MAY · 1947

# electronics

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SCALE MODEL ANTENNA TEST

# electronics

A McGRAW-HILL PUBLICATION

## MAY • 1947




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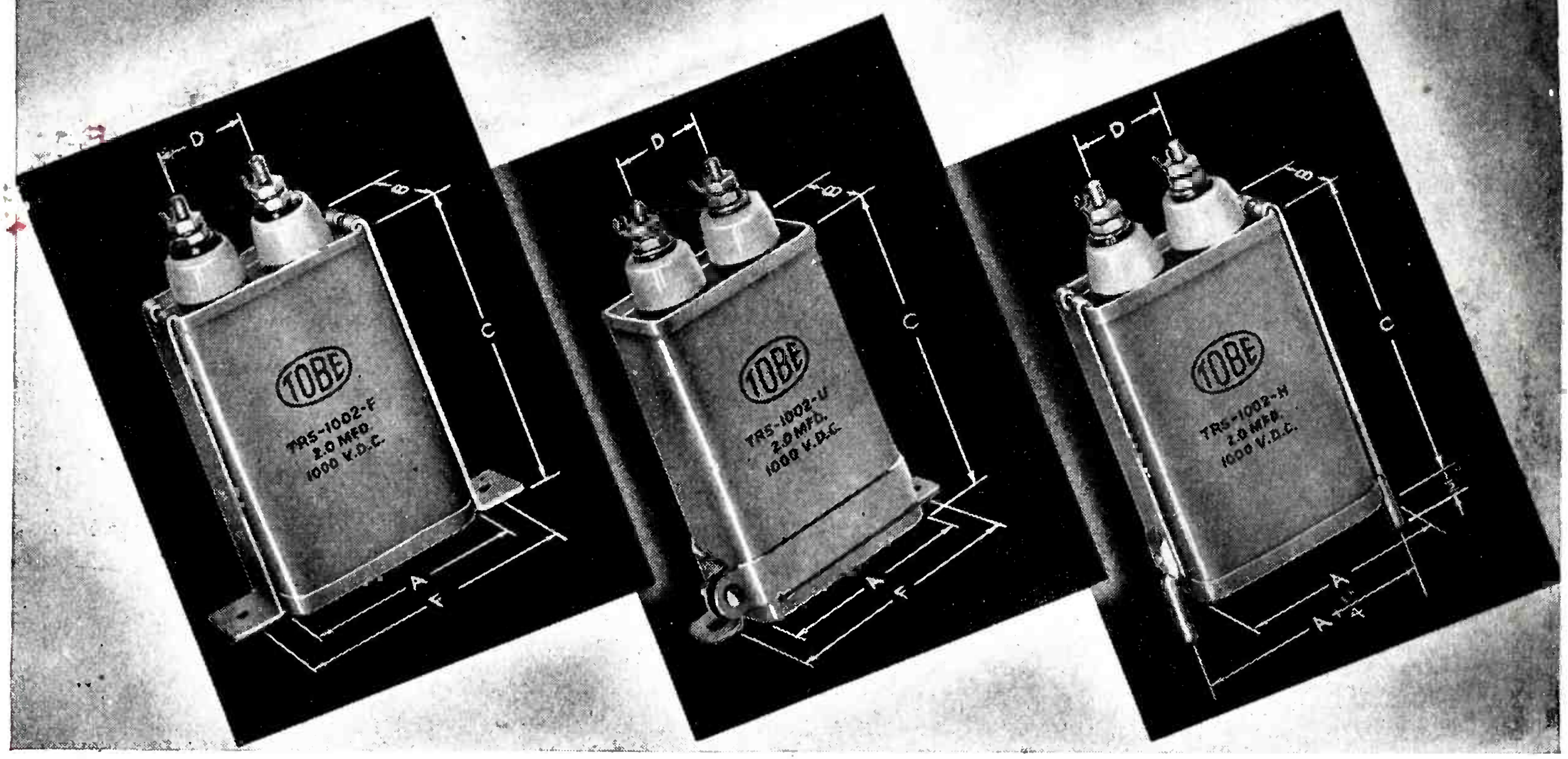
# FOR TRANSMITTING • TIMING • FILTER CIRCUITS




# TOBE TYPE TRS

THESE SPECIFICATIONS — the standards to which Tobe Type TRS capacitors are built — certify the ability to sustain high transient voltages and temperatures in transmitting, timing, and filter circuits.

A wide versatility of mounting provisions, capacitance ratings ranging from .03 to 50 Mfd., voltage ratings from 600 to 6000 volts d-c, permit you to match capacitor components exactly to your requirements.

## *Specifications*

***Winding*****: non-inductive.**

***Impregnation*****: mineral oil.**

***Case*****: tinned, lead-coated steel, squeeze-seam type, hermetically sealed.**

***Terminals*****: brass studs with No. 10/32 threads; molded phenolic or glazed porcelain bushings: shake-proof solder lugs furnished. Metal-to-glass sealed terminals when specified. Oil-proof gaskets between all adjacent surfaces in assembly.**

***Capacitance Tolerance*****: 10%, 1 Mfd. and over; 20% below 1 Mfd.**

***Operating Temp.*****:—67F to 185F.**

***Markings*****: type, voltage, capacitance, and terminal identification ink-stamped on case.**

| CASE DIMENSIONS — Inches | | | |
|---|---|---|---|
| Size | Width | Thickness | Height |
| 1 | 1 13/16 | 1 1/16 | 2⅛ |
| 2 | " | " | 2½ |
| 3 | " | " | 2⅝ |
| 4 | " | " | 4 |
| 5 | 2½ | 1 3/16 | 2 |
| 6 | " | " | 2½ |
| 7 | " | " | 3½ |
| 8 | " | " | 4 |
| 9 | " | " | 4¼ |
| 10 | " | " | 4¾ |
| 11 | 3¾ | 1¼ | 3½ |
| 12 | " | " | 4 |
| 13 | " | " | 4¾ |
| 14 | " | 1¾ | 3¼ |
| 15 | " | " | 4¾ |
| 16 | " | 2¼ | 4 |
| 17 | " | " | 4¾ |
| 18 | " | " | 5 |
| 19 | " | 3 3/16 | 4¼ |
| 20 | " | 4 9/16 | 4* |
| 21 | " | " | 4¼* |
| 22 | " | " | 4¾* |

*Mtg. ctrs. 4⅜ x 3⅜ inches, except hook-type mtg. ctrs. are 4" x 3⅜".

| Mfd. | 600 V. D-C | | 1000 V. D-C | | 1500 V. D-C | | 2000 V. D-C | | 2500 V. D-C | | 3000 V. D-C | | 4000 V. D-C | | 6000 V. D-C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case | TRS-Type No. | Case |
| .03 | | | | | | | | | 25003 | 1 | | | | | | |
| .10 | | | | | 1510 | 1 | 2010 | 1 | | | 30001 | 5 | | | | |
| .20 | | | | | | | | | | | 30002 | 6 | | | | |
| .25 | | | | | 1525 | 1 | 2025 | 2 | | | 3025 | 6 | | | 600025 | 12 |
| .50 | 650 | 1 | 1050 | 1 | 1550 | 3 | 2050 | 3 | | | 3050 | 8 | | | | |
| 1.0 | 601 | 1 | 1001 | 3 | 1501 | 4 | 2001 | 7 | 2501 | 14 | 3001 | 16 | 4001 | 18 | 6001 | 22 |
| 2 | 602 | 3 | 1002 | 4 | 1502 | 9 | 2002 | 12 | 2502 | 15 | 3002 | 19 | | | | |
| 3 | 603 | 4 | | | | | | | | | | | | | | |
| 4 | 604 | 7 | 1004 | 10 | 1504 | 13 | 2004 | 16 | 2504 | 20 | 3004 | 22 | | | | |
| 5 | 605 | 8 | 1005 | 12 | | | | | | | | | | | | |
| 6 | 606 | 10 | | | 1506 | 15 | | | | | | | | | | |
| 8 | 608 | 11 | 1008 | 13 | | | | | | | | | | | | |
| 10 | 6010 | 12 | 10010 | 15 | | | | | | | | | | | | |
| 12 | 612 | 13 | 10012 | 16 | | | | | | | | | | | | |
| 15 | | | 10015 | 17 | | | | | | | | | | | | |
| 20 | 6020 | 16 | | | | | | | | | | | | | | |
| 40 | 6040 | 21 | | | | | | | | | | | | | | |
| 50 | 6050 | 22 | | | | | | | | | | | | | | |

**Specify mounting provision by adding suffixes to type numbers: For flange-type hook bracket add "F"; for adjustable wrap-around bracket add "U"; for hook-type bracket add "H." (Example: TRS-601-H.) Permanent feet, giving same mounting centers as adjustable wrap-around bracket, and adding ⅛" to height, can be furnished. (Add suffix "P" to type number.) All mountings except type "P" permit either upright or inverted installation.**

**Mounting holes in types "F," "P," and "U," clear No. 10 screw. Type "H" lugs are No. 10/32.**

TOBE

**TOBE DEUTSCHMANN** *Corporation* **CANTON, MASSACHUSETTS**


# Transmits only when spoken to at close range

A new Turner development . . . Now factories, machine shops, engine rooms, trains, aircraft, etc., can have sharp, clear communications. Turner engineers have solved the problem of effective speech transmission under adverse noise conditions. The Turner Model 15D-NC is so expertly designed and balanced it amplifies only sound originating close to its specially engineered diaphragm. Random sound (noise) arriving from a distance strikes both sides of the diaphragm simultaneously and is canceled out. This new microphone transmits only when spoken to at close range from the front.

***The* LOUDER *the noise*—*the* BETTER *the results***

By speaking directly into the front side of the Turner Model 15D-NC clear cut results are achieved at ordinary levels of conversation. The din, clatter, and clang of machinery and other disturbances are canceled out. In fact, the higher the noise level, the more effective will be the results observed.

***Designed for Convenience***

The Model 15D-NC is a rugged dynamic built to stand severe operating conditions. It is housed in an attractive hand held case of light, tough alloy. When not in use, it may be hung on a hook. If desired, a "push-to-talk" thumb switch is built into the handle for on-off operation or relay work. Available in 50, 200, 500 ohms, or high impedance.

### SPECIFICATIONS Turner Model 15D-NC

EFFECTIVE OUTPUT LEVEL: 56 db below 1 volt/dyne/sq. cm.

FREQUENCY RESPONSE: 50 to 5000 c. p. s.

OUTPUT IMPEDANCE: 50, 200, 500 ohms, or high impedance.

DIRECTIONAL CHARACTERISTICS: Close talking only.

DIAPHRAGM: High quality corrosive resistant aluminum.

MAGNETIC CIRCUIT: High energy magnetic circuit with moving voice coil. Both sides of diaphram exposed to balance out random sound.

CASE: Smooth, die cast alloy.

FINISH: Gray gunmetal enamel.

MOUNTING: Hand held. Hole provided at top of case for hanging on hook.

CABLE: 7 foot attached, single conductor, shielded.

DIMENSIONS: 7" long x 2⅜" wide x 1½" deep.

WEIGHT: Approximately 24 ounces.

OPTIONAL: "Push-to-talk" thumb switch for on-off or relay operation.

*Also available as Model 15D semi-directional dynamic without noise canceling feature. Level: 56 db below 1 volt/dyne/sq. cm. Response: 40 to 7500 c. p. s.*

*Visit the* **Turner Exhibit at the Parts Show Booth 49—Stevens Hotel, Chicago, May 13, 14, 15**

## THE TURNER COMPANY

905 17th Street N. E., Cedar Rapids, Iowa

**TURN TO TURNER FOR SOUND PERFORMANCE**

Microphones 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

# Announcing!

## . . . NEW 1304 CABINET TYPE REPRODUCER SETS

Here are two brand new Western Electric Reproducer Sets for broadcast stations, recording studios and other professional users—designed from the ground up to bring out the full quality of today's finest transcriptions and records.

The 1304A includes the popular 9A Reproducer; the 1304B has the new 9B. Both equipments are available, less cabinet, as the 304A and 304B Reproducer Panels respectively. An entirely new drive mechanism with a belt and one-step helical gear reduction at both 33⅓ and 78 rpm provides constant-speed operation and extra long life. Mechanical filters isolate the turntable effectively from vibration in the motor, the driving mechanism, and the cabinet.

A new, more efficient, *electrical* method of changing turntable speed, based on reversing the direction of rotation of the motor, eliminates the usual clash gears or planetary ball devices.

The attractively styled cabinet is adjustable in height to match various operating requirements. For full details, see your local Graybar Broadcast Equipment Representative—or write to Graybar Electric Company, 420 Lexington Avenue, New York 17, N.Y.

***Designed by Bell Telephone Laboratories***

# Western Electric

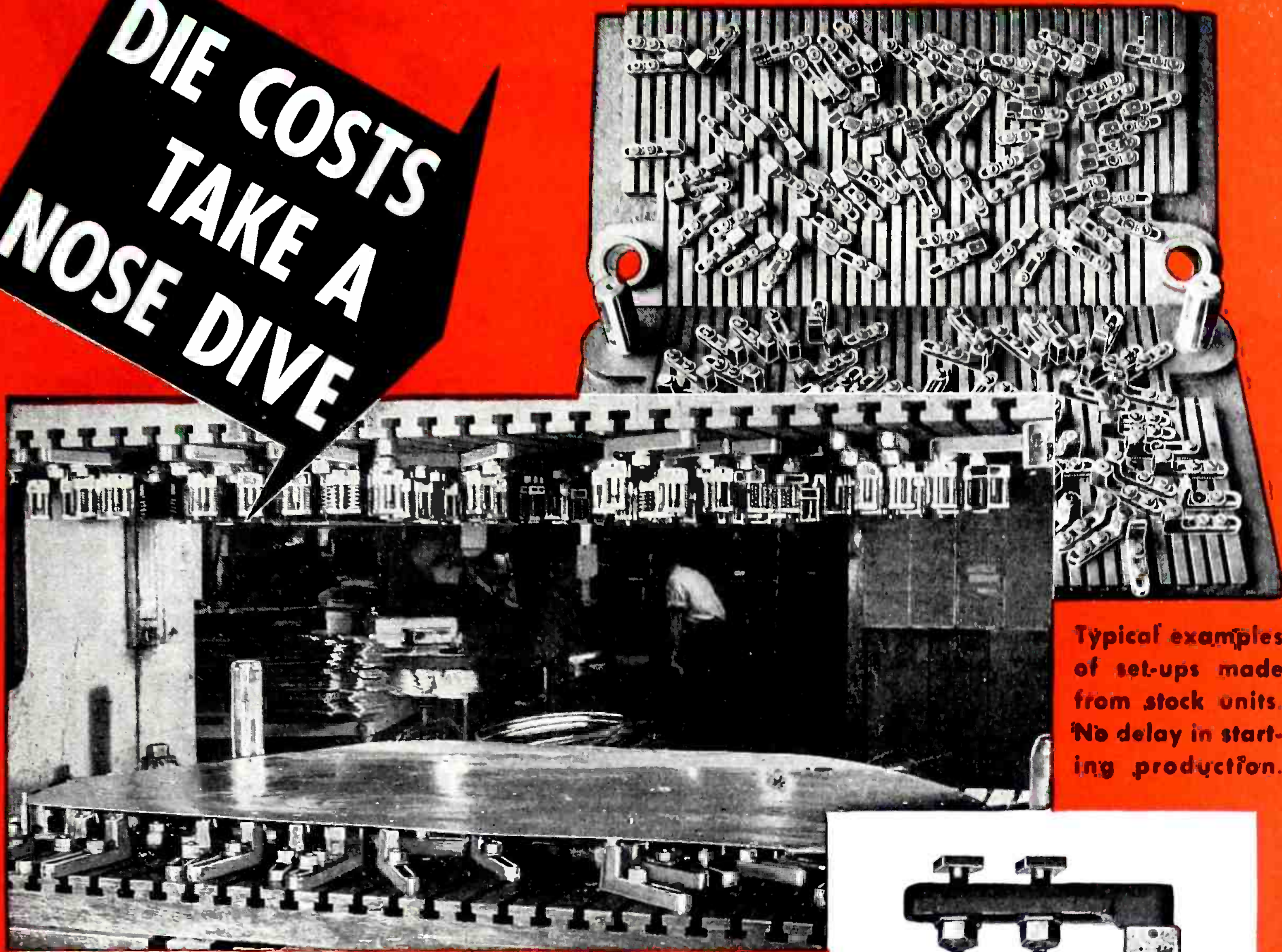
**—QUALITY COUNTS—**

Western Electric

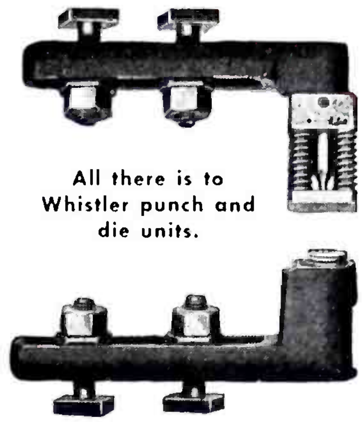
Distributed by GraybaR

OFFICES IN 93 PRINCIPAL CITIES

# DIE COSTS TAKE A NOSE DIVE



Typical examples of set-ups made from stock units. No delay in starting production.



All there is to Whistler punch and die units.

## WHISTLER Adjustable Perforating Dies Offer Added Production Economy

5-10-50 and even more different set-ups with the same dies? Impossible? Not when you use Whistler Multi-Use Adjustable Dies. For it's simple to rearrange these units . . . add or delete . . . get back into production within a few hours. Even so-called complicated arrangements are easy to set up. And, with first cost invariably less than for single purpose dies, this continued re-use of the same dies effects added economy in quickly writing off initial die investment. Over 750 prominent manufacturers have proven in their own plants that Whistler Adjustable Dies have sent costs into a nose dive.

No special tools are needed. Work in practically any size and type of press. Ordering now is particularly advantageous. Large stocks of standard diameter units from 1/32″ up are available for overnight shipments. Notching, group dies and special shapes and sizes can be quickly made to order. Write today to:

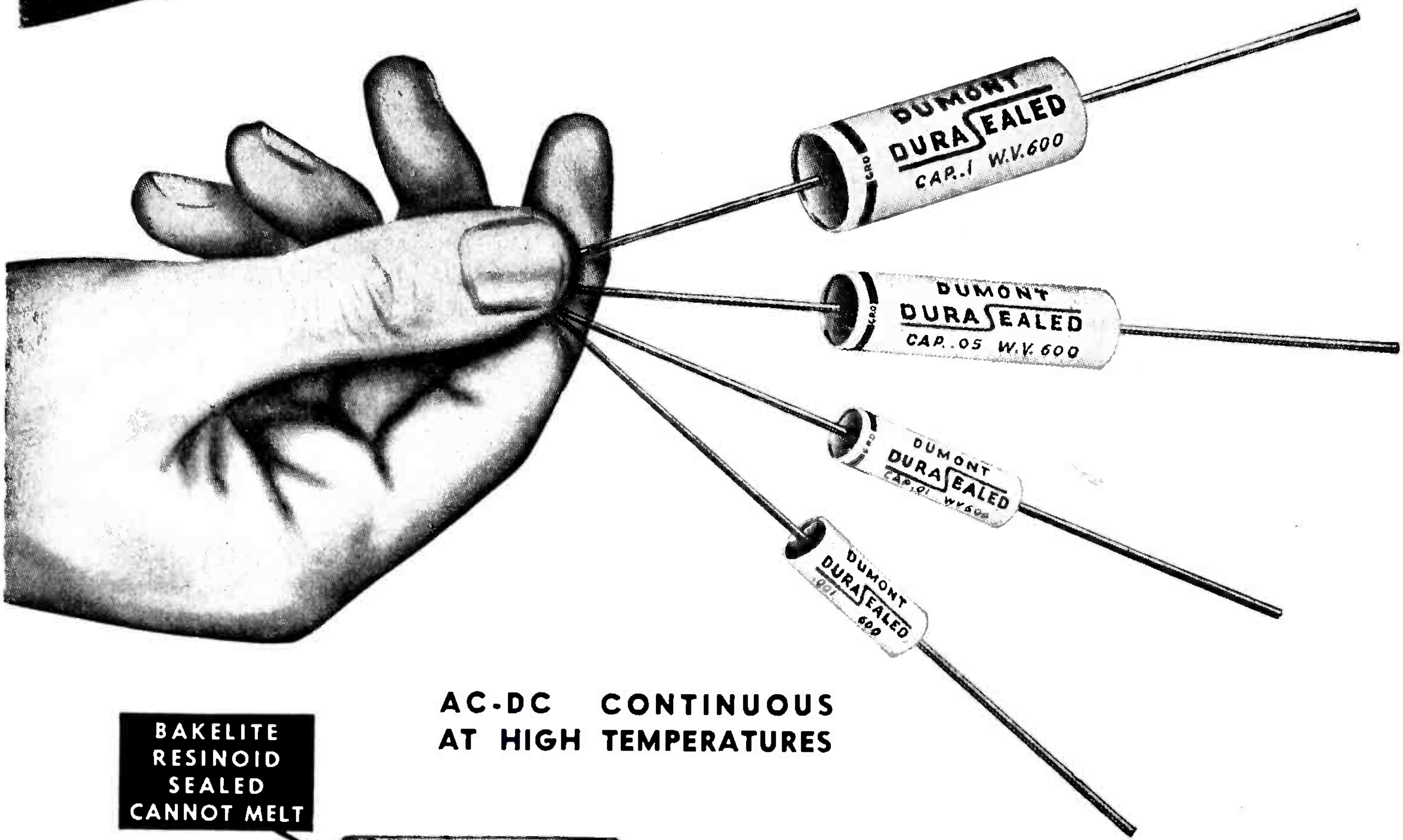

**WRITE FOR YOUR WHISTLER CATALOGS. Know the production advantages of Whistler Adjustable Dies.**

**S. B. WHISTLER & SONS, INC.**

752-756 MILITARY ROAD BUFFALO 17, NEW YORK

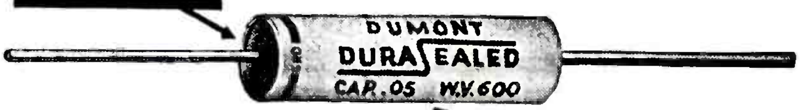
# AT LAST!

## SPECIAL WARTIME DEVELOPMENT NOW AVAILABLE FOR PUBLIC USE . . . TYPE P6 DUMONT *PAPER* CAPACITORS




AC-DC CONTINUOUS AT HIGH TEMPERATURES

BAKELITE RESINOID SEALED CANNOT MELT




BAKELIZED TUBES

PAT. PEND.

★ Dumont engineers scored in the greatest single achievement in paper tubular capacitors . . . meeting the most exacting requirements. This type P6 has the ends sealed in BAKELITE RESINOID. Leads cannot PULL OUT or MELT OUT. Bakelite treated tubes sealed in vacuum.

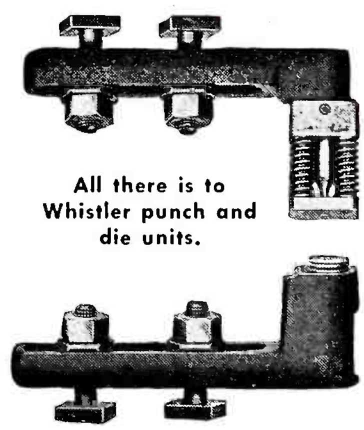
- ★ HEAT PROOF
- ★ MOISTURE PROOF
- ★ LONGER LIFE
- ★ VACUUM SEALED
- ★ SOLVES SPACE PROBLEMS

**DUMONT ELECTRIC CORP.**
*MFR'S OF CAPACITORS FOR EVERY REQUIREMENT*

34 HUBERT STREET
NEW YORK, N. Y.

# DIE COSTS TAKE A NOSE DIVE

Typical examples of set-ups made from stock units. No delay in starting production.



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**WRITE FOR YOUR WHISTLER CATALOGS.** Know the production advantages of Whistler Adjustable Dies.

**S. B. WHISTLER & SONS, INC.**
752-756 MILITARY ROAD BUFFALO 17, NEW YORK

# *Mono-Sequence Tuning in the*


## FOUR·20
### TRANSMITTER

With MONO-SEQUENCE tuning you can tune four circuits to four different frequencies WITH ONE CONTROL. It's a patented Hammarlund invention which gives you highly efficient tuning and ease of control. The Four-20 is a complete CW rig for 80, 40, 20, or 10 meters. Plug in a crystal and a key and you're ON THE AIR.


## FOUR·11
### MODULATOR

For years the name HAMMARLUND has stood for the finest in communications receivers. The same engineering skill and precision methods which produced the Super-Pro and the HQ-129-X, now bring you an entirely new transmitter. Combine the Four-11 Modulator with the Four-20 and you have a complete phone transmitter ready to go on any band. When you build that high power final, the Four-20 will make a perfect exciter and the Four-11 a fine speech amplifier.

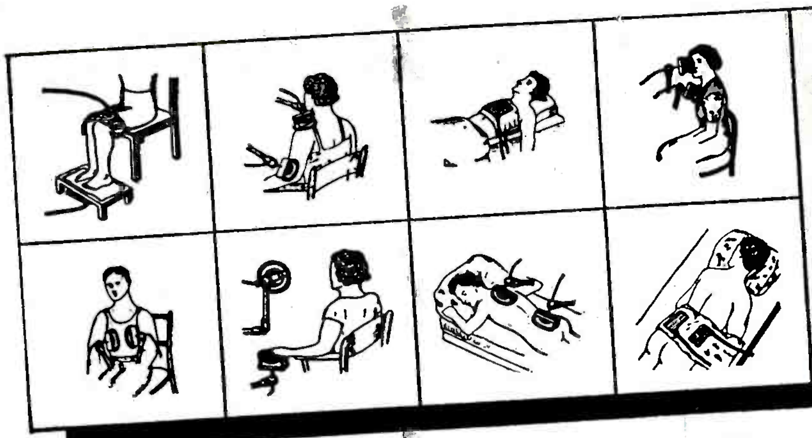
BACKED BY 37 YEARS OF KNOW-HOW

*write for*
Descriptive Booklet

THE SIGN OF QUALITY
ESTABLISHED 1910

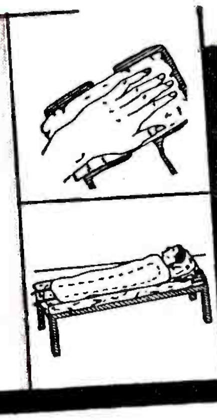
**HAMMARLUND**

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

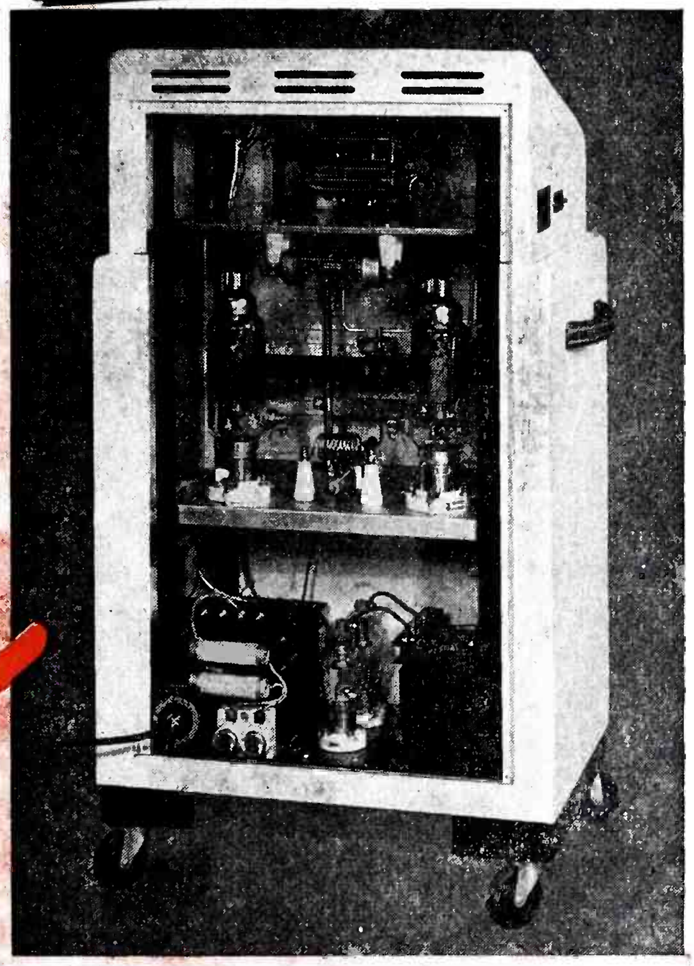


## THE OPERATION

**ULTRA SHORT WAVE DEEP HEATING** within any part of the human body with full safety and perfect control at stabilized frequency. Associated functions: minor surgery with "electronic knife" and coagulation.



## THE EQUIPMENT

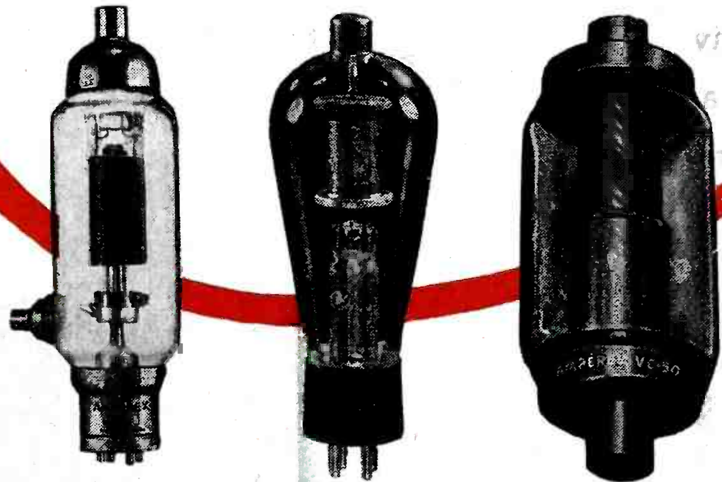


Used at Bellevue and all other New York City hospitals, and scores of other leading institutions, including Mt. Sinai, New York; Cook County, Chicago; Johns Hopkins, Baltimore.

**MULTRATHERM "SENIOR"**
Built and guaranteed by
**PEERLESS LABORATORIES**
467 Tenth Avenue, New York 18, N.Y.

All known technics with ample reserve energy from *single pair* of treatment terminals . . . relatively same output irrespective of electrode air-gap space . . . frequency stabilized at 27.32 (plus or minus) ½% megacycles as assigned by FCC. *Write for full details.*

# THE AMPEREX *tubes* THAT DO THE JOB!



2 AMPEREX **HF250** OSCILLATORS

2 AMPEREX **866A** RECTIFIERS

1 AMPEREX **VC50** CONDENSER

In electro-medical as in all electronic industrial, communication, rectification, special purpose and experimental equipment, Amperex tubes and circuits developed by Amperex spell performance, long life, and economy. As tube specialists, Amperex engineers are in a position to give detached counsel and information. *WRITE Amperex Application* Engineering Department.

POWER TUBE SPECIALISTS SINCE 1925

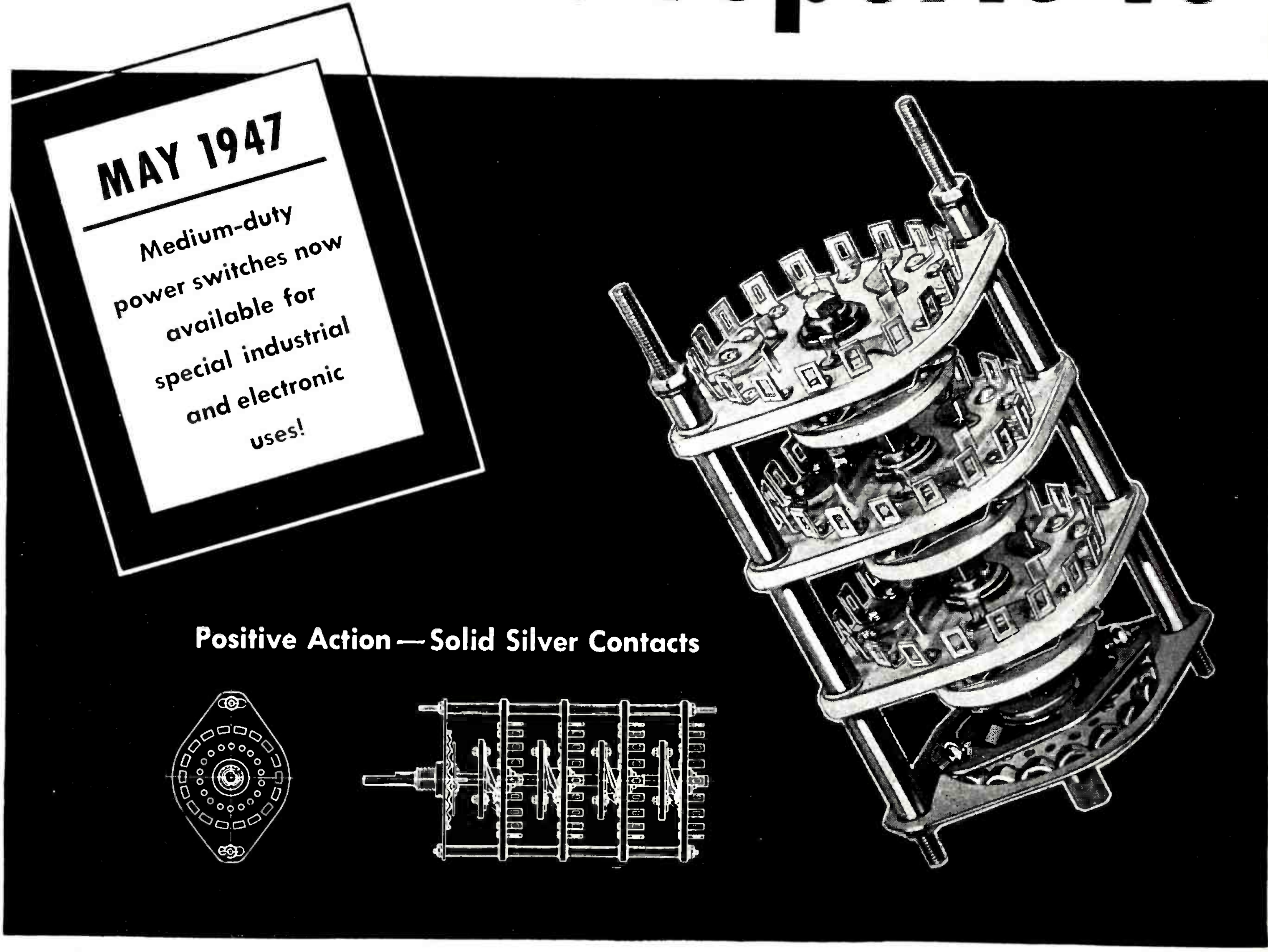
COMMUNICATION
RECTIFICATION
INDUSTRIAL
ELECTRO-MEDICAL
SPECIAL PURPOSE

**AMPEREX ELECTRONIC CORPORATION**

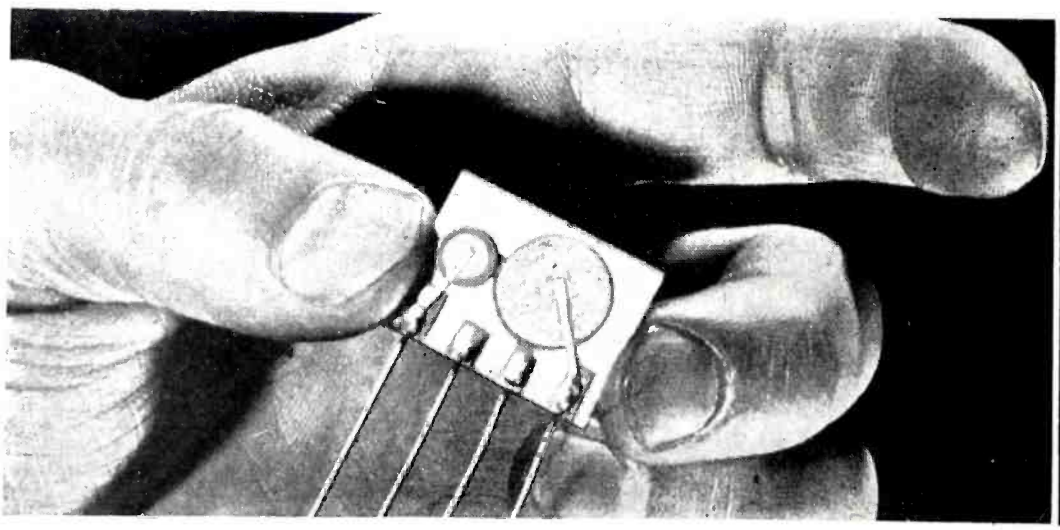
25 WASHINGTON STREET, BROOKLYN 1, N. Y. CABLES: "ARLAB"

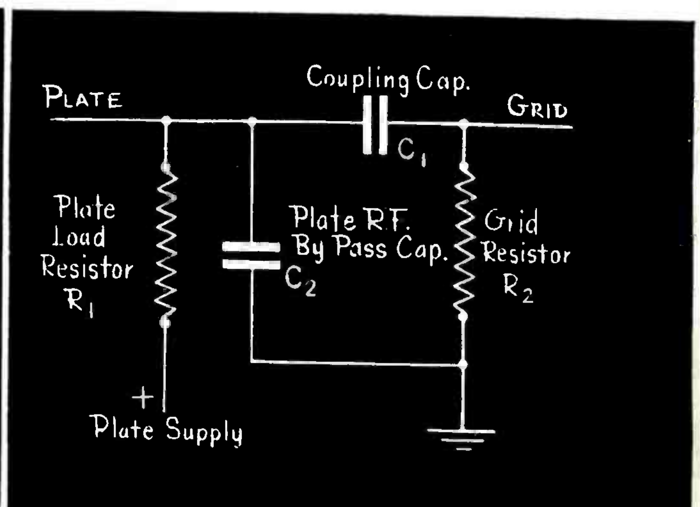
In Canada and Newfoundland: ROGERS MAJESTIC LIMITED, 622 Fleet Street West, Toronto 28, Canada

# Centralab reports to




**1** Specially designed for transmitters, power supply converters, and a broad new range of industrial and electronic uses, Centralab's medium-duty power switches give you efficient performance up to 20 megacycles. Tests prove that these switches have a minimum life operation of 25,000 cycles without failure. Rated at 7½ amperes, 60 cycles, 115 volts A.C. Minimum voltage breakdown between critical points is 3,000 volts RMS, 60 cycles. For complete information, send for Bulletin 722.

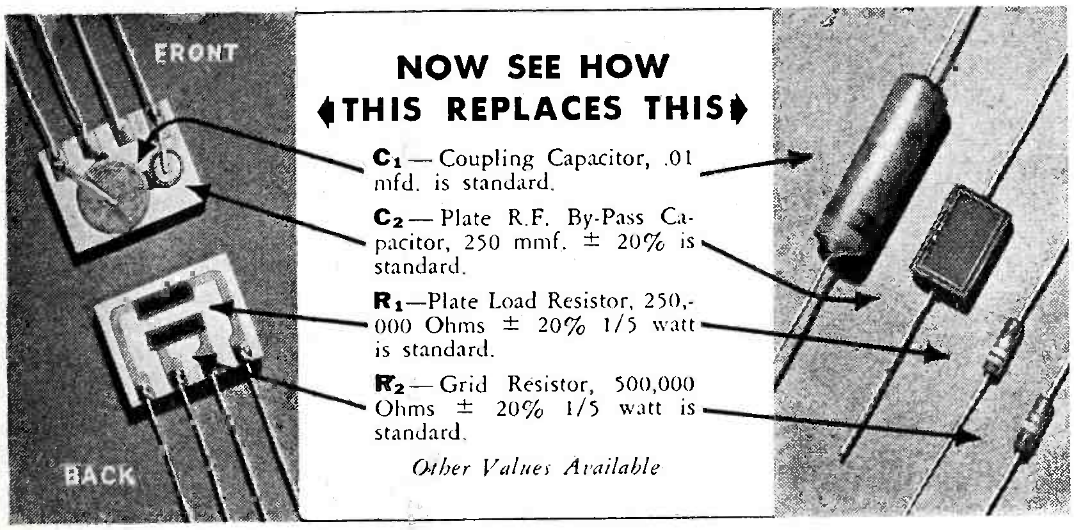




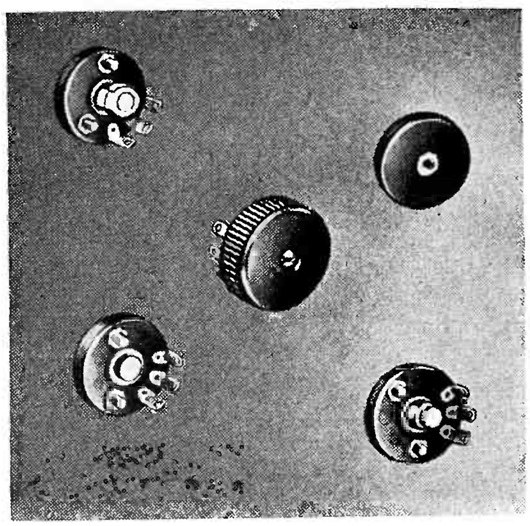

**2** First commercial application of the "printed circuit", and now available for the first time, Centralab's new *Couplate* is a complete interstage coupling circuit which combines into one unit the plate load resistor, the grid resistor, the plate by-pass capacitor and the coupling capacitor.

**3** Only four soldered connections are now required by the *Couplate* instead of the usual eight or nine (see above). That means fewer errors, lower costs!

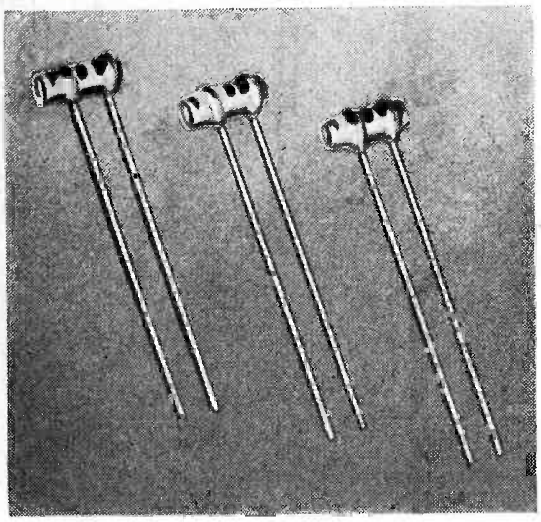
# Electronic Industry




**4** Integral Ceramic Construction: Each *Couplate* 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. Think of what that means in terms of time and labor savings! Send for bulletin 943.



**5** Look at Centralab's newest control for miniature receivers and amplifiers. No bigger than a dime, high quality performance is assured.

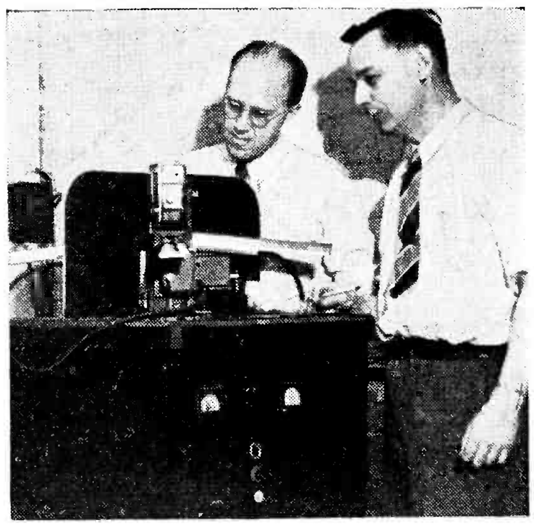


**6** Important: the recognized dependability and high quality of ceramic by-pass and coupling capacitors is now available at Centralab Distributors!

**Maximum Over-all Dimensions**

| TUBE | D | L |
|---|---|---|
| BC 20 | .200″ | .400″ |
| BC 25 | .200″ | .690″ |
| BC 32 | .225″ | .860″ |
| BC 35 | .285″ | 1.165″ |

**7** Here for the first time, is a line of ceramic capacitors which combines economy, small size and extreme dependability.



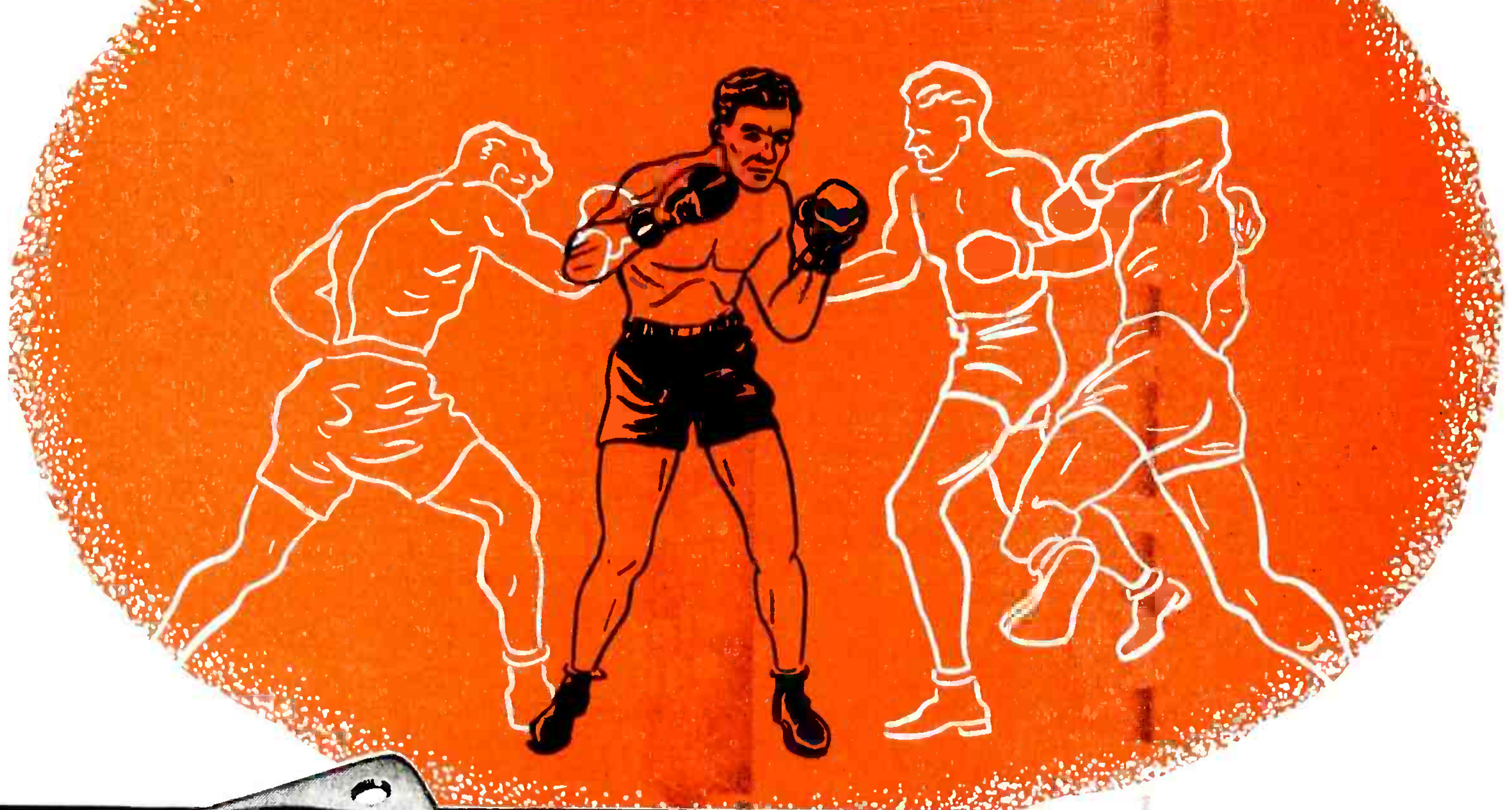
**8** Made from Centralab's original ceramic-X, this new line is result of our continuing research in high dialectric constant ceramics. Order Bulletin 933.

**Look to Centralab in 1947!** *First in component research that means lower costs for 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.**

# Vibration Attacks Your Product
## From All Directions




# Isolate It Completely with NEW LORD MULTIPLANE MOUNTINGS

a new standard of product performance . . .

Vibration now can be isolated from your product, through a greater range of frequencies *regardless of the direction of disturbing forces* . . . with new MULTIPLANE MOUNTINGS pioneered by Lord. Here, then, is a brand new standard of vibration control . . . and a brand new opportunity to boost performance standards and product sales.

Lord MULTIPLANE MOUNTINGS not only provide all-directional freedom—universal softness in all planes—but are simple, compact, one-piece mountings that give your design engineer the plus advantages of complete protection with less weight, easy installation, at very reasonable cost.

Like all Lord Products, MULTIPLANE MOUNTINGS feature the same *permanently-bonded-rubber-in-shear* principle that has made Lord first in the field of Vibration Control and Bonded Rubber Products. Put this specialized experience, backed by Lord research and engineering, to work on your problems. We'll be only too glad to serve you.

*For more information write for Bulletin 106*

Lord MULTIPLANE MOUNTINGS are ideal for instruments, electronic equipment, and other devices of high sensitivity, not to mention other applications including engine-generator sets, air-conditioning units, pumps, blowers, etc. Features like these insure vastly improved performance:

- **Simple, low-weight, one-piece construction.**
- **Easy, convenient, low-cost installation.**
- **Long life thru large bonding area—low bond stress.**
- **All-directional softness from multiple shear areas.**
- **Progressive cushioning of shockloads by snubbing shoulder.**

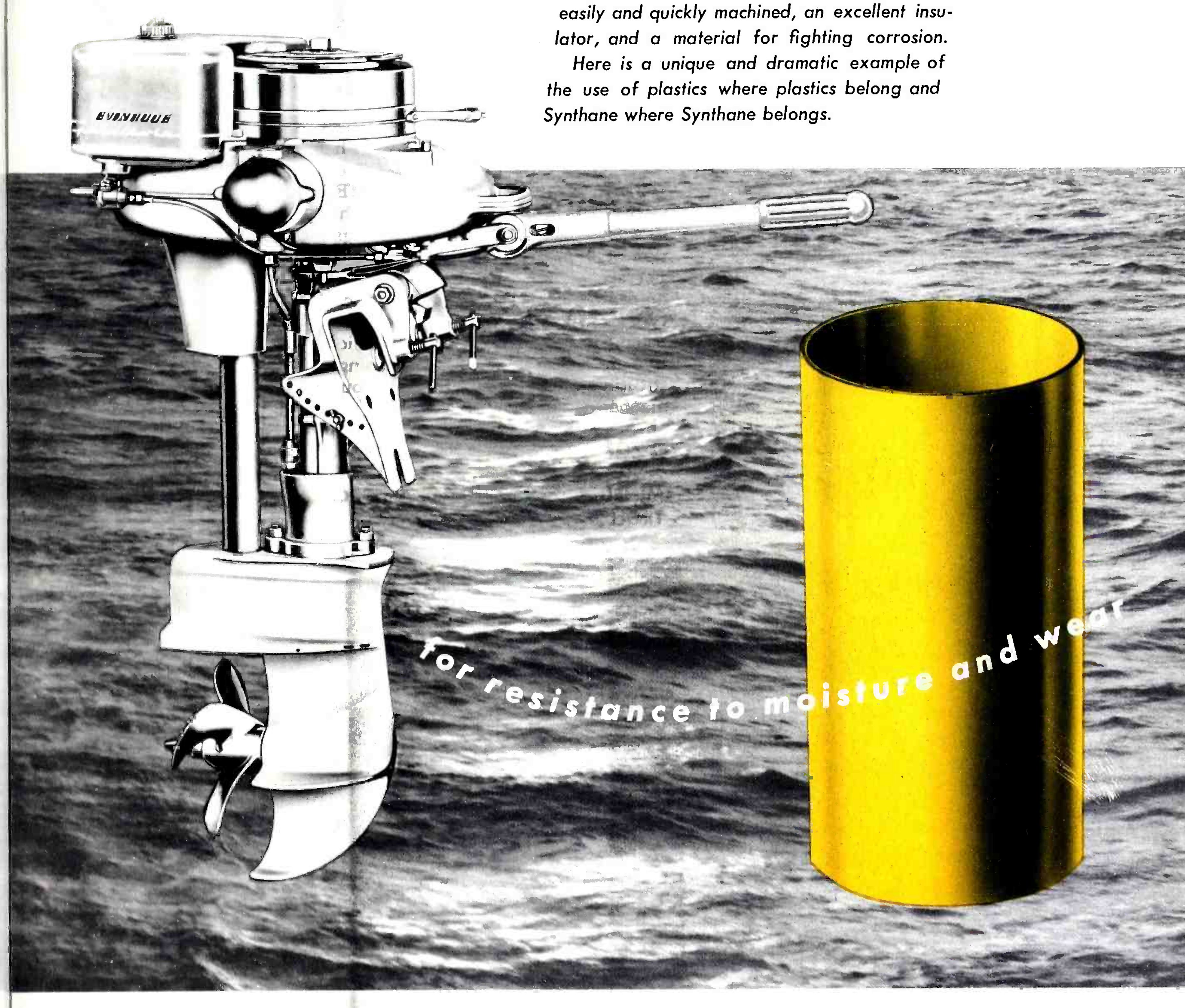
**LORD MANUFACTURING COMPANY ERIE, PA.**

FIELD OFFICES { New York, N.Y. Providence, R. I. Washington, D. C. Detroit, Mich. Chicago, Ill. Burbank, Cal.
Canadian Representative: Railway & Power Engineering Corp., Ltd., Toronto, Canada.

**Plastics where plastics belong**

*A rare combination of mechanical, electrical, and chemical properties fit Synthane (our type of plastic) for a countless number of useful applications. Aside from its moisture and wear resistant qualities, Synthane is also light, dense, strong, easily and quickly machined, an excellent insulator, and a material for fighting corrosion.*

*Here is a unique and dramatic example of the use of plastics where plastics belong and Synthane where Synthane belongs.*




*This outboard motor pivot bearing (above) requires no lubrication . . . resists both salt and fresh water, wears long and well . . . it's Synthane.*

*If these few of Synthane's many properties suggest a possible use of Synthane in your product, let us help you—in the design stage. Perhaps we can save you time and money. Meanwhile, get further information. Send today for the complete catalog of Synthane technical plastics. Synthane Corporation, 6 River Road, Oaks, Pennsylvania.*

SYNTHANE **where Synthane belongs**

DESIGN · MATERIALS · FABRICATION · SHEETS · RODS · TUBES
FABRICATED PARTS · MOLDED · MACERATED · MOLDED · LAMINATED

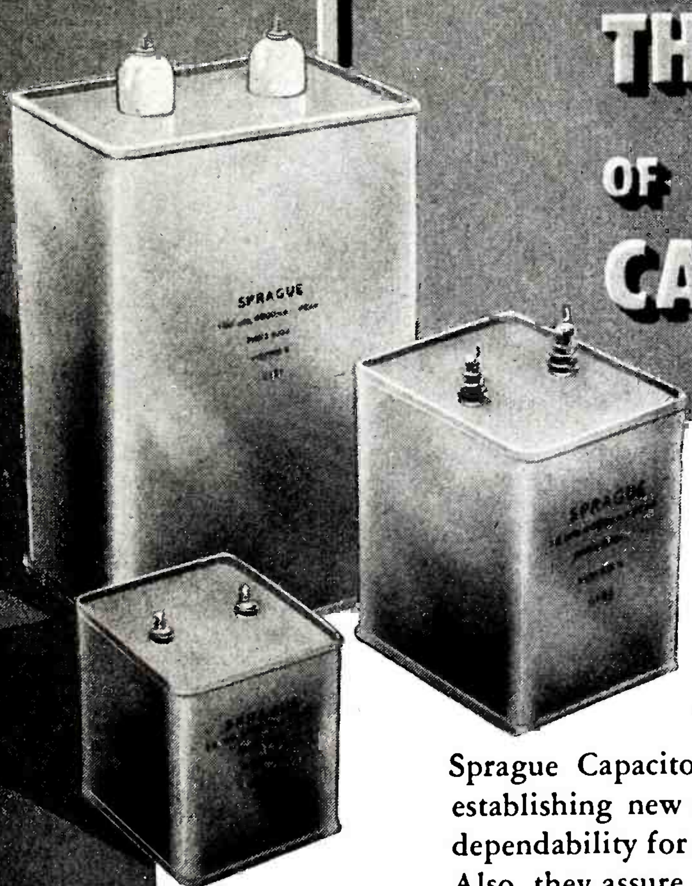
(over)

# SPRAGUE

# VITAMIN Q DIELECTRIC

(TRADEMARK REG. U. S. PAT. OFF.)

## HAS PERMITTED SUBSTANTIAL REDUCTIONS IN BOTH THE SIZE AND WEIGHT OF MANY OIL-FILLED CAPACITOR TYPES



### *TYPICAL!* Compact Capacitors for Photoflash and Energy Storage Uses

Sprague Capacitors with Vitamin Q dielectric have led in establishing new standards of compactness, light weight and dependability for electric flash tube (photoflash) photography. Also, they assure outstanding economies and greater efficiency for flash welding and time control circuits where duty cycles other than those used in photoflash work prevail. Write for Sprague Engineering Data Bulletin No. 3205.

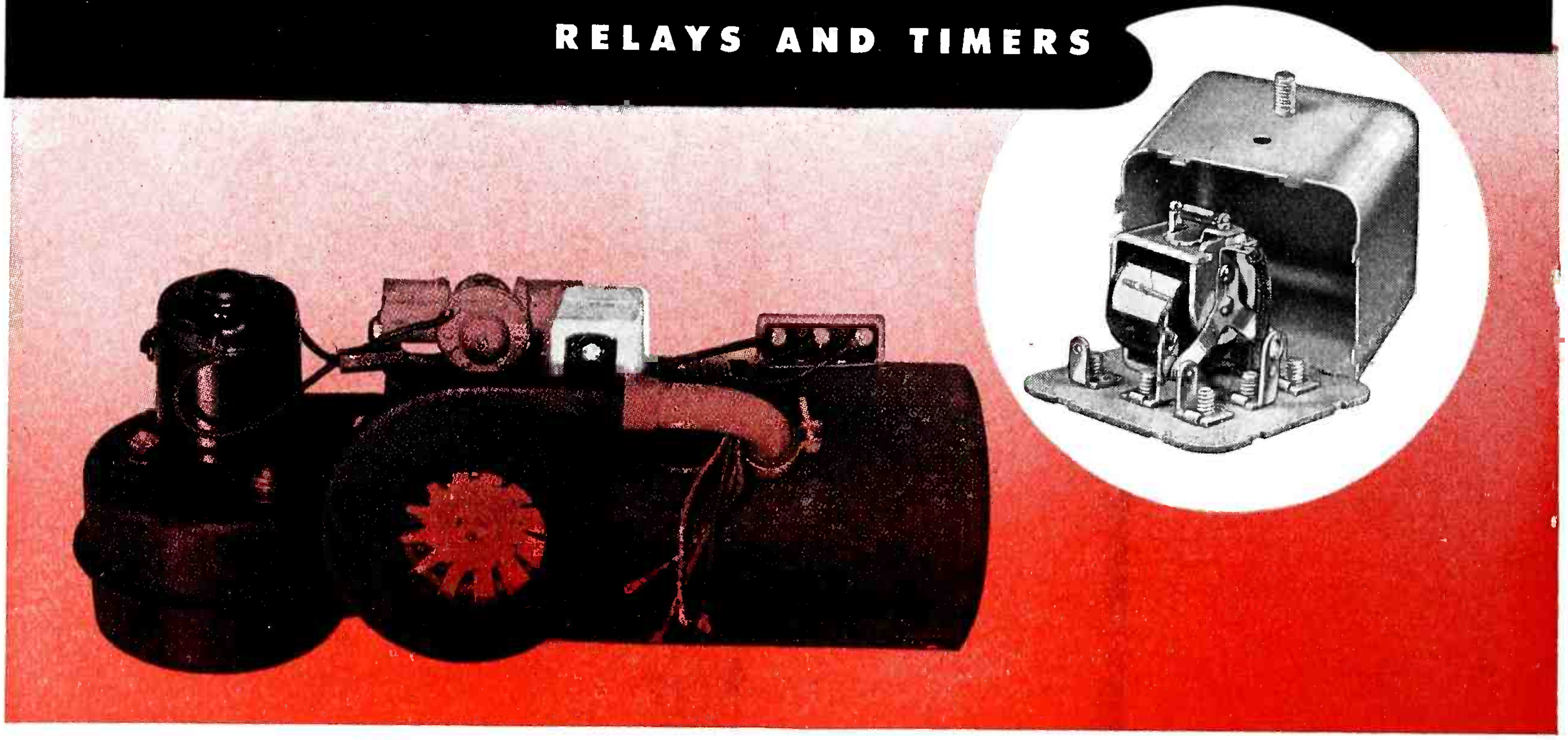
**SPRAGUE ELECTRIC COMPANY, North Adams, Mass.**

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

THE HIGH STANDARD OF YOUR NAME IS ASSURED WHEN YOU BUILD IN

# Potter & Brumfield

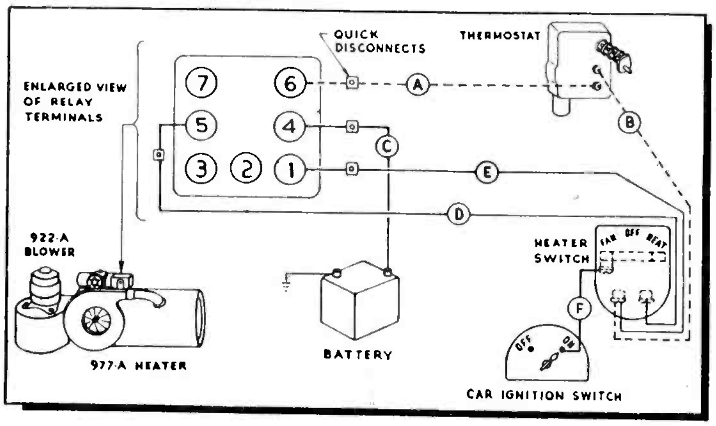
RELAYS AND TIMERS



## STEWART-WARNER CORPORATION'S FAMOUS *South Wind* CAR HEATER employs a single P&B relay for dependable automatic switching of all control circuits

● When specifications call for: Sensitive thermostatic actuation—wide range of operating voltage—extreme resistance to shock and vibration—positive multiple switching—millions of operations—extremes of temperature—weatherproof sealing—low cost and a thoroughly dependable supplier, Stewart-Warner specifies Potter & Brumfield.

The relay employed in the South Wind car heater is a special model, designed and built by Potter & Brumfield to meet the exacting requirements of these applications. This is a single example of the many special relay applications solved by P & B engineers to meet exacting requirements at low cost.




Potter & Brumfield standard relays and timers will meet most requirements. The standard line includes these general types:

- Small Light Duty
- Light Duty Multiple Circuit
- Telephone Types
- Small Power
- Heavy Duty Power
- Plate Circuit
- Sensitive
- Multiple Leaf
- Motor Starting Relays
- Synchronous Manual Reset Timers With Remote Signal Indicators

For complete details and specifications on standard P & B relays and timers, write for comprehensive, illustrated catalog. Your inquiries for special relays and timers are solicited. The assistance of our engineers, when desired, is always available.

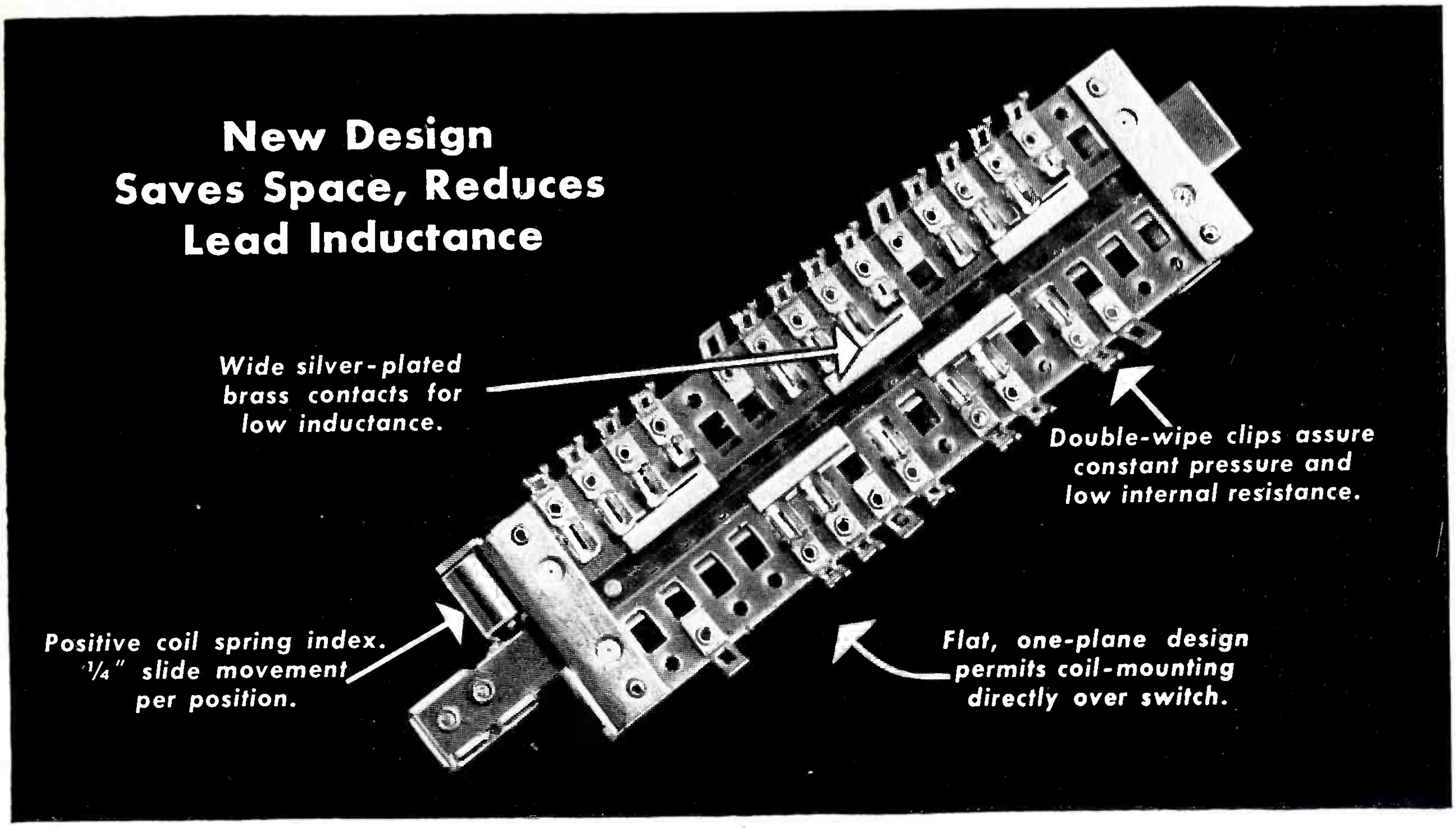
YOUR LOCAL ELECTRONICS PARTS DISTRIBUTOR STOCKS P & B RELAYS AND TIMERS

**POTTER & BRUMFIELD SALES COMPANY**
551 W. WASHINGTON BLVD., CHICAGO 6, ILLINOIS • FACTORY AT PRINCETON, INDIANA
*Export: 2020 Engineering Building, Chicago 6, Illinois*

# Centralab Announces a Revolutionary New

# SLIDE SWITCH

# for Improved AM and FM Performance!



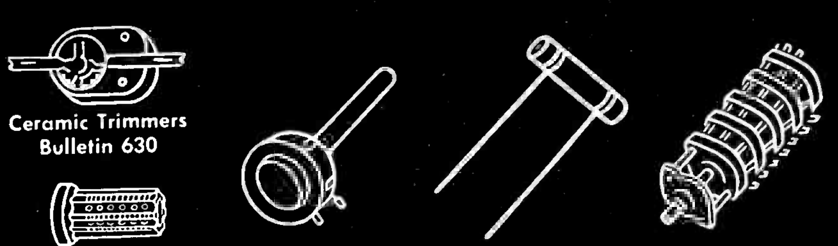

## Compact, Versatile, fits wide range of high frequency operations!

TO MEET an ever-growing demand, Centralab now offers you an outstanding new slide switch, designed for peak AM and FM performance plus maximum reliability and long service life.

Flat, horizontal design saves valuable space, for the first time allows short leads, convenient location to coils, reduced lead inductances for improved low and high frequency fidelity!

Note these fine points of construction and design: 4-point suspensions with "twisted ear" mounting on base or panel from .038" min. to .052" max. . . . Optional size or length of unit — min. 5 clips per side, max. 20 clips per side . . . Standard brass silver-plated clips and contacts with original CRL double-wiping clip design . . . Index life — over 10,000 cycle minimum RMA standard life test . . . 2 or 3 position, shorting type contacts . . . Movement of slide per position — ¼ inch.

Write for complete information on this important new switch development. Send for bulletin 953.



Ceramic Trimmers Bulletin 630

Ceramics Bulletin 720

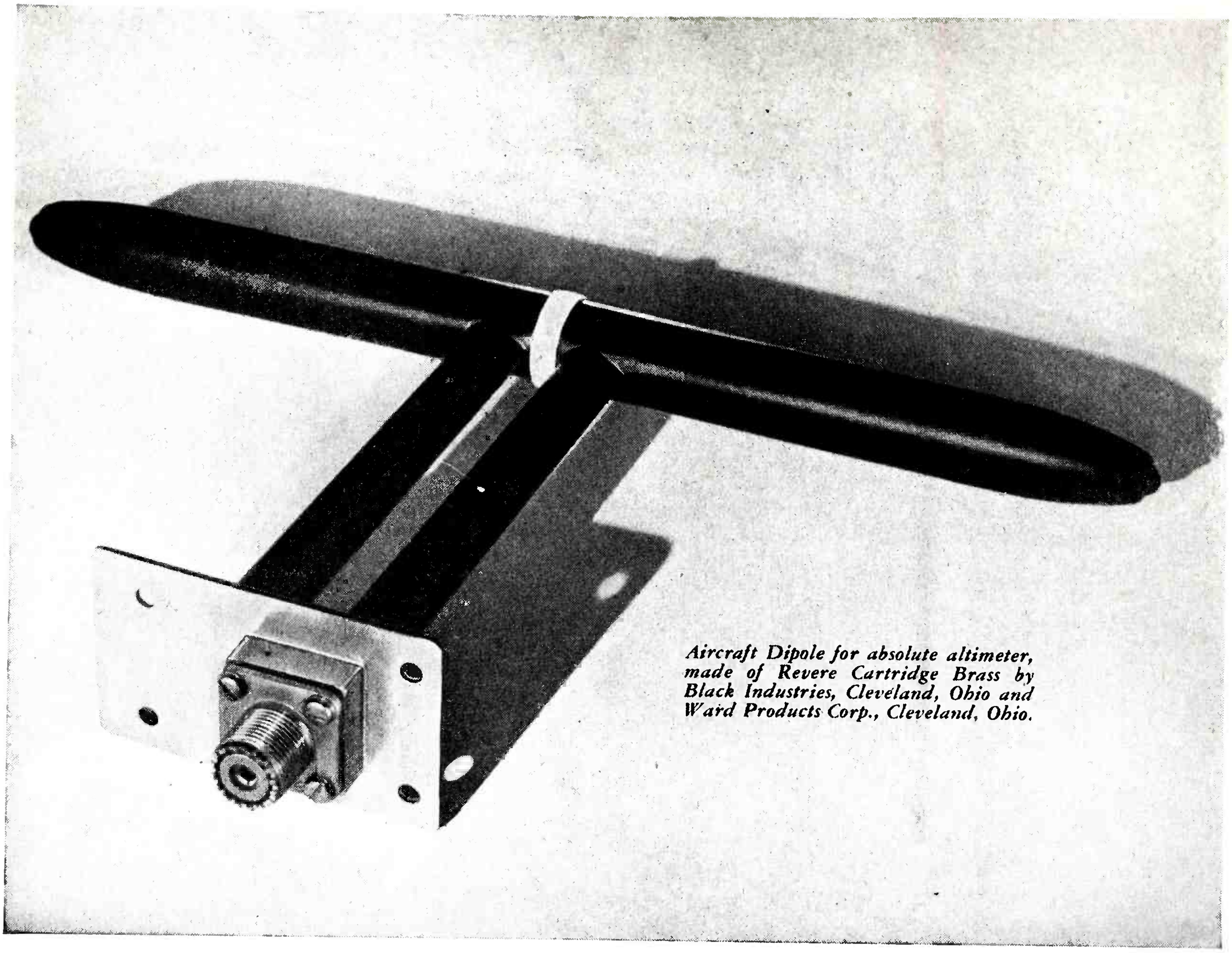
Variable Resistors Bulletin 697

Ceramic Capacitors Bulletin 630

Selector Switches Bulletin 722

**Centralab** CRL

Division of GLOBE-UNION INC., Milwaukee



*Aircraft Dipole for absolute altimeter, made of Revere Cartridge Brass by Black Industries, Cleveland, Ohio and Ward Products Corp., Cleveland, Ohio.*

# Metal by REVERE in this dipole

THIS dipole antenna is made chiefly of Revere 70-30 Cartridge Brass, an important feature of which is strength combined with easy workability. The dipole section is made of brass tube with the ends spun down. In order to reduce drag, the tube for the leads to the dipole was supplied by Revere specially drawn into an aerodynamic "teardrop" section. (Incidentally, Revere also makes electric-welded steel tube in the same cross section.) The base of the dipole is made of Revere brass sheet and rod. External surfaces have a black oxidized finish which is very durable and easy to obtain on brass. This is but one of many uses for Revere Brass in electronic equipment, others including cans for transformers and condensers, bolts and nuts, connectors, shafts and plates for variable condensers, name plates and similar applications requiring any or all of the following qualities: easy fabrication, corrosion resistance, and beauty. Revere offers mill products in the following forms: *Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings; *Aluminum Alloys:* Tube, Extruded Shapes, Forgings; *Magnesium Alloys:* Sheet and Plate, Rod and Bar, Tube, Extruded Shapes, Forgings; *Steel:* Electric Welded Steel Tube in standard or special cross sections.

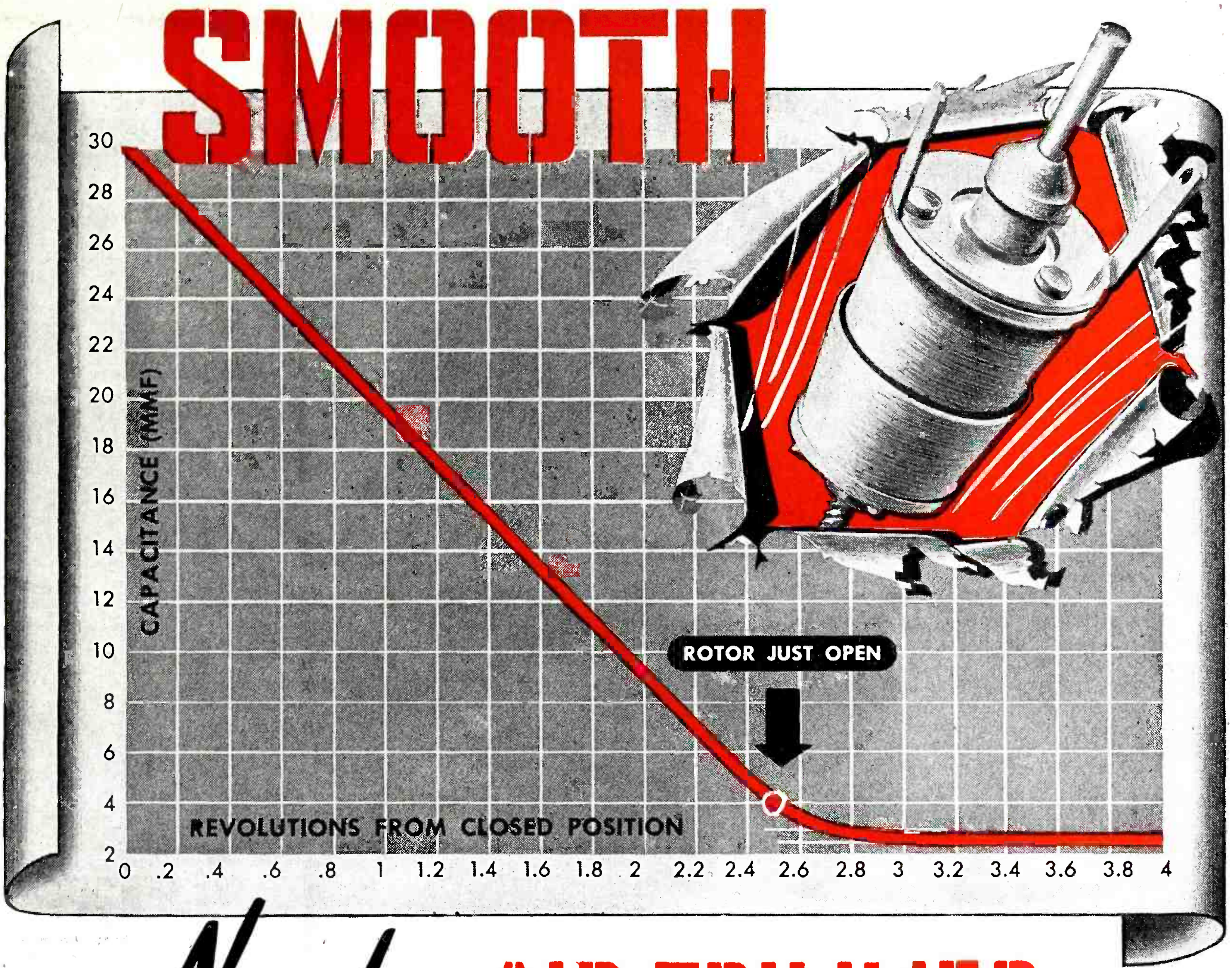
**REVERE**

**COPPER AND BRASS INCORPORATED**

*Founded by Paul Revere in 1801*

*230 Park Avenue, New York 17, New York*

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




# Norelco AIR TRIMMER

The smooth linear characteristics illustrated result from the mechanical design of the NORELCO Air Trimmer. This concentric design makes adjustment alignment and testing procedures extremely simple.

Permanence of adjustment and resistance to mechanical shock assures complete freedom from microphonism.

Low minimum capacitance, high "Q", light weight and small mounting area result in general acceptance of NORELCO Air Trimmer for applications in F. M. discriminators, Television I.F. transformers and other high frequency circuits.

**Exact Size**

A booklet describing the NORELCO Air Trimmer and a working sample will be supplied to interested manufacturers upon request. Contact our representative in your area, or write directly to Philips.

## ✓ CHECK THESE FEATURES:

- "Q" over 850 at 1500 kc.
- D.C. insulation resistance greater than 50,000 megohms for relative humidities up to 50%.
- Minimum capacity—2.5 mmf.
- Parallel Damping—greater than 3 megohms at max. cap.—when measured at 1500 kc.
- Maximum capacity—over 30 mmf.

Special variable air condensers ranging from 5 mmf. minimum are now available. Write us regarding specific applications.

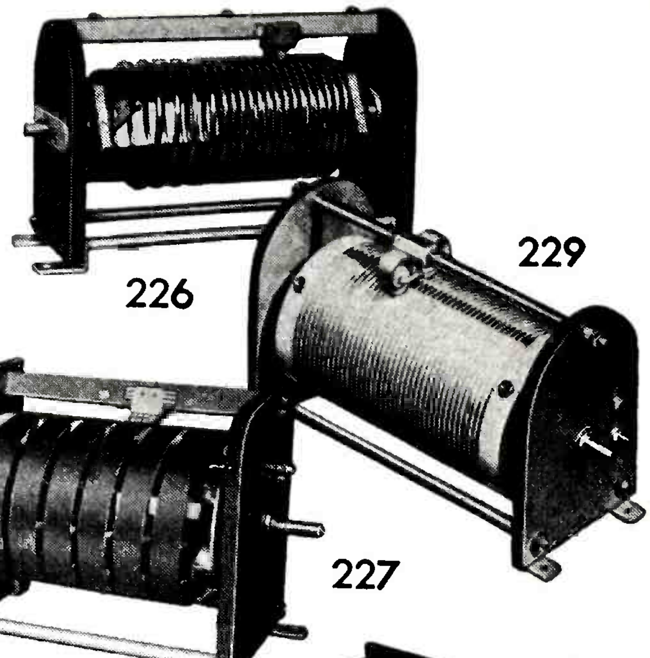
Norelco Reg. U. S. Pat. Off. ELECTRONIC PRODUCTS

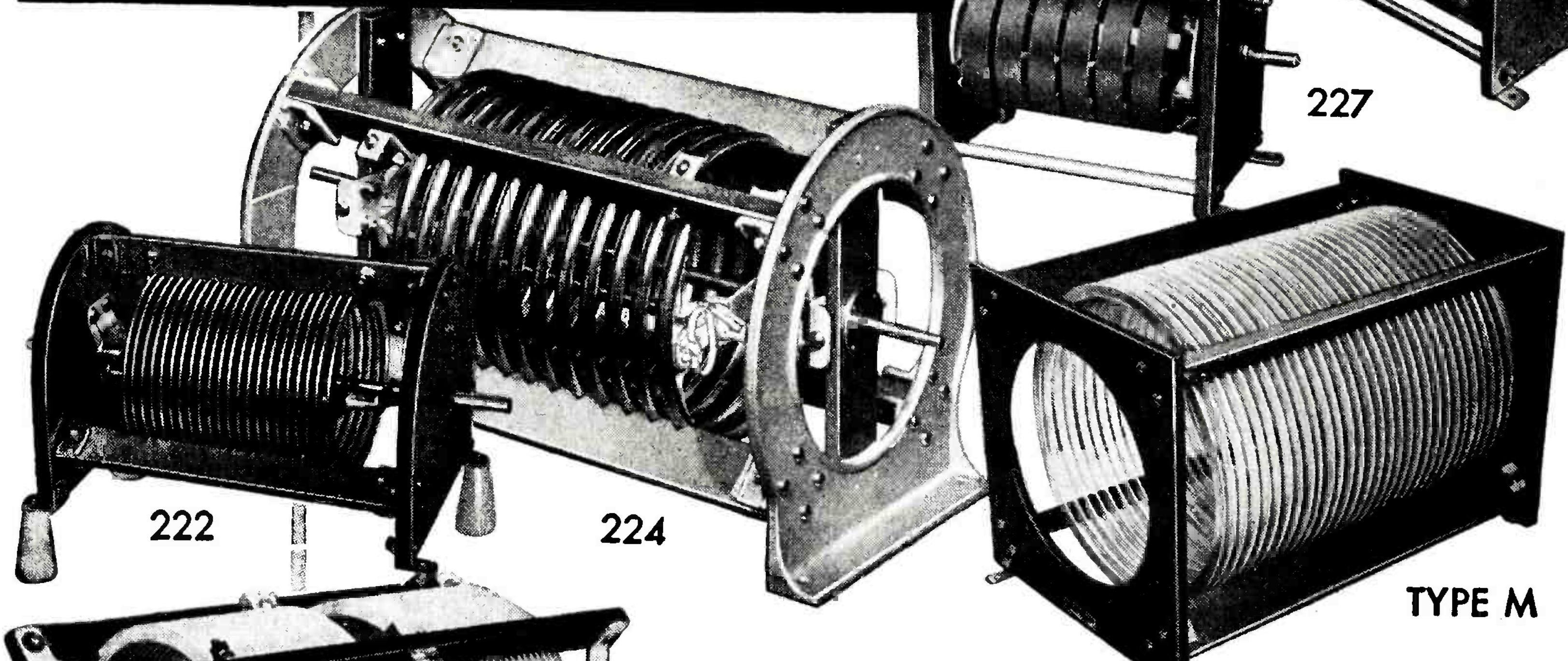
**NORTH AMERICAN PHILIPS COMPANY, INC.** DEPT. E-5, 100 EAST 42nd STREET NEW YORK 17, N. Y.

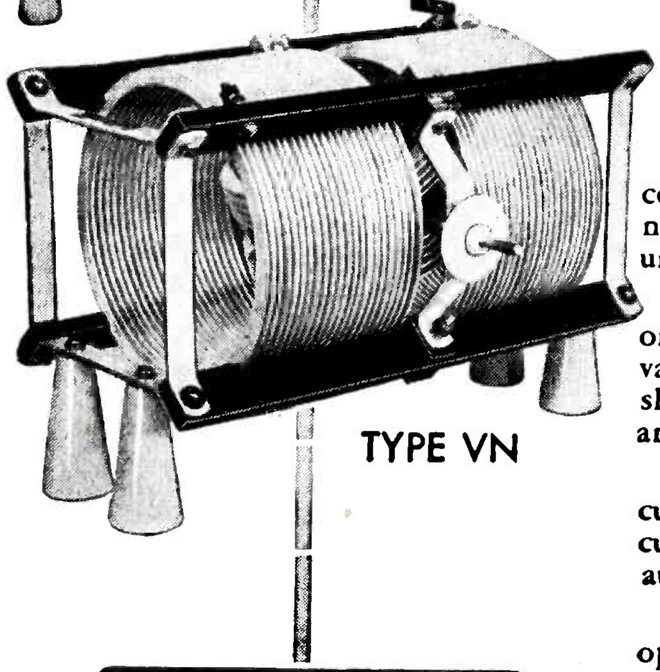
IN CANADA: PHILIPS INDUSTRIES, LTD., 1203 PHILIPS SQUARE, MONTREAL

# *Fixed and Variable* INDUCTORS *for*

**BROADCAST AND COMMERCIAL TRANSMITTING • ELECTRONIC HEATING HIGH CURRENT • HIGH VOLTAGE R.F. APPLICATIONS**




JOHNSON, a pioneer in high voltage, high current inductors for commercial equipment, offers you the benefits of many years of engineering achievement, highly advanced production techniques, and an unequaled choice of types and sizes.

The many variable types assure smooth tuning for low, medium, or high power applications. Types N and M can be supplied with variable coupling rotors, tuning flippers, or as variometers. Faraday shields may be incorporated in the Type M to minimize eddy currents and reduce electrostatic coupling.

The 227 series is engineered to meet the requirements of high current, high frequency, electronic heating and transmitter tank circuits. Dual models feature counter sliding contacts which provide automatic balancing for push-pull circuits.

The 226 series is recommended for high-frequencies and features optional variable pitch winding for wide band coverage. The 224 is wound with 3/8″ or 1/2″ copper tubing and offers the highest ratings of the types shown.

There is a JOHNSON inductor "your size" for they begin with small wire wound units for low power stages and extend through the big, high power, water cooled types. New data sheets covering the inductors shown have just been completed. We'll be glad to send them for your file or for your immediate requirements.

*Write for data sheet series* D

**JOHNSON PRODUCTS INCLUDE**

Transmitting Capacitors • Inductors • Tube Sockets • R. F. Chokes • Q Antennas • Insulators • Connectors • Plugs and Jacks • Hardware • Pilot and Dial Lights • Broadcast Components • Directional Antenna Equipment

**JOHNSON** *. . . a famous name in Radio*

E. F. JOHNSON CO. WASECA, MINNESOTA

## REVISED EDITION

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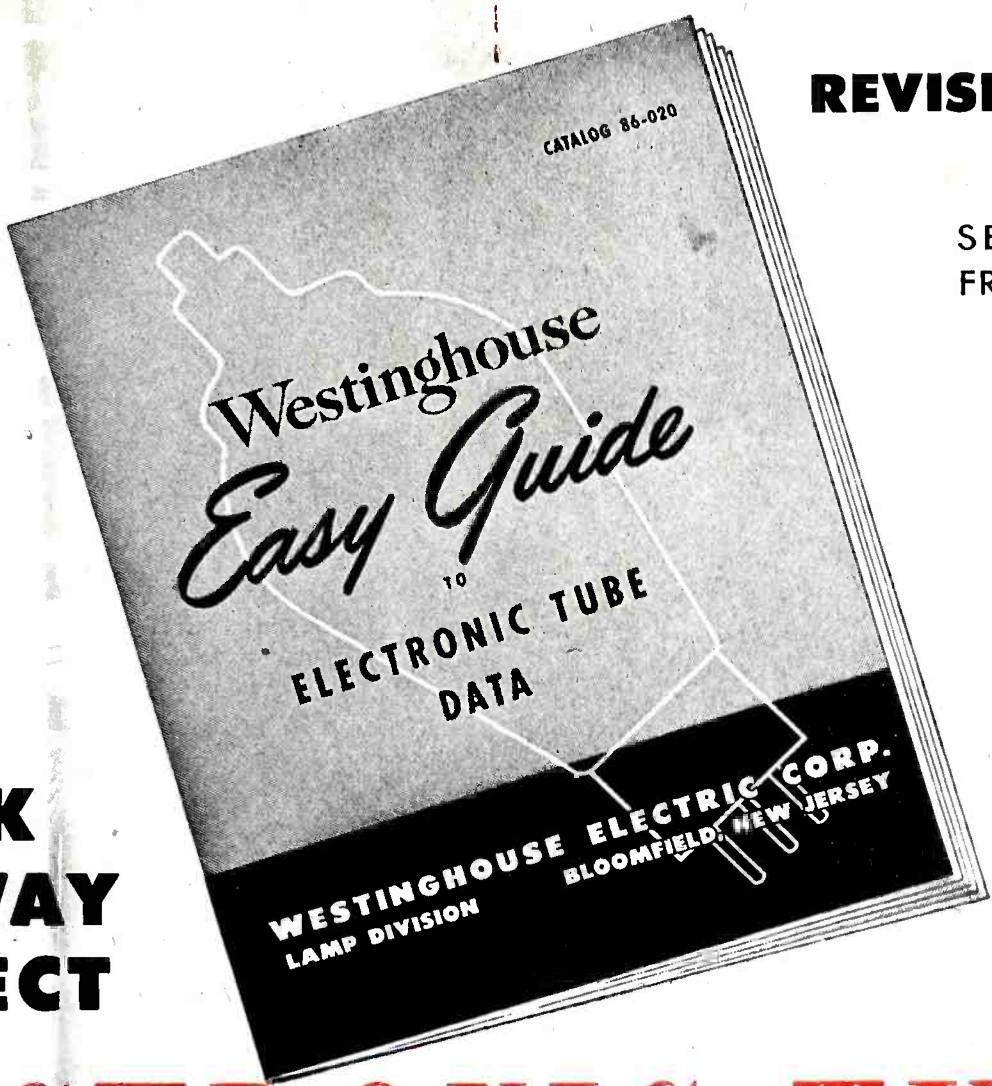



# A QUICK EASY WAY TO SELECT ELECTRONIC TUBES

Westinghouse offers you the right combination in electronic tubes:

**1. A complete line.** Westinghouse provides *Quality Controlled* tubes for industrial and communications applications.

**2. The Easy Guide.** This newly revised edition gives you a simple, quick way of selecting the proper Westinghouse tube for your purpose. It gives essential technical data on each tube and includes an interchangeability chart for selecting the appropriate Westinghouse tube for various competitive designations.

**3. Replacement tube service.** Westinghouse gives you prompt and efficient service through its district warehouses and distributors throughout the country. "One call does it all."

If you do not have your copy of the Easy Guide, send for one today. Electronic Tube Sales Dept., Westinghouse Electric Corp., Bloomfield, N. J.

**Westinghouse**

*Quality Controlled Electronic Tubes*

Electronic Tube Sales Dept.
Westinghouse Electric Corp., Bloomfield, N. J.

Please send me a copy of the Easy Guide.

Name . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Position . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Firm . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Address . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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

# Trained Fingers *KNOW!*

A trained golfer quickly senses the balance and precision of a matched set of fine clubs. The professional draftsman just as quickly recognizes dependable uniformity, smooth responsiveness in a pencil. TYPHONITE ELDORADO gives you that steady performance every time in every degree . . . for crisper, sharper blueprints.

**DIXON'S TYPHONITE**

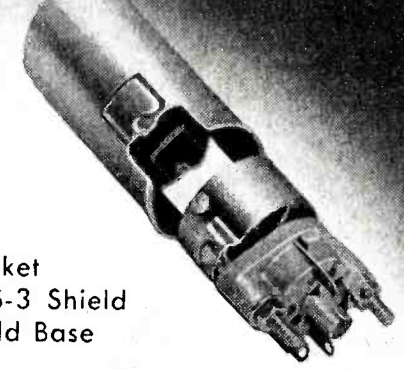
# ELDORADO


PENCIL SALES DEPT. 59-J5, JOSEPH DIXON CRUCIBLE CO., JERSEY CITY 3, N. J.

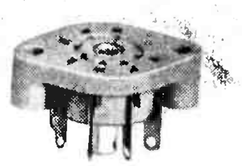
# NEW

## SOCKETS AND SHIELDS...

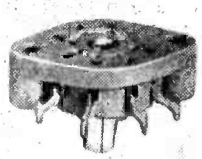
### for miniature button base tubes



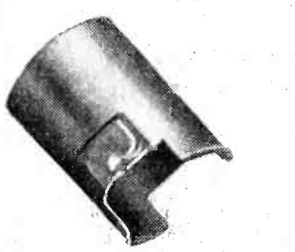
XOA Socket with XOS-3 Shield and Shield Base



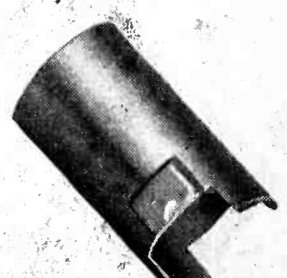
XOA Socket



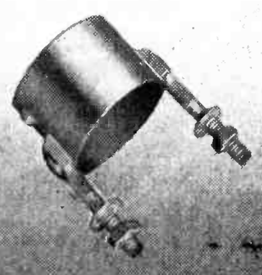
XOR Socket



XOS-1 Shield for $1\frac{3}{16}''$ high tube body (6AK5 type)



XOS-3 Shield for 2" high tube body (OA2 type). Also available: XOS-2 for 1 ½" high tube body (6C4 type)



Shield Base for XOS-1, XOS-2 or XOS-3

These new National sockets are of mica-filled natural molded Bakelite with silver-plated beryllium-copper contacts — designed for maximum dependability and adaptability. The contacts — either axially or radially mounted and removable for replacement — provide short leads and low inductance so vital to ultra-high frequency design. Sockets are built to JAN specifications — can be used with or without shields.

Made in three sizes to accommodate the various sizes of miniature tubes, the shields are of nickel-plated brass, with cadmium-plated phosphor bronze spring to provide correct tension to hold both tube and shield in place regardless of angle or vibration. Shield bases are of nickel-plated brass, with two 4/40" spade bolts mounting both socket and shield base.

You'll find hundreds of other parts, both new and old, to improve your apparatus in the new 1947 National Catalog.

National EST. 1914

# NATIONAL

**COMPANY, INCORPORATED**

MALDEN, MASS.

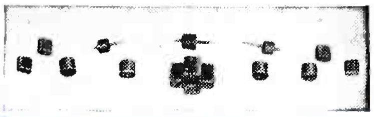
**MAKERS OF LIFETIME RADIO PRODUCTS**

ELECTRONICS

# Designers

## 4 improved magnet materials add design possibilities

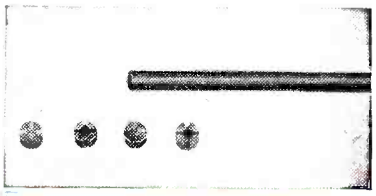
Augmenting the many sintered and cast Alnico alloys, 4 additional General Electric magnet materials greatly extend magnet design possibilities.



1

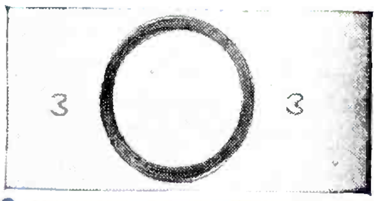
**1. VECTOLITE.** This light-weight, high-resistance magnet material is a combination of iron oxide and cobalt oxide. High in coercive force, it is finding wide application as a rotor magnet for d-c selsyns and in many types of moving magnet instruments. A number of shapes are shown in illustration 1.

**2. CUNICO.** An alloy of copper, nickel and cobalt, Cunico is malleable, ductile, and machinable and is supplied in wire, strip, or rod stock. Illustration 2 shows a rod of Cunico, and screw-machine magnets machined from it.



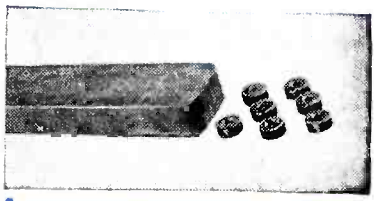
2

**3. CUNIFE.** Cunife has all the physical advantages of Cunico. However, this alloy of copper, nickel and iron has directional properties, and to secure best magnetic results must be magnetized only along the direction in which the material has been worked. It is supplied in wire stock in round, square, and rectangular form. Ductility of Cunife is shown in illustration 3.




3

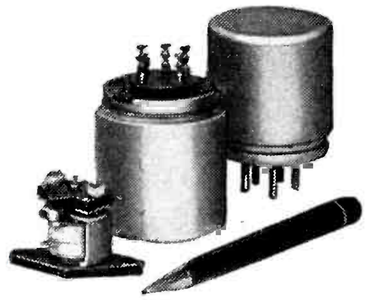
**4. SILMANAL.** High in coercive force, this alloy of silver, manganese, and aluminum is most useful in instruments where service in strong electrical fields is necessary. The Silmanal magnets in illustration 4 were rolled, punched, and machined from the ingot shown. For more information about these magnetic materials, write for Bulletin GES-3337.



4

### RELAYS THAT ARE REALLY SENSITIVE

For electronic applications where switching functions must be performed by small amounts of power, General Electric has a complete line of current-sensitive, d-c relays. These relays are built to withstand shock and vibration and will operate in ambient temperatures from −70F to 200F. They cover the range from 10 mw to 180 mw; 0.47 ma to 1470 ma; 0.07 ohms to 67,000



ohms coil resistance; and weigh from 0.1 to 0.7 pound. Contact ratings from 12 volts to 110 volts a-c/d-c with a contact rating at 24 volts d-c of 2.0 amperes non-inductive and 0.5 ampere inductive. Installation is easy with either the plug-in base or the solder-lug terminals. Write for Bulletin GEA-3819.

### ONE SWITCH CONTROLS MANY CIRCUITS

For transfer and control switching there is a G-E (Type SB-1) switch to do almost any job. Standard Type SB-1 switches are available from single-stage models to 12-position, 16-stage models. For more complex switching, special models are furnished up to 100 stages.

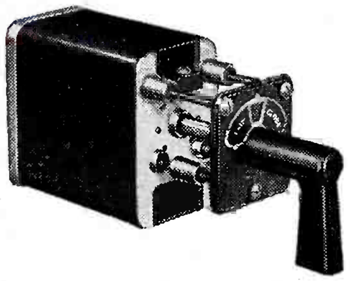
Precision construction makes operation easy, even in the larger models. Rated at 600 volts, 20 amp continuous, or 250 amp for 3 seconds, the long-lived, cam-operated silver contacts have stood more than 1,000,000 test operations without excessive wear.

Stages are isolated by dielectric bar-

GENERAL ELECTRIC

# Digest

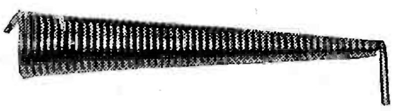
## TIMELY HIGHLIGHTS ON G-E COMPONENTS



riers. There is ample space for easy connection. Two types of locks permit locking in any position, and standard switches are dead front. Write for Bulletin GEA-1631.

### PUTS A LOT OF COIL IN A LITTLE SPACE

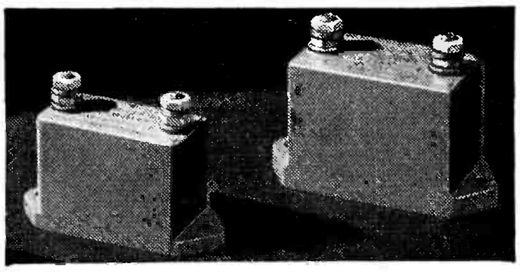
When product design puts a premium on space, G-E Formex* magnet wire lets you wind more compact coils.



Where coils wound in rectangular shapes crack enamel insulation, the tough film on Formex stands up. In fast winding operations, too, Formex takes the punishment. When coils must stand up year after year, depend on Formex, because age has little effect upon this polyvinyl-acetal insulation. Round Formex is available in standard sizes from 6 AWG to 44 AWG and in ultrafine sizes of 1¾, 1½, 1¼ and down to 1 circular mil in copper area. Rectangular Formex is also available. For full information on shapes, sizes and application methods, write for Bulletin GEA-3911.

### LECTROFILM CAPACITORS AT NEW LOW PRICES

Circuit designers now have complete freedom to use either high or low capacities in r-f blocking and by-pass applications — without paying a premium for high capacity—because General Electric case-style 65 Lectrofilm* capacitors are now all at one new price, approxi-

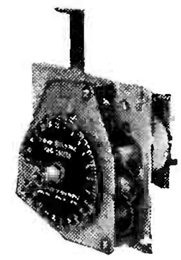


mately half of the previous level! Similarly, all listed ratings of case 70 designs are offered at one new, low price.

General Electric's development of Lectrofilm, a new capacitor dielectric, and the advanced methods used in manufacturing these capacitors have resulted directly in these new low prices. Lectrofilm capacitors are now the answer to new circuit economies, better circuit designs, lower over-all equipment costs. Bulletin GEA-4295.

### TO SELL RADIO LISTENING BY THE HOUR

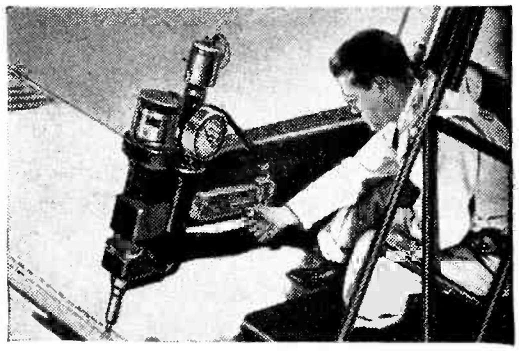
Dispensing 2 hours of use for each coin deposited, the General Electric Type TSC-9 coin-switch mechanism is suitable for installation in table-model radios such as hotels provide for guests. Powered by the widely used, reliable Telechron motor, and with silver contacts rated 2 amp, 110 volts a-c, the switch is constructed for long, mainte-



nance-free service. The Type TSC-9 switch may be connected to allow intermittent use of the radio until the time paid for has been exhausted. As many as 6 coins, providing a maximum of 12 hours use, may be deposited at one time. A continuous coin counter registers deposits up to $25.

### TRAINS BETTER WELDERS IN LESS TIME

Visual methods of employee education have proved their ability to increase output and decrease rejects. Now General Electric has produced a new, full-color, sound movie that uses animated drawings to teach the principles and applications of spot, projection, and seam resistance welding. The film takes you inside fifteen different industrial plants, and shows more than 100 applications of resistance welding where it is speeding production and cutting costs. Ac-



companying the film is an interesting "refresher" bulletin covering the salient points of the film.

*Ask your local General Electric office to lend you "This Is Resistance Welding"; no charge or obligation to you.*

*Reg. U.S. Pat. Off.

**GENERAL ELECTRIC COMPANY, Sec. D642-14**
Apparatus Dept., Schenectady 5, N. Y.

*Please send me:*

....GES-3337 (Magnet materials)
....GEA-3819 (Current-sensitive relays)
....GEA-1631 (Type SB-1 switches)
....GEA-3911 (Formex magnet wire)
....GEA-4295 (Lectrofilm capacitors)

NOTE: More data available in Sweets' File for Product Designers

Name ____________________

Company ____________________

Address ____________________

City ____________ State ____________

8010

# SATURATED SLEEVING*

## IF IT'S TURBO—IT SAFEGUARDS!

*TURBO Saturated Sleeving is available in various colors in sizes from .032" to .224" ASTM standard inside diameter in strands or continuous coils. It is recommended for all general applications that do not require unusually high dielectric strength. Dielectric breakdown is 1200 V. per A. S. T. M. test. TURBO Saturated Sleeving is a slow burning insulation.

## ...an all-purpose insulation with all-round advantages!

**ASK THE ENGINEER!** Most conditions which require an insulating material may be satisfied by the use of this general purpose insulation. TURBO Saturated Sleeving provides a flexible, high tensile strength cotton braided and impregnated insulation which is resistant to most common destructive agents—oils, acids and alkalies. These sleevings are especially recommended for industrial equipment, office machines, home appliances and similar light duty electrical devices. Investigate also the physical properties and characteristics of these other TURBO insulating products listed below

**Varnished Cambrics**.......... Closely woven cambric fabrics treated with multiple coats of baked-on varnish to provide protection against oils, moisture, alkalies, and voltage breakdowns under severe conditions. Supplied in sheets, rolls and tapes in standard thicknesses, weights and colors.

**Plastic Insulated Wire**...... Number 18 and finer stranded and solid conductor with a seamless extruded plastic insulation. Surpassing dielectric properties. Resistant to oils, organic solvents, acids, alkalies and oxidation. Minimum shrinkage and burning effects in soldering and potting.

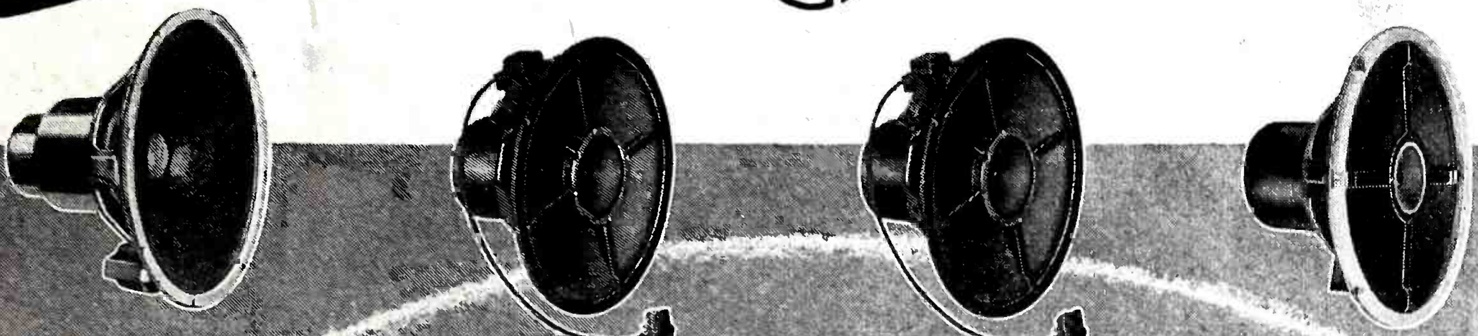
**Varnished Tubing**............ A superior braided cotton insulation featuring saturation impregnation of flexible varnishes. Strong, flexible, non-peeling, non-cracking, moisture, oil, acid and flame resistant. Dielectric breakdown ASTM test—Magneto grade—7000 V., Radio grade—4000 V.

**Fibrous Glass Tubing**........ Fabricated of flexible fibrous glass yarn braided and impregnated with flexible varnishes and baked to form an ideal insulator, highly resistant to most reagents and to physically and electrically destructive elements. Four grades (ASTM Test) from 1200 V. to 7000 V.

