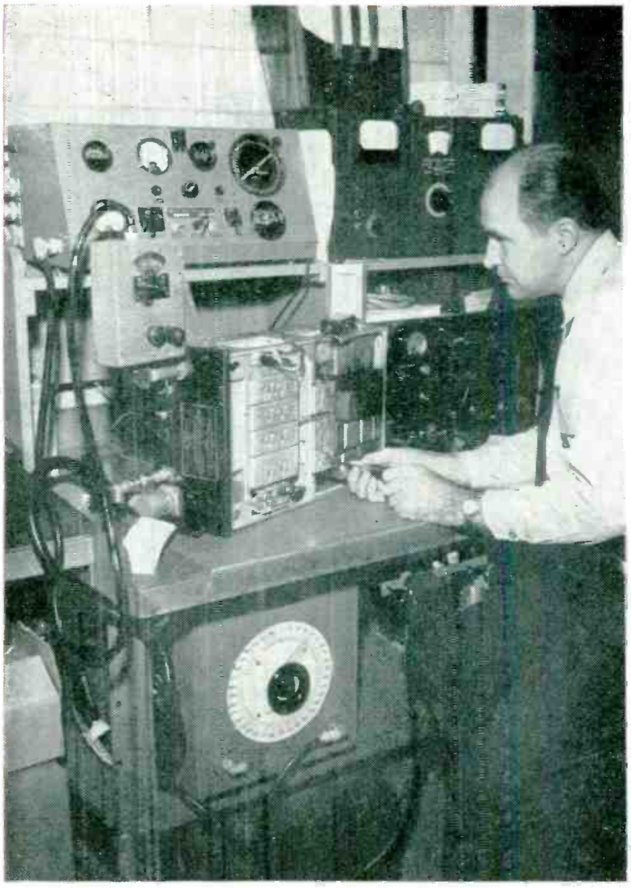


FIG. 1—Circuits of a Bendix adf receiver are completed by the accessories mounted in the cabinet at upper left. Operating conditions of the loop are simulated by the unit at lower left

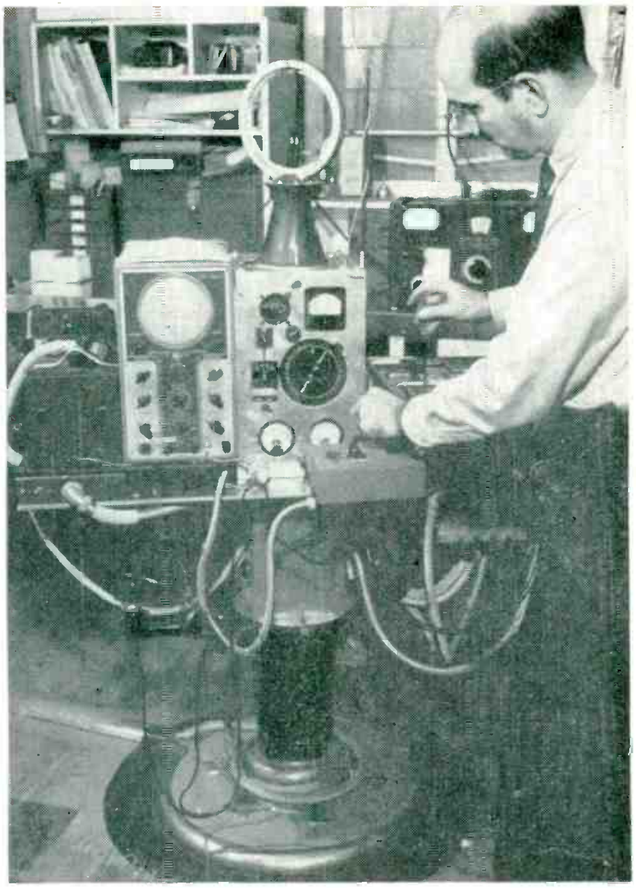


FIG. 2—A barber's chair provides a sturdy mount for rotating direction-finding equipment during final adjustment and performance check

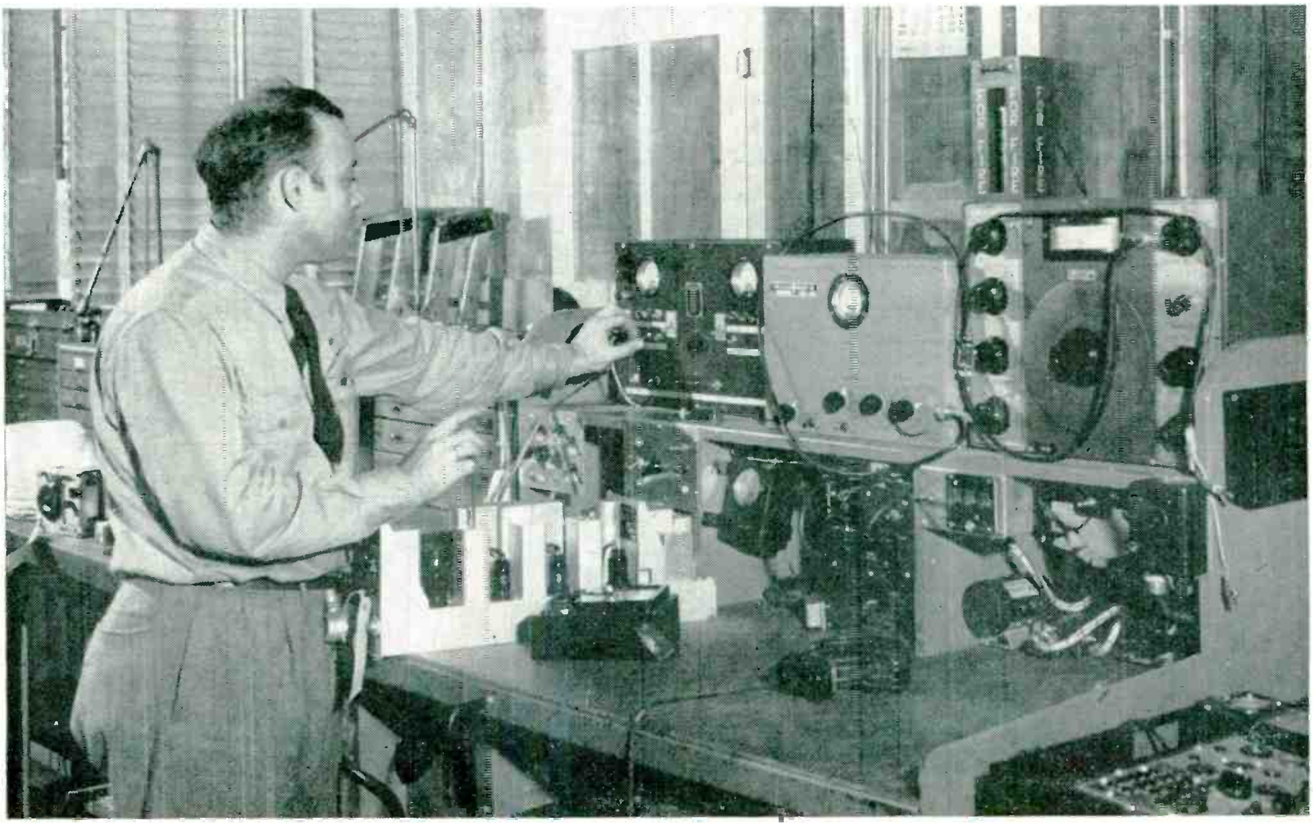


FIG. 3—Radio mechanic adjusts an AA-designed receiver test unit which simulates airplane wiring, controls and indicators

apparatus at upper left is a control and indicating unit consisting of various adf accessories used in the airplane. The unit thus simulates the actual installation in the aircraft, making possible a test under flight conditions. A tuning unit with heavy cable is adjacent.

An interesting unit is the loop simulator, shown at lower left of Fig. 1. It consists of two loops, both mounted on the same axial line, with mechanical means for driving the smaller of the two loops, which is used for signal input. The second loop is a standard automatic direction-finder loop which picks up the signal for the adf receiver, and its rotation follows rotation of the input loop.

The rotation of the equipment due to the plane's movement under actual flight conditions is simulated by rotation of the input loop which is fed from a standard signal generator. Using the loop simulator, complete alignment of the receiver can be accomplished with one exception, the alignment of the loop stage.

To align the loop stage of the receiver, the adjustments are made with the help of equipment which includes a rotatable mount that was formerly a barber chair, illustrated in Fig. 2. An azimuth card is attached to the base of the rotating member so that a receiver can be rotated and checked for sensitivity and ability to take a bearing on a weak signal, which is picked up from a short beam antenna, directed downward, above the chair. Calibrations of correction factors for various plane shapes and sizes are recorded on the azimuth card.

FIG. 5—A Wilcox vhf transmitter is adjusted after overhaul in the test rack

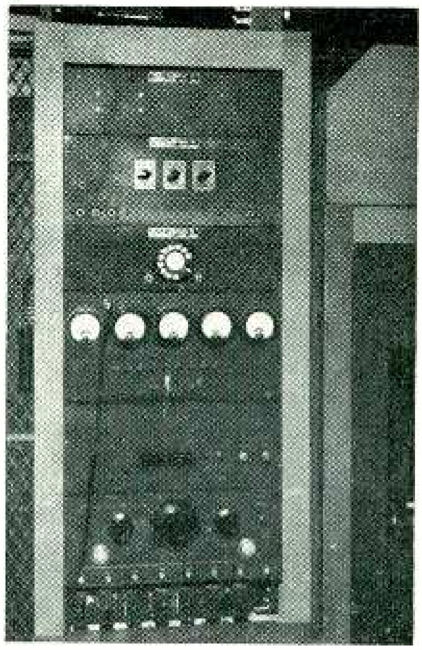


FIG. 6—Keying and dialing circuits are provided for testing ground transmitters

Receiver Tester

Several types of communication receivers are accommodated by the special receiver test unit being operated in the photograph of Fig. 3. It is accompanied on the shelf (right) by a 75-mc signal generator having modulation frequencies of 400, 1,300 and 3,000 cycles. This is used to align marker-beacon receivers.

The circuit of the special receiver test unit is shown in Fig. 4. This simulates the wiring to accessory equipment in the aircraft. Accessories are contained in the test unit. They include a low-voltage d-c supply using selenium rectifiers to replace the 12 or 28-volt batteries used in planes, a 250-volt d-c supply to replace the dynamotors, sensitivity controls, frequency-selector switch, and indicator lamps for the marker receiver (part of the instrument landing system). These units are wired to the several plugs shown in the diagram. Socket and cable sets are available for connecting the receiver test unit to various receivers. When the proper cable set is connected, the various circuits required by the receiver are completed just as they would be in a plane. Changes in the test unit are made from time to time to accommodate new types of receivers.

The test unit also includes an audio oscillator for checking the operation of the receiver sidetone channel. This channel is provided in aircraft receivers to permit a pilot to hear his own voice in his headphones while speaking into the microphone when transmitting by radio or communicating within the plane. Relays in the plane switch

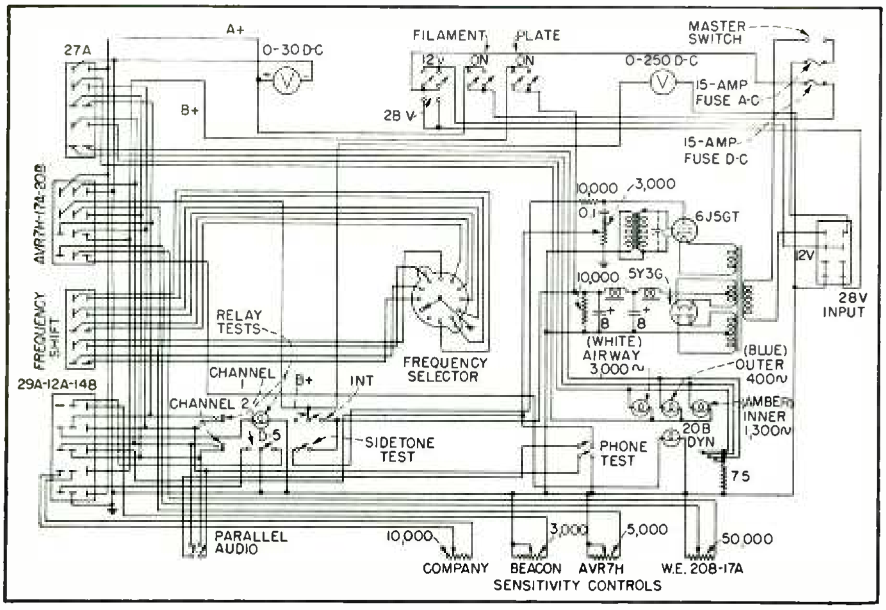


FIG. 4—Complete circuit of the special receiver test unit. Male plugs connect to cable sets for various receivers

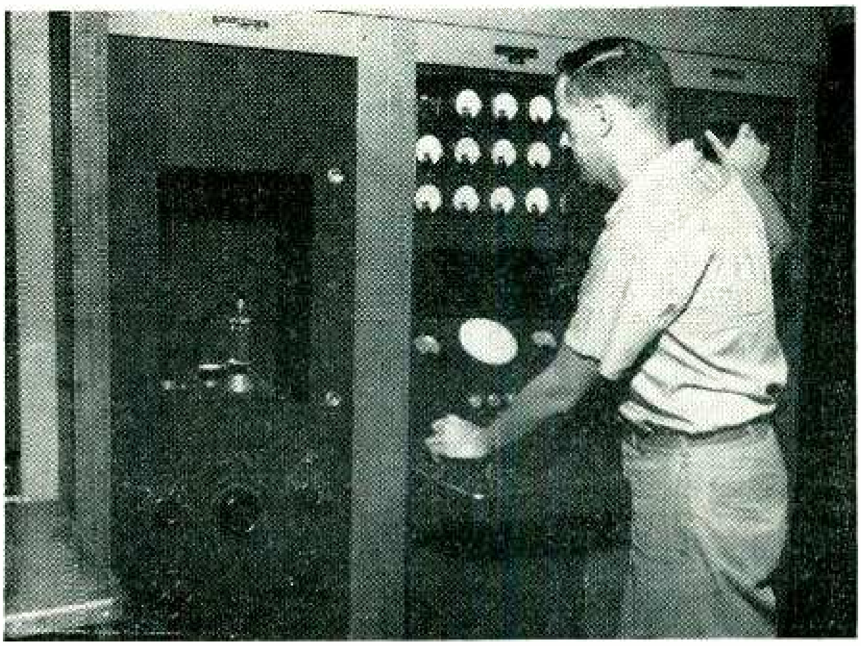


FIG. 7—Complete tube tester for transmitting and rectifier types is contained in these three racks and section above

a portion of the audio signal from the transmitter to the audio channel of the receiver and disable the screen circuits of the r-f and i-f circuits of the receiver. The test unit contains similar relays for connecting the audio oscillator into the sidetone channel to check its operation. A level of 50 milliwatts is considered minimum for headphone reception in the aircraft.

When a marker receiver for the ils is being tested, the white, blue and amber indicator lamps are automatically connected by the receiver cable set to receive the direct-current output of saturable reactors and filters in the receiver that actuate similar marker indicator lamps in the aircraft.

In Fig. 5 is a complete test rack used to adjust the Wilcox 601A vhf transmitter after overhaul. Single-channel tuning of the r-f exciter circuits is done by adjusting the plate circuit of each stage for maximum grid current in the following stage. The final amplifier tube is then inserted and its grid and plate circuits resonated. A dummy antenna is next connected, the output amplifier readjusted for resonance and all stages checked.

For testing remote transmitter control units as well as receiver installations under simulated use conditions, the test rack illustrated in Fig. 6 contains circuits which serve as equivalents of telephone lines, and supplies necessary power and keying and dialing circuits for complete operation. It also can be used to test high-frequency transmitters, chiefly the 50-watt W. E. 13 ground transmitter.

Transmitter Tube Tester

The tube tester illustrated in Fig. 7 is designed for heavy-duty rectifier tubes and transmitting tubes only. The tube tester provides a low-voltage rectifier test, a high-

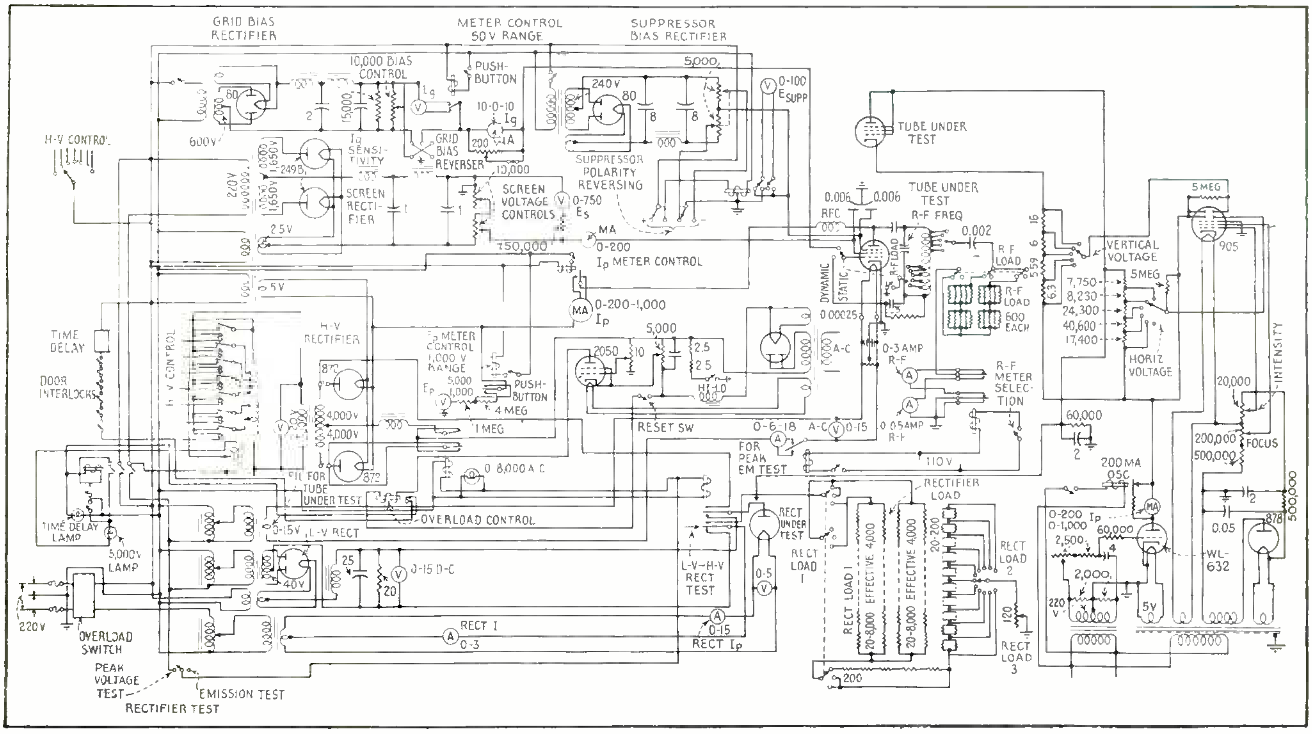


FIG. 8—Circuit of tube tester. A power tube is operated as an r-f oscillator under load conditions. The cathode-ray tube is used in an emission test

voltage rectifier test, a transmitting-tube static test, a transmitting-tube dynamic test, and a cathode-ray test of transmitting tubes. In the latter test, a visual emission curve is provided on the screen of the cathode-ray tube.

Separate adjustable power supplies are provided in the tube tester for the control grid, screen grid, suppressor grid and plate potentials of the tube under test. These potentials are individually controlled by the operator of the tester. As shown in the photograph, voltmeters for each circuit permit continuous monitoring of potentials and precise adjustment for various types of tubes. Up to 8,000 volts can be applied to tubes under various conditions of load.

The circuit of the tube tester is shown in Fig. 8. For the dynamic test of transmitting tubes, the tube is operated as an r-f oscillator to simulate the load conditions of the tube in its normal circuit. Power generated by the tube at a frequency of approximately 200 kilocycles is dissipated in a load composed of a number of 600-ohm resistors that are connected in a series-parallel arrangement to permit obtaining loads of 120, 240 and 480 ohms. Control of the load circuits is accomplished by means of three knobs at the top of the test stand.

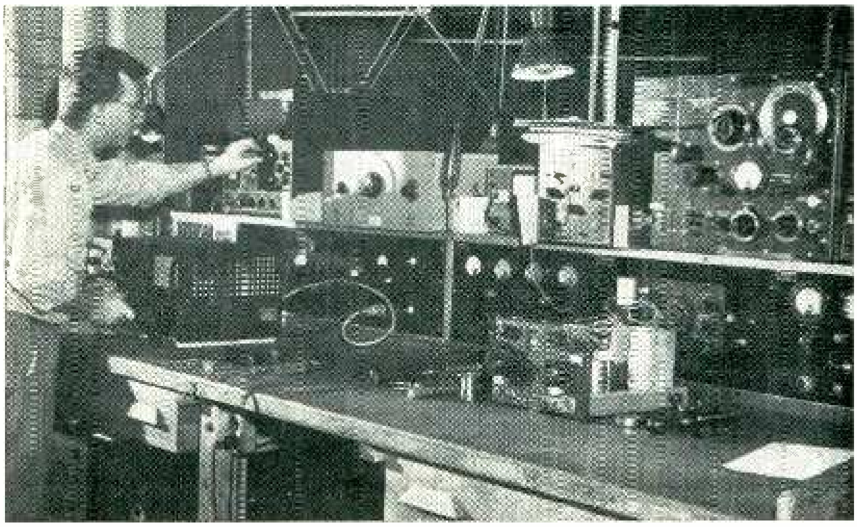


FIG. 9—Receivers employed in overseas flights are tested with this equipment

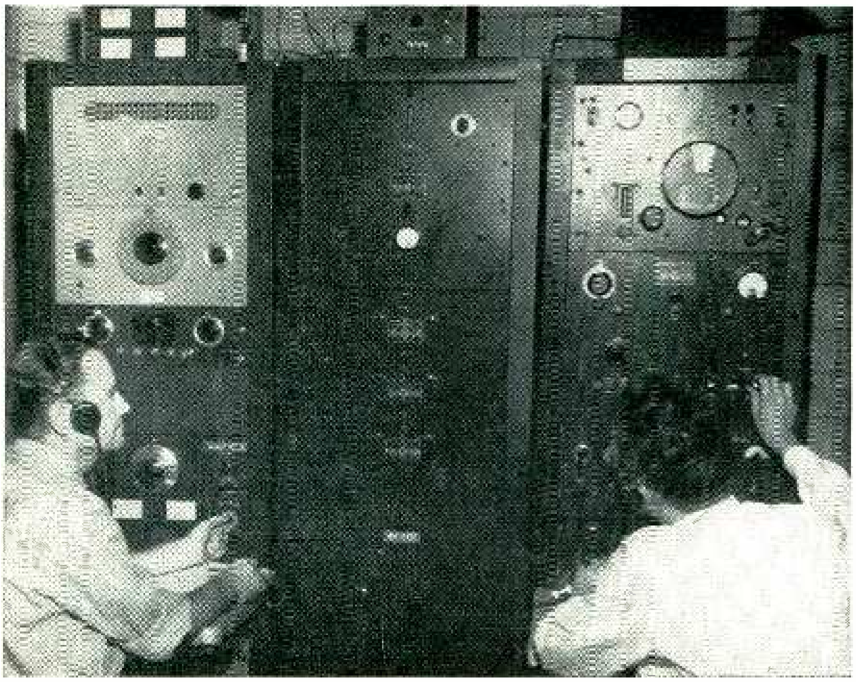


FIG. 10—Frequency-measuring equipment used in calibrating quartz-crystal blanks

Components Layout

A series of interlocking door switches, time-delay circuits and indicator lamps act as safety devices to protect the operator of the tube tester. After he has made proper selection of operating potentials to be applied to a tube under test, it is necessary for him to step on a foot switch to actuate the circuits.

The left-hand rack shown in the photograph (Fig. 7) contains the high-voltage selector and preheater supply unit, the oscillator and master socket unit with suppressor-polarity reversing switch, tuning, load, grid excitation and coupling controls, the r-f load and associated external 500-ma and 3-amp thermocouples.

The center rack section contains the meter panel with range-selector relays, the 905 cathode-ray tube, the control unit with its warning and indicator lights, 878 rectifier, 632 thyratron and associated controls for the cathode-ray circuit, 82 rectifier, 2050 thyratron and controls for the overload circuit and meter-range selector buttons.

The third rack section contains the variable high-voltage control, the variable low-voltage control unit using two power supplies to supply the grid and suppressor grid voltages, a 15-volt power supply unit which has a time relay and uses two type LVR 2-amp mercury-vapor rectifiers to supply low voltage for the rectifier test. The 1,000-volt power supply has a master-switch circuit breaker for the entire tester and uses two type 249T rectifiers which supply the screen voltage. The 4,000-8,000-volt power supply with the low-voltage high-voltage relay supplies the plate voltage for all tubes except rectifiers, which operate directly from the high-voltage secondary.

The fourth section, across the top of the three racks, is the rectifier load with associated controls. The instrument operates from a 3-kw line.

The panels shown in Fig. 9 test

and align radio equipment used in overseas aircraft. The apparatus on the upper shelf, from left to right, consists of an oscilloscope, audio oscillator, volt-ohmmeter, frequency standard and signal generator. The equipment below the shelf comprises control and meter panels.

The equipment used in crystal-frequency monitoring as well as testing of crystals is shown in Fig. 10. This equipment consists mostly of General Radio units and some AA-built units. Other gear, not shown in this photograph, tests crystals in their holders, measures activity, and permits grinding to proper dimensions.

Other Equipment

For rapid routine testing of dynamotors, the test stand of Fig. 11 has been built to check all types of dynamotors from the smallest type used in receivers to those used in transmitters. Adapters are provided to accommodate the different types so that a number of dynamotors can be connected to the instrument at one time. The test stand is arranged so that all the meters can be switched to a particular dynamotor being observed. The noise meter, actually a vacum-tube voltmeter with preamplifier, indicates excessive ripple due to faulty commutator brushes and in some cases due to electrostatic accumulations on ball bearings which discharge through the oil film.

Headsets and microphones are tested for sensitivity and frequency range in the instrument illustrated in Fig. 12. Headsets can be matched so that two headsets will be equal in volume at all frequencies. An audio oscillator furnishes a signal audible in the headset. The signal is picked up by a special dynamic microphone which feeds an oscilloscope and a meter that measures voltage output.

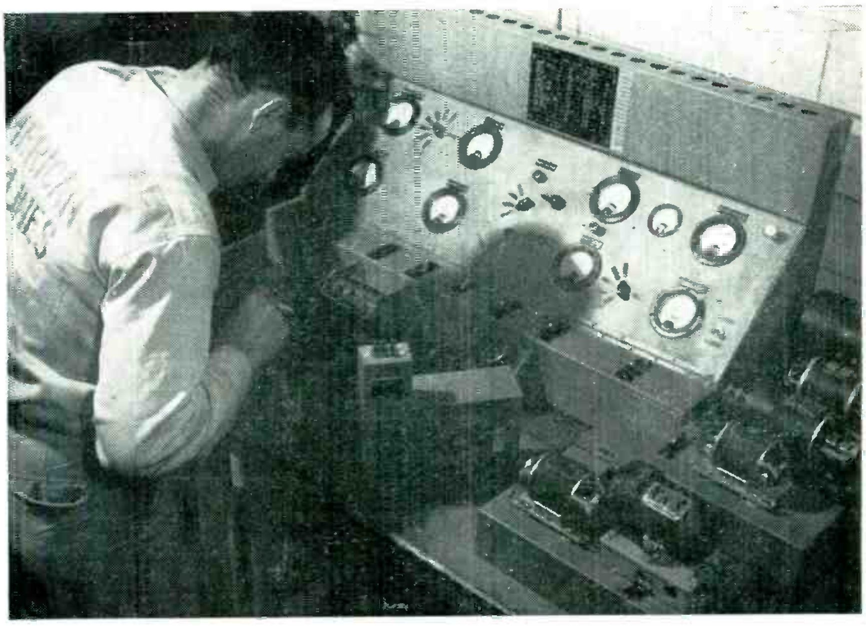


FIG. 11—A variety of adapter chassis permits testing dynamotors under load and for excessive noise

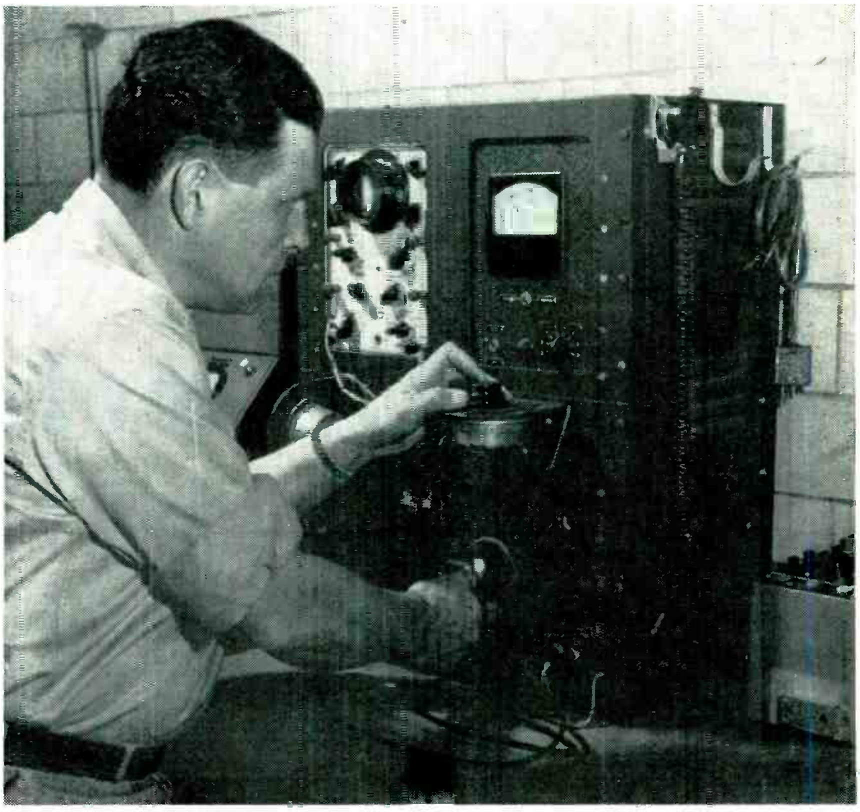
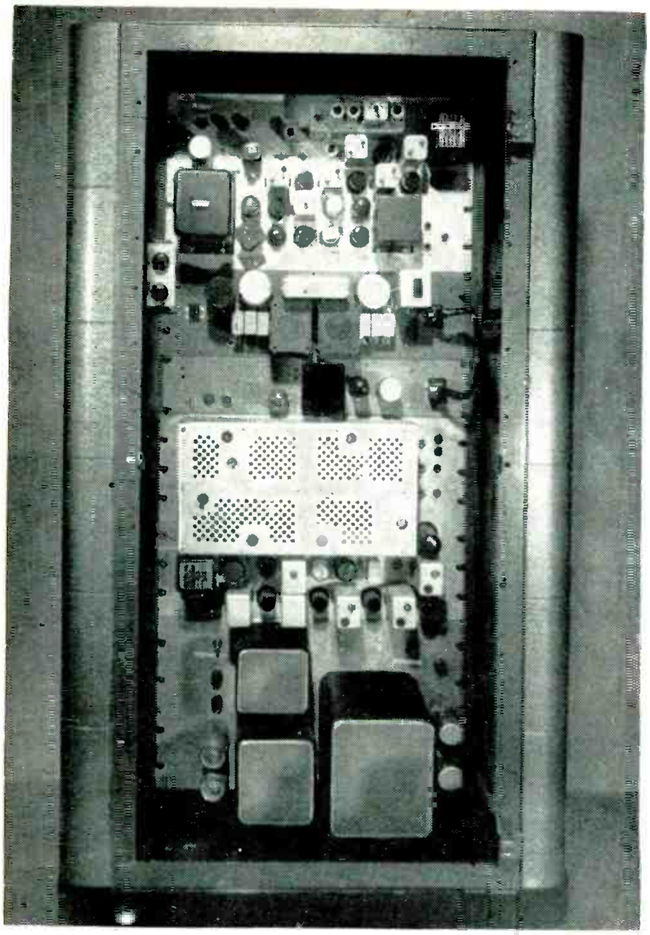


FIG. 12—Complete facilities for testing microphones and headsets

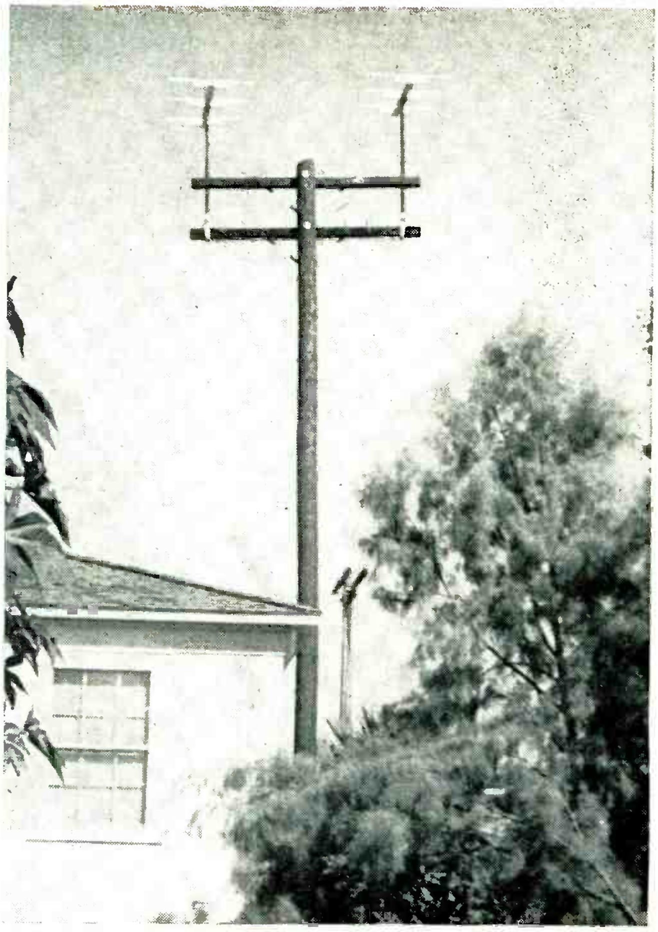
The radio overhaul shop at La Guardia consists of a main area for general overhaul, a separate manufacturing section, and several smaller rooms, screened or otherwise constructed for special testing. For screening purposes, the technicians in this shop prefer a screen composed of hot-galvanized-dipped wire of ¼-inch mesh instead of more closely woven copper screening. The objection found in the case of the copper is that it eventually oxidizes, resulting in incomplete screening in spots, whereas the galvanized bonded wire does not work apart or deteriorate at the joints.

Policy in connection with overhaul is the responsibility of the Director of Communications, G. E. Mears, and Stanley Irwin, Assistant Director.

The author wishes to acknowledge assistance in the preparation of this article on the part of Ralph Core, Supervisor, and Walter Grasel, Shop Foreman, of the radio overhaul shop.



Complete terminal comprising transmitter, receiver, interconnecting equipment and power supply



Typical antenna installation employed by a Texas telephone company

VHF Telephone Link

Standard radio equipment is modified and provided with a balancing network for matching into line-telephone equipment. Resulting extension of telephone service reaches isolated homes and business enterprises, or provides short-haul toll circuit over rough or impassable terrain where wire lines can not be run

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Many homes, businesses and communities in remote locations do not have telephone service because of the prohibitive expense of building the long wire lines necessary to reach them. In a number of these cases vhf radio circuits may provide the necessary telephone facilities at acceptable costs. Radio circuits offer the advantage of speed of installation and the elimination of pole lines, which are expensive to build and to maintain whenever long distances are to be bridged in remote regions. Such radio circuits, operated as part of a telephone system, are particularly advantageous where bodies of water or rough, hazardous terrain have to be crossed.

The need for a simple, reasonably priced unit to handle such cases has been indicated. For this reason, the development of a single-channel

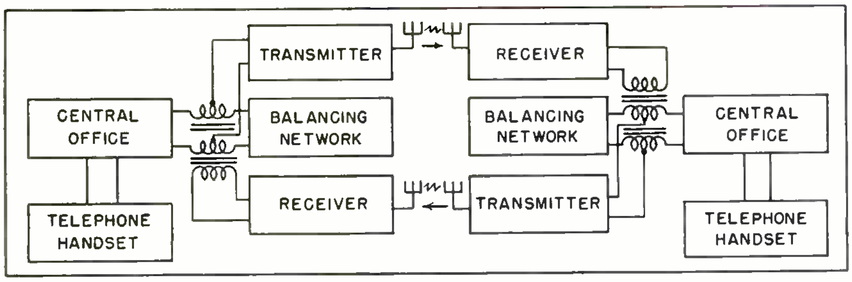


FIG. 1—Block diagram of a two-way radiotelephone circuit connected to conventional two-wire telephone system

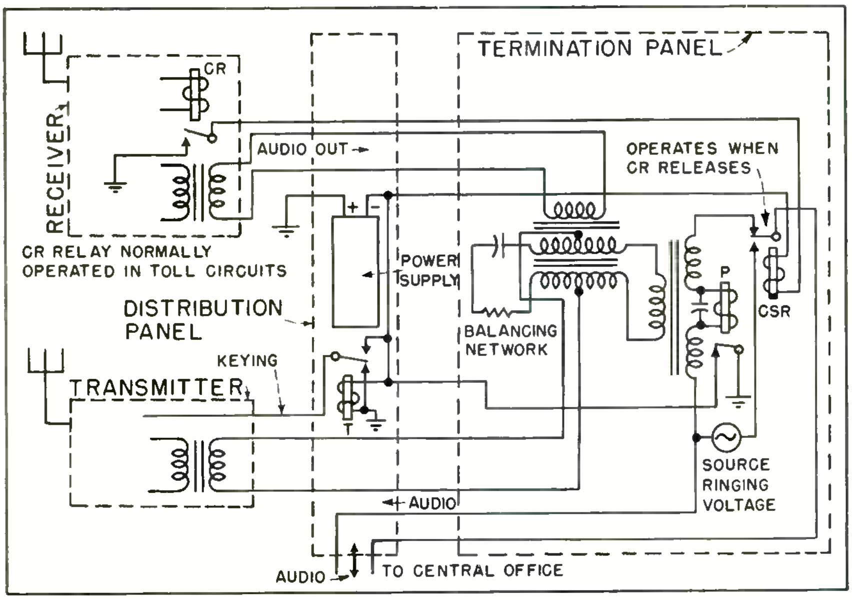


FIG. 2—Terminal equipment used to extend wire-telephone service by means of radio. It can be used in different ways, using optional interconnections

LICENSE REQUIREMENTS

Use of vhf radio circuits to supplement wire-line service by telephone companies is predicated on a number of factors under the cognizance of FCC. Present grants are on a "secondary" basis—dependent upon noninterference to the mobile service, and licenses require special handling in each case.

Certain additional licensee categories are now, or will be, eligible for point-to-point vhf grants under a proposed FCC rule. Included are railroads, petroleum industry, lumbering, and special industrial services. In some cases, such service is on a secondary basis; in others it is subject only to conditions of noninterference to presently established services. License applications in these categories will also require individual handling for each case.

The Commission's present allocations are shown in the *Federal Register*, p 8130 to 8156, Dec. 21, 1948. The major part of the proposed allocations plan is shown in the *Federal Register*, p 3376 to 3441, June 23, 1948.

—**The Editors**

for Isolated Communities

vhf link, operating in the 152-to-162-mc band, was undertaken in the Radio Department at General Telephone Service Corporation.

Interconnection Problems

When a radio circuit is to be used between two fixed points, there is no problem in operating a two-way system provided that four wires are furnished between the radio facilities and each operator's position. The nation's wire-telephone network, however, operates on a two-wire basis. Only two wires extend from the central office to each subscriber's instrument. In order to use radio as an extension of the telephone network, it is therefore necessary to match the four-wire radio network into the two-wire land-line telephone system.

While usable results can sometimes be obtained by paralleling transmitter input, receiver output, and line, it is generally found that the audio gain of the radio circuit must be kept down to very low values in this arrangement to prevent oscillations because of the feedback path existing around the radio-circuit loop. Owing to the variation of phase angle over the frequency band, even a transposition of the audio wires in such a feedback circuit will not eliminate this problem, although it will change the frequency of the oscillations.

To overcome these difficulties, a hybrid system for which a simplified block diagram is shown in Fig. 1, is used. In the ideal case, the balancing network is an exact replica of the impedance presented at the terminals leading into the wire-line system. Under these conditions, any voltages impressed by the receiver output will leave the points across which the transmitter is bridged at the same potential, and thus no energy is transferred to the transmitter. Incoming signals from the line, however, will produce a voltage across the transmitter. This arrangement theoretically permits high stable gain.

To obtain perfect balancing, it will be necessary to provide a special network for each of the innumerable varieties of lines that might be attached to the radio circuit through the switchboards at the central office. Fortunately, it is found in practice that a compromise balance may be used, that is, a balance that represents the impedance of the average wire line. By using this compromise balance, gain values may be obtained that are acceptable for telephone operations while maintaining a sufficient safety margin below the "singing" or oscillation point.

In the unit described here, hybrid circuits, as well as the signal circuits, are concentrated in a termination panel. For practical reasons, it was found desirable to interconnect all the units through a distribution panel, as shown in the block diagram of the system in Fig. 2.

Functions

There are three main functions which the radiotelephone unit can perform. It can be used to give telephone service to a single isolated subscriber; it can be used to give telephone service to a distant group of subscribers who are located sufficiently close together to permit their interconnection by means of a few miles of wire line; and the unit can be used for toll circuits between central offices. To obtain these different functions, some circuit changes must be made in the termination panel. The different circuits are obtained by changing straps on a terminal board contained in the unit.

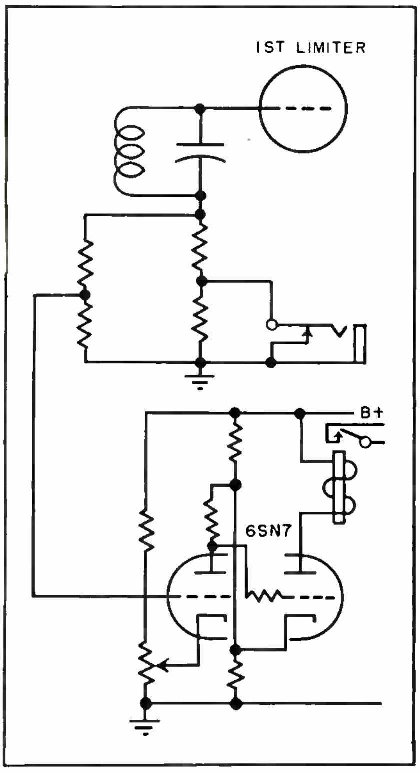


FIG. 3—Carrier-operated relay circuit for dial and ringdown operation

If service is to be given to a single remote subscriber, a termination panel is needed in the central office to match the four-wire radio circuit to the two-wire telephone system. At the subscriber end, however, it is not necessary to provide a hybrid system, and accordingly the termination panel can be removed from the subscriber's radiotelephone unit. At least one standard make of subscriber instrument can easily be rewired to provide a four-wire circuit, as well as the necessary control circuits for this application. This instrument is then directly connected to the distribution panel by means of a multiconductor cable. The subscriber, through his radio circuit, can then be connected to either a manual telephone exchange (using central battery supervision) or to a dial exchange.

Radio Party Line

More than one isolated subscriber may be given service from the same central office on the same pair of frequencies. When calling, the central office may distinguish between the different subscribers on this "party line" either by using coded ringing or by harmonic ringing. In the latter case, any one of a number of different ringing frequencies can be transmitted. The subscribers' bells are mechanically tuned to these different frequencies, and only one bell will ring for each frequency transmitted.

One problem occurs when the subscriber desires to talk to another subscriber who is connected to the central office by means of the same pair of radio frequencies and through the same radiotelephone terminal at the central office. If two subscribers are transmitting simultaneously, beat notes are likely to occur in the central-office receiver. For this reason, a switch must be provided in the subscriber instrument. Operation of this switch will put the subscriber's transmitter under the control of a pushbutton in the handset, and push-to-talk operation, as used in mobile radio, is then employed.

In some cases, several potential subscribers are located close together so that the building of a short-wire line will make it possible to interconnect subscribers. The vhf radio link can then be used to connect these subscribers to the central office; termination panels are needed at both the central office and the remote terminal. In this case, the subscribers' sets are connected across the standard two-wire telephone circuit. Manual or dial operation, as well as coded or harmonic ringing, are again available in this application.

Toll Circuits

A common form of toll circuit is the ringdown type, in which the operator applies ringing voltage to the line to activate a lamp or signal at the distant end when she initiates a call. Ringing current is reapplied either to recall the other operator after the connection has been established or to signify the termination of the call. The radiotelephone unit described here provides such ringdown toll circuits. Termination panels are needed at both ends. For voice transmission, such a circuit has advantages over a physical wire line, because voice-frequency gain is available in the radio units. This feature, combined with the voice-frequency gain stability resulting from the use of frequency modulation, permits the operation of a stable zero-loss or low-loss circuit. The same advantages in transmission quality are obtained on the subscriber circuit.

Other types of toll-circuit signaling are needed in some cases; and, for this purpose, an alternate panel, permitting full two-way dialing over the radio circuits, has been developed.

Description of Equipment

The radio transmitter and receiver used operate in the 152-to-162-mc band and are materially the same as those used for the low-power land transmitter and for the land receiver in urban-mobile systems. The fact that these units are already in quantity production results in acceptable price and delivery schedules, which could not be obtained if special units were to be designed and built for this service. Some minor modifications are made in these units to adapt them for the particular service and specifically to provide the supervisory signals that are necessary when connection is made to the existing telephone system. Supervisory signals are transmitted in these units by controlling the r-f carrier either by switching it on or off or by recurrent interruptions which are used for the transmission of ringing and dialing.

It should be noted that while the equipment described here operates in the 152-to-162 mc band, the same modifications may be made to equipment operating at other vhf bands, such as the 72-to-76 mc band.

Apart from the antennas and r-f lines, a complete radio terminal consists of the units illustrated: receiver, termination panel, distribution panel, transmitter, and power supply for transmitter. These units are permanently interconnected.

The receiver is a modified 152-to-162-mc fixed-frequency unit (RCA CR-3B) of the double-superheterodyne type using different harmonics of a single crystal oscillator for the local oscillator frequencies. This unit is tuned at the factory to a specified frequency. The receiver contains a carrier-operated relay and associated circuits to follow dialing and ringing pulses. The tube complement is as follows: two 6AK5 tubes operating as an r-f amplifier and first detector; three 6AG5 tubes operating as the oscillator, first multiplier and second multiplier; six-6SH7 tubes operating as a second detector, first and second i-f amplifier, first and second limiter, and second audio; two 6H6 tubes operating as the discriminator rectifier and the noise rectifier; one 6SL7 squelch tube and first audio tube; one 6K6 output tube; one 6SN7 relay tube and one 5Y3 rectifier.

Relay Circuit

Normally the carrier-operated relay provided in this receiver is operated from the squelch circuit. In order to get a low distortion figure for the dial and ringing pulses, it was found desirable to energize the d-c amplifier, normally used, from limiter current instead. In addition, faster time constants were incorporated. The relay circuit is shown in Fig. 3.

A more detailed description of the termination panel would go beyond the scope of this paper. However, Fig. 2, which represents a simplified schematic diagram, shows that operation of the receiver-carrier relay will apply a-c ringing voltage to the outgoing telephone line by means of the *CSR* relay in toll application and for the distant unit for subscriber operation. Ringing voltages, received from the line, operate polarized relay *P* and will interrupt the outgoing carrier by applying cutoff bias to the transmitter. In the subscriber terminals, a wiring change is made so that *P* relay will put the transmitter on the air as soon as the subscriber lifts his handset. The same hybrid circuit is used in all these applications; it is also shown in Fig. 1.

The distribution panel (Fig. 2) interconnects all units as shown. It also contains a power-supply unit with its positive side grounded. This power-supply unit, by means of relay *T* can apply cutoff bias to the transmitter. It also provides the d-c supply for the termination panel and the microphone current for single subscribers.

Transmitter

The transmitter used is the RCA CT-5A 45-watt 152-to-162-mc unit. Like the receiver, it is modified for this specific purpose. It is also pretuned prior to shipment, so that only minor adjustments are necessary to place it in operation. The major modification made in this transmitter permits keying by applying negative voltage to grid of the last tripler tube and final amplifier.

The normally-used transmitting and the receiving antennas designed specifically for use with this equipment are three-element directional types consisting of a driven element, reflector, and director mounted on a subassembly. They are connected to the radio terminal by means of coaxial cables. The antenna elevation needed may vary from one situation to another but, in general, antennas should be at least 30 feet above ground level and 15 feet above surrounding buildings. Under such conditions, normal operating range is in the order of 25 to 30 miles over flat country.

Installation

To support the antennas, a single telephone pole can generally be used. Normally, sufficient spacing is obtained when the two directional antenna structures are supported at opposite ends of a 10-foot crossarm. Coaxial cables, attached to the pole at proper intervals to give mechanical support, connect these antennas with the terminal unit. The cables are equipped with coaxial fittings that are connected to corresponding receptacles in the transmitter and receiver. For use in a central office, two wires from the main distributing frame are connected to a terminal block in the unit. For remote communities, the outside interconnecting wires, having been properly fused and protected, are similarly connected to the termination panel, and a microphone-supply battery is added. For single subscribers, a specially-wired subscriber set is plugged into the distribution panel, and the termination panel is omitted. Connection of a ground wire and insertion of the power plug into the 110 volt 60-cycle outlet makes the system ready for operation.

The power requirement of this unit is 477 watts for toll-circuit operation. In subscriber operation, it is 477 watts while transmitting, and approximately 380 watts for standby operation.

Cost

Although the present cost data are still preliminary and may require further revisions, the present indications are that the cost for a complete radio circuit will be below $3,000. On this basis, such circuits may well provide the means to permit telephone companies to give service to a number of locations where it is presently impracticable to do so.

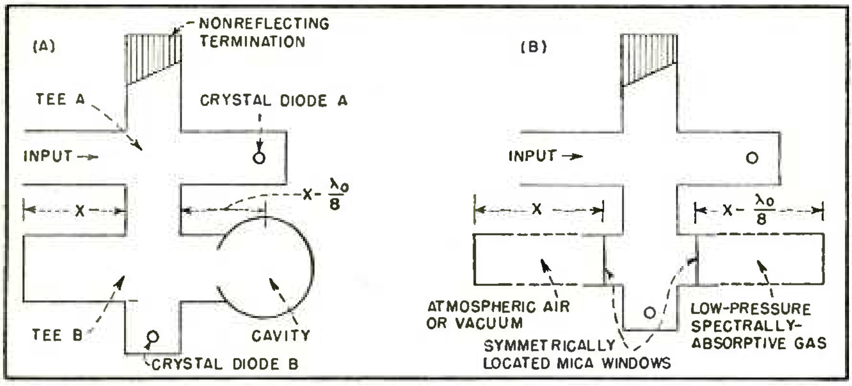


FIG. 1—Cavity-type discriminator (A) and similar spectrum-line discriminator (B) used for stabilizing frequency control

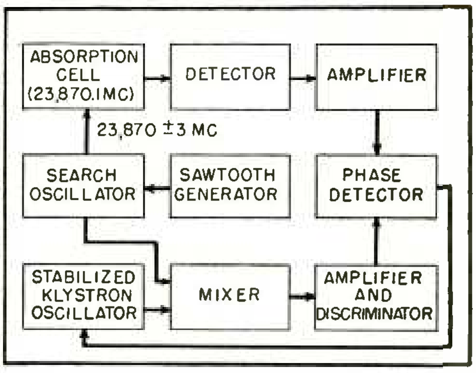


FIG. 2—Sampling stabilizer using a klystron oscillator

Stable TIME and FREQUENCY STANDARD

Spectral absorption of microwaves by gases is so stable that the National Bureau of Standards is using the phenomenon as a standard of time. Oscillators for communications and measurements at uhf can also be stabilized by utilizing the absorption principle

By using the absorption of ammonia gas at 23,870.13 megacycles as the primary standard of time in a new clock, the Bureau of Standards has shown the utility of microwave spectral absorption as a time and frequency standard. Not only does this spectrographic technique provide a more invariant time standard than heretofore available for scientific and engineering measurements, but it also provides a means for stabilizing ultra high frequency oscillators with an accuracy at least as good as that obtained at high frequencies by quartz-crystal control.

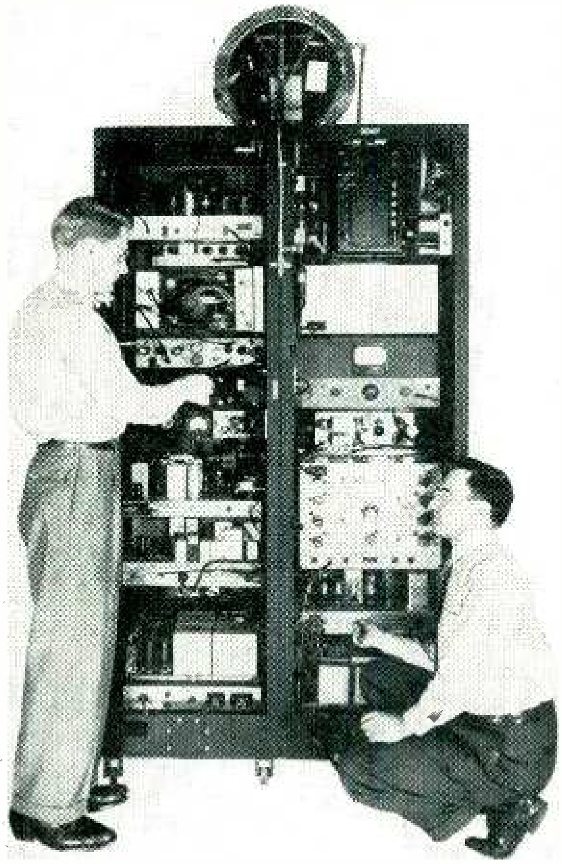
Quartz crystals (or magnetostriction bars) can be dimensioned so as to vibrate at the frequency (or one of its subharmonics) to be stabilized. On the other hand, absorption lines occur only at certain specific frequencies. Simple techniques can be used to relate any oscillator frequency to a convenient spectral absorption line. For many applications the equipment need not be elaborate; for the ultimate in refinement the system employed in the "atomic" clock (more strictly, a molecular clock) can be used.

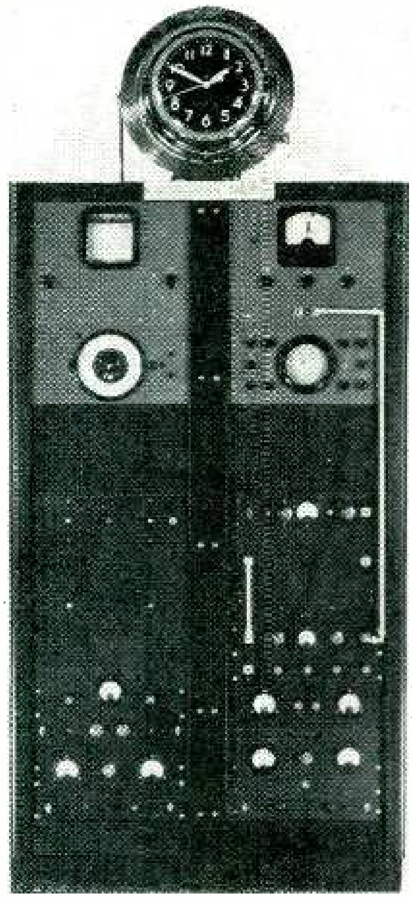
Stabilizing Oscillators

There are several basic methods of stabilizing the frequency of microwave oscillators to a degree comparable with that obtained by crystal control at lower frequencies. The reasons for the arrangement and the development of the techniques used in the clock to be described here will be more readily understood if these previously described methods are briefly reviewed.

As at low frequencies, a discriminator can be used to develop a voltage whose amplitude and polarity are indicative of the deviation of an oscillator's frequency from the center frequency of the discriminator. Such a technique has the merit that the discriminator can be more carefully stabilized in most instances than the oscillator itself. As used to stabilize microwave oscillators, a discriminator consists of two waveguide tees, a nonreflecting termination, a short waveguide and a cavity[1] as shown in Fig. 1A. The cavity, which determines the center frequency, can be proportioned for the highest selectivity and constructed for the greatest stability; but, were the cavity to be associated directly with the oscillator tube, its design would have to be compromised to meet the requirements of the tube.

The next step is to replace the cavity with a waveguide, containing a gas at low pressure, (Fig. 1B) whose spectral absorption line determines the center frequency of





Rear (left) and front (right) views of the Bureau of Standards clock. The tubing containing ammonia gas is wound in a helix around the large clock at the top

the microwave discriminator[2]. The cavity discriminator is readily adjusted for complete cancellation of the signal at the center frequency. Design of the gas line is not as simple because the line cannot be made long. If it is made long absorption will also take place just each side of resonance, broadening the apparent absorption band.

Spectrum Stabilization

With a cavity discriminator operating in the 3-cm band, a stabilizing output from the discriminator of 250 millivolts per megacycle has been obtained[1]; on the other hand, using the 3,3 spectral line of ammonia (in the 1-cm band) at a gas pressure of somewhat more than 0.1 mm of mercury in a spectrum-line discriminator, a stabilizing output of 70 millivolts per megacycle has been obtained[2]. Although the cavity discriminator gives the greater selectivity, the spectrum-line discriminator can be expected to have the higher stability.

The cavity discriminator can be built for any desired center frequency, or even made tunable. However, the spectrum-line discriminator can only be made for a center frequency at which there is an absorption line. (Although the absorption frequencies can be shifted by applying static electric or magnetic fields, this technique would reduce the stability of the line.) The next step, therefore, is to provide a means for relating the oscillator and discriminator frequencies.

The output from the master oscillator could be modulated or heterodyned with an auxiliary oscillator to obtain a signal at a spectral line, but this (usual) technique introduces some inherent instability from the auxiliary oscillator. (The auxiliary resonant circuit can be in either an oscillator or a tuned amplifier, the choice being one of system arrangement rather than of system stability.)

Frequency Sampling

Another method by which a microwave oscillator can be related to a spectrum line is to sweep an auxiliary oscillator through the absorption frequency of a gas and through the frequency of the master oscillator[3]. The method, in effect, moves the discriminator from the ultra high frequency portion of the system to a low-frequency (pulse) portion.

The action of this system, indicated in Fig. 2, is briefly as follows: the search oscillator is swept across the absorption frequency of the spectrum line. The signal from the search oscillator passes through the waveguide and is detected at

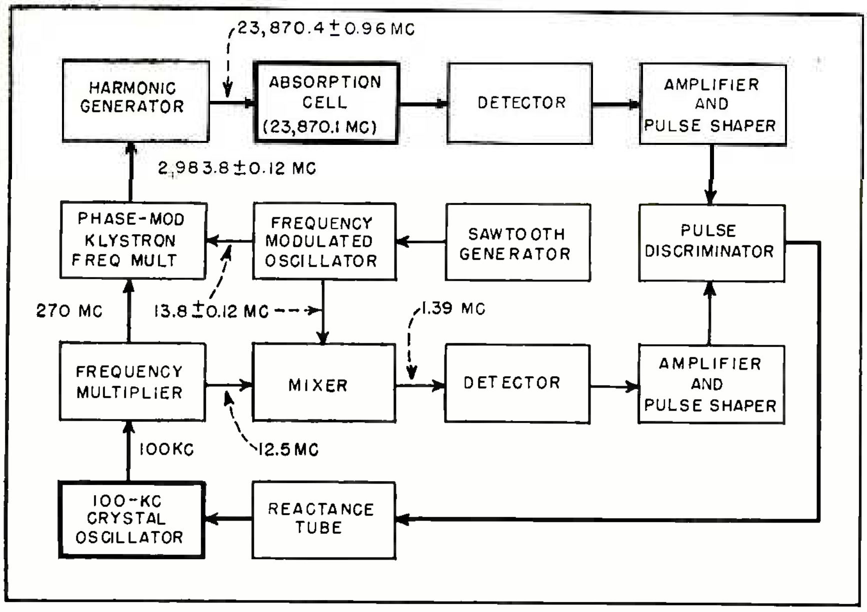


FIG. 3—Simplified block diagram of the NBS clock, based on 100-kc crystal driving a phase-modulated klystron multiplier

the far end. At the instant that the frequency passes through the absorption line, the detector output is interrupted, thus delivering a pulse that is amplified and passed to the phase detector (pulse discriminator). In a parallel path, the output from the search oscillator is mixed with the output of the master oscillator. The output from this mixing is a variable frequency, for which the transmission characteristic of an amplifier serves as a discriminator to produce a second pulse. The two pulses are passed to the phase (or coincidence) detector to generate a stabilizing voltage proportional to the time difference between the two pulses.

Sampling Rate

The stabilization that can be obtained with this system depends primarily on the rate of sampling (search frequency) and the gas frequency. (The resonant circuit of the amplifier that provides the discriminator action following the mixer also introduces a residual instability. As in continuous-control systems, the resonant circuit in the mixer output could be shifted to a beating or modulating oscillator operating on the output of either the search or master oscillator without changing the hypothetical stability, although there might be practical advantages for one of these three positions.)

Whereas the systems using microwave discriminators depend on high amplification to make full use of their inherent stability, the system using sampling and pulse-coincidence discriminator relies on high time resolution in the pulse circuits to realize its inherent stability.

Precision Time Standard

The technique described is suitable for most communication and laboratory applications. However, for the ultimate accuracy, as is required in the standard time service provided by the National Bureau of Standards, further refinement is necessary. In particular, because of the inherent inability of the searching technique to counteract frequency changes in the master oscillator taking place faster than the sampling rate, short-term stability needs to be incorporated. This feature is provided in the clock by using a fairly stable (crystal-controlled) master oscillator. In effect, crystal control of the master oscillator adds the analog of inertia to the frequency of the oscillator so that the stabilizing circuit need only contend with the slow drifts associated with a high-inertia system. The absorption frequency of the gas can then be sampled slowly enough to assure full response to its highly selective frequency characteristic.

In the clock, for which a simplified block diagram is shown in Fig. 3, a 100-kc crystal-controlled master oscillator is the circuit to be stabilized. Its frequency is multiplied and frequency modulated and again multiplied to the frequency region of the ammonia-gas absorption line that is used as the comparison standard. By using the multiplied master-oscillator frequency as the central frequency for the searching system, the clock is further freed from instabilities of auxiliary components. As in the previously described sampling system, a pulse is obtained as the signal sweeps through the absorption line. A second pulse is obtained by mixing the multiplied frequency from the master oscillator with the auxiliary frequency-modulated oscillator to obtain a second pulse. The time interval between these two pulses generates the control voltage for correcting the frequency of the master oscillator.

There is a finite interval between the two pulses. This time interval is a function of the intermediate frequency (1.39 mc) used with the mixer and the rate at which the sawtooth generator frequency modulates the auxiliary oscillator. The tuned circuit in the intermediate-frequency output of the mixer introduces a residual instability that could be eliminated (in either sampling system) by producing the pulse at zero beat (when the output from the mixer passes through zero). This method has the added advantage of any null system.

With the highly accurate and stable time standard available from a spectrum line, precision measurements in all branches of science and engineering can be made with a higher degree of confidence than heretofore. The technique also provides, in simpler form, the means for stabilizing communication circuits so that as efficient use can be made of the microwave portion of the radio spectrum as is now possible in utilizing the lower frequencies.—F. H. R.

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High-Speed TRIGGER CIRCUIT

For microsecond flash photography and projectile and impact research, precisely timed pulses actuate equipment following a sound, flash of light or other physical event under observation and subsequent analysis

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THE EQUIPMENT to be described is useful for applications in which triggering or firing pulses are required in a predetermined time pattern following any physical event (a sound, flash of light, interruption of a beam by a bullet, or making or breaking of a circuit). The purpose of this development was originally to incorporate into the Westinghouse Micronex ultra-high-speed x-ray equipment suitable electronic circuitry to make more precise the time of generation of the x-ray pulse. The exact application cannot be released from classified status at this time, but the functioning of the equipment will be described for a hypothetical though similar application.

General Objectives

Assume that an electrical impulse of known characteristics is to be applied to a subject, and that it is desired to take three pictures of the subject, *p*, *q*, and *r* microseconds after the start of this pulse. The task may then be divided as follows:

(1) Reliable generation of a single low-level keying pulse.

(2) Providing three variable delays, in order that the three pictures may be taken at any desired times following the application of the impulse.

(3) Generation of three high-level firing pulses, each initiating a suitable flash equipment (a spark gap, for example).

(4) Generation of an electronically-produced impulse, which for the classified application was required to be a single square current pulse of preset height and width.

The project was undertaken with the understanding that the equipment would be made as accurate as possible in the time coordinate. For this reason, radar components used in systems involving time jitter of the order of 0.05 microsecond were brought into use.

Referring to Fig. 1, a pulse with steep rise is produced by mechanically connecting a charged capacitor into the grid circuit of a 6SN7 or 7N7 twin triode. The two triode sections are used in parallel as a cathode follower; the output pulse is coupled to a 6AG7 cathode follower, and also to a 2050 thyratron, whose firing removes essentially all voltage from the capacitor until a reset button is operated. This prevents generation of multiple pulses. Equipment used in conjunction with Fig. 1 includes meter circuits (for checking 2050 bias, 7N7 bias, regulated and unregulated power-supply voltages), and power supplies for the initial pulse generator

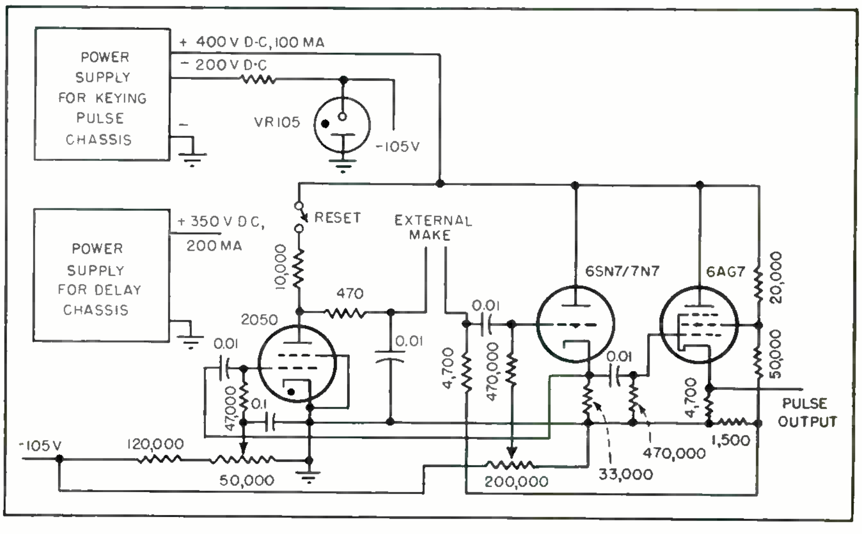


FIG. 1—Single pulses are generated with this circuit

*Now with Machlett Laboratories, Inc., Springdale, Connecticut.

and the following variable delay circuits.

Variable Delay Circuits

The problem of furnishing variable delay was analyzed from the standpoint of prediction, calibration, and reproducibility of delay, and therefore all R-C charging and discharging circuits were rejected in favor of artificial transmission line-type delay networks. The networks selected were designed for 125-ohm characteristic impedance, delay 1.4 μsec per unit, and a bandpass of 8 megacycles, insuring the accurate transmission of all pulse components not exceeding that frequency. Referring to Fig. 2, 19 such networks were placed in series, giving a maximum delay of 26.6 μsec. If desired, one of the units may be unboxed, and smaller units of time delay, down to 0.05 μsec, used. Also, for more delay more units may be placed in series.

It should be borne in mind, in assembling this type of equipment, that the propagation of electromagnetic waves along normal coaxial cables takes place at a velocity of approximately 120,000 miles per second, or about 630 feet per microsecond. Pulse transmission for a distance as short as 6 feet, then, produces automatic delay of the order of 0.01 μsec, which must be taken into account if calibration to 0.05 μsec is attempted.

The input pulse, which is positive, is first inverted in one-half of a 7N7 twin triode, becoming negative; all positive portions are then clipped off in the second half of this same tube, which also amplifies the pulse, which then proceeds to a 6V6 (triode connected) cathode follower, of 125 ohms output impedance. Several short-time-constant interstage coupling networks are used as differentiator-peakers. The pulse at 125-ohm impedance is applied to the 125-ohm delay lines, in series; the impedance match is completed by placing a 125-ohm noninductive resistance across the output of the 26.6-μsec line.

Three pairs of switches are so arranged that three output pulses may be obtained, at any three delays (independent) from 0 to 26.6 μsec. Each pulse, attenuated in the delay line, is fed to another 7N7 inverter, clipper, shaper and 7N7 cathode follower, to provide a narrow, low-impedance, steep-rising, positive-going pulse to energize the hydrogen thyratrons which follow.

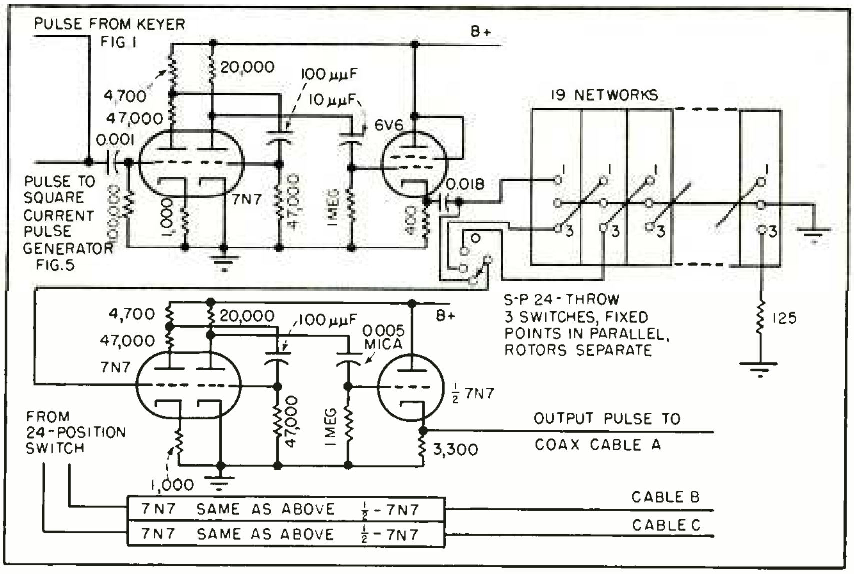


FIG. 2—This circuit provides a maximum delay of 26.6 microseconds

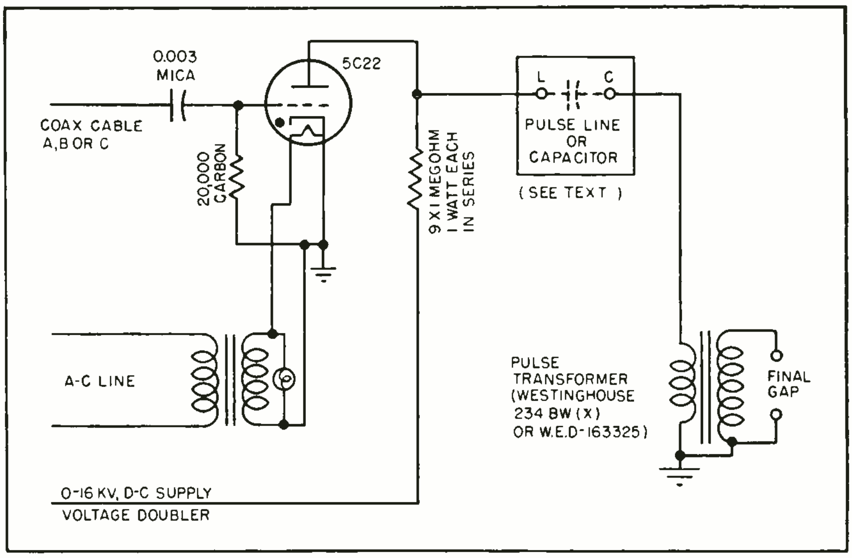


FIG. 3—Each high-level pulser employs a hydrogen thyratron

The pulse, as selected at various points on the delay line, is applied directly to the grids of negatively-biased triodes, thereby providing a high impedance which does not disturb the impedance match along the delay line. The input pulse to this delay unit is also brought out, undelayed, for use in initiating the single square current pulse.

High-Level Firing Pulses

Each delayed, shaped pulse is used to trigger a 5C22 hydrogen thyratron connected as in Fig. 3. This causes a charged capacitor or artificial pulse line to discharge through the primary of a pulse transformer, which may be a 1:10 trigger type for gap firing, or a magnetron type if a pulse of controlled duration is desired. In either case, a voltage pulse of height up to about 30 kilovolts and rise time of the order of 0.1 microsecond is obtained.

If a capacitor is used to discharge through the pulse transformer, the discharge shape is determined by the R, L and C constants of the circuit. To achieve minimum rise time and maximum voltage, the inductance in the circuit should be minimized by mounting the thyratron, capacitor, transformer and gap, (flash tube), as close together as possible. The peak

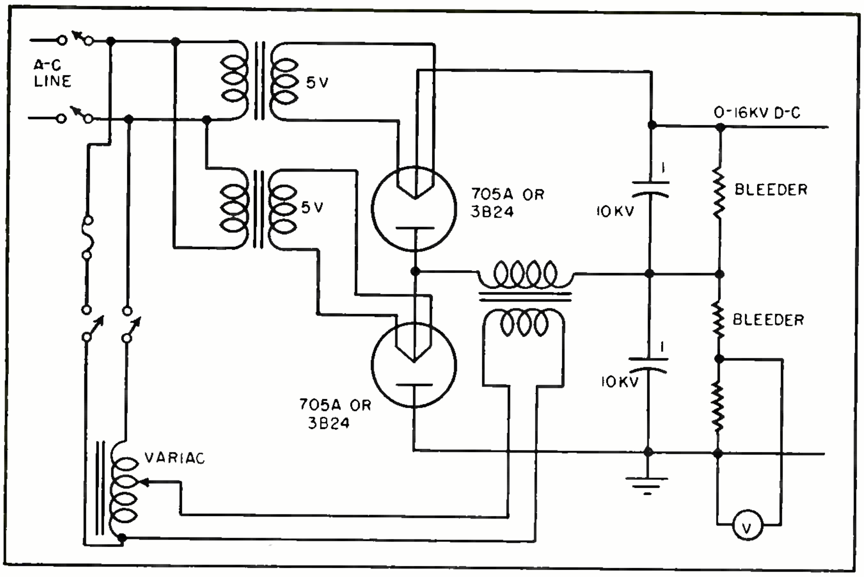


FIG. 4—Sixteen-thousand-volt power supply

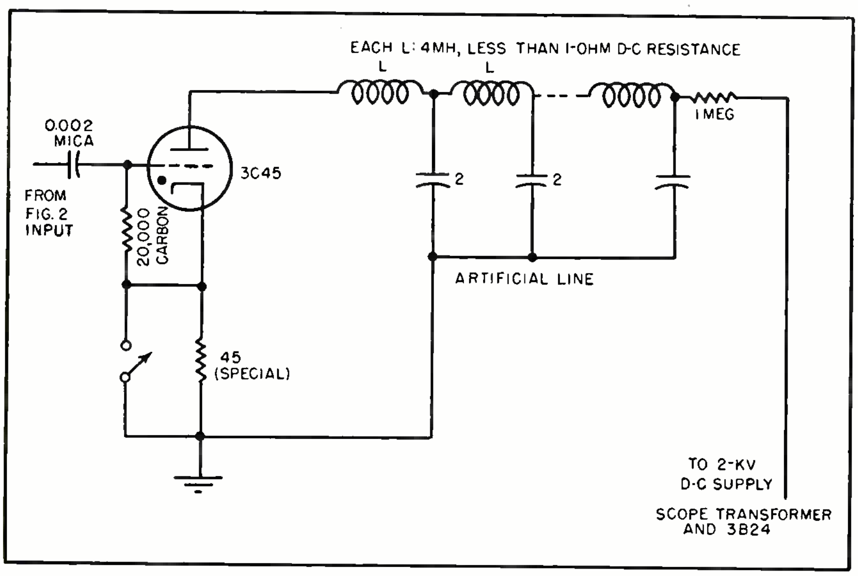


FIG. 5—Circuit of square-wave pulse generator

voltage available is equal to the charging voltage (not to exceed 16 kv for the 5C22) times the step-up ratio of the pulse transformer. Using an artificial pulse-forming line, properly matched, the peak is one-half this value.

All 5C22's will not stand off 16 kv d-c continuously; some can be aged up to this value. In any case, they must be well shielded, or all will be fired by the first high-level pulse generated in the vicinity.

Since very little average current is drawn at the high anode voltage of the 5C22's, essentially all the pulse energy being obtained from charged capacitors, the high-voltage power supply may be a voltage doubler, as shown in Fig. 4. Type 705A were used first because of availability in an existing power supply; actually 3B24's are satisfactory.

Square Current Pulse

The undelayed pulse is applied to a pulse shaper, a clipper, and to a 3C45 hydrogen thyratron square-pulse generator as shown in Fig. 5. The load is shown as a 45-ohm resistance in the cathode circuit; for the original application, a current of up to 10 amperes was required, through a resistance of the order of 1 ohm. A total resistance of 45 ohms was provided, which allowed the current to be varied, up to the maximum, by various combinations of series and parallel circuits. In order to insure reliable firing of the 3C45, a 2,000-volt anode supply was provided, again required to supply little average current.

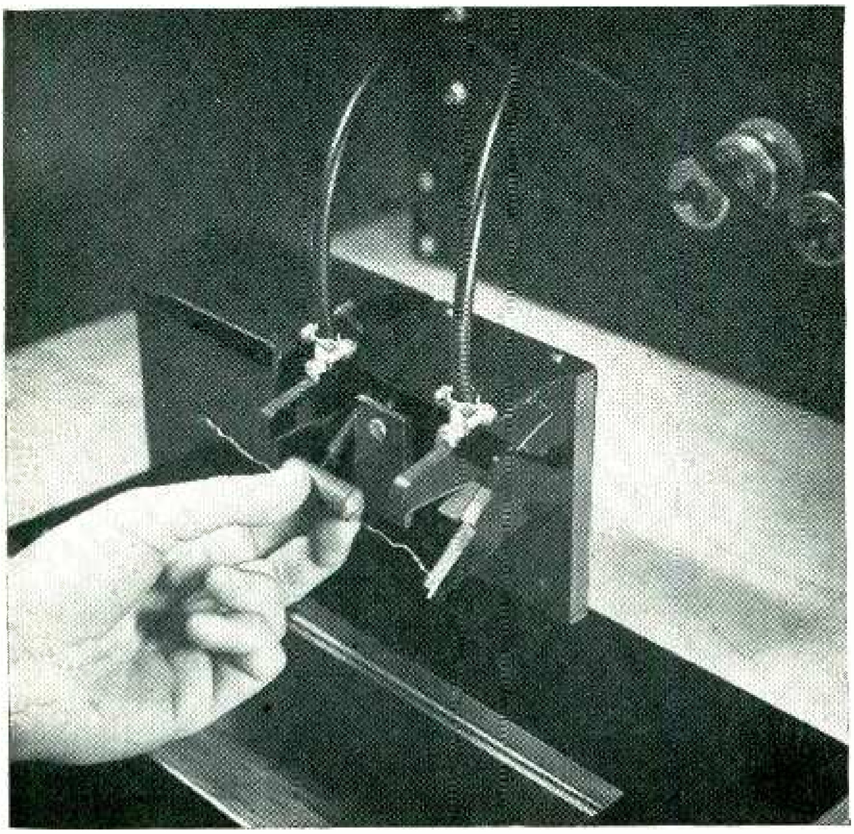
To provide a quick-rising, flat-top pulse, an artificial line was used in the 3C45 plate circuit as a current source. Since the requirements of this line are that it supply a 10-ampere pulse for at least 1 millisecond into a 45-ohm load, an open-end artificial line of ten L sections, of 45 ohms characteristic impedance, and delay per section of 90 microseconds was tried. The total pulse length here is 10 times 90 μsec in each direction along the line, or a total of 1.8 milliseconds.

As marked on Fig. 5, each inductance along the line is 4 millihenrys; each capacitance is 2 microfarads. The inductors, however, must have low d-c resistance in order not to attenuate the 10-ampere pulse current. In the first model, these were hand wound on small filter choke cores. Ideally, at least the first 30 μsec of this line should be made of small sections comparable to the commercial lines used for the variable delay, but the entire 900-μsec electrical length of this line cannot conveniently be (and need not be) made up of 8-megacycle wide, 1 or even 5-microsecond delay lines.

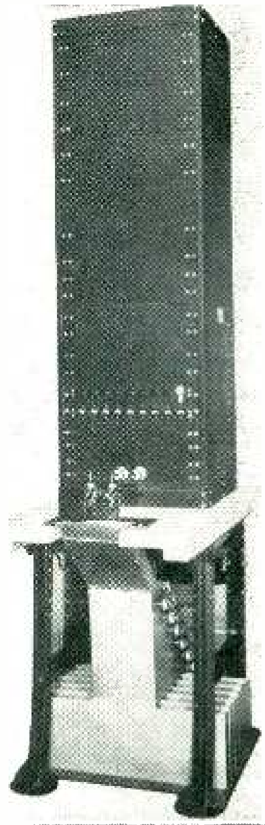
Charging this line to 1,800 volts and discharging it into a 45-ohm load, a maximum pulse current of 20 amperes is obtained. When the thyratron conducts, the line is placed across the cathode resistance which is always maintained at 45 ohms, the characteristic impedance of the line. The voltage across the load is instantaneously 900 volts, and remains at this value until the line discharges, twice its electrical length in microseconds later.

There are many uses for this type of synchronizing and triggering equipment. These include microsecond flash photography, projectile and impact research and explosive research. The equipment was developed by the author while employed at Picatinny Arsenal, Dover, N. J., and publication of circuit details at this time does not imply release from security classification of the associated equipment connected with explosives research. It is hoped that at a later date the complete equipment, with research results, may be described.

Automatic Bridge for



Universal jig for testing components with pigtails. Solenoid in box at left closes jaws when component touches ejector plate between jaws. Sorting chute opening is directly below jig



Front view of automatic bridge, showing jig, sorting chute and door-control solenoids, and bins

Eight different sets of ratio arms are switched, separately and in sequence, into a simple 1,000-cps Wheatstone bridge. Novel discriminator detects bridge balance and initiates operation of sorting mechanism. Unit construction facilitates trouble shooting

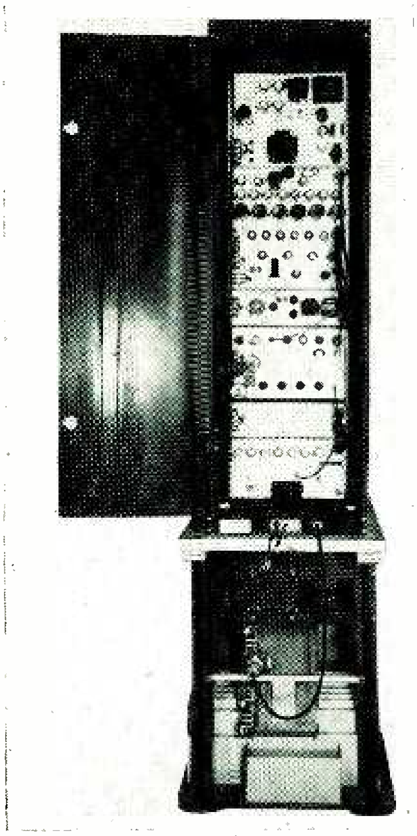
RESISTORS, capacitors, inductors, or any impedance elements ranging from 1 ohm to 5 megohms can be automatically tested and sorted at production speeds with the automatic bridge described in this article. Accuracies of the order of ±0.3 percent are obtainable with unskilled operators. The instrument sorts components into 8 groups (depending on the components' deviation from their specified value) at rates as high as 1,800 units per hour, or into 4 groups at 3,600 per hour.

The type of test jig employed is determined by the physical construction of the components being tested. The jig shown in the accompanying photograph is used in testing components having pigtails.

In operation, a standard of the value of impedance being tested is plugged into the rear of the cabinet. The components to be tested are then fed into the test jig which consists of two sets of metal-faced jaws which firmly grasp the component's pigtails. When contact is made, the testing cycle begins, and almost instantly the piece is measured and ejected from the jig into a sloping chute; one of the doors in the bottom of the chute opens, and the component falls into one of eight bins depending on its actual value. As the next component is put in the jig the cycle repeats.

The tolerance limits of the groups are fixed by plugging appropriate limit plugs into connectors in the rear of the cabinet. Typical limits for a 1,000-ohm component might be as follows: −20 percent, −10 percent, 0 percent, +10 percent, +20 percent, +30 percent, and +40 percent. These limits would permit sorting components into eight groups having the following ohmic ranges: (1) below 800, (2) 800 to 900, (3) 900 to 1,000, (4) 1,000 to 1,100, (5) 1,100 to 1,200, (6) 1,200 to 1,300, (7) 1,300 to 1,400, and (8)

Component Testing



Rear view, showing unit construction for easy replacement. Limit plugs and standard may be seen on bottom chassis

1,400 ohms and above.

Although these limits happen to be 10-percent steps throughout, larger or smaller steps, or any combinations of larger and smaller steps, could be used, with one limitation. To realize the full accuracy of the bridge, the minimum percentage steps must be held to 1 percent.

Operating Principle

A block diagram of the instrument is shown in Fig. 1. When it is in the rest position, the bridge ratio arms are such that any unknown within 800 percent of the value of the standard will cause a balance signal to be sent to the discriminator. This signal, when combined with the reference voltage from the oscillator, causes the discriminator circuit to send a ground signal to the switching unit.

When the switching unit receives this ground signal, it starts the testing cycle which consists of switching different sets of ratio arms into the bridge circuit, separately and in sequence, until the set which produces bridge balance with the value of unknown being tested is found. When this condition occurs, the bridge sends a balance signal to the discriminator which in turn sends another ground signal to the switching unit.

Upon receipt of this second grounding signal, the switching unit initiates the following actions: (1) The testing cycle is interrupted, (2) the jig ejector mechanism is actuated and the piece falls into the sorting chute, (3) the appropriate door in the sorting chute is opened, (4) two counters are operated, one for the particular bin into which the piece falls, and a totalizing counter, and (5) the bridge is returned to the rest position ready for the next piece.

Limit Bridge

Figure 2 shows the circuit diagram of the limit bridge. The limit jacks, J_1 through J_7, and the *standard* terminals are mounted in the rear of the instrument, while the *unknown* terminals are brought out through the front for connection to the test jig. The bridge has a 10-to-1 internal ratio arm (formed by R_1 and R_2) which is connected in the circuit in the rest position. This is the ratio which starts the testing cycle by sending a balance signal to the discriminator if the value of the component falls within 800 percent of the value of the standard.

If the component's value is within this range, the ground connection is moved (by the switching unit) from the center of the 10-to-1 ratio arm to the center of the arm containing J_1. The ground is then passed to the arm containing J_2 and so on until the ratio arm is reached which produces bridge balance with the piece being tested, at which time the piece is ejected. At the end of the cycle the ground is returned to the 10-to-1 ratio arm.

The entire bridge circuit and its components are carefully shielded, and low-capacitance coaxial cable is used for all bridge wiring. To reduce contact resistance in the various connectors, 12-prong plugs and sockets are used with the prongs wired in parallel for maximum contact area.

The limit bridge operates on a 1,000-cps voltage which is generated by the Wien bridge oscillator shown in Fig. 3. The oscillator is designed to operate over a wide range of frequencies, as determined by the constants contained in the plug-in phase-shift network. Under practically all kinds of operating conditions, however, the 1,000-cps bridge frequency has proved quite satisfactory.

Discriminator—Amplifier

The output signal from the bridge is fed into the circuit shown

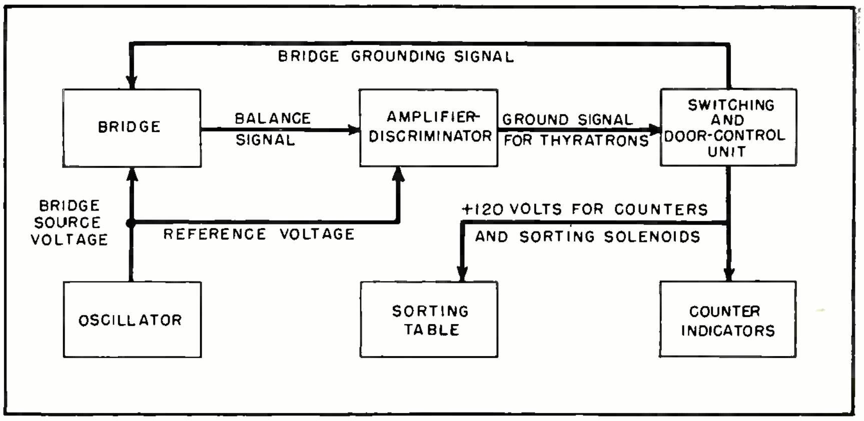


FIG. 1—Block diagram of Industrial Instrument's high-speed component tester and sorter

in Fig. 4. After passing through four 6SF5 amplifiers and a 180-degree phase-shifting network, the signal is limited by V_1, further amplified by V_2, and finally appears across R_1 in the plate circuit of V_2.

