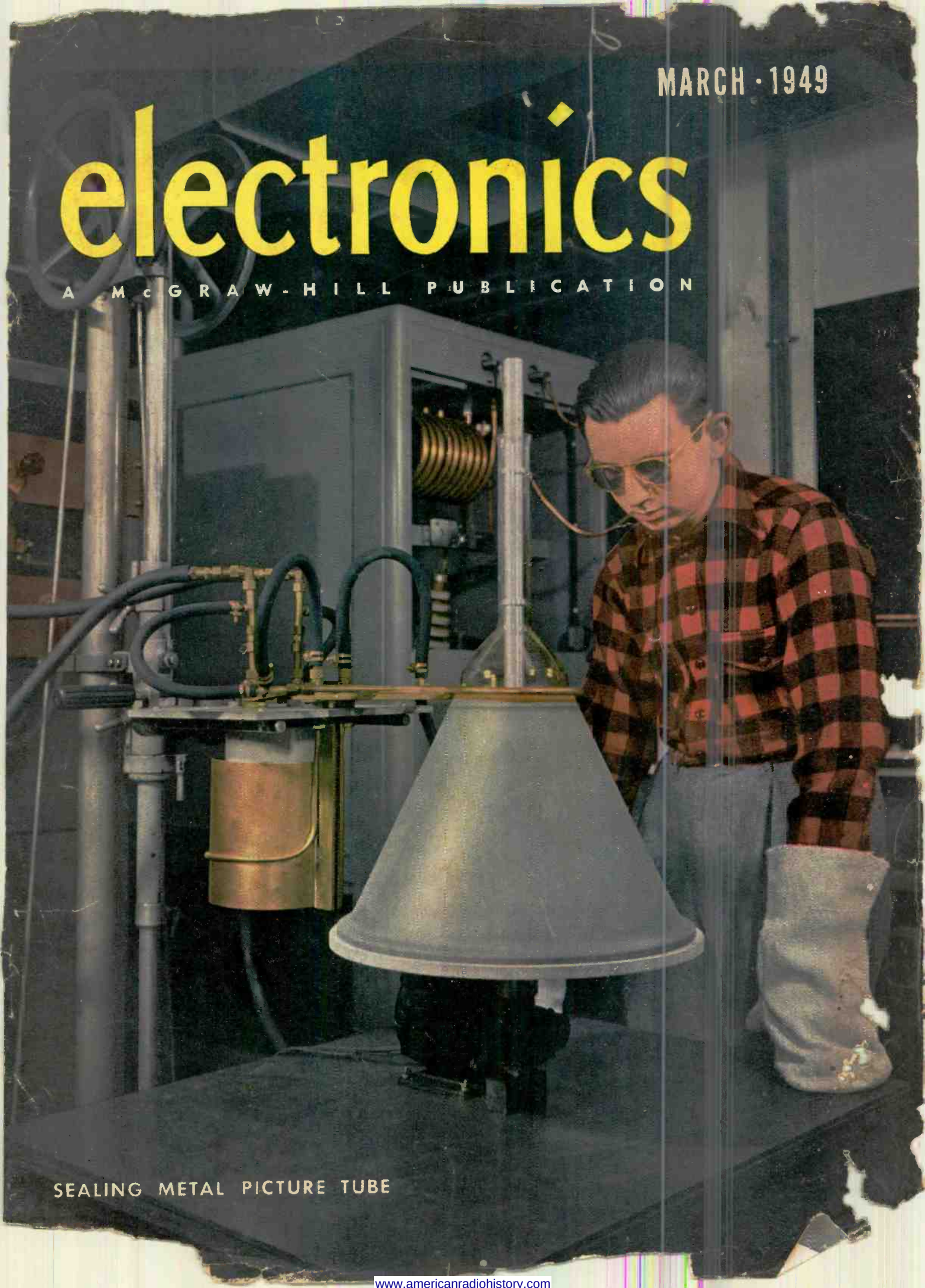
MARCH · 1949

electronics

A McGRAW-HILL PUBLICATION



SEALING METAL PICTURE TUBE

FOR HIPERM ALLOY TRANSFORMERS

The UTC Hiperm alloy audio transformers are specifically designed for portable and compact service. While light in weight and small in dimensions, neither dependability nor fidelity has been sacrificed. The frequency characteristic of the Hiperm alloy audio units is uniform from 30 to 20,000 cycles. These units are similar in general design and characteristics to the famous Linear Standard audio Series.

UTC Hiperm Alloy Transformers Feature

True Hum Balancing Coil Structure . . . maximum neutralization of stray fields.

Balanced Variable Impedance Line . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse couplings.

Reversible Maunting . . . permits above chassis or sub-chassis wiring.

Alloy Shields . . . maximum shielding from induction pick-up.

Multiple Coil, Semi-Toroidal Coil Structure minimum distributed capacity and leakage reactance.

High Fidelity . . . UTC Hiperm Alloy Transformers have a guaranteed uniform response of ±1.5DB from 20-20,000 cycles.

FOR IMMEDIATE DELIVER

From Your Distributor

Typical Curve for HA Series

Type No.	Application	Primary Impedance	Secondary Impedance	± 1 db from	Max. Level	Max Unbal. DC in primary	List Price
HA-100	Low impedance mike, pickup, or multiple line to grid.	50, 125, 200, 250, 333, 500 ohms	60,000 ohms in two sections	30–20,000	+22 DB	5 MA	$19.00
HA-100X	Same as above but with tri-alloy internal shield to effect very low hum pickup.						24.00
HA-101	Low impedance mike, pickup, or multiple line to push-pull grids.	50, 125, 200, 250, 333, 500 ohms	120,000 ohms overall, in two sections	30–20,000	+22 DB	5 MA	22.00
HA-101X	Same as above but with tri-alloy internal shield to effect very low hum pickup.						27.00
HA-108	Mixing, low impedance mike, pickup or multiple line.	50, 125, 200, 250, 333, 500 ohms	50, 125, 200, 250, 333, 500 ohms	30–20,000	+22 DB	5 MA	19.00
HA-106	Single plate to push-pull grids	8,000 to 15,000 ohms	135,000 ohms 1.5:1 ratio, each side	30–20,000	+22 DB	0	16.00
HA-113	Single plate to multiple line.	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	30–20,000	+22 DB	1 MA	18.00
HA-134	Push-pull 89's or 2A3's to line.	5,000 to 10,000 ohms	50, 125, 200, 250, 300, 500 ohms	30–20,000	+32 DB	5 MA	20.00
HA-135	Push-pull 2A3's to voice coil.	3,000 to 5,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	30–20,000	+32 DB	5 MA	19.00

The above listing includes only a few of the many Hiperm Alloy Transformers available . . . write for catalog.

United Transformer Co.

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

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

electronics

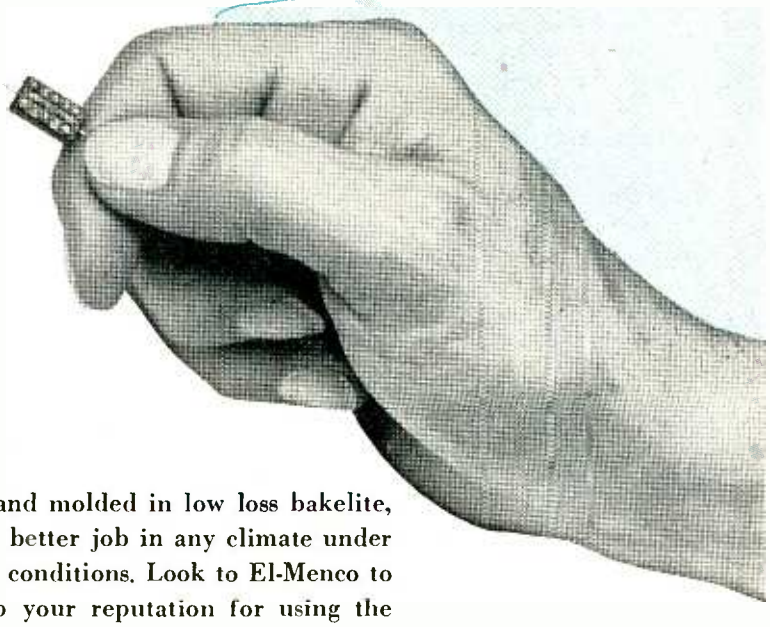
A McGRAW - HILL PUBLICATION

MARCH • 1949

James H. McGraw, Jr., President; Curtis W. McGraw, Vice-President and Treasurer; Eugene Duffield, Executive Assistant for Publications; Nelson Bond, Director of Advertising; James A. Gerardi, Secretary; and J. E. Blackburn, Jr., Director of Circulation.
ELECTRONICS, March, 1949, Vol. 22: No. 3. Published monthly, with an additional issue in June, price 75c a copy for U. S. and possessions, and Canada: $1.50 for Latin America: $2.00 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 two years, $12.00 for three years, Canada (Canadian funds accepted). $7.00 a year, $11.00 for two years, $14.00 for three years. Latin American countries $15.00 for one year, $25.00 for two years, $30.00 for three years. All other countries $20.00 for one year, $30.00 for two years, $40.00 for three years. Please indicate position and company connections on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

Smaller than your fingernail

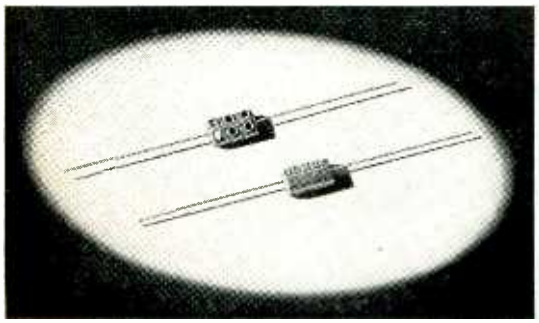
BUT SKY HIGH IN PERFORMANCE . . .



EL-MENCO CAPACITORS

One sure way to protect the performance of your radio, electrical and electronic equipment is to specify El-Menco fixed mica dielectric capacitors. These small-size, high capacity condensers not only meet Army and Navy JAN-C-5 specifications, but they are tested at *double* the working voltage.

All impregnated and molded in low loss bakelite, El-Menco Capacitors do a better job in any climate under the most severe operating conditions. Look to El-Menco to help you build and keep your reputation for using the superior components that make your electrical equipment superior.



NEW CM 15 MINIATURE CAPACITOR

THE ELECTRO MOTIVE MFG. CO., Inc.
WILLIMANTIC CONNECTICUT

Actual Size 1/32" x 1/2" x 3/16".
For Television, Radio and other Electronic Applications.
2 - 420 mmf. cap. at 500v DCA.
2 - 535 mmf. cap. at 300v DCA.
Temp. Co-efficient ±50 parts per million per degree C for most capacity values.
6-dot color coded.

Write on your firm letterhead for Catalog and Samples.

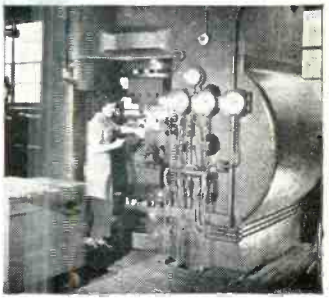
El-Menco

MOLDED MICA CAPACITORS **MICA TRIMMER**

Foreign Radio and Electronic Manufacturers communicate direct with our Export Dept. at Willimantic, Conn. for information.

ARCO ELECTRONICS, INC., 135 Liberty St., New York, N. Y. Sole agent for jobbers and distributors in U. S. and Canada.

For work that no other metals can do!



Fansteel controls every step in metallurgical processing beginning with the ore.

Fansteel
Tungsten and Molybdenum

Tungsten and Molybdenum are two of the most important refractory metals in electrical, electronic and mechanical industries. Their high melting points, low vapor pressure, resistance to arc erosion and great mechanical strength when combined with other metals intensify their values.

Both metals are used for electrical contacts, particularly in automotive ignition, vibrators, telegraph relays. They are components in the Fansteel Fastell® metals wherein their high resistance is combined with the electrical conductivity of silver or copper.

Heating elements in vacuum equipment—electric furnaces of temperatures 1600° C to 2000° C—on electrodes for inert gas welding and many other uses require Tungsten or Molybdenum.

Why not investigate Fansteel Metallurgy for better service and possibilities of economy in *your* problems? Fansteel Metallurgical Corporation, North Chicago, Illinois, U.S.A.

Tungsten and molybdenum ores are refined to pure metal powder by chemical operations. Powders are compacted to ingots in a powerful hydraulic press. (above). Ingots are sintered in hydrogen atmosphere furnaces by heavy electrical current. (lower picture). Intense heat causes the powder particles to fuse into a strong solid mass without melting.

PURE METALS

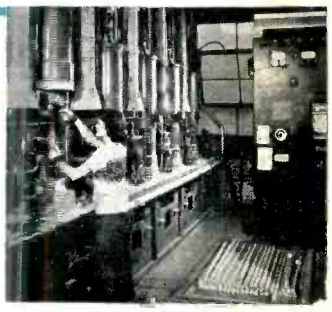
Tantalum, Tungsten, Molybdenum, and Columbium in sheet, rod, wire, special shapes and parts.

POWDER METALLURGY PRODUCTS

Finished or semi-finished shapes and parts of special analysis to achieve high strength, density, electrical conductivity, resistance to wear, impact, heat erosion, or combinations of these and other properties.

COPPER BASE ALLOYS

Copper alloyed with other elements, to combine high conductivity with strength, elasticity, resistance to heat, impact, or wear. Available in bars, rod, sheet, strip, castings, forgings, finished or semi-finished parts, for current-carrying springs and other parts, soldering tips, resistance welding electrodes, dies and fixtures.



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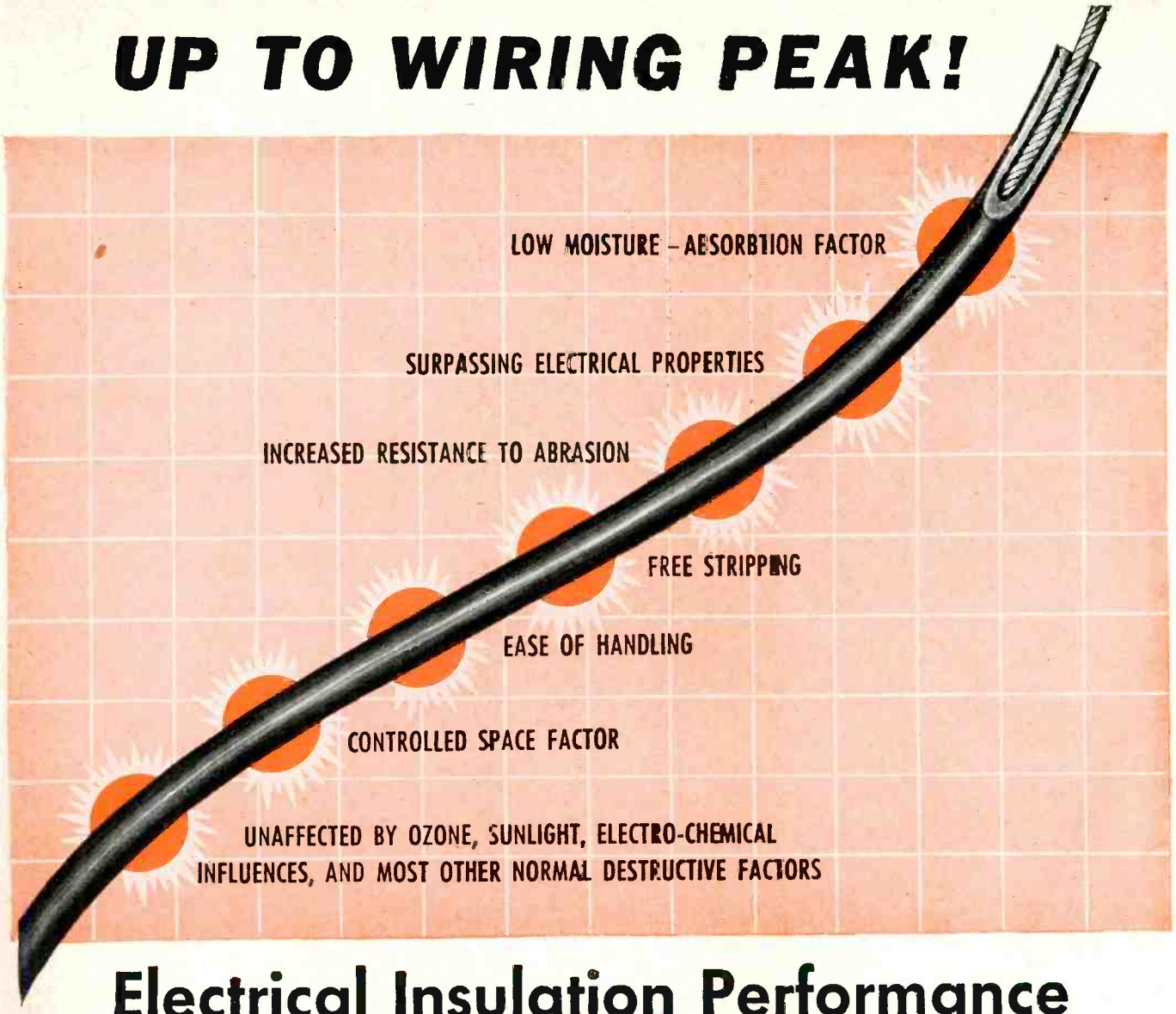
Fansteel

SPECIAL PRODUCTS *In Controlled Metallurgy*

UP TO WIRING PEAK!



Electrical Insulation Performance takes a *JUMP!* with new

TURBOTHERM PLASTIC INSULATED WIRE

Beyond which TURBOTHERM Insulated Wire, available with solid or stranded copper conductor, offers a flexible, assembly-facilitating process. This means production-time economy right at your own line and bench-manufacturing points. Your requirements of insulated wire within the gauge range of No. 14 down to No. 30 can be most advantageously served by TURBOTHERM. Ask for samples and become convinced.

Underwriters Laboratories Approved for 80 degree C. Appliance, Radio Hook-up and Instrument Wire; T. F. and T. F. F. for decorative wall brackets and candlelabra lighting fixtures, and small electrical tools and controls, where operation in oil at 60 deg C. is a requisite.

WILLIAM BRAND & COMPANY

276 FOURTH AVENUE, NEW YORK 10, N. Y.— 325 W. HURON STREET, CHICAGO 10, ILL.

OIL TUBING • SATURATED SLEEVING • VARNISHED CAMBRIC • PAPER AND TAPE • MICA AND MICA PRODUCTS

Top quality power tubes for more than 25 years

BROADCAST engineers from coast to coast have learned through the years to depend on Western Electric tubes for long life and top quality performance.

Included in Western Electric's line are power tubes and rectifiers for stations of every power, AM and FM. Designed by Bell Telephone Laboratories, these tubes are now manufactured for Western Electric by Machlett Laboratories, Inc., another pioneer in the development of electron tubes.

For full information on Western Electric tubes to meet your station's needs, call your local Graybar Representative—or write Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y.

Western Electric transmitting tubes will be on display at the I. R. E. Convention.

—QUALITY COUNTS—

Western Electric

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BILLIONTH

SPRAGUE CAPACITOR

Early this year the one-billionth Sprague Capacitor rolled off the fast-moving production lines in North Adams.

Fittingly enough, this billionth unit was one of the revolutionary new molded paper tubulars. Throughout the years, it has been engineering progress as typified by this development that has enabled Sprague to attain its present position as one of the largest, most diversified and most dependable sources of capacitor supply.

Other important developments which have helped materially in swelling the total of Sprague production include *Vitamin Q capacitors for higher voltages, higher temperatures and higher insulation resistance; *Hypass 3-terminal networks; glass-to-metal sealed capacitors; molded *Prokar capacitors for sub-miniature assemblies; high-voltage coupling capacitors; electrolytics for dependable operation up to 450 volts at 85°C., and many other types of capacitors.

*T. M. Reg. U. S. Pat. Off.

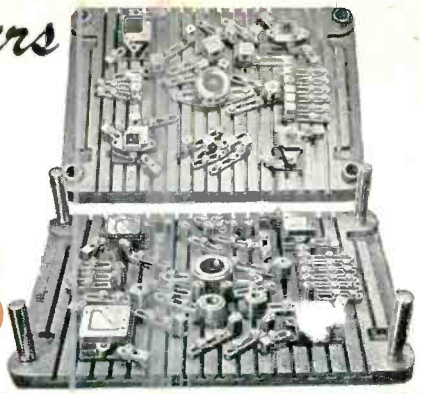
SPRAGUE

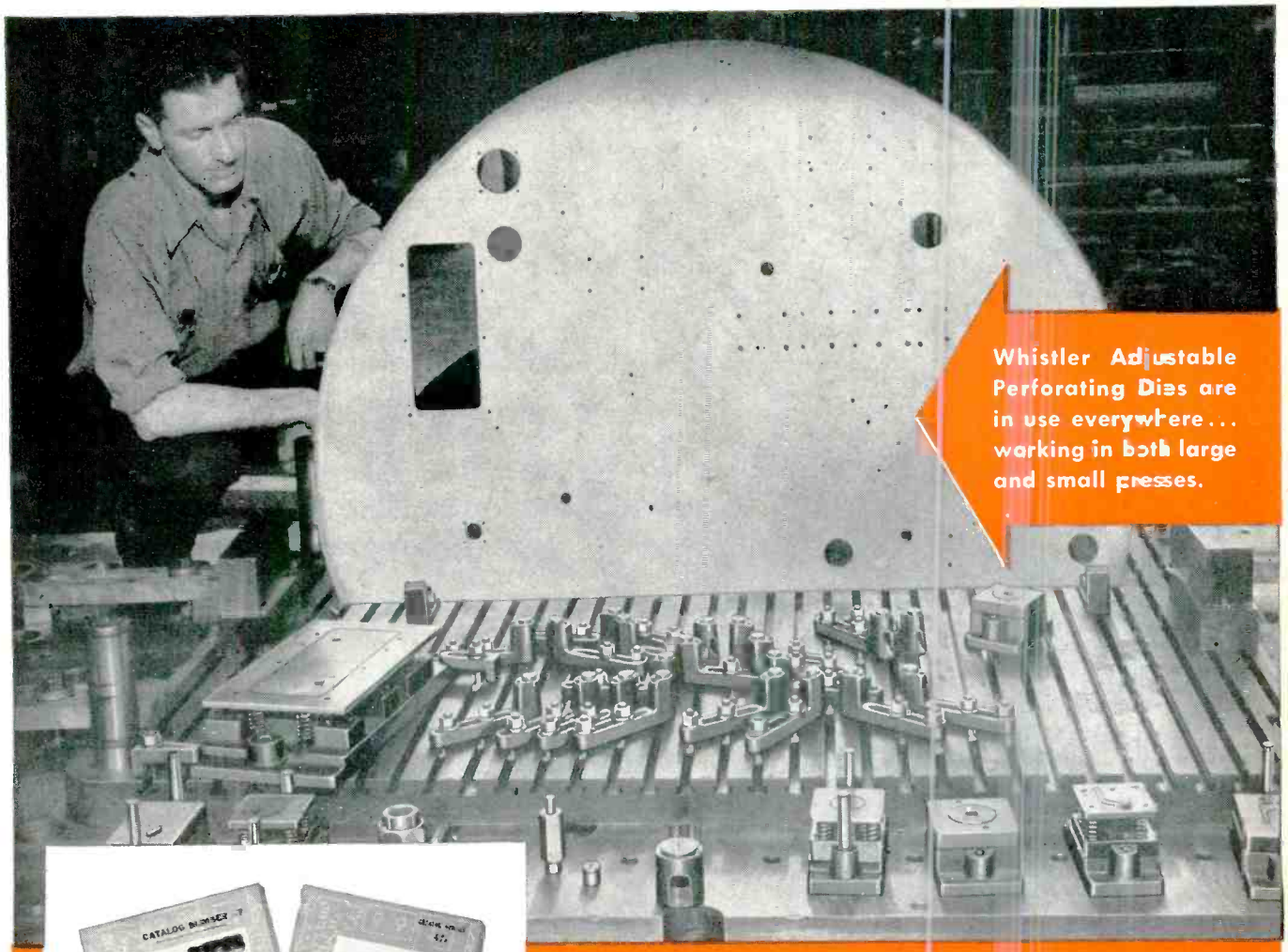
Pioneers of Electric and Electronic Progress

SPRAGUE ELECTRIC COMPANY • North Adams, Mass.

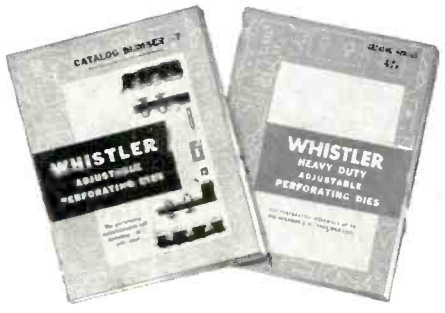
Get into Production in a few hours

with **WHISTLER ADJUSTABLE DIES**





Whistler Adjustable Perforating Dies are in use everywhere... working in both large and small presses.



There are plenty of other advantages in using Whistler Adjustable Dies. It makes sense to get the complete story. And it's easy to do. Write for your Whistler Catalogs today.

Whistler perforating dies now offer a double-barreled advantage in getting into production faster. Standard sizes of round hole punches and dies...1/32 to 3"...can be shipped promptly. Special shapes...squares, ovals, rectangles, group and notching dies, are quickly made to order.

Equally important, set-ups are simple...take only a short time. Same units can be rearranged or units added in setting up different jobs. Production is thus speeded while die costs are amortized through continued re-use.

No special tools are needed. All parts are interchangeable. The heavy duty series of punches and dies easily pierce materials up to 1/4" mild steel.

S. B. WHISTLER & SONS, Inc.

742 MILITARY ROAD, BUFFALO 17, NEW YORK

Heat dissipation can be

for resistors

Heat dissipation can be mighty tough . . . but not for IRC resistors. They are universally engineered for the lowest possible operating temperatures and maximum power dissipation within the smallest size units consistent with good engineering practice.

Long experience with the widest line of resistor types in the industry has provided IRC with a wealth of "know-how" on resistor heat dissipation. In Power Wire Wound Resistors for example, the complete range of tubular and flat types manufactured by IRC utilizes a special cement coating to attain rapid heat dissipation. This dark rough surface does double duty by effectively guarding the windings against harmful atmospheric moisture and corrosion. Use the handy coupon to get complete data on proven advantages of IRC Power Wire Wounds.

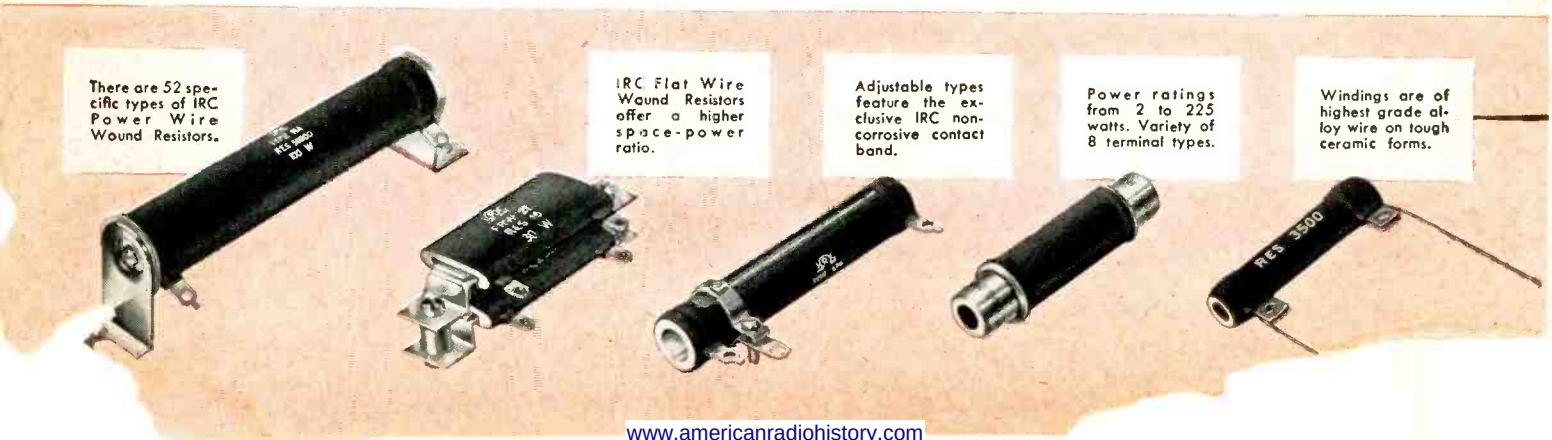
There are 52 specific types of IRC Power Wire Wound Resistors.

IRC Flat Wire Wound Resistors offer a higher space-power ratio.

Adjustable types feature the exclusive IRC non-corrosive contact band.

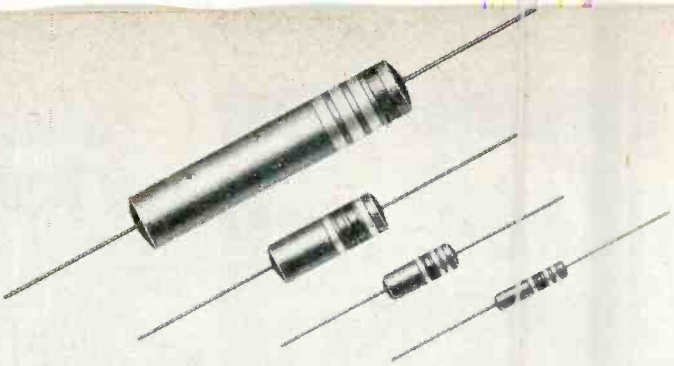
Power ratings from 2 to 225 watts. Variety of 8 terminal types.

Windings are of highest grade alloy wire on tough ceramic forms.

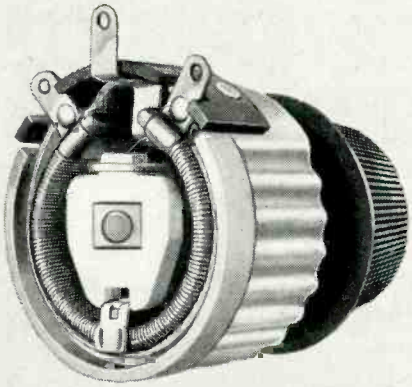


tough

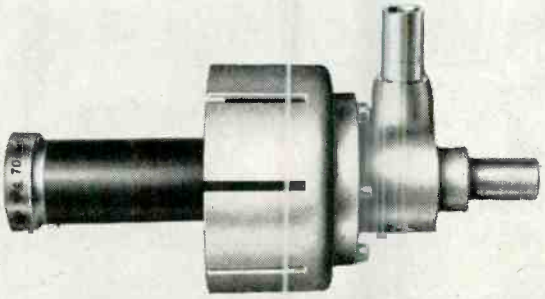
too!



New, ADVANCED BT Resistors obsolete present performance standards for fixed composition resistors. Extremely low operating temperature and excellent power dissipation in compact, light weight fully insulated units at 1/3, 1/2, 1 and 2 watts. These ADVANCED resistors meet JAN-R-11 specifications. All the facts are included in 12-page technical data bulletin B-1.



Heat dissipation properties of aluminum are used to full advantage in housing and winding core of IRC Power Rheostats, 25 and 50 watts. Type PR Rheostats operate at full rating at about half temperature rise of equivalent units. Can be operated at full power in as low as 25% of rotation without appreciable difference in temperature rise. Direct contact between rheostat and mounting panel allows rapid conduction to panel of a portion of heat dissipated. Send for Bulletin E-2.



Water-cooled LP Resistors utilize high velocity water stream flowing in spiral path against thin resistance film. High power dissipation is made possible by centrifugal force holding water in thermal contact with resistance surface. Resistance film less than 0.001" thick with active length much less than 1/4 wave length at FM and television frequencies, gives excellent frequency characteristics. Resistance values 35 to 1500 ohms; 15% tolerance standard; power dissipation up to 5 K.W. ac. Bulletin L-2 gives all the facts.

If you have the heat put to you for speedy service on small order resistor requirements for experimental work, pilot runs, etc., you'll appreciate the advantages of IRC's Industrial Service Plan. This enables you to get 'round-the-corner service from the local stocks of your IRC Distributor. He's a good man to know . . . we'll gladly send you his name and address.

IRC

Wherever the Circuit Says —WW—

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

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INTERNATIONAL RESISTANCE COMPANY
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Send me additional data on items checked below:

☐ Power Wire Wounds (tubular) ☐ Flat Power Wire Wounds
☐ Advanced BT Resistors ☐ Power Rheostats ☐ Water-Cooled Resistors
☐ Name and address of our local IRC Distributor

NAME.....

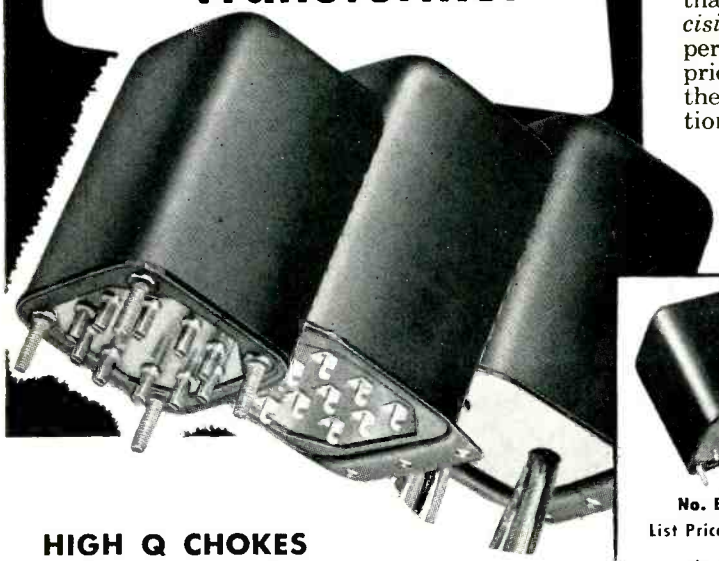
TITLE.....

COMPANY.....

ADDRESS.....

.....

CHICAGO... The Engineer's Transformer



Famous "Sealed in Steel" New Equipment Line

Chicago Transformer's New Equipment Line offers transformer engineering *ahead* of the trends in circuit design. It's the Transformer Line preferred by experts in the P.A., ham, communication and experimental fields, and by broadcast stations and manufacturers.

Check these features—*drawn steel cases* to provide compact, streamlined mounting; *conservative ratings* that meet all RMA and FCC recommendations; *precision characteristics* for stable, uniformly excellent performance—these, and many others. Check the prices—and you'll learn how little more these advanced units cost over conventional transformers.

Typical of the New Equipment Line are the outstanding audio transformers listed below. Get full details on the complete line—write for descriptive catalog today.

No. BO-6
List Price $23.00

Response within .2db, 30 to 20,000 cycles

New Full Frequency Range Output Transformer

No. BO-6. For use in high fidelity amplifiers. Couples push-pull 6L6's (7500 ohms, C-T) to 6/8 or 16/20-ohm voice coil. Center-tapped tertiary winding provides 15% inverse feedback to reduce harmonic distortion to a minimum. In drawn steel case, $4\frac{5}{16}$" x $3\frac{7}{8}$" x $3\frac{11}{16}$", with mounting studs and pin-type terminals.

There's a CHICAGO OUTPUT TRANSFORMER For Every Full Frequency Use

Cat. No.	Application	Impedance	Max. Power	List
BO-1	Single Plate to Line	Pri.—15,000 ohms at 0 to 10 ma d-c *Sec.—600/150 ohms CT	+20 dbm	$13.00
BO-2	P.P. Plates to Line	*Pri.—20,000 ohms CT *Sec.—600/150 ohms CT	+30 dbm	19.00
BO-3	P.P. Plates to Line	Pri.—5,000 ohms CT *Sec.—600/150 ohms CT	+40 dbm	17.00
‡BO-4	P.P. Plates to Line	Pri.—7,500 ohms CT *Sec.—600/150 ohms CT	+43 dbm	18.00
BO-5	P.P. Plates to Line	Pri.—10,000 ohms CT *Sec.—600/150 ohms CT; 16/8/4 ohms	+37 dbm	24.00

‡Tertiary winding provides 15% inverse feedback. *Split and balanced windings.

HIGH Q CHOKES

for Dynamic Noise Suppression Circuits

Two precision-built chokes with inductance values of .8 and 2.4 henrys respectively—accurate to within ± 5% with up to 15 ma d-c. Units have a minimum Q of 20. Exceptionally compact, $1\frac{11}{16}$" x $2\frac{3}{8}$" x $1\frac{7}{16}$".

No.	Inductance	List
NSI-1	.8 h	$10.00
NSI-2	2.4 h	10.00

Write for literature

Television Transformers *to fit today's leading TV circuits*

Because Chicago Transformer is the largest single supplier of transformers to the Television industry, you gain the advantages of "Original Equipment" components when you buy Chicago TV Transformers. Available now, the three units described here are part of a complete new line, soon to be announced.

Vertical Blocking Oscillator Transformer No. TBO-1. 60-cycle unit for creating the vertical sweep "saw-tooth" voltages required in conventional circuits.

Pri. Inductance: 1.15 hy ± 20% at 3 v., 1000 cycles
Pri. Leakage Inductance: 8 mh + 25%, −15%
Ratio, Primary to Secondary: 1 to 4.2

Exact equivalent to R. C. A. Part No. 20872. List Price, **$3.10**

TV Power Transformer No. TP-365. Designed to supply 405 volts d-c with two 5U4G's to an 80 mfd condenser input. Copper shorting band around core reduces external magnetic field; cuts image distortion to a minimum.

Pri.: 115 v., 60 cycles
H.V. Sec.: 362-0-362 v., a-c, .295 amps d-c
Fil. No. 1: 12.6 v., 5 amps, C-T
Fil. No. 2: 5 v., 2 amps
Fil. No. 3: 5 v., 6 amps

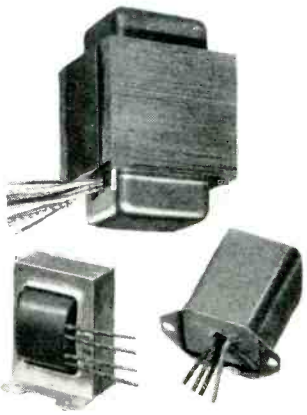
Exact equivalent to R. C. A. Part No. 20176. List Price, **$26.00**

Vertical Scanning Output Transformer No. TSO-1. Couples vertical output tubes to picture tube deflection yoke.

Pri. Impedance: 19,000 ohms at 30 v., 60 cycles, 13 ma d-c
Ratio, Primary to Secondary: 10 to 1

Exact equivalent to R. C. A. Part No. 20472. List Price, **$5.90**

Write for Descriptive Literature



CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET • CHICAGO 18, ILLINOIS

TRADE MARK REG.

Millions of nationally-known receivers produced annually are equipped with Chicago Transformers

800 ohms/cmf

Temp. Coeff. of Resistance: ± 0.00002 max. from −50°c to +100°c

Karma

the improved electrical resistance alloy!

Higher Ohmage makes possible Smaller Resistors—Increased Savings

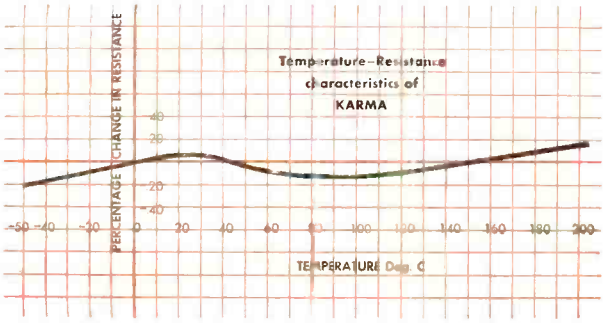
Compared with Manganin and Constanta (Advance*), the copper-base alloys widely used for high accuracy wire-wound resistors, the electrical resistivity of Karma* is exceptional — 800 ohms per circular mil foot, at 20°C, it is more than 2.7 times greater. Now you can wind even smaller precision resistors at still lower cost per ohm.

More Stable Resistance permits Wider Applications—at Wider Temperature Ranges

The comparably Low Temperature Coefficient of Resistance of Karma remains constant over a very much wider temperature range than that of Manganin or Constantan (Advance*). The "useful range" of Karma is more than 8 times that of Manganin and 4 times that of Constantan (Advance*). Karma, therefore, is especially adapted for service in precision resistors that are subjected to severe changes in temperature.

Low Thermal EMF Value against Copper assures Extreme Accuracy

In cases where error due to voltage generated by thermal EMF against copper must be confined to negligible proportions, Manganin has long been accepted as ideal for resistor windings. The thermal EMF value for Karma against copper is equal to that of Manganin itself!



High Resistance to Oxidation prolongs Electrical Properties

The superior surface oxidation resistance of Karma, essentially a nickel chromium alloy, enables it to retain its fine electrical properties longer than the copper-base alloys Manganin and Constantan (Advance*).

Higher Tensile Strength permits Faster Winding Speeds — saves Production Time

In addition to its outstanding electrical qualities, Karma affords physical advantages over the commonly accepted alloys. Its higher tensile strength permits faster winding speeds; its lower thermal expansion minimizes distortion and movement in windings.

In a word, this urgently needed Driver-Harris alloy offers *plus values all along the line*. Ask us about it. We shall be glad to supply you with complete data.

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

KARMA* 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

*T.M. Reg.U.S.Pat.Off. *Formerly D-H experimental alloy #[illegible]

You've got to be ready for Microgroove!

MICROGROOVE long-playing recordings are here to stay. This means that every broadcast station and recording studio must have quality equipment, especially for microgroove reproduction.

The new PRESTO type 153 reproducers include two separate Pickering diamond stylus heads for microgroove or regular recording, an exceptionally fine arm, and a 4-position compensating network.

Durability of equipment, fine performance, and economical first cost make these PRESTO reproducers ideal for microgroove and also for lateral standard recordings.

Write today for full specifications on the PRESTO 153M for microgroove recordings and 153R for regular recordings. Your nearest PRESTO distributor can show you the equipment.

FOR HIGHEST FIDELITY . . . IT'S PRESTO DISCS

Microgroove, even more than regular 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

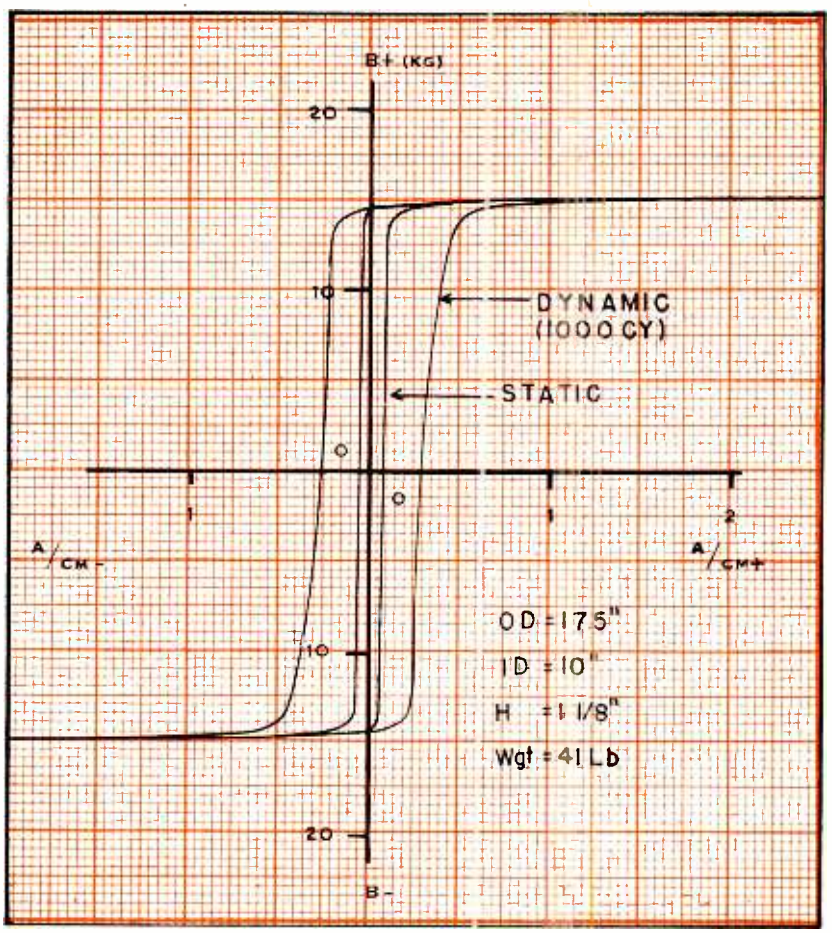
Paramus, New Jersey

Be ready for Microgroove!

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



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

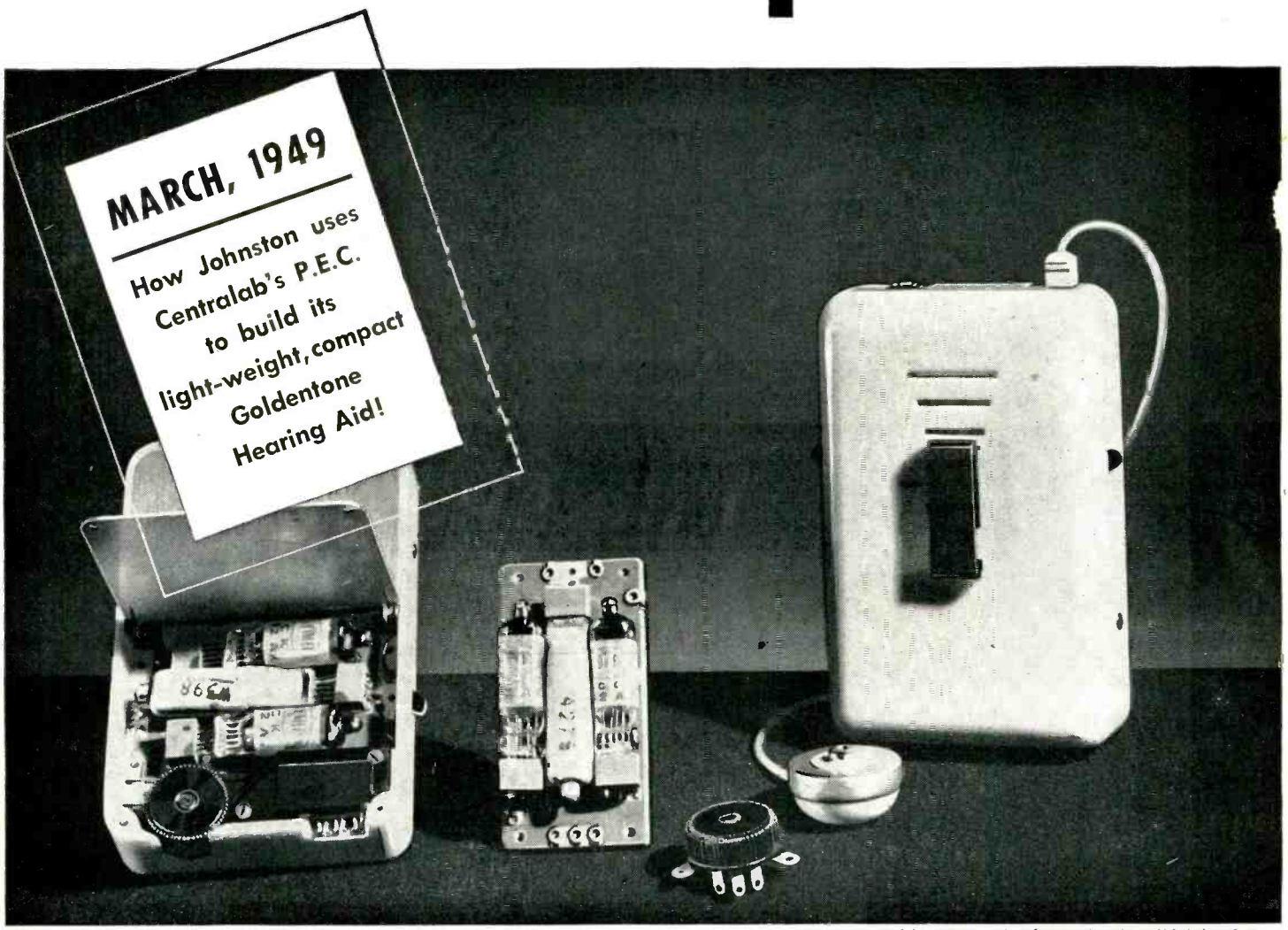
THE LEADER IN TECHNICAL EXCELLENCE

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

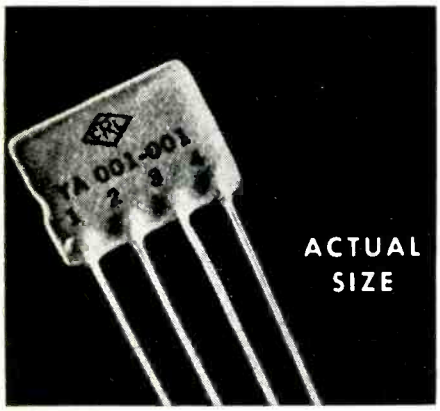
SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • RESISTORS • SPECIAL PRODUCTS

Centralab reports to

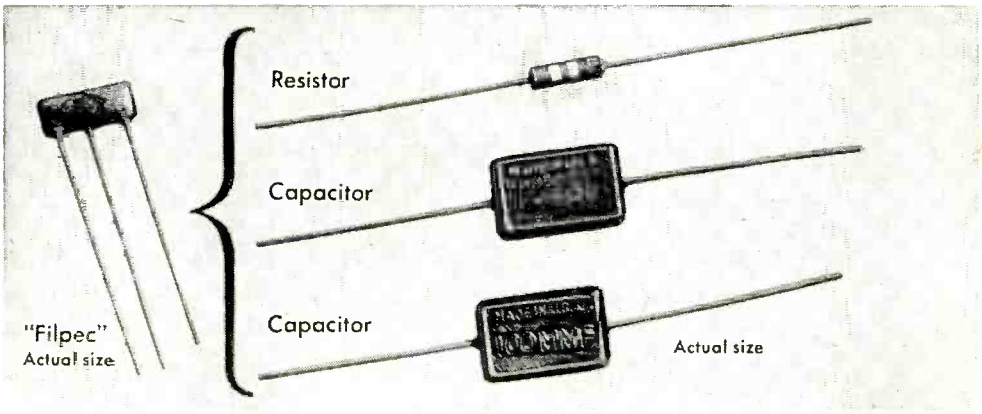


Models courtesy of Johnston Hearing Aid Mfg. Co.

1 Customer comfort . . . greater output . . . dependable performance. That's what Johnston wanted for its new Goldentone Hearing Aid. And that's what it got — with the help of Centralab's amazing P.E.C. Yes, *Ampec* — a complete three-stage audio amplifier — made it possible to save space and material by reducing the number of components needed. It cut production time by eliminating many assembling operations. It improved performance. For *Ampec* facts, see Bulletin 973.

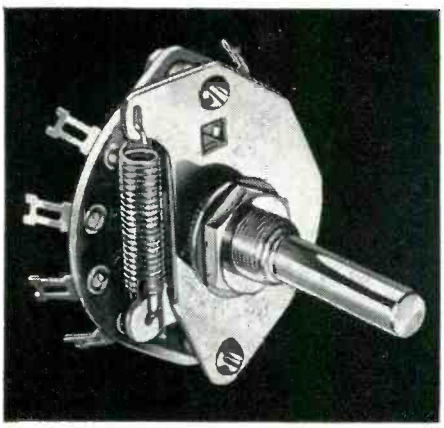


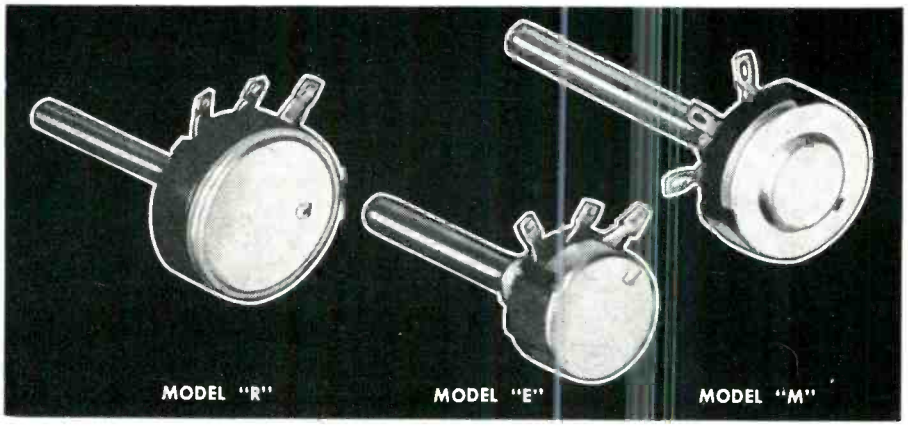
2 CRL's *Couplate* consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 42-6.



3 Centralab's *Filpec* is designed for use as a balanced diode load filter, combines up to three major components into one tiny unit, lighter and smaller than one ordinary capacitor. Capacitor values available from 50 to 200 mf. Resistor values from 5 ohms to 5 megohms. For complete information, write for Bulletin 42-9.

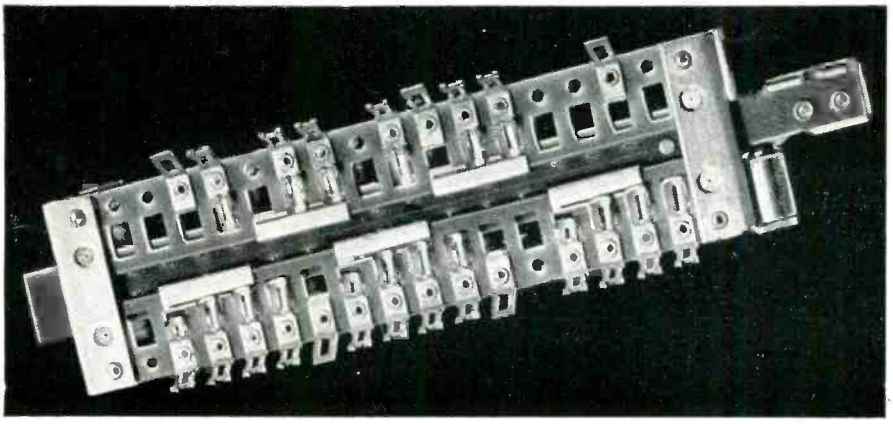
Electronic Industry

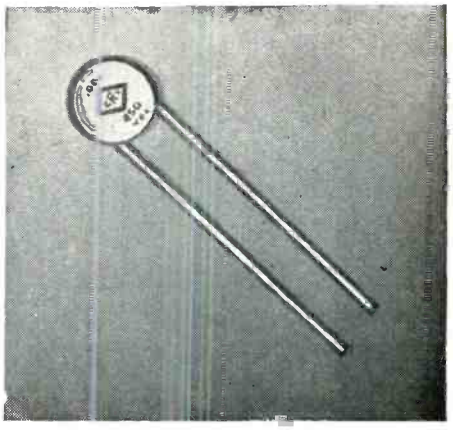




4 Great step forward in switching is CRL's New *Rotary Coil and Cam Index Switch.* Its coil spring gives you smoother action, longer life.

5 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, ¼ watt. Direct contact, 6 resistance tapers. *Model "M"*—composition type, ½ watt. For complete information, write for Bulletin 697.





6 Centralab's development of a revolutionary, new *Slide Switch* promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

7 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.

Be sure to visit Booths 234-235 at the I.R.E. National Convention March 7-10 New York City

NEW WESTON

MODEL 901 SERIES
A-C AND D-C PORTABLES

the modern concept

in **READABILITY . . .**

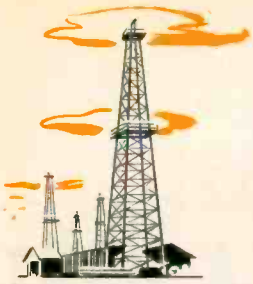
in **SHIELDING!**

Designed . . . and styled . . . to bring you Weston's concept of the finest general purpose portables ever produced! These instruments are offered with full assurance that their dependability will reflect credit upon the name they bear. Write for Circular A-22-A. Weston Electrical Instrument Corp., 618 Frelinghuysen Ave., Newark 5, N. J.

WESTON
INSTRUMENTS

Albany • Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Jacksonville • Knoxville • Little Rock • Los Angeles • Meriden • Minneapolis • Newark New Orleans • New York • Orlando • Philadelphia • Phoenix • Pittsburgh • Rochester • San Francisco • Seattle • St. Louis • Syracuse • Tulsa • In Canada, Northern Electric Co., Ltd., Powerlite Devices, Ltd.

Plastics where plastics belong

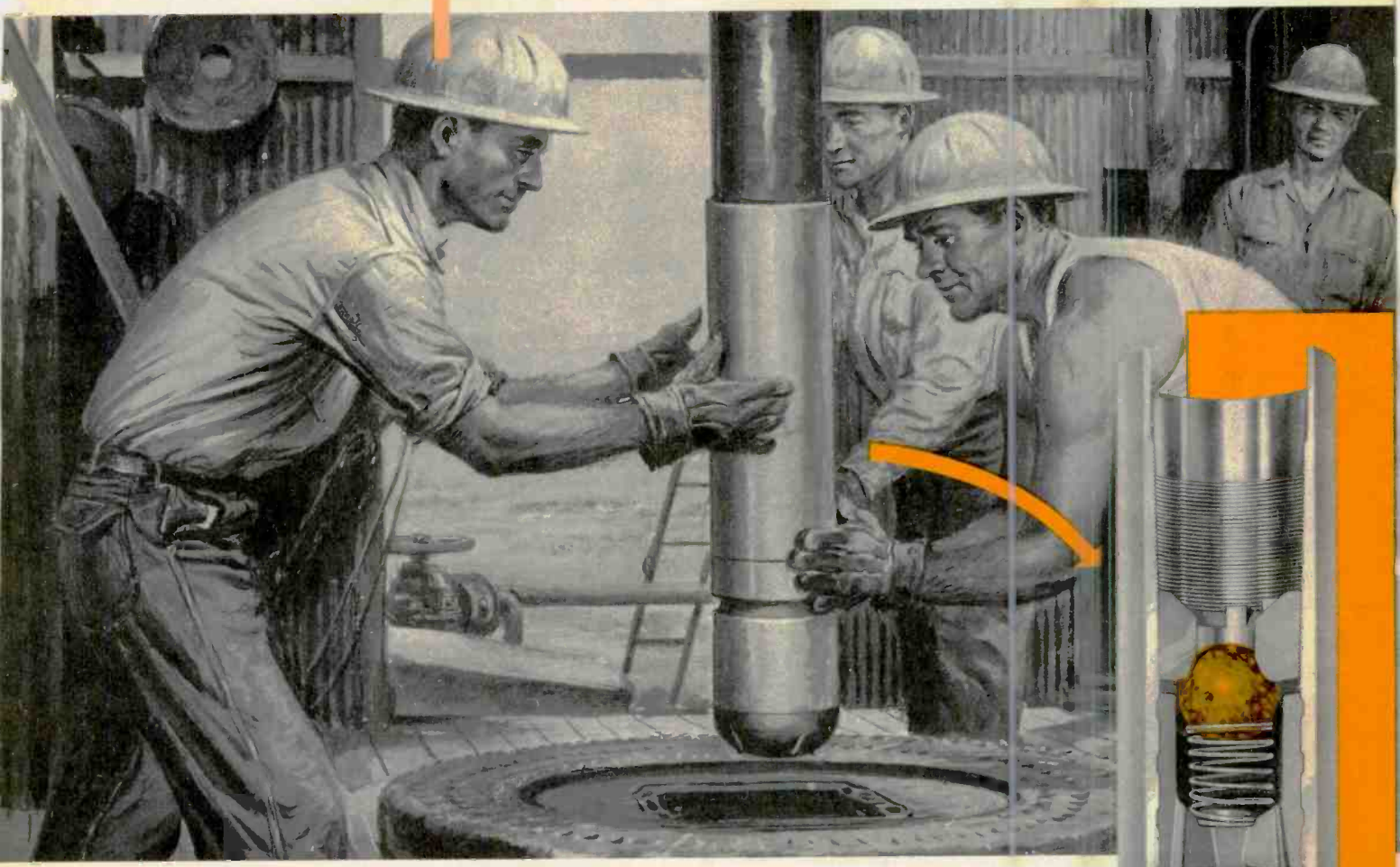


for strength, wear resistance, and ease of machining . . .

Structural strength, wear resistance, and ease of machining are three of Synthane's many properties which, in combination with its other mechanical, chemical and electrical characteristics make it one of industry's valuable materials.

A good electrical insulator, Synthane, the set plastic, is stable over a wide range of temperatures. Hard, dense and durable, it also possesses desirable moisture and corrosion-resistant qualities.

The ability of Synthane to stand up under adverse conditions is interestingly demonstrated by its use in the Turbo-Jet Float Shoe.



Various parts of Float Shoes, used in cementing oil wells, are fabricated from Synthane, for example, the valve ball and thrust plate in the shoe illustrated at the right.

Synthane resists the abrasive action of the liquid cement pumped through the shoe. It is thermosetting, so that it retains its original size and shape, yet is easily drilled out after the cement has set. Thus, Synthane's combination of strength, wear resistance, stability and ease of machining make it a perfect material for this difficult job.

If this brief review of Synthane's unique combination of desirable properties suggests its use in your product, let us help you with design, materials or fabricated parts. Write today for the new Synthane Plastics Catalog, 6 River Road, Oaks, Pennsylvania.

SYNTHANE

where Synthane belongs

SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-LAMINATED • MOLDED-MACERATED

PORTRAIT OF A HUNTER

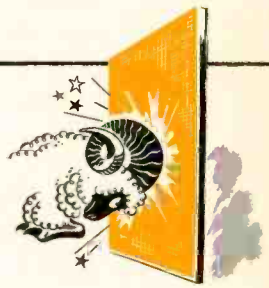
If you are always hunting for a better material, one which combines many valuable physical, chemical and electrical characteristics—consider Synthane laminated plastics.

Synthane has a place in almost every industry because its unusual *combination* of desirable properties can often make a good product or process better.

On a weight-for-strength basis Synthane compares favorably with many metals. It is durable, lightweight, high in tensile, compressive and flexural strengths.

Synthane resists corrosive atmospheres, moisture, oils and solvents. Synthane is also the set plastic, stable over a wide range of temperatures.

Synthane is an excellent insulator —with high dielectric strength, low power factor and low dielectric constant. The ease with which it may be machined adds to its value for practical applications.



Hard and dense, Synthane resists fatigue under repeated impact. Withstands abrasion, does not splinter.

If these properties of Synthane suggest its possible use in your product, let us work with you on materials or fabricated parts. Send Coupon for your copy of the Synthane Plastics Catalog . . . no obligation of course.

..FOR MORE ANSWERS ON PLASTICS..

SYNTHANE CORPORATION, 6 RIVER ROAD, OAKS, PA.

Gentlemen:

Please send me without obligation a complete catalog of Synthane technical plastics.

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*Company*_____

*Address*_____

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

SYNTHANE

DESIGN • MATERIALS • FABRICATION • SHEETS RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED-

LOW CURRENT PAYS OFF...

with the GENERAL ELECTRIC PM-EM* FOCUS COIL!

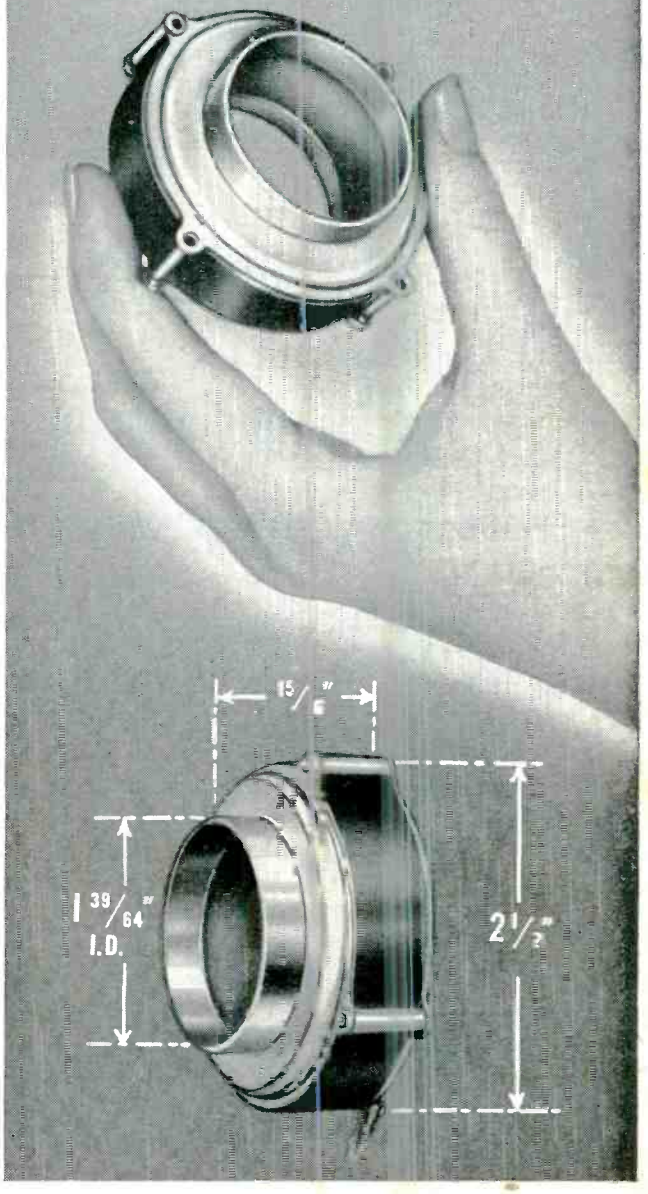
PERFORMANCE-ENGINEERED at Electronics Park, the General Electric Focus Coil is now being used by many leading television manufacturers. The reason for this widespread adoption of the G-E Focus Coil by design engineers is best explained by the following equation:

$$P_{EM} = I^2R = .109^2 \times 247 = 2.93 \text{ watts}$$
$$P_{EM-PM} = {}^2R = .029^2 \times 960 = 0.81 \text{ watts}$$
$$\text{Power Saving} = 2.12 \text{ watts}$$

In addition to its low current requirements (which permit the use of lower-priced power supplies) the G-E focus coil is small, compact and light in weight. These features provide additional space which TV set designers can use to advantage.

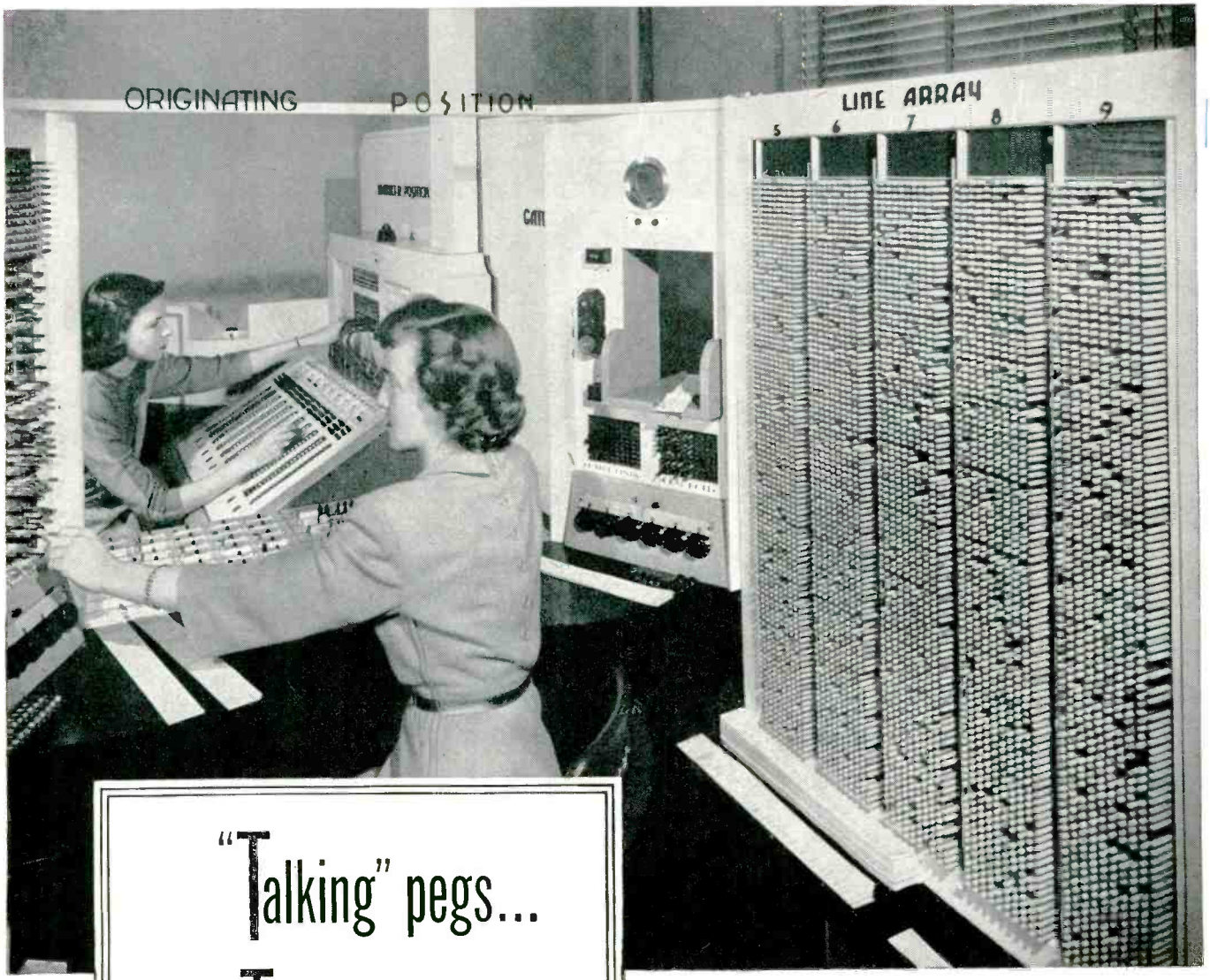
For complete information on the G-E Focus Coil and other television components, write: *General Electric Company, Electronics Park, Syracuse, New York.*

**Permanent Magnet—Electro-Magnet.*



You can put your confidence in—

GENERAL ELECTRIC



"Talking" pegs... and Talking people

THERE ARE 10,000 pegs in this machine, representing 10,000 subscribers in a crossbar telephone exchange—the latest switching system which handles dial calls with split-second swiftness.

The pegs represent many types of telephone users—two-minute talkers and ten-minute talkers . . . people who dial accurately . . . those who make a false start or two. They are starting a journey through a unique machine which analyzes the performance of dial equipment in a typical central office.

But while an actual crossbar exchange connects your call in a matter of seconds, this counterpart moves far more slowly. It gives the Bell Laboratories engineers who built it time to observe what happens to each call—where bottlenecks develop, which parts are overworked or underworked, which of the circuits are most used.

In a manual exchange, the number of operators may be changed to meet different traffic conditions. In crossbar, all switching is done by complex electromechanical devices, permanently built in. This machine shows how many devices of each kind there must be in a new exchange to give you the best of service with a minimum of expensive equipment.

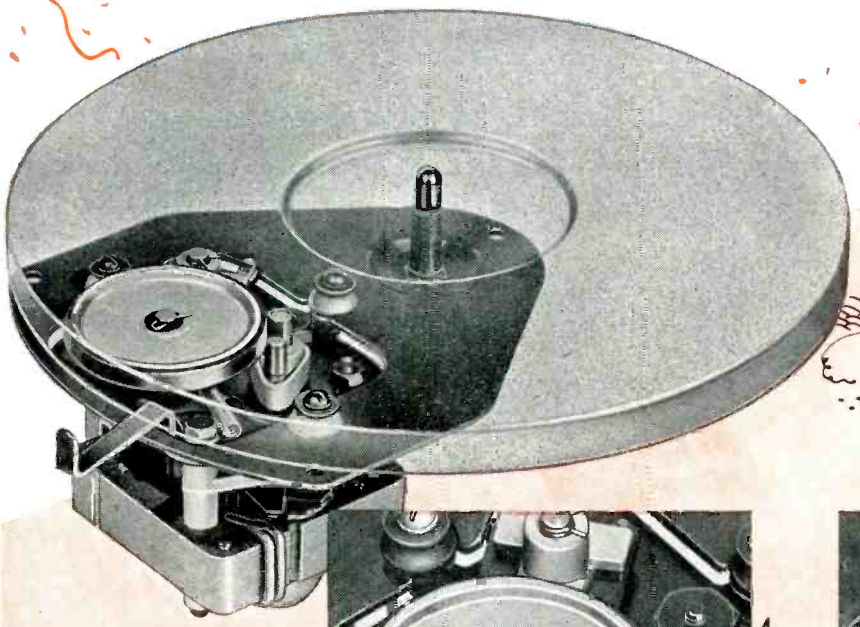
This traffic-study machine is one of the many ingenious research tools devised by the Laboratories as part of its continuing job—finding new ways to give you better and better telephone service.

BELL TELEPHONE LABORATORIES

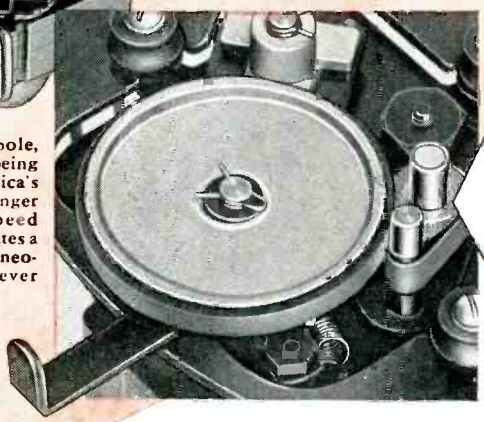
EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

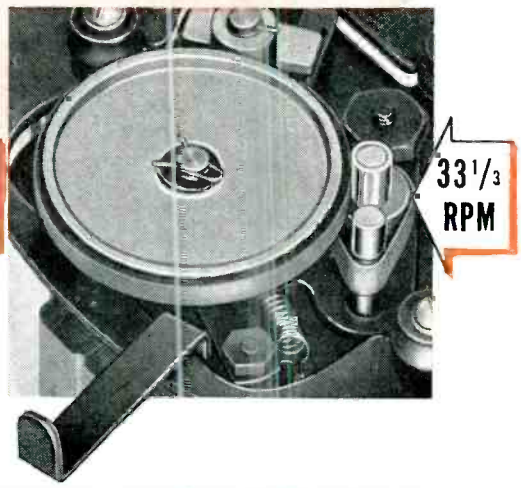
GENERAL INDUSTRIES

leads the L.P. Parade...



MODEL DM—Compact 2 pole, shaded pole motor, already being widely used by many of America's leading radio and record-changer manufacturers. Simple speed change mechanism incorporates a special long-lasting molded neoprene belt. Speed change lever extends beyond turntable rim





with a low cost, rim drive DUAL SPEED PHONOMOTOR

FOR BOTH 33⅓ AND 78 R.P.M. RECORDS

It's L.P. for *Larger Profits* when your record-changers and record-players will handle both the new long-playing microgroove and conventional 78 R.P.M. records. And it's General Industries—oldest name in the phonomotor field—which offers you an economical turntable unit to capture this popular, profitable market.

Like all GI Smooth Power products, this motor has undergone tests far more rigid than service conditions encountered in normal use. It is the result of years of research and development . . . built to exacting performance standards, but surprisingly low in cost.

General Industries offers prompt delivery of this motor in quantity lot shipments. For additional information, specifications and quotations, write *today.*

In addition to the Model DM, General Industries also manufactures a Model DR rim drive dual speed phonomotor. It is a heavy-duty 4-pole shaded pole motor for use where the ultimate in performance is desired. Novel speed change mechanism is both simple and positive in operation.

The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO

For Negative Resistance-Voltage Characteristics

GLOBAR

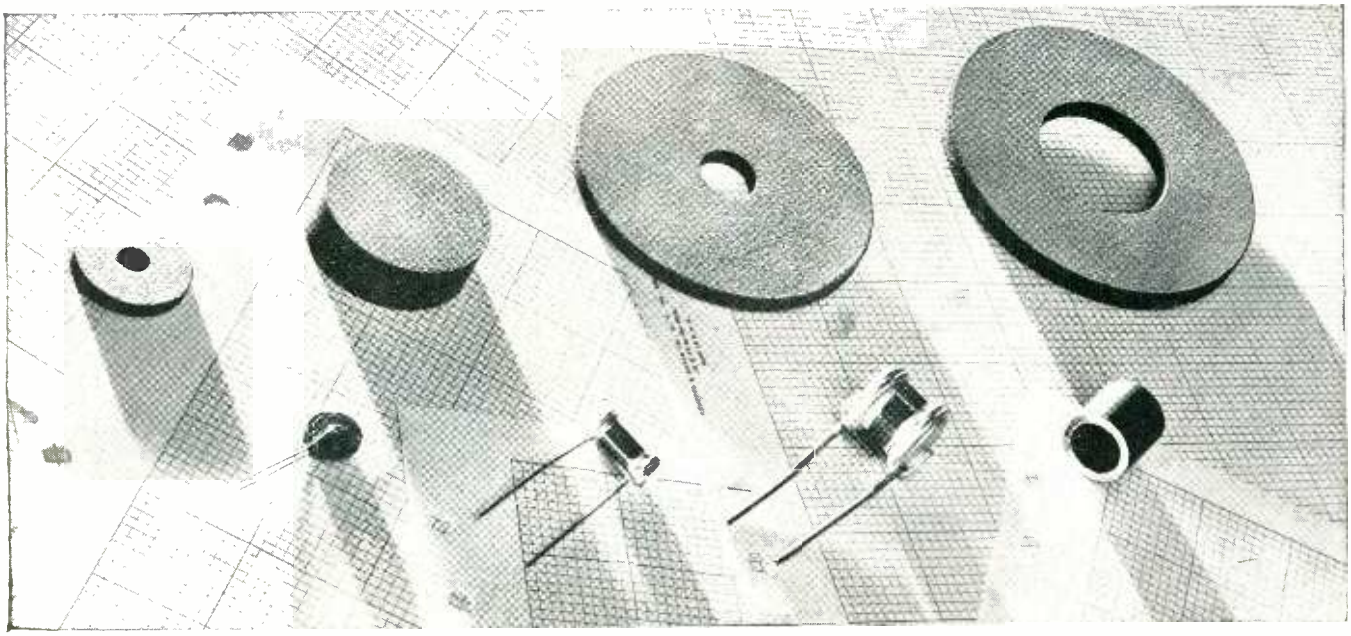
TRADE MARK

TYPE BNR RESISTORS

Responding instantly to voltage changes, GLOBAR type BNR Silicon Carbide Resistors provide increased resistance as a potential is decreased. Conversely, as a potential is applied, resistance decreases. These resistors have what is commonly referred to as "negative resistance-voltage". They are used to dampen the effect of transient voltages and provide instant protection for electrical circuits.

TYPICAL APPLICATIONS WHERE THESE RESISTORS OPERATE SUCCESSFULLY INCLUDE:

1. Oil burner ignition transformers to prevent high voltage feed back into line.
2. Small motors to prevent arcing of governor contact points.
3. Stabilizing rectifier circuits by limiting peak voltages.
4. Voltage control circuits in electronic devices.
5. Protection of solenoids in direct current circuits.



▶ Resistors of this type are readily made to meet exact specifications. Working samples are available on short notice. To be sure of receiving resistors made to correct specifications, the following information should be furnished:

- **a** Type of apparatus in which resistors are to be used.
- **b** Method of mounting and space limitations.
- **c** Normal operating voltage and peak voltage if available.
- **d** Resistance and inductance of the circuit if available.
- **e** Ohmic resistance of the resistor and allowable plus or minus tolerance.
- **f** Maximum voltage applied continuously or intermittently.
- **g** Duration of load and elapse of time between applications.

Furnishing this data will also avoid unnecessary delay and confusion.

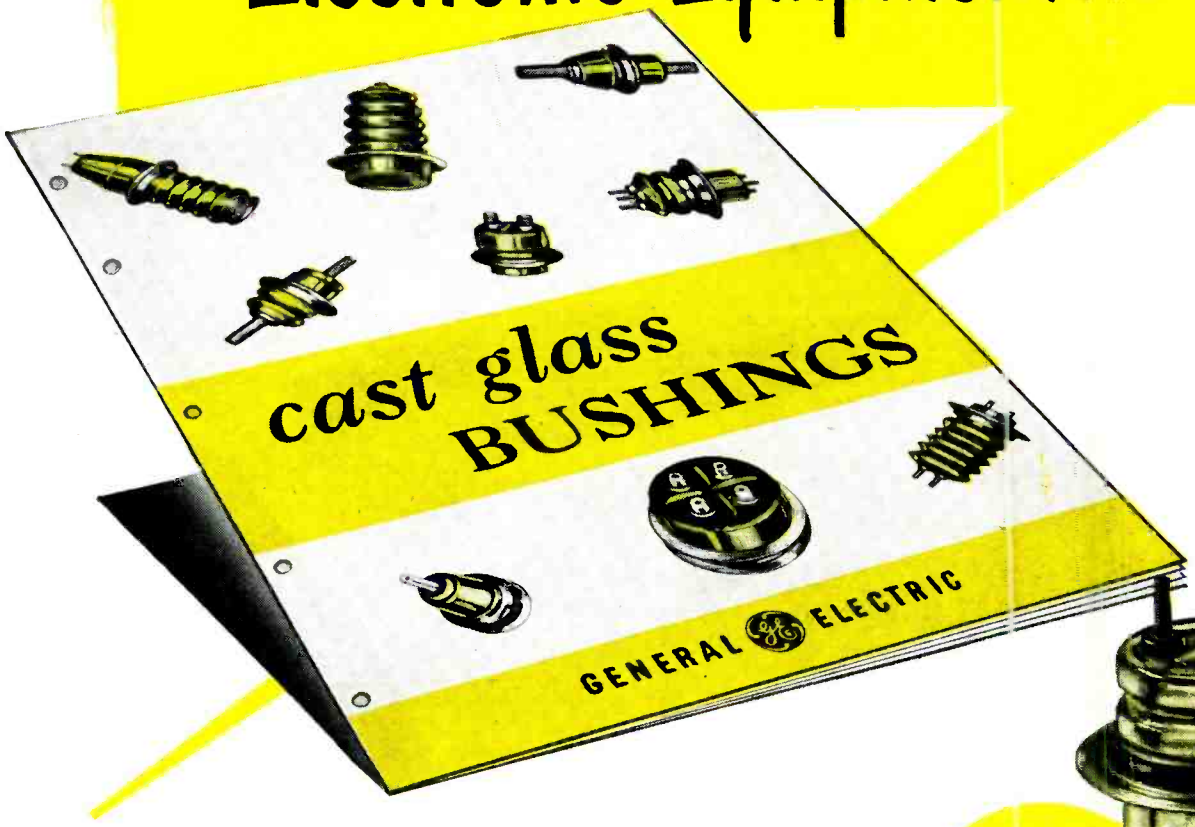
Bulletin GE-R1-B contains useful engineering data on GLOBAR BNR Ceramic Resistors. Copies will be supplied immediately upon request. No obligation of course. Write Dept. V-39, The CarborundumCompany, GLOBAR Division, Niagara Falls, N. Y.

GLOBAR Ceramic Resistors BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

If you manufacture Electronic Equipment...



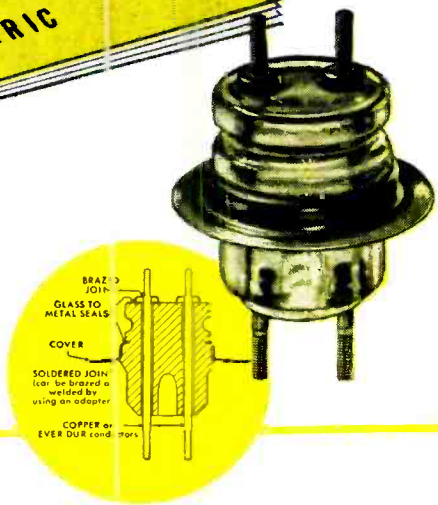
you'll want this NEW bulletin on glass bushings

General Electric is now offering to other manufacturers the cast glass bushings it has used so successfully on many types of electrical equipment.

These bushings are cast of a stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings can be attached directly to the apparatus without gaskets—by soldering, welding or brazing.

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, attack by fungus growth or severe changes in temperature. It eliminates moisture problems and often permits more compact, light-weight design of equipment.

Our new bulletin, GEA-5093, contains a complete listing of standard designs now available—giving withstand voltages, current ratings and physical dimensions. A copy of this bulletin is yours for the asking. Just write *Apparatus Department, General Electric Company, Schenectady 5, New York.*



Glass bushings are currently 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 1⅝ to 3⅜ inches and weight from 2½ oz. to 4 lb.

GENERAL ELECTRIC

FOR all products to be made by drawing, stamping and similar sheet metal operations, Revere sheet and strip of copper or brass offer maximum ease of fabrication. Not only are these metals naturally ductile, but they benefit further from the metallurgical skill which Revere has gained in 147 years of experience.

In composition, mechanical properties, grain size, dimensions and finish, you will find Revere metals highly uniform. They enable you to set up economical production methods and adhere to them. They can help you produce better products at faster production rates, with less scrap and fewer rejects.

Revere copper, brass and bronze lend themselves readily to the widest variety of finishing operations—polishing, lacquering, electro-plating. With these superior materials it is easy to make radio shields and similar products beautiful as well as serviceable.

That is why wise buyers place their orders with Revere for such mill products as—*Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings—*Aluminum Alloys:* Tubing, Extruded Shapes, Forgings—*Steel:* Electric Welded Steel Tube. We solicit your orders for these materials.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich. New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

47TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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AUTOMATIC MANUFACTURING CORPORATION

MANUFACTURERS OF

Coils and Capacitors

65 GOUVERNEUR STREET

NEWARK 4, N. J

PHONE HUMBOLDT 5-2100

January 19, 1949

Mr. T. R. Moore, Jr.
Sales Manager, Antara Products
Div. of General Aniline & Film Corp.
444 Madison Avenue
New York 22, N. Y.

Gentlemen:

You may be interested to learn that G.A.F. Carbonyl Iron Powders have been a major factor in the success of our K-TRAN. Never before has any radio component of unusual design been so universally accepted by the entire radio industry.

The excellent uniformity and high volume production of your product has enabled us to develop a special process for the production, in extremely large quantity, of a complex tuning core which is the "heart" of the K-TRAN.

Your product has enabled us to design into our K-TRAN both very high electrical performance and unparalleled mechanical and climatic stability, otherwise only obtainable in much larger and more expensive units, and eagerly sought after by K-TRAN imitators. We feel that it is only reasonable that you should realize the part you are contributing to the success of our product.

Very truly yours,

AUTOMATIC MANUFACTURING CORPORATION

John P. Tucker

J. P. Tucker
Application Engineer

JPT/hm

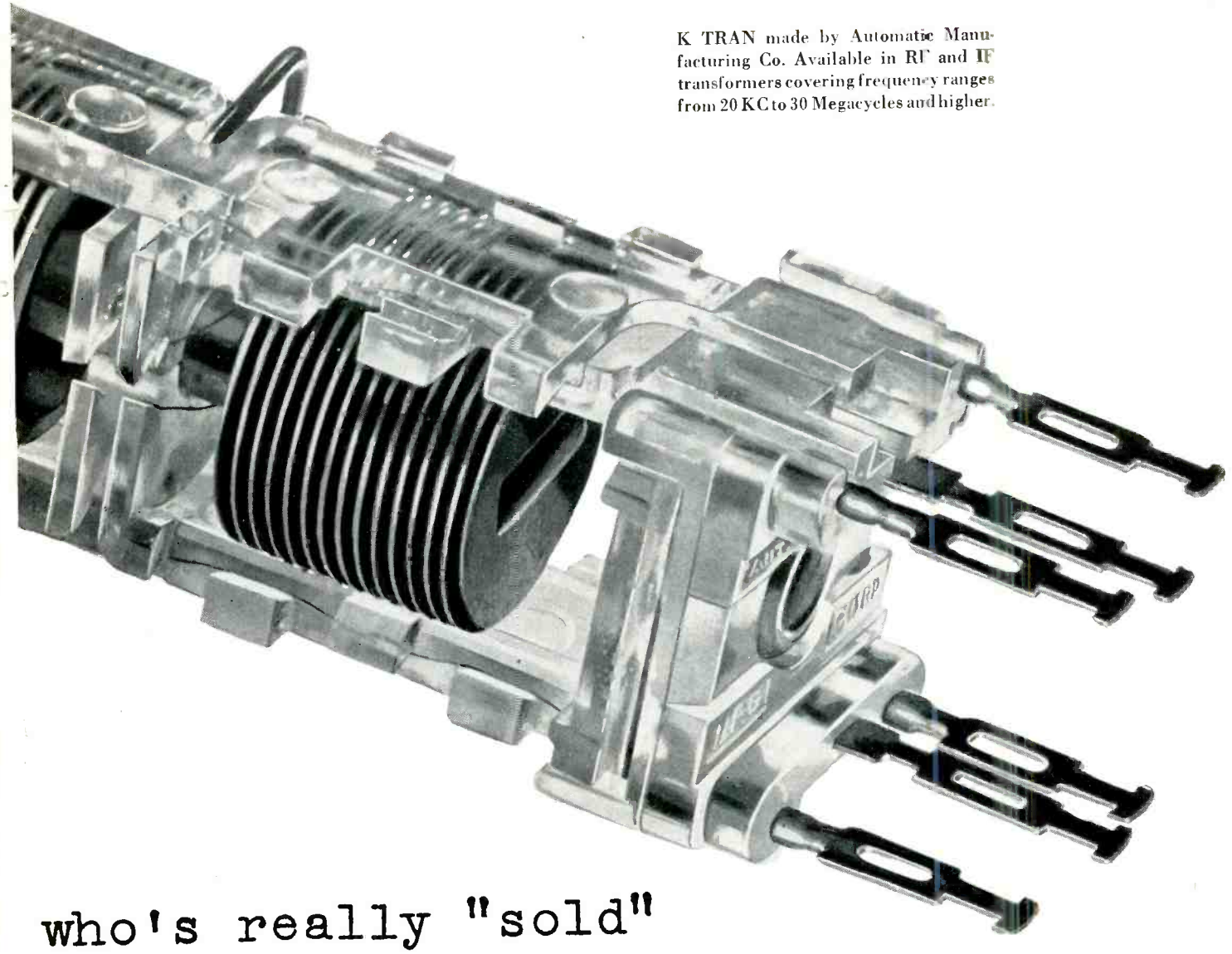
Here's a distinguished user

As the manufacturer of the famous "K-Tran" points out, when it comes to performance *with* economy, there's nothing to equal G. A. & F. Carbonyl Iron Powders.

No other iron powder gives the *superior* performance of Carbonyl Iron Powder. It is easier to control from the standpoint of manufacture. It is uniform, therefore requires very little control work on the part of the manufacturer.

G. A. & F. Carbonyl Iron Powders are easier to mold and machine. They save money because of assured longer tool life, and save time because tools need changing less often. Savings of 5 to 1 have been reported.

G. A. & F. Carb



K TRAN made by Automatic Manufacturing Co. Available in RF and IF transformers covering frequency ranges from 20 KC to 30 Megacycles and higher.

who's really "sold"

For the highest permeability for the Q developed, follow the advice of Automatic Manufacturing. Ask your core maker. Ask your coil winder. It's a well-known fact among electronics experts that Carbonyl Iron Powders are better!

See Antara Products' "Parade of Cores & Coils"—Booth 27 and 28, Radio Engineering Show of 1949 I.R.E. National Convention, Grand Central Palace, New York City, March 7-10. Carbonyl Iron Powders also on exhibition at the Spring Meeting of the Metal Powder Association, Drake Hotel, Chicago, April 5 and 6.

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

onyl Iron Powders

Where cables can't go

TIME SHARING MULTIPLEX can

Natural hazards are no longer obstacles to the telephone engineer. *Standard* Time-sharing Multiplex can provide a thoroughly reliable trunk system which is easy to install and maintain in the most difficult terrain.

Each equipment deals with up to 24 channels, handling any kind of A.F. traffic in the 300-3400 c/s range, including teleprinter and automatic telephone signals.

Time-sharing Multiplex ensures low crosstalk and noise levels, and fading does not affect speech levels.

A UHF carrier is used, and the normal line-of-sight range can be extended by automatic repeaters.

Complete terminal equipment occupies a double cabinet 7′ wide x 2′4″ deep x 6′6″ high, and aerials may be up to 100′ from the main equipment.

Write for Bulletin No. 511 which gives further facts and figures.

Standard Telephones and Cables Limited *Radio Division*

Associates of the International Telephone and Telegraph Corporation

OAKLEIGH ROAD, NEW SOUTHGATE, LONDON, N.11, ENGLAND

R.D.6.

PROGRESS REPORT ON P.E.C.

More and more Hearing Aid Manufacturers are turning to Centralab's *Printed Electronic Circuits* to Simplify Production . . . to Build Smaller, Finer Units!

JOHNSTON — finds special Ampec audio-amplifier cuts weight.

PARAVOX — uses custom CRL Ampec for quick assembly.

ALLEN-HOWE — was first to use P. E. C. in hearing aids.

BELTONE — replaces 45 parts with one P. E. C. unit.

MICROTONE — uses 12 P. E. C. units to save space.

The illustrated units are now on the market — Watch for at least 5 more by June First!

LOOK TO Centralab IN 1949!

CRL

Division of **GLOBE-UNION INC., Milwaukee**

Watch Master

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(.001%)

Type 2121 A.

TERMINATION
Front and Rear
CONSTRUCTION
Standard 8¾" x 19" Panel
HOUSING
8¾" x 19" x 8" Metal Cabinet
WEIGHT
25 pounds

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

product of

AMERICAN TIME PRODUCTS INC.

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

Operating under patents of the Western Electric Company

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 2121A.

Name.....

Company.....

Address.....

City..... State.....

— nothing short of being best . . .

ABBOTT LABORATORIES

North Chicago, Illinois.

uses this PLASTIC CAP as a functioning part of highly specialized hospital equipment, and it must be right!

"Many things difficult to design prove easy to performance." ★

Thanks to Samuel Johnson for a good, if unintentional description of the ingeniously designed *Abbott Venoclysis Equipment* — which, together with Abbott Intravenous Solutions is the choice of many hospitals.

★ The above is an excerpt from a professionally directed Abbott advertisement.

A Versatile Bit of Equipment, *states* ABBOTT

This dispensing cap, in conjunction with rubber tubing, is used for venoclysis. It is designed to fit all Abbott bottles containing intravenous solutions. A versatile bit of equipment, it makes possible several different variations in venoclysis technique.

This compact cap permits introduction of supplementary parenteral medication directly into the flow without disturbing the patient. It can be used with one bottle, or hooked up with additional bottles, in series. The sketches to the left, reproduced through the courtesy of Abbott Laboratories, show these caps as installed and arranged for a two-bottle series hook-up.

This Piece is *our Salesman* for *more* Plunger Molding

When you plan molding, consider the plunger method—and call Consolidated. By plunger-processing this intricately designed and threaded part of black Bakelite, we maintained precision quality, used fewer cavities, lowered tool costs and, through shortened cycles—increased production.

Of prime importance is the fact that the customer is well pleased . . . and the equipment well served. As a result of this and other Consolidated-solved problems, we invite the opportunity to apply our know-how to any and all custom molding assignments—plunger, compression, injection. Our experienced sales engineers are at your service. Inquiries invited!

CALL IN

Consolidated
MOLDED PRODUCTS Corporation
309 CHERRY STREET,
SCRANTON 2, PA.

YOUR BLUEPRINT

CMP

IN PLASTIC

Branches: NEW YORK, 1790 Broadway • CHICAGO, 549 W. Randolph St. • DETROIT, 550 Maccabees Bldg. • CLEVELAND, 46.4 Prospect Av. • BRIDGEPORT, 211 State Street.

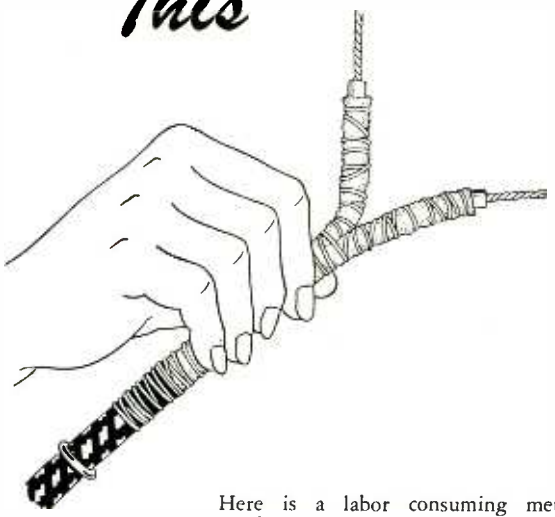
PRODUCT DEVELOPMENT • MOLD DESIGN • MOLD CONSTRUCTION • PLUNGER MOLDING • TRANSFER MOLDING • INJECTION MOLDING • COMPRESSION MOLDING

When the Underwriters Say:

"Where heater cord is used and the temperatures on the braid within the appliance exceed 90°C., supplementary insulation is required over the braid."

Would you choose--

This



Here is a labor consuming method of hand-wrapping an electric cord with thread to provide the supplementary insulation required by Underwriters' Laboratories, Inc.

or This?

Here is an electric heater cord with "pants" of BH Non-Fraying Fiberglas Sleeving, easily slipped over the leads and covered by a larger BH Fiberglas Sleeving. Saves minutes in assembly time. Approved by Underwriters' Laboratories, Inc.

Now BH Non-Fraying Fiberglas Sleeving gives you a better, faster way of providing supplementary insulation required by the Underwriters' for built-in heater cord. Recent assembly tests have shown savings of three minutes in the insulation of a single heater cord. Slow hand-wrapping methods take time, cost more and are not uniform. With BH Non-Fraying Fiberglas Sleeving, there are no threads to break or unravel. No possibility of partially-uncovered braid. No time spent in job-training employees.

By simply slipping a section of BH Fiberglas Sleeving over each asbestos covered lead, and then fitting a larger BH Fiberglas Sleeving over the braid, the job is completed quickly and efficiently. Stays snug, yet remains flexible as string because no hardening varnish or lacquer is used in BH Fiberglas Sleeving. Will not fray, crack or split when bent. Heat resistant to 1200°F. if necessary. Can be spread to cover knobs and terminals smoothly.

Leading appliance manufacturers in every section of the country specify BH Fiberglas Sleeving for supplementary insulation in their products. BH Non-Fraying Fiberglas Sleeving is made in all standard sizes and colors, in standard 36" lengths and 500' coils, or it may be supplied in short lengths to meet specific requirements. Use it in your plant, in your product. Write today for details.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH Fiberglas* SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-32, Conshohocken, Pa.

I am interested in BH Non-Fraying Fiberglas Sleeving _____ for (size or I.D.) _____ operating at temperatures of ____°F. at ____ volts. Send samples so I can see how BH Fiberglas Sleeving stays flexible as string, will not crack when bent.

(product)

NAME _____ COMPANY _____

ADDRESS _____

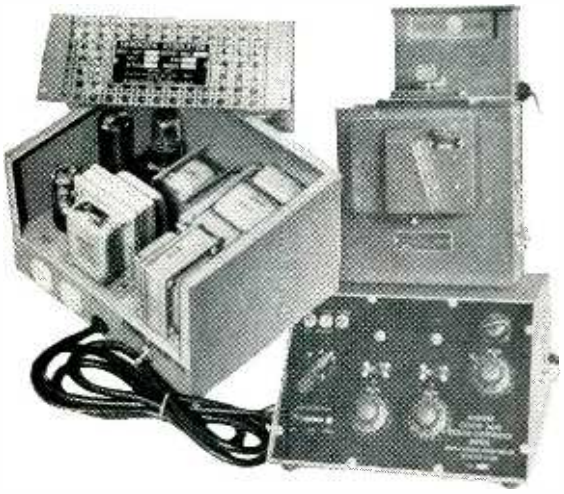
Send samples, pamphlet and prices on other BH Products as follows:

☐ Cotton or Rayon-base Sleeving and Tubing

☐ Ben-Har Special Treated Fiberglas Tubing

sorensen voltage regulators eliminate color changes

due to changes in lamp voltage



The Hunter Color and Color Difference Meter, shown here in phantom is a photo-electric tristimulus colorimeter equipped with photocell windows and measuring circuits so chosen as to permit the reading of three values of color direct from 10-turn potentiometer rheostats. Precise measurements of color and small color differences may be quickly obtained.

This is another precision instrument from which accurate measurements can be obtained only through accurate voltage regulation. The Sorensen Model 150A Electronic Voltage Regulator is employed with the Hunter Color Meter to eliminate color changes when the voltage of the lamp changes.

Where precise voltage control is essential to accurate reading, Voltage Regulators and Nobatrons by Sorensen offer you these essential advantages:

- **precise regulation accuracy**
- **excellent wave form**
- **fast recovery time**
- **constant output voltage**
- **insensitivity to line frequency fluctuations**

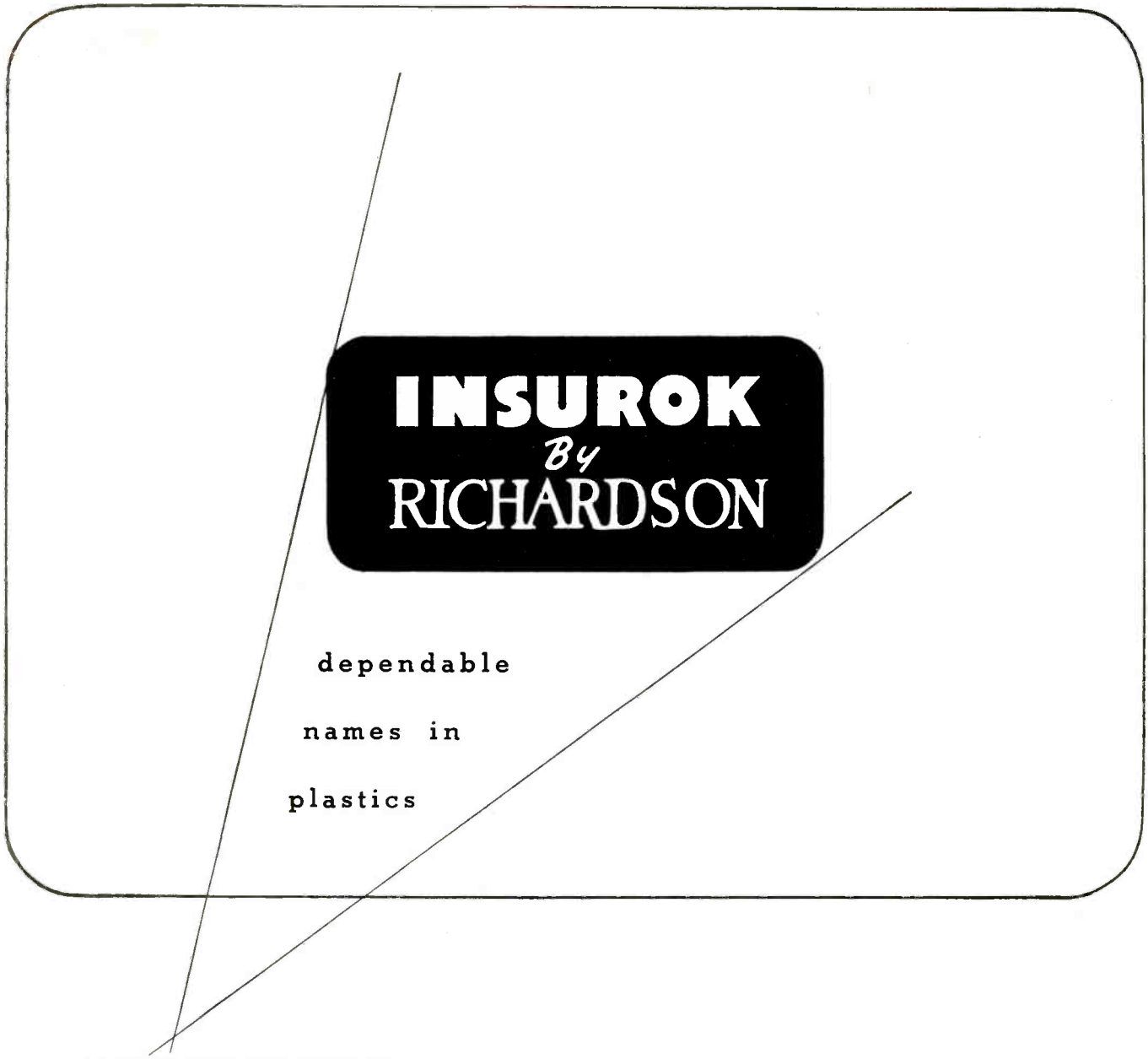
Write for catalog or tell us your voltage regulation problems. Our engineers will be happy to make specific recommendations.

THE FIRST LINE OF STANDARD ELECTRONIC VOLTAGE REGULATORS

Representatives in principal cities.

Sorensen and company, inc.

375 Fairfield Ave., Stamford, Connecticut



EXPERIENCE is just one of the factors that make the names of INSUROK and Richardson more significant to manufacturers whose products require laminated or molded plastics. Richardson customers benefit from this experience in many ways.

(1) Richardson experience with a wide variety of plastic materials helps you select the one that accomplishes your purpose most effectively, efficiently and economically.

(2) Richardson experience in the design and production of Laminated INSUROK and Molded INSUROK products has resulted in savings to scores of manufacturers.

(3) Richardson's many proven grades of Laminated INSUROK are available in sheet, rod or tube stock or in fabricated, punched or post-formed component parts for an endless variety of applications.

(4) INSUROK plastic products and Richardson services have played an important part in the development and refinement of many products.

It might be to our mutual advantage to know how these materials and services can work for you.

INSUROK is a registered trade-mark of The Richardson Company

The RICHARDSON COMPANY

GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND · DETROIT · INDIANAPOLIS · MILWAUKEE · NEW BRUNSWICK, (N. J.) · NEW YORK · PHILADELPHIA · ROCHESTER · ST. LOUIS

NOW AMERTRAN HIGH IMPEDANCE TRANSFORMERS

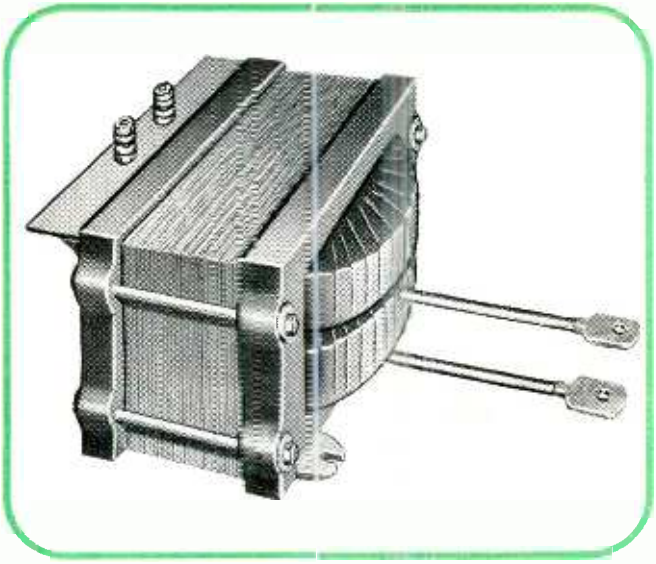
for every tube requirement!

To meet the need for filament excitation of large vacuum tubes, we are for the first time offering a complete line of high impedance transformers for this application. AmerTran High Impedance Transformers, designed for use with specific tubes, limit the inrush and operating currents to the values recommended by tube manufacturers.

You will find listed below a rating to be used with your particular tube requirements. Several ratings are furnished for certain tubes so that the designer may choose single or polyphase operation.

Attractive, economical, and light in weight, AmerTran High Impedance Transformers will meet your exacting requirements.

Consult our Sales Representatives listed below for further information.



