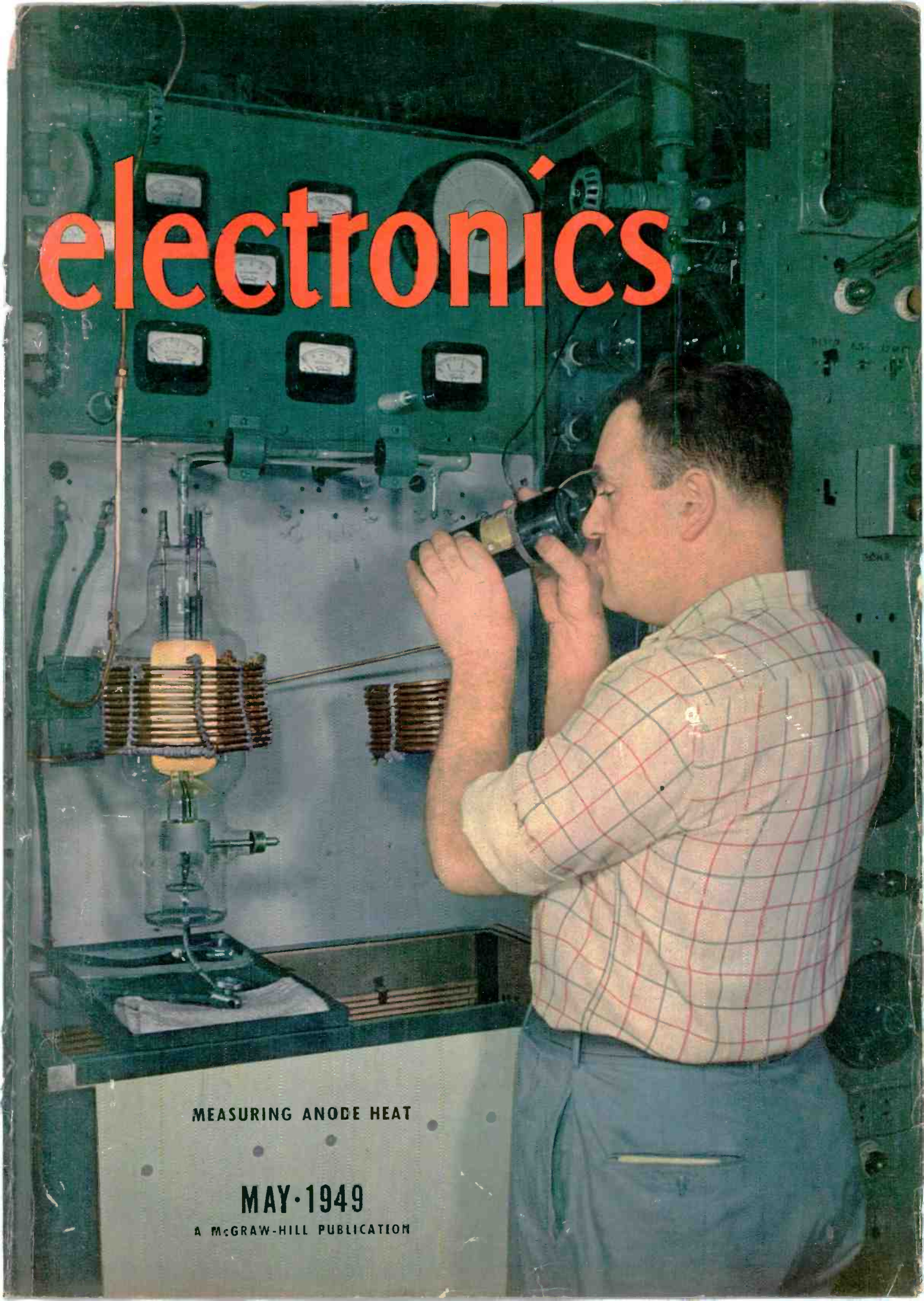
electronics



MEASURING ANODE HEAT

MAY·1949

A McGRAW-HILL PUBLICATION

FOR COMPACT HIGH FIDELITY EQUIPMENT

Ultra compact, lightweight, these UTC audio units are ideal for remote control amplifier and similar small equipment. New design methods provide high fidelity in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles. There is no need to resonate one unit in an amplifier to compensate for the drop of another unit. All units, except those carrying DC in Primary, employ a true hum balancing coil structure which, combined with a high conductivity outer case, effects good inductive shielding. Maximum operating level + 10 DB. Weight—8 ounces. Dimensions—1½" wide x 1½" deep x 2" high.

Unit shown is actual size. 6V6 tube shown for comparison only.

HERMETICALLY SEALED

On special order, we can supply any of the Ultra Compacts hermetically sealed per Jan T-27 Grade 1 Class A in our RC 50 case as illustrated. Dimensions; Height 2¼", Base $1\frac{9}{16}$" x $1\frac{9}{16}$".

ULTRA COMPACT HIGH FIDELITY AUDIO UNITS

Type No.	Application	Primary Impedance	Secondary Impedance	± 2 DB from	List Price
A-10	Low impedonce mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50,000 ohms	30-20,000	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids	50, 200, 500 ohms	50,000 ohms	50-10,000 multiple alloy shield for extremely low hum pickup	16.00
A-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall in two sections	30-20,000	15.00
A-18	Single plate to two grids split primary	8,000 to 15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	50-20,000	14.00
A-19	Single plate to two grids 8 MA unbolanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	30-20,000	18.00
A-24	Single plate to multiple line	8,000 to 15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	50-12,000	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	8,000 to 15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	50-20,000	14.00
A-26	Push pull low level plates to multiple line	8,000 to 15,000 ohms each side	50, 125/150, 200/250, 333, 500/600 ohms		15.00
A-30	Audio choke, 300 henrys @ 2 MA 6000 ohms D.C., 75 henrys @ 4 MA 1500 ohms D.C., inductance with no D.C. 450 henrys				10.00

The above listing includes only a few of the many Ultra Compact Audio Units available . . . write for catalog PS409

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

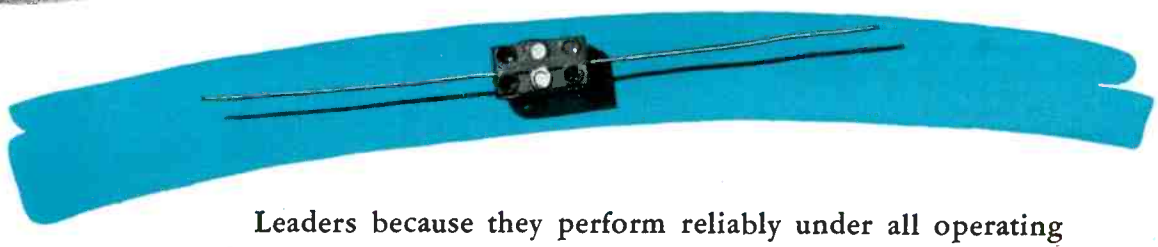
A McGRAW - HILL PUBLICATION

MAY • 1949

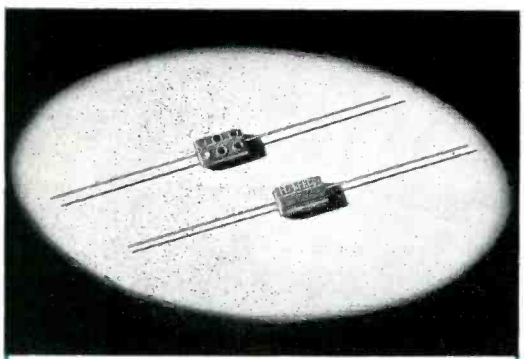
ELECTRONICS, May, 1949, Vol. 22; No. 5. Published monthly, with an additional issue in June, price 75c a copy for U. S. and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications 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.

EL-MENCO CAPACITORS

Leaders



Leaders because they perform reliably under all operating conditions, these fixed mica dielectric capacitors are used in electronic applications wherever long life and successful performance are demanded.



CM 15 MINIATURE CAPACITOR

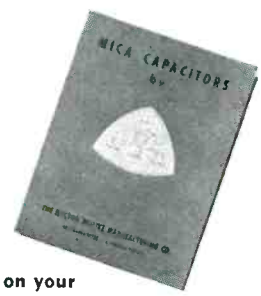
Actual Size $\frac{9}{32}$" x $\frac{1}{2}$" x $\frac{3}{16}$"
For Radio, Television and Other Electronic Applications
2 to 420 mmf. capacity at 500v DCw
2 to 525 mmf. capacity at 300v DCw
Temp. Co-efficient ±50 parts per million per degree C for most capacity values
6-dot standard color coded

Each tiny El-Menco Capacitor must pass life and humidity tests; meet standards set by the United States Army and Navy; pass tests at double their working voltages; prove their dielectric strength, temperature co-efficient and capacitance drift, and have their insulation resistance double-checked. These little leaders are molded in low-loss bakelite and wax-dipped for salt water immersion seal. They're available in a wide range, all impregnated, all precision-made, all JAN, RMA and RCM color-coded.

Why not protect your product's performance with capacitors made under these rigid conditions?

Specify **EL-MENCO**
TESTED ● RELIABLE ● LEADERS!

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



Write on your firm letterhead for Catalog and Samples

MOLDED MICA **El-Menco** **MICA TRIMMER**
CAPACITORS

FOREIGN RADIO AND ELECTRONIC MANUFACTURERS COMMUNICATE DIRECT WITH OUR EXPORT DEPT. AT WILLIMANTIC, CONN.
ARCO ELECTRONICS, INC. 135 Liberty St., New York, N. Y.—Sole Agent for Jobbers and Distributors in U.S. and Canada

For Electrical Contacts Requiring HIGH HARDNESS, HIGH CONDUCTIVITY *and positive freedom from transfer, pitting or sticking*

Fansteel

FANSTEEL METALLURGICAL CORPORATION · NORTH CHICAGO, ILLINOIS

TECHNICAL DATA BULLETIN

FASTELL "E"®

A silver molybdenum product of Fansteel metallurgy, widely used in:

INDUSTRIAL MOTOR STARTING SWITCHES

AIR CIRCUIT BREAKERS • AIRCRAFT RELAYS

Other devices carrying high current A.C. or D.C. resistance or inductive loads.

FASTELL "E"® is used as combination current-carrying and arcing tip and as an arcing tip only. It has remarkably low contact surface resistance when correct contact closing forces are used. For example, on 28 to 32 volt D.C. resistance loads, closing forces of the order of 45 to 85 ounces per pair of contacts have been found entirely satisfactory.

On higher voltage applications, where the general equipment design tends to even higher contact closing forces, Fastell "E" is outstandingly successful in keeping wear and contact resistance at a very low value. Fastell "E" is only one of 31 Fastell compositions. Fansteel Metallurgical Corporation, North Chicago, Illinois.

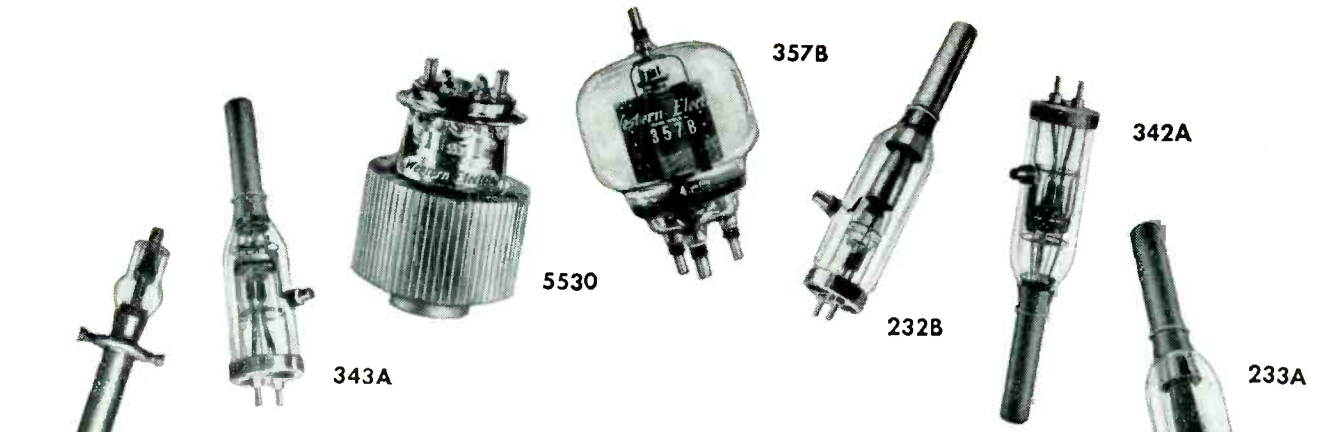
Fansteel Contact Engineers will welcome a consultation with you on any contact and contact assembly problem.

Complete information on Fastell "E", and other contact materials is available in the Fansteel Handbook for Engineers, on Electrical Contacts. Copy of this valuable book will be sent to you upon request without obligation.

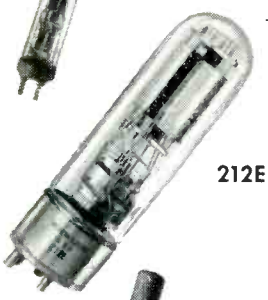
11301

Fansteel

ELECTRICAL CONTACTS and CONTACT ASSEMBLIES



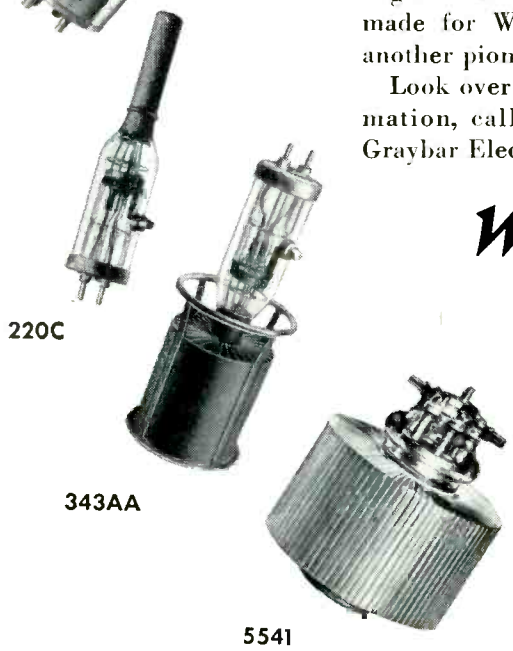
Western Electric Power Tubes for AM and FM



WHETHER your station operates on low power or high power, AM or FM, you'll find the tubes you want in Western Electric's line.

Always known for long service life and top quality performance, these broadcast power tubes and rectifiers—all engineered by Bell Telephone Laboratories—are now being made for Western Electric by Machlett Laboratories, Inc., another pioneer in the development of electron tubes.

Look over the listing of types below—and for further information, call your local Graybar representative or write Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.



Western Electric

—QUALITY COUNTS—

Western Electric's line of high power transmitting tubes includes:

212E	Air cooled triode, 275 watts
220C	Water cooled triode, 10 kilowatts
220CA	Forced-air cooled triode, 5 kilowatts
222A	Water cooled high vacuum rectifier, 25 kv. inverse voltage
228A	Water cooled triode, 5 kilowatts
232B	Water cooled triode, 25 kilowatts
232BA	Forced-air cooled triode, 8 kilowatts
233A	Water cooled high vacuum rectifier, 50 kv. inverse voltage
236A	Water cooled triode, 20 kilowatts
240B	Water cooled triode, 10 kilowatts
241B	Air-cooled triode, 275 watts
251A	Air-cooled triode, 1000 watts
255B	Mercury vapor rectifier, 20 kv. inverse voltage
270A	Air cooled triode, 350 watts
279A	Air cooled triode, 1200 watts
298A and B	Water cooled triode, 100 kilowatts
308B	Air cooled triode, 250 watts
340A	Water cooled triode, 25 kilowatts
341AA	Forced-air cooled triode, 5 kilowatts
342A	Water cooled triode, 25 kilowatts
343A	Water cooled triode, 10 kilowatts
343AA	Forced-air cooled triode, 5 kilowatts
357B	Air cooled triode vhf, 400 watts
363A	Air cooled pentode, vhf, 350 watts
379A	Air cooled triode, 1200 watts
5530	Forced-air cooled triode, vhf, 3 kilowatts
5541	Forced-air cooled triode, vhf, 10 kilowatts

Distributed by Graybar — Offices in 100 principal cities

DISTRIBUTORS: IN THE U. S. A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Co., Ltd.

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.

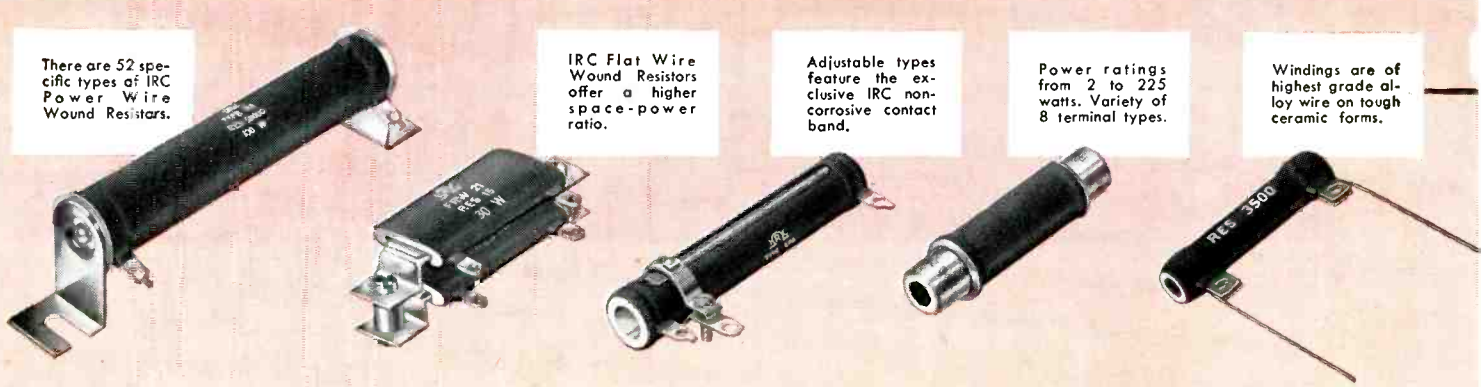
There are 52 specific types of IRC Power Wire Wound Resistors.

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

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

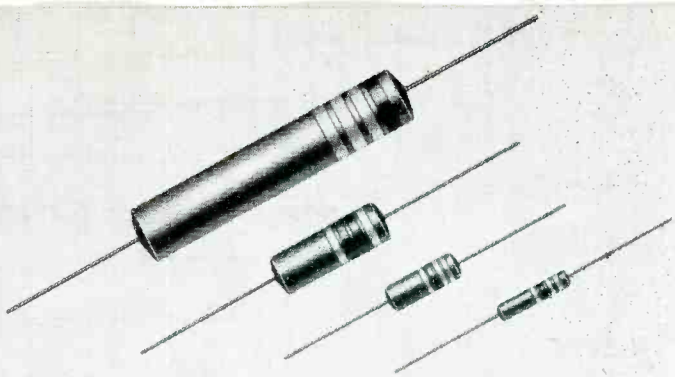
Power ratings from 2 to 225 watts. Variety of 8 terminal types.

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



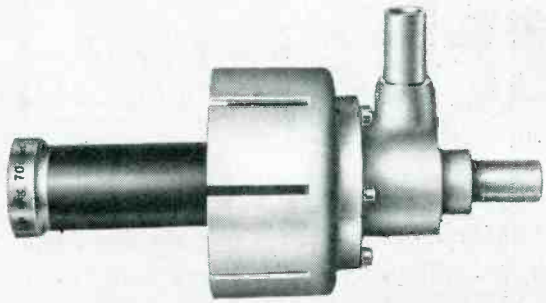
tough

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 ⅓, ½, 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 ¼ 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 F-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

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

J. F. ARNDT & CO., ADV. AGENCY

INTERNATIONAL RESISTANCE COMPANY
403 N. BROAD ST., PHILA. 8, PA.

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

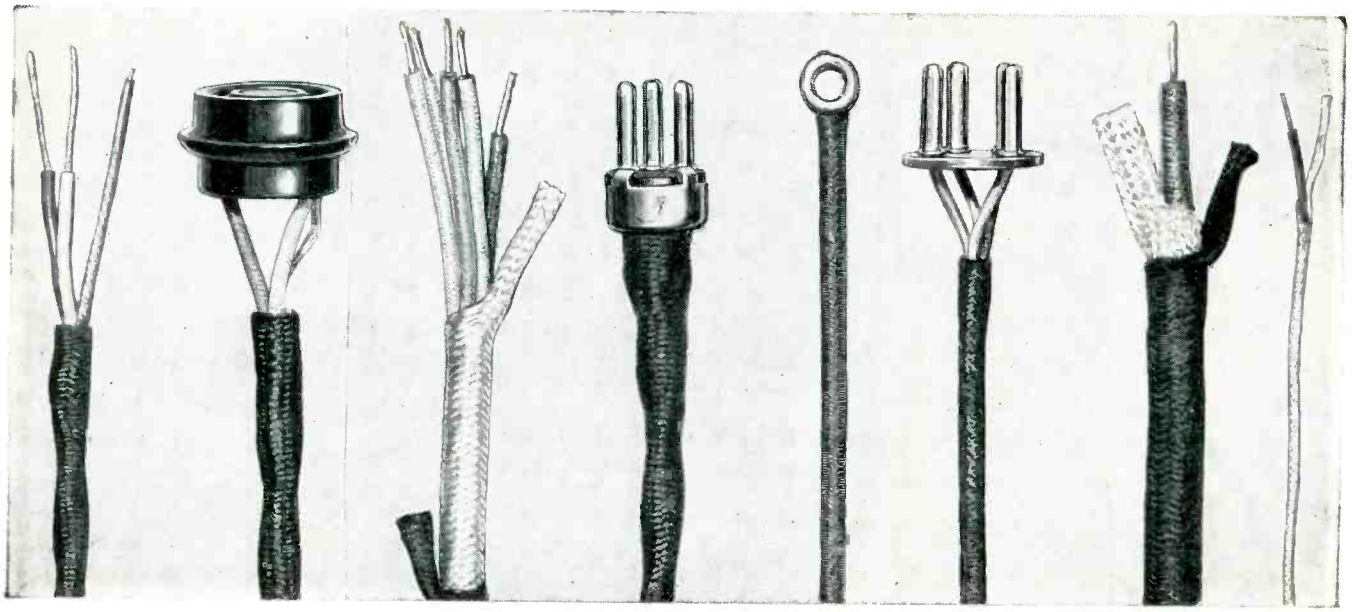
NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

.....



WIRES and CABLES

LENZ THE *lifeline* OF ELECTRONIC EQUIPMENT

When you list the qualities most desirable in a supplier of wires and cables for your electronic equipment, you will find that Lenz most nearly answers your description of a dependable source.

First, this company has the engineering background and experience, the knowledge of your requirements in wires and cables that are needed to help draft your specifications.

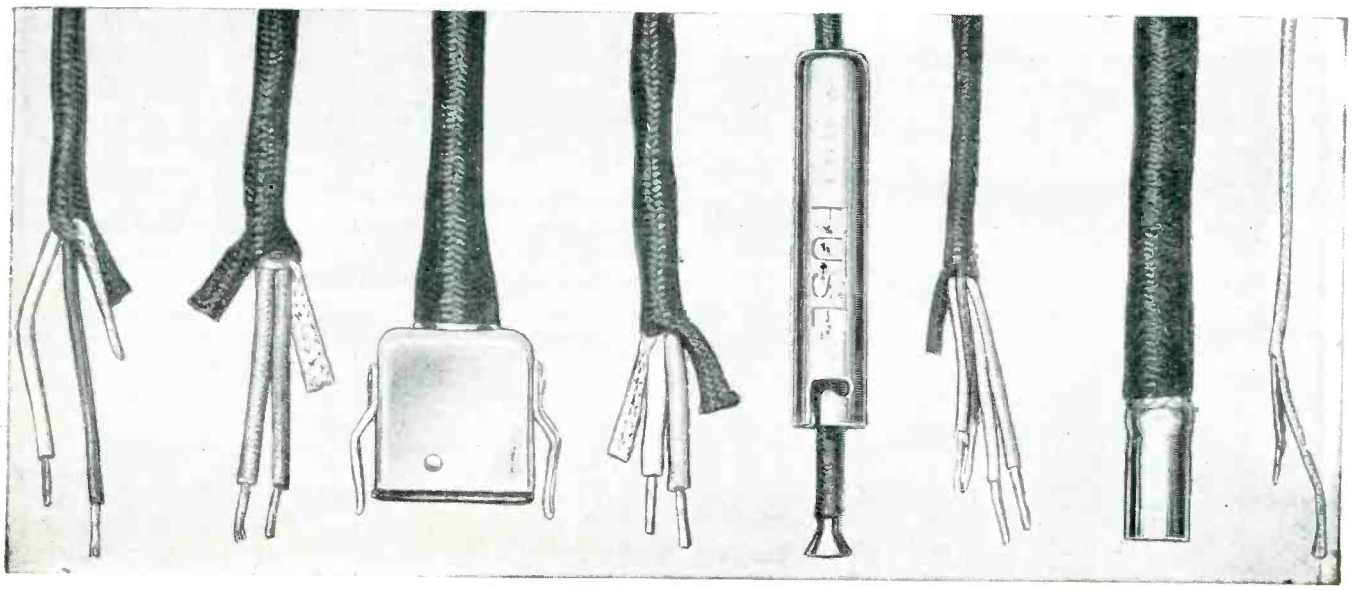
Second, it has the facilities to produce these wires and cables in volume exactly to specifications, economically and promptly.

Third, it is a reliable organization with over 40 years background of dependable service to the communications industry.

Make Lenz your principal source for wires and cables. A Lenz wire engineer will gladly consult with you regarding your special requirements. Correspondence is invited.

''IN BUSINESS SINCE 1904''

LENZ ELECTRIC MANUFACTURING CO. • 1751 No. Western Avenue, Chicago 47, Illinois

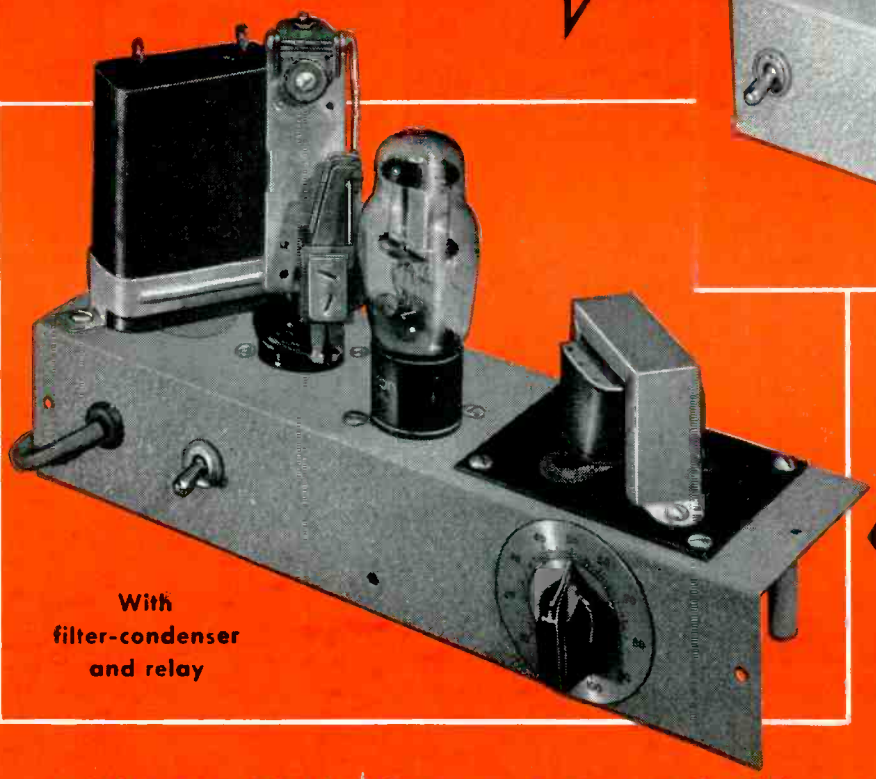


One CLARE RELAY will do the work...

of a Relay and Filter-Condenser in Many Plate Circuit Installations

This...

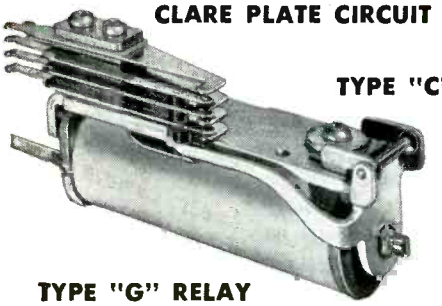
With CLARE Plate Circuit Relay alone



With filter-condenser and relay

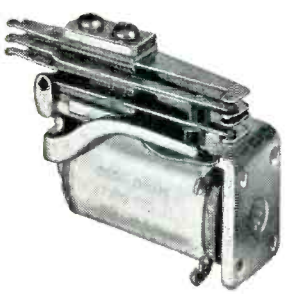
Not this!

THREE SIZES AND TYPES OF CLARE PLATE CIRCUIT RELAYS

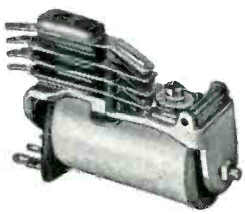


TYPE "C" RELAY

TYPE "G" RELAY



TYPE "J" RELAY



Utmost simplification of many plate circuit installations is possible with CLARE Plate Circuit Relays which make unnecessary the use of filter-condensers with or without induction networks.

By thus reducing the number of circuit elements, these CLARE Relays often make possible real savings of weight, wiring and cost.

If your design involves plate circuits, it will pay you to get full information at once. CLARE sales engineers are located in principal cities. You are invited to make use of their wide experience in every problem which involves the use of relays. Call them today, or write: C. P. Clare & Company, 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Write for Clare Bulletin No. 104

CLARE RELAYS

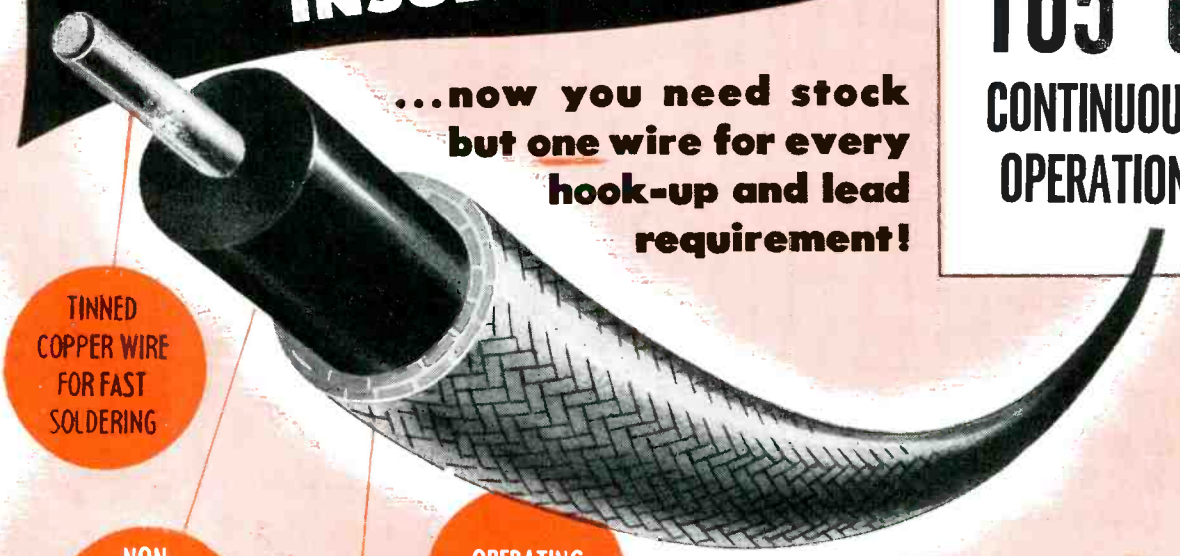
First in the Industrial Field

SOMETHING BRAND NEW IN HOOK-UP WIRE—

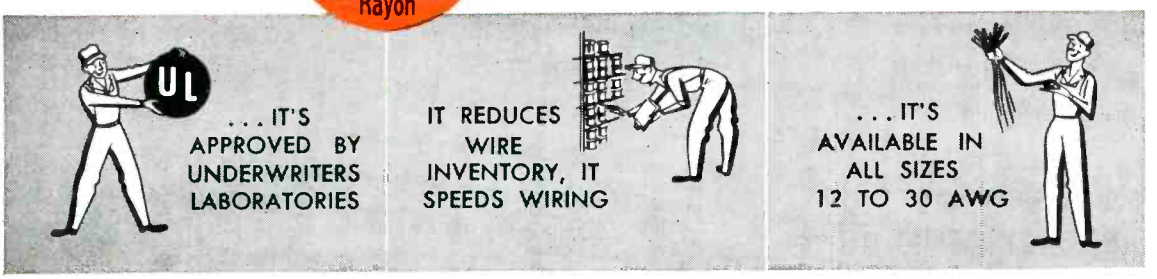
TURBOTHERM REL 16-A INSULATED WIRE

105°C CONTINUOUS OPERATION

...now you need stock but one wire for every hook-up and lead requirement!



- NON-POROUS, NON-FRAYING
- FREE STRIPPING INSULATION
- FLEXIBLE
- AVAILABLE FOR 300 AND 600 V.
- NON-DETERIORATING VINYL DIELECTRIC
- WITHSTANDS POTTING TEMPERATURES



TURBO REL-16A Insulated Wire is the biggest news in hook-up wire to be announced in recent years. Its unusual characteristics make it possible for the first time, to stock one single type of wire for all requirements—point-to-point wiring, cabling, equipment and component leads.

REL-16A is a free stripping insulated wire composed of a tinned copper conductor, covered with a layer of non-deteriorating vinyl plastic, overlaid with a close-woven lacquered glass jacket. The combination of free stripping and the tinned conductor enormously speed production. The vinyl dielectric gives permanent electrical protection, and the lacquered glass woven outer layer insures the utmost mechanical protection.

The overall qualities of REL-16A are so thoroughly outstanding that this is the first thermoplastic wire to earn Underwriters' approval recognition for 105° C continuous operation. Check the advantages—write for free sample today.

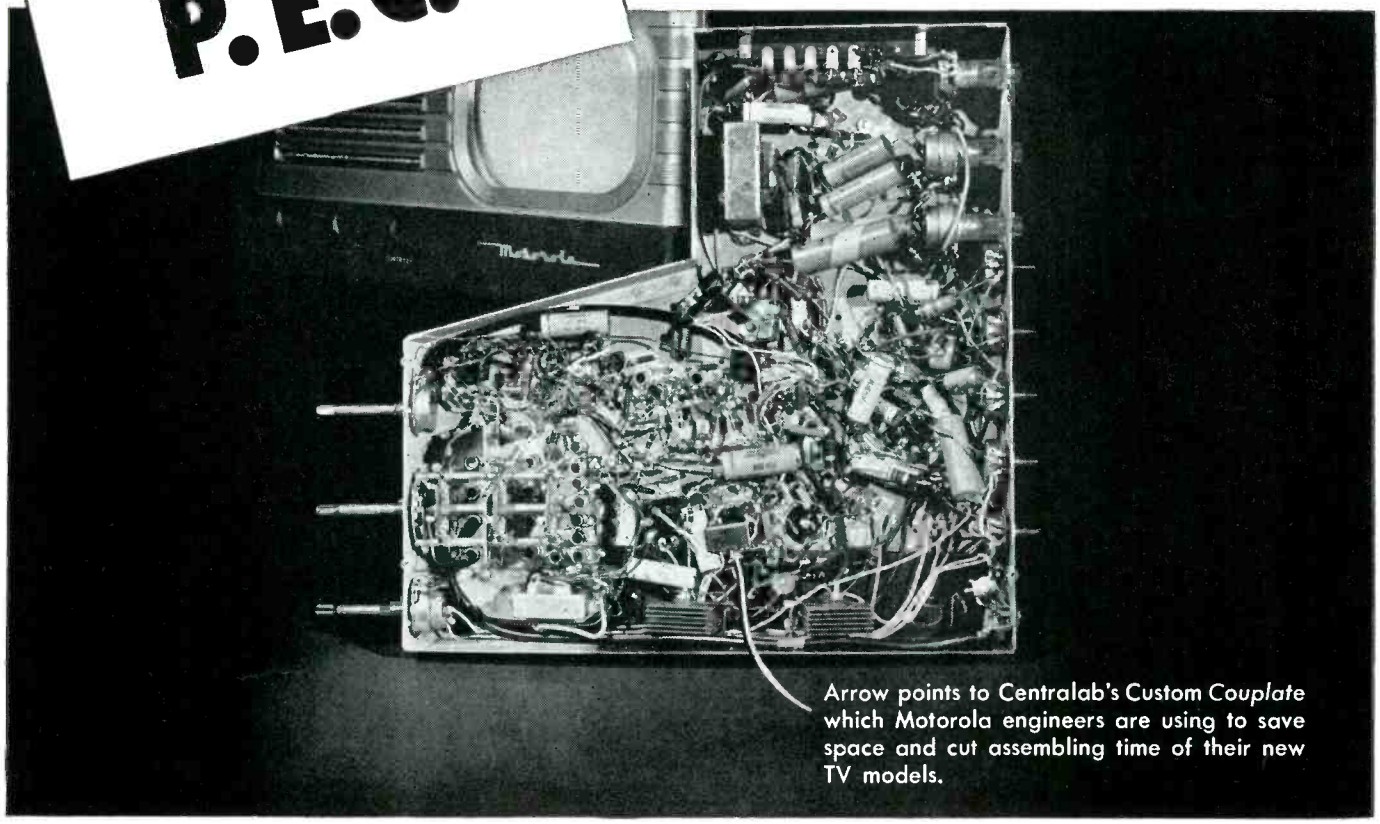
WILLIAM BRAND & COMPANY

276 FOURTH AVE., NEW YORK 10, N. Y. • 325 W. HURON ST., CHICAGO 10, ILL.

TURBO-IT SAFE-GUARDS-IT

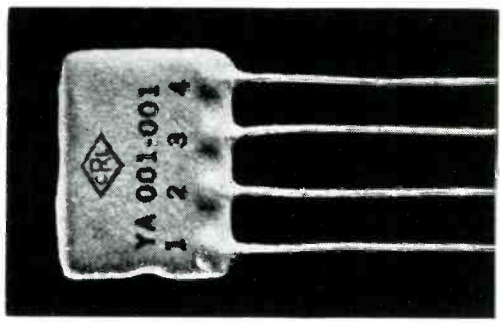
PROGRESS REPORT ON P.E.C.*

How Motorola is using Centralab's "P. E. C." to help build more and finer television receivers than ever before!

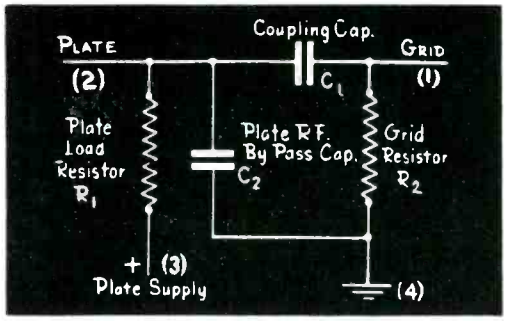


Arrow points to Centralab's Custom *Couplate* which Motorola engineers are using to save space and cut assembling time of their new TV models.

Chassis courtesy of Motorola Corp.



"COUPLATE" is made of high dielectric Ceramic X to give long life, low internal inductance, positive resistance to humidity and vibration. A circuit diagram of CRL's *Couplate* is shown below.



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

SPEEDED production and finer products go hand in hand where Centralab's amazing *Printed Electronic Circuit* is concerned. Take the case of Motorola's new television receivers. Engineers for Motorola find that CRL's *Couplate* — a printed interstage coupling plate — saves production time by cutting in half the number of connections to be soldered . . . that it speeds assembly by simplifying wiring operations. They also find that *Couplate* helps them produce finer TV receivers by practically eliminating loose or broken connections — from plate load resistor to coupling capacitor.

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

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

LOOK TO **Centralab** IN 1949!

Division of GLOBE-UNION INC., Milwaukee

The Weather-Proof Link—

TIME SHARING MULTIPLEX

Even where climates quickly kill cables, the ether is always ready to carry a *Standard* Multiplex Telephone Trunk Link.

The system is easy to install, thoroughly reliable in operation, and simple to service.

Each equipment deals with up to 24 channels which handle 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 may 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′ away from the equipment.

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

Standard Telephones and Cables Limited *Radio Division*

An I. T. & T. associate

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

R.D.5

FOR BEST WELDER PERFORMANCE—

G-E IGNITRONS!

Specify these sturdy control tubes for their quality (it's an industry byword) . . . their proved reliability!

ELECTRONIC welding is high-speed welding. Often it sets the plant production pace. Let the curve of welder efficiency drop, and end-of-line output slows to match. So designers and builders of welding equipment strive for fast-tempo performance that's dependable. They're aided by a formula that reads, "Use General Electric ignitrons for control."

Design plusses give these fine tubes leadership. Investigate the carefully annealed fernico metal-to-glass seals at all terminals — strong, tight, lasting. Study the special clamp construction at the end of the anode lead—how the copper strands, with no soldered connection, make direct electrical contact with the bus bar. Just two of many superior details in a product engineered with painstaking care!

Go on to *materials used* . . . the mercury for the cathode pool, which not only is the purest obtainable, but is further cleaned and redistilled by G. E.; the anode graphite—highest-grade that can be had; the oxygen-free copper of maximum conductivity in the anode lead.

Manufacture . . . to General Electric precision standards rigidly maintained! *Testing* . . . the most comprehensive in the field, with G-E ignitrons continually being checked at the factory under actual welder conditions at top ratings!

These are the tubes for the welding equipment on which your name will appear and your reputation must rest. Experienced G-E tube engineers gladly will assist you in ignitron choice and application. Phone your nearby G-E electronics office, or wire or write direct to *Electronics Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

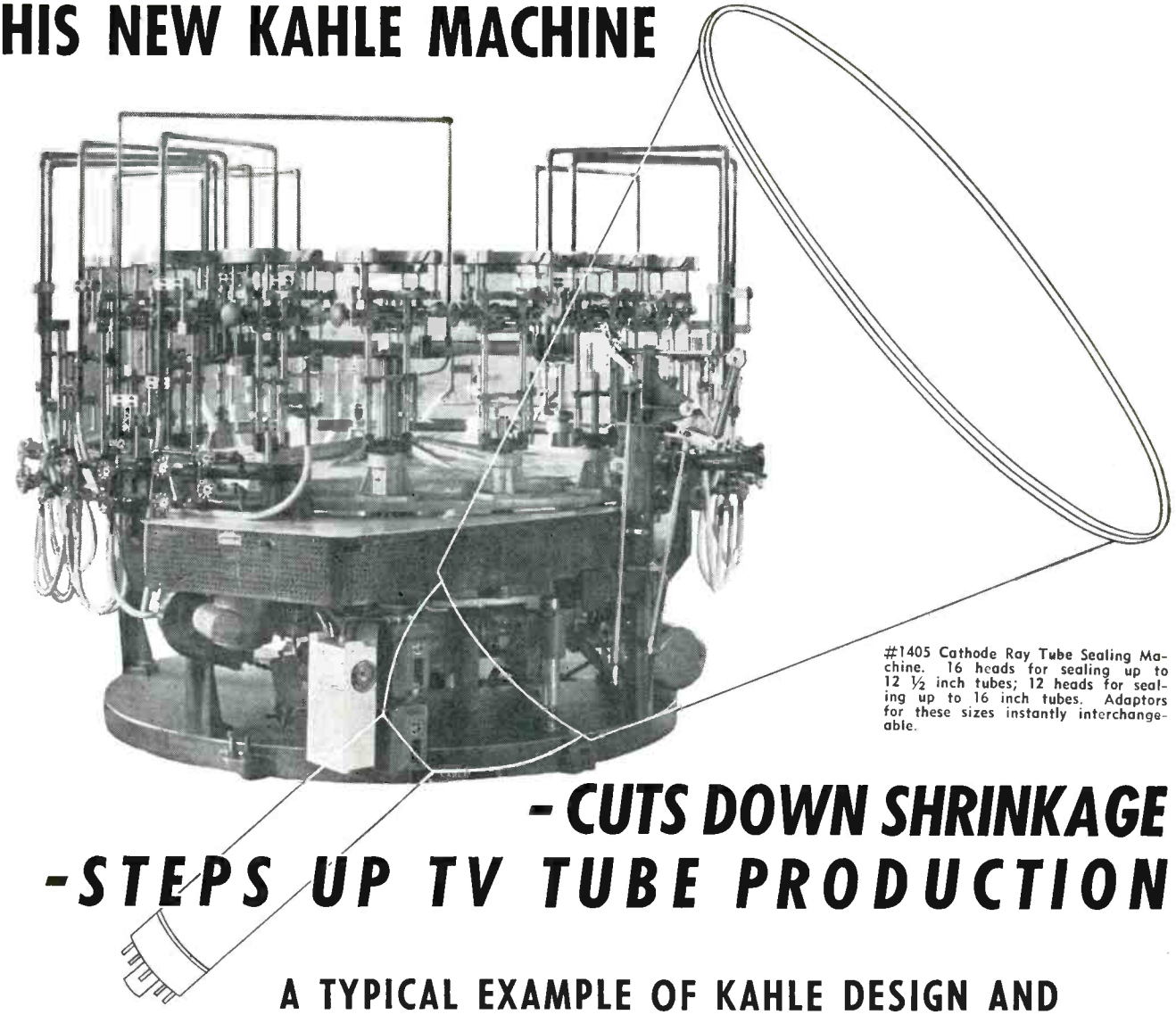
180-H27

FIRST AND GREATEST NAME IN ELECTRONICS

	Max kva demand	Corresponding avg anode current	Max avg anode current	Corresponding kva demand
GL-5550/GL-415	300	12.1 amp	22.4 amp	100
GL-5551/FG-271	600	30.2 amp	56 amp	200
GL-5552/FG-235-A	1,200	75.6 amp	140 amp	400
GL-5553/FG-258-A	2,400	192 amp	355 amp	800

Ratings are for supply voltages of 600 v rms and below. Ignitor requirements are 200 v and 30 amp.

THIS NEW KAHLE MACHINE



#1405 Cathode Ray Tube Sealing Machine. 16 heads for sealing up to 12 ½ inch tubes; 12 heads for sealing up to 16 inch tubes. Adaptors for these sizes instantly interchangeable.

-CUTS DOWN SHRINKAGE -STEPS UP TV TUBE PRODUCTION

A TYPICAL EXAMPLE OF KAHLE DESIGN AND ENGINEERING FOR THE ELECTRON TUBE INDUSTRY

Typical Kahle Customers Over the Years

General Electric Co.
Radio Corporation of America
Westinghouse Electric
Philco
Sylvania Electric
National Union
DuMont
Brown Boveri (Switzerland)
Lumalampan (Sweden)
North American Philips

Kahle Engineering Company is the specialist's specialist in electron tube machinery of all types. Our cathode ray tube machines show why. They are designed to do a specific job. From their massive, stable base up to their smooth, fast-indexing turret, they are built for the ultra-precision operations needed to produce perfect cathode ray tubes. Designed and constructed to run 24 hours a day.

We specialize in equipment and methods for manufacture of complete production units for cathode ray tubes, sub-miniature tubes, electronic tubes, fluorescent lamps, neon tubes, photo cells, x-ray tubes, glass products.

Consultations invited. Send for our new catolog.

Kahle Automatic Tube Machines have been in continuous use since 1941.

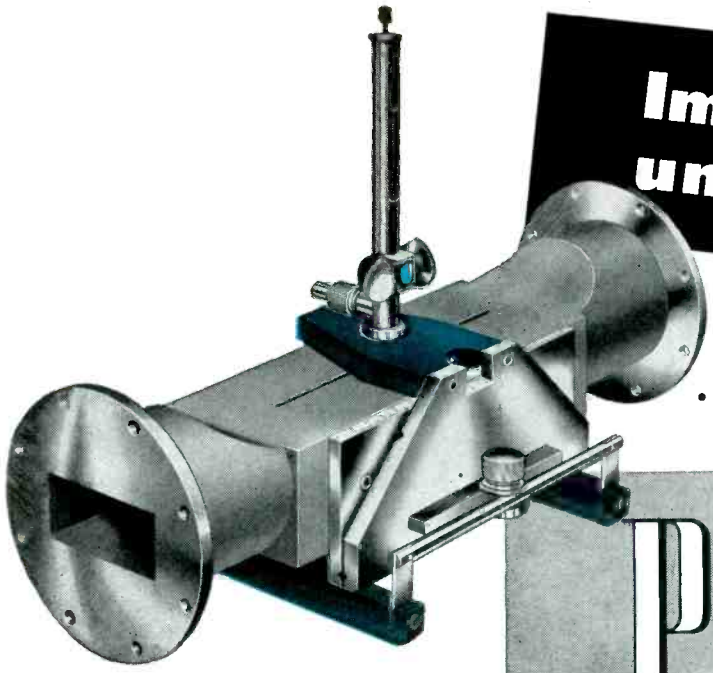
Kahle ENGINEERING COMPANY

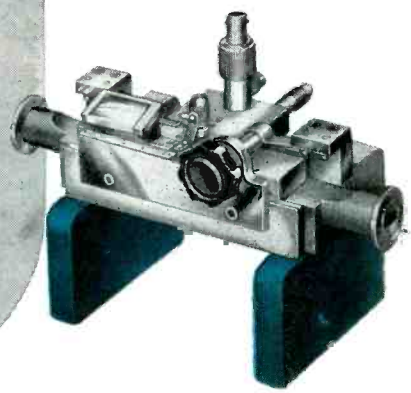
1309 Seventh Street
North Bergen, N. J.

Impedance unknown?

...AT 2,600 MEGACYCLES?

..AT 26,000 MEGACYCLES?





PRD SLOTTED SECTIONS AND PROBES

Features:

BALL BEARING CARRIAGE SUPPORT

SHOCK-PROOF FRICTION DRIVE

BROADBAND TUNING

CRYSTAL AND BOLOMETER DETECTION

SLOPE ELIMINATED BY ELECTRICAL LEVELLING

LOW REFLECTION CONNECTORS

CALIBRATED PROBE POSITION MEASURED TO OUTPUT COUPLING

Each product is designed, manufactured, and tested with the precision necessary to meet the exacting requirements of the microwave research engineer. An illustrated catalog may be obtained by writing Dept. E2 on company letterhead.

PRD Slotted Sections and Probes are now available for determining with maximum precision the phase and magnitude of impedances at microwave frequencies. These units are precision fabricated devices for use in exploring the standing wave patterns of r-f fields in microwave transmission lines.

The instruments shown are only two of an extended series of coaxial and waveguide slotted sections specifically designed for precise impedance measurement over the microwave spectrum from 1,000 to 40,000 megacycles per second. PRD offers a full complement of microwave measurement and test equipment including Attenuators, Frequency Meters and Standards, Tuners, Matched Loads, Directional Couplers, Signal Generators and Standing Wave Amplifiers.

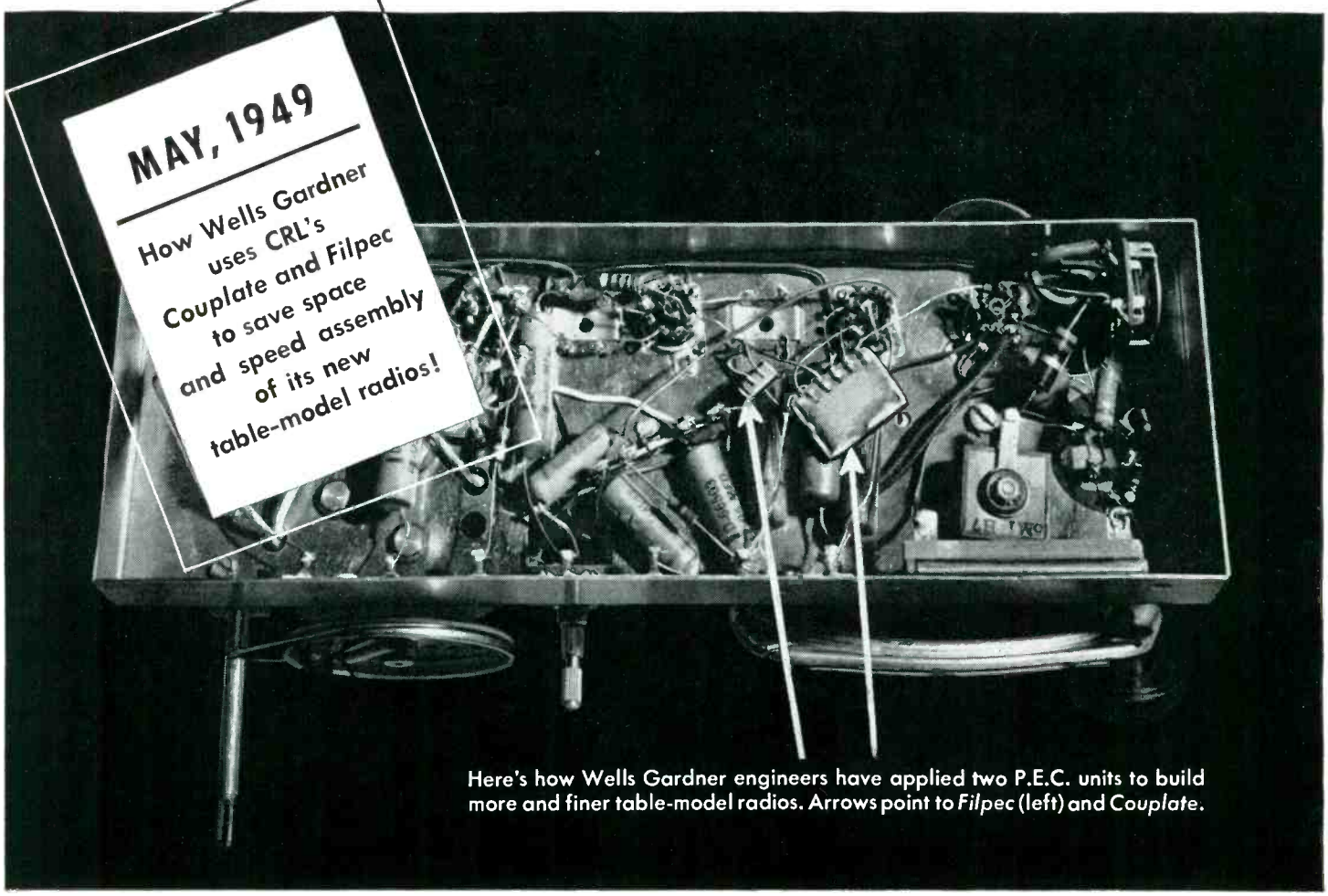
202 TILLARY STREET, BROOKLYN 1, NEW YORK

Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc.

Centralab reports to

MAY, 1949

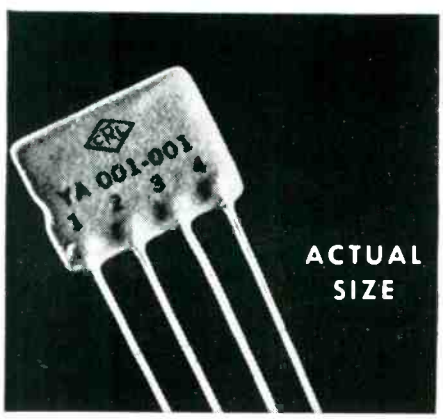
How Wells Gardner uses CRL's Couplate and Filpec to save space and speed assembly of its new table-model radios!



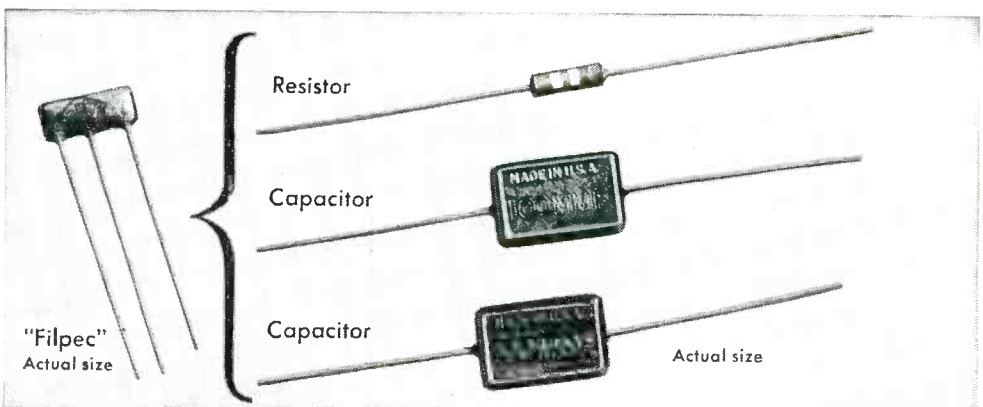
Here's how Wells Gardner engineers have applied two P.E.C. units to build more and finer table-model radios. Arrows point to *Filpec* (left) and *Couplate*.

Chassis courtesy of Wells Gardner & Co.

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

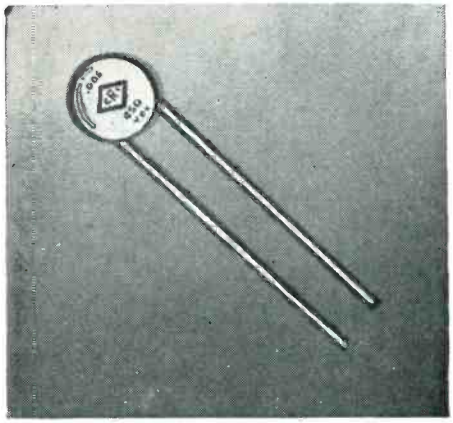


2 CRL's *Couplate* consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 42-6.

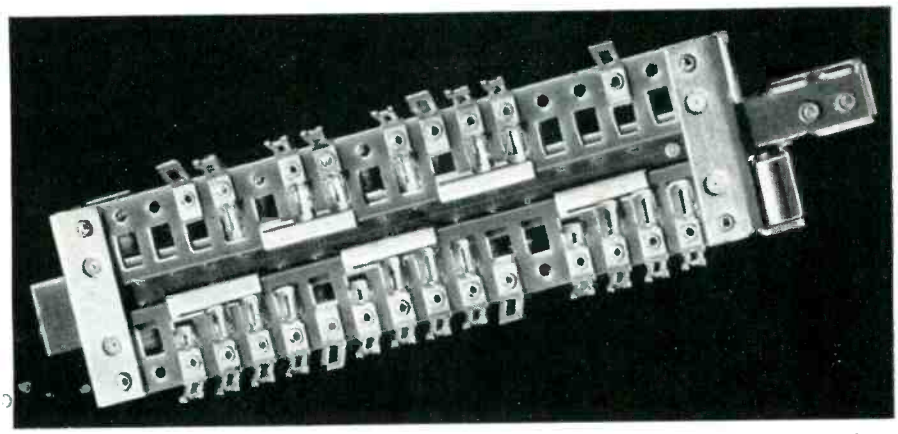


3 Centralab's *Filpec* is designed for use as a balanced diode load filter, combines up to three major components into one tiny unit, lighter and smaller than one ordinary capacitor. Capacitor values from 50 to 200 mmf. Resistor values from 5 ohms to 5 megohms. For complete information, write for Bulletin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

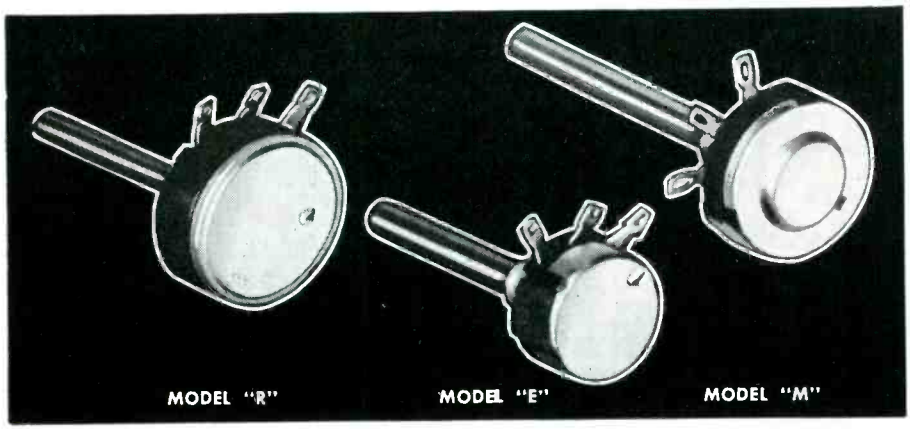
Electronic Industry



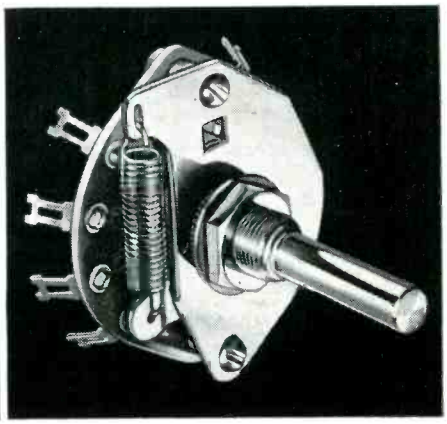
4 For by-pass or coupling applications, check CRL's original line of ceramic disc and tubular *Hi-Kaps*. For full facts, order Bulletins 42-3 and 42-4.



5 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.



6 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. Write for Bulletin 697.



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

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.

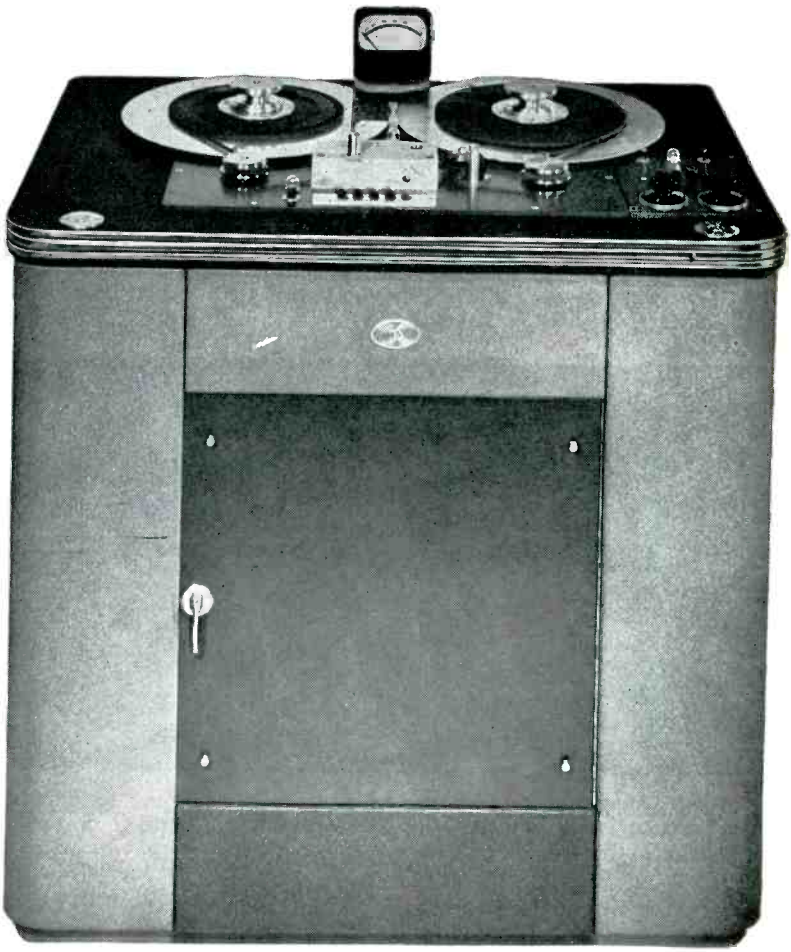
Now! A Top Quality Tape Recorder at a Reasonable Price

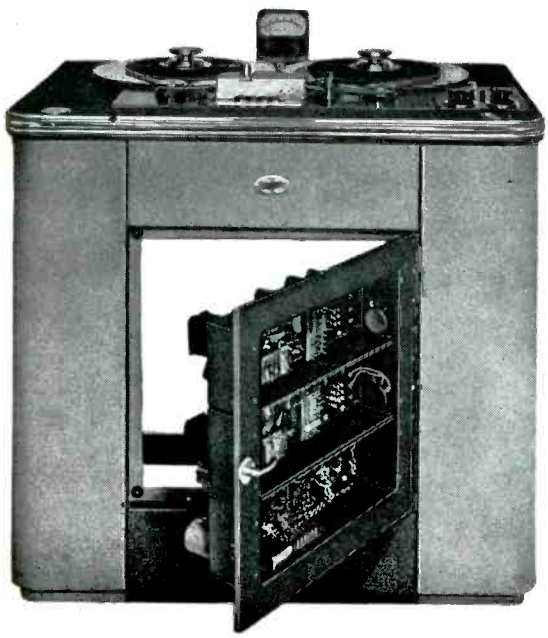
New PRESTO Magnetic Tape Recorder

AT LAST, a magnetic tape recorder that fully measures up to the most exacting requirements of broadcast network operations, independent stations and transcription producers, yet priced to have wide appeal.

Compare these specifications:

- Frequency response: 30 to 15,000 cps ± 1 db.
- Signal to noise ratio: Over 60 db below max. signal.
- Fast speed, 240 ft. per second forward and rewind, instantly reversible.
- Recording speeds 7½" or 15" per second (15" or 30" per second provided on request). Speed selection by special 2-speed motor.
- Reels direct mounted on motor shafts. Uses any type and size of reel up to 14".
- Erasing, recording and playback heads all mounted in separate housing — entire unit connected by plug-in for immediate replacement.
- Full-size illuminated scale V. U. meter on top panel.





Now! Greater Accessibility

Illustration shows how everything mechanical and electrical can be serviced from the front and top. Amplifiers and power supply are in swinging door behind removable panels. Mechanical units are mounted on top panel, hinged at rear so it can be opened upwards.

PRESTO

RECORDING CORPORATION

Paramus, New Jersey

Mailing Address:

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

NEW SPOKES FOR A BIG WHEEL . . .

C-D

first in Capacitors

NOW ADDS

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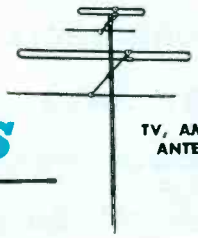
C-D Vibrators

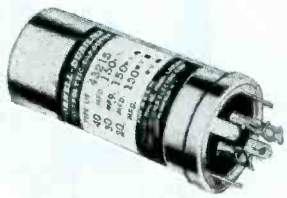
TYPE T & DYR DYKANOL PAPER CAPACITORS

"BLACK CUB" MOULDED PAPER TUBULARS



TV, AM & FM ANTENNAS

CORNELL-DUBILIER CD CAPACITORS



TYPE UP TV ELECTROLYTICS

AUTO VIBRATORS

to supply more of your component needs from one dependable source

another COG in the C-D machinery of progress!

The famous *Faradon** line of capacitors, Division of RCA, has now joined the world's largest capacitor family. C-D makes another great stride in its 40 years of increasing growth to serve industry with the finest capacitors for every radio, electronic and TV application.

New capacitor data sheets and catalog available on request. JAN catalog on paper capacitors also available.

Cornell-Dubilier Electric Corporation, Dept. K6-9, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester, and Brookline, Mass.; Indianapolis, Ind.; Providence, R. I. and subsidiary, The Radiart Corporation, Cleveland, Ohio.

CORNELL-DUBILIER

world's leading manufacturer of

CAPACITORS

AUTO VIBRATORS • TV and FM ANTENNAS

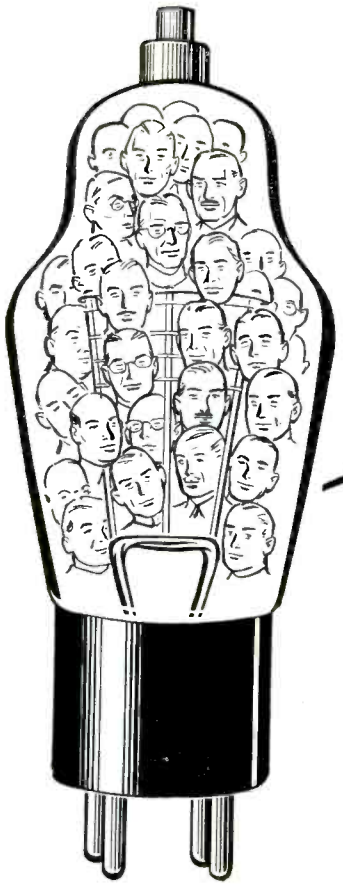
POWER CONVERTERS

1910 CORNELL-DUBILIER CD CAPACITORS 1949

Reg. U.S. Pat. Off.

now — larger than ever

The tube you call "electron" is filled with engineers!



These engineers are of many lores . . . **electrical · aero · process · maintenance · industrial control · design · research**

(to mention just a few)

Tune your sales message to the wave-lengths they use!

AS TO the favorite radio programs of readers of ELECTRONICS, your guess is as good as ours.

But this we do know! These technical "brains" read ELECTRONICS for *information*. This inspired industry is changing month by month. The "standard reference" wherein these changes are first recorded is ELECTRONICS. First in the field, its leadership has never been seriously challenged.

It will pay you to make your ads as meaty and informative as are the editorial pages. Forget the conventional advertising devices. Facts come first. Get from your engineering department the technical story about your product or service. Pack your message with data. Use engineer language as much as possible. Keep it up — you'll find that such advertising gets results!

electronics

DESIGN . . . PRODUCTION . . . USE

ABC *Established 1930* ABP

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RADIO AND TELEVISION MANUFACTURERS MAY BE RISKING THEIR REPUTATION IF THEY DO NOT KNOW THESE

Soldering Questions & Answers

WHAT IS ERSIN FLUX?

Ersin Flux, found only in Ersin Multicore Solder, is a high-grade resin which has been subjected to a chemical process to increase its fluxing action. This, however, does not in any way impair the non-corrosive properties of the original resin. Ersin is the *only* activated flux whose non-corrosive properties have been *proved in use* over a period of more than ten years by important and responsible manufacturers in America and Great Britain.

WHY IS A THREE CORED SOLDER DESIRABLE?

Because only with a fastidiously-produced three cored solder can you be sure of rapid melting and flux continuity, whereas, single cored solder will frequently have lengths without any flux at all. Ersin Multicore Solder contains three carefully-placed cores of non-corrosive Ersin flux which gives faster, precision soldering, without waste.

DOES IT COST MORE TO USE ERSIN MULTICORE SOLDER?

No, it actually costs less. While it is true that Ersin Multicore costs a fraction more to buy, pound for pound, it is so economical in use and goes so much further, that in the long run it is most economical. Further, Ersin's speed enables us to incorporate less flux in three cores than is commonly found in single-cored solder, so that, for any given weight, you actually get more solder when you buy Multicore.

WHY ARE 'DRY' JOINTS IMPORTANT?

" Dry " or " high resistance " joints are connections where insufficient flux, or no flux at all, was present during the soldering. This makes them inefficient as electrical connections. This situation is likely to cause more rejects on the inspection line than any other single factor. Further, if the flux did not fulfil its function, the residue would be liable to corrosion. Ersin Multicore Solder gives complete freedom from dry joints, hence cannot cause corrosion.

WHAT ABOUT FEDERAL SPECIFICATIONS AND AVAILABILITY OF SUPPLY?

Ersin Multicore conforms, of course, to all United States Government requirements for solder, including Federal Specifications QQ-S-571-b. Stocks are maintained in New York Warehouse for quick delivery.

As a manufacturer with a reputation to maintain, you can't afford to be less than 100% sure about the quality of the solder in the radio and television equipment you produce. Only Ersin Multicore Solder can give you assurance of high speed precision soldering, without waste. The reason is its carefully prepared three cored construction plus the Ersin flux which not only prevents oxidation during soldering but actually cleans any oxides from the surface. Ersin Multicore Solder was the first solder in the world to be made with three cores and is the only solder in the world which contains Ersin flux. It has become the standard by which all other solders are judged.

ERSIN

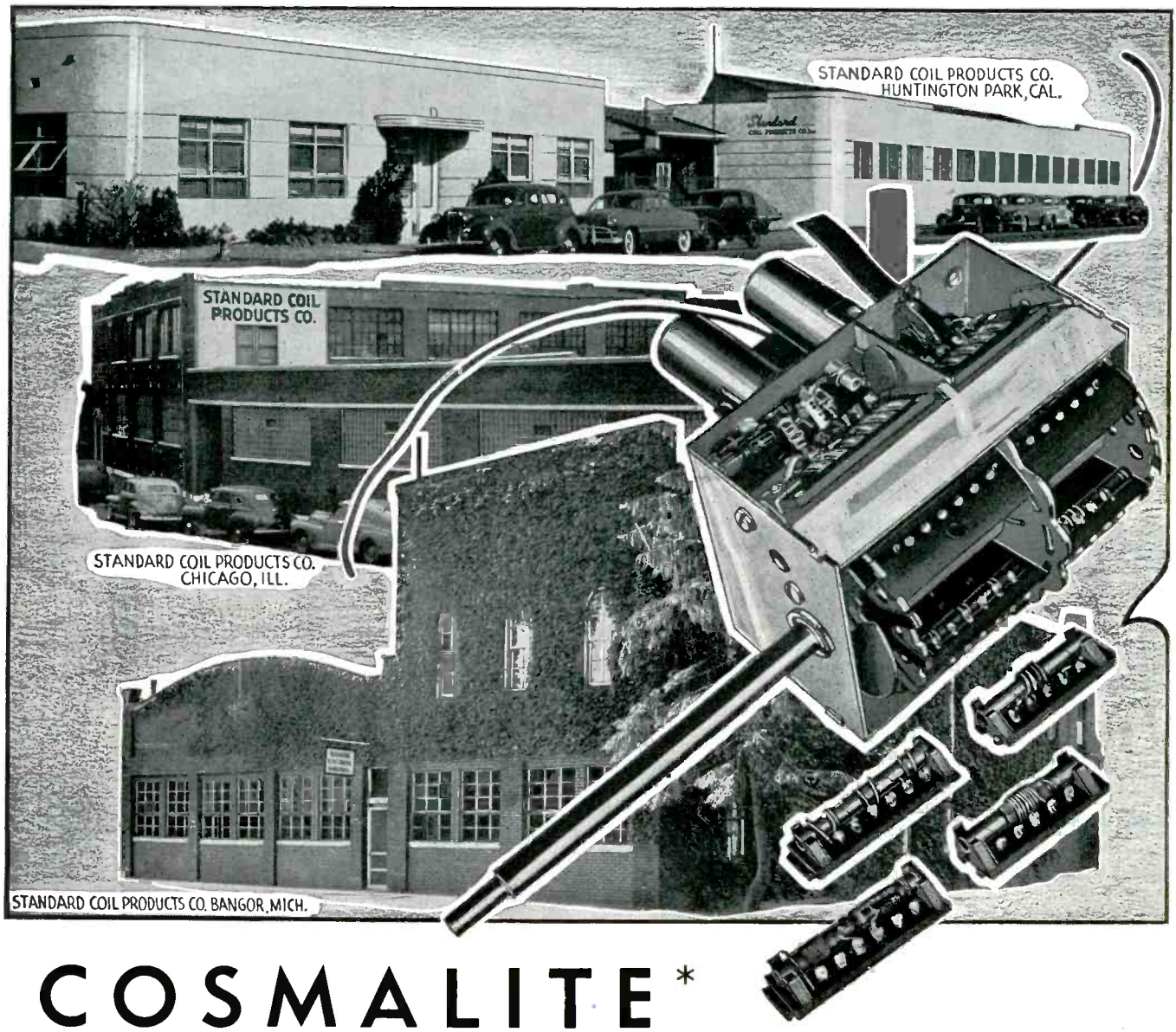
Multicore

THREE CORE SOLDER WIRE

MADE WITH NON-CORROSIVE EXTRA-ACTIVE ERSIN FLUX

Address U.S.A. and Canadian inquiries to: **BRITISH INDUSTRIES CORP.**
315, Broadway, New York 7, N.Y.

Inquiries regarding other territories to: **MULTICORE SOLDERS LTD.**
Mellier House, Albemarle Street, London, W.1, England



COSMALITE*

in STANDARD COIL PRODUCTS CO. TUNERS

Of course COSMALITE is used by the STANDARD COIL PRODUCTS CO., INC. in their Television and Auto Set Tuning Assemblies. It is the first choice of those who insist on precision and quality products at prices that are right!

The advantages of COSMALITE SHELLS for TELEVISION DEFLECTION YOKES are many. Of prime importance is the fact that we have available, without charge, the tools for punching and notching many types of Cosmalite shells and coil forms. This means attractive prices with quicker deliveries.

Consult us on your needs!

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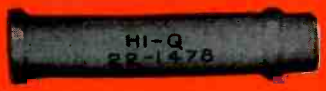
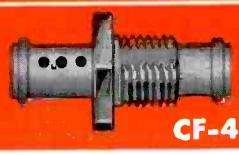
* Reg. U. S. Pat. Off.

Hi-Q

TUBULAR CERAMIC CAPACITORS

 CN-1 .200x .375	 SI-1 .234x .437	 CI-1 .250x .562
 CN-13 .200x .437	 SI-13 .234x .468	 CI-2 .250x .812
 CN-2 .200x .625	 SI-2 .234x .687	 CI-3 .340x 1.320
 CN-27 .230x .460	 SI-27 .275x .500	 CS-1
 CN-7 .230x .812	 SI-7 .275x .875	 CS-2
 CN-19 .253x .850	 SI-19 .312x .937	 CS-3
 CN-3 .253x 1.078	 SI-3 .312x 1.125	 CS-4
 CN-4 .340x 1.062	 SI-4 .375x 1.093	 CF-1
 CN-5 .340x1.500	 SI-5 .375x 1.600	 CF-2
 CN-6 .340x 1.875	 SI-6 .375x 1.968	 CF-3
		 CF-4

ALL DIMENSIONS ARE MAXIMUM

ELECTRICAL REACTANCE CORPORATION

GENERAL OFFICES:
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● IN ALL PRINCIPAL CITIES

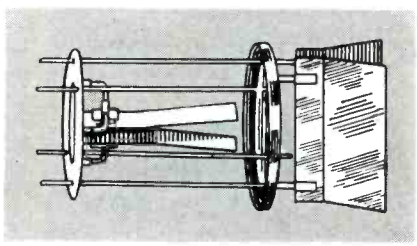
For wide-band oscillographs requiring extremely high writing rates and high vertical-deflection sensitivity. Electrostatic deflection and focus.

Another Du Mont "First"—the new Du Mont Type 5XP-! A multiple-intensifier design, it features deflection sensitivity never before achieved by a cathode-ray tube in either the low- or high-voltage category. Specifically:

At E_{b2} of 2000 volts and E_{b3} of 4000 volts, only 24 to 36 d-c volts/in. of deflection are required! This is approximately *three* times the sensitivity of a low-voltage tube such as Type 5LP-A. This superlative performance of the vertical plate system is due to the design of the plates and to a slight increase in overall tube length—only ⅞" longer than Type 5LP-A.

Also featured are the high ratios of E_{b3} to E_{b2} voltages—up to 10:1, and high overall accelerating potential—up to 25,500 d-c volts.

Because the usable vertical deflection is a function of the ratio E_{b3}/E_{b2}, the full-screen deflection available at ratio 1:1 is reduced to 2.5" at 2:1, 1.75" at 5:1, and 1.25" at 10:1 ratios, respectively.



Capacitance from D_3 to D_4 held to 1.7 μμf by virtue of this new deflection-plate design, despite longer length and closer spacing required for high sensitivity.

Another feature is the shielding between deflection plates D_1-D_2 and D_3-D_4 to prevent interaction between plate pairs. And for general shielding of the tube, Du Mont mu-metal shield Type 2502 is available.

A choice of phosphors is available, such as the P1, P2, P4, P5, P7 and P11 screens. The flat face makes for ease of visual measurement and photography.

As with all Du Mont tubes, Type 5XP- is available as a separate unit or in combination with a Du Mont oscillograph. Several Du Mont oscillographs already in use, notably Types 280, 256-D, 250-H and 248-A, are readily adaptable to this latest tube.

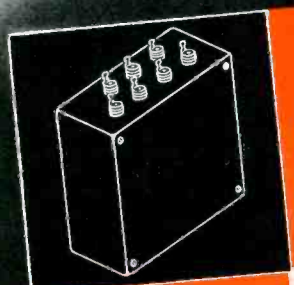
Write for detailed literature on the Type 5XP- tube and how it can be used in your Du Mont oscillograph.

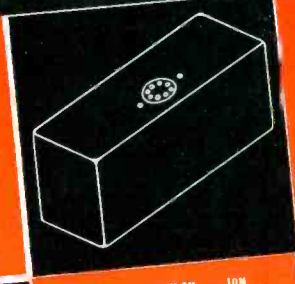
DUMONT *for Oscillography*

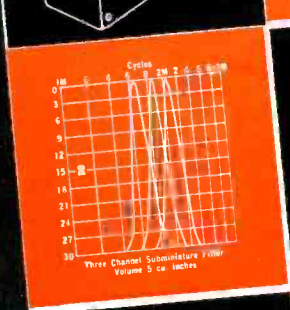
ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

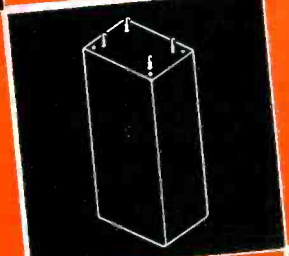
Check YOUR NETWORK PROBLEM WITH LOGIC

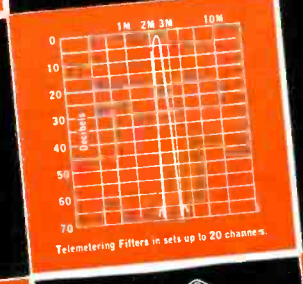
In any technical business the specialist has a unique value in his specific field. It is logical that a manufacturer of a specialty product should be of greater value in his particular field.

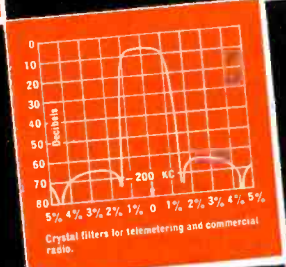


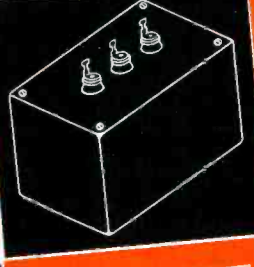


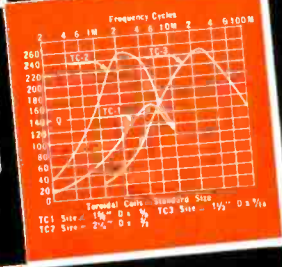


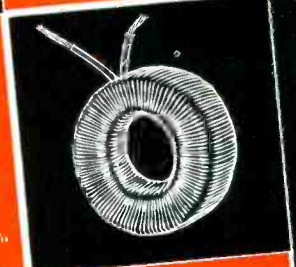


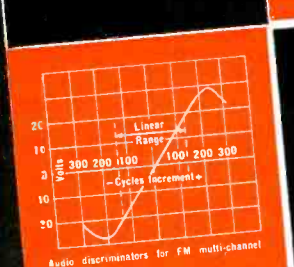


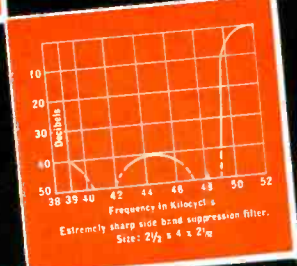


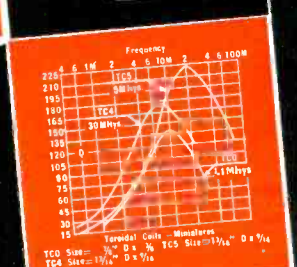


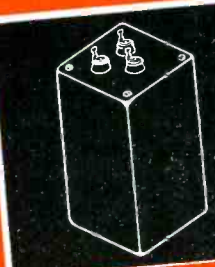


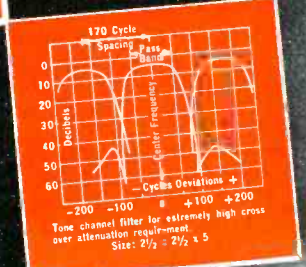












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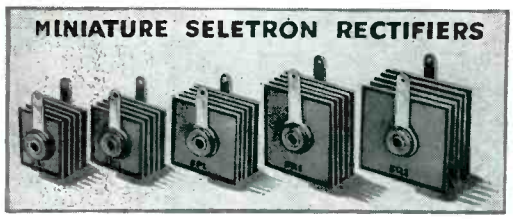

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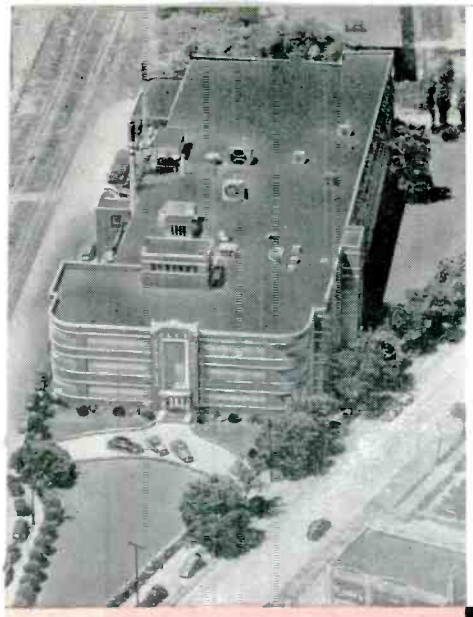

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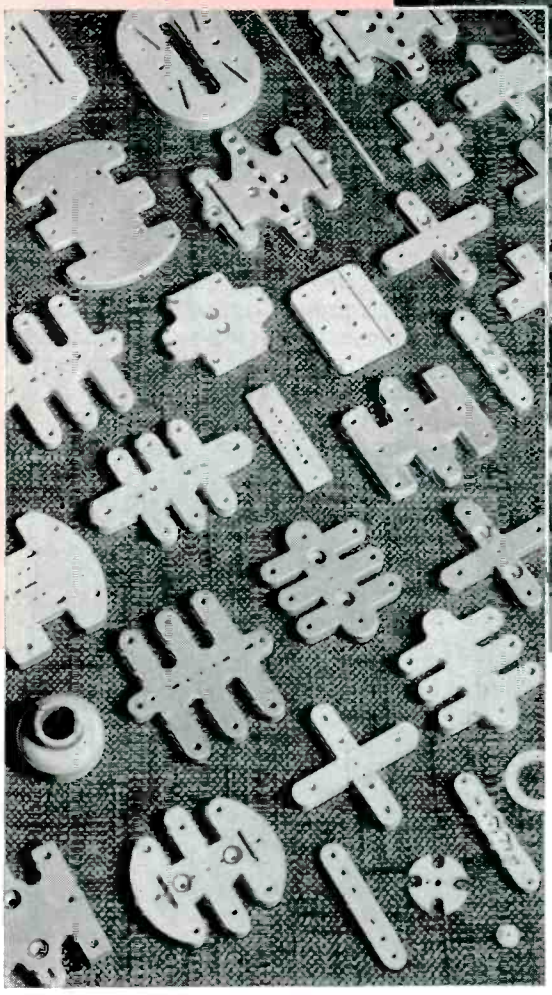

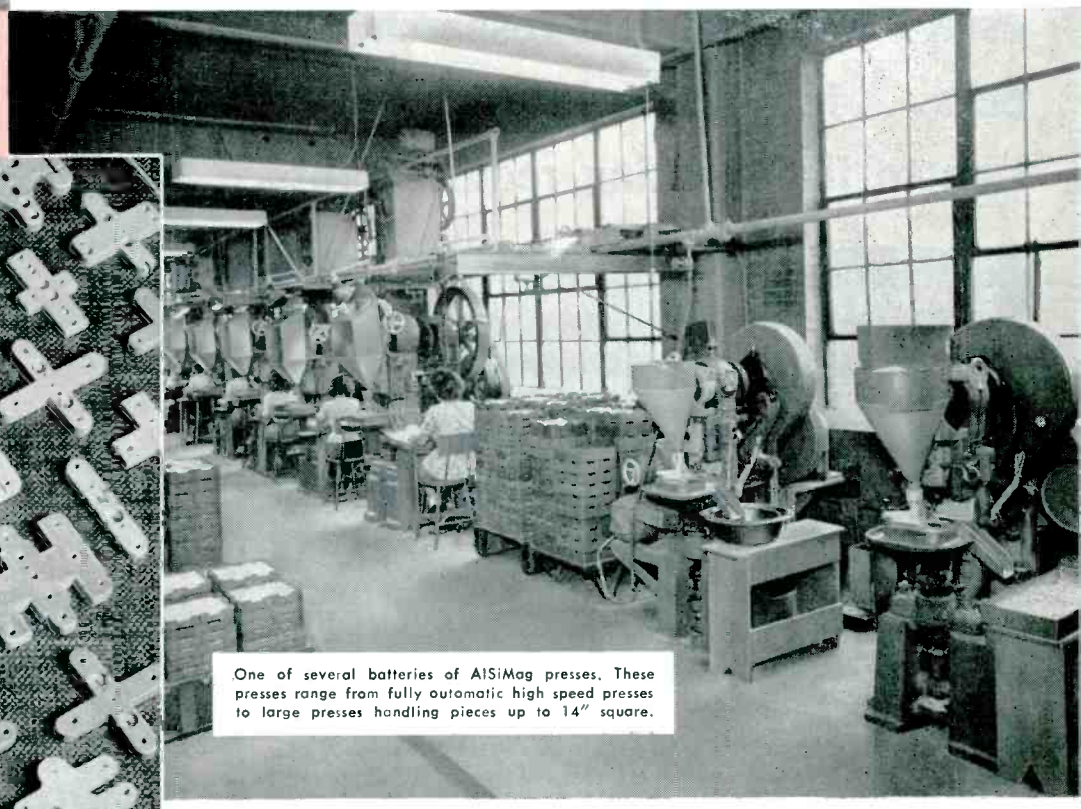

One of several batteries of AlSiMag presses. These presses range from fully automatic high speed presses to large presses handling pieces up to 14″ square.

For better, speedier service, AlSiMag makes its dies in its own modern die shop. This die shop serves only our customers, operates on a non-profit basis. Superior die pressing equipment and technique is another reason why American Lava Corporation is known as Headquarters for Custom Made Technical Ceramics.

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MYCALEX 410 MAKES HISTORY

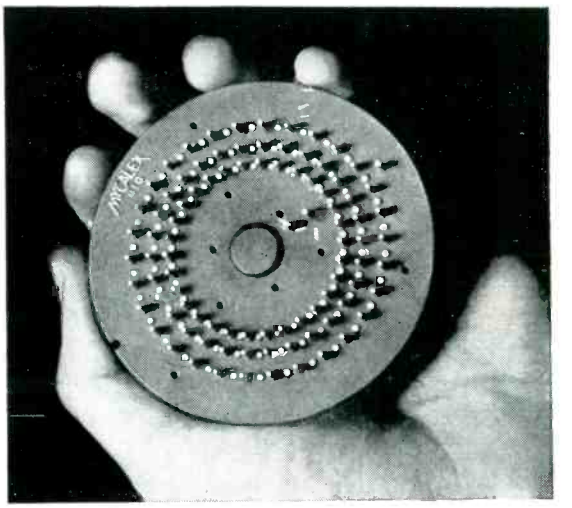
Sets astonishing high operational record for telemetering commutator used on aeronautical research projects . . . MYCALEX 410 only insulation to fill exacting requirements.

To March 18, 1949, more than 282 hours of maintenance free, high speed, clean signal telemetering commutator performance has been logged on MYCALEX 410 Units. . . . Experience indicated four hours was optimistic . . . specifications hoped for ten hours . . . and the challenging problem was solved by MYCALEX 410 molded insulation.

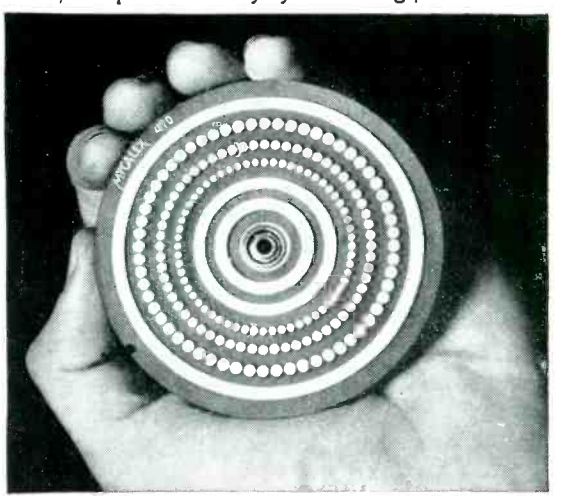
SPECIFICATIONS TO BE MET IN PRODUCING MYCALEX 410 MOLDED INSULATION COMMUTATORS FOR TELEMETERING

O.D. 2.996" + .000 — .002 • Location of 3 slip rings and the 3 contact arrays from the center has a total tolerance of ± .001. • Contact spacing 6° apart ± 1 minute. • Parting line thicknesses on insulation body are + .002 —.000. • Concentricity between ball bearing bushing and O.D. .0015. • Assembly height from face of slip rings and contacts to Mycalex 410 has tolerance of + .002 —.000. • Every contact must be tested from its neighbor contact for infinity on a 500 volt megger meter • Plate ambient —20° C. to + 100° C. • Plate to operate at 95% humidity must not warp, crack, change in dielectric constant or resistivity • Contacts to resist high temperatures and must not loosen when repeatedly heated by soldering.

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



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.



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.

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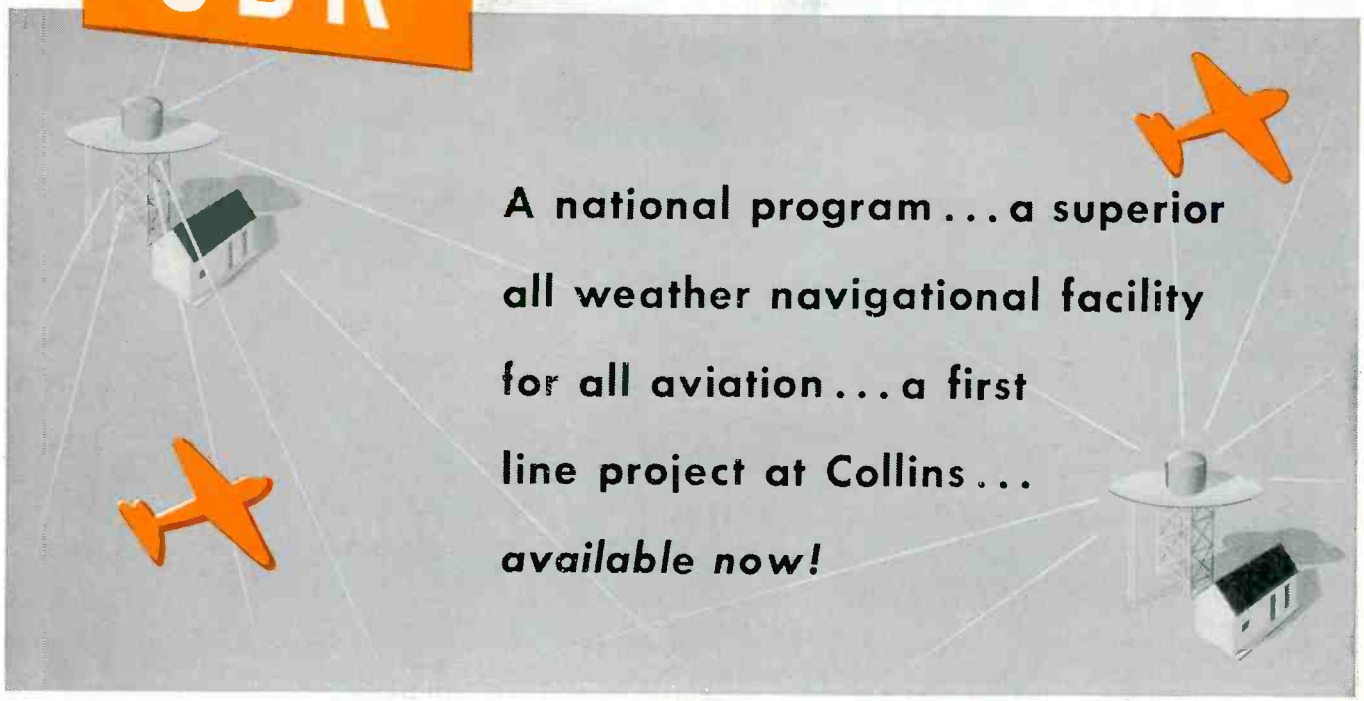
ODR* OMNIDIRECTIONAL RANGE



Rapid progress toward successful completion of the ODR system of radio navigation in the United States is a prime example of Government-Industry cooperation:

The CAA designed and installed the national network of ODR stations—300 operating now—200 more going in fast. Aeronautical Radio Inc., airline subsidiary, wrote the aircraft equipment specifications. Collins, leading its field, designed and built the equipment.

A thousand Collins sets have been ordered by foremost airlines, government agencies and individuals . . . one half of these have been delivered . . . current deliveries, 30 per week. The complete job was done —receivers, power units, instruments, test equipment, antennas, accessories for all types of installations. They are on the production line, ready, tested, CAA type certificated.

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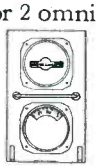
Collins 51R VHF (108—136 mc) 280 channel navigation receiver.  Control box.  Omni-bearing selector.  Deviation indicator.  Radio magnetic indicator.  Omni-bearing indicator and power unit mounted on accessory unit.

This accessory unit will provide mounting for 2 omni-bearing indicators, 3 servo amplifiers for RMI, and power units for two 51R receivers.  VHF navigation antenna. 

*Now officially referred to by the CAA as VOR (Visual Omni-Range).

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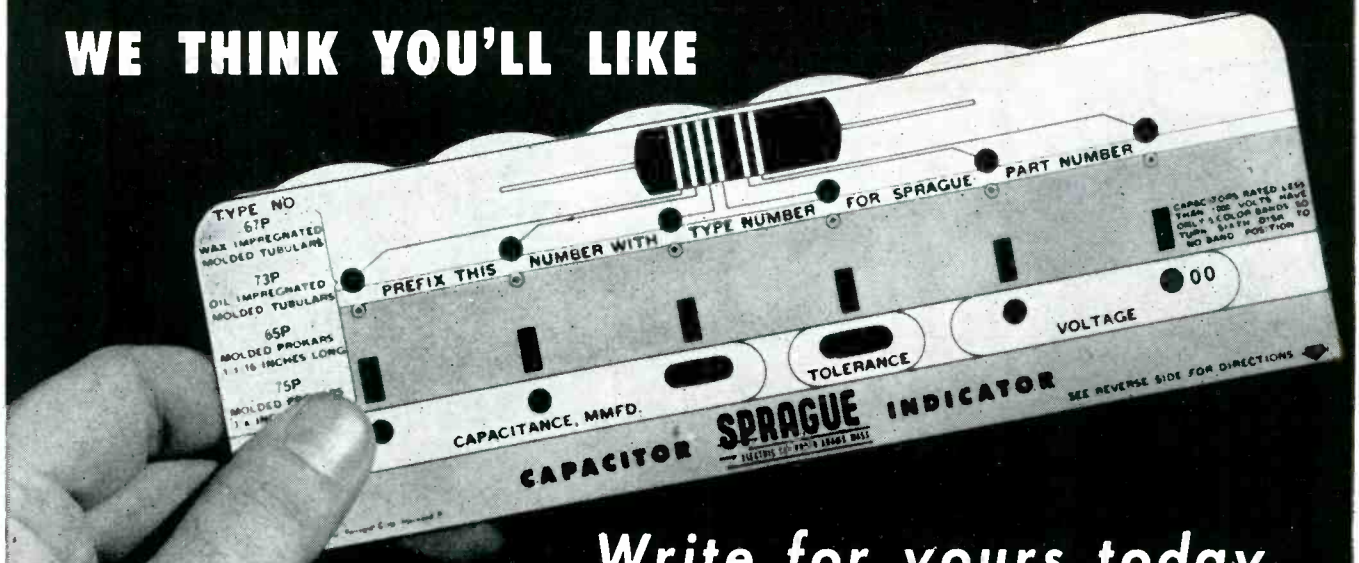

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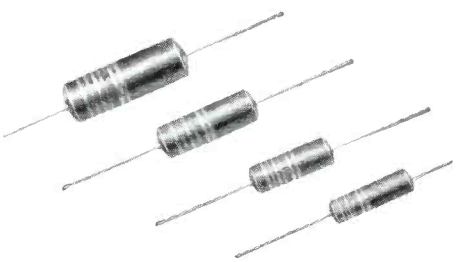
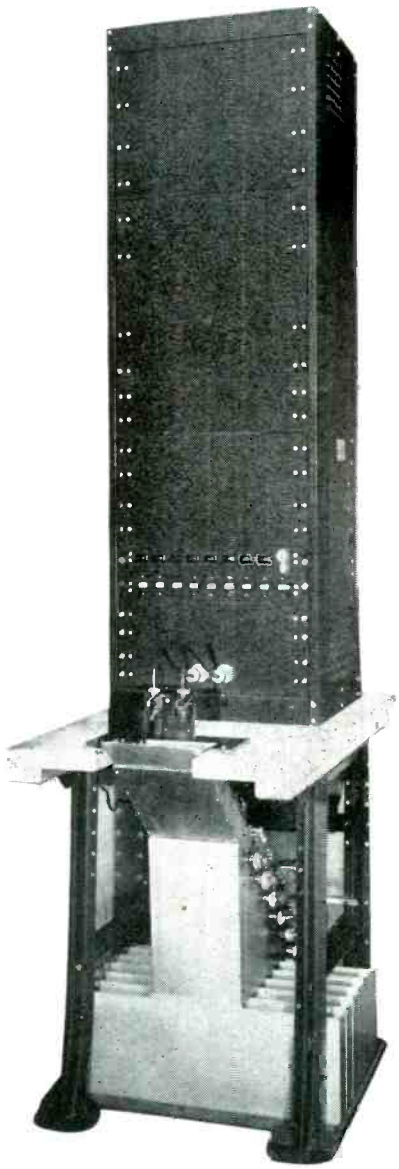


SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASSACHUSETTS

FOR PRODUCTION TESTING AND SORTING OF COMPONENTS . . .

THE AUTO-BRIDGE



The Auto-Bridge is an automatic impedance bridge operating at high speed for testing resistors, capacitors, inductors, or impedances and sorting units into as many as 8 groups according to values predetermined by plug-in standards. Units ranging from 10 ohms to 5 megohms may be checked and sorted at the rate of 2400 per hour into 8 groups, or 3600 per hour into 4 groups. Accuracy of measurement within plus or minus 0.3% can be obtained at 1000 cycles on resistors within the range from 10 ohms to 1 megohm.

- The Auto-Bridge eliminates the human factor and therefore the greatest single source of error in repetitive testing routine.
- It provides extreme flexibility of operation in going from one test run to another. Only 2 minutes required to change a setup by means of plug-in standards.
- Test pieces are fully at rest while being measured, for maximum accuracy.
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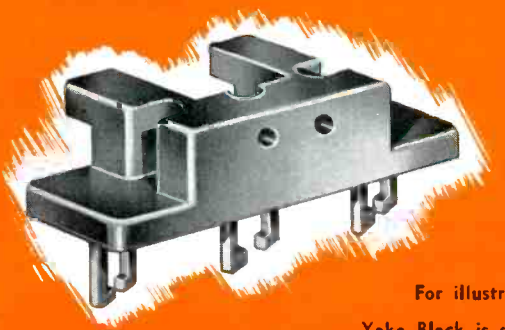

For illustration purposes
Yoke Block is shown inverted

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NEW SMALL

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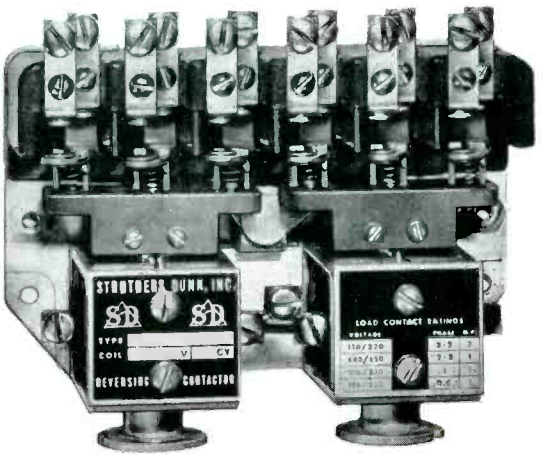
S-D



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The Election of November 2, 1948 GAVE NO MANDATE FOR SOCIALISM

The President and those who support his legislative program have objected to the substance of my previous editorial, which appeared under this headline: "Now is the Time to FIGHT SOCIALISM in Washington."

In that editorial I explained how Washington is poised to follow the disastrous policy of forcing industry to skimp on new plants and new equipment. That policy landed Britain in the numbing embrace of the Socialists. I cited the experience of Britain to show how such skimping on industrial tools can bring a nation to economic stagnation . . . and Socialism.

The President, in his recent Jackson Day speech, brushed aside this warning . . . "They are again trying to frighten the people with the old worn-out bugaboo that Socialism is taking over in Washington." Senator Francis J. Myers of Pennsylvania asserted that I was guilty of "warfare against any reasonable effort to keep our system of free enterprise working."

These criticisms may be sincere. But they are not well-founded.

I want to show why they are not well-founded by basing this editorial on Washington rather than Britain.

In Washington the Administration has proposed a legislative program, the key parts of which would clearly put the country far on the road to Socialism. Let us see how.

There are two steps in the process:

FIRST: The government by its taxation program undermines private industry so that it cannot provide itself with the necessary new plant and tools.

SECOND: The government itself steps in to provide the plants and equipment that it has blocked industry from getting. *That is Socialism.*

Here is how Washington is promoting Socialization of the steel industry—and of other industries.

Steel has been expanding its capacity and improving its equipment chiefly by plowing back its profits. During the last three years it has spent $1.4 billion for new plants and new tools. That was more than the companies had available from their own earnings. But profits provided more

continued on next page

than half of that money—more than $700 million. The remainder came from loans and from depreciation reserves set aside out of the earnings to replace worn-out equipment.

Profits must continue to provide the funds needed to pay for the bulk of the steel industry's necessary expansion. That is because private citizens, their income slashed by heavy taxes, have not been willing to buy steel stocks even at prices ruinously low for the companies and their present stockholders. The stock market currently prices the mills and other facilities of the nation's principal steel-producing companies at far less than fifty percent of the cost of reproducing them.

Let us take another example. Profits are essential to expansion in the electric light and power industry also. This year private companies are planning to buy $2 billion worth of new plant and equipment. To do that without going overboard in debt, they must sell to the public some $300 million worth of common stock. A squeeze on their profits would make that sale virtually impossible.

For tens of thousands of small business enterprises profits afford virtually the only practical source of funds for new equipment and expansion.

In the face of these and many other examples that might be cited, what is the most effective way to prevent industry from re-equipping itself and expanding is capacity to meet our essential needs?

Obviously, it is to cut down profits. And that is what the Administration is trying to do. The President has declared that steel prices are too high, and is demanding that Congress raise taxes sharply on all corporations.

There you have the first step toward socializing industry.

Next comes step two. Have the government supply the tools and equipment which, by taxation, it prevents industry from getting.

The Administration has proposed legislation to carry out this second step. It is called the "Economic Stability Act of 1949," for short, the "Spence Bill."

This bill gives the President the power to provide industrial facilities—in steel, power or any other industry—where he finds that a shortage is hampering or is likely to hamper the economy.

True, the bill says that the government is not to construct new plants if private companies will do it through government loans, on terms prescribed by the President. That may be just one step short of complete socialization. But it is only a short step. And the Spence Bill authorizes the government to take that step.

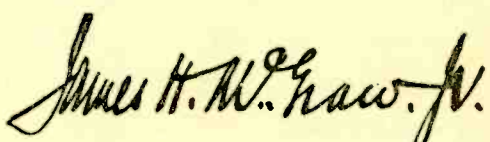
By itself, the Administration's "Stability Act" sounds harmless enough. It would have the government build plants only as a last resort. But it provides also that if private enterprise cannot turn out all the goods the country needs, the government can and should step in and provide the equipment to do it.

Now, take that power together with an Administration tax program that undercuts the ability of private enterprise to supply the new plants and equipment it needs out of its own earnings. That combination promotes government ownership and operation of industry.

And that is Socialism.

The American people, of course, have the right to live under any system they choose—Capitalism, Socialism, Fascism, Communism, or what-have-you. But before Socialism or any other "ism" is imposed upon us from above, the people should know the facts. If this editorial shall have contributed in some small degree to that end it will have served its purpose.

The election of November 2, 1948 gave no mandate for Socialism.



President, McGraw-Hill Publishing Company, Inc.

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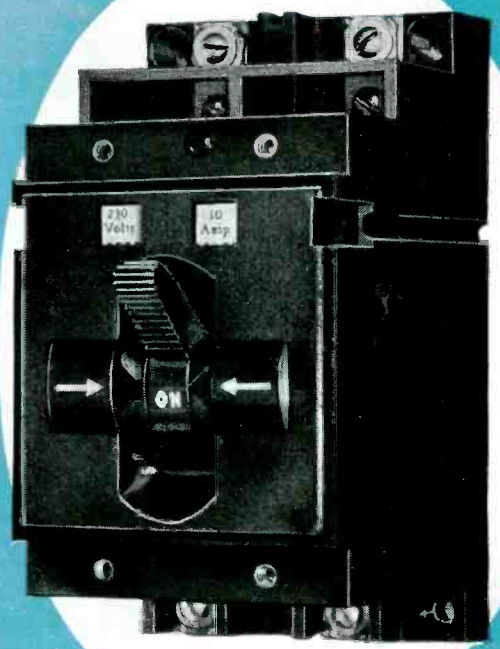
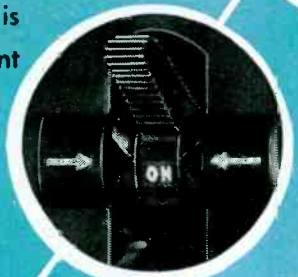
That's why

HEINEMANN MAGNETIC CIRCUIT BREAKERS

are used in the rectifier shown below



Many of these Cathodic Protection Rectifiers are installed by Good-All Electric Mfg. Co. in mountain country, swamps, and desert country—often inaccessible for months. Thus, it is absolutely essential that all component parts function with 100% reliability in all temperatures.



The HEINEMANN CIRCUIT BREAKER shown above gives absolutely dependable, yet flexible circuit protection. Although the breaker trips INSTANTLY on short circuit or dangerous overload, a magnetic-hydraulic time delay retards the trip unit in case of minor, temporary overload. Rotation of the high speed latch releases contacts which are under heavy spring pressure, while the high speed blow-out, through magnetic action, gives instant arc interruption.

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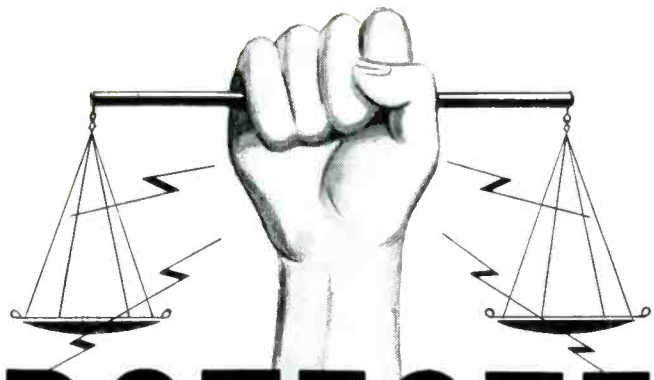

WITH FULLY PROTECTED

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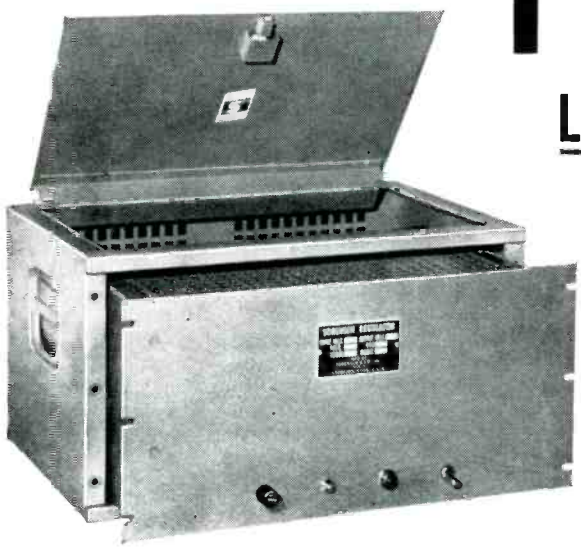

Sorensen Electronic Voltage Regulators *alone* give you all these extra safety features:—

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- Additional protection against overvoltage by use of a Heinemann Circuit Breaker.
- Protection against overload through a Klixon Overload Protector.

The Sorensen Voltage Regulator is simple and compact, easy to install. It has *only four tubes* — all standard except the special Sorensen Diode*. It is designed to fit in a small space — ideal for either relay rack mounting or cabinet mounting.

Don't take chances! There is *one* sure, safe protection for delicate instruments and complex equipment — *Sorensen Voltage Regulators.*

SPECIFICATIONS
for the 1000S Model

Input Voltage Range	95—125 V.
Output Voltage Range	adjustable between 110—120 V.
Output Load Range	0—1 KVA
Regulation Accuracy	± 0.1% against line ± 0.2% against load
Harmonic Distortion	less than 2%
Power Factor Range	down to 0.7 P. F.
Recovery Time	3 to 6 cycles
Line Frequency Range	50 to 60 cycles

Other Models from 150 VA to 15 KVA single phase and 45 KVA three phase.

NOBATRON and B-NOBATRON

Send for information on these highly stabilized D. C. Regulators.

Literature Available! Send for your Saturable Core Reactor Data Booklet — It's FREE

*The SORENSEN SAFETY DIODE

Why does Sorensen make its own Diode?

1. to preserve rigid quality control
2. to permit interchangeability of diodes
3. to insure proper ageing of the tube, a process which improves stability and permits Sorensen to unconditionally guarantee its diode tubes for 2500 hours.
4. to give you a diode with an octal base, eliminating pin-resistance difficulties.

Sorensen and Company, Inc.
375 Fairfield Ave., Stamford, Connecticut

ERIE TRIMMERS

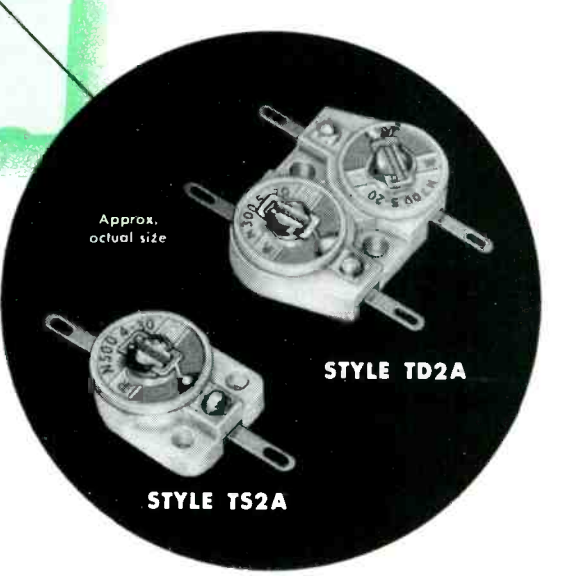
easy assembly
dependable performance
reasonable cost

These Erie Resistor Trimmers are compactly designed for easy installation on the assembly line and give the design engineer wide latitude in chassis layout. They have a rugged stability that spells long life and dependable performance.

Erie Trimmers have the quality that indicates their use on the highest priced sets, with a price tag that permits their adoption for the most competitive FM and TV numbers. Specifications are given below. Samples will be sent to interested manufacturers on request.

STYLES 531 and 532

Capacity Ranges: 0.5-5 MMF & 1-8 MMF
Working Voltage: 500 V.D.C.
Max. Temperature: 75°C
Q Factor @ 1 MC.: 1,000 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: 531 for panels .015" to .039"; 532 for .040" to .065"



STYLES TS2A and TD2A

Capacity Ranges:
Zero Temp. Coeff. 1.5-7 MMF & 3-12 MMF
N300 Temp. Coeff. 3-13 MMF & 5-20 MMF
N500 Temp. Coeff. 4-30 MMF & 7-45 MMF
Working Voltage: 500 V.D.C.
Q Factor @ 1 MC.: 500 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: TS2A, Single Condenser;
TD2A, Dual Condenser

STYLES 554 and 557

Capacity Ranges:
Zero Temp. Coeff. 1.5-7 MMF, 3-12 MMF & 5-25 MMF
N750 Temp. Coeff. 5-30 MMF & 8-50 MMF
Working Voltage: 350 V.D.C.
Q Factor @ 1 MC.: 500 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: 554 Mounted with Spring-Clip; 557 for Sub-panel or Bracket Mounting

ER Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

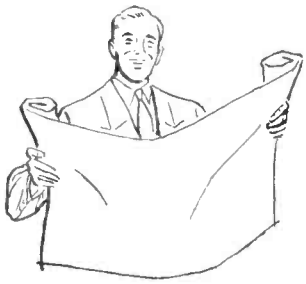
LONDON, ENGLAND • • TORONTO, CANADA

Now you can work with

REMALLOY

Permanent Magnet Material

(Manufactured under license from Western Electric Company)



It's fully available for the first time

How you can get it!