A reference voltage from the oscillator is introduced at the cathodes of the discriminator, V_3. When the voltage across R_1 has the proper phase relationship to the reference voltage (as is the case when the bridge is approximately balanced), V_4, which is normally cut off, will conduct, closing the relay in its plate circuit, and passing a ground signal to the switching unit.

Switching Circuits

The heart of the switching circuit, Fig. 5, is the free-running multivibrator, V_8, which is capable of running at two speeds as determined by the position of the switch in its grid circuit. The single-shot multivibrators, V_9, V_{10}, and V_{11}, form a frequency-dividing chain since they are triggered only by negative pulses from preceding stages.

Each of the grids of the tubes in the frequency-dividing chain is attached to the grid of one of the six

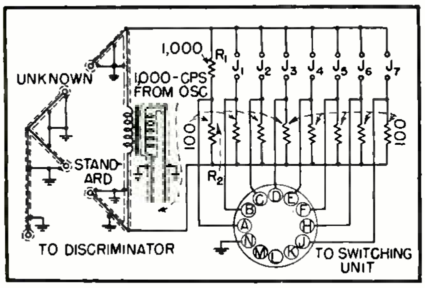


FIG. 2—Bridge circuit. Limit plugs in J_1 through J_7 determine range of tolerance groups into which components are sorted. Resistors R_1 and R_2 form 10-to-1 ratio arm which is connected when bridge is in rest position

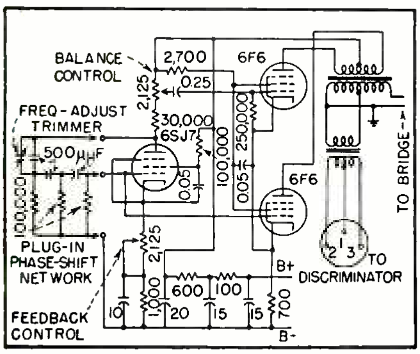


FIG. 3—Circuit diagram of Wien bridge oscillator which produces bridge voltage and discriminator reference voltage

Table I—Operating Schedule for Switching and Door-Control Unit

Position	Bridge Connection Grounded	Relay position: E–energized, D–de-energized								Thyraton Connected
		RE[1]	RE[2]	RE[3]	RE[4]	RE[5]	RE[6]	RE[7]	RE[8]	
Rest	A	E	D	E	D	E	D	D	E	V^{20}
1	B	D	E	D	E	D	E	E	D	V^{22}
2	C	E	D	D	E	D	E	E	D	V^{14}
3	D	D	E	E	D	D	E	E	D	V^{15}
4	E	E	D	E	D	D	E	E	D	V^{16}
5	F	D	E	D	E	E	D	E	D	V^{17}
6	H	E	D	D	E	E	D	E	D	V^{18}
7	J	D	E	E	D	E	D	E	D	V^{19}
Rest	A	E	D	E	D	E	D	D	E	V^{20}

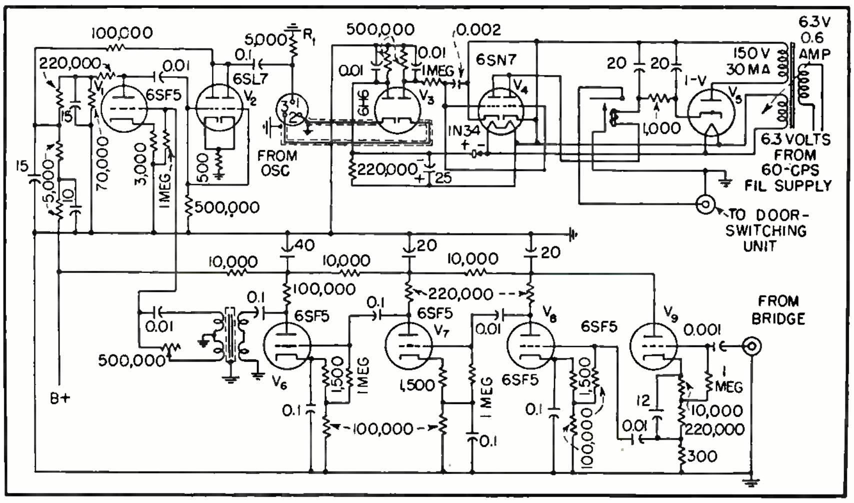


FIG. 4—Discriminator-amplifier circuit diagram. Crystal diode provides bias for discriminator by rectifying 6.3-volt filament supply

paralleled-6SN7 relay-control tubes. Whenever the grid of one of the frequency-dividing multivibrators goes positive, the corresponding relay-control tube grid goes positive, the tube conducts, and the corresponding relay is energized.

The six relays which are controlled by the relay-control tubes have several functions. They connect the proper door-control thyratron (one for each limit) to the input from the discriminator, and they send the ground signals back to the bridge as previously mentioned. A schedule for the operation of these relays and several other components in the switching unit for a complete test cycle is shown in Table I.

All the limit thyratrons, except V_{22} which corresponds to the low limit group, have door-control solenoids in their plate circuits. There is no solenoid for this first group since the piece falls into a bin at the end of the chute. These limit thyratrons also actuate the bin counters.

The grid of V_{21} is connected to the input from the discriminator at all times so that it will operate on all ground signals from the discriminator after the test cycle has begun. Its function is to operate the jig ejector and the totalizing counter for every piece that is tested.

The thyratrons are held nonconducting, until they receive a grounding signal, by a negative voltage from the bias supply, and the cathodes of the limit thyratrons are grounded through a common resistor to prevent more than one tube's firing at a time.

The bridge is stopped from stepping by cutting off one-half of the free-running multivibrator, V_8. This is done by applying a blocking bias through V_{23} and the contacts of RE_8, RE_1, RE_3, and RE_5 when they are in the rest position, to which the switching system auto-

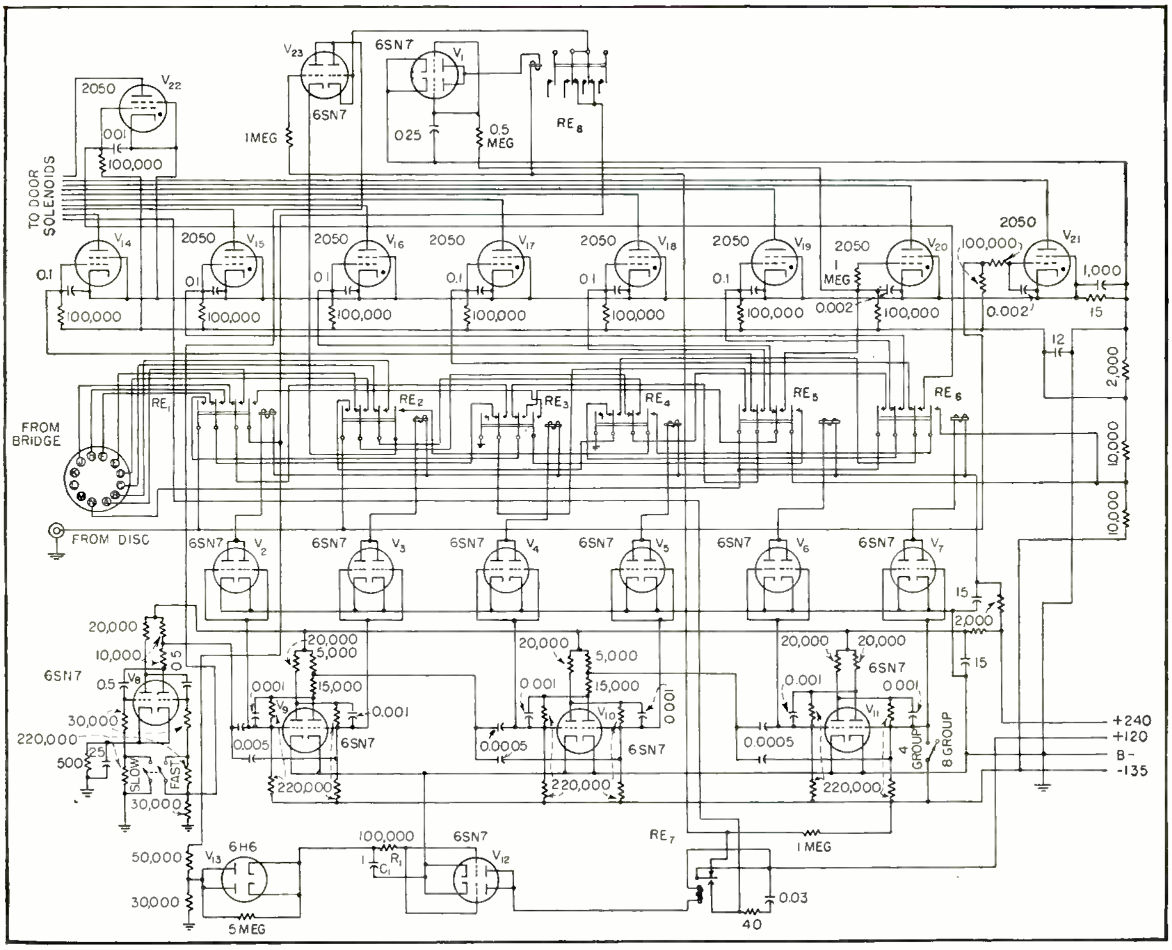


FIG. 5—Schematic diagram of switching and door-control circuits. Sequence of operation is explained in Table I. Frequency of free-running multivibrator is approximately 48 cps

matically returns after each testing cycle. The function of V_{23} is to keep the multivibrator V_8 from stepping the bridge beyond the first test position until RE_7 has applied plate voltage to the thyratrons.

The only way the blocking bias can be removed from V_8 is by putting a test piece in the jig, which will cause a ground signal to be sent from the discriminator to the grids of V_{20} and V_1. When V_1 conducts, RE_8 is energized, and the bias is removed from V_8 Relay RE_8 is immediately deenergized, but the circuit connecting the blocking bias to V_8 is interrupted as RE_1, RE_3, and RE_5 move out of the rest position.

Relay RE_7 switches the 120-volt supply from V_1 to the plate circuits of the thyratrons during the testing cycle. This arrangement makes only V_1 sensitive to the initial ground signal from the discriminator, which starts the cycle; and the other thyratrons become sensitive to the second ground signal which indicates bridge balance. When the frequency-dividing multivibrators cease to operate, the 120-volt supply is returned to V_1.

This switching arrangement is accomplished by V_{12} and V_{13}, which control the operation of RE_7. The same negative bias which cuts off V_8 is applied to the plates of V_{13} and indirectly to C_1, charging it negatively to hold V_{12} cut off. When this negative bias is removed, V_{13} conducts and C_1 discharges through it, allowing V_{12} to conduct. Relay RE_7 is thus energized. When the testing cycle is completed, the negative bias again appears, and the grid-cathode capacitor begins to charge. The time delay introduced by the charging of this capacitor is provided to allow the piece being tested to fall down the chute and into the proper bin before the door closes. The capacitor discharges rapidly, ensuring that the plate voltage is on the thyratrons as soon as the testing cycle begins, so that the door can open.

The 4 and 8-group switch effectively disconnects V_{11} in the multivibrator chain for testing cycles where only 4 groups are required, instead of 8.

General

When capacitors are being tested, special sets of limit plugs must be used if the capacitors are to be sorted according to their deviation in terms of capacitance, because of the inverse ratio between capacitance and capacitive reactance. Proper operation of the bridge on capacitors and inductors is possible only when the units being tested have nearly the same phase angle as the standard.

The model AB-1 Auto Bridge was developed by Industrial Instruments Inc. of Jersey City for use by manufacturers and consumers of large numbers of component parts. Special jigs have been developed for testing and sorting such things as potentiometer elements, and experiments show promise for a jig which will permit automatic feed as the components leave their assembly lines.—J.D.F.

TELEVISION FRONT-END

Design equations for several types of r-f amplifier stages of a television receiver are derived and illustrated. Emphasis is placed on the problem of optimizing the signal-to-noise ratio while satisfying gain, bandwidth and adjacent-channel rejection requirements. Mixer stages are discussed in Part 2 to follow

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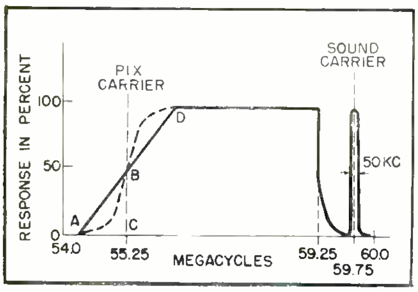

FIG. 1—Ideal response characteristic for receiving channel 2. For other channels, substitute the appropriate frequencies

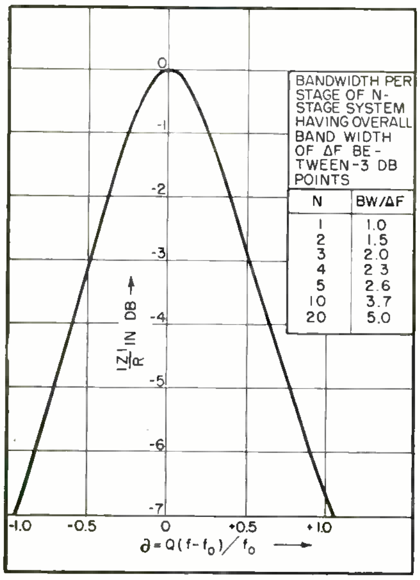

FIG. 2—Plot of normalized scalar impedance of parallel *RLC* network having a Q of 10 at resonance

THE CIRCUITS to be considered in this paper are the r-f amplifier and mixer portions of a receiver intended to operate in the standard 12 television channels.

The design is based on inductive tuning, the design process being the same whether the tuning is continuous or in steps. It is not intended to prove the superiority of certain circuit configurations over others, but rather to indicate the factors to be considered and the method of evaluating them in the design process.

Initial Premises

Initial premises in the design are the exclusive use of 6.3-volt miniature tubes, the use of 75-ohm coaxial-cable input and output and the use of a 26-mc intermediate frequency.

To review FCC standards, the vestigial sideband character of the transmitted signal is such that the receiver would ideally have the response characteristic shown in Fig. 1 for reception of signals on channel 2. Note that the sloping response in the vicinity of the picture carrier is linear and that the response is 50 percent at picture-carrier frequency.

It is not important what the frequency is at *A* and at *D*, but only that *A* be within the channel and that the curve between *A* and *D* is such that when the area *ABC* is pivoted about *B* until *A* coincides with *D* the resultant response curve is flat from 55.25 mc up to 59.25 mc. (For instance, the dashed curve *ABD* would be quite acceptable.) The reason for this is that the equivalent video response curve for any modulated-carrier amplifier is obtained by adding the percent response at $f_c + f_m$ (where f_c is the carrier frequency and f_m is the modulating frequency) to the response at $f_c - f_m$ and plotting the resulting sum against f_m for all values of f_m between zero and the frequency corresponding to full sideband width. Thus, for the example of Fig. 1, the equivalent video response at 100 kc is equal to the sum of the r-f response at 55.15 and that at 55.35 mc, while the equivalent video response at 1 mc is the sum of that at 54.25 mc and that at 56.25 mc. Invariably the smoothest curve *AD* implies the best phase response.

Figure 1 shows that the maximum possible equivalent video bandwidth would be slightly less than 4.5 mc since the best that can be done below 55.25 mc is to provide a response supplementing the upper sideband to give a flat equivalent video response, and since the response of the picture channel is necessarily zero at the sound transmitter frequency. The maximum realizable equivalent video bandwidth will therefore be taken as 4

DESIGN

Part I

of a two-part article

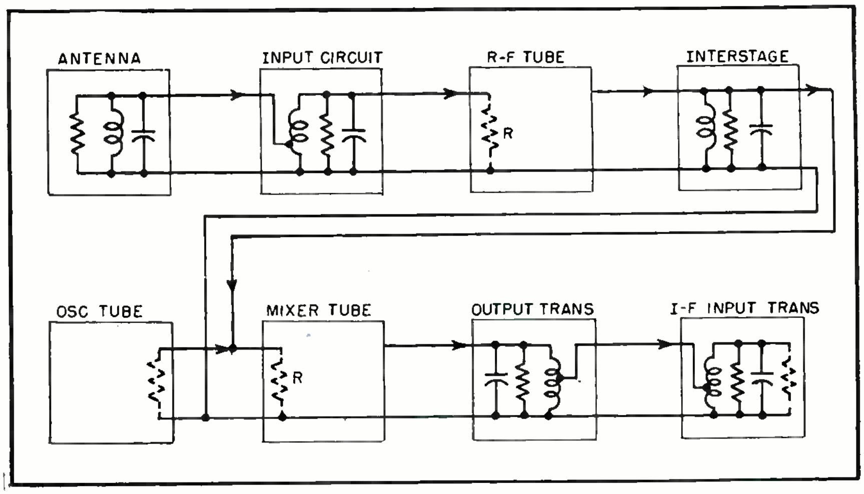

FIG. 3—Noise analysis block diagram. Symbol *R* denotes a fictitious noise-equivalent resistor

mc wide at the 6-db-down points.

With 55.25 mc as the bottom of the received band (the frequency below midband at which gain is 6 db down) which is 4 mc wide, the band center for this channel is 57.25 mc, and the band center of the receiver will correspondingly be 3.25 mc above the bottom of any channel to which the receiver is tuned. As will be shown later maximum gain and bandwidth are obtained with minimum capacitance shunting the load circuit of an amplifier stage, so the circuits will be resonated by tube and wiring capacitances alone and the circuit inductance will be changed to change stations.

Synchronous single-tuned interstage networks will be considered rather than coupled circuits or stagger-tuned circuits, even though the latter two are theoretically better. It has been proven that both of the latter circuits provide a greater usable bandwith for a given gain, but the stagger-tuned system is difficult to track properly over the specified range, and the coupled-circuit system requires one additional tuning element per interstage.

Figure 2 shows the computed variation in scalar impedance of a parallel *RLC* circuit over a band of frequencies centered at the antiresonant frequency of the *LC* combination. The scalar impedance has been shown in terms of 20 $\log_{10} |Z|/R$, or simply db down from the impedance at resonance, and frequency has been presented as Q times the percent deviation from antiresonant frequency.

For this circuit, Q is defined as the ratio $R/\omega_o L$ where ω_o is the antiresonant radian frequency.

The significance of Fig. 2 is that in any system of cascaded amplifiers having single-tuned load circuits, the gain of each stage will vary with frequency in the manner shown by the curve. If each of three identical stages were 3 db down in gain at the extremes of a band of width Δf centered about a frequency f_o, the unit as a whole would have a gain 9 db down (from that at f_o) at the extremes of the band Δf.

Data derived from the curve have been tabulated to the right of the curve, showing the bandwidth per stage required for an N-stage system to have an overall bandwidth of Δf between the -3 db points.

Preliminary investigation shows that two tuned circuits (through which the signal must pass) will be used in any r-f head using a grounded-grid r-f amplifier, and three tuned circuits will be used in other r-f head configurations. It will be assumed arbitrarily that for an overall receiver bandwidth of 4 mc between -6 db points, the i-f amplifier will be allowed -3 db from maximum gain and the r-f head will be allowed -3 db from maximum gain at the edges of the 4-mc band. According to the table of Fig. 2, each tuned circuit in an r-f head having a grounded grid r-f stage must be 6 mc wide, and each tuned circuit must be 8 mc wide in other r-f heads.

So far, the discussion has neglected the matter of reception of the 59.75-mc sound carrier with its $\pm$25-kc deviation under 100-percent modulation. Since the sound carrier is 2.5 mc from the resonant frequency of the tuned circuits, a study of Fig. 2 reveals that the gain is down 4.4 db from maximum gain at sound carrier frequency for an r-f head having a grounded-grid stage, and 4.2 db down for other heads. This loss relative to picture-channel midband gain can be made up in the high-gain sound i-f amplifier since it is relatively easy to obtain extra gain in narrow-band circuits.

Noise Considerations

In practice, the designer considers each noise source along the path of the signal from the input up to the point in the circuit at which new noise contributions are trivial in importance due to the increasing magnitude of the signal and the noise from earlier circuits. We must start, therefore, with a block diagram, Fig. 3, and determine the level of the signal and of the noise for as many points along the circuit as seems necessary.

It will be necessary to develop certain gain and grid-equivalent noise-resistance equations that do not appear in the literature, and to bring out carefully the difference between the correct manner of combining the noise powers from each of two actual resistances and the correct manner of combining noise power from a real resistance with that of a fictitious resistance.

Pentode R-F Amplifier

There are four basic circuits from which to choose: the conventional pentode r-f amplifier of Fig. 4, the grounded-grid amplifier of Fig. 5, the cathode-follower amplifier of Fig. 6, and the cathode-coupled amplifier of Fig. 7, the latter discussed in Part II. The pentode amplifier will be discussed first, calculating the tube-noise equivalent resistance referred to the grid, then the optimum antiresonant resistance of the circuit connected to the grid will be computed. Then it will be shown how the noise powers from the real and the equivalent resistances combine, the optimum plate circuit antiresonant resistance will be computed and signal and noise voltages will be referred from the grid to the plate.

To facilitate calculation, the actual tube with its shot effect, current-division noise, and other sources of noise voltage is replaced by a theoretically noiseless tube in whose grid circuit there is a fictitious resistor having a thermal-agitation noise voltage which produces the same noise voltage in the output of the theoretical tube as there is in the output of the actual tube. This fictitious resistor, the grid-equivalent noise resistor of the tube, is a legitimate and accurate equivalent because the noise energy of a resistor has essentially the same flat frequency spectrum as the tube noise. The value of the use of an equivalent noise resistor lies in the fact that noise powers add directly, rather than noise voltages adding directly. Therefore, noise-resistance values may be added directly as though the resistors were in series, and the total noise voltage computed accordingly.

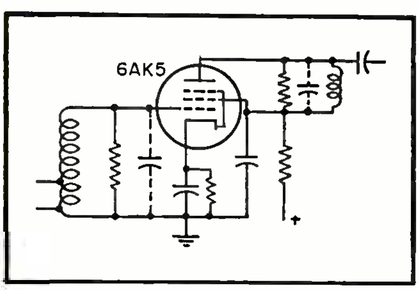

FIG. 4—Pentode r-f amplifier

As an equivalent of the situation wherein noise-powers from a real and a fictitious resistor must be added together, assume that two different resistors of value R_a and R_b generate noise in the grids of two identical noiseless amplifiers using pentodes having infinite r_p. Assume that each amplifier has a voltage gain, A, and that the amplifiers have a common load of R_L. Then the total noise voltage across the load resistor is given by

$$E_{np} = (P_n R_L)^{1/2} \tag{1}$$

where P_n is the total noise power produced in R_L by the two tubes. As shown later, the thermal-agitation noise voltage from a resistor R_a can be expressed as

$$E_a = K(R_a)^{1/2} \tag{2}$$

The power produced in the plate load due to a noise voltage E_a at the grid is

$$P_a = \frac{A^2 E^2_a}{R_L} \tag{3}$$

The total power P_n can be expressed

$$P_n = P_a + P_b \tag{4}$$

where P_b is defined by Eq. 3 with subscript b substituted for a. Substituting for P_a and P_b from Eq. 3 in Eq. 4,

$$P_n = \frac{A^2}{R_L}(E^2_a + E^2_b) \tag{5}$$

We can now substitute Eq. 5 in Eq. 1,

$$E_{np} = [A^2(E^2_a + E^2_b)]^{1/2} \tag{6}$$

$$E_{np} = A(E^2_a + E^2_b)^{1/2} \tag{7}$$

Now, substituting from Eq. 2 in Eq. 7,

$$E_{np} = A[K^2(R_a + R_b)]^{1/2} \tag{8}$$

But $\quad E_{np} = A E_{ng} \qquad (9)$

so $\quad E_{ng} = K(R_a + R_b)^{1/2} \qquad (10)$

The artifice of two tubes having a common load resistor emphasizes the fact that these two noise contributions (one from a real resistor, one from a fictitious resistor) could not react on each other earlier in the circuit than the plate load. In the case of two real resistors connected in parallel in a given circuit, the equivalent resistance of the two is computed from the well-known parallel relationship

$$R = R_a R_b/(R_a + R_b) \tag{11}$$

and the noise voltage is simply computed for the equivalent resistor.

Further Development

For the grounded-cathode pentode amplifier circuit of Fig. 4, the grid-equivalent noise resistance is given by[1]

$$R_{eq} = \frac{I_p}{I_k}\left(\frac{2.5}{G_m} + \frac{20 I_s}{G_m^2}\right) \tag{12}$$

where I_p, I_k, and I_s are the d-c plate current, d-c cathode current, and d-c screen current respectively, and G_m is the plate transconductance in mhos. In the case of a 6AK5 tube operated at $E_p = 75$ v, $E_{ss} = 75$, $E_g = -0.6$, $I_p = 6.0$ ma, $I_s = 1.5$, $G_m = 5{,}000$ micromhos, then $R_{eq} = 1{,}360$ ohms.

From the thermal-noise-voltage equation[2],

$$E = 2(KT\Delta f)^{1/2} \times (R)^{1/2}, \tag{13}$$

where

K = Boltzman's constant = 1.374×10^{-23} joules per degree K.

T = absolute temperature of resistor in degrees Kelvin.

R = resistive component of impedance across which voltage is developed.

Δf = bandwith of circuit through which noise voltage is transmitted. (This definition of Δf as the overall receiver bandwidth differs from that shown ordinarily because we have specified that the receiver as a whole has a bandwidth of 4 mc, which makes it unimportant whether noise components exist in the r-f section over a greater band than 4 mc).

We find that for $T = 300$ degrees Kelvin and $\Delta f = 4$ mc,

$$E = 0.26\,(R)^{1/2} \text{ microvolts} \tag{14}$$

For the calculated value of R for the 6AK5, E = 9.6 microvolts. This is the tube-noise voltage referred to the grid, not the grid-circuit noise voltage.

From classical transformer theory, E_{grf}, the signal voltage at the grid of the r-f stage is:

$$E_{grf} = E_{ant}\,(R_g/R_{ant})^{1/2} \qquad (15)$$

where E_{ant} is signal voltage from the antenna, R_{ant} characteristic resistance of the antenna transmission line, R_g antiresonant resistance of the grid circuit (this quantity is directly measurable with an r-f impedance bridge as opposed to R in Eq. 12). It is evident that for maximum signal at the grid the value of R_g should be as high as possible. Further, if we compare Eq. 14 with Eq. 15 we see that the ratio of signal voltage at the grid to noise voltage from R_g is not dependent on the value of R_g. On the other hand, an increase of R_g will bring about an increase in E_{grf} and noise voltage from R_g together, with respect to the tube-noise voltage which is not dependent on R_g. As a result, the net S/N ratio is improved due to the tendency for the tube-noise voltage to become relatively insignificant. Thus an increase in R_g improves both gain and S/N. We must now determine just how large R_g can be made without violating any of the design requirements.

H. W. Bode shows[8] that for a constant-shunt C and R, regardless of location of the pass band of a network in the frequency spectrum,

$$\Delta f \propto 1/RC \qquad (16)$$

where f is the bandwidth of the circuit in cps, R is the shunt resistance of the circuit, and C is the shunt capacitance of the circuit. In the case of a simple parallel RLC circuit,

$$\Delta f = 1/2\pi RC \text{ cps} \qquad (17)$$

where f is the frequency at which the scalar impedance is 3 db down from maximum value, or

$$R = 1/2\pi\,(\Delta f)C \qquad (18)$$

From the equation it is evident that since the required bandwidth is fixed, R will be maximum for minimum shunt C. Since both the circuit gain and S/N are maximum for maximum R, it is imperative that C be held to the absolute minimum. The input capacitance for a 6AK5 tube and wiring in the circuit shown in Fig. 4 can be held to 7 μμf total. For an 8-mc bandwidth, from Eq. 18, R = 2,850 ohms, the maximum permissible value of R_g for 8-mc bandwidth.

The shunt impedance of the antenna as seen looking into the grid side of the input transformer may have sufficient variation of its reactive component over the band of a given channel to render it worthy of close scrutiny. It has been found that the reactance variation is small enough that the antenna does not narrow the receiver pass band, but on the other hand it is not small enough to allow the antenna to be properly treated as a pure resistance over the pass band of a given channel.

Inasmuch as it is necessary to match the antenna to the grid circuit to prevent reflections on the line, if the antenna impedance were purely resistive over the band the effective resistance shunting the circuit would be halved by connecting the antenna into the circuit, and the reactance would be unaffected. In such an event the r-f stage grid circuit would have twice the bandwidth previously computed. With present antennas it appears not to be good design practice to depend on the antenna for band widening, but it is surely permissible to use the reduced grid circuit antiresonant resistance in computing resistor noise voltage. The latter voltage is therefore 9.8 microvolts. The total noise voltage at the grid of the 6AK5 amplifier is then E_{ng} = 13.7 microvolts.

If the impedance of the antenna transmission line is 75 ohms, from Eq. 15, $E_{sg} = 6.16 \times E_{ant}$ microvolts. Thus, a signal of 22.2 microvolts at the antenna would yield a S/N ratio of 10 if there were no noise contributions of importance beyond the r-f amplifier grid.

Gain

To assess the importance of noise sources beyond the first grid, we must next compute the gain of the first stage. The total shunt capacitance of the interstage circuit between a 6AK5 r-f amplifier and a 6AK5 mixer is about 14 μμf for a carefully designed circuit. The interstage antiresonant resistance for an 8-mc bandwidth is 1,425 ohms. The gain of a pentode of transconductance 5,000 micromhos operating into a tuned tank circuit of antiresonant resistance R is given at the resonant frequency by

$$A = G_mR = 7.12 \qquad (19)$$

The signal voltage at the 6AK5 amplifier plate is then

$$E_{sp} = AE_{sg} = 43.8\,E_{ant} \qquad (20)$$

Similarly, the noise voltage at the plate due to r-f stage tube noise and grid-cricuit noise is

$$E_{np} = AE_{ng} = 97.5 \text{ microvolts} \qquad (21)$$

The most convenient process for introducing the noise contribution of the interstage circuit resistance and the mixer tube is to compute the noise-equivalent resistance for the noise power transmitted from the r-f grid to the r-f plate, and then add to this quantity the interstage circuit resistance and the noise-equivalent resistance of the mixer tube. The r-f stage noise-equivalent resistance referred to the plate can be computed from Eq. 14 as follows:

$$R_{np} = \left(\frac{E_{np}}{0.26}\right)^2 \qquad (22)$$

where R_{np} is the desired resistance referred to the plate, and E_{np} is the noise voltage at the plate from the grid, as before. Substituting from Eq. 21 in Eq. 22,

$$R_{np} = A^2(E_{ng})^2/(0.26)^2 \qquad (23)$$

and, substituting for E_{ng} from Eq. 14,

$$R_{np} = A^2R_{ng} \qquad (24)$$

wherein R_{ng} represents the total noise resistance in the r-f grid circuit and tube. Then R_{np} = 141,200 ohms.

This value of equivalent noise resistance is quite large compared to the values of circuit impedance and equivalent tube-noise resistance encountered so far. Therefore we can at least make a good first approximation to the correct S/N ratio of the complete unit without any further data. This approximate r-f head S/N ratio can be computed from the data given, $S/N = E_{sg}/E_{ng}$ = 0.450 E_{ant}. Although it is current practice to express the S/N characteristic of a receiving system by use of the system noise figure, it is more convenient to use S/N voltage ratio as defined above for purposes of calculation, and then convert to noise figure as a final basis for comparison.

To summarize the data computed

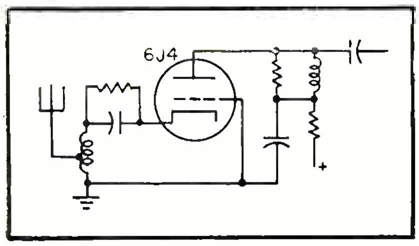

FIG. 5—Grounded-grid triode-amplifier

on the 6AK5 grounded-cathode r-f amplifier, $E_{sp} = 43.8\ E_{ant}$, $R_{np} = 141{,}200$ ohms. We find later that for the case of a 6AK5 grounded-cathode amplifier coupled to a grounded-grid mixer the interstage capacitance is only 7 $\mu\mu$f, so that the interstage resistance level can be doubled, which doubles the r-f gain and yields $E'_{sp} = 87.6\ E_{ant}$, $R'_{np} = 564{,}800$ ohms.

Triode Grounded-Grid Amplifier

Next consider the grounded-grid triode amplifier circuit of Fig. 5. The noise-equivalent resistance of a triode grounded-cathode amplifier referred to the grid is given by Terman[4] as

$$R_n = 3/G_m \text{ ohms} \tag{25}$$

Using Eq. 14 the equivalent noise voltage at the grid of the tube is

$$E_{ng} = 0.26\ (R_n)^{1/2} \text{ microvolts} \tag{26}$$

However, in the grounded-grid amplifier, as in any other amplifier having impedance in the cathode circuit, the application of an a-c voltage e_n between grid and ground will produce an a-c plate current,

$$I_n = \frac{\mu\, e_n}{r_p + Z_L + Z_K\,(\mu + 1)} \tag{27}$$

where I_n is the resultant plate current, r_p is the a-c plate resistance of the tube, Z_L is the load impedance between plate and ground, Z_K is the impedance connected between cathode and ground, and μ is the amplification factor of the tube. In response to the current I_n, there will be a voltage E'_{nc} from cathode to ground,

$$E'_{nc} = E_{ng}\frac{\mu Z_K}{r_p + Z_L + Z_K\,(\mu + 1)}\mu v \tag{28}$$

which refers the noise voltage to the true input of the grounded-grid amplifier. Since both plate load and cathode circuit are resonant at the same frequency, at the center of the transmission band of the amplifier, Eq. 28 becomes

$$E'_{nc} = E_{ng}\frac{\mu\, R_K}{r_p + R_L + R_K\,(\mu + 1)}\mu v \tag{29}$$

where R_K is the resistive component of impedance connected between cathode and ground. However, the input impedance of a grounded-grid amplifier at resonant frequency is given by Jones[5] as

$$R_1 = \frac{r_p + R_L}{\mu + 1} \text{ ohms} \tag{30}$$

and the input transformer must match this resistance if reflections are to be avoided in the transmission line to the antenna. Then,

$$R_K = R_1$$

$$R_K = \frac{r_p + R_L}{\mu + 1} \tag{31}$$

Substituting for R_K from Eq. 31 in Eq. 29 we have,

$$E'_{nc} = E_{ng}\frac{\mu\dfrac{(r_p + R_L)}{(\mu + 1)}}{r_p + R_L + (\mu + 1)\dfrac{(r_p + R_L)}{(\mu + 1)}}$$

$$E'_{nc} = E_{ng}\frac{\mu}{2\,(\mu + 1)} \text{ microvolts} \tag{32}$$

It can be shown in general that

$$E'_{nc} = E_{ng}A_{gk} \text{ microvolts} \tag{32.1}$$

where A_{gk} is the gain from grid to cathode that would be obtained if a signal were injected between grid and ground. Equation 32 shows the value of the tube noise voltage of a grounded-grid triode amplifier referred to the cathode circuit for the particular case where the cathode load resistance matches the input resistance of the tube. To simplify the equation for circuits using a tube of μ appreciably greater than 1,

$$E'_{nc} = \frac{E_{ng}}{2} \tag{33}$$

Comparing Eq. 33 to Eq. 26 and 25, for the particular value of R_K selected,

$$R'_n = \frac{R_n}{4} \tag{34}$$

and

$$R'_n = \frac{0.75}{G_m} \tag{35}$$

where R'_n is the noise equivalent resistance (of a grounded-grid amplifier stage) referred to the cathode.

If desirable or necessary to provide a different cathode impedance than R_1 in Eq. 30 the noise resistance changes. In general, referring to Eq. 26 and 32.1 we have

$$R'_n = R_nA_{gk}^2 \tag{24.2}$$

From inspection of Eq. 29, if μ is much greater than one, then for those circuits in which R_K is of the same order as, or greater than, $(r_p + R_L)$, we can write approximately,

$$E'_{nc} = E_{ng} \tag{36}$$

For this grounded-grid r-f amplifier circuit, however, we must match the input circuit to the antenna, so the equivalent noise resistance is given by Eq. 35. For a 6J4 operated at 15 ma of plate current, $G_m = 0.012$ mho, $r_p = 4{,}500$ ohms, and $\mu = 54$, so that $R'_n = 62.5$ ohms.

Since the plate-circuit impedance of a class-A amplifier is the actual load impedance shunted by the a-c plate resistance of the tube, in the case of the triode amplifier the correct antiresonant impedance of the load circuit proper is appreciably higher (for a given bandwidth) than for a pentode. The 6J4 triode has substantially the same output capacitance as the 6AK5, so that the same interstage antiresonant resistance of 1,425 ohms is required. With an a-c plate resistance of 4,500 ohms, the load circuit itself should have an antiresonant resistance of 2.080 ohms (R_L in Eq. 30). Substituting the proper values in Eq. 31, $R_K = 120$ ohms. The total noise resistance in the input (cathode) circuit is then 122.5 ohms, since $\frac{1}{2}R_K$ ($\frac{1}{2}$ because of the shunting effect of the antenna) and R'_n add directly as required by Eq. 11.

If we change notation in Eq. 15 to refer to R_K instead of R_g, and E_K instead of E_g, we have

$$E_{Kggrf} = E_{ant}\,(R_K/R_{ant})^{1/2}, \text{ or}$$
$$E_{sK} = 1.27\ E_{ant}$$

The tube gain is simply the ratio of R_L to R_K, since the same signal current flows through both plate load and cathode circuit. Thus,

$$A = R_L/R_K = 17.35 \tag{37}$$

The signal voltage at the plate of the grounded-grid r-f amplifier is then

$$E_{sp} = A\ E_{sK} = 22.0\ E_{ant} \tag{38}$$

The total cathode noise resistance referred to the plate circuit is, Eq. 24, $R_{np} = 36{,}800$ ohms. To perform the same input circuit S/N calculation (as a first approximation to the receiving system S/N), already done for the 6AK5: $E_{nk} = 2.87$ microvolts, and $S/N = E_{sk}/E_{nk} = 0.442\ E_{ant}$.

A signal of 22.6 microvolts at the antenna would be required for an S/N of 10. Note that S/N is better for the 6AK5 grounded-cathode amplifier than it is for the 6J4 grounded-grid amplifier thus far. On the other hand, the 6J4 cathode circuit has a very interesting characteristic. Since R_K is 120 ohms, and the shunt capacitance across the cathode circuit totals about 7 $\mu\mu$f, we find from Eq. 17 that $\Delta f = 1/2\pi RC = 190$ mc. This means that the cathode circuit may be tuned to 135 mc and there is no need for adjustment to receive stations between 54 and 216 mc.

We shall later show that $R_L = 4{,}500$ ohms is desirable for the 6J4 grounded-grid r-f when used with a 6J4 grounded-grid mixer, and for that condition, $R_K = 164$ ohms, $R_{ant} = 144.5$ ohms, $E_{sk} = 1.48\ E_{ant}$, $A = 27.5$, $E_{sp} = 40.7\ E_{ant}$, $R_{np} = 104{,}500$ ohms, and $S/N = 0.475\ E_{ant}$.

Cathode-Follower Amplifier

In the cathode-follower r-f amplifier circuit of Fig. 6, the optimum step-up ratio for the output transformer is needed in addition to the other calculations encountered in the previous circuits.

When an a-c grid-to-cathode voltage of E_{gK} volts is applied to a cathode follower whose load resistance, R_K, is small compared to the a-c plate resistance, the resultant cathode current is

$$I_k = E_{gk}G_k \qquad (39)$$

where G_k is the cathode transconductance. The voltage across a cathode load, R_K, is E_K where

$$E_K = I_KR_K = E_{gK}G_KR_K \qquad (40)$$

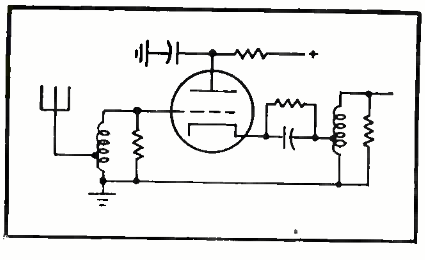

FIG. 6—Cathode-follower r-f amplifier

The grid-to-ground voltage that was required to produce this cathode voltage is

$$E_g = E_{gK} + E_K = E_{gK}(1 + G_KR_K) \qquad (41)$$

and the gain from grid to cathode is

$$A_{cf} = E_K/E_g = G_KR_K/(1 + G_KR_K) \qquad (42)$$

From Eq. 15 the step-up from antenna to grid is $A_1 = (R_1/R_{ant})^{\frac{1}{2}}$ and the step-up from cathode to output resistor R is $A_2 = (R_2/R_K)^{\frac{1}{2}}$ where R_K is the load resistance presented to the cathode by the output transformer.

The total gain of the cathode-follower amplifier from antenna to R_2 is

$$A = A_1A_{cf}A_2 \qquad (43)$$

Substituting for A_{cf} and A_2, each of which is dependent on R_K,

$$A = \frac{A_1G_k\,(R_kR_2)^{1/2}}{1 + G_kR_k} \qquad (43.1)$$

To determine the value of R_K for maximum gain the derivative of A with respect to R_K is set equal to zero. The gain A_1 is dependent on R_K only by virtue of the dependence of input capacitance of the tube on the grid-to-cathode gain, A_{cf}, which is in turn dependent on R_K. The degree of dependence of A_1 on R_K is so slight that A_1 changes only 20 percent as R_K goes from zero to infinity, so we shall assume A_1 to be invariant with R_K in performing the differentiation. Then

$$\frac{dA}{dR_k} = A_1G_k\,(R_2)^{1/2} \times \frac{d}{dR_k}\,[(R_k)^{1/2}/(1 + G_kR_k)]$$

and it can be found that

$$R_k = 1/G_k \qquad (44)$$

The driving impedance seen by the load of a cathode follower is equal to $1/G_K$, so the above result is quite in keeping with the usual relationship for matching a load to a generator for maximum power transfer. Note that the above condition has no relation to the condition for maximum power output from a cathode follower when the available input signal is unrestricted. Substituting for R_K from Eq. 44 in Eq. 43.1, we have

$$A = \tfrac{1}{2}A_1\,(G_KR_2)^{1/2} \qquad (45)$$

$$A = \tfrac{1}{2}\,(G_kR_1R_2/R_{ant})^{1/2} \qquad (46)$$

Having obtained the basic gain equation for the circuit, we can evaluate the signal and noise transmissions to the output. The cathode-follower r-f amplifier grounded-grid mixer combination would not require an interstage transformer, so we need only consider the combinations involving a straight pentode mixer or a cathode-coupled mixer in computing the value for R_2. For both the 6AK5 pentode mixer and the 6J6 cathode-coupled mixer, the input capacitance of tube, socket, and wiring is about 7 $\mu\mu$f, so R_2 must be 2,850 ohms for an 8-mc bandwidth. Using either the 6J6 (sections paralleled) or the 6J4 as r-f stage, the G_K is 12,000 micromhos for an obtainable operating condition. The output transformer ratio $R_2/R_K = R_2G_K = 34.2$ impedance ratio. With such an impedance step-up, the 5 $\mu\mu$f cathode-to-ground capacitance of the cathode-follower adds only 0.146 $\mu\mu$f to the capacitance loading across R_2, so we may neglect it.

The input capacitance to either a 6J6 or a 6J4 cathode follower is about 6 $\mu\mu$f so R_1 is 3,320 ohms for an 8-mc bandwidth.

The cathode follower gain is then $A = 19.5$.

Computing the tube noise-equivalent resistance from Eq. 25, since the presence of cathode feedback does not modify the inherent S/N of the tube, $R_n = 3/G_K = 250$ ohms. The grid-circuit antiresonant resistance is made up of the transformed antenna resistance in parallel with the 3,320-ohm damping resistor, or 1,660 ohms net noise resistance. The total noise resistance effective in the input circuit is $R_{nt} = R_n + R_1 = 1{,}910$ ohms.

The amplified and transformed total noise resistance at the ouput side of the output transformer can be computed with the aid of Eq. 24,

$$R_{n2} = (A_{cf}A_2)^2R_{nt} \qquad (47)$$

By Eq. 43, 45, 47,

$$R_{n2} = \tfrac{1}{4}\,G_kR_2R_{nt} = 16{,}350 \text{ ohms} \qquad (48)$$

From Eq. 26 the noise voltage across R_2 (excluding the noise from R_2 itself as well as the mixer noise which is yet to be computed) is $E_{n2} = 33.3$ microvolts.

Since the gain is 19.5, $S/N = AE_{ant}/E_{n2} = 0.585\ E_{ant}$. A signal of 17.1 microvolts at the antenna would produce an S/N of 10 for this circuit if there were no further noise contributions.

Stabilized Decade-Gain

With an input impedance of over 200 megohms and less than 6-μμf shunt capacitance, this single-probe instrument permits simultaneous observation of voltage, waveshape, and other characteristics of signals on high-impedance circuits with practically negligible loading effect

Amplifier being used for simultaneous voltage and waveshape observation

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INPUT IMPEDANCE of an electrical test instrument is a major factor in considering its applications and general usefulness. It is axiomatic of all sciences that a process which is being observed should not be affected by the means of observation; and for electrical work, it is necessary that indicating and recording devices have no great effect on a circuit whose characteristics and performance are being measured. Otherwise, no knowledge would be gained of the circuit in its normal operating condition, and the results obtained in the test condition would be untrue and misleading.

The Problem

More specifically, a measuring instrument should have an input impedance which is large compared with the circuits to which it is connected and take only a small fraction of the power available. If the low audio-frequency output voltage of a pentode amplifier stage which has a 10,000-ohm plate load resistor were measured with a 10,000-ohm voltmeter, a large error would be expected. But only a 1-percent error results with a 1-megohm voltmeter. If, however, a 1-megohm plate load resistor were used in the amplifier, a 50 to 100-megohm voltmeter would be required for a 1-percent loading error. Capacitance loading introduces similar errors at the higher frequencies.

Instruments have been built more and more sensitive to keep the loading errors small. Meters now commonly used for d-c voltages have D'Arsonval movements of 20,000 ohms per volt, and various electronic voltmeters have input resistances of from 10 to 1,000 megohms. Sensitive a-c voltmeters and cathode-ray oscilloscopes have inputs of 0.5 to 10 megohms shunted by about 20 to 50 μμf at their input terminals.

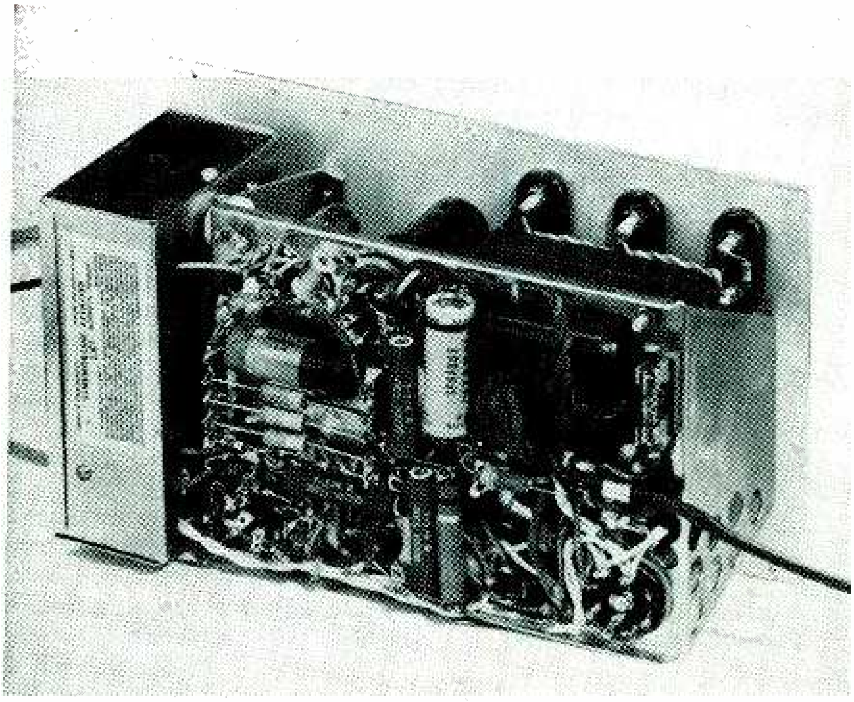
For measuring the output signal voltages of high-impedance circuits, such as the pentode amplifier with the 1-megohm load resistor, the direct connection of 1-megohm and 35-μμf voltmeters and oscilloscopes plus an extra 10 to 60 μμf added by the test leads causes a large loading error. Most coupling means commonly used between the signal source and the test instrument in order to reduce the loading error are not wholly satisfactory. Inherent capacitances can cause undesirable loading on the circuit being tested as well as a nonuniform response of the test instrument to frequencies of interest. Unshielded high-impedance leads pick up spurious voltages, and shielding adds to the capacitance errors. Also, the desired signal is often reduced below the capabilities of the measuring instrument; and, in general, each test instrument requires its own coupling network.

The Answer

A proposed circuit[1] has a much higher impedance than usual at the working end of the test leads, and a modification of this circuit in conjunction with a stabilized amplifier produces an instrument with a number of desirable features. Its high-impedance input of greater than 200 megohms shunted by less than 6 μμf for frequencies up to 150 kc can be connected to almost any circuit with small loading effects, no loss of signal, or introduction of hum.

The stabilized amplifier has a low dynamic output impedance, so that one or several measuring instruments can be connected to it with-

Isolation Amplifier



Under-chassis view. The type-75 tube is mounted inside the insulated shield box

out error. It is thus possible to observe simultaneously and accurately the voltage, waveshape, tone, or other characteristics of signals on high-impedance circuits. Only one pair of test leads is required for all observations. In addition, gains of 10.0 and 100 as well as 1.00 are available, and the noise-level is low enough so that 100 microvolts can be measured with reasonable accuracy.

The circuit diagram is shown in Fig. 1. Tubes V_1 and V_2 are used for the input circuit, and V_3 and V_4 form the stabilized amplifier. The high input impedance is obtained by enclosing the input circuit in a shield, shown dotted in Fig. 1, which is driven at almost the same instantaneous potential as the test signal conductor. The circuit being tested, therefore, supplies only a fraction of the usual charge, thus the apparent capacitance is greatly reduced. Similarly, only a fraction of the usual current flows through the resistive paths, greatly increasing the apparent resistance. Another point of view is that the instrument, in driving the inner shielding, is providing the charging and leakage current for the cable, relieving the circuit being tested of that function, thus creating the illusion of high impedance. Undesirable electrostatic fields are eliminated by enclosing the driven shielding by a second cable shield and by the metal cabinet which are maintained at ground potential.

Figure 2 shows a cross-section of the signal probe test lead, with the central signal conductor enclosed by the driven shield, which in turn is enclosed by the shield at ground potential. An insulating jacket covers the cable so that no metallic grounds are present along the lead. A Bakelite ferrule holding the banana-plug probe insulates the end of the cable. The test leads are 30 inches long, allowing convenient separation between the circuit being measured and the test equipment.

Input Capacitance

The input capacitance is the sum of three components: the grid-plate capacitance of V_1; the capacitance of the grid and signal wiring to all other conductors at a-c ground potential; and the capacitance due to the test cable. If C_4 is the actual cable capacitance between the signal conductor and the driven shield, E_S the potential of the signal conductor, and E_B the potential of the driven shielding, then the contribution of the test cable to the input capacitance is $C_4\ [1 - (E_B/E_S)]$. The resistive component of the input impedance is made up almost entirely by the current flowing through R_1 and leakage effects within V_1. The contribution of R_1, is $R_A = R_1/[1 - (E_A/E_S)]$, where E_A is the potential at A in Fig. 1, and E_S is the potential of the signal conductor.

In order to obtain a high impedance, the ratios of E_A/E_S and E_B/E_S should be as high as possible, which requires V_1 and V_2 each to have a high μ and a high load im-

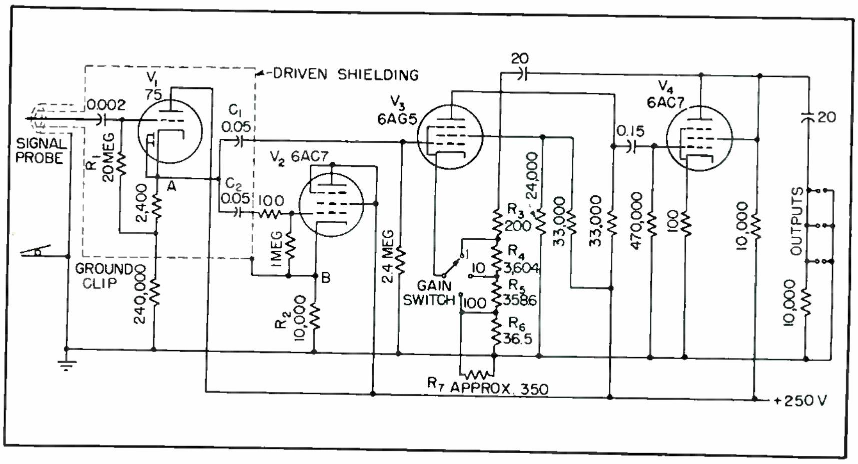


FIG. 1—Isolation amplifier circuit diagram. See text for resistor tolerances

pedance compared with r_p. Inside the instrument, the signal conductor and the grid are isolated by the driven shielding from as many other conductors at different a-c potentials as possible. The grid-plate capacitance of V_1 should be as small as possible, and the tube should have high leakage resistances. With these conditions in mind, a type 75 tube was chosen for V_1, a triode-connected 6AC7 selected for V_2, and the circuit elements shown in Fig. 1 were worked out. Each stage has a gain of approximately 0.98. The 75 has its grid connection at the top of the bulb, isolating it from the filament leads, which would add capacitance and induce hum potentials onto the high-impedance conductor if a single ended tube had been used. The driven shield box, shown in the illustration fastened by porcelain insulators to the front of the chassis, completely encloses V_1 and its circuit, and eliminates as much grid-ground capacitance as possible. The 75 also has a low grid-plate capacitance.

The sole function of V_2 is to provide signal to the driven shielding. Its load at low frequencies is R_2, and is the reactance of all the capacitance between the driven shielding and ground at the higher frequencies.

The input impedance of the unit measures about 300 megohms shunted by 5.7 μμf. Figure 3 shows the response of a circuit with 1.0-megohm series resistance shunted by 20 μμf when measured with a probe having such an impedance. The network is representative of a high-gain amplifier stage with the plate and load resistances shunted by tube capacitances, socket leads, and wiring and component capacitances. For comparison, probe impedances of 10 megohms shunted by 20 μμf and 1 megohm shunted by 50 μμf are also included. The upper curves (B) show the apparent response of the network if measured with instruments having the input impedances shown, and the lower curves (C) give the percent error resulting from the loading.

Stabilized Amplifier

In addition to driving V_2, V_1 also drives the stabilized amplifier por-

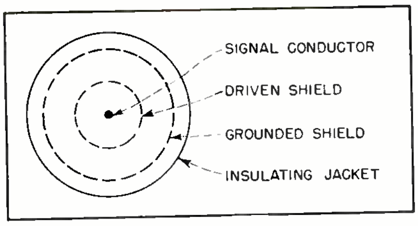


FIG. 2—Signal-probe cross section

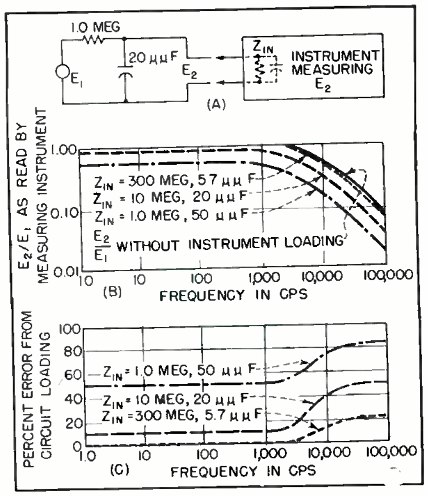


FIG. 3—Errors in high-impedance measurements due to circuit loading

tion of the instrument. It might be noted that the coupling capacitors C_1 and C_2 are included in the shield box to lessen the capacitive load on V_1, making higher gains with uniform frequency response possible. The amplifier has two functions. First it provides overall gain steps of 1.00, 10.0, and 100, and second it has a low dynamic output impedance so that several test instruments can be connected to it. The design is conventional for a two-stage feedback circuit. Tube V_3 is a 6AG5 and V_4 is a 6AC7 connected as a triode in a resistance-capacitance amplifier. The degenerative cathode circuits of V_3 and V_4 introduce feedback as well as that obtained by coupling the plate of V_4 to the cathode of V_3 through C_5, R_3, R_4, R_5, R_6 and R_7. In each position of the gain switch, the plate-cathode contribution is approximately 20 db.

Because of the gain of 0.98 in V_1, the V_3-V_4 amplifier circuit has gains of 1.02, 10.2, and 102 to produce decade gains overall. The choice of working gain is made with the selector switch on the panel. The gains are controlled by varying both the amount of plate-cathode feedback and the degeneration in V_3, by connecting the cathode of V_3 to various points on the voltage divider formed by R_3, R_4, R_5 and R_6. The tolerances in percent are: $R_3 \pm 1$, $R_4 \pm 0.1$, $R_5 \pm 0.1$ and $R_6 \pm 0.5$. By using close tolerance resistors, the gains of 1 and 10 fall within a small fraction of a percent of their nominal values, and it is not necessary to adjust each instrument.

Parameter variations, principally the 6AG5 tubes, make an individual alignment of the gain of 100 necessary if the initial error is to be less than 2 or 3 percent. Resistor R_7 is selected to bring the gain to its correct value with nominal line voltage. There is sufficient feedback so that instruments which have operated almost daily for a year show no measurable variation. Line voltage changes from about 100 to 130 volts cause a 2-percent change in gain. The gain of the amplifier is constant within 2 percent below 5 cps to above 150 kc, which corresponds with the frequency region of high input impedance.

Output tube V_4 can deliver 10 volts rms into a 3,000-ohm load connected to the output terminals with distortion well below 0-1 percent. The dynamic output impedance depends upon the amount of feedback, thus upon the gain setting, and is 300 ohms at 100, 70 ohms at 10, and 10 ohms at 1. At the highest value, 300 ohms, three indicating instruments each with 0.2-megohm resistance and 200-μμf shunt capacitance, including the connecting cable, cause less than 2 percent loading error of the amplifier for frequencies less than 150,-000 cps. Three sets of output terminals are provided on the panel, so that three instruments can be connected easily.

The instrument is housed in a cabinet 6 x 4½ x 10 in. and it is intended to be set on a laboratory bench alongside the instruments which it drives. In use, a voltmeter and a cathode-ray oscilloscope are the usual instruments connected to the output, and the test leads are moved about the circuit being measured. The small probe is convenient to handle, and the one connection provides signal for both indicating instruments.

REFERENCE

(1) H. L. Daniels, Tubeless Probe for VTVM, ELECTRONICS, p 125, Feb. 1945.

Directional Antennas for A-M Broadcasting

Simplified and practical method of calculating radiation patterns for two and three-tower arrays when determining coverage and protection. An example is given that provides a convenient check list of the operations involved in plotting a complete pattern

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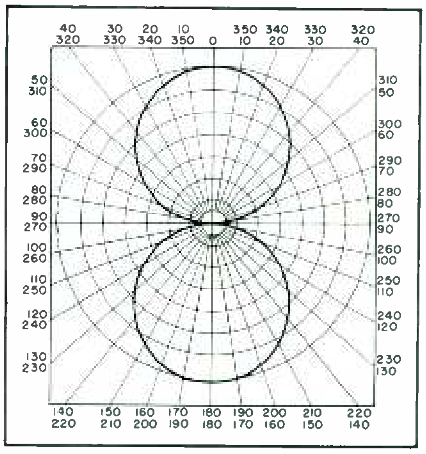
ALTHOUGH directional antennas have long been in use by a-m broadcasting stations, some engineers regard them with awe, and surround them with an aura of mystery. Many regard the calculations involved as being beyond their capabilities when, in fact, nothing more than an elementary knowledge of the basic operation of a single antenna and the ability to perform simple trigonometry is required. It is the object of this article to disperse some misconceptions, and simplify directional-antenna calculations for two and three-tower arrays.

Almost every textbook opens its antenna section with an illustration of the fundamental laws of radiation from an antenna and these laws will not be repeated here. Since the radio engineer is usually more interested and concerned with the effect of his antenna on co-channel and adjacent-channel stations he will, presumably, prefer to see how to design an antenna to do a specific job.



Pattern from two antenna elements of equal height spaced 45 degrees, with equal currents in each element and phase angle of 180 degrees

Two-Tower Array

Figure 1 shows the basic diagram for the field at one point caused by two antennas. The nomenclature used to perform the functions is given below, although all engineers do not necessarily use exactly the same symbols for some parameters.

- θ_r = angle between reference line R-R' and axis of array
- I_1 = current in tower 1
- I_2 = current in tower 2
- T = ratio of I_2 to I_1 (current ratio for similar towers, or field ratio for dissimilar)
- ψ = phase angle of tower 2 with reference to tower 1
- ϕ_h = phase difference between tower 2 and tower 1 at point P_h
- P_h = point at infinity, or such distance that lines drawn from the towers to P_h may be considered parallel (horizontal)
- P_v = same as P_h, except above the horizon in vertical plane
- α = vertical angle to P_v in space
- θ_h = angle between R-R' and line to P_h
- S = spacing between towers in degrees (360 degrees equals one wavelength)
- θ = angle between axis of array and true north, used when plotting on chart to obtain correct orientation for coverage required and protection
- G = height of tower in degrees

When calculating the radiation pattern for a two-tower array, it is usual to number the towers 1 and 2, and to place them at random. "Random" is used in the sense of being an arbitary placement dependent on the whim of the engineer, subject to the dictates of common sense and necessity. In practice, the engineer usually has an approximate idea of the basic pattern obtainable from certain standard combinations of tower spacing and phasing. From these he can estimate how the final pattern will appear. But eventually the problem boils down to one of trial and error until a pattern is obtained, with reasonable constants, which gives the protection required.

Tower 1 is taken as the reference tower and all quantities are stated with reference to this tower. The reference line R—R' is drawn through tower 1, at random. A point P_h is located on a circle whose center is equidistant between towers 1 and 2, and such a distance that lines joining P_h-tower 1, and P_h-tower 2 may be regarded as parallel (actually the error is so slight that it may be ignored in practice).

Calculation

The basic information has now been presented in a form which enables the designer to see what he is doing and how each step may be taken. Consider the field at P_h. The radiation from tower 1 has to travel farther than the radiation from tower 2 by a distance $S \cos (\theta_r - \theta_h)$. This is also the case if P_h is on the other side of the axis. Line A-A' of the array, that is for values of $(\theta_r - \theta_h)$ between -90 degrees and $+90$ degrees, $S \cos (\theta_r - \theta_h)$ is plus, but when it is between $+90$ and $+270$ $S \cos (\theta_r - \theta_h)$ is negative. This provides the first clue to the manner in which the pattern is obtained, since, depending on the length of the paths to P_h, all signals arriving at

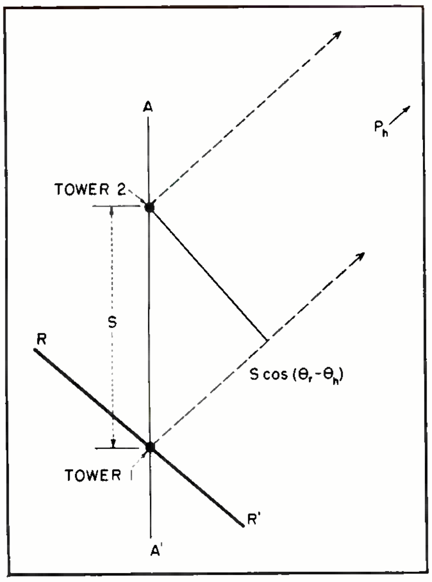


FIG. 1—Basic diagram of field created by a two-tower array

P_h will either reinforce or buck each other, thus giving rise to the characteristic pattern for these parameters.

Consider the initial phase difference at the towers. It will be observed that the phase relationship of the fields at P_h resulting from the radiation from towers 1 and 2 is due to the different path lengths. Therefore the tower phase difference must be added to the phase difference to obtain the total phase difference. The total phase difference between towers is referred to tower 1. If the current in tower 1 leads the current in 2, the phase angle ψ is negative; if it lags in tower 1 then ψ is positive. Thus the total phase difference at point P_h is given by the expression:

$$\phi_h = \psi + S \cos (\theta_r - \theta_h)$$

For the purpose of this discussion it will be assumed that the antennas are identical, although it often happens that due to a desire to use an existing tower in conjunction with a new one, two dissimilar towers will be used. With this assumption the field from each tower is proportional only to the magnitude of the current in the respective towers, and since they are identical the only thing which can cause the fields to differ is a current difference. From this we have a measure of the field strength at P_h in the magnitude of the relative tower currents. Vectorial representation of the component fields by the magnitudes of I_2 and I_1 makes possible the addition of vector I_2 to the reference I_1 at the phase difference angle ϕ_h. A vector I_H is produced, which represents the resulting field strength. In that direction

$$I_H = I_1 + I_2 \angle \phi_h$$

To obtain the antenna pattern necessary to determine the direction of the lobes of radiation of various values it is necessary to compute the field at P_h for all angles from the center of the axis of the array. If R-R' is made to coincide with the axis of the array, only azimuths of from 0 to 180 degrees need be calculated and $S \cos (\theta_r - \theta_h)$ then becomes $-S \cos \theta_h$. It will a so be apparent that in the case of a two-tower array, the towers must be equidistant from the center of the circle, and therefore the pattern will be symmetrical. This makes it necessary to compute only one side of the array. These values are now plotted on polar paper and a unit pattern is obtained. Before this can be used directly to compute field strengths at various points it must be converted to absolute field strength E_H.

$$E_H = K \times I_H \qquad K = \frac{\text{Array rms}}{\text{Unit rms}}$$

Value K is a constant which is determined by dividing the rms of the unit pattern into the assumed rms value of the array. The easiest way to do this is to measure the unit area with a planimeter, and convert it to a circle of equal area. The radius is measured in the same units as I_2 and I_1 (used to plot the unit pattern) and divided into the array root mean square value.

General engineering experience has determined over a long period of time that under average conditions of efficiency a given power into the antenna will produce a known field strength at one mile. The FCC has incorporated these figures into the Standards of Good Engineering Practice, and so by multiplying the field intensity at one mile produced by one kilowatt, by the square root of the power increase, the assumed rms value for the array will be found. In practice, the FCC will not usually approve an array below this minimum efficiency. The horizontal pattern is now obtained by plotting the values of absolute field intensity (E_H) for 360 degrees at intervals of 10 degrees (or less in critical directions). From this it can be determined whether the required protection or coverage is being obtained.

Vertical Pattern

The method of calculating the vertical radiation pattern of a two-element array is very similar to that for the horizontal pattern, the only difference being a slight modification of the horizontal method, and the application of the radiation characteristic of a vertical antenna. Most readers are familiar with the fact that a single vertical antenna does not radiate equally in all vertical directions, but, as is shown in Fig. 2, the intensity varies with the angle of elevation above the horizon. If it is assumed that an antenna is operated with its lower end

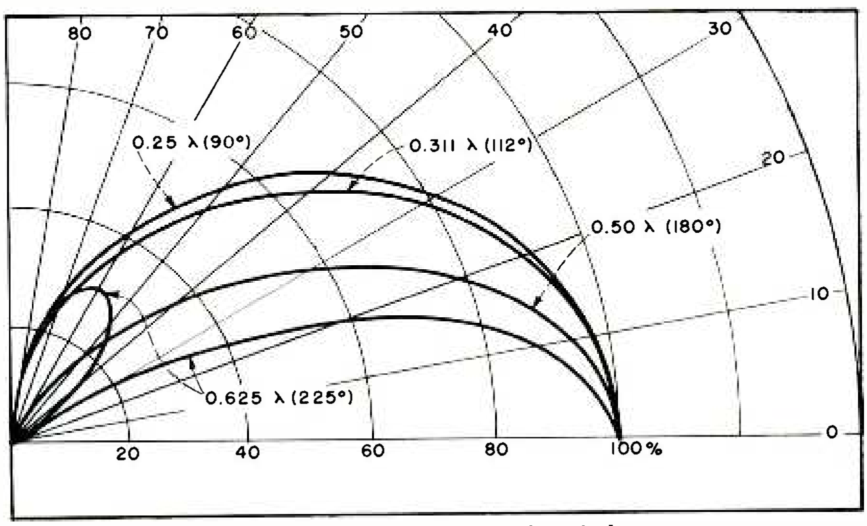


FIG. 2—Vertical radiation patterns of vertical antennas

grounded and that the current distribution is sinusoidal, then the radiation pattern is given by

$$F = \frac{\cos(G\cos\alpha) - \cos G}{\sin\alpha\,(1 - \cos G)}$$

where G is antenna height in degrees.

As was done in computing the horizontal patterns, the radiation at any point P_v in the vertical plane is obtained by adding vectorially I_2 and I_1 at the pertinent phase angle, and then multiplying this result by the vertical radiation factor.

Just as for horizontal patterns, the total phase difference of the component fields observed at point P_v is obtained by adding the phase difference caused by the difference in the length of the radiation paths, and the initial phase difference of the antennas.

This is given by

$$\phi_v = \psi_v + S\cos(\theta_r - \theta_h)\cos\alpha$$

As in the case of the horizontal pattern the vectors I_2 and I_1 are added at the phase angle ϕ_v. The resulting vector is then multiplied by F, the radiation factor, and the same conversion factor K as was used in the horizontal pattern. The resulting signal strength at one mile E_v, is plotted in mv per m on polar paper as a vertical section through 90 degrees in the horizontal direction involved.

Thus

$$E_v = I_1 + I_2\angle\phi_v \times F \times K$$

Three-Tower Array

The method of calculation for a three-tower array is exactly the same as for two towers except that the third tower has to be included in the formulas. Figure 3 shows the basic form for calculating the field at P_h from a three-tower directional array. Tower 1 is the reference tower and is in the center. The same nomenclature as before is used with the addition of the following symbols to take care of the third tower:

I_3 = current in tower 3
T_3 = ratio of current in I_3 to I_1
ϕ_{h3} = phase difference between tower 1 and tower 3
ψ_3 = phase angle of tower 3 with reference to tower 1
S_3 = spacing between towers 3 and 1 in degrees
θ_{r3} = angle between R-R' and axis of towers 1 and 3

The field at any point will be determined by the magnitudes of the currents in the three towers and their phases. Radiation from tower 1 travels a distance of $S\cos(\theta_r - \theta_h)$ more or less than radiation from tower 2. Also radiation from tower 1 travels a distance of $S_3\cos(\theta_{r3} - \theta_h)$ more or less than radiation from tower 3. If $(\theta_r - \theta_h)$ or $(\theta_{r3} - \theta_h)$ is between -90 and $+90$ degrees the distance is greater: if $(\theta_r - \theta_h)$ or $(\theta_{r3} - \theta_h)$ is between $+90$ and $+270$ degrees, the distance is shorter.

As in the case of a two-tower array, the initial phase differences must be added to those resulting from the different distances to P_h. Thus the total phase difference with reference to tower 1 from towers 2 and 3 is given by

Towers 1:2 $\phi_h = \psi + S\cos(\theta_r - \theta_h)$
Towers 1:3 $\phi_{h3} = \psi_3 + S_3\cos(\theta_{r3} - \theta_h)$

If the three towers are similar, adding the vectors for the currents in the three towers at the correct phase angle will produce a vector representing the resultant field strength of the unit pattern I_H

$$I_H = I_1 + I_2\angle\phi_h + I_3\angle\phi_{h3}$$

From here on the method is exactly the same as for two towers, with the exception that in all but special cases the pattern is not symmetrical and therefore all values of θ_h from 0 to 360 degrees have to be computed.

The vertical radiation factor F is computed from

$$F = \frac{\cos(G\cos\alpha) - \cos G}{\sin\alpha\,(1 - \cos G)}$$

The phase difference at point P_v is computed from

Towers 1:2 $\phi_v = \psi + S\cos(\theta_2 - \theta_h)\cos\alpha$
Towers 1:3 $\phi_{v3} = \psi_3 + S_3\cos(\theta_{r3} - \theta_h)\cos\alpha$
Adding $I_v = I_1 + I_2\angle\phi_v + I_3\angle\phi_{v3}$

Then the absolute signal strength at one mile at any angle α above the horizon in any direction θ_h is:

$$E_v = I_v \times K \times F$$

Example

The following example of the method shows the calculation of the radiation in one azimuth for the array with the constants shown below:

$I_1 = I_2 = 4$ amperes
S = 45 degrees
ψ = 180 degrees
$G = 0.311$ (112 degrees) $G_1 = G_2$

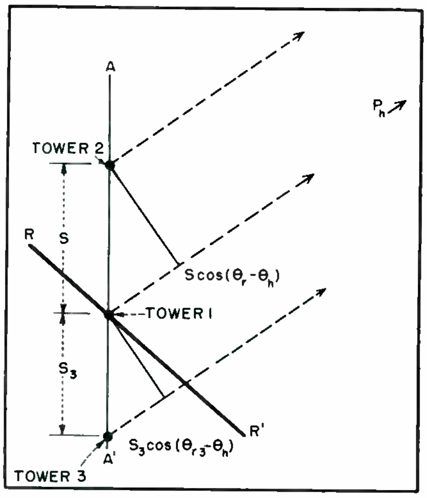


FIG. 3—For calculating the field of a three-tower array, the center tower is used as the reference point

To obtain the unit horizontal pattern, the radiation at every 10 degrees is calculated. For example: suppose θ_h = 40 degrees: θ_v = 20 degrees:

Then

$$\phi_h = \psi + S\cos(\theta_r - \theta_h)$$

Simplifying: $R - R'$ is made to coincide with the axis of the array. Then

$$\phi_h = \psi + (-S\cos\theta_h)$$
$$= 145.5 \text{ degrees}$$

Now $I_H = I_1 + I_2\angle 145.5$ degrees
$= 4 + 4\angle 145.5$ degrees

Adding vectors = 2.367

This is the scalar length of a horizontal vector at 40 degrees. To obtain the complete pattern, this operation is repeated every 10 degrees. To obtain the absolute field at one mile the factor K must be applied.

$$K = \frac{\text{rms array}}{\text{rms unit}} \quad \text{say,} \quad \frac{175\sqrt{5}}{1.2} = 325$$

Then

$E_H = K \times I_H = 325 \times 2.4 = 780$ mv per m at azimuth 40 degrees.

To obtain the vertical pattern (unit) at 20 degrees the procedure is the same except that the vertical formula is used and the vertical radiation factor F has to be calculated from:

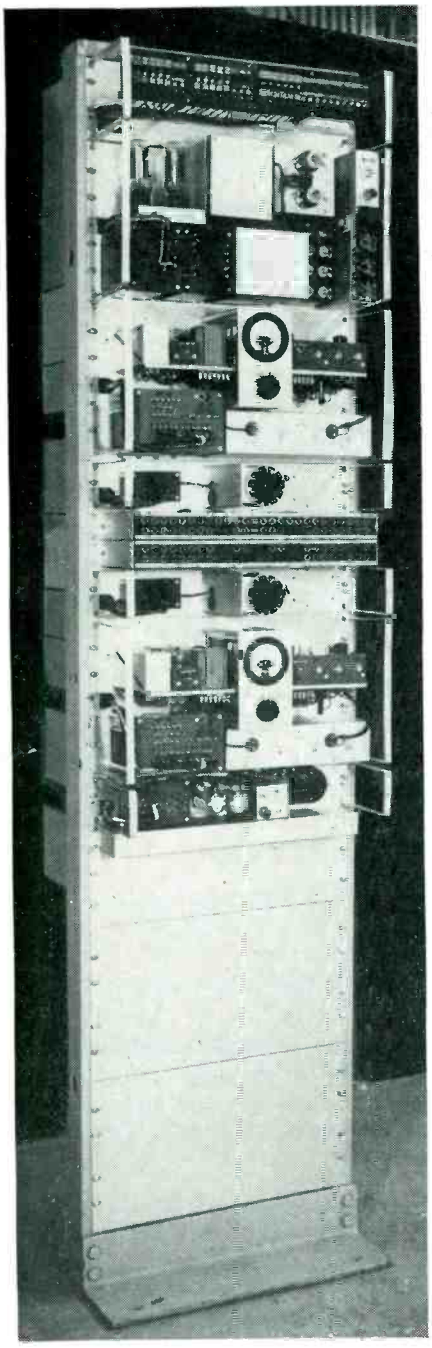
$$F = \frac{\cos(G\cos\alpha) - \cos G}{\sin\alpha\,(I - \cos G)}$$

This is then applied to $I_v \times K$, becoming

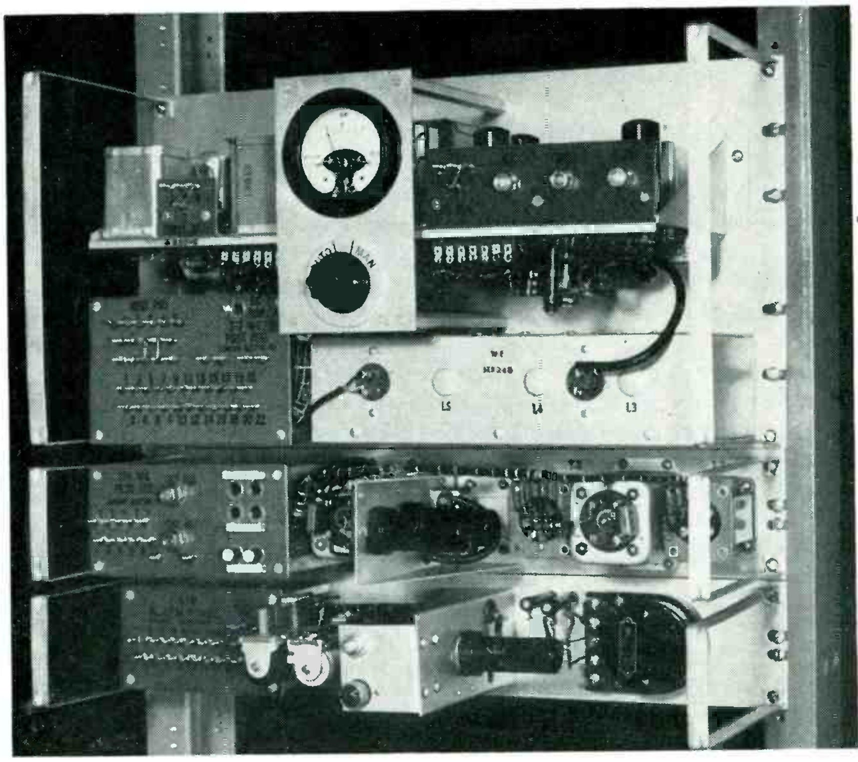
$$E_v = I_v \times K \times F$$

substituting: $E_v = I_v \times 325 \times 1.36$
$= I_v\,(448)$

Carrier Communication



Complete Lenkurt type-32 three-channel carrier repeater



Closeup of pilot regulator used in repeater. Intermediate units have two regulators, one for each direction, while terminals require only one regulator

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IN THE FIELD of carrier communication on open-wire lines, the three-channel, 30-kc carrier system is widely used to add three voice circuits without affecting operation of the existing physical circuit.

Where these lines are long in terms of total attenuation, repeaters are placed at suitable intervals to restore operable levels in the audio material transmitted. Attenuation on such lines, however, is not a constant. It varies in two ways: (1) it increases from dry-to-wet and cold-to-warm weather; (2) it increases more at the high end of the frequency spectrum, in an effect known as twist. This causes the higher-frequency channels to operate in unfavorable weather at relatively lower levels than the lower-frequency channels of the same carrier system.

Automatic regulators have been used to compensate for these effects. However, the pilot regulator described here is one of the first to perform these functions with an all-electronic circuit which permits the elimination of all moving parts, relays, motors and physical contacts from the regulating circuit.

The regulator forms part of a standard rack-mounted carrier unit and consists of three equipment panels: (1) a pilot oscillator which produces pilot-frequency current for transmission on the line from one terminal of the system to another; (2) the regulator itself, which determines attenuation of the pilot frequency on that line and adjusts the level of the terminal or repeater for constant output level regardless of attenuation or twist ahead of it; (3) an alarm which signals the attendant with light and bell when any abnormal operating conditions have exceeded the scope of the regulator.

Pilot Oscillator

The pilot oscillator circuit is given in Fig. 1. One oscillator is used in the transmitting branch of each terminal of a system. When installed in an East terminal (transmitting to the West) it operates on 5.9 kc, whereas at a West terminal it generates a frequency of 29.6 kc.

Stability of both output level and frequency are most important considerations in this oscillator. It

Level Regulator

All-electronic control unit corrects twist and maintains constant level for three-channel carrier telephone or telegraph communication on open-wire lines despite varying weather conditions. Variations up to 20 db are held within 2 db without adding distortion products

uses two 6N7 triodes in a push-pull-parallel circuit, with inductor L_1 and capacitor C_2 in a parallel frequency-determining circuit. Inductor L_1 has an iron-powder pot and adjustable core for fine setting of the pilot-oscillator frequency. Fixed bias is provided by cathode resistor R_1. This resistor is wired to test points as shown to facilitate measurement of plate current in terms of voltage drop.

Positive feedback goes through capacitor C_1 and variable resistor R_2. A stabilizing variable-bias network maintains constant output level by picking up a voltage from the secondary of transformer T_1, rectifying it in germanium diodes, and filtering it in R_9 and C_4 before feeding it to the grids to create automatic correction for any tendency toward output-level variation.

Jacks J_1 and J_2 are provided for patching-in a 600-ohm db meter for adjusting feedback control R_2 to give correct oscillator level. Pilot-frequency output-level adjustment is made with resistor R_8 to establish the conventional output of minus 49 dbm at jacks J_3 and J_4. This output circuit, consisting mainly of R_{12} and R_8 in series, has an impedance high enough to allow bridging across the input of the transmitting amplifier of the carrier terminal with negligible loss to through transmission. When the pilot-frequency signal leaves the transmitting amplifier its level is 8 dbm.

Arrangement of the output jacks is designed to permit disconnecting the pilot oscillator from the transmitting amplifier when necessary for adjustments or substitution of a test oscillator. An additional carrier-frequency output is provided to supply current at pilot-oscillator frequency for modulating an extra reduced-fidelity channel available in these systems for use as a service circuit or as a voice-frequency channel for subdivision into a total of nine telegraph subchannels.

Pilot-transmitting filter *PTF*, consisting of L_2 and C_3, is series resonant at the pilot frequency. This precludes the possibility of appreciable pilot-frequency harmonics being present at the transmitting-amplifier input.

Pilot Regulator

The pilot regulator, shown in block form in Fig. 2, is essentially a variable attenuator. One regulator is connected into the carrier-receiving branch of each terminal of a system. Additionally, two are required for each intervening repeater—one to handle each direction of transmission. The circuit arrangement permits switching of the regulating action to either the manual or the automatic section. This provides for emergency opera-

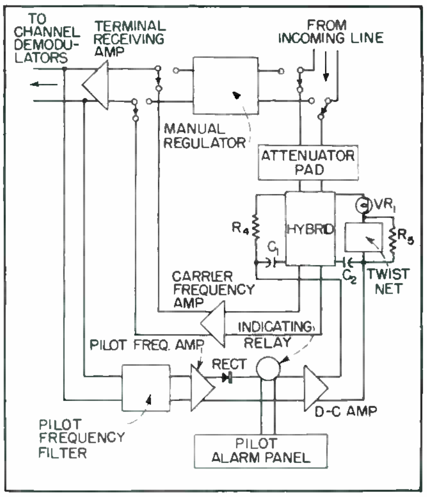


FIG. 2—Block diagram of pilot regulator. Control of attenuation is achieved in the hybrid transformer by the sampled pilot frequency derived from the carrier-frequency receiving amplifier

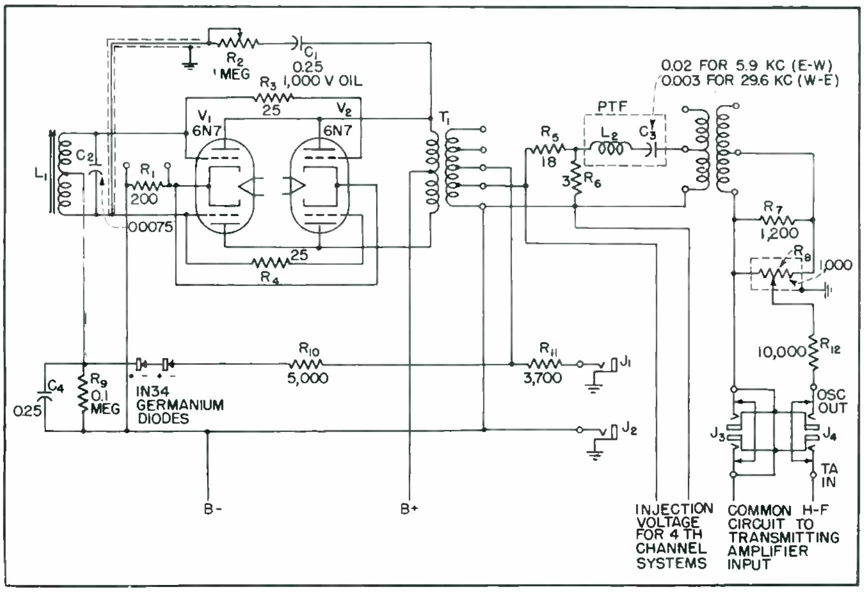


FIG. 1—Pilot oscillator circuit. Pilot-frequency currents originating here are transmitted over the line to determine the amount and kind of attenuation and then control the succeeding repeater or terminal to restore normal level and correct twist

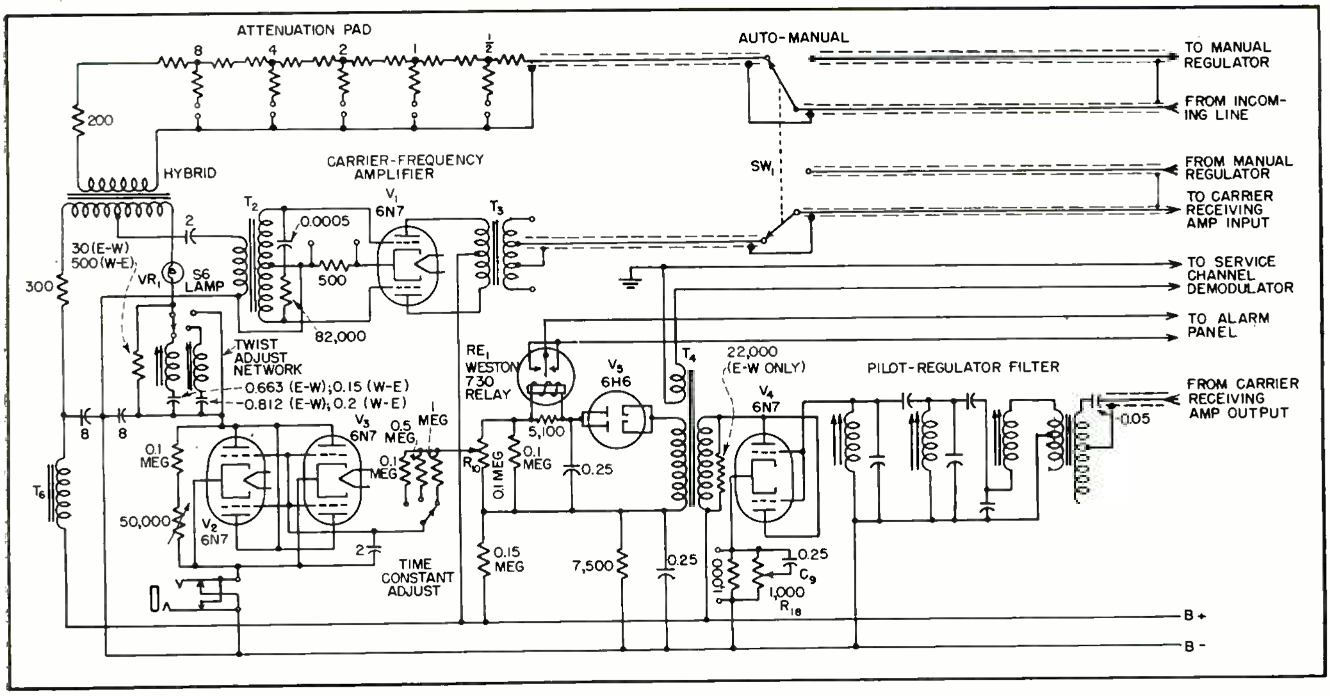


FIG. 3—Pilot regulator circuit. Reactance in the twist network in the right-hand arm of the hybrid bridge gives a frequency-discrimination factor that restores flat frequency characteristics

tion and for servicing the automatic circuit.