	Tube Types	Input VA	Primary Volts	Frequency CPS	Secondary Volts	Secondary Amps.	Max. Amps. Limited to	Sec. Test KV	Catalog Number
R. C. A.	8014	265	230	50/60	15.0	14.5	30A	5	162-001
	8D21	530	230	50/60	3.2	125.0	220A	5	162-002
	7C24	480	230	50/60	12.6	29.0	50A	5	162-003
	891-892 891R-892R 891-891R	800	230	50/60	11.0	60.0	120A	5	162-004*
	892-892R	1600	230	50/60	22.0	60.0	120A	5	162-005
	889A-RA	1920	230	50/60	11.0	125.0	187A	5	162-006*
	5671	4390	230	50/60	11.0	285.0	425A	5	162-007
	880	5630	230	50/60	12.6	320.0	480A	5	162-008
	5592	5700	230	50/60	11.0	412.0	750A	5	162-009
	898A	9700	230	50/60	33.0	210.0	315A	5	162-010
	9C21-9C22	10200	230	50/60	19.5	415.0	750A	5	162-011
WESTERN ELEC.	5530	385	230	50/60	5.0	55.0	82.5A	5	162-021
	5541	580	230	50/60	7.5	55.0	82.5A	5	162-022*
	228A-236A-240B 220C-220CA	1180	230	50/60	21.0	40.0	60A	5	162-023
	341AA, 343A, 343AA	1740	230	50/60	21.5	57.5	86.25A	5	162-024*
	342A	1880	230	50/60	20.0	67.0	100A	5	162-025
FEDERAL T. & R.	7C23, 7C25	380	220	50/60	11.0	28.5	57.0	5	162-031
	5680	565	220	50/60	13.0	36.0	72	5	162-032
	8C25	980	220	50/60	7.0	100	150	5	162-033
	F125A, F125R	1360	220	50/60	13.6	65.5	92.5	5	162-034
	F129B, F129R	1720	220	50/60	20.0	71.0	142	5	162-035
	F124A	2600	220	50/60	27.2	68.5	103	5	162-036
	9C28, 9C29, 9C30, 9C31	2850	220	50/60	15.0	135	202.5	5	162-037
	F134	21800	220	50/60	25.0	625	937.5	5	162-038
EIMAC	1500T	255	220	50/60	7.5	25	40	5	162-041
	3XZ500T	505	220	50/60	7.5	48	72	5	162-042

*Scott Taps (115/199/230)

THE AMERICAN TRANSFORMER CO., 178 Emmet St., Newark 5, N. J.

Sales Representatives

Holliday-Hathaway Co., 238 Main Street, Cambridge 42, Mass.
Joralemon, Craig & Co., 112 South 16th Street, Philadelphia, Pa.
Holliday-Hathaway Co., 276 South Drive, Rochester 12, New York
Royal J. Higgins Co., 600 So. Michigan Ave., Chicago 5, Illinois
Don L Davis, 3021 No. 3rd St., Harrisburg, Pa.
Emmett N. Hughes, 1709 W. 8th St., Los Angeles, California

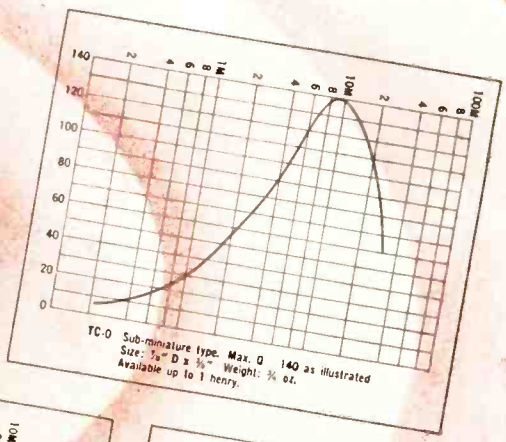
AMERTRAN

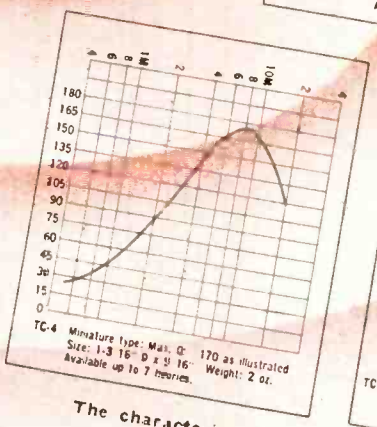
MANUFACTURING SINCE 1901 AT NEWARK, N. J.

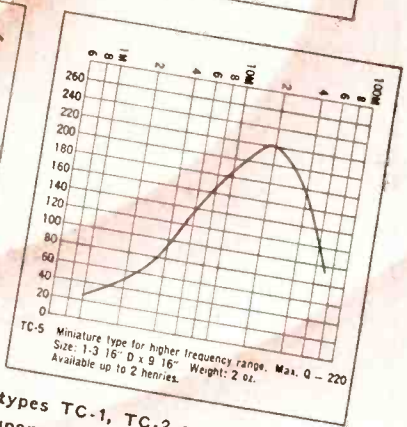
Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

BURNELL & CO., A LEADER IN THE DEVELOPMENT OF MINIATURE AND SUB-MINIATURE COILS AND FILTERS.. INTRODUCES.. THE 'WEDDING RINGS', WORLD'S SMALLEST HIGH 'Q' TOROIDAL COILS

ACTUAL SIZE







Since discovering that toroidal coils are the solution to problems in compactness of communication and control equipment, design engineers have been confronted with the ever pressing problem of miniaturization.

A major step towards a solution has now been found and we take pleasure in presenting to the electronics field, the penultimate in the design of miniature high Q coils, the types TC-4 and TC-5 and the ultimate, sub-miniature TC-0 which is not much larger than a thumb nail.

For many applications, design engineers will benefit from our specialized experience in the manufacture of miniature components and filters by utilizing the performance capabilities, degressively, of their larger associates (Types TC-1, TC-2, TC-3) but compressed into midget proportions, permitting an elegant solution to the importunate problem of miniaturization.

All of the TC series are toroidally wound on molybdenum permalloy cores providing high Q with a stability unattainable by any other material.

The characteristics of the types TC-1, TC-2 and TC-3 are available upon request.

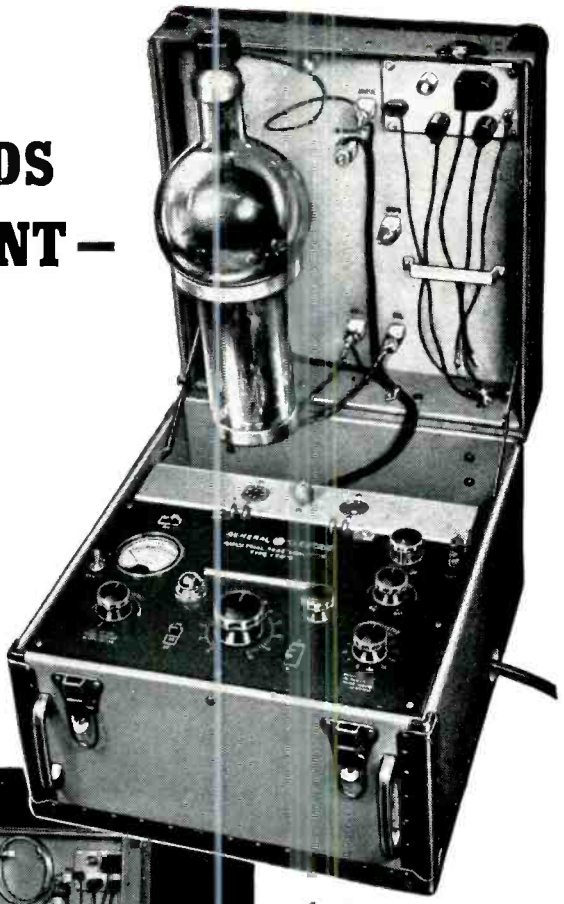
EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

ALL INQUIRIES WILL BE PROMPTLY HANDLED

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

WRITE FOR TECHNICAL INFORMATION

TIME OUT FOR TEST AVOIDS TIME OUT FOR EQUIPMENT—

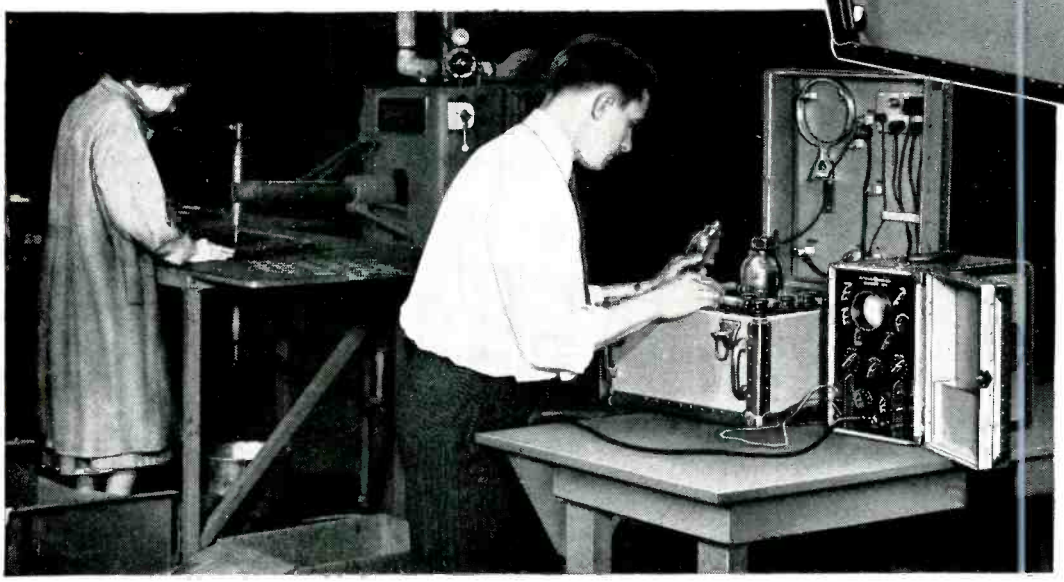


General Electric Industrial Tube Analyzer Type YTW-3

GENERAL ELECTRIC INDUSTRIAL TUBE ANALYZER—TYPE YTW-3—The widespread use of thyratron and phanatron tubes in modern industrial operations demands a test device that can quickly and accurately determine the performance characteristics of these types.

The General Electric analyzer, type YTW-3, has been designed as a compact, portable unit—simple in operative procedure so that non-technical personnel can learn to use it in a short time. This permits frequent tube tests that will maintain equipment at a high level of efficiency and avoid costly shut-downs due to tube failure in critical operations.

The analyzer measures the peak arc drop voltage of these rectifier tubes under maximum rated load or under specific application load. Readings are taken directly from a large dial which controls an accurate slide-back type voltmeter.



General Electric Industrial Oscilloscope Type YNA-4

GENERAL ELECTRIC INDUSTRIAL OSCILLOSCOPE—TYPE YNA-4—This industrial oscilloscope was built for one specific job—industrial testing. Designed to meet strict plant safety requirements, it is enclosed in an insulated case. The cathode ray tube is rubber mounted with a protective window in front of the tube.

A special power transformer provides isolation from the power line circuits for safer and more dependable operation.

Covers a wide range of trouble shooting and preventive maintenance applications in connection with welding, control, and power rectifier equipment. Also invaluable in the production testing of switches, relays and other electrical components. In welding operations particularly, its fundamental value can be recognized quickly. When the quality of welds begins to deteriorate, checks with the industrial scope locate the trouble and aid in maintaining quality.

For complete information on these industrial test equipments and other performance-engineered instruments write: *General Electric Company, Electronics Park, Syracuse, New York.*

You can put your confidence in—

GENERAL ELECTRIC

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

JENSEN MANUFACTURING COMPANY
Division of the Muter Company
6607 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

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

Write for Data Sheet 143

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

PICK UP AND GO

New

250 VA STABILINE IE VOLTAGE REGULATOR

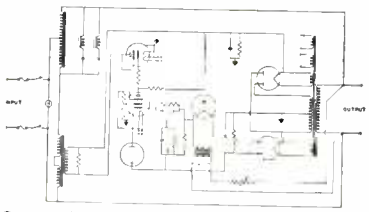
The new 250 VA STABILINE Type IE51002 is the latest addition to the Superior Electric line of dependable instantaneous electronic automatic voltage regulators. It's easy to carry this compact, portable unit to any location in shop or laboratory — from one test station or operation to another. And packed into its black wrinkle-finished case are the same superior characteristics of workmanship and performance found in STABILINES of larger capacity.

Here are the ratings for the new 250 VA STABILINE Type IE51002 — **Input Voltage Range:** 95 to 135 volts. **Output Voltage Range:** adjustable between 110 and 120 volts. **Rated Output:** 0 to 250 volt-amperes. **Frequency in Cycles:** 60 ± 10%. **Load Power Factor:** 0.5 lagging to 0.9 leading. **Waveform Distortion:** *never* exceeds 3%. **Stabilization:** ± 0.1 volts of preset value. **Regulation:** ± 0.15 volts of preset value. **Recovery Time:** 3 to 6 cycles.

Among the many advantages of this new voltage regulator is the fact that all tubes but one are standard -- and the non-standard tube is made by a well-known manufacturer. Tube replacement is thereby made easy — at no extra trouble to you. The 250 VA STABILINE Type IE51002 is easy to order, too. There are no annoying suffixes to watch on your order — no "extras" to buy. The standard cataloged model provides equal or improved characteristics over so-called "special designs".

Each unit is complete, offering all the superior features. Operation is simple. No extra parts or accessories are needed — no special adjustments to achieve maximum performance and service.

The new 250 VA STABILINE Type IE51002 is a self-contained unit measuring 11½" x 11½" x 10¼". It's complete with carrying handle, 6' cord and plug, 2 outlet receptacles and a pair of Superior 5-Way Binding Posts. Fuses are located in the input for complete protection. There's a handy "on-off" switch, pilot light and a screwdriver adjustment for output voltage.



Connection diagram showing operating circuit of the new 250 VA STABILINE Type IE51002.

Rear view showing compactness and superior workmanship in the IE51002.

Write today for complete information.

4039 MEADOW STREET
BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

SE CO

Powerstat Variable Transformers ● Voltbox A C Power Supply ● Stabiline Voltage Regulators.

a NEW and SENSATIONAL *Motorola* "FIRST" that makes 2-WAY RADIO more valuable than ever before!

NOW...Your cars hear only your calls!

Motorola "QUIK-CALL" SELECTIVE SIGNALING EQUIPMENT

Just press a button to call your cars—individually, or by groups

Now you can control and direct calls to your fleet, or to any one car in your fleet with the new Motorola "QUIK-CALL" selective signaling equipment! Your cars can be called only by *your* base station. Another "FIRST"—Motorola "Quik-Call" prevents your cars from receiving calls sent by other transmitters on the same or adjacent channels...they need not hear any calls except those coded from your station alone. Interference from diathermy is completely locked out during standby and, most important, skip interference false calling and squelch opening is eliminated.

Motorola "QUIK-CALL" prevents nuisance interference from stations in nearby communities, reducing driver fatigue and increasing the utility of any radio system.

Developed after two and one half years of exacting research, Motorola "QUIK-CALL" is based upon the use of a pure tone generator of instrument precision, called the Vibrasender, and a responding resonant responder—called the Vibrasponder. These "electro-mechanisms" in various combinations, are capable of calling your fleet (with the single-key system) or of selectivity calling up to 1,350 individual units (with the 24-key system) with the precision and speed of adding machine operation.

A product of Motorola Research Laboratories

Motorola "QUIK-CALL" can be added to your present *Motorola* equipment

It doesn't matter whether you're installing a whole new communications system, or if you already have 2-way radio...the Motorola "QUIK-CALL" can be adapted to your system in bringing it up to date. Enjoy the advantages of this new kind of 2-way radio.

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DESCRIPTIVE BOOKLET
MAIL THIS COUPON TODAY

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Chicago 51, Illinois Dept. E

Please mail me a FREE copy of the descriptive booklet on Motorola "QUIK-CALL" selective signaling equipment.

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Address.....

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

★You can Reduce Costs

★You can Improve Performance with

ARNOLD

PERMANENT MAGNETS

Where's the manufacturer these days who doesn't need all the competitive and cost advantages he can get? Maybe you have new electrical or mechanical equipment in mind—designs or re-designs that should employ permanent magnets for best results. Maybe you have existing applications that permanent magnets will do *better*—save you time and money in production, and step up the efficiency of your product.

In either case, let Arnold's engineering service help you to find the answers to your magnet problems. Arnold offers you a fully complete line of permanent magnet materials, produced under 100% quality-control in any size or shape you require, and supplied in any stage from rough shapes to finish-ground and tested units, ready for final assembly. Write direct, or to any Allegheny Ludlum branch office.

W&D 1295

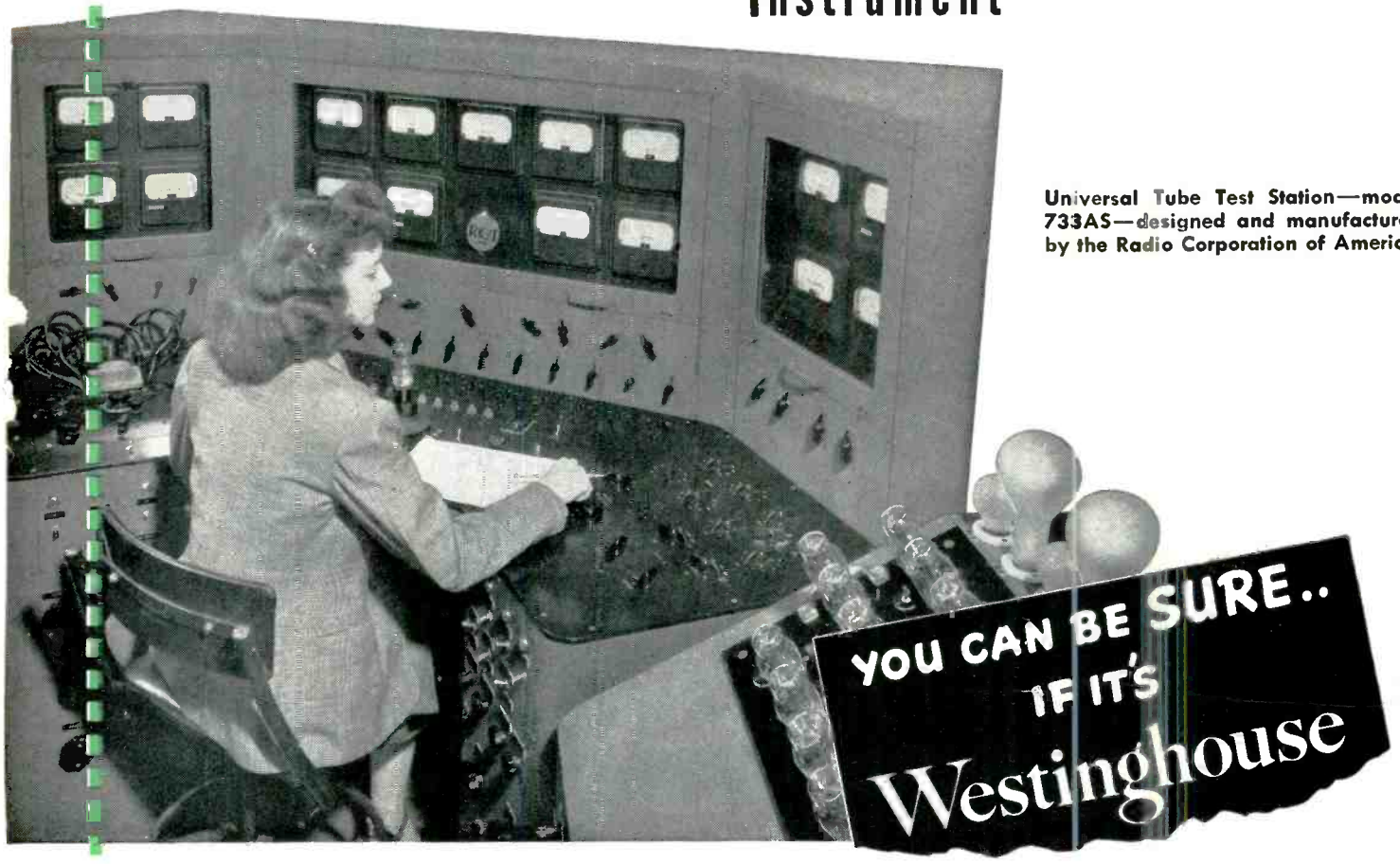
THE ARNOLD ENGINEERING CO.

Subsidiary of **ALLEGHENY LUDLUM STEEL CORPORATION**

147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

HERE'S on-the-job Proof of Westinghouse Instrument Performance!



Universal Tube Test Station—model 733AS—designed and manufactured by the Radio Corporation of America.

Where Accuracy, Simplicity, Readability mean so much they choose . . .

Westinghouse Instruments

. . . *unfailing performance* and *co-ordinated space-saving design* . . . these, too, were instrument "musts" for the receiving tube test station manufactured by RCA.

Westinghouse Instruments easily met these requirements. The result . . . an exact, diverse and rapid control over the quality of all modern types of receiving tubes.

What Are YOUR Electrical Measuring Problems?

Would they include . . . reliable performance? . . . styling? . . . size? . . . readability? . . . or different types of service? . . . portable? . . . switchboard? . . . panel? . . . recording?

The completeness of the Westinghouse line of electrical measuring instruments will answer your special or ordinary problems. Every Westinghouse Instrument is backed by more than 60 years of skill and experience in every field of industry. J-40366

Westinghouse Instruments Also Provide You With . . .

- Dials that *stay* white under all conditions
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Westinghouse Instrument Specialists are available in the field for consultation on your instrument problems. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

Send for Booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-3363.

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Electrical Measuring Instruments for ANY Job

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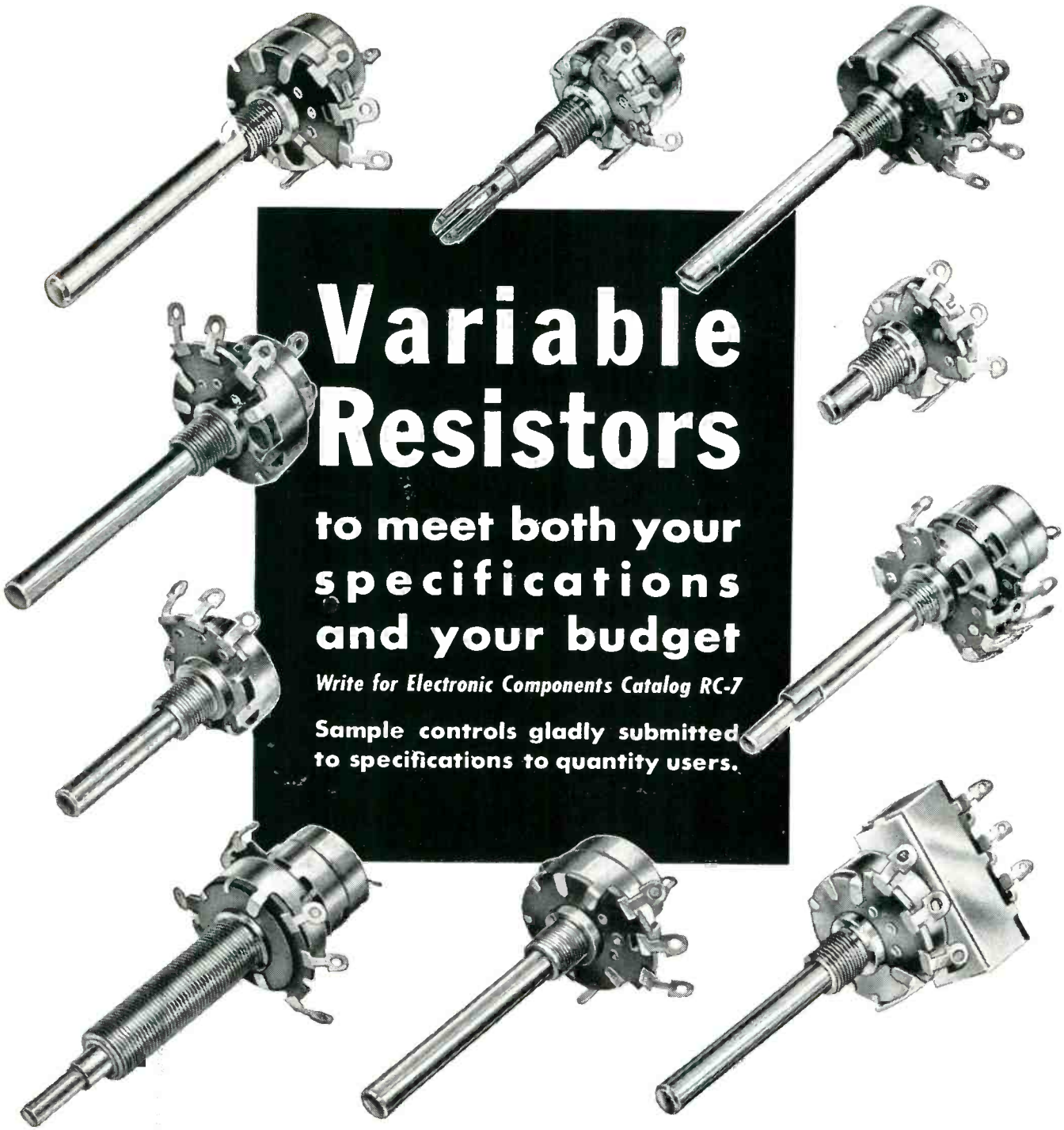

Variable Resistors

to meet both your specifications and your budget

Write for Electronic Components Catalog RC-7

Sample controls gladly submitted to specifications to quantity users.

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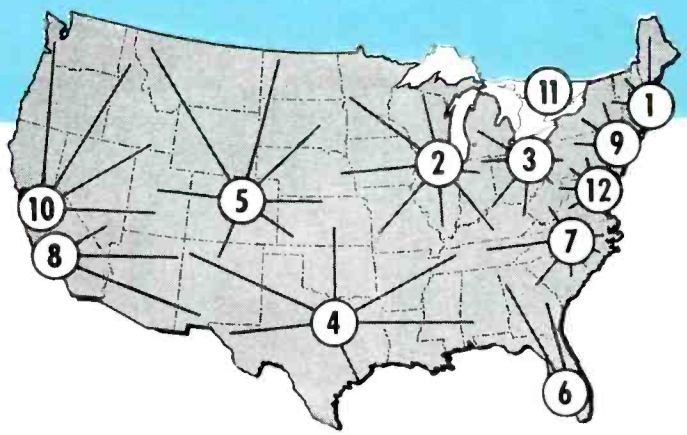
Fixed and Variable Resistors • Iron Cores (All standard and special types) • Switches (inexpensive line, slide and rotary-action types) • Sintered Alnico II Permanent Magnets . . . and hundreds of molded iron powder, metal, carbon and graphite products.

Electronic Components Division

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

hp GIVES YOU PERSON-TO-PERSON HELP WITH YOUR MEASURING PROBLEMS



***-hp-* has selected** the best independent organizations in America to provide you with personal attention to your measuring problems. Their technical men have complete information about *-hp-* instruments and can help you select the correct measuring equipment for your needs. The *-hp-* direct-to-consumer sales policy saves you money, and the *-hp-* field service program saves your time. Whenever or *wherever* you need personal help on measuring problems, call the nearest *-hp-* field representative.

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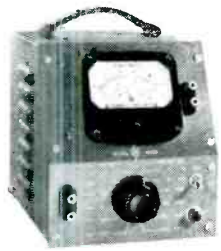
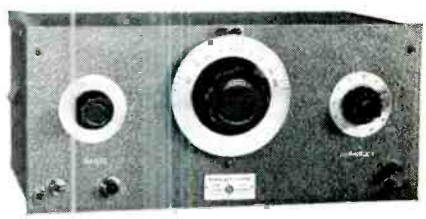
NEW, HIGH SENSITIVITY, WIDE RANGE VOLTMETER



-hp- 400C Voltmeter

This new *-hp-* voltmeter makes fast, accurate readings from .1 mv to 300 v., 20 cps to 2 mc. Voltage range 3,000,000 to 1. Panel switch selects 12 ranges. Input impedance 10 megohms.



-hp- 200C Oscillator

One of 5 basic *-hp-* audio oscillators. *-hp-* 200C covers frequency range of 20 cps to 200 kc. Constant output, low distortion, great stability. No zero setting necessary during operation.

For complete details, write direct or see your -hp- representative.

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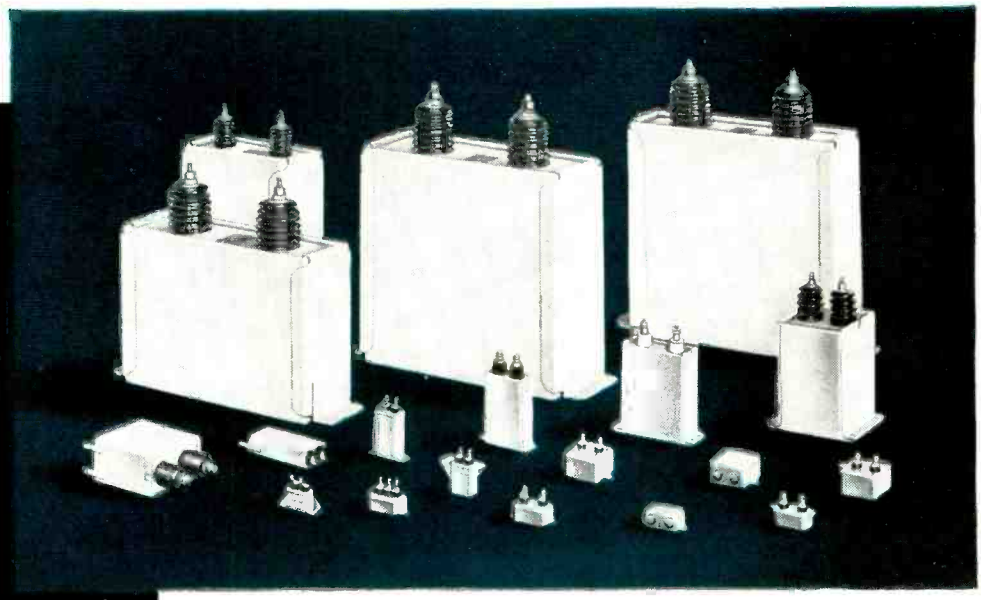
ELECTRONICS

Designers



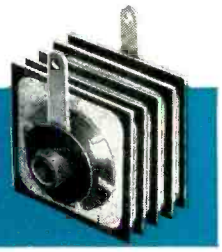
take your choice... FIXED PAPER-DIELECTRIC CAPACITORS

Readily available for DC electronic applications, these capacitors are manufactured in accordance with joint Army-Navy specifications JAN-C-25. Case styles include types CP 53, CP 54, CP 55, CP 61, CP 63, CP 65, CP 67, CP 69 and CP 70. Capacitance ratings are from .01 Muf to 15 Muf, and voltage ratings are listed from 100 to 12,500 volts.

These capacitors are constructed with thin Kraft paper, oil or Pyranol* impregnated, which provides stable characteristics and high dielectric strength. Plates are aluminum foil, manufactured according to detailed specifications. Special bushing construction provides for short internal leads, preventing possible grounds and short circuits. The cases have a permanent hermetic seal to provide longer life. A variety of mounting arrangements are available for various installation requirements. Write for detailed description and operating data: Bulletin GEA-4357A.

*Pyranol is General Electric's non-inflammable liquid dielectric for capacitors.

SAVE SPACE CUT COSTS



Less than one inch long, and only one inch square, this postage-stamp-size selenium rectifier offers radio builders substantial savings in production costs. Only two soldering operations and a minimum of hardware are necessary for installation in places where a rectifier tube and socket won't fit. They're built to safely withstand the inverse peak voltages obtained when rectifying (half-wave) 110-125 volts, rms, and feeding a capacitor as required in various radio circuits. Tests prove that selenium rectifiers will outlast the conventional type of rectifier tubes, at the same time costing less. Send for bulletin GEA-5238.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

HOLDS OUTPUT VOLTAGE CONSTANT

This 500-va voltage stabilizer is suitable for a wide variety of electronic applications where constant voltage is demanded. Voltage variations from 95 to 130 volts are absorbed almost instantaneously and output voltage maintained at 115 volts (plus or minus 1 percent). There are no moving parts, no adjustments to make. This unit will operate continuously at no load or short circuit without damage to itself. It will limit the short circuit current to approximately twice stabilizer's normal full load current rating. Other sizes available range from 15 to 5000 va. For details, check bulletin GEA-3634B.

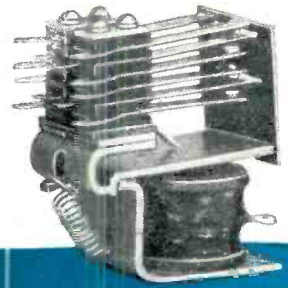
WANT TO TIME TUBE LIFE?

Suitable for installation in radio transmitters, these G-E time meters provide accurate record of tube operating time. They record in hours, tenths of hours, or minutes. Ratings range from 11 to 460 volts. Installation on a panel or switchboard is simplified by quick-wiring leads. Timer harmonizes with other panel instruments in appearance and size. Dependability is assured by Telechron* motor drive. Also available for portable use or conduit and junction box mounting. Check bulletin GEC-472.

FOR YOUR TELEVISION SETS

General Electric's television cord set comes in 6-foot lengths, made of 2/18 Pot-64 brown Flamenol* rip-cord. Set has brown plastic plug and new brown Flamenol connector molded on opposite end. Rip-cord has smooth finish, resists oil, water, acids, alkalies, or sunlight deterioration. Rating is 7 amps., no. 18 wire. Set is designed for assembly on television receiver rear panel, automatically disconnects when panel is removed. Write for further information.

*Trademark Reg. U. S. Pat. Off.



DEPENDABLE CONTROL FOR AUTOMATIC DEVICES

G.E.'s multi-contact relays are inexpensive units built specifically for appliances and vending machines. Construction features assure quiet, reliable operation, and compactness makes them adaptable to a variety of devices such as coin changers, phonographs, and television receivers. Single-circuit contacts or combinations of contacts for multi-circuit application are attached to the same sturdy frame and coil assembly, affording a multiplicity of relay forms. Ratings are 5 amperes at 115 volts or 24 volts, a-c or d-c. Get details from Bulletin GEC-306.

General Electric Company, Section A667-1
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-3634B Voltage Stabilizers
- ☐ GEA-4357A D-C Capacitors
- ☐ GEA-5238 Selenium Rectifiers
- ☐ GEC-306 Multi-contact Relays
- ☐ GEC-472 Tube Timers

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

−35°C to +45°C

Aerocom's new V.H. frequency AM radiotelephone transmitter is designed and built to operate amid ice and snow or steaming jungles, and what's more, this fine transmitter will give long trouble free efficient service with low maintenance and operating costs. Built in two models VH-200 and VH-50 to meet your communications needs.

Model VH-200

The model illustrated (VH-200) operates on one Crystal Controlled frequency (plus one closely spaced frequency) anywhere in the range 118-132 Mcs. or 132-165 Mcs., A-2 (with accessory unit) or A-3 AM. Nominal carrier power 200 watts up to 132 Mcs., reduced power up to 165 Mcs. Low temperature operation using gas filled rectifiers. Normal temperature operation using mercury vapor rectifiers. Relative humidity up to 95%. Model VH-50 has similar characteristics except nominal carrier power is 50 watts. Complete technical data on both models on request. *Aerocom* builds other radiotelegraph and telephone transmitters with accessories, and invites your inquiry if you have a communications problem.

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3090 Douglas Road, Miami 33, Florida

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

CAUTION

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Flexite

THE FLEXIBLE, EXTRUDED PLASTIC TUBING THAT RESISTS HIGH TEMPERATURES ABOVE • • • • 105° C

FLEXITE PHYSICAL & ELECTRICAL PROPERTIES

a—**tensile strength, minimum average** ..... 2500 PSI

b—**ultimate elongation, minimum average** 300%

c—**dielectric strength, minimum** ..... 800 v/mil

d—**flammability** ..... non-inflammable

e—**heat resistance**—after 100 hours at 300° F. the tubing is not brittle and when flexed does not crack.

f—**heat endurance**—recommended for continuous operating temperatures up to 105° C., and when baked at 125° C. for 2,000 hours does not become brittle.

g—**low temperature flexibility** ..... —30° C.

h—**heat shrinkage** ..... ASTM Standards

#20 — #17 incl. — less than 8%
#16 — # 6 incl. — less than 5%
5 and larger — less than 3%

i—**oil resistance**—highly resistant to effects of transformer and lubricating oils, does not stiffen when continuously exposed to them.

Colors—black, white, red, green, yellow and blue are standard colors.

Dimensions and Tolerances—standard sizes to fit B & S wires #20 to #0 inclusive, as specified by ASTM Spec. D922-47T.

Wall Thickness—in accordance with ASTM Spec. D922-47T, as follows:

#20 — #10 incl. — .016" ± .003"
9 — # 0 incl. — .020" ± .003"

Standard Lengths—Standard 36" lengths or continuous lengths in coils. Sizes #20 — #10 incl., will be supplied on paperboard spools when so ordered.

Quality—uniform in quality and condition, smooth on both inside and outside, free of defects such as pin-holes, blisters, foreign inclusions and other imperfections.

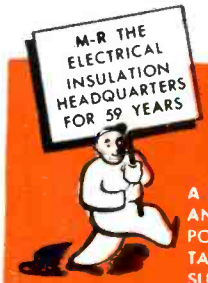
Test Methods—properties enumerated in above specifications shall be determined according to Tentative Methods of Testing Nonrigid Polyvinyl Tubing, American Society for Testing Materials, Designation D876-46T.

YES, FLEXITE is the electrical insulation tubing that sets new standards for resistance to extreme high temperatures. Compounded of a plasticized copolymer of vinyl chloride and vinyl acetate and manufactured with a true wall thickness, smooth inside and outside, FLEXITE PLASTIC TUBINGS offer the greatest resistance to high and low temperatures, are extremely flexible and have great tensile strength

Other significant properties of FLEXITE compare more than favorably with tubings of similar nature. Check the specifications of FLEXITE, compare them with the requirements for your products and if you wish against other insulations for identical use . . .

YES, FLEXITE sets a new high standard for protection against high temperatures, high dielectric, stretching, tearing, abrasion, exposure to acids, oils and alkalies, flammability, etc., etc., etc. — . . . samples and additional information will be sent upon request.

And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers . . . Flexite-Norm . . . write for specifications.



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Follow the Leaders to

Eimac

TUBES

The Power for R-F

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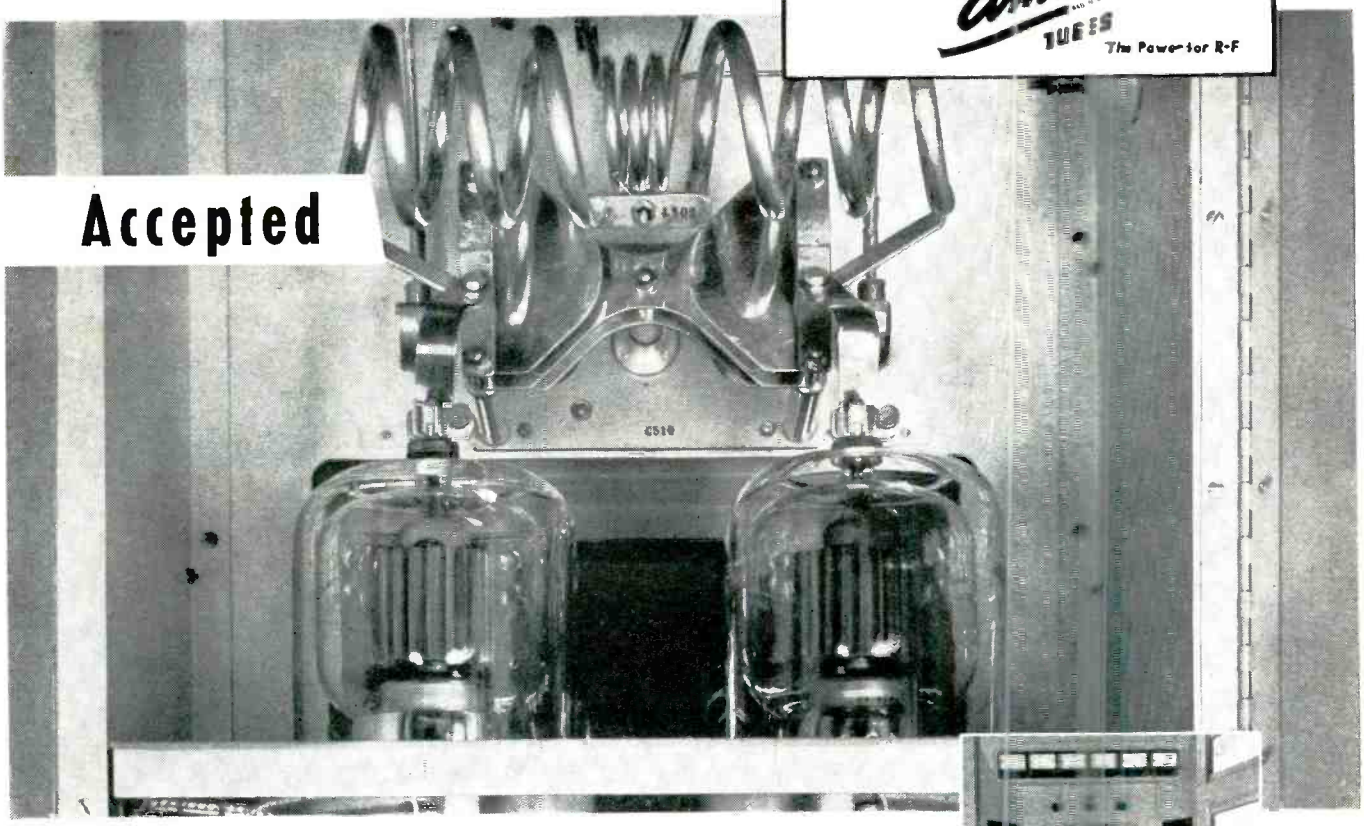
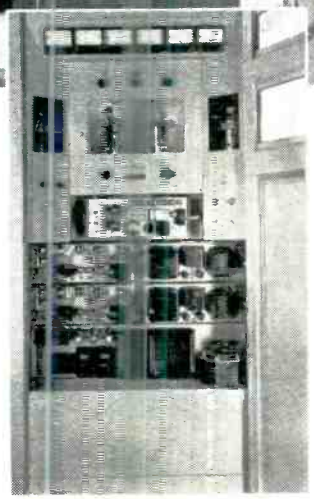


For Emergency Services . . . . The Link 3000UFS Transmitter and Eimac 4-1000A Tetrodes

Here's a team that fills the bill by providing the dependability of performance required by police and other emergency communication services.

Link Radio, well known manufacturers of radio communication equipment, in designing their 3 kw 30-50 Mc. FM transmitter choose Eimac 4-1000A tetrodes to power the final amplifier. The high power-gain of these tubes enabled Link to use their standard 50 watt transmitter as a driver. The resulting compact simplified transmitter is ideally suited for control through telephone circuits from remote locations. A single pair of telephone lines carries transmitter modulation, power control, overload relay reset, and frequency selection plus receiver output and selection.

Because of their power-gain abilities, stability and other exceptional characteristics, the 4-1000A tetrode offers the design engineer interesting potentialities . . . write direct for further information, data is available.



LINK 3000 UFS

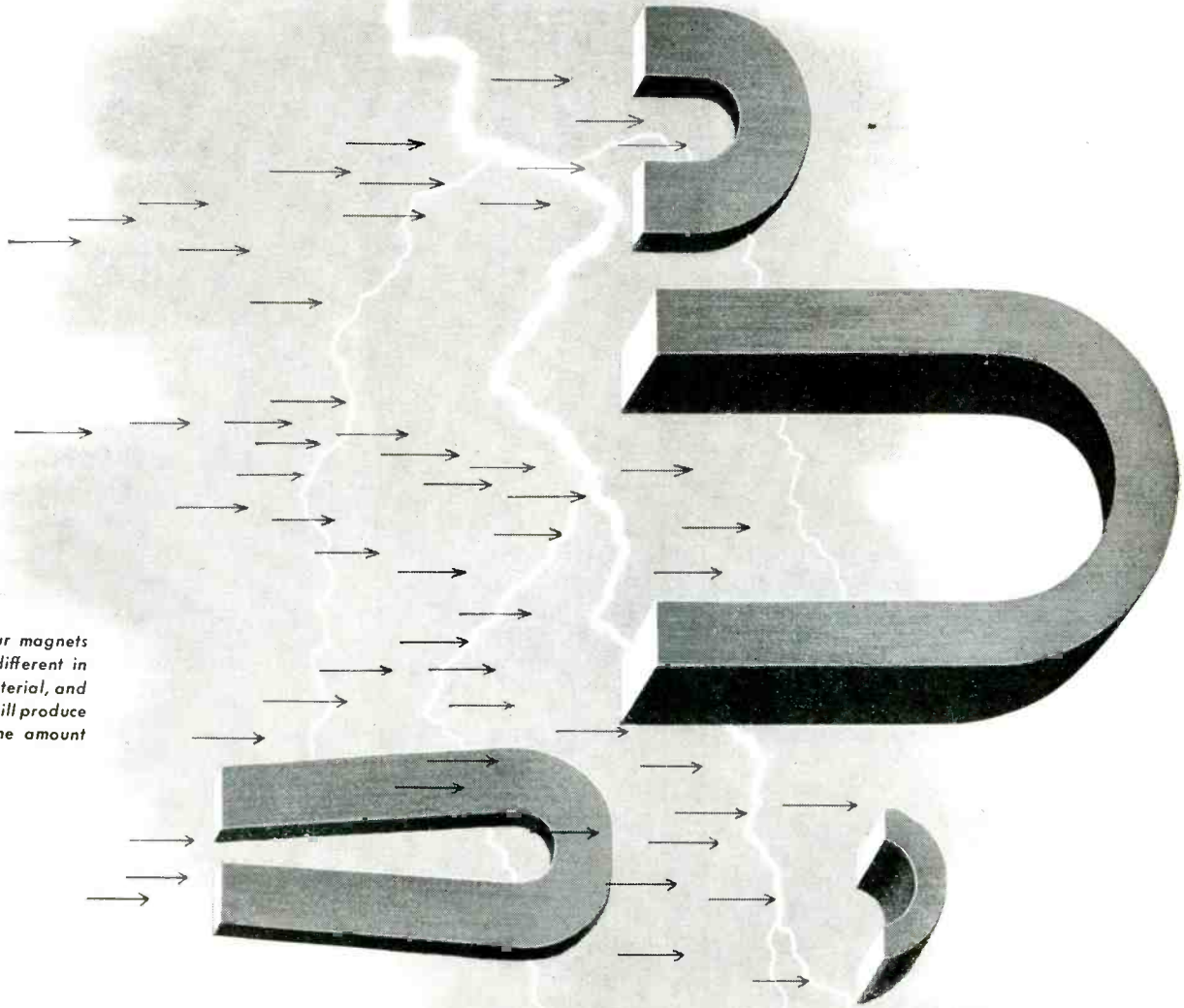
EIMAC 4-1000A TETRODE

EITEL-McCULLOUGH, INC.

212 San Mateo Ave., San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO



Each of the four magnets shown here is different in size, weight, material, and price; yet each will produce exactly the same amount of energy.

"PACKAGED ENERGY" SAVES SPACE, CUTS COSTS

INDIANA permanent magnets fit your need like a doctor's prescription—the right material, the right design, the *right* magnets to *do your job best.*

When you buy *Indiana* permanent magnets, you buy *product improvement* . . . new and higher efficiency . . . new versatility . . new economy. Today, *Indiana* magnets are performing operations that were impractical only a few years ago—actually replacing many mechanical and electrical devices—and with less weight, less bulk, *lower cost.*

For example, certain radar magnets of Alnico originally weighed 14 pounds. Through *redesign* by *Indiana,* their size was reduced materially and their weight cut to 3½ pounds. Both were of identical material; both produced the same energy. The substantial savings in weight and cost were accomplished wholly by a change in design. Consultation with our engineers may result in similar savings for you.

NEW! BOOKLET NO. 4-E3—TELLS ALL ABOUT PERMANENT MAGNETS. A NOTE ON YOUR COMPANY LETTERHEAD WILL BRING YOU A FREE COPY.

Indiana is the *only* manufacturer of all types of commercially used permanent magnet alloys. Continuous research and production control assure top quality and uniformity of *all* your *Indiana* permanent magnets, regardless of size or quantity. Call on our Special Design Service in solving *your* problems.

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PRODUCERS OF "PACKAGED ENERGY"

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SPECIALISTS IN PERMANENT MAGNETS SINCE 1908

PLANTS: VALPARAISO, INDIANA; CHAUNCEY, N. Y.

FOR ELECTRONIC HEATING

A great h-f tube now more dependable to install—because its *new* G-E water-jacket *seals more tightly, the higher the water pressure!*

GL-880 POWER TRIODE

WITH this step forward in tube installation technique, G.E.'s service-proved GL-880 triode becomes a "must" component of your next high-frequency-heater circuit. The new water-jacket is completely new in concept and design. Cooling water itself forces the seal—a neoprene "O" ring—always tighter. Even bursting pressures involve no leakage.

A simple, easily applied metal split-ring (see sketch) with large threads, exerts the start-off sealing effect, locking tube and "O" ring in place. After that the pressure of the circulating water takes over, producing an ever-more-effective seal.

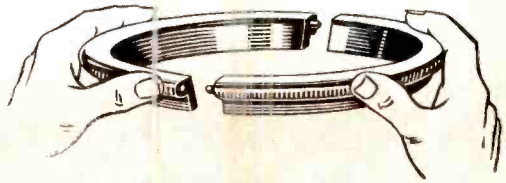
The new jacket is clean in contour, designed to reduce the chance of corona. Chrome-plating accents smart appearance and helps ward off corrosion. Bosses inside the jacket center the anode of the tube, so that water flows equally over the surface to be cooled. This protects against "hot spots" which would cause gassing and shorten tube life. In every way General Electric's superior new water-jacket contributes to satisfactory GL-880 performance!

Get further facts, including the favorable price, without delay. Phone your nearby G-E electronics office, or wire or write *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

CHARACTERISTICS, TYPE GL-880

Filament voltage		12.6 v
current		320 amp
Max plate ratings, Class C telegraphy:	(for dielectric h'g)	(for induction h'g)
voltage	10,500 v	15,000 v
current	6 amp	4.5 amp
input	60 kw	67.5 kw
dissipation	20 kw	20 kw
Frequency at max ratings	25 mc	1.5 mc
at 50-percent ratings	100 mc	———

Hands alone apply the split-ring that locks tube and neoprene seal in place. This method suffices for the water pressures commonly used to cool electronic tubes.



Other features of the new GL-880 water-jacket: its sealing properties are unaffected by production-tolerance differences in tube dimensions . . . All cast parts are centrifugally cast, to avoid porosity. In the three places where brazing is used, special electronic brazing assures a tight, uniform connection. Non-ferrous metals are employed throughout to minimize corrosion . . . A firmer tube installation results from the jacket's being designed to fit flush against the mounting flange . . . Either tapped or soldered water connections are available, depending on the customer's needs.

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180-H26-8850

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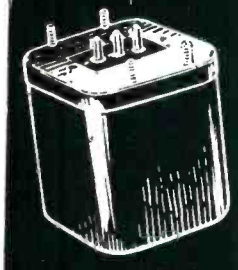

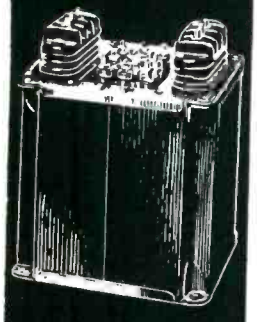

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KENYON now serves many leading companies including: **Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.**

Yes, *electronification* of modern industrial machinery and methods has been achieved by KENYON'S engineered, efficient and conservatively rated transformers.

For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! *Inquire today for information about our JAN approved transformers.*

Check Your Requirements

"T" LINE TRANSFORMERS
HERMETICALLY SEALED TRANSFORMERS
"A" LINE TRANSFORMERS

- ✓ PLATE TRANSFORMERS
- ✓ FILAMENT TRANSFORMERS
- ✓ REACTORS
- ✓ CHOKES
- ✓ MODULATION TRANSFORMERS
- ✓ INTERSTAGE TRANSFORMERS
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Now — for the first time in any transformer catalog, KENYON'S new modified edition tells the full complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for the latest edition of our catalog *now!*

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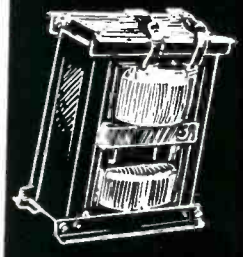
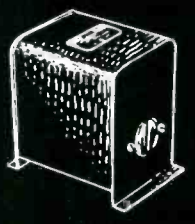
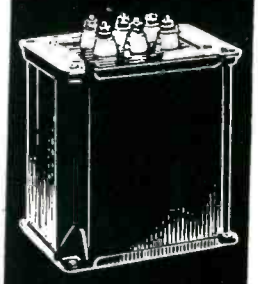
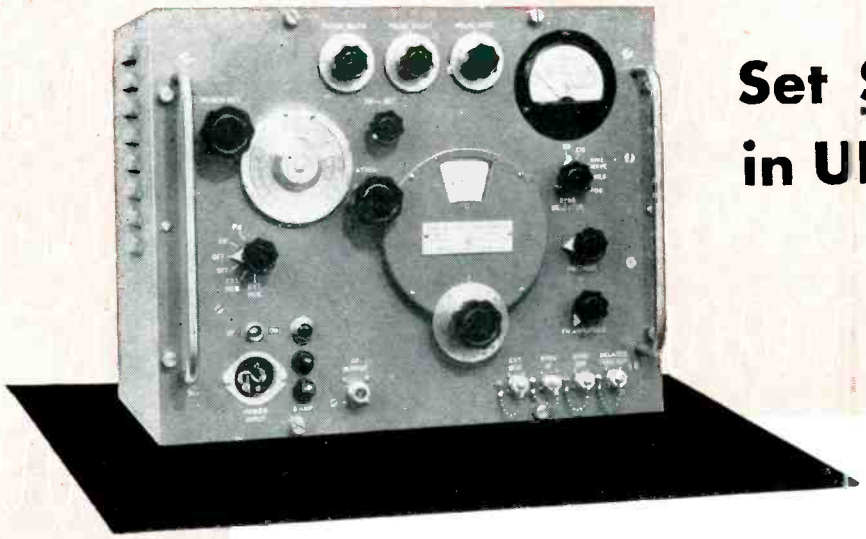






KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

MARION ...helps HEWLETT-PACKARD



Set Standards in UHF Signals

The Hewlett-Packard Model 616A is the only UHF Signal Generator which covers the 1800—4000 mcs frequency range and is directly calibrated in frequency and voltage output. Designed to withstand U. S. Aircraft Service conditions, it is used by the U. S. Air Corps, Army, Navy, research laboratories, schools and colleges throughout the world.

At -hp's- request, Marion developed a small, specially designed panel-mounting type of meter for the Model 616A UHF Signal Generator. This indicates power level and gives fast direct readings in decibels. Thus does it play a vital part in helping -hp- generate UHF signals with accuracy so precise that it sets standards used to measure *receiver sensitivity, signal-noise ratio, conversion gain, standing wave ratios, antenna gain* and *transmission line characteristics.*

When you need general or special-purpose meters for electrical indicating or measuring functions, you are invited to call on Marion. We at Marion have had long and *practical* experience in helping others with these problems. We would like to help you too.

THE NAME "MARION" MEANS THE "MOST" IN METERS

M·E·I

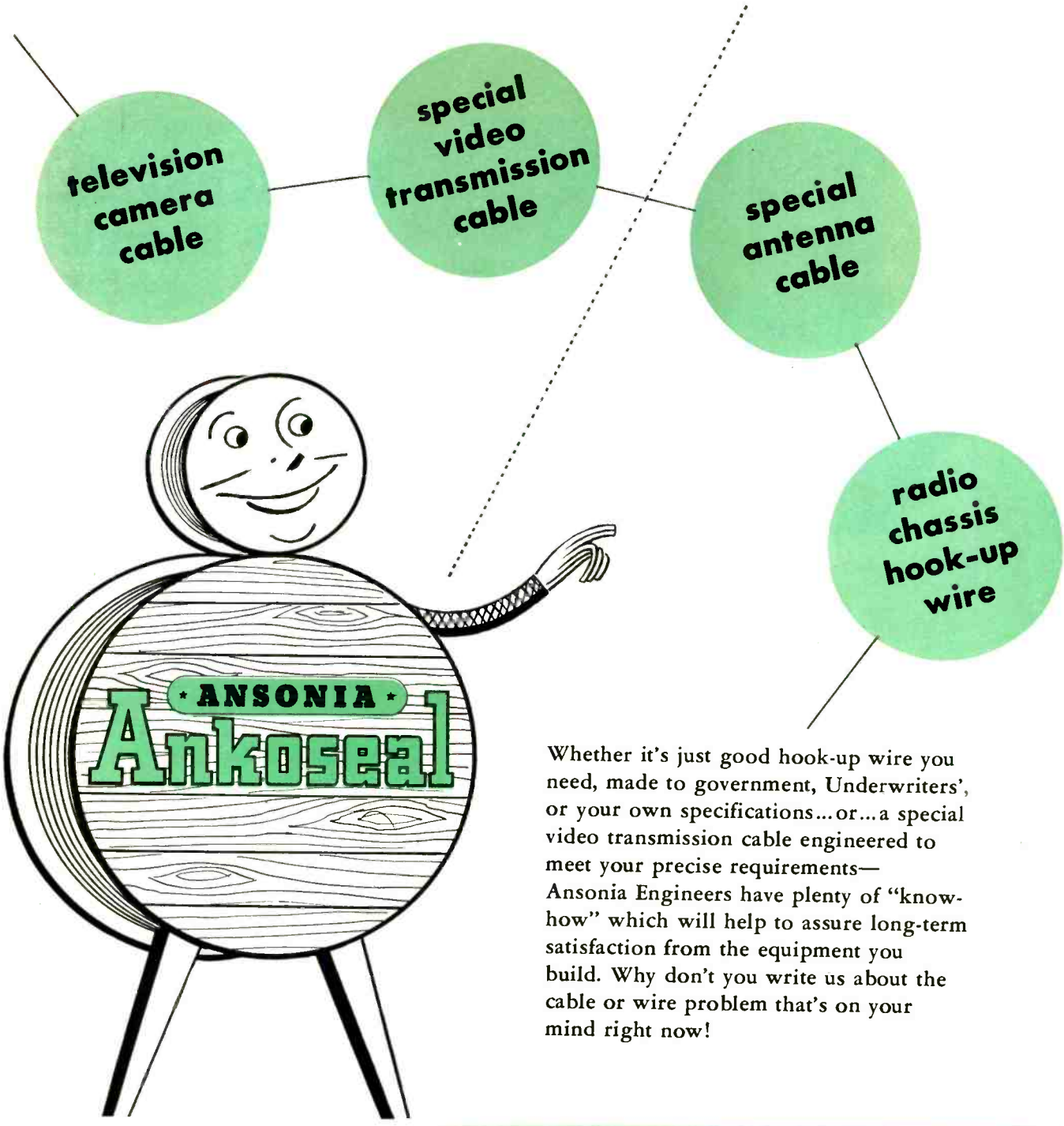
MARION ELECTRICAL INSTRUMENT COMPANY

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

"Which of these is on your mind?"



Whether it's just good hook-up wire you need, made to government, Underwriters', or your own specifications... or... a special video transmission cable engineered to meet your precise requirements— Ansonia Engineers have plenty of "know-how" which will help to assure long-term satisfaction from the equipment you build. Why don't you write us about the cable or wire problem that's on your mind right now!

THE ANSONIA ELECTRICAL COMPANY

SUBSIDIARY OF NOMA ELECTRIC CORPORATION

ANSONIA, CONNECTICUT

A NEW ADDITION TO THE ALLEN-BRADLEY PLANT FOR PRODUCING A-B FIXED AND ADJUSTABLE RESISTORS

A REPORT to the Radio Industry about Allen-Bradley Radio Resistors

Radio manufacturers have discovered that fixed resistors of run-of-mine quality will not meet the requirements of television circuits.

This situation has, overnight, created an unprecedented demand for the top quality and stability found in Allen-Bradley fixed resistors. In spite of weekly shipments of many millions of Bradleyunits in ½-watt, 1-watt, and 2-watt ratings, the current demand still far exceeds the capacity of the Allen-Bradley radio resistor department . . . and our customers are unhappy with our resistor deliveries.

But a large addition to the Allen-Bradley factory is under way. Much additional resistor production machinery is under construction. However, it will take time before these facilities will be ready for the increased production of Bradleyunits.

Meantime, Allen-Bradley is working twenty-four hours per day—seven days per week—to produce the maximum output of Bradleyunits. It is physically impossible to do more at this time.

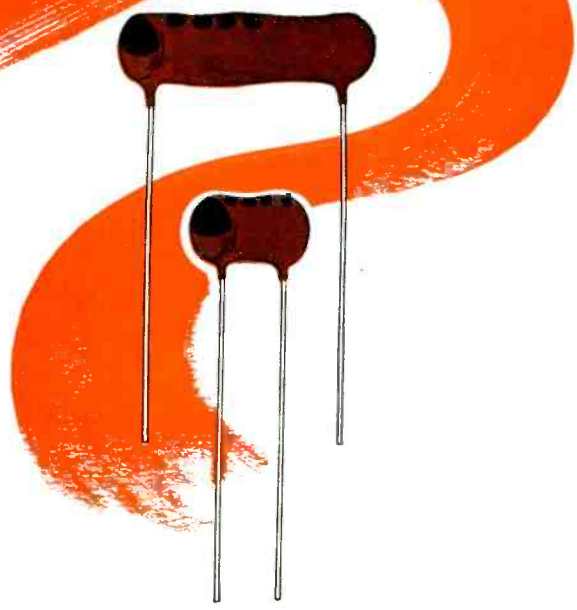
During this stringency, we appeal to the radio industry to restrict its use of our products to applications in which Bradleyunit quality performance is absolutely essential.

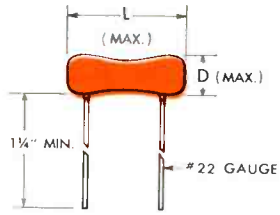
ALLEN-BRADLEY COMPANY, 110 W. GREENFIELD AVE., MILWAUKEE 4, WISCONSIN

New...

for positive identification...

ERIE Radial Lead Insulated CERAMICONS® now have distinctive *red bodies*





DIPPED PHENOLIC INSULATED

Style	Dia. "D"	Length "L"	Max. Cap.
331	.240	.460	715 MMF
332	.240	.710	1500 MMF
338	.312	.550	2000 MMF
337	.312	.937	4100 MMF
333	.315	1.250	5100 MMF
344	.415	1.213	8000 MMF
335	.415	1.650	.012 MFD
336	.415	2.025	.016 MFD

ERIE brings order out of confusion . . . by the simple expedient of giving ERIE radial lead, dipped phenolic coated Ceramicons distinctive red bodies.

In the past manufacturers have found it almost impossible to differentiate between the various makes of such condensers. The common brown body color has sometimes caused confusion in incoming inspection departments and in the final assembly lines. In addition, it has been difficult to fix responsibility for any service reports.

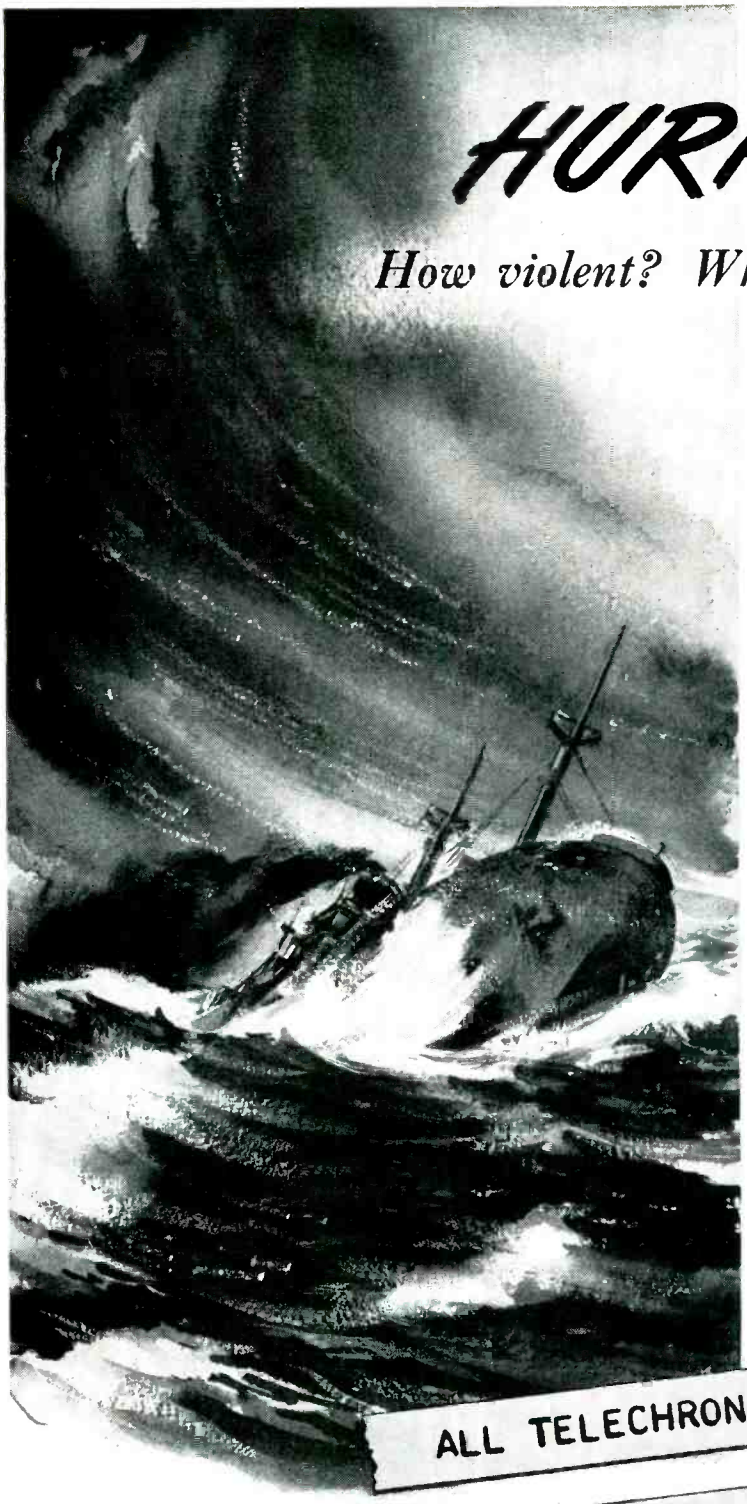
Now, ERIE Radial Lead Insulated Ceramicons are positively and unmistakably identified . . . and the red body also makes it easier to read all RMA color code dots. ERIE axial lead ceramicons will continue to have molded low-loss phenolic insulation.

When you see ceramic condensers with the red body color, you can be sure you have high-quality, dependable ERIE radial lead insulated Ceramicons which will "stay put" in your chassis for the life of the set.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND TORONTO, CANADA.



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.

Telechron®

ALL TELECHRON TIMING MOTORS ARE INSTANTLY . . . CONSTANTLY SYNCHRONOUS

Telechron Inc. A General Electric Affiliate
40 Union Street
Ashland, Massachusetts

Please send me information on Telechron Synchronous Motors (maximum torque: 2 pound inches at 1 rpm). My possible application is:

- ☐ Instruments
- ☐ 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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NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

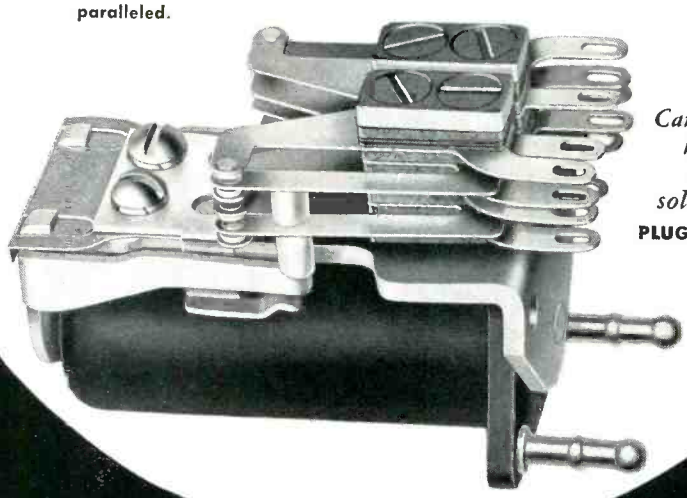
COIL POWER: From 40 milliwatts to 7 watts D.C.

CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS:
$1\frac{5}{8}$" HIGH, $2\frac{7}{32}$" LONG, $1\frac{3}{32}$" WIDE

These are the dimensions for the 6 pole relay.

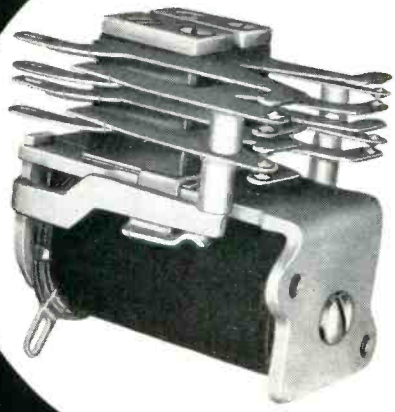
Will meet Army and Navy aircraft specifications as a component unit.



Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING-SPECIAL.

SK RELAY



MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

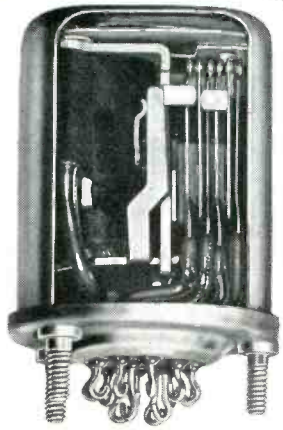
CONTACTS: Same as "LK".

DIMENSIONS: $1\frac{1}{2}$" HIGH, $1\frac{9}{16}$" LONG, $\frac{31}{32}$" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS. PLUG-IN—SPECIAL.



SK, HERMETICALLY SEALED

AL-132

ALLIED CONTROL CO. INC. 2 EAST END AVE., NEW YORK 21, N. Y.

BE SURE TO SEE ALLIED AT THE I.R.E. SHOW. BOOTH 280 GRAND CENTRAL PALACE, NEW YORK CITY.

Top to bottom: two Collins 51N-4 communication receivers, Collins 706A-1 radioteletype converter, and Collins 707A-1 power supply.

Announcing

. . . the New Collins Radioteletype Receiving Package

● The new Collins radioteletype receiving package is engineered for applications where extreme reliability is required in the reception and conversion of single channel or multiplex printer transmissions.

The Collins 706A-1 converter, heart of the package, is designed to operate from the output of two Collins 51N-4 communication receivers arranged for diversity reception of frequency shift signals.

The electrical circuits of the 706A-1 consist of two input filters, two limiters, two discriminators, a channel selector, a mark-hold circuit, and output amplifier circuits which provide proper direct current voltages to operate printer equipment located either locally or remotely. All d-c and a-c voltages for the converter are provided by the 707A-1 power supply.

The 51N-4 receivers employed are highly efficient single-channel superheterodynes, thoroughly engineered for reliable continuous duty. The use of six tuned circuits ahead of the mixer gives more than 60 db rejection of image response.

New Collins radioteletype transmitting equipment is also in production. We will be glad to give you further information on request.

Be sure to visit our booths 75 through 80 at the I. R. E. Convention

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, New York 18, N. Y.

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Introducing A NEW TEAM TO

Combining Research—Development—Manufacturing Skill

Here's great news for broadcasters and industrial tube users. Machlett Laboratories and Graybar Electric Company have joined forces in a new distribution line-up to bring you more efficient and complete service on electron tubes.

For over a half century, Machlett has pioneered and made notable contributions to the development of the electron tube art. Today, through its modern plant, development laboratories and skilled personnel, Machlett tubes will set the highest standard of performance in broadcast and industrial service.

This combination of Machlett and Graybar is your best assurance of getting superior tubes. For better value—better service—try Machlett tubes now distributed via Graybar.

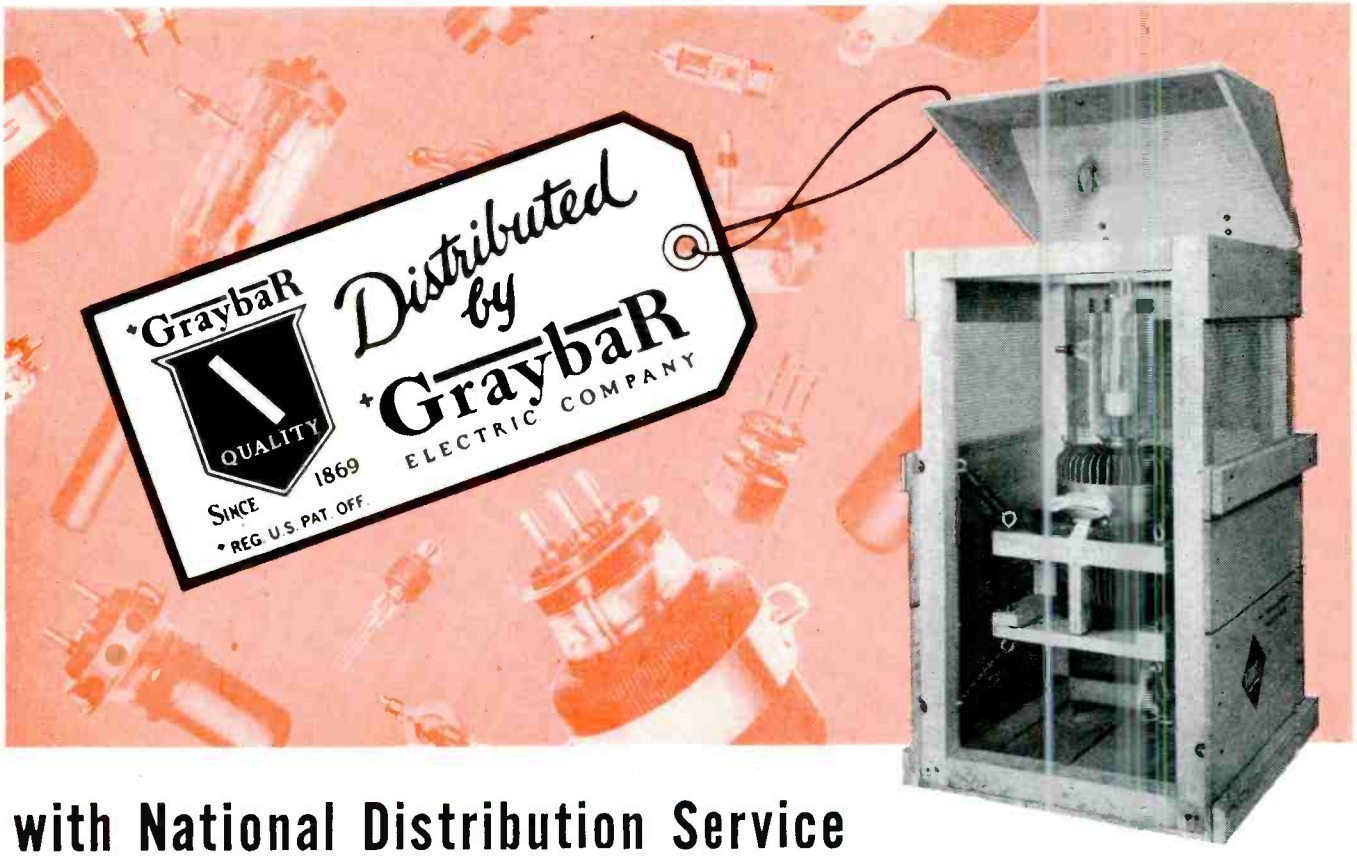
TO SEE THE FULL LINE OF MACHLETT TUBES, VISIT THE GRAYBAR BOOTH, NO. 96-97, AT THE IRE SHOW, MARCH 7-10.

MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

Famous as the outstanding manufacturer of X-ray tubes, the name, Machlett, on electron tubes has been the mark of quality, top performance and long life for more than 50 years. Experience, skill and a "singleness of purpose" to produce the best in electron tubes have made Machlett first choice around the world.

MACHLETT LABORATORIES, INC., Springdale, Connecticut

SERVE BROADCASTERS AND INDUSTRY



with National Distribution Service

In keeping with its policy of "Bringing You Broadcasting's Best Equipment," Graybar is proud to assign its Tag—the Symbol of Distribution—to the Machlett line of electron tubes for both broadcasters and industry.

This new connection will bring you dual benefits: (1) products from an outstanding manufacturer of electron tubes, (2) distribution service from an organization offering specialized assistance in choosing the best type of product for your requirements.

Machlett tubes can now be quickly and conveniently ordered through near-by Graybar "Supply Stations" located in over 100 principal cities from coast-to-coast. When you order Machlett tubes "via Graybar," you'll have the right combination for extra service and performance.

Call your local Graybar Representative. Graybar Electric Company, Inc., Executive Offices: Graybar Building, New York 17, N. Y.

EVERYTHING ELECTRICAL TO KEEP YOU ON THE AIR

via Graybar

These are the Graybar Broadcast Equipment and Electron Tube Specialists in key cities:

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E. W. Stone, Cypress 1751

BOSTON
J. P. Lynch, Kenmore 6-4567

CHICAGO
E. H. Taylor, Canal 4104

CINCINNATI
J. R. Thompson, Main 0600

CLEVELAND
W. E. Rockwell, Cherry 1360

DALLAS
C. C. Ross, Central 6454

DETROIT
P. L. Gundy, Temple 1-5500

JACKSONVILLE
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KANSAS CITY, MO.
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Transformer built by Moser-Glaser for Ciba Ltd., internationally famous manufacturers of chemical products. It is a "DLS-100", 94 kva, 220 volt, three phase, 50 cycle Adjustable Voltage Type with a five-step switch mounted on top. Switching is done under oil. All leads are insulated and protected by Natvar 400, the Extruded Vinyl Tubing with superior resistance to *both* heat and oil.

NATVAR 400 *in* SWITZERLAND!

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
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- Varnished silk
- Varnished special rayon
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- Slot insulation
- Varnished tubings and sleevings
- Varnished identification markers
- Lacquered tubings and sleevings
- Extruded vinyl tubing and tape
- Extruded vinyl identification markers

Ask for Catalog No. 21

Moser-Glaser & Co., A.G., well-known electrical manufacturing firm, Muttenz bei Basel, Switzerland, use Natvar 400 Extruded Vinyl Tubing to insulate and protect leads of their transformers. They know that it will meet operating temperature requirements (approved for 105° C), and at the same time provide uniformly superior resistance to oil.

This tubing is supplied through Micafil A.G., Zurich-Alstetten, Switzerland, Natvar agents for Switzerland, Austria, Bulgaria, Czechoslovakia, England, France, Germany, Greece, Holland, Hungary, Italy, Luxemburg, Rumania, Spain, Turkey and Yugoslavia.

Prompt deliveries can be made either from a conveniently located wholesaler's stock or direct from our own. Full Underwriters' report on request.

THE NATIONAL VARNISHED PRODUCTS Corporation

TELEPHONE RAHWAY 7-2171

CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE ★ WOODBRIDGE NEW JERSEY

"Give us the tools . . ."

McGraw-Hill Surveys BUSINESS NEEDS

If it can get the money American industry in 1949 will go full steam ahead with a vitally-needed program of improving its facilities. This program since V-J Day has kept business expanding and has made belated headway in modernizing industry.

Furthermore, if it can get the money American industry will carry on for the next five years with its unprecedented program of expenditure for new plant and equipment. Plans already made call for spending about $55 billion.

These are findings of the McGraw-Hill national survey of "Business' Needs for New Plants and Equipment." Major results of the survey, which have been rechecked since election day, are summarized on the following page. They report what American industry is now planning to spend for new plant and equipment. *They do not and cannot show what will be done if the plans are hamstrung by political action.*

In 1949, the survey shows, American industry plans to spend $14.1 billion for new plants and equipment. That is only about 5% less than was actually spent in 1948.

If these plans are carried out, actual capital expenditures this year may be somewhat larger than they were in 1948. That is because expenditures usually prove to be larger than planned.

Fulfillment of American industry's plans for investment in new plant and equipment this year would no doubt mean a continuation of general prosperity. The record shows that when capital expenditures are high general business thrives.

Even more remarkable than the 1949 prospect is the fact that:

Industry already plans to spend $41 billion in the years 1950-53 to improve its plants and equipment.

Plans tend to taper off, of course, as they are pushed further into the uncertain future, five years from now. But the striking fact is that plans for expenditures so far ahead are as great as they are. They show American industry's need for tremendous improvements in its plants and equipment.

Again, let there be no mistake. These survey findings are not a five-year forecast. They report what leading corporations now are planning to do – *if they can get the money.*

But – won't industry be top-heavy with plants and equipment if it carries through any such program?

The answer is clearly – "No".

Here are some of the reasons why not that were disclosed by the McGraw-Hill survey:

First, manufacturing industries are shifting emphasis from expansion to improving efficiency.

They have increased their total capacity 56% since 1939. Their expenditures in 1948 went almost 50-50 for expansion and improvement. But in the next five years they plan to spend three-quarters of their funds to replace and modernize facilities, only one-quarter for expansion.

Second, the prospective rate of expenditure for new plant and equipment is relatively low.

Planned expenditures for new plant and equipment in 1949 represent about 7.5% of the present value of all plant and equipment. That rate of capital expenditure is no higher than the rate during previous periods of prosperity. And industry must overcome years of starvation for new equipment, caused first by the depression of the 30's, then by diversion to war production.

Third, industry is following an extremely cautious policy in buying new equipment.

Three out of four companies report that they will not buy equipment unless it will pay for itself within five years. And a third of the companies report that they expect new equipment to pay for itself within three years. The reason most frequently given for such expectations was that all the money available can be spent on equipment which does pay for itself quickly.

The program of capital expenditure planned by American industry is one of the greatest bargains ever offered to the American people.

To pay for itself in a few years, as equipment must if most companies are to consider buying it, that equipment

continued on next page

WHAT THE SURVEY SHOWS

● HERE ARE THE MAJOR FINDINGS of McGraw-Hill's survey of "Business' Needs for New Plants and Equipment". Rechecked since Election Day, results show what industry is now *planning* to spend for new plants and equipment. They do not forecast what will actually be spent. The survey shows:

1. Industry now plans to spend $14.1 billion in 1949 – and almost $41 billion in the four years beyond, 1950-53.
2. Manufacturing industries alone plan to spend $7.2 billion in 1949. This is 7.5% of the estimated value – $96 billion – of all manufacturing facilities.
3. Manufacturers estimate conservatively that it would cost $136 billion to completely replace their facilities with the most modern plants and equipment available.
4. Postwar expansion is virtually complete in most manufacturing lines. Major exceptions: steel and petroleum refining.
5. Expansion programs of railroads, utilities, and oil companies still have two to five years to run.
6. Manufacturing industries have increased their capacity 56% since 1939. But expansion is slowing down. Increase planned in the next five years is only 13%.
7. Efficiency is emphasized more and more in planning new facilities. Manufacturers plan to devote almost three-quarters of their funds to replace and modernize. In 1948, 58% went to increase efficiency this way.
8. Equipment should pay for itself in five years or less, say three out of four manufacturing companies. New buildings, say 77% of them, should pay out in 15 years or less.
9. Profits and reserves are counted on to pay for new buildings and equipment by three out of four manufacturing companies. Some 15% expect to borrow, only 9% plan to sell stock. However, 20% would like to sell stock, only 4% want to borrow.
10. More liberal depreciation allowances for income tax purposes would prompt almost two-thirds of the companies to speed their purchase of new plants and equipment.

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

must promise to produce much better products or make great savings in labor and material. The savings go first to the companies buying the equipment but, as they always have, they soon spread to everyone in the form of better products at lower costs.

Where does industry expect to get the money to buy this bargain for the American people?

Most of the companies covered by the McGraw-Hill survey (76% of the total) count on their own resources – largely profits – to pay for new plant and equipment. About 15% of them expect to borrow money, although only 4% like the idea of getting saddled with fixed debt. Only 9% of the companies expect to sell stock to investors, although twice that many report they wish they could.

What are the chances that business can get the money?

The survey provides no answer to that question. No survey can.

The answer will come from Washington – in what Congress does about taxes on profits and taxes on the millions of Americans who might invest a part of their income in industry's new plants and equipment.

The answer will be found also in the energy and skill shown by investment bankers, particularly in mobilizing the resources of the millions of Americans whose incomes have increased enough since 1940 to make them potential direct investors in industry.

Still another important part of the answer will be given by labor leaders. About half the companies surveyed by McGraw-Hill are holding back on new construction – primarily because of high costs. What organized labor does about wages and productivity can swell or shrink that percentage.

The McGraw-Hill survey leaves no doubt that American industry is fulfilling its responsibility. It is planning the capital improvements needed to make the nation secure, prosperous, and progressive.

But business today lacks confidence and badly needs added incentives. Proper taxation and increased depreciation allowances are vital if we are to open the capital markets to finance industry.

What will happen now depends in large part on what is done in Washington. In his State of the Union message, the President said that "business should plan for steady, vigorous expansion." But in his budget message he proposed new taxes which would divert a substantial share of the money industry is using for expansion and improvement. Moreover, he said nothing about the vital issues now freezing the capital markets.

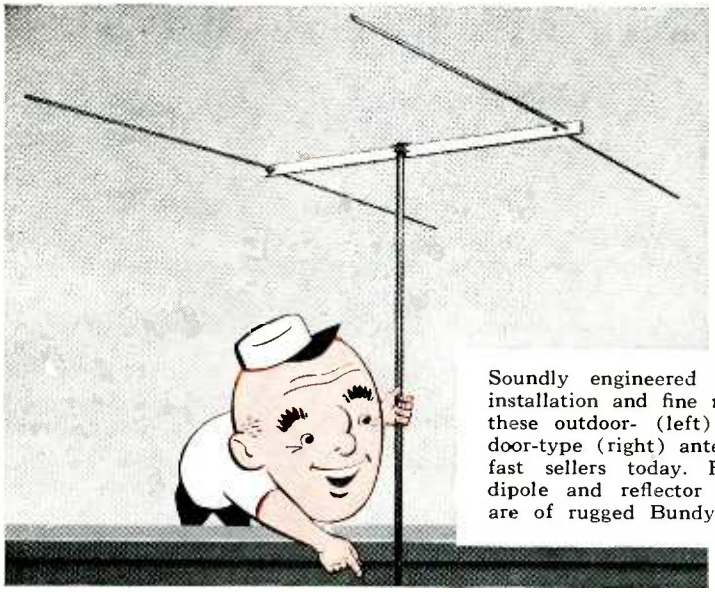
It is not possible to have it both ways. Fulfillment of the President's tax program means cutting industry's program for new and better equipment. It means slowing down industrial progress. It means delaying the advance toward much higher standards of living tomorrow in order to have a little more government spending today.

I urge you to see that your Representative and your Senator have all the facts on industry's needs for new plant and equipment. What they do to this program will have a decisive bearing on the nation's security and welfare.

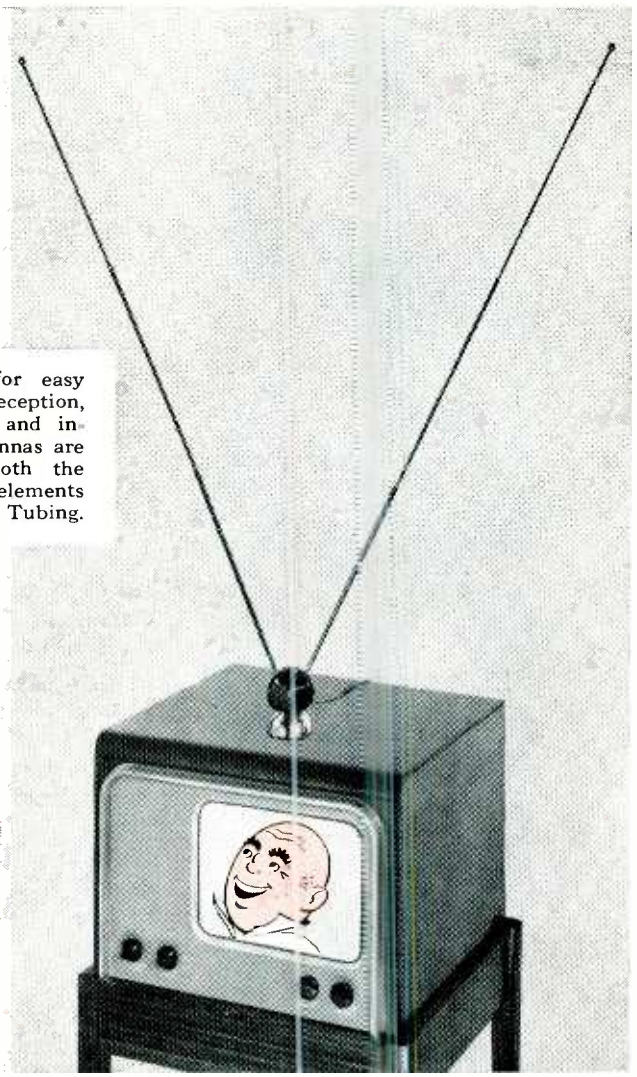
James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

This is the fourth editorial of a special series on industry's needs for new plants and equipment – and what these needs mean to all Americans.



Soundly engineered for easy installation and fine reception, these outdoor- (left) and indoor-type (right) antennas are fast sellers today. Both the dipole and reflector elements are of rugged Bundy Tubing.



Look at Bundyweld* for better TV antennas

Do you make television antennas, either the indoor or outdoor type?

If so, you most certainly should consider Bundyweld* Tubing. Many other manufacturers have and they are turning out better antennas at lower costs because of Bundyweld's special advantages.

Double-walled Bundyweld is strong yet ductile. Simply stated, this means greater ease of fabrication for you.

It can also be supplied in the hard-drawn condition. This makes it doubly well suited for dipole and reflector elements, which must take all kinds of wind and weather without swaying or sagging.

Bundyweld is inexpensive. It lowers production costs, saves production time, gives better television antennas at bigger profits to you.

See us at the Show

Stop in and say hello to us at Grand Central Palace, New York, March 7-10, if you're attending the I.R.E. National Convention. If you don't get an opportunity to visit our exhibit there, contact your near-by Bundy representative, among those listed below, for the full story on Bundyweld or write directly to *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

*REG. U. S. PAT. OFF. ®

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

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BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY INTERNATIONAL NICKEL COMPANY DISTRIBUTORS IN PRINCIPAL CITIES.

BUSINESS BRIEFS

By W. W. MacDONALD

Sylvania's Frank Mansfield says television sets are standing up much better than many manufacturers expected. According to a recent survey 58 percent of several hundred dealers contacted said that sets were performing virtually without service, 27 percent said the necessity for service was about the same as in connection with radios, 7 percent reported continual trouble, and the remaining 8 percent said they had not yet had enough experience to comment.

Regarding screen size, 84 percent of the dealers said sets with 10-inch tubes sold best in 1948, 9 said 7-inch, 6 said 12-inch, and 1 said larger direct-view and projection types. Concerning 1949, 44 percent said they expected 12-inch types to sell best, 42 said 10-inch, 2 said 7-inch and 12 expected to do best with very-large-screen models.

Tele Set And Tube Makers are understandably cagey about predicting the life of c-r tubes but it does seem to be narrowing down to something between two and four years under average conditions of use. This forecasts a very healthy replacement market.

Television Receiving Antennas will use about 53,000,000 feet of tubing in 1949. This estimate is based upon the assumption that the average array will consist of a high-band folded dipole and reflector and a similar arrangement for the low band, that 90 percent of the receivers installed will be equipped with outside antennas, and that 2,000,000 sets will be sold.

A Custom Home Builder on Long Island reports that his last three customers have specified television-antenna mounting brackets and conduits for transmission lines as part of their contracts.

Speaking Of Long Island, our Manager, Wally Blood, says he almost spent a lost weekend out there when he wandered off a main road to duck traffic. Then he remembered that television antennas point toward the big city, noted their position and drove home on the beam.

We Are Indebted to A. P. Bock of Westinghouse for suggesting a method by which the cost of operating industrial radio-frequency heating apparatus may be roughly determined.

Required generator power is estimated by applying to the job under consideration the equation

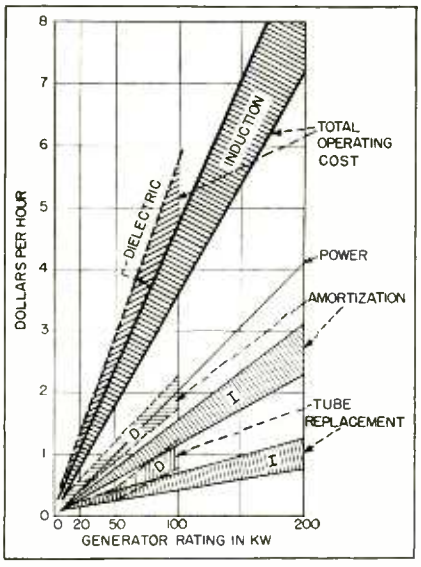
$$KW = \frac{\text{lbs/hr} \times \text{specific heat} \times \text{degrees rise F}}{3{,}413}$$

adding, if water is to be evaporated during the heating cycle,

$$KW = \frac{\text{lbs/hr of water evaporated} \times 970}{3{,}413}$$

then adding 10 percent of the overall figure for safety and, finally, looking up the cost of operating a generator of the required power in the accompanying graph.

Labor required to operate the



heating apparatus, generally unskilled and relatively inexpensive, is not included in the graph. Nor is the cost of any machinery needed to bring work to the heater. It should also be noted that figures resulting from the use of the graph apply to applications in which the heating apparatus is in

HERE'S THE FIRST BIG FM NEWS FROM REL FOR 1949!

THE REL MODEL 707 FM RELAY LINK

A complete 890 to 960 mc system for $3950

F.O.B. FACTORY—LONG ISLAND CITY, N. Y.

EQUIPMENT INCLUDES:

1. CRYSTAL CONTROLLED 5 WATT TRANSMITTER MOUNTED IN RELAY RACK CABINET
2. 15 db PARABOLIC TRANSMITTING ANTENNA
3. CRYSTAL CONTROLLED RECEIVER MOUNTED IN RELAY RACK CABINET
4. 15 db PARABOLIC RECEIVING ANTENNA
5. ONE COMPLETE SET OF TUBES AND CRYSTALS

. . offering wide application for FM STL, all other aural broadcast STL requirements, point-to-point communication, multi-channel voice relay systems.

The Model 707 FM Relay Link is a high quality equipment that meets or betters FCC and RMA requirements for FM studio-to-transmitter link in the 940 to 952 mc band or a one-way voice communication relay system within the 890 to 960 mc band. It is also recommended for inexpensive but highly reliable relay service where multiple voice frequency channels are desired. With suitable terminal equipment five such channels can be handled.

Salient features of this equipment include low first cost, low maintenance (all tubes are standard low cost types) and exceptional performance characteristics resulting from the application of the REL SERRASOID MODULATOR to the system. Complete details including field performance of the basic design covering many months will be supplied promptly on request on company letterhead. **Visit us at Booths 324-326 at the IRE Show, Grand Central Palace, New York.**

ELECTRICAL PERFORMANCE

- FREQUENCY: 890 to 960 megacycles.
- FM SIGNAL TO NOISE RATIO: 70 db. below 100% modulation.
- AUDIO RESPONSE: 0.5 db., 50 to 15,000 cycles.
- DISTORTION: Harmonic distortion is .50% at 100% modulation.
- CENTER FREQUENCY TOLERANCE: .003%.
- PRIMARY POWER: 115 volts, 60 cycles, single phase.
- TRANSMITTER AUDIO INPUT: Impedance—600/150 ohms Level—+10 dbm, balanced or unbalanced.
- RECEIVER AUDIO INPUT: Impedance—600/150 ohms Level — +18 dbm maximum, balanced or unbalanced.
- TRANSMITTER POWER OUTPUT: 5 watts.
- MODULATION BAND WIDTH: 50-20,000 cycles.
- SPACE ATTENUATION: For signal to noise ratio of 70 db. with 75 microseconds de-emphasis, 105 db. max.

REL **RADIO ENGINEERING LABS • INC**

35-56—36th STREET, LONG ISLAND CITY 1, N. Y.

more or less continuous use during the work day. Costs increase sharply where the duty cycle is short.

Power cost is figured at 1 cent per kilowatt-hour. Five years is allowed for amortization of initial costs, with the apparatus operating 16 hours per day. Tube life is estimated at 3,000 to 5,000 hours.

Licensed Radio Stations totalled 140,838 as of October 31, 1948, broken down as follows:

Broadcast	
Standard (a-m)	2,103
Frequency-modulation	996
Remote pickup	578
Television (experimental)	168
Television	124
Noncommercial educational	46
International	37
Studio-transmitter	22
Developmental	15
Facsimile	2
Non-Broadcast	
Amateur	81,170
Aeronautical	24,596
Marine	17,172
Police	4,308
Taxicab	3,188
Utility	2,025
General industrial	822
Experimental	555
Forestry	516
Petroleum	515
Railroad	235
Highway maintenance	141
Fire	97
Special emergency	92
Transit utility	83
Lumber	69
Citizens	66
Intercity busses and trucks	32
Common Carrier	
General mobile	855
Experimental	127
Fixed public telegraph	56
Fixed public telephone	27

Licensed operators totalled 534,917, broken down as follows:

Commercial	363,000
Aircraft radiotelephone	91,368
Amateur	80,549

Mort Kahn of Temco claims the average age of radio amateurs is rising. Anyone else, outside of ourselves, share that view?

Industrial Instrumentation is one of the most important influences on improved living standards, better working conditions and, ultimately, lower prices, according to Henry Dever of Brown Instruments.

Dever says that the ratio of instrumentation to overall plant expansion has increased fourfold since 1939, that measuring and controlling devices experienced a sales increase of 11 percent in 1948 over 1947, and that this same rate of expansion should carry through 1949 and possibly 1950.

Instrument sales totalled $30,000,000 in 1920 and $150,000,000

in 1940. In 1948, according to Dever, some 1,200 companies turned out about 20,000 types of instruments and instrument-equipped industrial apparatus having a sales value in excess of $2 billions.

Development of three electronic devices designed to facilitate the landing, departure and taxiing of aircraft in instrument weather has been suggested to the Air Navigation Development Board by the Air Coordinating Committee's Air Navigation Panel, as an initial step in the government's 15-year, billion-dollar, all-weather airways program.

The three devices for which priority is recommended are: Airport Surface- Movement Detection Equipment, the Airport Approach-Control Timer, and the Interim Private-Line Visual Communications System.

F-M Industry is now a billion-dollar industry, according to the F-M Association. The estimate covers total investment in stations and sets.

Taken To Task about a statement we made in January (p 71) to the effect that the cost of operating hearing aids might soon drop below one cent an hour, we hasten to add what we should have included in the original item. We meant the cost of operating *single-unit* aids with internal batteries. And we meant devices turning out high rather than so-called low or medium audio power.

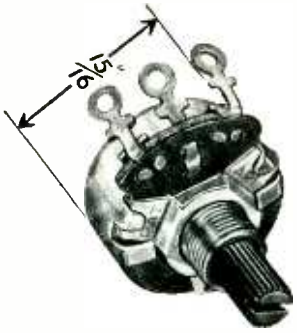
A number of aids using external batteries operate well below the cent-an-hour figure, some closer to a half cent. There are even a few operating for less than a cent an hour on internal batteries, turning out sufficient power to be useful to perhaps 50 percent of the potential users.

Hope this makes everybody happy.

Discussing Phonograph Records, an engineer of our acquaintance made what we consider an apt though somewhat cryptic remark. He says that so far as he can see the only immediate effect of the latest innovation will be to put a bigger hole in the business.

P. R. MALLORY & CO. Inc.

MALLORY Midgetrol



Has Designing Ways

MALLORY

sets the pace in carbon controls with the revolutionary Mallory Midgetrol.

NEW TELEVISION TYPES
Resistance stability specially provides for critical applications in television circuits. Insulated shafts are knurled for ease in adjustment. Shaft and current-carrying parts provide 2000-volt insulation.

NEW SMALL SIZE
The small size of 1 1/16" diameter saves precious space, can be specified where a 1 1/8" diameter control ordinarily would be required.

NEW FLAT SHAFT
It makes possible a standardization of products which means faster production schedules and faster deliveries.

NEW TWO-POINT SHAFT SUSPENSION
Double bearing suspension of the new flat shaft eliminates shaft wobble. Assures smooth, even contact pressure on the resistance element. Improves the quality of the control mechanically and electrically.

NEW RESISTANCE ELEMENT
Resistance element is automatically machine-coated and electronically selected to eliminate any chance of human error.

NEW CONSTRUCTION
Use of phenolic material eliminates metal-to-metal contact, thus there's no chance for mechanical noise.

NEW CONTACT ASSEMBLY
The contact assembly is made of a special Mallory contact alloy. New contact design makes the Mallory Midgetrol the quietest, smoothest control by laboratory tests.

NEW TYPE END TERMINALS
End terminals are hot tinned—can be formed, bent, or twisted many times without breaking. Terminal holes are large enough to easily and quickly secure all leads.

NEW SWITCH
Designed and manufactured by Mallory under the highest quality standards. This new switch is built for a long, trouble-free life and eliminates many switch problems.

...*It's the little Volume Control with BIG Advantages*

Are you planning for smallness, and yet want to deliver big results? Well, here's an all-new revolutionary volume control that lives up to Mallory's name.

It's rugged. It can take it. It gives longer life and it is the quietest by actual tests. Yes, the Mallory Midgetrol has designing ways . . . and more and more designers have fallen in love with its nine big features.

Mallory Midgetrol is the crowning result of years of work to pack all the dependability, all the toughness and all the precision work that has made Mallory famous into SMALLER space.

We earnestly suggest you study the many extra features offered by the Mallory Midgetrol which are listed in the box here. They, in total, prove again that the Midgetrol is worthy of joining the big Mallory line of volume controls of every type for every use.

You Expect More And Get More From Mallory

Precision Electronic Parts — Switches, Controls, Resistors

P. R. MALLORY & CO. Inc.

MALLORY

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

SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

CROSS TALK

▶**DUEL** . . . Along with many another publication, including the metropolitan dailies throughout the country, we feel impelled to comment on the present confused situation in the phonograph record field.

One fact is manifest: lack of interchangeability between the 78, 45 and 33⅓-rpm records is viewed with alarm by nearly all commentators, reflecting the general public and trade reaction. The feeling is shared by many broadcasters who desire to use all three types of disks, and by some manufacturers who supply record-reproducing equipment for broadcasting.

These attitudes will no doubt find expression in the marketplace, and are not the primary concern of engineers as such. But the situation has implications of grave importance to engineering. It brings up anew the troublesome question of whether intricate technical devices should be standardized in advance of public offering. Advance standardization is evidently necessary when, as in television broadcasting, there is a lock-and-key relationship between two parts of the system (transmitter and receiver), only one of which is operated by the public.

It may be argued that disks are different, in that the system (turntable and record) is operated as a whole by the ultimate consumer, who can select the system he likes best, or all three if he can afford it. To us, the difference is one merely of degree; three television systems using different scanning rates could exist together, and the public could take its choice, or all three. Only the shortage of spectrum space makes such a plan unthinkable.

No doubt there are valid differences in the technical quality and convenience of the three record systems now extant. Presumably one of them will demonstrate its superiority in the course of time and will be adopted to the exclusion of the others. To the extent that these differences in quality depend on differences in turntable speed, size of the spindle hole, and radius of the stylus tip, they should be exploited and their acceptance determined by the public. But to the extent that such differences make no substantial difference in the final result, the values should be standardized in advance of public offering. Nothing is gained by any other course; much may be lost.

Despite the fact that the present hue and cry about "trade war" is, in our opinion, overdone and likely to do harm to all facets of the record business, we cannot refrain from quoting an advertisement which recently appeared in the Toronto *Daily Star*. It offered a "duel-speed automatic record changer." Touché!

▶**BRIGHT** . . . We are indebted to W. C. White for calling our attention to a recent paper reporting, among other items, the brightness of the luminous spot formed on an experimental mercury cathode. The author of the paper, J. R. Haynes, reports quarter-microsecond sparks having a brightness of a million candles per square centimeter, or some six times brighter than the surface of the sun. Bill White guesses that few engineers know that such bright sources are available and that they might be put to good use. All those interested are urged to read Mr. Haynes's paper (p 891, April 15, 1948 issue of the *Physical Review*).

▶**OBIT** . . . Hendrick Johannes van der Bijl died on December 2nd in Johannesburg, after a long and distinguished career that encompassed many fields of professional interest, notably mining and electronics. Perhaps the majority of those active in the field of electronics, including all but the most recent additions to the staff of this journal, went through school at a time when the only electronics textbook was van der Bijl's "Thermionic Vacuum Tubes", first published in September 1920. After an early career with AT&T and Western Electric, Dr. van der Bijl turned to South Africa, where he entered the industrial life of that community with such vigor that he is credited as the father of that country's industrial revolution. When he died he was chairman of the Electricity Supply Commission and the South African Iron and Steel Industrial Corporation. His career is testimony to the fact that a vigorous, creative and penetrating engineer may also assume the burdens of industrial leadership.

Finding NEW PRODUCTS

The best ideas are generally to be found either in your own organization or by personal contact with distributors and customers. Evaluation of new-product market potential is best left to one competent man, who may be either a company executive or a consultant

By PAUL G. WEILLER
New York, N. Y.

IT IS GENERALLY AGREED that the war-induced sellers' market is fading fast. Aggressive selling is again the order of the day.

But selling alone is not enough. New products are also in order. So the hunt for new products is on—a hunt that seems to be a first-class headache to most companies.

For one thing, the belief that somewhere outside the organization there can be found an item mysteriously easy to make and even easier to sell at a prodigious profit is widespread. As a result, the finished and partially-finished brain-children of engineers already on the payroll are often left to gather dust. All kinds of proposals by outsiders are expensively investigated. Promoters and inventors by the score are gravely listened to. "Product-wanted" ads are run in newspapers to bring still more inventors and promoters to the conference table.

These activities consume much money and time, but they rarely bring the expected results.

Beware "Self-Selling" Products

A text book on the selection of new products is hard to imagine, because individual cases differ so widely. A simple set of precautions can, however, be formulated.

Do not look for miracles. The odds against finding a self-selling humdinger are a million to one at best. And if you do find such an item competition will probably reduce its attractiveness to the vanishing point before you can cash in.

Do not blindly assume that your proposed new product is unbeatable. An example will best illustrate this point. In 1928 an elaborate survey of the radio business was made for a banking house. A determination of the characteristics, appearance, dimensions and general design features of the best-selling receivers was part of it. As a by-product of the survey, the conclusions on receiver design were offered to three set manufacturers.

The first manufacturer said he needed no assistance because his new set was so superlative that it would drive all others off the market, and quickly too. The second manufacturer similarly refused to consider the results of the survey, being equally positive that his own set would drive all others from the market. Essentially the same conversation was repeated in the third case. Of the three receivers in question, only one ever saw the light of day. That one was a success, but it drove no one else out of business. All three firms had good new products, but so also did hundreds of others. Competition was too great, changes too rapid, and blind conceit changed dreams to nightmares for two out of three.

Stay in Your Own Field

If a suggested new product is even remotely related to your old line, the talent within your own organization should be able to produce it. Or, if your departments are overloaded or understaffed, an outside engineer can produce a design in cooperation with your organization.

If a new product is quite unconnected with your own line, and there may in some cases be good reason for going afield, your problem is more difficult to solve. You are then among new and unfamiliar surroundings. The hazards are much greater and harder to recognize, especially if your organization lacks an expert on whom you can rely for evaluation of the product idea during its various stages of development. Markets are still more difficult to estimate. Finally, if you have to buy a design or a patent outright from outside sources, worthwhile advice becomes so hard to get that the venture approaches a real gamble.

Selling Starts With Design

Whether you do your own development or buy a finished item or a new idea, sales appeal must be designed into its appearance at an early stage. Strive for individuality. Be sure that the new item has the imprint of your organization in its design. For here is an important point. If the new product is recognized by regular customers as yours and yours alone, this product-recognition will add to its sales appeal—for you. If you exaggerate in this respect, however,

WAYS AND MEANS

Waiting for a self-selling humdinger is usually a waste of time. Such items are few and far between, and competition quickly reduces their attractiveness.

Design new sales appeal into any product with which you are familiar, or one closely allied, and it will probably do better than something foreign to both company and customer.

Sales appeal does not necessarily mean super-duper performance. It may be better business to design for lower cost, greater convenience of operation or better appearance.

Ideas from engineering and sales departments can be equally valuable in the initial stages of a new-product search. But overall management should make the final decision.

you produce a freak. Freaks sometimes sell for a while, but they seldom have staying power.

The Performance Problem

Advertising copywriters so often scream that the particular wares they sell are the best. One wonders whether that old cliché has any punch left.

When your product belongs to a well-explored art, and that is true even of some electronic devices in spite of the youth of the art, it may be difficult to give it outstanding performance characteristics without increasing costs too much. Less costly designs might be best.

On the other hand, careful attention to production methods can result in economies that can be passed on to the customer in price reductions, or in the form of more or better materials in the product. Where, for example, an increase in apparent weight is desirable and is no functional detriment, a combination of the right material and skillful design can make equipment look sturdier. Convenience of operation, smoothness of controls and good visibility of dials, scales, and markings are other excellent selling points.