ARNOLD can supply REMALLOY in the form of BARS and CASTINGS or SINTERED TO SPECIAL SHAPES

How you can use it!

REMALLOY generally may be used instead of 36-41% Cobalt Permanent Magnet Steel—replacing it without design changes, and at a cost saving.

The first issue of the "Magneteer" contains complete technical information on Remalloy—*write for your copy.*

In addition to our customary production of all types of ALNICO and other permanent magnet materials, we now produce REMALLOY. The various forms in which it is available—bars, castings or sintered shapes—are all produced under the Arnold methods of 100% quality-control; and can be supplied to you either in rough or semi-finished condition, or as completely finished units ready for assembly. ● Let us help you secure the cost-saving advantages of REMALLOY in your designs. Call or write for further data, or for engineering assistance.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

ARNOLD

SPECIALISTS AND LEADERS IN THE DESIGN, ENGINEERING AND MANUFACTURE OF

PERMANENT MAGNETS

If you knew **Moly'**... as we know **Moly'**!

WHETHER you need Molybdenum for conventional use or for an unusual application, we can supply you with Elmet Molybdenum in sheet, rod or wire form.

F'rinstance: A manufacturer recently required some Molybdenum rod that could be machined and formed into unusual shapes. We introduced him to ELMET MOLY' — and solved his problem. It conformed perfectly to the unusual requirements of the job and was delivered to his complete satisfaction.

For Molybdenum for any application, you can rely on ELMET MOLY'. We've supplied it in sheet, rod or wire form for such varied uses as electronic tubes, windings for high temperature furnaces, precision laboratory apparatus, metal vaporization equipment and firing boats.

★ ★ ★

North American Philips also supplies Tungsten and other metals in fine wire form . . . bare, coated or plated with silver, gold, copper or enamel.

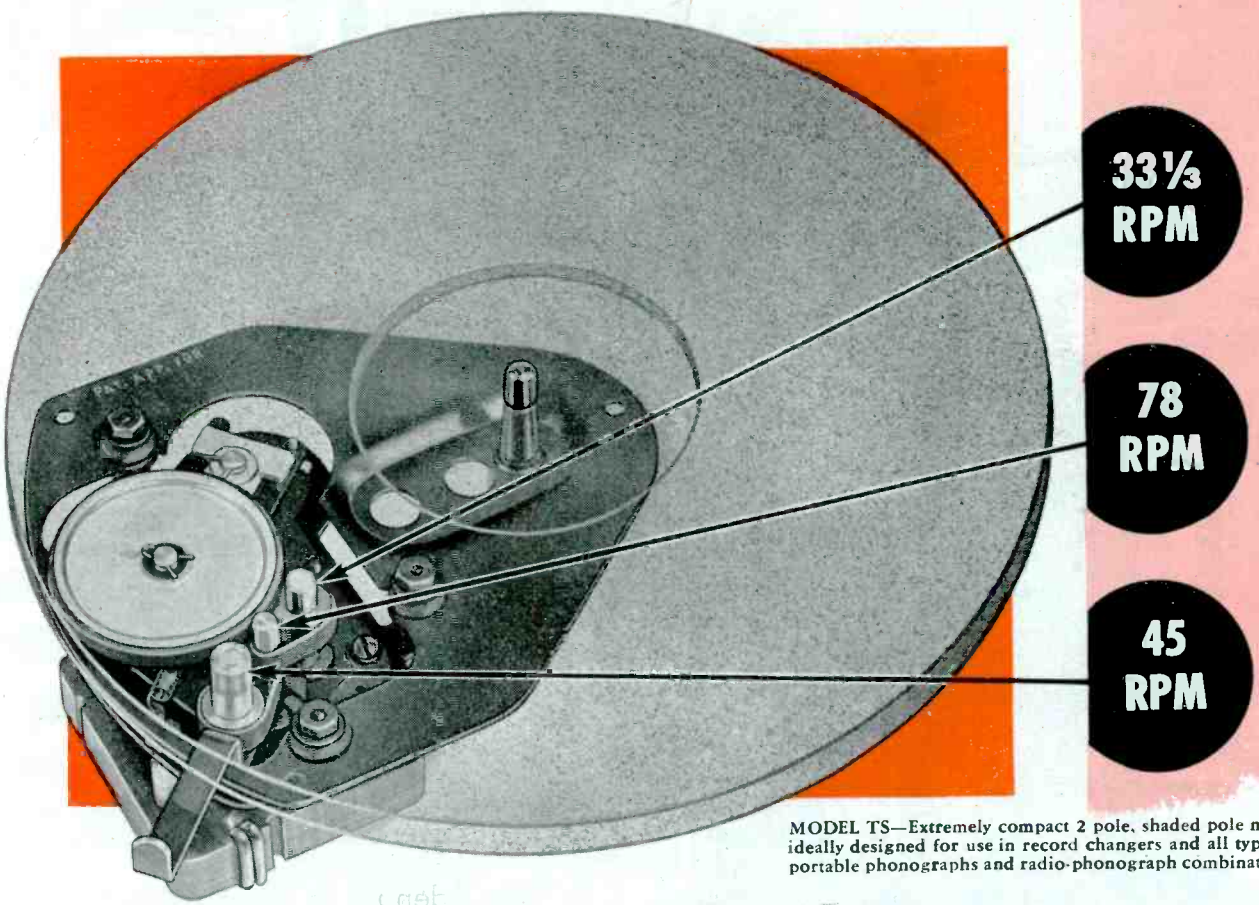
So, when you have a problem on Fine Wire, Tungsten, or Molybdenum, why not call on Fine Wire Headquarters. Phone, wire, or write to North American Philips, makers of NORELCO Fine Wires and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. FA-5, 100 East 42nd Street, New York 17, N. Y.

NOT ONE...NOT TWO...*But*

3 SPEEDS



MODEL TS—Extremely compact 2 pole, shaded pole motor ideally designed for use in record changers and all types of portable phonographs and radio-phonograph combinations.

with this revolutionary New G PHONOMOTOR!

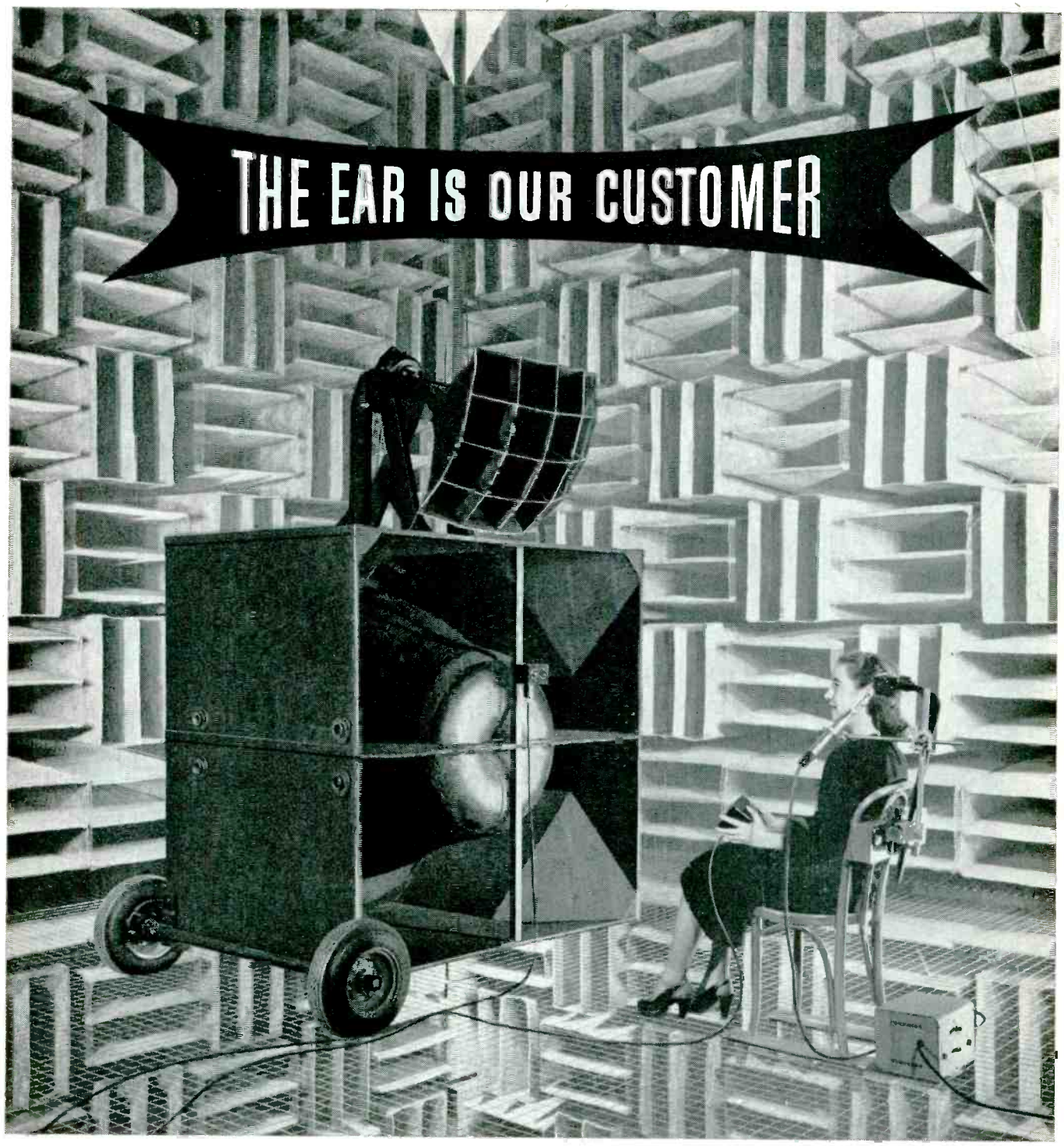
Here it is . . . General Industries' newest development in phonomotors . . . a dependable, single-powered unit for *all three* types of records—78 RPM, 33⅓ RPM and 45 RPM.

Speed shifting is accomplished by means of an external shift lever which ingeniously positions various spindles in contact with the idler wheel. At 78 RPM, the rotor shaft is in direct contact with the idler wheel. For the slower speeds, the rotor shaft is automatically disengaged and one of two secondary spindles is moved into contact with the idler wheel to produce the desired speed. Both secondary spindles are driven from the rotor shaft by specially compounded oil-resistant Neoprene belts.

For additional information—specifications, blueprints and quotations—write, wire or phone *today.*

The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO



What happens when you hear? What happens *inside* your ear when sound waves come in from a telephone conversation?

Bell Telephone Laboratories scientists have developed special apparatus to help answer these questions, for the telephone system is designed to meet the ear's requirements for good listening.

In the test pictured above, the young lady sits before loudspeakers in a soundproofed room with a small hollow tube, reaching just inside the ear canal. Sounds differing slightly in frequency and intensity come from a loudspeaker. The subject seeks to tell one from another, recording her judgment electrically by pressing a switch.

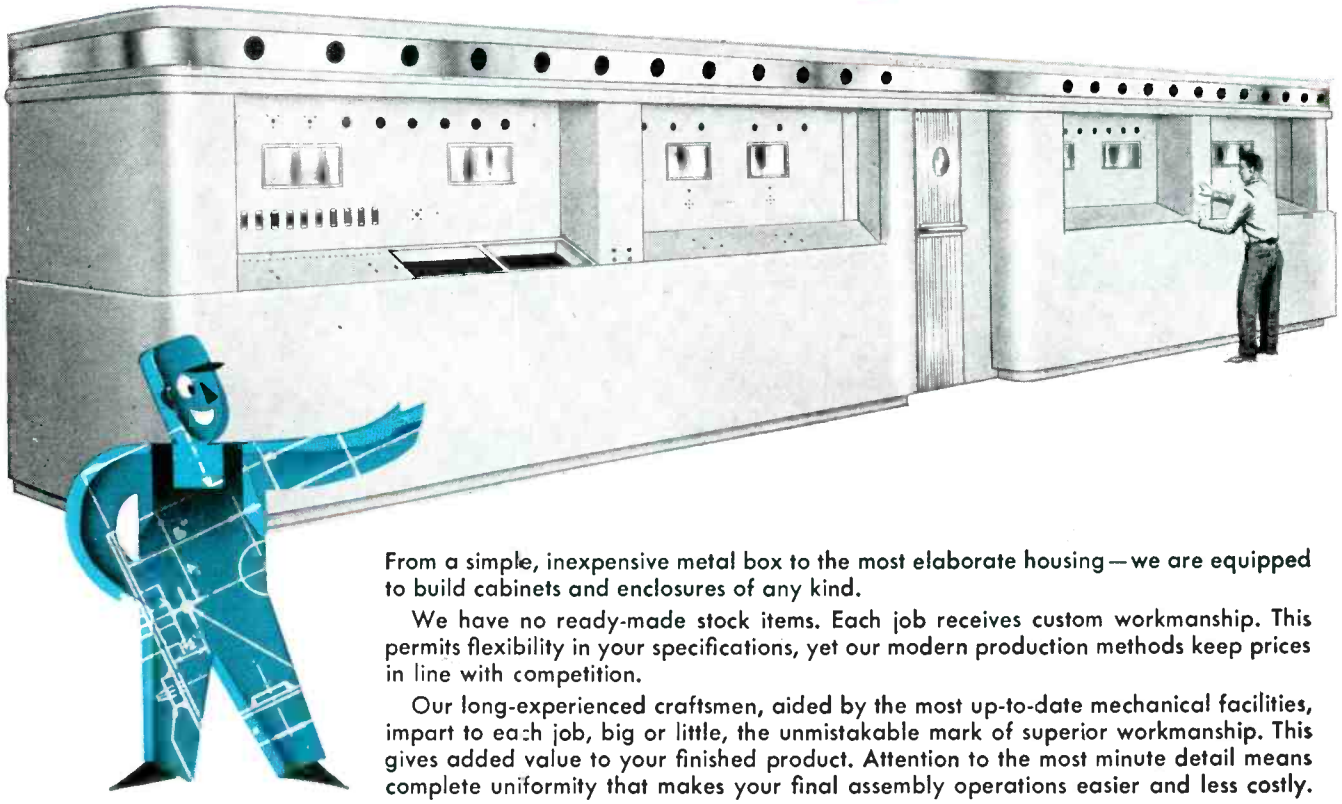
Meanwhile, the same sound waves pass down the hollow tube to a condenser microphone, and a record is made of the exact sound intensities she identified. Results help reveal the sound levels you can hear clearly and without strain—the sounds your telephone must be designed to carry.

Scientists at Bell Telephone Laboratories make hundreds of tests in this manner. It's just one part of the work which goes on year after year at the Laboratories to help keep Bell System telephone service the finest on earth.

BELL TELEPHONE LABORATORIES

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

Karp makes cabinets tiny or TITANIC!



From a simple, inexpensive metal box to the most elaborate housing—we are equipped to build cabinets and enclosures of any kind.

We have no ready-made stock items. Each job receives custom workmanship. This permits flexibility in your specifications, yet our modern production methods keep prices in line with competition.

Our long-experienced craftsmen, aided by the most up-to-date mechanical facilities, impart to each job, big or little, the unmistakable mark of superior workmanship. This gives added value to your finished product. Attention to the most minute detail means complete uniformity that makes your final assembly operations easier and less costly.

Our vast accumulation of stock dies often saves our customers the expense of special dies. Painting and finishing are done in an ultra-modern air-washed atmosphere—dustproof.

From design to delivery we offer you superior work and service in sheet metal fabrication. Tell us your needs. Write for informative literature.

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Custom Craftsmen in Sheet Metal

FREED "PRODUCTS of EXTENSIVE RESEARCH"

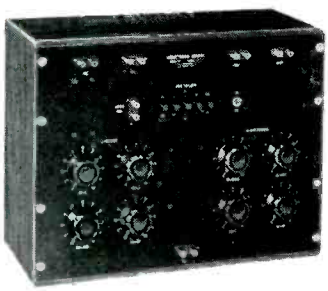
INSTRUMENTS & COMPONENTS!

HIGH FIDELITY OUTPUT TRANSFORMERS

Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	±½db from	Maximum level
F1950	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

"Q" INDICATOR

No. 1030 Frequency range from 20 cycles to 50 kilocycles. "Q" range from .5 to 500. "Q" of inductors can be measured with up to 50 volts across the coil. Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dielectric losses, and power factor of insulating materials.



INCREMENTAL INDUCTANCE BRIDGE

IMPEDANCE RANGE: One millihenry to 1000 henries in five ranges. Inductance values are read directly from a four dial decade and multiplier switch. This range can be extended to 10,000 henries by the use of an external resistance.

INDUCTANCE ACCURACY: Within plus or minus 1% through the frequency range from 60 to 1000 cycles.

COMPARISON BRIDGE

No. 1010 An invaluable instrument for precision laboratory adjustment and incoming inspection of resistors, capacitators and inductors . . . Entirely self-contained, A.C. operated and includes a three frequency oscillator, an A.C. bridge and a null detector.

NULL DETECTOR

No. 1140 For bridge measurements, providing visual null indications or aural indications when used in conjunction with headphones. The unit may also be used as a high gain amplifier for general laboratory work. Functionally, the instrument consists of a high gain linear amplifier with a 30 db input attenuator in addition to the variable gain control. Output voltage is 40 volts undistorted into 1 megohm load, and 10 volts into 20,000 ohms.

HERMETICALLY SEALED *COMPONENTS*

Decade Inductors

No. 1160
10 x 1 HY steps
10 x .1 HY steps
10 x .01 HY steps
500-15,000 cycles

No. 1161
10 x .1 HY steps
10 x .01 HY steps
10 x .001 HY steps
2000-50,000 cycles

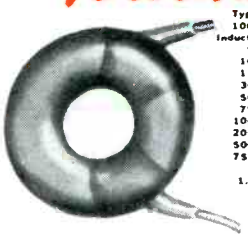
No. 1162
10 x .01 HY steps
10 x .001 HY steps
10 x .0001 HY steps
10,000-300,000 cycles

No. 1164
10 x 10 HY steps
10 x 1 HY steps
10 x .1 HY steps
50-1000 cycles

Discriminators

For telemetering and remote control applications using audio and supersonic frequency subcarriers.

Toroidal Inductors



Type T1 1000-15,000 cycles Inductance Value	Type #	Type T1-2 2000-30,000 cycles Inductance Value	Type #	Type T1-3 10,000-300,000 cycles Inductance Value	Type #
5 MHY	F-800T	1 MH	F-1800	.5 MH	F-1850
10 MHY	F-801T	2 MH	F-1801	1 MH	F-1851
15 MHY	F-802T	3 MH	F-1802	2 MH	F-1852
30 MHY	F-803T	4 MH	F-1803	3 MH	F-1853
50 MHY	F-804T	5 MH	F-1804	4 MH	F-1854
75 MHY	F-805T	10 MH	F-1805	5 MH	F-1855
100 MHY	F-806T	15 MH	F-1806	5 MH	F-1856
200 MHY	F-808T	30 MH	F-1807	10 MH	F-1856
500 MHY	F-809T	50 MH	F-1808	15 MH	F-1857
750 MHY	F-810T	75 MH	F-1809	20 MH	F-1858
1 HY	F-811T	100 MH	F-1810	30 MH	F-1859
1.5 HY	F-812T	150 MH	F-1811	40 MH	F-1860
2 HY	F-815T	200 MH	F-1812	50 MH	F-1861
3 HY	F-819T	300 MH	F-1813	50 MH	F-1862
4 HY	F-821T	400 MH	F-1814	75 MH	F-1862
5 HY	F-823T	900 MH	F-1815	100 MH	F-1863

High quality toroidal coils wound on molybdenum permalloy dust cores. All those listed above can be supplied in hermetically sealed cans, commercial type construction or open units. Other types can be supplied out of stock on special orders.

LOW FREQUENCY HI "Q" COILS

#1900	100 HY
#1901	75 HY
#1902	50 HY
#1903	25 HY
#1904	10 HY
#1905	5 HY
#1906	1 HY

Available from stock in the indicated inductance values.

Filters

Narrow band pass filters for remote control and telemetering applications.

High pass, low pass, band pass and band elimination filters for communication and carrier systems.

FREED TRANSFORMER CO., Inc.

DEPT. A.E. 1718-36 WEIRFIELD ST., BROOKLYN 27, NEW YORK

Follow the Leaders to

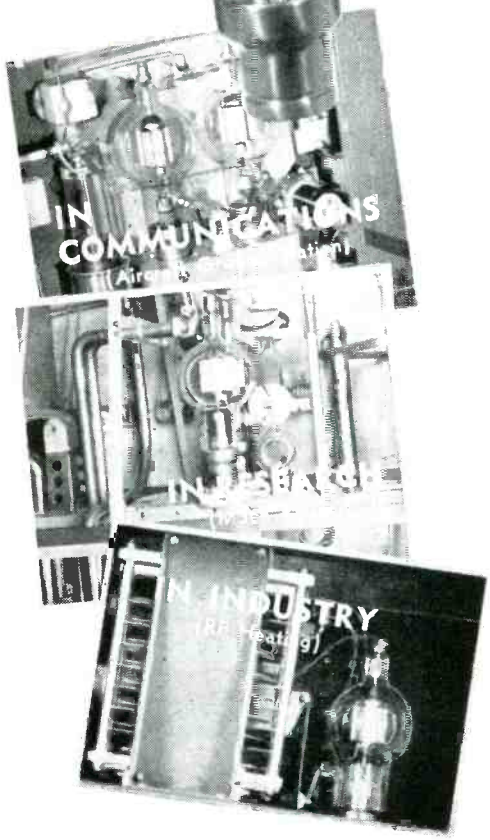
Eimac TUBES

The Power for R-F

Today, ever increasing demands for the famous Eimac triodes keep assembly lines producing record-breaking quantities.

Proven Acceptance

EIMAC
TYPE 450TH



Many years of reliable service in many types of application have established the Eimac 450T as the standout triode in its power class.

Recent technical achievements make the 450T a still better tube. Adoption of the Pyrovac plate and a non-emitting grid have amplified this already rugged tube's ability to "take it." Life expectancy and overload handling qualities have been increased multifold.

Comprehensive technical data on the Eimac 450T are immediately available . . . write direct.

EIMAC TYPE 450TH
ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	12.0 amperes
Amplification Factor (Average)	38
Direct Interelectrode Capacitances (Average)	
Grid-plate	5.0 μμfd.
Grid-filament	8.8 μμfd.
Plate-filament	0.8 μμfd.
Transconductance (I_b = 500 ma., E_b = 4000v.)	6650 μmhos

MAXIMUM RATINGS

Radio Frequency Power Amplifier and Oscillator
Class-C Telegraphy (Key-down conditions, 1 tube)
Frequencies below 40 Mc.

D-C Plate Voltage	6000 Max. Volts
D-C Plate Current	600 Max. Ma.
Plate Dissipation	450 Max. Watts
Grid Dissipation	65 Max. Watts

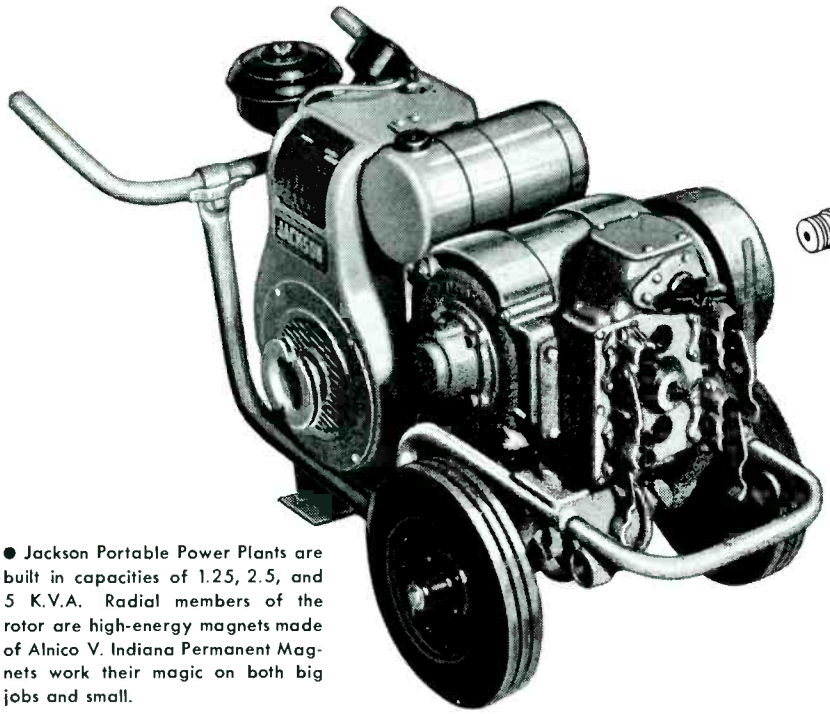
EITEL-McCULLOUGH, INC.

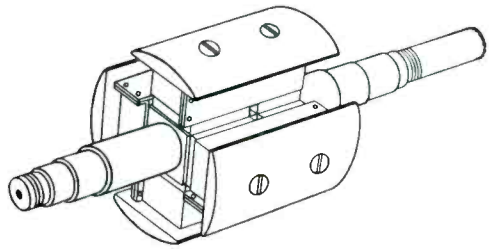
728 San Mateo Ave., San Bruno, California

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

217

THIS PERMANENT-MAGNET ROTOR MEANS RELIABLE ROUND-THE-CLOCK POWER





● Jackson Portable Power Plants are built in capacities of 1.25, 2.5, and 5 K.V.A. Radial members of the rotor are high-energy magnets made of Alnico V. Indiana Permanent Magnets work their magic on both big jobs and small.

121 FEWER PARTS... LESS MAINTENANCE WITH INDIANA PERMANENT MAGNETS

121 fewer parts in a better, *more dependable* generator! That's what Indiana Permanent Magnets have done for Jackson Portable Power Plants. The rotor now is a permanent magnet field. There are no brushes or collector rings . . . no commutator sparking or arcing. Less heat is developed. Over-all size and costs are reduced. Maintenance is minimized. Here, again, modern design with Indiana Permanent Magnets is a *product plus* that pays.

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO!

For four decades, the pace-setting design techniques at Indiana have made possible *new and better* permanent magnets. And, on countless different products, this versatile "packaged energy" improves performance, permits new functions, saves space *and money* . . . as mechanical force in holders and separating devices . . . in transforming electrical energy into mechanical motion, and vice versa . . . in changing the apparent characteristics of materials. Indiana offers you the *experience and know-how* of more than 30,000 different applications. Let's get our engineers together on *your* problems. Write today.

Free Book for Designers

Ask for free Book No. 4-E5—our new permanent magnet reference manual. A note on your company letterhead will bring a copy to your desk.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

Here's on-the-job proof of instrument performance!

largest hydroelectric development in the world . . . employs WESTINGHOUSE INSTRUMENTS

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, Pennsylvania.

Send for booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-3365.

The *Coordinated Design and Styling* of Westinghouse instruments contribute greatly to the space-saving arrangement and excellent appearance of this installation.

For such complex and exacting instrument applications, *reliability* is a "must". Every part of Westinghouse instruments is completely designed and manufactured by Westinghouse to insure proper relation with all other parts. This undivided responsibility and attention to all details assures you of unfailing performance.

What are YOUR electrical measuring problems?

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

The vast lines of Westinghouse electrical measuring instruments provide you with the answers to all of these problems. Every Westinghouse instrument is backed up by more than 60 years of skill, "know-how", and experience in every field of industry.

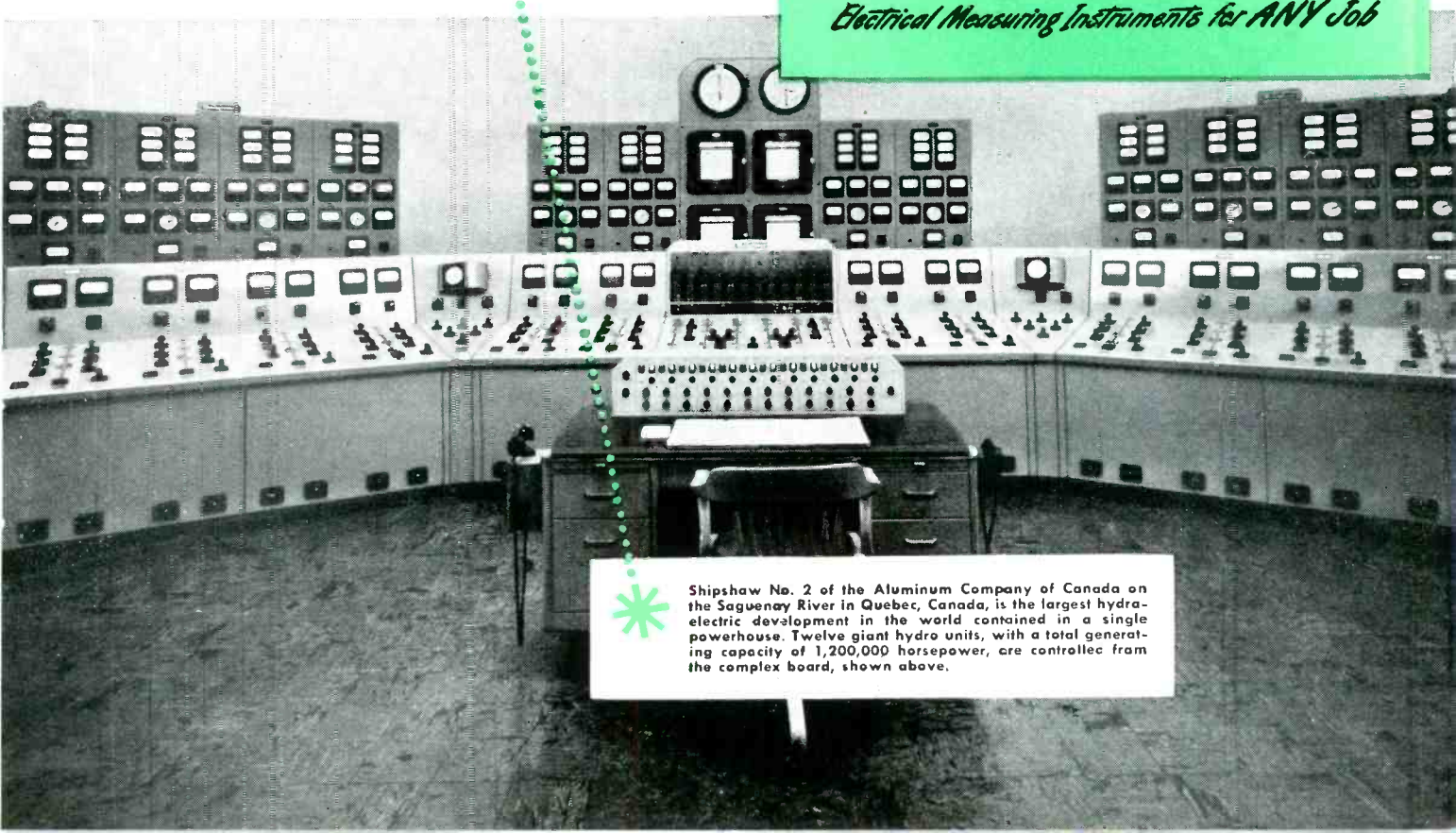
Westinghouse Instruments Also Provide You With

- Dials that *stay* white under all conditions.
- Magnets that stay permanent.
- Pivots with high shock capacity and low friction.
- Springs that remain constant for life.
- Quick delivery of more different ratings and types.
- Complete Nationwide Service.

J-40363

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

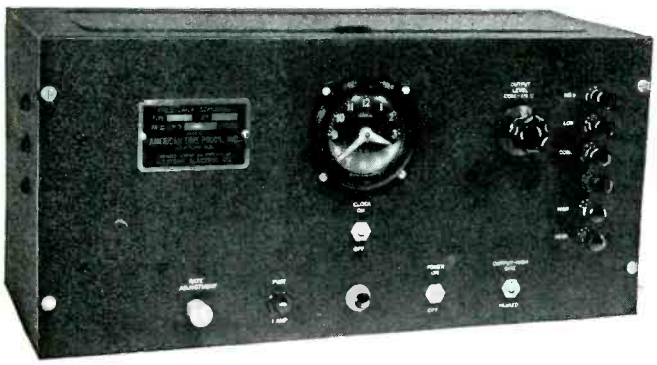
Electrical Measuring Instruments for ANY Job



Shipshaw No. 2 of the Aluminum Company of Canada on the Saguenay River in Quebec, Canada, is the largest hydroelectric development in the world contained in a single powerhouse. Twelve giant hydro units, with a total generating capacity of 1,200,000 horsepower, are controlled from the complex board, shown above.

Watch Master

Frequency Standards



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

Type 212

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.**

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 212

Name.....

Company.....

Address.....

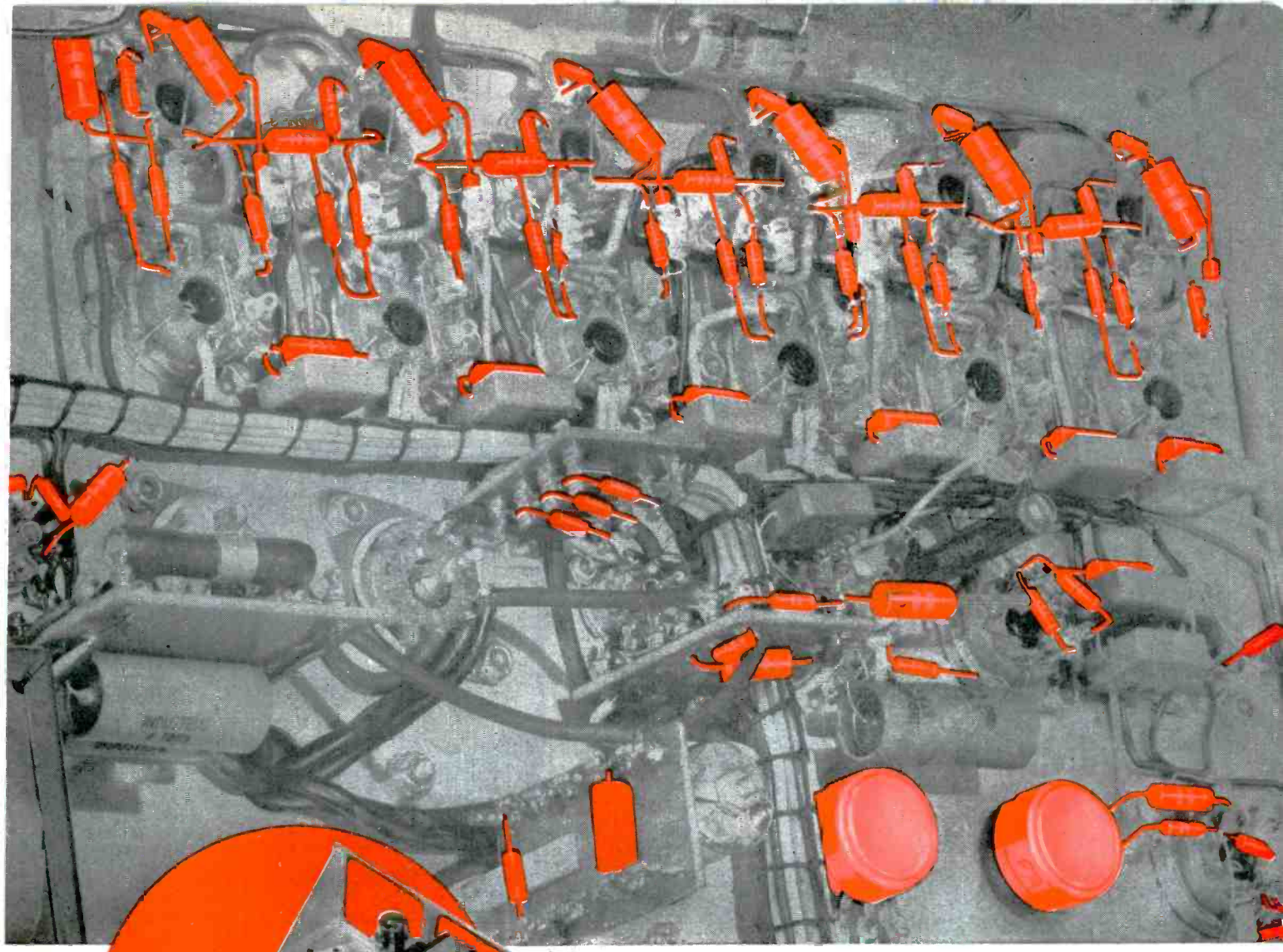
City..... State.....

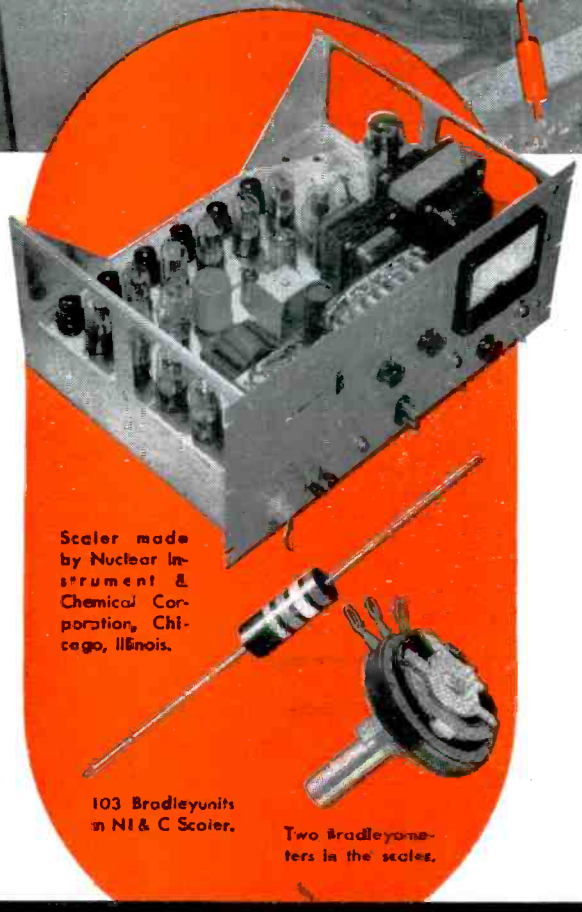
product of

AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue New York 19, N. Y.

Operating under patents of the Western Electric Company





Scaler made by Nuclear Instrument & Chemical Corporation, Chicago, Illinois.

103 Bradleyunits in NI & C Scaler.

Two Bradleyometers in the scaler.

105 ALLEN-BRADLEY FIXED AND ADJUSTABLE RESISTORS in this automatic scaling unit

"Our Model 163 Automatic Scaling Unit," says John L. Kuranz, of Nuclear Instrument & Chemical Corporation, Chicago, "contains 103 Allen-Bradley fixed resistors and two Bradleyometers. To achieve the dependability so necessary in this type of research tool, our tests show that only A-B resistors can be used. In addition to their functional superiority, their small size makes our portable instruments really portable."

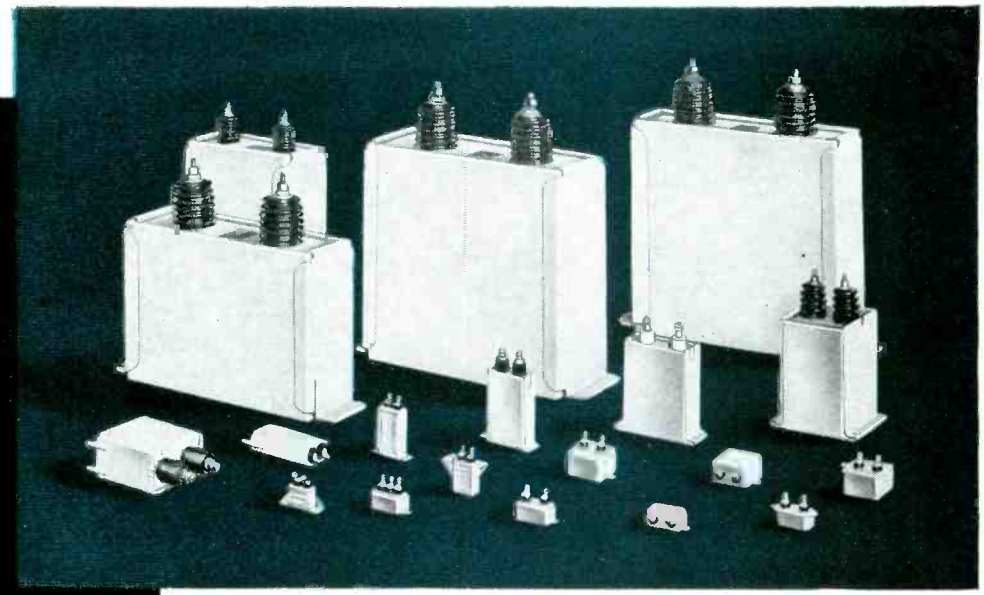
Where superlative performance is a *must* . . . where unfailing dependability is a basic requirement . . . as in nuclear research . . . you will find Allen-Bradley quality resistors. If you *must* meet high-quality standards . . . specify Allen-Bradley resistors.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

ALLEN-BRADLEY QUALITY **RADIO RESISTORS**

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

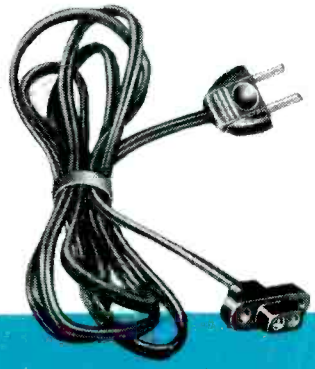
TIMELY HIGHLIGHTS ON G-E COMPONENTS

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?

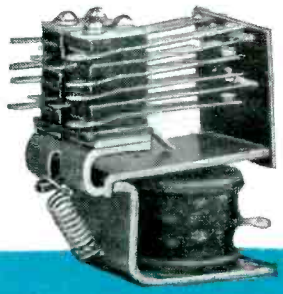
Suitable for installation in radio transmitters, these G-E time meters provide accurate record of tube operating time. They record in hours, tenths of hours, or minutes. Ratings range from 11 to 460 volts. Installation on a panel or switchboard is simplified by quick-wiring leads. Timer harmonizes with 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 E667-1
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 .....

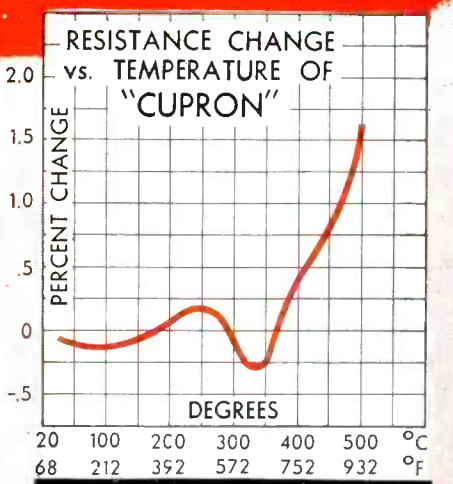
ADDRESS .....

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

Photomicrographics are only part of the story...

EVERY KNOWN TEST QUALIFIES WILBUR B. DRIVER ALLOYS FOR SUPERIOR INSTRUMENTATION!

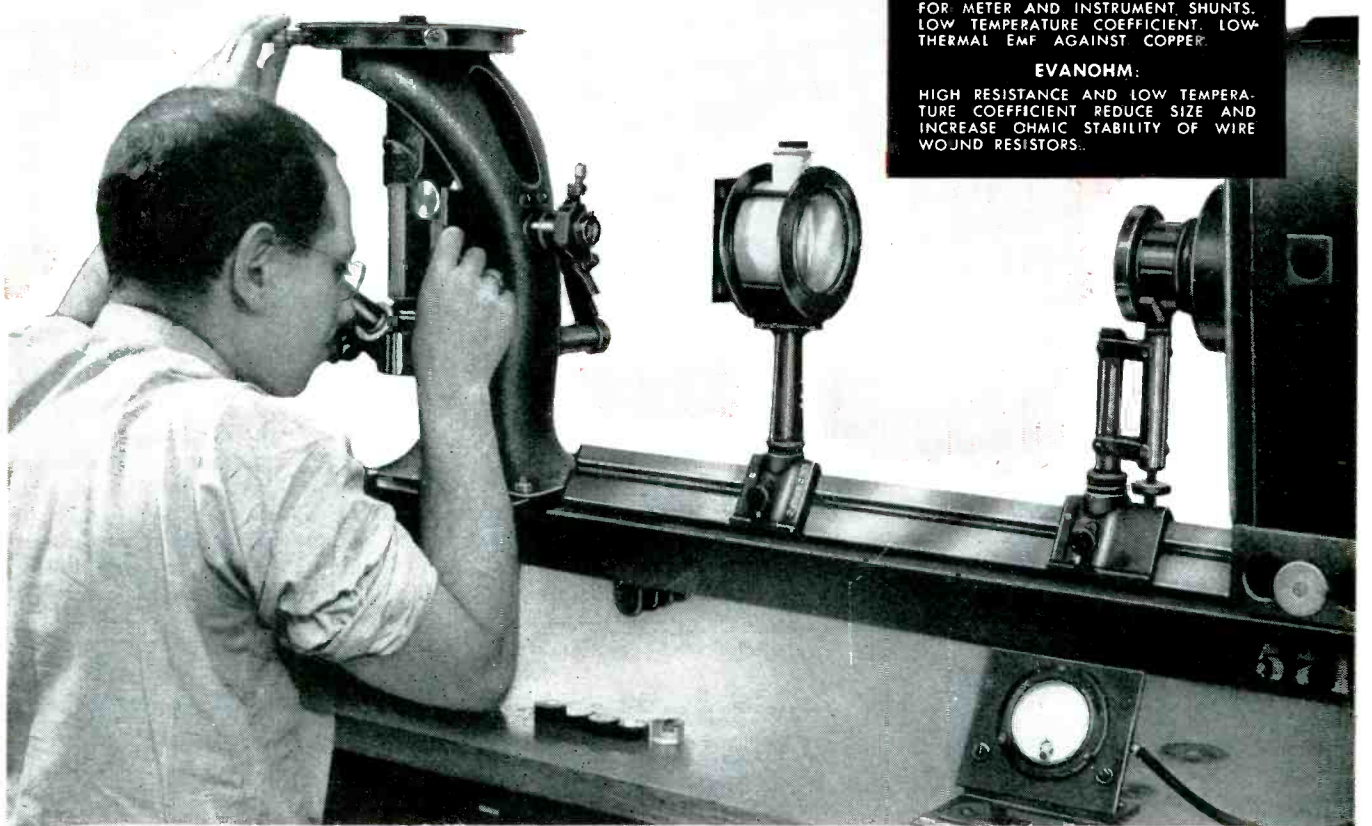
Photomicrographic checking of grain size and quality of metals is only one of the exhaustive tests which Wilbur B. Driver resistance alloys are subjected to throughout production. There are many others including ASTM life, tensile strength, yield point, hardness, micrometer and thorough testing for resistance. These constant checks plus industry-old experience, are the reasons you can depend on all Wilbur B. Driver alloys to perform as specified. The alloys listed are so produced, and are especially recommended for instrumentation.



CUPRON:
FOR CONTROLS, RHEOSTATS, ETC. LOW TEMPERATURE COEFFICIENT OVER A WIDE RANGE OF TEMPERATURE.

MANGANIN:
FOR METER AND INSTRUMENT SHUNTS. LOW TEMPERATURE COEFFICIENT. LOW THERMAL EMF AGAINST COPPER.

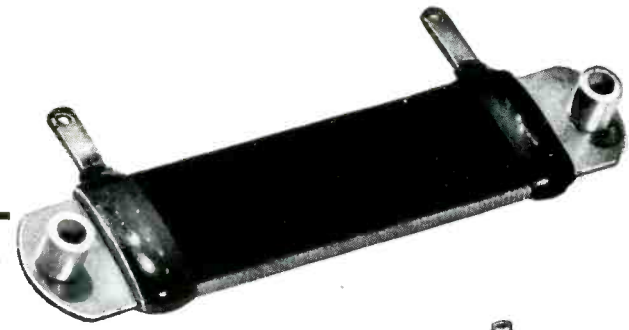
EVANOHM:
HIGH RESISTANCE AND LOW TEMPERATURE COEFFICIENT REDUCE SIZE AND INCREASE OHMIC STABILITY OF WIRE WOUND RESISTORS.



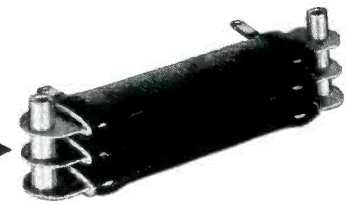
TOPHET
FOR TOP HEAT

WILBUR B. DRIVER CO.
150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY

Use one alone—



or stack 'em like hot cakes...



I-T-E OVAL RESISTORS SAVE SPACE!

When space is limited—as in aviation, sound, or electronics applications—I-T-E Oval Resistors and Oval Resistor Assemblies may be the solution you're looking for.

Specially designed to meet the exacting and changing needs of the electronics industry, these modern, wire-wound power resistors are distinguished by their high unit-area wattage ratios, which are due in part to the heat dissipation qualities of the mounting brackets.

An I-T-E Oval Resistor—or an assembly of I-T-E Oval Units—has a much higher wattage rating than that of a conventional round resistor of comparable size. You save space and, at the same time, gain the dependable performance of I-T-E *quality* resistors.

No matter what your resistor problem is—space, exacting service, or dependable performance—be sure to investigate I-T-E Oval Resistors. Complete technical information, as well as valuable application data, are contained in the new I-T-E Resistor catalog. Send for it today.

There's an I-T-E Resistor for Every Purpose→

I-T-E OVAL RESISTORS

Type	Watts	Length	Maximum Recommended Resistance	Mounting Centers
108 Oval	30	1¼"	10000	2"
200 Oval	40	2"	15000	2¾"
316 Oval	55	3½"	25000	4¼"
424 Oval	65	4¾"	35000	5½"
600 Oval	75	6"	50000	6¾"

POWER RESISTORS

The Leader In Technical Excellence

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

SWITCHGEAR • UNIT SUBSTATIONS • AUTOMATIC RECLOSING CIRCUIT BREAKERS • RESISTORS • SPECIAL PRODUCTS

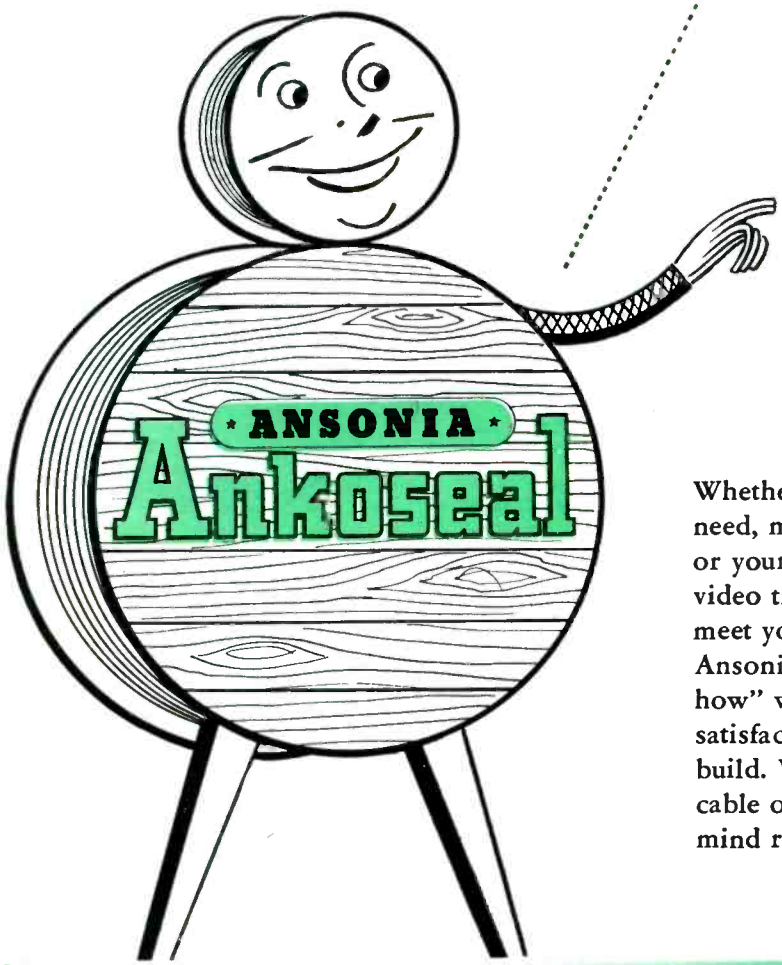
"Which of these is on your mind?"

television camera cable

special video transmission cable

special antenna cable

radio chassis hook-up wire



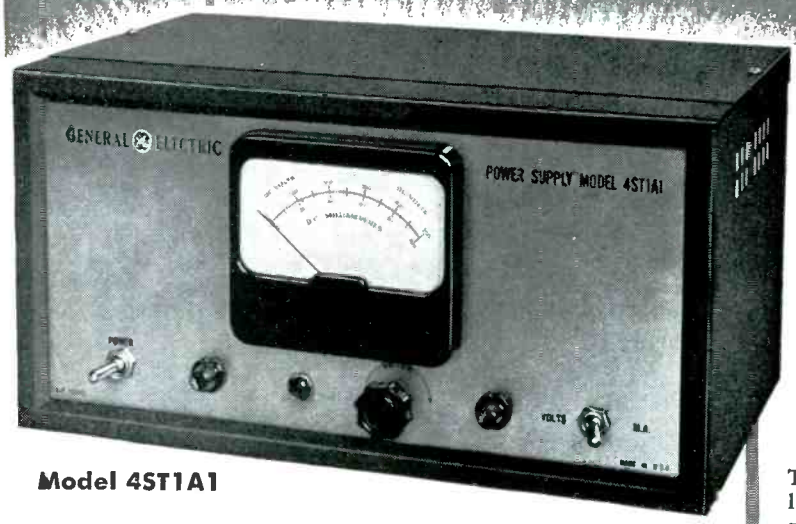
Whether it's just good hook-up wire you need, made to government, Underwriters', or your own specifications...or...a special video transmission cable engineered to meet your precise requirements—Ansonia Engineers have plenty of "know-how" which will help to assure long-term satisfaction from the equipment 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 SMALL REGULATED POWER SUPPLY TO MEET A *Big Demand!*



Model 4ST1A1

RESEARCH laboratories, educational institutions, and production test departments will welcome this new low-priced, small sized regulated power supply. Performance-engineered to meet practically every type of application within its field, and every budget requirement, it rounds out General Electric's very complete line of regulated power supplies. A striking number of features have been enclosed in this sturdy steel case—that will impress every engineer as noteworthy. Look them over—then order for immediate delivery.

- ★ 4½" built-in meter with clear, easily read scale.
- ★ Two position switch on panel permits operator to read either volts or milliamperes on the meter.
- ★ Operator can switch back and forth under load to monitor continuously.
- ★ The 4ST1A1 is continuously variable...180V to 300V at 60 milliamperes.
- ★ Maintains constant output with varying line voltage or varying load conditions.
- ★ Supplies separate AC voltage at 6.3V—center tapped at 2½ amperes.
- ★ The unit may be operated grounded or ungrounded.
- ★ All components have been ultra-conservatively rated.
- ★ Ripple is less than 10 millivolts RMS.

For complete information on General Electric Regulated Power Supplies write *General Electric Company, Electronics Park, Syracuse, New York*

You can put your confidence in—

GENERAL ELECTRIC

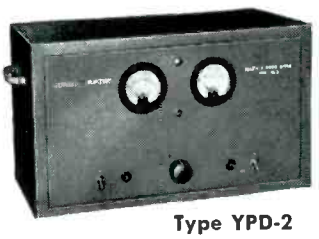
164-H1

See the wide range of Regulated Power Supplies that are made by—

GENERAL ELECTRIC

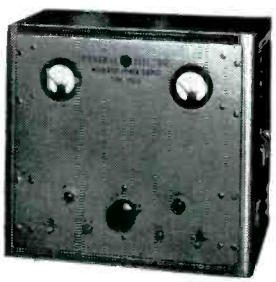
Type PS-4. Dual Regulated Power Supply providing two separately regulated supplies. Individual d-c current output 0 to 200 milliamperes; in parallel 0 to 400 milliamperes maximum. Voltage output: 250 to 400 volts.

Type PS-4



Type YPD-2

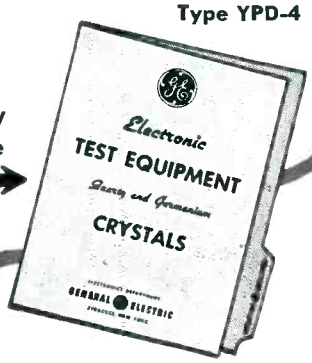
Type YPD-2. A medium power unit of high quality for use wherever a closely regulated d-c voltage of low ripple content is required. D-C current output 0-300 milliamperes. D-C voltage output 250-450 volts.



Type YPD-4. This unit provides a wide range of output voltages which makes it extremely versatile for laboratory work. D-C current output 0 to 0.125 amperes maximum. D-C voltage output 160 to 1500 volts.

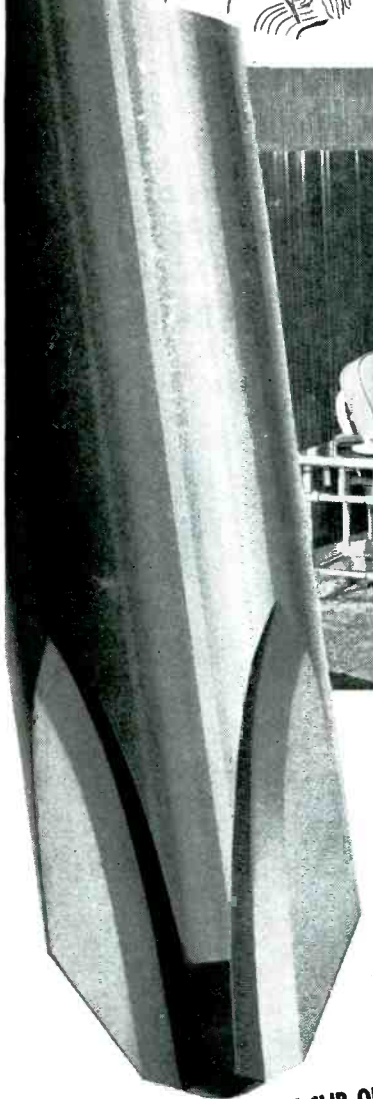
Type YPD-4

Send for a copy of our free catalog.



No Spoilage in Production...

No Spoilage of Sales...



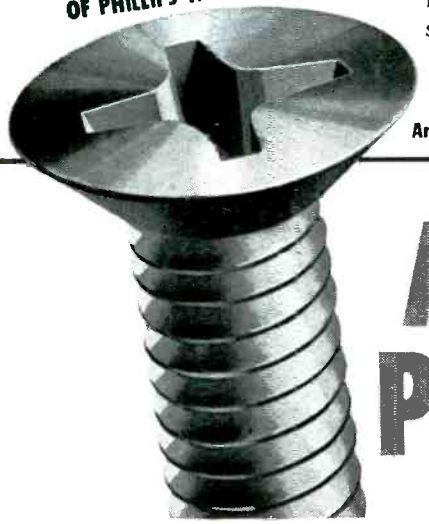
*"TROPITAN" Furniture by Ritts Co., Los Angeles, Cal.

...when AMERICAN PHILLIPS SCREWS are used to fasten fine furniture like this*

"EASY CHAIRS" TO BUILD: Take a look at this handsome living room. How would *you* like to try building furniture like *that*, with wobbly screws and slipping, slashing drivers? Well, neither would the builders of this visibly top-quality line. So they play safe. They use American Phillips Screws *instead of binding the frame together*, . . . and haven't a worry in the world about cost, spoilage, or complications in production. In fact, they guarantee the frame for life.

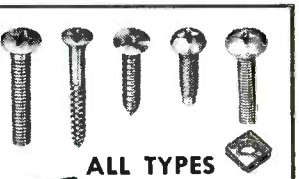
"EASY CHAIRS" TO SELL: Nor do they have any worry about their ultra-modern designs being spoiled by old-fashioned, ugly, slotted screws . . . nor about any burred screwheads left to injure customers and clothes and spoil repeat sales. For against all these former threats, they now have American Phillips Protection at every fastening point. Now, how about *you?* What fastening worries do *you* have? *Write.*

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



American Screw Co., Providence 1, R. I.; Chicago 11: 589 E. Illinois St.; Detroit 2: 502 Stephenson Bldg.

AMERICAN PHILLIPS *Screws*



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

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

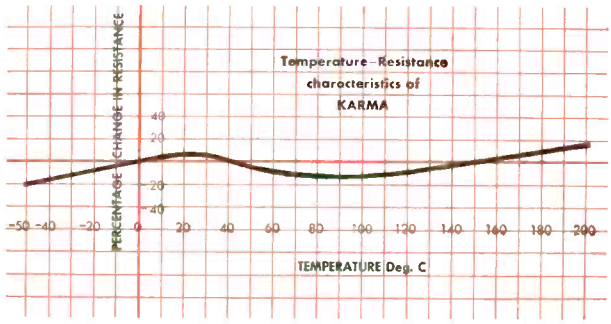
Compared with Manganin and Constanta (Advance*), the copper-base alloys widely used for high accuracy wire-wound resistors, the electrical resistivity of Karma* is exceptional — 800 ohms per circular mil foot, at 20°C, it is more than 2.7 times greater. Now you can wind even smaller precision resistors 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 #331

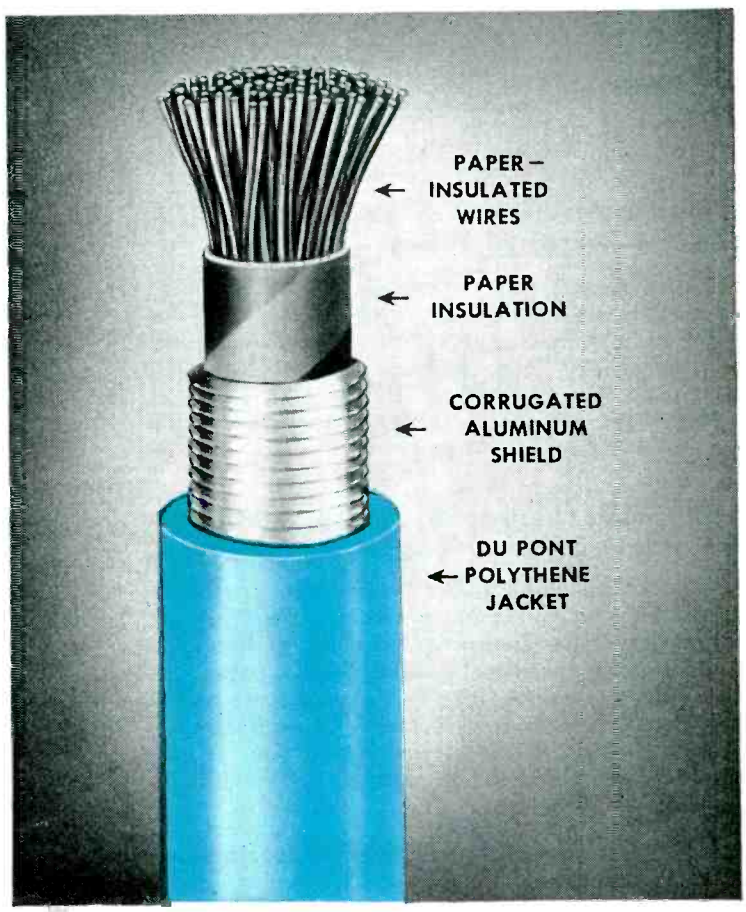
DU PONT POLYTHENE PLASTIC HELPS TELEPHONE ENGINEERS SOLVE TOUGH PROBLEM

New Jacket of Polythene and Aluminum is used as Shield on Telephone Cable

The shortage of lead for telephone cable sheathing was solved recently, after some years of research, by engineers of Bell Telephone Laboratories and Western Electric. They found an economical answer in a jacket of a new plastic, Du Pont polythene . . . extruded over an aluminum shield.

Polythene was chosen because of its mechanical properties, resistance to many chemicals, resistance to weathering when properly compounded, and ease of extrusion. And the moisture-resistance of the polythene-aluminum combination is excellent.

NEW WESTERN ELECTRIC CABLE CONSTRUCTION



"Alpeth" cable shown above, a joint development of Bell Telephone Laboratories and Western Electric Company, is now being manufactured by Western Electric.

ELECTRICAL ENGINEERS FINDING MANY NEW USES FOR DU PONT POLYTHENE PLASTIC

The use of polythene in telephone cables follows its widely accepted use in many other types of electrical equipment. In one current application, polythene is used to mold the potential coil to the electromagnet core of a new watt-hour meter. Polythene provides greater insulation strength, reliability . . . and extra-long life for this potential coil.

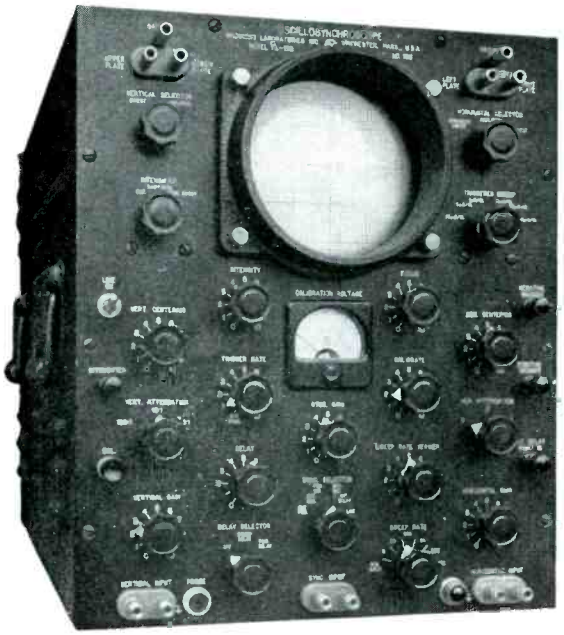
Polythene molding powders may be injection- or compression-molded . . . extruded as sheeting, tubing, or wire-covering. They are available in a range of colors. The demand for polythene still exceeds the supply, but continuing increases in production are being pushed to meet this situation.

Facts about properties of Du Pont polythene and examples of current use may be obtained by writing E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Empire State Building, 350 Fifth Avenue, New York 1, New York; 7 South Dearborn Street, Chicago 3, Illinois; or 845 East 60th Street, Los Angeles 1, California.

DU PONT
REG U S PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Browning

OSCILLOSYNCHROSCOPE
MODEL OL-15B



Combining the functions of

OSCILLOSCOPE and SYNCHROSCOPE

An Outstandingly Versatile Instrument Applicable to—

- **TELEVISION**
- **FACSIMILE**
- **PULSE MODULATION**
- **RADAR**
- **NUCLEAR PHYSICS**
- **COMMUNICATIONS**

GENERAL FEATURES

Five-inch cathode ray tube operating at 4,000 volts accelerating potential. Ordinarily supplied with P1 phosphor, others available on special order.

Vertical amplifier flat within 3 db. from 5 cycles to 6 megacycles. One inch deflection with .05-volt RMS input.

Horizontal amplifier flat within 1 db. from 5 cycles to 1 megacycle.

Built-in calibrating system for determining wave amplitude. No external meter needed.

Deflection plates and intensity grid available directly at front panel terminals.

No waiting for trace to reappear after adjusting gain or applying DC component to input.

Low capacitance, high impedance probe supplied for minimizing test circuit disturbance.

Reasonably symmetrical waves permit full screen vertical deflection.

Contained in single cabinet, weighs less than 100 pounds.

AS AN OSCILLOSCOPE

Linear sawtooth sweeps continuously variable from 5 to 500,000 per second in conjunction with the excellent vertical amplifier outlined. Permits observation of RF waves and envelopes to above 6 megacycles. Because of the extended ranges of the amplifiers and sweep generator, oscilloscopic capabilities are correspondingly increased over standard oscilloscopes.

AS A SYNCHROSCOPE

An internal trigger generator continuously variable from 200 to 5,000 cycles can be used to excite external equipment as well as the sweeps. The trigger can be made by panel control to lead or lag the start of the sweep by amounts up to 1,000 microseconds, making it possible to phase any part of a pulse or transient onto the screen for measurement. Sweep speeds of $\frac{1}{4}$, $\frac{1}{2}$, 1, 5, 20, and 200 microseconds per inch provide convenient image time expansion for detailed observation. As the sweep generator will sweep once for each incoming pulse, single transients or pulses occurring at irregular intervals can be observed or photographed.

• COMPANION INSTRUMENTS •

SWEEP CALIBRATOR MODEL GL-22

For accurately calibrating sweeps. Markers are provided at 1/10, $\frac{1}{2}$, 1, 10, and 100 microsecond intervals which may be applied as deflection or as intensity modulation. May be triggered directly from OL-15B. Write for bulletin MC-549.

FAIRCHILD OSCILLO-RECORD CAMERA

For permanent records of waveforms on 35mm. film. Single frames or variable continuous motion permit recording of all phenomena. Various lenses, magazines, etc. available. Easily set up with OL-15B. Write for bulletin MF-549.

Canadian Representative
MEASUREMENTS ENGINEERING
Arnprior, Ontario

BROWNING
Laboratories, Inc.
Winchester, Mass.
ENGINEERED FOR ENGINEERS

Minimize Control Size!

REDUCE COST!

WITH THESE NEW ALLIED RELAYS

The Allied PO and POY relays, replacing the DO and DOY relays, save space, save cost. These advantages will have special appeal for engineers in electronic, aircraft and other industries requiring medium power, all-purpose relays.

POY RELAY

A semi-sensitive, dual coil relay for operation in vacuum tube or other limited power circuits. Same contact rating and arrangement as PO.

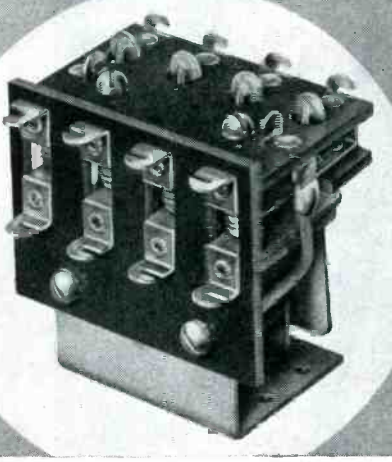
DIMENSIONS:
Same as PO.

COIL RATING:
Up to 110 volts D.C. at 600 milliwatts. Not supplied for A.C.

MOUNTINGS:
Standard, #6-32 tapped holes. Not supplied with stop nuts.

The PO & POY relays are adaptations of the well-known general purpose Allied BO relay, and like all other Allied relays may be obtained hermetically sealed.

Every part in these precision-built relays is designed to deliver thoroughly dependable service with extra long life. For complete information and operating characteristics of the new PO and POY and other precision-built Allied Relays, write us for latest Allied catalog.



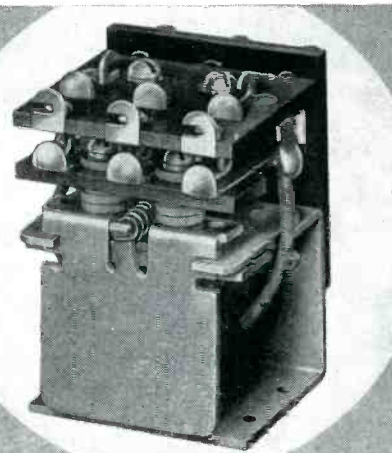
PO RELAY

This relay, shown above in the 4-pole model and shown below in the 3-pole model, is supplied in 2-, 3- and 4-pole normally-closed, normally-open or double-throw contacts. Its standard silver contacts have carrying capacity of 15 amperes at 24 volts D.C. or 110-volts A.C. non-inductive.

COIL RATING: A.C. 10.5 volt amperes nominal or 17.5 volt-amperes maximum at 25 to 60 cycles and up to 220 volts.

D.C. Up to 120 volts at 1 watt minimum or 8 watts maximum.

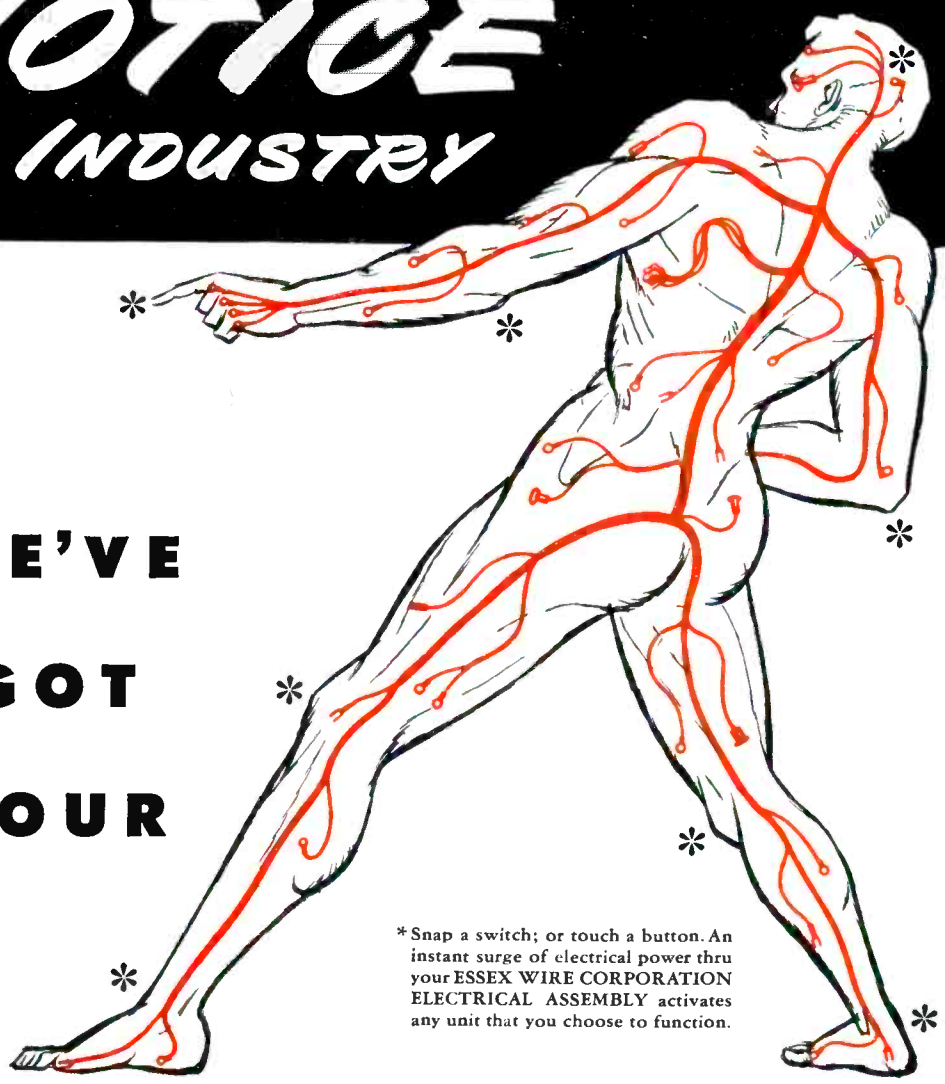
MOUNTING. Standard #6-32 tapped holes. Also supplied with #6-32 stop nuts.



ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

NOTICE TO INDUSTRY



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ESSEX WIRE CORPORATION MONTICELLO, INDIANA

BUSINESS BRIEFS

By W. W. MacDONALD

Referring Once Again to industry mobilization (p 68, Jan., et al) we herewith report that in mid-January Task Committee No. 1 of the Electronics Equipment Industry Advisory Committee came up with a Plan. It was approved by EEIAC February 16 and submitted to the Munitions Board, where it is still under official scrutiny at this writing.

Stripped of the whereases, the Plan essentially (1) throws cold water on the Contingent Contract idea, (2) suggests that a firm of industrial engineers be hired to determine Government's probable needs and the industry's possible capacity, (3) urges classification of government projects now under way "expedite" and "defer" and stopping of the latter on M-day, (4) proposes military deferment of key men and engineers as well as production personnel on major projects, (5) plumps for appointment of a four-man Procurement Program Directing Committee composed of three officers and a civilian to coordinate the activities of the three Services, (6) suggests the use of open competitive bids, competitive bidding by previously qualified bidders and negotiated contracts to fit specific cases.

These, we think, are the accurately briefed highlights of the Plan. If not, it is our impression that there will be plenty of time to make amends in these columns before the Munitions Board reaches any decision.

Screaming on the part of eastern manufacturers about the shift of the Instrument Show, held in Philadelphia in 1948, to St. Louis in 1949 seems to be subsiding. We hear that 1½ times as much exhibit space has already been sold, with the shindig still over four months away.

Color Television Adherents may find the following off-the-cuff thinking stimulating:

In a still photograph there are two factors of major importance . . . subject interest and technical quality . . . with color a possible third. In a movie there are three factors . . . subject, technical quality and motion . . . with color a possible fourth. In television there are four . . . subject, quality, motion and liveness . . . with color a possible fifth.

We don't know the precise importance of color in any of these pictures, but it obviously represents a smaller slice of the pie in television than in the other two cases.

TV-Station Box Score, as of January 1, 1949, looked like this:

Status	*Number*	*Cities*	*Est. Cost*
On the air...	50	30	$30,300,000
Under const..	74	41	
Pending	311	94	66,300,000
	435	165	$96,600,000

Breakdown of major business interests of the 435 stations on the air, under construction and pending:

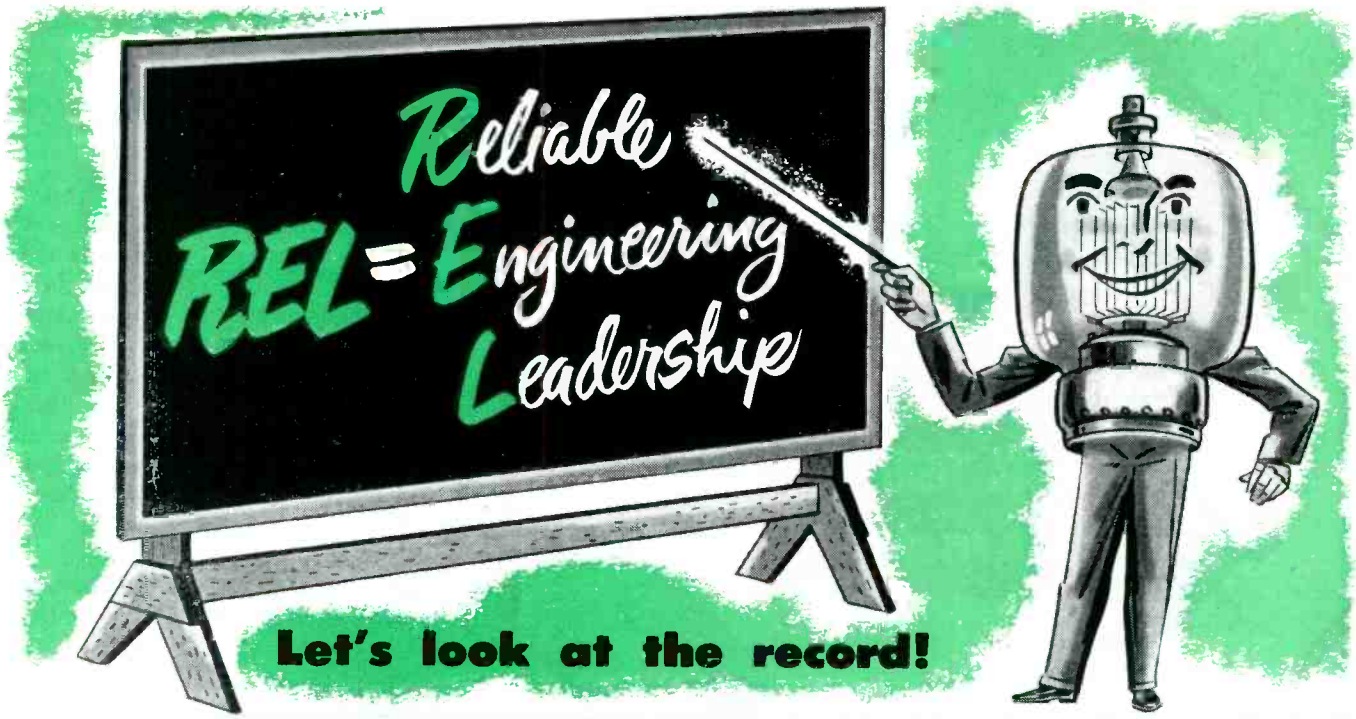
Newspaper publishing	128
Broadcasting only	66
Motion pictures, theatres, etc.	27
Radio manufacturing	25
Merchants, dealers, etc.	25
Misc. manufacturing	18
Real estate, insurance, etc.	17
Oil production	17
Educational institutions	10
Miscellaneous	76
Unknown	26

Of the 435 tv stations, 333 (76.7 percent) are affiliated with a-m or f-m stations.

Reader Frankel of W8CTW (and WBLK) thinks the average age of amateurs is *not* increasing (p 68, March), calls attention to the two youngsters pictured on the front cover of March *QST* and a yarn about a 12-year older in December by way of proof.

Ok om, that's three. But how about the other 81,167?

Magnetic Tape has so far been used chiefly for sound-recording. Telemetering and similar applications are, however, increasing. And we are told that use of tape to program important industrial operations is in the offing. One machine manufacturer, whose name must still be kept under wraps, is known to be experimenting with tape as a means of automatically cycling a lathe through a series of difficult



1935 FIRST TO BUILD FM EQUIPMENT!

REL manufactured the equipment used by Major Armstrong in the first public demonstrations of practical FM transmission.

1939 FIRST WITH COMMERCIAL FM!

REL was the first manufacturer to produce and install commercial transmitter equipment for FM broadcasting.

1939 FIRST WITH AN FM RELAY!

REL established the first studio to transmitter FM relay ever installed. This equipment is still functioning between Boston and Paxton, Mass., 43 miles airline over two ranges of hills.

1940 FIRST WITH 50 KW FM!

REL engineered and built the first commercial FM transmitter rated at 50 KW output.

1947 FIRST WITH THE "QUADRILINE"!

The *"Quadriline"* circuit structure, at one stroke, eliminated a host of expensive RF and mechanical construction problems at the 10 KW level.

1947 FIRST WITH AN FM NETWORK!

REL transmitting and receiving equipment was used exclusively to establish the first FM-all-radio-linked network. This net covered a total distance of 445 miles with total radiated power of approximately 450 KW.

1948 FIRST WITH UHF STL!

With the introduction of REL Model 694 STL equipment, the art and practice of FM broadcasting took another great stride forward free from the handicap of inadequate wire line facilities.

1948 FIRST WITH THE "SERRASOID" MODULATOR!

Simultaneously with the introduction of high performance STL equipment REL announced the amazingly efficient and economical *"Serrasoid Modulator."*

1949 CONTINUOUS ENGINEERING LEADERSHIP!

Look to REL and its program of exploiting wide-band FM on all fronts, where it is vital to secure large phase shifts with great linearity and low noise for the answers to multiplexing, telemetering, point-to-point and all other communications problems.

REL

RADIO ENGINEERING LABS • INC

35-54 36th STREET, LONG ISLAND CITY 1, N. Y.

operations, a job formerly requiring the services of a highly-skilled operator.

As The Trend in industry develops, and more manufacturers move from meters that merely indicate to types that record and then to instruments that effect automatic control of machines and processes, more engineering on the part of suppliers will be required. One manufacturer making all three types of gear reports that he has already found it desirable to quadruple engineering personnel.

One Of Our Biggest companies is said to be nearly ready for the market with an "inert-electrode" welder that meets rigid FCC specifications regarding radio interference.

The Air Force, at last report, was pushing a bill authorizing a network of early-warning radar stations in the continental United States and some outposts to the tune of $160,750,000. Of this amount, however, only $68,250,000 would go for electronic equipment and USAF is understood to have on hand $42,250,000 worth of gear, some of which would be useful in the program.

The remainder would still be a lot of new business.

Speaking Of Radar, the five Western Union nations are budgeting to buy themselves half-an-hour's warning of any air assault. The first important concrete result of cooperative measures for defense will probably be installation of detection gear stretching 1,500 miles from Lubeck on the Baltic to southern Tunisia.

The proposed radar screen would, we hear, cover Holland, Belgium, Luxembourg, France, the British Isles, Corsica, Tunisia and at least the coastal belt of Algeria. The French and British zones of Germany might be included. Italy, Denmark, Norway and the American zone of Germany have not at this writing been integrated in the plan but may be tied in eventually within the frame work of the Atlantic Pact.

Each of the countries mentioned

would finance construction and operation of equipment on territories under its control.

GI's Studying Radio by mail total 45,386, which is 26 percent of the 173,278 enrolled in postage-stamp courses.

Receiver Sales by RCA licensees during 1948 totaled 16,833,709 units, worth $711,725,715. Here's the way the total broke down:

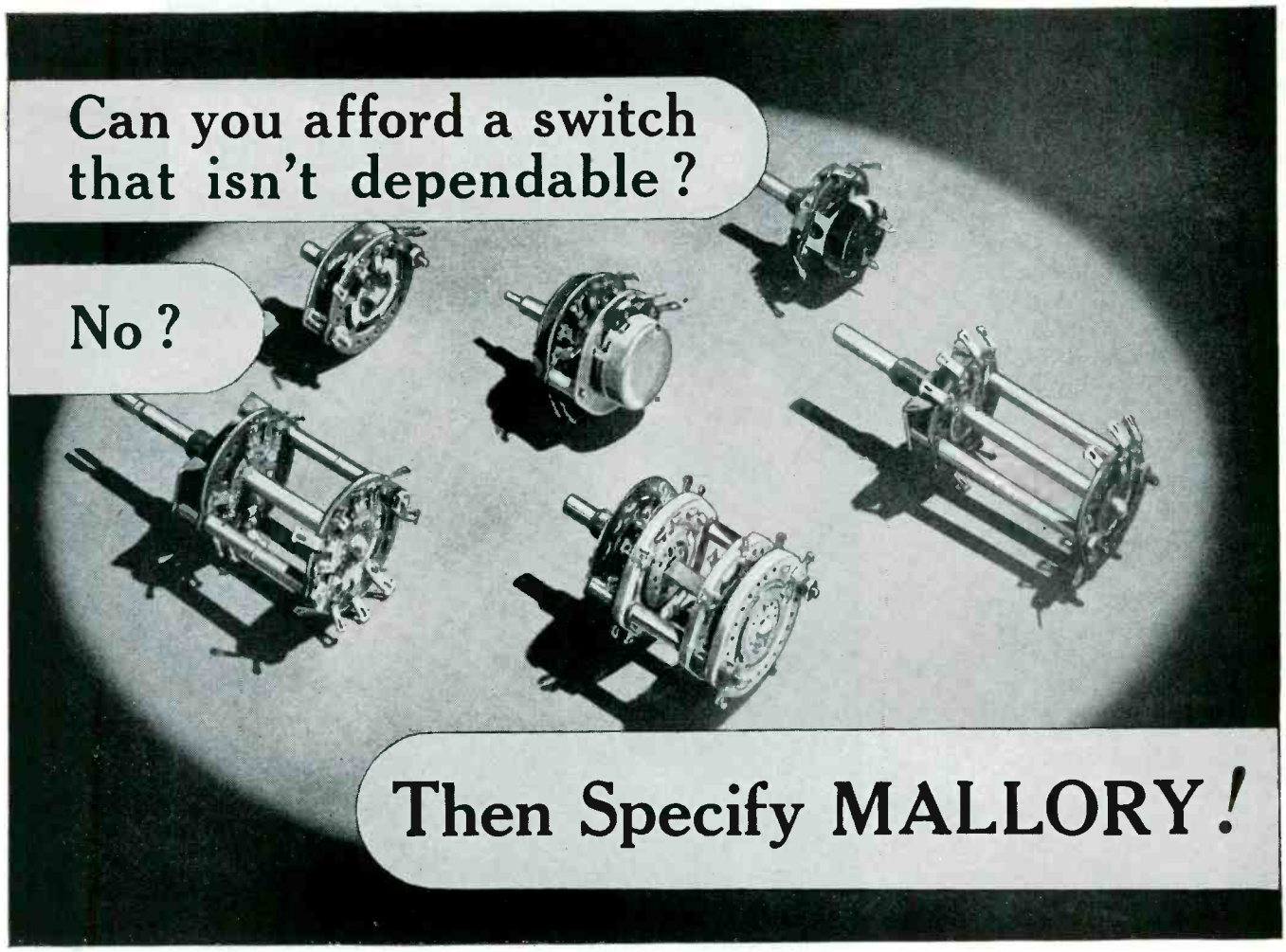
TYPE	UNITS	DOLLARS
Electric		
Table (under $12.50 billing price)	2,847,482	$27,174,693
Table (over $12.50 billing price)		
A-M	3,954,132	72,916,210
A-M/F-M	420,324	15,125,342
F-M (including converters)	84,827	2,131,190
Consoles		
A-M	81,982	5,174,943
A-M/F-M	43,544	3,919,029
Table-Radio-Phonos		
A-M	629,676	28,593,125
A-M/F-M	14,269	968,340
Console-Radio-Phonos		
A-M	631,618	59,469,316
A-M/F-M	805,092	115,031,095
Battery		
Portable A-C/D-C	2,559,274	45,600,190
Table	261,457	6,642,357
Consoles	263	11,387
Auto	3,113,721	98,979,298
Television		
Converters	3,632	935,436
Radio Table Models	578,763	109,608,204
Radio Consoles		
Direct viewing	196,233	44,561,145
Projection	12,085	6,838,333
Radio Phonos		
Direct Viewing	144,159	55,067,704
Projection	3,874	2,599,734
Phonographs		
Phono only	350,940	5,981,942
With radio attachment	6,623	211,480
Without Cabinets		
A-M	54,533	1,616,797
A-M/F-M	29,928	1,655,054
Television	5,278	913,371

Mortality among radio receiver manufacturers is notoriously high. Brand names, vanishing from the market since the business began, now total 788, according to Zenith's H. C. Bonfig.

At A Radio Show back in the early days one of our editors picked up a dummy tube filled with a mysterious amber liquid as an advertising stunt and, possessing an experimental nature, sampled the contents. The result proved exhilarating.

Remembering the experience, this same gent sampled the pinkish contents of a small vial distributed, also by way of advertising, by an exhibitor at the recent National IRE Convention. Then he rushed for the washroom.

What, we ask in the general direction of Camden, *is* in that little db-juice bottle?



ENGINEERING DATA SHEETS

Send for the Mallory Engineering Data Sheets on the RS series. They contain complete specifications for available circuit combinations with respective terminal locations, dimensional drawings — everything the engineer needs.

SPECIFICATION SHEETS

Specification sheets for all RS switches have also been prepared. These sheets are printed on thin paper to permit blueprinting. The sectional drawings indicate standard and optional dimensions—make it easy for you to order production samples built to your requirements.

There is a Mallory switch to fit your design — write for further details.

Design engineers who specify Mallory RS switches *know* they are getting the best that substantial construction and precision manufacturing can produce. They know that Mallory RS switches protect their good name because they provide maximum long-life and efficient dependable service.

Mallory RS switches are available with cam and ball type index assembly, or with positive indexing hill-and-valley double roller type index assembly.

These are the features that make Mallory switches famous for dependability and quality. All are advantages of extreme importance in television and high frequency applications where stability is essential.

- Insulation of high-grade, low-loss laminated phenolic.
- Terminals and contacts of special Mallory spring alloy, heavily silver-plated to insure long life at low contact resistance.
- Terminals held securely by exclusive Mallory two-point fastening—heavy staples prevent loosening or twisting.
- Double wiping action on contacts with an inherent flexing feature—insures good electrical contact with the rotor shoes throughout rotation.
- Six rotor supports on the stator—insure accurate alignment.
- Brass rotor shoes, heavily silver-plated—insure low contact resistance.
- All shoes held flat and securely to phenolic rotor by rivets—prevents stubbing—insures smooth rotation—*minimum of noise in critical circuits.*

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CROSS TALK

► **OVERSEAS** . . . The prospect of establishing television service in foreign countries, particularly in Europe and South America, has the international sales departments of American, British and Dutch manufacturers in a dither. The crux of the matter is the standards to be adopted. Should they follow American or British practice? Evidently, the adoption of one or the other might give a preferred position in the market. So far as studio and transmitting equipment is concerned, it is not difficult to meet the customer's desires regarding standards without major increase in cost. But receivers are different: if foreign standards depart too widely from those used by the manufacturer in his domestic product, the cost of exported sets may rise substantially, possibly enough to price them out of the market.

We feel strongly that, whatever standards are adopted in foreign lands, they should not restrict the utility of the service. Further, at the risk of starting an international argument, we venture to remark that two important aspects of the British standards are restrictive. One is the use of a 2.5-mc video band, as compared with the 4.0-mc standard in the U.S.A. The choice of a narrow bandwidth must inevitably restrict the detail of the images provided to foreign customers. The second is the 25-per-second picture transmission rate, adopted in Britain to conform with the 50-cps power supply frequency. This limits the brightness of flicker-free images to a value substantially lower than that possible with the 30-per-second American rate. It is true that the majority of European countries now in the market for television systems use 50-cycle power, and that the 25-per-second frame rate is attractive for that reason. But in South America and the Orient, 50 and 60-cycle systems are mixed, often in adjacent cities within range of a single station. Moreover, experience in America has shown that 30-frame sets can operate satisfactorily on 50-cycle power systems.

These are the only important items. We hold no strong brief for the horizontal polarization or the negative polarity of modulation used in the United States. But we do believe that television service overseas should have the benefit of the wider frequency range and the higher frame rate provided in the American standards.

► **RADLAB** . . . We have modestly refrained thus far from commenting in this column on a publishing venture of which the McGraw-Hill Book Company is particularly proud. This is the Radiation Laboratory Series, a truly definitive compilation of radar information in 27 volumes, prepared by staff members of the MIT laboratory. But we can hardly withhold the information, just announced, that the royalty earned on the 1948 sales of this series, and paid to the Treasury of the United States, amounted to $34,253.61. Our many friends of Radlab days will no doubt be gratified to know that, at long last, their efforts have resulted in a payment *to* the Treasury rather than *from* it. Incidentally, we think this Series is an excellent argument in favor of the growing trend among government activities to seek commercial publishers for important works of this type.

► **RAZORS ONLY** . . . While returning from a recent trip to the West Coast, we were so bold as to plug a portable television set into the 115-volt a-c socket provided in our Pullman bedroom for electric razors. Apparently there were at least 115 watts back of the socket, because the set went to work. An aerial made of twin-lead ribbon, hung on the window with suction cups, provided the pickup. So, going through Cleveland on the New York Central, we saw the fights from Madison Square Garden, courtesy station WNBK, and a basketball game, courtesy WEWS. Incidentally the set, with an aerial on the ground floor of a home in San Diego, picked up a good picture from KNBH atop Mount Wilson at Los Angeles, at an airline distance of 115 miles. This is no particular credit to the set, since everyone in San Diego gets the LA stations. But it does show that the California microvolts are just about as big as the California kilowatts. Total score for the trip: 20 stations in five cities.

Exposure to Microwaves

Recent experiments on animals with high-intensity 12-cm radiation indicate that a dangerous amount of heat may be generated beneath the surface of living tissue without causing fever or the sensation of pain

By W. W. SALISBURY
Director of Research
Collins Radio Company
Cedar Rapids, Iowa

JOHN W. CLARK
Research Division
Collins Radio Company
Cedar Rapids, Iowa

and H. M. HINES
Department of Physiology
University of Iowa
Iowa City, Iowa

A LARGE number of preliminary experiments conducted with anesthetized laboratory animals indicate that injury by exposure to microwave radiation may occur at relatively low field intensity. It has also been found that pain cannot always be relied upon to warn of a dangerous field.

The most vulnerable parts of the body are those not abundantly supplied with blood. Blood is an effective coolant and acts to distribute heat developed at the site of irradiation, preventing excessive local temperature rise. Certain parts of the body are not effectively cooled by the blood stream. Examples are the lens of the eye and some internal organs such as the gall bladder, urinary bladder and parts of the intestines. When such organs are subjected to microwave irradiation very high local temperatures may result.

Result of Experiments

A series of experiments was performed on rabbits to determine the extent of damage to the eye. These animals were chosen because their eyes closely approximate the size and shape of the human eye. It was found that cataracts were formed upon exposure for 10 minutes at a field intensity of about 3 watts per square centimeter at a wavelength of 12 cm. The cataracts do not become apparent immediately, but develop 3 to 10 days after exposure. Infrared, ultraviolet and x-ray radiations are known to produce painless lenticular changes in human eyes. Apparently, microwave exposure will produce similar results much more rapidly. However, to date no experiments have been performed on humans.

Pulsed Power

No experiments have yet been performed to evaluate the relative dangers of pulsed power as compared to continuous power. However, rough calculations of the thermal time constants of typical physiological structures indicate that these are long as compared to the interval between pulses in typical radar sets. Accordingly, it seems reasonable to evaluate the danger from apparatus of this type in terms of average power rather than peak power.

Experiments have been performed at wavelengths other than 12 cm. Preliminary results indicate a radical variation of physiological effects with wavelength. These can be ascribed to variation in loss factor of the body with wavelength.

At longer wavelengths where the loss factor is relatively low the temperature of the whole body is raised, giving rise to artificial fever and to a sensation of warmth but with little danger of tissue damage. At extremely high frequencies the loss factor is relatively high and energy is largely absorbed near the surface. This may cause severe surface burns, but ordinarily the sensation of pain will give ample warning in such cases. At wavelengths in the vicinity of 10 cm, on the other hand, the loss factor is such as to cause the highest temperatures to occur about a cm below the surface in structures not cooled by an abundant flow of blood. Figure 1 illustrates these points.

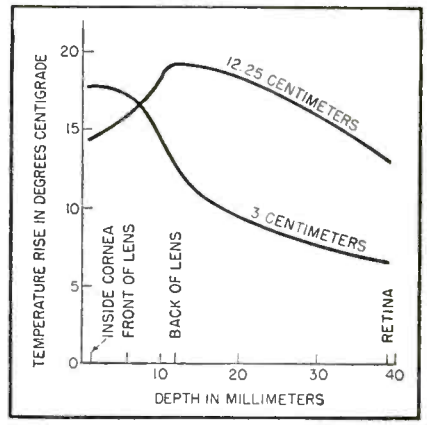


FIG. 1—Experimentally-determined variation of temperature in an excised beef eye exposed to microwave radiation

Technical Explanation

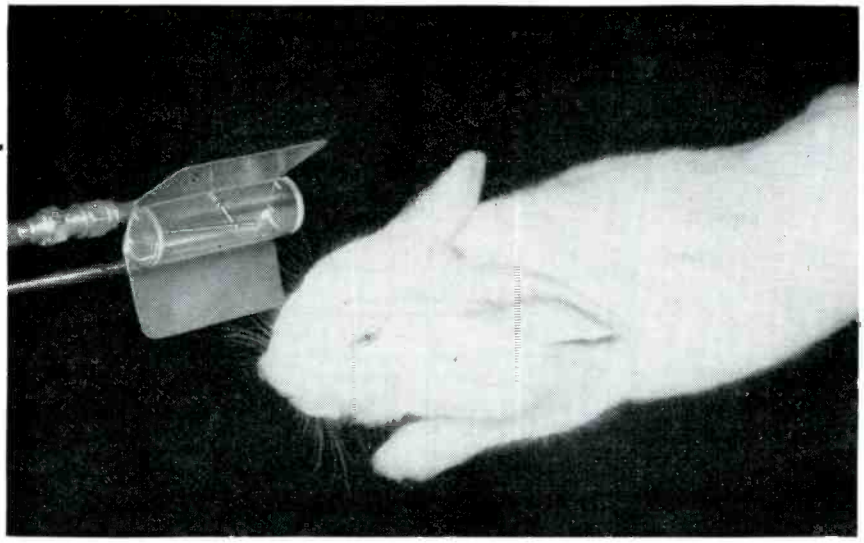
Consider a greatly simplified situation. A plane wave of electromagnetic radiation falls upon an idealized animal, assumed to be a homogeneous dissipative medium. The energy density in the electromagnetic field a distance x below the surface of the animal is

$$E = E_0 e^{-ax} \qquad (1)$$

where E_0 is the energy density

A WARNING—NOT A PRESCRIPTION

The purpose of the authors and editors in presenting this article is to warn workers against the dangers of uncontrolled exposure to high-intensity r-f energy, not to recommend for or against any method of diathermy or any particular frequency for medical treatment. The latter matters are the concern of competent medical specialists, who alone can define the tolerable dosage and method of application in specific cases



Anesthetized rabbit being irradiated with 12-centimeter radio waves

(measured in watts per square centimeter) at the surface and α is the attenuation constant of the medium. Since α is the fraction of the energy removed from the beam in one centimeter, the energy transferred to the medium as heat is just α times the energy density at the point in question. This transfer of energy from the beam of electromagnetic radiation to heat in the tissue is assumed to be solely due to dielectric heating. Let us define $H(x)$ as the number of watts per cubic centimeter of heat energy transferred from the beam to the medium. Then

$$H(x) = \alpha E(x) = \alpha E_o e^{-\alpha x} \quad (2)$$

It is well known that the loss factor and hence the attenuation constant of most materials increases with frequency. This is certainly true of water, which makes up the greatest part of most tissues. We can accordingly draw qualitative curves of $E(x)$ and $H(x)$ for our idealized animals at a low and a high frequency. These are shown in Fig. 2A and 2B respectively.

The temperature rise caused by a distribution of heat like that shown in Fig. 2B depends entirely upon the cooling of the medium. In absence of any cooling, the temperature at any point, $T(x)$, will be proportional to the total number of joules of energy that has been put into the medium at the point x. That is

$$T(x) = CH(x)t \quad (3)$$

where C is the thermal capacity per unit volume of the medium and t is the time of exposure. So in this case the shape of the temperature function is the same as that of the heat function.

A part of the body such as the eye, which is free from blood vessels, is cooled mostly by convection from the surface. In this case the temperature of the surface will be maintained at or near room temperature, T_o. Deep in the structure, however, the effect of conductive cooling is negligible and the temperature will vary as in Eq. 3. Figure 2C shows temperature curves for this case.

Findings Are Preliminary

Work to date has merely demonstrated the danger from exposure to microwaves, particularly in the vicinity of 10-cm wavelength. It must be emphasized that no standards of safety have as yet been established; in the meantime, microwave radiation should be treated with the same respect as are other energetic radiations such as X-rays, α-rays and neutrons.

Several previous investigators have failed to find damage due to microwave irradiations. This is probably due to either or both of two causes: the field intensity was not high enough, or the investigators did not wait long enough for latent damage to develop. The field strength known to be dangerous, 3 watts per square centimeter, is not likely to occur except in the immediate vicinity of a powerful transmitter. The area of cross section of a typical 10-cm waveguide is about 28 square centimeters. Accordingly, one must have a total power of about 90 watts to reach the danger level. In free space the energy is much less concentrated, so a much larger total power is required.

Acknowledgments

This paper is a preliminary report on a cooperative project between the Research Division of Collins Radio Company and the Department of Physiology of the University of Iowa. The experiments were supported by the Rand Corporation and the United States Air Force.

The writers acknowledge the assistance of J. E. Randall and P. R. Finger, of the Collins Research Division in developing and operating the apparatus which made this work possible, and of A. W. Richardson, Barbara Feucht and C. J. Imig of the Department of Physiology, University of Iowa, in the biological phases of the work.

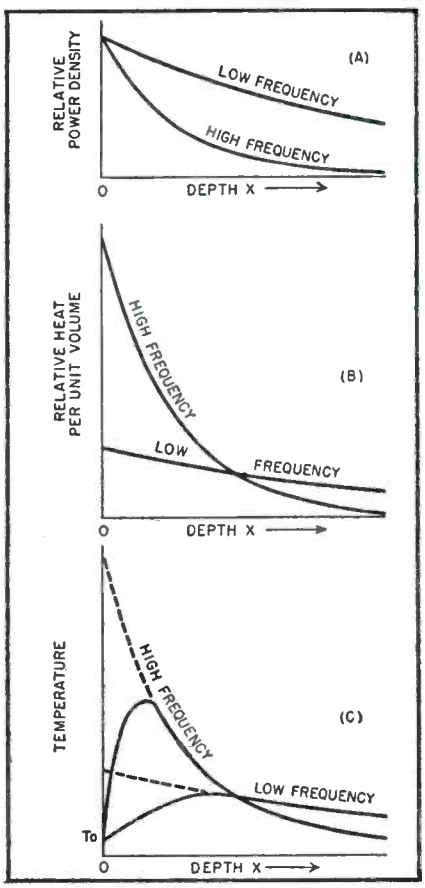


FIG. 2—Variations with depth in an idealized animal. Curves of (C) are calculated, assuming no cooling due to circulation of blood

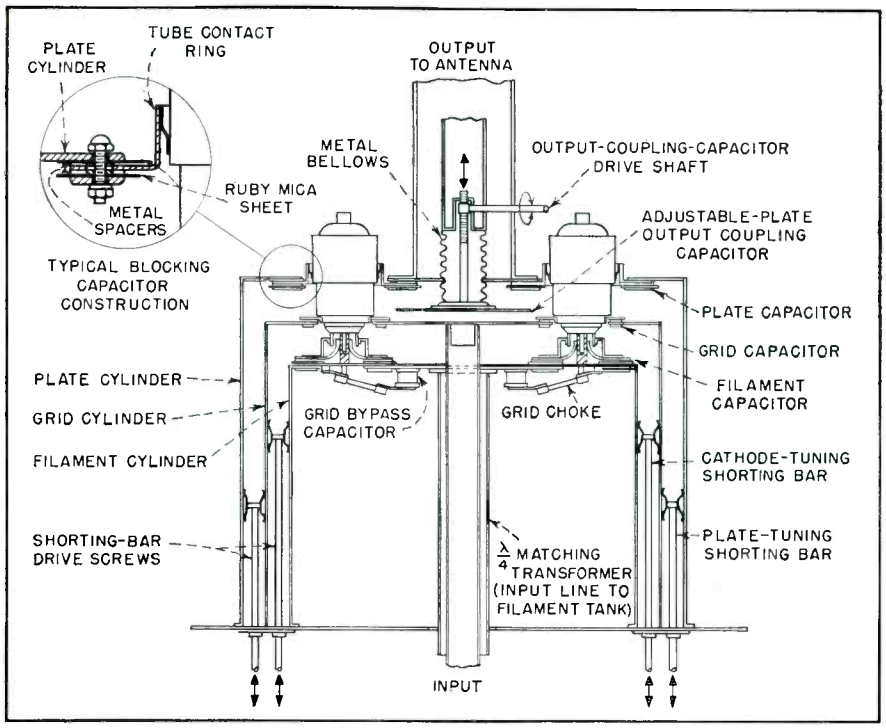


FIG. 2—Cross-section of the amplifier tank arrangement, with detail of typical blocking-capacitor construction

A Coaxial 50-Kw

The Symmetron amplifier, employing eight air-cooled triodes in a grid-separation circuit and driven by a 12.5-kw exciter, requires 118 kva at 90-percent power factor for rated 50-kw output. Tank design calculations and experimental values for production prototype are given

FREQUENCY MODULATION has become an established broadcasting service, the spread of which has created a demand for high-power frequency-modulated transmitters. The general manufacturing pattern followed has been to meet the demands of f-m broadcasters by supplying transmitters starting at 250 or 1,000 watts and, in building-block style, adding higher-power amplifiers as complete units. The basic transmitters are then used as exciter-drivers. The Symmetron 50-kw amplifier to be described has been specifically designed to complete a 50-kw transmitter utilizing a nominal 10-kw transmitter as the exciter-driver.

The R-F Tank Circuit

The design of a 50-kw radio-frequency amplifier for the 88-to-108-mc band presents numerous problems to the circuit designer. Many tube types, proved reliable in operation at lower frequencies, become unusable in this band owing to excessive interelectrode capacitances, high grid or filament-lead inductance, and the attendant difficulties presented by the physical dimensions of the tube elements approaching appreciable fractions of a wavelength at the operating frequency. Lumped circuit constants are, for the greater part, unusable because of the undesired effects of distributed inductance or capacitance. Linear circuit elements such as open-wire or coaxial transmission-line sections are suitable, but often tax the ingenuity of the designer in providing means for tuning, input and output coupling, and in obtaining satisfactory electrical clearances for the low-impedance tanks associated with high-power-level operation.

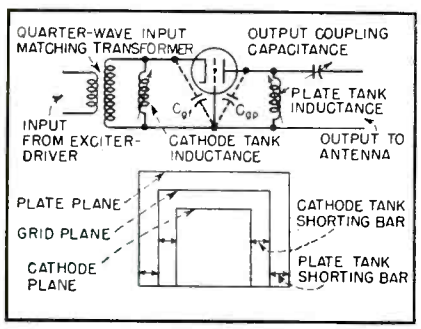


FIG. 1—Equivalent circuit and basic tank configuration of the amplifier

These difficulties justified the construction of a model to realize the greatest possibilities from an amplifier of commercial design. Consideration was given to different tank designs, with the following features regarded as essential: an amplifier using air-cooled tubes to eliminate the water jackets, pumps, cooling radiators, and other inconveniences of water-cooled tubes; a tank employing a grounded-grid, or grid-separation circuit, for design simplicity and reliability.

An investigation of possible tank designs, based on these considerations led to two alternatives, each appearing to satisfy operating requirements. It was decided in subsequent planning to complete each of these tank designs on paper to evaluate more thoroughly their respective merits.

The first tank type considered was of conventional grounded-grid, push-pull design using two type 3X12500A3 cluster-triode tubes. Shielded two-wire lines with loop coupling were used in the cathode and plate tanks. Inherent limitations and difficulties appeared as this design progressed. The shielded

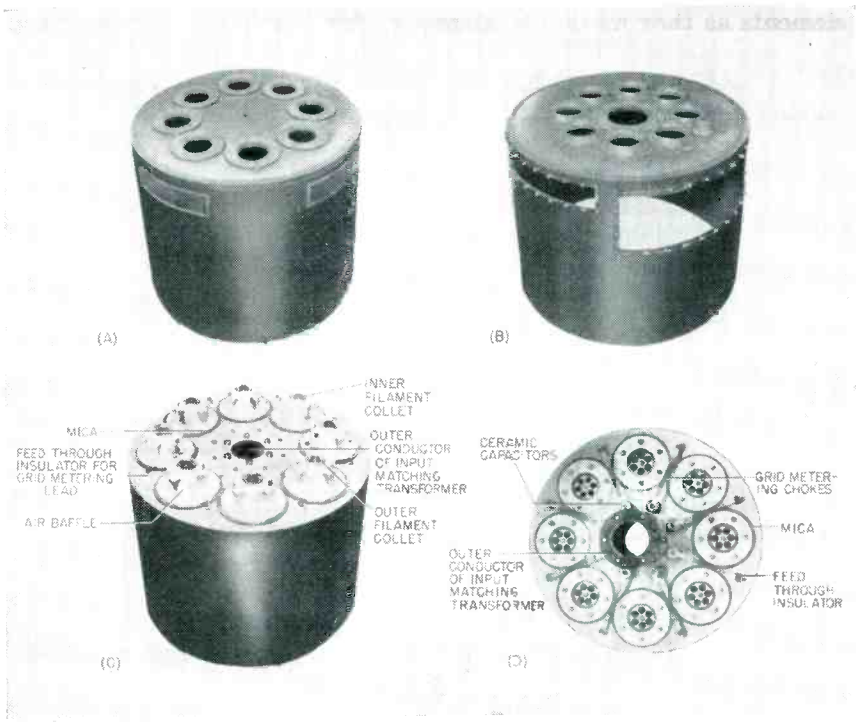


FIG. 3—Plate cylinder (A), grid cylinder (B), filament cylinder (C), and underside of filament cylinder top plate (D) used in the amplifier

F-M Broadcast Amplifier

By D. L. BALTHIS

Electronics and X-Ray Div.
Westinghouse Electric Corp.
Baltimore, Md.

plate tank, when designed for the low required impedance of approximately 35 ohms at 100 mc, left inadequate space for the output coupling loop and, in turn, the loop upset circuit symmetry. Contact was desired between the plate-line shorting bar and the shield enclosing the plate lines to prevent undesired resonance effects. This necessitated shunt feeding the lines through a blocking capacitor, or operating the shield at high d-c potentials in a protective enclosure. Likewise, the shorting bar and output coupling loop required adjustable mountings, since their positioning would have been dependent on the operating frequency. Similar difficulties existed in the design of the cathode tank. These problems, although solved on paper, resulted in a mechanically complex tank with numerous adjustable controls. This tank was regarded as impractical from a production standpoint and was eliminated from the program.

Development Model

The tank circuit regarded as worthy of model development was a coaxial-ring amplifier of new design employing eight type 3X2500A3 air-cooled triode amplifier tubes[1] in parallel. This design was completed on paper and followed by the construction of a test model which proved successful. An output in excess of 50 kw was obtained without stray radiation and with no tendency toward parasitic oscillations or moding. The apparent amplifier efficiency varied between 90 and 94 percent and the driving power required was approximately 12.5 kw for a 52-kw output. The only difficulty encountered was that the tuning range was limited to the low end of the 88-to-108-mc band, caused by the nominal plate tank impedance being too high. This impedance was lowered by reducing the diameter of the outer cylinder of the coaxial plate line. Proper operation throughout the 88-to-108-mc band resulted without further difficulty.

The tank circuit of the model is essentially duplicated in the commercial design. Consequently, the description to follow is applicable to either the test model or the commercial design.

The equivalent circuit of the 50-kw tank using lumped constants appears in Fig. 1, together with a cross-sectional view of the basic tank configuration. Referring to the circuit, it will be seen that the amplifier is a cathode-coupled, grid-separation circuit of straightforward design with only three adjustable tuning elements.

This circuit is operationally similar to the popular grounded-grid amplifier in that the input signal is applied between grid and filament, the output signal is removed between grid and plate, and the grid is used as a shield plane between filament and plate. It is not necessary for the grid to be at r-f ground potential in an amplifier of this type, although such may be the case in certain specific designs. Consequently, the term grid-separation will be adopted in describing this circuit. In turn, the grounded-grid amplifier becomes a special case of the more general grid-separation amplifier family.

In the equivalent circuit of Fig. 1, the input line is directly coupled to the cathode tank through a quarter-wave matching trans-

former that matches the cathode-tank impedance to the 51.5-ohm input transmission line. This matching transformer is of fixed design with no adjustable elements, and performs efficiently throughout the 88-to-108-mc band without alteration. The adjustable inductance elements are coaxial-line sections with shorting-bar tuning. The output capacitance is furnished by an adjustable air-dielectric capacitor coupling the output line between the grid and plate planes of the tank.

The cross-sectional view of Fig. 1 shows the basic mechanical configuration of the tank. This tank is a figure of revolution and, consequently, two coaxial-transmission-line sections are formed by the three cylinders extending downward from the plate, grid, and filament planes at the top of the figure. These coaxial line sections are tuned by ring-type shorting bars and, being less than one-quarter wavelength long, form the required plate and cathode inductive tank elements. The grid plane acts as a shield between the filament and the plate as shown in the equivalent circuit.

Mechanical Symmetry

It is essential that electrical and mechanical symmetry be preserved in high-frequency circuits employing linear circuit elements to assure balanced operation with uniform tube loading. The Symmetron amplifier employs coaxial tanks and the eight tubes are symmetrically inserted into the tanks about a common axis so that each tube automatically sees the same electrical and mechanical configuration for all operating frequencies.

The tank requires only three adjustable tuning controls—cathode tuning (shorting bar), plate tuning (shorting bar), and output coupling (capacitor). In the commercial design, these tuning controls are motor driven and tune through the complete 88-to-108-mc band without mechanical adjustment of the tank. In actual operation, tuning is accomplished with lever switches, while individual meters indicate the respective positions of the tuning elements as they move into place.

The cathode and plate shorting bars are used for both coarse and vernier tuning of the tank. These bars consist of phosphor-bronze contact-finger segments mounted about the inner and outer peripheries of a circular supporting ring. The contact-finger segments are three inches long, with twelve individual contact fingers per segment. The diameter of the smallest tank cylinder with which the contact fingers make contact is approximately twenty-two inches. This arrangement results in a corresponding large number of contact-finger segments for each tank cylinder, and a low current density for the individual contact fingers. The contact fingers extend on either side of the supporting member for balanced pressure loading. The contact surfaces of the fingers are formed in an elongated-spoon shape to form a free-sliding line contact and are buffed-chrome finished to provide a durable wearing surface against the silver-plated tank cylinders. It is interesting to note that the radio-frequency resistance of chrome is about the same as that of aluminum, and is sufficiently low for this application.