When the control is set for automatic operation, all carrier-band frequencies enter the regulator at the upper right and pass through an attenuation pad, a hybrid transformer, and an amplifier. The output of this amplifier is applied to the input of the terminal receiving amplifier whose output is sampled and fed back to the regulator through a pilot-frequency filter, a one-stage pilot-frequency amplifier, a rectifier and a d-c amplifier. The output of the latter is used to control passage of carrier-band frequencies through the hybrid transformer by the degree of unbalance of the hybrid-bridge circuit.

As bridge balance increases, carrier-band level at the regulator output terminals increases. The bridge in Fig. 2 is composed of R_4 and C_1 balanced by lamp VR_1, R_3, the twist-adjusting network and C_2. Thus, the level of carrier-band frequencies reaching the terminal receiving amplifier, and consequently the subscriber's handset, is determined by the received level of the pilot frequency.

Action of Regulator Circuit

Figure 3 shows the regulator circuit in detail. Again the regulator input is at the upper right. The attenuator is a five-element T pad arranged for strapping into the input with ½, 1, 2, 4, and 8-db attenuation factors which can be combined to match the manual attenuator at the center of its range. The output of the hybrid transformer passes through the carrier-frequency amplifier consisting of V_1 and goes through switch SW_1 to the carrier terminal receiving amplifier, which is not shown. The sampled output of this amplifier returns to the regulator at the lower right, entering the pilot-regulator filter. This sharp-tuned network feeds the paralleled grids of V_4, the pilot-frequency amplifier. Cathode degeneration and bias in this stage are controlled by C_9 and R_{18} to provide gain adjustment over a 6-db range for centering the pointer of meter-relay RE_1, a Weston type-730 sensitive relay which serves to actuate the alarm when the pilot-frequency level varies beyond the automatic-regulating range for any reason. This combination is also used in adjusting the regulator from time to time as required during normal operation.

After passing through the pilot-regulator filter, which selects the pilot frequency from the carrier band, the pilot frequency is amplified in V_4 and fed to transformer T_4. The output of the main secondary winding is rectified in V_5, a 6H6. Resistor R_{10}, the 6H6 load, feeds an adjustable portion of this rectified signal to the grids of the d-c amplifier stage (V_2 and V_3 in parallel) by way of the adjustable-time-constant network. An additional secondary on transformer T_4 supplies demodulating carrier voltage for the fourth or service carrier channel previously mentioned.

The d-c potential on the grids of V_2 and V_3 is proportional to the received level of the pilot frequency, which thus controls the current flow through lamp VR_1. As current varies, the lamp-filament temperature—and thus resistance—varies and the hybrid-bridge balance is altered, changing attenuation of the carrier frequencies in the hybrid and providing regulation. Because V_2 and V_3 operate as a d-c amplifier, small changes in rectified pilot voltage cause larger changes in current flow through VR_1.

Weather Conditions

Under normal weather conditions the pilot regulator is customarily set for an overall loss of 16 db between regulator input and output circuits. This loss includes pilot-regulator pad loss, regulator-hybrid-bridge loss, and regulator-amplifier gain. At a West terminal the regulator pad is normally strapped for a 10-db loss, the bridge introduces a 31-db loss under normal conditions, and the amplifier contributes a 25-db gain. The result is a 16-db loss. At an East terminal the regulator pad is strapped for a 6-db loss, the bridge operates at a 35-db loss, and the amplifier has a 25-db gain—making the net loss again 16 db. The difference in bridge-circuit attenuation results from the different frequencies utilized in opposite directions of transmission.

The twist network is a reactance circuit in series with the current-sensitive resistor VR_1 in one arm of the hybrid bridge in Fig. 3. This introduction of reactance makes the attenuation introduced by the bridge circuit dependent on frequency to a degree that can be preset by changing the resonant frequency of the network. Maximum twist correction is obtained when the impedance of the right side of the bridge varies most with frequency or when maximum reactance is in the circuit. No twist correction occurs when the twist network contains no reactance.

Under favorable weather conditions, current through VR_1 is relatively low, and is adjusted by R_{10} to give maximum bridge balance and attenuation (35 db) and increased high-frequency attenuation. The normal slope of the preceding line section adds to this high-frequency attenuation and both are offset by a slope-correction network contained in another portion of the carrier terminal. The resulting level to the amplifier is uniform as to frequency.

Under unfavorable weather conditions, pilot-current level is reduced, along with all other signals, by increased line attenuation. This raises plate current from the d-c amplifier and increases the resistance of VR_1, unbalancing the bridge

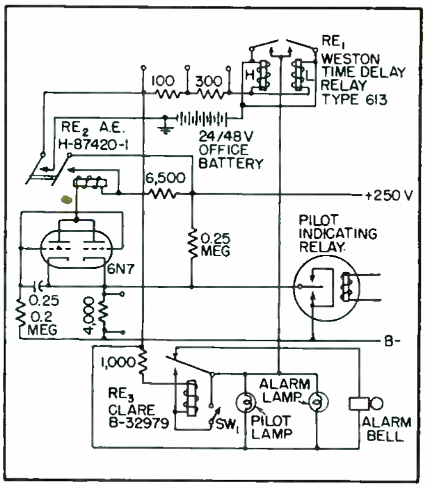


FIG. 5—Circuit of pilot-regulator alarm panel. Action of time-delay circuit at output of 6N7 is such that alarm is energized if operating conditions exceed regulator range for more than 30 seconds, to allow for transient effects on the line

to reduce attenuation in the hybrid transformer. Bridge unbalance, however, is most effective at higher frequencies due to action of the series-resonant circuit of the twist network. Thus, the higher-frequency attenuation which occurs here when the bridge is balanced tends to disappear most rapidly as the bridge becomes unbalanced. Since the line twist increases as the bridge twist decreases, the net effect on signals at the receiving amplifier is nil. The curves of Fig. 4 show this effect graphically.

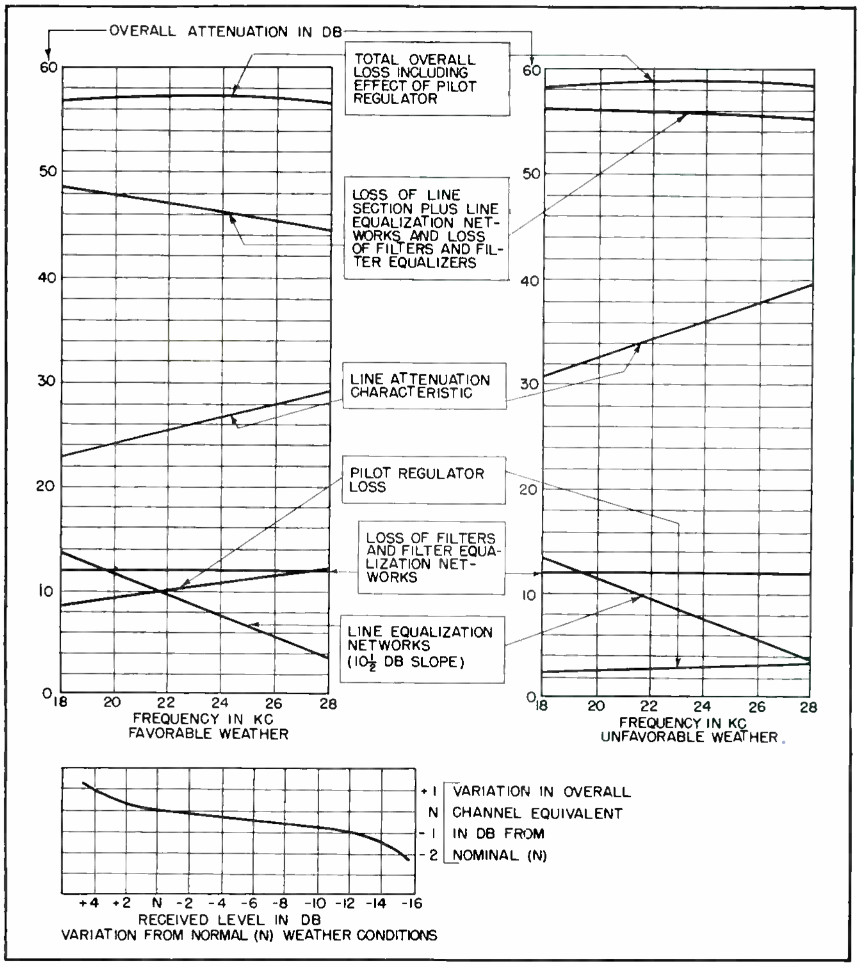
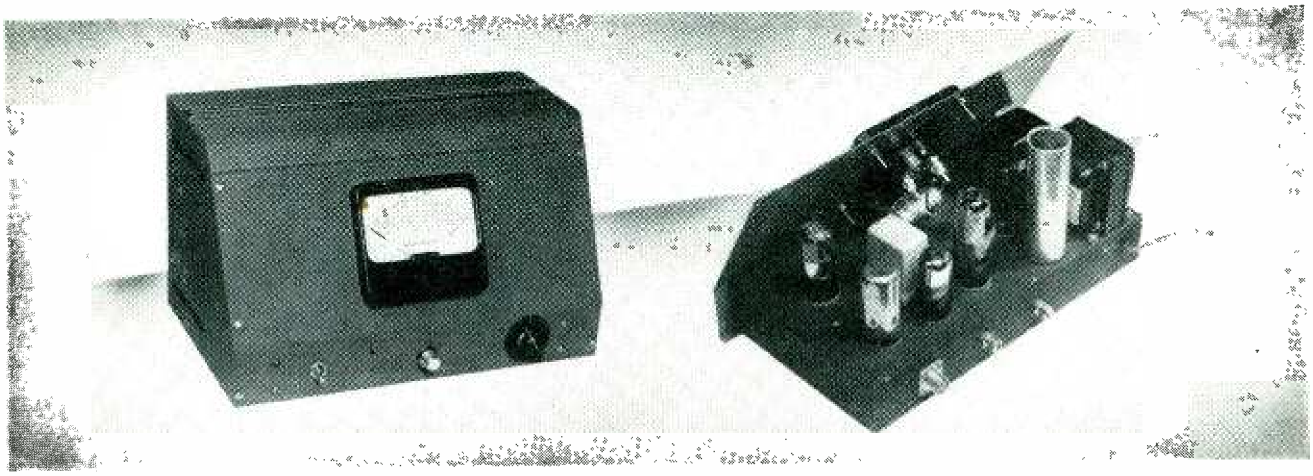


FIG. 4—Total loss over a carrier system, shown as a summation of various related factors. The action of the pilot regulator is to keep overall loss approximately the same under favorable and unfavorable weather operation. Effect of unfavorable weather is shown in lower graph

Alarm System

The meter-type sensitive relay shown in the output circuit of the 6H6 in Fig. 3 actuates a set of alarm signals if the regulator is unable, for longer than 30 sec, to maintain normal operating conditions. The alarm is shown schematically in Fig. 5. It utilizes a 6N7 with both sections in parallel to actuate a 30-second time-delay circuit RE_1 on either high or low pilot level and thereby give a visual alarm. Terminals are provided for the attachment of external lamps or an alarm bell.

Means are incorporated for silencing the bell but the visual signal remains until the pilot current is restored to a proper level. In repeater installations, where there are regulators for both directions of transmission, both can be connected to a single alarm panel.



Front and rear views of the frequency meter showing layout of the major components

A Compact Direct-Reading Audio-Frequency Meter

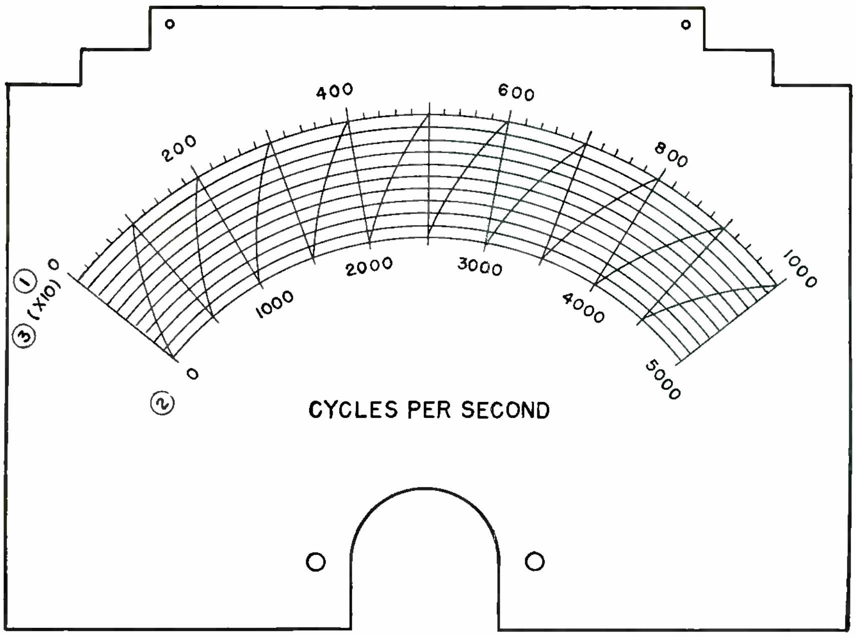
Simple, low-cost instrument with sufficient accuracy for most industrial or communications measurements employs a squaring amplifier, integrator, and pulse counter. It can be calibrated in the field from WWV transmissions

DESIGNED primarily for the measurement of audio frequencies in the range from 10 to 5,000 cycles the instrument to be described comprises part of the technique for obtaining and measuring an audible beat between a received, radio-frequency carrier of unknown frequency and a known or identifiable 10-kc marker derived from a 100-kc crystal clock.

Although exact carrier-frequency determination by this general method would require more precise instrumentation, it was desired to obtain a direct indication to show quickly at least the order of magnitude. The sense of the audio beat (whether the unknown is beating with the high or the low 10-kc marker) is also apparent with a minimum of ambiguity when the crystal standard or a following divider is varied slightly in frequency. The upper frequency limit of the direct-reading device is set by the fact that the unknown signal can never be farther than 5 kc removed from one of a pair of sequential 10-kc markers. The lower limit is set by practical considerations of circuit complexity and attendant cost.

Because of the potential usefulness of the meter for work with audio or industrial devices, it was constructed to read up to 10,000 cycles. Some redesign of the circuit is necessary to make it indicate reliably at frequencies much above this arbitrary limit. The ranges are 10 to 1,000; 10 to 5,000; and 10 to 10,000 cycles as constructed.

The circuit shown in Fig. 1 comprises a cascade amplifier followed by a cascade squaring amplifier. The output is differentiated and the resultant pips used to trigger a blocking oscillator. The oscillator grid is biased so that only the positive-going half of the oscillation appears at the grid of the final triode. This tube, initially biased to cutoff, has a microammeter shunted by a capacitor in its cathode circuit. The meter reads the integrated space current that is directly a function of frequency. Provided only that sufficient signal is furnished to the square-wave clipper tubes, the meter indications are independent of audio amplitude. Wave shapes normally encountered in continu-



Meter scale used for three audio ranges

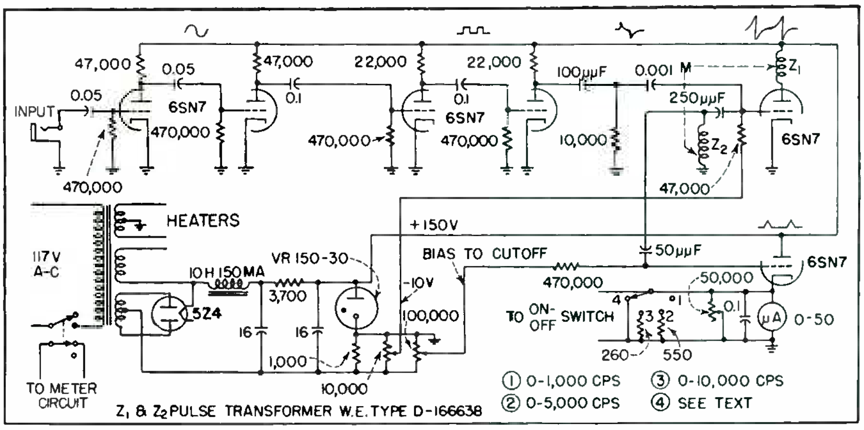


FIG. 1—Schematic circuit diagram of the audio-frequency meter

ous-wave radio are sufficiently close to sine wave shape to produce correct meter readings. The ultimate limitations resulting from wide departures from sine-wave input have not been examined.

The audio amplifier was found desirable, particularly at frequencies below some 200 cycles, because the poor low-frequency response of the circuits caused the square wave to deteriorate unless the instrument was furnished an inordinately large input signal. The addition of the cascade amplifier has reduced the input signal requirement to a maximum of less than 5 volts, about half this value being required at the higher frequencies.

Layout of the circuit is not critical provided normal precautions are observed. Oscillations (the meter reading about 800 cycles) were noted with the input circuit unloaded. The trouble was diagnosed as feedback from the blocking oscillator to the square-wave tube. A tube shield cured the trouble. Later, oscillations caused by feedback in the cascade amplifier were simply cured by bending the interstage coupling capacitor leads slightly so that the capacitor was farther from the input jack.

Initial tests and calibration of the meter were carried out with a cathode-ray oscilloscope and a laboratory-type commercial frequency meter. Using the laboratory oscillator as a standard, the scale of the 50-microampere meter was found to have a reasonably linear relationship to frequency. At no point is the deviation worse than 5 percent of full-scale deflection.

The electrical zero setting of the indicating meter is adjusted by cutoff bias on the last tube, with full-scale setting determined by the 50,000-ohm resistor. This latter control is necessary owing to the varying characteristics of replacement tubes of the same type. The meter multiplying shunts have been so chosen, using a variable resistor and matching its setting with fortuitous combinations of carbon resistors, that the top-scale adjustment will be essentially correct for each scale.

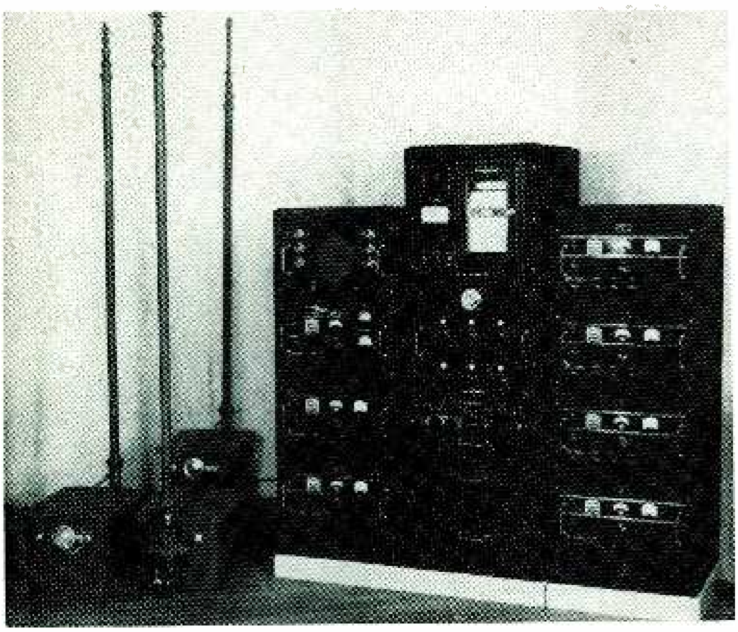
In the field or small laboratory the top-scale adjustment can be accurately set using the 440-cycle tone broadcast on 2.5 and 5 mc from WWV. Since this setting occurs at nearly midscale, the accuracy of the setting is sufficient. In regions where the 10-mc and higher frequencies broadcast from WWV can be heard, either the 440-cycle or 4,000-cycle tones can be used for field standardization, using either a low- or high-pass filter to separate the desired tones.

The seconds pulse superimposed upon the tone signal causes the meter needle to deflect slightly, but this momentary movement should not prove troublesome. It can be filtered out if desired.

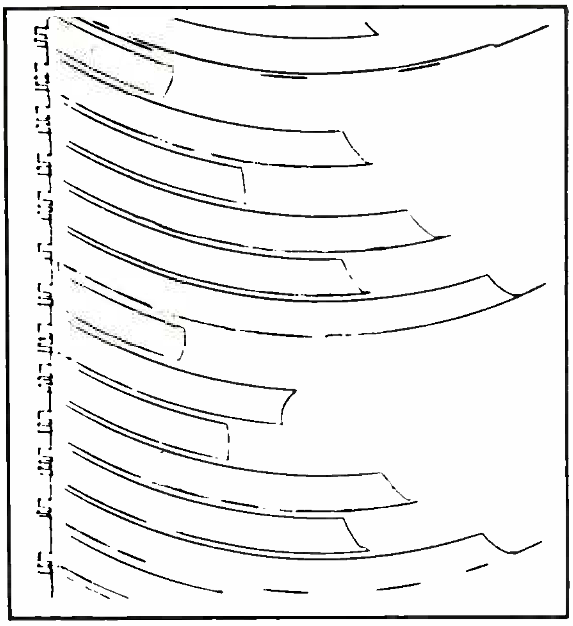
It will be noted from the circuit diagram that the meter is shunted by a section of the power switch and also one of the positions of the selector switch. Whenever power is turned off the bias on the final tube is almost instantaneously removed whereas the plate voltage bleeds down more slowly, causing the meter to deflect violently. The automatic shunt removes the effect. A somewhat similar effect when the instrument is turned on can likewise be avoided by shunting the meter through the selector switch.

Acknowledgments

The author is indebted to Martin Blumberg of Stanford University for the basic circuit and to F. H. Rockett, Jr. and other friends for suggestions in adapting it to the desired form, and for assistance in the initial calibration.—A. A. McK.



Loudspeaker monitor with noise generator and two receivers underneath in rack at left; control equipment and recorder in center rack; receivers at right



Representative record of two complete cycles of noise on six sequential frequencies

Atmospheric Noise

Observations of atmospheric noise down to 0.3 microvolt per meter between 75 kilocycles and 30 megacycles require receivers with special preamplifiers. Antennas are integrally mounted with the remote preamplifiers and connected by coaxial cables to recording equipment. Design data are given for a noise signal generator

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BECAUSE of the scarcity of long-term information on radio propagation and atmospheric noise in Canada, there has been, within the last few years, an accelerated program of research in this field.

The equipment to be described is used for the continuous measurement of noise levels as low as 0.3 microvolt per meter over the frequency range from 75 kilocycles to 30 megacycles. It comprises six modified communication receivers, a control chassis for channel selection and all major switching operations, attenuators, a graphic recorder, and a noise-signal generator. The antennas shown at the left in the photograph are mounted on the boxes that house the wide-band amplifiers, and are remotely located, being connected to the measuring equipment through coaxial cables.

The apparatus illustrated is outlined in the block diagram of Fig. 1.

Preamplifier Design

Because no suitable antenna could be obtained having a flat characteristic over the required frequency range, the frequency spectrum was divided into three ranges, each covering about 10 megacycles. By making the lengths of the antennas 15, 22, and 30 feet respectively, it was possible to keep the sensitivity of each individual antenna reasonably constant over its frequency range without resonance at any frequency. Variations in gain are known and taken into account when making final calculations for the noise strength.

The main problem in the design of a suitable amplifier lies in the fact that the noise figure for such a system must be kept at a minimum and the total equivalent noise from all sources including the receiver shall not exceed 0.3 microvolt. Experience has shown that the noise

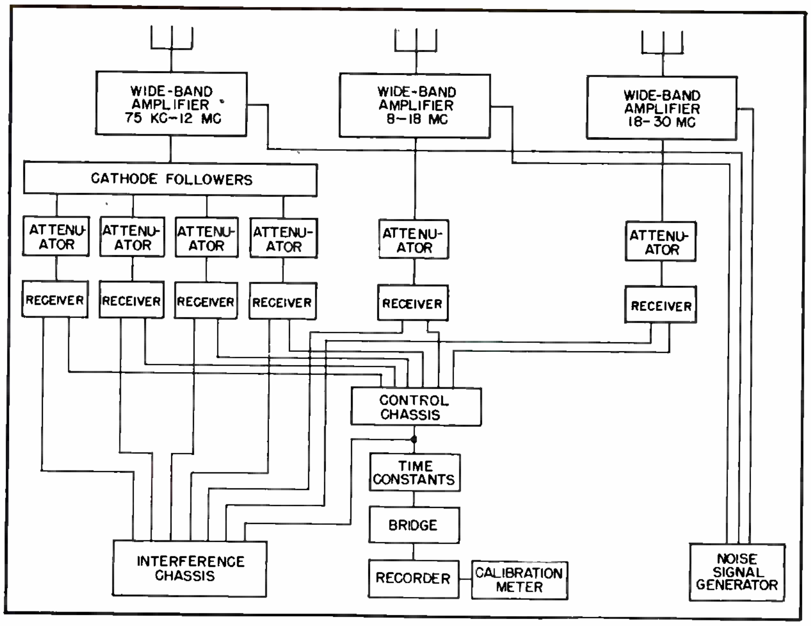


FIG. 1—Block diagram of the atmospheric noise-recording setup. Receivers are automatically switched

Measurement

level encountered in the Canadian North is very low, especially in the region of the frequencies above 15 mc.

The expression for the noise figure of a combination of two units in cascade is given by

$$N_{AR} = N_A + (N_R - 1)/G_A \quad (1)$$

when N_{AR} is the noise figure of amplifier and receiver in cascade, and G_A is the amplifier gain. It follows that the gain of the amplifier should be high. The first amplifier stage is the major noise contributing factor and should have good stability and low noise level.

Sources of Noise

The principal noise sources of the first stage are shot-effect noise, developed in the plate of the tube, and thermal agitation noise, which results from the equivalent input noise resistance of the tube and circuit. Thermal agitation noise becomes negligible if the equivalent noise resistance is not higher than 400 ohms. Numbers of different tubes were subjected to tests to determine their equivalent noise resistance and suitability for use in the first preamplifier stage. The noise resistance of a pentode showed approximately 700 to 1,500 ohms and, therefore, such a tube could not be used for this purpose. A 6AC7 connected as a triode showed a noise resistance of only 200 ohms, making this tube suitable for the first stage of the amplifier. The 6AK5 is a similar type of tube and may be used if connected as a triode. Although the triode has the advantage of a low noise level, the Miller effect presents a problem in the design. The grid-to-plate capacitance is increased by a factor of $(G + 1)$, G being the voltage gain of the stage. Using a 6AC7 as a triode with an input capacitance of 11 μμf and a gain of 7, this capacitance becomes about 70 μμf because of the Miller effect. By making the gain of the first stage unity, the capacitance increases only to twice its value through the Miller effect, and any variations in the input capacitance are small when performing such operations as changing tubes. Having thus selected the design, in Fig. 2, of the first stage, the following circuit is a grounded-grid amplifier, employing another 6AC7 as a triode. This tube provides full amplification. The complete arrangement represented by triodes V_1 and V_2, is termed the Wallman circuit[1].

The noise level of such an amplifier can be calculated and from the obtained results it may be seen that the thermal noise is of very small magnitude as long as the input resistance is kept low.

The equivalent thermal agitation noise current can be computed from the following equation:

$$\overline{I^2} = 4\,KTG\,df \quad (2)$$

and the equivalent shot-noise current from equation

$$\overline{I^2} = 4\,KTRS_m^2\,df \quad (3)$$

where $\overline{I^2}$ = mean-square current
K = Boltzmann's constant
T = absolute temperature (usually assumed 20 C)
G = total conductance at tube input
df = bandwidth in cycles
R = equivalent shot-noise resistance
S_m = tube mutual conductance

Assuming the bandwidth to be 10 kc we obtain from Eq. 2

$$\overline{I^2} = 1.62 \times 10^{16} G$$

and if the input resistance, $R_i = 1/G$ we obtain a thermal agitation noise of $I = 0.0127\ (R_i)^{\frac{1}{2}}$ microamperes. For the equivalent mean-square shot noise we get

$$\overline{I^2} = 1.62 \times 10^{16} RS_m$$

Assume the equivalent shot-noise resistance R is 200 ohms and S_m is 12×10^3 micromhos. Substituting these values in Eq. 3 the noise current of the first tube is then

I = 0.280 microampere
or V = 0.179 microvolt

The plate load impedance is equal to $1/S_m$ or 83 ohms.

To obtain the required bandwidth and amplification, the Wallman circuit is followed by a wide-band amplifier. To achieve a bandwidth of about 10 mc with a frequency response of ± 0.5 db over the entire range, a degenerative amplifier employing voltage feedback and staggered tuning was designed. The output was taken from a cathode follower, V_7, to match the 73-ohm impedance of the succeeding attenuators. The network consisting of R_3, R_4, and R_5 serves the purpose of providing proper match to the noise signal generator which is fed into the preamplifier at that point. The complete amplifier is housed in a watertight case with a strip-heater included to prevent condensation when operating the equipment at low temperature.

Receivers

Because the amount of noise passing through the receivers will depend on the effective noise bandwidth of the circuits, the six sets were carefully aligned to eliminate any possibility of variation in this bandwidth. For this purpose the selectivity control and avc control were fixed and the bfo was cut out entirely. The effective noise bandwidth B of the i-f amplifier of each set was then calculated from the equation

$$B = \int_0^\infty |G/G_o|^2 \, df \quad (4)$$

where G is the gain at frequency f and G_o the gain at resonant frequency.

The input resistance of a type AR88LF receiver, while nominally 200 ohms, actually varies widely around this value. On a typical set, values as low as 60 ohms at 4.4 mc and as high as 350 ohms at 30 mc have been measured with an impedance bridge. Therefore it is necessary to introduce a resistance network at the input to reduce these variations. The resistance seen by the input cable in this case varies only from 71.5 to 78.0 ohms. Although this arrangement involves a considerable loss of signal strength at all frequencies, the overall gain available is ample to take care of it. The noise output of the receiver is taken from the second detector stage as a rectified d-c voltage.

The major components of the control chassis are the sequence timing motor and selector switches that allow the six sets to be sampled in any required sequence. Each receiver is sampled for a period of 25 seconds, one complete sequence being completed in 3 minutes. A conventional R-C time constant provides a 60-second time delay for measuring average noise level. The time constant can be switched off for recording noise peaks. The recording meter is connected to the output of the time constant network by way of a balanced bridge circuit. The diagram in Fig. 3 shows this circuit which can be adjusted by varying the screen voltages on the tubes with the control R_6.

Recording the Noise

A sample of the recording chart illustrated shows two complete cycles of recorded noise levels, using six different frequencies. The markings on the left side of the chart indicate the amount of attenuation for each receiver used. In this case each little square wave indicates an attenuation of 20 decibels. Two sidepens, one for each margin, are available and can be used to record such information

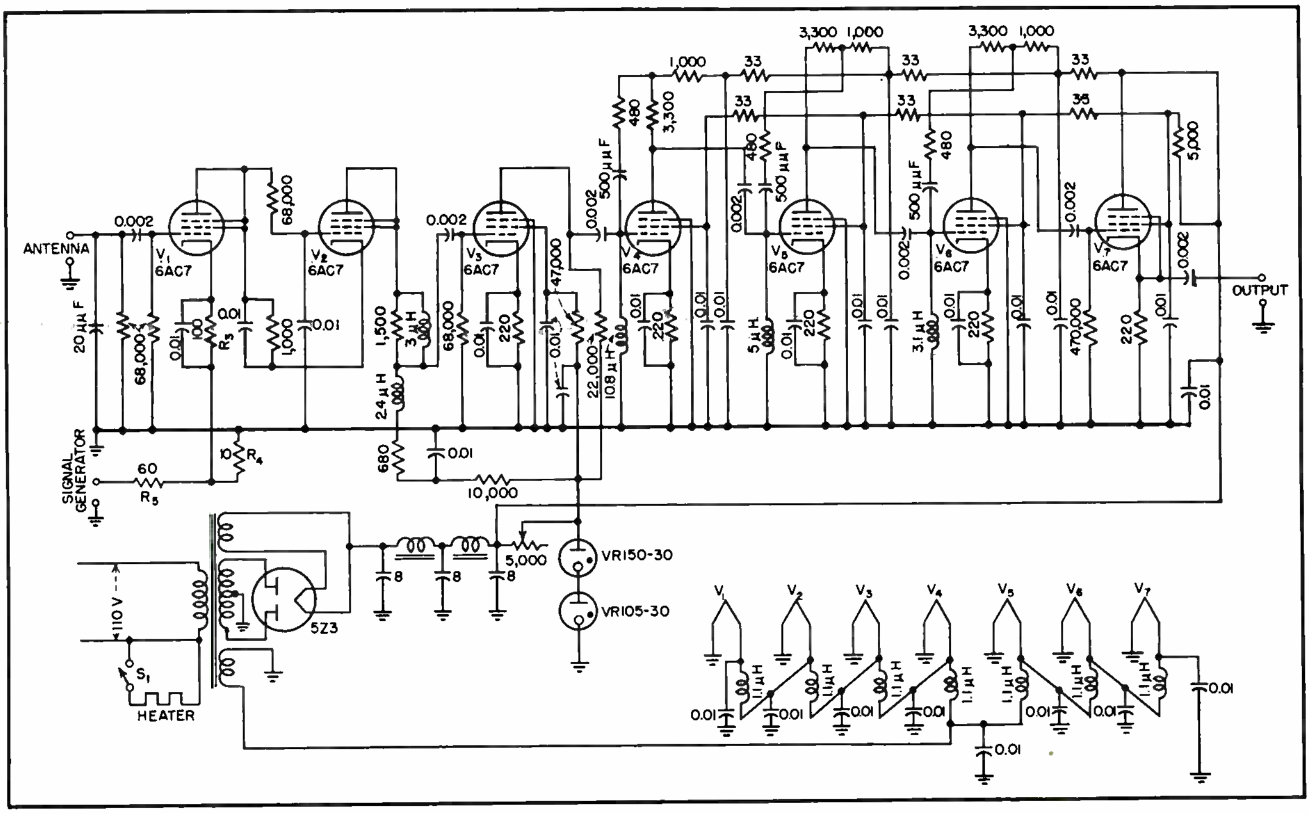


FIG. 2—Circuit diagram of the wide-band amplifier located at the antenna

as attenuation, time, or recording sequence.

The noise signal generator serves to calibrate the equipment and to compare the unknown incoming atmospheric noise with a known, calibrated noise signal. A temperature limited noise diode with an amplifier and monitor forms the basis of the generator. The noise diode is a tube specially constructed for this application. It has a pure tungsten filament with high current capacity. The load impedance of the noise diode consists of a 3,300-ohm resistance in parallel with 40 μμf capacitance, as shown in Fig. 4.

Noise Generator Connection

At frequencies from 2 to 30 mc, this network is connected in series with the tuned circuit at the grid of the first r-f stage. The tuned circuit is shorted out for the lower frequencies. Thus at low frequencies, the effective input grid impedance is near 3,300 ohms; at higher frequencies, the resonant impedance of the tuned circuit becomes the dominating factor. This circuit was chosen to achieve reasonable constancy of noise output over the entire frequency spectrum.

Plate Choke

The plate supply lead to the noise diode is effectively choked over the entire range by a network consisting of two resistors, a special choke and a bypass capacitor. The noise diode is followed by two r-f sections and the output is taken from a cathode follower stage to the preamplifiers.

The i-f section of a receiver is used for monitoring purposes. Its gain has been made invariable by introducing cathode biasing. The conversion gain of the mixer stage in front of the i-f amplifier remains satisfactorily constant over the frequency range. One meter indicates the noise diode current, and another shows the noise output of the generator.

The calibration will depend on the accuracy and stability of the equipment. If M microvolts of a sinusoidal signal are required at the input of the monitor mixer for full scale output and the noise bandwidth of the monitor is B_o cycles per second, then $M/(B_o)^{\frac{1}{2}}$ is the monitored noise voltage in rms microvolts per cycle bandwidth. The atmospheric noise signals are usually expressed in terms of microvolts per meter for a noise bandwidth of B_n. Therefore the atmospheric noise signal that gives the same recorded reading as a signal from the generator is in rms microvolts

$$(B_n)^{1/2} \times \left(M/(B_o)^{1/2} \right) = \text{Noise in rms microvolts per } B_n \text{ cycles bandwidth} \quad (5)$$

Conversion of microvolts to microvolts per meter can be made via the formula relating the two units. For a given antenna length h and given wavelength λ we obtain

$$\text{Microvolts} = \frac{h}{2} \, \frac{\tan \frac{\pi h}{\lambda}}{\frac{\pi h}{\lambda}} \text{ microvolts per meter} \quad (6)$$

A number of other factors have to be taken into account when calibrating the equipment but a detailed description of the entire calibration procedure would be beyond the scope of this paper.

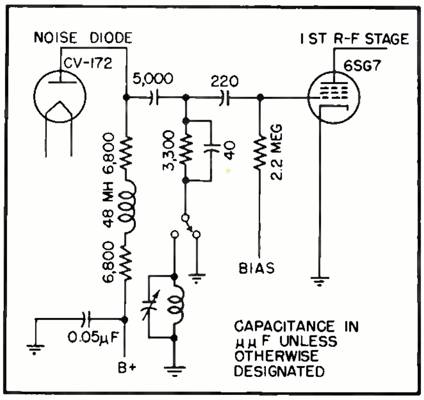


FIG. 4—Noise-initiating circuit for calibrating generator

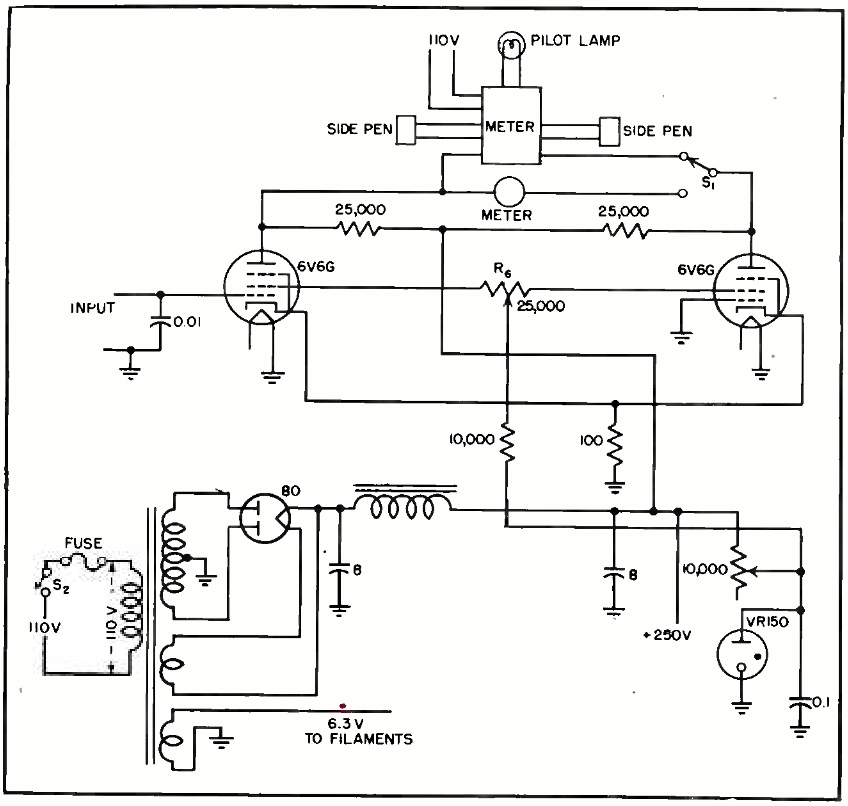


FIG. 3—Recording bridge circuit, balanced by adjustment of R_6

Acknowledgement

The writer wishes to express his thanks to R. A. Chipman of McGill University for his contribution and suggestions.

Reference

(1) H. A. Thomas and H. V. Cottony, Report CRPL-5-1, Central Radio Propagation Laboratory, National Bureau of Standards, Washington, D. C.

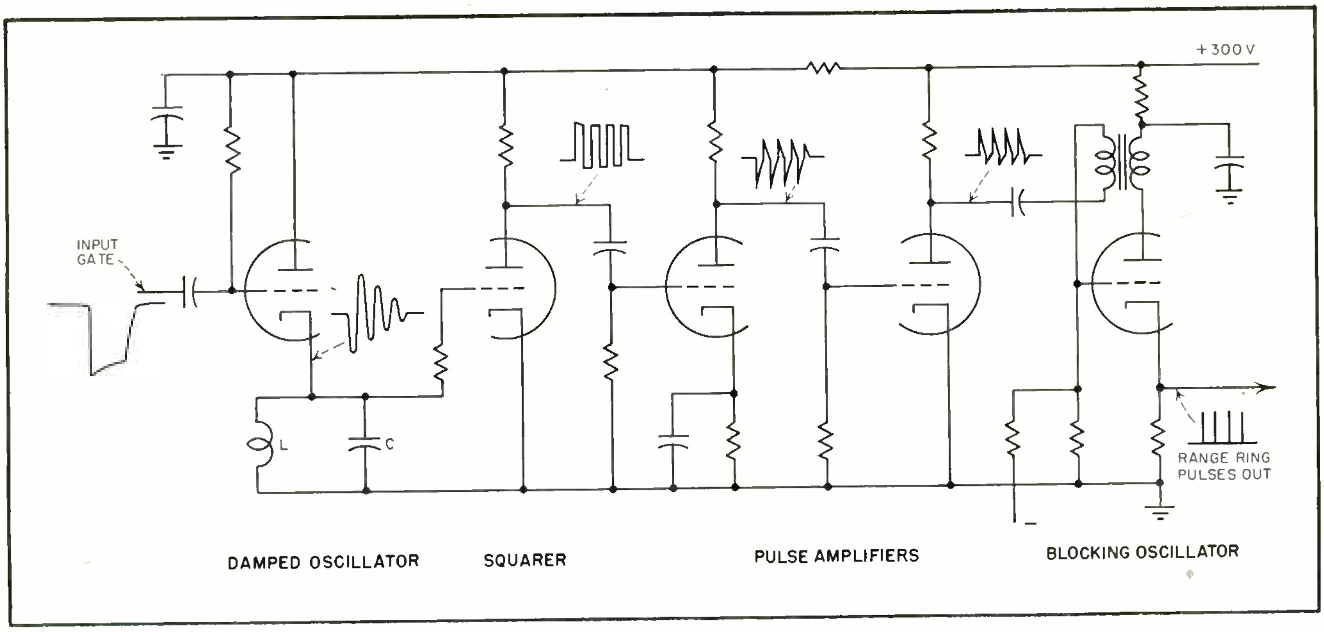


FIG. 1—Typical radar range ring pulse generator and voltage waveforms produced at the various stages

Radar Range Calibrator

By ROBERT L. ROD

Engineering Department
Radiomarine Corp. of America
New York, N. Y.

RADAR EQUIPMENTS utilizing the plan position indicator (ppi) type of visual presentation have superimposed upon the polar diagram a series of concentric circles or range rings which enable range estimations to be made to particular targets of interest. Depending upon the range scale in use, these rings are generally spaced 0.5, 1.0, 5.0, or 10 statute or nautical miles apart. Those objects which appear on the ppi between range rings may be fixed in range by interpolation. In order to insure the maximum in accuracy, the indicated distance to any ring as measured from the center of the cathode-ray tube, or zero range, is maintained well within one percent of the true range.

Range ring pulses, which intensity-modulate the ppi tube to form the rings, are generally formed by squaring the output of a shock-excited ringing oscillator by means of several amplifiers and differentiation of the resultant square wave. By correct choice of parallel resonant oscillator circuit components, the period of sine-wave output is made equal to the desired time interval between successive range rings. In production testing of radars it is necessary to utilize a simple and rapid system for precisely tuning the resonant circuit to the correct frequency.

Applications

The test instrument to be described permits range ring pulses generated in the radar to be compared with spaced pulses generated by a highly accurate calibrator. Thus, when the radar range ring pulses are in exact time coincidence with those obtained from the calibrator, the slug-tuned inductance in the radar range ring generator that determines the resonant frequency of the ringing is precisely adjusted. A standard triggered-sweep oscilloscope is used for making the necessary visual comparison checks.

The range calibrator may be conveniently used with any radar system that can be locked in synchronism with some submultiple of the test instrument's nautical or statute mile fundamental frequency of either 80.86 or 93.12 kilocycles. Radars utilizing free-running multivibrators or blocking oscillators to establish their pulse recurrence frequencies (prf) may be locked in step with the calibrator without altering repetition rates by more than a few hundred cycles during the calibration period. When both the radar and the calibrator are locked in synchronism, it is possible to align fixed and variable range rings as well as to measure the time duration of various waveforms throughout the radar. By modulating the Z-axis of a triggered oscilloscope with the calibrator pulses, a waveform under observation will be intensity-modulated by a series

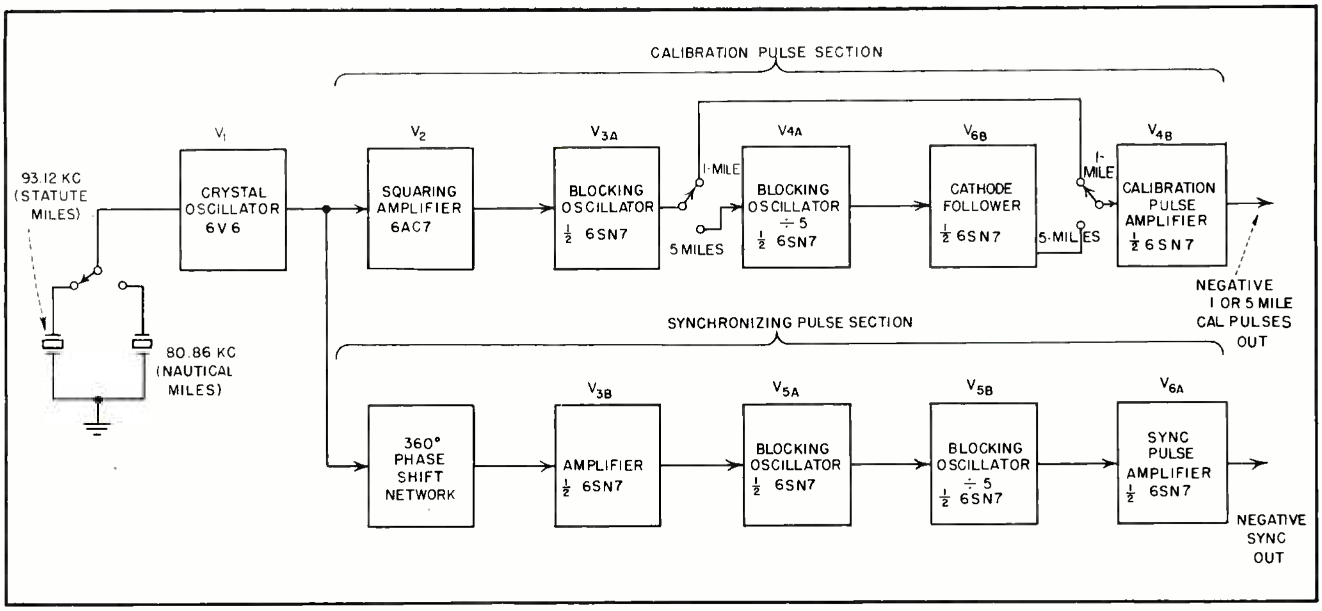


FIG. 2—Block diagram of the precision radar range calibrator

Design of an instrument for calibrating in production the concentric rings of a ppi indicator used for estimating distance. Range ring pulses generated in the radar are compared on a triggered oscilloscope with spaced pulses from a crystal-controlled calibrator

of dots spaced one or five miles apart, selected at will. Time intervals can then be accurately measured with a minimum of difficulty.

Systems used to generate range ring pulses are described in the literature. However, it is well to review one common type briefly. In Fig. 1, a typical circuit is shown wherein a pulsed ringing oscillator produces a damped sine wave. The period of the sine wave is made equal to the desired time interval between the range ring pulses which are developed by the following squaring, differentiating and blocking oscillator circuits. By the use of a reasonably high-Q resonant circuit in the cathode of the ringing oscillator, it is possible to produce five or more usable cycles having, for example, a period of five nautical miles, or 62.4 microseconds, between successive cycles. By center-tapping the inductance and adding a feedback triode, the oscillator can be made to have constant amplitude output for each cycle during the ringing time.[1] Sufficient amplification following the damped ringing oscillator will produce a practically perfect square wave.

Range ring oscillators of this type oscillate only during the application of a large negative square wave to the grid of a normally conducting tube. The abrupt cutoff of plate current flowing through the triode and the associated cathode inductance at the onset of the negative gate causes the parallel resonant LC circuit to oscillate. Since the onset of the gate pulse to the ringing oscillator stage is made to coincide with the pulsing instant of the radar transmitter, the time interval elapsing while the radio-frequency pulse travels out to a target and thence back as an echo can be compared on the ppi with the interval between successive range rings.

Accuracy

Neglecting such factors as the linearity of the ppi sweep, accuracy of the range rings is dependent upon the following factors:

(A) The resonant frequency of the ringing oscillator.

(B) The degree of amplification following the pulsed oscillator.

(C) The leading edge fall time of the negative gate used to ring the oscillator.

(D) The preciseness of all timing sequences throughout the radar system, generally known as system time delay.

It is the purpose of this paper to deal with an extremely accurate method for adjusting the resonant frequency, A, of the ringing oscillator. Factors B, C, and D may be accounted for by careful design so the end result will be the production of pulses coinciding with both the radio-frequency transmitted pulse and the start of the ringing, and the following 2π, 4π, 6π, and so on, points of the sine wave.

Inasmuch as the ringing oscillator is pulsed but part of the time, a direct comparison between the damped sine-wave frequency and a known frequency standard is cumbersome unless some provision is made for phasing and synchronizing the two waveforms. It is also impractical and inaccurate to preset the slug-tuned inductance against its particular capacitor outside the chassis by methods normally used for adjusting resonant circuits.

A practical device for calibrating range ring pulses is the instrument shown in Fig. 2 as a block diagram. Functionally, the range calibrator delivers a continuous series of sharp negative calibration pulses spaced either one or five miles apart, and a simultaneous series of negative synchronizing pulses occurring at a repetition rate one-fifth the frequency of the precision crystal oscillator. The synchronizing pulses are used in one application to lock a free-running radar master multivibrator into step with the sequence of operations occurring in the calibrator. Thus, the calibration pulses may be compared directly with those generated by the radar range ring generator.

Circuit Details

The complete circuit is given in Fig. 3. A 6V6 tetrode crystal oscillator, V_1, is used in the calibrator as the range ring frequency standard. The fundamental frequency is 80.86 kilocycles for nautical and 93.12 kilocycles for statute miles. (81.84 kilocycles corresponds to 2,000 yards.)

Following the crystal oscillator is a 6AC7 squaring amplifier, V_2, and a free-running blocking oscillator, V_{3A}, locked, one for one, to the fundamental crystal frequency. Output of this blocking oscillator is fed out of the unit through a single amplifier, V_{4B}, as negative calibration pulses spaced one mile apart. Alternately, pulses spaced five miles apart can be obtained by interposing a counting-down blocking oscillator, V_{4A}, and an isolation cathode follower, V_{6B}, between the one mile pulse generator, V_{3A}, and the output amplifier, V_{4B}. The additional blocking oscillator counts down by a factor of five to deliver 5-mile calibration pulses.

As shown in Fig. 3, part of the crystal oscillator output is also applied to a 360-degree phase shift network composed of a phase-shifting transformer and a precision variable phase-shift capacitor. By the use of this network, a voltage is developed at the grid of V_{3B} which may differ in phase with the output of the oscillator anywhere from zero to 360 degrees, depending upon the position of the rotor. To secure linear phase shift against rotor rotation, with little if any change in amplitude, the circuit must be carefully balanced. The 90-degree phase shift elements must be chosen[2] so that at the fundamental frequency, the resistance, R, equals the capacitive reactance of capacitor C.

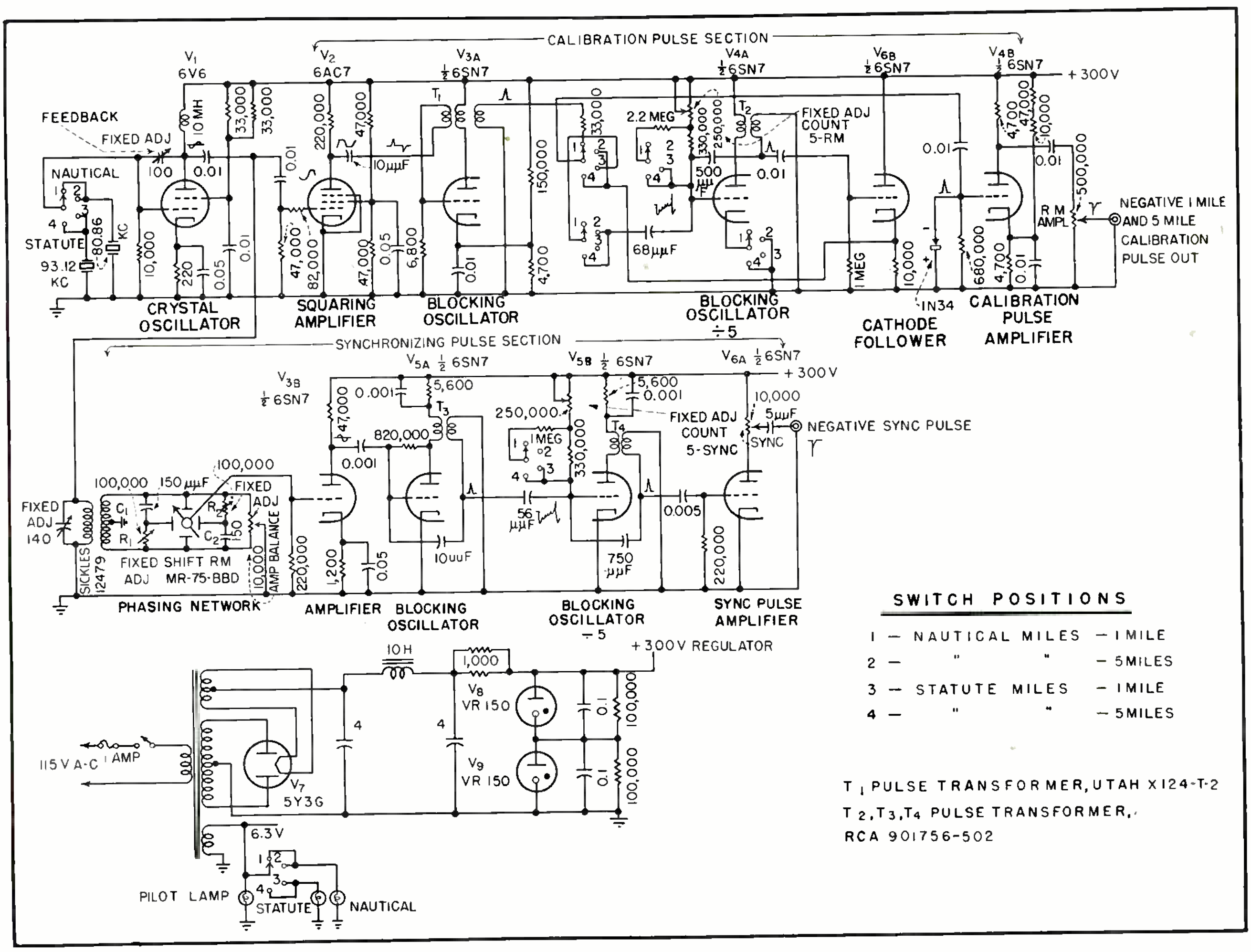
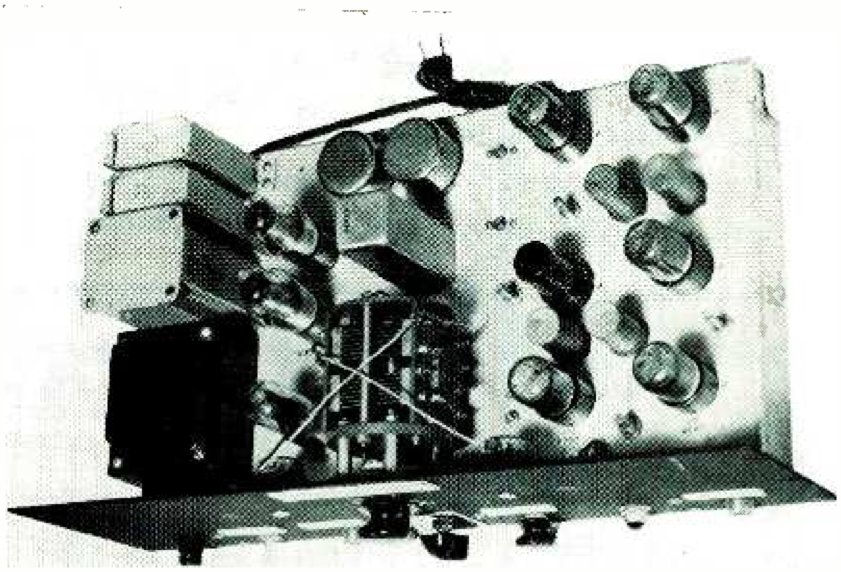


FIG. 3—Complete circuit of the instrument. All switches are ganged. The phasing network contains a butterfly-type capacitor



Production instrument for calibrating range ring pulses

The phase-shifted sine-wave at V_{3B} is amplified, as before, to synchronize the free-running blocking oscillator, V_{6A}, one for one to the fundamental frequency. Output pulses from V_{6A} are divided in repetition frequency by five in the following blocking oscillator, V_{6B}, to produce radar synchronizing pulses occurring at a frequency of 18.62 or 16.17 kilocycles, respectively, for the statute and nautical mile cases. Tube V_{6A} amplifies and inverts the synchronizing pulses, the control sync determining pulse amplitude delivered to the radar.

A great advantage in placing the phase shift network in the synchronizing pulse generator section, as compared to the original approach which located the shifter in the calibrating pulse section, is the elimination of errors created by phasing network distortion. Since it is imperative that the sine wave fed to the calibration pulse section be kept absolutely free from distortion for precise results, the location of the phase shift device to the noncritical synchronizing pulse circuit, in the final design, helped to improve the linear relationship between phase shift and the physical position of the rotor.

Radar Calibration Procedure

The phase shifted synchronizing pulses are fed out of the calibrator at intervals of 72.0 microseconds, when using the nautical mile crystal. The free-running multivibrator in the Radiomarine CR-101 Radar, for example, operates at a prf of approximately 3,000 cycles per second on the shorter ranges of 1.5 and 5 miles, equivalent to a period of about 333 microseconds. By coupling the synchronizing pulses into the multivibrator at correct amplitude, the radar will lock in at a somewhat higher pulse recurrence frequency of about 3,470 cycles on every fourth sync pulse. This prf increase is of minor consequence, since higher recurrence frequency is maintained only during the calibration period.

Similarly, when the CR-101 is operated on its longer ranges of 15 and 50 miles, the prf of the radar system is quartered to 750 cycles, corresponding to a period of 1,333 microseconds. Every 18th sync pulse then locks the unit in step, a change of about 115 cycles in the pulse recurrence frequency.

The procedure used to adjust the radar range rings is relatively simple. Negative synchronizing pulses from the calibrator are applied to the radar master multivibrator. Meanwhile, positive radar range ring pulses are fed to the upper vertical deflection plate of a triggered-sweep oscilloscope. Negative calibration pulses are then applied to the lower vertical deflection plate. After the radar has been locked to the calibrator by adjusting the synchronizing pulse amplitude, both sets of marker pulses will be visible on the oscilloscope, inverted in polarity.

Adjusting the phase-shifting capacitor appears to move the calibration pulses along the sweep. This is done until two pairs of successive pulses are coincident or close to coincidence above one another. The slug-tuned inductance in the ringing oscillator circuit is then adjusted so that the spacing between radar range ring pulses approaches that between the precision pips.

Slight adjustments must be made in phasing during this operation to insure that the reference markers remain coincident. At the exact alignment point, all the leading edges of all the various pulses will coincide. The synchroscope during this operation is triggered by the radar system so that its sweep and the radar trigger start simultaneously.

For estimating the duration of various pulse waveforms through the radar, the procedure is slightly altered. A waveform of interest is observed on a triggered-sweep oscilloscope intensity modulated in the Z-axis by the markers from the calibrator. At intervals of either one or five miles, the sweep will brighten up, forming a series of bright spots superimposed on the waveform. The phase-shift capacitor is rotated until any one spot coincides with the start time of the waveform. The time duration to any point of interest thereafter can be read in 1 or 5 mile steps. Interpolation between one-mile markers can be fairly accurately performed by noting the traverse of the phase-shift capacitor. Since every 360 degrees of rotation corresponds to one additional mile of spot movement, small angular displacements are practically proportional to equivalent fractions of a mile, providing that the phase-shift network is accurately aligned.

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Low-Distortion

One-hundred-percent modulation is obtained by combining out-of-phase carrier voltage with partially modulated signal in cancellation circuit. Uses exalted-carrier detector in overall feedback circuit. Regulated oscillator insures constant output amplitude

A LOW-DISTORTION amplitude-modulated signal source is essential for such jobs as adjusting a-m station monitors and testing high-quality broadcast receivers. With the signal generator described, audio distortions of better than 0.1 percent at 100 percent modulation are obtained by the use of several special circuits not commonly found in commercial testing equipment.

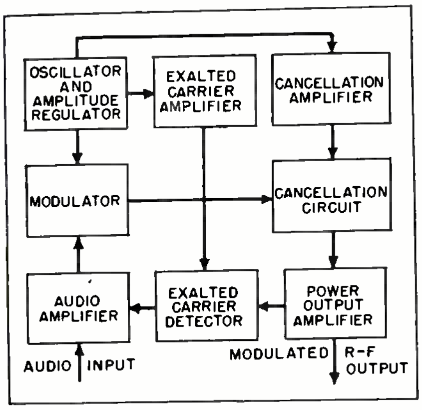


FIG. 1—Block diagram shows how high percent modulation is accomplished with low distortion

Referring to the block diagram in Fig. 1 and the circuit diagram in Fig. 2, it may be seen that the outputs of the a-f amplifier and r-f oscillator are combined in the modulator to produce an r-f signal which is about 75 percent modulated. One hundred percent modulation is effectively obtained by adding an out of phase component of the carrier signal through the cancellation amplifier. Negative feedback is employed in both the audio amplifier and modulator, and an exalted-carrier detector is used in an overall feedback circuit.

Circuit Details

The two-stage audio amplifier, whose function is to raise the level of the audio input signal to a value suitable for driving the modulator, employs about 25 db negative feedback from the plate of the second tube to the grid of the first. The amplifier distortion is less than 0.1 percent, and its gain is about 100 with 10 volts rms output.

The tunable broadcast-frequency oscillator which supplies the carrier component to the modulator and drives the exalted amplifier and the cancellation amplifier is a Hartley oscillator. Its output is regulated at 80 volts rms by the 6AG7 regulator circuit which eliminates the need for an amplitude control.

Modulator

A portion of the oscillator signal and the output of the audio amplifier are impressed on the control grid of the 829B modulator tube. The action is very similar to that of an ordinary grid-modulated amplifier.

The constants of the circuit were chosen to give a 75 percent modulated signal at the output of the modulator without the necessity of driving the grid positive. This eliminates the necessity of a low-impedance grid driving source and greatly reduces a source of modulation distortion.

The cathode circuit of the modulator is unique in that it provides a large amount of degeneration which effectively reduces the modulation distortion.

The cathode circuit not only furnishes a d-c bias voltage for the

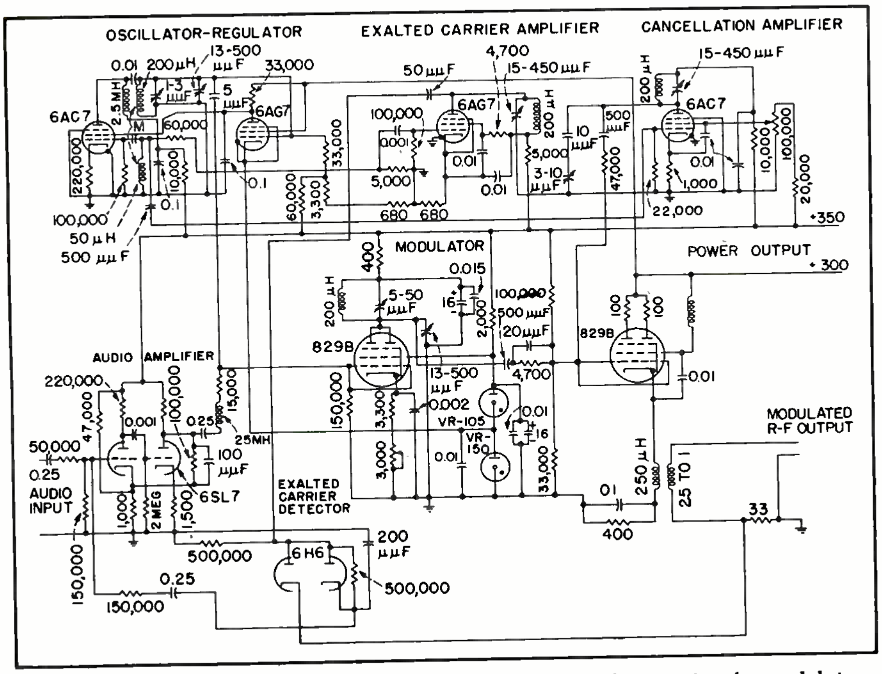


FIG. 2—Circuit diagram of signal generator. Value of cathode capacitor for modulator is determined by formula derived in text

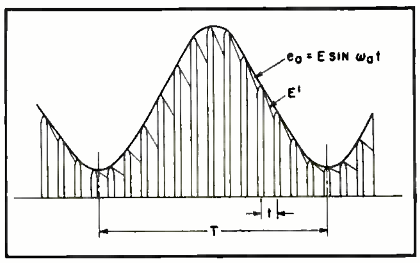
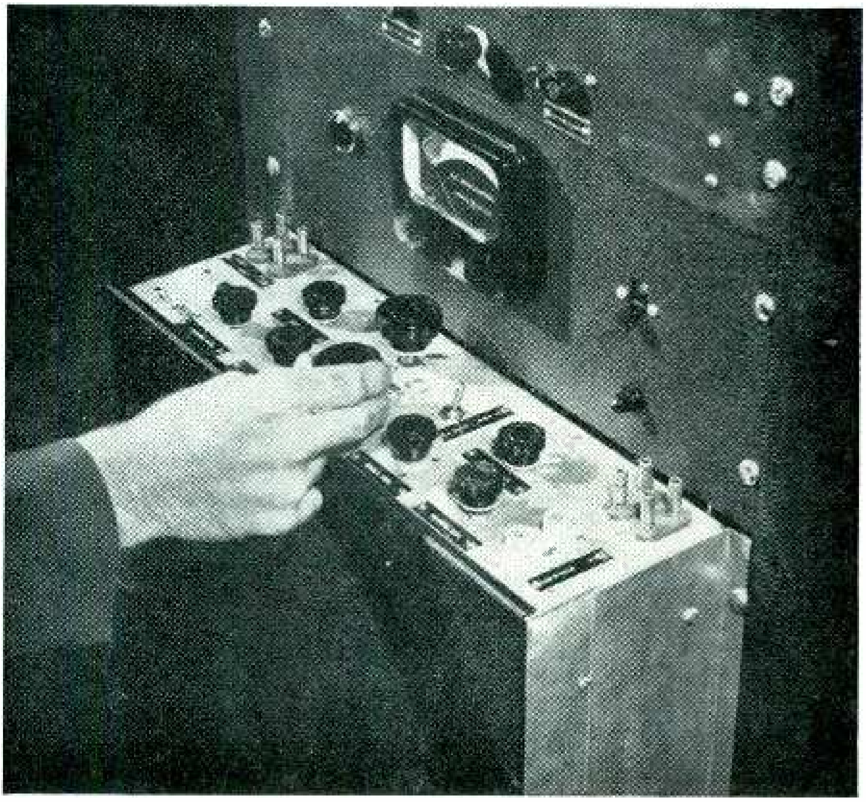


FIG. 3—Modulator cathode waveform showing the modulation envelope

A-M Signal Generator

By ERNEST S. SAMPSON
General Electric Company
Schenectady, New York



Rack-mounted version of low-distortion a-m signal generator

correct operation of the modulator but its action is much the same as that of an ordinary peak detector. The R-C time constant is long enough to maintain the peak r-f voltage between the r-f current pulses. It is important to make this time constant short enough to prevent audio negative peak clipping. Since a maximum of only 75 percent modulation is required from the modulator, the design of this circuit to prevent peak clipping is simple. Once the resistance R is determined by the value of d-c bias required for the modulator the following equation may be used to determine the capacitance C:

$$C = \frac{\sqrt{1 - K^2}}{R \omega K}$$

where K is the maximum percent modulation divided by 100, $\omega_a = 2\pi f_a$ and f_a is the highest audio modulation frequency in cps.

The above equation is derived in the following manner: From Fig. 3, let $e_a = E \sin \omega_a t$, where e_a is the modulation signal. Then the envelope of the peak r-f voltages applied across the R-C circuit will be represented by the equation

$$E' = \frac{E}{K} + E \sin\omega t$$

Differentiating the equation of the modulating signal to find its slope

$$\frac{de_a}{dt} = \omega E \cos\omega t$$

The slope of the voltage decay across the R-C circuit at the beginning of each decay period is $-E'/RC$. It is assumed that the voltage decay is linear for the short period between the r-f pulses. In order to prevent distortion due to negative peak clipping, it is necessary that the slope of the R-C circuit voltage decay always be equal to or slightly greater than the slope of the modulation envelope. Therefore,

$$-\frac{\frac{1}{K} + \sin\omega t}{RC} = \omega\cos\omega t$$

Since there is only one instant during the audio cycle that the above equation can be true, that time may be determined by differentiating with respect to t, then

$$RC = \frac{\cos\omega t}{\omega \sin\omega t}$$

Substituting this in the previous equation and solving for C, we obtain

$$\sin\omega t = -K$$

$$\cos\omega t = \sqrt{1 - K^2}$$

$$C = \frac{\sqrt{1 - K^2}}{KR\omega}$$

Cancellation Amplifier

The modulator output signal is added to the output signal of the cancellation amplifier in the cancellation circuit. The addition of these two signals results in a sum signal which has its modulation percentage increased to 100 percent from the 75 percent level at the modulator. The cancellation amplifier signal has a 180 degree phase relation with respect to the carrier of the modulator output signal.

This 180-degree phase relation is very accurately controlled by the tunable capacitor in the parallel resonant circuit which is the load impedance of the cancellation amplifier. To adjust accurately the phase of this amplifier, it is necessary to view the generator output waveform with an oscilloscope with slightly more audio applied to the generator input than is necessary for 100 percent modulation. This procedure will produce on the oscilloscope a picture which is similar to that of Fig. 4A. Perfect phase relationship reveals two sharp crossover points in the trough of the modulated signal as shown in Fig. 4B.

Since the voltage gain of the cancellation amplifier is not constant over the tunable frequency band, it is necessary to control the screen grid voltage of the amplifier for this purpose. Approximately the correct phase for proper cancellation is obtained at the amplifier output by driving its grid from the grid circuit of the oscillator. Good r-f waveshape is obtained not only by using the highly frequency selective tuned circuit in the plate circuit of the 6AC7 amplifier, but also by operating the amplifier class A with degeneration in the cathode circuit. Figure 4C shows a 100-percent modulated signal with perfect cancellation phase.

Power Output Amplifier

The power output amplifier is driven by the cancellation circuit and is a cathode follower. The 829B tube was chosen because of its high current-conducting capacity and its high transconductance. The grid input capacitance is greatly reduced by driving the screen grid at the same a-c potential as the cathode through the 0.01-μf screen to cathode capacitor. Expressed by an equation, the gain of a cathode follower amplifier is:

$$G = \frac{g_m r_k}{g_m r_k + 1}$$

where g_m is the transconductance of the tube and r_k is the equivalent cathode resistance. The grid input capacitance will be

$$C_i = C_o (1 - G)$$

where C_i is the new imput capacitance and C_o is the input capacitance with the cathode and screen at ground potential. The grid input capacitance to the 829B is reduced from 29 $\mu\mu$f to 3 $\mu\mu$f with the above mentioned arrangement.

The power output amplifier drives an air-core r-f transformer which is used to reduce the peak to peak amplifier current swing by a factor of 2.5 to 1. The air-core type of transformer was used because it made possible an impedance transformation without r-f waveform distortion which would result from an iron-core transformer. A tuned transformer could have been used but it would have meant an additional tuning control. The primary winding of the transformer is wound in a single layer on a cylindrical 1.5-inch diameter Bakelite coilform. The secondary winding is wound directly on top of the primary winding. The wire used for the secondary coil has a diameter 2.5 times that of the primary coil. This makes the coils equal in length which provides the maximum possible coefficient of coupling.

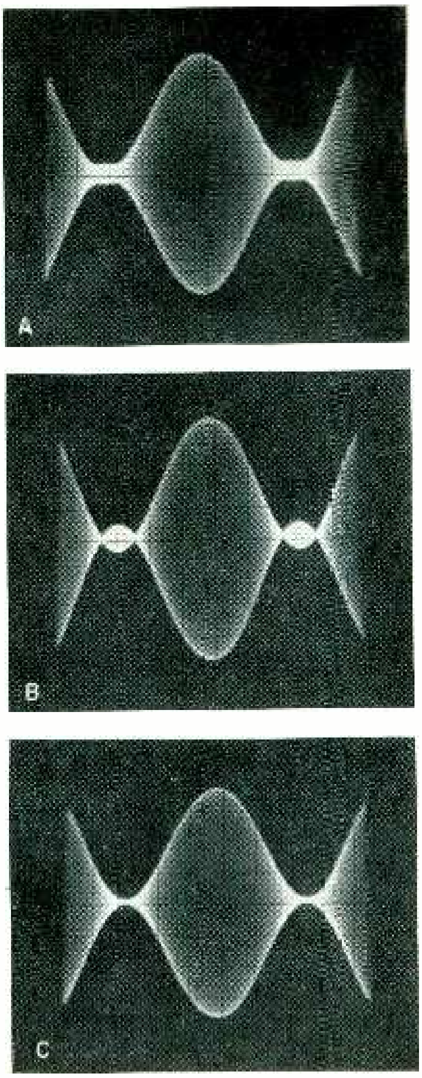


FIG. 4—Output waveform of a-m signal generator for (A) incorrect cancellation phase, (B) correct cancellation phase with overmodulation, and (C) correct cancellation phase and 100 percent modulation

Exaltation Circuit

The exaltation amplifier is driven from the grid of the oscillator tube in order to obtain the correct phase for its output which drives the exalted carrier detector. The correct phase for the detector is obtained by adjusting the variable tuning capacitor in the plate circuit of the exaltation amplifier.

The exalted carrier type of detector makes it possible to detect a 100 percent modulated r-f signal without introducing audio negative peak clipping. Negative peak clipping is eliminated by adding a large unmodulated r-f signal in phase with the modulated r-f signal at the detector. This effectively reduces the percent modulation. If the ratio of unmodulated to modulated signals is made large, the phase relation between the two signals does not have to be adjusted accurately. Improper phase relation introduces audio distortion but of small magnitude when a ratio of voltages of 30 to 1 is used in this generator detector. A 10-degree phase relation for the specified conditions will introduce 0.02 percent second harmonic component and zero third harmonic component for a 100 percent modulated signal.

The output of the modulation detector is applied to the input of the audio amplifier through an r-f filter circuit. The overall negative feedback is approximately 20 db and serves to reduce noise and distortion by that factor.

Operation and Performance

In aligning the signal generator to a particular frequency an oscilloscope must be used for viewing the modulated output. There are six controls that must be adjusted for alignment to a particular carrier frequency. The oscillator is adjusted to the desired r-f frequency. The modulator tuning control is adjusted to give maximum oscilloscope deflection, while the modulator bias control sets the desired output level. Cancellation tuning is set to give minimum r-f output level at the correct phase, and the cancellation gain is adjusted to give approximately 25 percent reduction in output level due to the cancellation amplifier. The exaltation tuning adjustment is set to give a minimum modulation while maintaining a fixed audio input level.

The r-f output level is variable between 6 and 8 volts rms across a termination of 60 to 100 ohms.

The writer acknowledges the important contributions of H. R. Summerhayes, Jr. of the General Electric Company in connection with the development of this signal generator.

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Receiver Gain Nomograph

Permits rapid determination of maximum required voltage gain when bandwidth and noise figure, required input to detector and antenna resistance are known

By PETER G. SULZER

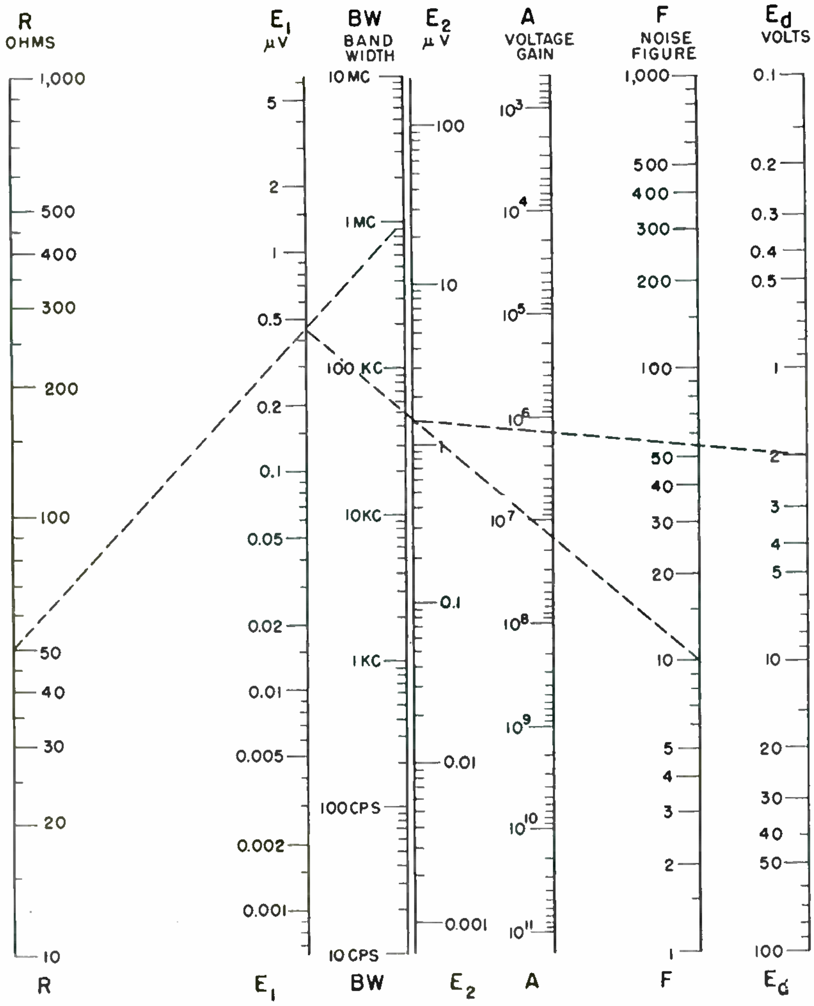
Department of Electrical Engineering
The Pennsylvania State College
State College, Pennsylvania

THE NOMOGRAPH permits rapid determination of the maximum required voltage gain of a radio receiver. Factors which enter into such a calculation are the resistive component of the antenna impedance, the bandwidth and noise figure of the receiver, and the required input to the detector.

The available power from the resistive component R of the antenna impedance is 4×10^{-21} watts per cycle of bandwidth at 290 Kelvin[1]. This permits calculation of the equivalent rms noise voltage E_1 at the receiver antenna terminals. The receiver, however, will have noise sources of its own, making the true equivalent input voltage greater than E_1. If E_1 is multiplied by $F^{0.5}$, where F is the noise figure of the receiver, the true equivalent input voltage E_2 is obtained. The maximum useful voltage gain of the receiver is that which will bring E_2 up to the level at which it is desired to operate the detector. Then, if the detector is to operate at a level E_d, the voltage gain A can be found by dividing E_d by E_2. These operations are carried out on the nomograph, as illustrated by the following example:

Suppose it is desired to design a radar receiver to work from a 50-ohm transmission line. The i-f bandwidth is to be 1 mc and the detector is to operate at a level of 2 volts so that signals weaker than noise will not be discriminated against by the curved detector characteristic. It is hoped to obtain a noise figure F of 10, and it is desired to find the required voltage gain with that assumed noise figure. Joining 50 ohms on the R scale with 1 mc on the BW scale by means of a straight-edge, it is found that $E_1 = 0.44$ microvolts. Connecting this point on the E_1 scale with 10 on the F scale, $E_2 = 1.4$ microvolts. Then, joining 1.4 microvolts on the E_2 scale with 2 volts on the E_d scale, A is found to be 1.4×10^6. Thus a voltage gain of more than 1,000,000 is required between the antenna terminals and the output of the last i-f stage.

It should be noted that the above calculations assume an impedance match at the antenna terminals. For best noise figure, a mismatch is usually desirable[1]. The resulting error in design can usually be absorbed by the necessarily large tolerance in gain which must be made to allow for variations in tubes and components.



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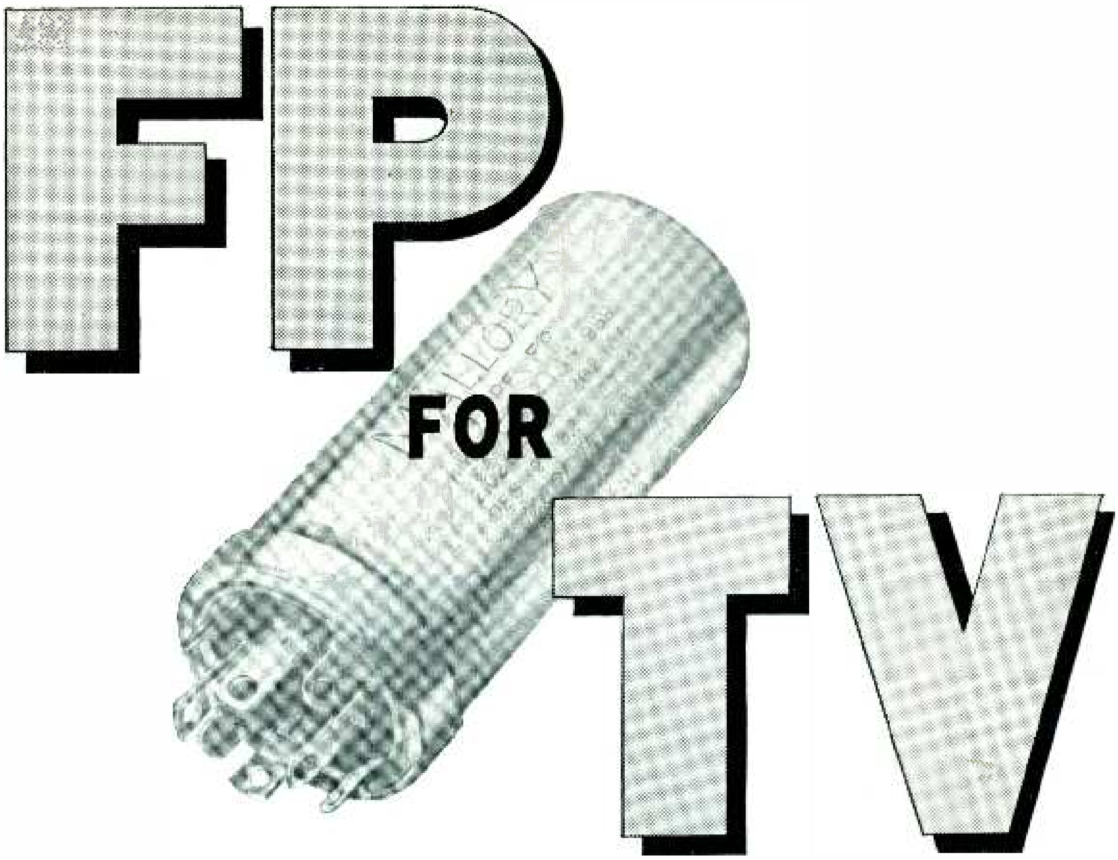

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Tubes Control Long Lines

ELECTRONIC telephone switching equipment in New York and Chicago long-distance centers of American Telephone and Telegraph Co. makes it possible for a long-distance operator to put through calls to distant telephones directly, without the aid of other operators en route. About a third of the long-distance calls originating in New York City are being routed through the new equipment.

The Bell System plans to extend this new method of operator toll dialing throughout the United States and Canada so that a single operator will be able to dial a number anywhere in the nation just about as easily as a subscriber now dials a local call in his own city.

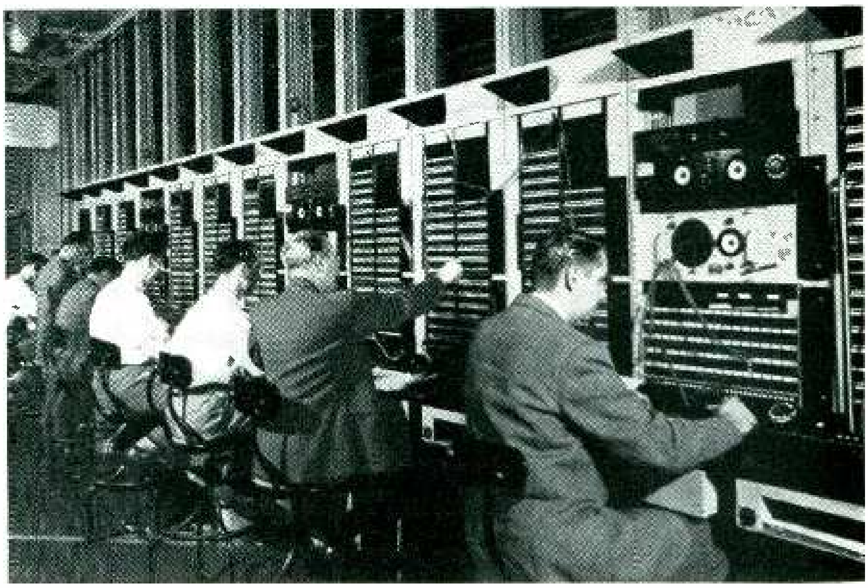
At present, operator toll dialing networks enable operators to dial calls straight through to the distant telephone in some 300 cities and approximately ten percent of long distance calls are handled by this means. This figure will be greatly increased during 1949, as new automatic switching centers are established.

The nationwide toll dialing system is based on the development of electronic devices which determine and arrange the routing of calls, taking over where the human hand and brain were once essential. The equipment can select possible routes between distant cities, direct switching operations at intermediate points along a route, and complete connections automatically in a matter of seconds.

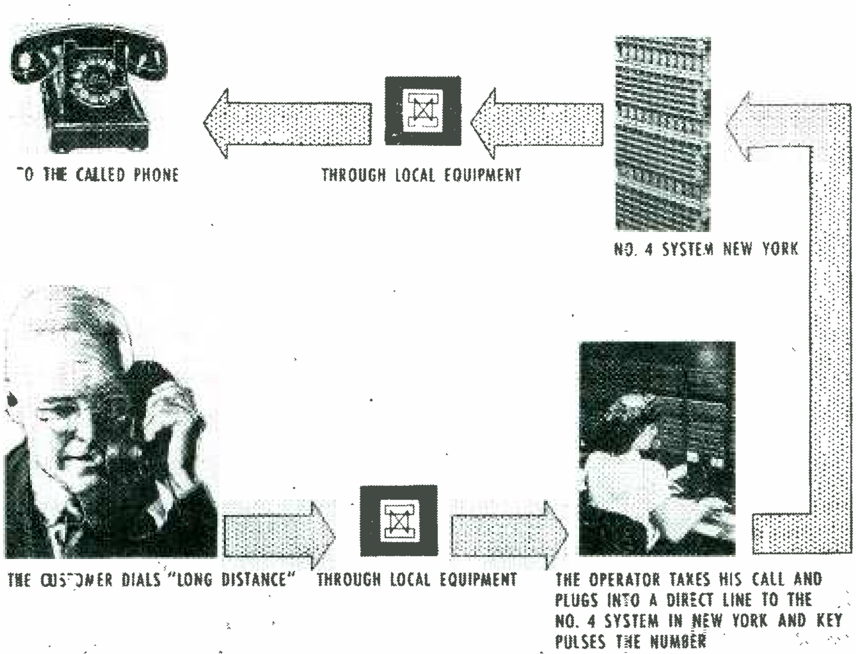
Long-distance calls now go through in about 2 minutes on the average. When the new system has become nationwide in scope and all the circuits now planned by the Bell System are in service, the average speed of all long-distance calls is expected to be about 1 minute.