**TURBO**

**WILLIAM BRAND & COMPANY**
276 FOURTH AVE., NEW YORK 10, N.Y. - 325 W. HURON ST., CHICAGO 10, ILL.

# *Listen*... IT'S A Jensen SPEAKER!



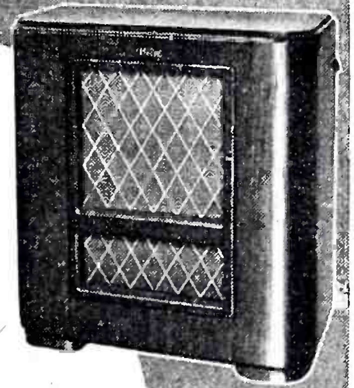
Model HNP-51 (15-inch)

Model JAP-60 (15-inch)

Model JHP-52 (15-inch)

Model JCP-40 (12-inch)

## JENSEN BASS REFLEX* REPRODUCERS with COAXIAL SPEAKERS



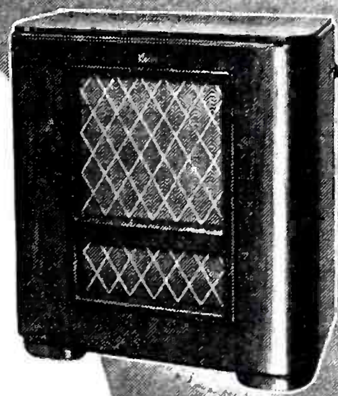
### TYPE "RD"

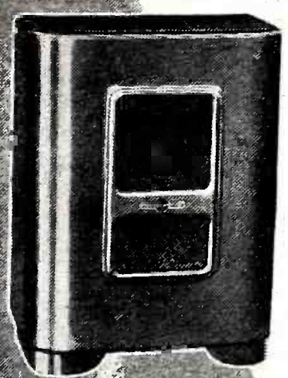
| REPRODUCER NO. | STOCK NO. | CABINET NO | SPEAKER NO. | IMPEDANCE, OHMS | LIST PRICE |
|---|---|---|---|---|---|
| RD-122 | ST-159 | D-121 | JCP-40 | 6-8 | |
| RD-151 | ST-160 | D-151 | HNP-51 | 500-600 | |
| RD-152 | ST-161 | D-151 | JAP-60 | 500-600 | |
| RD-153 | ST-162 | D-151 | JHP-52 | 500-600 | |

### TYPE "RA"

| | | | | | |
|---|---|---|---|---|---|
| RA-124 | ST-134 | A-121 | JCP-40 | 6-8 | |
| RA-151 | ST-136 | A-151 | HNP-51 | 500-600 | |
| RA-153 | ST-138 | A-151 | JAP-60 | 500-600 | |
| RA-154 | ST-139 | A-151 | JHP-52 | 500-600 | |

## JENSEN BASS REFLEX* CABINETS





### TYPE "D"

| MODEL NO. | STOCK NO. | SPEAKER SIZE | DIMENSIONS | | | LIST PRICE |
|---|---|---|---|---|---|---|
| | | | HEIGHT | WIDTH | DEPTH | |
| D-121 | ST-156 | 12" | 27⅞" | 31⅜" | 13⅜" | |
| D-151 | ST-157 | 15" | 27⅞" | 31⅜" | 13⅜" | |

### TYPE "A" (Finished)

| | | | | | | |
|---|---|---|---|---|---|---|
| A- 81 | ST-123 | 8" | 24" | 18" | 9¼" | |
| A-121 | ST-124 | 12" | 27" | 24¾" | 13½" | |
| A-151 | ST-125 | 15" | 32⅜" | 27⅜" | 13½" | |

### TYPE "A" (Unfinished)

| | | | | | | |
|---|---|---|---|---|---|---|
| A- 82 | ST-145 | 8" | 24" | 18" | 9¼" | |
| A-122 | ST-146 | 12" | 27" | 24¾" | 13½" | |
| A-152 | ST-147 | 15" | 32⅜" | 27⅜" | 13½" | |

*Designers and Manufacturers of Fine Acoustic Equipment*

**JENSEN MANUFACTURING COMPANY**

6607 SOUTH LARAMIE AVE., CHICAGO 38, U. S. A.

IN CANADA: Copper Wire Products Ltd., 11 King St. W., Toronto, Ont.

*Trade Mark Registered

**Jensen** SPEAKERS WITH ALNICO 5

*says* **JOHN M. DERBY CO.** *Chicago* (AUTHORIZED HALLICRAFTERS SERVICE CENTER)

# *Your CCO is a Natural!*

**NO GUESS WORK ABOUT IT . . . SIGNAL SELECTION IS POSITIVE AND PRECISE"**


Yes, as John Derby says, the CCO eliminates any question or interpolation because each signal is directly controlled by an individual crystal oscillating at the required frequency. No need to identify confusing beat frequencies when you have *direct crystal control* in the CCO.

Precision is assured by seven Bliley crystals which are "on frequency" as soon as the oscillator is energized. No warm up time needed and no aging effects to compensate. All frequencies are accurate, dependable and permanent with *direct crystal control* in the CCO.

This small compact instrument provides instant selection of crystals oscillating at 175 kc, 200 kc, 262 kc, 370 kc, 455 kc, 465 kc and 1000 kc. An external socket is provided to accommodate extra crystals that may be needed for special frequencies.

The CCO is a "techniquality" product of Bliley engineers and craftsmen who have pioneered in frequency control for over fifteen years. Ask your Bliley distributor, or write direct, for Bulletin 32 which gives complete details.

**$69.50**

*Complete with 7 Bliley crystals, tubes and concentric output cable.*

**Bliley**

**CRYSTAL CONTROLLED OSCILLATOR**

**BLILEY ELECTRIC COMPANY** • UNION STATION BUILDING, ERIE, PENNSYLVANIA


## CONSTANT CAPACITANCE GAS-FILLED CONDENSERS...

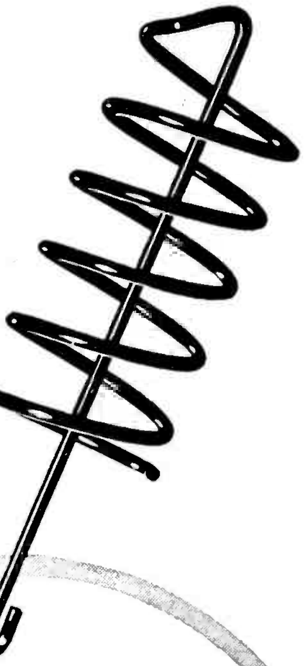
**As easy to tune as your home receiver, and once set, this gas-filled Lapp Condenser holds its capacitance under all conditions. No "warm up" required, no change in capacitance with change in temperature. As lump capacitance for service at high voltage and high currents, these gas-filled units save space, save power, and save trouble. Available in variable, adjustable, and fixed capacitance units. Condensers now in service range up to 60,000 mmf. (fixed), 16,000 mmf. (variable and adjustable). Current ratings to 500 amperes R.M.S., and voltage ratings to 60 Kv peak.**

# Lapp

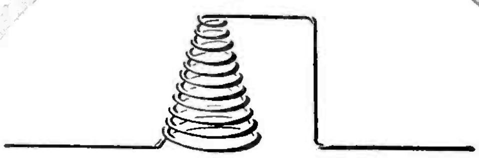
**LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK**


Washing-Machine Makers
"Wring Out"
More Production Savings-
Dealers Ring Up
More Sales
...when costs toboggan and style steps up
via AMERICAN PHILLIPS SCREWS
HERE'S THE PRODUCTION "WHY": Super speed on the line—from automatic, straight, "non-stop" driving! American Phillips Screws spare work and worker—make power driving really pitch for you in speedier handling . . . in savings on screws (fingers can't fumble, heads can't burr) . . . in scratchless, matchless safety for work surfaces. Many manufacturers making appliances, autos, or what-not, get a bonus in total time-savings up to 50%!
HERE'S THE PROMOTION "WHY": Customers like the streamlined look that this modern fastening furnishes. American Phillips Screws go with everything your product embodies that says high style and long service. Write American today for fastening facts that can cut your costs.
4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS
AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois Street
Detroit 2: 502 Stephenson Building
AMERICAN PHILLIPS Screws
ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

# "We didn't know you could do that with Callite tube & lamp components"

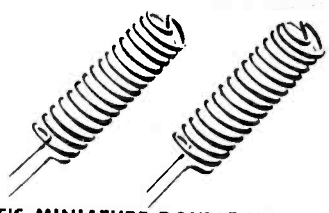


**CALLITE'S "M" SHAPED FILAMENTS** *for high-power projection lamps. Employing a tungsten wire of .010" diameter wound on a .035 molybdenum mandrel for 55 turns per inch, its faster crystal growth produces interlacing crystals whose structure maintains the stability and non-warping property of the coil, thus withstanding elevated temperatures. Used for vacuum and incandescent lamps of high wattage and heat dissipation.*



**CALLITE'S CONE-SHAPED TUNGSTEN FILAMENT.** *This heater wire, .020" in diameter, is specially designed to produce lamp filaments that will maintain a constant lumen output because it permits very little distortion of the coils (despite their unusual pattern) during the life of the lamp. Used for special types of incandescent and gas filled lamps.*

**CALLITE'S COILED-COIL HEATER.** *Employs a .375 milligram tungsten wire heater wound on a .004 molybdenum mandrel for 800 turns per inch. The coil is then rewound on a .030 steel mandrel and skip turned every 68 t.p.i. Result: a highly efficient coiled-coil heater for miniature electron tubes with high emission properties equal in performance to larger envelope tubes.*



**CALLITE'S MINIATURE DOUBLE HELICAL HEATER** *for radar and microwave transmitting tubes. This molybdenum-tungsten alloy filament, .0048" in diameter and 133 mm. in length, is coated with aluminum. Evenly wound, of high tensile strength, good ductility and uniform resistance, this filament is particularly adaptable for high and ultra-high frequencies in restricted spaces.*

**THE CALLITE COMPONENTS** featured above indicate the kind of engineering ingenuity and production proficiency with which Callite serves the lamp and tube industry. For 26 years Callite has supplied standard and special shapes in every industry where lamp and tube components are used. The same ingenuity and flexibility of the Callite organization is at your command for any component problem requiring quick, efficient solution. Callite Tungsten Corporation, 544 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

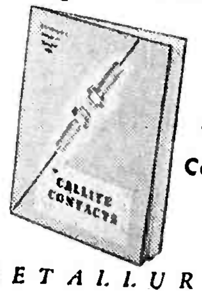
CALLITE TUNGSTEN CORPORATION

CT

**Callite**

**TUBE & LAMP COMPONENTS**

Hard glass leads, welds, tungsten and molybdenum wire, rod and sheet, formed parts and other components for electron tubes and incandescent lamps.

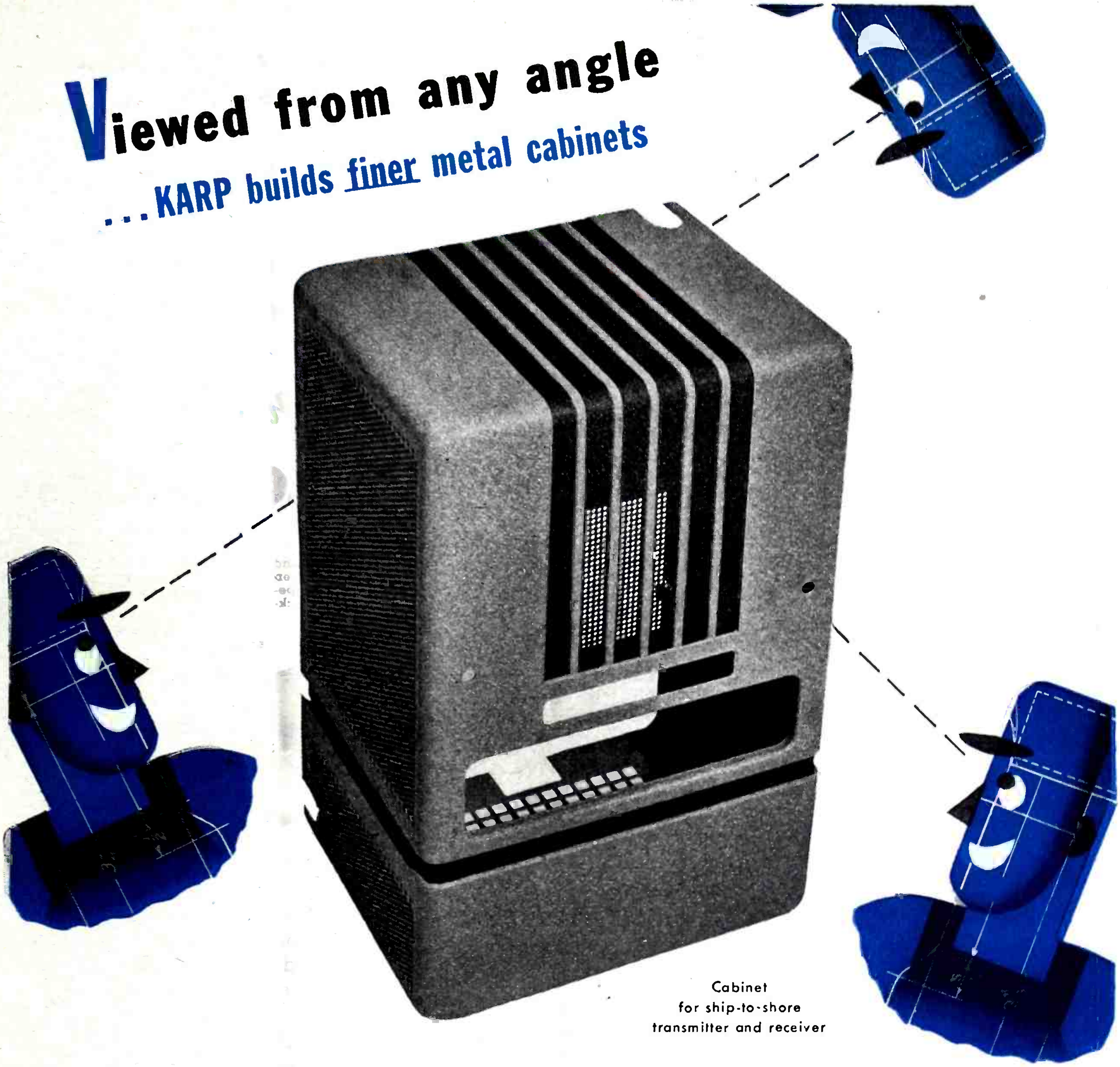



**write for Catalog #156.**

*OVER 26 YEARS OF PIONEERING IN TUNGSTEN METALLURGY*

# Viewed from any angle

## ...KARP builds finer metal cabinets



Cabinet
for ship-to-shore
transmitter and receiver

No matter how you look at it, you'll find many reasons why Karp-built cabinets, housings and enclosures will add value to completed equipment assemblies.

We will follow your designs with fidelity, or our design specialists can suggest design ideas which will enhance appearance, achieve ruggedness, save space or weight. Our work insures uniformity and accuracy—which mean production economy both in the fabrication and in your own assembling operations.

At your service is our staff's combined "know-how" gained in 22 years of specialization. Our tool and die department is so complete that we often save customers special die costs. We make our own dies and do all our own finishing. We do all kinds of welding—including spot-welding of aluminum with electronic timing controls.

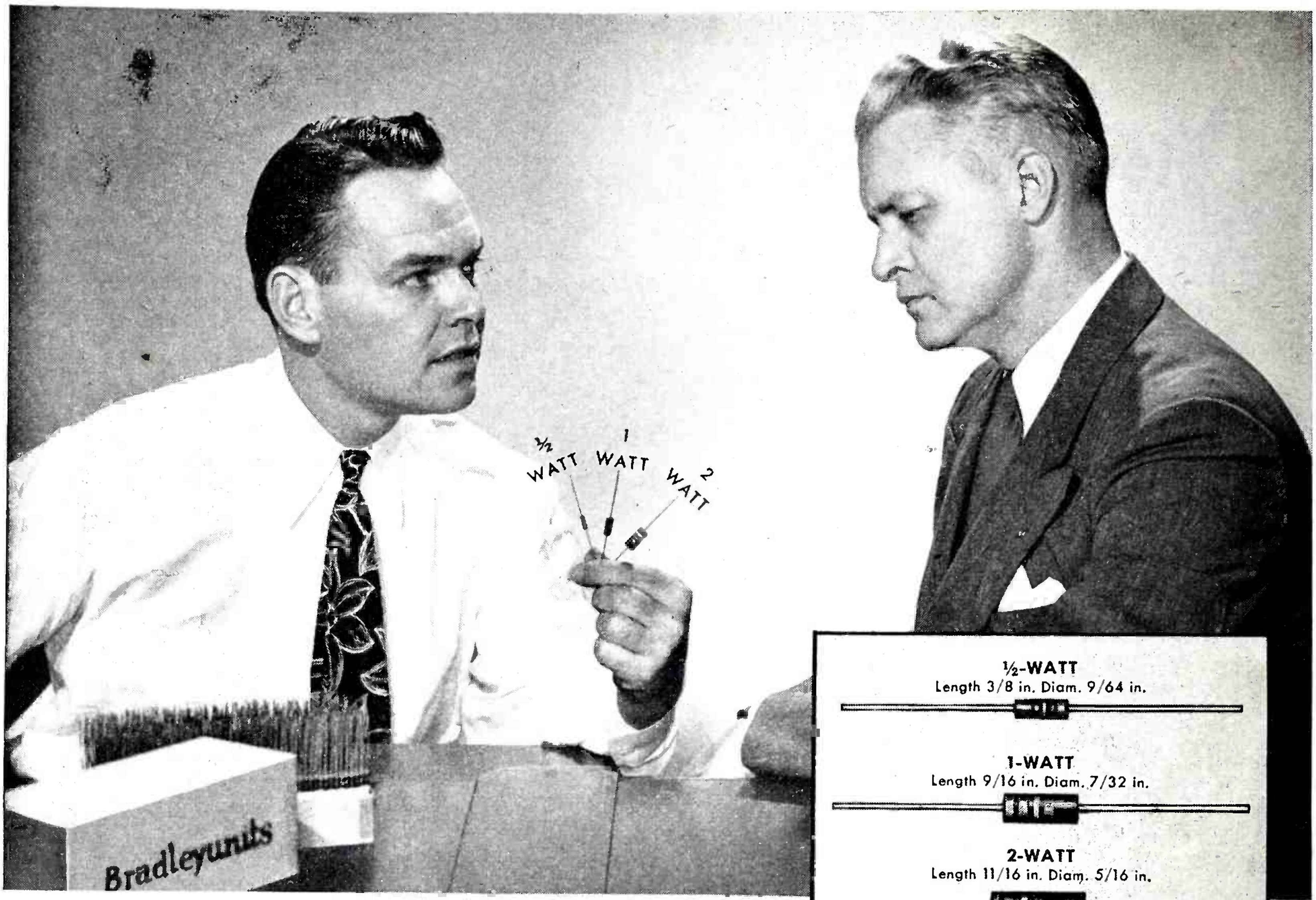
It's the hard-to-do type of craftsmanship that brings out the best in our trained minds and skilled hands. We invite your inquiries on any sheet metal fabrication.

***Any Metal • Any Gauge • Any Size***
***Any Quantity • Any Finish***

# KARP METAL PRODUCTS CO., INC.

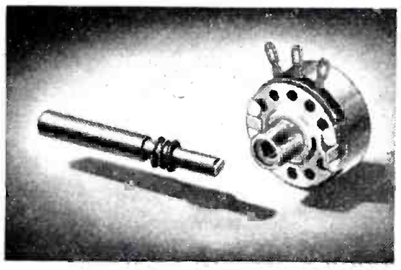
124 - 30th STREET, BROOKLYN 32, NEW YORK

*Custom Craftsmen in Sheet Metal*



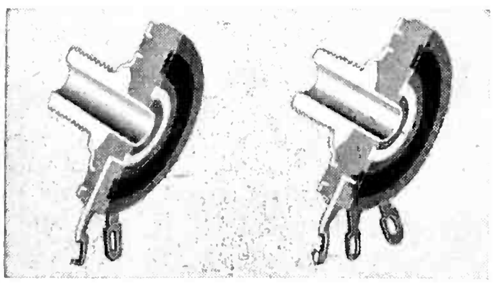

# *Small Size—Big Wattage Capacity*

## . . . and rated at 70 C Ambient Temperature



TYPE J BRADLEYOMETERS
provide any resistance-rotation curve

The resistor element is a solid-molded ring. During manufacture, the material is varied to provide any resistance-rotation curve. The one-piece element with imbedded terminals is permanent in shape and performance. Send for data sheet.



Fixed resistors are usually rated at ambient temperatures of 40 C. But Bradleyunit fixed resistors are rated at 70 C.

At this high temperature, Bradleyunits . . . in ½-watt, 1-watt, and 2-watt ratings . . . operate at full rating for 1000 hours with a resistance change of less than 5 per cent. All three sizes are offered in standard R. M. A. values from 10 ohms to 22 megohms, inclusive.

Bradleyunit resistors require no wax impregnation . . . yet they pass salt water immersion test. The solid molded construction assures high mechanical strength and permanent electrical characteristics. War time uses proved that Bradleyunits withstand wide variations in temperature and humidity. Send for resistor data sheets. Allen-Bradley Co., 110 W. Greenfield Avenue, Milwaukee 4, Wisconsin.

A-B

# ALLEN-BRADLEY

**FIXED & ADJUSTABLE RADIO RESISTORS**

QUALITY


# EAD MOTORS

## *A Dependable* CONTROL DEVICE *and* POWER SOURCE

*For Prompt Service*

**CONTACT THESE EAD REPRESENTATIVES**

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P. O. Box 108
South Gate, Calif.
Tel: Kimball 7244

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Tel: Ma. 0343

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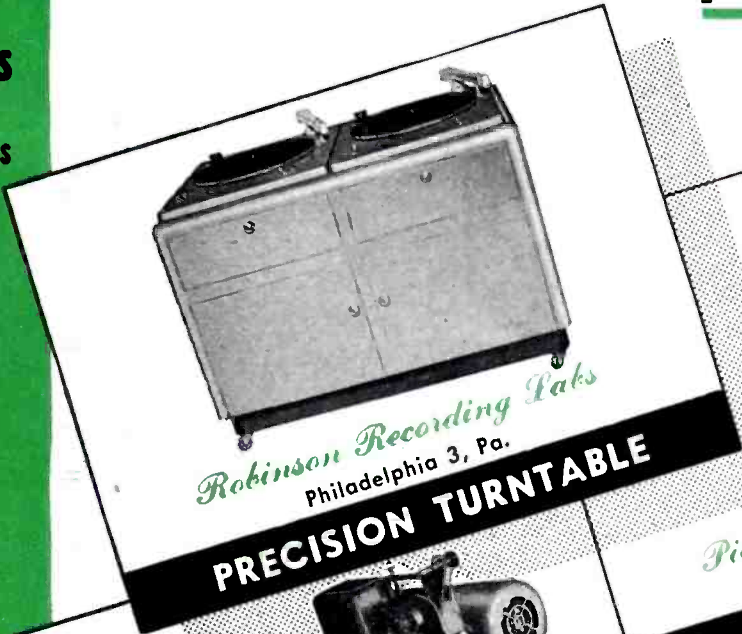
**AIRPARK CORPORATION**
412—5th Street, N.W.
Suite 501
Washington, D. C.
Tel: National 4642






E.A.D. MOTORS have found particular acceptance in a variety of applications, including such devices as recorders and projectors. They are dynamically balanced, resulting in a minimum of noise and vibration. They give smooth-running, quiet, constant speed performance. Replaceable "capsule" sleeve bearings with their large oil reservoirs and snap ring construction for rapid disassembly make for ease of maintenance and long operating life. Let us fit an E.A.D. Motor to your application.

| TYPE NO. | TYPE | H.P. | SPEED |
|---|---|---|---|
| L731HC-2 | CAPACITOR (Start & Run) | 1/20 | 1600 |
| KS73MCJ-1 | SYNCHRONOUS Capacitor (Start & Run) | 1/40 | 1800 |
| L73P-1 | CAPACITOR (Start & Run) | 1/75 | 1600 |

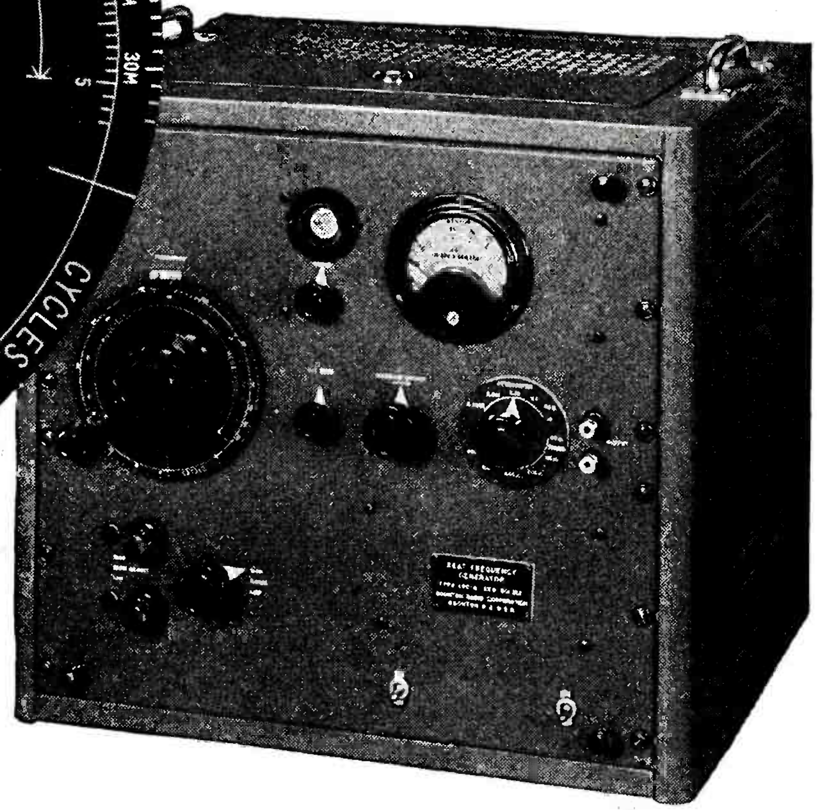
**EASTERN AIR DEVICES, INC.**

**585 Dean Street • Brooklyn 17, N. Y.**


# ENGINEERED FOR EASE OF OPERATION AND ADJUSTMENT

## THE BEAT FREQUENCY GENERATOR

*TYPE 140-A*



### AN IMPORTANT FEATURE

**of this instrument is the large dial scale which has been planned for maximum readability and rapid setting—the overall dial scale length from 20 cycles to 5 megacycles exceeds 22 inches. The low frequency scale overlaps the high frequency scale at 30 kc, permitting continuous frequency coverage over the entire audio spectrum without bothersome range switching.**

One of the most valuable instruments in the laboratory is a generator of signal voltage. Boonton Radio Engineers in designing the Type 140-A Beat Frequency Generator have provided an instrument of wide frequency coverage, capable of supplying accurate output voltages ranging from several microvolts to 30 volts and having a variety of output impedances from 20 ohms to 1000 ohms.

A 1-inch cathode ray tube has been provided to standardize the low frequency range against the power line frequency and to allow multiples of this frequency to be set with excellent accuracy by means of the cathode ray tube pattern.

An output attenuator having five decimal steps permits accurate setting of voltages as little as 1 millivolt. Engineers making gain or sensitivity measurements will particularly appreciate this feature.

**FREQUENCY RANGE:** 20 cycles to 5 megacycles in two ranges. Low range: 20 to 30,000 cycles. High range: 30 kc to 5 megacycles.

**FREQUENCY CALIBRATION:** Accuracy ±2 cycles up to 100 cycles, ±2% above 100 cycles.

**STABILITY:** About 5 cycles drift below 1000 cycles. On low range, drift becomes negligible percentage with increasing frequency. On high range, drift is 3% or less.

**ADJUSTMENT:** High and low ranges have individual zero beat adjustments. Low range may be checked against power line frequency with front panel 1-inch cathode ray tube.

**OUTPUT POWER AND IMPEDANCES:** Rated power output: One watt, available over the low frequency range from output impedances of 20, 50, 200, 500, 1000 ohms, and over both high and low frequency ranges from an output impedance of 1000 ohms.

**DISTORTION:** 5% or less at 1 watt output, 2% or less for ½ voltage output.

**VOLTMETER ACCURACY:** ±3% of full scale reading.

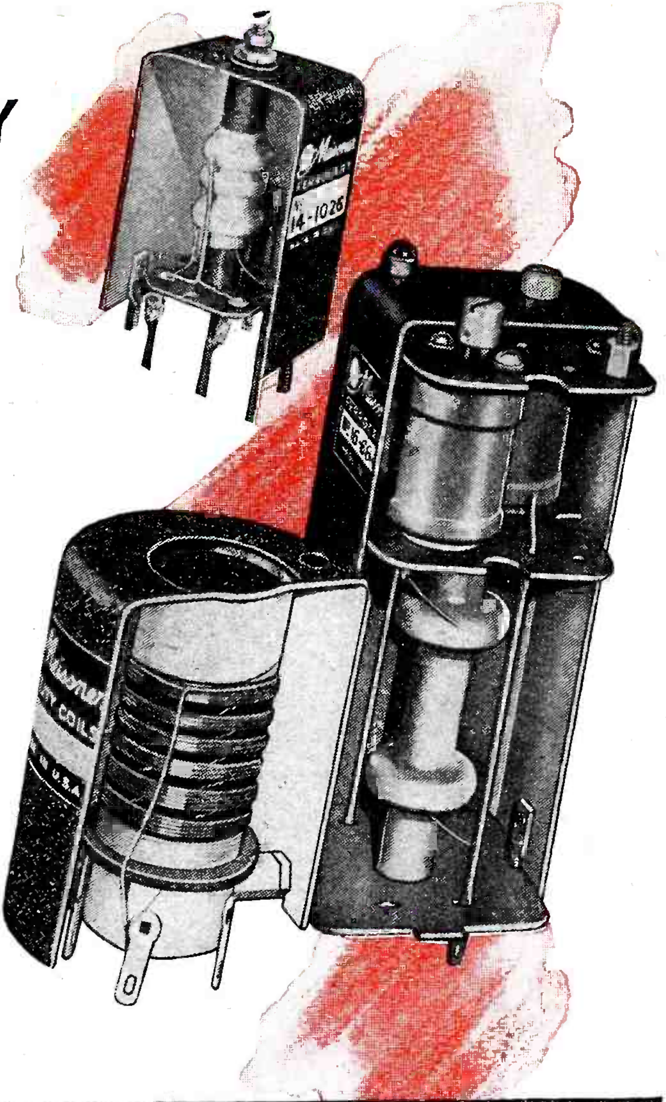
*Write for Catalog "D"*

**BOONTON RADIO Corporation**
BOONTON · N·J · U·S·A·

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

# MEISSNER

## FOR TWENTY-FIVE YEARS THE STANDARD OF COIL QUALITY




For over a quarter century the name Meissner has stood for the finest in electronic equipment. Founded in 1922 by the late William O. Meissner (famous for his outstandingly successful inventions in communications and electronics) this company has been the source of many new developments in the radio field.

First to build a complete line of jobber coils; first to design and build plastic IFs and to introduce Ferrous IFs, Meissner has long led in the development of fine coil equipment for every application. A pioneer in FM (holding the second license issued in this country) Meissner was also the first to manufacture radio receiver kits. The Meissner Signal Shifter is still the Number 1 requirement for the complete ham shack and the Meissner Analyst has saved thousands of man-hours for servicemen everywhere.

Today Meissner's original policy of aggressive research and development remains unchanged. Strengthened by 25 years of electronic manufacturing experience it is your guarantee of product quality . . . an assurance of perfect performance under all conditions.


MEISSNER MOUNT CARMEL, ILLINOIS

ELECTRONIC DISTRIBUTOR AND INDUSTRIAL SALES DEPARTMENT
**MAGUIRE INDUSTRIES, INC.**
936 N. MICHIGAN AVENUE
CHICAGO 11, ILLINOIS

*Meissner*

EXPORT SALES DIVISION, SCHEEL INTERNATIONAL INCORPORATED
4237-39 N. LINCOLN AVENUE, CHICAGO 18, ILL. CABLE ADDRESS-HARSCHEEL


# *Available*...THE RIGHT G-E THYRATRON for every motor-control application!

**Typical of General Electric's extensive and complete line of thyratrons** are the two tubes shown here—each designed for a specific socket in a motor-control panel, and built to perform its assigned task better and more dependably than another type.

**Why is mercury vapor also needed in a field-control thyratron** with inert-gas content for quick heating? ... Because, due to the high inductive field load, current momentarily flows through the tube after the anode voltage has gone negative. Consequently, at the time the current stops, negative voltage across the thyratron causes bombardment of the metal tube parts by positive gas ions left in the tube. This results in gradual absorption of the gas. *To compensate,* mercury vapor is added as a conducting medium, in the form of a supply that constantly is being replenished from free mercury within the envelope.

**The lower inductive load in armature-control work ordinarily causes minimum gas absorption** ... therefore, a quick-heating thyratron such as the GL-5545, with inert-gas content only, is more efficiently employed for this service than other tubes of similar ratings, by reason of greater compactness of design and smaller over-all dimensions.

**Every requirement of motor-control circuits** now on your drawing-boards, is met by a G-E tube with the correct design and ratings. Nor is this "tailored-to-measure" selection confined to thyratrons! General Electric also builds and supplies the receiving-type tubes needed for your control panels—for example, the 6SN7-GT and 6AQ7-GT for use as d-c amplifiers.

**G-E tube engineers are expert in aiding equipment designers** to choose the tubes that will perform best and most economically in motor-control and other circuits. This friendly service is available to *you* on request! Phone or write your nearest G-E electronics office, or *Electronics Dept., General Electric Company, Schenectady 5, N. Y.*

**RATINGS**

| | GL-3C23 | GL-5545 |
|---|---|---|
| Filament voltage | 2.5 v | 2.5 v |
| current | 7 amp | 21 amp |
| heating time | 15 sec | 60 sec |
| Anode peak voltage, forward and inverse | 1,250 v | 1,500 v |
| peak current | 6 amp | 80 amp |
| avg current | 1.5 amp | 6.4 amp |

**GENERAL ELECTRIC**

162-F4-8850

FIRST AND GREATEST NAME IN ELECTRONICS

# Keep the sparkle in your programs...

## with the New Collins 20T 1 kw AM transmitter

Let the brilliant overtones of high fidelity flow through circuits engineered *for* high fidelity. The 20T development, a new postwar success, reveals in each detail the quality of its design.

**Dual oscillators.** Two temperature-controlled oscillators, adjusted to your operating frequency, are self-contained in the 20T. A selector switch enables you to place the spare unit in operation when you remove the other for maintenance.

**Two cabinets.** Past practice has been to crowd a kilowatt transmitter into a single cabinet. The Collins 20T gives you two cabinets with lots of room, genuine accessibility, ample ventilation, and impressive appearance.

**Program protection *and* circuit protection.** In addition to magnetic circuit breakers and two-shot d-c overload relays, the 20T has high voltage capacitor fusing. Should a capacitor fail, the fuse opens the circuit and a spring bar shorts the capacitor terminals. The transmitter stays on the air and the faulty capacitor is indicated.

**Filament voltage regulator.** For longer tube life, and low noise and distortion levels, the 20T tube filaments have a constant voltage supply.

**Attractive styling.** The cabinets are attractively styled in three-tone gray. Their modern, distinctive appearance, simplicity of design, and pleasing color harmony will give many years of eye appeal and satisfaction.

Eye level metering—centralized controls—motor driven tuning elements—forced air cooling—high safety factors—30-10,000 cps audio response ± 1.0 db—3% audio distortion—minus 65 db noise level.

Only the Collins 20T gives you all these desirable and important features. Deliveries will begin early this year. We suggest you write for detailed specifications, study them, compare them, and then place your order for early delivery. Let us supply your entire equipment needs. You'll have an integrated system that will keep the sparkle in your programs and put a sparkle in your station.

FOR BROADCAST QUALITY, IT'S . . . COLLINS

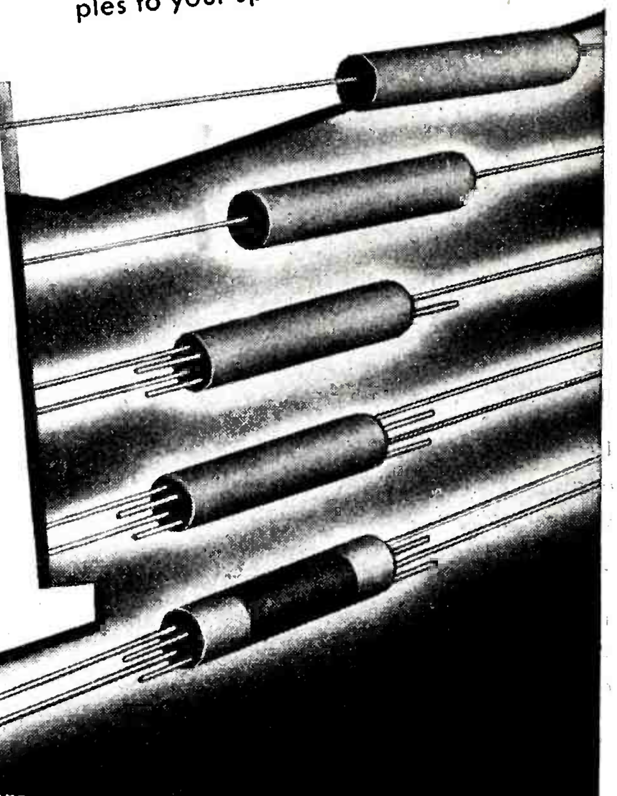
**COLLINS RADIO COMPANY, Cedar Rapids, Iowa**

11 W. 42nd St., New York 18, N. Y. 458 S. Spring St., Los Angeles 13, Calif.

# Improve YOUR Equipment ...Cut Assembly Costs


## ...with STACKPOLE MOLDED COIL FORMS

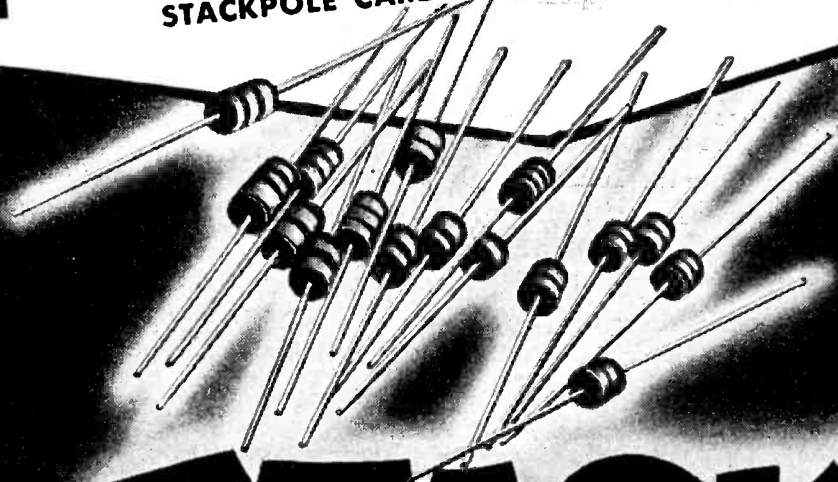
You can save money, speed production and increase the efficiency of your equipment by using Stackpole Molded Bakelite Coil Forms as mechanical supports for coil windings. They take less space and require a third fewer soldered connections. Coils may either be wound directly on the forms or wound separately, then slipped over the forms. Standard types include forms for universal winding, solenoid winding, tapped universal winding, antenna or coupled winding, iron cored universal winding, iron cored I-F transformer or coupled coils and many others. Molded iron center sections can be provided on forms where required. Write for details or samples to your specifications.



## ...with STACKPOLE "GA" LOW-VALUE CAPACITORS

When assembly time is considered, Stackpole GA Midget Capacitors may actually cost less than "gimmicks" formed by twisting insulated wires together —and are *many times* more efficient. Q is much improved, insulation resistance better, breakdown voltage higher, mechanical construction far superior. GA Midgets are sturdily molded. Leads are anchored and tinned. Standard values include 0.68; 1.0; 1.5; 2.2; 3.3 and 4.7 mmfd. Tolerances are ± 20%. Write for details.

*Electronic Components Division*
**STACKPOLE CARBON COMPANY, St. Marys, Pa.**



FIXED and VARIABLE RESISTORS • INEXPENSIVE SWITCHES • IRON CORES • POWER TUBE ANODES • SINTERED ALNICO II PERMANENT MAGNETS • RHEOSTAT PLATES and DISCS • ANODES and ELECTRODES, etc.

# STACKPOLE


# Another use for EDISON sealed-in-glass electrical controls

WHEN Fieldcrest Mills (Division of Marshall Field & Company, Inc.), makers of the famous "Fieldcrest" textiles, decided to add an electrically warmed blanket to their line, they engaged EDISON to engineer and produce in quantity the necessary electrical control. They specified that the control must be simple, silent, smooth, trouble-free, and rugged.

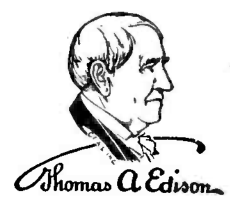
Edison met the specifications with a sealed-in-glass electrical control especially designed for the automatic regulation of blanket warmth.

**Simple, Silent, Smooth**

The EDISON sealed-in-glass electrical control for "Fieldcrest" thermostatic blankets has few component parts . . . it's *simple!* It doesn't buzz or click . . . it's *silent!* It has a small on-off differential . . . it's *smooth.* It's *trouble-free* because the sealed-in-glass principle prevents corrosion . . . keeps out dust and dirt. It's *rugged* and consistent in operation.

**Have YOU a Problem EDISON Sealed-in-Glass Controls Can Solve?**

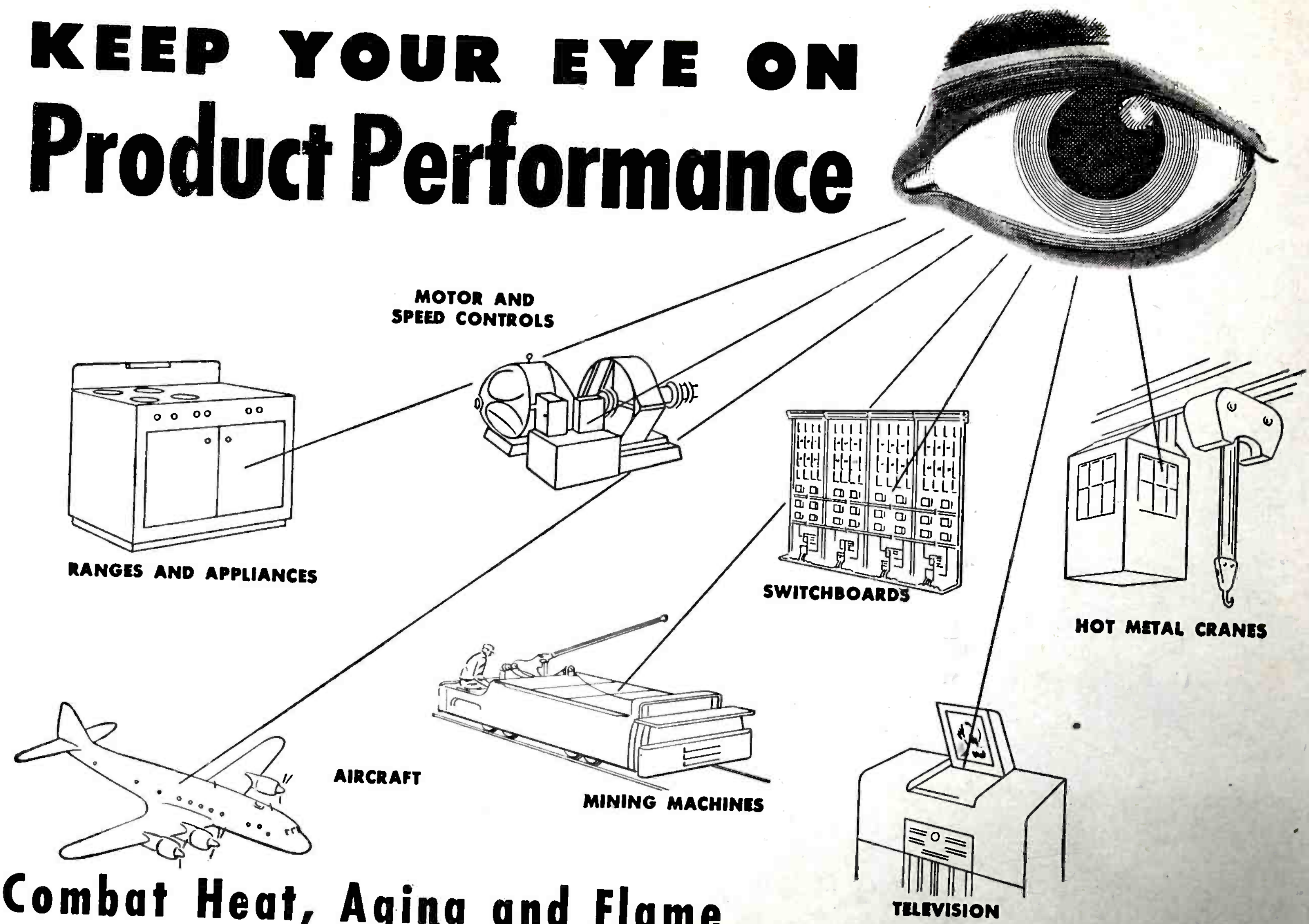
Your electrical control problem may be quite different. Possibly it has to do with current limiting, voltage control, or cathode protection. Whatever it is, if you need cooperation in the engineering and quantity production of sealed-in-glass controls, let's discuss your problem.




**THOMAS A. EDISON, INCORPORATED**
**INSTRUMENT DIVISION**
**27 Lakeside Avenue, West Orange, New Jersey**

**EDISON** Sealed-in-glass electrical controls

# KEEP YOUR EYE ON
# Product Performance




## Combat Heat, Aging and Flame with Rockbestos Wires and Cords

With every flick of the switch your products go on trial. If they continue to "work" *regardless of conditions* they sell themselves and help increase business. But every time they fail to operate they create dissatisfied customers and pile the expense of repairs, servicing or replacement on decreasing sales.

Protect your product's performance and maintain customer satisfaction by wiring with Rockbestos wires, cables and cords. They are *permanently insulated* with impregnated felted asbestos to prevent failure . . .

They won't bake out, crack or flow under high operating or ambient temperatures . . .

They won't rot, bloom or swell when in contact with oil, grease or corrosive fumes . . .

They withstand conductor-heating overloads without baking brittle . . .

They give a high degree of wire-fire protection because they won't burn . . .

They won't deteriorate under oxidation or with age . . .

They provide greater current carrying capacity through high heat resistance.

These reputation-protecting characteristics are built into 125 different standard Rockbestos constructions. Use them to guarantee dependable, long-range performance of radios, ranges, motors, cranes, electronic calculators and controls, or whatever you manufacture. For a catalog write to:

**ROCKBESTOS PRODUCTS CORPORATION**
**447 Nicoll Street, New Haven 4, Conn.**

PERMANENTLY INSULATED WIRES AND CABLES ROCKBESTOS

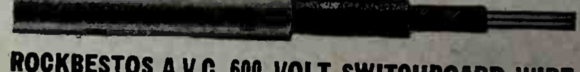
# ROCKBESTOS
### *The Wire with Permanent Insulation*

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO PITTSBURGH
ST. LOUIS LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

*A few of the 125 permanently insulated wires, cables and cords developed by Rockbestos.*

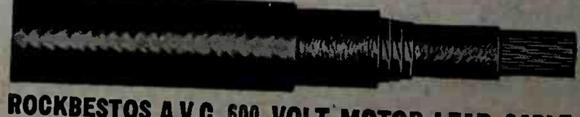
**ROCKBESTOS FIREWALL RADIO HOOKUP WIRE**

This heat, flame and moisture resistant wire, insulated with high-dielectric synthetic tapes and impregnated felted asbestos and covered with color-coded lacquered glass braid, may be run *continuously* at its maximum operating temperature of 125° C. without baking out. It is widely used in airborne, ground, marine and mobile communications systems, electronic devices and compact apparatus in which dependable performance is essential. Also ideal for small motor, coil, transformer and dynamotor leads. Sizes No. 22 to 4 AWG in 1000 volt rating and 12, 14 and 16 AWG in 3000 volt — also in twisted pair, tripled, shielded and multi-conductor constructions.



**ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE**
(National Electrical Code Type AVB)

This wire was designed to make complicated wiring jobs permanent. The impregnated felted asbestos wall beneath the flameproofed cotton braid is heat, flame and moisture resistant and assures fine appearance of boards as it gives on bends to prevent braid cracking. Sizes 18 to 4/0 AWG with solid or stranded conductors in black, grey or colors. Rockbestos A.V.C. Hinge and Bus Cable have the same characteristics.



**ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE**
(National Electrical Code Type AVA)

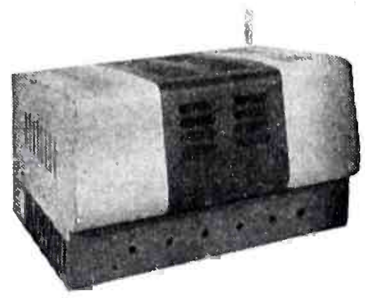
Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture. Sizes No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

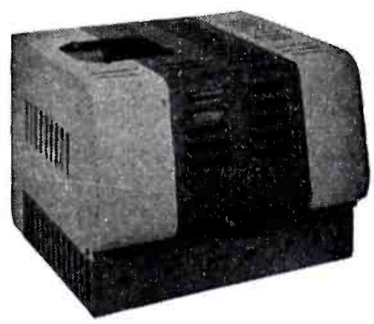

# TO EACH CUSTOMER FOR HIS SPECIFIC NEEDS

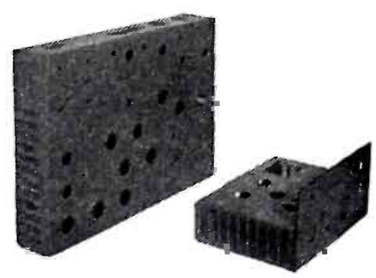
Unusual resistance to abrasion? High dielectric strength? Insurance of uninterrupted service in telephone communications? Each reel of Ansonia Ankoseal holds wire or cable earmarked for applications where it will do the best possible job. Our engineers can solve your cable problems.

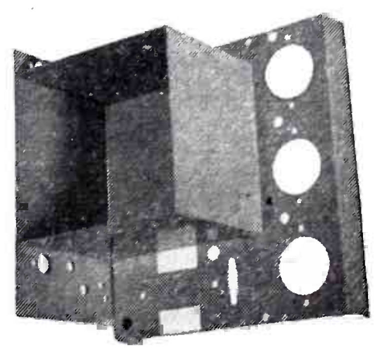

**THE ANSONIA ELECTRICAL DIVISION**
**ANSONIA, CONNECTICUT** *of*

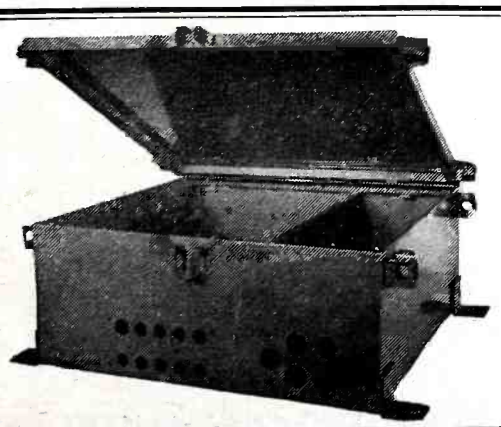
**NOMA ELECTRIC CORPORATION**

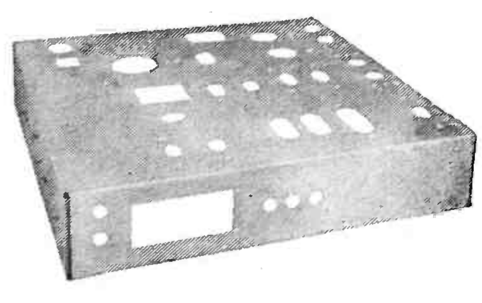


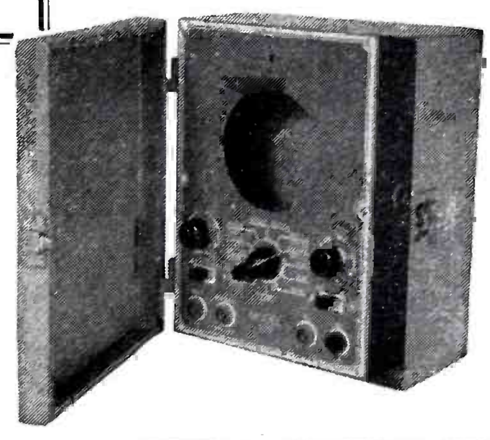


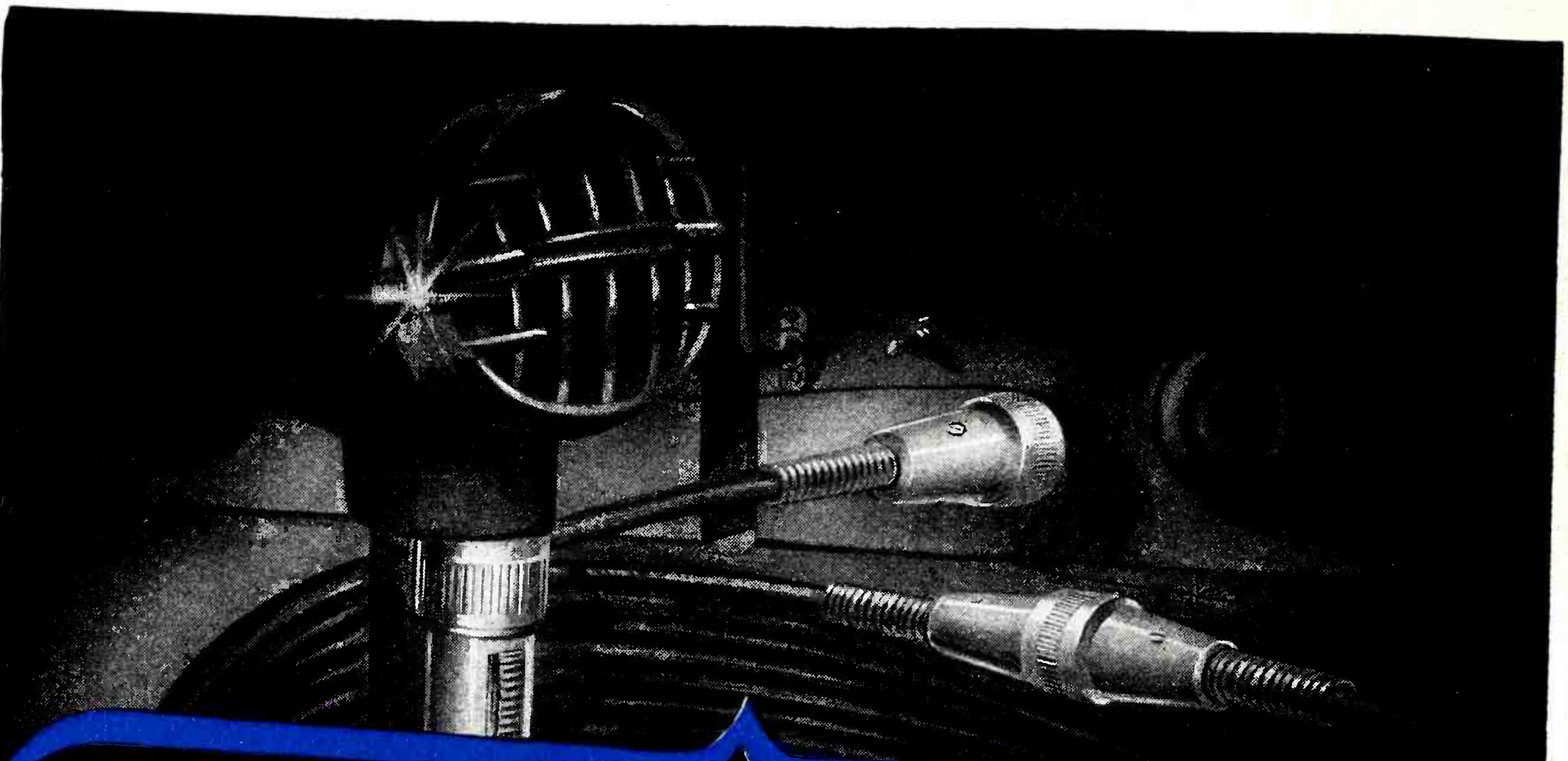












# LOWEST LOSS from Microphone to Chassis with Amphenol Connectors and Cables

Rated high in dielectric value, and with an improved power factor, Amphenol low-loss Microphone Connectors and Cables insure maximum efficiency in sound equipment. Dependable and easy to install, they are widely used by leading manufacturers of sound equipment apparatus, photo electric devices, home recorders and a complete range of similar items.

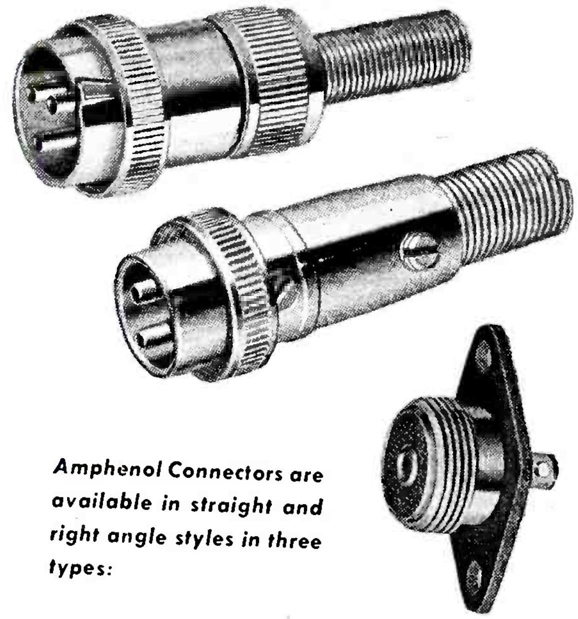
The Amphenol line is precision-built, compact, lightweight and complete. Microphone plugs, mating connectors and receptacles have unbreakable, chromium-plated brass shells and low-loss bakelite inserts. Cord protectors or cable clamps relieve strain on contacts. Threaded coupling rings screw onto mating coupling threads to provide "yank-proof" connections that are free from noise, leaks or shorts. Accidental disconnects are impossible. Multi-contact connectors are polarized.

**AMPHENOL MICROPHONE CABLES** are unusually low in capacitance for their small diameters.* Light in weight, their durable plastic jackets remain flexible down to —40° F. May be used with standard connectors and cord protectors.

Cables are available in either of two plastic jackets: Vinyl, for heavy auditorium and outdoor use where cables are long and the trampling of crowds is a factor; polyethylene for home and cocktail lounge applications.

Write today for new booklet describing Amphenol Microphone Connectors and Cables.

*Capacitance per foot ranges from 20 mmf. for Amphenol No. 21-120 (.242" diam.) to 35 mmf. for 21-156 (.155" diam.).



*Amphenol Connectors are available in straight and right angle styles in three types:*

**SERIES 91:** Three and four contact microphone style, used on all types of portable apparatus. Since 1934, the standard of the sound industry.

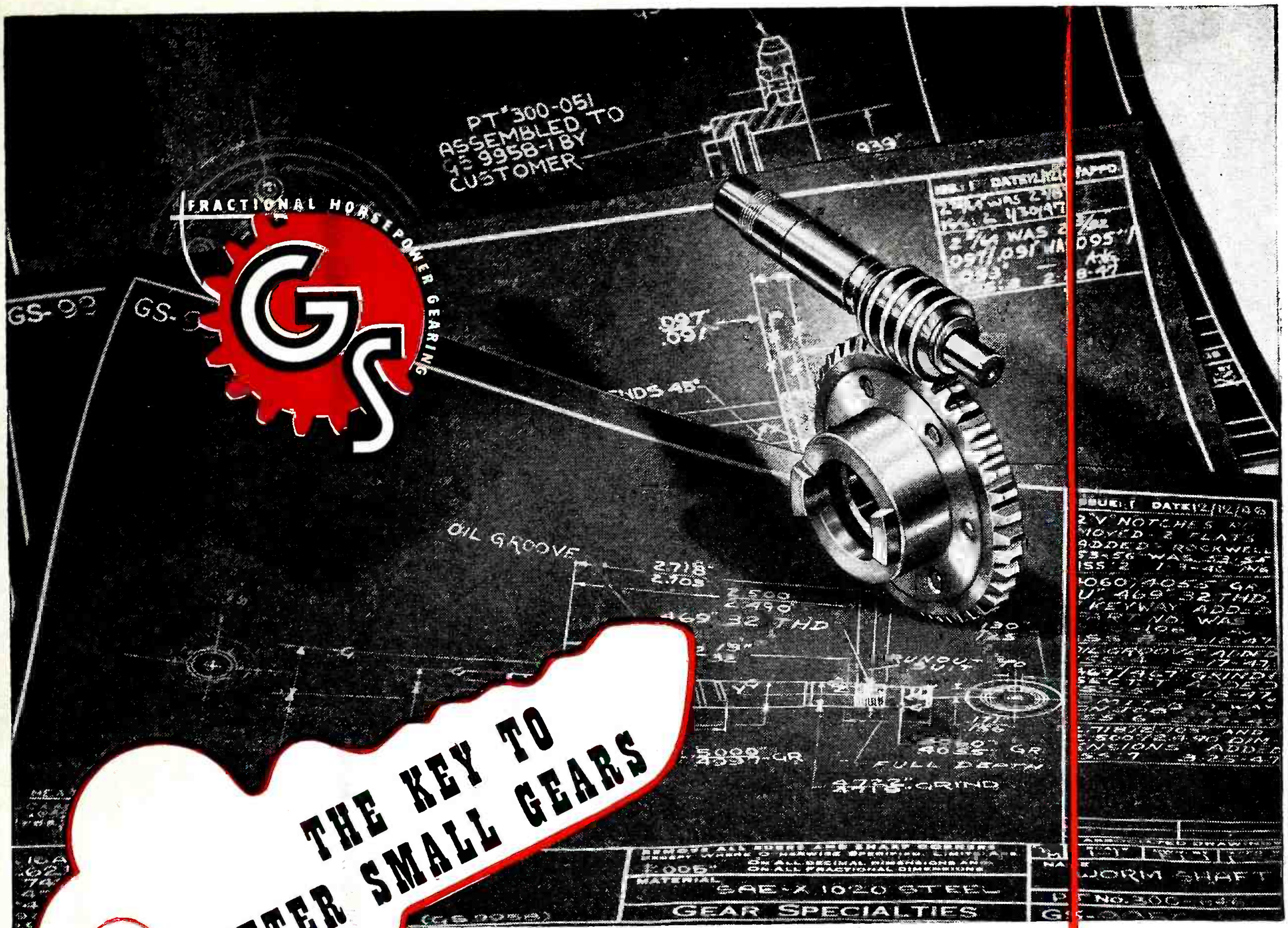
**SERIES 80:** For standard single and two wire shielded cables such as: coaxial and microphone cables, twisted pairs, concentric lines, photo cell leads, etc.

**SERIES 75:** For standard single conductor shielded cable. Widely used in amplifiers, transmitters, photo electric devices, home recorders and similar equipment.

**AMERICAN PHENOLIC CORPORATION**
1830 South 54th Avenue • Chicago 50, Illinois

AMPHENOL

COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS RADIO COMPONENTS • PLASTICS FOR ELECTRONICS




# THE KEY TO BETTER SMALL GEARS

Open the way toward getting UNIFORMITY in the Small Gears you buy! G.S. precision methods and machinery offer you the key to all that is newest and best in Fractional Horsepower Gear manufacture. Here, you'll get the friendly cooperation of *experts* . . men who have devoted a lifetime to the design and quantity production of *Small Gears exclusively.* Here, too, is every device known to modern science for producing gear after gear . . whether it's one hundred or one hundred THOUSAND . . to a degree of uniform accuracy heretofore considered impossible! If a Fractional Horsepower Gear is involved, by all means discuss its design and its function with a G.S. engineer. Get valuable information and cost estimates without cost or obligation. Discover for yourself why "G.S." has become the "WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS"!

**SEND FOR . .**

*the G.S. 4-page Bulletin which illustrates and describes many different types and applications of G.S. Small Gears. Will you ask for a copy on company stationery, please?*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WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

# *Arnold presents:*

CAST ALNICO I

CAST ALNICO II

CAST ALNICO III

CAST ALNICO IV

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CAST ALNICO XII

**SINTERED ALNICO**

*another step towards a complete line of permanent magnet materials .....*

## SINTERED ALNICO

In general SINTERED ALNICO MAGNETS do not compete with, but rather supplement, magnets produced by the cast method to widen the scope of potential permanent magnet applications.

Alnico magnets weighing roughly one ounce or less should be produced by the sintered method.

Heavier magnets of more intricate shapes can be produced. For some applications Sintered magnets are more economical because:

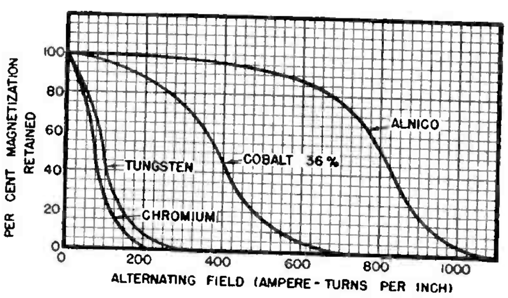
1. Magnetic characteristics are practically the same as Cast Alnico.
2. Sintered Alnico is a fine-grain, homogeneous material which has more uniform flux density, is easier to grind, and provides better surface finish.
3. Sintered Alnico magnets can be produced to closer dimensional tolerances:

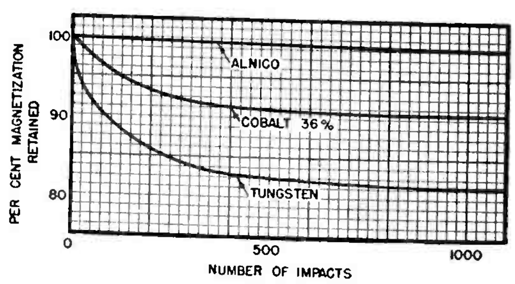
| SINTERED ALNICO II | CAST ALNICO II |
|---|---|
| 0.000 to 0.125 — + .005 | 0.000 to 2.00 — ± 1/64 |
| 0.126 to 0.625 — + .010 | 2.0 to 4.0 — ± 1/32 |
| 0.626 to 1.250 — + .015 | 4.0 to 6.0 — ± 3/64 |
| 1.251 to 3.000 — + .062 | |

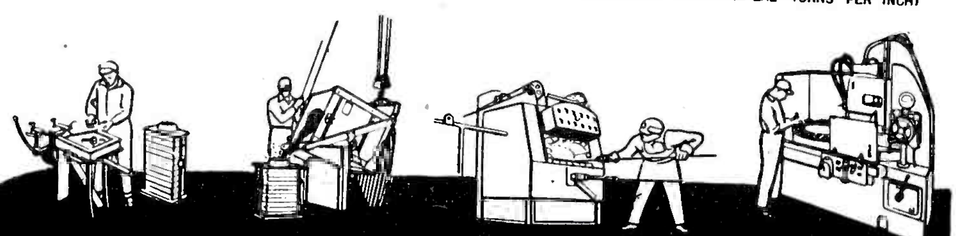
   Grinding can in many applications be eliminated.
4. More intricate shapes, including holes, inserts, etc., are more feasible.
5. Transverse modulus of rupture is several times greater.

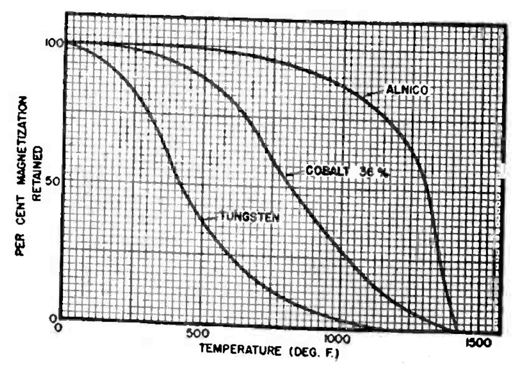
All Alnico, and particularly Sintered magnets, have very high values of Coercive Force (which is the capability of resisting demagnetization or loss of magnetism due to stray fields and from heat and vibration).

The curves show roughly the effect of these demagnetization factors on Alnico compared to other alloy steels.





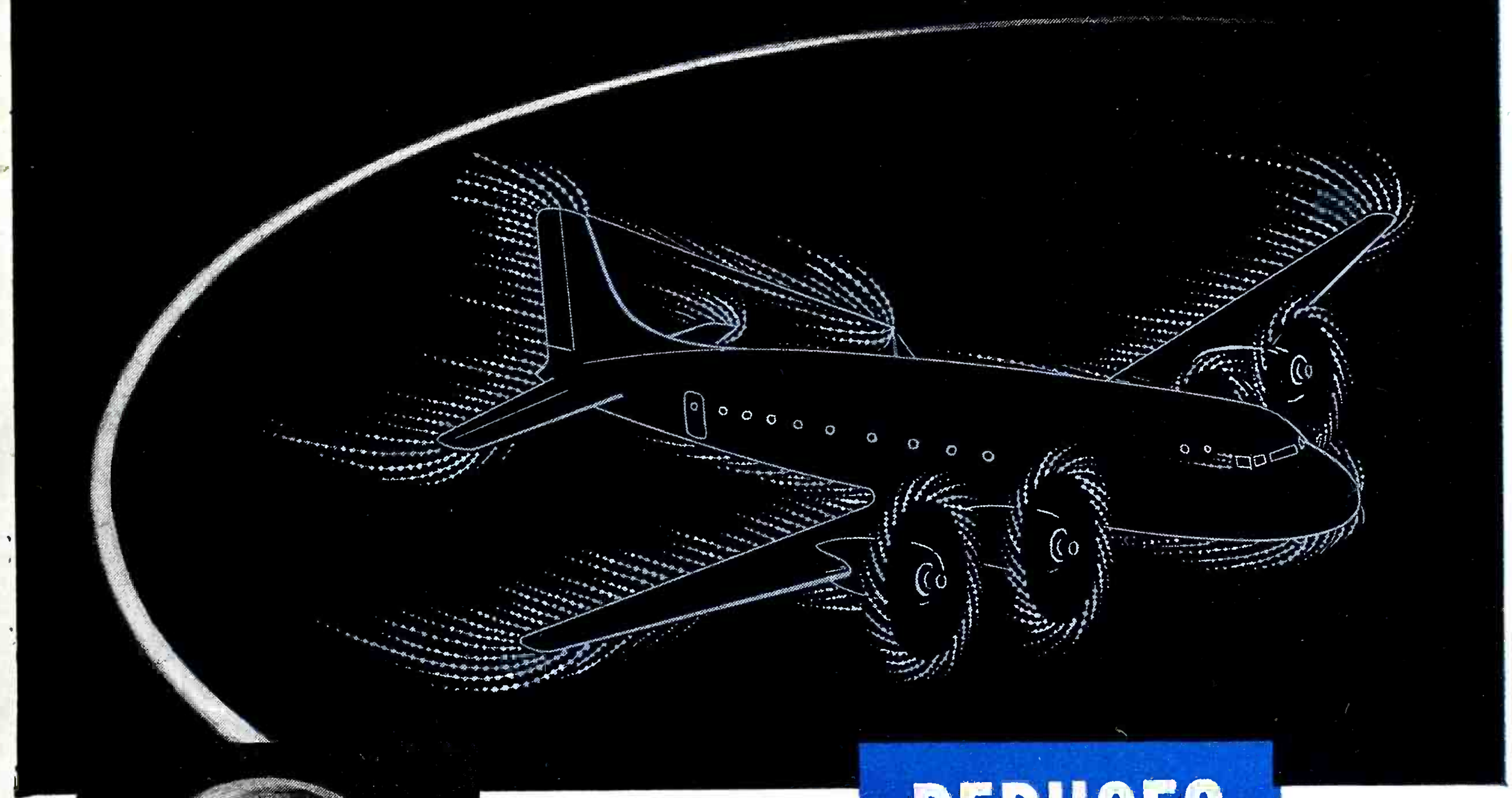

**THE ARNOLD ENGINEERING COMPANY**

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

*Specialists in the manufacture of PERMANENT MAGNET MATERIALS*

# Federal's Aircraft Antenna Wire



## REDUCES

## PRECIPITATION STATIC


### WHAT IS PRECIPITATION STATIC?

To the pilot, it's the ear-splitting noises he hears on his radio — frying sounds, intermittent crackling, moans and shrieks. It is caused by corona discharge (St. Elmo's Fire) of static potentials accumulated on a plane flying through rain, snow or dust, or near charged clouds — via protuberances on the aircraft surfaces including exposed antenna wires. This corona discharge is sometimes visible as a bluish halation radiating from the extremities of the plane, and it is the discharge *from the antenna* that is the first source of radio interference.

HERE'S A PRACTICAL, low-cost means of reducing precipitation static, a major flying hazard because it strikes when radio aids are needed most — in bad weather.

Working in close cooperation with the U. S. Army Air Technical Service Command and U. S. Navy, Federal has developed and perfected a quality *insulated* antenna wire which, together with proper antenna hardware, reduces precipitation static. This wire, Intelin Type K-1064, AN designation WS-5/U, has proved highly effective in actual service on U. S. Army and Navy planes. As a result of this service experience it has been adopted widely by the domestic airlines, and is now available for use on privately owned aircraft.

The copperweld conductor gives high tensile strength, and the durable, weather resistant polyethylene insulation assures long service life, even under the most severe conditions. Federal's Aircraft Antenna Wire can be obtained in the Type K-1064, designed to U. S. Army and Navy Specifications. For information, write today to Dept. D713.

### DATA

Federal's Intelin High-Strength Aircraft Antenna Wire Type K-1064

**OUTSIDE DIAMETER**

| | Conductor | Insulation |
|---|---|---|
| Nominal | 0.0508″ | 0.183″ |
| Minimum | 0.0498″ | 0.178″ |
| Maximum | 0.0518″ | 0.188″ |

**MATERIALS**

Conductor — #16 AWG H.S. Copperweld (30% Conductivity)

Insulation — Polyethylene (semi-transparent)

**TENSILE STRENGTH**

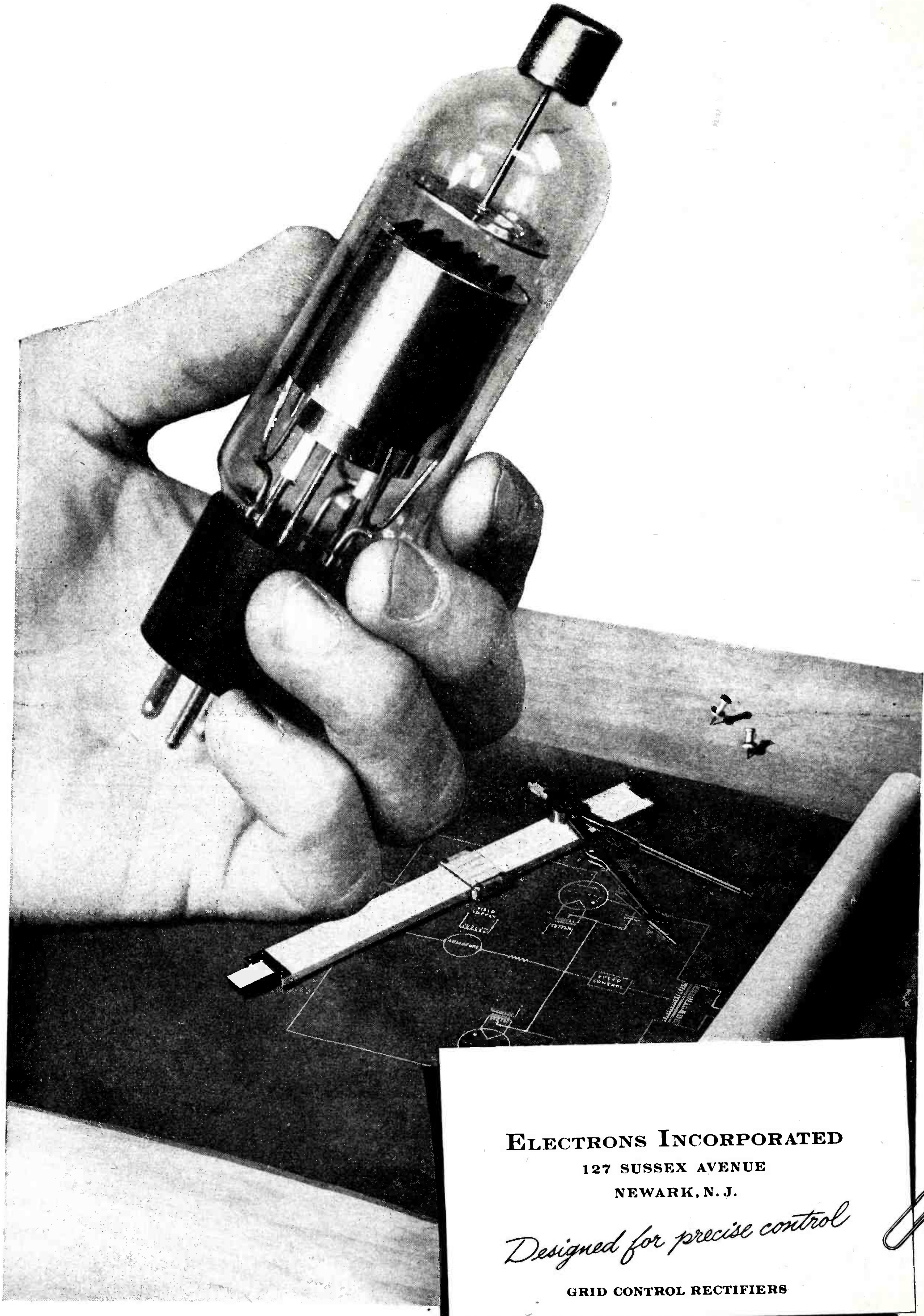
127,000 psi minimum

## *Federal Telephone and Radio Corporation*

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N.Y.C.

AN IT&T ASSOCIATE — FEDERAL TELEPHONE & RADIO FTR

Newark 1, New Jersey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127 SUSSEX AVENUE
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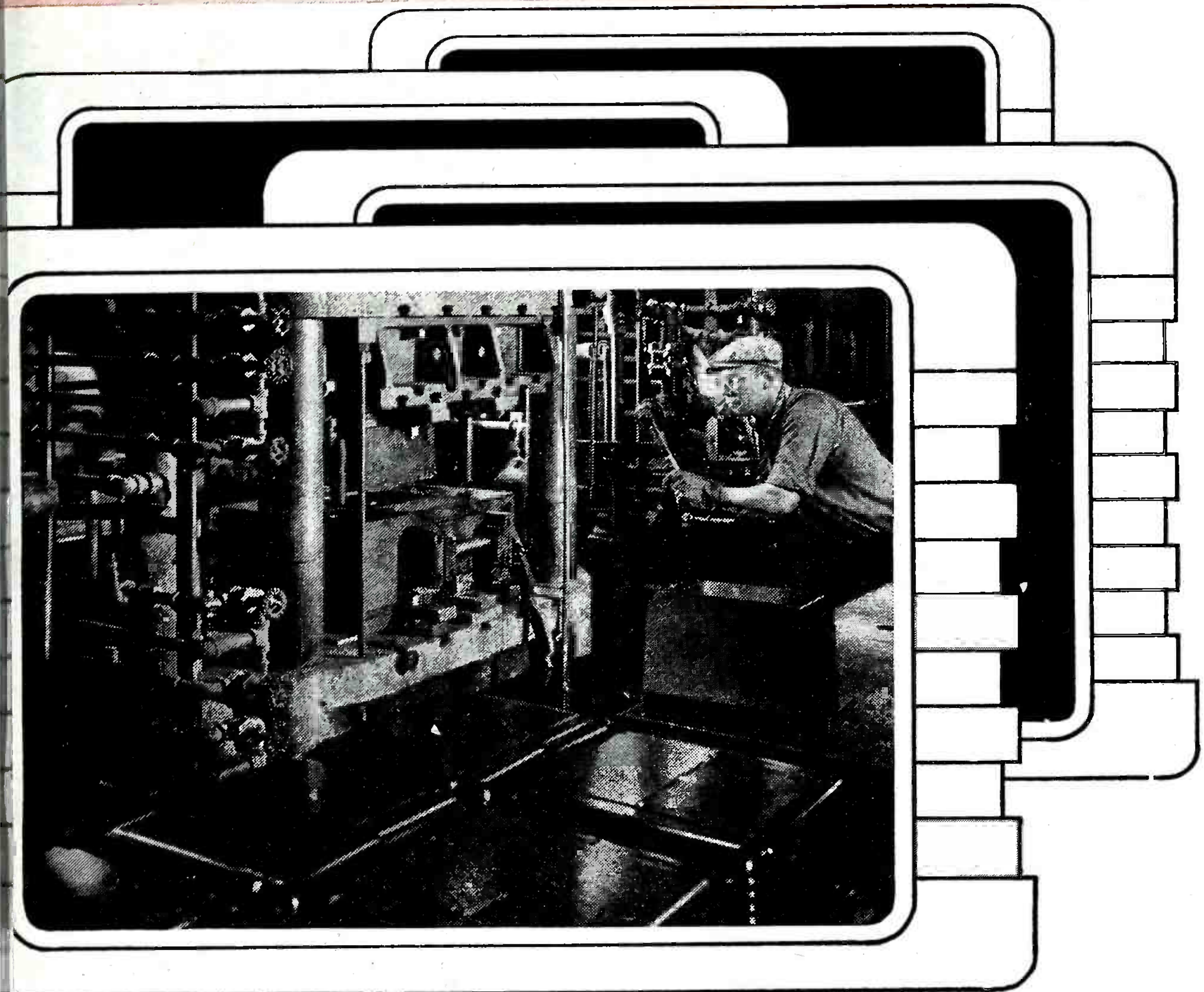
Designed for precise control
GRID CONTROL RECTIFIERS

*RICHARDSON MEANS *Versatility* IN PLASTICS



ther SHOT... Another MOLDED PART

...PERFECT as the ONE BEFORE!

Plastic molding is an art in itself... a skill which cannot be learned in a day. Richardson Plasticians have spent years acquiring the degree of knowledge necessary for this exacting work.

The result is obvious to any Richardson customer. For he sees that to mold correctly... is to mold uniformly. *And that means control every step of the way.*

**That kind of control means:**

*Designing cavities so material will properly fill.*

*Building molds with correct shrinkage allowances.*

*Know-how and facilities to mold Beetle, Bakelite, Plaskon, Tenite, Styron, Durez and many more.*

*Careful attention to a hundred other details.*

**INSUROK** *Precision Plastics*

*RESEARCH
*...a continuous transformation of possibilities into practical ideas in plastics.*

*DESIGNING
*... Artistic visualization. Creative engineering. Practical planning for efficient plastics production.*

*PRODUCTION
*... Complete machine shop facilities for manufacturing our own dies, molds, tools.*

*LAMINATING
*... Sheets, rods, tubes. Standard NEMA grades; over 100 special grades.*

*FABRICATING
*... Complete equipment for drilling, punching, sawing, turning, milling, etc.*

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Factories: MELROSE PARK, ILL. • NEW BRUNSWICK, N. J.

# FM station contro

Accurate indication of station performance with the new G-E FM Station Monitor, simplified station control with the new G-E Control Console — here are important General Electric contributions designed to help keep your station performance at top efficiency. For the facts about these important units—call your G-E broadcast sales engineer or write to *Electronics Department, General Electric Company, Syracuse 1, N. Y.*

## WITH THE NEW G-E FM STATION MONITOR TYPE BM-1-A


*For your FM Carrier.*

**General Electric FM Station Monitor type BM-1-A as mounted in Audio Rack FA-8-A**

Better station operation begins with *accurate* measurements. General Electric, pioneer designer of FM monitors, announces the BM-1-A—the new FM monitor that meets *all* FCC requirements for measuring *all* FM transmitter functions.

- **Center frequency indicator.** Direct-reading instrument measures carrier frequency over ±3000 c-p-s range, with or without modulation.
- **Modulation indicator.** Two-scale, direct-reading instrument shows frequency swing. Percentage scale, 0 to 133 percent. Decibel scale, −20 to +3 db range.
- **High-fidelity audio monitor.** Two volts output into 600-ohm balanced line. Frequency characteristic follows standard de-emphasis curve within ±0.5 db between 50 and 15,000 cps.
- **Over-modulation flasher.** Front panel control adjustable to indicate peaks exceeding any value between 50 and 120 per cent modulation.
- **Transmitter "proof-of-performance".** 20-volt high impedance audio output with less than 0.25 per cent distortion and noise level approximately 75 db below full modulation level. Will operate commercial distortion meters for FCC tests.
- **R-f input level indicator.** Approximately 1.0 watt in 50-ohm line, with indicator to show correct level.
- **Illuminated meter scales.**
- **Easy-to-get-at.** Hinged front panel provides ready accessibility.
- **Ready to operate.** Connect it to your transmitter. Plug it into your 115-volt, a-c line.
- **FCC approved.**

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

**GENERAL ELECTRIC**

160-E10-8814

# ...t a glance!

*For your FM or AM Transmitter*

**The G-E Desk-Top Control Console that *every* station can afford, type BC-3-A**

# WITH THE NEW G-E DESK-TOP CONTROL CONSOLE TYPE BC-3-A

Flexible and compact, equipped with every mixing and switching facility required by the modern broadcast station—FM or AM—the new G-E Control Console centralizes all major station functions under instantaneous finger-tip control.

- Control provisions for 2 local turntables and 2 microphones.
- Mixer circuits connect either microphone with either turntable.
- 8-position, push-button control for audio monitoring.
- Illuminated VU meter.
- Jacks for (1) "proof-of performance runs", (2) transfer-line switching to control-room rack, and (3) routine a-f measurements.
- Line transfer switch makes it possible to use telephone line for order wire service—*without equalization.*
- Monitor amplifier and speaker transfer switch.
- Master gain control in 0.5-db steps.
- Input connections for two audio lines.
- 4 heavy-duty switches for tower lights, sleet melters, lightning trip circuits, carrier alarm, etc.
- High degree of flexibility to meet operational requirements. Accessible terminal board.
- Two-tone, blue-gray cabinet with sloping panel, only 12 inches high, 40 inches long.
- Full visibility of controls and transmitter.
- Easy-to-get-at. Designed with piano-hinged front panel.
- Economical and easy to install.

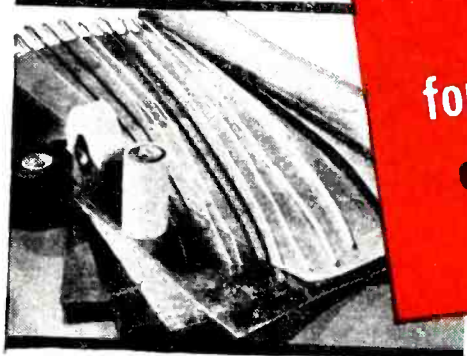
*Have you placed your order yet?*

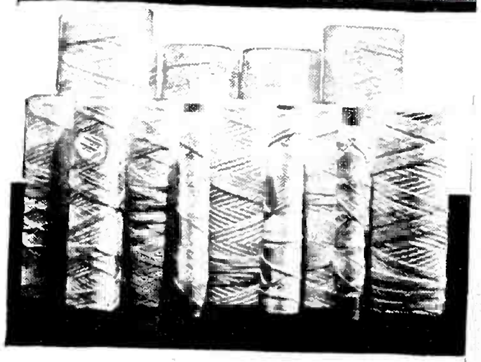
**G-E High-Fidelity Audio Facilities**

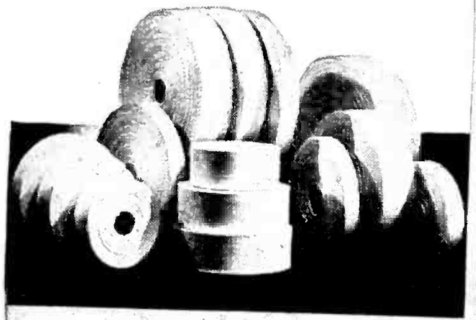
Write for the complete data on General Electric's new line of quality speech—input units—preamplifiers, program amplifiers, line and isolation amplifiers, monitoring amplifiers, monitoring loudspeakers. De luxe in performance and appearance. Flexible, convenient, reliable. Yet at a price *every* station can afford.

...TENNAS • ELECTRONIC TUBES • HOME RECEIVERS

**FM • TELEVISION • AM** *See G.E. for all three!*







# MIRAGLAS

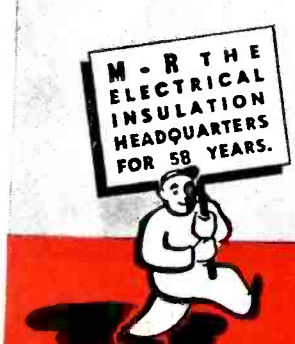
## *is the name*

**for woven TAPES, TUBINGS, SLEEVINGS, CORDS, CLOTHS, of fiberglas yarn for every electrical insulation requirement**

**MITCHELL-RAND,** using Owens Corning fiberglas yarn, processes and fabricates TAPES, TUBINGS, SLEEVINGS, CORDS and CLOTHS that are the optimum in electrical insulation . . . marketed under the trade name **MIRAGLAS,** they protect electrical equipment from the destructive forces that play havoc with ordinary electrical insulations; overloading, extreme high or low temperatures, moisture, corrosive acids, fumes or vapors, oils, grease, dust and dirt.

**MIRAGLAS** fiberglas INSULATIONS have an amazing background of use throughout industry—wherever used they feature fewer breakdowns, less maintenance, elimination of waste, savings in labor and materials and prove their standing as the optimum in electrical insulation protection.

Take note of the name **MIRAGLAS** . . . it stands for the ultimate in fiberglas electrical insulations . . . TAPES, TUBINGS, SLEEVINGS, CORDS, CLOTHS, ETC. Write today for details and characteristics.



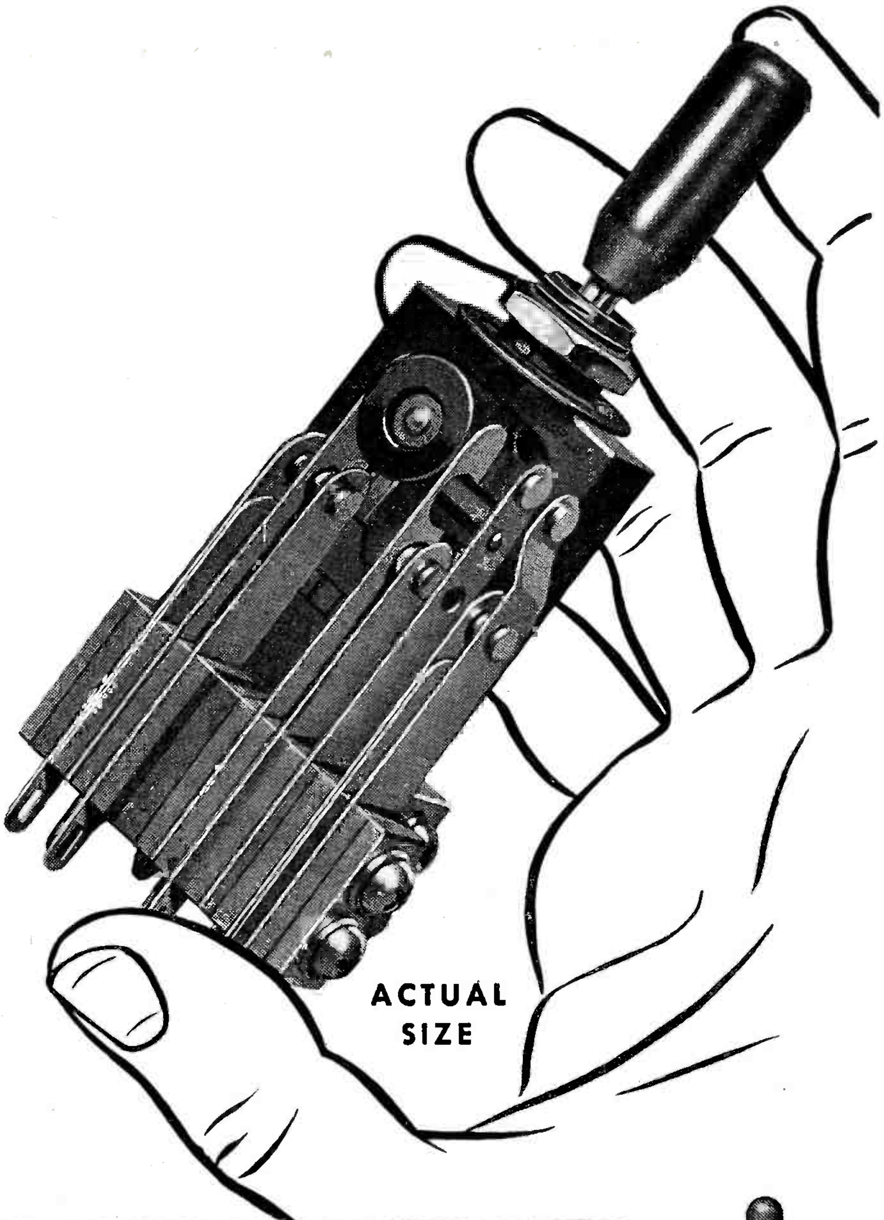

**MITCHELL-RAND INSULATION CO. Inc.**

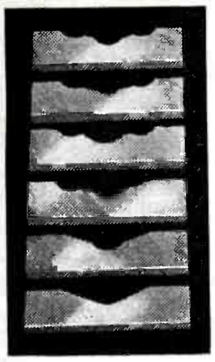
51 MURRAY STREET • COrtlandt 7-9264 • NEW YORK 7, N. Y.

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

# GENERAL CONTROL BUILDS

# *The world's most versatile* SWITCH

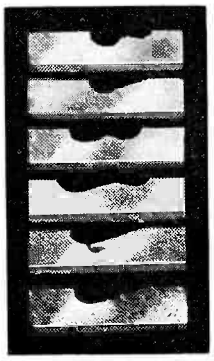


**MODEL**

**MCM**

**WITH PATENTED* DETENT INSERTS**



General Control Company announces a new feature for its Model MCM "Midget" lever switches—a feature which makes possible true *custom-built* switches from *standard* parts. By means of small, stainless steel inserts, shown above, the MCM "Midget" can be provided with a wide variety of detent actions to meet the most exacting requirements. Light or heavy action, two or three positions, locking or non-locking and special intermediate stops—all are possible with this versatile detent mechanism. The inserts are riveted in permanently at the factory. They preserve the original "feel" of the switch throughout its life—tests show negligible wear after 1,000,000 operations!

Write for details on the complete line of General Control lever switches, or, better yet, send us your switching requirements and take advantage of our engineering service.

*PATENT NO. 2,411,086

OTHER MCM FEATURES

★ Single hole mounting for easy panel fabrication.

★ Removable contact assembly for easy wiring.

★ Light weight—3½ oz. with 12 contact blades.

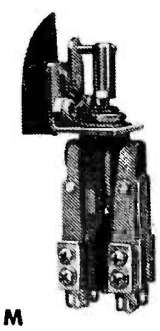
★ Small size—depth behind panel only 2¾ inches.

★ High capacity—5 amperes non-inductive at 115 volts AC.

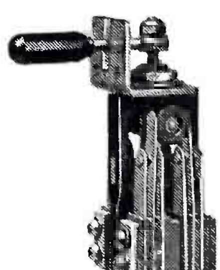
★ High dielectric strength—tested at 2500 volts AC to ground.

★ Versatility: Can be supplied with angle mounting bracket when space behind panel is limited. Rotary actuator available. Waterproof handle assembly for marine or aircraft applications.

**MCM**
With Waterproof Handle Assembly



**MCM**
With Rotary Actuator



**MCM**
With Angle Mounting Bracket

## GENERAL CONTROL COMPANY

**1202 SOLDIERS FIELD ROAD, BOSTON 34, MASSACHUSETTS**


**Friendly,** tactful, impartial, trained to serve, these Hytron commercial engineers form the liaison between us—maker and user of electronic tubes. Few in the radio tube plant can be circuit specialists. Few outside the tube plant can be tube specialists. Both of us need these commercial engineers trained to see clearly both sides of our common problems and help us solve them.

Often their job begins with a request for advice in selecting a tube. Investigation of the circuit application helps them recommend an available type, a slight redesign, or a brand new type. If a new type is found to be the only practicable and economical solution, they co-operate with design and production engineers to achieve the performance desired.

Specification of adequate factory testing procedures and preparation of characteristics sheets do not end their work. Returns are closely checked. If trouble occurs, they go into the field, help dig out the facts, and offer possible solutions—improvements in tube or application. And they stick tenaciously with the problem until it is solved.

Using a wealth of test equipment and know-how, these boys really sweat to make it easy to make Hytron tubes which will make you happy. Busy as the one-armed paperhanger, yet they always welcome the tube problems of equipment engineers. They are nice guys, and we thought you would like to meet them.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON RADIO TUBES

# HYTRON

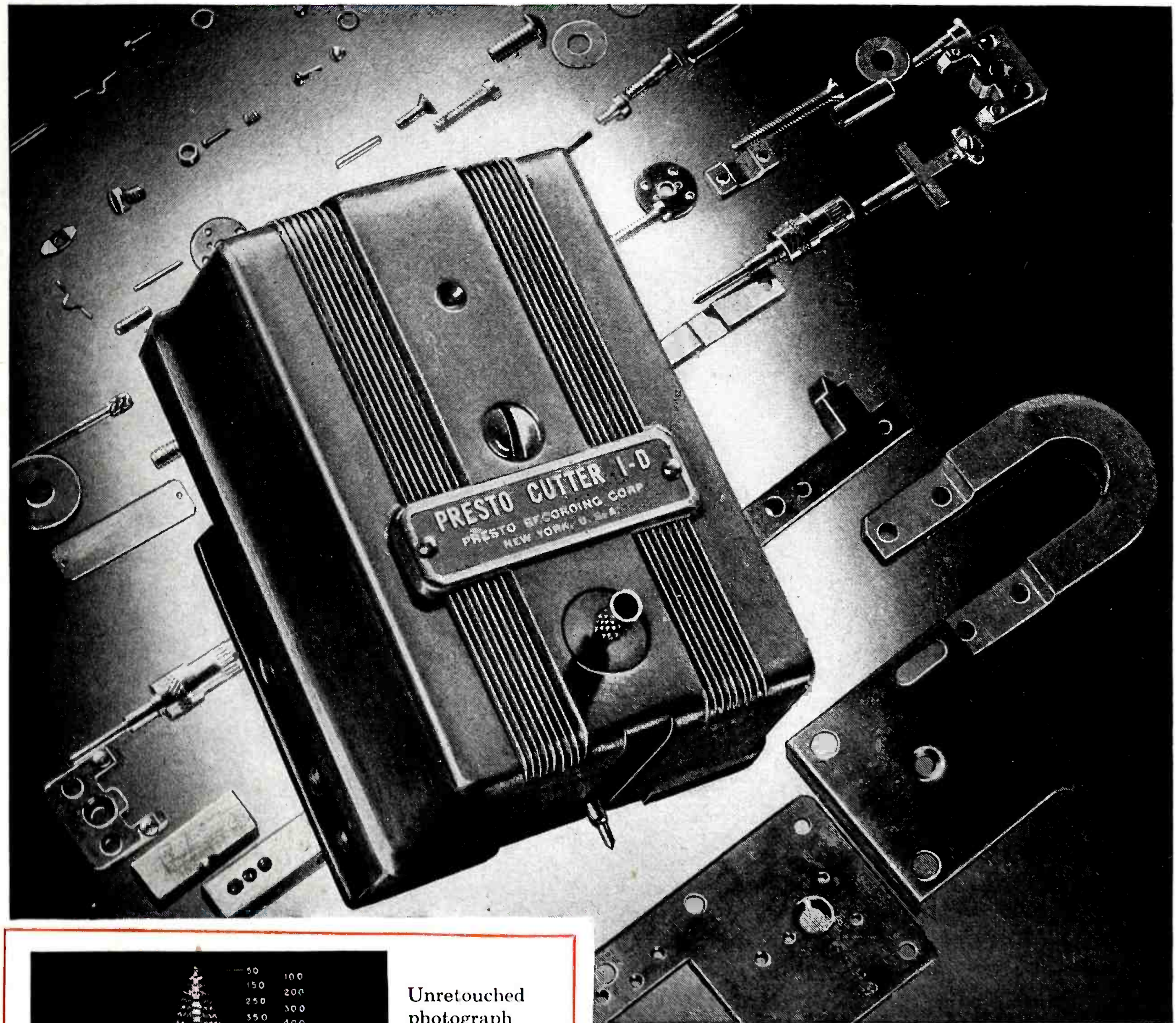
RADIO AND ELECTRONICS CORP.

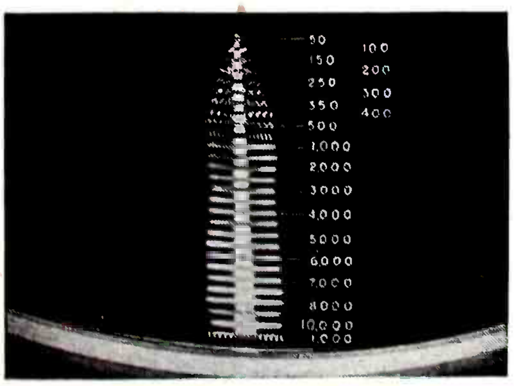
MAIN OFFICE: SALEM, MASSACHUSETTS

# NOW! a new standard of performance in cutting heads THE PRESTO 1-D

▶The new Presto 1-D Cutting Head offers: *wide range, low distortion, high sensitivity* and *stability through a temperature range of 60°-95° F.* The Presto 1-D Cutting Head is a precision instrument made entirely of precisely machined parts, expertly assembled and carefully calibrated. These factors, plus its sound basic engineering design, produce a cutter unequaled in performance by any other mechanically damped magnetic device.

▶Note from the light pattern below: The correct location of the cross-over point at 500 cycles, the 6 db per octave slope below this point, and flat response above 500 cycles, which is free from resonant peaks. The range of the cutter is 50-10,000 cycles. The Presto 1-D is damped with "Prestoflex" which is impervious to temperature changes between 60 and 95 degrees Fahrenheit.




Unretouched photograph showing the light pattern. Notice correct location of the cross-over point at 500 cycles.

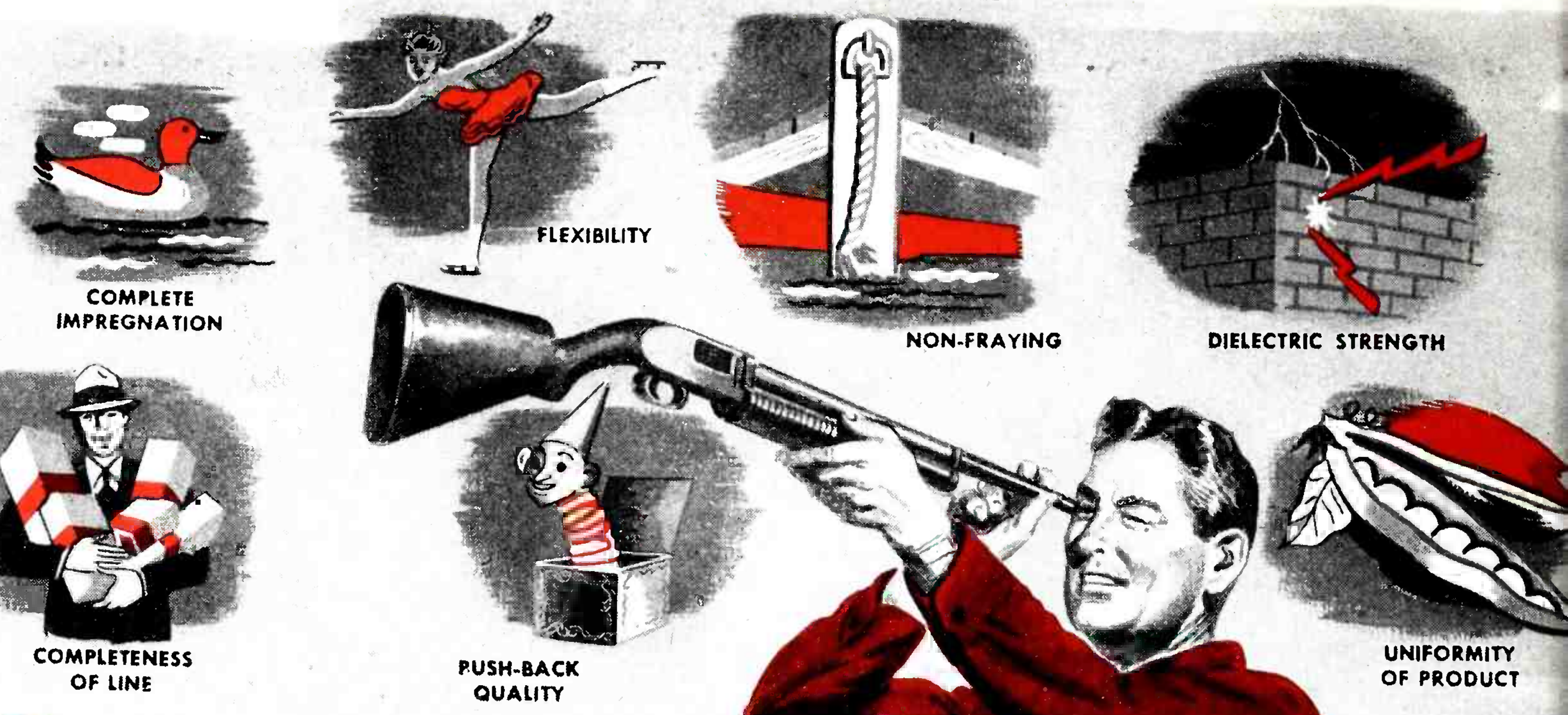
PRESTO

RECORDING CORPORATION

242 WEST 55TH STREET, NEW YORK 19, N. Y.

Walter P. Downs, Ltd., in Canada

*WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS*




# 7th among the Features of DIEFLEX VARNISHED TUBING PRODUCTS is...

## SMOOTHNESS OF BORE

SMOOTH inside bore is another big advantage that makes Dieflex varnished tubing or sleeving a superior product for manufacture of all types of electrical products. Smooth bore helps speed assembly and reduce manufacturing costs, just as do the other seven features of this quality insulation. These features, plus long life, make Dieflex attractive both for the product manufacturer and the ultimate user.

The inherent advantages of smooth inside bore, extreme flexibility, thorough impregnation with oleoresinous baking-type varnish, good push-back quality, and other characteristics shown on this page, are reasons for the widespread use of Dieflex varnished tubing products. Get these advantages for your own production. Dieflex is available with either a cotton or glass fiber base to meet every insulating requirement. Decide on Dieflex . . . it's "best for you."