Adjustable coupling to the 6¼-inch output transmission line is provided through the circular plate capacitor in the plate cavity of the amplifier tank. The outer conductor of the transmission line is attached directly to the plate tank. The inner conductor is extended to the positionable capacitor plate through a flexible metal bellows approximating the diameter of the inner conductor. This bellows provides a smooth transition between the capacitor plate and the inner conductor of the transmission line, and allows the capacitor plate to be positioned along the axis of the tank by a rack-and-pinion drive mounted inside the inner conductor. The capacitor couples the output line between the grid and plate planes of the tank for voltage-standing-wave ratios up to 1.75-to-1 (RMA standard). In addition, the output coupling capacitor can be used as a voltage divider to control the output power taken from the 50-kw tank for operation at reduced power.

The tank design minimizes danger to operating personnel from either r-f or d-c voltages. Glyptal-bonded, ruby-mica blocking capacitors isolate the d-c tube voltages from all of the tank cylinders. Radio-frequency voltages are confined to the interior of the tank by virtue of the basic electrical operating characteristics of cavity or coaxial line tanks, so that the exterior of the tank is free of dangerous r-f potentials and, at the same time, stray r-f radiation is held to a minimum.

Special Capacitors

The construction of the plate blocking capacitor is shown in the expanded view at the top left of the tank in Fig. 2. Each layer of mica shown is 50 mils thick, being formed from two mica disks 25 mils thick. These mica disks are common to all eight tubes and are 26 inches in diameter. The voltage stress across the mica is approximately 100 volts per mil. The eight tube anodes are tied together by affixing the individual tube anode contact rings to a common plate which is a part of the plate blocking capacitor. The d-c anode voltage is fed to this common plate at a single point through a feed-through insulator in the top of the plate tank. The top of the tank is, consequently, free of d-c potentials except for the protruding tube anodes and their associated contact rings.

The plate-blocking capacitor construction is also representative of that employed for the grid and filament capacitors. However, for purposes of individual tube metering, these respective tube elements are not tied together. Likewise, an additional mica capacitor section is employed in the filament-blocking capacitors to bypass the two filament leads of each tube together and prevent a build-up of r-f voltage across the tube filaments.

The individual grid-current metering leads are brought directly downward from the individual grid contact rings, through the cathode tank cavity, and out through the top plate of the filament cylinder, using feed-through insulators, to r-f

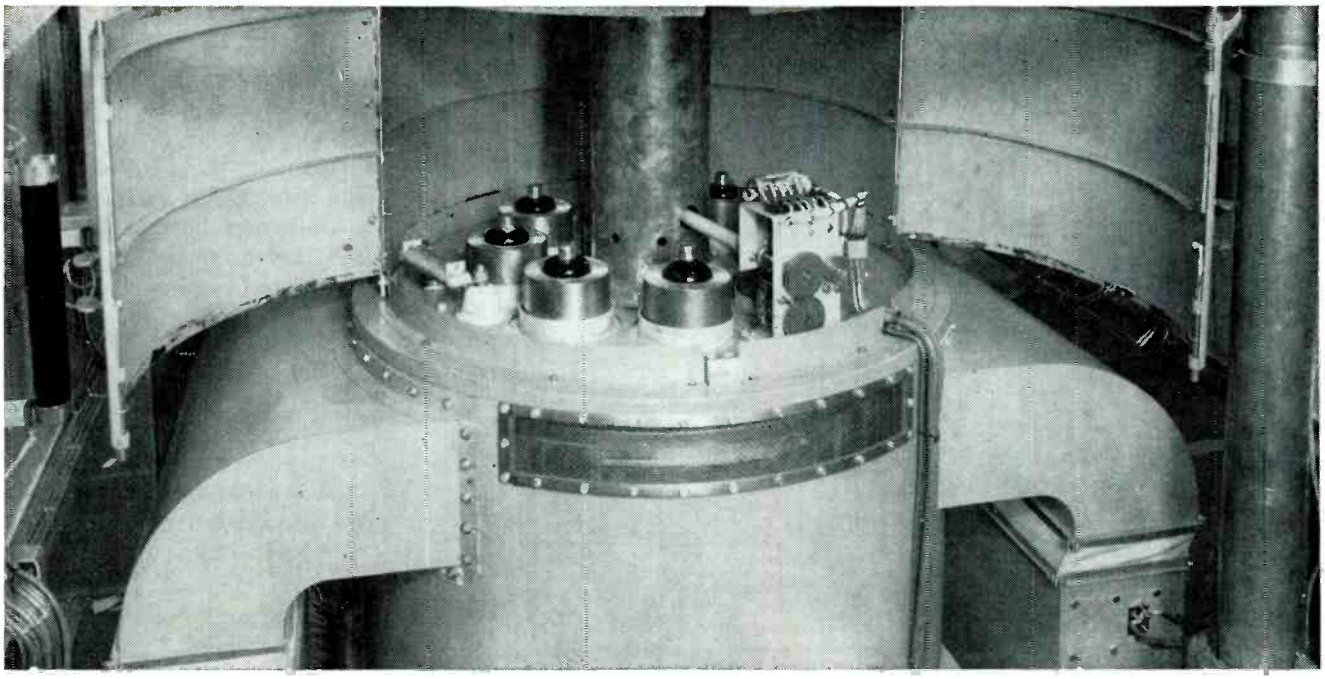


FIG. 4—Enclosed tank circuit showing air ducts entering at lower right and left. The plate choke is visible at the left of the tube compartment. The motor driving the output capacitor is at the right

chokes. These chokes followed by ceramic bypass capacitors prevent the r-f voltage, induced in the grid leads as they pass through the filament tank, from reaching the external metering circuit.

The quarter-wave transmission line matching transformer is shown extending directly downward from the center of the tank. This transformer is connected directly across the cathode cavity at the tank. The opposite end connects to the 3⅛-inch input transmission line.

In the selection of the type 3X2500A3 tube for the tank, full consideration was given to the important factors of interelectrode capacitance, lead inductance, cooling requirements, cost and life expectancy. The tube chosen is a 5.8-pound, relatively inexpensive, medium-mu transmitting triode with an external anode. The grid of the tube terminates in a ring interposed between plate and filament for grounded-grid or grid-separation circuit applications. Likewise, the tube contains a low-inductance thoriated tungsten filament structure of cylindrical design to permit a uniform transition between a tank employing linear circuit elements and the tube.

The 50-kw amplifier plate cylinder and top plate are shown in Fig. 3A. The eight anode contact rings can be seen extending through the top plate of the cylinder. These rings are attached to a common mounting plate and insulated from the top plate by sheet mica surrounding the rings. The d-c plate voltage is applied to the common mounting plate at a single point through the feed-through bushing. The output line is mounted directly in the center of the top plate. Two diametrically opposite tube viewing windows and two air-duct openings are provided in the cylinder. These openings are covered with ⅛-inch-mesh wire screen in the tank assembly to preserve the electrical symmetry of the circuit.

The grid cylinder and top plate are shown in Fig. 3B. The eight grid contact rings are symmetrically mounted in the top plate. These rings are individually insulated from the top plate for metering purposes by sheet mica that projects outward from the rings. Four screen-covered air openings in the cylinder allow cooling air to pass through the cylinder for the tube filament seals.

The filament cylinder and top plate appear in Fig. 3C. The tubes employ a coaxial filament structure and the inner and outer filament collets make contact to it. The air baffles direct cooling air brought in through the grid tank up into the filament-seal structures and out through the bottom of the filament-tank top plate. The eight feed-through insulators are a part of the grid metering circuit. The underside of the filament-cylinder top plate is shown in Fig. 3D. The eight radially mounted grid chokes are suspended between the feed-through insulators shown in the preceding figure and the ceramic bypass capacitors. The holes in the filament-blocking-capacitor disks permit exhaust of the cooling air from the filament seals. The filament leads to the tubes are attached to the bolt at the center of this disk and any one of the other bolts around the mounting ring.

A front view of the 50-kw amplifier test model with all components assembled is shown in Fig. 4. The tube compartment above the tank serves as the exhaust duct for the cooling air blown through the tube anode coolers and protects operating personnel from the d-c voltages on the tube anodes. These tube compartment doors are hinged for easy access. The anodes of the type 3X2500A3 tubes can be seen

projecting upward through the top plate of the plate cylinder. These tubes are readily removed from the tank by lifting vertically upward. The Teflon shaft extending into the 6⅛-inch transmission line from the output-coupling-capacitor drive-motor assembly engages the rack-and-pinion postioning drive built into the inner conductor of the 6⅛-inch line. The d-c plate potential is applied to the tank through the plate choke at the left of the compartment.

The cathode and plate tank tuning motors appear on the underside of the bed-plate mounting the tank cylinders. The grid bias resistors are located on the side walls of the cubicle frame, and the filament transformers on the cubicle floor.

Tank Design Calculations

The physical constants for a re-entrant tank of the type employed in the Symmetron amplifier can be calculated quite accurately through rigorous mathematical approaches, or approximated on the basis of lumped constants. The following analysis is given to illustrate the more important factors entering the design. This analysis will, for convenience, include in the order stated, the output coupling capacitor, the plate tank, and the cathode tank.

The output coupling capacitor couples the 51.5-ohm output transmission line directly across the plate cavity, or between the grid and plate planes of the tank. This capacitance must then act as a voltage divider between the tank and the output line to permit delivery of the rated power of 50 kw to the output load. If the antenna is matched to the line and the line is flat, the impedance looking into the output line will be 51.5 ohms. Likewise, the voltage standing wave ratio on the output line will be unity. However, under RMA design standards, allowable mismatches in the output line and antenna representing a maximum voltage standing wave ratio of 1.75-to-1 on the output line may be present. Under this condition, reading from a Smith chart, the input impedance of the output line may vary from 29.5 or 90.0 ohms to 61.7 ± j30.9 ohms, depending upon the length of the

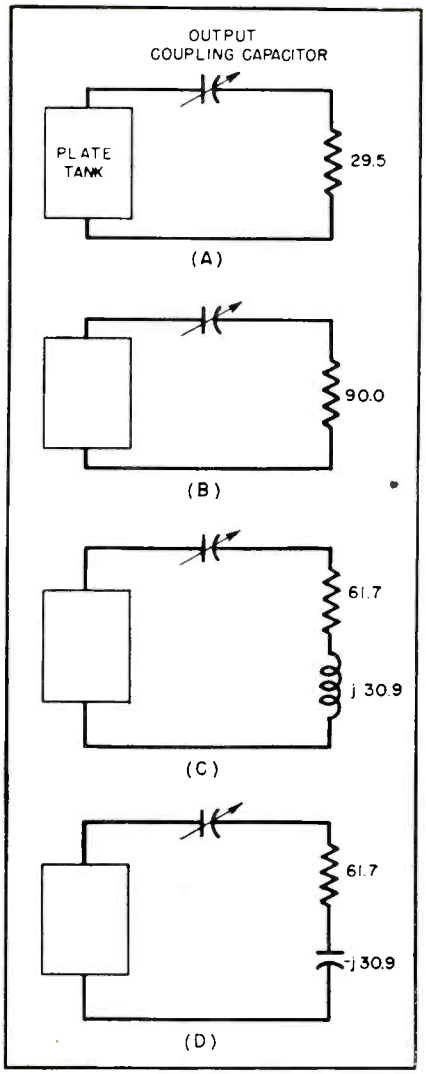


FIG. 5—Limit configurations seen by 50-kw amplifier with 1.75-to-1 vswr on output line

line. These values represent design limits, and the circuit seen by the plate tank may take any one of these limit configurations as shown in Fig. 5.

The r-f voltage across the tank can be approximately determined from tube handbook data. It then becomes a simple matter to compute the required coupling capacitance for each of the limit conditions. Typically, for the type 3X2500A3 tube, at an applied plate supply voltage of 3,700 v d-c, the grid bias voltage is −450 v d-c. Assuming class-C operation with a plate current angle of 120 degrees, the peak grid driving voltage is 450/cos 60 or 900 v peak.

In a properly excited class-C amplifier, the plate voltage will very nearly swing down to the value of the peak positive grid voltage. The latter is equal to 900 minus 450 volts, or 450 volts. The plate voltage swing E_p, is 3,700–450 volts, or 3,250 volts peak. However, in a grounded-grid, or grid separation amplifier, the grid-to-filament voltage also acts in series with the plate voltage swing to supply the load. The voltage across the load, E_L, therefore becomes

$$\begin{aligned} E_L &= E_p + E_g \\ &= 3,250 + 900 \\ &= 4,150 \text{ peak v} \\ \text{or } E_L &= 4,150 \times 0.707 = 2,930 \text{ rms v} \\ &\text{or approximately } 3,000 \text{ rms v} \end{aligned}$$

For the circuit of Fig. 5A, 50 kw must be developed in the load resistance of 29.5 ohms. This power is accomplished by a load current I of

$$\begin{aligned} I^2 &= \text{watts}/R \\ &= 50,000/29.5 \\ &= 1,690 \\ I &= 41.1 \text{ rms amp} \end{aligned}$$

For this current, the impedance Z seen by the plate tank must be

$$\begin{aligned} Z &= E/I \\ &= 3,000/41.1, \\ &= 73 \text{ ohms} \end{aligned}$$

This impedance is provided by the reactance of the output coupling capacitor X_c in series with the 29.5-ohms resistance. Therefore

$$\begin{aligned} Z &= [(29.5)^2 + (X_c)^2]^{1/2} \\ (73)^2 &= (29.5)^2 + X_c^2 \\ X_c^2 &= 4,459 \\ X_c &= 66.9 \text{ ohms} \end{aligned}$$

The value corresponds to a coupling capacitor size of 23.8 μμf at 100 mc. A similar determination of the coupling capacitance for the circuits in Fig. 5A, B, C or D indicates that the variable range of the capacitor should be from approximately 15 to 26 μμf. This capacitance range is conveniently obtained using a positionable plate in the plate cavity of about eight inches diameter, and at the same time allowing sufficient space to prevent voltage flashovers.

The Plate Tank

The plate tank impedance is provided by a capacitive reactance X_c, an inductive reactance X_L, and a resistive component R. In normal operation, using tube handbook data, this impedance Z is

$$\begin{aligned} Z &= E_L^2 \text{ rms/watts} \\ &= (3,000)^2/50,000 \\ &= 180 \text{ ohms} \end{aligned}$$

The inductive reactance X_L is that provided by the coaxial tank. The capacitive reactance X_c is provided by the grid-to-plate capacitance of the tubes, the capacitance of the top plates of the cylinders forming the coaxial tank, and the shunt capacitance reflected from the output transmission line.

The tube capacitance is eight times that of a single tube since the tubes are in parallel. Using tube handbook data, this is

$C_{tubes} = 20 \times 8 = 160\ \mu\mu f$

The capacitance provided by the tank construction is a function of the physical size of the tank. The diameter of the top plate of the grid cylinder is approximately 25 inches, and its spacing from the top plate of the plate cylinder about 2½ inches. The approximate capacitance provided by the top plate is represented by

$C_{tank} = 0.2244\ KA/d$
$K = 1$
$A = 3.14 \times (25)^2/4 = 490$ sq in.
$C_{tank} = 0.2244 \times 490/2.5 = 44\ \mu\mu f$

The capacitance across the tank provided by the output line and antenna may be determined by finding the shunt equivalents for each of the series circuits of Fig. 5. Typically, for the circuit of Fig. 5A the series circuit impedance Z is

$Z = R - j\,X_c$
$R = 29.5$ ohms
$X_c = 66.9$ ohms (at 100 mc)

Using straightforward algebra in conjunction with the basic formulas for the impedance of parallel circuits, it can be shown that the equivalent shunt capacitive reactance X_{c1} is

$X_{c1} = (X_c^2 + R^2)/X_c$, where X_c and R are the series circuit constants
$X_{c1} = [(66.9)^2 + (29.5)^2]/66.9$
$X_{c1} = 5{,}355/66.9 = 80$ ohms

This capacitive reactance of 80 ohms will be tuned out by the inductance of the tank when the tank is parallel resonant. The capacitance of the tank and tubes, as previously calculated, is 160 + 44 or 204 μμf. This represents a capacitive reactance of 7.8 ohms at 100 mc. The tank inductance X_L must be sufficiently large to look inductive by 80 ohms considering this 7.8-ohm capacitive reactance. The following relationship exists considering the parallel circuit formed by the tank inductance X_L and the loading capacitance of 7.8 ohms.

$jX_L(-j7.8)/(jX_L - j7.8) = j\,80$
$7.8\,X_L = 624 - 80\,X_L$
$87.8\,X_L = 624$
$X_L = 7.1$ ohms

The required inductive reactance can be computed in the same manner for 88 and 108 mc. If this computation is done for all four configurations shown in Fig. 5, the design limits in tuning reactance values required for the tank will be established. Actually, these calculated values are high because of the approximations employed. In the model, an inductive reactance of approximately four ohms was required at 100 mc, assuming that the coaxial cavity started at the level of the top plate in the grid cylinder and extended to the top surface of the shorting bar.

It will be seen from the foregoing that the required plate tank inductive reactances are low and of the order of four ohms. Values in this range are readily obtained with coaxial transmission line construction. In the production design tank, the surge impedance of the plate line is nominally 5.7 ohms using a plate cylinder having an inside diameter of 27⅝ inches and a grid cylinder having an outside diameter of 25⅛ inches. The shorting-bar travel, including safety allowances at either end of the band, is approximately 16½ inches.

The Cathode Tank

The cathode-tank impedance is that comprised by an inductive reactance X_L, a capacitive reactance X_c, and a resistive component R. The inductive reactance of the coaxial tank X_L is used to tune out the capacitive reactance X_c provided by the grid-to-filament capacitance of the tubes and the top-plate construction of the grid and filament cylinders. The resistive component R is that provided by the grid losses of the tubes and bias resistors and the resistive component created because the driver supplies power to the load.

The driving power required is approximately 12.8 kw (from tube handbook data) for an output of approximately 55 kw at a grid-bias voltage of −450. Assuming class-C operation with a plate current angle of 120 degrees, the grid driving voltage E_g is

$E_g = 450/\cos 60$
$E_g = 450/0.5 = 900$ peak v
$E_g = 900 \times 0.707 = 636$ rms v

The impedance Z of the filament tank is

$Z = E^2/P = 636^2/12{,}800$
$Z = 405{,}000/12{,}800 = 31.6$ ohms

This impedance of 31.6 ohms is matched to the 51.5-ohm input transmission line through a quarter-wave matching transformer made of a standard 3⅛-inch transmission-line outer conductor and a special inner conductor. As previously indicated, this matching section performs efficiently through the 88-to-108-mc band. It is, however, designed for a nominal frequency of 98 mc.

The capacitance across the cathode tank contributed by the tubes is eight times that of a single tube,

$C_{tubes} = 8 \times 48 = 384\ \mu\mu f$

The diameter of the top plate of the filament cylinder is approximately 22 inches, and the spacing to the top plate of the grid cylinder 2½ inches. The approximate capacitance contributed by the tank construction is

$C_{tank} = 0.2244\ KA/d$
$K = 1$
$A = 3.14 \times 22^2/4 = 380$ sq in.
$C_{tank} = 0.2244 \times 380/2.5 = 34\ \mu\mu f$

The combined capacitance of the tubes and tank in parallel is approximately 384 + 34, or 418 μμf. This capacitance represents a capacitive reactance of 3.8 ohms at 100 mc which, in turn, is tuned out by the inductive reactance of the tank. The design limits are obtained by computing the capacitive reactance for 88 and 108 mc and designing the coaxial tank to give an equal and opposite reactance.

In the model, the cathode tank impedance at 100 mc is 2.9 ohms, assuming that the coaxial tank starts at the level of the top plate in the filament cylinder.

In the production design, the cathode tank has about 7.6 ohms. The inside diameter of the grid cylinder is 25 inches and the outside diameter of the filament cylinder 22 inches. The travel of the shorting bar in the cathode, including a safety allowance, is about 16½ in.

REFERENCE

(1) R. L. Norton, B. O. Ballou, and R. H. Chamberlin, KSBR's 50-Kw High-Band F-M Transmitter, ELECTRONICS, p 80, Oct. 1947.

Balcony view of part of the $7,000,000 equipment display at the Grand Central Palace during the 1949 IRE national convention in New York City March 7-10

IRE National Convention

Biggest meeting in the 37-year history of the Institute of Radio Engineers drew attendance of 16,160. Seven million dollars worth of equipment was displayed. Most exhibits lived up to convention slogan, "Spotlight the New"

THE STATISTICAL SUCCESS of this year's national IRE convention is already history. During the four-day meeting, held in the Commodore Hotel and Grand Central Palace in New York City, March 7-10, over 16,000 scientists, engineers and technicians interested in the field of electronics witnessed the multimillion-dollar show which was prepared for them.

In all, over $7,000,000 worth of equipment was on display. This collection of gear was spread over three floors of the block-long Grand Central Palace in 220 exhibits.

Annual Awards

At the President's luncheon honoring incoming IRE president Stuart L. Bailey, Civil Aeronautics Administrator Delos W. Rentzel briefly outlined a program for new aids to air navigation. In his talk, Rentzel described navigational aids now in use in commercial air lines, including ILS and GCA landing systems. He predicted that such devices would eventually be within the reach of private aircraft owners, and that air lines would soon be operating on dependable precision schedules.

At the annual awards banquet Ralph Bown of the Bell Telephone Laboratories was this year's recipient of the IRE Medal of Honor for his extensive contributions to the field of radio and for his leadership in Institute affairs. Claude E. Shannon, also of BTL, received the Morris Liebmann Memorial Prize for original and important contributions to the theory of the transmission of information in the presence of noise, and R. V. Pound of Harvard University was presented with the Browder J. Thompson Memorial award for his paper "Frequency Stabilization of Microwave Oscillators."

Thirty-one IRE fellowship awards (ELECTRONICS, p 140, January) were presented at the banquet.

The main speaker of the evening was Frank Stanton, president of the Columbia Broadcasting System, who discussed television and its qualifications as an almost perfect mass medium. Stanton was introduced by toastmaster Raymond F. Guy (NBC).

Technical Papers

About 170 technical papers (p 138, March) were presented during the four-day meeting. Particular emphasis was placed on television, instruments and measurements,

IRE president Stuart L. Bailey (right) presents Medal of Honor to Ralph Bown for his original and important contributions to the field of radio

Highlights

electronic computers, navigation aids, and nucleonics.

In a symposium on Electronic Computing Machines one of the most talked about papers of the convention was presented. It described a computer which is capable of being programmed to play a game of chess.

Among the relatively new developments discussed during the Components and Materials technical session was a new class of plastics that are known to have substantial and predeterminable electrical conductivities.

Highlighting the third Instruments and Measurements session was a paper describing a special tungsten-filament X-ray tube which is energized at rates as high as 150 pulses per second at 150 kv and 60 amperes by a circuit similar to a radar line-type modulator.

UHF television was discussed at two separate technical sessions. One speaker predicted 1 to 1½ years before commercial use of these frequencies for television is a reality, while another thought a period of at least 3 years would be required.

Exhibits

On the third floor of Grand Central Palace the spasmodic clicking of nuclear instruments and the periodic beeping of the Army's moon radar mock-up blended with the rattle of machine guns and bomb explosions coming from the Air Force's packaged movies, which depicted advancements in modern warfare methods.

Another noise maker, which, though not strictly electronic in nature, attracted considerable attention, was the Navy's dropping-ball test for determining the impact resistance of different materials. The material which proved to be most impervious under these tests was, strangely enough, a glass composition which showed practically no effect when hit with the dropping ball.

The Signal Corps displayed a miniature village in which sub-zero weather conditions were simulated even to the extent that real snow was produced. Another exhibit featured a cigarette-package-sized transmitter using sub-miniature components.

The second floor, where ELECTRONICS had a booth, rang with the highs and lows of high-fidelity music as sound-system manufacturers displayed their wares in rooms just off the main exhibit area. This floor was dotted generously with component displays of every description, and a number of custom-built and build-it-yourself television receivers were shown. Television antennas were everywhere.

The main floor had the usual multi-booth displays. In one corner of the floor a cathode-ray tube indicator flashed blinding 20,000-volt pictures, while out in the center, taking advantage of the high ceiling in the Palace, a transmitting antenna company had erected a two-story tower all decked out with appropriate beacon lights.

Proving claims that new speakers and pickups would be "unaffected by excessive moisture and humidity", a complete phonograph operating amid a school of live (though somewhat bored) goldfish in a glass-sided aquarium filled with water was exhibited.

A time-proven crowd collector, the one-armed bandit, gave booth visitors an opportunity to test their luck in a television console game of chance. Special slugs were provided, one at a time for each participant, and when the machine payed off, the slugs were redeemable for chances on the console at the rate of ten slugs per chance. This popular sport was discontinued midway in the show, however, due to a legal technicality.

Three exhibitors gave engineers a chance to experience the feeling of being on the high-salaried end of television cameras. Three cameras, and their associated monitoring and viewing screens, kept constant vigil on the crowds. One camera, stationed at the railing of the balcony, was equipped with a Zoomar lens for close inspection of the main-floor exhibits.

A completely-equipped mobile television pick-up bus was parked in the freight room for inspection.—J.D.F.

Beam-Deflection MIXER TUBES for UHF

Deflection techniques applied to a mixer tube may permit operation of a television receiver up to 900 megacycles with performance superior to that of present receivers in regard to signal-to-noise ratio, oscillator radiation and gain

By E. W. HEROLD and C. W. MUELLER

RCA Laboratories Division
Radio Corporation of America
Princeton, New Jersey

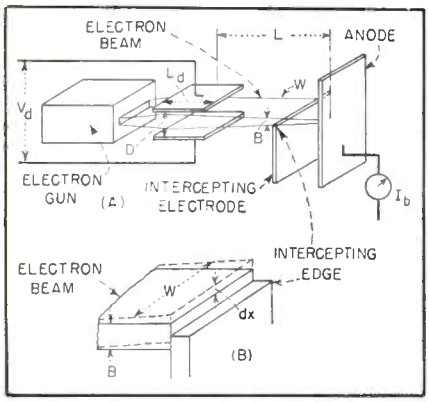


FIG. 1—Simplified beam-deflection tube: (A) schematic view; (B) enlarged view at intercepting edge

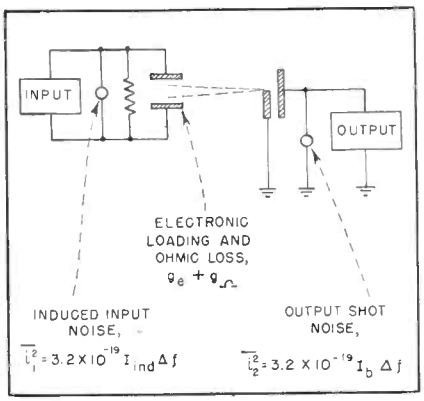


FIG. 2—Equivalent circuit of beam-deflection tube with noise generators and input resistance indicated

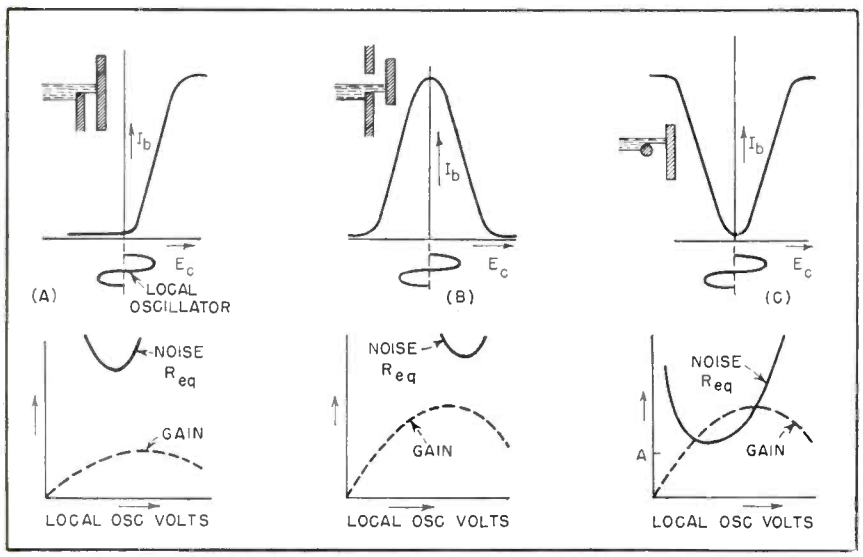


FIG. 3—A comparison of three methods of design and mixer operation for beam-deflection tubes. The method at the right gives high gain and an equivalent noise resistance not very different from that of amplifier operation, shown at *A*

AMPLIFIER AND MIXER tubes using beam deflection have been proposed in the past but the development to be described is among the few which appear to have marked advantages over more conventional tubes at the higher frequencies.

The present work started[1] because of an interest in multistage secondary-emission amplifier tubes, which require a higher ratio of transconductance to current than can be obtained with grid control. It was later found that beam-deflection tubes were advantageous by themselves, particularly for achieving a high signal-to-noise ratio independently of the use of a secondary-emission multiplier. Since it had already been shown that beam-deflection control was particularly well suited for superheterodyne mixer tubes,[2] this method of operation was given most attention.

Beam-Deflection Control

The general principles of beam-deflection control for amplifiers are perhaps most easily understood by reference to Fig. 1A, which shows a simplified beam-deflection tube. An electron gun forms a beam of rectangular cross section which passes between two deflection plates and is focused onto an intercepting edge. When deflection occurs, more or less current reaches the output anode so that an input V_d, which is applied between the deflection plates, causes a change in output current. Modifications, such as either a suppressor for secondary electrons, or use of an electron multiplier ahead of the anode, or addi-

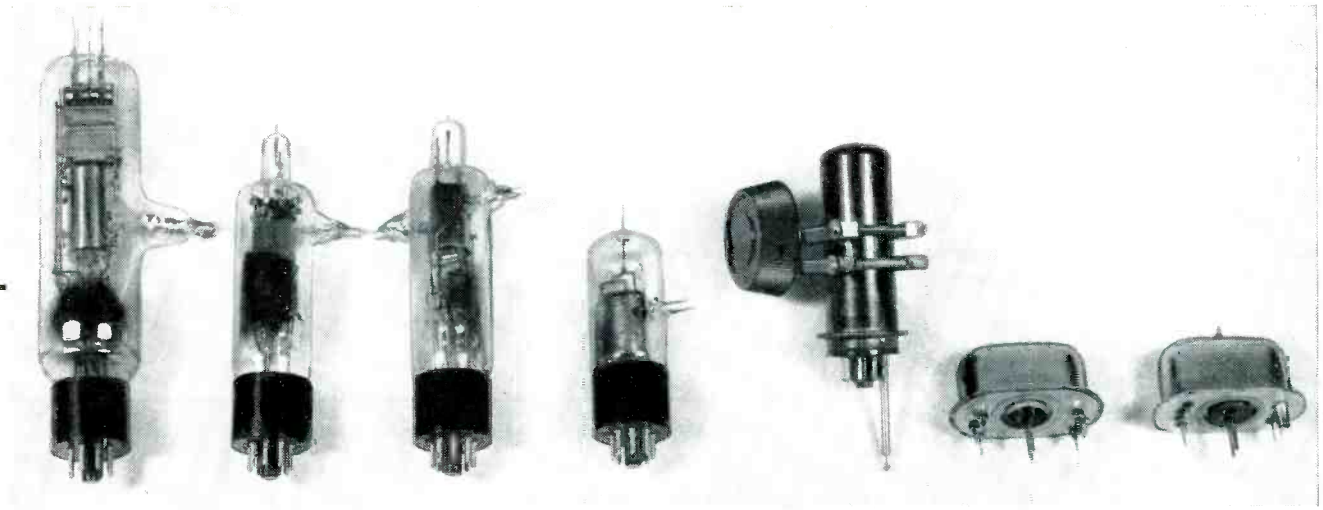


FIG. 4—Group of experimental beam-deflection tubes

tional pairs of deflection plates, are not shown but can be advantageously incorporated.

The reason a rectangular beam is used will be seen from Fig. 1B which indicates how the transconductance of such a device can be determined. The drawing shows an enlarged view of the electron beam as it reaches the intercepting edge on which it is focused. When the beam is deflected a small distance, dx, at the intercepting edge, a cross-sectional area, $W\,dx$, of beam is allowed to pass. This leads to an incremental change in anode current dI_b, which is the product of this area and the current per unit area, j_i, otherwise called the current density; thus

$$dI_b = j_i W\,dx.$$

Dividing this expression by the incremental deflection voltage, dV_d, gives the transconductance

$$g_m = \frac{d\,I_b}{d\,V_d} = j_i W \frac{dx}{d\,V_d} = j_i W S \qquad (1)$$

where S is the deflection sensitivity.

The total current in the beam, $I_{b\max}$, is the product of the entire beam area with the current density j_i

$$I_{b\max} = j_i W B \qquad (2)$$

Although j_i may vary across the beam thickness, the equation is made valid by defining B as an *effective* thickness and letting j_i represent the current density at the center of the beam. It is seen that the ratio of transconductance to current is S/B, which is independent of everything except deflection sensitivity and effective beam thickness. To appreciate the significance of this, it must be remembered that for ordinary grid control the initial velocity distribution of electrons limits the ratio of transconductance to current to a value of about 10 volts^{-1} theoretically, and 1 to 3 volts^{-1} practically. Beam deflection tubes, on the other hand, have been made to have a ratio of several hundred and are limited only by the practical difficulties of aligning a thin beam.

From Eq. 1, it is seen that the important factors in determining the transconductance are the beam width, W, and the current density j_i. To maximize these, the pencil-like beam and spherical lens optics of the cathode-ray or television picture tube is replaced in the present case by a rectangular beam with cylindrical optics to produce a high current density image. It is known[3] that the maximum achievable current density for a line focus is limited by the distribution and random direction of initial velocities of electrons from the thermionic cathode to approximately

$$j_{\max} \approx j_0 \frac{2}{\pi^{1/2}} \left(\frac{eV_0}{kT_k}\right)^{1/2} \sin\theta \qquad (3)$$

where j_o and T_k are current density and temperature of the thermionic emitter, V_0 is the beam voltage at the focus and θ is the angle (from the axis) at which the beam converges upon the focus point. For practical deflection tubes, which have a lens system and deflection plates between the object and image (see Fig. 1) θ will be small and cannot exceed $D/2L$ where D is the deflection-plate spacing and L is the distance from the deflection plates to the focus point (the "lever arm" of the deflection system). Thus, for an oxide-coated cathode at 1,000 K, Eq. 3 reduces to approximately

$$j_{\max} \approx 1.9\, j_0 \frac{D}{L} V_0^{1/2} \qquad (3A)$$

The low-frequency deflection sensitivity, using a modification of a standard formula,[4] is

$$S \approx \frac{L\,L_d}{2\,D\,V_0} \left(\frac{V_0}{V_1}\right)^{1/2} \qquad (4)$$

where L_d is the length of the deflection plates (assumed short compared to L), and V_1 is the average voltage of the deflection plates, while V_0 is the voltage of the subsequent parts of the system. Using Eq. 3A and 4 in Eq. 1, the maximum low-frequency transconductance becomes

$$g_{\max} \approx 0.95 j_0 W \frac{L_d}{V_1^{1/2}} \qquad (5)$$

This is independent of deflection-plate spacing and lever arm length but does depend on L_d, the deflection plate length.

For the higher frequencies, it is found that the useful length of the deflection plates is limited by the transit time. If this time is longer than one-half period of the applied frequency, the deflection field reverses during the time of transit and begins to cancel the deflection markedly. At a transit time equal to one-half period, the deflection is already down to a little over half that of Eq. 4 above.[1] Since the transit time in seconds over the

length L_d (in cm) is given by $\tau = 1.7 \times 10^{-8} L_d/V_1^{\frac{1}{2}}$, if we let this equal one-half of the period of the applied frequency, f, the $L_d/V_1^{\frac{1}{2}}$ in Eq. 5 is replaced by a quantity proportional to the reciprocal of frequency. Inserting this quantity in Eq. 5, and putting in the proportionality constant which includes the approximate loss in deflection, gives

$$g_{max} \approx \frac{18 j_0 W}{f_{mc}} \text{ mhos} \qquad (6)$$

where j_0 is in amperes per cm², W is in cm, and the frequency is in megacycles. When a beam-deflection tube is used as a mixer, the best conversion transconductance is between 50 and 60 percent of this amplifier transconductance (see later discussion).

It is worth examining Eq. 6 to determine the practical limitations on the quantities which are contained in it. These may be listed as follows: (1) The oxide-coated thermionic cathode limits the transconductance both through its temperature (which appears in the multiplying constant) and through its current density, j_0, which has an upper limit depending upon the life desired from the tube. (2) The beam width, W, is limited to such values which can still be aligned with an intercepting edge. (3) The deflection plates cannot practically be made as long as desirable for the lower radio frequencies because of contact potential variations over their surface, which produce random deflections and distort the beam. Thus, one cannot attain the transconductance of Eq. 6 at low frequencies. (4) One cannot ordinarily use a beam which grazes the deflection plates, as required by the derivation above, because of electron-optical aberrations and because, at high frequencies, there is then a serious increase in noise induced in the input circuit by the beam.

Signal-to-Noise Ratio

The fluctuation noise generators are shown in Fig. 2, in which the output noise is shown as the same as the temperature-limited shot noise formula.[5] Some of the early tubes had noise in excess of this due to a new phenomenon called "space-charge interaction noise" which was substantially eliminated by a reduction in beam length in the later designs. As in all tubes at high frequencies, a second major source of noise is found in the interaction of the beam with the input (deflection plates). Fortunately, when a balanced input circuit is used, the noise effects are largely balanced out and the equivalent shot-noise current, I_{tnd} of Fig. 2, is of the order of only 10 percent or less of the beam current. Since the beam current itself can be made small without loss of transconductance, this gives the deflection tube a large advantage over grid control or velocity - modulation tubes.

Since the signal-to-noise ratio is also dependent on the input resistance, Fig. 2 also shows this as a resistor comprised of the parallel electronic input conductance g_e and the ohmic conductance (due to circuit loss $g\omega$. The former is ordinarily negligible in comparison with the latter because of the small beam currents, which is again in contrast to conventional tubes. In beam tubes, there is no relation between the electronic loading and the induced input noise in a balanced input circuit.

The signal-to-noise ratio is best expressed in terms of the noise factor, which depends chiefly on the ratio of equivalent noise resistance to input resistance.[6] The former is given by

$$R_{eq} = \frac{2 e I_b}{4 k T_R g_m^2} = \frac{20 I_b}{g_m^2}$$

where T_R is room temperature. As an amplifier, maximum transconductance will occur when the beam is split in half by the intercepting edge so that $I_b = \frac{1}{2} I_{bmax}$ and

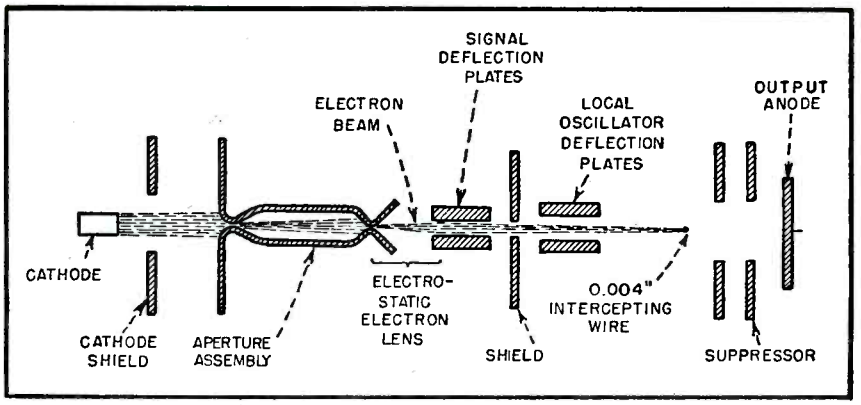


FIG. 5—Schematic cross section of double-deflection, nonradiating mixer tube

$$R_{eq}\Big]_{\text{amplifier}} = \frac{10 I_{bmax}}{g_m^2} \qquad (7)$$

In the experimental tubes, values of equivalent noise resistance of the same order as conventional amplifier tubes were obtained but with very much higher input resistance and much lower capacitances.

Mixer Operation

Figure 3 shows three possible ways of designing and operating the beam-deflection tube as a mixer, assuming additive deflection by signal and local-oscillator voltages. Their characteristics can be calculated by one of the usual methods.[7] Figure 3A is the conventional method, which leads to low gain and high equivalent noise resistance. By use of an aperture and phase-reversal conversion, the gain limitation can be overcome as in Fig. 3B, whereas the use of an intercepting wire as in Fig. 3C allows both low noise and high gain to be achieved.[8] For the latter case, Fourier analysis shows that the average mixer anode current is only 17 percent of the beam current and the conversion transconductance is 50 percent of the amplifier g_m. Thus

$$R_{eq}\Big]_{\text{mixer}} = \frac{20 I_b}{g_c^2} = \frac{14 I_{bmax}}{g_m^2} \qquad (8)$$

which is only 1.5 db higher than the amplifier value of Eq. 7 (point A in Fig. 3C). This is very remarkable compared with conventional mixer tubes which always have much poorer signal-to-noise performance than amplifier tubes. In the present instance, experimental work was done on both amplifier and mixer beam-deflection tubes but, since it was found possible to overcome all the major disadvan-

tages of the mixer, this type was emphasized.

Experimental Tubes

A photograph of some of the tubes which were made is shown in Fig. 4. At the extreme left is an early amplifier tube with a multistage electron multiplier. An experimental tube similar to the one in the photograph, but with a 5-stage electron multiplier, was built before the war[1] and had a transconductance of 100 milliamperes per volt, a plate current of only 5 milliamperes, an input capacitance of only 1.5 μμf, and an output capacitance of 3.5 μμf. Such a tube is capable of amplifying a band of 300 mc with a gain of 10, which is about thirty times as good as a conventional 6AK5.

The next two tubes in the photograph are early mixers and amplifiers using one-stage multipliers and particularly designed for high signal-to-noise ratio in the 300 to 1,200-megacycle range. The fourth tube is the type 1636, a 400-600 megacycle mixer which was produced for a time during the war but is now found only on surplus lists. The large metal tube is a 10,000-megacycle mixer with a built-in resonant cavity and a multiple deflection system consisting of tiny wires. Work at this frequency was slowed up when crystal mixers became so successful. The last tube, at the right, is a recent experimental tube for 300-1,500 megacycles in which local-oscillator radiation was eliminated. This tube is illustrative of the more recent type of experimental construction which has been used and so will be described in detail.

Deflection Elements

Figure 5 shows a cross-sectional view of the electrode arrangement. Two sets of deflection plates are used, the first pair for the signal and the second for oscillator voltage. One of the unique advantages of beam deflection is that such a separation is possible without loss in signal-to-noise ratio, such as occurred when pentode mixers were replaced by pentagrid mixers and converters. A shield between the two sets of deflection plates eliminates all coupling except a negligible amount through the central aperture. The signal plates are brought out through a pair of heavy parallel leads, in balanced fashion, while the oscillator deflection leads are brought out through a coaxial arrangement.

The electron gun is composed of a cathode and two narrow slits operated at +300 volts with respect to cathode. The electrostatic field between the last of the slits and the first set of deflection plates (which are at +140 volts, approximately) is used as a lens and focuses the beam. The second pair of deflection plates are again +300 volts, as is the intercepting wire, which is used in accordance with the discussion of Fig. 3 and is only 0.004 inch (0.01 cm) in diameter. The two small apertures allow a thin beam about 0.6 cm wide and 0.01 cm in thickness to enter the lens region. The deflection plates are made sufficiently short (the effective length is 3 mm) so that the transit time is about ½ period at around 1,200 mc.

To minimize lens aberrations and induced noise, the beam occupies only about ⅓ of the spacing between deflection plates. It is of interest that the input capacitance is only a little over 1 μμf, most of which is in the leads.

This tube uses a suppressor and output anode, since no electron multiplier is needed to obtain the required performance. Since the war, tubes of similar construction have been made with very small two-stage and four-stage electron multipliers; they are similar in performance and external appearance to the right-hand tube in the photograph, except for much higher gain.

It is of interest to compare the performance of such a tube, without multiplier, with the theoretical values derived above. The cathode current density was about 150 ma per cm² and the beam current through the two fine slits was 200 microamperes. If the deflection plates are placed at minimum spacing, so that they are grazed by the beam, Eq. 5 shows that

$$g_{max} = 0.95 \times 0.150 \times 0.6 \frac{0.3}{140^{1/2}}$$

$$= 2.2 \text{ ma per v.}$$

Since the deflection plates actually were spaced by about 3 times the grazing distance, we would expect about ⅓ of this or 0.7 ma per v. This is approximately the very best of the measured low-frequency values, but the average of a number of tubes is about 0.5 ma per v. The theoretical 1,200-megacycle value (Eq. 6) is about 60 percent of these figures, due to the transit-time loss.

Using Eq. 8, the mixer equivalent noise resistance of an average tube at 1,200 megacycles is computed to be 30,000 ohms. Since the input equivalent shunt resistance (which was almost entirely due to lead loss) was independently measured to be of the order of 20,000 ohms, if the induced noice is assumed to be about 10 percent of the shot noise in the entire beam, the minimum noise factor (using Eq. 30 of Reference 6) is

$$F_{calc} = 1 + 2\frac{R_{eq}}{R_{in}} + 2\sqrt{\left(\frac{R_{eq}}{R_{in}}\right)^2 + \left(\frac{R_{eq}}{R_{in}}\right) + 20\, I_{ind}\, R_{eq}}$$

$$= 12 \text{ (or 10.8 db)}$$

This is within a few tenths of a db of the average of measurements on an overall receiver in which each of a considerable number of tubes was tested. The best tube tested, which had close to the theoretical transconductance, gave an overall noise factor about 2 db better. A curve of overall noise factor versus frequency for this receiver, using an average tube, is shown in Fig. 6. The noise factor, of course, is a direct measure of noise-to-signal ratio, since it compares the actual ratio to the minimum existing in the antenna. Because of the interest in 500 to 1,000-megacycle television, comparative curves are given for a typical crystal mixer system using a 120-megacycle intermediate-frequency amplifier which has a 6AK5 pentode as first tube. The 6AK5 pentode noise factor is also given in the figure. The beam-

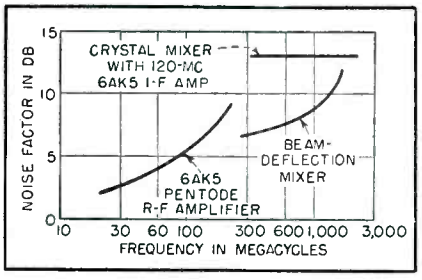


FIG. 6—Comparative noise factors as a function of frequency

deflection tube, over the 500-1,000 megacycle range, is substantially better than the other receiving methods.

With respect to freedom from local oscillator radiation, a table has been prepared showing the relationship of the beam-deflection mixer, of the type described, to other receiving systems. Table I shows that the radiation of the beam-deflection mixer as measured is sufficiently small to be called negligible for television service.

The comparisons of the table are made with the type of receiving systems in common use or commonly proposed for television service. In contrast to the crystal mixer, which would radiate enough from a dipole to give a field of several millivolts per meter at 100 feet, the beam-mixer radiation would be well below the noise level of a nearby television receiver, provided the local oscillator itself is sufficiently well-shielded.

Table I—Local Oscillator Radiation

Receiver System	R-F mc	I-F mc	Micro-watts Radiated
6AC7 Mixer	50–100	10	700.0
Triode R-F Stage	50–100	20	0.2
Crystal Mixer	500–1000	120	100.0
Beam-Deflection Mixer	500–1000	120	0.02

The addition of a 1, 2 or 4-stage electron multiplier, in place of the suppressor and anode, increased the gain by a factor of 4, 10 or 100, respectively, but the signal-to-noise performance was found to be substantially unaffected. Though a small increase in noise factor had been anticipated due to multiplier noise, this was not apparent.

Constructional Details

An important feature of tubes of the type described is the mechanical arrangement of parts. In the earliest work, cathode-ray tube technique was used, but was relatively unsatisfactory for the rectangular type of beam employed. Considerable credit must be given to two RCA Victor engineers, N. H. Green and W. H. Warren, who proposed a novel mechanical arrangement which was modified to meet the objective of the beam-deflection mixer. The photograph of Fig. 7 shows a view of the complete assembly and some of the parts of the tube. The entire assembly is based on the two metal stampings shown, which are welded together to form a rigid frame.

The deflection plates are made of pieces of mica wrapped with foil made of gold to eliminate chemical contamination on the surface. These deflection plates are riveted to the frame to assure alignment. The

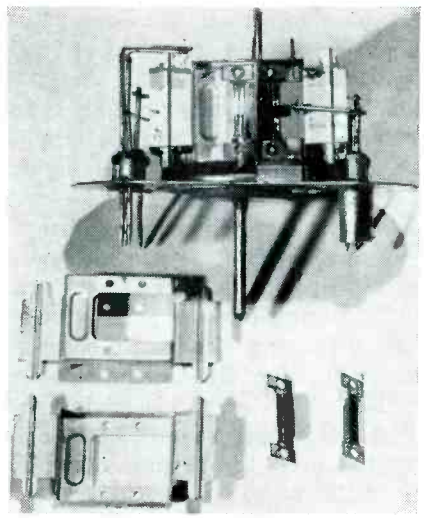


FIG. 7—Internal structure, frame stampings and deflection plates of experimental beam-deflection tube

small intercepting wire is also accurately aligned with the electron optical system by means of this frame. All parts, including the envelope are nonmagnetic. The complete assembly is shown in the photograph with the cathode end at the left and the signal-deflection plates brought out through the heavy central leads for the signal input. The local-oscillator deflection plates are shown to the right of the central shield and are brought out single-ended fashion through a coaxial connector at the right of the photograph.

In spite of the great accuracy with which the parts are aligned using the metal-frame technique, it was found that the transconductance and noise factor of some tubes could be improved by use of a fixed, correctly-oriented, nonuniform magnetic field, such as from a very small bar magnet. By using a cathode-ray tube characteristic trace, it could quickly be determined whether such a magnet would give an improvement in transconductance and its proper orientation could be found. On some tubes, therefore, this correcting magnet was soldered permanently in place on a stainless-steel envelope and was found to be entirely satisfactory under all normal operating conditions.

Conclusions

The work which was done in the application of beam-deflection principles to amplifiers and mixers has shown clearly that these principles are advantageous for reception above 300 megacycles. On the other hand, the limitations which were encountered are such that it is not likely that a beam-deflection type of tube can compete in performance with grid-controlled tubes below 30 megacycles, except for special applications. Limited experience obtained during the war in building small quantities of beam-deflection tubes has shown that many production problems must be solved before such tubes can be considered ready for commercial manufacture. Such tubes, at present, are still in the laboratory stage.

Contributions to the tube developments described herein were made by many colleagues at RCA Laboratories and the RCA Victor Division at Harrison among whom may be mentioned H. A. Finke, H. C. Thompson, H. Schwalbach and K. McLaughlin. Much of the work was supported by Signal Corps contracts during the recent war and, in one case, by a Navy contract.

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High-Speed Production of METAL KINESCOPES

New techniques employed in the manufacture of 16-inch and other television-receiver picture tubes reduce the cost of such glass-and-metal types. Single-platform tilting tables have been replaced by a series of continuous settling belts

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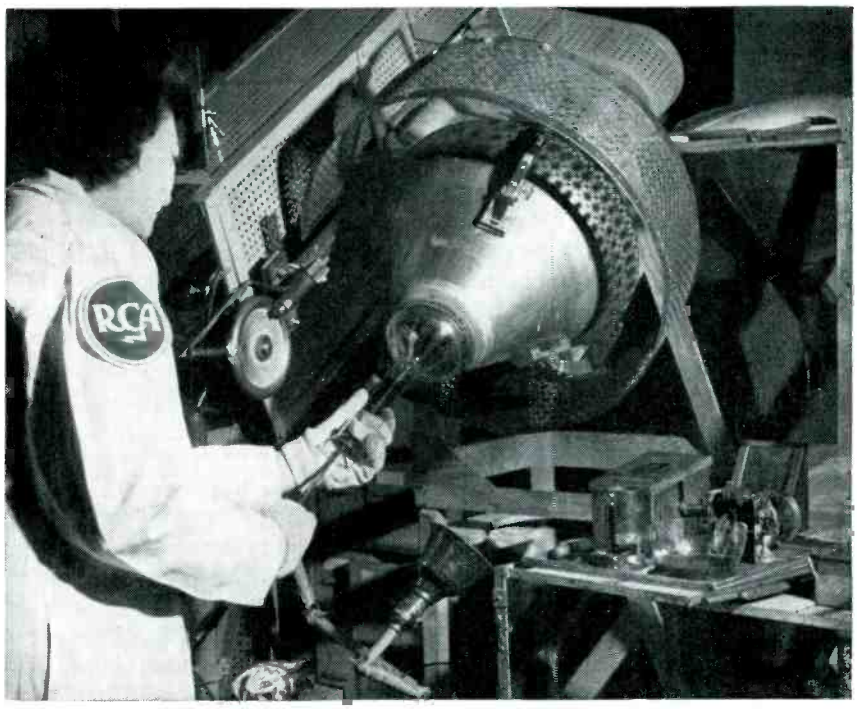
THE TYPE 16AP4, a 16-inch metal-cone kinescope now in production at the RCA Lancaster Plant, involves several innovations. The tube is designed for high-speed mass production on automatic machinery combined with rigid processing controls to produce a type with high quality and performance that lends itself readily to low-cost circuit designs.

Material Selection

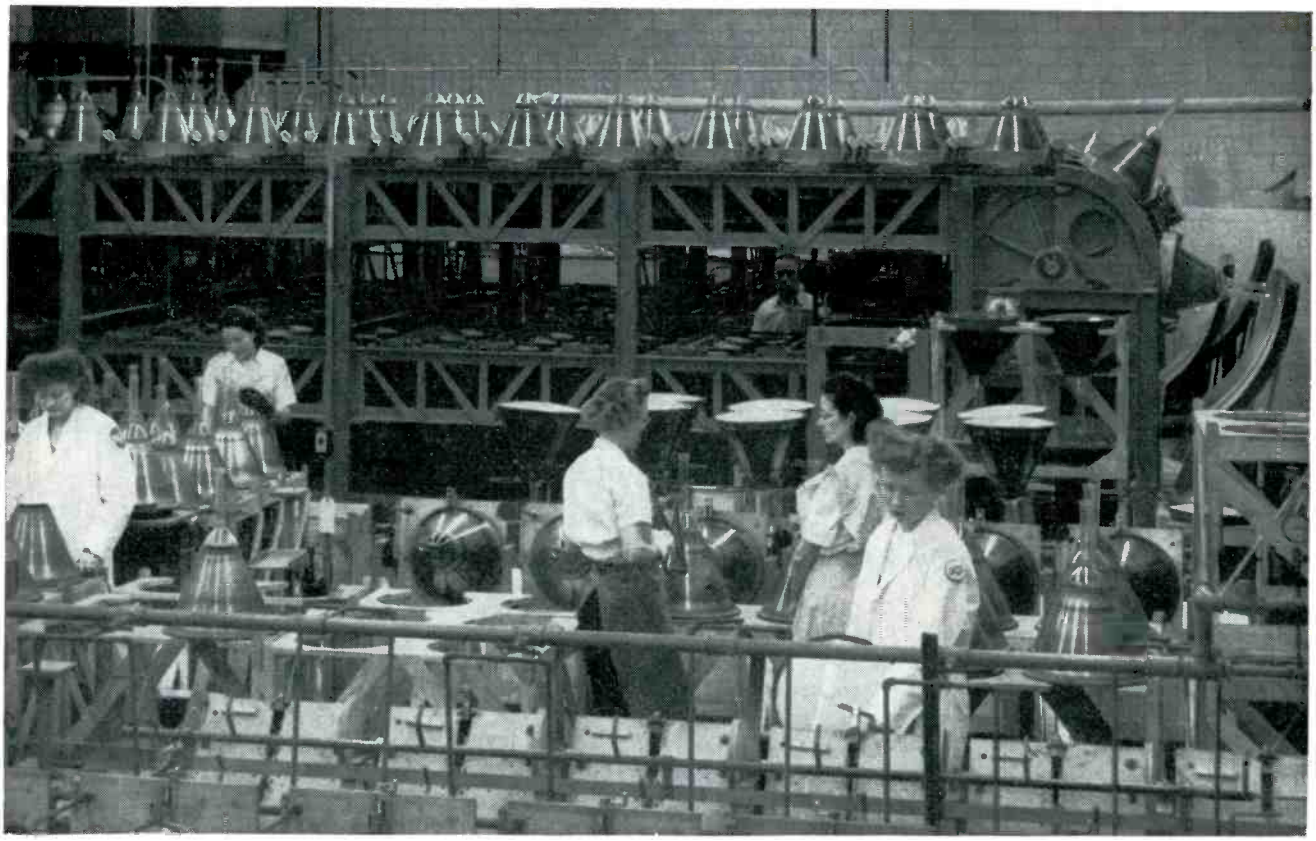
The metal-cone construction is one of several unique features of the type 16AP4. It has made possible, without sacrificing bulb strength, the use of a face plate made of relatively thin glass of high optical quality. The metal for the cone was selected on the basis of its glass-sealing properties; after considerable experimentation a modification of a high chromium-bearing commercial alloy, SAE type 446, was chosen. In addition to its excellent sealing properties, this alloy has good corrosion resistance and high strength.

The material used for the face plate of the metal kinescope is another innovation in the manufacture of cathode-ray tubes. In all-glass kinescopes, face plates are usually made by blowing or pressing molten glass against iron molds. Faces made by this method may have rough surfaces and often contain visible foreign particles which reduce the quality of the television picture. The new tube face plate, even though it must withstand an atmospheric pressure of about 3,000 pounds, can be made of high-quality window glass only $\frac{3}{16}$-inch thick because of the support supplied to it by the metal sealing flange. An additional feature of the face plate is its uniform curvature from center to edge. In conventional all-glass tube construction the curvature increases near the periphery and limits the useful face-plate screen area.

The glass neck assembly is made of lead glass No. 0120, which has a high electrical resistance. The sealing and annealing properties of this glass permit its use with the chrome-iron cone; it also seals readily to the stem glass containing the



A conductive coating is applied by means of a brush to the glass neck and metal-cone assembly



The single-platform tilting tables shown in the foreground were formerly used to settle screens. New settling belt in the background shows tubes (right) in the pouring position as fluid remaining after settling is automatically drained out. During transit along the belt fluorescent powder settles from a water suspension

connector leads. The high resistance of the glass provides required insulation between the deflecting yoke operating at ground potential and the internal conductive coating operating at an anode potential that may be as high as 15,400 volts, the absolute maximum rating.

Sealing Operation

One of the most important requirements in the development of the metal kinescope was that it be capable of manufacture on modern high-speed automatic equipment. Accordingly, the sealing operations were designed to require the minimum amount of time and attention.

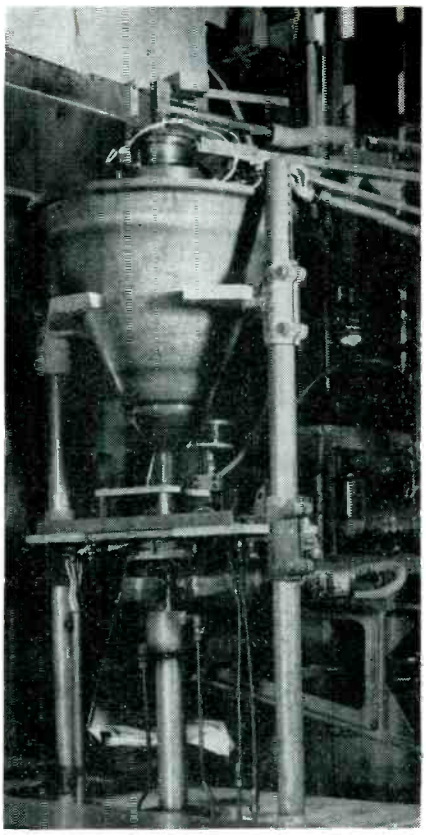
The glass neck assembly is sealed to the metal cone with a butt seal. The parts are held in accurate alignment by an interior mandrel. The entire sealing and annealing operation is accomplished on automatic equipment in a few minutes. The face-plate sealing operation, on the other hand, is more difficult because the strength of the finished tube depends to a large degree on the quality of this seal.

After much experimentation an automatic sealing operation was developed that only required close control by an operator during the final shaping of the seal. The sealing operation consists of placing the preassembled unit onto one head of the sealing machine, preheating the face-plate glass with gas fires as the machine indexes, and then heating the metal contact with the glass to approximately 1,200 C. After these operations, the sealed unit is carried through an oven where the glass and metal temperatures are equalized at a value near that for the annealing point of the glass. The finished unit is then removed from the machine.

Because the mechanical strength of the tube is extremely important, a percentage of the envelopes are taken from the production line and pressure checked. Statistical control methods are used in all such sampling. The samples are tested with an air pressure of 60 pounds per square inch (4 atmospheres), a value that is one atmosphere greater than the test pressure the finished tube is required to withstand. This figure provides a desirable margin to compensate for any loss in strength during subsequent processing.

Screen Application

A most important preliminary step in the application of the screen to the 16AP4 is the thorough cleaning of the interior of the bulb assembly. The slightest trace of dirt or grease would prevent phosphor particles from adhering properly to the face plate. Handling marks such as finger prints and etched areas in the face plate would affect the appearance of the screen and the eventual television picture. In addition, the presence of impurities able to mix with the screen can poison or change the emission characteristic of the phosphor. The presence of traces of metallic impurities, for example iron, cobalt, or nickel, can decrease the efficiency of the phosphor.



Tube on exhaust cart emerging from oven. Copper tubulation being pinched off by hydraulic jaws

It is interesting to note that the limits of most chemical purification processes coincide with the order of magnitude of activator usually necessary to produce efficient phosphors, and with the magnitude of a poison element detrimental to phosphors. The magnitude of the activator or impurity is in the range one thousand to one million parts of phosphor to one part of activator or impurity.

Washing the bulb assembly of the metal kinescope, like most other processes in its manufacture, has been mechanized. The bulbs are transferred from the sealing machine to the washing machine by means of a conveyor belt. As the washing machine indexes from position to position, the bulbs are lowered over successive sprays of sodium hydroxide, hydrofluoric acid, tap water, and distilled water in order to remove all foreign material from the bulb.

The screen is applied to the tube by settling the phosphor from a liquid suspension while the bulb is carried on a continuously moving belt advancing at the rate of a few inches per minute. The settling solution is introduced at one end of the belt and decanted at the opposite end when the belt moves over a large pulley. On the underside of the belt the sides and neck of the bulb is washed to remove any residual screen material and the screen is then dried. Because a high-quality television picture requires that the screen be free of all defects such as spots, holes, or colored areas, all screens are inspected by transmitted light, reflected light and ultraviolet radiation before the next manufacturing step.

After screen inspection, graphite coating is applied to the inside of the glass neck assembly. This coating connects with the metal cone and is the conductor that maintains the inside of the glass neck and glass cone at the same potential as the metal cone. The bulb assembly is then baked to insure the adherence of both screen and coating to the glass.

Electron-Gun Mounting

The electron gun of the type 16AP4 is a tetrode type with heater, thermionic cathode, control grid, screen grid, and No. 3 grid, and incorporates a tilted-lens ion trap. The gun is very similar in design and construction to that used in the type 10BP4 and utilizes the same assembly methods. Gun mounting is one of the few operations in kinescope manufacture requiring hand labor, but through the use of jigs and work-simplification methods a high rate of production with extreme accuracy has been obtained.

The gun mounted on a glass stem is joined to the bulb assembly by melting the glass neck of the bulb and fusing it to the glass of the gun stem. This operation is performed on automatic equipment that requires an operator only for loading and unloading.

Exhaust and Basing

One of the most important operations in the manufacture of cathode-ray tubes is the exhaust process by which the air is removed from the tube and the cathode activated. Until a few years ago cathode-ray tubes were exhausted one at a time on what was essentially laboratory equipment. Now, however, automatic equipment performs this operation.

Complete tube exhaust systems, mounted on carts, are slowly moved through a high-temperature oven and as the tube moves from position to position in the oven, the various exhaust processes are performed, electrical power being supplied to the electrodes of the tube by means of sliding contacts. At the end of the exhaust cycle the copper tubulation in the stem of the tube is automatically pinched off and a vacuum-tight seal produced. The tube is then transferred by means of a conveyor belt to the basing reel where the base is applied and baked with infrared heating to cure the basing cement. After this operation, the leads are soldered to the base pins.

Quality Control

Before the tubes can be tested the getters must be flashed and the cathodes aged to obtain stable emission. These operations are performed on the conveyor belt that carries the tubes from basing to testing.

Each tube is individually operated and inspected. The test operator not only checks the physical and electrical characteristics of the tube, but also inspects its overall quality and appearance. Each tube is painted while on the conveyor line that carries it to the packing department for packing and shipping.

To insure standard quality a sample lot of each day's production is set aside for additional tests prior to tube shipment. Some tubes are pressure-tested at 45 pounds per square inch to evaluate their strength; some are subjected to life test to determine how they will operate throughout life and others are stored for a period of time and then retested. If the tubes fail to pass any of these tests, a larger number of that same day's production is tested and if they, in turn, also fail to pass the tests, that day's production is either rejected or tested 100 percent.

Stable TEN-LIGHT

Six-stage ten-light decade counter uses by-passed cathodes and special coupling circuits to ensure positive trigger action for counts up to 200,000 per second. Component tolerance limits are extremely wide, and no special input pulse shaping is required

TEN-LIGHT DECADE SCALERS, which are more convenient to use than binary scalers, are usually either prohibitively complex, or not reliable enough for certain applications. The scaler described here employs only six stages to provide dependable ten-light decade counting up to 200,000 counts per second with line voltages between 80 and 150 volts, an unregulated B supply, and wide tolerances for nearly all components. Faster operation may be achieved with slight alterations.

The circuit uses a ring of five binary elements followed by a scale-of-two stage, as shown in Fig. 1. Input pulses may vary in amplitude and shape over a wide range because of the by-passed cathode interstage coupling method used between the Eccles-Jordan pairs.

Figure 2 shows the circuit for a complete decade. Capacitor tolerances are very broad, even the most critical allowing half or double the design center value. The most critical resistor is R_1, which must be held to a tolerance of ±10 percent. Other resistors may have much greater tolerances.

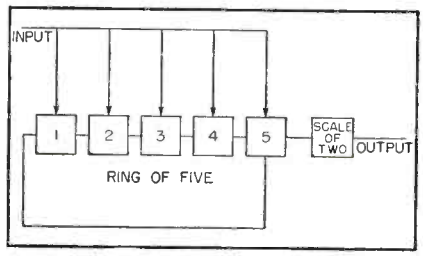


FIG. 1—Block diagram of simple ten-light decade scaler

Circuit Operation

In the following explanation, subscripts L and R refer to left and right triode sections. The normal condition is conduction in the left triode with the right side cut off. The reverse or *odd* condition exists as a steady state in only one element at a time and advances to the right by one element for each count, a

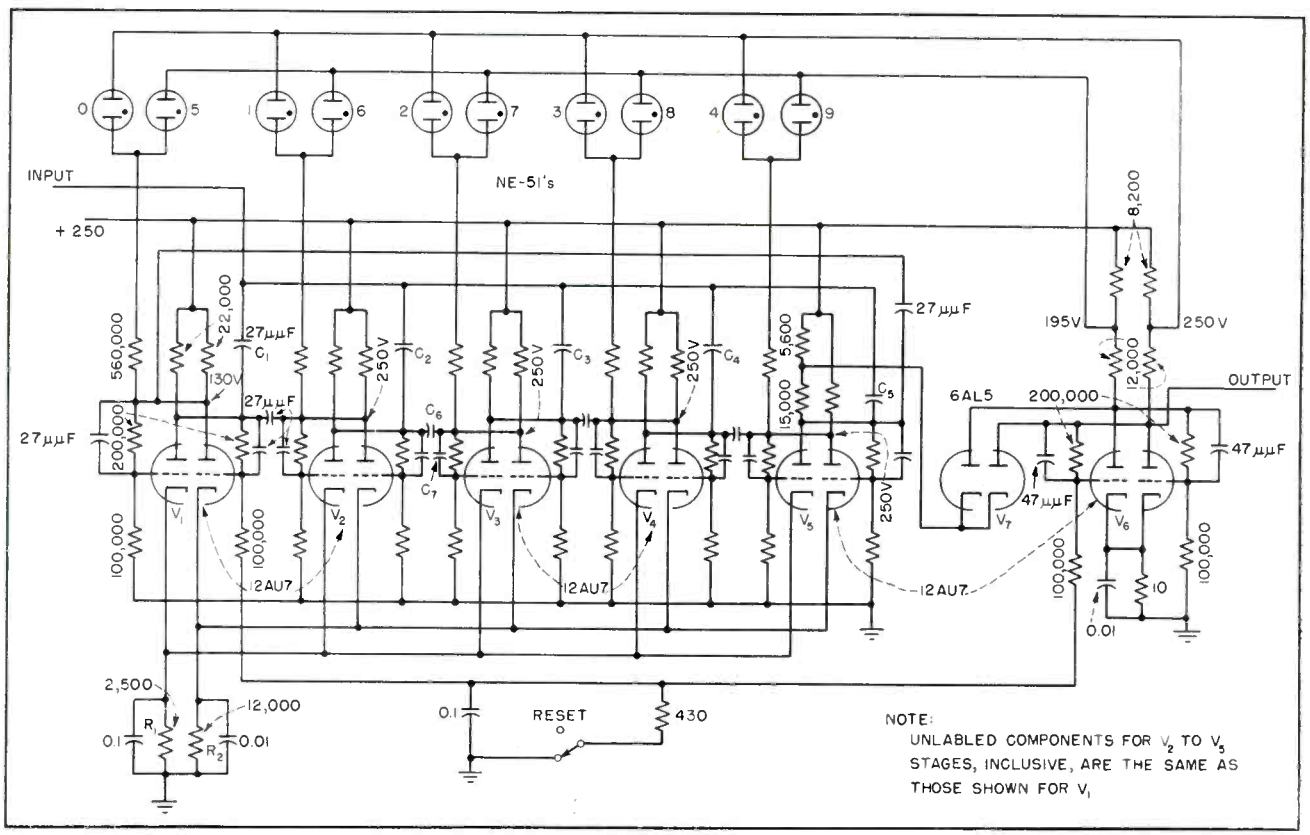


FIG. 2—Complete circuit diagram of decade counter. The double diode in the scale-of-two circuit increases reliability of trigger action, but it may be dispensed with in some applications

DECADE SCALER

By RICHARD WEISSMAN
Development Engineer
Nuclear Instrument and Chemical Corp.
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Front view of scaler unit for use with Geiger-Muller radiation detector

count being represented by one input pulse.

Cathode resistor R_2 is chosen to effect the desired voltage on the common right-hand cathode bus with only one right-hand section conducting. Resistor R_1 effects the same voltage drop with four left-hand sections conducting. The left- and right-hand cathodes are split in this manner to assure that the odd condition will exist in only one element at a time.

Assume that V_1 is the odd tube and it is desired to advance the odd condition to V_2. This can be done by a negative pulse either at grids G_{1R} or at G_{2L}. The negative input pulse through C_1 appears at both places, initiating the desired change in both V_1 and V_2. The flip-flop action in both tubes aids the input pulse in this respect. Since the cathodes are by-passed, input pulses through C_2, C_3, C_4, and C_5 are effectively shorted out through the respective plates P_{2L}, P_{3L}, P_{4L}, and P_{5L} before the transition, while during transition the pulse through C_6 is still shorted out by P_{3L}. Any tendency for the input pulse at G_{3L} appearing via C_2, C_6, and C_7 to cut-off P_{3L} is overcome by the input pulse at G_{3R}, in addition to being over-ridden by the positive pulse from P_{2L}.

As long as the input pulse rise time (before or after the pulse is differentiated by capacitors C_2 and C_3 through P_{2L} and P_{3L}) is short enough in comparison with the transition time and the pulse is of sufficient amplitude, wide variations may be permitted in pulse height and shape as well as in the values of interstage and input coupling capacitors.

The scale of two, represented by V_6, is coupled to the ring by the diode V_7. Referring to Fig. 2, it will be seen that stability requires that one plate in the Eccles-Jordan pair be conducting while the other is cut off; hence either diode plate may be at approximately plus 250 volts while the other will be at about 130 volts. The diode cathode will switch from plus 250 volts to 195 volts after the fifth count and back to 250 volts after the tenth count.

Scale-of-Two Operation

When the diode cathode goes negative, (at the fifth count) the negative pulse will be transmitted only to the more positive diode plate, the other being negative with respect to its cathode. This pulse, transmitted through the intrastage grid capacitor, causes the circuit to shift to the second stable position. At the next input pulse, the diode cathode will go positive, but this pulse will appear only at a grid whose plate is already conducting so no shift occurs.

Thus the scale of two shifts once every five pulses, putting out alternate positive and negative pulses for each shift; hence a negative (or positive) pulse once for every ten pulses.

Sufficient output from the scale of two is available to drive directly either a second decade or a single-stage triode amplifier which would be capable of operating a heavy mechanical register or solenoid mechanism.

Extra Components

The ten-light indicating system involves only the use of five additional resistors of noncritical value plus the lights themselves. Its operation may be seen readily by considering the voltages shown in Fig. 2, representing the initial state (zero count). During counts of 5 to 9, the left and right plate tap voltages of V_6 are interchanged since at the count of 5, V_6 switches. When a ring tube is in the normal state, the right-hand plate is at 250 volts, whence it may be seen that neither of its neons can light since it requires 90 volts to start the glow.

Of the two neon lights associated with the odd-state ring tube, only the one which returns to the 250-volt point can light, hence for counts of 0 to 4, only the left-hand neon of any pair can light while for counts of 5 to 9, the right-hand set of neons comes into action. With this circuit there is sufficient overvoltage to operate the neons even at a-c line voltages as low as 80 volts; while at 150 volts on the line the neons still function properly.

Wideband Television Transmission Systems

Amplifiers and auxiliary equipment having bandwidths in excess of 40 megacycles, for point-to-point video relay service and similar applications, are based on old theory but represent a new trend in equipment design

By EMILE LABIN

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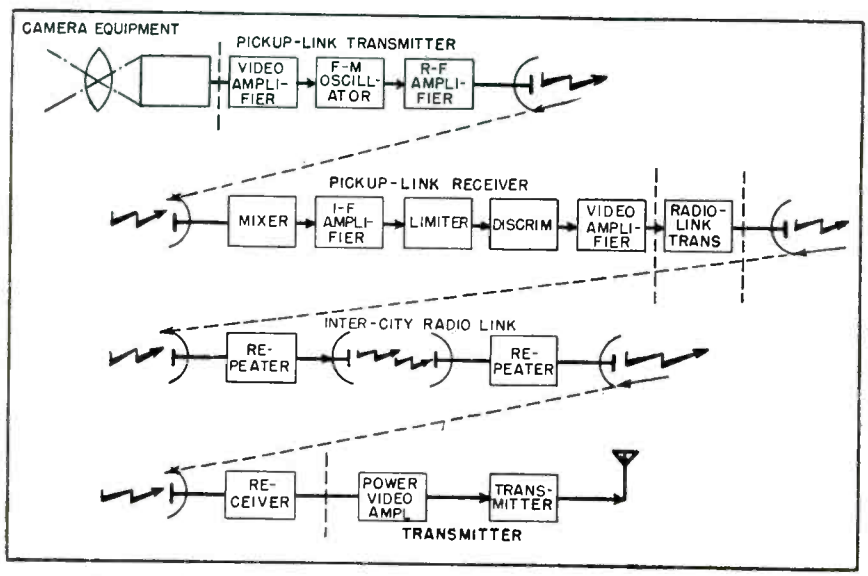

FIG. 1—Typical elements of a wideband television transmission system

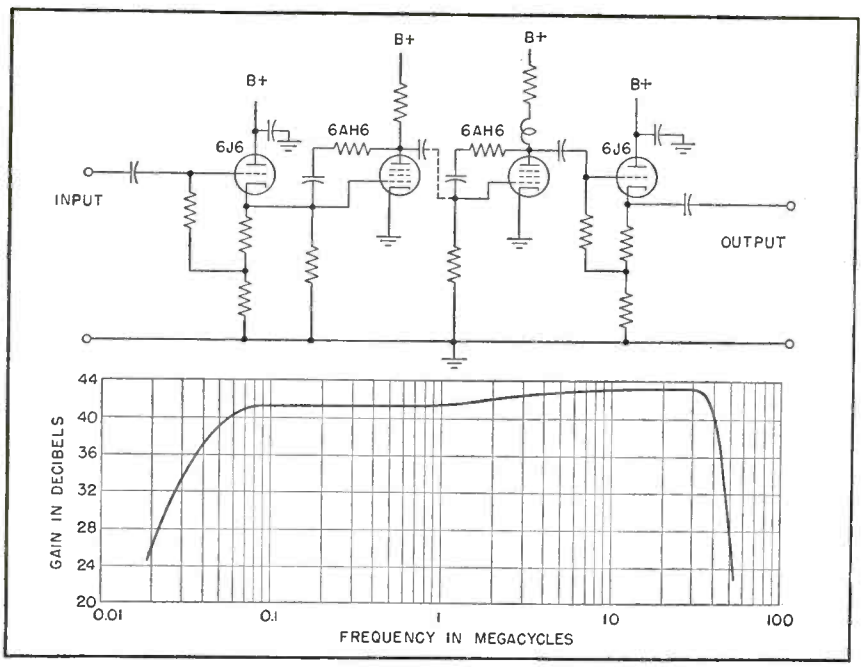

FIG. 2—Basic circuit and response of a 40-mc video amplifier using eight 6AH6 tubes (two shown) with plate-grid feedback in each stage

THIS PAPER considers the bandwidth requirements of the components of television networks and describes the design of transmission equipment in this field.

The complex series of transformations to which a relayed television signal is subject are outlined in Fig. 1. The signal at the output of the camera is amplified in video amplifiers, then sent through a coaxial line or a radio pickup link to a fixed relay station. From there, the signal is transmitted through radio relays or through a coaxial line to a distant city. There the signal is restored to its video form, amplified again by video amplifiers and finally applied to the transmitter which broadcasts the signal to the public.

To perform these transformations we need various tools, such as frequency-modulated oscillators, r-f amplifiers, i-f amplifiers, limiters, and discriminators with bandwidths which may have to extend, depending upon the video standards in use, from 10 to 100 mc. The higher figure applies to f-m transmission of high-definition monochrome or color pictures.

Video Amplifiers

Methods for designing broadband video amplifiers have been extensively studied, and many examples are known. There are two outstanding approaches: one uses feedback

Based on a paper presented to the International Television Convention, Zurich, Switzerland, September 9, 1948.

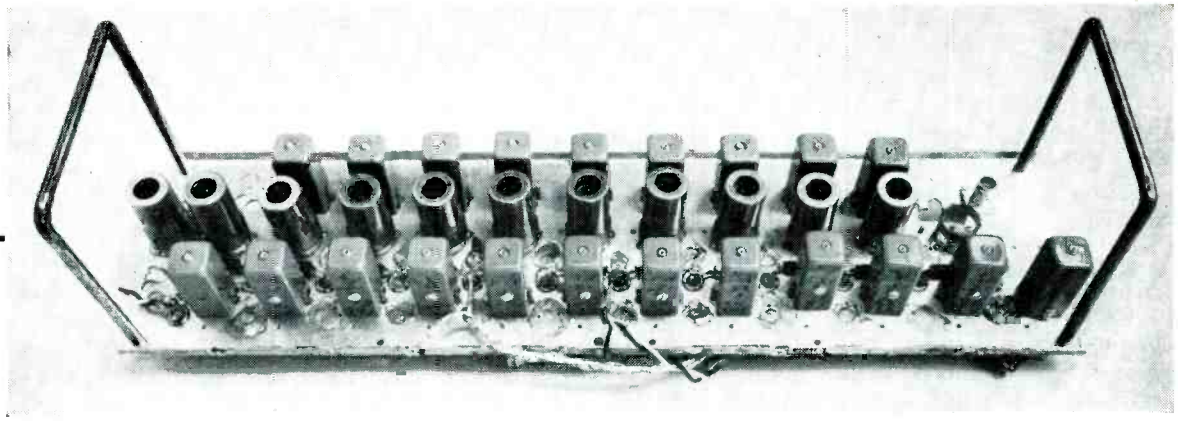

FIG. 4—Top view of the 45-mc additive amplifier pictured in Fig. 3

from a given stage to the preceding stage, the other an artificial transmission line. Figure 2 shows a feedback amplifier having a response curve flat within 2 db from 60 kc to 40 mc. It uses eight 6AH6 tubes and two 6J6 miniature type tubes. The overall voltage gain exceeds 40 db into 750 ohms. The maximum output voltage, before limiting, is 0.5 volt.

This amplifier utilizes the input admittance of a vacuum tube, produced by connecting its grid and plate with a resistance, as the load for the preceding stage of a cascaded amplifier. The input admittance resulting from the grid-plate resistance has a negative capacitance component which subtracts from the grid-ground capacitance and thereby extends the bandwidth.

Although the gain-bandwidth product of this amplifier is the same as that of an ordinary type using peaking coils, it possesses the great advantage of simplicity. There is only one coil; there is no shielding and practically no decoupling; the values of the components are uncritical. The alignment of such an amplifier is only a matter of minutes.

Figure 3 shows the basic circuit and frequency response of an amplifier of the additive type, using an artificial transmission line. The frequency response is flat within 1 db from a few kc to 45 mc. Figure 4 shows the construction of this amplifier, which uses nine 6AN5 miniature-type pentode tubes and has an overall gain of 11 db at a plate current of 33 ma per tube. The maximum output voltage is approximately 28 volts rms.

The principle of this amplifier was proposed many years ago. It is radically different from other types because the total gain is not the *product* of the individual gains, but the *sum* of the individual gains of each tube in the stage. It is essentially a low-frequency travelling-wave amplifier using low-pass filter elements to couple grids and plates in a parallel arrangement. The input signal travels from one grid to the next, while the signal amplified by the first tube travels from one plate to the next. Since grid and plate signals arrive at successive tubes at the same time, they add in time phase. The amplifier shown has proved to be very stable and the alignment was not critical in practice.

An amplifier built by M. M. Newman at the Lightning & Transients Research Institute, University of Minnesota, illustrates the possibilities of the additive circuit. It is a one-stage amplifier which has a voltage-gain ratio of 2.5 and is flat within 3 db up to 250 mc. The input and output impedances are 50 ohms. The stage actually consists of ten additive sub-stages, each one being composed of three 6AK5 type tubes. Actually, in each sub-stage, only one tube is active, the two others being connected for balancing purposes. When more gain is required, several stages of the same type are used in cascade. Dr. Newman has informed the writer that he has under development another bandwith amplifier of the same type going up to 750 mc

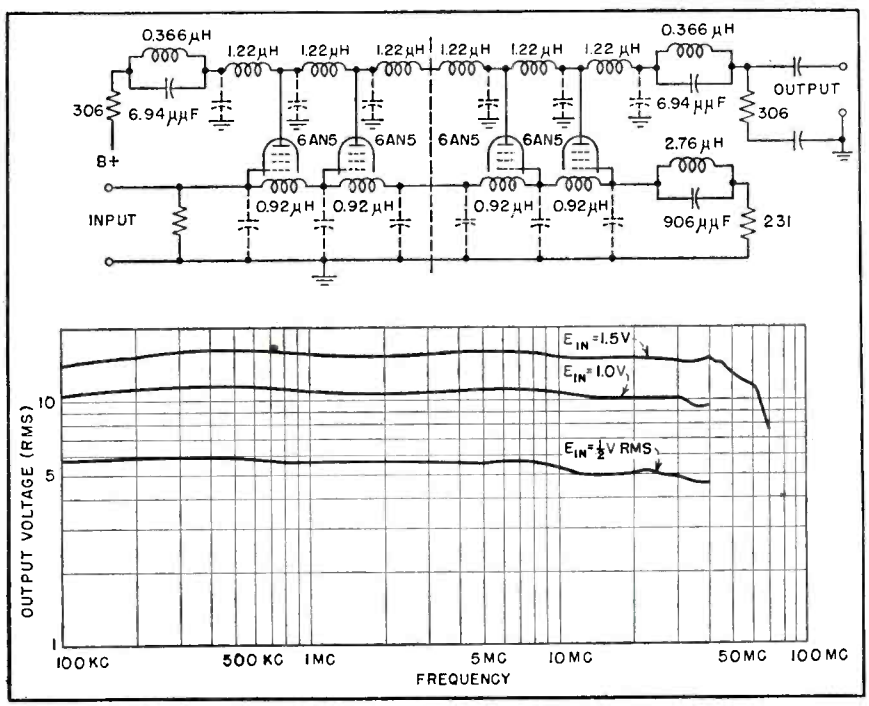

FIG. 3—Basic circuit and response of an additive amplifier having 45-mc bandwidth. Four of the nine 6AN5 tubes in the amplifier are shown. The voltage gain is 11 db

using 4 × 150 tubes.

In summary, video amplifiers of output powers of the order of 1 watt have been built, by using existing tubes and principles, up to 50 or 70 mc. In any event, low-power video amplification is not a limit to the use of most ambitious video standards.

R-F Components

In the television link from the camera to the studio or relay, it is necessary to modulate an r-f oscillator for f-m transmission over the microwave link. This can easily be done with existing reflex klystrons.

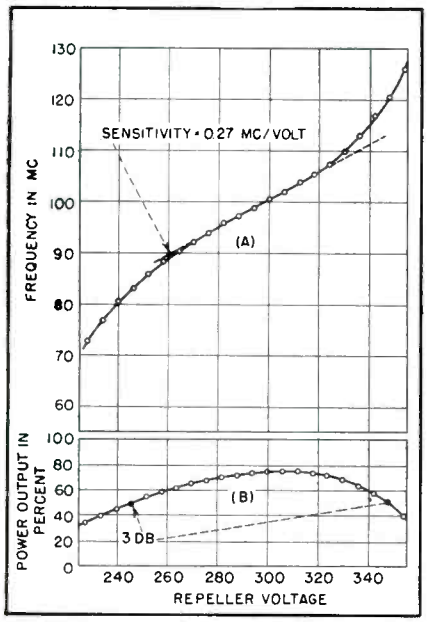

FIG. 5—(A) Wideband frequency-modulation characteristic of a reflex klystron and (B) power output as function of repeller voltage

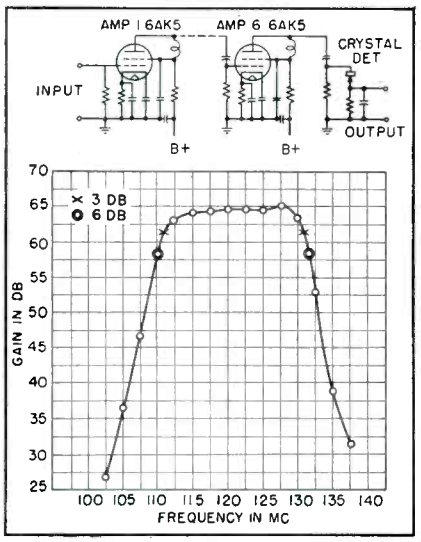

FIG. 6—Basic diagram and response of a 120-mc i-f amplifier using six 6AK5 tubes in staggered triples. The 6-db bandwidth is 21 mc, the gain 65 db

Figure 5 shows the response curve of a reflex klystron, an SCR-12, around 5,000 mc. A linear frequency displacement is obtained over an r-f bandwidth of the order of 40 to 50 mc. Similar curves can be easily achieved at other radio frequencies. Output powers obtained in this manner, of the order of a few watts, are sufficient for many applications. Nevertheless, more power is desirable even at very high frequencies when narrow beams can be obtained with reasonably sized antennas.

The output power of broadband radio links should be of the order of 10 watts to compensate for the increased noise generated in the very broad band and to achieve a sufficient margin against fades in propagation. Radio-frequency power amplifiers in the microwave regions have been designed for many years in the form of velocity-modulated tubes. Recent efforts have been made to extend this principle to a design which is better adapted to the broadband operation, like the travelling-wave tube.

Antennas and Propagation

Microwave antennas can easily cover frequency bands of the order of 2 to 1 when the input impedance of the antenna does not have to be rigorously constant. But when the distance between antenna and output stage of the transmitter becomes large, the impedance match required has to be quite accurate and the output bandwidth of the antenna structures is then reduced to the order of 5 to 10 percent of the carrier frequency. At 3,000 to 5,000-mc carrier frequency, then, a bandwidth of 150 to 300 mc can be accommodated.

Between the transmitter and receiver antennas, the signal travels in space and is affected by topography and the state of the atmosphere. The propagation of microwaves is a complicated subject which we will not treat here. However, it is entirely possible that propagation restrictions may represent, in final analysis, the most definite limitation on bandwidth and the only one against which little can be done. Frequency bands in common use today are narrower than 1 percent of the carrier frequency. Should it become necessary to expand to 10 percent of the carrier frequency, the propagation irregularities within the band may exceed acceptable tolerances.

I-F Amplifiers

When the message is received, it is usually transposed to a lower frequency in a microwave mixer. This operation can be done over very broad bands, because here again, the significant factor is the relative bandwidth. Since noise-free r-f amplification is difficult to achieve, most of the gain at the receiver or the repeater has to be obtained in the i-f amplifier. The gain required is generally of the order of 80 to 100 db.

Figure 6 shows the circuit and response curve of an i-f amplifier at 120 mc with a bandwidth of 21 mc. Figure 7 is a bottom view of the amplifier proper. The amplifier consists of six 6AK5 tubes arranged in stagger-triples mounted on a brass plate with top and bottom covers. The picture shows the simplicity of the electrical circuit and physical configuration. The principle of staggered stages used to be treated, pre-war, in a qualitative manner. A careful analysis of the circuit shows that it is possible to design accurately for much broader bandwidth than had been done in the past. Another i-f amplifier, with a bandwidth of 55 mc within 3-db points and a gain of 80 db in 12 stages, is shown in Fig. 8. The amplifier in Fig. 6 was designed by M. Silver, that in Fig. 8 by A. M. Levine, both of Federal Telecommunication Laboratories, Inc.

Staggered Damping

The second amplifier (Fig. 8) uses the principle of staggered damping as opposed to staggered tuning. The input stage consists of a grounded-grid amplifier in order to reduce the noise factor. The complete amplifier consists of four sets of triples, making a total of twelve stages of amplification. Each one of the stages is tuned to the same center frequency and has the same coupling elements, representing a double-tuned transformer. This makes construction quite simple since only one coil design and as-

sembly is required. The only difference between individual stages is the damping resistor across the secondary coil. In the example shown, three values of resistances have been chosen: 650 ohms, 240 ohms and 180 ohms. After a triple of this type, values of the resistances repeat themselves.

Limiters and Discriminators

To take full advantage of the properties of frequency modulation, the discriminator should be preceded by a limiter. Limiters for very broad bands are difficult to design because the clipping action of the limiters generate higher frequencies which have to be reproduced if the limiter is to perform correctly.

The limiter used with the 55-mc i-f amplifier consists of two cascade stages operated as very-broad-band amplifiers. The first limiter is a 6AK5 coupled by a series shunt video coupling network to two 6AK5 tubes in parallel. This coupling network is used so that the d-c restoring effect of the grids of the second limiter removes any changes due to averaging effect of noise. The grid current on the first limiter is used for the avc voltage applied to the i-f stages. The circuit impedances are so low in the broadband amplifier that the effect of the grid current is negligible on the limiting action.

The discriminator uses a 6AL5 tube as shown in Fig. 9, with line segments as tuned elements. Line discriminators are capable of extremely broad bands. The one shown has a linear voltage output over more than a 50-mc band. The distortion of line discriminators is especially small and from that point of view they are useful not only for television but also for microwave links using frequency-division multiplex.

Broadcast transmitters corresponding to video standards of 12 mc and supplying output power of 1 kw at 500 mc have been designed and one of them has been in experimental operation in New York for two years. For commercial operation, it will undoubtedly be necessary to use larger powers at these frequencies. Actually, the power requirements will go up in proportion to the bandwidth used. While there seems to be no reason why large powers of the order of 50 kw could not be obtained, the industrial realization is probably many years off.

Home receivers with much broader bandwidth than the ones now used would obviously be more expensive.

Conclusion

From the foregoing, it is evident that the essential tools for television links with video standards up to 15 mc are available, or nearly so, although the equipment is expensive. The difficulties now encountered in the United States in taking full advantage of the existing standards of 6-mc channels only prove that while the techniques for broader bands exist in the laboratories it will take many years before they could be made available to the public.

It is very interesting to note that the weakest elements in the chain we have examined are the output stage of powerful broadcast television transmitters and the home receiver. This indicates that the most promising field for improved television standards, provided adequate cameras become available, may not be for broadcast television, as we understand it for home reception, but for theatre television where broadcasting with large powers in not required and where the cost of the receiver is not as determining a factor.

A comparable situation exists in the film industry, where two standards are used: the 16-mm film for home projectors and the 35-mm film for theatres. It seems most likely that television will follow in the future this same example.

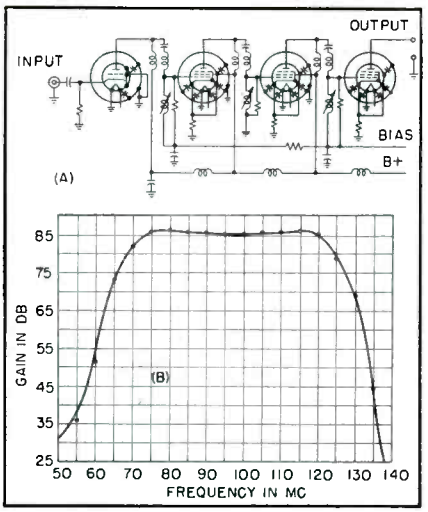

FIG. 8—Input and first stages (A) of a 100-mc i-f amplifier. The complete amplifier employs 12 stages, displays 85-db gain across a band of 53 mc

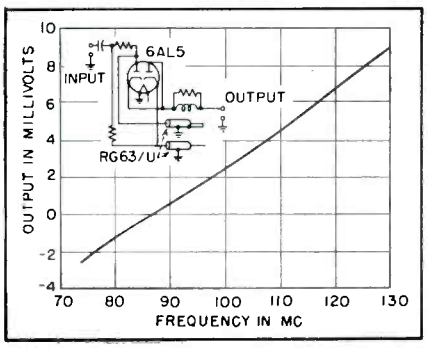

FIG. 9—Diagram (inset) and response curve of a wideband discriminator, using 8-inch lengths of RG63/U cable as the tuned elements

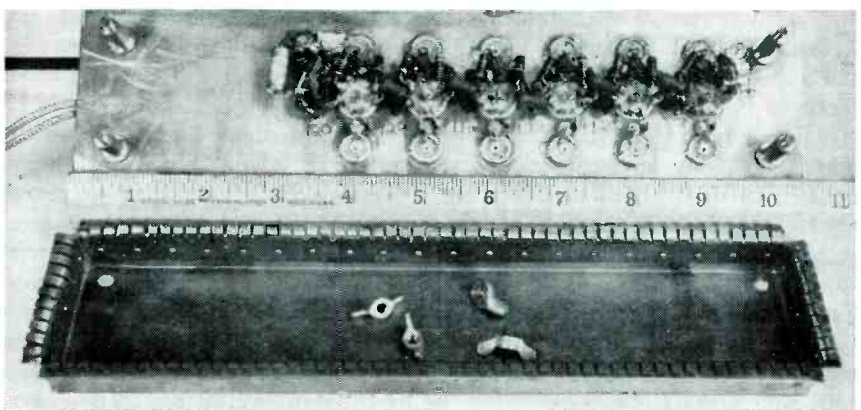

FIG. 7—Under-panel connections of the i-f amplifier shown in Fig. 6

Acknowledgment

Some of the equipments described in this paper were developed for the most part under the sponsorship of Camp Coles, United States Army Signal Corps Laboratories.

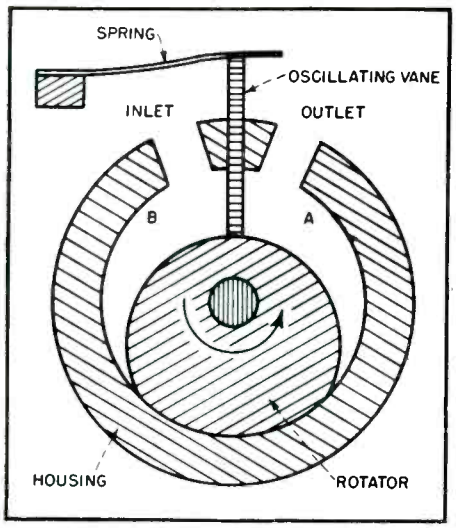

FIG. 2—Basic elements of rotary oil pump

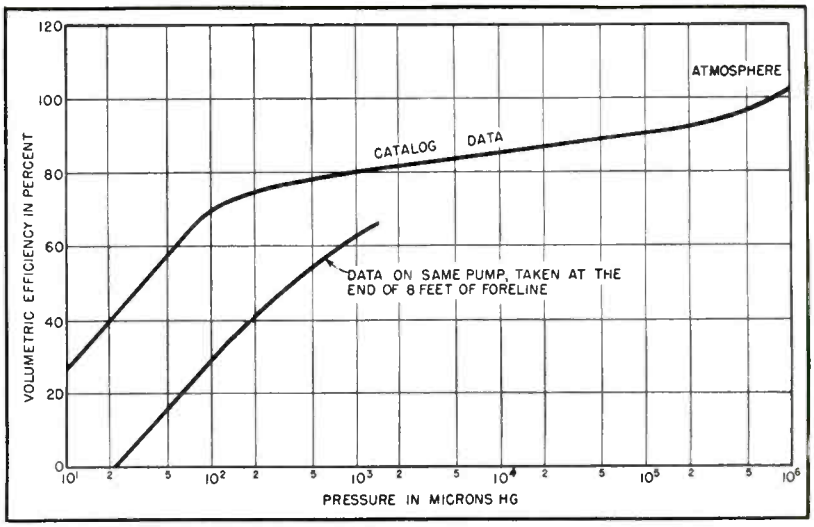

FIG. 3—Volumetric efficiency versus pressure for a typical forepump

Modern Vacuum-

Television cathode-ray tube demand dictates the use of highly efficient evacuation equipment. A vapor-type pump meeting all the stringent requirements is described in detail. Automatic controls for further improvement of production rates are suggested

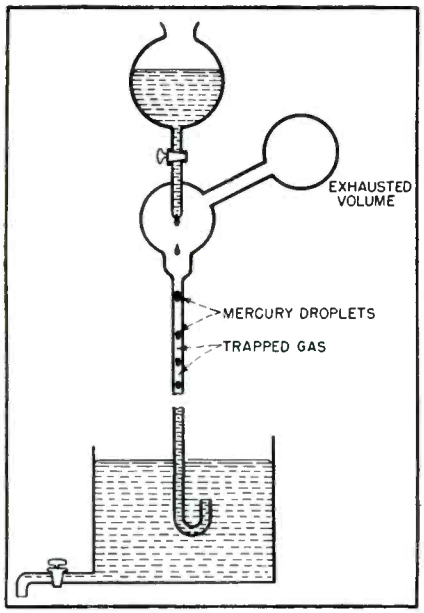

FIG. 1—Early mercury-droplet pump for producing low pressures

THE FIELD of electronics depends upon man's ability to remove gas from confined spaces. This statement may be open to criticism when considering such things as magnetic amplifiers and transistors, but it seems likely that it will be some time before the need for vacuum can be eliminated.

Certainly it is difficult to imagine a means of producing television pictures without the use of an evacuated envelope. Since the great expansion today is in the television branch of electronics and because approximately 20 percent of the total equipment cost in a picture-tube plant is represented by the exhaust machines alone, it is hoped that the following discussion will aid in designing the latter economically and adequately.

The need for removing air is twofold: (1) At relatively high pressures the distance an electron can move without collision, scattering, and ionization becomes small as compared to the required length of a cathode-ray tube. (2) High pressures mean large concentrations of gas molecules that physically or chemically react with the electron emitter (cathode).

Early Pump Designs

To appreciate the requisites involved in adequately lowering gas pressure it is necessary to review some of the fundamental concepts of matter. When working with vacuum it is most useful to remember: (A) All matter is composed of molecules, most conveniently visualized as small spheres, in a state of constant agitation. (B) These molecules move in straight lines,

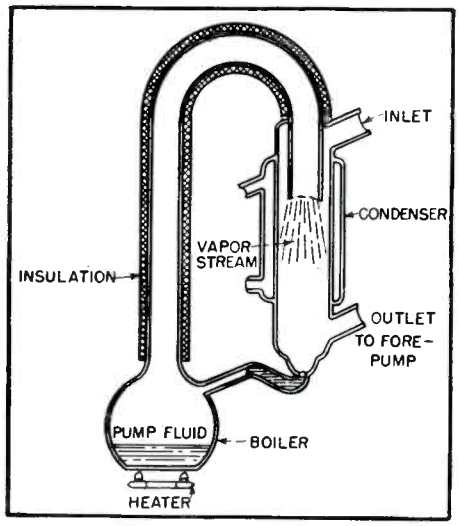

FIG. 4—Mercury-vapor pump

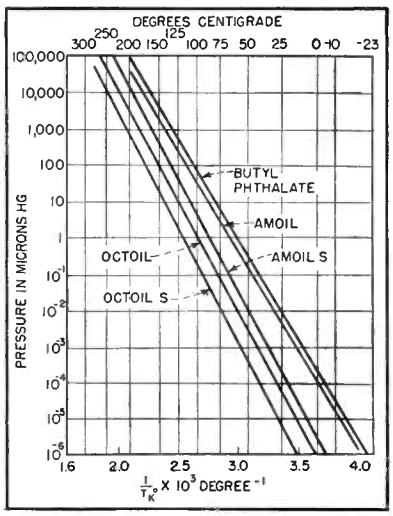

FIG. 5—Pressure for various pump oils

Pump Design

By GLENN L. MELLEN

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between collisions with other molecules, at a velocity determined by temperature. (C) At all temperatures above absolute zero there exist, over any solid or liquid, molecules in the vapor phase.

Following von Guericke's original air pump and the Magdeburg sphere demonstration, the first pump capable of producing very low pressure was by Toepler. In a modification of this by Sprengel[1] shown in Figure 1, small volumes of gas from the exhaust region are trapped between mercury droplets in a capillary tube. The trapped gas is compressed to some higher outlet pressure by the integrated weight of the droplet column. The pump is able to produce partial pressures of noncondensibles comparable with that found in the best vacuum tubes. It still finds use in specialized applications such as in vacuum fusion apparatus for the micro-determination of gas in metals. Zero back-leakage and low pumping speed (fractions of a liter per second) are its major asset and liability.

Rotary Pumps

The rotary pump and its subsequent refinements have made possible today's production equipment in the vacuum field. This pump, Figure 2, has three basic elements: a rotator, revolving in a housing, with an oscillating vane that divides the inlet from the outlet.

Each cycle the quantity of gas in region *A* is pushed out of the pump, while a new volume *B* is formed to trap further gas for compression on the following cycle. The pump is run in oil to seal and lubricate the sliding surfaces. Several designs founded upon this principle are characterized by constant volumetric displacement per cycle and vary only in volumetric efficiency versus inlet pressure.

At the blank off (ultimate vacuum) of such pumps two things contribute to the prevention of further pressure reduction. The first is the fact that the limits of mechanical precision and subsequent wear permit appreciable back leakage of gas into the exhausted volume. The second contributing factor is to be found in the sealing and lubricating oil or in the contaminants it contains.

Compounding rotary pumps will produce air pressures in the neighborhood of a few tenths of a micron (760,000 microns equal 1 atmosphere). The total pressure, however, is generally of the order of a few microns and is mainly determined by the vapor pressure of residual contaminants in the oil. In fact, the major function of the outlet (high pressure exhaust) stage in compound pumps is that of decontamination of the sealing oil fed to the inlet stage.

Consider such a contaminant as water at a temperature of 20 C. At this temperature the vapor pressure of water is approximately 20,000 microns. Visualize a small drop of water in region *B* of Figure 2. The droplet will rapidly volatilize, raising the pressure toward 20,000 microns until it is all converted into vapor, thus preventing some gas from flowing through the inlet. After the line of the sliding contact of the rotator passes the vane, the gas formerly in *B* is represented by the compression volume *A*. When, during the compression cycle, the pressure in *A* is raised above 20,000 microns the water vapor condenses into the liquid phase, with a consequent great reduction in volume, and thereby results in little or no flow through the outlet. It can be seen that a reversible process (ignoring thermodynamics) is set up where there is no net pumping.

Rotary pumps used on high-vacuum systems are limited to usual blank-off pressures ranging from 1 to 10 microns at best. Typi-

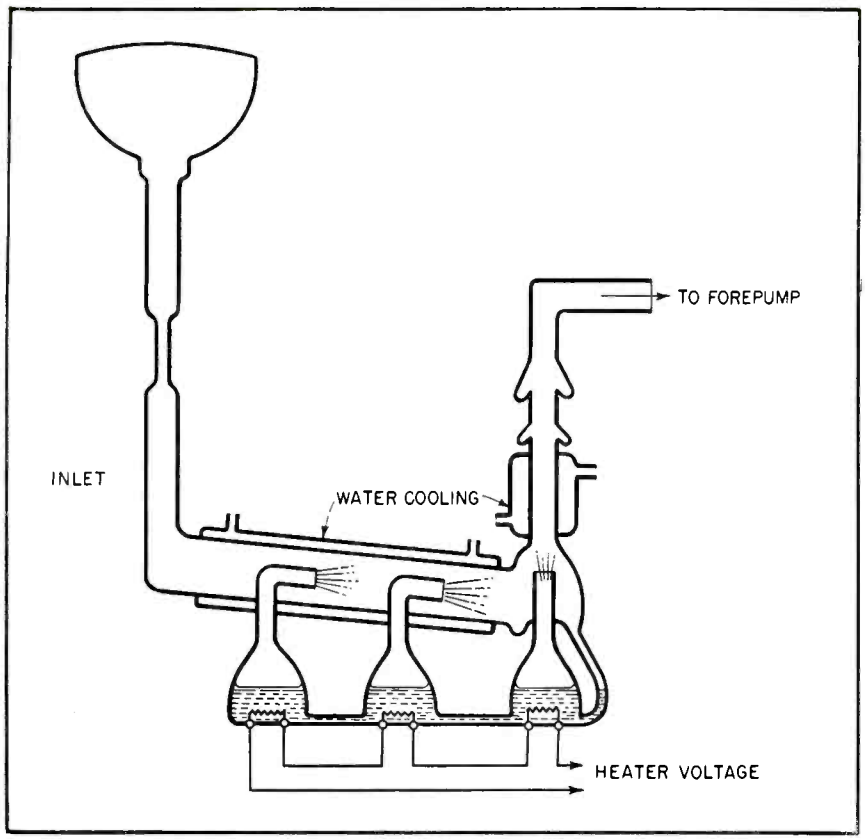

FIG. 6—Three-stage fractionating oil-diffusion pump

cal manufacturer's data are shown in Fig. 3. At blank off the pumping speed (liters per second or cubic feet per minute, of volume *measured at the vacuum pressure*) is zero and its value at higher pressures is determined by which of the two limiting processes mentioned above is predominant. It is important to know the actual speed-pressure characteristics in order to adequately match a rotary forepump to a vapor (diffusion) pump. For use with long forelines the speed at the end of the line must be known.

Vapor Pumps

The pressures attainable on mechanical pumps are 3 to 5 orders of magnitude higher than those permissible in cathode-ray tubes, hence some other device is necessary to remove the remaining gases. Into this breach the so-called vapor[2] pump fits quite well, although the mechanical drag pump[3] will also do the job. Because of its low pumping speed and the critical machining tolerances necessary to its manufacture, the latter has been little used in the country, up to the present time, and has enjoyed application only in Europe.

While peak speeds of mechanical forepumps range from fractions of a liter to a few hundred liters per second, vapor pumps have been built with speeds in excess of 5,000 liters per second. Since these speeds are measured at widely separated pressures, it is possible for a forepump to handle the capacity of the vapor pump (speed × pressure equals capacity, in micron liters per second, or micron cubic feet per minute).

The vapor pump was derived from Gaede's original diffusion pump by Langmuir[4] and has been a prime factor in the growth of industrial high vacuum. Its simplest form is represented in Figure 4, and the essential elements are a pumping fluid, a boiler, a condensing surface, an inlet, and an outlet. For the present it will be assumed that the vacuum system, exclusive of the forepump, is constructed of glass. Pumping fluid vapor issues from the boiler and drives gas molecules in the general direction of the outlet in much the same fashion as leaves are swept from the sidewalk with a hose. Carrying the analogy further, only those leaves that get in the path of the stream are swept ahead. Were there a strong enough countering wind, some leaves might sneak back.

It must be emphasized that, at the pressure where vapor pumps operate, no sucking action exists. There are negligible intermolecular collisions to force gas toward the pump. The pump is merely a hole that gas molecules can enter by random thermal diffusion. The action of the vapor stream is to reduce the probability of gas diffusion back through the inlet below the probability of diffusion forward into the inlet. The condenser is necessary to allow for recycling of the pumping fluid.

A single-stage vapor pump will produce a partial pressure of noncondensible gas that is dependent upon the boiler head and forepressure. The higher the head, or the lower the forepressure, the lower will be the pressure in the exhaust volume (with subsequent qualifications). It is impractical to use boiler heads that will operate against atmospheric pressure at the outlet and still produce submicron pressure at the inlet, hence a mechanical pump is used. Pressure ratios of noncondensibles across a single stage of 10 to 1 to 100 to 1 are usual and up to 50,000 to 1[5] have been achieved.

The total pressure in the exhausted volume would be the partial pressure of the noncondensible, as dictated above, plus the vapor pressure of any liquid that is seen at the inlet, at the temperature of the exhausted volume walls. In the case of Figure 4, where mercury might be used as the pumping fluid, this pressure would be approximately 2 microns at 20 C, 5 microns at 30 C, and less than 10^{-21} microns at liquid nitrogen temperatures. This is the reason for the trap on exhaust systems before the advent of low vapor pressure pumping fluids.

Analysis of the action is something like this: Gas diffuses through the trap into the vapor pump and is compressed to a pressure where the mechanical pump can push it out against atmospheric pressure. Hot mercury vapor diffuses back to the cooler walls, be-

tween the trap and the pump, and condenses. Cooled mercury vapor at the wall temperature diffuses to the cold finger in the trap and freezes. Any mercury vapor that misses the finger and gets into the exhaust volume will diffuse around until it either is trapped by the cold finger or held by some physical or chemical bond in the exhaust volume. The pump pumps the air; the trap pumps the mercury. Positioning of the trap should be such that it does not see hot pump fluid over an optical path, in order that the rate of collection of pump fluid will be held to a minimum. Remembering fundamental concepts, it will be seen that the rate of oil transfer will be high, if an optical path exists from the hot oil to the cold finger.

Cascading single stages by the use of either individual pump units or multiple jets in series in a single pump permits the realization of blank-off pressures that are relatively independent of forepressure. Permissible forepressures as high as 1,000 to 4,000 microns can be obtained by this means when mercury is employed as the pumping fluid. A trap is still necessary to pump the back-diffused mercury vapor.

Vapor Pump Fluids

In 1928 highly purified oils of high molecular weight made their appearance for use as vapor-pump fluids.[6] Their major attribute is that they are fluids of low vapor pressure at room temperature, as shown in Fig. 5[7]. Unfortunately, high molecular weight does not go along with resistance to thermal decomposition. The chemical bonds of complex oil molecules are sufficiently weak so that some may be broken by the heat required to vaporize the oil. Nonetheless these oils with their inherent weaknesses are capable of producing the low pressures required in vacuum tubes without the use of traps[8] and without the potential personnel hazard accompanying the use of mercury vapor.

The action of pumping is exactly the same with oil as with mercury, but in general oil and mercury are not interchangeable in the same pump because of the necessary design differences that arise from optimum boiler pressures, heat input, and other factors. Multiple jets fed from a common boiler containing Octoil will produce ultimate pressures as indicated on an ionization gage[9] in the region of a few hundredths of a micron. The partial pressure of air may well be 10^{-4} to 10^{-5} microns, with the remaining due to the vapor pressure of the worst decomposition product in the pumping fluid.

Except for the case of cracking the ends off a long-chain organic structure to form two fractions of very high and intermediate vapor presure, these products at room temperature have vapor pressures above that produced by the forepump. Thus the oil is mostly decontaminated by the loss of the highest fractions to the forepump. It is the intermediate exceptions above that will be the worst fraction in the oil.

Referring to Figure 5 and comparing the vapor pressure of pure Octoil at 25 C to the above blank off of a few hundredths of a micron, it will be seen that the worst fraction accounts for an ultimate some two orders of magnitude higher than that theoretically possible with the pure product. The use of high boiler pressures to achieve high backing pressure characteristics with oil is inadvisable since it is accompanied by an increase in the decomposition rate and a subsequent increase in the ultimate pressure. Less effective decontamination with higher contaminant concentration accounts for the latter. Higher temperatures cause a greater rate of oil decomposition and higher forepressure prevents loss of some of the fractions of higher vapor pressure. Forepressures under 100 microns are generally required on glass pumps.

The next stage of development in the glass-pump series is covered by the independent work of many investigators. Figure 6 illustrates a pump of this type.[10] Here three separate jets are fed by three individual boilers. All the condensate is returned first to the boiler feeding the outlet end of the pump. Any oil in the boiler feeding the inlet jet must have been passed through the other two boilers. In the process of passing through it was decontaminated to such a degree by boiling off the high vapor pressure components that the worst fraction present in this stage permits an ultimate pressure within an order of magnitude of the theoretical. Pumps operating in this manner are called fractionating or purifying.

Modern Vapor Pumps

In the last decade high-vacuum production systems have trended away from glass equipment in an

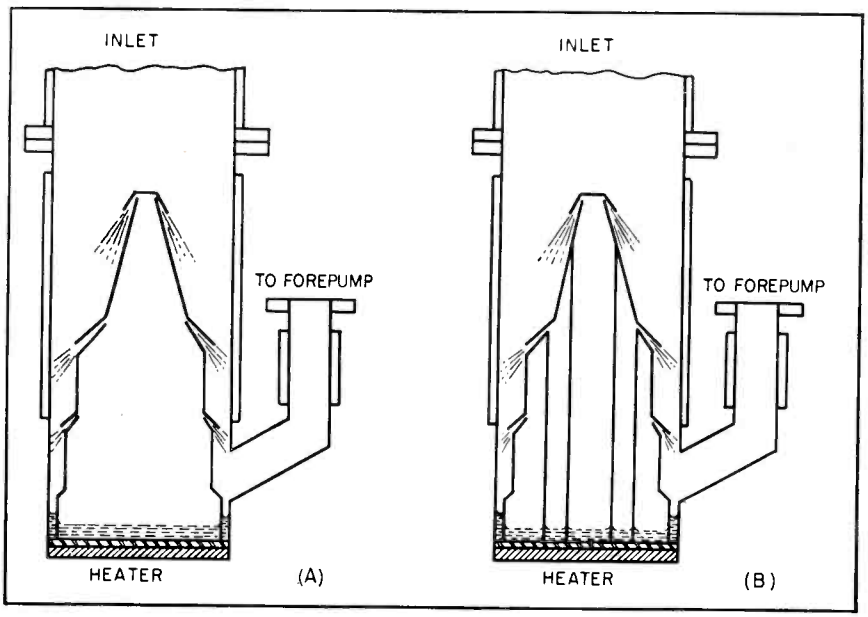

FIG. 7—(A) Metal vapor pump of the nonpurifying type and (B) of the purifying type

effort to gain ease of maintenance and freedom from accidental breakage. Closer mechanical tolerances in production, higher operating temperatures, freedom from heat-shock fracture, and massive construction are a few of the advantages to be derived. From the standpoint of cathode-ray tube production, ease of repair or replacement by a maintenance crew is of major importance to big installations.

A typical nonpurifying vapor pump of metal construction is shown in Fig. 7A. Body and cooling jackets are drawn, or rolled-and-welded, tubing and jets are spinnings, stampings, or machinings, depending upon the physicial size and precision required. All jets are fed from a common source of vapor. Backing pressure requirements are not as stringent as those for a glass pump. Since closer mechanical tolerances can be held, especially in the outlet jet-to-wall clearance, values in the vicinity of 300 microns are possible with proper design. Peak speeds may be had from a few liters per second to over 5,000. Take-apart joints are generally gasketted with neoprene or some suitable plastic material. The leakage or outgassing of these joints must be minimized by proper design for good performance in the vicinity of 0.05 micron and lower.