The entire country is being divided into about 80 numbering plan areas and each of these will be designated by a distinctive three-digit code. Then each office within an area will be designated by a three-digit office code, one which does not conflict with the code of any office within the area nor with any other area code.

The operator will usually be able to complete any toll call by dialing a maximum of 10 digits—the six



Long-lines technicians monitor the workings of the new electronic equipment for dialing long-distance calls



Steps in the new system when a customer in Oshkosh makes a long-distance call to New York City

The 25B is a mighty good buy!

Here are some of the reasons why

General Advantages:

1. The Western Electric 25B Speech Input Console provides highest quality studio control for AM, FM and TV audio.

2. It is versatile ... handles two studios ... provides duplicate channel operation without interference.

3. It's easy to operate ... all controls are functionally located for convenience of operator in controlling programs.

4. It's a complete unit with its own table ... attractive, sturdy, well designed ... and *it's moderately priced.*

Technical Advantages:

1. It covers complete FM frequency range. Has high signal-to-noise ratio and exceptionally low distortion.

2. It is easy and economical to install ... plug-in cables carry all external leads to wall boxes (included with 25B)

3. It's fully accessible ... opens up to expose all components.

4. It includes 7-position mixer; line and microphone transfer keys; dual line amplifiers and volume indicators; separate built-in tube check meter; regulated power supply.

For immediate delivery of one or more 25B Speech Input Consoles, call your nearest Graybar Broadcast Representative—or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

Western Electric

—QUALITY COUNTS—

Distributed by GraybaR — Offices in 100 principal cities

DISTRIBUTORS: IN THE U. S. A. —Graybar Electric Company. IN CANADA AND NEWFOUNDLAND —Northern Electric Company, Ltd.

THE FRONT COVER

MOISTURE content of cloth emerging from a textile dryer is indicated directly and continuously by the Fielden Drimeter pictured on the front cover of this issue. Accuracy is within ±1 percent irrespective of the speed at which the cloth moves between the sensing electrodes, and readings are not affected by salts, dyes, size or other finishing materials used on the cloth. The instrument was developed in England, and is now being introduced here by Fielden Electronics, Inc., Huntington, Long Island, N. Y.

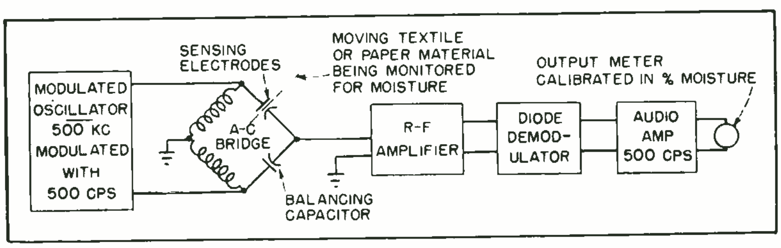
Changeover from sense of touch to electronic moisture measurement has boosted output an average of 25 percent on slashers or driers through elimination of overdrying. In addition, drying only to normal moisture content saves fuel and power, lowers operating costs and improves quality of fabrics. Over 800 installations of the instrument have been made in textile mills throughout the world. In one instance, machine output was increased enough to pay for the entire installation in one month.

Operation depends on detection of minute changes in the capacitance of a two-plate condenser through which the cloth passes. Capacitance charges as small as 0.001 $\mu\mu$f are readily detected. The greater the amount of moisture in the fabric, the greater is the capacitance because the specific capacitance of water is high in relation to that of cellulose and animal fibers. Voltage between the electrodes is less than 0.1 volt hence there is no shock hazard.

Electronic circuitry employed is indicated in the block diagram below. The instrument employs a special drift-free bridge circuit and amplifier having sufficient stability to permit furnishing the meter with standard precalibrated percentage-moisture scales. Scales now in production are 0–20 percent for cotton, 0–40 percent for wool, 0–20 percent for viscose., 0–20 percent for jute, and 0–20 percent for linen. A duplicate meter can be provided for remote indication.

Adjustment for operation merely involves running the machine dead-slow for a few minutes (or using a dry sample between electrodes) so that out-turn is definitely dry, and adjusting a knob on the instrument panel until the indicator points to DRY on the scale. An accessory calibration unit permits resetting without use of dry samples, as is desirable during constant processing of short runs of various standard materials.

An accessory automatic control unit is also available for coupling the moisture meter to the speed-changing mechanism of the drying machine. Two variables are fed into the automatic control—a voltage varying with moisture content, derived from the Drimeter. and a voltage varying with drying machine speed, obtained from a small alternator belted to the machine. The control unit applies a speed correction proportional to deviation from desired moisture content. The higher the speed of the machine, the more frequent are corrections in speed. If the machine stops or if the yarn or fabric runs out, the control becomes inactive. Integration of sensing element output over a period of 2 to 3 seconds makes the control insensitive to wet patches such as are produced by damp seams. Atmospheric humidity has no effect on accuracy, because 100-percent humidity is small compared to ½-percent moisture in fabric.



Ten keys on each of these switchboards in New York City permit the operator to ring telephones in many cities without the aid of other operators

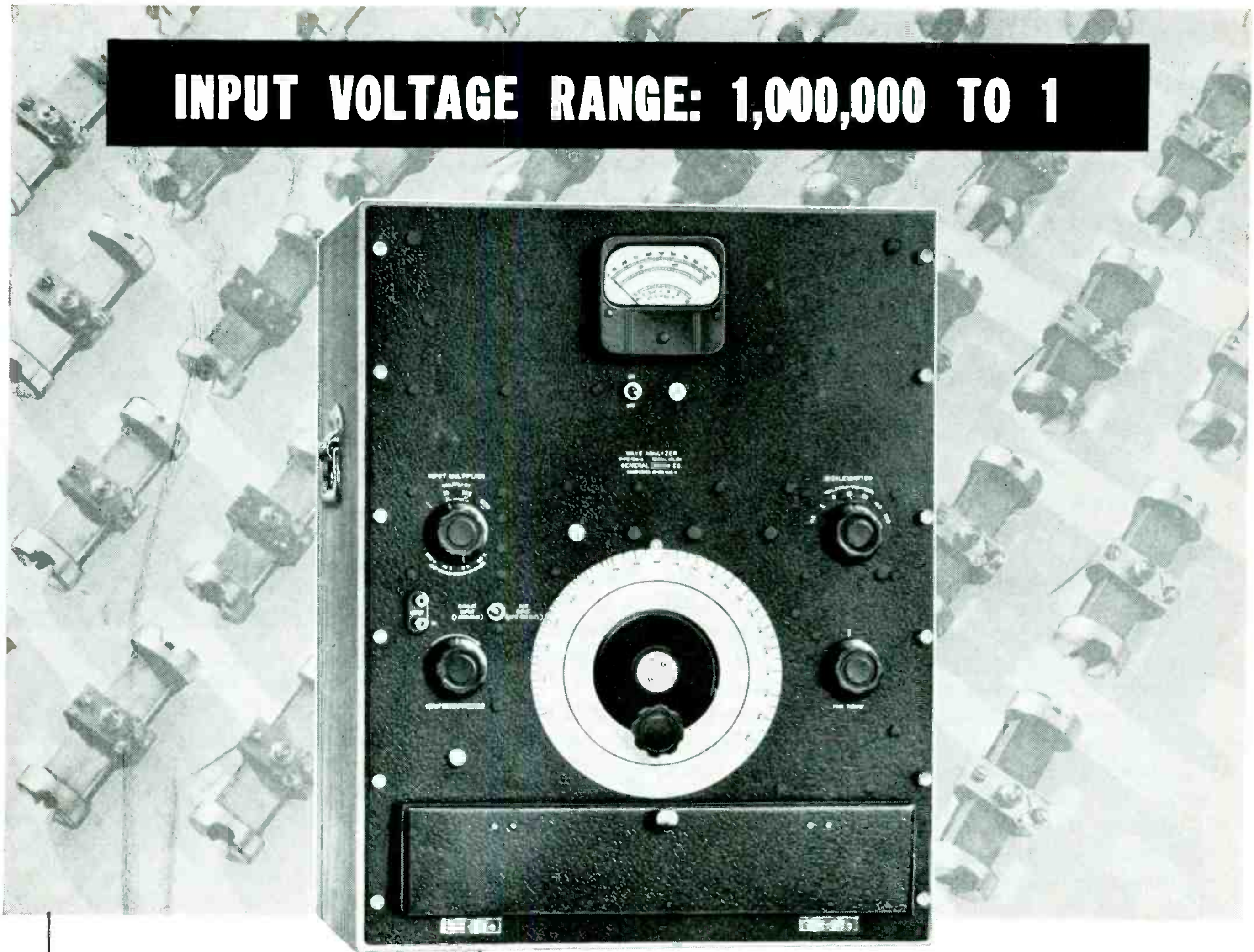
digits of the area and office codes and the four digits of the called telephone number. In calling distant cities, the operator does not actually dial the numbers. Instead she uses a ten-button key set which operates about twice as fast as an ordinary dial. For each punch of a key, a tone pulse is sent out over the voice channels to the switching center.

Each tone pulse is a combination of two different audible frequencies, which are sorted out and classified by the brains in the switching equipment, which then interprets their meaning. This switching equipment also provides the electronic hands which assume much of the complex switching operation.

Six frequencies spaced 200 cycles apart from 700 to 1,700, inclusive, are employed. Two of these frequencies are used for each pulse and each pulse represents one digit. Piquant harmonies are not in store for most long-distance telephone users, however. The equipment practically never makes the tones audible to the calling party.

Called No. 4 equipment, the new switching equipment is capable of performing all types of toll-office switching. It handles incoming calls from distant cities, outgoing calls to other cities, or calls routed through it between two other cities. After dialing by the long-distance operator, a call proceeds entirely automatically. All connections are

(continued on p 140)



THE ELECTRON ART

Edited by JOHN MARKUS

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Electrostatic Cathode-Ray Memory for Computers

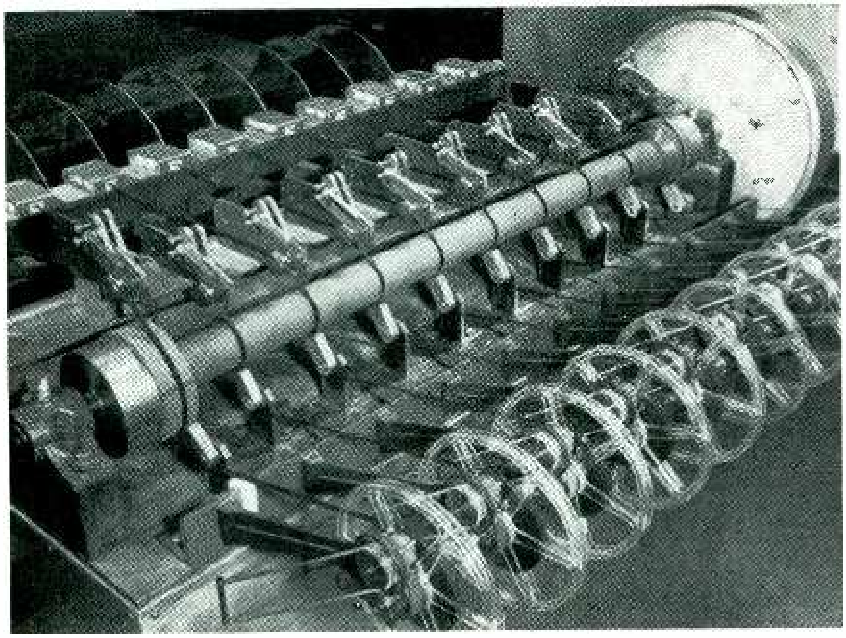
A NEW electronic storage system making use of an ordinary cathode-ray tube screen was described recently at a meeting of the British Institute of Electrical Engineers. The new electrostatic memory was developed by F. C. Williams and T. Kilburn of the University of Manchester for use with the electronic digital computer being built at the Royal Society Computing Machine Laboratory. Present plans also call for its use as the high-speed memory for the NBS Interim Counter, a small-scale electronic computing machine being built at the National Bureau of Standards for use until several large-scale machines become available.

The storage of information is accomplished by static charges built up on the screen of an ordinary cathode-ray tube. The binary digits 0 and 1 are stored as a "dot and dash" of charge respectively. The information is obtained from the screen by scanning with the cathode-ray beam, then picking up the signals induced on a metallic foil cemented to the face of the tube. These signals are characteristic of the digits stored. Because the charges slowly leak from the screen, it is necessary that they be continually regenerated by reading the information every 1/25 second and recording on the screen.

Checking performance of miniature tubes and special pulse transformers in NBS electronic lab prior to incorporation in new electronic digital computer that is scheduled to use a high-speed electrostatic cathode-ray memory storage device

While the processes involved in storage, reading and scanning are complicated, the equipment needed for construction of this memory device is said to be simple and readily obtained. It is reported that as many as 2,048 digits have been stored for periods of hours on an area of 154 square centimeters of a cathode-ray tube screen.

MASS PRODUCTION OF MUSICAL TAPE



First commercial machine for mass production of recorded music on reels of tape, for competition with phonograph discs in homes, radio stations, schools and theaters. Developed and offered for lease by Minnesota Mining and Mfg. Co., St. Paul, the machine can in one hour turn out 48 hours of tape recordings that are indistinguishable from the master tape transcription. The paper or plastic tape coated with iron oxide dust particles can be recorded with a single magnetic pattern in the center or with two magnetic paths side by side to give twice the playing time. The master and the tapes to be copied are run side by side on a common capstan to insure fixed relationship of speed, which can be 3¾, 7½, 15 or 30 inches per second

Cam Tracking Mechanism

ADJUSTABLE CAMS are used to obtain proper tracking and to avoid the necessity for holding the associated equipment to excessively close tolerances in production in an ingenious mechanism developed at Airborne Instruments Laboratory. The accompanying cutaway drawing shows the construction of such a cam arrangement used for single-control tracking of a klystron oscillator and radio-frequency preselector. The cams maintain the correct reflector voltage of the local reflex oscillator, proper tuning of oscillator and preselector, and give a linear dial frequency calibration.

Two cams coupled by antiback-

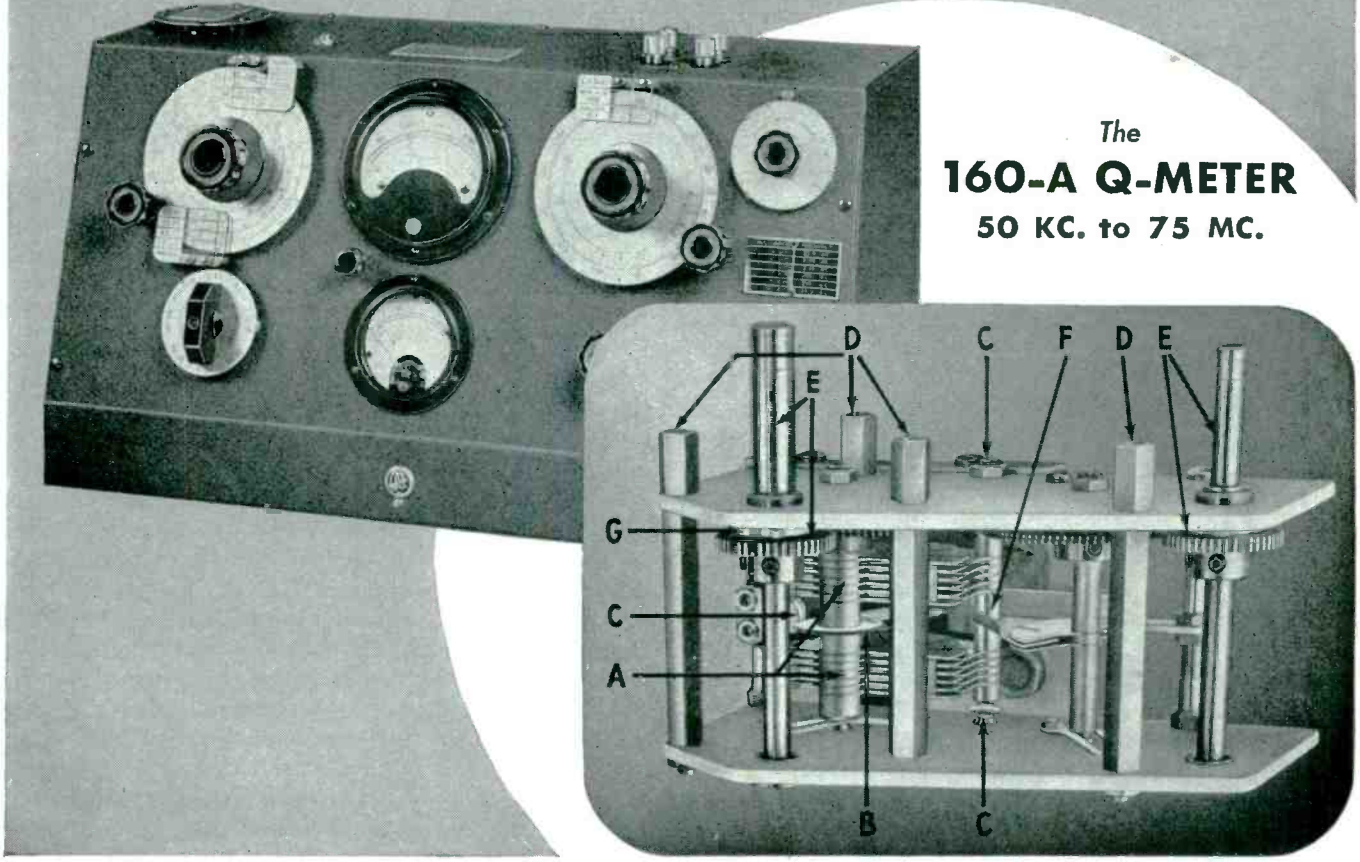
For the *MEASUREMENT* of

Q, INDUCTANCE and CAPACITANCE

The

160-A Q-METER

50 KC. to 75 MC.



Radio frequency circuit design often requires the accurate measurement of Q, inductance, and capacitance values. For this application, the 160-A Q-Meter has become the universal choice of radio and electronic engineers throughout the country.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached only after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

This is but one of the many desirable features of the 160-A Q-Meter which contribute to its outstanding accuracy and dependability.

Be sure to include the 160-A Q-Meter in your new equipment plans for 1948.

Write for Catalog "F"

BOONTON RADIO *Corporation*
BOONTON·N·J·U·S·A·

Shown above is the Q tuning capacitator assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Parallel connection of dual rotor and stator assemblies minimizes internal inductance and resistance.
B. Spring silver fingers contact both sides of silver disc to provide low series resistance.
C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.
D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.
E. Precision-cut brass spur gears and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.
F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.
G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

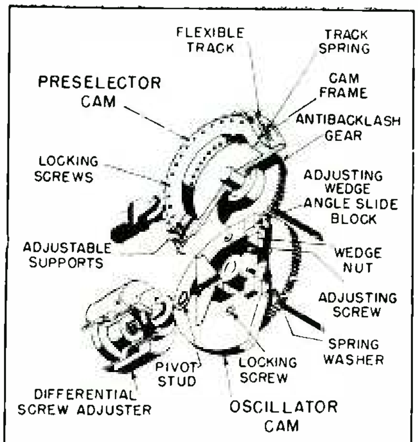
Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero,—3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS



CAM MECHANISM FOR SINGLE-CONTROL TUNING

Adjustable cams relieve production tolerances and simplify tuning adjustments

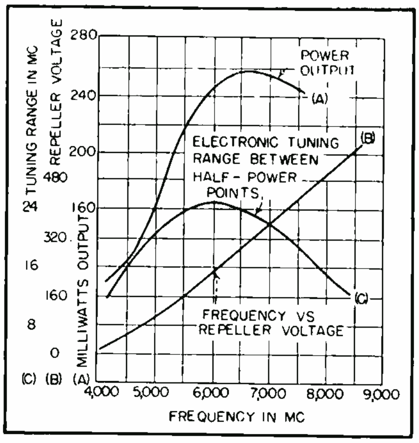
lash gears provide these functions. The preselector cam contour covers about 270 degrees of rotation and is adjustable at approximately every 14 degrees. To permit this adjustability, the cam track is formed by a flexible ribbon held against adjustable supports by spring tension. Each support is held in a guide hole in the cam frame and rests on a screw by which its radial position can be adjusted. A locking screw then holds the supports fixed. Final adjustment of the cam track is made by centering the plunger on a support, then feeding in a signal of the frequency indicated by the dial reading and adjusting the support until maximum output is obtained. The process is repeated for each support.

The oscillator tuning cam, which covers about 180 degrees of rotation, is precut to the average klystron tuning characteristic and made adjustable at three points. When the oscillator is first placed in service, and when the tube is replaced, the cam is adjusted for proper tracking at each end and at the center of the tuning range. The end adjustments are made by spreading the two hinged plates of which the cam is formed, using the angle slide blocks for fine adjustments. The center adjustment is made by the differential screw on the plunger.

Pulsed Reflex Oscillator

THE RANGE of microwave frequencies from 2,000 to 12,000 megacycles can be generated by a velocity-modulated external-cavity reflex oscillator, type QK-205, that has been developed recently by Raytheon Mfg. Co. as type QK-205 (RMA type 5721). A special feature of the tube is the high-impedance modulation grid which permits pulsed operation from a low-potential source.

Some of the tube's operating characteristics are given in the accompanying table and the graph. The wide frequency range and high efficiency have been obtained by careful study of the electron behavior in the interaction gap and the drift space. Power loss due to the presence of the glass envelope in the cavity has been minimized by controlling the shape of the glass in the portion of the tube entering the resonant cavity.



Curves showing performance of QK-205 tube in the middle region of its operating range

Mechanically the tube has been made sufficiently sturdy so that, for example, the grid rings that contact the coaxial cavity can be machined after the tube is assembled. This machining assures concentricity of the rings. The protruding repeller contact, which often is responsible for breakage of conventional tubes, has been replaced by a female jack. The miniature size of the tube makes it readily adaptable to compact equipment.

This new tube is intended for use as a wide-band oscillator in conjunction with tunable coaxial cavities. The choice of cavity dimensions is determined by the possibility of exciting the $TE_{x,M}$ or circumferential mode; a noncontacting plunger is recommended. The diagram shows a suitable cavity for the 4,290 to 8,340-mc range that operates without mode interference.

Typical Operating Characteristics of Wide-Range Reflex Oscillator

Mode conditions	1 3/4 repeller, 1/4 cavity modes	2 3/4 repeller, 3/4 cavity modes	3 3/4 repeller, 3/4 cavity modes
Frequency in mc[A]	2,000–5,000	4,290–8,340	7,500–12,000
Grid No. 2 and No. 1 potential in volts[B]	7,000	1,000	1,250
Cathode current in ma	13	20	20
Reflector potential in direct volts[C]	40–600	60–600	60–600
Power output, milliwatts	80	100	30
Average efficiency in percent	0.44	0.9	0.21

[A] With suitable cavity, which for the 3 3/4 repeller mode requires quarter-wave cavity mode for suppression. Cavity for 4,290–8,340 mc range has 0.393-inch diameter inner conductor and 0.787-inch inner diameter for outer conductor. Cavity is tuned by noncontacting Z choke type plunger that is chrome finished to minimize wear of silver-plated cavity walls

[B] Control grid is adjusted for desired cathode current, which will require a positive direct voltage between about 10 and 25 volts; control grid current is approximately 5 ma

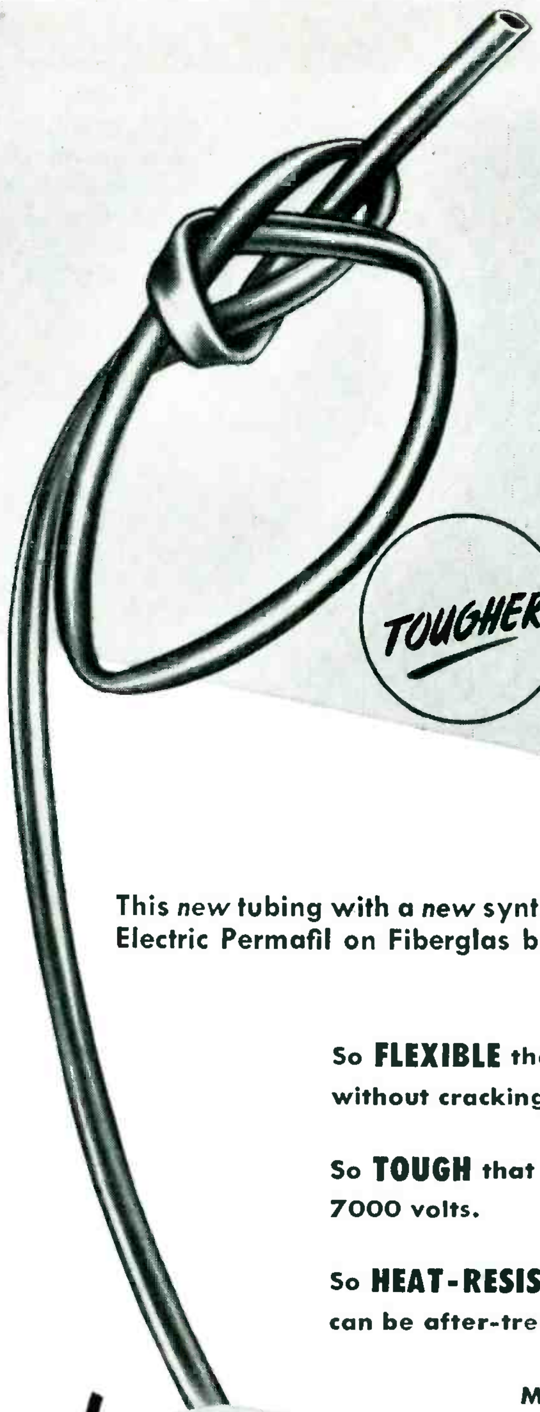
[C] Adjust for maximum power output

Note: For pulsed operation pulse repetition rate is 40 to 4,000 pps with pulse duration from 0.5 to 10 microseconds.

Brightness and Contrast in Television

THE EFFECTS OF different degrees of brightness and contrast on television pictures were described by Peter C. Goldmark of CBS at the AIEE Winter General Meeting in

(continued on p 161)



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VARGLAS TUBING

Impregnated with GE PERMAFIL

TOUGHER

...more FLEXIBLE

...more HEAT-RESISTANT

Send for FREE Sample!

This *new* tubing with a *new* synthetic coating of General Electric Permafil on Fiberglas braid is . . .

So **FLEXIBLE** that it can be twisted, bent, wrapped, tied in knots . . . without cracking or peeling.

So **TOUGH** that severe use will not destroy its dielectric property—7000 volts.

So **HEAT-RESISTANT** that it will withstand high temperatures and can be after-treated in baking and varnishing operations.

Made in standard colors, in a wide range of sizes. It is available in coils—so that you can cut the exact lengths you need, without waste.

And . . . this is a premium tubing at a reasonable price. Send coupon for free sample and full information.

Varflex CORPORATION

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Please send me full information as well as a free sample of your new Varglas Tubing impregnated with G. E. Permafil. I am particularly interested in samples suitable for..

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

NEW PRODUCTS

Edited by A. A. McKENZIE

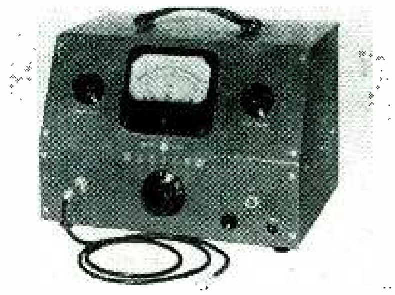
Radiation Survey Meter

PRECISION RADIATION INSTRUMENTS, INC., 1101 N. Paulina St., Chicago 22, Ill. Model 102 allows measurement of low-energy beta particles and alpha particles as well as gamma and X-radiations. The new counter tube has a thin mica window 1.5 mg per sq cm, allowing detection of Carbon 14 and other radioactive tracers. The tube is

self-quenching with a Geiger threshold at 825 volts plus or minus 25 volts, and has a 200-volt plateau. The tube itself is mounted within a specially designed probe that enables differentiation between alpha, beta, and gamma radiations. Utilizing a plug-in circuit for easy servicing, the instrument has a battery life in excess of 400 hours. Price is $289.50 delivered complete.

Microwave Power Meter

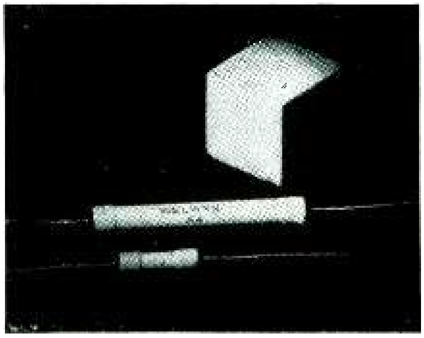
HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Type 430A microwave power meter directly indicates on a large meter the power developed in a standard barreter. The instrument is self-balancing and can be used over any frequency depending upon the associated barreter and mount. The unit comprises an a-c bridge, one arm of which is a barreter. The bridge is in balance with zero r-f power in the barreter. As r-f power



is applied to the barreter, an equivalent a-c audio power is automatically removed. Thus the bridge remains in balance. A vacuum-tube voltmeter reads the change in audio power level. It is this meter, calibrated in milliwatts that gives a direct indication of the r-f power in the barreter. The new meter covers a power range from 0.02 to 10 milliwatts. Ranges are related in 5-db steps and continuous readings are available from minus 20 dbm to plus 10 dbm. The power range can be extended by use of attenuators or directional couplers. Accuracy of the meter is within plus or minus 5 percent of full-scale readings.

Carbon Resistors

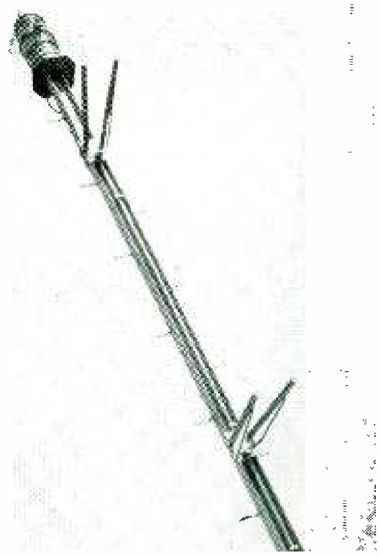
WELWYN ELECTRONIC COMPONENTS INC., 234 East 46th St., New York 17, N. Y. High stability resistors are now offered in a range from 100 to 50,000 ohms in 1-percent tolerance, and in wider ranges in a 5-percent tolerance of resistance values. Available in ¼, ½, 1, and 2-watt sizes, these resistors are stocked in decade and RMA preferred values. In manufacture, the



resistor element is a homogenous film of pure carbon deposited on a porcelain tube. After aging, fitted brass end caps are applied, into which the terminal leads are staked and soldered. The completed resistor is brought to the required resistance value by spiralling in automatic machinery.

F-M Antenna

ANDREW CORP., 363 East 75th St., Chicago 19, Ill. The Multi-V is a new two-bay f-m broadcast antenna with a power gain of 1.6 and a power-handling capacity of 10 kw. It can be either top or side mounted. Electrically, the antenna consists of

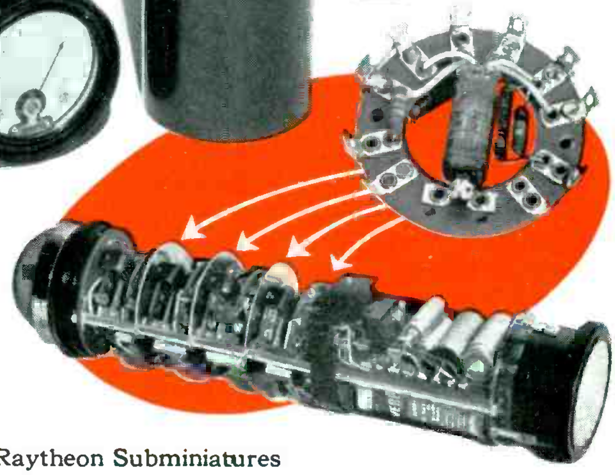


two radiating elements spaced at one wavelength. Each element is esentially an unbalanced folded dipole formed in the shape of a vee. The configuration results in an omnidirectional horizontal pattern. The elements are fed in phase by a single transmission line through a full-wave phasing length and are matched to the feed line by means of a quarter-wave matching section. Voltage standing-wave ratio varies from a maximum of 1.4 at 88 mc to less than 1.2 from 93 to 108 mc. Bulletin 86 gives complete details.

Microwave Dielectrometer

CENTRAL RESEARCH LABORATORIES, INC., Red Wing, Minn. Now available for measuring the dielectric constant and loss of a wide variety of materials at nominal frequencies of 1,000, 3,000, and 9,000 mega-

Thanks to
RAYTHEON
Filamentary, Low Battery Drain
SUBMINIATURE TUBES



This Scott Sound Level Meter made by Hermon Hosmer Scott, Inc., Cambridge, Mass., employs four Raytheon Type CK512AX and one Type CK526AX Tubes with a normal filament current of 0.06 amps. Battery life is approximately 50 hours with intermittent use. Yet the complete assembly is only 11⅝″ long and 2½″ in diameter—only slightly larger than a flashlight!

Handy size...increased product serviceability and salability . . . are only some of the advantages of Raytheon Subminiatures with their flat shape and extremely low filament drain that permits the use of tiny batteries.

All Raytheon Subminiatures can either be soldered in or plugged into readily available sockets.

Raytheon Subminiatures are *reliable* — the result of nine years of continuous production and application experience.

Raytheon's are readily available from nearby stock — over half a million on tap at all times. They are standard throughout the world — more are in use than all other makes combined! Over three hundred Raytheon Special Purpose Tube Distributors are ready to serve you quickly and intelligently.

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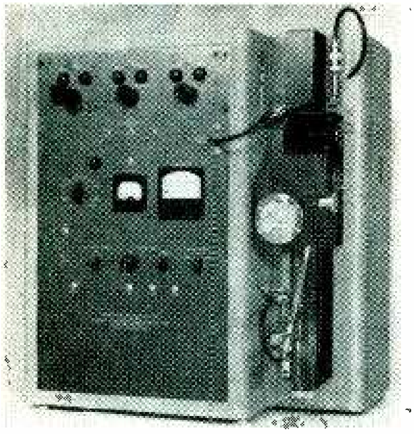
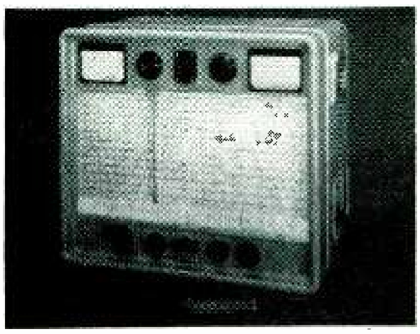


cycles is the microwave dielectrometer illustrated. The instrument comprises a slotted waveguide, precision traveling probe, modulated klystron oscillators, probe output amplifier, and associated power supply. The sample to be measured is inserted ahead of a short-circuiting plug and the effect of this arrangement on the standing-wave pattern in the guide provides data for calculating the dielectric constant and loss of the material. At 1,000 and 3,000 megacycles the waveguide is used as a coaxial line operating in the TEM mode, and at 9,000 mc either as a circular pipe operating in the TE_{11} mode or as a coaxial line operating in the TE_{10} mode. The range of measurements of dielectric constant extends from 1 to 100; dissipation factor can be determined between 0.0001 and 1.0. Accuracy in the order of 2 percent is possible for most materials.

Standard Signal Generator

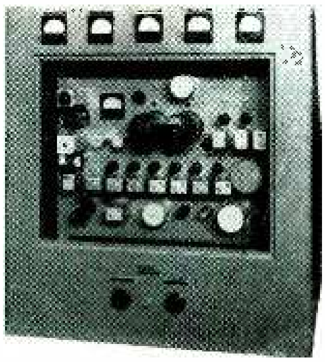
MARCONI INSTRUMENTS LTD., St. Albans, Herts., England. Standard signal generator type TF 867 has a frequency coverage from 16 kc to 30 mc and the calibration is displayed on an expanded scale giving a discrimination of one part in ten thousand of the total scale length. Output is continuously variable from



0.4 microvolt to 4 volts. A crystal oscillator is provided for frequency calibration. Amplitude modulation up to 100 percent at 400 cycles or 1,000 cycles internally is possible, or any frequency from 50 cycles to 10 kc can be applied externally. Meters show output level and modulation depth.

College Broadcaster

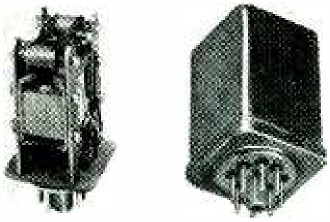
GATES RADIO CO., Quincy, Ill. Type BF-E-10 transmitter illustrated has been designed for f-m broadcasting in the noncommercial educational band. Power output is nominally 10 watts. Direct crystal control gives a frequency stability of plus or minus 500 cycles. The



phase shift modulator has a modulation capability of 100 kc. Frequency response is within 1.5 db of the standard 75-microsecond pre-emphasis curve. Distortion is less than 1.5 percent from 50 to 100 cycles and less than 1 percent above 100 cycles. Power input is about 165 watts. Transmitter sells for $1,750 complete with one set of tubes, one crystal and oven.

Polarized Relay

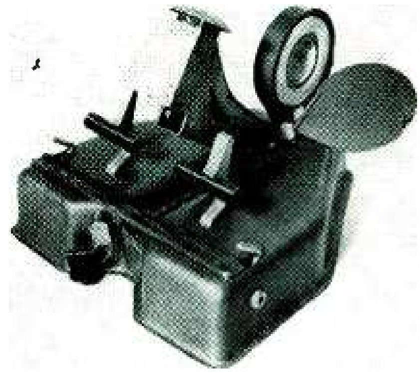
SIGMA INSTRUMENTS, INC., 70 Ceylon St., Boston, Mass. Type 7JOZ miniature polarized high-speed telegraph keying relay has spdt contacts. It is hermetically sealed and fits an octal tube socket. Designed for operation at 50 to 150 words per minute, it is serviceable up to 250 wpm. Transfer time, dependent upon the driving circuit, is generally less than 1 millisecond. Windings available include a matched pair with resistance around 150 ohms each for differential, polar, or polarential service



as well as other combinations up to 14,000 ohms in a single winding. The standard twin-150-ohm model operates satisfactorily on 5-ma reversals in one winding, and just trips at approximately 1 ma.

Magnetic Tape Splicer

ELKEN MFG. CO., Hollywood, Calif. An automatic splicer for cutting and patching magnetic tape can be used to edit program material in about ten seconds. In operating the splicer, the magnetized tape is placed in a groove and any selected spot is cut to an accuracy of a few thousandths of an inch, using a



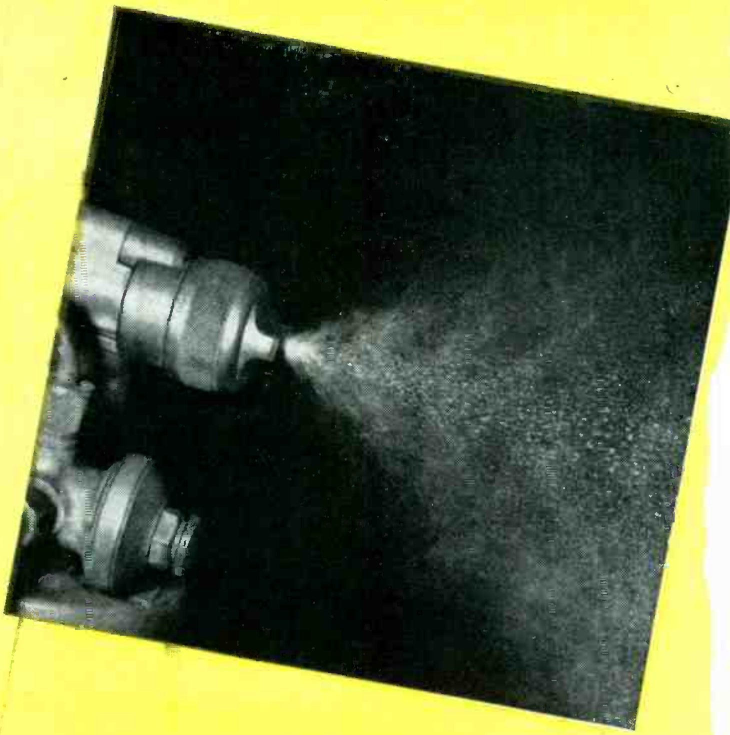
spring-loaded blade controlled by a thumb-pressure trigger knob. The final operation issues the proper amount of cellulose tape to join the butted ends and at the same time trims the excess binder.

Record Camera Accessories

FAIRCHILD CAMERA AND INSTRUMENT CORP., 88-06 Van Wyck Boulevard, Jamaica 1, N. Y. A new universal mount for the Oscillo-Record camera eliminates the need for extra standard mounts for different types of oscilloscopes and is especially recommended when a 1,000-foot external magazine is to be used. A new adapter for mounting a standard 35-mm 1,000-foot or 400-foot magazine on the camera

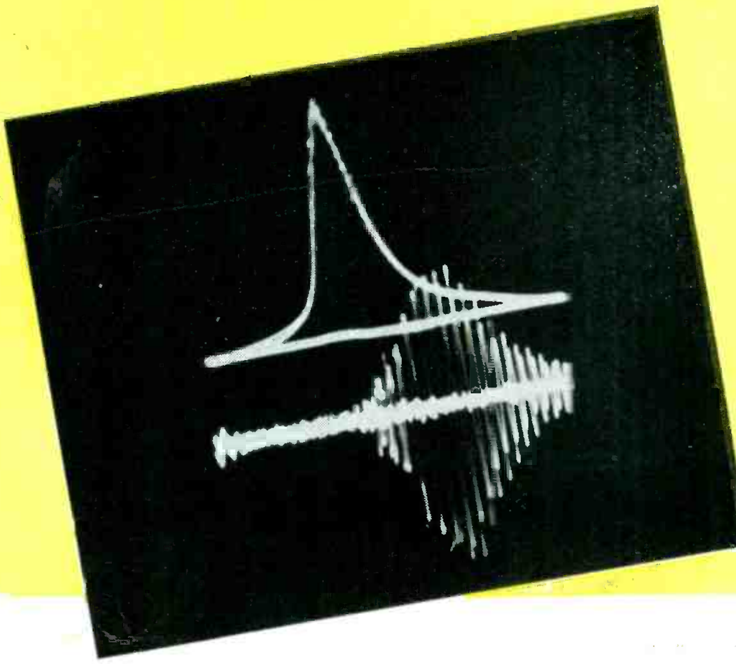
(Continued on page 179)

3 WAYS PHOTOGRAPHY STOPS TIME



1. HIGH SPEED STILLS—taken in as little as a millionth of a second—give you sharpest possible detail of a flash of fast action. They can be timed to catch the important instant of continuous motion. In the illustration, taken at 1/100,000 second, spray from a lacquer gun has been "stopped" to study dispersion of material.

2. HIGH SPEED MOVIES—slow down action far too fast to see otherwise—expand 1 second of operation into 4 minutes of viewing time. They allow the study of fast moving parts in operation—show why they stand up or fail. The illustration shows three frames of a high speed film made to study the action of a tire meeting an obstacle at high speed.



3. RECORDING OSCILLOGRAPH TRACES. When fast actions can be translated into electrical impulses, they can be traced on the oscillograph and photographed. In the illustration, the upper trace represents the pressure of detonation in the cylinder of a knocking gasoline engine—the vibrations in the lower trace have a period of about 1/100,000 second.

FUNCTIONAL PHOTOGRAPHY

. . . is advancing industrial technics

Camera close-ups, like these from the automotive industry, are helping unravel problems for all kinds of industries and businesses. They are pointing the way to better products at less cost—to more efficient production methods—to greater ability to lead competition.

You can use such photographic technics in your business, either with facilities of your own or through one of the many fine commercial laboratories. In either case, Kodak will be glad to help with information or suggestions.

Eastman Kodak Company, Rochester 4, N. Y.

"Kodak" is a trade-mark

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"dag" Colloidal Graphite in Television

The NEW **"dag"** CRT Interior Wall Coating, a colloidal graphite dispersion, is widely used to improve the performance of television viewing tubes.

Specifically developed by Acheson Colloids engineers for CRT interior surface coating, this dispersion provides a colloidal graphite film which serves as a final high voltage anode, and improves screen contrast by absorbing reflected light.

"dag" CRT Wall Coating sticks fast to all types of glass. A simple adjustable applicator gives a uniform coating from tube face to tube neck while the envelope is turned in a lathe.

Electrical and electronic manufacturers use **"dag"** colloidal graphite because it is opaque, electrically conductive, chemically inactive, diamagnetic, resistant to electron bombardment, low in photoelectric sensitivity and a gas adsorbent. Can this unique combination of properties be helpful to you? Mail coupon TODAY for more information.

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PORT HURON, MICHIGAN

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

RMA-IRE Spring Meeting

RADIO ENGINEERS of the RMA and IRE will hold their fourth annual spring meeting April 25, 26 and 27 at the Benjamin Franklin Hotel, Philadelphia. Mornings during the three-day conference will be devoted to technical sessions; afternoons will be occupied by committee meetings and inspection trips.

Technical program is as follows:

Monday, April 25

10:00 A. M. Chairman—A. N. Curtiss

A Three Kilowatt Medium Frequency Transmitter Utilizing Iron Core Interstage and Output Circuits, by L. F. Deise and L. W. Gregory of Westinghouse Electric Corp.

The Use of the Cavity Resonator in the Mobile Communications Field, by Henry Magnuski of Motorola, Inc.

The Symmetron 50 Kilowatt F-M Broadcast Amplifier, by L. D. Balthis of Westinghouse Electric Corp.

An Instantaneous Deviation Control for Phase Modulation Transmitters, by Marion Winkler of Motorola Inc.

Tuesday, April 26

9:30 A. M. Chairman—M. R. Briggs

Television Recording Technique, by R. V. Little, Jr. of RCA.

The Utiliscope, Pioneer of Industrial Television Systems, by M. Cawein and J. A. Good of Farnsworth Television & Radio Corp.

A New Television Visual Modulator, by A. J. W. Rhodehamel of GE.

The Reality of Invisible Forces, by E. Finley Carter of Sylvania Electric Products Inc.

Wednesday, April 27

9:30 A. M. Chairman—O. W. Pike

High-Efficiency Cooler for Forced-Air-Cooled Power Tubes, by M. B. Lemeshka and A. G. Nekut of RCA.

Audio Power Amplifier with Positive and Negative Feedback, by John M. Miller, Jr. of Bendix Radio.

Longitudinal Interference in Audio Circuits, by H. W. Augustadt of Bell Labs.

Commercial PTM Telephone Microwave Link, by N. J. Gottfried of Federal Telecommunication Labs and W. J. Logan of Maritime Telephone & Telegraph Co.

Terminology for Acoustics

A PROPOSED American Standard Acoustical Terminology was recently published for a year's trial and study. Those interested are invited to make use of the proposed dictionary during the next year and to comment upon their experiences with it. The new trial edition was prepared by a sectional committee sponsored by the ASA with cooperation of the IRE.

New material in the proposed revision of the 1942 edition defines terms used in work on ultrasonics, recording and reproducing, underwater sound, general acoustical instruments, and shock and vibration. Sections appearing in the earlier edition also contain new material.

The proposed standard can be obtained at one dollar per copy from the Subcommittee on Acoustical Terminology, Z24A, of the ASA, Inc., 70 E. 45th St., New York 17, N. Y.

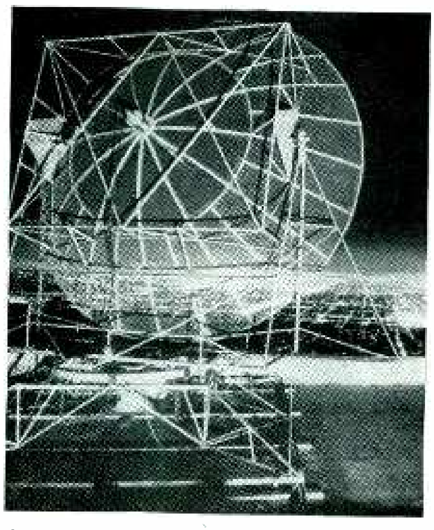
Tube Committee Reorganization

THE AMERICAN STANDARDS ASSOCIATION Sectional Committee on Electron Tubes C-60, formerly sponsored by the Electrical Standards Committee, is now sponsored by the Joint Electron Tube Engineering Council. While originally the unit was concerned only with industrial electron tubes, it has been reorganized and its scope is being broadened to include definitions, classifications, methods of rating and testing, dimensions and interchangeability of electron tubes for all applications.

This new committee includes representatives of the American Association of Electrical Engineers, the American Association of Railroads, Electric Light and

LINE-OF-SIGHT TV TRANSMISSION FROM MOUNTAIN-TOPS

Largest concentration of television transmitters is at Mt. Wilson, Calif., twenty-five miles from Los Angeles and 5,700 feet high at the tower locations. Maximum line-of-sight range is provided for six transmitters, a seventh expected to be ready soon, and two relay towers. Pictured above are, right to left: KTTV; KLAC; KNBH; KTLA; KECA; a Pacific Tel. & Tel. Co. relay tower; KFI, with KFMF (f-m only) in front of it; and a Pacific Tel. & Tel. relay tower. At left (base of small knoll) KTSL is building a transmitter



Giant parabolic reflector above KTSL, atop 1,600-ft Mt. Lee, Calif. Television shows originating in Hollywood studios, whose lights are seen in the background, are beamed directly to the 16-ft saucer, which has a focal length of four feet

MEETINGS

MARCH 28–29: Third Annual Meeting, Armed Forces Communications Association, Shoreham Hotel and Naval installations, Washington, D. C.

APRIL 4–8: SMPE 65th Semi-annual Convention, Hotel Statler, New York.

APRIL 6–12: 27th Annual Convention of the National Association of Broadcasters, Stevens Hotel, Chicago, Ill.

APRIL 11–12: AIEE Conference on the Industrial Application of Electron Tubes, Statler Hotel, Buffalo, N. Y.

APRIL 11–15: Sixth Western Metal Congress and Exposition, Shrine Auditorium, Los Angeles, Calif.

APRIL 18–20: Eleventh annual Midwest Power Conference, Sherman Hotel, Chicago, Ill.

APRIL 25–27: Fourth Annual Spring Meeting of the RMA and IRE, Benjamin Franklin Hotel, Philadelphia, Pa.

MAY 2–4: URSI-IRE Joint Meeting, National Bureau of Standards, Washington, D. C.

MAY 12–13: Fourth Annual Spring Meeting of the Instrument Society of America, Royal York Hotel, Toronto, Canada.

MAY 16–20: Radio Parts Industry Trade Show and RMA Silver Anniversary Convention, Hotel Stevens, Chicago, Ill.

JUNE 20–24: AIEE Summer General Meeting, New Ocean House, Swampscott, Mass.

AUG. 29-SEPT. 1: National Conference of Associated Police Communication Officers, Hotel New Yorker, New York City.

AUG. 30-SEPT. 1: Fifth Annual Pacific Electronic Exhibit sponsored by the WCEMA, and the 1949 IRE western regional convention, Civic Center, San Francisco, Calif.

SEPT. 12–16: Instrument Society of America National Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

SEPT. 26–28: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

Power Group; the Institute of Radio Engineers; the Joint Electron Tube Engineering Council; the National Bureau of Standards, the National Electrical Manufacturers Association; the Radio Manufacturers Association; Telephone Group; the Army-Navy Electronic Engineering Agency, and liaison from the Canadian Standards Association. Chairman is O. W. Pike of GE's Electronics Department.

Precision Resistors

CHARACTERISTICS and measurements of precision resistance apparatus are covered in a new 32-page booklet entitled "Precision Resistors and Their Measurement", NBS Circular 470. Contained herein are chapters on resistance materials and construction methods, methods of comparison of resistors, special apparatus for precision measurements, calibration of precision bridges and resistivity of solid conductors.

The publication is obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 20 cents per copy.

Storms Forecast Here by Radiophoto from Sweden

EVEN when the sun is obscured in New York, uninterrupted daily forecasts of sunspot activity are now being made by RCA Communications, Inc. via solar photographs taken in Sweden and transmitted to this country by radiophoto. Calculation of the effect of sunspot activity on shortwave transmission provides advance warning of magnetic storms and permits rerouting of telegraph traffic to circuits outside affected areas.

Until recently forecasts of radio conditions have depended upon success in observing the sun through a refracting telescope installed atop the RCA Central Radio Office at 66 Broad St., New York. Need for a supplementary source of data during cloudy periods led to the present cooperative arrangement with the Royal Board of Swedish Telegraphs in Stockholm Observatory in Saltsjobegen, Sweden.

Thermocouple Wire Code

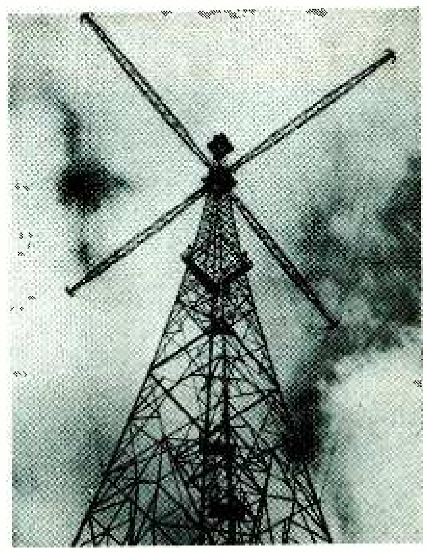
A FOUR-PAGE pamphlet dealing with coding of thermocouple and extension wire has been released by the Instrument Society of America as part of its program for achieving greater uniformity in the field of instrumentation. Designated as Tentative Recommended Practice RP1.1, the pamphlet includes tables giving recommended symbols for the following thermocouple combinations and extension wire:

Iron-Constantan (types J and Y); chromel-alumen; platinum, ten percent rhodium-platinum; platinum, 13 percent rhodium-platinum; and copper-Constantan.

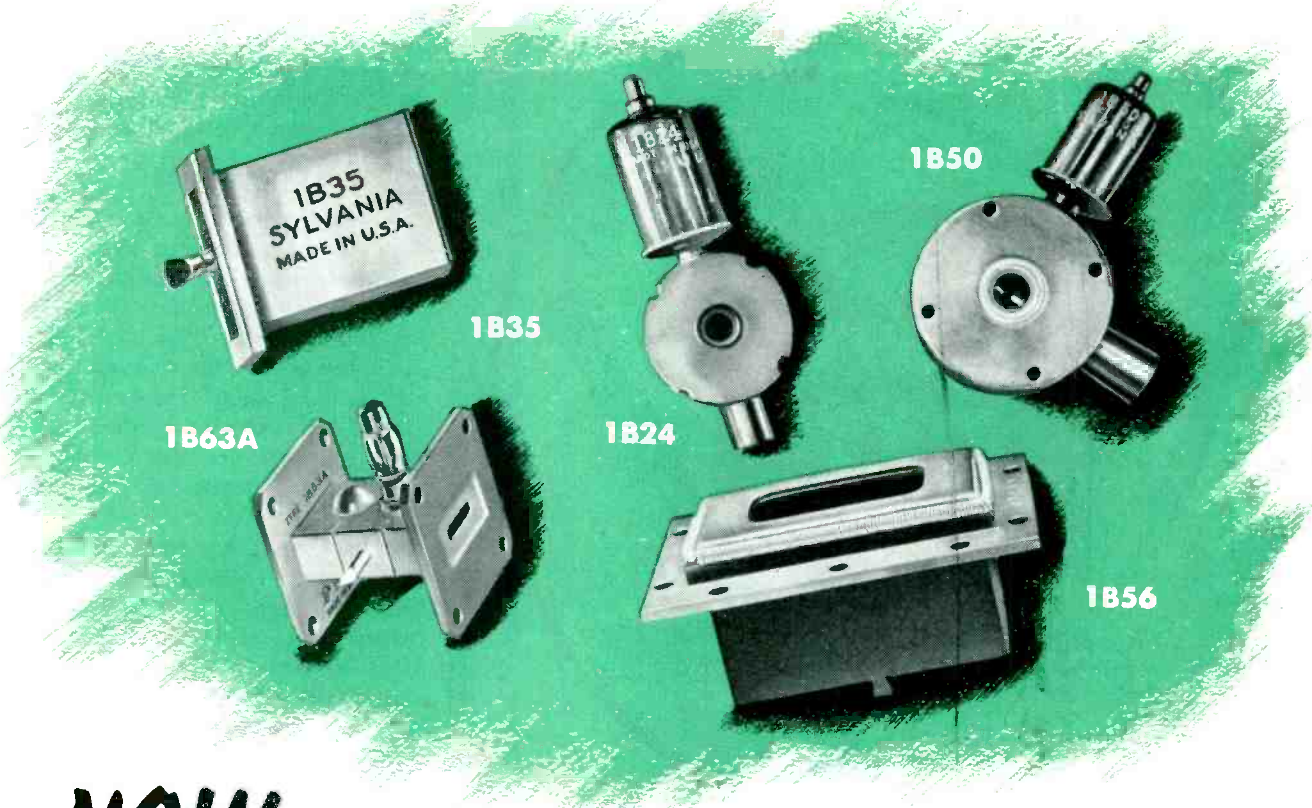
The four-page standard, free to members and $1 for non-members,

(continued on p 215)

NEW BRITISH RADAR NAVIGATIONAL AID



A view of the 325-ft steel lattice transmitting tower at the master station of the Lane Identification system, Puckeridge, Herts., England. Transmissions go out automatically at one-minute intervals 24 hours a day, seven days a week, so ocean-going ships approaching Britain can fix their position and set their receivers for the subsequent voyage up channel



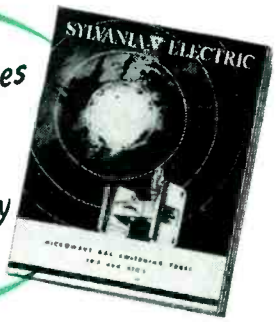
NOW . . . a comprehensive line of *24* microwave gas switching tubes **TR, ANTI-TR, PRE-TR** types!

If you need gas switching tubes—for radar or other microwave applications—this extensive Sylvania line will meet all your requirements.

The Sylvania line is the outgrowth of Sylvania's wartime experience as the world's largest producer of gas switching tubes—and of an intensive program of continuing research since the war.

The Sylvania line comprises 24 tubes: 11 TR's, 11 Anti-TR's and 2 Pre-TR's. Many of the newly introduced types offer the advantages of longer life, shorter recovery time and suitability for broad band applications.

New bulletin gives full details! mail coupon for your copy



Sylvania Electric Products Inc.
Electronics Division, Dept. E-2904
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:

Please send me your new bulletin on TR, Anti-TR and Pre-TR tubes. I am also interested in receiving literature covering applications of your other products in the fields of:

☐ *Communications, Television and Industrial Electronics*
☐ *Radioactivity* ☐ *Radar and Microwaves*

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ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

TUBES AT WORK

(continued from p 126)

made mechanically, and proper circuits are selected by the equipment in accordance with the dialed codes.

Crossbar Switch

Nucleus of the No. 4 system is the crossbar switch, an electrically operated switch that connects any one of ten circuits to any one of ten other circuits. In addition it can establish as many as ten virtually simultaneous connections in any order and independently of each other. Larger crossbar switches can handle twice as many connections.

Link frames are used to interconnect these crossbar switches and form one large system. The link frames can be interconnected to form a larger system or train, which is composed of a number of link frames. Larger No. 4 systems generally employ two trains, one for through and outward traffic and the other for inward traffic.

Common Equipment

The crossbar switch cannot interpret the codes dialed by the operator or select the proper circuits to complete the call. Instead, common control equipment has been designed to receive and interpret the digits dialed by the operator and then actuate the proper crossbar switches.

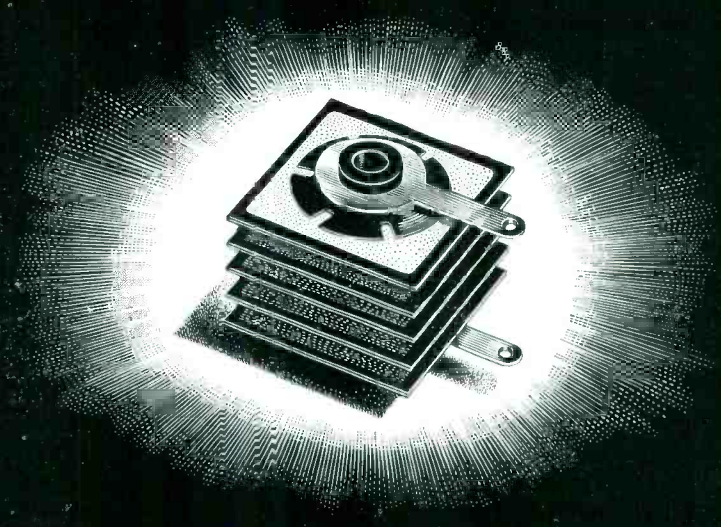
Brains of the No. 4 system is equipment called a marker, which interprets the dialed numbers. A marker automatically selects the routing of calls and then tells a mechanism, a sender, how to forward the signals that will reach the called telephone over the appropriate circuits.

Once a particular connection has been established, the common control equipment is released and becomes available for handling other calls.

The development of the No. 4 switching system meant a much wider scope for multifrequency key pulsing. Equipment was designed which could send and receive this type of signal at the rate of seven digits per second.

Until recently, the signals that govern the lamps on toll switchboards to indicate the progress of calls required separate signalling

Cut your Costs 4 ways...



with General Electric's "Inch-Cube" Selenium Rectifiers

Cut Initial Costs—Selenium rectifiers cost less than the sockets and tubes they eliminate.

Cut Installation Costs—Only one part to handle—only two connections to make—and this miniature power plant is installed —ready to operate.

Cut Chassis Costs—Use a smaller chassis. Selenium rectifiers can be mounted where a rectifier tube and socket won't fit.

Cut Inspection Costs—With no multiple-pin socket, no filament circuit, the inspector has only two simple soldered joints to check.

Application Data

Model	Height (Inches)	Width (Inches)	Length (Inches)	Normal RMS Volts	Max. RMS Volts	Max. Inverse Peak Volts	Temp.	Max. Peak Current (Ma)	Max. RMS Current (Ma)	Max. D-C Current (Ma)
6RS5GH1	1	1	15/16	117	130	380	50	1000	250	100
							60	750	200	80
6RS5GH2	1	1	11/16	117	130	380	50	800	200	80
							60	650	163	65

High-voltage selenium rectifiers can be used in place of rectifier tubes in many radio and electronic circuits.

Model 6RS5GH1 is recommended for general use while the smaller model, 6RS5GH2, should be used when space is extremely limited.

Each rectifier is composed of 5 one-inch-square selenuim rectifier cells specially assembled to give constant and uniform spring contact pressure on the cells regardless of temperature variations. Each unit is coated with a moisture-resistant varnish to provide protection against humidity and condensation. These units have ample current capacity to safely withstand the inverse peak voltage obtained when rectifying 110–125 volts, rms, while feeding a capacitor—as required in many radio circuits. Ambient temperatures of 50C to 60C are readily withstood. Tests have proved that these rectifiers will outlast the conventional type of rectifier tubes. The forward voltage drop through the rectifier is extremely low—approximately five volts at rated capacity.

For complete details contact your local G-E representative, or write for a new free bulletin on Selenium Rectifiers.

APPARATUS DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY 5, N. Y.

GENERAL ELECTRIC

456-11

channels similar to telegraph signals. Now, these signals can be transmitted over the same channels used for conversations.

Load Match Test

By HEINZ E. KALLMANN
New York, N. Y.

IT IS SOMETIMES DESIRABLE to check the impedance matching of a load when there is no proper test equipment on hand. If the load under test happens to be itself an indicator of current, such as a meter or a receiver (without avc), then the following simple test may be made. All the extra pieces of equipment needed are three resistors, each equal to the desired matching impedance. The indicator-load should be sensitive enough to give ample indication when fed from its source, at about one half of the regular load current.

The test consists of making up a bridge circuit, which is somewhat unconventional in that it uses the unknown impedance as an indicator in one of its arms, and that there is a switch in the null-arm where the meter would usually be. As shown in Fig. 1, the impedances in three arms of the bridge are made equal to R, the proper matching impedance of the load under test. But the load may have an impedance $R_L = R + \rho$, where the amount of the matching error, ρ, is positive if R_L is too high, and negative if R_L is too low. The generator, with source impedance R_i, need not be matched and the degree of its mismatch, $\alpha = R_i/R$, need not be known.

If ρ is zero, the load is matched and the bridge is in balance. Then one half of the generator current flows through each bridge arm and no current will flow through the switch S if it is closed. Therefore,

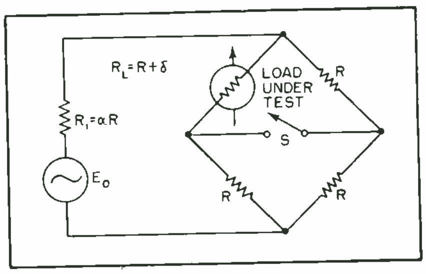


FIG. 1—Simple test setup for determining match between voltage source and load

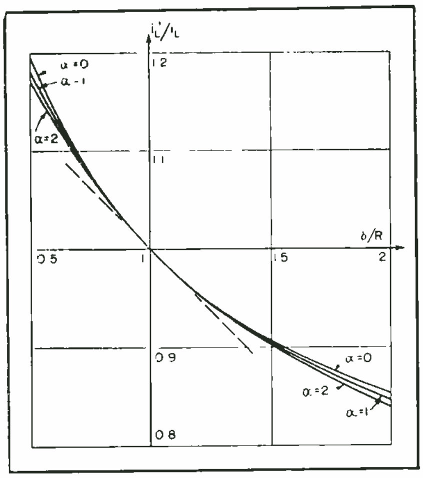


FIG. 2—Curves showing usefulness of match-test bridge circuit

turning this argument around, if opening and closing the switch S does not cause any change in the currents through the bridge arms (through R_L), then the bridge must be in balance and $R_L = R$.

If, however, R_L is not properly matched, then closing of switch S will permit flow of current through the null arm and the currents flowing through the other bridge arms will be altered accordingly.

To determine the error ρ it is enough to observe the change of the current through the load impedance R_L, from the value i_L when the switch S is open to i_L' when S is closed. The ratio of these two current values can be computed from the parameters of Fig. 1 and is found to be:

$$\frac{i_L'}{i_L} = 1 - \frac{1}{\dfrac{4R}{\rho} + \dfrac{2\alpha + 3}{\alpha + 1}}$$

This ratio is equal to unity for $\rho = O$; no change in current.

In general, the ratio depends somewhat on the mismatch of the source impedance R_s; its values are plotted in Fig. 2 for R_L ranging from $0.5R$ to $2R$; the three curves shown are computed for different source impedances, one curve assuming that the source is matched, $\alpha = 1$, one curve for negligible source impedance, $\alpha = 0$, and one curve, $\alpha = 2$, assuming a source impedance of $2R$. It can be seen that the effect of the source impedance on the bridge measurement is negligible for all practical purposes.

The only detail of the diagram that matters in practice is the

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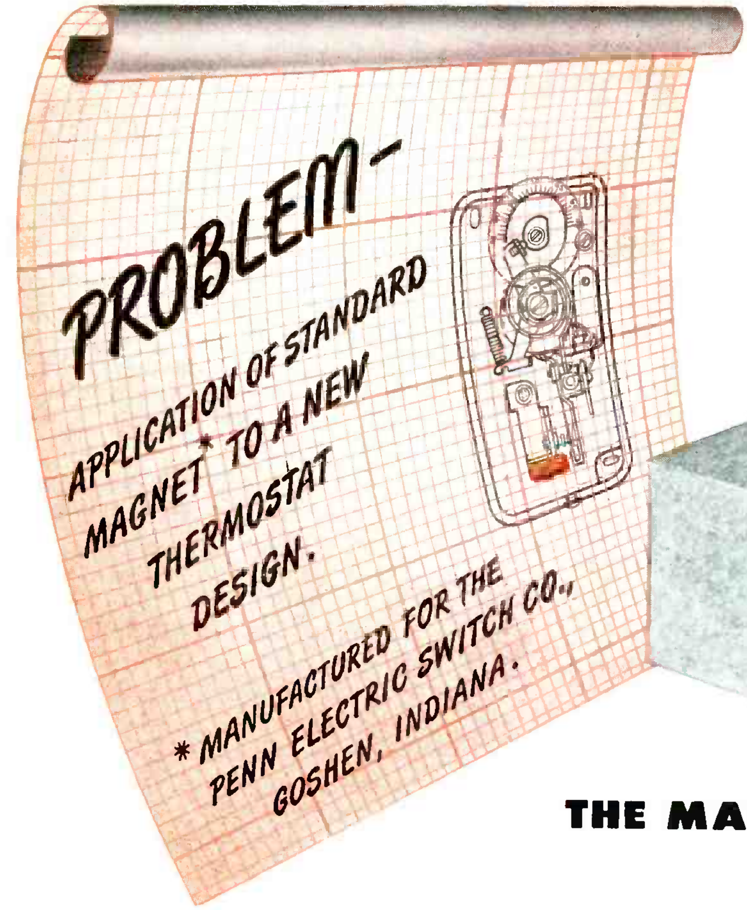
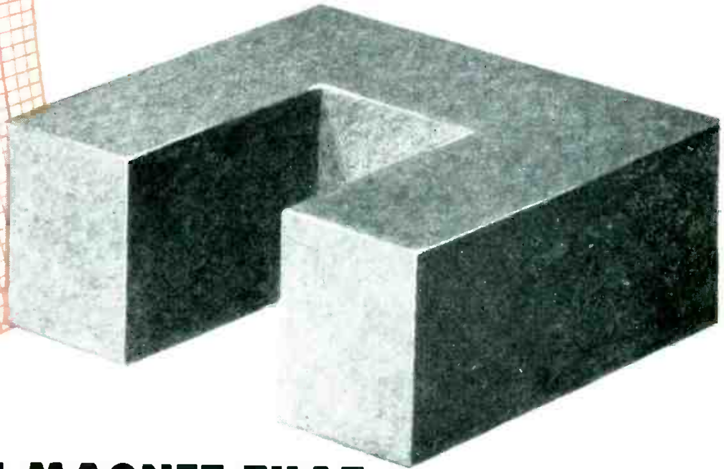
PERMANENT MAGNETS



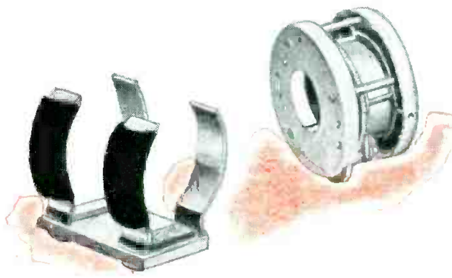


THE MAGNET THAT *Heats Your Home*

Here's a magnet that's simple in design yet is the heart of Penn room thermostats. . . . thermostats which *anticipate* heat requirements before temperature *changes.* The Sintered Alnico 2 permanent magnet snap-acting contact mechanism responds almost instantly to temperature variations.

This application is an excellent example of cost-saving by using stocked G-E permanent magnets. Since the magnet is stocked there are no special tool charges. And orders for stocked magnets are filled quickly, eliminating costly production slow-downs to you.

Perhaps a standard listed magnet can be used in your applications. And if a standard G-E permanent magnet will not meet your requirements, our engineers will be glad to design one specially for you. Remember, too, that General Electric manufactures all grades of cast and sintered Alnico as well as special magnet alloys.



G-E Permanent Magnet SUB-ASSEMBLIES

Here's a new product which may lower your permanent magnet costs. Permanent magnet component assemblies are specially designed to your specifications—ready for immediate installation in your final product. All permanent magnets are mounted for maximum efficiency. And, assembly and calibration operations are completely eliminated at your plant. For your free copy of General Electric's new bulletin on G-E Permanent Magnet Sub-assemblies mail the coupon shown below.

CHEMICAL DEPARTMENT, SECTION 14-4
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

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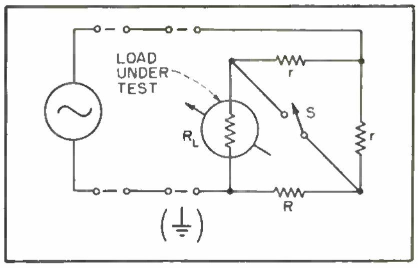


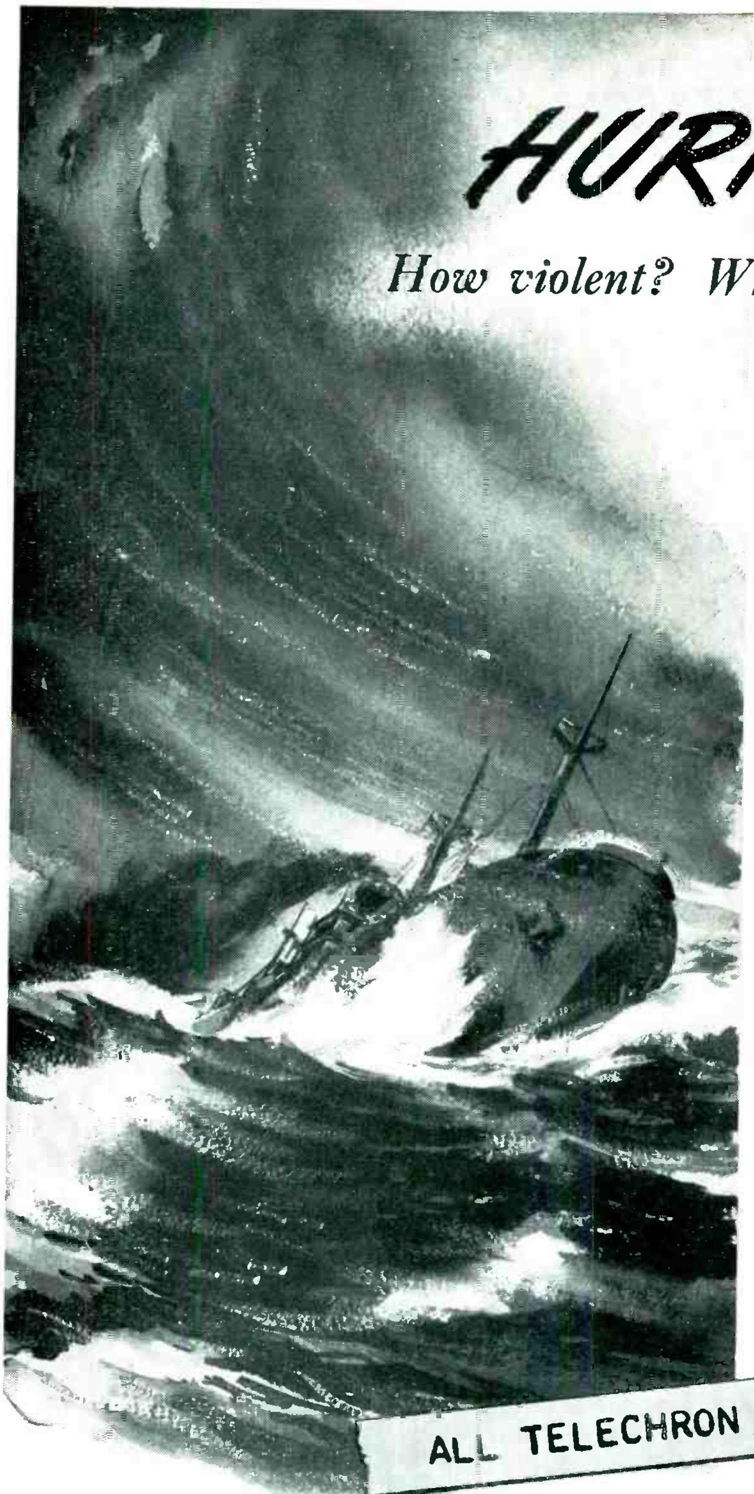
FIG. 3—Alternate test setup for use where three resistors of value R are not readily available

tangent of the curves near $\rho = 0$, shown as a broken line. It indicates which way and how much the load current changes with closing of the switch S. The load current decreases with closing of S when ρ is positive, or when the load impedance is too high, and vice versa. For small error ρ, the load current decreases by about 1 percent for each 4-percent error in matching impedance.

The smallest detectable change in load current thus sets a generally modest limit to the precision of the test. But within this limit, the load impedance may be checked and adjusted without need of any meter calibration or knowledge of its curvature. The test is equally applicable to d-c, audio, and high radio frequencies, for balanced and unbalanced systems; and it permits leaving one source and one load terminal grounded where that is necessary.

To make the test, open one of the load connections and insert the combination of three small resistors as shown in Fig. 3. Two of their leads may be bent to form the switch S, to be prodded with a pencil for closing. If there are no three resistors of the value R available, one will do, marked R in Fig. 3; and the two others, marked r, may be of somewhat different value though equal to each other.

In certain r-f adjustments, it is an advantage that the source and feeder remain loaded with their proper load impedance R. With all four resistors equal to R, the bridge, with open or closed switch, presents to the source the impedance R; and even if R_L is not equal to R, the impedance presented by the whole bridge is much more nearly correct. The impedance presented by the bridge to the load R_L



HURRICANE!

How violent? Where heading? How fast?

Hurricane warnings that save so many lives on land and sea—where do they come from? From seismograph recorders, perhaps better known for their earthquake-locating power. These sensitive instruments, stationed all over the country and on Atlantic and Pacific island outposts, locate and plot the minute-by-minute movement of violent atmospheric disturbances . . . and pen the vital data on tape.

The heart of each of these life-savers is a Telechron Timing Motor . . . *instantly, constantly synchronous.* No other motor could be trusted with the tremendous responsibility of feeding facts to the scientists who dedicate their time and talent to this most important work.

Have you a timing problem?

What variable factors do you want to control or record with split-second accuracy? The chances are that the correct application of a standard Telechron Motor is the answer to your problem. A Telechron Application Engineer can quickly tell you. Consult him early in your planning and save time and trouble. In the meanwhile, fill in and mail the coupon below today for up-to-the-minute facts about Telechron Synchronous Motors.

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Please send me information on Telechron Synchronous Motors (maximum torque: 2 pound inches at 1 rpm). My possible application is:

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- ☐ Timers
- ☐ Electric Appliances
- ☐ Cost Recorders
- ☐ Advertising, display items
- ☐ Juke Boxes
- ☐ Air Cond. & Heat'g Controls
- ☐ Communications Equipment

Other (please fill in)

- ☐ ____________
- ☐ ____________
- ☐ ____________

NAME ____________

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CITY ____________ ZONE ____ STATE ____________ depends on R_t and on whether the switch S is open or closed: for $R_t = R$, it is $0.6R$ in the former case and $1.66R$ in the latter.

Tester for VR Tubes

By STEPHEN S. PESCHEL
Mount Vernon, N. Y.

VOLTAGE-REGULATOR tubes frequently light up or glow when they are not functioning properly—not stabilizing the voltage at the load terminals. When used to stabilize an oscillator circuit for instance, they may flash on keying without going out, and give all outward appearances of working properly, but in reality they may be loafing on the job. Where voltage-regulation of the order of 1 percent may be needed, tests may disclose an actual regulation of 5 percent. Where such tubes are used in the series-type of electronically-regulated power supply for voltage reference, it is also important to use VR tubes that work properly.

With very rare exceptions new VR tubes, when operated properly, do stabilize voltages within the limits stated in tube handbooks. However, accidental current overloads will impair their operation, and frequently make them entirely useless as regulators. Unless the gaseous discharge or glow changes to an arc discharge and actually burns the tube completely, the tube may appear to glow normally. Some sort of a checker is needed to test these tubes.

Reviewing theory briefly, VR tubes are specially constructed gaseous glow tubes which maintain a rather constant voltage drop when current through them is varied over quite a range. A fundamental voltage-stabilizing circuit using a VR150 is shown in Fig. 1. The limiting resistor is

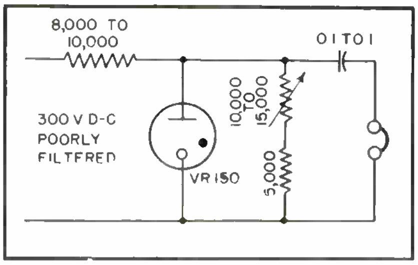

FIG. 1—Fundamental voltage · regulating circuit using VR150

RADIO-TELEFAX UNITS WITH SYLVANIA TUBES

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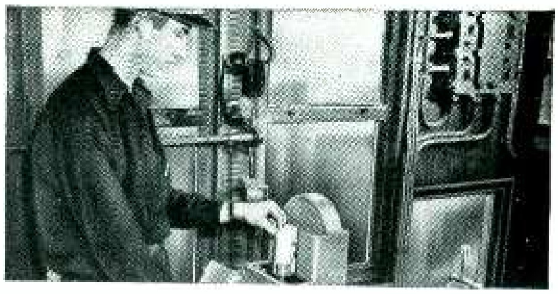
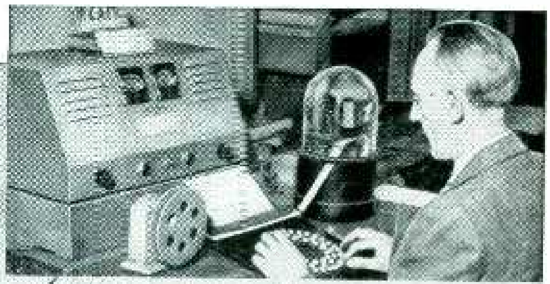
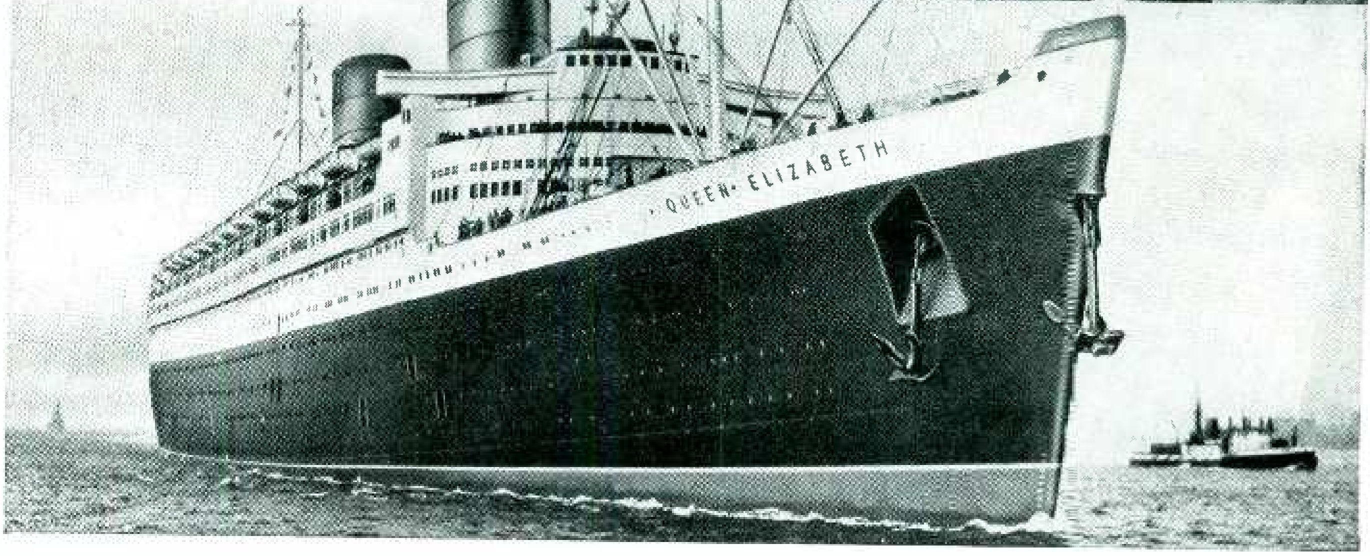


Pilot boat Captain sending written message of arrival of the big ship through Link unit equipped with Sylvania tubes, and in short order . . .

★ ★ ★

. . . message arrives in Western Union Marine News room as facsimile reproduction, then is transmitted by an operator and simultaneously appears on tickers at offices of newspapers, customs, postal and immigration authorities, taxi, steamship companies and many others.





Link radio equipment used in Western Union Marine Reporting Service

RADIO-TELEFAX, a new type of telegraph communication, reports ship arrivals as part of Western Union's Marine Reporting Service.

Out at sea, the captain of the New York Pilot Boat spots incoming liners, writes a message such as "SS QUEEN ELIZABETH INCOMING AT 1644" on a telegraph blank and inserts it in an automatic Telefax transmitter. The unit then transmits it to Western Union over a VHF radio channel. It arrives as a *facsimile* of the sent message!

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SYLVANIA ELECTRIC

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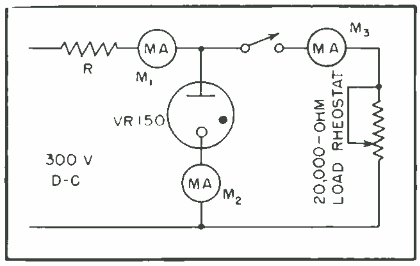


FIG. 2—Experimental setup for demonstrating filtering action of VR tube

necessary to limit tube current to a safe value. The resistance is generally selected to permit maximum permissible current thru the VR, say 30 ma, with load disconnected. Its value is calculated by dividing tube current into the voltage difference (supply voltage less tube drop). In the above example, $R = (300 - 150/30$ ma $- 5,000$ ohms.

The supply voltage should be higher than the starting voltage, which is generally about 30 percent higher than the operating voltage. A high supply voltage calls for a high limiting resistor, which aids regulation.

Referring to Fig. 1, with no load (switch open) and R adjusted for maximum permissible current thru the VR150, say 30 ma, obviously both milliammeters, M_1 and M_2 will indicate the same current of 30 ma. With load rheostat set at full 20,000 ohms and the switch closed, M_3 will indicate the load current of 7.5 ma, M_2 will decrease from 30 to 22.5 ma, and M_1 will read the sum of M_2 and M_3 or 30 ma. As the rheostat is slowly cut out, M_3 will increase at the same rate as M_2 decreases, until the VR tube goes out. Then M_1 and M_3 will read the same, and M_2 will be zero.

The more commonly used VR tubes will regulate to within 1 to 3 volts out of 105 or 150 volts, when tube current is varied between 5 and 30 ma. At smaller current variations, voltage regulation will naturally be better.