### DIEFLEX PRODUCTS LIST

**MADE WITH BRAIDED COTTON SLEEVING BASE**

- VTA Grade A-1 Magneto Grade Varnished Tubings
- VTA Grade B-1 Standard Grade Varnished Tubings
- VTA Grades C-1 and C-2 Heavily Coated Saturated Sleevings
- VTA Grade C-3 Lightly Coated Saturated Sleevings
- Heavy Wall Varnished Tubings and Saturated Sleevings

**MADE WITH BRAIDED GLASS SLEEVING BASE**

- VTA Grade A-1 Magneto Grade Varnished Fiberglas Tubings
- VTA Grade C-1 Extra Heavily Saturated Fiberglas Sleevings
- VTA Grade C-2 Heavily Saturated Fiberglas Sleevings
- VTA Grade C-3 Lightly Saturated Fiberglas Sleevings
- Silicone-Treated Fiberglas Varnished Tubings and Saturated Sleevings

## INSULATION MANUFACTURERS CORPORATION

*CHICAGO 6
565 W. Washington Boulevard
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*Local Stocks Available

ELECTRICAL IMC INSULATION

*CLEVELAND 14
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DAYTON 2
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*IMC Representatives*
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# OUR TEACHERS—

## *They Need The Help Of Business Now*

THIS is an appeal to raise school teachers salaries—fast. Such appeals are commonly addressed, rather vaguely, to the conscience of the community. This one is not. It is addressed directly to the business community, and to its hard core of common sense.

As a whole, the school teachers of the nation are taking an economic beating. So, too, are their close associates and co-workers, the librarians. In purchasing power, public school teachers salaries, after taxes, average about 20 percent less than they did eight years ago. Beginning salaries of librarians, always low, have fallen behind an equal amount in purchasing power. College and university teachers are not much better off. The pressure is particularly heavy on those in the lower ranks. As a group, teachers and librarians are close to the bottom of the economic heap.

Unless this situation is remedied promptly, it is confidently to be expected that:

1. The more competent teachers will continue to desert our schools in droves, and our libraries will remain inadequately staffed. More than 350,000 teachers — many of them the very able ones—have left the public school teaching staff of about 900,000 in the last six years. More than 100,000 of the replacements are "substandard." They cannot meet the minimum educational requirements of their jobs which, by admission of the profession itself, are none too high.

2. Those who remain will be organized increasingly into economic pressure groups. Teachers strikes and the rapid growth of unionism among teachers at present clearly indicate what is in store.

Many business men are so deeply disturbed by the resort to the strike weapon by some teachers to enforce their salary demands that their sympathy for the general plight of our teachers tends to be dulled. Such an attitude is understandable. It avails nothing, however, in eliminating the crisis in education caused largely by teachers salary troubles.

The crisis in education is a crisis for the nation as a whole. The work of our schools, colleges and libraries is such that its deterioration means deterioration of the nation. However, the salary crisis in education is in special measure a crisis for the business community. That community has a special stake in having a well-educated and well-disposed constituency.

### Education and Unionism

There may be room for disagreement as to whether teachers should organize themselves in trade unions, and follow trade union tactics. However, there is no conceivable room for disagreement as to whether organization of teachers into a fighting economic pressure group under the lash of a teachers salary crisis would be a body blow to business. Among many teachers it would foster an abiding hostility to the institution of business which, occupying a key position in the life of the community, had not done its utmost to make such unionization unnecessary by taking a lead in relieving the teachers salary crisis.

In our work of publishing technical periodicals and text books, we at McGraw-Hill meet and come to know many teachers and librarians. We know that, as a group, they have little appetite for participation in militant economic pressure groups. They are far more interested in making a militant assault on ignorance and prejudice through concentration on their professional work. If, through neglect of their economic needs by the business community, they feel forced to resort to trade union organization and tactics, the teachers and librarians can be expected to have an abiding resentment toward the institution of business. That resentment will, in turn, be communicated in no small measure to the coming generation. Such is the nature of the educational process.

The crisis in education is not, of course, exclusively a matter of salaries. Unsatisfactory working conditions also play a part. Many schools are dilapidated and terribly overcrowded. So are some libraries. Some small-town school boards oppressively insist that the school teachers be the paragons of piety the board members wish they were themselves. Protection of a proper degree of academic freedom is sometimes missing. The teacher is rarely accorded a prestige comparable to the importance of the job. Elements such as these aggravate the crisis in education. But the first and absolutely essential step toward surmounting the crisis is to provide tolerable salaries.

Because of the enormous diversity of local conditions affecting teachers and librarians salaries, no general rule for emergency action would fit all cases. From state to state, average yearly expenditures on education in 1940 varied all the way from about $30 per pupil to about $150. Some states, like Nebraska, finance their schools almost exclusively from local taxes. Others, like Delaware, rely almost entirely on state taxes. Some states and communities have already acted to meet the salary crisis. Others have not. Variations such as these limit any generalization.

### Guide for Emergency Action

But as a general proposition it can be safely said that the minimum requirements of the emergency will not have been met so long as the salaries of class room teachers and junior members of college faculties and library staffs have not been increased by the amount necessary to keep them abreast of the increase of about 50 percent in the cost of living since 1939. In many cases, a temporary cost of living adjustment might prove the best way to handle the problem.

This suggestion, let it be repeated, is not offered as a solution of the salary problem, but as a start. With their salaries increased enough to meet the increased cost of living, the teaching and library groups as a whole would still have cause to envy the current economic position of industrial workers. Since 1939, the average of weekly earnings of industrial workers after taxes, has outstripped the rise in the cost of living by about 21 percent.

However, a start and an absolutely essential start would be made toward giving America the sort of educational system it must have not only to fulfill its ideals but holds its own in this highly competitive world. We worry, and I think rightly, about having the free world engulfed by Russian Communism. According to the best figures available, the U.S.S.R. is spending about twice as large a share of its total national income for education as we are. The figures compared include our expenditures for both public and private education. That comparison is really something to worry about.

### States Should Take Lead

In dealing with the salary crisis it is up to the teachers to display a maturity and integrity worthy of their profession. Teachers have many employment advantages, such as long vacations. They should not slur them over in making comparisons of their annual incomes. Also employment in teaching and libraries has been notably stable. Teachers and librarians should not ignore that fact in comparing their position with those whose employment has been far less steady.

At the same time, the great fiscal difficulties involved in solving the crisis in teachers and librarians salaries must not be used as an excuse for postponing effective action. The states are better equipped financially and otherwise to take such action than is the federal government and, with the localities directly involved, should take the lead. If the price of effective action is a heavier tax burden for communities already too heavily burdened that price must be paid. The crisis presents a major emergency. To handle it as anything less is to court irreparable damage to the nation as a whole, and a special measure of damage to business as well. The intelligent self-interest of business requires that it leave nothing undone to meet and master the crisis in education.

James H. McGraw, Jr.

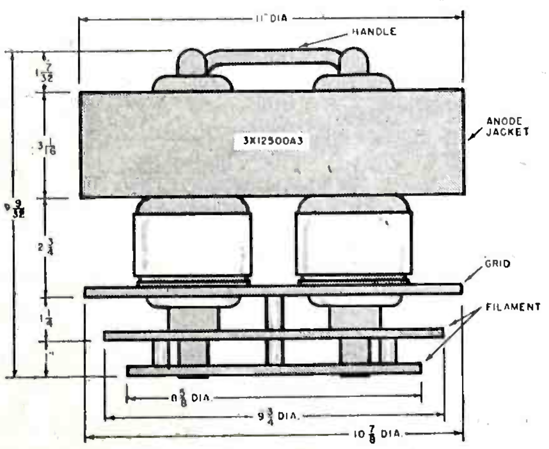
*President McGraw-Hill Publishing Company, Inc.*

THIS IS THE 57TH OF A SERIES


## A REVOLUTIONARY NEW EIMAC TRIODE

YES . . . The 3X12500A3 is truly revolutionary . . . packaged power . . . that will fill not several, but all applications for a power-amplifier or oscillator from zero to 110 Mc. It will do a low frequency job better than "special low frequency" tubes. It's performance at vhf has long been the aim of vacuum tube researchers. The 3X12500A3 is smaller (over-all 11"x9") and lighter (net 32 lbs.) than any comparable tube. . . . Yes, it is truly a revolutionary tube.

**Audio**
**Induction heating**
**Broadcasting**
**Dielectric heating**
**Communication**
**Television**
**Industrial**
**FM Broadcasting**
**Research**




RADIO FREQUENCY POWER AMPLIFIER
Grounded-Filament Circuit

Class-C Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies below 85 Mc.)

| | |
|---|---|
| D-C PLATE VOLTAGE | 5000 MAX. VOLTS |
| D-C PLATE CURRENT | 8 MAX. AMPS. |
| PLATE DISSIPATION' | 12,500 MAX. WATTS |
| GRID DISSIPATION | 600 MAX. WATTS |

TYPICAL OPERATION (Frequencies below 50 Mc., per tube)

| | | | | |
|---|---|---|---|---|
| D-C Plate Voltage | 3500 | 4000 | 5000 | volts |
| D-C Grid Voltage | −420 | −360 | −400 | volts |
| D-C Plate Current | 7.2 | 6.4 | 8 | amps |
| D-C Grid Current | 2 | 1.7 | 1.9 | amps |
| Peak R-F Grid Input Voltage | 735 | 630 | 710 | volts |
| Driving Power (Approx.) | 1.3 | 0.95 | 1.35 | kw |
| Grid Dissipation | 480 | 350 | 590 | watts |
| Plate Input | 25.2 | 25.6 | 40 | kw |
| Plate Dissipation | 5.2 | 5.6 | 10 | kw |
| Plate Power Output | 20 | 20 | 30 | kw |

RADIO FREQUENCY POWER AMPLIFIER
Grounded-Grid Circuit

Class-C FM Telephony or Telegraphy

MAXIMUM RATINGS (Frequencies below 110 Mc.)

| | |
|---|---|
| D-C PLATE VOLTAGE | 4000 MAX. VOLTS |
| D-C PLATE CURRENT | 8 MAX. AMPS. |
| PLATE DISSIPATION' | 12,500 MAX. WATTS |
| GRID DISSIPATION | 600 MAX. WATTS |

TYPICAL OPERATION (110 Mc., per tube)

| | | |
|---|---|---|
| D-C Plate Voltage | 3700 | 4000 volts |
| D-C Grid Voltage | −450 | −550 volts |
| D-C Plate Current | 7.2 | 7.4 amps. |
| D-C Grid Current | 0.9 | 1.1 amps |
| Driving Power (approx.) | 6.4 | 7.6 kw |
| Useful Power Output | 27.4 | 30 kw |
| Apparent Overall Efficiency | 102 | 101 per cent |

**EITEL-McCULLOUGH, Inc.**
**1651 San Mateo Avenue, San Bruno, California**

*Follow the Leaders to*

Eimac REG. U.S. PAT. OFF. TUBES

*The Power for R-F*

EXPORT AGENTS: FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO 11, CALIFORNIA

# BUSINESS BRIEFS

By W. W. MacDONALD

**Equipment Prices** are going to stay just about where they are throughout the year. Continuing shortages of materials, high labor costs, and a healthy consumer demand all militate against cuts. Fear of pricing gear out of the market keeps a check-rein on increases. Changes, up or down, will be rare.

From where we sit it looks like price reductions, if any, cannot occur before 1948. When they do occur they will probably be small and more effective as a competitive sales weapon than as a market stimulant.

**Packaged Wiring** is a distinct possibility for certain types of electronic apparatus. Stimulated to research and development along these lines by high labor costs, and perhaps shown the way by so-called printed circuits, at least three firms are known to be experimenting with schemes which may prove more practical for run-of-mine apparatus.

Experimenters have in mind possible elimination of costly wire-by-wire assembly work, and the soldering of connections individually. A further aim is to achieve extreme uniformity of wiring, with resultant reduction in the cost of alignment and testing if not in actual production. The various engineering approaches, about which we are not at liberty to say more at present, are quite dissimilar.

**Speaking Of Labor,** a small New England manufacturer in our field has just initiated a 50-50 profit-sharing plan with his employees, hopes that their productivity will rise. Profit sharing is not new in the field of electronics but the rate mentioned certainly is.

More about how the plan pans out later.

**Final Transmitter Figures,** covering sales by RMA members in 1946, total $6,491,067, broken down as follows: A-M transmitters $2,401,303; television transmitters $845,141; f-m transmitters $752,259; a-m and f-m studio equipment $1,784,060; television studio equipment $72,127. The rest went for antennas and miscellaneous equipment.

**Selective Calling System** design and/or the development of highly directional softspeakers should be stimulated by the news item about a man who called a taxi to take him to the railroad station and amused himself during the ride by listening to the company's central office radio-dispatch other cabs.

He was less amused when he heard one ordered to his home to pick up a fare bound for a local tavern, detoured his own cab to the tavern and found his wife there with another man. Now he is suing his wife for divorce. And his wife is suing the taxi company for divulging private and personal information.

**Chicago IRE Members** were asked to indicate their ten major business interests, in order of importance. The weighted result follows:

| | |
|---|---|
| Electronics | 90% |
| Research | 80 |
| Measurement and Instrumentation | 75 |
| Receivers and Transmitters | 72 |
| Industrial Electronics | 67 |
| Television | 64 |
| Frequency Modulation | 52 |
| Ultra High Frequencies | 45 |
| Very High Frequencies | 43 |
| Electroacoustics | 41 |
| Inspection Trips | 40 |
| Antennas | 40 |
| High Frequencies | 35 |
| Vacuum Tubes | 34 |
| Lecture-Refresher Courses | 31 |
| Lecture-Postgraduate Courses | 30 |
| Manufacturing | 29 |
| Education | 26 |
| Management and Operations | 25 |
| Wave Propagation | 21 |
| Medical Electronics | 21 |

Principal hobbies, incidentally, were photography and amateur radio (Move over boys!).

**College Courses** on servo mechisms are increasing in popularity, and the fact that students taking such courses must of necessity learn something about mechanical as well as electrical and electronic engineering may eventually have a very beneficial effect upon our business.

One of the major stumbling blocks in the path of electronic engineers interested in designing apparatus for use in industry has

# Audax

Trade Mark

# TUNED-RIBBON
## reproducers

**MUSICALLY** . . . *The Tuned-Ribbon message in a few words . . .*

***"Startlingly Realistic"***

**One of the many superlatives used by Electronic Industries magazine* in an editorial describing this new development. It brings to reproduced music something that was not there before.**

**TECHNICALLY** . . . ***The Tuned-Ribbon Reproducer actually meets the long sought for theoretical ideal of —***

- **Near-zero mass**
- **Linear response to 15 k.c.**
- **Practical output (about —30 db)**
- **Point Pressure 14 grams**
- **Jewel point**
- **NO torsional action**


TUNED-RIBBON Pickup *Model DL-81 (actual size — special arm not shown)*

****Send for complimentary reprint of this editorial***

# AUDAK COMPANY

**500 Fifth Avenue New York 18**

**CREATORS OF FINE ELECTRO-ACOUSTICAL APPARATUS SINCE 1915**

long been their inability to understand machines for which controls must be designed, coupled with the inability of men who know the machines to understand what tubes can and cannot do. The future crop of electronic engineers may jump this hurdle.

**From An Engineer** now in management, who ought to know, come three tips for technicians with similar aspirations:

(1) Consider the market potentialities, and the economics, before plunging into any project, however intriguing it may be technically. (2) Act and even dress like a business man, rather than a schoolboy. (3) Plan personal working time intelligently and so convince management that you could direct the work of others.

**Proof Of Performance** over a period of years is more impressive to industry than any amount of salestalk about electronic equipment, so as fast as folks out in the field feed it to us we'll print it.

For instance: Sperry Products, back in 1928, equipped a special car to test rails for internal faults as it rolled along the right-of-way. Now there are 19 of them. They'll cover about 175,000 miles in 1947.

**Selenium Photocell Production** is the subject of several requests for information recently received by this columnist. Off-the-record ragchews with several manufacturers indicate that around 400,000 were made in 1945.

We are not too happy about the wide range of estimates from which the figure was arrived at and would welcome informed sharpshooting. If it turns out that the figure is off the beam we will buy a 24-inch sliderule so that our subsequent errors can be more accurate.

**The Receiver Market** looks like this to *Collier's:*

Some 47.9 percent of the families reached by the magazine intend to buy one or more new sets this year. 49.3 percent of this total will buy console combinations (Ed. Note: If they can get them), 23.7 want table-type radios, 19 percent want table combinations, 8.3 percent consoles, and 5.7 portables.

F-M interests 38.5 percent of the publication's audience, 33.3 percent say they don't know what it means, 18.4 percent are undecided, and 9.8 are not interested. 16.5 percent plan on buying television receivers, 70.2 do not plan on buying, 13.3 percent don't know.

**Something To Watch** is the market for railway entertainment equipment (see p 118). Several manufacturers are working closely with railroads to break the monotony of long train rides by installing centralized sound systems utilizing wire recorders and radio tuners as sources of music. The application calls for high-quality, rugged gear which is profitable to make and to sell.

**Telephone Equipment** production is beginning to jump, as indicated by the following figures from Western Electric:

| | *1941* | *1946* |
|---|---|---|
| Telephones | 2,305,000 | 4,154,000 |
| Central Office Switchboards* | 1,023,100 | 1,398,800 |
| Coaxial Cable (miles) | 50 | 2,000 |
| Carrier Systems | 850 | 1,250 |
| Teletype Printers | 12,770 | 13,720 |

* *Dial lines, and manual operator positions.*

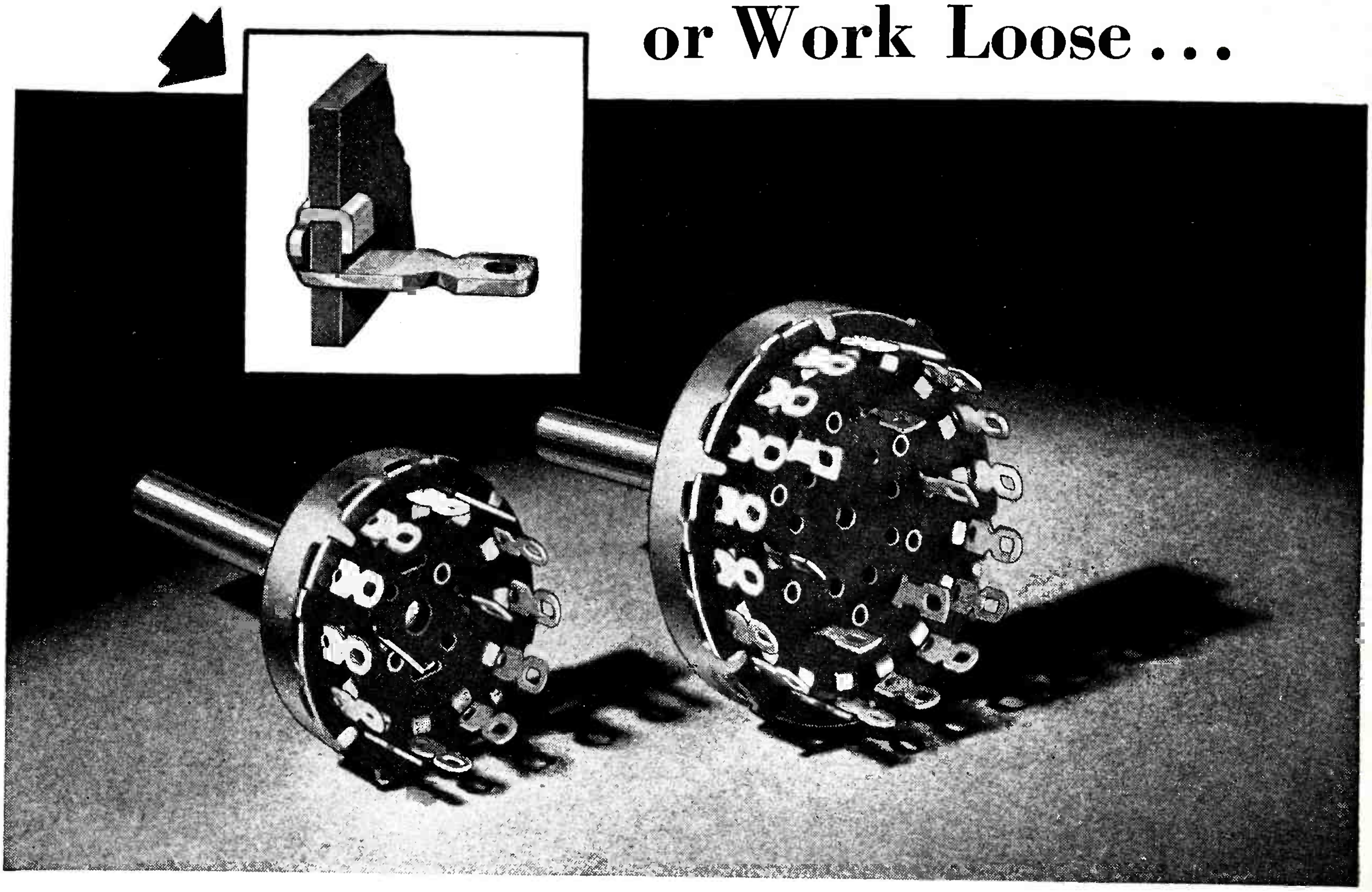
**Market Tips:** We realize that truly packaged merchandise is what makes American business go 'round, but think it our duty to report that a lot of people lately have called us up to ask where they can buy tuners, amplifiers, record-changers and speakers in separate units.

They seem to want high-fidelity, concealability, plus plugs that permit them to hook up the stuff themselves. And they seem willing to pay for it.

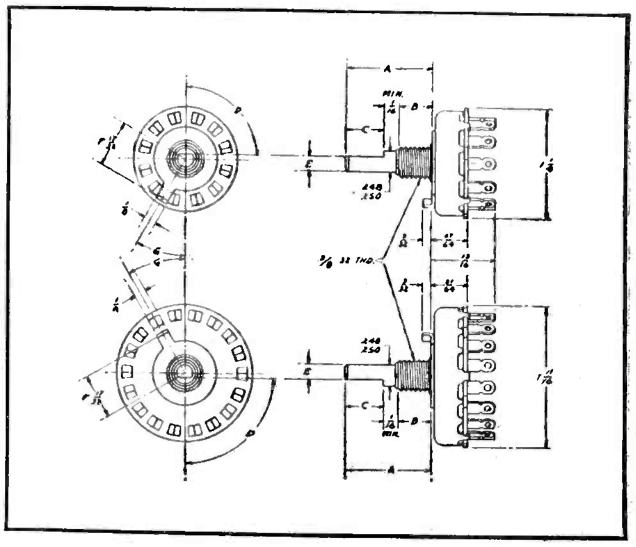
**FCC Has Received** 200,000 license applications covering 40 classes of radio service since the end of the war. The total number of licensees and permittees is nearing 530,000.

**Story Of The Month** is the one about the electronic engineer who, at the beginning of a speech, said that his story had two points, like a pair of horns . . . with a lot of bull in between.

# This Terminal Won't Pull Off or Work Loose . . .



## . . . IT'S ONLY ONE FEATURE OF THIS COMPACT LOW VOLTAGE MALLORY SWITCH



The inset at the top of this picture shows how the terminals of Mallory 3100 Switches are doubly fastened by a wrap-around method which holds them tight and secure against damage and at the same time provides them with a smoother contact surface.

What the picture cannot show is that the stator is made of low-loss XXX Phenolic especially selected for good insulation properties at high humidities . . . that a metal web spaced between the terminal contacts improves non-shorting construction . . . that terminals and stator together provide an excellent solder shield.

Small size, of course, is another distinguishing feature of these 3100 Switches, of which millions have been sold to manufacturers of radios, inter-communication systems and test equipment. The larger model, shown above, is 1$\frac{11}{16}$″ in diameter and has 18 position 20° indexing, embracing one to six circuits. The smaller model, with 12 position 30° indexing, embracing one to four circuits, is only 1$\frac{1}{4}$″ in diameter.

For more details, send for Mallory 3100 SWITCH Engineering Data Folder. A wide range of standard stock types is available through convenient Mallory Distributors.

**ASK FOR 3100 SPECIFICATION SHEETS**

Printed on tracing paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to order production samples built to your exact requirements.

P. R. MALLORY & CO. Inc.

**MALLORY SWITCHES**

**(ELECTRONIC, INDUSTRIAL and APPLIANCE)**

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

# CROSS TALK

◀ **LEGALISTIC . . .** On this page two months ago we had occasion to question the virtue of a television system used to monitor water level in the boilers of a power-generating station, on the score that such a complicated electronic system was hardly called for in the circumstances. It now appears that television is used to meet a legal requirement, a safety regulation stating that the water level must be under the direct visual observation of a responsible individual at all times. Further, we are told, the oldtime glass-tube water-level indicator is still the most reliable device now available, and simple telemetering devices have proved hard to invent. This being the case, the use of television would appear to be a practical telemetering means. But we still wonder whether even a simple television system (the system in question uses only 19 tubes) is foolproof enough to satisfy the spirit of a safety regulation requiring direct visual observation at all times. If the safety authorities and the insurance companies are satisfied, so, obviously, are we. We want television, and every other electronic system, to find the widest possible use in industry, whenever and wherever it can do a better job.

◀ **TAXI . . .** Dispatching taxicabs by radio is a new and lively art, not without sinister aspects. A divorce proceeding has been instituted based on a conversation overheard on a cab loudspeaker. An attempt to undermine the morals of an installing engineer in Washington has been made by a cab driver who offered a 25-dollar bribe for the privilege of having his cab equipped one week ahead of schedule. Assuming the cab driver knew his odds, it would appear that the installation would be worth to him, more than $1,250 a year.

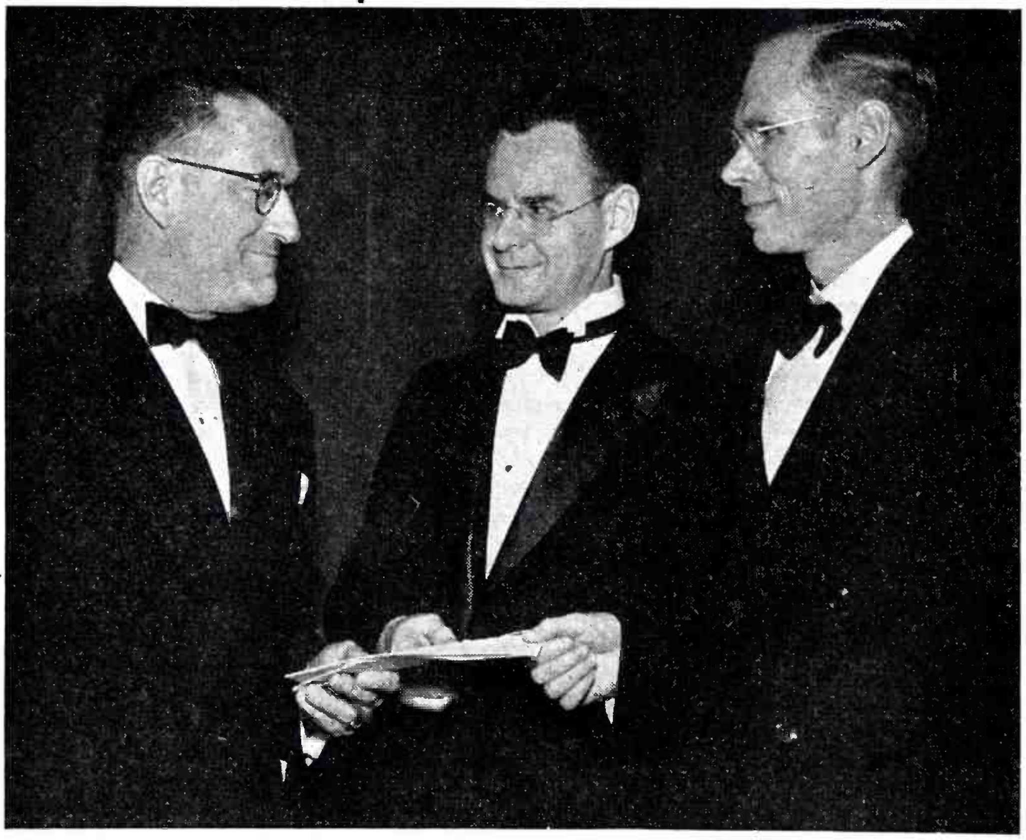
Another rather alarming aspect is the economic effect of the frequency shortage. In days past, entrepreneurs have been prevented from *going into* business by the lack of frequencies (though not lately in the a-m broadcasting business). But, since the two taxicab frequencies can accommodate only two cab companies unless they pool facilities, there is a possibility that cab companies beyond the second in each interference area will be *forced out* of business.

Speaking of mobile communication, we heard the other day the story of the Bell Labs engineer whose car is fitted for the new automobile-telephone service, connecting to the Bell system exchanges. Approaching a friend's house in Summit, N. J. on a foggy night he became lost, called the friend on the mobile phone and was "talked in" to a safe curbside landing by the most direct route. The fact that the 150-mc circuit extended from Summit to New York City, or 50 miles round trip, did not prevent this felicitous use of aviation's talk-down technique.

▶ **PAID . . .** All signs point to rapid adoption of radar in transoceanic marine passenger service, less than a year after civilian radar was first offered. The most compelling instance of its efficacy is the recent crossing of the Queen Elizabeth, during which she proceeded by radar at full speed for 720 miles through dense fog, saving twice the cost of the radar unit in a single day. In passenger service, even in small vessels carrying lower fixed costs, the economics of the situation will force general acceptance, it is hoped, before a preventable collision occurs and forces it through legislation. In cargo service there is still much reluctance to take on radar, particularly if an extra man must be hired to operate and maintain the equipment. But if radar sufficiently precise to permit docking in fog is forthcoming, even in freight service the savings will quickly outdistance the cost.

# IRE Highlights

Over 12,000 technicians attend highly successful 1947 National Convention. Institute awards three memorial prizes, 25 fellowships. Many new products shown in 185 well-manned exhibits. Estimated 8,000 overflow four meeting halls to hear unprecedented and in some respects unwieldy total of 121 technical papers



Presentation at the banquet, all of which was televised, of the Morris Liebmann Memorial Prizes for 1946 and 1947. Left to right: IRE president W. R. G. Baker, Albert Rose, and John R. Pierce

OVER 12,000 technicians attended the 1947 National Convention of the Institute of Radio Engineers in New York, almost double the number expected and by far the heaviest turnout ever seen at a meeting of this kind. Some 300 paid $10 for membership and thereby gained admittance to the Hotel Commodore and the 185 exhibits at Grand Central Palace denied the general public, about 3,000 non-members planked down $3 for tickets entitling them to temporary privileges of members, and it is estimated that at least 8,000 sat in on one or more of the 121 papers presented at 24 technical sessions during their four-day run.

### Speeches, Awards, Fellowships

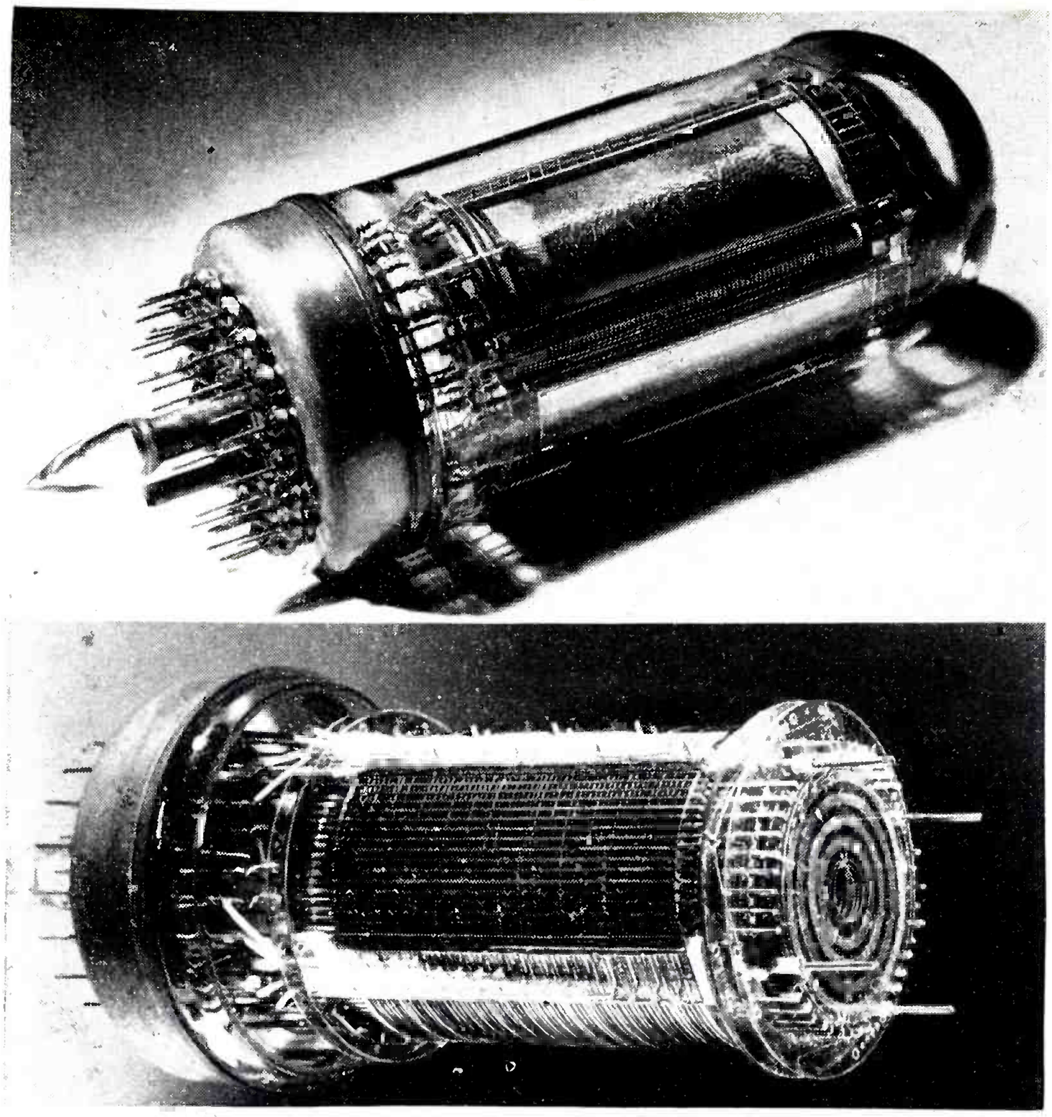
Significant among statements made during general session, president's luncheon, and banquet, were three by IRE president W. R. G. Baker, who said that the industry can advance no faster than its engineers, that the Institute's membership has now reached the unprecedented total of 20,000, and that these men can look forward to the future with confidence. Retiring president F. B. Llewellyn further emphasized expansion in the field by intimating that it would be necessary to study ways and means of avoiding a technical paper log-jam at the next National Convention. FCC chairman Charles R. Denny said that we are on the threshold of an immense expansion in the use of radio in our everyday lives, that new services would be moved from experimental to commercial frequencies as soon as possible, that

**Typical crowd and a few of the many elaborate exhibits on the main floor of Grand Central Palace, viewed from the balcony, where booths were similarly set up to handle attendance without undue jamming**

allocations equitable to both communications and electronic heating would represent a major headache for the next decade, that the high-frequency spectrum between 4 and 25 megacycles is a potential bottleneck to the expansion of worldwide communications, aviation, and shipping, and that the World Telecommunications Conference beginning this month at Atlantic City would probably result in an international allocation plan satisfactory to all nations but not precisely what anyone recommends. C. B. Jolliffe of RCA, Harry S. Rogers of the Polytechnic Institute of Brooklyn, and Edward U. Condon of the National Bureau of Standards urged engineers to break out of their shells and accept a greater share of leadership in business and government as well as in science. Vice Admiral Charles A. Lockwood, Jr. said he hoped more of the many electronic devices used by the Navy during the war would soon be put to work commercially.

Morris Liebmann Memorial Prizes for 1946 and 1947 were given to Albert Rose (RCA) for his contributions to the art of converting optical images to electrical signals, and particularly the image orthicon,

**Technicians flocking into one of the four meeting halls in which papers were presented concurrently**



Two views of memory tube in which a multiplicity of images may be stored for later release as, for example, in a calculating machine (RCA)

and to John R. Pierce (Bell Labs.) for his development of a traveling-wave amplifier tube having both high gain and very great bandwidth.

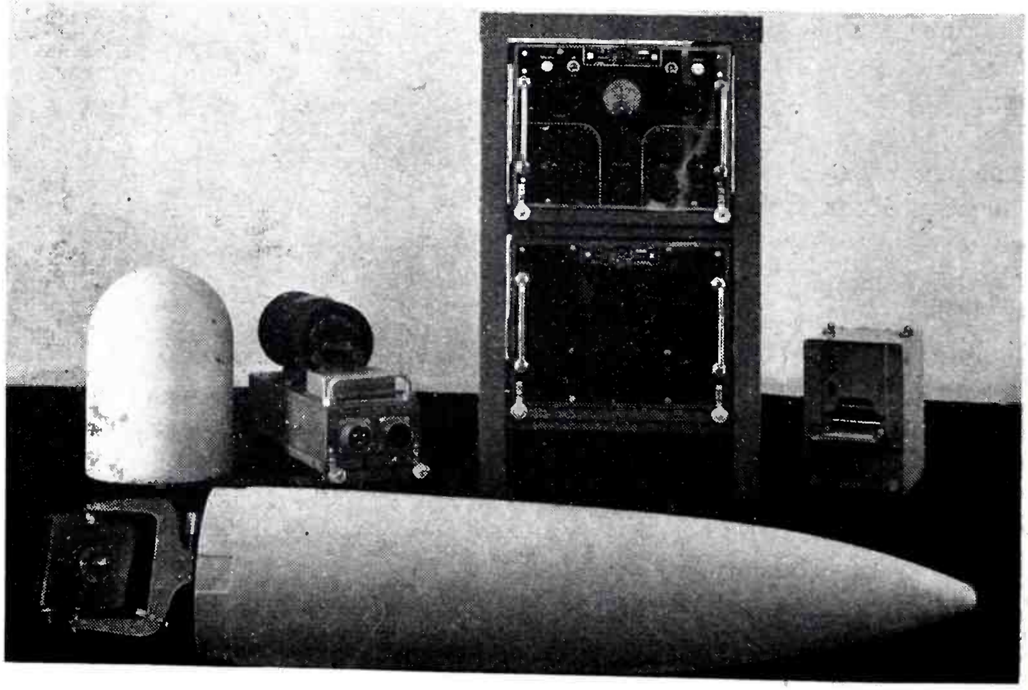
The Browder J. Thompson Memorial Prize for 1947 was given to C. L. Dolph (Bell Labs.) for his paper "A Current Distribution for Broadside Arrays Which Optimizes the Relationship Between Beam Width and Side-Lobe Level."

IRE Fellowships were awarded to George P. Adair (*FCC*), Benjamin de F. Bayly (*Cons.*), George L. Beers (*RCA*), Lloyd V. Berkner (*JRDB*), Edward L. Bowles (*MIT*), Robert S. Burnap (*RCA*), Robert F. Field (*GR*), Donald G. Fink (*Electronics*), William W. Hansen (*Stanford*), David R. Hull (*BuShips*), Fred V. Hunt (*Harvard*), Karl G. Jansky (*Bell Labs.*), Ray D. Kell (*Princeton*), Charles V. Litton (*Litton Eng.*), James W. McRae (*Sig. Corps*), Ilia E. Mouromtseff (*Westinghouse*), Daniel Earl Noble (*Galvin*), Pedro J. Noizeux (*Transradio*), Robert M. Page (*Nav. Res. Lab.*), John A. Pierce (*Cruft*), Frank H. R. Pounsett (*Research Enterprises*), Conan A. Priest (*GE*), Winfield W. Salisbury (*Collins*), Robert Watson-Watt (*Brit. Min. of Air.*), and Edward N. Wendell (*Federal*).

**Exhibits**

The big first floor and the second-floor balcony of the Palace housed the well-decorated and well-manned exhibits of 158 manufacturers. An additional 27 booths were occupied by the military and other government services, publishers (including ourselves), and representatives. Exhibitors were, in the main, satisfied with attendance and, particularly, with its quality. A few companies that would ordinarily be expected to have booths were, as predicted in March (*Business Briefs*, p 74) missing. Reasons for their absence include the relatively high booth cost and rental of large and prominent areas to financially well-heeled firms, a few suggesting that the number-in-the-hat method of assigning space might prove desirable for future shows. The industry was well represented.

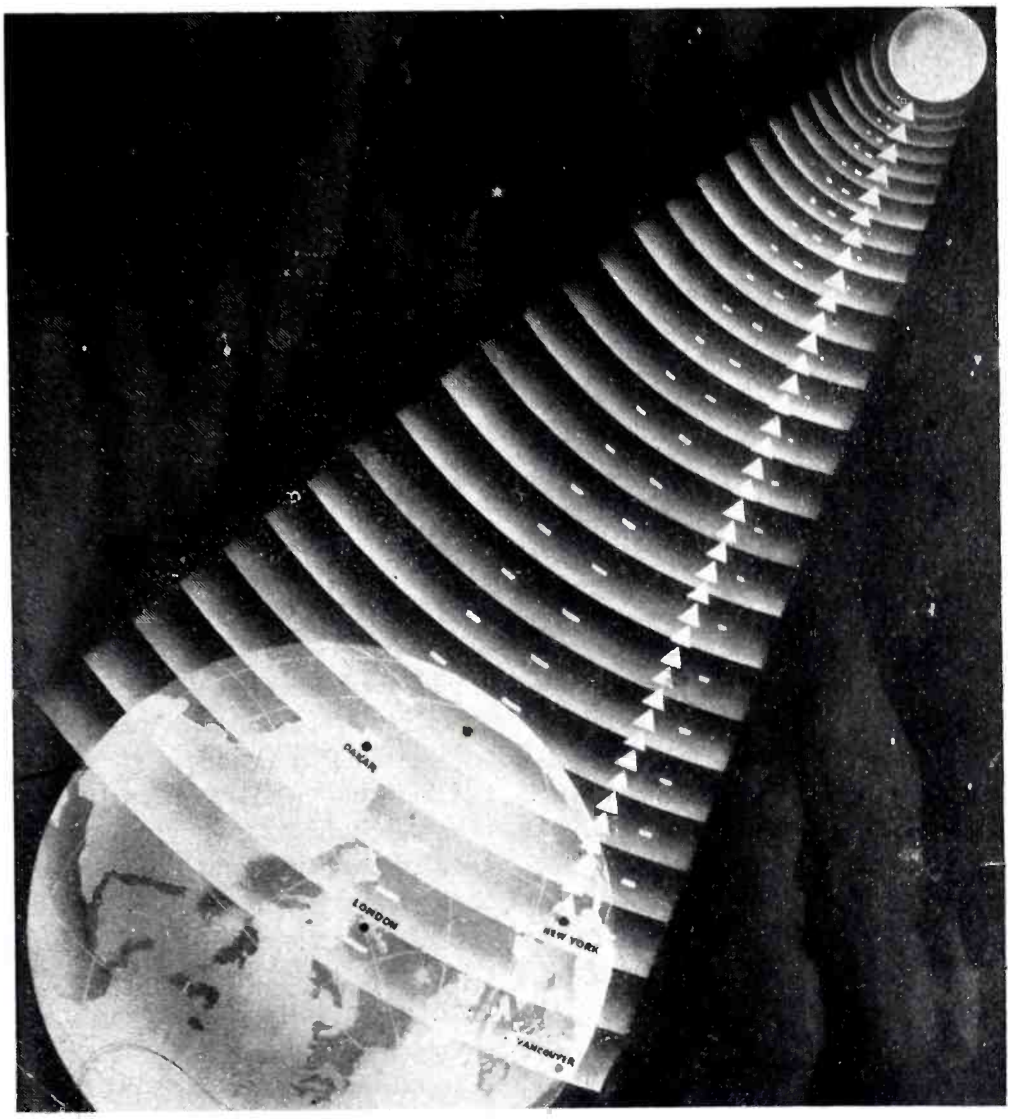
Checkup of the booths to determine what manufacturers were featuring in their displays disclosed that 30 percent placed the spotlight upon communications equipment of one kind or another, along with components and accessories for such equipment. Some 20 percent headlined laboratory or production measurement apparatus, indicating increased activity in the design and promotion of test instruments for the electronic and other fields. Com-



Airborne magnetometer used during the war to detect the presence of submarines beneath the surface of the sea, and now of wide interest to geologists (AIL) ponent parts suitable for general electrical as well as radio applications were featured by 19 percent. Raw materials were the stock in trade shown by 11 percent. Tubes were up front in 8 percent of the exhibits. Industrial electronic equipment displays were in the spotlight in 6 percent. Allied equipment neither electronic nor electrical but required in the production of most products in our field occupied the center of the stage in 6 percent of the booths.

#### Highlights

Technical trends and developments of major interest, judging from conversations with engineers around the exhibits, ragchews with people before and after meetings, and committee scuttlebutt, appeared to be the following:

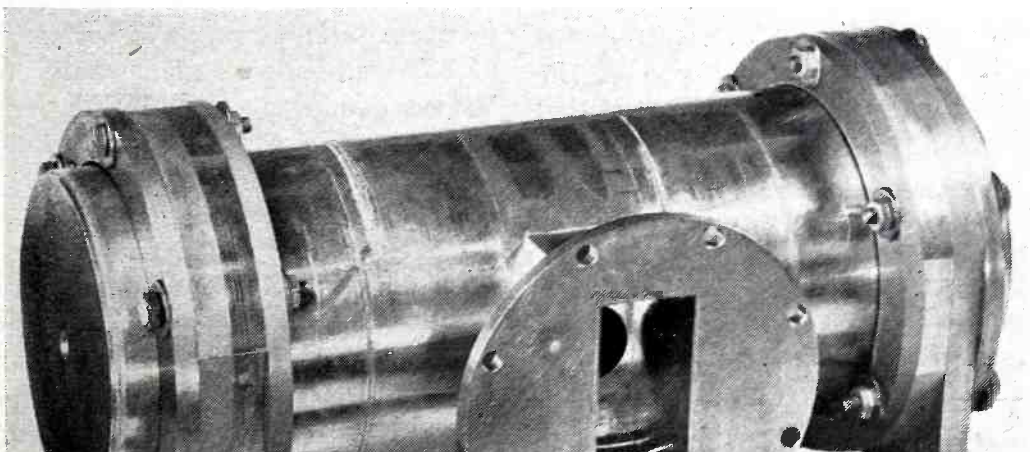


Artist's sketch showing a method by which microwave radio signals could be used for long-distance communications by reflecting them from the moon (Federal)

◖Commercial investigation of the possibility of reflecting microwave radio signals from the moon, along the lines indicated by Signal Corps experiments announced during last year's IRE show with such dynamic effect, with the hope that long-distance communication can be made possible and overcrowding at lower frequencies reduced.

◖Introduction of so-called memory tubes capable of accepting a multiplicity of mathematical or other data, storing the information indefinitely, and returning any part or all of it to the user on demand.

◖An imminently closer relationship between physicists and electronic engineers, on the one hand because physicists need the help of engineers particularly in the field of instrumentation, and on the other because nuclear physics especially may provide engineers with new tools, as for example in the design of tubes.


Six-section cavity, used for the linear acceleration of electrons at microwave frequencies in studies of nuclear physics (MIT)

◖Development of production and Testing techniques capable of increasing the number of television receivers available at the end of the line and reducing their ultimate cost, and adaptation of wartime circuits to the same end.

◖Various schemes for obtaining higher power outputs from the final amplifiers of f-m transmitters.

◖Modifications in existing pulse systems for communication, aimed at the ever-present problem of transmitting more intelligence in less bandwidth.

◖Expansion in the field of industrial electronic heating and, with an eye on the distant rather than the immediate future, development of practical devices of this type for the mass market in American homes.

◖Simplification of wartime-developed computers and calculators to meet commercial needs at commercial prices.

◖Refinements in magnetic recording devices, and particularly those lending themselves to broadcast station use.

◖Adaptation of telemetering techniques, at present advancing at a rapid rate due to military interest in guided missiles, to industrial jobs.

◖Widespread work on electronic instruments and systems for air and marine navigation, carrying with it the implication that the ultimate market in this branch of the field may be top drawer.

◖Growing availability of microwave components and equipment, coupled with slow application of the gear despite the certainty that it must some day be the workhorse of radio.

◖Design of high-gain vhf and uhf antennas, antennas radiating circularly polarized signals which reduce multipath reflections and, because of a current situation with respect to apartment-house television antennas pointed out in April (p 88) and elsewhere in this issue, design of master receiving systems for video signals.

### Technical Sessions

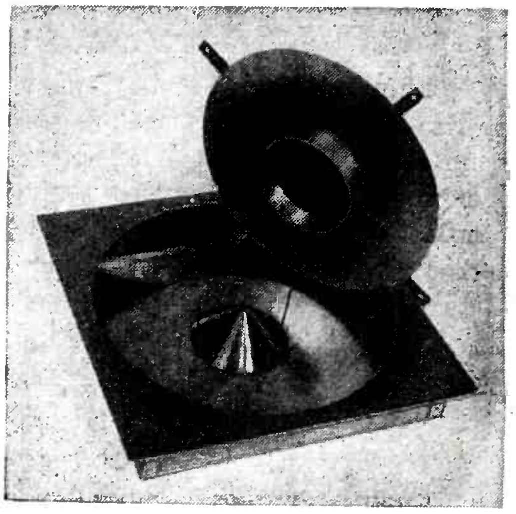
Technical sessions were well attended, most of them at least starting out with seats filled and, in some instances, with standees. Introducing an interesting innovation to accommodate the crowds, session chairmen in several instances repeated meetings later. In a few cases attendance dwindled during sessions, as listeners discovered that they were already familiar with the topics under discussion, or that details were not to be given. Meeting facilities were considerably better than at past meetings and people attending were for the most part tolerant of any confusion that did occur, realizing the extreme difficulty of handling such an unexpected crowd, the large number of papers scheduled and commented upon in April (*Crosstalk*, p 87), and complications introduced by the necessity for holding concurrent meetings at both the Commodore and the Palace.

Highlights of the technical sessions, covered by ELECTRONICS editorial staff members (JM, VZ, FR, AMcK), were as follows, judging by audience reaction:

**Particle Accelerators:** Cyclotrons, synchrotrons, synchro-cyclotrons, betatrons, and linear accelerators were described, with evident interest on the part of many in the audience hitherto concerned largely with communications circuits. For each type of particle to be accelerated and each phenomenon to be investigated there is one most suitable kind of machine and size of machine. All of them involve electronic circuits, either for power generation or control.

Interest was particularly high in connection with a description of a microwave linear accelerator consisting of 20 feet of waveguide with irises placed at intervals of about one foot to decrease the velocity of propagation of an electromagnetic wave down the guide. Electrons injected axially into one end of the guide are bunched and accelerated by a field, arriving at the far end at high velocities. The action is related to that of the travelling wave tube, but in the accelerator the electron beam travels slower than the wave and thus absorbs energy from it. The chief design problem is to supply power to the guide, to be accomplished by placing properly phased magnetrons at intervals along it.

**Measuring Equipment:** Two methods of presenting three-dimensional cathode-ray tube data proved generally intriguing. One provides perspective in a single tube by employing keystoning circuits to distort the image and so fool the eye very much as an artist would do it. The other employs two cathode-ray tubes viewed through Polaroid glasses.

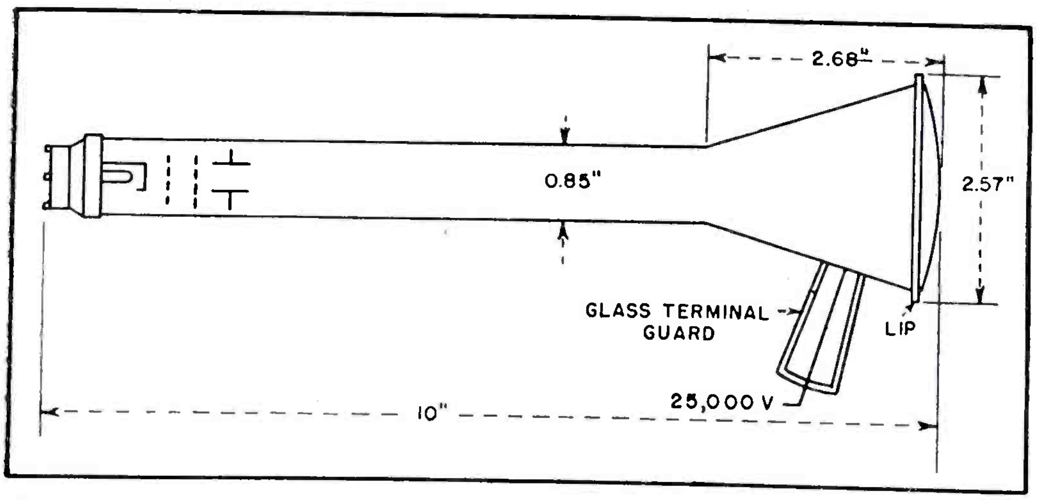


Annular-slot antenna designed to improve coverage from aircraft without introducing serious drag (AIL)

**Radar and Communications:** Of greatest interest was a description of a recently declassified radio relay set employing "lighthouse" triodes operating on 2,300 mc to establish communications over a line-of-sight 5-mile path, running 20 watts input and utilizing a new pulse-code or pulse-count method of modulation particularly adaptable to teletypewriter service.

**F-M Reception:** Discussion revolved largely around the operating characteristics of more or less well-known detectors, and methods of checking their performance. Several papers scheduled to be given at this session were not given.

**Aids to Navigation:** Audience familiarity with d-f equipment, radar, loran, and responder systems described caused the spotlight to be




Extremely compact cathode-ray tube designed for projection television receivers. Maximum diameter of the tube is just a little over 2½ inches, but it is capable of projecting a 12 by 16-inch picture (Philips) centered on a relatively new method of reducing precipitation static in aircraft installations. A number of sharp points, mounted within slotted cylinders through which slipstream air passes, are installed in the trailing edges of a wing. Motion of air carries away ions resulting from corona discharges at the points.

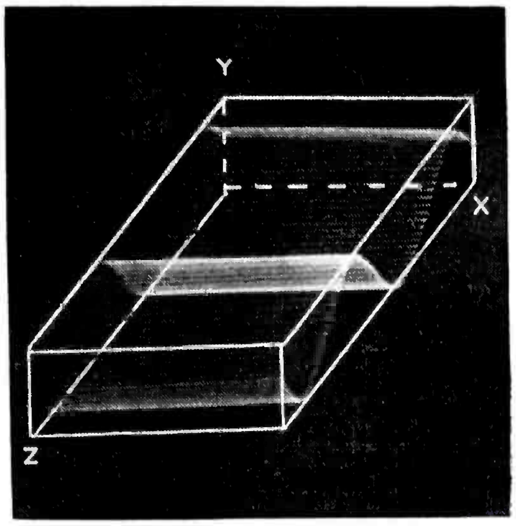
**Nucleonics Instrumentation:** The need, among physicists, for improved and new electronic instruments was stressed in several papers. Particularly needed are counting circuits of high resolving power and Geiger-Muller tubes of standardized design. A vibrating-reed electrometer in experimental use was described.

**Microwave Components:** Broad band i-f amplifiers with center frequencies above 100 mc, using four 6AK5 tubes, have been built for bandwidths of more than 2 mc, it was disclosed. Among means of obtaining wide passbands at these frequencies is inverse feedback.

**Television** (2 separate sessions): Broadcast station engineers seemed especially interested in the so-called "synchrolite" film projector system which reduces synchronizing difficulties. The receiver boys listened closely to discussions of the relative merits of various tubes and circuits utilized in receiver front ends, and particularly the suggestion that push-pull triodes might be efficiently used in r-f, oscillator, and mixer. Both sessions were well attended, and the audience stayed right to the end.

**Computers:** The Selectron, a so-called memory tube, comprises a source of electrons, a mica target coated with fluorescent material visible to an external phototube, and means for exposing selected portions of the target to the electrons.

A system of crosswires constitutes the grid; if two adjacent wires are negative or if one is negative and the other positive they stop electrons, while if both wires are positive electrons flow through that window area of the tube and reach the target. By paralleling various




Three-dimensional cathode-ray tube portrayal of a sinusoidal wave traveling down a waveguide, with the lines simulating the waveguide formed by an auxiliary lantern-slide projector

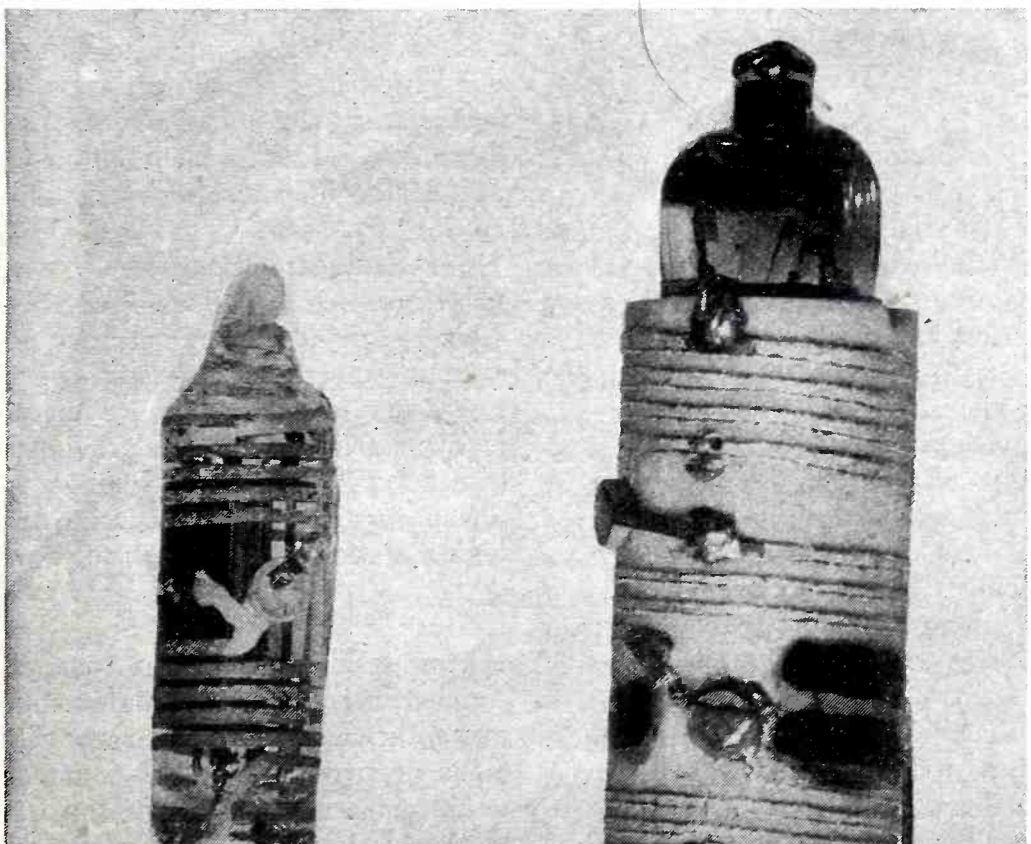
combinations of grid wires in either direction it is possible with 16 connections horizontally and 16 vertically to secure control over a total of 4,096 windows through which electrons can reach the mica. The charges created on various portions of the mica remain there for hours. To unstore them, one window at a time may be opened by appropriate switching circuits.

**Power Tubes:** Transmitter engineers were interested to hear that magnetrons are now useful in f-m and television equipment up to 4,000 mc, using a technique of controlling electron beams for changing frequency. A pair of 9C24 water-cooled triodes of ring-seal construction has been successfully used to give 20-kw f-m output on 92.1 mc and they have also worked out well in a 5-kw television transmitter.

**Circuit Theory:** Designers interested in the development of multistage amplifiers capable of faithfully reproducing complex waveshapes were told that phase bandwidth as well as amplitude bandwidth must be considered.

**Electronic Controls:** Seemingly out of place in this session but having considerable popular interest, a demonstration of a two-meter transmitter small enough to fit into an average lipstick holder by virtue of its use of printed circuits constituted the session highspot. Expansion of the packaged wiring idea, not necessarily printed, is foreseen.

An airborne magnetometer ca-



Two versions of a 2-meter transmitter, complete except for microphone and batteries, utilizing printed circuits. In one case wiring and components are placed right on the inch-long tube envelope, while in the other they are printed on a ceramic sleeve (NBS) pable of detecting field changes of 1 gamma in the earth's 50,000-gamma field proved generally interesting, as did a description of a variable r-f follower in which mechanical movement of one capacitor plate causes enough detuning to initiate movement of another plate for retuning.

**Air Traffic Control:** Many suggested systems were reviewed, with the audience split into about an equal number of partisan groups but quite aware of the fact that until standards are adopted internationally little stabilization in this branch of the field can be achieved. Keen interest was evident.

**Microwave Techniques:** F-M transmitters operating in the range from 88 to 108 mc may be tested off the air into resonant-cavity type dummy loads. Such loads, it seems, can now be designed to handle up to 50 kw.

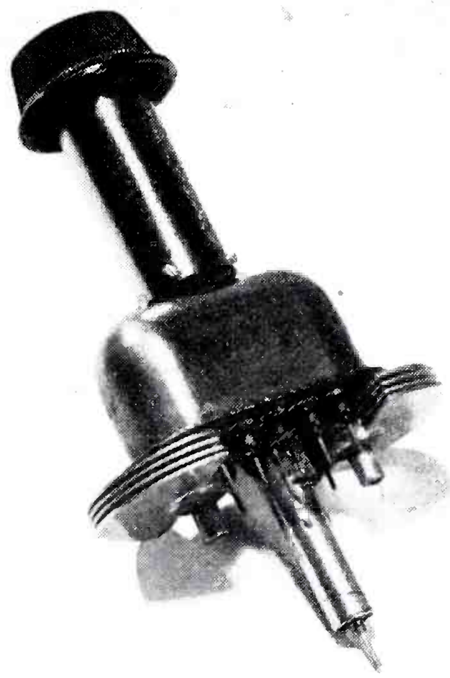
**Broadcasting and Recording:** Interest appeared to be about equally divided between equipment for monitoring f-m transmitters and refinements in the design of magnetic recording heads.

**Oscillator Circuits:** The theory of oscillator synchronization was explained in terms of variation in frequency with changes in load impedance, suggesting an approach to practical circuits for use in linear voltmeters, a-m demodulators, f-m demodulators, synchronous amplifiers, and servo systems.

**Basic Research:** It quickly became obvious to the audience that many new developments are in the offing, indicating a generally high level of national scientific health. The impact of electronics on other scientific fields has been tremendous. This has been particularly true in connection with astronomy and meteorology. The importance of nonlinear resistors and inductors was emphasized, and a need for nonlinear capacitors underscored.

**Wave Propagation:** Round-the-clock records of ionosphere reflections, shown in a moving picture, illustrated what happens at critical frequencies when layers shift. An instrument which plots phase fronts of waves emerging from antennas operating in the centimeter region was described.

**Relay and Pulse Systems:** Mathematical analysis of the possibility of worldwide radio communication by reflection of microwave signals from the moon appeared to indicate the economic feasibility of telegraph, teletype, or speech transmission with reasonable power, though antenna structures and moon-tracking gear would probably be sufficiently complicated to preclude any but commercial installations. During presentation of this paper, highest in news value during the session, it was pointed out that on a New York-Paris channel the moon could be used as a reflector only during an average of seven hours or so per day when it was visible at both sites.



Magnetron suitable for use in high-power f-m and television transmitters (RCA)

There was considerable interest in the suggestion, in another paper, that severe fading on microwave radio relay links could generally be greatly reduced by employing two receiving antennas spaced as little as six feet apart in a diversity system.

**Receiver Circuits:** Surprisingly little that was new was divulged during this session. An ultrasonic filter using a few postage-stamp-size pieces of stainless steel and magnetostrictive terminations of nickel, adaptable to superheterodyne receivers at low cost and giving practically perfect flat-top and steep-sided i-f response, easily dominated discussion.

**Vacuum Tubes:** Radio-frequency induction welding is proving very useful in the manufacture of microwave tubes requiring close tolerances, and is simplifying production line assembly. Using this technique to form ring seals and joints, a vhf triode providing 100 watts output up to 1,200 mc has been developed.

The need for higher conversion transconductance and lower output noise in either conventional tubes or crystal mixers has led to the development of an experimental beam-deflection type. Used as a mixer in the 500 to 1,000 mc range, this tube outperforms conventional tubes and radiates only about 0.02 microwatt of r-f.

**Antennas:** A discussion of antennas capable of radiating and receiving circularly polarized waves brought out the point that the adverse effects of reflections may be minimized in this manner since a wave radiated with a right-hand twist or characteristic, when reflected ,would have a left-hand twist to which a matching receiving antenna would be relatively unresponsive.

A close second in interest at the session was a description and demonstration of gear permitting aircraft antenna designs to be scaled down, installed on a model aircraft, and tested at microwave frequencies.

**Waveguides:** Considered the most interesting paper at this session, again judging by audience reaction, was a description of a waveguide phase-changer using circularly polarized waves to provide a continuously adjustable change of phase in transmitted power with negligible loss.

### Publication of Papers

The large number of papers, coupled with their simultaneous presentation at four concurrent sessions at two places, led a number of engineers to suggest that it might be desirable for the IRE to gather them all together in a book. No plans for so doing are in evidence at this writing. However, certain of the papers have appeared since the meeting in publications such as ELECTRONICS, or will appear in coming months, and the I.R.E. Proceedings will publish others.

—W. MacD.

# WWV Schedules

**Summary of technical services now available, with significance of code signals and time ticks. Four new transmitters, on 20, 25, 30, and 35 mc, have recently been added, and accuracy of all carrier frequencies has been boosted to better than one part in 50,000,000**

RADIO STATION WWV, operated by Central Radio Propagation Laboratory, National Bureau of Standards, Washington, D. C., now has seven or more transmitters operating day and night, insuring reliable coverage of the United States and extensive coverage of other parts of the world and making available six services.

STANDARD RADIO FREQUENCIES.—Any desired radio frequency, including microwave frequencies, may be accurately measured in terms of the available standard radio frequencies listed in the table.

STANDARD AUDIO FREQUENCIES.—Accuracy of the 440 and 4,000-cps audio frequencies is better than one part in 50,000,000. Doppler and other transmission effects may cause slight fluctuations at times, but the average is accurate.

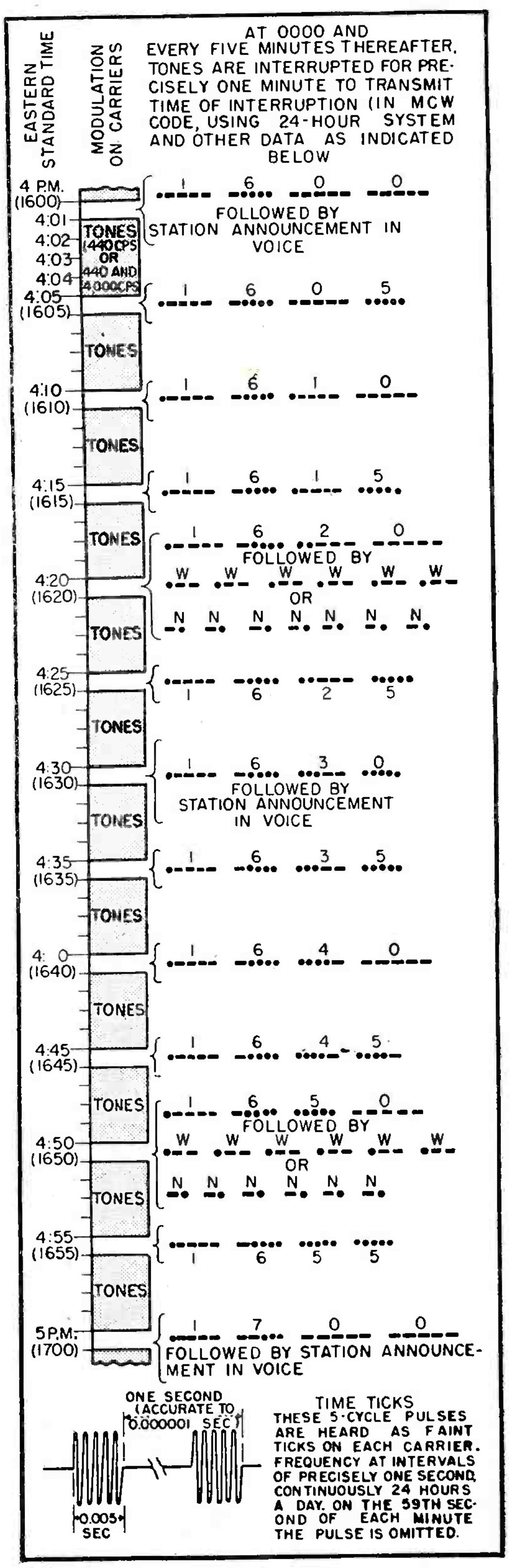
TIME ANNOUNCEMENTS.—Audio tone modulation frequencies are interrupted precisely on the hour and each five minutes thereafter for time announcements in International Morse Code, as indicated in the diagram. The time given is the moment of interruption of the tone modulation. Each interruption lasts precisely one minute, affording an interval for checking r-f measurements free from audio.

STANDARD TIME INTERVALS.—Faint time ticks in the background during the tone broadcasts and one-minute announcement periods serve as useful standard time intervals of one second. The ticks are synchronized with tone interruption to provide precise longer intervals of 1, 4, and 5 minutes also.

STANDARD MUSICAL PITCH.—The 440-cps tone is the standard musical pitch, A above middle C.

RADIO PROPAGATION DISTURBANCE WARNING NOTICES.—These are in code at 20 and 50 minutes past each hour, and apply to paths that lie in or near the northern auroral zone. W signifies warning of radio propagation disturbance in progress or anticipated within 12 hours on North Atlantic transmission paths, while N means no warning (normal propagation). Low signal intensities, rapid fading, and complete blackout are the effects. Shifting to lower frequencies may help. The warnings do not apply to sudden ionospheric disturbances due to sunspots, which are unpredictable and cause blackouts lasting from a few minutes to two hours.

**Example Of WWV Hourly Transmissions On All Frequencies**

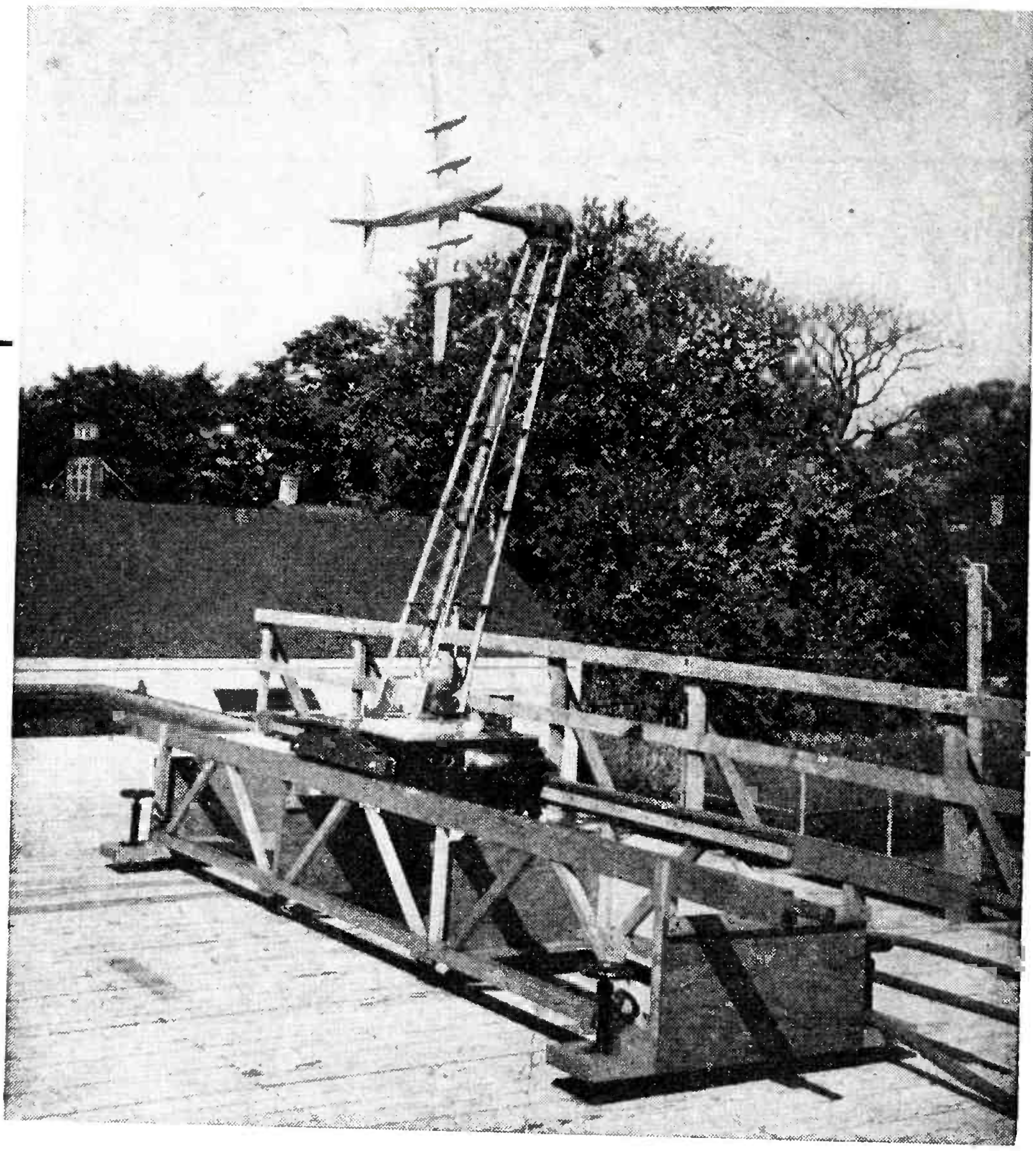



**DAILY BROADCAST SCHEDULE OF WWV**

| Carrier Frequency in mc | Hours on the air, E.S.T. | Hours on the air, 24-hour system | Power output in kw | Audio frequency in cps |
|---|---|---|---|---|
| 2.5 | 7 p.m. to 9 a.m. | 1900 to 900 | 1 | 440 |
| 5 | 7 p.m. to 7 a.m. | 1900 to 700 | 10 | 440 |
| 5 | 7 a.m. to 7 p.m. | 700 to 1900 | 10 | 440 and 4,000 |
| 10 | continuously | 0000 to 2400 | 10 | 440 and 4,000 |
| 15 | continuously | 0000 to 2400 | 10 | 440 and 4,000 |
| 20 | continuously | 0000 to 2400 | 0.1 | 440 and 4,000 |
| 25 | continuously | 0000 to 2400 | 0.1 | 440 and 4,000 |
| 30 | continuously | 0000 to 2400 | 0.1 | 440 |
| 35 | continuously | 0000 to 2400 | 0.1 | 440 |

# Aircraft Antenna

Tower for rotating aircraft model through 360 degrees of any desired plane while in the beam of a microwave antenna (see color photo on front cover)



PRACTICAL aircraft antennas are never designed solely from theoretical first principles. In the frequency ranges where aircraft dimensions are comparable with radio wavelengths it is extremely difficult to predict accurately the radiation pattern which a particular antenna installation will exhibit because the entire aircraft is actively a part of the antenna system. Only experimental measurements, therefore, will conclusively establish the actual performance of a new antenna or the effectiveness of a familiar antenna in a new location.

In the day of slow aircraft with antennas draped about the exterior of the plane it was feasible, although terribly expensive, to flight-test an antenna and rearrange it until satisfactory results were obtained. The advent of high air-speed has required enclosure of antennas in the general streamlined structure of the aircraft. It is, therefore, imperative that the position and size of all antennas be established while the aircraft is still on the drafting board and, consequently, before flight tests can possibly be made.

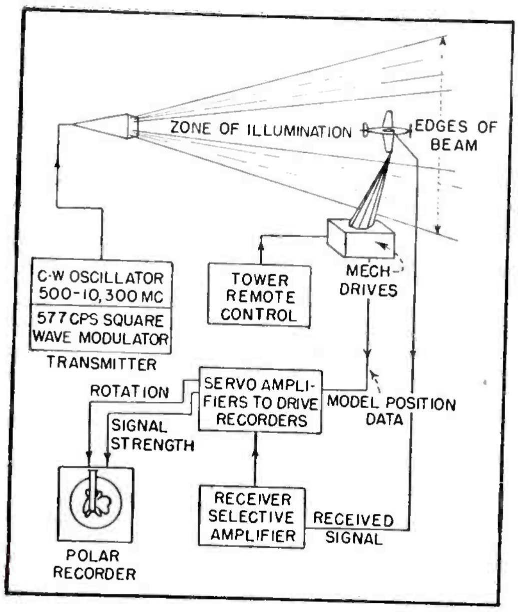



**FIG. 1—Block diagram of complete system for measuring aircraft antenna radiation patterns in miniature**

A mockup of the aircraft could obviously be used for test purposes, but it would have to be suspended well above the ground to simulate flight conditions, and would be clumsy to maneuver. Modern microwave techniques, however, make it possible to conduct the experimental measurements in miniature.

### Scale-Model Tests

By reducing the aircraft, its antennas, and the wavelength of the radio signals in identical ratio all the geometrical properties of the full-scale system are preserved, and it becomes possible to make measurements on aircraft models no larger than those used as toys. Thus, for example, an aircraft 30 meters in wingspread with an antenna 30 cm high working with 3-meter (100-mc) signals can be perfectly represented by a model 1 meter in wingspread with an antenna 1 cm high if 10-cm (3,000-mc) radiation is used.

With available test frequencies between 500 mc and 10,300 mc and with usable model size between 5 feet and somewhat above 1 foot, we can ordinarily model operating frequencies from below 5 mc to above 500 mc, using small models at the lower frequencies and larger models for the higher frequencies.

Fortunately, an antenna has identical directional characteristics whether used for receiving or transmitting. Thus it is necessary to measure only one characteristic to establish both. It is convenient to use the model antenna as the receiving antenna in all cases, thereby eliminating the necessity of housing the transmitter in the model

# Pattern Plotter

**Technical details of technique in which an aircraft, its antennas, and the signal wavelength are reduced in identical ratio and microwave techniques utilized to obtain as many as 40 complete radiation patterns per hour**

By OTTO H. SCHMITT and WILLIAM P. PEYSER

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plane or feeding a microwave signal to it by cable.[1] The problem thus resolves itself into one of providing a suitable model aircraft and antenna, providing a radio-frequency field to illuminate it, and providing means to rotate the model and record automatically the received signal as a function of rotation.

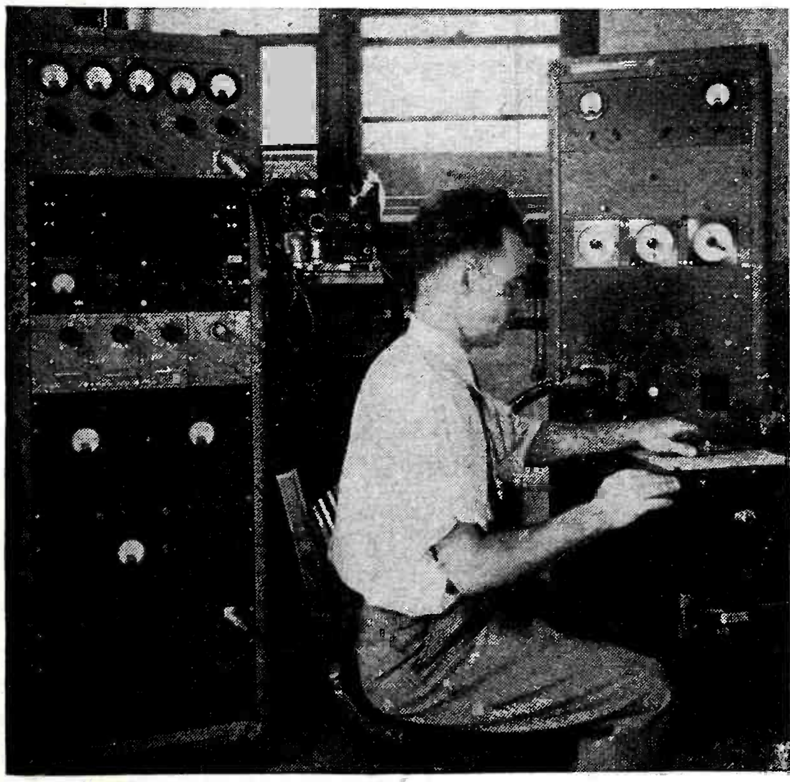
#### Complete System

The general arrangement of the complete pattern-measuring system is shown diagrammatically in Fig. 1. Continuous-wave transmitters, square-wave modulated at an audio rate, produce any desired radio frequency between 500 and 10,300 mc. Two separate oscillators, each with its own power supply, are employed to cover continuously this entire frequency range. They share a common modulator, and all primary a-c power is drawn from an a-c regulator which is followed by electronic regulators in all d-c circuits to give high stability. Square-wave modulation with 50-percent duty cycle at precisely 577 cps is provided by the modulator unit.

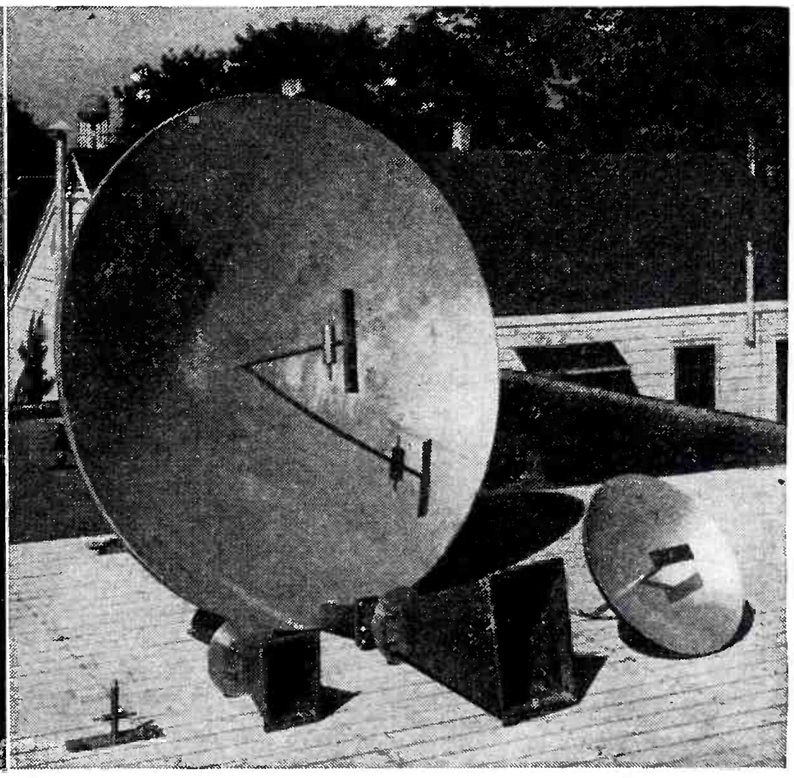
A 2C39 oilcan triode in a grid-separation coaxial-cavity oscillator circuit is used in the transmitter, which covers the 500-2,760 mc range. Tuning is expedited by means of prepared charts specifying the values of cathode and plate line adjustment. Final tuning is, of course, done against a wavemeter. This low-frequency transmitter produces from 50 watts (at its lowest frequency) to at least 5 watts (at its highest frequency), and it is usually throttled down to prevent excessive field strength at the model.

Overlapping the above range and reaching from 2,660 to 10,300 mc, the klystron transmitter uses very highly regulated power supplies for reflector, grid, and accelerator voltages. Five reflex klystrons of the 2K series cover the entire band and are mounted permanently in individual readily-interchangeable plug-in units.

The functioning klystron, a blower, an r-f impedance-matching transformer, and safety devices are



Microwave transmitter rack (left), audio and synchro control rack (right), and antenna pattern recorder used in conjunction with model-supporting tower and antenna outside



Pyramidal horns and parabolic reflectors for covering frequency range from 500 mc to 10,300 mc to provide required wavelengths for scale model antennas mounted in a small remote unit which can be located close to the transmitting radiator, to which it can be connected by a few inches of coaxial cable.

The klystron can be controlled from the transmitter once it is tuned. An output indicator provides an indication both at the remote klystron and at the operating position for use in tuning. In addition, a tunable crystal probe is provided to permit continuous monitoring of the antenna output.

#### Radiator Family Used

In pattern-measuring work a beam of radiation of angular width just sufficient to illuminate the model uniformly, but not wide enough to cause much reflection from nearby floors or other objects, is required. To meet this condition a family of five radiators, each covering about an octave in frequency, has been developed. These, within their ranges, give nearly uniform angular coverage of 5 to 8 degrees in both H and E planes and have little cross-polarization. The two radiators for the three low-frequency ranges (500-1,000, 1,000-1,800, and 1,750-3,150 mc) are parabolas with wide-band exciters. Interchangeable exciters permit double use of one parabola.

Two pyramidal horns cover the ranges 3,100-5,700 and 5,650-10,300 mc. The horns are fed by tapered-ridge wide-band waveguide exciters which maintain about 2:1 standing wave ratio to 50 ohms over their ranges. Dielectric correctors placed at the mouths of the horns improve their patterns.

All of the radiators fit interchangeably into a single mount. Provision is made to rotate the radiators quickly from vertical to horizontal polarization.

#### Tower and Models

Airplane models for this system are built precisely to scale (in the patternmaker's fashion, of light, easily worked woods, balsa, sugar pine, spruce, and mahogany) and are hollowed out to house tuning units and to save weight. Models are flame-sprayed first with aluminum and then with copper to provide a highly conductive, easily solderable surface without greatly increasing weight. A skilled model maker requires about one working week to produce a typical model. Once made, a model is usually employed in testing a variety of antennas or one antenna in several positions until a satisfactory location is found. Patches on the model to cover old antenna test locations are readily made with thin sheet copper and solder.

The tower upon which the model is mounted for tests is built of dry spruce strips with thin mahogany bulkheads, braced with tensioned lacings of Fiberglas cord. The Fiberglas cord has elastic constants comparable with those of piano wire so that the resultant tower is extremely rigid, though light in weight and without metal. Wood and lacing are impregnated with a plastic. Mechanical power for rotation of the model is transferred to the tower head by a dielectric torque tube; the model is driven by means of spiral bevel dielectric gears supported in dielectric ball bearings. A draw-in collet arrangement permits quick and secure attachment of models.

The tower is tilted 15 degrees off the vertical to permit the model to rotate about itself rather than about the tower, thus decreasing the width of radio beam required. The tower provides for three independent powered motions of the model. The whole tower moves back and forth on a trestle and it rotates about a vertical axis. In addition, the model can be rotated about its own mounting axis.

#### Bolometer-Type Detector

Contained in the airplane model is the r-f portion of the receiving system. It consists of an impedance-matching unit which may be of the single or double stub variety, and a bolometer (or a crystal) to demodulate the r-f signal. A detachable tuning tool which can reach into the interior of the model is used to tune the stubs.

The actual detector usually employed in this work is a bolometer which may be either a specially designed Wollaston wire unit or a common instrument Littelfuse of 5 or 10 ma rating. The bolometer is kept at a temperature not far below burnout by a constant d-c biasing current. As modulated r-f reaches the fuse its very fine wire heats and cools in response to the individual modulation cycles, and consequently changes in resistance. These changes in resistance in a current-carrying circuit are equivalent to an audio-frequency voltage input at modulation frequency.

The audio signal is led by a doubly shielded cable to a high-gain audio amplifier located in the receiver rack. The position of this cable in the field of radiation must be carefully chosen, especially at the lower r-f frequencies, to minimize the disturbance introduced in the field.

#### Audio Amplifier

The audio amplifier has a very high gain (154 db) and low input noise level. Such characteristics are

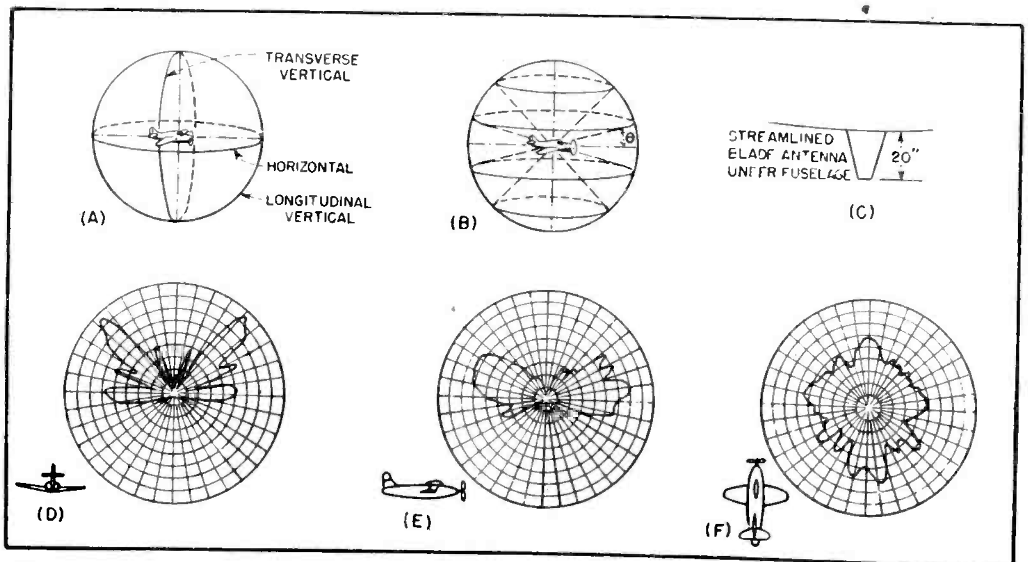



**FIG. 2—Principal plane patterns are shown at (A), conical radiation pattern planes at (B), streamlined blade antenna used in tests at (C), and principal plane patterns for streamlined blade antenna at (D, E, and F)**

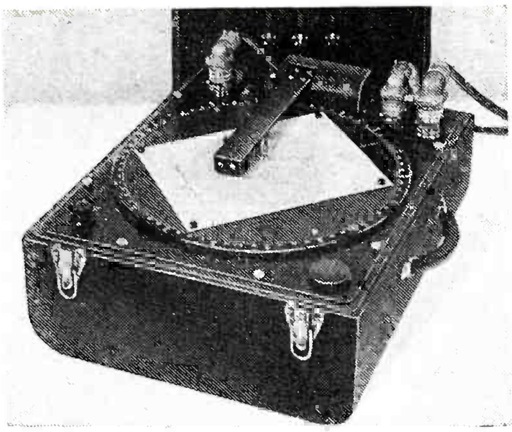
necessary because the klystrons used are low r-f output power devices, delivering only 0.25 to 1 watt to the transmitting radiator. Low noise level is achieved by sharp tuning of the amplifier to 577 cps. Amplifier bandwidth is 6 cps, which permits reasonably rapid response, yet allows an equivalent background audio noise level at the bolometer of 1/40 microvolt or less, only a little above resistance noise level. Surprisingly enough, this low-level audio-frequency signal can be sent without preamplification over a conventional doubly-shielded microphone cable more than 100 feet long.

Bolometer resistance varies linearly in response to temperature change, which in turn is proportional to power input, not to voltage. In recording patterns in terms of power this is an advantage, for the bolometer amplifier yields this information automatically.

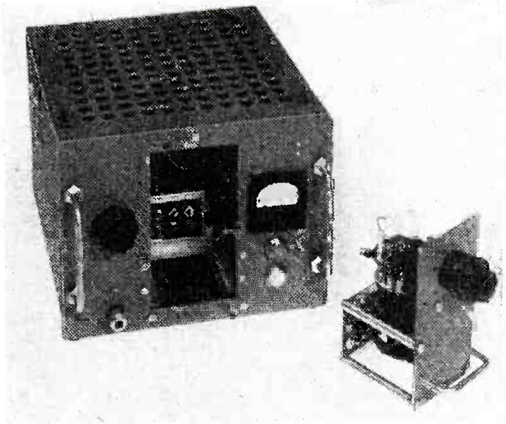
To obtain recorder output in terms of antenna voltage instead of power, the square root of the received signal—instead of the received signal itself—must be plotted. The high-gain audio amplifier incorporates a special square-root section to accomplish extraction of this square root through introduction of nonlinear feedback. This section of the amplifier may be switched in or out at will.

A single well-regulated power pack feeds rectified power to the entire high-gain amplifier and the bolometer. Despite high gain and the presence of sharply tuned band-pass circuits the amplifier has no tendency to oscillate. This stability results mainly from the very low power supply impedance (about 5 ohms) and from good decoupling and shielding. Filament heating with a-c is used throughout.

The polar recorder developed for use with the system permits automatic plotting of the audio amplifier output voltage as radial distance against angular position of the aircraft model given by synchro or selsyn generators in the tower base. Two separate high-speed servo motor systems position the turntable and pen respectively. Switching equipment connects the turntable servo to any chosen tower motion.



Antenna pattern recorder



Oscillator with plug-in klystron unit

The recording pen is driven by a servo motor of exceptionally low inertia, writing on polar charts in accordance with the signal from the high-gain amplifier. A precision potentiometer followup system equipped with rate circuits for high-speed deadbeat operation ensures accurate pen positioning.

A pinhole showing a light at the exact center of the turntable aids in centering the polar charts, which are specially printed on tracing paper to permit easy reproduction. A scribed radial line on the turntable surface is lined up with the zero axis of the paper and the paper is clipped to the steel surface with small Alnico rosette magnets.

### Operation of System

The airplane model, complete with scale model antenna and bolometer circuit, is mounted on the tower head in the uniform radiation field produced by the proper radiator. The model is rotated and the received signal is recorded on the polar recorder, plotting signal strength against angular position of the model with respect to the source of the radio field.

The angles of elevation and azimuth used in recording antenna patterns represent one pair of the many possible coordinates by means of which the field about an aircraft can be described. In these coordinates the type of patterns shown in Fig. 2A are known as principal plane patterns, and those shown in Fig. 2B are known as conical patterns. Samples of principal plane patterns for the streamlined blade antenna of Fig. 2C are shown at D, E, and F.

Conical patterns are taken by allowing the elevation angle (tower rotation) to assume successive values 5 to 10 degrees apart, each time rotating the model airplane 360 degrees about its mounting axis. A typical family of patterns will include the three principal plane patterns and nineteen conical patterns. Since the horizontal principal plane is included among the conical patterns, however, the family total is twenty-one patterns for any one antenna at one frequency and one polarization.

Once the model is mounted on the tower and the transmitting and receiving systems have been tuned, actual pattern measurements proceed rapidly. Forty-two patterns, representing complete data for an antenna at one frequency and for both polarizations, have often been secured in one hour.

The authors wish to acknowledge the able assistance of the following men, now or formerly with Airborne Instruments Laboratory, in the development of this aircraft antenna radiation pattern measuring system: Roger E. Avery, Wesley A. Fails, Winfield E. Fromm, R. A. Isberg, George W. Smith, and Gerard D. Sullivan.

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# CARRIER-TYPE

**Flat frequency response from 1,250 cps down to zero frequency is obtained by making various types of gage circuits modulate a conventional RC-coupled amplifier. Applications include static and dynamic tests of railway rolling stock, tracks, and bridges**

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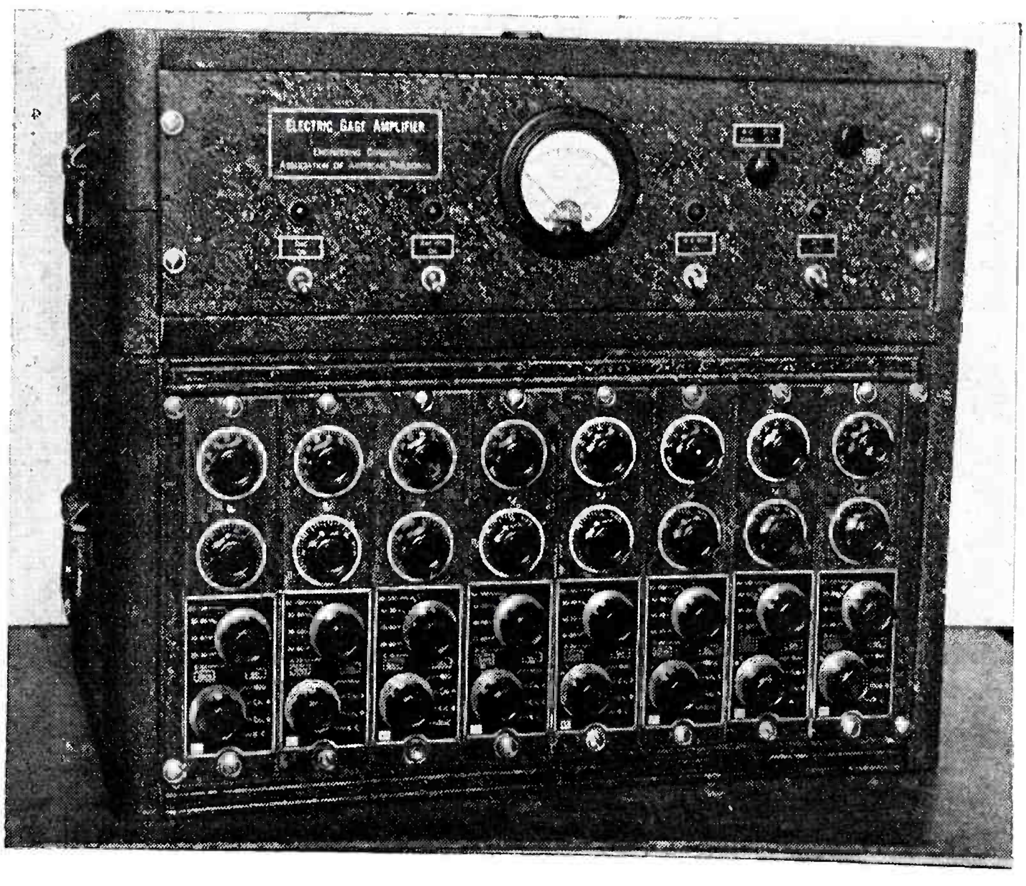
THE MOST DESIRABLE amplifier for general research is one which can be employed with almost any sort of primary element—or with a series of interchangeable primary elements of different types—and which can employ any one of several different types of indicating or recording instruments. Railway engineering research involves the use of electrical gaging devices for measuring and recording the various mechanical magnitudes such as strain, movement, pressure, and acceleration, for dynamic measurements of strains or movements occurring in rails or their fastenings, rail joints, bridges, or other structures associated with the track, for measuring strains and accelerations in various parts of locomotives and pressures in their cylinders, for measuring strains, movements, and accelerations occurring at critical locations in passenger and freight cars, and for measuring riding quality of the several types of equipment. Static measurements of many magnitudes are also made, with electric gages often supplanting the mechanical types.

It is convenient, whenever possible, to convert the unknown magnitude (of whatever form) into a movement or strain, and thus reduce the number of kinds of primary elements needed. The most desirable arrangement is to have a very few kinds of primary elements, and a single type of amplifying system for all measurements. The amplifying system described here represents an attempt to arrive at such a system.

Bank of eight amplifiers, with a common power supply fitting on top of the amplifier cabinet. Heavy steel cases provide the required sturdiness for use on railroad tracks or trains




#### Essential Requirements

The following requirements were considered essential:

(1) Frequency response continuous from 0 to 1,250 cps and uniform over this range.

(2) Output current (into a 16-ohm instrument) at least as great as 60 milliamperes, in either direction from an arbitrary zero position.

(3) Sufficient gain to give full output from an input signal of only 0.3 millivolt.

(4) Operation with connecting cables as long as 400 feet on the input end.

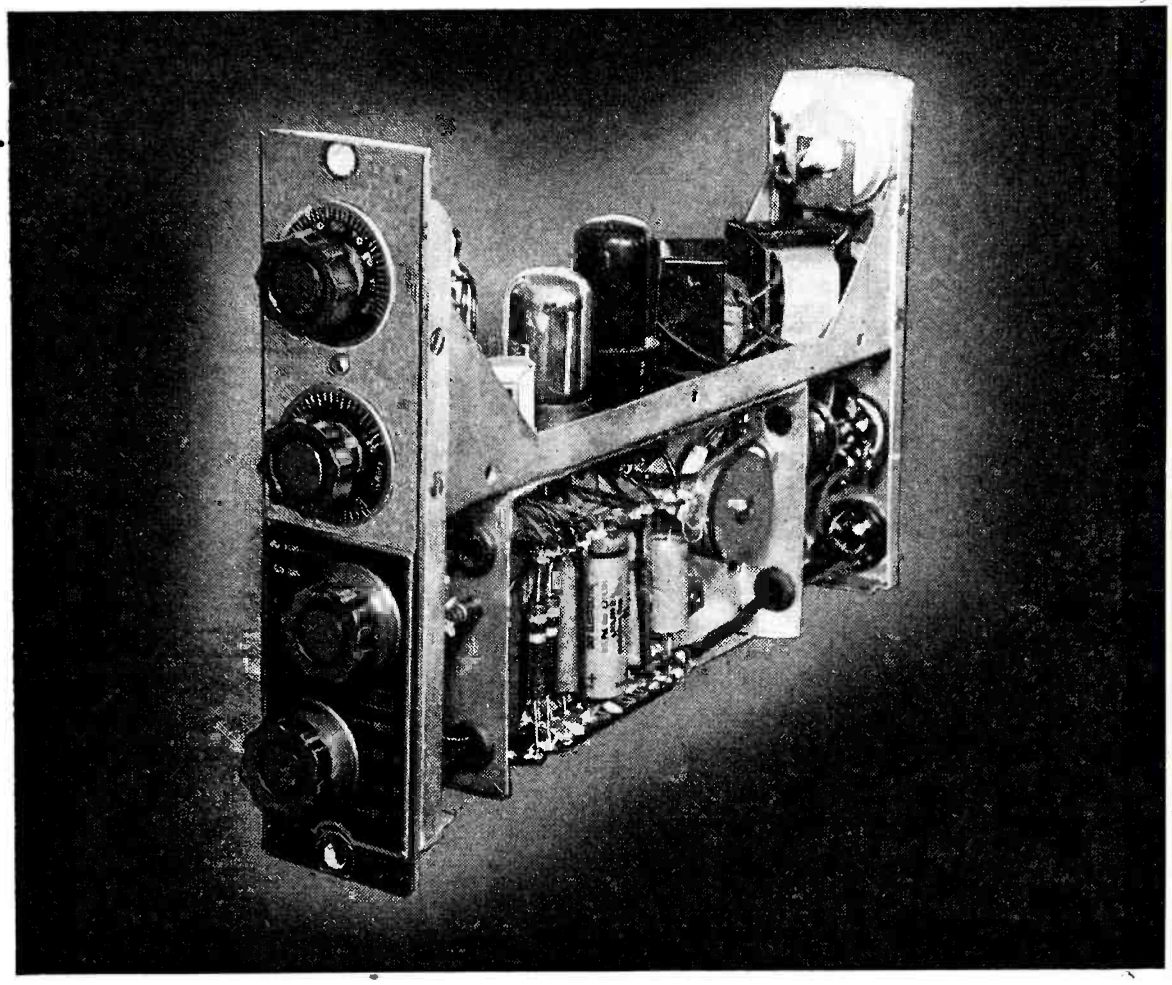
(5) Operable in field conditions, with a prime source of power subject to variations in voltage and frequency of plus or minus 10 percent.

(6) Sufficient ease of operation and stability of adjustment so that one man can handle as many as 24 channels of measuring equipment, including the recording oscillographs, and possessing sufficient resistance to outside influences (vibration, temperature change, etc) that long continuous runs can be made without need for frequent checking of adjustments.

In addition, it was considered desirable that these conditions be fulfilled:

(7) Complete interchangeability

# AMPLIFIER for Electric Gages



Chassis of an individual amplifier

of power supplies, and of the separate amplifier channels.

(8) Bulk, weight, and mechanical design to be such as to permit ease in handling, shipping, and installation in test cars and buildings. Power demand to be low, for field operation; the source of power in field operation to be a small gas-engine generator. All items of equipment to be operated from 115-volt, 60-cycle current.

(9) No special electrical components to be used; no electron tubes of special characteristics to be required.

(10) A circuit embodying a phase-discriminator to be employed with carrier-type operation. This provides that when the output of an a-c bridge circuit is amplified, there is no amplifier output until some unbalance occurs. The output then represents, in both direction and magnitude, the direction and magnitude of the unbalance of the bridge. This facility, in addition to contributing enormously to ease of operation, makes the use of an arbitrary zero point unnecessary.

In the development of the final design, it was found possible to incorporate all the above features. Primary design considerations were dictated by the first group of requirements, since there is no practicable method by which all these can be fulfilled excepting through the use of a carrier-type system with a low-impedance output circuit. Direct-coupled amplifiers have been successfully used in somewhat similar applications, but were immediately ruled out here by the simultaneous requirements of high current output and low primary power demand. Extended-response resistance-capacitance coupled amplifiers cannot be made to have the true zero-frequency response required, and in addition are increasingly difficult to design as the low-frequency response is extended. The only choice is the carrier-type system.

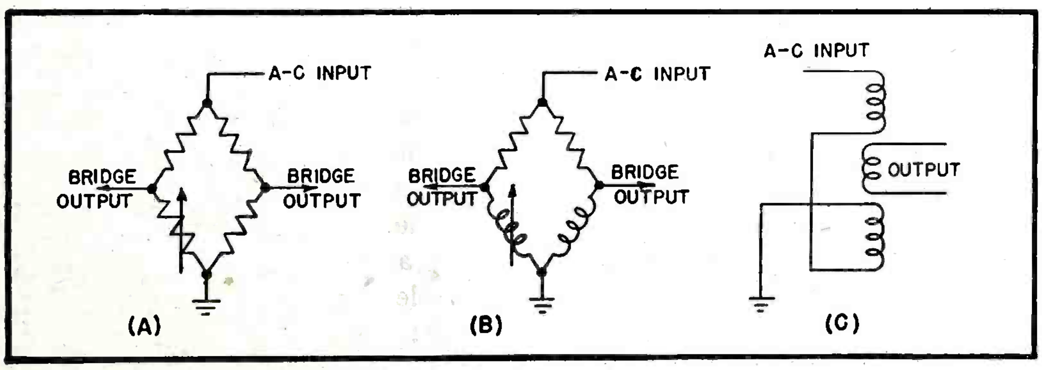



FIG. 1—Typical input circuits used with carrier-type amplifier

#### Final Circuit

The heart of any carrier-type amplifier system is an orthodox amplifier, usually resistance-capacitance coupled. The system finally developed employs a simple three-stage amplifier of conservative but careful design, incorporating two triode voltage amplifier stages and a pentode output stage. Contrary to popular practice, little negative feedback is employed—only about 5 percent, and this through dressing of leads.

The input circuits were to be designed for mechanical measurements, hence the most desirable arrangements was that in which modulation of the carrier frequency was accomplished in the primary element itself or in its associated bridge circuit. Most gaging applications employ some type of four-arm a-c bridge circuit either as a part of the pickup or as a modulating device, in conjunction with either wire-type variable-resistance strain gages or with variable-inductance gages of some form.