Pre-Design Surveys

One good way to determine possible sales appeal is the pre-design survey. Send out an experienced sales engineer to call on distributors or users of your future product. Have him try to determine what they like or dislike about similar products now on the market. This is not a job to be done with a questionnaire and subsequent tabulation. The investigator must weigh each piece of information in accordance with his own estimate of the informant's knowledge.

In the 1928 survey of the radio business already referred to it became evident that the cabinets of best-selling radio receivers were of the same width and height within about 2 inches. Sets with different dimensions did not sell as well. In this case the motivation was hard to discover but the facts were nevertheless clear.

If the survey is dealing with a tool you may find preference for some particular shape or weight. If it is an electronic control, a dial with large, heavily-blocked lettering which can be seen at 100 feet might be a major sales point. In any event, the objective of a properly conducted survey is not a mess of figures, comments or quotations; rather, it is a clear and definite idea of what the new product should be, based on careful interpretation and analysis of the collected opinions of potential customers. The following example illustrates how a market survey can reveal needs for new products.

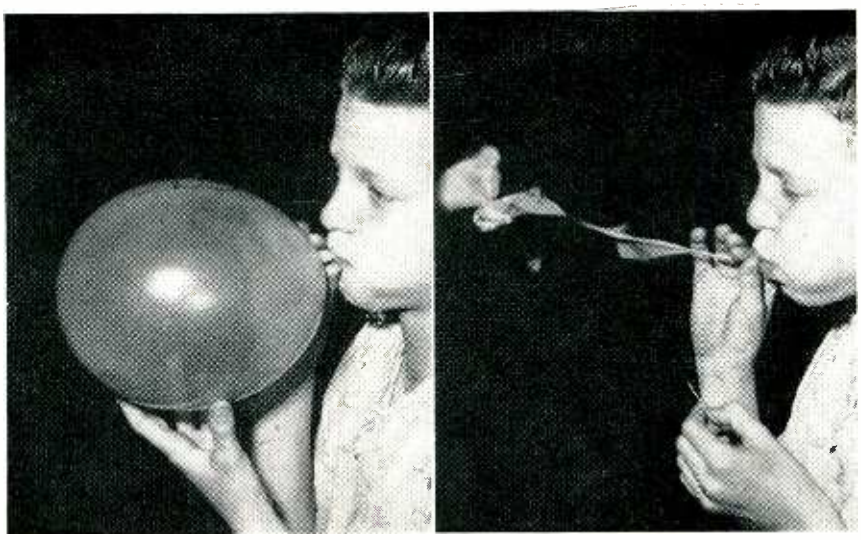
During the middle thirties one large company was selling an electronic timer giving excellent performance for $1,200. Another manufacturer offered a timer for $160, which also sold in quantities in spite of rather poor performance. It appeared logical to assume that still another timer which could do about 70 percent of the jobs the expensive timer did and was easy to install and to maintain could be marketed at $300. The assumption was later borne out in practice.

Testing The Market

Some time ago a young sales manager read a paper on market analysis before one of the engineering societies. He described the conventional type of market survey and then said "You wind up with a nicely bound tome with gold letters on the cover and a lot of figures in the text. Most people are inclined to take such data as facts. But they are not facts at all. They are only the surveyors' opinions".

The story emphasizes one point. A market survey is only as good as the men who make and analyze it. It is a job for the top men in your organization, not for the newest junior salesmen, because the value of the survey to you can never exceed the knowledge and judgment of the surveyors. It is impossible to get dependable data on such an important subject by routine methods, no matter how elaborate they may be.

The final, all-important deciding rule in choosing new products is this: Choose the man who will do the choosing wisely and then do not interfere with him. This is one task which is seldom carried out successfully by a committee.



Examples of action-stopping photographs taken with unit, using microphone and amplifier to trigger flashtube. Microphone was placed three feet from balloon, giving about three milliseconds delay to allow progression of action after balloon was pierced with pin

Portable Repeating Flash Unit

Unique combination of vibrator, transformer and cold-cathode rectifier tubes produces over 800 flashes of Sylvania type R4330 flashtube from one set of four 67½-volt batteries, at one-tenth the cost of expendable lamps. Voltage-regulator circuit maintains storage-capacitor at 2,000 volts ±1.25 percent to insure uniform photographic exposures

By W. H. FRITZ

Manager, Battery Engineering Dept.
National Carbon Co., Inc.
New York, N. Y.

REPEATING FLASH UNITS employing a high-voltage power supply, an energy-storage capacitor and a gas-filled discharge tube to convert electrical energy into light are receiving wide attention in the fields of industrial and studio photography. These units make it possible to use even an ordinary box camera to take short-exposure photographs that would otherwise require elaborate camera equipment.

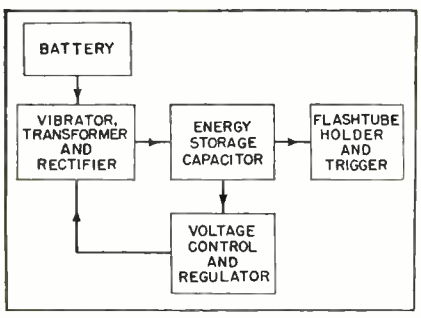


FIG. 1—Block diagram showing essential units of dry-battery-operated repeating flash unit

Repeating flash units are generally relatively bulky high-capacitance studio units that operate from the a-c line and provide high light output. There is also a need, however, for portable units operating independently of line power and providing lower light output. This article deals with the design and construction of the latter type, operating from standard radio dry batteries.

Design Requirements

Portability places severe restrictions on the equipment designer. To be truly portable, a repeating flash unit must be small and light. Little or no maintenance and simple operation are necessary to its success. The effective light output should approximate that available from a midget expendable photoflash lamp, and the light output in each of a succession of flashes should be consistent, to insure uniform exposures. The last consideration is particularly important in taking color pictures. These performance specifications should be met with low operating cost per flash, which calls for high circuit efficiency.

Another requisite of repeating flash units is short energy-storage-capacitor charging time between flashes. However, the charging time need be no less than the time normally required to advance the film in the camera (or change the film holder), cock the shutter and refocus. These operations usually require from 10 to 15 seconds, although in some cases photographers may reduce this time interval.

Dry-battery-powered flash unit connected to camera. Model-airplane ignition-coil and trigger-circuit components are mounted in flashtube holder

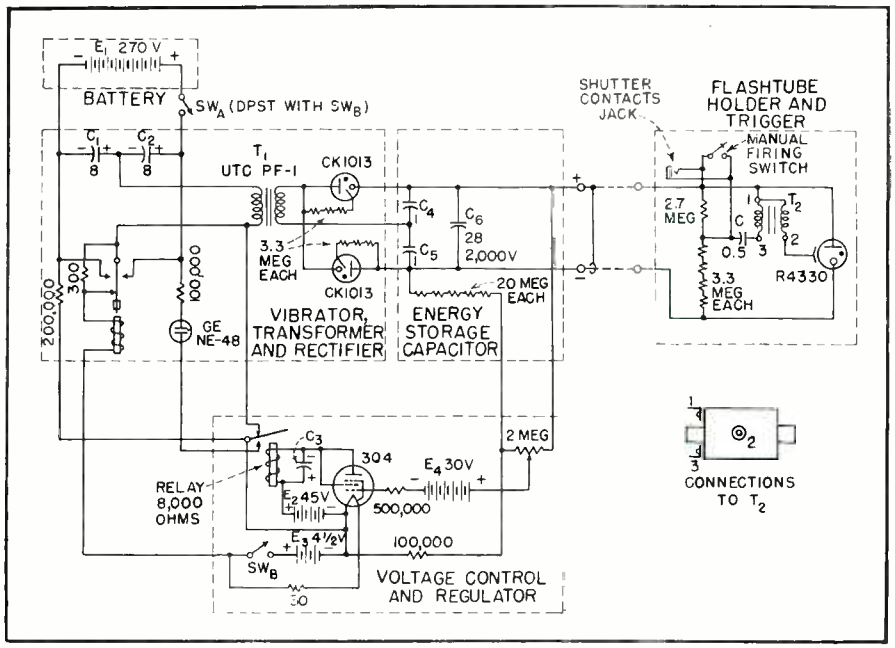


FIG. 2—Complete circuit diagram. Four 67½-volt radio batteries making up primary battery at upper left last for over 800 flashes before voltage drops below point at which regulator can maintain constant light intensity. Neon pilot lamp glows to indicate that storage capacitor is fully charged

Capacitor charging time depends upon the capacitance value and the equivalent series resistance of the power supply. Experiments indicate that for charging time under 10 seconds, the primary source of energy must be capable of delivering an instantaneous peak power of approximately 50 watts at the start of the charging cycle. The rate of energy delivery drops off exponentially as the energy-storage capacitor gathers charge.

It is desirable to keep the primary current low, particularly when dry batteries are used. The use of a battery providing approximately 270 volts and an appropriate voltage-multiplying system requires only moderate battery current for reasonably rapid capacitor charging. The dry-battery-powered repeating flash unit described here incorporates such a system arranged as in Fig. 1 and connected as in Fig. 2.

The energy in the light flash is obtained from the battery shown as E_1, which consists of four Eveready No. 467 miniature 67½-volt units of the type widely used in personal-portable radios. The four batteries are connected in series to yield a nominal open-circuit potential of 270 volts. Energy from E_1 is converted into light via a vibrator, transformer, rectifier, storage capacitor and flashtube.

If more economical operation is desired, five heavy-duty 45-volt units can be used. Their use will place a severe weight restriction on the device, however, and will reduce portability.

Vibrator Power Supply

The voltage-multiplying system employed in the flash unit is an unusual combination of vibrator, transformer and rectifier tubes. The method of establishing a flow of alternating current in the transformer primary is of particular interest. It can best be explained by reference to Fig. 3, which shows an elementary vibrator circuit of the new type and voltage waveforms at different circuit points.

It will be assumed that both similar capacitors C_1 and C_2 are charged to voltages e_1 and e_2, the sum of which is E_1, the battery voltage. When the vibrator reed contacts the upper pole, C_1 is discharged through the load resistance R while the charge in C_2 is increased by current also flowing through R. Note that both charge and discharge currents flow the same way through load R.

When the vibrator reed reverses direction and touches the lower pole, the process is reversed. Now C_2 discharges through R, and C_1 charges through R. In this condition the two currents are also additive, but in the opposite direction.

It can be shown that regardless of the initial voltage distribution across C_1 and C_2, an equilibrium condition is reached, after a few cycles, in which voltages e_1 and e_2 are symmetrical. The wave shape shown in Fig. 3 is a function of the load resistance, the output voltage e_R approaching more nearly a square wave as the load resistance is increased.

Mathematical development shows that the system will have a power-transfer characteristic that may be readily computed. It is a function of E_1, C_1, T, and R, where T is the time interval in which the vibrator reed contacts either of the two poles. Assuming zero vibrator-reed transfer time, the power output P in watts is

$$P = \frac{E_1^2 C}{T} \tanh \frac{T}{4RC_1} \qquad (1)$$

The vibrator frequency may be expressed as $f = 1/2T$, hence Eq. 1

can be rewritten as

$$P = 2fE_1^2 C_1 \tanh \frac{1}{8fRC_1} \qquad (2)$$

It can also be shown that the power output approaches a maximum when the load resistance approaches zero. Then the power output is independen of R so Eq. 2 becomes

$$P_{max} = 2fE_1^2 C_1 \quad (\text{when } R \rightarrow 0) \qquad (3)$$

A practical example will illustrate what to expect of a particular combination of elements. When f = 80 cps, E_1 = 200 volts, and C_1 = C_2 = 8 μf, P_{max} = 51.2 watts. This condition is closely approximated in the repeating flash unit described. The vibrator circuit is essentially a voltage halver when R is large.

In the circuit of Fig. 2, the primary winding of transformer T_1 is substituted for the load resistance R. Transformer T_1 is a standard readily available type normally used to step up 117 volts at 60 cycles to high voltage for photoflash work. Its turns ratio is approximately 15:1. The filament winding tap on the secondary is disregarded.

A conventional voltage-doubling system is used in the secondary circuit, employing two Raytheon type CK1013 cold-cathode rectifier tubes. This combination provides a peak voltage considerably in excess of the nominal 2,000 volts which is the normal energy-storage-capacitor voltage. The reason for this will be evident when the voltage control circuit is explained.

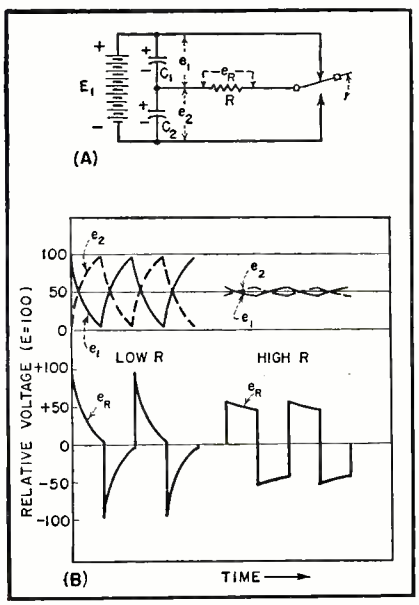


FIG. 3—Basic inverter circuit, and corresponding output-voltage waveforms. For simplicity, vibrator-reed transfer time is assumed to be zero here

Main energy-storage capacitor C_6 is a 18-μf, 2,000-volt unit. This capacitance is slightly augmented by two 1-μf capacitors in series, C_4 and C_5, which are essential to the voltage doubler. The measured capacitance of the combination is 30.5 μf in the model built by the author. At 2,000 volts the available stored energy is 61 watt-seconds.

Use of the approximate conversion relation of 40 lumens per watt for flashtubes indicates an approximate light output of 2,500 lumen-seconds. This is somewhat lower than the design objective, but it has proved adequate for black-and-white negatives of good density without resorting to special development procedure.

Voltage Regulator

With age and use, the closed-circuit voltage at E_1 will be reduced. Unless a voltage-regulating circuit is provided, the capacitor voltage and the light output will become a function of the battery condition. One method of overcoming this disadvantage is to provide a considerably higher open-circuit rectifier output voltage than the voltage to which the capacitor is charged. The voltage-regulator circuit serves to stop the vibrator when the storage capacitor voltage e_c reaches a predetermined value. This action is shown in Fig. 4. When the capacitor voltage drops slightly, the vibrator starts and runs until the upper limit is again reached. This action maintains essentially constant voltage across the storage capacitor and also reduces the charging time by using only the steep portion of the capacitor voltage curve.

The voltage control and regulator circuit shown in Fig. 2 employs a triode-connected 3Q4 tube whose grid is overbiased by the 30-volt battery at E_4 when the storage-capacitor voltage is zero. As the capacitor voltage increases, a positive potential tends to cancel the negative 30-volt grid potential. At some point, depending upon the setting of the 2-megohm potentiometer, the 3Q4 tube becomes conductive and the sensitive relay in its plate circuit operates. This stops the vibrator and makes the neon indicator lamp glow to indicate full capacitor charge. As current leaks from the storage capacitor, its voltage drops to a point where the regulator starts the vibrator again. This action is repeated until the main power switch is turned off.

Battery E_3 delivers driving power to the vibrator and also lights the 3Q4 control-tube filament. A separate 45-volt battery E_2 supplies plate current to the 3Q4 tube. This was done, rather than tapping E_1, to provide uniform plate voltage in the control circuit.

Careful tension adjustment in the sensitive control relay results in maintenance of voltage across the storage capacitor at 2,000 volts ± 1.25 percent. Since light is proportional to the voltage squared, it will be within ± 2.5 percent of nominal. The nominal working voltage can be controlled over a range from 1,400 to 2,500 volts by rotation of the potentiometer.

Flashtube and Trigger

A Sylvania type R4330 flashtube was used in the model. This was connected in a conventional trigger circuit. The bleeder resistors used in the trigger circuit are higher in value than those normally recommended, to conserve energy in the standby condition. The trigger coil, shown in Fig. 2 as T_2, is a model airplane ignition coil.

When the manual firing switch is closed or when shutter contacts close, capacitor C_7 is suddenly discharged through the ignition coil primary. The secondary voltage is then high enough to start ionization in the flashtube and the energy-storage capacitor is immediately discharged through the flashtube helix. The resulting sharply peaked light flash has an effective duration of approximately 0.0002 second, which is sufficient to stop most normal action. All of the trigger-circuit components are contained in the handle of the flashtube holder.

An interesting mode of operating high-voltage flashtube devices of the type described is to trigger them by sound. Using open-flash technique in subdued light will then result in very striking pictures.

For example, a bursting balloon was photographed by substituting a microphone, a small amplifier and a thyratron for the firing switch. By locating the microphone at a known distance from the source of sound, the delay between the initial sound of bursting and the flashtube triggering could be controlled.

Circuit Performance

Because of limited time and measuring equipment, empirical methods were used to arrive at approximate integrated efficiency values for various battery conditions. It was assumed that the battery E_1 and associated multiplying circuit were replaced by a hypothetical battery having E_m as its open-circuit voltage and an internal resistance of R_m ohms. It was also assumed that these values remain constant over one charging cycle; while not strictly correct, this assumption introduces only moderate error.

The input power over the charging cycle and the storage-capacitor voltage were measured. These values are plotted in Fig. 4. Then, assuming that the capacitor-voltage curve was a true exponential relation, the hypothetical voltage E_m and resistance R_m may be determined from the terminology of Fig. 4 and the relations

$$R_m = \frac{T}{C \log_\epsilon \left(\frac{e_1}{E_2 - e_1}\right)} = \frac{0.434\,T}{C \log_{10} \left(\frac{e_1}{E_2 - e_1}\right)} \quad (6)$$

This expression can be solved for R_m since all other values are known.

$$E_m = \frac{e_1^2}{2e_1 - E_2} \quad (7)$$

Here again, both values on the righthand side are known.

As shown in Fig. 4, an imaginary battery having an open-circuit emf of E_m volts and R_m ohms internal resistance can be substituted for the vibrator supply, to compute instantaneous and integrated efficiencies for various conditions of the battery E_1. The rate of energy transfer into the storage capacitor may be expressed as

$$p_2 = \frac{E_m^2}{R_m}\left(\epsilon^{-\frac{t}{R_m C}} - \epsilon^{-\frac{2t}{R_m C}}\right) \quad (8)$$

The integral of this curve between 0 and $2T$ is total energy stored in the capacitor. This area divided by the entire area under the curve for p_1 yields the integrated efficiency for one flash. The curve of p_1, the power taken from E_1, is determined by measuring the closed-circuit voltage across, and the current out of, the battery E_1. Values obtained for integrated efficiency range from 30 percent for a new battery to 35 percent after 675 flashes.

A practical test of the experimental model yielded 840 flashes spaced at random over 88 days from one set of primary batteries. The maximum number of flashes in one day was 60; the minimum was 5. With fresh batteries, the charging time was 6.1 seconds. At the end of the test, the charging time had increased to 15 seconds. An unused set of batteries 11 months old will charge the capacitor to 2,000 volts in approximately 7.5 seconds. The indicated cost-per-flash ratio of this repeating flash system compared with the use of expendable lamps is approximately 1 to 10.

Photographic Effectiveness

In taking flash pictures, it is common practice to use guide numbers. The guide number for a particular lamp, film type and shutter speed is constant, and is expressed as $f \times d$, where f is the effective relative aperture number and d is the lamp-to-subject distance. A published chart (General Electric Flashtubes—Technical Information, January, 1948) relates stored energy, film speed and approximate guide number. The approximate guide numbers for four Kodak films as obtained with the use of the chart are:

Film	ASA Exposure Index (Daylight)	Guide No.
Super Panchro Press (Sports)	250	120
Super XX	100	90
Plus X or Verichrome	50	60

These guide numbers have yielded good results. As a check on the validity of the numbers, the author has on several occasions taken an outdoor picture with exposure meter, an outdoor picture with a GE No. 5 expendable lamp and another outdoor picture using the experimental repeating flash unit, all on the same roll of film.

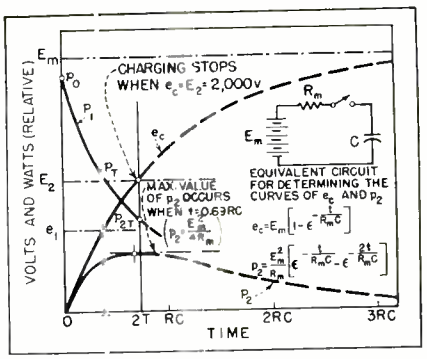


FIG. 4—Generalized performance curves for flash unit, where T is time interval during which vibrator reed is against one of its contacts

The roll was then taken to a commercial photofinisher with no special instruction as to development. Negatives of good density in each case produced very satisfactory prints. Higher guide numbers than those shown may be used by resorting to special negative development.

Conclusions

The experimental model fullfilled most of the design objectives. It would be relatively simple to adapt the device to line as well as battery operation by tapping the secondary winding and switching out the voltage-regulator circuit, for the transformer primary is designed for 117-volt 60-cycle line operation.

As built, the unit has commercial limitations, chief of which is its marginal light output. More stored energy would be desirable, but this poses another problem, for the charging time is close to the maximum tolerable limit with the present energy-storage capacitor. As built, the unit is usable with shutters having built-in X-type synchronizer contacts. It cannot be used, unless modified, with solenoid-type shutter trippers.

Not enough work has yet been done with the experimental model to justify any conclusions regarding its effectiveness with color film. The light available is marginal, unless the lamp-to-subject distance is kept small.

The writer wishes to acknowledge the assistance rendered by Raytheon Mfg. Co., Sylvania Electric Products Co. and General Electric Co. in supplying some of the components and design information used in this article.

Television Field

Procedure used at television broadcast station WEWS to meet FCC proof-of-performance requirements for all holders of construction permits. Methods of running radials, plotting median values of signal intensity, and determining elevation profile

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EACH holder of a construction permit for television broadcasting is required to make proof-of-performance field intensity measurements before a station license is granted by the Federal Communications Commission.

Continuous recordings of measured field intensity must be made along at least eight radials. Routes taken by the measuring car must follow, as closely as possible, the radials which were submitted with the application for a construction permit. The chart recordings must be analyzed and the distance to the 5,000 and 500-microvolt-per-meter contours determined from the measurements. The FCC must be furnished with a complete description of the measuring procedure which includes: method of making measurements, sample recordings, plot of the median values versus distance for the several radials, routes over which the field intensity measurements were made and the intervals for which median field intensity values were determined. A summary of the tests and the results thereof must be submitted in order that it may be determined if the effective radiated power, visual and aural, is in accordance with the values specified in the construction permit.

Making the Field Survey

Continuous recordings of field strength for radio station WEWS were made along eight radials as specified in the FCC *Standards of Good Engineering Practice*. These radials followed, or paralleled, the theoretical radials as closely as possible. Recognized measuring equipment was used with a recording device that was driven directly from the speedometer of the station wagon in which the equipment was mounted.

Measurements were made with a chart speed of approximately five inches per mile. Where possible the car was driven at a uniform speed of 30 miles per hour. Locations and speedometer readings were marked on the chart at frequent intervals to fix the relation between the measured field intensity and the location. A sensitive aneroid altimeter was also mounted in the measuring car and altitudes were marked on the chart as desired. Since the altimeter operation depends upon barometric pressure it can not be expected to give continuously accurate altitude readings. Recording the altitudes did, however, prove to be helpful in analyzing the tapes. If certain recorded signal levels appeared too high or low it was usually found that the altitude variations accounted for the change. Measurements were made to a point on each radial which was well beyond the 500 microvolt-per-meter contour except where Lake Erie intervened.

Station WEWS operates on channel 5 (76 to 82 mc) with a radiated power of 16.3 kw video and 8.15 kw aural. The transmitter is rated at 5-kw peak power and operates into a three-section Super-Turnstile antenna which is triplexed with WEWS-FM. The f-m carrier operates on 102.1 megacycles with a radiated power of 10.3 kw. Rated power gain for the antenna is 3.8 for channel 5 television and 4 for 102.1 f-m. The transmission-line efficiency is 88 percent. The effective height of the antenna above average terrain from two to ten miles is 642 feet. Effective height above mean sea level is 1,526 feet.

All measurements were made while the transmitter was operating at authorized 5-kw peak power with either picture or sine-wave modulation. The output power was determined by measurement into a water-cooled load. A suitable peak-to-average power-correction factor, obtained by measurement, was used to determine the true peak field intensity for the television signal.

The field car is a wooden station wagon modified for the installation of a recording field set and receiving antenna. The field set and the

PROOF OF PERFORMANCE

REQUIRED: Find the distance from the television station to the 5,000 and 500 microvolt per-meter contours. Photostats of all basic data must be submitted to the FCC in affidavit form.

FIELD MEASUREMENTS: Continuous recordings of field strength from a carefully adjusted transmitter along a minimum of eight radials, with careful checking of location by map and land marks

COMPUTATION: Plotting corrected median values of signal strength against airline distance by sectors (not less than 15 sectors for each radial). Plotting calculated field intensity for each radial. Plotting elevation profile (shown for sector midpoints) against same airline distance scale. Finding average elevation of terrain between two and ten miles from transmitter

EQUIPMENT: Car or truck with standardized antenna; calibrated receiver and field-strength meter (the two may be combined); continuous-chart recorder driven from the speedometer shaft; altimeter (optional); FCC *Standards of Good Engineering Practice Concerning Television Broadcast Stations;* USGS Topographical Quadrangle sheets; Sectional Aeronautical Charts

Intensity Measurements

recorder are mounted on a heavy table. Vibrations while driving serve to advantage in keeping the recording pen free from drag against the paper tape. The Measurements Corp. uhf noise and field strength meter, model 58, used is a laboratory-type, five-band superheterodyne receiver with gain standarized at a fixed value. To insure accuracy the instrument possesses a self-contained calibration circuit, a preselector stage having high image rejection, a balanced-to-ground attenuator network and provisions for obtaining either peak or average measurements. The average measuring position was used at all times due to the high susceptibility of the peak measuring position to ignition noise and other electrical disturbances.

A horizontal dipole antenna was used for all measurements. Special authority was obtained from the FCC for use of a dipole antenna since nondirectional antennas gave insufficient signal-to-noise ratios in low signal areas.

The recorder, an Esterline-Angus type AW with suitably damped movement, was driven through reduction-gear boxes from the speedometer drive shaft.

Calibration of the field intensity meter was made frequently in accordance with the operating instructions furnished by the manufacturer of the instrument. Such calibration is accomplished by applying a voltage of known magnitude to the input terminals of the r-f amplifier and adjusting the receiver gain until the output meter reads a particular value. The stand-

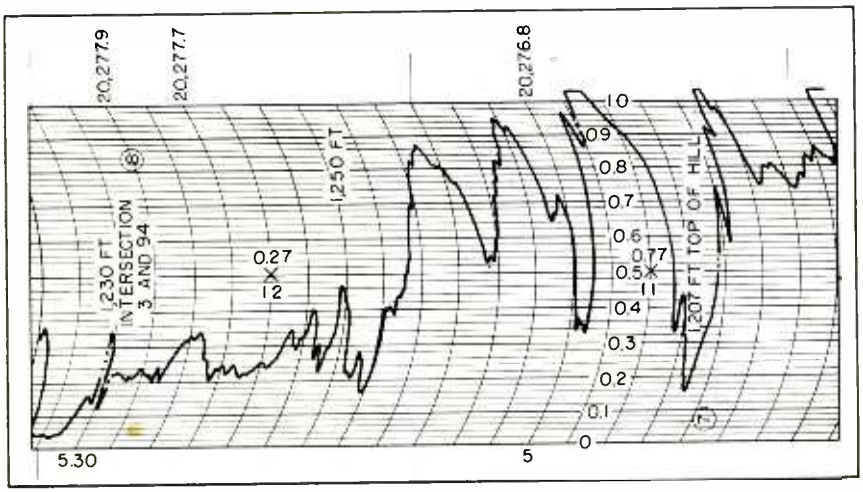


FIG. 1—Portion of recorded chart with field information, marked off into two sectors for analysis

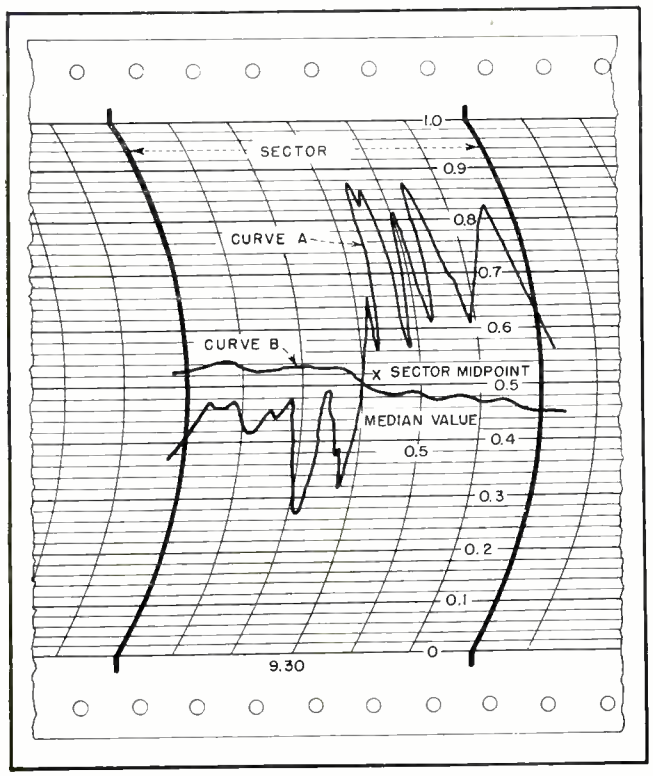


FIG. 2—Sample chart with two curves drawn to exhibit median values of 0.5 within one sector

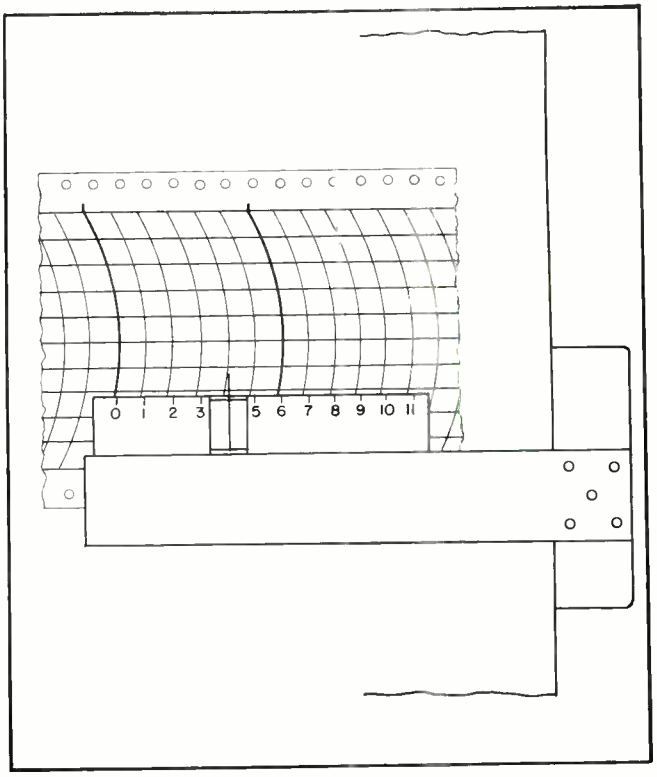


FIG. 3—Modified slide rule used for quickly determining median values by summation

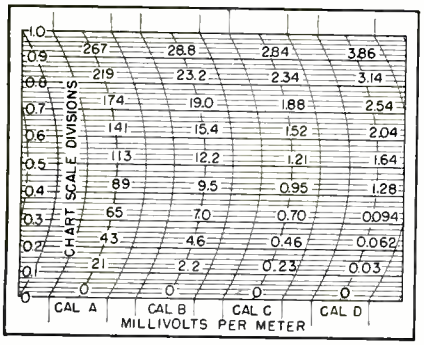


FIG. 4—Chart calibration for different attenuator settings

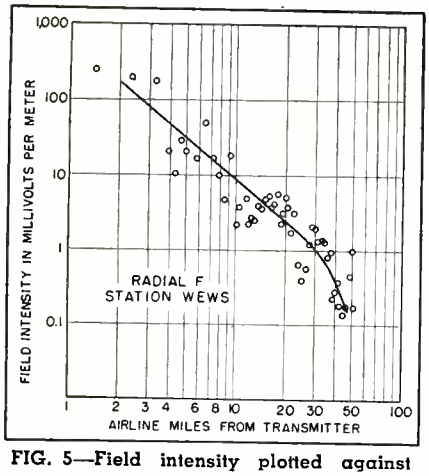


FIG. 5—Field intensity plotted against airline distance

ard signal level source in the field meter is provided by a shot-noise diode.

In order further to insure accuracy of calibration, the field meter was sent to the National Bureau of Standards for certification. All correction factors submitted by that agency are reflected in the final field strength values chartered for field intensity versus distance.

Calibration measurements made in the field revealed that the dipole antenna mounted on the station wagon had the same gain as the standard dipole antenna adjusted to 77.25 megacycles. Therefore, the conversion factor between the recording antenna and the standard dipole furnished with the instrument is a factor of unity.

The height of the receiving dipole, as installed in the station wagon, was 10.5 feet. Field intensity readings were multiplied by 2.86 to convert to an equivalent 30-foot antenna height. Use of this factor assumes that the field strength increases in a linear manner with height in accordance with theory. This assumption is not strictly valid but the FCC approved the use of 2.86 in the absence of any more definite or proven conversion factor.

All recordings were made while driving away from the transmitter. The dipole antenna was positioned at all times for maximum response. The station-wagon position, as determined by field checks, had no measurable effect on antenna gain while making the radial recordings. This condition held even when the station wagon was driven at right angles to the radial measured.

The field intensity meter was set up at a fixed location and used to measure the relative field intensities for various conditions of transmitter operation. A factor of 1.26 was found necessary to convert from the field intensity reading obtained when receiving a 1,000-cycle sine wave plus synchronizing pulses, (or normal picture modulation) to the field intensity reading corresponding to the peak radiated power output of 16.3 kw. The conversion factor is the average of five separate measurements.

Using the National Bureau of Standards calibration, and considering the peak-to-average factor plus the antenna height conversion factor, the following equation is applicable to the measurements taken on WEWS at 77.25 megacycles.

$$V = KM\ (1.26)\ (2.86)/F \qquad (1)$$

When V = field intensity in microvolts per meter

K = corrected value of attenuator (NBS)

M = corrected value of meter reading (NBS)

F = 0.96 field intensity factor (NBS)

1.26 = peak-to-average conversion factor.

2.86 = 10.5 - to - 30 - foot antenna conversion factor.

Upon completion of the measurements, each recorder chart was divided into sectors. Sector lengths for the first 20 miles were 1 mile and from 20 miles to the end of the radials the sectors were two miles long.

Figure 1 shows a sample recording with two sector divisions. The X points 11 and 12 represent the midpoints of the two sectors which are approximately one mile each in length. The figures 0.77 for 11 and 0.27 for 12 represent the 50-percent median field intensity values for these two sectors.

Determining Median Values

The distinction between median and average should be clearly understood. Median refers to a point midway in position. As used in the chart analysis, median represents the horizontal line along the chart which has as many points below as there are above it. In determining median values, therefore, it is necessary to determine not equal areas above and below a given line but an equal number of points above and below a given line.

In Fig. 2 the curves A and B each have a 50-percent median value of 0.5 in terms of the recorded chart scale because each

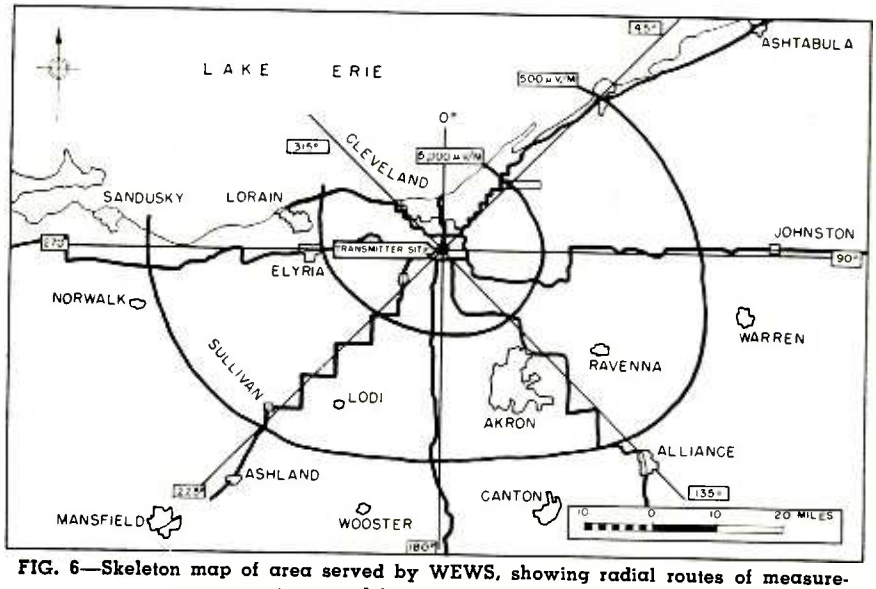


FIG. 6—Skeleton map of area served by WEWS, showing radial routes of measurement car and important signal contours

curve crosses the 0.5 chart line only once and this at the sector midpoint. In other words, for 50 percent of the time the two curves are above the 0.5 line and 50 percent of the time they are below it. In analyzing the recordings to determine the 50-percent median field it becomes necessary to locate that horizontal line which has the curve below it for half the time and above it half the time. By inspection, a line is taken that appears to be approximately correct. Then a test is made to determine whether or not this line represents the correct value.

If, throughout the entire sector, the recording curve is above the line in question for just half the time, the correct value has been estimated. If not, another try must be made and the process repeated. This summation process can be done by sliding a sheet of paper along the proper chart line, making successive marks on the paper to add the various short line lengths. Dividers might be used in like manner. Both of these methods are tedious and subject to inaccuracies. The writer devised a satisfactory median calculator from a 25-cent slide rule as shown in Fig. 3. A hairline indicator about ¾-inch long is fastened to the cursor of the slide rule at right angles to the rule length. When used in conjunction with a T-square the slide rule can easily be moved along any chart line. As the hairline indicator guides the cursor along the small line-lengths to be added, the top side of the rule provides a reference for the summation process. The rule should be calibrated in chart scale divisions.

The field intensity in each chart sector for all recording tapes was analyzed to determine the median field and this field intensity was associated with the corresponding sector of the radial. The chart scales were converted to millivolts (rather than microvolts) per meter by reference to separate calibration curves for each attenuator step. The calibration curves took into account all of the correction factors shown in Eq. 1. During the field recordings a note was made on the chart whenever the attenuator step was changed. When the tapes were divided into the one and two-mile sectors care was exercised to see that sector divisions did not overlap between attenuator settings. This condition, of necessity, caused some sector lengths to vary from the normal one or two-mile divisions.

A summary of the recording chart calibrations is shown in Fig. 4. For making the actual conversions, separate graphs of chart scale readings versus field strength in millivolts per meter were used for each attenuator setting. These charts were plotted on linear graph paper.

After median values were determined for all sectors for each of the

Table I—Radial F., Southwest 225 Degrees

Sector	Elevation in Feet at Sector Midpoint	Airline Miles from Transmitter	Median Field Intensity in mv per m Corrected for 30-foot Antenna	Location
1	1,000	1.45	248	Rt 3 at Pleasant Valley
2	1,140	2.35	200	On Rt 3
3	1,260	3.25	175	Rt 3 & Wallings Rd
4	1,140	3.92	21.0	On Rt 3
5	1,010	4.35	10.6	On Rt 82, North Royalton
6	890	4.70	29.3	Rt 82 at York Rd
7	880	5.00	21.0	On Rt 82
8	820	5.90	15.4	Rt 82 & W 130th St
9	900	6.55	50.0	On Rt 82
10	930	7.40	16.7	Jct Rt 82 & 42
11	970	7.96	10.0	On Rt 42
12	1.020	8.65	4.80	On Rt 42
13	1,220	9.3	18.6	On Rt 42, Cuyahoga-Medina County Line
14	1,150	10.15	2.30	On Rt 42
15	1,190	10.65	3.65	On Rt 42
16	1,120	11.46	4.80	Jct Rt 42 & 303
17	1,048	11.95	2.30	On Rt 303
18	993	12.6	2.79	On Rt 303
19	880	13.22	2.64	On Rt 303 CL & W RR
20	840	13.86	3.85	Jct Rt 303 & 252
21	840	14.48	3.70	On Rt 252
22	880	15.25	4.38	On Rt 252
23	900	16.10	5.30	On Rt 252
24	940	16.55	3.85	CL & W RR on Rt 252
25	970	17.19	4.10	On Rt 252
26	983	18.29	5.55	Jct 252 & 18, Mallet Creek
27	990	18.89	2.30	On Rt 18
28	1,018	19.55	3.20	On Rt 18
29	1,043	20.25	5.10	On Rt 18
30	1,035	20.75	3.85	On Rt 18
31	1,020	21.65	1.80	Jct 18 & 76, Litchfield
32	1,060	22.7	3.16	On Rt 76
33	1,100	21.0	0.68	On Rt 76
34	980	25.4	0.42	Jct Rt 76 & Rt 162, Chatham
35	860	26.75	0.58	On Rt 162
36	900	28.05	1.21	Jct Rt 162 & 301, Spencer
37	940	29.36	2.11	On Rt 301
38	1,011	30.46	2.06	On Rt 301
39	1,060	31.83	1.38	Jct Rt 301 & 224, Homeville
40	1,100	33.21	1.42	On Rt 224, Medina-Ashland County Line
41	1,120	34.5	1.33	On Rt 224
42	1,150	35.48	0.85	Jct Rt 224 & 58, Sullivan
43	1,214	37.3	0.96	Jct Rt 58 & 89
44	1,170	38.82	0.23	On Rt 58

Table II—Summary of Measurements

Radial	Bearing in degrees	Average Terrain Elevation in Feet	Antenna Elevation Above Average in Feet	Distance To 5 mv per m Contour in Miles		Distance To 0.5 mv per m Contour in Miles	
				Computed	Measured	Computed	Measured
A	0	695	831	20.4	Lake E.	44.5	Lake E.
B	45	805	721	18.5	14	42.4	33
C	90	835	691	18.4	15.2	40.9	39.2
D	135	1,025	501	16.0	15.0	39.5	41
E	180	1,150	376	14.5	12.6	34.0	32
F	225	965	561	16.8	13.6	38.5	38.5
G	270	825	701	18.7	18.0	41.5	45
H	315	770	756	19.5	Lake E.	42.5	Lake E.

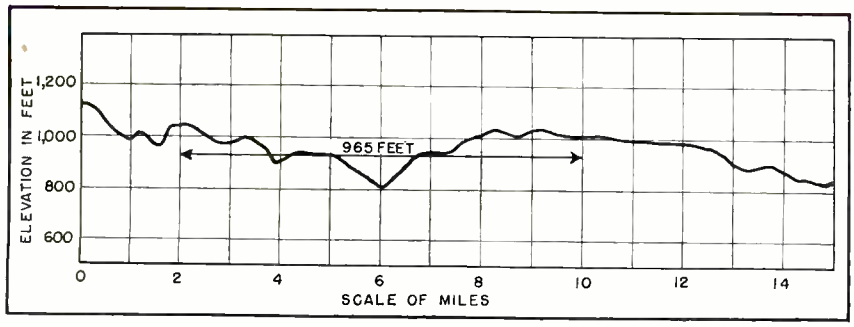


FIG. 7—Actual profile along radial *F* plotted from map elevations

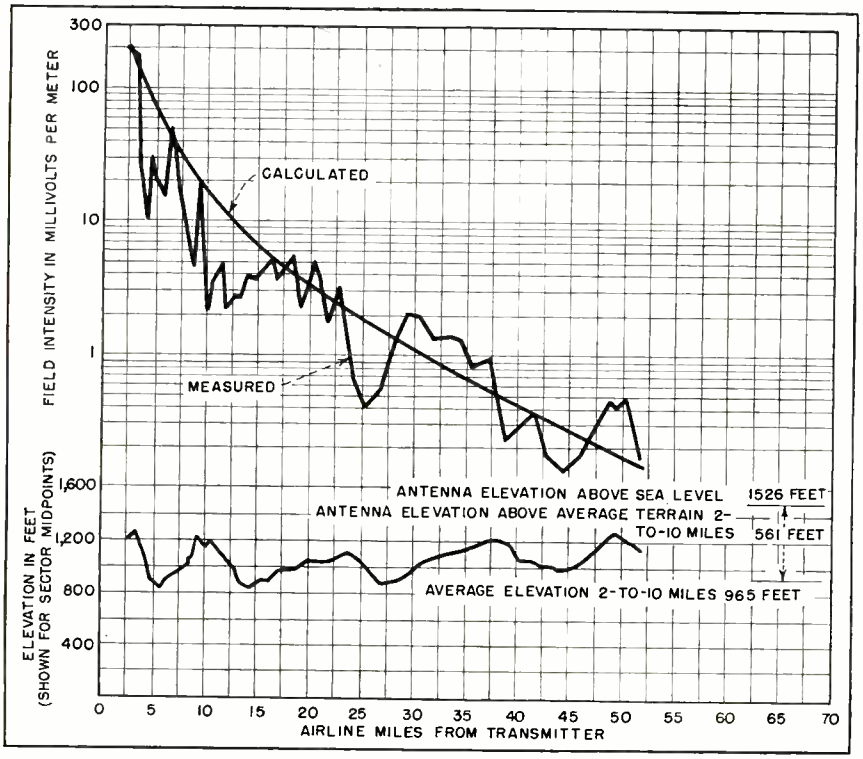


FIG. 8—Final summation of field strength information as presented to FCC. Elevation based on sector midpoints is plotted against distance

eight radials, the routes followed by the measuring car were plotted on USGS Topographical Quadrangle sheets and each sector midpoint was marked and identified by number. Airline distances were determined from this map. The elevation taken at sector midpoints gave a better correlation with field strength values than did those plotted along the car route, or along the theoretical radial.

Airline distance from transmitter to sector midpoint, elevation at the sector midpoint, median field intensity in millivolts per meter and location along the routes were tabulated as shown in Table I for radial *F*. Similar tabulations were made for the other seven radials. Median points (sector midpoints) were plotted for each radial on logarithmic 7 × 2.2-cycle K&E 369-127G paper and a smooth curve drawn between the points. Figure 5 shows the curve for radial *F*. Field intensity is plotted in millivolts per meter versus airline miles from transmitter. The distance to the 5 and 0.5 millivolt-per-meter contours for each radial was read from these curves and used to draw the contour lines shown in Fig. 6. This map also shows the routes used with respect to the theoretical radials. Table II shows a summary of measurements that gives an interesting comparison of the distance to the 5 and 0.5 millivolt per meter contours for each radial, both measured and computed, the latter values being based on the FCC ground-wave signal chart. The profile along the *F* radial as plotted from map values, and shown in Fig. 7, was used in determining the 2 to 10-mile average elevation.

Figure 8 shows the median points plotted for field intensity in millivolts per meter versus airline miles from the transmitter. These curves show a comparison of the theoretical signal strength, (based on the two to ten-mile average) with the measured signal strength. Elevation is shown for sector midpoints. The field intensity portion of these curves is plotted on K&E 359-81LG semilogarithmic paper, 4 cycles × 10 to the inch, 5th lines accented. The elevation portion is plotted on K&E 359-11L linear paper, 10 × 10 to the half inch, 5th lines accented. The two sections were joined together with rubber cement. In the preparation of the final photostats for submission to the Commission a film negative was made of each chart, which could be used for making either photostats or blueprints. The photostatic process allowed a reduction of the charts to notebook size and permitted easy correction of any inking errors. Where an inking error occurred a new piece of graph paper was pasted over the old and the lettering redone. However, if desired, the graph paper used and referred to here by number can be used as a direct negative for making blueprints.

A period of three months was required for analysis of the tapes and preparation of the necessary FCC engineering exhibits. Approximately 1,000 miles of driving over northern Ohio roads was made by the field measuring car. For the f-m survey another 1,000 miles of driving was required since independent measurements were made on the f-m transmitter fields. Good correlation was obtained between the f-m and television recording tapes.

The field survey and analysis described in this paper was made under the general supervision of the writer. R. K. Olsen, chief transmitter engineer for WEWS and WEWS-FM, assisted with the field work and the tape analysis. Carl E. Smith and Thomas B. Friedman, consulting radio engineers of Cleveland, were engaged to make the continuous-tape field measurements, assisted by either Mr. Olsen or the writer.

Heterodyne Eliminator

Beat-note interference is attenuated by means of a frequency converter which inverts the numerical order of all frequencies either side of a desired carrier and places the off-frequency interference on the cut-off side of an asymmetrical filter

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

OVER-CROWDING of the radio-frequency spectrum has led to the development of a number of signal-separating devices for use in conjunction with standard communications receivers.

The unit described in this article is capable of high attenuation of interference close in frequency to that of a c-w or modulated carrier, with no loss in transmitted intelligence. The system has been employed extensively in radio intelligence work where standard communication receiver selectivity proved to be inadequate.

Principle of Operation

This particular type of heterodyne eliminator is known as an asymmetrical off-frequency inverter, and is suitable for both phone and c-w reception. The circuit diagram, excluding power supply and audio amplifier, which are conventional, is shown in Fig. 1.

The unit is suitable for use with a communications receiver having an i-f of approximately 455 kc. No receiver realignment or circuit changes are required. The inverter is connected to the receiver by a small coaxial cable, the end of which has an insulated loop. This loop is placed over the plate pin of the first i-f amplifier tube and the tube replaced in its socket.

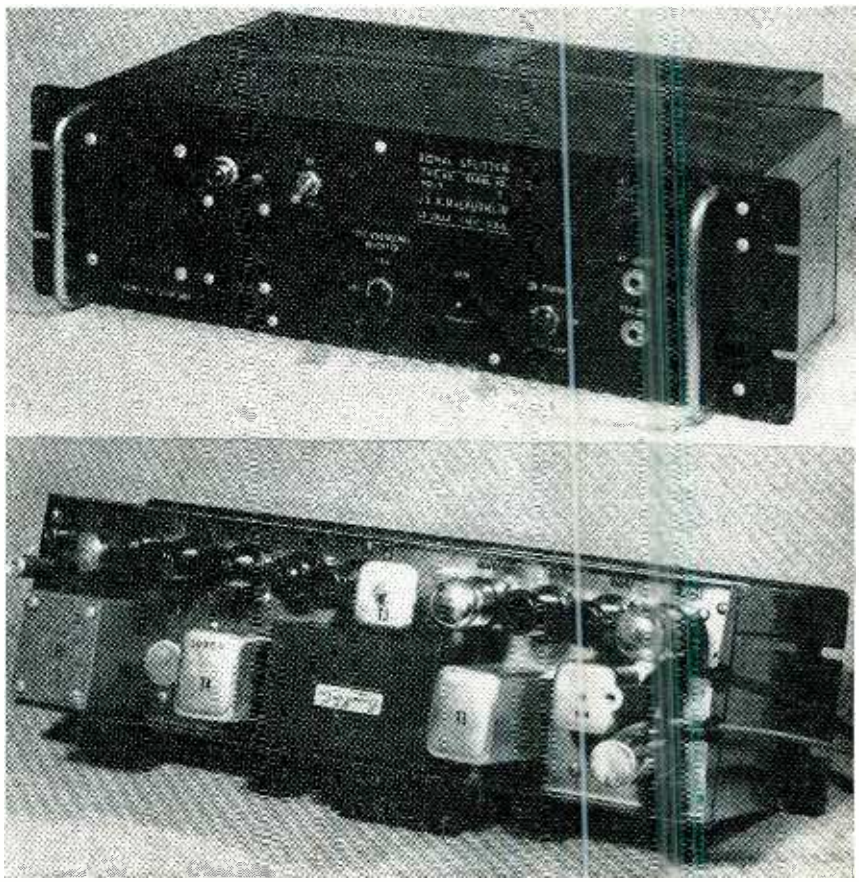
The block diagram, Fig. 2, illustrates the functions of the elements employed. The front end of the system is the off-frequency inverter (mixer), which consists of two crystal-controlled oscillators either of which will convert the desired carrier to a frequency of 50 kc.

When the oscillator lower in frequency than the desired carrier is employed the numerical order of all off-frequencies will remain unchanged. However, when the oscillator higher in frequency is substituted the numerical order of the converted off-frequencies will be inverted. Should the desired carrier be off the center frequency a positive amount in the first case, this error will appear negative in frequency by the same amount in the second case. This holds true for all frequencies off the symmetrical center frequency of the system.

Filter Design

An asymmetrical high-pass filter is connected to the output of the off-frequency inverter. When an undesired carrier is present in the high-pass side of the filter, it can be frequency shifted to the cut-off side by switching oscillators, whether or not it originally was above or below the desired carrier frequency. In the case of a phone signal, one side of this asymmetrical filter's selectivity is suitable for attenuation of off-frequencies close enough to produce beat-notes and yet broad enough on the other side to permit the passing of speech frequencies without attenuation. This passband can of course be extended to permit high-fidelity reception.

Toroidal coils make possible the design of a compact high-pass filter



Two views of complete unit, including power supply and two-stage audio amplifier

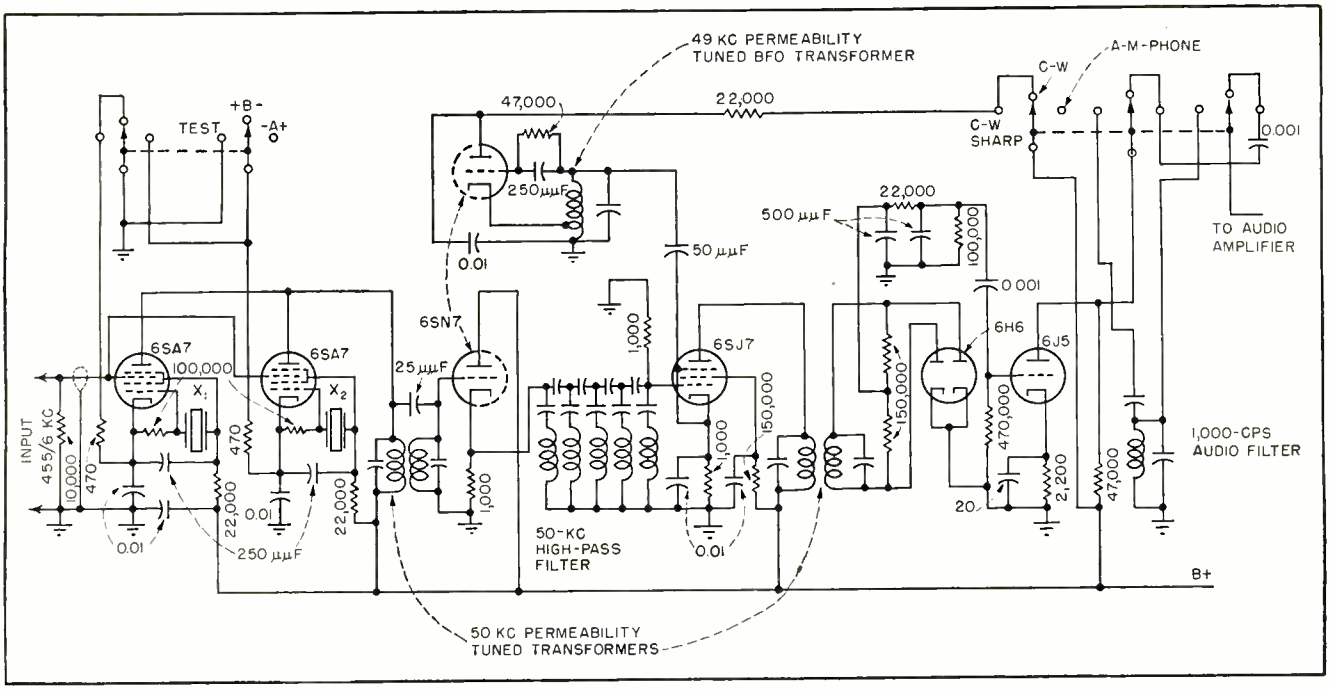


FIG. 1—Schematic diagram of off-frequency inverter. Crystals X_1 and X_2 operate 50 kc above and below the i-f frequency

with attenuation characteristics suitable for this service. The unit used is sealed in a 2½ x 2½ x 4-inch case. The desired high-pass attenuation characteristic is supplied by two medium-Q 50-kc transformers. They also supply sufficient attenuation to reduce the return peaks on the cutoff side of the fixed high-pass filter.

The high attenuation in the cutoff side of the asymmetrical filter also supplies the selectivity needed for elimination of the audio-frequency image inherent in heterodyne c-w reception. The overall frequency response curve of this filter is shown in Fig. 3. The beat-frequency oscillator is preset at 49 kc to produce with the desired signal an audible beat-note of 1,000 cycles. The audio-frequency image will therefore result from a signal of 48 kc. It will not be heard, since this frequency is down more than 100 db.

The actual value of attenuation of the heterodyne beat-note will depend on the rectifying action of the detector. This action will be influenced by the relative strength of the two signals appearing at the detector's input. Under normal receiving conditions, rectifying action of the detector with regard to the desired signal will be linear. However, in the case of the audio-frequency image the high attenuation of the filter will weaken this signal's energy to a point where the detector's action becomes square law. These factors must be considered in evaluating the attenuation of beat-note interference both in c-w and phone reception.

To achieve the selectivity required for c-w reception, a sharply peaked audio filter after detection is more practical and economical than attempting to obtain this selectivity in the 50-kc filter. If this filter is made asymmetrical, signal frequencies can be inverted here as in the first filter by switching the off-frequency inverter oscillators in the front end of the system. Figure 4 shows the response curve of a commercial 1,000-cycle filter suitable for this use. It has an attenuation of approximately 40 db per octave, which makes its asymmetrical frequency characteristics 2-to-1 in db. In other words, an interfering signal 200 cycles above the frequency of the desired one will produce a beat-note of 1,200 cycles in one off-frequency switch position with an attenuation of 10 db. In the opposite switch position the beat-note is changed to 800 cycles and an attenuation of approximately 20 db is achieved. This 2-to-1 asymmetrical filter gives high selectivity with good economy.

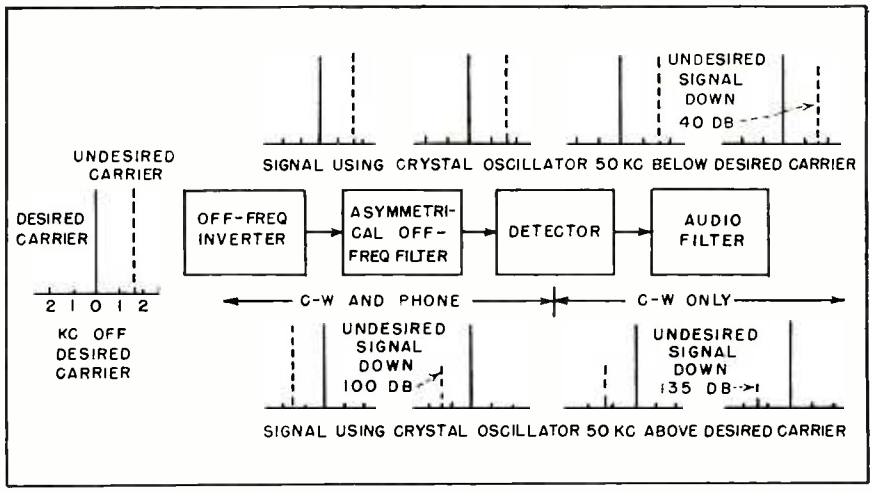


FIG. 2—Simplified block diagram of heterodyne eliminator showing effects of circuit components on undesired carrier with and without off-frequency inversion

It is well known that extremely selective circuits have a tendency to ring on c-w signals, which destroys their usefulness. An asymmetrical filter, however, will provide considerably more useful selectivity before this ringing state is reached.

Tuning Technique

The tuning of a c-w signal on an asymmetrical off-frequency inverter receiver is simpler and faster than on a conventional type.

The asymmetrical off-frequency inverter eliminates the need for two variable c-w controls found essential in communications receivers for elimination of the audio-frequency image and off-frequency interference. (The variable BFO and the crystal filter phasing control). The phasing control provides a form of asymmetrical response. Because the standard communications receiver lacks the ability to invert off-frequencies, it is necessary in the presence of interference in the broader side of the crystal filter, to move the phasing control to this side for attenuation. These variable adjustments are superfluous in the asymmetrical off-frequency inverter system.

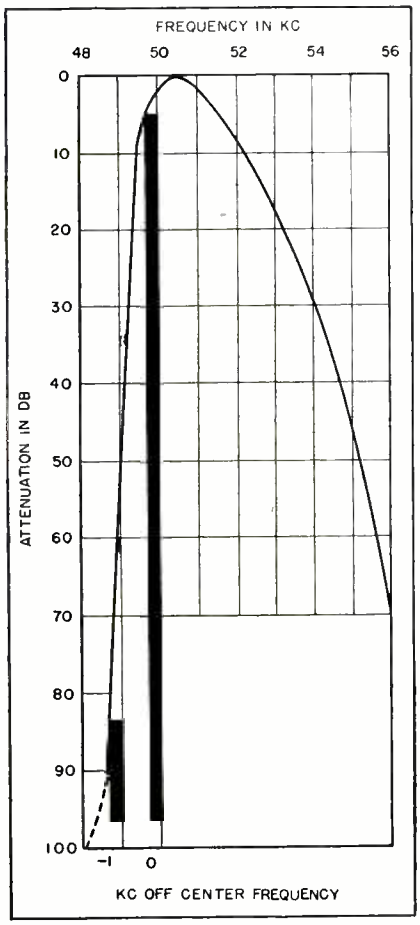


FIG. 3—Frequency response curve, showing attenuation of off-frequencies

The usefulness of the system for phone reception in the presence of interference is obvious. However, to be practical a sound tuning technique for location of the desired phone signal's carrier in the correct position of the asymmetrical filter has to be employed. In some earlier models, suitable for high-fidelity reception, a tuning indicator connected to a sharply peaked 50-kc carrier amplifier was employed. Another scheme which suggested itself was the use of a locked-in oscillator to supply an exalted carrier. Such devices are commonly employed in single-sideband communication, where channel separation is sufficient to preclude heterodyne interference. However, in the type of work we are more interested in, where communication is always imperiled by off-frequency interference, the exalted-carrier system proved impractical. Too often the close-in off-frequency interference takes control of the locked-in oscillator, destroying its usefulness.

The tuning of a desired phone signal in present models is by aural means. When no interference is present the desired signal is tuned to maximum response and intelligibility as in normal receiver practice. This is made possible by peaking the nose of the response curve. By rocking the tuning control slightly the operator can sense the cut-off side of the filter by the rapid attenuation feel of this side, compared to the other. The correct location of the carrier (50 kc) will of course be toward this cut-off side, slightly below peak response. A good operator will, with practice, be able to hit this point with high accuracy. However, a tuning error of plus or minus 500 cycles is permissible.

High-Precision Tuning

A test position is provided on the off-frequency inverter switch for high-precision tuning of the desired carrier when necessary. In this position both oscillators are employed, which will produce two signals moving in opposite directions as the receiver is tuned. The difference between the two signals will be heard as a beat-note, and the correct carrier position will be indicated at zero-beat.

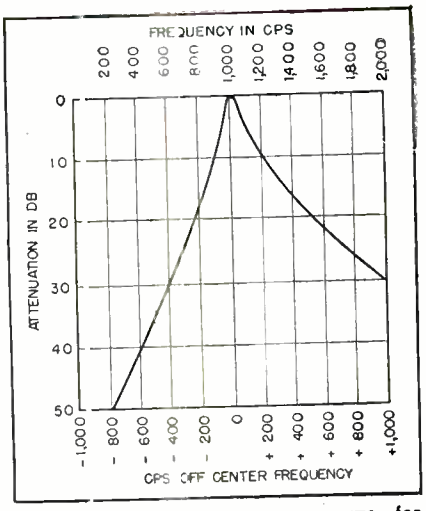


FIG. 4—Frequency response curve for 1,000-cps audio filter

The tuning technique in the presence of a heterodyning beat-note is quite simple. With the off-frequency inverter switch in one position and the receiver tuned to maximum beat-note interference, the opposite switch position will remove the heterodyne. Since the side the interference was originally on, with respect to the carrier, may be in doubt, this procedure should be followed in both switch positions. When the correct switch position for greatest attenuation is found, a slight detuning will give further attenuation, particularly if the beat-note interference is low in frequency.

Figure 3 shows the increase in attenuation to low frequencies a slight detuning of the desired carrier towards the cut-off side achieves. The left hand edge of the solid line at 50 kc indicates a frequency shift of the carrier of approximately 300 cycles. At this point the carrier will be down 5 db. The bottom of the curve illustrates the increase in attenuation this small frequency shift gives a signal 1 kc removed from the desired carrier. Thirty-db greater attenuation has been realized. Frequencies closer to the carrier than 1 kc will receive proportionate improvement in attenuation. Frequencies below the voice range can be satisfactorily attenuated in the a-f amplifier.

Vibration Testing

Electronic techniques that can be applied to complete airplanes, accessory equipment and structural parts on the ground to simulate vibrations encountered in flight, and methods of measuring, recording and analyzing intensity and frequency of resulting motions

By ABNER R. WILLSON

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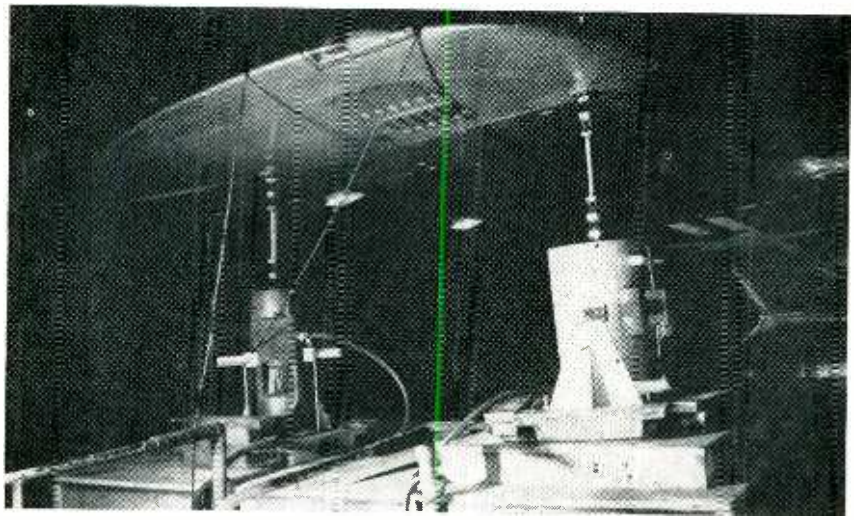
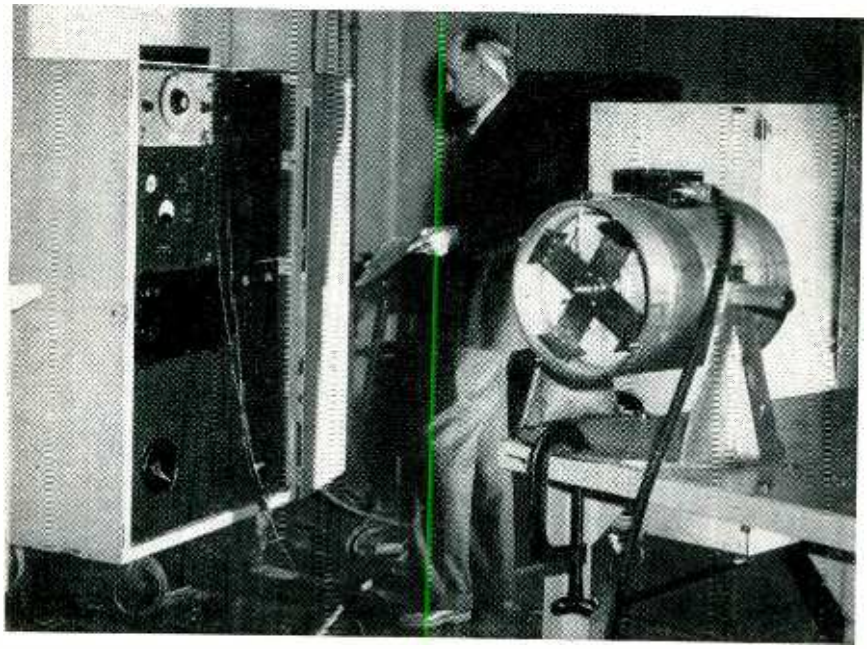


Setup for vibrating wing of airplane. Large vibrator is attached near wing tip, at front spar, and small vibrator is attached at rear spar



Electronic power source and one of vibrator units (clamped to table) used to simulate vibration stresses and strains an airplane would encounter in flight

IT IS THE GOAL of an airplane manufacturer to have his accidents in the laboratory rather than in the air. Vibration is recognized as the cause of many failures and malfunctions, and is attaining more importance with each increment of airplane weight and speed.

The low-frequency vibrations of the main structural members and the possibility of dangerous flutter caused by mechanical coupling of their several frequencies are prime factors in an airplane's safety. Low frequency is defined as frequencies ranging from 0.5 to 50 cps.

The elimination of higher-frequency vibrations at high g's is also imperative for reliable operation of controls and other functional equipment such as relays, valves, ducts, coupling hoses, racks and radio equipment.

It is recognized that fatigue resulting from vibratory forces requires structural members to be several times as strong as is necessary for static loads alone. While the safe static working load of an aluminum alloy member may be upwards of 30,000 lb per sq in., the same member will fail in a few hours if working under half this load while vibrating at large amplitudes. The magnitude of vibration is often expressed as $g = 2\ x_0\ f^2/19.56$, where g is the acceleration expressed as multiples of the acceleration of gravity, $2x_0$ is inches of double vibration amplitude (peak to peak), and f is the frequency in cps. Amplitudes needed at various frequencies to produce g's from 0.01 to 192 are plotted in Fig. 1 to

# of Airplanes

emphasize the exponential nature of this relationship. Note that at 500 cycles the vibration of less than 0.001 inch is sufficient to give 10 g's, whereas at 10 cycles the vibration must be about 2 inches to produce the same acceleration.

Values of g for fatigue testing of equipment to be installed at various locations in a large airplane are also shown in Fig. 1. The entire frequency range specified for each area should be explored for resonance, and endurance testing should be conducted at the resonant frequencies. Note that resonant frequencies for torsion are generally higher than those for bending.

Resonant frequencies of the principal structural parts of a typical modern large airplane are given in Table 1, as obtained from recorded results of vibration tests. The resonant frequencies of control and auxiliary equipment may be much higher, ranging from 50 to 500 cps.

Types of Vibration Testing

There are three general types of vibration testing. Fatigue vibration testing is used to establish the comparative lives of various materials and structural components under various frequency and load conditions. Vibration testing of structural components, control surfaces and controls is used to determine resonant frequencies and vibration amplitudes and to investigate the probability of a dangerous flutter condition caused by dynamic mechanical coupling. Vibration testing of auxiliary equipment is used to determine operating characteristics under simulated airplane vibration conditions. These tests also determine whether or not shock mounting is necessary.

In fatigue testing, the load and frequency are held constant and the test specimen is kept vibrating until failure occurs. This procedure is repeated for enough different loads to permit plotting a curve of load vs the total number of cycles before failure of the test specimen.

One end of the test specimen is fastened to a vibrating beam and the other end is fixed, as shown in Fig. 2. The load on the specimen is adjusted by changing the tension on a spring or changing the weight on the beam. The beam may be actuated by an electromagnetic transducer that is self-synchronous, with a pickup attached to the beam. The electromagnetic drive is required to furnish only the losses in the vibrating system, consequently five or six thousand pounds of vibrating load may be

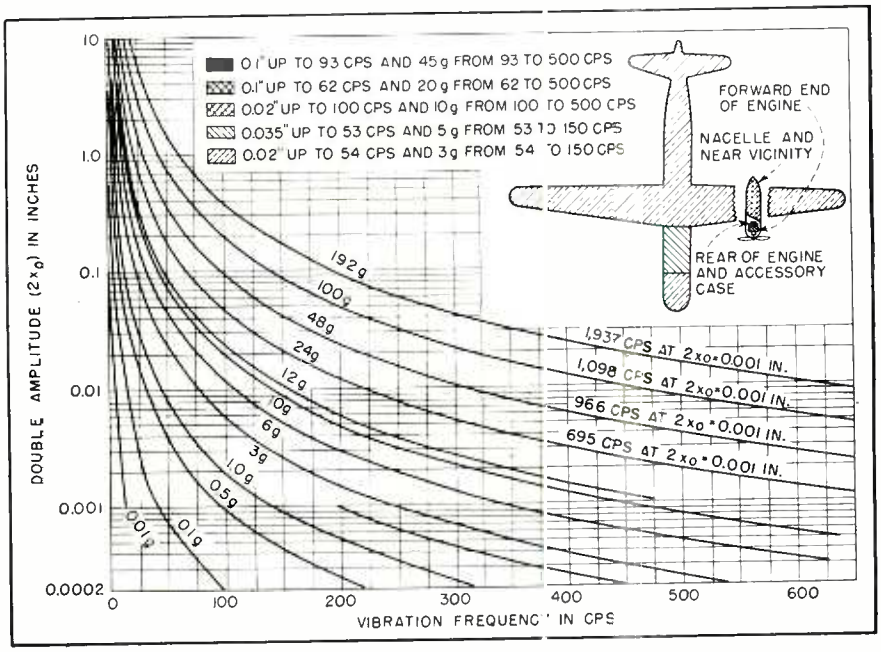


FIG. 1—Vibration amplitudes required to produce accelerations up to 192 g's at various frequencies up to 600 cps. Maximum double amplitudes and peak accelerations that equipment must withstand in various areas of a representative large airplane are indicated at upper right; values include a factor of safety and hence are larger than normal. Boundaries between areas are not sharply defined

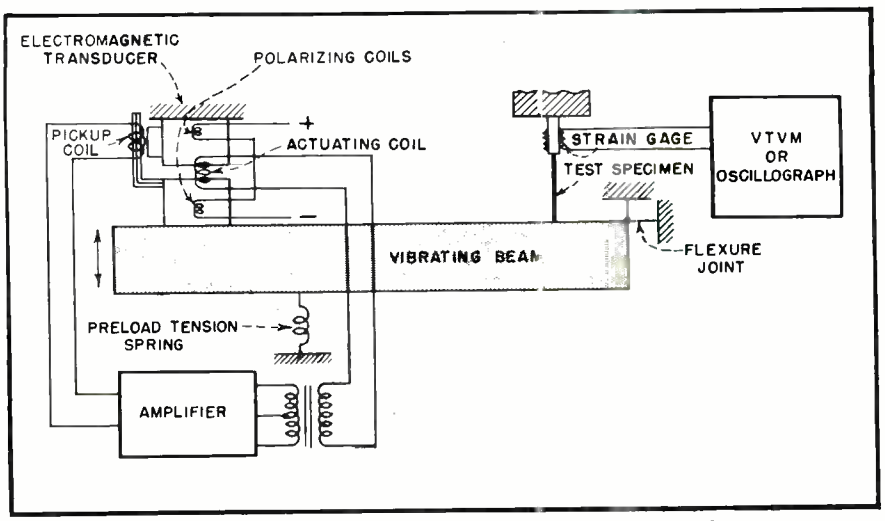


FIG. 2—Vibrating-beam setup for conducting fatigue tests of individual test specimens used in airplane construction. Voltage output of pickup coil is amplified and fed back to actuating coil to produce vibration at natural frequency of system

obtained from a comparatively small driving force, of the order of a hundred watts.

In structural vibration testing a structural member of an airplane, such as a wing, stabilizer or aileron, is shaken by a sinusoidal force throughout a wide frequency range, at sufficient amplitudes to excite the several resonant frequencies or modes.

In a typical large airplane vibration test some 28 characteristic modes have been identified and analyzed. These modes are indicated in Table 1, with the resulting resonant frequencies. The vibrating force during the several phases of this test was applied at 29 different attachment points, and 352 oscillograph records were taken of the frequency, amplitude and damping of the vibrations which occurred at some 113 test locations.

Airplane vibrations are transmitted from the engine to delicate instruments and pieces of control equipment. Some of these vibrations and their harmonics excite vibrations of sufficient magnitude in some types of equipment to cause faulty operation or even failure.

Vibration tests of individual pieces of equipment reveal these weaknesses. For example, one type of relay chattered so severely at 70 to 150 cps that a redesign was necessary. In some radio tubes the elements resonate around 350 cps and cause faulty operation of the equipment of which they are a component. One type of electromagnetic valve functioned erratically in the range of 100 to 150 cps. A small rectifier malfunctioned in one piece of equipment when vibrated at 200 to 250 cps. Some switch contacts failed between 300 and 500 cps.

Typical Airplane Test

Figure 3 shows a typical layout of vibrators and accelerometer-type signal pickups on a four-engine airplane. Two vibrators are used together, located at each wing tip and at each stabilizer tip, to excite the various symmetrical and antisymmetrical bending and torsional modes. For symmetry the actuating coils of the two vibrators are connected in phase. One actuator is reversed to provide 180-degree out-of-phase vibration when it is desired to excite the antisymmetrical modes.

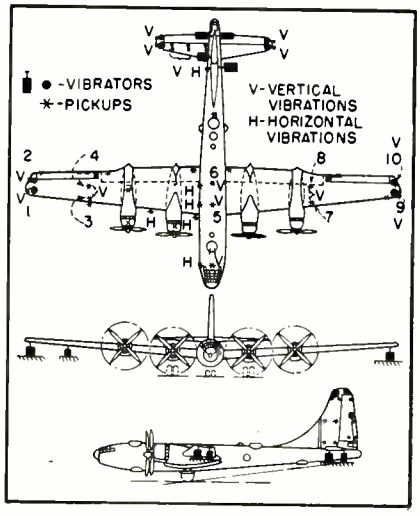


FIG. 3—Typical layout of vibrators and pickups for vibration testing of large airplane. Typical test run employs either two or four vibrators and ten pickups, such as those numbered 1 to 10

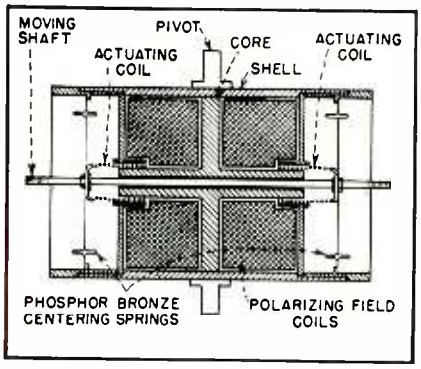


FIG. 4—Cross-section of vibrator unit

Four vibrators are operated together for exciting torsion. They are attached at the leading and trailing edges of each wing tip or each stabilizer tip. All four are driven from a single oscillator but separate power amplifiers drive each pair of vibrators. Four combinations of in-phase and out-of-phase operation are conveniently switched on the control panels.

For locations near the ground the vibrators merely rest on platforms or aerostands whose height and angle may be quickly adjusted with a self-contained hydraulic hand pump. When the vibrator attachment point is high in the air, as for vibrating a fin, the vibrators are slung from roof supports with flexible aircraft control cables. The 300-lb weight of a vibrator is sufficient to react the vibrating force.

Connecting a wing tip or other flexible member to the oscillating shaft of the vibrator frequently presents a mechanical problem because there is always some movement which causes misalignment. Several types of connecting links have been used, including universal joints and 90-degree X-type flat spring links. The X-type links operate quietly, permit about 7 degrees of misalignment and do not loosen the fitting even during long runs under full vibrator load.

Vibrating Equipment Details

The Boeing electromagnetic vibrating equipment used for exciting the types of vibration discussed above is housed in two identical cabinets, each of which contains an oscillator, a driver amplifier and its rectified power supply, a coupling transformer used between driver and power stage, a power amplifier and its rectified power supply, an output transformer for impedance-matching power tubes to vibrator actuator coils, and a rectified power supply for vibrator polarizing fields. The vibrators are separate, two for each power unit. The electronic equipment provides sinusoidal output down to 3 cps. For lower frequencies down to 0.3 cps a separate motor-triggered thyratron power supply is used.

The vibrators are in effect oversize loudspeakers, with voice coils on both ends and a push rod instead of cones. They are of two sizes; the 300-lb unit is 12 inches in diameter and 17 inches long, while the 150-lb unit is 8 inches in diameter and 20 inches long. As shown in Fig. 4, the moving shaft extends entirely through the core and projects beyond the shell for connection to a flexible coupling or a flat mounting disc. A polarizing field is induced with two coils, usually operated at 5,000 to 8,000 ampere-turns. The actuating coils are mounted on each end of the shaft.

Two pairs of phosphor-bronze loop springs mounted at 90 degrees keep the actuating coils centered in the magnetic air gap. These springs are stiff in transverse shear but very flexible in longitudinal bending. The shell is pivoted to rotate about the midpoint, so that the vibrator may be attached at any angle from vertical to horizontal.

The power input to the actuating

coils during a normal test run may vary from 50 to 600 watts. These coils are wound with glass-enamel magnet wire on glass-cloth plastic bobbins, and weigh much less than equivalent coils made from regular enameled magnet wire on aluminum bobbins.

The actuator coils in the vibrators are driven by one of the two power supply arrangements shown in Fig. 5. The vibrators must deliver a force which is truly sinusoidal, for otherwise some of the harmonic components would excite mechanical vibrations of amplitudes magnified beyond that which pure sinusoidal excitation gives. Oversize capacitors and transformers are therefore essential for amplification of the required low-frequency sine waves without distortion, and all amplifier tubes are operated class A.

The coupling transformer used between the TZ40 driver stage and the 250TH power stage has an impedance ratio of three to one and weighs about 60 lb. The coils are pie wound, with primary and secondary coils alternately spaced within a shell-type iron core.

The final output of the all-electronic unit is sinusoidal down to about 3 cps. At lower frequencies than this the oscilloscope shows considerable distortion and the output power drops off rapidly because the transformer current is fast approaching direct current.

The plate voltage for the power tubes is obtained from a conventional full-wave rectifier using type 872 tubes. The voltage is controlled on the primary side with a 50-ampere Powerstat. The tube load seldom exceeds 500 ma at 3,000 volts.

The plate voltage for the driver amplifier tubes is obtained from a conventional full-wave power supply using type 866 tubes. A similar supply, not shown, serves the polarizing field coils of the vibrators.

Because the frequencies at which the amplifier operates approach direct current (2 to 3 cps), it is necessary to provide many turns of magnet wire and a large iron cross-section for the output transformer. The resulting unit weighs 195 lb, and can deliver more than a kilowatt of low-frequency energy into the vibrator actuating coils. The impedance ratio is 100 to 1. The secondary a-c voltage is from 250 to 400 volts and the power output is from 300 to 600 voltamperes into one vibrator.

Throughout the operating frequency range the actuator coil impedance varies from about 25 to 75 ohms. Taps are provided to change the transformer impedance ratio, but experience has indicated that sufficient power is available without changing taps. A typical test seldom requires full power, normal operation being about one-fourth of full output.

Table I—Resonant Frequencies in Typical Large Airplane

Mode	Frequency in cps
WING	
1st symmetrical bending	3.33
2nd symmetrical bending	9.67
3rd symmetrical bending	25.51
1st anti-sym. bending.	6.62
2nd anti-sym. bending.	13.17
Symmetrical torsion	....
1st anti-sym. torsion..	4.10
2nd anti-sym. torsion	21.47
AILERON	
1st symmetrical rotation	7.67
2d symmetrical rotation	45.51
1st anti-sym. rotation	.....
2nd anti-sym. rotation	47.00
Anti-sym. torsion	26.51
Tab rotation	18.50
Tab torsion	51.68
FUSELAGE	
1st side bending	3.80
2nd side bending	16.67
Torsion	5.23
Vertical bending	14.74
STABILIZER	
Symmetrical bending	11.47
Anti-symmetrical bending	25.00
Torsion	33.84
ELEVATOR	
Symmetrical rotation	5.27
Anti-sym. rotation (torque tube torsion)	14.29
Symmetrical torsion	34.50
Anti-symmetrical torsion	38.51
Tab rotation	25.00
RUDDER	
Torsion	28.34–29.17

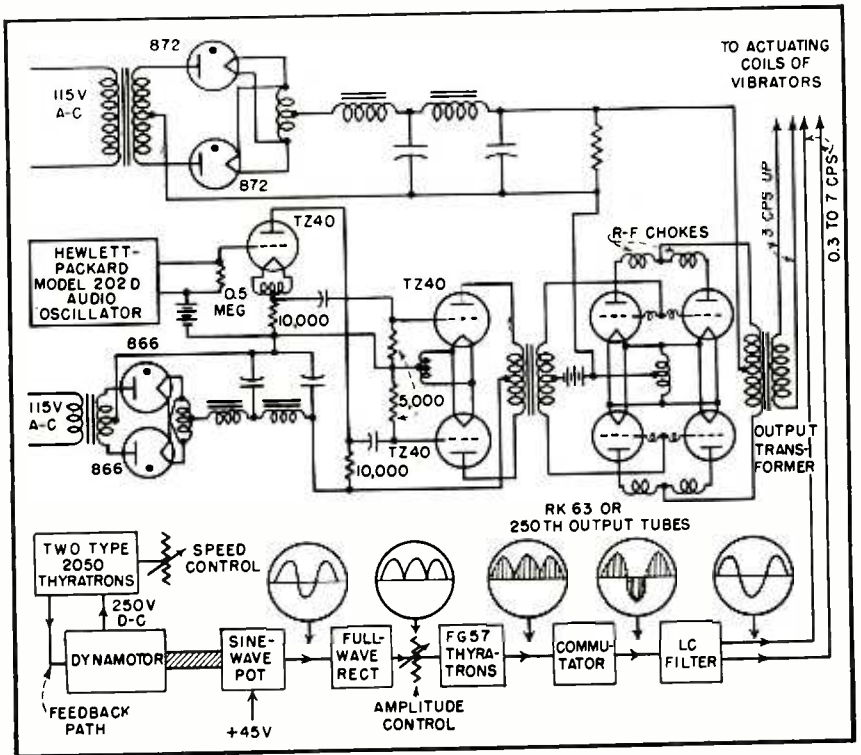


FIG. 5—Circuit used for driving actuating coils of vibrators above 3 cps, and block diagram of motor-triggered thyratron system used at lower frequencies

0.3 to 7-cps Generator

The low end of the required frequency spectrum is obtained from a separate power unit that is essentially a pair of thyratrons fired by a motor-driven sine-wave potentiometer, as shown in the lower part of Fig. 5.

The 250-volt winding of the dynamotor that drives the sine pot is energized by a pair of 2050 thyratrons. Motor speed is controlled by a voltage divider in the rectifier control circuit. A feedback loop from the dynamotor stabilizes the

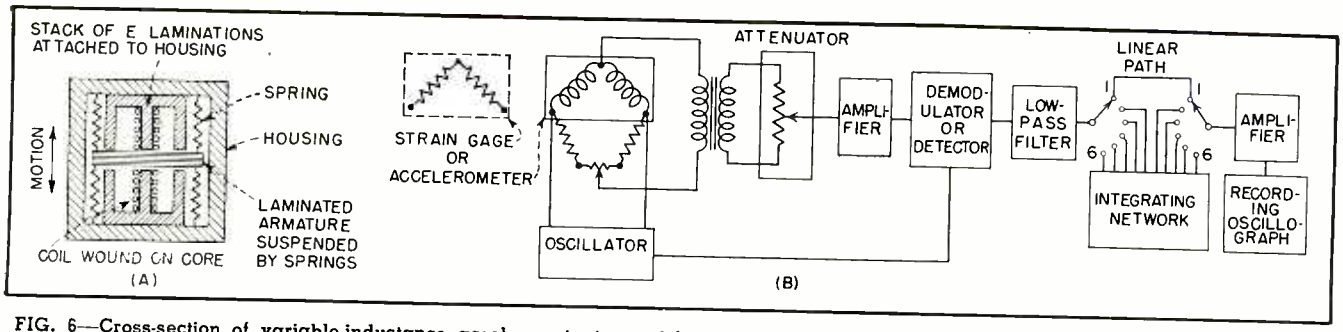


FIG. 6—Cross-section of variable-inductance accelerometer-type pick up and block diagram of carrier amplifier system used with this pickup and with strain gages for recording vibration and strain

speed. The sine-wave potentiometer is a square card of resistance wire with 45 volts d-c across its terminals. It rotates against brushes from which is obtained a sine-wave voltage whose frequency is determined by the drive motor speed as stepped down by a worm gear ratio of 25 to 1.

The sinusoidal output of the potentiometer is rectified, and the resulting half-waves fire the main FG57 thyratrons. A voltage divider varies the grid input and thereby regulates the output. The envelope of the thyratron output is commutated and filtered to obtain a final sine-wave output.

Measuring Methods

The final objective of a vibration test is to obtain an accurate and checkable record of the frequencies, amplitudes and damping of the vibrations which occur at the various test locations.

If a force is applied to the free end of an elastic member such as a wing (cantilever beam) and the force removed, the member will vibrate at its resonant frequency. The rate at which the vibrations die out is a measure of its damping.

In airplane structural testing a continuous vibrating force is applied and the frequency of the force is varied until the peak amplitude of the vibrating member indicates resonance. At this point an ammeter in the actuating coil of the vibrators takes a dip because less force is required at resonance. At this resonant point an oscillograph record is taken. While the oscillograph is still recording, the power to the vibrators is cut and the oscillograph then records the decaying vibrations as the member comes to rest. From this part of the record is obtained the damping of the member. Damping may also be obtained from the rate at which the record amplitude increases as the forcing frequency approaches resonance.

Accelerometer Details

The three types of signal pickups used for measuring vibration are accelerometers, velocity pickups and strain gages. The signal amplitude of an accelerometer is proportional to acceleration, but the signal voltage may be integrated to obtain either velocity or displacement. The signal amplitude of the velocity type is proportional to velocity, but may be integrated for displacement. The signal amplitude of the strain gage type is proportional to displacement.

The cross-section diagram in Fig. 6A shows the construction of a typical variable-inductance accelerometer-type pickup. Motion of the frame changes the air gaps between the armature and the stacks of E laminations, thereby changing the inductances of the two coils. As shown in Fig. 6B, these coils serve as adjacent arms of a standard Wheatstone bridge whose output is proportional to the acceleration of the exciting motion.

Accelerometer output $k(x_o)f^2$ may be integrated in the amplifier to $k(2x_o))$. This equation is true from zero frequency to some frequency near the natural frequency of the accelerometer seismic mass, which is in the order of 80 to 100 cps. The seismic mass must be properly damped or it will vibrate at its own natural frequency. Damped or not, it will not function as an accelerometer at frequencies greater than its resonant frequency. The higher frequencies are therefore obtained from the velocity-type pickup which has a resonant frequency in the order of 5 cps and is usable above this value.

An accelerometer is used with a carrier-type amplifier and integrating network like that in Fig. 6B, to drive the galvanometer elements in a recording oscillograph. The accelerometer output signal, in the order of microvolts, must be amplified from 15 to 60 db to swing the oscillograph galvanometers sufficiently to obtain a usable record. The same circuit arrangement is also employed for modulated carrier-type strain gages.

A switch in the integrating network provides a choice of the following six characteristics: (1) linear path for acceleration; (2) velocity path linear down to 2 cps, wherein filtered detector output is integrated once through a series resistor and shunt capacitor; (3) velocity path as before but the integrating constants chosen to discriminate against frequencies below 8 cps; (4) displacement linear down to 2 cps, wherein filtered detector output is integrated twice with a reactance-resistance network; (5) displacement as before but with constants chosen for cut-off below 8 cps, (6) strain gage, with no integration and with some of previously introduced feedback eliminated to obtain increased gain.

Velocity-Type Pickups

The construction of a typical self-generating velocity-type pickup is shown in Fig. 7A. Motion of the housing produces relative motion between the permanent magnet and the fixed voice coil, thereby generating an a-c voltage that is proportional to the velocity of the relative motion. The pickup output, equal to $k'(2x_o)f$, is fed directly into an integrating network using a reactance-resistance circuit to produce

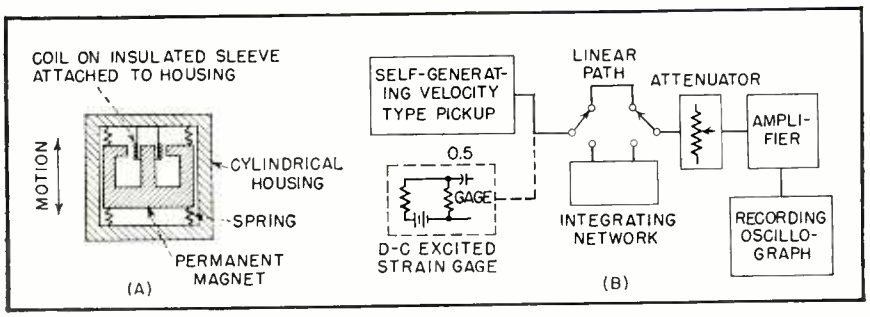


FIG. 7—Cross-section of self-generating velocity-type pickup and block diagram of typical linear and integrating amplifier used with it and with strain gages

for the following amplifier a signal that is proportional to pickup displacement, as indicated in Fig. 7B. This arrangement is also used for d-c excited strain gages, where the output is directly proportional to the amplitude of motion.

Recording Oscillograph

The recording oscillograph has 14 isolated galvanometer systems, and a timing line system, all acting simultaneously on 6-inch-wide photographic paper. The light beams reflected from the galvanometer mirrors may also be scanned on a viewing ground glass. A record number is automatically photographed on each record. A device momentarily blanks out each of the elements consecutively to permit identification of each trace.

The oscillograph records taken during a vibration test provide data which defines the frequency, amplitude, and relative phase relationships of the vibratory motions which occur at each pickup location. These data may all be obtained from a single sweep record for which the frequency of the vibrators is changed at a constant slow rate by a motor driving the frequency-control dial. The sweep is usually from 2 to 40 cps. The vibratory force is held constant during the sweep.

As the frequency passes through resonant points the amplitudes of the traces on the scanning screen of the oscillograph build up to peaks, then decay as frequency is further increased. A sweep requires about a minute and may require a hundred feet of record paper. A short check record is also taken of each major resonant frequency while the oscillator frequency is held constant.

Figure 8 is the oscillograph record of data taken during the vibration of an airplane empennage to obtain body torsion. Two vibrators were attached to each stabilizer tip, at the front and rear spars, with the two pairs 180 degrees out of phase so as to produce a twisting moment about the longitudinal axis of the fuselage. This is shown by the comparatively large displacement of pickup 49 on top of the fin and by the 180-degree phase difference of the two stabilizer tips (30–38 and 29–37).

The db values at the pickup locations in Fig. 8 represent the attenuation needed to make all traces have approximately equal amplitudes, and hence are an indication of pickup outputs. The full amplifier gain is about 60 db. The amplification for pickup 49 was only 6 db, but 42 db of gain was necessary for the signal from pickup 35.

Acknowledgements

The author expresses appreciation to several engineers of the Boeing Vibration Laboratory Group for assistance in the preparation of this article. John J. Sheppard prepared the material for the sections explaining pickups and record analysis. Donald W. Nelson developed the low-frequency vibrator power unit. The X-type spring link couplings were developed under the direction of Harold L. Adams, chief of Boeing's Structural Test Unit. Floyd A Swenson and Paul T. Sauber contributed information and assistance.

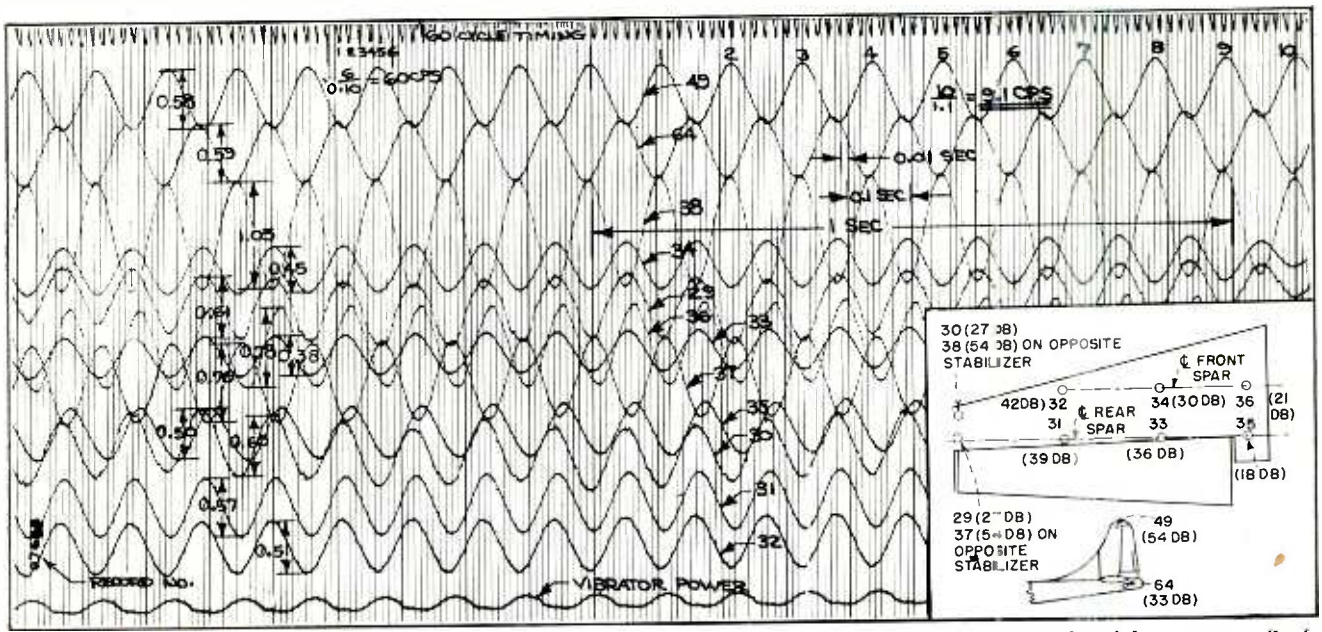
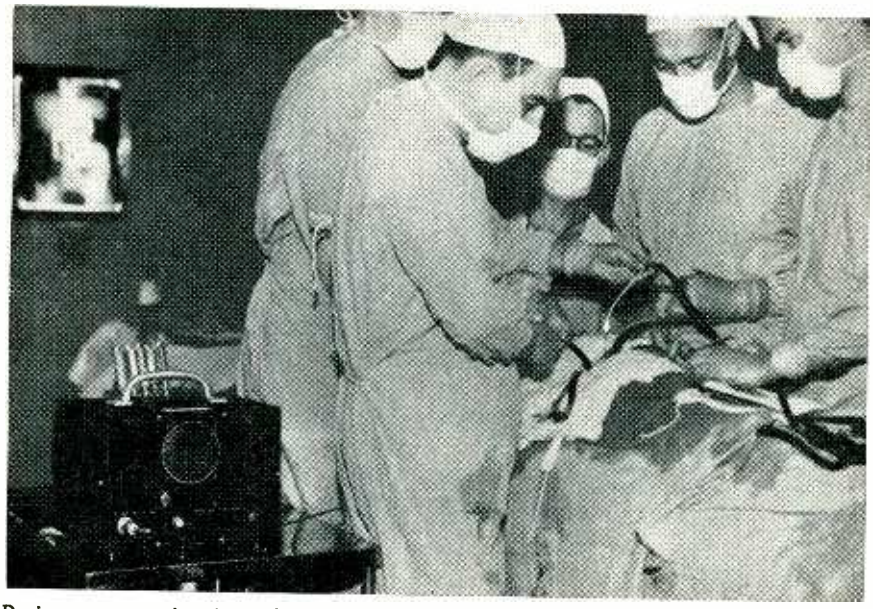


FIG. 8—Example of oscillograph record obtained for airplane-body torsion test. The ten traces are produced by correspondingly numbered pickups at location shown in lower right. Vertical timing lines are 0.01 sec apart, with heavy lines every 0.1 sec



During an operation for gall bladder removal or for gallstones, surgeons use electro-acoustic detector to locate stones that are otherwise difficult to find

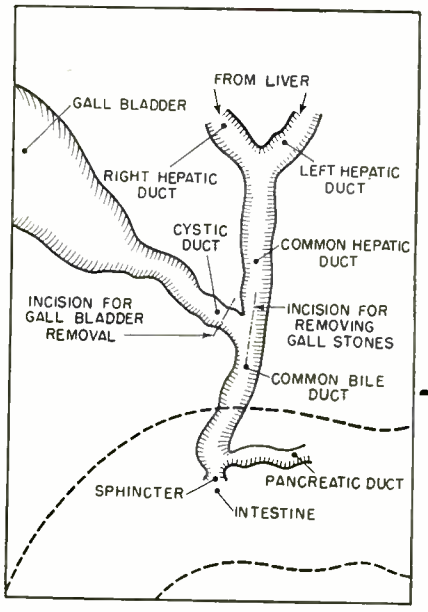


FIG. 1—Diagram of biliary tract shows bile ducts in which gall stones may lodge

Locating Gallstones

A SERIOUS PROBLEM which confronts surgeons during gallstone operations is to determine whether all the stones have been removed from the bile ducts. In some operations which are otherwise successful one or more stones are left in the bile ducts, principally because of inability to detect their presence. Convalescence may be prolonged and difficult, and a second operation may be required.

Need for Locating Gallstones

Referring to the diagram of the biliary tract shown in Fig. 1, the bile ducts are small tubular structures which convey bile from the liver to the intestine. The right and left hepatic ducts which drain the right and left lobes of the liver join to form the common hepatic duct which, in turn, is joined by the cystic duct from the gall bladder to form the common bile duct. After joining with the pancreatic duct, the common bile duct terminates in a small sphincter, or circular muscle, in the wall of the intestine. The sphincter allows bile to flow into the intestine but effectively seals the duct against reverse flow.

Gallstones form in the gall bladder (rarely in the bile ducts) and may pass through the bile ducts into the intestine if they are small enough to go through the sphincter. If not, they are arrested at the sphincter and block the flow of bile into the intestine.

Usually the obstructing stones cannot be seen or felt, and present methods of detecting them are often inadequate. The most effective method consists of repeatedly passing a grasping forceps up and down the ducts, removing the stones as they are encountered. Passage of instruments and catheters through the sphincter into the intestine is regarded as strong evidence that the obstruction has been relieved but does not demonstrate that all stones adjacent to the sphincter or in the proximal ducts have been removed. The use of x-rays, taken during operation with a radio-opaque dye injected into the ducts, has been suggested but not widely used.

An equally important problem is whether to open the common bile duct to explore for stones during operations for removal of the gall bladder. In many instances the presence or absence of stones in the bile ducts cannot be determined in any other way. Opening of the common bile duct is undesirable if unnecessary. An instrument which could be passed through the cystic duct upon removal of the gall bladder to detect the presence of stones in the bile ducts might there-

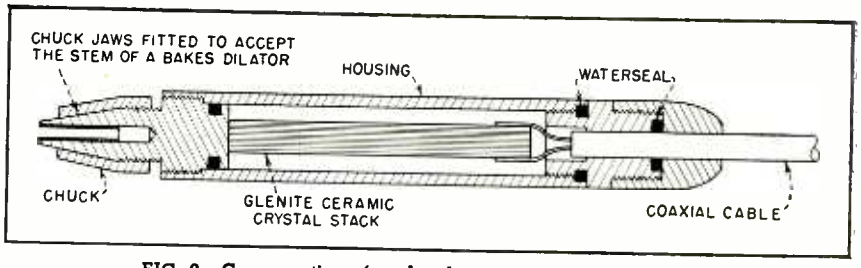


FIG. 2—Cross section of probe shows its simple construction

Piezoelectric pickup with long probe produces distinctive sound, through amplifier and loudspeaker, when gallstones are touched, thus simplifying their location during an operation and minimizing chances of overlooking any stones

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fore be of considerable value.

In seeking to develop a new detection instrument it was thought that a means could be devised to exploit the shock wave produced when a metal probe encounters a gallstone. Several devices, consisting of electroacoustic transducers using either magnetostrictive or piezoelectric-crystal elements mounted either at the front or at the back end of a slim rod-like probe and connected through an amplifier to a loudspeaker, were accordingly constructed and tested.

It was found that characteristic signals were produced whenever the sensitive probe came in contact with a stone. The audible signals, which consisted either of a clicking noise when the probe was tapped against the hard surface of a stone, or of a scratching noise when the probe was scraped against a stone. were easily distinguished from a soft hissing produced when the probe was slid against tissues.

The acoustical situation is similar to the striking of any metal rod. If the rod is undamped, a ringing sound will result and can be produced by almost any slight shock, including impact with even relatively soft bodies. If the rod is highly damped, a sharp click results and can usually be created only by striking the rod with a hard object. This latter effect is the one most desirable to achieve in such an instrument as this. The natural damping produced by the walls of the ducts help to create such an effect, and audio resonances are further suppressed by a tuned circuit in the amplifier, tuned to pass audio frequencies but displaced from any audio resonance frequency present in the probe structure.

In both of two later models of the device the transducers are mounted at the back end of the rod, inside the probe handle. This design was found to provide a more sensitive transducer which is easier and cheaper to construct.

Instrument Construction

Figure 2 shows a cross section of the prototype probe. In this model the sensitive element is mounted in the handle, and the rod, serving as the probe and consisting of a standard Bakes dilator, is attached to it by means of a simple chuck. The sensitive element consists of a stack of Glenite ceramic piezoelectric elements, (ELECTRONICS, p 97, Dec. 1948) soldered together in series. This relatively new material, which comes in sheets 10 mils thick, although not as sensitive as Rochelle salt, is 16 times as sensitive as quartz, is quite rugged, and is capable of withstanding temperatures up to 117 C. Fourteen of these sheets are soldered together to produce a packet 0.1875 by 0.25 by 1.5 inches. A disk, machined integral with the chuck, is cemented to the end of the packet with No. 55–6 Chrysler Cycleweld. The chuck, and the disk carrying the packet to which the crystal leads are attached, are screwed into the housing against a waterseal.

Figure 3 shows a schematic circuit diagram of the amplifier-loudspeaker unit. The amplifier has a gain of over 100 decibels in four stages and the output is used to drive a loudspeaker. The first two stages are resistance-capacitance coupled, and the third stage has a single tuned circuit as the plate load in order to lower the noise output and improve the signal quality. The tuned circuit has a Q of 25 and a resonant frequency of 1.5 kc.

The need for such a device as this was suggested by C. K. Kirby, and it was at his request that this work was done. The technical ideas for the device came out of a conference attended by the authors of this paper, and by L. W. Camp and L. N. Miller. V. M. Albers offered many helpful suggestions during the development.

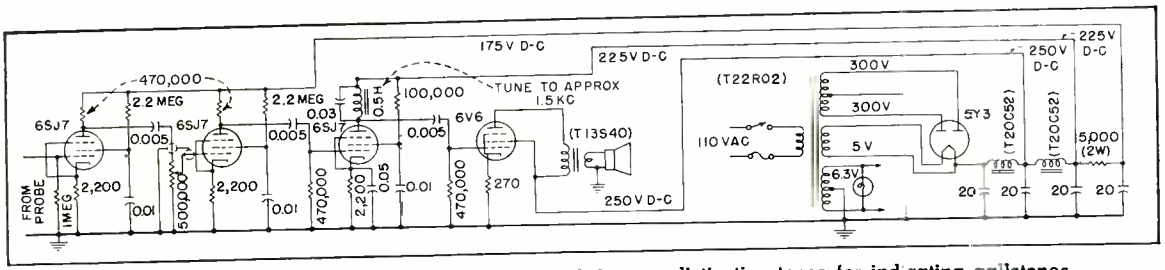

FIG. 3—Circuit diagram of amplifier: tuned circuit insures distinctive tones for indicating gallstones

MULTI-V ANTENNA for F-M Broadcasting

Folded dipoles are bent into V's to form a lightweight array that can be mounted atop existing a-m antennas. The array is tuned by extensions on each arm, without seriously changing the impedance match and radiation pattern

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THE MULTI-V ANTENNA is a simple lightweight transmitting array designed for operation in the f-m broadcast band from 88 to 108 megacycles. A basic two-bay design can be attached readily to the sides, corners or top of existing a-m radiators. Additional bays may be added for higher gain.

The radiating portion of the antenna elements takes the shape of a V, or strictly speaking, of a truncated V. This configuration gives a horizontal radiation pattern that is close to circular.

To increase the antenna impedance the folded dipole principle commonly used in receiving antennas is employed. This permits the use of a 51.5-ohm main feeder line. There being no need to feed both halves of the system when the folded antenna principle is used with antennas of low radiation resistance, this technique also reduces the number of transmission lines to half that otherwise required.

Although it is possible to build antennas that will cover the entire f-m band without adjustment, it is necessary to provide adjustments if the array is to be relatively small and light. The complication of these adjustments varies considerably with existing f-m antennas, and in most cases adjustments change both horizontal pattern and impedance. Usually pattern variations are tolerable, but impedance changes need to be counteracted by matching elements or tunable stubs.