The design can be modified to effect purification of the oil feeding the top jet by the addition of partitions that identify a separate boiler region with each jet, as in Fig. 7B. Oil returning to the inner boiler after condensation must first pass through the region feeding the bottom two jets. Here the highest fractions are vaporized, leaving a good approximation of pure oil to feed the top jet. Metal pumps of this design using Octoil will produce total pressures without traps of a few ten-thousandths of a micron.

C-R Tube Production

A pump of this type is described in detail in the following paragraphs. Prior to its development, the vacuum exhaust of such large volumes as 12 to 20-inch cathode-ray tubes had been done on individual vacuum systems that had the following cycle:

(1) A tube has just been finished and sealed off.
(2) Because hot pump-oil cannot be exposed to atmospheric pressure for any appreciable length of time without excessive decomposition, the vapor-pump heater is turned off and allowed to cool.
(3) When the pump is sufficiently cooled, the mechanical pump is turned off and air is admitted to the vacuum system.
(4) After sealing on a new tube, the mechanical pump is started and the pressure is reduced to a point where the vapor pump may be turned on.
(5) When the vapor pump has finally heated to the point where it is working, the finish exhaust of the tube begins.
(6) While the tube is held to whatever pressure the vapor pump will produce, the elements are processed to eliminate all possible gas from the final product.
(7) Finally, the getter is flashed in the tube and, after this pressure burst has been pumped away, the tube is sealed off.

Steps two and five may be eliminated, with an appreciable saving in time, if the vacuum system is designed to hold the vapor pump hot at all times and still protect it from high-pressure gas. A system of this type has been designed, as in Fig. 8, with the following design requirements. It must:

(1) Be capable of producing the required low pressures of 5×10^{-4} to 3×10^{-3} microns on a 160-minute production cycle (2-inch purifying pump: anything smaller is difficult to handle with ordinary tools).
(2) Have reasonably high backing pressure characteristics so that high-pressure gas bursts will be adequately handled (close jet-to-wall spacing on outlet stage plus moderate boiler pressure).
(3) Allow for ease of cleaning and maintenance (one wrench, a screwdriver, and pliers are the only tools necessary to expose all its components).
(4) Permit the vapor pump to remain hot at all times (a low-impedance packless high-vacuum valve plus suitable foreline and roughing valves).
(5) Be rustproof to maintain high capacity near blank-off pressures (stainless steel, copper, and aluminum construction).

The ultimate pressure of this system was 6×10^{-4} microns, as in-

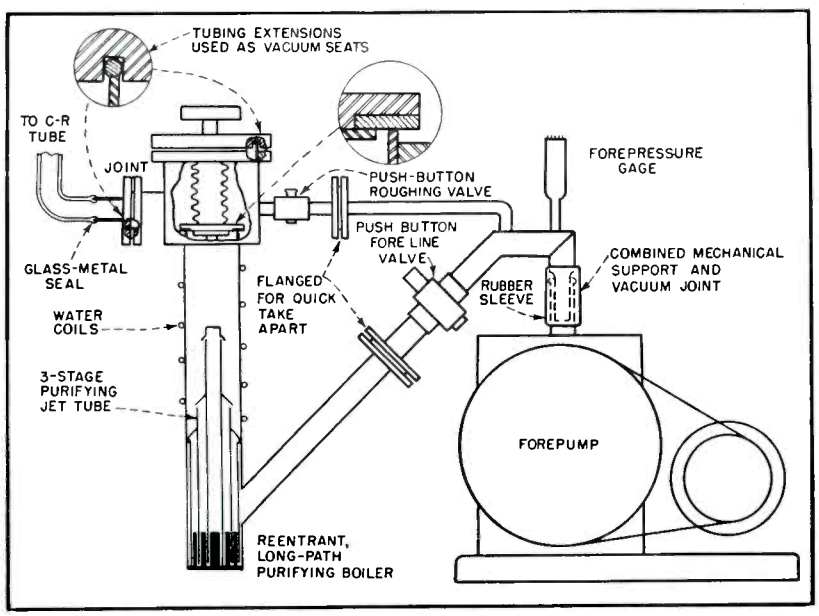

FIG. 8—Complete pumping system designed for the evacuation of 12 to 20-inch television cathode-ray tubes

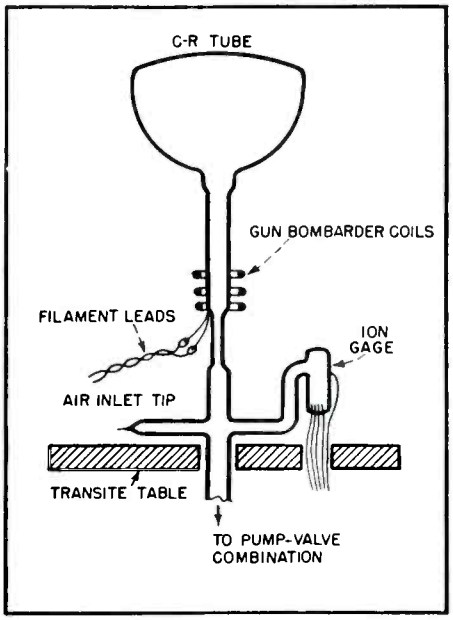

FIG. 9—Method of attaching cathode-ray tube and ion gage

dicated on an ionization gage placed at the end of the glass tubing. This indication was observed at a room temperature of 25 C. Temperature at blank off of any pump without traps should be specified, since the vapor pressure of the oil and consequently the ultimate indication is a function of temperature.

When tested without the valve assembly, this pump will generally produce 2 x 10^{-4} microns, under the conditions noted above. The difference in these pressures may be accounted for by the appreciable outgassing of the mechanical elements of the valve. It is interesting to approximate the size of the leak or outgassing that will give this pressure difference. Assuming the pump has a speed of 50 liters per second for all values below 1 micron, the capacity that describes the 4 x 10^{-4} microns increase in pressure is (50 x 4 x 10^{-4}) = 2 x 10^{-2} micron liters per second. One cubic centimeter of gas at NTP equals 760 micron liters. Therefore, this capacity becomes approximately 10^{-1} cc per hour. In other words, 10 hours would be required to leak in one NTP cc of gas in order to justify an increase of pressure of 4 x 10^{-4} microns.

The pump-valve combination was part of an exhaust dolly riding an oval track that carried the cathode-ray tubes through the bake-out ovens. The tube was attached as shown in Fig. 9. The oval was divided into two production lines with tip off of finished tubes and seal on of new ones occurring at the ends. Following the seal on of a new unit, the operations of the vacuum system were as follows: (The vapor pump is hot, the high vacuum (HV) valve is closed, the foreline (FV) valve is open, and the roughing valve (RV) is closed.)

(1) FV closed, RV opened—tube and valve are pumped to approximately 200 microns (2 minutes).
(2) RV closed, FV opened, HV opened (tube is now being exhausted through the vapor pump; dolly carries tube through bake-out).
(3) After final processing and tip off of tube, the system is made ready for another unit by closing HV and breaking air inlet tip.

Conclusions

An exhaust history is shown in Fig. 10, and an analysis of this leads to some interesting conclusions about the order of processing and about potential production increase.

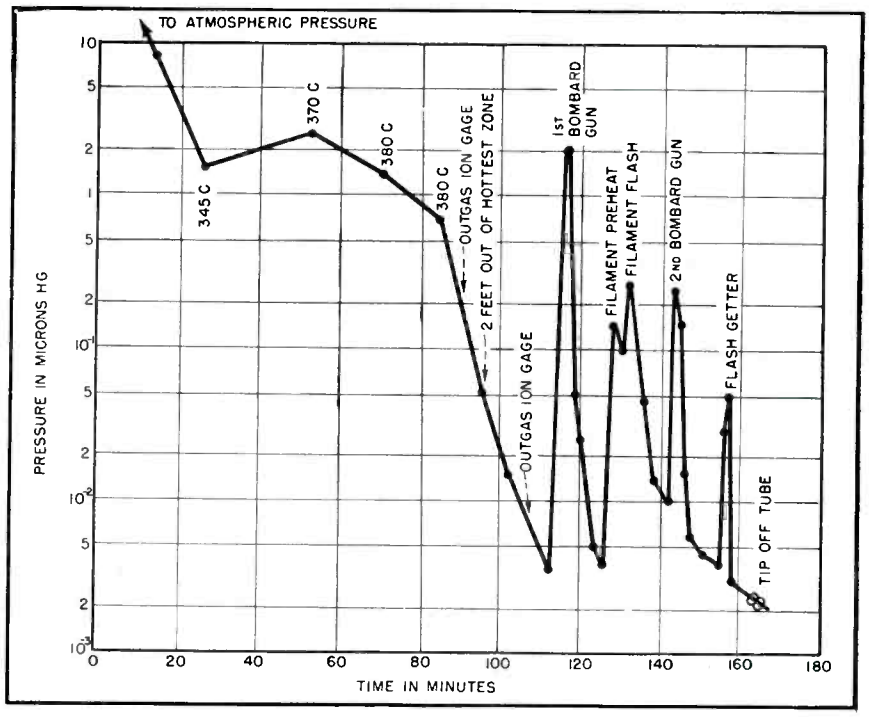

FIG. 10—Time-pressure exhaust history of an actual television tube on the system described

It will be noted that the pressure while the tube is in the ovens is moderately high. Calculation of the amount of outgassed material pumped during the period from 20 to 80 minutes gives a figure of approximately 7 NTP cc. It is assumed for the above calculation that the mean speed of the system including the glass tubing is one liter per second. Also note that after the tube has left the hot zones in the oven, the gun bombardment and filament processing release sufficient gas to cause reasonably high pressure bursts. It probably would be more desirable to carry on these operations while the tube is in the hot zones inasmuch as the newly cleaned glass surfaces will now re-absorb some gas during these pressure bursts. The net result of this will be to increase the length of time required to attain a given final pressure. It is conceivable that if these operations were done in the 50 to 80-minute interval that tip off could occur at approximately 120 minutes with a net savings of almost three quarters of an hour. Finally, the slope of the pressure-time curve at tip off indicates that the system is far from an ultimate pressure and that a few more minutes of pumping time could easily result in a decrease of pressure by a factor of two.

The pump-valve system described has been used in the production of cathode-ray tubes for a sufficient period of time to prove its usefulness to the industry. Automatic operation is indicated, such as mechanical or hydraulic operation of valves, so that savings could be made in the labor required on the exhaust line. This automatic operation could take the form of valves mechanically driven from a cam track, with the addition of a triggering mechanism to close the high-vacuum valve in the event of glass breakage during the processing of the tube.

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Wide-Range

Cascaded cathode followers with reactive loads produce 180-degree phase shift with constant loss over wide range of frequencies. Frequency modulation is accomplished by varying plate current of phase-shift stages. Three useful generator circuits are described

THE TESTING and adjustment of amplifier systems by means of a frequency-modulated signal generator and an oscilloscope has become commonplace during the past decade. In the case of f-m and television receivers it is virtually the only satisfactory method of testing. This paper is concerned with the development of a new type of oscillating circuit particularly suited to the requirements of this method.

The circuit to be described consists of an amplifier and a phase-shifting system. It will oscillate over any range of frequencies for which the amplifier can be made to have constant gain and phase shift, and for which the phase-shift system can be controlled to produce the correct phase change while having constant loss.

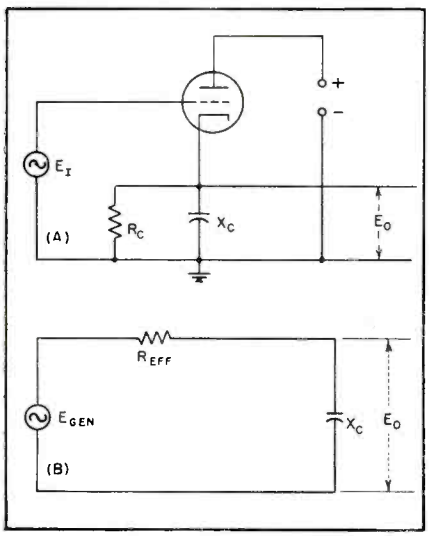

FIG. 1—Reactance-loaded cathode follower and equivalent circuit

A single-stage resistance-coupled amplifier has uniform gain and constant 180-degree phase shift at frequencies up to the point where the distributed capacitances become important. Such an amplifier has been found adequate for oscillators operating as high as 38 mc.

The novel feature of this circuit is the phase-shifting system itself. The ordinary cathode-follower amplifier, when operating into a capacitive-reactance load, is ideally suited to shift the phase of the oscillating current while maintaining constant loss. In practice, three or four such phase shifters are used in cascade to produce 180-degree phase shift.

The reasons the cathode-follower is so effective will be apparent after analyzing the operation of such a reactance-loaded amplifier, Fig. 1A. The cathode follower may be considered equivalent to an a-c generator in series with a resistance and capacitance, Fig. 1B. In this case, the effective resistance may be calculated by:

$$R_{EFF} = \frac{R_P}{1 + \mu} \qquad (1)$$

In practice R_c, Fig. 1A, is made sufficiently high so that it can be omitted from Eq. 1. In Fig. 1B,

$$E_{GEN} = \frac{\mu}{\mu + 1} E_I \qquad (2)$$

The plate resistance of the usual triode tube may be varied over wide limits by simply changing its plate current. At the same time the amplification factor remains nearly constant. For this reason, the effective resistance Eq. 1 can be made to change while the generator voltage Eq. 2 stays the same.

In Fig. 1B, the phase of the output voltage may be found by:

$$\theta = tan^{-1} \frac{R_{EFF}}{X_C} \qquad (3)$$

and the magnitude by:

$$E_O = E_{GEN} \cos \theta \qquad (4)$$

Figure 2 shows the circuit of a complete deviable oscillator using four phase-shift stages. Each stage produces 45 degrees shift in order to have the required 180 degrees. A shift of 45 degrees per stage is obtained by making the capacitive reactance of each stage equal to the

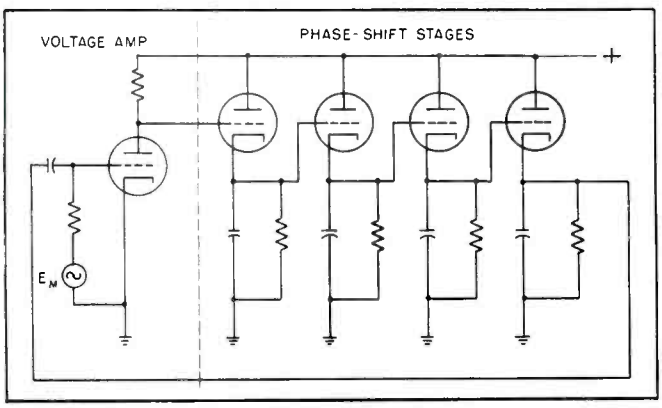

FIG. 2—Fundamental circuit of cascaded cathode-follower phase-shift oscillator

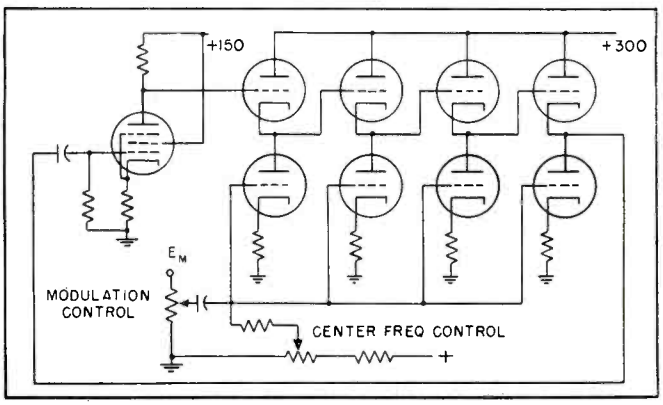

FIG. 3—Addition of series control tubes permits more uniform control of phase shift

Deviable Oscillator

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equivalent resistance of the stage.

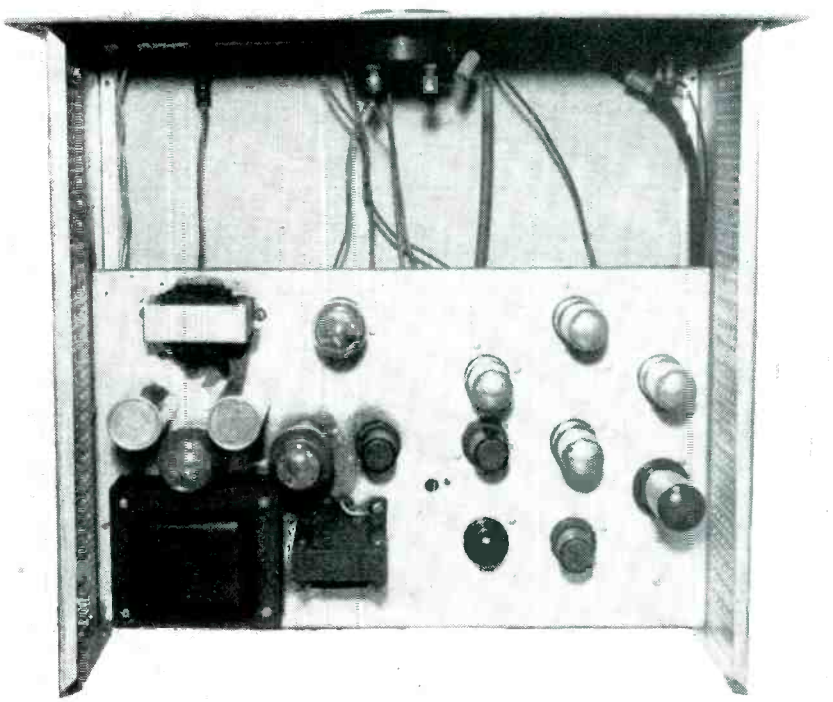
Since E_{GES} (Eq. 2) is always slightly less than unity, E_o/E_G per phase-shift stage in the circuit of Fig. 2 is approximately 0.7. A loss slightly in excess of four times will occur, and is readily overcome by the amplifier shown ahead of the phase-shift stages.

Actual frequency modulation of the circuit is accomplished by simultaneously varying the plate current of all four cathode-follower stages. Figure 2 shows the modulating voltage applied to the amplifier grid, where it is amplified and applied to the four cathode followers. The circuit will oscillate at the frequency where the effective resistance in combination with the capacitive reactance will result in a 45-degree shift per stage. Each time the effective resistance is altered by changing the grid bias of the phase shifter, the circuit will operate on a new frequency at which the reactance of the fixed capacitors is equal to the new effective resistance. It will be seen from Eq. 2 and Eq. 4 that the voltage loss of the phase shifters remains constant because the amplification factor of the triode tubes does not change, and because the phase shift required is also constant. Therefore, the strength of oscillation tends to remain uniform as the frequency is varied.

Design Considerations

An ideal frequency-modulated oscillator would have the following characteristics: (1) Equal output voltage at all frequencies, (2) Low harmonic distortion, (3) Output frequency proportional to control voltage, (4) Capable of operation at high frequencies, and (5) High

Top view of wide-range audio-frequency generator. Useful frequency range is 150 cps to 15,000 cps



Broadcast frequency sweep generator using cascaded cathode-follower phase-shift oscillator circuit

This paper was presented at the National Electronics Conference in Chicago.

ratio of maximum to minimum frequency.

By proper design and careful selection of components, oscillators of the type shown in Fig. 2 can be constructed to approach these characteristics. One such oscillator has a frequency ratio of 100 to 1. Another can be made to sweep from 16 to 38 mc. All of the experimental oscillators built to date have a remarkably straight frequency vs modulating-voltage characteristic.

In attempting to obtain optimum performance, equal phase shift per stage is a very important requisite. The voltage gain in the phase-shifting section is a function of the cosine of the phase angle (Eq. 4). Maximum gain is obtained when the phase angles are equal. If, for example, two of the phase-shifting stages of Fig. 2 have 60 degrees phase shift apiece, and the other two stages 30 degrees, the total loss will be approximately five and one half times instead of slightly more than four times. It is necessary to select tubes with similar grid voltage vs transconductance characteristics. The transconductance with the tube operating close to cutoff is important at the low-frequency end of the oscillator range. Transconductance at zero bias is likewise important when the oscillator is at the extreme high-frequency end of its range. It is also important that the capacitors used in the phase-shift circuit be equal.

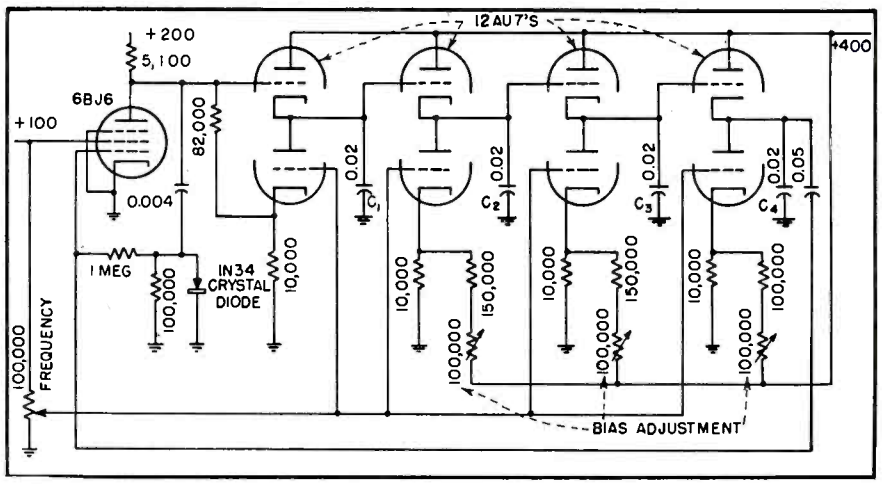


FIG. 4—Wide-range audio-frequency signal generator has maximum-to-minimum frequency ratio of 100 to 1. Automatic-gain-control crystal diode holds output constant

Figure 2 shows the modulating voltage coupled in through the amplifier grid. This modulating voltage can have an undesirable effect upon the amplifier. Also, each successive cathode-follower stage receives a little less modulating voltage. The addition of series control tubes, Fig. 3, is a major improvement. The transconductance of the phase-shift tubes can be

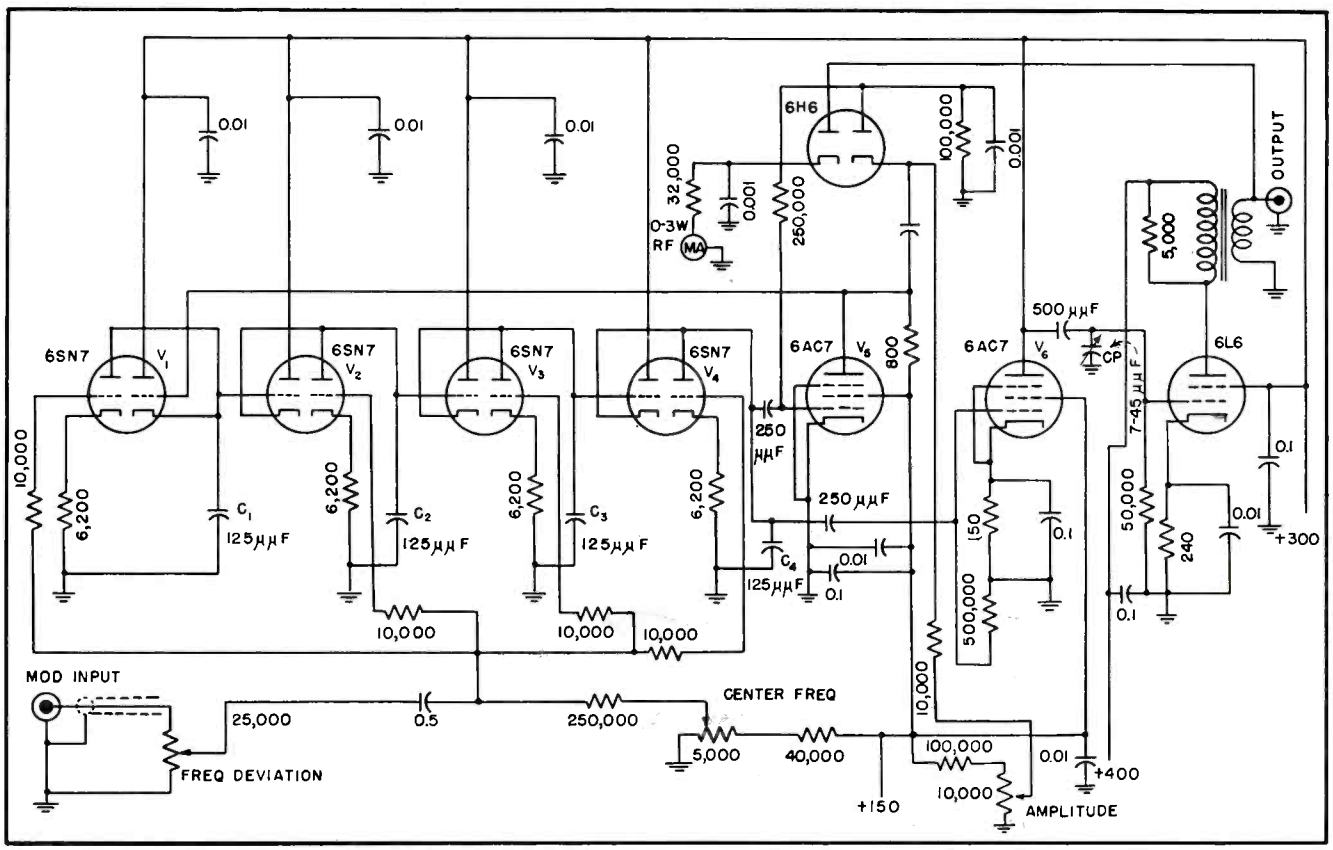


FIG. 5—Broadcast-frequency sweep generator may be used to test a receiver's sensitivity over a range of 540 to 1,700 kc. By applying 20-cps sawtooth voltage to *Mod Input*, output frequency deviates linearly with respect to time

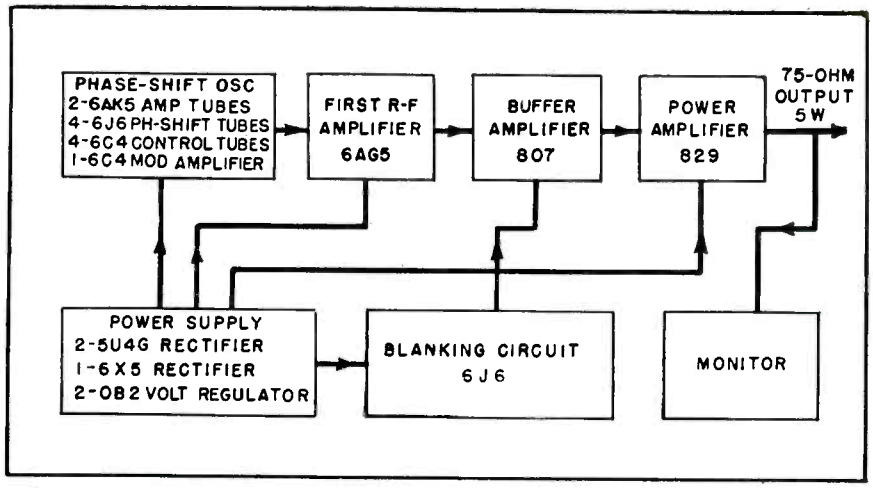


FIG. 6—Block diagram of frequency-modulated transmitter covering the range 22 to 28 mc for use in testing television picture i-f amplifiers

varied more uniformly by having a control tube for each phase-shift tube. The cathode resistors are replaced by the control tubes with the following beneficial effect. Since the plate resistance of the control tubes increases as the effective resistance of the phase-shift tubes increases, operation at lower frequencies is possible.

Automatic gain control of the amplifier is advisable when the output must be unusually uniform in voltage or where minimum harmonic distortion is desired. In common with other oscillators, the amplitude of oscillation builds up until some element of the circuit overloads. Usually the grid of the amplifier develops enough self-bias to limit the output to a satisfactory level.

Frequencies as high as 40 mc may be attained by using high-transconductance miniature triodes, and obtaining the phase shift by making use of the distributed capacitance of the tubes and wiring. Best results are obtained by careful balancing of these capacitances.

Some phase shift will usually take place in the amplifier plate circuit at the higher frequencies due to the distributed capacitance present. This condition is not undesirable because the presence of a small amount of phase shift there means that each cathode follower need not shift the phase quite as much. Due again to the fact that the voltage gain is a function of the cosine of the phase angle (Eq. 4), the voltage loss is not quite as great for five stages of phase shift as for four. The result is that the strength of oscillation at the high-frequency end of the range is increased.

The frequency vs modulating-voltage characteristic curves are phenomenally straight, as shown in Figure 8. Apparently, the plate resistance of ordinary triode tubes

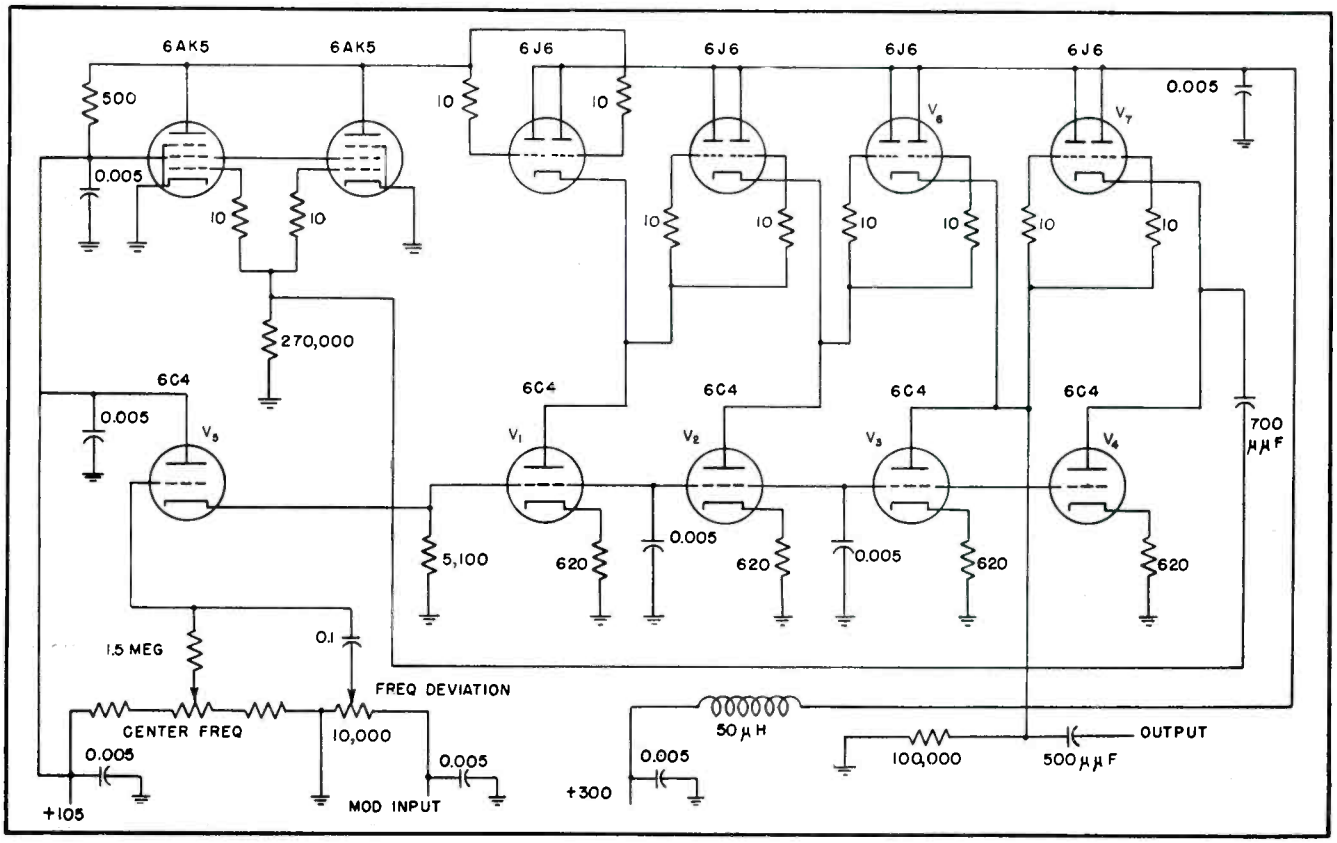
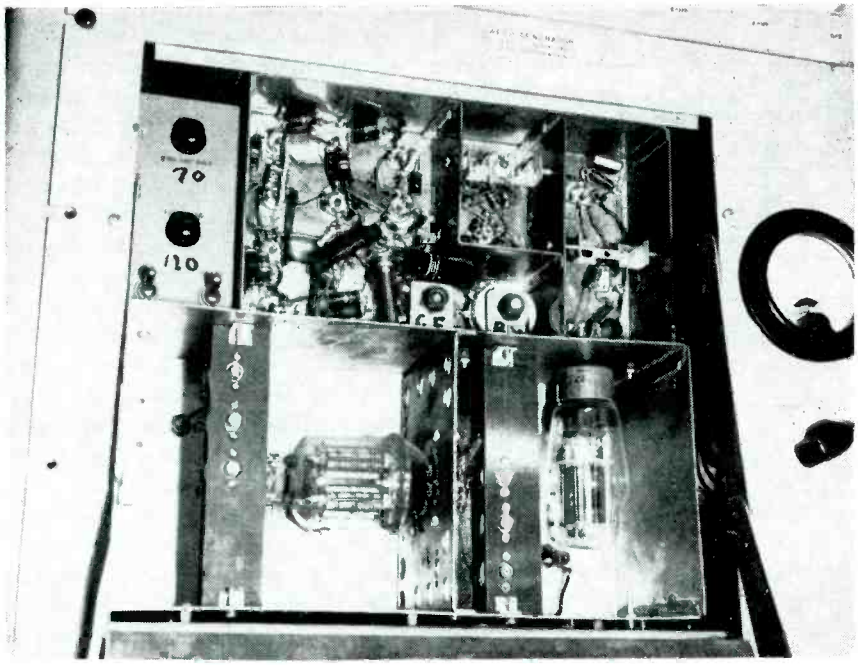


FIG. 7—Phase-shift oscillator section of television i-f sweep generator. This portion of the generator should be well shielded to prevent currents in the power stages from affecting stability and linearity. Power stages (not shown) are conventional



Bottom view of television i-f frequency sweep generator

varies inversely with the plate current.

Wide-Range Audio Generator

The circuit of Fig. 4 will cover a frequency ratio of 100 to 1. A 6BJ6 is used as an amplifier, and four 12AU7's are used as phase-shift and control tubes. One half of each 12AU7 is the cathode follower, and the other half is the associated control tube. Capacitors C_1, C_2, C_3, and C_4 are used to produce phase shift. An automatic-gain-control crystal diode was added to the original circuit in order to hold the output constant. A small amount of fixed bias has been applied to the second, third, and fourth control tubes. This bias is adjusted for maximum output at the lowest operating frequency. The useful frequency range of 150 cycles to 15 kc is obtained by varying the frequency-control potentiometer. This manual control could be replaced by a source of a-c voltage such as a sawtooth generator if desired. Minimum distortion and most uniform output is available at the cathode of the last phase-shift tube.

Broadcast Frequency Sweep Generator

The circuit of Fig. 5 was developed to provide a frequency-modulated signal, sweeping the broadcast band. Receivers may be tested for sensitivity over the range of 540 to 1,700 kc in one operation by means of this transmitter.

Four 6SN7's V_1, V_2, V_3, and V_4 are employed as combined cathode-follower and control tubes in the phase-shift system. The 6AC7, V_5 provides the amplification required for oscillation. One half of a 6H6 is used as an automatic gain control on the oscillator, and the other half as power output monitor. Oscillator voltage is amplified by V_6 before being impressed upon the grid of the 6L6 power amplifier. The plate of the 6L6 is transformer coupled to the output (normally 75 ohms). This transformer has a turns ratio of 4 to 1, and must pass the range of 500 to 2,000 kc.

A sawtooth voltage of 20 cycles per second is normally applied to the modulator input, producing a frequency-modulated signal that deviates linearly with respect to time. The same sawtooth voltage is applied to the horizontal plates of the test oscilloscope, while the transmitter output is fed through suitable transmission lines and attenuator to the receiver under test. One such transmitter may be used to operate as many as 1,200 test positions simultaneously.

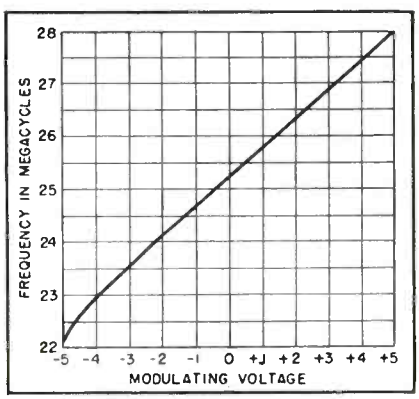


FIG. 8—Curve showing extreme linearity between modulating voltage and output frequency

It is desirable that the output voltage be flat and relatively distortionless over the frequency range of 540 kc to 1.7 mc. Capacitor *CP* is used to adjust the amplifier gain at the high-frequency end of the range. Selection of tubes may also be necessary to keep the output flat within ±5 percent, and to keep harmonic distortion below 10 percent.

Television I-F Sweep Generator

Figure 6 is the block diagram of a frequency-modulated transmitter covering the range of 22 to 28 megacycles, and used to test television picture i-f amplifiers. The phase-shift oscillator section of the transmitter is shown in detail in Fig. 7, and described in the next paragraph. The balance of the transmitter is conventional in design. Figure 8 is a frequency vs voltage curve for the transmitter, and illustrates how closely it approaches a straight line.

The 6AK5's of Fig. 7 are the amplifiers, which together with the 6J6 phase-shift tubes cause oscillation. The 6C4 tubes V_1 to V_4 inclusive, are series-control tubes. The center frequency control voltage as well as the a-c modulating voltage is applied to the series control tube by means of a cathode-follower amplifier, V_5. The r-f output is taken from the cathode of V_6 rather than V_7 in an effort to keep the distributed capacitance in the phase-shift circuit as nearly equal as is practical, since the phase shift is caused by distributed rather than lumped capacitance at these higher frequencies.

The phase-shift oscillator should be well shielded in order to prevent currents in the output power amplifier from affecting the stability and linearity of the transmitter.

Servo-Controlled Tensile Strength Tester

Bonded-wire type strain gage drives recorder through oscillator-amplifier system to produce load-elongation diagrams of materials ranging from finest single textile fibers to complex plastics and rubbers. Drive motor for pulling jaws is energized by amplidyne and servo amplifier controlled by selsyns

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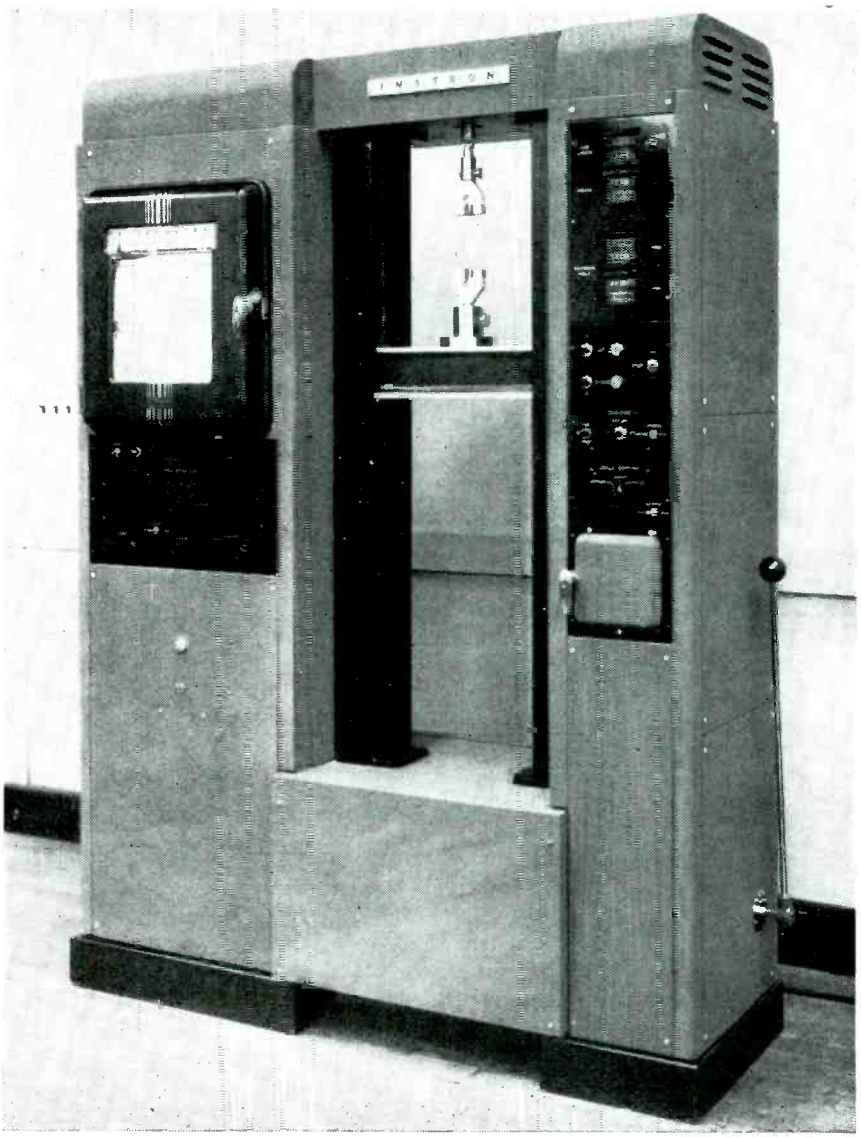
THERE HAS BEEN a growing need to study more thoroughly and to utilize from an engineering standpoint such materials as plastics, textiles and rubber. This effort has been considerably hindered by the complexity of their physical properties, not only because there are so many characteristics to be evaluated, but also because most of the functions are strictly interrelated and time-dependent.

To present an example, elastic modulus in the case of metals is usually considered to be a constant under normal conditions. On the other hand, in a textile fiber or plastic material the value of elastic modulus is strongly dependent on the amount of extension, the degree to which recoverable and non-recoverable creep has taken place, and the past history with respect to such other variables as humidity and temperature.

Instrument Requirements

In both research and commercial development the need has been felt for refined techniques of tensile measurement, particularly with regard to the dynamics of the test method. Simple ultimate-strength determinations are of diminished importance, because an adequate description now requires to varying extents such other measurements as instantaneous elastic modulus, creep, relaxation, and recovery, all with respect to time as well as temperature and humidity.

In order to design a tensile test-



Complete Instron tensile strength tester. Pulling jaws in center section are controlled by pushbuttons on righthand panel. Gearshift lever at right provides 10-to-1 reduction of pulling-jaw speed. Results of tests are made available immediately by Leeds and Northrup Speedomax strip-chart recorder on lefthand panel

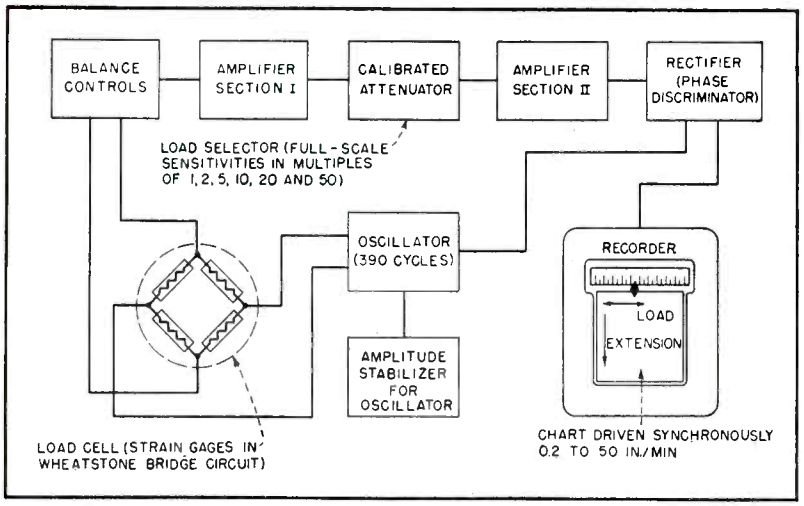


FIG. 1—Block diagram of tensile-testing instrument, showing use of strain gages in a-c bridge circuit for weighing applied load

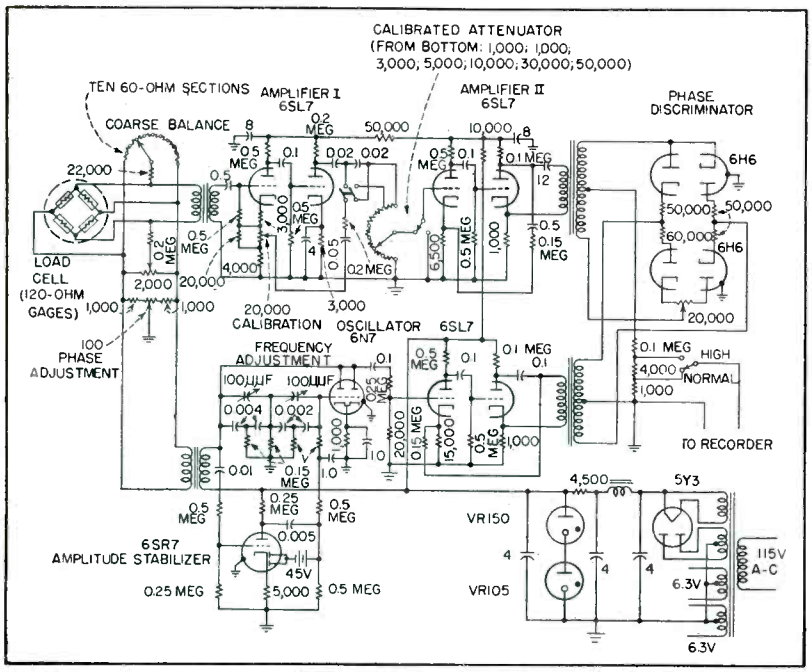


FIG. 2—Circuit diagram of oscillator and amplifier used with a-c bridge to drive recorder

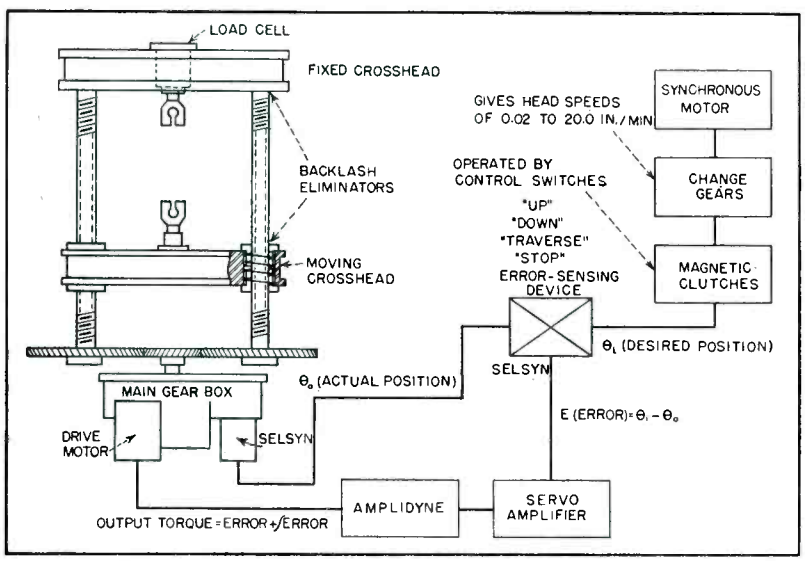


FIG. 3—Block diagram of servomechanism drive system used for controlling moving crosshead

ing instrument that would meet as many of these requirements as possible, three major conditions were to be satisfied. First, a considerable versatility of control should be incorporated in order that a varied loading history might be applied to the sample. Second, the dynamic characteristics of the machine itself should not obscure the properties to be measured. Furthermore, a wide range of load sensitivities is advisable, in order that accurate testing can be performed on elements as small as the finest single fibers, as well as final materials having high ultimate strengths.

In the instrument to be described, electronic principles were utilized in both the load weighing system and the drive mechanism in the effort to achieve these results.

Design Principles

The weighing system for detecting and recording the tensile load applied to the test sample is based upon the use of the bonded-wire type of strain gage. These gages, incorporated into interchangeable load cells to cover the prescribed ranges, are arranged in a Wheatstone bridge circuit, the output of which is amplified to operate a Leeds and Northrup Speedomax recorder. The pulling jaw is mounted on a moving crosshead motivated by two vertical drive screws and an amplidyne-controlled positional servomechanism. The chart of the recorder is driven synchronously at various speed ratios with respect to the crosshead, so that load-elongation diagrams may be obtained with a wide choice of scale factors for both load and extension.

These features are combined to give the following general characteristics:

(1) Full-scale load sensitivities are available in a single instrument extending from 2 grams upward to 5,000 pounds, with each removable load cell incorporating as much as a 50-to-1 choice of ranges.

(2) Inasmuch as the load cells themselves have a high natural frequency, the speed of response of the weighing system is limited mainly by the recorder, which in this case will travel full scale in somewhat over one second, and is independent

of the load range in use.

(3) The weighing element deflects a maximum of 0.003 inch upon application of its top rated load. This feature is of importance in that the motion of the pulling jaw alone will determine the rate of extension of the sample, thereby enabling the time-dependent properties of the sample to be correctly evaluated. Also, the disintegration during rupture of inextensible materials may be investigated without sudden load fluctuations causing deflections of the weighing jaw that would interrupt the continuity of sample extension.

(4) On account of their low deformation under load the cells exhibit none of the effects of mechanical inertia that might cause premature rupture of the sample or similar distortion of its stress-strain characteristics.

(5) Through the operation of the servo-controlled drive, means are available for obtaining exact crosshead speeds over the range from 0.02 to 20 inches per minute by the use of light change gears in the low-power reference system.

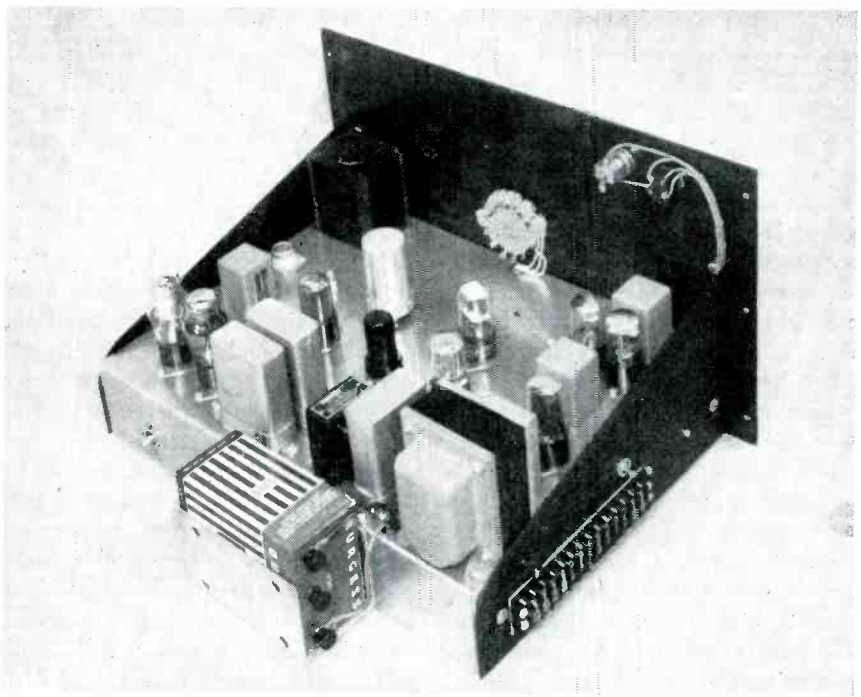
(6) Once selected, these crosshead speeds remain synchronously constant in either direction of motion for all loads up to maximum capacity.

(7) By the action of small magnetic clutches in the reference drive, the motion of the pulling jaw may be almost instantaneously started, stopped and reversed, thus enabling practically any variety of complex loading histories to be applied to the sample.

Load Weighing System

The load cells for the more sensitive ranges use a modified bending beam as the strain-sensitive element. With the exception of the 2-gram unit, the load is transmitted to the cantilever through a spindle supported axially by means of diaphragms. For the higher ranges a diaphragm-supported tension bar is used. This type of construction gives a needed rigidity and ruggedness to the assembly and effectively discriminates against non-axial loading. All four arms of the strain-gage bridge are located in the cell for maximum temperature stability.

As shown in Fig. 1, the bridge is excited by a 390-cycle phase-shift oscillator, in which considerable attention has been given to achieving good amplitude and frequency stabilization. The output of the cell is connected to a coarse and fine balancing network consisting of a ten-turn potentiometer and a ten-step switch, thus allowing large initial loads to be balanced out without sacrificing sensitivity of control. The signal is amplified in a conventional circuit stabilized with feedback, but incorporating an attenuator calibrated to 0.1-percent accuracy to provide a selection of full scale load sensitivities in the ratio of 1, 2, 5, 10, 20 and 50. An additional control provides for varying the overall sensitivity of the circuit continuously between these steps, in order that calibration of the load selector may be set in terms of any desired units of load.



Chassis of oscillator and amplifier unit

Circuit Details

A phase-discriminating type of rectifier circuit, with its polarizing voltage obtained from the oscillator, converts the amplified bridge signal to d-c for operation of the potentiometer recorder. The complete circuit is presented in Fig. 2. The rectifier also operates as a gate circuit to eliminate the effects of hum pickup and of phase unbalance due to stray capacitance in the bridge.

It was desired that each load cell cover as wide a range of sensitivities as possible, and therefore the minimum strain in the weighing element to produce a full-scale response was designed to be approximately 30 microinches per inch. The maximum capacity of each cell is limited mainly by the allowable deflection and is up to fifty times this value, depending on the cell in use.

The elements of the servomechanism drive system are shown schematically in Fig. 3. Two selsyns are used to produce a voltage proportional to the error between the desired position of the crosshead at any moment and its actual position. The error signal is amplified by a circuit containing anti-hunt provisions and made to operate an amplidyne motor-generator. This unit supplies the controlling power to the d-c drive motor, which then rotates in such a direction as to cause the error to approach zero.

Because the output of the amplifier and amplidyne is proportional to the sum of both the error and its time integral, the error of the crosshead position is kept to less than 0.0005 inch even under steady-state conditions of load and velocity. Furthermore, the time constants of the system are so designed that it will usually correct in less than 0.5

second for sudden changes in these conditions, such as a desired quick reversal of crosshead motion.

Any rotation of the low-power pilot selsyn therefore produces an equivalent change in the position of the pulling jaw of the machine. The reference unit is driven by a mechanism containing a small synchronous motor, a simple gear-change arrangement to give the desired head speeds, and a set of quick-acting magnetic clutches which cause the crosshead to move either upward, downward, in rapid traverse, or provide a fast braking action.

Inasmuch as both the recorder chart and the crosshead are now synchronously driven, the time axis becomes an accurate measure of the jaw position and sample extension. This correspondence is further improved by spring-loaded devices on the drive screws which eliminate backlash from that source, while the gear meshes in the main drive are held to sufficiently close tolerance as to introduce negligible error.

Because the reference system has very low mechanical inertia, it is started, stopped and reversed almost instantaneously under the action of the magnetic clutches. The main drive cannot of course respond as fast to a sudden change, but because the servo operates on positional error it must very quickly get in step again, as illustrated in Fig. 4. For comparison, the probable response of a velocity-controlled system is included to demonstrate the manner in which a lag or error would be introduced at each reversal until the cumulative error in recorded extension would be appreciable.

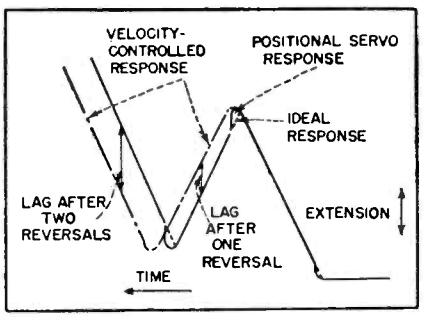


FIG. 4—Analysis of response of positional servo

A shift lever located on the side of the instrument operates a disc-type clutch in the main gear box to connect a 10-to-1 speed reduction. Thus the speed changes available in the selsyn drive are supplemented to provide the complete range of jaw speeds of from 0.02 to 20 inches per minute.

The operation of the pulling head is controlled manually by push-buttons located on the panel. Certain functions can be made automatic by the adjustable dials at the top of the panel, which are directly driven from the drive screws. Each of these controls consists of a fine dial graduated in 0.005-inch intervals of crosshead motion, geared by a planetary reduction to a coarse dial graduated in the number of integral inches up to the total crosshead travel. Precision switches are actuated by these dials to perform the following functions:

(1) Stop the return or upward motion of the jaw at any desired point in order that a reproducible gage length will be obtained each time a new sample is inserted in the machine.

(2) Either stop the crosshead at a point set slightly beyond the maximum expected sample extension, or initiate a rapid return motion so that the head will automatically come back to the gage length setting.

(3) Cycle the crosshead at its preset speed between any two points within the extension of the sample, so that determinations may be made of the hysteresis properties of the material. These controls can also act to stop the head at either of these points for relaxation measurements.

(4) Additional switches are located in the recorder, enabling similar cyclic tests to be made between any two load points.

(5) For more complicated routines, these controls may of course be combined so that the instrument will cycle between a value of extension at one limit and load at the other.

Advantages of Servo Drive

Versatility of control has been achieved without undue complexity as far as the components are concerned, which is clearly one of the benefits to be derived from a servo type of drive. The overall system is also readily adaptable to testing under conditions of constant rate of loading, pending the development of a suitable XY recorder to chart both load and extension as independent variables with respect to time. The development of suitable extensometers to measure strain in the sample directly will broaden this basic usefulness of the instrument by permitting constant rate-of-strain measurements. Auxiliary devices are already under investigation for adapting the instrument to compressional, flexural and torsional tests, retaining the same flex-

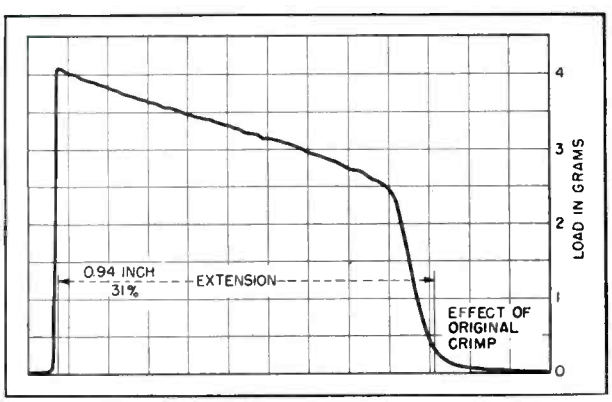


FIG. 5—Record obtained for single fiber of wool, illustrating high sensitivity range. Magnification ratio is 10 to 1

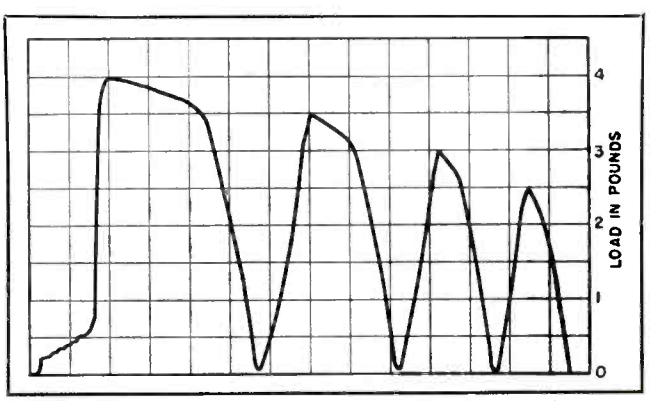


FIG. 6—Record for repeated loading of paper, illustrating magnification ratio of 50 to 1 as applied to inextensible material

ibility of loading control as previously described.

The tensile tester, because of its special characteristics, has potential applications in a large variety of fields. Its utility has already been mentioned in the research and development of textiles, plastics and similar materials in which a complex physical structure predominates. There are many other fields, such as paper or fine wire and foils, in which either the low inherent extensibility or the low strength of the material has made inadequate any previous techniques. A few typical records are described to illustrate these points.

Typical Applications

Figure 5 is a load-extension curve of a single fiber of wool, using a high-sensitivity load range. The spring effect of the original crimp in the fiber is readily apparent, as well as the subsequent elastic and flow regions under straight tension.

Figure 6 illustrates the characteristics of a sample of high-grade paper in tension. In this case the specimen was stretched until the load reached a number of successively increased values, with the tension being released each time by reversing the jaw motion. The record shows that a form of work-hardening takes place in paper, since the flow region for each loading cycle begins at the maximum previously applied load. By slightly modifying the technique, the amount of permanent deformation could be readily determined as a function of varying amounts of load or extension.

Figure 7 shows a tear test of a fabric especially designed to resist rip. A strengthened yarn is woven into the material at regular intervals as an inhibitor.

Figure 8 is an interesting demonstration of the sensitivity of an adhesive test as performed on the instrument. A length of Scotch tape was applied to a piece of the same chart paper as that upon which these records were made. As the tape was slowly pulled off, more or less random fluctuations of load would be expected as the adhesive separated from or pulled out the fibers in the paper. However, distinct dips in the curve were produced as each of the fine rulings in the chart was encountered, with a somewhat broader indication occurring at the heavier division. In other words, the adhesive action was definitely sensitive to the presence of the ink in the chart printing.

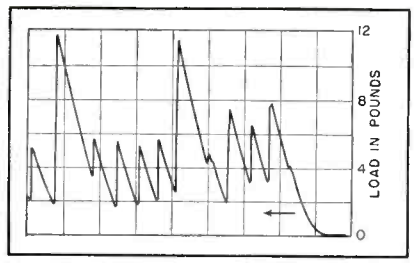


FIG. 7—Record obtained for rip-stop fabric-tear test of strengthened fabric

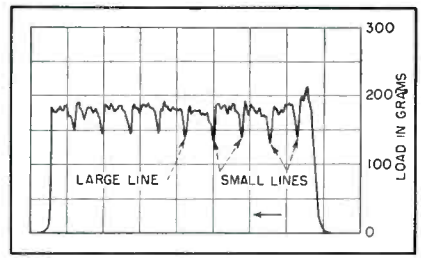


FIG. 8—Example of adhesion test record wherein Scotch tape is pulled from chart

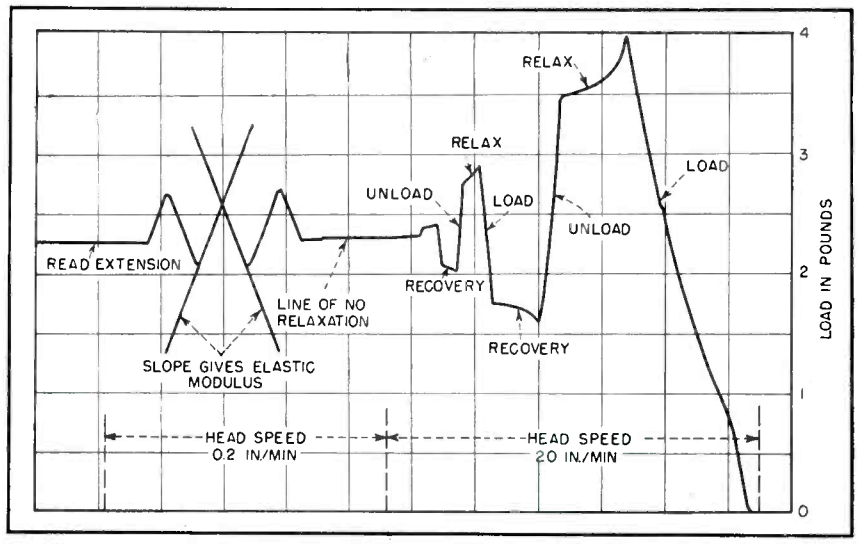


FIG. 9—Determination of elastic modulus of nylon yarn by bracketing technique

Figure 9 is an example of a possible technique for isolating for purposes of evaluation a certain property of a material, in this case elastic modulus. A simple load-elongation test of nylon will not give an indication of modulus, since the flow characteristics predominate for even low values of extension, and also because the modulus itself is a function of extension and other past history.

The routine in this case was as follows: the sample was extended until the load reached 4 pounds, then the pulling jaw was stopped and the load allowed to relax with time as the extension was held constant. The sample was then released to a lower value of load and the jaw again stopped. This time the load will gradually increase as the sample recovers from its previous conditioning. If this procedure is continued with decreasing increments of load, a point can be reached by a process of successive approximation or bracketing, at which the load will not change in either direction when the jaw is stationary. In other words, a condition of dynamic equilibrium has been set up in the sample such that the relaxation effect is being exactly counterbalanced by the recovery from its previous loading, so that temporarily only the truly elastic properties remain. It is now only necessary to cycle over short displacements about this line and measure the resultant slopes to obtain the elastic modulus of the material at this value of extension.

Acknowledgment

Acknowledgment is gratefully made to Harold Hindman, who as a persevering co-inventor and business partner has contributed more than equally of inspiration and ability to the tedious experimental development and final design of this instrument, and who has shared the rigors of launching a new enterprise.

TELEVISION FRONT-END

Design equations for cathode-coupled r-f amplifier and several types of mixer stages of a television receiver are derived and illustrated in this final article. Emphasis is placed on the problem of optimizing the signal-to-noise ratio while satisfying gain, bandwidth and adjacent-channel rejection requirements

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A LOGICAL combination of the cathode-follower r-f amplifier and the grounded-grid triode amplifier, which were discussed in Part I of this paper, is the cathode-coupled r-f amplifier shown in Fig. 7. Analysis of this circuit shows that it has some advantages over each of its parent circuits.

Remembering that R_1 in Eq. 30 represents the input resistance to a grounded-grid stage, and that R_K in Eq. 42 is the load resistance of a cathode follower, the choke in the cathode lead (Fig. 7) is made antiresonant with stray capacitance at the center of the transmission band, so that to a close approximation $R_1 = R_K$.

Then, using the equations, the overall gain of the cathode-coupled amplifier is

$$A_{cc} = \sqrt{\frac{R_0}{R_{ant}}}\left[\frac{G_{m1}R_L}{1 + G_{m1} \times \frac{r_{p2} + R_L}{\mu_2 + 1}}\right]$$

For a bandwidth of 8 mc per interstage, the required damping resistor value is calculated from Eq. 18 to be 1,400 ohms. Likewise, for the same bandwidth in the antenna-to r-f grid transformer, a damping resistor value of 3,320 ohms is required.

For the 6J6, G_m is 5,000 micromhos, r_p is 6,600 ohms, and μ is 33, so $A_{cc} = 21.4$.

To calculate the signal-to-noise voltage ratio of the cathode-coupled amplifier, we need to combine the noise contributions of the two tubes. The equivalent noise resistance at the high side of the antenna-to-grid transformer is half of the damping resistor value, or 1,650 ohms. The grid-equivalent noise resistance of the cathode-follower stage having a G_K of 5,000 micromhos can be readily computed to be 600 ohms. Adding these, the total noise resistance is 2,250 ohms.

The ratio of cathode voltage to grid voltage in the cathode follower is 0.541, and the value of grid circuit noise resistance transmitted to the cathode of the cathode follower is

$$R_{n1} = A^2{}_1 R_n = 658 \text{ ohms} \qquad (24)$$

To introduce the noise contribution of the grounded-grid section of the cathode-coupled amplifier, we must use the relationship given by Eq. 29,

$$E'_n = E_n \frac{\mu R_K}{r_p + R_L + R_K(\mu + 1)} \text{ microvolts}$$

In this application R_K, the cathode load for the grounded-grid section, is the output impedance of the cathode-follower section. Since the output impedance of a cathode follower is the same as the input impedance of a similar tube used as a grounded-grid amplifier with no plate load, we may use Eq. 30 in the form, $R_o = r_p/(\mu + 1)$ ohms, where R_o represents the dynamic portion of the output impedance of a cathode follower. Using previously quoted values for a single section of a 6J6, $R_o = 194$ ohms.

Substituting this value for R_K in Eq. 29 along with other values previously given, $E'_n = 0.452E_n$. Making use of Eq. 26, we find that $R'_n = 0.205\ R_n$. Since R_n has already been computed to be 600 ohms, $R'_n = 123$ ohms. This value of R'_n can now be added to the 658-ohm contribution of the input transformer and cathode follower to give the total noise contribution of both tubes and the input circuit, viewed at the common cathode point, as 781 ohms. Applying Eq. 24 again to determine the value of the above noise resistance as

Table I—Amplifier Circuit Summary (Excluding Interstage and Mixer Noise)

Circuit	Tube	Voltage Gain	S/N	Output R_n
Grounded-Cathode	6AK5	43.8	$0.450E_a$	141,200
		87.6	$0.450E_a$	564,800
Grounded-Grid	6J4	22.0	$0.362E_a$	55,000
Cathode-Follower	6J4	19.5	$0.585E_a$	16,350
Cathode-Coupled	6J6	21.4	$0.495E_a$	27,600
		39.1	$0.537E_a$	78,500

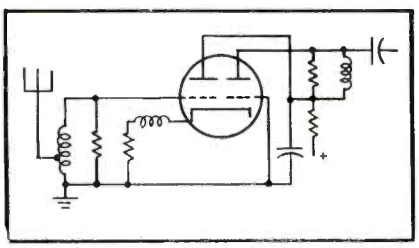

FIG. 7—Cathode-coupled r-f amplifier

DESIGN

Part II

of a
two-part article

viewed at the final output point of the cathode-coupled amplifier, we have R_n = 27,600 ohms where 5.95 is the cathode-to-plate gain of the grounded-grid section as determined in the computation of A_{cc}. The noise voltage in the output can be computed using Eq. 26, ignoring the noise from the interstage transformer and the mixer, E_{np} = 43.2 microvolts and $S/N = 0.495\ E_a$.

For operation with a grounded-grid mixer (Fig. 10c), R_L should be 2,850 ohms. For this condition A_{cc} is 39.1 for the combination with the 6J4 mixer, A_{cf} is 0.580 (ratio of grid voltage to cathode voltage in the cathode follower), R_{n1} is 757 ohms, E'_n is $0.420E_n$, R'_n is $0.1765\ R_n$, R'_n is 106 ohms, the noise resistance contribution of the transformer and cathode follower is 757 ohms, the total noise resistance seen at the common cathode is 763 ohms, R_{n1} is 78,500 ohms (viewed at the final output point of the cathode-coupled amplifier), the cathode-to-plate gain of the grounded-grid section is 10.14, E_{np} is 72.8 microvolts, and S/N is $0.537E_a$.

Pentode Mixer

E. W. Herold shows[6] that G_c, the conversion transconductance of a pentode plate detector having signal and oscillator voltages both introduced at the control grid, is

$$G_c = 0.23G_o \qquad (49)$$

if the oscillator voltage swings the mixer from zero bias to cutoff and G_o is the cathode transconductance of the tube, that is the change in

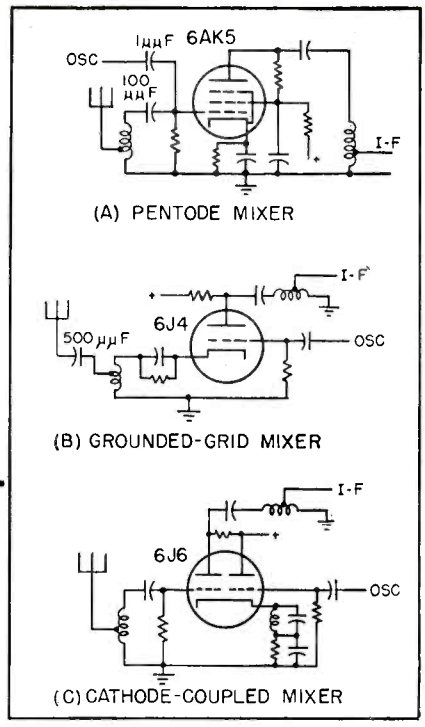

FIG. 8—Several mixer circuits for use without an r-f stage

cathode current per-unit-change in grid voltage. Since Herold has made the assumption that G_o and I_o are 1.25 times the corresponding plate transconductance and plate current (a valid approximation for many pentodes) for purposes of this paper we may express Eq. 49 in terms of G_m by a suitable change of constants. Thus,

$$G_c = 0.287\ G_m \qquad (50)$$

With a peak G_m of the 6AK5 mixer of 0.01 mho, the conversion transconductance is G_c = 0.00287 mho.

To transform the signal down to a 75-ohm impedance level for transmission to the i-f amplifier, we may either tap down on the plate coil for the output, or make use of a small (5 μμf) capacitance series resonant with the net inductive reactance of the plate tank. The latter method has the advantage of simpler coil construction and the disadvantage of adding about 50 percent to the capacitance shunting the circuit. In the interests of maximizing gain and bandwidth, we will then use the tapped coil, or autotransformer circuit.

If the output of the mixer were impressed on a purely resistive 75-ohm load, the total capacitance shunting the mixer plate circuit is the (approximately) 5-μμf output capacitance of the mixer. However, the actual load connected to the output will be a second r-f transformer whose resonant-frequency input impedance is 75 ohms resistive. If we use an autotransformer to terminate the receiving end of the output coaxial, its net effect on the mixer plate circuit will be to connect in shunt the grid circuit of the first i-f amplifier stage. Assuming the use of such an input transformer and a 6AK5 first i-f amplifier, the total effective capacitance shunting the mixer plate circuit will be 14 μμf, which will call for a net antiresonant resistance of the load of 1,425 ohms (see calculation for 6AK5 amplifier-to-6AK5-mixer interstage) consisting of 2,850 ohms shunted across the mixer plate circuit and 2,850 ohms across the first i-f stage grid circuit. The conversion gain, A_c, is the product of conversion transconductance and load impedance, so A_m = 4.09.

The mixer plate transformer must be designed to transform from a 2,850-ohm level to a 75-ohm level so there will be a voltage step-down from mixer plate to coaxial output jack. The net voltage gain from the grid of the mixer to the coaxial output jack is $A'_c = A_m\ (75/2850)^{\frac{1}{2}} = 0.664$.

For the 6AK5 mixer of Fig. 8, the noise resistance is shown by Herold[6] to be R_{nm}, where

$$R_{nm} = \left(15 + 21\,\frac{I_o}{G_o}\right) G_o \qquad (51)$$

and where I_o and G_o refer to zero bias cathode current and cathode transconductance of the mixer tube respectively. Changing from G_o to G_m as before,

$$R_{nm} = \frac{12 + 16.8\ I_p/G_m}{G_m} \qquad (52)$$

For a 6AK5 tube at a screen voltage of 120 volts, the zero-bias plate current is 20 ma and the zero bias transconductance is 10,000 micromhos or 0.01 mho. Therefore, by Eq. 29 the tube noise equivalent resistance referred to the grid is R_{nm} = 4,560 ohms.

Table I and the data computed for the 6AK5 mixer form Table II, which summarizes the features of the 6AK5 mixer in combination with various r-f amplifiers. The

quantity, R_{int}, used in Table II is the sum of mixer equivalent-grid noise resistance and interstage noise resistance; while R_n is the sum of R_{int} and the output noise resistance for the appropriate r-f amplifier as listed in Table I. The quantity $R_n\ (A'_c)^2$ is in turn equal to R_n referred to the coaxial output jack of the unit.

Technically, before computing E_n, we should add the transformed total noise resistance of the first i-f input circuit plus the first i-f tube equivalent-grid noise resistance, but practically the term is negligible (2,850 ohms circuit resistance plus 1,360 ohms first i-f tube grid equivalent-noise resistance equals 4,210 ohms which is transformed in impedance in the ratio 75/2,850 to yield 111 ohms effective at the coaxial cable jack).

The 6J6 Mixer Circuit

For the 6J6 mixers of Fig. 9, the equivalent noise resistance is[6]

$$R = 13/G_o \qquad (53)$$

for the mixer section of the tube, where G_o is the zero bias transconductance in mhos of the tube. An additional source of noise in this circuit is the triode section that is used to transmit oscillator voltage to the mixer proper. The noise resistance of a triode is (Eq. 25) $R = 3/G_m$, where G_m is the average transconductance of the tube in mhos. To a reasonable approximation, the average transconductance is equal to half of G_o, the peak transconductance, so we may write the total noise resistance for the twin-triode mixer as

$$R_e = 19/G_o \qquad (54)$$

Under the intended operating conditions, the peak transconductance, G_o, of a 6J6 is 6,500 micromhos so, R_e = 2,920 ohms. As in the case of the 6AK5 mixer, the tube noise resistance is small but not negligible, compared with the total noise resistance in the plate of the preceding r-f stage.

The conversion transconductance is[6]

$$G_c = 0.28\ G_o = 0.00182 \text{ mho.} \qquad (55)$$

Since the output capacitance of the 6J6 is substantially the same as that of the 6AK5, the same load impedance can be used and the conversion gain A_c = 2.59.

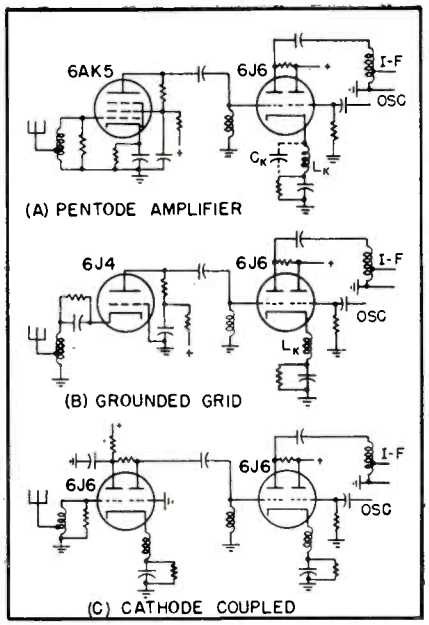

FIG. 9—Circuits employing a 6J6 mixer. For narrow-band cathode circuit at (A), C_K or 100 μμf is added and L_K is adjusted to resonate with C_K at the oscillator frequency. For wide-band cathode circuit at (B), L_K is adjusted to resonate with stray capacitance

Table II—Summary of Performance of 6AK5 Mixer with Various Amplifiers

R-F Amplifier	Tube	R_{rf}	R_{int}	R_n	$R_n\ (A'_c)^2$	E_n	Gain	S/N
Grounded-Cathode	6AK5	141,200	6,000	147,200	65,000	66.3	29.1	$0.440E_a$
Grounded-Grid	6J4	55,000	6,000	61,000	26,900	42.6	14.6	$0.343E_a$
Cathode-Follower	6J4	16,350	7,400	23,750	10,470	26.6	13.0	$0.489E_a$
Cathode-Coupled	6J6	27,600	6,000	33,600	14,800	31.6	14.2	$0.449E_a$

Table III—Performance of 6J6 Mixer with Various Amplifiers

R-F Amplifier	Tube	R	$R(A'_c)^2$	R_{nt}	E_n	S/N	Total Gain
Pentode	6AK5	145,500	25,650	266,760	42.5	$0.433E_{ant}$	18.40
Grounded-grid	6J4	59,300	10,470	10,580	26.8	$0.345E_{ant}$	9.24
Cathode-Follower	6J4	20,100	3,540	3,650	15.7	$0.521E_{ant}$	8.18
Cathode-coupled	6J6	31,900	5,630	5,740	19.7	$0.456E_{ant}$	8.98

The cathode circuit may be either a low-impedance-level selective-narrow-band circuit resonated at local oscillator frequency, in which case it must be tuned from station to station; or it may be a broad-band circuit, in which case it cuts the conversion gain to one half (this can be proved by use of Eq. 27 to determine the gain of a tube whose cathode load impedance is the cathode output impedance of a similar tube) but does not have to be tuned. The conversion gain for the 6J6 mixer with a wide-band cathode circuit is therefore 1.30. Since we use the same impedance transformation ratio in the 6J6 mixer plate circuit as in the 6AK5 mixer circuit, (the two tubes have practically the same output capacitances), the gain of the 6J6 from signal grid to coaxial output jack is A'_c = 0.42 for the switched cathode circuit and 0.21 for the fixed cathode circuit.

We may repeat the process used in setting up Table II for the 6AK5, this time introducing the quantity R_{nt} which is equal to $R(A'_c)^2$ plus the transformed noise resistance of the first i-f stage, 111 ohms. In Table III, the figures given are for the tunable cathode circuit. For fixed-tuned operation, the gain figures are half of those shown.

Grounded-Grid Mixer

The grounded-grid mixer shown in Fig. 10 has several features that require an analysis quite different from that for the pentode. In the case of the circuits of Fig. 10A and 10C it is found that the impedance level of the amplifier plate load can be doubled (for the same overall r-f head bandwidth) thus doubling amplifier gain. Assuming that the input impedance to the mixer is about 80 ohms and that the input capacitance is 7 μμf, the bandwidth of the mixer cathode circuit is approximately 285 megacycles. From a different viewpoint, the circuit behavior can be summarized by saying that the grounded-grid mixer

input provides no significant capacitive loading on the r-f amplifier-mixer interstage.

In the case of the grounded-grid amplifier grounded-grid-mixer combination of Fig. 10B, it is not only possible to increase the impedance level of the amplifier plate load, but it is also conceivable that some impedance lower than the maximum allowed by the bandwidth would give a maximum gain for the overall unit due to the interaction of the stages on each other.

In the case of the cathode-follower r-f amplifier grounded-grid-mixer, the circuit is indistinguishable from a cathode-coupled mixer operating without an r-f amplifier except for one point. The single point of difference between the two circuits is the choice of the plate to be used for output. This "no r-f cathode-coupled mixer" configuration is the better so we shall drop the cathode-follower r-f grounded-grid-mixer combination and discuss its twin in a later section.

The primary feature that requires individual treatment for each r-f amplifier circuit associated with a grounded-grid mixer is the cathode load impedance presented to the mixer by the amplifier and the influence of this impedance on cathode-equivalent noise resistance of the mixer.

Referring to the pentode r-f grounded-grid-mixer circuit of Fig. 10A, the a-c plate resistance of the pentode is of the order of 0.3 megohm, so that with an interstage impedance transformation ratio of (for instance) 3,000:100 ohms, the load resistance presented to the mixer cathode is about 10,000 ohms. This is such a large cathode load resistance that the grid-to-cathode gain, A_{gK} in Eq. 32.1 is essentially unity. Therefore Eq. 53 gives the desired noise resistance, 867 ohms. This is small but not completely negligible compared to the output noise resistances of other amplifiers.

In the 6J4 grounded-grid r-f 6J4 grounded-grid-mixer combination we are faced with the problem of providing maximum voltage transfer to the input impedance of the mixer. Since the plate load impedance of a mixer is very low at the signal frequency, the input impedance of the grounded-grid mixer is simply $1/G_m$, a constant. There exists the possibility that either the maximum-voltage transfer requirement or the bandwidth requirement may fix the interstage transformer ratio. An analysis reveals that the total gain from antenna to mixer output jack is given by

$$A = G_c\left[R_{IF} \times \frac{\mu_1 + 1}{G_{m2}} + \frac{R_L}{r_{p1} + R_L}\right]^{1/2}$$

where R_L is the load resistance presented to the r-f amplifier plate by the interstage transformer, G_c is the conversion transconductance of the mixer, and μ_1 and r_{p1} refer to the r-f tube. It is apparent that as R_L ranges from r_{p1} to ∞ the gain increases only 40 percent, so that there is no great advantage in using a high transformer ratio. If we use $R_L = r_{p1} = 4{,}500$, the interstage bandwidth is 10 mc so the interstage gain is down 0.7 db at 2 mc each side of carrier frequency, and according to Fig. 2, the mixer plate circuit is permitted a bandwidth as small as 4/0.85 or 4.7 mc. Resistor R_{IF}, the mixer plate resistor, is then 2,420 ohms total for a 14-$\mu\mu$f mixer plate circuit total capacitance.

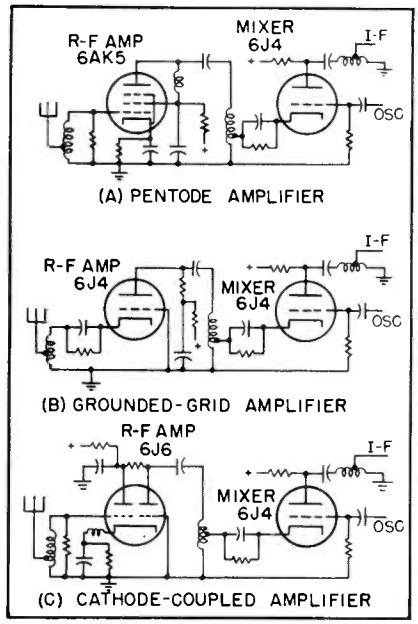

FIG. 10—Three types of r-f amplifiers feeding a 6J4 grounded-grid mixer

From the above, the mixer input impedance is 80 ohms, so the r-f plate-to-mixer cathode voltage transformation ratio is $A_T = 0.1675$ for the 6AK5-6J4 and the 6J6-6J4 combinations, and $A_T = 0.1330$ for the 6J4-6J4 combination.

At the 6J4 mixer cathode we thus have the following voltages and resistances:

R-F Amp	Mixer	E_s	R_n
6J4 G-G	6J4	5.41 E_{ant}	2,850 ohms
6AK5 G-C	6J4	14.7 E_{ant}	16,700 ohms
6J6 C-C	6J4	6.55 E_{ant}	3,150 ohms

The conversion transconductance, G_c, is 0.0042 mho, so for the 6J4-6J4 combination, the conversion gain A_c is 10.14, and for the 6AK5-6J4 and 6J6-6J4 combinations $A_c = 5.88$.

The voltage ratio for the mixer plate to coaxial output transformer is $A_o = 0.176$ for the 6J4-6J4, and $A_o = 0.231$ for the 6J6-6J4 and 6AK5-6J4 combinations.

The net mixer-cathode to coaxial-

Table IV—Summary of Tubes and Circuits

R-F Amplifier	Mixer	Gain	K	A_{min}	Tuned Circuits
6AK5 G-C	6AK5	29.1	0.440	17.6	2
6AK5 G-C	6J6 (fixed cath)	9.2	0.433	17.3	2
6AK5 G-C	6J6 (tuned cath)	18.4	0.433	17.3	3
6AK5 G-C	6J4	20.0	0.436	17.5	2
6J4 C-F	6AK5	13.0	0.489	19.6	2
6J4 C-F	6J6 (fixed cath)	4.1	0.521	20.8	2
6J4 C-F	6J6 (tuned cath)	8.2	0.521	20.8	3
6J4 G-G	6AK5	14.6	0.343	13.7	1
6J4 G-G	6J6 (fixed cath)	4.6	0.345	13.8	1
6J4 G-G	6J6 (tuned cath)	9.2	0.345	13.8	2
6J4 G-G	6J4	9.7	0.388	15.5	1
6J6 C-C	6AK5	14.2	0.449	17.95	2
6J6 C-C	6J6 (fixed cath)	4.5	0.456	18.3	2
6J6 C-C	6J6 (tuned cath)	9.0	0.456	18.3	3
6J6 C-C	6J4	8.9	0.445	17.8	2
None	6AK5	11.8	0.332	13.3	1
None	6J6 (fixed cath)	3.44	0.457	18.3	1
None	6J6 (tuned cath)	6.88	0.480	19.2	2
None	6J4	1.93	0.239	9.6	0

output gain is then $A = A_s \times A_c = 1.79$ for the 6J4-6J4 combination, and $A = 1.36$ for the other combinations.

The voltages at the coaxial output jack are tabulated below:

R-F Amp	Mixer	E_s	E_n	S/N
6AK5	6J4	20.0 E_{ant}	45.8	0.436 E_{ant}
6J4	6J4	9.70 E_{ant}	25.0	0.388 E_{ant}
6J6	6J4	8.90 E_{ant}	20.0	0.445 E_{ant}

No R-F Amplifier

If each of the three mixers were operated with no r-f stage as shown in Fig. 8 we would have a somewhat different picture. We lack only a formula for noise resistance of a 6J4 mixer having a 75-ohm cathode circuit resistance. Substituting this value of R_K and previously known values for the other factors in Eq. 29, the noise voltage is 46.9 percent of that for a grounded-cathode triode mixer. Equations 26 and 53 show that $R'_n = 2.76/G_o$. For the 6J4 with $G_o = 0.015$ mho, $R'_n = 191$ ohms.

All of the data required for the various mixer circuits operating with no r-f amplifier are tabulated below.

6AK5 Mixer, Fig. 8A	
Tube noise resistance referred to grid	4,500 ohms
Grid circuit antiresonant resistance	3,540 ohms
Total noise resistance at grid	6,270 ohms
Noise voltage at grid	20.6 μv
Gain, antenna jack to grid	6.87
Gain, grid to output jack	1.72
Total grid noise resistance referred to output	18,550 ohms
Total noise resistance at output	18,660 ohms
Noise output voltage	35.5 μv
Signal output voltage	11.8 E_{ant}
Signal-to-noise ratio	0.332 E_{ant}

6J4 Mixer, Fig. 8B	
Tube noise resistance referred to cathode	191 ohms
Input circuit resistance	75 ohms
Total input noise resistance	230 ohms
Total input noise voltage	3.94 μv
Gain, cathode to output jack	1.93
Total input noise resistance referred to output	857 ohms
Total noise resistance at output	968 ohms
Noise output voltage	8.09 μv
Signal output voltage	1.93 E_{ant}
Signal-to-noise ratio	0.239 E_{ant}

6J6 Mixer, Fig. 8C	Switched Cathode Coil	Fixed Cathode Coil
Tube noise resistance referred to grid	2,000	.....
Grid circuit antiresonant resistance	6,300	.....
Total noise resistance at grid	5,150	.....
Noise voltage at grid	18.7	.....
Gain, antenna jack to grid	9.17	.....
Gain, grid to output jack	0.75	0.375
Total grid noise resistance referred to output	2,900	725
Total noise resistance at output	3,010	836
Noise output voltage	14.3 μv	7.52 μv
Signal output voltage	6.88 E_{ant}	3.44 E_{ant}
Signal-to-noise ratio	0.480 E_{ant}	0.457 E_{ant}

The associated i-f amplifier should be designed to have as much of the required gain of the receiver as stability against regeneration will permit. For the particular conditions existing in this case, it has been found practical to have a gain of 100 db, or a voltage step-up of 100,000 to 1, in the combined i-f and video amplifier. Since a video output of 40 volts is sufficient to fully modulate the kinescope grid for most tubes, an i-f input of 400 μv is needed. It has been experimentally determined that a signal-to-noise voltage ratio of 20 db or 10 to 1 is necessary for good reception. This means that the r-f and mixer should provide at least enough signal gain that there will be an accompanying 40 μv of noise at the coaxial output jack. If the signal-to-noise ratio is expressed as $S/N = KE_{ant}$ and if S/N is set equal to 10, then $E_{ant} = 10/K$. The minimum acceptable r-f section gain is then that needed to bring E_{ant} up to a 400-μv level, $A_{min} = 400/E_{ant}$ and $A_{min} = 40K$. From these data we can set up Table IV shown on the preceding page.

Summary

Table IV shows that the 6AK5 mixer is the only mixer with no r-f stage that has almost as much gain as A_{min}, although the 6J6 with tuned cathode has one of the best signal-to-noise ratios of all circuits considered. Of the combinations employing a 6J4 grounded-grid r-f amplifier, only the 6J4-6AK5 combination has more gain than A_{min}.

One surprising point demonstrated by these data is the lack of signal-to-noise superiority of the 6J4 grounded-grid amplifier compared to the 6AK5 amplifier. The reason is that the low input impedance to the grounded-grid stage permits only a small signal voltage step-up before the signal finds itself on common ground with tube noise for all further amplification.

Of those combinations using a 6J4 grounded-grid amplifier, the 6AK5 mixer provides most gain, with only one tuned circuit and with a slight margin over the minimum acceptable gain. Another possibility brought out by the data in Table IV is that of using a grounded-grid 6J4 r-f amplifier followed by a 6AK5 r-f amplifier and a 6AK5 mixer where the total range of frequencies over which the unit is to work does not exceed 190 mc, and where maximum obtainable gain is needed. Such a combination would have a voltage step-up of 548 or a gain of 54.8 db (which would reduce required i-f and video gain about 70 db), a signal-to-noise ratio of 0.496 E_{ant}, and would require only two tuned circuits.

Of the several mixers operated with a 6AK5 r-f stage, although all combinations have a gain of $\frac{2}{3}$ or more times A_{min}, the 6AK5 mixer provides the most gain with nearly the same S/N and the minimum number of tuned circuits. The 6AS6, which is a 6AK5 having the suppressor brought out to a separate pin, could be used as a mixer with oscillator voltage injection at the suppressor. This circuit would reduce the capacitance shunting the amplifier-mixer interstage, which would make possible a slightly higher interstage impedance and increase gain, but a lower conversion transconductance (due to screen dissipation limitations) would produce about the same overall gain and signal-to-noise ratio as the 6AK5 mixer. Pentagrid mixer tubes such as the 6BE6 have such low conversion transconductance as to be out of the question.

The 6J4 c-f r-f combinations exhibit the best obtainable S/N ratios, but unfortunately at the expense of gain. The 6J4 c-f r-f-6AK5 mixer provides a very good S/N of 0.489 E_{ant} with a gain only 3 db short of A_{min}.

Although the 6J4 as a grounded-grid mixer without r-f amplification and the 6AK5 mixer operated with no r-f amplification look good on the basis of tube and tuned-circuit economy, both should be vigorously rejected on the basis of excellent capability of transmitting oscillator power to the antenna.

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(2) Reference 1, Eq. 116, p 477.
(3) H. W. Bode, "Network Analysis and Feedback Amplifier Design", D. Van Nostrand Co., Inc., p 213, 1945.
(4) Reference 1, p 294.
(5) M. C. Jones, "Grounded-Grid Radio Frequency Voltage Amplifiers", Eq. 5, *Proc. IRE*, p 423, July 1944
(6) Reference 1, p 572.

Lead Sulfide Photoconductive Cells

Practical operating data and characteristics of recently improved lead sulfide cells. Present applications of the cells include sound-on-film transducers using infrared instead of conventional light sources, spectrophotometry, pyrometry and industrial controls

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ALTHOUGH photoconductivity was observed on natural galena many years ago, the modern lead sulfide cell is a relatively recent development. A clear picture of the electrical properties of semiconductors was obtained just before the war and it was applied in the U.S.A., Britain and Germany to develop infrared detectors for military uses in optical telephony and telegraphy which could not be intercepted by the enemy nor jammed like radar.[1]

The methods of manufacturing these cells are greatly variable.[2,5,6,7] A grid of conductive material such as carbon or platinum is ruled on the inside surface of a bulb or on glass plates and the grid is electrically connected to terminals sealed into the glass bulb. A layer of lead sulfide is then deposited either chemically or by evaporation in vacuum or in air at reduced pressure on the area between the bars of the grid. This deposition can be simultaneous with or it can be followed by an activating heat treatment at determined temperature and pressure conditions. Finally the activated surface is sealed off in vacuum or otherwise protected against atmosphere.

The original PbS lattice has lost the sulfur at some small regions and has therefore an excess of Pb. On other regions the sulfur has been replaced by oxygen either built into the lattice or absorbed interstitially, the desired final product being a homogeneous mixture of both types. Furthermore, a dipole layer of O_2 atoms may be absorbed on the surface and barrier layers can be formed at the contact surface with the conductive grid material. The properties of the cells will greatly depend on this structure; thus the spectral response varies considerably with the amount of oxygen in the layer and its thickness (absorption); noise is greatly dependent on the material of the contacts and the formation of the barrier layer at the contacts and at the boundaries between PbS crystalline particles with excess or defect impurity; the electrical resistance and the sensitivity are also functions of the thickness and the layer structure.

In view of the physical relationships governing the resistance and the signal to noise ratio, the sensitive surfaces must be made small in area. This in most cases is a favorable feature as it allows the design of commercial tubes in miniature and subminiature size.

In Fig. 1 are represented such tubes. Tubes *A* and *B* have a single grid on the side, *C* has a double grid on the side, and *D* is an end-on type cell.

Light Sensitive

The spectral response of typical lead sulfide cells is represented in Fig. 2 and compared to the spectral response of the S-1 response and S-4 response phototubes and to the visibility curve of the eye. It should be pointed out that in this graph the maximum of sensitivity for each curve is arbitrarily set to 100. Two curves are given for the lead sulfide surface, one shows the spectral response of a typical commercial cell with a maximum around 1.2–1.5 μ, the other that of a cell with a maxi-

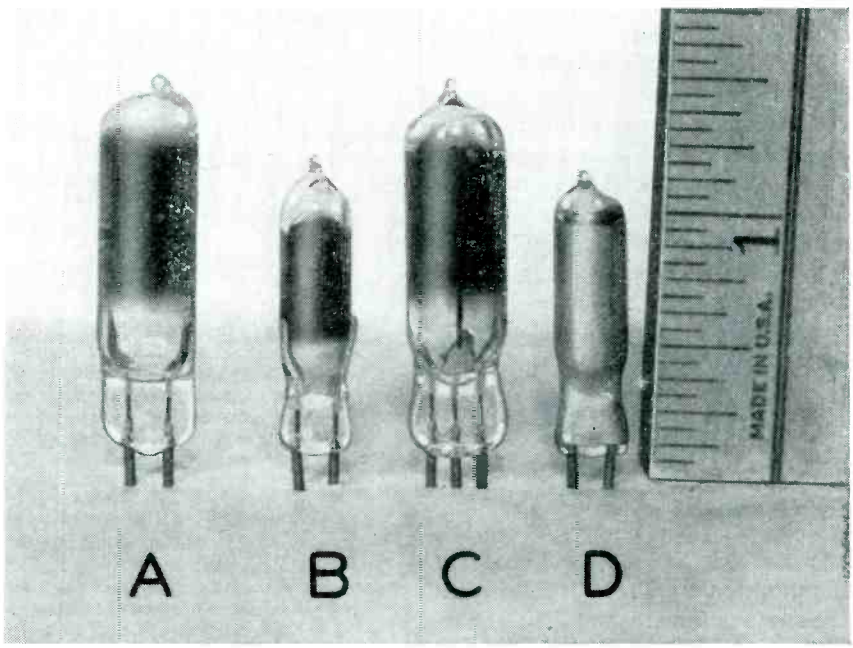

FIG. 1—The tallest lead sulfide cell shown above is about 1½ inches high. Types *A* and *B* have a single grid on the side, type *C* has a double grid and type *D* is the end-on cell

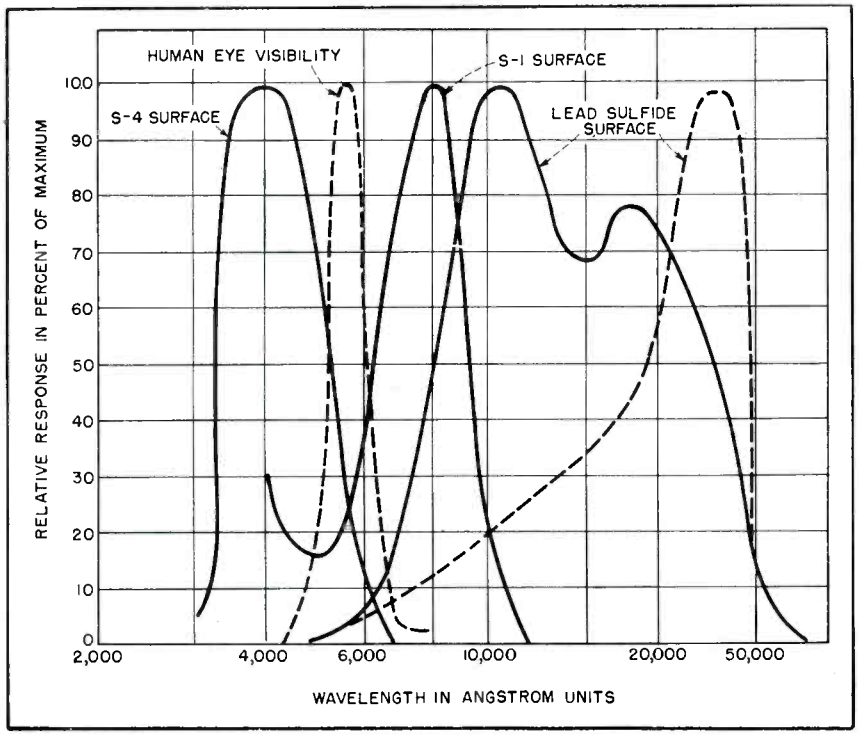

FIG. 2—Spectral response curves of S-1, S-4 and lead sulfide surfaces

mum at around 2.6 μ. The spectral response is variable between these two limits as to the position of the maxima, the appearance of double maxima and other factors. Since the maximum of curve 2 in absolute units is often much lower than the maximum of curve 1 it is possible for cells of type 1 to have even better response in the far infrared than cells of type 2. Cooling to low temperature shifts the long wave threshold to longer wavelengths.[4]

The dark resistance of the cells depends greatly on the type of activation and the temperature. At room temperature most commercial cells have dark resistances between 0.2 and 5 megohms with an average around 0.75 megohm. Cooling increases the resistance. The resistance increases by a factor of about 2 when the temperature decreases from 30 C to 0 C.

Electrical Action

Radiant flux falling on the active surface of the cell decreases its resistance. The change in resistance $\Delta r/r_d$ is linear with increasing illumination up to 0.001 lumen on the surface for areas of $\frac{1}{8} \times \frac{1}{8}$ inch. If a constant d-c voltage is applied to the cell and a resistance in series, this drop in the cell resistance will lead to an increase in the voltage drop across the load. If the photoconductive cell is replaced by a photoemissive tube the same radiant flux will also produce an increase in voltage across the load. This voltage sensitivity can be expressed by the equations:[11]

Photoemissive tubes

$$\frac{dV}{df} = \frac{Rs}{1 + Rf\frac{ds}{de}}$$

$$= Rs \quad \text{(Vacuum tubes)}$$
$$= RsA \quad \text{(Gas tubes, } R < 1 \text{ Meg)}$$

Photoconductive cells

$$\frac{dV}{df} = -\frac{ER\,dr}{(R+r)^2\,df}$$

$$= -\frac{E\,dr}{4r\,df} \quad \text{(Optimum Value } R = r\text{)}$$

V = Voltage developed across load resistor R
R = Load resistor
f = Flux in lumens or watts
s = Luminous sensitivity of photoemissive tubes in microamperes per lumen at some specified color temperature
e = Voltage developed across the photoemissive tube
ds/de = Change in s per unit change in voltage across photoemissive tube
A = Gas amplification of gas photoemissive tubes
E = Voltage supply in circuit
r = Resistance of photoconductive cell
r_d = Dark resistance of photoconductive cell
dr = Change in resistance of photoconductive cell due to a change in radiant flux df

Therefore photoconductive and photoemissive tubes can be directly compared. Data is plotted in Fig. 3 for photoelectric surfaces with three different responses: the photoemissive responses S-4 and S-1 and the photoconductive surface lead sulfide. The color temperature range of the tungsten lamp was 1,700–2,900 K. In these graphs the total radiant flux in watts falling on the photoelectric surfaces is a constant for all color temperatures. The voltage sensitivity is expressed in volts per microwatt of radiation impinging on each surface.

On the photoemissive tubes the voltage sensitivity is practically independent of the area of the surface for constant radiant flux; on the lead sulfide cell voltage sensitivity is inversely proportional to the area as it will be shown later. For the vacuum photoemissive tubes, voltage sensitivity is directly proportional to the load resistance; for the gas photoemissive tubes, the voltage sensitivity is approximately proportional to the gas ratio if the load resistance is of the order of 1 megohm or less. Optimum values of voltage sensitivity for the lead sulfide cell and a given voltage are obtained using a load resistance equal to the light resistance of the cell.

Curves 1 and 2 in Fig. 3 give the voltage sensitivity as a function of

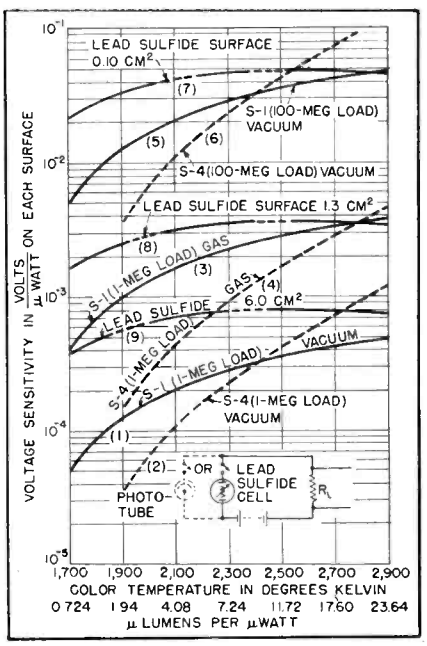

FIG. 3—Voltage sensitivity of different photoelectric surfaces as a function of the color temperature

color temperature for the S-1 and S-4 photoemissive vacuum tubes when the load resistance is 1 megohm. The average sensitivity of the S-1 tubes is taken as 20 μa per lumen and that of the S-4 tubes is 40 μa per lumen. These values are taken at a color temperature of 2,870 K. Curves 3 and 4 are for photoemissive gas tubes. The average sensitivity of both S-1 and S-4 gas tubes is 160 microamperes per lumen. Curves 7, 8, and 9 give the voltage sensitivity of the lead sulfide surface in function of color temperature for cell areas of 0.1 cm^2, 1.3 cm^2, and 6 cm^2 respectively. The voltage sensitivity of the lead sulfide cell corresponds to that of an average cell.

In comparing these various surfaces, consider curves 3, 4, and 8. For high color temperatures around 2,900 K it is apparent that the S-4 surface gives the best voltage sensitivity, the S-1 surface next best, while the lead sulfide surface gives slightly lower sensitivity than that of the S-1 surface. At color temperatures around 1,700 K however, just the reverse is true; voltage sensitivity for the lead sulfide being by far the greatest while that of the S-1 surface is down by a factor of 4 and that of the S-4 surface by a factor of 100. From these curves it is evident that the only advantage of lead sulfide cells with areas larger than 1 cm^2 is for operation with light sources of relatively low color temperatures. But even at high color temperatures the lead sulfide gives a decided advantage when the available radiant flux can be condensed on a small area of the order of 0.1 cm^2 ($\frac{1}{4} \times \frac{1}{8}$ inch).

Frequency Response

The question of dynamic sensitivity (frequency response) of PbS cells is still under investigation. Statements made are contradictory; some measurements indicated for certain cells a flat response in the audio range, others showed a considerable loss at 5,000 cycles. Plotted in Fig. 4 (right scale) are measurements made on typical commercial cells (type *A* and *B*) as compared to measurements made on vacuum and gas-filled photoemissive tubes, the sensitivity of the vacuum phototube being taken as a zero-db level throughout the audio range.

These measurements were made with 50-cycle black and white film rotated at different speeds on a drum. The radiation of an exciter lamp (calibrated at 2,870 K) was projected by a Simplex optical system on the film. Under these conditions the drop in response of the PbS cell seemed to be only slightly greater than the drop of a gas filled S-1 response tube.

This result should be considered as preliminary only, as there are indications that at lower color temperatures the frequency response may drop off much more rapidly.

The luminous sensitivity of lead sulfide cells in a-c operation can also be expressed in terms of signal-to-noise ratio. In photoemissive high-vacuum tubes noise is due to the shot effect of thermal emission. At room temperature and photoemissive current of the order of 0.1–1.0 μa this noise is considerably higher than the noise in the series resistor.

The noise in photoconductive materials is given by the sum of the noise due to thermal fluctuations of electrons in the resistive material (Johnson noise) and noise due to a voltage component, probably related to the barrier layers at the different boundaries. This noise is near 20 db lower than the noise in typical gas tubes. It can be shown that the predominant voltage component is directly proportional to the applied voltage and inversely proportional to the square root of the sensitive area. At higher voltages or higher frequencies, the thermal noise component is increased.

It can also be shown that the signal produced by the same radiant flux on different size areas is proportional to the applied voltage and inversely proportional to the area. The signal-to-noise ratio is therefore practically independent of the voltage until a certain point is reached where the ratio starts to decrease, due to an increase in thermal noise. For constant flux the signal-to-noise ratio is inversely proportional to the square root of the sensitive area but for constant flux density (illumination) the ratio is directly proportional to the square root of the area.

The signal-to-noise ratio increases considerably when the temperature is lowered. A change from 30 C to 0 C increases the ratio by 8 to 10 db.

Noise Data

In Fig. 4 (left scale)is shown the noise in microvolts rms per unit bandwidth measured at room temperature and a voltage of 35 volts at the cell. The two curves correspond to average cells *A* and *B* of Fig. 1 (grid area $\frac{1}{8} \times \frac{1}{8}$ inch). It can be seen that the noise drops off considerably towards higher frequencies. Noise in microvolts over

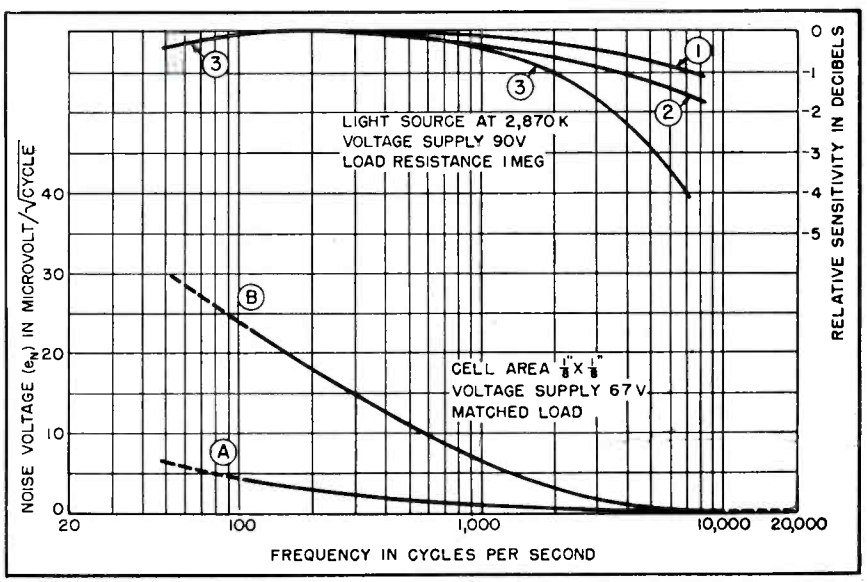

FIG. 4—Curves *A* and *B* show the average noise output of cells *A* and *B* of Fig. 1. Curve 1 shows the signal sensitivity of S-4 response gas cells; curve 2 applies to S-1 gas tubes; and curve 3 to the signal sensitivity of lead sulfide surfaces

a frequency range (or the equivalent noise input) can be calculated using the equation

$$e_N = \sqrt{\int_{f_1}^{f_2} e_{N_f}^2 \, df},$$

where e_{N_f} is taken from Fig. 4. If this bandwidth is sufficiently small so that e_{N_f} can be considered constant this reduces to

$$e_N = e_{N_f} \sqrt{B}$$

where B is the effective rectangular power bandwidth.

Signal-to-noise ratios can be approximately calculated for any color temperature, bandwidth, voltage, and cell area with the use of Fig. 3 and 4 and the relationships shown above. For example, the signal-to-noise ratio of cell *A* and 0.1 cm² area at a color temperature of 2,870 K, at 1,080 cycles and a bandwidth of 2 percent or 21 cycles at half power points for a signal of 1 microlumen can be calculated as follows:

This bandwidth corresponds roughly to an effective rectangular bandwidth of 27.1 cycles. The noise is calculated by multiplying the square root of the effective rectangular bandwidth times the noise per unit bandwidth at 1,080 cycles to give 6.66×10^{-6} volts. The signal is taken from the voltage sensitivity at 2,870 K which is 4.3×10^{-2} volts/μ watt and divided by a conversion factor of 22.73 to obtain volts/μ lumen. The signal-to-noise ratio is then given by

$$\frac{1.89 \times 10^{-3}}{6.66 \times 10^{-6}} = 49.1 \text{ db.}$$

If this calculation is carried out at 1,700 K the corresponding figure is 66.5 db.

There have been up to now no indications of deterioration of the cell surface on life test. Exposure to air does not deteriorate the surface immediately as in photoemissive cells but causes a slow drift in resistance and sensitivity. Rise in temperature beyond 100 C should be avoided.

Summing up, the lead sulfide cell is a rugged, nonmicrophonic device of miniature size, linear response, and low noise level. This is particularly favorable for use in applications where the frequency is below 10,000 cps, the color temperature in the range 400 K to 2,900 K and the light flux can be concentrated on a small area up to 0.1–1.0 cm². Under these conditions photoconductive PbS cells can yield considerable advantage over photoemissive tubes.

Circuits and Applications

The circuits used on PbS cells are similar to the standard circuits used on phototubes. Slight modifications must be incorporated to account for the change in voltages and the initial dark current. It should be remembered that the photoconductive cell is a lower impedance device, thus allowing the use of longer connecting cables, an item of importance in industrial control work.

In Fig. 5, 6, and 7 are represented some typical circuits, and the comparison of the indicated values with values used in corresponding current circuits for photoemissive tubes will give an indication for the designer concerning the modifications to be introduced in phototube circuits when phototubes are replaced by PbS cells. In Fig. 5 is represented a thyratron relay triggered by an increase in light, in Fig. 6 a thyratron relay triggered by a decrease in light, and in Fig. 7, a circuit sensitive to modulated light which can be used as a first stage in sound reproduction or in industrial applications where the device is responsive to a chopped light source regardless of background illumination.

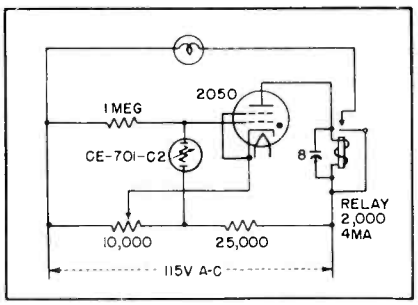

FIG. 5—Thyratron relay operated by an increase in light

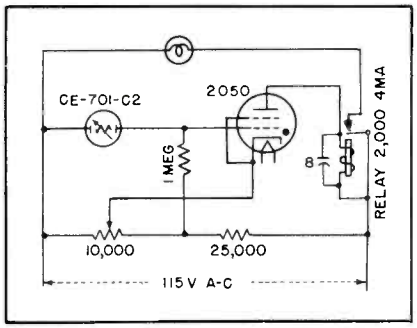

FIG. 6—Thyratron relay operated by a decrease in light

In all applications the question of light sources and optics will arise. The preceding considerations show that PbS cells will operate efficiently on tungsten lamp sources. It also follows that advantages can be obtained from the high infrared response by using light sources of low color temperature or selective emitters with infrared radiation. One method of procedure consists in running tungsten lamps at lowered voltage which also has the beneficial effect of increasing their life.

Another method consists of using resistance wire such as nichrome and running it at temperatures around 1,000 C. In this case, the 60-cycle hum from a-c supplies is considerably decreased; however there is a loss in signal.

As a third solution the use of indirectly heated exciter lamps has been proposed. In these lamps indirectly heated cathodes of receiving type tubes are used as light sources. The hum is practically nil; however, due to a limitation in color temperature given by the materials used, the signal is also impaired.

The use of long-wave infrared excitation is furthermore complicated by the fact that the optical glasses have marked absorption between 2 and 3 μ and that the present optics are chromatically corrected for much shorter wavelength. In some applications, like sound reproduction, a proper balance of all the factors involved such as spectral response of the tube, emission characteristics of the light source, properties of the optical system and absorption characteristics of the film material has yet to be attained in practice.

The first practical achievements have been in the motion picture industry and in the field of spectrophotometry and pyrometry although considerable work is being done on installations for industrial control use.

There are at present three 16-mm sound projectors using lead sulfide cells on the market. In a projector designed by the Apollo Division of

the Excel Movie Products, Inc., the properties of the PbS cell were put to profit in a radically new design of the sound head which lowered cost considerably. In this case the cell is excited by a nichrome wire and the optical system is greatly simplified. A Revere projector follows more conventional design principles for high quality sound reproduction.

A greater expansion of the use of PbS in the motion picture industry will be possible when solutions are found for light sources and optics. At present, films with dyed tracks cannot run on PbS cells with the same efficiency as on photoemissive cells with S-4 response. Furthermore, investigations continue concerning the frequency characteristics of PbS cells and the possible improvements to be made in this respect.

Measurements

Several papers have been published concerning the use of PbS cells in stellar photometry, spectrophotometry, and pyrometry.[3,9] It has been found that these cells compare very favorably with thermocouples as they have an equivalent signal-to-noise ratio and a much faster response. For measurements further in the infrared up to 5-6 μ, cells with PbSe and PbTe surfaces have been developed using techniques similar to those used on PbS cells.[13-17]

The good infrared response will offer advantages when cells of this type will be used in burglar alarms and controls of all kind using dark infrared radiation. The small size will offer advantages when the distance between the radiation source and the cell is short, such as it generally is on protective devices on machine tools. When the longer distances are required the circuits and the optical systems and the source must be designed to compensate for the smaller amount of radiant flux falling on the lead sulfide cell.