In all such bridge circuits, the magnitude of the signal produced varies with the degree of unbalance of the circuit, and the direction of unbalance is indicated by the phase of the output potential. Therefore, each amplifier input circuit has an auxiliary pair of bridge arms, with adjustable phase angle, to provide both resistance and reactance balance for an equal-ratio bridge circuit to be connected externally. It is possible to produce almost a 90-degree phase shift in either direction with this circuit without appreciable change in sensitivity, so that either inductive primary elements or capacitive elements can be used if desired—although at a lower efficiency than resistive elements.

The amplifiers, therefore, although designed specifically for use with resistive primary elements, can be employed with any primary element so constructed as to provide a signal varying in magnitude with the mechanical magnitude, and in phase with the mechanical direction. Representative primary elements, shown in Fig. 1, include a resistive bridge (A), an inductive bridge circuit (B), and a mutual-inductance-type primary element (C) which has a pickup coil spaced between two oppositely poled exciting coils so that the polarity and magnitude of the potential induced in the moving coil are affected by its position between the fixed exciting coils.

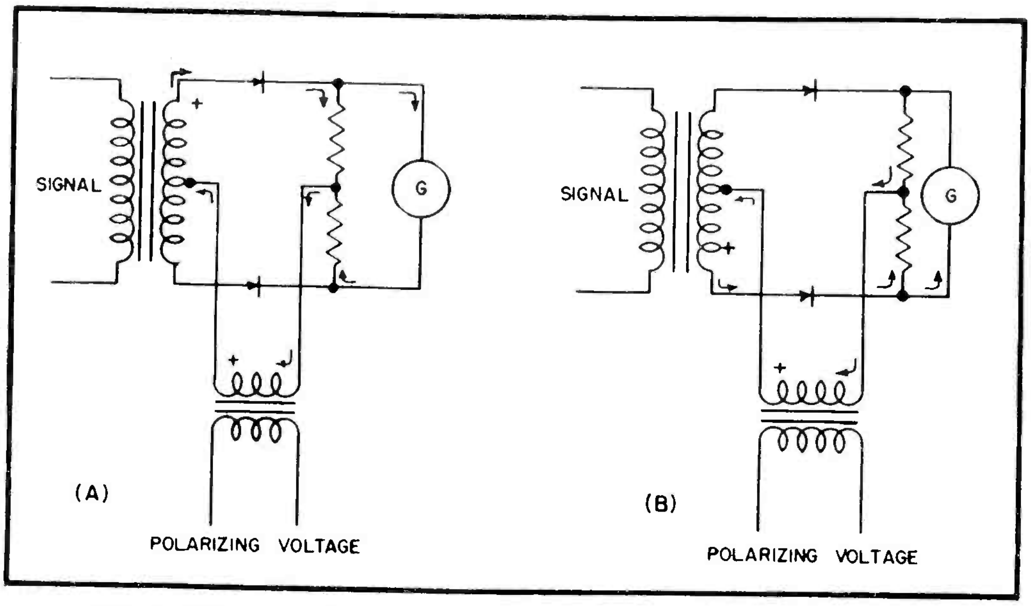


FIG. 2—Directions of current flow in bridge-type demodulating circuit

### Demodulating Circuit

The demodulating circuit employs dry-disc contact rectifiers to provide currents of the order of 0.1 ampere for a low-impedance instrument.

The simplest demodulator circuit for audio-frequency carriers is the full-wave rectifier-filter combination, which provides an output varying in amplitude with the magnitude of the signal entering the amplifier. To indicate polarity, it is necessary to operate always with some unbalance of the bridge circuit, and with some output from the amplifier. This system has many advantages as regards simplicity of construction, but it does not have so great a useful range as do some of the phase-discriminating circuits, nor does it offer the same convenience in operation.

A further advantage of the phase-discriminating output circuit is that it is possible to incorporate some degree of rejection against out-of-phase components, and thus reduce the zero drift and possible change in calibration when there is a change in the capacitance of the connecting leads. This is of considerable practical importance in field testing.

The output circuit selected for these amplifiers is a modification of one of the oldest devices of the type—the Walter phase-selective rectifier bridge. It differs from the original form primarily in that the points of connection of signal and of polarizing voltage are interchanged; this provides increased efficiency, although it requires much more polarizing energy and requires too that the wave-form of the polarizing current be good. Half-wave rectification only is afforded.

Directions of current flow for the two 90-degree periods during which current flows through the indicating instrument *G* are shown in Fig. 2. As constructed, the output circuit is capable of providing output current as high as 75 milliamperes in either direction from the balance point when it is used with a 16-ohm galvanometer. A complete amplifier circuit is shown in simplified form in Fig. 3, along with its output circuit.

The filter in the galvanometer circuit is a simple low-pass type. The carrier frequency most often employed is 4,000 cps. Since the galvanometers ordinarily used have little response above 2,500 cps and are not expected to be used above 1,500 cps, sharp-cutoff filters are not required. Tuned filters, often used in such apparatus, have the disadvantage that any stray currents which may be picked up in field conditions may produce modulation frequencies which will not be removed by the filters, and which will cause hash on the record.

Each bank of eight amplifiers is served by a power deck which provides 30 watts of 4,000-cycle carrier for the input bridge circuits, 180 milliamperes of direct current at 300 volts for plate and screen grid circuits, and 12 amperes of heater current at 6.3 volts, as well as polarizing current for the phase-discriminating circuit. Only the heater current is not electronically regulated.

### Checking Response of System

No matter how stable an amplifying system is, when it is used in conjunction with magnetic oscillographs it is advisable to have some means of checking the system response—not merely that of the amplifier. In field use, where the equipment is subjected to severe vibration, moisture, and extremes of heat and cold, one may expect the recording galva-

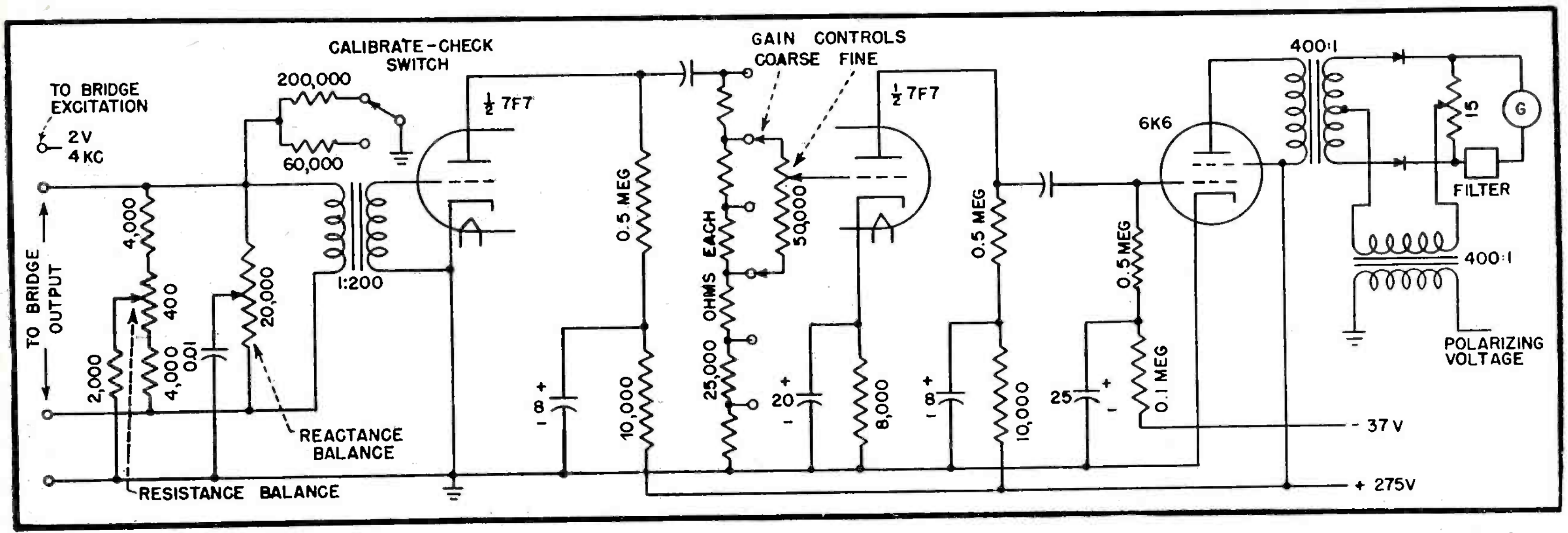



FIG. 3—Simplified schematic of amplifier, showing connections to demodulating circuit. Switching circuits have been omitted

nometers to experience changes in sensitivity. A four-position calibrate-check switch on the amplifier panel provides checking facilities as well as two modes of amplifier operation. One of the four positions is for carrier-type operation; two others (shown in Fig. 3) provide two known bridge unbalances, and the fourth position converts the amplifier into an orthodox resistance-capacitance coupled amplifier. For most applications, it has been more satisfactory to employ as calibrating standards fixed increments of bridge unbalance, rather than fixed increments of signal.

#### Operation of Equipment

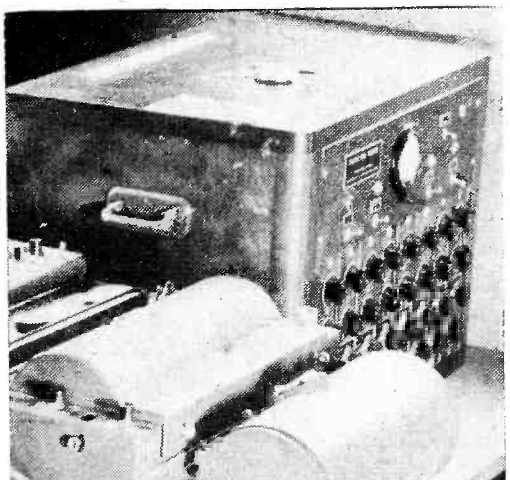
The power deck contains four switches; the first turns on the carrier oscillator (through a time-delay switch to avoid voltage surges) and its power amplifier; the second switch turns the amplifier heaters on; the third turns on the heater circuits of the amplifier plate voltage supply; the fourth turns on the plate supply itself. A single voltmeter is provided; it normally indicates the voltage of the carrier supply, but can at will be switched over to indicate either of the regulated plate voltages.

Each amplifier has five controls—a resistance balance control, a reactance balance control (screwdriver adjustment), a fine gain control, a coarse gain control, and the checking switch previously described. All are continuously variable excepting the coarse gain control, which is variable in 20-percent steps. The fine gain control has a range of 20 percent; the total gain at any time thus is equal to the sum of the dial readings.

In practice, the reactance balance does not usually require attention after an installation is made (unless extremely wide ranges of temperature are encountered), while the resistance balance control is altered each time the gage impedance changes. Ordinarily there will be an adjustment of the resistance balance control whenever there is a temperature strain unaccompanied by stress. Locking devices are provided for the dials.

#### Standard Components Used

In the entire system, there is but one electrical component which is not a stock item, easily obtainable in normal times. That one is the inductor in the carrier-frequency filter, and if necessary it can be replaced by a standard part. This adherence to stock items greatly facilitates repair and maintenance, although at the cost of some efficiency. It is probable that a special input transformer would improve the performance of the amplifiers, especially with regard to hum-rejection in 60-cycle fields; this is the weak spot in any high-gain system employing transformers. The stock transformers now in use show no hum pickup except at the very highest sensitivities.



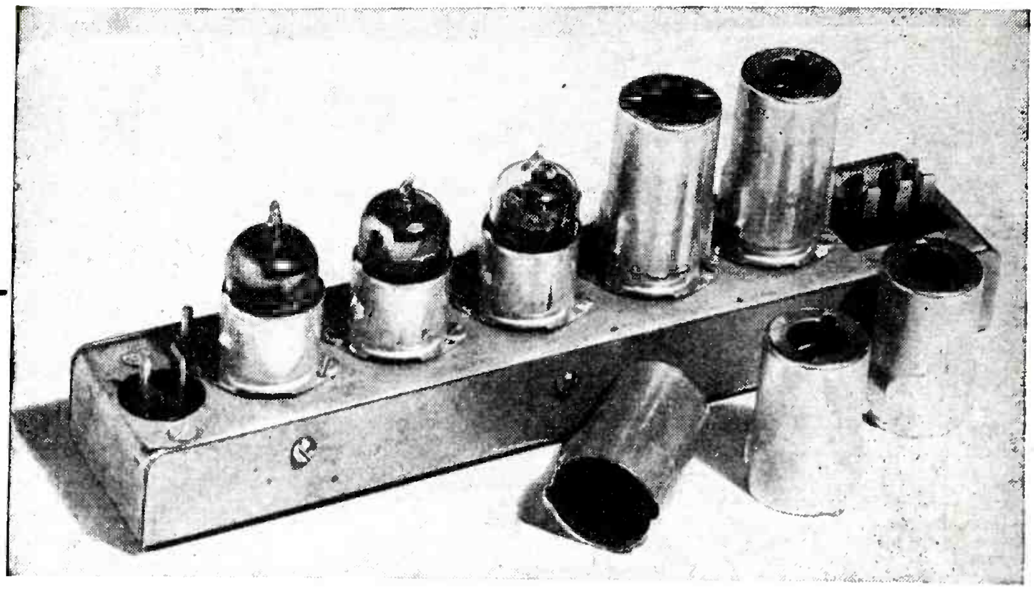
Amplifier bank alongside recording galvanometer

#### Stability

During a 19-day test period the amplifying system was subjected to temperature changes of more than 40 degrees F and the cables to changes of more than 70 degrees F. For the first 15 days the maximum variation in sensitivity was only about 1.5 percent, while the maximum at the end of the test was about 2 percent. This degree of stability is more than satisfactory, because in practice the system response is checked frequently and any drift is promptly corrected.

The primary element used in this test was a wire-type resistance strain-gage bridge, with the amplifier sensitivity set to provide a galvanometer deflection of 1 inch for a stress of 20,000 pounds per square inch in steel—a strain of about 0.0007 inch per inch. The maximum drift of the galvanometer zero point during the test was about 0.1 inch, corresponding to a strain of about 0.00007 inch per inch. Considering the severity of the test—the steep temperature gradients and the fact that the measuring gage and the compensating gage (both stock gages, not hand-picked) were on different types of steel, this is a very good check.

FIG. 1—Five-stage channel amplifier of the Intra-Video master system. One such unit is used for each television channel locally assigned and for the f-m band



# TELEVISION ANTENNAS for Apartments

On February 1st, 1947, the New York real estate management firm of Wood, Dolson Company announced to tenants in the 100 apartment buildings under its management that television installations would be prohibited in these buildings until a master antenna system had been developed and installed. The effect of this announcement on the television industry was immediate and pronounced. What had been a dimly-recognized problem of low priority became overnight the outstanding issue of the commercial television world.

The initial reaction was one of resentment toward the landlords, who were accused of attempting to stifle television before it had a chance to prove its value. But this feeling quickly gave way to an appreciation of the apartment owner's problems and a desire to work out a solution on a cooperative basis. A committee of the Television Broadcasters Association was formed to study the matter, under the chairmanship of Ernest A. Marx. This committee met with the Real Estate Board of New York to exchange views and to work out the legal and technical details of a plan which would allow installations to proceed pending availability of master antenna systems.

Failing such a plan, it was clear that the sale of television receivers to the urban public would fall far short of the predicted figures, particularly if the trend toward prohibition of antennas continued. The Greater New York Taxpayers Association (composed predominantly of realty interests) urged all landlords to withhold permission to erect antennas, and similar advice was given in an editorial in the February issue of *Real Estate News*.

A fair idea of the magnitude of the problem can be derived from official figures[1, 2] on the distribution of population in various types of dwellings. In New York in 1943, for example, the seven million people of the city lived in 2,218,000 dwelling units (a dwelling unit is a one-family home or an apartment in a multiple-dwelling house or apartment building). Of these, 649,000 or 29 percent of the householders, lived in one and two-family houses. The remaining 71 percent were tenants in apartment buildings. In the Borough of Manhattan 98 percent of the families live in buildings housing three or more families.

It is true, of course, that many of the apartment buildings listed in these figures are small, and might readily accommodate antenna facilities for those tenants desiring them. But of the 142,000 apartment buildings listed in New York in 1943, 22,700 housed twenty or more families, and 7,060 provided elevator service. Twenty-two percent of the tenants paid 50 dollars or more monthly rent. And, as an index of the use of modern electrical devices, 60 percent of the dwelling units provide mechanical refrigerators.

Although comparable figures are not available in all urban centers, it is safe to conclude that at least half of the families living within range of present and proposed television stations occupy rented apartments and must secure permission from their landlord before installing a television aerial.

If we assume that, in the long run, the television receiver will be as essential a feature of the home as the electrical refrigerator, the market for receivers in New York will exceed a million sets, and half to three quarters of these installations will be subject to veto by the landlord.

### The Landlord's Position

The landlord's objection to unrestricted erection of television antennas is based primarily on the

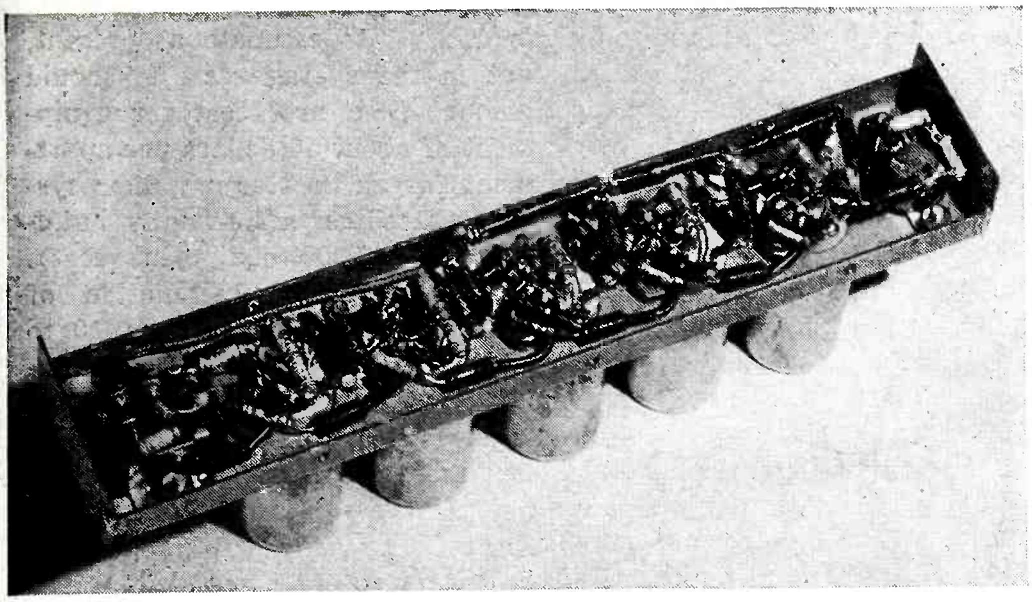


FIG. 2—Internal construction of channel amplifier shown in Fig. 1. Single-tuned staggered circuits are employed to secure flat response on each channel, high attenuation outside

**Ban on individual antenna installations, threatening to cut off half of potential audience, forces television industry to study economic and technical aspects of service in multiple dwellings. Survey by ELECTRONICS' editors describes interim plan and equipment to solve problem**

fact that such antennas and their supports are heavy and bulky enough to do serious damage if they fall from the roof to the street below. For such an unfortunate event and for any death, injury or damage thereby caused, the owner of the property is legally responsible. In addition to this legal liability, the apartment owner views with alarm the erection of any structure which tends to deface or damage his building, and he is particularly allergic to long runs of unfastened transmission line or cable, which may blow against the windows of tenants otherwise not involved and which in any event detract from the appearance of the building. He is concerned also with various municipal regulations governing the erection of structures on buildings and the stringing of conductors.

The complaint most often voiced by the landlord is against the tenant who puts up his own bootleg installation, with little or no concern for safety or official regulations. The workmanlike jobs done by professional installers, employed by the set maunfacturer, are more often tolerated. In fact, since installation concerns have adopted the practice of making no installation whatever without the landlord's permission, complaints in such cases are forestalled in advance. But even a professional installation may blow down in a gale, or a tenant taking the nocturnal air may trip over a guy wire and break a leg.

Even if the landlord takes a cooperative attitude with the first tenant who applies for permission, he is likely to be involved in a political situation when the second or third tenant applies. For the first installation preempts the best position on the roof; the second installation may introduce reflections which produce ghosts or loss of detail in the first installation. This situation adjudicated, the third installation may give trouble to the first two and so the chess game proceeds. The landlord, understandably, would prefer not to referee such contests. When satisfactory positions have been found for as many antennas as the roof will safely admit, the problem of the next applicant, and all those following, remains. Must late-comers be refused on a first-come first-served basis? Or can they hook on to the antennas already erected? These are questions which, phrase them as you may, spell headache, one which the apartment owner and his agent would naturally prefer to avoid.

The solution looked for is, clearly, not a blanket prohibition of all television installations for all time. The realty interests realize that even a temporary prohibition is bad business; and in the long run, when competition once again rears its head in the realty field, television service must be available to keep apartments rented. What the landlord wants are the answers to two questions: How can I be protected against liability, and how can I serve all my tenants on an equal footing? The first is a question for the insurance agent and the lawyer; the second for the television engineer.

### Legal and Technical Aspects

Legal protection is a fairly straightforward matter. The tenant or the installing company, or both acting together, can agree to purchase an insurance policy which will pay all costs and judgments arising from the presence of or damage caused by the television installation. Such a policy must, of course, be consonant with other liability policies held by the landlord, the details of which can be worked out by the insuring company. The installer must secure all necessary municipal permits and satisfy the landlord and the local building authorities that the installation is safely erected.

Serving all tenants with equal satisfaction is fundamentally a technical problem, albeit with economic overtones. The ultimate, and most expensive, solution is the master antenna system, with outlets in every apartment. Such systems employ a separate booster amplifier such as the one shown in Fig. 1 and Fig. 2, with consequent high signal level on all television channels assigned in the locality, the f-m band, and on broadcast and shortwave bands as well. Such systems (including television channels) have existed on paper for several years; they have appeared in fully engineered form only in the early months of this year, and production is still in the early stages. This solution to the problem exists; the only serious drawback is cost. Such systems will be a part of the plans of many new apartments, and they will find their way into many of the larger existing structures.

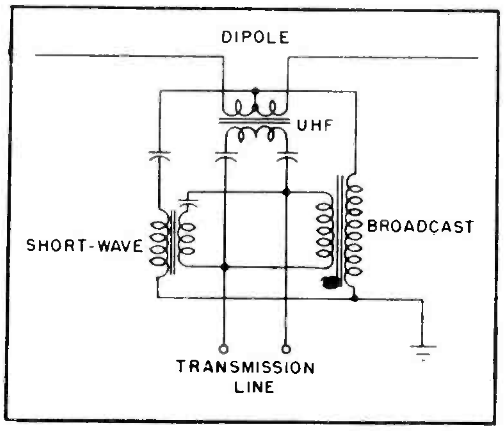



**FIG. 3—Antenna coupling unit for non-amplifier system designed to abstract broadcast, shortwave and television signals from a single vhf dipole**

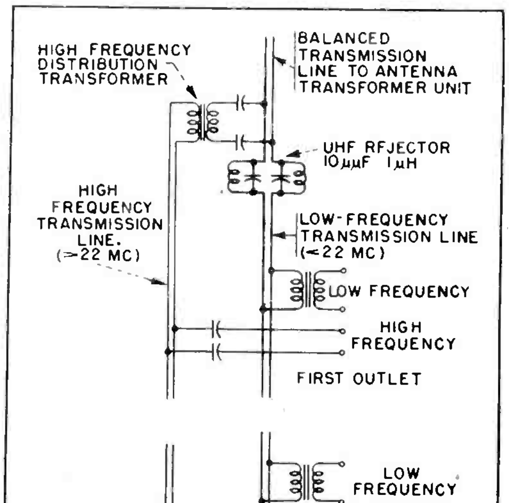



**FIG. 4—Pre-war distribution system, employing a rejector filter and transformers to separate low from high frequencies**

There are, in addition, simpler, less expensive systems which will serve as interim measures in large apartments and permanently in smaller buildings. Such systems make use of the fact that several receivers may operate simultaneously from a single antenna, without intervening booster amplifiers, provided all are matched to the transmission line and provided also that the signal level available is high enough to permit division of the voltage among the several sets and to override any reradiation which might be conducted from one set to the other. In the average high-signal location within a city, five or six sets may be so accommodated. If room is found on the roof of the apartment for four or five separate antennas, 20 to 30 receivers might be so connected, which should take care of the immediate needs of even a large apartment building. When a new receiver is added to such a system, care must be taken to avoid adverse reaction on the sets already connected, a responsibility which must be assumed by the installing company.

Whichever system is installed, the costs must ultimately be borne by the owner of the television set. If the amplifier-type of master system is installed, it becomes a permanent improvement to the property and as such is purchased by the landlord as an investment. He is reimbursed by any one of several methods. One proposal is a straight fee for the service, paid by the set owner as long as he uses the service. This is equivalent to an increase in rent paid only by tenants actually receiving the service. In another proposal, applicable particularly to apartment buildings in which all apartments are connected to the system, the cost may be paid by a blanket increase in rent levied on all tenants, on the basis that the service is provided whether it is used or not.

The actual amount of such costs is difficult to estimate at present, but in the average case it should amount to a first cost for equipment of about 50 dollars per apartment for an booster amplifier system (based on a 50-family building and $2,500 equipment cost). Costs for initial installation of wire and cable range from 10 to 25 dollars per outlet, and the running costs, for power and routine maintenance, are about one dollar per month per outlet. Assuming depreciation on a five-year basis, the monthly charge would amount to from two to three dollars per month. These figures are, of course, subject to wide variations depending on the number of outlets served by the booster equipment and the type of construction adopted in running the cable. The monthly charge could easily run as high as ten dollars per month in a small building serving, say, ten families. Eventually, of course, the costs may be absorbed in the general rent level, as have costs associated with mechanical refrigerators.

The non-amplifier type of installation has no running costs and the initial costs are much less. In such systems, in fact, the landlord may have no investment whatever, all costs being borne equitably by the tenants connected. Furthermore, payment of these costs may be covered by the installation fee customarily charged (either as a separate item or as part of the selling price of the receiver) by the set manufacturer. When a receiver is connected to an amplifier-type of system, the installation charge, or some equitable share of it, may be rebated to the customer who can apply it against the monthly charges levied by the landlord.

#### The TBA-REB Interim Plan

In March, the Television Broadcasters Association, through the Marx Committee, offered to the Real Estate Board of New York a plan which would protect the landlord and allow installations to proceed at once. This plan involved six main points:

(1) *Appearance*—The number of separate antennas to be installed on each roof is to be limited

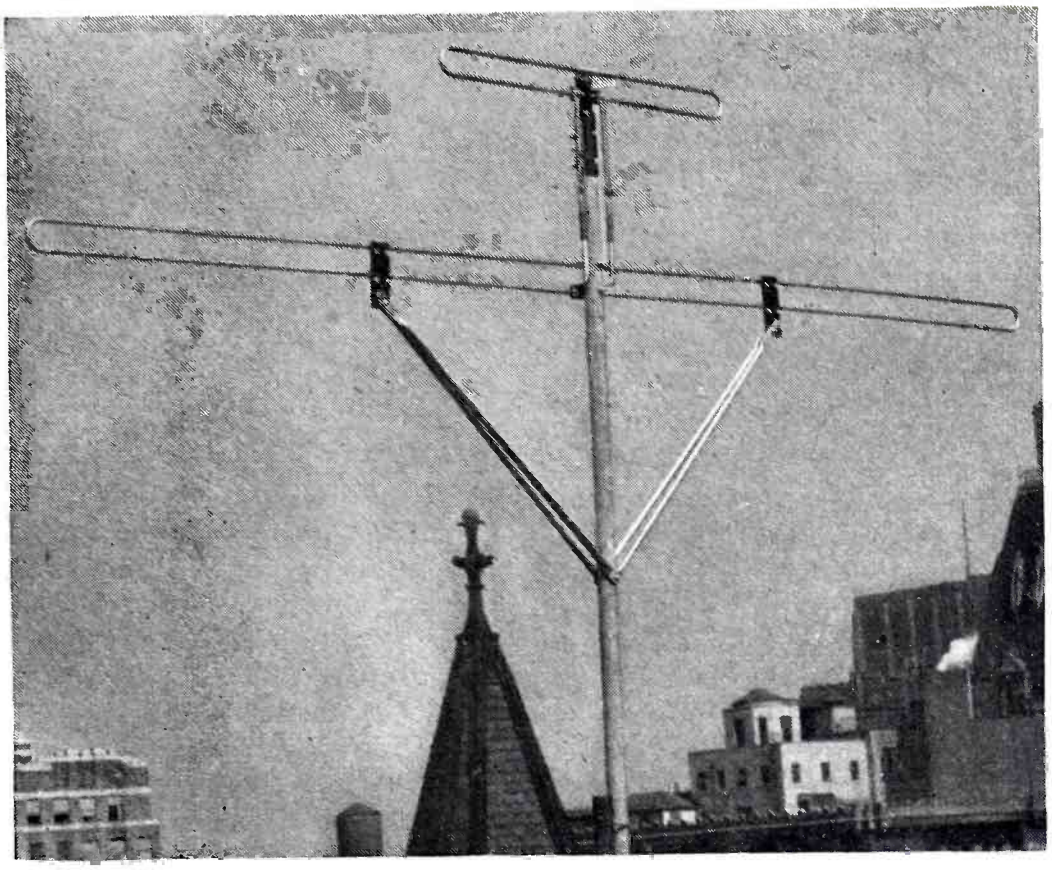


FIG. 5—Double folded-dipole antenna designed by Amy, Aceves and King to cover low and high frequency regions. The upper dipole is 28 inches long, the lower 94 inches long. An anti-resonant circuit prevents third harmonic operation of the lower element on the high frequencies, preserving the figure-eight reception pattern shown in Fig. 6

so as to protect the appearance of the building. Four or five antennas, widely spaced, would be the limit in most cases. (2) *Damage Protection*—The TBA will draw up installation standards which will assure rigid construction and protection against damage to the property or its surroundings. The landlord would be advised to withhold permission to erect unless these standards were complied with. (3) *Building Violations*—Permits for the installation will be obtained from municipal or other authorities having jurisdiction. (4) *Liability*—The installing service company will provide an insurance certificate to indemnify the landlord against personal and property damage. (5) *Tenant Satisfaction*—Separate antennas, up to the limit mentioned above, will be allowed for the first tenants applying, with the understanding that each additional antenna shall be installed only if it causes no interference with those already in place. When the limit is reached, or interference caused, succeeding applicants would be required to connect to one of the transmission lines already in place, assuming the responsibility for matching impedances on all sets so connected, and subject to maintaining satisfactory reception in all cases. No antenna or connection will be removed by any tenant at the expiration of his lease. (6) *Expense*—All costs are to be borne by the tenant or the installing company.

At the time of going to press, this plan was still under discussion, but it was hoped that it would be accepted, in substance, by the Real Estate Board and recommended to all owners and management firms associated with the Board.

#### Development of Master Systems

A survey of manufacturers shows that four firms either have master antenna systems available now or plan to offer them in the near future; the consulting firm of Amy, Aceves and King, the Radio Corporation of America, the Telicon Corporation, and United States Television Corporation. The first two firms have for many years designed and installed master antennas for standard broadcast and shortwave services, particularly in the New York area. Amy, Aceves and King has specialized in the non-amplifier type of system, starting installations in New York apartment houses as early as 1930. In 1940, Aceves described[3] a non-amplifier system suitable for broadcast, shortwave and television distribution, shown in Fig. 3. The antenna proper is a dipole, tuned to the then-existing television band (50-80 mc), and transformer-coupled to a 100-ohm balanced transmission line. The broadcast and shortwave signals are derived from the center tap of the coupling transformer primary, thus effectively placing both halves of the vhf dipole in parallel The broadcast and shortwave signals are imposed on the 100-ohm transmission line through transformers. At each outlet, the low-frequency signals are picked off by a transformer and rejector filter arrangement shown in Fig. 4, while the high-frequency signals are derived through capacitive coupling from a separate transmission line. The far end of each transmission line is matched by a 100-ohm resistance.

By 1941, systems of this general type were installed during the construction of over twelve hundred new buildings, the cost (including conduit for the transmission line) being about 25 dollars per outlet, of which about half was spent for labor. As many as 50 to 75 outlets were provided in each installation. Similar installations were placed in about 1,000 existing buildings, the cable being run down interior courts, along fire stairways, etc. The cost

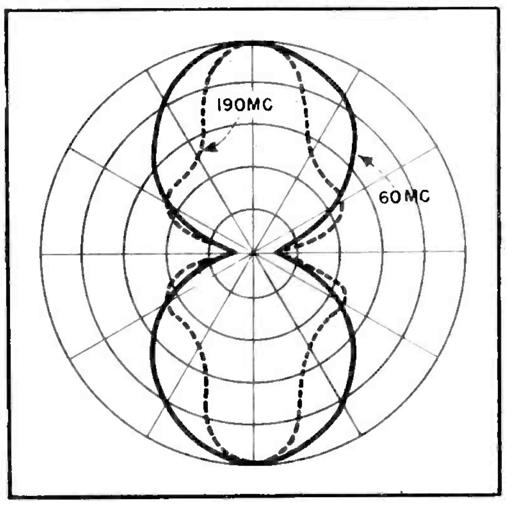



FIG. 6—Horizontal coverage diagrams of antenna shown in Fig. 5, taken at typical frequencies in the low and high frequency regions of the television band

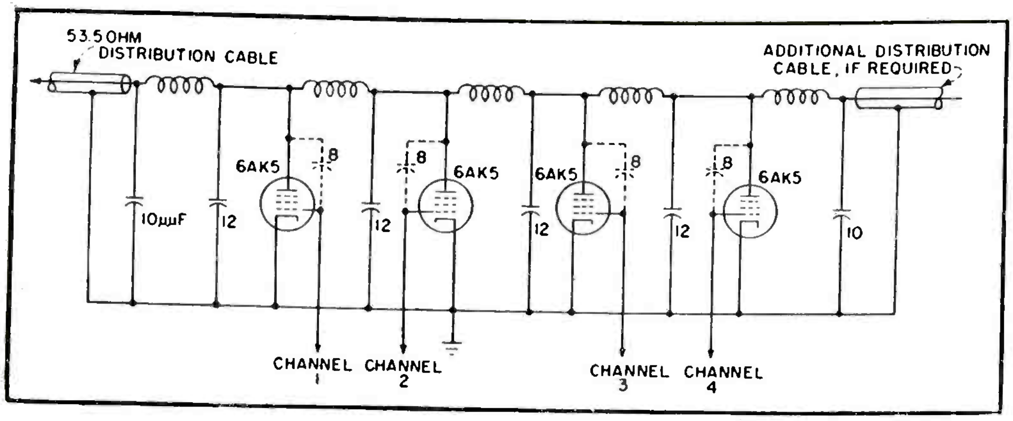



FIG. 7—Low-pass filter (cutoff 300 mc) used as a common load impedance for the final stages of channel amplifiers (four shown)

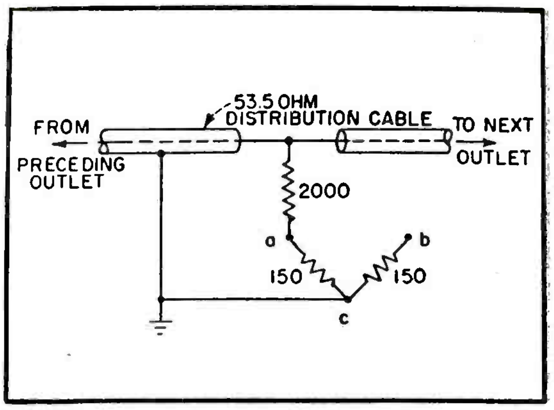



FIG. 8—Customer outlet connection of the Intra-Video system

of adding the system to existing structures was 8 to 10 dollars per outlet. Amy reports that, despite present protestations to the contrary, owners of Park Avenue apartments were quite willing to have cables fastened to the outside walls of their buildings, provided the work was done neatly and the color of the cable covering was chosen to match the wall.

The chief exponent of the amplifier type of master system for broadcast and shortwave reception prior to the war was the Radio Corporation of America. The Antenaplex system in its original form employed a booster amplifier for the broadcast band with an individual coupling tube at each outlet. Approximately 100 of these systems had been installed in the New York area by 1941, when installations were curtailed by the war. The cost was about 50 dollars per outlet. Later designs incorporated separate booster amplifiers for several shortwave bands and for the f-m band. The latest version of the system, enlarged to cover all assigned television channels, is described in detail below.

The design of a master system for television service involves many problems not met in the broadcast and shortwave services. For an analysis of the requirements for television service, the editors consulted H. E. Kallmann, who designed the Telicon system. The end point of this analysis is a system employing a separate antenna for each television station within range, and a separate booster amplifier on each channel, the output of the amplifiers being combined and fed to one or more cables which feed the outlets. Since the only amplifier systems thus far offered (RCA and Telicon) both operate on this general scheme, the design may be assumed to have general acceptance and is worthy of review.

#### Analysis of Amplifier Requirements

Amplifier design turns on four main questions: (1) Whether to use a single antenna or one for each station, (2) whether to use a single amplifier or one for each channel, (3) how to avoid interaction among the several connected receivers, and (4) how to proportion and adjust the gain in each channel to provide adequate (but not excessive) signal level on all channels at each outlet.

Consider first the antenna. If a single antenna is used, it must cover a very wide band of frequencies (44 to 216 mc) and it must be substantially omnidirectional to permit use in central locations among a number of stations. This implies a low gain antenna, but this is not a serious drawback since the signal level in such central locations is generally high, while in outlying low-signal locations some directivity can be employed. The compelling disadvantage is the fact that an omnidirectional antenna cannot discriminate against ghost images caused by multipath reflections. If sufficient space were available it might be possible, in theory, to construct an antenna having individual lobes pointing toward each of the stations, but when it is considered that such lobes must exist only at the particular frequency of each station (to avoid picking up interference from strong adjacent signals), the design problem seems so formidable as to be practically out of the question. The preferable arrangement, from the standpoints of size, simplicity and flexibility, is a multiplicity of separate dipole and reflectors, each tuned and oriented for optimum reception from a particular station. Since the maximum number of channels assigned in any one locality is seven, and since several dipoles and reflectors can be mounted on a single pole, it would appear quite feasible to erect the necessary number of separate antennas without elaborate construction or hazard.

The question of a single booster amplifier as against separate amplifiers for each channel is equally simple to resolve, since there is at present no amplifier capable of covering the wide band of 44-216 mc, save possibly the travelling-wave tube which is not adaptable to the vhf range. Moreover, the wide disparity in signal strengths to be expected from the various stations requires compensating differences in gain on the several channels, which would be difficult to obtain in a single amplifier. So individual amplifiers are indicated, despite the large number of tubes and the power consumption entailed. The separate amplifier provides many types of flexibility: it can be matched at input and output to the impedances present, and it replaces the energy lost in impedance matching. It can provide a high level of signal, thus permitting a high degree of padding at each outlet to overcome interaction between sets, and to overcome any local pickup of signal at or near the antenna terminals of the set, which would tend to produce ghosts or loss of detail. Finally, and most important, the separate amplifier can incorporate any desired degree of selectivity against strong signals on adjacent channels. In extreme cases as many as seven stages of stagger-tuned amplification may be required to provide a flat response over the 6-mc desired channel, with adequate selectivity against adjacent signals separated 6 to 12 mc from the desired station.

The third question, control of interaction between connected receivers, is answered by an attenuating pad at each outlet which provides adequate isolation, so that even a shortcircuit at the receiver input cannot affect the rest of the system. This attenuation also reduces local oscillator reradiation to negligible proportions. As previously mentioned, a high level of signal on the distribution cable is required to overcome the padder loss, but this is provided by the booster amplifier. The padder is readily constructed to match any of the several receiver input impedances likely to be encountered (300-ohm balanced and 75-ohm unbalanced are the most widely employed).

The answer to the fourth question, the gain required in each channel amplifier, depends on the minimum input signal at the antenna, the desired signal level at the receiver terminals and the losses intermediate to these points. Kallman argues that a signal at the antenna as low as 25 microvolts should be provided for, and that a signal level at the receiver of about one millivolt is sufficient to produce a high quality picture, and will overcome any local pickup usually encountered at the set. To this 40-to-1 voltage gain requirement must be added a 25-to-1 voltage loss in the padder at each outlet, and an additional 3-to-1 loss in the amplifier stage which couples to the common distribution cable. The total gain thus reqired is $40 \times 25 \times 3 = 3000$ times in voltage, or 70 db. Cable losses amount to about 4 db per 100 feet at 100 mc in the RG/58-U 53.5 ohm cable commonly used for distribution. Assuming 100-foot cable risers, the maximum voltage gain required is of the order of 75 db. This high value is necessary, of course, only for very weak signals in the 25-microvolt category. If a 25-millivolt signal is present, for example, the gain of the amplifier for that particular station is reduced by 60 db. On very strong signals (100 millivolts and above) attenuation must be introduced to avoid excessive signal strength and possible cross modulation. The gain for each channel must be adjusted at each installation.

Unfortunately even if strong signals are available on all channels, it is not possible to dispense with the amplifier stages since selectivity demands a number of separate tuned circuits. A minimum of 30 db selectivity against the next occupied channel (6 mc removed from the edge of the desired channel) is considered essential, and this can be obtained, with adequately uniform response across the desired channel, only with four or more stages. These figures are subject to some variation, depending on the required excellence of reception assumed in the design, but they illustrate the general trend.

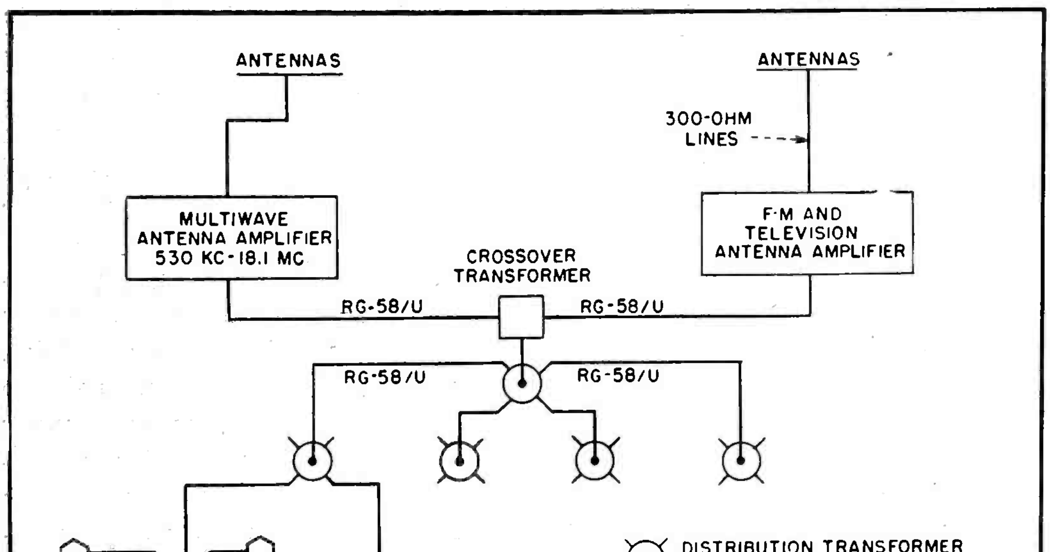



**FIG. 9—Antennaplex distribution diagram for 64 outlets, providing broadcast, shortwave, television and f-m signals over a single cable with transformers to multiple branch points. This system can be extended to 256 outlets without additional amplifier equipment**

### Typical Master Systems

The attributes of master systems are best illustrated by typical designs now available or on the drawing boards. Two non-amplifier systems are in evidence, designed by Amy, Aceves and King and by RCA. They are similar in that both involve resistive networks at each outlet, matching a 300-ohm balanced transmission line from a single broadband antenna and providing a maximum of six outlets per system. The RCA system, intended primarily for dealer demonstrations, has a fixed number of six outlets, all of which are installed even if fewer outlets are required. The Amy, Aceves and King system has adjustable resistor pads which are proportioned according to the number of outlets required. The latter system also incorporates within the outlet box an automatic spring-loaded switch which inserts a matching resistance when the outlet plug is removed, thus assuring that the remainder of the system is not disturbed. The antenna in non-amplifier systems must cover two widely separated bands (44 to 88 mc and 174 to 216 mc). The antenna most used is the folded dipole. A typical example, constructed in two separate sections to cover the two regions, is shown in Fig. 5. Figure 6 shows typical coverage diagrams of this antenna.

The Telicon Intra-Video system employs separate folded dipoles, with reflectors where necessary, on each locally assigned television channel and the f-m band (88-108 mc). Each dipole feeds a separate booster amplifier, employing 6AK5 high-gm pentodes with stagger-tuned single-circuit coupling between stages. Depending on local selectivity requirements, each amplifier has from five to seven stages, with a maximum voltage gain of approximately 75 db. The gain is adjustable by means of an adjustable fixed bias from substantially zero to 75 db. During installation, the gain is adjusted until the voltage at the output stage is of the order of 25 to 50 millivolts.

The outputs of the several booster amplifiers are combined in the network shown in Fig. 7, which resembles a low-pass filter. This filter is designed for a characteristic impedance of 53.5 ohms, to match the RG-58/U distribution cable and with a cut-off frequency well above 300 mc. This arrangement preserves the amplitude and phase characteristic over each of the desired channels, but the low value of load impedance on each stage limits the final stage gain to less than unity. A single 53.5 ohm distribution cable is fastened to one end of the coupling network. If more than one distribution cable is required, they are connected one to each end or, perhaps, two each in parallel, and the surge impedance of the network made proportionately lower to match their combined shunt impedance. As many as four distribution cables may be connected.

Along each distribution cable are connected as many receiver outlets as are required. Thirty or forty outlets may be accommodated on each cable, since the power abstracted by each is about one percent, whereas the cable losses are likely to exceed this amount if the outlets are spaced 20 feet or more. The outlet itself is the size of a standard electric outlet box and contains the circuit elements shown in Fig. 8. The padding resistor for isolation is a 2000-ohm unit connected to the Electronics 9444 Galley Four center conductor of the distribution cable. The outlet connection itself is a receptacle for a three-prong plug, connected as shown in the diagram. Terminals *a* and *b*, with *c* unconnected, provide a 300-ohm balanced termination, whereas terminals *a* and *c*, with *a-b* shorted, provided a 75-ohm unbalanced termination, against ground. This combination of resistors attenuates the 25 to 50 millivolt signal existing on the distribution cable to 1 or 2 millivolts at the outlet termination. Any change of impedance at the outlet terminals, caused by switching the receiver tuned circuits, or even a shortcircuit, has but negligible effect on the power abstracted from the distribution cable. Hence impedance interaction and reflections between sets are not problems.

The booster amplifiers are located in a box near the roof of the building and are constructed for plug-in attachment, so they can be replaced as a unit by unskilled persons in event of failure. All amplifiers are fed by a regulated power supply, the power consumed by a four-channel installation being of the order of 120 watts.

The RCA Antenaplex system is similar in principle, employing separate antennas and amplifiers for all locally assigned television channels, the f-m band, and for broadcast and shortwave as well. Ordinary dipoles and reflectors are recommended for the lower frequency television channels (44-88 mc), while folded dipoles and reflectors are used for the upper frequency channels (174-216 mc). The antennas are connected through 300-ohm polyethylene twisted transmission line to the channel amplifiers. These employ 6J6 double triodes, two stages (four triodes) for the lower channels, three stages for the upper, and four stages for the f-m band (88-108 mc). The nominal voltage output of these amplifiers is one volt. A single 5U4 rectifier serves as the power supply, and a resistor network delivers the required plate voltage regardless of the number of amplifier units connected.

Doublet antennas are provided for the broadcast and shortwave spectrum, providing continuous coverage from 530 kc to 18.1 mc. A standard amplifier (type MI-5011) amplifies and combines the broadcast and shortwave signals. The amplifier output is in turn combined with the outputs of the television channel amplifiers through a crossover transformer, the secondary of which is matched to RG—58/U 53.5-ohm coaxial distribution cable. This cable leads, as shown in Fig. 9, to a group of distribution transformers, which branch out to as many outlets as required. A single system can feed as many as 256 outlets in this manner, and if two sets of amplifiers are employed, as many as 512 outlets may be accommodated. The nominal voltage at each outlet it 3 millivolts. The distribution transformer provides the necessary isolation at each junction and outlet. Figure 9 shows a typical arrangement for sixty-four outlets, which may be readily extended to 256 outlets. The customer outlet contains two fittings, a coaxial plug for television and f-m, and a three-pin jack for broadcast and shortwave. A receiver matching transformer is provided to convert the unbalanced outlet termination to a balanced form, either for 300 ohms or 50-75 ohms. In a 256-outlet system the signal passes through four distribution transformers and perhaps 500 feet of RG—58/U cable, the total attenuation of which is low enough to provide a 1 to 3 millivolt signal from the 1 volt nominal output of the booster amplifiers.

In new buildings, ½-inch or ¾-inch conduit is recommended to contain the distribution cables. Information is now available to architects and engineers planning new structures so that such conduit can be installed during construction, even though the installation of the master antenna system itself is contemplated at a later date.—D. G. F.

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(1) "Recapitulation of Building Classification for 1945-46," Tax Department, City of New York. Figures for 1946 show little change from those of 1943 (reference 2).

(2) Consolidated Edison Company's Survey of the New York City Market (copyright 1945).

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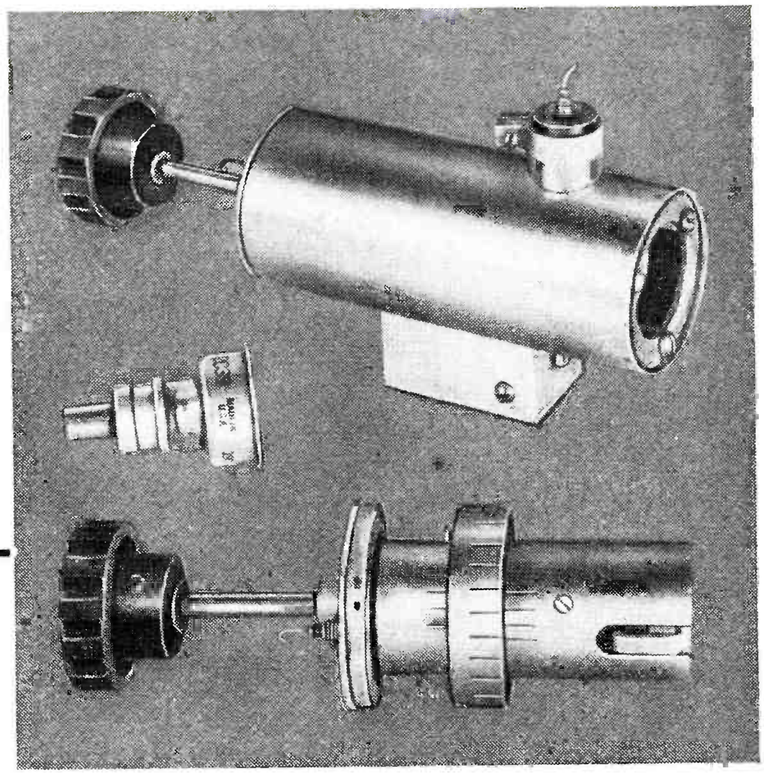
Mathematical analysis of the factors governing frequency stability of uhf oscillators during load impedance changes, and method of reducing frequency variations in a 1,000-mc oscillator by means of a series capacitor in anode circuit



Complete 1,000-mc oscillator employing series-capacitance method of frequency stabilization (above), and view of cavity unit and 2C39 lighthouse tube used in it

# Improving Stability of UHF OSCILLATORS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CERTAIN APPLICATIONS for microwave oscillators require that they maintain frequency within specified limits under various conditions. Such conditions involve, among others, changes in the oscillator tube interelectrode capacitance and changes in the load impedance.

The latter condition is of particular interest in applications where it is necessary to tune a microwave oscillator by using a dummy load, such as before installing the oscillator in an airplane. Besides the initial difference in impedance which may occur between the dummy load and the antenna system to which the oscillator is finally connected, a further change in load impedance may occur as a result of antenna icing under extreme conditions.

For these reasons it is desirable to determine the measurable factors which are responsible for the frequency stability of uhf oscillators. An even more desirable goal is the determination of the frequency stability of a particular oscillator in terms of its physical dimensions and the electrical characteristics of the oscillator tube. An analysis of these factors has led to the development of simple triode oscillators having stability characteristics which can be calculated accurately enough for most engineering purposes.

### Frequency Pulling

Oscillator frequency variations due to variations in load admittance are due to the fact that the admittance as seen by the oscillator tank circuit is not a pure conductance, but may have a susceptive component. If the susceptive component is capacitive, it decreases the oscillator frequency; if inductive, it increases the oscillator frequency.

Usually the oscillator is connected to a transmission line of characteristic admittance $G_0$ through some kind of a coupling system. Specifications usually indicate the maximum load mismatch which can be expected in terms of the maximum standing wave ratio $S$ on the transmission line. Since the line may be of any arbitrary length, it is conceivable that conditions may obtain whereby the maximum susceptive component of the line input admittance may be presented to the oscillator.

The maximum susceptive component is a function of the standing wave ratio $S$; from the admittance plot in Fig. 1A, this can be seen to be

$$\Delta B = \pm 0.5 \, (S - 1/S) \, G_0 \qquad (1)$$

The equivalent lumped circuit of the oscillator tank circuit is given in Fig. 1B, where $C$ is the equivalent lumped circuit capacitance of the oscillator tank circuit.

Usually the oscillator does not

work directly into the transmission line, but rather into a coupling network which is connected to the line. The admittance actually connected across a tank circuit is generally only a small fraction of the admittance seen looking directly into the line. If we call the transformed characteristic admittance $G_0'$, then it can be shown that the maximum susceptive component presented to the oscillator tank circuit will be

$$\Delta B' = \pm 0.5 \,(S - 1/S)\, G_0' \qquad (2)$$

The oscillator frequency for a purely conductive load will be the familiar

$$f = 1/2\pi\sqrt{LC} \qquad (3)$$

Squaring this expression, differentiating with respect to $C$, and simplifying gives

$$\frac{df}{dC} = -\frac{f}{2C} \qquad (4)$$

or differentiating in terms of a change in susceptance $dB$, the result is

$$\frac{df}{f} = -\frac{dB}{4\pi fC}$$

Substituting for $dB$ the value in Eq. 2 and changing $df$ to $\Delta f$, we obtain a formula which relates the maximum frequency shift obtainable by load phase variation to the standing wave ratio $S$, the load conductance $G_0'$ presented to the tank circuit for $S = 0$, and the equivalent capacitance $C$ of the oscillator tank. Thus

$$\frac{\Delta f}{f} = \pm\frac{(S - 1/S)\, G_0'}{8\pi fC} \qquad (5)$$

Now $S$ is usually fixed by the antenna designer and $G_0'$ is a function (for maximum power output) of the oscillator tube characteristics. Hence $C$ is the only one of these factors which depends upon the physical dimensions of the oscillator.

In a simple lumped-element circuit, $C$ consists entirely of the tube plate-grid capacitance in parallel with any capacitance provided by the feedback circuit and any capacitance which might have been added for tuning purposes.

For practical purposes $G_0'$ in high-voltage pulsed oscillators may be replaced by $2P/E_{bb}^2$, where $P$ is the power delivered to the load and $E_{bb}$ is the peak pulse voltage applied to the anode of the tube. This substitution is justified if the peak plate-grid voltage swing is nearly equal to $E_{bb}$. In practically all cases encountered, this assumption appeared to be very nearly correct when the oscillator was delivering maximum power to the load. To a good approximation then

$$\frac{\Delta f}{f} = \pm\frac{(S - 1/S)\, P}{4\pi fC\, E_{bb}^2} \qquad (5a)$$

When the tank circuit is made up from a section of transmission line, the equivalent capacitance will be greater than for the simple lumped circuit case because of the distributed capacitance of the line.

**Coaxial-Line Tank Circuit**

In the 1,000-megacycle region, coaxial line tank circuits for triode oscillators are generally used because the radiation loss is lower than is obtained from open-wire lines; consequently, we shall devote our attention entirely to the discussion of coaxial line circuits.

For simplicity let $C$ in Fig. 1C represent the entire lumped capacitance placed across the end of the coaxial line of characteristic impedance $Z_0$. For a condition of resonance,[1] we find that

$$\frac{\lambda}{2\pi cC} = Z_0 \tan\frac{2\pi l}{\lambda} \qquad (6)$$

where $\lambda$ = wavelength in centimeters, $l$ = length of tank in centimeters, and $c = 3 \times 10^{10}$ centimeters per second.

If we find the value of $d\lambda/dC$ for this case, we can then equate this value to $d\lambda/dC_e$ for the equivalent lumped circuit case. We will then have a means of working with the rather complicated equations for the coaxial line in terms of constants applied to a simple lumped circuit. This gives a value for $C$ which can be used in Eq. 5 to predict the behavior of a particular oscillator toward load impedance variations.

Differentiating Eq. 6 gives

$$\frac{d\lambda}{dc} = \frac{\lambda}{C\,[1 + \theta\,(\tan\theta + \cot\theta)]} \qquad (7)$$

where $\theta = 2\pi l/\lambda$ = electrical length of the line in radians. The value of $d\lambda/dC_e$ for the lumped-element case is simply

$$\frac{d\lambda}{dC_e} = \frac{\lambda}{2C_e} \qquad (8)$$

Equating Eq. 7 and 8 and solving for $C_e$ gives

$$C_e = \frac{C}{2}\,[1 + \theta\,(\tan\theta + \cot\theta)] \qquad (9)$$

Since it is easier to plot a function which goes to zero rather than one which goes to infinity, let us plot the function

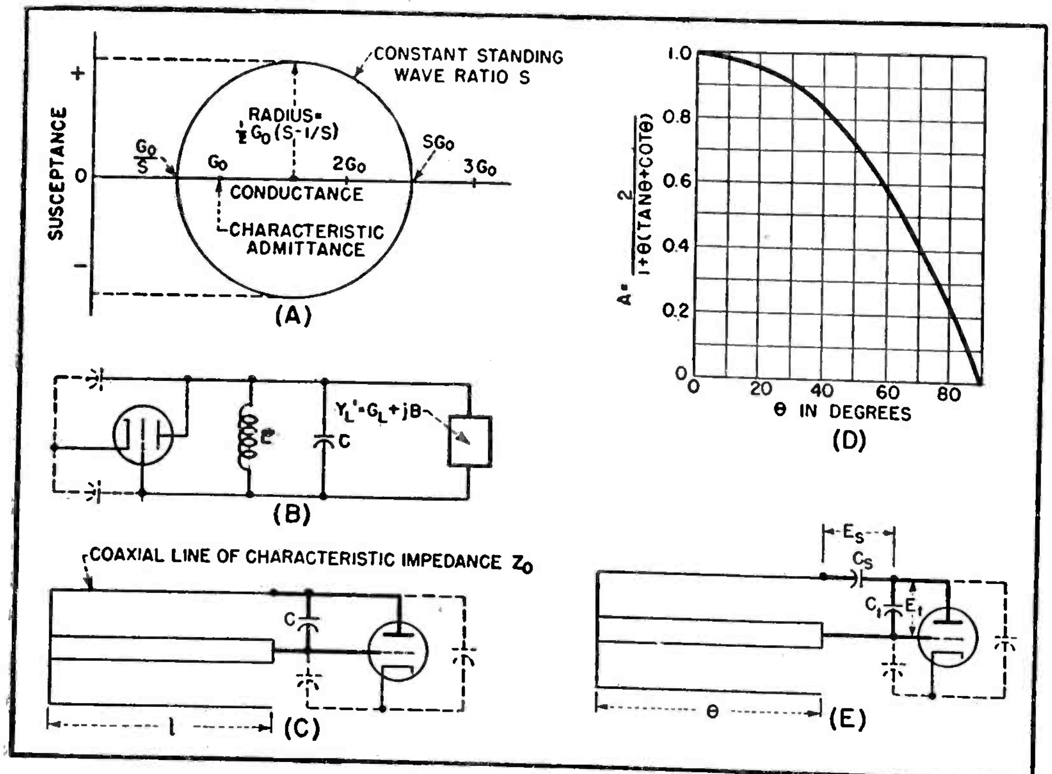


**FIG. 1**—(A) Locus of all possible admittances looking into transmission line; (B) simplified equivalent lumped circuit of Colpitts oscillator; (C) equivalent tank circuit of coaxial line oscillator, in which resonance occurs when reactance of C is equal to the inductive reactance of the section of closed coaxial transmission line; (D) variation of factor A with electrical length θ of coaxial line; (E) circuit of series-capacitance method of stabilization

$$A = \frac{2}{1 + \theta\,(\tan\theta + \cot\theta)}$$

as a function of $\theta$ as in Fig. 1D. Thus

$$C_e = C/A \qquad (10)$$

As an example of the application of Eq. 10, if we have an oscillator for which $C = 3\mu\mu f$ and $\theta = 66$ degrees at $\lambda = 30$ centimeters ($Z_0 =$ 24 ohms), we find that $C_e = 6.1\mu\mu f$. In many applications this is too small a value to give the required stability as determined by Eq. 5 and thus we might try to raise $C_e$ by increasing $\theta$. Doing this is not always feasible, however, because of the increased difficulty of providing tuning in the closer-spaced lines required in order to satisfy Eq. 6. Increasing $C$, on the other hand, may cause $l$ to become too small to allow efficient tuning. In order to circumvent these difficulties and still achieve a sufficiently large $C_e$, an additional capacitance in series with the tank circuit has been used.

### Use of Series Capacitance

We can best analyze this method by using the concept of energy storage in the circuit capacitances. The total energy stored in all the capacitances in the circuit will be found and equated to the energy stored in a single lumped capacitance having the same applied voltage as the tube load impedance.

The series capacitance circuit is shown schematically in Fig. 1E. Since the current through $C_s$ in a high-$Q$ circuit is the same as that through $C_t$, the voltage developed across $C_s$ is

$$E_s = E_t\,C_t/C_s \qquad (11)$$

The total voltage across the line will be $E_s + E_t$ or $E_t\,(1 + C_t/C_s)$. We have shown previously that the equivalent lumped capacitance of a resonant coaxial line circuit is given by Eq. 10. In this case $C$ is made up of $C_s$ and $C_t$ in series or

$$C = \frac{C_s\,C_t}{C_s + C_t} \qquad (12)$$

The energy stored in the entire tank is then

$$W = \frac{E_t^2\,(1 + C_t/C_s)^2\,C_s\,C_t}{A\,(C_s + C_t)}$$
$$= \frac{E_t^2\,C_t\,(C_s + C_t)}{AC_s} \qquad (13)$$

Equating this expression to the energy stored in a simple lumped capacitance $C_e$ with voltage $E_t$ across

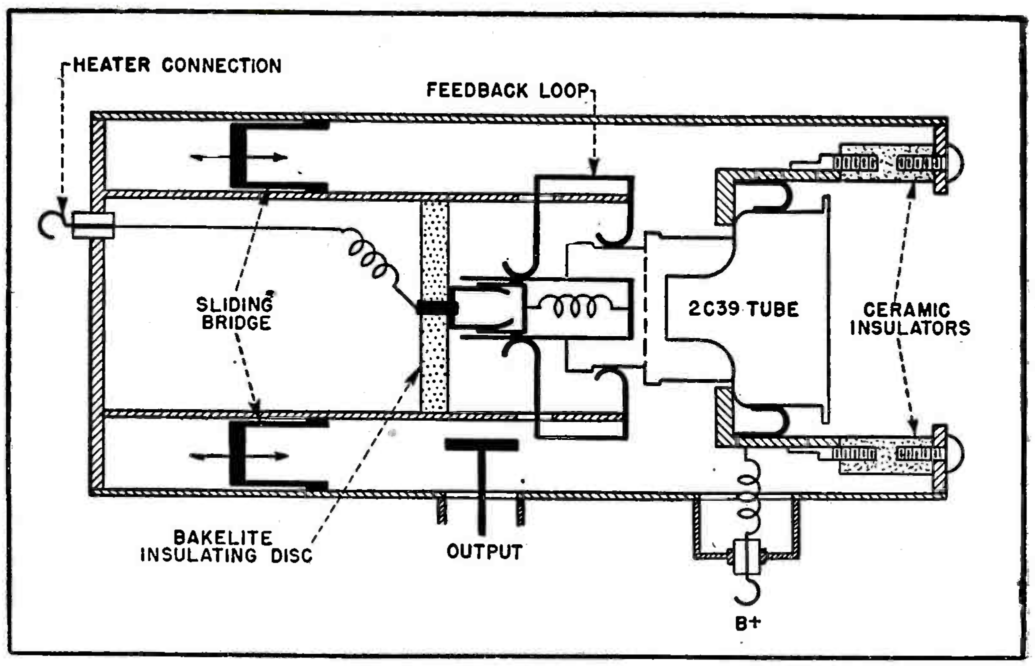

FIG. 2—Cross-section of 1,000-mc oscillator assembly using series capacitance method of stabilization

it, we arrive at an expression for the equivalent capacitance seen by the tube and the load

$$C_e = \frac{C_t\,(C_s + C_t)}{AC_s} \qquad (14)$$

If we use the same impedance line and make $C_t$ equal to $3\mu\mu f$ as in the previous example ($Z_0 = 24$ ohms), with $C_s = 2.2\mu\mu f$, $\theta$ will increase to 79 degrees because of the fact that $C_t$ and $C_s$ in series are tuning the line. For $\theta = 79$ degrees, $A$ is found to be 0.24 and thus $C_e$ will be $29.5\mu\mu f$ as compared to $6.1\mu\mu f$ obtained without the use of the series capacitance.

It should be remembered, however, that increasing the equivalent capacitance of the tank circuit is not without undesirable effects. As the capacitance increases the tank circuit losses also increase, and thus a compromise between stability and efficiency must be made. For a particular application 25 to $35\mu\mu f$ was considered sufficient. An oscillator was built using the values for $C_t$ and $C_s$ given above. The measured equivalent capacitance was about $25\mu\mu f$ which is in good agreement with the theory. This same general theory, when applied to several other types of oscillators, yielded equally good results.

### Practical Oscillator

The oscillator shown in Fig. 2 is an example of one that was built on the basis of the foregoing theory. A 2C39 triode was used with 2,000-volt, one-microsecond pulses applied to the anode through the coil and capacitor shunt feed illustrated. Under these conditions about 1,600 watts peak power was obtained at 1,000 megacycles.

Feedback was obtained in this particular design by means of loops tied to the cathode and extending into the plate-grid cavity. The capacitance equivalent to $C_s$ consists of the short section of open-ended coaxial line surrounding the anode of the tube. The anode radiator on the 2C39 was removed in order that the series capacitance could be reduced to about $2\mu\mu f$. Tuning was accomplished by means of a sliding metallic bridge which was used to vary the length of the coaxial line tank circuit.

The overall efficiency of the oscillator was about 35 percent at 2,000 volts. Operation at 300 volts and 120 milliamperes gave an output of about 4 watts or 11 percent efficiency as an unpulsed oscillator. For pulsed operation, peak power output in watts increases with peak pulse voltage in an essentially linear manner, with power going from about 350 watts to about 2,400 watts as voltage is increased from 1,000 volts to 2,500 volts.

The author wishes to express his indebtedness for the assistance and encouragement given by Dr. A. J. Ruhlig of Naval Research Laboratory during the preparation of this paper.

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# Rate-Of-Change

**Varistor-compensated circuit converts nonlinear voltage variables into linear voltage variables. Application in radio altimeters shows rate of climb directly, with short time lag**

By R. W. TREHARNE, J. A. KAMMERER and R. HOFSTADTER

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VARIABLE RESISTANCE properties of certain materials such as Thyrite can be used to straighten many nonlinear voltage characteristics. Thus the rate of change of a quantity represented by a nonlinear function of voltage can be obtained by conventional voltage differentiating circuits.

As one application of these principles, an electronic vertical velocity meter is described which has the advantage of having smaller time lags than those associated with barometric rate-of-climb meters.

### Circuit Principles

When a quantity is represented by a linear d-c voltage, a measure of the rate of change of the quantity can be obtained by conventional d-c voltage differentiating schemes. However, if a quantity is represented by a nonlinear d-c voltage, the rate of change of the quantity cannot be obtained by a simple voltage differentiation process since the slope of a nonlinear voltage curve is not constant.

This prohibition perhaps is more apparent when expressed symbolically, for if a quantity, $\theta$, is represented by a voltage, $V$, so that

$$\theta = f(V)$$

it is evident that the rate of change of $\theta$ with time is given by

$$d\theta/dt = [df(V)/dV]\ [dV/dt]$$

and that $dV/dt$ will represent $d\theta/dt$ only if $df(V)/dV$ is a constant.

In present day radio altimeters, for example, altitude is represented by a nonlinear function of voltage. Thus, the vertical velocity indications obtained by direct differentiation with respect to time of the altimeter output voltage are not proportional to the rate of change of altitude of the aircraft.

The circuit described below was developed for use with a radio altimeter[1] to give true vertical velocity indications by first straightening the nonlinear altimeter output characteristic and then differentiating with respect to time in an orthodox manner. The basic circuit principles, however, have application wherever it is necessary to measure the rate of change of a function represented by a nonlinear voltage. A similar circuit, for example, could be used to measure the angular velocity of the brush of a nonlinear potentiometer.

### Circuit Details

The vertical velocity meter circuit, shown in Fig. 1, presents a novel combination of a varistor compensating network and a balanced double-triode stage.[2, 3]

The nonlinear altimeter output voltage across $R_1$ is impressed across a network consisting of varistor $X_1$, a parallel resistor $R_9$ and a series resistor $R_2$. The most essential component of this network is varistor $X_1$. By virtue of its variable resistance characteristics, this component controls the current flow in the network so that the resulting voltage across $R_2$ is essentially proportional to altitude.

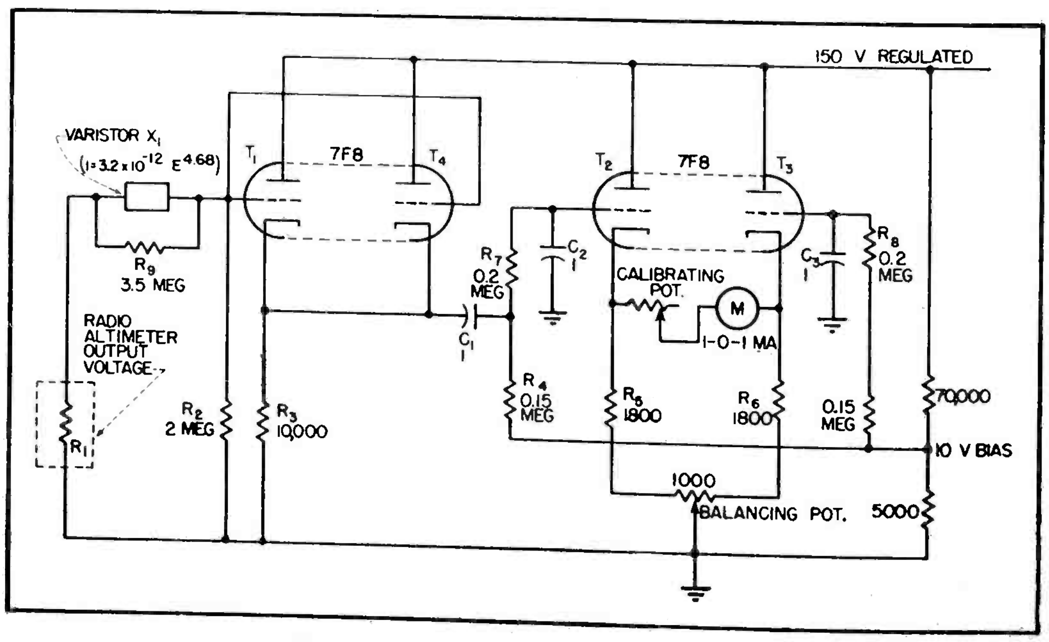


FIG. 1—Vertical velocity meter circuit

# Meter

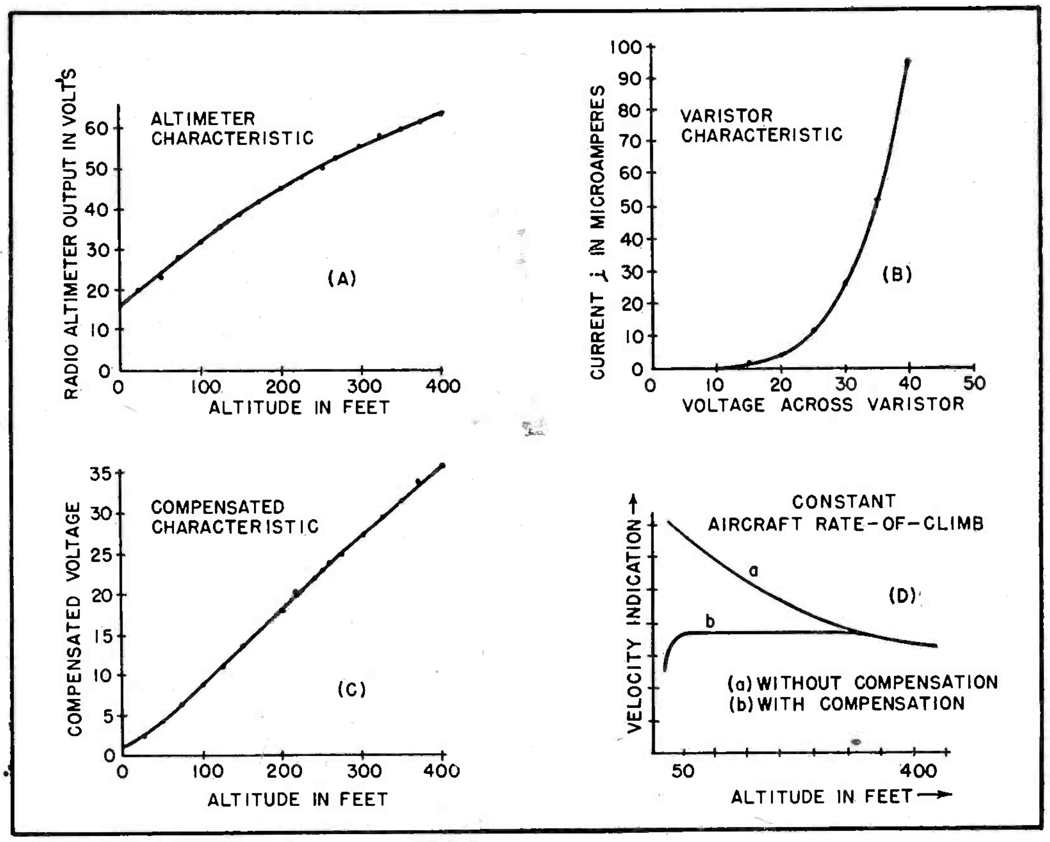


FIG. 2—(A) Nonlinear voltage output of radio altimeter. (B) Varistor characteristic. (C) Varistor-compensated altimeter characteristic. (D) Comparison of rate-of-climb indications of uncompensated and compensated altimeter

To minimize loading effects upon the altimeter voltage source, the voltage proportional to altitude is first reproduced across cathode resistor $R_3$ of cathode follower $T_1$, $T_4$. The actual differentiation process is then performed by the resistor-capacitor network $C_1R_4$.

The usable voltage after differentiation appears across grid resistor $R_4$. The polarity of this voltage depends upon the direction of the rate of change of altitude (climb or dive) and the magnitude is a measure of the vertical velocity of the aircraft.

The grid of $T_3$ of the balanced double-triode $T_2$, $T_3$ is maintained at a constant potential. Thus the voltage across cathode resistor $R_6$ is simply a zero reference voltage. Included is a balancing potentiometer. When the aircraft rate of change of altitude is zero, the voltage across $R_5$ of $T_2$ is equal to the voltage across $R_6$ of $T_3$ and there is no deflection of the meter needle. However, when the aircraft changes altitude a change of voltage across $R_5$ of $T_2$ causes the meter needle to deflect from its zero center position. In this particular application the meter was calibrated to read directly in feet per minute.

### Minimum Time Lag

The main advantage of this type of vertical velocity indicating device over conventional barometric rate-of-climb meters is that there are no large time lags present. In fact, in test flights it was found desirable to introduce a small time lag into the circuit to dampen the meter needle. The capacitor-resistor networks $C_2$, $R_7$ and $C_3$, $R_8$, each with a time constant of 0.2 second, were added for this purpose. These components provide good damping without appreciably affecting the fast response of the circuit.

The basic problem in the design of such a circuit is to select a varistor-resistor network which most nearly compensates for the nonlinear voltage curve to be straightened. In the vertical velocity meter, a compensating circuit for a nonlinear voltage curve of decreasing voltage gradient was required. However, by interchanging components $X_1$ and $R_2$, and by making use of the voltage across $X_1$, the basic circuit for the compensation of a nonlinear voltage curve of increasing voltage gradient can be obtained. Since the effective characteristic of any given varistor can be changed by shunting the varistor with a parallel resistance, $R_9$, it is conceivable that some combination of varistors and resistors can be devised to straighten almost any type of nonlinear voltage gradient, provided that the curvature does not change too rapidly.

None of the simple circuits proposed above can compensate for a nonlinear voltage gradient which changes sign. Moreover, all such voltage-straightening schemes reduce circuit sensitivity. In the vertical velocity meter application, the input voltage sensitivity dropped from 0.145 volt per foot (average value) to 0.096 volt per foot, but this sensitivity was more than enough to give full meter deflections (2,000 feet per minute) on a 1.0 ma zero-center type meter.

### Summary of Results

Figure 2A to C shows how the varistor circuit compensates the altimeter output characteristic. Figure 2D summarizes the results obtained with the vertical velocity meter circuit. The case of an aircraft in a constant rate of climb or dive is considered and a theoretical plot (curve *a*) of the vertical velocity indications which would result from the direct differentiation of altimeter output voltage is compared to a plot (curve *b*) of the actual vertical velocity indications obtained with this circuit.

It can be seen that varistor compensation gives true constant-velocity indications over most of the useful range of the altimeter.

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# Emergency Broadcast PICKUP TECHNIQUES

**Equipment and methods used in remote broadcasts and news coverage require extreme flexibility. Disc and wire recorders, telephone lines, and radio-relay links must all be available for use on short notice**

**By GEORGE RILEY**

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IN THE early morning hours of December 12, 1946 a call was received in the Master Control room of WOR. As in many cases, the call brought news,—this time a disaster. A fire had started in an ice house on 184th St. in New York City and the walls had collapsed on a section of a tenement building. Immediately the wheels were set in motion to dispatch men and equipment to the scene of the disaster. Field equipment is kept in readiness for just such occasions. For this particular field pickup the engineer assigned placed a wire recorder and a portable field amplifier in a taxicab and drove to the scene of the fire.

In the meantime, wire lines to feed live programs were ordered from the telephone company. Special lines between Master Control and the telephone company's 36th St. test room are maintained for use on occasions when insufficient time is available for the installation of regular lines. The 36th St. office cross connects the remote line to one of these special lines when needed.

The engineer arriving at 184th St. immediately co-ordinated with the special events announcer in picking the most advantageous spot for describing and recording events at the fire. He then set up the recorder and connected a power line from the recorder to the nearest available a-c supply which was located in a nearby tavern. The announcer had by this time located several people who had first witnessed the disaster. A number of on-the-spot interviews were re-

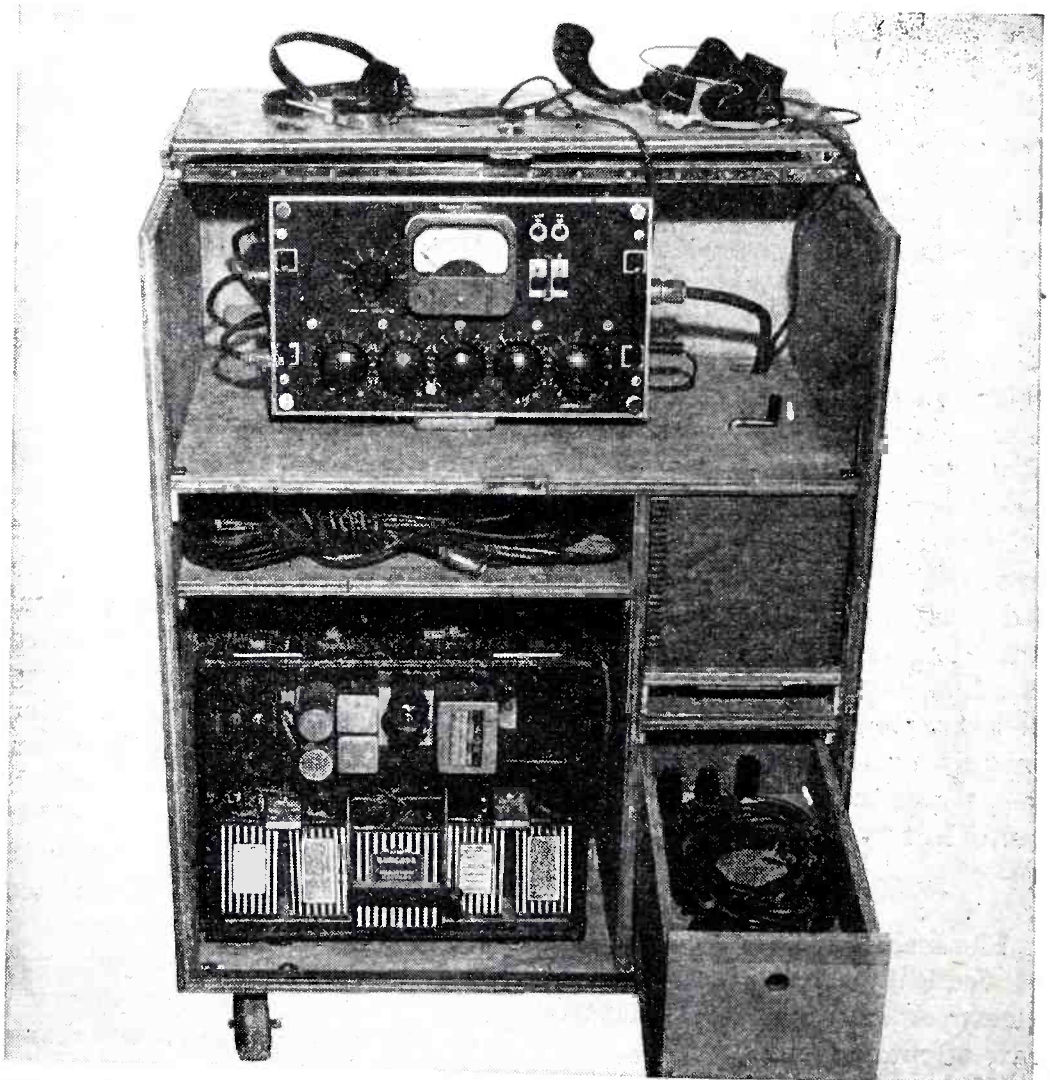
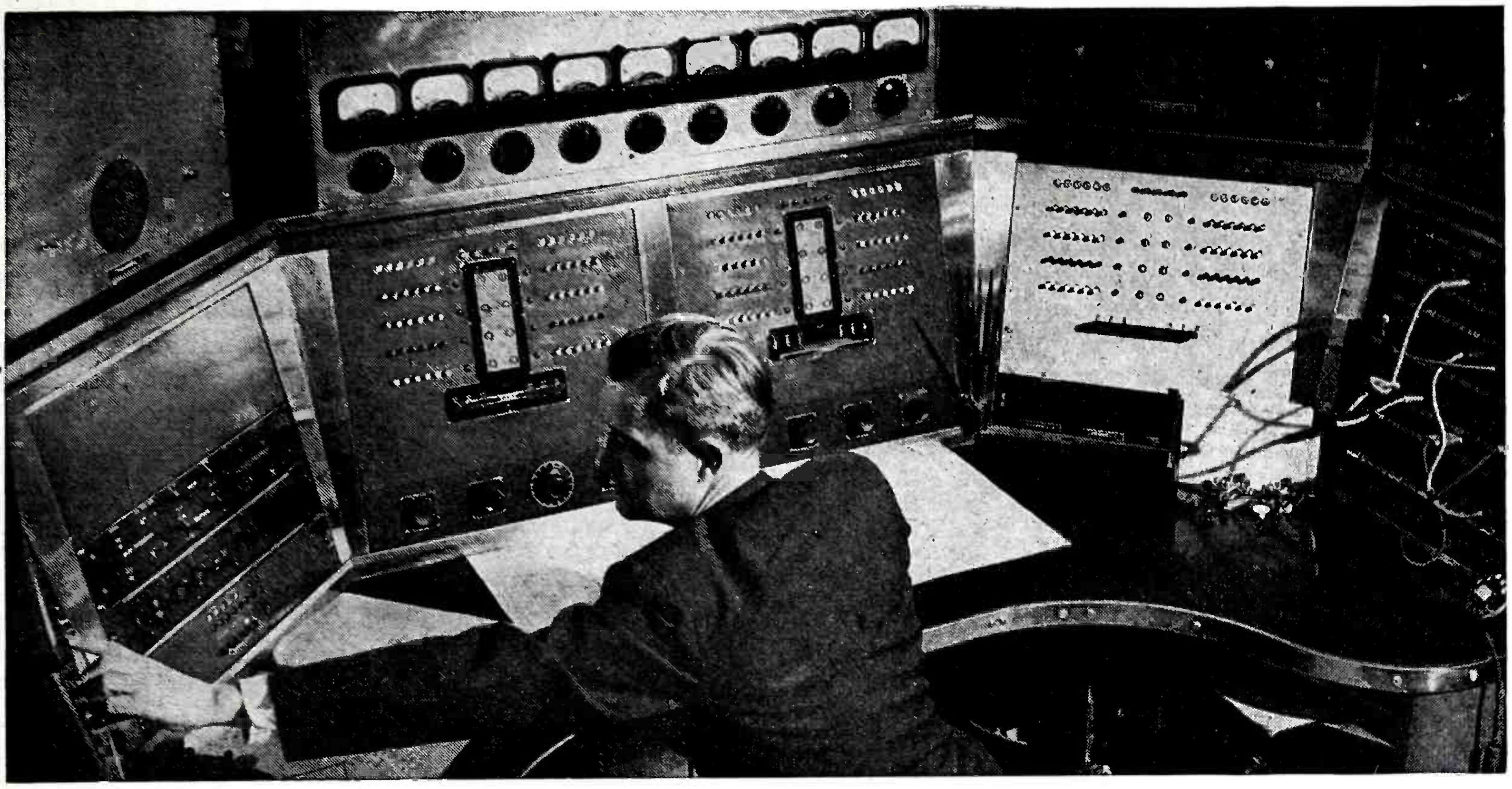


FIG. 1—Remote pickup equipment for scheduled broadcasts includes mixer-amplifier, telephone equipment, a-c and battery power supplies mounted in cabinet with spares



WOR Master Control at which all remote lines, radio-relay links, and cue circuits are fed to transmitters and network

corded on a magnetic wire, the reels were sent back to the studio, recorded on transcriptions, edited, and played back on the air. While this activity was going on, a second engineer arrived with field amplifiers. After setting up the equipment, he assisted the telephone man in completing the installation of the radio lines. It was necessary to connect lines to a termination box at the rear of a building across the street from the tenement building and extend them to an advantageous location for a description of the fire. After completion of the line installation, tests were made to Master Control and several programs concerning the disaster as well as interviews with eyewitnesses were broadcast. The whole operation is typical of many broadcasts originated by the Special Features Division and handled by the Field Engineering Division. There are times when telephone lines are not available and then short-wave facilities or on-the-spot recordings must be used.

#### Field Amplifiers

Field amplifiers in use are of two types. One is normally operated from an a-c power source but also contains an auxiliary battery supply to be used in the event of power failure. The other type operates entirely on batteries. The a-c amplifier is invariably used at locations of regular broadcasts such as hotels, night clubs and various scheduled pickup points throughout the New York area. At these locations the amplifier, power supply and all accessories are housed in a cabinet, shown in Fig. 1, that also serves as the operating position for the engineer. The amplifier is mounted on a slide that is pulled forward when the cabinet is opened to provide an operating shelf. To the right of the amplifier is the telephone set and ringer; the telephone box is located directly underneath. Below the amplifier is storage space for cables, headphones, and microphone signs. The amplifier case and power supply are located beneath. Cable connections are made through holes in the partitions and at the rear of the cabinet. In the lower right section of the cabinet are two drawers, one for storing spare tubes and microphones. The other is a utility drawer and contains cleaning rags, instruction book, field operation report forms and balance sheet. At the conclusion of each broadcast the engineer places all of the equipment in the cabinet and locks the doors.

The battery operated amplifier is normally used for special broadcasts or one-time events. These amplifiers are made by different manufacturers and the battery supplies have a useful range of from ten to thirty hours. The batteries in these as well as in the a-c operated amplifiers are inspected and tested regularly as well as each time they are returned from use on a field pickup.

Both types of amplifiers have a power gain of approximately 90 db. This gain is more than sufficient for amplifying the low-level dynamic microphone input to the plus 8 vu output level that is fed on the lines. Low-level mixing is utilized with four inputs and a master gain on all amplifiers except for several compact, dual-input battery amplifiers. These compact amplifiers have an additional feature incorporated in the inputs. A switch is available to cut in a variable equalizer for attenuation of the low frequencies when used for voice, especially in noisy locations or where low-frequency reverberation is troublesome.

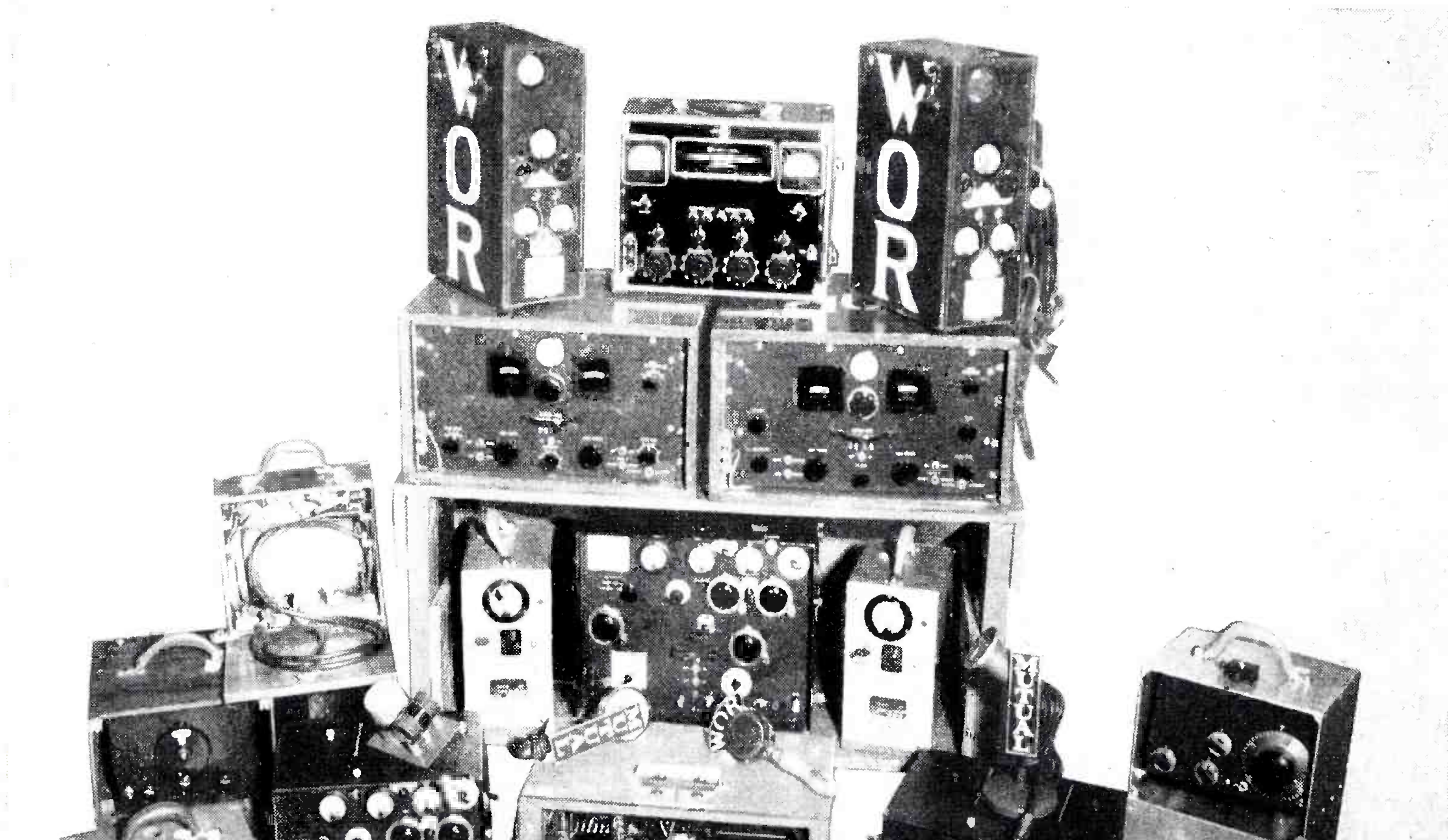
#### Recording Equipment

Three types of equipment are used to record programs in the field. A standard portable unit for 33⅓ and 78 rpm is employed for scheduled field pickups where the program material requires several microphones and other facilities. The recording amplifier has been modified to operate with an input level of plus 8 vu to accommodate the output of any of the field amplifiers. Mixing is thus provided for any number of microphones necessary for program requirements. This equipment is a-c operated but an auxiliary d-c to a-c inverter is provided where only d-c is available and a gasoline engine driven generator supplies power where no commercial electric power is available.

There are many programs to be recorded that require only a single microphone and quite frequently are called for on very short notice. A wire recorder answers the needs of this requirement, being compact, easily set up and operated. This equipment operates on 110 volt a-c and records a continuous half-hour program. The wire can be reused after the modulation has been electronically erased. A complete set of spare tubes and accessories is carried with the recorder. Inverters are used to provide 110 volts a-c from either a 12-volt battery or 110-volt d-c line. The wire recorder is returned to the Field Engineering room after recording a program and there is set up on the bench to play back the program that the Recording Division transcribes for playback on the air. The bench in the field room is provided with wire line terminations, monitor, and equalizer.

**Automatic Recorder**

The third type of recorder regularly employed in the Field Engineering Division is a 78-rpm compact spring-wound battery-powered disc recorder developed by the British Broadcasting Company during the war for use by paratroopers behind enemy lines. This recorder, shown in Fig. 2, provides an excellent means of transcribing spot interviews and news from any location. The entire operation of setting up the equipment and recording the program can be completed in a few minutes. The finished recording is returned to the studio and may be played on the air on any turntable that runs at 78 rpm. The recorder turntable is driven by a powerful hand-wound spring motor controlled by a speed governor similar to the type used on ordinary phonographs. The motor drives the turntable with sufficient torque for cutting the record at a constant speed of 78 rpm for three minutes which completes one side of the standard ten-inch recording blank used with the machine. An automatic release lifts the cutter head, stops the motor and turns off the amplifier when a predetermined length of recording is completed. A three stage battery-powered amplifier supplies sufficient audio




**Part of short-wave field equipment for broadcasts from locations without wire lines**

power to drive the crystal cutter head. An avc circuit limits the output to prevent overcutting on the record. The microphone is a specially designed crystal type with a clamp handle for clipping it to any convenient mounting. The input is equalized for a good overall frequency response from the microphone through the cutter head. The volume is regulated by a two position gain switch, one for close talking and the other for distant pickup. A neon light is built into the recorder for use as a modulation or volume indicator to show when audio is actually being applied to the cutter mechanism. Spare recording blanks as well as the microphone and cord are stored in the cover of the recorder. A spare parts kit contains tubes, batteries, recording head, stylus and parts.

### Short Wave Facilities

Programs are frequently originated from locations where telephone wire lines are either not available or nonexistent. Relay broadcast radio frequencies are assigned by the FCC for broadcast station use in linking the field pickup point with the studio. The station owns and maintains ready for immediate operation seven portable transmitters and one permanently installed cue transmitter. Four of the transmitters can be used on any of the four frequencies assigned in the 1.6- to 3.0-mc band while three of the portable transmitters and the cue transmitter can transmit on any of the four frequencies assigned to WOR in the 30- to 40-mc band.

The Field Engineering Division is notified of a program to be originated at a location that requires the use of short wave facilities and immediately surveys the requirements of the pickup. Proper frequencies, power source, receiving location, necessary equipment and other facilities must be considered. A permanent receiving station is maintained in central New York City at which point communication is maintained with field pickups within range by means of a cue transmitter. Receiving points are installed at the nearest telephone line connection if not within range of the permanent station. The engineers

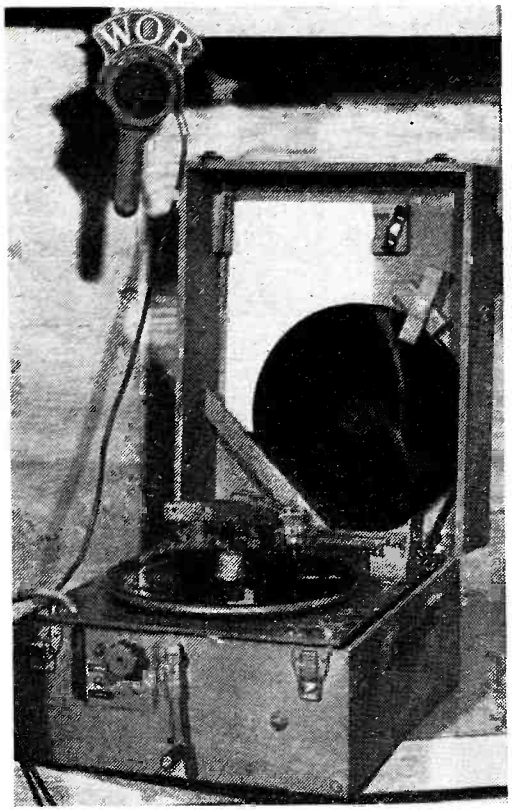



FIG. 2—Complete portable spring-driven recorder for spot news interviews

assigned to the relay broadcast location assemble all the necessary equipment and transport it to the point of program origination. Antennas are erected, transmitters, power supplies, field amplifier, and cue receiver are set up for operation. The transmitter is tuned, power adjusted and communication established with the receiving location. The transmitter frequency is measured to determine that it is correct and a test is conducted with the main studio via the cue transmitter link. The program order-circuit is established and cues for the program are taken either via the cue transmitter or, when on-the-air, from the regular WOR program received on a portable receiver. Program operation thereafter is similar to a regular field pickup.

Some of the short wave facilities of the Field Engineering Division are illustrated. The two pack transmitters at the top of the picture are complete low-frequency and high-frequency units. A rod antenna, loaded for the low-frequency unit, connected on top and a microphone plugged into the socket on the front panel complete the installation. The pack transmitter is carried on the back of the engineer or announcer and tuned for proper output in that position by the controls on the side. A battery-operated cue receiver is carried for program orders. Two hand-held high frequency "mikemitters" (not shown) operating at a power of 0.2 watt are similarly used for shorter distance transmissions.

Three intermediate-frequency and one high-frequency relay transmitter of 25-watts power output are available for relay transmissions over long distances. The intermediate-frequency transmitters are of interest for several features incorporated in their construction. The oscillator tube is a type 6L6 with the crystal in the grid circuit and the plate tank circuit tapped for each frequency. The oscillator frequency switch selects the crystal and the proper oscillator plate coil tap. The oscillator drives two type 807 tubes in parallel. The output of the 807 stage can be tuned either by a tapped parallel tank circuit or a $\pi$-tuned coupling circuit, selected by a switch. The $\pi$-coil is tapped and proper inductance is selected by a twelve position switch. With this circuit arrangement, antennas of any length can be properly matched to the transmitter for a maximum transfer of power.

The high-frequency transmitter consists of a 6L6 oscillator, two 6L6 doublers and a pushpull 807 output stage. The output tank Q was improved considerably by silver plating the coil and all connections. The transmitter output is link coupled to a coaxial fitting on the front of the transmitter. Coaxial line voltage is measured by means of a vacuum tube voltmeter connected across the line.

Plate power for these transmitters is supplied either by a 110-v a-c power unit or a 12-v d-c motor generator. The 110-v a-c unit furnishes filament power from a separate 12-volt filament transformer while the 12-volt primary batteries supply filament power when the motor generator is used. The regular field audio amplifiers provide a plus 8-vu level to the audio input of the transmitters. The modulators in the relay transmitters are pushpull 6L6 tubes operating class $AB_1$. Frequency monitors are provided to check the frequency of the transmitters either at the field pickup or at the receiving location.

# Ionosphere Equipment For Field Use

A simplified technique for pulsed ionosphere measurements uses unattended recording equipment. The receiver is remotely located from the variable-frequency transmitter but automatically follows frequency excursions throughout the signal spectrum

By
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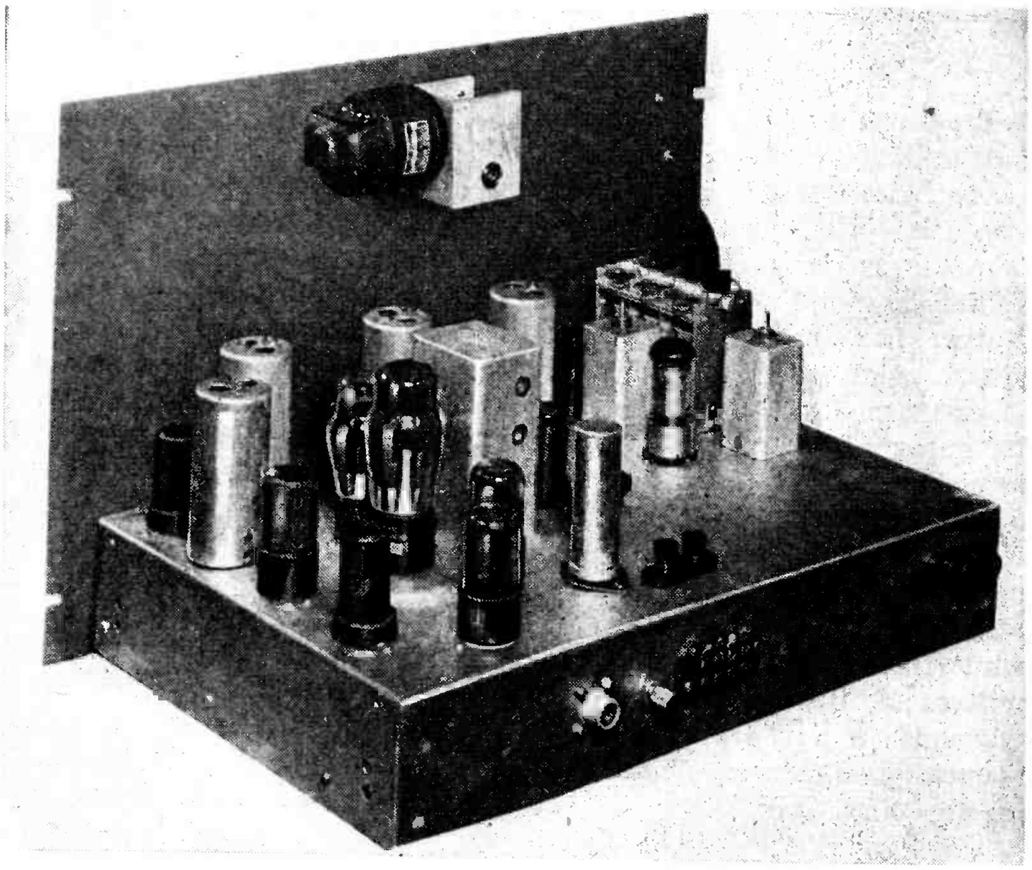
In investigations of the ionosphere the relationship between the E-layer critical frequency and time, during a solar eclipse, is of fundamental importance. The radiation received from the sun decreases and then returns to normal in a cycle that consumes a few hours, at the most, compared with the period of the normal day-and-night cycle. Comparison of eclipse observations with data taken on normal days yields information that aids materially in understanding the behavior of the ionized regions above the earth's surface.

The partial solar eclipse of November 23, 1946, was observed in the Boston area about noontime. On a normal day there is a flat maximum of the E-layer critical frequency at about local noon; this eclipse, therefore, promised to show a dip in an otherwise relatively flat curve as illustrated. The dip results from reception of decreased solar radiation,[1] and the magnitude and shape of the curve are related to the variation of the exposed area of the sun during the eclipse period. The critical frequency in this case dropped from about 3.4 mc to 2.8 mc, which is commensurate with a 50-percent eclipse taking place at noon.

This research was made possible through support extended Cruft Laboratory jointly by the Navy Dept. (Office of Naval Research) and the Signal Corps, U. S. Army.

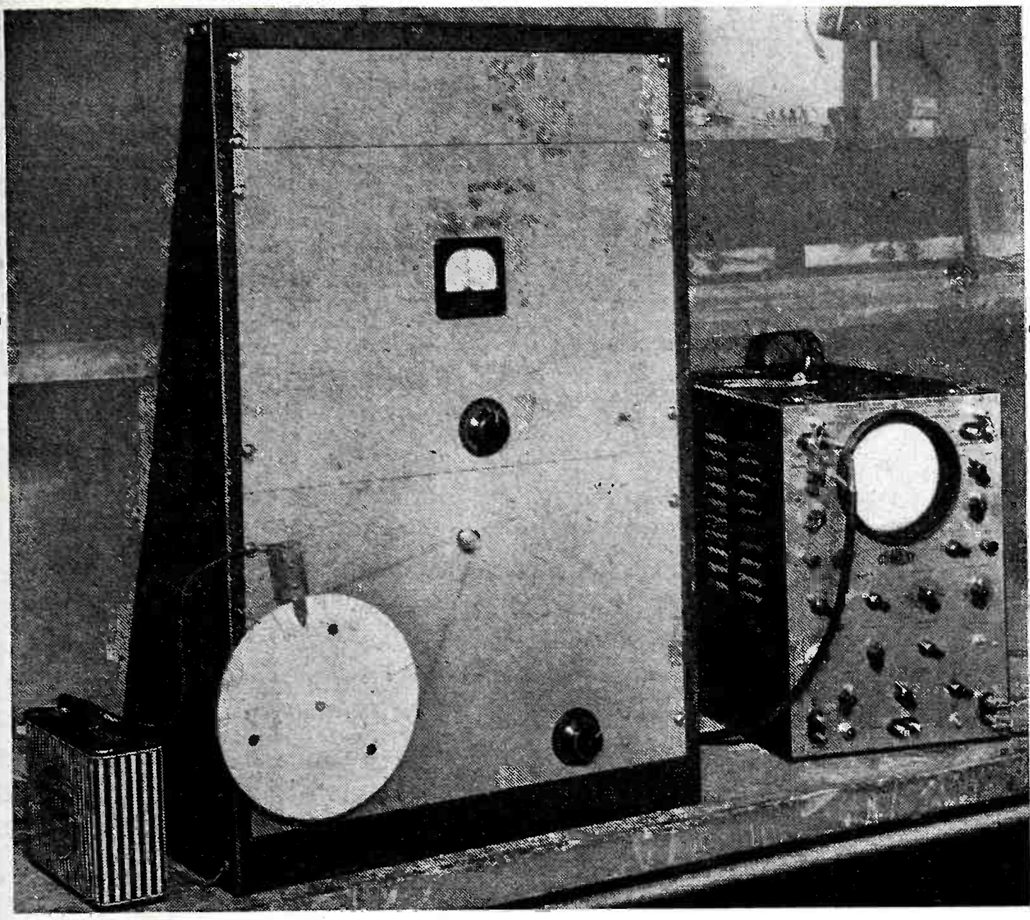


Rear view of receiver chassis showing motor and gear reduction box. The discriminator circuit is contained in the center shield can

### Ionosphere Measurement Systems

As there is no known method of postponing an eclipse, limited time was available for the design and construction of a complete working system, and some of the more elaborate and involved equipment arrangements were avoided in favor of simpler gear capable of obtaining the necessary data with reasonable accuracy.