With the multi-V one adjustment tunes the antenna to resonance for each frequency in the f-m band without materially affecting impedance values. Tuning is accomplished by extending secondary arms, primary arms remaining a fixed length determined by the highest frequency of operation. This tuning scheme also has a distinct advantage in connection with the power-handling capacity of the system. In antennas of this general type, where the effective operating length is about a quarter wavelength, the highest voltage occurs at the open end. It is important, therefore, to keep open ends far apart. The diverging arms of the V antenna meet this requirement and provide a safety factor in addition.

In the development of the antenna element, it was found that the condition of horizontal pattern uni-

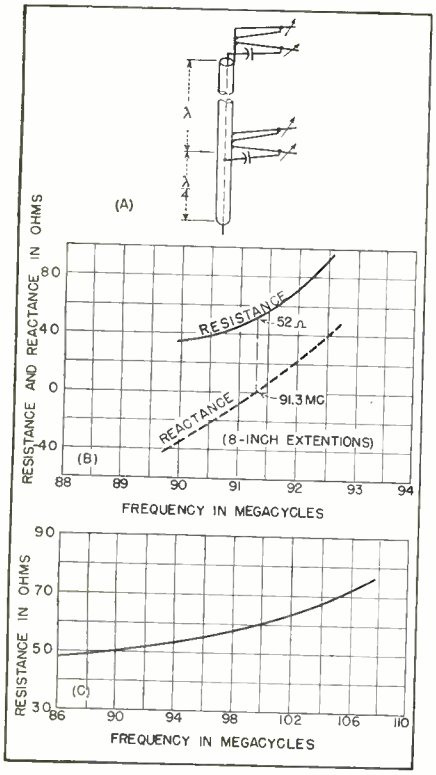


FIG. 1—(A) Circuit of two-element array, (B) driving impedance of one bay with extensions fixed for resonance at 91.3 mc, and (C) resistance of one bay at resonance as it is tuned over the f-m band

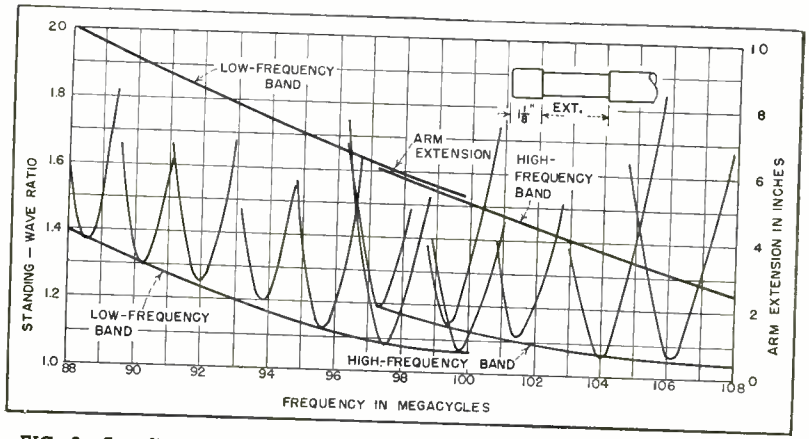
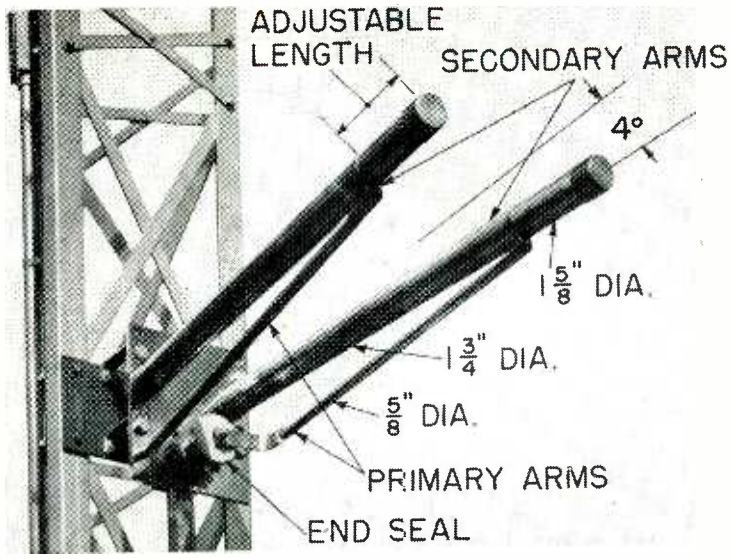


FIG. 2—Standing-wave ratio curves about resonance of antennas when tuned to various frequencies in the band, showing uniform performance



One element of the V antenna, mounted on an existing a-m antenna tower, showing the details of its construction. For usual installations, two elements on a supporting I-beam would be mounted on the top of the a-m tower

formity was possible only by operating at a frequency several megacycles above resonance; in other words, with a positive reactance present in the direct driving impedance. A series capacitor placed in the transmission line just below the end seal unit supplies the proper necessary reactance correction over the band.

Feeding the Array

In connecting two bays of the V antenna, it was necessary to make some arbitrary choices for the sake of simplicity. The widest frequency coverage results when equal-length lines to each bay are provided, and this is commonly done by placing the junction point halfway between them. If the impedances at the junction are higher than the characteristic impedance of the main line it is best for bandwidth to parallel them. If they are less than this value, it is best to connect them in series. However, this requires a balun and means for reversing the phase of one of the elements. A simpler method is to run one line to the top bay and tap it at the second bay. This scheme effectively places the antenna elements in parallel at the junction point, so such a system is best adapted to driving impedances of values higher than 51.5 ohms (ideally 103 ohms).

The driving impedance inherently varies over the frequency range, and because it is impractical to step up to precisely 103 ohms by means of the folded-dipole principle, a compromise is acceptable and a matcher is utilized to transform the impedance at the junction point to one that averages 51.5 ohms over the frequency range. The resultant schematic diagram is shown in Fig. 1A. Each antenna element has its series capacitor, and the common impedance at the junction point is matched to 51.5 ohms. Note that the feed line is completely isolated for direct currents, permitting an insulation resistance check without disconnection of the elements.

The single - interconnection scheme makes it necessary to feed the antenna with a line one wavelength long between the two bays. In addition, the use of rigid line for this purpose fixes the vertical spacing also at a wavelength. Specifically due to the reduced velocity of propagation in the lines used (it is necessary to support the inner conductor at regular intervals with a dielectric material), the spacing becomes $K\lambda$ where K is the relative velocity of propagation and λ is the wavelength in free space.

The radiators proper consist essentially of straight pieces of hard-temper copper tubing. Each pair of arms has a $\frac{5}{8}$-inch-diameter fixed length and a 1–$\frac{3}{4}$-inch-diameter length with a telescoping 1–$\frac{5}{8}$-inch extension for frequency adjustment. The single excited input conductor is connected to a standard end seal to support its free end.

The two elements are identical but they are attached to the tower differently. The lower bay is fastened rigidly to the tower. The upper bay is held by a set of four straps, which permit vertical movement but prevent horizontal movement. This mounting affords a simple means of allowing for ex-

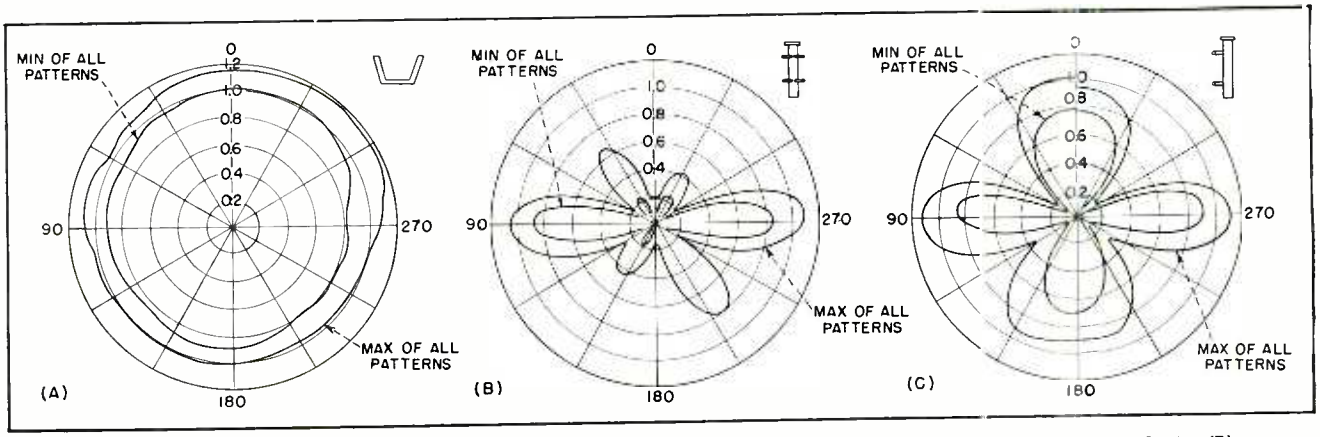


FIG. 3—Horizontal radiation pattern limits (A) show relative independence of tuning adjustment. Vertical pattern limits (B) across V (see insert showing orientation of array) and (C) along V, show somewhat greater variation

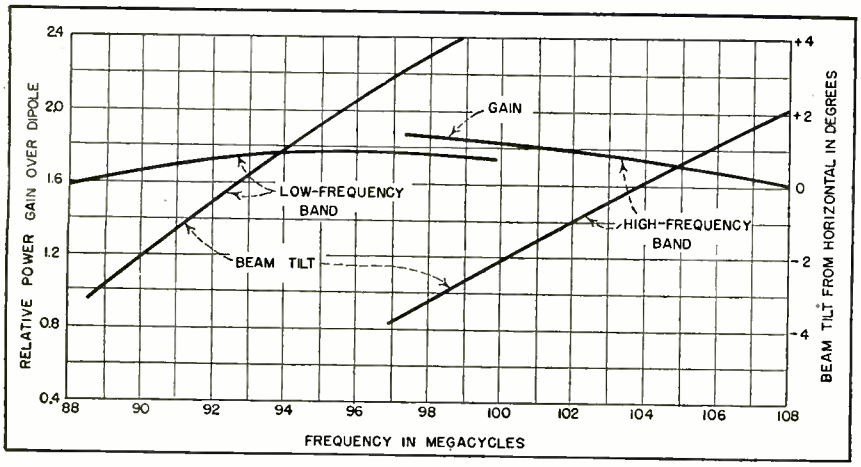


FIG. 4—Changes in radiation patterns shown in Fig. 3 produce slight changes in effective antenna gain, which is mostly due to changes in tilt angle of major lobe of beam. The decreased gain at the edges of the band are chiefly due to this tilt

pansion differences in the copper of the interconnection line and the steel of the tower. It also allows the tower to bend without stressing the copper line unduly.

The support for one type V antenna is a steel H-beam so oriented that the well on one side forms a protective enclosure for the transmission line and matcher. The climbing steps are attached to the edges of the flanges on the opposite side, so that unusual freedom for climbing is achieved. Each of the elements has a series capacitor built into the inner conductor of the transmission line just below the end seal. The capacitor consists of a coaxial element with appropriate support insulators. The matcher element consists of an oversized inner conductor and a multiplicity of standard insulators, electrically a quarter-wavelength long and having the proper effective characteristic impedance. The junction line is made in two lengths to suit two frequency bands.

When the extensions of the large radiator arms are set for a given frequency of operation (91.3 mc, for example), the driving impedance of each element is indicated by the curves of Fig. 1B. These curves demonstrate the ability of the antenna to operate over the modulation band with an associated f-m transmitter and transmission line. A family of these curves serves to determine the matcher characteristics, using the values of resonant resistance, of which 52 ohms is representative for 91.3 mc. A collection of the resonant resistance values may be plotted as shown in Fig. 1C. This particular curve indicates that the uniformity is sufficient to permit the construction of just one matcher to cover the entire f-m range. The matcher for the system is therefore designed for a characteristic impedance of 39.8 ohms and is made effectively a $\lambda/4$ long at the center of the range.

Measurement of standing-wave ratio on the main feed line is made with the entire antenna mounted well away from reflecting and absorbing surfaces. A series of measurements made over a frequency band, corresponding to fixed positions of the radiator extensions, is of vital importance. Curves of these measurements are shown in Fig. 2. Two corresponding curves showing the necessary arm-extension settings are also given in this figure. The uniformity of the results demonstrates the reliability with which the arms may be set in the factory.

Horizontal and Vertical Radiation

Horizontal field patterns were measured and plotted over the f-m range. The magnitude of the plots was adjusted to give the same radiation in the horizontal plane as an antenna with equal radiation in all directions with a power gain of 1.0. The variations from a circle over the f-m range are so small that the limits can be shown by two curves as in Fig. 3A.

The corresponding vertical patterns are shown in Fig. 3B and 3C. The first is taken perpendicular to the neutral plane and the second is taken in this plane. The difference is due to symmetry for the first case and lack of it in the second.

It might appear that the vertical radiation represented by Fig. 3C would lead to low gain in the horizontal plane, but it should be pointed out that this field is effective in a small solid angle whereas the field in the horizontal direction is effective in a large solid angle. The limit curves also seem to indicate greater variations than those of Fig. 3A, but this is not harmful as it is due to the variation in tilt of the horizontal beam and side lobes as the phase relations between the currents of the two bays vary across the bands.

From the horizontal patterns and two major vertical patterns it is possible to calculate with sufficient practical accuracy the gain of the antenna system, in the horizontal plane, over a dipole antenna. The calculated curves are in Fig. 4.

When the antenna is operated at 93 mc or 103 mc, for which frequencies the junction lines produce exactly in-phase currents at the two bays, the horizontal beam is precisely horizontal. Below these frequencies the beams tilt downward, and above these frequencies the beams tilt upward. By splitting the f-m range into two bands, as previously mentioned, the tilt has been kept to a low enough value so that the gain is not impaired. Figure 4 also shows curves of beam tilt obtained from the experimental curves.

Because of the wide separation of the high-voltage portions of the radiators, the individual elements are well suited for high-power operation. A conservative rating of 5 kw per bay has been placed on the antenna, although field experience probably will justify a greater power rating.

The writer wishes to acknowledge the able assistance of H. M. Anderson and C. W. Meyer in the development of this antenna.

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Ceramic Transmitting CAPACITORS

Improved dielectrics and new design features increase ratio of power-handling capacity to physical size for units used in transmitting applications. Experiments reveal possibility of even higher ratings by use of cooling fins and forced air ventilation

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NEW TYPES of dielectrics and new design features permit the manufacture of ceramic transmitting capacitors combining high load ratings with small physical dimensions.

Low-loss ceramics with Q values of 1,000 and more and permittivities up to 90 are now well established as dielectrics for small capacitors used in broadcast and television receivers. Their low losses, small size, and the ease with which they may be used to compensate for the temperature coefficient of associated circuit elements are advantages which make them superior to other dielectrics in many circuits.

Early Uses

It seems, therefore, an obvious step to make use of the low losses of ceramic dielectrics for the design of transmitting capacitors with a good ratio of power handling capacity to volume. The first types of this kind originated in Germany and took the form of plates or pots in rutile (TiO_2) or steatite material, shown in Fig. 1. The edges of the silvered electrode layer were extended on to sheds familiar from high voltage insulator design, which served to taper off the electric field on the edges of the electrode layer, and to provide a flashover path consistent with the rated working voltage.

An added advantage of this type of capacitor is that ceramic dielectrics, which are formed from fully vitrified material, do not suffer from the progressive deterioration which is generally associated with many other dielectric materials normally impregnated with or immersed in hydrocarbon materials.

Subsequent wartime development in Great Britain was mainly concentrated on the improvement of the ceramics used, while adhering to the original pot shape. Thus materials based on magnesium titanate were produced which gave Q values of 10,000 to 20,000.

Metallizing Technique

Ceramics intended for transmitting capacitors have to comply not only with the usual requirements for receiver applications, but they must also show low losses under the stress conditions obtaining at high r-f loads. In addition, such capacitors are usually rated for a maximum body temperature of approxi-

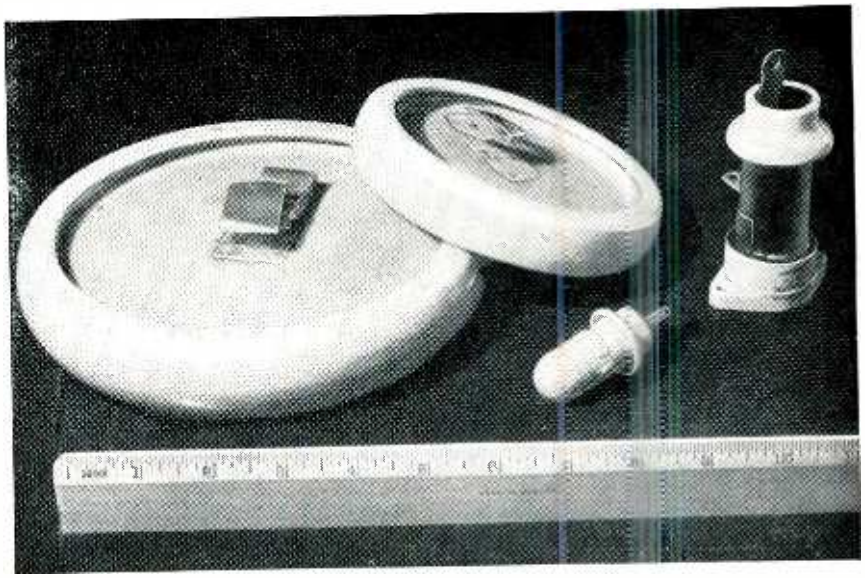

FIG. 1—Ceramic pot and plate transmitting capacitors of German origin

mately 100 C, and the dielectric strength as well as all other properties have to be satisfactory at this temperature.

Measurements show that a material with a low static power factor—as measured on a Q-meter—will not necessarily show a good dynamic power factor when subjected to an appreciable r-f voltage. This voltage coefficient of power factor is, therefore, an important parameter, and most of the development work on transmitter ceramics has been directed toward the production of low-loss ceramics where this factor and the static power factor have been kept to a minimum.

Apart from the losses attributable to the properties of the dielectric, which are mainly a function of voltage, losses due to the r-f current will occur in the metal film forming the conductive layer on the body of the capacitor. This layer is usually produced by applying one or more coats of a silver solution consisting of finely divided metallic silver or silver oxide suspended in a suitable vehicle, which also contains such additions of fluxes as are required to produce good adhesion to the ceramic after firing to 700 or 800 C. Considerable research has recently been carried out to devise a coating with minimum losses and with satisfactory mechanical properties.

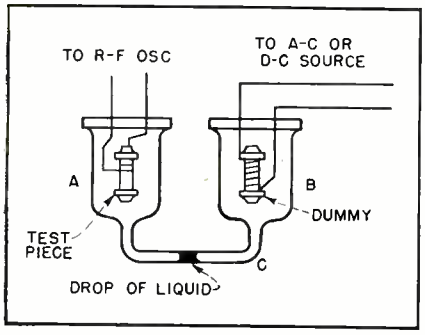

FIG. 2—Thermal method for determination of losses of ceramics under r-f load

Owing to the flux content and the incomplete sintering of the silver layer, its conductivity may be appreciably less than that of pure silver. Any skin effect will tend to concentrate the current along the junction of the ceramic and the silver layer. Any reinforcement by plating will therefore be of relatively small assistance, and it is generally more convenient to provide fittings designed to cut down the maximum current density on any portion of the silver layer.

Both the firing conditions and the composition of the silver solution will have a considerable influence on the losses produced by the r-f current.

Loss Measurement

The measurement of losses under r-f load can be carried out by a variety of methods. One simple and reliable arrangement suitable for small test pieces is that shown in Fig. 2. Containers A and B are of identical volume. The test object is suspended in A and a replica of the test object fitted with a suitable heater winding is placed in B. A drop of colored liquid in the capillary C serves as a sensitive pressure-differential indicator. When r-f power is applied to the test object the heat generated by the r-f losses will expand the air in A and drive the drop in the capillary towards B. By regulating the heat input to the heater in B pressure equilibrium can be restored and the input into the heater will correspond to the r-f losses in the test piece. By fitting both containers with a suitable heater jacket measurements can be carried out at elevated temperatures.

If a series of measurements are carried out on a test piece, and the losses are plotted against frequency with the r-f load in kva as parameter, the curve in Fig. 3A results.

It can be seen that increased losses occur both at the low-frequency end where the r-f voltage for a given load is highest, and at the high-frequency end where a heavy r-f current occurs.

Since the losses under any working conditions are a combination of dielectric losses occurring in the ceramic and electrode losses occurring in the silver layer, it is of importance to consider separately the two kinds of losses, so as to assess their relative importance under given working conditions.

Dealing first with the high-frequency end, we may assume that the electrode losses will be: $W = I^2R + W_d$, where W represents the total losses, I is the r-f current, R the resistance of the silver layer, and W_d the dielectric losses.

Plotting the losses as a function of I^2 results in Fig. 3B, and it can be seen that to the right of point A the curve continues as a straight line. In this part of the working range the losses are proportional to I^2R and the dielectric losses are a constant. By extending the straight portion of the curve to the left, dielectric losses W_d for frequencies corresponding to currents

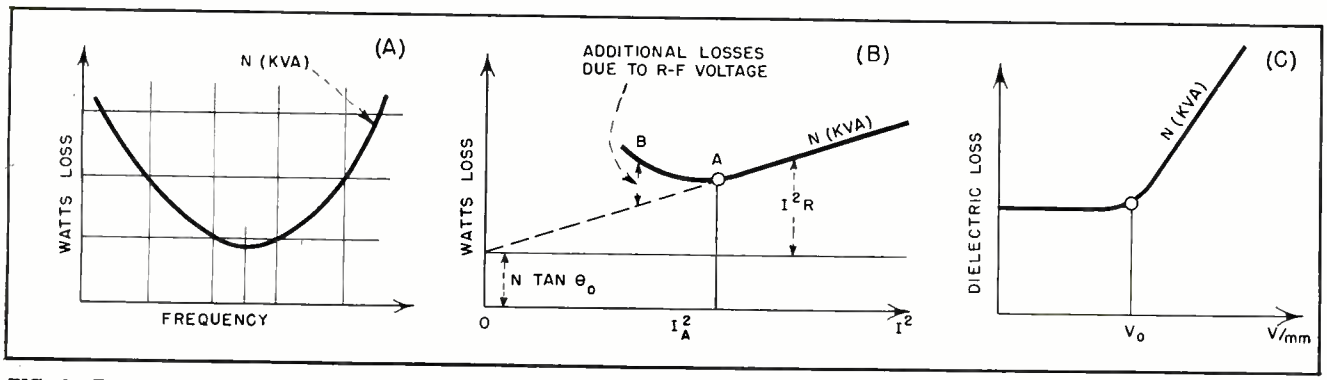

FIG. 3—Typical curves showing losses in ceramics as functions of frequency, the square of the r-f current, and the r-f voltage

greater than I_A can be evaluated, and we can say $W_d = N \tan \theta_o$, where $\tan \theta_o$ is the power factor of dielectric at low r-f voltages (static power factor), and N is the r-f load.

If we examine now the portion AB of the load curve, it can be seen that the total losses increase in spite of the fact that the I^2R losses become smaller. It must, therefore, be assumed that the increase of losses is due to additional dielectric losses, and that these additional losses are related to the increased r-f voltage which occurs at the low end of the frequency range, for a given load. Plotting the loss curve minus the I^2R losses as a function of the specific voltage in V/mm across the dielectric results in the curve of Fig. 3C. It can be seen that the dielectric losses are constant below the voltage V_o corresponding to conditions at point A in Fig. 3B. At voltages exceeding V_o a rise in power factor takes place which is roughly proportional to the voltage, and we can call this a voltage coefficient of power factor.

Care must be taken to check whether the simplified assumptions outlined above actually hold good for a particular ceramic as all the parameters involved may be to a greater or lesser degree functions of frequency and temperature.

Body Shapes

The choice of the shape for the ceramic body is partly governed by the application, capacitance, and operating voltage desired. The main objectives are, however, good heat dissipation, possibility of forced air cooling, and ease of manufacture. The original pot and plate shapes have now been superseded by a tubular "Hi-load" design as illustrated in Fig. 4. The tubular shape has resulted in a considerable increase in permissible power rating due to its better heat dissipation. The middle size body in Fig. 4, which is about the same value as the larger pot capacitor in Fig. 1, will give about three times the r-f rating of the former. About 30 percent of this increased rating is due to improved dielectrics. The large body in Fig. 4 is the largest ceramic capacitor in rutile manufactured on a commercial scale. Its rating is 150 kva with a maximum r-f voltage of 10 kv peak, and a maximum current of 70 amp. Capacitance is 4,000 μμf.

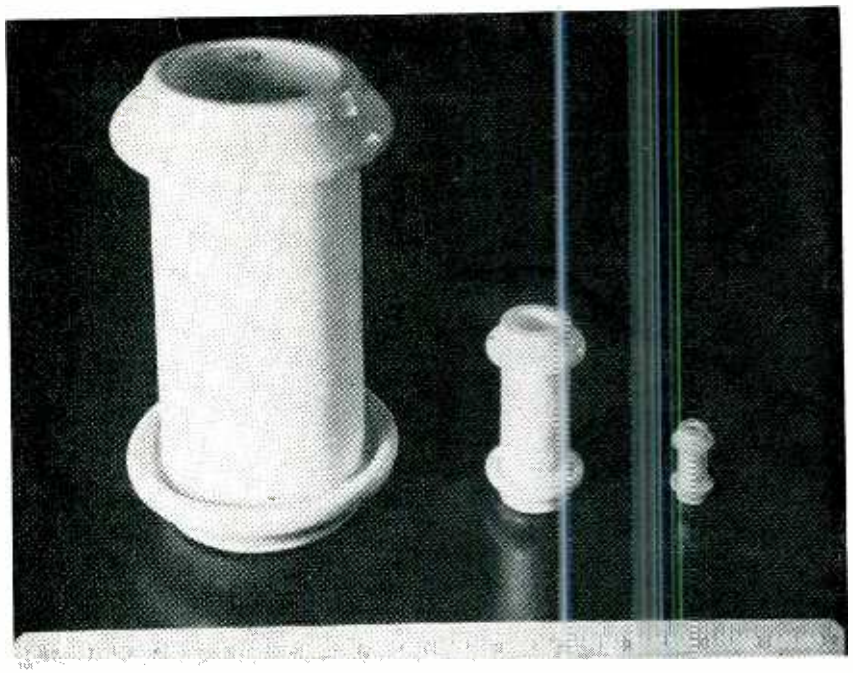

FIG. 4—Various sizes of high-voltage capacitor bodies. Large size is largest ceramic capacitor in rutile manufacturing on a commercial scale

Various types of mounting electrodes have been developed. They are designed to produce an even current distribution over the silver layer, and to offer little resistance to the air current if forced cooling is employed. The small types, which fit most applications, have two spiders soldered to the ends of the inner silver layer. These are connected by a rod with suitable terminals, thus giving facilities for lead-through applications or series connection when the r-f voltage exceeds that of the single capacitor.

A capacitor with three radial mounting lugs is available for use where several capacitors are to be connected in parallel. In that case, the capacitors are mounted in a plate with suitable holes. A lead-through flange fitting is intended for bypassing r-f on a high-voltage supply, and would be mounted in the panel between the power supply and the r-f unit. Body dimensions of these capacitors are 3½" x 1¾" and capacitance is 1,000 μμf.

Experimental work has been done on radiators similar to those used on vacuum tubes (Fig. 5). Even mild blasts as produced by an ordinary desk fan will produce a considerable increase in the permissible ratings.

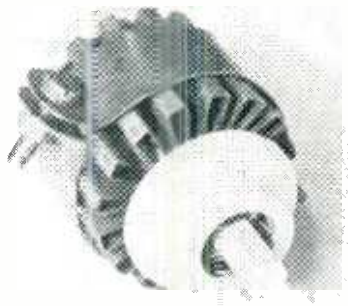

FIG. 5—Experimental capacitor with cooling fins

Rating for a temperature rise of 75 C in still air is 30 kva with 20 amp maximum and maximum r-f voltage of 7.5 kv peak. With 15 ft per sec air cooling the maximum kva figure is increased to 110 kva with 30 amp max. The same body fitted with a radiator will give 200 kva with 50 amp max. The increased current rating is due to the better current distribution produced by the radiator.

Train Television

Special circuit techniques, incorporated in an experimental receiver, and ram's horn antennas provide generally satisfactory pictures on a railroad train where conditions are usually considered too extreme for normal reception

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RECEPTION of television programs in a moving train is a severe test of a receiver and its antenna due to many sources of electrical noise along the right of way and obstacles in the path of the signal. Such problems were encountered in the first public demonstration of train television, held last October on the Baltimore and Ohio "Marylander", as previously reported in these pages[1].

As a train travels past buildings, through cuts, under bridges and trestles and suddenly passes other steel trains, there are extreme variations in the received field strength of the television broadcast signals. Moreover, there is often a rapid change in picture quality as the propagation path may be direct at one spot, then a few feet farther on multiple-signal paths of different lengths may be simultaneously effective, producing ghosts in the picture.

Practical experience with the vagaries of television reception aboard a moving train has been obtained with an experimental receiver. The pictures generally look best when the train is either standing still or traveling fast. At high speed, the automatic gain control circuits of the receiver take care of variations in the amplitude of the signals and any ghost patterns which are obtained do not last long enough to seriously degrade the observed pictures. If a train is moving slowly, ghosts last long enough to be quite annoying at times.

Antennas

The maximum available clearance for an antenna above the steel roof of the standard railway car is approximately 15 inches for a width of only about 5 feet. At greater distances from the center line of the track, the clearance line is still lower and at the full width of the car the clearance line is below the roof of the car at its center. Since a train often changes its direction with the curvature of track, the antenna should be omnidirectional. Between Baltimore and Washington, for example, the direction of the train changes plus and minus 90 degrees from the general southwesterly direction.

A horizontal ring-type antenna was first tried. If the ring diameter was reduced sufficiently to give an omnidirectional pattern the pickup was then considerably less than the maximum for a folded dipole. A ram's horn antenna, a folded dipole with the ends bent back as shown in Fig. 1, was found to be satisfactory, with a ratio of maximum to minimum pickup in the horizontal plane of about 3 db.

Two antennas were used, since either one alone was found to have a greater standing-wave ratio than was considered desirable over the range from 54 to 216 megacycles. The larger antenna was usually quite satisfactory on the low channels and the smaller antenna usually gave the sharper picture on the high channels. However, when the train was standing still, this situation was sometimes reversed due to the standing-wave pattern in space existing at that particular spot.

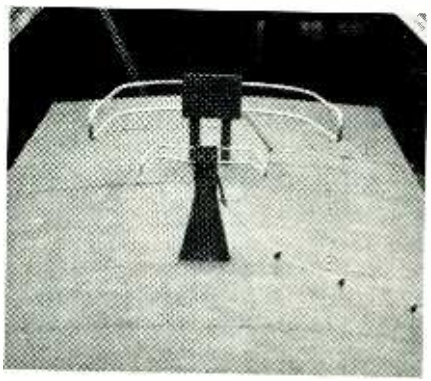

FIG. 1—High and low-band ram's horn antennas installed on the roof of a railway car

A separate transmission line (300-ohm twin lead) was brought into the car from each antenna with about one-foot insulator spacing on the car roof to withstand vibration and constant high wind velocities due to train speed. A switch on the receiver was used to select the desired antenna line.

Receiver Circuits

The experimental television receiver used in the train tests has a 12-channel turret input tuner[2]. It has a 300-ohm balanced input using three twin triodes, one for a push-pull grounded grid r-f amplifier, a push-pull mixer and a push-pull oscillator. The four-stage i-f amplifier is stagger-tuned and has an overall bandwidth of approximately 3.8 megacycles with the picture carrier at 36.1 mc and sound carrier at 31.6 mc. A germanium crystal is used for video detector with sync peaks negative, followed by a single stage of video amplification direct coupled to the cathode of the 10FP4 aluminized picture tube. The picture agc circuit holds the i-f amplifier black level output very constant. The picture contrast is adjusted by varying the screen potential of the video amplifier.

The agc circuit may be best considered with reference to Fig. 2, a simplified receiver circuit. The twin-triode pulse clamper operates only during the back porch interval when its grids are driven positive

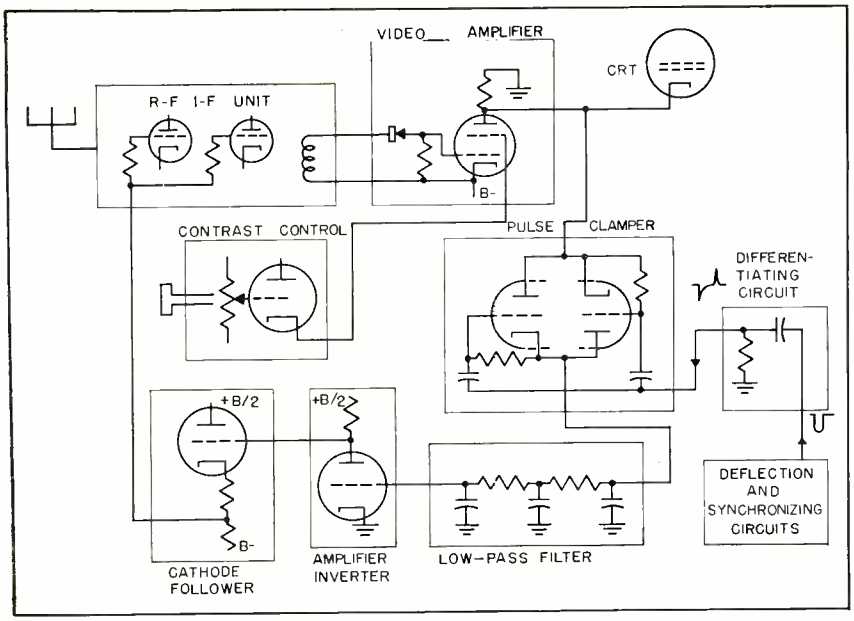

FIG. 2—Simplified block diagram of the receiver and circuit of the pulse clamper

by the trailing edge of the differentiated negative pulse derived from the horizontal sweep flyback. This type of agc circuit was first discussed by members of the Bendix staff in October 1946 and a receiver incorporating it was built in July 1947.

Ideally this type of circuit would set the gain during the conduction interval, hold that level for one picture line, then reset for the succeeding line. This line-by-line agc would be ideal, but a wide-band feedback loop would be necessary to adjust gain completely in such a short interval. The low-pass filter prevents true line-by-line action. The cutoff was designed to give a high attenuation at half line frequency where agc oscillations are most likely to occur when a line-by-line clamp is used.

The amplifier stage is necessary to invert the agc signal and provides extra gain so that the i-f output is held extremely flat. The cathode follower maintains a low impedance and provides a convenient way of adjusting the d-c level to the proper bias region for i-f control without excessive loss of gain.

The action of the agc is to hold the blanking level constant at the picture-tube cathode. The contrast control in this circuit avoids the undesirable effect of changing black level with contrast variation. The screen-grid voltage of the video amplifier is controlled. This has only a minor effect on overall agc gain and does not appreciably change the instantaneous voltage on the plate when clipping occurs. Of course, the input grid voltage required to reach cutoff (clipping level) does vary with the screen voltage.

Since the video stage is a d-c amplifier, a cathode follower is used to control the screen grid voltage thus achieving the necessary low d-c impedance with minimum bleeder current. Excellent immunity to impulse noise is achieved by making the sync peak level close to cutoff in the video.

Sync Operation

The synchronization of this receiver is greatly improved over that in other receiver models using the same synchronizing circuits but not having the double-clamp agc circuit. This improvement is due to the clipping level in the video amplifier being substantially equal to the peak synchronizing signal output, which would not be possible without a very stable agc circuit.

At no time during the train tests was horizontal synchronization ever lost due to any condition in the receiver unless the received signal strength was so low as to make the picture completely unrecognizable. The vertical synchronization was not quite as good but was nevertheless exceptional in comparison with many commercial receivers.

The receiver uses the intercarrier sound method with two twin-triode clippers (limiters) in cascade, the first grid being coupled to the video amplifier plate. There is a 4.5-megacycle sound trap between the video plate and the cathode of the picture tube. The twin-triode clipper is superior in this application to the more commonly used cascaded pentode limiters.

A conventional type discriminator and audio amplifier with push-pull output is used to drive twin p-m loud speakers, one on each side of the picture tube. The maximum sound output (at low distortion) is sufficient to give a high sound level for a viewer located close to the receiver. However, the noise level due to track noise and train rumble is so high as to indicate the desirability of multiple loudspeakers with reasonably low sound output level distributed along the car.

The lights and other electrical equipment on a train are supplied from a 32-volt train battery, or from a separate battery in each car. A d-c generator, driven from an axle of the car, is used to keep the battery charged. The voltage on the car lines may drop to 28 volts (or less) when the train is stopped and rise to nearly 40 volts when the generator is running. The television receiver was designed for 117 volts at 60 cycles. This voltage was obtained from a Bendix type MP-54A inverter, designed for train radio communication systems. The regulator of the inverter was adjusted to operate at 60 cycles. It maintained the output frequency within a small fraction of a cycle, with an output voltage variation of about ± 1 volt, with the input varying from 28 to 40 volts.

We wish to acknowledge the assistance and cooperation of many of our associates, including David Fales III, antenna engineer, and B. H. Ochterbeck mechanical engineer. Cooperation of the Baltimore and Ohio Railroad made it possible to test and demonstrate the practicability of train television.

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(1) Train Television, ELECTRONICS, p 219, December 1948.

(2) H. Goldberg, G. W. Clevenger and E. L. Crosby, Jr., Unitary Television Tuner, IRE Convention, March 1948.

A-M and Narrow-Band F-M

Conclusion of a report that evaluates two types of voice modulation used in mobile naval communications. Theoretical effects are checked against field trials. General equipment specifications are outlined

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THE THEORETICAL SOLUTIONS for output s/n ratio of an f-m system with no limiting and with ideal (mathematically perfect) limiting were derived in forms capable of providing figures in the weak-signal region where the available solutions did not satisfactorily extend. The following equation was obtained for the no-limiter case

$$\left(\frac{s}{n}\right)_0 = \frac{2x^4d^2}{\left[\frac{2}{3}-\frac{(2-\gamma_c)^4}{24}+2x^2\gamma_c\left[4\rho^2+2d^2+\frac{\gamma_c^2}{3}\right]\right]^{1/2}} \quad (1)$$

where $\left(\frac{s}{n}\right)_0$ = rms output signal-to-noise ratio (no limiter)

x = rms unmodulated carrier-to-noise ratio at the input to the f-m detector

d = ratio of maximum carrier-frequency deviation to the half-bandwidth at the input to the detector (for example, half-bandwidth of the r-f plus i-f amplifiers)

γ_c = ratio of output bandwidth (for example, audio-amplifier bandwidth) to the half-bandwidth at the input to the detector

ρ = detuning ratio, that is, ratio of amount by which the carrier frequency is detuned from the discriminator center-frequency to the half-bandwidth at the detector input

This equation has been derived for the case of square-law rectifiers, but it also provides a very good approximation for an f-m detector with linear rectifiers, particularly when the value of d is considerably less than 1. The approximation holds well for all values of x but is best for $x > 2$. It is limited to the overall condition that the sum of the deviation from center-frequency plus the amount of detuning plus the output bandwidth does not appreciably exceed the half bandwidth at the input to the detector $[(d + \rho + \gamma_c) \leqq 1]$.

F-M Signal-To-Noise Ratio with Limiting

The equation for the ideal limiter case was derived for square-law rectifiers in the f-m limiter-detector system but is also a very good approximation for a detector with linear rectifiers. It becomes inaccurate, however, at values of x less than 2, but can be extended by a graphical method to the lower values of x. Like Eq. 1, it is limited to the condition that $(d + \rho + \gamma_c) \leqq 1$.

$$_L\left(\frac{s}{n}\right)_0 = \frac{\sqrt{3}\,dx\,(x^2+1)\sqrt{\frac{1}{\gamma_c}}}{[12\rho^2+6d^2+(x^2+1)^2\gamma_c^2]^{1/2}} \quad (2)$$

where $_L\left(\frac{s}{n}\right)_0$ = rms output signal-to-noise ratio with perfect input limiting. When the input carrier-to-noise ratio is large ($x \geqq 10$), and the input carrier is exactly centered on a perfectly symmetrical and balanced discriminator characteristic ($\rho = 0$), Eq. 2 assumes the simpler form

$$_L\left(\frac{s}{n}\right)_0 = \sqrt{3}\,xR\sqrt{\frac{1}{\gamma_c}} = xR\left(\frac{3f_i}{2f_a}\right)^{1/2} \quad (3)$$

where $R = \frac{d}{\gamma_c} = \frac{f\Delta}{f_a}$ = deviation ratio (or the modulation index, m_f, when the modulating frequency equals the audio cutoff frequency)

$f\Delta$ = frequency deviation from the center frequency

f_i = input bandwidth at the detector

f_a = output bandwidth (or audio-cutoff frequency at the high end)

Equations 1, 2, and 3 are based on such ideal assumptions as a perfect rectangular input selectivity curve, a perfect limiter with no threshold level, and ideal slope filters for the frequency discriminator,

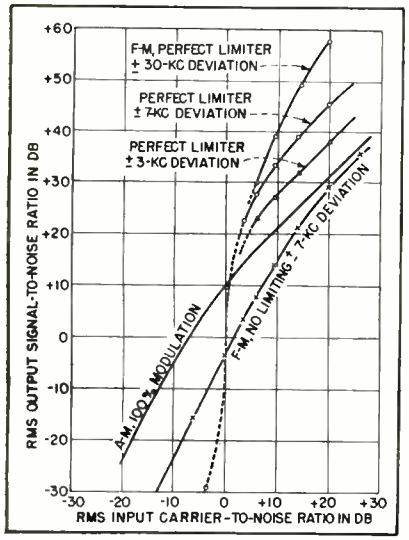

FIG. 15—Theoretical range performance of f-m and a-m

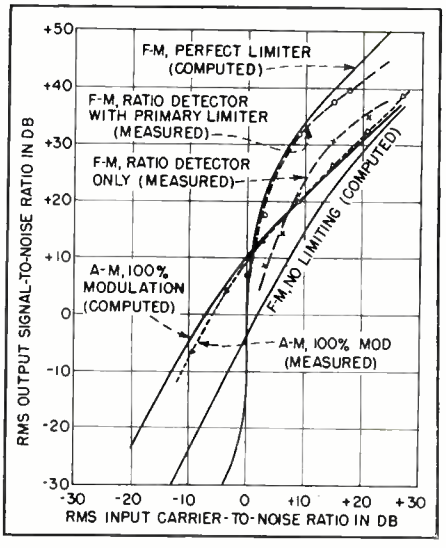

FIG. 16—Theoretical limits of experimental range

in UHF Communications

Part II

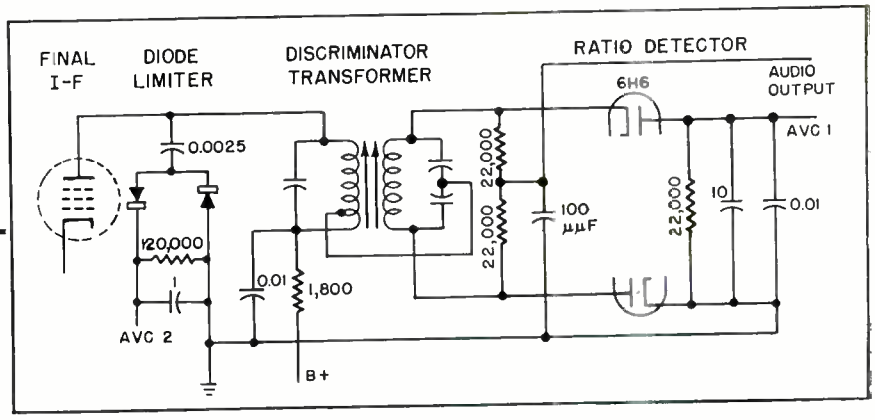

FIG. 17—Circuit of f-m detector with added primary-side limiter

with perfect symmetry and balance throughout.

Theoretical A-M Signal-To-Noise Ratio

The output s/n equation for the a-m case is based on square-law detection but is also a very good approximation for linear detection. Its accuracy is greater for the lower values of modulation percentage.

$$\left(\frac{s}{n}\right)_0 = mx^2 \left\{\frac{2\beta}{f_a\,[1 + x^2\,(2 + m^2)]}\right\}^{1/2} \quad (4)$$

where $\left(\frac{s}{n}\right)_0$ = rms output signal-to-noise ratio
m = modulation depth in percent
β = half-bandwidth at the input to the detector
x = rms unmodulated carrier-to-noise ratio at the input to the detector
f_a = output (a-f) bandwidth (or audio cutoff frequency at the high end)

The input selectivity curve is assumed to be a perfect rectangle.

Theoretical Range Curves

Figure 15 shows the computed a-m and f-m output rms signal-to-noise ratios corresponding to increasing values of input rms carrier-to-noise ratio (c/n) for the conditions of the subject a-m/f-m investigations. The output values with perfect limiter for input c/n ratios below +6 db were derived as follows:

The ±7-kc deviation f-m no-limiter curve was constructed, using Eq. 1, for c/n ratios from −10 to +40 db. As stated previously, Eq. 1 holds quite closely for all values of x. It was then assumed that the noise energy for c/n ratios of −6 db and less could be considered as an equivalent carrier exhibiting the same capture or depression effect on the desired signal as the desired signal exhibited with regard to noise for c/n ratios of +6 db and above. The f-m curve for the perfect limiter case was then drawn as much below the no-limiting curve for $c/n = -6$ db, −10 db, and so on, as it was above the no-limiting curve for $c/n = +6$ db, +10 db, etc. The two curve sections resulting were then joined by extension, passing through the no-limiting curve at $c/n = 0$ db, which was considered the capture transition point. The computed values for $c/n = \pm 3.5$ db have been plotted as a guide to construction.

The f-m perfect limiter curve for ±7-kc deviation crosses the a-m theoretical curve for 100 percent modulation at about +11-db output signal-to-noise ratio. These two curves were used for computing the theoretical range comparison in Fig. 6. Increasing the maximum deviation from ±7 to ±30 kc ($m_f = 10$) changes the ideal limiter a-m/f-m crossover point very little, as shown by the 30-kc deviation curve. On the other hand, the increased deviation results in improvement of output signal-to-noise ratio for input c/n above about +5 db. Decreasing the deviation to ±3 kc ($m_f = 1$) affects mainly the output levels corresponding to c/n ratios of over about +2 db, with the a-m/f-m crossover estimated as occurring at about +12 db s/n. The ±3-kc and ±30-kc no-limiting curves which were used in construction of the corresponding perfect-limiter curves are not shown in Fig. 15 for the sake of simplicity.

Experimental Range Curves

A series of signal-generator measurements was made on an f-m receiver of the same type as used in the comparison trials discussed above, to verify the theoretical curves of Fig. 15 and to determine the relative position of the ratio detector within the no-limiting-to-perfect-limiting area. Companion a-m measurements were made on the same receiver, after rewiring the final detector for a-m operation. The experimental curves, which were plotted against microvolts input from the signal generator, were matched to the theoretical curves, which were in terms of input c/n ratio, by assuming that the experimental a-m curve was substantially identical with the perfect theoretical case at about +20-db output s/n. This assumption was supported by previous measurements of i-f amplifier output versus receiver input in microvolts. The resultant overlay is shown in Fig. 16. The curve for ±7-kc deviation with the ratio detector without added limiting (the condition for the laboratory and field trials) shows the experimental a-m/f-m crossover at +18.5-db output s/n, a close check with the average crossover of the laboratory trials

(as indicated in Fig. 5A).

To determine the effect of more nearly ideal limiting, the half-wave secondary shunt-limiting inherent with the ratio detector was supplemented by shunt-limiting on the discriminator primary side. This added limiting was made full-wave, since it demanded very few additional components over a half-wave limiter and would serve to hold the operating level of the ratio detector more nearly constant. Germanium diodes were used, because of their economy of space, low forward-resistance, and low self-generated contact potential with consequent low inherent limiting threshold. The circuit diagram for this modification is shown in Fig. 17. Connection of the primary-side limiter resulted in an insertion-loss, in reserve gain only, of 2 to 4 db.

The resulting performance is shown by the curve marked ratio-detector with primary limiter in Fig. 16. It comes within 1 to 2 db of the theoretical perfect-limiter performance in terms of output s/n from about +1 to +15-db input c/n ratio. The lower portion of all the measured curves for output s/n ratios below about +10 db was determined from wave-analyzer measurements which segregated the desired signal by filtering out much of the noise. Magnetic-tape recordings made of the f-m performance shown in Fig. 16 provided aural confirmation of the experimental measurements and also revealed some difference in character of the noise background, the added primary limiter case producing a smoother noise output with a somewhat higher apparent pitch.

Theoretical Effect of Detuning

Equations 1 and 2 were also solved at various c/n levels for values of ρ (the detuning factor) up to about 90 percent of the half-bandwidth of the i-f system. Two sets of the resulting curves, for c/n of +9.5 and +20 db, are plotted in Fig. 18. These show the deterioration of output s/n with increase in detuning and indicate that with no limiting, the deterioration is substantially independent of the c/n ratio. With perfect limiting, however, detuning is much more damaging at the lower c/n values; at the higher c/n values, detuning causes little s/n deterioration.

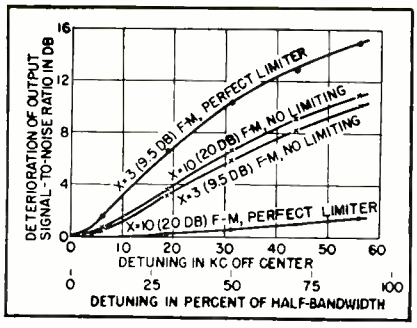

FIG. 18—Theoretical deterioration of output s/n with detuning

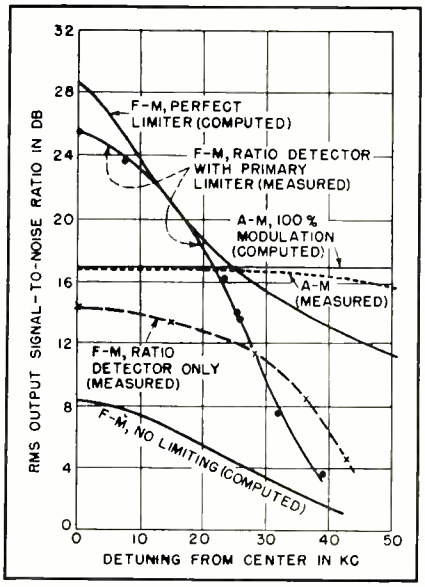

FIG. 19—Experimental detuning measurements to theoretical limits

Figure 19 shows the measured effects of detuning both the a-m and the f-m versions of the receiver used in the experimental confirmation of the theoretical range data. The measurements were taken at a signal input level corresponding to a c/n ratio very close to +6 db. The theoretical limits for detuning with this c/n value are also shown in the graph. The departure of the experimental curves from these limits above about 25 kc or 40-percent detuning can be ascribed in part to the difference between the rectangular selectivity curve postulated in the mathematical treatment and the more nearly trapezoidal form of the actual selectivity characteristic.

The ratio detector with its imperfect half-wave limiting is less affected by detuning than the more nearly ideal limiter case obtained with the added primary limiter. The crossover between the two experimental curves occurs at 28-kc detuning. Magnetic-tape records confirmed that up to about 30 kc off center, the ratio detector with primary limiter sounded better than the ratio detector alone, with considerable difference in character of noise output. Deterioration of s/n with detuning of the a-m receiver departed from the theoretical a-m performance shown in Fig. 18 by an amount determined largely by the difference between the actual and mathematical selectivity curves.

Limiting of Impulse-Noise

Measurements were made of f-m output s/n ratio with and without the added primary limiter in the presence of impulse-noise interference. These showed that the improvement in output s/n with additional limiting that was obtained with only fluctuation noise present was also obtained in the presence of impulse-noise interference. The improvement in performance was equivalent to 2 to 5 db less required f-m transmitter power to produce given output s/n from +5 to +25 db. This decrease of required transmitter power will make the f-m performance under conditions as shown in Fig. 7 more nearly equal to a-m performance with the noise limiter on. The f-m impulse-noise reduction was, however, much more dependent on perfect symmetry and centering on the discriminator characteristic, and the detuning curves with impulse noise closely resemble those for fluctuation noise as shown in Fig. 18.

Figure 20 shows the desired-signal depression and noise-exaltation effects encountered in cochannel operation, as measured at a desired-carrier input level which provided +20-db output s/n ratio from the a-m receiver. The noise curve obtained for the f-m case with added primary limiter shows the peak which is characteristic of an f-m system with limiting approach-

ing theoretical optimum. This peak occurs in the vicinity of an undesired-to-desired carrier amplitude ratio of 1. The noise increase is caused by abrupt phase shifts in the resultant of the two carriers, which produce sharp bursts of energy, resembling noise, in the output of the f-m detector. These phase shifts are maximum for equal amplitude of the two carriers and are less on either side of equality. The halfwave limiting typical of the ratio detector masks this peak, as shown by the curves.

The low contact-potential of the germanium crystal diodes used to obtain improved limiting results in a decreased capture threshold. Thus the f-m curve for 30-db output s/n depression for the ratio detector alone case (Fig. 8) shows that +7.5-db undesired-to-desired carrier-level ratio is required to produce such a value of depression for a desired input signal level corresponding to +30-db output s/n without interference. With the added primary limiter, however, only +4 db undesired-to-desired carrier-level ratio is required to produce the same depression (Fig. 20A). As previously mentioned, the intelligibility comparison curve (Fig. 9), with better limiting and the same initial interference-free output s/n, can be expected to show a greater downward tilt between −10 and 0-db undesired-to-desired carrier ratio.

The slope of the desired-signal output curve in the region where capture is well under way is an index to the degree of capture. In Fig. 20, the slope for the f-m case with ratio detector alone is 76 deg, while with added limiting, it is 78 deg; the a-m curve with avc off has a slope of about 50 deg, which becomes about 60 deg with avc on. Perfect capture would be indicated by a slope of 90 deg. It should be noted that the a-m capture slope with avc off will increase with increasing input signal level as the amplifier stages preceding the final detector begin to exhibit saturation effects. With linear detection, no saturation effects, and no avc, the a-m capture curve should have a slope of 45 deg, or one db of desired-signal depression for db of increase in interfering signal. With square-law detection, however, substantially no a-m capture should occur.

As Fig. 20B shows, the a-m system exhibits very little change in output noise with increase of interfering carrier level, while large noise changes occur in the f-m system. The output signal-to-noise ratio depression effects observed in the adjacent-channel trials are caused by phenomena essentially identical with those occurring in the common-channel case. With limiting approaching the ideal, the depression effects in the f-m system will be intensified for any given initial interference-free value of output s/n, as the interfering carrier approaches the desired-carrier frequency; the curves of Fig. 12 can therefore be expected to take a steeper downward tilt toward 0-mc frequency separation.

Range Results

It is generally considered desirable to restrict the distance or range rating of a communication system to a safe-communication range which provides not less than about +15 to +20-db output signal-to-noise ratio for peak or 100-percent modulation, but the usefulness of lower s/n ratios must not be overlooked. It has been established by the series of tests mentioned previously that +5-db output s/n for peak or 100-percent modulation represents a low-limit below which 300 to 3,000-cps voice message systems must, in general, never be allowed to fall. Figure 21 shows the horizontal or azimuthal radiation pattern for a good uhf vertical dipole antenna installation on shipboard. The outstanding characteristic of such patterns, despite all precautions, is rapid and large variation in radiation intensity with bearing. Vertical patterns for the same antenna would also reveal variations with elevation. The maneuvering of ships and planes with transmitting and receiving-antenna patterns such as that shown would result in large fluctuations of signal input to the receivers, even though the range or distance were maintained constant. Thus, at the safe-communication range limit, radical variations of output s/n could be expected to occur in the f-m system, with the signal abruptly disappearing and reappearing as the relative bearings and inclinations from the vertical varied with pitching, rolling, banking, and turning of the communicating craft. The less abrupt range cutoff characteristic of the a-m system would be particularly advantageous under such conditions; its relative freedom from downward a-m limitations would also be desirable.

Figure 22 is a plot of the output s/n variation for both types of

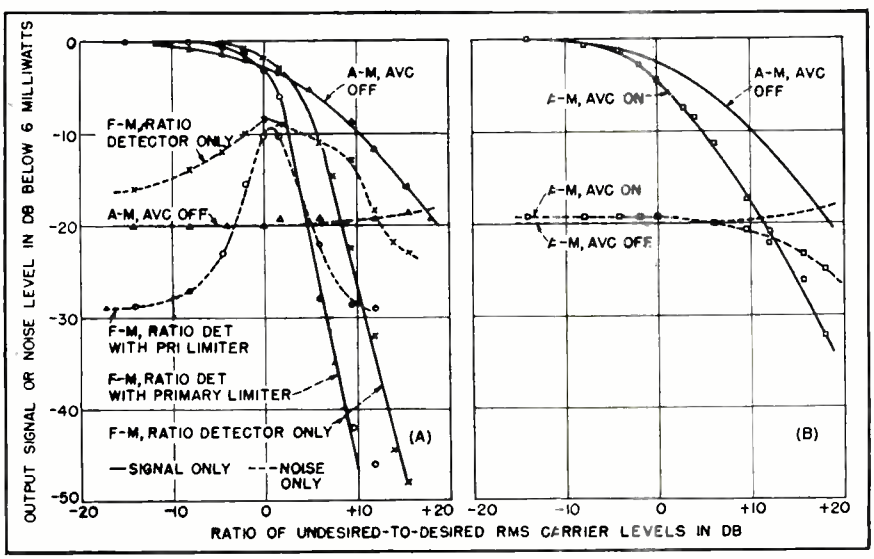

FIG. 20—Cochannel effects for a-m and f-m, using two signals

modulation as the receivers with perfect receiving-antenna patterns assumed move through a sector of 170 deg to 240 deg bearing relative to the radiation pattern shown in Figure 21. The O-db circle on the pattern represents approximately the average radiation level that would be applicable for safe-communication range estimation. The curves of Fig. 22 have been plotted for that constant distance or range at which the a-m system provides +20-db output s/n for a radiation level corresponding to the O-db circle on the antenna pattern. The unmodulated carrier-power output of the f-m transmitter is the same as that of the a-m transmitter in this comparison. The graphs show that the a-m output s/n generally holds up better than the f-m s/n in the antenna pattern hole from about 185 to 225 deg relative bearing. At no time does the a-m output signal drop below the +5-db low-limit of intelligence.

Curve C of Fig. 22 approaches the theoretical limit of performance. It, however, represents operation under carefully maintained and controlled conditions which, unfortunately, cannot be expected when normal service conditions prevail. Slight misalignments and drifts of the discriminator circuits; receiver and transmitter oscillator initial frequency displacements and subsequent drifts, with resultant detuning; changes in reserve r-f gain with tube aging that have consequent influence on limiter levels will all combine to reduce the f-m advantage at received signal levels above the a-m/f-m output s/n crossover where it would otherwise be much better than a-m.

Noise Interference Results

The single-signal range investigations revealed the relative performance of the two types of modulation in the presence of fluctuation noise. Amplitude-limiters of the noise-peak class which are applicable to voice-modulated a-m systems have little or no reduction effect on such noise. These limiters can, however, perform very effectively on impulse noise, particularly when fairly broad r-f or i-f bandwidths precede the a-m detector. Best results are normally obtained in receivers operating at the higher radio-frequencies, although excellent performance has been obtained even in the vlf range with some of the simplest types of limiters.

The impulse-noise interference studies showed that the a-m system with a simple series-diode type noise limiter was at least as good as the f-m system in the weak-signal range, even when the f-m equipment approached the theoretical ideal limit. The f-m system was, however, inherently capable of better performance above about +20-db output s/n. On the other hand, the f-m system was also liable to serious deterioration with regard to impulse-noise suppression with detuning, or when discriminator symmetry and balance were disturbed by misalignment or drift, whereas the a-m system was essentially unaffected by detuning or by dissymmetry of the selectivity characteristic preceding the a-m detector.

Effective a-m receiver limiters produce distortion of the detected modulation resembling the speech-clipping or amplitude-compression that can be deliberately introduced in transmitters. Such clipping or compression is, in the presence of impulse noise, generally more advantageous when applied at the receiving end of an a-m circuit. Because good f-m limiting does not under normal single-signal conditions, result in any considerable distortion in the detector output, f-m has an inherent advantage for truly high-fidelity reproduction when the discriminator characteristic is linear and symmetrical, and the signal carrier is properly centered thereon.

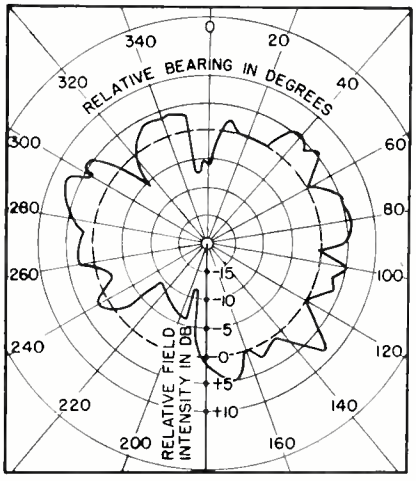

FIG. 21—Horizontal pattern of ship's uhf vertical dipole

Common-Channel Operation

Capture effect is not, in general, desirable in communication systems in which both transmitting and receiving terminals are highly mobile. For a number of reasons, knowledge of the presence of another, weaker transmission on the same channel as the desired signal is of military importance. A minimum vulnerability to deliberate or accidental jamming is also essential in any system in which many communication circuits must be maintained under rapidly changing conditions of position and signal strength. The same characteristics which make f-m output signal-to-noise ratio superior to a-m above the weak-signal region of operation also tend to make f-m systems more vulnerable to jamming and capture. Deliberate reduction of the f-m capture and masking effects to approach a-m performance in this regard will usually result in loss of much of the f-m s/n output advantage above the weak-signal region.

On the other hand, capture can be put to good use in f-m communication or broadcast systems in which the transmitting and receiving terminals are relatively fixed in geographical location and the receivers are well-designed, carefully maintained, and properly operated. Although anomalous propagation may at times work havoc with reception when geographical allocations are based on capture as a consideration, the average performance, except in the fringe area of nearly equal field intensities, should be good. Police f-m radio systems are an example of such an application; by proper choice of frequency and geographical allocations, the fringe area can be at a distance between two systems such that undesired capture very seldom occurs.

Audible-tone heterodyne interference will occur in both a-m and f-m systems when the frequency separation between two carriers is less than the upper audio-frequency cutoff of the receivers. In addition to heterodyne beats, the f-m

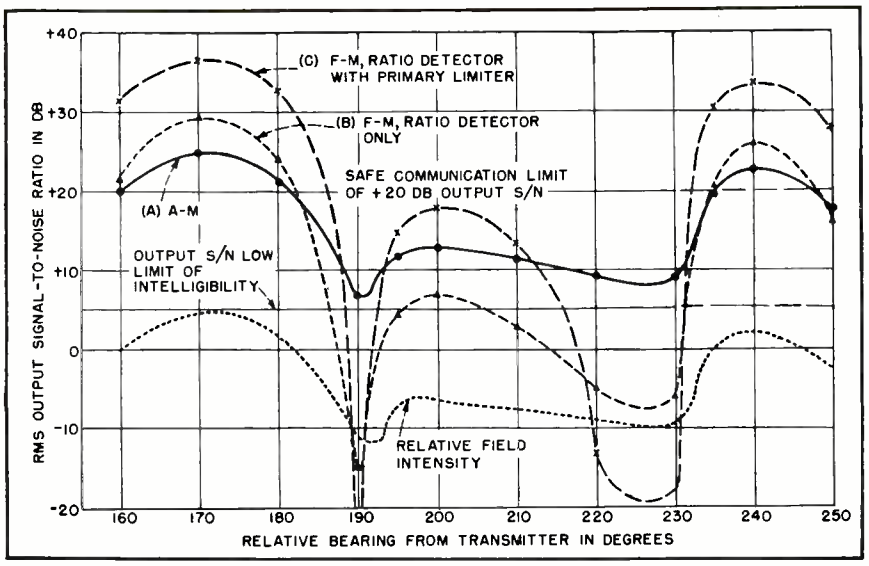

FIG. 22—Output s/n variation for 160 to 250-degree sector of antenna pattern

system output will exhibit fluctuation-noise increase and swish effects due to modulation as the undesired-signal carrier increases toward equality with the desired-signal carrier at the input to the limiter-detector system.

Adjacent-Channel Operation

Cross-modulation effects in a-m systems usually determine the minimum channel-separation frequency which can be tolerated when transmitting and receiving antennas working in different channels are located close to each other, as on a ship. Output *s/n* depression in an a-m system is usually negligible compared to cross-modulation. The cross-modulation interference takes the form of crosstalk in the receiver output; it can be reduced by additional selectivity preceding the first tube of the receiver, use of better remote-cutoff tubes, and various other means. The f-m systems are generally free of cross-modulation but are subject to output signal-to-noise ratio depression effects produced by essentially the same mechanism as cochannel capture. Increased selectivity preceding the f-m detector is about the only practical means of reducing this effect without sacrificing f-m performance in other regards.

The a-m crosstalk due to cross-modulation in speech communication will usually consist of another conversation; it will always be at a lower average level than the desired conversation under normal conditions, with the usual breaks and pauses, and can be segregated from the desired message to some extent by concentration on the part of the listener. The *s/n* depression effect with f-m is, however, a function of the relative interfering carrier level and is essentially unaffected by the modulation of the undesired signal. It has no breaks or pauses so long as the undesired carrier is on, and the listener's ability to concentrate on the desired message through continuous fluctuation noise will determine how much intelligence he can obtain from the desired signal. The absolute low limit without repeats will be the same as for single-signal operation; about +5-db peak output *s/n* for the conditions of this problem.

Multipath Propagation

In general, multipath reception of an f-m signal with its resultant phase-interference effects can produce more output distortion than similar multipath reception experienced with an a-m signal. As the frequency deviation is increased for a given modulation frequency, the number of significant interference points in the spectrum of the signal also increase, making wide-deviation f-m even more vulnerable to multipath propagation effects.

While no specific tests for multipath reception were made in this problem, a considerable body of contract research reports and other technical literature concerning this aspect of radio communication was studied, leading to the above generalization. Inspection of the field test data has also indicated that more marked and severe fluctuations or fades in signal output from the receivers were experienced with f-m than with a-m. This comparison was made for signal-input levels which eliminated, in so far as possible, the weak-signal region where f-m begins to exhibit its abrupt cutoff effects with decreasing input level; the f-m output fluctuations observed could, however, have been partly due to the downward a-m capability limitations of the ratio detector. This limitation appears to be characteristic to some degree of all practical f-m detector systems and is most apparent with low signal-input levels, where the limiter circuits are usually operating near their threshold region. It is obviously undesirable under the conditions of signal fading characteristic of multipath propagation.

Pre-Emphasis and De-Emphasis

Standard f-m broadcast pre-emphasis would have contributed very little to the performance of either system used in the subject comparison, due to the 6-db cutoff at 3,000 cps already provided in both systems. Some tests were, however, made with 400-cps tone modulation and de-emphasis in the experimental receiver starting at 500 cps; the results obtained are shown in comparative form in Fig. 23.

Considering the effect of de-emphasis in terms of the reduction it allows in input *c/n* ratio for a given value of output *s/n* ratio, the improvement with f-m with limiting approaching the theoretical ideal is not more than 1-db reduction in *c/n* ratio until the detector input *c/n* ratio exceeds about +3 db With the ratio detector, however, the improvement is considerably greater. The a-m system benefits most, particularly in the linear region above $c/n = 0$ db. One result of de-emphasis, which is due to the relative slopes of the a-m and f-m curves, is an increase of about +5 db in output *s/n* ratio at the a-m/f-m crossover, which becomes about +15 db instead of about +11

db for the nearly ideal case of the ratio detector with primary limiter, and about +23 db instead of about +18 db for the ratio detector only. The de-emphasis characteristic used was one which leads to a practicable transmitter pre-emphasis characteristic, since, with male voices, the peak speech energy region in frequency occurs below 500 cps.

The reduction in the input *c/n* ratio required for a given value of output *s/n*, as made possible by de-emphasis, is the direct equivalent of a decrease in transmitter radiated power required in the communication system. Taking +20-db output *s/n* as the reference value, de-emphasis as incorporated in the tests would permit 1-db (about 20 percent) reduction in transmitter power rating for the f-m system with nearly ideal limiting, 3-db reduction (50 percent) for f-m with the imperfect limiting of the ratio detector only, and about 4 db (about 60 percent reduction) for a-m.

Transmitter Design

In addition to performance considerations, a comparison of a-m and f-m systems must take into account circuit and other physical differences in the transmitters and receivers. For transmitters, the following statements can be made.

The audio modulating power required for an a-m transmitter is greater than that required for an f-m transmitter. High-level plate modulation of an a-m transmitter requires audio power approximately equal to 50 percent of the d-c power input to the final carrier amplifier. The use of f-m can result in a reduction of transmitter primary input power and elimination of many of the circuit components necessary to produce the a-m high-level modulating power output. The saving for an f-m transmitter over an a-m transmitter generally becomes a greater absolute value in terms of the total primary power, weight, and space as the output power rating of the transmitter is increased. For the 30-watt transmitters used in the a-m/f-m comparison trials, it is estimated that this saving would amount to between 10 and 20 percent in primary power input, and total weight and space.

This saving is partially offset by the necessity for providing phase-modulator and integrating circuits or other frequency-modulating means in the f-m transmitter.

F-M Modulators

Distortion-free modulation of f-m transmitters is not simple or easy of achievement, particularly in crystal-controlled designs. It may require use of much higher orders of multiplication than would be necessary in an equivalent a-m transmitter, particularly with large deviations, and thereby tend to negate transmitter simplification and spurious response improvements such as are possible with harmonic-mode crystals. In fact, f-m, because it represents a controlled frequency instability, tends to oppose the frequency stabilization incorporated in a transmitter.

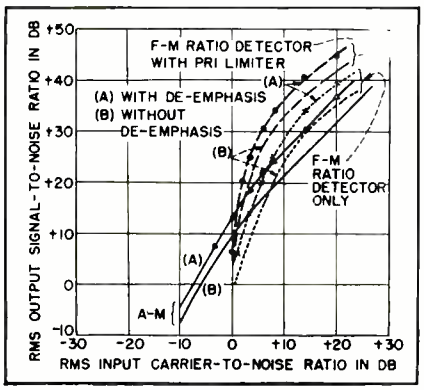

FIG. 23—Comparison with and without de-emphasis, both systems

The advent of effective and simple low-level a-m modulation techniques may reduce the f-m advantage. At 100-percent modulation, the transmitter requires 1.8 db additional radiation power for its sidebands as compared to the zero-modulation condition. Since, however, peak modulation occurs only part of the time with speech transmission, various devices may be used to reduce the average modulating power required by the a-m transmitter.

In general, f-m receivers require two elements not normally necessary in a-m receivers. Some means must be provided to minimize or eliminate the amplitude variations present in the received signal before final detection, and a means of converting low-percentage frequency variations into closely equivalent amplitude variations for detection must also be incorporated.

The means for minimizing amplitude variations usually takes the form of one or more types of amplitude limiters. Many of these devices possess serious shortcomings in that they exhibit threshold effects, and peculiarities with respect to transient response. Even the best of them forces compromise in receiver design not normally necessary in an a-m receiver. Conversion of low-percentage frequency variations into directly proportionate amplitude variations requires linear phase discriminators which are highly sensitive to small changes in carrier frequency. For instance, in the uhf system under consideration, the average carrier-frequency deviation due to speech modulation was less than ±0.001 percent. With good limiting, the frequency discriminator in this case requires a frequency stability for optimum performance which approaches quartz-crystal tolerances. Since maintenance of this high degree of precision and frequency accuracy by manual means is a practical impossibility under operational conditions, some form of automatic centering means, such as afc, must be considered. Such devices, if used, result in added complications which tend further to compromise the f-m system.

A-m receivers require some form of amplitude limiter to provide impulse-noise reduction comparable to f-m receiver performance. Several simple and effective circuits which are not affected by detuning are available for this application, but their use generally involves added output-harmonic distortion at high modulation levels not usually present in limited-carrier f-m receiver output.

Acknowledgement

The author acknowledges his indebtedness to the many persons who cooperated in the prosecution of this problem, with particular thanks to Robert M. Maiden and James D. Wallace, Jr.

Radio-Frequency SWEEP GENERATOR

An overdriven amplifier is used as the switching tube in a resistance-capacitance sweep generator. To synchronize the sweep with the phenomena to be observed, the base frequency of the sweep circuit is multiplied to drive the equipment that is being tested

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VIEWING phenomena of very short duration has been made quite convenient for low-recurrence rates by the synchroscope and high writing-speed cathode-ray tubes having isolated deflection circuits. However, methods for observing high-recurrence-rate phenomena have been less thoroughly treated.

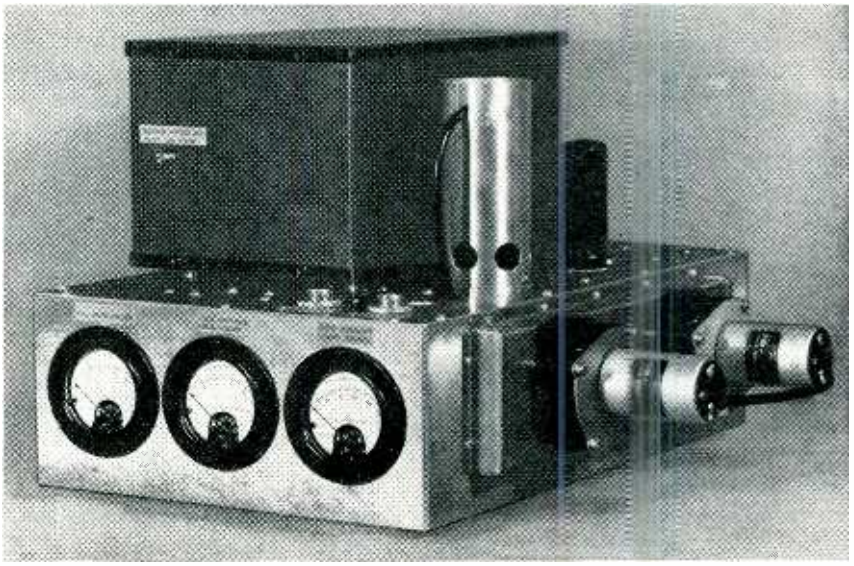
The method described here is suitable for viewing the radio-frequency output of high-frequency transmitters and the pulse output of high-recurrence-rate pulsers, especially when the output frequency is derived by harmonic amplification from a lower-frequency base oscillator.

An overdriven amplifier is used to produce a sawtooth sweep from a sinewave. This sweep, being rich in harmonics, is followed by harmonic amplifiers that produce a synchronous output to drive the transmitter or pulser. The method is simple and is easily incorporated within the equipment with which it is to be used.

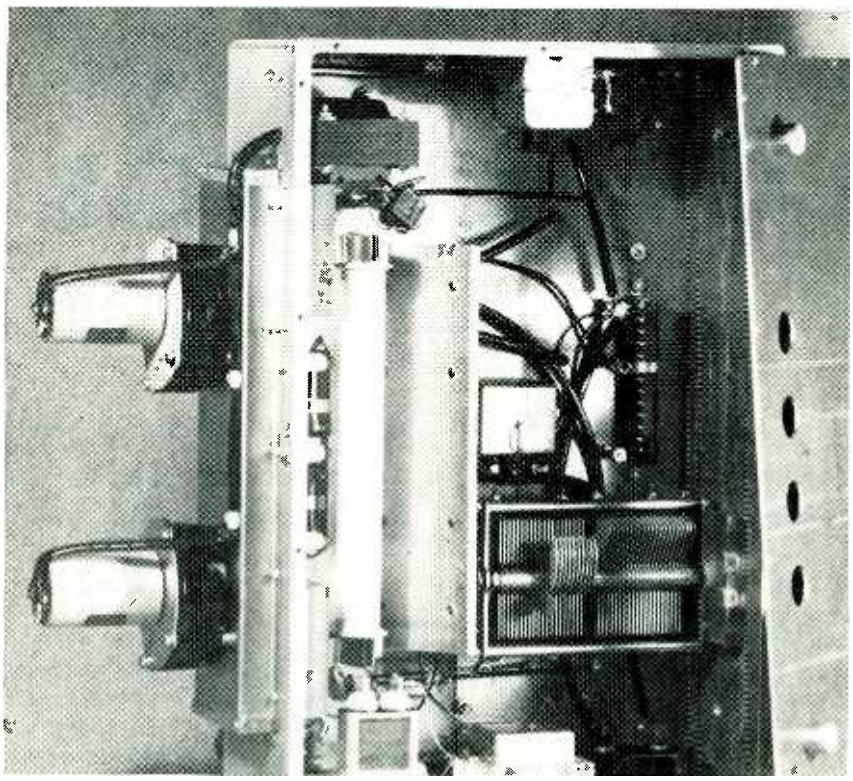
Design Problems

Laboratory oscilloscopes commonly generate their sweeps by resistance-capacitance charging or discharging circuits, using gas-tube switches and series-pentode linearizing devices. When sweep recurrence rates appreciably beyond 50 kc are desired, two difficulties arise: (1) The gas tube will not deionize sufficiently between operations; (2) The output capacitance of the sweep generator becomes too large as a result of the fact that the series pentode must be connected with its cathode, rather than its plate, following the generated sweep voltage. Whether it is arranged to charge or to discharge the sweep-generating capacitance as the sweep is generated, the pentode must be connected in the unfavorable polarity. (Whether the capacitance charges or discharges is merely a matter of whether it is connected from plate to the positive terminal of the high-voltage supply or from plate to the negative terminal of the high-voltage supply.)

The excessive capacitance imposed by the series tube results from two sources. First, there is the cathode-heater capacitance in series with the interwinding capacitance of the filament transformer. If the voltage developed across the cathode-heater capacitance is excessive, a filament-type tube must be used and the full interwinding capacitance may be imposed across the sweep output. This may be several hundred μμf, but can be materially reduced by spacing the secondary winding of the filament transformer away from the core and primary winding and accepting the leakage reactance which results. Secondly, the requirement that the



Sweep generator includes electron-coupled oscillator in box on top and sweep circuit in chassis below; blowers are for resistors in sweep circuit



Underside of oscillator and sweep circuit chassis shows special constant-impedance-capacitor voltage divider that controls the sweep amplitude

control grid and screen grid potentials of the series tube be maintained constant with respect to the cathode, in order to obtain constant-current characteristics, also presents difficulties. The control grid is no special problem, but in order to maintain the proper screen grid voltage, the potential of the entire screen voltage supply must follow the generated sweep voltage.

These factors lead one to seek a hard-tube sweep generator and some other means of linearizing. A sweep can be generated by an overdriven amplifier. Such an amplifier, when driven by a large sinusoidal input, can be caused to produce in the plate circuit a sharp negative pulse having a duration of one-quarter the period of the input wave. Using such a tube as a switch, one can cause a capacitor to charge for three-quarters of the input wave period and discharge through the conducting tube for one-quarter of the period. Thus an exponential sawtooth, with the rise time three times the fall time, is generated. A common method for obtaining approximate linearization is to use a charging voltage greatly in excess of the desired sweep amplitude so that only a small portion of the exponential curve is used. A blocking capacitor, between the switch tube and the sweep generating capacitor, moves the axis of the output wave up so that it swings alternately positive and negative by the same amount. Centering voltage for the horizontal-deflection plates is thus eliminated, even with a plate grounded.

Capacitance Divider

The sawtooth voltage is a suitable source of harmonic voltage for generating a higher frequency, synchronous sinewave output for use with any type of modulation. In this event the input to the succeeding harmonic amplifiers must be of constant amplitude, but at the same time it may be desirable to vary the sweep amplitude. This necessitates the use of a constant-impedance divider to satisfy both conditions simultaneously.

The divider is formed by placing a variable capacitor in series with the indicator capacitance which consists mainly of the coaxial cable capacitance. This is a satisfactory method of control except that the net shunting capacitance is still varied somewhat. The effect can be eliminated by ganging a compensating capacitor, with specially shaped rotor plates, to the sweep amplitude control capacitor. A resistor in series with the coaxial cable carrying the sweep to the indicator may be required in order to prevent the initiation, with each sweep cycle, of oscillations on the line due to improper impedance termination at the receiving end.

The rotor plates of the divider capacitor must be specially shaped to provide the required constant impedance. This capacitor is at the output of the circuit shown in Fig. 1. Let C_1 be the capacitance of the cable to the indicator, C_2 the amplitude control capacitance (1,000 $\mu\mu$f), C_3 the minimum capacitance of C_2, and C_4 the compensating capacitance produced by the special rotor. The two sections are ganged so that C_4 increases as C_2 decreases.

The shape of the rotor can be determined by analysis. It is required to maintain a constant total capacitance C_T across the circuit, therefore $C_4 + C_N = C_T$, where C_N

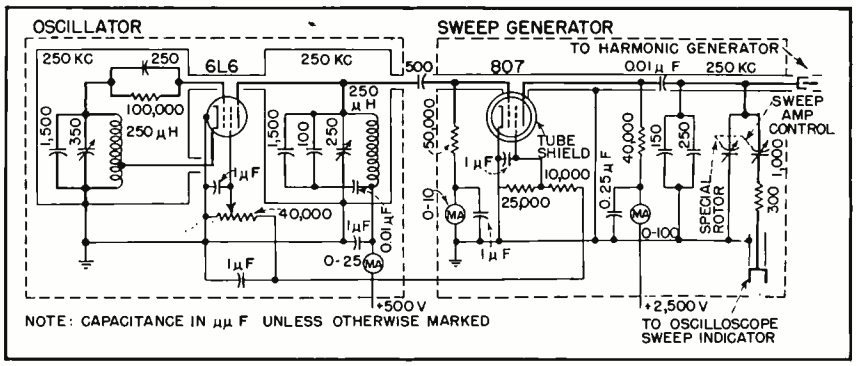


FIG. 1—Circuit of 250-kc oscillator and sweep circuit: sweep takes ¾th of a cycle and retrace takes ¼th cycle of the oscillator's frequency

is the resultant of C_1, C_2 and C_3 neglecting the 300-ohm damping resistor. Both C_4 and C_N are functions of the angular position, but C_T is not. By writing the differential equations for the capacitances as functions of angular position and solving, we find that

$$r^2 = r_{MAX}^2 \left(\frac{C_1 + C_3}{C_1 + C_2 + C_3}\right)^2 + r_1^2 \left[1 - \left(\frac{C_1 + C_3}{C_1 + C_2 + C_3}\right)^2\right]$$

where r is the radius of the rotor, r_{MAX} is the maximum radius of the plates (determined by the original capacitor dimensions), and r_1 is the radius of the arc cut in the stator plates to accept the rotor shaft.

If C_2 is known as a function of ϕ (it may be assumed to be $K\phi$ if constant radius plates are used for C_2), then r is computed for various angles from 0 to 180 degrees. Enough plates so shaped are used on C_4 to maintain C_T constant. In general an integer number of plates will not produce perfect compensation. Enough plates are used to produce overcompensation and r_{MAX} is reduced on one or more plates. Inasmuch as the foregoing equation for r neglects edge effects near the limits of ϕ, which will have to be compensated by cut-and-try methods, it is also reasonable to simplify the calculations by assuming that r_1 and C_3 are zero. The minimum capacitance of C_4 serves only to increase C_T.

Using the Equipment

Figure 1 shows a 250-kc electron-coupled oscillator and sweep generator, of the type described above, with outputs to an indicator and harmonic amplifier. Figure 2 shows waves obtained with the equipment. By this method, one can supply a synchronous sweep for indication of any output which is obtained by harmonic amplification. In the case of a transmitter whose output frequency is much greater than four times the base frequency, it is desirable to take the sweep generator input from an intermediate point so that a reasonable ratio of output frequency to sweep frequency will be maintained. The method is less suitable for transmitters operating straight through on one frequency, for the sweep generator input then must be developed by use of a synchronized multivibrator, as is done in a synchroscope when used for synchronous sampling, or preferably by regenerative modulation.

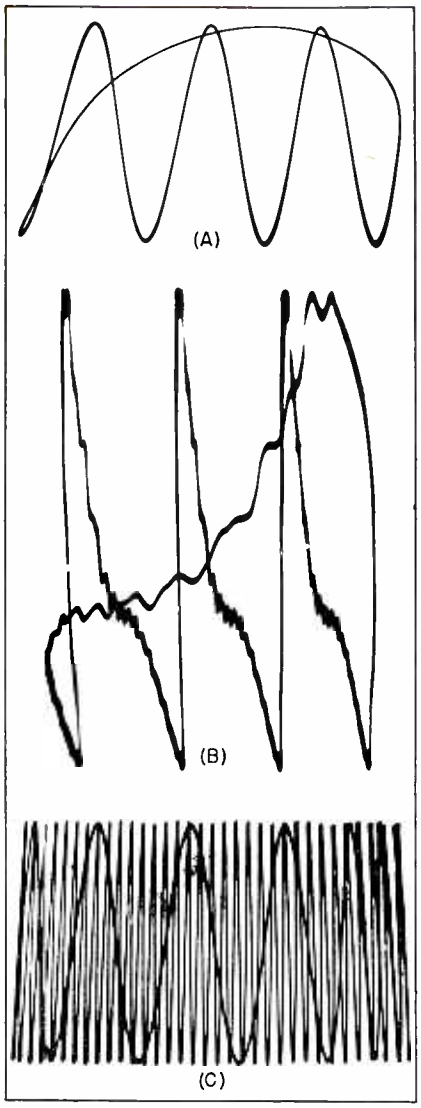


FIG. 2—(A) Trace of a 1-mc wave on the 250-kc sweep, (B) parasitic oscillation in a 1-mc wave, and (C) a 10-mc wave on the 250-kc sweep

It is revealing to be able to view the performance of circuits at higher frequencies. For example, in the 250-kc oscillator shown, a small transient, reinitiated with each cycle and having a frequency of about 100 mc, was a source of perplexity for some time. The transient was found to be initiated by dynatron action at that point in the cycle where the instantaneous plate voltage fell below the screen voltage. Without the high speed sweep, the transient would not have been easily detected and the source of trouble would therefore have been very difficult to diagnose.

In the case of large duty-ratio pulses, the sweep is equally suitable. As the duty ratio becomes smaller, it is desirable to increase the sweep frequency. This may be carried, by harmonic amplification, to the point where the sweep frequency is greater than the pulse recurrence frequency. The only objection to this situation is a bright, solid base line produced on the screen. In general, a blanking pulse for the return trace is not required. By proper phasing of the voltage to be viewed, the return trace (though not linear) can be used for expansion as shown in Fig. 2. Blanking and intensification do become desirable when the sweep frequency greatly exceeds the pulse recurrence frequency. Writing speed becomes a limitation only when pulses of extremely short duration and small duty ratio are displayed.

The final consideration in the design of such an indicator, is the choice of a cathode-ray tube with suitable characteristics. In order to prevent feeding of the unknown voltage into the sweep through the interelectrode capacitances of the cathode-ray tube, it is desirable to use a tube having the deflection plate connections on the neck, such as the Du Mont 5JP1. Coaxial lines can then be used to carry the sweep and unknown voltages to the tube. The capacitance of one deflection plate to either plate of the other pair, is ordinarily about the same due to mechanical symmetry and can be balanced more perfectly with external capacitance. Hence, if each plate of the other pair has equal impedance to ground, each receives equal voltage from the first plate and no perturbation results. This impedance balance can be obtained by using push-pull deflection voltage. Inasmuch as feeding can occur in either direction, it is desirable to use push-pull voltages for both deflection circuits if the frequencies are high enough to cause cross-feeding within the tube. Using balanced deflection circuits has the further advantage of reducing defocusing effects by greatly reducing the potential excursion of points between a pair of plates so fed.

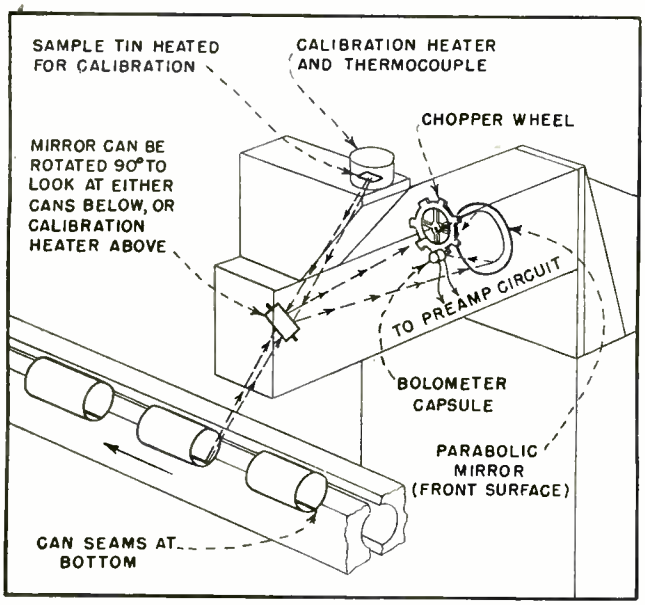


FIG. 1—Infrared radiation from heated tin cans or from calibration heater is beamed through chopper wheel to bolometer capsule

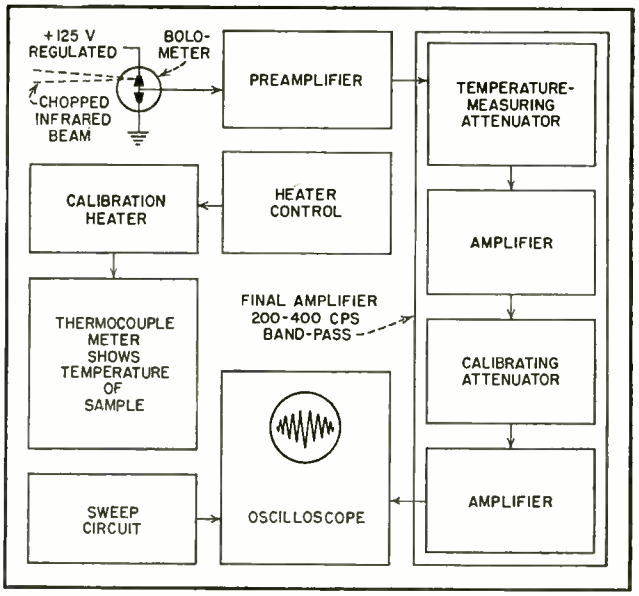


FIG. 2—Signal from bolometer is 300-cps voltage varying in accordance with intensity of infrared radiation

Industrial HIGH-SPEED

Accurate measurement of the temperatures of tin cans moving at high speeds is made possible by the use of infrared pyrometry. Special amplifier and sweep circuits provide maximum flexibility of equipment for operation under a variety of conditions

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THE INSTRUMENT described in this article was designed to meet the need for a device that would accurately and continuously measure the temperature of a soldered seam on the sides of tin cans as they move past the measuring point at rates as high as 6 cans a second.

On the machine which forms the cylindrical portion of the tin can, the seam to be soldered is subjected to a series of heating and cooling operations. The proper adjustment of the heating flames and the flow of cooling air which will give the best soldering job can only be found by measuring the temperature of the soldered seams as the cans pass from one operation to the next at normal operating speeds.

Inaccessibility and the rapid motion of the cans prohibited the use of physical-contact measuring devices, and the relatively low temperatures involved (400 to 700 F) made infrared pyrometry the only possible method of temperature measurement. Although the cans pass the pyrometer at a maximum rate of only six cans a second, the time available for measurement on each can may be as short as 1/100-second because the pyrometer must look at an angle into the end of the can in order to receive the infrared radiation from the hot seam being soldered.

Operating Principle

The infrared energy being emitted by the heated seam is picked up by the optical system as shown in Fig. 1. The infrared beam thus formed is then passed through a 15-slot 1,200-rpm chopper wheel which creates a pulsating beam that is in turn focused on a thermistor flake in the bolometer capsule. The thermistor is thus alternately heated and cooled at the rate of 300-cps.

The thermistor which receives the infrared beam is connected in series with an identical compensating thermistor across a well-filtered d-c voltage, as shown in Fig. 2. The signal appearing between the two thermistors is a 300-cps voltage resulting from the changes in resistance of the one receiving the infrared signal from the optical system.

In the bolometer used, the thermistors were mounted in an evacuated capsule in order to minimize microphonic effects, and the thin thermistor flakes were backed by quartz to obtain the shortest possible thermal time constant.

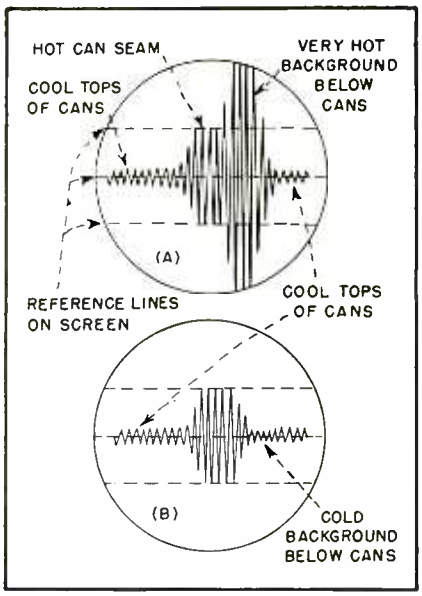
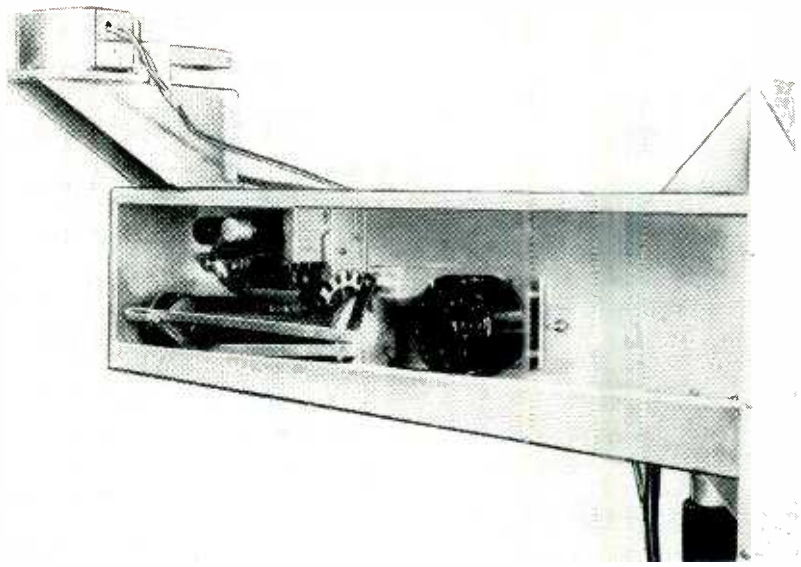


FIG. 3—Typical oscilloscope patterns. Envelope indicates relative temperatures



View of optical system, chopper wheel and motor, and calibration heater of infrared pyrometer

INFRARED PYROMETER

The 300-cps signal from the bolometer circuit varies in amplitude in accordance with the intensity of the infrared radiation, and thus with the temperature of the area being viewed. It is then amplified and fed into a cathode-ray oscilloscope which is used essentially as a null indicator, the temperature being read on a calibrated attenuator in the amplifier system which is adjusted to give a predetermined signal height on the oscilloscope screen.

Since there is a wide variation in the infrared emissivity of different surface coatings used on cans, provision is made for calibration of the pyrometer from a sample of the material being used. The sample is heated by a small electric heater, and its temperature measured by a thermocouple in conjunction with a meter which is calibrated in degrees Fahrenheit. The calibration heater is so positioned (Fig. 1) that by simply flipping a mirror, the operator can check calibration by focusing on the sample instead of the moving cans.

An oscilloscope is used instead of a meter for the null indicator because it is necessary to pick out the desired signal from other temperature signals which are of no interest. Two typical oscilloscope patterns are illustrated in Fig. 3.

Scope Pattern Interpretation

The horizontal sweep circuit frequency is adjusted to give one sweep as each can passes the optical system. In Fig. 3A the optical system is at a position on the assembly line where it sees an extremely hot area between cans (such as the heating flame which raises the seam temperature well above the solder's melting point and allows removal of excess solder). Figure 3B shows the pattern when the optical system views a cold area between cans, such as the factory floor, or relatively cool parts of the machinery.

Looking at Fig. 3A, and picturing the cans passing the optical system (as shown in Fig. 1) the relatively cool can tops may be seen to give a low signal. As the hot seam just enters the viewing area, the signal begins to rise until the whole viewing area is focused on the seam, at which time the signal levels

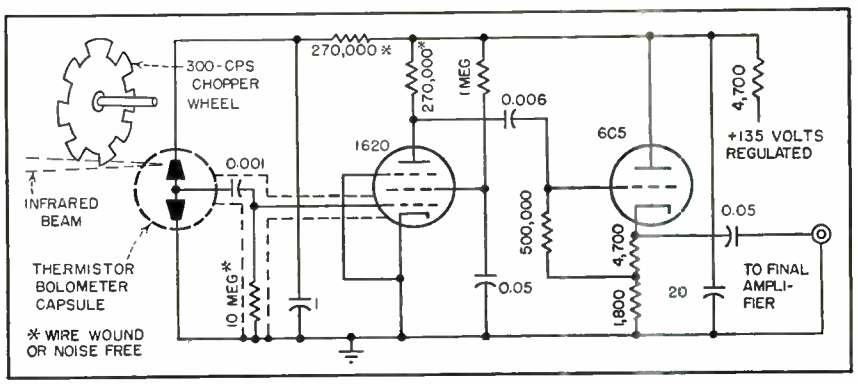


FIG. 4—Circuit diagram of preamplifier. Extremely rigid wiring in the input circuit is necessary to prevent microphonics

off at a value corresponding to the seam temperature. As the seam leaves the viewing area, and the heating flame comes into view, the signal again begins to rise, leveling off at a point corresponding to the temperature of the flame.

The cycle repeats at a frequency of from 1 to 6 cps, depending on can speed, giving temperature pictures which allow visual averaging of the small variations in emitted energy from can to can.

Amplifier Circuits

The elimination of noise was the biggest problem in the design of the amplifiers. Vibration, and an acoustic noise level of about 100 db on the factory floor, made microphonics the most serious source of noise. Since temperature measurements must be made from a bolometer signal of a few microvolts, and since the output of the bolometer is at a d-c level of 68 volts above ground with an impedance of 0.75 megohm, the signal lead from the bolometer to the preamplifier can act as a condenser microphone if it is not extremely rigid and properly shielded. Figure 4 shows the circuit diagram of the preamplifier. Special noise-free resistors were used at critical points, and a 1620 (low-microphonic 6J7) was chosen for the input tube.

Direct current is used on the filaments of the preamplifier tubes to eliminate hum pickup, and a very well-filtered plate supply is required. The 6C5 is simply used as a cathode follower to lower the impedance for transmission to the final amplifier.

The stagger-tuned final amplifier is shown in Fig. 5. The circuit is designed for uniform band pass between 200 and 400 cps, with rapid attenuation on both sides of the band to minimize pickup and noise. Push-pull output was used in the final amplifier to maintain linearity and therefore balance about the center reference line on the oscilloscope screen for any setting of the various attenuator adjustments.

The *factory adjustment* is simply a control to set the general gain level before the instrument is put into operation. The *calibration attenuator* is adjusted as follows:

The optical system is focused on a sample which is heated by the calibration heater to a known temperature, as measured by a contact thermocouple instrument. The *temperature attenuator* (dial calibrated in temperature units) is then set to this known temperature of the sample, and the calibration attenuator is adjusted to bring the deflection of the oscilloscope to the two fixed reference lines on the screen of the scope.

When the optical system is focused on an area of unknown temperature, the temperature attenuator is readjusted to give the same deflection on the oscilloscope, and the temperature of the unknown is read directly in degrees on the temperature attenuator dial.

Sweep Circuit

In the particular application for which this instrument was designed, cans passed along the assembly line at rates of from 1 to 6 cans a second, depending on size. The sweep generator shown in Fig. 6 is capable of producing the linear sweep voltages required at these low frequencies. To achieve this, direct coupling to the oscilloscope plates was used.

It was found advantageous to provide for sweep expansion and thus allow inspection of a particular part of a cycle. The capacitor switching arrangement shown accomplishes this without affecting the frequency or phase of the sweep voltage, so that identification of the part being expanded is maintained.

The first 884 functions as a relaxation oscillator, establishing the sweep frequency and triggering the second 884. The VR150 insures stability of the sweep frequency. The sweep voltage is generated by the second 884, which acts essentially as a single-sweep generator because of its connection to the diode-connected portion of the 6SN7.

Sweep expansion is accomplished by switching to the smaller capacitors in the plate circuit of the sweep generator so that the voltage will rise more rapidly. The piling up of vertical signals at the end of the expanded sweep was not objectionable for this particular application, but it could easily be eliminated if necessary.

The instrument is designed to measure temperatures from 400 to 700 F with an accuracy of better than ±5 F. A standard oscilloscope is used and, if desired, it may be removed from the unit and used for general laboratory purposes.

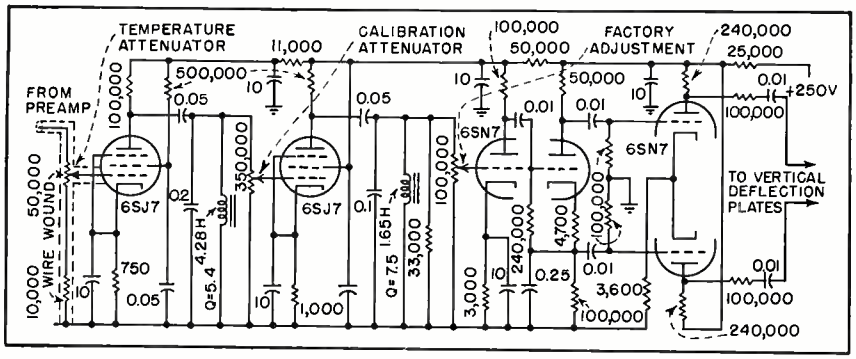


FIG. 5—Stagger-tuned final amplifier passes only frequencies between 200 and 400 cps to minimize noise

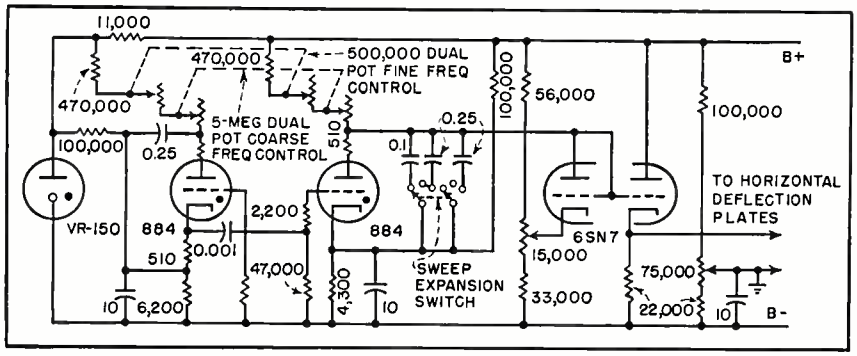


FIG. 6—Sweep frequency adjustable from 1 to 7 cps. Direct coupling is used to maintain linearity of sweep at these low frequencies

Flush-Mounted Antenna for Mobile Application

Small annular slot antenna with the same radiation pattern as a dipole can be built into the metal roof of a car. Theoretical development and experimental results are given for operation at mobile-service and citizens-band frequencies

By DONALD R. RHODES

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THE FREQUENCIES initially used for two-way mobile radio were relatively low, so the problem of radiating and receiving signals was usually solved by placing as long an antenna as possible in a convenient physical location. This position was not critical because of the ease with which low-frequency radiation could be diffracted around the conducting surface of an automobile body, and the length was not critical because of the physical impracticability of erecting a vertical rod more than a small fraction of a wavelength in height.

The problem of providing an antenna at the high frequencies in use today is not as easily solved and requires careful consideration of all the influencing factors. As the frequency is increased the effects of diffraction around an automobile diminish, creating electrical shadows,—barriers to the propagation of radio-frequency energy. The antenna dimensions can no longer be chosen arbitrarily but must be part of a systematic engineering design.

Considering that the antenna should have a nearly omnidirectional pattern and that its energy should be directed along the horizon for ground communication purposes, the most natural antenna choice is the vertical stub above ground now being used by police, taxicabs, telephone companies, and others in the 150-mc region. Although a vertical stub on an automobile roof is electrically excellent, its size and appearance leaves much to be desired. Release of the citizens communications band by the Federal Communications Commission will create an additional widespread popular demand for two-way mobile radio systems and the problem of designing a less conspicuous antenna will no doubt present itself.

Fundamental Principles

A short stub antenna mounted above a ground plane can be considered an electric dipole in free space. A small circular-loop antenna may be considered a magnetic dipole on the axis of the loop

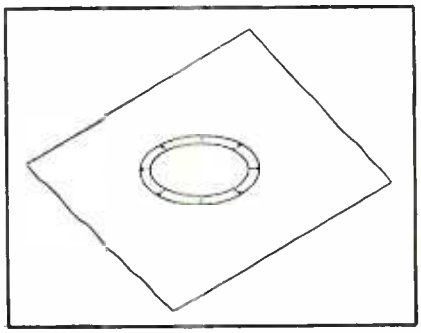

FIG. 1—An annular slot cut in a conducting surface, excited by a uniform radial electric field

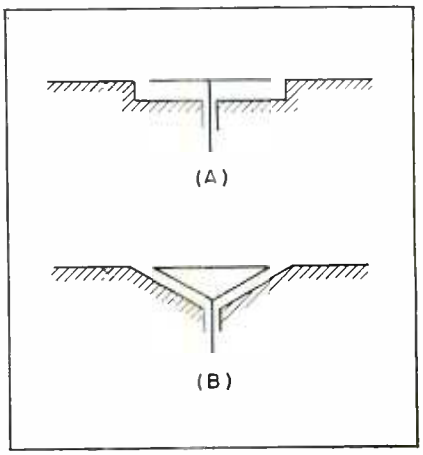

FIG. 2—Cross-sectional view of two possible feed systems for the annular-slot antenna

and has the same radiation pattern as an electric dipole with the radiated electric and magnetic fields interchanged. Furthermore, a circular loop carrying magnetic current rather than the conventional electric current will produce the same pattern as the electric dipole if the radiated fields are interchanged. A small magnetic-current loop can not be distinguished from a short electric dipole lying in the axis of the loop. Thus a small magnetic-current loop can be substituted for the vertical stub above ground with no change in the radiated field pattern.