It is recommended the same principles be used as for photoemissive tube [12] that is, parallel beams for moderate distances, concentrated beams for short distances and modulated beams for long distances or for use where the level of extraneous illumination is high. In this

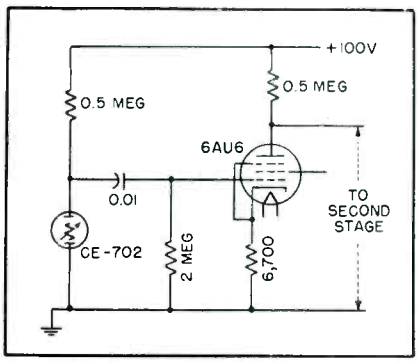

FIG. 7—Input stage for lead sulfide modulated light amplifier

last application it should be remembered that although the signal at constant radiant flux may be lower in the case of PbS cells than in the case of photoemissive tubes, the photoconductive cells have a considerable advantage in the signal-to-noise ratio, especially in cases where it is not possible to use vacuum tubes and high load resistors.

In certain applications, especially for outdoor work, some difficulty may be encountered due to the high temperature coefficient of these cells. In this case it is possible to design a cell circuit in which a second cell of the same type would be used to compensate for temperature changes.

Counting and Sorting

PbS cells and in particular the double surface cell, Fig. 1C, are of particular interest in devices for photoelectric measurement, counting and sorting of very small objects. In an industrial application at present under development, the PbS cell registers diameter differences of less than 10 mils.

Some applications may derive advantage of the fact that it has not been possible to date to manufacture a good end-on phototube with S-1 response in a miniature bulb of approximately ¼-inch outside diameter. There is definitely a large field of applications for a miniature end-on tube with infrared response to work in conjunction with small incandescent lamps. Such cells could be used stacked in large numbers in tabulating machines, in electric signs with a varying design or text, and in all other similar applications where a configuration of holes in a continuous band should be translated into electric impulses.

The lack of a good phototube of miniature dimensions has possibly been one of the reasons why the multiple attempts to develop a photoelectric phonograph pickup have not led to a popular product. The photoconductive cell seems to be a promising tool in this case too.

These few examples are given only as an illustration of the broad potentialities of the PbS cell in electronic equipment. The area of its applications does not completely overlap the area of use of photoemissive tubes; thus new and broad fields may be opened to the designer of industrial photoelectric equipment.

Acknowledgment

Acknowledgment is due to N. Anderson, C. H. Davidson and J. S. Kirk for their multiple suggestions in writing this paper, to C. H. Davidson for his measurements and studies of noise and frequency response and to V. A. Carpenter for the design of the frequency response tester.

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(17) T. S. Moss, Spectral Sensitivity of PbTe Layers, *Nature*, **161**, p 766, 1948.

TRANSFER FUNCTIONS for R-C and R-L Equalizer Networks

By E. W. TSCHUDI

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Farmingdale, N. Y.

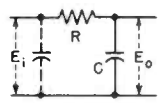
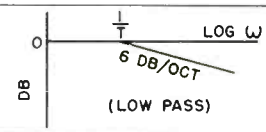
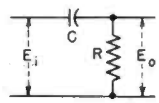
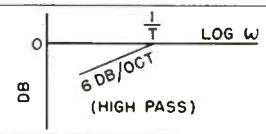
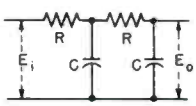
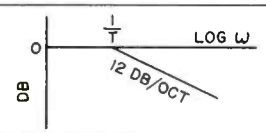
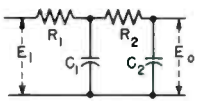
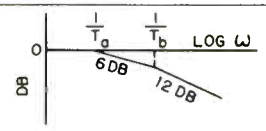
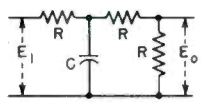
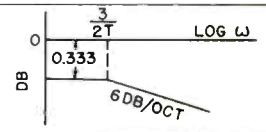
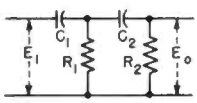
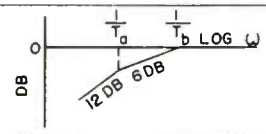
THE accompanying tabulation of transfer functions or the ratio of output to input voltage (E_o/E_i) is the result of attempts to determine the electrical equivalent network of a pneumatic servo system and to find a satisfactory equalizer for that system. The phase angle ϕ between E_o and E_i is also given in the tables. Transfer functions of the elementary networks are common knowledge and are included for the sake of completeness. Wherever possible the gain curves are represented by asymptotes and the corner frequency which is the intersection of these asymptotes. Where two or more corners exist, they must be of the order of a decade apart in order that the gain curve may be represented by asymptotes. When it is desired to compute the actual gain, p should be replaced by $j\omega$ in the transfer function and the amplitude computed in the usual manner for complex quantities; squaring the real and then squaring the imaginary components separately, adding them and then taking the square root of the sum. For example in No. 1,

$$A = \sqrt{\frac{1}{1 + T^2\omega^2}}$$

and the gain is 20 log A. In networks including inductance, the ohmic resistance of the inductance, R_L, is represented as a practical necessity. Phase response curves are not included since it is comparatively simple to compute the phase angle at several representative frequencies. In general the phase angle is positive when the associated gain increases and negative when the gain decreases (attenuation).

The inclusion of phantom shunt impedances in No. 1 and 8 indicates the transfer functions are not affected by their presence. The values of T_a and T_b in the corner frequencies of No. 4 and 6 are the roots of the quadratic expressions in the denominators of these transfer functions. They are different from the two time constants T_1 and T_2 that are, respectively, the products of R_1C_1 and R_2C_2.

(Continued on p 118)

	NETWORK	TRANSFER FUNCTION	GAIN CURVE
(1)		$\frac{1}{1+Tp}$ $\phi = -\tan^{-1} T\omega$	
(2)		$\frac{Tp}{1+Tp}$ $\phi = 90° - \tan^{-1} T\omega$	
(3)		$\frac{1}{1+3Tp+T^2p^2}$ $\phi = -\tan^{-1} \frac{3T\omega}{1-T^2\omega^2}$	
(4)		$\frac{1}{1+(T_1+T_2+R_1C_2)p+T_1T_2p^2}$ $\phi = -\tan^{-1} \frac{(T_1+T_2+R_1C_2)\omega}{1-T_1T_2\omega^2}$	
(5)		$\frac{1}{3+2Tp}$ $\phi = -\tan^{-1} \frac{2T\omega}{3}$	
(6)		$\frac{T_1T_2p^2}{1+(T_1+T_2+R_1C_2)p+T_1T_2p^2}$ $\phi = 180° - \tan^{-1} \frac{(T_1+T_2+R_1C_2)\omega}{1-T_1T_2\omega^2}$	

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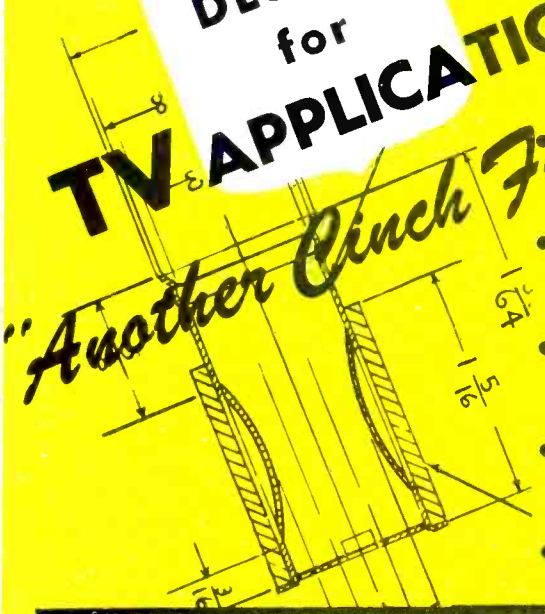
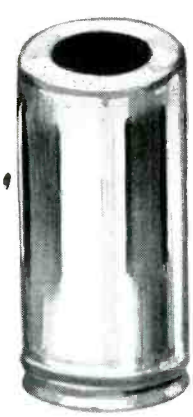
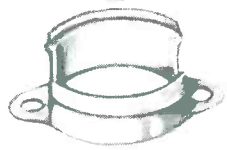




No. 60M13781
Without Lead

No. 16G12422
With Lead



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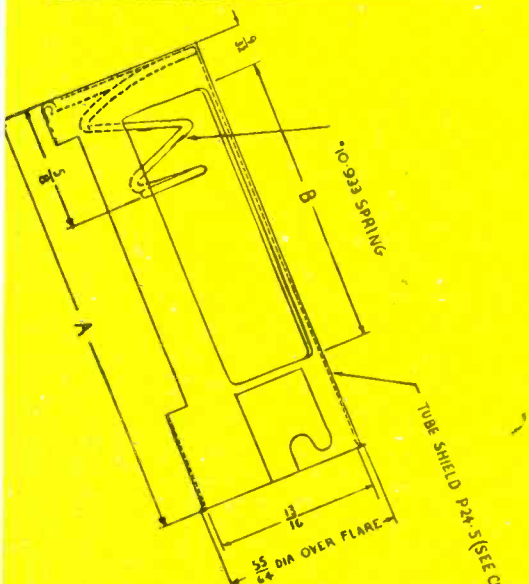
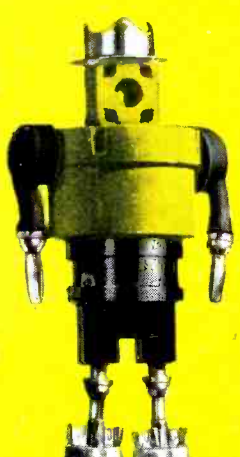
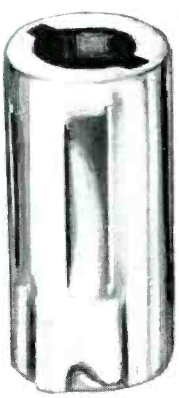
CINCH Electrostatic Shields





To dampen vibration, lead weighted shields are a must for television reception—the CINCH shield for the miniature snap-on type socket has internal spring "fingers" that grip and hold tube. And for use with any CINCH "J" type socket, miniature and Noval, as pictured.



No. 16G13729
Miniature Without Lead

No. 16G13940
Noval Without Lead

No. 16G13728
Miniature With Lead

No. 16G13938
Noval With Lead

Tube retainers with ventilating windows . . . designed to provide a "J" slot type tube shield for tube retention purpose only.

MINIATURE:		NOVAL:	
1⅜" long	No. 16G13744	1½ long	No. 16G13740
1¾" long	No. 16G13742	1-15/16" long	No. 16G13934
2¼" long	No. 16G13597	2⅜" long	No. 16G13936

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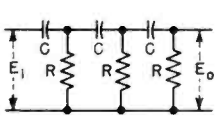
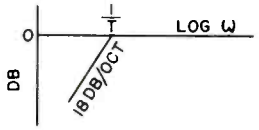
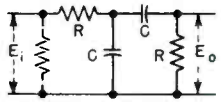
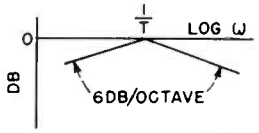
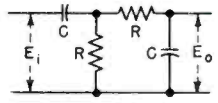
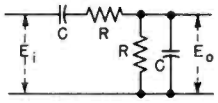
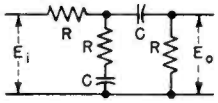
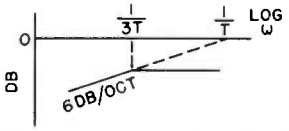
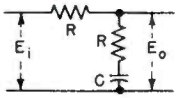
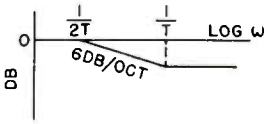
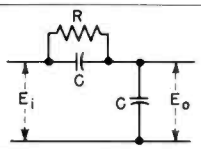
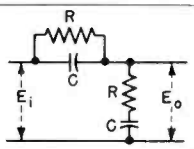
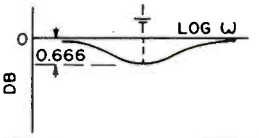
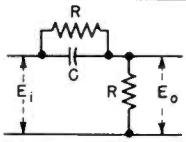
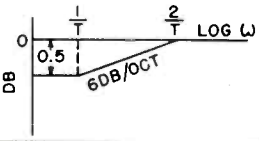
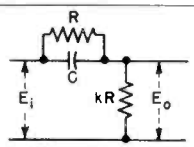
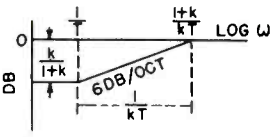
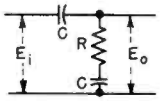
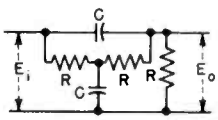
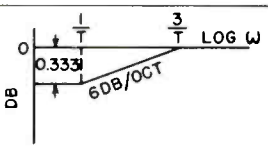
CHICAGO 12, ILLINOIS

TRANSFER FUNCTIONS (continued from p 116)

NETWORK	TRANSFER FUNCTION	GAIN CURVE
(7) 	$\frac{T^3p^3}{1+5Tp+6T^2p^2+T^3p^3}$ $\phi=270°-\tan^{-1}\frac{(5-T^2\omega^2)T\omega}{1-6T^2\omega^2}$	
(8) 	$\frac{Tp}{1+3Tp+T^2p^2}$ $\phi=90°-\tan^{-1}\frac{3T\omega}{1-T^2\omega^2}$	
(9) 	$\frac{Tp}{1+3Tp+T^2p^2}$ $\phi=90°-\tan^{-1}\frac{3T\omega}{1-T^2\omega^2}$	SAME AS 8
(10) 	$\frac{Tp}{1+3Tp+T^2p^2}$ $\phi=90°-\tan^{-1}\frac{3T\omega}{1-T^2\omega^2}$	SAME AS 8
(11) 	$\frac{Tp}{1+3Tp}$ $\phi=90°-\tan^{-1}3T\omega$	
(12) 	$\frac{1+Tp}{1+2Tp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}2T\omega$	
(13) 	$\frac{1+Tp}{1+2Tp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}2T\omega$	SAME AS 12
(14) 	$\frac{(1+Tp)^2}{1+3Tp+T^2p^2}$ $\phi=2\tan^{-1}T\omega-\tan^{-1}\frac{3T\omega}{1-T^2\omega^2}$	
(15) 	$\frac{1+Tp}{2+Tp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}\frac{T\omega}{2}$	
(16) 	$\frac{k(1+Tp)}{(1+k)+kTp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}\frac{kT\omega}{1+k}$	
(17) 	$\frac{1+Tp}{2+Tp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}\frac{T\omega}{2}$	SAME AS 15
(18) 	$\frac{1+Tp}{3+Tp}$ $\phi=\tan^{-1}T\omega-\tan^{-1}\frac{T\omega}{3}$	

(continued on p 120)

Teaching Surgery by Television!

Through the use of television medical students and visiting doctors are as close to the operating field as the surgeon himself.

COURTESY OF RADIO CORPORATION of F AMERICA

. . . and Mallory borrows the surgeon's rubber gloves for exacting manufacturing

There are more rubber gloves in this picture than you can see. They are worn by Mallory craftsmen in assembling the Mallory FP Capacitor. Thus no human hand* touches any vital part during processing and assembly.

Mallory knows there can be no compromise with quality—in television. New standards are essential for long life, dependability and trouble-free operation. The "rubber glove" technique is typical of Mallory's exacting standards.

Mallory FP Capacitors are accustomed to severe service—have been operating at 85° C. for years. Even though this extreme temperature may not be apparent in your particular model, it's good to know that Mallory gives you an extra margin of safety. So make it Mallory and be safe.

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured. Adopted as standard by RMA, it is famous for dependable performance.

**The chlorides present in perspiration cause destructive corrosion which shortens the capacitor's life in the field.*

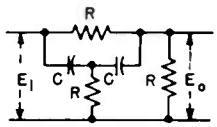
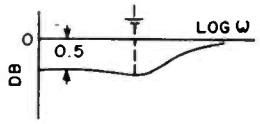
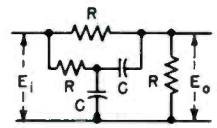
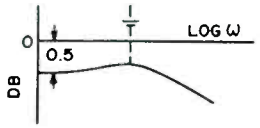
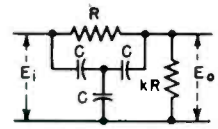
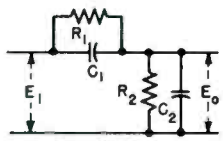
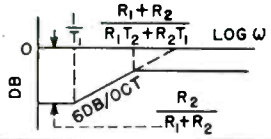
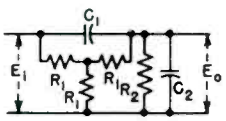
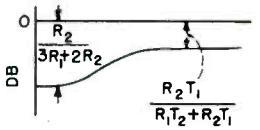
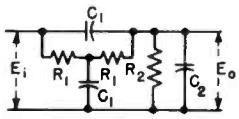
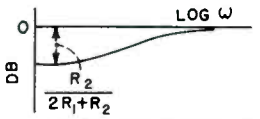
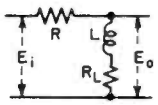
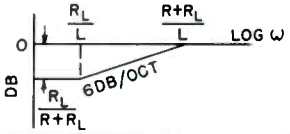
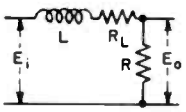
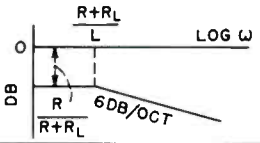
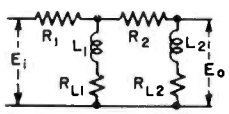
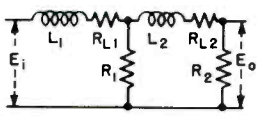
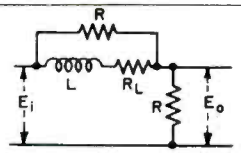
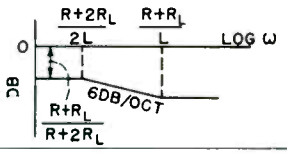
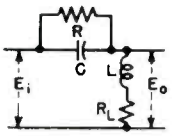
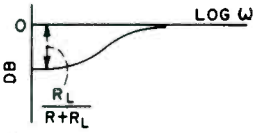
P. R. MALLORY & CO. Inc.

MALLORY

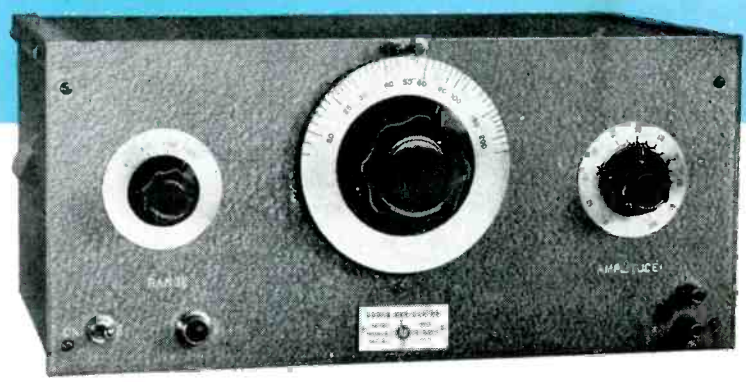
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

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

NETWORK	TRANSFER FUNCTION	GAIN CURVE
(19) 	$\frac{(1+Tp)^2}{2+5Tp+T^2p^2}$ $\phi = 2\tan^{-1}T\omega - \tan^{-1}\frac{5T\omega}{2-T^2\omega^2}$	
(20) 	$\frac{1+3Tp}{2+5Tp+T^2p^2}$ $\phi = \tan^{-1}3T\omega - \tan^{-1}\frac{5T\omega}{2-T^2\omega^2}$	
(21) 	$\frac{k(3+Tp)}{3(1+k)+2kTp} = \frac{k[9(1+k)+2k\omega^2T^2+3(1-k)]\omega T]}{9(1+k)^2+4k^2\omega^2T^2}$ $\phi = \tan^{-1}\frac{T\omega}{3} - \tan^{-1}\frac{2kT\omega}{3(1+k)}$	j-TERM NEGATIVE FOR $k>1$ ZERO FOR $k=1$ POSITIVE FOR $k<1$ $A = k\sqrt{\frac{9+T^2\omega^2}{9(1+k)^2+4k^2T^2\omega^2}}$
(22) 	$\frac{R_2(1+T_1p)}{(R_1+R_2)+(R_1T_2+R_2T_1)p}$ $\phi = \tan^{-1}T_1\omega - \tan^{-1}\frac{(R_1T_2+R_2T_1)\omega}{R_1+R_2}$	
(23) 	$\frac{R_2(1+3T_1p)(1-T_2p)}{(3R_1+2R_2)+R_2(3T_1-2T_2)p-3T_2(R_1T_2+R_2T_1)p^2}$ $\phi = \tan^{-1}3T_1\omega - \tan^{-1}T_2\omega - \tan^{-1}\frac{R_2(3T_1-2T_2)\omega}{3R_1+2R_2+3T_2(R_1T_2+R_2T_1)\omega^2}$	
(24) 	$\frac{R_2[1+(2T_1-T_2)p+T_1(T_1-2T_2)p^2-T_1^2T_2p^3]}{(2R_1+R_2)+(R_1T_1+3R_2T_1-R_2T_2)p+(R_2T_1^2-3R_2T_1T_2-2R_1T_2^2)p^2-T_1(R_1T_2^2+R_2T_1T_2)p^3}$ $\phi = \tan^{-1}\frac{(2T_1-T_2+T_1^2T_2\omega^2)\omega}{1-T_1(T_1-2T_2)\omega^2} - \tan^{-1}\frac{[R_1T_1+3R_2T_1-R_2T_2+T_1(R_1T_2^2+R_2T_1T_2)\omega^2]\omega}{2R_1+R_2-(R_2T_1^2-3R_2T_1T_2-2R_1T_2^2)\omega^2}$ (LEADING ANGLE)	
(25) 	$\frac{R_L+Lp}{R+R_L+Lp}$ $\phi = \tan^{-1}\frac{L\omega}{R_L} - \tan^{-1}\frac{L\omega}{R+R_L}$	
(26) 	$\frac{R}{R+R_L+Lp}$ $\phi = -\tan^{-1}\frac{L\omega}{R+R_L}$	
(27) 	$\frac{(R_{L1}+L_1p)(R_{L2}+L_2p)}{[(R_1+R_{L1})(R_2+R_{L2})+R_1L_1]+[(R_1+R_{L1})L_2+(R_2+R_{L2})L_1+R_1L_1]p+L_1L_2p^2}$ $\phi = \tan^{-1}\frac{L_1\omega}{R_{L1}} + \tan^{-1}\frac{L_2\omega}{R_{L2}} - \tan^{-1}\frac{[(R_1+R_{L1})L_2+(R_2+R_{L2})L_1+R_1L_1]\omega}{(R_1+R_{L1})(R_2+R_{L2})+R_1L_1-L_1L_2\omega^2}$	
(28) 	$\frac{R_1R_2}{[(R_1+R_{L1})(R_1+R_2+R_{L2})+R_1^2]+[(R_1+R_{L1})L_2+(R_1+R_2+R_{L2})L_1]p+L_1L_2p^2}$ $\phi = -\tan^{-1}\frac{[(R_1+R_{L1})L_2+(R_1+R_2+R_{L2})L_1]\omega}{(R_1+R_{L1})(R_1+R_2+R_{L2})+R_1^2-L_1L_2\omega^2}$	
(29) 	$\frac{R+R_L+Lp}{R+2R_L+2Lp}$ $\phi = \tan^{-1}\frac{L\omega}{R+R_L} - \tan^{-1}\frac{2L\omega}{R+2R_L}$	
(30) 	$\frac{(R_L+Lp)(1+Tp)}{(R+R_L)+(R_LT+L)p+LTp^2}$ $\phi = \tan^{-1}\frac{L\omega}{R_L} + \tan^{-1}T\omega - \tan^{-1}\frac{(R_LT+L)\omega}{R+R_L-LT\omega^2}$	

hp OSCILLATORS GIVE YOU PRECISE TEST VOLTAGES from ½ cps to 10 mc!



–hp– MODEL 200C

From ½ cps to 10 mc, there's an *–hp–* resistance tuned oscillator engineered to your exact need. Ten precision oscillators in all, including a portable unit that operates from batteries. Each has the familiar *–hp–* advantages of high stability, constant output, wide frequency range, low distortion and no zero set during operation. *–hp–* precision oscillators are used by radio stations, manufacturers, research laboratories and scientists throughout the world.

SPECIFICATIONS OF –hp– OSCILLATORS

INSTRUMENT	FREQ. RANGE	OUTPUT	DISTORTION	FREQ. RESPONSE	PRICE
–hp– 200A	35 cps to 35 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc	$120.00
–hp– 200B	20 cps to 20 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc	120.00
–hp– 200C	20 cps to 200 kc	100 mw/10v	Less than 1% to 20 kc	± 1 db to 150 kc	150.00
–hp– 200D	7 cps to 70 kc	100 mw/10v	Less than 1% 10 cps to 70 kc	± 1 db throughout range	175.00
–hp– 200H	60 cps to 600 kc	10 mw/1v	Less than 3%	± 1 db, 60 cps to 600 kc	350.00
–hp– 200I	6 cps to 6 kc	100 mw/10v	Less than 1% above 10 cps	± 1 db, 6 to 6000 cps	225.00
–hp– 201B	20 cps to 20 kc	3 w/42.5v	Less than ½% (1 watt output)	± 1 db throughout range	250.00
–hp– 202B	½ cps to 50 kc	100 mw/10v	Less than 1% 1 to 1000 cps	± 1 db, 10 to 50,000 cps	350.00
–hp– 202D	2 cps to 70 kc	100 mw/10v	Less than 2% 10 cps to 70 kc	± 1 db, 7 cps to 70 kc	275.00
–hp– 204A (Battery Op'd.)	2 cps to 20 kc	2.5 mw/5v	Less than 1%	± 1 db throughout range	175.00
–hp– 650A	10 cps to 10 mc	15 mw/3v	Less than 1% 100 cps to 100 kc	± 1 db throughout range	475.00

For complete details on any –hp– instrument, write direct to factory or contact the –hp– technical representative nearest you.

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

400-mc Oscillator with Subminiature Tube

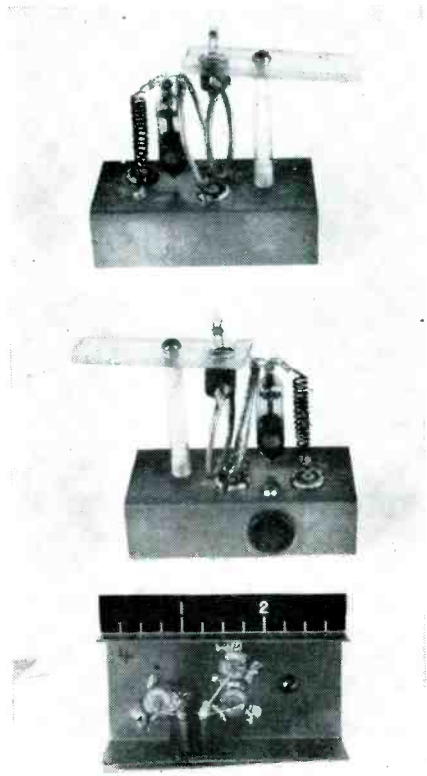
By Eugene A. Fattey

Receiving Tube Section
Thermionics Branch
Evans Signal Laboratory
Belmar, New Jersey

The oscillator to be described operates at 400 megacycles and provides over one watt of useful r-f power with a plate-circuit efficiency of 40 to 45 percent when using a type 5703 subminiature tube. Although designed for laboratory investigation of filamentary and heater-cathode type subminiature tubes, the comparatively high efficiency and compact design of this oscillator extends its usefulness to practical applications as well as laboratory use.

Tests have indicated good performance in the amateur and citizen frequency bands between 400 and 500 megacycles when using various types of commercially available subminiature tubes. Although power output diminishes quite rapidly above 500 megacycles, an output of 446 milliwatts was obtained at 720 megacycles from tube type 5703.

As shown in Fig. 1, the circuit diagram is quite conventional electrically. All unnecessary chokes and capacitors have been eliminated to provide the utmost in simplicity consistent with high efficiency. Provision has been made for use of an external variable grid leak for initial adjustment purposes.



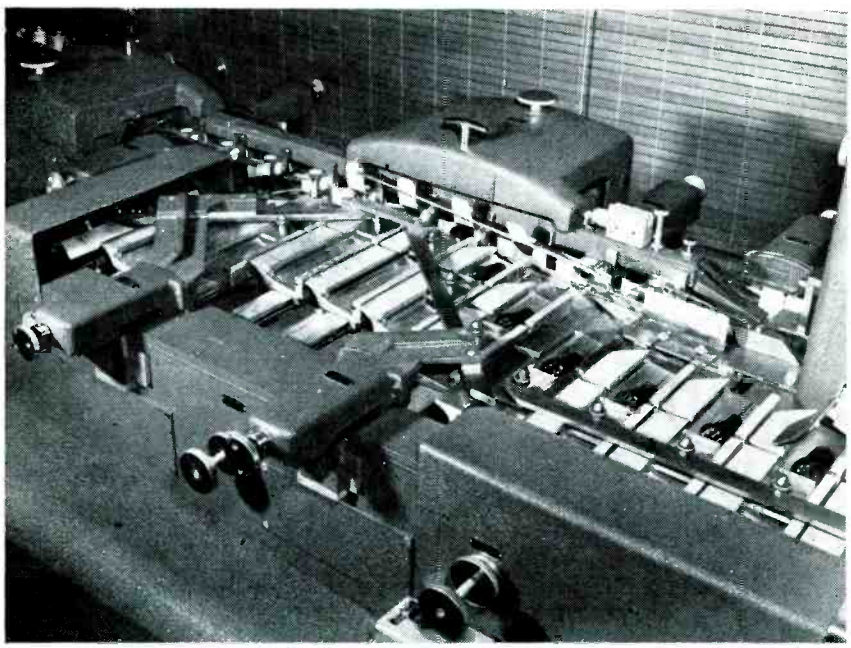
Front, rear and underside views of oscillator

The filament choke is of the bifilar wound type and has a fairly broad effect over a range of about 10 percent of the operating frequency. The number of turns may be altered to provide feedback control. Too many turns will be evidenced by critical load coupling and failure to obtain maximum output when the plate voltage is turned off and on.

In testing heater-cathode type tubes, a difference in results has been observed depending on which side of the filament the cathode is connected. For example, in testing tube type 5703 it was found that connecting the cathode to the filament lead adjacent to the plate lead gave increased efficiency.

The photographic views together with the chassis and other parts layout of Fig. 2 give all the necessary physical details of construction. The plate and grid inductances are formed of No. 12 copper wire to provide a loop about 1½ inches outside diameter. The load lamp inductance is also formed from a loop of No. 12 copper wire 1⅜ inches out-

MACHINE BOXES TUBES



This GE automatic tube cartoner feeds flat folding cartons from a magazine, makes up the carton, inserts a tube, closes the top and bottom tuck-in flaps, and imprints the tube type designation on the top panel of each carton in one continuous automatic operation at the rate of 160 cartons a minute

SOLDERING TIPS

Good soldering technique and maximum efficiency demand uniformity in the flux content, strand size, core size, and alloy of the solder. If any of these qualities are lacking, it means that from time to time there will be a marked difference in the results and a loss in economy.

As an example, a solder that does not contain a uniform flux content might result in too much residue, which may be very harmful to the finished work; or in direct opposite, there might not be enough flux to properly remove the oxides, resulting in a faulty soldered connection. All Kester Flux-Core Solders are made with various core sizes containing a flux content ranging from ½ of 1% to as much as 7% by weight. These core sizes are available in each of 68 different strand sizes, ranging from .009 to .250". Not too much emphasis can be placed upon the importance of the correct core and strand size in relation to the specific job that must be done.

A very important factor in controlling core sizes is that various core sizes or openings can be obtained only by making the solder with a *single core*. Multiple core solders have insufficient flexibility in ther flux content to meet the many fluxing situations encountered in industry today. With Kester you have at single core, but that single core is available in six different sizes or openings designed to provide varying percentages of flux, so essential to precision soldering.

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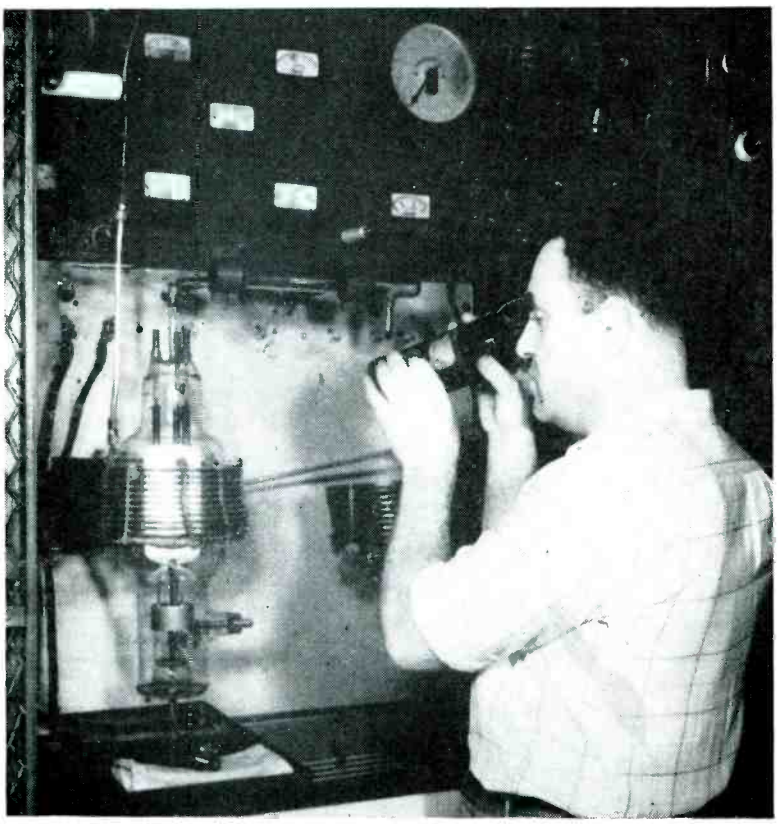
THE FRONT COVER

THE operator checks the anode temperature of a ZB3200 transmitting tube with an optical pyrometer at the Brooklyn, N. Y. plant of Amperex Electronic Corporation. The photo shows the tube on exhaust where induction heating is utilized to raise internal metal parts to high temperatures. This drives off any residual gas and provides the long tube life so essential to this radiation-cooled unit which has a plate dissipation rating of 2,500 watts.



side diameter, wired as shown.

A capacitance tuning effect is provided by using the base of the No. 47 panel lamp as one plate of a capacitor and one-half the base of a similar type of lamp base as the other plate. The load lamp circuit may be tuned to resonance by adjusting the improvised capacitor to the oscillator frequency with a signal generator or simply by experiment.

A small loop of No. 18 wire soldered to the base of the load lamp will facilitate application of a calibrating voltage later. This load circuit represents a compromise between the ideal and one with practicability. Since a No. 47 panel lamp has a rather high impedance at 400 megacycles, it is not entirely suitable for use in a series tuned circuit.

An increase of several percent in power output can be obtained by tapping the load lamp, from which the base has been removed, across a portion of a resonant load circuit so as to obtain a better impedance match. However, this type of circuit is somewhat more difficult to construct and requires a blocking capacitor if provision is to be made for introducing a d-c calibrating voltage. Also, tuning is extremely sharp, requiring a carefully designed tuning capacitor if resonance is to be maintained.

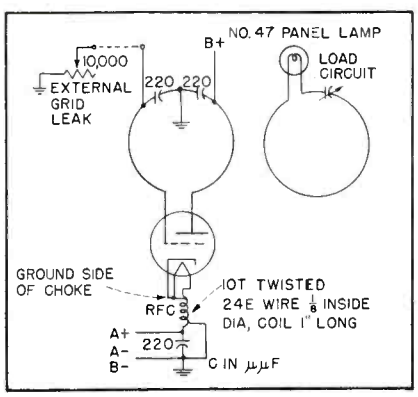


FIG. 1—Circuit of the 400-mc oscillator. The fixed capacitors are button type

Very loose coupling is also required, necessitating more chassis space and a departure from compactness. Although the load circuit used in this oscillator has a broad tuning effect and some impedance mismatch, the latter can be partly corrected by resonating at a frequency 10 to 20 percent lower than the operating frequency.

The following collection of data shows operating conditions used in evaluating tube type 5703, together with the average of results obtained in testing 10 tubes. All tubes tested showed good stability, with only a one to two-percent change in frequency noted when changing tubes.

Output

Test of tube type 5703 at E_f of 6.3 volts and E_b of 135 volts gave a plate current of 20 ma, grid current 5.2 ma, grid resistance 1,500 ohms, and power output 1.143 watt at 400 mc at an efficiency of 42.3 percent. By silver plating all metal parts of the oscillator and optimizing conditions, a useful power output of 1,259 milliwatts has been obtained at a plate efficiency of 46.6 percent.

Power output was measured by the following method. A photocell was used to note the degree of brilliancy of the load circuit lamp. The oscillator was then shut off and direct current applied to the load lamp until the photocell indicated the original value. The direct-current power required for this was assumed to be the equivalent of the r-f power previously obtained.

This oscillator lends itself well to the study of antennas and arrays. A half-wave antenna loads easily when coupled loosely at the center near the grid and plate button capacitors. A No. 48 panel lamp at the center of a half-wave receiving antenna will glow when two feet distant from the transmitting antenna. This distance can be increased by the addition of directors and reflectors.

It is believed that information thus far obtained points the way to still higher efficiency. Tests have indicated that the power dissipated as heat by the oscillator tube repre-

(continued on p 138)

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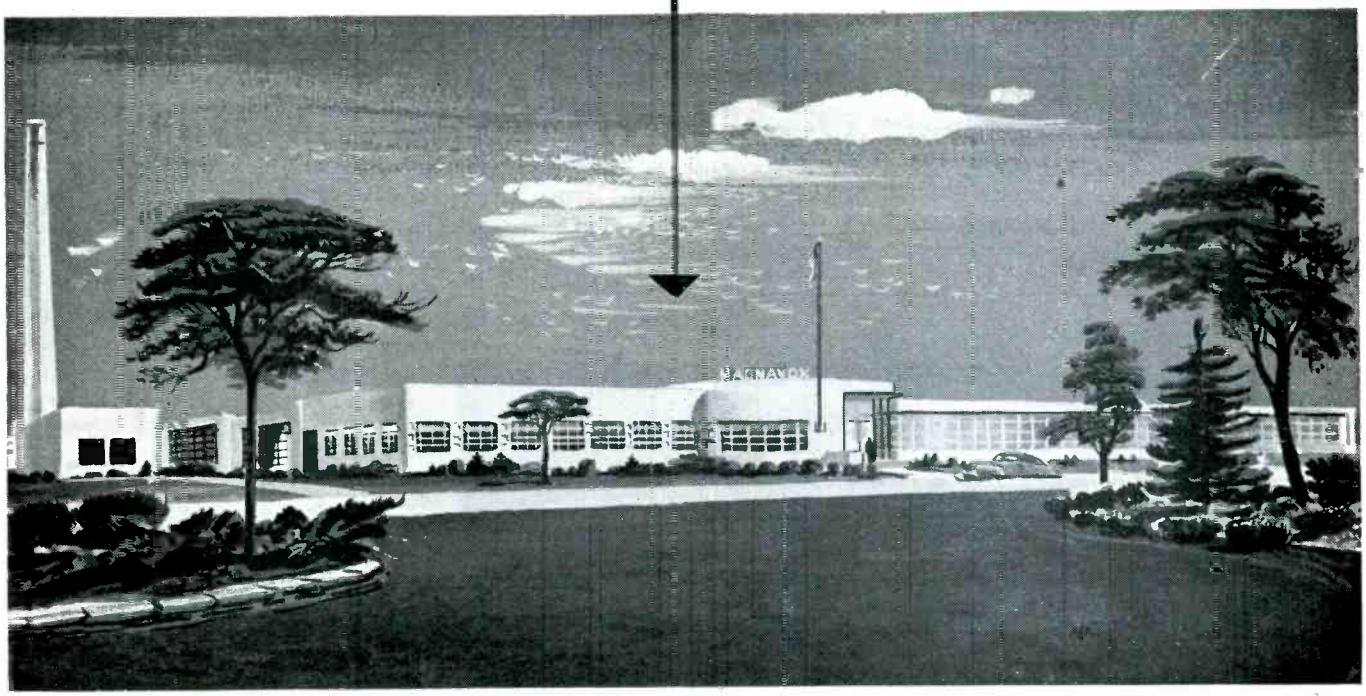

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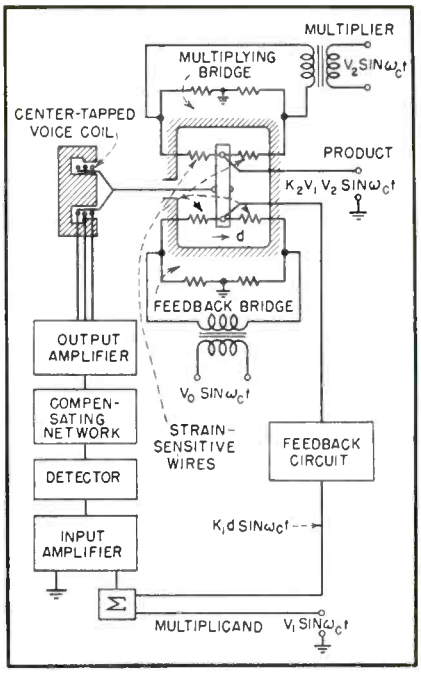
THE ELECTRON ART

Edited by JOHN MARKUS

Strain-Gage Multiplier

AN INSTRUMENT for multiplying modulated carrier voltages in an analog computer has been recently developed at the Dynamic Analysis and Control Laboratory of MIT. The basic multiplying element in this instrument is a wire-resistance strain-gage Wheatstone bridge. One of the modulated voltages, the multiplier, is applied to the input terminals of the bridge network, and the second modulated voltage, the multiplicand, controls the degree of unbalance of the bridge. The product voltage appears as the modulated output of the bridge network.

The application in which the multiplier is employed required an accuracy of 0.1 percent of full-scale output and a multiplication time constant of less than two milliseconds. These specifications were met by the system shown in the diagram. The multiplicand is compared with a signal provided by a second, constantly excited strain-gage bridge. This feedback bridge is coupled mechanically to the multiplying bridge in such a fashion that the degrees of unbalance in the two bridges are proportional. This arrangement effectively applies negative feedback around those elements which are most likely to drift and introduce error. Both the multiplying bridge and the feedback bridge are driven by a transducer that is no more than a precision loudspeaker.



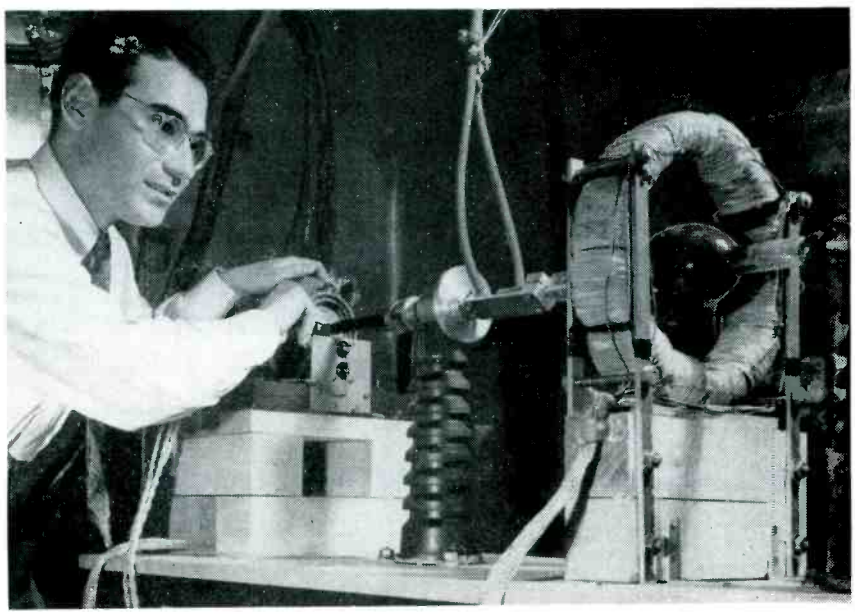
Block diagram of multiplier arrangement for use in analog computer

The latest type of multiplier built by the laboratory has three multiplying bridges and one feedback bridge all mounted on the same frame and is thus capable of forming three products or the fourth power of a single quantity.

While the multiplier was originally designed for 400-cycle suppressed-carrier voltages, it operates satisfactorily at almost any audio frequency and with modification could be made to operate even above this range. It is not readily adapted to d-c operation, however.

This instrument was described at the 1949 IRE National Convention by C. H. Woods, E. St. George, L. Isenberg and A. C. Hall of Massachusetts Institute of Technology.

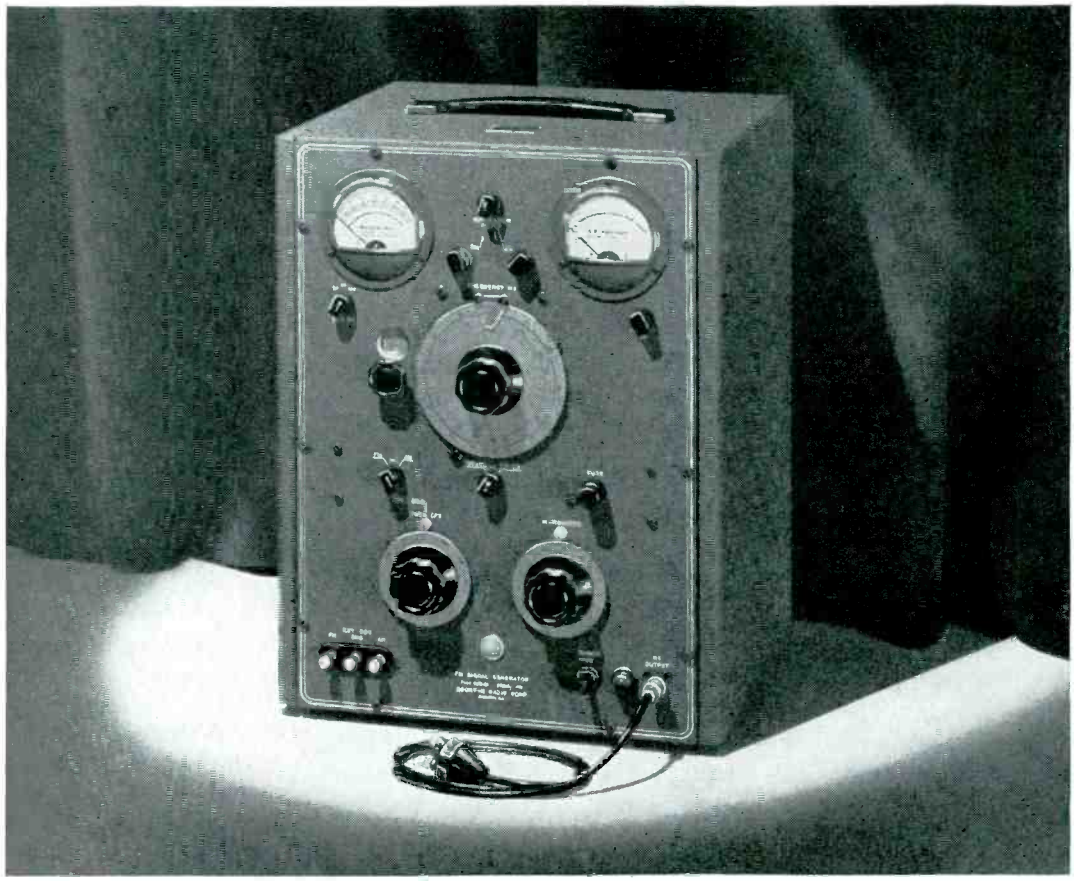
GYRATION IMPROVES X-RAY TUBE EFFICIENCY



Large coil produces rotating magnetic field that moves focal spot of electron beam in circle on target face in order to distribute heat over greater surface area of target. Motor-driven lathe arrangement synchronized with magnetic field gyrates entire tube to keep external x-rays at a fixed point of focus despite wiggling of electron beam. Experimental apparatus shown was developed by graduate student Arthur I. Berman at Palo Alto x-ray lab of Stanford University

Electronic Slide Rule

A NOVEL parametric electronic computer that operates on the principle of a slide rule but accepts data supplied in the form of electrical voltages was the subject of a paper presented by Charles J. Hirsch of Hazeltine Electronics Corp. at the 1949 IRE National Convention. Much as with an alignment chart, data voltages are aligned in time in the same manner that data quantities are aligned in distance on a



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In January, 1946, at the I. R. E. National Convention in New York City, a preliminary engineering model of the type 202-A FM-AM Signal Generator was displayed for the first time. Many well known FM and television engineers, invited to comment frankly on performance specifications, suggested refinements and features which they believed would be most desirable in the finished design.

Utilizing this valuable information, Boonton Radio Corporation's engineers worked another full year before they were ready to place their approval on the final design—the type 202-B FM-AM Signal Generator.

The advantages of this essential instrument were recognized immediately. Since its enthusiastic reception, the 202-B has increased in popularity and today it is generally accepted as the acknowledged standard of FM-AM signal generator performance. Practically every well known radio manufacturing concern is now placing increasing numbers of this versatile instrument in full time use, assisting their engineers and research staffs to design and produce better, lower cost radio and television receiving equipment.

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slide rule. Since the time scales of this electronic slide rule may be calibrated according to any function of time which can be electrically realized, a large variety of operations can be performed. Such time scales may be logarithmic, linear, trigonometric, or combinations of these.

A capacitor discharging through a resistor supplies a logarithmic time scale. If x and y are known functions of time and n is a known constant, the computer can perform the following operations: x^n; xy; $x \int y$; $x+y$; $\sin x$; $\sin nx$; $\sin^{-1} x$; $\cos x$; $\cos \int nx$; $\cos^{-1} x$; $\log x$; $\int x dt$; $\int x dy$; dx/dy. Since the operations are completed in a very short time (milliseconds or less), they can be repetitive and performed on variable parameters.

Vacuum tubes are used mostly as switches which are either on or off, so that constancy of tube characteristics is relatively unimportant. Just as slide rules can be made to have any desired accuracy if they are long enough, this computer can be made as accurate as desired if high enough voltages and rapid enough samplings are taken.

Such computers can be made up to suit individual problems such as navigational off-set or arbitrary course computers. Another application is an inexpensive and relatively small differential analyzer.

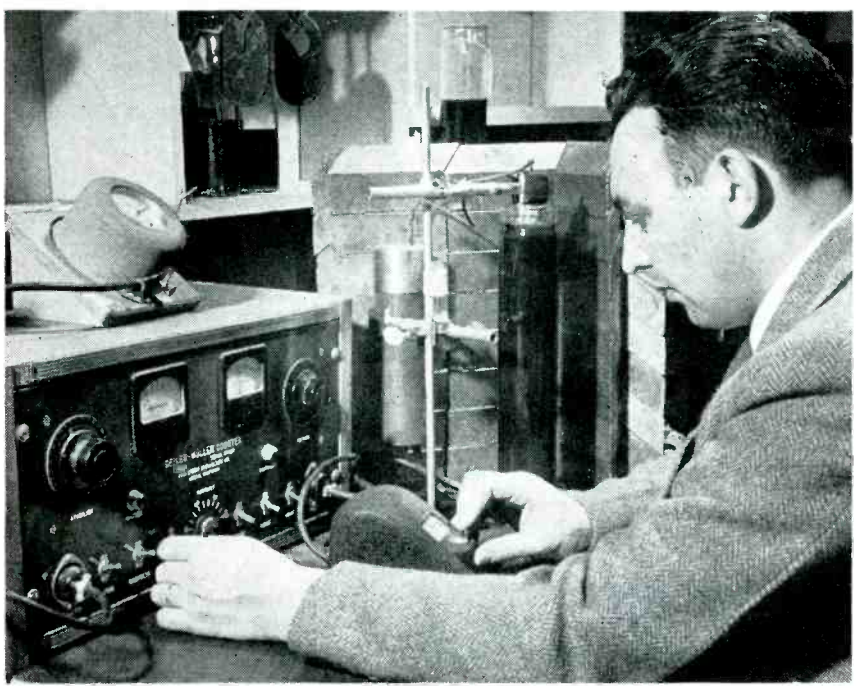
Radioactive Rings Reveal Wear

EXPERIMENTS with piston rings made radioactive in the uranium chain-reacting pile at the Oak Ridge National Laboratory have been carried out by California Research Corporation, a subsidiary of Standard Oil Co. of California, to test the effect of fuels and lubricants on engine wear.

This peacetime application of nuclear fission to industry has enabled the research engineers to run fuel and lubricant tests in a much shorter time than present methods permit.

In beginning a typical fuel or lubricant test, a radioactive piston ring is taken from its 300-pound lead safety box and carefully placed on the test engine's piston. Then, after three or four hours of operation, a sample of oil is taken from the engine's crankcase. The oil is tested with a delicate Geiger counter which immediately indicates the amount of metal worn from the activated ring—minute particles of iron flushed away by the oil.

With radioactive rings in a test engine, the amount of wear can be measured so closely that as little as one-millionth of an ounce of metal worn from the rings can be detected.



Making Geiger counter test of oil sample taken from test engine after several hours operation with radioactive piston ring, to determine amount of metal transferred from the ring to the oil

Radar Delay Network Tester

A COMBINATION impulse generator and electronic switch for testing radar component networks was described by T. R. Finch of Bell Telephone Laboratories at the 1949 IRE National Convention. This test facility may be used to test any network that can be arranged to store a d-c charge, such as delay and pulse-forming networks with delay, pulse duration and response rise time in the range of 0.04 to 20 microseconds.

The test circuit was developed to reduce the time required for production testing of wide-band pulse and video networks and to facilitate the development of new networks by providing the design engineer with a laboratory tool that presents instantaneously and visually the network characteristics of interest.

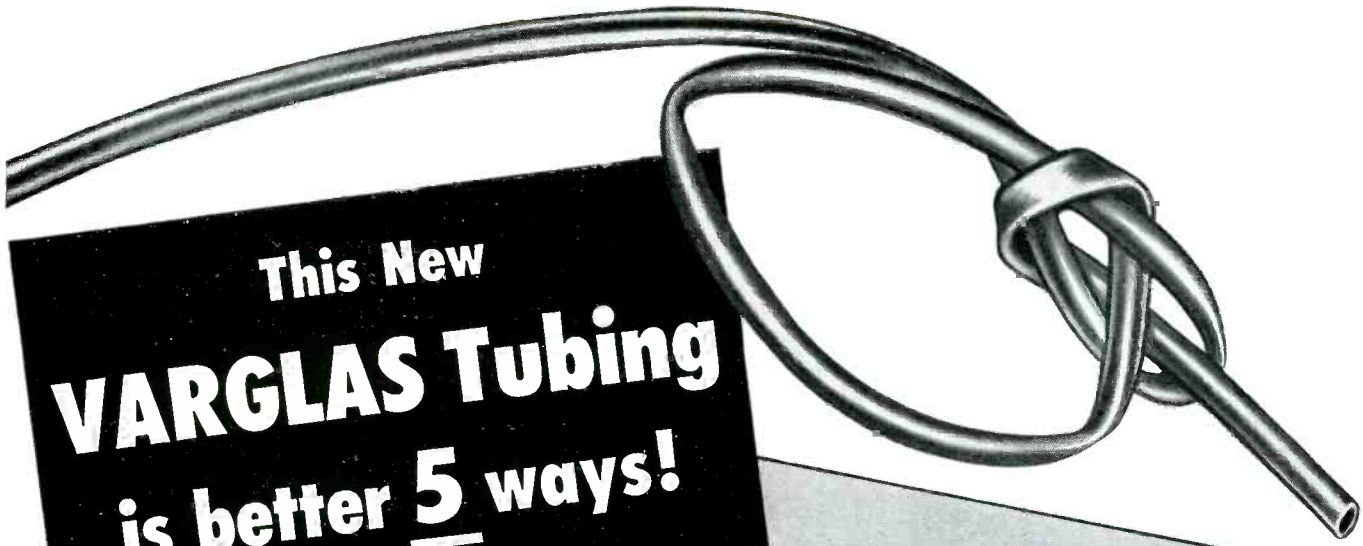
Special Features

The impulse generator-electronic switch is distinguished from commercially available electronic switches by the following features:

(1) It provides an impulse generator which energizes the networks under test and discharges these networks through a zero-impedance switch, resulting in pulse patterns related to the transmission characteristics of the networks. These microsecond pulse patterns are repeated at a rate of 480 pulses per second.

(2) It provides a start-stop sweep and beam intensifier synchronized with the impulse generator that may be directly connected to the horizontal plates and grid respectively of a cathode-ray oscilloscope. Thus a time interval of a few microseconds only, phased with each pulse, is displayed on the cro screen. These circuits are continuously var-

(continued on p 160)



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NEW PRODUCTS

Edited by A. A. McKENZIE

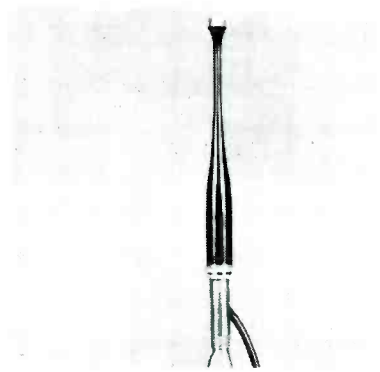
Projection Television

RADIO CORP. OF AMERICA, Camden, N. J. Life-size projection television system TLS-87 features an optical barrel that can be suspended from the ceiling. Designed particularly for night clubs or other custom in-

stallations, the system uses a screen 6 x 8 feet with either front or rear projection. Microphone and phonograph units are furnished so that the 30-watt sound system can be used for other purposes than the television sound.

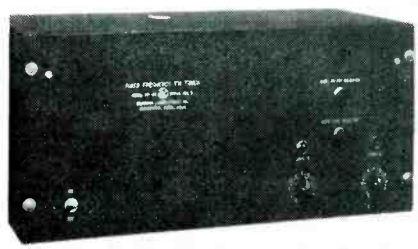
Inconspicuous Mike

ALTEC LANSING CORP., 161 Sixth Ave., New York 13, N. Y. Type 21B omnidirectional microphone designed for broadcast and public address use is not susceptible to wind pressure and stands up well under loud sounds or shocks. The complete microphone system (type M11) comprising amplifier and potential supply has an output level of minus 50 dbm in a sound field of 10 dynes per square centimeter. Output impedances are 30 to 50, 150 to 250, and 500 to 600 ohms. The amplifier can be placed up to 400 feet from the microphone. Weight of the microphone assembly itself is 3¾ ounces.



Fixed F-M Tuner

BROWNING LABORATORIES, INC., Winchester, Mass. Now available in three models for use in the 88-to-108-mc f-m band are crystal controlled receivers with characteristics suitable for monitoring, relay reception, and store installations. Model RP-23 is a dual-limiter receiver with 20-db quieting for 10-microvolt input. Response is within 1 db from 30 cycles to 17 kc. The



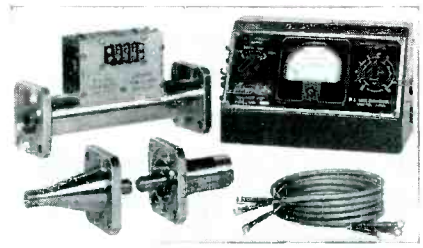
audio stage provides a 1-volt rms output with quieting signal. Antenna input is 72 or 300 ohms.

Model RP-24 uses the same tuner and has a relay that operates on tones from 15 to 20 kc received from the transmitter to select in sequence two preset audio volume levels.

Model RP-25 utilizes the same tuner but has two relay circuits controlled by tones of different frequencies independently. All models are rack panel style.

Power and SWR Meter

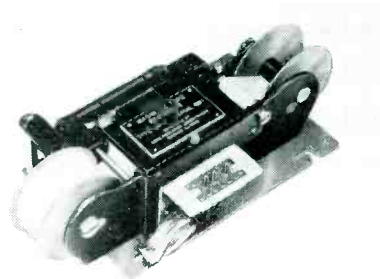
M. C. JONES ELECTRONICS CO., 96 North Main St., Bristol, Conn. A new series MM400 of wide frequency range instruments for measuring r-f power and standing-wave ratio on 51.5-ohm coaxial transmission lines are direct reading and require no correction factor



over the entire range from 50 to 500 mc. The instruments are designed for laboratory measurements and for monitoring both transmitter and antenna performance. A single meter reads incident power, reflected power, net power to load, and the standing wave ratio of the load. Full scale power ranges of 400, 1,200 and 4,000 watts are available. The new series can be used with 1, ⅝ or ⅞-inch air line and with RG-17/U and RG-8/U coaxial cable.

Magnetic Tape Recorder

COOK RESEARCH LABORATORIES, 1457 Diversey Parkway, Chicago 14, Ill. Type MR-4 magnetic tape recorder is a miniature 13-channel unit weighing 24 ounces. It includes one reference frequency oscillator



plus 12 information channels and has a recording time of 2½ minutes. Small size and light weight make it suitable for recording data in airborne equipment, flight testing and guided missile work.

Infrared Analyzer

PERKIN-ELMER CORP., Glenbrook, Conn. A new analyzer, model 12-D, for continuous automatic analysis of as many as six different components in a flowing stream of sample, either in the liquid or gas phase comprises several units illustrated. An automatic turret turns to twelve different positions, one reference standardization point and one absorption point for each of six com-

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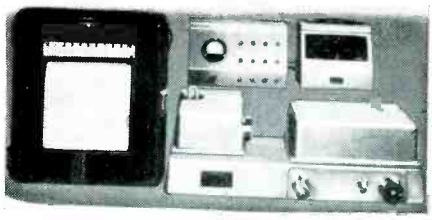
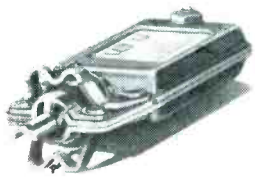


ponents, for the infrared monochromator. A Leeds & Northrup strip chart is automatically synchronized with the turret. The stable a-c amplifier compensates for changes in ambient temperature, source intensity, and window dirt.

Turnover Pickup

ASTATIC CORP., Conneaut, Ohio. The type LQD cartridge uses two separate independent needles, one with one-mil tip radius for long-playing records and the other needle with three-mil tip radius for standard recordings. These special needles



lift from a snap-in position in the cartridge for replacement. Frequency response of the new cartridge is from 50 to 7,000 cycles. Output voltages are 1.2 at 1,000 cycles with a 78-rpm test record, 0.75 volt with 33⅓-rpm test record No. 281. Recommended needle pressures are 15 grams for 78 rpm and 6 to 8 grams for 33⅓ rpm.

UHF Generator

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Model 614A signal generator for direct reading between 800 and 2,100 megacycles is direct reading in

microvolts or decibels. The instrument has a constant internal impedance standing wave ratio of 3 db and accuracy is plus or minus 1 db throughout the frequency range. The r-f output ranges are 0.1 volt to 0.1 microvolt and can be made continuous, pulsed, or frequency modulated either from internal or external signals. It may be synchronized with either positive or negative pulses or sine waves.

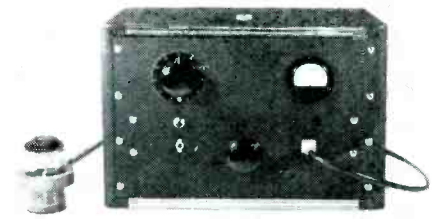
Electronic Stopwatch

AMERICAN CHRONOSCOPE CORP., 316 West First St., Mount Vernon, N. Y. Model 100 high-speed chronoscope measures time from 10

microseconds to 1 second with a direct indication on a 5-inch dial. Accuracy is better than one scale division or 1 percent on any range. The timing impulse is voltage pulse, short circuit or open circuit. Bulletin 100 gives further details on the use of the instrument.

Ultrasonic Generator

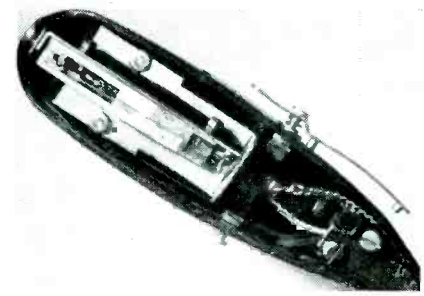
ULTRASONIC ENGINEERING CO., 4 North Eighth Ave., Maywood, Ill. Type CL ultrasonic equipment uses a special transducer connected to the generator by a coaxial cable that carries a low-voltage high-frequency current. Base of the transducer comprises a transparent lucite tube surrounded by a ring containing the primary winding of the step-up Tesla coil. Inside the tube is the secondary winding. The crystal is mounted above the secondary coil upon nylon rods between bakelite and glass discs. The tube is closed by a cap containing a bakelite diaphragm 1/100-in. thick mechanically connected with the vibrating crystal by oil which fills the entire assembly. Standard frequency of the generator is 450 kc with an alternate crystal and



coil available for conversion to 900 kc. Other attachments are available for clinical or laboratory work.

All-Record Pickup

SONOTONE CORP., Elmsford, N. Y. A single pickup with dual side-by-side points set in one needle will play all three speeds of the old and new phonograph records. The pickup element is the new piezoelectric



ceramic type. Movement of a lever switches from one sapphire point to another, at the same time changing the pressure of the pickup arm on the record.

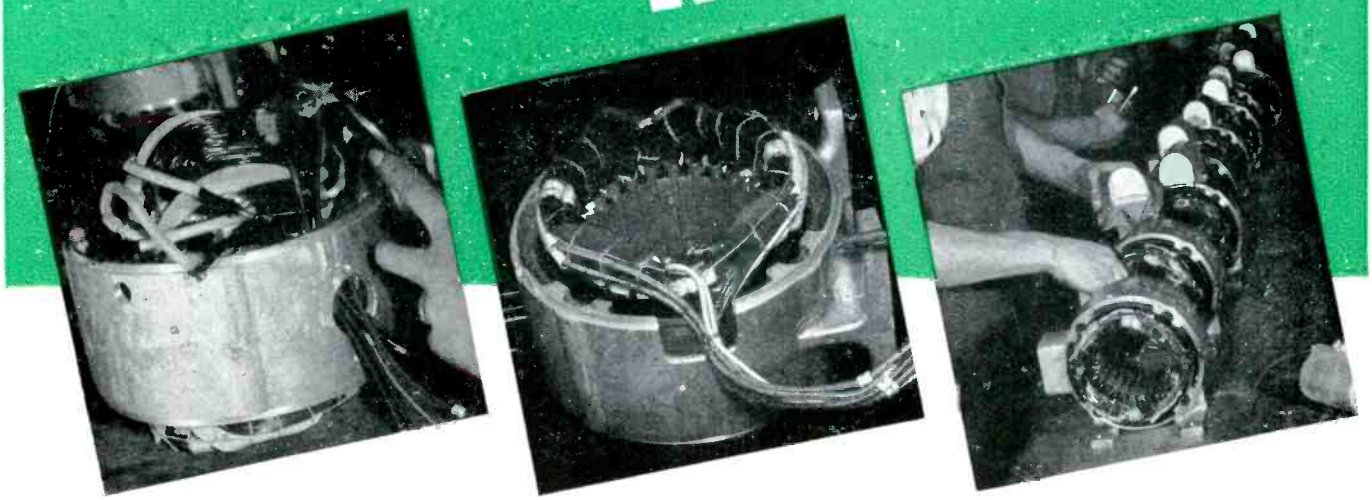
Telemetering Gyros

G. M. GIANNINI & CO., INC., 254 West Colorado, Pasadena 1, Calif. Telemetering rate gyros are available for rotational measurements from 10 to 1,000 degrees per second and position gyros with one and two-axis electrical sensory elements. Production gyros with accuracies of

(continued on p 185)

American MOTOR LEADS

are insulated and protected *with* NATVAR 400



The compact 1 HP single phase 115/230 volt, capacitor start—induction run motor, manufactured by American Electric Motors, Inc., Los Angeles, is especially recommended for use around dirt or dust-filled machines such as table saws or other woodworking tools. The centrifugal starting switch is totally enclosed, and the solid welded copper bar armature is mounted on high quality, standard size ball bearings, lubricated for life. Leads are insulated and protected with Natvar 400.

American Electric Motors, Inc., Los Angeles, manufactures a line of induction motors, both single phase and polyphase, and a line of grinders and buffers. An excellent indication of their performance and value is the fact that they are widely distributed by a principal mail order chain.

Natvar 400 Extruded Vinyl Tubing is used on motor leads, because it is approved for 105°C continuous operating temperatures, it simplifies assembly, and gives better all around insulation and protection with considerable savings in labor and material costs and reduced waste.

Natvar 400, in addition to its ability to withstand heat, also has uniformly superior resistance to oil. It is available for prompt delivery either from a nearby wholesaler's stock or direct from our own. Full Underwriters' Laboratories report on request.

Natvar

Natvar Products

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

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THE NATIONAL VARNISHED PRODUCTS Corporation

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RAHWAY 7-2171

CABLE ADDRESS
NATVAR: RAHWAY, N. J.

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Medical Teaching By Television

NATURAL-COLOR television for the teaching of surgery and medicine will have its pioneering demonstration at the annual meeting of the American Medical Association at Atlantic City, N. J., June 6 to 10. The project is being sponsored by Smith, Kline & French Laboratories, a Philadelphia pharmaceutical house.

To assure suitability of equipment, the Medical School of the University of Pennsylvania and the Engineering Research Laboratories of the Columbia Broadcasting System are collaborating in its design. Cooperating with CBS in the production of the equipment are Zenith Radio Corp. and Webster-Chicago Corp.

Standard Broadcasts From Hawaii

RADIO STATION WWVH, recently established by the National Bureau of Standards on the island of Maui, Territory of Hawaii, is now broadcasting on an experimental basis continuous time and frequency standards on 5, 10 and 15 mc. Omnidirectional antennas radiate approximately 400 watts of power on each carrier frequency.

The program of broadcasts of WWVH is essentially the same as that of WWV, and the experiment should determine whether the former may be usefully received at many locations not served by the latter, and whether simultaneous reception of both in some localities will or will not interfere with ordinary use of the standard frequencies and time signals.

Accurate time signals in the form of audio-frequency pulses (0.005 second duration) are transmitted on each carrier frequency at intervals of precisely one second; on the 59th second of each minute the pulse is omitted. Standard musical pitch is provided by modulating each carrier at a standard audio-frequency of 440 cps (A above middle C). The audio-frequency starts precisely at the beginning of each hour, is broadcast for four minutes and it is interrupted for one minute repeatedly. Greenwich Mean Time is given in Morse code every five minutes.

There are short interruptions made after each hour and half-hour to permit operations of automatic ionospheric sounding equipment at the Hawaiian field station and to compare local standards at WWVH with broadcasts by WWV.

Looking north on the island of Maui, toward Bureau of Standards radio field station. Building at left houses WWVH frequency controls and transmitting equipment. Field crew is completing erection of vertical half-wave 10-mc antenna. Transmitting and recording apparatus for ionospheric propagation measurements occupies low building at right. At extreme right is vertical quarter-wave 5-mc antenna

Postwar Loran Changes

WORLD-WIDE standard loran coverage existing at the end of the war has diminished somewhat in scope due to the absence of further military requirements in certain areas. It has been discontinued in the regions of the Phoenix and Fiji Islands, the Palau-Morotai region, the northwest coast of Australia, the Bay of Bengal, the overland areas of China and the extreme northern portion of the Bering Sea.

The Hydrographic Office of the Navy Department recently announced that, while overall loran service remains substantially the same, certain changes designed to improve service for present needs are under way. A new master transmitter for one of the Pacific triplets has been placed on Iwo Jima proper. Major changes are scheduled in the Aleutian area, where a master station is being established at Adak, with slaves at Unimak and at a new location on Attu. This change, and minor shifts and rate redesignations on the U. S. east coast, are due to take effect later this year.

The Coast Guard is now installing the first of its postwar 160-kw transmitters which are crystal controlled and feature reduced bandwidth characteristics. New high-power amplifiers delivering 1,000-kw peak power are scheduled for installation later this year. Both equipments will afford increased ranges over the 100-kw peak power transmitters which have been in use up until now.

Audio Engineering Course

A SERIES of twelve two-hour lectures on audio subjects, sponsored by the New York Chapter of the

0.001% ACCURACY

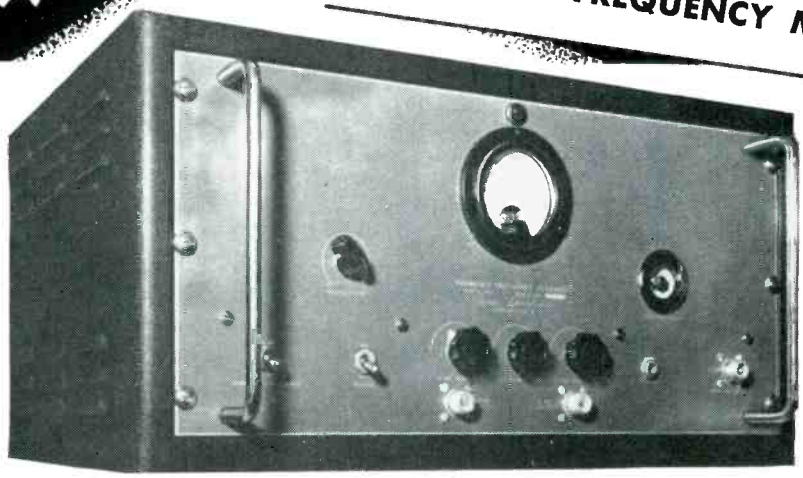
Recommended for:

Calibration of...

- RECEIVERS
- WAVE METERS
- OSCILLATORS
- SIGNAL GENERATORS

Harmonic Voltage Source for:

FREQUENCY MEASUREMENTS



with the IMPROVED LAVOIE C-200 A HARMONIC FREQUENCY GENERATOR

The Harmonic Frequency Generator has been improved for frequency standardization of receivers and frequency meters up to and beyond 2000 Megacycles. Also, by means of a beat detector built into the instrument, it is possible to standardize oscillators and signal generators with equal facility.

Further circuit refinements have produced a frequency accuracy of 0.001%, which extends from 100 Megacycles to 2000 Megacycles in either 10 Megacycle or 40 Megacycle steps.

The output voltage is supplied at a UG-58/U 50-ohm connector with output coupling controls to obtain peak performance for a given harmonic. A milliammeter is incorporated in the instrument to facilitate easy adjustment of the output controls. The output voltage may be either unmodulated or modulated with 400 cps internal oscillator. The generator provides output voltages every 10 Megacycles or every 40 Megacycles. This selection is made by a switch on the front panel. The harmonic voltage is in the order of thousands of microvolts for each harmonic with a value of approximately 50,000 microvolts at 100 Megacycles and 1500 microvolts at 1000 Megacycles.

Provision is made for the standardization of signal generators and oscillators by the incorporation of a beat frequency detector in the generator. The output of this beat frequency detector may be monitored, either aurally or visually with a tuning eye indicator.

To facilitate harmonic identification, frequency identifiers can be supplied for any harmonic frequency (multiple of 10 Megacycles) between 100 and 1000 Megacycles. The identifier is adjusted at our factory.

This instrument is supplied with accessories needed for its operation, including tubes, 5 Megacycle crystal, output coupling cable and instruction book.

COST: C-200A — $395.00 F. O. B. (IDENTIFIERS $25.00 EXTRA)

U H F

Write for Illustrated Descriptive Folder

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

***Specialists* in the Development and Manufacture of UHF Equipment**

Audio Engineering Society, was begun on Thursday evening March 17, and will continue on consecutive Thursdays until June 2. The course is being held in Room 311, RCA Institutes, Inc., 350 W. 4th St., New York.

Topics being covered are as follows:

Psycho-Acoustics, by Lewis S. Goodfriend of Stevens Institute of Technology; Architectural Acoustics I, by Cyril M. Harris of Bell Labs; Architectural Acoustics II, by James Y. Dunbar of Johns Manville Co.; Audio Engineering Mathematics, by Nicholas J. Rose of Stevens Institute of Technology; Transducers I, by Norman C. Pickering of Pickering & Co., Inc.; Transducers II, by Theodore Lindenberg of Fairchild Recording Equipment Corp.; Amplifier Design, by W. R. Ayres of RCA Victor; Attenuators and Mixers, by J. P. Smith, Jr. of The Daven Co.; Equalizers and Wave Filters, by P. W. Rounds of Bell Labs; Amplifier & System Measurements, by Ivan G. Easton of General Radio Co.; System Layout Philosophy, by Donald H. Castle of NBC; System Layout Methods, by John D. Colvin of ABC.

Subscription fees for single lectures are $2.00 for members or applicants, $3 for non-members; for the complete course, $12.00 for members or applicants, $18.00 for non-members. Further information may be obtained from F. Sumner Hall, course chairman, 153 West 33rd St., New York 1, N. Y.

MEETINGS

MAY 2–4: URSI-IRE Joint Meeting, National Bureau of Standards, Washington, D. C.

MAY 5–7: Twentieth anniversary meeting, Acoustical Society of America, Statler Hotel, New York City.

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.

JUNE 20–24: AIEE Summer General Meeting, New Ocean House, Swampscott, Mass.

JUNE 27–29: Conference on Ionospheric Research, The Pennsylvania State College, State College, Pa.

JUNE 27-JULY 1: 1949 Annual Meeting of the American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

AUG. 29-SEPT. 1: National Conference of Associated Police Communication Officers, Hotel New Yorker, New York City.

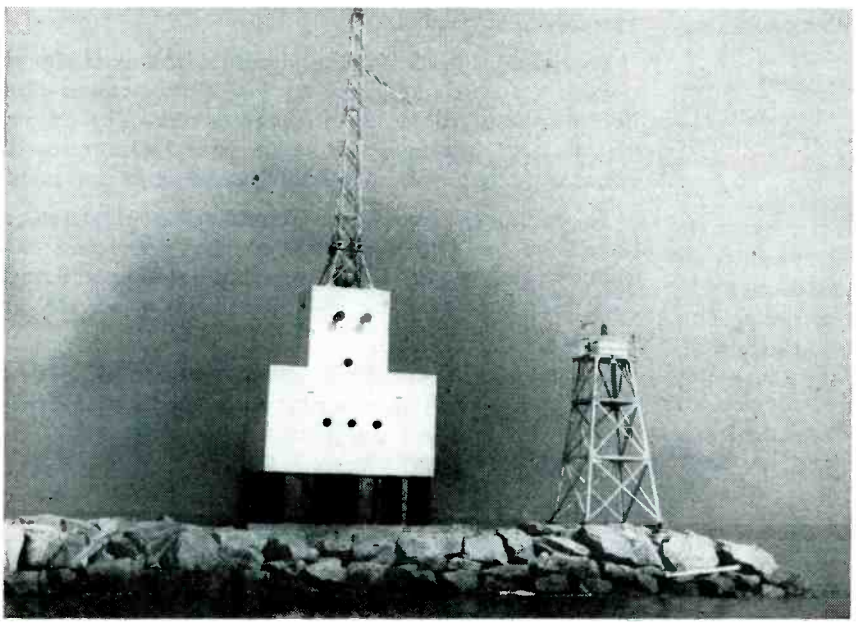
AUG. 30-SEPT. 1: Fifth Annual Pacific Electronic Exhibit sponsored by the WCEMA, and the 1949 IRE western regional convention Civic Center, San Francisco, Calif.

SEPT. 12–16: Instrument Society of America National Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

SEPT. 26–28: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

Nov. 14–18: 23rd NEMA Annual Meeting, Haddon Hall Hotel, Atlantic City, N. J.

AUTOMATIC LIGHTHOUSE



No crew is required at this Coast Guard light and radio beacon, located at the entrance to the channel of the harbor at Long Beach, Calif. Fog horns are operated by Anrac high-frequency radio waves transmitted from San Pedro Light, five miles away. The 1,000-watt, 140,000 candle-power light can be seen 13 miles off the entrance to the channel. It has an automatic lamp changer

Broadcast Engineering Conference

PART of the recent NAB Convention at the Hotel Stevens, Chicago, was the Third Annual Broadcast Engineering Conference, held April 6 to 9.

Technical program was as follows:

Thursday, April 7

9:00 A.M.—A. James Ebel of WMBD, Peoria, Ill., presiding:

A Method of Selecting an FM/TV Transmitting Site, by E. S. Clammer of RCA Victor.

The Practical Solutions of TV Installation Problems, by Robin D. Compton of WOIC (TV), Washington, D. C.

Making and Analyzing TV and FM Field Intensity Measurements, by George P. Adair, consulting radio engineer, Washington, D. C.

The Design, Development and Operation of a TV Mobile Unit, by Willis I. McCord of Allen B. DuMont Labs.

Operation of the Image Orthicon Camera, by John H. Roe of RCA Victor.

A 2,000 Mc Television Relay Link, by Martin Silver of Federal Telecommunication Labs.

12:30 P.M. Royal V. Howard, Director NAB Department of Engineering, presiding:

Engineering Education and the Broadcast Industry, by William L. Everitt of the University of Illinois.

2:15 P.M. John H. DeWitt, Jr. of WSM, Nashville, Tenn., presiding:

AM, FM and TV Audio Measurements, by Frank H. McIntosh, consulting radio engineer, Washington, D. C.

The NAB Recording & Reproducing Standards for Disk and Magnetic Record-

(continued on p 217)

Products of continuing research by the world's largest manufacturer of germanium diodes, these 5 new types open up interesting new fields of application. They are available for immediate delivery in reasonable quantities.

Mail coupon for descriptive literature

Sylvania Electric Products Inc.
Electronics Division, Dept. E-2905
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:

Please send me descriptive literature on Germanium Diodes 1N54, 1N55, 1N56, 1N57 and 1N58. I am also interested in receiving literature covering your other products in the fields of:

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ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS

(continued from p 124)

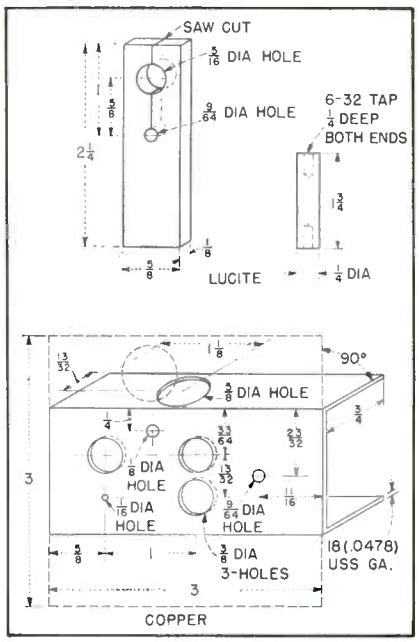


FIG. 2—Chassis layout and load circuit parts

sents approximately 44 percent of the total plate-circuit input. Although part of this loss may be inherent in the tube design itself, it is quite conceivable an investigation would reveal that an appreciable portion of this loss could be converted into r-f power by still further improvement in circuitry.

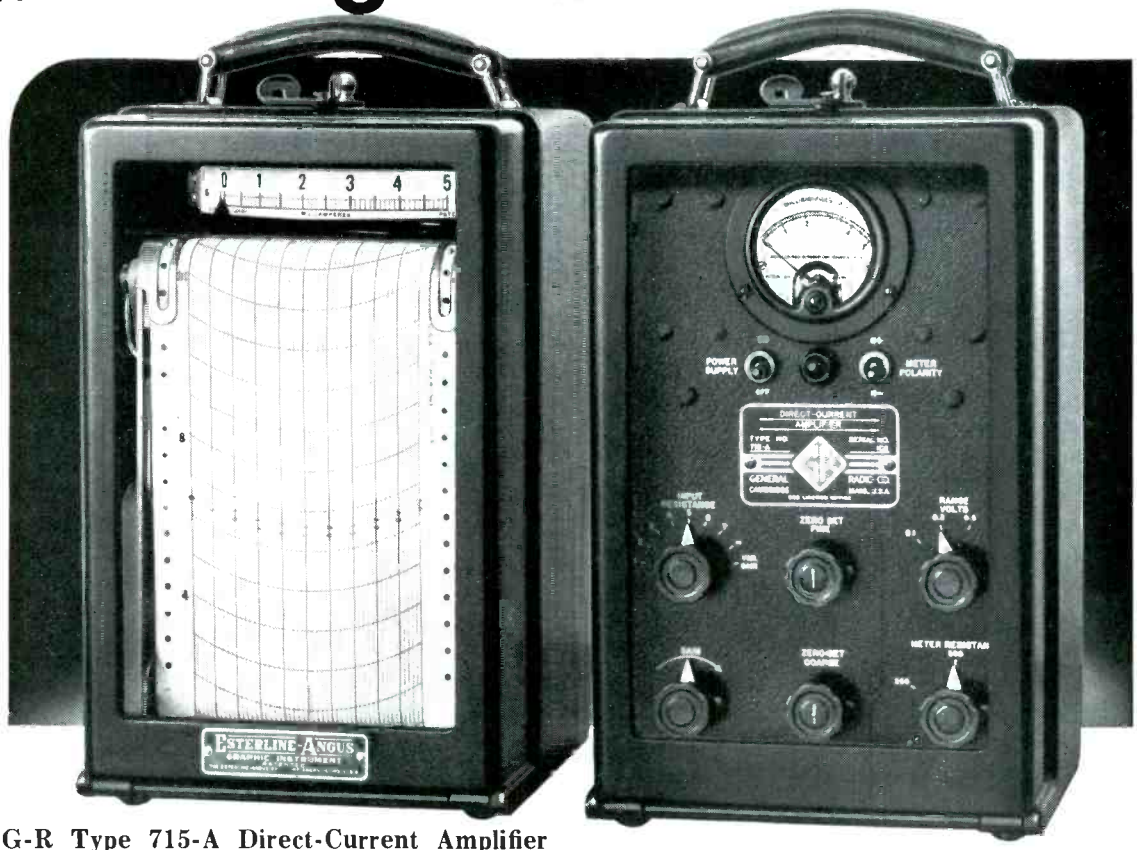
Spark Guard for Electrostatics

BY S. M. MILANOWSKI
Consulting Engineer
Los Angeles, California

AN ELECTRONIC safety device known as a spark guard has enabled manufacturers of electrostatic paint-spray equipment to comply with standards of the National Board of Fire Underwriters in producing high-voltage units that will not create a fire or safety hazard when utilized in a vapor-laden atmosphere.

Electrostatic spraying, previously described in ELECTRONICS, is the mass-production finishing technique which reduces material costs and minimizes both time and labor requirements, having lowered overall expenditures for coatings by as much as $100 per hour in a number of factories. It normally consists of spraying conveyor-borne articles with organic lacquers or enamels through a strong electrostatic field, which at least temporarily po'arizes the sprayed coating particles—

For CONTINUOUS Recording of Small Voltages and Currents



• **The G-R Type 715-A Direct-Current Amplifier** was designed particularly for operation with the Esterline-Angus 5-milliampere recorder to be used as a calibrated recording voltmeter. With appropriate selection of built-in input resistances the combination also is a recording milliammeter or microammeter.

The amplifier can be used in automatic process control circuits where its output operates relays to control the device which feeds the input of the amplifier. It may be operated from frequency meters, sound and vibration measuring equipment, photoelectric cells, resistance strain gauges, resistance thermometers and other similar devices.

The Type 715-A D-C Amplifier has high gain, operates from an a-c line, is very simple to use, requires practically no attention, can be used for very long periods for continuous recording, is exceptionally free from effects of line voltage variation, and has a wide range of built-in input voltage and resistance combinations.

Full-scale output has been made 5 milliamperes to operate the 5 m-a recorder. This full-scale output can be obtained on calibrated ranges from input voltages of 0.1, 0.2, 0.5 and 1.0 volt. The input resistance can be varied between 100 ohms and 10 megohms in powers of 10 by means of a panel switch.

The amplifier is supplied either in a cast metal case to match the Esterline-Angus recorder, or in a walnut cabinet.

SPECIFICATIONS

RANGE: Four switch selected calibrated ranges supplying 5 m-a linear output in recorder circuit for input voltages of 0.1, 0.2, 0.5, and 1.0 volt.

ACCURACY: Approximately 1% as a calibrated voltmeter.

INPUT: From 100 ohms to 10 megohms, in powers of 10, to adjust input resistance and permit use of instrument as calibrated millivoltmeter or microammeter. Short- and open-circuit positions on selector switch. For over one volt input variable gain control provided to adjust voltage to desired value. Input resistance is then about 150,000 ohms.

GRID CURRENT: In input circuit is less than 0.002 microampere.

OUTPUT CIRCUIT: Designed to operate 5 m-a meter on panel, or Esterline-Angus 5 m-a recorder. Provided with compensating resistance to match external device to normal resistance of 1,000 ohms.

TYPE 715-AE D-C AMPLIFIER
(Metal Case) $345.00

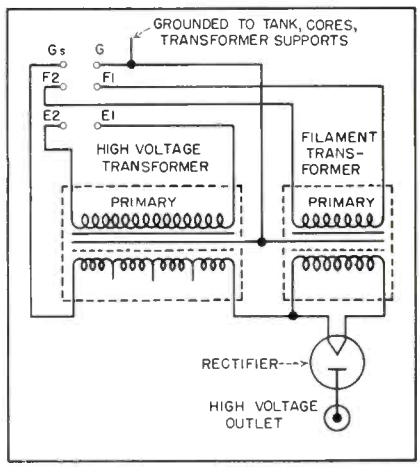
TYPE 715-AM D-C AMPLIFIER
(Walnut Cabinet) $300.00

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

causing them to be attracted to the surfaces of conveyor-grounded articles, which have an opposite static charge.

If the articles that are being sprayed are suspended a suitable distance above the ground, and if highly-efficient ventilators are utilized in conjunction with well-insulated transformers, rectifiers and other components, electrostatic spraying is not a dangerous process because the 100,000-volt potential it utilizes can be controlled for very low amperage (0.010 amp or less). But if the ventilation equipment fails to function properly, or if some other accident occurs (such as the falling of parts from the overhead conveyor within the electrostatic spray booth), an undesirable sparking condition may result—starting a fire or creating some unpredictable hazard for nearby personnel, if allowed to continue for any length of time.



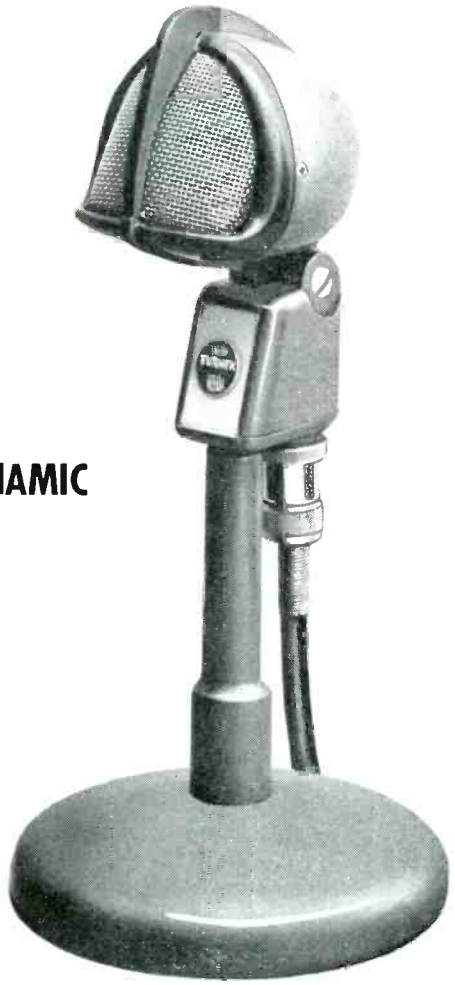
Circuit of high-voltage pack that provides up to 100,000 volts for electrostatic painting, flocking or detearing

The purpose of the spark guard is to deenergize all electrostatic spray equipment, simultaneously causing a warning bell to ring, the instant a sparking condition occurs.

Fundamental component of the spark guard is a 2050 thyratron tube, whose plate circuit receives power from a constant-voltage transformer installed in the main power supply of the electrostatic equipment as a safeguard against possible fluctuations in factory line voltage. When the electrostatic equipment is activated, the thyratron is in series with the holding voltage circuit of a five-pole magnetic contactor so that (no matter

Announcing

A STRIKING NEW MICROPHONE BY TURNER



Available with push-to-talk or slide switch and/or satin chrome finish at slight increase in cost.

THE TURNER MODEL 25X-25D CRYSTAL OR DYNAMIC

New . . . all new from its precision engineered crystal and dynamic circuits to its specially designed case. The Turner 25X-25D combines quality performance, convenience, and style with world famous Turner *dependability*. Features include Alnico V magnets, high quality moisture sealed crystals, smooth, wide range response to voice and music pickups, 90° tilting head for semi- or non-directional operation, 20 ft. removable quick-change cable set, mechanical shock-proof interior mounting, and high quality construction throughout. Finished in two-tone umber gray with chrome plated grill.

The new Turner 25X-D may be mounted on desk stand as illustrated or used with any standard floor stand. It is recommended for call system, public address, recording, amateur communications and general purpose sound work.

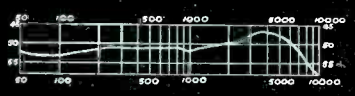
SPECIFICATIONS MODEL 25X CRYSTAL

Effective output level	52 db below 1 volt/dyne/sq.cm.
Frequency response	Essentially flat from 50-9000 c.p.s.
Output impedance	High impedance.
Directional characteristics	Semi-directional. Non-directional when tilted back 90°.
Diaphragm	High quality corrosive resistant aluminum.
Crystal circuit	High quality Rochelle salt crystal. Moisture sealed. Barometric compensator. Shock-mounted.
Case	Die cast alloy.
Finish	Two-tone umber gray with chrome plated grille.
Mounting	5/8" - 27 standard coupler.
Cable	20 ft. removable set.
Dimensions	2 3/4" x 2 15/16" x 3 3/4".
Weight	14 oz., less coupler and cable.

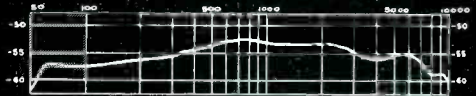
SPECIFICATIONS MODEL 25D DYNAMIC

Effective output level	54 db below 1 volt/dyne/sq.cm.
Frequency response	Essentially flat from 50 to 10,000 c.p.s.
Output impedance	30,200 and 500 ohms—wired for balanced line; high impedance wired single ended. Please specify when ordering.
Directional characteristics	Semi-directional. Non-directional when tilted back 90°.
Diaphragm	Specially designed aluminum diaphragm with low-mass voice coil.
Magnetic circuit	Alnico V magnet.
Case	Die cast alloy.
Finish	Two-tone umber gray with chrome plated grille.
Mounting	5/8" - 27 standard coupler.
Cable	20 ft. removable set.
Dimensions	2 3/4" x 2 15/16" x 3 3/4".
Weight	18 1/2 oz., less coupler and cable.

Typical Frequency Response



Typical Frequency Response (High Impedance)



Note the good low frequency response

THE TURNER COMPANY 905 17th St. N. E., Cedar Rapids, Iowa

TURNER

Licensed under U. S. patents of the American Telephone and Telegraph Company and Western Electric Company, Incorporated. Crystals licensed under patents of the Brush Development Company

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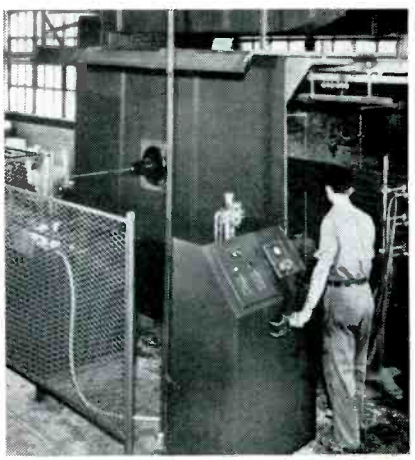
when or where it may occur) a sparking condition will cause the thyratron to fire, energizing a two-pole relay which in turn opens the holding voltage circuit of the five-pole contactor. Consequently, the high-voltage transformer circuit is opened—causing the warning bell to ring as all spray booth operations are halted.

Transformer equipment is not inactivated by the spark guard or by the thyratron, since the basic power package is not within the spray booth and can be turned off at the convenience of operating personnel. However, exhaust fans are deenergized because their installation is such that they will function only in conjunction with conveyor, spray, and electrostatic grid or discharge electrode units (a preliminary safety precaution).

Supply voltage for the thyratron is rectified with a 6X5 tube, and passes through a 2-amp fuse enroute to the main element of the spark guard. Grid bias voltage on the thyratron is manually regulated for desired sensitivity for various field currents by means of a 10,000-ohm potentiometer on a spray-booth control panel.

A locking switch is further provided, so that the spark guard can be bypassed if necessary to maintain production on an emergency basis in the event a component of the spark guard fails and cannot be immediately repaired or replaced. Normally this locking switch is open.

An eight-prong plug provides



Control equipment for operating the spray-painting booth in the background. The large feed-through insulator in the wall of the booth conducts the high voltage to vertical rods arranged as grids

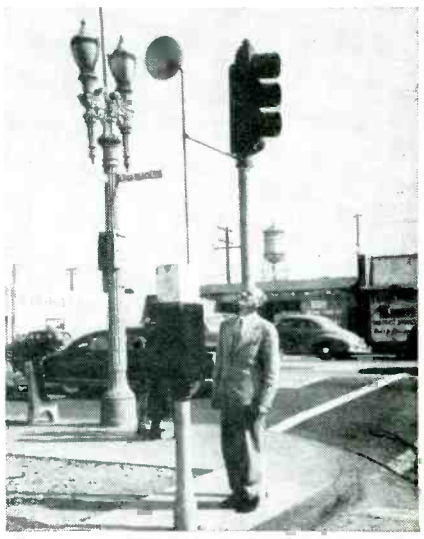
electrical connections between the spark guard and relay sections, and a filament circuit is used to start heating the electron tubes as soon as a main operating switch is closed. If the heating action takes place in a satisfactory manner, current will be conveyed to a white light on the control panel; then, as the tubes reach a suitable operating temperature, current is conveyed to a red pilot light on the control panel—serving as a starting signal for the booth operator.

When or if a sparking condition occurs in subsequent operations, the red pilot light serves as a visual supplement to the signal bell and will remain extinguished until the sparking condition is corrected or until the spark guard is bypassed.

Siren-Controlled Traffic Regulator

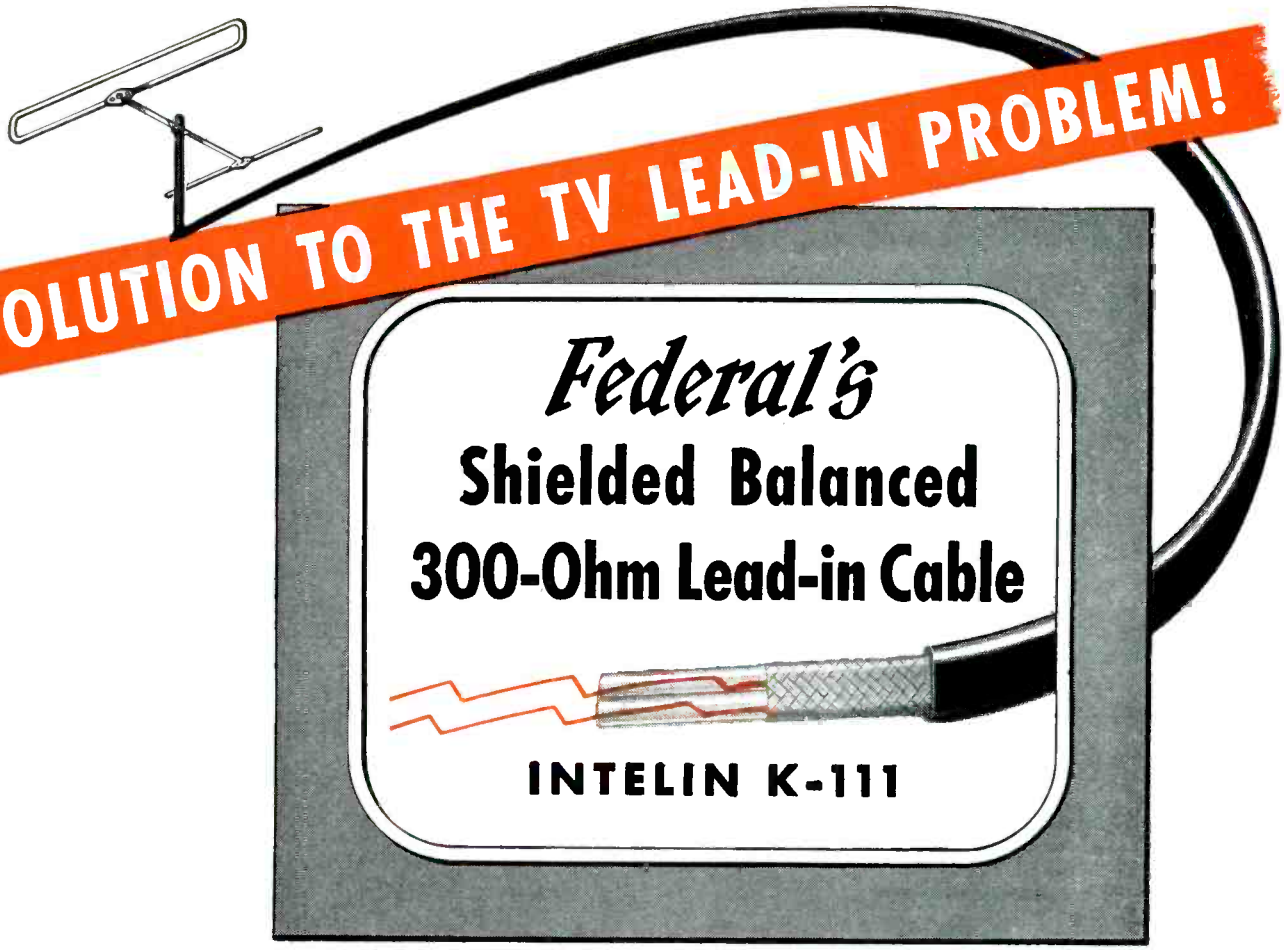
CROSSING HAZARDS created by the passing of a speeding fire engine or police car through a busy intersection has long presented a serious problem to the traffic engineer. A new device, called the Signal Ear by its inventor, Carl Glock, has been developed to forecast the arrival of any siren-blowing vehicle and operate traffic light circuits which will halt traffic in all directions and allow the emergency vehicle to pass without danger of collision.

The siren detector is a parabolic sound reflector which is mounted at traffic light level, as shown in the



Siren-controlled traffic ear installed in Lynwood, California, has been in constant use since its installation several months ago

SOLUTION TO THE TV LEAD-IN PROBLEM!



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

A MAJOR ADVANCE IN TELEVISION TECHNIQUE

Developed by FEDERAL
Offered Only by FEDERAL
Patent Pending
AVAILABLE IMMEDIATELY

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

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

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

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

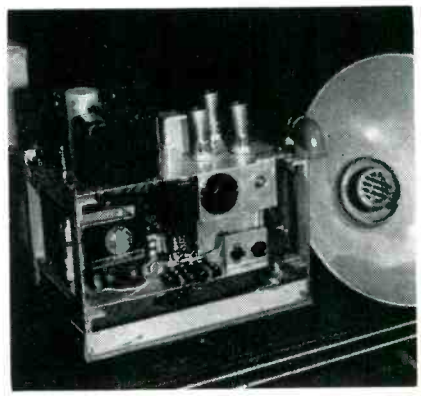
Intelin K-111 is also recommended for a pick-up-free connection between antenna post and input stage of FM and TV receivers—and for test equipment and other HF applications. For information, write to Department D-113.

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.

Federal Telephone and Radio Corporation

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

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.



All control-circuit components are enclosed in the foot-square box beside the reflector housing the microphone

accompanying photograph of an experimental installation in Lynwood, California. As the siren approaches the device, a microphone mounted inside the reflector picks up the sound, lights a tiny pilot lamp inside the signal box (at the base of the reflector support), and trips a relay which turns the traffic lights in all directions first to amber and then to red.

The pickup circuits are tuned only to high-frequency sounds and, according to the inventor, no other sustained noise but a siren is capable of tripping the relay switch. The entire mechanism is weatherproof and tamperproof.

In the event that a second sirened vehicle is approaching the intersection from another direction, the nearest will trip the relay with its siren, giving it the right of way through the crossing.

The inventor claims that installation of the Signal Ear is being considered by more than a score of cities, and that at least four have given commitments that installation will be included in their 1949-50 budgets.

Infinite Rejection Beam

By W. F. Hoisington
UHF Resonator Co
Rye, New York

In the manufacture of high-gain multielement beam antennas, it has not been unusual to be asked for an antenna that would cut out completely a station in back of the beam on the same frequency. One standard 16-element f-m beam showed over 6,000 to 1 power ratio on transmission, but a check of the

The H-2-P

A NEW PURIFYING JET OIL DIFFUSION PUMP,

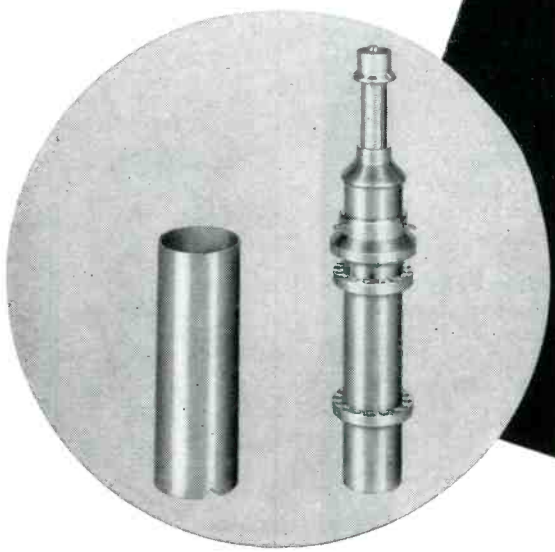
for electronic tubes and general laboratory use.

The blank-off pressure of this all-metal pump, untrapped, is 2×10^{-7} mm of Hg, measured on an ionization gauge.

The speed and forepressure characteristics of the pump are remarkable. Speeds at three significant points follow—
50 litres per second at 10^{-5} mm Hg. 60 litres per second at 10^{-4}
35 litres per second at 2×10^{-3}

High Vacuum mm Hg. is maintained when the pressure is increased to 0.34 *mm Hg.*

This pump is designed for *unlimited continuous service* The jet tube is so constructed that it may be completely disassembled in a few moments. This makes every part of the pump freely accessible for cleaning. The heater is buttoned to the bottom of the pump and can be replaced easily. The permanent maintenance of this pump in condition to achieve the pressures and speeds listed above is assured by its construction. Recommended particularly for the requirements of Cathode Ray Tube production. Special models for exhaust equipment will be made to customer's specifications. For further details, please write—Vacuum Engineering Division, National Research Corporation, Cambridge 42, Mass.



HIGH VACUUM FOR INDUSTRY

NATIONAL RESEARCH CORPORATION

Vacuum ENGINEERING DIVISION

ratio on reception gave a much lower figure.

Further investigation showed that very strong reflections were present in almost every location tested, and that by moving the beam one-half wavelength in space, front-back ratios both higher and lower than the above figure were obtained. These reflections are the source of television ghosts, and are considerably aggravated by the low f-b ratio of the average television receiving antenna.

Further study of the theory of screening, reflection and shielding in radio and optics showed that diffraction, interference effects and leakage were at their most troublesome point where the physical structure approached one-half wavelength. In the microwave region, where beam apertures of tens and even hundreds of wavelengths can be obtained, the problem is easier. A new approach forms the basis of the patent principle to be described.

The infinite rejection beam (hereafter designated I.R.B.) has three main parts: the receiving element or elements, the reflector or reflectors, and the rejector or rejecting elements. In the economical example shown in Fig. 1, suitable for television reception, the first two parts

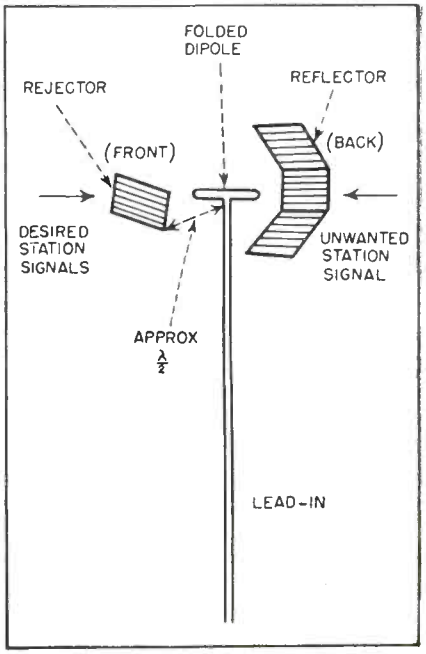


FIG. 1—Basic illustration of the rejector principle applied to a television receiving antenna. Reflector and rejector dimensions are in accordance with conventional antenna practice

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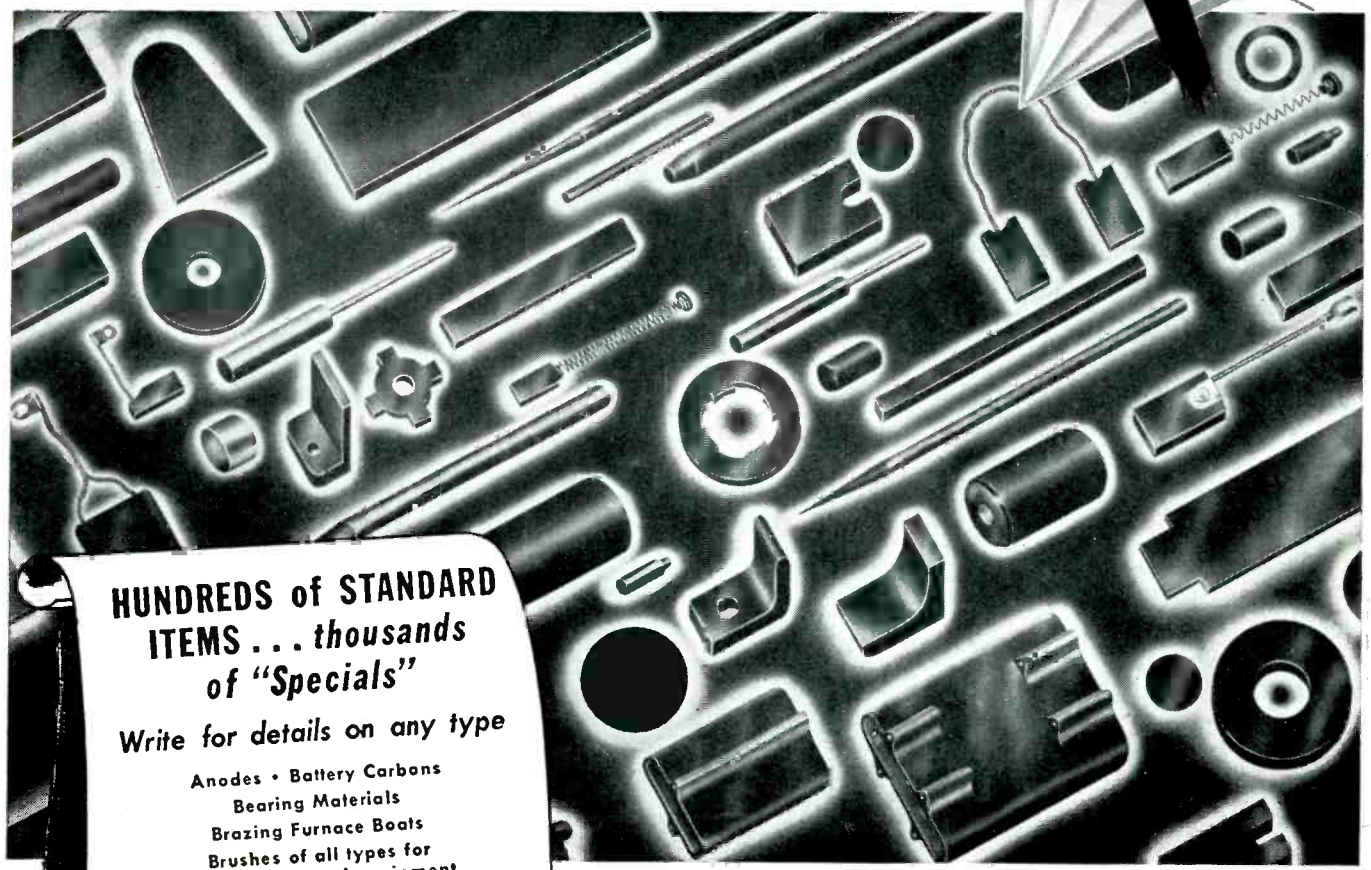

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The unique electrical, mechanical, physical and chemical properties of Stackpole carbon, graphite and carbon-graphite products solve countless problems of friction, temperature, arcing, corrosion, shaft sealing, voltage regulating and others. So broad is the line of standard Stackpole products, so extensive the facilities for "specials" that it is practical to list only a few of them here. Let Stackpole engineers recommend and quote on your next requirements.

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may consist of a simple folded dipole of proper impedance, a fixed screen or wire reflector in the normal position approximately one-fourth wavelength in back of the dipole, and the rejecting element which is placed in front of the dipole.

Theory of Operation

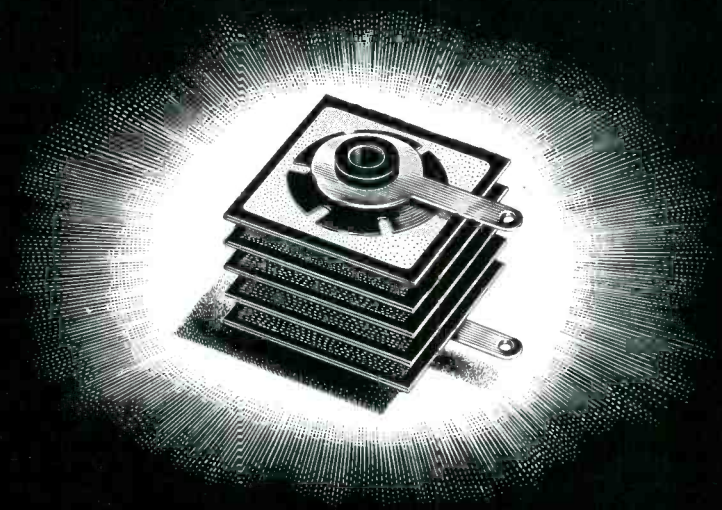
A desired signal is received from the front on the dipole. The reflector also receives a signal and sends it back to the dipole in proper phase, reinforcing the dipole signal. This is standard so far, the main requirement for the I.R.B. being that some f-b ratio must be obtained—the higher the better. The unwanted signal, geographically located in back, or at any angle in the back 270 degrees approximately, is also received on the dipole and more or less attenuated by the reflector, depending on design. The rejector now throws a cancellation signal from the unwanted station onto the dipole-reflector beam.

The use of a screen in front of the dipole might seem detrimental to reception but this is not so in any large degree. The almost exact half-wave position in front of the dipole is the worst possible position for reflection action and only drops the desired signal a few db.

The positioning of the rejector is done by any of the usual methods for positioning a television antenna against ghosts (one main use of the I.R.B. can be against a strong ghost). The new, or second, unwanted signal now adds up 180 degrees out of phase with the first unwanted signal. This is done by adjusting the rejector to a position approximately one-half wave away from the dipole. The rejector can be adjusted to produce a signal cancelling an unwanted signal from an adjacent-channel station as well.

The geographical situation of the respective stations or source of interfering signal is taken care of by positioning the rejector arm in azimuth so that it may be placed in proper reflection relation as regards the unwanted station and the dipole. In general, for good reception in the more or less diamond-shaped interference area in between cochannel or adjacent-channel television stations the rejector will be on the far

Cut your Costs 4 ways...



with General Electric's "Inch-Cube" Selenium Rectifiers

Cut Initial Costs—Selenium rectifiers cost less than the sockets and tubes they eliminate.

Cut Installation Costs—Only one part to handle—only two connections to make—and this miniature power plant is installed—ready to operate.

Cut Chassis Costs—Use a smaller chassis. Selenium rectifiers can be mounted where a rectifier tube and socket won't fit.

Cut Inspection Costs—With no multiple-pin socket, no filament circuit, the inspector has only two simple soldered joints to check.

Application Data

Model	Height (Inches)	Width (Inches)	Length (Inches)	Normal RMS Volts	Max. RMS Volts	Max. Inverse Peak Volts	Temp.	Max. Peak Current (Ma)	Max. RMS Current (Ma)	Max. D-C Current (Ma)
6RS5GH1	1	1	15/16	117	130	380	50	1000	250	100
							60	750	200	80
6RS5GH2	1	1	11/16	117	130	380	50	800	200	80
							60	650	163	65

High-voltage selenium rectifiers can be used in place of rectifier tubes in many radio and electronic circuits.

Model 6RS5GH1 is recommended for general use while the smaller model, 6RS5GH2, should be used when space is extremely limited.

Each rectifier is composed of 5 one-inch-square selenuim rectifier cells specially assembled to give constant and uniform spring contact pressure on the cells regardless of temperature variations. Each unit is coated with a moisture-resistant varnish to provide protection against humidity and condensation. These units have ample current capacity to safely withstand the inverse peak voltage obtained when rectifying 110–125 volts, rms, while feeding a capacitor—as required in many radio circuits. Ambient temperatures of 50C to 60C are readily withstood. Tests have proved that these rectifiers will outlast the conventional type of rectifier tubes. The forward voltage drop through the rectifier is extremely low—approximately five volts at rated capacity.