Since VR tubes will regulate against very rapid current fluctuations, they will also regulate against a-c ripple voltage, which may be likened to a periodic current variation. The use of VR tubes on a poorly filtered power supply frequently produces results ordinarily obtained through the use of an additional section of filter. The

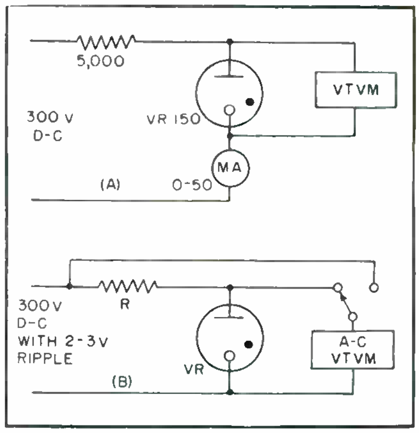


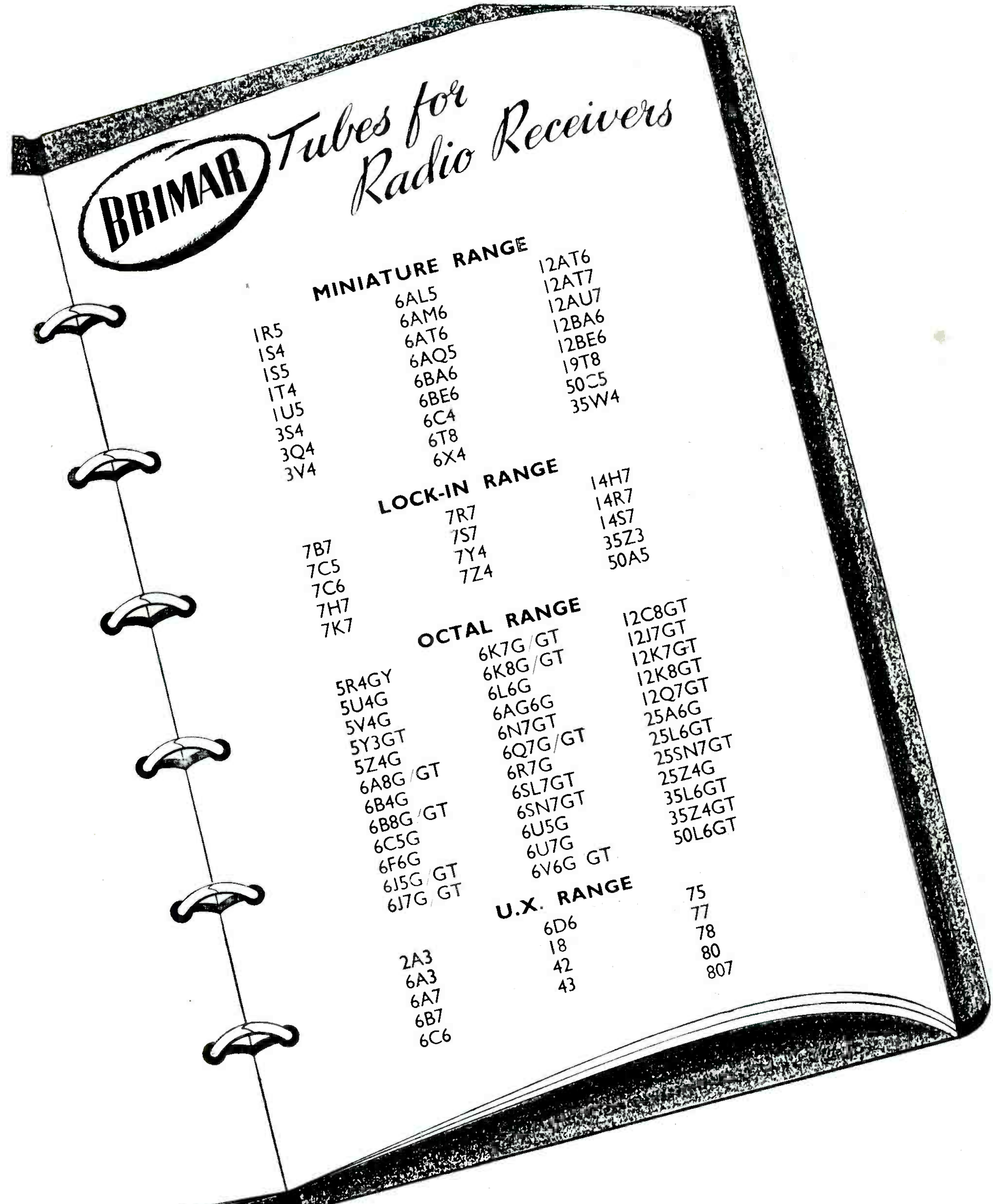
FIG. 3—Methods for determining voltage-current *(A)* and hum-reduction *(B)* characteristics of voltage-regulator tubes

filtering action of VR tubes may be easily demonstrated by a simple experiment, Fig. 2.

With all load resistance in the circuit, and the VR tube glowing, a faint hum may be heard in the phones. As the 10,000 to 15,000-ohm rheostat is decreased, a point will be reached where the glow will disappear, at which time the hum in the phones will increase considerably. Measurements with any a-c vtvm capable of reading a few millivolts will show approximately a hundred-fold reduction in ripple, when measured across the power supply and then across the VR tube.

One method of checking VR tubes amounts to an examination of the voltage-current characteristic by varying tube current while noting the change in voltage drop across the tube, Fig. 3A. While the current is varied between 5 and 30 ma, tube drop may change from 153 to 150 volts. Unless a large, open-scale voltmeter is used it may be difficult to see this small change. Greater accuracy may be obtained by inserting a fresh B battery of 135 volts in series with the voltmeter and in opposition to normal current flow, to buck out all but some 15 volts. A low-range vtvm may then be used, when a differential of 2 or 3 volts will be more readily noticeable.

The second method of checking VR tubes takes advantage of the fact that the filtering action of the tube goes hand in hand with regulating ability. An average VR105, for instance, regulates better than the average VR90; it also attenuates ripple better. A simple circuit,



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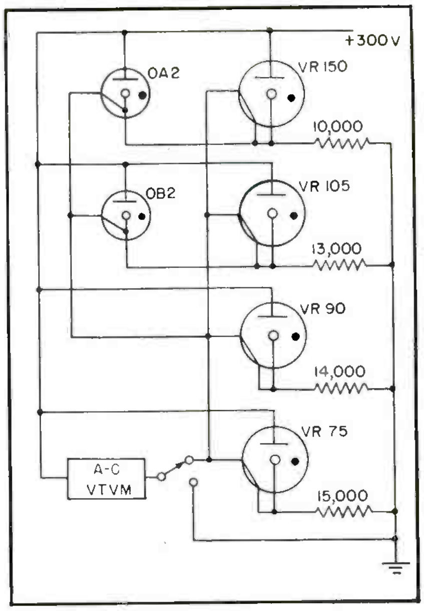

FIG. 4—Circuit diagram of simple VR tube checker. Use is made of internal jumpers to complete circuits

Fig. 3B, illustrates this type of VR tube checker.

A VR tube checker with a small self-contained power supply was constructed, and more than 100 various VR tubes were checked to demonstrate its usefulness. As shown in the schematic of Fig. 4, a separate socket for each type was installed. Advantage was taken of the built-in jumper within the tubes to complete both the power circuit and the metering circuit. Limiting resistors were adjusted to pass exactly 15 ma thru any type of VR tube during test.

Only one tube was tested at one time, by plugging it into the appropriate socket, and reading the hum in millivolts on a Ballantine a-c vtvm. The double-throw pushbutton enabled reading the power supply hum voltage ahead of the VR circuit. Since the power supply hum voltage remained constant at 2.25 volts, the push button was not often used.

The results of these comparative checks which are listed in Table I, show that good tubes had low ripple and were constant in the value of ripple. Defective tubes showed a high ripple and in addition some of these had wide fluctuations in ripple output, in one case 30 to 80 mv. This last group was seen to flicker, due to periodic changes in the areas where the glow took place.

Some of the tubes tested, particularly the OA 2 series, were defi-

EXTRA HERE'S NEWS EXTRA

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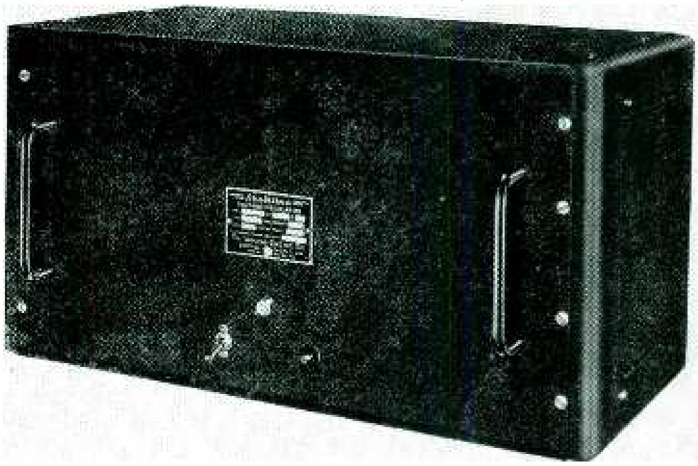
ANOTHER NEW TYPE IE HAS BEEN ADDED TO THE FAMILY OF STABILINE VOLTAGE REGULATORS



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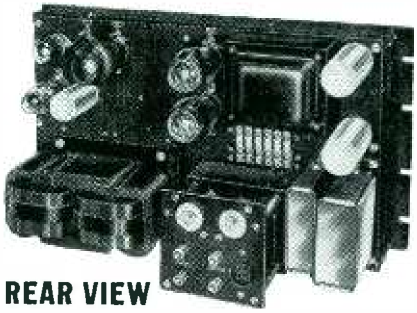
All the tubes, but one, are standard — this one made to Superior Electric specifications by a well-known manufacturer and easy to order when replacement is necessary. The 500VA STABILINE Type IE51005 is easy to order, too. No suffixes to confuse you — no "extras" or "special designs" to increase the cost. STABILINE *standard* models give you the performance of other "specials".

Complete information on the Type IE51005 and other STABILINES of various ratings and capacities is available upon request.

RATINGS

Input Voltage Range: 95 to 135 volts. **Output Voltage Range:** Adjustable between 110 and 120 volts. **Rated Output:** 0-500 volt-amperes. **Frequency in Cycles:** 60 ± 10%. **Load Power Factor Range:** 0.5 lagging to 0.9 leading. **Waveform Distortion:** *never* exceeds 3%. **Stabilization:** ± 0.1 of 1% of the preset value. **Regulation:** ± 0.15 of 1% of the preset value. **Recovery Time:** 3 to 6 cycles.



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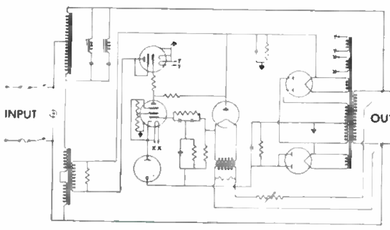
Here's compact, well-organized construction of IE51005, built to give long, trouble-free service.



CIRCUIT DIAGRAM

Operating circuit and components of the new 500VA STABILINE.

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Table I—Results of Tests on 100 VR Tubes

Tube Type	Good Tubes (mv hum)	Best Tubes (as low as)	Bad Tubes (as high as)
OA2	25 mv	18 mv	80 mv
VR150	19 mv	12 mv	45 mv
OB2	11 mv	7 mv	25 mv
VR105	13 mv	10 mv	23 mv
VR90	36 mv	28 mv	60 mv
VR75	17 mv	15 mv	24 mv

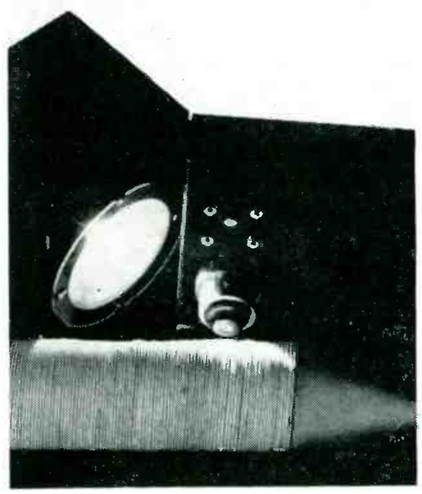
nitely known to be defective, as they were removed from equipment for that reason. Most of these had been overloaded considerably, which accounts for the high average ripple in the OA2 series.

The rest of the averages bear out tube handbook data, particularly that the VR105, and its miniature counterpart, the OB2, appear to be most efficient.

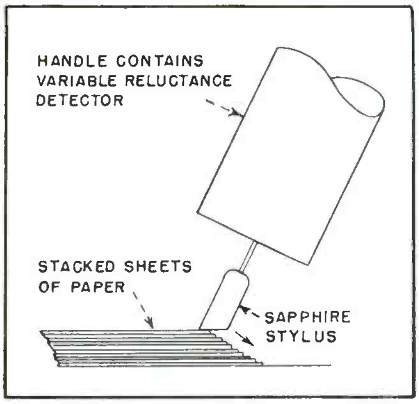
New Count Detectors

ELECTRONIC COUNTER circuits have been discussed at length in the literature (ELECTRONICS, June 1944, March 1947). These circuits, because of their simplicity and dependability, are finding more and more applications, a few of which are described below.

Basically, there are two general classifications of count detectors for electronic counters, namely, photoelectric and electromagnetic. Hitherto, the counting of extremely small objects with photoelectric detectors required the pieces being



Closely-spaced small objects are accurately counted by this new narrow-beam count detector in conjunction with standard electronic counter

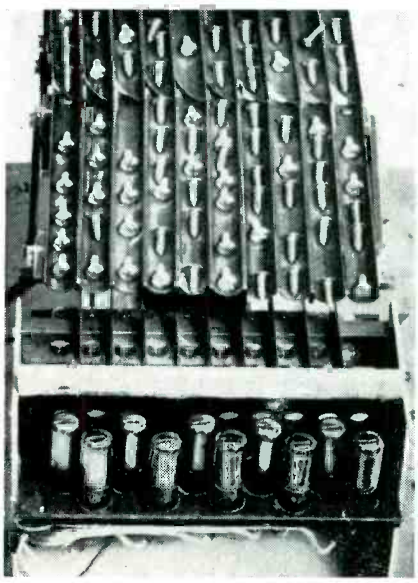


The number of sheets in a pile of paper is rapidly and accurately determined by brushing this sapphire stylus over serrated surface formed by riffling pile

counted to be spaced widely, and this was not always practical and sometimes impossible.

A new high-resolution photoelectric count detector has been developed by the Potter Instrument Company of Flushing, New York. It has a beam width of only $\frac{1}{16}$th inch, and a change in light intensity of 20 percent will actuate the circuit. In the accompanying photograph the device may be seen counting closely-packed paper cups. The light source is placed immediately beside the detector and so positioned that the reflection from the edges of the cups falls on the detector.

This system is applicable wherever closely-spaced objects are to be counted. The surface need only be rough enough to cause a 20-percent reflected light change in the $\frac{1}{16}$th-



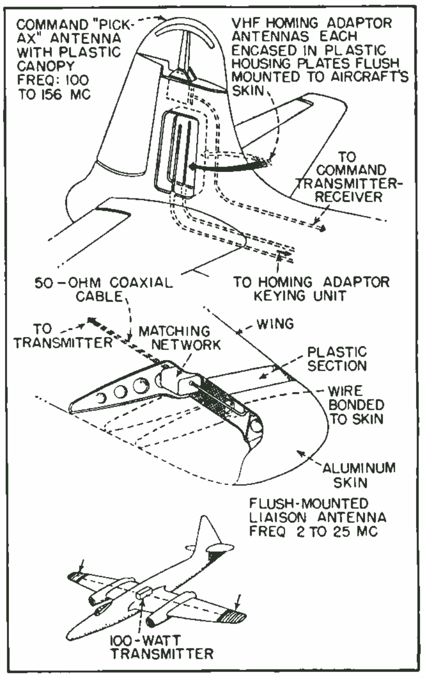
Ten paralleled phototubes view separate holes through which screws fall at rates as high as 6,000 per minute. Circuit resolves and totalizes simultaneous counts inch detector beam area.

The disadvantage of having to feed objects past a counting point one at a time has also been removed. A device which is capable of resolving and totalizing as many as ten simultaneous counts is shown counting screws. Counting rates as high as 6,000 per minute are made possible by dropping the screws through holes which are viewed by 10 parallel phototubes.

An extremely handy method of counting stacked sheets of paper is illustrated in the accompanying drawing. To find out how many sheets a particular pile of papers contains, the pile is riffled, and a sapphire-tipped stylus is brushed across the serrated surface thus formed. This stylus is mechanically linked to an iron armature which varies the reluctance of a magnetic circuit each time the stylus bumps from one sheet to the next.

Flush-Mounted Aircraft Antennas

TO REDUCE AERODYNAMIC DRAG due to radio antennas on aircraft flying at very high speeds, the Air Materiel Command has found it necessary to mount antennas inside the airplane structures. The first result from experiments with this



Flush mounted antennas for use in high-speed aircraft. Tests show them superior to exterior antennas in many ways problem was the development of the "pick-ax" antenna which is flush mounted in a plastic cap on the airplane's vertical stabilizer. Similar installations for command communications are now being specified for many types of aircraft.

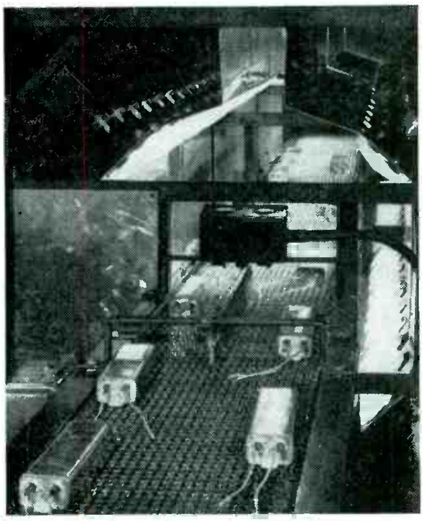
Instrument-approach and radio-compass antennas for high-speed bomber and fighter aircraft are also being moved inside the airplane. Several different types of internal installations are shown in the accompanying drawing.

For larger planes, where as many as nine antennas are required, practically all fuselage, wing and empennage extremities may be used to house antennas. Flight tests have proved that such installations perform as well or better than exterior antennas.

Infrared Checks Capacitor Leakage

A NEW application of infrared radiation is that of detecting leakage in metal-cased capacitors, as practiced at the Coventry works of the British Thomson-Houston Co. Ltd.

The capacitors are first placed in a degreasing bath to ensure that the outer casings are completely free from any traces of the petroleum jelly with which they are filled. A wire-mesh conveyor belt then carries them in two rows, at a speed of 18 inches per minute, into the infrared oven where they



Capacitors passing through Mazda infrared oven during test for leakage are subjected to a moderate heat. While passing through the oven the petroleum jelly is melted and if leaks occur in the metal casings, they are indicated by the presence of grease.

The infrared oven is constructed along the usual lines, the lamps and polished aluminum ventilation control panels being housed within an enclosure of aluminum sheeting on an angle-iron framework. Great care has been taken to secure adequate ventilation which, although permitting cold air to circulate and to cool the lamp caps, ensures that the air inside the oven remains at a reasonably constant temperature. Ventilation problems are simplified as no solvents are used during the process. The ventilation control panels ensure the utmost efficiency by reflecting any stray infrared rays back on the capacitors. A total of seventy-two lamps are mounted in four rows, two rows on each side of the oven.

The electrical circuit of the infrared lamps is wired to the circuit controlling the conveyor belt so that should the belt stop, the lamps will automatically go out, avoiding overheating of the capacitors which are still in the oven.

THREE-SPEED PLAYER

Two pickup arms and a speed-adjustable motor permit this record player to handle conventional records, as well as those of Columbia and RCA Victor. The large diameter hole of the latter is accommodated by a brass collar that slips over the normal spindle. Developed by Scott Radio Laboratories, Inc. of Chicago, the player is automatic on 78-rpm disks and manual on long-playing types

(continued from p 130)

New York City. The following is an abstract of the information presented in that paper.

Introduction

A good picture should appear to the eye to have a contrast range of approximately 30 to 1. This means that the highlights of such a picture, when viewed with surrounding illumination, should be about 30 times brighter than the darkest shade obtainable at the same time.

Paintings, drawings and photographs usually display deep satisfactory shades of blacks since the dyes, paints or printing inks employed for black are extremely light absorbent, thus ensuring adequate contrast range. Regardless of the amount of light directed onto a photograph or painting, the contrast range remains the same.

Motion pictures and television derive their blacks from an absence of light and hence cannot present darker shades than those determined by the surrounding light. In order to approximate the contrast range of the original scene, the highlights of these images have to be many times brighter than the ambient room illumination. Motion picture projectors are unable to furnish this extra brightness and, therefore, the pictures must be viewed in the dark. Television pictures, however, are generally viewed in normally lighted rooms. Let us examine what happens to television images under such conditions.

The light reflected from the walls of the average artificially-lighted room is seldom in excess of 5 foot lamberts. Allowing for reflection loss, this also represents the maximum highlight brightness of the pictures and photographs on the walls of such a room. During the day, with natural illumination, the brightness values are higher. It is safe to assume that television would rarely be viewed in rooms where the illumination of the area surrounding the receiver would be more than 20 foot lamberts.

The majority of the current black-and-white direct-viewing television receivers, when located in rooms where the ambient illumination is 20 foot lamberts, reflect approximately 15 foot lamberts from their screens. In order to obtain a contrast range of 30 to 1 in pictures produced by these receivers, the necessary highlight brightness would have to be 15 x 30, or 450 foot lamberts.

It is quite conceivable that commercial direct-view type receivers some day will be capable of furnishing a highlight brightness of 450 foot lamberts. It is doubtful, however, that this would be a satisfactory solution, since viewing such a bright image without a correspondingly bright surrounding would be uncomfortable. Assuming that the presently used field repetition rate of 60 per second were employed, such a picture would, in addition, display objectionable flicker.

Actually, many receivers do not furnish more than 30 foot lamberts measured on a blank raster. Thus, with an ambient illumination of 20 foot lamberts, the maximum contrast range will not be in excess of 3 to 1 (the ratio of the maximum highlight brightness of 30 plus 15 foot lamberts to the reflected ambient room light of 15 foot lamberts). If one wished to obtain a contrast range of 30 to 1 with these receivers, the reflected illumination from the screens would have to be not more than one-thirtieth of the maximum highlight brightness, or 1 foot lambert.

For adequate image recognition, contrast range is thus more important than mere brilliance. This is substantiated by the curves shown in Fig. 1 and 2, which show that increasing image brightness beyond about 2 foot lamberts has little effect on contrast discrimination and visual acuity.

Figure 1 illustrates how visual acuity varies with brightness. A visual acuity of 1.0 represents the capacity of the eye just barely to resolve detail which occupies one minute of the visual angle, which corresponds to a resolving power of 20/20. The test object used in

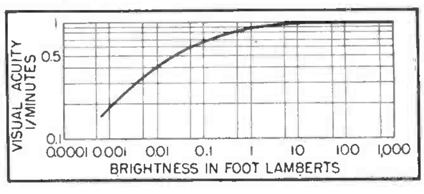


FIG. 1—Curves showing effect of increasing brightness on visual acuity

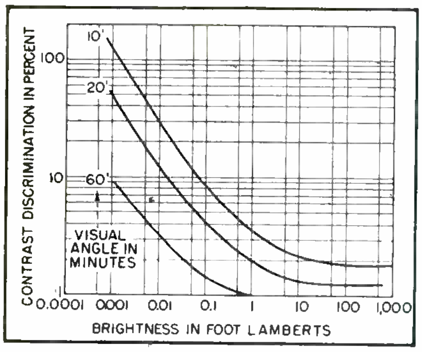


FIG. 2—Increasing brightness pays off in terms of contrast discrimination only to a certain extent, as shown by this set of curves for several different visual angles

plotting this curve was a grating consisting of black and white bars.

Applying this visual acuity of approximately 1, a television picture with 500 active scanning lines would have to be viewed a distance of about seven times the picture height in order that the available detail be resolved.

Figure 2 indicates the smallest contrast the eye can see at different brightnesses as applied to three different sizes of test areas. The relative position of the three different curves shows the inverse ratio between object size and required contrast for perception.

Experimental Set-Up

To determine experimentally the validity of the above theories, the simple test set-up shown in Fig. 3 was used at the CBS laboratories to determine the effect of trading higher brightness and low contrast range for lower brightness and high contrast range, by the use of a 33-percent-transmission neutral density filter placed in front of a 15 x 20-inch screen on which colored picture slides were projected.

Without the neutral density filter, the projected color picture had a highlight brightness of 60 foot lamberts and contrast range was about 13 to 1. With the filter in front of the screen, the highlight

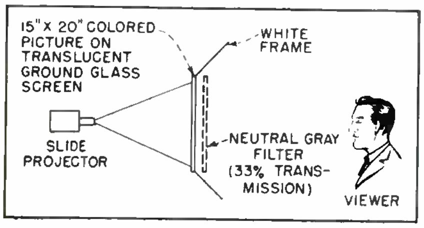


FIG. 3—Simple test setup used at CBS laboratories to determine effect of neutral density filters for typical observers

brightness was reduced to one-tenth of its original value, or roughly, ½ foot lambert. As a result the contrast range was trebled and became 40 to 1.

In each test, picture highlight brightness was adjusted to measure 60 foot lamberts without the filter. Of a total of 49 observations, 43 resulted in preference for the picture with the filter, while the remaining 6 indicated no preference. Not one observer reported preference for the picture with greater brightness but less contrast.

Experiments with visual acuity and with contrast recognition have shown that both reach their optimum for a given brightness when the surrounding illumination is about the same as the locally illuminated area. A surrounding which is too bright or too dim tends to decrease the effectiveness of the visual functions.

In the CBS color television system, color filters in front of the cathode-ray tube reduce highlight brightness from 200 foot lamberts (at the screen) to 20 or 25 foot lamberts. This loss of light is, however, compensated for to a large extent by greatly improved contrast range in the presence of ambient illumination.

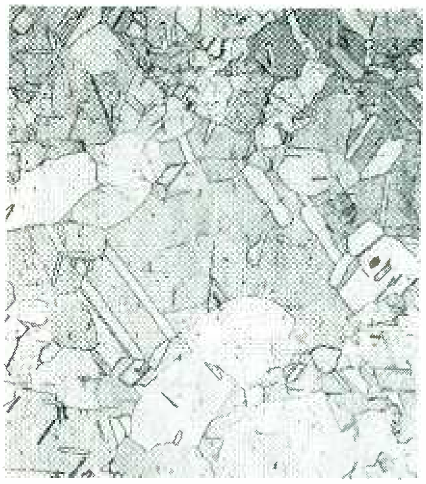
From the aforesaid, it is evident that in the presence of surrounding illumination, improved picture rendition can be provided in direct-viewing black-and-white receivers through the use of neutral density filters. These filters may be thin layers of cellophane, or any other suitable light-absorbing material. This process of improving rendition through reduction of picture brightness appears to be paradoxical, and for that reason is misinterpreted frequently.

Copper in Electronic Tubes

By R. Carson Dalzell

Chief Technical Advisor
Revere Copper and Brass, Inc.
New York, N. Y.

Copper plays an important role in electronic tubes, hence a knowledge of its general properties assists one in understanding the electrical and mechanical characteristics of tubes. Furthermore, although only the few engineers who are directly con-



Photomicrograph of cross-section of oxygen-free copper shows its uniform grain size at 75 times enlargement

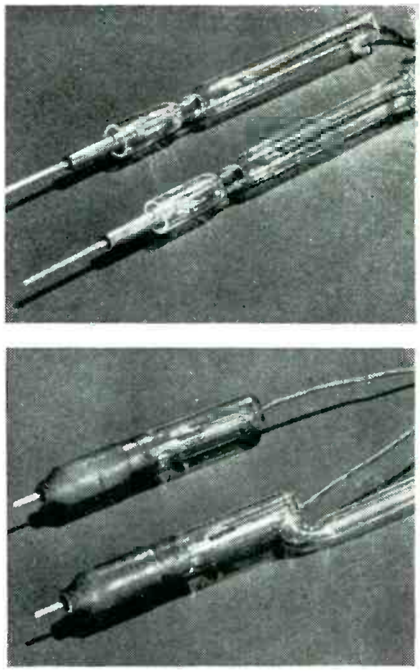
cerned with tube design need be familiar with tube materials in detail, equipment designers can make fuller use of tubes and appreciate better what special features can and cannot be built into them with the present state of the art if they know more about the materials of which tubes are made.

Properties of Copper for Tubes

Because electronic tubes are evacuated either permanently or prior to being filled with special gases, they must be made of materials that are as free from deleterious gas as possible.

Oxygen-free high-conductivity (OFHC) copper is uniformly dense and relatively free from porosity so that it neither permits air to enter a tube made from it nor complicates exhaustion. The high purity and uniformly small grain size of this copper minimize the likelihood of faults at copper-glass seals and give high electrical and thermal conductivity. It may be drawn, spun, formed, rolled, cold extruded, turned, milled and shaped. All of these techniques are used in tube fabrication to obtain the wide variety of shapes needed.

Because this copper forms an adherent and uniform oxide that the glass of a seal can wet, it produces vacuum-tight seals. It is sufficiently ductile so that, in forming seals by the Housekeeper or modified Housekeeper methods, it is unnecessary to match the coefficient of thermal expansion of the glass and the copper. This copper also brazes well so that vacuum-tight soldered



Two types of pipe seals: (above) coaxial press seals and (below) feather edge seals for magnetron filament leads

joints can be made between the copper of a glass seal and other metal parts of a tube. The copper can be cleaned by standard methods and also has low vapor pressure at high temperatures and under vacuum as it does not contain impurities that would boil off during pumping and poison the cathode. Other grades of copper are apt to become embrittled by exposure to the gas flame used in making the copper-to-glass seal or during brazing.

Common Types of Seals

There are three common basic types of seals, each of which has its particular applications: (1) pipe or lead seals, (2) disc or ribbon seals and (3) seals to external anodes.

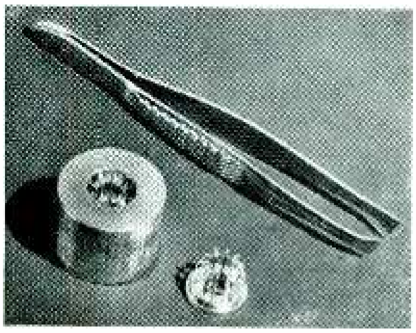
The filament connections to magnetrons illustrate the pipe-type seal. For these seals the leads are made of OFHC copper rod, to which flexible leads can be attached if needed. The rod is oxidized and the softened glass pressed about it in a glass lathe. Another form of pipe seal is made by first drilling an accurately centered hole in the rod, through which the lead will pass. The end that is to fit into the magnetron anode block is threaded and the outside diameter turned down. Then a cone is fastened at the other end by turning, rolling or spinning on a mandrel. This produces a feather edge that is only 0.0015 to 0.0025 inch thick, to which the glass is

Disc seals such as in this T-R tube are possible because of the thinness and ductility of the copper

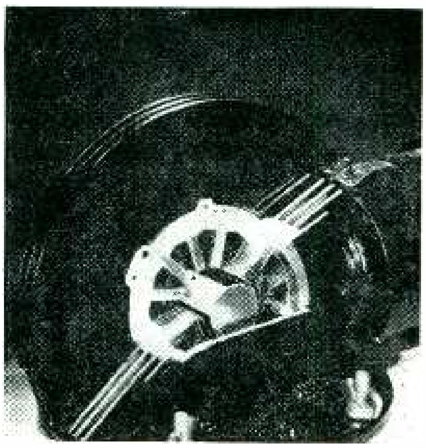
sealed. Tubing might be used in place of rod, but its use would limit the latitude of design. However, by turning the parts from appropriately sized tubes and brazing them together, machining and scrap co ts can occasionally be reduced.

At ultrahigh frequencies, seals that permit direct passage of the electric fields are used. A typical example is the disc or ribbon seal in klystrons and T-R tubes. They are made of OFHC copper with a deep-drawing temper by first stamping wrinkles in the disc to permit expansion and contraction under heating and cooling and then by finish-drawing to final shape. To retain the small grain size and prevent excessive work hardening during drawing, it is necessary to anneal the copper between drawings. Small grain size in this application is important because it gives a smooth (low-resistance) surface. The copper part of the seal is very thin, about 0.001 inch, and so can be butt-sealed effectively to the glass.

In high-power transmitting tubes the anode forms a part of the external tube envelope so that it can be cooled. Copper that is nonpor-



Tube parts can be machined from solid copper or built up and brazed together from smaller pieces



Anodes of magnetrons are made in quantity from stampings consolidated into a vacuum-tight whole by silver brazing. Alternate stampings have larger outside diameter to form cooling fins. Such techniques simplify production of complex shapes

ous (high density) and has high electrical and thermal conductivity is required in this application. The anodes are formed by deep drawing, the edge being rolled or machined to a feather edge for sealing to the glass portion of the tube. Cooling fins can be milled in the side walls of the anode or built up separately and brazed on.

Fabrication Techniques

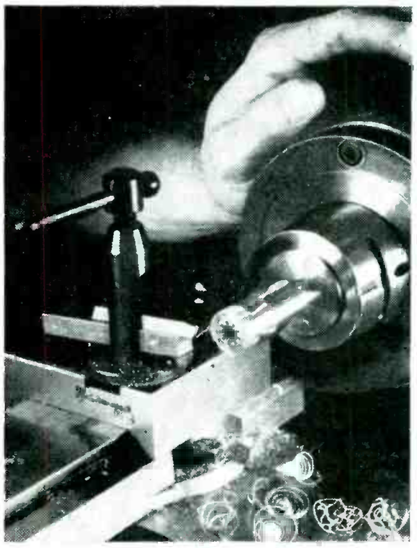
Although the machining qualities of OFHC copper are only fair in comparison with some other metals commonly encountered in the shop, techniques have been developed for its working. In preparing the metal for further machining in volume production, carbide-tipped standard slitting or high-speed steel saws are recommended. For cutting with carbide-tipped tools, a top rake angle of 20 to 30 degrees and a 5 to 8-degree side clearance angle are best; cut at 250 to 300 feet per minute.

Precision-ground taps should be used for internal threading, maintaining close tolerances on the pitch diameters of the tap. In some cases standard gun taps can be used. External threading can be done with self-opening die heads on which the chasers have a 15-degree radial hook to facilitate chip clearance. (Landis, Geometric or Jones and Lamson tapping heads have been used with success.) Coolants must be free of sulphur to avoid contamination. (Paragon Lardoil, Cutrite and sulphur-free Acorn No. 10 cutting oils give good results; others can be used.) Spiral milling cutters are preferred, four-flute fast spiral end mills producing the best results for end milling.

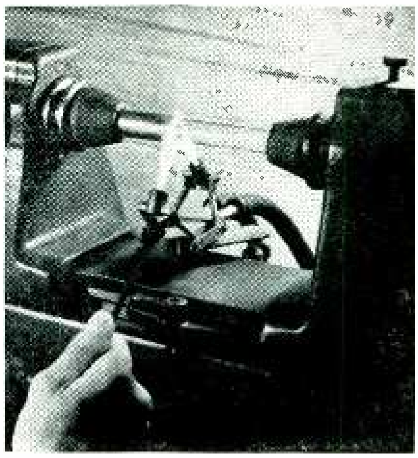
Once the copper part has been shaped for the seal, it is chucked on one spindle and the glass tubing on the other of a glass lathe. As both parts revolve, multiple jets of utility gas, air and oxygen are played on the main body of the copper part. The tapered feather edge, which is very thin and susceptible to oxidation, heats by conduction from the main body. The glass part is next heated until it becomes plastic. The two parts are moved together until they fuse to form the seal.

The oxidizing flame that heats the parts forms a uniform layer of oxides on the copper, the cuprous oxide acting as wetting agent for the glass and at the same time adhering strongly to the base metal. A carbon spatula and air pressure can be used to shape the glass for the seal. To clear the copper before beginning the seal or if excess oxide is formed, a solution of acetic acid and sodium chloride is used.

Disc seals can be formed in several ways. The disc and glass can be jigged inside a glass cylinder containing an inert gas (CO_2 or N_2) and induction heated, the glass adjacent the copper heating sympathetically. In this method either a borated or a preoxidized copper disc is used. This technique avoids the need for removing excess oxides from the disc after the seal is formed. Another technique is to pass a preoxidized disc, on which



Properly shaped carbide-tipped tools enable oxygen-free copper to be machined without working contaminates into it



End seal being made in glass lathe illustrates technique whereby pipe and external anode seals are made

powdered glass has been placed, through an oven to form a glass nub to which the glass of the tube can later be joined in a glass-glass seal.

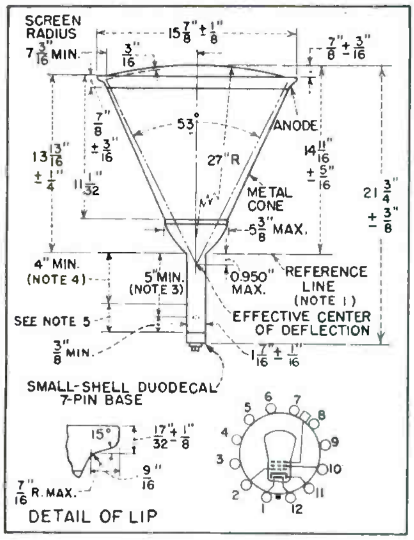
Press leads at the outer end of filament pipe tubulations are made with borate wire. External anode seals are made in a glass lathe with gas heating or on a jig with induction heating.

Whereas large anode blocks for magnetrons and the like were initially machined from solid copper blocks, it is simpler and quicker in production to build them up by brazing stamped parts together. Alternate stampings are made of different outside diameters to provide radiating fins. To braze the parts they are placed in fixtures interspersed with silver solder wire or gaskets and passed through reducing-atmosphere furnaces. Capillary action makes the solder flow between the copper parts. For this method of fabrication eutectic silver, a silver-copper alloy, is usually used.

Metal-Wall Picture Tube

REGISTRATION of the new 16-inch metal-wall television picture tube as type 16AP4 has been announced by the RMA Data Bureau simultaneously with release of defining data as set forth here and in the accompanying diagram.

The tube has a white P4 screen of medium persistence, and uses magnetic focusing and deflection along with a magnetic ion trap. Heater requirements are 6.3 volts



Dimensional specifications and basing diagram of type 16AP4 tube.

NOTE 1: Reference line is determined by position where hinged gauge 1.500" + 0.003" — 0.000" I.D. and 2" long will rest on cone

NOTE 3: Distance to internal pole pieces. Plane through pin No. 6 and tube axis passes through line joining centers of pole pieces. Direction of principal field of ion-trap magnet should be such that North Pole is adjacent to pin No. 6 and South Pole to pin No. 12

NOTE 4: Location of deflecting yoke and focusing coil must be within this space

NOTE 5: Keep this space clear for ion-trap magnet

at 0.6 amp. Maximum ratings are: E_b = 14 kv; E_{c2} = 410 v; E_{c1} = −125 v. Typical operating values are: E_b = 12 kv; E_{c2} = 300 v; E_{c1} = −33 to −77 v.

New Microwave Triode

ALTHOUGH the present New York to Boston microwave radio relay system using velocity-variation tubes can be extended to somewhat longer distances without appreciable distortion, it is fairly certain that severe amplitude and phase distortion would occur if a coast-

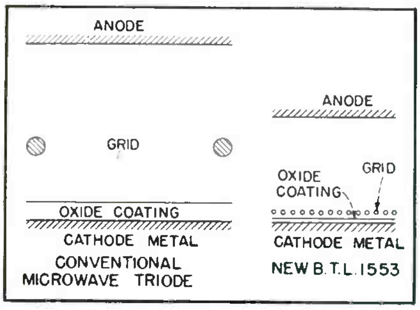


FIG. 1—Comparison of electrode spacing in ordinary microwave triode and the recently-developed BTL 1553

to-coast linkage were attempted. Moreover, the required equalizer networks would be difficult and costly to apply. This situation is due to a fundamental limitation on the amount of bandwidth and gain obtainable with klystrons. Realization of this led to the development of a new close-spaced planar triode for 4,000-mc operation. Technical details presented here are based on papers presented by J. A. Morton and R. M. Ryder of Bell Labs at a New York City IRE Section Meeting and at the AIEE Winter General Meeting.

Triode Design Limits

In a triode the upper transconductance limit of approximately 11,000 micromhos per ma is reached when cathode and grid are so close that the electron velocity produced by the grid voltage is small compared to the average Maxwellian velocity of the cathode emission. Ordinary microwave triodes are still a factor of 20 to 25 below this limit.

By translating the known requirements on gain, bandwidth and power output into specifications on the actual triode dimensions, it was found that the input spacings of existing commercial planar triodes had to be reduced by a factor of about five times and cathode emission densities had to be increased by about 3 to 4 times. A tube design was then evolved in which the required close spacings could be produced to close tolerances by methods that do not require specialized laboratory skills.

Tube Construction Details

For comparison, Fig. 1 illustrates the electrode spacing of the new BTL 1553 tube and a commercially available microwave triode. The cathode oxide coating of the new tube is ½ mil thick, grid-cathode spacing is 6/10 mil, grid wires are ⅓ mil in diameter wound at 1,000 turns per inch and the grid-anode spacing is 10 mils.

The cathode subassembly is illustrated in Fig. 2A. The nickel cathode core is mounted in a ring of low-loss ceramic in such a manner that the nickel and ceramic surfaces may be precision ground flat and coplanar. A four-legged molyb-

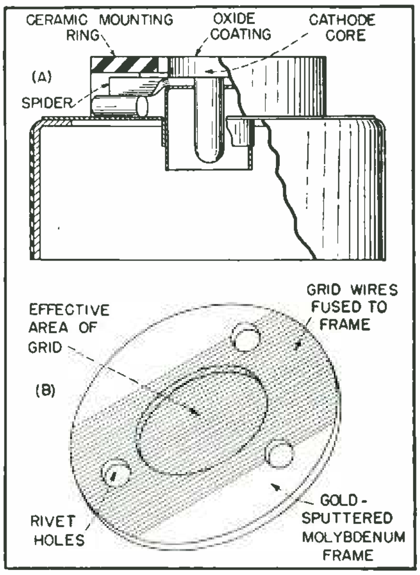


FIG. 2—Cutaway view of cathode subassembly (A) and grid structure (B)

denum spider supporting the cathode is held in the ceramic in such a way as to prevent buckling by providing free radial expansion without any axial movement.

A special automatic spray machine applies a smooth $\frac{1}{2}$ mil $\pm$ 0.2 mil oxide coating on the cathode under controlled specifiable conditions that ensure long life. The coatings are two to four times as dense as in existing commercial practice.

The grid assembly is shown in Fig. 2B. The grid wires are $\frac{1}{3}$-mil tungsten wire wound at 1,000 turns per inch around flat polished molybdenum frames which have been previously gold sputtered. The winding tension is held to about 15 grams, which is 60 percent of the breaking strength of the wire, by means of a drag cup motor brake. This unusually high tension is essential to prevent sagging under influence of cathode heat.

The gold is melted to braze the wires to the frame. The mean deviation in wire spacing is less than about 10 percent. Proper spacing of the grid is obtained by means of a thin copper shim placed between the cathode and the grid frame.

The grid and cathode assemblies are held together under several pounds force, maintained by a molybdenum spring on the bottom of the assembly, by three synthetic sapphire rivets which are fired on the ends with matching glass. The cathode connector is welded to a glazed capacitor can which provides an internal bypass capacitance

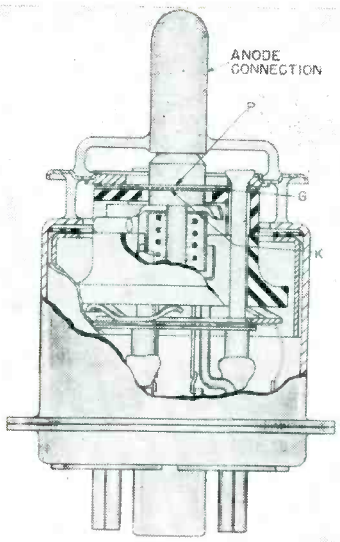


FIG. 3—Cutaway view of assembled triode, showing relative positions of elements

from the cathode to the shell of the bulb.

The final assembly is shown in Fig. 3. The grid-cathode by-pass assembly is inserted into the preformed Kovar-7052 glass bulb and the press carrying the heater is welded to the cathode can. The grid-anode spacing of 10 mils is easily obtained by means of the adjustable anode plug.

Electrical Performance

Characteristics for the type 1553 triode are given in the accompanying table. At a plate current of 25 ma, the transconductance per milliampere is about 2,000, or one fifth

Characteristics of 1553 Microwave Triode

Low-Frequency Characteristics (10-percent tolerance)
$V_p = 250$ v, $I_p = 25$ ma
$V_g = 0.3$ v
$g_m = 50{,}000$ μmhos $C_{kg} = 10$ $\mu\mu$f
$\mu = 350$ $C_{gp} = 1.05$ $\mu\mu$f
$r_p = 7{,}000$ ohms $C_{kp} = 0.005$ $\mu\mu$f

Amplifier at 4,000 mc (bandwidth 80 to 100 mc)
Class A — Gain 7 to 10 db
Class B — Gain 4 to 6 db; power output 0.5 to 1 watt; plate dissipation 6 watts

Modulator (65 to 4,000 mc)
Bandwidth: 60 to 80 mc
Gain: 4 to 6 db
Power output: 20 milliwatts
Local oscillator power: 150 milliwatts

of the theoretical upper limit. At lower currents this figure is higher; at 10 ma it is 3,000.

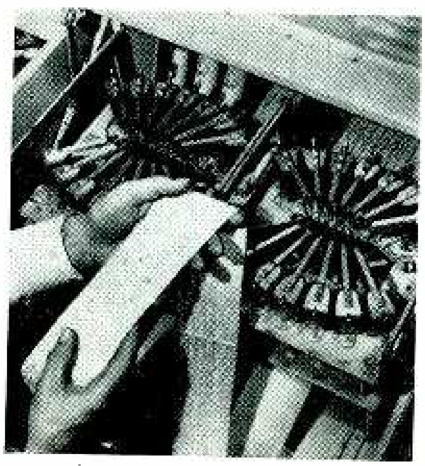
One stage of class-A amplification using simple resonant cavities and coupling windows will provide 7 to 10-db gain at 4,000 mc over a 3-db-down bandwidth of 80 to 100 mc.

A new amplifier circuit has recently been developed which provides considerably greater gain-band products with the 1553 triode in the 4,000-mc range. For example, gains of 8 db at bandwidths of 200 mc for a gain-band product of 1,250 mc have been obtained.

The tube also works well as a harmonic generator. It has produced enough power for use as a 4,000-mc transmitting oscillator from a chain of multipliers beginning with a piezoelectric crystal oscillator at 40 mc. The last stage of this array is a 1553 doubler going from 2,000 to 4,000 mc with a gain of from 0 to 3 db at an output level of 300 milliwatts.

SURVEY OF NEW TECHNIQUES

AN AUTOMATIC message accounting system that will be extended to other central offices has been installed in the Philadelphia area of the Bell Telephone System. In operation, the equipment first determinates the type of message rate for the call. A tape perforator records the numbers of the calling and called parties and the time the call begins and ends. The tape is

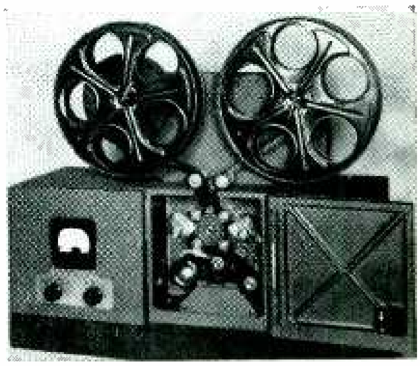


Tape punching equipment records a coded pattern for calling and called numbers, month, day and time to tenths of minutes at which each conversation begins and ends

then transferred to the accounting office where another machine tabulates the stored data ready for billing. Like the dial system, this equipment is a stride in reducing telephony to an entirely automatic basic.

RURAL RADIO receivers in Russia are being powered by wind-driven generators. The present sets that are in production at a Moscow factory, each of which operates hundreds of loudspeakers and has provision for a record player and microphone for reproducing speeches at collective farm meetings, are too powerful for average collective farm communities. Accordingly, factory engineers have designed a compact set the 6–8 volt generator of which is driven by wind vanes of 7-feet diameter. Storage batteries float on the line to operate the receiver, which has a 3-watt output for operating 30 to 40 loudspeakers, and lighting. This receiver is undergoing laboratory testing prior to organization for mass production.

MAGNETIC recording techniques are used to simplify operation of motion picture equipment on location in a new RCA recorder (Model PM-61). The unit is a modification of a photographic recorder. Although it employs standard size 35-mm film, one side of the film is coated with iron oxide powder. Immediate playback is thus possible; the life of the record is virtually limitless.



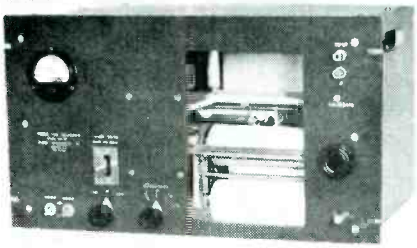
Magnetic recording makes possible this portable film sound recorder for use on location, which has reduced size and weight over comparable optical equipment. Unit at lower center houses both recording and playback heads

(continued from p 134)

comprises a mount casting and attaching bracket supporting a motor and magnetic clutch for the magazine take-up drive. For users who desire continuous viewing of the c-r tube screen during recording, there is now available a binocular split-beam viewer equipped with a special color-selective filter that obviates the danger of fogging film when a P11 screen is used.

Graphic Sound Recorder

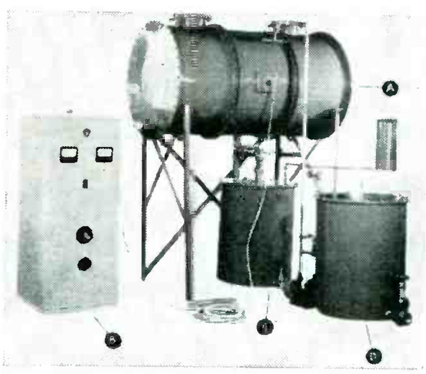
SOUND APPARATUS Co., Stirling, N. J. Model FRA direct ink-recording instrument plots a curve of any changing measurable quantity that can be converted into a d-c or a-c voltage. Ranges can be recorded on either a linear or logarithmic scale. The unit illustrated is available in



56 double-chart-speed combinations from 45 inches per minute to 0.5 inch per hour and for recording frequency ranges from 2 to 200,000 cycles. A calibration control is built in. Typical applications include the fields of acoustics, electro-acoustics, noise and vibration, loudness, strain and pressure, and field strength.

Electronic Gas Filter

TRION, INC., 1000 Island Ave., McKees Rocks, Pa. Unit 11594 is a new electronic gas filter to enable steel mills to clean the coke oven gas that accrues as a by-product in



ULTRA SENSITIVE D. C. AMPLIFIER

An Electronic Replacement For Sensitive Galvanometer Systems

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d.c. and low frequency a.c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

It has been employed for the amplification of infra-red detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

Among the advantages of this amplifier are the following:

1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 μ V after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

THE PERKIN-ELMER CORPORATION

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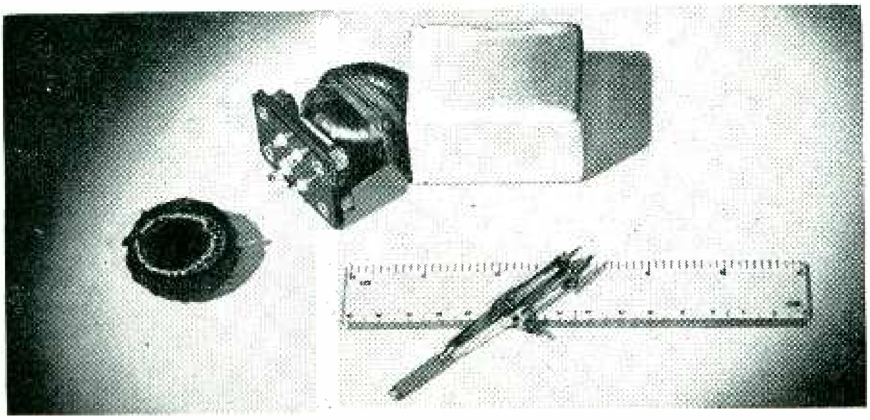

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Made with two balanced windings, tapped or untapped, impregnated or not, as required. Also available with close-coupled secondaries for impedance-matching applications. Write for further data:

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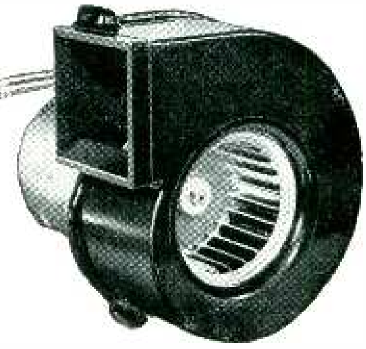

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400-800 Cycles—140 C.F.M.
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GEAR MOTORS, AXIAL FLOW FANS AND MOTORS ALSO FURNISHED

These Induction Motors and Blowers are designed for use with engine driven alternators supplying variable frequency power throughout a wide range. They are very suitable for use in cooling tubes and amplifier boxes, band switching or driving mechanisms on military and electronic equipment.

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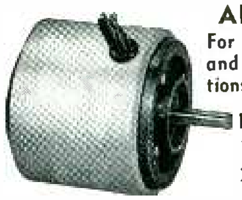

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PURE WAVE FORM

1, 2, or 3 Phase

2, 4, 6, 8, or 12 poles

All Frequencies

Special Types for customer needs
Standard Types Available.
Continuous Duty

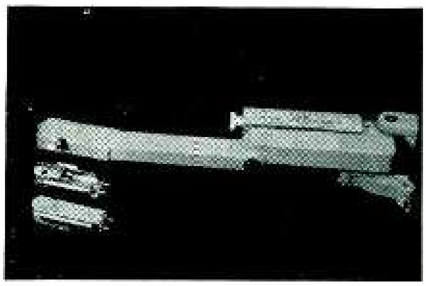
N2A	115V; 3 Phase, 45VA, 400 cycle at 6000RPM
N2B	115V; 2 Phase, 15VA, 60 cycle at 3600RPM
N3C	15V; 1 Phase, 1.1VA 180 cycle at 3600RPM
N4A	70V; 1 Phase, 10 VA, 60 cycle at 3600RPM
N6A	45V; 1 Phase, 25 VA, 1000 cycle at 5000RPM

EASTERN AIR DEVICES, INC.
585 DEAN ST., BROOKLYN 17, N.Y.

DESIGNERS AND BUILDERS OF STANDARD AND SPECIAL ROTATING EQUIPMENT the manufacture of coke. Power requirements are 11 kw, either 110 or 220-volt, single-phase, 60-cycle a-c.

Pickup Arm

PROCTOR SOUNDEX CORP., 133 North 6th Ave., Mount Vernon, N. Y. The new pickup arm features a carrier which slides the cartridge in and



out of the unit offering instant substitution with all standard and l-p microgroove cartridges; a stylus pressure scale inscribed in grams and a zero setting pointer; and a stylus pressure selector knob.

Dynamic Noise Suppressor

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. The new oversize output transformer of the 210-A laboratory amplifier with dynamic noise sup-

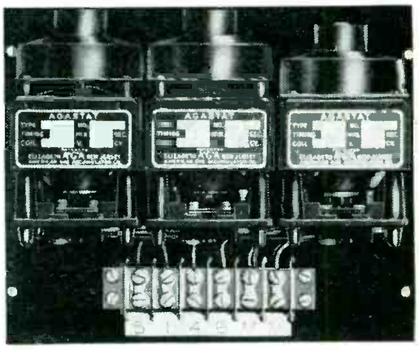
pressor reduces hum level to 86 db below maximum power output under normal operating conditions. Actual hum power level is 0.05 microwatt.

Accelerometer Tube

MULLARD ELECTRONIC PRODUCTS LTD., Century House, Shaftesbury Ave., London WC2, England. Type DDR100 accelerometer tube is an all-glass loctal type that may be mounted in any attitude, for the measurement and recording of vibration on aircraft in flight. It is a double diode with anodes elastically supported so that the anode impedance is varied when the tube is subjected to acceleration. In practice, the tube is rigidly clamped to the structure under test and the measurement is expressed in terms of a current change in a Wheatstone bridge circuit of which the anode-cathode impedance of the accelerometer tube forms adjacent arms. The frequency range over which the response to a sinusoidal acceleration can be considered independent of frequency is 0 to 250 cycles. The resonant frequency of the tube is 1 kc and the maximum acceleration range is 100g.

Time Delay Relay

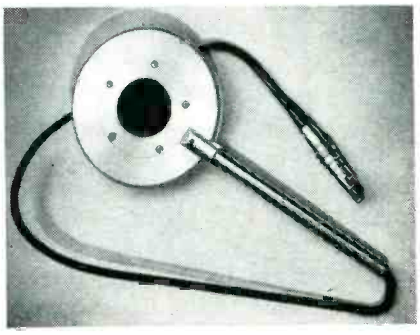
AGASTAT DIVISION, AMERICAN GAS ACCUMULATOR CO., 1029 Newark Ave., Elizabeth 3, N. J. The new time-delay relay for radio and television transmitters provides an



initial time delay of one minute. Time delay starts when the coil is energized. Once the timing cycle is complete the unit switches off. Restoration of power within 1 to 15 seconds instantaneously re-establishes the circuit. After 16 seconds, time delay is proportional to the length of time of the power failure.

Piezoelectric Gages

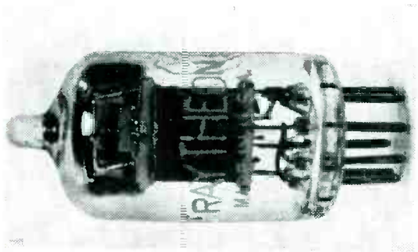
CAMBRIDGE THERMIONIC CORP., 437 Concord Ave., Cambridge 38, Mass., now has available piezoelectric



gages for measuring pressures of instantaneous nature from a few pounds to 30,000 psi. Their usefulness lies in their ability to measure shocks of high magnitude when transmitted through liquids, gases, and, at times, through solids.

Ruggedized 6AK5

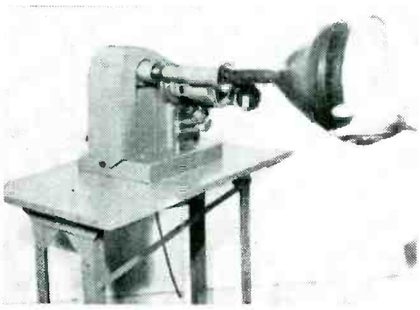
RAYTHEON MFG. CO., Newton, Mass. Type CK5654 is a ruggedized version of the type 6AK5 tube that incorporates several additional fea-



tures. The heater is designed to withstand at least 5,000 on and off cycles at 7.5 volts. The type was developed especially for applications such as in aircraft equipment in which the standard tube sometimes failed.

C-R Tube Printer

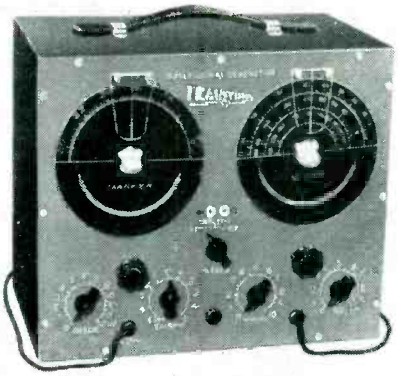
MARKEM MACHINE CO., Box 480, Keene, N. H. Model 13A cathode-ray tube printer is used to imprint upon the base of television tubes the manufacturer's trade mark and



type number. The operator places the end of the tube into the fixture, depresses a foot treadle and the machine places the imprint on the tube.

Sweep Signal Generator

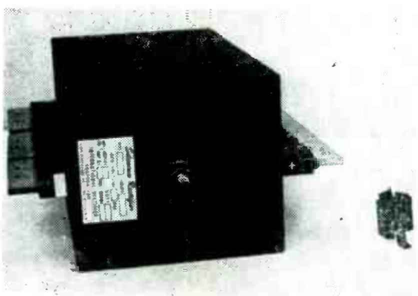
TRANSVISION, INC., New Rochelle, N. Y. Model SG sweep signal generator for television and f-m covers the range from 0 to 227 mc with no band switching. Sweep width is



variable from 0 to 12 mc, and a marker generator is built in. Output impedance is 5-125 ohms. There are directly calibrated markers, 20 to 30 mc for trap, sound and video i-f alignment.

Selenium Rectifiers

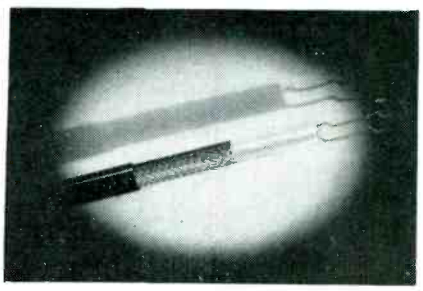
INTERNATIONAL RECTIFIER CORP., 6809 S. Victoria Ave., Los Angeles 43, Calif. The selenium rectifier stack illustrated features a special moistureproof finish capable of withstanding salt spray for periods



up to 200 hours. Plates are made in six different sizes. Power requirements from 2 volts and 150 ma up to 5,000 volts and 10,000 amperes can be handled with efficiencies varying from 65 to 85 percent. Each plate is rated at 26 volts rms inverse voltage.

Television Leadin

FEDERAL TELEPHONE AND RADIO CORP., 100 Kingsland Road, Clifton, N. J. Intelin L-111 is a new 300-ohm shielded, balanced line de-



signed for connecting television antennas to receivers. External noise that would normally be picked up by an unshielded line acting as an antenna is thereby eliminated.

High Voltage Supply

GENERAL ELECTRIC CO., Schenectady 5, N. Y. A new wide-range power supply with continuously variable voltage output from 500 to

50,000 volts has a maximum current output of 1 milliampere. It has been designed for use in electron diffraction studies research on high-intensity cathode-ray screens, electron microscopy, and projection television experiments. High voltage is obtained by means of an r-f oscillator at 40 kc.

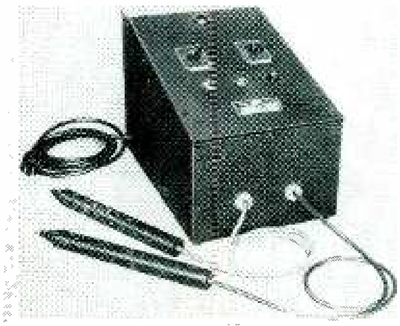
Ceramic Mikes

ASTATIC CORP., Conneaut, Ohio. With the exception of a few special types, each of the well-known crystal microphones manufactured by the company is now available with piezoelectric ceramic elements. The new units are identical in outward appearance to the older crystal

types. The latter units are immune to extreme climatic and artificial heat and the operable humidity range is extremely wide.

Breakdown Tester

ELECTRICOIL TRANSFORMER CO., 417–421 Canal St., New York 13, N. Y. A portable insulation breakdown tester now in production has an output up to 11,000 volts rms in 100-volt steps. Breakdown actuates



a buzzer and pilot lamp. A high reactance circuit limits output current to a low value to prevent destruction of the material under test and to lessen operator hazard.

Input Transformer

UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N. Y. The MA-1 Adaptor is an input transformer designed for matching low-

impedance microphones and pickups to high-impedance circuits. The unit matches any source from 50 to 500 ohms impedance to grid. Response is essentially flat from 50 to 10,000 cycles.

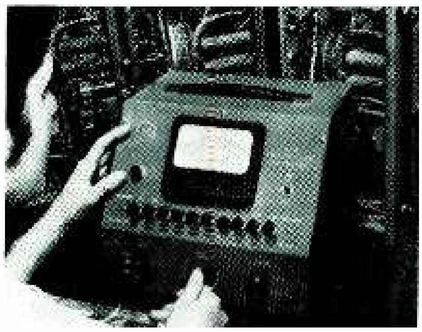
Antistatic Welding

MID-STATES EQUIPMENT CORP., Chicago, Ill. A remote-control device for welding machines with automatic arc stabilizer shuts off the high-frequency unit whenever the

welding electrode is not actually in contact with (grounded by) the workpiece. In this way, the high-frequency emanations that otherwise cause severe interference to broadcast radio and television can be eliminated.

Industrial VTVM

GENERAL ELECTRIC CO., Schenectady, N. Y. Type AA-1 vacuum-tube voltmeter has a calibrated range from 0.001 to 300 volts at all fre-



quencies from 10 cycles to 1.5 megacycles. In addition, the meter scale is graduated in decibels covering a range from minus 52 to plus 52 db from a reference level of 1 milliwatt at 600 ohms. A ten-position push button switch selects the desired working range.

Diode Probe

RADIO CORP. OF AMERICA, Camden, N. J. Type WG-275 twin-diode probe has recently been made available for use with Voltohmyst meter type WV-95A. The probe has a substantially flat response from 30 cycles to 250 megacycles and reads sine-wave voltages directly in rms values. Peak-to-peak voltages of both sine and complex waveform can be obtained by multiplying the meter-scale reading by a factor of

2.83. In measuring unsymmetrical voltage waves, the full-wave circuit of the diode probe eliminates errors inherent in half-wave probes.

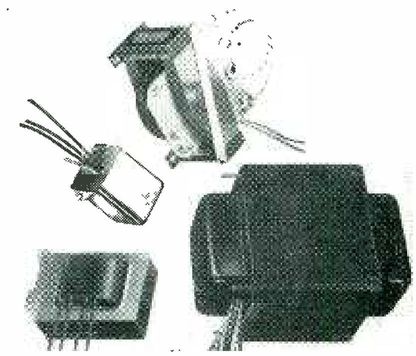
Gamma Survey Meter

BAY INSTRUMENTS AND DEVELOPMENT, 2200 Woolsey St., Berkeley 5, Calif. Type H300A gamma-ray survey instrument has been designed for uranium prospecting. A resistor-quenched Geiger tube (available separately) permits

small size and circuit simplicity. The tube, operating at 300 volts from a single battery actuates headphones without amplification. The probe can be used on cords up to 250 feet for sounding test holes.

Television Transformers

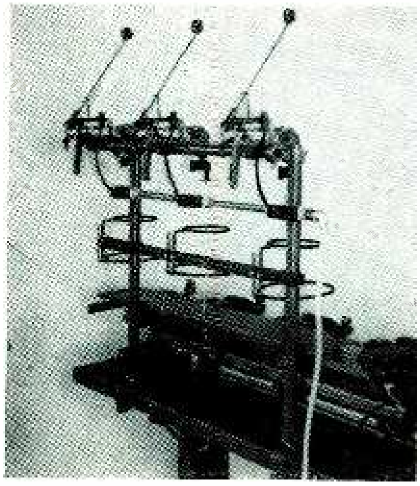
CHICAGO TRANSFORMER DIVISION, 3501 W. Addison St., Chicago 18, Ill. Now available from stock is a complete line of television transformers designed to fit the circuits of leading television receiver manu-



facturers. Included are power, vertical blocking oscillator, vertical scanning output, and horizontal scanning output transformers. A four-page illustrated catalog with complete descriptions and dimensions is available.

Wire Breakage Detector

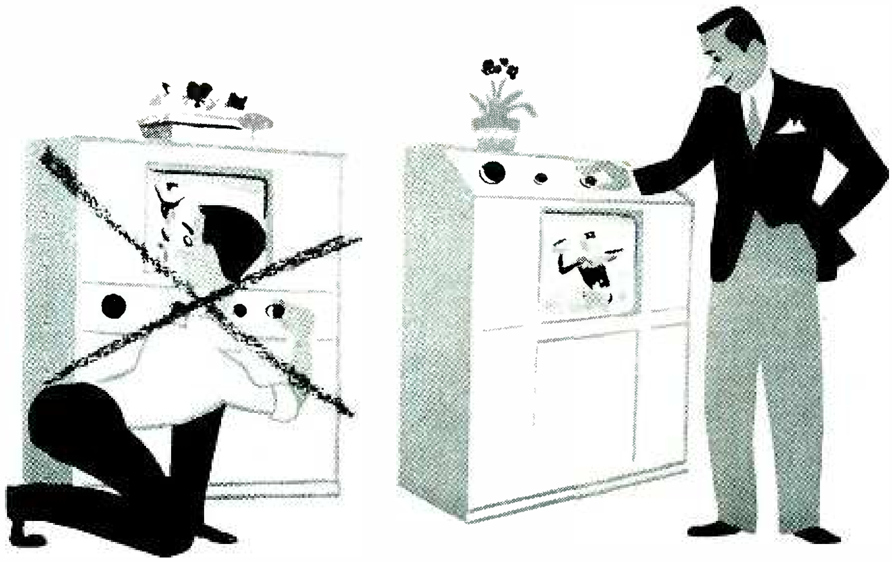
UNIVERSAL WINDING CO., Providence 1, R. I. A new type of wire breakage detector is now available for application to either overend or unrolling tension used on No. 102 Universal coil-winding machines. The device operates through a lever



activated by the tension compensators. This lever is equipped with a splash type mercury switch that is connected to the counter solenoid. When the mercury switch is agitated, it operates the solenoid which in turn disengages the clutch in the winding head and stops the arbor.

Low-Current Chopper

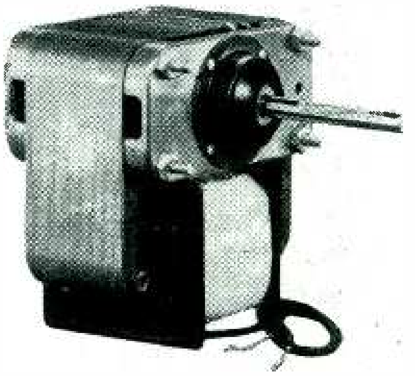
STEVENS-ARNOLD INC., 22 Elkins St., South Boston 27, Mass. Type 240 d-c or a-c chopper is a single-pole, double-throw electromechanical chopper, rectifier (demodulator) or square-wave generator



that will operate at any frequency in the range from 10 to 500 cycles. Contacts will handle up to 0.05 ampere. Further details of coil ratings and mechanical arrangements are given in catalog 232A. New ratings have been assigned the type 222 so that it can be used up to 0.5 ampere.

Two-Pole Motors

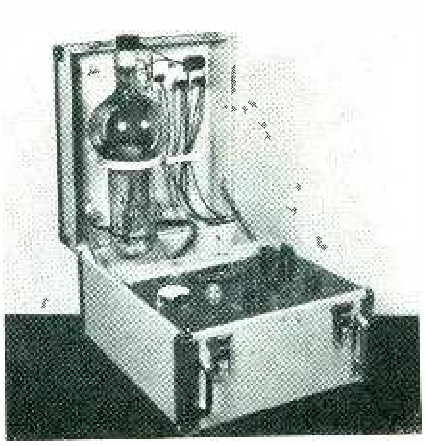
RUSSELL ELECTRIC CO., 340 W. Huron St., Chicago 10, Ill., announces the type 350 line of shaded pole skeleton motors based on a 3½-in. square frame lamination. De-



signed for efficiencies up to 35 percent and starting torques up to 60 percent, the units are available in capacities from 0.04 to 0.1 h-p, 3,000 rpm.

Industrial Tube Analyzer

GENERAL ELECTRIC CO., Syracuse, N. Y. Type YTW-3 industrial electronic tube analyzer supersedes the earlier type TT-1 and was developed specifically for use with thyratron and phanotron tubes used in welding and control operations. The device measures the peak arc drop voltage of these tubes under maxi-



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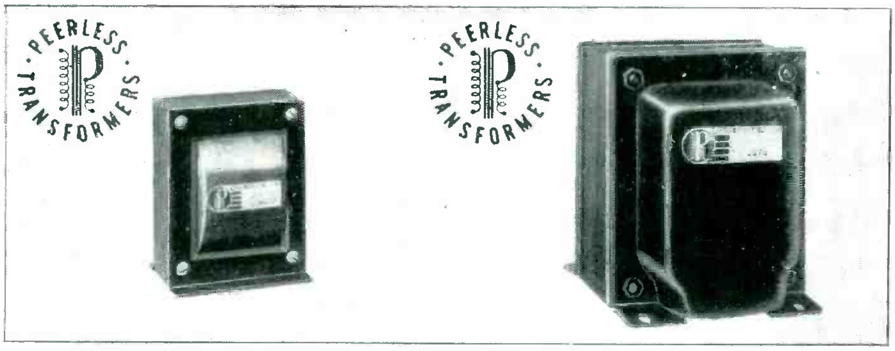

Model 13837 CHOKE
5.5 H., 225 ma. DC. 70 ohms resistance. **Size:** 2½" x 2⅜" x 3⅛"—**Weight:** 2¾ lbs.
PRICE—*quantities of 500*—**$1.68 ea.**
Special quotations for larger quantities.

*Changes in specifications will be made to meet individual manufacturers' requirements.

Model 5678 POWER TRANSFORMER
Primary—115 volts 60 cycles
Sec. No. 1—800 volts CT, 225 ma. DC.
Sec. No. 2—6.3 volts, 8 amps.
Sec. No. 3—6.3 volts, .6 amps.
Sec. No. 4—5 volts, 3 amps.
Sec. No. 5—5 volts, 2 amps.
Size: 4" x 5" x 4½"—**Weight:** 11 lbs.
PRICE—*quantities of 500*—**$5.72 ea.**
Special quotations for larger quantities.

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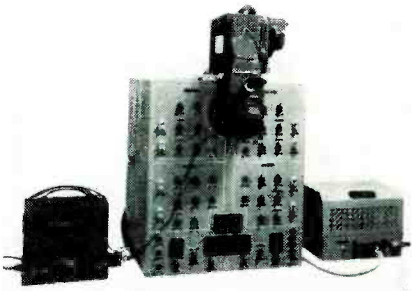
mum load, or if desired, under a specific application load. Readings are taken directly from a large dial that controls a slide-back type voltmeter.

Four-Channel Oscilloscope

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa. Model H-4GRT four-channel oscilloscope is a laboratory indicator for



registering phenomena from d-c to 500,000 cps. Inputs as low as 0.03 volt rms to the a-c amplifiers will trigger the sweeps while inputs of 0.5 volt rms to the d-c amplifier or external sync terminals will also initiate the sweeps.

Metallized Paper

SMITH PAPER INC., Lee, Mass. A new metallized paper developed particularly for the manufacture of capacitors consists of a kraft base upon which is spread a very thin uniform layer of lacquer that greatly increases insulation resistance and dielectric strength. The final operation is the deposition of a layer of zinc on one side of the paper. This metallized face obviates the need for foil, thereby reducing the space factor. A further feature of the technique is the improved self-healing quality of capacitors manufactured with the new materials, so that such capacitors can be subjected to repeated breakdowns without impairing continued satisfactory use.

Power Triode

RADIO CORP. OF AMERICA, Harrison, N. J. Type 5770 power triode is water and forced-air cooled for grounded-grid service. In unmodulated class-C service it has a maxi-

mum plate dissipation of 50 kilowatts. It can be operated at full ratings to 20 megacycles and at reduced ratings to 35 mc. Full tentative data have been published.

New Tube

MULTI-TRON LABORATORIES, 5512 West Harrison St., Chicago 44, Ill. A new tube using a principle of secondary emission so far unexploited is now available for d-c amplification, nuclear studies, and ultrahigh frequency applications.

Time Calibrator

OWEN LABORATORIES, 9130 Orion St., San Fernando, Calif. Type 160 time calibrator is used to measure elapsed time between any two points on an oscilloscope trace. The unit requires a single connection to the oscilloscope sweep sawtooth voltage, but no a-c or d-c power is necessary. Marker intervals are 1 millisecond, 100, 10, or 1 micro second. Error is dependent upon the oscilloscope input characteristics but will generally not exceed plus or minus 5 percent. Approximately 20 micromicrofarads is

added to the normal input capacitance of the scope. Input impedance at the sweep terminal of the unit is equivalent to 470,000 ohms paralleled with 6 micromicrofarads.

Inverters for Television

ELECTRONIC LABORATORIES, INC., Indianapolis, Ind. New inverters for changing d-c to a-c operate with an automatic remote starting system. They have been particularly designed for television use. Model 110R15 is for table model sets and model 110R30 is suitable for console models.

Dual Changers

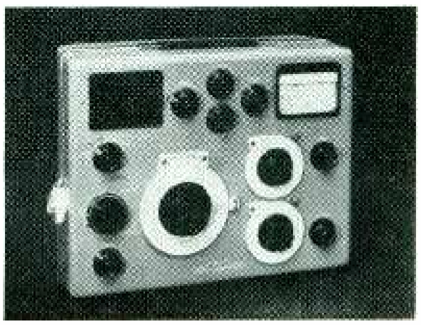
WEBSTER-CHICAGO, Chicago, Ill. Two new automatic record changers, models 246 and 256 provide automatic or manual play of standard or long-playing microgroove records at 78 or 33.3 rpm. Equipped with a tandem-tip needle, the changers are now available to manufacturers.

Pointer Galvanometers

G-M LABORATORIES, INC., 4300 North Knox Ave., Chicago, Ill. A new line of pointer galvanometers suitable for building into testing equipment is now available. Typical characteristics of type 570-603: movement resistance, 100 ohms; sensitivity, 0.2 microampere per millimeter; external critical damping resistance, 400 ohms.

R-F Test Set

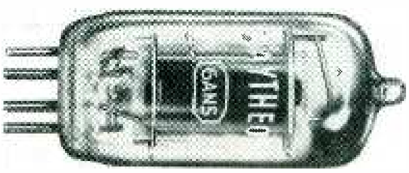
MARCONI INSTRUMENTS LTD., St. Albans, Herts., England. The r-f test set type TF 890 has been designed for checking over complete



radar equipments. It operates on 180-v 500-cps or 80-v 1,000-cps mains. The instrument comprises a twin-limbed waveguide assembly carrying a thermistor power bridge, cavity wavemeter, crystal detector-mixer, and a frequency-swept klystron oscillator with associated time base, i-f amplifier and cathode-ray monitor.

Miniature Pentode

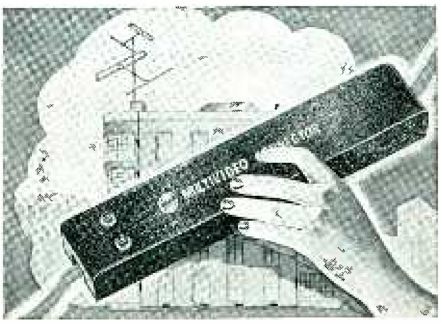
RAYTHEON MFG. CO., Newton, Mass. Type 6AN5 miniature pentode can be used in many of the applications for which the metal type 6AG7 has been previously employed. In addition, the new type is useful at vhf



as a frequency multiplier, wide-band r-f and i-f amplifier, class C r-f amplifier, and switching tube for computers. It has a normal plate current rating of 35 ma and a transconductance of 8,000 micromhos.

Video Interconnector

REEVES SOUNDCRAFT CORP., 10 East 52nd St., New York 22, N. Y. The Multivideo Connector is a device



for connecting a number of television sets to one antenna. Each receiver requires one of the units that will retail for $12.85.

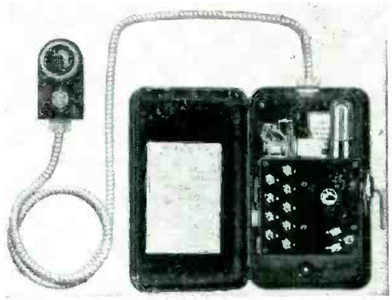
Television Tester

RADIO CORP. OF AMERICA, Camden, N. J. The attenuator coupler illustrated was designed for aligning, tuning and testing a microwave re-

lay transmitter and receiver. A section of the RG50/U-type waveguide, this 24-inch coupler is modified to provide proper signal attenuation.

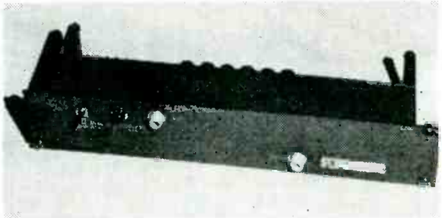
Photoelectric Control

PHOTOSWITCH, INC., 77 Broadway, Cambridge 42, Mass. Type 20DJ1 photoelectric control is used for general industrial and machinery application, particularly for counting, conveyor control, short-range signal systems, motor or valve control, production inspection, machinery safeguards, and stop-motion control in the textile, paper, and wire industries. Designed for high-speed operation, the relay operates in 0.05 second. Operating range is 10 feet. A sensitivity adjustment provides for relay operation at any predetermined level of illumination within the range of 10 to 50 foot-candles. Maximum rating of the dpdt control relay is 10 amp, 115 v a-c.



Traveling-Wave Amplifier

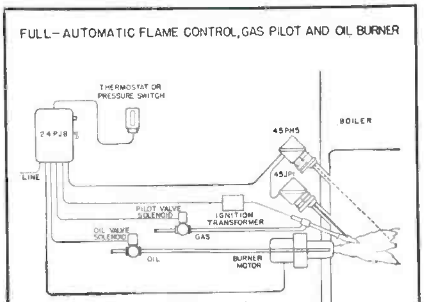
SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 200-A chain amplifier has a bandwidth of 200 mc and a gain of 10 db per stage. With a useful range from 100 kc to 220 mc at an impedance level of 200 ohms, the unit is



adapted for use in television testing, nuclear instrumentation, oscillography and general laboratory measurements.

Flame-Failure Control

COMBUSTION CONTROL CORP., 77 Broadway, Cambridge 42, Mass. A new flame-failure control for supervising both pilot gas flame and main oil flame comprises type



SYSTEM FF-2

45JP1 electronic flame rod, type 45PH5 photoelectric scanner, and type 24PJ8 programming control. Relay contacts will directly handle a 1-h-p motor. Further details are given in bulletin CH4753.

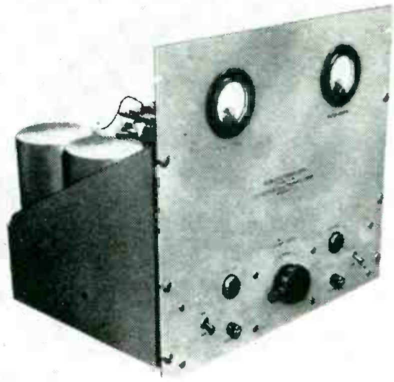
Kilovoltmeter

BRADSHAW INSTRUMENTS CO., 348 Livingston St., Brooklyn 17, N. Y. Model 4000 Kilovoltmeter has been designed for x-ray and television use in measuring voltages up to 50,000 v d-c. It is based upon a 20 microampere meter with an input impedance of 1,250 megohms. The

sensitivity of the instrument is 50,000 ohms per volt at 25 kv. Shielded probes and test leads are provided as well as a normal-reverse switch so that the probes become essentially independent of polarity. The large-scale meter makes it possible to read accurately voltages as low as 3,000 v. Price is $67.50.

Regulated Power Supply

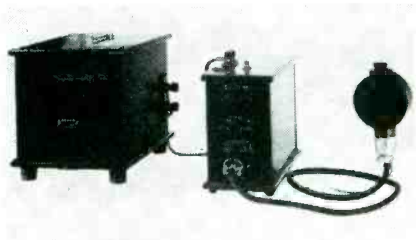
CHATHAM ELECTRONICS, 475 Washington St., Newark, N. J., has announced a series of laboratory-type regulated power supplies. Model E-48 has an input of 105 to 125



volts, 60 cycles, 750 watts. Output is variable from 160 to 1,500 volts, 125 ma d-c. Ripple is less than 0.05 volt peak-to-peak.

Multiplier Photometer

FARRAND OPTICAL CO., INC., 4401 Bronx Blvd., New York 66, N. Y., offers an electron multiplier photometer for general purpose measure-

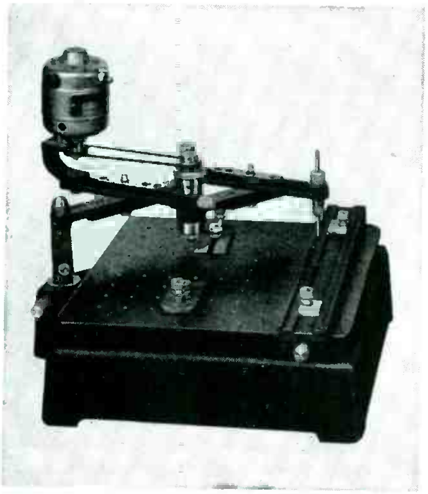


ment of very low light intensities. It is comprised of three units: detector, power supply and controls, and galvanometer. Detailed description is contained in bulletin 804.

Cabinet Exhaust Fan

ROTRON DIVISION, 180–220 Weeden St., Pawtucket, R. I. Cabinet flushing fans designed particularly for radio transmitters and electronic

—MICO—
2 & 3-DIMENSIONAL ENGRAVER



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Permits accurate reproduction of three-dimensional master on any of four reduction ratios.

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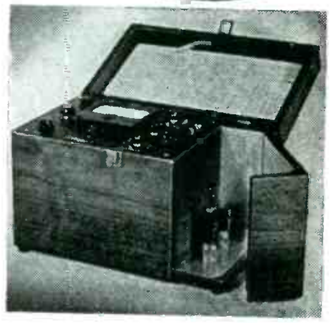
S·S·White MOLDED RESISTORS

The "All-Weather" Resistors

ARE USED IN THIS SUPER-SENSITIVE ULTROHMETER

An S.S.White 100 Megohm Resistor is used as the plate load resistor for the first tube in the D.C. amplifier in this instrument which measures very small d.c. currents and voltages over an extreme range of values. The manufacturer, Beckman Instruments Division of National Technical Laboratories, says of the S.S.White Resistor "it has been very satisfactory"—which checks with the experience of many other electronic equipment manufacturers who use S.S.White Resistors.

Photo courtesy of National Technical Laboratories, So. Pasadena, Calif.



WRITE FOR BULLETIN 4505

It gives essential data about S.S.White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

S. S. WHITE RESISTORS
are of particular interest to all who need resistors with inherent *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
10 to 10,000,000 MEGOHMS
STANDARD RANGE
1000 OHMS to 9 MEGOHMS

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1. Higher Dielectric Strength
2. Greater Structural Strength
3. Lower Overall Production Costs
4. Fewer Rejects (Core won't collapse after winding)
5. Shape and Size Tolerances the Same After Winding.
6. Better Quality because Parkwood Tubing is made of a combination of phenolic impregnated paper and mahogany veneer.

AVAILABLE IN THESE DIMENSIONS

SQUARE
1/4"x1/4" minimum inside dimension.
2"x2" maximum inside dimension.

RECTANGULAR
3/16"x3/8" minimum inside dimension.
1 1/2"x3" maximum inside dimension.

WALL THICKNESS
.020" through .060" ± .005" tolerance.

Write — TODAY — for complete details and prices

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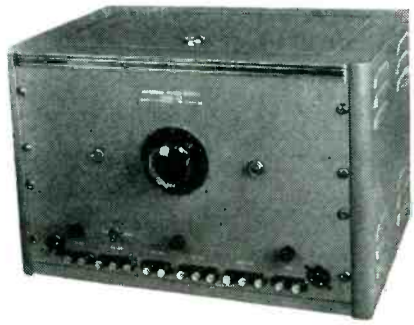
WAKEFIELD, MASSACHUSETTS

instrument cabinets have further reduced motor-winding temperature rise and improved resilient mounting incorporated in the unit. They can be mounted directly over dust filters in either push or pull operation.

Universal Power Supplies

ELECTRONICRAFT, INC., 5 Waverly Place, Tuckahoe, N. Y. Model 101 universal power supply provides 5 a-c voltages, 3 d-c channels, 3 d-c



unfiltered, and a filament supply. Other units provide other voltage ranges suitable for laboratory and industrial applications. A brochure is available.

Regulated D-C Supply

BETA ELECTRONICS CO., 1762 Third Ave., New York 29, N. Y., announces the model 252 regulated d-c power supply for applications re-

quiring very good regulation and stability. Input is 115 volts, 60 cycles, 400 watts; and output is adjustable from 260 to 300 volts d-c, negative grounded. With load changes from 400 to 600 ma the output voltage change at any setting is less than 0.05 percent.

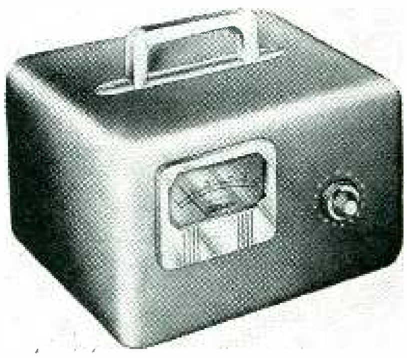
Multitester

BRADSHAW INSTRUMENTS CO., 348 Livingston St., Brooklyn 17, N. Y. A new test meter model 30 covers

21 ranges; up to 1,250 v a-c, 1,000 v d-c, 100 ma d-c, 1 megohm, and from minus 10 to plus 57 db in five ranges. Sensitivity is 1,000 ohms per volt.

Field Strength Meter

TRANSVISION, INC., New Rochelle, N.Y. Model FSM-1 is a compact portable television service instrument complete with self-contained power supply for operation from



120 volts, 60 cycles. The unit is capable of measuring field strength from 50 to 50,000 microvolts at the 300-ohm input terminals.

Hermetic Solder

CERRO DE PASCO COPPER CORP., 40 Wall St., New York 5, N. Y. Cerroseal-35 is an Indium solder that

NO OBSOLESCENCE

ONE AMPLIFIER for ALL RECORDS
*. . . plus *Dynamic Noise Suppression*

New developments in recording, regardless of turntable speed or pick-up point, will not obsolete the H. H. Scott type 210A amplifier because it already includes every feature necessary for faithful reproduction of recorded or broadcast music.

And in addition, the built-in *Dynamic Noise Suppressor assures freedom from rumble, hiss, and the scratch that inevitably increases with each playing of any record.

Brilliant, relistic reproduction of every record, 33, 45, or 78 RPM . . . and of FM and AM broadcasts as well . . . is certain now and for many years to come with the H. H. Scott 210A amplifier.

Hear it TODAY and you'll agree that it satisfies tomorrow's requirements. For complete technical data, write Dept. 904E2

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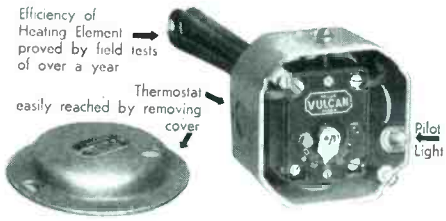

Economical Hot Water ELECTRICALLY
with this new VULCAN Immersion Heater

THERMOSTAT can be set for any desired temperature. No danger of overheating.

EASILY INSTALLED by simply inserting in tank or boiler and connecting to the nearest convenient outlet. * The one-inch tapered pipe thread fits standard domestic type hot water boilers.

FLEXIBLE Permits placing small tanks where hot water is to be used.