Physically a magnetic-current loop can be realized by an annular slot in a conducting plane if the slot is excited by a uniform radial electric field as shown in Fig. 1. It has been shown from diffraction theory by Pistolkors[1] that the relative radiation pattern of a narrow annular slot in a perfectly conducting ground plane can be expressed as follows

$$|E_\theta| \simeq kr\, J_1\,(kr \sin\theta)$$

where θ is the angle between the direction of measurement and a line perpendicular to the ground plane, r is the radius of the annular slot, k is $2\pi/\lambda$, and J_1 is the first order Bessel function. This same expression was obtained by Foster[2] for the radiated magnetic field of a circular loop with uniform electric current. The relative radiation pattern of a thin wire stub above a perfectly conducting ground is given by the following[3]

$$|E_\theta| \simeq \frac{\cos\,(kl\cos\theta) - \cos kl}{\sin\theta}$$

where l is the length of the stub. If the slot radius is small the expression for radiated electric field may be simplified by neglecting all but the first term of the expanded Bessel function. Likewise the expression for the electric field radiated from a short stub may be simplified by neglecting all but the lowest-order terms in the expanded sine and cosine functions. For a small slot

$$|E_\theta| \simeq \frac{(kr)^2}{2}\sin\theta$$

and for a short stub

$$|E_\theta| \simeq \frac{(kl)^2}{2}\sin\theta$$

thus we have an exact analogy between the radiated field of a short

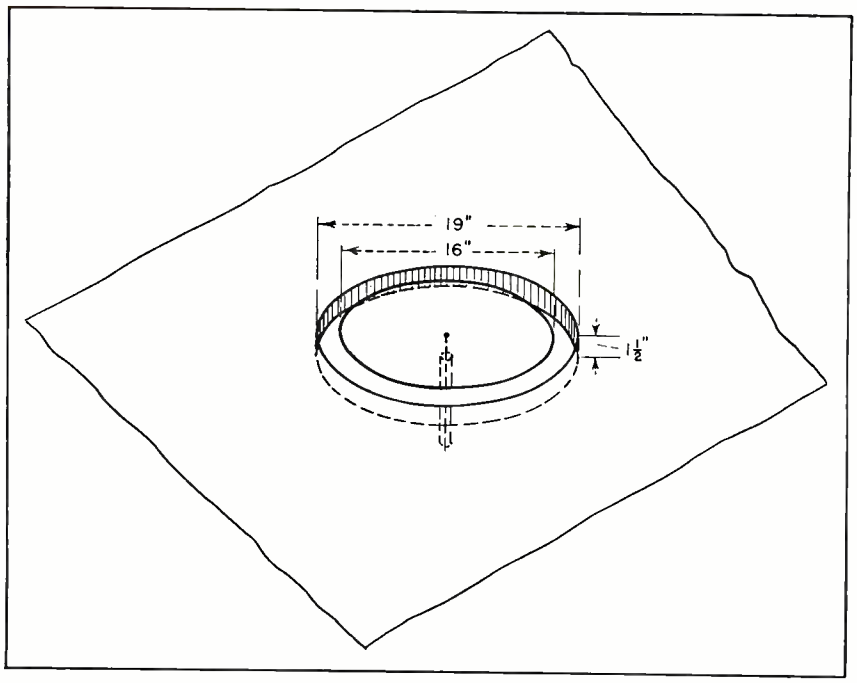

FIG. 3—Sketch showing dimensions of full-scale experimental annular slot. The radiation pattern of this slot was measured at 150 mc and 450 mc

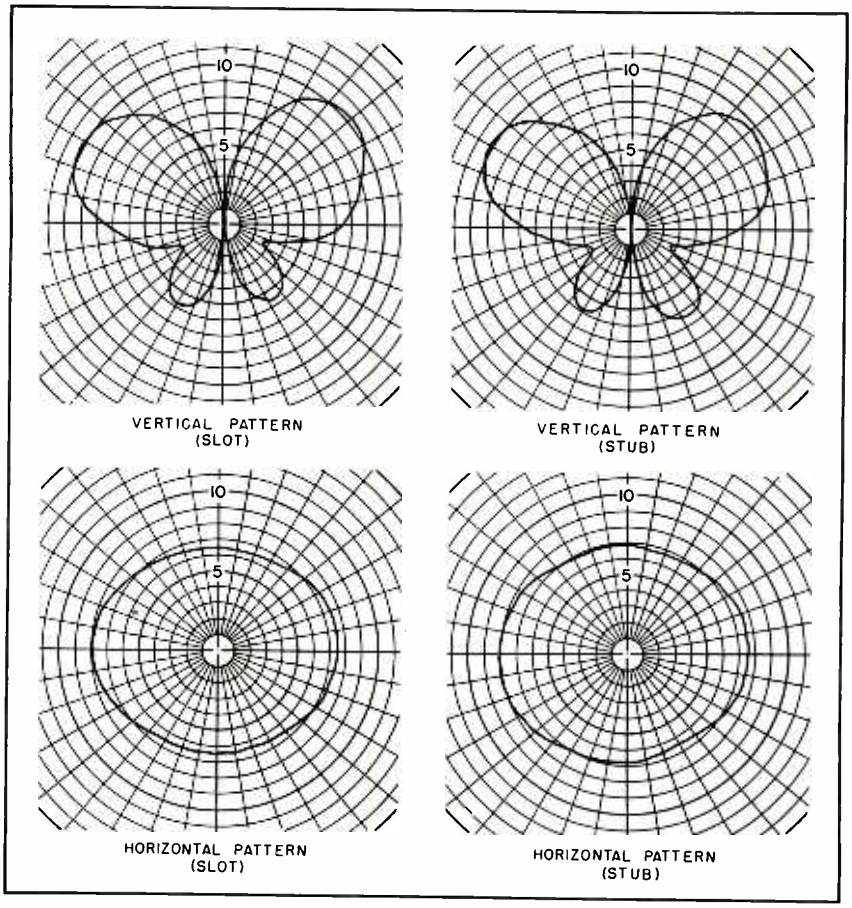

FIG. 4—Radiation patterns in the vertical and horizontal planes of an annular slot and a vertical stub, measured at 150 mc

vertical stub and a small annular slot.

The requirement of a uniform field at the surface of the slot necessitates a symmetrical feed system, the particular feed system used to be determined largely by space limitations and the input impedance desired. Two possible feed systems which can be used to produce a uniform radial electric field at the slot are shown in cross-section in Fig. 2. Both feed systems consist essentially of a radial two-conductor transmission line coaxially fed. Type A has a cylindrical cavity which occupies less space than the conical cavity of type B. However type B provides a more gradual transition of energy from the source to free space and will therefore have a different input impedance. The impedance will depend entirely upon the manner in which the cavity matches the transmission line to the impedance of free space.

Radiation Patterns

To illustrate the analogy between a small annular slot and a short stub above ground for a practical case, a one-seventh scale model of an automobile roof was constructed and the annular slot of the form shown in Fig. 3 was installed. The vertical and horizontal radiation patterns were measured in free space at model frequencies corresponding to the full-scale frequencies 150 mc and 450 mc and are shown in Fig. 4 and 5, respectively. Then the annular slot was removed and replaced by a short vertical stub. Radiation patterns for the vertical stub were measured under the same conditions as the slot patterns and are shown for comparison in Fig. 4 and 5. It can be seen that there is, indeed, a striking similarity between the corresponding slot and stub patterns. The correspondence is better at 150 mc than at 450 mc because there the slot is small in terms of wavelength. This suggests that a smaller slot than the one illustrated could be used at 450 mc with an increase in signal level in the horizontal plane for a given power input to the antenna.

Since the radiation patterns shown were measured on a model in free space the true pattern of an antenna on an automobile will be modified by reflection from the ground and from other reflecting surfaces. Radiation below the horizon as indicated in the vertical plane patterns will be reflected from the ground and will add vectorially to the energy radiated along and above the horizon. Because of the difficulties inherent in determining the magnitude and phase of energy reradiated from innumerable objects the vertical plane patterns can serve only as an approximate indication of the space distribution of energy radiated from the actual automobile antenna system.

An antenna of the flush-mounted type should preferably be fabricated by the automobile manufacturer and considered part of the overall vehicle design. If one of the types of feed suggested in Fig. 2 is used, the lower portion of the cavity may be included in the car-top die or constructed separately and welded into place. The width of the slot gap is not critical, so the upper portion of the cavity may assume any convenient proportions.

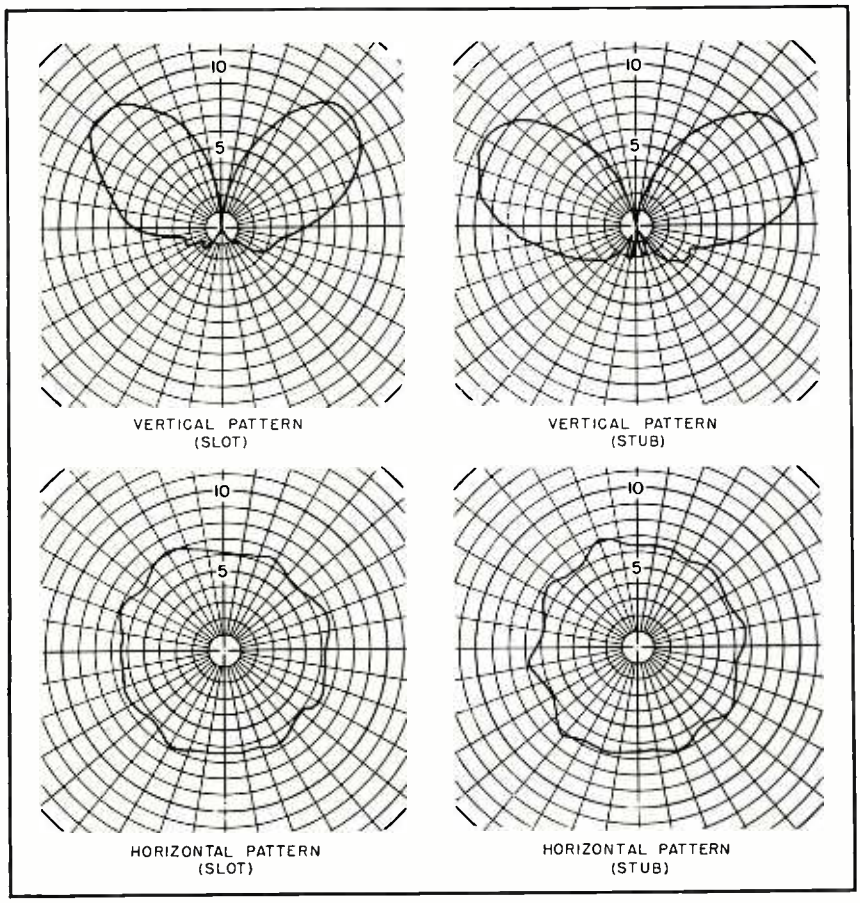

FIG. 5—Radiation patterns in the vertical and horizontal planes of an annular slot and a vertical stub, measured at 450 mc

Fabrication

Several types of dielectric material are available to fill the cavity and exclude rain, snow and dirt. It is important that a nonconducting paint be used over the slot area to prevent excessive loss of power. The final result should yield an efficient, self-contained radiating system for two-way mobile radio.

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High-Fidelity Response From Phonograph Pickups

Basic requirements for high-fidelity phonograph reproduction are discussed briefly. Ways of introducing feedback to compensate for nonlinearity in inexpensive crystal pickups are shown. Includes typical curves for various feedback networks

By ELWIN J. O'BRIEN
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ONE CLASSIFICATION of sound divides its components into two groups, pure tones and complex sounds. To be classified as a true high-fidelity sound-reproducing system, an amplifier and its associated components must be capable of reproducing both the pure and the complex sound components exactly as to pitch and intensity, and its output must be free from new frequencies introduced by intermodulation or harmonic distortion in any part of the system.

Intermodulation is defined as the production of frequencies equal to the sum and difference of integral multiples of two or more of the frequencies transmitted to a system. Any resonance in a system will produce nonlinear or intermodulation distortion, unless suitable compensation is provided.

Resonance can occur in any mechanical system containing inertia and elasticity. The effect of a constant driving force applied to an electroacoustic device where resonance is present, such as a crystal pickup, is to produce transient complex vibrations. These vibrations, in the presence of inherent nonlinearity, beat with the periodic vibrations of the music to produce discordant sounds.

Additional transient vibrations, those which produce annoying surface noise, are caused by granular irregularities in records. These random irregularities will produce transient oscillations if there is any resonance in the pickup arm or the pickup itself, and again, in the presence of nonlinearity, intermodulation products will be generated and the surface noise voltages will be increased.

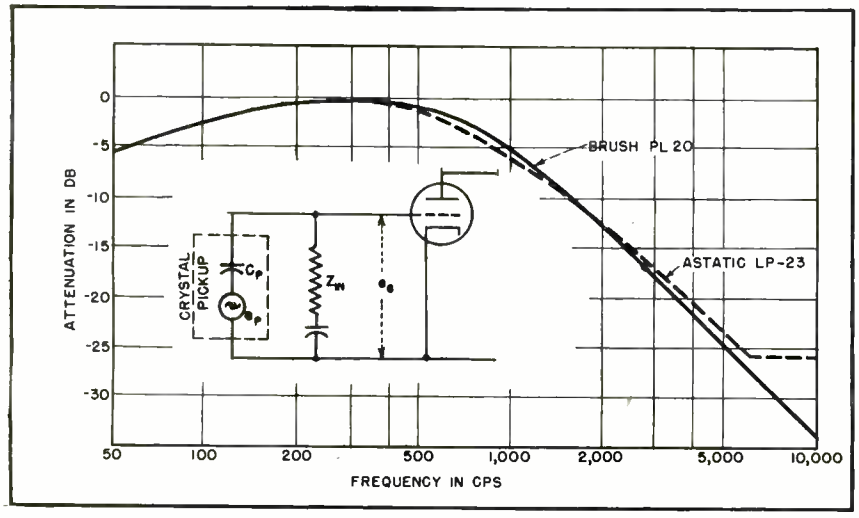

FIG. 1—Relative voltage output curves for typical crystal pickups without feedback, and equivalent circuit for input section of a typical amplifier

Typical unequalized response curves for two popular crystal pickups as obtained from an ideal lateral test record are shown in Fig. 1 along with the equivalent circuit of the ideal unit. The ideal crystal pickup would be equivalent at audio frequencies to a zero impedance generator in series with a capacitor and would have a frequency response for a constant needle amplitude that decreases at the rate of 6 db per octave. Actually, however, inherent resonance causes high voltages to be generated in the pickup itself and its arm at certain frequencies.

Negative feedback applied to the pickup circuit will reduce this resonance. Each of the two general types of feedback, voltage and current, tend to make the voltage output a replica of the signal voltage, but their effects on the impedance of the circuit are different. Voltage feedback lowers the internal impedance of an amplifier, while current feedback raises the impedance.

Feedback

The voltage amplification with voltage feedback is $A_F = A/(1 - A\beta)$ where A is amplification without feedback and β is the fraction of the output voltage introduced in the input of the amplifier. If the amplitude of the feedback factor β is made a function of frequency, the amplification A_F with feedback will also be variable with frequency.

It is therefore possible to use negative feedback as an equalizer for a phonograph pickup. If all the low frequencies below the turnover are attenuated equally by

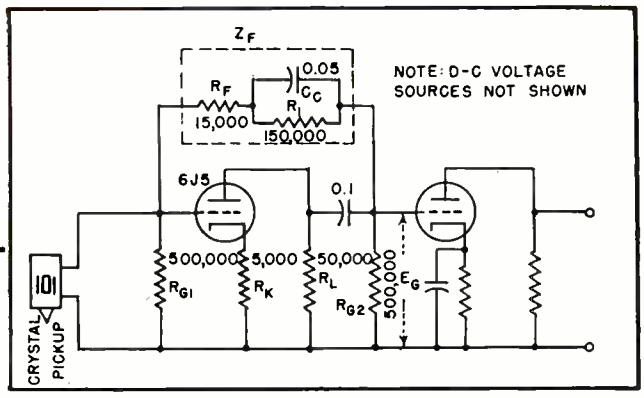

FIG. 2—Typical schematic diagram for phono input circuit employing feedback

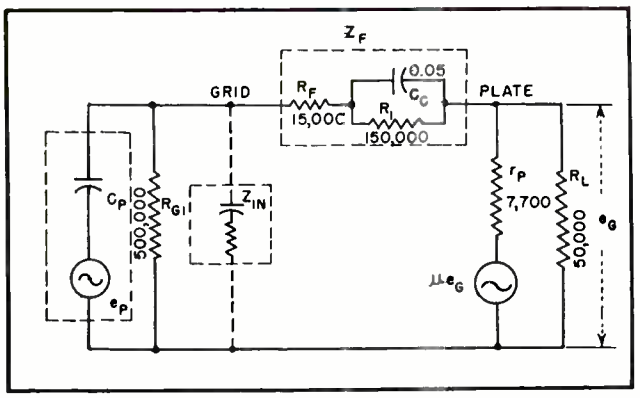

FIG. 3—Equivalent circuit for first stage of amplifier shown in Fig. 2

about 25 db and the frequencies above the turnover are allowed to increase at the rate of 6 db per octave we should have a perfect crystal phonograph pickup equalizer.

Considering the above principle, the phonograph amplifier circuit shown in Fig. 2 was developed experimentally for an Astatic LP-23 or a Brush PL-20 cartridge.

This amplifier, using both voltage and current feedback, includes the pickup impedance in the feedback loop. Calculations for gain and input admittance, using the equivalent circuit shown in Fig. 3, are shown in Table I along with tabulated results for several frequencies. It can be seen that the gain above 500 cycles increases at the rate of about 6 db per octave and, since the amplitude on typical test records drops off at this rate, a flat voltage output would be expected when making frequency response tests.

Table I—Calculations for gain, voltage input to second stage, and input impedance, and tabulated results for feedback circuits

Voltage Gain Calculation[1]

$$A_F = \frac{-\mu Z_L}{r_p + (\mu + 1) R_K + (1 + \mu\beta) Z_L}$$

where $Z_L = R_L R_{G2}/(R_L + R_{G2})$

$\beta = Z_G/(Z_G + Z_F)$

$Z_G = -j\, X_{CP} R_{G1}/(R_{G1} - j\, X_{CP})$

and $Z_F = R_F - j\, X_{CC} R_1/(R_1 - j\, X_{CC})$

then $\beta =$

$$\frac{-j\, X_{CP} R_{G1}/(R_{G1} - j\, X_{CP})}{-\mathrm{j}\,\frac{X_{CP} R_{G1}}{R_{G1} - j\, X_{CP}} + R_F - j\,\frac{X_{CC} R_1}{R_1 - j\, X_{CC}}}$$

Input admittance Calculations[2]

$$Y_{IN} = Y_F\,[(Y_o + g_m)/(Y_o + Y_F)]$$

where $Y_F = 1/Z_F$

$Y_o = 1/R_L + 1/r_p$

and g_m is the transconductance of the tube

$$Y_{IN} = \frac{1}{Z_F}\left[\frac{\frac{1}{R_L} + \frac{1}{r_p} + g_m}{\frac{1}{R_L} + \frac{1}{r_p} + \frac{1}{Z_F}}\right]$$

Frequency	Gain With Feedback	Voltage and Input Admittance at Amplifier Grid			
		E_G		Z_{IN}	C_{EQ} in μf
100	0.818	0.00143	33.8°	1,265–j1,890	0.813
500	0.827	0.00437	70.4°	1,310–j166	0.682
1,000	0.832	0.00788	78.6°	1,230–j247	0.643
5,000	0.888	0.0592	78.6°	1,880–j79	0.4
10,000	1.000	0.118	89°	1,880–j32	0.497

Input Impedance

Table I shows that the input impedance Z_{IN}, shown dotted in Fig. 3, can be represented by a resistor of approximately 1,500 ohms and a capacitor of approximately 0.5 μf across the pickup, forming a capacitance voltage divider with the capacitance of the crystal pickup (Fig. 3). This nullifies the effect of the crystal capacitance on the grid voltage when used in the normal manner. The output voltage of the feedback amplifier, then, is proportional to the velocity of the modulated groove, making the resultant pickup response equivalent to a magnetic pickup above the turnover point. The increasing variable capacitance with decreasing frequency below the turnover point also produces a constant voltage over this portion of the frequency range. These two effects produce a flat frequency response over the whole range.

The low impedance placed across the pickup also has the effect of damping out any natural resonance in the pickup, causing the needle to follow the groove without extra oscillation. The high damping has the effect of reducing surface noise by preventing the forced natural oscillation of the needle when an irregularity in the record groove has been struck.

In order to appreciate fully the high-fidelity results, a listening demonstration of the circuit is desirable. However, the frequency response must be adjusted by playing a calibrated test record, since an adjustment by ear alone, because of listening habits, will seldom give a flat frequency response.

It is possible to equalize almost any of the commercial permanent-sapphire-needle crystal pickups to a flat response over the frequency range of 50 to 10,000 cycles and have only a relatively small amount of noise present. The old model removable-needle types are more difficult to equalize and damp critically because of the increased inertia.

For a typical measure of the

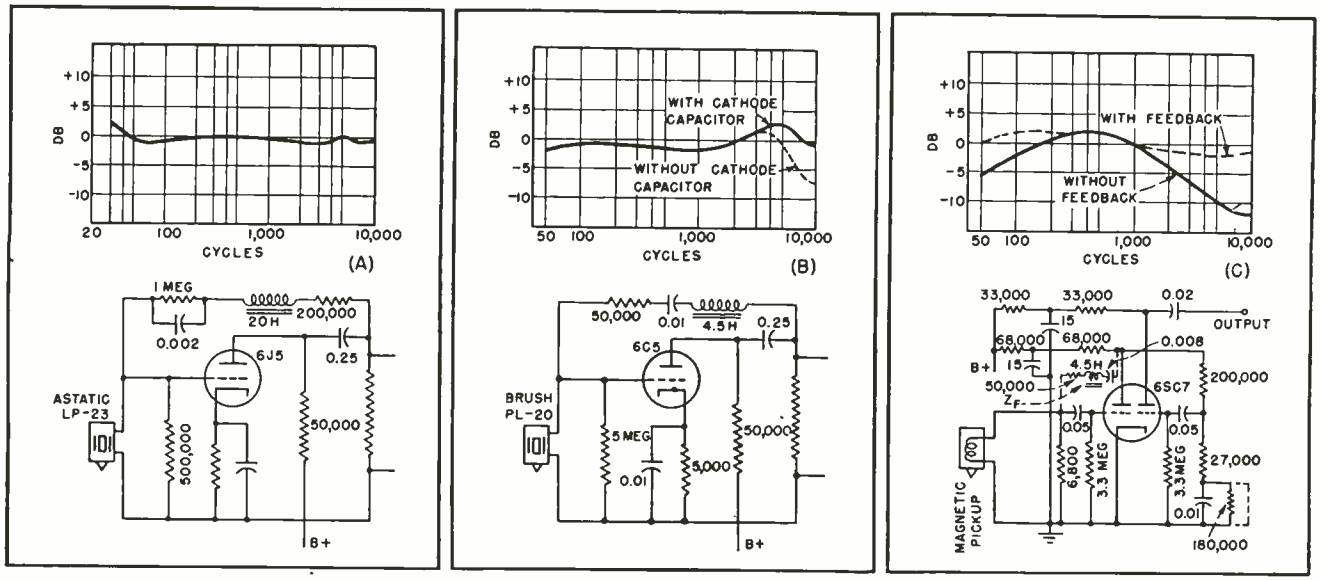

FIG. 4—Input circuits for several popular pickup types using feedback, with associated response curves

flexibility of feedback as an equalizer, the following experimental data are presented:

The original circuit as used with an Astatic HP-36 crystal phonograph pickup using the LP-23 cartridge is shown in Fig. 4A. The low-frequency boost can be removed by decreasing the value of the 1-megohm capacitor shunt in the feedback network. Fig. 4B shows a similar circuit used with a Brush PL-20 pickup. Both of these circuits, because of the relatively small amount of feedback, can be classed as selective feedback equalizers.

The effect of feedback on a magnetic pickup may be seen in Fig. 4C together with the GE phonograph preamplifier schematic diagram. The solid curve is the normal amplifier response with the GE pickup, while the dotted curve was obtained with the dotted feedback network connected and the 180,000-ohm resistor shorted.

The curves of Fig. 5 show that practically any shape of response curve may be obtained by a variation of the feedback network. The results shown in 5B were obtained with increased amounts of feedback and can be classed as equalization by control of input admittance.

If the new Astatic QT-j cartridge with removable sapphire needle is used the feedback resistance should be reduced as shown in Fig. 5C. The increased amount of feedback is necessary to remove the 3,000 to 5,000-cycle resonance peak introduced in the pickup to improve the normal frequency response of the cartridge. This boost is not desirable when feedback equalization is used. From these curves it can be seen that the frequency response of the circuit is essentially independent of pickup type or manufacturer, provided the internal capacitance of the pickups is low compared to the input capacitance of the tube circuit.

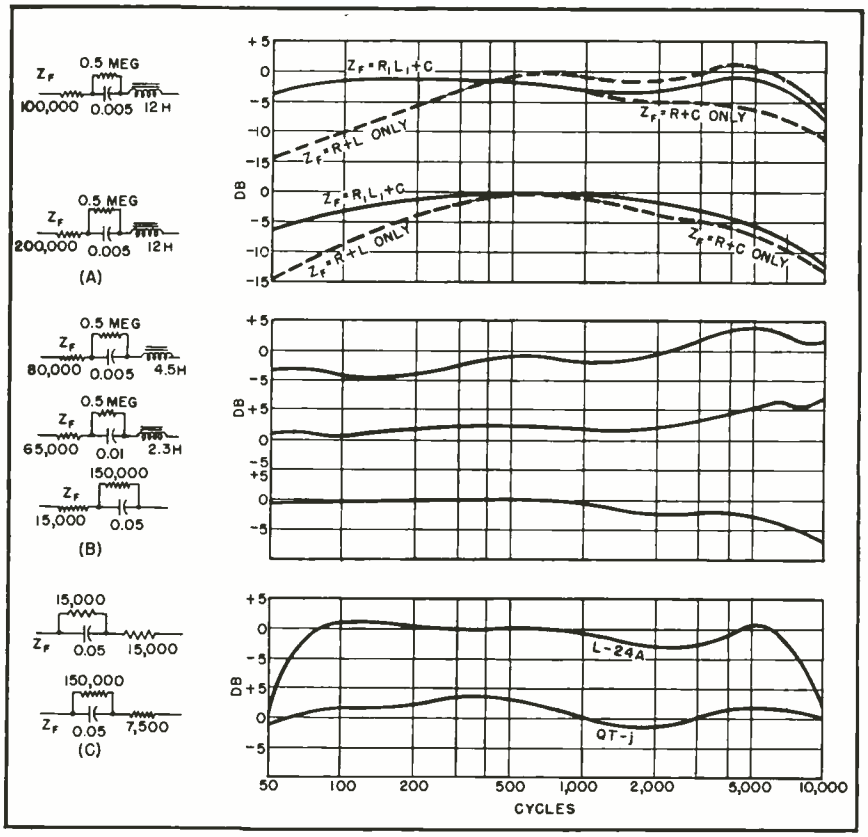

FIG. 5—Typical curves for different types of feedback networks, including one suitable for a magnetic pickup

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(2) R. I. Sarbacker and W. A. Edson, "Hyper and Ultra High Frequency Engineering," p 430, John Wiley & Sons, New York, 1943.

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VARIOUS nomographs, charts, and calculators are available for the calculation of the inductance of coils, but most of these graphical aids do not cover the range of values of interest to the designer of coils for television, f-m, and radar i-f frequencies. The accompanying nomograph has been designed to fulfill this need. Unlike other coil nomographs, it gives in one operation the number of close-wound turns required to get a desired inductance.

The nomograph is based on a modification of H. A. Wheeler's inductance formula[1]

$$L = \frac{r^2 n^2}{9r + 10l} \text{ microhenrys} \qquad (1)$$

where r is the radius of the coil in inches, l its length in inches, and n the number of turns. In close-wound coils, l is a function of n. Substitution of nd, where d is the diameter of the wire in inches, for l in Eq. 1 gives an equation which can be solved for n to give

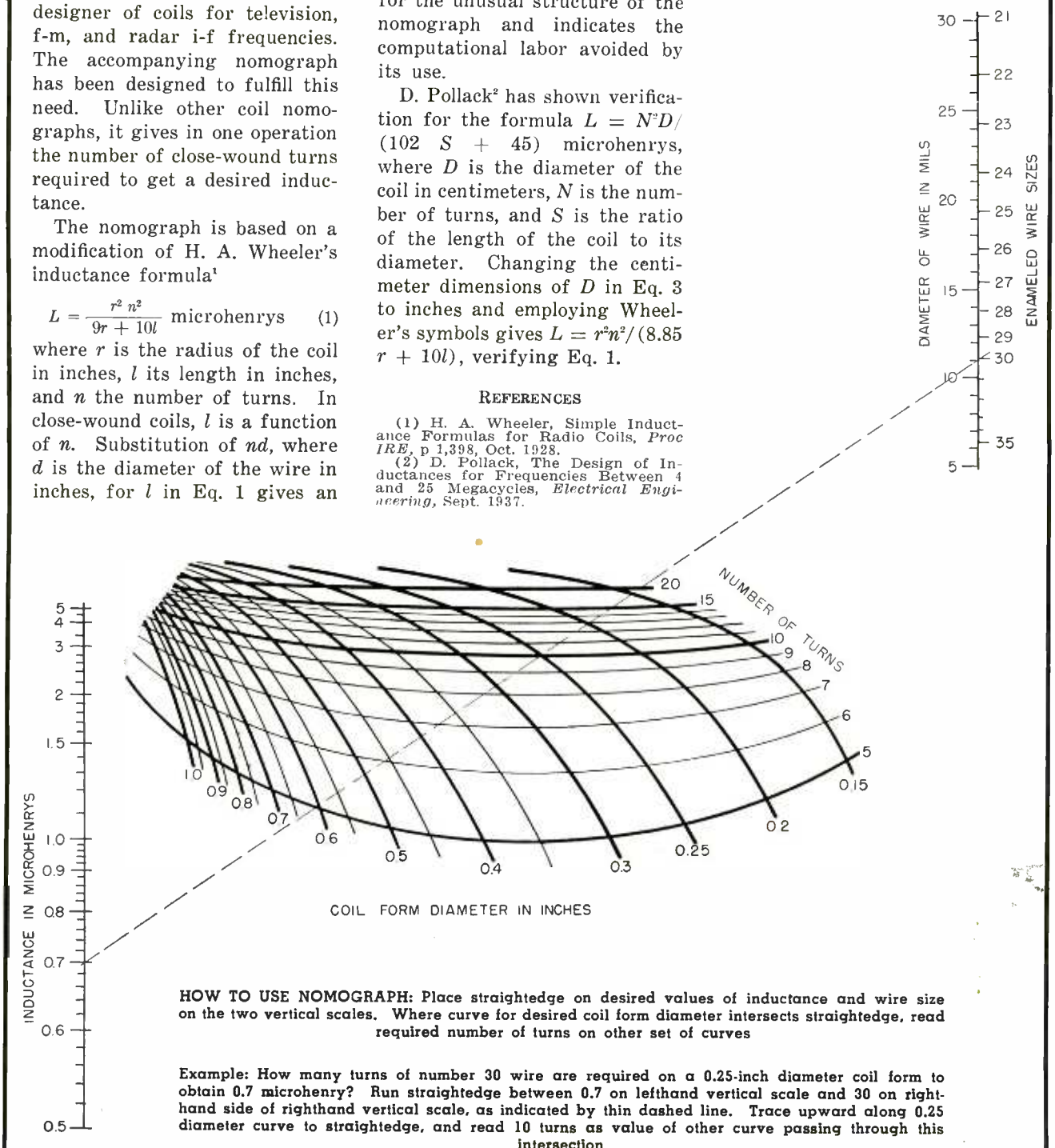
$$n = \frac{10dL + \sqrt{100d^2L^2 + 36r^3L}}{2r^2} \qquad (2)$$

The complexity of Eq. 2 accounts for the unusual structure of the nomograph and indicates the computational labor avoided by its use.

D. Pollack[2] has shown verification for the formula $L = N^2D/(102\ S + 45)$ microhenrys, where D is the diameter of the coil in centimeters, N is the number of turns, and S is the ratio of the length of the coil to its diameter. Changing the centimeter dimensions of D in Eq. 3 to inches and employing Wheeler's symbols gives $L = r^2n^2/(8.85\ r + 10l)$, verifying Eq. 1.

REFERENCES

(1) H. A. Wheeler, Simple Inductance Formulas for Radio Coils, *Proc IRE*, p 1,398, Oct. 1928.
(2) D. Pollack, The Design of Inductances for Frequencies Between 4 and 25 Megacycles, *Electrical Engineering*, Sept. 1937.



HOW TO USE NOMOGRAPH: Place straightedge on desired values of inductance and wire size on the two vertical scales. Where curve for desired coil form diameter intersects straightedge, read required number of turns on other set of curves

Example: How many turns of number 30 wire are required on a 0.25-inch diameter coil form to obtain 0.7 microhenry? Run straightedge between 0.7 on lefthand vertical scale and 30 on righthand side of righthand vertical scale, as indicated by thin dashed line. Trace upward along 0.25 diameter curve to straightedge, and read 10 turns as value of other curve passing through this intersection

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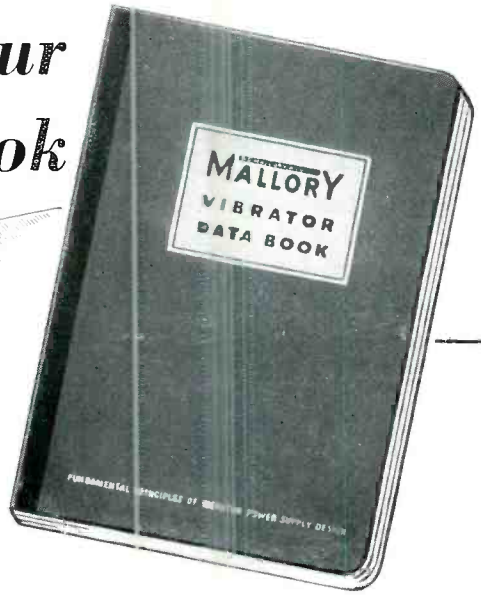

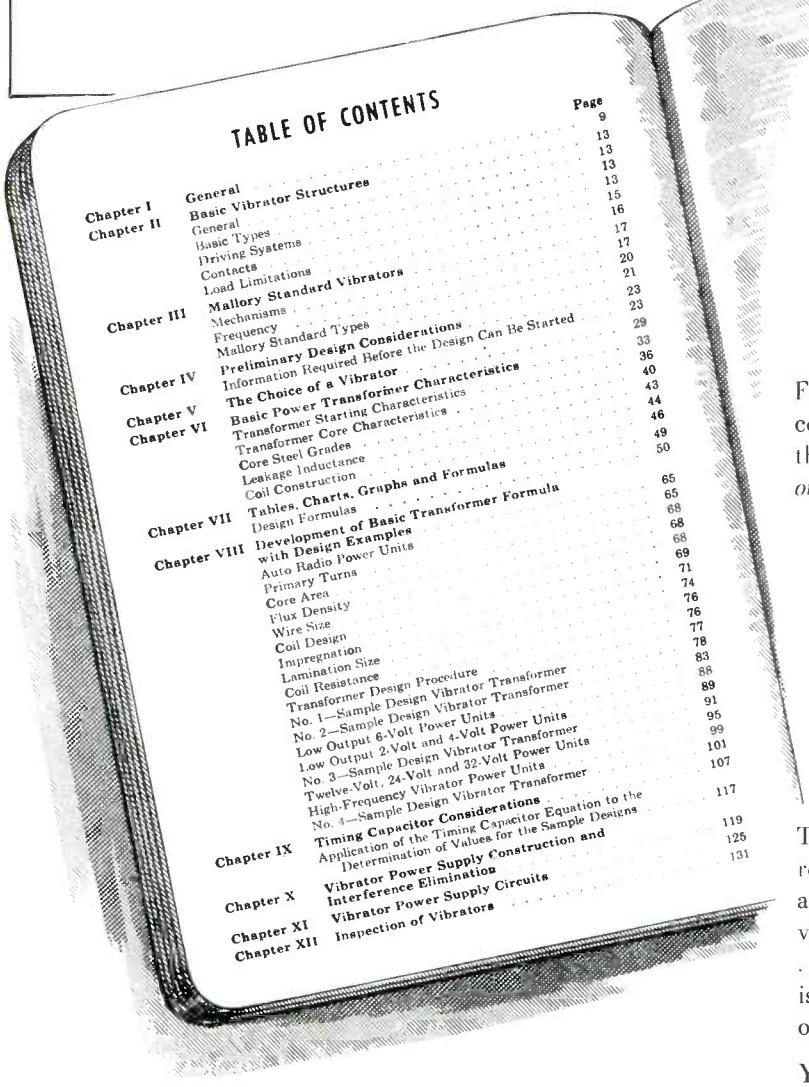

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TUBES AT WORK

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Edited by VIN ZELUFF

Two-Way Radio for Tractor Maintenance

By F. R. BREWSTER
McGraw-Hill World News London Bureau

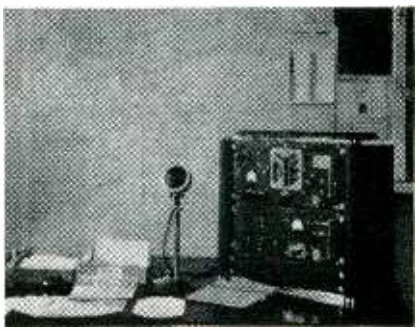
FARMERS in remote hill villages in Lanarkshire, Scotland, can have help sent to them by radio if they have trouble with their farm machinery or if they suddenly need new spare parts for their tractors.

Livewire Lanark engineer Daniel Ross has established his own radio station and a system of two-way radiotelephony between his headquarters and a fleet of five vans with which he services several hundred Ferguson tractors he has sold to farmers in the county.

To the road-licensing authorities one 14-hp van is DVD600, but to Ross and driver Bill Boyd, it is Ross Able (its sister vans are Ross Baker, Ross Charlie, Ross Dog and Ross Easy).

Inside the vans a panel below the dashboard holds the two-switch controls. Behind the driver's seat a case some eighteen inches square houses receiver and transmitter. Range of the equipment varies from 25 to 40 miles, according to local conditions. On routine monthly service checks of tractors on farms, the receiver is switched on, a green light showing under the dashboard, and the van is parked close to the tractor being serviced. This permits the driver-operator to hear calls that come through from headquarters.

Parking the repair car on the farmer's field alongside the tractor allows the mechanic to tinker and hear calls from headquarters



Headquarters station of the tractor-repair service

Control Station

Back at headquarters, ex-Wren Jessie Young moves counters about a map of Lanarkshire as the vans report their whereabouts, and decides which van is nearest to the farmer who needs help. It is much the same job Jessie did for Fleet Air Arm planes at Donnybristle during the war.

Without the two-way radio equipment, a farmer might lose a whole afternoon of precious time before a van could be contacted and sent to his rescue. With the chancy weather of southern Scotland that wasted afternoon might be serious.

"I reckon", said Mr. Ross, "that I save a gallon of petrol a day on every van. But that's not the important thing. What matters is that help gets to the farmers quickly. We are selling a system of completely mechanized farming; it's up to us to keep pace."

The radio telephones use amplitude modulation and are designed by the Telecommunications Division of Pye Ltd., Cambridge. The system incorporates at headquarters a 12-watt transmitter, crystal-controlled to operate on a single frequency around 80 megacycles, allotted to private users by the G.P.O. under international agreement, a vhf receiver and a vertical coaxial dipole aerial giving omnidirectional coverage.

In each service van there is a 12-

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CHATHAM 5594 THYRATRON

Xenon filled thyratron. Operates through ambient temperatures from —55° C to +90° C without auxiliary equipment to maintain bulb temperature. Fil. 2.5 volts, 5.0 amperes . . . Peak inverse 5000 volts; anode current 0.5 amps. average, 2.0 amps. peak.

CHATHAM 884 THYRATRON

An Argon filled thyratron for use as a sweep circuit oscillator in cathode ray tube circuits. Stable oscillator. Heater 6.3 volts, 0.6 amp. . . . Peak forward plate voltage 300 volts, 75 ma. average plate current.

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A cold cathode glow discharge tube designed for voltage stability. D.C. operating voltage 82 volts —operating current range 1 to 2 mAdc.

CHATHAM 4B32 RECTIFIER

A rugged half wave Xenon filled rectifier. Operates in any position throughout an ambient temperature range of —75° C to +90° C Fil. 5 volts, 7.5 amp. . . . Inverse peak anode voltage 10,000 volts, 1.25 amp. average anode current.

CHATHAM 866-A RECTIFIER

A rugged half wave Mercury Vapor rectifier to withstand high peak inverse voltages. Heavy duty filament. Fil. 2.5 volts, 5.0 amp. . . . Peak inverse anode voltage 10,000 volts, .25 amp. average anode current.

CHATHAM 1B3GT RECTIFIER

High voltage vacuum rectifier for Television and similar applications. Low filament power permits efficient operation from R.F. supply. Filament 1.25 volts, 200 ma. . . . Inverse peak plate voltage 30,000 volts, 2 ma average plate current, 17 ma. maximum plate current.

CHATHAM 3B28 RECTIFIER

This rugged half wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of —75° C to +90° C Fil. 2.5 volts, 5.0 amp. . . . Inverse peak anode voltage 10,000 volts, .25 amp. average anode current.

CHATHAM 1Z2 RECTIFIER

A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Fil. 1.5 volts, .290 amp. . . . Inverse peak plate voltage 20,000 volts, 2 ma. average plate current, 10 ma. peak plate current.

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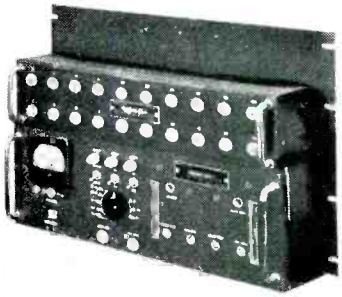

• Pulse life test equipment built by CHATHAM checks receiver type tubes under pulse operating conditions.

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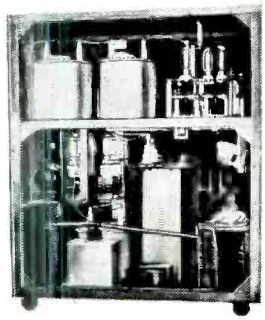

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THE FRONT COVER

BOTH ends of the conical metal shell of 16 and 19-inch cathode-ray tubes for television receivers can be sealed by high-frequency induction-heating equipment. The accompanying photograph shows the setup employed in sealing the glass face to the metal shell. A single-turn coil is mounted around the joint to be made and fed with energy from the 40-kilowatt Scientific Electric electronic generator in the background. This heats the outer edge of the metal cone sufficiently to melt the glass in contact with it and form the seal. The tube assembly is rotated throughout the heating and sealing time to provide a uniform seal. To prevent the glass disk from dropping into the cone when the glass melts, air at low pressure is supplied to the inside of the tube assembly. After removal from the heating jig, the tube is cooled slowly at room temperature.

In sealing the glass neck of the tube to the metal wall, as illustrated on the front cover, rotation is also used but the molten joint is alternately stretched and compressed a few times just as in conventional glassblowing, without use of air pressure.

watt crystal-controlled transmitter, matching receiver, audio amplifier, and power-supply unit, mounted together in a shock-absorbing cradle behind the driver's seat, and a control unit mounted under the dashboard comprising a five-position switch controlling the radio and a three-position volume control switch, a moving-coil microphone with a press-to-talk switch, and a quarter-wavelength tuned aerial of flexible steel rod.

Cost

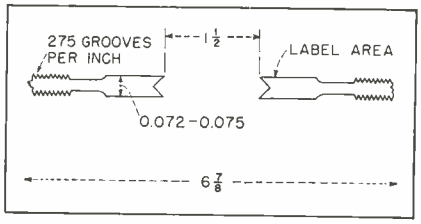
The bill for the fixed station was 180 pounds; equipment for each of the vans 140 pounds. License fee charged by the G.P.O. is 5 pounds a year for each station, whether fixed or mobile, plus an additional 5 pounds for the overall operation. Total license fees for the headquarters station and five vans, 35 pounds ($140).

Mr. Ross believes he is the first to use two-way radiotelephone equipment for directing tractor-servicing operations. Licenses for private commercial operation have been issued only during the past 18 months or two years; some 150 licenses have been granted. About half of these users are public utility firms; the other half are largely made up of car-hire operators and other commercial users.

New Record Design

SIMPLIFICATION of record-changer design is achieved by RCA Victor with the introduction of a new type of record having a 1½-inch spindle hole. This permits the extremely fast changing mechanism to be built right into the center post.

Construction of the new 6⅞-inch record is illustrated in the accompanying cross-section drawing. The overall diameter is 6⅞ inches but the thickness is not uniform; a



Construction details of 45-rpm record

collar is created around the label area, which is thicker than the playing area. Thus an air space between adjacent records in a stack is provided so that the playing surfaces do not touch.

An indentation is provided on the record where it touches the center post to fit the knives of the center-post changer mechanism. The records are formed of vinyl plastic and rotate at 45 rpm. At this speed, the maximum playing time is five minutes and five seconds. The recommended needle tip radius is 0.001 inch, groove width is 0.0025 to 0.003 inch and recommended tracking weight is 5 grams.

The associated record player contains a 1½-inch-wide red plastic-topped center post which houses the

(continued on p 140)

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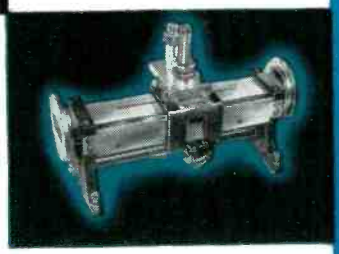

Impedance Meter

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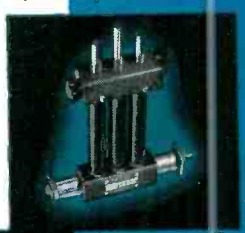
■ Sperry with its long experience and knowledge in microwave techniques has developed virtually every instrument essential to this phase of electronics. The Microline instruments shown here are only a few of the several hundred which are available. Our nearest district office will be glad to give you additional information on Microline instruments and how they apply to your individual requirements.

Triple-Stub Transformer



Detector Wave Meter

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THE ELECTRON ART

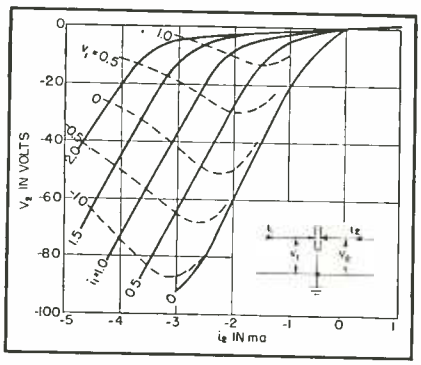
Edited by FRANK H. ROCKETT

Coaxial Transistor

DEVELOPMENT of a semiconductor amplifier using two point contacts pressing against opposite sides of a germanium disk was announced by W. E. Kock and R. L. Wallace, Jr. of Bell Telephone Laboratories, Inc. at the AIEE Winter Convention in New York City. The germanium disk has a spherical depression ground and lapped into either or both faces to give a spacing of only a few thousandths of an inch between coaxially mounted contacts.

Amplification of the coaxial transistor compares favorably with that of the conventional semiconductor triode having both points on the same germanium face. Advantages of the new construction are improved mechanical stability of the points since they rest in depressions, complete electrostatic shielding between the input and output circuits, and elimination of construction problems involved in placing two spring contacts side by side within a few thousandths of an inch.

Principle of operation is identical with that of the wedge-shaped transistor devised by J. N. Shive of



Direct-current amplifying characteristics of typical sample of new coaxial transistor. These curves compare moderately well with those of a unit having both points on the same side of the germanium

Bell Laboratories, wherein amplification is obtained with contact points on opposite sides of a germanium wedge that is a few thousandths of an inch thick at the location of the contacts. The geometry of the wedge transistor is reproduced in circularly symmetrical form in the coaxial transistor. The current amplification process in both cases is apparently occurring within the semiconductor and not at the surfaces.

Since high polish of the active surfaces of germanium permits passage of higher currents before burnout occurs, the spherical depressions in the 20-mil-thick, $\frac{1}{8}$-inch diameter germanium blank are lapped with diamond lapping compound and electropolished after initial grinding. Where maximum current capacity is not required, the conventional procedure of etching and electrically forming the collector point by passing large currents in the reverse direction yields quite satisfactory results. Amplifier action occurs also with the depression in only one face.

High-Frequency Impedance Plotter

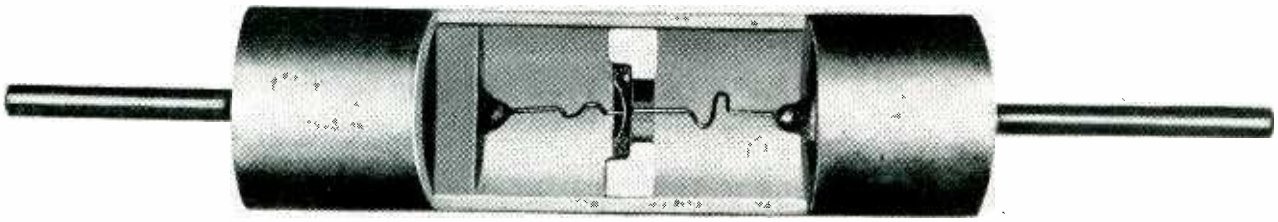
By RICHARD C. RAYMOND and CARL E. DRUMHELLER

Department of Physics
The Pennsylvania State College
State College, Pa.

A HIGH-FREQUENCY impedance-measuring system consisting of a circular slotted line that is scanned rapidly by a probe, an oscilloscope and a mechanical computer has been developed. It is fairly accurate for standing wave ratios less than 4 to 1 and covers a range from 140 to 1,200 mc. For rapid surveys in which accuracy is not important at large standing wave ratios but in which it is necessary to make many measurements, this equipment reduces the labor.

Basis of Operation

To reduce the measurements to the magnitude and phase angle of the impedance being studied, the standing wave is presented on an oscilloscope and then transferred to



Cutaway view of coaxial transistor as designed for moderate quantity production. The germanium disk positioned between the contact points has a depression on only one face here; grinding of both faces gives added mechanical stability

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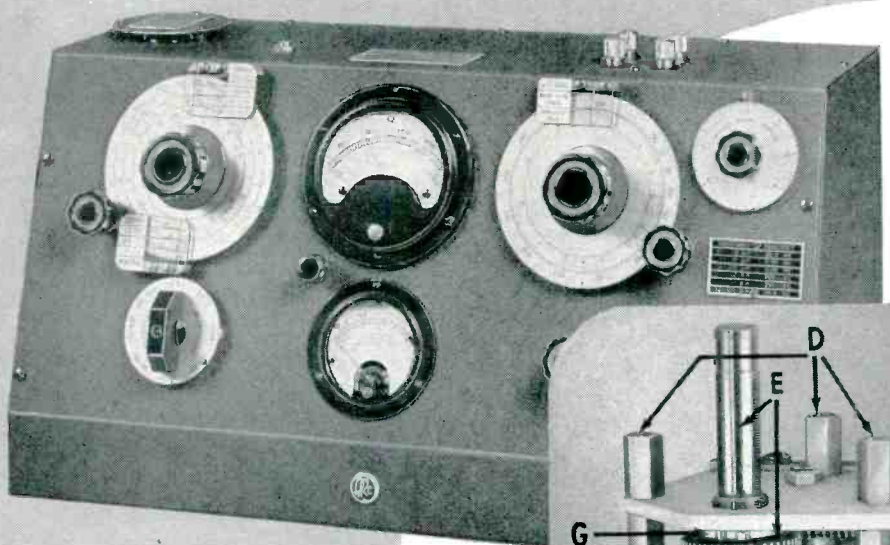
Q, INDUCTANCE and CAPACITANCE



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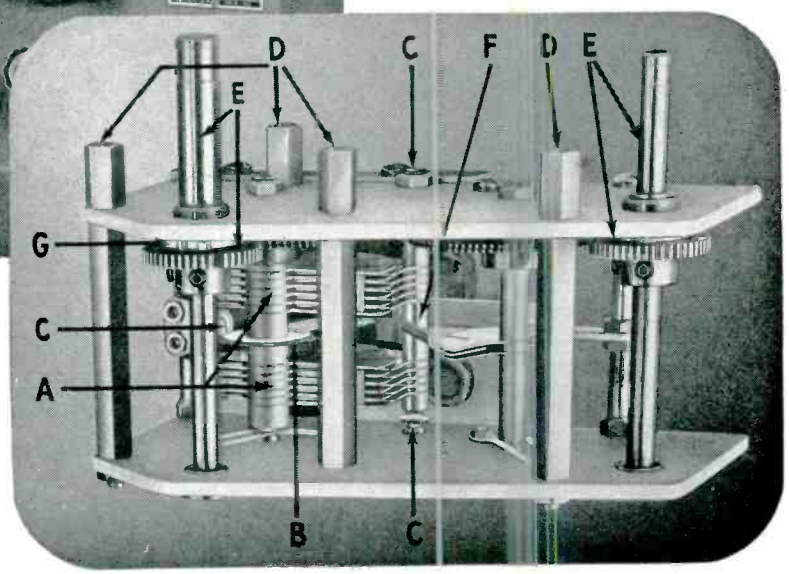
50 KC. to 75 MC.



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"

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.

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

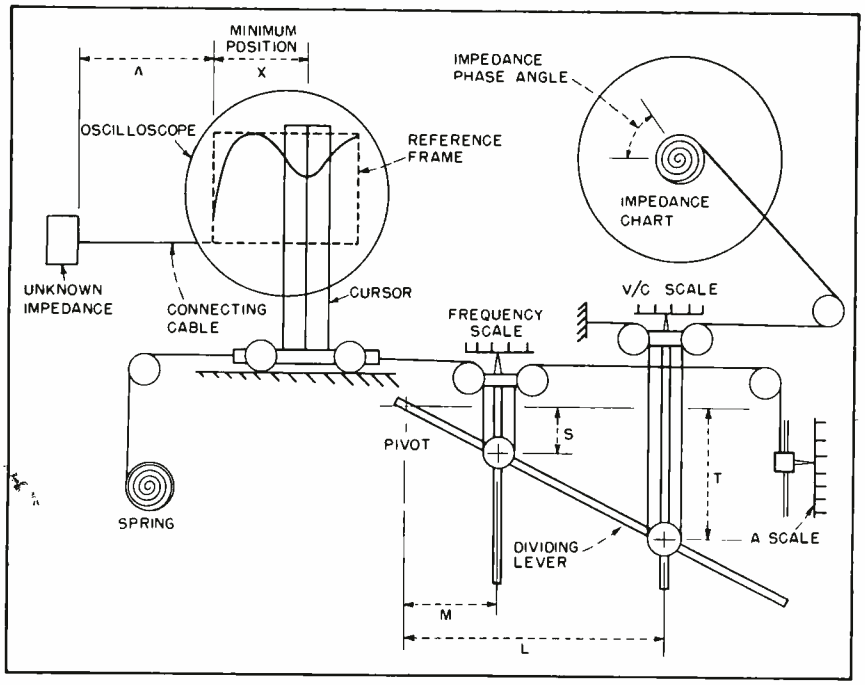


FIG. 1—Mechanical computer transfers position of minimum of standing wave ratio pattern traced on c-r tube to phase angle of unknown impedance on Smith chart

a circular impedance chart by the cord-and-linkage computer of Fig. 1. The trace on the oscilloscope is obtained as shown in Fig. 2, showing second portion of the computer.

An oscillator feeds a circular slotted line through an impedance matcher. The slotted line is a section of a coaxial line formed in a circle of 11-inch mean diameter, made by turning grooves in two brass discs. The center conductor of copper wire is supported in a polystyrene ring milled to accept it and with a slot for the probe. At one end the line smoothly joins a straight section terminating in a coaxial fitting. The other end of the line is brought through the back cover. Because the line is proportioned to have the same characteristic impedance and diameter as the cable with which it is used, tapers are unnecessary.

Measurement and computation of impedance at very high frequencies are simplified with this mechanical plotter used with an oscilloscope.

This circular construction of the slotted line enables the probe to be moved continuously around it. The varying r-f current thus picked up is fed through a detector to a balanced amplifier that is flat from 30 cps (the frequency with which the probe travels around the line) to about 100 cps to a 12-inch cathode-ray tube, which gives a useful swr plot 6 by 8 inches. The vertical amplifier must have sufficient sensitivity to produce full-scale deflection with inputs of the order of 100 microvolts. The linear sweep circuit is synchronized with the rotating probe. The trace on the crt is then the squared swr as a function of position along the line. This is the same information that would be obtained on a manually-operated slotted line, and the load impedance could be obtained from it by the same computations. However, it is simpler to use a mechanical computer.

Phase Angle and Magnitude

There are two computations necessary. These are performed by two motions for plotting a point on the impedance chart: (1) a rotation of the chart corresponding to a measured line distance in half wavelengths and (2) a radial motion corresponding to a standing wave ratio. The first computation is accomplished by the mechanism of Fig. 1, the second by that of Fig. 2.

The standing-wave pattern on the oscilloscope is adjusted to a reference frame using the centering and gain controls. When the detector probe passes through the short space in the circular line between the input and output connectors, there is no signal, thus a zero reference is established as shown in the lower left-hand corner of the oscilloscope (Fig. 1) to which the reference frame is positioned. To determine the angle of rotation of the impedance chart, the distance from the unknown impedance to the current-minimum shown on the oscilloscope must be found. If a connecting cable is used between the unknown impedance and the slotted line, its electrical length must be considered. This is done by the *A* scale, which is calibrated at the oscilloscope in terms of equivalent length of the cable. The elements of the dividing lever are then set to the proper positions on their scales, one for operating frequency, the other for the relative velocity on the wave in the slotted line. The lever is then moved so that the vertical cursor intersects the swr pattern at its minimum. With the computer built to the proper dimensions for the particular parameters used in the setup (velocity of propagation in the slotted line, circumference of chart driving drum and so forth), the chart is rotated to show the proper phase angle.

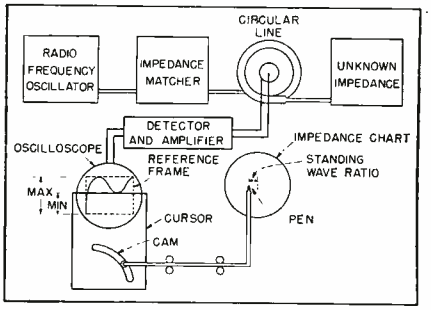


FIG. 2—Standing wave ratio, obtained from circular slotted line, is displayed on oscilloscope, then transferred to impedance chart to give value of unknown impedance

The magnitude of the unknown

(continued on p 166)

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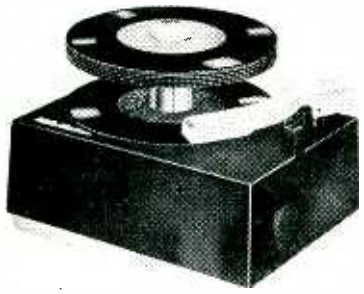
Edited by A. A. McKENZIE

New Record Player

RADIO CORP. OF AMERICA, Camden, N. J. A new record player operating at 45 rpm uses records 6⅞ inches in diameter that play for approximately 5 minutes. A record has 275 grooves per inch with



width varying between 0.0025 and 0.003 inch. The playing needle with a 1-mil tip tracks at 5 milligrams pressure. Owing to the geometry of the discs, a simple but effective changer is possible.

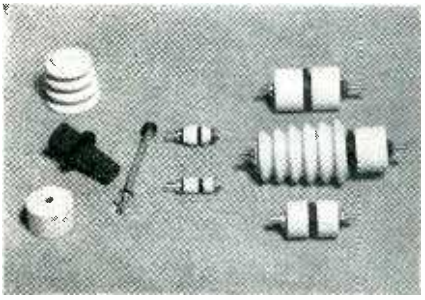
Slotted Line

HEWLETT-PACKARD Co., 395 Page Mill Road, Palo Alto, Calif. Type 805A slotted line substitutes two parallel planes and a rigid central circular conductor for the conventional coaxial arrangement. Slot

opening is less than 0.001 inch, keeping leakage low. Residual vswr can be held to less than 1.04. Frequency range for the new slotted line is 500 to 4,000 mc and characteristic impedance is 50 ohms.

Hermetic Bushings

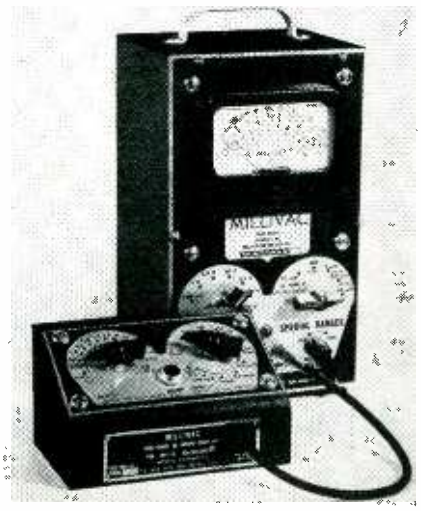
LUNDEY ASSOCIATES, 694 Main St., Waltham, Mass., has available a



new line of steatite-neoprene compression type terminals designed for use in hermetically sealed transformers and capacitors and other electronic equipment where relatively high voltages are involved.

Micromicroammeter

MILLIVAC INSTRUMENTS, Box 3027, New Haven, Conn. Type MV-171 d-c micromicroammeter comprises the type model MV 17A meter and MV-171 shunt box. Current meas-



urements in the range from 10 micromicroamperes and 10 amperes are possible. Time constant is 0.3 second, resulting in practically instantaneous readings. Details are given in bulletin II-121.

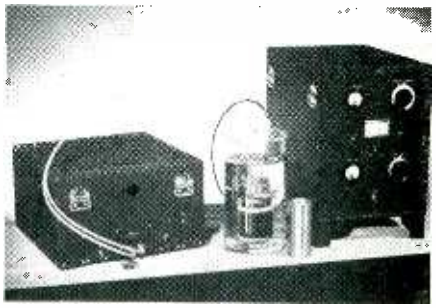
Pantograph Engraver

MICO INSTRUMENT Co., 80 Trowbridge St., Cambridge 38, Mass. Type 252 pantograph engraving machine can be used to make small

dies and molds for plastics, rubber, glass, die castings, and templates. Three-dimensional milling is accomplished by tracing the shape of an enlarged master with the stylus. A micrometer depth control graduated in thousandths of an inch of feed, has a range of 0.25 in.

Ultrasonic Generators

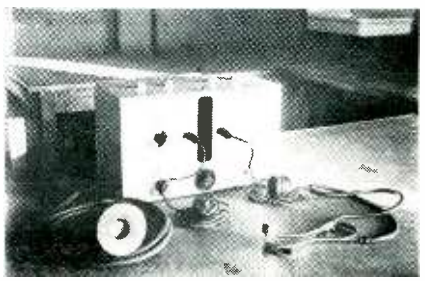
CENTRAL SCIENTIFIC Co., 1700 Irving Park Road, Chicago, Ill. Two new ultrasonic generators are now



available for research and laboratory work. Type U-300 Ultrason delivers 300 watts of sound energy to an oil bath. Model 100 delivers 6 watts. Both operate at 450 kc.

Polystethoscope

C. CURIE, 2 rue Idrac, Toulouse (Hte-Gne), France. The electronic stethoscope illustrated permits a group of students to listen simultaneously to the auscultation of a



Developed for the Thermionics Branch of Evans Signal Laboratory

This Filamentary Subminiature Type 1AD4, has comparable Gm (2000 umhos) to the Type 6SX7GT at only one-fifteenth of the A power, one-tenth of the B power and less than half of the B voltage.

This Subminiature Heptode Mixer, Type 1AE5, using separate oscillator, has higher conversion transconductance than any other Filamentary Subminiature Mixer.

ADD THESE TO THE LIST OF SMALL SIZE, BIG PERFORMANCE

RAYTHEON SUBMINIATURE TUBES

Standard Throughout the World for 10 Years

Raytheon Filamentary Subminiatures *improve product salability* . . . reduce size . . . are flat shaped . . . permit small batteries because filament drain is extremely low . . . *fit standard sockets* or can be soldered or welded into the circuit . . . are *quickly available from stock*, over half a million on hand at all times . . . are *standard throughout the world*, more in use than all other makes combined. Application recommendations are backed by unsurpassed production and engineering experience and resources.

→ NEW TYPES

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	Typical Operating Conditions: Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	9.5	120	2.5	−2.0
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			−2.0
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			−2.0
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
FILAMENT TYPES												
→ 1AD4	Shielded RF Pentode — High Gm	0.300x0.400	1.5	1.25	100	2000		45.0	8.0	45.0	0.8	0
→ 1AE5	Heptode Mixer	0.300x0.400	1.5	1.25	60	200 conv. cond.		45.0	0.9	45.0	2.0	0
2E31-32	RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	0
2E35-36	Output Pentode for pocket radio	0.290x0.390	1.56	1.25	30	385	1.2	22.5	0.27	22.5	0.07	0
2E41-42	Diode Pentode for pocket radio	0.290x0.390	1.56	1.25	30	375		22.5	0.35	22.5	0.12	0
2G21-22	Triode Heptode for pocket radio	0.300x0.400	1.56	1.25	50	75 conv. cond.		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK502AX	Output Pentode	0.285x0.385	1.5	1.25	30	550	6.0	45.0	0.6	45.0	0.15	−1.25
CK503AX	Output Pentode	0.285x0.385	1.5	1.25	30	550	9.5	45.0	0.8	45.0	0.25	−2.0
CK505AX	Voltage Amp. Pent.	0.285x0.385	1.5	0.625	30	381		22.5	0.125	22.5	0.04	−0.625
CK506AX	Output Pentode	0.285x0.385	1.5	1.25	50		25.0	45.0	1.25	45.0	0.40	−4.5
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.400	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK522AX	Output Pentode 20 ma. filament	0.285x0.385	1.5	1.25	20	450	1.2	22.5	0.30	22.5	0.08	0
CK523AX	Output Pentode	0.285x0.385	1.5	1.25	30	360	2.5	22.5	0.30	22.5	0.075	−1.2
CK524AX	Output Pentode	0.285x0.385	1.5	1.25	30	300	2.2	15.0	0.45	15.0	0.125	−1.75
CK525AX	Output Pentode	0.285x0.385	1.5	1.25	20	325	2.2	22.5	0.25	22.5	0.06	−1.2
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	−1.5
CK527AX	Output Pentode 15 ma. filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.290x0.390	1.5	1.25	20	275	1.2	15.0	0.20	15.0	0.05	−1.5
CK533AX	Output Pentode	0.285x0.385	1.5	1.25	15	425	2.0	22.5	0.4	22.5	0.1	0
CK535AX	Output Pentode	0.285x0.385	1.5	1.25	20	275	1.2	15.0	0.20	15.0	0.05	−1.5
CK551AXA	Diode Pentode	0.300x0.400	1.56	1.25	30	235		22.5	0.17	22.5	0.043	0
CK553AXA	RF Pentode	0.300x0.400	1.56	1.25	50	550		22.5	0.42	22.5	0.13	0
CK571AX	10 ma. Filament electrometer tube, Ig = 2x10⁻¹⁵ amps.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20			−3.0
CK573AX	Triode, high frequency output	0.300x0.400	1.5	1.25	200	2000		135	14.0			−7.5
CK574AX	Shielded Pentode RF Amplifier	0.290x0.390	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	625	60.0	67.5	2.75	67.5	1.1	−6.25
CK5676/CK556AX	Triode, UHF Oscillator for radio use	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator for radio use	0.300x0.400	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	RF Pentode	0.300x0.400	1.5	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5x10⁻¹³ amps.	0.285x0.400	1.25	0.625	20	1.5†		12	0.22			−3.0
CK5785	High voltage rectifier	0.285x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.63	Operating voltage 85. Operating current range 5 to 35 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ℞ RK ℞

†Voltage Gain (times)

NEW — Write for Socket and Mounting Notes for Flat Press Subminiature Tubes.

RAYTHEON MANUFACTURING COMPANY
SPECIAL TUBE SECTION
Newton 58, Massachusetts

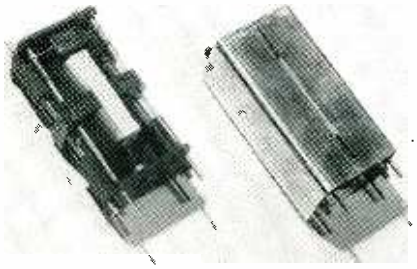
RADIO RECEIVING TUBES • SUBMINIATURE TUBES • SPECIAL PURPOSE TUBES • MICROWAVE TUBES

RAYTHEON *Excellence in Electronics*

sickness without additional discomfort to the patient. The device has been in use by groups of about ten students, but many more could be served by the same amplifier.

Special I-F

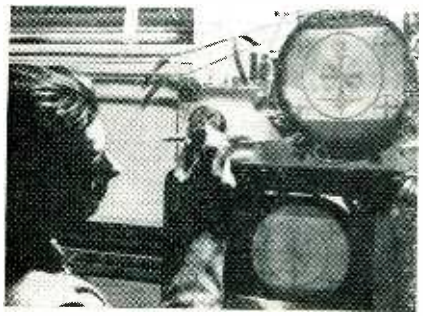
HAMMARLUND MANUFACTURING CO., 460 West 34th St., New York 1, N. Y. Type SS-50 is a double per-



meability tuned i-f transformer for use in the region of 50 kc. A single i-f stage using two of the transformers gives attenuations ranging from 6 db at 0.8-kc bandwidth down to 60 db at 5.0-kc bandwidth.

New Television Tube

GENERAL ELECTRIC CO., Syracuse, N. Y. A new television picture tube with a diameter of 8½ inches will give a fifty-percent increase in picture size to small set owners at no



appreciable extra cost. A metal type using magnetic focusing and deflection, the new tube will get into production during 1949. Samples will be available soon.

Dual-Channel Oscilloscope

ELECTRONIC TUBE CORP., 1200 East Mermaid Lane, Philadelphia 18, Pa. Model H-2GTC oscilloscope is a laboratory instrument for registering two separate phenomena ranging from d-c to 1 megacycle. To provide greatest flexibility, the deflection amplifiers are designed as

removable units. Tube furnished is the dual-gun 5SP1, although type 5SP11 for photographic applications can be substituted.

Signal Generator

AIRCRAFT RADIO CORP., Boonton, N. J. Type H-12 signal generator covers the frequency range from 900 to 2100 megacycles. It can be

operated as a calibrated source of continuous-wave r-f energy or as an amplitude pulsed r-f source. It is the commercial equivalent of the military TS-419/U illustrated.

Educational Broadcasting

RADIO ENGINEERING LABORATORIES, 35–54 36th St., Long Island City, N. Y. Model 706 10-watt transmitter using the Serrasoid modulator

can be used on any single frequency in the f-m broadcast band, or employed as a driver for high-power stages. It has been particularly designed for broadcasting by schools and colleges within a limited service area. Total weight is 90 pounds and cost is $1,595.

Matching Transformer

THE WORKSHOP ASSOCIATES, INC., 66 Needham St., Newton Highlands, Mass. The T-72 broad-band impedance-matching transformer is designed for use at frequencies of

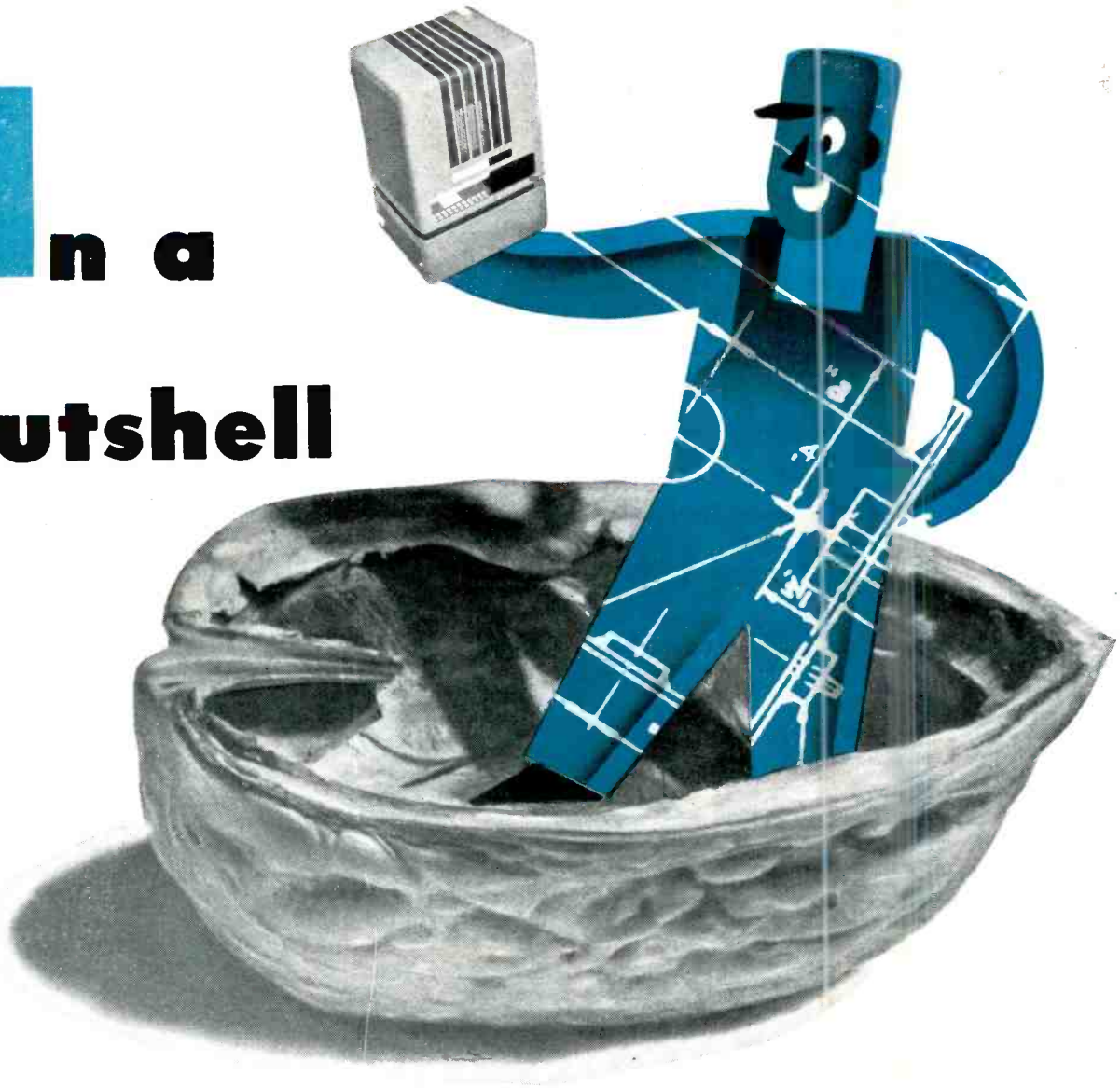
50 to 225 mc. It consists of an r-f transformer with a specially designed polyiron core, mounted in a small aluminum container. At one end is mounted a standard miniature connector for attachment to 72-ohm unbalanced coaxial line. Out of the side a 6-inch piece of 300-ohm balanced line is provided.

Microwave Signal Generator

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. A broadband microwave signal generator covering the frequency range from 4,200 to 10,300 mc includes a direct reading frequency meter and a variable attenuator calibrated directly in db below 1 milliwatt. Provision is

(Continued on p 191)

In a nutshell



. . . . the Karp story is this:

We're a group of sheet metal fabrication specialists with almost 25 years' experience in our craft.

We believe we have some of the most ingenious men in the industry—especially in our engineering department and among our skilled craftsmen.

We have 70,000 square feet of ultra-modern plant, with every up-to-date aid in the way of tools and machinery.

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KARP METAL PRODUCTS CO., INC.

215-63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

East-Midwest Television Network Opened

A COAXIAL cable link between Philadelphia and Cleveland via Pittsburgh was placed in operation Jan. 12, 1949 to unite the Bell System eastern and midwestern television networks. The combined network now covers an area where one-fourth of the nation's population lives. It extends over 2,100 miles, of which 1,740 route miles are coaxial cable and 370 route miles are radio relay. Cities now served by cable are New York, Philadelphia, Baltimore, Washington, Richmond, Pittsburgh, Cleveland, Buffalo, Toledo, Chicago and St. Louis. Radio relay is used between New York and Boston, Toledo and Detroit, and Chicago and Milwaukee.

The Bell System network now uses 540 booster amplifiers along the cable to maintain the energy of the television signal as it travels from city to city. Some 250 additional amplifying devices in the television terminals in telephone buildings in each city on the network are used to put the broadcasters' programs on the channels.

In addition to intercity television facilities the Bell System, through its associated companies, also provides broadcasters with television channels between local pickup points and their studios, between the studios and the broadcasting transmitters and between the studios and their networks.

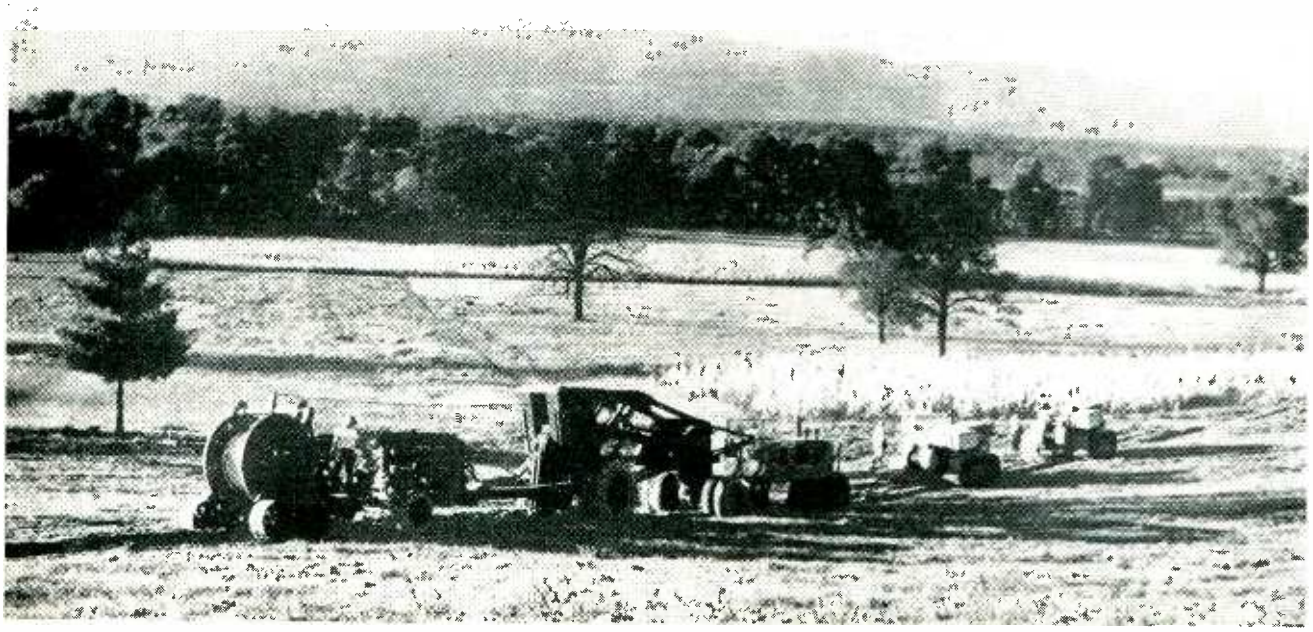
Worker makes a splice on a section of the coax cable between Pittsburgh and Cleveland, part of the link joining the Bell System's eastern and midwestern television networks. Splices are made in a temporary pit dug into the ground to the level at which the cable is placed by the plow

Plans for the expansion of these networks depend on the development of the television industry. More television channels, both radio relay and coaxial cable, are planned along the existing main routes of the Bell System television networks and extension will also be provided from the present networks to additional cities.

New Advances in Printed Circuits

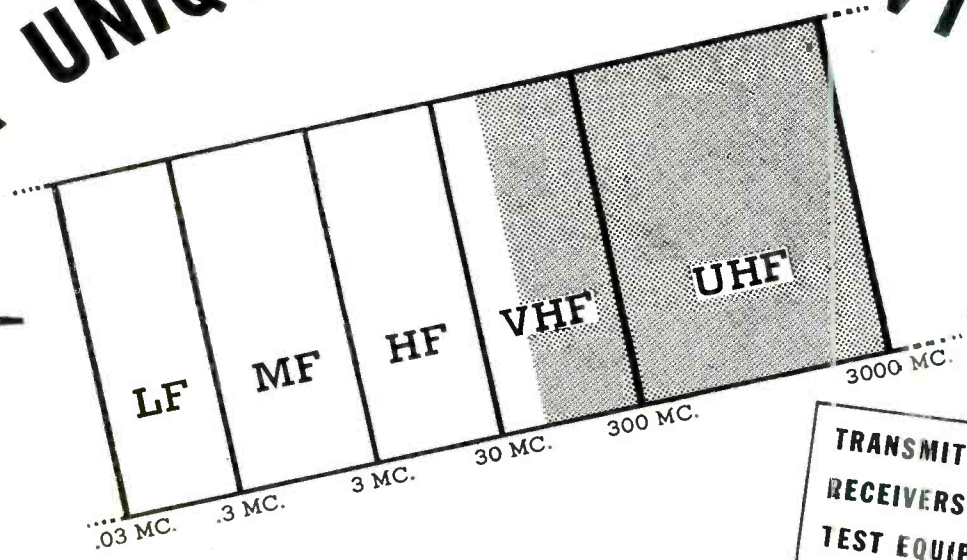
THE PROCEEDINGS of the Printed Circuit Symposium held last October by the Aeronautical Board's Aircraft Radio and Electronics Committee, under the supervision of the National Bureau of Standards, have been published in a 73-page booklet designated as "New Advances in Printed Circuits." This NBS Miscellaneous Publication M 192 is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C., at 40 cents (cash only) per copy.

Topics covered, as presented by representatives of industry and government laboratories, include the status of printed circuits; conductive silver preparations; printed resistors; trends in military communication; vitreous-enamel dielectric products; printed electronic



A 27-ton giant cable plow rolls along the route of the expanding network. Just behind the plow, the cable may be seen entering the slotted plowshare

A UNIQUE UHF SERVICE



LAVOIE LABORATORIES offer you a unique service in that we *specialize* in the development, design and production of U.H.F. equipment.

Our Engineering Department as well as our shops and shop methods, are geared to U.H.F. production, assuring CORRECT design, PRECISION work and LOW UNIT cost.

We are prepared to collaborate on *every phase* of U.H.F. work—in the confidential development of new ideas or the re-design of old products. A few, typical, completely-developed LAVOIE products are listed at the right.

If you will address us on your letterhead, we shall be glad to send you a resume of LAVOIE U.H.F. facilities.

- TRANSMITTERS
- RECEIVERS
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- OSCILLOSCOPES
- ELECTROMYOGRAPHS
- PULSE GENERATORS
- RADAR RECEIVERS
- UHF RADIO SETS
- SIGNAL GENERATORS
- WAVEMETERS
- HARMONIC GENERATORS
- FREQUENCY STANDARDS
- PRECISION EQUIPMENT
- ANTENNAS and MOUNTS
- UHF EQUIPMENT
- ELECTRONIC PRODUCTS
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- FREQUENCY METERS
- VIDEO AMPLIFIERS
- FIXED FREQUENCY RECEIVERS

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components on glass, plastic and other nonconductors; imprinted circuit inlays; spraying techniques; mechanization of electrical wiring; die-stamped wiring; typical commercial applications. The booklet also summarizes the present status of this art and includes discussions of technical questions raised at the symposium.

IRE Convention Program

TWENTY-SEVEN technical sessions and six symposia will be featured at the 1949 convention of the IRE at the Hotel Commodore and Grand Central Palace, New York City, March 7 to 10. A total of 143 papers will be delivered at the sessions, on subjects embracing virtually the entire radio-electronic art; symposia will cover nuclear science, network theory, electronic computers, radio aids to navigation, semiconductors and marketing. No more than five sessions will run concurrently.

On March 8, B. E. Shackelford, past-president of the IRE, will be toastmaster at the president's luncheon to introduce incoming president Stuart L. Bailey. Toastmaster at the annual banquet on March 9 will be Raymond F. Guy of NBC.

Technical program is as follows:

Monday P. M., March 7

Systems I—Modulation Systems

Development of a High Speed Communication System, by Donald S. Bond.

Distortion in a Pulse-Count-Modulation System with Nonuniform Spacing of Levels, by P. F. Panter and W. Dite.

Cross-Talk Considerations in Time-Division Multiplex, by S. Moskowitz, L. Diven, and L. Feit.

Experimental Verification of Various Systems of Multiplex Transmission, by D. R. Crosby.

Interference Characteristics of Pulse-Time Modulation, by E. R. Kretzmer.

Factors Involved in the Design of an Improved Frequency-Shift Receiving System, by Colin C. Rae.

Antennas I

Some Properties of Radiation from Rectangular Waveguides, by J. Bolljahn.

Elliptically Polarized Radiation from Inclined Slots on Cylinders, by G. Sinclair.

A Broadband Transition from Coax to Helix, by C. O. Lund.

Theory of End-Fire Helical Antennas, by A. E. Marston and M. D. Adcock.

Equivalent Circuits for Coupling of Waveguides by Apertures, by N. Marcuvitz.

Symposium: Network Theory

Modern Developments in the Topology of Networks, by R. M. Foster.

A Summary on the Status of Linear Network Theory, by E. A. Guillemin.

Recent Developments in Broadband Active Networks, by J. C. Linvill.

A General Review of Linear Varying Parameters and Nonlinear Circuit Analysis, by W. R. Bennett.

Instruments and Measurements I—Microwave

Measuring the Efficiency of a Superheterodyne Converter by the Input Impedance Circle Diagram, by H. Wheeler and D. Dettinger.

Electrolytic-Tank Measurements for Microwave Delay Lens Media, by S. B. Cohn.

Impedance Instrumentation for Microwave Transmission Lines, by P. A. Portmann.

A Michelson Type Interferometer for Microwave Measurements, by B. A. Lengyel.

A Broadband High-Power Microwave Attenuator, by H. J. Carlin.

An Absolute Method for Measuring Microwave Power of Low Intensity, by H. Herman.

Audio

The Reproduction of Sound, by H. F. Olson.

New Developments in Studio Design in Europe, by L. L. Beranek.

The Technique of Television Sound, by R. H. Tanner.

The Measurement of Nonlinear Distortion, by A. Peterson.

Tuesday A.M., March 8

Antennas II

Antenna Systems for Multichannel Mo-

(continued on p 226)

MEETINGS

MARCH 7–10: IRE Annual Convention, Hotel Commodore and Grand Central Palace, New York City.

MARCH 28–29: Third Annual Meeting, Armed Forces Communications Association, Shoreham Hotel and Naval installations, Washington, D. C.

APRIL 4–8: SMPE 65th Semiannual 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 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.

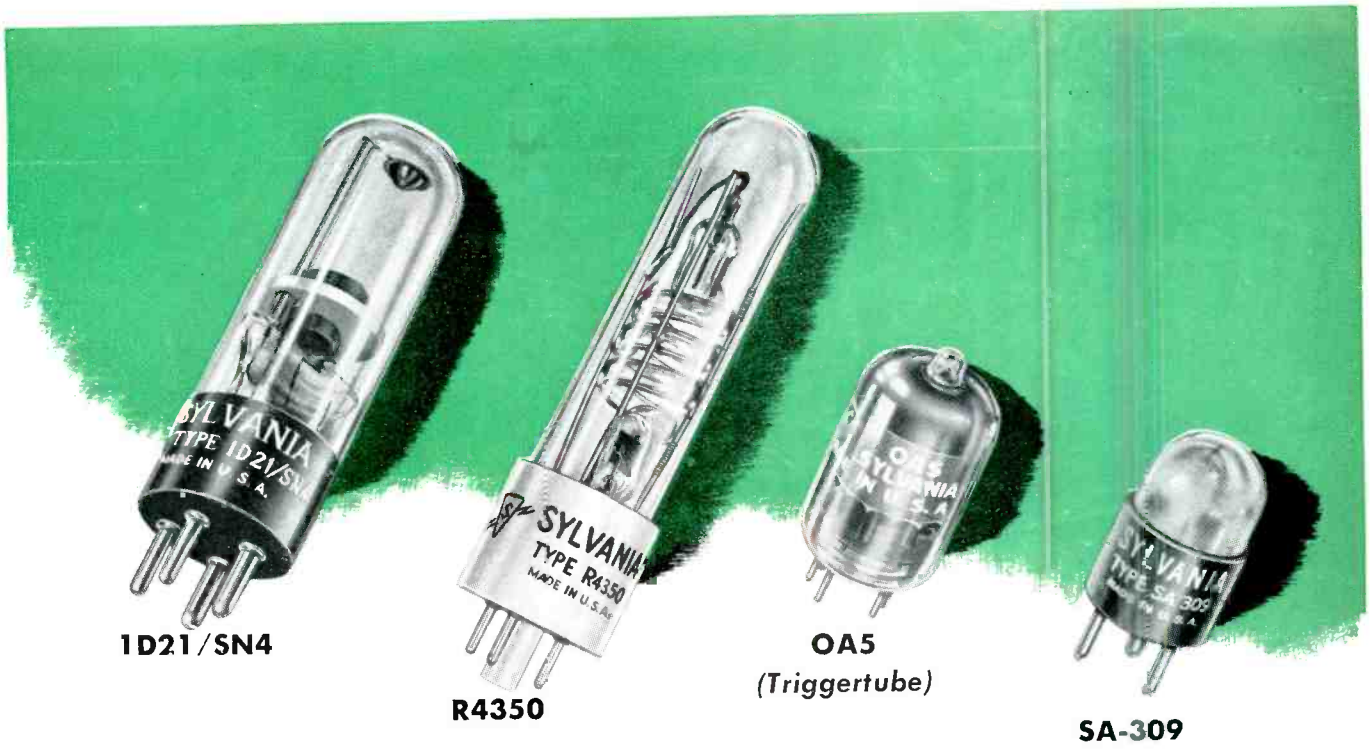
MAY 12–13: Fourth Annual Spring Meeting of the Instrument Society of America, Royal York Hotel, Toronto, Canada.

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.

COILS PRESENT TRANSPORT PROBLEM

Two giant coils, one weighing 92 and the other 97 tons, are made secure aboard the Seatrain New Jersey for shipment to New Orleans, La. Built at the Brooklyn (N. Y.) Navy Yard for the cyclotron at the Carnegie Institute of Technology, Saxonburg, Pa. (about 375 mi. from N.Y.C.), the coils were too large to go by rail or highway and had to be shipped coastwise to New Orleans, and thence by river to Pittsburgh, Pa., a short highway haul to Saxonburg. The coastal route is about 3,000 miles



1D21/SN4

R4350

OA5
(Triggertube)

SA-309

If it's a STROBOTRON it's made by SYLVANIA

THERE'S just *one* source of supply for the Strobotrons you need for "freezing" the motion of reciprocating or rotating machinery —Sylvania Electric!

Sylvania Strobotrons SA-309 and R4350 produce high-intensity, bluish-white light pulses . . . are ideal for applications where true-color viewing is essential. The R4350 flashes at rates up to 15 per second; the SA-309, up to 100 per second.

Type 1D21/SN4 provides a source of neon-red light, at frequencies up to 240 flashes per second.

Typical applications of Sylvania Strobotrons include: automotive timing; wheel balancing; adjustment of packaging machinery; regulation of high-speed multi-color printing presses.

TRIGGERTUBE TYPE OA5 provides a convenient means of triggering the SA-309, R4350 or 1D21/SN4 from current sources of very low value. The OA5 may also be used for electronic relay and switching applications as well as for other regular Strobotron purposes.

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(continued from p 126)

Simplified record changer for the new records

fast-drop mechanism. Its eight-record capacity allows about 42 minutes of total playing time.

Surge-Testing Motor Windings

IT IS COMMON KNOWLEDGE that voltage distribution in motor windings may change with frequency, and that the voltage distribution produced by a complex surge (as might occur in service) will be nonlinear. Therefore, it is necessary that the voltages used in testing motor windings for voltage breakdown should be of the same complex nature.

It is further known that the breakdown time depends on the waveshape of the voltage being applied. A sine wave, for instance, will cause more rapid breakdown than a voltage of the same peak amplitude and frequency in the form of recurring pulses, because the time during which the voltage exceeds a certain value will be greater in the case of the broader sinusoidal waveshape.

The schematic diagram in Fig. 1 shows a means for subjecting motor windings to tests with these facts considered. The power-frequency trigger circuit initiates the horizontal sweep of the scope and starts the thyratron conducting. Capacitor C, which has been charged through V, on the previous half cycle, discharges through the thyratron into the reversing switch

outstanding advantage offered in Highest Quality Potentiometer

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- Precision ground, stainless steel, double thread, lead screw guides the rotating contact, *guarantees* smooth action, low uniform torque and accurate settings — *permanently*.
- Rotor assembly, supported on two bearings, assures long life and low torque.
- Ends of resistance element *soldered* to terminals *before molding*.
- Anti backlash spring in contact guide—assures you positive setting and resetting.
- The 43½" length of resistance element gives you a finer resolution.

DEPT. 31 ***GIBBS Division***

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which directs the current surge first through the unit being tested and then through a standard. So, two traces will appear on the screen of the cathode-ray tube, and if they both coincide, the unit being tested is similar in every respect to the standard used for comparison.

Experience in using this set-up reveals that different patterns on the scope indicate different faults in the winding, but that similar faults give similar patterns.

Many different types of motor windings are in use. Each of these has its own characteristic impedance and therefore voltage distribution. So in order to use this testing equipment intelligently, a preliminary analysis of the surge

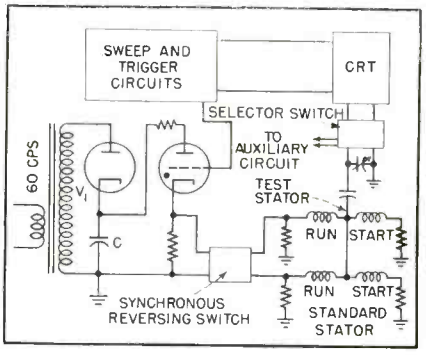


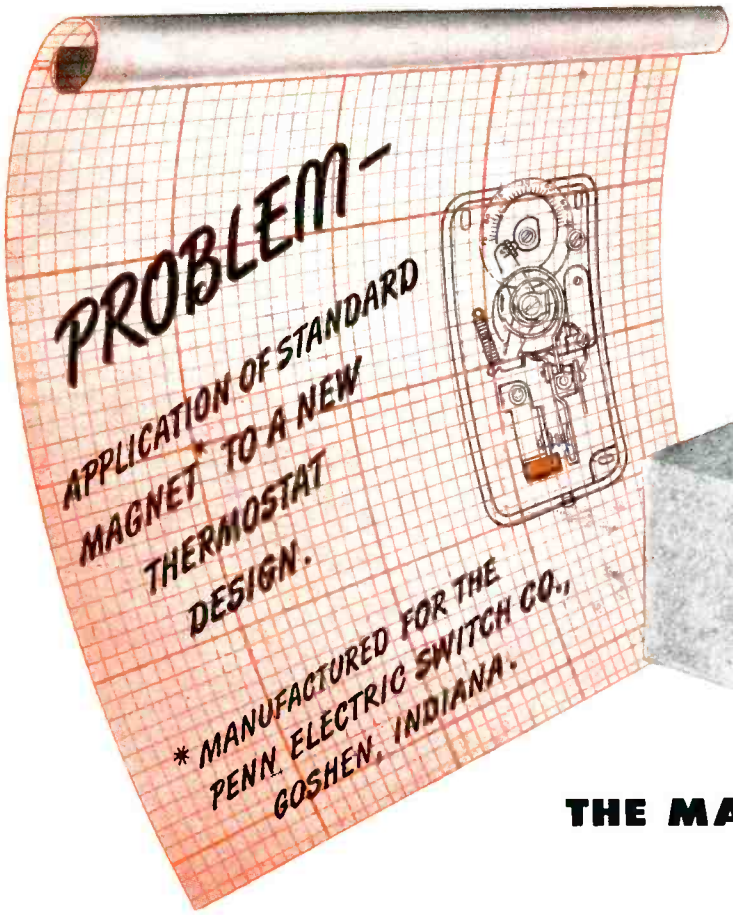
FIG. 1—Schematic diagram for motor winding fault finder

must be made to see if it is of the type desired.

This test idea is not limited to motor windings. Such a device has been used to find weak spots in the insulation of small transformers and reactors and led to their correction.

For use in locating winding faults, a few pieces of auxiliary equipment must be used with the winding tester. Pickup coils are placed near the sections of the winding in which the short appears. By amplifying the induced voltage and observing the waveshape on the insulation tester scope, the section containing the short will immediately become obvious.

With an experienced operator, faults and their locations may quickly and easily be found with this device. Marion C. Halleck of General Electric's Fort Wayne Works Laboratory is responsible for the development of this equip-



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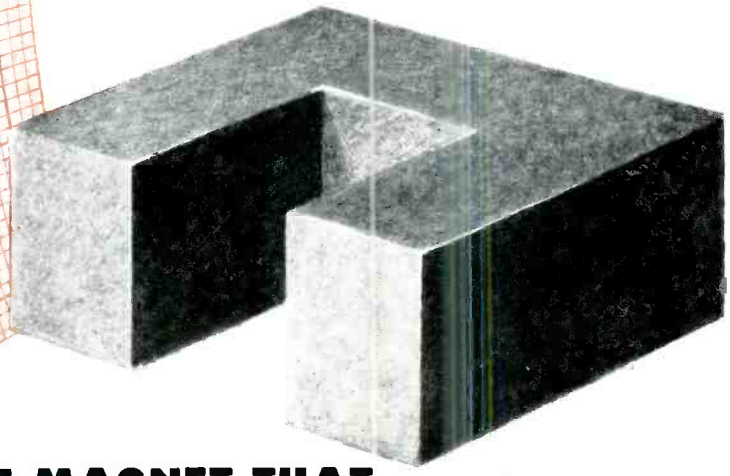

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CD49-83

ment which has been used extensively for surge testing many types of windings.

Conversion of Aircraft Equipment.

By JOSEPH ALBIN
New York, N. Y.

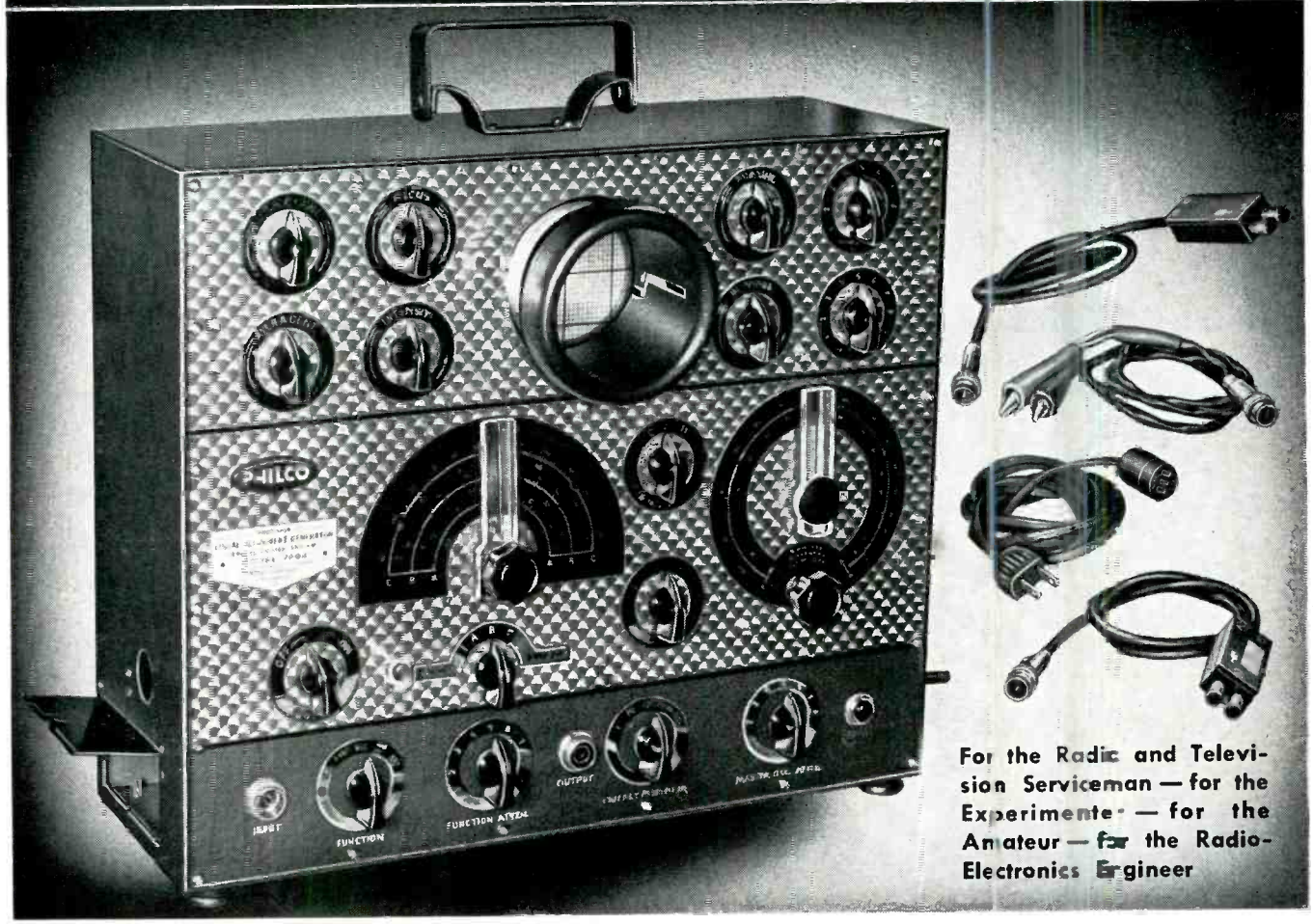
WEIGHT-SAVING is an important factor to an airline when it decides to rework surplus or other equipment. Another factor to be considered is fitting the reworked equipment mechanically and circuitwise to operate along with existing instruments and wiring. Thus the possible economy achieved by conversion needs to be considered in conjunction with these other factors.

FIG. 1—More frequencies and an easier reading front panel are provided by conversion changes

Solving such problems leads to certain interesting reworking operations. Some of these that have been done in the radio overhaul shop of American Airlines at La Guardia Field will be described.

In Fig. 1, a mechanic is shown making modifications to a crystal selector panel used in ARC/1 vhf aircraft equipment. This relay unit is the frequency control unit of a glide path receiver, part of the instrument landing (blind landing) system used in all American Airlines aircraft. The purpose of the rework is to increase the number of frequencies available in the receiver by adding four relays to have a total of ten. The mechanic is

PHILCO MAKES HISTORY IN TELEVISION TEST EQUIPMENT



For the Radio and Television Serviceman — for the Experimenter — for the Amateur — for the Radio-Electronics Engineer

PHILCO 7008 VISUAL ALIGNMENT GENERATOR

The only completely self-contained and moderately priced instrument for aligning television and FM receivers. Includes 5 different signal generators with their associated controls; a complete oscilloscope with centering, gain, focus, intensity, phasing and blanking controls, and power supplies; separate RF probe for measurements of sensitive high frequency circuits. Removable crosshatch screen for ultra-short 3'' cathode-ray tube. Compartment for cables and RF probe.

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- **No. 7008 Philco Visual Alignment Generator**
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Today's wide use of electronic devices in industrial plants, laboratories and communications services requires new precision instruments for radio measurements, in compact, portable, inexpensive form. Here, Philco has long been a leader—providing equipment for radio's best informed group of service technicians, the 25,000 members of Philco Service. For fast, accurate work experience-wise servicemen choose Philco Test Equipment. Know the reasons why Philco is preferred, by writing for technical literature.

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FIG. 2—Popular on the two-meter amateur band, the SCR 522 has been adapted by American Airlines as a ground station receiver

shown handling the original panel containing the relays and associated components.

On the left of the illustration is another example of rework on a control panel, comprising a change in type of switches and type of indicator. In place of engraved numbers to show all channels at once a knob having a window is used. This change permits the number of a single channel to stand out plainly with less ambiguity than formerly.

Figure 2 shows an SCR 522 vhf receiver which has been converted into a ground station receiver for use on a 115-volt a-c line. A new power supply is substituted in place of the 28-volt aircraft power supply. The former automatic solenoid-operated method of controlling frequency is superseded by a mechanical method for local control by the operator. The frequency selection is now accomplished by a cam-operated switch. A few circuit changes were made, and the crystal panel was relocated for purpose of accessibility.

The adaptation of another aircraft receiver to ground station use is done in Fig. 3 on a former AVR 7A beacon receiver in aircraft. It is now used for monitoring local beacon transmitters. Added parts are a power supply, output transformer, a small loud speaker to avoid use of headphones and a panel and chassis for mounting in a standard relay rack.

Final rework procedures are established after planning on a drafting board and a model has been

FIG. 3—The AVR 7A beacon receiver is fitted to a standard rack panel and chassis which also contains the accessory units to make it a complete receiver

tried out. Necessary metal parts are fabricated in the manufacturing section of the radio shop, where necessary hand and power tools are available for turning out work in required quantities.

Transmission-Line Fault Finders

IN A RECENT Association of American Railroads report, several different types of transmission-line fault finders were described. They all employ the pulse-echo technique, taking advantage of the fact that electrical echoes occur within transmission lines wherever any impedance irregularities exist.

The Lookator was developed by J. T. Schott of Bell Labs for locating faults on telephone lines. When connected to a telephone circuit, the Lookator shows the condition of the circuit along its length by means of a trace on a cathode-ray tube. If steady or swinging faults are present, their general nature can be detected, and their distance from the Lookator can be measured by a simple procedure. The device is thus a fault locator that permits the operator, in effect, to look out over the circuit. The visual method of examining a telephone circuit, without making any of the usual location measurements, makes the device useful for examining a circuit while it is being installed, thus

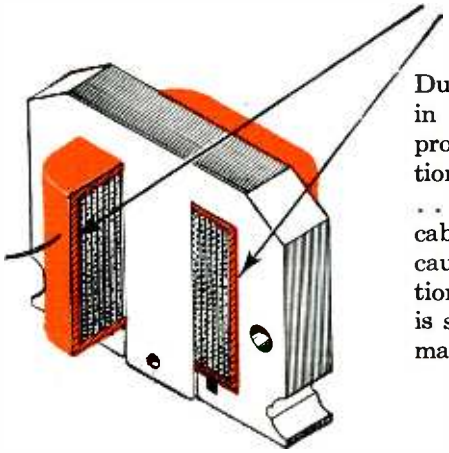
First all-new watt-hour meter in 50 years

GENERAL ELECTRIC CO. says: "The I-50 is the first all-new watt-hour meter in 50 years—new in conception, design, operation, and use of modern materials and techniques. It has greater sustained accuracy, longer life."

For greater insulation strength, reliability and secure positioning, the potential coil is molded to the electromagnet core with Du Pont polythene. This plastic combines high dielectric strength with low moisture-absorption.

employs Du Pont POLYTHENE

G. E.'s new potential coil stands about 15 kv under impulse, and 10 kv under 60-cycle breakdown. The polythene insulation stands up under humidity, sunlight and increased temperatures. It's non-corrosive, resists tracking (90 seconds minimum by ASTM test), permits better-insulated leads and neater mechanical design.



Du Pont polythene serves today in a myriad of better electrical products. Wire and cable insulation . . . insulating films and tapes . . . insulating discs for coaxial cables—those are just a few. Because of its remarkable combination of good properties, polythene is steadily replacing many other materials for electrical work.

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finding errors and faults immediately.

The principle employed for locating faults with the instrument and its associated equipment is to measure the time for an electrical pulse to travel from some reference point of measurement out to a fault and return in the form of a reflected pulse to the reference point. Knowing the speed of transmission of the pulse over the particular facility, the distance to the fault can be found. In practice the time is determined automatically by the equipment. This is accomplished by properly setting a measuring dial, noting its reading and using a previously prepared calibration curve for the location of the trouble.

The Lookator consists of an oscillator, an initial-zero adjusting circuit, a pulse generator, a hybrid coil with its associated adjustable balancing network, a receiving circuit, a measuring circuit, a sweep circuit, and a cathode-ray tube with associated control circuits. Keys are provided for testing and talking on either a two or four-wire basis. The bridge-stabilized 220-cycle oscillator controls the rate at which the pulses are generated. The pulses, having individually the approximate shape of a positive lobe of a 3-kc sine wave, are delivered to the line through a hybrid coil and a set of keys. The balancing network forms part of the hybrid-coil circuit, and may be adjusted to balance any line impedances likely to be encountered.

Deflection Voltages

The outgoing pulses travel along the line to the impedance irregularity caused by a fault. They are here reflected, and return along the line to the Lookator, where they enter the receiving amplifier, and appear as a vertical deflection on the screen of the cathode-ray tube. A second output of the oscillator feeds through the measuring circuit into the sweep circuit, where it controls the frequency of the horizontal sweep.

The zero-adjusting circuit and the measuring circuit permit the phase of the voltage supplied to the pulse generator and sweep circuits to be controlled individually. Consequently, the time at which func-

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Trend Is to New Low Prices for Lighter, Smaller 7" and 10" TV Sets

SMALL, COMPACT POWER SUPPLY HANDLES AM-FM-TV COMBINATION

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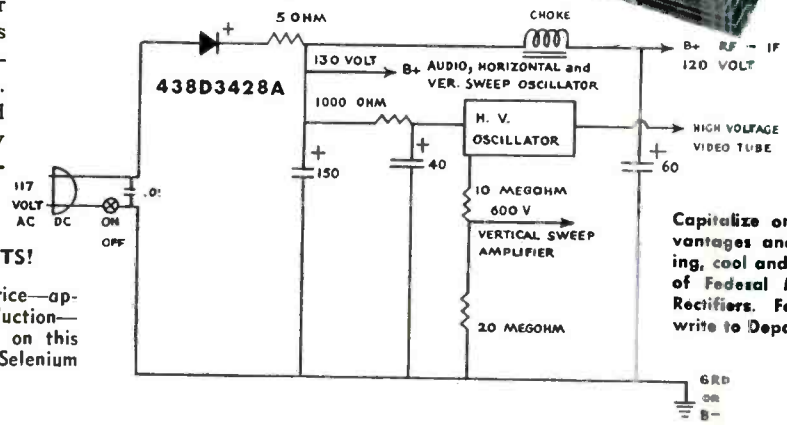
YES, this mighty miniature makes big television headlines! Its hitherto unapproached power-handling capacity promises a virtual revolution in television design. Think of the possibilities . . . a single Selenium Rectifier power supply able to handle an AM-FM-TV combination . . . AC-DC television . . . drastic reductions in size, weight and price of 7" and 10" sets.

These important savings result not only from the small size of this new Federal Miniature Selenium Rectifier, but its elimination of large, heavy, expensive transformers and expendable rectifier tubes in the power supply. What's more, it can be used with smaller condensers with lower voltage ratings.