For complete details contact your local G-E representative, or write for a new free bulletin on Selenium Rectifiers.

APPARATUS DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY 5, N. Y.

GENERAL ELECTRIC

466-11

side of the dipole from the unwanted station.

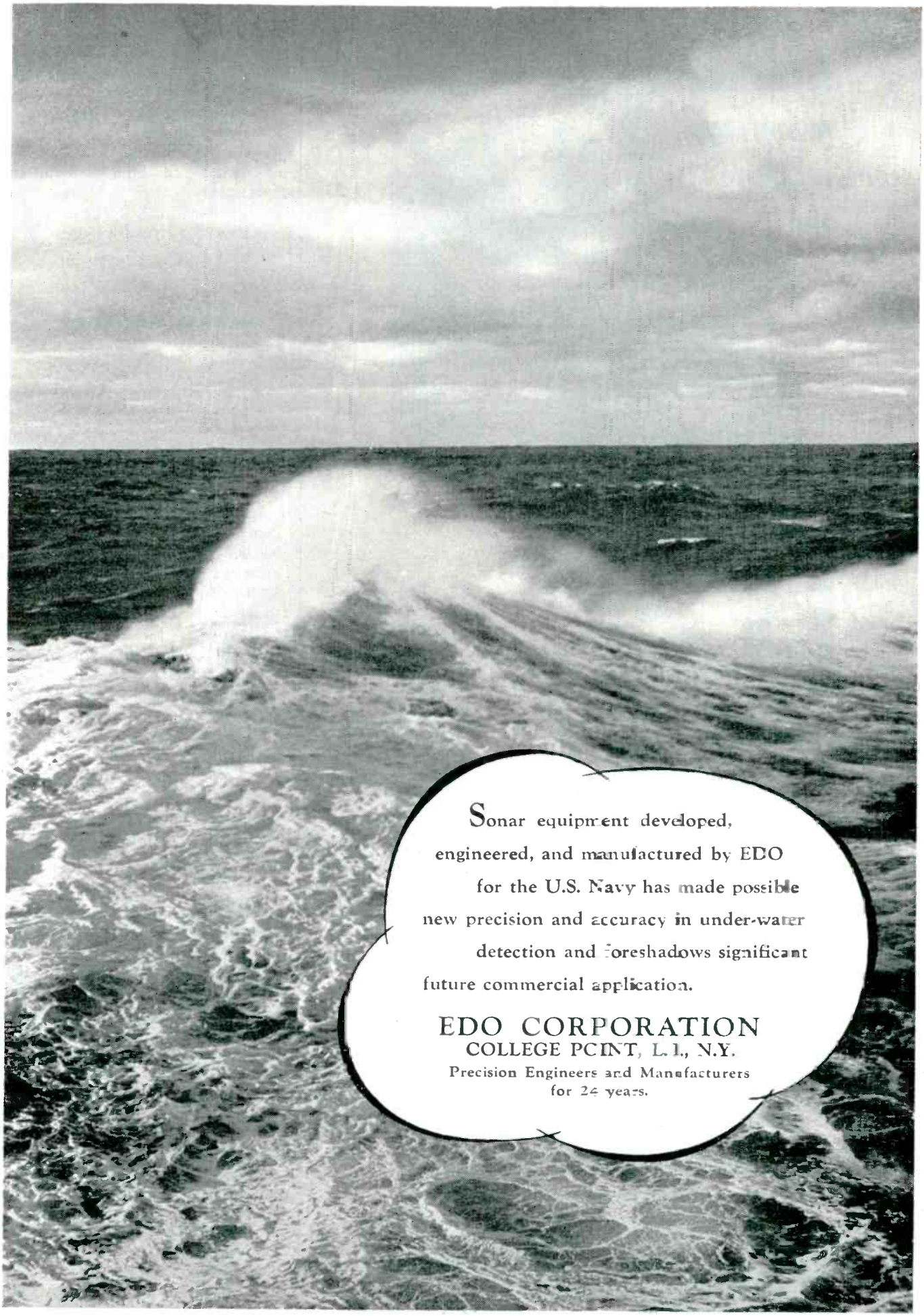
Amplitude of the second unwanted signal is adjusted to equal that of the first unwanted signal by turning the rejector on its axis so that more or less signal is reflected. This results in cancelling out to zero the unwanted signal. The rejector will even knock out a strong residual or leakage signal in an unshielded receiver or lead-in. This is why the arrangement has been named the Infinite Rejection Beam.

Results

Just how close two cochannel stations may be placed without interference between them on receivers using the I.R.B. is not known exactly, but the following results have been noted at Rye, N. Y., about 25 miles from New York City. The two high-band stations at present operating in N.Y.C., WPIX and WJZ-TV, are easily dropped to zero on the back of the beam and held there. A sensitive receiver (search and identification type that goes down to a few microvolts) fails to reveal a trace of the stations mentioned when tuned through the frequencies. A few degrees of orientation and the signals begin to show, and facing the I.R.B. on N. Y. bring them in to full strength and gives fine pictures.

WNBT, channel 4, from an antenna some 1,000 feet high can be dropped to zero but not held there consistently at this location due to cars, planes and trucks and swaying telephone and electrical wires. At 50 miles, the powerful low-band signals would probably handle as indicated above for WPIX and WJZ-TV. For receiving the previously unwanted station, similar means to those now existing may be used, such as rotators or another antenna.

On transmission with a 32-element beam, the I.R.B. will produce an absolute null at any desired angle as long as this is more than approximately 45 degrees from the front center line. This is not unlike the configuration of towers for pattern use on a-m broadcasting. Possibilities exist for same-frequency relay use, but when used on a strong nearby transmitter the receiver null becomes very sensitive to moving objects and acts like a


Sonar equipment developed, engineered, and manufactured by EDO for the U.S. Navy has made possible new precision and accuracy in under-water detection and foreshadows significant future commercial application.
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Precision Engineers and Manufacturers for 24 years.

radar for cars and planes. However, on certain mountain locations the I.R.B. may greatly assist relay and similar operations.

In conclusion, it would seem that same-channel stations on the present low band may be placed as near as 100 miles and high-band stations much nearer, when the simple form of economical I. R. B. is available in quantity for receivers located in between.

Nondestructive Testing Laboratory

THE most complete laboratory of x-ray and other nondestructive testing apparatus in the world was introduced officially to the scientific world in March when the Naval Ordnance Laboratory held its first nondestructive testing symposium.

Included in the lengthy array of x-ray apparatus at NOL is the 10,000,000-vo't betatron, first mobile betatron manufactured; a mobile 2,000,000-volt x-ray machine similar to those now in use in military and civilian plants for inspecting welds, castings and forgings; a 400,000-volt machine for similar work; a crane-mounted and a truck-mounted 250,000-volt machine; a 160,000-volt fluoroscopic unit; a photofluorographic machine, using low-cost 4 × 5 films instead of the costly and cumbersome 14 × 17 films; and apparatus for x-ray diffraction, with provision for directly recording x-ray intensities and for analysis of material with fluorescence effects of x-ray.

The laboratory building contains eight x-ray rooms. One of these—housing the 10-mev betatron and a 2-mev x-ray machine—has walls 3 feet thick and is entered by a maze rather than a door, since the cost and time factors involved in opening and closing huge 3-foot-thick doors would be prohibitive.

Purpose of the laboratory will be to set standards in nondestructive testing methods that will make them more effective in raising the quality of ordnance and other military equipment used by the Navy, and decrease the cost of nondestructive testing for the benefit of Navy suppliers.

Manufacturers have been asked by the laboratory to bring their

IN A RADIO SET

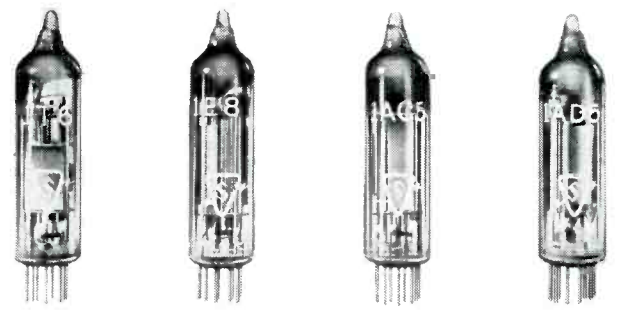
how small can you get?

Sylvania's four tiny new tubes hold the answer

The miniature radio set shown here is an example of what can be done through the use of Sylvania's new subminiature tubes.

These specially designed and engineered T-3 subminiatures are battery-type receiving tubes perfect for very small radios or amplifiers. Short tube leads provided in conventional pin arrangement permit these tubes to be plugged into appropriate subminiature sockets. They can be operated over a wide range of battery voltages. Low current requirements result in battery economy.

Send for complete ratings and characteristics. Sylvania Electric Products Inc., Advertising Dept., R-1105, 500 Fifth Ave., New York 18, N. Y.

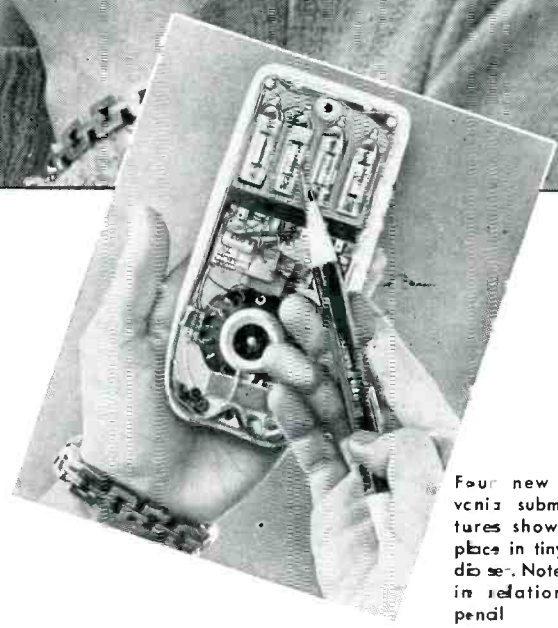


Type 1T6 (diode pentode)

Type 1E8 (converter)

Type 1AC5 (output pentode)

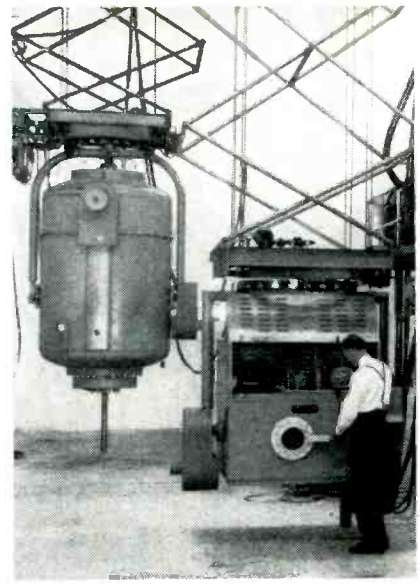
Type 1AD5 (RF pentode)



Four new Sylvania subminiatures shown in place in tiny radio set. Note size in relation to pencil

SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS; PHOTOLAMPS



Two-million volt resonant x-ray generator and 10-million volt mobile betatron installed at Naval Ordnance Laboratory at White Oak, Maryland

special problems to NOL. Through improvement in manufacturing processes, guided by x-ray, NOL hopes to save industry thousands of dollars in production costs.

Fine-focus medium-voltage equipment is available in the form of a conventional rotating anode type of apparatus and in the form of a German constant-potential, transmitted-beam, magnetic-focusing 150-kv apparatus. In conjunction with these two equipments a photoroentgen camera is available. For ballistic, fragmentation, and explosive studies, a Micronex flash discharge unit is set up in the fourth room. This machine is capable of being transported to the explosive area.

Frequently, it is necessary to inspect hazardous ordnance in the explosive areas. For lighter components, an industrial unit altered to permit road travel is available. For the inspection of heavier items, for instance, fuzes in large projectiles, radium units are used.

The Laboratory is interested in the development of many plastic items in connection with ordnance whose fabrication is assisted by very soft x-ray examination.

The x-ray equipment acquired, and yet to be acquired, by the laboratory will have a value of close to $300,000, and will weigh approximately 30 tons, according to engineers of the General Electric Co. and its affiliate General Electric

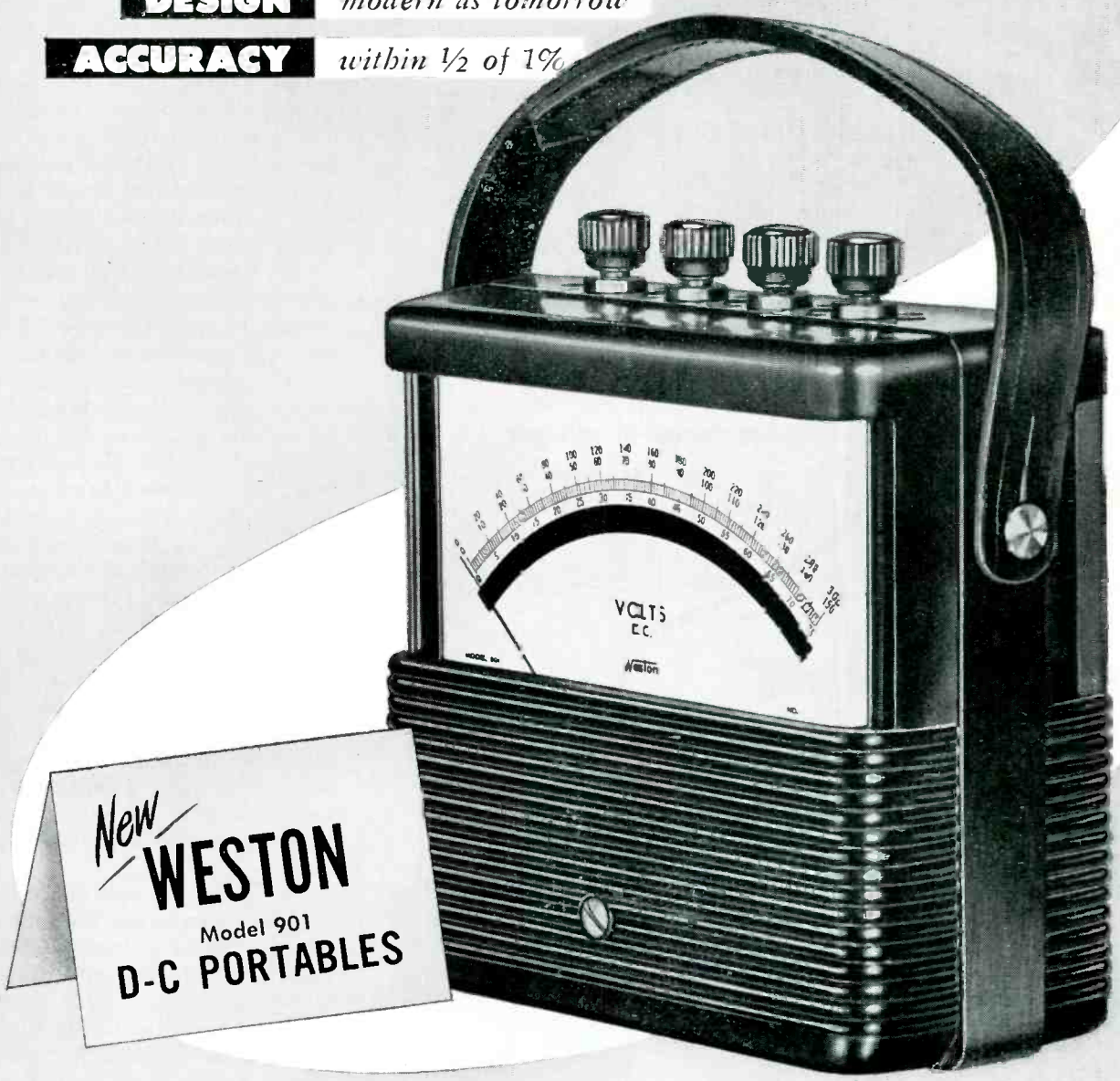
MECHANISM *completely new*

SCALE *unmatched readability*

SHIELDING *far beyond prior concepts*

DESIGN *modern as tomorrow*

ACCURACY *within ½ of 1%*



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Available in D-C, Model 901; and A-C, Model 904, single and multiple ranges of wide coverage. Ask your local Weston representative for the facts, or write . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey.

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X-Ray Corp., which supplied the majority of the x-ray apparatus.

Betatron Data

Design of the 10-million volt betatron itself centered around the size of the vacuum tube and the frequency with which x-ray pulses were to be produced. For example a large vacuum tube surrounded by a large magnet operating at 60 cycles could undoubtedly be built to produce the same x-ray intensity as the present machine which operates at 1,920 cycles per second. It was soon found that the upper limit of frequency was set by the losses produced in the magnetic circuit. By the use of forced oil cooling and a combination of a-c and d-c magnetization, the 1,920-cycle (32 times 60) operation was arrived at.

Two thousand pounds of a very special alloy steel containing 42 percent nickel were used for the magnetic circuit. The laminations are only four thousandths of an inch thick. The machine is housed in a steel tank and transformer oil is circulated through the magnet for cooling and passed through a water-cooled heat exchanger. The vacuum tube contains a well-focused electron gun for introduction of the electrons into the vacuum, a conducting coating on the inside of the glass wall to collect stray electrons and a platinum target accurately located within the envelope on a tungsten stem mounted on the glass wall.

The 10-million volt betatron delivers between 50 and 100 roentgens per minute at 1 meter from the target. At a target film distance of 6 feet a radiograph with a density of 2 on type A film can be taken in 11 minutes through 9 inches of steel. Unlike other betatrons the operation is relatively quiet, the 1,920-cycle pitch being of low intensity and easy to listen to.

The 10-million volt betatron has proved itself a very useful tool for industrial radiography of objects of such dimensions that they cannot be handled with one or two-million volt equipment and also for many objects of steel, aluminum, magnesium or any other materials which are very irregular in shape and wall thickness where a radiograph of great latitude and clarity of detail is desired.

WILCOX... first choice of MID-CONTINENT AIRLINES

MCA equips entire fleet with WILCOX 70 channel VHF transmitters and receivers

Mr. Daryl Devault, superintendent of communications for MCA, says:

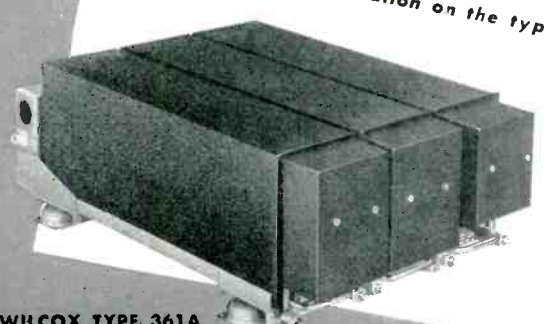
"Wilcox VHF has brought closer the airlines' ultimate goal of all-weather flying — and in doing so it has proved an essential aid to Mid-Continent Airlines in maintaining a perfect safety record dating back to 1934 — and operating efficiency, which in 1948 reached a mark of 98.73 per cent.

"Mid-Continent pilots hail the equipment for the static-free, 'telephone clear' reception it assures them in plane-to-ground communications in all kinds of weather."

For many years Mid-Continent has used Wilcox ground station transmitters and receivers exclusively. Their proven performance, dependability, and easy maintenance earned the confidence of operation personnel throughout the system. That's why Wilcox was first choice again for MCA's airborne communications equipment.

Write Today...

for complete information on the type 361A VHF Airborne Communications System



WILCOX TYPE 361A
COMMUNICATIONS SYSTEM
118 — 136 Mc. Band

WILCOX
ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI

(continued from p 128)

iable in trace speed and supply the time base for the visual indicator.

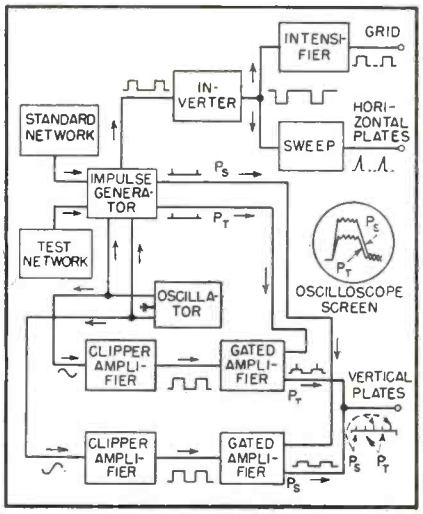
(3) Provides wide-band signal delay so that the synchronized start-stop sweep circuit may be actuated a fraction of a microsecond before the pulse patterns appear.

(4) Provides a switching circuit which is positively synchronized with the impulse generator and sweep circuit. Thus switching synchronization and adjustment is unnecessary.

Operation of Circuit

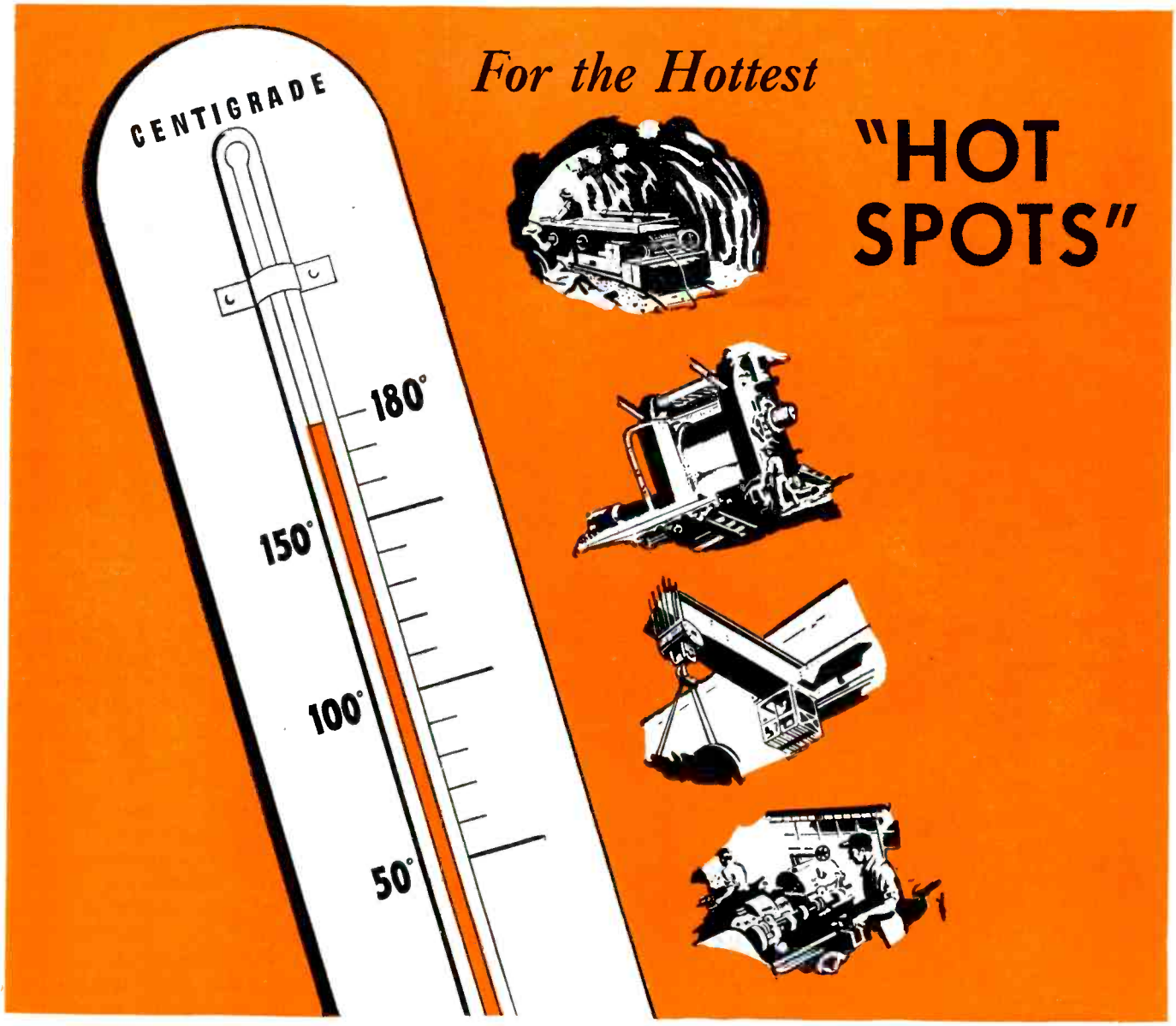
The accompanying block diagram illustrates the basic circuit performance. The impulse generator is so arranged that the standard network and the network under test can be discharged simultaneously through the contacts of a reed-type mercury-wetted relay operated from a 240-cps sine-wave source giving 480 closures per second. When the contacts are open, the networks are charged through a resistance to a potential of approximately −50 volts. When the contacts close, the two networks discharge and a rising voltage is simultaneously applied to the inverter. From this impulse generator the transient characteristics of the networks are derived.

The four amplifier stages comprise a switching circuit that serves to commutate signals characteristic of the networks under test, so that first one signal and then the other is impressed on the screen of the cro, at a sufficiently high rate of switching that both characteristics seem



Block diagram of tester

A MAGNET WIRE



HOW CAN MAGNET WIRE, *even Silotex**, withstand continuous operation at extreme high temperatures?

The answer is in war-developed *silicones*, now brought to the magnet wire field by Anaconda in amazing glass insulated Silotex—bonded with *silicone varnish*. Such insulation qualifies for the new A.I.E.E. high-temperature rating of "Class H"... 180°... a 140° rise in temperature over an ambient 40° C!

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to appear simultaneously.

The sweep circuit merely provides the time scale for the plot that appears on the cro screen.

Switching Action

The clipper amplifiers receive 240-cycle input voltages from the oscillator, one 180 degrees out of phase with the other, and convert these into square waves 180 degrees out of phase. These square waves are locked with the frequency of relay contact closures since both are driven from the same oscillator. However, the contacts make two closures per square wave cycle and are approximately 90 degrees out of phase with the leading edge of each square wave.

The spiked pulse signals generated in the impulse generator by the networks under test are applied through gain controls to the control grids of the gated amplifier tubes, while the square-wave voltages of the clipper amplifiers are applied to the screen-grids of these tubes. With 125-volt square-wave amplitudes with respect to ground and a 100-volt positive d-c bias on the screen grids, the screen voltages alternate between +225 and −25 volts with reference to ground. The gated amplifier tubes are normally cathode-biased so that with no signal on the control grids and +225 volts on the screens only a small amount of plate current flows and very little screen current. When the signal pulses appear simultaneously on the respective control grids, the screen of one tube will be +225 volts and the other −25 volts hence one tube will conduct and the other will be blocked. Due to the phase relationship of the screen voltage (180 degrees out of phase), the signal voltages are interlaced in the common plate circuit as first one signal is amplified and then the other. Thus, each signal appears at the rate of 240 pulses per second on the screen.

The start-stop sweep circuit is initiated at the same time that the signal pulses are generated. Since it requires approximately 0.2 microsecond to produce the linear sweep voltage, a wide-band delay network is inserted in the common plate circuit of the gated amplifier tubes to provide 0.5 microsecond delay so

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that complete pulse patterns are shown.

For most conditions of operation, the intensity control on the cro is set so that there is no visible spot on the screen, and intensity voltage is provided by a 6AC7 in the intensifier stage only during the sweep interval.

Interferometer for Microwaves

DEVELOPMENT of a modified Michelson type interferometer for use in the microwave region was described by Bela A. Lengyel of Naval Research Laboratory at the 1949 IRE National Convention in New York City. The basic feature of the instrument is that it compares phase and amplitude of an approximately plane wave with that of a reference signal.

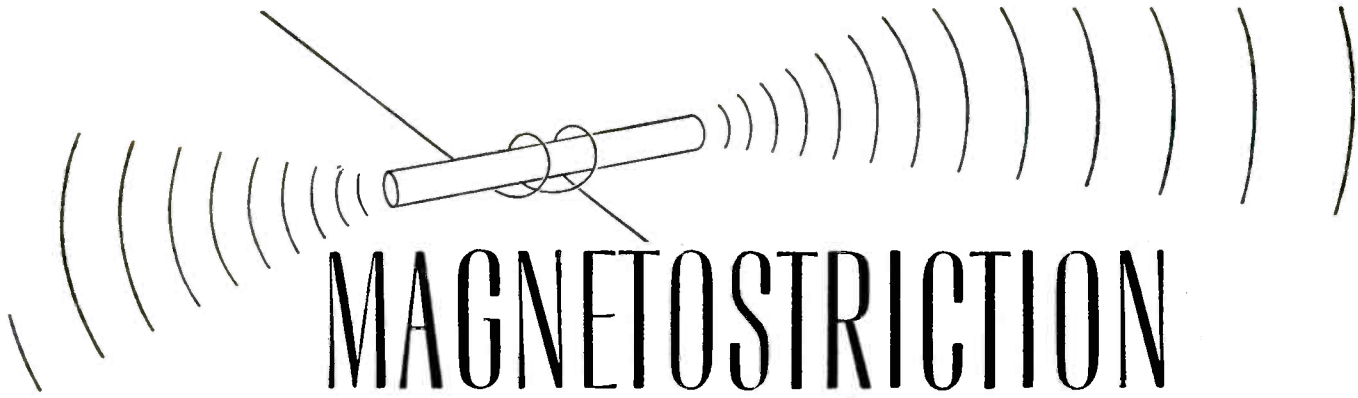
Principal applications include precision wavelength measurements, the measurement of dielectric constant and attenuation in dielectric materials available in the form of uniform sheets and the study of phase delay and reflections in the parallel-plate or metal-loaded media.

As shown in Fig. 1, the half-silvered mirror of the optical instrument is replaced by a plastic sheet O on which conducting dots have been sprayed. A part of the incident radiation is transmitted through O into horn H_2. It is then united with a signal from the transmitter led through a waveguide and a variable attenuator. The signals are fed into opposite branches of a magic tee, one of the remaining arms being connected to the detector, the other to a matched load.

The silvered brass plate M serving as the movable mirror is mounted on a lathe bed and is constrained to move in the direction of its normal. Its displacement is measured with a micrometer or a dial indicator gage mounted on the lathe bed.

Wavelength Measurements

The simplest and most useful application of the interferometer is to the measurement of wavelengths in the 3-cm band and shorter. As reflector M is moved, maxima and



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Like Hertzian waves, Roentgen rays, and radioactivity . . . magnetostriction was once just a physicist's plaything.

Early experimenters noted with interest the unusual behavior of magnetized ferromagnetic materials . . . the "spontaneous" dimensional changes; and inversely, the permeability changes when dimensions were forcibly altered.

But as magnetostriction developed from laboratory demonstration to practical application, it was discovered that few materials offered sufficiently high magnetostrictive response. When the essentials of economy, workability, and availability were considered, the number of suitable materials was still more limited.

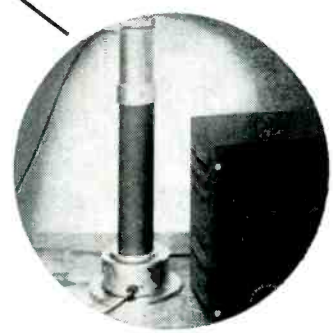
• • •

Both research and practice have now established Nickel as a satisfactory solution to this problem. Nickel's magnetostrictive contraction of approximately thirty parts per million is exceeded only by a few costly special alloys.

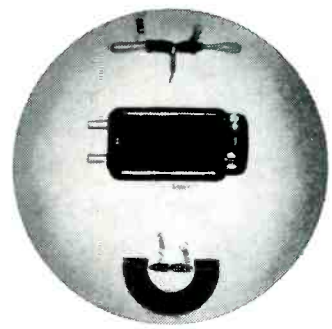
Nickel offers, in addition, excellent corrosion resistance, good resistance to the destructive effects of extreme temperatures, plus strength and hardness equal or superior to that of low-carbon steel. For special applications, even greater hardness can be obtained in "Z"* Nickel (Type B) through heat treatment, with only a small loss in mechano-magnetic characteristics.

If you are interested in magnetostrictive oscillators . . . either for manufacture or application . . . Inco's Technical Service Department will gladly put at your disposal data accumulated from both research and practice.

For your reference files, write for: "*Magnetostriction*", and "*66 Practical Ideas for Metal Problems in Electrical Products.*"



Bacteria Killer. A 9 Kc magnetostrictive oscillator used for sterilization in the chemical and pharmaceutical industries. The magnetostrictive material is laminated Nickel. Made by Raytheon Manufacturing Co., Waltham, Mass.



Phonograph Pick-Up: The magnetostrictive unit in this device is a 20-mil Nickel wire which is stretched between the poles of a horseshoe magnet. Variations in torsion caused by deflections of the needle produce flux variations in two pick-up coils that are wound around the stretched Nickel wire.

A FEW OF MANY APPLICATIONS FOR MAGNETOSTRICTIVE EQUIPMENT

- "Sonar" and related devices for detecting submarines and ships.
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- Electrical filters, such as band pass filters for radio receiving sets.
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- Strain gages.
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- Phonograph pick-ups.
- Frequency control of oscillators operating below 100 Kc.
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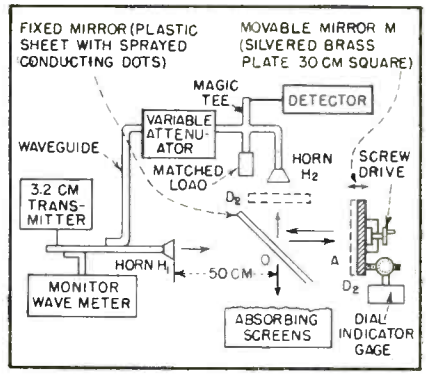


FIG. 1—Block diagram of modified Michelson interferometer for microwave measurements

minima alternate in the detector, the distance of adjacent minima corresponding to a reflector displacecent of $\lambda/2$. An accuracy in the determination of λ of 0.0001 cm can be achieved easily in the 3-cm band.

Dielectric Constant Measurements

The interferometer is well suited to the rapid determination of the dielectric constant (specific inductive capacity) of materials available in large, reasonably uniform sheets that are only moderately reflecting and absorbing.

The amplitudes in the two branches of the interferometer are first equalized by adjustment of the attenuator for the highest standing wave ratio, then the position of M for a minimum signal in the receiver is obtained. Next the dielectric sheet is introduced at D_1 and the displacement of M (toward O) required to restore a minimum is noted. This displacement is a measure of the phase delay caused by the introduction of the dielectric sheet in the path of the rays, and can be used for computation of the dielectric constant k. As in optics, it is advantageous to use $n = k^{0.5}$. Let the shift of the minimum position be $\Delta/2$. This means a shortening of the path by Δ. When the multiple reflections within the sample are neglected, the change in path length caused by the introduction at normal incidence of a sheet of thickness d and index of refraction n is $(n-1)\ d$, hence $n = 1 + \Delta/d$.

When $n > 1.5$, the multiple reflections between the two faces of the sheet are no longer inconsequential and the value of n will be in error unless the sheet happens to have a thickness which is an integral mul-

REDUCING EXTRANEOUS NOISE IN RECORDING

By A. C. Travis, Jr.*

Discussing disc recording with experts in broadcasting and sound studios off and on for ten years brings one inevitably to the point of trying to generalize the recording engineer's problem. Inadequate as making statistics out of memory may be, so overwhelming is the impression of unanimity that a simple summary promptly springs to mind. Regardless of what high-fidelity ambitions may haunt the recording engineer, his soul-searing fear is simply that of making a sub-standard recording of irreplaceable material.

The commonest single cause of sub-broadcasting-standard disc recordings is extraneous noise. So complex are the reasons and cures for this destroyer of otherwise good broadcasting material that they transcend the possible scope of a short article. To oversimplify however, it is noteworthy that recorded extraneous noises behave somewhat like breakfast foods. They may hiss, swish, crackle, or pop. Since even these few categories of noise cover a lot of Puffed Rice, space requirements hold us down to a limited discussion of "hiss".

The blame for excessive hiss level in disc recordings is generally shared by the blank record and the sapphire stylus. At this point buck passing reaches championship proportions. Most often, however, neither suspect is ever definitely exonerated. The trouble simply disappears by itself. The history of recording disc manufacture, of course, allows little doubt of the fact that with some brands "grey cutting" discs crop up unpredictably from time to time. It is also an admitted fact that sapphire styli may vary so greatly as to make up to 12 db difference in surface noise level. Such variation, while unintentional, usually occurs where low prices dictate loose microscopic tolerances in sapphires.

Some of the more tricky causes of "hiss" include cutting cold discs fresh from the delivery truck, allowing smog (fog-born soot & dirt) to settle in the grooves, and misalignment of the cutting stylus. Nitrate-coated discs (so-called "acetates") seldom cut quietly unless the aluminum bases are at a temperature between 7° and 90°. Fine or coarse airborne dirt, moisture, or damp dust can spoil the polishing action of the best stylus. Stylus misalignments to be avoided include more than a degree or two off vertical and twist of the shank in installing the stylus in the cutting head.

Today, except for occasional tricky recording problems, the most nervous engineer can fortunately forget his worries. With the new, constantly-improved Reeves Soundcraft discs and Soundcraft styli combining to keep extraneous noise 55 to 65 db below peak signal, it's mighty hard to muff a recording. Soundcraft products have indeed established disc recording anew on a standardized *predictable* basis.

*Vice Pres., Reeves Soundcraft Corp.

tiple of the quarter wavelength in the sheet.

Highly Reflecting Materials

When the material to be measured is highly reflecting it is practical to employ the interferometer as the free space analog of the von Hippel shorted-line instrument. The dielectric sheet is then placed at D_2. Again the shift of the position for minimum is observed. In this manner it is possible to calculate the distance of the first minimum of the electric field from the face of the dielectric sheet. Von Hippel's method requires this distance x_0 and m, the amplitude standing wave ratio, for the calculation of the complex propagation constant in the sheet. On the interferometer m is determined by moving the sample sheet and the metal mirror and keeping the detector fixed.

While a power standing wave ratio of 10^6 is easily obtained in an empty guide or coaxial line, such is not the case for the interferometer. This fact limits the application of von Hippel's general method to the case of highly absorbent sheets.

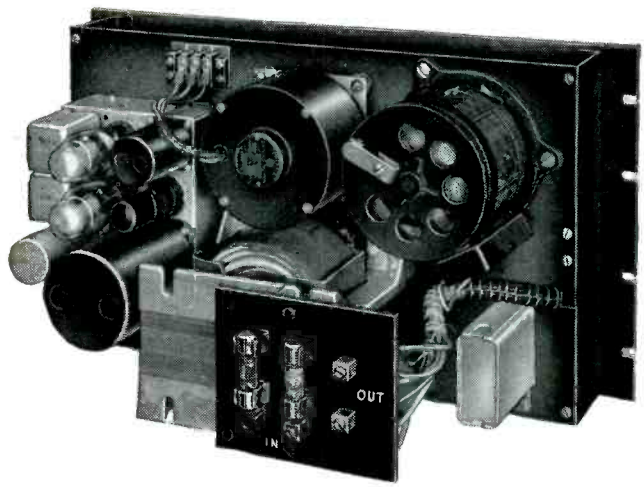
Finally, the interferometer is a useful instrument for measurements of parallel plate media of nominal dielectric constant less than one, and of loaded or synthetic dielectric materials intended for microwave lenses. These media cannot be placed in a guide; all measurements must be performed in free space.

Limitations of Instrument

The limitations of the microwave interferometer are inherent in the transmitting and receiving antennas, which are not reflectionless and which do not produce a narrow beam such as is commonly available in optics. Diffraction and scattering become the factors that limit the performance of the instrument. Another limiting factor is the presence of unwanted reflections.

Omnidirectional Aircraft Antenna

THE DEVELOPMENT of a practical aircraft antenna to receive omnirange signals is of particular interest to the commercial airlines and the Air Force. Many CAA omni-



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This new, improved STABILINE Automatic Voltage Regulator Type EM4102 is smaller, lighter and provides performance characteristics not found in previous designs. Its response speed is faster, too—only 3 seconds are required to correct for the wide line voltage excursion of 95 to 135 volts.

Into the compact assembly of the STABILINE Type EM4102 is packed all the features you find in every STABILINE Electromechanical Voltage Regulator: zero waveform distortion; high efficiency; adjustable output voltage over a wide range; complete insensitivity to magnitude and power factor of load. It has no effect on system power factor—requires no critical adjustments. New design in this unit affords greater accessibility for servicing and maintenance. It's available as a cabinet or standard 19" rack panel model. The cabinet model is easily converted to rack mounting if desired.

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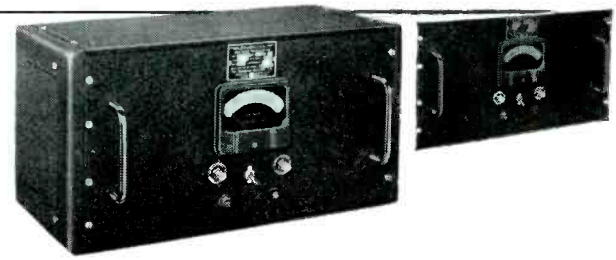

The new 2KVA STABILINE Type EM4102; available as a cabinet or as a ready-to-install rack model. Cabinet type is easily converted for rack mounting.

RATING

Input Voltage Range: 95 to 135 volts.
Output Voltage Range: Adjustable between 110 & 120 volts.
Output Current: 20.0 amperes.
Output KVA: 0 to 2 KVA.
Input Frequency Range: 50/60 cycles.
Waveform Distortion: Zero (0.0%)
Recovery Time: 3 seconds for line voltage excursions of 95 to 135 volts, or 0.075 seconds/volt.
Power Factor Range: Complete insensitivity to the power factor of the load.

The unit is housed in a black, wrinkle-finished cabinet measuring 20-9/16" x 10-3/4" x 9-3/4". Located in the front panel are an easy-to-read 4" voltmeter, a handy "On-Off" switch, screwdriver adjustments for output voltage and for sensitivity control, and a quick-reference pilot light.

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directional range stations have been in operation for some time throughout the country but little use has been made of them mainly for lack of airborne equipment. The antenna problem has proven difficult on account of the omnidirectional pattern required, coupled with the requirement for horizontal polarization, broad-band coverage, and low drag.

Conventional antenna designs have not proven satisfactory for the purpose, and it has been evident that a fundamentally new type of structure has been required. The objectives have now been attained through the development and application of a unique Notch feed principle for a folded dipole bent into a U shape. This new Collins 37-J omnidirectional aircraft antenna was described by J. P. Shanklin of Collins Radio Co. at the 1949 IRE National Convention as a nearly optional device that now makes it possible to proceed with the practical operation of omnirange systems.

The Notch-type feed system makes possible the required coverage to the extended frequency range in the 108–122 mc band. The feed allows the dipole to be an unbroken piece of metal, performs impedance matching functions, and serves as an unbalanced to balanced transformer. The antenna is horizontally polarized, has 6-lb total variation of free space azimuth pattern of such nature as to correct for the effect of the aircraft fuselage, has a swr less than 4 to 1 when mounted on a DC-3 fuselage, uses the same mounting flange as AN-AS-27/A, and has an aerodynamic drag of 2.63 lb at 250 mph.

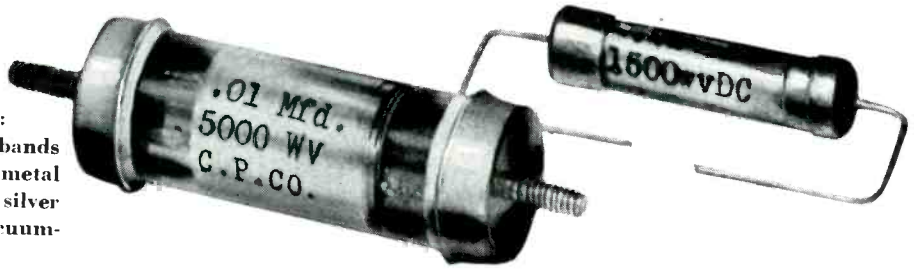
Novel Regulator Circuit

By Y. P. Yu
Associate Professor
Electrical Engineering Dept.
North Dakota State College
Fargo, N. D.

ELECTRONIC REGULATORS are widely used in laboratory and industrial equipment. Basically they consist of a conversion element that changes the regulated variable to a form suitable for feeding the regulator, and a comparison circuit in which the regulated quantity is

glassmike

a container style for **PLASTICON** *(plastic film dielectric)* **CAPACITORS**



Glassmike Construction: Glass tube with silver bands fused on each end; metal caps are soldered to silver bands producing a vacuum-tight assembly.

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Type ASG — For DC filtering, low power coupling and bypass applications. Smallest high voltage-low capacitance units made. Extremely low noise level. Temperature range: —60°C to +125°C.

Type AOG — Same uses as type ASG. Tempereature range: —40°C to +105°C. (manufactured only for large quantity orders)

Type AAG — Low voltage (below 1000 VDC). High resistance, low dielectric absorption, "integrator" capacitor.

Type LSG — High Q capacitor, superior to mica in all AF and RF applications. Temperature range: —40°C to +75°C.

Type LAG — Extremely low dielectric absorption, ultra high insulation resistance, very low dissipation factor. For use in electronic computers, differential analysers, frequency determining circuits, bridge standards.

Type TSG — Extremely wide temperature range (—70°C to +200°C). Very low dissipation factor. For use in RF "power" applications and Pulse Forming Networks.

Type TAG — Low temperature coefficient (20 to 50 ppm/°C). Low dielectric absorption. Ultra high resistance and low dissipation factor. For use in frequency determining circuits. (From —80°C to +200°C).

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compared to a standard to develop a control signal that actuates the regulator. A novel comparison circuit that has high sensitivity and stability is shown in Fig. 1.

Operation of Comparison Circuit

The action of the comparison circuit depends on making the plate currents of both T_1 and T_2 practically independent of the output voltage E_c and supply voltage E_{BB}. This independence is accomplished by using pentodes and by placing large cathode resistors in series with them. For the sake of discussion, assume that both tubes are identical. Then, as long as E_1 equals E_2, the plate currents of the tubes will be equal and E_c will remain constant.

Action as a comparator is obtained by making E_1 the standard voltage and E_2 the output of the conversion element. An increase of E_2 will increase the plate current of T_2 and discharge C. This action in turn reduces E_c, which actuates the regulator in such a direction as to reduce E_2. As soon as E_2 returns to its desired level, C stops discharging. Thus E_c remains at a lower value than previously so as to maintain the correction. If the cause of the disturbance disappears, the process is reversed.

The advantages of this circuit are that: (1) the constant-current element T_1 as the plate load of T_2 affords an effective way to increase the sensitivity without using a multistage directly-coupled amplifier, and (2) a memory device C instead of an error signal to hold the control element on the desired position allows full correction of the regulator output voltage. Compared to usual degenerative regulators in which an error voltage,

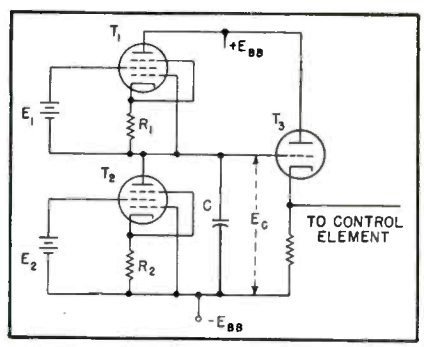

FIG. 1—Basis of comparison circuit is the current balance discriminator using series pentodes. A capacitor across the output gives the circuit a memory

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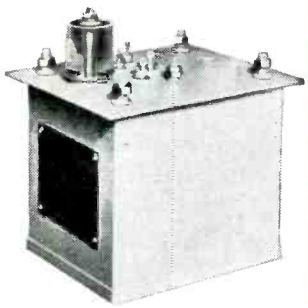
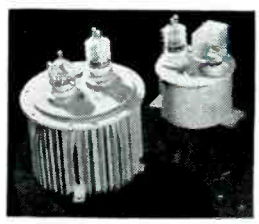
Rectifiers

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



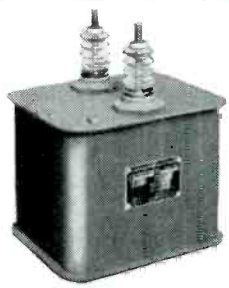
Pulse Transformers

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



Resonant Reactors

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



Filament Transformers

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

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

Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, no catalog is available. Please include with your inquiry, functional requirements and any physical limitations. *Apparatus Dept., General Electric Co., Pittsfield 42-304, Mass.*

GENERAL ELECTRIC

401-60

which may be small but cannot be zero, is required to actuate the regulator, this comparison circuit with a memory has high sensitivity.

To place the comparison circuit into operation, vary E_2 until the regulator output reaches the desired level, then adjust the self-biasing resistors or E_1 to give equal plate current for T_1 and T_2. Proper functioning of the circuit depends on C having negligible leakage. The largest leakage current, if usual precautions are taken, will be between cathode and (grounded) heater of T_1. Separate heater windings for the heaters of T_1 and T_2 will minimize this trouble. Leakage through the grid of T_3 can be reduced by connecting this grid to the cathode of T_1 instead of directly across C; R_1 will introduce a degenerative feedback to compensate the leakage.

Application to Regulator Problems

Figure 2 shows the comparison circuit applied to a direct-voltage regulator in which T_7 acts as the control element and T_4 and T_5 are the comparison tubes. Gas diodes T_6 and T_7 instead of a voltage dropping resistor as a conversion element permits the screen of T_5 to receive practically the entire error voltage. The output of the comparison circuit, which is the voltage across C, is fed through cathode follower T_3 to the control grid of T_1. Gas diode T_2 establishes the correct bias for T_1 and also provides a reference voltage for T_4. Tests on this circuit show that the variation of the output is less than 0.25-percent for a 20-percent

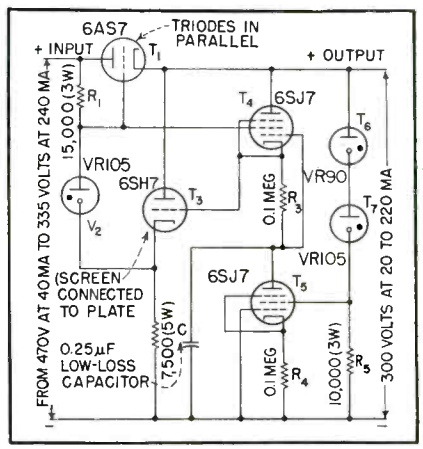


FIG. 2—Voltage regulator shows how comparator can be used to provide high stability and sensitivity. Typical values are shown for a representative circuit

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change in input (line) voltage or a 40-percent change in load current. Better regulation could be obtained by using a battery instead of T_2 as a standard.

The comparator circuit has many other applications. For example it can be used to stabilize the output amplitude of an oscillator. The output of the oscillator can be rectified to develop the control voltage (E_c in Fig. 1). The circuit can then be made to regulate the C-bias on the oscillator tube. Similarly, the comparator can be used to stabilize other parameters. If a phototube is used to develop the control voltage, the comparison circuit can actuate an illumination regulator.

Disposal of Radioactive Wastes

Dumping hot atomic wastes without killing everything in the area was the chief problem taken up at the Atomic Energy Commission's recent two-day seminar in Washington, D. C. for sanitary engineers and government engineers. Viewpoints and conclusions of the various speakers are summarized here.

Where there is radioactivity, there is no chemical or physical means of getting rid of it. You either wait for it to die away, dilute it, or isolate it somewhere, preferably under ground. With this in mind, the best procedure is to hit the problem at its source—to design for fewer hot wastes.

Large amounts of water and air used in cooling nuclear reactors account for by far the largest volume of waste, but except for occasional traces of carbon 14 (half-life 5,100 years) most radioisotopes found in these coolants are short-lived. Gaseous and liquid wastes in less volume, but often intensely active, come from other sources, such as chemical separation, material processing, metallurgy, machining, incineration and laboratory research.

Dust and Gas Disposal

Dust from material processing is removed by mechanical separators, electrostatic precipitators and filters. In the metallurgy and machining of beryllium and uranium, dust

and metallic oxides are removed by ventilation and filtering. Permitted concentration of alpha-emitting materials is held to 5×10^{-7} micrograms or 3×10^{-8} microcuries per liter of air.

Fumes, mists and gases are ventilated, scrubbed and filtered. Concentrations collected are either buried or delayed, diluted and discharged, depending on radiation intensity and half-life period.

Most significant radioisotope found in the discharge air from air-cooled piles is argon 41. Short half-life of this isotope (110 minutes) means that mechanical filters and precipitrons to take out other possible contaminants are all the treatment necessary before discharging the air through 200 to 300 foot stacks. However, air-cooled installations must be elaborately instrumented with meteorological devices which will halt piles' operation when poor aerial diffusion conditions are apparent.

The air-cooled reactor now under construction at Brookhaven, Long Island, presents special problems. Being in a highly populated area, more elaborate meteorological control will be needed. The discharge stack will be 300 feet so that aerial contamination of the area will be held below 10^{-9} microcuries per liter. Tolerance levels of wastes that might get into nearby water supply systems has been set almost at the resolution of the instruments. Slugs removed from reactors will be buried without any attempt to recover re-usable substances.

Here are some of the checking devices AEC employs to make sure none of its plants suddenly start exuding billows of deadly radioactive dust:

(1) Geiger counters suspended throughout various stages, to check activity of radio-argon, radio-iodine, radio-xenon, etc.

(2) Geiger counters with filters attached to give cumulative readings.

(3) Precipitrons from which foils are periodically removed and checked for radiation concentration.

(4) Large ion condensers which are charged every eight hours, the discharge being read with a fiber electrometer.

(5) Air way filters drawing at

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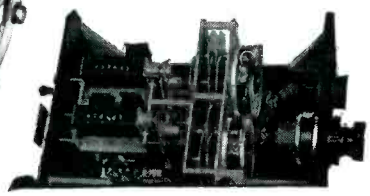
Accurate
Computing

Fairchild
Precision
Linear Potentiometer



In this integrating computer accurate resetability in both the single-solution computer potentiometer and the integrating potentiometer eliminates hunting and carry-over errors.

Fairchild's low-torque Linear Potentiometer—which is a small precision instrument—can be reset to any selected resistance or angle of rotation with an accuracy that is unsurpassed in any other single-turn potentiometer.

This precision performance is maintained over a million cycles of operation with long-life precious metal alloy contacts. For complete data address: Dept. 'G', 88-06 Van Wyck Boulevard, Jamaica 1, New York.

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FOR

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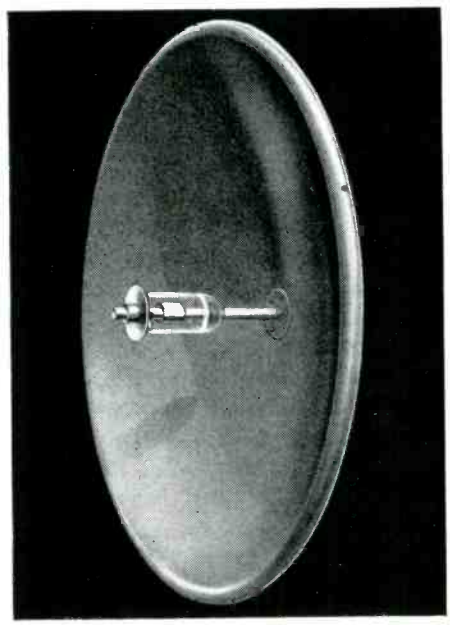
The Workshop can supply parabolic antennas in a wide range of types, sizes and focal lengths, plus a complete production and engineering service on this type of antenna.

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.



40-inch, 2000 mc. Antenna with
Plexiglas radome for weather protection

SPECIFICATIONS—Model 2000

FREQUENCY RANGE	—1990 to 2110 mc.
INPUT IMPEDANCE	—52 ohms nominal
V.S.W.R.	—1.05 or better at specified frequency
POLARIZATION	—Vertical or horizontal
REFLECTOR SIZE	—40″ 48″ 72″
GAIN	—25 db. 27 db. 30 db.
SIDE LOBES	—20 db. down or better
INPUT CONNECTION	—Weatherproof type "N" fitting. Special fittings are available for RG-8/U, RG-17/U, or 7/8-inch copper line.
MOUNTING	—Three types available
WIND LOADING	—All elements will withstand an actual wind velocity of 80 m.p.h. when coated with one-half inch of ice.

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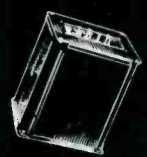

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the rate of 60 cubic feet a minute at Brookhaven (240 cfm at Oak Ridge), whose filter paper is removed after each run and given a 24-hour photographic film check.

(6) Collection frames placed over area around reactor piles. Dust settled here is given periodic film checks.

Disposal of Waste Liquids

In the case of water-cooled reactors, the water is first filtered to remove most of the impurities. Those that remain become active while passing around the pile. This hot water is decayed in underground storage tanks and passed into a large holding pond, then into lakes and rivers.

Other liquid wastes get similar but more thorough treatment. Those bearing uranium are segregated and stored indefinitely. Others are held up, flocculated, and settled in a series of tanks before final discharge into rivers.

As an alternative method for processing liquid wastes, much attention is being given to the activated sludge method of treating ordinary domestic and industrial sewerage. Colonies of bacteria, their cellular membranes swollen by the water, offer a vast surface for holding radioactive materials. Particularly encouraging is the fact that these bacteria seem to thrive in water of rather high activity. Experiments indicate that 95 percent of up to 1.4 micrograms of uranium or plutonium per liter can be absorbed by the sludge. Two stages give 99-percent removal.

Disposal of Solid Wastes

For the most part solid wastes are simply buried. Where concentration of activity is not too great, they can be burned. However, fumes must be processed and the ashes buried. A building that has become too active must be torn down piece by piece and buried.

Hottest solids come from chemical processes where highly active fission products must be segregated from unused uranium and plutonium. This equipment must be operated by remote control behind heavy cement barriers. Fumes are scrubbed and filtered (with special asbestos, glass fibers or sand) and

discharged through 200–300 foot stacks. Main activity results from radio-iodine. Permissible limit of isotope iodine in vegetation is 2.0 microcuries per kilogram. Atmospheric limit is set at 3.5×10^{-6} microcuries per liter of air. The whole process is meteorologically controlled by diffusion conditions. Solid wastes are buried 10 or 12 feet underground in an area that is fenced off, guarded and monitored.

In research laboratories, high-level working areas should be kept separate from so-called clean areas. Plumbing should be given particular attention because goosenecks and other parts of the drainage system tend to accumulate small amounts of radioactive wastes until they reach unsafe concentrations.

Current research and future plans include closed-cycle incinerators, closed-cycle cooling systems, and an evaporation method of treating liquids which promises a decontamination factor of 100,000. Still another procedure involves the use of ion exchange resins, perhaps even combined with evaporation. The resin would be burned and the small amount of ash buried.

Chemical precipitation methods are under study too, especially where specific wastes are concerned. Advantage here would be that many non-active salts could be recovered for future use. AEC's goal is no radioactive discharge to nature. It expects tolerances will be set at or near natural backgrounds of areas involved.

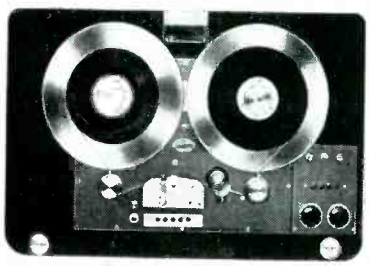
SURVEY OF NEW TECHNIQUES

X-RAY exposures of 10 microseconds are made on 9.4-inch wide film moving at 150 frames a second using the 14-inch long, 150,000-volt tube and pulsing equipment developed under D. C. Dickson at the Bloomfield, N. J. plant of Westinghouse Research Labs and sponsored by the Navy's Bureau of Ordnance. The high-speed x-ray motion pictures, which give slow-motion pictures when projected, are used to study the burning action of rocket fuels and can be applied to studies of rapid industrial and biological processes.

better than plus or minus 2 percent have been standardized with 2,000, 2,500, and 5,000-ohm resistance pickoffs. Natural frequencies to 40 cycles per second are available damped or undamped.

Tape Recorder

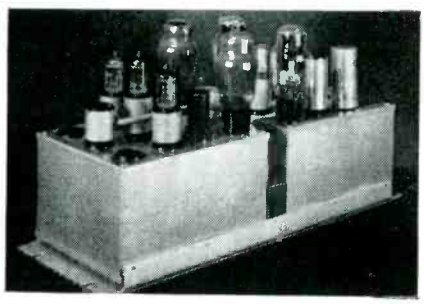
PRESTO RECORDING CO., Box 500, Hackensack, N. J. A new magnetic tape recorder for broadcast and other commercial use has provision for tape reels up to 14-in. diameter, giving 73 minutes of playing time



at a tape speed of 15 in. per second, or 146 minutes at 7.5 in. per second. A safety button prevents accidental erasure of material. Very fast forward and rewind speeds can be obtained. The drive system employs three motors with a synchronous type operating the capstan.

Fifty-Watt Audio

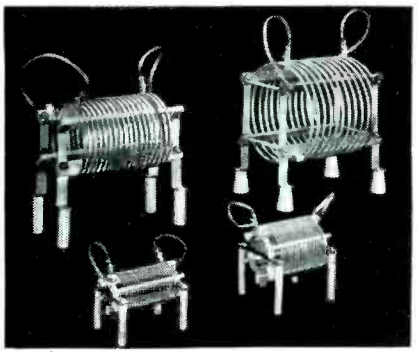
MCINTOSH ENGINEERING LAB., 910 King St., Silver Spring, Md. A new 50-watt audio amplifier of novel design uses a pair of type 6L6 tubes in the output stage has an efficiency of 60 percent at full output. The rms intermodulation product is 1 percent or less providing that the peak power output does not exceed 100 watts. Gain can be varied between 45 and 100 db. Noise is 80 db below 50-watt output. Output impedance is 500 ohms balanced and 4, 8, 16, or 32 ohms, balanced or unbalanced. Several of the ampli-



fier and power supply units are plug-in types. Arranged for high-impedance input, there is also provision for plugging in special pre-amplifiers. A square wave with a 10-microsecond rise time is reproduced through the amplifier without measurable distortion of wave shape.

Fixed Inductors

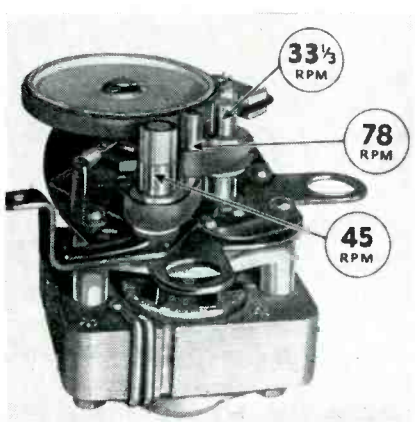
ANDREW CORP., 363 East 75th St., Chicago 19, Ill. Announcement has been made of a new line of heavy duty r-f inductors for broadcast transmitters, phasing and tuning



equipment, r-f heating equipment and heavy current filter circuits. These fixed inductors available in 10, 20 and 30-ampere current ratings can be made variable by means of tapping clips for either shorting or nonshorting types of change. Bulletin 85 gives complete details.

Three-Speed Motor

GENERAL INDUSTRIES Co., Elyria, Ohio. Three turntable speeds are secured in a new motor by positioning various spindles on contact with the idler wheel. Speed shifting is accomplished by movement of a detented shift lever. The mechanism is powered by a two-pole



shaded-pole motor. The three-speed principle is also available for manual motor assemblies.

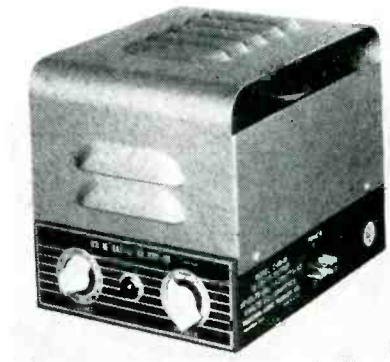
Dry Cell

NATIONAL CARBON CO., INC., 30 E. 42nd St., New York 17, N. Y. Improvements in the Eveready Ignitor

No. 6 dry cell give it approximately 20-percent longer service on the heavy intermittent test of the American Standards Association, and about 25-percent increase on the light intermittent test.

Mobile Amplifier

NEWCOMB AUDIO PRODUCTS CO., Hollywood, Calif. Model E-10-M is a 10-watt mobile amplifier designed for use on 6-volt d-c or 117-volt, 60-



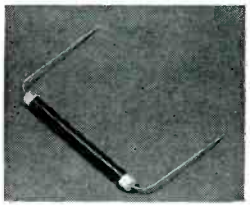
cycle power. Frequency response is from 50 to 10,000 cycles within 2 db. The unit has five tubes: a 6SC7, a 6SF5, two 6V6GT's and a 6X5GT.

Thickness Gage

BRANSON INSTRUMENTS, INC., 436 Fairfield Ave., Stamford, Conn. The Coatingage is an instrument for measuring the thickness of non-magnetic coatings on iron or steel. Measurements are made rapidly

BRADLEY RECTIFIERS

SMALL HIGH VOLTAGE SELENIUM RECTIFIER



Rated at 5 ma D. C., Bradley's new selenium rectifier Model SE8M measures only ⅜" in diameter and is thus one of the smallest rectifiers available at its rating. It is completely sealed and is companion to Model SE8L, rated at 1.5 ma D. C. and only ¼" in diameter.

PHOTO CELLS

SIMPLIFY PHOTO CELL CONTROL

Luxtron* photo cells convert light into electrical energy. No external voltage is required to operate meters and meter relays directly from Bradley photo cells, improving control over your processes, reducing your costs. Housed model shown. Many different sizes and shapes, mounted and unmounted.

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a SPARK PLUG ADAPTER
FOR PRESSUREGRAPH PICKUP
THAT MOUNTS IN A STANDARD SPARK PLUG PORT

Combining a spark plug and a pressuregraph pickup, the NEW SPARK PLUG ADAPTER makes it possible to run dynamic pressure tests without interrupting the firing of a single cylinder—and without the drilling of special holes.

Utilizing the spark plug as an integral part of the unit, the Adapter can be screwed into a cylinder head as simply and quickly as an ordinary spark plug. The Adapter comes in either 14 or 18 mm size, with both spark plug core and diaphragm easily interchangeable. Will fit any Model 3709-B Pressuregraph pickup now in operation.

Use of this new Adapter provides increased efficiency and convenience in running pressuregraph tests, and also permits checking of standard automotive, marine or aircraft engine performance without the special handling usually required by other test methods.

IT'S FOR YOU

Write today for free booklet of electronic methods for displacement, showing photographs of pressure curves obtained under dynamic conditions in engine research.

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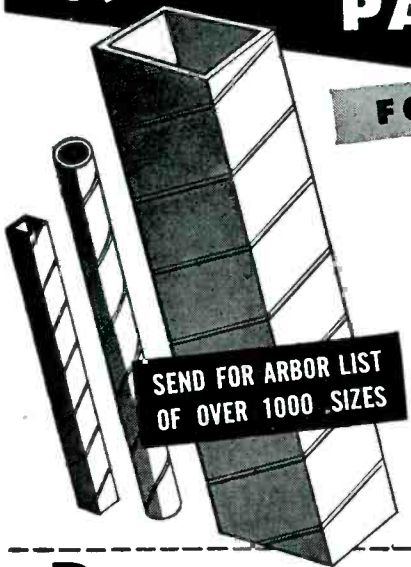
Large or Small
SQUARE, ROUND OR RECTANGULAR PAPER TUBES
FOR COIL WINDING



Inside Perimeters from .592" to 19"

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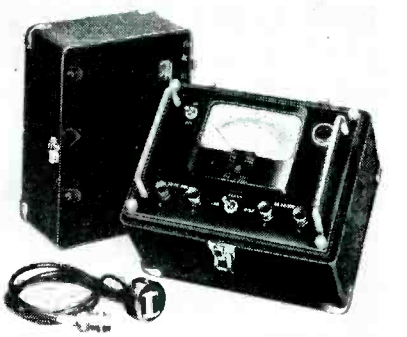
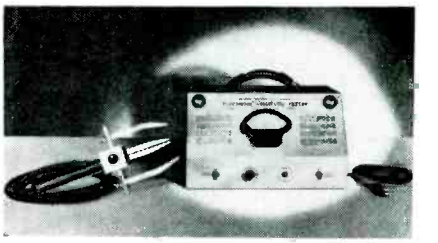


without damage to the coating and the thickness is directly indicated over the range 0.0001 to 0.5 inch. Operation depends upon changes in the reluctance of a magnetic circuit. When the probe coil is in direct contact with the base metal the reluctance is low and the self-inductance of the coil is high. The bridge is then balanced for zero thickness. An increase in the gap between the coil and the base metal unbalances the bridge and causes current to flow through the indicating micro-ammeter.

Armature Tester

NATIONAL ELECTRIC COIL CO., 794 Chambers Road, Columbus 16, Ohio, offers the electronic bar-to-bar tester, a compact device designed for indicating and locating shorts



in armature windings. It contains a vacuum tube oscillator section which generates 3,000-cycle a-c voltage of about 15 volts no load, and an electronic voltmeter section with an output impedance of 500,000 ohms to the vacuum-tube amplifier. The unit operates on 110 volts, 60 cycles.

Miniature Pentode

RAYTHEON MFG. CO., Newton, Mass. Type 6AN5 miniature pentode which can be used in many applications employing type 6AG7 is now available in quantity. In addition, the 6AN5 is useful at very high frequencies as a frequency multiplier, wide-band r-f and i-f ampli-

fier, class C r-f amplifier and switching tube for computers. The tube has a normal plate current rating of 35 ma and a transconductance of 8,000 micromhos.

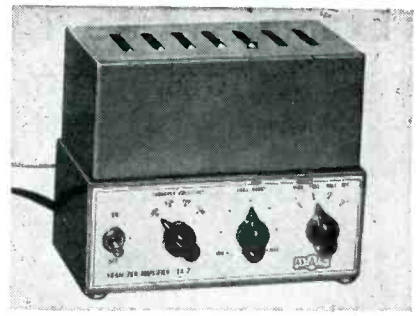
Portable Tape Recorder

STANCIL-HOFFMAN CORP., 1016 North Highland Ave., Hollywood 38, Calif. The Minitape unit is a miniature tape recorder weighing less than 10 pounds including self-contained power supply. Standard flashlight batteries are used for the

motor drive and miniature B batteries for the amplifier. Five-inch reels containing 600 feet of tape give a recording capacity of fifteen minutes when run at 7½ inches per second tape speed. Frequency response is flat to 5,000 cycles. A high-pass filter cutting off at 100 cycles is available for out-of-door recording.

Equalizer Preamps

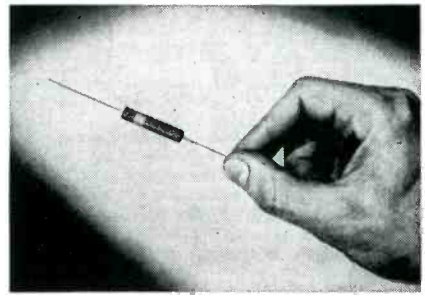
ASTATIC CORP., Conneaut, Ohio. Equalizer-preamplifiers suitable for use with the Magneto-Induction



pickup for both regular and long-playing records are now available in three different styles. Model EA-1 is designed for installation in radio sets and audio amplifiers. Model EA-2 is self-powered and provides bass boost, treble roll-off and a selection of turnover frequency. Model EA-3 is another self-powered unit with bass boost and equalization.

Insulated Choke

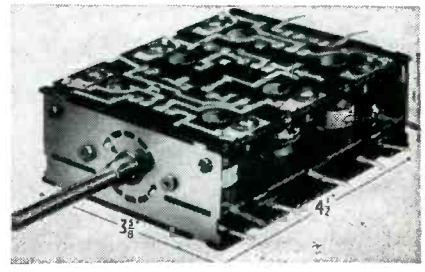
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. A new line of insulated chokes recently announced has been designed particularly for television



and f-m receiver requirements. Two types CLA and CL-1 are available. Resistance is low enough for use as filament choke in moderately high-power tubes. The Q is suitable for broad-band tuning in f-m and television regions.

Prefab Wiring

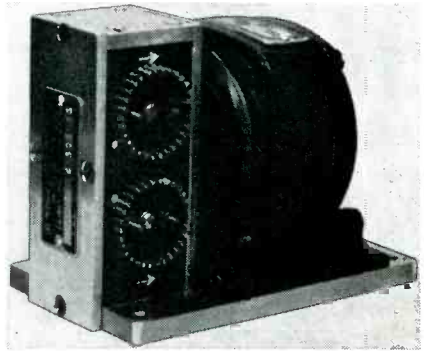
WRIGHT AND WEAIRE LIMITED, 138 Sloane St., London SW1, England. The chassis illustrated is one approach to the use of automatic wiring in which certain components re-



tain their more conventional appearance. The coil pack illustrated comprises coils, switches, trimmers and padders completely wired and ready for instant incorporation into any standard superhet receiver.

Multichannel Switch

THE APPLIED SCIENCE CORP. OF PRINCETON, Box 44, Princeton, N. J., has developed a multichannel switch driven by a 60-cycle synchronous motor. The 4-pole model shown here is 2 × 3 × 4 inches in



physical size and has 30 contacts per pole. These switches may be used for telemetering applications, for the display of characteristic curves and multichannel voltage comparison.

C-R Tube Shields

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden 48, Mass. Magnetic metal tube shields of Mu-

metal and Nicoloi illustrated are representative of a complete line manufactured for this and other shielding purposes.

Microwave Telephone Link

FEDERAL TELEPHONE AND RADIO CORP., Clifton, N. J. A multichannel f-m microwave radio link capable of simultaneously transmitting more than seven two-way telephone conversations has been developed to furnish point-to-point communications or as part of a wire communications system for bridging

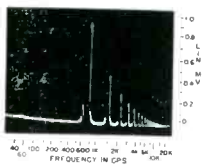
In only **1 SECOND!**

COMPLETE AUDIO WAVEFORM ANALYSIS

with the

AP-1 PANORAMIC SONIC ANALYZER

Oscillograph of waveform to be analyzed



Panoramic Sonic Analysis of the same wave

Provides the very utmost in *speed, simplicity* and *directness* of complex waveform analysis. In only one second the AP-1 *automatically* separates and measures the frequency and amplitude of wave components between 40 and 20,000 cps. Optimum frequency resolution is maintained throughout the entire frequency range. Measures components down to 0.1%.

- Direct Reading
- Logarithmic Frequency Scale
- Linear and Two Decade Log Voltage Scales
- Input voltage range 10,000,000:1

AP-1 is THE answer for practical investigations of waveforms which vary in a random manner or while operating or design constants are changed. If your problem is measurement of harmonics, high frequency vibration, noise, intermodulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

Write NOW for complete specifications, price and delivery.

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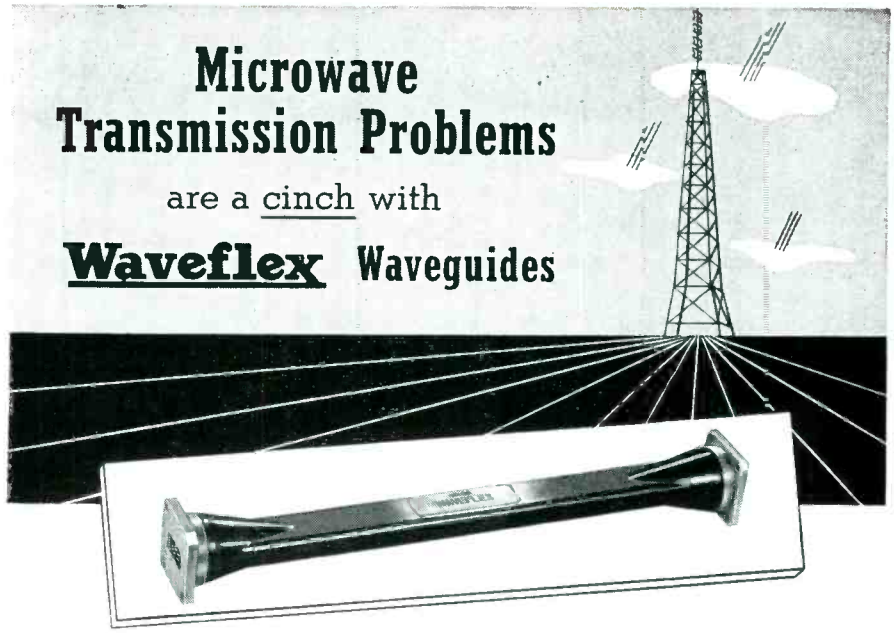
Microwave Transmission Problems

are a cinch with

Waveflex Waveguides



The WAVEFLEX waveguide incorporates *all* of the advantages of rigid waveguides while offering the additional feature of flexibility. Designers of radar, FM, and television transmission equipment have discovered that this combination of properties simplifies many of their design problems.

WAVEFLEX waveguides offer lower attentuation loss, excellent impedance match, and extreme flexibility without loss of efficiency. They are made in accordance with joint Army-Navy specifications. Let us work with you in developing special waveguides for your special applications.

Literature on request

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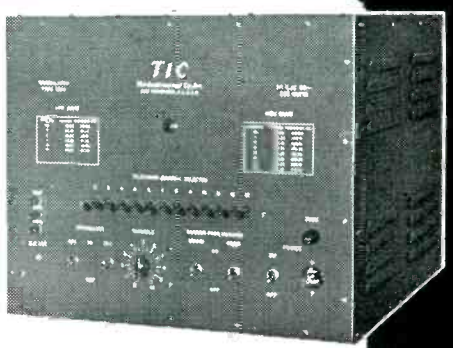
A **Titeflex** Product

Developed by TEL INSTRUMENT FOR THE TELEVISION INDUSTRY

New Type 12 CHANNEL R.F. SWEEP GENERATOR



- Instant Channel Selection by Push Button
- Rated for Continuous Service
- Pulse Type Markers at picture and sound carrier frequencies. Either or Both May be Turned On or Off.

No spurious markers produced. Accuracy 0.02% Xtal controlled.

TYPE 1200

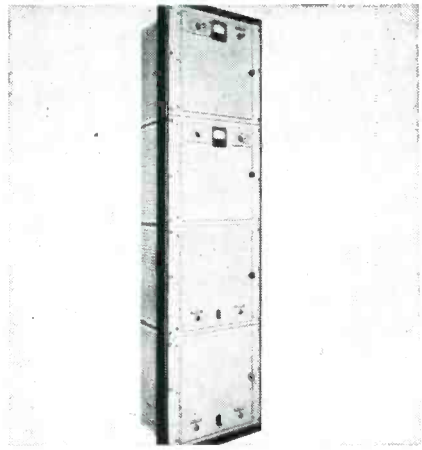
Precision Wobbulator for television production line. 15 M.C. band width on all channels. Output is oscillator fundamental frequency. Zero signal output reference baseline always present. Output 1 v. across 75 ohms. Attenuator range 60 Db. Monitor signal provided.

PRICE $1330 F.O.B. E. RUTHERFORD, N. J.

Write for Full Data

Tel-Instrument Co. Inc.

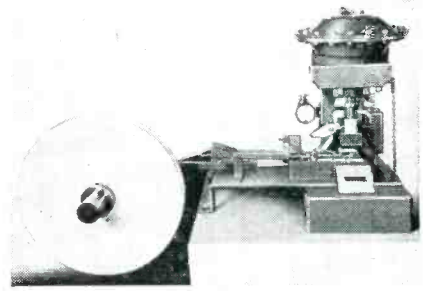
50 PATERSON AVENUE • EAST RUTHERFORD, N. J.



difficult terrain or rivers. Use of the FTL-13-A and 9-H-1 carrier equipment permits simultaneous transmission of the seven two-way voice channels with additional facilities available for inclusion of 14 two-way telegraph channels.

Terminal Attacher

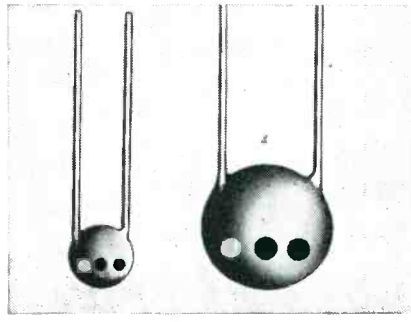
PATTON-MACGUYER CO., Providence, R. I. A new terminal attaching and soldering machine attaches terminals of various sizes and types at the rate of 1,200 per hour. The machine utilizes terminals in strip



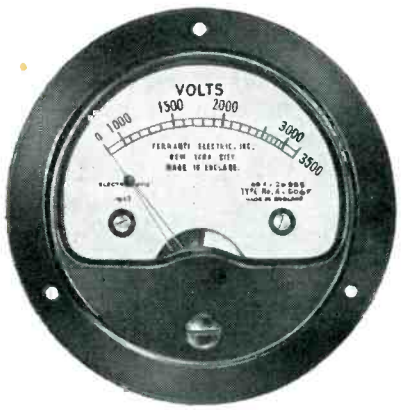
form supplied on reels. Details of the operation of the machine, which is sold outright, can be supplied. Samples of wire and terminal to be attached should be furnished.

Miniature Capacitors

RADIO MATERIALS CORP., 1708 Belmont Ave., Chicago 13, Ill. The 1,000-μμf Discap bypass capacitors



A TRUE ELECTROSTATIC VOLTMETER



This instrument permits voltage readings on AC or DC circuits of very high resistance. The only current drawn is the very small leakage current and a very low capacitance current on AC circuits. Very useful for the many high voltage—low current circuits employed in nuclear research. Available with full scale voltages ranging between 300 and 3500 volts. Special laboratory instrument available with full scale reading of 150 volts. Full scale capacitance ranges from 8 mmfds for the 3500 volt model to 100 mmfds for the 150 volt instrument. Magnetic damping. 2½" dial. Write for complete specifications.

FERRANTI

FERRANTI ELECTRIC, INC.
30 Rockefeller Plaza • New York 20, N. Y.
FERRANTI, LTD., Hollinwood, England
FERRANTI ELECTRIC, LTD., Toronto, Canada

KNURLING MAKES UNBRAKO SOCKET SET SCREWS SELF-LOCKERS

Reg. U. S. Pat. Off.

"UNBRAKO" KNURLED THREAD Pat'd.

Knurling of Socket Screws originated with "Unbrako" in 1934.

Set Screws must "stay put". To make sure they do—**LOCK THEM!** Yes, no matter what your set screw application may be, there's an "UNBRAKO" Self-Locking Set Screw to lock your requirements, because all patented "UNBRAKO" Set Screws can be made SELF-LOCKING through KNURLING. *They positively won't shake loose.*

The patented Knurled Thread of this "UNBRAKO" Socket Set Screw is swaged—making it a most excellent Self-Locker for applications requiring cone, oval, flat or other points except cup, and for use with hardened shafts.

Write us for the name and address of your nearest "UNBRAKO" Industrial Distributor and for your copy of the "UNBRAKO" Catalog.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

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CHICAGO • DETROIT • ST. LOUIS • SAN FRANCISCO

REDUCE ASSEMBLY REJECTS WITH...

TINNED STEATITE HERMETICALLY SEALED TERMINALS

GENERAL CERAMICS and STEATITE CORPORATION — STEATITE INSULATORS

- ...THAT WITHSTAND HIGH SOLDERING TEMPERATURES
- ...ARE IMMUNE TO ROUGH SHOP HANDLING
- ...HAVE TINNED SHOULDER FOR RAPID ASSEMBLY
- ...FOR 200°C SERVICE ON SPECIAL ORDER

A tinned surface, permanently bonded to the glazed body of these terminals permits rapid soldering to any metal enclosure. Exceptional strength of the steatite body practically eliminates assembly rejects that frequently result when other types of terminals are subjected to soldering temperatures or rough handling. Leads are brought out through an axial hole in the center of the bushing and terminated on the tinned lug. A drop of solder on the hole effects a complete hermetic seal. For complete information concerning tinned steatite terminals, call or write today.

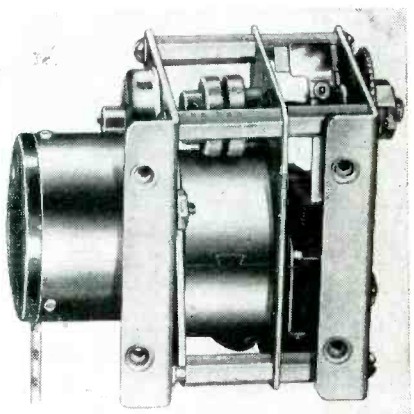
General CERAMICS and STEATITE CORP.
OFFICES and PLANT: CROW'S MILL ROAD, KEASBEY, N. J.

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

measuring ½ inch in diameter are rated at 400 volts and tested at 1,000 volts. The 5,000-μμf units have the same diameter, carry a service rating of 600 volts, and pass a 1,200-volt test. They are made moisture proof over a phenolic coating by a chlorinated rubber lacquer casing.

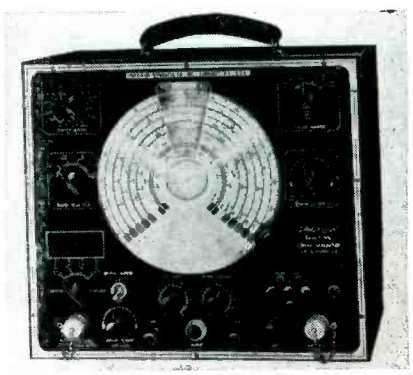
D-C Timers

HAYDON MFG. CO., INC., Torrington, Conn. The 9200 series d-c motor is a low-voltage permanent-magnet type with uniform torque and speed characteristics requiring no mechanical governor. The basic motor has a speed of 900 rpm at 6 v although the actual output speed is affected by changes in voltage, temperature, and load. Several types of timers utilizing d-c motors are available for a variety of services requiring separate time delays or timing intervals.



Sweep Signal Generator

PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst, L. I., N. Y. Series E-400 sweep signal generator offers continuous frequency coverage from 2 to 240 mc in five bands; continuous narrow and wide band sweep



direct reading from 0 to 1 mc and 0 to 10 mc. External a-m input terminals afford direct means for amplitude modulation of the complete r-f range, with or without the presence of f-m. External deviation input terminals allow direct sweep operation at any desired frequency.

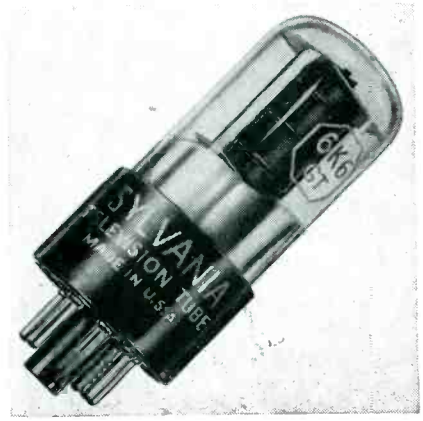
D-C Amplifier

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa. Model EDA high-gain d-c amplifier is designed to be used with an oscilloscope for viewing phenomena

ranging from d-c to 30,000 cps. Amplifier and power supply are separate units mounted in a relay rack type of cabinet. Power consumption is 250 watts, 115 volts, 60 cps. Gain is 25,000 adjustable in steps of 100, 80, 60, 40, 20 and 0 percent. Maximum output voltage is 400 volts peak-to-peak.

Special Tele Tubes

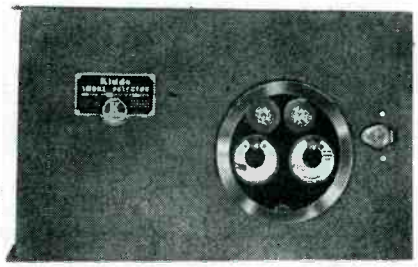
SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. A new line of specially processed receiving tubes for replacement service in television receivers is now available. The new tubes are identified by orange and green cartons. Included are the follow-



ing types: 1B3GT, 6AG5, 6AL5, 6BG6G, 6J6, 6K6GT, 7B4, 7B5, 7C5, 7F7, 7H7, 7N7, and 7Z4. Except for the types 1B3GT and 6BG6G which are made only for television receivers, the list prices for the special tubes will be slightly higher than for corresponding regular types.

Smoke Detector

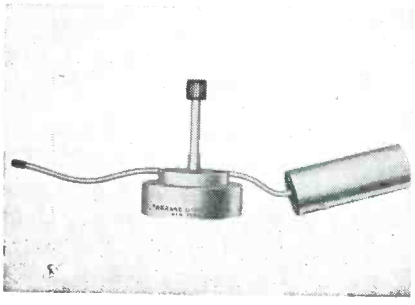
WALTER KIDDE & CO., INC., 40 East 34th St., New York 16, N. Y. A new single unit photoelectric smoke detector operates on the principle of a continuous sample of air being drawn from the protected space



through an individual piping system into an analyzer tube. In this tube, the air sample passes through a filter screen that removes dust and dirt and then into a beam of light focused on a photocell. Smoke cuts down the amount of light reaching the cell and sets off an alarm.

Thermocouple

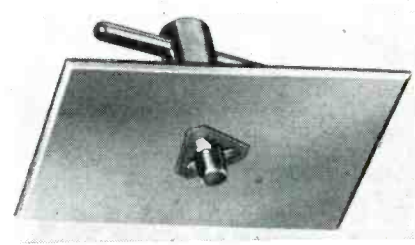
FARRAND OPTICAL CO., INC., 4401 Bronx Boulevard, New York 66, N. Y. A new thermocouple of the Hornig-O'Keefe type is particularly suitable for thermal radiation measurements employing chopped or modulated radiation at frequencies up to 10 cycles per second. Active target surface is ¾ mm square. Spectral range with KBr window is 0.3 to 25 microns. The resistance is between 6 and 10 ohms. The d-c



sensitivity is greater than 6 watts per volt, obtained for a time constant of approximately 35 milliseconds. Dimensions of the thermocouple case have been chosen to subtend approximately 10 percent of the area of a 60 mm diameter spherical mirror when the housed thermocouple is placed at its focus.

Triangular Retainer

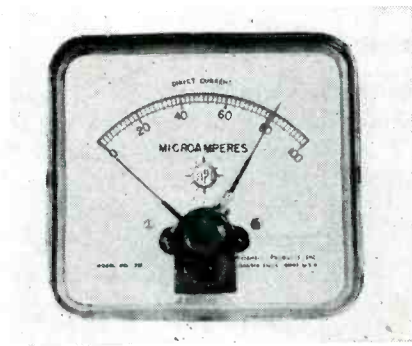
WALDES KOHINOOR, INC., 47–16 Austel Place, Long Island City 1, N. Y. Truarc triangular retainer type 5305 has been developed par-



ticularly to prevent end play on relatively soft shafts as cold rolled steel, castings and plastic materials. Complete information and specifications can be obtained from the manufacturer.

Meter Relay

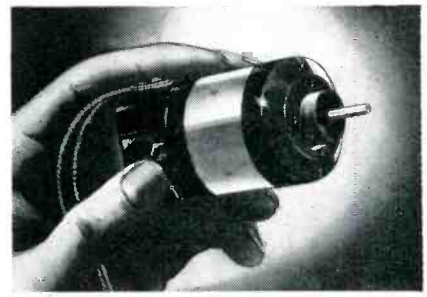
ASSEMBLY PRODUCTS INC., Chagrin Falls, Ohio. Positive contact on changes in current or voltage of as little as 0.5 microampere or a frac-



tion of a millivolt is possible with the meter illustrated. The contact point is adjustable over the entire scale arc.

Subminiature Motor

HOLTZER-CABOT, INC., 125 Amory St., Boston 19, Mass. Type RBDS-0810 motor operates on a field current of 6 ma with a stalled armature current of 0.8 amp. Maximum speed is 14,000 rpm, weight is 8½



oz, and it delivers 1/500th horsepower. The d-c motor has two independent high-impedance field windings for reversible operation. It is 1⅜ inches in diameter and measures 2 9/16 inches between hubs.

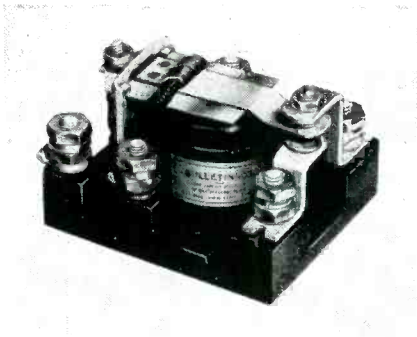
Radio Terminal Connector

CANNON ELECTRIC DEVELOPMENT Co., 3209 Humboldt St., Los Angeles 31, Calif. A new RTC series of connectors recently made available requires low separation force, simple mounting method, moisture-drain holes in receptacle

section, provision for lacing down wires to plug after soldering to contacts. Two types of connection are available, crimp-on or solder. Minimum flashover is 2,500 volts and the contacts will carry up to 5 amperes. Complete information as to size and contact combinations is written up in bulletin RTC-1.

Aircraft Relays

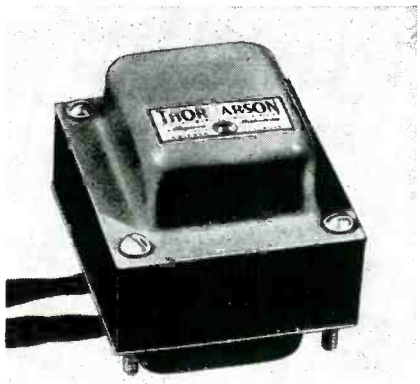
WARD LEONARD ELECTRIC Co., Mount Vernon, N. Y. Bulletin 103 aircraft power type relays have been designed for remote and automatic control purposes in locations in which conditions of vibration and shock are present. Basic parts are mounted on a molded phenolic base with front-connected port type terminal inserts. These d-c relays



withstand acceleration tests above 10 g as well as vibrations of 60 cycles with ⅛-inch amplitude.

Replacement Transformers

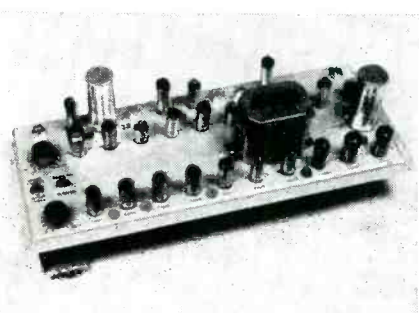
THORDARSON ELECTRIC MFG. DIV., MAGUIRE INDUSTRIES, INC., 500 West Huron St., Chicago, Ill. A new line of replacement transform-



ers, called the 24-line, is now available in power and output types. Further specifications are available from the manufacturer.

Stabilizing Amplifier

GENERAL ELECTRIC CO., Syracuse, N. Y. Type TV-16-A stabilizing amplifier is designed for use in studios and at transmitters as a picture line amplifier or as an amplifier for remote line and radio relay links. Frequency response is flat within 5 percent from 0 to 5



mc; input voltage range is from 0.2 to 3 v, peak to peak, composite video, 10 to 40 percent supersync; output is from 1.5 to 2.5 v, peak to peak, adjustable, also 0.3 to 0.5 v, monitor output.

Pocket Tester

TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 698 battery tester measures in the range from 1.5 to 90 volts. A three-color

scale gives additional indication of the ability of the battery under test to supply the power required of it in actual use. The instrument weighs 1¼ pounds.

Tele Booster

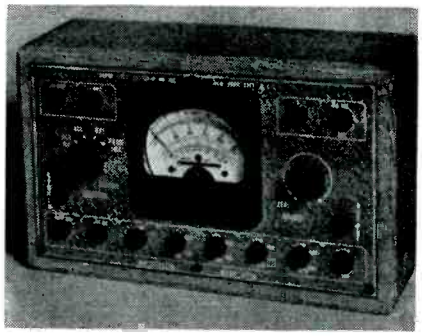
BUD RADIO, INC., 2118 East 55th St., Cleveland, Ohio. Television antenna booster TAB 81 provides separate amplifiers for high and low channels. The equipment which is connected between leadin and receiver is completely enclosed. List price is $29.75.

Pocket Signal Generator

RADEX CORP., 2076 Elston Ave., Chicago 14, Ill. The Pocketracer is an r-f and audio signal source of the interrupter type that operates on a small self-contained flashlight cell. Current consumption is 50 ma. Price is $4.50.

Multitester

RADIO CITY PRODUCTS CO., 152 West 25 St., New York, N. Y. Model 447A is a streamlined version of the model 447. With a new battery arrangement and magnesium panel the equipment is somewhat lighter. Voltages up to 2,500 d-c, and 1,000



a-c, current up to 1,000 ma d-c and 10 amp, and resistance up to 1 megohm can be measured directly with the instrument. Output voltage can also be measured.

Literature

Television Tuner. Guthman International Corp., 75 West St., New York 6, N. Y. A recent four-page folder covers the model 34-1024 television tuner and channel selector which features a high gain and good selectivity. Circuit diagram, dimensional drawing and operational data are included.

Miniature Tubes. Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass. The third edition of the reference guide for miniature electron tubes contains pertinent characteristics, data and basing diagrams for 91 types, regardless of make.

Magnetic Amplifier. Vickers Electric Division, Vickers Inc., 1815 Locust St., St. Louis 3, Mo. Bulletin VT-2000 devotes 32 pages to a description of circuits, characteristics and applications of the magnetic amplifier.

Variable Capacitors. E. F. Johnson Co., Waseca, Minn. Catalog 702 covers a line of ceramic soldered variable capacitors. The four-page illustrated description gives chief features, specifications and list prices.

Selenium Rectifiers. Fansteel Metallurgical Corp., North Chicago, Ill. Bulletin RDP-112 is a 16-page booklet of engineering information pointing out the limitations as well as the capabilities of selenium rectifiers. The booklet is designed to aid in the selection,

purchase and use of rectifiers.

Dry Electrolytic Capacitors. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., has published an engineering reference data folder on types FP and WP capacitors. Detailed diagrams and specifications are included.

Replacement Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J., has made available a 56-page encyclopedia, No. 163, on replacement capacitors for motor-starting and other a-c applications. Included in the guide are alphabetical and numerical listings of motor part numbers, a cross index of replacements, a catalog listing and technical information.

Relay Catalog. Potter & Brumfield Sales Co., 549 W. Washington Blvd., Chicago 6, Ill. Catalog 149 illustrates and describes a line of 15 basic models of general purpose appliance, motor-starting and telephone-type relays with 7,000 different specifications.

Voltage Regulation. Sorensen and Co., Inc., 375 Fairfield Ave., Stamford, Conn., now publishes a four-page bimonthly house organ devoted to new developments in the voltage-regulation field. Anyone interested may write to be placed on the free mailing list.

Interval Timer. R. W. Cramer Co., Inc., Centerbrook, Conn. Bulletin 130 describes the function, application, distinctive features and construction of the type IG interval timer. Time ranges and price list are included.

Gamma Counter Tubes. Ballantine Laboratories, Inc., Boonton, N. J. A small folder describes a line of G-M counters intended mainly for cosmic ray research. A table of specifications covers the types now in production.

Converter Catalog. Carter Motor Co., 2644 N. Maplewood Ave., Chicago, Ill. Catalog 349 consists of 16 illustrated pages giving complete electrical and mechanical specifications on a line of converters throughout the entire range of input and output voltages, including models for television opera-

tion, as well as those for recording, sound projection and mobile communications applications.

High-Frequency Instruments. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J. Bulletins and reprints now available give information with specifications on the Mega-Sweep, Mega-Match and Mega-Pulser. A catalog with more complete technical data may be obtained by formal request.

Connector Supplement. Cannon Electric, 3209 Humboldt St., Los Angeles 31, Calif., has issued a 12-page supplement to the type K bulletin which includes new information on the K and RK types aircraft firewall connectors, the K31SL wall-mounting receptacle, K pressurized receptacles, and 16 new insert arrangements in various shell sizes for all types radio, sound, electronic and electrical equipment.

Broadcast Microphones. Electro-Voice, Inc., Buchanan, Mich., has published bulletin 144 on the new ultra-wide-range, high-fidelity, high-output, dynamic microphones specially developed for f-m and a-m broadcast service.

Mercury Plunger Relays. Ebert Engineering and Mfg. Co., 185–09 Jamaica Ave., Hollis 7, Long Island, N. Y. Four types of mercury plunger relays are described and illustrated complete with specifications and dimensional drawings in a recent four-page folder.

Galvanic Cell Corrosion. The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. An eight-page booklet is designed to provide the production man as well as the engineer with the reasons for galvanic cell corrosion and methods for helping to overcome it.

Connector Supplement. Cannon Electric, 3209 Humboldt St., Los Angeles 31, Calif. has recently issued a 12-page supplement to the

Type K bulletin entitled KS-1. Among the new insert arrangements are various layouts with one to eight coaxial contacts, including one for television cameras.

Tube Notes. Radio Corp. of America, Harrison, N. J. Data and application notes recently published for various tube types include bulletins on the 5770 power triode, 5771 power triode, 5786 power triode, and 5762 power triode.

Voltage Regulator. Electro Engineering Works, 6021 College Ave., Oakland 11, Calif. Three types of voltage normalizers are described in a catalog sheet that gives dimensions, wattage ratings and weights.

Mixed Grille. Muirhead & Co., Ltd., Beckenham, Kent, England, has recently sent out a set of catalog bulletins describing a miniature tuning fork, acoustic strain gage, inductive potentiometer, D'Arsonval galvanometer, phonic motors, phonic motor clock, and a portable darkroom designed for facsimile work.

Laminated Plastic. The Formica Co., Cincinnati, Ohio, puts out an external house organ entitled "This Formica World", which describes painlessly the various forms of use for the company's product.

Oscillograph Service. Allen B. Du Mont Laboratories, Inc., Instrument Div., 1000 Main Ave., Clifton, N. J. Engineering development and model shop facilities of the company's instrument division are now available and offered to the industry for design and development of special cathode-ray instruments.

Silicone Rubber. General Electric Co., Pittsfield, Mass. A 24-page illustrated bulletin CDP-584 describes silicone rubber and its properties.

Distribution Transformers. American Transformer Co., 178 Emmet St., Newark 5, N. J., has issued bulletin 210-01 describing and

illustrating a line of distribution transformers. Dimensions and mechanical data are included in the 8-page booklet.

Coaxial Cable. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 48 describes, in 8 pages, type 737 semiflexible coaxial cable, for broadcast and communications use.

Television Lights. Kleigl Bros., 321 West 50th St., New York 19, N. Y. An old, wellknown company in the field of theater lighting offers Bulletin No. 53 to acquaint the television field with its products that are particularly applicable therein.

New Tele Camera. Television Equipment Corp., 238 William St., New York 7, N. Y. A new company announces a new television camera for industrial or broadcast service in a four-page folder. Camera, viewfinder, camera control, power supply, mixer amplifier, and distribution amplifier are summarized.

Decals. Palm, Fechteler & Co., 220 West 42nd St., New York 18, N. Y., has a two-color catalog complete with samples showing how and why decalcomanias should be used on your product.

High Vacua. Distillation Products, Inc., 755 Ridge Road West, on high-vacuum apparatus is made available in an instructive 8-page bulletin, well illustrated.

Audio Apparatus. Fairchild Recording Equipment Corp., 154 St. & 7th Ave., Whitestone, N. Y., recently released catalog sheets on equalizers, a diameter equalizer, and a vu panel, with complete specifications.

Superantenna. The Antenna Research Laboratory, Inc., 797 Thomas Lane, Columbus 2, Ohio. A broadband television receiving antenna weighing 30 pounds and listing at $77.50 is described in a catalog sheet ARL-12. Gain over the television bands varies from better than 4 to about 13 db. Pat-

terns are given for each channel.

Electric Eyes. Photobell Co., New York, N. Y., has a single-page leaflet describing its type J photorelay equipment and an electric eye circuit handbook.

Laboratory Gear. National Technical Laboratories, South Pasadena, Calif. A series of brochures describing the line of Beckman instruments includes: pH electrodes and accessories, photopen recorder, spectrophotometer, ultrometer, infrared spectrophotometer, photoelectric quartz spectrophotometer, and a reprint of an article on the latter equipment.

Meters. Beede Electrical Instrument Co., Inc., Penacook, N. H. A new catalog of electrical indicating instruments is now available from this old-time manufacturer.

Coax. E. F. Johnson Co., Waseca, Minn., has just issued a temporary listing of copper tubing coaxial line, fittings and accessories.

Waveguides. Technicraft Laboratories, Inc., Thomaston, Conn. Bulletin F-2 shows three types of flexible waveguides and describes their proper uses. Of special interest is a discussion of rigid-flexible combination assemblies.

Rectifier. Reliance Electric & Engineering Co., 1076 Ivanhoe Road, Cleveland 10, Ohio. Bulletin K-2125 is a sheet catalog bulletin describing the VSX rectifier for industrial use.

Radioactive Roundup. Tracerlab, Inc., 55 Oliver St., Boston 10, Mass., puts out Tracerlog. The February 1949 issue contains articles of general interest to workers in the field of nuclear physics and instrumentation. Copies will be sent free to those requesting them.

Seismography. Diamond Instrument Co., North Ave., Wakefield, Mass. Catalogs of pen-recording seismographs show illustrations and give descriptions of the various components in the measurement of earth tremors, natural or man-induced for survey work.

ing, by Robert M. Morris of ABC, New York, N. Y.

Magnetic Tape Recording and Reproducing, by S. J. Begun of Brush Development Co., Cleveland, Ohio.

Properties of Magnetic Tape and Their Relation to Magnetic Recording, by Reynolds Marchant of Minnesota Mining & Mfg. Co., St. Paul, Minn.

A New Portable Audio Amplifier for AM-FM-TV, by William W. Dean of GE.

Friday, April 8

9:00 A.M. William B. Lodge of CBS, presiding:

A Loop-Antenna System for Television Broadcasting, by A. G. Kandoian and R. A. Felsenheld of Federal Telecommunication Labs.

A New and Low-Cost Television Transmitting Antenna, by M. W. Scheldorf and Lawrence R. Krahe of Andrew Corp.

Design Problems in Triode and Tetrode Tubes for High Frequency Operation, by Howard Doolittle of Machlett Labs.

Development, Design & Application of Super Power Frequency Modulation, by J. E. Young of RCA Victor.

Automatic Selection of Broadcast Program Circuits, by John A. Green and Robert D. Essig of Collins Radio Co.

High Voltage Metallic Rectifiers Applied to Broadcast Transmitters, by Charles K. Hooper and Nelson B. Tharp of Westinghouse.

12:30 P.M. Neal McNaughten of NAB Department of Engineering, presiding:

Atomic Energy is Here for Good, by Lincoln R. Thiesmeyer of Brookhaven National Lab.

2:15 P.M. J. R. Poppele of WOR, presiding:

Iconoscope Film Pickup Systems, by Harry R. Smith of Allen B. DuMont Labs.

The Improved 16 MM Synchrolite Projector, by H. B. Fancher of GE.

Kinescope Recording, by Ralph V. Little, Jr., of RCA Victor.

A Cathode Ray Tube Video Scanner, by Roger D. Thompson of Allen B. DuMont Labs.

General Purpose Television Studio Lighting, by Richard Blount of GE.

Television Receiving Antenna Design and Installation, by Lewis Winner of Bryan Davis Publishing Co.

Saturday, April 9

9:00 A.M. Oscar C. Hirsch of KFVS, Cape Girardeau, Mo., presiding:

Training of AM & FM Engineering Personnel for TV Operations, by Whitney M. Baston of NBC.

Recent Advances in Broadcast Facsimile, by John V. L. Hogan of Radio Inventions, Inc.

A Progress Report on Ultra High Frequency Television by Thomas T. Goldsmith, Jr., of Allen B. DuMont Labs.

FCC-Industry Roundtable — Royal V. Howard of NAB, moderator:

For the Commission: John A. Willoughby, acting chief engineer; Edward W. Allen, Jr., chief of the technical information division; James E. Barr, chief of the standard broadcast division; Cyril M. Braum, chief of the f-m broadcast division; Edward W. Chapin, chief of the laboratory division; Curtis B. Plummer, chief of the tv broadcast division.

For industry: A James Ebel of WMBD; E. K. Jett of WMAR; K. W. Pyle of KFBI; O. W. Towner of WHAS; E. M. Johnson of MBS; Frank Marx of ABC.

Computer Course

THE OFFICE OF TECHNICAL SERVICES recently announced availability of a 48-lecture course on the design of electronic digital computing machines. Originally sponsored by the Army and Navy in 1946, the lectures have since been revised and collected.

Limited supplies may be purchased in four volumes from the Moore School (home of the ENIAC

and EDVAC), University of Pennsylvania, Philadelphia 4, Pa., at $5.00 per volume. When this supply is exhausted the four volumes may be secured in microfilm for $22.00, or in photostat for $74.00 from the Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C.

Also available from the Library of Congress is PB96703, Preliminary Discussion of the Logical Design of an Electronic Computing Instrument, prepared by the Institute for Advanced Study at Princeton, N. J. This 57-page report is available at $2.75 in microfilm, $7.50 in photostat.

NBS Expands Electronics Staff

RECENT changes in the National Bureau of Standards' electronics department involved the appointment of several new members to the staff. The appointees and their previous affiliations are as follows:

Charles A. Mabey, formerly director of research for the Bristol Co., will supervise electronic miniaturization, circuits and processes as assistant chief of the Engineering Electronics Laboratory.

Hans Kohler, formerly with the Signal Corps Research Laboratories, will be engaged in theoretical work in the Electronics Division.

John W. Utecht, formerly senior engineer for induction and dielectric heating with the Alloy Engineering and Casting Co., will work on development of new electronic ordnance devices and related equipment in the Ordnance Engineering Laboratory.

John R. Pellam, formerly with the MIT Research Laboratory of Electronics, will be concerned with research in the Cryogenics Laboratory.

William M. Piper, formerly project engineer in charge of research and development of batteries and related equipment for the Army Chief Signal Officer, will do research in the Ordnance Mechanics Laboratory of the Electronics Division.

Arthur E. Newlon, formerly senior radio engineer with Stromberg-Carlson, will work in the Ord-

nance Research Laboratory of the Bureau's Electronics Division.

Harvey W. Lance, formerly of the staff of the Naval Research Laboratory, will work on electronic systems for guided missiles in the Missile Intelligence Laboratory of the Bureau's Electronics Division.

Ionospheric Research Conference

TO ACQUAINT scientists in the field with the latest theoretical and experimental developments in ionospheric research, a three-day conference and symposium will be held at The Pennsylvania State College on June 27, 28 and 29. Eight to twelve papers and discussion-conferences will deal with present-day research on radio-wave propagation via the ionosphere.

The conference is being sponsored jointly by The Pennsylvania State College and the Geophysical Research Directorate of the U. S. Air Forces. Further details may be had from A. H. Waynick of the Radio Propagation Laboratories, The Pennsylvania State College, State College, Pa.

Airport Installs PTM Link

A PULSE-TIME-MODULATED microwave radio link was recently installed by Aeronautical Radio, Inc. of Washington, D. C., at the Municipal Airport, Mexico City. The equipment was developed by Federal Telecommunication Laboratories, Inc.

Providing 24 communications channels between the airport control room and a remotely controlled receiving station nine miles away at Maria Licia, the link makes available four times as many channels as the previously used f-m circuit.

The transmitting antenna is located 30 feet high on a mast about 25 feet from the radio equipment building at Maria Licia, in which the microwave transmitter and multiplex modulator are housed. Time modulated signals are directed by means of this parabolic antenna to the airport via the 2 000-mc carrier. Signals are intercepted by another parabolic receiving antenna six feet

in diameter atop a 100-foot CAA range tower, about 100 yards from the airport tower.

Besides providing additional channels the ptm link offers low-cost maintenance, an economical replacement for landlines, less danger of sabotage, and faster and more dependable communications between planes and ground stations at the airport and between stations of the aeronautical radio system.

Spring Technical Conference

THE THIRD ANNUAL SPRING TECHNICAL CONFERENCE held April 23 in Cincinnati by the IRE's Cincinnati Section covered television horizons not widely discussed heretofore. Emphasis was placed upon uhf techniques as applied to monochrome reception in the 475 to 890-mc band.

Speakers at the one-day session were: E. W. Allen of FCC; C. E. Nobles of Westinghouse; O. M. Woodward, Jr. of RCA Labs; R. F. Romero of RCA Industry Service Labs; R. F. Wakeman of DuMont Labs; A. V. Haeff of NRL; J. D. Reid of Avco Mfg. Corp.; E. W. Commery of GE; and D. G. Fink of McGraw Hill.

Operator License Changes

THE FCC has proposed changes of its rules and regulations to provide for a one-year period of grace during which applications for the renewal of expired commercial radio operator, amateur operator or amateur station licenses may be filed. Also included in the proposal was the modification of renewal service requirements for commercial radio-operator licenses both with and without examination.

Opinions filed by those interested on or before April 25 will be considered by the FCC before final action is taken.

Acoustical Society Meeting

THE TWENTIETH anniversary meeting of the Acoustical Society of America will be held May 5, 6 and 7 at the Hotel Statler, N. Y. A program comprising seventy papers has been planned covering the theme

"Acoustics and Man." Included are sessions many of particular interest to electronic engineers. That portion of the program is as follows:

Thursday, A.M., May 5

Acoustics in Communications

Invited paper by Harry F. Olson.

The Acoustic Impedance of Closed Rectangular Loudspeaker Housings, by W. F. Meeker, F. H. Slaymaker and L. L. Merrill of Stromberg-Carlson.

Non-Linear Distortion in Dynamic Loudspeakers Due to Magnetic Effects, by W. J. Cunningham of Yale Univ.

A Continuously Adjustable Filter for Audio Frequencies, by G. E. Tisdale of Yale Univ.

On the Propagation of Sound in Narrow Conduits, by O. K. Mawardi of Harvard Univ.

Simplified Acoustic Impedance Measurements, by R. W. Leonard of UCLA.

The Least Discriminable Intensity for Random Noise, by J. D. Harris of U. S. Naval Medical Research Lab, New London, Conn.

Uniform Speech-Peak Clipping in a Uniform Signal-to-Noise Spectrum Ratio, by D. W. Martin of RCA.

Thursday, P.M.

Acoustics in Communication, by Ralph Bown of Bell Labs.

Acoustics in Comfort and Safety, by Vern O. Knudsen of UCLA.

Acoustics and Modern Physics, by Philip M. Morse of MIT.

Acoustics in the Arts, by Harvey Fletcher of Bell Labs.

Friday, May 6

Visit to Bell Labs at Murray Hill, N. J.

Welcoming Address, by Ralph Bown.

Demonstration Lectures, J. C. Steinberg, presiding:

Recent Research on Barium Titanate Used as a Transducer Material, by W. P. Mason.

Recent Studies of Transistors in Transducer Applications, by R. L. Wallace, Jr.

The Ring Armature Receiver—An Improved Transducer for Telephone Use, by W. C. Jones.

Action Pictures of Sound—A Motion Picture Portrayal of Dynamic Spectra, by R. C. Mathes.

Methods for Focusing, Guiding and Refracting Sound Waves, by W. E. Kock.

Tour of Selected Laboratories Areas: High Power Ultrasonics, Ultrasonic Analysis, Speech Research, Hearing Research, Crystal Growing, Acoustical Measurements, Acoustical Instruments, Visit to Free-Field Room.

Saturday, A.M. May 7

Acoustics in Comfort and Safety

The Acoustic Gallstone Detector, by E. G. Thurston and E. A. Walker of Ordnance Research Lab.

Universal Phonograph Stylii, by J. D. Reid of Avco Mfg. Corp.

Levels and Spectra of Noise in Industrial and Residential Areas, by G. L. Bonvallet of Armour Research Foundation.

Sound Transmission of Walls with Known Receiving Room Conditions, by F. G. Tyzzer, L. G. Ramer and J. Ancell of Armour Research Foundation.

Transient Sounds in Rooms, by D. Mintzer of MIT.

Proposed Acoustic System for Ordnance Research Laboratory Water Tunnel, by P. M. Kendig of ORL.

Acoustic Filter for Water Filled Pipes, by R. M. Hoover, D. Laird and L. N. Miller of ORL.

The Properties of Gaseous Solutions as Revealed by Acoustic Cavitation Measurements, by F. G. Blake, Jr. of Harvard Univ.

The Ripple Tank as a Device for Studying Wave Propagation, by H. D. Rix of The Pennsylvania State College.

A New High Speed Inkless Recorder, by A. W. Niemann and L. P. Reitz of Sound Apparatus Co.

The Present Status of Piezoelectric Transducer Crystals, by H. Jaffe of The Brush Development Co.

Scattering of Ultrasonic Waves in Water by Cylindrical Liquid Filled Ob-

stacles, by P. Tamarkin of Brown Univ.
Absorption Measurements in Magnesium Sulfate, by R. T. Beyer, M. C. Smith and R. Barrett of Brown Univ.

Saturday, P. M.

Acoustics in Comfort and Safety
Acoustics in Research

Ultrasonic Radiation from an Ideal Piston Source, by G. S. Heller of Brown Univ.

Improved Devices for the Concentration of Ultrasonic Energy, by P. J. Ernst of Villanova College.

Distortion of Acoustic Beam Patterns by Echoes and Electric Pick-Up, by A. O. Williams, Jr., W. Keck and M. C. Smith of Brown Univ.