One possible arrangement is to place the transmitter beside the receiver with the controls located so that both units are hand-turned by an experienced operator. This probably represents the simplest



**Sweep-frequency receiver and associated monitor scope. Receiver and motor drive on lower chassis, with d-c amplifier and motor control circuits above**

design, but requires a skillful and patient manipulator, if not a crew of them, for any extended operation. A second system is one in which both the transmitter and receiver are individually driven by synchronous motors operating from a common power main. This is used widely in present day sweep-frequency gear and is exceedingly reliable. The disadvantage is that the tuning characteristics of the two units must be carefully tailored to match throughout the entire frequency range.

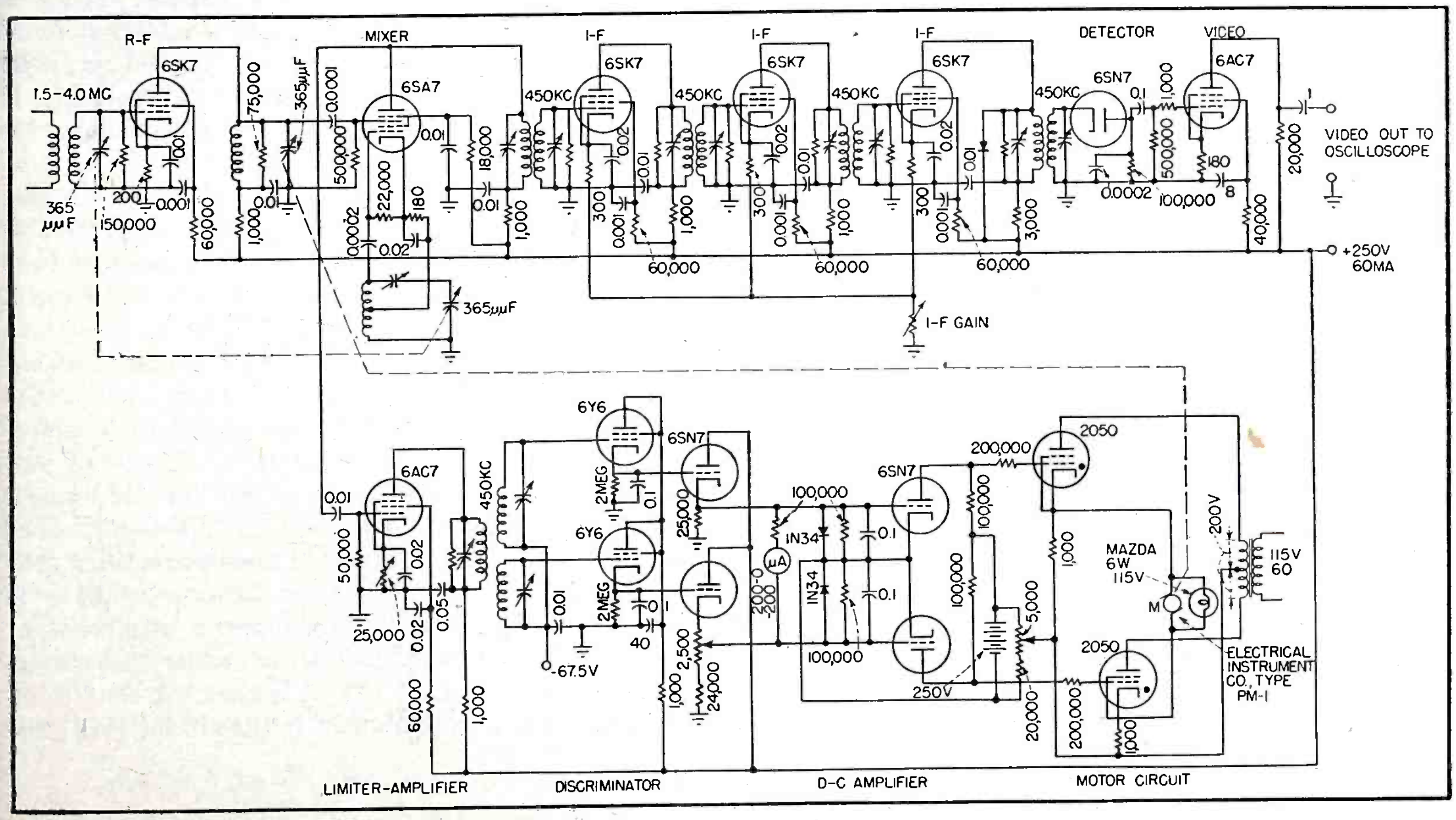
Probably the most modern, integrated design is one in which a common motor-driven tuned oscillator, in conjunction with heterodyning, serves to control both transmitter and receiver frequencies.[2] Good results are obtained by this method but the complexity is justified only where a wide frequency range is mandatory, and if the equipment is intended for continuous operation over a long period.

#### Field Requirements

The equipment requirements for eclipse observations are as follows:

(1) Since all of the activity centers around the receiver and recording equipment, it is desirable to

**Circuit diagram of the receiver used in ionosphere measurement work and described in detail in the text**



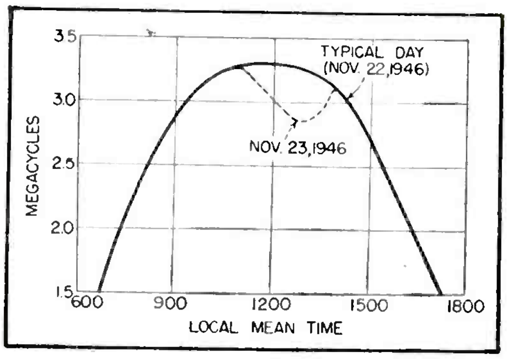



FIG. 1—Variation of E-layer critical frequency with time

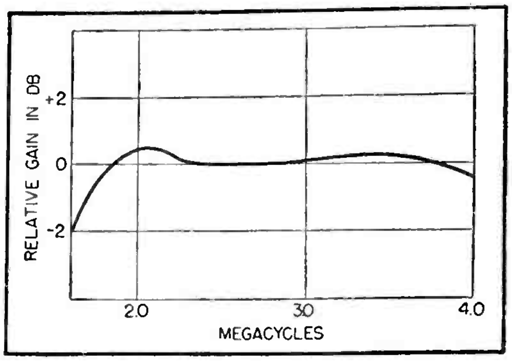



FIG. 3—Receiver gain as a function of desired frequency

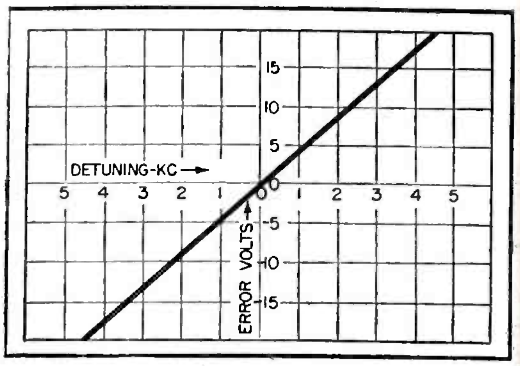



FIG. 4—Discriminator output characteristics with 100-microvolt signal at antenna

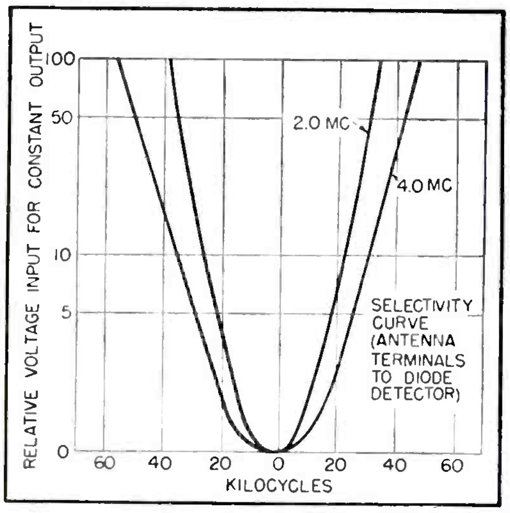



FIG. 2—Overall bandwidth of receiver

locate the transmitter with its high-voltage circuits apart from these. Some separation between the transmitting and receiving antennas is also desirable to reduce the amplitude of the ground wave, or main bang, in the receiver. Unless specially gated attenuator circuits are contained in the receiver, operation of the two units in the same room results in terrific receiver overloading.

(2) The receiver should be substantially automatic in its tuning, leaving the operating personnel free to develop the records and plot the data as secured.

(3) The entire equipment should be simple so as to reduce construction time, and so that it may be easily set up at any distant point.

#### Transmitting Equipment

The transmitter consists of a pulsed variable-frequency power oscillator of about 10-kw peak power, coupled into a long-wire resistance-terminated horizontal antenna. The primary features of this antenna are that it will radiate some power over the frequency range used, and that the input impedance characteristics are such that the antenna does not materially influence the oscillator frequency. The frequency range is 1.5 to 4.0 mc. The transmitter sweeps continuously between these two limits, requiring four minutes for the complete cycle. The emitted pulses rise in 30 microseconds, are about one hundred microseconds long, and are spaced one-tenth of a second apart.

#### Recording the Signals

The recording equipment was installed in another building about a half-mile away, and comprised servosweep circuits, an oscilloscope fitted with a continuously recording camera, and the sweep-frequency receiver described below. The trace of the scope is horizontal and is intensity-modulated by the video output of the receiver, combined with height markers.

The sweep-frequency receiver uses a folded doublet half-wave horizontal antenna cut for 2.9 mc and fed with a 300-ohm twin lead transmission line. The tube lineup consists of a 6SK7 r-f amplifier, a 6SA7 mixer, three 6SK7 broad-band i-f amplifier stages, a 6SN7 diode detector and a 6AC7 video amplifier. The r-f, mixer, and oscillator circuits are tuned by a three-gang 365 $\mu\mu$f-per-section tuning capacitor. The shaft of this capacitor carries an 8-inch diameter aluminum disk dial. The edge of the disk is grooved for a dial drive cord, and the face is covered with cardboard, suitably marked with a frequency calibration. Slots are cut in the cardboard so that an electrical contact can complete a relay circuit, thus providing frequency marks on the record as the receiver tunes.

#### Circuit Analysis

The r-f and mixer stage gain is fixed as indicated in Fig. 2. The i-f stage gain is adjusted by a resistor common to the cathodes. The total bandwidth of the i-f section is about 40 kc at the half-power points. The overall bandwidth is less than this due to the selectivity of the r-f and mixer circuits, and consequently varies with frequency. If the r-f and mixer circuits are damped heavily, the overall bandwidth approaches that of the i-f alone, but this is accompanied by a degradation of the desired signal-to-image response ratio. Corresponding to the selectivity curves shown, the image response is down 54 db when the receiver is tuned for a desired signal of 2.0 mc, and 32 db when tuned for 4.0 mc. The overall gain against frequency is essentially constant as shown in Fig. 3.

The output of the mixer stage, besides feeding the i-f channel, also feeds a 6AC7 limiter-amplifier tube which in turn excites a three-coil frequency discriminator. The peaks of the discriminator are spaced about 15 kc above and below the center i-f. The usual diode detectors are replaced by 6Y6 tubes connected as so-called infinite impedance detectors. In order to realize a satisfactory average rectified voltage across the detector loads, it is necessary to employ a time constant in excess of the recurrence interval of the r-f pulses. A conflicting requirement is that if the load voltage is to be able to follow the variations in amplitude of successive pulses, a small time constant is indicated. The design was compromised at 0.2 seconds with a 2.0-megohm resistor and 0.1$\mu$f capacitor. If the leakage resistance were no problem a higher impedance circuit with the same time constant—say, 20 megohms and 0.01 $\mu$f—would require less charging current from the tube for the same voltage output. A 6SN7 tube connected as a pair of cathode followers is used as an isolation stage. Across these latter cathodes is connected a zero-center voltmeter that serves as a tuning indicator. The voltmeter reads zero when the receiver is properly tuned so that the pulses fall in the center of the i-f pass band. The magnitude and polarity of the voltage are proportional to detuning over a range of about 10 kc either side of the center frequency as shown in (Fig. 4).

In order to suppress the effects of varying signal strength (resulting from changes in radiated power from the transmitter and varying antenna efficiencies at both receiver and transmitter as a function of the frequency) it is desirable to provide limiting in the 6AC7 tube. This same limiting, of course, tends to remove the selectivity effects of the front-end circuits to a certain extent. A rather subtle disadvantage of limiting is that since the desired r-f pulses are short compared to the recurrence interval (100 $\mu$sec compared to 100,000 $\mu$sec) continuous carrier signals of much smaller amplitude can produce equivalent discriminator action during the long interval between pulses. In other words, with a given desired pulse voltage at the antenna terminals, the more limiting, the more sensitive the discriminator is to weak, undesired, continuous-wave signals. The relationship between antenna terminal voltage and the voltage at the plate of the limiter amplifier is shown in Fig. 5. The received ground-wave pulses average about 100 millivolts, so that there is sufficient limiting to take care of changes in signal strength of 2 to 1 or 3 to 1. There is another factor that tends to favor the c-w signals. The detector load capacitors charge up to produce an average d-c voltage which more nearly approaches the peak value of the signal voltage when that signal voltage is continuous rather than pulsed.

#### Automatic Tuner

The difference voltage caused by detuning, hereafter called error voltage, is amplified by a 6SN7 d-c amplifier. The plates of this tube are connected to the normally biased-off grids of two type 2050 thyratron tubes. The thyratrons are connected with a power transformer and a small motor in a bridge circuit. The motor has a permanent-magnet field so that the direction of rotation of the armature depends on the polarity of the voltage applied to it. If either grid of the 6SN7 is made negative with respect to the cathode, the appropriate thyratron grid goes positive and plate current flows through the motor armature. The motor will, of course, rotate in the opposite direction when a negative voltage is applied instead to the opposite 6SN7 grid. Having one 6SN7 grid go positive is undesirable, so two 1N34 diodes are arranged to convert the entire error voltage into a negative component appearing at one 6SN7 grid only. It will be seen that the diodes force the 6SN7 cathode reference potential to follow whichever grid is more positive with respect to ground. This feature doubles the sensitivity of the servo amplifier.

Figure 6 shows the motor speed as a function of error voltage. The flat spot in the center of the characteristic is deliberate, and can be varied by adjustment of the thyratron grid bias. A nonlinear resistance in the form of a 6-watt 125-volt lamp is connected across the motor armature and this, in conjunction with the flat spot, practically eliminates hunting. When

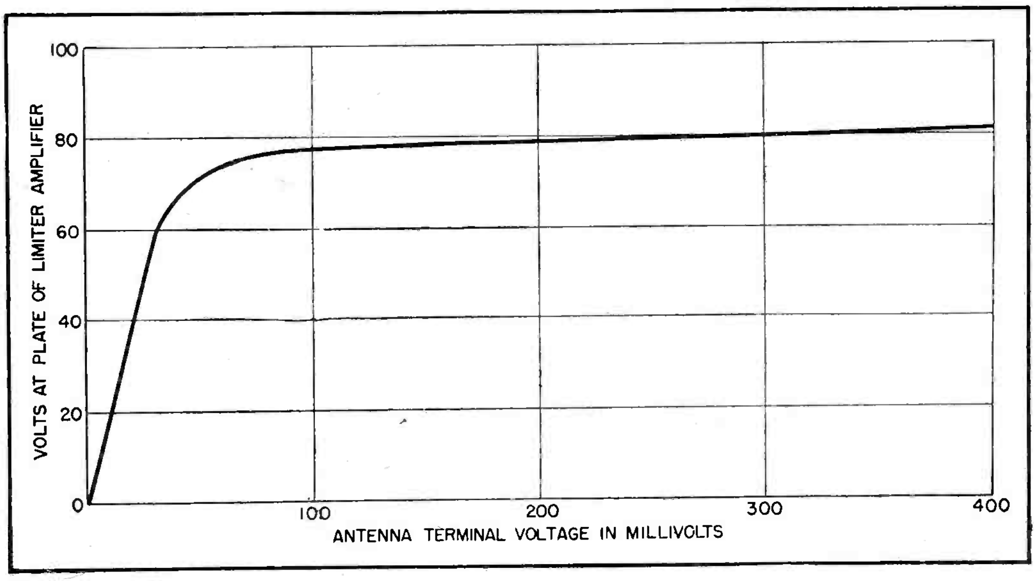



FIG. 5—Linearity characteristics from antenna terminals to discriminator input

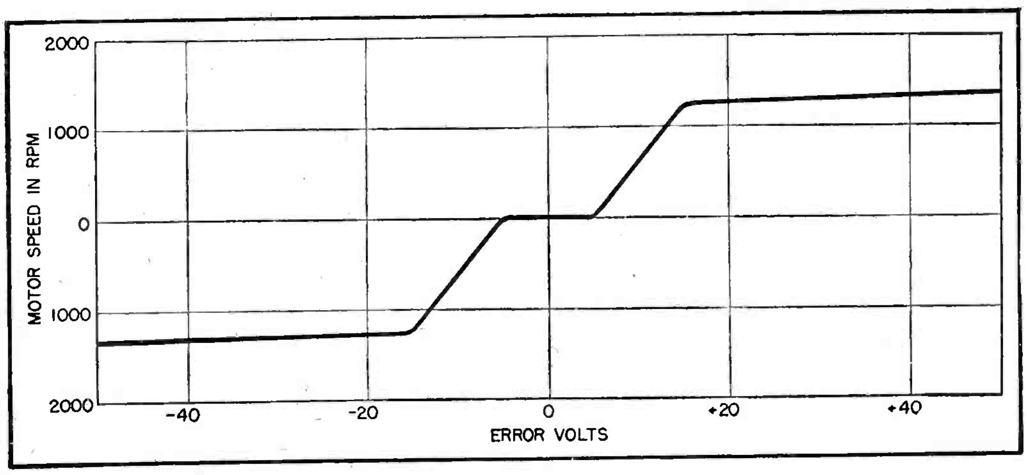



FIG. 6—Motor speed as a function of error voltage applied to d-c amplifier

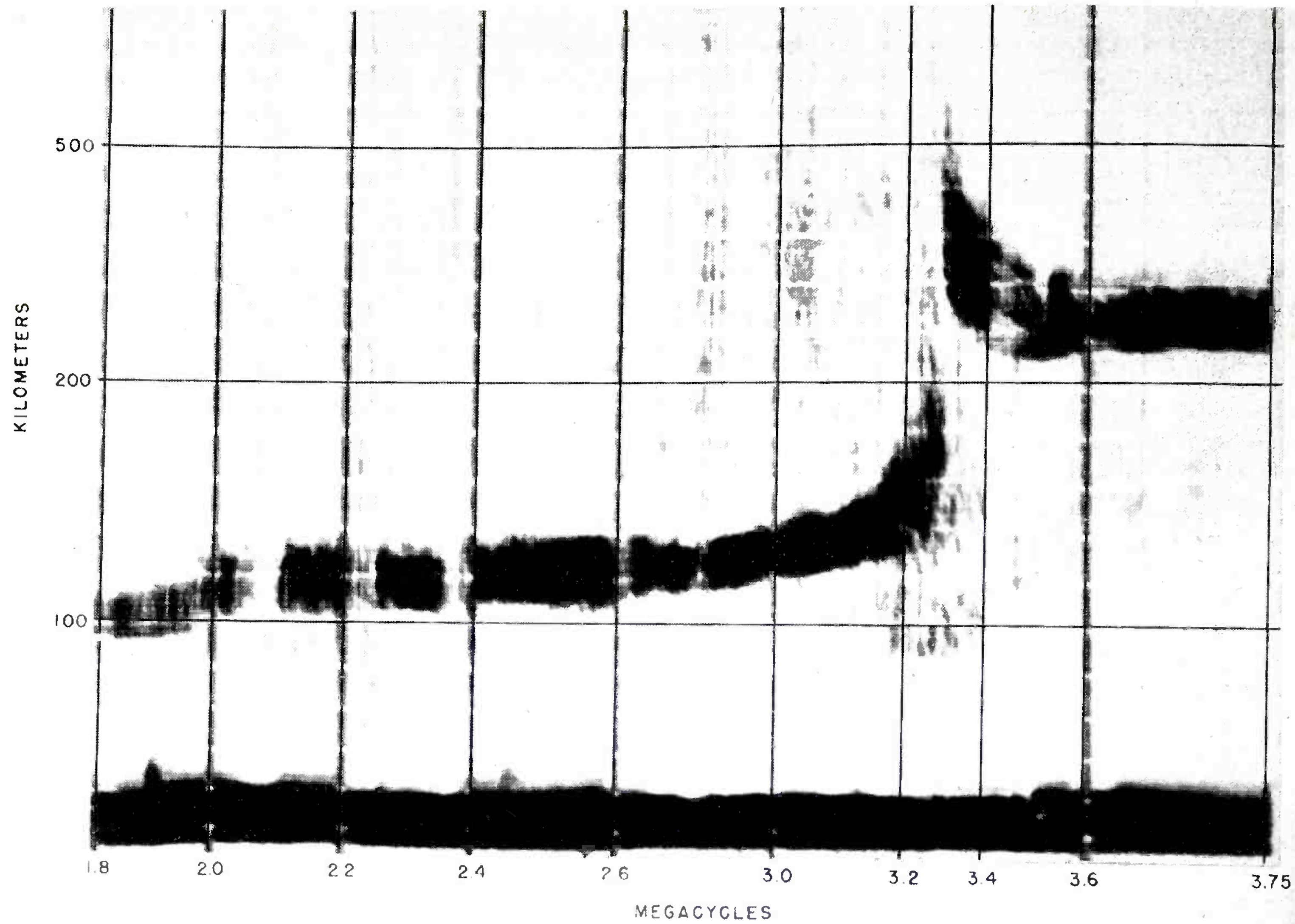



FIG. 7—Sweep-frequency record of November 24, 1946, at 1222 local mean time, showing the E-layer critical frequency at 3.3 megacycles (vertical incidence). This control data was taken the day after the eclipse

the error voltage decreases to about 5 volts, the voltage applied to the armature approaches zero, the lamp filament cools, and its resistance decreases. The low resistance dissipates the power generated by the coasting armature, thereby acting as a brake and preventing overshoot.

The motor drives an 80-to-1 worm gear reduction box terminating in a ¾-inch diameter pulley. This pulley cord drives the main tuning dial.

When the pulse signals are properly tuned in with appropriate adjustments, the motor-driven tuning follows the transmitter frequency faithfully. Since the ground wave from the pulse transmitter is at least 100 times greater than the strongest reflection (this statement concerns the arrangement described and would not hold true for a greater separation between transmitter and receiver), discriminator action, and consequently receiver tuning, tracks on the ground wave only.

Observation of the tuning meter indicated that the receiver tuning was generally within 2 kc of the transmitter frequency. The shape of the reflections as observed on a monitor scope indicated that this amount of detuning was in no way detrimental.

It must be remembered that the receiver as described needs to be located so close to the transmitting antenna that the ground-wave signals greatly override all noise bursts and signals from other sources.

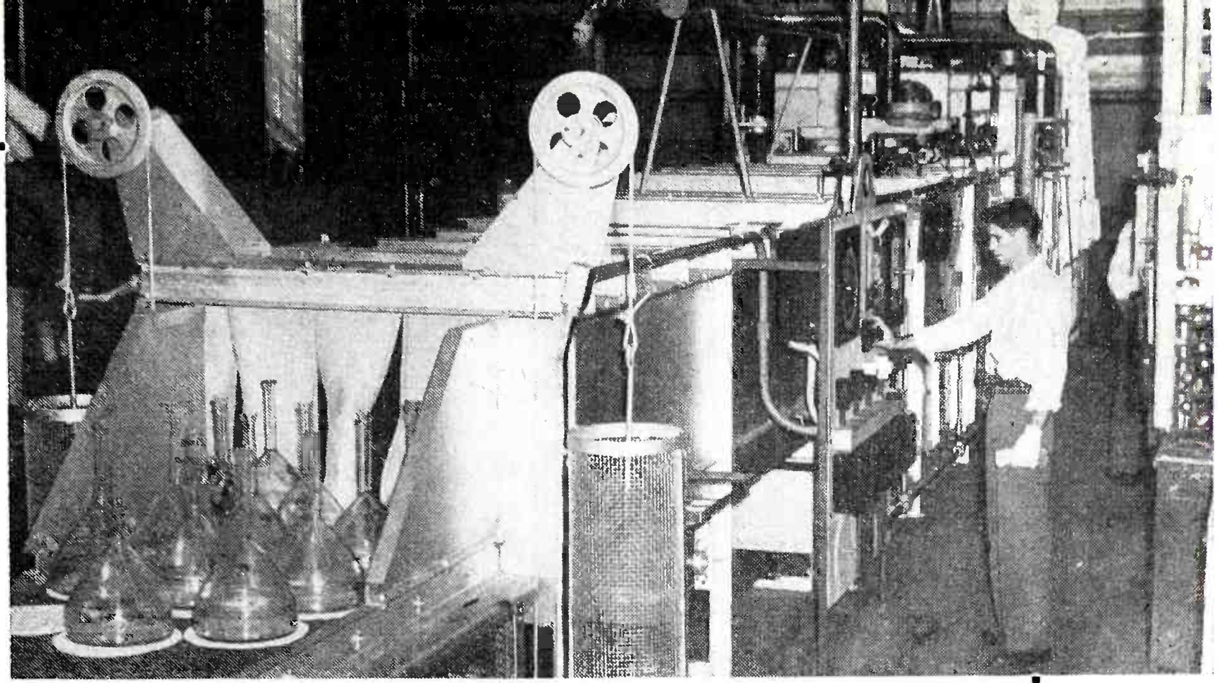
In order to make the receiver less sensitive to general channel interference, the limiter-amplifier circuit might be gated so as to be operative only for a period of a few hundred microseconds at the time of each ground-wave pulse. Synchronization with the transmitter timing would then be required, but this could be obtained readily from the oscilloscope sweep circuit. An improvement along this line would allow greater separation between transmitter and receiver. The attendant advantage is that the ground wave would be greatly reduced in amplitude, possibly to the extent that it would be comparable to the E-layer reflection. Loran pulse-matching technique demonstrates the improved measuring accuracy obtainable when pulse amplitudes are equalized. It is reasonable to expect that in the future some adaptation of this technique will find its way into ionosphere sounding equipment.

A typical sample of the records obtained is illustrated. This particular frame is part of the control data (1222 local mean time, November 24, 1946). It shows very clearly the transition from E-layer to F-layer taking place at 3.3 mc. Approximately one thousand similar pictures are included in the eclipse and control data records.


REFERENCES

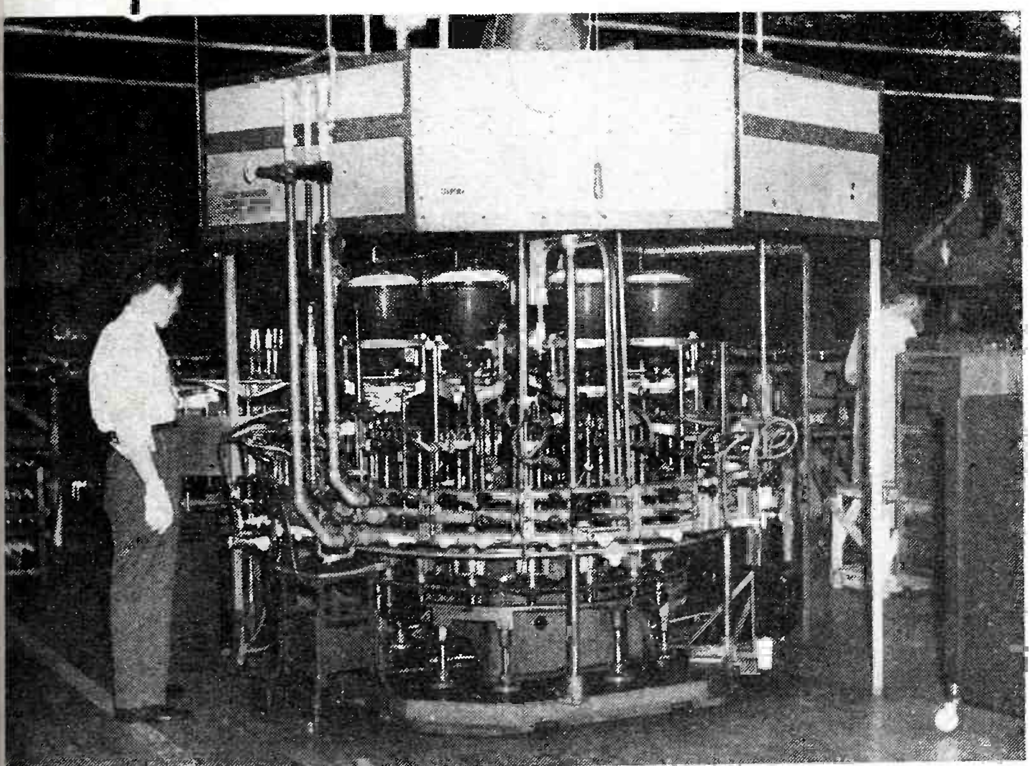
(1) Harang, L., Radio-Echo Observations at Tromsö during the Solar Eclipse on July 9, 1945, *Terr. Mag. and Atmos. Elec.*, 50, No. 4, 1945.

(2) Sulzer, P. G., Ionosphere Measuring Equipment, ELECTRONICS, p 137, July 1946.



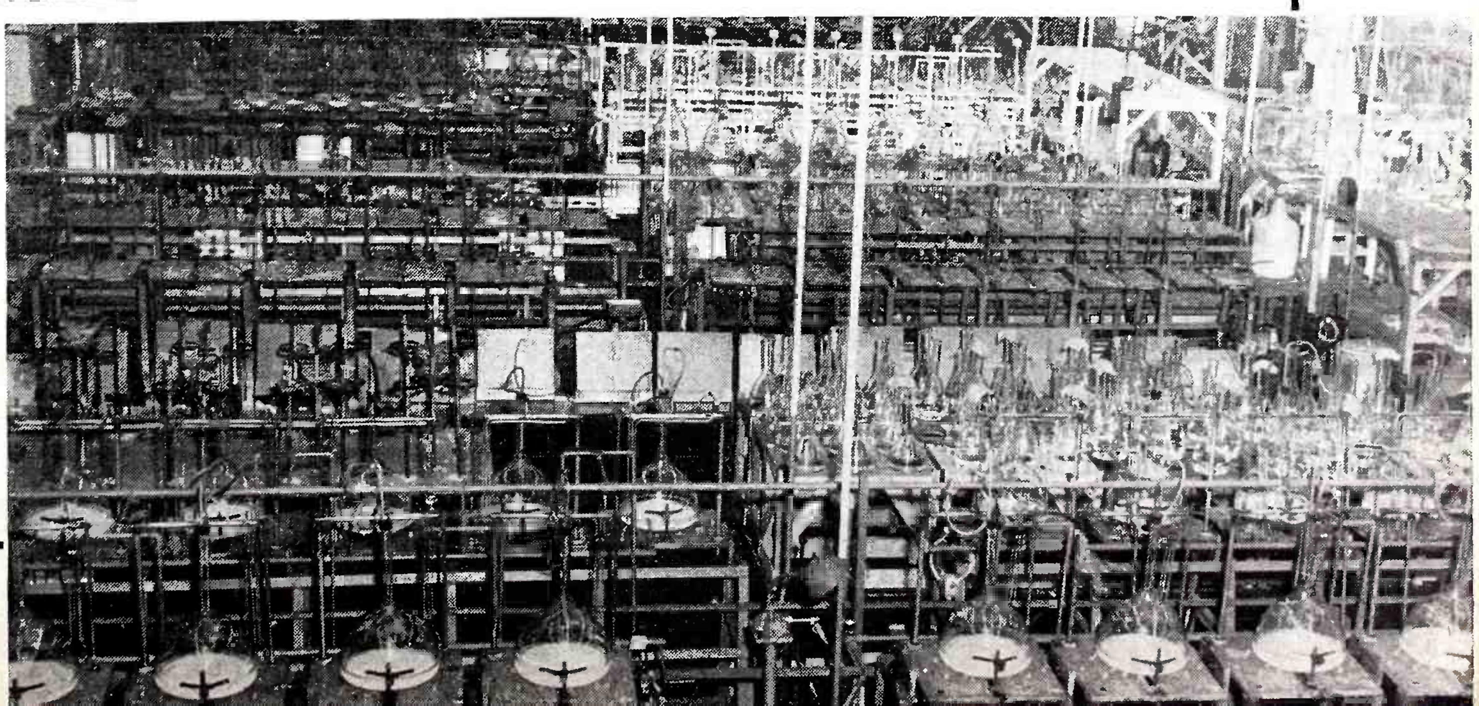
Annealing the glass of cathode-ray tube blanks is done at 450 C by passing them through this continuous gas-fired radiant lehr (glass-heating oven) for four to six hours. A contact button is sealed into the tapered wall before the blanks enter the lehr

# TELEVISION TUBE PRODUCTION

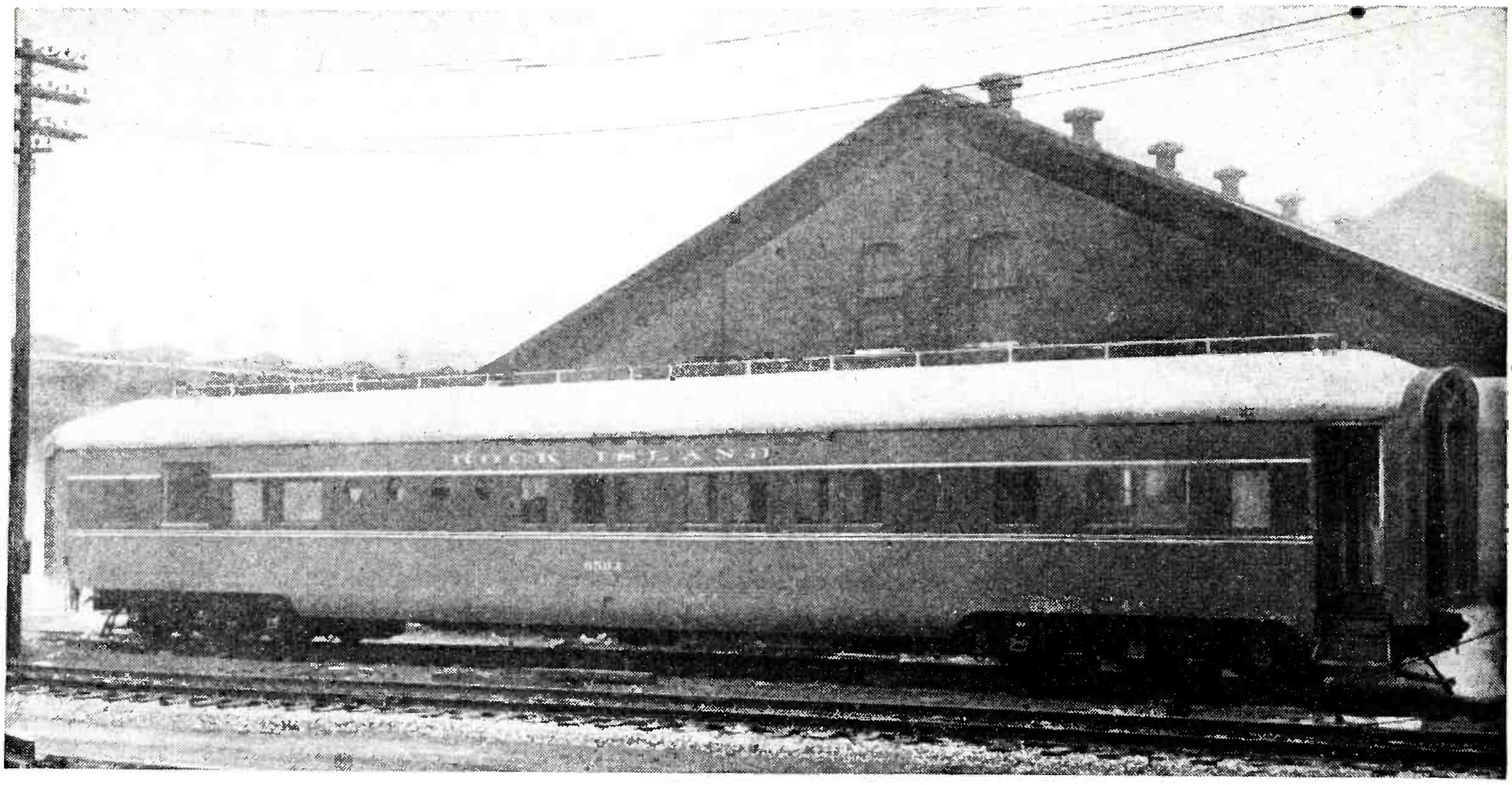


As tubes index at stations in this machine, the electrodes are inserted, flares and bulbs are sealed, and their cullets are cut off, all automatically. Various patterns of gas flames perform these operations at the Lancaster, Pa. plant of RCA Victor while the overhead hood draws off combustion products and heat

Phosphor particles settle on the inside face of each tube out of a liquid suspension and excess solution is decanted off, forming the screen. Built on its own foundation, the floor is composed of a heavy concrete slab floating on a layer of cork



# Railway



Overhead power lines and factories, typical of railroad trackside in cities, must be considered in railroad radio operation

PROBLEMS involved in the successful design of railway entertainment systems are quite different from those of fixed systems. Since a train enroute generally travels quite a long distance and will pass localities possessing an extremely high noise level due to power installations and the like, steps must be taken to provide adequate sensitivity, automatic volume control, and noise suppression.

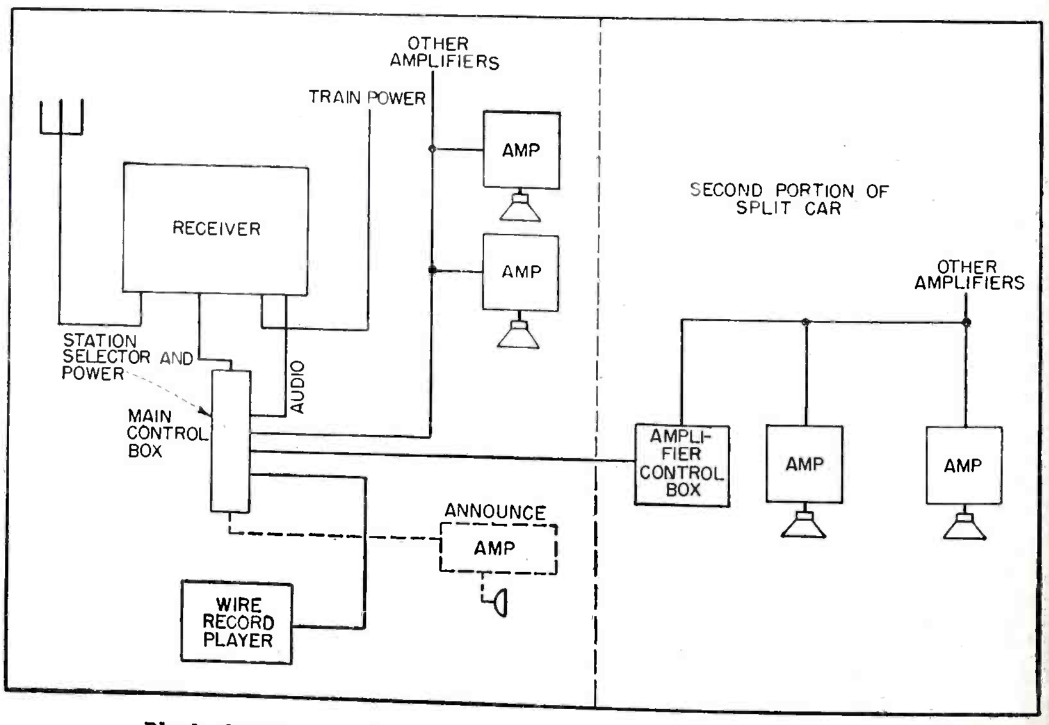
Modern trains possess very little space for mounting equipment, therefore, all units must be constructed so that they are able to be mounted in out-of-the-way places and thereby remotely controlled. Extreme low-frequency vibration is present, necessitating design of a good vibration mount. In addition, railway operating conditions dictate that the antenna may be no more than eight inches above the car roof.

The problem of overall distribution of sound requires overcoming changing noise level which at times may be fairly high compared to normal room noises. The acoustical distribution must not blast or present any areas of high level. Yet it must maintain such a level that a person listening to a newscast can apply the selective ability of the human ear to hear the program material with ease. Adjacent passengers must be able to carry on a normal conversation without interference from the radio program.

### Major Units of System

The general installation plan is the result of tests and conferences between engineers of the American Phenolic Corporation, Rock Island Railway, and engineers of the Collins Radio Company. It consists of a remotely controlled receiver, independent ceiling amplifiers and loudspeakers, a wire record player, and control boxes for controlling and setting up the desired program.

A master control box is located in the same car as the receiver. The audio output of the receiver is fed through this control box, as is the audio output of the wire record




Block diagram of the equipment installed in one railroad car

# Entertainment System

**Quartz Crystals in a double superheterodyne permit reception of pretuned distant stations when they become local to a train enroute. Design problems involve noise from power installations, limited antenna pickup, sensitivity, and acoustic distribution of received program material to passengers**

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*Chicago, Illinois*

player. The master control box then feeds a car line to any number of low-level amplifiers located throughout the car. If the car is a truncated or split car, an additional control box takes its output from the master control box and feeds amplifiers in the second section of the car. Then passengers in either section of the car may listen to the receiver output or the record player independently of each other.

The car line between the control boxes and amplifiers is a small four-wire line containing two audio and two power leads and is mounted in the ceiling.

Each amplifier supplies a small p-m loudspeaker that covers an area in the shape of a cone from the ceiling to the floor, the circumference of the base coverage being approximately 12 feet. Six of these speakers, effectively spaced through the length of the car, produce even sound distribution throughout the entire car.

It is possible to feed any number of cars from one receiver by using a train line. However, investigation has shown that such a line is quite expensive and it is more economical in the long run to install a receiver in any desired car. Then each car is an independent unit and may be used on any train regardless of what type of installation the other cars possess.

Remote control (arrow) and loudspeaker near ceiling in a Rock Island dining car

### Receiver

Early in the design of the receiver it was recognized that, due to extreme temperatures, vibration, and other factors, crystal control would have to be employed to insure accurate tuning of all stations over long periods of time. A conventional 455-kc intermediate frequency requires local oscillator crystals to operate roughly between one and two mc. It is difficult to manufacture satisfactory crystals in the neighborhood of 1.8 mc that have high activity, accuracy of calibration, and stability. Also the cost of good crystals in this neighborhood is high. Discussion with crystal manufacturers showed that crystals between three and four mc were the most economical and reliable.

In the receiver, the only switching necessary is local oscillator crystal switching and r-f coil switching. Only one tuned circuit per channel is employed. A magnetic stepping switch permits any one of ten channels to be selected from a remote position.

Permeability-tuned inductances are used to set up each frequency. The second converter has an input of 2.6 mc and an output of 175 kc for the second i-f. This frequency was chosen because it provides high i-f gain and the desired selectivity characteristics.

A compromise was made between fidelity and adjacent-channel interference. Since a perfect selectivity curve, a rectangular figure, cannot be obtained and can only be approximated by using a very large number of tuned circuits, a narrow bandwidth was decided upon. A number of extensive tests indicated a modulation frequency of 3,500 cps as the maximum that should be passed. Since the high-frequency components in the audio output would be attenuated due to the selectivity curve of the i-f transformer, a rising frequency response was used to improve fidelity. The result is a fairly flat audio response up to 4,000 cps, dropping off very sharply thereafter.

### Antenna

Noise has been a large factor in limiting successful reception on trains in motion. This problem was met in two ways. First, through the design and development of an antenna system by the American Phenolic Corporation. The antenna is mounted seven inches above the top of the car and is approximately 77 feet long. It provides the maximum possible pickup for such a low effective height with minimum noise and attempts to duplicate the precipitation - static - free antenna system used by the Services. It is weather proof, and is built to withstand extreme shock and vibration.

The antenna is made of tubing and conforms with all ICC requirements as to weight, height, and strength. The 50-ohm coaxial transmission line is connected to the center of the antenna and the antenna impedance varies from 28 ohms at 1,500 kc to 85 ohms at 600 kc.

Since this antenna is so close to the car roof it obviously presents a very low effective antenna height which in practice is approximately 0.2 meter. The length of the antenna can never approach $\lambda/2$ at broadcast frequencies, so it can never appear as a pure resistance and appears as a capacitive source. The 50-ohm coaxial transmission line aids greatly in the reduction of pickup of man-made noise.

The second solution of the noise problem involves the receiver. A rather new noise-suppression circuit is used that may be called a noise-cancelling circuit. Conventional clipper circuits cannot be used where high fidelity is desired because any clipping above certain modulation percentages results in objectionable distortion. This clipper is adjusted so that no distortion results at 100-percent modulation, but some sacrifice in noise suppressing action had to be made to eliminate distortion at 80-percent modulation.

### Individual Amplifiers

Each loudspeaker amplifier on the Rock Island consists of a 6J5 phase inverter driving pushpull 25L6s in class A. These deliver approximately 600 mw with less than three percent harmonic distortion.

The amplifier is mounted in a small steel box 9×11×5 inches. The amplifier chassis is mounted to the front panel of the box by thumb screws so that the entire unit may be easily removed for maintenance. Jensen speakers having high acoustic output are used throughout.

### Remote Control

The remote control unit is a small box located at any convenient position. Controls are provided to select any one of 10 predetermined stations, to select either radio or wire recorder program, to turn the amplifiers and radio on or off, and to control the audio level to the line feeding the remote amplifiers.

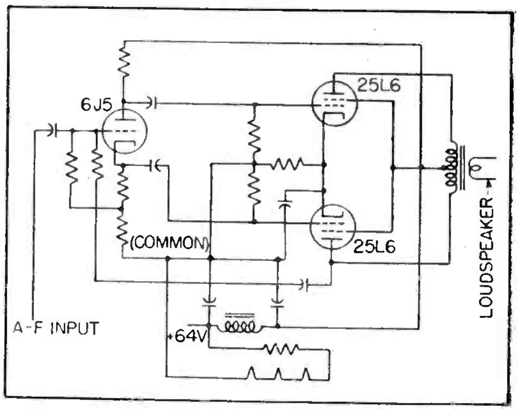
Station selection is accomplished by varying an open-seeking type switch which positions the stepping unit in the receiver. Audio from the receiver or from the wire record player, depending upon where the switch is set, is fed to a 500-ohm potentiometer, the arm of which is connected to the grids of all of the remote amplifiers. The radio-off-records switch supplies power to either the radio or the record player or neither, and switches audio from either to the potentiometer feeding the car line.

A second type of remote control unit is used in truncated cars. It enables passengers in the second section of the car to control volume independently and to select either radio or recorded programs.

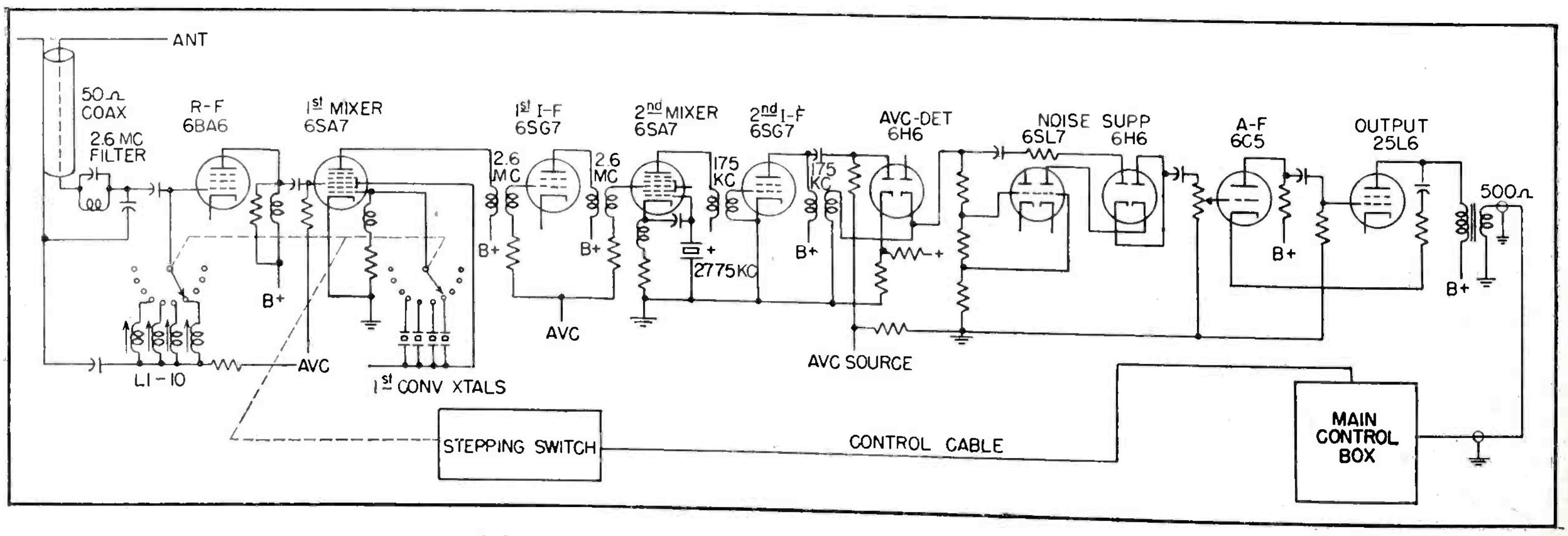
The radio-off-record switch selects either the receiver audio or record player audio and switches the record player on in event passengers in the first section are listening to the radio. The audio is then fed to a 500-ohm potentiometer again, the arm of which feeds the amplifier grids.

### Wire Record Player

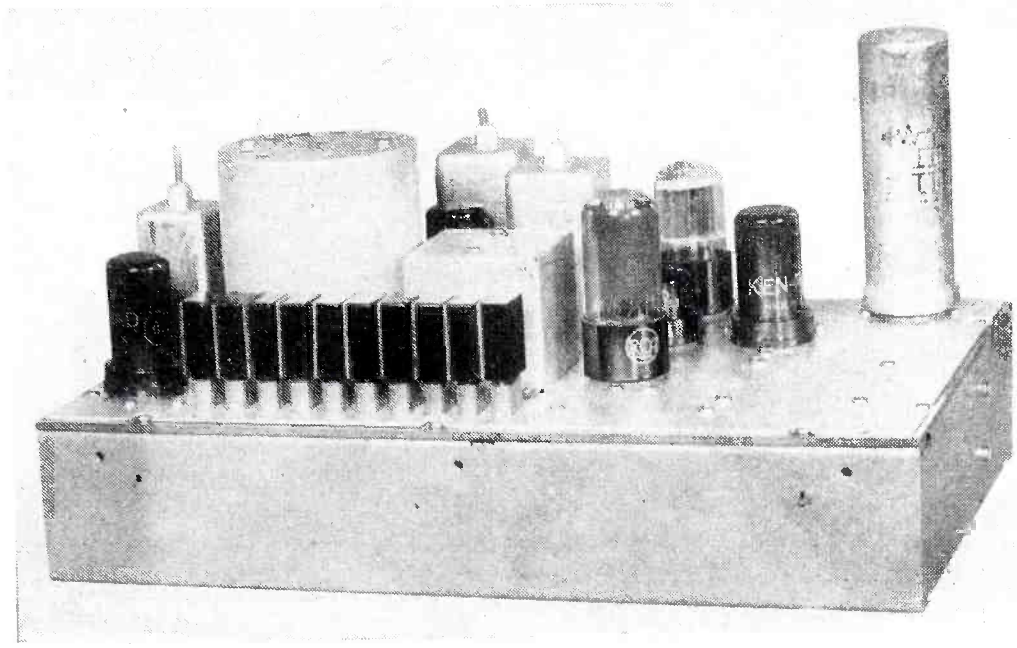
The wire record system consists of three units mounted in one small




Circuit of a loudspeaker amplifier




Schematic of the essential portions of the receiver



Crystal mountings and components on top of chassis

case. The first two units are individual wire playbacks containing news programming material for one hour with motors which can be reversed quickly and rewound at the same rate as the playback. The third unit consists of the necessary amplifier and equalizers to bring the output of the playback heads from −85 db to approximately +20 db across 600 ohms at 1,000 cycles. The output from the reproduced wire signal is within two db from 70 to 7,000 cps.

A 64-volt d-c motor was used for the record player. Magnetic regulation is employed and holds the shift speed to better than one percent variation of its 3,600 rpm. Rock Island trains have 64-volt d-c generators and this voltage is used on all units. The 64 volts is filtered and used for filaments, B supply, and to operate the station-selector stepper.

The pressure type capstan drives the wire at a constant rate of two feet per second regardless of depth of wire on the spools. At the end of an hour's playing, the unit automatically turns off. When the steward or porter again starts the unit, the second recorder begins to play while the first recorder reverses direction and starts its rewinding procedure.

This mechanical switchover was chosen in preference to the automatic type since program changing and special announcements might be inserted at the end of a one-hour program. This system makes allowance for a two-hour program of variety music before any musical repetition is begun. In dining car operation, a period of 45 minutes usually allows a complete meal to be served and a turnover of passengers within the car itself, and because of this there would be no duplication of program material.

**Station Selections for Des Moines ROCKET**

| Call | City | Mile Post | Power Watts | Station Freq. KC | Crystal Position | Rock Island Channel | Crystal Freq. KC |
|---|---|---|---|---|---|---|---|
| WMAQ | Chicago | 0 | 50,000 | 670 | 1 | 14 | 3,270 |
| WGN | Chicago | 0 | 50,000 | 720 | 2 | 19 | 3,320 |
| WBBM | Chicago | 0 | 50,000 | 780 | 3 | 25 | 3,380 |
| WENR | Chicago | 0 | 50,000 | 890 | 4 | 36 | 3,490 |
| WHBF | Rock Island | 181 | 5,000 | 1,270 | 5 | 74 | 3,870 |
| WOC | Davenport | 183 | 5,000 | 1,420 | 6 | 89 | 4,020 |
| WSUI | Iowa City | 237 | 5,000 | 910 | 7 | 38 | 3,510 |
| WHO | Des Moines | 358 | 50,000 | 1,040 | 8 | 51 | 3,640 |
| KRNT | Des Moines | 358 | 5,000 | 1,350 | 9 | 82 | 3,950 |
| KSO | Des Moines | 358 | 5,000 | 1,460 | 10 | 93 | 4,060 |

### Announcing System

It is planned for certain trains to have announcing systems to be used by the conductor. While the Collins system does not include an announcing system, it lends itself quite easily to such an installation. It consists of a dynamic microphone and a small preamplifier and is connected into the system at the main control unit.

Depressing a push-to-talk switch at the microphone superimposes this audio output on the car line at a higher level. A small four-pin connector at the master control box ties the announcing system in with the rest of the units.

### System Operation

After the system has been installed the selection of stations is arranged to:

1—Correspond with the route the train travels

2—Obtain maximum coverage of stations during the hours of 7 a.m. to 12 midnight, as most stations are off the air from 12 to 7 a.m.

3—Allow for increased signal strength of stations at night

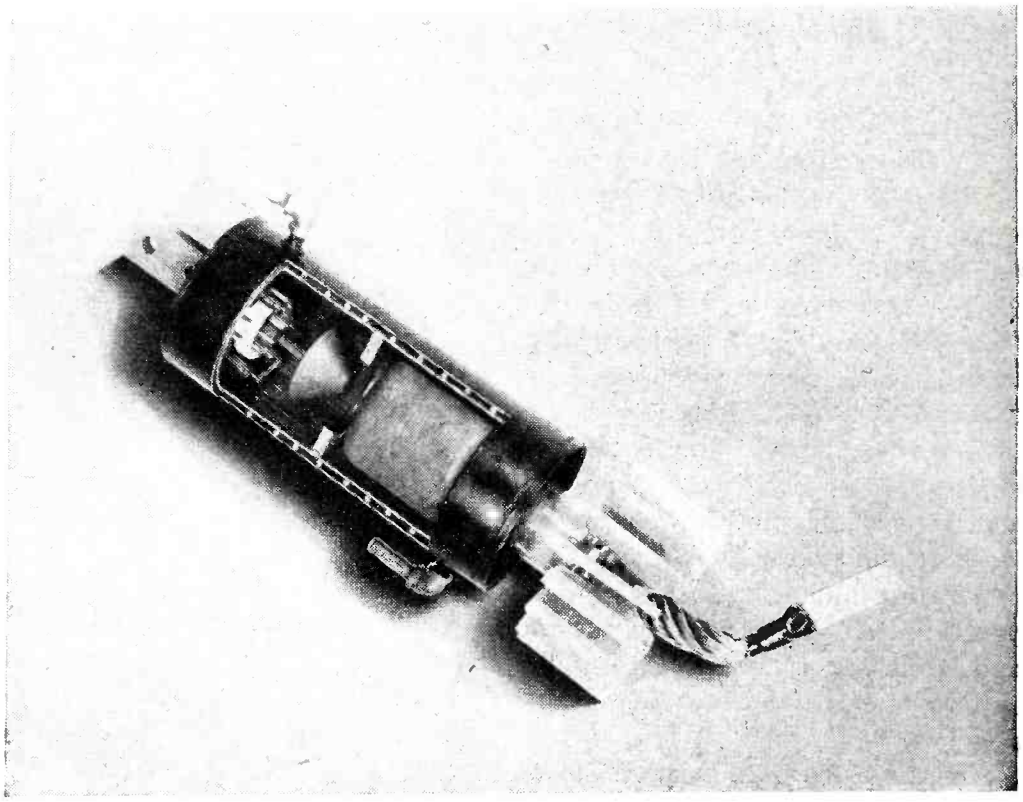
4—Obtain as completely as possible, coverage of all major networks.

The Table shows how stations are selected for the Chicago to Des Moines ROCKET of the Rock Island Line. This train leaves Chicago at 5 p.m. on its run from Chicago to Rock Island, Davenport, Iowa City, and Des Moines, Iowa. The average coverage of the four Chicago network stations, with noise-free reception, would be at least from Chicago to Rock Island, a distance of 181 miles. However, as the Mississippi River is crossed, this coverage is further supplemented by radio stations at Rock Island, Davenport, Iowa City and Des Moines.

When trains are on longer runs, it becomes more difficult to obtain full coverage, and tests indicate that a train going to the West Coast from Chicago would need to carry another pretuned receiver which could be plugged in, replacing the original, at a point about half way to the Coast. The use of crystals to set up frequencies makes it quite simple for the operator to pretune a receiver for distant stations with the knowledge that the set will receive them when they are within range.

# Characteristics of

CIRCUIT AND TUBE DESIGNERS, and users of equipment that incorporates ignitrons are confronted with the problem of knowing under what conditions the ignitor will reliably fire the ignitron. Variable factors governing electrical characteristics of mercury-pool ignitors of the resistance type were measured and are presented here as guides to designers.



Cutaway of rectifier type ignitron

### Ignitor Operation

An ignitron is a mercury-pool tube which is caused to conduct each cycle by the action of its ignitor. The ignitor is a rod of high-resistance material, one end of which is submerged in the mercury pool. If a current of the order of ten amperes is passed through the rod into the mercury, the ignitor being positive, an arc spot will form on the mercury surface. The positive pole of the arc is, for an instant, the upper region of the ignitor or its supporting structure and then is transferred to the main anode of the tube.

By controlling the passage of current through the ignitor, the ignitron can be made to conduct or not as wished, or the time of initiation of the arc spot can be made early or late in the alternating-voltage cycle. Thus, the ignitor takes on a function similar to that of the grid of a thyratron tube. However, there are very important differences in that the instantaneous power required to fire the ignitron is much higher than that required to control a thyratron, firing characteristic varies considerably from tube to tube, and instantaneous firing power varies through a wide range from cycle to cycle.

It is the purpose of this report to present data taken on the characteristics of an ignitor, showing the magnitude of variations from the mean of the ignitor firing characteristic and showing how the characteristics vary as certain parameters that influence them are changed.

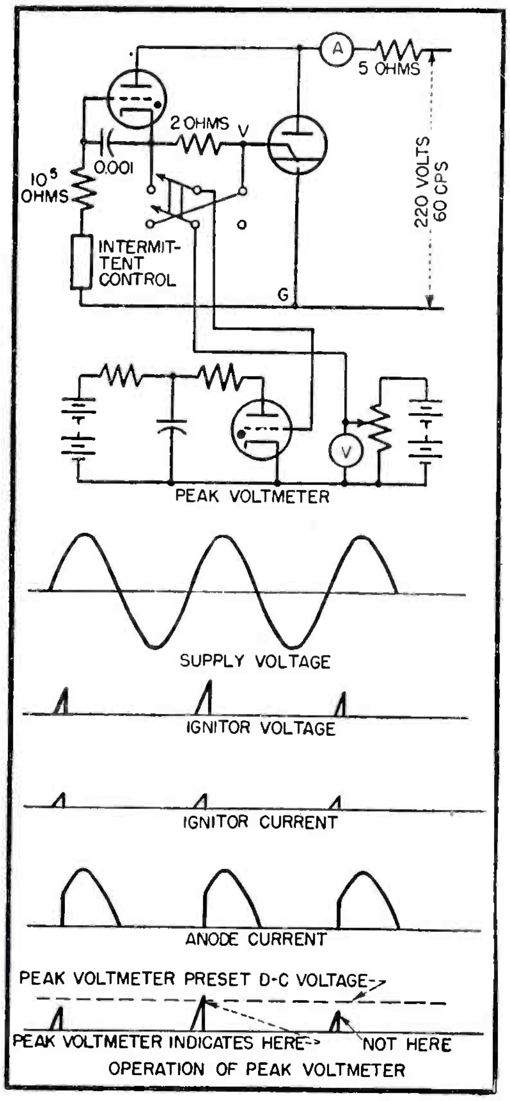



FIG. 1—Test circuit for studying ignitron characteristics, and typical wave shapes

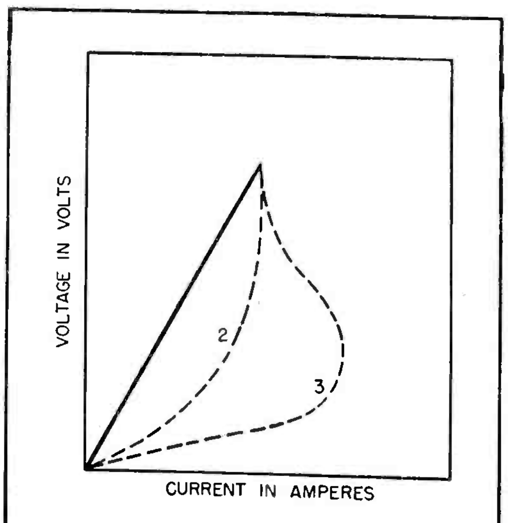



FIG. 2—Oscilloscopic traces of arc transfer show high currents for slow transfers

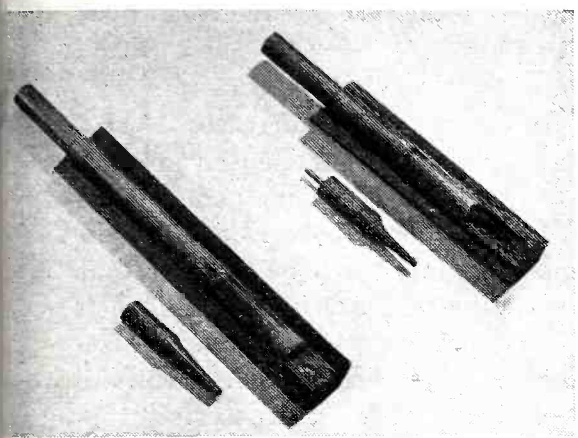
### Test Methods

Most of the data in this report was obtained by test with the circuit shown in Fig. 1. In this circuit an ignitron tube, or the ignitor in a demountable testing tube under vacuum, is operated in a half-wave circuit from an alternating supply of 220 volts with the anode current limited by a 5-ohm resistance to about 17 amperes as read on a d-c meter. The thyratron in the ignitor circuit is operated with the grid phased to cause firing early in the period of the positive cycle of the anode voltage. Thus, the current through the ignitor starts at a low value and increases nearly uni-

# Resistance Ignitors

**Ignitron rectifiers are made conductive by ignitors. Current, voltage, and firing time of resistance ignitors vary from tube to tube and with operating conditions. Typical variational ranges, from which designers can set tolerance limits, are presented**

By D. E. MARSHALL and W. W. RIGROD*



**Finished ignitors and the blanks from which they are ground; left, for rectifier service; right, for welder service**

formly until the ignitor fires. Resistance of the ignitor is found to be nearly constant over the period of a cycle; therefore ignitor voltage is similar in wave shape to that of the current as shown.

Measurements with this circuit consist of determining separately a limit to the peak voltage and to the peak current required to fire an ignitor. The peak voltmeter shown consists of a thyratron which will discharge a capacitor and thereby light whenever the ignitor voltage exceeds the preset thyratron negative grid bias as read by the d-c voltmeter. Peak current is read in a similar fashion by measuring voltage across a resistor in the ignitor circuit. The preset d-c bias voltage is increased until the peak voltmeter just does not indicate in a period of 30 seconds. The ignitor may be fired either continuously or intermittently. Intermittent duty reduces heating of the ignitor and is used to study the characteristic of the ignitor when operating cold. Unless otherwise stated, the data was taken with continuous operation.

Voltage and current values so obtained are not those corresponding to simultaneous occurrence. That is, their ratio is not the true resistance of the ignitor. A true indication of variation of the ignitor's resistance during operation can be obtained by using a cathode-ray oscilloscope connected to the testing circuit, the horizontal to thyratron plate, vertical to V, and ground to G. Horizontal deflection is proportional to current flowing through the ignitor and vertical deflection to voltage drop in the ignitor. The current increases until the ignitor fires, the slope of the resulting line being proportional to the instantaneous resistance of the ignitor. When the ignitor fires, the voltage falls. The current just after the ignitor fires may either increase or decrease depending on the speed of transfer of the positive end of the arc from the ignitor to the anode. This speed of transfer may be slow if the ignitron is operating at low temperature. Under such conditions, the peak meter may read too high a current, giving the maximum transfer current rather than the ignitor firing current. Typical oscilloscope traces as influenced by tube temperature are shown in Fig. 2. Curve 1 shows trace during current buildup to the firing point (degree of linearity indicates constancy of ignitor resistance) ; curve 2 indicates fast trans-

*Report initiated and sponsored by the Joint Electron Tube Engineering Council.

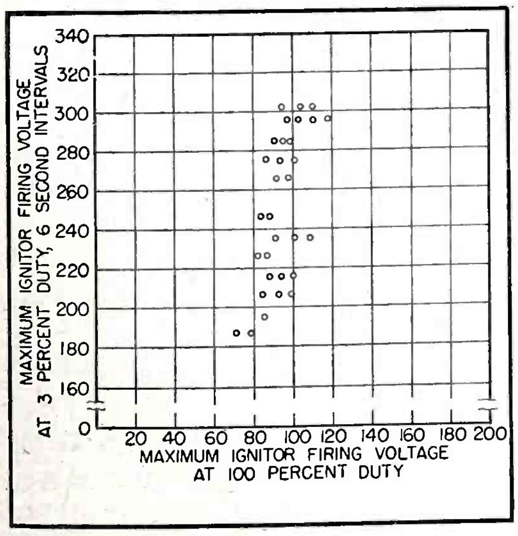



**FIG. 3—Influence of intermittent duty on firing voltage of the ignitor**

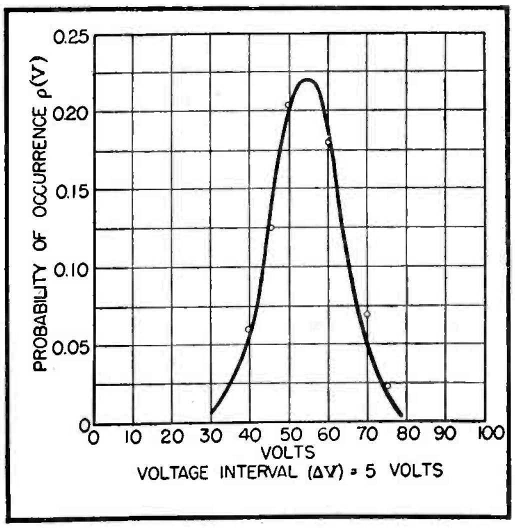



**FIG. 4—Probability of occurrence of ignitor firing at a given voltage in 656 cycles**

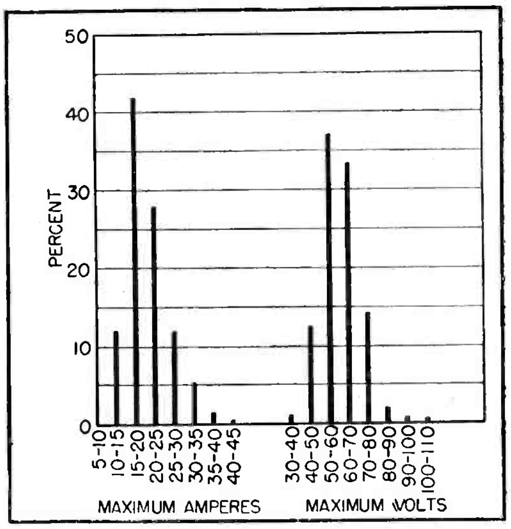



**FIG. 5—Distribution of firing characteristics of welder ignitrons at full duty**

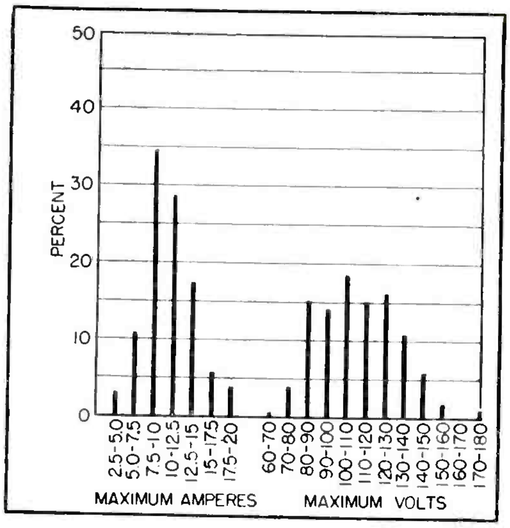



**FIG. 6**—Distribution of firing characteristics of rectifier ignitrons at full duty

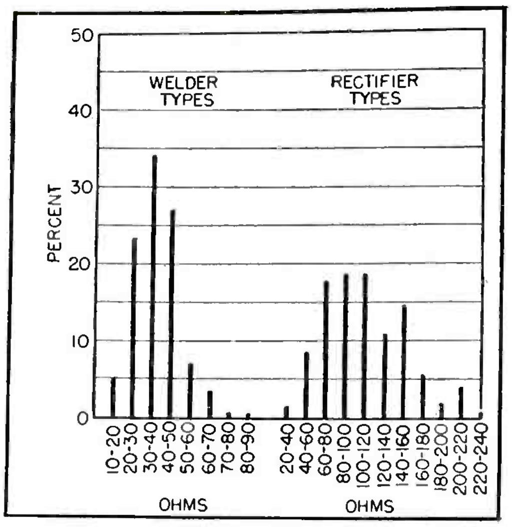



**FIG. 7**—Typical distribution of cold resistance of ignitors of ignitron tubes

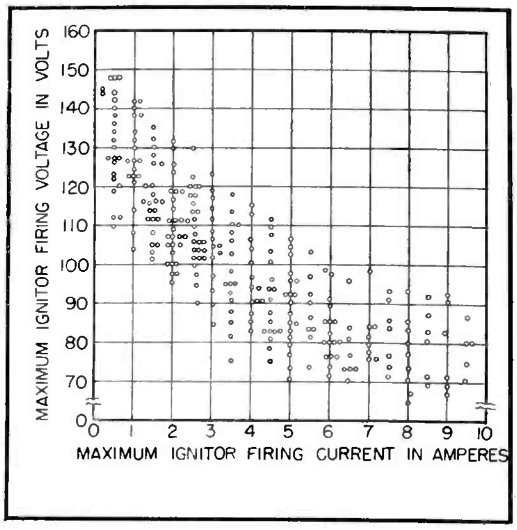



**FIG. 8**—Distribution of maximum firing voltage against maximum firing current

fer of arc from ignitor to anode; curve 3 is for slow transfer. Data described below was taken with the tube warm enough to insure that the peak current was that of the ignitor firing and not the transfer current.

#### Firing Characteristics

COLD FIRING—Operating the above circuit intermittently will indicate approximately the characteristic the tube will have when starting cold. Figure 3 shows a typical variation of maximum firing voltage of a group of ignitors between 100 and 3 percent duty operation. The abscissa shows the voltage at 100 percent duty and the ordinate at 3 percent. For these ignitors, the change in voltage was from 1:2 to 1:3. This characteristic is of great importance in welding control where tubes are required to fire reliably at low duty.

CONTINUOUS FIRING—When the test circuit is continuously operated at equilibrium, it is found that the firing voltage of the ignitor changes in value from cycle to cycle. Figure 4, taken from a paper by Arnott, shows the distribution of the firing voltages in continuous operation as measured by an oscillograph over a period of 656 cycles. As may be seen, the ignitor firing voltage varies over a considerable range. It is important to assign a single value of firing voltage to an ignitor corresponding to a fixed probability of firing.

On the rule that the ignitor firing voltage is that value which will not be exceeded by the ignitor more than once in 30 seconds, the maximum firing voltage will be that value on the curve which corresponds to a probability of about 0.0002. Inspection of the curve shows that this particular ignitor would be considered to have a maximum firing voltage of about 80 volts. However, the ignitor will fire most of the time between 50 and 60 volts, but very rarely at less than 30 volts.

FIRING CURRENT—Measurements of the 100 percent duty characteristics of a commercial production lot of ignitron tubes are shown in Fig. 5 and 6. Figure 5 shows a distribution of the characteristics of a total of 910 tubes containing ignitors designed for welding-control service and Fig. 6 gives the same information for a total of 250 ignitors designed for rectification. The former have in general a higher current and lower voltage range than the latter to compensate for the low duty voltage rise.

COLD RESISTANCE—Resistance of a cold ignitor as read by an ohmmeter is a convenient rough method of checking its condition. Figure 7 shows the distribution in values of cold resistance for the above lots of tubes. The welder types have on the average the lower resistance.

FIRING VOLT-AMPER—If maximum firing voltage and current of a batch of ignitors are plotted against each other, each ignitor maximum voltage being plotted against its maximum firing current, a plot similar to Fig. 8 results. Here, one sees that on the average, ignitors firing at higher currents fire at lower voltages.

IMMERSION DEPTH—Figure 9 shows data taken on an ignitor tested at a series of different depths of immersion in the mercury pool. Standard immersion depth is between $\frac{5}{16}$ and $\frac{3}{8}$ inch. It will be noticed that maximum firing current rises when the immersion increases and resistance and maximum firing voltage decrease. This characteristic is mainly of interest to pool-tube designers, but also indicates the change in ignitor characteristics to be expected if the ignitron, for instance, is not installed in a vertical position. Vibration of the tube in operation can also cause a variation in instantaneous depth of immersion of the ignitor.

#### Rate of Current Rise

If an ignitor is connected to a source of voltage of considerable magnitude through an inductor, the current through it will increase with time at a nearly uniform rate. At some time later, the current will reach a value at which the ignitor will fire. Voltage across the ignitor will also rise at a uniform rate because the resistance of the ignitor will change only slightly in the interval involved. Current and voltage at which the ignitor fires under these conditions are an experimental function of the rate of change of the current. Curves showing such experimental data taken on a typical ignitor are shown against voltage in Fig. 10 and against current in Fig. 11.

Data was taken by measuring with an oscilloscope the time elapsing from the start of current to the firing of the ignitor, using different inductances in ignitor circuit. At the same time, the firing current and voltage were observed in each case, using the method shown in Fig. 2. Maximum values of current and voltage occurring in a 30-second interval were estimated from the oscilloscope trace.

The curves are illustrative of the typical variation of the quantities involved. They show that when current builds up linearly, voltage required for firing decreases as the interval required by the circuit to supply the firing voltage increases. The curve for light intermittent duty (3 percent) lies considerably higher in voltage than for continuous duty (100 percent). The difference is believed due to the negative temperature coefficient of resistance of the material of which this type of ignitor is made. While resistance of the ignitor is very nearly constant during one firing operation, it will decrease considerably as the average current through it increases.

Current at light duty varies similarly to the voltage as the duration of ignitor current changes, indicating that resistance is not changing greatly. However, at continuous duty, current increases very considerably as the duration of ignitor current increases, indicating that ignitor resistance decreases very considerably.

Firing voltage at 3 percent duty is replotted in Fig. 12 against rate of change of voltage, as calculated for points on the curve of Fig. 10. At high rates of voltage rise, peak firing voltage increases about 2.0 volts per volt per microsecond. This increase is in rough agreement with some experiments made earlier where an ignitor was made to fire in an interval of about a microsecond by a 3,000 volt firing pulse.

#### Resistance Welding Control

An approximate idea of numerical factors involved in operation of ignitors in resistance welding circuits can be gained by the following very simplified calculations.

Assume that a resistance welder having a very low power factor is being operated with the ignitor firing at a phase retard angle of 90 degrees from voltage zero. Under these conditions the current form through the ignitron, and initially through the ignitor, will be very nearly a half sinewave. Rate of change of current at the start of current can be estimated as follows. The equation for the current is $i = 1.4I\sin\omega t$ where $I$ is demand current in rms amperes, and $t$ is time starting at zero current (voltage maximum). The rate of change of current at the beginning of the current flow is $(\partial i/\partial t) = 1.4I\omega$, at $t = 0$. For 60 cps $(\partial i/\partial t) = 5.34 \times 10^{-4}I$ in amperes per microsecond at $t = 0$. Assume three cases: $I = 40$, 1,000, and 10,000 amperes.

(1) $I = 40$ amperes, $(\partial i/\partial t) = 0.021$ ampere per microsecond at $t = 0$. The current rise is shown by the dashed line to the right in Fig. 11. An intersection with the ignitor characteristic occurs for 100 percent duty at 11.0 amperes at 500 microseconds, and for 3 percent at 6.0 amperes at 267 microseconds. The corresponding firing voltages from Fig. 10 would be 70 and 140 volts respectively. It is interesting to note that reduction of the demand current below 40 amperes would cause the intersection with the ignitor current characteristic to move rapidly towards higher currents.

(2) $I = 1{,}000$ amperes, $(\partial i/\partial t) = 0.534$ ampere per microsecond at $t = 0$. The current rise is shown by the dotted line to the left in Fig. 11. In this case, an intersection with the ignitor characteristic is obtained at 10.6 amperes at about 20 microseconds, for both 3 and 100 percent duty. Reference to Fig. 10 at the same time gives 310 volts for 3 percent duty and 220 volts for 100 percent duty.

(3) $I = 10{,}000$ amperes, $(\partial i/\partial t) = 5.34$ amperes per microsecond at $t = 0$. Inspection of Fig. 11 indicates that with the current increasing at this rate, the ignitor could not fire at a current below about 20.0 amperes, which would be reached in about 4 microseconds. Ignitor firing voltage would be nearly 500 volts at 3 percent duty.

If this voltage is above that available in the circuit, the ignitor would not fire in the above time, but would have to wait. The delay in firing can be estimated as follows. Assume the circuit voltage to be 220 volts rms or 310 volts peak. The voltage applied to the ignitor will no longer increase linearly, but will follow a curve whose slope decreases with time. The voltage approaches a maximum of less than 300 volts. It is reasonable to expect that under these conditions, the ignitor will be heated by passage of prefiring cur-

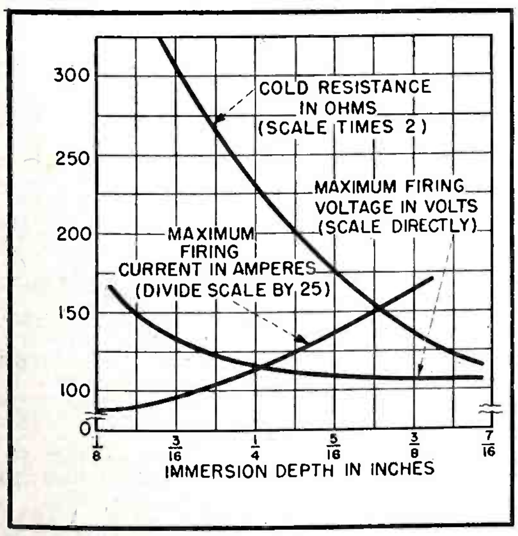



**FIG. 9—Typical variation of ignitor characteristics with immersion of ignitor**

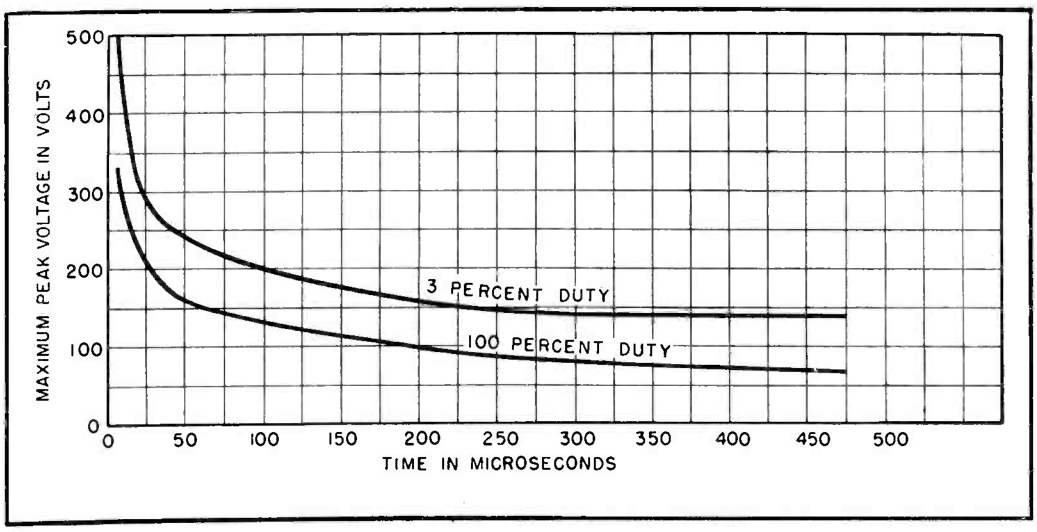



**FIG. 10—Ignitor firing voltage as a function of linear buildup of voltage on ignitor of welding type ignitrons shows higher firing voltages at fast buildup**

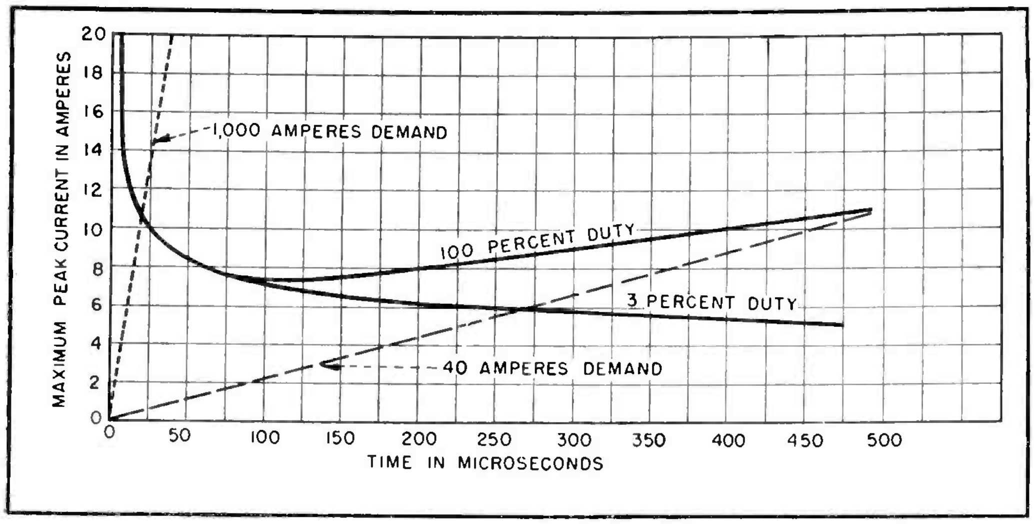



**FIG. 11—Ignitor firing current varies as a function of time of linear buildup of ignitor current in welder type ignitrons, showing a minimum for full duty operation**

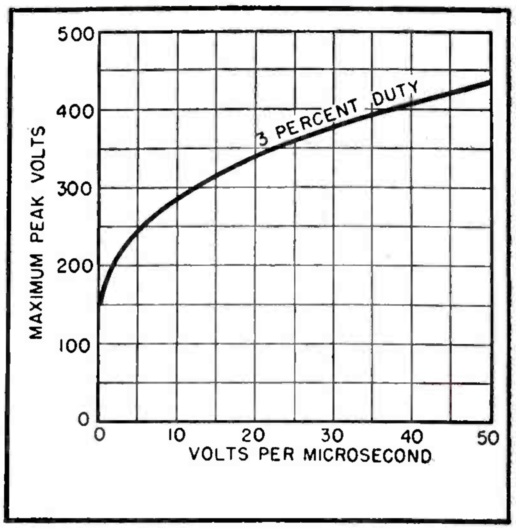



**FIG. 12—Ignitor firing voltage versus rate of rise of applied voltage**

rent and, therefore, will fire in less time than if the rise of current were linear. Therefore, the curve of Fig. 10 can be considered as a limiting curve. With 300 volts applied to the ignitor, firing will occur within 20 microseconds at 3 percent duty and 7.5 microseconds at 100 percent duty.

These considerations represent maximum requirements to enable this ignitor to fire in times less than those calculated 99.95 percent of the time. Reference to Fig. 4 indicates that less voltage is required to fire most of the time, therefore, the average delay in firing is less than that calculated.

Measurements on this particular tube made with the peak voltmeter at 100 percent duty gave as its maximum firing characteristic 56 volts, 16 amperes. Reference to Fig. 5 indicates that it was in the range of the most probable characteristic in current and voltage.

### Ignitrons as Rectifiers

To assure smooth and reliable operation, ignitrons used in rectification are fired by separate excitation circuits. One such circuit is shown in Fig. 13. A capacitor is charged from an a-c source at the time the ignitron anode is negative. The charge is then available to fire the ignitor at any time in the forward cycle. Firing of the ignitor is controlled by a thyratron whose grid is phase controlled.

The maximum voltage available for firing the ignitor as a function of the maximum current through the ignitor is shown in the curve. The firing circuit has a natural frequency of about 900 cps. Initial rate of rise of current is 0.310 ampere per microsecond. Thus, a 10-ampere ignitor would fire in about 30 microseconds. At this speed, the ignitor current will usually be at a minimum.

The high regulation of this circuit fits in well with the distribution in ignitor characteristics (Fig. 8), wherein high-voltage ignitors require less current to fire than low-voltage ignitors.

### Rating of Ignitors

Data sheets giving characteristics of ignitrons show the ignitor current to be expected at high duty and slow firing on the one hand, and the ignitor voltage at low duty on the other. A maximum interval of 100 microseconds is usually given, based on the application of a constant voltage to the ignitor. The ignitor will fire at rated voltage under these conditions within this time. However, in those cases when the voltage rises linearly, a greater time interval for the ignitor to fire must be expected as indicated in Fig. 10.

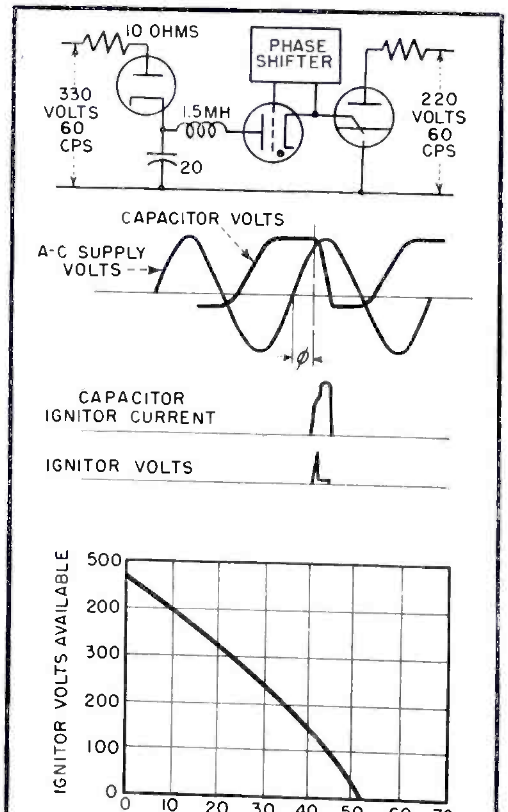



**FIG. 13—Typical ignitor firing circuit uses charge stored on capacitor to fire ignitor**

In general, it is important to realize that an ignitor will not fire at a single value of current or voltage, and that no two ignitors are altogether alike. Their firing characteristics vary from cycle to cycle and are dependent on operating conditions. However, it is believed that this report indicates that definite characteristics can be described, permitting a reasonably accurate prediction of behavior in specific circumstances.

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# Stability of Crystal Oscillators

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**Factors affecting crystal oscillator drift and practical means of minimizing them are discussed. Design of a secondary frequency standard serves as an example**

IN DEVELOPING an ultrahigh-frequency secondary standard, it was decided to use a fixed-tuned crystal oscillator as a frequency base. Use of such oscillators in standard frequency generators and for stabilizing the frequencies of radio carriers is familiar. However, in designing a secondary frequency standard it is advisable to re-evaluate the factors affecting oscillator stability.

In the particular design under discussion, it was considered essential to have a constancy of frequency of ±0.001 percent for long periods of time. A crystal operating at 100 kc was to be used. This stability figure was derived from the fact that a final accuracy of ±0.0025 percent was required of the completed instrument. Allowable error must be distributed over several factors: stability of the crystal, human error in calibrating the tunable oscillator, tunable oscillator tracking error, and tunable oscillator short-time instability. It would seem entirely proper, therefore, that the crystal be reliable within the stated figure.

### Factors Affecting Stability

We shall consider the factors which will contribute to a satisfactory crystal calibrator of ±0.001 percent accuracy.

CRYSTAL TEMPERATURE COEFFICIENT—All too commonly we accept the crystal temperature coefficient supplied by the manufacturer without seriously considering what it means. A temperature coefficient of one cycle per megacycle per degree Centigrade, for example, does not indicate that we need only multiply our temperature range by this figure to find the maximum frequency change. Figure 1A indicates that temperature coefficients are not linear with temperature. It does indicate, however, that that is approximately true for a relatively narrow range of temperature. If the crystal is operated in an oven at the best portion of its characteristic, we can expect good results. It is important to note that seldom do two crystals, cut from the same slab and processed in the same manner, possess identical temperature coefficients of frequency.

CRYSTAL AGEING—Careful measurements on crystal-controlled oscillators show progressive frequency changes, such as those plotted in Fig. 1B, which are rightly attributed to ageing. It is believed that the grinding process tends to leave a surface accumulation of both the abrasive and pulverized quartz. This material dusts from the surface with a resulting slow change of frequency. Such ageing is noted even with carefully washed and acid-etched plates. It is also believed that microscopic surface fractures left by the grinding process contribute to the ageing effect. A minimum operating period of two weeks seems to be required to reduce ageing to a tolerable value and it is possible that at the end of this period some crystals must be rejected.

TEMPERATURE CONTROL—A relatively simple thermostatically controlled oven will maintain the crystal temperature to within plus or minus one degree Centigrade of

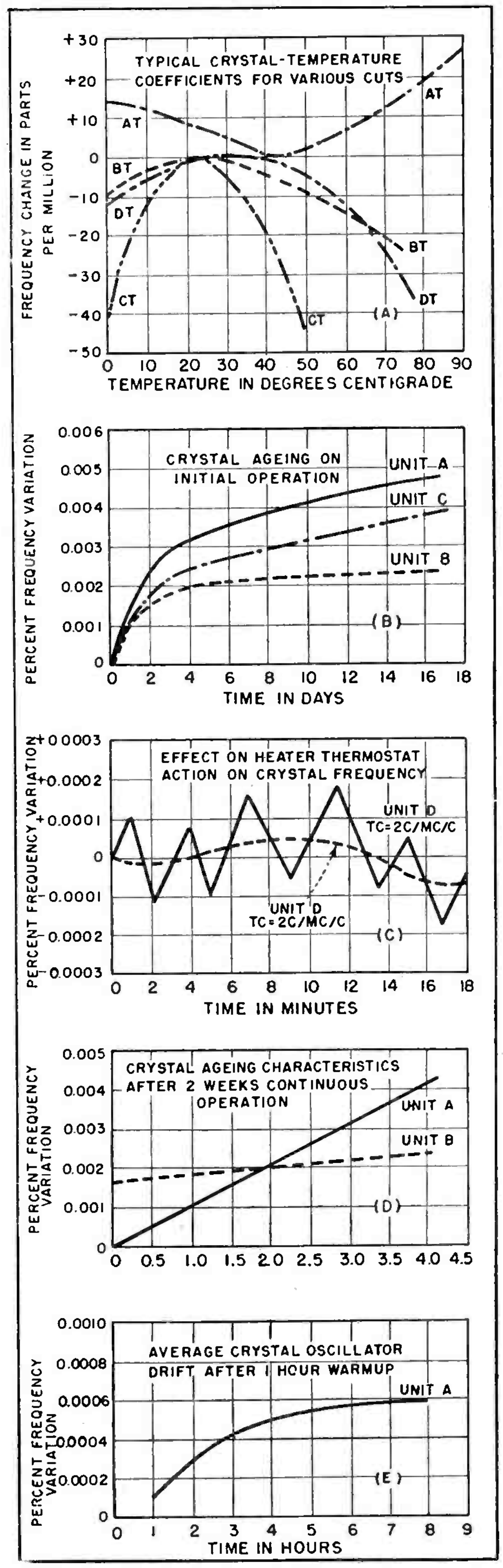


**FIG. 1—Typical instabilities of crystals**

some selected temperature. The temperature variation affects the frequency in the manner depicted in Fig. 1C. Experience has shown, however, that the thermostat itself ages, and that the crystal may well run a few degrees cooler after some months of operation.

CRYSTAL MOUNTING — It goes without saying that the matter of properly mounting a crystal is highly specialized and must remain a problem of the crystal manufacturer. Judged by the writer's observations, crystal mounting is perhaps the limiting factor in overall stability. Very few completely assembled ovens and crystals on the market seem entirely satisfactory. Two highly developed commercial units are compared in parts of Fig. 1; ageing is shown at Fig. 1D. Fig. 1E shows warmup. Obviously, unit B is a great improvement over unit A. Because unit A employs a spring mount with crystal contacts which are not located at the nodal points, we would expect both ageing of the springs and shifting of the contact points. Lessening of spring pressure tends to cause ageing to higher frequencies while conversion of the metallic coating to an oxide results in increased crystal pressure and, consequently, shift to a lower frequency. Incidentally, both crystals had directly deposited silver electrodes.

### Oscillator Test Circuit

Figure 2 shows a test setup capable of measuring minute frequency shifts in either relative or absolute terms. The 100 kc crystal oscillator, and its associated buffer stage, is contained within a test chamber capable of producing and maintaining known ambient temperatures. The buffer feeds a harmonic amplifier which produces a few millivolt output at 10 mc. This harmonic amplifier is fed to the input of a 10 mc receiver tuned to WWV, and the crystal is purposely detuned to produce a beat note of perhaps 200 cps with the standard signal. The low-pass filter removes the 4,000-cps modulation normally on the WWV carrier but passes the 440-cps modulation plus the 200-cps beat note. The resulting output is fed to one pair of deflection plates of a standard oscilloscope, the other pair of plates being fed by a calibrated audio oscillator.

Examination of the test setup indicates that all measurements are made against a 10-mc primary standard accurate to at least one part in ten million. The 100th harmonic of the 100-kc crystal is being compared with this standard, and crystal frequency shifts are thus made 100 times more evident. A shift of one cps at 10 mc is the equivalent of a 0.01-cps shift at 100 kc. The output of the receiver contains two different frequencies, one the normal 440-cps modulation of WWV and the other the 200-cps beat note. When the audio signal-generator frequency is varied, two 1:1 frequency ratio patterns are obtained. The pattern obtained at 440 cps serves to calibrate the audio-frequency generator and the 200 cps pattern is a direct measure of the beat note frequency. The procedure is seen to be entirely satisfactory for our requirements. Shifts of five-cps crystal frequency can be read directly on the audio signal generator. It is easily possible to estimate shifts of one cps. The resulting accuracy of measurement is thus in excess of 0.5 part per million.

### Circuit Selection

Reviewing requirements for a secondary standard, we realize that sound engineering is the ultimate aim, and that standard components should be employed insofar as possible. Extremely complex circuits, difficult production testing, and costly special parts should be avoided. Our unit should be: accurate to within ±0.001 percent over periods exceeding one month, stable over ambient temperatures commonly encountered in the United States (32 to 120 F), and reasonably stable under shock.

To satisfy the first two requirements, we recognize the need of temperature control because an accuracy of only about ±0.02 percent is considered normal with uncontrolled low-drift crystals. The oven is also required to combat the wide range in ambient temperature. The third requirement rules out any but rigid crystal mounts.

The circuit used is shown in Fig. 3. In addition to simple construction, it has other attractive features. Many thermostatically controlled ovens with enclosed crystal holder have at least one massive contact plate designed to have high thermal capacity. A circuit such as this one in which this contact can be grounded is desirable. A convenient method of accurately setting the crystal to a frequency standard is also necessary. A small air trimmer $C_1$ is used in the circuit to make this adjustment. The rotor is

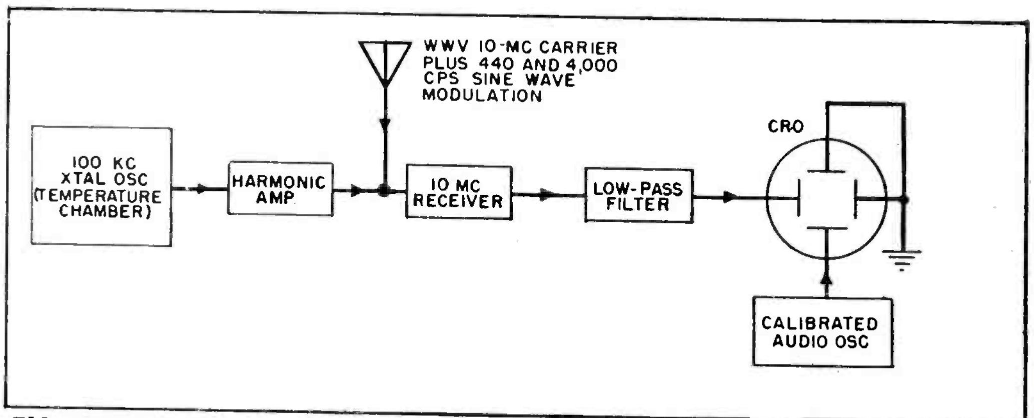


FIG. 2—Block diagram shows technique used in checking stability of crystal oscillators against WWV

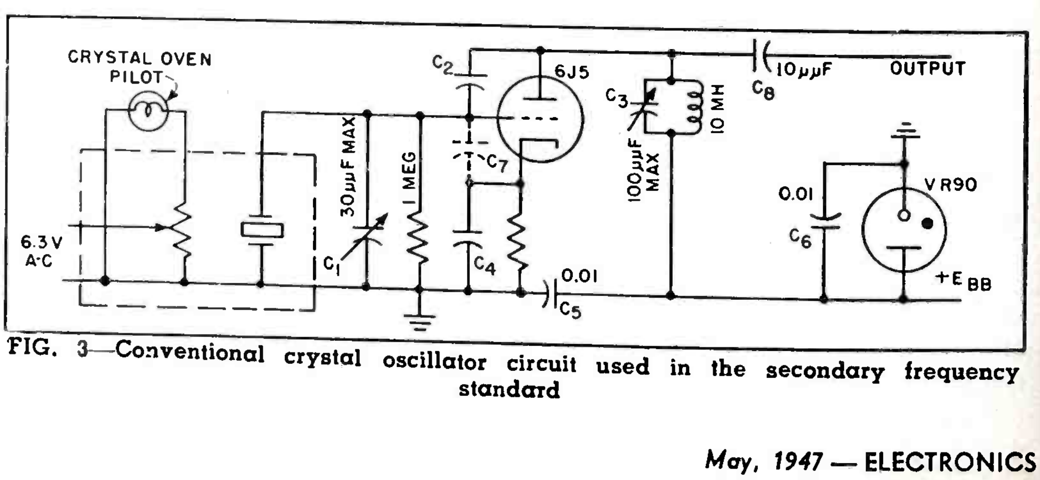


FIG. 3—Conventional crystal oscillator circuit used in the secondary frequency standard

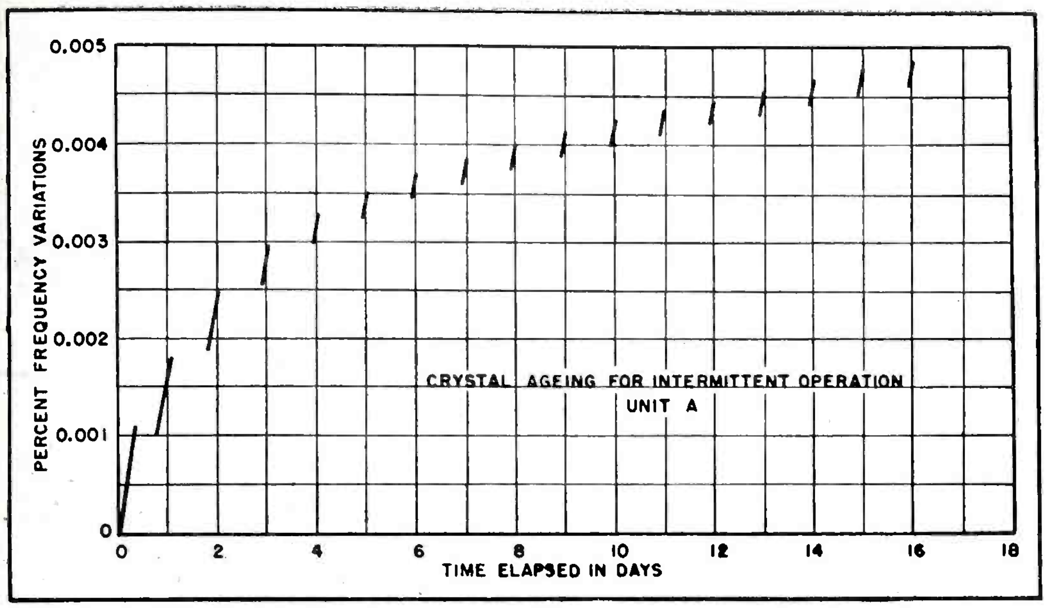


**FIG. 4—A typical crystal and oven assembly can be expected to have this ageing characteristic for intermittant operation during its first few weeks of operation**

grounded, which removes effects of hand capacitance. Crystals designed for this method of tuning are produced about 25 cps high in frequency because wiring capacitance plus the capacitance in $C_1$ lowers the crystal frequency. An undesirable feature of this circuit is the fact that variations in tube input capacitance, designated $C_7$, also tune the circuit. A high ratio of $C_1$ to $C_7$ is desirable in reducing this effect.

Now, having chosen our circuit, we should apply those means of stabilization which will increase its effectiveness.

Adequate protection against low impedance changes is afforded by lightly coupling a pentode buffer amplifier to the oscillator. If this buffer is run Class A, it will draw negligible grid current and avoid the possibility of reflecting load changes back to the oscillator plate circuit.

### Optimum Conditions for Stability

The oscillator plate circuit itself deserves more than casual mention. The crystal is being operated in a shunt resonant condition which requires that the plate circuit be inductive in order that proper phase conditions for oscillation exist. This is simply another way of saying that the plate circuit must be tuned to a frequency higher than 100 kc in order that the crystal oscillate at all. Hight and Willard (Proc. I.R.E., p 549 May 1937) have found that by proper choice of $C_2$ and $C_3$, a high degree of protection against frequency changes due to variations in electrode voltages and circuit constants is provided. The tuning procedure is to alternately adjust $C_3$ and $C_3$ for the highest oscillator frequency. In the circuit shown, the plate circuit is then resonant at about 300 kc.

Figure 4 is a combination of curves from Fig. 1B and 1E, and indicates the ageing trend if the crystal oscillator is operated for eight out of every 24 hours. It is apparent that day-to-day shifts are progressively less, and that the ageing curve is much more prolonged in terms of days although not necessarily in total hours. The difficulty of predicting what would happen under such operating conditions makes it essential to operate the unit continuously for highest stability.

Effects of moderate variations in either filament or plate supplies are not as great as would ordinarily be expected, if the circuit is properly designed. The complete circuit, as shown, has an instantaneous crystal frequency shift of about ±5 cps or one part per million when the line voltage is varied abruptly from 95 to 125 volts. A less rapid shift is also evident after the heater voltage has assumed its new potential. The effects, however, are so slight that they are difficult to identify. During the above check, the VR tube still controls the plate supply voltage. The choice of regulator was made on the basis of its excellence as a regulator plus tube-to-tube uniformity. Experience has dictated that the VR-105, VR-150, VR-90 and the VR-75 are to be preferred in that order.

We are now in a position to judge overall stability if we consider one additional factor, namely, temperature stability under an ambient temperature range from 32 to 120 F or about 50 C. Manufacturers' data indicates a change in frequency of about ±0.0001 percent for a high-quality crystal and a well designed oven. Here are the figures:

| Cause of Drift | Percent Drift |
|---|---|
| Instability due to ambient temperature | ±0.0001 |
| Approximate ageing per month | ±0.0007 |
| Instability due to line voltage variation | ±0.0001 |
| Total | ±0.0009 |

From the tabulation above, it can be seen that the most significant weakness is the comparatively high shift of frequency due to ageing, which is in turn largely attributed to the mounting of the crystal.

Desired accuracy can, however, be attained by careful oscillator circuit design and by thorough production testing. All crystals must be aged at least two weeks and those with high ageing characteristics rejected. Knowing the ageing trend of each crystal, the oscillator itself can be tuned to take advantage of anticipated drift. It should be pointed out that any such detuning would amount to only about 0.1 cps at 100 kc in an average case.

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* Prepared by Editor as a practical guide to recent related literature.