Here's the diagram of a suggested circuit for an AC-DC power supply for 7" and 10" electrostatic deflection tubes.



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A new low price—approx. 30% reduction—now in effect on this Federal Selenium Rectifier.

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.

Capitalize on these design advantages and the instant starting, cool and efficient operation of Federal Miniature Selenium Rectifiers. For technical data, write to Department F219.

Federal Telephone and Radio Corporation

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

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Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.

tions in the sending and sweep circuits take place can be adjusted as desired with respect to each other.

Since the oscillator frequency is fixed, a measure of the difference in phase between the a-c voltages controlling the electrical events in the two circuits will be a measure of the time required for the pulse to travel from the Lookator to the fault and back again. It is then possible to prepare a curve showing the relationship between time in arbitrary scale divisions and the distance out to known points on a particular facility.

The Lookator can be used for many other purposes such as general laboratory testing, for adjusting networks properly to balance lines, for adjusting line terminations, for observing short time changes in the height of the Ionosphere, and in its present form for indicating the presence of large crosstalk coupling and showing about where the irregularity responsible for the crosstalk is located.

Telemetroscope

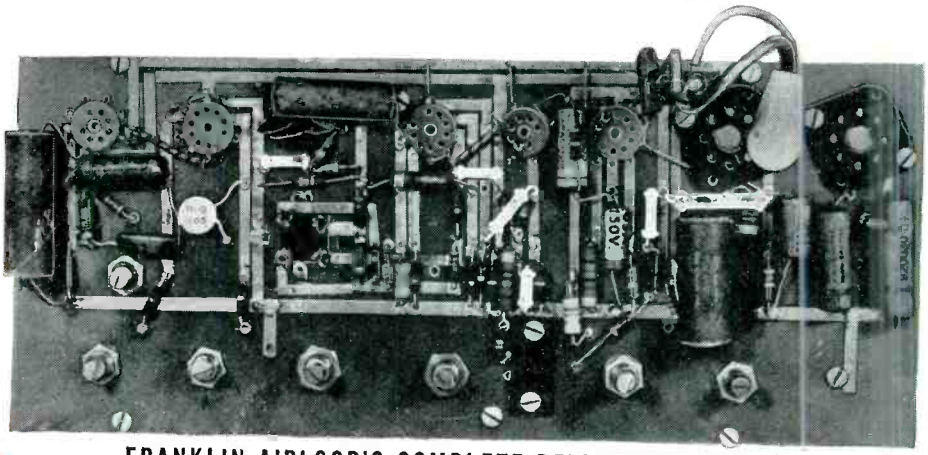
The Tobe Deutschmann Telemetroscope is a portable, self-contained, instrument that makes it possible for the operator to see, on the screen of a cathode-ray tube, the condition of an electric circuit, whether in cable or in open wire line, and to determine almost instantly the location of a fault existing at the time of test. It locates open circuits, grounds and short circuits. Field tests on both underground and overhead lines have demonstrated that these faults can be located with an accuracy of about 100 feet in ten miles, within one or two minutes after the faulted circuit is isolated from the system and the instrument is connected.

Direct mileage calibration of the time base allows the distance to the fault to be determined almost instantly by station operating personnel who need have no familiarity with the theory of operation of the instrument.

The Telemetroscope comprises a pulse-generating circuit, means for impressing the pulses on the circuit to be tested, a high-gain receiver, a cathode-ray oscilloscope tube, a calibrating circuit, the usual oscil-

Hi-Q COMPONENTS

Specified by FRANKLIN Airloop CORPORATION



FRANKLIN AIRLOOP'S COMPLETE DEFLECTION CIRCUIT

● The great demand for lower cost television receivers is one of the big problems confronting engineers today.

Die stamped inductances as developed by the Franklin Airloop Corporation are a partial answer to reduced manufacturing costs. Truly a precision operation, its successful performance is dependent upon precision components.

Hi-Q components — noted for their *precision* — *dependability* — *uniformity* and *miniaturization* contribute their part, not alone to Franklin, but to all manufacturers whose standards demand these 4 **Hi-Q** features.

Our engineering department is available for consultation with your engineering staff in the design of new circuits and the application of **Hi-Q** components to them. Why not write us today?

The **Hi-Q** Disc Capacitor used in the above deflection circuit is a high dielectric capacitor designed for application where physical shape is more adaptable than tubular units. Close connections are easily made, reducing inductance to a minimum.

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loscope control circuits; and all necessary power supplies.

Controls on the front panel of the instrument include the usual focusing and positioning controls for a cathode-ray tube, the time-base expansion control (horizontal amplifier), the vertical amplifier control, a control for matching the impedance of the instrument to the impedance of the circuit under test, and a control for adjusting the calibrating circuit to the correct speed of propagation for the individual cable or line.

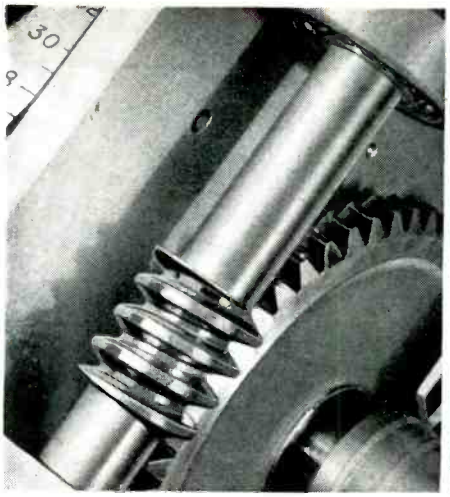
The distance graduation appears on the scope screen as a series of vertical lines spaced along the time base at intervals corresponding to known, equal distances over the full measuring range of the instrument. The interval between range markers is established, in manufacture, at the value best suited to the service in which the Telemetroscope is to be used. It is normally about one-tenth the total range of the instrument. Thus a five-mile instrument has range markers every half-mile, while a hundred-mile instrument has range markers ten miles apart.

The time-base expansion control provides ten-to-one expansion of any part of the scale to permit accurate checking of any portion of the circuit. A scale having fifty graduations is provided on the face of the scope; this allows a circuit discontinuity or impedance change, within the line length corresponding to any two range markers, to be located with an accuracy of one part in fifty.

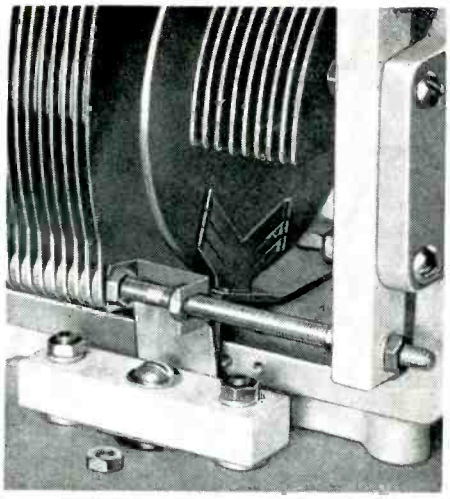
The Telemetroscope employs 23 tubes, all of which are standard types, including the 5-inch cathode-ray tube.

The Fault-Finder

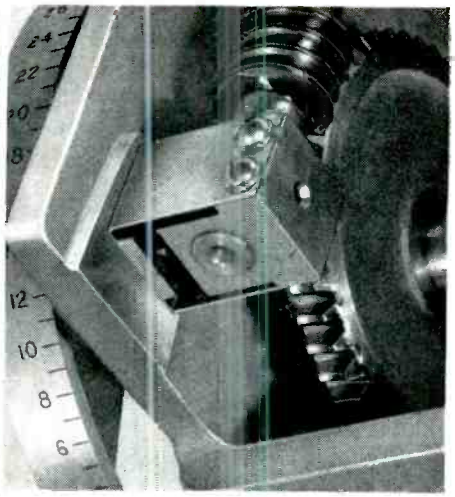
The Fault-Finder is a similar device, but in addition to determining the position of the discontinuity, it reveals the nature of the fault. If the reflection is caused by an open circuit or increase in line spacing, the reflected pulse will show positive (above the base line) on the cathode-ray tube screen, and if caused by a partial or complete short circuit or decrease in line spacing, the reflected pulse will show negative (below the base line). The



This 50-to-1 worm drive, equipped with a 3½ inch dial, is used for the fine setting adjustment. Backlash is kept very low by spring pressure on the worm shaft. Eccentricity from set screws and misfit is eliminated by cutting the worm and its shaft from an integral steel shafting.



Two small, waxed steatite bars insulate the stator plates. A Figure of Merit (Dissipation Factor x Capacitance) of 0.04 $\mu\mu$f is secured (0.003 $\mu\mu$f with quartz insulators). Connection to the rotor is through spring-tempered silver alloy brushes bearing on a silver-overlay brass disc.

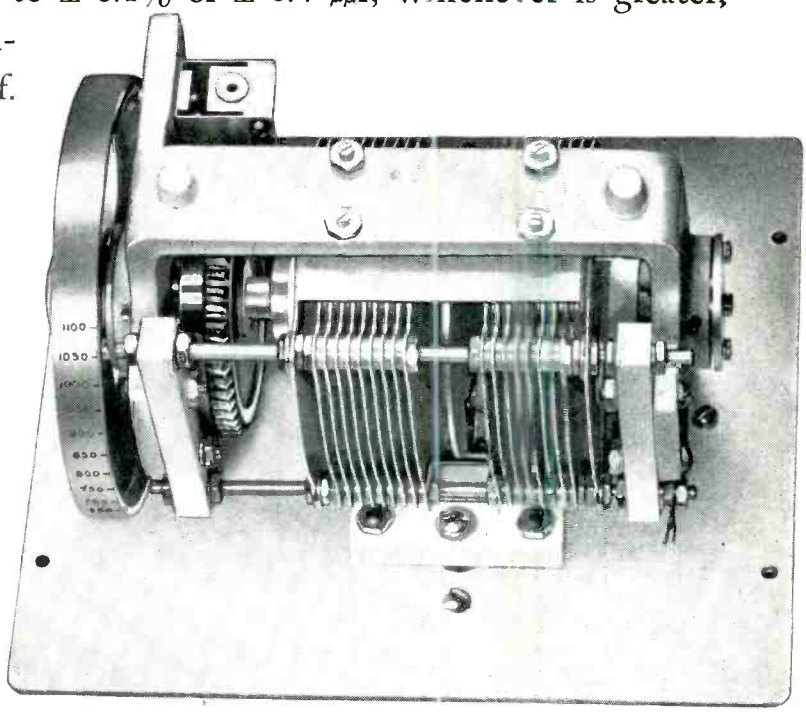


The worm shaft is held to a tolerance of 0.0004 inch; radial eccentricity of the worm gear is less than 0.002 inch. The main rotor shaft is held to a tolerance of 0.0005 inch and its bearing surfaces to 0.0002 inch. Ball bearings are used on worm and main rotor shafts.

The STANDARD of Variable Capacitance

Recently the accuracy of the well-known G-R Type 722 Precision Condensers has been increased, making these standards of variable capacitance of even greater use in the laboratory and as the variable element in many instruments such as oscillators and frequency meters.

Typical of the three different models of this condenser is the Type 722-N, with extra low metallic resistance and inductance. This condenser (illustrated) is direct reading to ± 1 $\mu\mu$f. When the corrections (charted on the front panel) are applied to the direct-reading settings the accuracy is increased to ± 0.1% or ± 0.4 $\mu\mu$f, whichever is greater, and the corresponding accuracy for capacitance differences is ± 0.1% or ± 0.5 $\mu\mu$f.



SPECIFICATIONS

- **CAPACITANCE RANGE:** 100 to 1100 $\mu\mu$f, direct reading
- **STANDARD CALIBRATION:** Direct reading in $\mu\mu$f at 1 kc to ± 1 $\mu\mu$f. Mounted correction chart gives corrections to 0.1 $\mu\mu$f at multiples of 100 $\mu\mu$f.
- **WORM CORRECTION:** For very precise measurements a worm correction calibration can be supplied. When these are applied capacitance can be determined within ± 0.1 $\mu\mu$f or ± 0.1%, whichever is greater, and capacitance differences to ± 0.2 $\mu\mu$f or ± 0.1%
- **METALLIC RESISTANCE:** Series resistance about 0.008 ohm at 1 Mc
- **SERIES INDUCTANCE:** Approximately 0.024 μh
- **TEMPERATURE COEFFICIENT:** Approximately 0.002% per deg. C.

● TYPE 722-N PRECISION CONDENSER	$160
Worm Correction Calibration	50
Quartz Insulation	85

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

magnitude of the reflected pulse permits the observer to estimate the resistance of the fault.

With proper coupling networks, the Fault-Finder can be used on any transmission line, whether high-voltage power line, cable, or telephone circuit. Ordinary twisted pair will show a very irregular pattern on the screen of the tube because of the large number of impedance variations along its entire length caused by changes in wire spacing. The type of line will determine the maximum length over which faults can be detected.

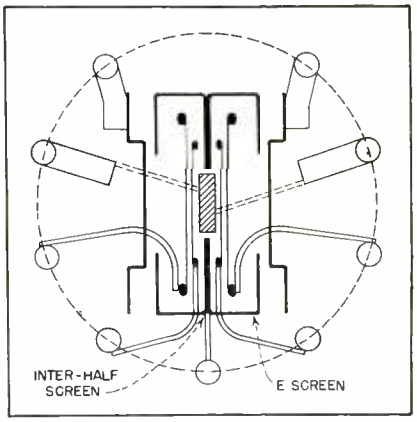
The Type F-1 transmits a sharp d-c pulse of about 5 microseconds duration, and 900 volts amplitude. Normal range of the instrument on a high-voltage power transmission line is 100 miles, but provision is made for receiving reflections from as far as 200 miles. The Fault-Finder is a product of Radar Engineers of Seattle, Washington.

Multi-Purpose British Radio Tube

By JOHN H. JUPE
Enfield, England

TO AID IN THE PRODUCTION of radio receivers which could be sold at low prices all over the world, John A. Sargrove, the British inventor, has developed a multipurpose tube known as the Sargrove-Tungsram UA-55.

It is capable of meeting the largest possible number of applications, sometimes a little better and sometimes nearly approaching the efficiency of specialized tubes but always with the object of being the least expensive tube obtainable in



Cross-sectional diagram of UA-55 electrodes, showing internal leads to pins

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Sub-miniatures, seven- and nine-pin miniatures, standard types, and the great Lock-In radio tubes are all included in the famous Sylvania line . . . all represented in the leading makes of home receivers—from portable models to console combinations and television receivers.

It is the high quality of these Sylvania tubes that has made them preferred . . . has made them famous throughout the world.

For full information about Sylvania tubes, see a Sylvania Distributor, or write Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.

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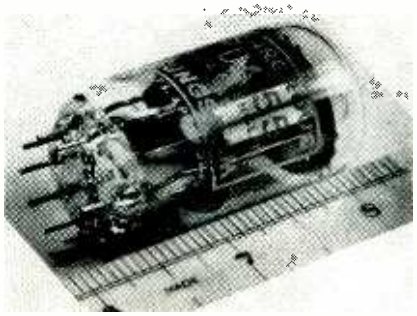
RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; PHOTOLAMPS; ELECTRIC LIGHT BULBS

order to meet the requirements of overseas markets of low spending power.

The structure of the new tube is shown in the accompanying drawing. It will be noticed that there is a superficial resemblance to a beam tetrode, except that the whole structure is split along the cathode axis, into two halves. The two beam-forming plates are of an unusual shape, having an "E" shaped cross-section. The center limbs come very close to the narrow edges of the flat cathode and with the latter, form the separating screen between the two halves of the tube. The outer limbs of the E act as beam-forming electrodes and also as screens from anodes to control grids.

The main novelty is in the grids, where much development work has



Sargrove-Tungsram multi-purpose tube UA-55

yielded a construction having many new and valuable features.

The half control grids and half accelerator grids are ladder-like structures all having the same number of grid wires per inch. To permit a high anode current at comparatively low voltage the grids are rather open meshed and close to the cathode. The accelerator grid wires are aligned behind the control grid wires, without any special optical aids, by the novel method of grid making, which results in grids having wires and side rods substantially at right angles to each other. On being dropped into the holes in the bottom mica, they register and align themselves to the bottom grid wires of both control and accelerator electrodes. This provides further economies in production and ensures a reliable tube, inasmuch as it will hold throughout its life the initial high ratio of anode current to screen current, which is

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FLEXIBLE CABLE *Shielded with* "326" MONEL TAPE

Recommended for use under wet, corrosive, abusive conditions. Good for voltages up to 35,000.

More corrosion-resisting than tinned copper—"326"* Monel shielding offers a new way to extend cable life.

No other metallic sheathing will give you the equal of Monel's resistance to corrosion and mechanical abuse. In addition, "326" Monel is essentially non-magnetic at the service temperature—a property of primary importance in the efficient transmission of power. These magnetic properties are not appreciably influenced by hot or cold work.

Ease of brazing and welding are other advantages of "326" Monel shielding.

More information on flexible "326" Monel shielded cable for power transmission and "tough-service" cords is available from individual cable manufacturers. For names and addresses, please fill in the coupon.

*Trade-Mark

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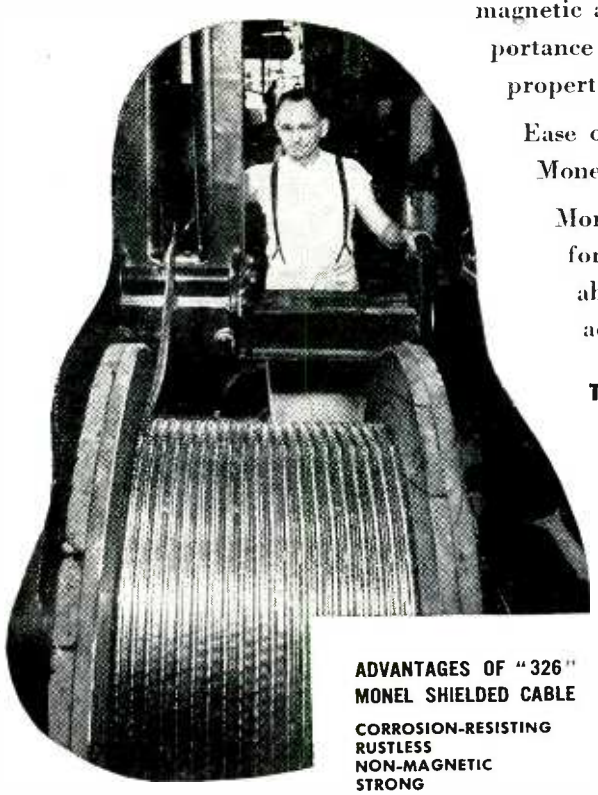

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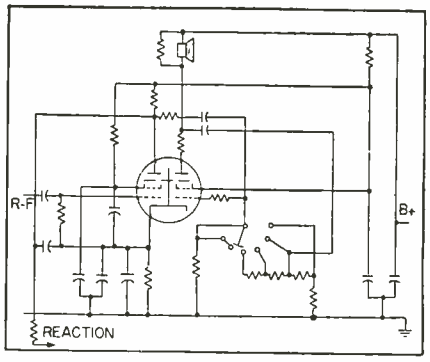

Typical circuit using UA-55 as tetrode-detector and tetrode output in a receiver

about ten to one.

The screening of the input and output electrodes, as well as the inter-half system screening is completed between the main structures and the bottom base by further interposed wing-type screens, shielding the two anode leads from each other, as well as from all the other electrodes.

To enable the characteristics of the tube, used as a whole or in separate halves, to be varied at will, both halves of the accelerator grid have been brought out separately. To do this, as well as to accommodate the two control grids and two anode connections, one cathode and two heater leads a nine-pin base became necessary. By using an arrangement similar to that used on miniature tubes no trouble has been experienced.

Characteristics

Power Amplifier—With anode and accelerator potentials of only 90 volts, the output is greater than 1 watt (load 2,500 ohms). It has a very useful transconductance of 7,000 μmhos at these voltages and at a grid bias point of −5 volts.

Voltage Amplifier—By dropping the accelerator potential to +15 volts a high impedance tube is obtained for voltage amplifier stages, with a transconductance of 4,500 μmhos.

Variable Mu—By applying +10 volts to the accelerator on one side of the cathode and +25 volts on the other, a variable-mu tube is obtained, in fact by varying the two voltages many types of variable-mu tubes can be made, or even variable-variable mu tubes.

Triodes—Each half of the tube can be separately made into a triode in three different ways, producing

achieving a new high of efficiency!

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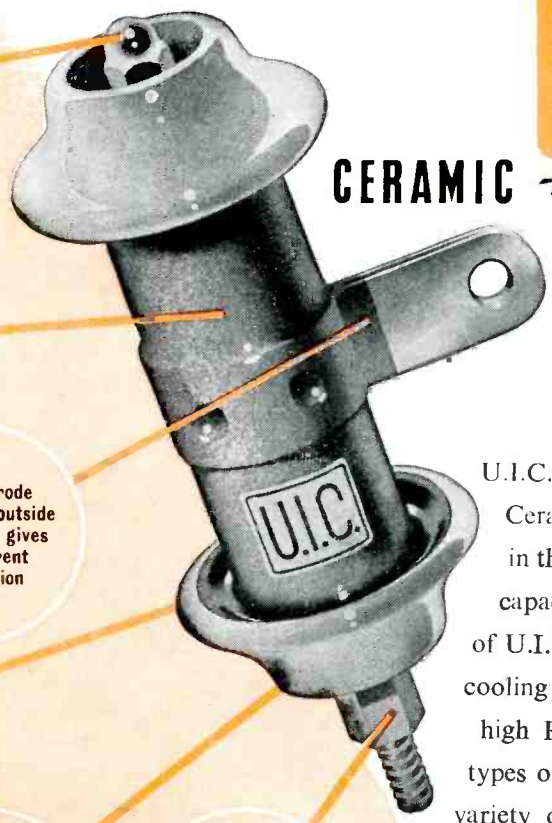
CERAMIC *Hi-Load* CAPACITORS

Designs registered U.S.A., U.K. and other territories.

for R.F. Heaters and Transmitters



Special silver layer gives low-loss high conductivity electrode surfaces

Special ceramic body gives low losses under R.F. load

Tag electrode soldered to outside silver layer gives even current distribution

Glazed sheds give ample flash-over path in all conditions of humidity

Aero-dynamic shape gives improved cooling, particularly with forced draught

Heavy rod with double spider mounting gives reliable heavy current connection to inside silver layer

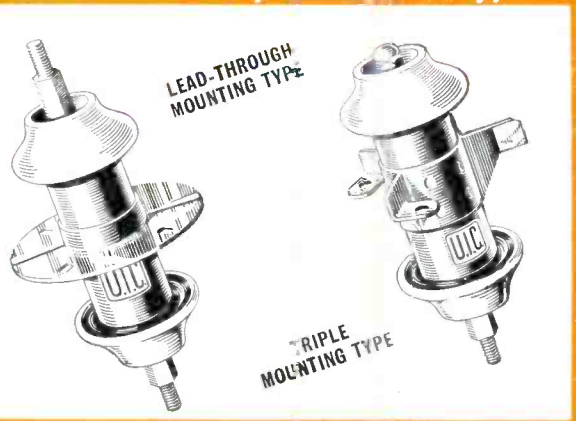
TAG MOUNTING TYPE

U.I.C. of England, pioneers in the manufacture of Ceramic Transmitter Capacitors, are foremost in the application of aerodynamic principles to capacitor design. The new aerodynamic shape of U.I.C. "Hi-Load" Capacitors gives optimum cooling in still air. With forced draught their high R.F. ratings can be multiplied. All three types of mounting assist cooling and cater for a variety of applications, such as single stand-off tag fitting, parallel and series banking for very large powers, and lead-through types for anode by-pass.

Examples from a wide range of Types

Type	HLS2031	HLT2021	HLT2021	HLC2011	HLC2014★
Capacitance	200mmF	330mmF	500mmF	1250mmF	1000mmF
Max. R.F. Load	70KVA	50KVA	50KVA	25KVA	40KVA
Peak Voltage	7.5KV	7.5KV	7.5KV	7.5KV	7.5KV
Max. R. F. Current	30 Amps	30 Amps	30 Amps	30 Amps	30 Amps
Body Dimensions	1⅜" x 3½"	1⅝" x 3½"	1¾" x 3½"	1¾" x 3½"	1⅝" x 3½"

★ *Lead-through type, all other examples tag type.*



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entirely different characteristics.

By connecting the screen grid to the anode, a high-slope, low-impedance tube results. It is suitable for use as an oscillator with the other half of the tube as a tetrode mixer.

Connecting the two grids together gives a triode suitable for positive-drive power amplifiers or a high-impedance, low anode-current amplifier. The third triode arises when the second grid is used for input and the normal control grid is connected to a slightly positive cathode. It gives a choice of impedance between the other two methods of connection.

Rectifiers—Although the UA-55 may be considered complex for a rectifier, it is possible to make its use as such economically feasible by using for this purpose those tubes which are outside normal tolerances as double tetrodes.

Mixer Oscillator—At an anode voltage of only 90, and a total cathode current of 9 ma, the conversion conductance is 700 μmhos.

Detector and A-F Amplifier—In these positions the new tube can be made to act quite satisfactorily, especially as a bi-phase demodulator and a-f amplifier. A tetrode-detector/tetrode output circuit is also excellent for an inexpensive export receiver.

R-F Amplifier—Owing to its relatively high input capacitance (0.07 μμf for one-half) the UA-55 is not suitable for really high-gain r-f or i-f stages. It can, however, be used in short wave or television broad-band amplifiers, where gain is low.

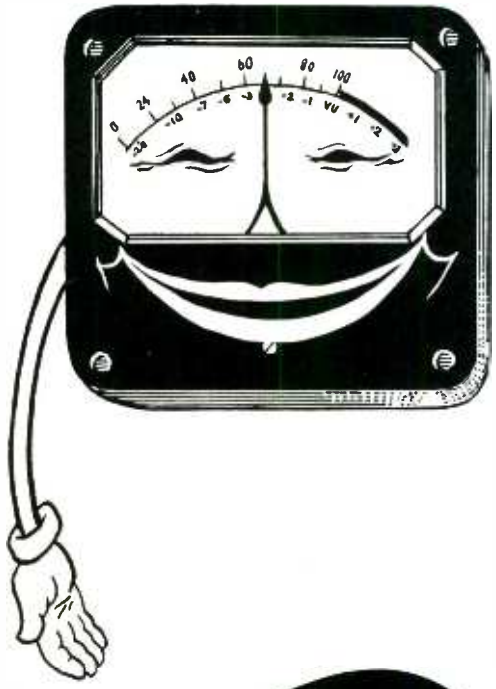
Using simple but unorthodox circuits, stable i-f stages operating up to about 460 kc can be built, with a gain between 300 and 500.

Superheterodyne — The heaters of four tubes can be connected in series to run directly off 220-volt mains, with 22 watts consumption. A four-tube six-stage superheterodyne receiver is thus an easy arrangement to design.

Well-Drilling Control

EXACT WEIGHT for a drill bit as it penetrates oil-bearing formations thousands of feet below the earth's surface is provided by a new auto-

SOME OF OUR BEST FRIENDS ARE VU METERS*



Some discs hiss, some swish, and some whistle. With Soundcraft the recording engineer whistles while he works.

VU meters in hundreds of AM, FM, and television stations have been telling engineers that Soundcraft discs make the *most consistently* quiet recordings known to radio programming.

To their unvarying ease of cutting, Soundcraft discs owe their rapid growth to America's best seller. Realizing the potential pricelessness of every instantaneous and master recording, Soundcraft has never broken faith with its users by experimenting with the formula.

The Soundcraft trick is in the coating: micro-grain "acetate", micro-filtered in application, cured in micro-filtered air, produced in a plant that makes its own seasons. Because Soundcraft produces a grade for every purpose, these discs are the economy product for competition-conscious stations.

If, perchance, you are not already a Soundcraft disciple, mail the coupon and learn why you should be following the other experts to *consistently* good sound reproduction.

**Volume unit meter commonly used for measuring sound level in audio systems*

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matic electronic control.

Developed cooperatively by companies in the oil and refining industries, drilling equipment makers and industrial instrument engineers, the system makes use of a strain-gage assembly, a Brown Instruments Division electronic potentiometer which operates as a weight indicator on the drilling bit, and a pneumatic brake which maintains the desired weight. The brakes feed the drilling line at a rate which assures a constant and predetermined weight on the bit through all types of sub-surface formations.

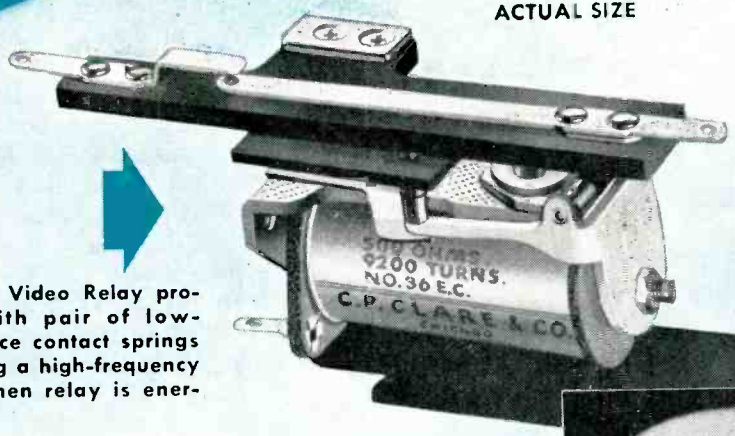
Automatic feed and uniform weight is becoming important because of increasingly deeper drilling, which entails greater drill-pipe torque, and to a decreasing sensitivity of heavier equipment to the feel of the driller. Use of electronic control is reported to have resulted in faster and more efficient drilling while eliminating manually controlled equipment losses and too little or too much weight on the drill bit.

COACHING VIA RADIO

Radio apparatus enables an instructor to coach during an actual practice game in London, England, without stopping play. Players are equipped with a light harness carrying a miniature-tube device on a headpiece, and communication is made between the touchline microphone and the player by means of a copper-braid antenna strung across the field and pinned firmly close to the ground

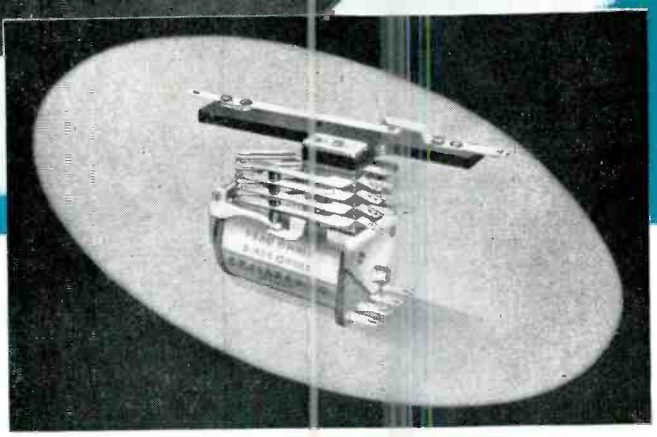
How Big does a Video Relay have to be?

ACTUAL SIZE



Type "J" Video Relay provided with pair of low-capacitance contact springs for closing a high-frequency circuit when relay is energized.

This Type "J" Video Relay shows how a number of auxiliary contact springs may be added for switching circuits which do not carry high-frequency currents.



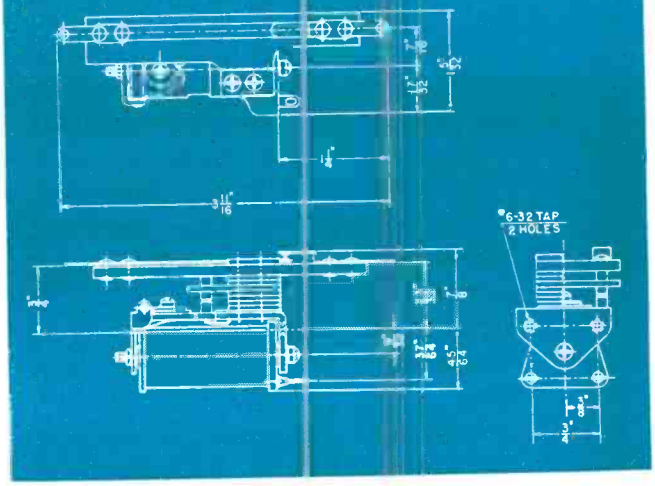
RCA Engineers posed this question to CLARE when available relays for their purpose proved too large, too cumbersome.

The close cooperation between engineers of the two companies which resulted has produced the CLARE Type "J" Video Relay, which meets every requirement for switching these high-frequency currents . . . and occupies but 7 cubic inches.

Success of this cooperation between RCA and CLARE engineers in developing a superior small-size, low-capacitance relay is not only important to this, the world's largest manufacturer of radio and television equipment, but it is of vital interest to every television engineer whose designs are often frustrated by the 17 cubic inches that other typical video relays require.

Clare sales engineers are located in principal cities. They will be glad to give you full information on this new video relay. Their counsel and advice may help you solve other relay problems. More and more, industrial designers bring their problems to Clare, whose long experience in meeting and solving them can save you many hours of tedious and costly experiment. Call your nearest CLARE sales engineer, or write to: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois.

Dimensions of CLARE Video Relay



Capacitance of CLARE Video Relay

Tests show that this new CLARE relay with a contact gap of 0.025" has the following capacitances:

Interspring Capacitance, Contact Open

0.5 mmf. at 3 megacycles
0.5 mmf. at 10 megacycles
0.55 mmf. at 20 megacycles

Spring-to-Frame Capacitance, Contact Closed

1.4 mmf. at 3 megacycles
1.45 mmf. at 10 megacycles
1.8 mmf. at 20 megacycles

Write for Clare BULLETIN 106

CLARE RELAYS

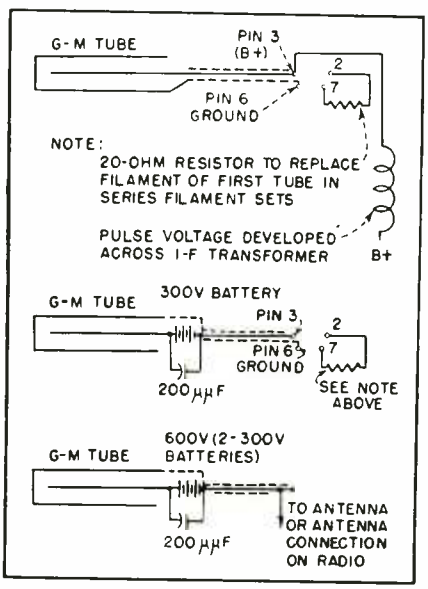
First in the Industrial Field

impedance is determined by the standing wave ratio. The trace on the oscilloscope is adjusted, using the gain control, so that it touches the top and bottom of the reference frame, as shown in Fig. 2. The horizontal cursor is then aligned with the minimum. This position is transferred, through a cam that is made by plotting the square law characteristic of the detector, to the impedance chart.

With this equipment the characteristics of wideband systems can be determined quickly and the effects of adjustments on them readily observed. Both the phase angle and impedance magnitude determined with the equipment are determined with reliability for swr less than 4 to 1. Because of the square law response of the detector, the magnitude of the impedance is in error at higher ratios, but the phase angle is still in good agreement with other measurements.

Standard Broadcast Radios as Nuclear Indicators

SELF-QUENCHING Geiger-Muller tubes can be connected to standard broadcast receivers to form indicators of nuclear radiations. The diagram shows the manner in which



Impulse delivered to r-f section of radio by self-quenching G-M tube shock excites the resonant circuits in the front end, producing a damped wave that makes a click in the loudspeaker. The rapidity of clicks increases as one approaches a radioactive area. That the equipment is operating can be determined by holding a radium treated watch dial near the G-M tube

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The "EXTRA SOMETHING" that spells TOP PERFORMANCE

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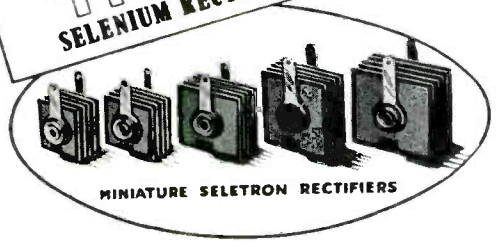
SELENIUM RECTIFIERS



MINIATURE SELETRON 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"	$1\frac{3}{16}$"	1½"	1"
Plate Width	⅞"	1"	$1\frac{3}{16}$"	1¼"	1"

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the counter tube can be connected to a typical receiver. The G-M tube responds to beta or gamma rays from radioactive elements or fission products, producing clicks or thumps from the loudspeaker in proportion to the density of the radioactivity.

In the first connection the G-M tube must be the type that operates at about 300 volts, which is difficult to manufacture and is short lived. However, further developments of halogen-filled tubes may overcome these difficulties. The second connection shows a means (battery) for operating a 600-volt tube. The third connection, by not requiring an adapter on the tube socket, would be easier to make to the receiver. The first connection has the advantage of being compact, but in any case batteries for this application are small and have a life substantially equal to their shelf life. The G-M tube in each case is the self-quenching vapor-filled type having a life in the order of 10^8 counts.

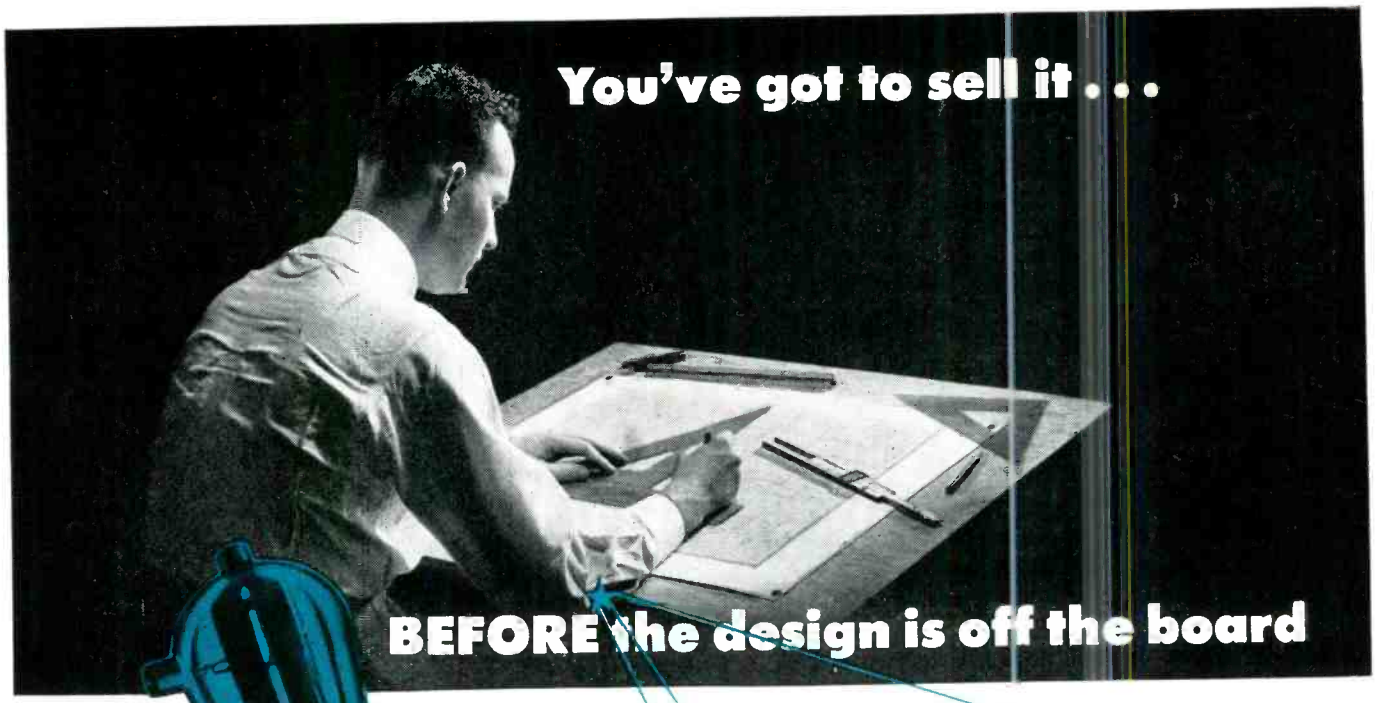
The purpose of thus using a radio receiver with a G-M tube is to provide a readily procurable detector of radioactivity. As most homes have at least one receiver, all they would need to detect radioactivity would be the G-M tube and possibly the battery. Car radios could be used in prospecting and to warn of contaminated areas, especially in the event of a national emergency, without the need for constructing precision detectors in large quantities. Of course, as W. D. Schafer of the Los Alamos Lab who developed this adaptation points out, the indications are only qualitative. The merits of the method are its simplicity and availability.

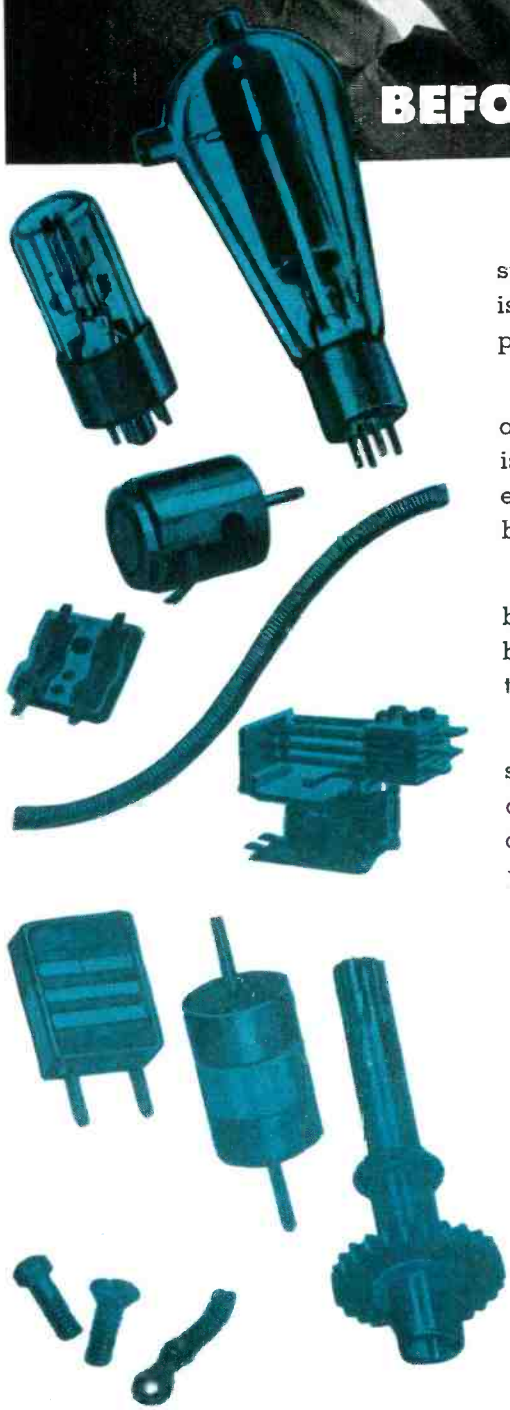
Electronic Analog Computer

By H. R. Hegbar

Manager Electronics Section
Electronics and Control Aerophysics Dept.
Goodyear Aircraft Corporation
Akron, Ohio

CREATIVE ENGINEERS have long been burned with the necessity of performing laborious complicated mathematical operations in transforming their ideas to numerical design values. Digital computers, from desk calculators to complex





To sell to the electronic industry you've got to put your product story across — to the engineer as he is planning — BEFORE* his design is off the board. That's the time when buying decisions are started and purchases are made for experimental models.

Because electronic components or equipment are the results of a precise science, the electronic manufacturing industry's purchasing is engineer-dominated. Every product used is specified only on its electrical, mechanical or physical characteristics which are determined by the engineer BEFORE* the design is off the board.

When the experimental model is completed and approved, and before production starts, purchases are made, this time in quantity, based on products used in the experimental model. It's obvious then, that buying decisions are made BEFORE* the design is off the board.

How do you reach design engineers at this important buying stage? Salesmen can't be there all the time — but ELECTRONICS is — and it's the one publication that engineers consistently use for technical data and product information. Make sure that, each month, you keep your product story before them.

ELECTRONICS Annual Mid-June BUYERS GUIDE, *because of its complete information and year 'round use, has become the industry's basic buying book and therefore the ideal medium in which to present, in condensed form, complete information on all your products for ready reference by engineers when designs are on the board.*

THE 12 MONTHLY, AND THE ANNUAL BUYERS' GUIDE ISSUES OF

electronics

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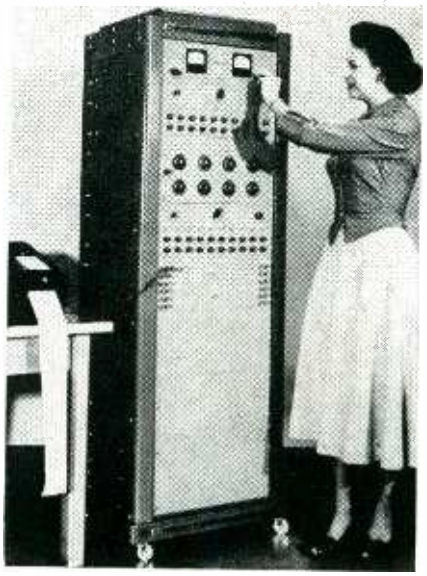

Linear differential equations are solved by math technician Marion Crawford on this compact computer in one-tenth the time required by hand computation; the answer is recorded as a curve on the paper tape

electronic machines, make possible the solution of complicated research problems involving much data. The analog computer, on the other hand, in which continuous rather than incremental information is used, provides engineers with workable design constants at a minimum expenditure of time and effort. For these reasons the computer developed for the United States Air Forces by the Goodyear Aircraft Corporation's Electronics and Control Aerophysics Dept. is of the compact electronic analog type.

This computer employs stable, high-gain plug-in d-c amplifiers, which, with associated input and feedback networks, become functional units performing the linear operations of summing, multiplying, integrating, and so forth. Each of these operations may be performed with an error of less than 0.1 percent. When properly connected, the computer obtains the general solutions to sets of simultaneous differential equations having constant coefficients. It is particularly useful in the field of aircraft stability analysis, simulating the dynamic characteristics of the airframe and autopilot.

Each computer contains 20 universal d-c amplifiers that can be used for any of the linear operations. It also contains 10 one-microfarad polystyrene capacitors for

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for the following applications:

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- Differential Analysers
- Frequency Determining Circuits
- Bridge Standards, etc.

Characteristics

- **LOW DIELECTRIC ABSORPTION** —.01-.02% residual
- **LOW DISSIPATION FACTOR** —.0002-.0003 at 1 Mc
- **CONSTANT Q and CAPACITANCE** —from DC to 100 Kc
- **HIGH INSULATION RESISTANCE** —10^{12} ohms/mfd. average
- **NEGATIVE TEMPERATURE COEFFICIENT** —minus 400-500 ppm/°C.

Cat. No.	Cap. Mfd.	Dimensions
LAG101	.0001	19/32x1 3/16″
LAG201	.0002	19/32x1 3/16″
LAG501	.0005	19/32x1 3/16″
LAG102	.001	19/32x1 3/16″
LAG202	.002	19/32x1 3/16″
LAG502	.005	3/4x1 3/4″
LAG103	.01	3/4x1 3/4″
LAG203	.02	3/4x2 1/4″
LAG503	.05	29/32x2 1/4″
LAC 104	.1	2 1/4x1 3/4x1″
LAC 204	.2	2 1/4x2 1/2x1 3/16″
LAC 504	.5	4x2 1/2x1 3/16″
LAC 105	1.	4x3 3/4x1 1/4″
LAC 205	2.	4x3 3/4x2 1/4″
LAC 505	5.	6x3 3/4x4 9/16″

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Specify Tolerance—Std.—2%, 5%; 1% to order.
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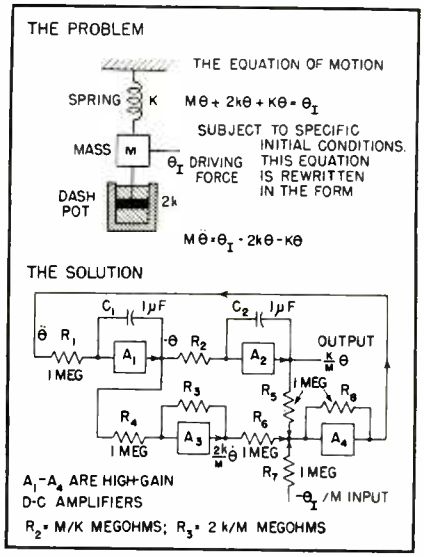
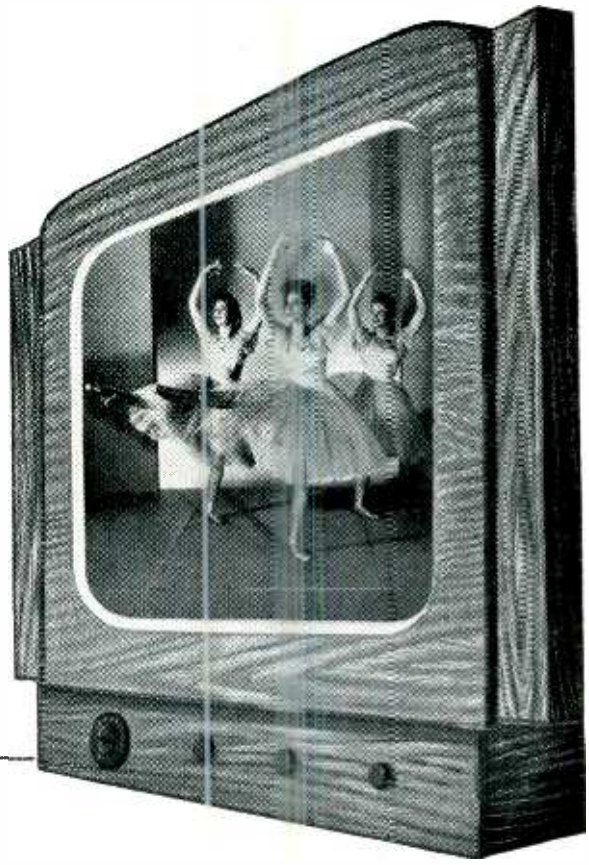


Computer arranged to solve illustrative mechanical problem: First two amplifiers are integrators, third multiples by a constant, fourth is a summer and each amplifier changes the sign of its input and can be adjusted to multiply by a constant. Unused portions of computer are not shown

use in integrating circuits and 10 precision potentiometers for varying the design parameters that are being studied. Other constants of the problem are fixed by plug-mounted resistors furnished with the computer. The complete unit includes a variable, accurate step-function generator and circuits for applying initial conditions in the form of voltages across the integrating capacitors. Dual voltage limiters simulate mechanical or other limits that may be inherent in some problems.

Problems are wired at the rear of the computer by interconnecting amplifiers, resistors, capacitors, potentiometers, limiters and source voltages on a patch-board. Design changes may be studied by varying the controls on the front of the computer where initial conditions and step-function voltages are set and applied and constants are varied. When the complexity of the problem exceeds the scope of one computer, two or more units may be connected to provide the required computing capacity.

The complete electronic sliderule weighs 650 pounds and is contained in a standard 19-inch relay rack cabinet 6 feet high. The computer houses all required regulated power supplies in addition to the functional circuits; it requires about 1,000 watts at 105–125 volts. Solutions to problems are available as



ATV LEAD-IN LINES

Get Good Receptions!

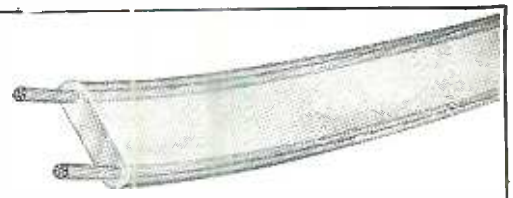
YOU WILL BE MORE CERTAIN to get the best receptions from your television or FM set when you specify ATV* lead-in lines.

The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables.

48446

An Anaconda Trade-Mark



A TYPE ATV LEAD-IN FOR EVERY NEED

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 150 and 300 ohms impedance unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ANACONDA

Anaconda Wire and Cable Co.

variable voltages and currents and may be recorded with any instrument having an input resistance greater than 25,000 ohms and a frequency response commensurate with the frequency components in the solution.

Pulse-Sinewave Converter

By W. M. CAMERON
Technical Officer
Division of Radio & Electrical Eng.
National Research Council
Ottawa, Canada

ALTHOUGH in most apparatus using pulse techniques the desired end result is in pulse form, there are exceptions such as in pulse frequency-modulation systems and radar radio links where sinewave output is desired. A simple and useful method of converting the output pulses to sinewaves is to produce a positive and a negative exponential, which are then folded to produce a wave having approximately sinusoidal characteristics. The circuit for doing this requires few components.

Wave Synthesis

Several practical considerations suggest the sort of converter most suited to this problem. The pulse energy, when averaged over a recurrence cycle, is quite low. Thus, although low-pass filters are conventionally used to obtain sinewaves from pulses, it would be preferable that the converter con-

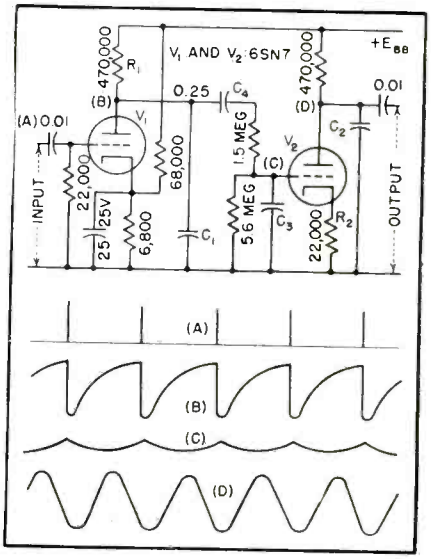


FIG. 1—Circuit for converting pulses to sinewaves is simple and more compact than a passive filter. Component values are for a representative application

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Locate it- ...with an MB PICKUP

Any trace of vibration comes to light when you attach this sensitive electrical pickup to your product. A rugged, precision-built product, it will withstand rough treatment.

When bolted to equipment under test, this velocity-type pickup faithfully converts vibratory motion to an electrical output. Signal can be visualized with an oscilloscope. Major industries today find it indispensable for accurate analyses. Write for bulletin 124.

Reproduce it- ...with an MB EXCITER

You can't beat this electro-dynamic exciter for shaking "bugs" out of products. With its frequency and force adjustments, you can "scan" a product for vibratory response—or fatigue-test it.

Take one case where a manufacturer of turbines was beset by blade failures. With an MB Exciter, he was able to resonate blades to destruction quickly—while studying their motions with stroboscopic light. In this way, he got to the cause of the trouble *visually!* More data in our bulletin 210B.

Isolate it- ...with ISOMODE* MOUNTS

Because Isomode mounts have equal spring rates in all directions, they're efficient at all angles — and they isolate all modes of motion!

That's why, by adopting Isomode units, one company was able to simplify suspension brackets and save on manufacturing costs in *addition to* improving vibration control! Another has been better able to cushion heavy duty engines—*without* redesigning the mounting system! Ask for bulletin 202 and Design Chart.

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

You can see why more and more engineers contact MB when they run into trouble with vibration. We'll be happy to cooperate with you on *your* problems. For more information and for bulletins on the above MB products, write to Dept. E5.

Will you be at the I. R. E. show in N. Y.?
See our demonstration in Booth 250, March 7-10.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

tain an internal power source to furnish an output of reasonable amplitude. This requirement implies the use of vacuum tubes, but the number of tubes should be held to a minimum. The converter output should have reasonably low harmonic content, so that additional filtering can be a minimum, but cannot use resonant circuits for this purpose because the output frequency should be a function of the pulse rate.

Figure 1 shows a circuit that meets these requirements. The first tube is biased to cutoff. A positive pulse on its grid causes C_1 to discharge through the tube for the duration of the pulse, after which it charges slowly through R_1. The exponential wave thus obtained is applied through an R-C network to the grid of V_2. The plate circuit of this tube also has a long time constant that prevents any sharp discontinuities from appearing in the output wave. The curves on the diagram show the waveforms at various points when the circuit is operating at the frequency for which the second harmonic is the least. With an input pulse of 30 volts peak, the output has an amplitude of about 17 volts peak to peak.

Design and Performance

For tube and component values as shown in Fig. 1, the values of C_1 and C_2 for least second harmonic distortion at frequency f_{ll} are given approximately by the empirical formula

$$C_1 = C_2 = 3.70 \times 10^6 \ (f_{ll}^{-1.08}) \ \mu\mu F$$

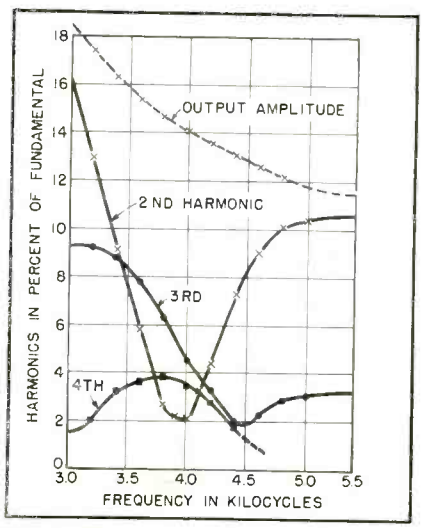


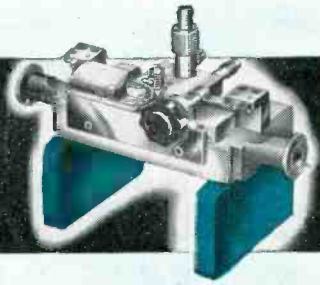
FIG. 2—Measured variations of voltage output and percent harmonics show performance of pulse-to-sinewave converter

PRD

PRECISION MICROWAVE MEASUREMENT COMPONENTS

TYPE 211—PRECISION WAVEGUIDE SLOTTED SECTION
(½" x ¼" Waveguide)

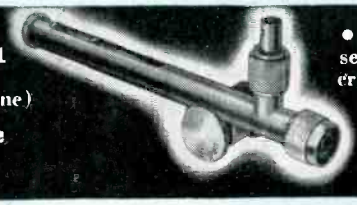
Broadband Operation; Crystal and Bolometer Detection; Ball Bearing Carriage Support



• Similar slotted sections and probes in standard rectangular waveguide and coaxial line sizes make possible precise impedance measurements over the microwave spectrum from 1000 to 40,000 megacycles per second.

TYPE 612—TUNABLE CRYSTAL AND BOLOMETER MOUNT
(Type N—⅜" Coaxial Line)

Broadband Operation; Accurate Square-Law Detection



• The instrument illustrated serves both as a general purpose crystal or bolometer detector and as an harmonic generator for the multiplication of crystal-controlled u-h-f signals into the microwave region.

TYPE 575—REACTION TYPE FREQUENCY METER
(1½" x ¾" Waveguide)

Micrometer Precision; Full Waveguide Frequency Coverage; Ease of Operation

• Currently available in three waveguide sizes to provide coverage from 3950 to 10,000 megacycles per second, these frequency meters combine simplicity of operation, precision, and reliability.

TYPE 559-A—PRECISION FREQUENCY METER
(1" x ½" Waveguide)

Direct Reading Dial; Linear Drive; Hermetic Sealing; Temperature Compensation

• This unit is representative of a complete new line of precision frequency meters available with reaction or transmission coupling, and providing maximum accuracy even when exposed to extremes of temperature and humidity.

TYPE 170—PRECISION CALIBRATED VARIABLE ATTENUATOR
(2" x 1" Waveguide)

Metallized-glass Attenuating Element; Precise and Permanent Calibration; Negligible Insertion Loss

• A full complement of fixed and variable attenuators and broadband terminations in standard waveguide sizes provides coverage from 2600 to 40,000 megacycles per second.

The instruments illustrated above are the result of the continuing efforts of PRD's skilled staff to provide the microwave research engineer with test equipment of ultimate accuracy and reliability over broader and broader frequency bands. Techniques of novel character are used to give the many outstanding features available in the complete PRD line of precision microwave measurement and test equipment. An illustrated catalog may be obtained by writing on company letterhead to Dept. E-1.

Polytechnic RESEARCH and DEVELOPMENT COMPANY · Inc

202 TILLARY ST., BROOKLYN 1, NEW YORK

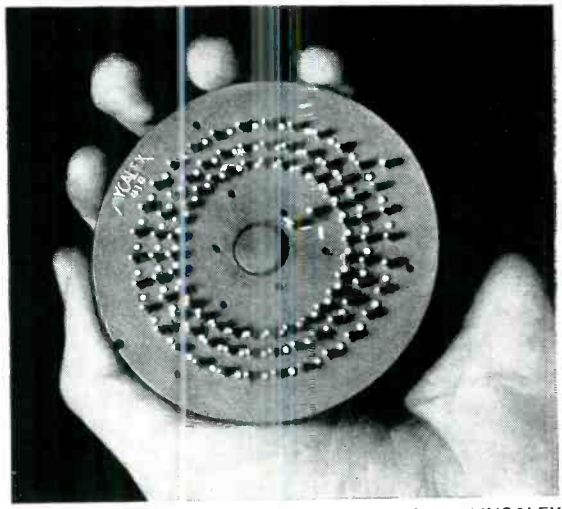
and C_3 is ten percent of this value. The coupling capacitor C_4 should be kept large so that it does not introduce appreciable phase shift. Part of the justification for this approximate formula is that the impedances in the circuit are adjusted to produce only slight loading on previous loops in the networks. The approximation is within ten percent of the rigorous result, which is commensurate with the tolerance of commercial components.

Other factors than component values influence the waveform. With plate supply voltages of 200, 150 and 100 volts the corresponding second harmonics were 15, 17.3 and 20 percent at 2,200 cps. Values ranging from 14.5 to 21 percent were found at the same frequency when other tubes of the same type were substituted. Figure 2 shows the harmonic content from a typical converter (measured on a General Radio type 636-A Wave Analyzer) expressed as a percentage of the fundamental. Four converters operating within the band from 500 to 4,000 cps but having different f_H were tested. The second harmonic present at f_H was 2.7, 3.2, 4.0 and 2.1 percent respectively.

In planning an adaptation of this converter for other ranges or tube complements, the two functions of the circuit should be kept in mind. The part of the circuit to the left of C_1 produces an exponential wave from the pulse input. A large exponential voltage change across C_1 is desired and will be obtained when the impedance of R_1-C_1 is high and V_1 has low plate resistance and high emission capability; a sharp cutoff tube requires lower input pulses than a remote cutoff type. The part of the circuit to the right of C_4 is a dynamic filter in which R_2 is in series with the plate resistance of V_2 during both charging and discharging of C_2, the voltage change across C_2 being effected by varying the plate resistance. With other tubes, R_2 should be chosen for best filter action. While one might obtain the required filtering with a passive L-C network, the size of the inductances necessary at these frequencies that will match a driving impedance in the order of 0.5

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.

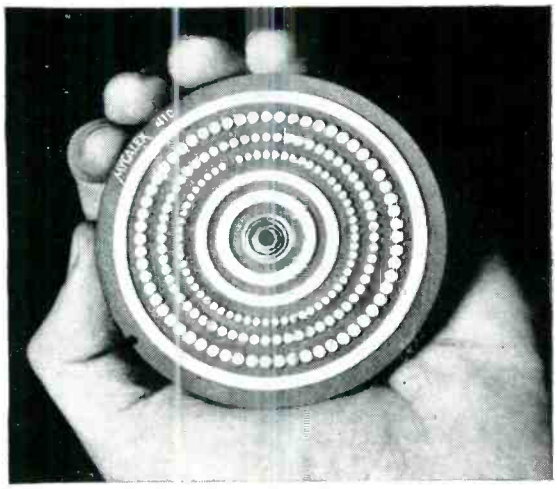


Illustrated are top and bottom views of the MYCALEX 410 molded insulation commutators manufactured to the specifications of Raymond Rosen Engineering Products, Inc., for Air Material Command and Navy telemetering projects. This commutator, with 180 contacts and 3 slip rings of coin silver, samples sixty 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.



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.

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.

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.*

* You are cordially invited to visit our display at the Radio Engineering Show, Booth 82 on the main floor, where you will see in test the MYCALEX 410 COMMUTATOR, above described . . . . also on display will be a great many high frequency electronic components molded of MYCALEX 410 insulation.

megohm is the main drawback.

When the electronic converter circuit is used in frequency-modulation equipment, the deviation should be limited to five percent of the recurrence frequency. A circuit of this type was used successfully in a pulse frequency-modulation system that carried audio frequencies to 2 kc on a mean recurrence frequency of 5 kc.

CBS Listener-Counter

OPERATION of a newly developed Instantaneous Audience Measurement system known briefly as IAMS was described by Peter C. Goldmark, director of engineering research for Columbia Broadcasting System, at a recent IRE New York section meeting. The system involves having 1,000 transceivers located in preselected homes and actuated by pulses sent out by a master broadcasting station along with its regular program. When interrogated, the transceivers broadcast uhf pulses in turn that are picked up and collated at the measuring location. Results appear in the form of a graph on paper tape, showing the percentage of sets in use and tuned to a particular station at the time of interrogation.

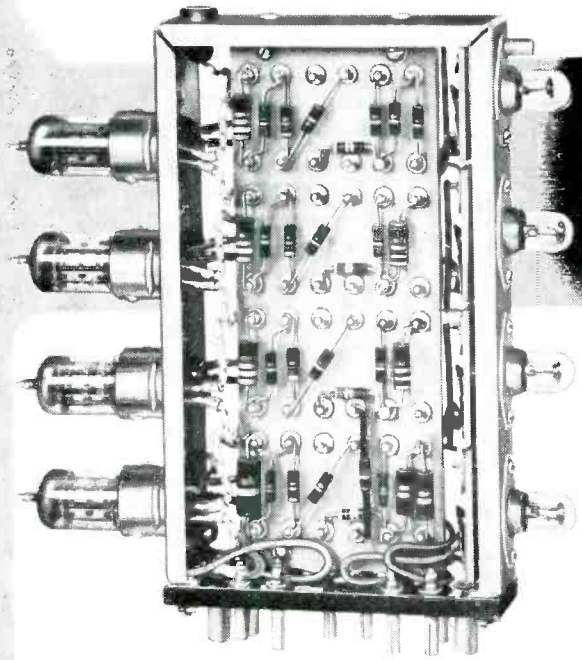
Each transceiver is about the size of a cigar humidor. Installation merely involves plugging into a wall outlet and connecting to the a-m, f-m and tv sets in the home. Additional features that can be incorporated include a yes-no push-button that allows the listener to vote on various questions asked over the air, and means for identifying in which of three income groups and three geographic groups the responding transceivers are located.

Motor-driven clocks in the transceivers are synchronized with a master clock at the transmitter that has its face divided into 60 information segments, 20 each for a-m, f-m and tv sets. As the hand of the clock in each transceiver reaches a segment, the transceiver sends out a pulse if the set and station assigned to that segment are on in that home. The clock hand makes one revolution in 2½ minutes, and the 1,000 transceivers polled at

ONLY THE *POTTER* DECADE COUNTER

OFFERS:

-the simplest and most reliable decade circuit



Plug-in type decade using 12AU7 tubes. Note the simple, accessible construction.

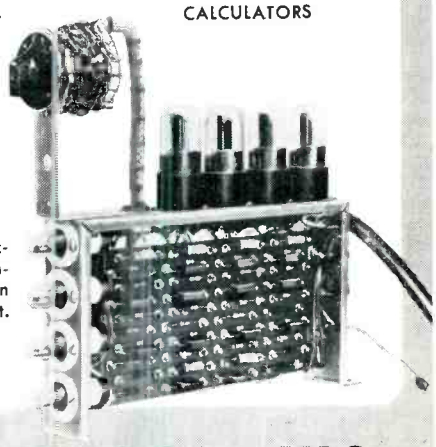
The POTTER 4-tube Decade Counter Circuit has been proven by over five years of actual operation in Government proving grounds as well as in numerous industrial applications in which a precise count is required for packaging or automatic machine control. The Decades are available either as components to be used in your equipment, or in a packaged POTTER Scaler, Predetermined Counter, or Precision Counter Chronograph. Modified or specially-designed counting, timing and calculating equipment can be supplied for special applications.

For an accurate appraisal of your problem, call or write Department 6-A.

- **DIRECT DECIMAL READ-OUT** — four neon glow lamps designated 1—2—4—8, provide a direct indication (0 to 9) of the four trigger stages without a complex resistor matrix.
- **WIDEST BIAS RANGE** — (best test for a counter circuit) insures stable operation.
- **PREDETERMINED COUNTS** — exclusive complementary predetermining makes possible a simple count selector switch and single pulse output at the predetermined count.
- **SMALLEST NUMBER OF COMPONENTS**—uses only four tubes, four glow lamps and the minimum number of parts.
- **DEPENDABLE**—all components are the finest. Examine any of our counters to see the best in electronic construction.

APPLICATIONS:

PULSE AND SINE WAVE COUNTING
PRECISION TIMING
FREQUENCY MEASUREMENTS
RADIATION MEASUREMENTS
AUTOMATIC MACHINE CONTROL
FREQUENCY DIVIDING
MEMORY AND TRANSLATION
PACKAGING BY PREDETERMINED COUNT
FLUID AND GAS FLOW MEASUREMENT
BUSINESS MACHINE CALCULATORS



Single Predetermined type decade using 6SN7 tubes. A simple switch provides selection of any predetermined count.

WHEN YOU ATTEND THE IRE SHOW

We extend a cordial invitation to visit our plant in Flushing — only 30 minutes from Grand Central.

POTTER INSTRUMENT CO • INC

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YOU CAN COUNT ON POTTER!

each of the 60 segments can thus send up to 60,000 separate responses to the system receiving antenna. During the nine months of operational tests this antenna has been atop the Chrysler building along with a special uhf receiver and binary counter capable of counting up to 250,000 units per second. The output of the counter is coded and sent over phone line to CBS headquarters, where the information is uncoded and recorded on a Leeds and Northrup instrument that gives the desired information at a glance.

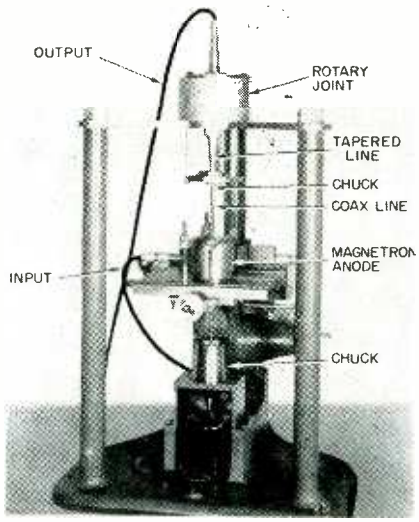
Rotating Probe Machine

By George L. Stambach
Naval Research Laboratory
Navy Department
Washington, D. C.

To investigate the nature of field patterns in multicavity magnetrons, rotating probes have been used. The machine developed at this laboratory possesses novel features that make it simple and reliable in use.

Construction of Machine

The rotating probe machine is a device for exploring fields in regions of cylindrical symmetry and, as developed for use with magnetrons, displaying the field intensity distribution on a synchroscope. Its use permits the identification of oscillation modes in magnetrons without laborious measurements. The accompanying photograph of



Field patterns inside magnetrons can be measured easily with this probe machine.

Announcing

THREE IMPORTANT NEW PANORAMIC INSTRUMENTS FOR AF to UHF SPECTRUM ANALYSIS

MODEL **SB-7***

Panoramic Ultrasonic Analyzer, Model SB-7 for easy, fast Ultrasonic Analysis

FEATURES

- Direct Reading
- Linear Frequency Scale
- Continuously Variable Scanning Width
- Linear and 40db linear log amplitude scale
- Stabilized Frequency Calibrations
- Continuously Adjustable Selectivity
- Wide Input Voltage Range

USES

- High Frequency Vibration Analysis
- Transmission Line Investigations
- Carrier System Monitoring
- Harmonic Analysis
- Feedback System Studies
- Material Testing
- Telemetering
- Medical Studies

An entirely new instrument, the SB-7 is engineered to meet the urgent demands for panoramic reception of ultrasonics—demands ranging from high speed panoramic analysis of jet engine vibrations to panoramic-simplified monitoring of telemetering subcarriers.

The SB-7 an automatic scanning receiver graphically presents frequency and level of signals in the ultrasonic spectrum. Special control features enable selection and spreading out of any narrow band for highly detailed examination.

PANALYZOR MODEL **SB-8*** PANADAPTOR MODEL **SA-8***

Versatility PLUS in RF Spectrum Analysis

FEATURES

- Variable Resolution 10:1 Range
- Long persistance Cathode-ray Tube . . . 5" Screen
- Synchronous or non-synchronous scanning
- Variable Scanning Rates
- Signal Amplitude Compression
- Continuously Variable Scanning Width

USES

- Analyzing AM and FM Transmitters
- Testing Industrial RF Equipment
- Spotting Spurious Oscillation and Modulation
- Monitoring Communications Frequencies
- Telemetering
- Checking Diathermy Units
- Investigating Pulsed RF Signals

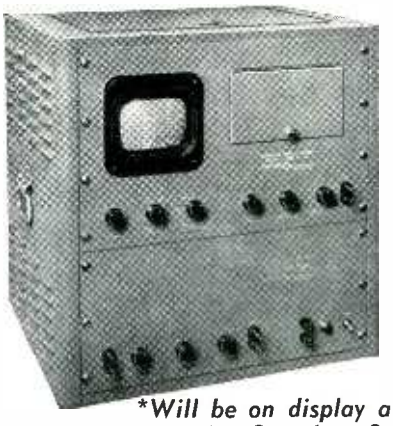
Incorporating completely new design features to provide long and short persistence Panoramic displays with extremely fine signal resolution, the SB-8 and SA-8 offer increased possibilities in RF spectrum analysis.

Typical new applications include . . . Energy distribution investigations of pulsed RF signals with *low p.r.f.'s* • Side band analysis of AM and FM signals modulated by *low audio frequencies* • Monitoring of signals *very closely adjacent* in frequency.

Both Panalyzor and Panadaptor Models are available in the following three types: T-200, T-1000 and T-10,000 having scanning widths of 200 kc, 1 mc and 10 mc respectively.

PANORAMIC SONIC ANALYZER, MODEL AP-1*

Complex Audio Wave Analysis with Speed PLUS



Model AP-1 assures faster and far simpler audio analysis by *automatically* separating and simultaneously measuring the frequency and amplitude of complex wave components.

Whether your problem is investigation of harmonics, transmission characteristics of lines or filters, vibration, intermodulation, noise or acoustics, the startling advantages offered by the Panoramic Sonic Analyzer will provide solutions faster.

ADVANTAGES: Quick graphic views of the 40-20,000 cps spectrum are provided once per second • Chances of missing weak or high frequency components are removed • Random changes in wave content can be observed • Operation is comparatively simple • Measures amplitude ratios as high as 1000:1

FEATURES: • Logarithmic frequency scale • Linear and linear log voltage scale • Wide input voltage range • High sensitivity • Direct reading • Calibrated for absolute or relative amplitude measurements.

**Will be on display at the March IRE Convention, Booth 241-2*

Write for Complete Specifications on the above four instruments

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PANORAMIC, NEW YORK
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the machine shows its essential parts.

The magnetron anode assembly is clamped on a table that can be moved horizontally and vertically to permit centering and exploring the field axially or radially. The anode is excited by a loop or waveguide coupling into one of its cavities. The magnetron's cathode is replaced by the coaxial line of the rotating probe. The probe proper consists of a short wire projecting radially from the center conductor of the line through a hole in the outer conductor. The voltage induced on this probe is the integrated effect of the radial electric field between the tip of the probe proper and the outer surface of the cylinder (face of the replaced cathode).

The lower end of the coaxial line of the probe is held and driven by a chuck, the details of which are shown in Fig. 1. The upper end of the line is coupled through a rotat-

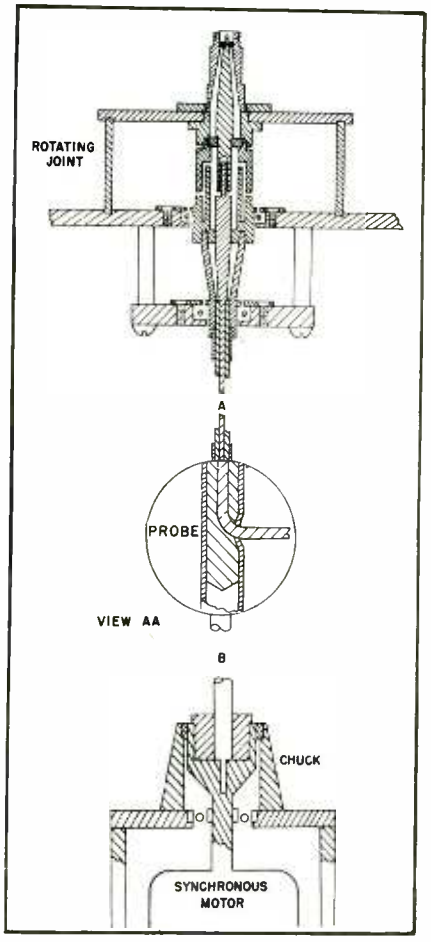
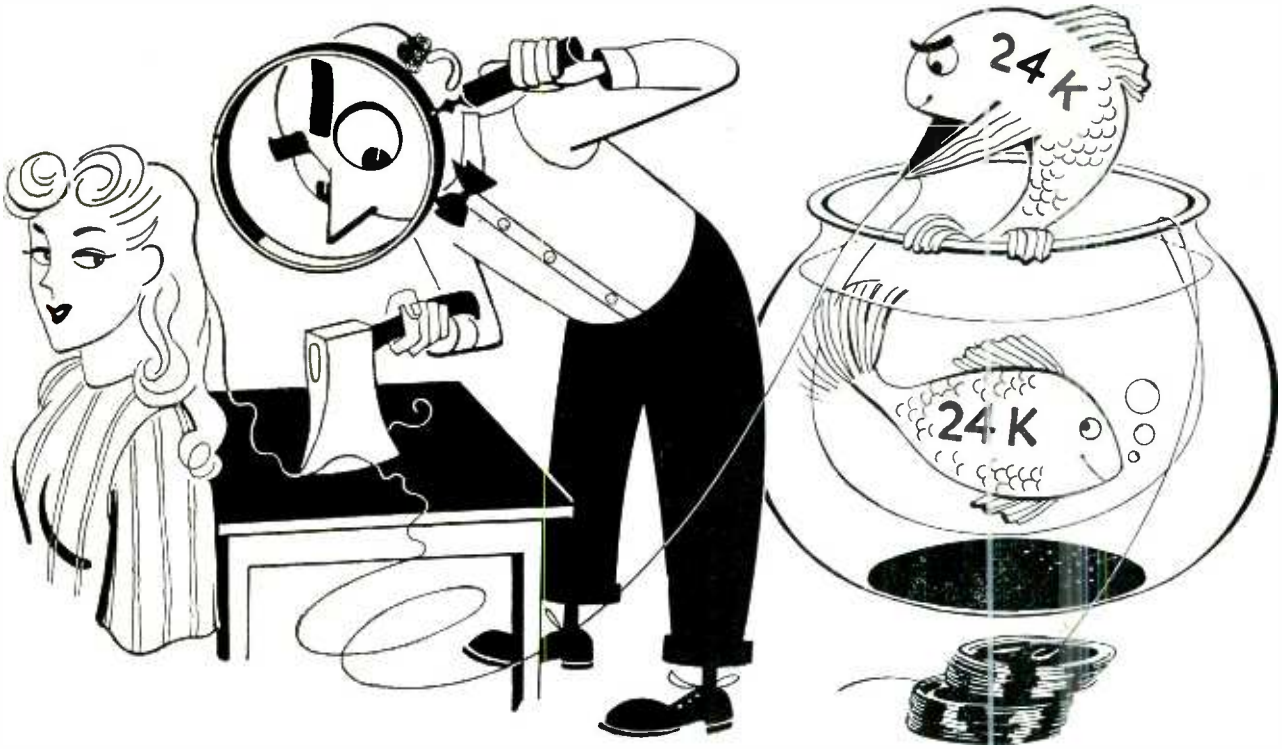


FIG. 1—At the top is the cross-section of the rotating r-f joint, in the middle is the probe, and below is the centering chuck. The rotating joint eliminates sliding electrical contacts

We'll gladly **SPLIT A HAIR** for you . . .
and gold-plate it, too!



FINE Wire Headquarters often gets the darndest problems . . . solves 'em, too! Here's a typical example:

A manufacturer of special-purpose electronic tubes required a quantity of .00028" fine Tungsten wire, which is 1/10th the diameter of a human hair. And this had to be plated with a coating of gold to a uniform thickness of .000006". Uniformity of the goldplating was as important to performance characteristics of the wire as the exact diameter of the wire itself.

Fine Wire Headquarters accepted this challenge, went to work with speed and accuracy and delivered this gold-plated hair-splitting assignment to the customer's complete satisfaction.

★ ★ ★

North American Philips specializes in drawing, enameling and plating extremely fine wires in practically all metals and alloys.

So, when you have a problem on Fine Wire, Tungsten, or Molybdenum, why not call on Fine Wire Headquarters? Phone, wire or write to North American Philips, makers of NORELCO Fine Wires and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.

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Export Representative • Philips Export Corporation • 100 East 42nd Street, New York 17, N. Y.

ing radio-frequency joint to the detector, which can be simply an untuned crystal rectifier if the signal is strong enough, or a tuner and receiver as shown in Fig. 2. The output of the detector feeds the synchroscope which is synchronized with the rotation of the probe. The rotating joint was designed for 10 centimeters, and, although it is frequency sensitive, its impedance remains constant with angle of rotation, and good patterns have been obtained over the range from 7 to 35 centimeters; Fig. 1 shows the details of its construction.

In mounting an anode on the table for measurement, the probe is removed through the lower chuck, the anode assembly mounted

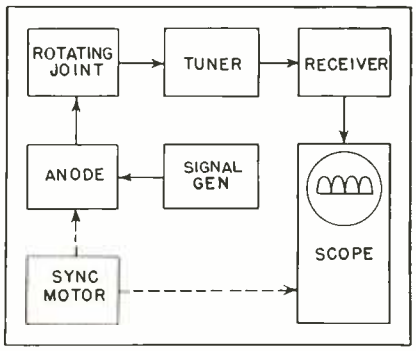

FIG. 2—Block diagram shows association of other measuring equipment with the rotating probe machine

firmly on the table, the table above the chuck, the probe returned to position, and the anode finally centered on it. The chuck and rotating joint are precision machined because a small eccentricity of the probe produces considerable shifting of the resonant frequency of the anode thus distorting the patterns obtained. This chuck holds the shaft to less than one-thousandth of an inch deviation.

Measuring Magnetron Modes

Under the usual condition that the only modes of a magnetron that are of interest are those in which the cavities act as quarter-wave resonators, there are as many indepent modes as there are cavities. Each of these modes has its particular field configuration. In turn, the field pattern of any mode can be analyzed into a series of configurations varying sinusoidally with angular position around the cavity. The probe samples the radial ponent of voltage of the

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Net Weight	28 lbs. 6 ozs.

18" P.M. LOUDSPEAKER
Type T11/1801/6

Maximum Power Capacity	50 watts peak A.C.
Response	35/4,000 c.p.s.
Fundamental Resonance	55 c.p.s.
Voice Coil Impedance	6 ohms.
Total Flux	267,000 lines
Overall Depth	9.9/16"
Net Weight	35 lbs.

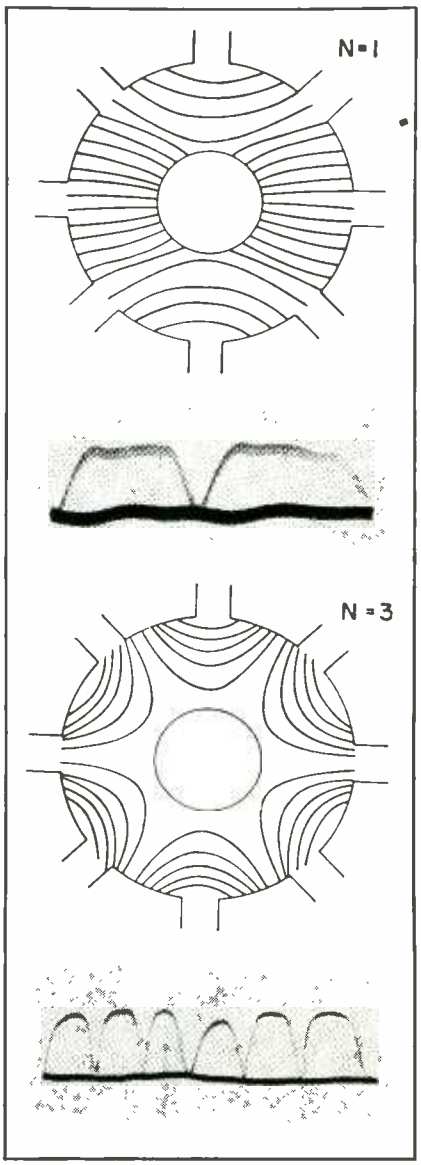


FIG. 3—Comparison of theoretical field patterns for first and third modes with measured component at cathode show nature of distortions inside magnetron

urations. Because the higher harmonics of the field pattern fall off rapidly with radius, the short probe is more sensitive to the lower components.

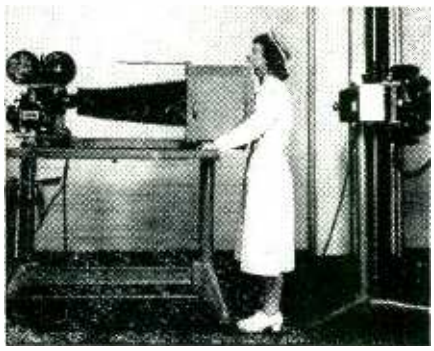
The presence of the metallic probe disturbs the field configuration. The probe should, therefore, be as short as possible.

Figure 3 compares the field configurations for the first and third modes of an eight cavity magnetron with the measured field strength as displayed on the synchroscope. The magnetron anode was fed with pulsed power so that the field strength periodically fell to zero, thus producing the base line shown in the oscillograms. If the pattern is distorted due to extraneous in-

terference, ripple in the receiver, or other noise, the base line is distorted the same as the pattern so that accurate measurements can still be made.

SURVEY OF NEW TECHNIQUES

X-RAY MOVIES (cinefluorographs) are being used in studying movements of joints and swallowing. The technique, developed at the Department of Radiology of the University of Rochester School of Medicine and Dentistry and described at the annual meeting of the Radiological Society of North America, permits such studies as the detailed movement of x-ray opaque contrast medium through the arteries and veins. As an adjunct to medical education, it will permit teaching students or assistants in considerably less time than that now required. The apparatus, shown in the accompanying picture, limits the x-ray dosage received by the patient to those levels commonly used in routine diagnostic x-ray procedures by diaphragming the x-ray beam to cover only the part of the body under study and by synchronizing the x-ray output with the camera movement so that there is radiation only while the film is being exposed. The equipment at Rochester had its origin in an Eastman Kodak Co. 16-mm unit and subsequently changed to 35 mm. A General Electric transformer, control and CRT 1–2 tube provide the source of x-rays that produce an image on a Patterson E2 fluorescent screen. This image is focused on the motion picture film by a specially designed Bausch & Lomb f0.85 lens.



A nurse demonstrates the use of cinefluorographic equipment. The motion picture camera and fluoroscope screen are mounted on a lathe bed for rigidity

made for both c-w and pulse operation with rise time of 0.1 microsecond. The r-f attenuator is of the waveguide-below-cutoff type with matched resistive loops. Army-Navy designation of the equipment is TS-602/U.

C-R Sweep

JAMES MILLEN MFG. CO., INC., Malden, Mass. A new oscilloscope amplifier and sweep unit has been developed for use with any of the line of 2-, 3-, and 5-in. rack panel oscilloscopes. Type 90920 comprises

horizontal and vertical amplifiers, a hard-tube sawtooth sweep generator and power supply mounted on a standard 5¼-in. panel.

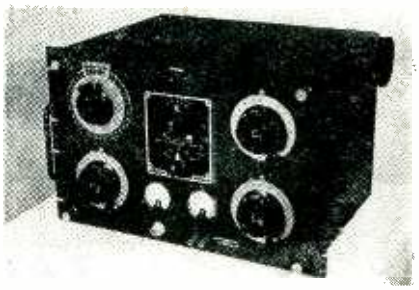
Servo Analyzer

FLIGHT RESEARCH ENGINEERING CORP., P. O. Box 1-F, Richmond 1, Va. The type 5 servo analyzer is a general purpose servo test instrument for measuring dynamic response of d-c or 400 cycle a-c servo-

mechanisms, servo amplifiers and networks. It is suitable for testing servos whose resonant frequencies are in a range between 0.1 and 60 cps. A 17-page booklet of operating instructions is available.

Artificial Antenna

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC., Miami, Florida. The artificial antenna illustrated permits tuning aircraft transmit-



ters at the test bench. Various settings simulate characteristics of any airborne antenna.

Tele Monitor

ALLEN B. DUMONT LABORATORIES, INC., 1000 Main Ave., Clifton, N. J. Type 2116 picture monitor for television broadcast station use has a

20-in. picture tube and operates from a composite picture signal on a 75-ohm line with a level between 0.5 and 2.5 peak-to-peak volts.

Ribbon-Line Plug

JAMES MILLEN MANUFACTURING CO., INC., Malden, Mass. The new type 37412 plug designed for use with 300-ohm polyethylene r-f transmission line fits the type 33102 socket previously available for

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mounting control crystals. Pin spacing is half-inch, with pin diameter 0.095 inch.

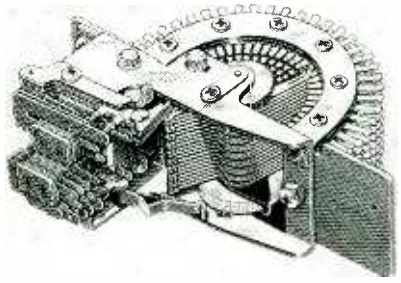
Radio Noise Locator

ELTRON, INC., Jackson, Mich., has announced a lightweight device designed to quickly locate radio noise sources on all types of electrical power circuits. The unit weighs 11 pounds, is equipped with an illuminated output indicating meter, ac-

curate sensitivity switch, loop antenna and earphones. In operation the sensitivity control is set to maximum and the antenna held parallel to the electric circuit while one moves parallel to the circuit.

Twenty-Six Point Switch

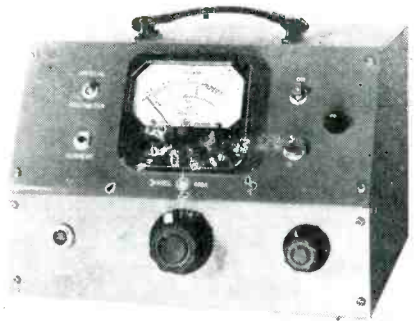
C. P. CLARE & CO., 4719 Sunnyside Ave., Chicago 30, Ill. A new high-speed spring-driven stepping switch with from one to ten bank levels, each comprising 26 contacts is now



available. Remote operation at a maximum of 30 steps per second and self-controlled operation at about 60 steps a second is possible with a 48-volt power supply. Only direct current can be used for operation.

Standing-Wave Indicator

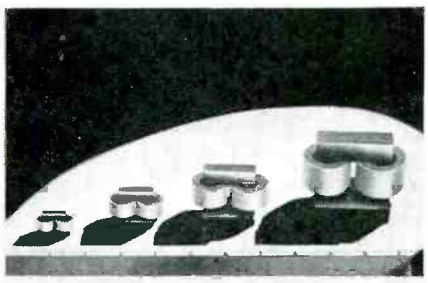
HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Type 415A standing wave indicator, designed for use with type 805A



parallel-plane slotted line measures relative audio voltages detected by a crystal rectifier or bolometer. Used with other slotted-line systems, it will determine flatness of a coaxial or waveguide system, measure impedance, locate sources of reflection and determine percentage of reflected power. The instrument comprises a high-gain amplifier with low noise level operating at a fixed audio frequency. Amplifier output is measured with a square-law vtvm. Calibration is in db and vswr. As furnished, the indicator operates on 1,000 cycles. Other frequencies from 300 to 2,000 can be obtained on special order. Overall amplifier Q is about 20.

Magnetic Amplifiers

VICKERS ELECTRIC DIVISION, VICKERS INC., 1815 Locust St., St. Louis 3, Mo., has a wide line of magnetic amplifiers for lamp and furnace



controls, line-to-line voltage regulators, instrument amplifiers and control relays. General use of tubeless amplifier circuits is involved. Power supply requires merely the single-phase or polyphase a-c line voltage. They feature high ratio output power to control power.

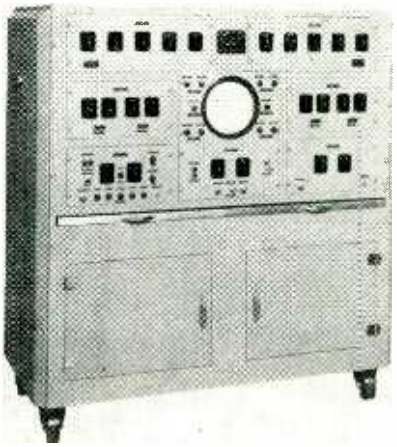
Short Leads

ELECTRO WIRE SERVICE, 5 Beekman St., New York 7, N. Y. Very short hookup leads or shunts are avail-

able in lengths from ¾ to 1½ inch in No. 22 tinned wire in a choice of seven different colors. Other lengths, gages, insulations, or colors can be furnished on special order.

Five-Channel Oscilloscope

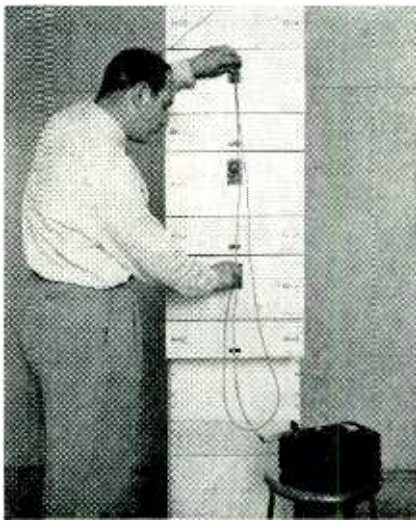
ELECTRONIC TUBE CORP., 1200 E. Mermaid Ave., Philadelphia 18, Pa. Model E5GVM five-channel oscil-



loscope illustrated has been designed for medical research. A five-gun c-r tube is employed. Amplifiers used are suitable for certain responses such as respiration and changes in blood pressure.

Carrier System

LENKURT ELECTRIC CO., 1113 County Road, San Carlos, Calif. Designed for simple convertibility, the new wire-line or radio-link type 33 carrier system permits installation of a single channel by itself and the later addition of one or two



more channels as required. The loop gain of 30 db allows satisfactory service up to 250 line-miles without repeaters. Nominal transmitting level is +14 dbm. Minimum received level for a zero-db equivalent is −16 dbm. Either 2 or 4-wire operation can be used. Modulation of a single-sideband fully-suppressed carrier is employed.

Spectroradiometer

SYLVANIA ELECTRIC PRODUCTS, INC., Emporium, Pa. An automatic recording spectroradiometer for

production control of commercial television tubes plots energy output of tube screens throughout the entire visible light spectrum in 48 seconds.

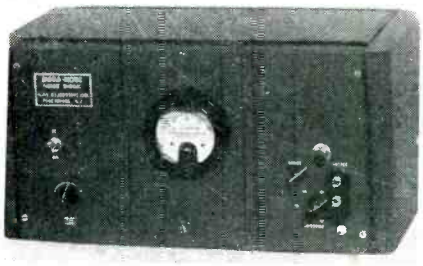
New Resistors

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia, Pa. A new insulated fixed composition resistor designated type BT is now being produced in ½, ½, 1, and 2-watt ratings. The new resistor

meets JAN-R-11 specifications. Temperature coefficient varies from 0.02 percent per degree C for low ranges to 0.14 percent per degree C for high ranges. Other significant details are included in technical data bulletin B-1.

Noise Generator

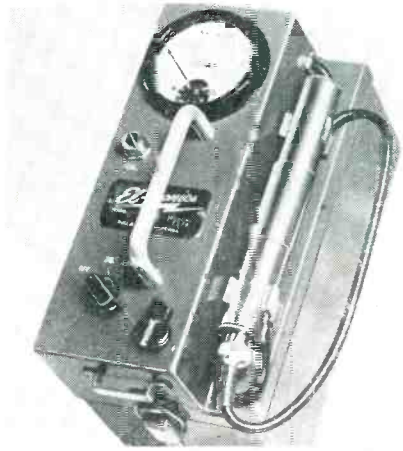
KAY ELECTRIC CO., Pine Brook, N. J. The Meganode is a calibrated source of random noise covering the frequency range from 0 to 220 mc. Output impedances of 50, 70, 100,



150, 300 ohms and infinity are selected by a front-panel control. Noise figure ranges from 0 to 17 db up to 0 to 23 db are available. The direct-reading instrument can be used to determine noise figure of television, f-m, or radar receivers. The fob price is $295.

Gamma Survey Meter

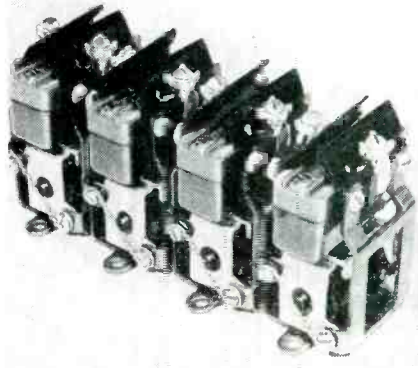
EL-TRONICS, INC., 2647 North Howard St., Philadelphia 33, Pa. A new beta-gamma survey meter



model SM-3 provides direct readings in three full-scale ranges of 0.2, 2.0, and 20 milliroentgens per hour. Ninety percent of final reading is reached in 3 seconds.

Aircraft Relay

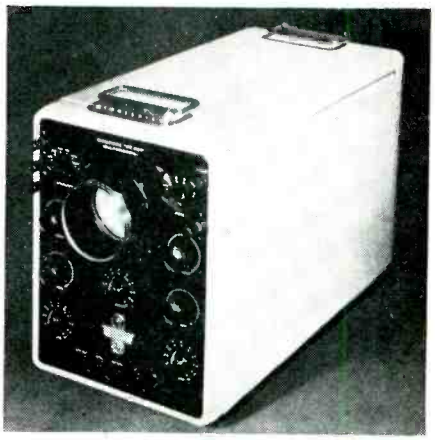
COOK ELECTRIC CO., 2700 Southport Ave., Chicago 14, Ill. This miniature aircraft Diaphlex relay has



main supports made entirely of anodized aluminum for corrosion resistance. Coil resistance is 150 ohms, 28 volts d-c; switch is snap action spst with magnetic blowout, normally open, rated at 10 amperes, 110 volts, d-c inductive. The unit is suitable for operation from — 65 to + 160 F.

D-C Scope

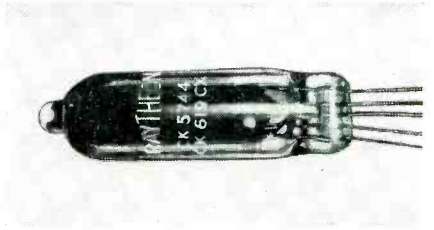
AMERICAN BRITISH TECHNOLOGY, INC., 57 Park Ave., New York 16, N. Y. The latest in a series of d-c oscilloscopes manufactured by



Furzehill Laboratories is type 1684N. Its range extends from zero to 50 kc with negligible phase distortion up to 30 kc. Vertical amplifier has a maximum sensitivity of 2.5 millivolts per inch.

Subminiature Triode

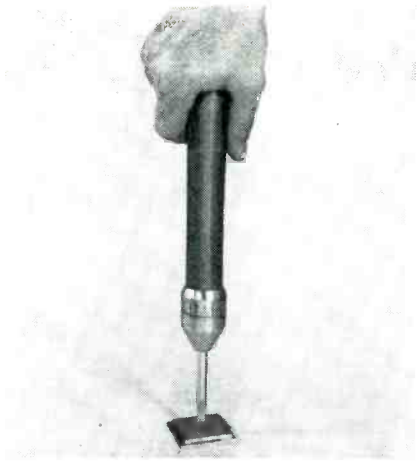
RAYTHEON MFG. CO., Newton, Mass. Type CK5744/CK619CX is a subminiature high-mu triode suitable



for general purpose use as a high-frequency mixer in superheterodyne circuits when a separate oscillator is provided.

Torque Indicator

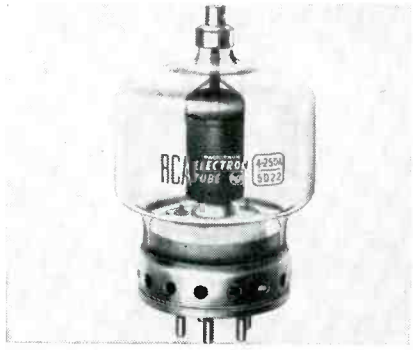
MORILL AND MORILL, 30 Church St., New York 7, N. Y. Torac torque indicator is a light, high-precision instrument for calibrating screwdrivers and wrenches. It is fur-



nished in four standard ranges from 0-to-2 up to 0-to-20 pound-inches. Further details are given in circular 461.

Power Tetrode

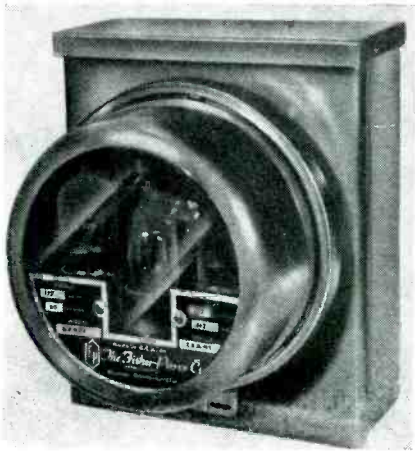
RADIO CORP. OF AMERICA, Harrison, N. J. Type 4-250A/5D22 is a forced air-cooled power tetrode with



maximum plate dissipation of 250 watts. Full ratings obtain up to 75 mc and reduced ratings to 120 mc.

Photocontrol

FISHER-PIERCE CO., INC., 70 Ceylon St., Boston 21, Mass. Series 62405 outdoor photoelectric lighting control is a single unit photorelay and



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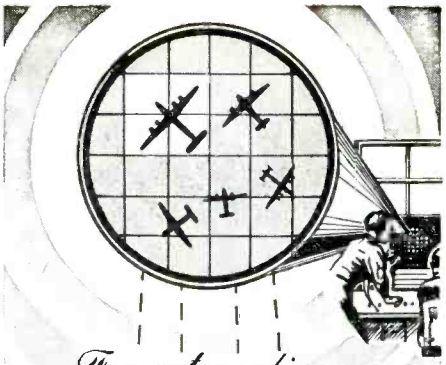

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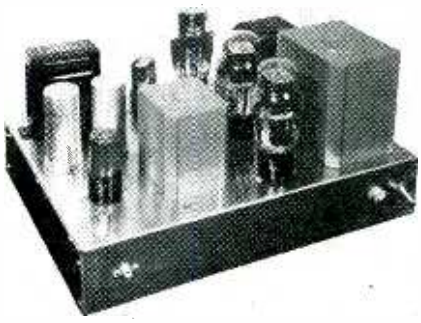
synchronous time switch for billboards, parking lots, rural street lights. The contactor in the unit will switch up to 30 amperes of incandescent light load.

All-Triode Amplifier

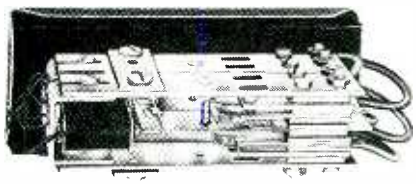
BROWNING LABORATORIES, INC., 742–750 Main St., Winchester, Mass. Model AA-20 high-fidelity amplifier features all-triode voltage-gain and power stages for response within 1 db from 10 to 17,000 cycles with



less than 1.5-percent harmonic distortion at 14 of the rated 15 watts output. Hum level is 65 db below maximum rated output. The unit is designed for use with the RJ-20 tuner.

Tandem Vibrator

KURMAN ELECTRIC CO., INC., 35–18 37th St., Long Island City 1, N. Y. The tandem vibrator unit illus-



trated has been designed for heavy duty applications. It measures 5⅝ x 2¼ x 3⅝ inches.

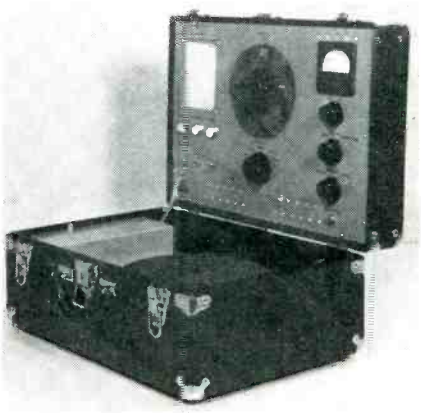
Radial Projector

JENSEN MFG. CO., 6601 S. Laramie Ave., Chicago 38, Ill. Model VR-241 ST-789 Hypex projector has a developed acoustic path length of 54 inches and a useful frequency response range from 140 to 6,000 cps. Voice coil impedance is 16 ohms;

power rating is 25 watts maximum signal input. The driver unit has a phenolic diaphragm and Alnico-5 magnetic.

Portable Audiometer

MICROTONE CO., Minneapolis, Minn. The audiometer illustrated graphically demonstrates hearing losses,



and is designed to aid the proper selection of hearing aids for the particular deficiency encountered.

P-M Speakers

RADIO CORP. OF AMERICA, Harrison, N. J. Two new permanent magnet

speakers type 308S2 and 408S2 have ¾-inch diameter voice coils and 8-inch cones. Each speaker has a power handling capability of 6 watts. Holes are provided for mounting output transformers.

Industrial Miniature Tube

GENERAL ELECTRIC CO., Schenectady, N. Y. Type GL-5610 7-pin miniature electronic tube has a

plate dissipation of 3 watts and its characteristics include heater voltage, 6.3 v; plate current 17 ma; plate resistance 3,500 ohms.

Projection Tele Lens

SPELLMAN TELEVISION CO., INC., 130 W. 24th St., New York 11, N. Y. The f 1.9 projection television lens can be used to project picture sizes

from several inches to 7 × 9 feet. It incorporates in the barrel a removable corrective lens for use with a 5TP4 projection tube. Dimensions: 7 inches long, 4¼ inches in diameter; f 1.9; ef, 0.5 inch.

Test Probes

PRECISION APPARATUS CO., INC., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y. The series TV high-voltage safety test probes afford direct measurement facilities up to 30,000 volts d-c. Featured

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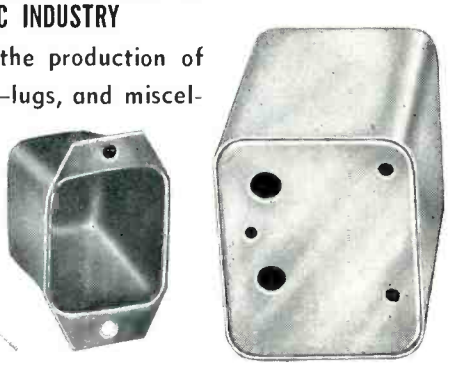

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A special process has been developed to overcome fragility and give sturdiness to this STANDARD unit. Range —200 to 1200 kc. CT and DT cut. Hermetically sealed and filled with dry nitrogen. Good stability over wide temperature range. Meets government specifications. Write or wire for additional information.

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CARLISLE, PENNSYLVANIA

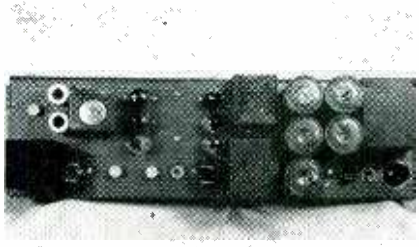
are the extended high dielectric anti-leakage paths, multi-channeled guard barrier, and directly-grounded arc-back barrier and shield. Standard models cost $15.45 each.

Speaker Replacements

RADIO CORP. OF AMERICA, Harrison, N. J. A new line of replacement speakers comprises 14 permanent-magnet and three field-coil types. Several elliptical speakers are included. In some of the models a universal transformer mounting bracket and adapter plate are included.

Audio Amplifier

SCHUTTIG AND CO., Ninth and Kearny Sts., N. E., Washington 17. D. C. Type S190A regulated output amplifier is a three-stage push-pull device to provide constant output level which can be adjusted for



any value between minus 10 and plus 5 db. An independent noise-suppressing circuit eliminates noise between transmissions. Input impedance is low, ranging from 25 to 600 ohms. Maximum gain is 75 db.

Titanium Metal

E. I. DUPONT DE NEMOURS AND CO., INC., Wilmington 98, Delaware. Ductile titanium metal, sometimes used for electron tube anodes, is now becoming available in small quantities through operation of a pilot plant. The metal is comparable to stainless steel in strength and corrosion resistance, but weighs little more than half as much per unit volume.