PRACTICAL for wash rooms . . . or anywhere in factories, stores, offices or institutions where hot water is needed.

CAN BE USED with present hot water systems without disturbing existing piping.

* Or 1¼" if desired.

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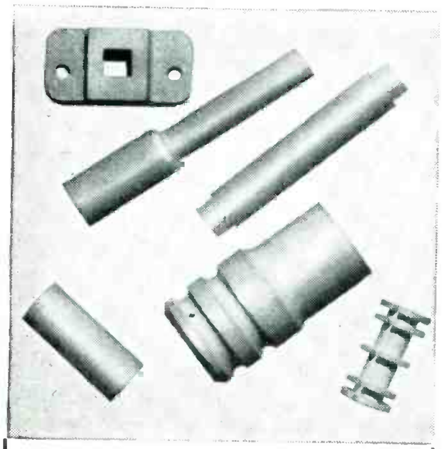
Lavite STEATITE CERAMIC



Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

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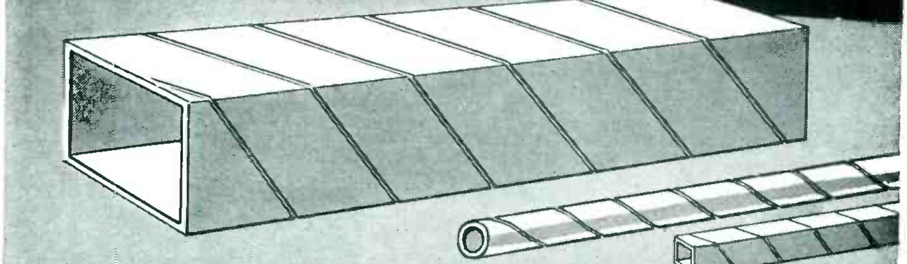

PARAMOUNT SPIRAL WOUND PAPER TUBES

SEND FOR ARBOR LIST OF OVER 1000 SIZES
Convenient, helpful listing of over 1000 stock arbors. Includes many odd sizes of square and rectangular tubes. Write for Arbor List today. No obligation.

Square • Rectangular • Triangular
Round and Half-Round

With a wide range of stock arbors . . . plus the specialized ability to engineer special tubes . . . PARAMOUNT can produce the exact shape and size you need for coil forms or other uses. *Hi-Dielectric, Hi-Strength.* Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for YOU.

Inside Perimeters from .592" to 19.0"

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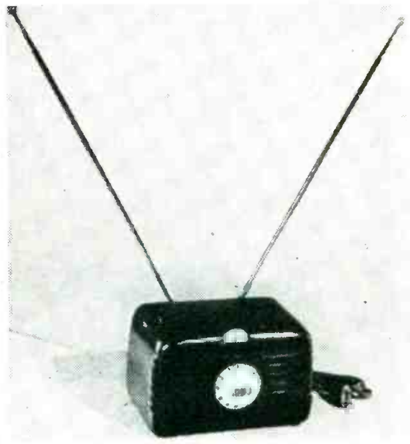
616 LAFAYETTE ST., FORT WAYNE 2, IND.
Manufacturers of Paper Tubing for the Electrical Industry

adheres directly to clean smooth glass, mica, and some ceramics. It also bonds to the same metals as ordinary solders. Working temperature is approximately 260 F on glass. The substance can be applied with a cotton swab and has several advantages over the litharge and glycerine seal.

Indoor Antenna

JERROLD ELECTRONICS CORP., 121 N. Broad St., Philadelphia, Pa. The new In-tenna combines an adjustable dipole with a wide-band



high-gain television preamplifier. Designed to eliminate all kinds of interference, this compact indoor antenna retails for $42.50.

Ball Bearings

MINIATURE PRECISION BEARINGS, INC., Keene, N. H. A new miniature bearing accepts a ⅛-in. shaft and requires only a ¼-in. housing. The bearing is a full-race radial type with fifteen 1-millimeter balls. Either chrome-alloy steel or stainless steel are available.

Mobile Radio

RADIO CORP. OF AMERICA, Camden, N. J. The Carfone two-way mobile radio equipment is designed to

operate in the 152 to 174-mc band. Highly selective circuits make possible operation in channels between stations now on the air without spillover into adjacent channel. The equipment is available for commercial or government use.

Literature

Miniature Tubes. Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass. A four-page folder contains characteristic data for 77 miniature tube types. Basing diagrams and tube outlines are included.

Components Reference. American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill. Catalog 73 provides a quick reference to a line of radio-electronic products. It features a complete index, grouping of parts by their uses, proximity of related items, graphic illustrations and mounting diagrams.

Tubular Rheostats. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 41 describes various styles of standard, screwdrive, double, graded, switchboard, metal-caged and noninductive rheostats. Charts are shown and examples given as assistance in proper selection of the instruments.

Circuit Controller. Electric Regulator Corp., 79 E. 130 St., New York 35, N. Y. Bulletin 502 gives pertinent facts on the applications and general construction of the Regohm rheostatic regulator. The unit is applicable to electronic tubes, saturable reactors and close differential relays.

Speed Measurement. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., has released bulletin 35–14 presenting the description, operation and selection of chronometric, centrifugal and resonant reed tachometers. A price list for over 60 speed measuring instruments is also available.

Pocket Meters. The Sterling Mfg. Co., 9205–9223 Detroit Ave., Cleve-

NEW PRODUCTS (continued)

land 2, Ohio. Catalog 300 is designed as a reference for a line of ammeters, voltmeters, milliammeters, battery cell testers and hearing aid testers. A variety of precision measuring instruments for the automotive and electronic fields is treated.

Permanent Magnets. General Electric Co., Pittsfield, Mass., has issued a 28-page illustrated catalog on cast and sintered Alnico magnets and special magnetic alloys. Property tables are included for reference.

Thermocouple Meters. Rawson Electrical Instrument Co., 111 Potter St., Cambridge 42, Mass. Bulletin 502 covers portable thermal meters and multimeters with vacuum thermocouples for the measurement of a-c or d-c. Units described were designed for true rms readings, nonsinusoidal waveform and low power.

Magnetic Contactors. Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y., has announced development of the bulletin 4454 size 4 and bulletin 4455 size 5 a-c magnetic contactors for motor, heater and lamp control purposes. The units are 150 and 300 amperes respectively, and are completely described and illustrated in a recent 4-page folder.

Magnetic Recorder. Press Wireless Mfg. Co., Inc., Hicksville, L. I., N. Y. A seven-page brochure describes and illustrates the Communi-vox magnetic paper recorder using letter-size sheets of coated stock. Specifications and applications are listed.

Resistance Box. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. Chief features of the type 110 slide-wire resistance box with maximum resistance of 11,000 ohms, specifications and prices are given on one side of a sheet recently issued.

Soldering Manual. Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill., has released a 28-page technical manual affording a complete analysis of the properties

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Engineers and Designers who insist on dependable components have adapted ADVANCE RELAYS into their control circuits. They are specifying ADVANCE products, and are submitting their relay problems to us. Our expanded engineering and plant facilities, plus the recognized dependability of ADVANCE RELAYS, make it possible for us to offer the most complete line of relays for light, intermediate and heavy duty applications. Proved and Improved relay performance through ENGINEERED adaptability.

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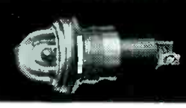
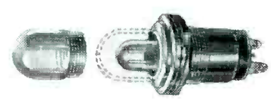
ENJOY MAXIMUM LIGHT VISIBILITY!

JOHNSON 147-1217
1 inch - Lucite Cap



Lucite Cap permits mounting bulb far forward for maximum visibility—especially suitable for neon glow lamps. Fits 1" hole. Has polished chrome bezel. Available in red, amber, opal and clear. Uses NE-45 Neon. No resistor required.

JOHNSON
147-1143
11/16 inch
Lucite Cap



Especially suitable for NE-51 neon glow lamp. Soldered terminals. Fits 11/16" hole. Bulb also mounted far forward for maximum visibility. Soldered terminals. Choice of red, amber, opal or clear.

JOHNSON carries in stock a complete line of standard pilot light assemblies to meet every ordinary need. Special assemblies, to meet your most exacting requirements, can be furnished in production quantities on special order. Your inquiries are invited.

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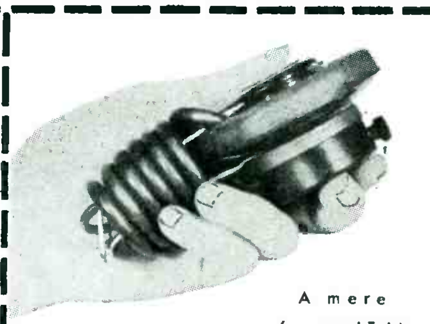

A mere 6 ounces! Folds compactly.

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GET MAXIMUM EFFICIENCY IN TESTING WITH ROANWELL'S STYLE 197 FOLDING HANDSET

Wearer's hands are free at all times with the Roanwell Folding Handset! Combination mouth-to-ear unit makes it possible to talk and move head simultaneously without loss of contact or time. Lightweight receiver and single wire head band eliminate headache complaints. Folded, it can be stowed away in pocket. Interchangeable with conventional telephone apparatus.

Now being used extensively for maximum efficiency in testing by such outstanding organizations as:

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Roanwell specializes in fitting assemblies to your exact needs. Write for details of typical assemblies . . . and a copy of our new catalog.

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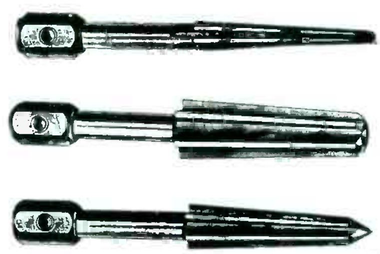
— another XCELITE *Original!*



Fits your XCELITE "Combination-Detachable" Screwdriver or No. 14 Nut Driver. Short enough for work in close quarters —where a longer reamer is useless. Ideal for enlarging holes in plastics, wood or sheet metal. See your dealer.

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Dept. C Orchard Park, N. Y.

3 sizes available: ⅛ to 5/16, ¼ to ½, ½ to 11/16. Shown above ½ actual size.

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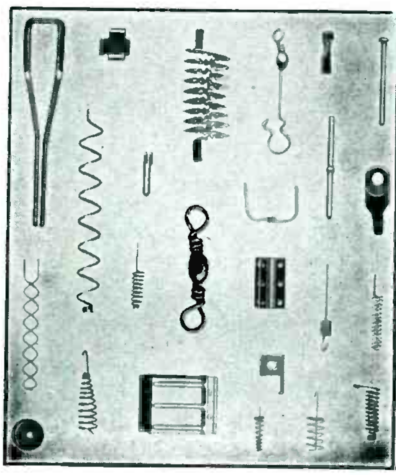
First to use plastic for screwdriver handles



SMALL PARTS

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to ⅛-inch. Any length up to 12 feet.

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Inquiries will receive prompt attention.

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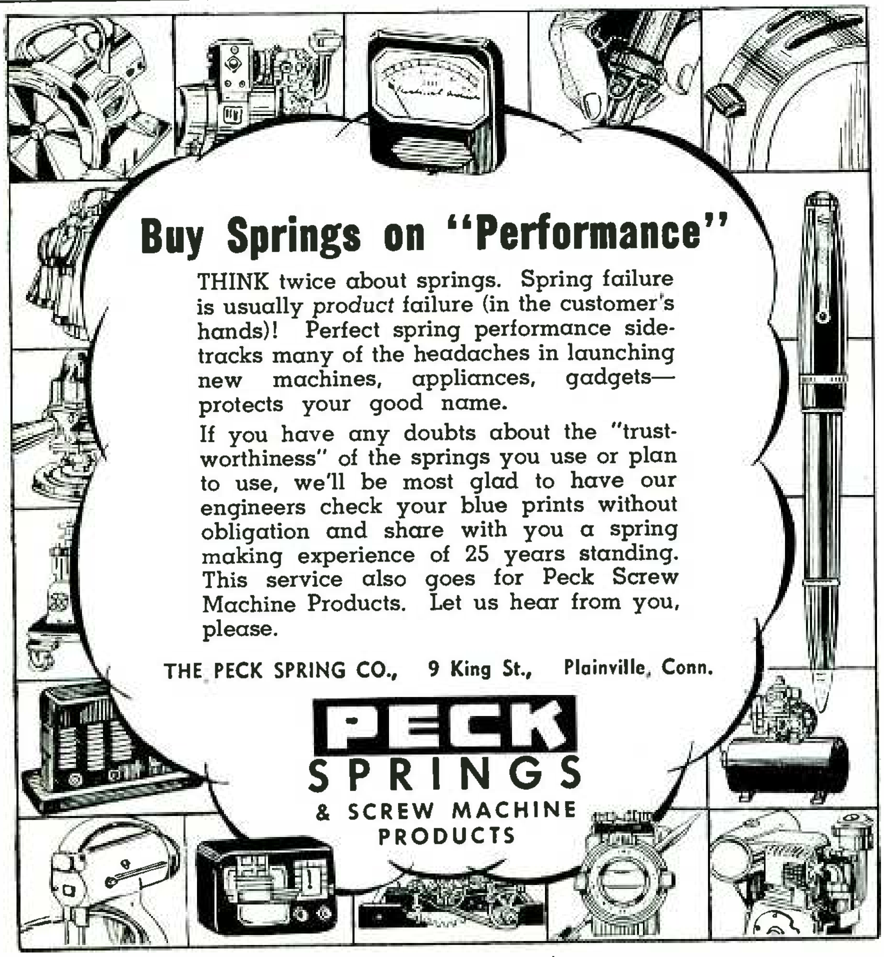


and application of soft solder alloys and soldering fluxes.

Speed Control. Reliance Electric & Engineering Co., 1076 Ivanhoe Rd., Cleveland 10, Ohio. Bulletin K-2101 explains how the VSS short-stroke dancer roll provides control tension for loops of material in process and control of motor speed in proportion to the position of some object or mechanism. Among other data presented are a family of curves of available range of VSS output and pictorial and schematic representations of a typical installation.

F-M Antennas. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Technical information on the high-gain studio-transmitter link parabolic antennas, (for use in the 920 to 960 mc f-m relay band), is found in bulletin 902.

Precision Readings. Hewlett Packard Co., 1756 Page Mill Rd., Palo Alto, Calif., has published a four-page folder giving detailed specifications on the type 400C vtvm and two battery-operated instruments: the 204A audio oscillator and 404A vtvm. Prices of the instruments are included.

Electromagnetic Unit. Meta-Magnet Associates, P. O. Box 3664, Orlando, Florida. A recent folder describes the Meta-Magnet, a new form of electromagnet for demonstration purposes which attracts nonferrous metals as well as iron. On 60 cycles 115 volts the unit described picks up and holds silver coins and pieces of aluminum.

Logarithmic Attenuator. Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif. A small folder gives description, applications and specifications for the Logaten, a wide-range logarithmic attenuator whose output is proportional to the logarithm of its input for a range of 50 db.

Transformer Catalog. General Radio Co., Cambridge 39, Mass. An 8-page catalog covers a line of new Variac continuously adjustable transformers. Essential dimensions, illustrations and data to aid in selection are included.

(continued from p 138)

is available from the National Office of the Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa.

Tube Conference Program

TECHNICAL program for the AIEE conference on the industrial use of electron tubes being held April 11 and 12 at the Statler Hotel, Buffalo, N. Y., is as follows:

Monday, April 11

9:30 A. M. Session I—Industrial Electronic Control Applications—W. C. White of GE presiding:

Electronic Control of D-C Motors, by Ben Cooper of GE.

Electronic Regulators and Regulating Systems, by W. C. Roman of Westinghouse.

Electronic Control of A-C Power, by E. W. Hutton of GE.

Electronic Relaying Devices and Photoelectric Control, by F. T. Bailey of Westinghouse.

6:30 P. M. Dinner—Address on Control Aspects of Atomic Power, by K. H. Kingdon, Assistant Director of the GE Research Lab in charge of the Knolls Atomic Power Lab.

8:30 P. M. Session II—Problems of Electronic Equipment Users—J. A. Gienger of Eastman Kodak presiding:

Effects and Need of Primary Voltage Control, by Frank J. Hosticka of Visking Corp., Chicago.

Additional papers pertaining to the problems of the users of electronic control equipment are being organized with speakers from representative industries.

Tuesday, April 12

9:00 A. M. Session III—Problems of Electronic Equipment Design—H. L. Palmer of GE, presiding:

Tube Ratings as applied to Industrial Control Equipment, by O. W. Livingston of GE.

Desirable Improvements in Tube Characteristics & Ratings, by E. H. Vedder of Westinghouse.

Problems Related to Components Used in Industrial Electronic Equipment Design, by Rolland Russo, of Clark Controller, Cleveland.

Selection and Use of Capacitors in Electronic Control Equipment, by W. J. Thacker of GE.

1:30 P. M. Session IV—Problems of the Tube Designer—C. H. Willis of Princeton, presiding:

Ratings of Ignitrons for A-C Control, by D. E. Marshall of Westinghouse.

Ratings of Ignitrons for Rectification, by H. C. Steiner of GE.

Ratings of Mercury Thyratrons, by H. L. Thorson of GE.

Ratings of Inert Gas Tubes, by D. V. Edwards of Electrons Inc., Newark.

Ratings of Radio Receiving Type Tubes, by George Hanchett of RCA.

Phototube Characteristics, by A. M. Glover of RCA.

Loran Aids Cable Ships

TESTS have recently proven the value of loran to the efficient operation of cable ships. Based upon experience aboard the C. S. Lord Kelvin, Western Union Telegraph Co. has reported the importance of the technique in maintaining the flow of communications through the more than 30,000 nautical miles of cable operated by the company.

The captain of the Western Union Cable ship pointed out that when certain cables lie close together loran enables correct charting of both, with subsequent ease in returning to either when repairs are necessary.

Sperry Gyroscope Co., manufacturers of loran, have announced that deliveries of Mark 2 loran will soon begin to the U. S. Coast Guard and Army Transportation Service.

Electrical Engineering Building Dedicated

FORMAL DEDICATION of the new $2,000,000 electrical engineering building of the University of Illinois at Urbana, Ill., will take place May 19, 20 and 21. The building has ample classrooms and laboratories for experimental work in communications, illumination, measurements, servomechanisms and electrical machines.

Featured in the dedication ceremonies will be a symposium whose main theme is "Expanding Frontiers in Electrical Engineering." Topics and speakers are as follows:

Electron and Ion Dynamics, by Albert W. Hull of GE, W. C. Hahn of GE, and A. L. Samuel of the University of Illinois; Semi-Conductors, by Frederick Seitz of Carnegie Tech, W. Shockley of Bell Labs, and Lloyd P. Smith of Cornell University; Statistical Problems in Electrical Engineering, by Norbert Wiener of MIT, D. O. North of RCA Labs, and K. Norton of National Bureau of Standards; Application in fields of Illumination, Machines and Sound, by Ward Harrison of Nela Park Labs, Gabriel Kron of GE and William J. Fry of the University of Illinois.

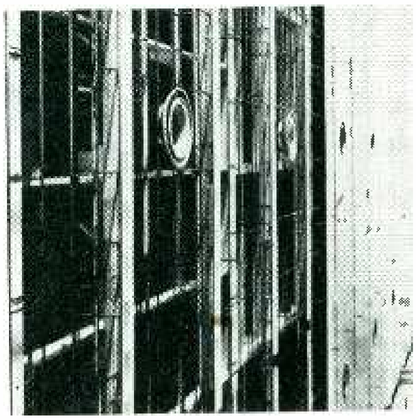
BUSINESS NEWS

RADIO CORP. OF AMERICA, Camden, N. J., recently awarded certificates to sixty-nine engineers enrolled in its sixth television technical training program. Since the beginning of the program nearly 400 engineers have received training in basic theory, design, operation and mainte-

nance of television broadcast equipment.

CORNING GLASS WORKS, Corning, N. Y., has begun mechanized production of 15 and 16-inch all-glass television bulbs by means of new types of glass-working machine. The process will permit price reductions of 24 percent.

WESTERN ELECTRIC CO., has installed over 500 specially designed air diffusers in its Allentown, Pa., plant to create the ideal environment for the manufacture of vacuum tubes, varistors and other precision electronic equipment.



Adjustable combination supply and return air diffusers serving main floor of manufacturing building at Western Electric's Allentown plant

TUNG-SOL LAMP WORKS INC., tube manufacturers, have expanded facilities by moving their Chicago plant to 351 E. Grand Ave., Chicago 11, Ill.

GENERAL ELECTRIC X-RAY CORP., LTD. is the new name of Victor X-Ray Corp. of Canada, Ltd., manufacturers of medical and industrial x-ray apparatus and supplies.

STANDARD-THOMSON CORP., Dayton, O., will establish an electronics and aircraft equipment division as part of the company's increasing production for the aircraft industry. James P. Malstrom has been appointed head of the new division.

ACRO ELECTRIC CO., Cleveland, Ohio, manufacturer of snap-action switches, has changed its name to the Acro Switch Co.

BRANSON INSTRUMENTS, INC., manufacturers of ultrasonic thickness gages and testers, have moved from Danbury, Conn., to larger quarters at 436 Fairfield Ave., Stamford, Conn.

COIL CO. OF AMERICA, New York, N. Y., is the new name of Nigberg Electrical Labs., manufacturers of coils and special windings for television.

PERSONNEL

JAMES F. KOEHLER, engaged in airborne radar development during the war, is now chief engineer in charge of the design of specialized government and industrial electronic equipment at Philco Corp.

KENNETH H. KINGDON, for the past two years in charge of the Knolls Atomic Power Laboratory, has been made assistant director of the GE research laboratory, Schenectady, N. Y.

WILLIAM E. SHOUPP, manager of electronic and nuclear physics research at Westinghouse Research Laboratories since 1943, was recently named director of research of the company's new atomic power division.

WILLIAM BROWN, formerly with the RCA Laboratories industry service division, has joined the Television Equipment Corp. as secretary and chief engineer.

CAMERON PIERCE, ABC television operations supervisor in Hollywood, Calif., has been elected president of the Society of Television Engineers of Los Angeles.

SIDNEY L. CHERTOK, formerly associated with Solar Mfg. Corp., has been appointed to the application engineering staff of Sprague Electric Co., North Adams, Mass.

HENRY P. KALMUS, formerly with the research laboratory of Zenith Radio Corp., has been appointed to the staff of the National Bureau of Standards and will conduct investigations in advanced electronic techniques in the Bureau's Ordnance Research Laboratory.

RAYMOND F. FOSTER, a development engineer on television receivers at General Electric Co., Syracuse, received one of the 1948 Charles A. Coffin awards for his work on the improvement of television receiver circuits.

FRANK H. ROCKETT, JR., formerly associate editor of ELECTRONICS, has joined the staff of Airborne Instruments Laboratory, Mineola, N. Y., to assist in editing and providing technical review for research reports published by the Laboratory. He worked on the proximity fuze project at the Applied Physics Laboratory of Johns Hopkins University and taught in the laboratories at Lehigh and Columbia Universities before joining ELECTRONICS in 1945.

F. H. Rockett, Jr. J. W. McRae

JAMES W. MCRAE, formerly director of electronic and television research, has been placed in charge of development of transmission, switching and electronic apparatus at Bell Telephone Laboratories.

ISAAC L. AUERBACH, formerly with Eckert Mauchly Computer Corp., is now engineer in charge of the tube division at Electronic Tube Corp., Philadelphia, Pa.

E. D. MCARTHUR, holder of 39 patents in the field of electronics, has been promoted to head of the GE Research Laboratory's High-Frequency Electronics Division. He was formerly in charge of the uhf vacuum-tube section.

PHILIP N. ROSS, previously associated with Westinghouse as a central station engineer, and since 1946 assistant to the director of the power pile division at the Oak Ridge National Laboratories, has been appointed assistant director of research in the new atomic power division of the Westinghouse Electric Corp.

HAROLD M. HEIMARK, former consulting radio communication engineer, was recently appointed chief

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Aircraft Radio Corporation

Equipment for:

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- ISOLATION AMPLIFIERS (10 inputs — 2 outputs)

Name of nearest sales and installation agency on request

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MICROSECOND TIMING! THE NEW 1.6 mc INTERVAL TIMER

(COUNTER CHRONOGRAPH)

...measures and records time intervals with a resolution of 1/1,600,000 seconds

This instrument determines and indicates directly the elapsed time between electrical "Start" and "Stop" signals derived from the beginning and ending of a time interval to be measured. A 1,600,000 c.p.s. crystal oscillator is used as the time base. The instrument, which is completely self contained, counts the number of cycles from this time base which occurs during the time interval measured. Price $925.00

★ Extremely High Accuracy — 1.6 Megacycle crystal oscillator time base.

★ Direct Indication of Intervals up to one second — recycling of the counter can be observed or recorded for longer intervals.

★ High Resolution measures intervals in steps of 0.625 microsecond.

★ Retains Indication of Measurement until reset.

★ Easy to Actuate — positive pulses from common or separate sources can be used.

★ Stable — no adjustments required.

High Speed Electronic Counters and Precision Internal Timers for All Applications — Address Inquiries to Dept. 6B

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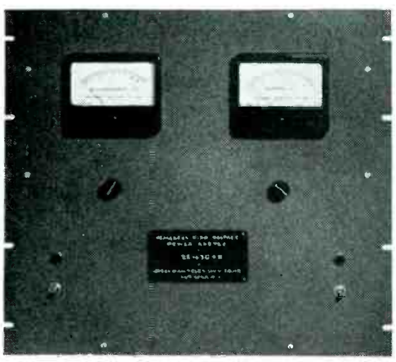
INSTRUMENT Potter COMPANY

HI-VOLTAGE REGULATED RF POWER SUPPLY



25 to 30 KV at 1 Ma. Maximum

Regulation within 1% from no load to full load at any output voltage within rating.

Within 1% for line voltage variations from 95 to 125 volts at any output voltage or load within ratings.

Ripple voltage within 1% at any output voltage.

No. of Tubes: 11

Dimensions: Length — 19", Height — 17¼", Depth — 15".

Also available in voltage ranges of 15 to 20 KV, 20 to 25 KV.

Focus voltage tap available upon request for use with 5TP4 Projection Kinescope.

Write for Specification Sheet for Model RP30 Supply.

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engineer for Doolittle Radio, Inc. of Chicago, Builders of precision radio communication equipment.

ROGER M. WISE, president of the tube consulting and engineering firm bearing his name, has joined Philco Corp. along with his staff of tube engineers. The Wise organization will occupy new laboratories in the Lansdale Tube Co. plant.

A. V. ASTIN, engaged in the development of proximity fuzes during the war, has been advanced from assistant chief to chief of the Electronics Division, National Bureau of Standards, succeeding the late Harry Diamond.

JOHN W. COLTMAN, former head of the x-ray section of the Westinghouse Research Laboratories, has been named manager of the Electronics and Nuclear Physics Department at the Laboratories.

J. W. Coltman

J. W. Nelson, Jr.

J. W. NELSON, JR., formerly development engineer and sales engineer in GE's Government Division in Syracuse, N. Y., has been named head of the Air Force Sales Section in the division.

F. E. BAKER, formerly section engineering manager of Westinghouse Electric's Specialty Transformer Department, was recently appointed manager of the department.

D. F. J. SHEA, associated with the electronics division of the Bureau of Ships during the war, was recently elected a director and vice-president of Hazeltine Research, Inc.

HENRY A. STRAUS, previously with the Atomic Energy Commission and engaged in Navy radar development during the war, was recently appointed principal research engineer at Bendix Radio Division, Baltimore, Md.

NEW BOOKS

Vacuum Tube Amplifiers

Edited by GEORGE E. VALLEY, JR. AND HENRY WALLMAN. *McGraw-Hill Book Co., New York,* 1948, 743 *pages,* $10.00.
Volume 18 *of the MIT Radiation Laboratory Series.*

THE TEN authors of Vacuum Tube Amplifiers have put a great deal of useful material into its fourteen chapters, and the two editors have kept it pretty much to the point. People doing work in the fields covered will want to refer to the book.

Most of the chapters deal with very practical matters, such as stagger-tuned and double-tuned interstages, feedback, pulse response, stabilized computer amplifiers, low-noise amplifiers and various gain and noise measuring techniques. Some matters which did not come within the scope of the work at the Radiation Laboratory are not dealt with, as for instance broad band amplifiers with much feedback such as Bode discusses, high-efficiency transmitter amplifiers, and phase equalization.

The approach is usually that of analyzing practical circuits and cases, citing experimental results and making an evaluation. The mathematics is chiefly algebraic manipulation.

Chapter 13 on Minimal Noise Circuits gives an especially good account of an important matter which is skimped in most books.

Some chapters are different. Chapter 1 tells in 64 pages how to understand and use Laplace transforms in obtaining the transient response of networks. The 108 pages of Chapter 12 give a mathematical treatment of shot and thermal noise which will leave some who are able to understand a good deal of the book groggy. Most of the results given are worth having; however, equation 500, dealing with secondary emission noise, is wrong although equation 496 is correct.

This book isn't like a handbook; many handbook-like results are presented, but they are derived as well as presented. The general results are often inferred after an analysis of many particular cases. Thus, grounded-cathode, grounded-grid and grounded-plate circuits are considered independently rather than as amplifiers with varying amounts of feedback, and general remarks about the effect of feedback on noise figure are made later. Too, there is much emphasis on valuable particular information. The book should be accepted as what it is, an organized group of technical papers, mostly very good, fitting together well to cover a large segment of the very large field of vacuum-tube amplifiers. — J. R. PIERCE, *Bell Laboratories.*

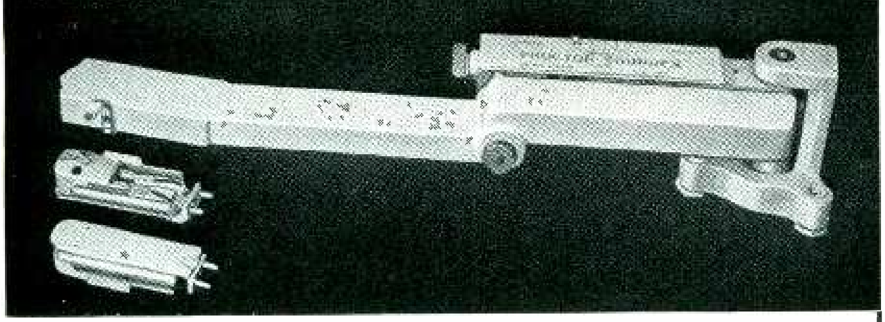
Radar Primer

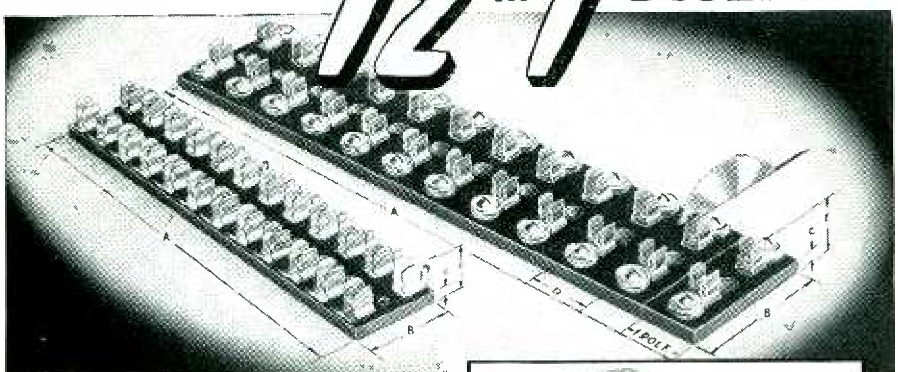
By J. L. HORNUNG, *Supervisor of Radio-Electronics, Walter Hervey Junior College. McGraw-Hill Book Co., New York,* 1948, 218 *pages,* $3.50.

SINCE its declassification, many books and articles have been written about radar. For the most part, these treatments have been of a highly technical nature, far beyond the comprehension of the average citizen, or over-simplified discussions without any real meat. This book, however, gives a comprehensive treatment of this technical subject at the level of the student of elementary physics, the radio operator, the electronic technician and the teacher of general science.

The fundamentals of radar, the determination of distance, direction, and altitude, and the various methods of presenting this data are clearly described. The similarities, differences and limitations of marine and aeronautical radar sets, plus such special applications as the radar altimeter, beacons, air traffic control and ground-controlled approach (GCA) landing systems and long range navigation (Loran), are presented in considerable detail. In addition, there are sections on point-to-point microwave systems, pulse-time and pulse-position modulation systems, sonar, the history of radar, and television, the latter section being more extensive than the others.

The book is well illustrated with photographs of actual radar sets, installations and indicator displays supplementing appropriate drawings and diagrams. The test questions at the end of each chapter and the selected bibliography at the close of the book will be of special interest to the serious students and





teachers of the subject. If desired, the book can be used as an elementary text. It will be especially valuable to persons employed in airline and shipping activities.—R. H. SCHAAF, *National Radio Institute, Washington, D. C.*

Radio Engineering

By E. K. SANDEMAN, *John Wiley & Sons Inc., New York,* 1948, 775 *pages,* $6.50.

THE JACKET of this new volume for practicing radio engineers states that the book is "a storehouse of fundamental radio techniques, stressing practical methods and applications, designed for novice or expert." There can be little quarrel with this bookmaker's blurb—the book has a great deal of fundamentals and a great deal of practical useful material much beyond the mere matter of calculating impedances and working with complex numbers.

The fact that the book is by an Englishman and had its origin in instructions for BBC engineers means only that some of the terms are English and that it is a book of practice, not theory.

The first 250-odd pages deal with circuit components; then follow tubes, amplifiers, modulators, oscillators, transmitters and antenna systems. Although these are chapter headings which occur in many radio books, the treatment here is unusual in that one is taught the design of the circuit involved and the theory is treated only insofar as is necessary. How to line up class C amplifiers or line up long, medium or short-wave antenna systems, a great deal on amplifier load lines and how to use them, much about class B and C amplifiers, the causes of parasitics in r-f amplifiers, frequency multipliers and dividers are but a few of the topics covered.

In the chapter on oscillators will be found a clear analysis of the modified Colpitts circuit in which the tuning inductance and capacitance are in series, thus bringing much-needed light to a subject which has been written up rather extensively lately but without much clearness.

Such matters as receivers, measuring equipment, filter design, interference and noise, level compression and expansion are to be covered in a second volume not yet ready. The practical man or one who must learn while he plies his trade will find this a useful book.—K. H.

Industrial Electronics and Controls

BY ROYCE G. KLOEFFLER, *Head, Dept. of Elec. Eng., Kansas State College. John Wiley & Sons, Inc., New York,* 1949, 478 *pages,* $5.50.

THIS easily understandable survey of the theory and applications of electronics in industry was written primarily for college engineering students. Those who have had basic electron tube theory can omit the first five chapters. On the other hand, the first eight chapters can be used very nicely as an introductory course in tubes. Simple basic circuits receive emphasis, and operating explanations are based on the direction of electron flow throughout.

Industrial electronics is very properly introduced with a comprehensive chapter presenting twenty components and circuits for control. These include amplifiers, oscillators, saturable-core reactors, phase-shift circuits, free-wheeling circuits, time-control circuits, non-linear resistors, long-tailed pairs, light control devices, temperature-control devices, position-control devices, rotary amplifiers and anti-hunt circuits.

A chapter on servomechanisms and one on rectification and inversion complete the student's preparation for the final ten chapters dealing each with a specific industrial electronic application, as follows: High-Frequency Heating; Resistance Welding; Electrostatic Precipitation; Electronic Operation of D-C Motors; Photoelectric Control Devices; Electronic Regulators; Electronic Power Controls; Amplidyne Servomechanisms; X-Ray Applications; Special Photo Applications.

Problems and questions appear after approximately half the chapters, and references are cited after most of the chapters. In general, the writing style is clear, concise

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and to the point, with no attempt on the part of the author to show off how much he really does know. As a result, the treatment is well-rounded and ideally suited for engineering student use. Illustrations are well chosen and executed to teach as well as stimulate the interest of the reader.—J.M.

• • •

Books Received for Review

PRACTICAL ANALYSIS: GRAPHICAL AND NUMERICAL METHODS. By F. A. Willers, Professor at Freiberg Mining Academy; translated by R. T. Beyer. Dover Publications, Inc., New York, 1948, 422 pages, $6.00. Presentation, evaluation and comparison of the various numerical, graphical and instrumental methods available for analysis, over the entire range from simple slide-rule calculations through interpolation, integration, differentiation and empirical functions to mechanical integrators.

INSTALLATION AND SERVICING OF LOW POWER PUBLIC ADDRESS SYSTEMS. By John F. Rider. John F. Rider Publisher, Inc., New York, 1948, 204 pages, $1.89. Fundamentals of sound, theory of microphones and pickups, impedance matching, amplifier and loudspeaker characteristics, suggestions for installing low-power sound systems (under 50 watts), and servicing.

PRINCIPLES OF RADAR. By Dennis Taylor and C. H. Westcott. The Macmillan Co., New York, 1948, 141 pages, $3.50. For engineers, physicists and advanced students who know radio and desire the over-all principles of radar. Future books in this British-authored series will cover radar techniques and radio navigation.

SCIENTIFIC AND INDUSTRIAL GLASS BLOWING AND LABORATORY TECHNIQUES. By W. E. Barr and Victor J. Anhorn. Instruments Pub. Co., Pittsburgh, 1948, 380 pages, $6.00. Practical instructions for experimenters in small laboratories who often have occasion to make simpler glass seals themselves, and advanced information intended to help laboratory workers design complex glass equipment more intelligently. Considerable data on construction of samples of new vacuum tubes and similar devices, including glass-to-metal-seals.

FOUNDATIONS OF MODERN PHYSICS. By Thomas B. Brown. John Wiley & Sons, Inc., New York, Second Edition, 1948, 391 pages, $5.00. Descriptions and explanations of experiments remain the distinguishing feature as in the 1940 edition, with major revisions of sections on electronics and nuclear physics and minor revisions throughout.

THEORIE ET APPLICATIONS DES TUBES ELECTRONIQUES. By D. G. Fink. Dunod, 92, Rue Bonaparte (VI), Paris, 1948, 296 pages (paper cover), 1,160 francs (approx. $5.40). French translation of the author's book "Engineering Electronics", using original diagrams but with all notations changed to equivalent French terminology.

THE STRUCTURE OF MATTER. By F. O. Rice and E. Teller. John Wiley & Sons, Inc., New York, 1949, 361 pages, $5.00. Introduction to phenomena that can be explained with the help of quantum mechanics but with a minimum of mathematics. Chapter titles include The Hydrogen Atom, The Periodic System, Motion and Position of Nuclei in Molecules, Atoms and Molecules in Electric Fields, Van der Waals Attraction Forces, The Chemical Bond, Forces in the Solid State, Magnetic Properties of Matter, Molecular Vibrations, Electronic Spectra, Nuclear Chemistry, and State of Matter in Stars. This is the introductory book in the Wiley Structure of Matter Series.

BIBLIOGRAPHY ON X-RAY STRESS ANALYSIS. By H. R. Isenburger. St. John X-Ray Laboratory, Califon, N. J., 1949, 17 pages looseleaf unbound, $3.00. 240 references and subject index.

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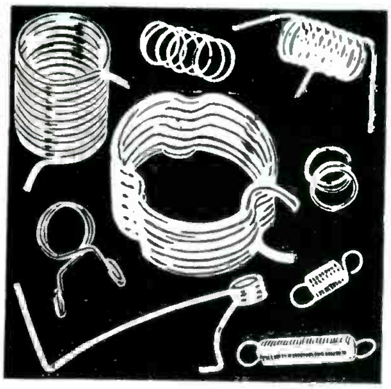

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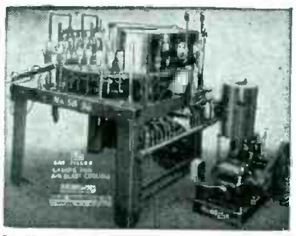

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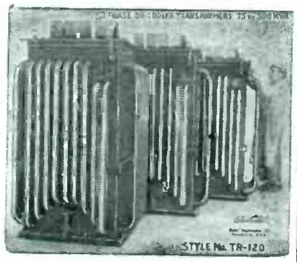

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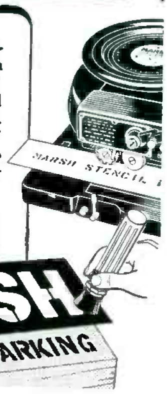

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Backtalk

This department is operated as an open forum in which our readers may discuss problems of the electronics industry or comment upon articles that ELECTRONICS has published

TV Synchronization

DEAR SIRS:

I WAS VERY MUCH INTERESTED in your short note in "Cross Talk" on the possibility of splitting the video signal under certain conditions into a high-speed component and a low-speed component.

The history of the development of the composite video signal is quite obscure to me, possibly because I am one of the relatively late comers to the field of television. However, for a long time, we have felt that the present approach to transmitting all the needed information describing a video picture has led to many complications. The solution to these complications has often, in turn, produced others, most often costwise.

Pending an article in your magazine tracing the development and reasons for the composite video signal, I would like to offer for consideration the following modification of the signal.

Since the transmission of the picture information is, in itself, a major problem in camera design, the following proposal might lend itself to much simplification both at the transmitter and the receiver.

It is proposed that in any locality where television stations exist that a master station be set up, operating on a relatively long wavelength. This station would transmit only the synchronizing pulses. Each transmitting station could be linked to this master station by cable and have remote pickups by a radio link. All receivers in the area would have a section tuned to this master station.

With this station operating, the synchronizing and sweep systems of the cameras would be very similar to that used in receivers. Since all stations would be locked together by this master synch transmitter and all receivers are also linked to the same transmitter, as the receiver was changed from one station to the next, the picture would always be in frame. In addition, the problem of switching from one camera to the next is also simplified.

Often the limitation to receiving a picture is the weakness of the synch pulses. With the master transmitter operating on a longer wavelength, where the horizon effect is not as great, weak signals can probably be received successfully. In addition, since we visualize very strong synch pulses, which could even be of f-m nature, it becomes conceivable that the synch pulses in systems may be used to initiate the sweeps without recourse to intermediary timers.

S. L. Reiches
Lennox Engineering Associates
Cleveland, Ohio

AFC—ARC

Dear Sirs:

Existing nomenclature is frequently somewhat inadequate for use in connection with television circuitry. In specifying *afc* in television receivers, a further qualification must be made as to whether reference is to local oscillator control or horizontal sweep oscillator control.

An arbitrary distinction might be made by applying the term automatic frequency control to sinusoidal oscillators, in this case the local receiver oscillator, and using the term automatic rate control, or *arc*, with reference to a pulse repetition oscillator, of which the horizontal sweep oscillator is a type.

Leo Mackta
Brooklyn, New York

Repeller Storage Tube

Dear Sirs:

It was stated in the original draft (p 106, Aug. 1948) that a signal-to-noise ratio gain of the $\sqrt{10}$ (author's note: not "10^3") was theoretically possible, this improvement in signal-to-noise ratio for periodically recurring signals being obtained *at a sacrifice in speed of reception*. Reference to this reduction of speed was omitted from the published article.

The oscillograms reproduced in the published article were not properly matched and therefore contained misleading captions. The correct oscillograms with proper captions submitted by the authors were unfortunately misplaced by the publishers.

J. T. deBettencourt
Raytheon Manufacturing Company
Waltham, Massachusetts

H. Klemperer
MIT (formerly with Raytheon)
Cambridge, Massachusetts

Good Idea, But . . .

Dear Sirs:

Steven Pantages' conductor-jumper safety suggestion (*Backtalk*, Feb. 1949) might be O.K. for low-current electronic and radio work, but in the case of high-power transmission lines, it's a question as to whether it is better to get electrocuted by the juice or to get massacred by a blast of molten metal.

Ted Powell
Engineering Dept.
Hazeltine Electronics Corp.
Little Neck, N. Y.

Additional Employment Advertising on pages 232 & 233

(Continued from page 231)

POSITIONS WANTED

GRADUATE ENGINEER seven years experience in aircraft and naval electronics, desires position under competent supervisor who can add to my know-how. Prefer Sales and Service or Field Research on specialized equipment. PW 7779, Electronics.

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TECHNICAL SECRETARY—Experienced with terms of radion, television, and navigation. Can read schematics, technical rewriting. PW 8310, Electronics.

ELECTRICAL ENGINEER BSEE, 8 years excellent experience, electronics, microwaves, radar. Executive and some sales experience. PW 8324. Electronics.

ELECTRONIC ENGINEER, having both B.S. and M.S. degrees in E.E. wants permanent position in research, design or development with manufacturer of television receivers or other equipment. Have good general knowledge of television. Have 3½ years experience not in TV but in electronics and electro-mechanical design and development. Interested in all phases of TV. Age 24. PW 8296, Electronics.

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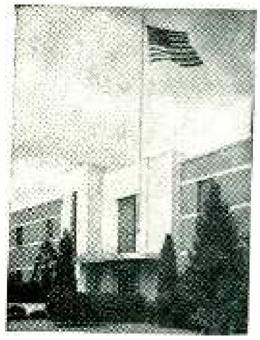

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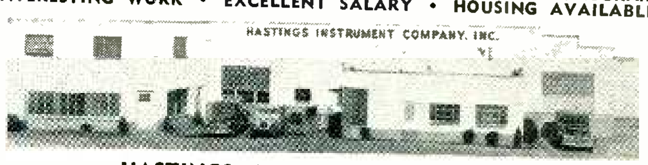

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Type	Price
891	110.00
902P1	7.95
904	9.95
905	11.95
913	7.95
920	2.95
923	.98
925	1.40
929	1.25
930	1.10
931A	4.95
954	.75
955	.75
956	.75
957	.75
958A	.75
1608	4.95
1611	.98
1613	.75
1614	1.75
1616	1.39
1619	.75
1621	1.98
1622	1.75
1624	1.75
1625	.49
1626	.49
1628	4.95
1629	.69
1631	1.50
1633	1.65
1634	.79
1635	1.10
1636	5.95
1638	.98
1641	.79
1642	.98
1644	1.49
1654	1.98
1851	1.25
1852	1.06
1853	1.06
1960	.95
2050	1.19
2051	.98
5514	4.95
5516	5.95
5562	10.00
7193	.39
8003	5.95
8005	4.95
8011	2.95
8012	4.95
8013A	2.95
8014A	24.95
8016	1.49
8020	3.95
8025	7.95
C5B	12.95
C6J	12.95
CEQ72	1.95
CK1005	.39
CK1006	.69
CK1090	4.95
EF50	.79
ELIC	4.95
EL3C	4.95
EL225	1.95
F123A	12.95
F660	150.00
FG17	3.25
FG27A	9.95
FG33	8.95
FG67	12.95
FG81A	6.95
FG105	19.95
FG172A	32.50
FG235	59.50
FG238B	160.00
GL146	11.00
GL530	49.50
GL559	5.35
GL697	150.00
HF100	3.95
HF210	17.95
HY65	2.49
HY69	2.49
HY75	1.25
HY615	1.25
HYE1148	.48
KU610	9.95
ML101	150.00
RK21	3.95
RK22	4.95
RK25	2.95
RK33	.98
RK34	.59
RK59	3.95
RK60	.79
RK65	24.95
RK72	1.95
RK73	3.95
RX120	10.00
SD809	4.95
TZ40	2.95

Type	Price
UH50	5.95
V70D	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR105	.98
VR150	.75
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
Z225	1.95
ZB120	6.95
ZP477/12DP8	14.95
OA2	1.69
OA3/VR75	.98
OA4G	1.06
OB2	2.05
OB3/VR90	.75
OC3/VR105	.98
OD3/VR150	.75
OY4	.88
OZ4	.88
OZ4G	.88
O1A	.50
1A3	.72
1A4	1.28
1A4P	1.56
1A5GT	.72
1A6	1.28
1A7GT	.80
1B3GT	1.49
1B4	1.56
1B5/25S	1.28
1B7GT	1.06
1C5GT	.88
1C6	1.28
1C7G	1.28
1D5GP	1.55
1D7G	1.28
1D8GT	1.56
1E5GT	1.38
1E7G	1.56
1F4	1.06
1F5G	1.06
1F6	1.56
1F7G	1.56
1G4GT	1.06
1G6GT	1.06
1H4G	.88
1H5GT	.66
1H6G	1.28
1H6GT	1.28
1J6GT	1.28
1L4	.80
1LA4	1.06
1LA6	1.06
1LB4	1.06
1LC5	1.06
1LC6	1.06
1LD5	1.06
1LE3	1.06
1LG5	1.06
1LH4	1.06
1LN5	1.06
1N5GT	.80
1P5GT	1.06
105GT	1.06
1R4	1.06
1R5	.80
1S4	.96
1S5	.72
1T4	.80
1T5GT	1.06
1U4	.80
1U5	.72
1V	.88
2A3	1.28
2A4G	1.28
2A5	.88
2A6	1.06
2A7	1.06
2B7	.88
2F5	.88
2V3G	1.98
2X2A	1.25
3A4	.39
3A5	1.49
3A8GT	1.98
3B7	.36
3D6	.36
3O4	.88
305GT	.96
3S4	.80
3V4	.80
5AZ4	.50
5R4GY	1.15
5T4	1.28
5U4G	.60
5V4G	.96
5W4	1.06

Type	Price
5W4GT	.66
5X4G	.72
5Y3GT	.42
5Y4G	.60
5Z3	.72
5Z4	1.06
6A3	1.28
6A6	1.06
6A7	.80
6A8	.80
6A8GT	.80
6AB5/6N5	.88
6AC7/1852	1.16
6AC5GT	1.16
6AB7/1853	1.06
6AD6	.88
6AD7G	1.28
6AF6	1.25
6AG5	1.06
6AG7	1.28
6AH6	1.56
6AJ5	.99
6AK5	1.56
6AK6	.96
6AL5	.80
6AL7GT	1.06
6AQ5	.80
6AQ6	.72
6AQ7GT	.88
6AR5	.66
6AS7G	4.95
6AT6	.60
6AU6	.80
6AV6	.60
6B4G	1.28
6B5	1.56
6B6G	.88
6B7	1.28
6B8	1.28
6B8G	1.28
6BA6	.80
6BE6	.72
6BG6G	1.92
6BH6	.80
6BJ6	.80
6C4	.39
6C5	.66
6C5GT	.66
6C6	.80
6C7	1.28
6C8G	1.28
6D6	.66
6D8G	1.28
6E5	.85
6E6	1.06
6F5	.66
6F5GT	.66
6F6	.80
6F6GT	.66
6F7	1.06
6F8G	1.28
6G6G	1.06
6H6	.60
6H6GT	.60
6J5	.54
6J5GT	.54
6J6	1.16
6J7	.80
6J7GT	.80
6J8G	1.28
6K5GT	.96
6K6GT	.60
6K7	.66
6K7GT	.66
6K8	.96
6K8GT	.96
6L5G	1.06
6L6	1.42
6L6G	1.16
6L6GA	1.16
6L7	.96
6L7G	1.16
6N6G	1.56
6N7	.96
6N7GT	.96
6P5GT	.96
606G	1.06
607	.80
607GT	.72
6R7	1.06
6R7GT	1.06
6S7	1.28
6S7G	1.28
6S8GT	1.06
6SA7	.66
6SA7GT	.66
6SB7Y	.88
6SC7	.82
6SD7GT	.49
6SF5	.66
6SF5GT	.72
6SF7	.80
6SG7	.80
6SH7	.39
6SJ7	.66

Type	Price
6SJ7GT	.66
6SK7	.66
6SK7GT	.66
6SL7GT	.96
6SN7GT	.88
6SQ7	.60
6SQ7GT	.60
6SR7	.72
6SR7GT	.72
6SS7	.66
6ST7	.88
6SV7	.88
6T7G	1.24
6U5/6G5	.72
6U6GT	.72
6U7G	.72
6V6	1.28
6V6GT	.80
6W7G	.88
6X4	.60
6X5GT	.60
6Y6G	.96
6Y7G	.88
6Z7G	1.28
6ZY5G	.88
7A4/XXL	.72
7A5	.72
7A6	.72
7A7	.72
7A8	.72
7AD7	1.06
7AF7	.72
7AG7	.88
7AH7	.88
7B4	.72
7B5	.72
7B6	.72
7B7	.72
7B8	.72
7C4/1203A	.39
7C5	.72
7C6	.72
7C7	.72
7E5/1201	1.06
7E6	.72
7E7	.88
7F7	.88
7F8	1.06
7G7/1232	1.06
7H7	.80
7J7	1.06
7K7	1.06
7L7	.88
7N7	.88
7Q7	.72
7R7	.88
7S7	1.06
7V7	1.06
7W7	1.06
7X7/XXFM	1.06
7Y4	.72
7Z4	.72
10	.69
12A	.60
12A6	.39
12A6GT	.39
12A7	1.28
12A8GT	.80
12AH7GT	.88
12AL5	.80
12AT6	.60
12AT7	1.16
12AU6	.80
12AU7	.96
12BA6	.72
12BE6	.72
12C8	.69
12F5GT	.72
12H6	.39
12J5GT	.39
12J7G	.80
12J7GT	.80
12K7GT	.66
12K8	.88
12K8GT	.96
12Q7GT	.72
12SA7	.66
12SA7GT	.66
12SC7	.72
12SF5	.80
12SF5GT	.80
12SF7	.80
12SF7GT	.80
12SG7	.72
12SH7	.39
12SJ7	.66
12SJ7GT	.66
12SK7	.66
12SK7GT	.66
12SL7GT	.88
12SN7GT	.80
12SQ7	.60
12SQ7GT	.60
12SR7	.39
12SR7GT	.39

Type	Price
12X3	.98
12Z3	.88
14A7/12B7	.88
14AF7/XXD	.88
14B6	.88
14B8	.88
14C5	.88
14C7	.88
14E6	.72
14E7	.88
14F7	.88
14F8	1.06
14H7	.88
14J7	1.06
14N7	1.06
14Q7	.88
14R7	.88
14S7	1.06
14W7	1.06
14X7	1.06
14X4	.88
19	1.28
19T8	1.56
22	1.28
24A	.88
25A6	1.06
25A6G	1.06
25AC5GT	1.16
25L6GT	.66
25Y5	1.16
25Z5	.60
25Z6GT	.60
26	.72
27	.60
28D7	.39
30	.39
31	.39
32	1.28
32L7GT	1.28
33	.39
34	.39
35/51	.80
35A5	.72
35B5	.80
35L6GT	.66
35W4	.46
35Y4	.72
35Z3	.72
35Z4GT	.60
35Z5GT	.50
36	.39
37	.39
38	.39
39/44	.39
41	.66
42	.66
43	.66
45	.66
45Z3	.60
45Z5GT	.72
46	1.06
47	.96
49	.88
50	1.56
50A5	.88
50B5	.66
50L6GT	.66
50Y6GT	.72
53	1.06
56	.72
58	.80
57	.80
59	1.06
70L7GT	1.56
71A	.80
75	.66
76	.66
77	.66
78	.66
79	.88
80	.46
81	1.56
82	1.06
83	1.06
83V	1.28
84/6Z4	.72
85	.88
89	.72
89Y	.39
117L7GT	1.56
117M7GT	1.56
117N7GT	1.56
117P7GT	1.56
117Z3	.60
117Z4GT	1.16
117Z6GT	.96
FM-1000	1.28
UX120	1.38
UX200	1.28
9001	.89
9002	.39
9003	.69
9004	.49
9005	.98
9006	.49

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ELECTRONIC BARGAINS—READ and SAVE PLENTY

TUBE SOCKETS

JOHNSON SOCKET—for 304TL, 304TH, 213..$1.00
Ceramic miniature tube sockets........ .25
Ceramic octal sockets for all currently popular tubes........ .12
Shielded aluminum socket with built-in by-pass condensers. Designed for 829, 832, 826........ 1.75
Ceramic Socket for 829, 832, 826........ .39

Acorn Ceramic Sockets for 955, etc........ .49
Mykroy Socket for 813, 4E27, 4-65, etc........ 1.25
4, 5, 6, 7 Pin Ceramic Sockets........ .12

11-Pin Ceramic Scope Sockets for 5BP1, 5AP1, PE74, etc........ .69
14-Pin Scope Sockets for 10BP4, 12JP4, etc........ 1.49

Ceramic socket for 803, complete with shock mount (Johnson No. 216)........ 1.25

Mykroy Socket for VT127A.. 1.25

CONDENSERS

A B C

A. 1mfd-3000V DC upright Round Can........ $1.25
B. .05mfd-2500V DC for Television Circuits........ 1.09
C. 20mfd-450V—10mfd-25V........ .98

Dual .05 @ 9000vDC working PC-2151-1........ $14.50
23F49-G2 1mfd 5000vDC working........ 6.75
6mfd 1500v working DC........ 2.89
.1mfd 7500v working DC C-59-644........ 3.95
TJH 25010-G 1mfd 2500v working DC........ 2.25
2mfd 4000vDC working 23F47........ 5.50
.005-.005-.01mfd 10,000 working DC........ 5.95
2.5-2.5-5.0mfd 600v working DC C-8B........ 1.60
4mfd 600vDC working CP70EIDF 405 V........ .95
2mfd 1000vDC working 23F11........ 1.25
4mfd 400v working 25F785........ .95
.5mfd 2000vDC working 26F698........ 2.40
.2mfd 5000vDC working C-8B-2784........ 3.00
8mfd 2000vDC working TJU 20080G........ 4.95
.1mfd 1200vDC working 26F628........ 12.50
4mfd 1000vDC working CSF 481903-10........ 1.95
.25mfd 4000vDC working CSF482163-20........ 3.95
.04-.04mfd 7500vDC working 26F415G2........ 6.50
8-8mfd 600vDC working PT-SC-2 plug-in capacitor........ 1.25
4mfd 1500 working v. DC 1509........ 2.10
1000mfd 2 vDC—Metal upright can with nut........ .98

WIRE and CABLE

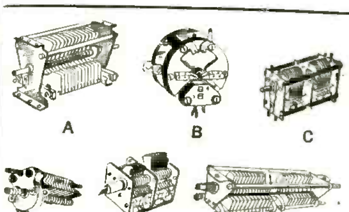
Coaxial—RG8U, 50 ohms imp........ $ .10 per foot
RG58U, perfect for television 50 ohms impedance........ .06½ per ft.
RG59U, 72 ohms impedance........ .06½ per ft.
RG11U, 72 ohms impedance........ .12 per foot
RG13U, 72 ohms impedance Double shielding........ .15 per foot
RG22U, 92 ohms impedance (twin lead in shield)........ .15 per foot
RG34U, 71 ohms impedance (will handle 200 watts of RF........ .35 per foot
Federal—K200, 200 ohms impedance (twin lead, perfect for handling RF power) Less than 1 DB loss at 100 mc........ .08 per foot
Hard drawn copper wire, No. 12 enamel........ .01½ per ft.

HANDY UTILITY SPOOLS

Plain Enamel	Double Cotton	Double Silk
12	12	12
14	14	14
16	16	16
18	18	18
20	20	20
22	22	22
24	24	24
26	26	26
28	28	28
30	30	30
32	32	32
34	34	34
36	36	36
38	38	38
40	40	40

ALL ONE PRICE **38c** PER SPOOL

VARIABLE CONDENSERS



A B C D E F

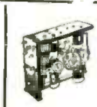
B. C3002—Butterfly condenser—built in tank circuit 200 to 1000 mcs........ $1.98
E. C4115—2 gang superhet for broadcast band........ .98
C. C4419—Dual 200mmf per section, ceramic insulation will handle 100 watts........ 1.19
F. C200D—Johnson 200mmfd per section 2000 volts spacing—9" long........ 3.95
Johnson 150 dd 70-150mmfd per section used in BC610........ 7.95
A. C4646—Bud 250mmfd, air gap .100 will handle 2000v—8" long........ 3.95
D. 100mmfd screw driver adjustment........ .39

R. F. CHOKES

A B

A. 2½ millihenry, mounted on mycalex........ $ .40
B. Same as above with pigtails........ .15

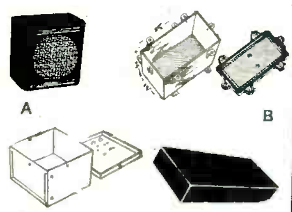
R. F. UNIT



Designed for the BC312. Contains six coils which cover from 1500kc to 18mc. Has a ceramic band switch to change from any coil, each coil is tuned with an air padder. Build your own receiver or signal generator with this assembly. A marvelous Buy at $1.98

BOXES & CABINETS

A. Speaker Cabinet—size 12/12/7½ black crackle with highly polished chromium plated decorative strips. Metal grill. $2.95
B. Waterproof Metal Box—large enough for ant. tuner, size 4½"x5½"x8½". Can be used outside $2.00
C. Metal Box with Cover—A million uses. Size 4¼/4¼/3 4 for........ $ .98
D. Blank Chassis—All sizes in stock—black crackle 13/17/3 $1.98



A B C D

KITS

522 Power Supply Kit—contains all necessary voltages to operate SCR-522 includes all components and chassis. $14.95

Elco VTVM kit—Reads up to 1000V, also up to 1000 megohms. Easy to read diagram........ $23.95

Single Dial Conversion Kit—for SCR-522 receiver. Install in less than one hour........ $3.00

Volt Ohm Milliameter Kit—2500V.DC. 1000V AC 1 megohm. Complete..$14.95

Eico 5" Oscilloscope Kit—Model 400-S A complete 5" scope in kit form at the amazingly low price of $39.50

High Frequency Probe—will fit most VTVMs. Will measure RF voltages to over 200mcs with a minimum of circuit loading. In kit form........ $3.75

TAP AND DIE KIT

H466 Threadswell—Here is a complete radio man's tool kit. All popular sizes of taps and dies for radio use. Mounted in a metal tool kit includes the tap handle and die handle—no radio man can afford to be without this kit. List, $16.00. Your Cost $12.00

WELLER SOLDERING GUN

H4110—Heats instantly—cools instantly, carry one in your tool box—no wasted time—once you have used this iron you will never go back to an old fashioned soldering iron.
Single heat........ $12.95
(Most popular model) Dual heat........ 14.95
Extra tips fo rabove........ package of 4 .25

MOTOR DRIVEN GRINDER

Dual Grinder 1/3 horse power motor.
THIS IS A WONDERFUL BUY—$36.50

MINIATURE TUBE PULLER

For removing miniature tubes........ $ .88

BOOKS

West Coast Radio Hand Book $3.00
ARRL Handbook 2.00
CQDX .50
Radio Amateur Call Book........ 1.50
How to Become a Radio Amateur........ .25
Hints and Kinks........ .50
Radio Amateurs Log.. .50
Conversion Manual No. 1........ 2.50
Conversion Manual No. 2 (now off the press).. 2.50

HEAD PHONES

F604—Lo. imp. phones 600 ohms complete w/5 ft. of rubber cord. Adj. chin band. TH37—Navy..$1.75

HF100—The ever popular H16U complete with output transformer and ear pads. high impedance $1.89

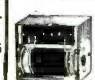
MICROPHONES

M4107—Crystal handmike complete with 100 feet of shielded cable high impedance—perfect for P.A. or speech amplifier or transmitter. High sensitivity. 2⅛ dia. $5.95

Dynamic mike used with famous Mark II transmitter. Can be used anywhere.

a wonderful value—black bakelite frame, complete with 3 feet rubber cord and PL55 plug........ $1.75
CM305—Carbon throat mike—a good buy........ .49

DYNAMOTOR

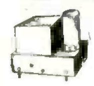


D 4064—Designed for the BC-312 receiver, 12 volts input—235 volts @ 90ma output. Complete with filter........ $2.49

PE 94—Designed for the SCR-522, 28 volts input—output 300 volts @ 250ma DC. 150 volts @ 50ma bias. 12 volts @ 10A for filaments........ $8.75

HEAVY DUTY DYNAMOTOR 28 volts input @ 18A. Output 1000 volts DC @ 150ma. 380V @ 40ma. Complete with filter. $19.95

VIBRATOR POWER SUPPLY



N268—12V input. 200V @ 85 ma. output...$3.50

Ant. Mounting Base

H487—Here is a mounting base to mount your mobile antenna. Flexible and sturdy........ $ .49

COLLAPSIBLE ANT.

Made of dural. Opens up to 3 ft. 3 in. Collapses to 1 ft. Has ¼-20 mounting stud. AN30—WHILE THEY LAST../.$1.49

AUDIO AMPLIFIERS

A4060—A five watt audio amplifier complete with tubes and output transformer. Both vol. and tone controls. Has excellent frequency characteristics........ $11.25

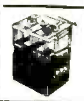
KEYING RELAY

Made to mount in a tube socket D.P.D.T. relay—sealed in vacuum 300 ohm coil will follow 100 words a minute..$2.00

PUSH BUTTONS

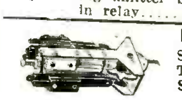
Red stop button black start button ideal for controlling xmitter break-in relay........ $1.25

STORAGE BATTERY



B4011—2V plastic case, 30A capacity — size 5¾ inches $3.49

MOSSMAN SWITCHES

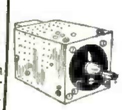


S4118—Triple pole double throw........ $1.25
Ten pole double throw........ 2.10
SWITCH—Very heavy duty D.P.S.T. 40 amp. 12 volts........ $1.25

SELSYN MOTORS

110v 60 cycle input
For indicating direction of your beam or actually driving it..$12.95 per pair
Type 1—light duty—for use as indicators........ $9.95 per pair

RECEIVER

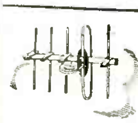


Here is the answer to the lazy man's Q5er. A 200 to 400 KC receiver using standard tubes—Mfg. by the Detrola Co. to rigid Air Corps specs. Designed for 28 volts but can easily be converted to 115V AC or DC. Tube complement 2—25L6, 1—6SA7 1—6K7 1—6SK7 1—6SQ7. This receiver contains a stage of T.R.F........ $4.95

RUBBER SHOCK MOUNTS

H404—1½" sq. Mounted in metal flange, 4 of these mounts will eliminate vibration and will handle 50 lbs. Use them in receivers and Xmitters for mobile applications........ $ .10

BEAM ANTENNAS



Five element 2 meter beam with folded dipole. Guaranteed 60DB gain. Feeds with 50 ohm cable. Thousands already in use........ $8.50
10 meter wide spaced 3 element beam with T match. Very heavy elements. Manufactured by Hy-lite. Very, very popular........ $45.00
For Television all channel folded dipole and reflector, upper and lower channels........ $13.20
Same as above—a real competitive item........ 8.40
All wave window antenna........ 9.00

HEAVY DUTY PM SPEAKER

8" speaker, seven ounce alnico 5 magnet. Ripple edged cone........ $3.89
12" speaker, same as above........ 6.75

RECESSED Male Plug

H4226 — A popular item. Makes disconnecting of the A.C. line a cinch........ $ .18

20% DEPOSIT WITH ORDERS UNLESS RATED

NIAGARA RADIO SUPPLY CORP.

160 S. GREENWICH STREET NEW YORK 6, N. Y.

Phone Digby 9-1132-3-4

RADIO-RADAR SETS

YD-2
SE New
SF New
SG New
SN New
SO-1 Used
SO-13 Used
SQ Used
CPN-6 Unused
APS-3 Used
APS-4 Used and New
APS-15 Near Comp
QBG-1 New
TBM Used
TDE Used
RAK-7 New
TBK-19 New
DAB
DP-12
RC-145 New
RC-148 New
SCR-518 New

MICROWAVE TEST EQUIPMENT

THERMISTOR BRIDGE: Power meter I 203-A. 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case as shown....$72.50
TS12/AP VSWR Test Set, 3cm. New, complete in 2 units, with all access $450
Bell Labs. Dual Mount mixer-beacon assemblies. 2 complete mixer-beacon mounts on gold-plated waveguide section.$50.00
Slotted Line, Bell Labs. 1⅛" x 5/16" guide, goldplated.$150.00
TS 108-AP dummy load....$40.00
W. E. I 138. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input. reg. Pwr. supply. With crt diag new........$150
3 cm. **Wavemeter:** 9200 to 11,000 mc transmission type with square flanges $15.00
3 cm. **stabilizer** cavity, transmission type $20.00
3 cm. Wavemeter, Micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,000 Mc $75.00

VARISTORS

D-168549	$.95	D-171631	$.95
D-162482	$3.00	D-167176	$.95
D-166271	$2.50	D-168687	$.95
D-162356	$1.50	D-171812	$.95
D-161871A	$2.85	D-171528	$.95
		D-163298	$.95

THERMISTORS

D-167332 (tube).......... $.95
D-170396 (bead).......... $.95
D-167613 (button)........ $.95
D-166228 (button)........ $.95
D-164699 for MTG, in "X" band Guide.............. $2.50
D-167018 (tube).......... $.95

MICROWAVE ANTENNAS

APS-15 Antennas. New $99.50
AN MPG-I Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms, 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00) $250.00
APS-4 3 cm. antenna. Complete. 14½" dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete..$65.00
AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases $89.50
RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4¼' x 3', rectangle, new $85.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam, 115 v.a.c. drive. New..........$100.00
SO-13 ANTENNA, 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New $120.00
Used $45.00
DBM ANTENNA. Dual, back-to-back paraholas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AS125/APR Cone type receiving antenna, 1000 to 3200 megacycles. New $4.50
140-600 MC. CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm. antenna, used, ex. cond............$49.50

MICROWAVE GENERATORS

AN/APS-15A "X" Band compl. RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc. & beacon), 1B24 TR, rcvr-ampl, duplexer, HV supply, blower, pulse xtmr, Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV Pl Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl. pkg. new..............$210.00
APS-15B. Comp. pkg. as above, less mod......$150.00
"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A mixer, TR, receiver, duplexer, blower, etc., and complete pulser. With tubes, used, fair condition......$75.00
10 CM, RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input 707-B receiver-mixer $150.00
Modulator-motor-alternator unit for above....$ 75.00
Receiver-rectifier power unit for above..........$25.00
Rot. ant. with parabolic reflector for above. New $ 75.00

MAGNETRONS

Tube	Frq. Range	Pk. Pwr. Out.	Price
2J31	2820–2860 mc.	265 KW.	$25.00
2J21-A	9345–9405 mc.	50 KW.	$25.00
2J22	3267–3333 mc.	265 KW.	$25.00
2J26	2992–3019 mc.	275 KW.	$25.00
2J27	2965–2992 mc.	275 KW.	$25.00
2J32	2780–2820 mc.	285 KW.	$25.00
2J37			$25.00
2J38 Pkg.	3249–3263 mc.	5 KW.	$35.00
2J39 Pkg.	3267–3333 mc.	87 KW.	$35.00
2J40	9305–9325 mc.	10 KW.	$65.00
2J49	9000–9160 mc.	58 KW.	$85.00
2J55 Pkg.	9345–9405 mc.	50 KW.	$35.00
2J61	3000–3100 mc.	35 KW.	$65.00
2J62	2914–3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	50 KW.	$55.00
5J30			$39.50
714AY			$25.00
718DY			$25.00
720BY	2800 mc.	1000 KW.	$50.00
720CY			$50.00
725-A	9345–9405 mc.	50 KW.	$25.00
730-A	9345–9405 mc.	50 KW.	$25.00
Klystrons: 723A/B $12.50.		707B W/Cavity	$20.00
417A $25.00		2 K41	$65.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
5200	21/32 in.	3/4 in.	$17.50
4850	3/4 in.	5/8 in.	$12.50
1500	1 5/8 in.	1 1/2 in.	$12.50
D161392*	1 5/8 in.	1 5/16 in.	$12.50

*Mfr's Number.

TUNABLE PKGD. "CW" MAGNETRONS

QK 61 2975–3200 mc. QK 62 3150–3375 mc.
QK 60 2800–3025 mc. QK 59 2675–2900 mc.
New, Guaranteed ....Each $65.00

PULSE EQUIPMENT

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS, Sweeptime: 100 to 2,500 microsec. in 4 steps fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New as shown............$125.00
MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 114 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
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules..................$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk); pulse rate 200 PPS, 1.5 m'crosec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50
APS-10 MODULATOR DECK. Complete, less tubes $75.00
APS-10 Low voltage power supply, less tubes....$18.50

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec., 400 PPS, 50 ohms imp $42.50
G. E. #25E5-1-350-50P2T. 25 KV. 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 ohms impedance $45.00
G.E. #6E3-5-2000-50P2T. 6KV. "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance.$6.50
G.E. #3E (3-84-810; 8-2.24-405) 50P4T: 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections. .84 Microsec. 810 PPS. 50 ohms imp.: Unit 2, 8 Sections, 2.24 Microsec. 405 PPS, 50 ohms imp.............................$6.50
7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance. 3 sections...............$7.50
7.5E4-16-60-67P. 7.5 KV, "E" circuit, 4 sections, 16 microsec. 60 PPS, 67 ohms impedance..........$15.00
7.5E3-3-200-6PT 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. 67 ohms imp.. 3 sections............$12.50

DELAY LINES

D-168184: .5 microsec. up to 2000 PPS, 1800 ohm term $4.00
D-170499: .25/.50/.75/. microsec. 8 KV. 50 ohms imp. $16.50
D-165997: 1¼ microsec....................................$7.50

PULSE TRANSFORMERS

G.E.K.-2745 ....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS..................$39.50
W.E. #D166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. #K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms. Sec. Imp: 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW. Bifilar 2.75 Amp $64.50
W.E. #D169271 Hi Volt input pulse Transformer $27.50
G.E. K2450A Will receive 13KV. 4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $4.50
G.E. #K2748A Pulse Input, line to magnetron..$36.00
#9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1¼" 19/32.....................$1.50

MICROWAVE PLUMBING

WAVEGUIDE directional coupler, 27 db. Navy type CABV-47AAN, with 4 in slotted section $42.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe —as shown $32.00
"S" BAND CRYSTAL MOUNT, gold plated, with 2 type "N" connectors $12.50
PICKUP LOOP, Type "N" Output.............$2.75
TR BOX Pick-up Loop...........................$1.25
POWER SPLITTER, 726 Klystron input, dual "N" output $5.00
MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated.....................$27.50
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or d.c. arranged switching motor. Mfg. Raytheon. CRP 24AAS. New and complete...................$150.00
10 CM. END-FIRE ARRAY POLYRODS.....$1.75 ea.
"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output.....................$3.00
721-A TR CAVITY WITH TUBE, Complete with tuning plungers $12.50
10 CM. McNALLY CAVITY Type SG...........$3.50
WAVEGUIDE SECTION. MC-445A, rt. angle bend. 5½ ft. OA 8" slotted section..................$21.00
10 CM OSC. PICKUP LOOP, with male Homedell output $2.00
10 CM DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fitting...............$4.50
10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola..........................$8.00

⅞" RIGID COAX.—⅜" I. C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple $3.00
RIGID COAX to flex coax connector...........$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length...........................$5.00
RT. ANGLES FOR ABOVE.......................$2.50
RT. ANGLE BEND 15" L OA.....................$3.50
FLEXIBLE SECTION, 15" L Male to female.....$4.25
MAGNETRON COUPLING to ⅞" rigid coax with TR pickup loop, gold plated.........................$7.50

⅞" RIGID COAX.—¼" I. C.

⅞" **RIGID COAX. BEAD SUPPORTED** per ft...$1.20
SHORT RIGHT ANGLE BEND.......................$2.50
ROTATING JOINT, with deck mounting.......$15.00
RIGID COAX slotted section CU 60/AP..........$5.00

3 CENTIMETER PLUMBING

(STD. 1" x ½" GUIDE, UNLESS OTHERWISE SPECIFIED)

TRANSITION: 1" x ½" to ⅜" x ⅞", 14 in. L...$8.00
"X" BAND PREAMPLIFIER, consisting of 2-723A/B local oscillator-beacon feeding waveguide and TR/ATR Duplexer sect. inc. 60 mc. IF amp..........$47.50
RANDOM LENGTHS of waveguide, 6 in. to 18 in. long ....$1.10/ft.
WAVEGUIDE RUN, 1⅛" x ½" guide, consisting of 4 ft. section with rt. angle bend on one end and 2" 45 deg. bend other end.......................$8.00
WAVEGUIDE SECTION, 1⅛" x ½" choke to choke. 4 ft. long $10.00
"X" BAND pressurizing gauge section, with 15-lbs. gauge pressurizing nipple $18.50
45 DEG. TWIST. 6" Long..............................$10.00
12" SECTION. 45 deg. twist, 90 deg. bend......$6.00
11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy construction, silver plated.......$4.50
15 DEG. BEND 10" choke to cover...............$4.50

5 FT. SECTIONS choke to cover. Silver Plated $14.50

18" FLEXIBLE SECTION $17.50
"E" and "H" PLANE BENDS..........................$12.50
BULKHEAD FEED THRU..............................$15.00
"X" BAND WAVEGUIDE, 1¼" x ⅝" OD. 1/16" wall, aluminum ....per ft. $ .75
WAVEGUIDE, 1" x ½" ID, per ft..................$1.50
TR CAVITY for 724-A TR tube......................$3.50
3" FLEX SECTION, square flange to circular flange adapter $7.50
724 TR tube (41-TR-1)...............................$2.50
SWR MEAS. SECTION. 4" L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00
ROTARY JOINT with slotted section and type "N" output pickup $17.50
WAVEGUIDE SECTION, 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend.........$4.50
SLUG TUNER/ATTENUATOR, W.E. guide, gold plated $6.50
TR/ATP DUPLEXER section with iris flange......$8.00
TWIST 90 deg. 5" choke to cover, w/press nipple.$6.50
WAVEGUIDE SECTIONS 2½ ft. long, silver plated with choke flange $5.75
WAVEGUIDE, 90 deg. bend E plane. 18" long....$4.00
ROTARY JOINT, choke to choke.....................$17.50
ROTARY JOINT, choke to choke, with deck mounting $17.50
S CURVE WAVEGUIDE, 8" long cover to choke..$3.50
DUPLEXER SECTION for 1B24.......................$10.00
CIRCULAR CHOKE FLANGES, solid brass..... .55
SQ. FLANGES. FLAT BRASS.....................ea. .55
APS-10 TR/ATR DUPLEXER section with additional iris flange $10.00
CU 105/APS 31 Directional coupler, 25 db.....$15.00
CU 106/APS 33 Directional coupler, 25 db.....$15.00
FLEX. WAVEGUIDE....................................$4.00/Ft.
"X" BAND calibrated attenuator....................$85.00
SHIELDED KLYSTRON tube mounts with rough attenuator outputs $90.00
2½" FLEXIBLE SECTION, cover to cover......$5.00

1.25 CENTIMETER

"K" BAND FEEDBACK-TO-PARABOLA HORN with pressurized window $30.00
MITRED ELBOW cover to cover.....................$4.00
TR/ATR SECTION choke to cover..................$4.00
FLEXIBLE SECTION 1" choke to choke.........$5.00
ADAPTER. rd. cover to sq. cover....................$5.00
MITRED ELBOW and S sections choke to cover..$4.50

MISCELLANEOUS

DEHYDRATING UNIT, 60 lb. capacity, 115 v, 60 cy operation. 2' x 22" x 15", new and complete..$425.00
F129 SPP-2, COAX WAVETRAP...................$12.50

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.

COMMUNICATIONS EQUIPMENT CO.

131-B Liberty St., New York, N. Y. P. Plishner Chas. Rosen Digby 9-4124

BC-929 SCOPE

An excellent foundation unit for a Hi-Gain Scope. Gives type "A" display.

Original 115V 400 cy oper., but simple conversion makes it operable on 110V, 60cy. New, Complete with Tubes: 2—6SN7, 2—6H6, 1—6B6G, 1—6X5, 1—2X2, 1—3BP1. As shown $24.95

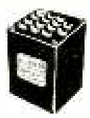
GREAT TUBE VALUES

01-A	$.45	12SF7	$.49	861	$40.00
1B24	4.85	12SR7	.72	874	1.95
2C21	.69	15R	1.40	876	4.95
2C22	.69	28D7	.75	1005	.35
2J21-A	25.00	30 (Spec.)	.70	1619	.21
2J22	25.00	45 (Spec.)	.59	1624	.85
2J26	25.00	39/44	.49	1629	.35
2J27	25.00	35/51	.72	1961	5.00
2J31	25.00	227A	3.85	9002	.65
2J32	25.00	225	8.80	9004	.47
2J38	35.00	268-A	20.00	CEQ 72	1.95
2J39	35.00	355-A	19.50	EF 50	.79
2J55	35.00	417A	25.00	F-127	20.00
2J40	65.00	530	90.00	FC 258A	165.00
2J49	85.00	531	45.00	GL 562	7.50
3J31	55.00	532	3.95	FC 271	40.00
2X2/879	.69	559	4.00	GL 562	75.00
3BP1	2.25	562	90.00	GL 623	75.00
3C24	.60	615	.89	GL 697	75.00
3C30	.70	703-A	7.00	ML 100	60.00
3D6	.79	704-A	.75	QK 59	65.00
3CP1	3.50	705-A	2.85	QK 60	65.00
3D21-A	1.50	†707-B	20.00	QK 61	65.00
3DP1	2.25	714AY	25.00	QK 62	65.00
3EP1	2.95	715-B	12.00	*RCA 932	.65
3FP7	1.20	720BY	50.00	VR 91	1.00
3Q5	.79	720CY	50.00	VR 130	1.25
5BP1	1.95	721-A	3.60	VR 135	1.25
5BP4	4.95	723-A/B	12.50	VR 137	1.25
5CP1	3.75	724B	1.75	VU 120	1.00
5FP7	3.50	725-A	25.00	VU 134	1.00
5J30	39.50	726-A	15.00	WL 532	4.75
6G	2.00	800	2.25	WN 150	3.00
6SC7	.70	801-A	1.10	WT 260	5.00
7C4	1.00	804	9.95	†with cavity	
7E5	1.00	815	2.50	Cavity only	5.00
7E6	.72	836	1.15		
10Y	.60	837	1.95	*Photocell	
12A6	35	843	.59		
12K8Y	.65	860	15.00		

COAX CABLE

RG 9/U 52 ohms....................................$.24/Ft.
RG 17/U. 52 ohms imp..............................$.48/Ft.
RG 57/U. Twin Cond. 95 ohms.......................$.55/Ft.
RG 18/U. 52 ohm im. armored.......................$.51/Ft.
RG 23/U. twin coax. 125 ohm imp. armored..........$.50/Ft.
RG 28/U. 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV.........$.50/Ft.
RG 35/U. 70 ohm imp. armored......................$.50/Ft.

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 $4.75

CERAMICON CONDENSERS
$7.50 per 100

3 mmf	±5%	60 mmf	±3%
5 mmf	±5%	67 mmf	±20%
4 mmf	±5 mmf	115 mmf	±2%
8.5 mmf	±5 mmf	120 mmf	±5%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	—
50 mmf	±20%	1000 mmf	±5%

Silver-Mica Button Capacitors (Standard Brand) $9.50 per 100

185 mmf ....±2.5 mmf
175 mmf ....±2.5 mmf
500 mmf ....±10%

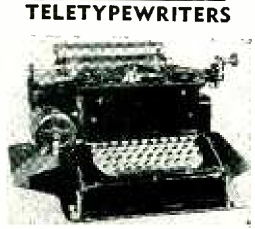
CARBON PILE VOLTAGE REGULATORS

Type "A" Coil current .105 to .115 amp. 80 volts, Leland Electric $3.00
Type "C" Input: 22-30 v. coil, 30 amps. Output: 19 v. 5.7 amps Spec #VR9000-2c. Leland Electric.....$3.00
#35X045B: 22v, .1 to 3 amps, for K-14B Gunsight. Webster $3.00

TEST SET 159 TPX

Measures frequency between 150 & 200 mc. by heterodyne method. Power of Xmtr can be directly measured. Measures DC voltages up to 500 Volts. Original operation on 110 V. 400 cy. but conversion kit makes it operable on 110 V. 60 cy. new, and complete with tubes, crystal, cal. chart, antenna, meter..............$29.95

TELETYPEWRITERS



Original TELETYPE, with standard keyboard. DC motor: 110 vdc, type 5BY 36A1. 1/30 hp. 1725 RPM. Units are slightly used in excellent condition, as illustrated $110.00

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Prices*
DM 416	14	6.2	330	.170	RU 19	$15.95N
DY-2/ARR-2	28	1.1	250	.060	ARC-5	
DM 36	28	1.4	220	.080	SCR 508	8.75N
DM 53AZ	14	2.8	220	.080	BC 733	7.00N
PE 73CM	28	19	1000	.350	BC 375	
DM 21	14	3.3	235	.090	BC 312	3.45N
DM 21CX	28	1.6	235	.090	BC 312	3.45N
DM 25	12	2.3	250	.050	BC 367	2.49LN
DM 28R	28	1.25	275	.070	BC 348	8.95N
DM 33A	28	7	540	.250	BC 456	5.50N
DM 42	14	46	515	.110	SCR 506	6.50LN
			1030	.050		
			2/8			
PE 86	28	1.25	250	.060	RC 36	3.95
PE 101C	13/26	12.6/	400	.135	SCR 515	5.25N
		6.3	800	.020		
DAG 33A	18	3.2	450	.060		4.50N
SP 175	18	3.2	450	.060		4.75N
BD AR 93	28	3.25	375	.150		4.95N
23350	27	1.75	285	.075	APN-1	3.50N
35X045B	28	1.2	250	.060		3.50N
ZA .0515	12/24	4/2	500	.050		3.95N
ZA .0516	12/24	8/4	12/275	3/.110		5.50N
B-19 pack	12	9.4	275	.110	Mark II	9.95N
			500	.050		
D-104	12		225	.100		14.95N
			440	.200		
DA-3A*	28	10	300	.260	SCR 522	8.95
			150	.010		
			14.5	.5		
			150	.010		
5053	28	1.4	250	.060	APN-1	3.95N
DA-7A	26.5		1100	.400	TA-2J	25.00N
CW 21AAX	13	12.6	400	.135		17.50N
	26	6.3	800	.020		
			9	1.12		
BD 77KM	14	40	1000	.350	BC 191	
PE 94	28	10	300	.260	SCR	15.00N
			150	.010	522	
			14.5	.5		

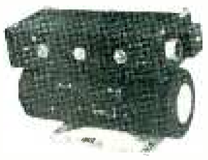
N—New. LN—Like New. *Less Filter Box & Relays

Replacement dynamotors for PE 73, less filter box..............$12.00

HAND GENERATORS

GN 35: 350 v. 60 ma; 8v, 2.5 A. New, with hand cranks.......$12.50
GN 45: 500 v, 100 ma; 6v, 8 amps. Slight use, ex. cond, with cranks $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) $49.95
PE 218-H: Same as above except size: 16½" x 6" x 10". New $49.95
PE 218H, used, good cond. $25.00
PE 206: 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

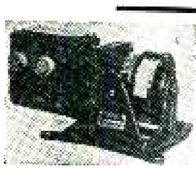
30' US ARMY SIGNAL CORPS RADIO MASTS

Complete set for the erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig Corps #2A289-223-A. New ....$39.50 per set of 2

6-VOLT RELAY PANELS

Comes complete with relays mounted on bakelite panel with 25 terminals:
1—SPST (NC) 1—DPST (NO)
1—SPST (NO) 2—DPST (Make 1, break 1)
Board Dim: 10" lg x 6" W x 2⅝" H..............$9.95

*LEAR POWER UNITS



24 vdc drive, 90:1 gear ratio. High power. Originally designed for landing gear retraction. Bicycle type sprocket for multi-purpose drive. Large quantity available $16.50

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-170968: 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-166602: 16 mfd @ 400 vdc, temp comp 50 to 85 deg C $12.50
D-161270: 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg C $12.50

CROSS POINTER INDICATOR

ID 24-ARN-9 Dual 0-200 microamp, movement in 3" case. Each movement brought out to 6-term receptacle at rear. Originally used in ILS equipment. New..$5.50
ZA Type $10.00

A Complete Line of SubSig Replacement Transformers. Send for List.