# Design of Transmission Line

**Graphs are presented based on equations for short-circuited lines. From these graphs, dimensions of a concentric or parallel line for a given frequency, impedance, and selectivity can be directly determined, along with conditions for optimum efficiency**

A STRAIGHTFORWARD procedure is outlined for the design of transmission line tank circuits. At high frequencies, short-circuited transmission lines are often used to replace inductances in tank circuits. This paper discusses tank efficiency, condition for resonance, impedance of tank circuit, conditions for maximum impedance, and selectivity of the tank circuit. Specifically, design charts are given for concentric and shielded parallel line tank circuits having dimensions as shown in Fig. 1.

#### Tank Efficiency and Resonance

The purpose of the plate tank circuit of any class-C amplifier or multiplier is to transfer efficiently to the load the power delivered by the plate of the tube[1]. The unloaded impedance of the tank circuit should be 10 or 20 times the loaded impedance. The tank efficiency in percent is then

$$100\,\frac{R_o}{R_o + R_L} \qquad (1)$$

where $R_o$ is the unloaded impedance of the tank, and $R_L$ is the impedance coupled into the tank from the load. This equation can be written in the form

$$100\,\frac{Q_U - Q_L}{Q_U} \qquad (2)$$

where $Q_U$ is the unloaded tank Q, and $Q_L$ is the loaded tank Q. Both equations, of course, yield the same result.

The condition for resonance of a capacitance-loaded transmission line is defined by the equation

$$X_C = Z_o \tan (2\pi l/\lambda) \qquad (3)$$

where $X_c$ is the reactance of loading capacitor in ohms, $Z_o$ is the characteristic impedance of the line in ohms, given in Fig. 2, $l$ is the

### Very High Frequency Amplifier—Parallel Wire Tank Circuit

A 823-A beam tetrode is to be used in a push-pull class-C amplifier in the 144 to 148-mc amateur band. Space considerations limit the outside diameter of the shield to 3 in. and the length to 6 in. or 15.2 cm. In the design of a shielded parallel wire tank circuit, using the notation of Fig. 1, $c$ is determined by the spacing between plate leads from the tube, which is 0.848 in. Assuming $\frac{1}{16}$-in. wall tubing is used for the outer conductor, making $b = 2.875$ in. or 7.3 cm, then

$$q = c/b = 0.848/2.875 = 0.295$$

Using $q = 0.3$, we find (from Fig. 5) that maximum unloaded tank impedance occurs at $r = 18$ and $\psi(r,q) = 9{,}520$. For this value of $r$, $a = b/r = 2.875/18 = 0.16$ in. which can be approximated by using $\frac{5}{32}$-in. tubing. The characteristic impedance is (from Fig. 4) then 265 ohms. At 146 mc, the wavelength is $(3 \times 10^4)/146 = 205$ cm, $l/\lambda$ is $15.2/205 = 0.074$, and $C/\lambda$ is (from Fig. 3) equal to 0.04, hence $C$ is $0.04 \times 205 = 8.2$ $\mu\mu$f, which includes the tube capacitance. The unloaded tank impedance is found from Eq. 7, for which $\phi(l/\lambda)$ is (from Fig. 3) equal to 0.23

$$R_o = bf^{\frac{1}{2}}\,\psi(r,q)\,\phi(l/\lambda) = 7.3(146^{\frac{1}{2}})9{,}520(0.23) = 194{,}000 \text{ ohms}$$

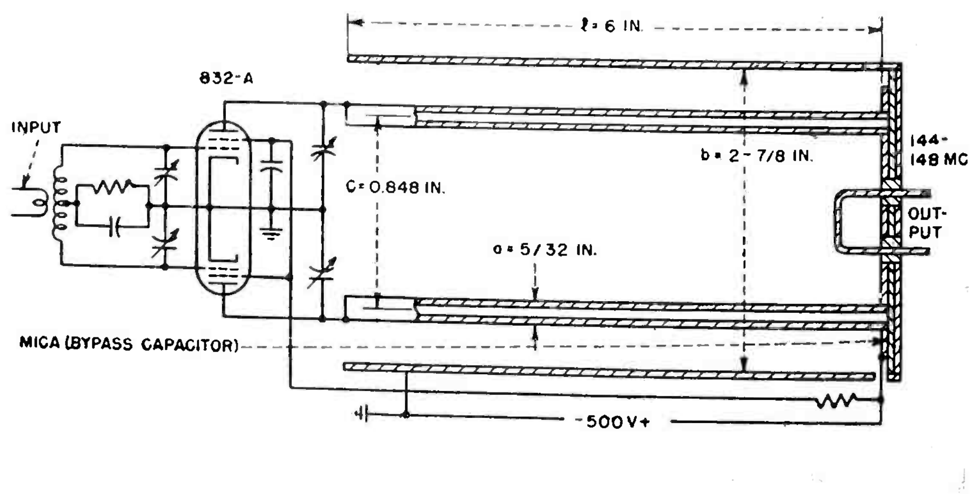
and the Q (from Eq. 8), for which $\theta(r,q)$ is (from Fig. 6) equal to 17.8, is

$$Q = bf^{\frac{1}{2}}\,\theta(r,q) = 7.3(146^{\frac{1}{2}})17.8 = 1{,}570$$

Assuming that 20 watts are delivered to the load at 900 volts peak to peak plate swing, giving $R_L = E_p^2/2P = 20{,}200$ ohms, we find (using Eq. 1) that the tank circuit efficiency is

$$100\,\frac{R_o}{R_o + R_L} = 100\,\frac{194{,}000}{194{,}000 + 20{,}200} = 90.5 \text{ percent}$$

which is quite satisfactory. The accompanying drawing shows the circuit and the construction of the output tank circuit



# Tank Circuits

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length of line in cm, and $\lambda$ is the wavelength in cm.

Equation 3 can be rewritten as

$$\frac{\;}{\lambda} = \frac{\tan^{-1}(X_C/Z_O)}{2\pi} = \frac{\tan^{-1}(1.59 \times 10^5/fCZ_O)}{2\pi} \quad (4)$$

### Citizens' Band Class-C Amplifier—Concentric Line Tank Design

A 2C40 disc-seal tube[4] is to be used as a class-C amplifier in the citizens' band at 465 mc. The tank circuit is to be a concentric line with the outer conductor at 2-in. outside diameter by $\frac{1}{16}$-in. wall copper tubing. The loading capacitance is to be $2\mu\mu$f, which includes tube and tuning capacitance. Using the notation of Fig. 1, the diametric ratio $r$ for the optimum Q with fixed loading capacitance is found (from Fig. 6) to be between 3.6 and 9.2. Assume that the outside diameter of the inner conductor $a$ is to be ½ in. or 1.27 cm. The value of $b$ (inside diameter of outer conductor) is 1⅞ in. or 4.76 cm. Thus

$$r = b/a = 4.76/1.27 = 3.75$$

Using this value of $r$, we obtain (from Fig. 4 for a concentric line) a characteristic impedance $Z_O$ of 80 ohms, a value (from Fig. 5 for a concentric line) for the function $\psi(r)$ of 6,700 ohms, and (from Fig. 6 for a concentric line) a value of 42 for the function $\theta(r)$. Furthermore, from the foregoing values, the product $fCZ_O$ appearing in Eq. 4 is, for $C$ in $\mu\mu$f (not farads)

$$fCZ_O = (465 \times 10^6)\,2\,(80) = 7.45 \times 10^4$$

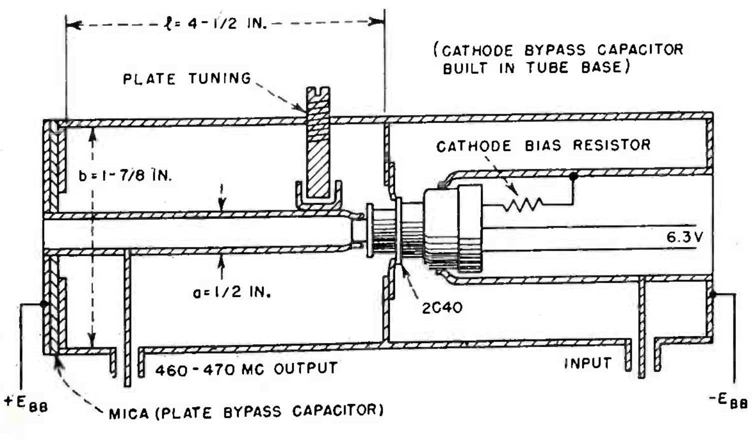
Thus (from Fig. 2) $l/\lambda = 0.18$. The wavelength $\lambda$ is $(3 \times 10^4)/465 = 64.5$ cm, therefore $l$ is $0.18 \times 64.5 = 11.6$ cm or 4.57 in., which gives (from Fig. 3) $\phi(l/\lambda) = 0.54$. Then the unloaded impedance of the tank circuit (from Eq. 16) is

$$R_O = bf^{\frac{1}{2}}\,\psi(r)\,\phi(l/\lambda) = 4.76(465^{\frac{1}{2}})6{,}700(0.54) = 372{,}000 \text{ ohms}$$

and the Q (from Eq. 17) is

$$Q = bf^{\frac{1}{2}}\,\theta(r) = 4.76(465^{\frac{1}{2}})42 = 4{,}320$$

The drawing shows the mechanical arrangement of the tank circuit. The cathode line can be designed by the same method.



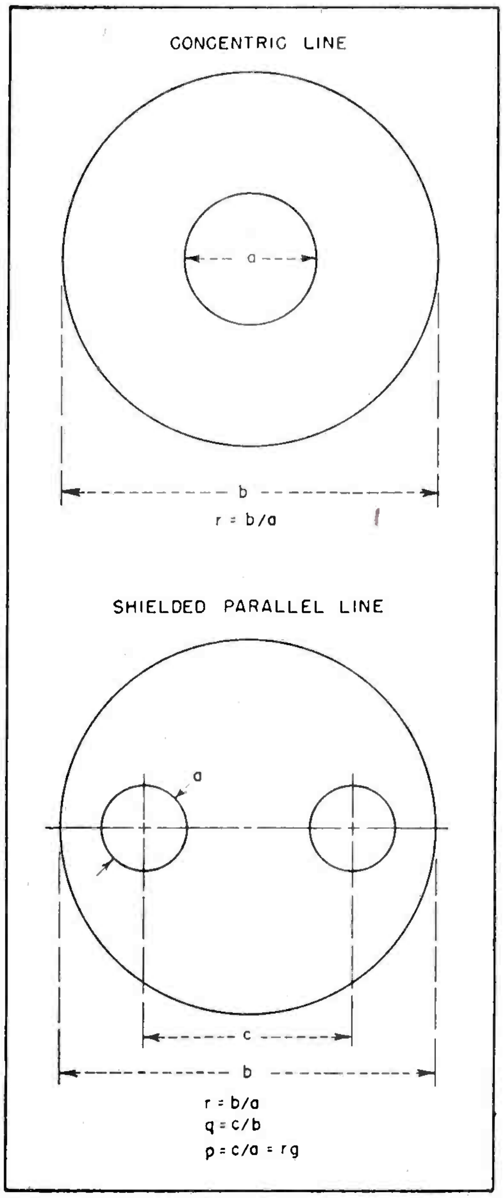




**FIG. 1—(A) Size of concentric line is expressed by dimensionless ratio. (B) Size of shielded parallel line is expressed by two dimensionless ratios**

where $f$ is the resonant frequency in mc, and $C$ is the loading capacitance in $\mu\mu$f. This relation is shown in Fig. 2 together with the relations for length in electrical degrees.

In some cases, the length may be fixed by physical limitations in size. Under these conditions, Eq. 3 can be rewritten as

$$\frac{C}{\lambda} = \frac{5.3}{Z_O \tan(2\pi l/\lambda)} \quad (5)$$

This relation is plotted on Fig. 3, using the lefthand scale, for several values of $Z_o$.

#### Impedance and Selectivity of Tank

The unloaded impedance of the tank circuit is given by the equation

$$R_O = \frac{4\pi Z_O^2}{R_S\lambda}\left[\frac{1 - \cos(4\pi l/\lambda)}{(4\pi l/\lambda) + \sin(4\pi l/\lambda)}\right] = 4.19 \times 10^{-4}\,(fZ_O^2/R_S)\,\phi(l/\lambda) \quad (6)$$

where $R_S$ is the series resistance of

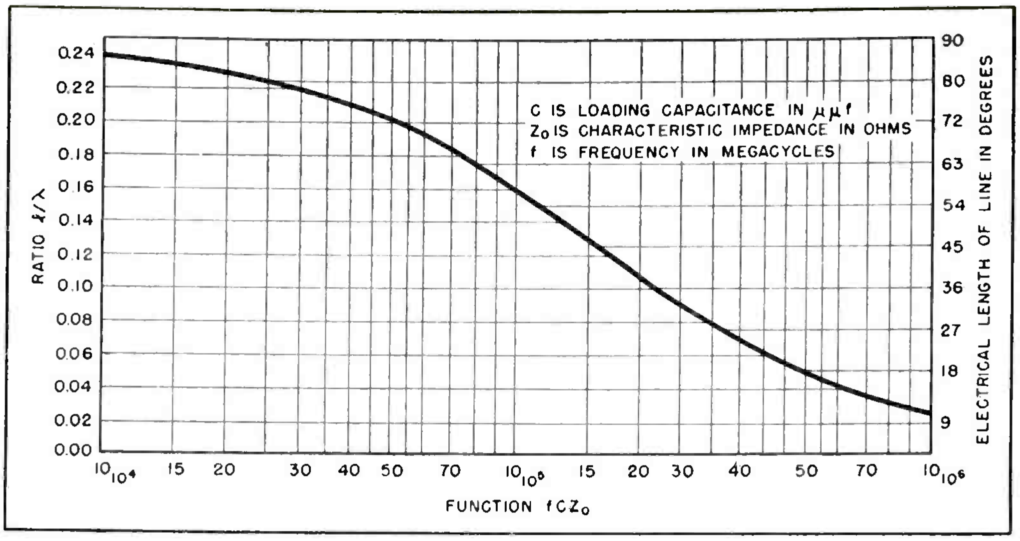



**FIG. 2**—Length of line relative to resonant wavelength is a function of the capacitance loading and characteristic impedance

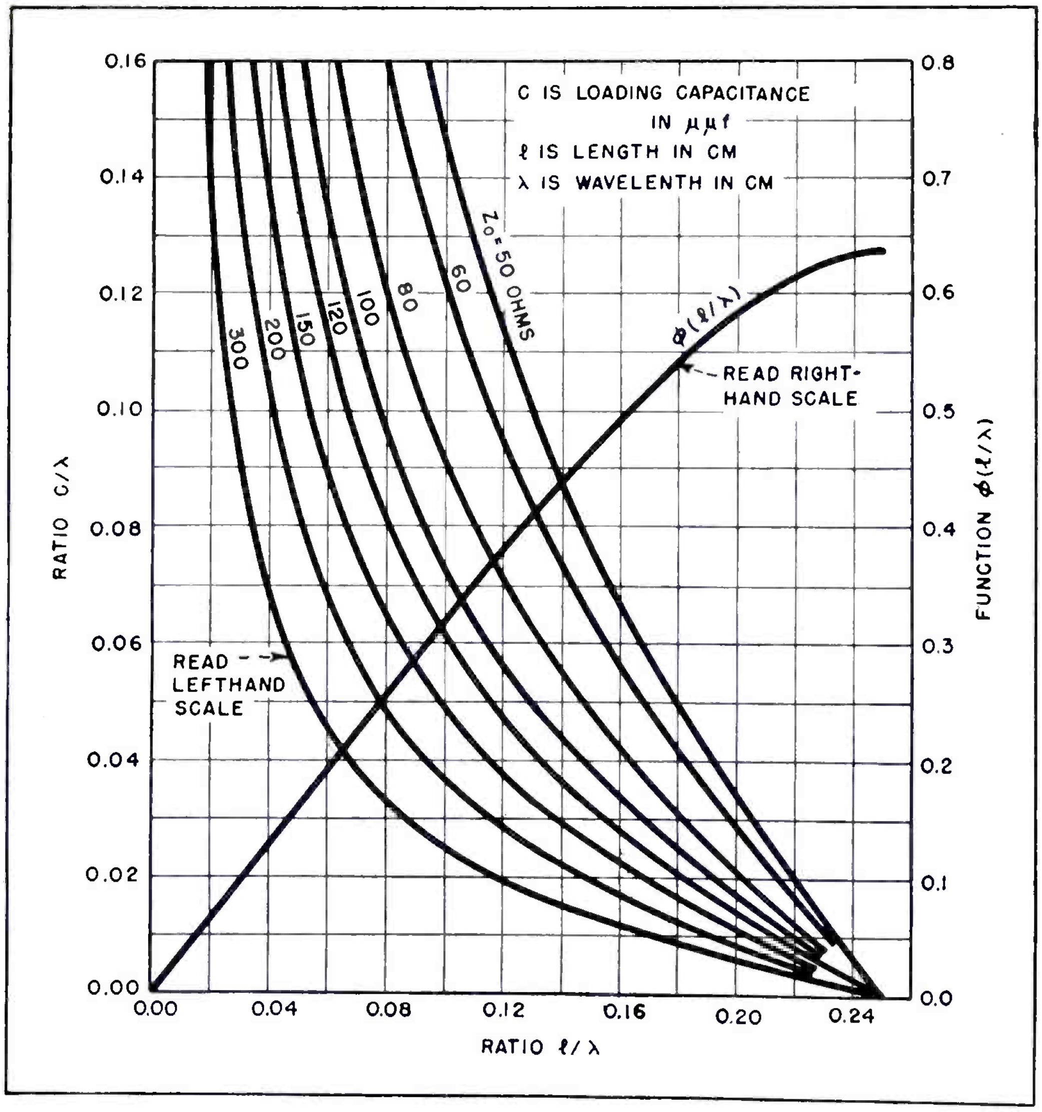



**FIG. 3**—Left hand scale gives ratio of loading capacitance to wavelength as a function for line length (see Fig. 2) for various characteristic impedances (see Fig. 4). Right hand scale gives unloaded impedance length parameter (see Eq. 6)

the line in ohms per cm and $\phi\,(l/\lambda)$ is given on Fig. 3 using the right-hand scale. The derivation of Eq. 6 is given in Appendix I.

As will be shown later, $R_s = K\,(f^{1/2}/b)$ where $K$ is a function of the line geometry and material, and $b$ is an outside dimension of the line geometry. Equation 6 becomes

$$R_o = bf^{1/2}\,\psi\,(a, b, c, \ldots)\,\phi\,(l/\lambda) \quad (7)$$

where $a, b, c, \ldots$ are dimensions of the line geometry. The function $\psi\,(a, b, c, \ldots)$ is readily determined for any line configuration for which $Z_o$ and $R_s$ can be analytically defined. Later $\psi\,(a, b, c, \ldots)$ will be determined for concentric and shielded parallel lines.

Transmission line reactances vary more rapidly with frequency than lumped reactances; as a result the selectivity expressed as the **Q** is larger than for an equivalent lumped reactance. The following equation is derived in Appendix II, assuming a lossless loading capacitance

$$Q = 2.09 \times 10^{-4} f\,(Z_o/R_s) = bf^{1/2}\,\theta\,(a, b, c, \ldots) \quad (8)$$

Equation 8 shows that the selectivity is independent of the length, a rather unexpected result. Because $\alpha = R_s/2Z_o$, it is readily seen that the condition for maximum selectivity is the same as for minimum attenuation.

### Conditions for Maximum Impedance

From the standpoint of tank efficiency, it is desirable that the unloaded tank impedance be as large as consistent with good design. The conditions for maximum impedance are readily determined for two extreme cases. They are (A) length limited by physical considerations of size and (B) loading capacitance fixed at a certain minimum determined by maximum tube capacitance.

(A) Length Fixed—It is readily seen from an examination of Eq. 7 that the maximum impedance occurs at the maximum of the function $\psi\,(a, b, c, \ldots)$, because $\phi\,(l/\lambda)$ is constant.

(B) Loading Capacitance Fixed—Let us start with Eq. 6. From observation of $\phi\,(l/\lambda)$ on Fig. 2 it is readily seen that $\phi\,(l/\lambda)$ is approximately linear to $(l/\lambda) = 0.15$. Using the series expansion for sin $(4\pi l/\lambda)$ and cos $(4\pi l/\lambda)$ and neglecting terms of higher order than two, we obtain

$$\phi\,(l/\lambda) \cong \pi\, l/\lambda \qquad (l/\lambda) < 0.15 \quad (9)$$

But the condition for resonance demands that

$$l/\lambda = \frac{1}{2\pi}\tan^{-1}(X_c/Z_o) \cong X_c/2\pi Z_o \qquad (l/\lambda) < 0.08$$

or

$$\phi(l/\lambda) = X_c/2Z_o \quad (10)$$

Substituting Eq. 10 in Eq. 6, we obtain

$$R_o = 2.09 \times 10^{-4} f\, X_c\,(Z_o/R_s) = b f^{1/2}\,\theta\,(a, b, c, \ldots)\,X_c \quad (11)$$

Equation 11 is seen to be Eq. 8 multiplied by $X_c$. Thus the maximum impedance occurs at the maximum for the selectivity. This relation is true only for short lines. For longer lines, the condition for maximum impedance increases toward the condition for the maximum for fixed length, because for $X_c/Z_o$ decreasing, $l/\lambda$ approaches a limit of 0.25, a constant.

### Concentric and Parallel Lines

All the needed equations have been presented for the general case. Equations 6 and 7 give the relations for unloaded impedance $R_o$, and Eq. 8 the relation for selectivity or the Q. The proper relations can be determined readily for any line configuration for which $Z_o$ and $R_s$ can be determined.

The remainder of the discussion will be concerned with the specific relations for concentric lines and shielded parallel lines.

Let us define the following parameters: $a$ is the outside diameter of inner conductor, $b$ is the inside diameter of outer conductor, $c$ is the center to center line spacing in cm, and $\rho_s$ is the skin effect surface resistivity of the conductor in ohms per square cm. These dimensions are shown on Fig. 1.

Let us determine $\rho_s$, as it enters into the calculation for all line configurations. Resistivity $\rho_s$, is defined as

$$\rho_s = \rho/\delta \tag{12}$$

where $\rho$ is the specific resistivity of material in ohms per cubic cm and $\delta$ is the skin depth in cm. For copper at 20 C, $\rho = 1.724 \times 10^{-6}$ ohms per cm cube, and $\delta = 6.62 \times 10^{-3}$ per $f^{1/2}$ cm. Therefore, $\rho_s$ for copper becomes

$$\rho_s = 2.61 \times 10^{-4} f^{1/2} \tag{13}$$

For other materials, $\rho_s$ is proportional to the square root of the resistivity of the material relative to copper.

Concentric Lines — Using the above notation, Ramo and Whinnery[2] give the following relations for $Z_o$ and $R_s$

$$Z_o = 60 \ln (b/a) \tag{14}$$

$$R_s = \frac{\rho_s}{\pi}\left(\frac{1}{a} + \frac{1}{b}\right) = 2.61 \times 10^{-4} f^{1/2} (1 + b/a)/\pi b = \frac{8.31 \times 10^{-5} f^{1/2}}{b}\left(1 + \frac{b}{a}\right) \tag{15}$$

Equation 6 then becomes

$$R_o = 18{,}150\, b\, f^{1/2} (\ln b/a)^2 \phi(l/\lambda)/(1 + b/a) = b f^{1/2} \psi(r) \phi(l/\lambda) \tag{16}$$

where $r = b/a$. Substituting Eq. 14 and 15 in Eq. 8, we obtain

$$Q = 151\, b\, f^{1/2} \ln (b/a)/(1 + b/a) = b f^{1/2}\, \theta (r) \tag{17}$$

Equations 16 and 17 have been derived independently by Hansen's derivation.[3]

Shielded Parallel Lines—Using the same notation, Ramo and Whinnery[2] give the following relations for $Z_o$ and $R_s$

$$Z_o \cong 120 \left\{ \ln \left[ 2p \frac{(1 - q^2)}{(1 + q^2)} \right] - \frac{1 + 4p^2}{16p^4} (1 - 4q^2) \right\} \tag{18}$$

$$R_s \cong \frac{\rho_s}{\pi b} \left\{ r \left[ 1 + \frac{1 + 2p^2}{4p^4} (1 - 4q^2) \right] + 4q^2 \left[ 1 + q^2 - \frac{1 + 4p^2}{8p^4} \right] \right\} = 1.66 \times 10^{-4} \frac{f^{1/2}}{b} \left\{ r \left[ 1 + \frac{1 + 2p^2}{4p^4} (1 - 4q^2) \right] + 4q^2 \left[ 1 + q^2 - \frac{1 + 4p^2}{8p^4} \right] \right. \tag{19}$$

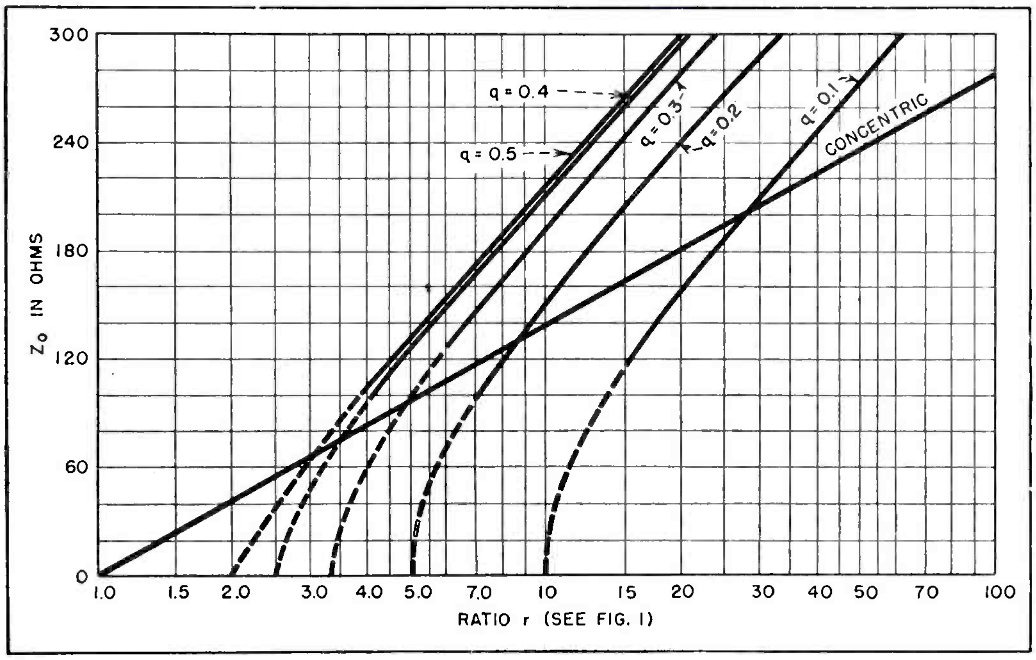



**FIG. 4—Characteristic impedance is shown as a function of dimensionless ratios of line size. Using this and the four other curves presented herewith, one can design transmissions line tank circuits. The cross-sectional dimensions of either a coaxial or shielded balanced line (Fig. 1) are used with Fig. 6 (next page) to obtain the optimum proportions. Capacitive loading effects of tube are obtained from Fig. 2 and 3. This (Fig. 4) graph is used to obtain impedance of the line for use with Fig. 3. Figures 3, 5, and 6 give angular functions that are substituted into the appropriate Eq. 4, 5, 7, 8, 16, or 17 as outlined in the two boxes on the opening pages**

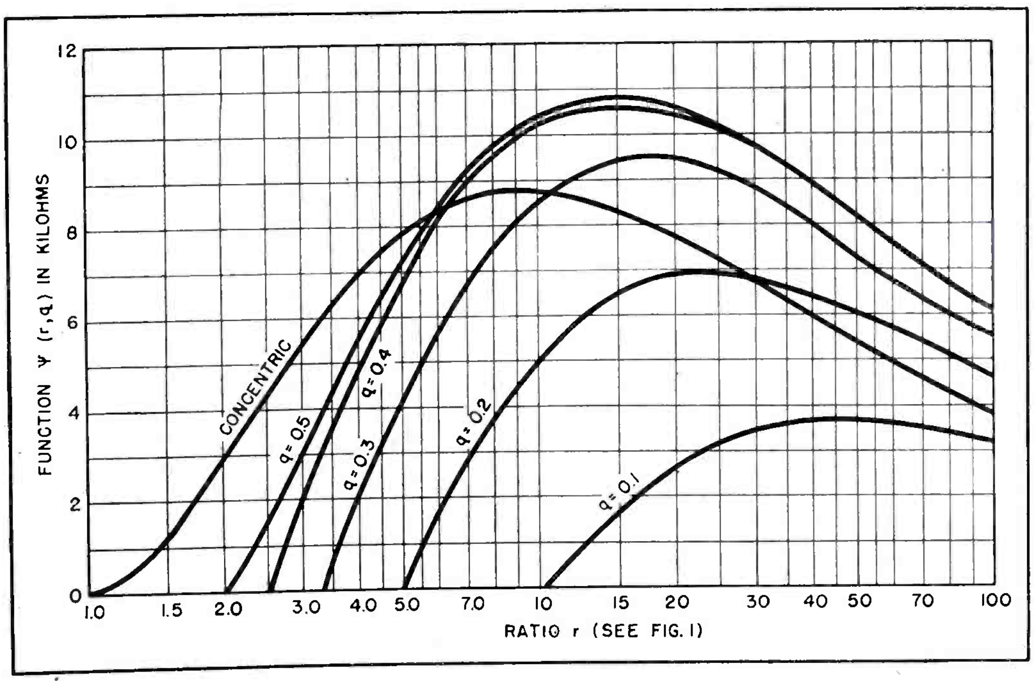



**FIG. 5—Unloaded tank impedance cross-section parameter (see Eq. 7) is given as a function of the dimensionless ratios of line size**

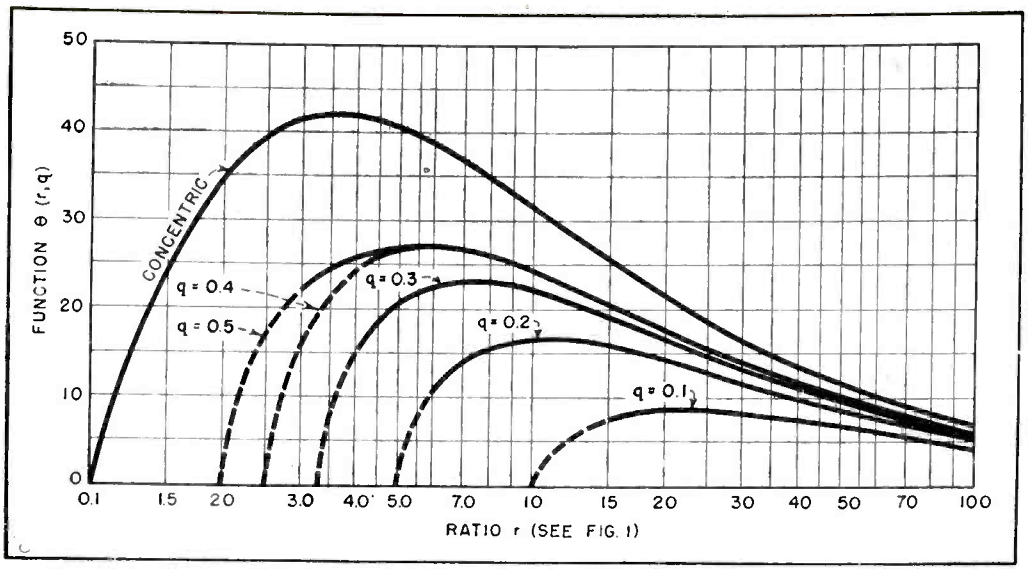



**FIG. 6—Selectivity function (see Eq. 8) indicates optimum relative line dimensions for any application. If design is begun with this graph, optimum tank efficiency can be obtained**

where r $= b/a$, $q = c/b$, and $p = c/a = rq$. Substituting Eq. 18 and 19 in Eq. 6 and 8, we obtain $\psi(r,q)$ and $\theta\ (r,q)$ respectively.

Figure 4 shows characteristic impedance versus $r$ for concentric and shielded parallel lines (the latter for several values of $q$); Fig. 5 shows unloaded tank impedance versus $r$ and $q$, and Fig. 6 shows $Q$ versus $r$ and $q$. It should be noted that the curves for the shielded parallel line apply approximately for $q' = 1 - q$. Because relations for shielded parallel lines are only approximate, they do not apply for values of $p$ (Eq. 18 and 19) close to one. As a result, the extrapolated curve in this region is shown as a dotted line.

### Appendix I

Although these transmission-line equations are conventional, they need to be re-arranged into forms more useful for graphical presentation.

The formula for the unloaded impedance of a tank circuit can be derived by using the notation of Table I. The sending end impedance of a short-circuited transmission line is given by the equation

$$Z_s = Z_C \tanh \gamma l = Z_C \tanh (\alpha + j\beta) l$$
$$= Z_C \frac{\sinh 2\alpha l + j \sin 2\beta l}{\cosh 2\alpha l + \cos 2\beta l}$$
$$\cong Z_C \frac{\alpha l}{\cos^2 \beta l} + j \tan \beta l \qquad (20)$$

For a well-designed line $\alpha l$ is very small, $\cosh 2\alpha l \cong 1$, and $\sinh 2\alpha l \cong 2\alpha l$.

Next $Z_c$, $\alpha$ and $\beta$ must be determined. Both $Z_c$ and $\gamma = \alpha + j\beta$ are defined as follows (transmission line tank circuits are usually made with air dielectric, therefore $G_s$ is zero)

$$Z_C = (Z/Y)^{1/2} = [(R_S + j\omega L_S)/j\omega C_S]^{1/2}$$
$$= (L_S/C_S)^{1/2} [1 - j (R_S/\omega L_S)]^{1/2} \qquad (21)$$

$$\gamma = (ZY)^{1/2} = [(R_S + j\omega L_S)(j\omega C_S)]^{1/2}$$
$$= j[\omega^2 L_S C_S (1 - jR_S/\omega L_S)]^{1/2}$$

But $(R_S/\omega L_S) << 1$, $(L_S/C_S)^{1/2} = Z_O$, and $\omega (L_S C_S)^{1/2} = 2\pi/\lambda = \beta$, therefore

$$Z_C = Z_O (1 - jR_S/2\omega L_S) \qquad (22)$$

$$\gamma = \omega (L_S C_S)^{1/2} [(R_S/\omega L_S) + j]^{1/2}$$
$$\cong (2\pi/\lambda)[(R_S/2\omega L_S) + j]$$
$$= \alpha + j\beta \qquad (23)$$

From Eq. 23, $R_S/2\omega L_S = \alpha/\beta$. Substituting the value in Eq. 22 gives

$$Z_C = Z_O (1 - j\alpha/\beta) \qquad (24)$$

Substituting Eq. 24 into Eq. 20 gives

$$Z_S = Z_O \left[ \left( \frac{\alpha l}{\cos^2 \beta l} + \frac{\alpha \tan \beta l}{\beta} \right) + j \left( \tan \beta l - \frac{\alpha^2 l}{\beta \cos^2 \beta l} \right) \right]$$

The term $\alpha^2 l/\beta \cos^2 \beta l$ is negligible compared to $\tan \beta l$, therefore

$$Z_S = Z_O \left[ \left( \frac{\alpha l}{\cos^2 \beta l} + \frac{\alpha \tan \beta l}{\beta} \right) + j \left( \tan \beta l \right) \right]$$
$$= R + jX \qquad (25)$$

Now resonate the impedance $Z_s$ with a capacitive reactance of $-jZ_o \tan \beta l$. The parallel impedance presented by this combination is then

$$R = \frac{X^2}{R} = \frac{(Z_O \tan \beta l)^2}{Z_O [(\alpha l/\cos^2 \beta l) + (\alpha \tan \beta l)/\beta]}$$
$$= \frac{Z_O \beta}{\alpha} \left[ \frac{1 - \cos 2\beta l}{2\beta l + \sin 2\beta l} \right] \qquad (26)$$

But $\beta = 2\pi/\lambda$, and $\alpha = R_S/2Z_O$, therefore

$$R_O = \frac{4\pi Z_O^2}{R_S \lambda} \left[ \frac{1 - \cos (4\pi l/\lambda)}{(4\pi l/\lambda) + \sin (4\pi l/\lambda)} \right]$$
$$= 4.19 \times 10^{-4} (f Z_O^2/R_S) \phi (l/\lambda) \qquad (27)$$

Equation 27 is Eq. 6.

### Table I—Symbolic Notation

| | | |
|---|---|---|
| $Z_S$ | = | sending end impedance of line in complex ohms |
| $Z_C$ | = | characteristics impedance of line in complex ohms |
| $Z$ | = | series impedance per unit length of line |
| $Y$ | = | shunt admittance per unit length of line |
| $R_S$ | = | series resistance per unit length of line |
| $L_S$ | = | series inductance per unit length of line |
| $G_S$ | = | shunt conductance per unit length of line |
| $C_S$ | = | shunt capacitance per unit length of line |
| $\alpha$ | = | attenuation constant of line |
| $\beta$ | = | phase constant of line |
| $\gamma$ | = | propagation constant of line |
| $\omega$ | = | angular frequency |

### Appendix II

To derive the formula for selectivity, expressed as Q, of a tank circuit, consider that $\Delta X_c = X(\Delta f/f_o)$. For a line Terman[5] gives the equation

$$\Delta X_L = X (\Delta f/f_O) (2 \beta l/\sin^2 \beta l) \qquad (28)$$

The total change in reactance with detuning is

$$\Delta X = \Delta X_C + \Delta X_L$$
$$= X (1 + 2 \beta l/\sin^2 \beta l) (\Delta f/f_O)$$

where $X = Z_o \tan \beta l$. Let $(\Delta X/Z_o) = (R/Z_o)$, which is the condition for half power, then

$$(\tan \beta l) (1 + 2 \beta l/\sin 2 \beta l) (\Delta f/f_O) = \left( \frac{\alpha l}{\cos^2 \beta l} + \frac{\alpha \tan \beta l}{\beta} \right) \times$$
$$\left( \frac{2 \beta l + \sin 2 \beta l}{2} \right) \left( \frac{\Delta f}{f_O} \right) =$$
$$\left( \frac{\alpha}{\beta} \right) \left( \frac{2 \beta l + \sin 2 \beta l}{2} \right) \left( \frac{\Delta f}{f_O} \right) = \frac{\alpha}{\beta} =$$
$$\frac{R_S/2Z_O}{2\pi/\lambda} = \frac{R_S \lambda}{4\pi Z_O} = \frac{3 \times 10^4 R_S}{4\pi f Z_O}$$

From the definition of the Q

$$Q = \frac{1}{2 (\Delta f/f_O)} = \frac{4\pi f Z_O}{6 \times 10^4 R_S}$$
$$= 2.09 \times 10^{-4} f (Z_O/R_S)$$

which is Eq. 8.


### References

(1) Terman, Frederick E., "Radio Engineering Handbook", McGraw-Hill Book Co., Inc., p 449.

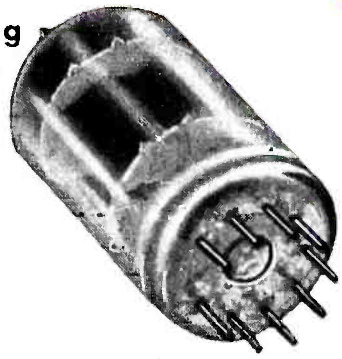
(2) Ramo and Whinnery, "Fields and Waves in Modern Radio", John Wiley and Sons, p 332.

(3) On Resonators Suitable for Klystron Oscillators, Hansen, W. W., and Richtmyer, R. D., *Jour Appl Phys*, p 189 March 1939.

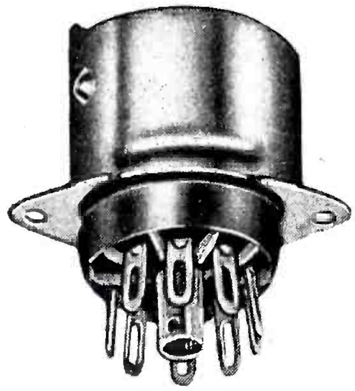
(4) McArthur, E. D., Disc-Seal Tubes. ELECTRONICS, p 98, Feb. 1945.

(5) Terman, Frederick E., Resonant Lines in Radio Circuits, *Elect Engr*, p 1046, July 1934.

16G12626—Shield—1½″ long
16G12627—Shield—1-15/16″ long
16G12628—Shield—2⅜″ long



# New "NOVAL" Nine Prong Miniature Sockets



53F12625
Military type dome top casting.
Attached Base—Mica Filled
Molded with .093 mtg. hole
1⅛″ mtg. center

53F12617
Saddle Type—Mica Filled
Molded with .093 mtg. hole
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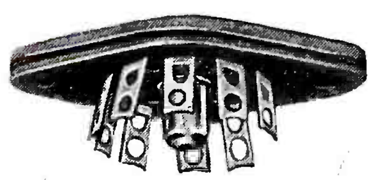

56E12571—Laminated Noval
1⅛″ mtg. center

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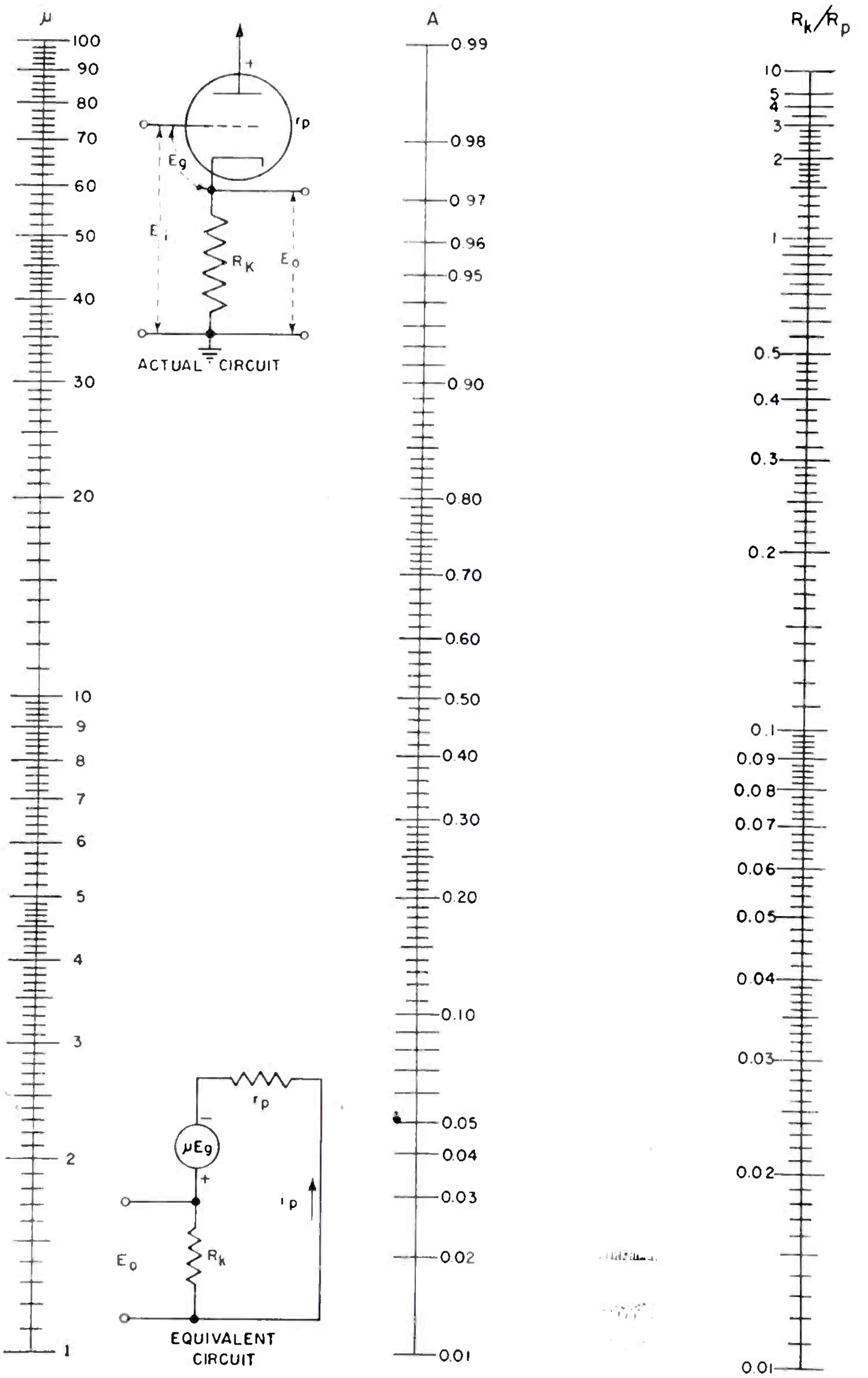
By **MELVIN B. KLINE**

*Senior Electronic Engineer, Research and Development Division*
*Allen B. Du Mont Laboratories, Inc., Passaic, N. J.*

# Cathode Follower NOMOGRAPH

Gain, amplification factor, and the ratio of cathode load resistance to tube plate resistance are related in this first of a series of three cathode-follower nomographs




THE CATHODE-FOLLOWER has become one of the most useful tools of the electronic engineer because of its desirable characteristics as an impedance transformer.

Neglecting the effect of interelectrode and other shunting capacitances, the actual and equivalent circuits of the cathode-follower are as shown on the nomograph. Circuit equations are

$$\mu E_g = (R_k + r_p)\, i_p \qquad (1)$$
$$E_o = R_k i_p \qquad (2)$$
$$E_i = E_g + E_o \qquad (3)$$

Since the gain $A$ is the ratio of output voltage to input voltage, solution of these equations results in the following expression for the gain of a cathode-follower

$$A = \frac{E_o}{E_i} = \frac{\mu R_k}{r_p + R_k\,(\mu + 1)} \qquad (4)$$

Dividing by $R_k$ and letting $R_k/r_p = n$

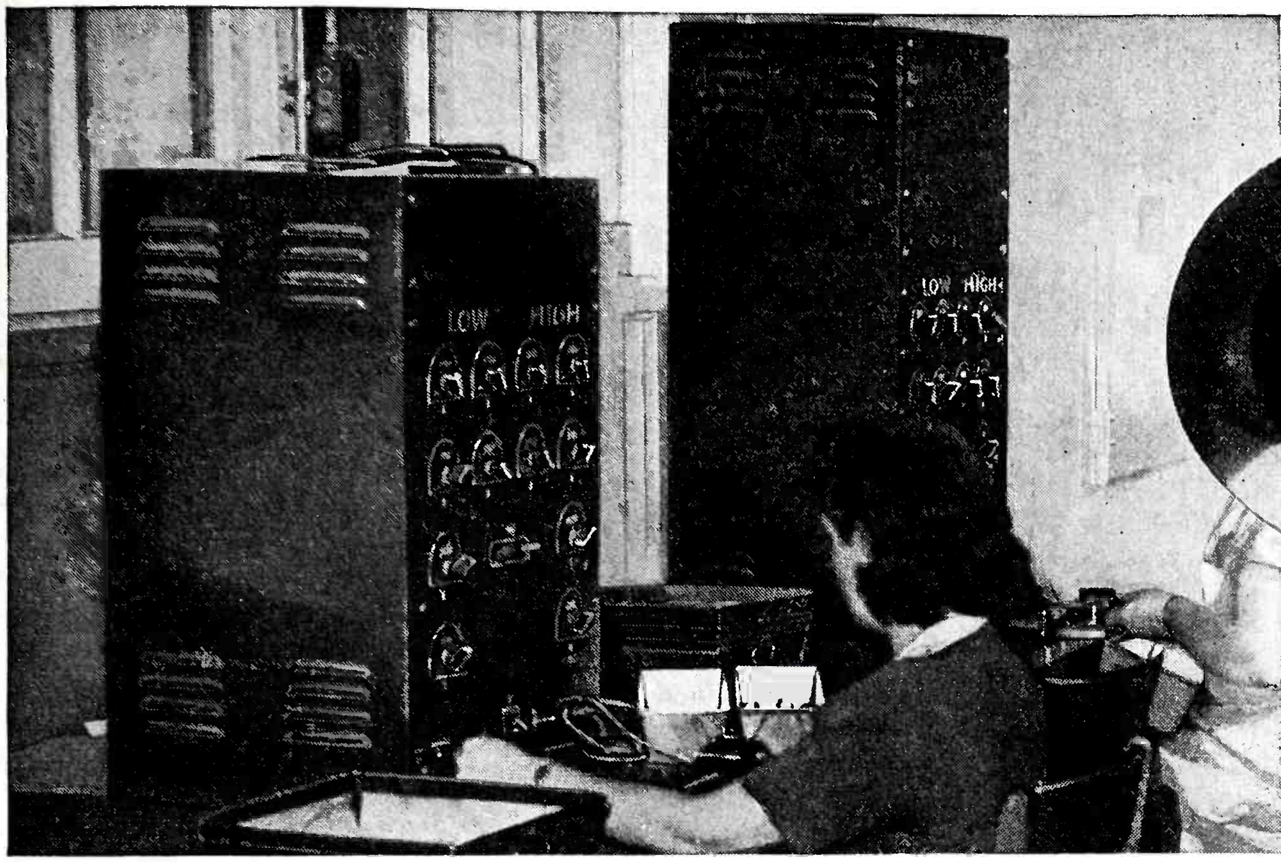
$$A = \frac{\mu}{\mu + 1 + (1/n)} \qquad (5)$$

When $n$ is very large ($R_k >> r_p$), the gain approaches a maximum value of 1.

Very often, the engineer wants to know how much gain (actually loss) he will get from a cathode-follower using a specific tube and cathode resistor. The nomograph relates tube amplification factor $\mu$, gain $A$, and the ratio $n$ of cathode load resistance $R_k$ to tube plate resistance $R_p$.

The cathode-follower nomograph in the next issue relates gain, transconductance, and cathode load resistance, since transconductance is generally easier to work with than amplification factor when dealing with pentodes. The third nomograph will give output impedance when transconductance and cathode load resistance are known.

# ACCURATE TAPER CONSTRUCTION




Mallory operators testing electrical characteristics of taper shown above.

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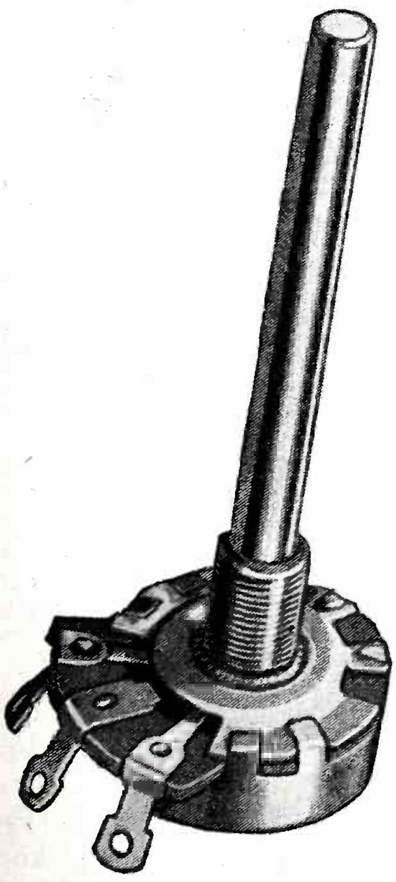

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# TUBES AT WORK

## Including Industrial Control

Edited by VIN ZELUFF



### Television System for Industrial Applications

A VERSATILE system of industrial television has been developed by engineers of Emerson Radio, the first reported use of conventional 525-line technique for such a purpose. Designed for visual inspection of critical operations on a production line from a remote point, the system has been operating daily for several months in the company's plant in New York City. Production-line assembly of table model radio receivers is monitored by the camera unit and the resulting picture appears on receivers in the offices of executives of the company.

The arrangement of the complete system as set up in an industrial plant is shown in Fig. 1. Located at strategic points in the factory are camera pickup units trained upon the portion of an assembly line or processing machine desired. Each camera unit contains two microphones for pickup of the accompanying sounds in the plant. Both the video signals and the audio signals are fed into a central control unit that channels them to the receivers. To provide complete versatility, on-the-air television receivers are provided for reception and distribution of important news events and other broadcasts.

At the viewing points, perhaps in the executives' offices, are located television receiving units with binaural audio systems. Dialing a selector system at these receivers permits choice of viewing scenes of workers in the plant or broadcasts over the air. Binaural sound reproduction has been found to aid in creating an illusion of being on the floor of the plant in the mind of the person viewing the screen.

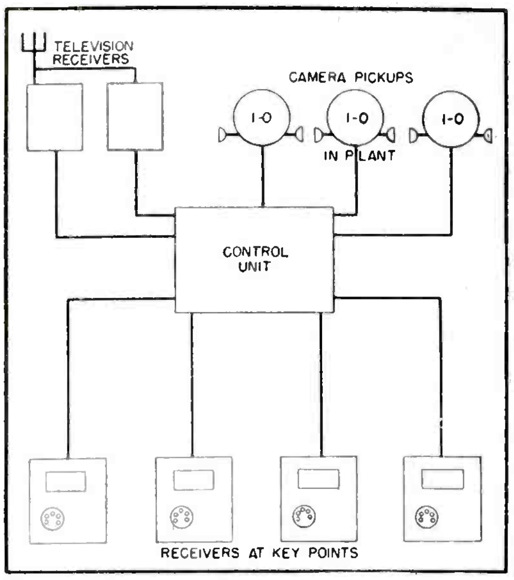
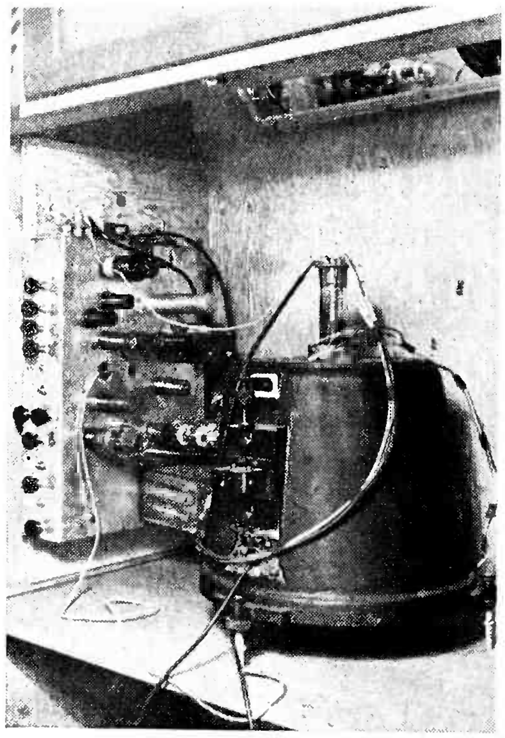


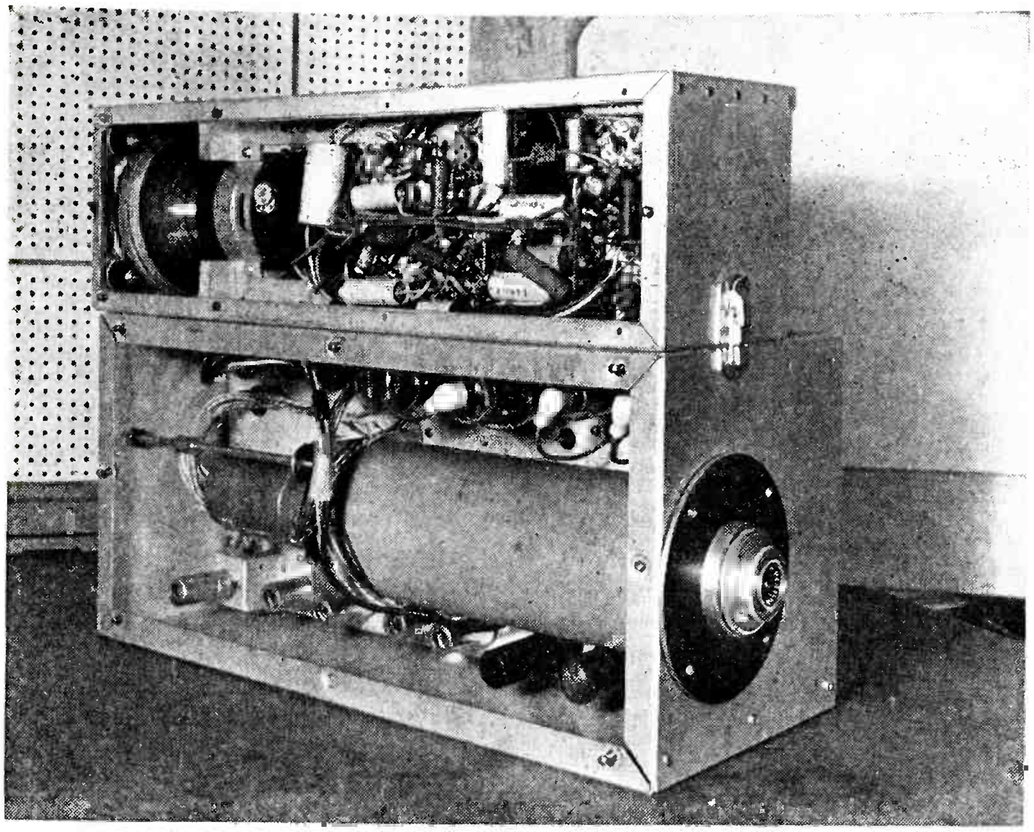

FIG. 1—Basic units of television system for monitoring manufacturing operations in a factory

A standard 525-line image showing the assembly line in operation appears on the screen of the receiver unit while vice-president Dorman D. Israel and chief engineer Maurice Levy discuss the advantages of the system

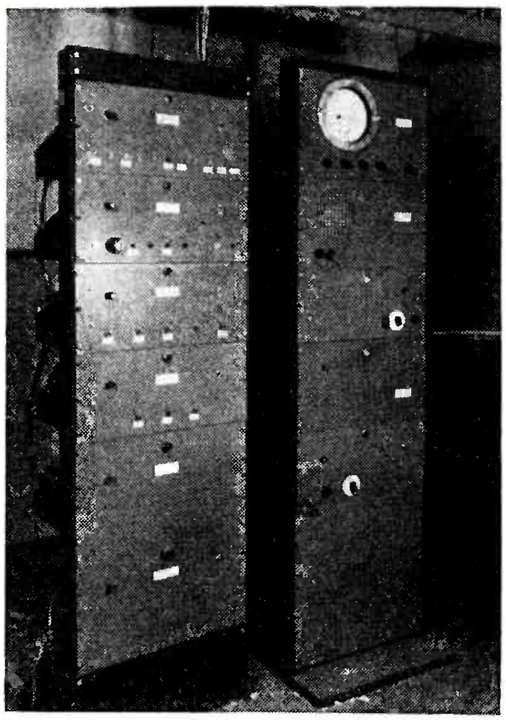


Housing of the optical elements of the Schmidt system and the projection tube in the receiver cabinet. Vertical and horizontal controls are on the chassis at left and additional power supplies are mounted on a shelf below

A detailed breakdown of the system is shown in Fig. 2. Each pickup unit contains an image orthicon having a three-inch diameter, type 2P23. A lens in front of the tube permits focusing. Standard RMA synchronizing pulses are supplied to



In the camera pickup unit, the image orthicon is shielded and mounted behind the lens. The five-inch electronic viewfinder faces the rear of the instrument and can be removed in its own cabinet if needed remote from the camera case



The central control unit contains a shading signal generator, mixing amplifier, RMA signal generator, synch generator, and power supplies at left. The video and audio monitors and channel-selector circuits are at right

this from the central control unit.

For focusing the camera unit, a five-inch type 5FP4 cathode-ray tube with magnetic deflection is provided as an electronic viewfinder. Video amplifiers and deflection circuits for both c-r tubes are included in this unit. About 7,000 volts for the 5FP4 are obtained from the built-in power supply. The latter also supplies 1,500 volts and 400 volts for the image orthicon and other tubes in the pickup unit, making a total of 32 tubes used in the television circuits of the pickup unit.

The video signal output of the camera unit is fed over twin coaxial cable to the central control unit. In the Emerson plant, about 1,000 feet of cable are employed for the video signal and the audio signal is carried over a separate line. For some installations an r-f carrier audio system may be needed and r-f oscillators and amplifiers would then be incorporated in the pickup unit for a two-channel audio system. Using frequencies higher than five megacycles, the modulated r-f signal could then be handled on the same coaxial cable that carries the video signal.

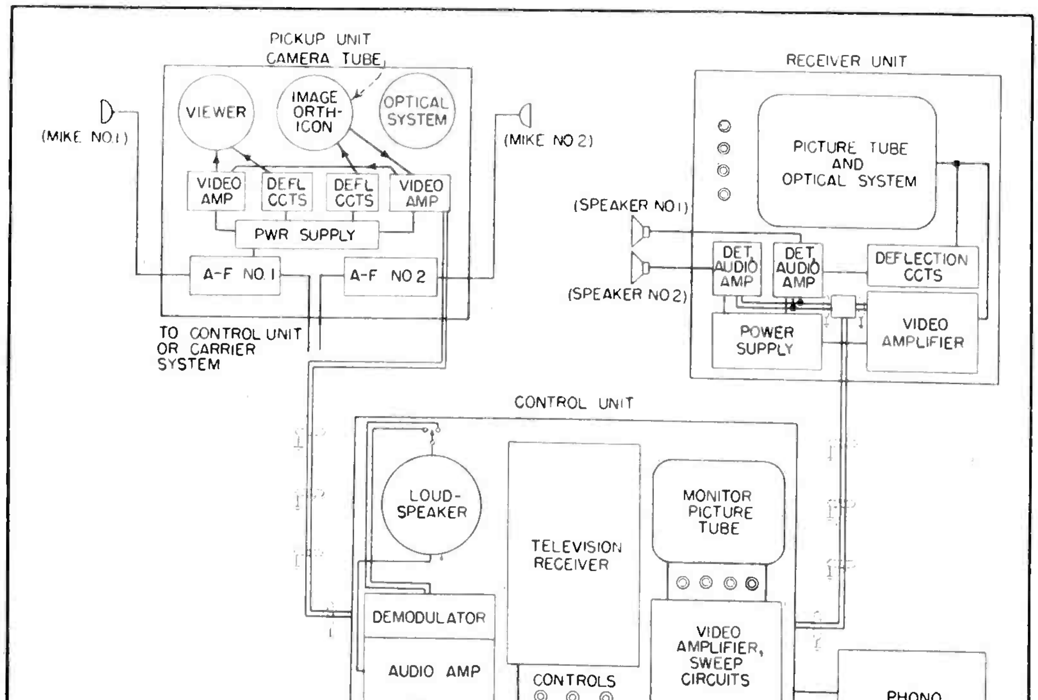



FIG. 2—Breakdown of electronic circuits. The central control unit normally handles several camera pickups and receiver units

The central control unit originates the standard RMA synchronizing signals used throughout the system. It contains a receiver for the picture signal that supplies a seven-inch cathode-ray tube type 7EP4 used for monitoring the video lines to insure that a satisfactory picture is being supplied to the receiver viewing units. Audio monitoring is provided by a loudspeaker and ampilfier in this unit. For the carrier system, demodulators would be necessary as well.

The receiver unit illustrated presents a 16x22-inch picture on its screen. This is projected from a five-inch c-r tube, type 5TP4, arranged in the Schmidt system with a plastic aspherical lens for correction. An alternative would be a ten-inch direct-viewing tube for a smaller unit. Deflection circuits and video amplifier for the receiver are included in this unit as are also the audio circuits and loudspeakers for the two-channel system.

In addition to the many possible applications in industry for time

(Continued on p 156)

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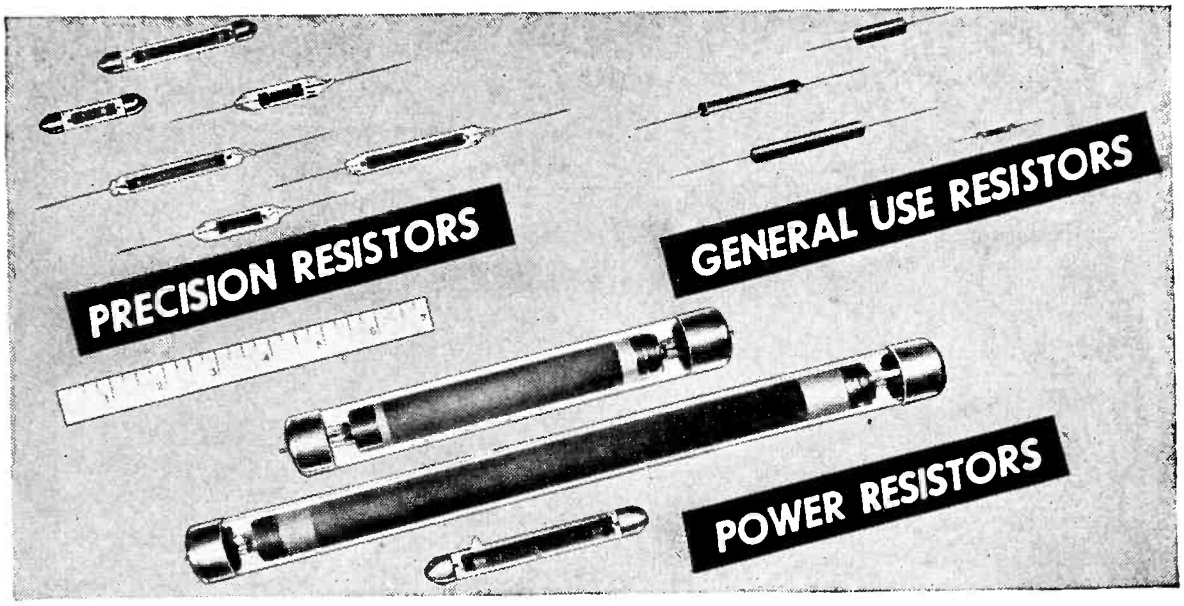


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# THE ELECTRON ART

Edited by FRANK ROCKETT



## Spectrometer Vacuum Leak Detector

By G. A. Doxey

*Special Products Division*
*General Electric Co.*
*Schenectady, N. Y.*

Very small inleaks can be evaluated and located in high-vacuum systems, and leaks in any closed metal or glass system that can be evacuated (such as radio tubes, refrigerator parts, or boiler tanks) by using the mass spectrometer shown in Fig. 1. The technique is to connect a specially constructed mass spectrometer to the system, which is then evacuated. A tracer gas, usually helium, is allowed to enter the evacuated system through any leaks. If the tracer gas does enter, it is identified by the mass spectrometer. The spectrometer built for this purpose by General Electric can detect an inleak so small that only one cubic centimeter of helium at atmospheric pressure will enter the system in 16 years.

Helium is used as tracer gas because of its light mass and because it has little tendency to form compounds with other gases in the system. When the leak detector is attached to the system, and a leak exists, the tracer gas passes through the opening and is ionized in the spectrometer tube. The ions are accelerated by an electrostatic field and deflected in a magnetic field. These fields are adjusted to allow only helium to pass through a narrow slit to a collector plate. An indicating instrument registers the presence and the concentration of helium in the system and thus the relative size of the leak.

*Utility of Leak Detector*

The outstanding advantages of this instrument are that it locates small leaks in the presence of large ones, has high sensitivity (detects one part helium in 200,000 parts air), has quick response (one second from the time helium enters a leak in small systems), pressure in test sample over a wide range does not affect results, it is clean (tracer gas used does not contaminate system), is speedy in operation, permitting production-testing of small parts as illustrated in Fig. 2, and is sufficiently simple to operate to save time of skilled personnel in testing very large all-metal high-vacuum systems.

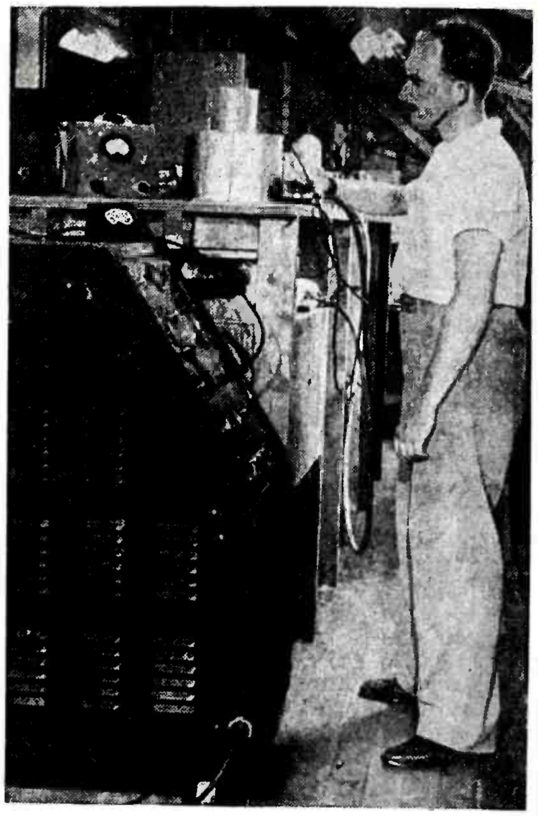

FIG. 2—Hermetically sealed instruments in production are searched for leaks by envelope method

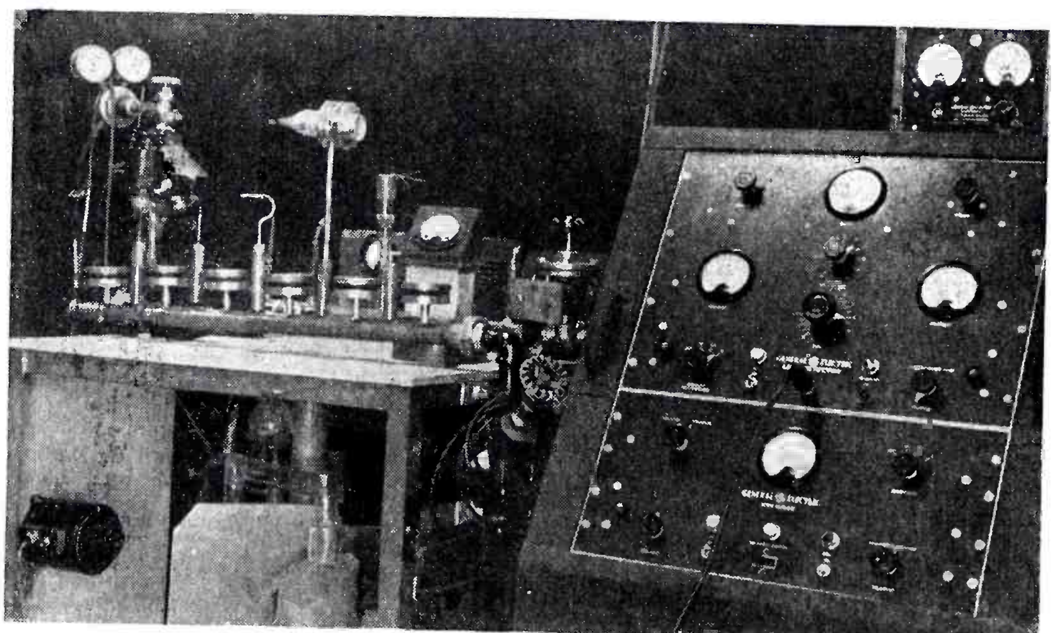

FIG. 1—Spectrometer leak detector is used to locate inleaks in vacuum tubes by jet method

Whereas the mass spectrometer as a leak detector might be thought of as laboratory equipment, it can be adapted for industrial use by redesign and rearrangement of its parts. The main components of this leak detector, indicated in Fig. 3, are: (1) mass spectrometer tube—includes ion source, deflecting magnet, ion collector, and preamplifier; (2) diffusion pump—has a liquid nitrogen trap which will produce a vacuum in the mass spectrometer tube of $7 \times 10^{-6}$ mm of mercury, or lower;

(3) roughing vacuum pump—rotary-oil type; and (4) necessary controls for these.

An ion gage control gives continuous indication of spectrometer-tube pressure in the range of 1 to 0.0001 microns ($10^{-3}$ to $10^{-7}$ mm of

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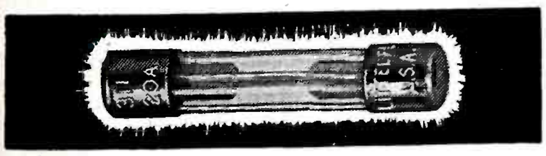

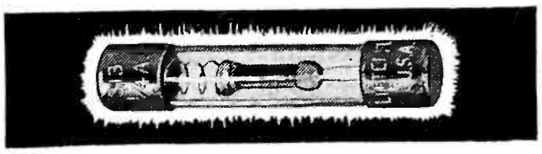

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NITE-T-LITE • SWITCH LITE • IGNITION FRITZ • NEON INDICATORS • SWITCHES • CIRCUIT BREAKERS • FUSES, MOUNTINGS AND ACCESSORIES mercury). There are two VGI-A tubes (1 spare) mounted between the spectrometer tube and the diffusion pump. The ion gage control has an adjustable automatic cutoff which is usually set at $4 \times 10^{-5}$ mm of mercury. Pressure increases in the spectrometer tube beyond this point will trip the cutoff circuit and thus remove power from the ion gage and spectrometer-tube filament. The emission regulator of the ion-gage control stabilizes filament emission against changes in line voltage or tube pressure. In ordinary continual use, the spectrometer filament will last about two weeks. Filaments are interchangeable and are easily replaceable.

A leak detector panel provides necessary voltages for the spectrometer-tube filament and the ion source. The emission regulator for the spectrometer tube filament automatically regulates emission current at one of four predetermined values regardless of changes in line voltage or tube pressure. Four settings give four sensitivity ranges for detecting various sizes of leaks. The leak detector panel has a receptacle for connecting the portable indicator, which can be held by the operator when using a helium jet.

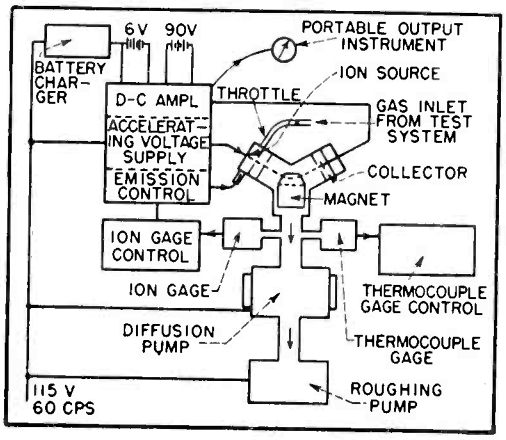


FIG. 3—Block diagram shows essential components of spectrometer leak detector

Batteries and battery charger provide plate and filament voltage for the amplifier. The battery charger, which is connected to the a-c line, is used when necessary to charge the storage battery to normal voltage.

All these parts are enclosed in a cabinet mounted on wheels to facilitate moving the leak detector from one test area to another. A thermocouple vacuum gage and control, a throttle valve, and a standard leak are also furnished with each leak detector.

The thermocouple vacuum gage and control has a range of 0-100 microns (0 to 0.1 mm mercury). It is used first as a check on rough vacuum before turning on the diffusion pump, and second, to check high vacuum before turning on the ion gage.

The throttle valve is provided for maintaining pressure differential between leak detector and test system. The standard leak can be used for checking sensitivity of the instrument or for measuring, by comparison, rate of leakage.

*Techniques for Detecting Leaks*

Two methods of leak detection are commonly used: the envelope method and the jet method. The envelope method involves the use of an envelope or container of helium to surround the system or vessel being leak-tested. Helium will diffuse through any leaks which may be present and will give an indication of total leakage.

To find the location of a leak, the jet method is used. A small helium jet is held about ½ in. from the suspected area and moved at the rate of ½ in. per second. As the jet passes over the leak, helium is drawn into the system and is registered on the output instrument. If the jet is made very fine with a small flow, leaks can be located within about ⅛ in.

Before leak detection can be started, a vacuum must be drawn in the spectrometer tube. This requires water for the diffusion pump jacket, liquid nitrogen for the cold trap, and electric power for the rotary pump and diffusion pump heater. The time required to pump the spectrometer tube down to operating pressure is about one and a half hours.

Test samples are connected to the leak detector through a throttle valve which allows adjustment of the flow through the leak detector for different values of pressure in the test sample. While pressure in the mass spectrometer tube, as indicated by the ion gage, must not be more than about $2 \times 10^{-5}$ mm, pressure in the test system can be much higher. With high sample pressures it is necessary to close the throttle valve partially, thus reducing sensitivity of the leak detector, as shown in Fig. 4. If the sample pressure is above the molecular flow range, the speed of response will be reduced.

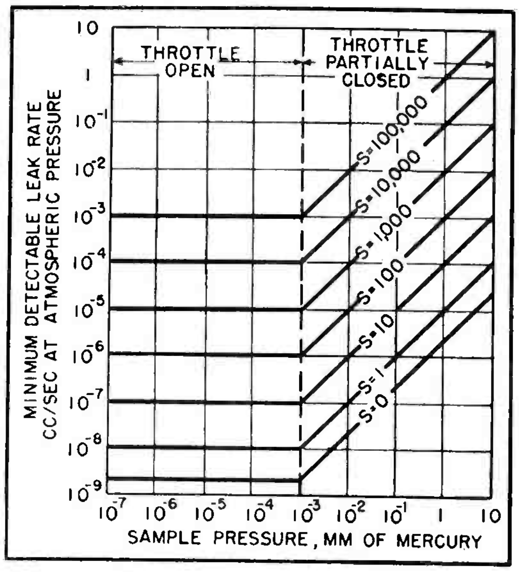


FIG. 4—Sensitivity of General Electric leak detector depends on speed of auxiliary pumping equipment S in liters per second

When the pressure in the test sample is above $10^{-3}$ mm, the maximum allowable pressure rise in the leak detector can be maintained by adjustment of the throttle valve to achieve maximum obtainable sensitivity. However, if the sample pressure is less than $10^{-3}$ mm, and an auxiliary pumping system is used, it is sometimes not possible to maintain maximum pressure rise. In this case, it may be desirable to connect the leak detector between the diffusion pump and the roughing pump on the sample system, or to throttle the auxiliary pumping system, in order to maintain the pressure in the leak detector.

Smallest detectable leak is $2 \times 10^{-9}$ standard cu cm per second ($1.5 \times 10^{-6}$ micron liters per second), corresponding to a partial pressure of helium at the ion gage tube of $5 \times 10^{-11}$ mm mercury. Normal helium concentration in air can be shown on the leak detector.

Over-all response time of the leak detector to helium diffusion through the leak is usually of the order of one second. When helium is removed from the leak, the signal will disappear as quickly as the helium is pumped from the system. Cleanup time for the leak detector itself is about three seconds, and for the test system a little longer, depend-

(continued on p 194)

# *Anaconda* —OUT FRONT IN TELEVISION LEAD-IN LINES

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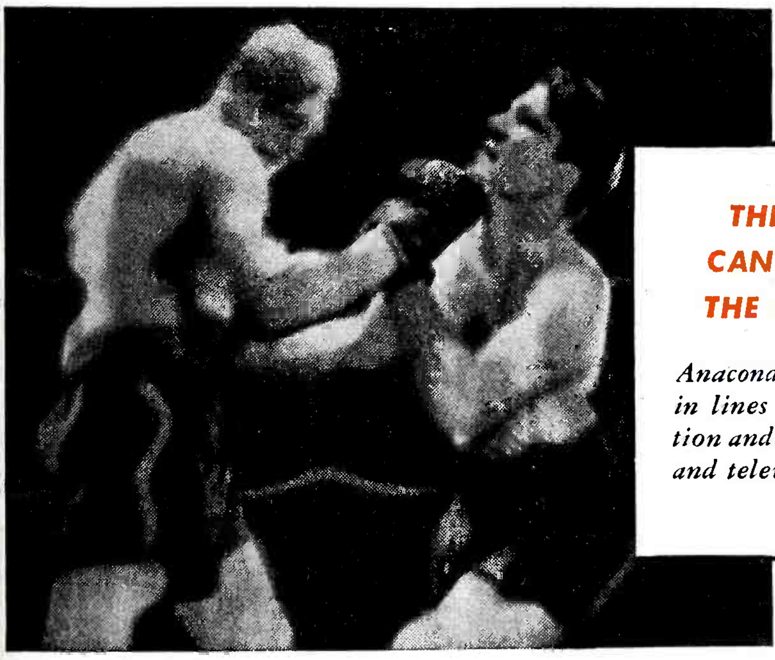

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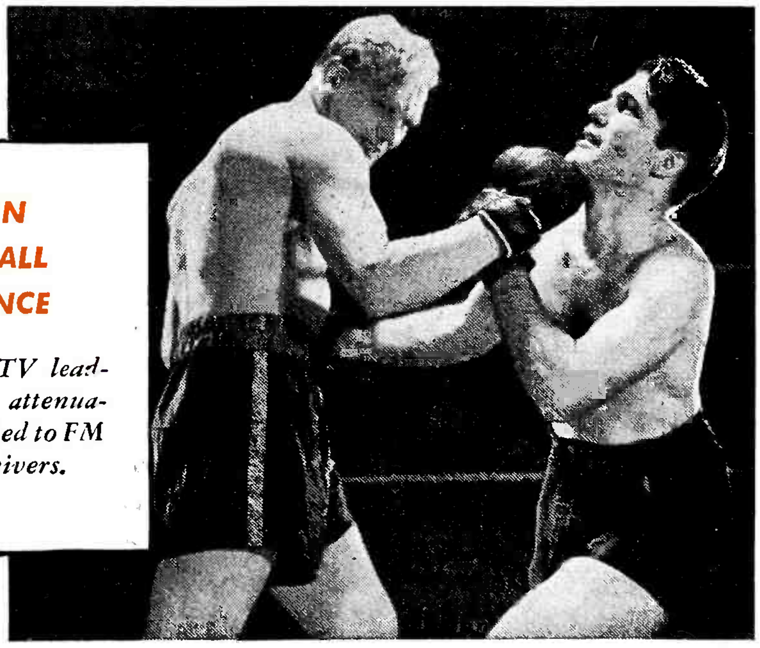

Anaconda Type ATV* lead-in lines are designed for minimum signal loss and maximum freedom from distortion in FM and television reception. The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion.

There is a wide selection of correctly engineered lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded—each designed to fulfill the exacting requirements of wide-band reception.

*An Anaconda Trade-Mark

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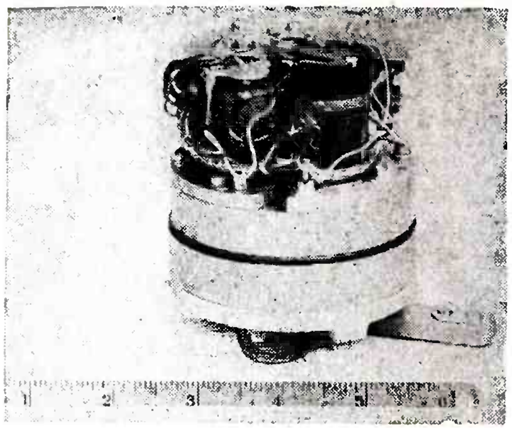
ANACONDA from mine to consumer

**ANACONDA WIRE AND CABLE COMPANY**

# NEW PRODUCTS

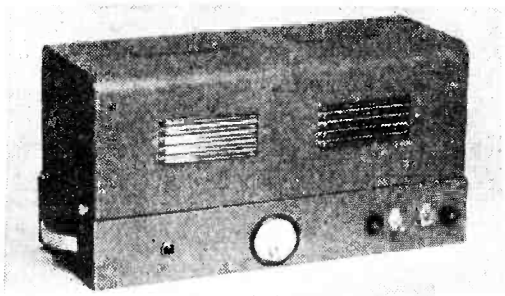
**Edited by A. A. McKENZIE**

**New equipment, components, packaged units, allied products; new tubes. Catalogs and manufacturers' publications reviewed.**



### Frequency Standards (1)

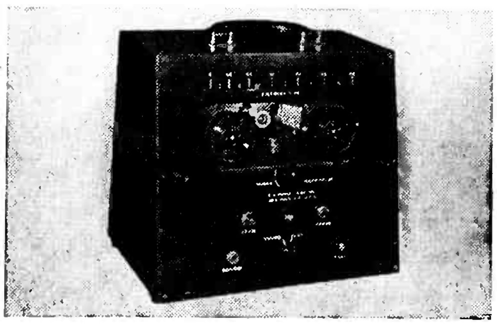
ERNST NORRMAN LABS., Williams Bay, Wis. Frequency standards suitable for manufacturers of facsimile and similar apparatus are



available as units, accuracy depending upon the type of crystal used. Complete frequency standards like the Model 101-IN 50-watt inverter illustrated are also manufactured. Type 2050 tubes are used in the output stage. Chassis is 7 x 17 in. and the unit weighs 27 pounds.

### Wire Recorder (2)

R. C. POWELL & Co., Inc., 57 William St., New York 5, N. Y. First of five models employing the WiRecorder unit to go into production will be that illustrated, designed for general commercial use. The recorder utilizes a stainless steel wire, a mile and a half of which winds on a spool 2½ inches in diameter and ¾ inch thick, and will



record continuously for one hour. Recordings may be edited by cutting out the unwanted wire with scissors, and tying the ends with a square knot. The knot will pass through the machine without perceptible noise.

### Electric Servo Unit (3)

GLOBE INDUSTRIES, 125 Sunrise Place, Dayton, Ohio. The type D-6 servo is designed to operate on 24 volts d-c and delivers 100 inch-pounds at an input of less than 0.5 amp. At this load it operates at a minimum of 1 rpm. Stall torque of this unit is greater than 250 inch-pounds. The servo can absorb the shock of a four-pound weight dropped on the end of a two-inch torque arm from a height of five inches while the arm is horizontal, with the servo operating under a load of 100 inch-pounds. Each unit has a minimum life of 5,000 oscillations under a 100 inch-pound load, and is capable of operating under a temperature range of minus 65 to plus 160 degrees F. The equipment illustrated with a cover installed is completely watertight. The strength of the gears and torque arm is such that the motor can be stalled without stripping the gears or breaking the torque arm. Back lash in the gear train is less than plus or minus a half of a degree. The servo unit can be made to traverse any angle less than 180 degrees, plus or minus two degrees. An automatic centering mechanism is also provided that centers the torque arm within the limits of plus or minus one degree. Length of the servo is four inches and the diameter is three and one-fourth inches. It weighs 2.0 pounds.

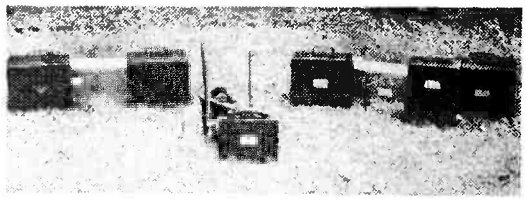
**USING THE NUMBERS**

Readers desiring further details concerning any item listed in the New Products department can obtain the information by using the cards furnished as a stiff, colored insert elsewhere in this department.

Place the number (appearing to the right of the heading) of one item in which you are interested in a circle and then fill out the balance of the card according to directions appearing on the colored sheet. Unnumbered items listed at the end should be procured direct from the manufacturer or publisher upon payment of the fee noted.

### Raydist (4)

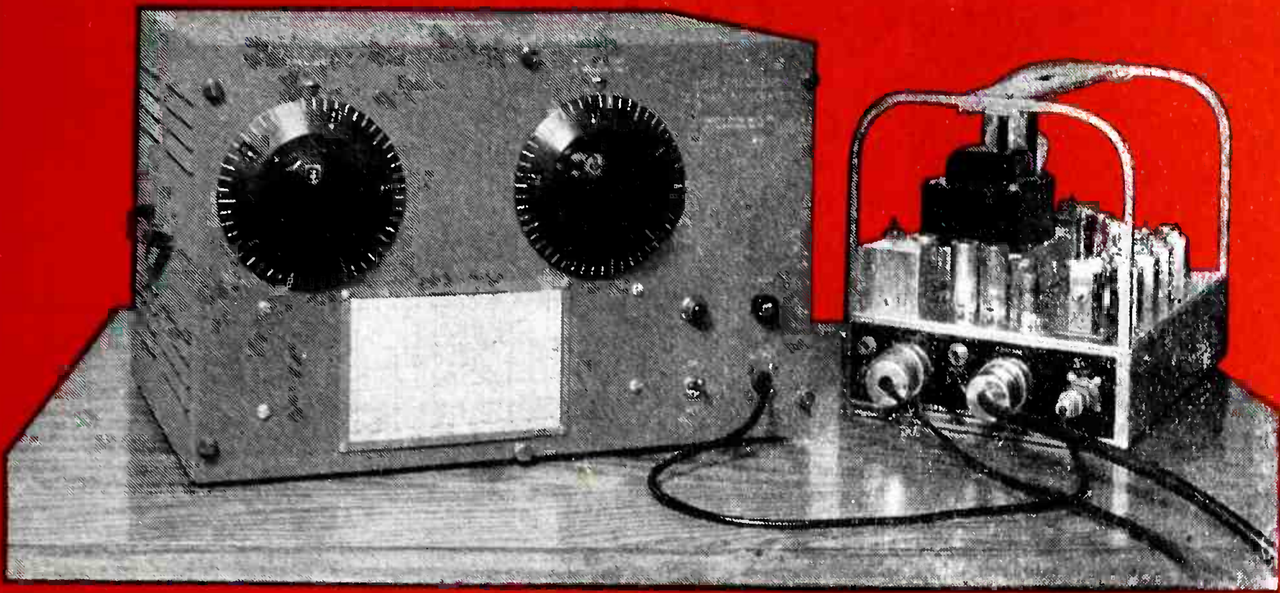
HASTINGS Instrument Co., Box 1275, Hampton, Va. Raydist is a radio system of unusual precision



for measuring distance and position, being capable of detecting a 1-inch movement of a small radio transmitter. It is also capable of measuring longer distances and is not limited to line-of-sight measurements. In the Raydist system, error results only from variations in frequency of a single transmitter and from radio propagation phenomena. By the use of a high-quality quartz-crystal-controlled transmitter, accuracy is limited only by the consistency of radio propagation. Bulletin R-19 describes the system in greater detail.

### Low-Cost Wire Recorder (5)

SEARS, ROEBUCK AND Co., 925 South Homan Ave., Chicago 7, Ill. An interesting radio and phonograph combination includes a wire re-



Model 196TS High Frequency Signal Generator being used to align a Harvey 152-162 Mc. Mobile Receiver.

# A New Signal Generator

140-170 Mc.

## With Electronically Controlled Constant Output

A VHF Signal Generator that gives you really constant output with extremely low leakage. Constant output makes it unnecessary to reset the carrier level each time the frequency or attenuator settings are changed. Use it for alignment, checking sensitivity, image response and taking band-pass curves of receivers. The Model 196TS signal generator is simple to operate, economical to own and accurate in performance.

CHARACTERISTICS

| | |
|---|---|
| Osc. Output: | Constant to 1/5 db over the frequency range. |
| Output Impedance: | 50 ohms. |
| Attenuation: | Piston type attenuator; linear, directly calibrated in db. |
| Range of Attenuation: | 0-114 db below .1 volt |
| Low Leakage: | Approx. .2 microvolts. |
| Frequency Calibration: | Each unit individually calibrated on attached chart. |

SIZE: 10¾″ x 10¾″ x 16½″

WEIGHT: 30 Lbs.

FINISH: Attractive gray crackle.

HARVEY OF CAMBRIDGE

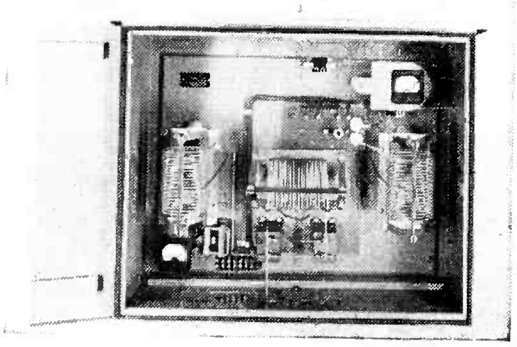
**HARVEY RADIO LABORATORIES, INC.**

**439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS**

corder that uses a large drum driven by the turntable as a takeup reel. Recordings are stored on a 3½ inch spool of stainless steel wire capable of holding an hour's program. Selling price of the combination is $169.50.

### Antenna Tuning Unit (6)

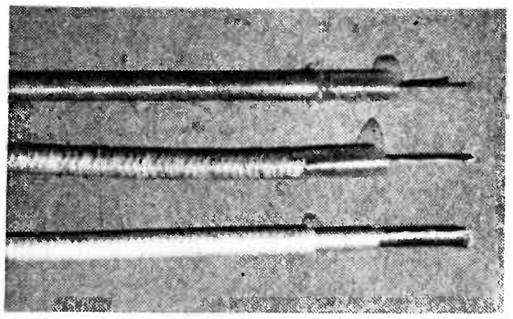
RAYTHEON MFG. CO., 60 East 42nd St., New York 17, N. Y. Two new antenna tuning units, the RT-1000, suitable for a-m broadcast stations of from 250 to 1,000 watts power, and the RT-5, which is suitable for a-m stations of from 5,000 to 10,000 watts power are similar in all respects except the power they can handle. They provide a convenient means for matching antennas of widely diverse characteristics to either concentric or open-wire transmission lines; in addition, they possess appreciable harmonic reduction properties. Both units are T type and are adaptable for use with directional antenna systems. The circuit consists primarily of a single T-section low pass filter network which can be adjusted for proper matching of the resistance of the antenna to the resistance of the transmission line. All components are housed in a weatherproof



cabinet. The antenna current meter may be read through a glass window in the front door without opening the door.

### High Temperature Wires (7)

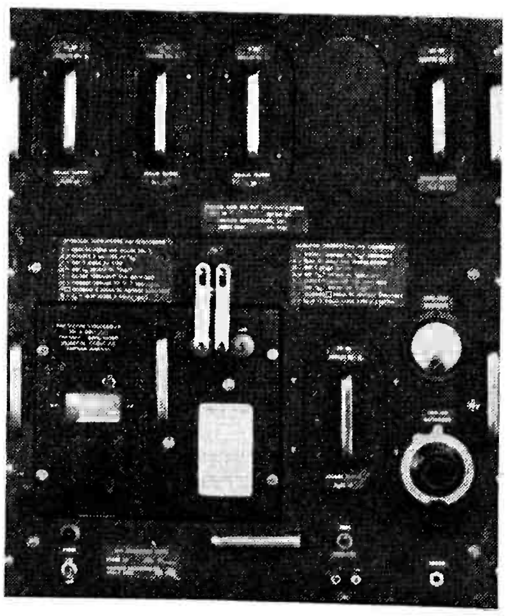
BOSTON INSULATED Wire and Cable Co., Uphams Corner Postal Station, Boston, Mass. A new line of Teflon-



insulated wire and cable developed for high-voltage use has improved flexibility, low loss, small diameter, and can be continuously subjected to temperatures as high as 150 to 300 C. Among other features of the new conductors are less tendency towards corona and no carbon tracking after a breakdown. Using the new insulation, a 50-ohm coaxial cable with a loss of 7 db a hundred feet at 100 mc has been constructed that is only an eighth of an inch in diameter. Of the aircraft cables illustrated, the two upper types are used for high tension or ignition at 250 and 150 C respectively. The lower cable is rated for 5,000 volts at 155 C.

### Inductance Meter (8)

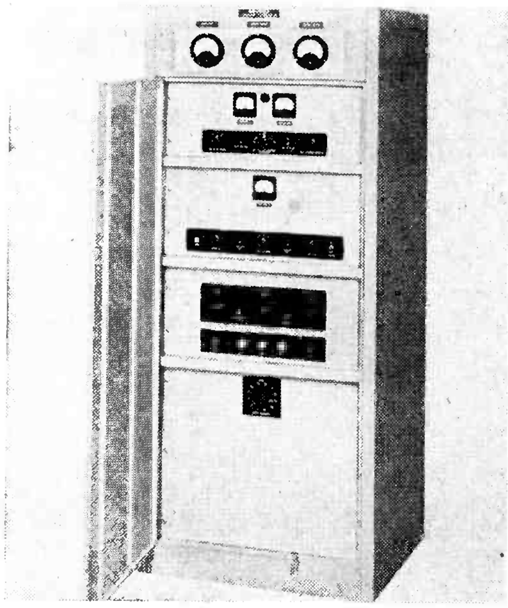
WHEELER LABORATORIES, Inc., 259-09 Northern Blvd., Great Neck, N. Y. The Model 10 r-f inductance



meter has been designed for use in the region between that served by the conventional 1,000-cycle bridge and the array of equipment usually employed at radio frequencies. In five decades it covers continuously the ranges of 1 microhenry to 100 millihenrys. The instrument can also be used for direct measurement of small capacitance up to 1,000 micromicrofarads, or for indirect measurement of larger capacitance. The equipment is rack mounted.

### Vibration Amplifier (9)

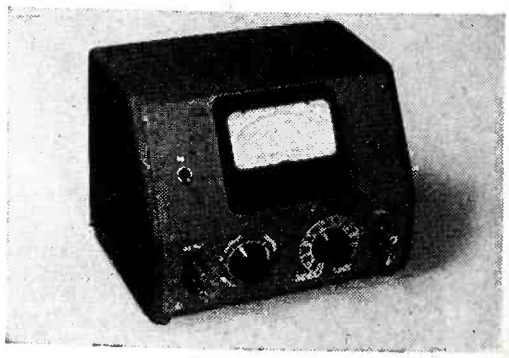
THORDARSON ELECTRIC MFG. DIV. of Maguire Industries, 936 N. Michi-



gan Ave., Chicago 11, Ill. A series of 1,000-watt audio amplifiers has been designed for vibration testing. Hum level has been held 48 db below full output. A final stage to deliver 2,500 watts is available for higher power vibrating equipment.

### Audio Voltmeter (10)

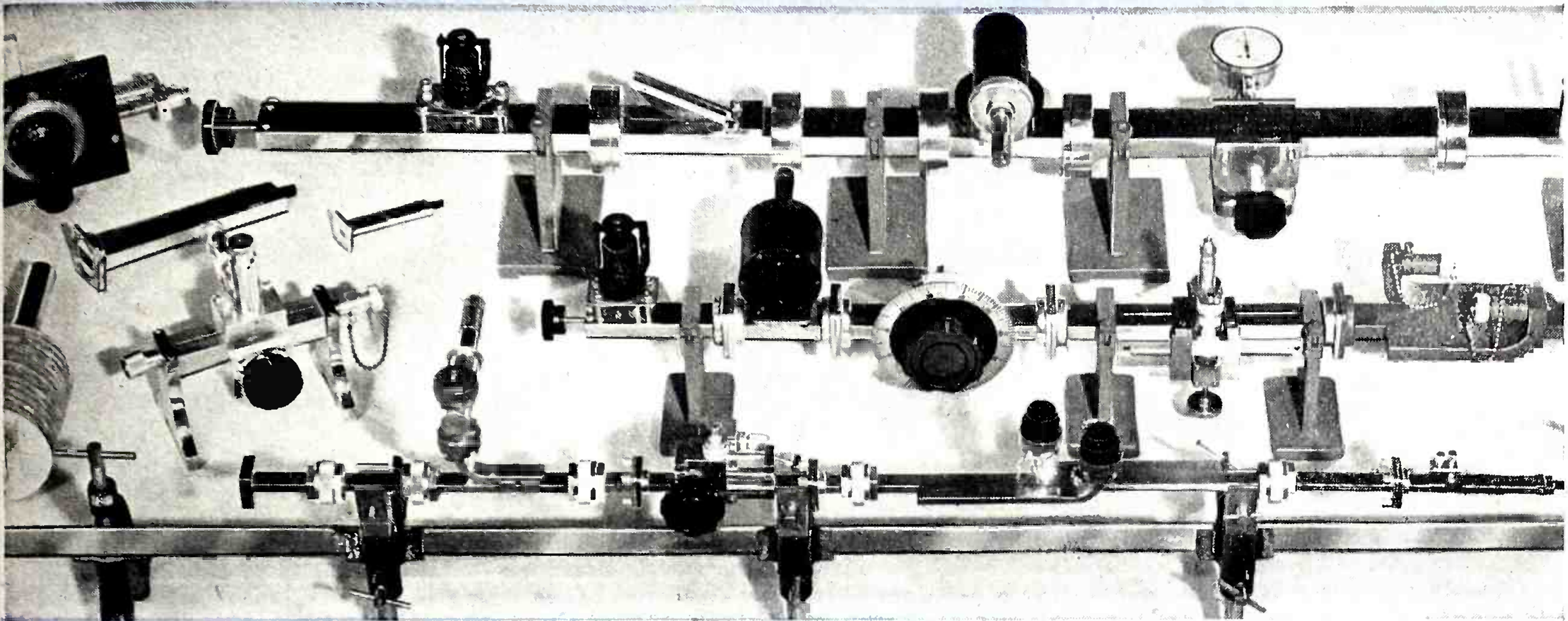
INSTRUMENT ELECTRONICS, 42-17A Douglaston Parkway, Douglaston, L. I., N. Y. The Model 47 audio



(continued on p 214)

# DE MORNAY • BUDD
# STANDARD TEST EQUIPMENT

## For Precision Measurements in the Microwave Field



The complete line of De Mornay·Budd standard test equipment covers the frequency range from 4,000 mcs. to 27,000 mcs. It provides all R. F. waveguide units necessary for delicate, precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

To eliminate guesswork, each item of this De Mornay·Budd test equipment is individually tested and, where necessary, calibrated, and each piece is tagged with its electrical characteristics. All test equipment is supplied with inner and outer surfaces gold plated unless otherwise specified.

**NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.**

**The three test set-ups illustrated above include:**

**Tube Mount**
**Flap Attenuator**
**Frequency Meter**
**Calibrated Attenuator**
**Tee**
**Stub Tuner**
**Tunable Dummy Load**
**Standing Wave Detector**
**Type "N" Standing Wave Detector**
**Directional Coupler**
**Hight Power Dummy Load**
**Cut-Off Attenuator**
**Stands, etc.**

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FOR
97% OF ALL
RADAR SETS

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# NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

**Abstract of FCC color television report; radar association formed; television conference program; dates of forthcoming meetings**

### Telecommunications Conferences

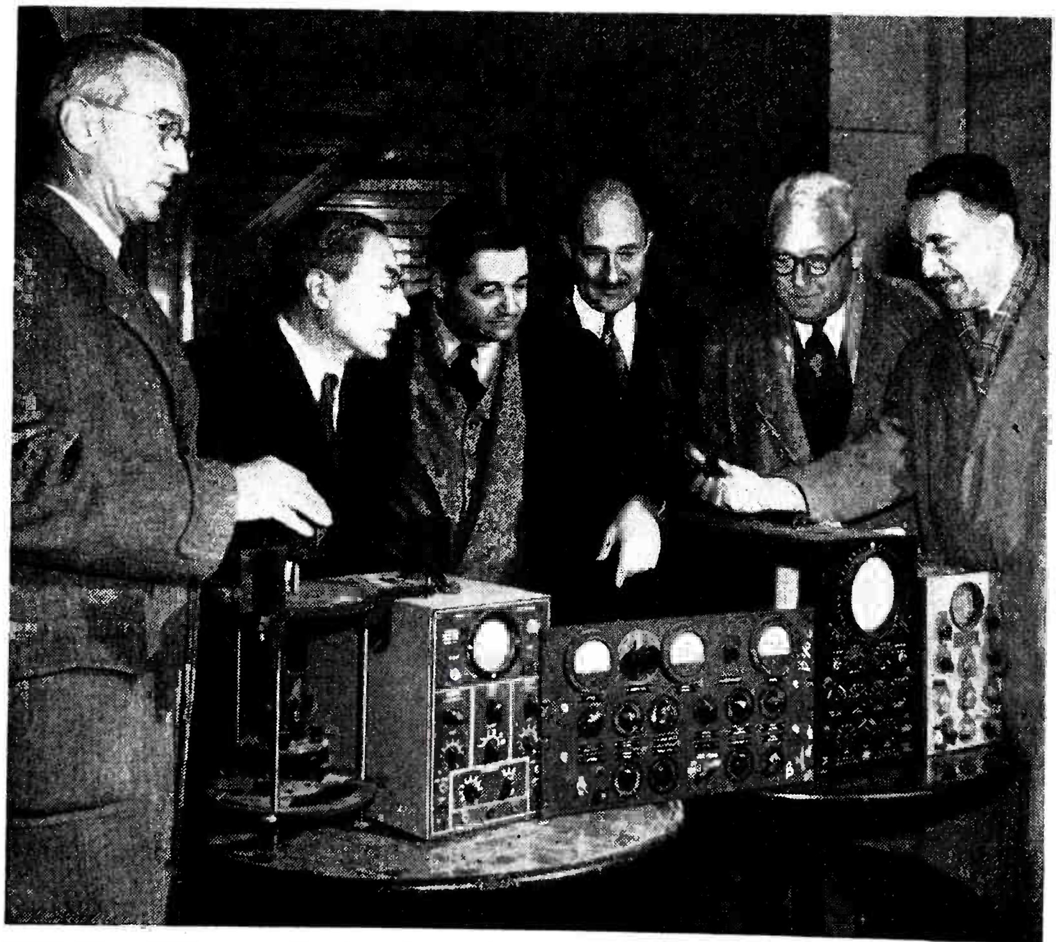
EXISTING international telecommunication agreements will be revised at three World Telecommunications Conferences to be held during the spring and summer in Atlantic City, New Jersey. The first of these conferences, the Radio Administrative Conference, will begin on May 15, 1947 and continue to about the end of June. This will be followed in succession by the Plenipotentiary Telecommunications Conference and the Short Wave Broadcasting Conference.

The International Telecommunications Union consists of a membership of approximately eighty countries which are party to the International Telecommunications Convention now in force (Madrid 1932). The convention and its appended agreements control the world-wide operation of telecommunications.

### Denmark Adopts DECCA

THE DANISH Government has decided to adopt the Decca Navigator system for provision of navigation aids around the coasts of Denmark. A contract reportedly has been let for construction of a chain of stations. The new system will be coordinated with the existing English chain.