Laminate Insulator

ST. REGIS PAPER CO., 230 Park Ave., New York 17, N. Y. A new pheno-

lic laminate recently announced shows resistance of 2,500 megohms when tested under JAN-P-13 specifications, and 10,000 megohms when tested according to the ASTM method. The new material is suitable for hot punching or stamping.

Floating Battery Chargers

POWER EQUIPMENT CO., 55 Antoinette St., Detroit 2, Michigan, has announced a new line of electronically controlled and regulated floating battery chargers for power

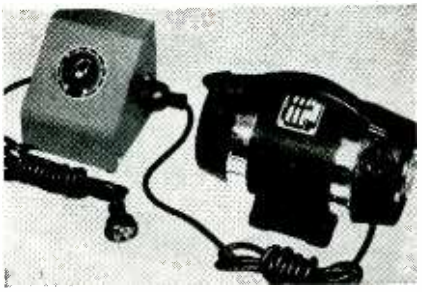
stations, communications and other applications. Electronic overload protection limits current to the preset maximum value and reduces terminal voltage below battery voltage until peak requirement is passed.

Impedance-Phase Meter

TECHNOLOGY INSTRUMENT CORP., 1058 Main St., Waltham 54, Mass. Type 311-A r-f Z-angle meter was designed primarily to fulfill the requirements of broadcasting for measurements at radio frequencies of antennas, transmission lines, coupling networks, as well as general laboratory measurements. Frequency range is 100 kc to 2 mc with phase angle range from zero to 90. Upper impedance range varies between 500 and 5,000 ohms depending upon frequency.

Television Converter

CARTER MOTOR CO., 2644 N. Maplewood Ave., Chicago 47, Ill. Model D1010CT television converter is designed to operate 7-in. television



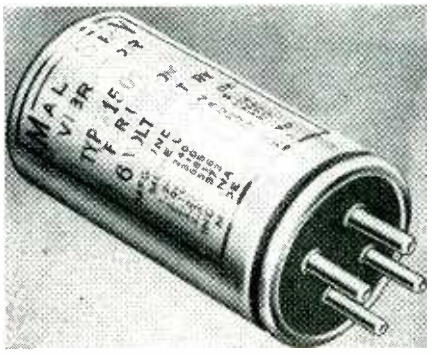
receivers of 125 watts power or less, from 115 volts d-c. The picture control illustrated regulates the converter frequency and eliminates frequency waves and picture flutter. See bulletin 948 for further information.

High-Voltage Capacitors

AMERICAN CONDENSER CO., 4410 N. Ravenswood Ave., Chicago 40, Ill. New Amoil capacitors rated at 6,000 volts d-c are now available in capacitance values ranging from 0.0005 to 0.05 microfarad. The units are impregnated with a newly developed petroleum oil similar in characteristics to mineral oil.

Vibrator

P. R. MALLORY & CO., INC., 3050 E. Washington St., Indianapolis 6, Ind., has developed the type 1501 vibrator for use on 6-volt batteries.



It is applicable to f-m receivers, push-to-talk transmitters, test equipment and special commercial uses.

Static Eliminator

CANADIAN RADIUM AND URANIUM CORP., 630 Fifth Ave., New York 20, N. Y. The Alphatron static eliminator utilizes polonium to produce ionization about 1,000 times greater in effect than an equivalent weight of radium. The units act to

PRECISION POTENTIOMETERS

Toroidal and Sinusoidal

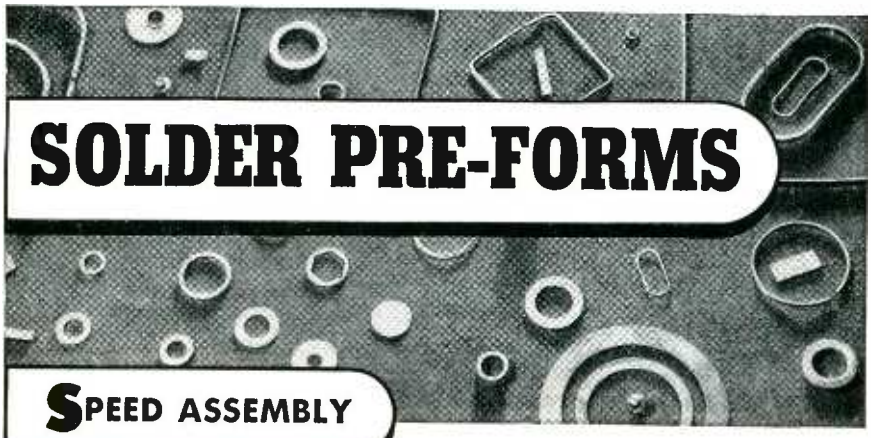
For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servomechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are $4\frac{3}{8}$" diameter x 4 11/32 long plus shaft extension $\frac{1}{4}$" diameter x $1\frac{1}{4}$" long.

Write for Bulletin F-68

THE GAMEWELL COMPANY

Newton Upper Falls 64, Massachusetts



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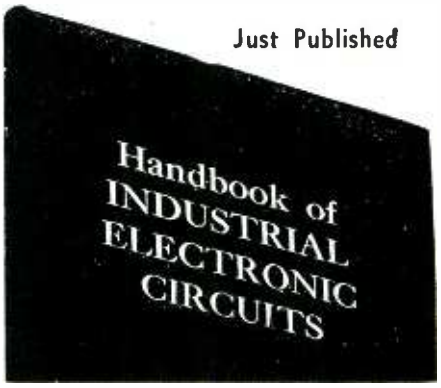
• with full diagrams and data for each one

WHETHER you want to brush up on the wiring system of a five-hundred-watt ultrasonic generator circuit or need complete information on a circuit for detecting either metallic or non-metallic objects—you'll find all the answers in the pages of this handy manual. It contains all types of circuits—from counting to welding control, both simple and advanced. It brings you hundreds of industrial circuits developed during the war when research and practical improvements hit an all-time high.



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Associate Editors of 'Electronics'

272 pages, 433 diagrams, $6.50

HERE'S a ready source of information about the circuits you need for any industrial electronic application. For every circuit, you find a clearly-drawn diagram along with a brief yet comprehensive discussion of . . . how it works . . . performance characteristics . . . everyday practical applications, etc. With this data as a starting point you can easily convert the theoretical circuit to actual practice.

Covers all types of circuits—

- audio frequency
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- cathode-ray
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- counting
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- limiter
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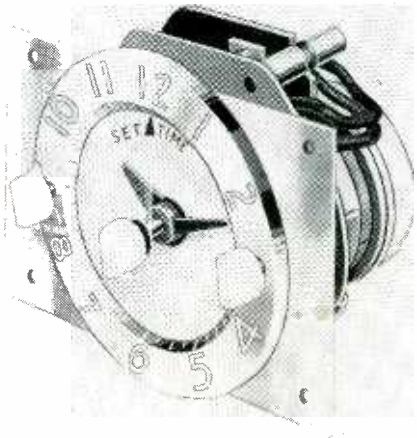
eliminate fire and explosion hazards by dissipating static charges caused by friction of belts against pulleys and from similar sources.

Radio Timer

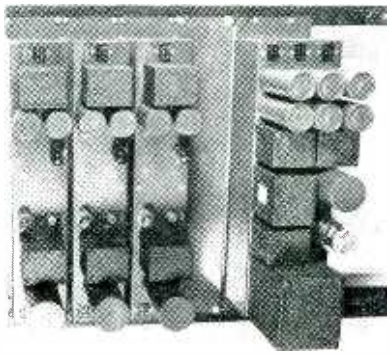
INTERNATIONAL REGISTER CO., 2614 W. Washington Blvd., Chicago 12, Ill. The RC-1021 radio clock timer



can be set to turn a radio on or off at any time.

Triple Amplifier

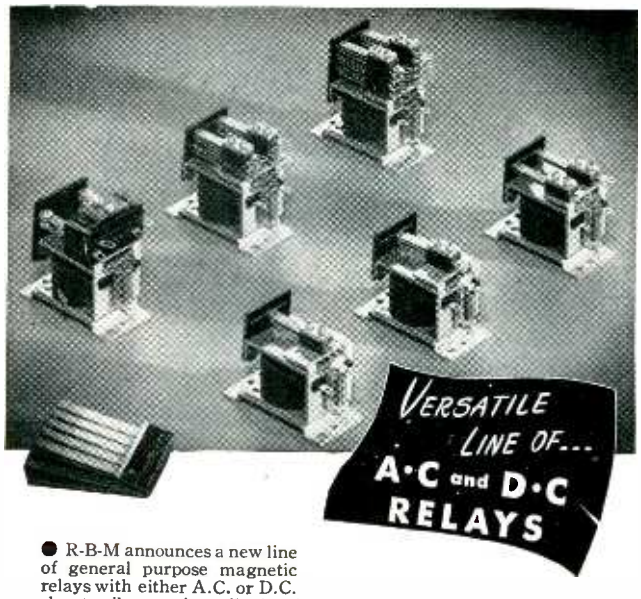
SCHUTTIG AND CO., Ninth and Kearny Sts., N. E., Washington 17, D. C. Type S183 triple power amplifier comprises three identical amplifier units operating from a



common power supply. Each unit provides a maximum output of 2 watts and a gain of 60 db. The response is essentially flat over the range 100 to 4,000 cycles.

Tube Guard

STAVER MFG. CO., 254 Atlantic Ave., Brooklyn 2, N. Y. The Mini-Spring tube guard consists of a hard steel, cadmium-plated post and an alloy coated, hard drawn steel wire



● R-B-M announces a new line of general purpose magnetic relays with either A.C. or D.C. shunt coils or series coils for electronic applications.

Relays are available in standard contact arrangement of single and two pole normally open, normally closed; or double throw with light and heavy contacts. Four and six pole double throw relays are available with 3 ampere contacts at 32 volts or less.

For further information write for Bulletin 570. R-B-M DIVISION, Essex Wire Corporation, Logansport, Ind. Address Dept. D-3.

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—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

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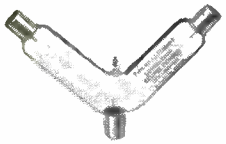
SPECIAL PURPOSE VACUUM TUBES BY ECLIPSE-PIONEER

TT-1 3000 mc Temperature Limited Noise Diode Tube.



Y-Type Position Convectron—Vertical Sensing Tube.

Chronotron Thermal Time Delay Tube.

We're not in the standard vacuum tube business. But we are definitely in the business of developing and manufacturing special purpose vacuum tubes—tubes that are not generally available. During the past three years, for example, our facilities have produced, such devices as the Chronotron thermal time delay tube, the Convectron* vertical sensing tube, the TT-1 3000 mc temperature limited noise diode tube, counter tubes, glass enclosed spark gaps, and phono pickup tubes. Quantities of all these are now serving many phases of industry in a wide variety of applications. We invite your use of our facilities to develop and produce your requirements of special purpose vacuum tubes. Your inquiries concerning the scope of our facilities or details of any of our tubes will be given immediate attention.

*REG. U. S. PAT. OFF.

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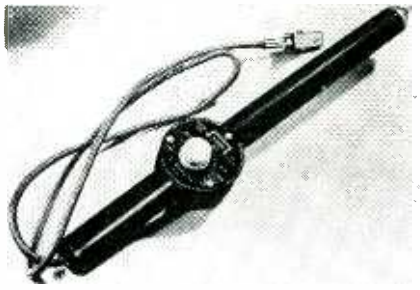
CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

spring. It is designed for easy mounting and quick installation or removal of a tube in electronic equipment.

High-Voltage Tester

INDUSTRIAL DEVICES, INC., Edgewater, N. J. Hi-Volt model 500 covers a range from 1,600 to 15,000 volts a-c. The device is intended for testing high-voltage trans-



formers such as used for oil-burner ignition and television. Featured in the unit are a 15-megohm multiplier incorporated in the 7-inch prod and a neon indicator.

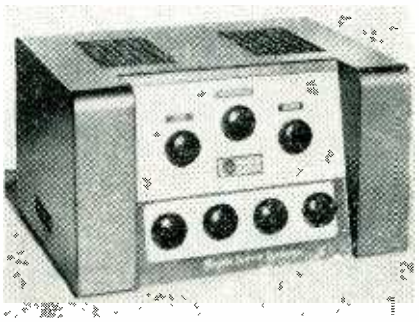
VOM

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 630 volt-ohm-mil-ammeter features six

d-c voltage ranges for testing television and other high-resistance d-c and a-c circuits; six a-c ranges for audio and other high-impedance a-c circuits; precision resistors, and complete insulation.

Anti-Feedback Amplifier

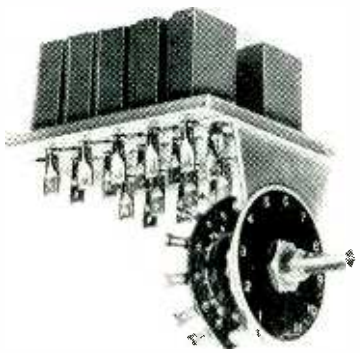
DAVID BOGEN CO., INC., 663 Broadway, New York, N. Y. The HX50, a new 50-watt amplifier, incorporates anti-feedback control. A tone



corrector gives bass control from −20 to +20 db at 60 cycles, and treble control of +20 to −20 db at 10,000 cycles. The unit uses a push-pull 807 output stage.

Crystal Selector

E. F. JOHNSON CO., Waseca, Minn. The instant crystal selector provides 10 crystal sockets and an 11-position switch so that the unit



provides selection of the crystal group and some other channel such as a variable frequency oscillator. The holder accommodates crystals with half-inch spacing.

Wire Markers

WESTERN LITHOGRAPH CO., 600 E. Second St., Los Angeles, Calif. E-Z code wire markers are short narrow strips mounted on a card. When pulled off and wrapped around a wire, adhesive causes the

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Welded Contact
Self-Healing
Molded Plastic Case

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GENERAL ELECTRIC Germanium Diodes have 3 distinct advantages that are immediately apparent.

1. **WELDED CONTACT.** Electrical stability is improved through the welding of the platinum whisker point to the germanium pellet. This rigid construction also enables G-E diodes to withstand reasonably severe shock or vibration and makes them practically immune to microphonic effects.

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General Electric is prepared to supply high back resistance and high peak inverse voltage units in production quantities.

For complete information on G-E Germanium Diodes write today to: *General Electric Company, Electronics Park, Syracuse, New York.*

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Synthetic Calcium Tungstate Crystals for Radioactivity Counters

We are pleased to announce the availability in research quantities, of clear, single crystals of synthetic calcium tungstate which fluoresce when exposed to radioactive radiations, cathode rays, and X-rays.

This fluorescence can be detected and amplified sufficiently by a photo-multiplier tube to count individual pulses. Good optical transmission, and rapid decay time qualify this material for use in this application. In addition, these crystals are unaffected by atmospheric exposure.

Synthetic calcium tungstate crystals are currently available in rods ⅛ inch in square section, up to 2 inches in length; other forms are under development. Windows and small parts can readily be fabricated from the rod.

For further information, please write to the New Products Division.

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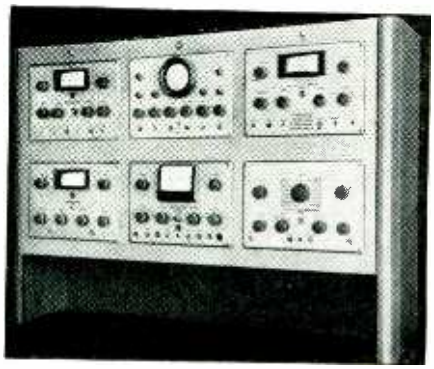
marker to stick. The designations are waterproof and will not fade. Preprinted in numbers, letters, and standard codes, they can also be furnished to specifications.

Test and Display Rack

RADIO CORP. OF AMERICA, Harrison, N. J. Rack WS-16A was designed to serve as a cabinet for six matched units of test and measuring equipment and as a service rack



for quick servicing of a-m, f-m and television receivers in shops, laboratories and schools. Intended for mounting on top of a workbench, the rack's lower shelf is eight inches above the bench top. Measurements are 4 × 3 × 1 ft.

Precision Switch

UNIMAX SWITCH DIVISION OF THE W. L. MAXSON CORP., 460 W. 34th St., New York 1, N. Y. Model KMX metal-cased precision switch has a die-cast gasketed aluminum housing protecting it against

splashing oil, moisture and abrasive. Bulletin KMX-26 containing full details is available.

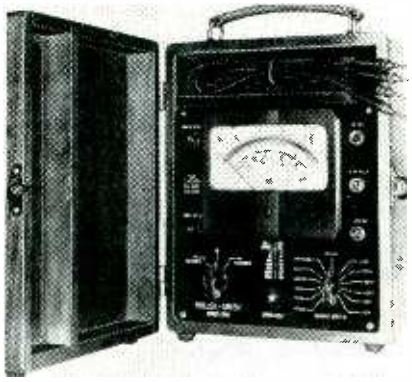
Marine Radiophone

APPLIED ELECTRONICS CO., 1246 Folsom St., San Francisco 3, Calif. Model 23 marine radiotelephone in-

corporates a 4-channel crystal-controlled transmitter and broadcast receiver, together with a 2 to 3-mc receiver.

Multimeter

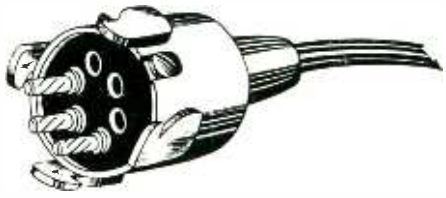
ROLLER-SMITH, Bethlehem, Pa. Model 500 volt-ohm-milliammeter measures to 7,500 volts a-c or d-c at 20,000 ohms per volt. Measure-



ments as low as 10 μamp, 0.2 volt, and 1 ohm are easily read. Catalog 4423 describes the meter in detail.

Television Connectors

MINES EQUIPMENT CO., 4215 Clayton Ave., St. Louis 10, Mo. The new push-latch connector illustrated was originally developed for



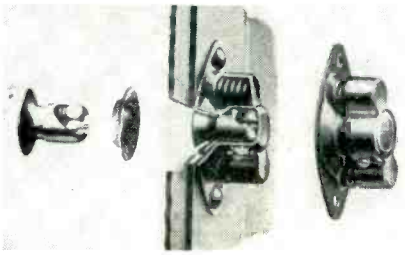
signal and communications circuits but is also adaptable to a-m, f-m, and television applications as well as for service in public address connections.

F-S Exciter

ERCO RADIO LABORATORIES, INC., Garden City, N. Y. Type 250-T frequency shift exciter has been designed to replace the existing crystal or master oscillator in any transmitter in order to key the transmitter by the f-s method. A front-panel switch permits selection of three crystal-controlled operating frequencies each preset to individual carrier frequency and mark-space shift requirements.

Cowling Fastener

DZUS FASTENER CO., INC., Babylon, N. Y. The new cowling fastener illustrated has been designed to



meet demands of modern high-speed aviation as embodied in specification AN-F-8b.

Literature

Insulation Resistance Testers. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 21-20-14 deals with the "Megger" heavy-duty type insulation resistance testers. Hand-driven, motor-driven and multivoltage instruments, their features, ranges and applications are described in detail.

Densitometer. Western Electric Co., Inc., 120 Broadway, New York 5, N. Y. The RA-1100B integrating sphere densitometer useful in all photographic fields, particularly in measurements of sound track density is described and illustrated in a new 6-page brochure. Specifications given include power

supply, dimensions, weight and finish.

Miniature Tube Characteristics. Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass., announces publication of a tube characteristic chart listing over 70 miniature receiving types. The 4-page folder gives all pertinent characteristics, applications, terminal connection diagrams and outline drawings.

Antennas and Accessories. L. S. Brach Mfg. Corp., 200 Central Ave., Newark, N. J., has issued loose-leaf catalog No. 1304 giving details of its tele and f-m antennas, antenna accessories, police, fire alarm and telephone accessories, and other items such as the Test-O-Lite for checking electrical circuits.

Precision Potentiometer. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass., recently released a bulletin describing the type RV2 precision potentiometer. Illustrations, specifications and prices are included.

Electronic Instruments. Furzehill Laboratories Ltd., Boreham Wood, Herts, England. A new brochure devotes 28 pages to a description and illustration of various types of c-r oscilloscopes, voltmeters, power supply units and other electronic instruments.

Socket and Mounting Notes. Raytheon Mfg. Co., Inc., 60 E. 42 St., New York 17, N. Y. An 8-page booklet gives information about subminiature tube sockets and explains other methods of connecting to the tube, shielding it and potting it in plastic.

Tape Recorders. Amplifier Corp. of America, 396 Broadway, New York 13, N. Y. Compiled from an analysis of over 5,000 letters, this booklet lists everyday questions and answers on the performance, construction, specifications and availability of Twin-Trax dual-channel magnetic tape recorders.

Broadcast Equipment. RCA Victor Division, Camden, N. J. Those requesting on broadcast station letterhead may obtain three new brochures. Form 2J-4367 on the a-m broadcast transmitter; Form 2J-4604 on the broadcast two-

studio consolette, and Form 2J-4622 on consolette switching systems.

Transformer Catalog. Eisler Engineering Co., Inc., 750 S. 13th St., Newark 3, N. J. A 26-page transformer catalog No. TR-49 describes and illustrates a line of transformers from 0.25 to 400 kva and potentials up to 15,000 volts for every class of service.

Relay Catalog. Comar Electric Co., 2701 Belmont Ave., Chicago 18, Ill. Recently released is the new loose-leaf catalog illustrating relays, transformers, coils and terminals. It is available to those requesting on company letterhead.

Speech Clipper. Electro-Voice, Inc., Buchanan, Mich., has issued bulletin 145 on the model 1000 Speech Clipper. It explains how the unit clips tops and bottoms from speech frequencies which rise above a preset amplitude. List price and specifications are given.

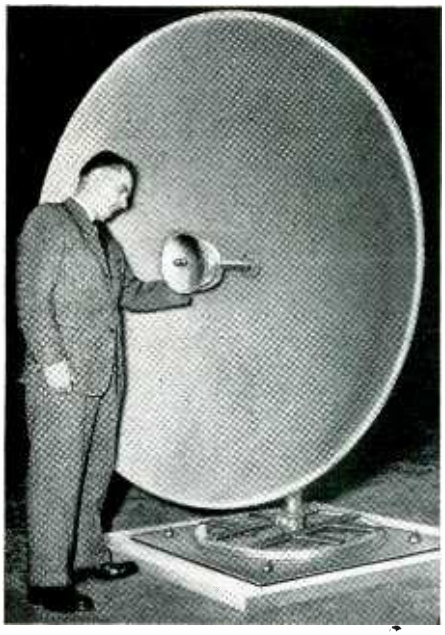
General Catalog. Meissner Mfg. Division, Maguire Industries, Inc., Mt. Carmel, Ill. Catalog 48B lists and illustrates a group of products including a television receiver, components, tuner, amplifier and a line of kits and coils.

Dial Light Catalog. Dial Light Co. of America, 900 Broadway, New York 3, N. Y., has recently published a very complete 192-page catalog, Form L-149, that lists its line of dial and pilot lamp assemblies, dimming devices, lens holders, light shields, and other accessories. Factors in the choice of lamp and housing are clearly explained to the designer.

Phototelegraph. Muirhead & Co., Ltd., Beckenham, Kent, England. Bulletins B-621-B, B-574-C, B-618-B, and B-575-E all describe various units of the Muirhead-Jarvis and Muirhead-Belin phototelegraphic equipment for use on wire lines or radio, including fixed station and portable transmitters.

Loudspeakers. Goodmans Industries, Ltd., Lancelot Road, Wembley, Middx., England. Brochures are available on a line of loudspeakers and high-fidelity transformers. A twin-diaphragm, or coaxial speaker, is included.

Visit our booth (No. 39) at the I. R. E. Show



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- **Television and Facsimile Relay Work**
- **Multi-channel Point-to-Point Relay**
- **Research and Development Laboratories**

The Workshop can supply parabolic antennas in a wide range of types, sizes and focal lengths, plus a complete production and engineering service on this type of antenna.

Workshop test equipment and measurements for the determination of antenna characteristics is outstanding in the industry. These facilities, coupled with the wartime experience of its engineers on high frequency antennas, assure exceptional performance.

PARABOLAS — Precision-formed aluminum reflectors. Can be supplied separately, if desired.

MOUNTINGS — Various types of aluminum reinforced mountings can be supplied with all antennas.

R. F. COMPONENTS — Precisions machined and heavily silver plated. Critical elements protected by low-loss plastic radome.

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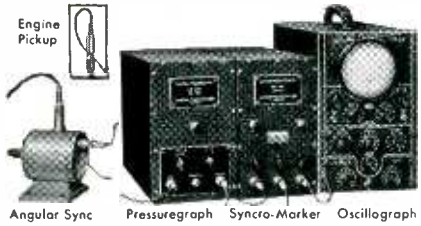

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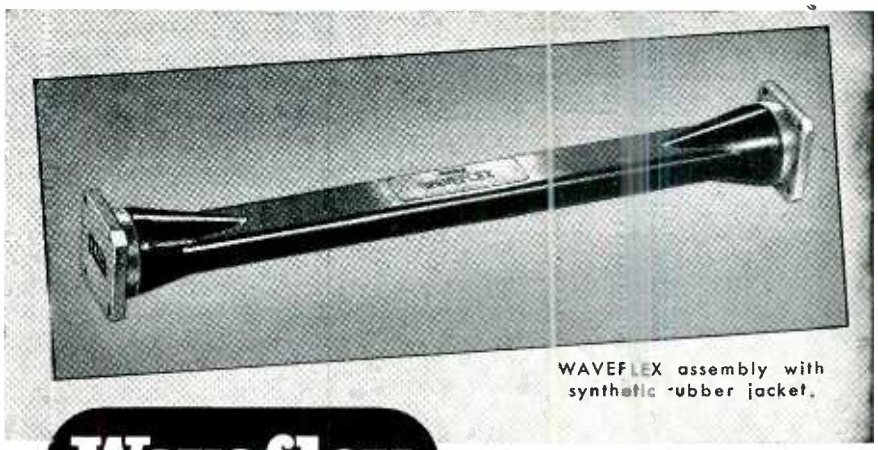

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NEWS OF THE INDUSTRY

(continued from p 138)

bile Telephone, by W. Babcock and A. W. Nylund.

Wide-Angle Metal-Plate Optics, by J. Ruze.

The Measurement of Current and Charge Distributions on Transmitting and Receiving Antennas, by T. Morita.

The Diffraction Pattern from an Elliptical Aperture, by R. Adams and K. S. Kelleher.

A Low-Drag Aircraft Antenna for Reception of Omnidirectional Range Signals in the 108- to 122-Mc Band, by J. Shanklin.

Passive Networks I—Synthesis

Amplifier Synthesis through Conformal Transformation, by J. Pettit and D. L. Trautman, Jr.

Exact Design of Bandpass Networks Using n Coupled Finite-Q Resonant Circuits ($n = 3$ and 4), by M. Dishal.

Network Approximation in the Time Domain, by W. H. Huggins.

A Method of Synthesizing the Resistor-Capacitor Lattice Structure, by J. L. Bower, J. T. Fleck and P. F. Ordung.

The Design of Frequency-Compensating Matching Sections, by V. Rumsey.

Instruments and Measurements II—Oscillography

An Impulse Generator — Electronic Switch for Visual Testing of Wide Band Networks, by T. R. Finch.

A 50-Mc Wide-Band Oscilloscope, by A. Levine and H. Hoberman.

A Timing-Marker Generator of High Precision, by R. C. Palmer.

The Evaluation of Specifications for Cathode-Ray Oscillographs, by P. S. Christaldi.

Photographic Techniques in Cathode-Ray Oscillography, by C. Berkley and H. Mansberg.

Electronic Computers

The Binac, by J. P. Eckert, Jr., J. W. Mauchly and J. R. Weiner.

An Electronic Differential Analyzer, by A. B. Macnee.

An Analog Computer for the Solution of Linear Simultaneous Equations, by R. M. Walker.

The Electronic Isograph for a Rapid Analogue Solution of Algebraic Equations, by B. O. Marshall, Jr.

A Parametric Electronic Computer, by C. J. Hirsch.

Tuesday P.M., March 8

Symposium: Electronic Computers

The Binac, by J. W. Mauchly.

Mark III Computer, by H. H. Aiken.

IBM Type 604 Electronic Calculator, by Ralph Palmer.

Electrostatic Memory for a Binary Computer, by F. C. Williams.

Counting Computers, by G. R. Stibitz.

Programming of a Chess Game on a Computer, by Claude Shannon.

Wave Propagation I—Television

VHF Television—Propagation Aspects, by E. W. Allen, Jr.

Propagation Variations at VHF and UHF, by K. Bullington.

Propagation Tests at UHF, by J. Fisher.

A Test of 450-Mc Urban-Area Transmission to a Mobile Receiver, by A. Aikens and L. Y. Lacy.

Echoes in Transmission at 450 Mc from Land to Car Radio Units, by W. R. Young and L. Y. Lacy.

Passive Networks II—Analysis

Impedance Curves for Two-Terminal Networks, by E. Michaels.

An Analysis of Triple-Tuned Coupled Circuits, by N. Mather.

The Bridged Parallel-Tee Network for Suppressed-Carrier Servo Systems, by C. F. White.

Transient Response of Linear Networks with Amplitude Distortion, by M. Di Toro.

Spectrum Analysis of Transient-Response Curves, by H. Samulon.

Components and Materials

Subminiaturization of IF Amplifiers, by G. Shapiro and R. L. Henry.

New Applications of a Four-Terminal Capacitor, by A. A. Pascucci.

Frequency Control Units, by A. E. Miller.

Type 5811 and Type 5807 Tubes. The Smallest Commercial Pentode Amplifiers, by L. G. Hector and H. R. Jacobus.

Conductive Plastic Materials, by M. A. Color, A. Lightbody, F. Barnet and H. Perry.

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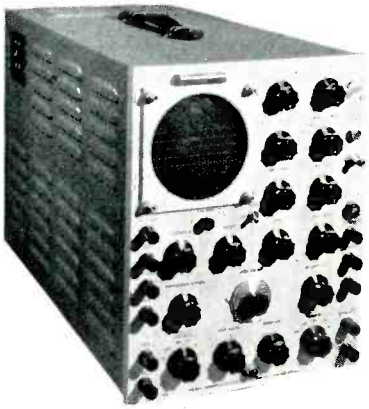

Tektronix Type 511-AD Oscilloscope
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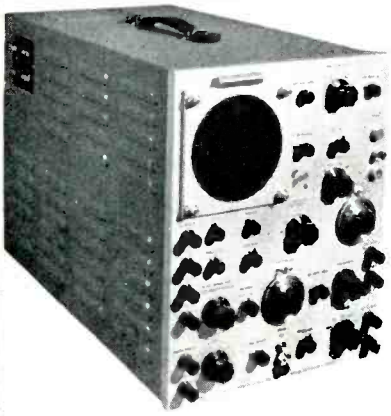
Wide Band, Fast Sweeps

The **Type 511-AD**, *with its 10 mc. amplifier, 0.25 microsecond video delay line and sweeps as fast as .1 microsec./cm. is excellent for the observation of pulses and high speed transient phenomena. Sweeps as slow as .01 sec./cm. enable the 511-AD to perform superlatively as a conventional oscilloscope.*



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The **Type 512** *with a sensitivity of 5 mv./cm. DC and sweeps as slow as .3 sec./cm. solves many problems confronting workers in the fields where comparatively slow phenomena must be observed. Vertical amplifier bandwidth of 1 mc. and sweeps as fast as 3 microsec./cm. make it an excellent general purpose oscilloscope as well.*

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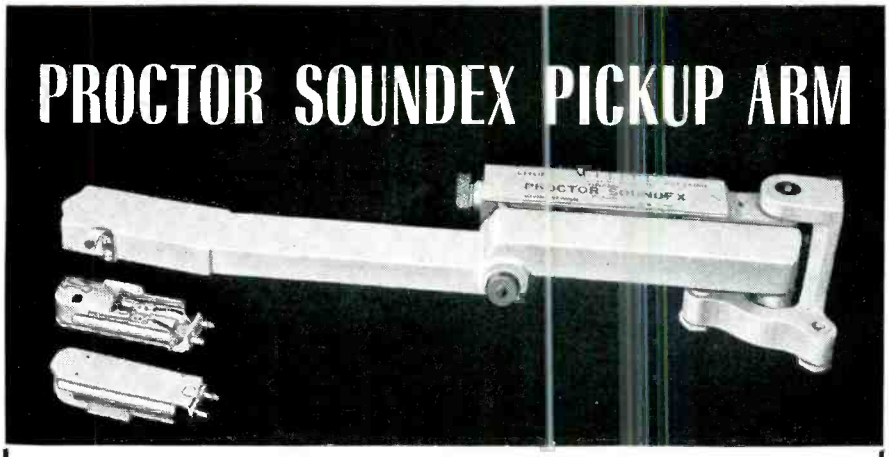

Proctor—a pioneer in the design, engineering and manufacture of a long line of recording and transcription equipment—announces the above illustrated pickup arm—embodying important new functional features—and designed for use with the latest lightweight high compliance cartridges.

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NEWS OF THE INDUSTRY (continued)

Radioisotopes, by J. Carlin.
The Design of a G-M Counter Tube for High Counting Rates, by W. Managan.
Electrometer Tubes and Circuits, by F. H. Starke.
Proportional Counter Equipment for Beta Detection, by W. Bernstein.
A High-Voltage Supplier for Radiation-Measuring Equipment, by R. Weissman and Stewart Fox.

Symposium: Nuclear Science

The Fundamental Particles, by D. J. Hughes.
The Detection and Measurement of Nuclear Radiation, by H. L. Andrews.
The Effects of Ionizing Radiation on Tissue, by J. P. Cooney.
The Application of Nuclear Radiation to Industry, by J. R. Menke.

Wednesday A.M., March 9

Television I

A Unidirectional Reversible-Beam Antenna for Twelve-Channel Reception of Television Signals, by O. M. Woodward, Jr.
A Method of Multiple Operation of Transmitter Tubes Particularly Adapted for Television Transmission in the Ultra-High-Frequency Band, by G. H. Brown, W. C. Morrison, W. L. Behrend and J. G. Reddeck.
Transient-Response Tests in the WPTZ Television Transmitter, by R. C. Moore.
The Synchronization of Television Stations, by R. D. Kell.
Television by Pulse-Code Modulation, by W. M. Goodall.

Symposium: Radio Aids to Navigation

The Radio Technical Commission for Aeronautics—Its Program and Influence, by J. H. Dellinger.
Frequency Allocations to the Aeronautical Services above 400 Mc, by V. I. Weihe.
Experimental Multiplexing of Functions in the 960 to 1660-Mc Frequency Spectrum—Its Influence on Weight and Complexity of Equipment, by P. C. Sandretto and R. I. Colin.
The Philosophy and Equivalence Aspects of Long Range Radio Navigation Systems, by M. K. Goldstein.
The Future in Approach and Landing Systems, by H. Davis.

Active Circuits I

G Curves as an Aid in Circuit Design, by K. A. Pullen.
A Direct-Coupled Amplifier Employing a Cross-Coupled Input Circuit, by J. N. Van Scoyoc and G. Warnke.
Annular Circuits for High-Power Multiple-Tube Generators at VHF, by D. H. Preist.
Considerations on Electronic Multicouplers, by W. R. Aylward and E. G. Fubini.
Improved Degenerative Regulators, by Y. P. Yu.

Instruments and Measurements III

Radar Circuit Powered X-Ray Movie Equipment for Operation at 150 Frames per Second, by D. C. Dickson, Jr., C. T. Zavales and L. F. Ehrke.
An AM Broadcast Station Monitor, by H. Summerhayes.
The Speed of Electronic Switching Circuits, by E. Williams and D. F. Aldrich.
A Magnetostrictive Delay Line, by E. Bradburd.
An Electromechanical Strain-Gage Multiplier, by C. Woods, E. St. George, L. Isenberg and A. C. Hall.

Electronics I—Tube Design and Engineering

Microphonism Investigation, by Lester Feinstein.
A Critical Survey of Methods of Making Ceramic-to-Metal Seals and Their Use for Vacuum Tube Construction, by R. P. Wellinger.
Rugged Tubes, by G. W. Baker.
An Improved Method of Testing for Residual Gas in Electron Tubes and Vacuum Systems, by E. W. Herold.
Design Factors, Processes, and Materials for the Envelope of a Metal Kinescope, by R. D. Faulkner and J. C. Turnbull.

Wednesday P.M., March 9

Television II

The Measurement of the Modulation Depth of Television Signals, by R. P. Burr.
Development and Performance of Television Camera Tubes, by R. B. Janes, R. E. Johnson and R. S. Moore.
An Anastigmatic Television Deflection

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RUGGED Construction with EXTREMELY HIGH torque movement (200,000 dyne cms for 1 cm deflection)

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Yoke and Associated Circuits, by K. Schlesinger.

A High-Efficiency Sweep Circuit, by B. M. Oliver.

Progress Report on UHF Television, by T. T. Goldsmith.

Wave Propagation II

An Analysis of Distortion Resulting from Two-Path Propagation, by I. H. Gerks.

On the Origin of Solar Radio Noise, by A. V. Haeff.

Geometrical Representation of the Polarization of a Plane Electromagnetic Wave, by G. A. Deschamps.

Propagation Conditions and Transmission Reliability in the Transitional Microwave Range, by T. F. Rogers.

A Forward-Transmission Echo-Ranging System, by D. B. Harris.

Active Circuits II

A Laboratory and Analytical Analysis Comparing the L-C Toroidal Filter with the Parallel-Tee Feedback Amplifier Filter, with the Parallel-Tee Feedback Amplifier Filter, by A. J. Stecca.

A Peak-Picker Circuit, by M. J. Parker.

Low-Frequency Synchronized Sawtooth Generator Providing Constant Amplitude Sweep with Aperiodic Synchronization Input, by P. Yaffee.

High-Power Sawtooth Current Synthesis from Square Waves, by H. E. Kallmann.

Regenerative Amplifiers, by Y. P. Yu.

A Rectifier Filter Chart, by R. Lee.

Instruments and Measurements IV

High-Impedance Millivolt Measurements above 5 Mc, by W. K. Volkers.

Some Aspects of the Performance of Mixer Crystals, by P. D. Strum.

A Wide-Band Audio Phasemeter, by J. R. Ragazzini and L. A. Zadeh.

A Device for Admittance Measurements in the 50- to 500-Mc Range, by W. R. Thurston.

An Improved RF Capacitometer, by E. F. Travis and T. M. Wilson.

A Radio Frequency Discharge Phenomena and its Application to Mechanical Measurements, by K. S. Lion and J. W. Sheetz.

Electronics II—Electron-Tube Cathodes

The Effects of Various Barium Compounds with Respect to Cold-Cathode Behavior as a Function of Life in a Glow Discharge, by H. Jacobs and A. P. LaRocque.

Oxide-Cathode Properties and their Effects on Diode Operation at Small Signals, by G. C. Dalman.

Microanalysis of Gas in Cathode-Coating Assemblies, by H. Jacobs and B. Wolk.

Exposure of Secondary-Electron-Emitting Surfaces to the Evaporation from Oxide Cathodes, by C. W. Mueller.

The Use of Thoriated-Tungsten Filaments in High-Power Transmitting Tubes, by R. B. Ayer.

Thursday A.M., March 10

Systems II—Relay Systems

A Microwave System for Television Relaying, by J. Z. Millar and W. B. Sullinger.

Synchrodyne Phase Modulation of Klystrons, by V. Learned.

Intercity Television Radio Relays, by W. H. Forster.

Video Design Considerations in a Television Link, by M. Silver, H. French and L. Staschover.

A Six-Channel Urban Mobile System with 60-Kc Spacing, by R. C. Shaw, P. V. Dimock, W. Strack and W. C. Hunter.

Navigation Aids I

The Determination of Ground Speed of Aircraft Using Pulse Radar, by I. Wolff, S. W. Seeley, Earl Anderson and W. D. Hershberger.

The Dimeal Aircraft Approach and Landing System, by L. B. Hallman, Jr.

Theoretical Aspects of Nonsynchronous Multiplex Systems, by W. D. White.

Band-Pass Circuit Design for Very-Narrow-Band, Very-Long-Range Direction Finder Receivers to Minimize Bearing Error Due to Receiver Mistuning, by M. Dishal and H. Morrow.

Crystal Control at 100 Mc for Aerial Navigation, by S. H. Dodington.

Symposium: Marketing

Market Research, by E. H. Vogel.

The Application of Market and Field Research in Product Planning and De-

sign, by O. H. L. Jensen.
Sales Planning and Distribution, by Lee McCanne.
National Advertising, by M. F. Mahony.
Sales Training and Sales Promotion, by W. E. Macke.

Electronics III—Electron-Tube Theory

General Solution of the Two-Beam Electron-Wave-Tube Equation, by A. V. Haeff, H. D. Arnett and W. Stein.
Aspects of Double-Stream Amplifiers, by J. R. Pierce, W. B. Hebenstreit and A. V. Hollenberg.
On the Theory of Axial Symmetric Electron Beams in an Axial Magnetic Field, by A. L. Samuel.
Electron Beams in Axial Symmetric Magnetic and Electric Fields, by C. C. Wang.
Space-Charge Effects and Frequency Characteristics of CW Magnetrons Relative to the Problem of Frequency Modulation, by H. W. Welch, Jr.

Thursday P.M., March 10

Symposium: Germanium and Silicon Semiconductors

Electrical Properties of Germanium and Silicon, by K. Lark-Horovitz.
The Metallurgy of Germanium and Silicon Semiconductors, by J. H. Scaff.
Theory of Rectification, by F. Seitz.
Transistors, by W. H. Brattain.

Information Transmission and Noise

Design in Nature as Exploited, by the Communication Engineer, by L. A. de Rosa.
Experimental Determination of Correlation Functions and the Application of these Functions in the Statistical Theory of Communications, by T. P. Cheatham, Jr.
The Transmission of Modulation Through Band-Limited Transmission Systems, by W. P. Boothroyd and E. M. Creamer, Jr.
Signal-to-Noise Improvement Through Integration in a Storage Tube, by J. V. Harrington and T. F. Rogers.
The Theory of Receiver Noise Figure, by L. J. Cutrona.

Navigation Aids II

Very-High-Frequency Airborne Navigational Receiver and Antenna System, by A. G. Kandoian, R. T. Adams and R. C. Davis.
Certain New Performance Criteria for Localizer and Glide-Slope Ground Installations, by P. R. Adams.
Phase and Other Characteristics of 330-Mc Glide-Path Systems, by S. Pickles.
Principles of Volume Scan, by D. Levine.
The Control of Structural Resonance Effects on the Radio Bearings of an Aircraft High-Frequency Direction Finder, by M. Goldstein.

Oscillators

An Analysis of Oscillator Performance under Varying Load Conditions and an Electronic System for Automatic Load Compensation, by E. Mittelmann.
Low-Power Wide-Tuning-Range UHF Oscillators, by J. N. Pettit and F. J. Kamphoefner.
Reactance-Tube Modulation of Phase-Shift Oscillators, by F. R. Dennis and E. P. Felch.
A Low-Distortion AF Oscillator, by C. W. Clapp and C. L. Hackley.
An Automatic-Frequency-Control System for Mechanically Tuned Oscillators, by J. G. Stephenson.

Electronics IV—New Forms of Tubes

The Graphechon—A Picture Storage Tube, by L. Pensak.
The Pencil-Type UHF Triode, by G. M. Rose and D. W. Power.
Practical Applications of the Resnatron in the High-Power Transmitter Field, by W. W. Salisbury.
The Electron Coupler—A New Tube for the Modulation and Control of Power at the Ultra-High Frequencies, by C. L. Cuccia and J. S. Donal, Jr.
A Low Power Wide-Band CW Magnetron, by L. R. Bloom and W. W. Cannon.

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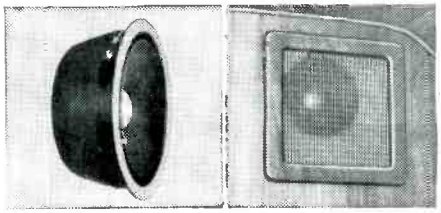

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Power Rating	12 watts
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Required Amplifier Output Impedance	4-8 ohms
Voice Coil Diameter	1¾"
Speaker Diameter	8¼"
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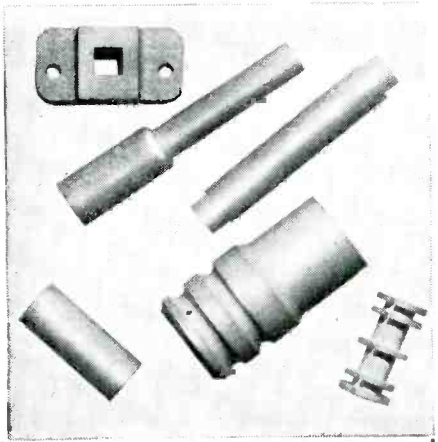

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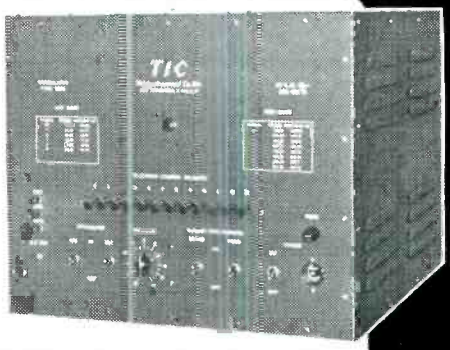

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Precision Wobbulator for television production line. 15 M.C. band width on all channels. Output is oscillator fundamental frequency. Zero signal output reference baseline always present. Output 1 v. across 75 ohms. Attenuator range 60 Db. Monitor signal provided.

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signers and tube manufacturers, an AIEE conference on the industrial application of electron tubes will be held in the Statler Hotel, Buffalo, N. Y., on April 11 and 12, 1949.

Program for the first day will include a technical session on the application of electron tubes in control and other industrial equipment, an inspection trip to the Westinghouse plant in Buffalo and a presentation of papers by several users of electron tubes describing their operating experience and their maintenance schedules.

The second day will feature a discussion of the items considered by manufacturers in designing equipment using tubes. A technical session will follow, dealing with methods used in building and rating tubes for industrial applications.

Sponsors of the conference are the AIEE subcommittee on electron tubes of the Electronic Committee, the subcommittee on electronic control of the Industrial Control Committee and the Niagara Frontier Section of the AIEE.

Communication Instructors Wanted

VACANCIES have been announced for the position of general communication instructor at Scott Air Force Base, Illinois. Duties are to instruct or supervise instruction of officers and enlisted men of the Air Corps, Reserves or friendly foreign nationals in communications subjects in accordance with a definite instructional program of prescribed course of study, to prepare or assist in preparing text material for class instruction, and to perform related duties.

Minimum qualifications are five years of experience as electronics instructor, or five years experience in repair, installation and maintenance of electronic equipment, or a combination of both aggregating five years. Study in colleges and recognized radio training schools may be substituted year for year for experience under certain conditions.

Salary is $3,727.20 per year. Age limits are from 18 to 62. Applications should be submitted on Stand-

ard Form 57, obtainable at any first or second class post office, or from Scott Air Force Base, Illinois.

National Telemetering Forum

SEVERAL companies and organizations interested in telemetering systems and components recently organized a group known as the National Telemetering Forum. Purpose of the organization is to provide a freer exchange of telemetering information and more widespread discussion of technical problems. Only personnel who are invited and cleared to receive classified information may attend the Forum's meetings.

Meetings are held approximately bimonthly at the place of business of any of the participating organizations who volunteer to serve as hosts. The host acts as chairman of each technical meeting, and is also responsible for issuing invitations and for preparing and distributing a report of the activities.

The last meeting was held February 14 and 15 at the Warwick Hotel, Philadelphia, with the Raymond Rosen Engineering Products, Inc., acting as hosts. Topics discussed were the design of commutators for telemetry applications and pre-flight preparation and calibration of telemetered missiles.

All inquiries concerning the Forum should be directed to one of the following officers of the organization: chairman, W. J. Mayo-Wells of the Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.; vice-chairman, George Adams of Boeing Airplane Co., Seattle 14, Washington; secretary, H. B. Schultheis of the Pacific Division, Bendix Aviation Corp., North Hollywood, Calif.

URSI-IRE Meeting

A JOINT meeting of the International Scientific Radio Union (URSI) and the IRE will be held in the East Building Lecture Room, National Bureau of Standards, Connecticut Ave. and Van Ness Street, N. W., Washington, D.C., on May 2, 3 and 4, 1949. During the first two days papers of a fundamental scientific and research character will be presented on the following

topics: radio standards, methods of measurement, terrestrial radio noise (natural and man-made), communication theory, antennas, circuits, electron tubes, semiconductors and properties of matter. The last day will be reserved for meetings of various national commissions.

Booklets listing the program titles and abstracts will be available for distribution before the meeting. Correspondence should be addressed to Dr. Newbern Smith, Secretary, U.S.A. National Committee, URSI, National Bureau of Standards, Washington 25, D.C.

Eta Kappa Nu Awards

THE OUTSTANDING young electrical engineer of 1948, chosen by Eta Kappa Nu, national honor society for electrical engineers, was Abe Mordecai Zarem, manager and chairman of physics research for the Stanford Research Institute, Los Angeles, Calif. He has conducted research on transient electrical discharges and has deve'oped a method for photographing them. Another achievement is his invention of the Zarem camera. The recognition award, bestowed annually upon a young engineer (35 years of age or less and out of college under 10 years) "for meritorious service in the interest of his fellow men", was presented on January 31, 1949 at the Winter General Meeting of the AIEE.

One of the two honorable mentions for the recognition award was given to Milton E. Mohr, member of the technical staff of Bell Telephone Laboratories, Inc. Holder of 13 U.S. patents, he was responsible for the r-f sections of the broadcast receivers recently exhibited by Bell Labs to demonstrate circuits in which transistors might be used instead of vacuum tubes.

The second recipient of an honorable mention certificate was Jay Wright Forrester, associate director of the Servomechanisms Laboratory, MIT. His major technical contributions have come in the past three years. The group of 200 persons that he heads is working on a new electronic digital computer technique to solve aircraft analyzer

simulator problems. Using the electrostatic storage principle he has carried his research to the development and construction of a versatile line of test equipment for the computer field, as well as new construction and measurement techniques.

BUSINESS NEWS

SYLVANIA ELECTRIC PRODUCTS, INC., recently purchased a plant at Seneca Falls, N. Y., to expand television picture tube production.

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., has opened new and expanded research laboratories at 202 Tillary St., Brooklyn, N. Y.

CORNELL-DUBILIER ELECTRIC CORP. has purchased from Maguire Industries, Inc. all the stock of the Radiart Corp. of Cleveland, Ohio, manufacturers of auto radio vibrators and auto and television antennas.

FURST ELECTRONICS, manufacturers of specialized electronic laboratory instruments, has moved to enlarged quarters at 12 S. Jefferson St., Chicago, Ill.

VIDEO CORP. OF AMERICA, television receiver manufacturer, has moved to new and larger quarters at 229 W. 28th St., New York City.

RAULAND-BORG CORP., a newly formed organization, has purchased the sound division of the Rauland Corp. from Zenith Radio Corp. to continue manufacture and sale of sound products.

THE ACRO ELECTRIC CO., Cleveland, Ohio, manufacturers of rolling-spring snap-action switches, has been purchased by a group including Willard F. Rockwell, Jr., president of the Rockwell Mfg. Co., Pittsburgh, Pa.

KIMBLE GLASS DIVISION OF THE OWENS-ILLINOIS GLASS CO. has taken over the parent company's Columbus, Ohio, plant to expand television bulb manufacturing operations.

MULTI-TRON LABORATORY, Chicago, Ill., was recently established to con-

duct research and development in the fields of electronics, radiation, optics and nuclear physics. Nicholas D. Glyptis is the director.

VICKERS INC., magnetic amplifier manufacturers, recently announced expansion of their line of electrical

Vickers Electric Division new plant

products and a move to larger quarters in St. Louis, Missouri.

ELK ELECTRONIC LABORATORIES, New York City, was recently formed to specialize in the design and development of test equipment for the communications, radar and allied fields.

THE WHEELER INSULATED WIRE CO., INC., has moved from Bridgeport to Waterbury, Conn., to provide more adequate space for expansion in electronic and television fields.

GAROD ELECTRONICS, LTD., Long Beach, Ontario, Canada, is a new company formed by Garod Electronics Corp., to manufacture radio and television receivers.

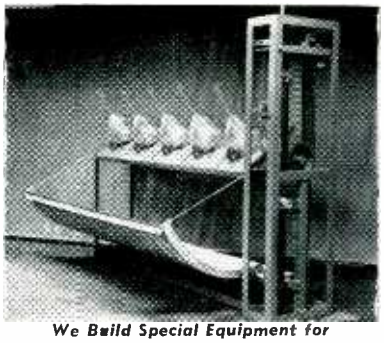
GENERAL ELECTRIC RESEARCH LABORATORY, Schenectady, N. Y., recently established a crystallography division to work on problems of interatomic arrangement, particularly with respect to the structure of crystals.

PERSONNEL

ROBERT E. MOE, with GE since 1934, has been appointed division engineer for electronic receiving tube product lines of the company's tube divisions, with headquarters at the Owensboro, Ky., plant.

ARTHUR V. NICHOL, after 18 years with Philco Corp., has been named chief engineer responsible for the development of auto radio.

WILLIAM A. GRAY, formerly with Raytheon Mfg. Co., has established



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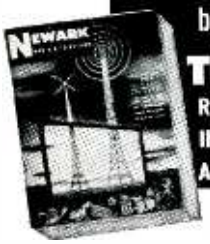

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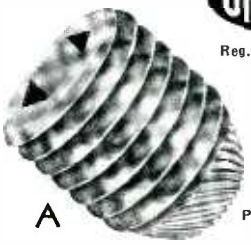

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RICHARD M. SOMERS has been promoted from assistant chief engineer to chief engineer of the Ediphone Division of Thomas A. Edison, Inc., West Orange, N. J.

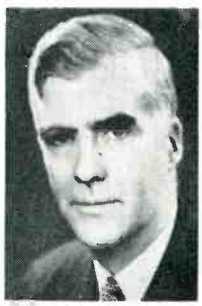
PALMER M. CRAIG, chief engineer of Philco's radio division since 1943, was recently appointed director of engineering of electronics division of engineering department.

P. M. Craig

H. G. Booker

HENRY G. BOOKER, formerly lecturer in mathematics at Cambridge, England, and researcher on radio propagation in the substratosphere, was recently appointed a professor of electrical engineering at Cornell University, Ithaca, N. Y.

GEORGE E. ZIEGLER, acting chief administrator of the Midwest Research Institute in Kansas City, Mo. for six months, was recently appointed director of the Institute.



G. E. Ziegler

R. M. Hanson

ROBERT M. HANSON, formerly with the Thordarson Electric Co., Chicago, Ill., is now chief engineer at Audio Development Co., Minneapolis, Minn.

JENNINGS B. DOW, wartime chief of the electronics section of the Bureau of Ships in Washington, D.C., has been elected executive vice-president of Hazeltine Electronics Corp.

NEW BOOKS

Cybernetics

By NORBERT WIENER, *Professor of Mathematics, Massachusetts Institute of Technology. The Technology Press, John Wiley and Sons, Inc., New York,* 1948, 194 *pages,* $3.00.

THIS BOOK, a study of "control and communication in the animal and the machine", transcends the field of electronics. Written by one of the great intellects of our time, it brings together a vast range of related sciences and philosophies in a coherent theory of man and the machine as mechanisms, a theory couched in the terms of physiology and electrical communications. It is required, if difficult, reading for every physiologist and electronist who has the slightest interest in the future of these arts.

It is an interesting fact that the young intellects who have pioneered in the new theory of communications, Shannon, Tuller and Sullivan, all were students of Professor Wiener at MIT during the past decade. This book, which reports work carried out during the same ten years, covers the essentials of this new theory, and states the new law, regarding transmission of intelligence in the presence of noise, on page 104, in more general form than has appeared elsewhere. But it is typical of the book that this important result and its derivation are included in almost parenthetical fashion, a footnote as it were to the larger issue of the book. This issue is the question of how the muscles, sinews, nerves and brains of living bodies can be described, and their actions explained, in terms of the recent theory of communications.

The book is simple to read in parts, often deceptively so, but a large part of the book, particularly Chapters II and III, is couched in mathematical terms. While these do not interrupt the thread of the argument, it should be noted that there are only a few hundred men alive today who can read every word and symbol in the book, and lay valid claim to understanding it all. Fortunately Professor Wiener has a very great command of the language and he is evidently attempting to make the subject as simple as his standards of rigor will allow.

If this review has no other effect

than to convince readers of this journal that "Cybernetics" is worth twenty hours of the best effort one can give it, at any level of understanding, it will have served its purpose. This is a book to own, to read and re-read. More, it is a book worth going back to school to understand.

There is no slight doubt in this reviewer's mind that the avenues of thought and the demonstrations in this book will affect profoundly the future course of a dozen sciences, including communications in all its branches, mathematical computation, physiology, even psychiatry. The analogy between the anxiety complex of psychiatric states and the overcrowded telephone exchange is not merely an interesting idea, fully and carefully developed in this book. It is very possibly a grand idea, in the classic tradition of Newton and Maxwell, one which may permit an engineering approach to the anxieties and troubles which so beset us as individuals and nations. Professor Wiener is fully aware of this possibility and makes the point that such an approach may be the only hope of our civilization. One cannot find a better avenue of effort in engineering, to balance such studies against those that produced the proximity fuze. The communications engineer has the vocabulary, at least, with which to start on the fascinating new road along which this book beckons.—D.G.F.

Industrial Electronics Reference Book

By ELECTRONICS ENGINEERS OF THE WESTINGHOUSE ELECTRIC CORPORATION. *John Wiley & Sons, Inc., New York*, 1948, 680 *pages*, $7.50.

THIRTY-SIX chapters, written singly or jointly by various Westinghouse engineers, start the readers with atomic theory (E. V. Condon and E. G. F. Arnott), take him through the entire field of industrial electronics, and end up with a nine-page maintenance and troubleshooting section by C. J. Madsen.

Although basic information predominates in the various chapters, this is in every instance brought up to date or even ahead of other

printed literature to such an extent that the book in its entirety constitutes a survey of the present status of the art and science of industrial electronics.

Design engineers will find here the equations, graphs, theoretical analyses and voluminous references needed for intensive development of new tubes and new devices containing tubes. Practical engineers, with their own inherent ability to skip over pages containing math, will find a wealth of data and ideas for applying existing successful electronic solutions to new problems in industry.

Particularly deserving of mention is the chapter by Venable and Kinn on radio-frequency heating, which covers the entire field from theory of induction heating through examples of applications, with emphasis on practical aspects of load coil design and requirements for successful induction soldering and brazing. Dielectric heating theory and practice are covered with equal thoroughness.

For getting so many different authors to produce such commendable material on such a variety of topics with a minimum of overlapping, the Westinghouse Book Committee deserves every credit. Anyone who has edited an engineering handbook or a library of books by a group of authors knows the problems involved in getting engineers to write to an outline for a deadline.—J.M.

Cathode-Ray Tube Displays

By T. Soller, M. A. Starr, and G. E. Valley, Jr. *Volume 22 of MIT Radiation Laboratory Series. McGraw-Hill Book Company, New York*, 1948, 746 *pages*, $10.00.

The subject matter of this book is considerably broader in scope than might be indicated by the title. Means of providing cathode-ray tube displays are treated in detail, and design data on special circuit components such as focus coils and deflection yokes are included. Like most books of this group the text is in part a reworked and editorialized version of project reports prepared by the Radiation Laboratory staff members. Recognized authorities on the several

subjects are included in the list of contributing authors.

The book contains a detailed treatment of all types of cathode-ray tubes, both electrostatic and magnetic, used to present radar displays. A less detailed analysis of the associated circuits is provided since circuitry is the subject of several other books in the series.

Much of the material contained was of a classified nature during the war and is available here for the first time to all electronic engineers. Particularly good treatment of cathode-ray screen characteristics including specialized types is included. A practical disadvantage to the text is the lack of adequate descriptive subheadings for sections dealing with a number of specialized circuits. Considerable tabular data on video amplifiers and cathode-ray tubes is included which is of real practical value to the design engineer. Actual circuit values are given for most circuits described.

While television as such is not covered, the basic material on both tubes and circuits is of importance to the television design engineer. It is felt that this volume will be a valuable addition to the reference library of the electronic engineer who employs cathode-ray techniques.—HORACE ATWOOD, JR., *Industrial Television, Inc., Clifton, New Jersey.*

• • •

Books Received for Review

PHYSICS FOR ARTS & SCIENCES. By L. Grant Hector, Herbert S. Lein and Clifford E. Scouten. The Blakiston Co., Philadelphia, 1948, 731 pages, $5.50. For beginners in physics at colleges. Part I deals with mechanics, heat and sound; Part II, on electricity, optics and nuclear physics, was previously published as "Electronic Physics" and has been brought up to date.

POST WAR COMMUNICATIONS MANUAL, including aircraft and marine radio. Compiled and published by Howard W. Sams & Co., Inc., Indianapolis, Ind., 1948, 264 pages, paper cover, $3.00. Service data on about 50 communications receivers produced from the end of the war to mid-summer of 1948. The information is arranged in the same style as the Photofact folders put out by the same company.

RADIO OPERATING QUESTIONS AND ANSWERS. By Arthur R. Nilson and J. L. Hornung. McGraw-Hill Book Co., New York, 1948, 9th edition, 524 pages, $3.60. Review questions and answers for commercial radio operator examinations, arranged according to the six elements used in the tests. Includes questions and answers recently added to elements 2, 3 and 4 covering f-m and television techniques.

Backtalk

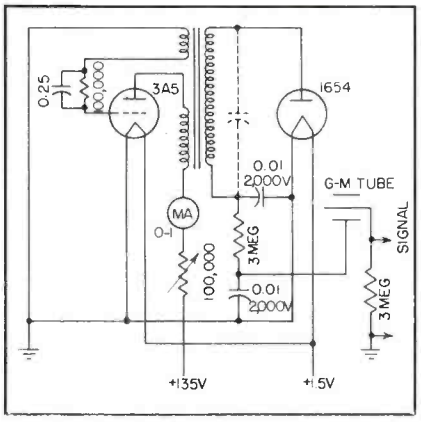
This department is operated as an open forum in which our readers may discuss problems of the electronics industry or comment upon articles that ELECTRONICS has published.

High Voltage

DEAR SIRS:

THIS is in reference to a recent article (p 100, Dec. 1948) on portable high-voltage G-M power supplies by Alexander Thomas. I should like to answer some of Mr. Thomas' comments on the r-f power supply, in which his principal objection is the inefficiency of this type of design due to losses in the r-f transformer.

In designing portable G-M radiation detectors, I experimented with all of the types of power supplies described in the article, and finally settled on the circuit shown. It was discovered that using a powdered-iron core transformer with a high-impedance secondary resulted in a very satisfactory oscillator whose tank circuit was the reflected impedance of the secondary at resonance. (The operating frequency was approximately 11 kc.)



This system produced an oscillator which was always tuned to the frequency required to generate the highest possible voltage in the secondary. The objection to this circuit at first was as Mr. Thomas claimed, the excessive losses in the transformer, so that it required 10 ma at 135 volts to produce 1,500 d-c volts with a G-M load of 3 μa. This figure of 10 ma was of course

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excessive and made the circuit impractical. By adjusting the grid-leak to change the oscillator into a blocking oscillator with an oscillation time of about 10 percent, the plate current was reduced to well under 1 ma.

This type of oscillator is possible only because of the extremely high impedance of a G-M circuit which draws only a maximum current under any conditions of about 3 μa. The output voltage remained 1,500 volts with very satisfactory regulation in the region of 0 to 5-μa load.

An additional advantage to this type of circuit is that the output voltage may be continuously metered without the use of a bleeder as in Mr. Thomas' circuit, with the resulting increase in efficiency. Metering is accomplished in the plate circuit of the oscillator tube, since it was found that the rectified high voltage is exactly proportional to the plate current of the oscillator.

It is my opinion that the r-f type of power supply will prove very useful for many portable G-M radiation detectors.

PAUL ABRAMSON
Chief Engineer
Electronics Associates
New York, N. Y.

Grenz Rays

DEAR SIRS:

IT MAY be of interest to some of your readers who have considered the possibility of Grenz-ray radiation from television picture tubes to know that no appreciable amount can be detected in the proximity of the tube.

No fogging of dental x-ray films was found, using a lead aperture pattern, after approximately twenty hours of exposure. The films were distributed around the cabinets and tubes of receivers, including a 27-kilovolt projection type, but no radiation was detected at any position. This procedure would not detect a minimal amount of radiation which might possibly be detected by a thin-window Geiger counter, but it shows that the radiation produced is at most of very small order of magnitude. Information of this type is relevant at this time in view of the emphasis on the study of environmental causes of cancer.

LEO MACKTA
Brooklyn, New York

(Continued from page 288)

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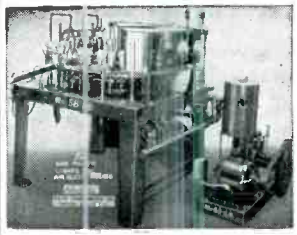

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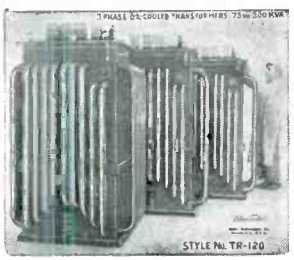

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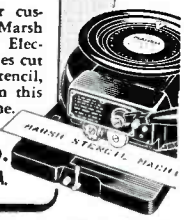

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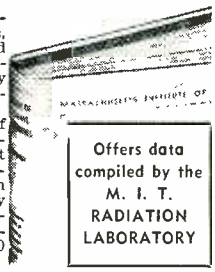

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(Continued on page 256)

Additional Position Vacant Ads on Pages 256 & 257

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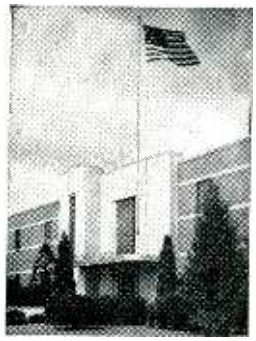

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1D7G	1.28
1D8GT	1.56
1E5GT	1.38
1E7G	1.56
1F4	1.06
1F5G	1.06
1F6	1.56
1F7G	1.56
1G4GT	1.06
1G6GT	1.06
1H4G	.88
1H5GT	.66
1H6G	1.28
1H6GT	1.28
1J6GT	1.28
1L4	.80
1LA4	1.06
1LA6	1.06
1LB4	1.06
1LC5	1.06
1LC6	1.06
1LD5	1.06
1LE3	1.06
1LG5	1.06
1LH4	1.06
1LN5	1.06
1N5GT	.80
1P5GT	1.06
1Q5GT	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
2P5	.88
2V3G	1.98
2X2A	1.25
3A4	.39
3A8GT	1.98
3B7	.36
3D6	.36
3O4	.88
3Q5GT	.96
3S4	.80
3V4	.80
5AZ4	.50
5R4GY	1.15
5T4	1.28
5U4G	.60
5V4G	.96
5W4	1.06
5W4GT	.66

Type	Price
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
6AB7/1853	1.06
6AC5GT	1.16
6AC7/1852	1.16
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
6Q6G/6T7G	1.06
6Q7	.80
6Q7GT	.72
6R7	1.06
6R7GT	1.06
6S7	1.28
6S7G	1.28
6S8GT	1.06
6SA7	.66
6SA7GT	.66
6SB7Y	.88
6SC7	.72
6SD7GT	.49
6SF5	.66
6SF5GT	.72
6SF7	.80
6SG7	.80
6SH7	.39
6SJ7	.66
6SJ7GT	.66

Type	Price
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	.92
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	1.06
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
12S17GT	.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	1.06
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
57	.80
58	.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
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- AC, AF, IF, RF Ranges 20 cycs. thru 100 megacycles.
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- Current ranges—6 ranges from 1.2 ma. to 12 amps. Plus or minus 2% absolutely stable.

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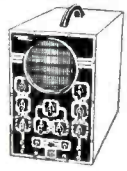

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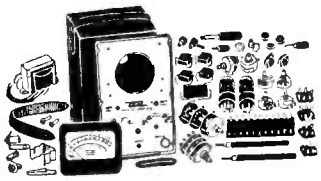

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Comes complete, nothing else to buy.

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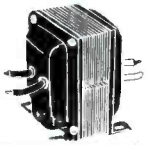

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Folded di-pole driven element. All-aluminum construction. Feed with low impedance coaxial cable.

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5069600, Delco, 27 V., 250 R. P. M.
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5069611, Delco, 12 V., 10,000 R. P. M.
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5067043 Delco, 12V., 10,000 R. P. M.
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Price $15.50 ea. net.

2J1F1 Selsyn Generator, 115 volts, 400 cycle. **Price $3.50 ea. net.**

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WUX Flushing, N. Y.

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Telephone INdependence 3-1919

RADIO RADAR SONAR Sets

SE (new)
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SO-1 (used)
SO-13 (used)
SQ (used)
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APS-4 (used & new)
APS-15 (near comp.)
QBG-1 (new)
TBM (used)
TDE (used)
RAK-7 (new)
TBK-19 (new)
RC 148 (new)
RC 145 (new)
Send for add'l info.

MICROWAVE TEST EQUIPMENT

THERMISTOR BRIDGE: Power meter 1 203-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..... $425
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-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity, 2700 to 2900 Mcs calibrated as shown..... $65.00
TS 108-AP dummy load..... $65.00
W. E. 1 138. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00
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-171631	$.95
D-167176	$.95
D-168687	$.95
D-171812	$.95
D-171528	$.95
D-163298	$.95
D-168549	$.95
D-162482	$3.00
D-166271	$2.50
D-162356	$1.50
D-161871A	$2.85

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

COAX PLUGS

831SP	$.35
831AP	$.35
831HP	$.15
UG 21/U	$.85
UG 86 U	$.95
UG 254/U	$.75
UG 255/U	$1.25
UG 146/U	$1.00
UG 85/U	$1.25

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			$45.00
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
4850	3/4 in.	5/8 in.	$12.50
2500	1 5/8 in.	1 11/16 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

MICROWAVE PLUMBING

10 CENTIMETER

WAVEGUIDE directional coupler, 27 db. Navy type CABV-47AAN, with 4 in. slotted section, as shown $42.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $32.00
"S" BAND CRYSTAL MOUNT, gold plated, with 2 type "N" connectors $12.50
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 ABEND 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

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

3 CENTIMETER PLUMBING

(STD. 1" x ½" GUIDE, UNLESS OTHERWISE SPECIFIED)

"X" BAND PREAMPLIFIER, consisting of 2-723A/B local oscillator-beacon feeding waveguide and TR/ATR Duplexer section, including 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 $6.75
DUMMY LOAD, TS 332/UP $22.50
"X" Band pressurizing gauge section, with 15-lbs. gauge and 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 $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" I.D. 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/ATR 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
ROTORY 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 ..... $4.60/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

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, revr-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 Pk Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl. pkg. new..... $210.00
APS-15B. Complete pkg. as above, less modulator $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
Rotating antenna with parabolic reflector for above. New $75.00

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 #804P 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 l'ps. 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 microsec; 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

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 $39.50
W.E. #D166173 HI-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 ke 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. #D16927I 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 1⅛" 19/32..... $1.50

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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	24.50N
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/ 6.3	400 800	.135 .020	SCR 515	5.25N
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	3.95
			150	.010		
			14.5	.5		
#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		
			0	1.12		
BD 77KM	14	40	1000	.350	BC 191	20.00N 14.00LN
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

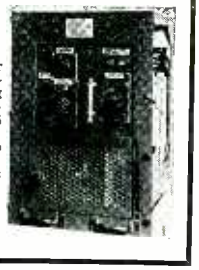
HAND GENERATORS

GN 35: 350 v, 60 ma; 8v, 2.5 A. New, with hand cranks.....$12.50
GN 45: 500 v, 100 ma; 6v, 3 amps. Sight use, ex. cond, with cranks $12.50

GREAT TUBE VALUES

01-A	$.45	12A6	$.35	860	$15.00
1B24	4.85	12K8Y	.65	861	40.00
2C21	.69	12SF7	.49	874	1.95
2C22	.69	12SR7	.72	876	4.95
2J21-A	25.00	15R	1.40	1005	.35
2J22	25.00	28D7	.75	1619	.21
2J26	25.00	30 (Spec.)	.70	1624	.85
2J27	25.00	45 (Spec.)	.59	1629	.35
2J31	25.00	39/44	.49	1961	5.00
2J32	25.00	35/51	.72	9002	.65
2J38	35.00	227A	3.85	9004	.47
2J39	35.00	225	8.80	CEQ 72	1.95
2J55	35.00	268-A	20.00	EF 50	.79
2J40	65.00	355-A	19.50	F-127	20.00
2J49	85.00	417A	25.00	FC 258A	165.00
3J31	55.00	530	90.00	GL 562	7.50
2X2/879	.69	531	45.00	FC 271	40.00
3BP1	2.25	532	3.95	GL 562	75.00
3C24	.60	559	4.00	GL 623	75.00
3C30	.70	562	90.00	GL 697	75.00
3D6	.79	615	.89	ML 100	60.00
3CP1	3.50	703-A	7.00	QK 59	65.00
3D21-A	1.50	704-A	.75	QK 60	65.00
3DP1	2.25	705-A	2.85	QK 61	65.00
3EP1	2.95	†707-B	20.00	QK 62	65.00
3FP7	1.20	714AY	25.00	*RCA 932	.65
3Q5	.79	715-B	12.00	VR 91	1.00
5BP1	1.95	720BY	50.00	VR 130	1.25
5BP4	4.95	720CY	50.00	VR 135	1.25
5CP1	3.75	721-A	3.60	VR 137	1.25
5FP7	3.50	723-A/B	12.50	VU 120	1.00
5J30	39.50	724B	1.75	VU 134	1.00
6G	2.00	725-A	25.00	WL 532	4.75
6SC7	.70	726-A	15.00	WN 150	3.00
7C4	1.00	800	2.25	WT 260	5.00
7E5	1.00	801-A	1.10	†with cavity:	
7E6	.72	804	9.95	Cavity only	5.00
10Y	.60	815	2.50		
		836	1.15	*Photocell	
		837	1.95		
		843	.59		

MASTER OSCILLATOR UNITS



M.O. units designed for open-2-18 mc TBK, Flexible plug in units using type 860 tube in ECO circuit. Tunes 2000 to 4565 kc in 6 bands. Freq. Determining elements are enclosed in shock mounted oven assembly, and has frq monitor PU link coupled to output. Net Wt: 138 Lbs, Dim: 21 in, d x 14½ in. W x 25½ in. H. New (with tube)...$150.00

PRECISION CAPACITORS

D-163707: 0.4 mfd @ 1500 vdc, —50 to plus 85 deg C.....$4.50
D-163035: 0.1 mfd @ 600 vdc, 0 to plus 65 deg C.$2.00
D-170908: 0.152 mfd, 300 v, 400 cy, —50 to plus 85 deg C.....$2.50
D-164960: 2.04 mfd @ 200 vdc, 0 to plus 55 deg C $2.50
D-168344: 2.16 mfd @ 200 vdc, 0 to plus 55 deg C.$3.00
D-161555: .5 mfd @ 400 vdc, —50 to plus 85 deg C.....$3.00
D-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

TELEPHONE EQUIPMENT

F.T. & R. 101-A APPLIQUE

Provides necessary balancing facilities for four wire repeater when used on two wire lines which may be voice-frequency telephone lines of open wire, or non-loaded or loaded cable. Std. 19" channel iron rack mtg. Price, new, complete with tech manual $54.00

SB-19/GT CONSOLE

Provides facilities for patching and monitoring network of lines for telephone intercom, radio reception, telegraph reception, recording, etc. Complete central office supervising position $350.00

EE-89A REPEATER

Extends range of field telephone apparatus, such as EE-8 up to 25 miles, when inserted in a line. New, with spare tube and instruction manual, less standard type batteries $21.50

BC 686 LINE AMPLIFIER

With magneto ringer; 3-tube 25L6 amplifier. For local point-to-point telephone operation, remote operation of Phone Xmtr, remove reception of receiver output, monitoring facility. Requires only 24 vdc for tube "B" plus supply for full operation.
New, less tubes, in wooden chest $18.50
Per pair for 2-way pt-to-pt operation $35.00

F.T. & R. 102-B REPEATER EE-99

May be used as Terminal or Intermediate Repeater. 20 cycles ringing & DC Telegraph. Applicable on simplex operations. Monitoring facilities, equalizing facilities. Dry or storage battery operation. New $55.00
Telephone switchboard lamp holders: 10 lamp holders per strip....$4.25
LAMPCAPS FOR TELEPHONE SWITCHBOARDS, GREEN, RED, WHITE .....$.05 ea.
Large quantities available.

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 KJ $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

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.....$4.75
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
M-7474319: Pri: 115 v, 400 cy. Sec: 6.3 v, 2.7 amp; 6.3 v, .66 amp; 6.3 v, 21 amp.....$2.95
32332: Pri: 115 v, 400-2400 cy. Sec: 400 vct, 35 ma; 6.4 v, 2.5 amp; 6.4 v, .15 amp.....$2.25
332-7138M: Pri: 115 v, 400-2400 cy. Sec: 640 v, .5 ma, 2.5 v, 1.75 amp.....$3.85
352-7179: Pri: 115 v, 400-2400 cy. Sec: 6.5 v, 12 amp ct, 250 v, 100 ma; 5 v, 2 amp.....$3.50
#9069: Pri: 115/80 v, 400-2600 cy. Sec: 650 vct, 50 ma; 6.3 vct, 2 amp; 5 vct, 2 amp.....$2.15
352-7096: Pri: 115/80 v, 400-2400 cy. Sec: 2.5 v, 1.75 amp, 3 KV ins; 5 v, 3 amp; 6.5 v, 6.5 amp; 6.5 v, 1.2 amp $3.95
KS 9607: Pri: 115 v, 400-2400 cy. Sec: 734 vct, 177 ma, 1710 vct, 177 ma.....$5.95
D-166333: Pri: 115 v, 400-2400 cy. Sec: 6.3 v, 0.9 amp, 7.7 v, 0.365 amp.....$2.79
GE #7471957: Pri: 100/110/120/130 v, 400-2400 cy. Sec: 2.5 v, 20 amp, HV ins.....$4.85
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

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.

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 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 (Erie, Contralab) $9.50 per 100

18 mmf .....±2.5 mmf
17 mmf .....±2.5 mmf
500 mmf .....±10%

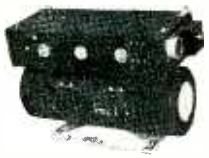
CARBON PILE VOLTAGE REGULATORS

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 simple conversion makes it operable on 110 V, 60 cy. new, and complete with tubes, crystal, cal. chart, antenna, meter $29.95

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, 400 cy, 500 volt-amps, Dim: 13" x 5½" x 10¼". New.....$12.50
GE 5D21NJ3A: Input: 28 vdc, 35 amp. Output: 15 v, 400 cy, 485 volt-amps. Dim: 9" x 4½" diam. New $49.95

AUTOMATIC CODE EQUIPMENT

TAPE PULLERS. (McElroy) TP 890, 110-120 v, AC $12.50 ea.
TAPE BRIDGES: (McElroy) TG 815, complete..$3.50
TAPE LOOPS: For TG-8 and TG-9.....$1.00
BLANK CODE TAPE: 4" rolls, ⅜" wide. Per roll $.15

MINE DETECTOR

Model AN/PRS 1 Detector will detect buried Metallic and Non Metallic objects, such as: rocks, pipes, water pockets, etc. Ideal for home owners, campers, prospectors. Uses meter and phones for visual and aural indications. Price: New, including detector, amplifier, phones, resonator, and all cables...$12.75
With Batteries $21.65

ARC—3 AUDIO TRANSFORMERS

T-102, #55544 T-104, #55547
T-103, #55546 T-105, #55554
T-206, #55320

Price, each .....$.95
MOD XMFR: PP 807's to PR. 807's CL. "C"...$1.65
DRIVER XMFR: 6U6 Driver to PP 811 Grids....$1.45
UNIVERSAL OUTPUT: Amertran Silcor, PRI: 20,000/16,000/5000/4000 ohms. Sec: 500/15/7.5/3.85 ohms. 30db. continuance Flat to 17,000 CY.....$2.75

A Complete Line of Subsig and Raytheon XFMRS in Stock. Send for List

OIL CONDENSERS

1 mfd @ 25,000V, Type A6734.....$99.50
2x.1 mfd, 7000V, 25F774 .....$4.95
1.5 mfd, 6000 vdc $12.50
.25 mfd, 20,000 vdc $17.50
10 mfd, 1000 vdc .....$ 1.79
3x10 mfd, delta connected synchro-capacitor, 90 v, 6* cycles .....$ 4.95
.1 mfd 6000 vdc, 25F509G2.....$ 6.50

Typewriter Desk Wells Mounted on Steel Panel for Standard Rack Mtg. 10½" H x 19" W x ⅛" Thick. Well is 22" Wide, 20" Deep. Affording Full Working Space. Grey Crackle Finish. New .....$9.90 ea.

Inserts, M-300, for HS-30 HEADSETS.....$4.00/M
RADIOSONDE TRANSMITTERS, T-49/AMT-1 $3.75 ea.
TRANSFORMERS for Collins ART13 Transmitters, GE #7472063, GE #7472065.

HEADSETS

Dynamic Mike and Headset Combination. A high quality, efficient unit, used in B-19 tank Xmtrs. Mike and phones completed, new.....$3.75
HEADSET, WE #716A, with dual plug patch cord $9.95

COMMUNICATIONS EQUIPMENT CO.
131-"E" LIBERTY ST., NEW YORK, N. Y. DIGBY 9-4124

RELAYS

FOR EVERY PURPOSE

Over a Million in Stock!

Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.

Our capable engineering staff is prepared to offer assistance in the selection of correct types to suit your exact requirements.

Each relay is brand new, standard make, inspected, individually boxed and fully guaranteed.

The following list represents only a tiny portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-101	24V	1500.	DPST (NO)	Auto. Elec.	$1.35
R-102	24V	400.	SPDT	Auto. Elec.	1.10
R-103	24V	DUAL-1000	3PST (NO)	Auto. Elec.	1.35
R-105	24V	600.	3PST (NO)	Clare	1.20
R-106	24V	1300.	3PST (NC)	Clare	1.25
R-152	12V	50.	DPDT-SPST (NO)	Guardian	1.10
R-153	12V	200.	SPDT-SPST (NO)	Stromberg	1.25
R-154	12V	200.	SPST (NO)	Clare	1.20
R-155	12V	100.	SPST (4NO4NC)	Auto. Elec.	1.15
R-158	6V	50	4PST (NO)	Stromberg	1.10
R-159	6V	50	DPST (NO)	Stromberg	1.10
R-160	6V	12	3PDT-3PST (NO)	Auto. Elec.	1.05
R-161	6V	10	3PST (2NC-1NO)	Auto. Elec.	.90
R-121	150V	5000.	2PST (NO) SPDT	Clare	1.65
R-123	150V	6300	SPST (NO)	Clare	1.75
R-602	150V	6500	3PST (NO)	Clare	1.75
R-515	24V	750	SPST (NO)	Clare	1.25
R-517	12V	250	DPST (ND)	Clare	1.20
R-519	250V	14000.	SPDT	Auto. Elec.	1.95
R-520	250V	14000	DPDT	R.B.M.	2.10
R-521	32V	1000.	DPDT	Kellogg	1.20
R-166	24V	DUAL-200.	DPDT-SPST (NO)	Stromberg	1.59
R-168	24V	DUAL-200.	4PST (NO)	Auto. Elec.	1.20
H-240	250-350V	40000	DPST (NO)	Auto. Elec.	2.95
H-241	48V	650	SPDT-SPST (NO)	Clare	1.25

TYPE 18 DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-109	24-48V	4000.	SPDT	Auto. Elec.	$1.50
R-110	24-32V	3500	SPDT	Auto. Elec.	1.50
R-112	90-120V	6500	SPST (NC)	Auto. Elec.	1.75
R-114	24V	500	4PST (NO)	Auto. Elec.	1.30
R-603	24V	400	DPST (NO)	Auto. Elec.	1.25
H-238	24V	150	DPDT-SPST (NC)	R.B.M.	1.25
H-239	24V	180	DPST (NO)	Auto. Elec.	1.25

SEALED DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-125	24V	300.	DPDT	Clare	$2.75
R-126	90-120V	2000	DPDT	Clare	3.00
R-504	24-70V	2800	SPDT	GE-C103C25	3.00

V TYPE DC TELEPHONE RELAYS

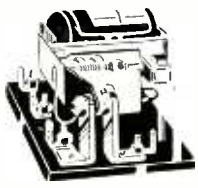
Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-164	24-32V	1000.	SPST (NO)	W. E.	$1.20
R-512	24-48V	3500	DPDT	W. E.	1.30
R-513	12-24V	300	DPDT-DPST (NC)	W. E.	1.20
R-514	4-6V	60	SPDT	W. E.	1.05
R-526	6V	35	DPDT-SPST (1NC-1NO)	W. E.	1.05

AC-STANDARD TELEPHONE RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-212	90-135V	—	NONE	Clare	$0.95
R-213	5-8V	—	DPST (NO)	Clare	1.50
R-605	24V	—	3PST (NO)	Auto. Elec.	.95
R-606	24V	—	DPST (1NO-1NC)	Auto. Elec.	.95
R-607	24V	—	SPST (NO)	Auto. Elec.	.95

DIRECT CURRENT MIDGET RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-132	24V	300	DPDT	Clare	$1.20
R-133	24V	300	NONE	Clare	.60
R-134	24V	250	4PDT	Clare	1.20
R-135	24V	300	SPST (NC)	Clare	1.15
R-137	24V	300	SPDT	Clare	1.15
R-138	24V	300	4PST (NO)	Clare	1.15
R-139	24V	200	4PDT	Clare	1.15
R-140	24V	280	SPDT	R.B.M.	1.15
R-141	24V	280	3PST (NO)	R.B.M.	1.15
R-142	24V	400	DPDT	Allied Cont.	1.20
R-143	24V	280	SPST (NO)	R.B.M.	1.15
R-144	24V	250	SPST (NO)	Allied Cont.	1.15
R-145	24V	300	DPST (NO)	Allied Cont.	1.15
R-146	12V	126	DPST (1NO) (1NC)	Clare	1.10
R-147	9-14V	75	SPDT	Guardian	1.05
R-148	12V	100	DPDT-SPST (NC)	Price Bros.	1.10
R-149	6-8V	45	SPST (NC)	Clare	1.00
R-150	6V	30	SPST (NO)	E-Z Elec.	.95
R-522	2-6V	2.	SPST (ND)	R.B.M.	.65
R-523	90-125V	6500	DPDT	Clare	1.90
R-222	12V	100	DPST (NO)	P & B	.95
H-242	24-32V	300	DPDT	R.B.M.	1.20
H 243	24-32V	300	4PDT	R.B.M.	1.20



SENSITIVE DC RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-218	4-6V	1800.	SPDT	Kurman 220C	$1.95
R-220	75V	5000	SPDT	Allied Cont.	1.20
R-221	18-24V	5000	SPST (NO)	Allied Cont.	1.15
R-174	250V	5000	DPST (NO)	G.M.	1.85
R-175	350V	11000	DPDT-DPST (NO)	G.M.	2.95
R-176	24V	250	DPST (NO)	G.M.	1.50
R-177	24V	300	4PDT	G.M.	1.65
R-600	8-12V	5000	SPDT	S-Dunn-KS	2.10
R-507	24-48V	1000	SPDT-DPST (NC)	Guardian	1.15

TYPE BO DC RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-169	24V	250	SPST (NO)	Allied Cont	$1.95
R-171	24V	230	DPDT	Allied Cont.	2.15
R-172	5-8V	30	DPDT-SPST (NO)	Allied Cont.	1.70
R-173	2-6V	5	SPST (NO)	Allied Cont	1.25
R-529	24-48V	1000	DPDT	Allied Cont.	2.50

TYPE BJ DC RELAYS

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-204	12V	65	DPST (NO)	Allied Cont.	$1.15
R-205	24V	260	DPDT	Allied Cont.	1.25
R-224	12V	75	SPST (NO)	Allied Cont.	1.15
H-237	27V	230	DPDT	Allied Cont.	1.25

HEAVY DUTY KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-248	28V DC	150	SPST (NO) 10A.	Guard 36471	$1.05
R 244	75V AC	265	SPST (NO) 20A.	Leach 1327	1.75
R 206	24V DC	150	5PDT-3 AMP.	P&B-KL	1.20
R-207	24V DC	210	4PDT-3 AMP.	P&B-KL	1.10
R-219	50V DC	1500	DPST (NO) 15A.	P&B-SP	1.25
R-217	115 AC	600	SPDT-10 AMP.	St. Dunn 1XAX	2.25
R 525	24V DC	200	DPDT-10 AMP.	Guard. 34464	1.25
R-508	110 AC	600	SPDT-6 AMP.	Guard. 37189	1.95
R-506	24 V DC	300	DPST (NO) 6A.	—	.95
R-510	24 V DC	200	3PDT-10 AMP.	Guard 516983	1.05
R-604	24 V DC	200	SPST (NO) 30A.	St. Dunn-B2A	1.25
H-608	115 AC	—	SPST (NO) 20A	St. Dunn-1HXX	2.25
R-620	12V DC	35	3PST (NO) 10A.	Guard-BK2	1.05
R-223	28V DC	150	SPST (NO) 40A	Price Bros.	1.35
H-230	12-24V DC	80.	DPST (NO) 10A.	—	1.20
H-231	24V	230.	DPST (NO) 5A.	R.B.M.	1.15

DC-TYPE 76 ROTARY RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-197	9-16V	70	DPDT	Price Bros.	$1.65
R-198	9-16V	125	6PST (3NO) (3NC) SPDT	Price Bros.	1.65
R-199	24-32V	250	SPDT-DPST (NC)	Price Bros.	1.65
R-200	24-32V	275	3PDT-SPST (NC)	Price Bros.	1.65
R-201	24-32V	250	DPST (NO) SPDT (NC) DPDT	Price Bros.	1.65
R-601	9-14V	60.	3PST (NO)	Price Bros.	1.65

DIRECT CURRENT KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-190	12V	65	DPDT 10 AMP	Advance Elec. Type 2000-A	$1.15
R-191	28V	125	DPDT 10 AMP	Guardian	1.20
R-192	12V	44	3PDT 10 AMP	Allied Cont. Type NB5	1.35
R-193	5-8V	11	OPDT 10 AMP	Leach	
			SPST (NO)	Type 1027	1.05
R-194	24V	265	DPST (NO) 10 AMP	Leach Type 1054SNW	1.25
R-195	6V	32	DPDT 3 AMP	G.E.Co.	1.15
R-196	12V	50	DPDT 10 AMP SPST (NC)	Guardian	1.15
R-242	24V	170	SPDT 2 AMP	Leach Type 1253DEW	1.25
H-236	5-8V	18.5	SPDT 10 AMP	Leach-BFM	1.05

CUTLER HAMMER HEAVY DUTY CONTACTORS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-178	24V DC	100	SPST (NO) 100A.	6141H34A	$3.85
R-179	6V DC	6.5	SPST (NO) 50A.	6041H83A	3.00
R-180	12V DC	25.	SPST (NO) 50A.	604H308	3.25
R-181	24V DC	65	SPST (NO) 100A.	6041H8B	3.85
H-232	24V	55.	SPST (NO) 50A.	Metal Cased	3.25
H-233	6V	15	SPST (NO) 50A.	Metal Cased	3.15
H-235	24V	70.	SPST (NO) 100A.	Type B6	3.85

DIRECT CURRENT AIRCRAFT CONTACTORS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-182	28V	80	SPST (NO) 25 A	Guardian	$1.85
R-183	24V	60	SPST (NO) 50 A.	Allen Bradley Type B6A	2.75
R-184	28V	50	SPST (NO) 100A.	General Elec	2.95
R-185	24V	100	SPST (NO) 50 A	Leach 5055ECR	2.75
R-186	24V	132	SPST (NO) 50 A.	Leach 7220-3-243	50
R-187	24V	100	SPST (NO) 50 A.	Allen Bradley	2.95
R-188	24V	200	SPST (NO) 75 A.	Allied Cont.	2.95
H-234	14V	45	SPST (NO) 30 A.	—	1.65

ANTENNA CHANGEOVER RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-192	6-12V DC	44	2PDT 10 AMP	Allied-NB5	$1.35
R-231	12VDC	100.	DPDT 6 AMP	G. E.	1.95
R-256	24-32V DC	—	SPDT-DPST (NC) 1KW	Guardian	1.45
R-501	110 AC	4.	DPDT (1KW)	G. E.	2.45
R-503	12-32V DC	100	SPDT-5PST	G. E.-500 W.	1.95

COMBINATION PUSH BUTTON AND REMOTE RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
H-244	12-24 V DC	Dual-60	SPDT	CR2791-R106C8	$1.65

ADJUSTABLE TIME DELAY RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-246	115 AC	—	SPST (NO) or (NC) 10 AMPS	R. W. Cramer 1-120 Sec.	$8.95

DC MECHANICAL ACTION RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-245	12V	25.	4° Lever	G.M.	$0.95
R-527	6-12V	200.	2° Lever	—	.95

TYPE C.M.S. RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-511	24V DC	200	MICRO-SW SPST (NO)	Clare	$2.45

DC CURRENT REGULATOR

Stock No	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-509	6-12V DC	40	SPST (NC)	G. E.	$0.85

LATCH AND RESET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-500	12V DC	10.	DPDT-10 AMP	St. Dunn-CX-3190B	$2.85

DC-ROTARY STEP RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-621	6-12V	30.	3 POLE 23 POSITION	W. E.	$10.95

DC-RACHET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Manufacturer	Net Each
R-230	5-8V	2.	SPDT-DPST (NO)	Guardian	$2.15

Special Sample Engineering Offer

Any ten relays listed (one of each type) with the exception of Stock Nos. R-621 and R-246—only $10.00.

ORDER DIRECTLY FROM THIS AD OR THROUGH YOUR LOCAL PARTS JOBBER

Manufacturers: Write For Quantity Prices.

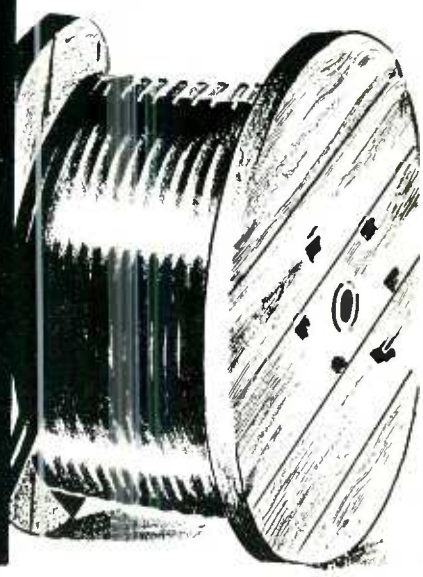
Distributors: Write For The New Wells Jobber Manual.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT.-SL, CHICAGO 10, ILL.

COAX CABLE

TREMENDOUS VALUES IN GUARANTEED COAXIAL CABLE • ANTENNA WIRE MICROPHONE AND HIGH VOLTAGE CABLE



COAX CABLE

RG-7/U	97.5 ohms impedance; outside diameter .370"; black vinyl jacket; polyethylene insulation. On original manufacturer's reels of 2040 feet	$37.50/M
	100 ft. coils	.04/ft.
RG-29/U	53.5 ohms impedance; outside diameter .184"; black vinyl jacket. Packaged on 4000 ft. reels	27.50/M
	1000 ft. reels	32.00/M
	100 ft. coils	.035/ft.
RG-29/U-W	Same characteristics as RG-29/U except cotton braided covering. Per 1000 feet	25.00/M
	100 ft. coils	.03/ft.
	RG-29/U is ideal for television to eliminate lead-in pick up of local interference. RG-29/U is similar to RG-58/U.	
RG-57/U	2 conductor Coax. 95 ohms; Kilowatt Rating. Any length	.18/ft.
RG-8/U	Limited quantity	40.00/M

LOW LOSS BEADED COAX CABLE, 72 ohms impedance.

	Type 72-12 — for ultra high frequency, with black vinyl covering supplied in any length desired	.11/ft.
	Type 72-12-W — Same as above except varnish cambric covering supplied on 60 ft. coils, only	.07/ft.

OTHER WIRE AVAILABLE FROM WELLS

PWD-20-2	Plastic coated assault wire two-conductor twisted Type W-130. Available on 1000 to 2500 ft. steel reels, individually boxed	7.00/M
PWD-20-3	3000 ft. payout reels (packed two reels per box)	6.50/M
PWD-20-10	10,000 ft. steel reels	6.25/M
AWT-18-1	Army Field Wire, Type W-110B. Two conductor, stranded, rubber covered, weather proof. 1000 ft. reels	10.00/M
AWT-18-10	Army Field Wire, Type W-110B. Two conductor, stranded, rubber covered, weather proof. ½ mile steel reels	9.50/M
AWT-18-20	Army Field Wire, Type W-110B. Two conductor, stranded, rubber covered, weather proof. 1 mile steel reels	9.00/M
KW-3	Flexible Phosphor Bronze No. 18 bare aerial wire 300 ft. spool	1.00/Sp
KW-10	Flexible Phosphor Bronze No. 18 bare aerial wire 1000 ft. coil	3.00/M
AJ-18	Aerial Wire, No. 18, Copperweld, solid — on 3000 ft. reels, only	4.00/M
SWB-20	Single conductor No. 20, shielded, over-all braid, 1000 ft. reels	15.00/M
SC-20-1	Single conductor, ANJC-48, No. 20, stranded, glass braid, lacquered 1000 volt insulation, 2000 ft. reels	10.00/M
SC-20-3	Single conductor No. 20 glass braid, lacquered, 3000 volt insulation for Transmitters, 1000 ft. coils	12.00/M
MW-1	Shielded, single conductor microphone cable, rubber covered, extra flexible, inter-conductor stranded silver wire, 500 ft. coils	12.50/coil

MANUFACTURERS: WRITE FOR QUANTITY PRICES.

JOBBERS: REGULAR DISTRIBUTOR'S ARRANGEMENT APPLIES • ORDER FROM THIS AD.

WE CARRY A COMPLETE STOCK OF COAX CONNECTORS . . . WRITE FOR LISTING NO. 100M.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

RELIANCE SPECIALS

PRECISION RESISTORS

WIRE WOUND 1% Tol. or Better

Any Order For
100 pieces.....10% Off
1000 pieces.....20% Off

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	2,193
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	1235Ω	4,451Ω	15,000Ω
.324	13.15	260	5,000	15,750
.502	46	270	5,900	17,000
.557	52	298.3	6,500	20,000
.627	55.1	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	18,000Ω	70,000Ω
2.58	10.1	3,300	50,000	75,000
3.39	10.9	7,000	55,000	
5.05	270	9,000	65,000	

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000		600,000
125,000	160,000	320,000	522,000	700,000

1 Megohm, 1 Watt, 1%—65c 5%—40c

115V RELAYS 60 cyc.

Mfg.	No.	Contacts	Price
SD	91XDX103	4PDT, 6A	$3.50
SD	TD 435 (time delay)	SPST, N.O.	2.75
Leach	1355	DPST, N.C.	1.90
Leach	1127	DPDT	2.45
Leach	2124 SMX (Micalux)	4PST. N.O.	3.50
Advance	965 B	DPST, N.O., 10A	2.10
Advance	SA 1000X (Isolantite)	DPDT, 10A	2.95
Paragon	CPX-24166	60 sec. delay, 10 A.	6.50

FILAMENT TRANSFORMERS

WESTINGHOUSE #6D4298

Tested at 34,000 volts

Pri: 115 V. A. C., 60 Cyc.

Sec: 5V @ 6.5 Amp.

ONLY $8.50

CHOKE

400 MA. 12 Henry 90 Ohms, 6,000 V.D.C. Test Herm. Sealed. 4½" x 5⅝" x 4½", 12 lb..$3.85

200 MA. 10 Henry, 115 Ohms, 3¾" dia. x 4½", 6¾ lb. $1.95

3 AG FUSES 3 AG

1/8 Amp.	$4.00 per C	2 Amp.	$2.50 per C
1/4	4.00	3	2.50
3/4	4.00	4	2.75
1	2.50	10	3.00
1 1/2	2.50	15	3.00

115 V TRANSFORMERS 60 cyc.

24 Volt, 10 A, cased.....$4.75, 10 for $45.00

2.5 Volt, 6.5 A. CT. each of two windings cased. $2.45

5 Volt, 60 A. CT. 5000 V. insulation.....$6.75

300 Volt, 4 A each of two windings, open, tapped primary, net weight: 70 lb.....$17.50

STEEL JUNCTION BOX

Water-tight, 14 ga. steel. 17"x25"x6½". Screw type brass hinge on lid. Approx. 50 lb....$2.95

SHIELDED WIRE—#18

SINGLE CONDUCTOR

50 ft.—$1.00 1000 ft.—Only $12.50

CAPACITORS

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.1	25,000	$19.95	.2	750 V.A.C.	
.012	25,000	6.20	(2,200	V.D.C.)	$.39
.03	16,000	5.75	1	2,000	.95
(.375@	16,000 and		.4	1,100	.30
(.75@	8,000(dual)	14.95	4	1,000	1.00
.1	7,500	1.95	3	1,000	.80
.1-.1	7,000	2.45	2	1,000	.65
.1	7,000	1.85	1	800	.40
.02-.02	7,000	1.65	10	600	1.35
.1	6,000	1.75	4	600	.69
.03-.03	6,000	1.65	2	600	.39
1	6,000	8.50	1	600	.29
.01	5,000	1.35	8	500	.90
2	4,000	5.50	.1	500	.19
.25	3,000	1.75	.5	500	.24

POSTAGE STAMP MICAS

8.2mmf	50mmf	200mmf	560mm	
10	56	220	600	.00
15	60	250	650	.0026
18	70	270	680	.003
20	90	300	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¢ .01mfd 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	300	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¢

TOGGLE SWITCHES

H & H D.P.D.T.; 3A., 250 v., Molded Body, Bat Handle .....Only 60¢ ea. $50 per hundred

H & H S.P.D.T.; 6A., 125 v., Molded, Ball Handle .....30¢ ea.

C-H D.P.S.T.; 10A., 125 v., Molded, Bat Handle Luminous tip .....40¢ ea.

G.E. D.P.D.T.; 3A., 125 v., Molded, Ball Handle 45¢ ea.

H & H Power switch. D.P.D.T., 10A., 125 v., Ball Handle .....$1.80 ea.

C-H D.P.D.T.; Center Off, 20A., 125 v., Bat Handle .....$1.75 ea.

TIME DELAY RELAY

115 V. 60 Cyc.

Raytheon # CPX 24166, KS 10193-60 Sec.