POWER EQUIPMENT

STEP DOWN TRANSFORMER: Pri. 440/220/110 volts a.c. 60 cycles. 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7"....................$40.00
PLATE TRANSFORMER: Pri: 117 v. 60 cy. Sec. 17,600 @ 144 ma. with choke. Oil immersed. Size: 26" x 29" x 13" American $120.00
FIL. TRANS. UX6899. Pri: 115 v. 60 cyc. Sec: Two 5 v. 5.5 amp wdgs. 29 KV test $24.50
VOLTAGE REG. Transtat. Amertran type RH 2 KVA load, input: 90/130 v. 50-60 cy. output 115 v..............$40.00
ITE CIRCUIT BREAKER, 115 A, 600 v. Mod KI $15.00
UX 6801 (Raytheon): Pri: 110 v. 60 cy. 1 ph. Sec: 22,000 v. 234 ma. 5.35 KVA. Dim: 23"x24"x10¾".
PLATE XFMR: Pri: 198, 22, 240 v. 60 cy. 1 ph. 16.7 KVA. Sec: 3650 v. 30 KV test.
FIL XFMR: Kenyon: Pri: 210/215/220/225/230/235/240 vac, 60 cy. Sec: 11v, 35 amp: 10 v, 35 amp ct: 7.5 v, 35 amp ct: 5 v, 35 amp ct #S-10768.........$37.50
FIL TRANS: KS8767: Pri: 115 v, 60 cy. Sec: 2 wdgs: 5 v @ 5 amps each 15 KV Test $15.00

POWER CHOKES

Swing. Choke: 4.5 to .8 hy; .2 to 1 amp $10.95
.03 hy, 2 amp. $1.45
8.5 hy, 125 ma....................$1.50
25 hy, 65 ma....................$1.10
6 hy, 150 ma....................$1.50
Dual 7 hy, 75 ma, 11 hy, 60 ma.....$1.65
Dual 2 hy, 100 ma....................$ .75
.116 hy, .15 amp....................$4.50
.01 hy, 2.5 amp....................$1.50
.35 hy, .35 amp....................$7.50
Dual 2.5 hy, 130 ma....................$1.25
.1 hy, 12 amp, 40 ohms....................$16.00
Dual .5 hy, 380 ma....................$ .95
Dual .5 hy, 380 ma....................$ .95
5 hy, 40 ma. 312 ohms....................$ .65
2 hy, 200 ma....................$ .75
Dual 120 hy, @ 17 ma....................$2.45

VOLTAGE REGULATORS

Mfg. Raytheon: Navy CRP-301407: Pri: 92-138 v, 15 amps. 57 to 63 cy, 1 phase. Sec: 115 v, 7.15 amp, .82 KVA, .96 PF. Contains the following components:
REGULATOR TRANSFORMER: Raytheon UX-9545. Pri: 92-138 v. 60 cy, 1 PH. Sec: 200/580 v. 5.5/5.26 amps, 4000 v. rms test.
FILTER REACTOR: .156 hy, 5 amps, 4000 v. test. Raytheon UX 9547.
TRANSFORMER: Pri: 186 v. 5 amps; Sec: 115 v. 7.2 amps. Size 12" x 20" x 29". Net Wt. approx. 250 Lbs.
Entire unit enclosed in grey metal cabinet with mounting facilities. New, as shown.....$99.50

COMBINATION TRANSFORMERS

#5104, 800 vct, 150 ma: 5 v, 3 amp: 6.3 v, 6. 25 amp. $6.95
KS 8031, 585 vct, 86 ma; 5 v. 3 amp; 6.3 v, 6 amp. $4.25

TRANSTATS (AMERTRAN)

Input: 0.115 v. 50-60 cycle. Max. output: 115 v, 100 amp. All units are new, guaranteed $95

OIL CONDENSERS

1.5 MFD., 6000 vdc....................$12.50
1 MFD., 25,000 volts $99.50
.25 MFD., 20,000 vdc....................$17.50
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3x10 MFD., delta connected synchro-capacitor, 90 v. 60 cycles $4.95
.1 MFD., 6000 vdc, 25F509G2....................$6.50
2X.1 MFD., 7000VDC $4.95

400 CYCLE TRANSFORMERS

352-7273: Pri: 115 v, 400 cy. Sec: 6.3v, 2.5 amp; 6.3 v, .06 amp; 6.3 v, .9 amp: 5v, 6 amp; 700 vct ... 2-5U4's. For APS-15. T201....................$3.75
352-7176: Pri: 115v, 400 cy. Sec: 6.3 v, 20 amp; 6.3 v, .5 amp; 6.3 v, .5 amp; 320 v (2-6X5's). For APS-15. T202 ....$5.25
352-7278: Pri: 115 v, 400 cy. Sec: 2.5 v, 1.75 amp, 3500 v (2X2). For APS-15. T203, (Anode #2 5FP7) $5.85
352-7070: Pri: 118 v, 440 cy. Sec: 2.5 v, 2.5 amp: 2.5 v, 2.5 amp; (2000 v ins.): 6.3 v, 2.25 amp; 1200 v tapped at 1000 and 750 v. p/o AN/APS 15....$4.95
#7469105: Pri: 115 v, 400 cy, Sec: Tapped to give 742.5 v, 50 ma; 709 v, .0477 amp; 671 v, .045 amp $2.95
D-163254: Pri: 115 v, 400 cy. Sec: 6.3 v, 12 amp; 6.3 v, 2 amp; 6.3 v, 1 amp. P/O AN/APQ-5......$5.85
KS-9685: Pri: 115 v, 400-2400 cy. Sec: 6.4 vct, 7.5 amp: 6.4 v, 3.8 amp: 6.4 v, 2.5 amp.........$4.35
PLATE XFMR: Pri: 115 v, 400 cy. Sec: 9800 v. or 8600 v, @ 32 ma dc....................$12.50
#12033, Plate Xfmr, Pri: 115 v, 800 cy. Sec: 4550 vct. 250 ma $7.95

COMMUNICATIONS EQUIPMENT CO.
131-"B" LIBERTY ST., NEW YORK, N. Y. DIGBY 9-4125

SAVE

BRAND NEW GUARANTEED

INVERTERS

12117-2, Pioneer. Input 24 volts D. C. Output 26 volts, 400 cycle, 6 V. A.

Price $20.00 each net.

153F, Holtzer Cabot. Input, 24 volts D. C. Output 115 volts, 400 cycle 3 phase, 750 V. A. and 26 volts 400 cycle, 1 phase, 250 V. A., Voltage and frequency regulated also built in radio filter.

Price $125.00 each net.

12123-1-A, Pioneer. Input 24 volts D. C. Output 115 volts, 400 cycle, 3 phase. Voltage and frequency regulated. 100 V.A.

Price $75.00 each net.

WG750, Wincharger, PU 16. Input 24 volts D. C. Output 115 volts, 400 cycle, 1 phase, 6.5 amps. Voltage and frequency regulated.

Price $40.00 each net.

149H, Holtzer Cabot. Input 28 volts at 44 amps. Output 26 volts at 250 V. A. 400 cycle and 115 volts at 500 V. A. 400 cycle.

Price $39.00 each net.

149F, Holtzer Cabot. Input 28 volts at 36 amps. Output 26 volts at 250 V. A. 400 cycle and 115 volts at 500 V. A. 400 cycle.

Price $35.00 each net.

12117, Pioneer. Input 12 volts D. C. Output 26 volts, 400 cycles, 6 V. A.

Price $22.50 each net.

5D21NJA General Electric. Input 24 volts D. C. Output 115 volts 400 cycle at 485 V. A.

Price $14.00 each net.

WESTON FREQUENCY METER

Model 637, 350-450 cycle, 115 volts.

Price $10.00 each net.

WESTON VOLTMETER

Model 833, 0 to 130 volts. 400 cycle.

Price $4.00 each net.

PIONEER AUTOSYNS

AY1, 26 volts, 400 cycle.
Price $4.00 each net.

AY20, 26 volts, 400 cycle.
Price $5.50 each net.

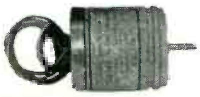
AY30, 26 volts, 400 cycle
Price $10.00 each net.

AY31, 26 volts, 400 cycle. Shaft extends from both ends.
Price $10.00 each net.

AY38, 26 volts, 400 cycle. Shaft extends from both ends.
Price $10.00 each net.

PIONEER PRECISION AUTOSYNS

AY101D, new with calibration curve.



PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve.
Price $35.00 each net.

PIONEER TORQUE UNITS

Type 12602-1-A.
Price $30.00 each net.

Type 12606-1-A.
Price $34.00 each net.

Type 12627-1-A.
Price $70.00 each net.

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A.
Price $17.50 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.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 volt D. C. 7000 R. P. M. 1/100HP.
Price $2.90 each net.

RATE GENERATORS

PM2, Electric Indicator Company, .0175 V. per R. P. M.
Price $7.25 each net.

F16, Electric Indicator Company, 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 Indictator, 110 volts, 60 cycle, 1 phase.
Price $14.00 each net.

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(Resolvers)

FPE 43-1, Diehl, 115 volts, 400 cycle.
Price $20.00 each net.

FJE 43-9, Diehl, 115 volts, 400 cycle.
Price $20.00 each net.

SYNCHROS

If Special Repeater, 115 volts, 400 cycle. Will operate on 60 cycle at reduced voltage.

Price $15.00 each net.

2J1M1 Control Transformer 105/63 Volts, 60 cycle.
Price $20.00 each net.

2J1G1 Control Transformer, 57.5/57.5 volts, 400 cycle.
Price $1.90 each net.

2J1H1 Selsyn Differential Generator, 57.5/57.5 volts, 400 cycle.
Price $3.25 each net.

5G Generator, 115 volts, 60 cycle.
Price $25.00 each net.

W. E. KS-5950-L2, Size 5 Generator, 115 volts, 400 cycle.
Price $3.50 each net.

5G Special, Generator 115/90 volts, 400 cycle.
Price $15.50 each net.

5SF Repeater, 115/90 volts, 400 cycle.
Price $19.00 each net.

2J1F1 Selsyn Generator, 115 volts, 400 cycle.
Price $3.50 each net.

Write for complete listings

Western Union Address: WUX Flushing, N. Y.

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Telephone INdependence 3-1919

SAVE

BRAND NEW GUARANTEED

A. C. MOTORS

5071930, Delco, 115 volts, 60 cycle, 7000 R. P. M.
Price $4.50 each net.

36228, Hayden Timing Motor, 115 volts, 60 cycle, 1 R. P. M.
Price $3.15 each net.

Hayden Timing Motor—110 V. 60 cycle 3.2 Watts, 4 R. P. M., with brake.
Price $4.00 each net.

45629R Hayden Timing Motor, 110 volts, 60 cycle, 2.2 watts, 1/240 R. P. M.
Price $3.15 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 volts, 60 cycle, 2 R. P. M., 4 watts.
Price $5.00 each net.

SERVO MOTORS

CK1, Pioneer, 2 phase, 400 cycle.
Price $10.00 each net.

CK2, Pioneer, 2 phase, 400 cycle.
Price $4.50 each net.

FPE-25-11, Diehl, Low-Inertia, 75 to 115 V., 60 cycle, 2 phase.
Price $16.00 each net.

FP-25-2, Diehl, Low-Inertia, 20 volts, 60 cycle, 2 phase.
Price $9.00 each net.

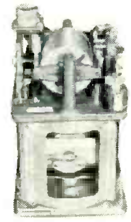
FP-25-3, Diehl, Low-Inertia, 20 volts, 60 cycle, 2 phase.
Price $9.00 each net.

MINNEAPOLIS HONEYWELL TYPE

B Part No. G3030AY, 115 volts, 400 cycle, 2 phase, built-in gear reduction, 50 in lbs. torque.
Price $7.50 each net.

GYROS

Schwein Free & Rate Gyro type 45600. Consists of two 28 volt D. C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $10.00 each net.



Schwein Free & Rate Gyro, type 46800. Same as above except later design.
Price $11.00 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 volts, 400 cycle, 3 phase.
Price $20.00 each net.

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter.
Price $8.00 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.

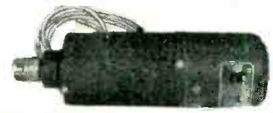
Pioneer Type 12800-1-D Gyro Servo Unit. 115 volts, 400 cycle, 3 phase.
Price $8.00 each net.

Norden Type M7 Vertical Gyro. 26 volts D. C.
Price $19.00 each net.

Norden Type M7 Servo Motor. 26 volts D. C.
Price $20.00 each net.

General Electric Type 8672162 Azimuth Gyro Assembly Contains Delco Type 5067125 Constant speed motor and Signal assembly.
Price $12.75 each net.

D. C. MOTORS



5069625, Delco Constant Speed, 27 volts, 120 R. P. M. Built-in reduction gears and governor. **Price $4.25 each net.**

A-7155, Delco Constant Speed Shunt Motor, 27 volts, 2.4 amps., 3600 R. P. M., 1/30 H. P. Built-in governor.
Price $6.25 each net.

5BA10J18D, General Electric, 27 volts, 0.7 amp., 110 R. P. M.
Price $3.50 each net.

5066665, Delco Shunt Motor, 27 volts, 4000 R. P. M. Reversible, flange, mounted. **Price $4.50 each net.**

C-28P-1A, John Oster Shunt Motor, 27 volts, 0.7 amps., 7000 R. P. M., 1/100 H. P. **Price $3.75 each net.**

D. C. AMACO FIELD MOTORS

5069600, Delco, 27 V., 250 R. P. M.
Price $4.50 each net.

5069466, Delco, 27 V., 10,000 R. P. M.
Price $3.00 each net.

5069611, Delco, 12 V., 10,000 R. P. M.
Price $4.00 each net.

5069370, Delco, 27 V., 10,000 R. P. M.
Price $4.70 each net.

5067125, Delco, 27 V., 10,000 R. P. M. With Governor.
Price $6.50 each net.

S. S. FD6-16, Diehl, 27 V., 10,000 R. P. M.
Price $3.75 each net.

S. S. FD6-18, Diehl, 27 V., 10,000 R. P. M.
Price $3.75 each net.

S. S. FD-6-21, Diehl, 27 V., 10,000 R. P. M.
Price $3.75

GENERAL ELECTRIC D.C. SELSYNS

8TJ9-PDN Transmitter, 24 volts.
Price $3.75 each net.

8DJ11-PCY Indicator, 24 volts. Dial marked —10° to +65°.
Price $4.00 each net.

8DJ11-PCY Indicator, 24 volts. Dial marked 0 to 360°.
Price $7.50 each net.

INSTRUMENT ASSOCIATES

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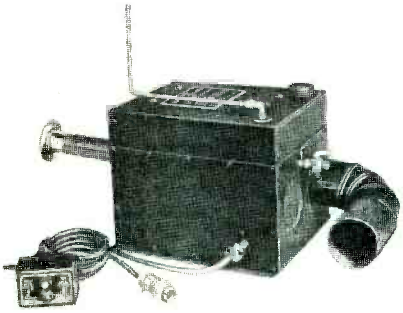
Gasoline Heater—Motorola Model GN-3-24



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.

@ $22.50 F.O.B. N. Y.

COMBINATION OFFER

150 VOLT A.C. METER
Triplett 331-JP, 3½" Rd flush case

30 AMP A.C. METER
Triplett 331-JP, 3½" Rd flush case

Both meters for $7.95

D. C. MILLIAMMETERS

0-1 DeJur Amsco 2½" rd Spec Sc....$2.50
0-1 G.E. 2½" rd, sc cal 140/500....$3.00
0-1 G.E. 2½" rd Spec Sc....$3.50
0-1 SIMP 125 2½" rd fl bake case....$3.50
0-1 W.H. 2½" rd bl sc, Spec sc....$3.00
0-1 McClintock 3" sq 65 ohms Spec Sc....$3.50
0-1 McClintock 3½" rd....$3.50
0-1 SUN 3½" rd....$3.00
0-1 W.H. 3½" rd 53.7 ohms resist MR35W001 DCMA....$7.50
-.1 -0-1.25 Miniature MA, black sc, Aircraft style G-1, 1¾" sq bake case, Bulova Watch Co..$3.95
0-1.4 HICK 3½" rd 70 ohms, w. Micromhos sc $3.50
0-1.5 HICK 2½" rd met cs....$2.00
0-2 RS 20 MV mvt Spec sc....$2.50
0-3 GRUEN 2½" rd....$2.00
0-3 GRUEN 2½" rd Spec Sc....$2.00
0-3 SIMP 2½" rd....$2.25
0-3 WESTON 2½" rd met cs....$2.50
5-0-5 W.E. 2½" rd fl conc style, bake cs, sc cal 50-0-50....$3.00
0-10 HICK 2½" rd met sc, Spec Sc....$2.50
0-12.5 R.S. 1¾" sq 50 MV....$4.50
0-15 Simp 3½" rd....$4.50
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0-20 G.E. 3" sq....$3.75
0-25 Weston 3½" rd....$4.95
0-30 G.E. 3½" rd....$3.50
0-50 G.E. 3½" rd....$3.95
0-80 G.E. 3½" rd....$3.75
0-100 Weston 2½" rd....$3.95
0-150 Gruen 2½" rd....$3.00
0-200 Gruen 2½" rd....$3.00
0-200 Marion 3½" rd....$4.00
0-200 Simp 3½" rd....$4.50
0-200 Weston 3½" rd....$4.95
0-200 W.H. 3½" rd....$4.50
0-300 G.E. 3½" rd....$4.95
0-500 W.H. 2½" rd....$3.95
0-500 Weston 301 3½" rd....$4.95

"VIBROTEST" INSULATION RESISTANCE and A.C.-D.C. VOLTAGE TESTER

RESISTANCE RANGE: 0-200 Megohms (at 500 volt test potential) 0-2000 ohms.

VOLTAGE RANGE: 150-300-600 Volts D.C.
150-300-600 Volts A.C.

Push button action for resistance readings. Operates from internal power supply off two # 6 dry cells. Large 4" meter and Knife edge pointer insures accurate readings. Complete with test leads & instructions in metal carrying case as illustrated.

Associated Research Model # 201.

(Brand new but slightly shelfworn from Gov't stock room) ....**Your Net Price $38.00**

PORTABLE CHRONOMETRIC TACHOMETER

Measures shaft speeds from 10 RPM to 20,000 RPM.
Measures lineal speeds 5 FPM to 10,000 FPM.
Meets Navy Specs. ½ of 1% accuracy.
With accessories, in case 5" x 3½" x 1½". List Price $75.00. Net Price $24.50

PORTABLE TACHOMETER MULTIPLE RANGE

Continuous Indicating Shaft or lineal speeds from 300-1200, 1000-4000, & 3,000 to 12,000 RPM. Meets Navy specs. 18-T-22 Type B, Class A. With accessories in case 7⅛" x 4" x 5". List Price $75.00. **NET PRICE**....$24.50

TACHOMETER same as above, except ranges are 300 to 1500, 1,000 to 5,000 and 3,000 to 15,000.
Your Net Price $25.50

D. C. MICROAMMETERS

0-50 G.E. 3" sq 2000 ohms Spec Attenuator Mult sc....$6.50
0-200 W.H. 3½" rd 230 ohms 43 MV, MR35W200-DCUA....$8.50
0-200 SUPER 4" Rect 500 ohms Special sc...$7.50
0-400 TRIUMPH 4" Rect 500 ohms, Special sc $5.50
0-500 DeJur Amsco 2½" rd....$3.00
0-500 Gruen 2½" rd....$3.95
0-500 Simp 2½" rd....$3.50
0-500 TRIP 2½" rd....$3.50
0-500 G.E. DO-41 3½" rd fl bake case, sc cal 0-20 KV....$4.50
0-500 W.H. 3" sq SPEC SC....$4.95
0-550 G.E. 3" sq Spec Sc....$4.50

D. C. AMMETERS

0-1.5G.E. 3½" rd....$4.95
0-2 Simp 3½" rd fl bake cs....$4.00
0-5 Gruen 2½" rd....$3.50
0-15 Sun 3½" rd....$3.50
0-15 Trip 3½" rd....$3.50
0-15 W.H. 3½" rd surf mtd....$4.00
0-30 Hoyt 2½" rd met sc....$3.50
30-0-30 Beede 2½" rd met cs....$2.50
30-0-30 G.E. 2½" rd met cs....$2.95
30-0-30 U.S. Gauge 2" met cs bl sc....$3.50
0-200 Weston 506 2½" rd W 50 MV shunt....$1.50
0-300 G.E. 2½" rd W 50 MV shunt....$7.50

D. C. VOLTMETERS

0-3 Simp 2" rd met cs ring mtd....$2.00
3-0-3 W.H. 2½" rd surf mtd 200 r/v....$1.25
0-5 W.H. 2½" rd 200 r/v....$3.50
0-10 Sun 2½" rd 100 r/v....$2.50
0-15 G.E. 2½" rd bl sc....$2.50
0-15 Gruen 2½" rd....$3.50
0-15 McClintock 2½" rd bl sc 1000 r/v....$3.00
0-20 Weston 2½" rd 1000 r/v....$3.50
0-30 DeJur Amsco 2½" rd....$2.50
0-30 G.E. 2½" rd 250 r/v....$2.95
0-50 Readrite 2½" rd stamped met sc....$1.00
0-50 W.H. 3½" rd 200 r/v....$3.95
0-600 Simp 2½" rd w ext res....$4.00
0-750 Weston 3½" rd met cs 1000 r/v....$11.00
0-1.5 KV DC W.H. 3½" rd 1000 r/v....$7.25
0-15 KV DC G.E. 3" sq 500 ua mvt, less mult $4.95
0-15 KV DC W.H. 3½" rd 1 MA mvt, less mult $4.50

FREQUENCY METER. JBT 30-F Dual Range covers frequency ranges from 48-52 cycles & 58-62 cycles; Dual element, vibrating reed type, 115 volt, 3½" rd flush metal case....$5.95

FREQUENCY METER. Range 350 to 450 cycles, 115 volt A.C. Iron core dynamometer type movement, 5 cycles per scale division, black scale luminous markings, Weston Model 637, 3½" Aircraft style....$4.95

DECIBEL METER. Weston 506 minus 10 to plus 6, 6 MW in 600 ohms, 2½" rd fl bake case..$5.50

DECIBEL METER. G.E. DO-46, minus 10 to plus 6 DB, 3½" rd fl bake case. Zero DB equals 1.9 volts....$8.95

DECIBEL METER. Weston 301 type 61, minus 10 to plus 6, 3½" rd fl bake case, 6 MW 600 ohms, Zero DB equals 1.9 volt. High speed type .29 — .35 Seconds to final reading. Only 2 — 6% overthrow, 5000 ohms at Zero DB, 16-50 Damping factor. Complete with external wire wound precision resistors to extend the range to any or all of the following ranges:
— 20 to plus 16 DB
— 30 to plus 26 DB
— 40 to plus 36 DB
Ideal for sound and broadcasting applications Total List Price $37.50 Your cost only....$11.50

SIGNAL STRENGTH "S" METER. Simpson 25, 5 M.A. 6 ohms mv't. Scale calibrated—6 to 100 DB above 1 Microvolt, illuminated mvt....$4.50

HOUR METER. Totals to 99,999.9 hours and repeats. W. H. NH-35, 3½" rd fl bake case. Operates on 230 volt 60 cycle....$8.50

RECTIFIER TYPE MILLIAMMETER. Weston Model 545, type 81, 4" Aircraft type, full scale, equals 1.1 MA AC, 940 UA DC mvt., 70 ohms resistance of moving coil, bl sc, calib 0-270° $6.50

RECTIFIER TYPE MILLIAMMETER McClintock 2" rd fl metal case, ring mtd. 1 MA AC Special black scale....$2.50

R.P.M. INDICATOR. Black scale calibrated 900-0-900 R.P.M., 1-0-1 MA mvt., Weston Model 502, 6" sq fl bake case....$18.00

BOWL INSULATOR. Clear Glass Corning Type C, Overall dia 8¾" Pin ⅝" x 11½", All brass fittings S.C. stock #3G-1830-67076.1....$6.00

A. C. AMMETERS

0-30 Trip 3½" rd....$4.00
0-30 Trip 3½" rd met cs....$3.50
0-50 G.E. 3½" rd....$4.50
0-50 W.H. 3½" rd....$4.95
0-60 W.H. 4½" rd surf mtd cs....$8.00
0-60/120 Burl 3½" w ext current transformer $7.50
0-60/120 Burl 3½" less current transformer..$4.50

A. C. VOLTMETERS

0-15 G.E. 2½" rd bl sc 800 cy....$2.50
0-15 G.E. 2½" rd bl blank scale IS-122....$2.50
0-15 G.E. 3½" rd bl sc....$3.00
0-15 Weston 476 3½" rd....$4.50
0-15 W.H. 3½" rd....$3.95
0-40 Weston 517 2½" rd fl met cs, bl dial luminous mkgs 400 cy....$3.50
0-40 W.H. 2½" rd bl sc, lum mkgs, 400 cy...$2.95
0-75 Weston 2" rd met cs ring mtd....$2.95
0-130 W.H. 3½" rd BLANK SCALE, red line at 115 V....$3.00
0-150 G.E. 3½" rd....$5.50
0-150 Trip 3½" rd met cs....$4.00
0-150 Trip 3½" rd w res for 300 V....$5.50
0-500 G.E. AO-22 3½" rd fl bake cs....$12.00

R. F. AMMETERS

0-120 MA RF, Simpson 25 3½" rd fl bake cs, sc cal "0-10 Output Units" with external thermocouple $5.50
0-120 MA RF, Simpson 3½" rd fl bake case...$8.50
0-120 MA RF, Weston 425, 3½" rd fl bake case $8.50
0-250 MA RF G.E. 2½" rd bl sc cal 0-5....$3.50
0-250 MA RF, W.H. 2½" rd bl spec sc....$3.50
0-500 MA RF, Weston 3½" rd with ext thermocouple....$9.50
0-1 G.E. 2½" rd bl sc....$2.95
0-1 G.E. 2½" rd fl bake case....$3.50
0-1 RF A G.E. 2½" rd met cs....$3.00
0-1 G.E. 3½" rd....$7.50
0-1.5 G.E. 2½" rd met cs bl sc....$2.95
0-1.5 Weston 2½" rd met sc bl sc....$2.50
0-1.5 Weston 3½" rd....$8.25
0-2 Simp 2½" rd....$3.50
0-2 Weston 3½" rd....$8.50
0-2.5 Weston 2½" rd....$3.95
0-2.5 Simp 3½" rd....$4.95
0-2.5 McClintock 3½" rd....$4.50
0-2.5 Weston 3½" rd....$8.50
0-2.5 W.H. 3½" rd....$5.50
0-3 Simp 2½" rd....$3.50
0-3 Weston 3½" rd w Ext thermocouple....$11.50
0-3 W.H. 3½" rd....$5.50
0-4 G.E. 2½" rd bl sc....$2.95
0-5 G.E. 3½" rd....$7.50
0-5 Weston 3½" rd....$8.50
0-6 G.E. 2½" rd bl sc....$2.50
0-8 G.E. 2½" rd bl sc....$2.95
0-10 Weston 3½"....$6.50
0-20 Weston 2½" rd....$3.50
0-20 G.E. 3½" rd....$4.95
0-30 Trip 3" sq W e/t leads & couple....$8.00

All items are Surplus—New—Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit. Orders accepted from rated concerns, public institutions, etc., on open account.
The above is only a partial listing of the many items we have in stock. Send for free circular.
MANUFACTURERS, EXPORTERS, DEALERS—we invite your inquiries.
NOTICE—We Repeat—all items are Surplus—New—Guaranteed. All prices FOB, NY

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We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, laboratory standards, etc.

OVER 50,000 METERS IN STOCK

We also have in stock various surplus components, tubes, code keying and recording units, code training sets, tachometers, analyzers, tube testers, converters, precision resistors, current transformers, transmitters, receivers, condensers, and other electronic units, parts and accessories.

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AUTOSYNS

Pioneer Types AY-1, AY-14, AY-20, AY-30, AY-54D, 2320, and AY-101D.

Prices on request

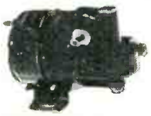
Pioneer Fuel Pressure Transmitter Type C-14A. 0-25 lbs. 26 v. 400 cycles. Stock #SA-131. **Price $3.75 each.**
Pioneer Oil Pressure Transmitter Type 4150-3B3. 0-200 lbs. 26 v. 400 cycles. Stock #SA-25. **Price $3.75 each.**
Pioneer B9A Dual Oil Pressure Indicator. 0-200 lbs. Use with 2S-25. Stock #SA-215. **Price $9.50 each.**

D. C. MOTORS

Blower Assembly MX-215/APG
John Oster C-2P-1L 28 v. DC. 7000 RPM 1/100 hp. #2 L-R Blower.
Stock #SA-202. **Price $2.95 each**

Universal Electric DC
W.E. KS-5603-L02. 28 v. DC. 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233.
Price $1.95 ea. plus 15c p.p.

Delco 5069466 Motor
Alnico PM field. 27.5 v. DC. 1" x 1" x 2" lg. Pinion gear on shaft. Stock #SA-65. **Price $2.95 each plus 15c p.p.**



EMC DC Gearhead Motor
115 v. DC. Type SPN-39562. Shunt wound. Reversible with s. p. d. t. switch. Output shaft speed approx. 8 rpm. Motor diam. 2½" x 2½" with 2" gear housing extension. Stock #SA-246. **Price $8.50 each.**

ALSO MANY OTHER TYPES MAKES AND RATINGS

DYNAMOTOR

D-101, 27 v. DC in @ 1.5 amps. DC output 285 v. @ .060 amps. Stock #SA-187. **Price $1.50 ea.**

C-1 Autopilot Servo Unit—28v. DC 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**

SPECIALS

400 Cycles
Three Phase

INVERTER

Holtzer Cabot MG-153—Input 28 volts DC at 52 amps. Output three phase 115 volts 400 cycles at 750 V.A. 0.90 P.F. Also second output of 26 volts 400 cycles at 250 V.A. Voltage and frequency regulated.
New—Perfect .... **$99.50 ea.**
New—Surface Damages .... **59.50 ea.**

Leland SD-93—(10258)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 V.A. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209.
Price $79.50 each

ALSO IN STOCK

Navy Type **CRV-21AAR G.E. 5AS121LJ2**
General Electric 5D21NJ3A
Holtzer Cabot MG-149H
Holtzer Cabot MG-149F
Wincharger PU7/AP
Wincharger MG-750
Pioneer 12123-1A
Pioneer 12117-2
Pioneer 12117-5
PE-218

TACHOMETER GENERATORS

Army Type E10 Transmitter. 400-3500 rpm. 26 v. 400 cycle operation or 6-10 v. 60 cycles. Stock #SA-213. **Price $9.50 each.**
Dual Indicator. For use with 2S-213 Transmitters. Stock #SA-214. **Price $9.50 each.**

RATE GENERATORS

Elinco PM-2
2.0 v. DC per 100 rpm. Use to 2000 rpm.
ELINCO F-16. 2 Phase AC. 1.3 v. AC per 100 rpm. 60 cy. output at 1800 rpm.

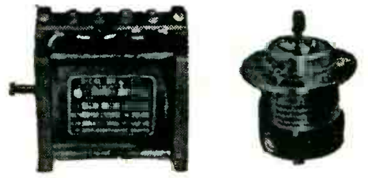
SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver plated coaxial type. 5-10 mmf.
Stock #SA-167. **Price $2.75 each.**

LP-21-LM Compass Loops

New
Stock #SA-99.
Price $9.50 each

AC-SERVO MOTORS

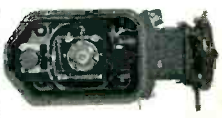


Pioneer—CK-2 and 10047-2A for 400 cy.
Kollsman—776-01 for 400 cycles.
Diehl—FP-25-3, **FPE-25-11** (CDA-211052) and ZP-105-14 for 60 cycles.
Prices on Request

GYROS

Sperry A5 Vertical Gyro. Part No. 644841, 115 volts 400 cycle 3 phase.
Sperry A5 Directional Gyro Part No. 656029, 115 volts 400 cycle, 3 phase.
Schwein Free & Rate Gyro type 45600.
Schwein Free & Rate Gyro, type 46800.

GYRO SERVO UNIT

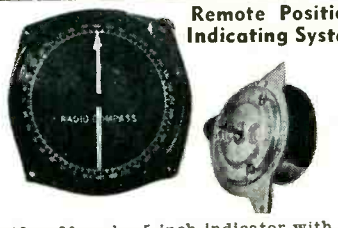


Pioneer 12800-1-D. 115v. 400 cy. Low inertia motor and follow-up Autosyn. Stock #SA-160 **Price $6.95 each**

⅛ HP DC Motor—G.E.5BA25MJ409. 24 v. 7.5 amps. 7500 rpm. Cont. duty. 5" lg. x 2½" diam. ¾" shaft ext.
Stock #SA-235 **Price $4.75 each.**

Bodine NYC-13 AC Motor
115 v. 60 cycles. 1/40 hp. 1800 rpm. Cont. duty. .55 amps. Stock #SA-245.
Price $9.50 ea.

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**

SYNCHROS

Navy Types
1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 6DG, 6G, 6DG, 7G, etc.
Prices on Request

Servo-Tek products co.
4 Godwin Ave.
Paterson, N. J.

Open account shipments to rated concerns

All prices F.O.B., Paterson, N. J.

VOLTAGE REGULATOR

Any unfiltered source of 350-400 volts DC may be connected to this unit to provide filtered and regulated output at 150 and 300 volts. Contains 12 Hy choke: 3-4 mfd. capacitors; bleeder, divider and current limiting resistors, etc. Ideal in the Lab for experimental set-ups. Complete, brand new with 2-VR 150 tubes.

Brand New $7.95

STEPDOWN TRANSFORMER

Input: 115V 60 cycles.
Output: 20 V., at 10 amps. Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications, etc.

Brand New $2.45

BRIDGE TYPE SELENIUM RECTIFIER

Input: 36V A.C.
Output: 28V D.C. at 1.1 amps.

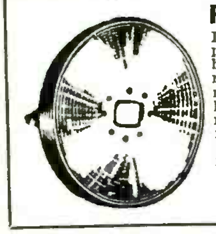
Brand New $2.75

LINEAR SAWTOOTH POTENTIOMETER

W.E. No. KS 15138

The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

Brand New $5.75



PARABOLOIDS

Ideal for microwave experimental use. Sturdy, beautifully built spun magnesium dishes with reinforced perimeter and horizontal and vertical mounting brackets on rear. Size 17½" dia. x 4" deep. Center hole 1½" x 1⅝".

Brand New. Per Pair, $8.75

NAVY MOTOR GENERATORS

Allis-Chalmers

115V. D.C. to 120 A.C. 60 cy. 1 ph., 1.25 KVA 3600 RPM, ball bearings, centrifugal starter, fully enclosed, splashproof.

Brand New—$97.50

Same machine with 230V D.C. input **$125.00**

Also available: 2kw., 115V D.C. to 115V, 50 cycle, 1 ph. and 2.5k.w., 115V D.C. to 115V, 60 cy., 1 ph. machines. Write your requirements.

WESTERN ELECTRIC MERCURY CONTACT RELAYS

TYPE D-168479

These relays are glass sealed, mercury-wetted contact switches surrounded by operating coils and encased in metal housings, mounted on an octal tube base.

TYPICAL APPLICATIONS

- High speed keying
- Tabulating, sorting and computing machines
- Relay Amplifiers
- Vibrator Power Supplies
- Servo-mechanisms

CHARACTERISTICS

- High speed of operation
- Constant operating characteristics
- Freedom from chatter
- High current capacity
- Long, trouble-free service

Single Pole, Double Throw Contacts. Two coils of 700 ohms and 3300 ohms. Operating current with coils connected in series 6.6 ma. Release current 5.2 ma.

When operated under specified conditions this relay has a life expectancy of 1000 hours at 60 operations per second.

Overall length—3-3/8"

Overall dia.—1-5/16"

Brand new Priced at a fraction of Government cost **$4.75**

Send for 4 page Technical data.

PANORAMIC ADAPTER AN/APA-10

Includes 21 tubes and 3" scope tube. Converted for operation 115 v. 60 cycles. Tested and guaranteed in perfect operating condition.....$195.00

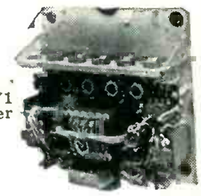
SOUND POWERED TELEPHONES

Type TP-3

For two-way signalling for voice communication. No batteries needed. May be used on metallic or grounded circuits, open-wire lines, cables or circuits using local-battery telephones, switchboards; two-way-ring-down trunk circuits of common battery switchboards, etc. Contained in treated waterproof fabric cases with adjustable carrying straps.

Brand New $39.50

SERVO AMPLIFIER



G.E. Type 2CV1V1 including dust cover not shown.

BRAND NEW $9.50

10 CM WAVEGUIDE

Solid bronze, 90° elbow flatwise bend.

Brand New $20

SO-1 RADAR ANTENNA ROTATORS

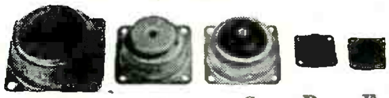
These Radar Antenna Rotating mechanisms are now being used by many television companies and experimental laboratories for rotating microwave and other transmitting and receiving equipments. The SO-1 Radar Rotator pedestal is ideal for this purpose because of its high torque and sturdy, weatherproof construction.

Drive mechanisms consist of a high precision speed-reduction worm gear train driven by a reversible D.C. Motor. On the low-speed end of the worm train, a spur gear drives a larger spur gear attached to the rotating assembly. The latter is virtually locked in position by the gear train when the drive motor is off, preventing drifting of the antenna in high winds.

Brand New $249.50

Selsyn Direction Indicator equipment specifically designed for use with these Rotators is available on special order. Write for further information.

SHOCK MOUNTS



A B C D E

A. Lord #20, 3" x 3" x 1¾".........	.40
B. U. S. Rubber #5150 C, 2⅝" x 2⅝" x 1⅛".....................	.30
C. Lord 15, 2⅝" x 2⅝" x 1⅛"........	.25
D. Lord #10, 1¼" x 1¼" x ⅝"........	.10
E. Lord #3, 1¼" x 1¼" x ⅜"........	.10

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT INC.

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SURPLUS BARGAINS — — NOW ! !

L & N MICROMAX

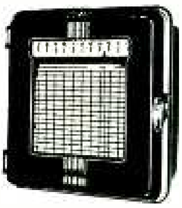
D. C. POTENTIOMETER

Rebuilt, Reconditioned, Adjusted Electrically and Mechanically.

#s in 4000 Group Series

Model S INDICATING & RECORDING CONTROLLER

Single Point, Curve Drawing. Continuous Line, One set HIGH & LOW Contacts. 110V A.C. Motor.



Ranges:

0—1200°F C/A
0—1500°F C/A
0—1800°F C/A
200—2000°F C/A
1000—2000°F C/A
1000—3000°F Plat./10%R

$210.00

MODEL R INDICATING & RECORDING CONTROLLER

Single Point. Curve Drawing. Continuous Line. Chart Speed 1 RPM/24 Hrs. 1 set HIGH & LOW Adjustable Contacts.

115V A.C. Motor.

Ranges:

0— 800°F C/A
700—1400°F C/A
200—2000°F C/A

$135.00

Model C INDICATING CONTROLLER

Single Point, Non-Recording Open Type. Contacts for use with External Relay. HIGH-COMMON - LOW. Contacts for Controlling. 115V. A.C. Motor.

Ranges:

0—1500°F I/C
0—1600°F C/A
0—1800°F C/A
200—2000°F C/A
600—2000°F C/A

$110.00

TRANSTATS

Type RH Input: 115 V. ±10%. Output: 115 V. Made as a line voltage corrector ±10% of input voltage, or can be connected to give ±20% of input. Rating .25 KVA.

Your price **$6.50**

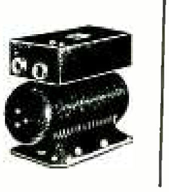
RATING 3KVA, MAX AMPS 26

same as above, can also be reconnected to be used as an isolation type step down with variable secondary. Input: 115V. Output: 0-30V, at 30 Amps.

Your price **$18.00**

GE DYNAMOTOR TYPE D US ARMY PE-73-CM,

for use with BC 375.



Input—28V D.C. Output—1000V D.C.—at 350 MA. With Voltage Regulator. Weight 30 lbs. NEW! in original container.

$5.75

PANEL METERS

Code—R-Round, S-Square, B-Bakelite, M-Metal, F-Flush, SF-Surface, FS-Full Scale

A. C. VOLTS

Weston	517	0–10	2" R-M	2.95
Weston	517	0–15	2" R-B	2.95
Weston	517	0–150	2" R-B	**3.50**
Simpson	125	0–150	2" R-M	2.95
Weston	476	0–1.5	3" R-B	4.50
Whse	RA35	0–7.5	3" R-B	**3.95**
Weston	476	0–8	3" R-B	**3.95**
Trpltt	331JP	0–150	3" R-B	**4.50**
GE	AO22	0–150	3" R-B	5.50
Brlngton	32XA	0–150	3" R-B	4.50
Whse	NA35	0–15/300	3" R-B 3 Studs	5.95
Whse	DY–2	0–15	4" R-M Ext. Mult	9.75
Weston	642	0–75	4" R-M SF or F	7.50
Whse.	RA37	0–300/600	4" S-B w/2 to 1 Potential Transformers	**9.75**

AC AMPS

Whse	NA35	0–3A FS. 0–120 Scale	3" R-B	4.95
Trpltt	431 AC	0–5A FS. 0–150/300 Scale	3" S-B	4.95
Trpltt	332JP	0–30	3" R-M	**4.95**
Weston	642	0–75	4" R-M SF or F	7.50
Whse	RA37	0–75/150	4" S-B w/external Current Transformers	**9.75**

DC MICROAMPS

Weston	301	0–100	3" R-B	12.50

DC MILLIAMPS

McClntk	2001	0–1	2" R-B	**3.95**
Weston	506	0–1	2" R-B Spec Scale	4.50
Sun	525	0–2	2" R-B	2.50
Weston	506	0–3	2" R-B	3.95
Weston	506	0–15	2" R-B	3.50
GE	DW41	0–25	2" R-B Wide Flange	**3.50**
GE	DW41	0–30	2" R-B	3.50
Weston	506	0–50	2" R-M	3.95
McClntk	2001	0–100	2" R-B	3.50
Simpson	25	0–1	3" R-B Spec Scale	**4.50**
GE	DO41	0–1	3" R-B	4.95
GE	DO41	0–1	3" R-B Black Spec Scale	**4.50**
Weston	301	0–1	3" R-B Spec Scale	**7.50**
Simpson	25	0–5	3" R-B	4.75
GE	DO41	0–10	3" R-B	4.75
Whse	NY35	0–15	3" R-B	4.50
Simpson	25	0–15	3" R-B	3.95
GE	DO53	0–20	3" R-B	3.95
Weston	301	0–25	3" R-M	**5.95**
Weston	301	0–30	3" R-M	5.95
Weston	301	0–100	3" R-B	6.50
Whse	NX35	0–200	3" R-B	4.50
Weston	301	0–200	3" R-B	**6.50**
Weston	301	0–300	3" R-B	**6.50**
Weston	301	0–500	3" R-B	**6.50**
Weston	301	5–0–5	3" R-B Spec Scale	5.50
GE	O58	0–8	4" S-B Blk Scale	7.50
GE	DO58	0–30	4" S-B	7.50

DC AMPS

Weston	506	50–0–50MV	2" S-B Spec Scal	3.95
GE	DO50	50MV	3" S-B Spec Scale	2.95
Weston	301	0–1	3" R-M	6.50
GE	DO41	0–1.5	3" R-B	4.75
Simpson	25	0–10	3" R-B SF	4.50
Weston	301	0–10	3" R-B	7.50
Trplett	421	0–1.5	4" S-B	3.50
Whse	KX24	Concentric 50–0–50MV	4" S-B BlkSpecScale	**14.95**
Whse	KX24	Concentric 50MV	4" S-B Spec Scale	**14.95**

DC VOLTS

Sun	378	0–3	2" R-B	2.50
GE	DW40	0–15	2" R-B Short Flange	3.50
Weston	506	0–20	2" R-B	3.50
Simpson	125	0–35	2" R-M	**2.50**
Weston	506	0–40	2" S-B	3.95
Weston	506	0–250	2" R-M	5.50
Weston	301	0–30	3" R-M	5.95
Weston	301	0–150	3" R-M Blk Scale	**5 95**

All Scales, White, All Cases Flush Unless otherwise specified.

STRUTHERS-DUNN RELAYS

D.P.S.T., Normally open, 115 V, 60 Cycle, AC coil, 30 Amp. contacts, fibre base with 4 holes for mounting. Dimensions, 4½" L x 3" W x 3¾" H.

A Real Buy At **$2.50**

WESTON MODEL 271 Microammeter

Another of the famous Weston fan shaped line. Very large scale 5.8" long. These meters were made by Weston to General Radio specifications, with special mirrored scale and knife edge pointer. Accuracy 1%.

0-600 Microamps
170 M.V.
Coil Res: 250 Ohms

Your Price **$22.50**

GE TYPE DO 50 DC AMMETER

50 MV FULL SCALE RECTANGULAR 3¼" x 3", Barrel 2¾" DIAM, x 1½" DEEP, MOUNTING HOLES 2⅝" x 2⅝" c. to c. Special Scale, can be used with Ext. Shunt for any range, bakelite case

A BUY! Price ...... **10 for $27.50**

GE TYPE DO 50 DC VOLTMETER

3 volts full scale, 100 ohms. 1V. special scale, same dimensions as above, bakelite case.

A BUY! Price ...... **10 for $27.50**

A SCOOP on a 'SCOPE DUMONT

Used! Guaranteed

Model 164-E

3" CRT operates at accelerating potential of 1100 V — brilliant well - defined trace. Vert amp voltage gain approx 43, horiz amp voltage gain approx 55. Freq. range vert. & hor. amp both uniform ±3 DB from 5-100,000 CPS Input impedance 1 megohm vert, .8 megohm hor. Operates 115 V, 40-60 cycle.

Price New $115.00
Your Cost $77.50

WHSE PORTABLE GALVANOMETER

Type PX-12, Movement 7 MA, special scale, solid connecting terminals, contains a 1 Volt internal cell which can be easily removed for conversion to DC AMMETERS & VOLTMETERS, with leather case and canvas carrying strap.

A buy at $4.95

STEP DOWN TRANSFORMERS SPECIAL

Made by GE heavy duty, considerable over-design, open frame, ideal for rectifier application, size: 3½" x 3½" x 4".

PRI—115 Volts 60 Cycles
SEC—15 V at 12 Amps **$3.75**

GE Step Down Power Transformer

GE Type M Cat #61021, Enclosed. Size: 4-9/16" H x 4⅞" W x 12¼" L.

PRI—460 V 60 Cycles: SEC—115 V
RATING—750 Watts **$9.00**

GE STEPDOWN TRANSFORMER

Cat. No. 61G5, Fully Enclosed, Wall or Bench Mounting, Isolation Type

PRI—230 Volts, SEC—115 Volts
RATING—250 Watts, 60 Cycles

Dimensions—8Hx4¾Wx4½D, Shipping Weight approx. 21 lbs. $6.75

HIGH VOLTAGE CAPACITORS

1 MFD 20 KV DC 18"x13½"x5" $25.00
.1 MFD 25 KV DC-13"x7"x4" 9.85
.001 MFD 50 KV DC-5⅛"x7¾"x4" insulators 4" dia. x 7" high 12.50

Cap Mfd.	Volts D. C.	Height Width Length	Price
10	1000	5–7/8 x 1–3/4 x 3–7/8"	$1.85
4	1000	5–7/8 x 2–3/4 x 1–1/4"	.85
1	1000	3–5/7 x 2 x 1–1/16"	.50
1	500	2" x 1–1/4" x 1–1/16"	.25
.25	1000	1–1/2 x 1" x 3/4"	.25

ALL PRICES INDICATED ARE FOB OUR WAREHOUSE NYC. SHIPMENTS WILL BE MADE VIA RAILWAY EXPRESS UNLESS SUFFICIENT POSTAGE IS INCLUDED OR OTHER INSTRUCTIONS ISSUED. WE WILL REFUND EXCESS POSTAGE IN STAMPS.

POWERTRON Electrical Equipment Co.

117 LAFAYETTE STREET *Phone:* WOrth 4-8610 NEW YORK 13, N. Y.

TUBES

- TRANSMITTING
- RECEIVING
- INDUSTRIAL
- SPECIAL PURPOSE

Guaranteed by WELLS

Brand new, standard make tubes by the thousands are ready for immediate delivery at the lowest prices in our history. Check this list for exceptional values in magnetrons, cathode ray tubes, voltage regulators, transmitting tubes and also neon, pilot and flashlight bulbs. Be sure to order enough for future needs directly from this ad or through your local parts jobber.

Type	Price
O1A	$ 0.50
OZ4	1.05
IB22	5.55
1R4/1294	.65
1R5	1.12
1S5	1.12
1T4	1.12
2C26	.55
2C26A	.70
2C44	1.25
2J22	14.85
2J31	14.85
2J32	14.85
2J38	18.95
2J48	16.55
2X2/879	.75
3A5	1.10
3B22	3.95
3B25	1.15
3BP1	3.75
3C24/24G	.49
3D6/1299	1.25
3E29/829B	3.95
3FP7	2.95
3HP7	2.95
3Q5	.95
REL-5	19.95
5AP1	3.75
5BP1	2.85
5BP4	3.95
5CP1	3.85
5GP1	6.55
5J23	14.85
5J29	14.85
6AC7	.95
6B7	.99
6C6	.75
6C8G	1.05
6C21	19.95
6D6	.60
6F8G	1.05
6H6	.52
6J5	0.52
6L7	.90
6SG7	.95
6SL7	.65
6SN7GT	.85
7A7	.70
7C4/1203	.45
10/VT-25	.52
12A6	.85
12C8	.35
12SG7	.68
12X825, 2 amp. Tungar	2.95
FG-17	2.95
RK20A	4.95

Type	Price
REL-21	$ 3.65
23D4 Ballast	.35
28D7	.45
30/VT-67 (For Walkie	.95
33/VT-33 Talkies)	.95
34	.35
RK-34	.45
36	.55
37	.55
38	.55
39/44	.34
41	.55
45 Spec. VT-52	.55
46	.85
49	.75
EF50/VT-250	.65
RK60/1641	.65
72	1.10
CEQ-72	1.55
76	.55
77	.55
VR-78	.68
80	.41
83	.85
83V	.95
VR-90	.70
VT-90/8011	2.55
VR-92	.65
100R	3.45
FG-105	10.95
VR-105	.90
VT-127 English	.35
VT-127A Triode	2.55
VR-150	.70
VT-158	9.85
211	.65
215A	1.95
218	4.45
249C	2.95
282B	4.35
304TH	6.55
304TL	.90
316A/VT-191	.75
350B	2.55
371B	2.55
388A	6.45
417A	19.85
GL434A	4.95
446A	1.55
446B	1.55
GL471A	2.95
WL-530	24.95
WL-531	19.95
532A	3.55
GL-559	3.75
KU-610	7.45
Hy-615	1.25
WL-681	19.95

Type	Price
700B	$ 9.95
700C	9.95
700D	9.95
702A	2.95
704A	1.95
705A	2.65
707A	19.50
707B	23.25
710A	2.15
714AY	9.95
RK-715B	7.95
717A	.90
721A	3.95
724B	4.25
725A	19.95
726A	19.95
801	.60
801A	.80
803	7.75
804	10.45
805	5.75
807	1.20
810	7.95
811	2.35
813	7.85
814	3.75
815	2.85
826	.49
829	3.25
829B	3.95
830B	3.75
832A	3.50
837	1.25
838	3.25
841	.55
843	.55
851	39.50
WL-860	2.55
861	34.50

Type	Price
864	$ 0.55
865	2.55
866A	1.40
869B	28.95
872A	2.45
874	2.15
884	1.50
954	.55
955	.55
956	.55
957	.55
1005	.45
1148	.40
1201	.95
1616	1.25
1619	.55
1624	1.25
1625	.45
1626	.45
1629	.45
1636	4.75
2050	.78
2051	.95
7193	.35
8011	2.55
8012	4.35
8020	3.25
9001	.70
9002	.65
9003	.55
9004	.55
9006	.55

NEON BULBS FOR RADIO USE:

NE-2	$0.06
NE-15	.06
NE-48	.24
NE-16	.24
NE-51	.06

Pilot and Flashlight Bulbs

Stock No.	Mazda No.	Volts	Watts	Bulb	Base	Price Each
350-40	64	6-8	E3 CP	G-6	DC Bay	$0.07
350-50	1820	28	.1 amp.	T-3¼	Min. Bay	.12
350-31	57	12-16	1.5 CP	G-4½	Min. Bay	.08
350-42	Spec.	12	6 Watts	S-6	Cand. Scr.	.13
350-20	1446	12	.2 amps.	G-3½	Min. Scr.	.07
350-14	49	2	.06	T-3¼	Min. Bay	.06
350-15	3S6	120	3 Watts	S-6	Can. Bay	.11
348-22	PR-10	6	.5 amps.	B-3½	Min Flang	.05
350-18	1477	24	.17 amp.	T-3	Min. Scr.	.16
350-55	323	3	(AIRCRAFT)	T-1¾	953	.22
350-19	Proj. Bulb	120	500 W	T-20	Med. Pf.	1.45
LB-103	44 (Ruby)	6-8	.25 amp.	T-3¼	Min. Bay	.04
LB-102	1195	12-16	50 CP	RP-11	DC Bay	.14
LB-104	313	28	.17 amp.	T-3¼	Min. Bay	.11
350-24	12A	12	.09 amp. 11	T-2	Tel Base	.18
LB-107	24-A2 W E	24	.75 amp. 105	T-2	Tel Base	.18
350-63	S-14 ARGON	105	2½ Watt	Med.	Screw	.22
LB-109	TELEPHONE TYPE NEON			T-2		.17
350-41	943	6-8	100 CP	G-16½	S. C. Pref.	.65
350-43	11A/T4C	18	.11 amp.	T-4	Cand. Scr.	.14

Manufacturers: We carry thousands of electronic parts in stock.
Send us your requests for quotations.

Use This Page for Ready Reference

Distributors: Our standard jobber arrangement applies. Order directly from this ad.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

To Serve You BETTER . . .
We are now in a new, larger headquarters. Our Stock Is Larger and More Varied.

NOTE THE NEW ADDRESS!

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
2-140Y	$.05	8-141	.27	15-141Y	.69	5-142	.21	10-142Y	.58
3-140 3/4W	.12	8-141 3/4W	.38	17-141Y	.78	6-142	.25	11-142YMSX	.76
3-140	.10	8-141MSX	.38	20-141	.65	8-142	.38	12-142	.48
5-140Y	.19	9-141Y	.42	20-141Y	.93	9-142Y	.52	12-142Y	.68
2-141	.09	10-141 3/4W	.47	2-142	.10	9-142	.37	17-142	.67
3-141	.11	11-141Y	.51	3-142YMSX	.23	10-142 3/4W	.58	17-142Y	.97
5-141Y	.25	11-141	.36	4-142	.18			18-240	.35

Any order for 10 pieces—10% off; for 1,000 pieces—20% off.

115V RELAYS 60 cyc.

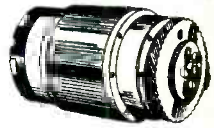
Mfg.	No.	Contracts	Price
SD	TD 435 (time delay)	SPST. N.O.	$2.75
Leach	1355	DPST. N.C.	1.90
Leach	2124 SMX (Micalux)	4PST. N.O.	3.50
Advance	965 B	DPST, N.O., 10A	2.10
Advance	SA 3000X (Isolantite)	DPDT, 10A	2.95

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1⅛" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core $1.50
Spec.—10, 111, Chicago Transformer equivalent of 9262 (above)....................$1.50
7472407, GE, core ⅝" x 1⅝" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC)........$1.25
80G16, GE $1.25
D161310. 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high, 120 to 2350 ohms....................$2.00
D166638, W. E., cased 1¾" x 1¼" x 2¼, 2 semitorridal windings, each 150 turns $1.25
352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 1⁄ ohm, 3½ ohm, 140 cy. to 175 Kc......$1.25
352-7251-2A, similar—shorter pulses......$1.25
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out. (250 KVA @ ¼ micro second)....................$15.00
800 KVA G.E. K2731, 28,000 Volt pk. output. Bifilar, pulse width: one microsecond $19.50

Mounting Brackets—(Bakelite) for selsyns and differentials shown below..............25¢ pair

SELSYNS



115 V., 60 Cyc.
3¼" dia. x 4½" body.
#C78248
$7.25 pair

DIFFERENTIAL

#C78249
ONLY
$2.25 ea.
115 V., 60 Cyc.

Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.

WW PRECISION RESISTORS 1%

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	235Ω	4,451Ω	15,000Ω
.334	13.15	260	5,000	15,750
.502	46	270	5,900	17,000
.557	52	298.3	6,500	20,000
.627	55	400	7,000	25,000
.76	75	723.1	7,500	30,000
1.01	97.8	2,500	8,000	100,000
1.53	125	2,850	8,500	150,000
2.04	180	3,427	10,000	
2.25	210	4,000	14,825	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	50,000	70,000
5.05	270			75,000

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000	522,000	600,000
125,000	160,000	320,000		700,000

1 Megohm, 1 Watt, 1%—65c.; 5%—40c

PRECISION POTENTIOMETERS

6 WATT

20,000Ω	Muter	314A	$1.70
20,000	GR	314A	2.50
10,000	De jur	292	.95
6,000	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	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70
600	GR	314A	2.25
200	GR	214A	1.40
40	GR	214A	1.40

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
20	GR	301	1.10

12 WATT

10,000Ω	GR	471-AS15	3.50
10,000	GR	371T	2.50
10,000	GR	471A	3.50
10,000	Muter	371T	2.50
10,000	De jur	271T	2.00
5,000	De jur	271T	2.00

HARDWARE

HARDWARE ASSORTMENT—(mostly brass) screws, nuts, washers, solder lugs. 3 lbs. $1.00
Vernier dials For BC221, 2⅝" dia. 0-100...$.85
Allen Set Screws, 4-40 x ⅛, 4-40 x 3/16, 6-32 x ⅛, 8-32 x ⅛, 8-32 x 3/16, 8-32 x 5/16—100 ....$1.50
Glyptal Cement—5 gal. $11, 1 gal. $2.50, 1 qt. 75¢

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	25¢
Fafnir 38K	5/16"	7/8"	9/32"	45¢
ND5202C13M	1/2"	1 3/8"	1 3/8" (dual)	1.25
ND 88503	43/64"	1 37/64"	21/32"	1.00
MRC 206SF	1 5/32"	2 7/16"	5/8"	1.25
Fafnir 545	2 1/6"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

STEEL JUNCTION BOX

Water-tight, 14 ga. steel, 17"x25"x6½". Screw type brass hinge on lid. Approx. 50 lb....$2.95

CHROMALUX STRIP HEATER, 115 V. A. C., 60 Cyc. 750 watt curved, 20" x 1½". .only 95¢
BRASS BINDING POST, Eby, screw down with 8-32 mounting screw, per hundred......$3.75
SLIP RING ASSEMBLY—5 silver plated rings on molded bakelite rotor. Stator holds 2 silver carbon brushes for each ring. Rotor 3⅞" O.D., fits 1¾" shaft. Complete with brushes. $2.95
HANDLES—Brass 5/16" round stock, 4¾" long, 1½" high; black, tapped 8-32...........10¢
GEAR ASSORTMENT—Experimenter's dream. Approx. 100 pieces, many stainless......$6.50
GEAR REDUCTION UNIT—16½ to 1 ratio. Aluminum housing 5¼" x 7" x 7½"......$5.00
PLIERS (Linesman's) 8" Utica #1950......$1.69
FIELD WIRE—W110B; whole mile......$14.00
26 CONDUCTOR CABLE—50 ft. length...$7.50
#18 SHIELDED WIRE—50 ft., $1; 1,000 ft., $12
MULTIMETER—Superior 770, 6 AC, 6 DC, 4 current, 2 res. ranges, 1 year guar......$13.90

CAPACITORS

POSTAGE STAMP MICAS

8.2mmf	50mmf	200mmf	560mmf	.0015mfd
10	56	220	600	.002
15	60	250	650	.0026
18	70	270	680	.003
20	90	350	800	.0039
22	100	370	.001mfd	.0051
25	140	400	.0012	.007
40	150	470	.0013	.008
47	180	500	.00135	.01

Price Schedule

8.2mmf to .001mfd 5¢ — .003mfd to .008mfd 12¢
.0012mfd to .002mfd 7¢ — .01 mfd 18¢

SILVER MICAS

10mmf	125mmf	400mmf	665mmf	.0024mfd
22	150	430	700	.0025
39	180	466	750	.0027
50	200	470	800	.003
62	240	488	820	.0033
66	250	500	.001mfd	.0039
68	330	510	.0012	.005
100	360	525	.0013	.0051
110	370	540	.0015	.0068
120	390	560	.002	.01

Price Schedule

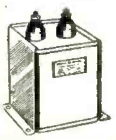
10mmf to .001mfd 10¢ — .003mfd to .0068mfd 50¢
.0012mfd to .0027mfd 20¢ — .01mfd 65¢

CERAMIC

3mmf	10mmf	22mmf	50mm	91mmf	200mmf
3.44	15	27	96	100	1000
4.7	16	33	68	115	1090
6.8	18	40	75	140	$700 per 100
8	20	47	82	180	

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C	Price
.1	25,000	$19.95	.02-.02	7,000	$1.65
.012	25,000	6.20	1	6,000	8.50
.03	16,000	4.50	.1	6,000	1.75
{.375@	16,000 and		.03-.03	6,000	1.65
{.75@	8,000(dual)	14.95	.01	5,000	1.35
1	7,500	12.50	2	4,000	4.50
.1	7,500	1.95	.25	3,000	1.75
.1-.1	7,000	2.45	.2	750 V.A.C.	
.1	7,000	1.85	(2.200	V.D.C.)	.39
			1	2,000	.95
			4	1,000	.90
			3	1,000	.80
			2	1,000	.65
			.05	1,000	.29
			1	800	.40
			10	600	1.00
			4	600	.69
			2	600	.39
			1	500	.19
			5	500	.24



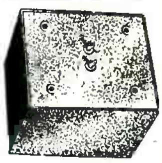
2 mfd 4,000 V. D. C. #23F47 SPECIAL! $4.50

POWER TRANSFORMER

300 V., 4A. (2 Sec.)
300 V., 4 Amp.
110/220/440 Volt,
60 Cyc. $17.50

400 MA CHOKE

12 H
90 Ω
6,000 V. D.C. TEST
$3.85



TRANSFORMERS

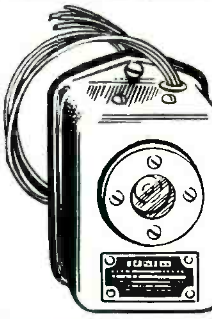
115V. 60 Cy.-24V., 10 A. $4.75......10 for $45.00
2.5V., 6.5 A. CT each of two windings. $2.45
5V., 60A. CT.....$6.75

5 V., 6½ A. Transformer
Tested 34 Kv
115 V., 60 Cyc.
Uses 8020 Tube
#6D4298
$8.50

200 MA. 10 H CHOKE
115Ω.....$1.95

SPAGHETTI SLEEVING—Asst. sizes—3 ft. lengths. 33 pieces Only $1.00

TIME DELAY RELAY



Raytheon CPX 24166 KS 10193-60 Sec.

- Adj. 50-70 Seconds
- 2½ second recycle, spring return
- Micro Switch Contact, 10A
- 115 V., 60 Cycle
- Holds On as long as power is applied
- Fully Cased.

ONLY $6.50

BC 1072A IFF X'MITTER

150 to 200 Mcs. 115 V. 60 Cyc.

POWER SUPPLY gives: 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 vac. (Also contains: 11 tubes 6J5, 826, 6SN7, 5U4G, etc.), 5 KV. meter, Blower, Condensers and many other useful parts too numerous to list. Slightly used. Shipping Wt. 245 lbs.

All This ONLY..............$22.50

MINIMUM ORDER $3 — All orders f.o.b. PHILA., PA.

RELIANCE MERCHANDIZING CO.

12th St. Cor. Buttonwood — Telephone STevenson 7-3035

RADIOMEN'S HEADQUARTERS ✳ WORLD WIDE MAIL ORDER SERVICE ! !

BUFFALO RADIO SUPPLY, ONE OF AMERICA'S LARGEST ELECTRONIC DISTRIBUTORS, IS IN A POSITION TO SUPPLY MOST OF THE REQUIREMENTS OF FOREIGN PURCHASERS, DIRECTLY FROM ITS GIGANTIC STOCKS OR THOSE OF ITS AFFILIATES. EXPORT INQUIRIES ARE SOLICITED BOTH FROM EXPORT HOUSES AND FROM FOREIGN GOVT. PURCHASING COMMISSIONS HERE AND ABROAD. EXPENSE CAN BE REDUCED AND REQUIREMENTS FILLED WITH A MINIMUM OF DELAY BY CONTACTING BUFFALO RADIO SUPPLY INITIALLY.

$12.95 Takes All Three BIG BARGAINS

1. SENSATIONAL, FASCINATING, MYSTERIOUS SELSYNS. Brand new Selsyns made by G. E. Company. Two or more connected together work perfectly on 110V AC.

Any rotation of the shaft of one Selsyn and all others connected to it will rotate exactly as many degrees in the same direction, following unerringly as if the units were connected together by shafting instead of wire. This is true whether you twist the shaft of the master unit a fraction of a revolution or many revolutions. Useful for indicating direction of weather vanes, rotating directional antennas, or controlling innumerable operations from a distance. Complete with diagram and instructions. Per Matched pair $4.95.

2. ALUMINUM GEAR BOX 18x8x7 that contains two powerful electric motors and two matched gear trains, 62 gears in all varying in size from ½ to 4 inches in diameter. This unit is readily converted to rotate a beam antenna or any other similar use $5.00

3. HOME WORKSHOP AT BARGAIN PRICE. Accurate and precise 2 speed guaranteed hobby lathe, the essential machine for the home workshop. Sturdy enough for light production work or factory standby service. Supplied with 56" of belting for connecting to any available electric motor or power take-off. Also included in this unbelievable offer are such accessories as a ½" drill chuck with specially hardened tool steel jaws, a 4" electric furnace high speed grinding wheel, a cotton buffing wheel with a large supply of buffing compound, and a 4" steel wire scratch brush. Your cost $6.00. Sole export agent. Distributor inquiries invited.

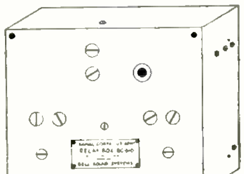
GENERAL ELECTRIC RT-1248 15-TUBE TRANSMITTER-RECEIVER

TERRIFIC POWER—(20 watts) on any two instantly selected, easily pre-adjusted frequencies from 435 to 500 Mc. Transmitter uses 5 tubes including Western Electric 316 A as final. Receiver uses 10 tubes including 955's, as first detector and oscillator, and 3—7H7's as IF's with a slug-tuned 40 Mc. IF transformers, plus a 7H7, 7E6's and 7F7's. In addition unit contains 8 relays designed to operate any sort of external equipment when actuated by a received signal from a similar set elsewhere. Originally designed for 12 volt operation, power supply is not included, as it is a cinch for any experimenter to connect this unit for 110 AC, using any supply capable of 400 DC at 135 MA. The ideal unit for use in mobile or stationary service in the Citizen's Radio Telephone Band where no amateur license is necessary. Instructions and diagrams supplied for running the RT-1248 transmitter on either code or voice in AM or FM transmission or reception, for use as a mobile public address system, on 80 to 110 Mc, as an FM broadcast receiver, as a Facsimile transmitter or receiver, as an Amateur Television transmitter or receiver for remote control relay hookups, for Geiger-Mueller counter applications. It sells for only $29.95 or two for $53.90. If desired for marine or mobile use the dynamotor which will work on either 12 or 24V DC and supply all power for the set is only $15.00 additional.

LINE FILTERS

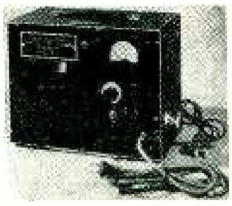
Each unit contains two 4 Mfd oil filled condensers and a high inductance 50 Amp. choke in fully shielded case. Suitable heavy current connectors are provided to attach to your input & output cables for insertion into the connectors at the ends of the filter box. A filter with innumerable uses on oil burners, refrigerators, boats, automobiles and wherever noise is to be suppressed or interference abolished. A $17.00 VALUE FOR $1.98.

SIGNAL CORP. INTERCONNECTOR RELAY BOX 730A



This valuable unit, made by Bell, and more familiarly known by the U. S. Army designation BC616, is encased in a highly polished aluminum case 6½" x 5½" x 2½", and contains 150 mfd. of condenser capacity, sensitive relays, resistors, and terminal strips. Order several at the give-away price of only $1.95.

AT LAST YOU CAN AFFORD A LABORATORY STANDARD MICRO-VOLTER



78E Standard Signal Generator. 50 to 70 Mc. Unmodulated or with 400 cycle modulation.

The famous Measurements Corp. Model 78E, 5 Tube Laboratory Standard Signal Generator (that sold new, FOB, Boonton, N. J., for $310.00 net), is available in perfect condition for 25 to 60 cycles, 115V AC operation. Until now this is the sort of top-flight lab equipment that discriminating buyers have only vainly hoped would be released at a bargain price. Worth every cent the manufacturer asks, but available FOB Buffalo while our limited supply lasts for only $79.95.

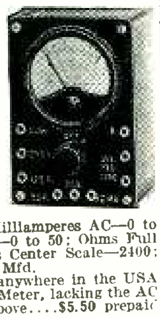
Such companies as Admiral Corp. and John Meck, Inc., have ordered from us and repeated many times on these 78 generators for use in their labs and production line testing.

Uses 1-19002, 1-7Y4, 1-VR 150-30, 1-7C7, and 1-7C5 tubes. Output continuously variable from 0 to 100,000 Microvolts.

RT-1655 Only $14.95

11 tube crystal controlled superheterodyne receiver that covers the FM band. The ultra modern circuit uses the latest types of tubes including 7 miniature 6AJ5's. Beautiful chassis and aluminum cabinet. Tubes and diagram included.

SENSATIONAL VALUE IN AC-DC POCKET TESTER



This analyzer, featuring a sensitive repulsion type meter housed in a bakelite case, represents the culmination of 15 years achievement in the instrument field by a large company specializing in electronic test equipment. Specifications of the AC-DC Model Volt-Ohmmilliammeter: AC Volts—0-25, 50, 125, 250; DC Volts—0-25, 50, 125, 250; Milliamperes AC—0 to 50; DC Milliamperes—0 to 50; Ohms Full Scale—100,000; Ohms Center Scale—2400; Capacity—.05 to 15 Mfd.

Total Price, prepaid anywhere in the USA —$7.00. Similar DC Meter, lacking the AC operated ranges of above....$5.50 prepaid

AMPHENOL coax plug 83-1SP or PL259 ....49c

AMPHENOL coax junction 83IJ or PL358 ....49c

AMPHENOL coax chassis Connector 83-1R or SO239 ....49c

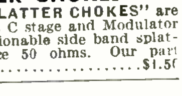
AMPHENOL coax angle plug adapter 83-1AP or M359 ....49c

100 ft. **RG59U** 72 ohm coax cable, new—not surplus $6.90

SPLATTER CHOKES

These Tapped **"SPLATTER CHOKES"** are used between Class C stage and Modulator to eliminate objectionable side band splatter. DC resistance 50 ohms. Our part No. 8660 ....$1.50

PORTABLE ELECTRIC DRILL

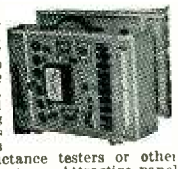


Terrific Value only $20.95 Equipped with ¼" Jacobs Geared Chuck and Key

Not an intermittent duty drill, but a full size rugged tool. Most convenient type switch, natural grip handle, and balance like a six-shooter. Precision cut gears—turbine type cooling blower—extra long brushes. No stalling under heaviest pressure because of powerful 110 Volt AC & DC motor and multiple ball bearing thrust. Other bearings are self-aligning lifetime-lubricated Oilite type. Made for toughest year-in and year-out service in plant or on construction jobs. Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use.

Full refund (you pay transportation) if not pleased with drill after trial.

1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER



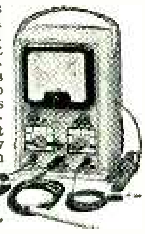
with new 9 pin socket to handle all future tube developments. No possibility of good tubes reading "bad" or bad tubes reading "good" as on dynamic conductance testers or other ordinary emission testers. Attractive panel and case equal to any on the market in appearance . . . Large 4½" meter . . . Calibrated Micrombo scale as well as a Bad-Good Scale . . . Front panel fuse . . . Individual sockets for all tube base types —voltages from .75 volts to 117 volts and complete switching flexibility allow all present and future tubes to be tested regardless of location of elements on tube base . . . Indicates gas content and detects shorts or opens on each individual section of all local, octal and miniature tubes including cold cathode, magic eye and voltage regulator tubes as well as all ballast resistors. Name of the nationally known manufacturer withheld because of special price offer.

Model "C" — Sloping front counter case $52.95

Model "P"—Handsome hand-rubbed portable case $57.95

Built-in roll chart with either of above $5.00 extra.

VACUUM TUBE VOLT-OHM-CAPACITY METER



There are more features engineered into this all purpose instrument than in any other instrument on the market regardless of price. It was designed not only to meet present conditions but to be readily adaptable to future needs. At the sensationally low price of this precision instrument no school, plant, lab or service shop need deprive itself of the "new look" in measuring equipment. Here are a few of the many features of this outstanding meter:

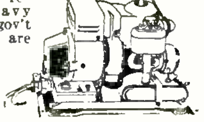
- 5 inch easy to read meter.
- 6 DC voltage ranges from 0 to 1000 V (Input resistance as high as 1 megohm per volt.)
- 5 AC voltage ranges from 0 to 1000 V (No dry disc rectifier to age and destroy the accuracy of this VACUUM TUBE VOLTMETER).
- 6 Resistance ranges from 2/40 ohm to 1000 megohms.
- 4 Capacity ranges from .000025 to 20 MFD.
- A zero center range for balancing FM discriminators.
- Isolating resistor built into probe.
- Sturdy natural finish hard wood case.

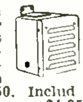
This outstanding development of one of the leading manufacturers of test equipment costs only $39.95 complete with all leads, as illustrated.

OUR PE-109 POWER PLANT

DIRECT CURRENT

This power plant consists of a gasoline engine that is coupled to a 2000 watt 32 volt DC generator. This unit is ideal for use in locations that are not serviced by commercial power or to run any of the surplus items that require 24-32v-DC for operation. The price of this power plant tested and in good condition is only $79.95 F.O.B. Buffalo, or we can supply in strictly "as is" condition for $58.95 F.O.B. New York City. These latter are exactly as received, in heavy steel-strapped gov't cases, and we are unable to determine if the individual units are new, or what the condition is if used, while the $79.95 are some of the same that we have brought to Buffalo for testing and repair if necessary. We do not recommend gambling on the "as is" condition, except for quantity purchasers. We can also supply a converter that will supply 110v AC from the above unit or from any 32v DC source for $12.95.





Latest LS-7 type PM Speaker in a fully-enclosed black crackle finished metal cabinet. This speaker and case match communication receivers, and in addition make perfect intercom remote stations. Our price, $4.50. Including output transformer.............$4.95

BEST BUY of the MONTH

1. **AUDIO AMPLIFIER**—Brand new, dual stage triode amplifiers having 2 of the valuable and scarce ouncer type audio transformers that sell for over $10.00 apiece. Neat aluminum case, fully enclosed (largest dimension 6 inches). Perfect for intercom systems, phono amplifiers, mike amplifier, or signal tracer amplifier for testing radio sets. A sensational bargain at only $3.40 each.
2. **BANDSWITCHING TUNING TURRET** made by Western Electric. Covers 4 bands above 100 MC. All coils wound with #14 silver-plated wire. Complete with tuning condensers and powerful electric driving motor. Diagram included. ONE OF OUR MOST TERRIFIC VALUES—ONLY $2.95.
3. The dual meter—one 50 uA and one 200 uA movement in the same case. This meter is ideally suited for use as a combination modulation percentage and carrier shift indicator. If desired the movements may be removed from the case and used separately. All meters are in perfect operating condition, but a few have cracked glasses.

This super value costs only $1.95.

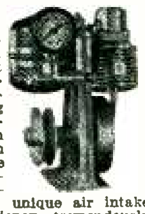
SUPER SPECIAL

POWER UNITS for Fairchild bombsights. A limited quantity of these arrived too late for a photo, but each unit is brand new, includes 8 electric motors or generators, 6 of which are of the permanent magnet field type; relays; 20 precision resistors plus numerous others of the ordinary kind; and 9 tubes which alone have a total value of $15.00. All for $14.95.

"SO" RADAR SET

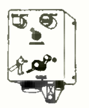
complete with 9 tubes including picture tube. This Plan-Position-Indicator Oscilloscope has a self-contained pack designed to run from the 110V. power supply on LST or PT Boats. It provides a 5" diameter picture adjustable at will to an 80, 40, 4 or 2 mile circle with the boat at the center, showing location of land, other ships or any obstruction, so that navigation can be carried on in pitch darkness or pea-soup fog with as much safety as in brightest sunlight. Your cost $39.95

COMPRESSED AIR INSTANTLY ANYWHERE



Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball-bearing on connecting rod and oil impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. **PATENTED** unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than one minute. Comes complete with 100 lb. gauge, although finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides, annealing or brazing with natural gas, inflating tires, etc. Price $14.50 postage prepaid anywhere in the U.S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose available for only $7.75 with pint container, also prepaid. 25% required on all C.O.D. orders.

STROMBERG CARLSON Power Switching Relay Box. Neat 3⅛x4x5⅛ steel case with tight fitting cover finished in Stromberg's usual beautiful chocolate color crackle finish. $.98.



REMOTE CONTROL UNIT—Aluminum case 4x3x2 containing 2 potentiometers, triple pole switch, 4 knobs phone jack, gear mechanism and revolution counter. 99c With 8 prong JAN connector to fit box $1.39.

BIKE RADIO

The year's hottest sensation. Powerful superhet in beautiful maroon crackle finish case with built-in 3' gleaming chrome telescopic whip antenna. Exactly like a car radio except works off self-contained standard portable radio batteries, easily obtainable anywhere. Theft-proof mount ing bracket attached by anyone to bicycle or motorcycle in 3 minutes. Readily installed on any vehicle from a wheelbarrow to a witch's broom. Radio removable from mounting bracket instantly by means of special key provided, so that it can be carried anywhere for use as a portable if desired. Weight 5 lbs.

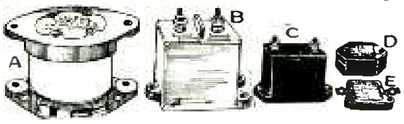
Your cost with batteries............$24.95

Without batteries $22.50

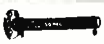
BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. E BUFFALO 3, N. Y.

Finest of Surplus — **PEAK ELECTRONICS CO.** — **Fraction of Cost**

HIGH VOLTAGE—CURRENT MICAS



#	MMF	VDC	Price	#	MMF	VDC	Price
D	.001	600	$.18	C	.0015	5 KV	$1.60
E	.01	600	.24	C	.003	5 KV	1.90
E	.02	600	.26	C	.005	5 KV	2.50
E	.027	600	.26	B	.007	5 KV	2.75
D	.039	600	.30	A	.00024	6 KV	4.50
C	.01	1 KV	.45	A	.001	6 KV	4.75
C	.056	1 KV	.50	B	.002	6 KV	3.50
C	.07	1 KV	.55	B	.003	6 KV	3.75
D	.02	1200	.35	A	.004	6 KV	4.95
C	.024	1500	.65	B	.006	6 KV	4.25
C	.033	1500	.75	B	.0005	8 KV	2.90
C	.015	2 KV	.80	B	.0006	8 KV	2.90
C	.02	2 KV	.90	B	.001	8 KV	3.25
D	.002	2500	.45	B	.0015	8 KV	3.50
E	.005	2500	.55	B	.002	8 KV	4.00
C	.025	2500	1.25	B	.003	8 KV	4.75
C	.001	3 KV	.90	B	.004	8 KV	5.50
C	.002	3 KV	.95	B	.005	8 KV	5.75
D	.005	3 KV	.70	A	.0005	10 KV	5.95
C	.005	3 KV	1.24	A	.002	10 KV	6.95
C	.006	3 KV	1.50	B	.0005	12 KV	4.90
D	.002	3 KV	.70	A	.008	12 KV	26.50
C	.0001	5 KV	.75	A	.001	25 KV	32.50
C	.0005	5 KV	.85	A	.0005	30 KV	24.50



50 megohm 35 watt Standard Brand Resistor with mount. $1.95 each. 10 for $15.00

Precision 15 Meg. 1% Accuracy Resistor. Non-inductive, 1 watt, hermetically sealed in glass. .29 ea. 10 for..........$2.50

1% PRECISION RESISTORS

Wire Wound—Standard Make

2000-2500-5000-8500-10,000 ohms ....ea. .35
50000-95000 ohms ....ea. .30
100000-750000-1 meg ....ea. .79

W. W. POWER RHEOSTATS

25 Ohms 25 Watt .... .49
250 Ohms 50 Watt .... .69
300 Ohms 50 Watt .... .69
150 Ohms 50 Watt .... .89
Dual 200 Ohms 50 Watt.......... .89

WIRE WOUND RESISTORS

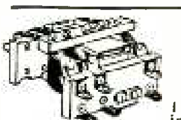
5 Watt type AA, 20-25-50-200-470-2500-4000 ohms .... .09 ea.
10 watt type AB, 25-40-84-400-470-1325-1900-2000-4000 ohms .... .15 ea.
20 watt type DG, 50-70-100-150-300-750 1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms .... .20 ea.
30 watt type DI, 100-150-2500-3000-4500-5300-7500-18000-40000 ohms .... .24 ea.

ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms.......... .25
50 Watt: 80, 100, 500 Ohms.......... .35
75 Watt: 40, 80, 100, 150, 200 Ohms.......... .39
100 Watt: 20, 50, 75, 120, 180 Ohms.......... .49
150 Watt: 50, 100 Ohms.......... .59

1500, 5000 Ohm 100 Watt Ferrule Resistors.
20,000 Ohm 50 Watt Ferrule Resistors.
Any Types 6 for .95¢
Deduct 25% on lots of 100 any types.

DUNCO RELAY DPDT 6 Volt 60 cycle coil. A.C. $1.69



ADVANCE D.P.D.T. ANTENNA RELAY

110 V. 60 cycle coil Steatite insulation. Only $1.95 each.
As above but 3 P D T.......... $2.75
As above but 4500 ohm DC Coil.......... 1.75

OIL CONDENSERS

20 mfd 330 vac—1.85
5 mfd 150 vac—.49
1 mfd 600 vdc—.29
2 mfd 600 vdc—.39
4 mfd 600 vdc—.59
6 mfd 600 vdc—.79
3/3 mfd 600 vdc—.79
10 mfd 600 vdc—.95
2 mfd 1000 vdc—.79
4 mfd 1000 vdc—.95
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25
6 mfd 1500 vdc—2.95
1 mfd 2000 vdc—1.45
2 mfd 2000 vdc—2.25
4 mfd 2000 vdc—3.65
2 mfd 4000 vdc—5.50
1 mfd 5000 vdc—4.50
.1/.1 mfd 7000 vdc—2.25
.1 mfd 7500 vdc—1.95
1 mfd 7500 vdc—9.25
4 mfd 8 kv dc—15.95
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.03 mfd 15 kv dc—5.75
.05 mfd 12,500 vdc—12.95
.75/35 mfd 8/16 kv—7.95
.02 mfd 20 kv dc—7.95
2 mfd 18 kv dc—59.50

METER SPECIALS—BRAND NEW

2" Weston 0-250 volt DC.......... $ 2.95
2" GE 0-30 amps DC.......... 2.95
2" GE 0-1 amp RF (internal thermo).......... 2.95
2" GE 0-5 Ma DC (amp scale).......... 1.95
2" GE 0-1 Ma DC (volt scale).......... 2.95
2" GE 0-500 Ma DC.......... 2.95
2" McClintock 0-100 Ma DC.......... 2.95
2" GE 0-30 volts DC 1000 ohms/v.......... 2.45
2" Gruen 0-3 volts DC 1000 ohms/v.......... 2.49
2" Weston 150-0-150 micro amps.......... 3.49
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3" GE 0-200 Ma DC.......... 3.95
3" Industrial Running Time 110v/60.......... 7.95

FEDERAL ANTI-CAPACITY SWITCH. Double Pole Double Throw. .85¢ ea.; 10 for $7.50

H.V.-H. CURRENT PLATE TRANS.

1500-0-1500 volts at 1.5 amps. Tapped at 1350 and 1250. Pri. 110/220 volts 50/60 cycles in 2 Separate windings. Built to rigid Navy specs by Amertran. Suitable for broadcast transmitters, induction heating, etc. Continuous duty. 10 x 10 x 7. Swt 125 lbs.

Now only $39.95

As illustrated above. 1500-0-1500 volts at 600 ma. Pri. 110/220 v. 50/60 cycles. 8 x 8½ x 7 s.w.t. 78 lbs. .... now $27.50

HIGH CURRENT TRANSF. 820 Volts CT at 775 Ma. Pri. 110/220 volts 60 cycles. Fully Cased $6.95

RECTIFIER TRANSFORMER 110/220V 60 cy primary. Secondary 70-75 volts 3 amps plus 35-37 volts (pri in series). Fully cased..........ea. $1.89

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps ±1 DP. GREAT VALUE..........ea. $2.75

THORDARSON PLATE TRANSF. 2370 volts CT at 250 MA tapped at 300-0-300 volts, plus 215 volt 55 MA bias winding, 110 volt 60 cy. pri. Fully shielded ....ea. $11.95

GENERAL PURPOSE TRANSFORMER

Ideal for Bias, Filament, Isolation, Stepdown, etc., 2 isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amp. Fully cased..........Now $1.49 ea.

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6 Henry 80 ma 300 ohms ....3 for $ .99
6 Henry 70 ma 200 ohms ....2 for .99
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Swing. Choke 1.6/12 Henry 1 amp/100 ma 15 ohms 24.50
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MEGOHM METER

Industrial Instruments model L2AU 110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter can be extended to 500000 megohms with external supply. Sloping hardwood Cabinet 15"x8"x10". Brand new with tubes plus running spare parts including extra tubes. Great value Only $69.50.

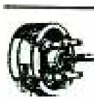
VARIABLE CERAMICONS

1.5 to 7 MMF.... .24 | 4 to 30 MMF...... .24
3 to 18 MMF.... .24 | 7 to 45 MMF...... .24

FIXED CERAMICONS

Capacity in MMF: 1-2-3-4-5-8-10-12-15-17-18-20-25-30-35-40-50-60-85-120-200-500. Your cost any capacity .... .09 each

Voltage Regulated Power Supply—input 110 v. 60 cy. Delivers 150 v. DC—Well filtered (3 chokes) uses VR 150 and 6x5. Has extra 6.3 v winding. Swell for eco's freq. meters, etc., 16x3⅝x5 with tubes. Only $6.85



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4 Stator Single Rotor. 0-360 Degrees Rotation ....Only $2.95 each

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425-750 MCS AN-APT 2. Contains 10 tubes:
(1)—307 (2)—703A (2)—6AC7 (1)—6AG7 — (2) — 5R4GY (1)—2x2 (1)—931A. Unit has blower motor and 400 cycle pwr supply complete with all tubes, etc.
BRAND NEW. Now $12.95 ea.

STEPDOWN TRANSFORMER

220/110 volts, 100 watts. Fully encased. 5⅛ x 4¼ x 5⅛. 110V. 60 cycle..........$2.49 each

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831AP-UG12U-UG21U-UG-14U-UG146U-831 R-831SP .... .35¢ ea.

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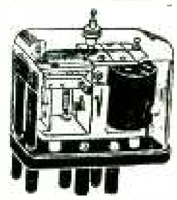
110 Volt 60 cy. Pri.—H.V. Ins.—Fully Cased

6.3 V 10 Amps.......... $1.89
5 Volts 15 Amps.......... 2.95
2.5 Volts 10 Amps.......... 3.75
5 Volts Ct 3 Amps.......... 1.50
2.5 Volts Ct 21 Amps.......... 4.95

MULTI-SECONDARIES

5v CT 13.5A, 5v CT 7A, 5v CT 7A.......... 5.95
5¼v CT 21 Amp, 7.5v 6 Amp, 7.5v 6A.......... 5.95
10 volts CT 13 Amps, 7.5v 2.5 Amp.......... 5.50
6.3v 21 Amp, 6.3v, 2A, 2.5v, 2A.......... 4.75
5 volts 4A, 6.3 volts 3 Amp.......... 2.50
2.5v CT Amps, 2.5v CT 20A.......... 7.95
2.5v CT 10A, 6.3v 1A, 5v 3A, 5v 3A.......... 4.50



WESTINGHOUSE

Type MN Overcurrent Relay, Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $7.95

SCOPE TRANSFORMERS

Hermetically Sealed—Pri 110 v 60 cy.

2500 volt @ 12 ma.......... $4.95
2300 volt @ 4 ma, 2.5v @ 2 amp.......... 5.95
4300 volt @ 4 ma.......... 9.75
625, 1050 volt @ 20 ma, 20 v @ 4.5 A, 2x2.5v @ 2.5A 4.95

PLATE AND FIL. TRANSF. PRI 110v 60 cy. sec. 1120 volts CT @ 600 ma, 6.3v CT @ 3A, 2x5VCT @ 6A Hermetically sealed..........$9.95 ea.