### INSPECTION TOUR OF ATOMIC LABORATORY



Research equipment at the Brookhaven National Laboratory of Associated Universities, Brookhaven, N. Y. being inspected by members of the executive committee for this new government project dealing with atomic research. Left to right: Edward Reynolds of Harvard; Dr. I. I. Rabi of Columbia; Dr. J. B. Zacharias of M. I. T.; P. S. Macaulay of Johns Hopkins; G. A. Brakely of Princeton; Dr. Philip Morse, a director of the laboratory

### Radar Allocations

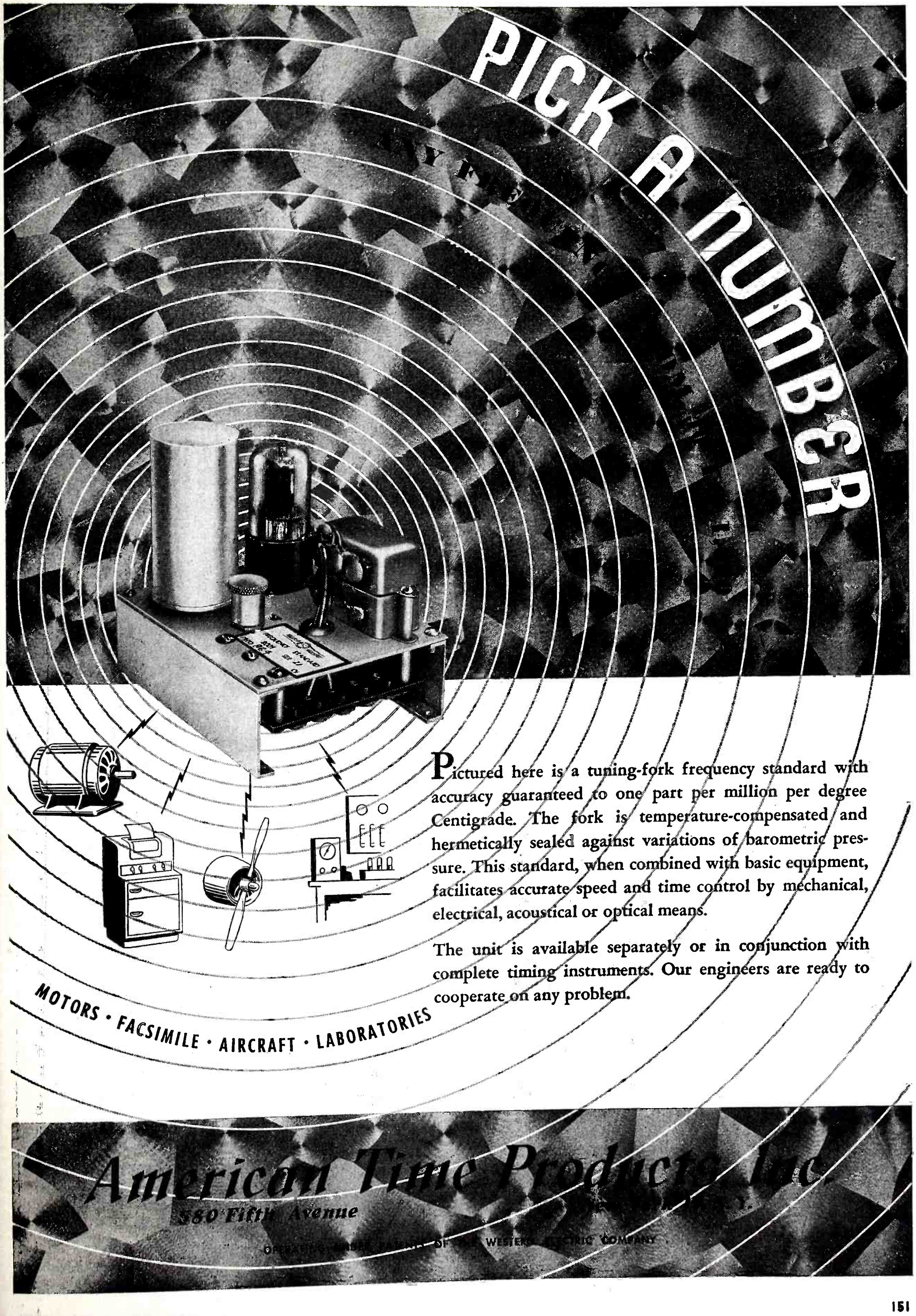
Three frequency bands, namely, 3,000-3,246 mc, 9,320-9,500 mc, and 5,460-5,650 mc (together with the associated racon bands 3,246-3,266 mc, 9,300-9,320 mc, and 5,440-5,460 mc) have been allocated by the FCC for shipboard radar. Commercial type merchant marine radar equipment is available in the first two bands and many experimental licenses have already been issued for its use.

Proponents of radar in the 3,000-3,246 mc band claim a superior ability to distinguish targets in all kinds of weather. Advocates of radar in the 9,320-9,500 mc band claim a superior definition and increased dependability for navigating through narrow channels. Equipment for the third band is not yet generally available; the Commission allocated this band, in addition to the other two, to provide an opportunity to determine whether it might combine the advantages claimed for the other two bands.

At the present time, licenses for radar are issued on an experimental basis and for a term of one year, but five-year licenses will be issued on a regular basis for operation of acceptable shipboard radar as soon as rules and regulations can be prepared and promulgated by the Commission.

### FCC Denies CBS Petition for Sequential Color Television

IN A DETAILED 14-page report adopted March 18, 1947, the Federal Communications Commission denied the petition of Columbia Broadcasting System, filed on Sept. 27, 1946, requesting authorization to operate commercial color television stations in the frequency band 480 to 920 mc. At the same time, the Commission commended CBS, Dr. Peter C. Goldmark, and those


PICK A NUMBER
Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.
The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.
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American Time Products, Inc
580 Fifth Avenue
OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

who worked under him for the great strides they have made in the field of color television in so short a period. Excerpts from the report follow.

*CBS Sequential System*

"The color television system proposed by Columbia provides for channels 16 mc wide, with color transmitted sequentially. Under the proposed sequential system each picture is scanned through separate color filters—red, green, and blue, in turn. These transmissions in the separate colors follow each other at the rate of 48 times per second. These three color transmissions are accepted by the receiver by means of a color wheel containing filters of red, green, and blue, which rotates in front of the television screen in synchronism with a similar color wheel at the transmitter. When the images of the three colors are so received, the eye is enabled to see the picture in full color.

*Importance of Setting Standards*

"Before permitting a new television service to become established on a regular basis, a decision must first be made on fundamental standards. Otherwise, manufacturers of receivers could not start to build receivers, and the public could not purchase receivers with any confidence that they would be able to receive programs from all television stations, or that their receivers would not become useless immediately after they were purchased if the existing stations should change any of the fundamental standards. Under these conditions, it is entirely unlikely that television receivers would be bought on any mass basis.

"The justification for allocating so much of the radio spectrum to television broadcasting—78 mc for channels 1-13 and 440 mc for experimental television—is that television is an important medium for bringing news, education, culture, and entertainment to large segments of the population. With the great demand for frequencies on the part of the other radio services which cannot be met in full, the Commission would not feel justified in allocating so many frequencies to television at the expense of the other radio services, if it were inevitably destined to be limited to small audiences.

"Before approving proposed standards, the Commission must be satisfied not only that the system proposed will work, but also that the system is as good as can be expected within any reasonable time in the foreseeable future. In addition, the system should be capable of permitting incorporation of better performance characteristics without requiring a change in fundamental standards. Otherwise, the danger exists that the standards will be set before fundamental developments have been made, with the result that the public would be saddled with an inferior service, if the new changes were not adopted, or if they were adopted, receivers already in the hands of the public would be rendered useless.

*Two Grounds for CBS Denial*

"Judged by the foregoing test, the Commission is of the view that the standards for color television proposed by Columbia Broadcasting System should not be adopted. In the Commission's opinion the evidence does not show that they represent the optimum performance which may be expected of a color television system within a reasonable time. The Commission bases this conclusion on two grounds. In the first place, the Commission believes that there has not been adequate field testing of the system for the Commission to be able to proceed with confidence that the system will work adequately in practice. Secondly, the Commission is of the opinion that there may be other systems of transmitting color which offer the possibility of cheaper receivers and narrower bandwidths that have not been fully explored up to the present time.

*Importance of Field Testing*

"Before approving a new system of television, it is indispensable that there be an adequate program of field testing. Receivers and transmitters must be subjected to numerous tests over a long period of time and at a diversified set of locations and operating conditions so that operation under average home conditions is closely approximated. Without such field testing, there is no assurance that all fundamental defects have been eliminated. . . . The record in this case discloses that while Columbia has done an extensive amount of testing of its system,

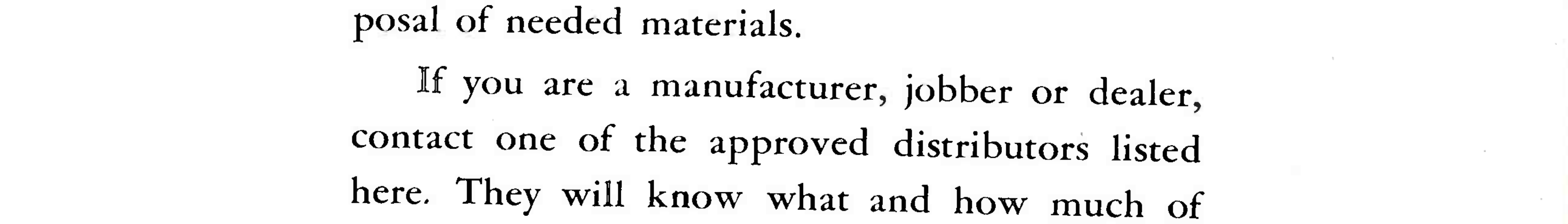
(continued on p 261)

## FCC MEMBERS INSPECT TELEVISION FACTORY

**RCA's production line for table model television sets is looked over with interest by FCC Commissioners in Camden. Left to right: Commissioner Paul A. Walker, Chairman Charles R. Denny, RCA Victor vice-presidents W. W. Watts and J. B. Elliott, and Commissioners Ewell K. Jett, Ray C. Wakefield, and Rosel H. Hyde**


War Surplus electronic tubes, devices and equipment declared surplus by the armed forces are available for purchase through "Approved Distributors". The War Assets Administration put this plan in operation to expedite the disposal of needed materials.

If you are a manufacturer, jobber or dealer, contact one of the approved distributors listed here. They will know what and how much of this property is available for immediate delivery. This is your opportunity to obtain needed equipment at a considerably reduced cost.



**TUBES AT WORK**
(continued from p 140)

and motion studies, quality control, and monitoring of dangerous processing operations, the system offers advantages to schools and colleges.

## Automatic Control of Battery Charging

By E. L. DEETER and A. C. PLAUTZ

*Naval Ordnance Laboratory*
*Washington, D. C.*
*Douglas Aircraft Company, Inc.*
*Santa Monica, California*

TO OPERATE special electronic equipment designed for a-c line use it was necessary to convert the d-c available on a ship. Furthermore, it was imperative that storage batteries be utilized as an emergency source in case the ship's power supply failed. The automatic electronic control system herein described was

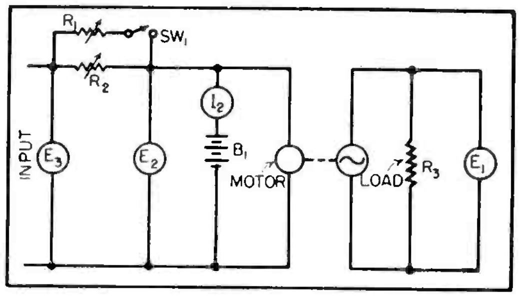


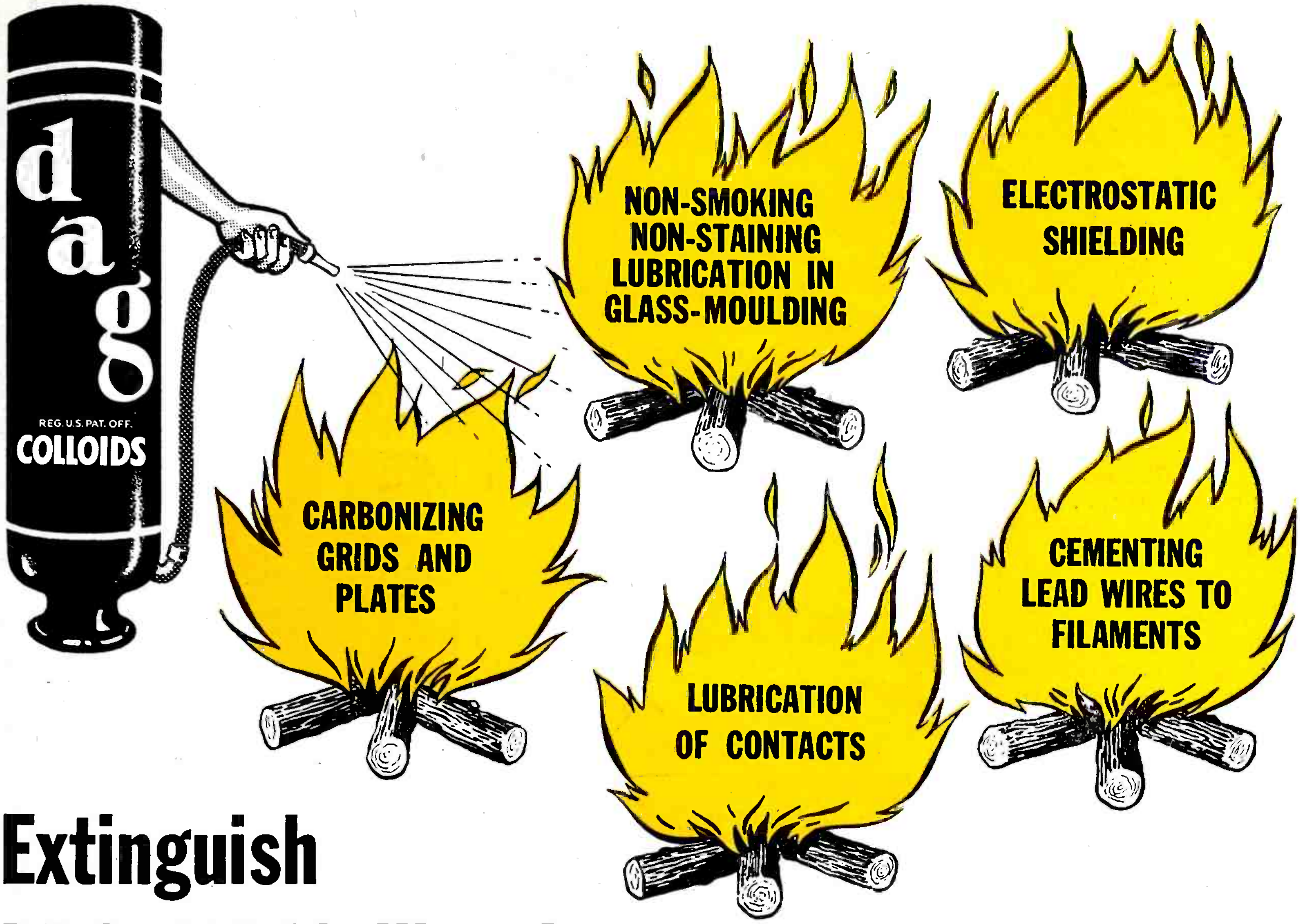

FIG. 1—Basic charging circuit in which a manually operated switch is used for illustration

developed to insure a constant d-c supply for the rotary converters.

In the basic circuit of Fig. 1, the rotary converter, supplying a-c to a fixed load, is connected on the d-c side to a power source having an emf considerably higher than that required to operate the converter properly. A series resistor, $R_2$, is varied to adjust the current and voltage. The emergency battery $B_1$ is connected across the converter input and will draw current when its voltage drops to a value below that of $E_2$. Connected in this manner, the battery affords an excellent filter for line voltage variations that are inherent in most d-c distribution systems.

Let us assume that the storage battery $B_1$ has been properly charged, and in this instance shows an emf of 36 volts. If the resistance of $R_2$ is slowly decreased, the discharge current $I_2$ of the battery will likewise decrease as the voltage across $E_2$ increases. When $E_2$ becomes 36 volts, no current will flow in or out of the battery, and it will float on the line.

However, this condition is not

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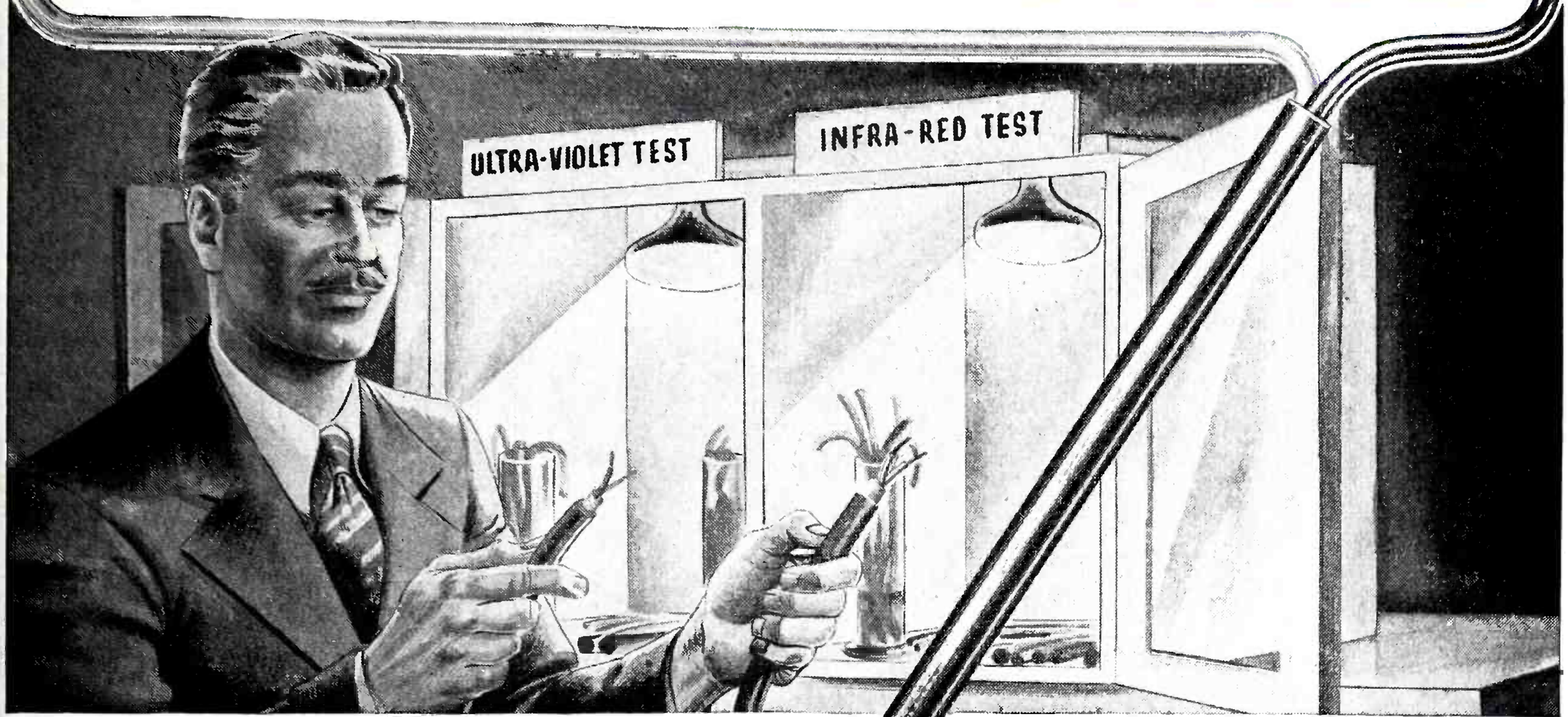
# *Compare* other plastic or rubber insulated wire and cable with PLASTICON




ARE you familiar with the advantages of plastic — the properties that make it superior for practically any insulating application?

Did you know that most leading wire manufacturers now utilize thermoplastic in ever-increasing degree?

Do you know that Plastic Wire & Cable Corporation is the world's largest exclusive manufacturer of plastic-insulated wire and cable products ... that it manufactures the greater percentage of the total output?

DO you know why PLASTICON, product of Plastic Wire & Cable Corporation, offers you more by any standard of comparison?

Write for our useful technical bulletin crammed with facts and figures which offers you extensive information on PLASTICON. Better still, write us describing your requirements, and our engineers will gladly explain how PLASTICON products can fill them. Plastic Wire & Cable Corporation, 408 East Main Street, Jewett City, Connecticut.

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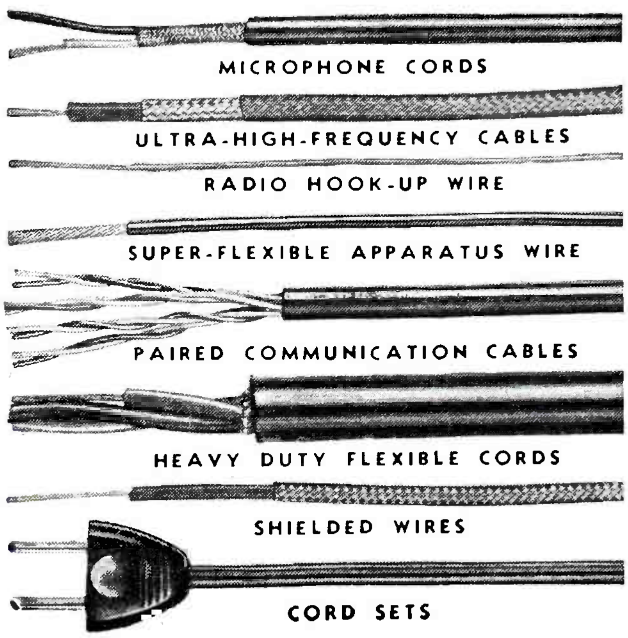
2. *Cannot fray, crack or rot.*
3. *Low moisture absorption.*
4. *Greater mechanical strength.*
5. *Higher abrasion resistance.*
6. *Flexibility at all temperatures.*
7. *High chemical resistance.*
8. *Wide range of permanent gem-like colors.*
9. *Non-combustible.*
10. *Lasting appearance.*



easily maintained and is not desirable with this control system. The resistor $R_2$ is increased, or set to a value that allows a slight discharge of the battery. If, after the battery voltage has decreased to 35 volts, the switch $SW_1$ is closed, the battery will start its charging cycle, provided the resistor $R_1$ is of the proper value to raise the voltage across the battery. By proper choice of the resistors, and with a constant converter load, the times of the charge and discharge cycle may be made equal.

*Thyratron Circuit*

The function of the electronic control circuit is to operate $SW_1$, at the proper time intervals. The method by which this is accom-

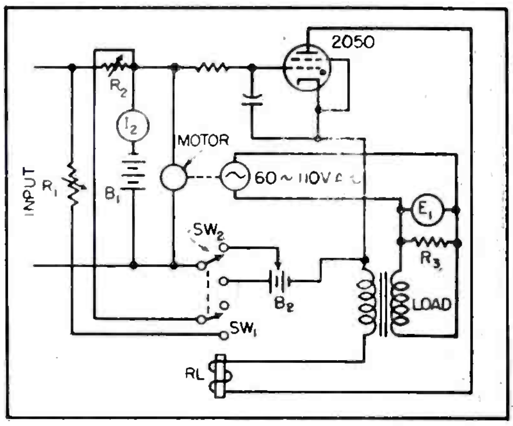


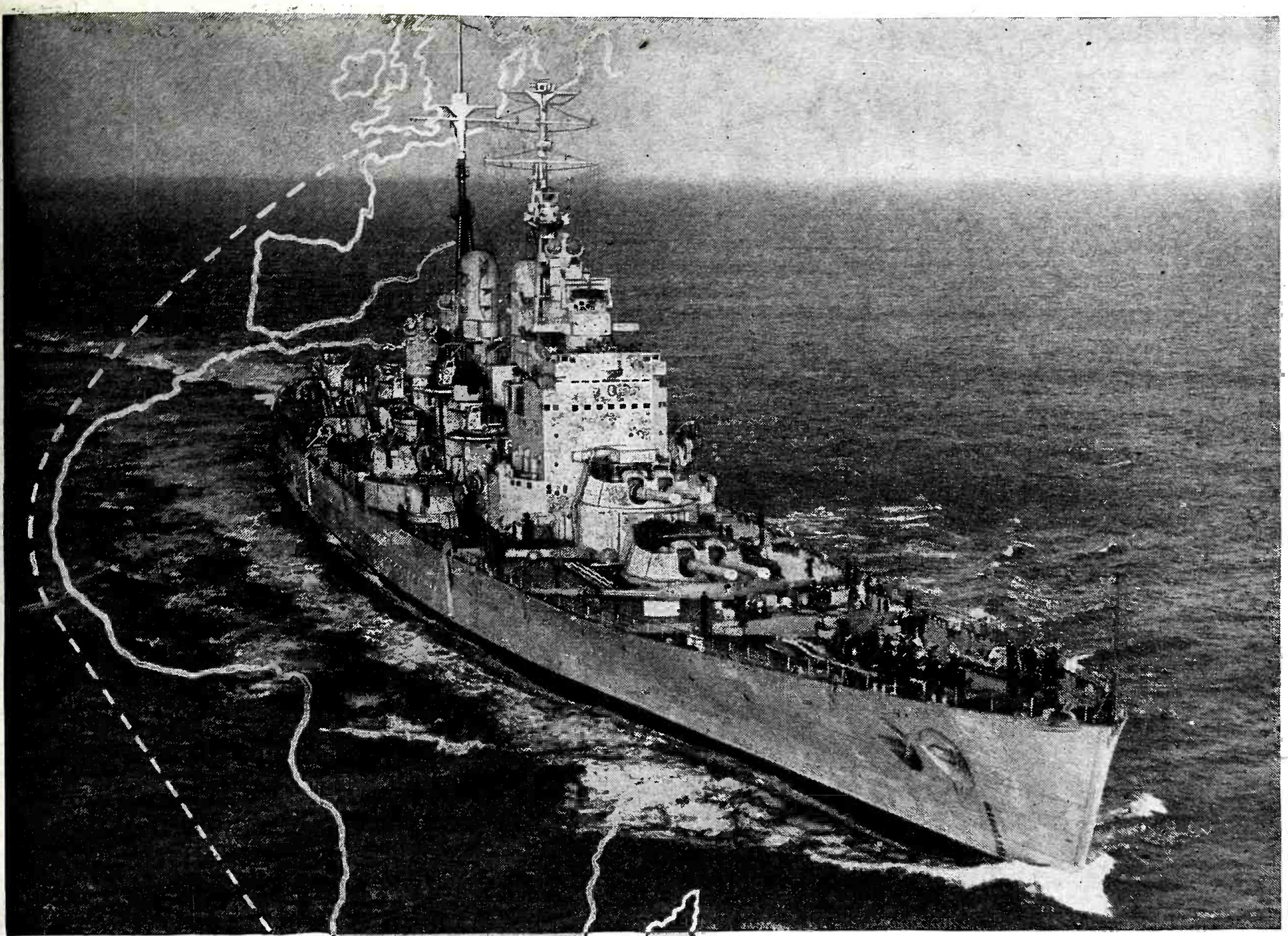

FIG. 2—Electronic charging control circuit with battery $B_2$ supplying a reference voltage

plished may best be explained by reference to Fig. 2. In this schematic a battery $B_2$ is placed in series with, and its polarity opposing battery $B_1$.

The bias voltage on the 2050 gas tube will be the algebraic sum of the two battery potentials. Suppose the storage battery $B_1$ has been slightly discharged and has an emf of 35 volts. If the $B_2$ source is 33 volts, the gas tube will be biased to two volts negative and will not allow the tube to ionize on the positive peaks of the plate supply.

A further slight decrease in the emf of $B_1$ causes the bias to become less negative and the gas tube ignites to close the relay *RL* when the critical bias condition is reached.

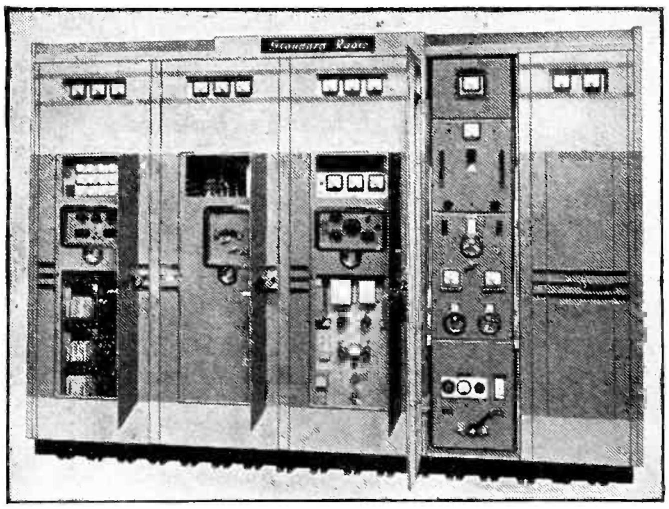
Closing of relay *RL* places the resistance of $R_1$ in parallel with the $R_2$ resistance and initiates the charging cycle. It is also responsible for another change vital to the operation of the control circuit. The transfer switch $SW_2$ places a higher potential in series with the battery



The major problem in establishing communication facilities for the Royal Party during their voyage to South Africa was the provision of a radio transmitter so compact as to be accommodated with ease between decks, yet capable of giving connection with any telephone extension in Great Britain and South Africa and of transmitting programmes to be re-transmitted by the B.B.C. and South African Broadcasting stations.

To meet these requirements a *Standard Radio* D.S.10 Transmitter was installed in H.M.S. Vanguard.

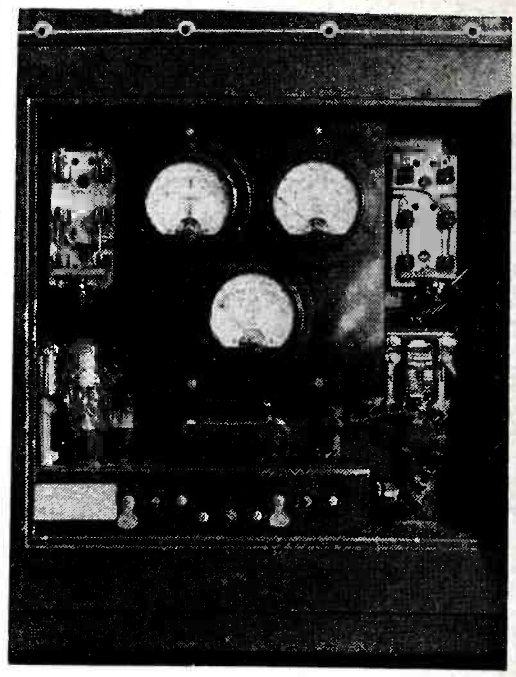
The results obtained on radio telephony, radio transmission of pictures and automatic telegraphy over long distances during the tour will be examined with keen interest by all concerned and may lead to the adoption in other warships of the facilities available in Vanguard.



*Standard Radio* Type D.S.10 5 kW Transmitter—first of its kind to use air-blast cooling of valves. It has a frequency range of 2.5 to 25 Mc/s and operates on up to three C.W. channels with independent keying ; or on two C.W. channels with common keying or one C.W. and one PHONE channel with simultaneous transmission on two different frequencies. The equipment is remarkably compact and is designed for tropical conditions.

# Standard Radio

**Standard Telephones and Cables Limited** · Radio Division · OAKLEIGH ROAD · NEW SOUTHGATE · LONDON · ENGLAND



A constant d-c supply to a rotary converter from the unit above provides a stable a-c voltage for critical equipment

$B_1$, lowering the bias on the tube to a lower negative value than that causing the transfer. This incremental decrease determines the amount of charge (and emf increase) necessary to interrupt the charging cycle.

Using a battery as shown by $B_2$ in Fig. 2, the battery voltage of $B_1$ would vary $1\frac{1}{2}$ volts between cycles, as the smallest increment usable would be $1\frac{1}{2}$ volts. In the circuit of Fig. 3, this increment may be adjusted to any desirable value over a considerable range. Circuit resistances and associated voltage drops limit the minimum practical increment to about a half volt when the total battery is of the order of 36 volts.

In Fig. 3, a regulated d-c supply is substituted for battery $B_2$ of Fig. 2. Controls $P_1$ and $P_2$ of the regulated supply make it possible to adjust the starting and stopping point of the charge and discharge cycle.

The control unit operates from the a-c output of the converter, as-

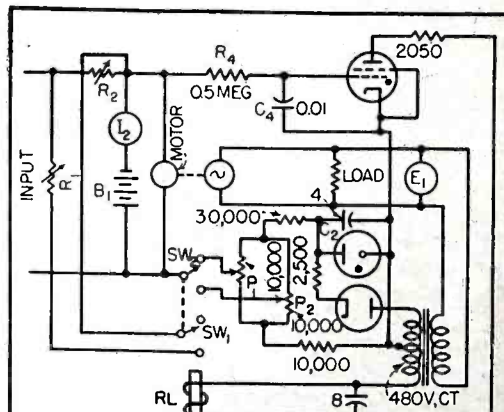



FIG. 3—Stabilized voltage source replaces the reference battery in the final circuit

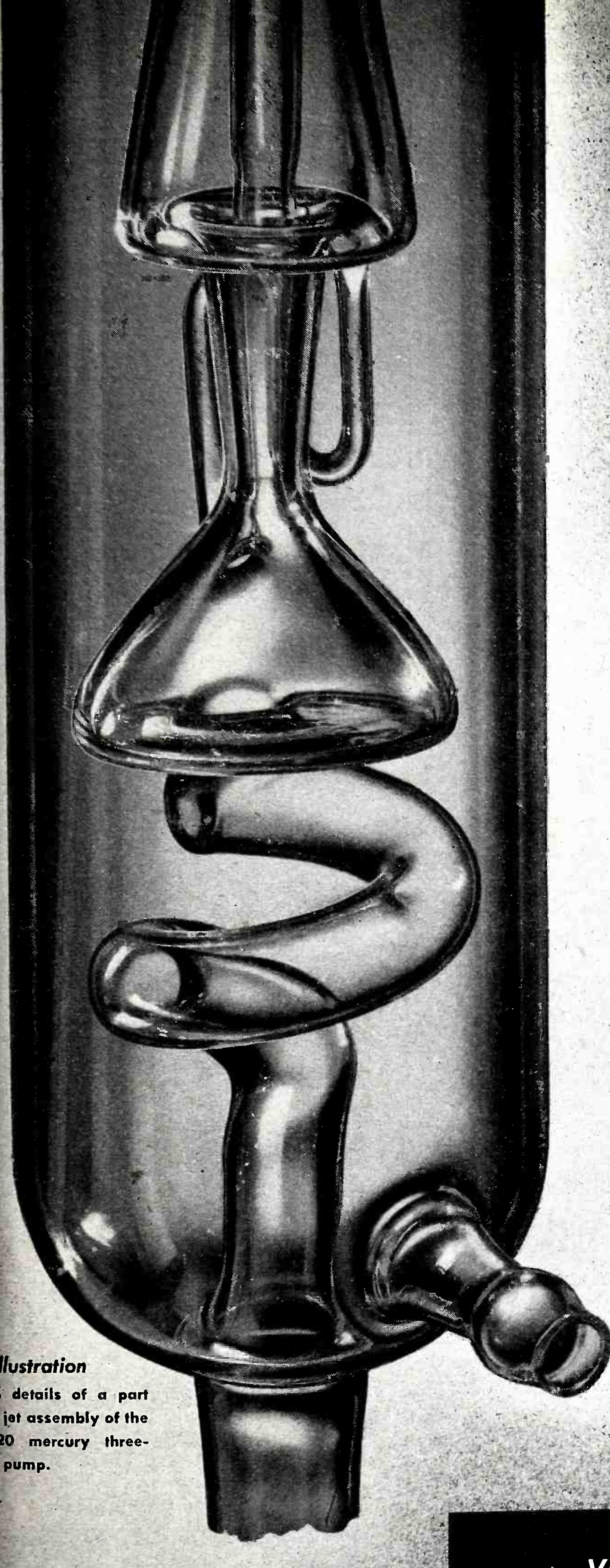


illustration
ws details of a part
he jet assembly of the
G-20 mercury three-
ge pump.

# To speed High Vacuum Research

***DPI Glass Vacuum Pumps*** equip the laboratory with essential tools for electronic development and many other physical and chemical studies. Fabricated with meticulous care in our own glass shop, the standard models meet all normal requirements. The ultimate vacuums obtained range from $1 \times 10^{-5}$ to $5 \times 10^{-8}$ mm of mercury. These pressures are achieved without the aid of cold traps. The principal models are as follows:

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*Type GF-20*—A two-stage pump embodying the fractionating, self-conditioning principle; air- or water-cooled; the most versatile model for general laboratory use.

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*Type GF-5A*—A miniature two-stage pump, similar to Model GF-20, but much smaller in size and with slower pumping speed; recommended for installations where space is a factor.

*Type GHG-20*—A glass mercury pump (illustrated) which will operate against a forepressure at 10 mm; for special applications such as gas analysis, mass spectrometers, and exhaust of rectifier tubes.

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*Vacuum Equipment Division*

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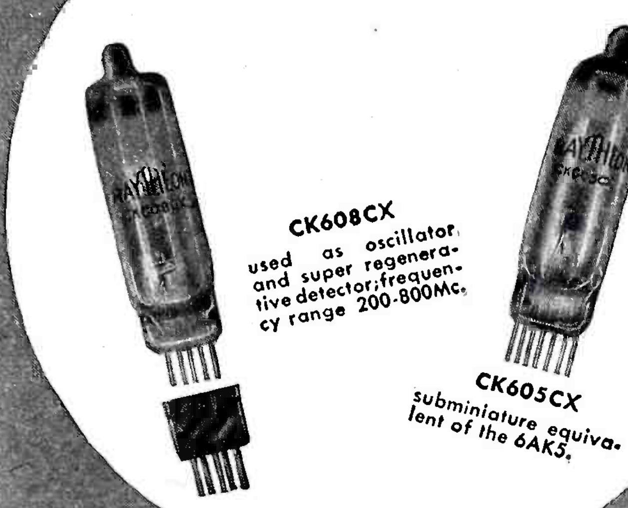
**Rochester 13, New York**

# 2 NEW RAYTHEON SUBMINIATURES

Look over these two new members of the famous RAYTHEON subminiature line. Note in the table below their special characteristics. And remember:

Since 1939 Raytheon has produced some *four million* subminiature tubes for commercial applications. There are more Raytheon subminiatures in use throughout the world than *all other makes combined.*

Remember, too, that all Raytheon subminiatures can be either soldered in, or plugged into commercially available sockets.




**Write for Data Sheet on Tubes Listed**

## Characteristics of RAYTHEON Subminiature Tubes

| Type No. | Remarks | Bulb Size Inches | Heater Volts | Heater MA | Mutual Conductance Umhos | Power Output MW | Voltage Gain X | Typical Operating Conditions: Plate Volts | Plate Current MA | Screen Volts | Screen Current MA | Grid Volts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HEATER CATHODE TYPES** | | | | | | | | | | | | |
| CK605CX | Characteristics of 6AK5 | 0.38 | 6.3 | 200 | 5000 | | | 120 | 7.5 | 120 | 2.5 | -2 |
| CK606BX | Diode, equivalent to one-half 6AL5 | 0.28 | 6.3 | 150 | | | | 150 ac | 9.0 dc | | | |
| CK608CX | Triode UHF Oscillator, ¾ watts at 500 Mc | 0.38 | 6.3 | 200 | 5000 | | | 120 | 9.0 | | | -2 |
| CK619CX | Triode High mu. | 0.38 | 6.3 | 200 | 4000 | | | 250 | 4.0 | | | -2 |
| **FILAMENT TYPES** | | | | | | | | | | | | |
| 2E31 | RF Pentode for pocket radio | 0.28 | 1.25 | 50 | 500 | | | 22.5 | 0.4 | 22.5 | 0.3 | 0 |
| 2E35 | Output Pentode for pocket radio | 0.28 | 1.25 | 30 | 385 | 1.2 | | 22.5 | 0.27 | 22.5 | 0.07 | 0 |
| 2E41 | Diode Pentode for pocket radio | 0.28 | 1.25 | 30 | 375 | | 20 | 22.5 | 0.35 | 22.5 | 0.12 | 0 |
| 2G21 | Triode Heptode for pocket radio | 0.28 | 1.25 | 50 | 75 conv. cond. | | | 22.5 | 0.20 | 22.5 | 0.30 | |
| RK61 | Gas Triode, Radio Control for model planes, etc. | 0.52 | 1.4 | 50 | | | | 45 | 1.5 | special circuit | | |
| CK502AX | Output Pentode | 0.28 | 1.25 | 30 | 550 | 6.0 | | 45 | 0.6 | 45 | 0.15 | -1.25 |
| CK503AX | Output Pentode | 0.28 | 1.25 | 30 | 550 | 9.5 | | 45 | 0.8 | 45 | 0.25 | -2.0 |
| CK505AX | Volt. Amp. Pent. | 0.28 | 0.625 | 30 | 180 | | 30 | 22.5 | .125 | 22.5 | 0.04 | 0 |
| CK506AX | Output Pentode | 0.28 | 1.25 | 50 | 500 | 25 | | 45 | 1.25 | 45 | 0.4 | -4.5 |
| CK507AX | Output Pentode | 0.28 | 1.25 | 45 | 575 | 11 | | 45 | 0.9 | 45 | 0.3 | -2.0 |
| CK510AX | Double Space Charge Tetrode Amplifier | 0.28 | 0.625 | 50 | 65 ea. unit | | 150 both units | 45 | 0.06 | | | 0 |
| CK512AX | Low microphonic voltage amplifier | 0.28 | 0.625 | 20 | 160 | | 28 | 22.5 | 0.125 | 22.5 | 0.04 | 0 |
| CK520AX | Output Pentode ⅝ volt filament | 0.28 | 0.625 | 50 | 180 | 4.5 | | 45 | 0.24 | 45 | 0.07 | -2.5 |
| CK521AX | Output Pentode 1 mw out at 10 volts | 0.28 | 1.25 | 50 | 400 | 6.0 | | 22.5 | 0.80 | 22.5 | 0.22 | -3.0 |
| CK522AX | Output Pentode 20 ma filament | 0.28 | 1.25 | 20 | 450 | 1.2 | | 22.5 | 0.30 | 22.5 | 0.08 | 0 |
| CK551AXA | Diode-Pentode | 0.28 | 1.25 | 30 | 235 | | | 22.5 | 0.17 | 22.5 | 0.04 | 0 |
| CK553AXA | RF Pentode | 0.28 | 1.25 | 50 | 550 | | | 22.5 | 0.42 | 22.5 | 0.13 | 0 |
| CK556AX | Triode, UHF Oscillator for radio use | 0.28 | 1.25 | 125 | 1600 | | | 135 | 4.0 | | | -5.0 |
| CK568AX | Triode, UHF Oscillator for radio use | 0.28 | 1.25 | 70 | 650 | | | 135 | 1.9 | | | -6.0 |
| CK569AX | RF Pentode | 0.28 | 1.25 | 50 | 1100 | | | 67.5 | 1.8 | 67.5 | 0.48 | 0 |
| CK570AX | Electrometer Triode Max. grid current $5 \times 10^{-13}$ amps. | 0.28 | 0.625 | 20 | 125 | | 1.5 | 12 | 0.22 | | | -3 |

*All Tubes Listed Are Available Without Priorities Or Government Clearance*

RAYTHEON

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**RAYTHEON MANUFACTURING COMPANY**

*Special Tube Section, 55 Chapel Street, Newton 58, Massachusetts*

RADIO RECEIVING TUBES • SPECIAL PURPOSE TUBES • TRANSMITTING TUBES suring constant filament voltage for the tubes.

A small time constant at the control grid of the 2050 tube is introduced by means of $R_4$ and $C_4$. The capacitor $C_2$ is essential in preventing chatter of the relay when the cycling increment is less than one volt.

## Mercury Memory Tanks in New EDVAC Computer

A NEW electronic supercalculator to be known as the EDVAC (electronic discrete variable computer) is being constructed in the Moore School of Electrical Engineering at the University of Pennsylvania by members of the

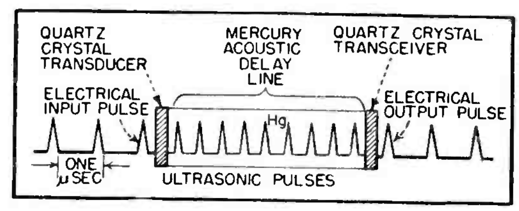



**Diagram illustrating action of mercury memory storage tank unit used in EDVAC electronic computer now under construction at University of Pennsylvania**

school's research staff, with T. Kite Sharpless as technical director of the research group. When the entire machine is completed it will be sent to the Ballistic Research Laboratory at Aberdeen Proving Ground.

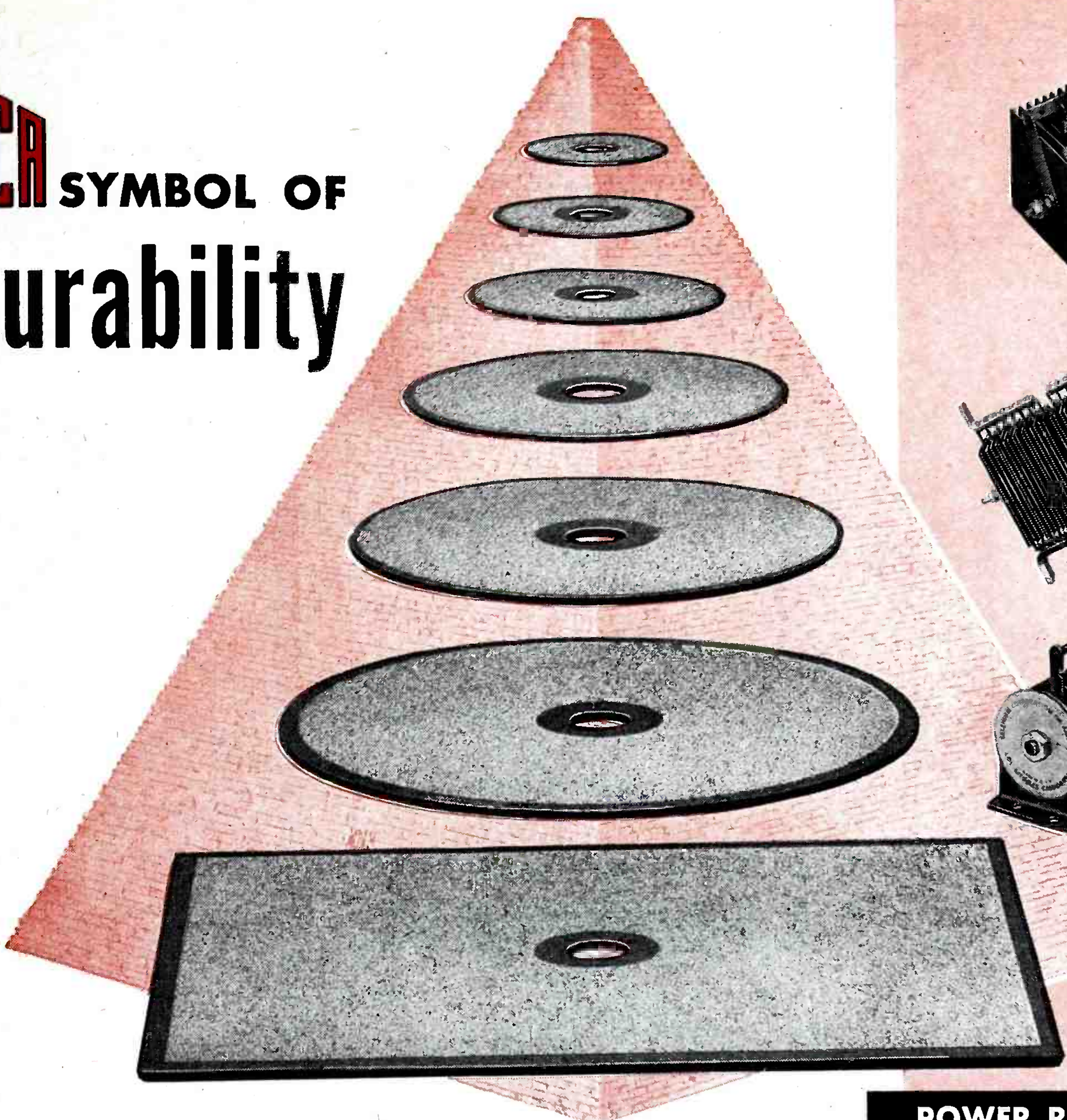
A feature of the new machine is a mercury-tank memory unit capable of storing up to eight 10-digit numbers and referring to any one of them in an average time of one five-thousandth of a second. The numbers are in the form of groups of 32 electrical impulses, spaced one-millionth of a second apart. They are trapped in a mercury tank, where they circulate until called for during the solution of a problem. Enough units will be used to give the apparatus a memory capacity of 1,000 numbers.

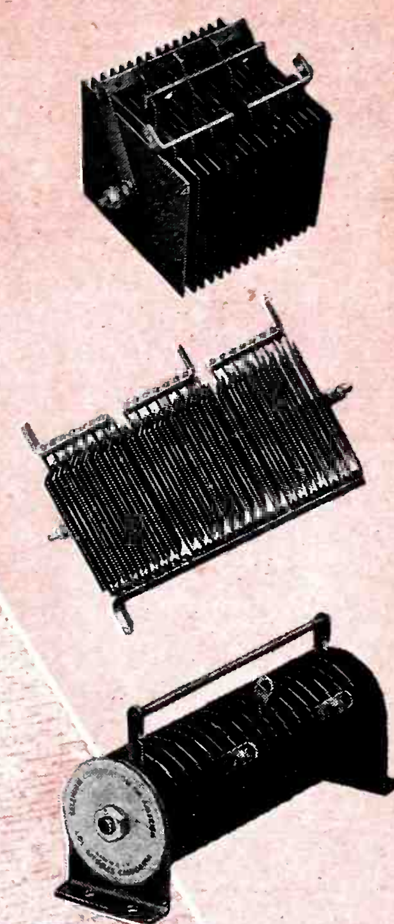
In the ENIAC, constructed during the war at the University of Pennsylvania and recently moved to Aberdeen Proving Ground, numbers were stored by chains of thousands of electronic tubes occupying a great deal of space. Comparatively little space, however, is required for the mercury-pool memorizing units in the EDVAC.

A new electronic multiplier in the

SCA SYMBOL OF

# durability





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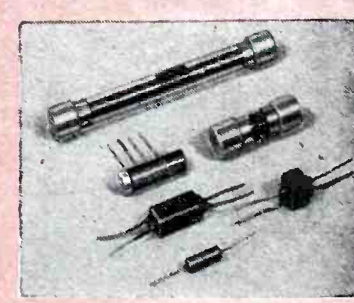
SCA Selenium Pyramid reflects all the durability of the ancient Egyptian pyramids. Selenium Rectifiers are ENGINEERED FOR ENGINEERS. Improved performance at lower costs through ENGINEERED adaptability. Selenium Corporation of America meets exacting specifications of modern electronic developments. Manufacturers of a broad line of Selenium Power and Instrument Rectifiers, Self generating Photo-Electric Cells and allied scientific products.

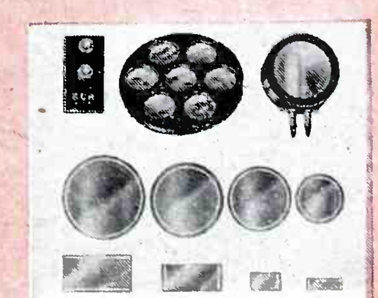
Selenium Rectifiers are rapidly becoming standard in industry for all rectifier applications. Selenium Corporation of America's engineering experience can be called upon for the development and production of special rectifiers for any application.

## CHECK THESE OUTSTANDING FEATURES

- ✔ Permanent characteristics
- ✔ Adaptability to all types of circuits and loads
- ✔ Unlimited life—no moving parts
- ✔ Immunity to atmospheric changes
- ✔ High efficiency per unit weight
- ✔ From 1 volt to 50,000 volts rms.
- ✔ From 10 micro-amperes to 10,000 amperes
- ✔ Economical — simple to install — no maintenance cost
- ✔ Hermetically sealed units available



**INSTRUMENT RECTIFIERS**



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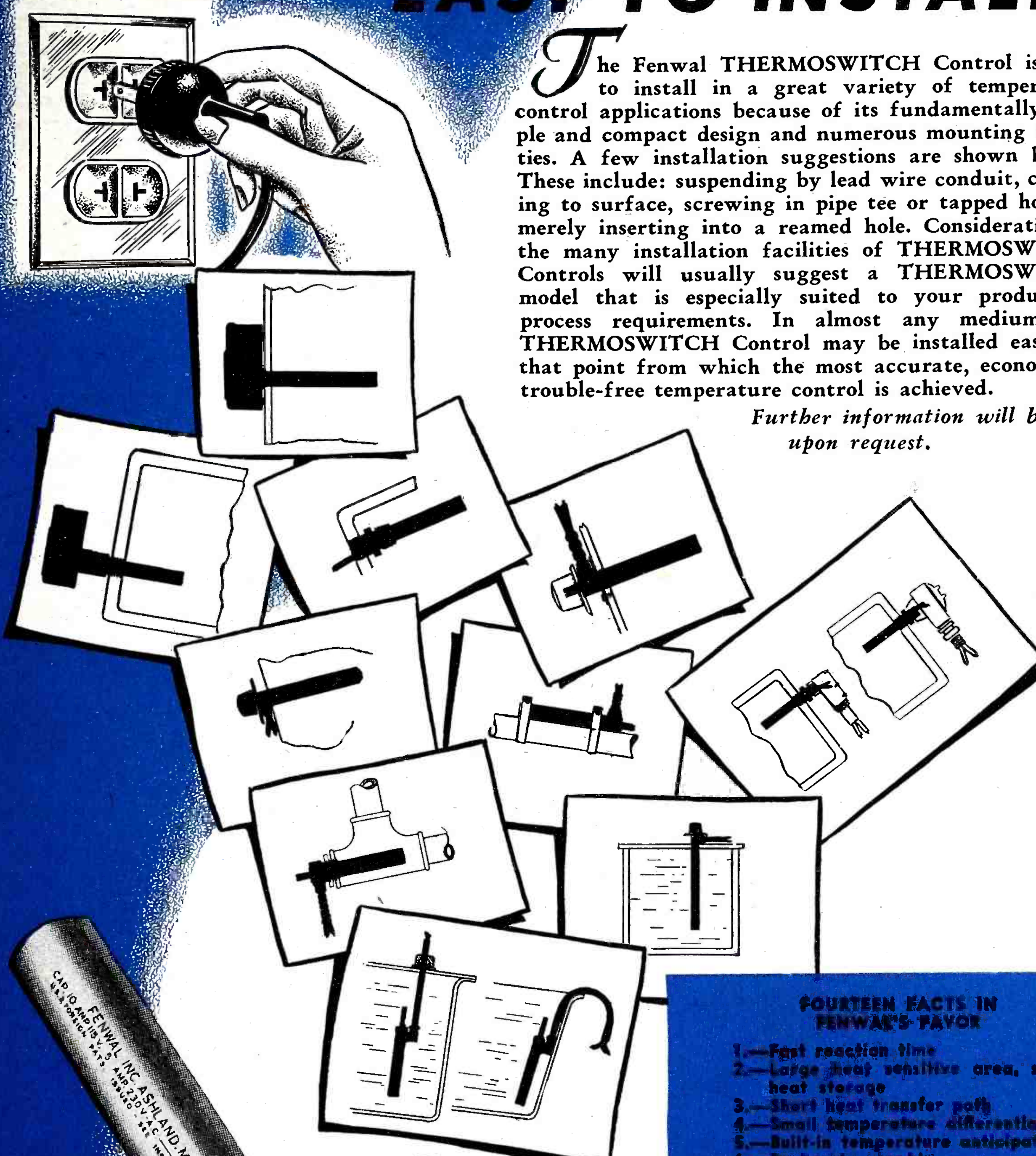
# EASY TO INSTALL*

The Fenwal THERMOSWITCH Control is easy to install in a great variety of temperature control applications because of its fundamentally simple and compact design and numerous mounting facilities. A few installation suggestions are shown below. These include: suspending by lead wire conduit, clamping to surface, screwing in pipe tee or tapped hole, or merely inserting into a reamed hole. Consideration of the many installation facilities of THERMOSWITCH Controls will usually suggest a THERMOSWITCH model that is especially suited to your product or process requirements. In almost any medium, the THERMOSWITCH Control may be installed easily at that point from which the most accurate, economical, trouble-free temperature control is achieved.

*Further information will be sent upon request.*




HEX HEAD THERMOSWITCH CONTROL

**FOURTEEN FACTS IN FENWAL'S FAVOR**

1.—Fast reaction time
2.—Large heat sensitive area, small heat storage
3.—Short heat transfer path
4.—Small temperature differential
5.—Built-in temperature anticipation
6.—Enclosed assembly
7.—Minimal vibration effects
8.—Tamper-proof and sealed
9.—Rugged construction
10.—Adjustable over wide temperature range
11.—Minimum size
12.—Directly responsive to radiant heat
13.—Uniform sensitivity over adjustable temperature range
* 14.—Readily installed

* #14 of "14 Facts In Fenwal's Favor"

Fenwal

**FENWAL INCORPORATED**
43 PLEASANT STREET
ASHLAND MASSACHUSETTS
Thermotechnics for Complete Temperature Regulation

EDVAC will multiply two 10-digit numbers in one-thousandth of a second, which is about three times as fast as can be done by the ENIAC, the fastest existing computer. This increase in speed of operation is made possible by specially-designed circuits which operate at a million cycles per second, as compared with 100,000 cycles per second in the ENIAC.

The EDVAC will have automatic programming involving the use of magnetic tapes upon which the problem is put in code by input mechanisms and the result obtained therefrom by output mechanisms.

As contrasted with the 18,000 electronic tubes in the ENIAC, there will be only 3,000 in the EDVAC, and the new machine with its operating area will occupy an area about 20 feet square, which is only about one-fifth of the space required to house the ENIAC.

### *Mercury Tank Details*

The fact that the electrical impedance of a quartz crystal can be made to match very closely the electrical impedance of mercury has made possible a low-loss, reliable storage device for coded pulses. X-cut quartz crystals ground to tolerances of 0.0005 inch by Reeves-Hoffman Corp. are used to change electrical pulses to ultrasonic mechanical pulses which can be stored in a mercury acoustic delay line, and of reconverting these pulses into electrical pulses when they are needed.

Essentially the memory devices consist of a mercury tube with X-cut quartz crystals mounted at either end in intimate contact with the mercury. Electrical pulses spaced one microsecond apart are applied to the pool by one crystal, and the resulting ultrasonic pulses travel much more slowly through the mercury than did the electrical pulses which excited the crystal.

The mechanical pulses in the mercury are reconverted into electrical pulses by the crystal at the other end of the tube, are amplified, and then fed back to the transducing crystal. There is thus a closed cycle of pulses being stored, the number of which is dependent only on the physical length of the mercury delay line.

The pulses fed into these memory


# hour saver...dollar maker

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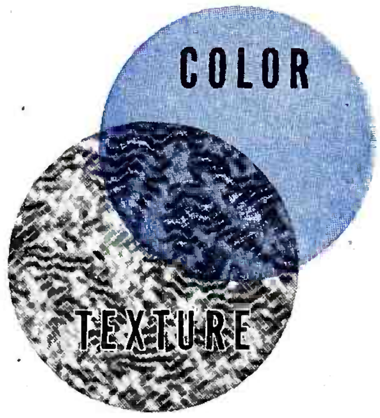


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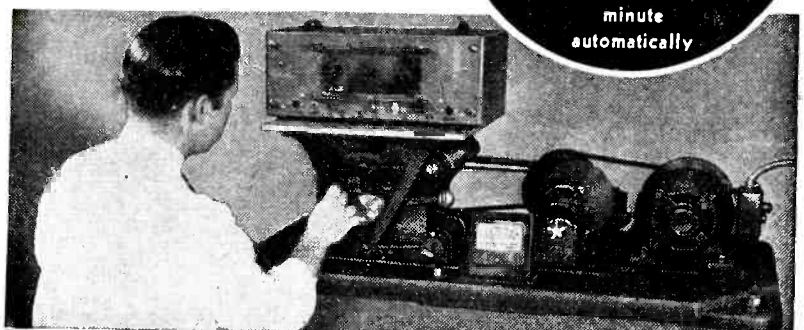
VERTICAL ACTION
600 to 3,300 vibrations per minute automatically



10 to 55 cycles per second, automatic with automatic acceleration and deceleration. 10 to 60 cps, manually.

Load capacity 100 lbs.; other models 10 to 25 lbs. capacity. 8 models to choose from.

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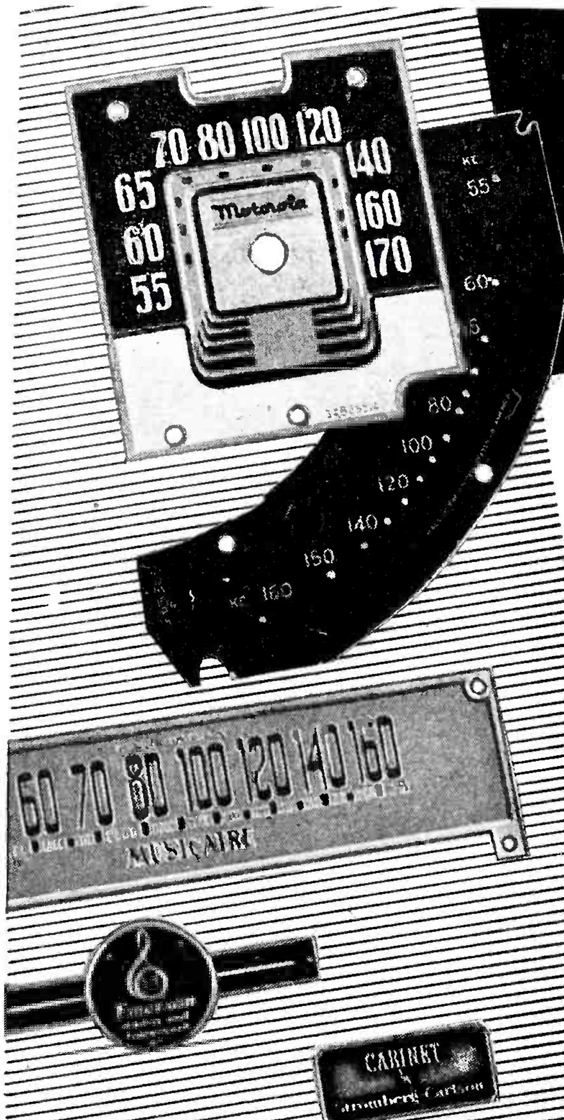


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*The* TABLET & TICKET CO.

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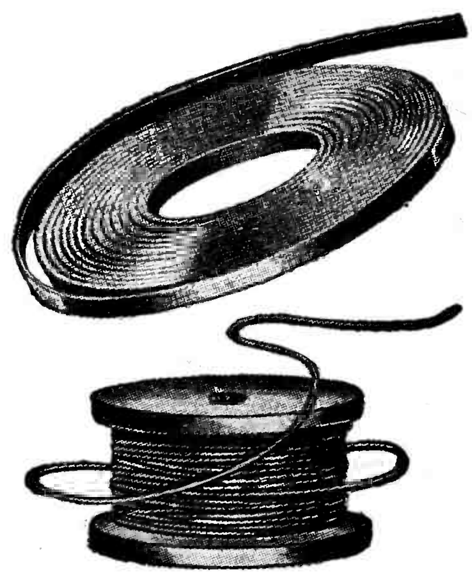
ELEPHANT BRAND

# PHOSPHOR BRONZE *WIRES*



The production of "Elephant Brand" Phosphor Bronze Wire has been *completely controlled by us* from ingot to finished size, since 1874. *It is a true bronze wire,* containing nothing but virgin copper, tin, and phosphorus. The introduction of phosphorous into this composition *reduces the oxides* and, with the purified metals, forms a most *homogenous and uniform* alloy. These essential factors are *established scientific facts,* and have proven the superiority of "Elephant Brand" Phosphor Bronze Wire.

*This wire contains no zinc*—which eliminates the danger of season-cracking, thus has the *highest fatigue limit.* It is *made in various tempers* to meet specific requirements. "Elephant Brand" Wire is *drawn accurately to size,* is *absolutely uniform* throughout the coil, and *will not season—crack,* regardless of the time that it is carried in stock. All wire can be supplied bright-annealed. Available in the following forms:

**ROUND WIRE.** In coils for spring manufacturers
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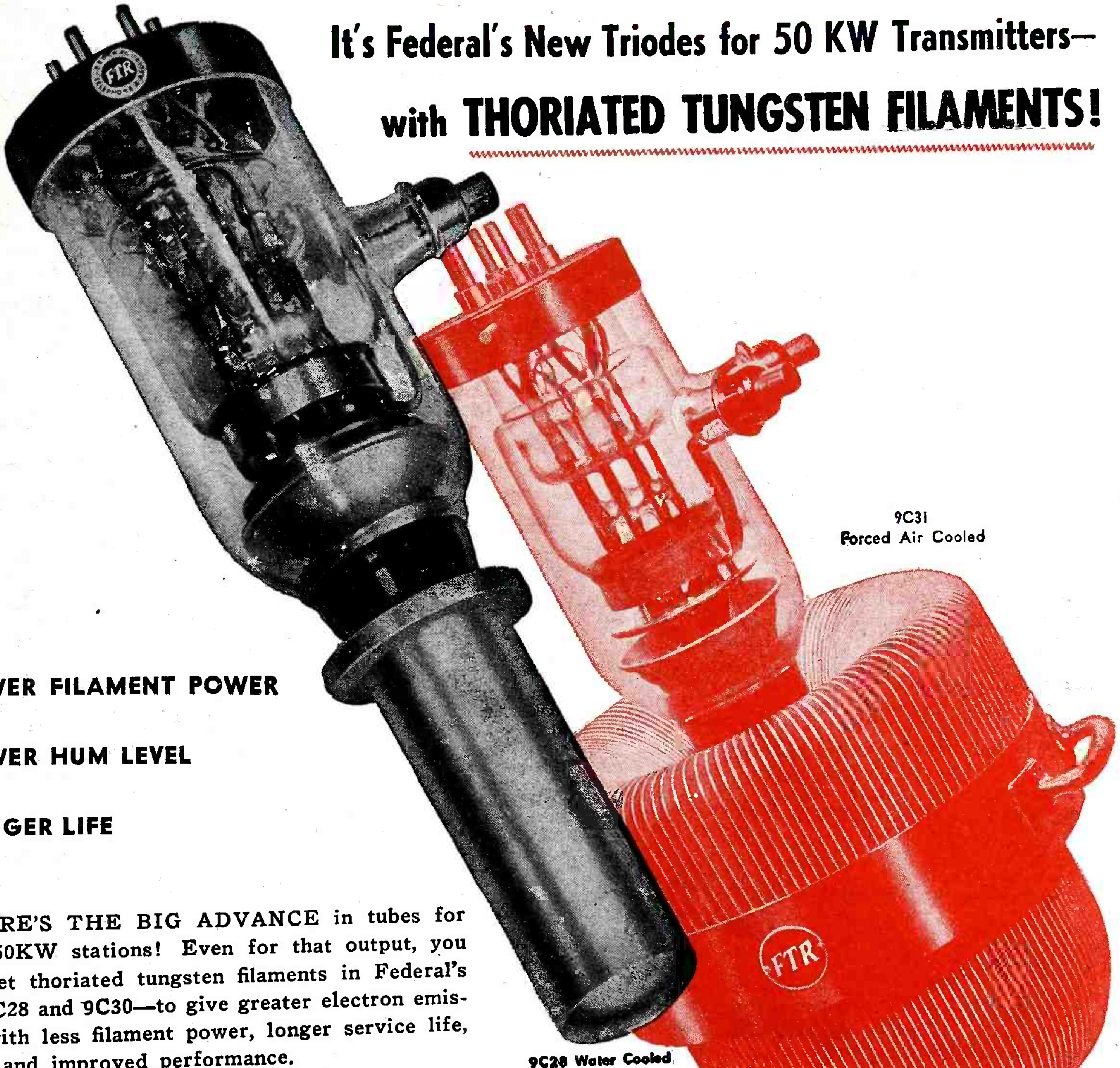
# BIGGEST NEWS IN AM!

## It's Federal's New Triodes for 50 KW Transmitters— with THORIATED TUNGSTEN FILAMENTS!



9C31
Forced Air Cooled

9C28 Water Cooled

- LOWER FILAMENT POWER
- LOWER HUM LEVEL
- LONGER LIFE

HERE'S THE BIG ADVANCE in tubes for 50KW stations! Even for that output, you now get thoriated tungsten filaments in Federal's new 9C28 and 9C30—to give greater electron emission with less filament power, longer service life, stable and improved performance.

Rated conservatively, these Federal tubes have the electrical and structural design to withstand overloads. Months of actual field tests demonstrate their exceptional durability. Both the 9C28 and 9C30 are water cooled for maximum output. Alternate types (9C29 and 9C31), with air cooling, are also available. In a pair of either type you'll find new operating economy and low tube costs.

Federal's 38 years of tube engineering and manufacture show up once more in this latest "first". No wonder Federal tubes have consistently set the standards for performance in AM broadcast service. We'll be glad to send you more data on these tubes. Write department K413.

**PARTIAL TECHNICAL DATA**

| | 9C28 | 9C30 |
|---|---|---|
| Filament voltage | 15 v. | 15 v. |
| Filament current | 135 amp. | 135 amp. |
| *Maximum Ratings* | | |
| Plate Voltage | 12,000 v. | 15,000 v. |
| Plate Current | 10 amp. | 8 amp. |
| Plate Input | 100 kw. | 120 kw. |
| Plate Dissipation | 40 kw. | 40 kw. |

## *Federal Telephone and Radio Corporation*

In Canada:— Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors:— International Standard Electric Corp. 67 Broad St., N. Y.

An IT&T Associate

100 Kingsland Road, Clifton, New Jersey

systems can be stored indefinitely with complete accuracy. Multiple electronic switching or gating circuits are used to introduce and withdraw any one or more pulses from the memory system as required. Variations in the speed of the ultrasonic vibrations due to changes in temperature, humidity, or other causes are automatically compensated for by varying the frequency of the 1-mc master pulse generator.

## Improvements in Phonograph Oscillators

BROADCAST station type design has been built into the phonograph oscillator whose circuit is shown in Fig. 1. Hum modulation reduction due

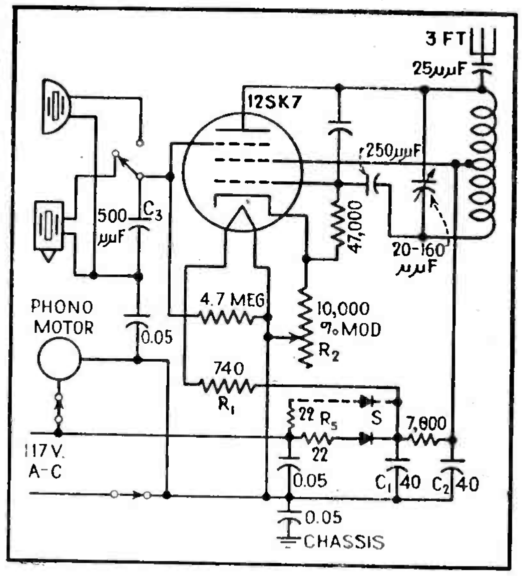



FIG. 1—Circuit of versatile phonograph oscillator using a selenium rectifier

to d-c on the heater of the oscillator tube and variable percentage of modulation have been incorporated by its designer, George Eannarino, field engineer with Federal Telephone and Radio Corp.

The oscillator contains one tube, a 12SK7, and a Federal selenium rectifier in the power supply. Modulation can be accomplished by either a crystal pickup or a crystal microphone.

The use of the dropping resistor $R_1$ prevents large initial surges of current from flowing through the filament, thereby increasing the life of the tube. A 200-ma selenium rectifier is used but if this is not available two of the more common 100-ma types can be used in parallel with an additional resistor as indicated by the dotted line in Fig. 1.

The output of the power supply

**MEASURE TOTAL DISTORTION**
**Between 20 cps and 20 kc**

# -hp- 330B DISTORTION ANALYZER

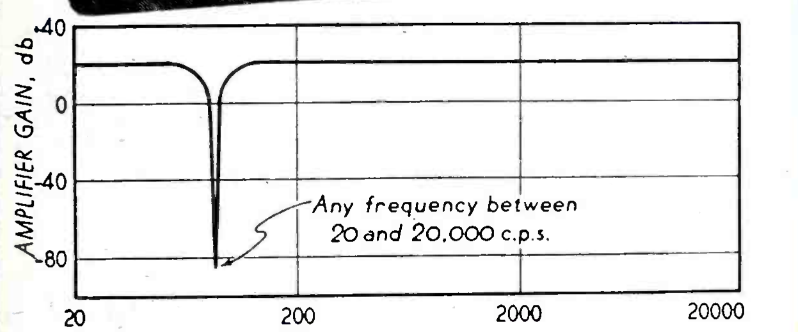



Figure 1

**CHECK THESE SEVEN IMPORTANT FUNCTIONS:**

1. **Measures total audio distortion.**
2. **Checks distortion of modulated r-f carrier.**
3. **Determines voltage level, power output.**
4. **Measures amplifier gain and response.**
5. **Directly measures audio noise and hum.**
6. **Determines unknown audio frequencies.**
7. **Serves as high-gain, wide-band stabilized amplifier.**

This fast, versatile -*hp*- 330B Analyzer measures distortion at *any* frequency from 20 cps to 20 kc. Measurements are made by eliminating the fundamental and comparing the ratio of the original wave with the total of remaining harmonic components. This comparison is made with a built-in vacuum tube voltmeter.

The unique -*hp*- resistance-tuned circuit used in this instrument is adapted from the famous -*hp*- 200 series oscillators. It provides almost infinite attenuation at one chosen frequency. All other frequencies are passed at the normal 20 db gain of the amplifier. Figure 1 shows how attenuation of approximately 80 db is achieved at any pre-selected point between 20 cps and 20 kc. Rejection is so sharp that second and higher harmonics are attenuated less than 10%.

### Full-Fledged Voltmeter

As a high-impedance, wide-range, high-sensitivity vacuum tube voltmeter, this -*hp*- 330B gives precision response flat at any frequency from 10 cps to 100 kc. Nine full-scale ranges are provided: .03, .1, .3, 1.0, 3.0, 10, 30, 100 and 300. Calibration from +2 to −12 db is provided, and ranges are related in 10 db steps.

The amplifier of the instrument can be used in cascade with the vacuum tube voltmeter to increase its sensitivity 100 times for noise and hum measurements.

Accuracy throughout is approximately ±3% and is unaffected by changing of tubes or line voltage variations. Output of the voltmeter has terminals for connection to an oscilloscope, to permit visual presentation of wave under measurement.

### Measures Direct From R-F Carrier

The -*hp*- 330B incorporates a linear r-f detector to rectify the transmitted carrier, and input circuits are continuously variable from 500 kc to 60 mc in 6 bands.

Ease of operation, universal applicability, great stability and light weight of this unique -*hp*- 330B Analyzer make it ideal for almost any audio measurement in laboratory, broadcast or production line work. Full details are immediately available. Write or wire for them—today Hewlett-Packard Company, 1437A Page Mill Road, Palo Alto, Calif.

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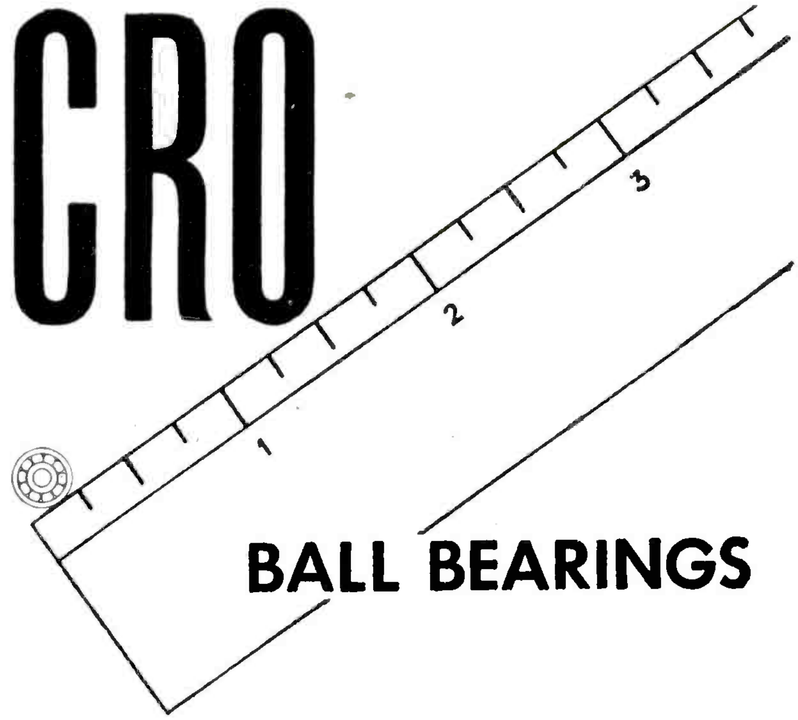
# MICRO

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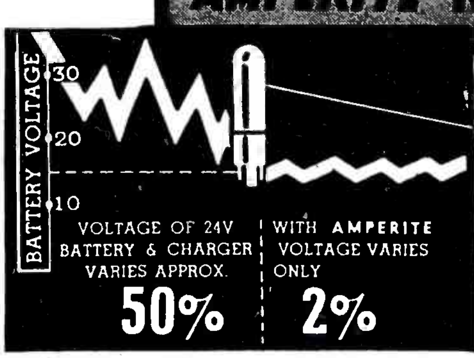



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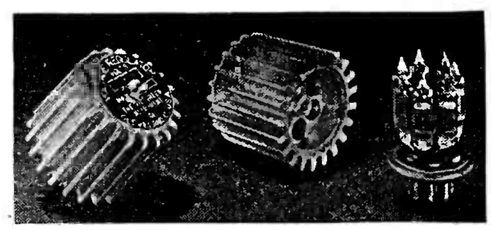
The VX series of subminiature vacuum tubes are especially adaptable to electrometer applications in fine instrumentation and for circuits used in radiation measurement. Feature 10 ma. filament current, grid resistance of $10^{15}$ ohms. Unusually stable.



The voltage regulator unit consists of 7 subminiature gaseous voltage regulator tubes uniquely assembled in one unit as illustrated. Particularly adaptable where regulation requires a flat top (130 volts) with close accuracy and space conservation.

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Unusually stable over a voltage range of 1 to 100 volts.

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after the filter is 84 volts. However, this output is based on the fact that $C_1$ and $C_2$ are exactly 40 $\mu$f. If they are not, the output may vary. This is corrected by changing the value of $R_5$ until the proper value is obtained, or by replacing the capacitors.

*Modulation Adjustment*

Resistor $R_2$ is a modulation control and is normally set at 80 percent modulation. This can be done by applying the output of the oscillator to an oscilloscope and varying $R_2$ until the desired percentage of modulation is obtained. If a scope is not available 80 percent modulation can be obtained by the following empirical method. Set $R_2$ to zero resistance. Tune a receiver to the frequency of the oscillator and increase $R_2$ until a click is heard in the receiver. This point should be at approximately 80 percent modulation.

Capacitor $C_3$ can be adjusted for the most desirable tone quality. The value of this capacitor may vary for different phonograph pickups and should be carefully matched whenever a replacement of the pickup is made. Because of the widely varying frequency characteristics of various types of crystal pickups, it may be desirable in some cases to alter the circuit to compensate for the characteristics of the pickup. The following circuits show means of making such refinements.

In Fig. 2A, resistor $R_1$ controls the low-frequency response; larger

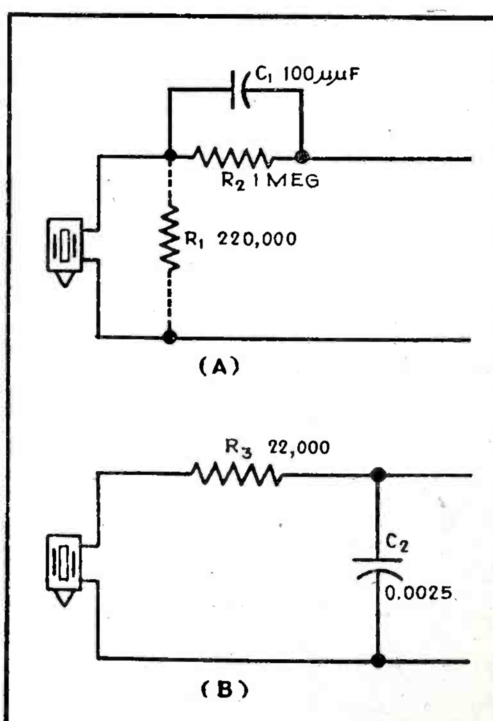


FIG. 2—Tone compensation circuits for use with a crystal pickup

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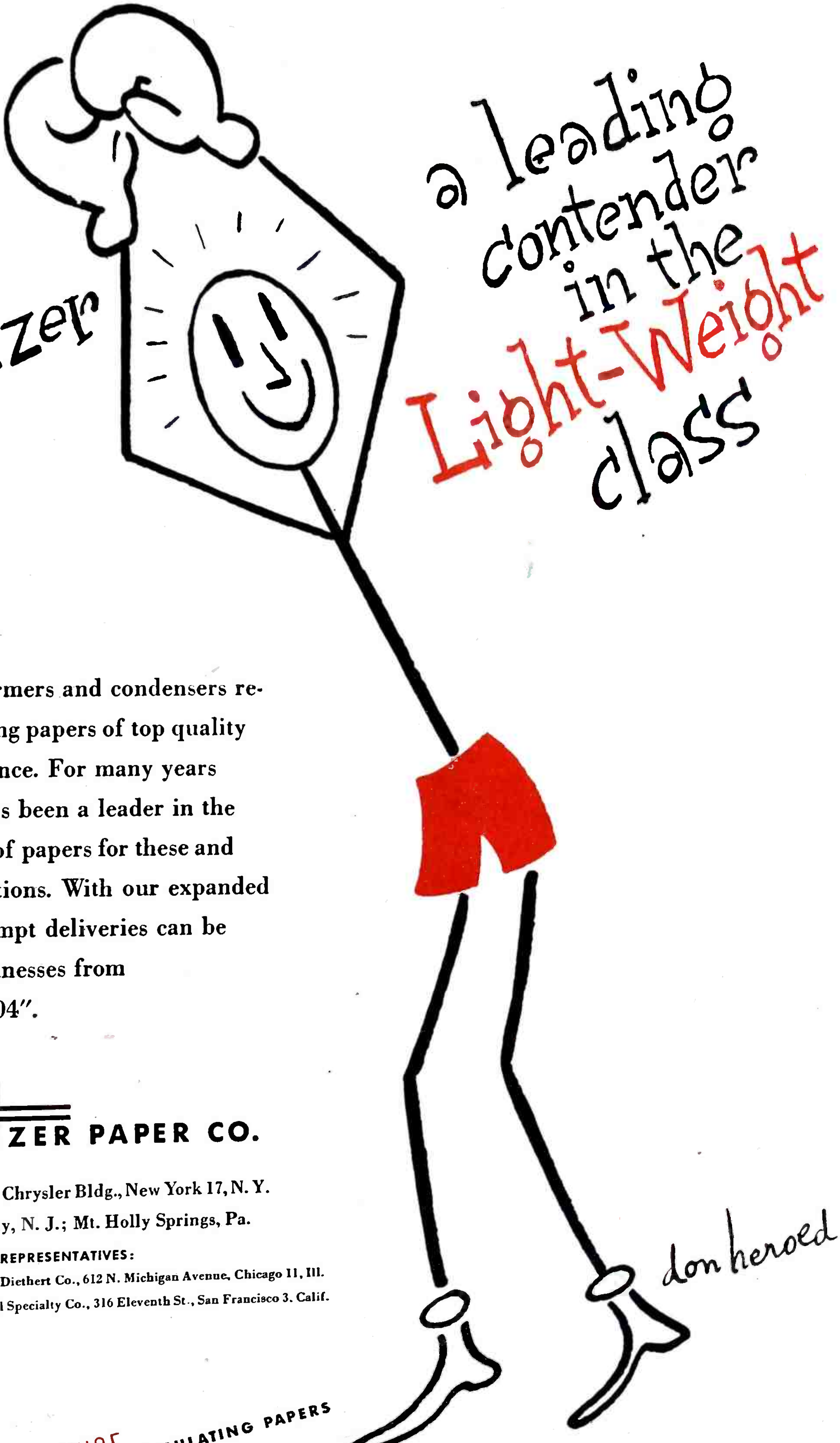


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values of $R_1$ give increased lows. For maximum low-frequency response, remove $R_1$. Resistor $R_2$ controls pickup output, smaller values of $R_2$ giving increased output. Capacitor $C_1$ controls high-frequency response; to increase highs, increase $C_1$.

Where a decrease in high-frequency response may be desired (for example, as an aid in reducing needle scratch on worn records), the circuit in Fig. 2B is applicable. In this circuit, $C_2$ acts as loading on the pickup and is also a controlling factor on the high-frequency response. Smaller values of $C_2$ give more pickup output and also more highs. Resistor $R_3$ gives a sharper high-frequency reduction; increasing $R_3$ decreases highs. The suggested values shown serve as a basis from which slight alterations

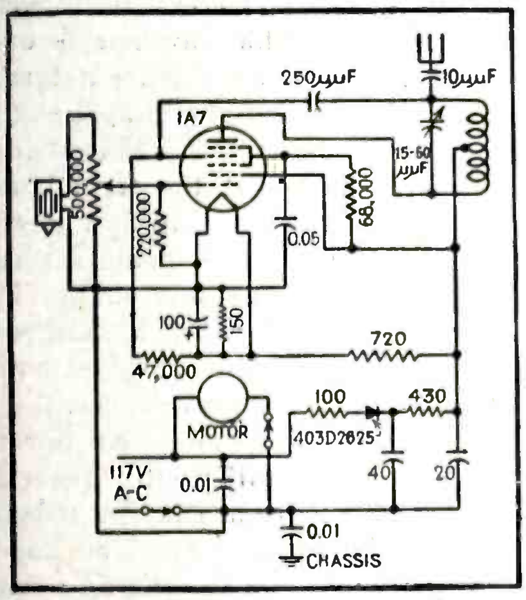


**FIG. 3—Use of a filament-type tube permits instantaneous operation when the switch is thrown**

may be made to suit individual cases.

### *Quick Heating*

For instantaneous starting, a 1A7 tube is connected as shown in Fig. 3. This circuit takes advantage of the fact that the selenium rectifier operates immediately. Since the 1A7 has direct cathode heating, the set will operate as soon as it is turned on. However, the 12SK7 is a sturdier tube and will take rougher handling and give better stability.

A crystal microphone can be inserted in either circuit (as shown in Fig. 1) by means of a double-pole switch. The microphone should be a high-gain type with an output of over 2.5 volts at 400 cycles for normal speech input. If a low-gain microphone is used a preamplifier stage is necessary, using a 12SQ7 for the circuit shown in Fig. 1 and a 1H5 for Fig. 3.

## Nomenclature System for Glass Bulbs

By Albert Brann

Westinghouse Electric Corp.
Bloomfield, N. J.

Many of the fundamental practices established by the lamp industry have been carried over almost bodily into the practices of the electron tube industry and the two industries have allied and overlapping interests.

Very early in its history, the electric lamp industry, together with the glass bulb industry, recognized the necessity of standardizing the nomenclature of the glass envelope which is an essential part of the lamp. This envelope is ordinarily known as a bulb, a term which the general public applies to the finished lamp itself. It is of interest to note that the term bulb was chosen because the first glass envelope used in the manufacture of an electric lamp was similar in shape to a plant bulb. Regardless of the shapes of the envelopes now used for either lamps or tubes, they are all known as bulbs. No fewer than thirty different general classes of shapes are in use today.

Recently the Joint Electron Tube Engineering Council (JETEC) felt it imperative that a system of nomenclature for bulbs be standardized. A committee representing the electric lamp, the electron tube and glass bulb industries was created and a national standard is well on its way to adoption. Because the same standard of nomenclature will be utilized by three different industries, it was considered desirable that its administration should reside in the American Standards Association.

Anyone desiring a designation for a new bulb can make application to the ASA where an assignment will be made within the rules of the standard and the new designation sent to the one requesting it.

Essentially, the proposed standard comprises a means for classifying individual glass bulbs in a system of nomenclature. In reality, it is a code which recognizes four

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attributes common to all bulbs and by which each bulb is differentiated from all other bulbs. These attributes are:

1. Shape—designated by a letter or a combination of letters such as A, B, PS.

2. Major diameter size—designated in eighths of an inch.

3. Characteristics which are retained in the finished electric lamp or electron tube—designated by a suffix letter.

4. Characteristics which are not retained in the finished electric lamp or electron tube—designated by a suffix number.

Illustration of Use of Code

| *Symbol* | *Attribute* |
|---|---|
| T | Shape |
| 9 | Major diameter size in eighths of an inch. |
| F | Features affecting interchangeability. |
| 1 | Features not affecting interchangeability. |

which combined gives the bulb designation T9F1.

No two bulbs have the same designation, however slight their differences. Bulbs of almost like design have almost the same designation, but not quite the same. For instance, the designation T9F1 will be changed if a bulb differs in the fourth attribute only, in which case the designation becomes T9F2 or T9F3, and so on. Similarly, if a bulb differs from T9F1 in the third attribute only, it becomes T9G1 or T9H1.

The letter symbol indicating the shape attribute of the bulb may denote its actual shape although this is not always the case. In general, however, it is mnemonic in character. For instance, the letter symbol P denotes the shape of a pear, G of a globe, C of a candle, F of a flame and T of a tube.

The A bulb lends special interest because it has a natural shape. Its shape has the contour taken on by a ball of molten glass which is allowed to stretch itself out under the pull of gravity. Under glass blowing conditions this characteristic tends to give a strong walled bulb with an even distribution of glass, thus

facilitating its manufacture and enhancing its quality.

The bulb designation does not apply to the weight of the bulb, nor to its wall thickness, nor to the composition of the glass, nor to any characteristic save the four attributes already discussed.

## 2,500-foot Vertical Antenna

SOME of the antenna problems besetting transmitter engineers might be solved by a type of antenna developed in Germany during the war. It consisted of an antenna supported by an electrically driven captive helicopter powered by cables from a portable generator on the ground.

The system was successfully flown for half an hour at 750 meters (about 2,500 feet) and for two hours at 500 meters. Several lower flights were also made.

Four trucks were used to transport the apparatus, one to carry the helicopter, launching platform and controls, and three to carry the electric generators and three winches. The first truck was stationed where the helicopter was to be launched. Winches from the other trucks were spaced equi-distantly around the launching point on the circumference of a 30 meter circle. The helicopter was set up on its platform, the counter-rotating propeller blades were attached, and the motor was started. As the helicopter went up, cables from the winches were paid out fast enough to permit ascent to 2,000 feet in about seven minutes. Tension had to be equalized on all the cables during ascent or descent.

An observation basket was located above the eight-meter propellers at the junction of three girder-type spreader arms which were fastened at their ends to the anchor cables. A 200-horsepower motor was located between the propellers. Both the 2,000 volts for the motor and the 30,000-volt r-f current for radio transmission were carried by the anchor cables. The winches were insulated with porcelain.

Complete plant tests had not been made when the war ended but the helicopter had proved to be stable and easily raised or lowered and there seemed to be no reason to sup-

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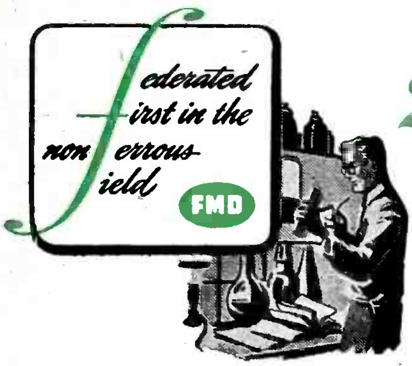


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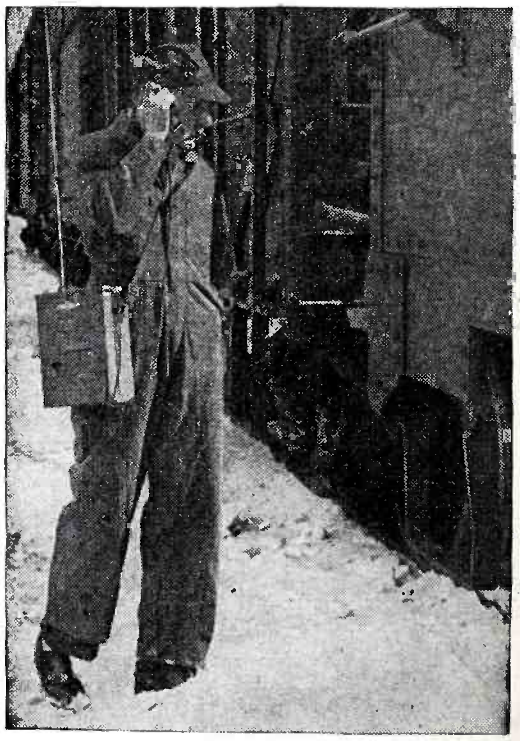
pose it was not practical. Additional work on the cables and better insulation of the winches were recommended.

## Two-Way Railroad Pack Set

DESIGNED primarily for use in connection with end-to-end vhf radio operation on freight trains, a new mobile, pack-set resembles the handie-talkie of war fame. Like that set, it contains a retractable vertical rod antenna which, when fully extended, measures 36 inches, and which retracts into the case to operate an on-off switch. When fully extended it is a half-wave type at the railroad radio frequencies of 158.25 to 161.97 mc.

Both transmitter and receiver are crystal controlled and designed for use with the standard Bendix f-m two-way train radio units. Both circuits are built on a single chassis using nine miniature type tubes. The transmitter uses 3.5 tubes and the remaining tubes are used in the receiver.

The receiver utilizes a superheterodyne circuit. The power supply consists of a completely enclosed bank of miniature nonspillable storage batteries which activate a tiny dynamotor, designed for a 6-volt input and a 100-volt output. The filaments operate from a 1.5 volt source. The battery unit is enclosed



Track-side railroad crewman communicates with conductor over two-way handie-talkie developed by Bendix engineers

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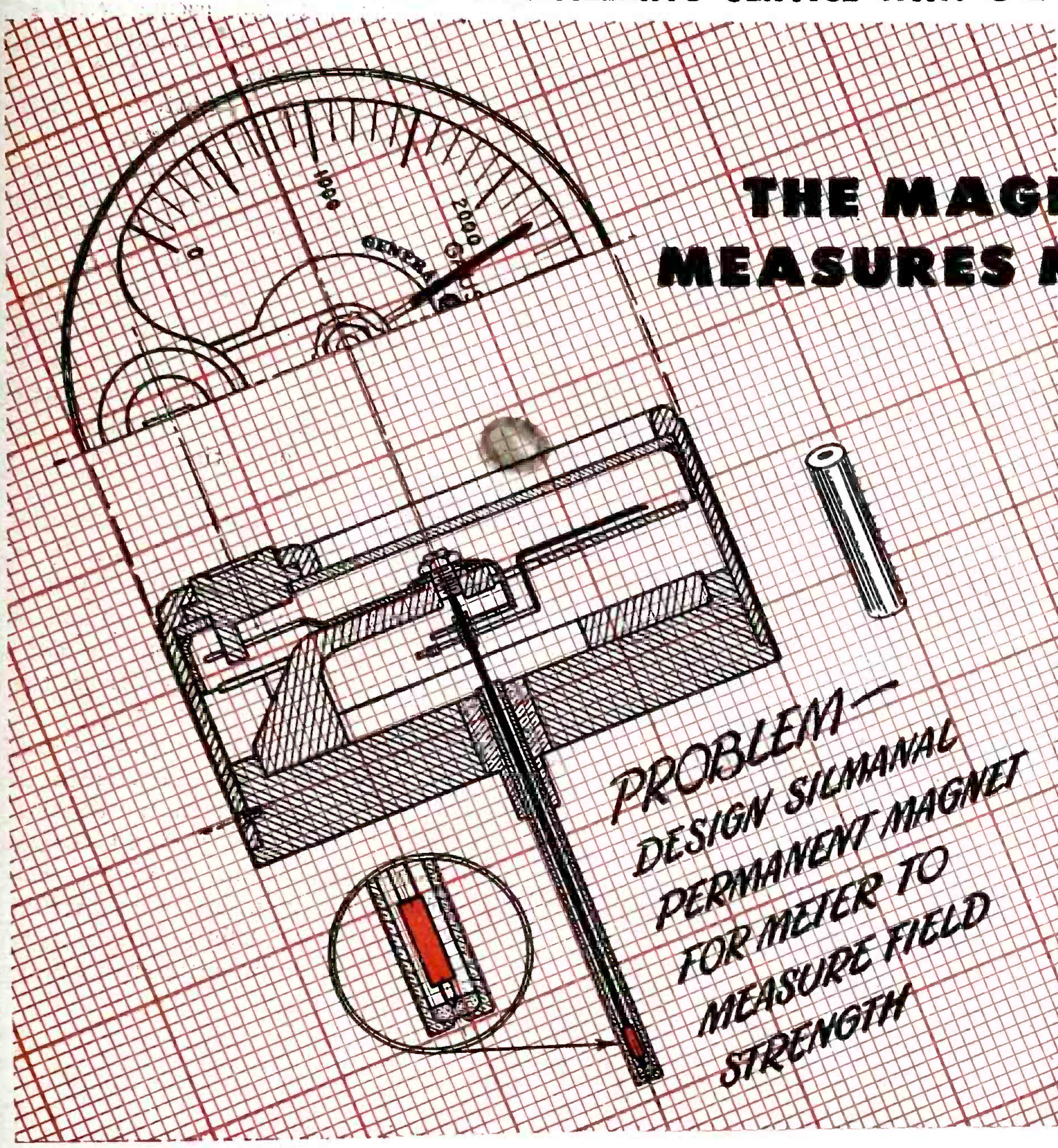


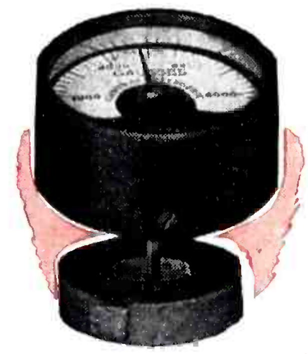

*A tiny SILMANAL cylinder magnetized along a diameter is the heart of the G-E gauss meter. When the probe is placed in the field of a permanent magnet or a d-c electromagnet, the SILMANAL magnet on the shaft tends to line up with the flux. Flux density is measured by rotating the instrument until the pointer reaches its highest reading. This occurs when the probe-magnet flux is at right angles to the flux being investigated. The pointer when at zero scale position indicates flux direction.*

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CDM-1 contains information about the characteristics and properties of G-E permanent magnet materials, their application and design. Listed in the catalog supplement, CDM-2, are sintered and cast Alnico permanent magnets available from stock. Proposed R.M.A. standard speaker magnets are included.

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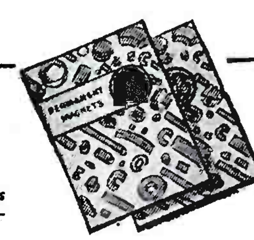


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in a metal box which is ventilated with an external escape vent so that no fumes accumulate within the enclosed case.

To economize on battery current, the transmitter is activated by a push-to-talk button on the earphone and the circuit is so designed that filaments of the receiver are not in use when the transmitter is in operation and vice-versa. Recharging may be done from either a-c or d-c sources. Approximately one mile solid communication is normally possible with pack-set to mobile or fixed station operation.

As a track-side extension of vhf voice railroad communication the Bendix pack set can be used by a flagman for communication with a train engineer or conductor and is particularly useful when the flagman is around a curve from the train.

Other train crew members can use it when inspecting a train to report to conductor in the caboose with accuracy and in detail. Track crews can communicate with an approaching train over a limited range and give definite information to the train crew without stopping the train.

## HAMS ON 2,300 MC

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Topside
Inside

**ELECTRON ART**

(continued from p 144)

ing upon system size and auxiliary pumping equipment.

## Miniature Capacitors

CERAMICS having exceptionally high dielectric constants have been developed that make it possible to build compact capacitors. Depending on thickness and diameter of the dielectric discs, capacitors can be made ranging from a few micromicrofarads to a microfarad. A disc a half inch in diameter with one plate of the capacitor coated on each side has a capacitance of 0.01 $\mu$f. These small capacitors are useful in hearing aids, airborne radar, and other applications requiring minimum space.

Capacitance of a capacitor is proportional to dielectric constant of its insulating material. High dielectric constants of titanates have been investigated by the Porcelain

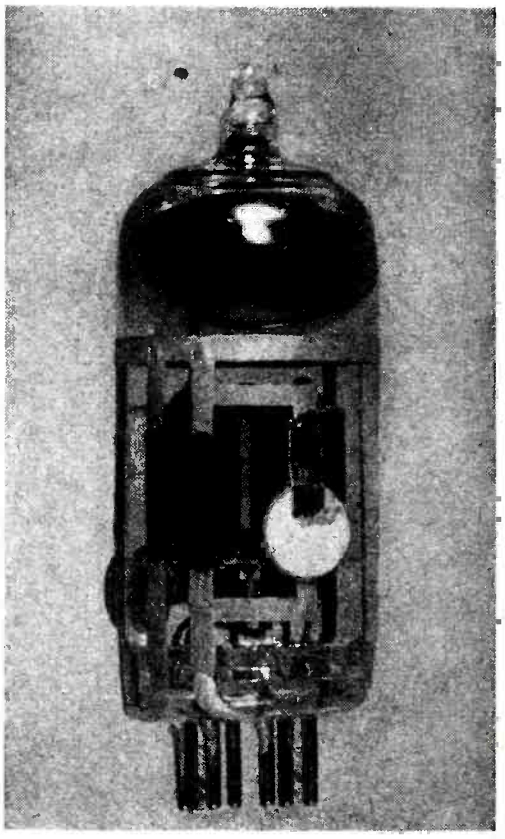

FIG. 1—Resistors and conductors are printed onto glass envelope; capacitors use high dielectric constant insulators to obtain high capacitance in small volume

and Pottery Laboratory at the National Bureau of Standards and processing techniques evolved. Figure 1 shows a miniature double stage amplifier in which capacitors made with these materials are used.

A systematic investigation of variations in properties produced by relative composition of alkaline earth titanates has been made to determine break-down voltage, elec-

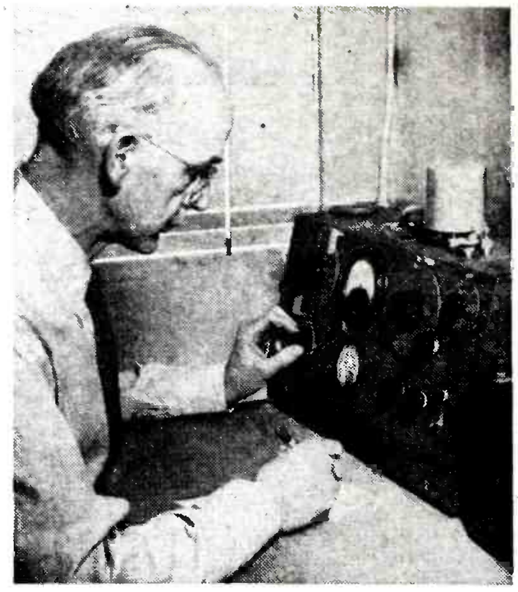

FIG. 2—Dielectric constants and figures of merit of various composition capacitor insulators are measured at 25 C and 40 percent relative humidity

tric power loss, and change in capacitance with temperature or humidity. Variations in purity and grain size make close duplication of dielectric properties difficult, but dielectric constants as high as 18,000 have been obtained. Power factor increases with concentration of barium titanates. These factors have been studied at one megacycle, as shown in Fig. 2, and at 3,000 mc using standing wave ratio measurements. Lower dielectric constants are obtained at 3,000 mc than at one megacycle.

## Sofar Sonar

SOUND FIXING AND RANGING (SOFAR) using sonar techniques was used to enable persons stranded at sea to signal their position. A five pound bomb, designed for the purpose, is dropped overboard. Hydrostatic pressure detonates the bomb at the depth of a permanent sound channel. This sound channel is formed by the negative temperature gradient wherein increasing depth of the ocean is accompanied by decreasing temperature of the water. Compressional waves travel faster in warm water than in cold, so that the waves are bent downward. Increase in water density with depth tends to bend the waves upward. Thus a wave launched at the depth of this temperature-density inversion echoes outwardly around the earth, traveling more than three thousand miles from its origin before becoming too weak to be detected. The sound channel is be-

tween three and four thousand feet below the surface.

During the war the Navy operated receiving stations throughout the world at locations deep enough for hydrophones to reach the permanent sound channel. The sound is received as a series of pulses with very abrupt endings, the first portion of the pulses being the sound waves refracted back and forth along the channel and the definite end being produced by the direct wave through the channel. Duration of the pulse gives an indication of the distance of the distress signal from the receiving station. Comparison of the times of arrival of the pulse at several stations gives a fix on the source of the sound accurate to a mile in 2,000. Studies of sounds transmitted in the same way may be used in exploration of underwater volcanoes and shoals. Behavior of sounds under Arctic and Antarctic waters is still to be investigated.

## Nonlinear Limiter

By Edmund R. Brill
*Harvard University, Cambridge, Mass.*

A LIMITER CIRCUIT is usually included in the intensity modulation channel of cathode-ray tubes to prevent blooming from strong signals. However, the limiting action prohibits discriminating between signals of different intensities above the level of saturation. The problem arose in connection with radar intensity modulation presentation, such as the plan position indicator, to develop a limiter that would protect the phosphorescent screen, yet to permit resolution of signals over a wide dynamic range of input. A nonlinear limiter using germanium crystal rectifiers was developed whose current versus potential characteristic follows a cube root and thus gives, in combination with a cathode-ray screen whose transfer characteristic (spot brightness versus control voltage) follows a cube law (as most screens do), an overall transfer characteristic that is linear. This compensation greatly increases the dynamic range that can be usefully presented by intensity modulation methods. The technique is applicable to gamma (contrast) control of television video signals, for wide dynamic range meters, and wide range chart

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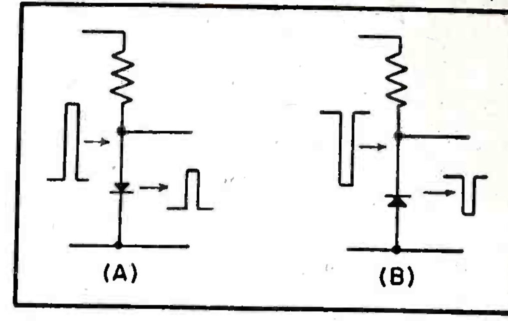



FIG. 1—Nonlinear compression circuits use crystal rectifiers

recording of such quantities as antenna patterns.

*Circuits*

The nonlinear limiter circuit is the voltage divider shown in Fig. 1 using a resistor and a crystal. The circuit at Fig. 1A is used for positive-going signals; that at Fig. 1B for negative-going signals. As the output is obtained across the crystal, it is desirable to make the ratio of crystal resistance to total divider resistance high. This characteristic can be obtained, without affecting the compression exponent, by using several crystals in series. The maximum input potential that can be applied to the divider is limited by the peak current that can be passed through the crystal without permanently altering its characteristic. At low input levels the circuits tend toward a linear transfer characteristic. Figure 2 shows the effect of the resistance of the resistor in a potentiometer using germanium crystals of the type manufactured by Western Electric.