Made by Paragon. Used to delay time of applying high voltage to rectifier tube. Adjustable 50-70 seconds. 3.6 watt, ½ R.P.M. clutch motor. Holds ON as long as power is applied. 2½ second recycle time. .....ONLY $6.50

Glyptal Cement { 1 qt. cans, GE #1286 75¢ ; 1 gallon cans.....$2.50 ; 5 gallon cans.....$11.00

HARDWARE ASSORTMENT—(mostly brass) screws, nuts, washers, solder lugs. 3 lbs.$1.00

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 .....$1.50

7472407, GE, core ⅝" x 1⅜" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC).....$1.25

80G16, GE $1.25

D161310. Western Electric, cased 1¾" dia. x 1⅞" high, impedance ratio 120 to 2350 ohms, molybdenum Permalloy tape core. Frequency response 50 Kc to 4 Mc.....$2.00

D166638, W. E., cased 1⅜" x 1¼" x 2¼", 2 semitorridal windings 150 turns ea. of two windings, used in portable oscilloscope..$1.25

352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm sine wave response 140 cy. to 175 Kc.....$1.25

352-7251-2A, similar to above but for 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 K2731, 28,000 Volt pk. output. Bifilar, pulse width: one microsecond.....$19.50

MULTIMETER

Superior 770: 6 AC, 6 DC, 4 current, 2 resistance ranges. Guaranteed for 1 year.....$13.90

JONES BARRIER STRIPS

Type	Price	Type	Price
2-140Y.....	$.05 ea.	20-141.....	$.65 ea.
3-140 3/4W...	.12	2-142.....	.10
3-140.....	.10	3-142Y MSX..	.23
5-140Y.....	.19	4-142.....	.18
2-141.....	.09	5-142.....	.21
2-141Y.....	.11	6-142.....	.25
3-141.....	.11	7-142.....	.29
5-141Y.....	.25	8-142.....	.38
8-141.....	.27	9-142Y.....	.52
8-141 3/4W...	.38	9-142.....	.37
8-141MSX....	.38	10-142 3/4W...	.58
9-141Y.....	.42	10-142.....	.40
10-141 3/4W...	.47	10-142Y.....	.58
10-141Y.....	.47	11-142Y MSX..	.76
11-141.....	.36	12-142.....	.48
11-141Y.....	.51	12-142Y.....	.68
15-141Y.....	.69	17-142.....	.67
17-141Y.....	.78	17-142Y.....	.97
20-141Y.....	.93	4-150.....	.46
		18-240.....	.35

Any order for 100 pieces—10% off; for 1,000 pieces—20% off

Vernier dials, 2⅝" dia. 0-100 in 360° black with silver marks, thumblock. For BC221....$.85

UNIVERSAL JOINT

ALUMINUM

1⅛" long x ½" O.D. ¼" ID

35c

ALLEN SET SCREWS

4-40x1/8	6-32x1/8	8-32x3/16
4-40x3/16	8-32x1/8	8-32x5/16
All sizes.....		$1.50 per C

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5E	3/16"	1/2"	5/32"	25¢
Fafnir 38K	5/16"	7/8"	9/32"	45¢
Timken	1/2"	1 3/8"	7/16"	85¢
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¢

CERAMIC CONDENSERS

$7.00 per 100

3mmf	10mmf	22mmf	68mmf	115mmf
3.44	15	27	75	200
4.7	16	47	82	1000
6.8	18	50	91	1090
8	20	56	100	

MINIMUM ORDER $3

All Orders f.o.b. PHILA., Pa.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey, Philadelphia 3, Pa. *Telephone RIttenhouse 6-4927*

— GEARS —

Sample Assortment

See our ad in the

OCTOBER, 1948, ELECTRONICS

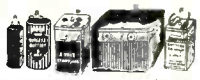
— Page 294 —

Write for our complete catalog

SNOOPERSCOPE INFRARED
Image-Converter Tube HiSensitivity simplified design 2" dia., Willemite screen-Resolution up to 350 lines/inch. Complete data & Tube, "TAB" SPECIAL **$8.98**
12DP7 GE MagnDeflTelev CR & Data SPECIAL $12.95, 2 for $25, 10 for $115.00
5FP7-5" CR Tube SPECIAL $1.49, 2 for $2.75
9LP7-9" CR Tube SPECIAL $2.69, 2 for 4.98
6L6 Metal RCA Kenrad ..... ea. 89c; 10/$8; 100/$70
G.E. GL434A sim7C29 1KW HF RF $7.95
866A Combination Tubes Sockets Xfmr 5.95
872A Combination Tubes Socket Xfmr 12.95

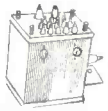
Write For Your FREE "TABOGRAM"

Storage & Dry Batteries



A. BR18/BB52/5oz/36Vmin S Baty 98c: 12 for $10
B. BURGESS 3V/F2BP/dated '47, 8 for $1.00
D. BB54/2V/27amp WILLARD S-Baty $1.89
E. WILLARD 4V/40AH/TBY S-Baty $4.95
E. BB2060/2V/11AH WILLARD S'Baty $1.89
WILLARD 6V/25AH/7½"L2½"W6½"H 3.39 @2for 5.98
EVEREADY Hevi-Duty Minimax BA43p/oSCR284 90/45/1½V w/octal sckt&handle 2 5/8x4¾x6¼" 3xStd Late 47 ..... ea. $1.39; 2 for $2.49; 10 for $10.00
Battery Acid (R'Expr Only) 1 pt 59c; 2 pts 98c.
USN Hydrometer Kit & Box $1.98

TELEVISION



TRANSFORMER TV POWER SUPPLY KITS
No RF bursts! Hi, Lo & Filam Voltages. FEATURING Herm Std W.E. USN oil filled XFMR Inputs 105/115/125VAC 50-425 cps Outputs HiV&600VCT or 300VCT/295MA & 6.3V/10A, 5V/8A, 2.5V/3A, 5V/3A. exc for 630TS to 16" CR 10000V & 300VDC & ALL Filaments Supply Kit. Above Xfmr & 2-3B24 Doubler-Rect & 5U4G rect. & ALL endsrs, sockets, choke & data. SPECIAL **$29.95**
5000V 300VDC & ALL Filaments KIT. Same Xfmr plus 5U4G & 3B24 rect., endsrs, choke, sckts, data **$21.95**
Xfmr Only: F1, LoFil Volts $16.95
Basic TV & CRT PWR KIT-2.5 KV Xfmr out of BC412 Scope with 2.5 V/1.75A for 2X2 fil & 6.3V/.6A winding KENYON S13336 or Equiv Only .. **$8.95**
Above Xfmr plus 2X2 Tube & Safety Socket $9.95

POWER PACKS—Basic Kits!
Complete CRT & Scope. Pwr Supplies—110V/60cyc Input.
KIT A Hi&Lo Plate & Fil Volts for TV or C'Ray'scope 1320 VOLTS H.V. & 375VCT/110ma; Filaments 5V/3A, 2.5V/3.25A, 6.3V/2.75A USN Herm Std 5¼x4½x3½", 5Y 3GT & 2X2 rect & sckts 2-10mfd electlytics & oil cndsrs & 8 Hy Ccd HiVins CHOKE "TAB" SPECIAL $11.95
KIT B-2400 VOLTS HiV: 2Xfmrs PLUS 2x866A rects & sckts & 2X2mfd 2000VDC cndsr & 12 Hy 300ma Csd HiVins CHOKE "TAB" Special $21.95
Single Xfmr 1200VCT, Only 5.50
Medium Power Kits for Your Rig-110V/60cyc.
KIT C-700 VOLTS CT/125Ma. Filaments 2x6.3V/2A, 5V/2A and 115V/100Ma. Isolation Winding FEDERAL Tel for USN HiV ins Herm Std 5x5x3¾" PLUS 5Y3GT rect. & sckt. 2-10 mfd electlytics & 10 Hy Csd CHOKE "TAB" Special 4.49
KIT D-500 VOLTS CT/60Ma & 6.3V/4A. Cylind USN HiV ins Herm Std 3¾Hx3" dia PLUS rect., 2-10mfd electlytics, & 30 Hy Csd H.V. ins CHOKE "TAB" SPECIAL $2.98
TELEVISION SIGNAL BOOSTER
Sonar TELEBOOSTER Ultra-sens 13 CHANNEL Booster w/2-6J6's In Sharp Tuned Ckts. SELF-POWERED! Fine Walnut Case, COMPLETE $15.98

TUBES . . . JAN & STANDARD TYPES

OA4G	$1.04	3D6/1299	[illegible]	6SF5	$.60	35W4	$.44
OZ4	.85	3E29/829B	3.95	6SG7	.71	35Z5GT	.45
1A4	1.26	3GP1	4.95	6SH7	.69	37	.78
1A5GT	.70	3JP12	2.95	6SJ7	.72	38	.39
1A6	1.26	3Q5G	.94	6SJ7GT	.58	39/44	.39
1A7GT/G	.69	4APl0	6.95	6SK7	.65	41	.58
1B3GT/8016	.69	4C35	19.90	6SL7	.75	50	1.56
	1.29	5AP1	2.75	6SL7GT	.94	50R5	.66
1B21/471A	2.95	5BP1/5GP1	1.95	6SN7	.86	50L6	.58
1B23	49.00	5BP4	3.95	6SN7GT	.69	81	1.56
1B24	4.89	5CP1	2.98	6SQ7	.59	83	1.05
1B27	4.89	5CP7	13.49	6SR7	.70	83V	1.05
1B62	4.95	5D21	19.00	6SS7	.71	84/6Z4	.72
1C6	1.26	5FP7	1.49	6T7G	1.53	114B	1.23
1C7G	1.26	5HP1	4.95	6U5/6G5	.81	117N7	1.54
1D5GP	1.25	5LP7	9.95	6U6	1.49	205B/VT2	1.98
1E4G	.89	5R4	1.25	6U7	.70	211	.89
1F4	1.04	5T4	1.15	6U7G	.58	215A	.25
1F7GV	1.54	5U4G	.59	6V6	.69	227	3.90
1G4GT/G	1.04	5V4G	.53	6X5	.81	231	.98
1H4G	.88	5W4	.87	6X5GT	.58	250TH	19.49
1H6G	1.28	5X4	.70	6Y6GT	.87	250TL	18.98
1J6	.96	5Y3G	.38	6Z7G	1.23	304TH	5.95
1J6G	1.35	5Z3	.81	7A4	.70	304TL	1.98
1L4	.70	5Z4	.88	7A6	.69	307A/RK75	4.25
1LA4	1.04	6-11 Ballast	.59	7A8	.69	327A	4.90
1LB4	1.04	6A3	1.26	7B5	.70	376/GL276	5.98
1LC6	1.05	6A4	1.53	7C4/1203A	.49	388A	.40
1LE3	1.04	6AB7/1853	.89	7E5	1.00	393A	5.95
1LH4	1.05	6AC7	.69	7E6	.70	446B	1.98
1LN5	.69	6AF6	.86	7E7	.85	559	.73
1N5GT	.69	6AG5	.99	7G7	1.04	575A/975	14.25
1P5GT	.69	6AG7	1.05	7L7	.86	701A	3.95
1P24	2.95	6AJ5	.98	7N7	.69	702A/702B	3.49
1Q5GT	1.04	6AK5	.89	7Q7	.86	703A	4.90
1S5	.70	6AL5	.69	7V7	1.04	704A	1.75
1T4	.69	6AS6	.98	9-3 Ballast	.59	705A 8021	2.25
1T5GT	1.04	6BA6	.59	9JP1	3.95	707B	
1V	.86	6B4G	1.15	9LP7	2.69	2K28	10.98
2A3	1.04	6B5	1.54	10	.67	710A 8011	2.75
2A5	.86	6B8	1.26	10-4B,		713A	1.63
2A6	1.04	6B8G	1.05	Ballast	.59	715B	8.90
2A7	1.04	6BE6	.59	10Y	.60	717A	.58
2B7	1.26	6C4	.27	12A6	.23	722A/287A	9.95
2C21/1642	.81	6C5	.54	12AH7GT	.87	723	4.95
2C26	.59	6C6	.71	12C8	.39	723A	5.50
2C34/RK34	.55	6C8G	1.05	12DP7	12.95	723AB	5.90
2C40/446A	.75	6C21		12GP7	14.75	725A	24.90
2C43/464A	4.49	450TH	24.90	12H6GT	.39	802	2.95
2C44	1.69	6D4	1.25	12J5	.39	803	7.95
2D21	1.20	6E5	.71	12K8	.85	804	9.75
2E22	1.45	6F6/1613	.69	12Q7GT	.70	805	4.50
2E25 HY65	3.49	6F8	1.04	12SA7GT	.64	807	1.15
2J21 725A	12.95	6G6G	1.04	12SC7	.70	808	2.25
2J26	12.95	6H6G	.49	12SH7	.71	809	2.90
2J31	16.95	6J4	5.95	12SJ7	.64	810	6.95
2J33	14.50	6J5	.56	12SJ7GT	.59	811	2.20
2J34	18.95	6J6	.96	12SK7	.58	813	6.95
2J42 700A	29.95	6J7	.70	12SL7GT	.86	814	2.98
2K25	24.49	6K5G	.86	12SQ7	.58	815	2.49
2K28	10.98	6K6GT	.69	12SR7	.39	816	1.15
2K29	6.98	6K7	.70	14B6	.69	826	.69
2V3	1.96	6K7G	.64	14R7	.86	828	10.00
2V3G	1.05	6K8	.86	15E	1.39	829	3.95
2X2	.49	6L5	1.04	24G 3C24	.69	832	3.75
3A4	.70	6L6	1.04	25B6	1.98	836	1.12
3B7/1291	.95	6L6M 1622	.90	25Z5	.53	837	2.25
3B24	1.29	6L7	.75	25Z6GT	.59	838	3.95
3BP1	1.49	6N7 1635	.85	28D7	.39	842	2.98
3BP1A	2.95	6P5G	.94	30	.39	843	.67
3C23	4.95	6S7	.87	31	.39	845	4.50
3CP1		6SA7	.54	32L7GT	1.19	845W	4.75
1808P1	4.95	6SA7GT	.49	35A5	.70	860	1.97
3D22	7.49	6SC7	.71	35L6GT	.58	861	11.90
						865	$1.00
						866	1.59
						866A	1.25
						868/PJ23	1.49
						872A	2.45
						876	.96
						878	2.47
						884	.89
						885	.96
						902	5.49
						918/CE1C	1.49
						922	1.49
						923	.95
						930	1.00
						931A	3.95
						954	.33
						955	.40
						956	.33
						957	.33
						958A	.63
						991	.67
						1294/1R4	1.04
						1603	6.75
						1609	.98
						1613/6F6X	.69
						1614/6L6X	1.50
						1616	1.39
						1619	.39
						1625	.40
						1626	.45
						1629	.58
						1641 RK60	.75
						1851	1.23
						2050	.69
						2051	.88
						7193	.38
						8013A	3.95
						8020	13.49
						9001	.40
						9002	.59
						9003	.49
						9004	.49
						9006	.40
						C6J	4.95
						CK1005	.35
						CRC/814	2.70
						CRD72	1.85
						F127A	8.00
						FG27A	9.90
						FG104	4.95
						FG105	1.95
						FG166	9.00
						GL434A	7.95
						GL534/	
						1S21	1.95
						KU627	6.49
						L628 Ballast	.59
						M55B	.39
						REL36 6J4	.98
						RX215	7.95
						UX6653	.69
						VR75	.98
						VR90/OD3	.74
						VR92	.23
						VR105 OC3	.74
						VR150 OD3	.90
						WE215A	1.80
						WL468	1.95
						WL531	1.95
						WL619	21.00

CRT Tubes Gtd against breakage only when Shipped R'Exp.

KITS

AMPLIFIERS
HIGH FIDELITY — A Hi-Fi circuit with perfect linear response, phase inverter & full tube complement featuring 2-2A3 PP output, 6SJ7 and 6SN7. All parts, tubes, controls, diagram & remarkable RCA Audio Amplif Chassis described below. Less Output Xfmr. THIS IS A TRULY GREAT BUY **$14.95**
17.5 WATT AMPLIFIER KIT—Similar above with all major components except 2-1619/6L6 delivering 17.5 Watts. 14 WATT AMPLIFIER KIT—Similar above except 2-6V6GT delvrng 14 Watts. 17.5 or 14 Watt Kit less output Xfmr, Only **$12.95**
RCA AUDIO AMPLIFIER CHASSIS for AMPLIFIER KITS above. Heavy duty porcelainized chassis. Gray rustproofed 7¼x12¼x2¼". 9 Amphenol sockets incl 6 octal, 3 inputs, output for pwr transf & choke. Chassis marked for 2 Mic, Vol, Tone, Fuse, Tubes (7). Complete with 3-FP triple section Electrolytics.

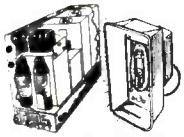
BASIC ALL-ELECTRONIC VTVM Kit. An ultra-sensitive tester; similar to RCA Volt-Ohmyst Jr. Includes PRECISION resistors, 4" Sq GE 200 microamp meter (reads 3-10-30-100-1000V DC; 10-30-100-300-1000 VDC; 1000/10000/1000000/1 meg/10 megohms), 11 megohms. Inpt res. Less case.. **$19.95**

BASIC 3" SCOPE KIT. Sensational visual tester foundation. 3BPI CRT plus 5Y3GT & 2X2 tubes. 115V60cysXfmr—1320V, 375 VCT/10ma, 5V/3A, 2.5V/3.25A. All cndsrs & choke for Lo & Hi Volts supply & sockets. Less chassis, amplifier & sweep circuits **$16.95**

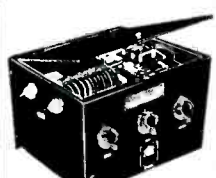
LAMPS, PILOT LIGHTS

Tungar* Bulbs		Aviation Lgts	
20X672*	2.95	C1249/12VGR	
199698*	2.95	25 for	1.00
289881*	2.50	Sealed Beam	
		4522/250W	1.49
MAZDA PL**		4560/600W	3.50
44**Box 10	.50	NEON BULBS	
47**Box10	.50	NE2-Qty100	4.50
49**Box10	.60	NE16/991	.25
64**@	.07	NE51/NE20	.08
S6/T4**	.15	Qty100-NE20	
10 for	1.39		6.00
100W/20V**		TEL. Slide Lamps	
	.25	6,24,30V ea.	18c
313/28V**	.10	100 for	$15
323/3V**	.10		

TELEVISION COMPONENTS
A. V'Outpt Xfmr sim RCA204-T2 ..... $2.98
B. Utah9318 H'BlkgOsc Xfmr H'sld ..... .98
C. UTC88662 V'BlckgOsc Xfmr H'sld ..... .98
D. Erie HiV Cndsr 500mmf/10KV ..... .40
D. Jeffers HiV Cndsr500mmf/20KV ..... .75
E. Yoke MagnDeflec sim RCA201D1 ..... $4.59
F. FocusCoil for Magn Kinescps 3.95
G. HiV Flybak H'OutXFMRsimRCA211T1 ..... 5.49
Ion-Trap Magnet RCA203D1 ..... 2.98
300 ohm TWINEX Cable 100 ft $2.25; 1000 ft.. $17.50
Heller Speed Tacker for fast TV Twinex Cable tacking w/5000 Hvy Dty Staples 13.95
Staples Hvy Dty 5000 Boxed 2.98
DECALS Television Set of 8 for ..... .49



BASIC FOTOFLASH KIT—Complete Pwr Suply Incl cndsrs, tubes, xfmrs, circ diag. all instructions & FOTOFLASH lamp & reflector. For 115 VAC Only ... **$29.95**
STUDIO KIT—Famed Air Corps 1503 Set for 115V AC or battery w/2 lamps & refls $53.95
FLASH-CONDENSERS—FILM
7Mfd/2500VDC/21.9Watt-Sec's $2.75
5 (109.5 Watt-Sec's) for 12.50
15mf/330VAC/2000VDC intermitnt $4.50
25mf/330VAC/2000VDC intermitnt 7.95
16mf/660VAC/3000VDC intermitnt 7.95



HI-POWER VARIABLE ANT, MATCHING NETW'K 1001A
IKW HF RF NEW 1.5 to 7mc's convertible HiFreqs PiNet adj IN&OUT CSD 15x15x23" RackMtg RibbonCoil &240mmf/7000V cndsr RFmtr, Insttrs & Manual. Matches most ANTS. 4" polished etched dials BRAND NEW (Coil turns loose.) Worth 10 times the price for parts alone. **$8.95**

DYNAMIC MIKE & XMFR SPECIAL!
A Terrific Bargain! Combination high gain dynamic mike transformer (UTC/Super Elec 3 wdg, 600CT & 4000 ohms tapped 250 & 150 ohms. Fully shielded H'sld plus excellent fidelity dynamic microphone. While they last....$1.49
COBALT BAR MAGNET. Wide Hystersis (hi-retentivity) charged COBALT bars 3⅞x½x¾". Pair for **79c**

2½ Mtr. Butterfly Cndsr.
30 mmf w/RF tank & choke SPECIAL..75c, 2 for....$1.25
PHASING CNDSR 90° quadrants 4 taps 360° SINE WAVE GENERATOR 2.39

BLOWERS—Cool that Tube!

40 CFM/28VACDC/LR Type $3.49
100 CFM/12VACDC 5.95
100 CFM/28VACDC 4.95
Xfmr 12 or 28V to 115VAC 1.69
250 CFM/28VACDC 8.95
250 CFM plus 28/115VAC Xfmr 10.95
150 CFM/110VACDC, Hvy Duty .. 7.95
FOXBORO GRAPHIC TAPE RECORDER Brand New—Write for specs $39.95
DUPLEXER USN CTZ50ACW for TELEVISION, Radar, FM—Write for specs $6.98
FILTER FL-5 New! 1020 cyc audio w/Switch.... 98c

ANTENNA AN-30 Telescopic Whip
Collapses 12" to 9 ft New
O'Seas pkg ea..... $1.49; 2 for $2.49
ANTENNA AT5/ARR1, ATI/APN2 30cm/12" lg w/coax conn w'prt gask&mtgFlange. Each ..... 98c; 3 for $2.00
ANTENNA AN130B Spring Swiveled Whip END Ld'd 33" lg..... $1.25; 2 for..... $1.98
ANTENNA P108/LU3 12cm lg w/coax fitting Each $1.98
ANTENNA AS23/APW/coax fitting..... 2.98
ANTENNA MS49-54, 18 ft Whip..... 3.98

FILTER CHOKES
13.5Hy/1Amp/42ohm/17KV ins $54.00
15-29Hy/150ma Swinging Cased 2.95
12HY/300ma..... $3.95; 3HY/40ma 3 for 1.00
15HY 400ma or 20HY/300ma/12KV ins..... 7.95
8HY/150ma NewUTCcrckedBkltT'bd 2 for.... 2.25
50HY/125ma Csd..... $1.95; 8HY/100ma..... 1.10
12HY 275ma $3.29; 15HY/80ma GE¢79@ 10 for 6.98
30Hy/50Ma ..... 49¢; 5 for..... 2.00

"TAB" MONEY BACK GUARANTEE
$3 MIN. ORDER F.O.B. N.Y.C.
ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

THAT'S A BUY "TAB" THAT'S A BUY

DEPT. 2E. SIX CHURCH ST. NEW YORK 6, N.Y., U.S.A. - CORNER CHURCH & LIBERTY STS. ROOM 200

"TAB" MONEY BACK GUARANTEE
$3 MIN. ORDER F.O.B. N.Y.C.
ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

SURPLUS BARGAINS — — NOW ! !

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

MICROVOLTER—FERRIS Model 20B

.2 to 100,000 microvolts output, continuously variable . . . operates on 115 V. 60 cycle AC . . . push button selector for 18 frequencies from 455 K.C. to 22 M.C. . . . with or without 400 cycle 30% modulation . . . frequency may be varied ±2% by screwdriver adjustment.

Your Price..... $100.00

BC 403E OSCILLOSCOPE

Made for Signal Corps by RCA for use in SCR-270D Radar—Can be converted to other uses — A Gold Mine for Parts — Shipping Weight: 400 lbs—Without Cathode Ray Tube 5BP4 ..... **NEW! $57.50**

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-5½"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

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

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

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
Weston	476	0-10	3" R-M	4.75
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	0-15/150	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	.95
Trpltt	431AC	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
Weston	301	0-2	3" R-B	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 Scale	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.

3PST, #1CXX100, Coil 115V. AC Contacts 115V. AC, 6 Amps, Bakelite Base, Dimensions, 3½" x 2½" x 2H"..... $2.95

HIGH VOLTAGE TRANSFORMER

GE Cat No. 7470609 can-enclosed with insulators
PRI—115/230 V. 50/60 Cycles
SEC—14000 V., Rating 1.4 Kva
Dimensions: 16"H x 12"W x 10"D.
Shipping Weight: 178 lbs.

A buy at $45.00

R. C. A. POWER TRANSFORMER

PRI—440/220 V. 60 CYCLES
SEC—125/115/105 V. at .8KVA
Bracket mounted, pri & sec terminal board. Dimensions: 5¾" H x 7½" W x 8" D, Shipping weight: approx 40 lbs.

Your price $12.50

STEP DOWN TRANSFORMERS SPECIAL

Made by GE, heavy duty, considerable overdesign, 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**

POWER TRANSFORMER

PRI—440/220 V. 60 Cycles
SEC—125/115/105 V., RATING .8KVA
RCA Open construction. Bracket mounted, pri & sec terminal board. Overall dimensions: 5¾" H x 7½" W x 8" D. Mounting dimensions: 6⅞" x 5⅞". **Price $12.50**

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

GE #K2731 PULSE TRANSFORMER

Pri. Imp. 50 Ohms
Sec. Imp. 450 Ohms

1 Micro-second, 635 PPS, Pri. Input 9.5 KV PK, Sec. Input 28 KV PK, BWR Out 800 KW, Bifiliar 2.75A.

A buy at..... $17.50

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**

RATING 1.85 KVA, MAX AMPS 16

same as above, can also be reconnected as isolation type transformer above Input 115 V, Output: 0-30 V, at 16 Amps.

Your price $17.00

DYNAMOTOR MADE BY G. E.

INPUT 28 V D.C. OUTPUT 1000 V D.C. CAPACITY 350 MA. With voltage regulator box on top. Approx. dimensions: 12" L x 6" Diam. Weight: 30 lbs.

A buy at $5.75

3PDT #1XCX114, Coil 115V. AC Contacts, 115 V. AC, 6 Amps, Micalex Base, Dimensions 3½" x 2½" x 2" H..... $3.95

4 Pole St, Coil 115V. AC, Contacts 115V. AC, 30 Amps, Fibre Base, Dimensions, 5" x 5" x 3" H. $4.95

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.**

SAVE MONEY!

DO YOU WANT TO MAKE YOUR DOLLAR GO FURTHER?

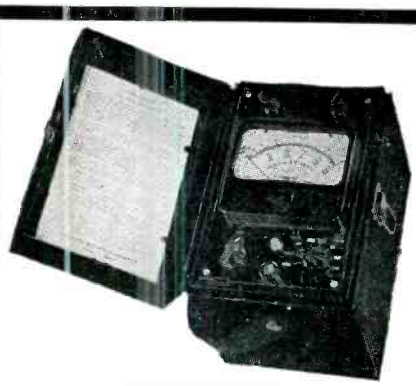
Take advantage of this opportunity—Buy BRAND-NEW-GUARANTEED SURPLUS MATERIAL at PRICES FAR BELOW DEALERS COSTS

MODEL TS-268/U CRYSTAL RECTIFIER TEST SET

The equipment is designed to provide a means of rapidly checking crystal rectifiers to determine if they are good or bad. The unit is completely self-contained in a waterproof, portable aluminum case 3"x6"x7". An automatic shut-off feature is provided in the form of a switch which is actuated when the case cover is closed. The operation of this switch opens the battery circuit, thereby precluding the possibility of leaving the equipment turned on when not in use.

The equipment operates from a 1½ volt dry cell power source, the battery supplying this power being mounted in the unit on the back side of the panel. All controls necessary for operation are readily accessible on the panel of the equipment. The panel also incorporates a Weston 301 0-1 D.C. Milliammeter, 100 ohms resistance, in a 3" square flush bakelite case which is calibrated in kilohms for resistance measurements and in milliamperes for current readings. The current scale is provided with colored sections which facilitate acceptance or rejection of crystals according to the type being tested. Complete as illustrated.

Your Net Price $17.50



"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

ROTARY CONVERTER

.750 K.V.A.,
115 Volt 9.4 Amp D.C.-Input
110 Volt 6.8 Amperes, 60 cycles, 1 phase-Output
3600 R.P.M., with Filter unit, Pincor type IK75
Your Net Price $65.00

ROTARY CONVERTER

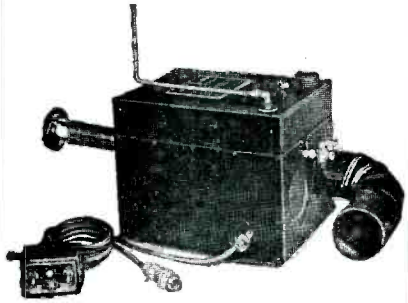
.225 K.V.A.,
230 Volt 1.5 Amp D.C.-Input
110 Volt 2.5 Amperes, 60 cycles, 1 Phase-Output
3600 R.P.M., with filter unit,
Janette type CA-16-F **Your Net Price $55.00**

MOTOR GENERATOR SET

1.25 K.V.A.,
230 Volt 6.8 Amp D.C.-Input
120 Volt 10.4 Amperes, 60 cycles, 1 Phase-Output
3600 R.P.M., Centrifugal starting,
Allis-Chalmers Mfg. **Your Net Price $100.00**

MOTOROLA MODEL GN-3-24

Gasoline Heater



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

PYROMETER PANEL

0-1200° F Bristol Co. Model 482F. Complete with 8 Iron-constant in right-angle-head thermocouples ½" pipe thread, 25 Position selector switch.
Your Net Price $80.00

A.C. AMMETER, Switchboard type, 0-60 Amp, Westinghouse DY-2, 4½" rd surf mtd case..**$8.00**

A.C. AMMETER, Port, 0-1, 0-5, 0-10 Amp. Mult. range, Weston 433 use with 461-4 C.T....**$55.00**

DUAL RANGE AMMETER, 0-3, 0-15 Amp. A.C., Weston 528 w. case & leads.....**$12.50**

D.C. VOLTMETER, Port. 0-10 Volts, 125 ohms per volt, Weston 489, (D.C. matching model of above 528 A.C. Meter.....**$9.50**

D.C. VOLTMETER, Port, 3-0-3 Volt, 200 ohms per volt, Westinghouse PX-4.....**$9.50**

D.C. VOLTMETER, Port, 0-3, 0-150 V., Dual range, W.H. PX-4.....**$17.50**

D.C. VOLTMETER, Port, 50 M.V. mvt., WH PX-4 range, R.S. Steel 6.....**$21.00**

D.C. AMMETER, Port, 50 M.V. mvt., WH PX-4 sc. cal 1000, 2000, 4000 Amp, less shunts...**$17.50**

VOLT OHM MILLIAMMETER, Port, Weston 665 .....**$45.00**

ZERO CENTER MILLIAMMETER, Weston 502, 6" sq fl ntd Switchboard meter. 1-0-1 M.A., Black Sc, calibrated 900-0-900 R.P.M.....**$18.00**

R.F. MILLIAMMETER. 0-120 M.A. R.F., panel meter, 3½" rd fl bake case, Simpson Model 35, AWS # MR35W120 R.F. M.A. **$8.50**

DECIBEL METER, Weston 506 minus 10 to plus 6, 6 M V in 600 ohms 2½" rd fl bake case..**$5.50**

DECIBEL METER. Weston 301, type 61, minus 10 to plus 6, 3½" rd fl bake case, 6 MW 600 ohms, Zero DB=1.9 volts. High speed type .29-.35 Second 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 followi g ranges
— 20 to + 16 DB
— 30 to + 26 DB
— 40 to + 36 DB

Ideal for sound and broadcasting applications (Quantity Available). Total List Price...**$37.50**
Your Cost Only.....**$11.50**

BOWL INSULATOR, clear glass, Corning #67076 Type C overall dia 8¾" Pin ¾" x 11½". All brass fittings S.C. stock #3G-1830-67076.1.**$6.00**

All meters are in round flush bakelite case with white scale and are standard in every respect unless otherwise specified.
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, N. Y.

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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Finest of surplus at a fraction of cost

PEAK ELECTRONICS CO.

Industrials Schools - Labs

CHOKE BARGAINS

6 Henry 30 ma 300 ohms.....3 for $ .99
6 Henry 70 ma 200 ohms.....2 for .99
8 Henry 160 ma 140 ohms..... .99
1.5 Henry 250 ma 72 ohms..... .59
6 Henry 300 ma 65 ohms..... 3.75
4.3 Henry 620 ma 42 ohms..... 6.95
10 Henry 750 ma 95 ohms..... 11.50
Swing, Choke 1.6/12 Henry 1 amp/100 ma 15 ohms..... 24.50
.07 Henry 7 amps .5 ohm..... 4.50

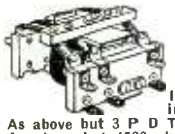
H.V.-H. CURRENT PLATE TRANS.

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

MEDIUM CURRENT PLATE

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



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

RECTIFIER TRANSFORMER

2 separate 110 v primaries. Sec. 70-75 v at 3 amps. 35-37 v (pri in series). Fully cased. Now only $1.89 ea.

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.

HIGH CURRENT PLATE TRANSFORMER

820 volts ct at 775 ma. Primary 110/220 v 25 to 60 cycles. Fully cased 6½ x 6½ x 7"....$6.95 ea.

Thordarson Plate Transf. 2370 volts ct at 250 ma. Tapped at 300-0-300 volts. Separate 215 volt 55 ma. bias winding. Pri 110v 60 cy. Fully shielded. $11.95 ea.

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 60 to 10,000 cps ± 1 DB. 10 watts $2.75

RADAR JAMMER

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 own supply complete with all tubes, etc.

BRAND NEW. Now $12.95 ea.

STEPDOWN TANSFORMER

220/110 volts, 100 watts. Fully encased, 5⅛ x 4¼ x 5⅛. 110V. 60 cycle.....$2.49 each

U. H. F. COAX. CONNECTORS

831AP-UG12U-UG21U-UG-14U-UG146U-UG-206U, 831R-831SP .....35¢ ea.

FILAMENT TRANSFORMERS

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
10 Volts Ct 3.25 Amps..... 1.75
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

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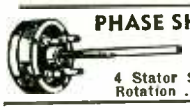

4 Stator Single Rotor. 0-360 Degrees Rotation .....Only $2.95 each

WE BC 1091A-Radar RF unit—With magnetron, etc., in pressurized tank..... 59.50

CWI 60 AAG range calibrator and power supply, hook, cables, etc. 29.50

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35 mmf	.39	75 mmf .3 spacing	$5.95
250 mmf	.49	150 mmf. .07 spacing	.95
325 mmf	.59	Dual 250 mmf .051 Spc.	2.75
APC 140	.35	125 mmf .07 Spc.	.89

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Heineman 5 Amp Circuit Brkr 110 VAC..... .95
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CD .002 3500 W V DC Type 9 Mica..... .49
CD 16 Mfd 450 WV Elect. in Can w/leads..... .39
JAN 6C4 Tubes New, Boxed.....4 for .99
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1000 and 25 WVDC Elect in Can..... .79
Trimm Commercial Phones Hi Imp..... 3.99
BZRS Microswitch S.P.D.T. 10 Amp..... .29
.0015 5% Silver Micas.....9 for .99
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2 Mfd 250 VAC Oil Cond.....5 for .98
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Corning Glass Slug Form and Var. Cap..5 for .99
Shielded Littlefuse Holders 3 AC.....10 for .99
CTC 3:1 PP Input, Hermetic Seal.....2 for .99

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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.

Precision 15 Meg. 1% Accuracy Resistor. Non-inductive, 1 watt, hermetically sealed in glass. 29 ea. 10 for $2.50.

50 Megohm, 50 watt, IRC Type NVC Resistor with mount. $1.49

1% PRECISION RESISTORS

Wire Wound—Standard Make

2000-2500-5000-8500-10,000 ohms .....$.39 ea.
50000-95000 ohms ..... .49 ea.
100000-750000-1 meg ..... .89 ea.

W. W. POWER RHEOSTATS

25 Ohms 25 Watt ..... .49
300 Ohms 50 Watt ..... .69
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VARIABLE CERAMICONS

1.5 to 7 MMF ....24 4 to 30 MMF 24
3 to 13 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

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.

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1	mfd	600 vdc—	.29	1 mfd 7500	vdc—9.25
2	mfd	600 vdc—	.39	4 mfd 8 kv	dc—10.95
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6	mfd	600 vdc—	.79		
3/3	mfd	600 vdc—	.79	.005/.01 mfd 12 kv	dc—5.50
10	mfd	600 vdc—.	95		
2	mfd	1000 vdc—	.79	.03 mfd 16 kv	dc—5.75
4	mfd	1000 vdc—	.95	.65 mfd 12,500	vdc—12.95
15	mfd	1000 vdc—2	.95		
2	mfd	1500 vdc—1	.25	.75/.35 mfd 8/16 kv	—7.95
6	mfd	1500 vdc—2	.95	.02 mfd 20 kv	dc—7.95
1	mfd	2000 vdc—1	.45	2 mfd 18 kv	dc—59.50
2	mfd	2000 vdc—2	.25	2 mfd 4000	vdc—5.50
4	mfd	2000 vdc—3	.65	1 mfd 5000	vdc—4.50

WESTINGHOUSE

Type MN Overcurrent Relay, Adjustable Form 250 ma. to 1 amp. Extenal Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $7.95

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
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2" McClintock 0-100 Ma DC..... 2.95
2" GE 0-30 volts DC 1000 ohms/v..... 2.45
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2" GE 0-10v ac 2.95
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3" Westinghouse 0-150 volts AC..... 3.95
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3" Westinghouse Running Time 110v/60.... 7.95
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FIL .01 1000 VDC .....$ .50
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FIL .07 1000 VDC ..... .50
FIL .024 1500 VDC ..... .75
FIL .033 1500 VDC ..... .75
F2L .015 2 KV DC..... .85
F2L .02 2 KV DC..... .90
F2L .025 2500 VDC..... 1.25
F2L .001 3 KV DC..... .90
F2L .002 3 KV DC..... .90
F2L .003 3 KV DC..... .90
F2L .005 3 KV DC..... 1.20
XR .0001 MMF 5 KV DC..... .75
F2L .0005 MMF 5 KV DC..... .85
F2L .001 MMF 5 KV DC..... 1.30
F2L .0015 MMF 5 KC DC..... 1.60
F2L .003 MMF 5 KV DC..... 1.90
XS .005 MMF 5 KV DC..... 2.50
F3L .007 MMF 5 KV DC..... 2.75
*GI .00024 MMF 6 KV DC..... 4.50
*GI .001 MMF 6 KV DC..... 4.75
F3L .002 MMF 6 KV DC..... 3.50
F3L .0025 MMF 6 KV DC..... 3.60
F3L .003 MMF 6 KV DC..... 3.75
*MX .004 MMF 6 KV DC..... 4.95
F3L .0005 MMF 8 KV DC..... 2.90
F3L .0006 MMF 8 KV DC..... 3.00
*PL .001 MMF 8 KV DC..... 4.95
F3L .0015 MMF 8 KV DC..... 3.50
F3L .002 MMF 8 KV DC..... 4.00
F3L .0025 MMF 8 KV DC..... 4.50
F3L .003 MMF 8 KV DC..... 5.00
F3L .01 MMF 8 KV DC..... 6.50
F3L .004 MMF 8 KV DC..... 5.50
F3L .005 MMF 8 KV DC..... 6.00
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*G2 .002 MMF 10 KV DC..... 6.95
*G2 .001 10 KV DC 5.95
XA .0005 MMF 12 KV DC..... 4.90
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* Ceramic Case. Tol ± 5%.

G.E SCOPE TRANSFORMER

Hermetically Sealed
Pri 110 v 60 cy. sec.

0-625-1050 v 20 MA, 20.3V 4.50A, 6.3V 3A, 2 x 2.5 V 2.5A $4.95

Hermetically Sealed

SCOPE TRANSFORMER

Pri 110v 60 cy. sec. 2500 v 12 ma.....$4.95

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

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SPECIALS OF THE MONTH

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The Opening of Our New Larger Quarters at 189 Greenwich St., N. Y. 7 (formerly at 63 Dey St.)

1 K.W. POWER SUPPLY KIT

2500-0-2500 Volts @ 500 MA
or
2000-0-2000 Volts @ 500 MA
(oil-filled Xformer from BC610) $39.95

1—Swinging choke	14.95
1—Smoothing choke	7.95
1—Filament Xformer	9.95
2—2 Mfd., 3000 v. Condensers, ea.	3.45
2—872A Tubes ..... each	1.95
2—Plate Caps for 872A .... each	.20
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All parts New! *Reduced to* **$79.50**

SELENIUM RECTIFIERS
Full Wave Bridge Type

INPUT		OUTPUT		
up to 18v AC	up to	12v DC	½ Amp.	$0.98
up to 18v AC	up to	12v DC	1 Amp.	1.95
up to 18v AC	up to	12v DC	5 Amp.	4.45
up to 18v AC	up to	12v DC	10 Amp.	7.45
up to 18v AC	up to	12v DC	15 Amp.	9.95
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up to 36v AC	up to	28v DC	5 Amp.	7.45
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up to 36v AC	up to	28v DC	15 Amp.	18.95
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up to 115v AC	up to	100v DC	.6 Amp.	6.95
up to 115v AC	up to	100v DC	5 Amp.	19.95
up to 115v AC	up to	100v DC	3 Amp.	12.95

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NATIONALLY ADVERTISED BRANDS
All Ratings D. C.

2x.1mfd.	600v	$0.35	1mfd.	2000v	$0.95
.25mfd.	600v	.35	2mfd.	2000v	1.75
.5mfd.	600v	.35	4mfd.	2000v	3.75
1mfd.	600v	.35	10mfd.	2000v	4.95
2mfd.	600v	.35	1mfd.	2500v	3.98
4mfd.	600v	.60	2mfd.	2500v	2.49
8mfd.	600v	1.10	.1mfd.	2500v	1.25
10mfd.	600v	1.15	25mfd.	2500v	1.45
3x.1mfd.	1000v	.45	.5mfd.	2500v	1.75
.25mfd.	1000v	.45	.05mfd.	3000v	1.95
1mfd.	1000v	.60	.1mfd.	3000v	2.25
2mfd.	1000v	.70	.25mfd.	3000v	2.65
4mfd.	1000v	.90	1mfd.	3000v	3.50
8mfd.	1000v	1.95	12mfd.	3000v	6.95
10mfd.	1000v	2.10	2mfd.	4000v	5.95
15mfd.	1000v	2.25	1mfd.	5000v	4.95
20mfd.	1000v	2.95	.1mfd.	7000v	2.95
24mfd.	1500v	6.95	3mfd.	4000v	6.95
.1mfd.	1750v	.89	2mfd.	3000v	3.45
.1mfd.	2000v	.95	2x.1mfd.	7000v	3.25
.25mfd.	2000v	1.05	.02mfd.	12000v	9.95
.5mfd.	2000v	1.15	.02mfd.	20000v	11.95

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10,000 mfd.—25 WVDC	$6.95
2x3500 mfd.—25 WVDC	3.45
2500 mfd.—3 VDC	.39
3000 mfd.—25 WVDC	2.49
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1000 mfd.—15 WVDC	.99
200 mfd.—35 VDC	.59
100 mfd.—50 WVDC	.49
4x10 mfd.—400 VDC	.89
4000 mfd.—18 WVDC	1.95
4000 mfd.—25 WVDC	2.95
4000 mfd.—30 WVDC	3.25

FILTER CHOKES
HI-VOLTAGE INSULATION

8 hy @ 550 ma	$7.95	325 hy @ 3 ma	$3.45
8 hy @ 300 ma	3.95	1 hy @ 800 ma	14.99
25 hy @ 160 ma	3.49	10 hy @ 250 ma	2.45
12 hy @ 150 ma	2.25	10 hy @ 200 ma	1.98
30 hy @ 70 ma	1.39	10/20 @ 85 ma	1.59
.05 hy @ 15 amps	7.95	15 hy @ 125 ma	1.49
.1 hy @ 5 amps	6.95	15 hy @ 100 ma	1.39
4 hy @ 600 ma	5.95	3 hy @ 50 ma	.29
200 hy @ 10 ma	3.49	30 hy Dual @ 20 ma.	1.49
600 hy @ 3 ma	3.49	8/30 hy @ 250 ma	3.50
.065 hy @ 2.5A	2.49	10 hy @ 100 ma	1.29

RADIO TUBES
NEW! STANDARD BRANDS!

1B24	$4.75	726A	$4.50	1LH4	$.79
1B26	4.95	800	1.69	1LN5	.79
1B29	.89	801A	.49	1Q5GT	.95
1N21	.59	802	2.95	1R5	.79
1N23	.59	803	3.75	1S4	.69
1N34	1.59	805	3.95	1S5	.59
1P24	.89	807	1.19	1T4	.59
2AP1	2.39	808	1.95	3Q4	.89
2C22	.19	809	1.98	3Q5	.69
2C26	.29	810	4.89	3S4	.59
2C40	.74	811	1.49	5Y4GT	.49
2C44	.69	812	1.39	6A7	.59
2C46	3.75	813	5.25	6A8GT	.59
2D21	1.19	814	2.75	6AG5	.89
2J21	12.45	815	1.45	6AG7	.98
2J22	12.95	816	1.10	6B4G	.95
2J26	9.95	826	.49	6BG6G	1.49
2J31	11.49	829B	2.89	6C6	.49
2J32	14.75	832A	2.49	6D6	.49
2J36	24.95	833A	29.50	6F5GT	.49
2J37	18.95	836	.79	6F6GT	.49
2J38	14.75	837	1.19	6F6	.59
2J39	18.95	838	2.95	6H6GT	.39
2J40	18.95	841	.50	6J5GT	.42
2J46	18.95	843	.39	6J5	.55
2J49	26.95	845	3.29	6J7GT	.55
2J51	69.50	851	17.95	6K6GT	.49
2J54B	18.95	860	1.98	6K7GT	.55
2J55	18.95	861	11.95	6L6G	.95
2K25	24.95	865	.79	6L6	1.23
2K28	6.95	866A	.98	6L7	.79
2V3G	.79	866JR	1.10	6Q7GT	.55
2X2	.27	869B	18.75	6SA7GT	.49
3AP1	2.39	874	.69	6SC7	.55
3BP1	1.39	876	.39	6SF5GT	.59
3B22	.59	878	1.29	6SH7	.49
3B24	1.29	884	.99	6SJ7GT	.49
3B26	.89	885	.78	6SK7GT	.49
3CP1	2.95	902P1	5.95	6SL7GT	.59
3C22	19.95	905	4.95	6SN7GT	.59
3C23	2.49	923	.69	6SQ7GT	.49
3C24	.29	954	.24	6V6GT	.59
3C30	.59	955	.35	6X5GT	.69
3C31	1.49	956	.45	7A8	.69
3DP1	2.25	957	.24	7B7	.69
3D21A	1.50	958	.35	7C5	.59
3E29	3.39	1611	.98	7C6	.69
4B24	2.25	1613	.58	7F7	.49
4E27	12.95	1616	.75	7Y4	.49
5AP4	4.75	1619	.21	12A8GT	.63
5BP1	1.49	1622	1.59	12AT6	.49
5BP4	2.45	1624	.85	12AU6	.75
5CP1	1.98	1625	.29	12BA6	.59
5D21	18.95	1926	.25	12BE6	.59
5FP7	.85	1629	.29	12J5GT	.49
5JP1	11.95	1630	1.98	12J7GT	.49
5J29	18.95	1638	.49	12Q7GT	.59
5J30	18.95	1654	1.98	12SA7GT	.49
5LP1	11.95	1851	.69	12SF5GT	.49
5R4GY	.89	2050	.68	12SF7GT	.59
5T4	.69	2051	.45	12SJ7GT	.49
5U4G	.45	8005	1.98	12SK7GT	.49
5V4	.72	8011	.65	12SQ7GT	.49
5X4	.59	8012	1.39	12SR7GT	.49
5Y3	.35	8013	.89	14A7	.69
5Z3	.55	8014	3.98	14B6	.69
5Z4	.79	8016	1.39	14Q7	.69
6AB7	.85	8020	.89	24A	.49
6AC7	.59	8025	3.45	25L6GT	.59
6AK5	.89	9001	.39	25Z5	.47
6AL5	.59	9002	.35	25Z6GT	.45
6C4	.25	9003	.35	26	.45
6D4	1.29	9004	.29	27	.49
6J4	5.49	9005	.39	30 Spec	.39
6J6	.89	9006	.29	32L7GT	1.19
6Q5G	1.25	CK1005	.29	35/51	.59
7EP4	17.95	CK1006	.69	35A5	.59
10Y	.19	CK1690	1.49	35L6GT	.49
12A6	.25	FF50	.50	35W4	.39
12DP7	13.95	F123A	8.95	35Y4	.69
12GP7	12.95	F127A	17.50	35Z3	.57
15E	.89	F128A	39.50	35Z5	.49
15R	.89	F660	39.50	36	.79
75TL	2.49	FG81A	3.95	41	.52
100TH	9.95	FG105	8.75	42	.49
211	.49	FG238B	29.50	43	.52
227A	3.75	GL146	7.95	45	.52
231D	1.49	GL605	39.50	47	.74
249C	.75	GL697	29.50	50A5	.89
250TH	19.49	HY75	1.25	50B5	.59
304TL	.89	HY615	.39	50L6GT	.59
304TH	3.39	ML100	19.95	50Y6GT	.59
316A	.35	ML101	39.50	56	.54
327A	4.95	ML502	39.50	59	.95
350B	1.95	UR75	.89	70L7GT	1.29
368AS	1.79	VR90	.65	71A	.59
371B	.99	VR105	.65	75	.65
450TH	29.95	VR150	.65	76	.49
527A	4.89	VT127A	2.49	77	.49
531	2.50	VU111	.49	78	.49
559	.75	OZ1	.59	80	.45
703A	2.95	1A5GT	.49	81	1.55
705A	1.49	1A7GT	.59	82	.89
706CY	18.95	1H5GT	.54	83	.89
714AY	6.95	1N5GT	.59	83V	.89
715B	9.95	1LA4	.95	84	.59
715C	18.95	1LA6	.95	89	.69
717A	.59	1LB4	.95	117L7GT	1.15
721A	1.59	1LC6	.95	117P7GT	1.15
723A/B	12.95	1LD5	.95	117Z3	.49
724A/B	1.75	1LE3	.95	117Z6GT	.69
725A	7.45				

All Tubes guaranteed, except for open filaments, shorts and broken glass, for which we check before shipment. Please specify how to ship.

500 WATT POWER SUPPLY KIT
(Ideal for BC-191 & BC-375E)

1—Transformer—Pri: 105/250v. 60 cyc. in 5v Steps Sec: 1120-0-1120v @ 500 MA	
2½v CT @ 10 AMPS.	
12v @ 14 AMPS.	
17v @ 2½ AMPS.	
32v @ .025 AMPS.	$32.50
2—Filter Chokes @ $7.95 ea.	
2—Condensers 3 Mfd @ 2000v DC @ $4.45 ea.	8.90
2—866 Tubes @ $.89 ea.	1.78
2—Plate Caps Ceramic @ $.20 ea.	.40
2—Sockets @ $.20 ea.	.40
1—Pair Hash Filter Chokes	.79

Extra Special Buy **$49.50**

TRANSFORMER—115 V. 60 Cy.
HI-VOLTAGE INSULATION

3710v @ 10 ma.; 2x2½v @ 3A	$9.95
2500v @ 15 ma	4.95
2500v @ 4 ma.; 2½v @ 2A, 6.3v @ 1 amp.	5.95
2150v @ 15 ma	3.95
1750v @ 4 ma.; 6.3v @ 3A	4.25
1600v @ 4 ma.; 700v CT @ 150 ma.; 6.3v @ 9A	6.49
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515-0-515v @ 175 ma.; 5v @ 3A; 2.5v. @ 5A	4.95
500-0-500v @ 25 ma.; 262-0-262v @ 55 ma.; 6.3v @ 1A; 2x5v @ 2A	4.49
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450-0-450 @ 300 ma.; 140-0-140 @ 100 ma. 36v @ 1A, 6.3v @ 5A, 5v @ 3A, 110/220 Dual. Pri	7.95
400-0-400v @ 200 ma.; 2.5v @ 2A; 5v @ 3A; 6.3v @ 9A; 6.3v; 9A	5.95
400-0-400v @ 200 ma.; 5v @ 3A	3.95
350-0-350v @ 150 ma.; 5v @ 3A; 6.3v @ 6A 78v @ 1A	3.95
385-0-385-550v @ 200 ma.; 2½v @ 2A; 5v @ 3A; 3x6.3v @ 6A—PRI. 110/220	6.25
350-0-350v @ 35 ma	1.25
340-0-340v @ 300 ma.; 1540v @ 5 ma	4.95
335-0-335v @ 60 ma.; 5v @ 3A; 6.3v @ 2A; 0-13-17-21-23v @ 70 ma.—PRI. 110/220	3.95
325-0-325v @ 120 ma.; 10v @ 5A; 5v @ 7A	2.25
300-0-300v @ 65 ma.; 2x5v @ 2A; 6.3v @ 2½A; 6.3v @ 1A	3.49
150-0-150 @ 80 ma.; 150 @ 40 ma.; 6.3v @ 3.5A; 6.3v @ 1A	1.98
150v @ 55A; 150v @ 2.13A; 5v @ 5A	3.95
120-0-120v @ 50 ma	.98
80-0-80v @ 225 ma.; 5v @ 2A; 5v @ 4A	3.95
24v @ 6A	3.50
3x18v @ 2A	3.95
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12.6v CT @ 10A; 11v CT @ 6.5A	6.95
6.3v @ 12A; 6.3v @ 2A; 115v @ 1A	3.45
6.3v @ 10A; 6.3v @ 1A	2.98
6.3v @ 1A; 2½v @ 2A	2.45
5v @ 10A; Dual 110v PRI	3.49
6.3v @ 21½A; 6.3v @ 2A; 2½v @ 2A	4.95
6.3v @ 1A	.98
8v CT 1A	.98
2.5v @ 20A.. 3.49 6v @ 15 amps RMS.	1.98
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Amertran "TRANSTATS" Voltage Regulator

11.5 KVA 50/60 cy. Commutator range 0-115 V. Max. Amps. 100. Reconnection diagram available for 230 V. 50 A operation. BRAND NEW. Factory Cases $100.00
.25 KVA. Fixed winding 115/1/60. Commutator range 103-126 V. Max AMPS. 2.17.....$9.45
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COMMAND SET EQUIVALENT—BC 430, Excellent VFO using 2 Type 45's and 2 Type 10 tubes, 40 WATTS CW with one coil. (COIL RANGES: 2 - 2.5, 2.5 - 3.2, 3 - 3.6, 3.6 - 4.5, 4 - 4.8, 6 - 7.3, and 7.3 - 9 MC. Your choice or coil.....$6.95

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SCR 178—TRANSMITTER RECEIVER. 2400-3700 KCS 10 W OUTPUT w/spare parts PHONE, AND CW opt. $45.00

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WILLARD STORAGE BATTERIES—Used in GE Portable Model LB530—2 V 20 AH. 4" x 3½" x 5⅛" @ $2.50 each, 10 $20.00, case lots of 36....ea. $1.50

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"FLASHLITES" BY KWIKLITE—2 cell metal—60c PLASTIC 75c; 3 CELL METAL—80c; PENLITES 35c

25' EXTENSION LIGHT heavy duty cord. Switch on handle. Metal bulb protector.....$2.10

BATTERY CLIP ASSEMBLY—8' two cond. cord w/2 prong Hubbell male and female connector, heavy duty Alligator battery clips on ends.....69¢

B & W 300 WATT TANK COILS—4.5-5.7 MC @ 75c; 20 METER W/LINK @ 95c; 40 METER W/LINK @ 95¢; Bud 160 METERS 50 W Socket type 55¢

WESTERN ELECTRIC PRECISION CRYSTALS—40 Meter Band 7270 KC 95c ea. 2 for.....$1.75

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GUYWIRE—1/16" Dia. Galv Perf Steel. Excellent elasticity. Rust proof. Ideal for TV antenna installations. 1000 ft. rolls.....$3.00/M

HEAVY DUTY PLATE TRANSFORMER—Amertran Pri 115/230 VAC 60 cy Soc. 4720/2365. KVA 1.66 RMS 12 KV. Wgt. 150# 11"x11"x9".....$27.50

RL-42B ANTENNA REEL—W/MOTOR AND GEAR BOX—Perfect Beam rotators. Wt. 4 lbs. magnetic clutch. Reversible with SPDT switch.....$3.95

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SELSYNS—Diehl/BENDIX SYNCHRO TRANSMITTERS. 115 V 60 cy. 3" Dia. ea. $4.35 Pr. $7.95

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SYNCHRON MOTORS. Model 600 110V 60 cy. 1 RPM ½" sh. $2.95

HEAVY DUTY AIR COOLED RESISTORS. .52 ohms or 10 ohms 1000W. Your choice.....$1.00

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G. E. 6227889G1, 60A.....49

PHONES—HS-30 600 OHM IMPD., rubber ear inserts LN 35c ea. 65¢ new. HS-23, 8,000 OHM IMPD., L.N. $1.00. New $2.00
"MIKES"—T-17 Hand mike, carbon.....95c
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YJ RADIO EQUIPMENT. Two Channel, automatic responding Radar Beacon or Racon. Designed for shore installation. Automatically transmits coded signals in reply to interrogating signals from craft equipped with radar or 1FF equipment. Replies to interrogating signals in the (A) Band 176 MC, (B) Bank, 515 MC. Rectifier power unit; A and B Band transpondors, transmitter and receiver complete with 30 tubes, 115/1/60 36" L. 18" H. 17" W. Wgt. 270 lbs. LN. Price.....$80.00

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PE94C, SCR522, 24VDC W/Filter.....$3.25
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DM410, 14V 2.6A; 240V 80 MAW/Filter.....$2.00
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40 HENRIES @ 20 MILS.....80c
150 HENRIES @ 1 MIL. 7,000 OHMS.....45c

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THORDARSON (70R62) 350-0-350 @ 115 V 80 cy. 145 MILS; 5 V @ 3 A; 6.3 VCT @ 4.5 A.....$4.25
JEFFERSON FIL—20 Volts @ 10 A.....$3.95
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OPEN CORE POWER. 18 V @ 6 A.....$2.95
POWER. 600 VCT 70 MA; 5 V 2 A; 6.3 V 2 A.$2.50
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MIKE TRANS—PRI 150 OHMS Sec. S. Grid, Ratio 20:1, "UTC".....85c
MIKE TRANS—PRI 35 OHMS Sec. 600/200 OHMS 75c
INPUT—Ratio 1:2. Freq. Resp. 500-15,000 within 3 DB 60c
AUDIO—FEDERAL "OUNCER" Pri 8000 OHMS SEC 600 OHMS.....60c
MIKE TRANS—"OUNCER" PRI 300 OHMS. Sec. .25 MEG 50c
OUTPUT TRAN. BC 221, 125 OHMS.....35c
Raytheon Fil Type U 8964. Sec; 2.9 V @ 19A....95c
Raytheon Fil Type U-8370 Pri—220/440 60 CY. SEC. #1, #2, #3—2.5 Volts @ 5 Amps. Sec. #4 2.5 Volts @ 15 Amps 3KV Test. Price.....$6.50
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B.C.-604 F.M. TRANSMITTER. Wide or narrow-band FM. 30 watt power output. Excellent possibility for ten or eleven meter exciter. Range 20-27.9 MC. Working space permits modification. Complete with tubes but less power supply and xtls. LN.....$11.50

All prices f.o.b. Boston. Orders accepted for rated concerns on open accounts. Net 30 days. Minimum order $3.00.

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2x50 MFD @ 150 WVDC TUBULAR.....@ 50c
40 MFD. @ 200 WDC TUBULAR.....@ 35c
16 MFD. @ 150 WVDC TUBULAR.....@ 20c
.1 MFD. @ 600 WVDC TUBULAR.....@ ea. 15c
.25 MFD. @ 600 WVDC OIL IMPREG TUBULAR CAW 481074 17c ea.; 10 for.....$1.50
Same as above but 400 volt 15c ea. 10 for.....$1.35
.01 MFD @ WVDC PAPER TUBULAR HERM. SEALED. 10c ea.; 10 for.....$1.50

RAYTHEON DEFLECTION COILS. #U8820 for 5FP7. CRT. Metal Cased.....$1.85

UNDERWATERSOUND EQUIPMENT MODEL QBC. INDICATORS CBM 55081 Ranges 0-1000 and 0-5000 yds. 115 V 60 cy.....$35.00

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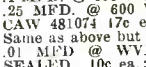
BECKMAN HELIPOTS



Model A, 10 turns, 3600° rotation, 20,000 ohms resistance, 5 watt 0.5 guaranteed linearity, 5% resistance tolerance. With aluminum stop as pictured $5.00 Without stop.$4.50

ALL METAL BINDING POSTS—40 for.....$1.00
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SHEET ALUMINUM ⅛"x24"x27" @.....$2.00

ARC-5 ACCESSORIES KC COIL/BC459A 30c; 4 for $1.00
#7278 SLUG TUNED IF FREQ. 7-9 MC 30c; 4 for $1.00

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FRICTION TAPE—½ lb., ¾" wide.....15¢ 10/1.00.
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ECLIPSE TYPE 1339-4-6. 115 AC W/Rectifier/Transformer Unit $2.95
ECLIPSE TYPE 1339-1-A. 115 AC.....$2.95
LELAND Set at 18 Volts.....$1.25

PHONO MOTORS—GENERAL IND 115 V 60 cy; .5 A., 80 RPM Minus turntable.....$2.50
Same as above but 115/230 Volt AC.....$4.00

SOCKETS—OCTAL TUBE—Either in red or blue bakelite, MTD in metal plate.....10¢
MINIATURE—"POLY" with metal flange. 10 for $1.25

MAGIC EYE—with 8" of wire attached. Each...25c
AMPHENOL—4 and 5 prong steatite sockets W/out MTG rings 6c ea.; 10 for.....50c
TRANSMITTING—Heavy Duty 8 prong isolantite. 15c ea.; 10/$1.25; 4 or 5 prong. Each.....12c
"CINCH" OCTAL ISOLANTITE WITH MTG PLATE 15c; 10 for.....$1.25

WAVE TRAP PERMEABILITY SLUG TUNED IF W/AIR TRIMMERS 1500 KC .....55¢; 4/2.00
MICRO SWITCH—NO or NC.....75¢
MICRO SWITCH—W/Leaf only NO.....69¢
MICRO SWITCH ASSORTMENT. 5 for.....$1.10
POINTER KNOBS 1¼" L. 1" H. ¼" SH, Black; 10/70¢.
PLAIN BLACK ROUND FLUTED 1" Dia. ¼" SH 8¢ 10/70¢.
Mounting Rock for ARC—5.....95¢

WEST. WATT HOUR METERS
Type CS 240V/60cy/1 ph 15 Amp., 3 Wire....$12.50
Type CS, 120V/66cy/1 ph 15 Amp. 2 Wire....$9.50
Type CA. 120V60cy/1ph 15 Amp.. 2 Wire.....$9.50

BELL RINGING TRANSFORMERS—Input 115V 60 cy Sec. 6 V 25 VA $1.69; 6V 200 VA.....$2.00
25V. 25 VA @ $1.00; 10.....7.50

METAL BOXES—
23½"x21"x18" (Clean) @ $8.45
10"x12"x38" (With compartments) $2.50
10"x15"x30" (With partitions).....$2.50
12½"x12½"x9" (Clean) $2.50

SHAFT COUPLING—bakelite ¼" 16¢.....10/1.25

HARDWARE BY THE POUND—Our assortment of screws, nuts, washers, cable clamps, lugs, spacers, springs, etc. 10 lbs. assortment.....$5.00
25 lbs. assortment.....$10.00

BRONZE #10 **LOCKWASHERS.** Per M.....$1.00
THROAT MIKE—T-30 39c; **LIP MIKE**—T-45..39c
INSUL BATTERY CLAMPS. Heavy duty...pr..30¢

B857

B986

B1536

NEW SWITCH INTERLOCKS. Cory Type B857, Single Key Oper. Used for Interlocking of doors, Vaults, Reactor or Resistor enclosures, oil circuit breaker tank compartment and disconnecting switches $1.98
Cory Type B986, Single Key Oper. SPST SW. w/Yale Cyl Lock. 60A tumbler lock.....$2.49
Cory Type B1536, Supervisory Oper., 2 key type.$2.95

STANDARD BRAND FIELD RHEOSTATS. 32 Ohms 2.5a 600 V max. 6" Plate.....$2.98
Dual 6" plate .062 ohms, 32.4A 600 V max...$7.50
Four 13" plate in series 100 Ohms 8-2A 345 V Max. $19.95

ESCO ELECTRO Sales Co.

DEPT. E3, 110 PEARL ST., BOSTON 10, MASS. . . . LIBERTY 2-5589 . . . HANCOCK 6-5069

SEARCHLIGHT SECTION

VOLTAGE REGULATOR UNIT

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

OSCILLOSCOPE 400-2600 CY. POWER SUPPLY

Input:
80 or 115 volts, 400 to 2600 cycles

Output:
1200 volts D.C. at 1.5 MA. 400 volts D.C. at 130 MA. 6.4 A.C. volts at 0.8 A (ins. for 1500v. D.C.) Includes tubes: 1—5R4GY, 1—2x2, 1—6AK5, cathode ray tube socket, resistanse capacitance filter, two focus controls, an intensity control and 6AK5 reinserter circuit.

Brand New $13.75

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.

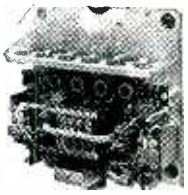
Brand New $5.75

SHOCK MOUNTS

	A	B	C	D	E
A. Lord #20, 3" x 3" x 1¾"					.40
B. U. S. Rubber #5150 C, 2⅜" x 2⅜" x 1⅛"					.30
C. Lord 15, 2⅜" x 2⅜" x 1⅛"					.25
D. Lord #10, 1¼" x 1¼" x ⅝"					.10
E. Lord #3, 1¼" x 1¼" x ⅜"					.10

BRAND NEW

G. E. 400 CYCLE SERVO AMPLIFIERS



Type 2CV1C1

Brand New $29.50

Metal Dust Cover Included

STEPDOWN TRANSFORMERS

Input: 115 V. 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

10 CM WAVEGUIDE

Solid bronze, 90° elbow flatwise bend.

Brand New $20

SELSYN GENERATOR

Type 2JIF3—115 volts—400 cycles. Brand New.

Price $3.95

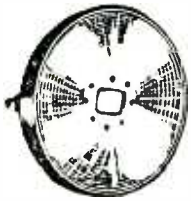
SELENIUM RECTIFIER

Bridge Type

Input: 30 V. AC.
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

MICROWAVE PARABOLOIDS



Ideal for Microwave experimental work.
Spun Magnesium dishes
Reinforced Perimeter
17½" Diameter x 4" Deep
Two sets mounting brackets on rear
Open center hole 1½" x 1⅝"

Per Pair, Brand New $8.75

MERCURY CONTACT RELAY

Western Electric D-163479

For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and contact operating characteristics under adverse atmospheric conditions. Hermetically-sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure. Single pole double throw contacts.

7000 hours life at 60 operations per second. Two coils of 700 ohms, and 3300 ohms. Operating current, coils series aiding—6.6 mils. Release current, coils series aiding— 5.2 mils. Four page Technical Data on request.

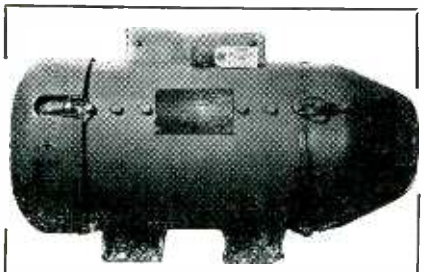
Brand New in Original Cartons, $4.75

SOUND POWERED CHEST SETS

No Batteries Required
Ideal for television installers, or any antenna measurement work. Leaves hands free to make adjustments. Set consists of microphone and headset as illustrated.

Brand New

Per Set $19.50



MOTOR GENERATORS

Brand new. Built by Allis Chalmers to rigid specifications of the U. S. Navy

K.V.A. output 1,250 — R.P.M. 3600
K.W. output 1. — Cont. Duty Ph. Single
P.F. 80 — Cycles 60
Volts input 115 D.C. — Volts output 120 A.C.
Amps input 14 — Amps output 10.4

Length 26"; width 12⅞" height 13" Compound accumulative A.C. and D.C. fields. Centrifugal starter. Splashproof covered. Frequency adjustable to load, plus or minus five cycles.

PRICE $97.50

Identical Machine, but 230 volts D. C. Input, $125.00

SOUND POWERED TELEPHONE HANDSETS

W. E. Type TS-10M.
Complete with 7 ft. cord.

Brand New. $16.95

POTENTIOMETER

20,000 ohms, complete with engraved dial assembly.

Brand New . . . $1.95

SOUND POWERED TELEPHONES

Type TP-3

For two-way signalling for voice communication. No batteries needed. May be used on metallic or ground-ed 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 eases with adjustable carrying straps.

Brand New $39.50

COAXIAL PHONE JACK ADAPTER P-106

Phone jack, one end. Coax Receptacle other end.

Brand New Price $1.35

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT

INC.

5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All Merchandise Guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

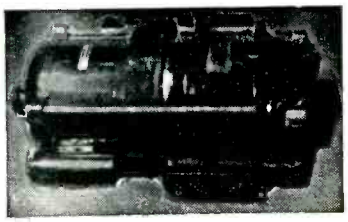
— THE BEST IN ELECTRONIC SURPLUS —

AMAZING "SNOOPERSCOPE" TUBE

An infra-Red Image Converter Tube made in Britain that enabled combat men to see in the dark and through camouflage. Type CRI-143. 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 $10.00
TWO, FOR $15.00

AMPLIDYNE MG SET
Motor 110/220, 60 C. A. C.



For Automatic or Remote Control of heavy equipment, Mfd. by General Electric. Generator is Type V-5875677, motor 73AB58; Navy type CG-21ABU. Generator delivers 250 volts, DC, 375 watts. Motor, 115 or 230 volts 1-phase, 60 cycles AC, rated at ¾ HP RPM-1725. Includes capacitor for starting, and instructions for 115 or 230 volt connections. Generator section can be removed, and entire assembly shortened to make valuable ¾ H.P. AC motor. Quantity sufficient to warrant this conversion. New Units.

PRICE, EACH $60.00

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

FOR OSCILLOSCOPE USERS

VOLTAGE DIVIDER PROBE. Permits viewing and measuring voltage waves of larger magnitudes than normally possible. Consists of 3-piece molded body containing resistors and capacity which make up divider circuit, plus coax cable and alligator clips for connections. Permits measuring and analyzing voltage peak values of 1400 volts, with less loading on source and less wave shape distortion. NEW, with technical bulletin.

PRICE, EACH $4.95

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

SPECIAL BARGAINS!

Simplex-Bludworth Motor-Generators, 110V. DC input, 110/1/60 AC output at .5KVA. New. EACH $85.00

Holtzer-Cabot M.G., 115V. DC input, 115/1/60 output at .460 KVA. EACH 85.00

ESCO M.G. 115V. DC input, 115V/1/60c. output, .460KVA. EACH 85.00

Mark II Hand Generators, delivers 162 volts at .03 amps, and 3.1 volts at .3 amps. Complete with seat pedestals, cranks, carrying bags, cords. Packed 4 to a case. NEW. Price per case of FOUR..... 30.00

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/GTA-2. 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 RF, 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

Wilcox, 96-200A 2-KW RF section, 125 to 525 KC. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Power supply separate unit not available, but can be built. Less tubes. **PRICE** $500.00

MACKAY SHIP TRANSMITTERS. The following Mackay ship-radio types are available: 150-AY, 151-A1, 149-A, 136-A, 104-M, 147-M. Some new, most in excellent condition. Write for prices.

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

RCA 2-CHANNEL A.F. AMPLIFIER. 250W. per channel, total 500W. Complete with power supply, voltage gain stages for low level input, metering circuits, in one cabinet approx. 6 ft. high. Operates from 110 volts 50-60c A.C. Almost new cond. with tubes. **PRICE** $750.00

BC-1100 (HP 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

110V, DC to 110V, AC M.G. for above, when used on DC source $85.00

Northern Radio ship to shore transmitter-receivers, 5 channels crystal controlled, 65W. output, 110V. DC. 1.5 to 5.6 mcs. With tubes. EACH $250.00

Halstead model 10LFA transmitters, A3, 25W. output, 200-400Kc. 110V 60c. operation. Condition N2. EACH $100.00

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.

20-40 MC RADIO BEACON EQUIPMENT

For SCR-508, 528, 608, 628, and Similar Sets

MODEL RC-163 is designed for ready connection to RADIO SET SCR-508, 528, etc., and 608, 628, etc.—or similar transmitting and receiving equipment. It permits directive transmission and reception, and can also be used for navigation by using two beacons on a base line. The beacon eqpt. consists essentially of a rotating directional antenna (Adcock type) synchronized to an automatic code keyer (which can be removed). Four sets of plug-in inductors are supplied to cover the 20 to 40 mc range. Designed to operate from a 12-volt storage battery, power consumed approximately 54 watts (4.5 amps.). Supplied with antenna array, antenna mount with rotating motor, code discs, audio oscillator, 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

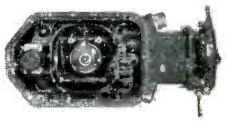
All Prices F.O.B. N. Y. C. All Material Offered Subject to Prior Sale

Phone— LOngacre 4-4490-1

TELEMARINE COMMUNICATIONS COMPANY

280 Ninth Ave., N. Y. 1, N. Y.

LOW PRICES • IMMEDIATE DELIVERY • FULLY GUARANTEED



GYRO SERVO UNIT

Pioneer 12800-1-D. 115v. 400 cy. Low inertia motor and follow-up Autosyn. Stock #SA-160. **Price $8.50 each**

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**

MICROWAVE ANTENNA

AS-217A/APG 15B. 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs.

Price $9.50 ea.

MAGNESYNS

Pioneer CL-3

Use as transmitter or indicator on 26 v. 400 cy. or 52 v. 800 cy. May be used as indicator with 360° potentiometer on DC.

Stock #SA-6 **Price $1.95 each**

Compass System

Kollsman remote transmitter and indicator for operation on 26 v. 400 cycles power source.

Stock #SA-22 **Price $6.95 each**

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 6DG, 7G, etc.

Prices on Request

Elinco B-64 DC Servo Unit—80 v. DC max. armature voltage, 27.5 v. field. 1/165 hp. 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.

Stock #SA-211 **Price $12.50 each**

Bendix A-14795 DC Motor—28 v. 1 amp. 1/100 hp. Series wound. Use on AC or DC.

Stock #SA-234. **Price $1.45 each**

G.E. Servo Amplifier—2CV1C1

Aircraft amplidyne control amplifier, 115 volt 400 cycles. Two channel. Uses 2 6SN7GT and 4 6V6GT tubes. Supplied less tubes. Stock #SA-168 **Price $9.50 each**

Edison Time Delay Relay—Vacuum sealed in glass, s.p.s.t. contacts normally closed. 30 v. 7 second delay to open. Many experimental applications.

Special Price Three for $1.95

MOTOR SPECIALS

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.

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.

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.**

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.**

Fractional Motors M-100. 3/16 HP.

Compound wound. Cont. duty. 115 v. DC. 5" diam. 8" lg. 1¾" shaft ext. x ½" diam. Stock #SA-171. **Price $6.75 each.** (230 volt models also available.)

Bodine NSH-53P. 1/12 HP DC Motor

80 volts armature; 115 volt field. Cont. duty. 0.81 amps. 2½ ratio gear reduction. Output shaft speed 880 rpm. Torque 4.1 in. lbs. Limited quantity.

Special Price $12.50 each.

Robbins and Meyers 1800 RPM AC Motor

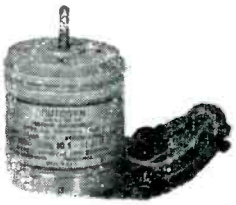
115 v. 60 cycles. Single phase. 1/50 hp. 0.94 amps. Cont. duty. Complete with capacitor. Frame SK-105. Limited quantity. **Special Price $9.50 each.**

3 HP DC Motor—230 V. DC.

2200 rpm. Double shaft extension. Base mounting for either horizontal or vertical operation. Limited quantity.

Price $17.50 each.

AUTOSYNS



Pioneer Types

AY-1, AY-14, AY-20, AY-30, AY-54D, 2320, and AY-101D.

Prices on request

DYNAMOTOR

D-101. 27 v. DC in @ 1.5 amps. DC output 285 v. @ .060 amps. Stock #SA-187. **Price $1.50 ea.**

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver plated coaxial type. 5-10 mmf.

Stock #SA-167. **Price $2.75 each.**

Remote Position Indicating System

6-12 v. 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

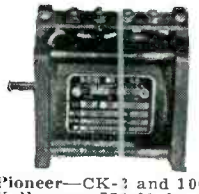
LP-21-I.M Compass Loops

New Original Cartons

Stock #SA-99.

Price $9.50 each

AC-SERVO MOTORS



Pioneer—CK-3 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

C-1 Autopilot Servo Unit—28 v. 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**

⅛ HP DC Motor—G.E. 5BA25MJ409. 24 v. 7.5 amps. 7100 rpm. Cont. duty. 5" lg. x 2½" diam. ¾" shaft ext.

Stock #SA-135. **Price $4.75 each.**

Sperry A-5 Amplifier Rack—614890

Contains Weston 350-450 cy. freq. meter and 0-130 volt voltmeter. Mounting for associated amplifiers.

Stock #SA-183 **Price $8.95 each**

Phase Shift Capacitor — 4 stators single rotor 0-360° phase shift, (Use in complex wave synthesis.) Stock #SA-114.

Price $4.75 ea.

TWX Pat-199.

Write for complete listing, or call ARmory 4-3366

SERVO-TEK PRODUCTS CO.

Incorporated
Surplus Division

Open account shipments to rated concerns.

All prices F.O.B. Paterson, N. J.

4 Godwin Ave. Paterson, N. J.

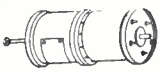
RADIOMEN'S HEADQUARTERS WORLD WIDE MAIL ORDER SERVICE !!

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.

$8.95 Takes All 3 BIG BARGAINS

1. 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 $3.00

2. SENSATIONAL FASCINATING, AMAZING SELSYNS. Brand new selsyns made by G. E. Co. Two or more connected together work perfectly on 110 VAC. 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 wires. This is true whether you twist the shaft of the master unit a fraction of a revolution or many revolutions. Useful for indicating the direction of weather vanes, rotating directional antennas, or controlling innumerable operations from a distance. Complete with diagram and instructions. Per matched pair.



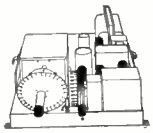
$4.95

3. 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

AUTO RADIO DEALERS! ATTENTION!

Nationally advertised brand of 1949 car radio which will fit practically any car and every pocketbook. Six tube superheterodyne with three gang condenser and 6½" speaker. **$32.20 for sample, or Dealer price $29.97 each, in lots of two or more.** Here is an item that no serviceman who repairs auto radios should be without. Nationally advertised ATR battery eliminator that supplies perfectly filtered 12 VDC or 6 VDC at 14 amp from 110 VAC $36.00

RT 1579 with tubes diagram & parts list only $14.95

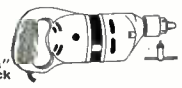


A three stage cascade 6SJ7's and 6F6 output stage high gain, high fidelity amplifier with 60 cycle, 110V power supply on the same 13½x14½ chassis, which is protected by a substantial steel cover over tubes and parts. Made by Western Electric with typical quality components such as a husky power transformer and oil condensers, this unit is obviously intended to give years of trouble-free service with no more need for repairs than a telephone. Disconnecting one wire each, from the special input and output filters, will result in as high a fidelity amplifier as can be obtained.

PORTABLE ELECTRIC DRILL

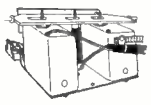
TERRIFIC VALUE ONLY $20.95

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 or DC motor and multiple ball thrust bearing. Other bearings 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.**

Stupendous Value in 3 sections PERMEABILITY TUNER

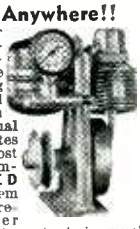


The entire variable tuning section of a deluxe General Motors radio. Amazingly tiny, 4x3x2½, though truly half of a radio. Shielded R.F. sections litz wire wound. All 3 tuned circuits adjustable at both low and high ends of dial. Amazingly tiny (4x3x2½). Compact enough to be used to pep up any 2 or 3 gang superhet or 2 gang TRF. Will substitute for entire original tuning system including variable condenser or if desired the original tuning condenser can be connected to these coils, and the coils set to proper inductance (no instruments required, and the set tuned just as before, although much greater sensitivity and selectivity will result. Can be used as a multiple section wavetrap that will cut out undesirable interference as with a knife, or if only a little bit better than average results with a slug-tuned wavetrap are necessary, the unit can be split up in a couple of minutes into 3 coils that can be used on 3 different jobs. These coils, supercompact and really hot, can also individually replace any broadcast band RF, oscillator, or 1st detector coil with improvement in results in any set. After seeing one of these units, you'll order a dozen just for general repair or replacement work. Cost the manufacturer several dollars. Your cost $1.49.

RT 1655 only $14.95

11 tube crystal controlled SUPERHET RECEIVER that covers the FM band. The ultra modern circuit uses the latest types of tubes. Beautiful chassis and aluminum cabinet. Tubes & schematic supplied.

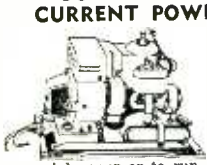
COMPRESSED AIR INSTANTLY, Anywhere!!



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 appr. 3500 cu. in. air per min. at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than 1 min. Complete with 100 lb. gauge, fingertip 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 U. S. Efficient adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose for only $7.75 with pint container, also prepaid.

Latest 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

OUR PE 109 DIRECT CURRENT POWER PLANT



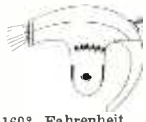
This power plant consists of a gasoline engine that is coupled to a 2000 watt 32 volt DC generator. This unit is ideal for use in locations that are not serviced by commercial power or to run many of the surplus items that require 24-32v-DC for operation. The price of this power plant tested and in good condition is only $79.95 F. O. B. Buffalo, or we can supply 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 used or what the condition is if used. The $79.95 units 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

1000 Cycle AUDIO FILTERS

Navy PD52010-1 low pass audio filters as mentioned in the "Peaked Audio" article in June CQ, and designated by the above number, are the exact electrical and physical equivalent of commercial audio filter units selling for $35.00 wholesale. They are infinitely better than the surplus "Radio Range Filters" being sold for reducing QRM, and at 2 KC off resonance for example, a 2 section filter using PD52010-1 is capable of twice the selectivity available thru the use of the Q5-er (the BC453 section of the 274N which has provided the amateur's previous highest standard of interference elimination). EXTRA SPECIAL —NAVY PD52010-1 with diagram..$5.00

Universal Microphone Co.'s latest model recorder platform with high quality recording amplifier, complete with all necessary controls for volume, tone playback, record, and Public Address applications. Unit includes chrome plated bullet crystal mike, crystal playback arm, and magnetic recorder head attached by special patented pantographic arrangement for making absolutely linear recordings. Complete with all tubes and matched speaker. Everything supplied but the cabinet for $49.95.

HEAT GUN



Streamlined pistol grip heat gun in vivid red housing, that delivers a powerful 20 Cubic Ft. per minute blast of hot air at 160° Fahrenheit. Ordinary blowers have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that produces a hurricane of either hot or cold air. Perfect for blowing out dirt or dust, drying out ignition systems, warming up carburetors, drying paint, thawing out radiators, etc. Warning:—Keep this away from your wife, or she will be using it to dry her hair because it will do it in half the time of her ordinary hair dryer, to say nothing of her using it to dry stockings or clothing, or defrost the refrigerator instantly. Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

Battery type BA38. 103.5v battery used in handy talkies and mine detectors. 1x1x 11½". Outdated but tests OK. $1.98

Standard type normally open **MICROSWITCHES** ....39¢
Leaf actuator **SPDT MICROSWITCHES** .....49¢

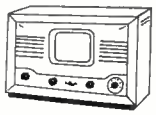
Brand new fully shielded **GE** single button mike transformer in beautiful silver finish case 99

Television 300 ohm twinline, per 500 ft. spool $9.95

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

THE NEWEST TELEVISION RECEIVER



The **LOWEST PRICED receiver** to retain ALL the necessary and important technical refinements found in the most expensive sets. Works all TV channels; has 26 inch screen. Automatic picture lock which prevents picture drifting and causing need for retuning during programs. Automatic sound level control. Minimum number of manual controlls make set easiest of any to operate. Beautifully grained mahogany cabinet hand-rubbed to a finish of distinction. With free indoor aerial. $149.95.

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 2/10 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 $39.50 complete with all leads, as illustrated.

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.

1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER

with new 9 pin socket to handle all future tube developments... **$49.95**

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 micromho 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 the tube base . . . Indicates gas content and detects shorts or opens on each individual section of all loctal, 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.

GENERAL ELECTRIC 150 WATT TRANSMITTER

Cost the Government $1,800.00

Cost to You—BRAND NEW EXPORT PACKED, $100.00

This is the famous transmitter used in U. S. Army bombers and ground stations, during the war. Its design and construction have been proved in service, under all kinds of conditions, all over the world. The entire frequency range is covered by means of plug-tuning units which are included. Each tuning has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits—all designed to operate at top efficiency within its particular frequency range. Transmitter and accessories are finished in black crackle, and the milliammeter, voltmeter, and RF ammeter are mounted on the front panel. Here are the specifications: FREQUENCY RANGE: 200 to 500 KC and 1500 to 12,500 KC. (Will operate on 10 and 20 meter band with slight modification for which diagrams are furnished). OSCILLATOR: Self-excited, thermo compensated, and hand calibrated. POWER AMPLIFIER: Neutralized class "C" stage, using 211 tube and equipped with antenna coupling circuit which matches practically any length antenna. MODULATOR: Class "B"—uses two 211 tubes. POWER SUPPLY: Supplied complete with dynamotor which furnished 1000V at 350 MA, from either 12 or 24 volts. Complete instructions are furnished to operate set from 110V AC. SIZE 21½x23x9¼". Total shipping wgt. 200 lbs., complete with all tubes including a full set of spares besides those tubes necessary for operation. Dynamotor power supply, seven tuning units, antenna tuning unit and the essential plugs.

STROMBERG-CARLSON Power Switching Relay Box. Neat 3½x4x5½ 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. 99¢. With 8 prong JAN connector to fit box $1.39.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. E-3 BUFFALO 3, N. Y.

ELECTRO IMPULSE LABORATORY

ATTENUATOR PADS, 50 ohms, unbalanced pi, 20 decibels ± 2 db.
Type 3, DC-400 mc, type N connectors.....**$12.50**
Type 7, DC-1000 mc, type N connectors....**$30.00**

MUTUAL INDUCTION OR PISTON TYPE ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, barrel diameter 5/8" **$30.00**

APR-1 RADAR SEARCH RECEIVER, complete with tuning units for range of 80-4000 mc, 30 mc I.F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):
TN-17, range 80-300 mc
TN-18, range 300-1000 mc
TN-19, range 1000-2000 mc
TN-54, range 2000-4000 mc

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven traveling probe, matched termination and various adapters, with carrying case, new.

X BAND POWER METER (TS-36/AP, 8700-9500 mc, .1 to 1000 milliwatts.

X BAND PICK-UP HORN AT-48/UP, with coaxial fittings **$5.00**

X BAND TEST LOAD TS-108/AP, new..... **$25.00**

S BAND TEST LOAD TPS-55 PB/T..... **$5.00**

S BAND MIXER, type N signal input, oscillator input, and I.F. output connectors, variable oscillator injection **$17.50**

MICROWAVE TEST CABLE, RG-9U cable with UG-21U connectors, 4½ feet long..... **$3.00**

SIGNAL GENERATOR, MEASUREMENTS 78E, 45-85 mc, 1-1000,000 microvolts, calibrated output.....**$100.00**

NOISE FIGURE METER, 10-400 mc, measures N.F. to 14 db,, 50 ohm impedance.

COMPLETE APS-4 RADAR, new.

COMPLETE SQ RADAR, 10 cm, 300 yards minimum, max. 3, 15, 45 miles, A, B, or P.P.I. presentation, 90-130 volts, 60 cps.

SD-3 SHIPBOARD RADAR EQUIPMENT, complete with all accessories, operates on 115 volts, 60 cps, new.

SA-1 RADAR TRANSMITTER, Receiver and Indicator, 115 volts, 60 cps, new.

RADAR JAMMER, T-26/APT-2, 435-715 mc, 110 volts 400 cps, new.

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case, new.....**$175.00**

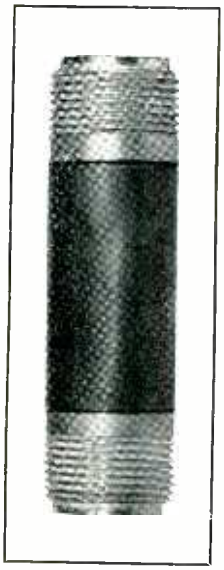
125/APR ANTENNA **$5.00**

TS-10/AP FOR APN-1..... **$40.00**

TS-203/AP CALIBRATED SELSYN..... **$13.00**

TRANSFORMERS, 115 volts, 60 cps primaries:
1. 6250, 3250 and 2000 volts, tapped primary, voltage doubler, 12.5 kv ins..... **$14.00**
2. 6250 volts 80 ma, ungrounded, G.E., voltage doubler, 12.5 kv ins.....**$12.00**
3. 2 secondaries at 500 volts 5 amps each, wt 210 pounds **$50.00**

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms..... **$3.00**



PULSE TRANSFORMER, UTAH 9280..... **$1.50**

PULSE TRANSFORMER, GE 68G 828G-1... **$5.00**

HYPERSIL CORE CHOKE 1 Henry, Westinghouse L-422031 or L-422032..... **$3.00**

VARISTORS: WE D-171528, D-161871-A each ..... **.75**

Clough Brengle Resistance Capacity Bridge, model 230A, new **$50.00**

Audio Signal Generator, Hickok 198, RC tuned 20-20,000 cps... ..... **$45.00**

CONNECTORS:

UG-10/U	.80	UG-167/U	2.00
UG-12/U	.80	UG-190/U	1.00
UG-21/U	.80	UG-201/U	2.00
UG-22/U	.80	UG-245/U	.60
UG-24/U	.80	SO-239	.28
UG-25/U	.80	PL-259	.28
UG-27/U	.50	(for small cable)	
UG-29/U	1.00	M-359	.28
UG-30/U	1.00	UG-266	1.00
UG-30/U special	1.00		
UG-58/U	.60	PL 54	.10
UG-59/U	.00	PL 81	.50
UG-83/U	.00	AN-3102-14S-5P	.25
UG86/U	.00	AN-3102-14S-2P	.25
		RC-10066-20-1P	.50

METERS:
0-350 VOLTS, WESTINGHOUSE NX-35 METER, 1000 ohms per volt, 3½"..... **$4.50**
0-200 MICROAMPS, MARION 2½" SEALED METER, scale 0-100 ..... **$4.50**
0-8 AMPS R.F. SIMPSON IS-39, 2% to 10 mc..... **$4.50**
0-3 MA TRIPLETT 3" square..... **$4.00**
0-10 AMPERES, TRIPLETT 327-A, 3" square.... **$4.00**
1-0-1 MA, MARION SEALED METER HM3, scale 100-0-100 ma, and 115-0-115 volts, 3½"..... **$4.00**
100 AMPERES METER SHUNT, G.E., for 500 meter.. **$1.50**

W.E. NETWORKS:
D-161638, D-161844, D-162627, D-162629, D-162631, D-162632, D-162624, D-162635..... .....**$1.00 each**

CAPACITORS:
Feed thru, ceramic, 55 mmfd, 000 VDC, threaded. **.10 each**
Feed thru, silver mica, disc type, 300 mmfd, 500 v. **.20 each**
Ceramic double cap, 55 mmfd, 10,000 v..... **.50 each**
Mica .005, 2500 W.V. DC..... .....**10 for 5.00**

TRANSMITTING OIL-FILLED CAPACITORS:

2 mfd	1000 WV	1.00
1 mfd	2500 WV	1.50
.25 mfd	4000 WV	.90
.15 mfd	4000 WV	1.00
2 mfd	4000 WV	5.00
.1 — .1 mfd.....	7000 WV	2.00
.075 — .075 mfd.....	8000 WV	2.00
.2 mfd	10000 WV	5.00
1 mfd	15000 WV	25.00

BATH-TUB CAPACITORS:

.1 — .1 mfd.....	400 WV	.08
.1 — .1 mfd.....	600 WV	.08
.5 — .5 mfd.....	1000 WV	.35
.5 — .5 mfd.....	3000 WV	.25
25 mfd	25 WV	.10

DM-43 Dynamotor, G.E., 24 v, 5.5/1030/2/87 volts at 250/280 ma, new, export packed.....**$10.00**

Loop MN 20.E for MN26, D.F., new..... **$10.00**

Flexible aluminum alloy conduit, with tinned copper braid, I.D. ½" or ¾", 88" long, with fittings..... **.50**

Stranded aluminum flexible shield conduit, I.D. 3/8"..... **.05 ft**

ELECTRO IMPULSE LABORATORY

6 Broad St. ***Red Bank 6-4247*** **Red Bank, N. J.**

Yes Sir! the **HOTTEST LIST** in the LAND. brim full of electronics, hydraulics, aircraft parts, gadgets Rush me your name TODAY

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 800cy). 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

500 CYCLE GENERATOR

4KVA 110 Volt single phase p/f 1 3400RPM. Just the thing to hook up to a 60 cycle motor as a power source to operate surplus 400-500 cycle equipment. Has 1-⅛" Keyed drive shaft, built-in exciter & separator DC output of 14V@40Amps. OD25½x12"dia. Wt. Approx. 200 lbs. Brand New. FOB EVERETT or MIDWEST.....

ea. $79.95

AMPLIDYNE

GE#5AM31NJ9A 28VDC input 60-0-60 VDC output at 8.8 Amps. 1 watt field power controls 530 Watts output power. The ideal DC motor speed control & AC generator voltage control. Brand New. .....

ea. $2.95

10,000 VOLT 23 MA TRANSFORMER

Pri. 115 Volt 60 cycle GE#56G9. UL approved. OD 7½x5x5". Wt. 14 lbs. Brand New.....

ea. $6.95

Satisfaction Guaranteed or your money back. Hundreds of bargains in our free illustrated list.

DICK ROSE ERECO
2912 Hewitt Ave. Everett 20, Wash.

INDUSTRIAL POWER SUPPLY EQUIPMENT

for worthwhile savings to you

CAPACITORS
Standard Brands

ELECTROLYTIC:

A-1

500 mfd @ 200 d-cwv; 2 insulated terminals; 2" dia. x 4⅛" can; mounting bracket; new, factory packed. (A-1) ... **$ .95**

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

9.12 mfd @ 1265 v a-c, 60 c single phase, 5 kvar.....$17.50

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

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**

POWER SUPPLY KITS

#1 YOU GET: Full wave high voltage transformer, rectifier, capacitor combination.
2 KENYON TRANSFORMERS type S-13483: 115 v 60 c pri.: 3,200 v ½ wave sec. @ 250 ma. Coupled together they give 3,200 v full wave @ 500 ma.
1 KENYON FILAMENT TRANSFORMER type T-389: 115 v 60 c pri.; 2.5v ct sec. @ 10 amps 9,000 v test.
2 866A tubes. 2 JOHNSON SOCKETS.
4 CAPACITORS, Cat. #23F47: 2 mfd 4,000 v d-c.
COMPLETE.....$35.00

#2 Do you need a low voltage supply? Then don't pass this up! There's
1 THORDARSON TRANSFORMER type T-92P21: 115 v 60 c pri.; sec. #1: 400-0-400 v @ 210 ma; sec. #2: 5v @ 3 amps; sec #3: 6.3 vct @ 5 amps;
1 THORDARSON CHOKE type T-74029: 15 h @ 150 ma.
2 CAPACITORS type PT-SC-2: 8/8 mfd @ 600 v d-c; oil filled; 4 prong plug-in type;
1 5T4 RECTIFIER TUBE; 1 SOCKET;
FOR.....$9.50

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

T-102—Filament Transformer, American Transformer Co. Spec. 29106, Type WS 1.150 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.

KILOVOLT METER

WESTON MODEL 301: 20 kv @ 1,000 ohms per v; 3" face calibrated to read 0 to 20 kv; 1 ma full scale deflection; flush type, calibrated for steel panel mounting; used with Weston precision 20 meg resistor (orig. cost over $125.00), which is included, plus standoff insulators and mounting clips.....$18.00

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

Voltage Regulators

TRANSTAT:
115 v 50/60 c input; 103 to 126 v output @ 2.17 amps.....$9.50
TRANSTAT:
115/230 v 50/60 c input; 0 to 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

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

CHROMOLOX STRIP HEATER: 115 v 300 w; ¼ x 1½" x 12" $1.00
FENWALL THERMOSTAT SWITCH: adjustable from —50° to +400° F.; 110/220 v; 2500 w contacts $1.60
WESTINGHOUSE METER MULTIPLIER: 1 meg; 1/100% accuracy; wire wound; noninductive $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

TUBES

TRANSMITTING

RK75/307A	4.50
750TL	47.50
WL533 750W U.H.F. Triode	17.50
714AY Magnetron	9.50
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

All Tubes New, Boxed

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371B	5.95
531	18.00
872A	1.75
3B22	2.95
4B28/289414 6 Amp. Rectigon	3.95

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POWER RHEOSTATS

25 Watt — 98¢ ea.

6 ohms	60 ohms	500 ohms
10 ohms	125 ohms	750 ohms
12 ohms	200 ohms	1000 ohms
15 ohms	250 ohms	2000 ohms
25 ohms	350 ohms	3000 ohms
50 ohms	400 ohms	5000 ohms

50 Watt — $1.24 ea.

5 ohms	50 ohms	2000 ohms
6 ohms	100 ohms	5000 ohms
8 ohms	150 ohms	7500 ohms
25 ohms	1250 ohms	10000 ohms

100 Watt — $2.25 ea.

7.5 ohms	2500 ohms	3000 ohms
7500 ohms		10000 ohms

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5 ohms	150 w 2.74
25 ohms	150 w 2.57
1250 ohms	150 w 2.74
500 ohms	75 w 1.97
1200 ohms	225 w 3.25
80 ohms	500 w 4.95

Discounts to quantity users

AB CONTROLS

Type J

ohms	ohms	ohms
60	2100	25000
100	2200	30000
150	4000	50000
200	4700	75000
400	5000	80000
500	10000	100000
600	11000	200000
1000	12000	250000
1200	15000	300000
1500	16000	500000
2000	20000	1.0 meg.
	5.0 meg.	

Type "JJ"

ohms	ohms
2 x 500	2 x 150 K
2 x 600	2 x 200 K
2 x 2 K	2 x 250 K
2 x 10 K	2 x 1.0 meg.

Type "JJJ"

ohms	ohms	ohms
3 x 750 K	3 x 800 K	3 x 1.0 meg.

Special Prices Quoted Upon Request

WRITE WIRE PHONE

VOLUME CONTROLS

CARBON

ohms	ohms
200	100000*
700	100000
1000	147000
2200*	150000*
4000	200000
5000	250000*
10000*	250000
10000	300000
20000	500000*
30000	500000
50000*	700000
75000	1.0 meg.*

15¢ 100 of a Type — Smaller Lots 20¢ ea.

WIREWOUND

ohms	ohms
15	1000*
20	1000
25*	2000
25	2500
35*	3000
35	5000*
50*	5000
100	5150
200*	10000*
200	10000
400*	20000
500	70000
700	200000

20¢ ea. 100 of a Type — Smaller Lots 25¢ ea.

DUAL CONTROLS

CARBON

2x10K* 2x30K* 2x250K 2x1.0 meg.* 2x2.0 meg.*

39¢ ea.

WIREWOUND

2x200 2x5K 2x7.5K* 2x10K 2x20K* 2x25K

48¢ ea.

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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
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1000 mfd 15 vdcw 1 section	.79
1000 mfd 25 vdcw 1 section	.88
1250/1250 mfd 10 vdcw 2 section	1.29
500 mfd 200 vdcw 1 section	2.49

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Famous makes—All Brands Guaranteed New Oil filled bathtubs

.033/400 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.16/600V	—28¢
.5/600 V	—25¢	2x.25/600V	—29¢
1.0/200 V	—22¢	2x.5/600 V	—34¢
1.0/600 V	—30¢	3x.05/600V	—30¢
2.0/600 V	—40¢	3x.1/600 V	—33¢
2x.05/1500 V	33¢	3x.25/600V	—38¢
2x.1/600 V	—29¢	3x1.0/100V	—25¢
2x.1/1000V	—31¢		

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4.0/50V	—30¢	200/12V	—20¢
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25/50V	—23¢	2x10/25V	—20¢
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50/25V	—23¢		

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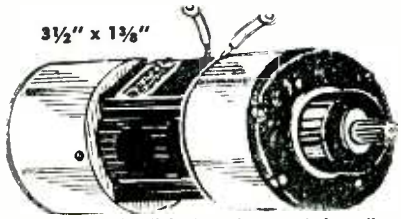
3½" x 1⅜"



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861	19.95
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1625	.25
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1A3	.29
954	.35
955	.45
957	.29

958A	.45
959	.45
9001	.55
9002	.35
9003	.45
9004	.55
9006	.35

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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.) NH-102 ..... $39.75

ALL FOLLOWING TRANSFORMERS 115 V. A.C. 60 CYCLE INPUT:

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ALL ABOVE ITEMS BRAND NEW— NOT SURPLUS!

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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

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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. MG-105. Prices: As is..... $39.50 Tested..... $49.50

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RECTIFIER UNIT—110 V. 6 0cycle input; output 12 V. DC 10 amps. Electronic Lab. Mfg. Price—NEW: $29.95

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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
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PRI: 210/220/230/240/250 VAC. 50/60 CPS.
SEC: 7.5 VAC C.T. @ 24 Amps. Herm. Sealed. Insulation 2500 Volts..... Price $11.95

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.125 MFD. 27 KV.DC.
With mounting brackets
$17.50

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Normally open or closed. Adjustable from —40 to +400° F. each **$1.25**

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HIGH CURRENT AMERTRAN

5.1 Volts at 190 Amps.
Primary 105/125 Volts

Can easily deliver 250 Amps. Insulation 35 Kv. Test. Approx. Shipping weight 96 lbs.

$17.50

Plus $2 crating charge

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

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

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
B4–1X2	1.2 AMP.	$7.95
B4–3X5	3.5 AMP.	15.95
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
B6–3X5	3.5 AMP.	21.95
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 0–25*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
B2–600	600 MA.	2.95
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

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

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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 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

RECTIFIER CAPACITORS

CF-13	6000 MFD	10VDC	$2.49
CF-14	3000 MFD	12VDC	1.69
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CF-9	200 MFD	150VDC	1.69
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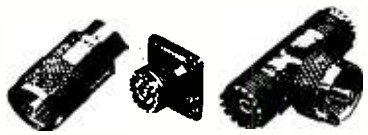

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RG22U	per 1000 ft.	120.00
RG29U	per 1000 ft.	37.50
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RG54U	per 1000 ft.	65.00
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UG-20/U	1.17	UG-160A/U	1.55
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UG-20B/U	1.41	UG-173/U	.30
UG-21/U	.99	UG-175/U	.15
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CRYSTALS—Mtd FT243 exacting S.C. Specs.

3525Kc	4190Kc	5235Kc
3735Kc	4780Kc	5485Kc
3980Kc	5030Kc	ea. 98¢; 3 for $2

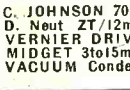
Write for other frequencies.

Hi Accy Xtal Frequency Standards

81.95Kc	$1.98	1000Kc, useable in BC221	$4.49
100Kc	5.98		
200Kc	3.98	4700Kc	.98
500Kc	12.98	5000Kc	3.98

CRYSTALS—Mtd htr Ovens HiAccy Stability 5010, 5025, 5055Kc, ea $14.98

Variable Condensers



A. 150mmf/3000VgapHF ... $1.00
B. DUAL 15mmf/sect/3000V gap ..... .79
B. DUAL 75mmf/sect/3000V gapHF 1.49
C. JOHNSON 70H30/74 mmf/3000V gap 1.29
D. Neut ZT/12mmf/5000Vgap&locknut ..... .98
VERNIER DRIVE 10-369mmf, ea. 79¢; 3 for .. 2.00
MIDGET 3to15mmf midline, ea. 49¢; 5 for 2.00
VACUUM Condenser 50mmf/7500V 1.98

PRECISION RESISTORS

NO MFGRS CHOICE, We ship types in stock*

.116	182	689	2850	14460
.42	199	697	2860	14500
.425	200	700	2900	15000
.607	209.4	733	3000	15500
.7	216	750	3100	16500
1.03	220	800	3290	17000
1.3	220.4	806	3295	17500
1.75	225	854	3384	18000
2.5	230	900	3500	18380
3.75	235	910	3509	18500
3	240	917	3700	18800
3.83	245.4	946	3730	19000
4	250	978	3760	19500
5.35	271	1000	4000	20000
5	275	1030	4200	20520
6.025	280	1056	4280	21008
6	286	1060	4300	21500
7.25	289	1100	4314	22000
7	299	1110	4440	22500
7.5	300	1150	4444	22990
7.8	310	1155	4500	23000
8.9	311.5	1162	4720	23150
10	320	1175	4750	23325
10.38	325	1200	4850	23400
10.48	340	1225	4885	24000
11.25	350	1250	4900	24600
12	366.6	1260	5000	25000
13.52	370	1322	5100	25200
14.2	375	1350	5210	25400
14.5	380	1355	5235	26600
15	389	1400	5200	27500
16	390	1495	5500	29000
16.37	400	1500	5600	29500
17	410	1510	5730	29900
20	414.3	1518	5910	30000
21	418.8	1600	6000	31000
25	425	1640	6140	33000
36	426.9	1646	6200	35000
20	427	1650	6300	37000
37	440	1670	6495	38140
48	450	1680	6500	38500
50	452	1710	6840	39500
51.78	470	1740	6990	40000
55	475	1770	7000	43000
60	478	1800	7500	47000
63	480	1818	7700	47500
68	487	1830	7930	48000
71.4	500	1865	8250	48660
74	520	1900	8500	49000
75	525	1910	8700	50000
80	540	1960	8800	52000
81.4	550	1980	8992	54000
89.8	575	2000	9000	56000
90	580	2045	9445	60000
95	588	2080	9500	61430
100	600	2095	9710	62000
101	607	2145	10000	64000
105	612	2160	10430	65000
105.7	625	2195	10500	68000
107	633	2200	10600	70000
113.1	640	2250	11000	72000
120	641	2300	11400	75000
121.2	649	2400	11500	77000
125	650	2450	11690	80000
147.5	657	2463	12000	84000
150	665	2485	12600	90000
160	669	2490	13220	91000
165	670	2500	13500	95000
170	675	2600	14000	
175	680	2635	14400	
179	684	2700	14440	

ABOVE SIZES EACH 30¢ @ ... TEN FOR $2.50

100000	166750	240000	380000	620000
110000	169360	245000	400000	621000
115000	180600	250000	402000	654000
120000	185000	265000	422000	750000
125000	198000	268000	458000	761300
130000	200000	275000	478000	800000
135000	201000	294000	500000	900000
140000	220000	307500	520000	930000
145000	225000	314000	521000	950000
147000	229000	330000	570000	
150000	235500	333500	575000	
155000	238000	353500	600000	

ABOVE SIZES EACH 40¢ ..... TEN FOR $3.50

1 Meg	2.5 Meg	3.9 Meg	9.05 Meg	20 Meg
1.2	2.855	4	10	
1.5	3	4.23	11.5	
1.8	3.5	4.5	12.83	
2	3.673	5	19.5	

ABOVE SIZES EACH 75¢ ..... TEN FOR $6.50

Vacuum Precision Hivolt Resistors

.12, .25, .6, .75, .83, .99 megohms
1, 1.5, 2, 3, 3.75 megohms 0.5% accuracy
SPECIAL $1.00@ ..... TEN FOR $7.50
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MVZ8/20 Watt/30 Megohms/25KV $1.98@6for 10.00
MFC105/1Mg./.5% accy/JanR-29 .. $1.98@6for 10.00
Type 2/20megJAN-R29/20KV/0.5%accy 29.95
SPRAGUE 20 meg/20KV/WW½% acey 10.98
IRC MVE-8/25Watt/40KV mtg brackets $1.98; 6/$10
IRC 100000 ohms 20 position Attenuator 2.98
IRC 250000 ohms 20 position Attenuator 4.98

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IN21, 21A, 22, 23, 23A ea ..... $1; 12/$10
IN21B, IN27 $2.00; 10 for $17.50; 100 for $150
IN23B, IN26 NEW ..... $2.75; 10 for $25.00
IN35 Dual Diode $2.69
D168391, Therm Compensator ..... $2; 3/$5
D170396 HF pwr meas ..... 90¢; 3 for $2.50
IC Bulb Time Delay ..... 90¢; 3 for $2.50
Varistor 38C USN CW20259 ..... 2.98

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BC457 Xmtr as is less tubes 3.49
BC456 Modulator as is less tubes 1.49
BC456 Modul w/Tubes & Dyn Good Used 4.98
Collins ART13 Sp Amp. less tubes 4.50
Same w/Clipper Kit, tubes, data, New 8.25
TA12 Xmtr Bendix 40WusedLN* 29.95
BC1162&3 p/oRC150, 150-210Mc w/tubes, New 25.95
BC1206 Seichel Carlson BattyRecvr 200-400Kc Good Used w/tubes(5) Special 3.95
Gibson Girl Xmitter 4.95
USN ABF/SCR695 Recvr and Equip LN* 9.95
BC1066 UHF Batty Recvr New 9.95
BC1-196 SigGen UHF Bat New 5.95
BC906 p/o IE46 Fq Mtr & Monitor 140 to 230 Mc, New 29.95
BC1073 WaveMtr, 150-210McUsed 10.95
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APN4 RCVR less tubes 14.95
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Same Mtg & X band Wavemeter 29.95
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Parallel Tunable Coax Cavity w/adj hat 300-400 Mc. LN* 4.95
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Pulse Xformer H&V BTO, GE, Raytheon UTAH specify Type. Write Qty prices 1.49
Remote Control Units SCR573 & 574 CRB23367 Selector Cont up to 110V60cy & CRB23368 op24 VDC Controls 2Xmtrs & Recvrs Automatic SEND RECEIVE switching on either of 2 channels. Write for Specs BOTH UNITS 29.95

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B) MICROSWITCH Pin Plunger SPDT 10A @ .. .54
C) MICROSWITCH Plunger SPDT/10A @ ..... .59
D) MICROSWITCH Plunger SPNO/10A @ ..... .69
E) ARROW H & H PLUNGER SPNO/6A @ ... .39
F) MICROSWITCH ROLLER SPNC 10A @ ..... .89
G) AH & H Toggle 6A/DPST 30¢ @ 4 for 1.00
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I) MICROSWITCH PLUNGER Button SPDT @ .69
J) MICROSWITCH SPNC/30 Amp/Cased @ .... .98
K) SWITCHETTE DPNO&NC 30c; SPNO @ .... .25
SQ'D START&STOP push button control ..... .98

METER 200 MicroampDC GE 4" Sq 5 scales AC&DCV&ohms Red &Black K.E. pointer NEW. Made for RCA Volt Ohmyst **$7.95**
METER 0-120 Ma RF Weston JAN 3½" round B'csd Accurate to 65 Mc **$12.95**
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Write for Complete Meter List.

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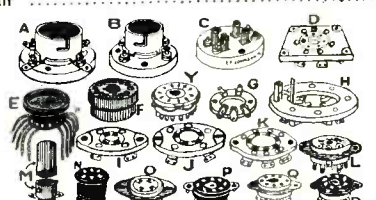
CarbonTet PYRENE 1qal 20olb Self Charging w/MTR LN* Shipped dry $10.98
GMT TIME MONTH DATE Clock Stamp LN* Used 6.98
USN Siren FOGHORN $1.98; 6 for 10.00
CLARE DS-H Automatic Stepping Relay 24/32 VDC 3-lever 10 steps 7.95
Sound-Pwrd Headset & Mic & Cable, ea. $10.98; Pair $19.49



SOCKETS—All Types!

A. RCA 5-pin GIANT for 803, RK28 USN ..... 90¢
B. Johnson 4-pin bayonet for 866, etc. ..... 49¢
C. Johnson Type124-213 for304TL, 152TL ..... 90¢
D. Johnson 7-pin Steatite 829B/3I29, 826.ea25¢;5/$1
E. Small Shell DUODECALfor2BPI,5TPI,5UP1 59¢
F. Med Shell DIHEPTAL Cinch mica Bklte ..... 69¢
G. 5-pin ACORN 1 9/16"dlaHaml'nd, ea25¢;5for$1.00
H. Johnson 122-234, 5D21, 721w/tube lock ..... 69¢
I. 4-prong STEATITE Johnson for 866 etc. 24¢:5/$1
J. 5-prong STEATITE Johnson for 807 etc. 27¢:4/$1
K. 7-prong STEATITE Johnson 1625 etc,ea 29¢:2/49¢
L. 7-pin NATIONAL CIR7L Steatite, ea24¢; 5 for $1
M. MIN 7-pin Mica147-913 & shield ..... 28¢
M. MIN 7-pin Amph 78-7PT, ea .... 11¢; 10 for 98¢
N. Amphenol fem78FP in 4,5,6,7,8 ea ... 16¢; 6 for 89¢
O. 4-pin Amphenol 49RSS4&mtg Ceramic .. 24¢:5for$1
P. OCTAL 8pin&plateSteatite Cinch ea. 9¢;12for$1
Q. OCTAL 8pin&plateSteatite Cinch ea. ... 18¢;7for$1
R. LOKTAL 9pin&lock mtg plateCINCH .11¢;10for$1
S. KLYSTRON socket Cinch, ea ..... 35¢; 10 for $3
T. LOKTAL Amphenol 49SSL steatite 24¢; 5 for $1
U. OCTAL Amphenol 78S8*micaBklte* .8c:25for$1.49
U. 11-Pin 78S11/931Amph ..... $15¢; 7 for $1
V. OCTAL Amphenol 49SS8 steatite .15¢; 12 for $1.49
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