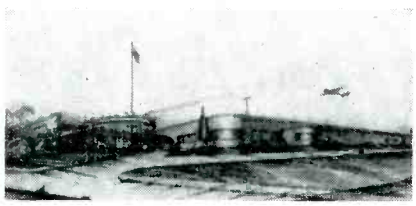
Intensity Distribution in Ultrasonic Beams, by W. Keck, G. S. Heller and J. D. Nixon of Brown Univ.

BUSINESS NEWS

GENERAL ANILINE & FILM CORP., Linden, N. J., has taken a lease on the carbonyl iron powder plant of the former Huntsville, Ala., Arsenal to increase production of high-frequency core material for the television industry.

TEL-O-TUBE CORP. OF AMERICA is expanding its cathode-ray tube manufacturing facilities by adding a 10,000 sq ft building to its present quarters in Paterson, N. J.

RADIO CORP. OF AMERICA recently began construction of a new 100,000 sq ft plant in Marion, Ind., for the



Architect's drawing of main building of RCA's new Marion, Ind., plant

mass production of 16-inch direct-view metal picture tubes for television.

SETCHELL CARLSON, INC., radio receiver manufacturers, have moved from St. Paul, Minn., to a new 60,000 sq ft factory at New Brighton, Minn., to begin manufacture of television and f-m as well as a-m sets.

G-V CONTROLS, INC., East Orange, N. J., has been organized to engage in the development and manufacture of electrical control equipment.

AIRBORNE INSTRUMENTS LABORATORY expanded research and production activities by occupancy of

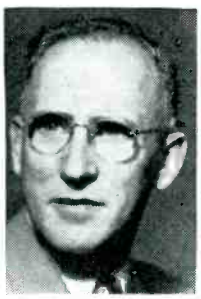
10,000 sq ft of additional space at 127 Second St., Mineola, N. Y.

PERSONNEL

C. J. BURNSIDE, associated with Westinghouse radio and electronic activities for 24 years, has resigned and organized an independent industrial consultant service with headquarters in Baltimore, Md.

RUTH G. KOPPEL, project engineer at Sperry Gyroscope Co., recently became the first woman officially enrolled as a member of Eta Kappa Nu, honorary electrical engineering fraternity. She was enrolled by the chapter of Polytechnic Institute of Brooklyn.

R. G. Koppel



W. F. Kean

WALTER F. KEAN, formerly manager of Andrew Corporation's broadcast consulting division, recently formed a consulting engineering firm under his own name at Riverside, Ill.

GEORGE C. HANSEN, former television studio supervisor at KSTP-TV in St. Paul, is now supervisor of technical services at Airborne Instruments Laboratory, Mineola, N. Y.

LEONARD MAUTNER, formerly manager and chief engineer of the television transmitter division of Allan B. DuMont Laboratories, Inc., has been appointed vice-president of the recently formed Television Equipment Corp., New York City.

ROBERT A. STAUFFER, associated with the National Research Corp., Cambridge, Mass., since 1942, has been elected its vice-president and director of research.

GEORGE F. RICHARDS, formerly electronic engineer at Sperry Gyroscope Co., Inc., has been elected

vice-president and treasurer of Teletronics Laboratory, Inc., manufacturers of electronically controlled products.

STERLING C. SPIELMAN, with Philco Corp. for the past 15 years, has been made chief engineer to handle television receiver development.

LUKE E. CLOSSON, also with the company 15 years, is the newly appointed chief engineer in the field of home radio at Philco Corp.

ROGER L. MERRILL, formerly an engineer with the Curtiss-Wright Corp., has been appointed to the staff of Battelle Institute, Columbus, Ohio, to engage in electrical engineering research.

VLADIMIR K. ZWORYKIN, vice-president and technical consultant at RCA Laboratories, has been awarded the 1948 Lamme Medal of the AIEE "for his outstanding contribution to the concept and design of electronic apparatus basic to modern television."

V. K. Zworykin

P. Ware

PAUL WARE, former consulting engineer, has been placed in charge of the e ectronic parts division of Allen B. Du Mont Laboratories, Inc. He developed and patented the Inductuner while previously associated with P. R. Mallory & Co.

WILLIAM E. NEILL, after six months with the television and microwave engineering department of Raytheon Mfg. Co., Waltham, Mass., has been appointed sales engineer of the department. He was formerly assistant chief engineer for television at WFIL-TV, Philadelphia.

KENDRICK H. LIPPITT, until recently associated with George C. Davis, broadcast radio consultant in Washington, D. C., was appointed chief engineer of the Technical Appliance Corp., Sherburne, N. Y., radio and tv antenna manufacturers.

NEW BOOKS

Microwave Antenna Theory and Design

Volume 12 in the Massachusetts Institute of Technology Radiation Laboratory Series. Edited by S. SILVER. *McGraw-Hill Book Co., New York,* 1949, 612 *pages,* $8.00.

THIS IS a valuable book for the microwave antenna designer. The eleven authors have drawn material from wartime experience at the Radiation Laboratory and many other sources not universally available. They have presented the material in a concise and complete manner. The editor has integrated their contributions into a most useful form. He has chosen to organize the book into four convenient divisions: basic theory, theory and design of feeds, theory and design of complete antenna systems and antenna-measuring techniques and equipment.

The first section, occupying a third of the volume, includes a detailed review of antenna circuit relations, reciprocity theorems, field equations, general properties of the electromagnetic field, wave propagation, scattering and diffraction phenomena and relations between aperture illumination and antenna pattern.

The section on antenna feeds is introduced by a chapter on transmission lines, and continues with chapters on dipole feeds, linear arrays, waveguide and horn feeds, and dielectric and metal-plate lenses.

Complete antenna systems are treated in the third section. Systems employing pencil beams, simple fanned beams and other shaped beams are considered.

A chapter on antenna installation problems, including a discussion of radome effects, is also a part of the third section. As in the preceding section the treatment of the material here includes explanation of the applicable theory, statement of many useful quantitative relations, discussion of practical considerations and examples of application in existing antenna designs.

The final section outlines techniques and describes equipment useful for experimental determination of antenna impedance, pattern and gain. This book is a desirable addition to the microwave engineers' bookshelf. It is written in an easily

understandable way, well illustrated and indexed. While it cannot be termed complete in the strictest sense, it gives a more extensive treatment of the subject than any other single source.

Complementary material is presented in Volumes 2 and 26 of the same series, including additional descriptions of existing antenna designs, radar scanners and radome considerations. With these three volumes, the engineer has considerably more than just a good treatment of microwave antenna basic principles.—DAVID F. BOWMAN, *Airborne Instruments Laboratory, Mineola, New York*

Advances in Electronics, Volume I

EDITED BY L. MARTON, *National Bureau of Standards. Academic Press, New York*, 1948, 475 *pages*, $9.00.

THIS is the first volume of what promises to be an annual survey of certain portions of pure and applied electronics or what the editors prefer to call physical electronics (dealing with the charged particles themselves) and engineering electronics (dealing with applications of devices using the charged particles).

Naturally, in a field as large as electronics and growing as fast intellectually, a choice must be made as to the particular aspects to be reviewed in any one volume. The chapter headings listed below indicate the extent of the present volume. Each chapter is by an expert. Each requires from 30 to 50 pages and thus may be considered as a small monograph. Each strives to bring the reader up to date on the present state of the art.

The book is well printed and easy to read. The illustrations are large and well made. There are extensive author and subject indices. Since each chapter would serve excellently as an orienting medium or a jumping-off place from which one can dig deeper into the intricacies of the subject, the volume as a whole has excellent reference value.

Chapter titles and their authors are: Oxide Coated Cathodes, by A. S. Eisenstein of Univ. of Missouri; Secondary Electron Emis-

sion, by K. G. McKay of Bell Labs; Television Pickup Tubes and the Problem of Vision, by A. Rose of RCA Labs; The Deflection of Beams of Charged Particles, by R. G. E. Hutter of Sylvania; Modern Mass Spectroscopy, by M. G. Inghram of Argonne Labs; Particle Accelerators, by M. S. Livingston of Brookhaven Lab; Ionospheric Research, by A. G. McNish of NBS; Cosmic Radio Noise, by J. W. Herbstreit of NBS; Propagation in the FM Broadcast Band, by K. A. Norton of NBS; Electronic Aids to Navigation, by P. A. Pierce of Cruft Lab.—K. H.

• • •

Books Received for Review

RADIO SERVICING, THEORY AND PRACTICE. By Abraham Marcus. Prentice-Hall, Inc., New York, 1948, 775 pages, $5.95. Twelve chapters dealing essentially with radio theory, one chapter on servicing instruments and three chapters on servicing proper, written as an intermediate text for those who know some radio yet are not engineers. Service Notes at the ends of many chapters deal with common defects in the parts or circuits covered in the chapters.

PRACTICAL TELEVISION SERVICING. By J. R. Johnson and J. H. Newitt. Murray Hill Books, Inc., New York, 1949, 334 pages, $4.00. Eight chapters (approximately half the book) on television receiving circuit theory, six practical chapters on receiver installation, servicing and troubleshooting, and a short concluding chapter on color television principles. Written primarily for those who have already mastered radio receiver servicing.

TABLES OF BESSEL FUNCTIONS OF FRACTIONAL ORDER. By The Computation Laboratory of NBS. Volume II. Columbia University Press, New York, 1949, 370 pages, $10.00. Tabulation of $Jv(x)$ for $\pm v = \frac{1}{4}, \frac{1}{3}, \frac{2}{3}$ and $\frac{3}{4}$, as sequel to volume containing $Jv(x)$ for same orders. Functional values are given either to ten decimal places or ten significant figures. Range of x is from 0 to 25, and the function $e^{-x}Iv(x)$ is tabulated in the range of x from 25 to 30.000. Tables of Everett interpolation coefficients, a list of constants and a table for facilitating interpolation with respect to v are also given.

HANDBOOK OF PLASTICS. By H. R. Simonds, A. J. Weith and M. H. Bigelow. D. Van Nostrand Co., Inc., New York. Second Edition, 1949, 1,511 pages, $25.00. Text of 1943 first edition has been largely rewritten to cover new and improved processes and products. Tables and data have been revised to reflect changes. Extensively indexed, with comprehensive listing of trade names and trade marks. Intended to present in one comprehensive reference work the fundamental basis and technology of the plastics industry.

BASIC ELECTRICAL ENGINEERING. By George F. Corcoran, Professor and Chairman, Electrical Engineering Department, University of Maryland. John Wiley & Sons, Inc., New York, 1949, 449 pages, $4.50. A textbook designed especially for use in an introductory course in electrical engineering. Includes d-c theory and circuit analysis, electric and magnetic field theory, inductance, capacitance, and a chapter on nonlinear circuit elements.

DIRECT CURRENT FUNDAMENTALS. By Joseph J. De France. Prentice-Hall, Inc., New York, 1949, 279 pages, $4.30. Written expressly for training electronic technicians at the technical institute level; based on electron theory.

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.

More On TV Synchronization

DEAR SIRS:

IN CONNECTION with the first article in February ELECTRONICS, you may be interested in the birth of the idea mentioned, as outlined in the article, "Wireless Synchronization" in the December 1931 issue of *Radio Engineering*. Synchronization went on and got as far as March 1935 issue of the IRE journal. At that point, "the more abundant life" got to be too much for it.

The 1931 article discusses a plan for the synchronization of several stations by so-called *syntraction*. The idea of a high-power low-frequency master wave, while not too bad for the broadcasting frequencies, is not very promising for television frequencies, since a very slight shift in space due to the Doppler effect on the low frequencies would represent several cycles of phase shift on the high frequencies, and there could also be phase shift in the interference pattern on the high frequencies independent of the low frequency shifts that the low frequency could not control. By syntraction, however, the phase at any one spot in the pattern can be held reasonably constant.

As far as I can see, Kell's system is the same as mine. He uses a frequency modulated transmission back to the transmitter; I used d-c. He uses a reactance tube whereas in the IRE article I showed a mechanical tuner, electronically controlled. The step to a reactance tube is a natural.

I used the same thing later and one such circuit was on the bench when the war came along to stop further development. However, I was then working on the syntractor as a method for controlling the frequency of high-powered radio-frequency heating machines, where the

BACKTALK (continued)

use of all the intermediate stages to build up the power from a crystal was economically prohibitive. The idea was to tune a high-powered oscillator to a crystal oscillator by a reactance-tube syntractor, and use the combination to excite a high-powered class C final. This, incidentally, is the pioneer method of afc.

VERNE V. GUNSOLLEY
Arlington, Va.

Rounded Corners

DEAR SIRS:

I AM WRITING in reference to the discussion of masking of television receiver screens (Crosstalk, Feb. 1949). I feel that your material should be expanded and that certain essential additional information should be passed along to your readers before any sound conclusions can be reached concerning the engineering aspects of this controversial problem.

A nominal amount of corner masking of the reproduced television image is desirable for several reasons. First, a certain amount of corner masking is frequently present in the transmitted image. (A large percentage of motion picture films have rounded corners. Furthermore, best resolution can be obtained on image-orthicon cameras, used for most live pickups, when the maximum photocathode area is employed. For this reason it is frequently the practice to set the camera scanning so that the edges of the tube working area just show at the corners of the reproduced image). Secondly, as you pointed out, a rounding of the corners makes it possible to produce a slightly larger image on a picture tube of given diameter.

In discussing this subject it should be pointed out that there is a guide as to the amount of corner masking, and it generally is followed by the television broadcasters. The RMA television test chart (rarely seen on the air, but daily used in the pre-broadcast adjustment of film field and studio cameras) shows the nominal corner radius limit as being one-quarter the vertical height of the complete image. This was shown in ELECTRONICS for December 1947. In addition to the camera adjustment,

the slide copy and pull-cards are proportioned in such a way that the essential information is contained not only within the indicated area, but a margin of a few percent is maintained all around the edges and the corners. This slight border prevents viewers from missing any information through mis-adjustment of the receiver (decentering or overscanning) and at the same time provides for some degree of proper pictorial composition.

With these facts as to the position of essential information in the transmitted television picture signal, it is of interest to compare the three types of receiver masks mentioned in your editorial. The following table assumes a useful screen diameter of ten inches.

A—Rectangular with rounded corners. Typical of conventional receivers
Dimensions . . . . . $6\frac{3}{8}$ x $8\frac{1}{2}$ in
(2-inch radius to corners)
Visible picture area . . . . 50.75 sq in
Unseen picture area . . . . 3.43 sq in
Loss in picture area . . . . 6.3 percent
No material loss of transmitted information as established by broadcasters

B—Right and left hand edges of scanned area tangent to tube sides
Dimensions . . . . . $7\frac{1}{2}$ x 10 in
(5-inch radius to sides)
Visible picture area . . . . 66.92 sq in
Unseen picture area . . . . 8.08 sq in
Loss in picture area . . . 10.8 percent
Some slight loss in corner information

C—Top and bottom of tube tangent to top and bottom of scanned area
Dimensions . 10-inch diameter circle
Visible picture area . . . . 78.54 sq in
Unseen picture area . . . 54.76 sq in
Loss in picture area . . . 41.1 percent
Severe loss of transmitted picture information

From the above table it is apparent that either receiver *A* or *B* will provide satisfactory reproduction of the essential transmitted picture information and that receiver *C* will not afford good service in this regard. To offset partially this completely unsatisfactory loss, it appears to be common practice (in receivers of the *C* type) to deliberately destroy the normal 3 x 4 aspect ratio and scan a square

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rather than a rectangle. This does reduce the percentage of lost area from approximately 41 percent to approximately 21 percent though it produces a rather grotesque distortion of faces and figures. It is evident that whether it be 21 percent or 41 percent, any such significant loss of picture information is going to result in ultimate dissatisfaction on the part of receiver owners. (Anyone watching a fast-moving sporting event such as football or baseball can attest to this).

Obviously, the producers of television programs are not going to reframe their shots in such a way that this hidden area contains no valuable program information. (Among other factors, a sizable percentage of present day programming is done by film, and restriction of action here is not under the control of operating personnel).

It is apparent that no revision of present operating standards will be accomplished to benefit the relatively small percentage of sets of this unorthodox layout. I then wonder whether the RMA, or some other organization looking after the public interest, should not take steps to prevent the buyer from being misled as to the results obtained with receivers employing this deflection arrangement. Of course, exception should be taken to those receivers having front-panel control making it possible to switch to conventional scanning.

It certainly is well, for the sake of the growth of the industry, that efforts be made to produce larger pictures more economically than has been possible in the past. However, this increase in size should not be at the viewer's expense (in missed program information). Neither is it fair to the largest percentage of set owners, or the broadcasters, to attempt to revise the operating standards at this late date. Effort could better be directed toward lowering production costs on larger screen cathode-ray tubes (perhaps, by expansion of such new techniques as the metal-sided tube now being produced in 16-inch size, and by further experimentation with rectangular faced tubes).

Yours for better television.

EARL D. HILBURN
Silver Spring
Maryland

CONTACTS

FOR THE FIELD OF ELECTRONICS

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

ENGINEERS

PROGRESSIVE ELECTRONIC RESEARCH AND DEVELOPMENT COMPANY

has several openings for Senior Electronic Engineers of superior ability, with experience in design and development. Excellent opportunities for top flight men. Send complete resumes and salary requirements to:

Personnel Department

MELPAR, INC.

452 SWANN AVENUE, ALEXANDRIA, VIRGINIA

RADAR, COMMUNICATIONS AND SONAR TECHNICIANS

W-A-N-T-E-D

For Overseas Assignments

Technical Qualifications:

1. At least 3 years practical experience in installation and maintenance
2. Navy veterans ETM 1/c or higher.
3. Army veterans TECH/SGT or higher.

Personal Qualifications:

1. Age, over 22—must pass physical examination.
2. Ability to assume responsibility.
3. Must stand thorough character investigation.
4. Willing to go overseas for 1 year.

Base pay, Bonus, Living Allowance, Vacation add-up to $7,000.00 per year. Permanent connection with company possible,

Apply by Writing to

A-1, P. O. Box 3414, Philadelphia 22, Pa.

Men qualified in RADAR, COMMUNICATIONS or SONAR give complete history. Interview will be arranged for successful applicants.

Electronic Engineers

BENDIX RADIO DIVISION
Baltimore, Maryland
manufacturer of
RADIO AND RADAR EQUIPMENT
requires:

PROJECT ENGINEERS

Five or more years experience in the design and development, for production, of major components in radio and radar equipment.

ASSISTANT PROJECT ENGINEERS

Two or more years experience in the development, for production, of components in radio and radar equipment. Capable of designing components under supervision of project engineer.

Well equipped laboratories in modern radio plant . . . Excellent opportunity . . . advancement on individual merit.

Baltimore Has Adequate Housing

Arrangements will be made to contact personally all applicants who submit satisfactory resumes. Send resume to Mr. John Siena:

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION
Baltimore 4, Maryland

ELECTRONIC ENGINEERS PHYSICISTS

"A leading Electronics Company in Los Angeles, California offers permanent employment to persons experienced in advanced research and development. State qualifications fully."

P 6606 Electronics
68 Post St., San Francisco 4, Calif.

WANTED

Mathematicians, Engineers, Physicists

Men to train in oil exploration for operation of seismograph instruments, computing seismic data, and seismic surveying. Beginning salary $250.00 to $300.00 per month dependent on background. Excellent opportunity for advancement determined on ingenuity and ability. Nature of work requires several changes of address each year; work indoors and out; general location in oil producing locations.

To apply write giving scholastic and employment background, age, nationality, marital status, and include recent snapshot to

NATIONAL GEOPHYSICAL CO., INC.
8800 Lemmon Ave. Dallas 9, Texas

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

SELLING OPPORTUNITY OFFERED

REPRESENTATIVE WANTED, New England territory, E.E. background preferred, for established line of voltage regulators. Our organization knows of this ad. Reply in confidence giving details of lines now handled. RW-8459, Electronics.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (39 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 278 Dun Bldg., Buffalo 2, N. Y.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. E, 241 Orange St., New Haven, Conn.

ENGINEERING OPENINGS! Broadcast-TV (1st 'phone license); Sales, Design-Development Engineers-Technicians needed for all phases radio-electronics. RRR-Radio-TV Employment Bureau, Box 413, Philadelphia, Pa.

POSITIONS WANTED

MANUFACTURING EXECUTIVE, well qualified background of business, production and engineering experience in Electronic and Electrical equipment, with associated Plastic Molding and Precision Machine products manufacturing. Competent to handle personnel, production, sales engineering and co-ordination of engineering and production in medium size plant or department. Experience includes volume and small lot specialized equipment production. Age 41 years, earning record $8000.00 annually, now located on West Coast. Will consider any section of country and cooperate in arranging personal meeting. Electronics, 68 Post Street, San Francisco 4, California. Reply PW 8499.

EXECUTIVE ENGINEER, Broad background of training and experience in the fields of electrical engineering and electronics, including Radar and Sonar. B.S. in E.E. and M.S. in E.E. Experienced in design of electronic equipment, in direction of technical personnel and coordination of development and design of extensive electronic systems. Cost conscious, capable and energetic. Available for responsible position. PW 8436, Electronics.

(Continued on the opposite page)

Additional Positions Vacant Ads on the opposite page

OPENINGS IN RESEARCH

WESTINGHOUSE LABORATORIES—PITTSBURGH

Electronics engineers and physicists for basic research in television and allied fields. Experience in electron optical devices, optics, circuits and systems.

For application write Mgr.
Technical Employment

WESTINGHOUSE ELECTRIC CORP.
306 Fourth Avenue Pittsburgh, Pa.

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Airplane Stability and control, Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

Send complete resume to employment office.

SPERRY GYROSCOPE CO.
Division of the Sperry Corp.
GREAT NECK, LONG ISLAND

POSITIONS WANTED
(Continued on opposite page)

TEACHING OR Research position wanted, experience in both industries and teaching, advances degree, widely published. PW 8535, Electronics.

MECHANICAL ENGINEER M.E., M.S. — 8 years experience instruments, servomechanisms, computors, microwave components, fract. H.P. control motors and control clutches. Background includes machine design, circuit analysis, machine shop, manufacturing supervision and electronic research lab. experience. PW 8571, Electronics.

JUNE 49 Honor Grad of leading Midwest Coll. BSEE. Grad Harvard-MIT Radar Course. Three yrs. exp. as Research & Development Officer. MOS 7050. Exp. with electronic bombing computers and telephone subs. equip. Tau Beta Pi-Eta Kappa Nu-Pres. Student AIEE. Prefer connection with quality conscious firm in Southwest U.S.A. PW 8593, Electronics.

SELLING OPPORTUNITY WANTED

FACTORY REPRESENTATIVE: Reputable individual with electronics background and wide business experience seeks to represent manufacturer of worthy product or products for distribution in East Coast area. All correspondence held in strictest confidence. Please address Box 489, Lynbrook, N. Y.

BUSINESS OPPORTUNITY

Here's a natural for you

electrically inclined people. Active coin machine business in Indian Head Resort Country in immediate area of over 15 million dollars public works projects. Virtually all post war equipment. Complete stocks of records and repair parts. Thriving year around business. Write BO 8605, Electronics.

TEC

ENGINEERS

TELEVISION EQUIPMENT CORPORATION offers an unusual opportunity for qualified engineers to participate in the growth of the rapidly expanding Industrial Television field.

Experience in video, pulse, electronic display and circuit techniques with good educational background required. Several positions are available ranging from junior to project engineers.

Compensation is commensurate with ability. Opportunity to participate in company profit sharing plan.

Apply by letter to Leonard Mautner, Vice President:

TELEVISION EQUIPMENT CORP.
238 William St. New York, 7, N. Y.

CONTRACT WORK

Established Chicago firm desires electronic manufacture contract work in component fabrication or complete unit assembly. Open for govt. work, engineering, development, or production.

CW-8481, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

SAVE RESEARCH TIME BY CONSULTING
The Indispensable Bibliographical Reference
ELECTRONIC ENGINEERING MASTER INDEX
Descriptive Literature on Request
ELECTRONICS RESEARCH PUBL. CO.,
2 W. 46th St., N. Y. 19

WANTED

(Additional Wanted Ads on page 264)

ELECTRONIC MANUFACTURERS

Electronics engineering firm will shortly open new office in Phila. with complete facilities for installation and maintenance of industrial electronic and communication equipment. All advantages of a district field engineering office are offered to reliable electronic equipment manufacturers. Our staff of experienced graduate engineers, working closely with your factory design sections, can supplement your present local sales office to offer your customers in the Mid-Atlantic region a complete technical consulting, installation, and warranty period maintenance service.

RA-8557, Electronics
330 West 42nd St., New York 18, N. Y.

TELEVISION ENGINEERS

Due to wide expansion in television program of long established radio and television manufacturing company, positions are now available for engineers with three or more years television experience.

Excellent working conditions in modern, well-equipped laboratory.

Company located in northwest portion of New York State.

Housing no serious problem.

Salaries commensurate with ability.

P-8503, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

TELEPHONE CARRIER EQUIPMENT (Western Electric) types, C, CF-1, CF-3, CF-4, CF-5, H, H-1.

TELEGRAPH CARRIER EQUIPMENT (Western Electric) X-61822A, CF-2, CF-6, 40AC1, 40C1

TELETYPEWRITERS—All Models

TELEPHONE SWITCHBOARDS—Manual and automatic.

RADIO TELEPHONE LINKS — AN/TRC-1, AN/TRC-3, AN/TRC-4, T-14/TRC-1 Transmitters, R-19/TRC-1 Receivers, Antennas.

W-8482, Electronics
330 W. 42nd St., New York 18, N. Y.

CONTRACT WORK

Electronics manufacturer now has facilities for handling additional contracts specializing in electronic equipment assembly, sub-assembly or complete unit manufacture. Television is our specialty.

CW-8470, Electronics
330 W. 42nd St., New York 18, N. Y.

SCIENTISTS AND ENGINEERS

Wanted for interesting and professionally challenging research and advanced development in the fields of microwaves, radar, gyroscopes, servomechanisms, instrumentation, computers and general electronics. Scientific or engineering degrees or extensive technical experience required. Salary commensurate with experience and ability. Direct inquiries to Mgr., Engineering Personnel, Bell Aircraft Corporation, P. O. Box 1, Buffalo 5, N. Y.

WANTED
WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6641, Electronics
330 West 42nd St., New York 18, N. Y.

NEW LOW PRICES!

ALL BRAND NEW
STANDARD BRAND

MINIMUM ORDER $5.00
QUANTITY PRICES ON REQUEST

Type	Price
1B22	$4.95
1B23	9.50
1B24	4.95
1B25A	4.95
1B26	4.95
1B27	4.95
1B29	.89
1B32	4.95
1B36	4.95
1B40	4.95
1B56	4.95
1C21	1.29
1P23	1.95
1S21	1.96
2AP1	3.95
2C4	1.18
2C21	.98
2C22	.39
2C26A	.28
2C34	.59
2C40	1.98
2C43	7.50
2C44	1.75
2C46	3.69
2D21	1.18
2E22	1.50
2E24	4.95
2E25	4.25
2E26	3.95
2E30	2.49
2J21A	12.39
2J26	8.95
2J31	10.95
2J32	13.95
2J33	24.95
2J34	24.95
2J37	17.95
2J38	13.95
2J49	24.95
2JB51	4.95
2J54B	17.95
2K25	24.95
2K28	24.95
2K33	34.95
3AP1	4.95
3B22	4.95
3B23	4.95
3B24	1.98
3B26	1.89
3B27	3.95
3B28	5.95
3BP1	3.95
3C22	18.95
3C23	4.95
3C24	.69
3C30	1.50
3CP1	3.00
3D21A	1.50
3DP1	3.95
3EP1	3.95
3E29	4.95
3FP7	3.95
3J31	49.50
4-65A	14.50
4-125A	27.50
4-250A	37.50
4A1	1.98
4AP10	6.95
4B24	4.95
4C35	19.95
4E27	12.95
4J26	110.00
5AP1	4.95
5AP4	5.95
5BP1	2.95
5BP4	4.95
5CP1	3.95
5CP7	13.95
5D21	29.95
5FP7	3.95
5GP1	9.95
5HP4	9.95
5JP2	11.95
5LP1	11.95
5LP5	14.95
5NP1	2.95
6AF6G	.88
6C21	24.95
6D4	2.75
6F4	5.95
6J4	6.50
7BP7	4.95
7EP4	17.95
9GP7	15.00
9JP1	7.95
10Y	.69
10SPEC	.69
10BP4	34.95
10CP4	39.50
12DP7	14.95
12DP8	14.95
12FP7	14.95
12GP7	14.95
12HP7	14.95
15E	1.50
15R	1.50
23D4	.49

Type	Price
24G	.98
35T	4.95
45SPEC	.49
75TL	3.95
100TH	12.95
100TS	3.00
114A	.69
114B	1.25
120	5.95
121A	2.65
205B	4.50
211	0.98
215A	3.00
217C	7.30
218	49.50
221A	2.95
231D	1.49
249C	3.49
250R	7.95
250TH	19.50
250TL	19.50
252A	4.95
254	19.95
259A	4.95
274A/B	1.25
282A/B	9.95
304TH	6.95
304TL	1.49
307A	4.95
316A	.69
322A	8.95
327A	4.95
331A	5.95
338A	4.93
350A/B	2.95
354C/D	19.95
368AS	4.93
371A/B	.89
393A	7.95
394A	4.50
417A	24.95
434A	7.95
446A/B	1.95
450TH	24.95
464A	7.50
527	12.95
531	24.50
575A	14.95
701A	4.95
703A	4.95
705A	2.95
706CY	18.95
707A/B	24.95
708A	7.95
710A	2.95
713A	1.65
714AY	6.95
715A/B	9.95
715C	24.95
717A	.99
720DY	34.95
721A/B	4.35
723AB	7.95
724A/B	4.95
725A	9.95
726A	23.50
750TL	49.50
800	2.25
801A	.98
802	3.75
803	8.95
804	12.95
805	5.95
807	1.25
808	1.89
809	2.93
810	7.95
811	2.45
812	2.95
812H	6.90
813	8.95
814	3.95
815	2.95
816	1.19
826	.69
828	6.95
829A/B	7.95
829/3E29	4.95
830	2.95
830B	5.25
832/A	4.95
833A	34.50
834	5.95
836	1.15
837	2.50
838	3.95
841	.69
843	.69
845/W	4.95
849A	60.00
849H	60.00
851	75.00
860	3.00
861	49.95
864	.69
865	2.98
866A	.99

Type	Price
868	1.95
869B	75.00
872A	2.95
874	2.49
878	2.49
884	1.49
885	.98
891	110.00
892	175.00
902PI	7.95
904	9.95
905	11.95
923	.98
925	1.40
931A	4.95
954	.75
955	.75
956	.75
957	.75
958A	.75
959	2.95
991	.75
1608	4.95
1611	.98
1613	.75
1614	1.75
1616	1.39
1619	.75
1620	4.95
1621	1.98
1622	1.75
1624	1.75
1625	.49
1626	.49
1628	4.95
1629	.69
1631	1.50
1634	.79
1635	1.10
1636	5.95
1638	.98
1641	.79
1642	.98
1644	1.49
1851	1.25
1852	1.06
1853	1.06
1960	.95
2050	1.19
2051	.98
5514	4.95
5516	5.95
5562	10.00
7193	.39
8003	5.95
8005	4.95
8011	2.95
8012A	4.95
8013A	2.95
8014A	24.95
8016	1.49
8020	3.95
8025	7.95
C5B	12.95
C6J	12.95
CEQ72	1.95
CK1005	.35
CK1006	.69
CK1090	4.95
EF50	.79
EL1C	4.95
EL3C	4.95
F123A	12.95
F660	150.00
FG17	3.25
FG27A	9.95
FG33	8.95
FG67	12.95
FG81A	6.95
FG105	19.95
FG172A	32.50
FG235	59.50
FG238B	160.00
GL146	11.00
GL502A	1.98
GL530	49.50
GL559	5.35
GL697	150.00
HF100	3.95
HF210	17.95
HY65	2.49
HY69	2.49
HY75	1.25
HY615	1.25
HYE1148	.48
KU610	9.95
ML101	150.00
REL36	.98
RK25	2.95
RK33	.98
RK34	.59
RK39	1.75
RK59	3.95
RK60	.79
RK65	24.95
RK72	1.95
RK7	3.95

Type	Price
RX120	10.00
SD809	4.95
T20	1.50
T55	3.95
T200	10.95
TZ20	1.50
TZ40	2.95
UH50	5.95
V70D	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR105	.98
VR150	.75
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
Z225	1.95
ZB120	6.95
ZP477/12DP8	14.95
0A2	1.69
0A3/VR75	.98
0A4G	1.06
0B2	2.05
0B3/VR90	.75
0C3/VR105	.98
0D3/VR150	.75
OY4	.88
0Z4	.88
OZ4G	.88
O1A	.50
1A3	.72
1A4	1.28
1A4P	1.56
1A5GT	.72
1A6	1.28
1A7GT	.80
1B3GT	1.49
1B4	1.56
1B5 25S	1.28
1B7GT	1.06
1C5GT	.88
1C6	1.28
1C7G	1.28
1D5GP	1.55
1D7G	1.28
1D8GT	1.56
1E5GT	1.38
1E7G	1.56
1F4	1.06
1F5G	1.06
1F6	1.56
1F7G	1.56
1G4GT	1.06
1G6GT	1.06
1H4G	.88
1H5GT	.66
1H6G	1.28
1H6GT	1.28
1J6GT	1.28
1L4	.80
1LA4	1.06
1LA6	1.06
1LB4	1.06
1LC5	1.06
1LC6	1.06
1LD5	1.06
1LE3	1.06
1LG5	1.06
1LH4	1.06
1LN5	1.06
1N5GT	.80
1P5GT	1.06
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
2V3G	1.98
2X2A	1.25
3A4	.39
3A5	1.49
3A8GT	1.98
3B7	.36
3D6	.36
3LF4	1.28
3Q4	.88
3Q5GT	.96
3S4	.80
3V4	.80
5AZ4	.50

Type	Price
5R4GY	1.15
5T4	1.28
5U4G	.60
5V4G	.96
5W4	1.06
5W4GT	.66
5X4G	.72
5Y3GT	.42
5Y4G	.60
5Z3	.72
5Z4	1.06
6A3	1.28
6A6	1.06
6A7	.80
6A8	.80
6A8GT	.80
6AB5/6N5	.88
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
6G6	.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	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

Type	Price
6SG7	.80
6SH7	.39
6SJ7	.66
6SJ7GT	.66
6SK7	.66
6SK7GT	.66
6SL7GT	.96
6SN7GT	.88
6SQ7	.60
6SQ7GT	.60
6SR7	.72
6SR7GT	.72
6SS7	.66
6ST7	.88
6SV7	.88
6T7G	1.24
6U/5G5	.72
6U6GT	.72
6U7G	.72
6V6	1.28
6V6GT	.80
6W7G	.88
6X4	.60
6X5GT	.60
6Y6G	.96
6Y7G	.88
6Z7G	1.28
6ZY5G	.88
7A4/XXL	.72
7A5	.72
7A6	.72
7A7	.72
7A8	.72
7AD7	1.06
7AF7	.72
7AG7	.88
7AH7	.88
7B4	.72
7B5	.72
7B6	.72
7B7	.72
7B8	.72
7C4/1203A	.39
7C5	.72
7C6	.72
7C7	.72
7E5/1201	1.66
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	.29
12A7	1.28
12A8GT	.80
12AH7GT	.88
12AL5	.80
12AT6	.60
12AT7	1.16
12AU6	.80
12AU7	.96
12BA6	.72
12BE6	.72
12C8	.69
12F5GT	.72
12H6	.39
12J5GT	.39
12J7G	.80
12J7GT	.80
12K7GT	.66
12K8	.88
12K8GT	.96
12Q7GT	.72
12SA7	.66
12SA7GT	.66
12SC7	.72
12SF5	.80
12SF5GT	.80
12SF7	.80
12SF7GT	.80
12SG7	.72
12SH7	.39
12SJ7	.66
12SJ7GT	.66
12SK7	.66
12SK7GT	.66
12SL7GT	.88
12SN7GT	.80
12SQ7	.60
12SQ7GT	.60
12SR7	.39

Type	Price
12SR7GT	.39
12X3	.98
12Z3	.88
14A7/12B7	.88
14AF7/XXD	.88
14B6	.88
14B8	.88
14C5	.88
14C7	.88
14E6	.72
14E7	.88
14F7	.88
14F8	1.06
14H7	.88
14J7	1.06
14N7	1.06
14Q7	.88
14R7	.88
14S7	1.06
14W7	1.06
14X7	1.06
14X4	.88
19	1.28
19T8	1.56
22	1.28
24A	.88
25A6	1.06
25A6G	1.06
25AC5GT	1.16
25L6GT	.66
25Y5	1.16
25Z5	.60
25Z6GT	.60
26	.72
27	.60
28D7	.39
30	.39
31	.39
32	1.28
32L7GT	1.28
33	.39
34	.38
35/51	.89
35A5	.72
35B5	.89
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	.95
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-1009	1.28
UX129	1.38
UX200	1.28
9001	.89
9002	.39
9003	.69
9004	.49
9005	.98
9006	.49

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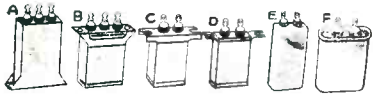

UPRIGHT OIL CAPACITORS
STANDARD BRANDS

Fig.	Mfd	Voltage	Terminals	Price
B	1	600VDC	2	35¢ 3 for $1.00
E	.25	400VDC	2	39¢ 3 for 1.10
E	.5	600VDC	2	35¢ 3 for 1.00
E	1	600VDC	2	39¢ 3 for 1.10
D	2 x .5	600VDC	3	49¢ 3 for 1.45
B	3 x .1	600VDC	3	55¢ 2 for 1.05
B	.25	400VDC	2	39¢ 3 for 1.10
B	.5	600VDC	2	35¢ 3 for 1.00
B	.5	600VDC	2	35¢ 3 for 1.00
E	1	400VDC	2	35¢ 3 for 1.00
B	.1	400VDC	2	40¢ 2 for 75¢
B	.4	600VDC	2	39¢ 3 for 1.10
D	.1	600VDC	2	45¢ 2 for 85¢
B	2 x .1	600VDC	2	50¢ 2 for 95¢
E	1.75	400VDC	2	35¢ 3 for 1.00
D	3 x .1	600VDC	3	55¢ 2 for 1.05
A	2 x .5	600VDC	3	49¢ 2 for 95¢
B	.1	600VDC	2	45¢ 2 for 85¢
B	.1	600VDC	2	45¢ 2 for 85¢
D	1	500VDC	2	45¢ 2 for 85¢
A	1	500VDC	2	45¢ 2 for 85¢
B	.1	600VDC	2	45¢ 2 for 85¢

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Typewriter Desk Wells Mounted on Steel Panel for Standard Rack Mfg. 10½" H x 19" W x ⅛" Thick. Well is 22" Wide, 20" Deep, Affording Full Working Space. Grey Crackle Finish. New .....ea. $8.95

INTERPHONE CONTROL BOX

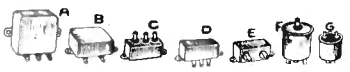
BC606-F. Metal case (4"x4"x2"d). Contains: Jk-34A (phone), Jk 33A (mike) Resis 2000ohm ½w, Pot 50000ohm, SPST Lum Tip, Term strip, Recep. & cover for Mag. Mike.
PRICE $1.00

CIRCUIT BREAKERS

Fig. A,	50A	28V		79¢
Fig. A,	100A	28V		79¢
Fig. A,	150A	28V		79¢
Fig. A,	10A	24V		79¢
Fig. B,	3A	117V		$1.95
Fig. C,	100A	250V	3 Pole	6.95

932 PHOTO TUBE

This Tube is a Gas Phototube having S-1 Response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data. Price.....$1.25



BATHTUB CAPACITORS

Fig.	Mfd	Voltage	Terminals	Price
D	3 x .1	600VDC	3	33¢ 4 for $1.29
E	3 x .1	400VDC	3	33¢ 4 for 1.29
C	.1	400VDC	2	20¢ 5 for 95¢
C	2 x .1	600VDC	3	29¢ 3 for 85¢
E	.025	600VDC	2	18¢ 5 for 85¢
A	2	400VDC	2	40¢ 2 for 75¢
C	.1	600VDC	2	25¢ 4 for 95¢
E	2 x .25	600VDC	3	29¢ 3 for 85¢
A	.5	1000VDC	2	45¢ 3 for 1.30
D	.1	600VDC	2	25¢ 4 for 95¢
E	3 x .1	600VDC	3	35¢ 3 for 1.00
E	.5	200VDC	2	20¢ 5 for 95¢
C	.05	600VDC	2	21¢ 5 for 1.00
E	.5	600VDC	2	25¢ 4 for 95¢
C	.5	120VDC	2	18¢ 5 for 85¢
E	.1	600VDC	1	20¢ 5 for 95¢
E	4	50VDC	2	25¢ 4 for 95¢
E	1	400VDC	1	25¢ 4 for 95¢
D	1	600VDC	2	30¢ 3 for 75¢
C	3 x .1	600VDC	3	33¢ 4 for 1.29
E	2 x .25	400VDC	3	27¢ 4 for 1.05
D	.5	600VDC	2	25¢ 4 for 95¢
D	2 x .1	600VDC	3	29¢ 3 for 85¢
D	.5	600VDC	1	20¢ 3 for 95¢
E	2 x .1	200VDC	2	20¢ 5 for 95¢
C	.5	400VDC	1	20¢ 5 for 95¢
	1	100VDC	2	15¢ 7 for 1.00
A	.02	1500VDC	2	45¢ 2 for 85¢
C	.5	600VDC	2	25¢ 4 for 95¢
C	.5	200VDC	2	20¢ 5 for 95¢
E	.4	50VDC	2	30¢ 3 for 85¢
E	.20	50VDC	2	25¢ 4 for 95¢

Write for Lists of Other Values

COMMUNICATIONS EQUIPMENT COMPANY *for your needs*

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.....$4.75

BAND PASS FILTER

#70473. Sharp band pass peaked at 700 cps. Band-width: 650 cycles at 20 db. Down from peak. High-to-high impedance. Can be plugged into phone output of receiver for good results. Cuts out QRM New, with circuit diagram.....$2.25

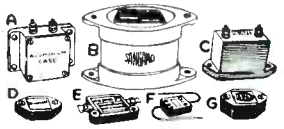
POWER EQUIPMENT

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". $37.50
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: 6.3 v. 2.5 amp: 6.3 v. .06 amp; 6.3 v. .9 amp; 5 v. 6 amp; 700 vct $4.75
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, .043 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: 340 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.....$1.35
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

WRITE TO C.E.C. FOR YOUR 400 CYCLE NEEDS



H.V. MICAS

Fig.	Mfd	Voltage	Price
D	.01	1200WVDC	50¢ 2 for 95¢
E	.00025	2500TVDC	29¢ 2 for 55¢
D	.00004	2500WVDC	39¢ 2 for 75¢
E	.000047	2500WVDC	39¢ 2 for 75¢
E	.01	500WVDC	25¢ 4 for 95¢
C	.002	3000WVDC	$1.05 2 for $2.00
C	.01	2000WVDC	1.50 2 for 2.90
C	.00003	2000WVDC	49¢ 2 for 95¢
C	.00009	3000WVDC	75¢ 2 for 1.45
C	.00082	3000WVDC	1.00 2 for 1.95
C	.002	3000WVDC	1.00 2 for 1.95
C	.005	5000WVDC	1.65 2 for 3.25
C	.0004	6000WVDC	1.50 2 for 2.95
C	.0006	3000WVDC	1.00 2 for 1.95
C	.0008	3000WVDC	95¢ 2 for 1.85
E	.0016	3000WVDC	65¢ 2 for 1.25
E	.000090	3000WVDC	40¢ 2 for 75¢
B	.08	1500WVDC	10.00 2 for 19.50
B	.03	2000WVDC	12.00 2 for 23.50
B	.045	2000WVDC	12.00 2 for 23.50
B	.00015	20 KVDC	24.00 2 for 47.50
B	.0001	20KVDC	24.00 2 for 47.50
B	.002	15KVDC	19.00 2 for 37.50
C	.006	2500WVDC	1.45 2 for 2.85
E	.00027	2500WVDC	35¢ 2 for 65¢

Send for Lists of Others

PRECISION CAPACITORS

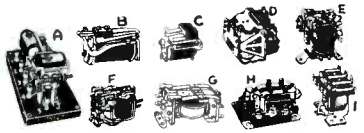
D-163707: 0.4 mfd @ 1500 vdc. —50 to plus 85 deg C.....$4.50
D-163035: 0.1 mfd @ 600 vdc, 0 to plus 65 deg C.$2.00
D-170908: 0.152 mfd, 300 v, 400 cy. —50 to plus 85 deg C.....$2.50
D-164960: 2.04 mfd @ 200 vdc, 0 to plus 55 deg C.$2.50
D-168344: 2.16 mfd @ 200 vdc, 0 to plus 55 deg C.$3.00
D-161555: .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

CERAMICON CONDENSERS
$7.50 per 100

3 mmf	±5%	60 mmf	±3%
5 mmf	±5%	67 mmf	±20%
4 mmf	±5 mmf	115 mmf	±2%
8.5 mmf	±5 mmf	120 mmf	±5%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	—
50 mmf	±20%	1000 mmf	±5%

Silver-Mica Button Capacitors (Standard Brand) $9.50 per 100

185 mmf	±2.5 mmf
175 mmf	±2.5 mmf
500 mmf	±10%



RELAYS

Type	Con-tacts	Rating	Res. Coil	Mfg	Price
H	DPDT (8A)	24-28V vdc	170 ohms	GECR2791B 100F3	$1.75
H	SPDT	28 vdc	175 ohms	GECR2791B	1.25
H	3PDT	24-28 vdc	175 ohms	GECR2791B	1.75
H	4PST	24 vdc	180 ohms	GECR2791G	1.75
G	DPDT, SPST	12 vdc	44 ohms	Leach 1067-490	1.45
G	DPDT	22-28 vdc	160 ohms	Leach	1.25
D	SPST	28 vdc	50 ohms	Allied BO48	1.39
I	DPST	14 vdc	85 ohms	Price X20-A	1.50
D	3PDT	24-28 vdc	280 ohms	Allied DOX-3	2.50
H	SPST	24-28 vdc	2490	GM 12917-1	2.00
D	DPDT	24 vdc	280	Allied BO635	2.00
D	3PDT (10A)	26 vdc	280	Allied KS 5910	1.10
D	DPDT	28 vdc	280	Allied BO 6D35	2.10
D	SPST (NC	75MA	60	Allied KS 5862	1.10
H	DPDT	20-30 vdc		Ounce 50XB	2.00
H	DPDT	10 14 vdc		Ounce 100AB	2.00
H	DPDT	24-28 vdc		PB21C057-A	1.75
H	3PDT	24-28 vdc		GECR2791	2.00
H	SPDT	24-28 vdc		GECR2791	1.75
A	DPDT	12 vdc		Ounce	2.40
A	SPDT	10-12v	125	Ounce	2.40
H	DPDT	27.5 vdc	400	Allied	1.10
D	DPDT	9-14 vdc		Allied	1.10
H	DPDT	24v60cy	50	Allied	1.40

ARC 3 MINIATURE RELAYS

Sealed Can	SPDT 5 Prong.		GECR2791C104	2.25
C	SPDT, 28 vdc	300 ohms	RBM55342	45¢
C	6 PST	22-28 vdc	300 ohms	RBM55528	45¢
C	SPST	22-28 vdc	300	RPM55251	45¢
C	DPDT, DPST	22-28 vdc	300	RBM55531	45¢
C	SPDT, SPDT	22-28 vdc	300	RBM55526	45¢

MAIL ORDERS PROMPTLY FILLED $3.00 MIN. ORDER

COMMUNICATIONS EQUIPMENT CO.

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SEND MONEY ORDER OR CHECK ONLY. $3.00 MIN. ORDER

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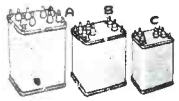

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FIL. 5V/6A $2.25
FIL. 6.3VCT/.6A, 5V/2A $1.85
FIL. 5087; 6.3VCT/1A, 6.3VCT/7A.....$2.75
FIL. 5103; 6.3V/1A, 6.3V/1A.....$1.95
FIL. 5123; 6.3VCT/5A, 6.3V/1A.....$2.25
FIL. 5127; 6.3VCT/3.2A, 6.3VCT/1A.....$2.25
FIL. 7470674; 8V/1.5A $2.95
FIL. 2.5/1.75A, 6.5/8A, 5/3A, 6.5/6.....$3.95
FIL. U7414; 2x2.5VCT/6.5A $3.25
FIL. U8161; 6.3VCT/7A, 6.3VCT/5A, 5VCT/6A 2x6.3V/.6A, 6.3V/.3A $3.95
FIL. U5829; 6V/2.5A $1.95
FIL. U6438A; 6.3V/2.5A, 2x2.5V/7A.....$3.25
FIL. U7112; 2x2.5VCT/6.5A, 2.5V/6.5A.....$4.25
FIL. U7114A; 6.3V/6A $1.95
PLATE. 800VCT/40MA, 760VCT/500MA $6.95
PLATE. 3415; 690V/450MA $4.95
PLATE. 68G699; 2x300VCT/150MA $2.25
PLATE. U7403; 70V/1A $2.25
PLATE. 510VCT/150MA, 650VCT/15MA $3.00
PLATE. 600VCT/.0166A, 250VCT/.077A $2.95
PLATE. 1620VCT/.4A, 3500T $11.95
PLATE. 2x200V/.35A, 2x20V/.01A $1.95
PLATE. U7450; 2x150V/.94A $4.50
PLATE. 30371; 246VCT/.83A $3.50
PLATE. GE 800V/5, 400V/2.5A, 128KVA.....$2.25
TELEV. 30345; 1470VCT/1.2A, 3500T.....$24.00
COMB. U8965; 78V/600MA, 6.3V.....$3.95
COMB. 5111; 2x300V/42MA, 55V/125MA, 45V/3.5 MA $4.50
COMB. CS5608; 880VCT/150MA, 5V/3A, 6.3V/ 6.25A $3.95
COMB. KS8931; 585VCT/86MA, 5V/3A, 6.3V/6A $4.25
COMB. 5055; 525VCT/75MA, 5V/2A, 6.3V/1.8A 10V/2A $4.45
TELEV. 5102; 1080VCT/55MA, 6.3V/1.2A, 6.3V/ 1.2A $5.95
COMB. U8848; 600VCT/155MA, 6.3VCT/5A, 5 VCT/3A, 2500T $3.95
COMB. U7899; 2x110VCT/.01A, 6.3V/1A, 2.5VCT/ 7A 1780 RMS.....$4.50
COMB. U8760; 6.3VCT/10A, 65V/.1A, 100VCT/ 1A, 40V/.1A, 18VCT/.1A, 18&6/.1A, 6.3/.1A.$5.25
COMB. 30354; 825VCT/.19A, 5VCT/3A.....$3.95
COMB. 30367; 5VCT/3A, 580VCT/.04A.....$2.95
TELEV. U8160; 1120VCT/.77A, 590VCT/.082A 3000VT $12.50
COMB. U9579; 24V/900MA, 770V/.0025 2.5V/3A 3500 Test $4.25
TELEV. 2300V/.004A, 2.5V/2A, 5500UT.....$8.95
COMB. U8375; 1120VCT/.6A, 2x5VCT/6-2A, 6.3VCT/3A, 6.3V/.3A $14.95
COMB. 30364; 6.3VCT/3A, 5VCT/6A, 610VCT/ .33A $4.50
COMB. U6434; 40V/.01A, 6.3V/1.25A.....$1.95
COMB. U8383; 215VCT/.3A, 5VCT/6A $2.29
COMB. 30360; 640VCT/.080A, 5VCT/3A, 6.3VCT/ 3.2A $3.95
COMB. U7821; 1500V/.004A, 6.3V/.6A, 2.5V/ 1.75A, 3500 Test.....$6.95

Send for list of other Values

FILTER CHOKES

.03HY/2A	$1.25	8.5HY/125MA	$1.50
25HY/65MA	1.00	6HY/150MA	1.50
Dual 7HY/75MA, 11HY/65MA			$1.65
7HY/140MA	$1.60	Dual 2HY/100MA	75¢
Dual 2.5HY/130MA	1.25	.116HY/150MA	4.25
.01HY/2.5A	1.45	.35HY/350MA	7.25
Dual .5HY/380MA	1.00	5HY/40MA	55¢
2HY/200MA	75¢	Dual 120HY/17MA	2.45
30HY/20MA	85¢	5HY/200MA	1.45
2.1HY/200MA	1.20	2x2.2HY/.55A	9.95
25HY/75MA	1.10	20HY/300MA	7.95
Dual .22HY/600MA, .44HY/400MA			1.75
.03HY/7A	$9.50	Dual 10HY/150MA	$4.00
Dual 1.52HY/167MA	2.49	Dual 2.2HY/550MA	5.95
5HY/200MA	1.49	1.35HY/1.1A	4.95
12HY/100MA	1.75	1HY/100MA	60¢
2x2.5HY/700MA	6.95	5.5HY/900MA	7.25

TRANSTATS (AMERTRAN)

Input: 0.115 v, 50-60 cycle. Max. output: 115 v, 100 amp. All units are new, guaranteed $95

UNIVERSAL OUTPUT TRANSFORMER

Amertran Silcor. PRI: 20,000/16,000/ 5000/4000 ohms. Sect. 500/15/7.5/5/3.75/ 1.25 ohms. 30 db. contin. Flat to 17,000 CY $4.75

COMMUNICATIONS EQUIPMENT COMPANY *for your needs*

PRECISION RESISTORS

1.01	125	1450	10000
3	128	1900	25000
5	150	2230	30000
5.05	200	4300	33000
10	250	5000	35000
10.1	300	7000	40000
18	430	7500	50000
43.5	468	8500	55000
50	800	10000	57000
75	920	12000	75000
82	1000	17000	We Ship Types
120	1100	17300	In Stock

Above Sizes Ea. 30¢ 10 for $2.50

100000	150000	200000	250000
120000	170000	220000	500000

Above Sizes Ea. 40¢ 10 for $3.50

Other Values in Stock. Send for List

OSCILLOSCOPE KITS

3" Oscilloscope BC929: Indicator using 9 tubes, 3BP1, 6SN7, 6H6, 6B6G, 6x5, 2x2. (Now 400 Cy) easily conv. To 60 cy., 115V. New, Complete w/tubes & conver. inst. $24.95

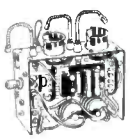
5" Oscilloscope BC 704: Less Pwr. supply, uses 8 tubes 5BP1, 6AC7, 6H6, incl. wooden carry case & diagram $32.00

GREAT TUBE VALUES

01-A	$.45	12K8Y	$.65	843	$.59
1B26	4.85	12SF7	.49	860	15.00
2C21	.69	12SR7	.72	861	40.00
2C22	.69	15P	1.40	874	1.95
2J21-A	25.00	28D7	.75	876	4.95
2J22	25.00	30 (Spec.)	.70	1005	.35
2J26	25.00	45 (Spec.)	.59	1619	.21
2J27	25.00	39/44	.49	1624	.85
2J31	25.00	35/51	.72	1629	.35
2J32	25.00	227A	3.85	1961	5.00
2J38	35.00	225	8.80	9002	.65
2J39	35.00	268-A	20.00	9004	.47
2J55	35.00	355-A	19.50	CEQ 72	1.95
2J40	65.00	417A	25.00	EF 50	.79
2J49	85.00	530	90.00	F-127	20.00
3J31	55.00	531	45.00	FC 258A	165.00
2X2/879	.69	532	3.95	GL 532	7.50
3BP1	2.25	559	4.00	FC 271	40.00
2C24	.60	562	90.00	GL 562	75.00
3C30	.70	615	.89	GL 623	75.00
3D6	.79	703-A	7.00	GL 697	75.00
3CP1	3.50	704-A	.75	ML 100	60.00
3D21-A	1.50	705-A	2.85	QK 59	65.00
3DP1	2.25	707-B	20.00	QK 60	65.00
3EP1	2.95	714AY	25.00	QK 61	65.00
3FP7	1.20	715-B	12.00	QK 62	65.00
3Q5	.79	720BY	50.00	VR 91	1.00
5BP1	1.95	720CY	50.00	VR 130	1.25
5BP4	4.95	721-A	3.60	VR 135	1.25
5CP1	3.75	723-A/B	12.50	VR 137	1.25
5FP7	3.50	724B	1.75	VU 120	1.00
5J30	39.50	725-A	25.00	VU 134	1.00
6G	2.00	726-A	15.00	WL 532	4.75
6SC7	.70	800	2.25	WN 150	3.00
7C4	1.00	801-A	1.10	WT 260	5.00
7E5	1.00	804	9.95		
7E6	.72	815	2.50	†With cavity:	
10Y	.60	836	1.15	Cavity only	5.00
12A6	.35	837	1.95		

932 PHOTOTUBE

This tube is a gas phototube having 5-1 response, particularly sensitive to red and near infrared radiation. Can be used with incandescent light source. Send for data. **PRICE** $1.25



FREQ. MULT. UNIT

ART-13 XMTR Assy 2 to 18MC Doubling Package set up, for two 1625 Tubes. No Coils. Complete. Assy Less Tubes w. CKT Diagram. ....**Price $9.95**

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 (as shown).....$3.00
#35X045B: 22v, .1 to 3 amps, for K-4B Gunsight. Webster...$3.00

CROSS POINTER INDICATOR

ID 24-ARN-9 Dual 0-200 microamp. movement in 3" case. Each movement brought out to 6-term receptacle at rear. Originally used in ILS equipment.
New $5.50
ZA Type $10.00

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Prices
PE 86	28	1.25	250	.060	RC 36	$3.95
DM 416	14	6.2	330	.170	RU 19	15.95N
DY-2/ARR-2	28	1.1	250	.060	ARC-5	4.75N
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	N
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 101C	13/26	12.6	400	.135	SCR 515	5.25N
		6.3	800	.020		
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	.060	SCR 522	8.95
			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		
			9	1.12		
BD 77KM	14	40	1000	.350	BC 191	N
						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 PE73, 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. Slight use, ex. con., with cranks.....$12.50

INVERTERS

PE 218-E: Input: 25-28 v dc. 92 amp. Output: 115 v, 350-500 cy, 1500 volt-amps. Dim: 17" x 6½" x 10". New, expert packed 49.95
PE 218-H: Same as above, except size: 16½" x 5¾" x 10". New.....$49.95
PE 218-H: Used, good cond. $25.00
PE 206: Input: 28 vdc, 38 amps. Output: 80 v, 800 cy, 500 volt-amps. Dim: 13" x 5⅜" x 10½". New.....$12.50
GE 5D21NJ3A: Input: 28 vdc, 35 amp. Output: 115 v, 400 cy, 485 volt-amps. Dim: 9" x 4½" diameter. New $49.95

*LEAR POWER UNITS

Type 133-C: 24VDC drive 90:1 gear ratio high pwr. Orig. designed for landing gear retraction. Bicycle type sprocket for multi purpose drive. **PRICE** $6.95

VOLTAGE REGULATORS

Mfg. Raytheon: Navy CRP-301407: Pri: 92-138 v, 15 amps, 57 to 63 cy, 1 phase. Sec: 115 v, 7.15 amp, .82 KVA, .96 PF. Contains the following components:

REGULATOR TRANSFORMER: Raytheon UX-9545. Pri: 92-138 v, 60 cy, 1 PH. Sec: 200/580 v, 5.5/5.26 amps, 4000 v. rms test.
FILTER REACTOR: .156 hy, 5 amps, 4000 v. test. Raytheon UX 9547.
TRANSFORMER: Pri: 186 v, 5 amps; Sec: 115 v, 7.2 amps. Size 12" x 20" x 29". Net Wt. approx. 250 lbs.
Entire unit enclosed in grey metal cabinet with mounting facilities. New, as shown.....$99.50

MAIL ORDERS PROMPTLY FILLED. $3.00 MIN. ORDER

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. "E" Mr. C. Rosen Ph. Digby 9-4124

SEND MONEY ORDER OR CHECK ONLY. $3.00 MIN. ORDER

ALL MERCHANDISE GUARANTEED. ALL PRICES, F.O.B. NEW YORK CITY. SHIPPING CHARGES SENT C.O.D.

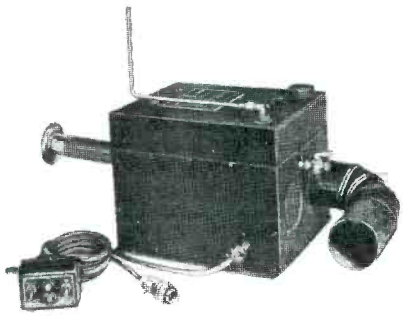
PORTABLE (CHRONOMETRIC) TACHOMETER

Jaeger Watch Co. Model #43A-6

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for lineal speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators, turbines, centrifugals, fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequalled Readability 2" Open face dial—each division on large dial equals 10 R.P.M.; each division on small dial equals 1,000 R.P.M.
- Greatest Accuracy—meets Navy specifications—guaranteed to be within ½ of 1%.
- Results of test reading remain on dial until next test taken.
- Push button for automatic resetting.
- Complete with the following accessories:
  1—Large pointed rubber tip
  1—Large hollow rubber tip
  1—6" circumference Wheel tip
  1—Operating Instructions
  1—Temperature Correction chart

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. of shafts or the lineal speeds of surfaces without any accessories or timing of any kind. Each unit comes complete in a red velvet lined carrying case 5"x3½"x1½". Net List Price $70.00—Surplus—New—Guaranteed. Your Cost $24.50 F.O.B. N. Y.

Gasoline Heater—Motorola Model GN 3-24



An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volts 60 cycles 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 9¼" high x 9½" wide. Complete with technical manual and parts list.

@ $22.50 F. O. B. N. Y.

PORTABLE TACHOMETER

Multiple Range Continuous Indicating

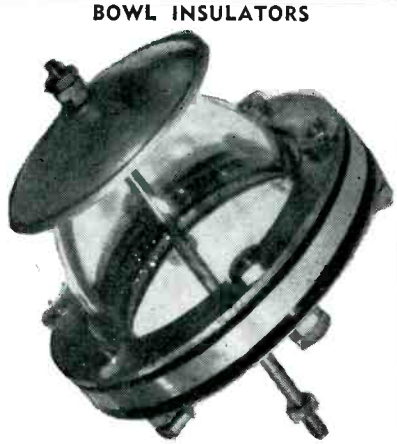
This unit is of the centrifugal mechanical type and is designed to show INSTANTANEOUSLY and CONTINUOUSLY the speed or change in speed of any revolving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M. and three in F.P.M.
  Low Range 300-1,200 (Each division equals 10 R.P.M.)
  Medium Range 1,000-4,000 (Each division equals 10 R.P.M.)
  High Range 3,000-12,000 (Each division equals 100 R.P.M.)
- Large open dial 4" diameter.
- Ruggedly constructed for heavy duty service.
- Ball bearing and oilless bearings—require no lubrication whatsoever.
- Readily portable—Fits neatly into hand.
- Gear shift for selecting low, med., high ranges.

Made by Jones Motrola, Stamford, Connecticut. Comes complete in blue velvet lined carrying case: 7⅛"L x 4"H x 5"W. List Price $95.00—Surplus—New—Guaranteed. Your cost $24.50 F.O.B. N. Y.

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

BOWL INSULATORS



Clear glass, Corning Glass Works No. 67076, Type C Comprises flanged bowl 4⅜" h x 6-15/16 O.D. at base. Center lead-in pin ⅜" dia. x 11½" long. Mounts by means of 6 studs through mounting flange. Overall dia 8¾". All brass fittings. S.C. stock #3G-1830-67076.1 ..... $6.00

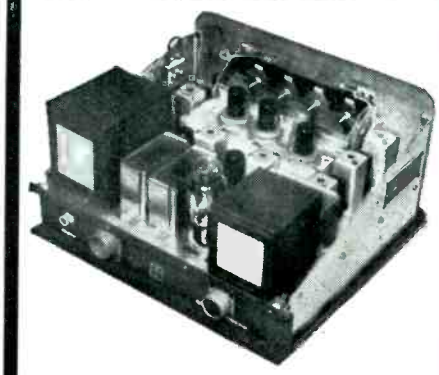
SALINITY INDICATOR

McNab Model M, Calibrated "0-10 Grains of Sea Salt per Gallon". Consists of a panel 14" W x 14" H x 8" D with a Westinghouse 6" sq meter calibrated in Grains of sea salt per gallon. Complete with Temperature Compensating Knob 60°-200°, 8 point cell selector, supervisor and check switch, Green & Red indicators.

Complete as above, Each $95.00
Cells for above panel, Each $60.00

PYROMETER PANEL

0-1200° 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



BC-1161-A RADIO RECEIVER

150 to 210 Megacycles. Operates off 115 volt 60 cycle Power supply. Inductance tuning for R.F., Antenna, detector and oscillator. With a few modifications this unit makes an ideal F.M. Receiver. Each set complete with circuit diagram and the 14 following tubes: 1—6SN7 Cathode Follower; 1—6H6 second Detector; 2—6SH7 1st and 2nd R.F. Amp.; 1—6SH7 Video Amp.; 3—6AC7/1852 1st, 2nd, 3rd IF Amp.; 2—6AB7/1853 4th, 5th IF Amp.; 1—9006 Mod.; 1—6J5 Osc.; 1—5U4G Recr.; 1—6E5 Tuning Indicator.

Complete in a metal cabinet 10" high 16½" wide and 15" deep ..... @ $34.50

BC-1160-A TRANSMITTER

157 to 187 Megacycles. Operates off 117 Volt 60 cycle. Contains 115 volt, 1525 R.P.M. Blower General Radio 200 B 1.5 Amp. Variac 10 tubes, 0-5 Kilovolt 3½" meter transformers, relays, circuit breakers too numerous to list. Complete in metal cabinet 17⅜" x 18½" x 18" with circuit diagram. @ $29.50

CODE TRAINING SET AN/GSC-T1

Made by T. R. McElroy, Boston.

Operates off 6, 12, 24, or 110 V D.C. or 110 V or 230 Volt, 60 cycle.

An excellent unit for schools or clubs for code training. This unit is designed for group training of telegraph code to students whereby each student sends a message from any prepared text to the instructor. It provides a visual signal through a blinker or an audible signal through a monitoring speaker. Has volume control, variable frequency oscillator, a phone jack for a monitoring headset, pitch and tone control, rotary switch for selecting the operating voltage and power supply.

Complete with spare fuses, power cord and battery adapter; 10 Telegraph Keys with 10' line each. 1 #6 x 5 tube and 2 #6AG6 tubes.

Complete in chest 10½" x 17" L x 13½" H—Net wt. 49 lbs.

Can be used anywhere—batteries A.C. or D.C. Durable—Good for a lifetime of Service! NET

"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

ZERO CENTER MICROAMMETER ideal for null indicator, Approx. 10-0-10 microampere movement. Scale approx. 1¾" long calibrated 0-20, resistance 1,600 ohms, Weston Model 301, 3½" rd fl bake case @ $6.50

D. C. MICROAMMETER 0-50 Weston Model 801, 4" x 4½" Rectangular bakelite case. Approx. 2,000 ohms resistance. @ $19.50

METER RECTIFIERS

Conant Type B	@ $1.75	ten for $15.00
Weston Full Wave	@ $1.75	ten for $15.00

All items are Surplus—New—Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit. Orders accepted from rated concerns, public institutions, etc., on open account.

The above is only a partial listing of the many items we have in stock. Send for free circular. MANUFACTURERS, EXPORTERS, DEALERS—we invite your inquiries.

NOTICE—We Repeat—all items are Surplus—New—Guaranteed. All prices FOB N.Y.

MARITIME SWITCHBOARD

336 Canal Street Worth 4-8217 New York 13, 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 acts, tachometers, analyzers, tube testers, converters, precision resistors, current transformers, transmitters, receivers, condensers, and other electronic units, parts and accessories.

★★★ SPECIALS ★★★

Mobile Minded? Citizens' Band Antenna

49¢ Threaded Coax Terminal HiFreq Insul Silv Pl Cont 12"/30cm AT1/APN2, AT5/ARRI w/waterpf gask, flange & ALL hardware for MOBILE mtg. BRAND NEW!

3 for $1; PL 250 for above ..... 35¢

Just In! RM29A Control Unit

Complete, Self-Contained Incl Ringer Circuit. 3-Position locking type selector provides 3 types of traffic: Monitor or Direct Radio Control or as a Telephone. BRAND NEW. **$8.95**

Pair (two) for $15.98

CORD CD-277 & PLUG PL-114 For Revrs BC-312-314-342-344. Fits Socket SO-4. BRAND NEW O'Seas Pkgd. $1.98

BATTERIES

Storage & Dry

A. BB206U 2V/11AH Willard S'Baty $1.89

B. BB54 2V/27AH Willard $1.89

C. Willard 4V/40AH TBY. 5.95

D. Willard 6V/25AH 7½x2½x6½"H $3.39; 2/ 5.98

E. BR18/BB52 5oz/36Vmin S' Baty ..... 98¢; 12/10.00

F. Burgess 3V/F2BP '47date, 8 for 1.00

G. Eveready HvyDty Minimax BA 43 outputs +90 ¢ 45 ¢ filament 1½ V $1.00

USN Hydrometer Kit & Box 1.98

Baty Acid (R'Exp Only) 1 pt. 59¢ 2pts. 98¢

GIBSON GIRL TRANSMITTER

T74/CRT3 p/o SCR578 Like New SOS xmtr, Crank, Dyn 28V&300V also Tubes Parts & 8280 Kc Xtal SPECIAL **$5.95**

G'GAL Sig Lamp&Ant ..... .89

G'GAL Hav'sackBag w'prf ..... .98

G'GAL BOX KITE 17x17x36" 2.98

G'GAL BALLOON 50"&Hydrogen gas generator 4.98

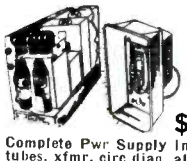
G'GAL PARACHUTE 12foot 2.98

Collins Art-13 Speech Amplifier

Dynamic or Carbon Mike or line inpt, Audio Driver to PPG & Monitor tube. Less Tubes **$4.50**

SAME W/CLIPPER KIT, TUBES & Data. New 8.25

Save Money with PHOTOFLASH! Replaces $2000 WORTH OF FLASH BULBS. Write for complete data!



BASIC PHOTO FLASH KIT

only **$29.95**

Complete Pwr Supply Incl enders, tubes, xfmr, circ diag, all instrctns & PHOTOFLASH lamp&reflector for 115VAC.

STUDIO KIT—Famed Air Corps 1169 Set for 115VAC or battery w/2 lamps&refls $53.95

PHOTOFLASH CONDENSERS—

7mf/2500VDC/21.9 Watt-Secs, ea. $ 2.75

Five (109.5 Watt-Secs) for.. 12.50

16mf/600VAC/2800VDC int 6.95

15mf/330VAC/2000VDC int. 4.50

25mf/330VAC/2000VDC int. 7.95

16mmPAN50ftlm GSA camera 54 rolls 5.49

RCA UNIVERSAL OUTPUT TRANSFORMER

10 Watts — 100 to 10000cyc Potted Fully Csd. Matches Spkr w/Voice Coils of 3 to 4 or 15 ohms to ANY TUBE or Line bet 50 & 10240 ohms **$1.89**

HiGain Dyn Mike Xfmr UTC/SuperElec 3wdg 600 CT&4000ohms tapped 250 &150 ohms. Fully Shielded Herm Sld **59c**

2 for ..... 98c; 10 for $4.50

Isolation Xfmr 115 to 115 Volts/150 Watt $2.98

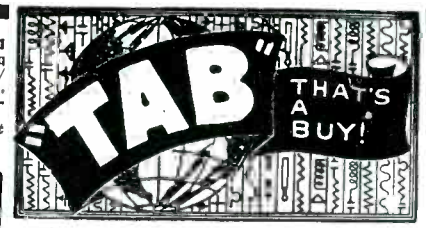
Variacs—Powerstat

Variac, 200B/175Watt0-135V GR $10.95

Variac, 200C/860Watt/0-135V GR $15.98

Variac, 100R/0-230or270 V/2KW/115or220Vin $39.95

POWERSTAT in115V out 0-130V/1KW, less Knob $18.00



Write for Your FREE Tabogram

Remarkable Buy!

2 J1G1 Selsyns

with DATA 24V or 110V 60 cyc AC Used Tested, TWO to **$1.49**

Bendix Autosyns 115V60cycAC NEW Cont Hvy Dty Oper. Incl diagrams SPECIAL, per pair $12.95

MUELLER Test Clip Insulators

Red & Black Prs.—20% Off Lots of 10

No. 13/Clip 11, 11A, Pair ..... 72¢

No. 23/Clip 21, 21A, Pair ..... 46¢

No. 26/Clip 24, 24A, Pair ..... 26¢

No. 47/Clip 45, 45C, Pair ..... 12¢

TUBES . . New Standard Types

1A4	$1.26	6AH6	$ .98	12C8	$ .65	826	$ .69
1A7GT	.69	6AJ5	.85	12SA7GT	.50	832	2.45
1B3 8016	.98	6AK5	.87	12SG7	.69	836	1.12
1B21/471	2.95	6AL5	.79	12SJ7	.64	851	16.95
1B23	4.90	6AS6	1.79	12SL7GT	.86	860	1.97
1B24	4.89	6AT6	.49	13-4 Bal.	.59	861	11.90
1B27	8.97	6B8G	1.05	20-4 Bal.	.59	865	1.00
1C6	1.26	6BA6	.59	24G/3C24	.69	872A	2.45
1D5GP	1.25	6BE6	.59	25Z5	.53	885	.75
1LN5	.75	6C4	.27	28D7	.39	905	4.89
1N5GT	.69	6C6	.71	37	.78	927/CE25	1.49
1P5GT	.69	6C8G	1.05	41	.58	930	.89
2A4G	1.08	6D4	1.25	45 VT52	.30	931A	3.95
2B22/GL559	.73	6E5	.71	83V	.81	954	.16
2C26	.59	6F6/1613	.55	84/6Z4	.72	955	.40
2C40	1.49	6H6GT	.38	205B/VT2	1.98	957	.25
2C43/464	6.98	6J5	.56	211	.89	1294/1R4	1.04
2C44	1.69	6J6	.85	215A	.25	1614	1.50
2C46/2C43S	6.98	6K5GT	.86	249C	.75	1619	.25
2D21	1.20	6K6GT	.69	250TH	19.49	1625	.39
2E22	1.34	6K7G	.64	250TL	14.95	1626	.45
2E25/HY65	2.48	6K8	.86	304TH	5.95	1629	.58
2J21	11.98	6L6	.89	304TL	1.98	1641/RK60	.75
2J31	9.95	6L7	.75	327A	2.90	2050	.67
2J33	14.50	6N7/1635	.85	350	1.89	2051	.45
2J34	18.95	6P5G	.94	371B	.85	6653UX	.69
2J48	45.00	6SA7GT	.49	380A	.79	7193	.18
2J50	45.00	6SF5	.60	388A	.40	8012A	1.49
2K29	6.98	6SH7	.69	446/2C40	.75	Tubes Gtd Exc Open Fil & Breakage	
2X2	.49	6SJ7	.72	450TH	18.98		
3A5	1.20	6SL7GT	.94	460/HF2001	1.98	**CATHODE RAY TUBES**	
3B7/1291	.95	6SN7GT	.69	468	8.98	3BP1	$1.49
3B24	1.29	6U5/6G5	.81	527	4.75	3CP1/1808P1	2.79
3C23	2.48	6U7G	.58	534/		3JP1/2	8.98
3D6/1299	.85	6V6GT	.69	VT127A	2.45	3EP1/1806P1	3.49
3E29/829B	3.85	6X5GT	.58	701A	3.95	5BP1/5GP1	1.95
4C35	19.49	6Y6GT	.87	705A/8021	1.65	5BP4	3.95
4B27/201	2.49	6Z7G	1.23	707B	8.95	5CP1	2.98
4J47	45.00	7A4	.70	710A/8011	.75	5CP7	12.95
5D21	18.75	7C4/1203A	.38	717A	.69	5FP5/1812P5	6.49
5J29	17.98	7E5/1201	.89	722A/278A	9.95	5FP7/1812P7	$1.49; 2 for 2.75
5R4GY	1.25	4AP10	5.98	723	4.95	5JP2	6.49
5T4	1.15	7L7	.86	723AB	7.49	7BP7	4.75
5U4G	.59	7V7	1.04	803	7.95	9GP7/9MP7	13.98
5W4	.87	9-3Ballast	.59	805	4.50	9JP1	3.95
5Y3GT	.38	10	.67	807	1.15	9LP7	$2.69; 2 for 4.98
5Z3	.81	10-4B Bal.	.59	808	1.50	12DP7 G.E. Magn Defl TV & data	2 for $25.00; 10 for 115.00 12.95
6AB7/1853	.84	10Y	.60	813	6.95		
6AC7	.69	12A6	.23	814	2.98	CR Tubes Gtd Only Via R'Exp	
6AG5	.85	12AH7GT	.87	816	1.10		

Antenna Netw'k 1001A

1KW RF NEW 1.5 to 7mc's convertible HiFreqs BiNet and IN&OUT CSD 15x15x23" RackMtg RibbonCoil & 240MMf/7000Vcondsr RFmtr. Insltrs&Manual. Matches most ANTS. 4" polished etched dials BRAND NEW(Coil damaged). Worth 10 times the price for parts alone! **$8.95**

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	21005
6	286	1060	4300	21500
7.25	289	1100	4344	22000
7	299	1110	4440	22500
7.5	300	1150	4444	22990
7.8	310	1155	4500	23000
8.9	311	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	14410	

Any Above, Ea 30¢; 10 for $2.50

100000	185000	294000	570000
110000	198000	307500	575000
115000	200000	314000	600000
120000	201000	330000	620000
125000	220000	333500	621000
130000	225000	353500	654000
135000	229000	380000	750000
140000	235500	400000	761300
145000	238000	402000	800000
147000	240000	422000	900000
150000	245000	458000	930000
155000	250000	478000	950000
166750	265000	500000	
169360	268000	520000	
180600	275000	520000	

Any above, Ea. 40¢; 10 for $3.50

MEGOHMS		2.855	4.5	9.05
1	1.75	3	4.7	9.5
1.1	1.8	3.3	5	10
1.2	1.9	3.5	5.5	11.5
1.25	2.2	3.673	6	12
1.3	2.25	3.75	6.5	12.83
1.35	2.5	3.9	7	13
1.4	2.7	4	7.5	19.5
1.5	2.75	4.23	8	20
1.65	2.8	4.25	8.5	

Any Above, Ea 75¢; 10 for $6.50

AMPLIFIER KITS—

10 Watts High Fidelity

HIGH FIDELITY—Self-Balancing, Cathode Follower circuit with perfect linear response phase Inverter, 2-2A3/6B4G PP, 6SJ-7GT, 6SN7GT. All parts, tubes, data, less output Xfmr, Incl RCA Chassis **$14.95**

SUPER HIGH-FIDELITY KIT—Incorporates ALL-ELECTRONIC stage for use with GE/Pickering, etc. var. reluctance magnetic & xtal pickups & Mike. PLUS ELECTRONIC BASS & HI-FREQ TONE BOOST TUBE CKT. Self-balancing cath foll. phase inv. 2A3/6B4G PP, 4 other stages plus all power & RCA Chassis, less outpt xfmr **$24.95**

4 Year FLASHER

Indispensable for Car or Boat. Neon Bulb Flashes Brilliantly in Dark. Works four (4) years without servicing w/handle $1.98

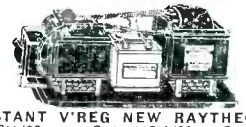
VIBRAPACKS

6VDC in 425V/110ma out $10.95

PE157 Pack ¢ Bat Chgr ¢ Spkr SCR593 ..... 8.95

12VDC in 190V/85ma out 3.49

PP/18AR inpt 12-13V out 24 VDC 6.95



CONSTANT V'REG NEW RAYTHEON in 95-130V/60 cy: Out 115V/60cy Cased 60 watts/1% Regltn $10.95

RAYTHEON—198 to 242V inpt/50-60cys; Output 220V/500Watts/6.5% Rgltn ... $36.00

SOLA CONSTANT V'REG USN Csd in 95or190V/50-60cys; Output 115or220V 2KW/17.4 Amps Cnstnt Duty, 1% Regltn LN* ... $130

Same NEW USN Cost $369. Only $162

V'Reg SOLA In 92/138V, Out 115V/26.1A/3 KVA NEW $185.00

V'Reg G.E. 57-63cyc/.78KVA/80%PF/95-130LineVolts, 113/115/117 Volts Out. $63.00

V'Reg SOLA In 105to125V/60cyc; Out 115V/80Watt NEW $16.95

V'Reg GE 115or228Vin, 115Vout/350 $34.95

SNOOPERSCOPE INFRARED

Image-Converter Tube. HiSensivity 2" dia. Willemite screen—350 lines/in. Complete data & Tube **$8.98**

METER 200 Microamp DC 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**

Range	Description	Each
5 Ma	Tuning GE 2½" Bklt Csd Special	$.98
50 Ma	GE 3½" B'Csd	12.95
10&40 Ma	2in1 HiDamping 4" Weston ½%	12.95
0-200 & 100-0-100	Microamp Twin Mvt an Aircraft type	2.95
25&2.5 Ma	GE Galvnmtr zero ctr	3.95
1 Amp	RF 2½" GE Bklt Csd	3.95
9 Amp	RF 2½" Wstghs B'Csd	2.49
15 Amp	DC 2½" Csd Hoyt	2.95
240 Amp	DC 50 MV mvt 2½" B'Csd AN Wstghs	1.29
30 Volt	DC AN 2½" B'Csd Wstghs	2.49
200or500V	DC 1000 ohms/V 3½" B'Csd W. E.	4.95
7.5 Volt	AC 3" Bklt Sq. RA35 Wstghs	3.98
15 Volt	AC 3½" Bklt Sq. Weston 476	4.95
150 Volt	AC 25-125 cyc 2½" Wstg&GE	3.95
10000 V	DC 1 ma basic 3½" B'Csd	10.95
—10-+6DB	Wstghs DB Mtr 3½" B'Csd	9.95

FL-5 Range or Voice Filters

filters out 1020 cycle audio Excellent for CW work w/ switch & diagram ... **98c**

RADIOSONDE AN/AMQ-1

Special Buy!

72.2 Mc Xmtr Using 3A5 FM HF BRAND NEW Complete w/ ultrasens Relay, Hygrometer, TempInd & diaphragm actuated Bellows BAROSWITCH mechanism in Orig Carton Less Batty **$4.49**

RELIANCE SPECIALS

NOTE THE NEW ADDRESS!

STEEL JUNCTION BOX
Water-tight, 14 ga. steel. 17"x25"6½". Screw type brass hinge on lid. 50 lb. Reduced to **$2.95**

SELSYNS
115 V., 60 Cyc.
3¼" dia. x 4⅛" body.
#C78248
$7.25 pair

DIFFERENTIAL
#C78249
ONLY
$2.25 ea.
115 V., 60 Cyc.

Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Mounting Brackets—(Bakelite) for selsyns and differentials shown above.....25¢ pair

WW PRECISION RESISTORS 1%

¼ WATT—25c

16.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20.	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
1.74	14.98	105.8	366.6	59,148

½ WATT—25c

250Ω	11.1Ω	235Ω	4,451Ω	15,000Ω
334	13.15	260	5,000	15,750
502	46	270	5,900	17,000
557	52	298.3	6,500	20,000
627	55	400	7,000	25,000
76	75	723.1	7,500	30,000
1.01	97.8	2,500	8,000	100,000
1.53	125	2,850	8,500	150,000
2.04	180	3,427	10,000	
2.25	210	4,000	14,825	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	50,000	70,000
5.05	270			75,000

1 WATT—40c

100,900Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000	522,000	600,000
125,000	160,000	320,000		703,000

1 Megohm, 1 Watt, 1%—65c.; 5%—40c

CAPACITORS

POSTAGE STAMP MICAS

8.2mmf	50mmf	200mmf	560mmf	.0015
10	56	220	600	.002
15	60	250	650	.0026
18	70	270	680	.003
20	90	350	800	.0039
22	100	370	.001mfd	.0051
25	140	400	.0012	.007
40	150	470	.0013	.008
47	180	500	.00135	.01

Price Schedule
8.2mmf to .001mfd 5¢ .003mfd to .008mfd 12¢
.0012mfd to .002mfd 7¢ .01 mfd 18¢

SILVER MICAS

10mmf	125mmf	400mmf	665mmf	.0024mfd
22	150	430	700	.0025
39	180	466	750	.0027
50	200	470	800	.003
62	240	488	820	.0033
66	250	500	.001mfd	.0039
68	330	510	.0012	.005
100	360	525	.0013	.0051
110	370	540	.0015	.0068
120	390	560	.002	.01

Price Schedule
10mmf to .001mfd 10¢ .003mfd to .0068mfd 50¢
.0012mfd to .0027mfd 20¢ .01mfd 65¢

CERAMIC

3mmf	10mmf	22mmf	50mm	91mmf	200mmf
3.44	15	27	56	100	1000
4.7	16	33	68	115	1090
6.8	18	40	75	140	**$7 per 100**
8	20	47	82	180	

OIL FILLED

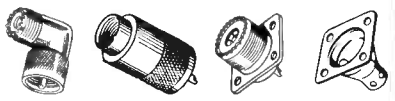
MFD	V.D.C.	Price	MFD	V.D.C	Price
.1	25,000	$19.95	.02–.02	7,000	$1.65
.012	25,000	6.20	1	6,000	8.50
.03	16,000	4.50	.1	6,000	1.75
.375@	16,000 and		.03–.03	6,000	1.65
.75@	8,000(dual)	14.95	.01	5,000	1.35
1	7,500	12.50	2	4,000	4.50
.1	7,500	1.95	.25	3,000	1.75
.1–.1	7,000	2.45	.2	750 V.A.C.	
.1	7,000	1.85	(2.200	V.D.C.)	.39
			1	2,000	.95
			4	1,000	.90
			3	1,000	.80
			2	1,000	.65
			.05	1,000	.29
			1	800	.40
			10	600	1.00
			4	600	.69
			2	600	.39
			1	500	.19
			5	500	.24

2 mfd
4,000
V. D. C.
#23F47
SPECIAL!
$4.50

RG 8/U *NEW-UNUSED 52 OHM*
COAXIAL CABLE

500 - 999 feet.....5c per foot
1,000 - 19,999 feet.....4c per foot
20,000 feet and up.....3½c per foot
No charge for REELS.

COAXIAL FITTINGS



Angle Adapter	Plug 35¢	Socket 35¢	Hood 10¢
20¢	PL-259	SO-239	83-1H
M-359	83-1SP	83-1R	
83-1AP			

PL-259-A, 83-SPN .....35¢
83-1F .....75¢
83-1J .....65¢
83-1R .....35¢
PL 305; PL 325; UG 13/U; UG 24/U; UG 27/U; UG 59/U; UG 87/U; also UG 85/U and UG 281/U with short length of coax attached.
EACH ONLY .....50¢

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1⅛" x ⅞" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core....**$1.50**
Spec.—10, 111, Chicago Transformer equivalent of 9262 (above).....**$1.50**
7472 '07, GE, core ⅞" x 1⅜" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC).....**$1.25**
86G16, GE **$1.25**
D161310. 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high, 120 to 2350 ohms.....**$2.00**
D166638, W. E., cased 1¾" x 1¼" x 2¼", 2 semitorrid windings, each 150 turns..**$1.25**
352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm, 140 cy. to 175 Kc.....**$1.25**
352-7251-2A, similar—shorter pulses.....**$1.25**
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out. (250 KVA @ ¼ microsecond).....**$15.00**
800 KVA G.E. K2731, 28,000 Volt pk. output. Bifilar, pulse width: one-microsecond..**$19.50**

JONES BARRIER STRIPS

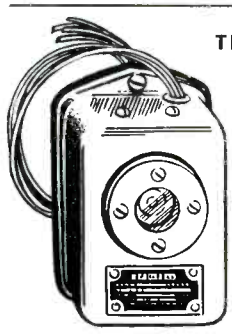
Type	Price	Type	Price	Type	Price
2–140 Y	$.10	7–141	$.26	17–141 Y	$.86
3–140 ¾ W	.13	8–141	.30	20–141 Y	1.01
3–140	.10	8–141 ¾ W	.42	5–142	.23
4–140	.13	9–141 Y	.47	6–142	.28
5–140 Y	.21	10–141	.36	8–142	.36
8–140	.23	10–141 ¾ W	.52	8–142 Y	.54
10–140 ¾ W	.40	11–141	.39	9–142	.40
13–140	.36	11–141 Y	.57	10–142 ¾ W	.64
15–140	.42	14–141	.49	10–142 Y	.64
2–141	.09	15–141 Y	.76	12–142	.53
5–141 Y	.27	17–141	.60	12–142 Y	.76
				17–142 Y	1.06

Any order for 100 pieces—10% off; for 1,000 pieces—20% off.

CHROMALUX STRIP HEATER, 115 V. A. C., 60 Cyc. 750 watt curved, 20" x 1½"..**only 95c**

SPAGHETTI SLEEVING—Asst. sizes and colors, 8 ft. lengths.....99 feet—**Only $1.00**

TIME DELAY RELAY



Raytheon CPX 24166
KS 10193-60 Sec.

- Adj. 50-70 Seconds
- 2½ second recycle, spring return
- Micro Switch Contact, 10A
- 115 V., 60 Cycle
- Holds On as long as power is applied
- Fully Cased.

ONLY $6.50

PRECISION POTENTIOMETERS

6 WATT

20,000Ω	Muter	314A	$1.70
20,000	GR	314A	2.50
10,000	De jur	292	.95
6,000	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70
600	GR	314A	2.25
200	GR	214A	1.40
40	GR	214A	1.40

4 WATT

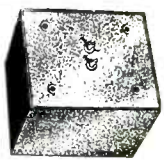
500Ω	Centralab	48–501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
20	GR	301	1.10

12 WATT

10,000Ω	GR	471-AS15	3.50
10,000	GR	371T	2.50
10,000	GR	471A	3.50
10,000	Muter	371T	2.50
10,000	De jur	271T	2.00
5,000	De jur	271T	2.00

POWER TRANSFORMER
300 V., 4A. (2 Sec.)
300 V., 4 Amp.
110/220/440 Volt,
60 Cyc. $17.50

400 MA CHOKE
12 H
90 Ω
6,000 V. D.C. TEST
$3.85



TRANSFORMERS
115V. 60 Cy.-24V., 10 A.
$4.75.....10 for $45.00
2.5V., 6.5 A. CT each of two windings. $2.45
5V., 60A. CT.....$6.75

115 V., 60 Cyc.
5 V., 6½ A.
Transformer
Tested 34 Kv
Uses 8020 Tube
#6D4298
$8.50

200 MA. 10 H CHOKE
115Ω.....$1.95

ALLEN SET SCREWS

4-40 x 1/8	6-32 x 1/8	8-32 x 3/16
4-40 x 3/16	8-32 x 1/8	8-32 x 5/16

ALL SIZES .....**$1.50** per 100

General Radio Frequency Meter Heterodyne Type No. 616-D 100 Kc-5,200 Kc (30 Mc. on harmonics). List Price.....**$695.00**
YOUR COST ONLY $295.00

Thermal Circuit Breakers—2 Amp; 3 Amp; 5 Amp; 6 Amp .....**EACH 50¢**
Vernier dials For BC221, 2⅝" dia. 0-100....**$.85**
Glyptal Cement—5 gal. **$11**, 1 gal. **$2.50**, 1 qt **75c**

G.E. D.C. MOTOR 1/6 H.P., shunt wound armature, 250 VDC @ 0.7 Ampere field, 60 VDC @ 0.37 Amp. **$12.00**
HANDLES—Brass 5/16" round stock, 4¾" long, 1½" high; black, tapped 8-32.....**10c**
GEAR ASSORTMENT—Experimenter's dream. Approx. 100 pieces, many stainless.....**$6.50**
FIELD WIRE—W110B; whole mile.....**$14.00**
26 CONDUCTOR CABLE—50 ft. length...**$7.50**
±18 SHIELDED WIRE—50 ft., **$1**; 1,000 ft., **$12**
MULTIMETER—Superior 770, 6 AC, 6DC, 4 current, 2 res. ranges, 1 year guar.....**$13.90**
AIRCRAFT GALLEY KIT from B-29. Contains 2½ gal. food warmers with stainless lids. Operating on either 115 V 60 cy., or 24 V D.C.; grill and chrome plated soup warmer 24 V D.C.; salt and pepper shakers; sugar dispenser; A.C. & D.C. line cords and canvas cover **$15.00**

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	25¢
Fafnir 38K	5/16"	7/8"	9/32"	45¢
ND5202C13M	1/2"	1 3/8"	1 3/8" (dual)	1.25
ND 88503	43/64"	1 37/64"	21/32"	1.00
MRC 206SF	1 5/32"	2 7/16"	5/8"	1.25
Fafnir 545	2 1/6"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

BC 1072A IFF X'MITTER

150 to 200 Mcs. 115 V. 60 Cyc.
POWER SUPPLY gives: 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 vac. (Also contains: 11 tubes 6J5, 826, 6SN7, 5U4G, etc.). 5 KV. meter, Blower, Condensers and many other useful parts too numerous to list. Slightly used. Shipping Wt. 245 lbs.
All This ONLY.....$22.50

MINIMUM ORDER $3 All orders f.o.b. PHILA., PA.

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TWO-SPEED PLANETARY DRIVE

Auxiliary speed reducer fits on condenser shaft back of panel or on dial knob shafts. Ratios 5 to 1 and 1 to 1. Fits any ¼ in. round shaft. 57c each . . . Two for 97c

PERMALLOY SHIELDS
for CATHODE RAY TUBES

3" Shield	$1.47
5" Shield	1.97

TRANSMITTING KEY

General purpose transmitting key on a heavy die cast base, all mounted on a swinging bracket thigh clamp. ⅛" pure silver contacts. Key can be easily removed from clamp. Adjustable bearings. Supplied with 5-foot cable and PL-55 phone plug.

Brand New. Each 57c

JEFFERSON TRANSFORMER

Step down (or up) power circuit transformer double wound 230V input 50-60 cycle, 115V output, 500 KVA

Brand New $12.97

LM-7 FREQ. METER

195 to 20,000 Kc modulated, complete with tubes and crystals, less power supply. Navy type, used, good condition **$79.47**

Less calibration book.

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NATIONALLY ADVERTISED BRANDS
All Ratings D. C.

2x.1mfd.	600v	$0.37	1mfd.	2000v	$0.97
.25mfd.	600v	.37	2mfd.	2000v	1.27
.5mfd.	600v	.37	4mfd.	2000v	3.77
1mfd.	600v	.37	15mfd.	2000v	4.97
2mfd.	600v	.37	4mfd.	2500v	3.97
4mfd.	600v	.57	2mfd.	2500v	2.47
8mfd.	600v	1.07	.1mfd.	2500v	1.27
10mfd.	600v	1.17	25mfd.	2500v	1.47
3x.1mfd.	1000v	.47	.5mfd.	2500v	1.77
.25mfd.	1000v	.47	05mfd.	3000v	1.97
1mfd.	1000v	.57	.1mfd.	3000v	2.27
2mfd.	1000v	.67	.25mfd.	3000v	2.67
4mfd.	1000v	.87	1mfd.	3000v	3.47
8mfd.	1000v	1.97	12mfd.	3000v	6.97
10mfd.	1000v	2.07	2mfd.	4000v	5.97
15mfd.	1000v	2.27	1mfd.	5000v	4.97
20mfd.	1000v	2.97	.1mfd.	7000v	2.97
24mfd.	1500v	6.97	3mfd.	4000v	6.97
.1mfd.	1750v	.87	2mfd.	3000v	3.47
.1mfd.	2000v	.97	2x.1mfd.	7000v	3.27
.25mfd.	2000v	1.07	.02mfd.	12000v	9.97
.5mfd.	2000v	1.17	.02mfd.	20000v	11.97

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10,000 mfd.—25 WVDC	$6.97
2x3500 mfd.—25 WVDC	3.47
2500 mfd.—3 VDC	.37
3000 mfd.—25 WV DC	2.47
2x1250 mfd.—10 VDC	1.27
1000 mfd.—15 WVDC	.97
200 mfd.—35 VDC	.57
100 mfd.—50 WVDC	.47
4x10 mfd.—400 VDC	.87
4000 mfd.—18 WVDC	1.97
4000 mfd.—25 WVDC	2.97
4000 mfd.—30 WVDC	3.27

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NEW! STANDARD BRANDS!

1B24	$4.87	725A	$7.97	1LC6	$.87
1B26	3.97	726A	4.57	1LD5	.87
1B29	3.47	800	1.87	1LE3	.97
1N21	.67	801A	.47	1LH4	.77
1N23	.77	802	2.97	1LN5	.67
1N34	1.37	803	4.87	1Q5GT	.97
1P24	.87	805	3.97	1R5	.67
2AP1	2.87	807	1.07	1S4	.67
2C21	.27	808	1.57	1S5	.57
2C22	.17	809	1.67	1T4	.57
2C26	.27	810	4.97	3Q4	.57
2C34	.27	811	1.97	3Q5	.67
2C40	.97	812	2.37	5U4	.47
2C44	.67	813	5.87	5Y3	.37
2C46	5.87	814	2.67	6A7	.57
2D21	1.07	815	2.47	6A8GT	.57
2J21	9.87	816	1.07	6AG5	.87
2J22	9.87	826	.47	6AG7	.97
2J26	9.87	829B	3.47	6B4G	.97
2J31	12.87	832A	3.47	6B6G	1.47
2J32	14.87	833A	29.97	6C6	.47
2J36	24.87	836	.97	6D6	.47
2J38	14.57	837	1.57	6F5GT	.47
2J39	18.47	838	2.67	6F6GT	.47
2J40	18.47	841	.47	6F6	.57
2J48	14.97	843	.37	6H6	.37
2J49	26.97	845W	3.87	6J5GT	.47
2J54B	18.97	851	14.97	6J7GT	.47
2J55	18.97	860	2.27	6K6GT	.47
2K25	23.97	861	9.97	6L6G	.97
2K28	8.97	864	.47	6L6	1.17
2V3G	.87	865	.67	6L7	.77
2X2	.37	866A	.97	6Q7GT	.57
3AP1	2.97	866JR	1.07	6SA7GT	.47
3BP1	1.37	869B	18.97	6SC7	.57
3B22	.57	872A	1.47	6SF5GT	.57
3B24	1.87	874	.67	6SH7	.47
3B26	.87	876	.37	6SJ7GT	.47
3CP1	2.67	878	1.17	6SK7GT	.47
3C21	3.97	884	.97	6SL7GT	.57
3C22	17.97	885	.87	6SN7GT	.57
3C23	2.47	902P1	4.97	6SQ7GT	.47
3C30	.47	905	1.87	6V6GT	.67
3C31	1.47	923	.87	6X5GT	.57
3DP1	1.47	954	.17	7A8	.67
3D21A	1.47	955	.37	7B7	.57
3E29	5.97	956	.37	7C5	.57
4B24	2.27	957	.27	7F6	.67
4E27	12.97	958	.27	7Y4	.67
5AP4	3.97	1611	.97	12A8GT	.57
5BP1	1.27	1613	.57	12AT6	.47
5BP4	2.47	1616	1.37	12AU6	.67
5CP1	1.97	1619	.27	12AB6	.67
5D21	18.97	1624	.77	12BE6	.47
5FP7	1.37	1625	.27	12J5GT	.47
5JP1	9.97	1626	.27	12J7GT	.47
5JP2	9.97	1629	.27	12Q7GT	.57
5J29	14.97	1630	1.87	12SA7GT	.57
5J30	18.97	1636	3.97	12SF7GT	.57
5LP1	13.97	1638	.47	12SJ7GT	.47
5NP1	8.97	1641	.37	12SK7GT	.57
5R4GY	1.07	1654	1.97	12SQ7GT	.57
5T4	.97	1851	.87	12SR7GT	.47
5Z3	.47	2050	.67	14A7	.57
5Z4	.77	2051	.47	14B6	.67
6AB7	.77	8005	2.47	14Q7	.57
6AC7	.67	8011	.87	24A	.67
6AK5	.87	8012	1.47	25L6GT	.57
6AL5	.67	8013	1.27	25Z5	.47
6C4	.27	8016	1.37	25Z6GT	.47
6J6	.87	8020	1.47	26	.47
6Q5G	1.97	8025	3.57	27	.47
7EP4	17.97	9001	.37	30SPEC	.27
10Y	.27	9002	.37	32L7GT	.97
12A6	.17	9003	.47	35/51	.57
12DP7	12.87	9004	.27	35A5	.67
12GP7	12.87	9005	.57	35L6GT	.57
15E	2.47	9006	.27	35W4	.47
15R	.97	CK1005	.27	35Y4	.57
24G	.57	CK1090	1.27	35Z3	.67
28D7	.37	EF50	.47	35Z5GT	.37
45 SPEC	.37	F123A	9.97	36	.77
75TL	2.47	F127A	17.97	41	.47
100TH	9.97	F128A	39.47	42	.47
211	.47	F660	39.47	43	.57
227A	2.97	FG81A	3.97	45	.57
249C	1.77	FG105	7.47	47	.77
250R	7.97	FG238B	29.47	50A5	.87
250TH	19.47	GL146	7.97	50B5	.57
250TL	19.47	GL697	29.47	50L6GT	.57
304TL	.97	HY615	.37	50Y6GT	.57
304TH	3.47	ML100	19.97	56	.47
316A	.47	ML101	39.47	59	.97
327A	2.97	ML502	39.47	70L7GT	1.07
350B	1.47	RK72	1.37	71A	.57
368AS	1.97	RK73	1.67	75	.57
371B	.97	VR75	.97	76	.47
450TH	29.87	VR78	.37	77	.47
530	4.97	VR90	.67	78	.47
531	2.97	VR105	.67	80	.47
559	.97	VR150	.67	81	1.57
575A	12.97	VR127A	2.37	82	.87
703A	1.97	VU111	.37	83	.87
705A	1.67	OZ4	.67	83V	.87
706CY	18.97	1A5GT	.47	84/6Z4	.67
715B	7.97	1A7GT	.57	89	.67
715C	18.97	1H5GT	.57	117L7GT	1.17
717A	.97	1N5GT	.57	117P7GT	1.17
721A	1.57	1LA4	.97	117Z3	.57
723A/B	12.87	1LA6	.87	117Z6GT	.87
724A/B	1.77	1LB4	.97		

All Tubes guaranteed, except for open filaments, shorts and broke glass, for which we check before shipment. Please specify how to ship.

NOW AVAILABLE

1000 KC

Crystal	$2.97
Socket	.07

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GE-1S21. 9200 volts peak, 8 amps. Used as antenna switch in Collins Art 13.

Brand New $2.47

TRANSFORMER—115 V. 60 Cy.
HI-VOLTAGE INSULATION

2500v @ 15 ma	$4.97
2150v @ 15 ma	3.97
1800v @ 10 ma; 6.3v @ 2A; 2.5v @ 2A	4.97
1750v @ 4 ma.; 6.3v @ 3A	4.27
1600v @ 4 ma.; 700v CT @ 150 ma.; 6.3v @ 9A	6.47
525–0–525v @ 60 ma.; 925v @ 10 ma.; 2x5v @ 3A; 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	6.97
515–0–515v @ 175 ma.; 5v @ 3A; 2.5v. @ 5A	4.97
500–0–500v @ 25 ma.; 262–0–262v @ 55 ma.; 6.3v @ 1A; 2x5v @ 2A	4.47
500–0–500v @ 100 ma.; 5v CT @ 3A	3.97
450–0–450 @ 300 ma.; 140–0–140 @ 100 ma. 36v @ 1A, 6.3v @ 5A, 5v @ 3A, 110/220 Dual Pri.	7.97
425–0–425v @ 75 ma; 5v @ 3A; 6.3v @ 1.5A	2.97
400–315–0–100–315v @ 200 ma.; 2.5v @ 2A; 5v @ 3A; 6.3v @ 9A; 6.3v; 9A	5.97
400–0–400v @ 200 ma.; 5v @ 3A	3.97
350–0–350v @ 150 ma.; 5v @ 3A; 6.3v @ 6A; 78v @ 1A	3.97
385–0–385–550v @ 200 ma.; 2½v @ 2A; 5v @ 3A; 3x6.3v @ 6A—PRI. 110/220	6.27
340–0–340v @ 300 ma.; 1540v @ 5 ma.	4.97
335–0–335v @ 60 ma.; 5v @ 3A; 6.3v @ 2A; 0–13–17–21–23v @ 70 ma.—PRI. 110/220	3.97
325–0–325v @ 120ma.; 10v @ 5A; 5v @ 7A.	2.27
300–0–300v @ 6 ma.; 2x5v @ 2A; 6.3v @ 2½A; 6.3v @ 1A	3.47
150–0–150 @ 80 ma.; 150 @ 40 ma.; 6.3v @ 3.5A; 6.3v @ 1A	1.97
150v @ 55A; 150v @ 2.13A; 5v @ 5A	3.97
120–0–120v @ 50 ma	.97
80–0–80v @ 225 ma.; 5v @ 2A; 5v @ 4A	3.97
24v @ 6A	3.47
3x10.3v @ 7A; CT	7.97
12.6v CT @ 10A; 11v CT @ 6.5A	6.97
6.3v @ 12A; 6.3v @ 2A; 115v @ 1A	3.47
6.3v @ 10A; 6.3v @ 1A	2.97
6.3v @ 1A; 2½v @ 2A	2.47
6.3v @ 21½A; 6.3v @ 2A; 2½v @ 2A	4.97
6.3v @ 1A . . . . . .97 8v CT 1A	.97
.6v @ 15 amps RMS	1.97
6.3v CT @ 3A; 5v CT @ 4A	3.97

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8 hy @ 300 ma.	$3.97	325 hy @ 3 ma.	$3.47
25 hy @ 160 ma.	3.47	1 hy @ 800 ma.	14.97
12 hy @ 150 ma.	3.47	10 hy @ 250 ma.	2.47
25 hy @ 65 ma.	1.37	10 hy @ 200 ma.	1.98
.05 hy @ 15 amps.	7.97	10/20 @ 85 ma.	1.57
1 hy @ 5 amps.	6.97	15 hy @ 125 ma.	1.47
4 hy @ 600 ma.	5.97	15 hy @ 100 ma.	1.37
200 hy @ 10 ma.	3.47	3 hy @ 50 ma.	.27
600 hy @ 3 ma.	3.47	30 hy Dual @ 20 ma.	1.47
		8/30 hy @ 250 ma.	3.47

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20 Watt: 1, 5, 50 Ohms ..... .19
50 Watt: 80, 100, 500 Ohms ..... .29
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100 Watt: 20, 50, 75, 120, 180 Ohms ..... .39
150 Watt: 50, 100 Ohms ..... .47
Deduct 25% on lots of 100 any types.

30 WATT WIRE WOUND RESISTORS

Ohms: 100-150-1500-2500-3k-4k-4500-5k-5300-10k-15k-18k-40k ..... .15 ea. 8 for .99

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W. W. POWER RHEOSTATS

25 Ohms 25 Watt ..... .39
150 Ohms 50 Watt ..... .59
250 Ohms 50 Watt ..... .59
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Dual 200 Ohms 50 Watt ..... .79
8 Ohms 150 Watts 1.79

1% PRECISION RESISTORS

2000-2500-5000-8500-10,000 ohms ..... ea. .25
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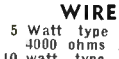
Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass. .25 ea. 10 for $2.00



50 megohm 35 watt Standard Brand Resistor with mount. $1.75 each. 10 for $12.00.

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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 $37.50

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 $24.50

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1050V @ 20Ma, 20V 4.5A, 2.5V 5A 4.75
4500V @ 4Ma 8.50

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Pri. 95-125 Volts 60 Cy Sec 115 Volts Regulated 120VA $16.50

HIGH CURRENT TRANSF. 820 Volts CT at 775 Ma. Pri. 110/220 Volts 60 cycles. Fully Cased $5.95

RECTIFIER TRANSFORMER 110/220 V 60 cy. primary. Secondary 70-75 volts 3 amps plus 35-37 volts (pri in series). Fully cased ..... ea. $1.75

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps ±1 DB. GREAT VALUE ..... ea. $2.49

THORDARSON PLATE TRANSF. 2370 volts CT at 250 MA tapped at 300-0-300 volts, plus 215 volt 55 MA bias winding. 110 volt 60 cy. pri. Fully shielded ..... ea. $11.50

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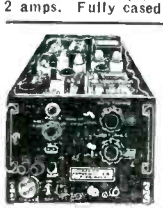
Ideal for Bias, Filament, Isolation, Stepdown, etc. 2 isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amps. Fully cased ..... Now $1.49 ea.



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425-750 MCS AN-APT 2, Contains 10 tubes:

(1) — 307 (2) — 703A (2) — 6AC7 (1) — 6AG7 — (2) — 5R4GY (1) — 2x2 (1) — 931A. Unit has blower motor and 400 cycle pwr supply complete with all tubes, etc.

BRAND NEW. Now $11.95 ea.

STEPDOWN TRANSFORMER

220/110 volts, 100 watts. Fully encased, 5⅛ x 4¼ x 5⅛. 110V. 60 cycle ..... $2.29 ea

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WESTINGHOUSE 3" Panel Meter 0-20 MA DC Model NX 35 ..... **$2.75 ea.**
SIMPSON 2" Panel Meter 0-20 MA DC (Amp scale) **$1.49**
6 MFD 600 VDC ..... .69 ea
1 MFD 2000 VDC Oil Cond ..... .69 ea.
1 MFD 600 VDC1 MFD 2000 VDC oil cond. ..... .69 ea.
50,000 ohm 1% Precision **WW Resistors** 7 for .99
DUAL PYRANOL CAPACITOR .37 Mfd @ 16 Kv DC plus .75 Mfd @ 8 Kv DC **$5.75**
.1 Mfd 7500v DC (can insulated) .99 ea.
1500, 5000 ohm 100 watt **FERRULE RESISTORS** ..... .11 each; 10 for $1.00

FILAMENT TRANSFORMERS

110V 60Cy Pri. Fully Cased.

5 Volt 15 Amp $2.75
2.5 Volt 10 Amp 3.49
5 V CT 3 Amp 1.49
2.5 Volt CT 21 Amp 4.75
6.3 Volt 1.2 Amp ..... .69

MULTIPLE—SECONDARIES

5¼V CT 21A, 7.5V 6A, 7.5V 6A 4.95
10V CT 13A, 7.5V 2.5A 4.95
6.3V 21 Amp. 6.3V 2A, 2.5V 2A 3.95
5 Volt 4A. 6.3V 3A 2.45
2.5V CT 20A. 2.5V CT 20A 6.95
2.5V CT 10A, 10V 3A. 5V 3A, 5V 3A 3.95

CHOKES

20 Hy 36 Ma 400 ohm ..... .49
6 Hy 80 Ma 220 ohm ..... 2 for .89
8 Hy 160 Ma 140 ohms ..... .99
1.5 Hy 250 Ma 42 ohms. Herm. Seal ..... .45
6 Hy 300 Ma 65 ohms 3.39
10 Hy 350 Ma (14 Hy 250 Ma) 140 ohm 3.69
4.3 Hy 620 Ma 42 ohms. Herm. Seal 6.49
.07 Hy 7 Amps .5 ohm 4.50
Sw. Ch. 1.6-12 Hy. 1 amp-100 Ma 15 ohm 19.95

U. H. F. COAX. CONNECTORS

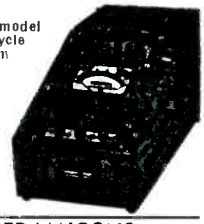
83IAP-UG12U—UG21U-UG-14U-UG146U-831 R-83ISP ..... .32 ea.

FEDERAL ANTI-CAPACITY SWITCH. Double Pole. Double Throw ..... .75 each; 10 for $6.50

PLATE AND FIL. TRANSF. PRI 110v 60 cy. sec. 1120 volts CT @ 600 ma. 6.3v CT @ 3A, 2x5VCT @ 6A Hermetically sealed ..... $8.95 ea.

MEGOHM METER

Industrial Instruments model L2AU 110/220 volts 60 cycle input. Direct reading from to 500000 megohms with meter can be extended to 50000 megohms with external supply. Sloping hardwood Cabinet 15"x 8"x10". Brand new with tubes plus running spare parts including extra tubes. Great value Only $59.50.



VARIABLE CERAMICONS

1.5 to 7 MMF ..... .20
3 to 13 MMF ..... .20
4 to 30 MMF ..... .20
7 to 45 MMF ..... .20

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 ..... .08 ea.

G.E. VACUUM SWITCH

9200 volts peak, 8 amps. Used as antenna switch in Collins ART 13.

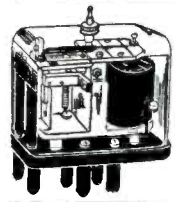
BRAND NEW $1.75

HERE'S VALUE

.004 1000 VDC Micas ..... 10 for .99
.01 600 VDC Micas ..... 10 for .99
1000 Mfd 25 VDC Electrolytics ..... 3 for .99
2 Meg. ½ 1% Meter Multip. IRC 1.95
25 Ma Littlefuses ..... 15 for .99
ERIE .0005 Ceramicons ..... 15 for .99
C-D 1 Mfd 400v DC oil Tubulars ..... 10 for .99
.0015 5% Silvor Micas ..... 10 for .99
JAN 6C4 Tubes. New. Boxed ..... 4 for .99
Heineman 5 Amp 110VAC CKT BRKR ..... .99
Heineman 25 Amp 110VAC CKT BRKR 1.29
2 Mfd 250 VAC Condensers ..... 6 for .99
705A Ceramic Sockets ..... 7 for .99
TRIMM "Commercial" Head Phones 3.75
10 Meg 10 Watt Resistor ..... .59
Allen Bradley .5 Meg Pot w/Switch ..... .79
4 Quadrant Phasing Capacitor 2.75
.02-400VDC Tubulars ..... 15 for .99
Allied DPDT 24VDC Relays ..... .39
BZR5 Microswitch SPDT 10 Amp ..... .29
Silver Var. Cond. .5-2.5 MMF ..... 7 for .99
MU Switch with Roller SPST 15A 110VAC ..... .39
C-H Toggle DPST 20 Amp 250VAC ..... .85

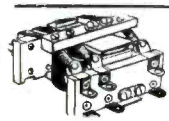
PANEL METERS—BRAND NEW

2" WESTON 0-1 Ma DC $3.50
2" GE 0-1 Ma DC (volt scale) 2.75
2" GE 0-5 Ma DC (amp scale) 1.95
2" WESTINGHOUSE 0-10 Ma DC 1.95
2" GE 0-500 Ma DC 1.95
2" GRUEN 0-3 Volt DC 1000Ω/v 1.95
2" GE 0-10 Volts AC 2.50
2" GE 0-30 Volts DC 1000Ω/v 1.95
2" WESTON 0-250 Volts DC 2.50
2" WESTON 150-0-150 Microamps DC 3.25
2" GE 0-200 Microamps DC 4.50
2" GE 0-30 Amps DC 1.95
2" GE 0-1 Amp RF (Internal Thermo) 1.95
2" WESTON 0-1 Amp RF (Internal Thermo) 2.50
3" McCLINTOCK 0-1 Ma DC 3.75
3" WESTINGHOUSE 0-2 Ma DC 3.75
3" GE 0-15 Ma DC (Square Case) 3.50
3" WESTERN ELECTRIC 0-80 Ma DC 2.85
3" DEJUR 0-100 Ma DC 2.95
3" GE 0-200 Ma DC 3.75
3" WESTINGHOUSE 0-50 Amps AC 3.95
3" WESTON 0-50 Amps AC 4.50
3" TRIPLETT 0-75 Amps AC 2.95
3" WESTINGHOUSE 0-15 Volts AC 3.95
3" WESTINGHOUSE 0-150 Volts AC 3.95



WESTINGHOUSE

Type MN Overcurrent Relay, Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $6.75



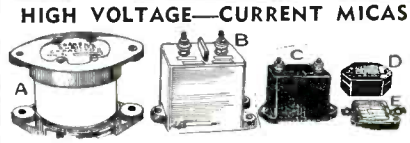
ADVANCE D. P. D. T. ANTENNA RELAY

110 V. 60 cycle coil Steatite insulation. Only $1.89 each

As above but 3 P D T $2.50

DUNCO RELAY 6 volt 60 cycle coil DPST $1.39
DPDT $1.69

HIGH VOLTAGE—CURRENT MICAS



Deduct 10% from Mica Prices Until June 1st Only

	MMF	VDC	Price		MMF	VDC	Price
D	.001	600	$.18	C	.0015	5 KV	1.60
E	.01	600	.24	C	.003	5 KV	1.90
E	.02	600	.26	C	.005	5 KV	2.50
E	.027	600	.26	B	.007	5 KV	2.75
D	.039	600	.30	B	.002	6 KV	3.50
C	.01	1 KV	.45	B	.003	6 KV	3.75
C	.056	1 KV	.50	A	.004	6 KV	4.95
C	.07	1 KV	.55	B	.006	6 KV	4.25
D	.02	1200	.35	B	.0005	8 KV	2.90
C	.024	1500	.65	B	.001	8 KV	3.25
C	.033	1500	.75	B	.002	8 KV	4.00
C	.015	2 KV	.80	B	.003	8 KV	4.75
C	.02	2 KV	.90	B	.004	8 KV	5.50
D	.002	2500	.45	B	.005	8 KV	5.75
E	.005	2500	.55	A	.006	15 KV	26.50
C	.025	2500	1.25	A	.0098	15 KV	32.50
C	.001	3 KV	.90	A	.0059	18 KV	28.50
C	.002	3 KV	.95	A	.003	20 KV	30.50
D	.005	3 KV	.70	A	.005	20 KV	33.50
C	.005	3 KV	1.24	A	.0012	25 KV	32.50
C	.006	3 KV	1.50	A	.0013	30 KV	36.50
D	.002	3 KV	.70	A	.00025	35 KV	26.50
C	.001	5 KV	.76	A	.0005	10 KV	5.95
C	.0005	5 KV	.85	A	.0001	10 KV	4.95

OIL CONDENSERS

Deduct 10% from Oil Prices Until June 1st Only.