Sola Constant Voltage Transformers Primary 95-125 volts 60 cycles Secondary 115 volts Regulated
30 VA $10.95
120 VA $17.95

35 WATT WIRE WOUND RESISTORS

100-1500-4K-5K-10K-15K-40K. Your choice 6 for .99

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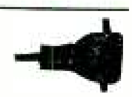

9200 volts peak, 8 amps. Used as antenna switch in Collins ART 13. BRAND new $1.75

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10 MMF Midget Variable Cond..........4 for .99
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AB ½ Meg Pot with Switch.......... .79
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Solar .02 600 VDC Dominoes..........9 for .99
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Weston 507 RF Meters, Less Thermo.......... .99
1/40 Amp (25 Ma) Littlefuses..........15 for .99
.25 MFD 600 V. Tubulars..........6 for .99
C-D 1 MFD 400 V Oil Tubulars..........9 for .99
Butterfly Cond 2-11 MMF Ball Bearings..2 for .99
50 MFD 50 Volt Elect. Tubulars..........5 for .99
.0015 5% Silver Micas..........9 for .99
Midget Closed CKT Jacks..........7 for .99
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MOBILE H.F. ROTARY DIRECTIVE ANTENNA ARRAY

Operating from 12 volts DC, this equipment (known as RC-163 Radio Beacon Eqpt.) will solve most of the antenna headaches of broadcast, FM, and television engineers concerned with mobile link operation. Also ideal for amateur stations, since the array is designed for 20 to 40 mc operation without any other change than that of a small plug-in inductor. Four coils are supplied for this frequency coverage, but other coils can be easily made for higher or lower frequencies. Designed for directive reception as well as transmission, antenna is Adcock type and arranged for vertically polarized radiation. Change to horizontal polarization can be easily accomplished by rotating crossarms (mechanically) 90 degrees. An automatic code keyer which sends various International Code characters as the antenna is made to rotate (for identifying each 15 degree position), makes it ideal for plane or ship homing or navigation. Code keyer easily removed for straight transmission. Power consumed approximately 54 watts (4.5 amps.), when rotating motor is "ON." Rotation is clockwise, and 2½ rpm. Supplied with antenna array, antenna mount with rotating motor, code discs, audio oscilator, phase-load box, mast sight, tuning indicator-receiver which checks field strength as well as frequency, valuable compass and tripod, control panel, all necessary cables and complete technical manuals for installation, theory and service. Equipment is NEW and export packed, two cases per complete set.

PRICE, EACH **$169.50**

AMAZING "SNOOPERSCOPE" TUBE

An Infra-Red Image Converter Tube (British mfr.) that enabled combat men to see in the dark and through camouflage. No scanning or amplifiers necessary! Uses only infra-red light source and simple high-voltage supply which can be easily built from toy ignition transformer and rectifier tube. An optical system for long-range work or where magnification of image is desired, can be made from toy telescope. Shows image in greenish-white color on 1⅜" screen. Has wonderful possibilities for darkroom work, fog penetration devices, night photography, etc. With technical data and diagrams. All NEW, individually boxed tubes.

PRICE, EACH **$8.00**

(2 for $15.00; 6 or more, $6.00 each)

FREQUENCY METER TS-69/AP

Frequency range 350 mc to 3,000 mc, continuous. Ideal for labs, schools, or for hams experimenting with eqpt. for civilian phone band. Black-crackle finished metal case, dim: 6"x6"x22", contains variable length coax resonating cavity with crystal rectifiers and 0-200 microammeter. Veeder-Root counter and calibration charts insure extreme precision. Telescopic antenna, and coax line probe, with metal carrying case for entire equipment. New equipment.

COMPLETE, EACH **$42.50**

SPECIAL BARGAINS!!

HANDY-TALKIE BATTERIES, for SCR536 or BC611. Type BA-38, 103.5 volt "B" battery, and type BA-37 1.5 volt "A" battery. All export packed and guaranteed perfect.
PRICE, Per Set (both batteries) **$2.50**

VT-127A Platinum Grid VHF Tube. **PRICE, EACH** $ 2.25

450 TH, GE or Machlett	**EACH**	24.00
807	**EACH**	1.20
813	**EACH**	7.50
861	**EACH**	32.50
872A	**EACH**	2.45
450TL	**EACH**	29.95
527	**EACH**	11.95
750TL	**EACH**	49.50

EXTRA SPECIALS!!

1100 Lbs. #18 DCC Magnet Wire, per lb. (lot price) ....37½¢

1,600 mfd, 15W.V.D.C., approx. 10,000, lot price. Each ....20¢

Adlake Time Delay Relays, type 902-72-1, 220V. 50/60 cycles, normally open. EACH $4.95

Same as above, but type 1040-65-4, 110 Volts. Each $3.45

32 VDC 110V AC CONVERTER

Mfd. by Kato Engineering, for marine or farm installation. Rotary type, compact and ruggedly built for continuous duty. Rubber shock mounting on filter case, with complete input and output filtering. Output 110 volts, 60 cycles AC. .225 KVA, but will operate efficiently on loads up to 300 watts. New units only.

PRICE, EACH **$39.95**

Quantities, 10 or more, Each **$32.00**

RADAR
TREMENDOUS ASSORTMENT

Hundreds of major radar components, mostly for navy types, includes power transformers, wave-guides, plumbing of all sorts, magnetrons, cavity chambers, echo boxes, connectors, antennas. Inspection invited, or write us your requirements.

SF RADAR, NEW and Complete, in original cases with operating spares. PRICE, Complete...$2500.00

General Electric Model 5AM78AB47 (Amplidyne) Motor Generator set. Motor 3HP, 440V, 3 phase. Output 250V. DC at 3 amps. and 60V. DC at 12.5 amps. Excellent Condition. EACH..........$80.00

SB-23/GTA-2. Console panel; fixed station; non-multiple; cordless board with patchboard, 28" line capacity, no trunks, no connecting positions; fully equipped 28 lines; manual operation; common battery type. 52-5/32"H x 28-5/32"W x 18-5/16D. Steel cabinet, floor mounting. Used with Army-Navy radar set; AN/CPS-4 and Signal Corp SCR-615; part of Army-Navy monitoring equipment AN/GT; New. EACH $150.00

SB-14/GT. Telephone Power Panel. Welded steel cabinet containing facilities to provide 24 volts D.C. power and 20 cycle ringing power for telephone circuits from a source of 110 volts 60 cycles AC; provides AC power outlet. Included in panel are battery charger (uses Sig. Corp. battery BB-55, not supplied); ringing generator, 6 circuit breakers and 6 power outlets; dimensions approx. 24" long x 15" W. x 45" H., weight approx. 395 lbs. New. EACH $175.00

RADIO TRANSMITTERS MODULATORS, AND POWER SUPPLIES

Immediate Delivery from Stock

2.5 KW Press Wireless, Model 2.5 consisting of 2 sections, one—the 2.5 KW P.A. with power supply, second section containing exciter-driver stages with crystal-controlled oscillator (with oven for constant temperature control). Emission A1. Freq. range 2 to 23 mc. Operates from 220 V.A.C. Excellent condition. **WRITE FOR PRICE.**

2 KW Power Amplifier, Press Wireless, as described above power amplifier section and power supply only. When used with above complete installation provides additional, instant-changeover frequency of operation. Also, ideal as a spare PA and power supply for above. **WRITE FOR PRICE.**

TCR—Radiomarine Transmitter, 125 watts (conservative) A1, A2, & A3. For ship or shore stations radio telephony; 6 channels in 2 to 3 mc band controlled by remote control box supplied. Complete R.F. modulator and power supply (for 110 or 220 V. 50/60 cycles AC) in one cabinet. Excellent condition with tubes and remote control box. **EACH** **$500.00**

BC—319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110-220 volts, 60 cycles AC. Excellent condition. Less tubes. **PRICE EACH** **$300.00**

LINK FM Transmitter Receiver. 70-100 mc. Model 1498 DC. 50 watts output, wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim: 34"x21"x11". NEW CONDITION. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE EACH** **$600.00**

RADIO TRANSMITTER BC-339, CW only, 1 KW output. Freq. range 4.0 to 26.5 mcs. Six crystal positions also M.O. four intermediate stages and two 833s final. Operates on 220 volts 50/60 cycles. Reconditioned. Complete with power supply and one set operating tubes. **PRICE**..........**$2100.00**

MODEL AT-14A TRANSMITTER. Mfd. by Phillips. Output A1 275 watts: A2, A3 225W. Freq. range 2 to 20 mcs. Four xtal positions & separate M.O. Operates on 110/200/220/240/260 volts 50/60 cycles. **PRICE,** complete with power supply & set of operating tubes.................. **$900.00**

MODEL SVC100L/110 TRANSMITTER. Output A1 150-watts, A2-A3-50 W. Mfd. by Phillips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from 90-260 volts 50/60c. A.C. **COMPLETE,** with tubes.......**$450.00**

BC-1100 (RC-263), 75W, A1, 50W, A2, 4 channel dial selection of channel. 1.5-10 mcs. 110-260V 25-60c. A.C., with remote control. New. **EACH**..............**$575.00**

Supreme ship-to-shore transmitter receiver, 110W output, 9 channel, 2-3 mcs., crystal controlled, for 110V. 60c. A.C. Condition N-2. Complete with tubes and microphone. **EACH** **$600.00**

NOTICE: Prices quoted above do not include crating or packing. Price for packing will be quoted upon specification as to whether export or domestic packing is desired.

All Prices F.O.B. N.Y.C. **All Material Offered Subject to Prior Sale**

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TRANSMITTERS & RECEIVERS FOR 10-20-40-80 METERS **$39.50**

This sensation of all surplus is a complete amateur radio station! Other ways to use it: Xmtr. VFO driver stage gives your BC-375-E RF output up to 150 watts. Make swell standby receivers with the BC-348 on round-table "rag chews." You get all this: 3 receivers—190-550 kc. "Lazy Q Fiver," 3-6 and 6-9.1 mc; 2 xmtrs., 4-5.3 mc, 5.3-7 mc; 4 dynamotors—28 v. DC input; 1 modulator with carbon mike input; 2 control boxes; 1 coupling box with r-f ammeter, ant. relay and 5000 v. 50 mmfd. WE vacuum condenser (ant. relays can be used with most rigs); and a complete set of 29 **popular tubes.** CAN BE SHIPPED F.O.B. ARIZONA, OKLA., OR VIRGINIA.

We still have a few BC-375 transmitters available at $20 each FOB Arizona complete with 5 tuning units. Transmitter and 1 tuning unit, dynamotor, antenna loading unit—FOB Oklahoma, only $15.00.

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Brand New and Priced for Quick Clearance!

Limited Quantity **$14.95**

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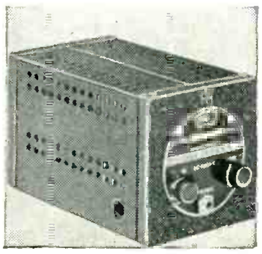
Price includes master station, one remote, and 50′ of wire. Rig it up as a "baby-sitter" with pick-up at baby's crib. Useful in office, or for instant contact with basement, garage, attic, kitchen. Simple to install—just plug it in to 110 v. AC or DC socket.

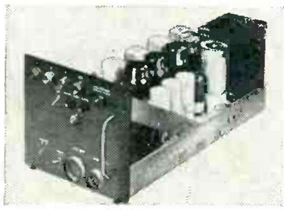


BC 1206 LAZY Q FIVER

SINGLE SIGNAL RECEPTION

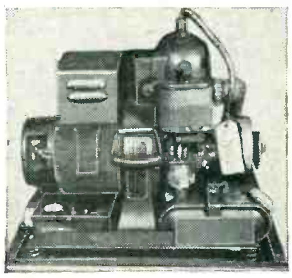
$9.95

The littlest BIG BUY ever offered! A BC-1206 Setchell Carlson receiver will take the place of BC-453 (Lazy Q Fiver). We think it's even better. Here's why: **Smaller** — 4″ x 4″ x 6⅝″; weighs only 3 lb. 14 oz. **Less current drain,** .75 amps at 24 v. DC. IF freq. 135 kc. A conventional superhet circuit is employed and is arranged so that AVC will prevent overloading on strong signals.



APN-4 RCVR—'SCOPE POWER SUPPLY

4 switch-selected screw-driver tuned RF channels; IF freq. 1050 kc, band-width 45-60 kc; RF freq. 16 2000 kc. Tubes: (2) 2Y2, (3) 6B4, (4) 6SK7, (1) ea. 5U4, 6SU7, 6SA7, 6H6, VR150. Makes fixed tuner for med. freq. police calls or PA system. Has power supply for 5″ scope, with 400 cycle trans. Electronic-controlled low v. supply; delivers 260 vdc. 150 mils reg. to .01%. Power supply alone worth more than price **$8.95**



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28 - 32 Volts D.C. ONLY **$74.50**

Single cylinder, 2-cycle gasoline engine with generator that is rated at 2,000 watts direct current, 70 amps. Has unlimited use around a farm; useful as field day power supply. More literature upon request.

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For converting SCR-274-N to 115 Volts AC.

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Price only $3.90

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• Speakers—Brand New

Permanent Magnet

4″	$ 1.60
5″	1.85
12″ Jensen in Metal Case	14.50

10% discount, purchase of 2 or more

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8 HY—500 MA—5000 V INS.
Price each $8.95

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.05 Mfd.	600 Volts	$0.15
10 Mfd.	350 Volts	.69
15 Mfd.	150 Volts	.60
16 x 16	450 Volts	1.20
20	250 Volts	.69
40	150 Volts	.75
50	150 Volts	.69
150	25 Volts	.54
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8 x 8 Can. Electrolytic		1.50

Tubes (New, in Original Cartons).

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12A6	69c	OD8- VR150	75c
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12SK7	69c	78	59c
12SF7	69c	89	59c
1625	89c	38322	$1.19
1626	79c	12J5-GT	69c
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DUAL POWER SUPPLY

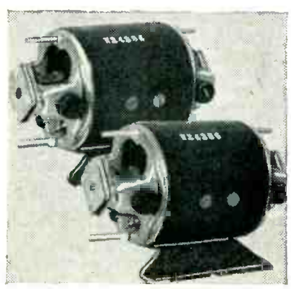
LOW DRAIN 6 VOLT TRANSMITTER AND RECEIVER POWER SUPPLY

Use our dual dynamotors by wiring them in series and use one on receivers and both in transmitter. High voltage output 600 volts at 48 watts. Low voltage 300 volts at 24 watts.

SAVE YOUR BATTERY!

$4.95 each

Both for $8.95



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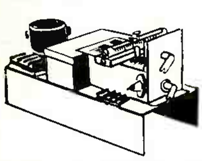
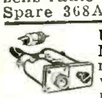


Compact, beautifully built line oscillator employing two W.E. 368AS (703A) "doorknob" tubes in push-pull. Exceptionally stable. 5W output at 420mc, 2W at 700mc. Independent grid and plate tuning. Adjustable output coupling and tuning assembly. Coaxial output connection. Built-in blower may be operated from 110VAC. Power requirements: 300VDC/150ma, 1.2V/4A, 1.2V/4A. 5¼"x6½"x11½". 7 lb. Supplied complete with tubes. Ideal for 420mc amateur operation or for use in the 460-470mc citizens radio band. **Stock No. APO-66**...$6.95
Spare 368AS/703A tubes $1.69



UHF 50 OHM COAXIAL POWER MEASURING ASSEMBLY. Panel mounting, silver-plated assembly with integrally coupled crystal mount. Type "N" UG-58U female receptacle (easily replaced by SO-239). Originally designed for power measurement at frequencies up to 700mc. **Stock No. APM-89** $3.95
MATING TYPE "N" MALE PLUG. For use with above. **Stock No. PCM-17**........$0.49

10 CM ECHO BOX AND PHANTOM TARGET. Resonant cavity with adjustable piston. Complete with 20 feet of cable and 10 cm dipole antenna. **Stock No. AWM-30**. **$4.95**

SPERRY MODEL 12 KLYSTRON TUNER for use with 2K39, 2K42, 2K43, 2K44, 417A. **Stock No. VKT-27** $1.95
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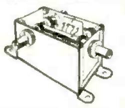
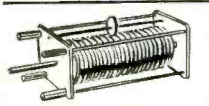
MAGNETRON MAGNET 4800 GAUSS. Pole tip dia. ¾". Gap 0.635". **Stock No. UMM-48** $7.00



50 OHM COAXIAL RELAY. Double coil actuating relay operates from either 12VDC/120ma or 24VDC/60ma. May be operated in plate return circuits to provide automatic transmitter-receiver antenna changeover. Supplied with British type connectors which are easily replaced by standard SO-239 (83-1R) receptacles or soldered to directly. Completely enclosed in compact housing. 2-¾" x 3" x 4-¾". An outstanding buy at **$2.49**. **Stock No. KDC-723.**



VARIABLE INDUCTOR. 67 microhenries max. Minimum near zero. Wheel type sliding short. Ceramic insulation. Quality construction. Barker-Williamson #1565. Originally used as transmitter plate tank coil to tune from 1½ to 20mc. Ideal for pi-networks, antenna tuners and plate tanks. **Stock No. LRF-32**...............**$1.95**

APC AIR TRIMMER. 35 mmf max. Screw slot adjustment. **STOCK NO. CAV-105.** 10 for $1.00
APC AIR TRIMMER. Two separate trimmers on ceramic base. Shield between sections. Each section 25 mmf max. **Stock No. CAV-104.** 10 for $1.00
AIR CAPACITOR 100 MMF MAX. ¼" dia. shaft. Receiving type. Ceramic insulation. Standard Brand. Similar to MC-100-M. Straight-line capacity. **Stock No. CAV-15** $0.72

SUPER-FLEXIBLE PIGTAIL WIRE. Sperry Special. Part No. P55357. Consists of 350 strands of 0.002" diameter soft copper wire. Total diameter: 1/32". Useful in applications where electrical connection is to be made to moving parts, e.g., variometers, variable capacitors, motor-brushes, etc. **Stock No. WFP-350. 10 foot rolls. $0.69 per roll.**

NON-INDUCTIVE PLAQUE RESISTOR 1000 OHM/40 WATT. Standard Brand. Type 22. Useful up to approximately 60mc. Two or more may be paralleled for higher wattage and lower resistance. Make excellent elements for AF and RF dummy loads or plate loads. ½"x1¼"x4½". **Stock No. RWF-175** $0.49

NON-INDUCTIVE CERAMIC RESISTOR. 350 ohms/24 watt. Standard Brand. **Stock No. RCF-52. 8 for**...............**$1.00**

3 WIRE TELEPHONE CORD. Quality rubber insulation. Non-kinking. Color coded. Spade-lug terminals. 6 feet long. ¼" OD. **Stock No. WCC-333. 10 for**...............**$1.00**

Tube Specials

1A7GT	$0.72	6L6GA	0.89	304TL	1.95
1B22	0.95	6L7	0.98	316A	0.89
1E7G	0.59	6N7	0.95	417A	14.95
1G6GT	0.49	6N7GT	0.79	559	1.19
1V	0.49	6Q7	0.72	705A	2.95
2A3	0.98	6SA7GT	0.60	723A/B	5.95
2C4	0.95	6SC7	0.69	725A	14.95
2C21/1642	0.29	6SF7	0.72	730A	12.50
2C34	0.29	6SH7GT	0.39	803	8.95
2C40	0.75	6SJ7	0.59	805	3.95
2C44	0.75	6SJ7GT	0.49	807	1.19
2D21	1.49	6SK7	0.72	811	1.95
2J26	14.95	6SL7GT	0.69	813	7.95
2J32	14.95	6SN7GT	0.89	814	3.95
2J38	14.95	6SR7	0.67	815	1.95
2J48	5.95	6SU7GT/Y	1.29	836	0.89
2J55	19.75	6V6GT	0.79	860	2.95
2K28	12.95	6V6	1.09	861	15.00
2X2	0.69	6X4	0.69	866A	0.95
3B7/1291	0.39	6X5GT	0.63	868/CE/IC	0.95
3C23	2.95	6Y6G	0.88	872A	1.69
3D21A	1.95	6Z5G	0.81	874	0.59
3E29	3.49	7C7	0.81	902A	3.95
3FP7	1.95	7G7	1.06	931A	2.95
3Q4	0.69	7Y4	0.72	954	0.39
4A1	0.49	7Z4	0.72	955	0.39
5BP1	1.95	12SF7	0.59	956	0.49
5CP1	1.95	12SG7	0.59	957	0.39
5FP7	0.49	12SH7	0.59	958A	0.39
5R4GY	1.09	12SJ7	0.59	959	0.39
5U4G	0.65	12SL7GT	0.79	991/NE-16	0.29
5V4G	1.09	12SQ7	0.65	1625	0.49
5Y3GT/G	0.49	12SR7	0.72	1626	0.39
5Z4	0.88	14H7	0.79	1629	0.29
6AC7	0.79	15E	0.98	1641/RK60	0.95
6AE5GT	0.79	RK21	0.95	2050	0.79
6AG7	0.89	25Z5	0.59	8013	1.49
6AU6	0.95	25Z6GT	0.59	8020	1.95
6C4	0.49	35W4	0.49	9001	0.39
6F6	0.89	EF50	0.49	9002	0.39
6F8G	0.89	RKR73	0.39	9003	0.39
6G6G	0.49	80	0.45	9004	0.39
6H6	0.49	85	0.72	9005	0.79
6H6GT/G	0.29	89Y	0.54	9006	0.39
6J5	0.57	117Z6GT/G	0.88	VR90	0.69
6J7	0.69	FG178	1.95	VR105	0.69
6K6GT/G	0.65	211	0.25	VR150	0.59
6K8	0.88	215A	0.95		
6L6	1.28	304TH	7.75		

OIL—FILLED CAPACITORS

Stock No.		Description	Price
CPO-195	2-2 mfd	600VDC cylindrical	$0.75
CPO-166	2½-2½-5 mfd	600VDC rectangular	1.37
CPO-48	4 mfd	600VDC rectangular	0.84
CPO-167	7 mfd	600VDC rectangular	1.15
CPO-112	10 mfd	600VDC rectangular	1.37
CPO-170	50 mfd	330VAC rectangular	4.95
CPO-13	2 mfd	1000VDC rectangular	0.95
CPO-124	4 mfd	1000VDC rectangular	1.19
CPO-19	8 mfd	1000VDC rectangular	1.71
CPO-180	½ mfd	1500VDC cylindrical	0.57
CPO-196	.1-.1 mfd	2000VDC rectangular	0.75
CPO-163	0.25 mfd	2500VDC cylindrical	1.06
CPO-22	0.25 mfd	3000VDC rectangular	1.71
CPO-544	2 mfd	4000VDC rectangular	4.95
CPO-553	3 mfd	4000VDC rectangular	5.95
CPO-171	0.1 mfd	5000VDC rectangular	3.65
CPO-125	2 mfd	5000VDC rectangular	7.30
CPO-154	1 mfd	6000VDC rectangular	7.60
CPO-37	.1-.1 mfd	7000VDC rectangular	1.95
CPO-562	.05 mfd	7500VDC cylindrical	1.75
CPO-47	1¼-1¼ mfd	7500VDC rectangular	13.00
CPO-173	0.02 mfd	10,000VDC cylindrical	2.95
CPO-172	0.25 mfd	20,000VDC rectangular	19.95

Note: 10 or more capacitors of a type 10% dis.

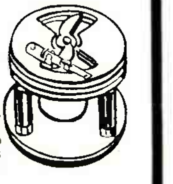
RF and DC PANEL METERS

Stock	Description	Price
MAD-251	0-2 ma DC Westinghouse 3½" round	$3.95
MAD-262	0-20 ma DC Westinghouse 3½" round	3.95
MAD-265	0-80 ma DC W.E. 3½" round	3.49
MAD-503	0-1000 ma DC DeJur 3½" round	3.95
MAD-276	0-30 ADC GE 2½" round	2.95
MVD-249	0-3 VDC Gruen 2½" round (0-1 ma DC basic movement)	2.95
MRT-355	0-100 ma RF Weston 425 3½" round	11.95
MRT-372	0-120 ma RF Weston 507 2½" round	8.95
MRT-367	0-1A RF GE 2½" round	2.95
MRT-394	0-20A RF GE 3½" round	6.95

50 MA. METER. 2-¾" square metal cased meter. 50 ma. full scale movement. Replaceable scale calibrated 0-3 volts with red and green areas indicating operating condition of a 2 volt storage cell. Wt. 4½ oz. A once-in-a-lifetime buy. Order a half dozen now while the supply lasts. **Stock No. MVD-58.** **$0.69 each. 6 for** $3.00

Delivery: Immed. from stock (subj. to prior sale).
Minimum Order: $5.00.
Terms: Rated organizations (U. S. and Canada). Open account.
Others: Cash with order, or 20% with order, balance C. O. D.
Foreign: Payment in U. S. funds with order or irrevocable letter of credit payable against documents in U. S. funds at New York.
Condition of material: The major portion of the material listed above is brand new. Some of the items have been removed from new equipments. Guarantee material clean and in operating condition.

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	$2.95
TN2A	75-300	1. 4	2.95
TN-30	135-485	2. 3	3.95
TN3A	300-1000	2, 5	4.95

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

BLILEY SMC-100 100 AND 1000KC CRYSTAL. Regularly sells for $8.75. **Stock No. QCM-19** **$5.95**

100KC LORAN CRYSTAL. ±15 cycles from −40° to +50°C. Supplied with mounting socket. **Stock No. QCM-17**...............**$6.95**

HAMMARLUND CERAMIC ACORN SOCKETS. 5 contact. Silver-Plated. **Stock No. XRT-25. 20 for**...............**$1.00**

CINCH MICA FILLED OCTAL SOCKETS. 1" dia. 1-5/16" mtg ctrs. **Stock No. XRT-20. 20 for** **$1.00**
1-1/8 dia. 1½" mtg. ctrs. **Stock No. XRT-40. 20 for** **$1.00**

3"-5" SCOPE TRANSFORMER. Primary: 115V/50-2600cps. Secondaries: 700VCT/70 ma, 750V (1050V peak) 10ma, 5V/2A, 6.3V/0.6A, 6.3V/4A. Hermetically sealed. 5½"x4"x4". **Stock No. TFF-56**...............**$2.49**

5"-7" TELEVISION OR SCOPE TRANSFORMER. Primary: 115V/60c. Secondaries: 2200VRMS (3000 Volts peak) 7ma, 2½V/2A/3000V ins., 6.3V/1A/3000V ins. Cased 2-¾" x 3" x 3½". **Stock No. TFF-81**..**$4.79**

4200 VOLT TELEVISION OR SCOPE TRANSFORMER. Primary: 115V/60c. Secondary: 3000VRMS (4200 Volts peak) 10ma. Hermetically sealed. 4½"x4-¾"x5½". **Stock No. TFF-83** **$5.95**

HV TFMR. 10,000-0-10,000 VOLTS @42 MA. Oil-filled, hermetically sealed. 11"x13" x6". **Stock No. TFF-451**...............**$29.95**

FILTER CHOKES

Stock No.	Description	Price
LFF-45	10H/120ma/600 ohms	$0.95
LFF-19	½ H/350ma/10 ohms/3000V	0.75
LFF-21	20H/300ma/125 ohms/5000V	9.95
LFF-144	2½H/700ma/16 ohms/1500V	4.95
LFF-450	1¼H/130ma/57 ohms	0.79

MULTIPLIER PHOTOTUBE HOUSING. Cast aluminum cylindrical housing containing a submagnal 11 pin socket (for 931A, 1P21, 1P22) and a dynode voltage divider network. Moisture proof construction. An integral 6 volt pilot lamp provides light source when used as a noise generator. A window may be drilled in the housing for use with an external light source. Operates with approximately 700 volts at 3-4ma. 2" dia. x 4" long. Supplied less phototube. **Stock No. AMP-65**...............**$2.95**

PRECISION HIGH TORQUE TYPE 5 SELSYNS. Bronze housing 4½" dia. x 5" long. 115V/60c operation. Brand new in original packing. Stock No. SEL-44......**$4.95 each**

110V/60CPS/0.38A BLOWER. Exceptionally quiet. 100 cu. ft. min. **Stock No. BLR-344**..**$8.95**

3" SCOPE INDICATOR. 3BP1 cathode ray tube mounted in a mu-metal housing with an adjustable light shield. May be mounted on a panel, table-top or clamped to a bar. When mounted on a table top or wall, the scope housing may be tilted at any angle up to 45° from the mount for comfortable viewing. Ideal for remote scope indicators. An outstanding buy at $5.95. Stock No. ASI-35.

All prices above are quoted domestic packed f.o.b. our warehouse, Corona, New York.

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Tel. HI ckory 6-3066-7-8

Cable: "Dublectron, New York". We will be pleased to send our bulletins to you regularly. Write or phone Dept. B-4 for our latest catalog.

ELECTRONICS CO. INC., 103-02 NORTHERN BLVD., CORONA, N. Y.

GUARANTEED GOV'T SURPLUS

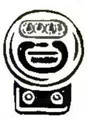
INVERTER PE 218D. Output 115V/400 cps/1500VA/1ph. Input 24-28VDC. Made by Wincharger. Complete with starting relays, hash filters, voltage and speed regulators. 5½"x11"x15". Brand new in original packing. **Stock No. GAC-10 $27.50**

SIGNAL CORPS 400 CYCLE POWER SUPPLY. Input 75-80-85-105-115-125V/400-2600cps. Output 450VDC/275ma, 6.3 VAC/3A. Complete with tubes. 6½"x7" x10". **Stock No. APU-85 $9.95**

6VAC/DC OSCILLATING WINDSHIELD WIPER ELECTRIC MOTOR. Completely enclosed 6V electric windshield wiper motor with gear train which converts rotating motor action to oscillating action. 30 to 200 (135°) strokes per minute depending on voltage. 3/16" output shaft. Easily installed. Great for hobbyists or moving display purposes. Shaft has high mechanical output. Makes fine agitator for photographic use. Draws 2 A. 3"x2"x2". 1½ lb. **Stock No. AMO-92 $1.95**

VEEDER ROOT COUNTER. To 999.9. Panel mounting type. **Stock No. VRC-43 $0.98**

WATTHOUR METERS



Watthour Meters. Induction type watthour meters for 60 cycle operation. 4 dials reading units, tens, hundreds and thousands of KWH to a total of 9999 KWH. Reconditioned and reset to 0. Like new. Guaranteed. 7½" high x 6" wide x 5" deep. 10 lbs.

2 Wire types: 5 amp/110v./60 cps./Sangamo type H and Type HC General Electric I-6. Stock No. MWH-22 **$5.95**

3 wire type: 5 amp./110 or 220v./60 cps./Sangamo type HC Westinghouse type OA, General Electric type I-14. Stock No. MWH-33. **$6.95**

DELAY LINE. 2 microsecond (one direction). 1500 ohms. Bandwidth 1mc. 8 section tapped. **Stock No. ZAL-22 $1.69**

DELAY LINE. 1¼ microsecond (one direction). 1500 ohms. Bandwidth 1mc. 6 section tapped. **Stock No. ZAL-13 $1.49**

DELAY LINE. 5 microsecond (one direction). 1500 ohms. Bandwidth ½mc. **Stock No. ZAL-14 $0.89**

1000 CPS BANDPASS TRANSFORMER. Center frequency adjustable over a small range. Input 1500 ohms. Output 100,000 ohms. Triple alloy shielded 1½"x1½"x2". **Stock No. ZBP-100 $3.95**

750 CPS BANDPASS TRANSFORMER. Center frequency adjustable over a small range. Input 23,000 ohms. Output 225,000 ohms. Triple alloy shielded. 1½"x1½"x2". **Stock No. ZBP-750 $2.49**

3 WINDING PULSE TRANSFORMER. Hypersil core. Turns ratio 1:1:2. 1¾" dia. x2". **Stock No. TPF-166 $1.95**

BLOCKING OSCILLATOR TRANSFORMER. Two winding 1.35:1. Ideal for television sweep oscillators. Compact. **Stock No. TFF-64 $0.95**

SLUG TUNED PEAKING COILS. Compact chassis mounting type. Ideal for wide band amplifiers or as low power RF tank coils. ⅛" dia x 1½" long.
125 to 225 microhenries Stock No. LRV-96 **$0.29**
175 to 275 microhenries Stock No. LRV-88 **$0.29**

ADJUSTABLE TRANSMISSION LINE. Silver plated brass tubing telescopic transmission line adjustable in length from 58 to 106 cm (23 to 42 inches). High quality soldered short at one end of line. Diameter ½". Spacing 2.05" o.c. Zo equals 255 ohms. Ideal for antenna matching stubs, adjustable antenna sections, "J" antennas, lecher wires, line oscillators, etc. 1½ lb. **Stock No. ZTL-82 $1.95**

DUBIN ELECTRONICS CO. INC.
103-02 Northern Blvd. Corona, N. Y.
Cable: "Dublectron, New York"
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INDUSTRIAL POWER SUPPLY EQUIPMENT

for worthwhile savings to you

NOTICE

Just received a limited quantity of new RA-38 high voltage power supplies.

POWER OUTPUT: Continuously variable 0-15000 v a-c or d-c @ 500 ma. 7.5 kw. **RIPPLE:** ½% @ 100 ma.—3% @ 500 ma. **REGULATION:** 15,800 v @ 100 ma.—15,000 v @ 500 ma.; 6,800 v. @ 100 ma.—5,000 v @ 50 ma. **POWER INPUT:** 115 v 60 cycle, single phase @ 125 amp max. output. **FULL WAVE BRIDGE RECTIFIER:** using 4 371-B high vacuum rectifier tubes. Designed for continuous duty, the unit contains a forced air blower. Air intake and output vents are fitted with dust filters. **CONTROLS:** include power on-off switch, filament on-off switch, filament voltage transtat control, plate voltage on-off switch, transtat plate voltage control, emergency disconnect switch. **RELAYS:** include main power relay, filament circuit relay, time delay relay, controlling plate power relay, plate circuit overload relay. **METERS:** include running time meter on power input, running time meter on power output, voltage and current meters in both a-c input and d-c output circuits, and a rectifier filament voltmeter. **PROTECTION DEVICES:** include automatic H.V. condenser discharge circuit, interlock switches on doors, and key interlocks on front panel. Provision is made for remote control of the power supply. The equipment is assembled in a steel cabinet which is mounted on skids by means of rubber shock mountings. **SIZE:** 63½" lg., 53¾" wd., 56⅞" hg. **NET WEIGHT:** 2040 lbs. **APPROX. SHIPPING WT:** 2100 lbs. Detailed information and prices on request.

MOTOR GENERATORS

G.E. Type CC-21991 input 115 v d-c., @ 5.7 amps. Output 115 v a-c 60 cycle, single phase 350 V.A. @ 85% $58.00

G.E. Type CC-21990 input 32 v d-c., @ 22 amps. Output 115 v. a-c 60 cycle, single phase, 350 V.A. @ 85% P. F. $63.00

Deland Type CLL-21985 input 115 v d-c @ 4.2 amps. Output 115 v a-c 60 cycle, single phase 240 V.A. @ 86% P. F. $47.00

T-102—Filament Transformer, American Transformer Co. Spec. 29106, Type WS .050 KVA, 50/60 cyc. Single phase, 35 KVA test, 12 KV D.C. operating. Primary 115 V., secondary 5 V., 10 amps with integral standoff insulator and socket for 250T, 371, 872 and 5563, etc. rectifier tubes........ **$12.50**
Net Wt. 15¾ lbs. Dim. 6½" W x 6" D x 12" H.O.A.

VOLTAGE REGULATORS

TRANSTAT: 115 v 50/60 cycle input: 0-115 v 100 amps 11.5 KVA output $95.00

TRANSTAT: 115/230 v 50/60 c input: 0-260 v output @ 2.5 amps. $21.50

TRANSTAT: 115 v 50/60 c input: 0 to 130 v output @ 10 amps. $24.50

VARIAC: 115 v 50/60 c input: 0 to 135 v output @ 5 amps; cased $14.50

Need power factor correction reactance? These units are rated @ 9.12 mfd., 1265 v a-c 60 cycle, single phase and have reactance factor of 5.0 kilovolt amps. New G.E. Pyranol **$17.50**

CAPACITORS

Standard Brands

2 mfd @ 600 v d-c; tubular oil .... $ .39

3.5/.5 mfd 1,000 v d-c, oil net wt. 1 lb. .... $ .90

1.0/1.0/1.0 mfd 3,000 v d-c test 1,200 v d-c working, isolated sections $1.20

1.25/1.25 mfd @ 7,500 v d-c net wt. 21 lbs. $12.50

1.0 mfd 25,000 v d-c; net wt 65 lbs. (C-107) $36.00

VACUUM CAPACITOR: 50 mmfd @ 32,000 v d-c; tubular; 2¼" dia. x 6½"; clip mounting: new, factory packed $4.95

KILOVOLT METERS

Weston 20 KV $18.00
Weston 4 KV 9.50
1000 ohms per volt Model 301 3" face 1 ma. F.S. flush type, calibrated for steel panel mounting with Weston 20 meg or Westinghouse 4 meg precision multipliers, standoff insulators, and clips.

A-C AMMETER

WESTON MODEL 476: 3" face, calibrated to read 0 to 120 amps. has 3 amps. full scale deflection; used with 40 to 1 current transformer, which is included. . $8.50

DRY DISC RECTIFIERS

Continuous Duty Ratings

3.5 v a-c, FWB, 1.8 v d-c @ 1.0 amp. .... $ .90
6.5 v a-c FWCT, 2.2 v d-c @ 3.0 amps. $1.20
0-36 v a-c, HW, 200 ma d-c, $ .75
0-54 v a-c, FWB, 1.6 amps d-c, $4.40
0-154 v a-c, FWB, 600 ma d-c, $6.85
0-180 v a-c, FWB, 400 ma d-c, $6.90

SOLA CONSTANT VOLTAGE TRANSFORMERS

95 to 125 v 50 c input; 115 v output:

30 va...	$6.00	250 va..	$18.00
60 va...	8.40	500 va..	34.00
120 va..	13.20		

SPECIALS

WESTINGHOUSE METER MULTIPLIER: 1 meg: 1/10% accuracy; wire wound; non-inductive $1.25

WESTERN ELECTRIC TIME DELAY RELAY: #250A; 110/220 v, 60 c: adjustable from 0 to 15 minutes $6.50

TUBE WL 386/ML-3W: 125 kv X-ray rectifier; oil immersion type; filament; 10 v @ 11.6 amps. $32.00

CRAMER TIME DELAY RELAY type TD2 120S: 0-120 seconds 115 v 60 c; synchronous motor driven; contact rating 10 amps 115 v; single pole normally open $4.95

G.E. LINE TRANSFORMER: 115/230—230/460 v; 37½ KVA 60 c; single phase; Cat. #60G-607 .... $210.00

TUBES

TRANSMITTING

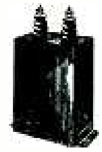
750TL	$47.50
730A Magnetron	10.75
THYRATRONS	
2D21 Min.	1.25
3C23	4.75
FG81A	4.75
C6A	8.50
C6J	9.50
931A Photo-Mult.	2.75
RECTIFIERS	
371B	5.95
872A	1.75

All Tubes New, Boxed

ELECTROLYTIC

A-1

500 mfd @ 200 d-c wv; 2 insulated terminals: 2" dia. x 4⅛" can; mounting bracket; new, factory packed. (A-1) .... $ .95



JF-1

.25/.25 mfd @ 6,000 v d-c or .125 mfd @ 12,000 v d-c; oil filled w/ mounting bracket; new, factory packed: 5" x 3½" x 9½" o.a. height. (JF-1) $3.75

MICA

CD-1

.001 mfd @ 25,000 v d-c; 25 amp @ 3,000 kc, 18 amp @ 1,000 kc, 11 amp @ 300 kc; 10½" x 4" x 9" o.a. height; new, factory packed (CD-1) $25.00

All merchandise in "as new" condition. Add approx. 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C. O. D. All prices f.o.b. Los Angeles Warehouse. Write for additional detail information on any of the above items and for special quantity discounts. **Telephone MAdison 6-5391**

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Yes Sir! the **HOTTEST LIST** in the LAND. brim full of electronics, hydraulics, aircraft parts, gadgets — Rush me your name TODAY

PHOTO ELECTRIC COMPASS

Kollsman photo electric compass model no. 729-B. Contains a liquid filled magnetic compass, a light source and a photo-electric cell. **New ea. $49.95**

800 Cycle Inverter

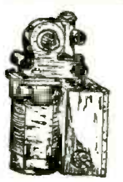
PE-206-A. Input 28 VDC—38 A. Output 80 V. 500 VA. Continuous duty. Mfg. by Leland #10494-2386. OD 10½ x 10½ x 6". Wt. 30 lbs. Complete with voltage regulator and noise filters.

New ea. $5.95

400 Cycle Inverter

GE#5D21NJ3A. Input 24/32 VDC-35 amps, output 115 VAC 4.2 amps. P/F 1, single phase, 8000 RPM. OD 9 x 5¼ x 6¼". Wt. 12 lbs. **New ea. $7.95**

LEAR ROTARY ACTUATOR Type 111



1 to 5 RPM. 10 to 27 volts AC/DC. Split field series reversible motor. Laminated field. Double spline output shaft. Adjustable limit switches. OD 8 x 5 x 4". Wt. 4¼ lbs.

New ea. $7.95

The answer to your remote control problems.

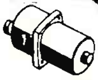
AY AUTOSYNS

These pioneer autosyns will operate on 6-12 Volts 60 cycle (26 V 400 cy 52V 800 cy). The receivers can be used as transmitters. Perfect condition.

DUAL INDICATOR

OD6x3¼x3¼". Wt. 1¼ lbs.

ea. $2.95



POSITION TRANSMITTER

OD5x2½x2½". Wt. ¾ lb.

ea. $1.49

SINGLE INDICATOR

OD4¼x3¼x3¼". Wt. ¾ lb.

ea. $1.69

AUTOSYN UNIT

OD2¼x2¼x2". Wt. 4 oz.

ea. $1.49

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DICK ROSE ERECO
2912 Hewitt Ave. Everett 20, Wash.

SELENIUM RECTIFIERS

AND SPECIALIZED ELECTRONIC COMPONENTS

VACUUM CAPACITORS

Standard Brands

12 Mmfd 20 Kv. $4.95
50 Mmfd 20 Kv. 4.95
50 Mmfd 32 Kv. 5.95

SILVER CERAMIC TRIMMERS

Type 820-Z 5-20 Mmfd Zero Temp	24¢
Type 822 5-20 Mmfd Neg. 300	24¢
Type 822-AZ 4.5-25 Mmfd Zero Temp.	24¢
Type 823-AN 20-125 Mmfd Neg. 650	33¢

FENWAL THERMOSWITCH

Normally open or closed. Ad'ustable from — 40° to + 400° F. . . . . $1.25 each

OIL CONDENSERS

2 Mfd 200VDC Bath	20¢
.5 Mfd 400 VDC	20¢
2 Mfd 400VDC Bath	30¢
6 Mfd 600VDC w/mtg clamp	79¢
10 Mfd 330VAC/1000VDC	1.55
50 Mfd 330VAC/1000VDC	4.95
8 Mfd 600VAC/2000VDC	3.50
.15-.15 Mfd 8000VDC	3.95
.125 Mfd 27 Kv	12.50

ELECTROLYTIC CONDENSERS

Cap	WV DC	Each	Lots of 10	Lots of 100
100 Mfd	50	.27	2.20	19.00
40 Mfd	150	.23	1.80	17.50
8-8-20 Mfd	350/150	.40	3.50	30.00
20-20 Mfd	400/250	.35	3.00	25.00
10 Mfd	450	.30	2.50	20.00
15 Mfd	450	.30	2.50	20.00
40 Mfd	450	.50	4.20	36.00

Full Wave Bridge Types

Input 0-18VAC — Output 0-13*VDC

Type#	Current	Price
B1-250	250 MA.	$.98
B1-500	500 MA.	1.95
B1-1	1 AMP.	2.49
B1-1X5	1.5 AMP.	2.95
B1-3	3 AMP.	3.49
B1-5	5 AMP.	5.95
B1-10	10 AMP.	9.95
B1-15	15 AMP.	13.95
B1-20	20 AMP.	15.95
B1-30	30 AMP.	24.95
B1-40	40 AMP.	27.95
B1-50	50 AMP.	32.95
B1-60	60 AMP.	36.95

Full Wave Bridge Types

Input 0-54VAC — Output 0-40*VDC

Type#	Current	Price
B3-150	150 MA.	$1.25
B3-250	250 MA.	1.95
B3-600	600 MA.	3.25
B3-5	5 AMP.	13.95
B3-10	10 AMP.	24.95

Input 0-72VAC — Output 0-54*VDC

Type#	Current	Price
B4-600	600 MA.	$3.95
B4-3	3 AMPS.	14.95
B4-5	5 AMP.	17.95
B4-10	10 AMP.	32.95

Input 0-115VAC — Output 0-110*VDC

Type#	Current	Price
B6-150	150 MA.	$1.95
B6-250	250 MA.	2.95
B6-600	600 MA	5.95
B6-3	3 AMPS.	18.95
B6-5	5 AMP.	24.95
B6-10	10 AMP.	36.95

Input 0-234VAC — Output 0-180*VDC

Type#	Current	Price
B13-5	5 AMP.	$54.95
B13-10	10 AMP.	69.95

Full Wave Bridge Types

Input 0-36VAC — Output 0-26*VDC

Type#	Current	Price
B2-150	150 MA.	$.98
B2-220	220 MA.	1.25
B2-300	300 MA.	1.50
B2-450	450 MA.	1.95
B2-1	1 AMP.	3.95
B2-2	2 AMP.	4.95
B2-3	3 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

Three Phase Bridge Types

Input 0-126VAC — Output 0-130*VDC

Type#	Current	Price
3B7-4	4 AMP.	$32.95
3B7-6	6 AMP.	48.90
3B7-15	15 AMP.	70.00

Input 0-234VAC — Output 0-250*VDC

Type#	Current	Price
3B13-4	4 AMP.	$56.00
3B13-6	6 AMP.	81.50
3B13-15	15 AMP.	120.00

CENTER TAPPED TYPES

Input 12-0-12VAC — Output 0-8*VDC

Type#	Current	Price
C1-10	10 AMP.	$7.95
C1-20	20 AMP.	12.95
C1-30	30 AMP.	17.95
C1-40	40 AMP.	21.95
C1-50	50 AMP.	25.95
C1-80	80 AMP.	34.95
C1-120	120 AMP.	46.95

* Select Proper Capacitor From List Shown Below, to Obtain Higher D.C. Voltages Than Indicated

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1	$ .35 per set
For Types B13	.80 per set
For Types 3B	1.20 per set

RECTIFIER CAPACITORS

CF-13	6000 MFD	10VDC	$2.49
CF-14	3000 MFD	12VDC	1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-3	1000 MFD	25VDC	1.69
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
CF19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	150VDC	3.25
CF-11	100 MFD	350VDC	2.25
CF-12	125 MFD	350VDC	2.49

Rectifier Transformers

All Primaries 115VAC 50/60 Cycles

Type#	Volts	Amps.	Price
XF15-12	15	12	$3.95
TXF36-2	36	2	3.95
TXF36-5	36	5	4.95
TXF36-10	36	10	7.95
TXF36-15	36	15	11.95
TXF36-20	36	20	17.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts.

RECTIFIER CHOKES

Type		Amps.	Price
HY2	.03 Hy	2	$2.25
HY3	.03 Hy	3	2.95
HY5	.02 Hy	5	3.25
HY8X5	.02 Hy	8.5	7.95
HY10	.02 Hy	10	9.95
HY12	.02 Hy	12	12.95
HY15	.015Hy	15	13.95

VARIABLE AIR TRIMMERS

Standard Brands—Screw Driver Adjustment

	Lots of 10	Lots of 100
7.5 MMF	$2.90	$27.00
25 MMF	3.10	29.00
50 MMF	3.30	31.00
100 MMF	4.10	39.00
140 MMF	4.90	47.00

METERS

O-15 MA.D.C. Weston #506 2" Rd	$2.95
O-50 A.D.C. Weston #301 3½" Rd., Enclosed shunt	5.50
O-60 A.D.C. West., w. shunt, 2½" Rd., aircraft type	3.25
O-120 A.D.C. West. w. shunt, 2½" Rd., aircraft type	4.95
O-8 V.A.C. G.E. 3½" Round	2.95
O-30 V.D.C. West. 2½" Rd., aircraft type	2.95
O-300 V.D.C. 2½" Rd., Bake Case	2.95

To avoid shipping errors, kindly order by type #. All prices subject to change without notice.

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BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

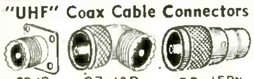
SELECTOR SWITCHES

NATIONALLY KNOWN MFRS.

Total Poles	Pos	Total Decks	Type	Price
1	2	1	ceramic....	$.25
1	3	1	ceramic....	.25
1	5	1	bakelite....	.25
1	6	1	bakelite....	.25
1	12	1	ceramic....	.45
1	21	3	bakelite....	.55
2	2	1	ceramic....	.30
2	2	1	bakelite....	.25
2	3	1	bakelite....	.25
2	3	1	ceramic....	.35
2	4	2	ceramic....	.50
2	4	2	bakelite....	.35
2	5*	1	ceramic....	.45
2	5*	2	bakelite....	.40
2	6	2	bakelite....	.35
2	6	2	ceramic....	.50
2	8	2	bakelite....	.40
2	11*	2	bakelite....	.68
2	11	2	bakelite....	.50
3	3	1	ceramic....	.35
3	3	1	bakelite....	.30
3	4	2	ceramic....	.50
4	2	1	bakelite....	.32
4	2	2	ceramic....	.50
4	3	2	ceramic....	.50
4	4	2	ceramic....	.50
4	5	2	ceramic....	.50
4	5	2	bakelite....	.40
4	11*	4	bakelite....	1.17
5	3	2	ceramic....	.50
5	3	3	ceramic....	.65
6	3	2	ceramic....	.50
6	3	2	bakelite....	.40
6	3	3	bakelite....	.55
6	5	3	bakelite....	.65
6	1*	6	bakelite....	1.68
8	2	2	bakelite....	.45
8	2	2	ceramic....	.60
9	3	3	bakelite....	.65
10	5	5	ceramic....	1.10
12	2	3	bakelite....	.65
12	3	4	bakelite....	.75
16	2	4	ceramic....	1.00
18	5	9	ceramic....	1.90

*Adjustable stops
(Special prices to quantity users.)

"UHF" Coax Cable Connectors



Cat. No.	Army No.	Type	Price
83-1AP	M-359	Angle Plug	$.39
83-1D	PL-271	Adapter	1.25
83-1F	PL-274	Feed Thru	1.15
83-1R	SO-239	Receptacle	.39
83-1SPN	PL-259A	Plug	.39
83-1SP¼"	PL-259	Plug	.48
83-22SP	UG-102/U	Twin Plug	.45

(Special Prices To Quantity Users)

JONES CONNECTORS

S-304-CCT..	$.19	P-333-FHT..	.94
P-306-AB...	.12		
S-306-AB...	.13	P-402-SB...	.24
P-306-CCT-L	.24	P-404-CCE..	.38
S-306-FHT..	.18	S-404-AB...	.29
P-308-FHT-L	.25	P-408-LAB..	.24
P-312-AB...	.19	S-408-LAB..	.33
S-312-AB...	.22	S-408-CCT..	.60
P-312-CCT-L	.33		
P-315-FHT..	.35	S-2408-LAB.	.33
P-315-EB...	.27	S-2408-SB...	.46
P-315-CCE..	.42	S-2412-DB..	.60
P-318-CCE..	.51		
S-318-CCE..	.55	P-508-CE...	2.00
P-321-AB...	.42	P-510-CE...	2.38
P-324-FHT..	.64	S-510-CE...	2.38
P-330-SB...	.88	P-510-SB...	2.09
S-330-SB...	.93	S-510-SB...	2.09
		P-512-CE...	2.75
P-101-¼"....	.20	S-101-D MOD	.27
P-101-⅜"....	.24		

THE BEST BUY EVER

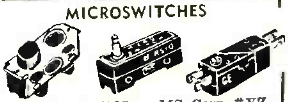
9c ea. SPECIAL April Only in lots of 100 or more

Oil Filled METAL TUBULAR .006 MFD 600V Standard Brand

JONES BARRIER STRIPS

Cat. No.	Price	Cat. No.	Price
4-140-Y.....	$.20	11-141-Y....	.66
5-140-Y.....	.25	12-141-Y....	.72
8-140.......	.27	13-141-Y....	.77
10-140-¾W..	.46	14-141-Y....	.83
10-240-W...	.33	15-141-Y....	.89
4-141.......	.19	8-142.......	.42
4-141-¾W...	.26	12-142......	.62
4-141-W....	.27		
5-141.......	.24	4-151.......	1.12
5-141-Y.....	.32	5-151.......	1.39
6-141-Y.....	.38		
7-141-Y.....	.43	4-152.......	1.63

MICROSWITCHES



A-SPST 10a/125vac MS Corp #YZ-RS13 type "S" plunger, metal housing norm open circuit....59¢
B-SPDT 10a/125vac MS Corp #B-RS10 type "S" plunger, 2-circ: one norm op & one norm cl......49¢
C-DPST 10a/110vac Snap-Action Switchette, GE #CR1070—C123—C3. 2-circ: one norm open and one norm closed ....29¢

OIL CONDENSERS

FAMOUS MAKES
MOST WITH CERAMIC PILLAR INSUL.

.1 Mfd—3000 vdcw..........	$0.75
.25 Mfd—3500 vdcw..........	1.15
1.0 Mfd— 500 vdcw..........	.28
1.0 Mfd— 600 vdcw..........	.35
2.0 Mfd— 400 vdcw..........	.35
2.0 Mfd— 600 vdcw..........	.39
4.0 Mfd— 500 vdcw..........	.59
4.0 Mfd— 600 vdcw..........	.69
6.0 Mfd— 400 vdcw..........	.75
6.0 Mfd— 600 vdcw..........	.79
10.0 Mfd— 600 vdcw..........	.98
14.0 Mfd— 600 vdcw..........	1.44
15.0 Mfd— 600 vdcw..........	1.87
15.0 Mfd—1000 vdcw..........	2.25
4-4-4 Mfd 400 vdcw 3 sec. 4 prong plugs in can 4⅛" high x 3" Diam.	$1.49

BATHTUB CAPACITORS

Famous makes

Oil filled bathtubs

0 33/400	V--17¢	.1 /600	V—22¢
.05/200	V—23¢	.15/600	V—23¢
.05/400	V—19¢	.25/200	V—19¢
.05/600	V—21¢	.25/400	V—21¢
.1/200	V—17¢	.25/600	V—23¢
.1/400	V—20¢	.5 /200	V—20¢
.5/400	V—23¢	2x.16/600	V—28¢
.5/600	V—25¢	2x.25/600	V—29¢
1.0/200	V—22¢	2x.5/600	V—34¢
1.0/600	V—30¢	3x.05/600	V—30¢
2.0/600	V—40¢	3x.1/600	V—33¢
2x.05/1500	V—33¢	3x.25/600	V—38¢
2x.1/600	V—29¢	3x1.0/100	V—25¢
2x.1/1000	V—31¢		

Electrolytic Bathtubs

4.0/50V	—30¢	200/12V	—20¢
25/25V	—22¢	300/6V	—30¢
25/50V	—23¢	2x10/25V	—20¢
25/75V	—25¢	2x200/9V	—35¢
50/25V	—23¢		

"UG" TYPE CONNECTORS

Army "AN" No.
UG-12/U..........
UG-18/U..........
UG-21/U..........
UG-24/U..........
98¢ ea.

GET ON OUR "PREFERRED" MAILING LIST FOR HARD-TO-GET ITEMS.

All prices f.o.b. N. Y. C.

Open accounts to rated concerns.

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ALEXANDER MOGULL CO., INC.
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Rotating Radar Antenna AS-18A/APS

. . . a real bargain for use in television and "ham" beam antennas, radio and television relay networks and experimental V.H.F. work. Includes rotating joint, J-67/APS-15 junction box, RE-5/APA-13 relay box, MX-160/APS-15 heater, CN-18/APA-14A torque unit, 28-volt D.C. drive motor. Reflector diam. 28.5". Shipping wt. 196 lbs. **$27.50** ea. net F.O.B.

SOUTHLAND AERO SUPPLY Company
Box 868, Dept. B Norfolk, Va.

SAVE AT AMSCO!

PARABOLIC REFLECTORS—15" spun alum. Alzak fin. for 1200 Mc. up..............pr.$3.00
PHASE SHIFT CONDENSERS—2 sections, split stator 4-15 mmfd. silver plated.......$ .65
CAPACITORS ELECTRO. 40-40 250 volts 6 for $1.79
VIBRATORS—7 prong 2 volt for GE portables Replaces LB-530 2 for.................$2.49
MICRO AMMETER—Beede 0-200 DC........$3.49
MILLIAMMETER—Beede 0-1000 DC........$2.79
METER RECTIFIERS Full Wave...........$ .95
Half Wave...................$ .65
WIRE-WOUND RESISTORS vitreous enameled 10 watt 1, 40, 100, 200, 2000, 10000 and 25000 ohms 25 Watt 12, 1000 and 5000 ohms $6.50

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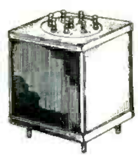
TRICKLE-CHARGER OR FIL. TRANSFORMER



Pri. 115V, 60 cycle AC. Secondary tapped at: 9-10-11-12 & 13 volts at 1½ amperes.

Truly an outstanding value!

Fully potted—grey finish—manufacturers quantities. **$1.95**

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1284 Market St. San Francisco, Calif.

TO HELP YOU...

find equipment you need

"Searchlight" Advertising

NEW TRANSFORMERS And CHOKES BY POWER CONVERSION CO.

TRANSFORMERS

INPUT: 115/230 V.A.C. 50 or 60 cycles. OUTPUT: 2500-0-2500 V.A.C. (2000 V.D.C. after choke input filter at 500 MA.) EH-102..................$39.75

ALL FOLLOWING TRANSFORMERS 115 V. A.C. 60 CYCLE INPUT:

OUTPUT: 750-0-750 V.A.C. (600 V.D.C. after choke input filter at 250 MA.) Includes 6.3 V.A.C. winding at 5 amps and 5.0 V.A.C. winding at 4 amps. EH-106 $7.95

OUTPUT: 625-0-625 V.A.C. (500 V.D.C. after choke input filter at 250 MA.) Includes 6.3 V.A.C. winding at 5 amps and 5.0 V.A.C. winding at 4 amps. EH-107 $7.35

OUTPUT: 600-0-600 V.A.C. at 250 MA. 12 V.A.C. at 3 amps; 12 V.A.C. at 3 amps and 5 V.A.C. at 3 amps. Designed for Army surplus transmitters. EH-108 ....$6.90

OUTPUT: 250-0-250 V.A.C. at 60 MA. 24 V.A.C. at 6 amps; 6.3 V.A.C. at 6 amps. Designed for Army surplus Receivers. EH-109..................$3.00

OUTPUT: 6.3 V.A.C. at 6 amps. EH-110...$2.25

OUTPUT: 24 V.A.C. at 2 amps. EH-111...$2.25

OUTPUT: 2.5 V.A.C. at 10 amps. center tapped and shielded. Open frame mounting insulated for continuous operation at 5,000 volts. EH-113.$4.20

CHOKES:

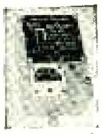
EH-115—8 Henries at 500 MA. filter choke, 5,000 volt insulation $8.67

EH-116—5-20 Henry 500 MA. swinging choke, 5,000 volt insulation $8.37

EH-117—8 Henries at 700 MA. filter choke, 7,500 volt insulation $12.90

EH-118—5-20 Henries at 700 MA. swinging choke, 7,500 volt insulation.......................$12.45

ALL ABOVE ITEMS BRAND NEW—NOT SURPLUS!



METER SWITCH

Battery Balancing Switch used to read battery voltage and to switch load from one battery to another. Contains 2" Weston Meter 0 to 15 DC Volts, switch DPDT—20 amp, 125 V. pilot light indicator, and pull sw. Case size: 4" x 6¼" x 2¾". Price: NEW..........$2.95

GASOLINE GENERATORS:

HOMELITE ENGINES—Consist of a 30 Volt DC, 50 ampere (1500 watt) generator driven by a single cylinder, 2 cycle air-cooled gasoline engine, approx. 3 HP. Rope or electric starting. No. EG-105. Prices: As is ....$39.50 Tested.......$49.50

DELCO ENGINES—Consist of a 12 Volt DC 750 watt generator driven by a one cylinder, four cycle air-cooled gas engine approx. 2 HP. with self-starter and voltage regulator. Used to charge batt. in Gov't. vehicles. No. EG-106. Price: Tested $79.50

INVERTER MG-149 F

Input 24 Volt DC; Output 26 Volt DC, 250 VA 400 cycle, or 115 V. 400 cycle 500 VA. Appear to be unused; are refinished and Tested. Price: $14.95

TRANSTAT VOLTAGE REGULATOR — #29144. Voltage Range 103-126 V. 2.17 amps. Price—NEW $9.95

MOTOR CONTROL RHEOSTAT STANDARD BRAND—Heavy-duty, wire-wound control. D-150. 150 Watt, 8.28 ohms, 5 amps. Price..........$1.75

GENERATORS

Input	Output	Stock No.	Price
9 V. DC	405 V. 95 MA	DM 635 X	$3.95
9 V. DC	450 V. 60 MA/with Blower	D 9450	3.95
12 V. DC	220 V. 100 MA	D 402	3.95
12 V. DC	440 V. 200 MA	D 401	7.95
12/24 V. DC	F/No. 19 MARK II	P/S No. 3	9.50
12/24 V. DC	440 V. 200 MA & 220 V. 100 MA	D 104	9.95
12/24 V. DC	500 V. 50 MA	USA/O151	1.95
13/26 V. DC	F/BC-645	PE 101	2.95
14 V. DC	230 V. 100 MA	DM 20	3.95
28 V. DC	F/Comm. Receivers	DM 32	1.95

Address Dept. E • All Prices Are F.O.B., Lima, O. • 25% Deposit on C.O.D. Orders

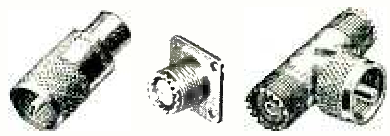
FAIR RADIO SALES

132 So. Main St. Lima, Ohio

Coaxial Cables and Connectors

Brand New!! JAN Approved!!

"UHF" COAXIAL CABLE CONNECTORS



83-1SP 83-1R 83-1T

No.	An. No.	Description	Price Each	Price per 100
83-1SP	(PL259)	Plug	35¢	28¢
83-1SPN	(PL259A)	Plug	35¢	28¢
83-168	(UG176U)	Reducing adapter.	15¢	12¢
83-1AC		Cap and Chain	67¢	60¢
83-1BC		Cap and Chain	38¢	34¢
83-1H	(UG106U)	Hood	12¢	10¢
83-1R	(SO239)	Receptacle	35¢	28¢
83-1AP	(M359)	Angle Adapter	28¢	22¢
83-1T	(M358)	Connector	$1.25	$1.12
83-1J	(PL-258)	Junction	85¢	70¢
83-22R	(UG103U)	Receptacle	50¢	40¢
83-22SP	(UG102U)	Plug	50¢	40¢

COAXIAL CABLES

RG5U	per 1000 ft.	$70.00
RG6U	per 1000 ft.	120.00
RG7U	per 1000 ft.	70.00
RG8U	per 1000 ft.	40.00
RG9U	per 1000 ft.	135.00
RG10U	per 1000 ft.	90.00
RG11U	per 1000 ft.	100.00
RG12U	per 1000 ft.	175.00
RG13U	per 1000 ft.	125.00
RG18U	per 1000 ft.	320.00
RG22U	per 1000 ft.	120.00
RG27U	per 1000 ft.	290.00
RG29U	per 1000 ft.	37.50
RG34U	per 1000 ft.	175.00
RG54A/U	per 1000 ft.	60.00
RG54U	per 1000 ft.	65.00
RG57U	per 1000 ft.	75.00
RG58U	per 1000 ft.	59.00
RG59U	per 1000 ft.	45.00
RG62U	per 1000 ft.	50.00
RG71U	per 1000 ft.	175.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50%

UG TYPE CONNECTORS

Deduct 10% from prices shown on orders of 100 or more per type

AN #	Price ea.	AN #	Price ea.
UG- 9/U	1.14	UG- 97/U	3.50
UG-10/U	1.56	UG- 98/U	1.55
UG-11/U	1.45	UG-100/U	2.34
UG-12/U	1.14	UG-101/U	2.95
UG-13/U	1.56	UG-107/U	2.25
UG-14/U	1.45	UG-108/U	1.75
UG-15/U	1.14	UG-109/U	1.75
UG-16/U	1.56	UG-114/U	1.50
UG-17/U	1.45	UG-115/U	1.35
UG-18/U	1.25	CW-123/U	.45
UG-18A/U	1.05	UG-155/U	.40
UG-18B/U	.99	UG-154/U	3.75
UG-19/U	1.28	UG-155/U	3.75
UG-19A/U	1.38	UG-156/U	4.25
UG-19B/U	1.45	UG-160/U	1.90
UG-20/U	1.17	UG-160A/U	1.55
UG-20A/U	1.26	UG-167/U	2.25
UG-20B/U	1.41	UG-173/U	.30
UG-21/U	.99	UG-175/U	.15
UG-21A/U	1.05	UG-176/U	.15
UG-21/BU	.99	UG-188/U	1.30
UG-22/U	1.08	UG-201/U	1.22
UG-22A/U	1.38	UG-202/U	2.75
UG-22B/U	1.34	UG-206/U	1.02
UG-23/U	.99	UG-208/U	28.50
UG-23A/U	1.26	UG-212/U	4.50
UG-23B/U	1.29	UG-213/U	4.50
UG-27A/U	2.25	UG-215/U	3.35
UG-28/U	2.34	UG-216/U	8.70
UG-29/U	1.22	UG-213/U	3.10
UG-30/U	1.75	UG-218/U	6.50
UG-33/U	30.00	UG-222/U	35.00
UG-34/U	35.00	UG-231/U	2.00
UG-35A/U	28.00	UG-236/U	11.75
UG-36/U	35.00	UG-241/U	2.20
UG-37/U	28.00	UG-242/U	2.50
UG-37A/U	30.00	UG-243/U	2.75
UG-57/U	.99	UG-244/U	2.50
UG-58/U	.63	UG-245/U	1.25
UG-59/U	2.75	UG-246/U	1.45
UG-59A/U	1.70	UG-252/U	4.50
UG-60/U	1.90	UG-254/U	1.82
UG-60A/U	1.30	UG-255/U	1.85
UG-61/U	2.05	UG-260/U	1.12
UG-61A/U	1.80	UG-261/U	.95
UG-62/U	28.00	UG-262/U	1.05
UG-83/U	1.50	UG-269/U	2.60
UG-85/U	1.65	UG-273/U	1.50
UG-86/U	1.69	UG-274/U	1.98
UG-87/U	1.40	PL-274	1.12
UG-88/U	1.17	UG-290/U	.85
UG-89/U	.95	UG-291/U	1.05
UG-90/U	1.05	UG-306/U	2.03
UG-91/U	1.25	UG-333/U	4.70
UG-91A/U	1.05	UG-334/U	5.75
UG-92/U	1.10	UG-352/U	6.00
UG-92A/U	1.35	UG-287/U	5.25
UG-93/U	1.25	UG-270/U	6.50
UG-93A/U	1.45	UG-259/U	4.10
UG-94/U	1.25	UG-279/U	2.40
UG-94A/U	1.05	UG-157/U	4.25
UG-95/U	1.10	MX-195/U	.55
UG-95A/U	1.35	UG-197/U	5.25
UG-96/U	1.25	UG-235/U	28.50
UG-96A/U	1.45		

Life Electronic Sales

91 Gold St. Tel: DIgby 9-4154 N. Y. 7, N. Y.

ELECTRONIC TUBES

JAN-CATHODE RAY-UHF-H.V. Rect.-SPEC. PURP.

3DP1	$2.35	304TH	$3.45	800	$ .98
4AP10	3.85	371A/B	.98	864	.19
5AP1	2.75	393A	3.95	878	2.45
5AP4	4.75	12GP7	11.95	1624	1.49
5BP4	4.65	408U	.09	1630	.94
5CP1	2.75	434A	3.35	8013	1.90
9GP7	6.75	2X2A	.68	9006	.32
9MP7	6.75	WL-468	9.75	6AC7	.70
MW22-2	4.85	559	.89	2x2	.45

On all orders over FIFTY dollars DEDUCT 20% Regular credit terms to rated buyers.

Gould Green

107 West Broadway, New York 13, N. Y.

D. C. MICROAMMETERS

0-100 ua. 4" sq. G.E. DO 58 ......$12.00
0-100 ua 4½" round Weston 643 .. 14.00
0-50 ua 4½" round Weston 643 .. 15.00
0-200 ua 3" sq. G.E. DO 50 ...... 8.00
0-50 ua 3" sq. G.E. DO 50 .... 12.00

R. F. MILLIAMMETERS

0-100 Ma 3½" r. Weston 425 .....$11.00
0-120 Ma 2½" r. Weston 507 ..... 7.00
0-10 Ma 4½" r. Weston (vacuum) 22.00
0-2 Ma 4½" r. Weston (vacuum) 26.00

A. C. VOLTMETERS

0-300 v 3½" r. Weston 476.......... $8.00

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

GIBSON GIRL ANTENNA KIT

Antenna Kit for Gibson Girl Transmitter. This kit was designed to improve the effectiveness of the Gibson Girl Transmitter by increasing the range several times. The kit includes 300 feet of special antenna wire, two balloons for raising the antenna, two hydrogen generators, a special box kite for antenna erection, and a searchlight. Complete kit $9.95.

BUFFALO RADIO SUPPLY
219 Genesee St. Buffalo 3, N. Y.

RADAR ANTENNAS

YAGI ANTENNA—ASB Radar 5 element wide spaced array (450 to 560 MC)..$ 7.00
SAME with Sperry type F hydraulic servo controls for remote rotation........$26.65
DOUBLE STACKED ASB YAGI—same freq. consists of two 6 element beams.$12.70
SAME with hydraulic servo controls for remote rotation......................$31.65
DOUBLE STACKED ASA YAGI—two 6 element beams (370 to 430 MC)......$29.40
SAME with hydraulic servo controls for remote rotation......................$48.75
AT-49A/APR-4—(300 to 3300 MC) $13.70
AT-38A/APT—(70 to 400 MC)..$13.70

GENERAL ELECTRIC FG-172 THYRATRONS

Brand new in original cartons. This tube is used in many industrial controls. FULLY GUARANTEED. SPECIALLY PRICED AT $14.80 EACH

$10.00 each in lots of 10

WESTINGHOUSE HYPERSIL Transformers

Pri. 115V 60 cy ¾ KVA—Sec. #1 240V at 1.56A, Sec. #2 240V at 1.56A, Wt. 30 lbs ....ea. $11.50

$10.00 each in lots of 10

HYDRAULIC SERVO CONTROLS

Type 1—Sperry type F (or equivalent) for transmitting rotary motion.
Type 2—SAME except receiver produces linear motion. Either type $20.00 per set (transmitter and receiver). **$17.85** each in lots of 10.

PHASE SHIFT CAPACITOR—4 Stators, single rotor......$1.92 each; 10 for $16.75

200 WATT WIRE-WOUND Ferrule Type RESISTORS

Fixed taps at each 10% of full resistance value. Dimensions 1⅛" dia. x 9½" long.

25 ohms	200 ohms	500 ohms	2000 ohms
50 ohms	300 ohms	1500 ohms	5000 ohms

77¢ each, 10 for $6.10

GENERAL ELECTRIC AMPLIDYNE Motor-Generator

Consists of G.E. model 5KC67BB475 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**

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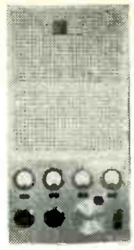
Telephones: MArket 7-6590 and 6591



4 Tube Flashing Bomber Induction Heater

An outstanding value. Raytheon induction heater. Radio frequency generator 1000KC, 1.2 KW. Input 550 V. 3 phase, 60 cy. Complete with tubes, 2 type 866 and 4 type RK-38. Can be easily converted for 110 V. AC operation by means of transformer. Used, but like new. Quantity limited. **$165.00 each**

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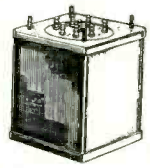
VIBRATOR TRANSFORMER



Primary, 6.3 volts. Sec. 450-0-450 AC. at 135 ma. Also 25V bias winding.

A wonderful buy on a beautiful item . . . . .

Fully potted—grey finish—manufacturers quantities. **$1.95**

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ELECTRONIC TUBE-MAKING MACHINERY

For manufacturing radio tubes, electronic tubes, cathode-ray tubes, lamps. New and used. Reasonably priced, satisfaction guaranteed.

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SHEET METAL MACHINERY

NEW and Used — Brakes — Shears
Forming Rolls — Folders — Punches — Di-Acro, Pexto, Niagara & Whitney Equipment.

R. D. BROOKS CO., INC.
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HIGH-VOLTAGE SUPPLIES

DEPENDABLE LABORATORY EQUIPMENT
Circuits of latest design • Superior construction
4 to 6 Kv, 115-volt a-c input........$18.50
4 to 6 Kv, 6-volt d-c input..........$28.50
25 to 30 Kv, 115-volt a-c input......$79.95

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202 East 44 Street, New York 17, New York

ELECTRONIC EQUIPMENT & PARTS

CONTRACTORS, Magnetic—110V coil— Contacts 440V 25A TPDB $11.25
OUTLET BOXES, hinged cover—8x12x4"......85¢
RECEIVER-TRANSMITTER #148-156......$6.50
Highly polished black bakelite sheets—.030x42x48—10¢ sq. ft. 1000 lbs.
METERS, Weston model 456—twin meter—5-0-5 ma. $40.00. Also
Sq. bakelite case—4"-0-5ma $3.75
Precision WW resistors—½&1 watt—50k-9k-2k-38.5k-800k-556.4k-500k-1 meg. Vitreous enamel resistors—10 watts to 300 watts—misc. res. 1ohm to 100,000. 25,000 at 8¢ ea. for lot.
VOLTAGE REGULATORS—110 or 220v in. 115v out1%—350 watts $45.00
VARIACS—1A and 6.A-O-135V.
TRANS., Step-up or stepdown 110 to 220 with taps on pri & sec. 100W and 800W. Ne 2 neon lamps 6¢
MAZDA LAMPS — 319A.19A, 3vAmber panel lamps 15¢. Also
302—1204—844—313—1251.
Bakelite washers—1/16x5/8x1/4 ....$2.00/M.
MOTOR-GEN.—27V 100A input—115V 400 cycle output 1500w $45.00
POLAROID FILTERS—90 deg. rotation. 3" dia. $2.50
GUNSIGHTS—N3C—$2.50. Model K10 and K11 ....$8.50
Rubber pressure hose—3ply—3/16x3/8........8¢/ft.
GASOLINE GEN., 10KW Onan-110-220v. 60 cy. $650.00
25KW Onan 220V 3 phase 60 cy..........$2000.00
ICE MACHINE, 3HP ammonia York, condenser & motor $350.00
Little Bear Cement.........................75¢/qt.
Rubber Cement ....$2.00/gal.
BATTERY CHARGERS—10batt. 10A.........$18.00
CO_2 Fire Ext. 1.4 lbs.........................$7.50

TURBO GOVERNOR—type B-Max RPM 2780 $2.50
OCTAL SOCKETS—moulded-holes 1-5/16 4¢ ea. 20M.
RELAYS—telephone type—DPDT—gold contacts—12,000 ohm. 90¢ ea. 100 or more.
POLARIZED RELAYS—WE D-164813...$5.00 ea.
NICHROME WIRE #36 DSC .0035—Res. 53/ft.
SPARK GENERATOR—for flame throwers....90¢

TUBE PARTS AND SUPPLIES

Bulbs—T16AK1C ....10¢ ea.
Getters—Kemet Types 677-6613-P-0558 20mg. 75¢ /1000
Ni ribbon—020x2. Carb. 010x1............75¢/lb.
Tungsten leads—several sizes...........$45.00/M.
Transformers and chokes—many sizes—write for list.
Cold test chamber—equipped with tem., humidity, and altitude controls, with recorders.
Photoelectric relays, complete...............$5.50
Dynamic mic and head set—Sound power....$3.75

GLASS TUBING 25c LB.

26 B 4602 0035 772	800 lbs.
35 A 7110 36030 040 772	1500 lbs.
34 B-34 D 772 35#030#040	1350 lbs.
49 Tube 050-060	390 lbs.
22 A 772 56# 020-035	500 lbs.
772 Cane	50 lbs.
27 A 772 55# 040-050	150 lbs.
27 B 0038 54# 040-050	100 lbs.
27 B 772 44# 040-050	40 lbs.
54 024# 030 754564	500 lbs.
255 #270 40#310-025	220 lbs.
OD. 1508-01726 wall .022-.031 21 Ga .001	750 lbs.
23 A G 12 Ga23 54# 039-050	50 lbs.

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ST. CHARLES, ILL.

1/15 H.P. REVERSIBLE MOTOR

$6.85 POSTPAID

Add 25¢ if West of Miss. River

115 V. A.C. 1600 R.P.M. brand new, complete with capacitor and grinding wheel adapter. Intermittent duty. Perfect for small tools, displays, fans, grinders, polishers, radio antennas, model railroads, driving small machines and home use.

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ELECTRONICS FOR LAND, SEA AND AIR

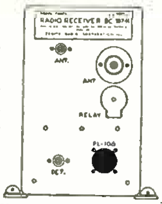
RA-62 Mallory Power Packs;
AN/CRC7 VHF Handitalkies, 140.58mc;
BC730C Constant Volt. Amplifiers;
TCE-2's, MG, starter, 6 coils;
Fed. Tel. and Radiomarine Receivers;
CRT-3 Gibson Girls, 2 Channel;
AN/TRT-1 50 watt trans. 12 or 24v. 6 xtal 27-40mc. Remote work, Comm. measurement lab; Etc.

Subject to prior sale, inquiries invited

GEORGE BELLING
4107 Brookdale Ave. Oakland 19, Cal.
Kellogg 2-1640

RADIOMEN'S HEADQUARTERS — WORLD WIDE MAIL ORDER SERVICE ! !

MARKER BEACON RECEIVER ONLY $4.95

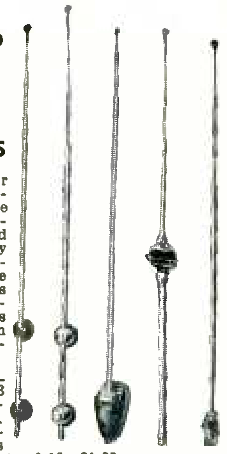


This as a regulation marker beacon receiver designed for reception of modulated signals on the 75-MC band authorized by the FCC; variable tuning permits coverage of 62-80 MC without circuit changes. Output of the receiver usually is used to flash an indicator lamp on the pilot's instrument panel and no adjustments are necessary during operation; simply turn the set on. The relay circuit in the set can be adapted to control external circuits, open doors, etc. It's ideal for experimenters! The set is housed in a handsome aluminum cabinet.

AUTO-TRANSFORMERS—Steps up 110v, or steps down 220v to 110 v—$1.95.
FIL. TRANSF.: 6.3v, 20 Amps.—$1.98; Universal Output Trans. 8 Watt—89c; 18 Watt—$1.29; 30 Watt—$1.69. **AUDIO TRANSFORMERS:** S. Plate to S. Grid. 3:1—79c; S. Plate to P.P. Grids—79c; Heavy Duty Class AB or B. P.P. inputs—$1.49; Midget Output for AC-DC sets—69c; **MIKE TRANSFORMER** for T-17 Shure microphone, similar to UTC ouncer type—$2.00. Stancor SB or DB mike to line or grid—$1.95.
POWER TRANSFORMERS — Half-shell type, 110V, 60 cy. Centertapped HV winding. Specify either 2.5 or 6.3V filament when ordering.

For 4-5 tube sets—650V, 40MA, 5V & 2.5 or 6.3V $1.49
For 5-6 tube sets—650V, 45MA, 5V & 2.5 or 6.3V 1.75
For 6-7 tube sets—675V, 50MA, 5V & 2.5 or 6.3V 1.90
For 7-8 tube sets—700V, 70MA, 5V & 6.3 or two 2.5V 2.35
For 7-8 tube sets—700V, 70MA, 5V & 6.3 (25 Cycle) 3.60
For 8-9 tube sets—700V, 90MA, 5V-3A, 2.5V-3.5A. 2.5-10.5A 2.85
For 9-11 tube sets—700V, 5V & 6.3V-4A. 2.85
For 9-15 tube sets—600V, 150MA, 5V & 6.3V. 2.95

BUFRAD CAR RADIO ANTENNAS



All of our car radio antennas are made of triple plated Admiralty Brass Tubing, complete with low loss shielded antenna leads and high quality fittings.

SIDE COWL — BR-1, 3 sections extend to 66". Your price—single units—$1.50; in lots of 12—$1.35 ea.

SKYSCRAPER—BR-2 has 4 heavy duty sections that extend 98". This super-aerial must be seen to be fully appreciated. Your price—single units—$2.45; in lots of 12—$2.25 ea.

TILT ANGLE—BR-3, may be adjusted to all body contours, 3 sections extend to 66". Single unit price—$1.50; 12 lot price—$1.25 ea.

VERSATILE—BR-4, single hole fender or top cowl mounting may be adjusted to conform with all body contours. 4 sections extend to 56". Single unit price—$2.90; 12 lot price—$2.75 ea.

THE MONARCH—BR-5, single hole top cowl mounting, 3 sections extend to 56". Single unit price—$1.90; 12 lot price—$1.75 ea.

AFTER SEEING OUR ANTENNAS AND COMPARING, YOU WILL NEVER BUY ANY OTHER MAKE!

ACRO CHASSIS CRADLES

Pays for itself in a week—Saves and eliminates broken tubes, coils, dials, etc. Cadmium plated steel, finger-tip control. A necessity for Television Service. Your Cost $4.69

STEATITE VARIABLE CONDENSERS

Ideal for high-frequency applications in receivers and low power transmitter stages. All types have standard ¼" dia. shafts.

10 mmf $.35—10 for $2.90—100 for $23.00
15 mmf $.35—10 for $2.90—100 for $23.00
25 mmf $.35—10 for $2.90—100 for $23.00
35 mmf $.40—10 for $3.40—100 for $28.00
50 mmf $.45—10 for $3.70—100 for $30.00
75 mmf $.50—10 for $4.40—100 for $38.00
100 mmf $.55—10 for $4.50—100 for $39.00
140 mmf $.80—10 for $7.40—100 for $64.00
160 mmf $1.00—10 for $8.50—100 for $70.00
140-140 mmf $1.60—10 for $12.50—100 for $100.00

Screw Driver Adjustment

$.20—10 for $1.80—100 for $16.00
$.20—10 for $1.80—100 for $16.00
$.20—10 for $1.80—100 for $16.00
$.25—10 for $2.30—100 for $20.00
$.25—10 for $2.30—100 for $20.00
$.30—10 for $2.70—100 for $25.00
$.40—10 for $3.60—100 for $32.00

MICROPHONES

Super Special—Highest quality all chrome bullet shaped CRYSTAL MIKE of top-flight nationally known brand—$5.95, Bullet DYNAMIC MIKE—$7.95, Mike Jr.—60¢, PUSH TO TALK MIKE with switch on handle—90¢, LAPELMIKES* (Specify whether carbon or magnetic) 93¢.

CONDENSERS

Paper Tubular 600 WV-001, .002, .005—8¢; .01, .05—9¢; .1—10¢; .25—23¢; .05—35¢; Electrolytics: 8 mfd 200v—20¢; 100 mfd 35v—20¢; 20 mfd 150v—25¢; 20/20 mfd 150v—35¢; 40/20 150v—46¢; 50 mfd 150v—43¢; 8 mfd 475v—34¢; 16 mfd 350v—65¢; Oil Condensers: 4 mfd 600v—69¢; 2 mfd 600v—49¢; 3x mfd 600v—29¢.

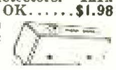
SPEAKERS

These PM speakers are the finest that are available. All have heavy oversize Alnico V magnets.

3½" .... $1.15....6 for $6.60
4" .... $1.15....6 for $6.60
5" .... $1.10...10 for $9.50
6" .... $1.50....6 for $8.70
7" (Car Radio Size) $4.50....6 for $21.50
8" ....10 oz. $3.95....6 for $20.50
8" ....21 oz. $4.95....6 for $26.50
10" ....21 oz. $5.50....6 for $30.00
12" ....21 oz. $7.95....6 for $42.00

Battery type BA38, 103.5v battery used in handy talkies and mine detectors. 1x1x11½". Outdated but tests OK......$1.98

Standard type normally open **MICROSWITCHES** ....39¢
Leaf actuator **SPDT MICROSWITCHES** ......49¢



Brand new fully shielded **GE** single button **mike transformer** in beautiful silver finish case .... 99¢
Miniature bayonet **pilot light sockets**—per hundred $2.50

Universal 4 lead broadcast band **oscillator coil** (can be converted to 3 lead type by addition of jumper). Six for.......... $1.00

SOS EMERGENCY TRANSMITTER SOS

This is the famous Gibson Girl Transmitter that saved so many lives during the war. It is used as a distress call transmitter on boats and airplanes. The Gibson Girl is the easiest transmitter in the world to operate. No instruction or experience necessary. No external power supply required for operation. It is merely necessary to turn the crank on the top of the transmitter and power is generated and the distress signal is automatically sent out on the international distress frequency. Brand New Gibson Girl transmitter complete with tubes $9.95

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GRAIN OF WHEAT LAMPS

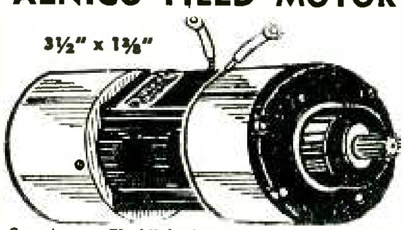
Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

Mazda G.E. 323 3V..19 A
Mazda G.E. 328 6V..2 A

Photo, 3 times actual size. Glass Bulb ⅛" x ⅜"
Either type **$1.50** doz. **$75.00** per M.

ALNICO FIELD MOTOR

3½" x 1⅜"



Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc., 250 RPM. FEW MORE AT.......... **$5.00**

A newly Written (1948) Book on Photoelectric tubes (Electric Eye) Circuits and Relays **$1.00**
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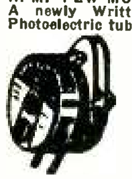

HAYDON or TELECHRON SYNCHRONOUS MOTOR to operate switches, etc., 1 Rev. per minute at this
SPECIAL PRICE **$3.85**
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50 Kc to 28 Mc. 0.1 to 2 Volts Output
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(1, 5, 10 Mc. Crystals—useful up to 500 Mc.)

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3404H DC SPOTLIGHT GALVANOMETER $40.00
.03 μamp per MM
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GRAY

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L & N

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G. E.

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RN2 WHEATSTONE BRIDGE.....$70.00
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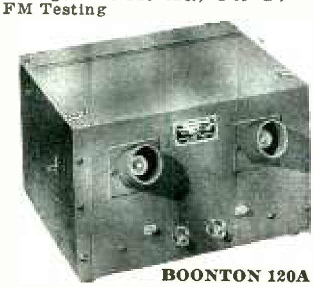

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Vacuum tube pump station complete w/pumps, manifold, ionization gauges, oven, etc.

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715B	15.00	RK72	1.30
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Imp. ratio 50 to 1000 to 1000 3 wndgs. Hypersil core working voltage: 15 KV W.E. type KS9798. Shipping wt. 3½ lbs.

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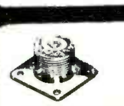

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FREE data, circuits designed by ROBT. G. HERZOG

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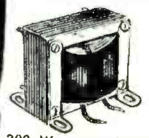

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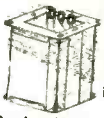

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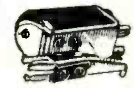
PP 6L6 to Servo mechanism with 10% feedback winding. MU metal core. $3.25 ea.

Dual unit PP 6V6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism. Both in 1 can.............$3.95 ea.



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Clare Sensitive 3500 ohms 6MA SPDT 3 amp contacts No. R30 ....$1.10 ea.

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2,000 ohms 3 PST N. O. 1 amp contacts CLARE #R94, 89¢ ea.

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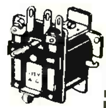
Price Rotary 14V. coil 30° rotation 8½ oz.-in torque. Single wafer, 98¢ ea.



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115 V. A.C. DPDT 10 amp contacts, manual release latch. 200 ohms. Allied .....98¢ ea.

Min. Order $2.50

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