20 mfd 330 vac—1.85
5 mfd 150 vac— .49
1 mfd 600 vdc— .29
2 mfd 600 vdc— .39
4 mfd 600 vdc— .59
3/3 mfd 600 vdc— .79
2 mfd 1000 vdc— .79
4 mfd 1000 vdc— .95
15 mfd 1000 vdc—2.95
6 mfd 1500 vdc—2.95
2 mfd 2000 vdc—2.25
4 mfd 2000 vdc—3.65
6 mfd 2000 vdc—3.95
2 mfd 4000 vdc—5.50
1 mfd 5000 vdc—4.50
.1/.1 mfd 7000 vdc—2.25
1 mfd 7500 vdc—9.25
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.03 mfd 15 kv dc—5.75
.05 mfd 12,500 vdc—12.95
.02 mfd 20 kv dc—7.95
2 mfd 18 kv dc—59.50

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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DEPARTMENT EA
SEND FOR BULLETIN

IMMEDIATE DELIVERY — LOW PRICES — FULLY GUARANTEED

SPECIALS

400 Cycles
Three Phase

INVERTERS

Holtzer Cabot MG-153—Input 28 volts DC at 52 amps. Output three phase 115 volts 400 cycles at 750 va. 0.90 P.F. Also second output of 26 volts 400 cycles at 250 V.A. Voltage and frequency regulated.
New—Perfect ..... **$99.50 ea.**
New—Surface Damages ..... **59.50 ea.**

Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209. **Price $79.50 each**

Holtzer Cabot MG-149H—Similar to MG-149F but draws 44 amps DC at 28 v. Output ratings are at 0.90 P.F. Equipped with high altitude brushes. Stock #SA-4. **Price $34.50 each**

General Electric 5D21NJ3A — Input 28 volts DC at 35 amps. Output 110 volts 400 cycles. 485 V.A. at 0.90 P.F. Weight 15 lbs. Stock #SA-41. **Price $12.50 each**

ALSO IN STOCK

Navy Type CRV-21AAR G.E. 5AS121LJ2
Holtzer Cabot MG-149F
Wincharger PU7/AP
Wincharger MG-750
Pioneer 10042-1A
Pioneer 12117-2
Pioneer 12117-5
PE-218

GYROS

Sperry A5 Vertical Gyro. Part No. 644841, 115 volts 400 cycle 3 phase.
Sperry A5 Directional Gyro Part No. 656029, 115 volts 400 cycle, 3 phase.
Schwein Free & Rate Gyro, type 46800.

Schwein Free & Rate Gyro—45600—Stock #SA-148. **Special Price $8.75 each.**

GYRO SERVO UNIT

Pioneer 12800-1-D. 115v. 400 cy. Low inertia motor and follow-up Autosyn. Stock #SA-160. **Price $6.95 each**

DYNAMOTOR

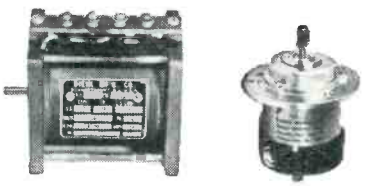
D-101 27 v. DC in @ 1.5 amps. DC out. 285 v. @ 0.60 amps. Stock #SA-187.
Price $1.50 each.

AUTOSYNS

Pioneer Types AY-1, AY-14, AY-20, AY-30, AY-54D, 2320, and AY-101D.
Prices on request

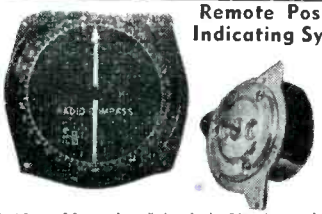
Pioneer Fuel Pressure Transmitter Type C-14A. 0-25 lbs. 26 v. 400 cycles. Stock #SA-131. **Price $3.75 each.**
Pioneer Oil Pressure Transmitter Type 4150-3B3. 0-200 lbs. 26 v. 400 cycles. Stock #SA-25. **Price $3.75 each.**
Pioneer B9A Dual Oil Pressure Indicator. 0-200 lbs. Use with 2S-25. Stock #SA-215. **Price $9.50 each.**

AC-SERVO MOTORS



Pioneer—CK-2 and 10047-2A for 400 cy.
Kollsman—776-01 for 400 cycles.
Diehl—FP-25-3, **FPE-25-11** (CDA-211052) and ZP-105-14 for 60 cycles.
Prices on Request

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-LM Compass Loops

New

QUANTITY PRICES ON REQUEST

MERCURY CONTACT RELAY

W.E. D-168479
Millisecond switching at up to 60 c.p.s. Technical data on request. Stock #SA-259. **Price $4.75 ea. Special qty. prices.**

D.C. MOTORS

Blower Assembly MX-215/APG
John Oster C-2P-1L 28 v. DC. 7000 RPM 1/100 hp. §2 L-R Blower.
Stock #SA-202.
Price $2.95 each

Universal Electric DC
W.E. KS-5603-L02, 28 v. DC. 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233.
Price $1.95 ea. plus 15c p.p.

Delco 5069466 Motor
Alnico PM field. 27.5 v. DC. 1" x 1" x 2" lg. Pinion gear on shaft. Stock #SA-65. **Price $2.95 each plus 15c p.p.**

DELCO CONSTANT SPEED MOTOR A-7155
1/30 hp. 3600 rpm. Cont. duty. 2½" diam x 5½" lg. ⅞" shaftextension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75 each.**

Delco 5069625 Constant Speed DC Motor. 27 v. DC. 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.** Qty. prices on request.

AC and DC Rate Generators
Elinco PM-2, Elinco B-68, E.A.D. J-36A, Elinco F-16, etc. Write for listing and prices.

⅛ HP DC Motor—G.E.5BA25MJ409. 24 v. 7.5 amps, 7500 rpm. Cont. duty. 5" lg. x 2½" diam. ¾" shaft ext.
Stock #SA-235 ..... **Price $1.75 each**

Bodine NYC-13 AC Motor
115 v. 60 cycles. 1/40 hp. 1800 rpm. Cont. duty. .55 amps. Stock #SA-245.
Price $9.50 each.

SYNCHROS

Navy Types
1G, 1F, 1CT, 5C, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.
Prices on Request

All prices F.O.B., Paterson.
Teletype PAT. 199
Phone ARmory 4-3366
Write for Listing.

Servo-Tek products co
4 Godwin Ave. Paterson, N. J.

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BUFRAD CAR RADIO ANTENNAS

All of our car radio antennas are made of triple plated Admiralty Brass Tubing, complete with low loss shielded antenna leads and high quality fittings.

SIDE COWL — BR-1, 3 sections extend to 66". Your price—single units —$1.75; in lots of 12—$1.50 ea.

SKYSCRAPER—BR-2 has 4 heavy duty sections that extend 98". This super-aerial must be seen to be fully appreciated. Your price—single units—$2.50; in lots of 12—$2.25 ea.

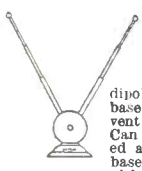
TILT ANGLE—BR-3, may be adjusted to all body contours, 3 sections extend to 66". Single unit price—$1.75; 12 lot price—$1.50 ea.

VERSATILE—BR-4, single hole fender or top cowl mounting may be adjusted to conform with all body contours, 4 sections extend to 56". Single unit price—$3.00; 12 lot price—$2.75 ea.

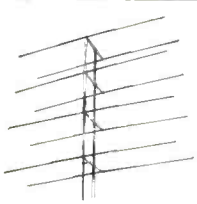
THE MONARCH—BR-5, single hole, top cowl mounting, 3 sections extend to 56". Single unit price—$2.00; 12 lot price—$1.75 ea.

Highest quality telescoping folded dipole rooftop type antenna with all the features usually expected in such an antenna, including use as dipole and reflector, and in addition a mounting bracket provided so that the antenna can be installed in any window in two minutes or less. Any slight loss in gain because of the reduction from rooftop height is more than compensated by the ability to orient the antenna instantly by opening the window and adjusting for maximum signal strength. Mounting bar can be installed horizontally or vertically in window frame or even between attic rafters, whichever is most convenient. Your cost $8.65. With high frequency attachment for channels 7 to 13 $11.00. Either type 10% less in dozen lots.

NO ROOFTOP CLIMBING HERE!



The **BUFRAD** Model BR8 portable indoor antenna adjusts easily to any channel and any station direction. Triple chrome-plated brass dipoles. Antique finished base with felt pad to prevent scratching furniture. Can also be readily installed attached to ceiling with base up. 300 ohm line furnished. Your cost $3.95. Lots of 12 at $3.50 each.



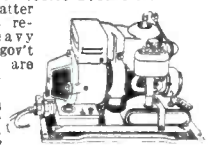
The famous **VEE-D-X LONG RANGE ANTENNA.** Consistant perfect results way beyond what usually are called fringe areas. The directional characteristics and extreme gain from this 4 bay unit provide the desired answer for those who have given up hope of satisfactory reception. An absolute necessity for reception over distances greater than 70 miles. Your wholesale price—$75.00.

AFTER SEEING OUR ANTENNAS AND COMPARING, YOU WILL NEVER BUY ANY OTHER MAKE!

OUR PE-109 POWER PLANT

DIRECT CURRENT

This power plant consists of a gasoline engine that is coupled to a 2000 watt 32 volt DC generator. This unit is ideal for use in locations that are not serviced by commercial power or to run any of the surplus items that require 24-32v DC for operation. The price of this power plant tested and in good condition is only $79.95 F.O.B. Buffalo, or we can supply in strictly "as is" condition for $58.95 F.O.B. New York City. These latter are exactly as received, in heavy steel-strapped gov't cases, and we are unable to determine if the individual units are new, or what the condition is if used, while the $79.95 are some of the same that we have brought to Buffalo for testing and repair if necessary. We do not recommend gambling on the "as is" condition, except for quantity purchasers. We can also supply a converter that will supply 110v AC from the above unit or from any 32v DC source for $12.95.



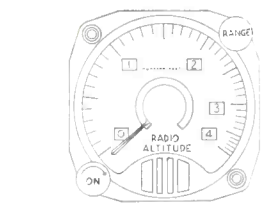
"SO" RADAR SET

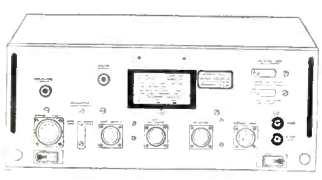
"SO" RADAR RECEIVER, complete with 9 tubes including picture tube. This Plan—Position—Indicator Oscilloscope has a self-contained pack designed to run from the 110 V. power supply on LST or PT boats. It provides a 5" diameter picture adjustable at will to an 80, 40, 4 or 2 mile circle with the boat at the center, showing location of land, other ships, or any obstruction, so that navigation can be carried out in pitch darkness or densest fog with as much safety as in brightest sunlight. Your cost $39.95.

ACRO TELEVISION CHASSIS CRADLE

Pays for itself in a week—Saves and eliminates broken tubes, coils, dials, etc. Cadmium plated steel, finger-tip control. A necessity for Television Service. Your Cost $4.69

ELECTRONIC ALTIMETER
Only $45.00





Brand new APN-1 14 tube electronic altimeter in original factory packing. This famous 18x9x7 unit, which weighs only 25 lbs. without plugs or cables, cost the gov't $2000 and includes a transmitter, a receiver, all tubes, an altitude meter, an altitude limit switch, and two easily installed 11" antennas. Working on the radar principle, the receiver measures the absolute altitude from 3 to 4000 feet, with precision enough for blind landings. In addition the altitude limit switch gives an alarm if the plane's height varies by more than 10 feet from a preadjusted value. Fills recent C.A.A. requirements effective Feb. 15, 1949, that all scheduled airlines must have terrain clearance indicators capable of giving warnings at 500, 1000 and 2000 ft. Another outstanding feature is that connections are provided to control an electronic automatic pilot. Send for our aircraft radio equipment catalog. Export inquiries invited.

Model for 12 to 14 volts D.C. $75.00
Model for 24 to 28 volts D.C. $45.00

COMPRESSED AIR

INSTANTLY ANYWHERE

Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball-bearing on connecting rod and oil impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. **PATENTED** unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than one minute. Comes complete with 100 lb. gauge, although finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides, annealing or brazing with natural gas, inflating tires, etc. Price $14.50 postage prepaid anywhere in the U.S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose available for only $7.75 with pint container, also prepaid. 25% required on all C.O.D. orders.

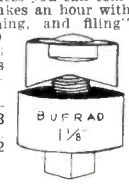
SENSATIONAL CAR RADIO BARGAIN

Nationally advertised brand 1949 car radio that will fit practically any car. We can't advertise the brand name because we are selling them below regular list price, but they are sure fire hits because of their outstanding performance. Plenty of eye appeal plus a host of other features that other car radios do not offer; a 3 gang condenser for razor sharp selectivity, an R.F. stage for extreme sensitivity, superhet circuit, A.V.C. to eliminate fading, and a 6½" speaker for good tone quality at any volume. Your cost..$27.95

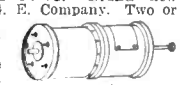
SAVE HOURS OF HARD WORK

Do the job in minutes with a BUFRAD Socket Hole Punch. Cut clean accurate holes for sockets, plugs, connectors, etc. Cutting holes in radio chassis is as simple as cutting butter with a hot knife with a BUFRAD punch. Just insert the punch in a ½" hole and turn with an ordinary wrench. In a minute or less you can complete a job which often takes an hour with the old "drilling, reaming, and filing" method. With BUFRAD punches you can make 15 different sizes of openings from ½" to 2¼" diameter.

½", ⅝", ¾", ⅞" sizes—$2.08
1", 1-1/16", 1⅛", 1-5/32", 1-3/16", 1¼" sizes—$2.42
1⅜", 1½" sizes—$3.10
2¼" size—$5.95



$12.95 *Takes All Three* BIG BARGAINS



1. SENSATIONAL, FASCINATING, MYSTERIOUS SELSYNS. Brand new Selsyns made by G. E. Company. Two or more connected together work perfectly on 110V AC. Any rotation of the shaft of one Selsyn and all others connected to it will rotate exactly as many degrees in the same direction, following unerringly as if the units were connected together by shafting instead of wire. This is true whether you twist the shaft of the master unit a fraction or a revolution or many revolutions. Useful for indicating direction of weather vanes, rotating directional antennas, or controlling innumerable operations from a distance. Complete with diagram and instructions. Per Matched pair $4.95.

2. ALUMINUM GEAR BOX 18x8x7 that contains two powerful electric motors and two matched gear trains, 62 gears in all varying in size from ½ to 4 inches in diameter. This unit is readily converted to rotate a beam antenna or any other similar use $5.00

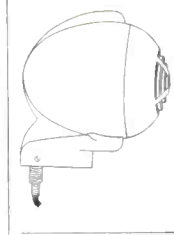
3. HOME WORKSHOP AT BARGAIN PRICE. Accurate and precise 2 speed guaranteed hobby lathe, the essential machine for the home workshop. Sturdy enough for light production work or factory standby service. Supplied with 56" of belting for connecting to any available electric motor or power take-off. Also included in this unbelievable offer are such accessories as a ½" drill chuck with specially hardened tool steel jaws, a 4" electric furnace high speed grinding wheel, a cotton buffing wheel and a large supply of buffing compound, and a 4" steel wire scratch brush. Your cost $6.00. Sole export agent. Distributor inquiries invited.

6.95 TAKES ALL THREE BIG BARGAINS

1. **AUDIO AMPLIFIER** — Brand new, push-pull output triode amplifiers having 2 of the valuable and scarce ouncer type audio transformers that sell for over $10.00 apiece. Neat aluminum case, fully enclosed (largest dimension 6 inches). Perfect for intercom systems, phono amplifiers, mike amplifier, or signal tracer amplifier for testing radio sets. A sensational bargain at only .....$3.40 each
2. **BANDSWITCHING TUNING TURRET** made by Western Electric. Covers 4 bands above 100 MC. All coils wound with #14 silver-plated wire. Complete with tuning condensers and powerful electric driving motor. Diagram included. ONE OF OUR MOST TERRIFIC VALUES—**ONLY $2.95,**
3. **The dual meter**—one 50 uA and one 200 uA movement in the same case. This meter is ideally suited for use as a combination modulation percentage and carrier shift indicator. If desired the movements may be removed from the case and used separately. All meters are in perfect operating condition, but a few have cracked glasses.

This super value costs only $1.95.

MICROPHONES



Super Special-Highest quality all chrome bullet shaped **CRYSTAL MIKE** of top-flight nationally known brand—$5.95. Bullet **DYNAMIC MIKE**—$7.95, **MIKE Jr.—60c, PUSH-TO-TALK MIKE** with switch on handle—98c, **LAPEL MIKES** — (Specify whether carbon or magnetic) 93c.

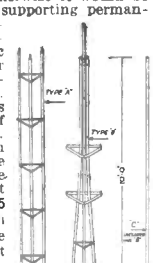
RT1711 Brand New 12 Tube, 110 Volt Receiver-Indicator-Oscilloscope complete with all tubes and power supply. Has telescoping hood over scope tube, which is equipped with a detachable calibrated screen. Has centering and amplitude controls and two video inputs. A natural for television. $39.95

SUPER SPECIAL

FAIRCHILD bombsight **POWER UNITS.** Our quantity of these is too limited to justify the space required by a photo, but each unit is brand new, contains 9 tubes which alone have a total value of $15.00; 8 electric motors or generators, 6 of which are of the permanent magnet field type; relays; and 20 valuable precision resistors plus a multitude of the ordinary kind, in addition to many condensers and potentiometers. All for only $14.95. We will ship but one to a customer while our small quantity lasts.

THE BUFRAD SECTIONAL TOWER

This latest addition to the famous line of BUFRAD antenna products makes up to a hundred foot tower from any desired number of ten foot sections of extremely strong welded construction. The sections are shipped assembled and painted, so that erection is a matter of minutes rather than hours. Assembly is a one man job, and is accomplished by climbing up the completed portion of the tower with the next 25 lb. section to be installed. Hand and footholds are provided to make the work safe and easy. Cap at top of tower provides bearing surface for rotating, and prevents water from entering tubes. Useful for police, or amateur transmitters, and in addition the tower will provide satisfactory TV reception where otherwise it would be impossible. Ideal for supporting permanent or temporary power lines, wind generators, stadium public address speakers or spotlights for gas stations or parking lots. "B" and "C" sections together cost a total of $15.75 and total 20 feet. "A" sections, which make up the entire tower except for the top, are each 10 feet long and cost but $12.75 apiece. Those who wish a mast base will be able to obtain one (not shown above), for only $6.00. The base is especially useful when erecting the tower on a sloping roof.



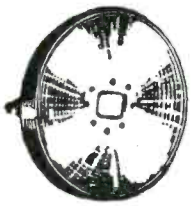
RT1655
Only $14.95

11 tube crystall controlled **superheterodyne receiver** that covers the FM band. The ultra modern circuit uses the latest types of tubes including 7 miniature 6AJ5's. Beautiful chassis and aluminum cabinet. Tubes and diagram included.

All sales final and no returns unless otherwise specified in ad of item. Right reserved to change prices and specifications at any time. Cable address BUFRAD.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. E BUFFALO 3, N. Y.

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-168479

For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and constant 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.

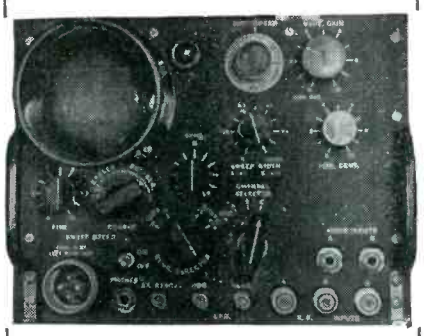
Brand New in Original Cartons, $4.75

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



MODEL AN/APA 10 PANORAMIC ADAPTER

Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5 AN/APR-4 SCR-587 or any receiver with I.F. of 455kc, 5.2mc, or 30mc.
With 21 tubes including 3" scope tube.
For operation from 75 to 125 V. 400 to 2600 cycle A.C. power source . . $149.50
Converted for operation on 115 V. 60 cycle source $195.00
80 Page Technical Manual $3.50

STEPDOWN TRANSFORMERS

Input: 115V 60 cycles.
Output: 20 V., at 10 amps. Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications, etc.

Brand New $2.45

SELENIUM RECTIFIER

Bridge Type

Input: 30 V. AC.
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

SOUND POWERED TELEPHONES

Type TP-3

For two-way signalling for voice communication. No batteries needed. May be used on metallic or grounded circuits, open-wire lines, cables or circuits using local-battery telephones, switchboards; two-way-ring-down trunk circuits of common battery switchboards, etc. Contained in treated waterproof fabric cases with adjustable carrying straps.

Brand New $29.50

NAVY MOTOR GENERATORS

Allis-Chalmers

115V. D.C. to 120 A.C. 60 cy. 1 ph. 1.25 KVA 3600 RPM, ball bearings, centrifugal starter, fully enclosed, splashproof.

Brand New—$97.50

Same machine with 230V D.C. input **$125.00**

Also available: 2kw., 115V. D.C. to 115V. 50 cycle, 1 ph. and 2.5kw., 115V D.C. to 115V. 60 cy., 1 ph. machines. Write your requirements.

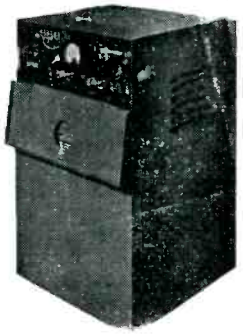
SOUND POWERED CHEST SETS

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**

SURPLUS

Raytheon "RECTICHARGERS"



Input: 115 volts AC, 60 cy., 1 Ph. . . . Output: 48 v. DC at 3 amperes regulated and adjustable. Charges 23 cell battery or may be used direct as battery eliminator.

The Raytheon "Recticharger" is designed to supply current at constant voltage to any load within its rating, and in addition to supply current to a storage battery connected across its load, of sufficient amount to maintain full charge. The function of the battery is to supply surge current due to sudden changes in load and to supply current above the rating of the "Recticharger" for temporary overload, and to act as a "stand-by" source of power in event of commercial power failure.

UNUSED, IN ORIGINAL PACKING CASES $69.50

SO-1 RADAR ANTENNA ROTATORS

These Radar Antenna Rotating mechanisms are now being used by many television companies and experimental laboratories for rotating microwave and other transmitting and receiving equipments. The SO-1 Radar Rotator pedestal is ideal for this purpose because of its high torque and sturdy, weatherproof construction.

Drive mechanisms consist of a high precision speed-reduction worm gear train driven by a reversible D.C. Motor. On the low-speed end of the worm train, a spur gear drives a larger spur gear attached to the rotating assembly. The latter is virtually locked in position by the gear train when the drive motor is off, preventing drifting of the antenna in high winds.

Brand New $249.50

Selsyn Direction Indicator equipment for use with these Rotators is available on special order. Write for further information.

SHOCK MOUNTS

	A	B	C	D	E	
A. Lord #20, 3" x 3" x 1¾"						.40
B. U. S. Rubber #5150 C, 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

POTENTIOMETER

20,000 ohms, complete with engraved dial assembly.

Brand New . . . 1.25

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unles 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.

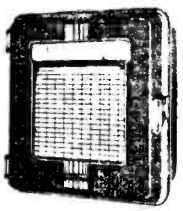
All Prices Subject to Change Without Notice

SURPLUS BARGAINS — — NOW ! !

L & N MICROMAX
D. C. POTENTIOMETER
Rebuilt, Reconditioned, Adjusted Electrically and Mechanically.
Serial #s in 4000 Group Series

Model S INDICATING & RECORDING CONTROLLER

Single Point, Curve Drawing. Continuous Line, One set HIGH & LOW Contacts. 110V A.C. Motor.

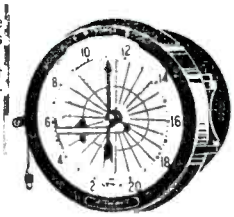


Ranges:
0—1200°F C/A
0—1500°F C/A
0—1800°F C/A
200—2000°F C/A
1000—2000°F C/A
1000—3000°F Plat./10%R

$210.00

MODEL R INDICATING & RECORDING CONTROLLER

Single Point. Curve Drawing. Continuous Line. Chart Speed 1 RPM/24 Hrs. 1 set HIGH & LOW Adjustable Contacts. 115V A.C. Motor.

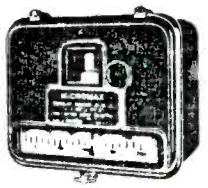


Ranges:
0— 800°F C/A
700—1400°F C/A
200—2000°F C/A

$135.00

Model C INDICATING CONTROLLER

Single Point, Non-Recording Open Type. Contacts for use with External Relay. HIGH-COMMON - LOW. Contacts for Controlling. 115V. A.C. Motor.



Ranges:
0—1500°F 1/C
0—1600°F C/A
0—1800°F C/A
200—2000°F C/A
600—2000°F C/A

$110.00

TRANSTATS

Type RH Input: 115 V. ±10%. Output: 115 V. Made as a line voltage corrector ±10% of input voltage, or can be connected to give ±20% of input. Rating .25 KVA.

Your Price **$6.50**

RATING 3KVA, MAX AMPS 26

same as above, can also be reconnected to be used as an isolation type step down with variable secondary. Input: 115V. Output: 0-30V, at 30 Amps. **Your price $18.00**

HIGH VOLTAGE CAPACITORS

1 MFD 20 KV DC 18"x13½"x5" $25.00
.1 MFD 25 KV DC-13"x7"x4" 9.85
.001 MFD 50 KV DC-5⅛"x7¾"x4" insulators 4" dia x 7" high 12.50

Cap Mfd.	Volts D.C.	Height	Width	Length	Price
10	1000	5-7/8 x	1-3/4 x	3-7/8"	$1.85
4	1000	5-7/8 x	2-3/4 x	1-1/4"	.85
1	1000	3-5/7 x	2 x	1-1/16"	.50
1	500	2" x	1-1/4" x	1-1/16"	.25
.25	1000	1-1/2 x	1" x	3/4"	.25

PANEL METERS

Code—R-Round, S-Square, B-Bakelite, M-Metal, F-Flush, SF-Surface, FS-Full Scale

A. C. VOLTS

Weston	517	0-10	2" R-M	2.95
Weston	517	0-15	2" R-B	2.95
Weston	517	0-150	2" R-B	**3.50**
Simpson	125	0-150	2" R-M	2.95
Weston	476	0-1.5	3" R-B	4.50
Whse	RA35	0-7.5	3" R-B	**3.95**
Weston	476	0-8	3" R-B	**3.95**
Trpltt	331JP	0-150	3" R-B	**4.50**
GE	AO22	0-150	3" R-B	5.50
Brlngton	32XA	0-150	3" R-B	4.50
Whse	NA35	0-15/300	3" R-B 3 Studs	5.95
Whse	DY-2	0-15	4" R-M Ext. Mult.	9.75
Weston	642	0-75	4" R-M SF or F	7.50
Whse.	RA37	0-300/600	4" S-B w/2 to 1 Potential Transformers	**9.75**

AC AMPS

Whse	NA35	0-3A FS. 0-120 Scale	3" R-B	4.95
Trpltt	431 AC	0-5A FS. 0-150/300 Scale	3" S-B	4.95
Trpltt	332JP	0-30	3" R-M	**4.95**
Weston	642	0-75	4" R-M SF or F	7.50
Whse	RA37	0-75/150	4" S-B w/external Current Transformers	**9.75**

DC MICROAMPS

Weston	301	0-100	3" R-B	12.50

DC MILLIAMPS

McClntk	2001	0-1	2" R-B	**3.95**
Weston	506	0-1	2" R-B Spec Scale	4.50
Sun	525	0-2	2" R-B	2.50
Weston	506	0-3	2" R-B	3.95
Weston	506	0-15	2" R-B	3.50
GE	DW41	0-25	2" R-B Wide Flange	**3.50**
GE	DW41	0-30	2" R-B	3.50
Weston	506	0-50	2" R-M	3.95
McClntk	2001	0-100	2" R-B	3.50
Simpson	25	0-1	3" R-B Spec Scale	**4.50**
GE	DO41	0-1	3" R-B	4.95
GE	DO41	0-1	3" R-B Black Spec Scale	**4.50**
Weston	301	0-1	3" R-B Spec Scale	**7.50**
Simpson	25	0-5	3" R-B	4.75
GE	DO41	0-10	3" R-B	4.75
Whse	NY35	0-15	3" R-B	4.50
Simpson	25	0-15	3" R-B	3.95
GE	DO53	0-20	3" R-B	3.95
Weston	301	0-25	3" R-M	**5.95**
Weston	301	0-30	3" R-M	5.95
Weston	301	0-100	3" R-B	6.50
Whse	NX35	0-200	3" R-B	4.50
Weston	301	0-200	3" R-B	**6.50**
Weston	301	0-300	3" R-B	**6.50**
Weston	301	0-500	3" R-B	**6.50**
Weston	301	5-0-5	3" R-B Spec Scale	5.50
GE	O58	0-8	4" S-B Blk Scale	7.50
GE	DO58	0-30	4" S-B	7.50

DC AMPS

Weston	506	50-0-50MV	2" S-B Spec 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

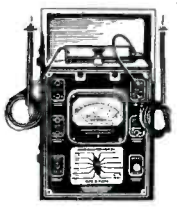
Sun	378	0-3	2" R-B	2.50
GE	DW40	0-15	2" R-B Short Flange	3.50
Weston	506	0-20	2" R-B	3.50
Simpson	125	0-35	2" R-M	**2.50**
Weston	506	0-40	2" S-B	3.95
Weston	506	0-250	2" R-M	5.50
Weston	301	0-30	3" R-M	5.95
Weston	301	0-150	3" R-M Blk Scale	**5.95**

All Scales White, All Cases Flush Unless otherwise specified.

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**

CIRCUIT ANALYZER



NEW! $57.50

WESTON Model 772, Type 6 with televerter to extend DC range to 5000 V.
SENSITIVITY—
20,000Ω/V-DC
1,000Ω/V-AC
RANGES: (All self contained) AC & DC Volts—2.5/10/50/250/1000
DC Amps—1/10 A
DC MA—1/10/50/250 MA
MICRO A—100 MICS
RESISTANCE—3000/30K/3 Meg/30 Meg Db — 6 Ranges from —14 to +54
In handsome wood case

GE TYPE DO 50 DC AMMETER

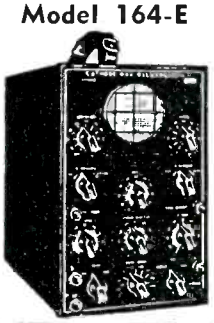
50 MV FULL SCALE RECTANGULAR 3¼" x 3", Barrel 2¾" DIAM, x 1½" DEEP, MOUNTING HOLES 2⅝" x 2⅜" c. to c. Special Scale, can be used with Ext. Shunt for any range, bakelite case.
A BUY! Price ..... 10 for $27.50

GE TYPE DO 50 DC VOLTMETER

3 volts full scale, 100 ohms, 1V, special scale, same dimensions as above, bakelite case.
A BUY! Price ..... 10 for $27.50

A SCOOP on a 'SCOPE DUMONT

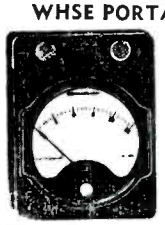
Used! Guaranteed
Model 164-E



3" CRT operates at accelerating potential of 1100 V — brilliant well - defined trace, Vert amp voltage gain approx 43, horiz amp voltage gain approx 55, Freq. range vert.& hor. amp both uniform ±3 DB from 5-100,000 CPS Input impedance 1 megohm vert, .8 megohm hor. Operates 115 V, 40-60 cycle.

Price New $115.00
Your Cost $77.50

WHSE PORTABLE GALVANOMETER



Type PX-12. Movement 7 MA, special scale, solid connecting terminals, contains a 1 Volt internal cell which can be easily removed for conversion to DC AMMETERS & VOLTMETERS, with leather case and canvas carrying strap.

A buy at $14.95

STEP DOWN TRANSFORMERS SPECIAL

Made by GE heavy duty, considerable overdesign, open frame, ideal for rectifier application, size: 3¼" x 3½" x 4".
PRI—115 Volts 60 Cycles
SEC—15 V at 12 Amps **$3.75**

GE Step Down Power Transformer

GE Type M Cat #61021. Enclosed. Size: 4-9/16" H x 4⅜" W x 12⅛" 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

RACK PANEL CABINET

42" H x 22" W x 16½" D
Heavy Gauge Metal, Black Wrinkle Finish, shipped knocked down, ready to assemble with rear door and hardware. Front Panel not included. Panel size 19⅛" x 36¾". Shipping weight 99 lbs.
NEW! A REAL BUY $17.50

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.**

ELECTRO IMPULSE LABORATORY

TS-155B/UP SIGNAL GENERATOR, pulsed, calibrated output, 110 v. 60 cy. NEW.

TS-125/AP CALIBRATED S BAND POWER METER.

TS-110/AP S BAND ECHO BOX.

MUTUAL INDUCTION OR PISTON TYPE ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, barrel diameter ⅝"..... **$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-19, range 1000-2000 mc
TN-18, range 300-1000 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**

ECHO BOX CUO-14AAY FOR OBU-RADAR

S BAND SIGNAL GENERATOR CAVITY with cut-off attenuator, 2700-2950 mc, 2C40 tube, with modulator chassis **$30.00**

TEST SET TS-278/AP, for AN/APS 13, synchronized, delayed pulse signal generator, 400-430 mc, calibrated waveguide below cut-off attenuator, synchronized marker generator, 115 v 60 cps, new complete.

S BAND MIXER, type N signal input, oscillator input, and I.F. output connectors, variable oscillator injection **$17.50**

HIGH PASS FILTER, cut-off at 1000 mc, coaxial, 50 ohms **$12.00**

MICROWAVE TEST CABLE, RG-9U cable with UG-21U connectors, 4½ feet long..... **$3.00**

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.

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**

RDF EQUIPMENT DP-15, 100-1500 kc, for ship use, complete with pedestals, azimuth scale, loop assembly, used, 110 v 60 cps..... **$250.00**

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**

PULSE TRANSFORMER, Westinghouse 145-EWP..... **$10.00**

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032 ..... **$3.00**

PULSE FORMING NETWORK, 20 kv, .92 microsecond, 50 ohms, 800 p.p.s..... **$40.00**

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-190/U	1.00
UG-12/U	.80	UG-201/U	2.00
UG-21/U	.80	UG-245/U	.60
UG-22/U	.80	SO-239	.28
UG-24/U	.80	PL-259	.28
UG-25/U	.80	(for small cable)	
UG-27/U	.50	M-359	.28
UG-29/U	1.00	UG-266	1.00
UG-30/U	1.00		
UG-30/U special	1.00	PL 54	.10
UG-58/U	.60	PL 81	.50
UG-59/U	1.00	AN-3102-14S-5P	.25
UG-83/U	1.00	AN-3102-14S-2P	.25
UG-86/U	1.00	RC-10066-20-IP	.50
UG-167/U	2.00		

TUBES:
W.E. 704A MINIATURE DIODE, and 705A H.V. RECTIFIER ..... **$2.00 each**

MAGNETRONS:
2J34 ..... **$15.00** — 14 AY..... **$15.00**
3J31 ..... **$15.00**

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-89, 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, 1000 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 600 WVDC ROUND CAN			10 for $2.00
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	300 WV	.25
25 mfd	25 WV	.10

DM-43 Dynamotor, G.E., 24 v. 515/1030/2/8/ 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**

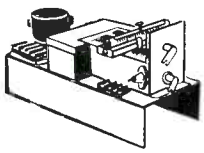
Stranded aluminum flexible shield conduit, I.D. ⅜"..... **.05 ft**

AB26CR MAST EQUIPMENT COMPONENTS such as Anchor screws, coupling units, base plates and guy cables, designed for 72 ft transportable mast. New Equipment.

ELECTRO IMPULSE LABORATORY

P. O. Box 250 — **Eatontown 3-0768** — **Red Bank, N. J.**

GUARANTEED GOVT SURPLUS



420—750 MC OSCILLATOR.

Compact, beautifully built line oscillator employing two W.E. 368AS (703A) "doorknob" tubes in push-pull. Exceptionally stable. 5W output at 420mc, 2W at 700mc. Independent grid and plate tuning. Adjustable output coupling and tuning assembly. Coaxial output connection. Built-in blower may be operated from 110VAC. Power requirements: 300VDC/150ma, 1.2V/4A, 1.2V/4A. 5¼"x6½"x11½". 7 lb. Supplied complete with tubes. Ideal for 420mc amateur operation or for use in the 460-470mc citizens radio band. **Stock No. APO-66...$6.95**
Spare 368AS/703A tubes **$1.69**

UHF 50 OHM COAXIAL POWER MEASURING ASSEMBLY. Panel mounting, silver-plated assembly with integrally coupled crystal mount. Type "N" UG-58U female receptacle (easily replaced by SO-239). Originally designed for power measurement at frequencies up to 700mc. **Stock No. APM-89** **$3.95**

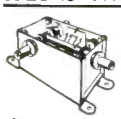
MATING TYPE "N" MALE PLUG. For use with above. **Stock No. PCM-17**.....**$0.49**

10 CM ECHO BOX AND PHANTOM TARGET. Resonant cavity with adjustable piston. Complete with 20 feet of cable and 10 cm dipole antenna. **Stock No. AWM-30..$4.95**

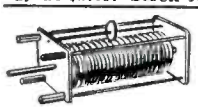
SPERRY MODEL 12 KLYSTRON TUNER for use with 2K39, 2K42, 2K43, 2K44, 417A. **Stock No. VKT-27** **$1.95**

MAGNETRON MAGNET 1900 GAUSS. Pole dia. 1-⅝". Gap 1½". **Stock No. UMM-21** **$5.75**

MAGNETRON MAGNET 4800 GAUSS. Pole tip dia. ¾". Gap 0.635". **Stock No. UMM-48** **$7.00**



50 OHM COAXIAL RELAY. Double coil actuating relay operates from either 12VDC/120ma or 24VDC/60ma. May be operated in plate return circuits to provide automatic transmitter-receiver antenna changeover. Supplied with British type connectors which are easily replaced by standard SO-239 (83-1R) receptacles or soldered to directly. Completely enclosed in compact housing. 2-¾" x 3" x 4-¾". An outstanding buy at **$2.49. Stock No. KDC-723.**



VARIABLE INDUCTOR. 67 microhenries **max.** Minimum near zero. Wheel type sliding short. Ceramic insulation. Quality construction. Barker-Williamson #1565. Originally used as transmitter plate tank coil to tune from 1½ to 20mc. Ideal for pi-networks, antenna tuners and plate tanks. **Stock No. LRF-32**.....**$1.95**

APC AIR TRIMMER. 35 mmf max. Screw slot adjustment. **STOCK NO. CAV-105. 10 for** **$1.00**

APC AIR TRIMMER. Two separate trimmers on ceramic base. Shield between sections. Each section 25 mmf max. **Stock No. CAV-104. 10 for** **$1.00**

AIR CAPACITOR 100 MMF MAX. ¼" dia. shaft. Receiving type. Ceramic insulation. Standard Brand. Similar to MC-100-M. Straight-line capacity. **Stock No. CAV-15** **$0.72**

SUPER-FLEXIBLE PIGTAIL WIRE. Sperry Special. Part No. P55357. **Consists of 350** strands of 0.002" diameter soft copper wire. Total diameter: 1/32". Useful in applications where electrical connection is to be made to moving parts, e.g., variometers, variable capacitors, motor-brushes, etc. **Stock No. WFP-350. 10 foot rolls. $0.69 per roll.**

NON-INDUCTIVE PLAQUE RESISTOR 1000 OHM/40 WATT. Standard Brand. Type 22. Useful up to approximately 60mc. Two or more may be paralleled for higher wattage and lower resistance. Make excellent elements for AF and RF dummy loads or plate loads. ½"x1¼"x4½". **Stock No. RWF-175** **$0.49**

NON-INDUCTIVE CERAMIC RESISTOR. 350 ohms/24 watt. Standard Brand. **Stock No. RCF-52. 8 for**.....**$1.00**

3 WIRE TELEPHONE CORD. Quality rubber insulation. Non-kinking. Color coded. Spade-lug terminals. 6 feet long. ¼" OD. **Stock No. WCC-333. 10 for**.....**$1.00**

Tube Specials

1A7GT	$0.72	6L6GA	0.89	304TL	1.95
1B22	0.95	6L7	0.98	316A	0.89
1E7G	0.59	6N7	0.95	417A	14.95
1G6GT	0.49	6N7GT	0.79	559	1.19
1V	0.49	6Q7	0.72	705A	2.95
2A3	0.98	6SA7GT	0.60	723A/B	5.95
2C4	0.95	6SC7	0.69	725A	14.95
2C21/1642	0.29	6SF7	0.72	730A	12.50
2C34	0.29	6SH7GT	0.39	803	8.95
2C40	0.75	6SJ7	0.59	805	3.95
2C44	0.75	6SJ7GT	0.49	807	1.19
2D21	1.49	6SK7	0.72	811	1.95
2J26	14.95	6SL7GT	0.69	813	7.95
2J32	14.95	6SN7GT	0.89	814	3.95
2J38	14.95	6SR7	0.67	815	1.95
2J48	5.95	6SU7GT/Y	1.29	836	0.89
2J55	19.75	6V6GT	0.79	860	2.95
2K28	12.95	6V6	1.09	861	15.00
2X2	0.69	6X4	0.69	866A	0.95
3B7/1291	0.39	6X5GT	0.63	868/CE/IC	0.95
3C23	2.95	6Y6G	0.88	872A	1.69
3D21A	1.95	6ZY5G	0.81	874	0.59
3E29	3.49	7C7	0.81	902A	3.95
3FP7	1.95	7G7	1.06	931A	2.95
3Q4	0.69	7Y4	0.72	954	0.39
4A1	0.49	7Z4	0.72	955	0.39
5BP1	1.95	12SF7	0.59	956	0.49
5CP1	1.95	12SG7	0.59	957	0.39
5FP7	0.49	12SH7	0.59	958A	0.39
5R4GY	1.09	12SJ7	0.59	959	0.39
5U4G	0.65	12SL7GT	0.79	991/NE-16	0.29
5V4G	1.09	12SQ7	0.65	1625	0.49
5Y3GT/G	0.49	12SR7	0.72	1626	0.39
5Z4	0.88	14H7	0.79	1629	0.29
6AC7	0.79	15E	0.98	1641/RK60	0.95
6AE5GT	0.79	RK21	0.95	2050	0.79
6AG7	0.89	25Z5	0.59	8013	1.49
6AU6	0.95	25Z6GT	0.59	8020	1.95
6C4	0.49	35W4	0.49	9001	0.39
6F6	0.89	EF50	0.49	9002	0.39
6F8G	0.89	RKR73	0.39	9003	0.39
6G6G	0.49	80	0.45	9004	0.39
6H6	0.49	85	0.72	9005	0.79
6H6GT/G	0.29	89Y	0.54	9006	0.39
6J5	0.57	117Z6GT/G	0.88	VR90	0.69
6J7	0.69	FG17S	1.95	VR105	0.69
6K6GT/G	0.65	211	0.25	VR150	0.59
6K8	0.88	215A	0.95		
6L6	1.28	304TH	7.75		

OIL—FILLED CAPACITORS

Stock No.		Description	Price
CPO-195	2-2 mfd	600VDC cylindrical	$0.75
CPO-166	2½-2½-5 mfd	600VDC rectangular	1.37
CPO-48	4 mfd	600VDC rectangular	0.84
CPO-167	7 mfd	600VDC rectangular	1.15
CPO-112	10 mfd	600VDC rectangular	1.37
CPO-170	50 mfd	330VAC rectangular	4.95
CPO-13	2 mfd	1000VDC rectangular	0.95
CPO-124	4 mfd	1000VDC rectangular	1.19
CPO-19	8 mfd	1000VDC rectangular	1.71
CPO-180	½ mfd	1500VDC cylindrical	0.57
CPO-196	.1-.1 mfd	2000VDC rectangular	0.75
CPO-163	0.25 mfd	2500VDC cylindrical	1.06
CPO-22	0.25 mfd	3000VDC rectangular	1.71
CPO-544	2 mfd	4000VDC rectangular	4.95
CPO-553	3 mfd	4000VDC rectangular	5.95
CPO-171	0.1 mfd	5000VDC rectangular	3.65
CPO-125	2 mfd	5000VDC rectangular	7.30
CPO-154	1 mfd	6000VDC rectangular	7.60
CPO-37	.1-.1 mfd	7000VDC rectangular	1.95
CPO-562	.05 mfd	7500VDC cylindrical	1.75
CPO-47	1½-1½ mfd	7500VDC rectangular	13.00
CPO-173	0.02 mfd	10,000VDC cylindrical	2.95
CPO-172	0.25 mfd	20,000VDC rectangular	19.95

Note: 10 or more capacitors of a type 10% dis.

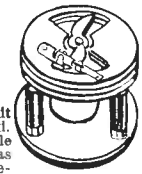
RF and DC PANEL METERS

Stock	Description	Price
MAD-251	0-2 ma DC Westinghouse 3½" round	$3.95
MAD-262	0-20 ma DC Westinghouse 3½" round	3.95
MAD-265	0-80 ma DC W.E. 3½" round	3.49
MAD-503	0-1000 ma DC DeJur 3½" round	3.95
MAD-276	0-30 ADC GE 2½" round	2.95
MVD-249	0-3 VDC Gruen 2½" round (0-1 ma DC basic movement)	2.95
MRT-355	0-100 ma RF Weston 425 3½" round	11.95
MRT-372	0-120 ma RF Weston 507 2½" round	8.95
MRT-367	0-1A RF GE 2½" round	2.95
MRT-394	0-20A RF GE 3½" round	6.95

50 MA. METER. 2-¾" square metal cased meter. 50 ma. full scale movement. Replaceable scale calibrated 0-3 volts with red and green areas indicating operating condition of a 2 volt storage cell. Wt. 4½ oz. A once-in-a-lifetime buy. Order a half dozen now while the supply lasts. **Stock No. MVD-58. $0.69 each. 6 for** **$3.00**

Delivery: Immed. from stock (subj. to prior sale).
Minimum Order: $5.00.
Terms: Rated organizations (U. S. and Canada), Open account.
Others: Cash with order, or 20% with order, balance C. O. D.
Foreign: Payment in U. S. funds with order or irrevocable letter of credit payable against documents in U. S. funds at New York.
Condition of material: The major portion of the material listed above is brand new. Some of the items have been removed from new equipments. We guarantee material to be clean and in perfect operating condition.

Wide Range Butterfly Wavemeter & Oscillator Elements



Precision wide range butterfly circuit elements. Sturdily constructed. Mounted in ball bearings. Suitable for motor drive. Ideal for use as wavemeters and oscillators (see description below).

Stock No.	Freq. (mc.)	Notes*	Unit Price
TN-20	105-330	1, 3	$2.95
TN2A	75-300	1, 4	2.95
TN-30	135-485	2, 3	3.95
TN3A	300-1000	2, 5	4.95

Brand new, in original packing.

*NOTES: 1) Aluminum construction
2) Silver-plated brass
3) Designed as oscillator element (955 acorn triode)
4) Has diode socket mounted on unit (955 as diode)
5) Has crystal diode mount for 1N21 crystal

BLILEY SMC-100 100 AND 1000KC CRYSTAL. Regularly sells for $8.75. **Stock No. QCM-19** **$5.95**

100KC LORAN CRYSTAL. ±15 cycles from −40° to +50°C. Supplied with mounting socket. **Stock No. QCM-17**.....**$6.95**

HAMMARLUND CERAMIC ACORN SOCKETS. 5 contact. Silver-Plated. **Stock No. XRT-25. 20 for**.....**$1.00**

CINCH MICA FILLED OCTAL SOCKETS. 1" dia. 1-5/16" mtg ctrs. **Stock No. XRT-20. 20 for** **$1.00**
1-1/8 dia. 1½" mtg. ctrs. **Stock No. XRT-40. 20 for** **$1.00**

3"-5" SCOPE TRANSFORMER. Primary: 115V/50-2600cps. Secondaries: 700VCT/70 ma, 750V (1050V peak) 10ma, 5V/2A, 6.3V/0.6A, 6.3V/4A. Hermetically sealed. 5½"x 4"x4". **Stock No. TFF-56**.....**$2.49**

5"-7" TELEVISION OR SCOPE TRANSFORMER. Primary: 115V/60c. Secondaries: 2200VRMS (3000 Volts peak) 7ma, 2½V/2A/3000V ins., 6.3V/1A/3000V ins. Cased 2-¾" x 3" x 3½". **Stock No. TFF-81**...**$4.79**

4200 VOLT TELEVISION OR SCOPE TRANSFORMER. Primary: 115V/60c. Secondary: 3000VRMS (4200 Volts peak) 10ma. Hermetically sealed. 4½"x4-¾"x5½". **Stock No. TFF-83** **$5.95**

HV XFMR 10,000-0-10,000 V @ 42 ma Pri 110 V., 60 cy. Oil Filled Hermetically Sealed. 11"x13"x6". **Stock No. TTF 451 $29.95**

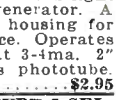
FILTER CHOKES

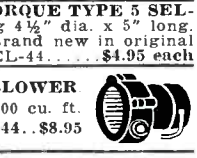
Stock No.	Description	Price
LFF-45	10H/120ma/600 ohms	$0.95
LFF-19	½ H/350ma/10 ohms/3000V	0.75
LFF-21	20H/300ma/125 ohms/5000V	9.95
LFF-144	2½H/700ma/16 ohms/1500V	4.95
LFF-450	1½H/130ma/57 ohms	0.79

MULTIPLIER PHOTOTUBE HOUSING. Cast aluminum cylindrical housing containing a submagnal 11 pin socket (for 931A, 1P21, 1P22) and a dynode voltage divider network. Moisture proof construction. An integral 6 volt pilot lamp provides light source when used as a noise generator. A window may be drilled in the housing for use with an external light source. Operates with approximately 700 volts at 3-4ma. 2" dia. x 4" long. Supplied less phototube. **Stock No. AMP-65**.....**$2.95**

PRECISION HIGH TORQUE TYPE 5 SELSYNS. Bronze housing 4½" dia. x 5" long. 115V/60c operation. Brand new in original packing. Stock No. SEL-44.....**$4.95 each**

110V/60CPS/0.38A BLOWER Exceptionally quiet. 100 cu. ft. min. **Stock No. BLR-344..$8.95**





3" SCOPE INDICATOR. 3BP1 cathode ray tube mounted in a mu-metal housing with an adjustable light shield. May be mounted on a panel, table-top or clamped to a bar. When mounted on a table top or wall, the scope housing may be tilted at any angle up to 45° from the mount for comfortable viewing. Ideal for remote scope indicators. An outstanding buy at $5.95. Stock No. ASI-35.

All prices above are quoted domestic packed f.o.b. our warehouse, Corona, New York.

DUBIN Tel. HIckory 6-3066-7-8

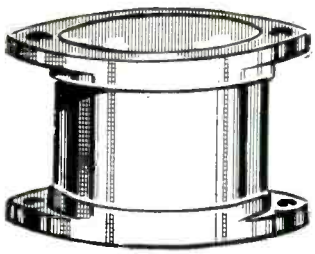
Cable: "Dublectron, New York". We will be pleased to send our bulletins to you regularly. Write or phone Dept. E-5 for our latest catalog.

ELECTRONICS CO. INC., 103-02 NORTHERN BLVD., CORONA, N. Y.

TRANSMITTING *Mica* CONDENSERS

PARTS SHOW VISITORS:

Be sure to visit our tremendous show rooms at 320 N. LaSalle St. Thousands of electronic components conveniently displayed.

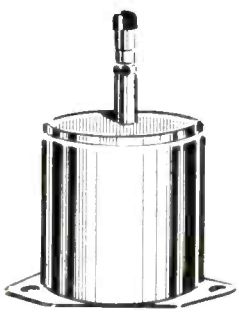


STYLE "AA"

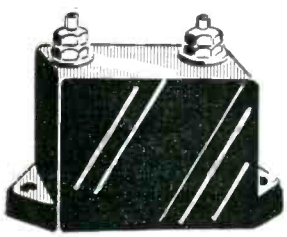
SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.

Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.

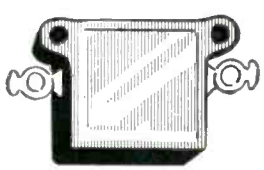


STYLE "A"



STYLE "B"

STYLE "C"



STYLE "D"

Cap. Mfd.	Wrkg. Volts	Price Each
Style "AA" CONDENSERS		
.02	3000	$4.50
.04	1000	3.50
Style "A" CONDENSERS		
25 mmfd	10000	$1.65
Style "B" CONDENSERS		
.00003	2000	$0.70
.000047	3000	.80
.00005	3000	.75
.00007	1140	.70
.00009	3000	.75
.000091	3000	.80
.0001	3000	.80
.000107	3500	.85
.00011	3000	.95
.00137	3000	.95
.00175	1500	1.00
.0002	1430	1.00
.0002	3000	1.00
.0002	5000	1.05
.00025	5000	1.10
.0004	3000	.95
.0004	5000	1.10
.0004	6000	1.55
.0005	2000	.95
.0005	3000	1.00
.00051	3000	1.00
.00055	3000	1.10
.0006	2500	1.05
.0006	5000	1.15
.000625	3000	1.05
.0007	3000	1.05
.00075	2500	1.05
.00075	5000	1.15
.0008	3000	1.00
.0008	5000	1.15
.001	4500	1.25
.001	5000	1.30
.0011	5000	1.35
.00125	2000	1.10
.0014	5000	1.35
.0015	3000	1.10
.0024	3000	1.15
.0025	2000	1.10
.00275	2000	1.10
.003	2000	1.20
.004	3000	1.50
.005	2000	1.40
.005	5000	1.70
.006	2500	1.30
.006	3500	1.45
.0068	3000	1.40
.008	3000	1.45
.01	2000	1.55
.01	1000	1.35
.02	600	1.30
.02	2000	1.60
.024	1500	1.60
.033	1500	1.60
.056	1000	1.70
.06	1000	1.70
.1	1000	1.75
Style "C" CONDENSERS		
.000005	2500	$0.40
.00005	600	.30
.0001	600	.25
.0001	1200	.35
.0001	2500	.40
.0002	600	.25
.0002	2500	.40
.00024	2500	.45
.00025	2500	.45
.0003	2500	.45
.00039	2500	.50
.0004	2500	.45
.0005	600	.35
.0005	1200	.40
.0005	2500	.45
.001	1200	.40
.001	2500	.55
.001	3750	.85
.0011	600	.35
.002	600	.35
.002	1200	.45
.002	2500	.55
.002	3500	.80
.0022	2500	.60
.003	600	.40
.0035	2500	.60
.0039	2500	.60
.004	2500	.60
.0045	600	.40
.0046	500	.45
.0047	2500	.65
.005	600	.35
.005	1200	.45
.005	2500	.60
.0051	1200	.45
.0051	2500	.65
.0056	2500	.65
.006	600	.40
.006	2500	.65
.0068	1200	.60
.007	600	.35
.0075	1200	.55
.009	600	.50
.01	600	.40
.01	1200	.45
.01	2500	.60
.0115	600	.40
.013	1200	.55
.015	1200	.55
.015	2000	.60
.015	2500	.60
.0175	1200	.55
.02	600	.35
.02	1200	.45
.022	1200	.45
.025	600	.35
.03	600	.35
.03	1200	.50
.033	600	.35
.033	1200	.50
.04	600	.35
.073	250	.40
Style "D" CONDENSERS		
.00004	600	$0.20
.00005	1200	.25
.00005	2500	.30
.0001	600	.20
.0001	1200	.25
.00015	2500	.35
.00024	2500	.35
.00025	1200	.25
.00025	2500	.35
.0005	1200	.30
.00051	2500	.35
.0007	600	.25
.001	600	.25
.001	1200	.35
.001	2500	.40
.0011	2500	.40
.002	600	.25
.002	1000	.30
.002	1200	.35
.002	1250	.35
.002	2500	.40
.0022	1200	.30
.0022	2500	.40
.0025	600	.25
.0025	1200	.30
.0027	600	.25
.003	600	.25
.003	1200	.30
.0033	1200	.30
.004	1100	.35
.004	1200	.35
.004	2500	.45
.0044	600	.25
.0047	2500	.40
.005	600	.25
.006	600	.25
.01	600	.30
.01	1200	.40
.01	1250	.40
.01	2500	.50
.02	600	.25
.022	600	.25
.025	1200	.35
.027	600	.25
.03	600	.25
.05	600	.30

This is only a partial listing. Write or wire for information on types not shown and for receiving set micas and silver micas.

We advise distributors to order immediately from this ad. Our standard jobber arrangement applies.

Manufacturers and Distributors: Write for our complete Mica Condenser Listing No. 103A.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

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-113. 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 1¾" screen. Has wonderful possibilities for darkroom work, fog penetration devices, night photography, etc. With technical data and diagrams. All NEW, individually boxed tubes.

PRICE, EACH **$8.00**
TWO, FOR **$15.00**

BAUSCH & LOMB SNOOPERSCOPE LENS UNIT

This lens unit will absolutely give clearer, sharper images when placed in front of the Infra-Red Tube described above. Increases range and permits use of less infra-red light. If you have had trouble in getting desired results from the tube, this lens unit is guaranteed to be the answer. Speed F 2.1, f.l. 3.5 inches. Originally designed for IP25 tube, but works even better with above British tube. With construction details for making infra-red image receiver.

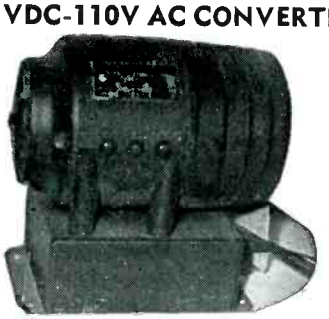
PRICE, EACH **$12.00**

FREQUENCY METER TS-69/AP

Complete EACH $42.50

Frequency range 400 mc to 3000 mc. Ideal for labs, schools, or for hams experimenting with eqpt. for civilian phone band. Black-crackle finished metal case, dim: 6"x6"x22", contains variable length coax resonating cavity with crystal rectifiers and 0-200 microammeter Veeder-Root counter and calibration charts insure extreme precision. Telescopic antenna, and coax line probe, with metal carrying case for entire equipment. With instruction sheet. New equipment.

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**

DECK ENTRANCE INSULATORS
Bowl and Flange Type

Manufactured by OHIO BRASS CO. for Army and Navy use. Has heavy galvanized metal flange 8⅞" diameter, porcelain bowl set in rubber gaskets, top bell is 6¼" in diameter. Brass feed-thru rod 11½" long. Insulation distance between top bell and flange is 4½". Quantities available.

NEW, price each, 12 or more **$2.00**
Spare porcelain bowls only, each ..... **$ .50**

CAPACITORS—1600 mfd 12WV electrolytic condensers. Quantities of 1,000 or more. EACH 20¢.

RADIO TRANSMITTERS MODULATORS, AND POWER SUPPLIES

Immediate Delivery

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.**

BC—319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes. **PRICE, EACH** **$300.00**

LINK FM Transmitter Receiver, 70-100 MC. Model 1498 DC. 50 watts output, wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim: 34"x21"x11". NEW CONDITION. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE, EACH** **$600.00**

RADIO TRANSMITTER BC-339, CW only, 1-KW output. Freq. range 4.0 to 26.5 mcs. Six crystal positions also M.O., four intermediate stages and two 833s final. Operates on 220 volts 50/60 cycles. Reconditioned. Complete with power supply and one set operating tubes. **PRICE** **$2100.00**

MODEL SVC100L/110 TRANSMITTER. Output A1 150-watts, A2-A3 50 W. Mfd. by Phillips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from 90-260 volts 50/60c. A.C. **COMPLETE** with tubes **$450.00**

BC-1100 (RC-263), 75W, A1, 50W, A2, 4 channel, dial selection of channel. 1.5-10 mcs. 110-260V 25-60c. A.C., with remote control. New. EACH **$575.00**

Supreme ship-to-shore transmitter receiver, 110W output, 9 channel, 2-3 mcs., crystal controlled, for 110V. 60c. A.C. Condition N-2. Complete with tubes and microphone. EACH **$600.00**

110V, DC to 110V, AC M.G. for above, when used on DC source **$85.00**

Halstead model 10LFA transmitters, A3, 25W. output, 200-400Kc. 110V 60c. operation. Condition N2. EACH **$100.00**

Wilcox, 96-200A 2-KW RF section. Int. Freq. 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**

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**

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.

NOTICE: Prices quoted above do not include crating or packing. Price for packing will be quoted upon specification as to whether export or domestic packing is desired.

All Prices F. O. B. N.Y.C. All Material Offered Subject to Prior Sale

TELEMARINE COMMUNICATIONS COMPANY

Phone—LOngacre 4-4490-1 **280 Ninth Ave., New York 1, N. Y.**

GRAIN OF WHEAT LAMPS

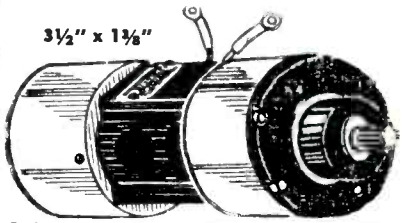
Mazda G.E. 323
3V..19 A

Mazda G.E. 328
6V..2 A

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

Photo, 3 times actual size. Glass Bulb ⅛" x ⅜"
Either type **$1.50** doz. $75.00 per M.

ALNICO FIELD MOTOR



Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc., 250 RPM. FEW MORE AT **$5.00**

A newly Written (1948) Book on Photoelectric tubes (Electric Eye) Circuits and Relays **$1.00**
10 for $7.50

HAYDON or TELECHRON SYNCHRONOUS MOTOR to operate switches, etc., 1 Rev. per minute at this
SPECIAL PRICE $3.85
Many other speeds available at $5.25 up

EST. 1923 BLAN EST. 1923
Experimenters and Inventors Supplies
64 Dey St., New York 7, N. Y.

WAR SURPLUS BARGAINS

GIGANTIC MAIL SALE!

- ELECTRONIC
- RADIO
- ELECTRICAL APPARATUS

Sale ends midnight June 1st

Amazing values. Opportunity for home experimenters, laboratories, schools, etc., to get fine new, or new condition guaranteed equipment at fraction of original cost. *We pay freight or postage.* Typical items are listed below.

	Sale Price
• 3000-watt, 115-volt, 60-c Power Plants	$299.50
• Wheatstone Bridges (o to 11, 110 ohms.)	59.50
• Weston Air Port Photo-Light Control Units	29.90
• Weston Model 689-IF Industrial Ohmmeter and case	12.90
• W.E. Desk or Wall C.B. Telephones and ringer (complete)	4.99
• RCA (5" 3" and 2") Cathode Ray Tubes	3.55
• RCA Liight, burglar alarm kit. Consists of rectifier, photo cell, thyratron, relay, sockets, etc.	4.49
• Drill press 31" polishing—grinding shaft and stone	1.29
• Burglar Alarm Units — Protect home and business	6.99
• High Pressure Steel Bottles (1800 lb.)	5.69
• Chromalux Heating Elements (24"—800-W)	2.19
• Selsyn Motors—Cost Gov't. $90. —110 V—60-C. Pair	4.99
• DeLuxe, Outstanding Electrical-Radio Home Lab kit 80 pieces	6.77
• Carbon Pile Regulator. Dozens of uses	.99
• Miniature Multi-Station Telephone. Fine for office-residence, inter-comm. Secret Line. A four star value. Pair.	7.89

Order from ad or send card for bargain laboratory, experimenter and amateur catalog. Satisfaction guaranteed. Our reference—National Bank of Commerce.

LECO ENGINEERING CO.
BOX 908 E-5 LINCOLN, NEBRASKA

Yes Sir! the
HOTTEST LIST
in the LAND. brim full of electronics, hydraulics, aircraft parts, gadgets
Rush me your name TODAY

D. C. AMMETERS

ALL BRAND NEW. Fits in 2¼" hole. Black Background fluorescent pointer & dial. **$2.79 ea.**

30-0-30 AMPS. DC. built in shunt.

60-0-60 Amps DC external shunt furnished.

0-120 Amps D.C. external shunt furnished.

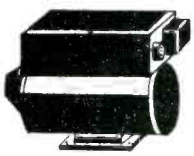
PHOTO ELECTRIC COMPASS

Kollsman photo electric compass model No. 729-B. Contains a liquid filled magnetic compass, a light source and a photo-electric cell.

Model No. 729-B

New ea. $49.95

800 CYCLE INVERTER



PE-206-A. Input 28 VDC—38 A. Output 80 V. 500 VA. Continuous duty. Mfg. by Leland #10494-2386. OD 10½ x 10½ x 6". Wt. 30 lbs. Complete with voltage regulator and noise filters.

New ea. $5.95

400 CYCLE INVERTER

GE#5D21NJ3A. Input 24/32 VDC-35 amps, output 115 VAC 4.2 amps. P/F 1, single phase, 8000 RPM. OD 9 x 5¼ x6¼". Wt. 12 lbs.

New ea. $7.95

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

NOTICE

JUST RECEIVED A LIMITED QUANTITY OF NEW RA-38 HIGH VOLTAGE POWER SUPPLIES

POWER OUTPUT: Continuously variable 0-1500 v a-c or d-c @ 500 ma. 7.5 kw. **RIPPLE:** ½% @ 100 ma.—3% @ 500 ma. **REGULATION:** 15,800 v @ 100 ma.—15,000 v @ 500 ma.; 6,800 v. @ 100 ma.—5,000 v @ 500 ma. **POWER INPUT:** 115 v. 60 cycle, single phase @ 125 amp max. output. **FULL WAVE BRIDGE RECTIFIER:** using 4 371-B high vacuum rectifier tubes. Designed for continuous duty, the unit contains a forced air blower. Air intake and output vents are fitted with dust filters. **CONTROLS:** include power on-off switch, filament on-off switch, filament voltage transtat control, plate voltage on-off switch, transtat plate voltage control, emergency disconnect switch. **RELAYS:** include main power relay, filament circuit relay, time delay relay, controlling plate power relay, plate circuit overload relay. **METERS:** include running time meter on power input, running time meter on power output, voltage and current meters in both a-c input and d-c output circuits, and a rectifier filament voltmeter. **PROTECTION DEVICES:** include automatic H.V. condenser discharge circuit, interlock switches on doors, and key interlocks on front panel. Provision is made for remote control of the power supply. The equipment is assembled in a steel cabinet which is mounted on skids by means of rubber shock mountings. **SIZE:** 33½" lg., 53¾" wd., 56⅞" hg. **NET WEIGHT:** 2040 lbs. **APPROX. SHIPPING WT:** 2100 lbs. Detailed information and prices on request.

ASD RADAR TRANSMITTER

3 centimeter, complete w/725A magnetron, cavity, two 723A/B klystrons, RKR 73, four 72's, 715B, 829B, two 724B's, two 6AC7's, IN23 crystal diode, high voltage supply, cooling blowers, etc. Input: 115 v 400 c. N-2 condition.....$110.00

SPECIALS

WESTINGHOUSE METER MULTIPLIER: 1 meg: 1/10% accuracy; wire wound: noninductive $1.25

RUNNING TIME METER: R. W. Cramer Type RT3H: 220 v 60 c; 3" square face: 5 figure indicator. (new) 6.95

FILAMENT TRANSFORMER: Constant current type, pri. 110/220 v 50/60 c, sec. 21.5 v 40.5 amps.....17.50

TUBE WL 386/ML-3W: 125 kv X-ray rectifier: oil immersion type; filament: 10 v ≅ 11.6 amps.....32.00

CRAMER TIME DELAY RELAY type TD2 120S: 0-120 seconds 115 v 60 c; synchronous motor driven: contact rating 10 amps 115 v; single pole normally open 4.95

STROBOLUX: General Radio Type 648-A. 115 v 60 c.....125.00

WESTON MEGOHMETER Model 796: Oak case 8" x 8" x 9".....40.00

NEW CAPACITORS

Standard Brand

OIL

2 mfd 600 v d-c, tubular	$ .39
3.5/.5 mfd 1,000 v d-c	.90
3x1.0 mfd 3 kv d-c test, 1.2 kv d-c wk. Isolated sections	1.20
1.25/1.25 mfd 7.5 kv d-c or .625 mfd 15 kv d-c Pyranol	12.50
.25/.25 mfd 6 kv d-c or .125 mfd 12 kv d-c	3.75
1.0 mfd 25 kv d-c; 65 lbs. net. Pyranol	36.00

ELECTROLYTIC

500 mfd 200 d-c wv, insulated terminals	.95

MICA

.001 mfd 25 kv d-c: 25 a @ 3,000 kc, 18 a @ 1,000 kc, 11 a @ 300 kc	25.00

VACUUM

50 mmfd 32 kv d-c: tubular	4.95

MOTOR GENERATORS

G.E. Type CC-21991 input 115 v d-c., @ 5.7. amps. Output 115 v a-c 60 cycle, single phase 350 V.A. @ 85% $58.00

G.E. Type CC-21990 input 32 v d-c., @ 22 amps. Output 115 v. a-c 60 cycle, single phase, 350 V.A. @ 85% P. F. .$63.00

Deland Type CLL-21985 input 115 v d-c @ 4.2 amps. Output 115 v a-c 60 cycle, single phase 240 V.A. @ 86% P. F. .$47.00

TUBES

NOTICE: All Tubes are New, of Standard Mfg., in original boxes

Type	Price
1B22	$5.75
1B23	9.75
1B24	4.75
2D21	1.25
2J62	47.50
3B22	2.75
3B24	1.75
3C23	3.75
4B28	2.75
6C21	22.50
6Q5G	1.25
15E	1.25
35TG	2.75
250R	7.50
250TH	19.50
250TL	19.50
*304TL	7.50
307A/RK75	4.50
316A	.75
371B	2.75
388A	2.75
450TH	22.50
700A	37.50
701A	4.75
702A	3.75
703A	4.75
704A	2.25
705A	2.25
706BY	17.50
706EY	19.50
707A	14.75
707B	16.50
708A	4.75
713A	1.25
714AY	5.75
715A	9.50
717A	.75
721A	2.75
722A	13.75
725A	17.50
730A	19.50
750TL	47.50
811	1.75
830B	4.75
872A	2.25
921	1.75
931A	2.75
C5B	8.50
C6A	8.50
C6J	9.50
FG81A	4.75
RK-75/307A	4.50
WE-203A	4.75
WL-531	17.50
WL-533	17.50

*Includes 115 v 60 c H.V. fil. trans. & socket.

T-102—Filament Transformer, American Transformer Co. Spec. 29106, Type WS .050 KVA, 50/60 cyc. Single phase, 35 KVA test, 12 KV D.C. operating. Primary 115 V., secondary 5 V., 10 amps with integral standoff insulator and socket for 250 T, 371, 872 and 5563, etc. rectifier tubes **$12.50**

Net Wt. 15¾ lbs. Dim. 6½" W x 8" D x 12" H.O.A.

VOLTAGE REGULATORS

TRANSTAT: 115 v 50/60 cycle input: 0-115 v 100 amps 11.5 KVA output $95.00

TRANSTAT: 115/230 v 50/60 c input: 0-260 v output @ 2.5 amps....$21.50

TRANSTAT: 115 v 50/60 c input: 0 to 130 v output @ 10 amps.....$24.50

POWER FACTOR Correction

9:12 mfd 1265 v a-c, 60 c, 1 ph, 5 kilovolt amps reactance. New G. E. Pyranol.....$17.50

METERS

WESTON

3" 476: 0-120 a-c amps, w/current transf	$8.50
3" 476: 0-130 a-c volts	4.95
3" 476: 0-130 a-c volts, plain face	3.50
3" 301: 0-800 d-c ma	4.95
3" 301: 0-1000 d-c ma	4.95
3" 301: 0-200 microamps	6.50
3" 301: 0-2.5 kv d-c w/multiplier	8.50
3" 301: Type 21 —10/+6 db, 6 mw 600 ohms	6.50
3" 301: 0-20 kv d-c w/precision multiplier	18.00
3" 301: 0-4 kv d-c w/precision multiplier	9.50

WESTINGHOUSE

3" NA-35: 0-150 a-c amps w/current transf	$10.00
3" NA-35: 0-120 a-c amps w/current transf	8.50
3" NA-35: 0-130 a-c volts, plain face	3.50
3" NA-35: 0-50 a-c amps	5.25
3" NA-35: 0-800 d-c ma	4.95
3" NC-35: —10/+6 db, 6 mw 600 ohms	6.50

SOLA CONSTANT VOLTAGE TRANSFORMERS

95 to 125 v 50 c input; 115 v output:

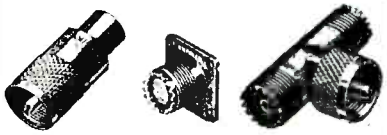
30 va...	$6.00	250 va..	$18.00
60 va...	8.40	500 va..	34.00
120 va..	13.20		

All merchandise in "as new" condition. Add approx. 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C. O. D. All prices f.o.b. Los Angeles Warehouse. Write for additional detail information on any of the above items and **for special quantity discounts. Telephone MAdison 6-5391**

1527 E. SEVENTH ST. EPCO LOS ANGELES 21, CALIF.

Coaxial Cables and Connectors
Brand New!! JAN Approved!!

"UHF" COAXIAL CABLE CONNECTORS



83-1SP 83-1R 83-1T

No.	An. No.	Description	Each	Price per 100
83-1SP	(PL259)	Plug	35¢	28¢
83-1SPN	(PL259A)	Plug	35¢	28¢
83-168	(UG176U)	Reducing adapter.	15¢	12¢
83-1AC		Cap and Chain	67¢	60¢
83-1BC		Cap and Chain	38¢	34¢
83-1H	(UG106U)	Hood	12¢	10¢
83-1R	(SO239)	Receptacle	35¢	28¢
83-1AP	(M359)	Angle Adapter	28¢	22¢
83-1T	(M358)	Connector	$1.25	$1.12
83-1J	(PL-258)	Junction	85¢	70¢
83-22R	(UG103U)	Receptacle	50¢	40¢
83-22SP	(UG102U)	Plug	50¢	40¢

COAXIAL CABLES

RG5U	per 1000 ft.	$70.00
RG6U	per 1000 ft.	120.00
RG7U	per 1000 ft.	70.00
RG8U	per 1000 ft.	55.00
RG9U	per 1000 ft.	135.00
RG10U	per 1000 ft.	90.00
RG11U	per 1000 ft.	100.00
RG12U	per 1000 ft.	190.00
RG13U	per 1000 ft.	125.00
RG18U	per 1000 ft.	320.00
RG22U	per 1000 ft.	120.00
RG27U	per 1000 ft.	290.00
RG29U	per 1000 ft.	37.50
RG34U	per 1000 ft.	175.00
RG54A/U	per 1000 ft.	60.00
RG54U	per 1000 ft.	65.00
RG57U	per 1000 ft.	75.00
RG58U	per 1000 ft.	59.00
RG59U	per 1000 ft.	45.00
RG62U	per 1000 ft.	50.00
RG71U	per 1000 ft.	175.00

Prices based on a minimum quantity of 500 ft.
For cut length add 50%

UG TYPE CONNECTORS

Deduct 10% from prices shown on orders of 100 or more per type

AN #	Price ea.	AN #	Price ea.
UG- 9/U	.95	UG- 97/U	3.50
UG-10/U	1.56	UG- 98/U	1.55
UG-11/U	1.45	UG-100/U	2.34
UG-12/U	1.14	UG-101/U	2.95
UG-13/U	1.56	UG-107/U	2.25
UG-14/U	1.45	UG-108/U	1.75
UG-15/U	.95	UG-109/U	1.75
UG-16/U	1.56	UG-114/U	1.50
UG-17/U	1.45	UG-115/U	1.35
UG-18/U	.99	CW-123/U	.45
UG-18A/U	1.05	UG-155/U	.40
UG-18B/U	.99	UG-154/U	5.35
UG-19/U	1.28	UG-155/U	5.35
UG-19A/U	1.38	UG-156/U	4.25
UG-19B/U	1.45	UG-160/U	1.90
UG-20/U	1.17	UG-160A/U	1.55
UG-20A/U	1.26	UG-167/U	3.00
UG-20B/U	1.41	UG-173/U	.30
UG-21/U	.99	UG-175/U	.15
UG-21A/U	1.05	UG-176/U	.15
UG-21/BU	.99	UG-188/U	.95
UG-22/U	1.08	UG-201/U	1.54
UG-22A/U	1.38	UG-202/U	2.75
UG-22B/U	1.34	UG-206/U	1.02
UG-23/U	.99	UG-208/U	28.50
UG-23A/U	1.26	UG-212/U	4.50
UG-23B/U	1.29	UG-213/U	4.50
UG-27A/U	2.25	UG-215/U	3.35
UG-28/U	2.34	UG-216/U	8.70
UG-29/U	1.22	UG-213/U	3.10
UG-30/U	1.75	UG-218/U	6.50
UG-32/U	20.00	UG-222/U	35.00
UG-33/U	20.00	UG-231/U	2.00
UG-34/U	17.50	UG-236/U	11.75
UG-35A/U	16.00	UG-241/U	2.20
UG-36/U	16.00	UG-242/U	2.50
UG-37/U	16.00	UG-243/U	2.75
UG-37A/U	16.00	UG-244/U	2.50
UG-57/U	.99	UG-245/U	1.25
UG-58/U	.65	UG-246/U	1.45
UG-59/U	2.75	UG-252/U	4.50
UG-59A/U	1.70	UG-254/U	1.82
UG-60/U	1.90	UG-255/U	1.85
UG-60A/U	1.30	UG-260/U	.99
UG-61/U	2.05	UG-261/U	.95
UG-61A/U	1.80	UG-262/U	1.05
UG-62/U	28.00	UG-269/U	2.60
UG-83/U	1.50	UG-273/U	1.50
UG-85/U	1.65	UG-274/U	1.98
UG-86/U	1.69	PL-274	1.12
UG-87/U	1.40	UG-290/U	.85
UG-88/U	1.17	UG-291/U	1.05
UG-89/U	.95	UG-306/U	2.03
UG-90/U	1.05	UG-333/U	4.70
UG-91/U	1.25	UG-334/U	5.75
UG-91A/U	1.05	UG-352/U	6.00
UG-92/U	1.10	UG-287/U	5.25
UG-92A/U	1.35	UG 270/U	6.50
UG-93/U	1.25	UG-259/U	4.10
UG-93A/U	1.45	UG-279/U	2.40
UG-94/U	1.25	UG-157/U	4.25
UG-94A/U	1.05	MX-195/U	.75
UG-95/U	1.10	UG-197/U	5.00
UG-95A/U	1.35	UG-235/U	28.50
UG-96/U	1.25		
UG-96A/U	1.45		

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107-M Variable Inductors.....$ 35.00
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E3108 Wheatstone Bridge.....$70.00

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Model 45 (0-75 V.D.C. ± 0.5%).....$35.00
796 Megohmeter (0-200 Megohms)..$50.00

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.00254 μamp per MM

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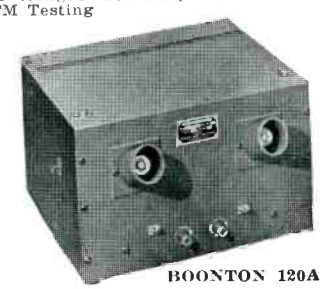

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0-10 Ma 4½" r. **Weston** (vacuum) 22.00
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211	.85	807	1.14
250TH	21.30	808	2.80
304TL	1.10	810	5.50
450TH	22.75	836	.95
450TL	36.50	861	27.50
803	4.50		

*Plus 20% Federal Excise Tax

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Normally closed. Opens with temp. rise
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50 Mfd 330VAC	4.95
8 Mfd 660VAC/2000VDC	3.50
.15–.15 Mfd 8000VDC	3.95
.125 Mfd 27 Kv	12.50

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Cap	WV DC	Each	Lots of 10	Lots of 100
100 Mfd	50	.27	2.20	19.00
40 Mfd	150	.23	1.80	17.50
8–8–20 Mfd	350/150	.40	3.50	30.00
20–20 Mfd	400/250	.35	3.00	25.00
10 Mfd	450	.30	2.50	20.00
15 Mfd	450	.30	2.50	20.00
40 Mfd	450	.50	4.20	36.00

Full Wave Bridge Types

Input 0–18VAC — Output 0–13*VDC

Type#	Current	Price
B1–250	250 MA.	$.98
B1–500	500 MA.	1.95
B1–1	1 AMP.	2.49
B1–1X5	1.5 AMP.	2.95
B1–3	3 AMP.	3.49
B1–5	5 AMP.	5.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95

Full Wave Bridge Types

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Type#	Current	Price
B3–150	150 MA.	$1.25
B3–250	250 MA.	1.95
B3–600	600 MA.	3.25
B3–5	5 AMP.	13.95
B3–10	10 AMP.	24.95

Input 0–72VAC — Output 0–54*VDC

Type#	Current	Price
B4–600	600 MA.	$3.95
B4–3	3 AMPS.	14.95
B4–5	5 AMP.	17.95
B4–10	10 AMP.	32.95

Input 0–115VAC — Output 0–110*VDC

Type#	Current	Price
B6–150	150 MA.	$1.95
B6–250	250 MA	2.95
B6–3	3 AMPS.	18.95
B6–5	5 AMP.	24.95
B6–10	10 AMP.	36.95

Input 0–234VAC — Output 0–180*VDC

Type#	Current	Price
B13–5	5 AMP	$54.95
B13–10	10 AMP.	69.95

Full Wave Bridge Types

Input 0–36VAC — Output 0–26*VDC

Type#	Current	Price
B2–150	150 MA.	$.98
B2–220	220 MA.	1.25
B2–300	300 MA.	1.50
B2–450	450 MA.	1.95
B2–1	1 AMP.	3.95
B2–2	2 AMP.	4.95
B2–3	3 AMP.	6.95
B2–5	5 AMP.	9.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
B2–30	30 AMP.	36.95

Three Phase Bridge Types

Input 0–126VAC — Output 0–130*VDC

Type#	Current	Price
3B7–4	4 AMP.	$32.95
3B7–6	6 AMP.	48.90
3B7–15	15 AMP.	70.00

Input 0–234VAC — Output 0–250*VDC

Type#	Current	Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–15	15 AMP.	120.00

CENTER TAPPED TYPES

Input 12–0–12VAC — Output 0–8*VDC

Type#	Current	Price
C1–10	10 AMP.	$5.95
C1–20	20 AMP.	10.95
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
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-2	2000 MFD	15VDC	1.69
CF-20	2500 MFD	15VDC	1.98
CF-3	1000 MFD	25VDC	1.69
CF-4	2X3500 MFD	25VDC	3.45
CF-5	1500 MFD	30VDC	2.49
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	150VDC	3.25
CF-11	100 MFD	350VDC	2.25
CF-12	125 MFD	350VDC	2.49

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	Lots of 10	Lots of 100
7.5 MMF	$2.90	$27.00
25 MMF	3.10	29.00
50 MMF	3.30	31.00
100 MMF	4.10	39.00
140 MMF	4.90	47.00

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To avoid shipping errors, kindly order by type #. All prices subject to change without notice.

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Includes following:

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1—Miniature sensitive relay SPDT with 100 ohm coil.
1—Temperature-sensitive resistance element.
1—Humidity sensitive strip.
1—Pressure, temperature, humidity chart, the entire unit is encased in the original packing and is brand new.

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SPECIAL! High Voltage D. C.

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Most are Jan Types in original packing

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Price, crystal and Holder-unassembled . . . . . $.19
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These units were designed and used by a large manufacturer to test the activity and frequency of quartz crystals in production.
Housed in an enclosed cabinet rack 8" x 8" x 16", the equipment includes the following:
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Externally mounted crystal sockets. **Price $7.95**

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Priv. 115 Volts 60 Cycles
Sec. 800 Volts, C.T., 300 MA, 2½ Volts C.T., 10A
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110 Volts Delta/440 Volts Delta 60 Cycles Heavy Duty—One Kilowatt.
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Building # 29 Municipal Airport #1
North Main St. Jacksonville, Florida

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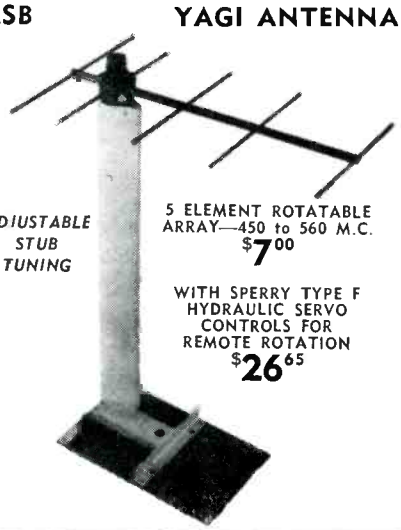

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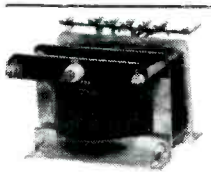
WITH SPERRY TYPE F HYDRAULIC SERVO CONTROLS FOR REMOTE ROTATION
$26.65



RCA HI-VOLTAGE TRANSFORMER
Pri—115/230V. 60Cy
Sec—6000V—80 MA
$11.80

GENERAL ELECTRIC FG-172 THYRATRONS
$14.50 EA.

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IN LOTS OF 10
BRAND NEW ORIGINAL CARTONS
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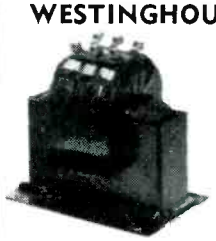
WESTINGHOUSE HYPERSIL TRANSFORMER



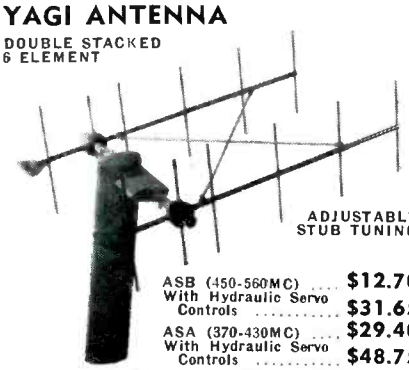
PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
Sec #2 - 240V - 1.56A
WT. - 30 LBS.
$11.50 EACH

$10.00 ea. Lots of 10

200 W. WIRE WOUND FERRULE RESISTORS
Fixed taps at each 10% of full resistance value.
25 ohms 200 ohms 500 ohms 2000 ohms
50 ohms 300 ohms 1500 ohms
77c Each **10 for $6.10**

YAGI ANTENNA

DOUBLE STACKED 6 ELEMENT



ADJUSTABLE STUB TUNING

ASB (450-560MC)	$12.70
With Hydraulic Servo Controls	$31.65
ASA (370-430MC)	$29.40
With Hydraulic Servo Controls	$48.75

LECTRONIC RESEARCH LABORATORIES

1021-23 Callowhill St. —*New Location*— **Phila. 23, Pa.**
Telephones: Market 7-6590 and 6591

Surplus Items for Communications!

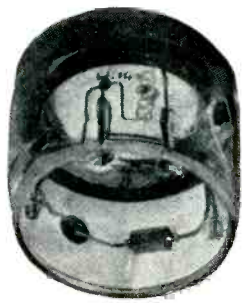
GUARANTEED!

BROADCASTERS and COMMUNICATORS note Atlantic City Convention and FCC dockets on F.M. radio-telephone relay and then write for comprehensive listing of our presently available equipment!

TRANSMITTERS—Wide variety of Collins, R.C.A., Westinghouse, W.E., Etc., in portable, mobile, ship, aircraft, ground control models up to 2½ K.W.

SPECIAL DEVICES—Vibrapacks; generators; CW-3 coils; whip antennas; specialized tubes.

TOWERS—New manufacturers stock, self supported or guyed towers, made of durable aluminum alloy, able to withstand 90 mph. wind top loading. In 10 ft. to 100 foot heights. Easy to assemble and disassemble. LIGHT, DURABLE and STRONG!



INFRA-RED IMAGE CONVERTER TUBE

Reproduces fluorescent Image on face of tube when used with Infra-Red Filters. Supplied with data and schematics for portable and fixed use.

NEW, with one filter FREE . . 9.00 ea.

Our NEW Catalogue mailed on request.

Cable: Communidev
Tel: AD-4-9277

COMMUNICATION DEVICES CO.

2331 TWELFTH AVENUE — **NEW YORK 27, N. Y.**

Subject to prior sale. FOB: WHSE

SURPLUS EQUIPMENT

EE-8 A Field Phones with leather carrying case-used-Each **$5.00**

Twin Dynamotor Power Supply Assembly Type CAY 21387—P.O. RBM-4 Radio equipment. Input 12 volt-output 205 VDC. 150 Ma.-Cased. Metered. Fused, Filtered—Brand New **$15.95**

Code Training Equipment-Model OAH—4 tube oscillator amplifier—complete. All cables, keys, phones, manual-spare parts-Brand New-Packed in OD Trunk **$39.95**

Signal Generator I-196A-New, with schematic & carrying case..... **$9.95**

Bendix TA-12 Transmitter excellent condition complete with tubes..... **$34.95**

Radar interference unit—British type 3-RFF 10D 3. 16588-New-Complete with cables, tubes. Schematic-self contained 220 V.-60 cycle-Power Supply in wooden chest-Approximately 75 lbs..... **$25.00**

Signal Corps. AC-output Meter Triplett Model 650-5 ranges to 150 Volts guaranteed excellent condition..... **$7.95**

GREENWICH SALES CO.

59 Cortland St. — **New York 7, N. Y.**

NEW and USED—Glass Working Machinery for Radio, Television and lamp making

Hydrogen Furnaces, Vacuum Pumps, Spot Welders, Diffusion Pumps, Stem, sealing and basing machines, annealers, glass cutters, blowers, gas boosters, etc.

HAYDU BROTHERS, Plainfield, N. J.

ELECTRONIC TUBES

JAN-C.R-UHF-H.V.R-SP.PURP

3DP1	$2.35	304TH	$3.45	864	$.19
4AP10	3.85	371A/B	.75	878	2.45
5AP1	2.75	393A	3.95	1624	1.49
5AP4	4.75	12GP7	11.95	1630	.94
5CP1	2.75	408U	.09	8013	.98
9GP7	6.75	559	.89	9006	.32
9MP7	6.75	800	.98	2x2	.45

On all orders over FIFTY dollars DEDUCT 20% Regular credit terms to rated buyers.

Gould Green

107 West Broadway, New York 13, N. Y.

FOR SALE

RCA 10 KW Short Wave Broadcast Transmitter, 2-18 Mc. Complete—Perfect.

THE NATIONAL INSTRUMENT CO.
FAR ROCKAWAY, N. Y.
Cables—Natinstru, N. Y.

SURPLUS

AN/ART-13 Xmtrs, new & complete with dyn. Domestic pkg..... $385.00
2000T tubes, Eimac 97.50
1500T tubes, Eimac 72.50
VHF var. condenser, butterfly constr, ceramic shaft. 3-gang 15-40uuf..... 4.90
4-gang 8-38uuf..... 5.90

FS-7997, Electronics
330 West 42nd Street, New York 18, N. Y.

WESTINGHOUSE HIPERSIL CORES

OVER 40,000 UNITS IN 20 DIMENSIONS, SEVERAL GAUGES; UP TO 16,000 UNITS IN SOME SIZES. AVAILABLE FOR IMMEDIATE DELIVERY. SEND FOR LIST WITH COMPLETE DESCRIPTIONS.

RAYTHEON MFG. CO.
Surplus Sales Dept. Waltham, Mass.
Tel. Waltham 5-5860—Ext. 2

MOTORS FOR SALE

Bodine NCI-12, 1/25 HP, condenser start and run. 27 in. oz. starting torque, 24 in. oz. running torque. Ball bearing 5/16 shaft extends 1¾". Requires 10 mfd condenser which we will furnish if desired. New mdse. in original Bodine packing. Up to 500 available.

GORDON SPECIALTIES CO.
906 W. North Ave. — **Chicago 22, Ill.**

WANTED

(Continued from page 239)

WANTED, AIRCRAFT RADIOS

AN/ART-13, BC-348, RTA-1B, AN/APN-9, R5A/ARN-7, AN/ARC-1, AN/ARC-3, BC-788-C, 1-152, MN-26, Test Sets with TS- or I- prefix, Dynamotors, Control Boxes, Transmitters, Receivers, Power Supplies, etc. State quantity, condition and best price first letter.

HI-MU ELECTRONICS
Box 105, New Haven, Conn.

SURPLUS BARGAINS!
TAW WIRE, MOLY RIBBON & WIRE

TAW WIRE (.012") .85 Kg. Mfd. Fansteel @ $60/Kg. MOLY RIBBON (.005"x1"xCoil) 30 Kg., MOLY HOOK WIRE (.005") .7 Kg., Both Mfd. Westinghouse @ $28/Kg. f.o.b. your plant. Merchandise Guaranteed.

J. M. HIRSCH COMPANY
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TELEPHONE HANDSET HANGER

NEW LOW PRICE **$1.49** POST PAID

Fits most types on market. Made of heavy duty aluminum casting. Excellent for desk, mobile or marine use. BRAND NEW.

ALVARADIO, Dept. E-1
903 S. Alvarado, Los Angeles 6, Calif.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

W-6654, Electronics
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HEAD PHONES

Schools, Laboratories, Industrial Users: We have available genuine Western Electric type 716-B laboratory-type head phones, complete and new. Don't confuse these with surplus military offerings. Worth $15, cost you $3.90.

THE OVERBROOK COMPANY
Massachusetts

FOR SALE

"Universal" 96W coilwinder

Now in operation. Excellent condition. Reasonably priced.

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HIghlands 2-1310

WANTED TO BUY

Western Electric CF-1, CF-2, CF-3, CF-4, CF-5, CF-6, H, H-1 Carrier, EE100, EE101A ringing equipments. All models teletype. All models RCA Marine transmitters. All W.E. C.B. switchboards.

W-8591, Electronics
520 North Michigan Ave., Chicago 11, Ill.

SERVO OUTPUT TRANSFORMERS

PP 6L6 to Servo mechanism with 10% feedback winding. MU metal core. $3.25 ea
Dual unit PP. 6V6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism. Both in 1 can, ea. **$3.95**

SO 239 (83-1R) "UHF" COAXIAL CABLE CONNECTORS
Sample 28¢
$25/C
$220/M

WESTON SENSITROL RELAY

Model 705-Type N(SR-2)
SPDT $14.95

FREE data, circuits designed by ROBT. G. HERZOG

EVERYTHING U WANT AT 50% LESS!

220-110V. Step-down Auto Transformer

300 W., open frame....$4.25 ea.
250 W., open frame....$3.75 ea.
25 W., channel frame...$1.49 ea.

ANTENNA SWITCHING RELAY

115 V. A.C. DPDT 10 amp contacts, manual release latch, 200 ohms. Allied ...$1.49 ea.
2 for $1.50

CRAMER TYPE DELAY RELAY

Type TD2-120S. From 2-120 sec., 115v, 60 cy., SPST (N.O.) 10 amp. cont. **$4.95**

RELAYS

Clare Sensitive 3500 ohms 6 MA SPDT 3 amp contacts
No. R30 .....$1.10 ea.

PRICE RATCHET STEPPING RELAY

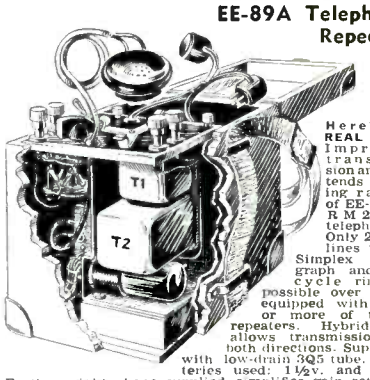
6 Volt 8.2 ohms Rotates 30° for each impulse delivered to the coil. Similar in size and shape to our #R97. Shipping wt. 2 lbs. #R96.
$1.99 ea. 2 for $2.00

Price Rotary 14V. coil 30° rotation, 8½ oz.-in torque. Single wafer.
#R97 $1.49 ea.
2 for $1.50

Min. Order $2.50

Universal general corp.
365 Canal St., New York 13, N. Y.
Prices Net FOB Our Plant
WAlker 5-9642

EE-89A Telephone Repeater



Here's a **REAL BUY.** Improves transmission and extends talking range of EE-8 and RM-29-A telephones. Only 2 wire lines used. Simplex telegraph and 20 cycle ringing possible over lines equipped with one or more of these repeaters. Hybrid coil allows transmission in both directions. Supplied with low-drain 3Q5 tube. Batteries used: 1½v. and 90v. Featherweight phone supplied, simplifies gain setting, BRAND NEW. Complete with instruction manual, ONLY $9.95 ea. Limited quantity.

EE-8 Telephone. Exc. cond. Canvas Bag. $14.95 ea. 2 for $26.95

RM-29A Telephone. BRAND NEW. Sealed Cartons. With NEW TS-13 and batt. $12.95

826 UHF Triode. Full ratings (86 watts output) up to 250 mc! Get real power on 2 meters with a pair of these tubes. BRAND NEW! Get yours NOW 75¢ ea. or 4 for $2.40.

WE717A PENTODE. Hams know this tube's ability to "soup up" any receiver. Has transconductance of 4,000 and is interchangeable with 6SK7. Low loss base and ultra-short leads. Functions better at high frequencies. ALL BRAND NEW! Orig. cost $3.75 ea. Your price 98¢ ea. or 4 for $3.25.

829 Twin Beam Tetrode. Ideal for UHF. Brand new in orig. cartons. $2.80 ea. or 4 for $10.80.

829B Twin Beam Tetrode. This well known tube is ideal for application at VHF. Full output (87 watts) up to 200 MEG! BRAND NEW! $3.95 ea. or 4 for $13.50.

832 Twin Beam Tetrode. NEW. $2.50 ea. or 4 for $8.80.

832A Twin Beam Tetrode. 26 watts output up to 200 MEG! BRAND NEW! ONLY $3.95 ea.

807 Beam Tetrode. One of the most popular tubes for r.f. application. Brand new, $1.12 ea. or 4 for $3.95.

810 Power Triode. This tube is a real powerhouse! 575 watts output up to 30 mc! Carbon anode. Grid outside of envelope for max. h.f. efficiency. BRAND NEW! Only $5.95 ea. or 4 for $21.95.

815 Twin Beam Tetrode. Full ratings (56 watts output) up to 125 mc! Requires only .18 watt grid driving power for full output. Brand new. Only $2.50 ea. or 4 for $9.20.

872 Rectifiers. New. $1.75 ea. or 2 for $3.25.

5U4G and 5Z3 tubes. New.....39¢ ea.

6AB7, 6AC7 tubes. New.....79¢ ea.

6L6G Nat'l Adv. Brand. NEW. Don't miss these at 79¢ ea. or 4 for $3.00.

CK-1005 Rectifier. Cut off pin #6 and you have an OZ4. Several different experimental circuits inc. with each order. Price 3 for $1.00 Postpaid.

NEED 866 TUBES?

Then you'll be interested in our large shipment of NEW 836 tubes, just received. Same base connections and very similar ratings to 866. Hi-vacuum eliminate flash trouble. Navy used them extensively in various equip. because of this reason. Internal voltage drop similar to 866. Characteristics: Fil. 2.5v. @ 5a. Plate curr. 500ma. (av.) for 2 tubes. Inv. Peak v. per tube, 5,000v. OUR PRICE IS THE SCOOP OF THE YEAR! 2 for $1.10. Be sure to get yours while quantity lasts.

HANDSET HANGER

Accommodates all makes and models (W. E. Kellogg, American, etc.) handsets such as TS-9, 11, 13, etc. Fastens to side of desk or on telephone or radio equipment. Felt facing protects handset. Black crackle finish only. $1.95 ea.

TS-10 Sound POWERED HANDSETS

These are what you have been waiting for! All BRAND NEW made by WE, RCA and Automatic Elect. Requires no batteries or transformers, of course! Useful for TV antenna installations, inter-comms, line communication, etc. "No battery" feature makes it possible to provide communications in plants where explosive chemicals are used. Clip a TS-40 on each end of a line and you have communication in a jiffy. Air-mail or wire your orders now as quantity is limited. Price $16.95 per pair

BC-221. Frequency Meter. Range 125KC to 20,000 KC. We have been fortunate to purchase another small lot of BC-221 Frequency Meters. In keeping with our policy of good merchandise, these units are all in excellent operating condition and each unit is checked before shipment. Perfect condition inside. Only minor scratches on outside of cases prohibit us from calling these units brand new. Get yours NOW as we know these will not last long! Complete with tubes, original calibration chart and crystal $59.95 ea.

BC-221 Power Supply Kit. Includes chassis, transformer, rectifier, all parts and diagram $5.85 ea.

BC-221 Modulation Kit. Converts any BC-221 for modulation. All parts and diagram included. ONLY $2.50.

BC-221 Set Spare Tubes. ONLY $1.29.

OFFENBACH & REIMUS CO.
372 Ellis St. San Francisco 2, Calif.

RADAR EQUIPMENT

APS-3 & APS-4 3cm search sets complete
SO-12 complete w/trailer & gas driven supply
SO-9 10cm shipborne search set compl. w/spares
APR-1 Receivers .....
QBF Sonar Sets.....— 750.00
SO-9 Pulse Networks 1 microsec. 15 Kwatt .....— 15.00
SO Pulse transformers.....— 15.00
AY-101D Autosyn w/calibration.....— 30.00
Weston mod. 45 0-25 amp. DC.....— 40.00
2J1G1 Selsyn motor.....— 2.00
PR-112 Power unit.....— 25.00
APQ-2 Transmitter & Power unit.....— 75.00
Westinghouse Freq. Met. 58-62 CY..— 22.50
G.R. Type 471A 50,000 ohms.....— 5.00
Selenium rectifier, full-wave 115vAC 250ma, DC .....— 1.20
BD-77 Dynamotor .....— 9.50
Vacuum tube pump station complete w/pumps, manifold, ionization gauges, oven, etc.

Tubes: 350	1.50	803	5.00
715B	15.00	RK72	1.30
723A/B	10.00	726A	12.50
725A	12.50	3BP1	2.50

Write for listings of other surplus bargains.

LERU LABORATORIES, INC.
360 Bleecker St. New York 14, New York

FREE TECHNICAL DATA CARD

Radio Elect. Color Codes, Formulas, Helpful Hints
Send for yours today

PHONO OSC—2 TUBE $2.75

Uses 35Z5, 12SA7, 2 Tubes $1.20

PHONO AMPLIFIER $16.95

3 Tube AC-DC
Volume and Tone Controls. Uses 12SQT7, 35Z5, 50L6.

Set of 3 Tubes...$1.35
Output Trans ... .32
5" Alnico Speaker 1.10
6" PM Speaker... 1.45
Alliance Phono Motors 2.50
Pickup $1.79 High Output Pickup... 1.99
Velvet Mixer Record Changer Plays 10" & 12" Records at the same time; 14"x14"..... $15.50

ALL ABOVE WIRED & TESTED

$1 Deposit on all orders. Free Catalog E

RADIO MAIL ORDERS 75 Barclay St. New York 7, N. Y.

SENSATIONAL! NEW! SOUND POWERED TELEPHONE HANDSET

No Batteries Needed.
No Power Supply Needed

HIGH FIDELITY SPEECH TRANSMISSION

Ideal for emergency or convenience applications. Operates up to 25 miles with #16 twisted wire; up to 15 miles with #19. And no auxiliary power is needed. Also operates over single wire with ground return. As many as 12 handsets can be operated in communications systems for group conversation. Explosion proof. No fire hazard. No spark is generated. Guaranteed one year by Wheeler Insulated Wire Co. (Div. of Sperry Co.). Shipping weight 3 pounds. Immediate delivery. Order Now.

$9.95

GIBSON GIRL SALE!

NYLON PARACHUTE Bright yellow. Supports 40 pounds. With Nylon shrouds.....$4.95
4" DIAMETER PURE RUBBER BALLOON Vacuum packed with Hydrogen generator, inflation tube and instructions.....$3.49
BOX KITE—LARGE 17" x 17" x 36" Dural tubing, feather weight. Snaps together in a jiffy. Adjustable for wind. Instructions included.....$2.95
ANTENNA WIRE 300' spool. Use in conjunction with kite or balloon for super antenna. High tensile strength.....$1.95
WATERPROOF SIGNAL LAMP With cord. Will float in water with no injury. Spare lamp included. $1.00
FAMOUS GIBSON GIRL XMITTER 500 kc. CW or modulated signals. Automatic keyer. Self powered hand generator. Water proof case. Made with latest design practices. Good ideas, good parts. Power supply furnished. Can be used for emergency field station by simple conversion. Manual included...$8.95
THE WHOLE WORKS! A $28.00 VALUE With two balloons and two spools of wire (Bag included at no charge).....Only $18.95

6 VOLT DYNAMOTOR

600 V DC @ 150 MA output. 5.6 V @ 28 amp. input. Size 6" L x 5" D. Not an oversize brute. Ideal for the mobile rig in cars or boats. Pioneer Genomotor.....$22.95

#8 STRANDED COPPER WIRE

250 V. Rubber insulation. Cotton braid overall. In 4' lengths only. Our Price 1¢ per foot.

ABELL DISTRIBUTING CO.
5 E. Biddle St., Dept. E-5, Baltimore 2, Md.

10 CENTIMETER

WAVEGUIDE directional coupler, 27 db. Navy type CABY-47AAN, with 4 in slotted section $42.50

SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $32.00

"S" BAND CRYSTAL MOUNT, gold plated, with 2 type "N" connectors $12.50

PICKUP LOOP, Type "N" Output.....$2.75

T12 BOX Pick-up Loop.....$1.25

POWER SPLITTER, 726 Klystron input, dual "N" output $5.00

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated.....$27.50

10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or d.c. arranged switching motor. Mfg. Raytheon. CRP 24AAS. New and complete.....$150.00

10 CM. END-FIRE ARRAY POLYRODS....$1.75 ea.

"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output.....$3.00

721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50

10 CM. McNALLY CAVITY Type SG $3.50

WAVEGUIDE SECTION. MC-445A. rt. angle bend. 5½ ft. OA 8" slotted section.....$21.00

10 CM. OSC. PICKUP LOOP, with male Homedell output $2.00

10 CM. DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fitting.....$4.50

10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola, ⅞" rigid coax input.....$8.00

⅞" RIGID COAX.—3⅛" I. C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00

SHORT RIGHT ANGLE bend, with pressurizing nipple $3.00

RIGID COAX to flex coax connector.....$3.50

STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00

RT. ANGLES FOR ABOVE $2.50

RT. ANGLE BEND 15" L. OA $3.50

FLEXIBLE SECTION, 15" L Male to female.....$4.25

MAGNETRON COUPLING to ⅞" rigid coax with TR pickup loop, gold plated.....$7.50

Rotating Joint p/o SCR584.....$35.00

Dipole Assy p/o SCR584.....$25.00

Flex Coax Sect. Approx. 30 ft.....$16.50

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

MICROWAVE ANTENNAS

APS-15 Antennas, New.....$99.50

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00) $250.00

APS-4 3 cm. antenna. Complete. 14½" dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete. $65.00

AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases.....$89.50

RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4¼' x 3', rectangle, new.....$85.00

TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New.....$100.00

SO-13 ANTENNA. 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New $120.00

Used $45.00

DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00

AS125/APR Cone type receiving antenna. 1000 to 3200 megacycles. New $4.50

140-600 MC. CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50

ASD 3 cm. antenna, used, ex. cond.....$49.50

RADAR SETS

RC 145 IFF SET. Consists of BC 1267 xmtr-rcvr, remote antenna controller and indicator 1-221, power supply RA 105-A. 1 kw. pulse oscillator operates on 154-186 mc. Operates from 117 v., 60 cy. New $190.00

SN RADAR-GE, low power, 5 and 25 miles ranges. Uses GL446 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact, ideal for demonstration and laboratory work. 115V 60C operation. Used. Excel. cond. $600.00

SE 10 CM SURFACE SEARCH RADAR. W.E., 20,000 to 80,000 yds. range. 250 KW. pk. power input to 706 magnotron. Thyratron modulator, variable pulse rate. Complete set including spare parts, tubes, waveguide and fittings. Send for price and additional information.

R85TPL-1 RADAR RCVR. Sperry.....$85.00

COMMUNICATIONS EQUIPMENT COMPANY *for your needs*

MICROWAVE PLUMBING

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

WAVE GUIDE ½"x¼" per ft.....$1.00

K BAND CIRC. FLANGES.....50

MISCELLANEOUS

DEHYDRATING UNIT, 60 lb. capacity, 115 v. 60 cy. operation. 2' x 22" x 15". new and complete..$425.00

F129 SPP-2. COAX WAVETRAP.....$12.50

PULSE EQUIPMENT

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS, Sweeptime: 100 to 2,500 microsec. in 4 steps fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New as shown.....$125.00

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 114 KW (12 KV at 12 amp). Duty Ratio: .001 max. Pulse duration: 5. 1.0 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715-B. 1-829-B. 3-'72's. 1-'73. New.....$110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules.....$49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk); pulse rate 200 PPS. 1.5 m'crosec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-10 MODULATOR DECK. Complete. less tubes $75.00

APS-10 Low voltage power supply, less tubes.....$18.50

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec.. 400 PPS. 50 ohms imp $42.50

G.E. #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

7.5E1-16-60-67P. 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

O-168184: .5 microsec. up to 2000 PPS. 1800 ohm term $4.00

D-170499: .25/.50/.75/. microsec. 8 KV. 50 ohms imp. $16.50

D-165997: 1¼ microsec. $7.50

PULSE TRANSFORMERS

G.E.K.-2745 .....$39.50

G.E.K.-2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS.....$39.50

W.E. #D166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $36.00

W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1. and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00

G.E. #K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms. Sec. Imp: 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW. Riflar 2.75 Amp..$64.50

W.E. #D169271 Hi Volt input pulse Transformer.$27.50

G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $4.50

G.E. #K2748A. Pulse input, line to magnetron..$36.00

#9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32.....$1.50

30' U. S. ARMY SIGNAL CORPS RADIO MASTS

Complete set for the erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig Corps #2A289-223-A. New .....$39.50 per set of 2

3 CENTIMETER PLUMBING

(STD. 1" x ½" GUIDE, UNLESS OTHERWISE SPECIFIED)

TRANSITION: 1" x ⅛" to 1¼" x 5/8", 14 in. L..$8.00

"X" BAND PREAMPLIFIER, consisting of 2-723A/B local oscillator-beacon feeding waveguide and TR/ATR Duplexer sect. incl. 60 mc. IF amp.....$67.50

RANDOM LENGTHS of waveguide. 6 in. to 18 in. long .....$1.10/ft.

WAVEGUIDE RUN, 1¼" x 5/8" guide, consisting of 4 ft. section with rt. angle bend on one end and 2" 45 deg. bend other end $8.00

WAVEGUIDE SECTION, 1¼" x 5/8" choke to choke. 4 ft. long $10.00

"X" BAND pressurizing gauge section, with 15-lbs. gauge pressurizing nipple $18.50

45 DEG. TWIST. 6" Long.....$10.00

12" SECTION. 45 deg. twist. 90 deg. bend.....$6.00

11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy construction. silver plated.....$4.50

15 DEG. BEND 10" choke to cover.....$4.50

5 FT. SECTIONS choke to cover. Silver Plated $14.50

18" FLEXIBLE SECTION $17.50

"E" and "H" PLANE BENDS.....$12.50

BULKHEAD FEED THRU.....$15.00

"X" BAND WAVEGUIDE, 1¼" x 5/8" OD. 1/16" wall, aluminum .....per ft. $ .75

WAVEGUIDE, 1" x ⅛" ID. per ft.....$1.50

TR CAVITY for 724-A TR tube.....$3.50

3" FLEX SECTION, square flange to circular flange adapter $7.50

724 TR tube (41-TR-1) $2.50

SWR MEAS. SECTION. 4" L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00

ROTARY JOINT with slotted section and type "N" output pickup $17.50

WAVEGUIDE SECTION, 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend.....$4.50

SLUG TUNER/ATTENUATOR, W.E. guide, gold plated $6.50

TR/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

WAGEGUIDE, 90 deg. bend E plane. 18" long..$4.00

ROTARY JOINT. choke to choke.....$17.50

ROTARY JOINT, choke to choke, with deck mounting $17.50

S CURVE WAVEGUIDE, 8" long cover to choke..$3.50

DUPLEXER SECTION for 1B24.....$10.00

CIRCULAR CHOKE FLANGES, solid brass.....55

SQ. FLANGES, FLAT BRASS.....ea. .55

APS-10 TR/ATR DUPLEXER section with additional iris flange $10.00

FLEX. WAVEGUIDE .....$4.00/Ft.

723A/B KLYSTRON MOUNT shielded on X Band Guide w/Rough Attenuator output.....ea. $75.00

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, rcvr-ampl. duplexer, HV supply, blower, pulse xtmr, Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV PI Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl. pkg. new.....$210.00

APS-15B. Comp. pkg. as above. less mod $150.00

"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A mixer, TR, receiver, duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00

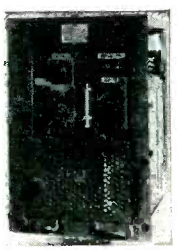
10 CM, RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator. 250 KW peak input 707-B receiver-mixer rotating yolk PPI for above $150.00

Modulator-motor-alternator unit for above.....$75.00

Receiver-rectifier power unit for above.....$25.00

Rot. ant. with parabolic reflector for above. New.$75.00

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

MAGNETRON MAGNETS

GAUSS	POLE DIAM.	SPACING	PRICE
5200	21/32 In.	¾ in.	$17.50
4850	¾ in.	5/8 in.	$12.50
1500	15/8 in.	1½ in.	$12.50
0161392*	15/8 in.	1 5/16 In.	$12.50

* Mfr's Number.

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QK 60 2800-3025 mc. QK 59 2675-2900 mc.

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ADVERTISERS INDEX

A "Brand New" SOLUTION TO YOUR AUDIO MEASUREMENT PROBLEMS

FEATURES

FREQUENCY RANGE: 20 cycles to 20 KC.

ACCURACY: Accuracy is ± o.1 db, from 20 cps to 20 KC.

OUTPUT LEVELS: Ranges of output level— +4 to —110 db and —10 to —124 db in steps of .1 db.

ACCESSIBILITY: All components accessible from front of rack panel — for ease of servicing.

IMPEDANCE RANGES:
(a) *Source Section* — 600-150 ohms internally terminated.
600-250-150-30 ohms unterminated.

(b) *Load Section*— 600-250-150-16-8-4 ohms.

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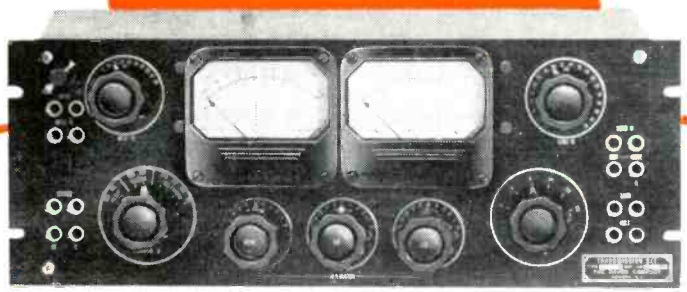
This is the instrument for which you have been waiting! For accuracy and efficiency, the Daven Type 11 A gain set, will fill your bill. Incorporating many of the features employed in more expensive models, this unit may be used to make all the precise measurements required by the FCC.

A new design feature, permits the servicing and inspection of all components from the front of the panel, with a maximum of ease and in a minimum of time. This is also a direct reading instrument, entirely eliminating time-consuming computations.

It is no longer necessary to use makeshift equipment for determining the transmission characteristics of audio systems. The Type 11 A gain set has been priced low enough to put it within the reach of the most limited budget.

APPLICATIONS

- Audio gain measurements.
- Audio loss measurements.
- Measurements of matching and bridging devices.
- Complex circuit measurements.
- Measuring mismatch loss.
- Frequency response measurements.



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