Other compression exponents can be obtained by using vacuum diodes or silicon crystal rectifiers. Connecting the two sections of a 6H6 as shown in Fig. 3 and with both resistors 10,000 ohms, a square root response was measured between 1.00 and 100 volts input; the output was about 0.25 volt at an input of 10 volts. As the resistors are

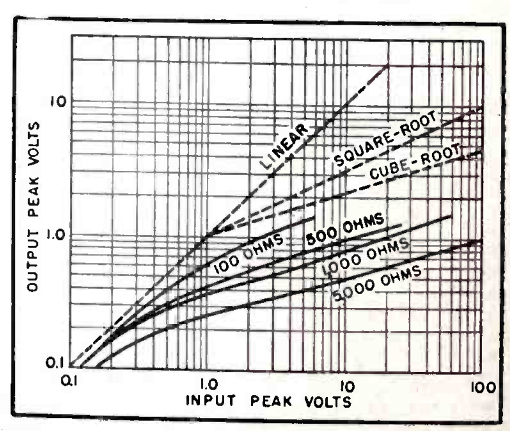



FIG. 2—Compression characteristic of germanium crystal divider varies with series resistance

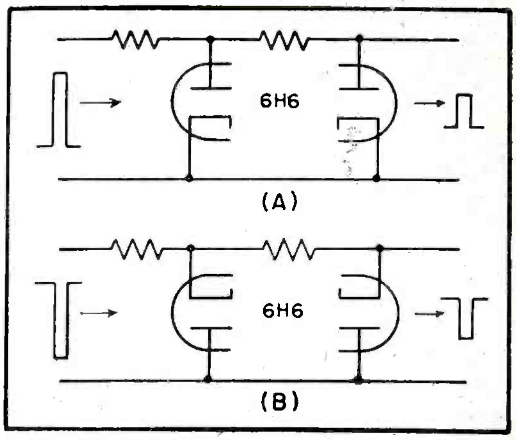



FIG. 3—Shunt diodes can be used in a nonlinear compression circuit

made smaller, the characteristic of the circuit changes from square root toward linear.

A silicon crystal, of the type manufactured by Sylvania Electric Products, used in the circuits of Fig. 1 with a 1,000-ohms series resistor gave a compression exponent between a half and a third at higher voltages, but approached a linear characteristic at input potentials below one volt.

In general, the characteristic of the crystal circuit over a wide range of input levels is the reciprocal of the exponent of the current versus potential characteristic of the particular rectifier. Several nonlinear compression circuits can be cascaded to obtain a characteristic whose exponent is the reciprocal of the sum of the reciprocal exponents of each individual circuit. The circuits will have to be isolated from each other by amplifiers, which will also be necessary to maintain the signal level. (Ed. Note: By taking the output across the resistor element of the voltage divider instead of across the crystal, a nonlinear expander is obtained. The technique has possibilities in electrical computers.) Work reported herein was done at RRL under contract OEM sr-411 with OSRD.

## Direct Frequency Measurement

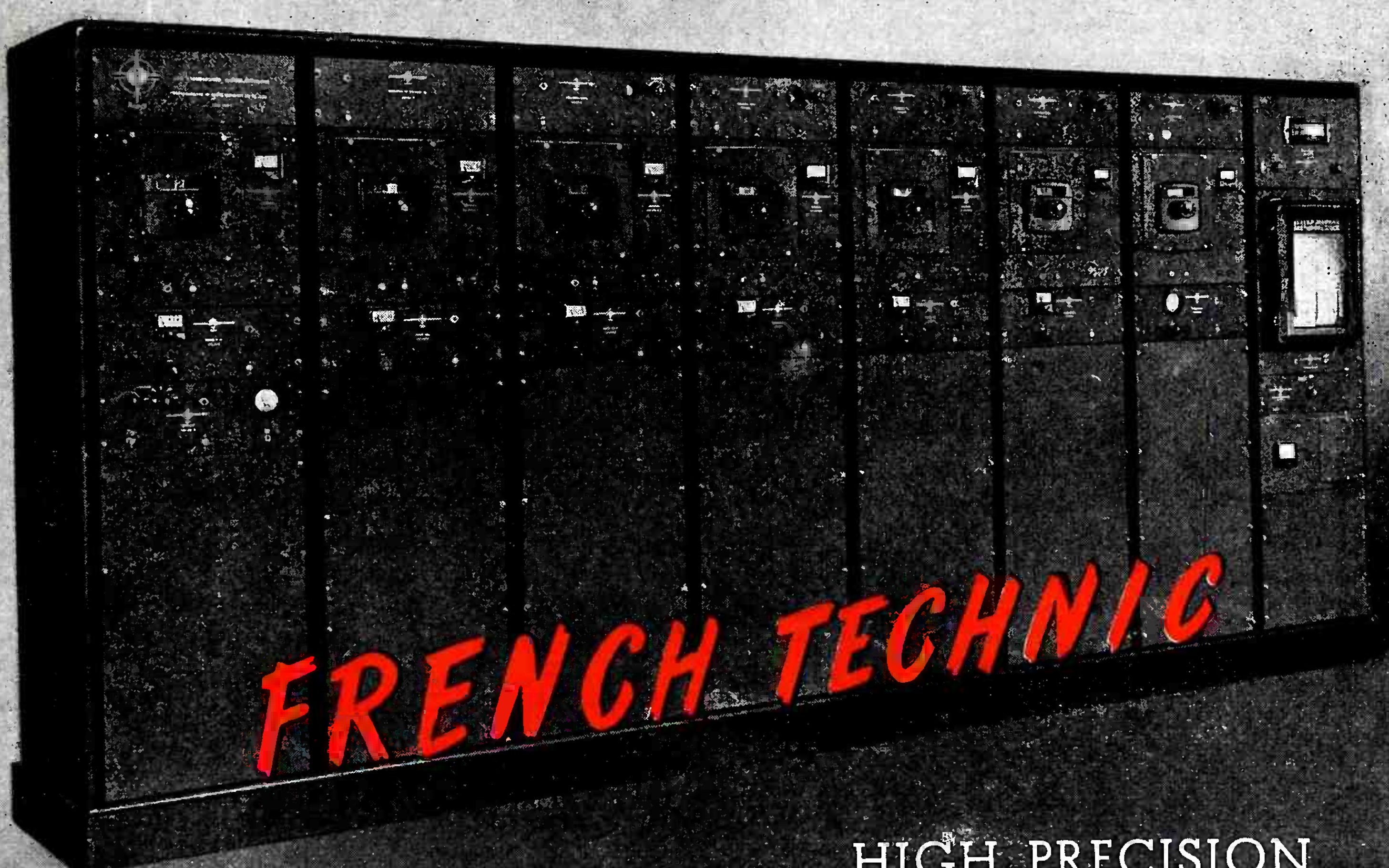
By L. M. Berman

*Chief Engineer*
*Frequency Department*
*Les Laboratoires Radioelectriques*
*Paris, France*

SUCCESSIVE DEMULTIPLICATION of the frequency to be measured provides a direct method of measurement. The frequency $f_x$ can be considered to be $k10^n + f_r$ where $k$ and $n$ are integers and $f_r$ is the residual fre-

LES LABORATOIRES RADIOÉLECTRIQUES

PARIS FRANCE




HIGH PRECISION

*frequency meter*

**up to 300 Mc/s**
**Absolute error 0,2 c/s**
**Relative error 10 - 7**
**Direct reading indicating error whitin 3 minutes.**
**No special experience requested**
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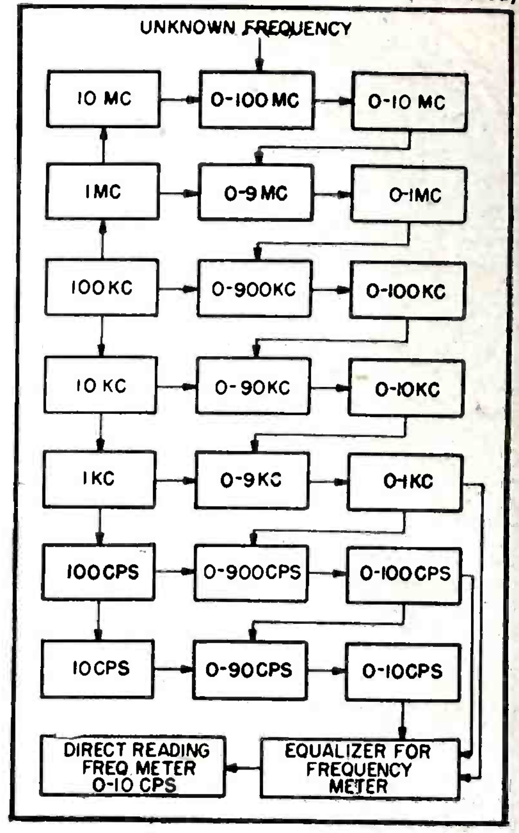



**To the left is a chain of decade standard frequency generators. In the center are harmonic generators, each driven from its decade frequency. These generators feed mixer circuits that are simultaneously fed by the unknown frequency. To the right are low-pass filters passing only components of the unknown frequency lower than the decade being measured. In this manner each digit of the frequency can be determined**

quency lower than $10^n$. To measure the unknown frequency, it is heterodyned with a standard frequency to produce a beat that will pass through a low-pass filter whose cutoff frequency is $10^n$. The required standard beating frequency for this condition is $k10^n$; thus, knowing the standard frequency in use when the low-pass filter is passing a signal, one finds $k$, the first digit of the frequency being measured.

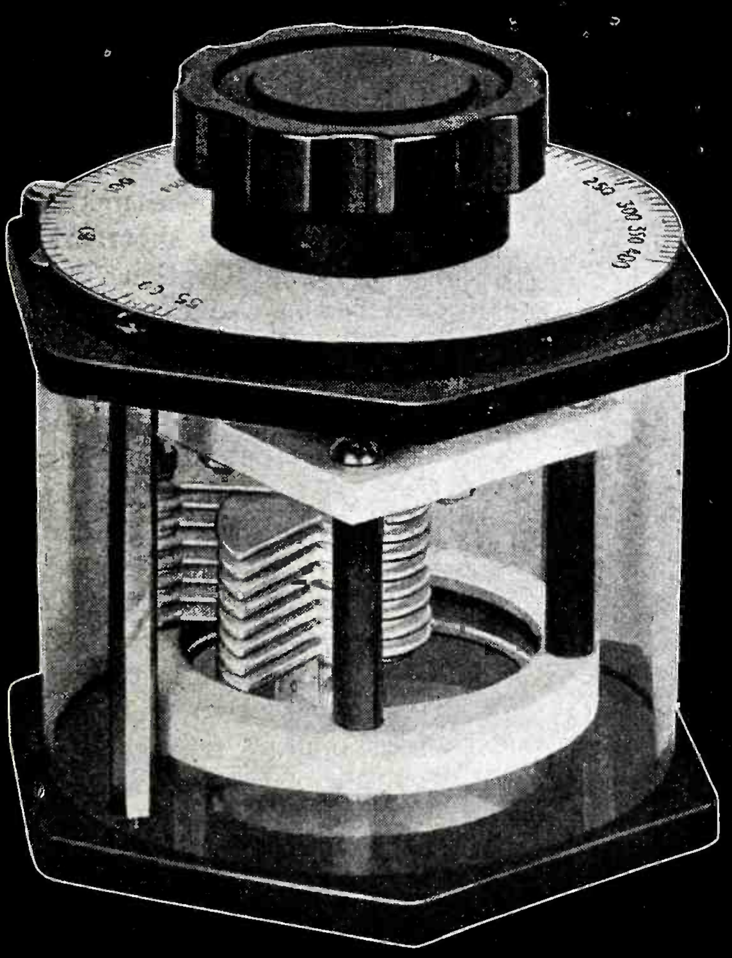
Residual frequency passed through the filter becomes a new unknown frequency that can be determined in like manner. Cutoff frequency of the second filter is $10^{n-1}$ and the standard beating frequency is $k_1 10^{n-1}$. Measurement consists of finding the required $k_1$ to obtain a signal through the filter; this $k_1$ is the second digit of the frequency. Number of successive demultiplications depends on the accuracy to which frequency is to be measured; a direct-reading frequency meter indicates the final residual frequency.

*Arrangement of Equipment*

The accompanying figure shows a frequency meter employing the principle of demultiplication. A

# WAVEMETERS
## 0.5 – 150 Mc
## 55 – 400 Mc
## IN STOCK!

TYPE 566-A — 0.5 to 150 Mc



TYPE 758-A — 55 to 400 Mc

● To meet an insistent demand, we have concentrated some of our production facilities on these two popular wavemeters and have managed to accumulate a moderate stock of each.

Both are of the well-known absorption type with accuracies sufficient for a wide variety of routine frequency checks on the ranges of coils, oscillators, receivers, transmitters, etc.

The Type 566-A Wavemeter consists of a variable air condenser, five plug-in coils and an incandescent lamp for resonance indication. The Type 758-A Wavemeter covers its entire frequency range with a single-turn loop the inductance of which is varied simultaneously with the capacitance. An incandescent lamp is used for resonance indication. For low power uses (less than about 2 watts), resonance indication is obtained by the reaction of the wavemeters on the plate or grid currents of the oscillator.

These wavemeters are compact, rugged, inexpensive and direct reading in terms of our primary standard of frequency.

### TYPE 566-A WAVEMETER

**FREQUENCY RANGE:** 0.5 to 150 Mc
**COILS:** Five plug-in type, all supplied. When not in use coils can be plugged into a rack on side of the instrument case
**DIAL CALIBRATION:** Direct reading in frequency
**ACCURACY:** ±2%, 0.5 to 16 Mc; ±3%, 16 Mc to 150 Mc
**RESONANCE INDICATOR:** Incandescent lamp
**ACCESSORIES SUPPLIED:** Two spare indicator lamps
**DIMENSIONS:** 4¾ x 5⅞ x 5¾ inches, over-all
**WEIGHT:** 3 pounds
**PRICE:** Type 566-A WAVEMETER — $60.00

### TYPE 758-A WAVEMETER

**FREQUENCY RANGE:** 55 to 400 Mc
**COILS:** A single turn loop; inductance and capacitance are varied simultaneously
**DIAL CALIBRATION:** Direct reading in frequency
**ACCURACY:** ±2%
**RESONANCE INDICATOR:** Incandescent lamp
**TEMPERATURE AND HUMIDITY:** Over ranges normally encountered, accuracy is independent of both
**DIMENSIONS:** 5 x 5 x 4¾ inches, over-all
**WEIGHT:** 1 pound, 12 ounces
**PRICE:** Type 758-A WAVEMETER — $35.00

***ORDER NOW—DELIVERY PROBABLY FROM STOCK***

# GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 | 920 S. Michigan Ave., Chicago 5 | 950 N. Highland Ave., Los Angeles 38

chain of relaxation oscillators and harmonic generators in the left hand column provides the standard frequencies for successive demultiplications. The 100-kc stage is synchronized by a crystal-controlled 100-kc oscillator (not shown). An oscilloscope on each relaxation oscillator (100, 10, and 1 kc) indicates proper synchronization. The harmonic generators are class-C amplifiers. Each decade frequency generator feeds a harmonic generator so that the first nine harmonics of that decade are available by switching. A vacuum-tube voltmeter shows the level of the selected harmonic. A 6L7 is used as mixer. A second vtvm indicates if a signal is passing the filter.

In operation the unknown frequency is applied to the first mixer. If it is lower than the cutoff of the first filter, the signal indicating vtvm will deviate; if not, then the proper beating frequency is selected from the harmonics of the highest decade oscillator. The process is followed through successive demultiplications; the residual frequency being indicated on the direct-reading frequency meter. As a check on the operation of the equipment, higher instead of lower harmonics can be used to produce the required beat-frequencies to pass the filters, and the unknown frequency found by subtraction.

To provide isolation from power-line frequency, the actual filters are band-pass. The 10 mc, 100, 10, and 1 kc filters pass from 600 cps to a frequency 600 cps above their normal ones; the 100-cps filter passes from 120 to 220 cps; and the 10-cps filter passes from 10 to 20 cps. The 100-cps standard frequency has been increased to 500 cps, and the 10-cps one to 110 cps. Thus harmonics of these last two beating frequencies are actually high. The direct-reading frequency meter indicating instrument scale has been increased by 610 cps so that the final frequency reading is correct without modification.

Reliable operation of the instrument depends on the mixers functioning on the proper portions of their characteristics, necessitating an input of ten millivolts below 10 mc and 0.8 volts above 10 mc. That there is sufficient voltage can be seen from the vitvm. The frequency

*Six popular types* for communication, television and industrial control applications

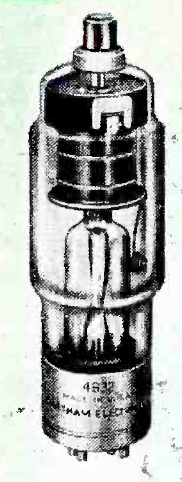
Each of the tubes illustrated below offers exceptional qualities in its particular field of application. Mechanical construction is especially rugged and greatly exceeds minimum requirements for the class of service for which the tube was designed. All voltage and load current ratings are conservative for maximum protection against accidental overload. For information on the complete line of CHATHAM rectifiers or for engineering collaboration in applying any CHATHAM tube to a particular circuit, call or write today, without obligation.

# HIGH PERFORMANCE CHATHAM RECTIFIERS

**ZENON RECTIFIERS:**
Types 4B32 and 3B28 are Zenon filled rectifiers capable of handling relatively high current loads with complete freedom from arc-back through an extended range of ambient temperatures (—75°C to +90°C).

**ZENON THYRATRONS:**
Thyratrons 5594 and 2D21 feature the rugged construction essential to long life in many industrial applications. Zenon gas fill insures stable grid control characteristics through ambient temperatures from —75°C to +90°C without the use of blowers, heaters, etc., to maintain bulb temperature.

**TELEVISION RECTIFIERS:**
Types 1Y2 and 1Z2 high vacuum rectifiers are specially designed to facilitate the engineering of economical high voltage power supply systems for cathode ray tubes. Ideally suited to television equipment, electrostatic precipitators, etc., they supply high voltage at low current values and operate efficiently from either a 60 cycle or RF power source.



**4B32 ZENON RECTIFIER**

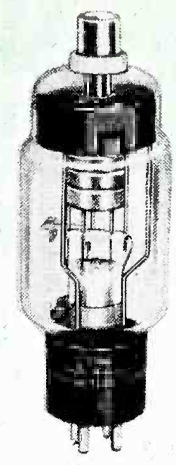
PEAK INVERSE VOLTAGE: 10,000 VOLTS

AVERAGE ANODE CURRENT: 1.25 AMPS.

PEAK ANODE CURRENT: 5.0 AMPS.

CONSTANT VOLTAGE DROP: 10 VOLTS

FILAMENT VOLTAGE: 5.0 V.A.C.



**5594 ZENON THYRATRON**

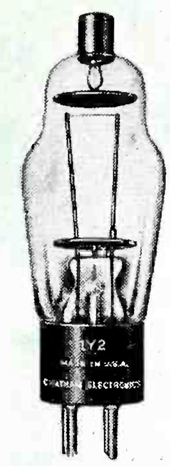
PEAK FORWARD ANODE VOLTAGE: 2500 VOLTS

PEAK INVERSE VOLTAGE: 5000 VOLTS

AVERAGE ANODE CURRENT: 0.5 AMPS.

PEAK ANODE CURRENT: 2.0 AMPS.

FILAMENT VOLTAGE: 2.5 VOLTS



**1Y2 RECTIFIER**

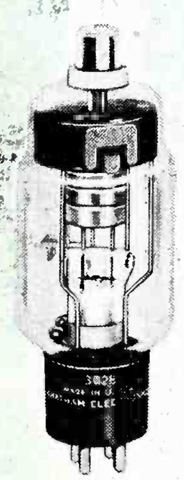
PEAK INVERSE VOLTAGE: 50,000 VOLTS

D.C. LOAD CURRENT: 2 MA.

PEAK ANODE CURRENT: 18 MA.

FILAMENT VOLTAGE: 1.25 VOLTS

FILAMENT CURRENT: 265 MA.



**3B28 ZENON RECTIFIER**

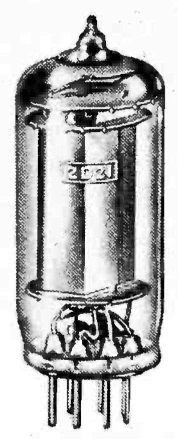
PEAK INVERSE VOLTAGE: 10,000 VOLTS

AVERAGE ANODE CURRENT: 250 MA.

PEAK ANODE CURRENT: 1.0 AMP.

CONSTANT VOLTAGE DROP: 10 VOLTS

FILAMENT VOLTAGE: 2.5 V.A.C.



**2D21 ZENON THYRATRON**

PEAK FORWARD ANODE VOLTAGE: 650 VOLTS

PEAK INVERSE VOLTAGE: 1300 VOLTS

AVERAGE ANODE CURRENT: 100 MA.

PEAK ANODE CURRENT: 500 MA.

HEATER VOLTAGE: 6.3 VOLTS

**1Z2 RECTIFIER**

PEAK INVERSE VOLTAGE: 25,000 VOLTS

D.C. LOAD CURRENT: 2 MA.

PEAK ANODE CURRENT: 18 MA.

FILAMENT VOLTAGE: 1.25 VOLTS

FILAMENT CURRENT: 265 MA.

**CHATHAM ELECTRONICS**

475 WASHINGTON ST., NEWARK 2, NEW JERSEY

measured by the demultiplier is, except for that portion read on the direct-reading instrument, independent of operator's judgment in reading an indicating instrument. Furthermore, no forehand knowledge of the order of magnitude of the unknown frequency is required.

## Survey of New Techniques

ELECTRONICS, regardless of how one defines it, can accomplish quite a variety of results and is concerned with numerous techniques. By way of indicating this diversity, here are brief descriptions of some recently developed electronic and related techniques.

Diameters of distant stars are measured by astronomers at Mt. Wilson observatory using diffraction bands produced when stars are eclipsed by the moon. Sharpness of diffraction patterns is a measure of the size of the light source. As bands of light produced during a stellar eclipse pass the telescope at roughly 1,000 mph, a 1P21 phototube converts them into electrical current that in turn is depicted on an oscilloscope. The oscilloscope trace is recorded on a continuously moving film. The pattern so produced shows characteristics of the diffraction pattern from which the star's diameter can be computed.

Saturable-core reactors, frequently used in control of large currents by small ones, are used in

Principles of spectrophotometry are applied to fluorimetry in this instrument developed by Dr. T. E. Friedmann to identify vitamins by their emitted light

measuring magnetic fields. Two identical coils, wound on thin strips of high-permeability alloy, are connected in series and excited from an oscillator. Secondary coils wound on each of these coils are connected in series opposition and across a voltmeter. The two transformers so formed are placed a short distance apart. If there is a difference in magnetic field between the cores of the two transformers, there will be a voltage indication. In this manner gradients of one thousandth of a gauss per meter in the earth's magnetic field can be detected by the gradiometer developed at Westinghouse Research Laboratories.

Nutrition of foods is measured by an electronic fluorimeter developed at Northwestern University. By an electronic amplifier employing a modified Wheatstone bridge, a wide range of sensitivity and absence of zero drift is obtained in this instrument that measures the light given off by vitamins. The instrument, manufactured by Central Scientific Co., is shown in the accompanying picture.

Movements of insects can be followed by attaching a small amount of radium sulphate to them and detecting the radioactivity with a Geiger-Muller tube. For convenient field use, a G-M tube having stability, low background noise, and high sensitivity has been developed by Century Electronics (London, England). With the tube and its associated power supply, sufficient output is obtained to operate a loudspeaker directly and to locate through four inches of soil an insect carrying five micrograms of tracer. Periodic ticks from the loudspeaker increase in rate as the insect is approached.

For high-frequency insulation, barium titanate, whose properties were discovered at the Soviet Academy of Sciences of the U.S.S.R., retains its characteristics satisfactorily over a wide range of high and low temperatures and high pressures. Its dielectric constant is 100 times that of mica.

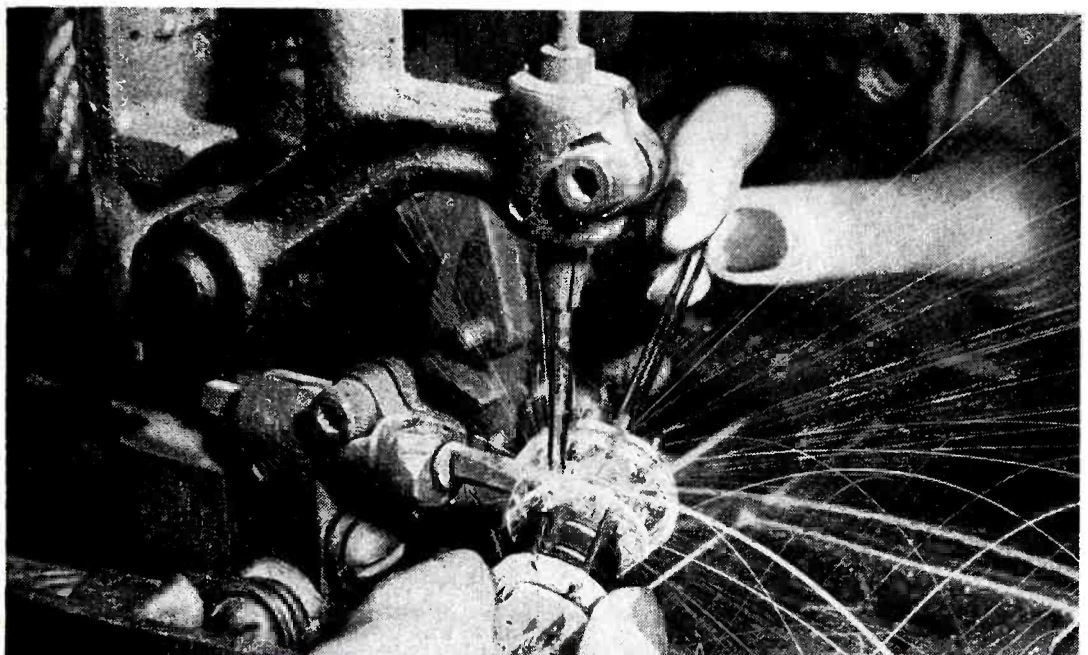
Noise, one of the most annoying obstacles in applying electronic techniques, is to be studied in a special hangar being built at the Naval Air Test Center, Patuxent River, Md. The hangar itself is large enough to accommodate all sizes of

# SYLVANIA NEWS

## CIRCUIT ENGINEERING EDITION

**MAY** *Prepared by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. **1947**

# INEXPENSIVE, IMPROVED ALLOY DEVELOPED FOR BETTER TUBE CONSTRUCTION



**WELDING CONNECTIONS. All connections in the Lock-In Tube are welded for greater durability. Short, direct connections result in fewer joints and lower loss.**

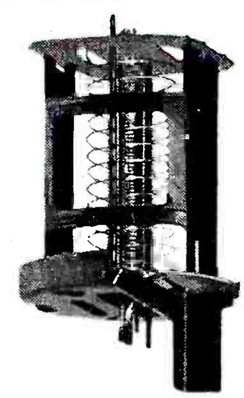
**GLASS HEADERS. Small cylindrical cups of glass and metal pins are pressed into the low-loss glass base to which is joined the small glass exhaust tubing.**

## Sylvania's #4 Alloy Integral Part Of Superior Lock-In Tube

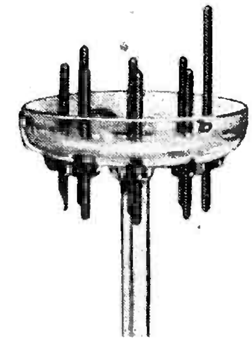
A specially developed metal product—#4 alloy—contributes greatly to the superiority of the Sylvania Lock-In Tube. It is inexpensive, an excellent electrical conductor, strong, and, most important of all, has a thermal expansion curve to match the all-glass header into which the #4 alloy element leads are directly brought. These same leads act as the socket pins—and are always in rigid contact with the header under varying heat conditions.

### LOCK-IN MOUNT AND GLASS HEADER

IMPROVED MOUNT .... elements are ruggedly supported on all sides. Meticulous accuracy is required to fit and weld each part to the others to become the finished mount. There are few welded joints and no soldered joints — the elements can't warp or weave.



ALL-GLASS HEADER .... through which element leads are directly brought — low-loss and better spacing of lead wires. These leads become the sturdy socket pins — effecting a much desired reduction in lead inductance and inter-element capacity.



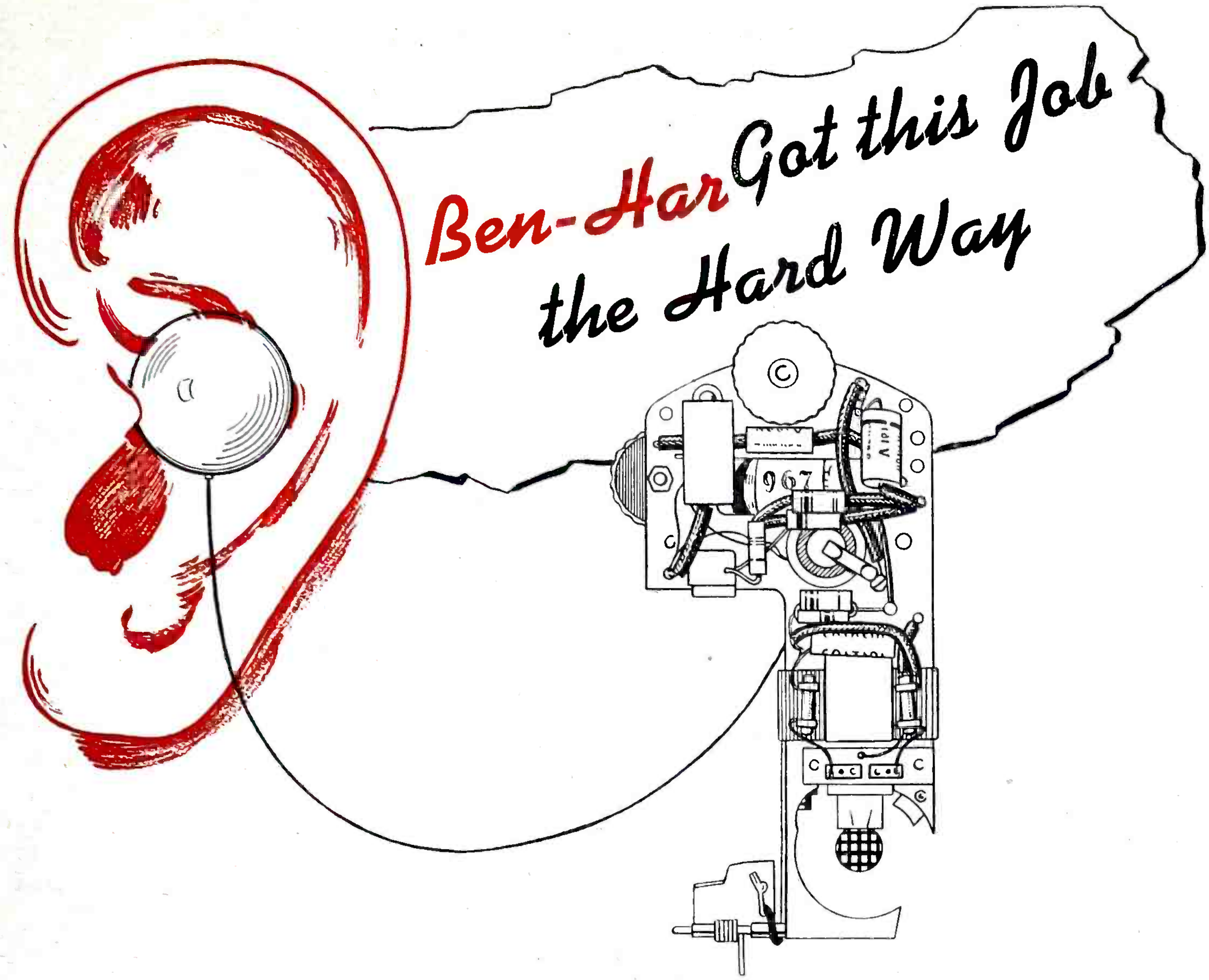
*Radio Tube Division, Emporium, Pa.*

# SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS planes. Shops, offices, and additional test rooms flank the hangar proper. In addition to the usual hangar door there is a shielded framework that, when closed, keeps out electrical disturbances but lets in light and air. Galvanized metal wire in $\frac{1}{8}$-in. mesh is used as the shield. Its installation will require about four miles of soldering in bonding all joints. Two layers of similar mesh are being laid in the concrete floor. Water pipes, entering the shielded volume, are bonded to the mesh. Because the mesh would distribute and dissipate heat, the automatic fire sprinkler system is inside the mesh, but bonded to it. Electrical lights are installed outside the shield so that their disturbances will not enter the test space. The screen over lights is $\frac{1}{4}$-in. mesh to permit passage of more light; there are no windows. Two solid copper shields spaced from each other surround the smaller test rooms. Bronze spring contacts join the screening at doors.

The International Committee of Weights and Measures, meeting during October 1946, designated an international ohm and volt to replace previously used absolute units. New international units were obtained by taking the means of units maintained by national laboratories of France, Germany, Great Britain, Japan, Russia, and the United States. The mean international ohm is 1.00049 absolute ohms; the mean international volt is 1.00034 absolute volts.

Optical glass is cleaned by electronic bombardment. Mirrors for television projectors are bombarded in vacuum chambers by electrons emitted from incandescent tungsten filaments and attracted to the mirrors by high positive voltages. The electrons heat the surface of the mirrors, thus evaporating the residue of moisture left on them after grinding and polishing. The surface cools almost instantly after bombardment. Mirrors are then coated by evaporating aluminum onto them while still in the chambers. Electronic bombardment was developed at Bausch & Lomb Optical Co. because the aluminum will not adhere to a heated surface. Other methods of drying the surface left mirrors warm.




Insulation is so important to the Maico Company, manufacturers of medical acoustic instruments, that they conducted a series of tests culminating in 108 hours in a moisture chamber. The sole survivor of the tests was Ben-Har Special Treated Fiberglas Tubing.

"Ben-Har is outstanding," according to Maico engineers, "in its ability to withstand the effects of body heat and humidity to which hearing aids are exposed. After 108 hours in the moisture chamber Ben-Har showed a resistance of 3,000 megohms compared to 5 megohms for double saturated cotton sleeving and even less for the single saturated cotton sleeving. All materials showed approximately the same megohms resistance before exposure to test conditions.

Ben-Har bends without cracking. Its extreme flexibility is ideal in the assembly of small parts. Ben-Har is non-fraying, will not support combustion.

Try Ben-Har in your own plant, in your own product—under actual service conditions. Find out about the production advantages that have led so many manufacturers to standardize on Ben-Har.

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

# BH Fiberglas* SLEEVINGS

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

USE COUPON NOW

Bentley, Harris Mfg. Co., E-10, Conshohocken, Pa.

I am interested in Ben-Har Special Treated Fiberglas Tubing_____ for __________
(size) (product)
operating at temperatures of_____°F. at_____volts. Send samples so I can see for myself how Ben-Har will not crack in a bend, will not support combustion.

NAME ________________ COMPANY ________________

ADDRESS ________________

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

☐ Cotton-base Sleeving and Tubing
☐ Non-fraying Fiberglas Sleeving

planes. Shops, offices, and additional test rooms flank the hangar proper. In addition to the usual hangar door there is a shielded framework that, when closed, keeps out electrical disturbances but lets in light and air. Galvanized metal wire in ⅛-in. mesh is used as the shield. Its installation will require about four miles of soldering in bonding all joints. Two layers of similar mesh are being laid in the concrete floor. Water pipes, entering the shielded volume, are bonded to the mesh. Because the mesh would distribute and dissipate heat, the automatic fire sprinkler system is inside the mesh, but bonded to it. Electrical lights are installed outside the shield so that their disturbances will not enter the test space. The screen over lights is ¼-in. mesh to permit passage of more light; there are no windows. Two solid copper shields spaced from each other surround the smaller test rooms. Bronze spring contacts join the screening at doors.

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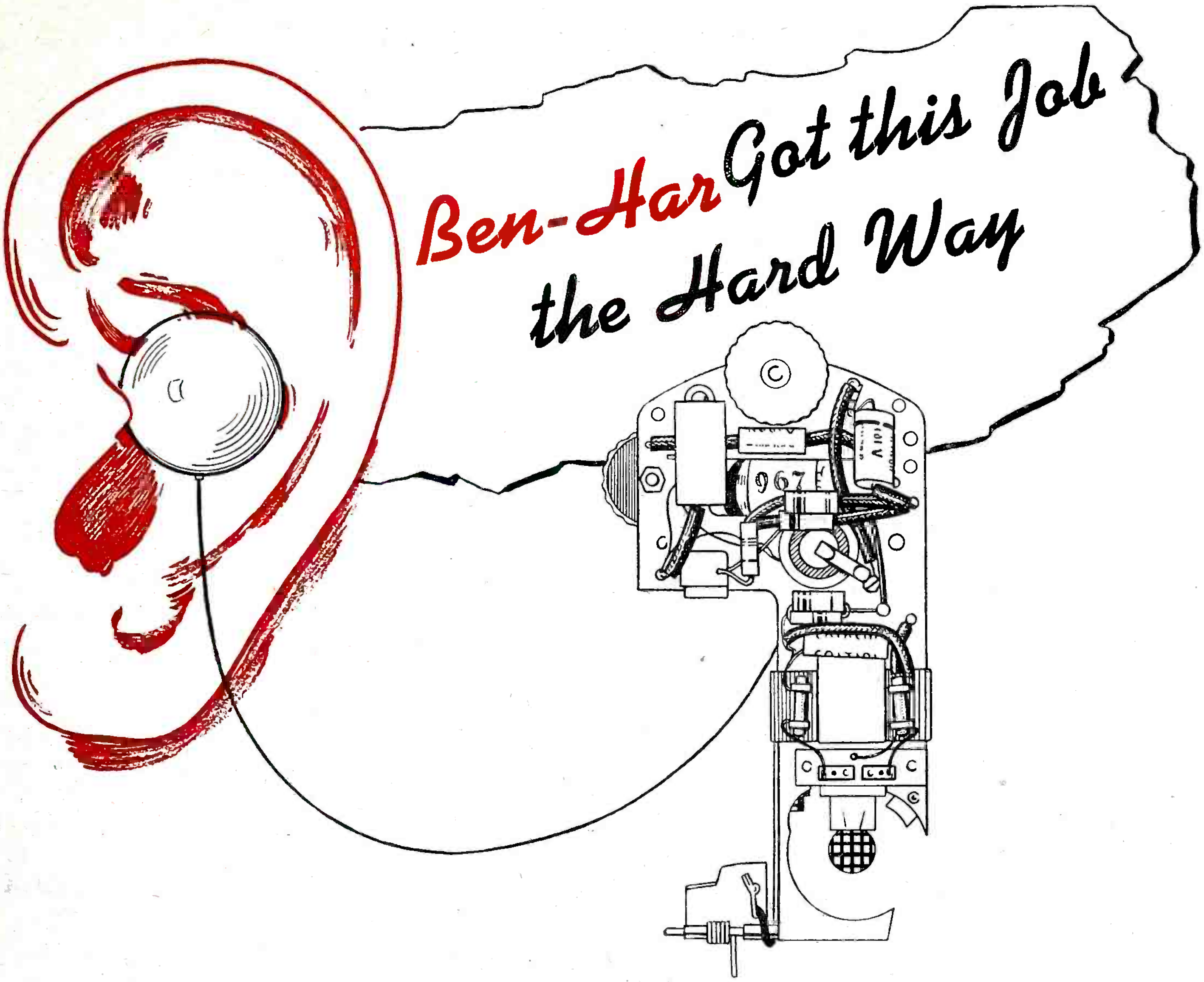


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USE COUPON NOW

Bentley, Harris Mfg. Co., E-10, Conshohocken, Pa.

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NAME_____ COMPANY_____

ADDRESS_____

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

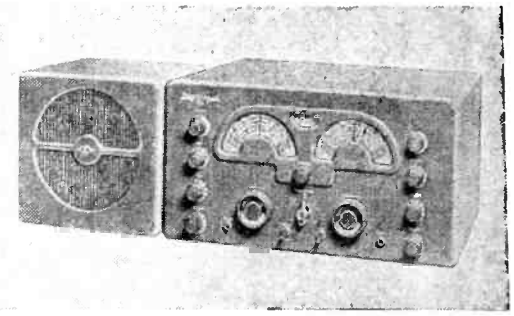
☐ Cotton-base Sleeving and Tubing
☐ Non-fraying Fiberglas Sleeving

**NEW PRODUCTS**
(continued from p 148)

frequency voltmeter is an adaptation of the model 45 circuit for audio measurements from 15 to 30,000 cycles. High available transconductance has been employed to obtain a large feedback factor and thus a stability that is independent of tubes and line voltage. Scale steps are provided every 10 vu from minus 84 to plus 55 vu. Voltages as low as 50 microvolts are directly measurable. Input impedance is 1 megohm and 12 micromicrofarads. A descriptive sheet giving further details is available from the manufacturer.

### Everyman's Receiver (11)

NATIONAL COMPANY, Inc., Malden, Mass. The NC-173 receiver covers the spectrum from 540 kc to 31 mc and 48 to 56 mc. Bandspread tuning is provided for the main amateur bands. The 13-tube superheterodyne has been engineered to



satisfy short-wave listeners, communications people including amateurs, as well as broadcast listeners who want versatile equipment. Voltage regulation stabilizes beat-frequency and crystal-filter operation. The receiver is equipped with noise limiter, signal-strength meter, low-and high-impedance audio output as well as a high-impedance input for phonograph pickup or other similar device. The price with speaker is $189.50.

### Microfilm Library (12)

ELECTRONICS RESEARCH Publishing Co., 2 West 46th St., New York 19, N. Y. The total editorial content of ELECTRONICS from April 1930 to December 1945 is now available on 35 mm microfilm and can be projected in any standard viewer. Nine rolls are required for this material. *Communications, Electronic Indus-*

# Here Permanent Magnets are Designed

## ···FOR RESULTS!

*The Indiana Steel Products Company offers you the advantages of the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet sub-assemblies.*

Results that pay off in performance are the results you get in permanent magnets made by *The Indiana Steel Products Company.* Here permanent magnets are functionally designed and manufactured to meet exacting specifications for *more efficient and economical* performance of the device or instrument they serve.

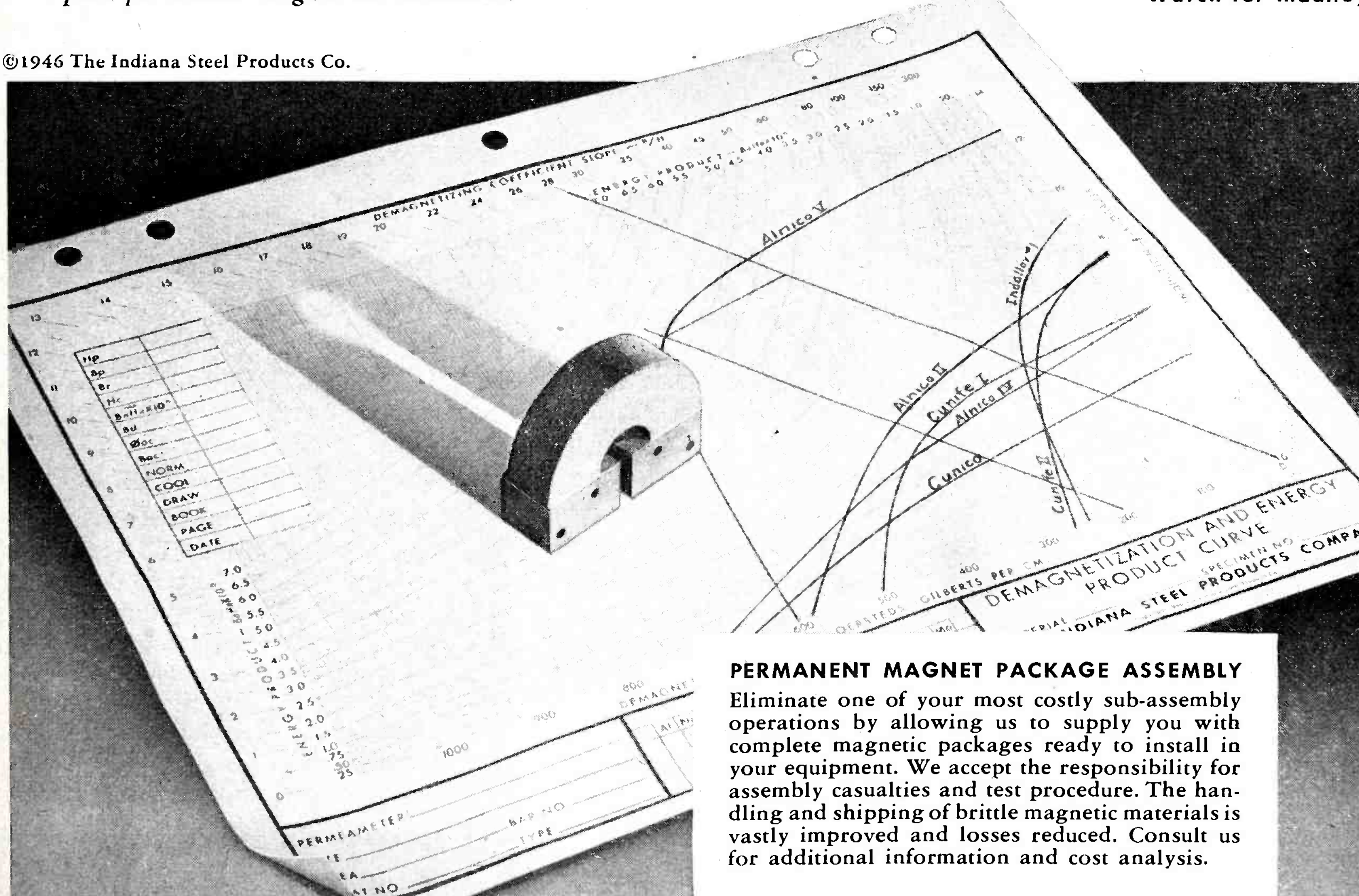
## *This Is No Secret Formula...*

The chart shows the typical demagnetization and energy product curves on which our engineers base their calculations. It shows the characteristics of various kinds of permanent magnet materials which can be expected in our production, and from which the optimum designs can be determined. Such fundamental information permits us to engineer the inside of your magnet so that each one will give you a maximum result.

**ALNICO (Cast and Sintered) • CUNICO • CUNIFE • VECTOLITE • SILMANAL**

***Watch for Indalloy***






**PERMANENT MAGNET PACKAGE ASSEMBLY**

Eliminate one of your most costly sub-assembly operations by allowing us to supply you with complete magnetic packages ready to install in your equipment. We accept the responsibility for assembly casualties and test procedure. The handling and shipping of brittle magnetic materials is vastly improved and losses reduced. Consult us for additional information and cost analysis.

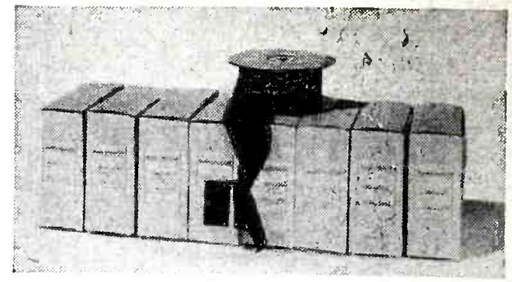
**THE INDIANA STEEL PRODUCTS COMPANY**

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

ISP

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

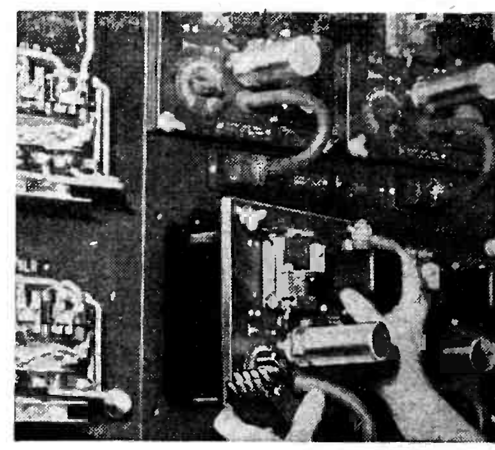
PLANTS { VALPARAISO, INDIANA
STAMFORD, CONN.



*tries*, and *FM & Television* have been similarly recorded. Price of each 100-foot roll is $11.50.

### Quick-Change Control Unit (13)

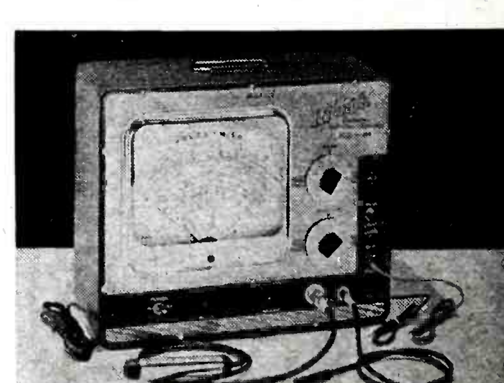
CUTLER-HAMMER, Inc., 243 North 12th St., Milwaukee, Wis. An electronic control unit panel equipped with captive wing nut mounting and multiple contact plug allows practically uninterrupted machine



operation. Maintenance on the control unit can be effected after a spare unit has been inserted in its place.

### Probe Meter (14)

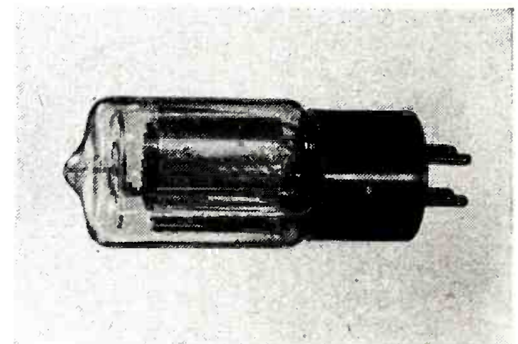
HICKOK ELECTRICAL Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio. The Model 209 electronic volt-ohm-capacitance - milliammeter with a low capacitance, high frequency probe is designed for use in measuring any voltage, capacitance or resistance that may be encountered in any radio receiver. It measures resistance accurately from



0.1 ohm to 10,000 megohms; capacitance of electrolytics, mica, paper, and variable air capacitors; a-f, i-f and r-f voltage from 30 cycles to 300 megacycles. Input impedance for a-c is 12 megohms shunted by 6 micro microfarads and for d-c is 15 megohms.

### Grid Control Rectifier Tube (15)

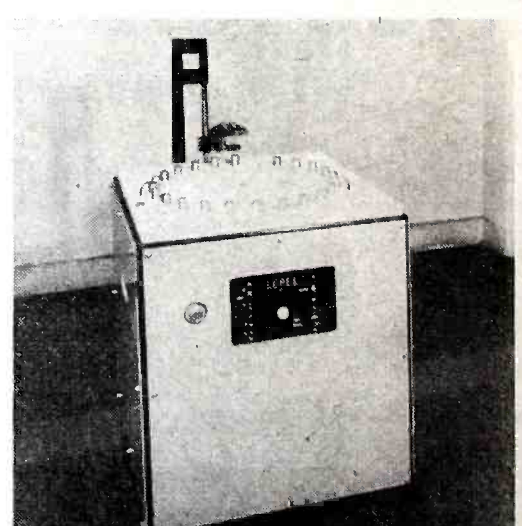
ELECTRONS INC., 127 Sussex Ave., Newark 4, N. J. The type EL C1J grid control, xenon-filled rectifier has an average drop of 8 volts. Characteristics include an average



anode current, 1.0 amp; peak anode current, 8.0 amp; maximum peak inverse voltage 700 v; and filament voltage, 2.5 v. The tube has been designed for motor-control, servo-amplifier, high-speed counting and similar circuits.

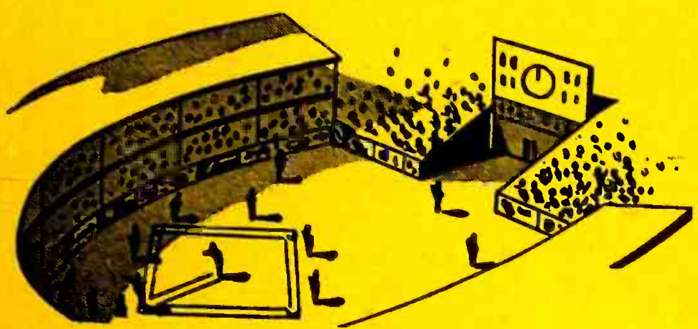
### Indexing Table (16)

LEPEL HIGH FREQUENCY Laboratories, Inc., 39 West 60th St., New York 23, N. Y., has announced a new indexing table, to be used for soldering, brazing and annealing of round or irregularly-shaped small parts. This unit has been developed particularly for heating of parts



## ℞ FOR STADIUMS

planning a bonanza baseball season. How often have you calculated the number of watts of power to cover a large stadium and then figured how many ordinary 30 to 50 watt amplifiers would be required with the attendant engineering problems of wiring, maintenance, vacuum tube replacement*, space requirements, trouble potentialities and installation costs?



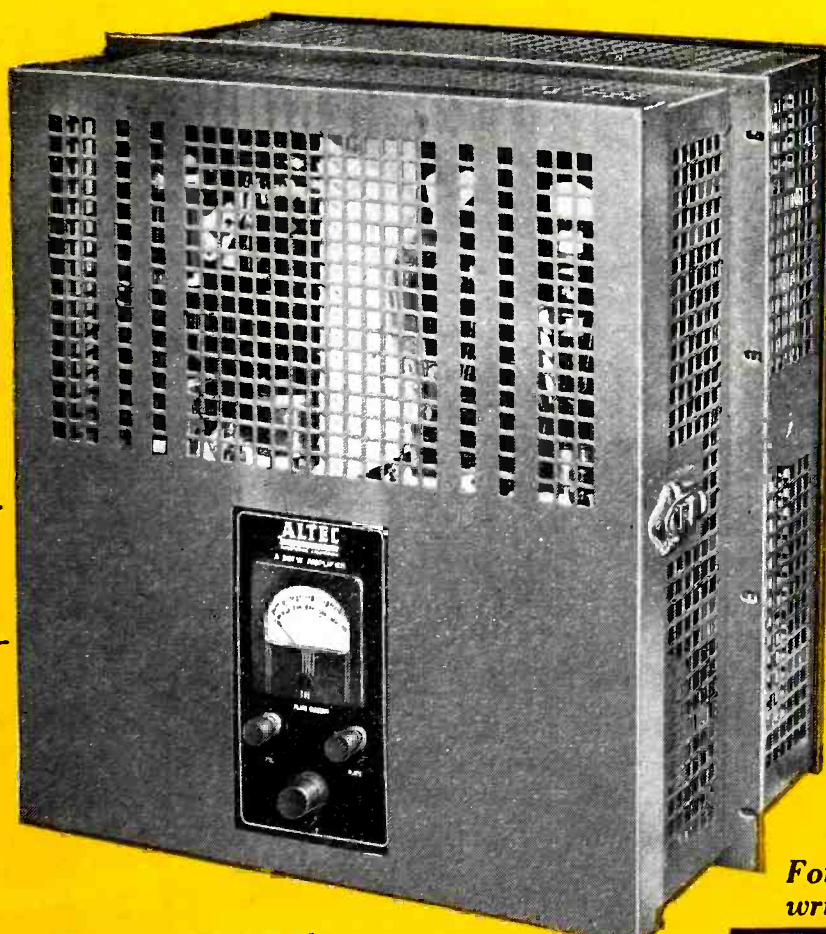
The A-287W amplifier is simplicity personified — one amplifier, 4 tubes, ¼ to ½ kilowatt of undistorted power in a space 19¼" high by 19" wide by 12½" deep.

When you have to quote in competition, systems using the A-287W will cost less per watt of audio power (honest power) delivered.

# ALTEC LANSING

## A-287W AMPLIFIER

¼ *kilowatt*
(nominal)



*Immediate Delivery*

It is being used in BRIGGS STADIUM, Detroit; GRIFFITH and ULINE ARENA, Washington; GARDENS, Pittsburgh; the ATLANTIC CITY CONVENTION HALL and is standard equipment for Drive-In Motion Picture Theatres.

**In the Altec Lansing A-287W amplifier, two tubes do the work of 40 tubes in ordinary PA amplifiers.*

*For technical data, write for bulletin W.*

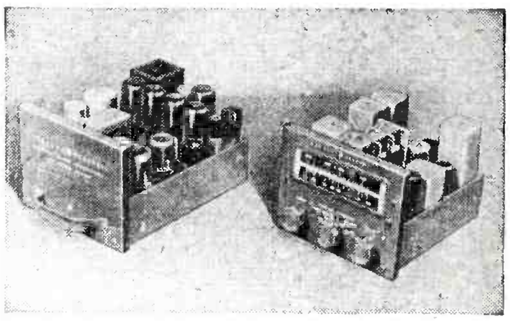
**ALTEC**
LANSING CORPORATION
1161 N. VINE ST., HOLLYWOOD 38, CAL.
250 W. 57th ST., NEW YORK 19, N. Y.

"Keep Advancing with Altec Lansing"

where shape or control of heat requires closer or more accurate coupling than can be achieved by moving the parts through a tunnel-type coil. The new table can be used in conjunction with any high-frequency converter or generator, and comes equipped with a built-in automatic timer.

### Private Plane Radiophone (17)

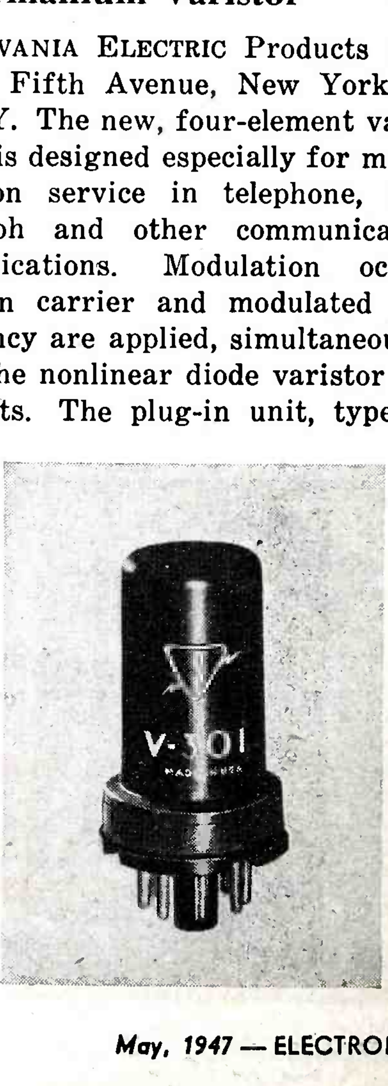
GENERAL ELECTRIC Co., Syracuse, N. Y. The new Type AS-1C equipment provides the private flyer with two-way tower and radio range communication as well as broad-



cast reception. The transmitter operates on 3105 kc with a carrier output of 12 watts. Equipment operates directly from a 12-volt power system.

### Germanium Varistor (18)

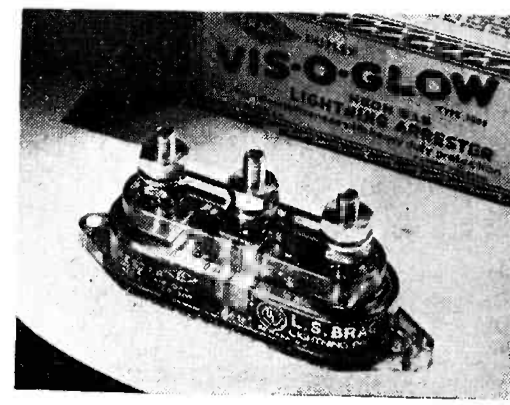
SYLVANIA ELECTRIC Products Inc., 500 Fifth Avenue, New York 18, N. Y. The new, four-element varistor is designed especially for modulation service in telephone, telegraph and other communication applications. Modulation occurs when carrier and modulated frequency are applied, simultaneously, to the nonlinear diode varistor elements. The plug-in unit, type V-



301, contains four germanium crystal diodes mounted in a compact metal shell supplied with an 8-pin octal base. The type V-307 has solder-type terminals and similar electrical characteristics. Diodes are selected for forward resistance of 85 to 120 ohms at 1.5 volts. Modulator ratings for each of the four diodes are as follows: maximum inverse voltage, 25 v; maximum average current, 20 ma.; maximum peak current, 40 ma.; maximum instantaneous surge current, 50 ma.

### Lightning Arrester (19)

L. S. Brach Mfg. Corp., Newark, N. J. The Vis-O-Glow is used to protect radio receivers from transient voltages induced by lightning or power lines. The arrester tube by-

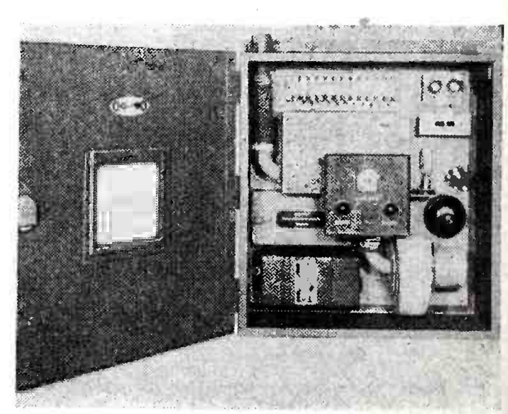




passes the surge to ground. A neon gas tube inside the Lumarith XF arrester glows while conducting lightning charges to ground. The device sells for approximately $1.95.

### Smoke Detector (20)

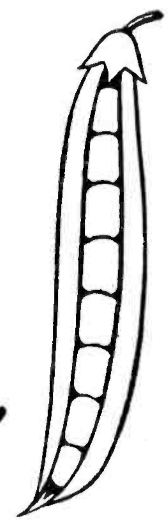
C-O-Two Fire Equipment Co., Box 390, Newark 1, N. J. A new industrial smoke detector, designed to detect fire in fur, storage or record vaults operates on the principle of light reflected by smoke particles onto a photoelectric cell. Air samples are continuously drawn into a

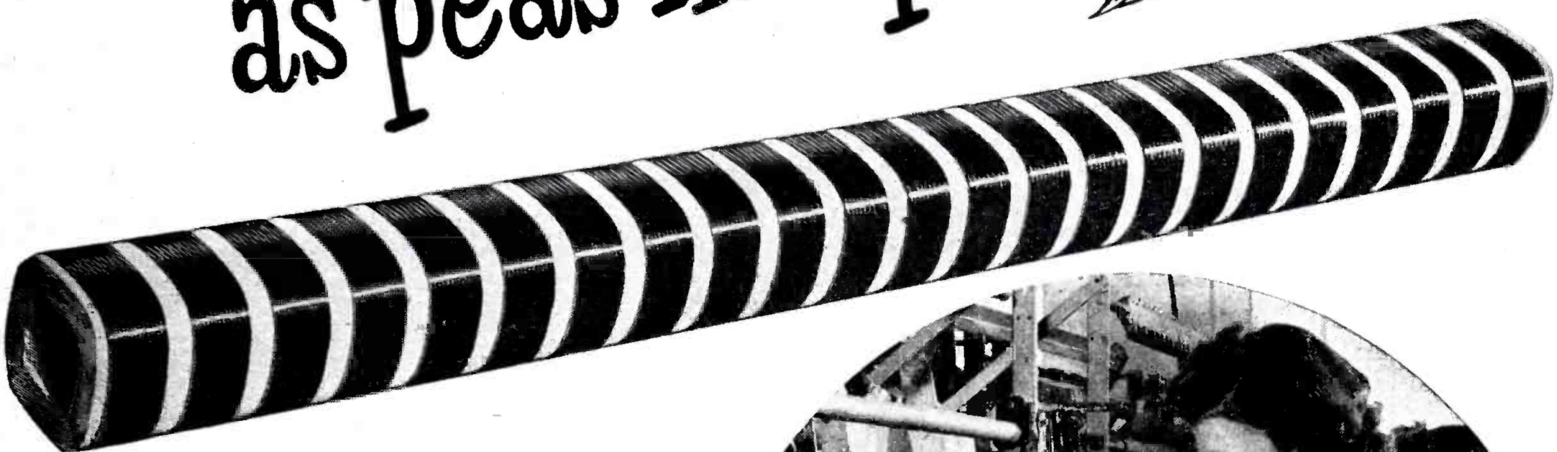


ESSEX *EXTRA-TEST* MAGNET WIRE

Insures Multiple-Wound Coils

# ALIKE
# as peas in a pod





Coil winding—particularly multiple (gang) layer-winding—demands wire uniformity to insure—

- Coils of uniform size and resistance value.
- Maximum turns in available space.
- Freedom from broken wires, pile-ups, crossed turns, run-backs, spaced turns, and frequent tension adjustment.

All of which means *better coils* plus *increased production.*

When you specify Essex *Extra-Test* Magnet Wire you're *sure* of finished multiple-wound coils "alike as peas in a pod."

WIRE SX PRODUCTS

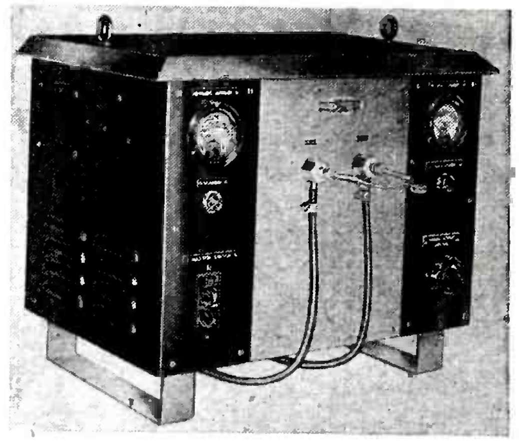
**ESSEX WIRE CORPORATION**
**FORT WAYNE 6, INDIANA**

Plants: Fort Wayne, Indiana; Detroit, Michigan; Anaheim, California
Warehouses* and Sales Offices: *Atlanta, Ga.; *Boston, Mass.; *Chicago, Ill.; *Minneapolis, Minn.; Dayton, Ohio; *Detroit, Mich.; Kansas City, Mo.; *Newark, N. J.; Philadelphia, Pa.; *St. Louis, Mo.; Cleveland, Ohio; Milwaukee, Wisc.; San Francisco, Calif; *Los Angeles, Calif.

detecting chamber. At the first sign of smoke, a red lamp is lighted and an alarm sounds.

### Bench Model Induction Heater (21)

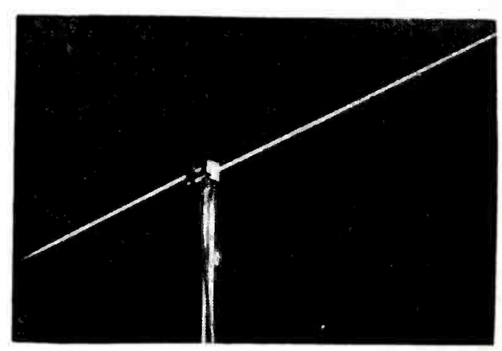
SCIENTIFIC ELECTRIC, Division of S Corrugated Quenched Gap Company, Garfield, N. J. A new 2-kw induction heating unit is 22 in. wide, 20 in. high and 16 in. deep. It comes complete with foot switch



and one work coil which can be from ½ to 2½ inches in diameter; the unit will operate with a coil of one turn to a maximum of 20 turns. The price is $650.

### F-M Receiver Antenna (22)

WESTINGHOUSE ELECTRIC CORP., Box 868, Pittsburgh 30, Pa. A new dipole with a swivel base for mount-



ing on any convenient structure is made of aluminum. Designed for the 88 to 108 megacycle f-m band, the new antenna retails for $9.95.

### Mercury Switches (23)

CHATHAM ELECTRONICS, 475 Washington St., Newark 2, N. J. A new line of mercury switches that are compact and light makes it possible to incorporate them in practically any equipment requiring positive

# electronics READER SERVICE . . .

# LITERATURE and NEW PRODUCTS

Manufacturers' Literature as well as further information on New Products described in this issue are important "working tools" for design and production departments. To make it easy to keep up to date, ELECTRONICS will request manufacturers to send readers the literature in which they are interested. Just fill out card as shown in the filled-in sample *(right), being particularly careful to write out in full all the information called for in each section of each card that is used.*

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| Write in circle number of item describing one item wanted → (14)<br>Your Company Name Jones Mfg. Co.<br>Address 3217 Lewis Ave.<br>Chicago 13, Ill.<br>Your Name Geo. Smith<br>Your Title Chief Engineer<br>ELECTRONICS, 330 W. 42nd St., N. Y. 18 | Write in circle number of item describing one item wanted → (32)<br>Your Company Name Jones Mfg. Co<br>Address 3217 Lewis Ave.<br>Chicago 13, Ill<br>Your Name Geo. Smith<br>Your Title Chief Engineer<br>ELECTRONICS, 330 W. 42nd St., N. Y. 18 |
| Write in circle number of item describing one item wanted → (37)<br>Your Company Name Jones Mfg. Co<br>Address 3217 Lewis Ave.<br>Chicago 13 Ill.<br>Your Name Geo. Smith<br>Your Title Chief Engineer<br>ELECTRONICS, 330 W. 42nd St., N. Y. 18 | Write in circle number of item describing one item wanted → (49)<br>Your Company Name Jones Mfg. Co.<br>Address 3217 Lewis Ave.<br>Chicago 13, Ill.<br>Your Name H. S. Towne<br>Your Title Adv. Mgr.<br>ELECTRONICS, 330 W. 42nd St., N. Y. 18 |

**SAMPLE CARD SHOWING CORRECT FILL-IN**

## HOW TO ORDER:

**1.** There are two postcards, each divided into four parts. Each of the four parts contains a box. You must write in this box the number that appears in this issue over the literature or new product item in which you are interested. Place one number only in each box.

**2.** Fill out completely (name, address, etc.) for each piece of literature or new product information you desire.

*Do not say* "same" in lieu of writing out full information called for when requesting more than one item.

**3.** This service applies only to literature and new product items in this issue. It does not apply to advertisements. Write directly to the company for information on its advertisements.

**PLEASE NOTE: Requests for unnumbered items must be made direct to the manufacturer.**

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached along perforated lines and dropped in the mail. Each individual request will be mailed by us to the company offering the information and for that reason must be completely filled out.

**PLACE 1¢ STAMP ON CARD • DO NOT USE AFTER AUGUST 1**

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|---|---|
| Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. | Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. |
| Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. | Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. |
| Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. | Write in circle number of item describing one item wanted → ◯<br>Your Company Name.................<br>Address.................<br>.................<br>Your Name.................<br>Your Title.................<br>ELECTRONICS, 330 W. 42nd St., New York 18, N. Y. |
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# An electronics service designed for
# READERS and MANUFACTURERS

***FOR THE READER . . .*** ELECTRONICS fundamental policy has always been to supply its readers with all the pertinent and timely industry news. The ELECTRONICS Reader Service supplements this policy by offering the reader an easy and effective means of obtaining complete, up to the minute data on new products and of maintaining at his fingertips comprehensive, practicable information on "who's doing what" in the industry.

In every issue of ELECTRONICS there's complete coverage of the month by month development by manufacturers of new materials, components and equipment, as well as brief mention of all the important, new, manufacturers' technical pamphlets and catalogs. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the new products described or they will want to read and make a permanent part of their industrial library some of the manufacturers' literature and catalogs. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

***FOR THE MANUFACTURER . . .***

ELECTRONICS Reader Service will also be welcomed by manufacturers who are desirous of placing the complete news of their product developments as well as their technical bulletins and catalogs in the hands of those members of the electronic industry . . . including design, electrical and production engineers, researchers, physicists, executives, and buyers —who have a particular interest in, or represent a potential buying power for, their products.

**SUGGESTIONS FOR THE IMPROVEMENT OF OUR READERS' SERVICE ARE INVITED**

ELECTRONICS is constantly seeking new and improved ways of providing its readers with the news and information they want and need, and of assisting the manufacturer in effectively delivering his message to electronic markets. If you have any ideas for us, send them along. They will receive prompt consideration.

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TYPE 20
(Grounded)

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STABLE CAPACITY FROM −55°C TO +85°C

MINERAL OIL FILLED TO ASSURE LONGER LIFE

# CREDENTIALS *that* QUALIFY!

EXCELLENT BY-PASS AND COUPLING QUALITIES

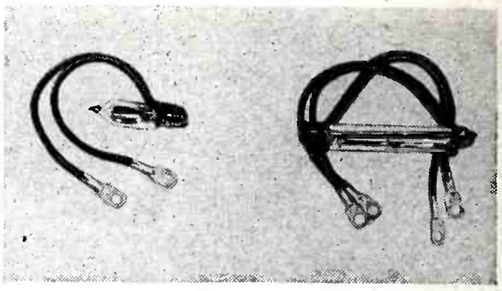
AVAILABLE WITHIN A RANGE OF 200 to 2000 VOLTS WORKING

TYPES 20 AND 21 AVAILABLE NOW FOR *IMMEDIATE DELIVERY*

# SANGAMO — CAPACITORS

SANGAMO CAPACITORS ARE NOW MANUFACTURED IN CANADA BY SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

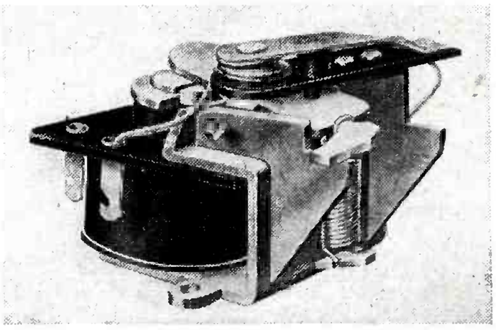
## SANGAMO ELECTRIC COMPANY · SPRINGFIELD, ILLINOIS



switching. Multiple contact types can be supplied in a single unit for simplified mounting.

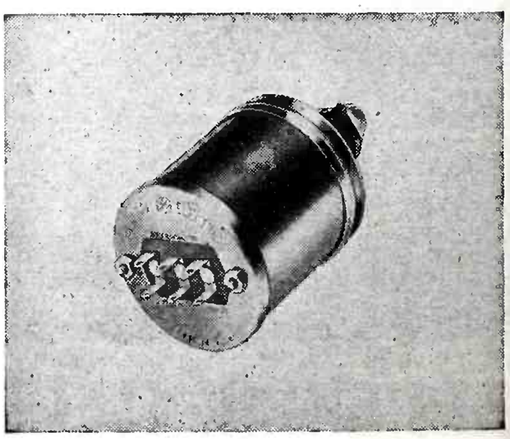
### Blower Motor Relay (24)

WARD LEONARD Electric Co., Mount Vernon, N. Y. The new Bulletin 109 relay is designed specifically for use with single-phase a-c capacitor motors for tube-cooling blowers, oil burners, and other applications. Operational difficulties inherent with centrifugal switches are eliminated. External or remote mounting of the relay is permissible eliminating maintenance difficulties. Contacts are single-pole normally-closed suitable for operation of a load as large as a 1 hp, 115 or 230 volt, 60 cycle capacitor motor.



### Constant Impedance Attenuators (25)

GENERAL ELECTRIC Co., Syracuse, N. Y. Constant impedance attenuators, dissipating 10 watts of power at any setting, have been added to the company's line of radio parts for servicemen and distributors. Providing absolute zero insertion



*NAME PLATE PROBLEMS?*

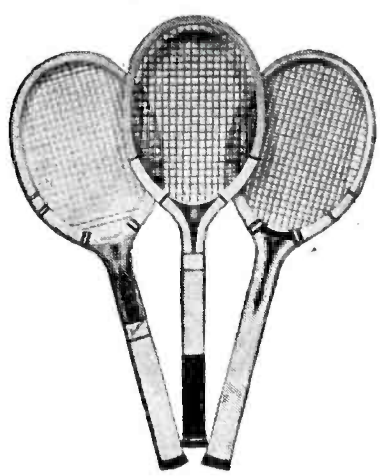
***Investigate the low-cost high-speed application of tough all-color, all-surface***

# MEYERCORD
## DECAL NAMEPLATES

Billions of Meyercord Decals are in use throughout the world. They provide a colorful, highly legible, permanent and easy method of applying any product identification, operating instructions, patent data, lubrication guides, and wiring diagrams. They save time, labor, and materials.

Meyercord Decal nameplates are vibration-proof, eliminate protruding edges and sharp corners, require no screws or rivets for application. Meyercord Decals are durable, washable, and can be produced in any size, colors or design. Popular water methods permit fast application.

Easy-to-use solvents or cements are specified when required. Meyercord research has developed Decals resistant to acid, petroleum products, alkali, alcohol, abrasion, temperature extremes and moisture. Can be used on rough, smooth or crinkled surfaces, flat, concave or convex.



Over fifty years of actual use has demonstrated that genuine Meyercord Decals retain their color and legibility for years without cracking or peeling. There is no commercial surface known for which Meyercord engineers cannot design a Decal for complete and perfect surface adhesion.

Meyercord Decals offer a new efficiency in product identification. Years of experience in setting up high-speed production lines for the application of Decal nameplates have developed many new and different techniques, which are now available to Meyercord customers.

***Technical consultation and designing service is available on request. Address inquiries to Dept. 9-5***

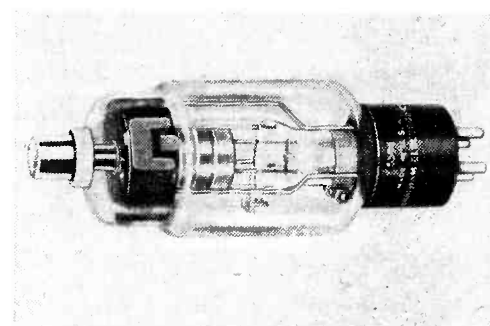
*Founder-Member Lithographic Technical Foundation*

**The MEYERCORD Co.**
World's Largest Decal Manufacturer
5323 W. LAKE ST. CHICAGO 44, ILL.

loss, input and output impedances of the new attenuators are practically constant throughout the entire range of control. Attenuation is linear up to 30 decibels in ten steps, beginning with absolute zero and progressing in three db steps up to 24 db, followed by infinity. The resistance element is wire wound on a fiber glass core and covered with a braided fiber glass insulation; insulated from all metal parts, the circuit elements will withstand 500 volts.

### Xenon Rectifier (26)

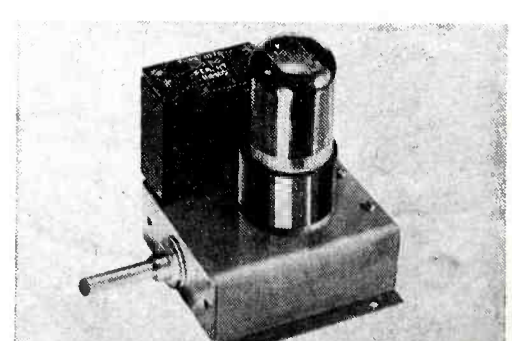
CHATHAM ELECTRONICS, 475 Washington St., Newark 2, N. J. The type 5594, xenon filled thryratron eliminates the need for auxiliary equipment to maintain bulb temperatures operating through an



ambient temperature range of from −50 to +90 C. Maximum ratings: peak forward anode voltage, 2,500 v; peak inverse anode voltage, 5,000 v; average anode current, 0.5 amp; peak anode current, 2.0 amp; filament voltage, 2.5 v; filament current, 5.0 amp.

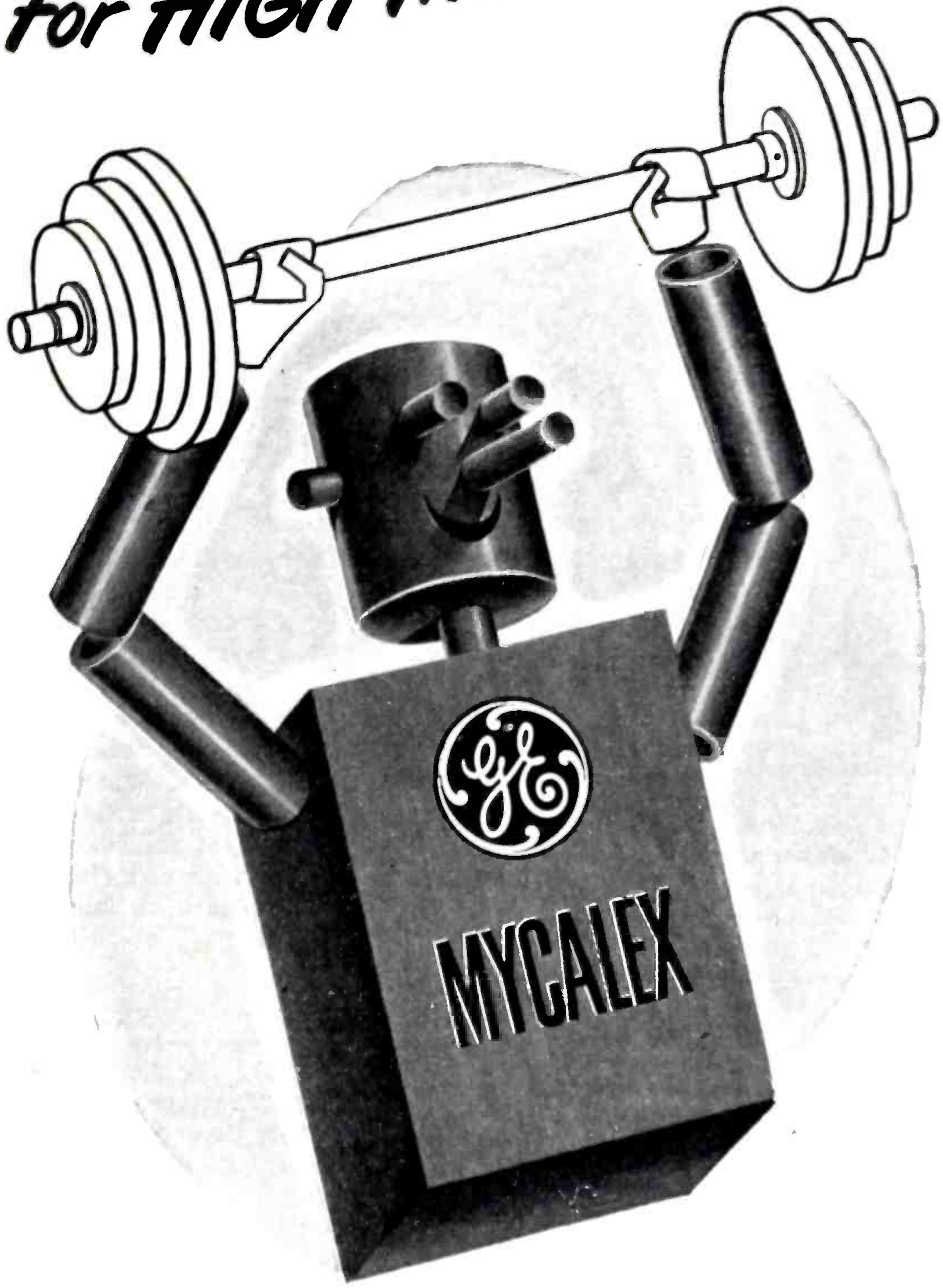
### Calibration Oscillator (27)

RADIO SPECIALTY Mfg. Co., Portland 14, Oregon. A new calibration oscillator uses a 100-kc crystal and an oscillator circuit with useful harmonics every 100 kc up to frequencies as high as 100 megacycles. The unit may be mounted inside

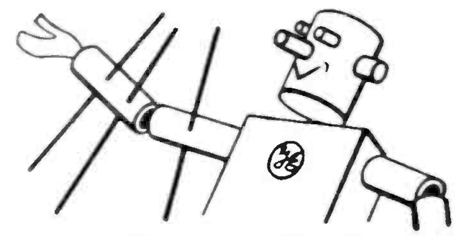


USE G-E MYCALEX INSULATION

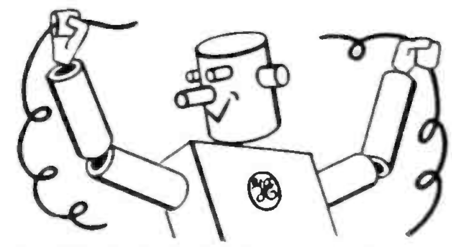
# For HIGH MECHANICAL STRENGTH...



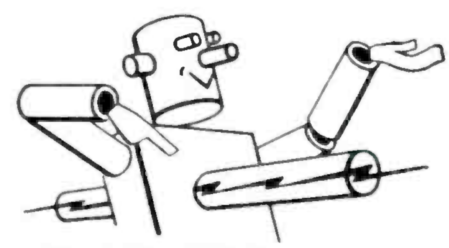

**Plus these 5**
**Insulation Advantages...**



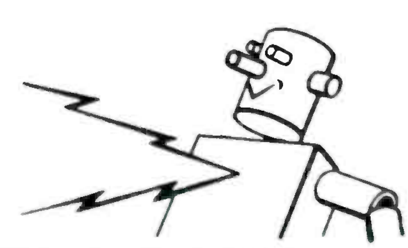
- FIRM BOND TO METAL INSERTS



- HIGH DIELECTRIC STRENGTH



- LOW LOSS FACTOR



- HIGH ARC RESISTANCE

- HIGH HEAT RESISTANCE

● General Electric mycalex offers a combination of properties to solve the most difficult insulation problems. And by giving complete protection to even the smallest electric parts, G-E mycalex permits a compactness of design difficult to achieve with other insulating materials.

This gray stone-hard compound of glass and mica is available in standard rods and sheets, or as molded or fabricated parts in the shapes you need. Samples of General Electric mycalex will be furnished you, free, on request.

General Electric mycalex specialists will be glad to fabricate sample parts for you to test—and can convert your designs to the speediest, most economical molding processes. General Electric's new booklet, "G-E Mycalex," is now available. For a free copy, write to Section S-19, Plastics Division, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.

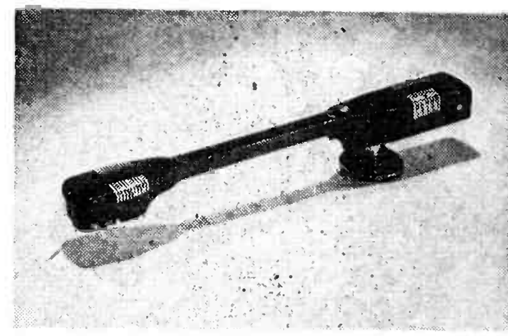
**GENERAL ELECTRIC**

CD47-M19

an ordinary communications receiver, with filament and plate supply taken from the equipment with which it is to be used. Plate current drain is small. Price is less than $15.00.

### Lateral Pickup (28)

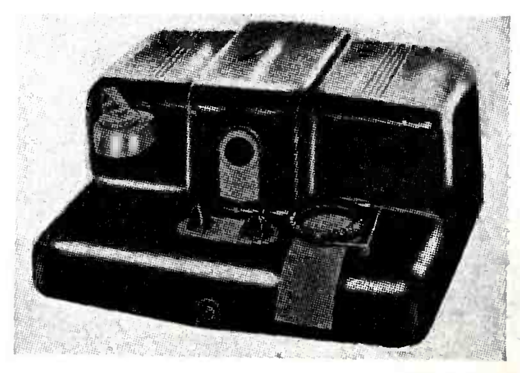
FAIRCHILD Camera and Instrument Corp., Jamaica, N. Y. A newly-designed, lateral pickup arm, Unit 542-M1, combined with dynamic cartridge and equalizer for a-m and f-m broadcasting and other profes-



sional uses has a stylus pressure of 25 grams. Its overall design permits even the tracking of warped records with minimum distortion. The new instrument provides frequency response with distortion of only plus or minus 2 db from 30 to 10,000 cycles.

### Watch Timer (29)

GIBBS DIV., George W. Borg Corp., Delavan, Wis. The type 207A Series watch rate recorder consists of a quartz oscillator, frequency divider, and synchronous motor driving a drum with a spiral. The watch under test is heard by a microphone, the output of which is fed to a tick amplifier and thence to a trigger tube that operates a solenoid. The solenoid actuates a printing bar against a carbon ribbon and paper strip above the spiral. The watch rate is then viewed or measured exactly as a function of the slope of the dotted line cre-



# Long-distance Television is twenty years old

*At the 1927 demonstration, Dr. Herbert E. Ives explained the television system developed in Bell Telephone Laboratories.*

April 7 is a notable day in communication history, for on that day in 1927 was the first demonstration of television over long distances. Large-scale images were flashed from Washington, D.C., by wire and from Whippany, N.J., by radio to a public demonstration in New York City. "It was," said a newspaper, "as if a photograph had suddenly come to life and begun to smile, talk, nod its head and look this way and that."

That was the first of many public demonstrations, each to mark an advance in the television art. In 1929 came color television, and in 1930 a two-way system between the headquarters buildings of A. T. & T. and Bell Laboratories. When the first coaxial cable was installed in 1937, television signals for 240-line pictures were transmitted between Philadelphia and New York and three years later 441-line signals were transmitted. By May, 1941, successful experiments had been made on an 800-mile circuit.

End of the war brought a heightened tempo of development. Early in 1946 began the regular experimental use of coaxial cable for television between New York and Washington, and a few months later a microwave system for television transmission was demonstrated in California.

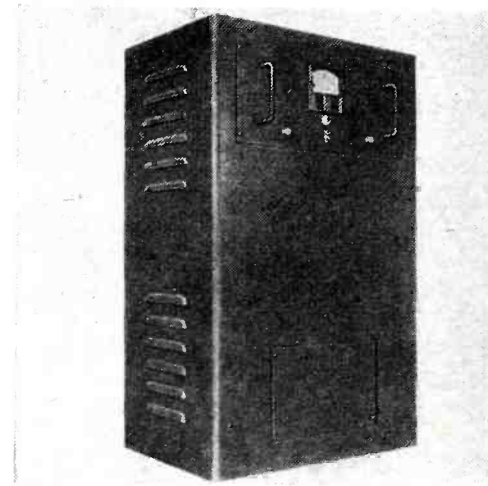
Transmission facilities will keep pace as a great art advances to wide public usefulness.

**BELL TELEPHONE LABORATORIES**

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE ated by the ticks on the paper strip. A line parallel to the sides of the strip would indicate a watch keeping perfect time, for instance.

### Voltage Regulator Line (30)

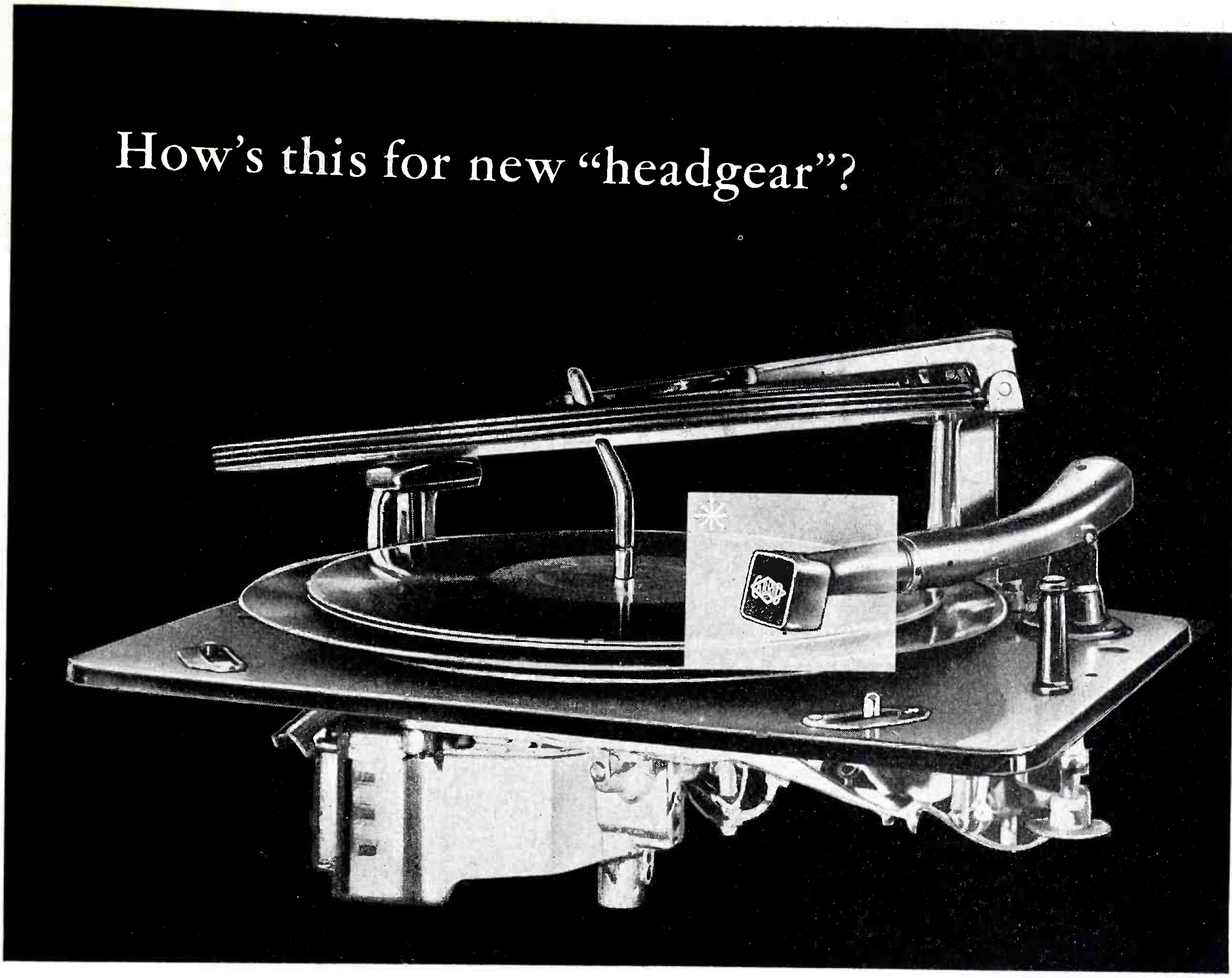
SUPERIOR ELECTRIC Co., 1077 Church St., Bristol, Conn. The entire line of electromechanical automatic voltage regulators has been redesigned to incorporate new electronic and other developments. The



equipment illustrated shows the removable control unit. Voltage-sensitive elements and relays can be plugged in or quickly removed for replacement.

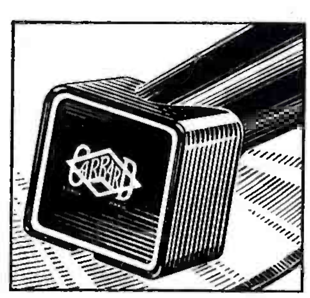
### Flow Meter (31)

HASTINGS Instrument Co., Inc., Box 1275, Hampton, Va. An ultrasensitive air velocity meter will accurately measure as low as five feet a minute. The air meter is applicable to measurement of wind velocities or measurement of flow in air and gas lines. Operation is based on a




*__magtronic pickup!__ It's the new Garrard magnetic moving iron pickup. Even a quick glance assures you there's something revolutionary here. The facts are: Garrard's Magtronic Pickup provides reproduction from 50 to 12,000 cps without intermodulation or distortion. It hits an amazing new low in needle pressure — ¾ of an ounce! You can guarantee permanent flexibility of the reproducer point. And the output is sufficient to fully load the average amplifier without the use of transformers or extra amplifier stages.

This is just another exclusive feature that sets Garrard so many rungs-of-the-ladder above other record changers. Beyond that, consider the fact that manufacturers of the finest phono-combinations are featuring Garrard as an additional mark of quality Among them are: FISHER • FREED-EISEMANN • LONDON GRAMOPHONE • PILOT RADIO • SCOTT.



**MAGTRONIC PICKUP FEATURES:**

- high-fidelity reproduction, flat to 12,000 cps.
- natural sapphire reproducer point
- output .4 volt at 1,000 cycles
- needle pressure ¾ oz.
- permanent flexibility; no rubber in armature damping system
- permanent reproducer point
- plug-in connection to pick-up

Let us send you a sample changer. Garrard Sales Corp., Dept. A, 315 Broadway, New York 7.

*they ask for it by name*

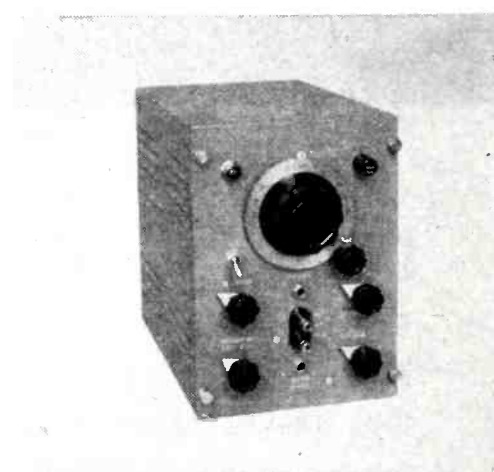
# GARRARD

**WORLD'S FINEST AUTOMATIC RECORD CHANGER**

combination of the hot-wire and thermopile principles. This arrangement increases the accuracy of the instrument by minimizing errors due to air temperature variations. The pickup element is a noble-metal thermopile in the air stream. Alternate junctions are arranged to have greater cooling than the adjacent junctions which are heated by alternating current. The temperature rise of the warmer junctions is measured by the d-c thermoelectric voltage generated. This instrument operates from 110 volts a-c. The standard range of the instrument is from 0 to 2,000 feet per minute. Fifty feet per minute is approximately 20 percent of full scale.

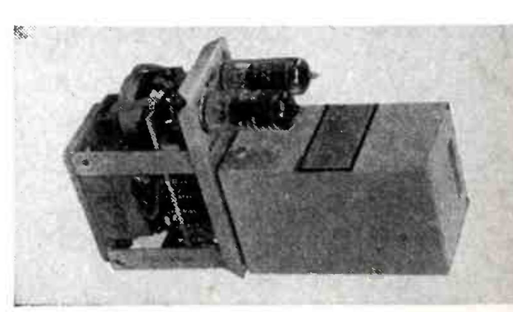
### Visual Alignment Signal Generator (32)

HARVEY RADIO LABS., Inc., 439A Concord Ave., Cambridge 38, Mass. The Model 204TS signal generator is used for circuit testing with an oscilloscope in the range 20 to 500 kc. A linear sweep deviation adjustable from 0 to 70 kc peak to peak is incorporated in the instrument.



### Isolation-Bridging Amplifier (33)

THE LANGEVIN CO., Inc., 37 West 65th St., New York 23, N. Y. The



# PLASTICON* ASG Silicone-Filled GLASSMIKES

1-3/8 x 3-1/2


# FOR HIGHER VOLTAGES

*Extreme Temperature Range from Minus 60° C to Plus 125° C*

*From 600 to over 30,000 Volts*

*Modern functionally designed capacitors. Metal ferrules are soldered to silver bands fused to each end of heavy-walled glass tubes. This vacuum tight assembly is fungus-proof and passes Signal Corps, Air Corps and Navy thermal cycle and immersion tests.*

***Announcing an illustrated technical booklet on uses of***

## *PLASTICON* GLASSMIKES*

***Contains the following subjects:—***

- CHART OF RF RATINGS
- Glassmike characteristics and design data
- Comparison of Glassmike and Mica Capacitors
- Uses of Glassmikes for improved RF and Audio bypassing
- Use in Audio and RF coupling
- Glassmike in television power supplies
- Video coupling
- Vibrator buffer applications
- Geiger Counter Capacitors
- Instrument capacitors
- And many other applications

***Due to the unprecedented demand we regret it is essential that a nominal charge of ten cents for handling and mailing be included when writing for the above free booklet.***

* *PLASTICONS: Plastic-Film Dielectric Capacitors*

**Order from your jobber: if he cannot supply you, order direct**

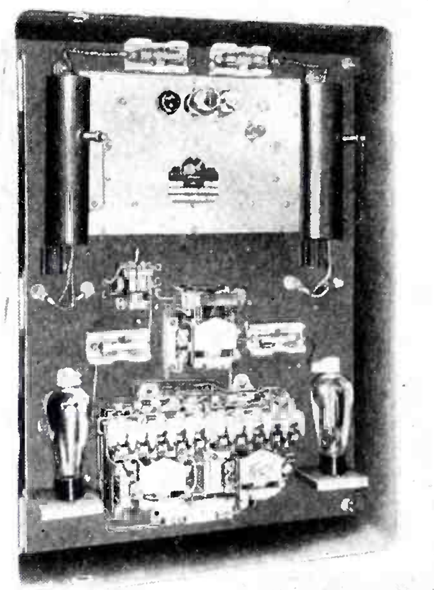
# Condenser Products Company

**1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS**

type 118-A amplifier is a small, plug-in bridging and isolation unit for 600 ohm lines. It operates with zero gain and provides better than 70 db isolation between line and bus. Equipped with a special Cannon plug, the unit is designed to fit into a rack-mounted frame for 12 such amplifiers. Amplitude is within plus or minus 1 db from 50 to 15,000 cycles. A catalog sheet is available.

### Motor Control (34)

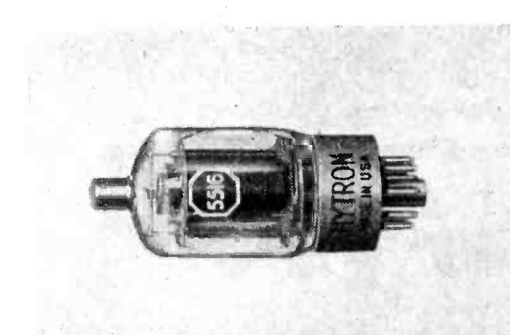
FEDERAL Electric Products Co., 50 Paris St., Newark 5, N. J. Two models of a new electronic motor control for operating d-c motors

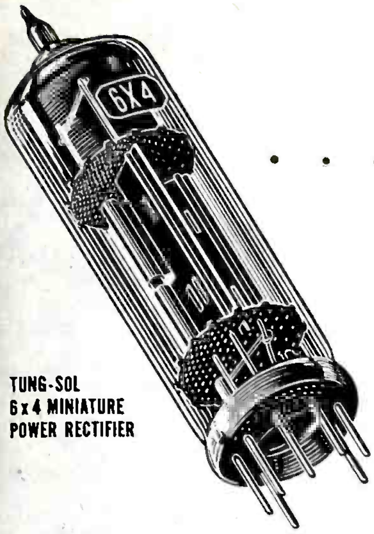


from a-c power have been announced. One model is a general purpose, reversing type applied to a 2 hp, 230 volt d-c motor, and the second is a special control for an abrasive surface grinder. For any speed setting, performance is practically equal to that of a synchronous motor even with a suddenly applied load.

### VHF Beam Pentode (35)

HYTRON RADIO and Electronics Corp., 76 LaFayette St., Salem, Mass. The type 5516 instant-heat-





TUNG-SOL
6x4 MINIATURE
POWER RECTIFIER

# . . . *Impromptu Discussions about Miniature Tubes*

"Those TUNG-SOL people have come out with another new one . . . their 6X4 power rectifier in miniature. It is electrically equivalent to the big 6X5GT but has all the many advantages of a miniature. While this 6X4 was planned for mobile service, it is so good that you can use it for a lot of other applications.

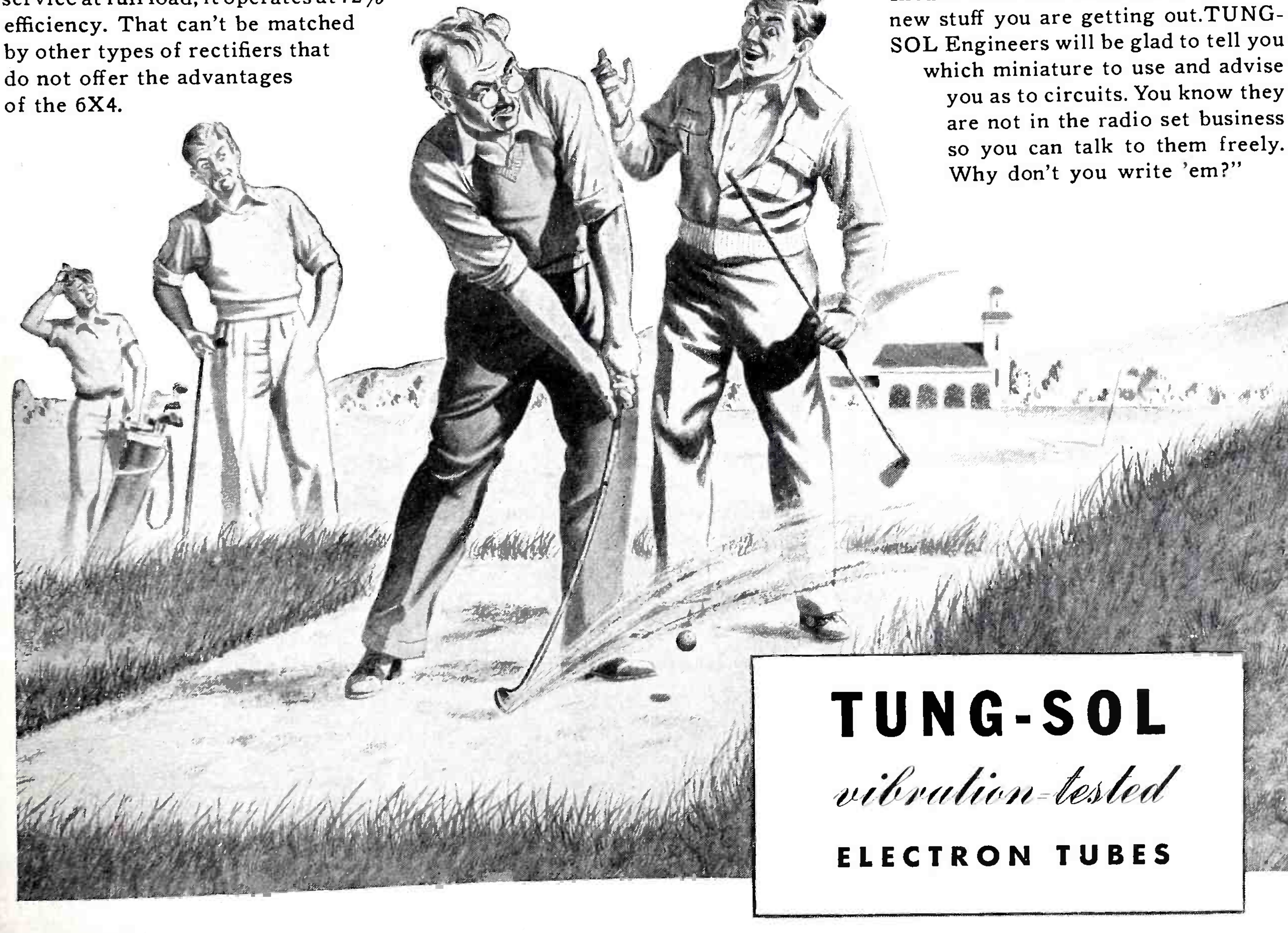
"You expect a rectifier to do its job under a wide range of operating conditions. The TUNG-SOL 6X4 certainly does. In full-wave condenser input service at full load, it operates at 72% efficiency. That can't be matched by other types of rectifiers that do not offer the advantages of the 6X4.

It provides 335 volts output at 70 milliamperes with 325 volts AC applied to each plate. Where regulation is a factor, use of the choke input circuit results in about 10% variation in output voltage over a 10 to 1 range of output current.

"How is it under extreme temperature variations? The 6X4 is always ready to 'start' in the coldest weather. Its use is seldom restricted by high ambient temperatures.

Conduction cooling through the tube socket will usually be enough even in compact 'boxed-in' equipment. The 6X4 respects Ohms law in the desert or in the Arctic. Its ruggedness is proof against both continual vibration and wide variations in heater supply voltages. With a tremendous reserve in emission, it makes little difference if its source of AC power is a vibrator or the Grand Coulee dam.

"Too bad, Joe, you dubbed your shot. I just wanted to tell you that you should look into miniatures for that new stuff you are getting out. TUNG-SOL Engineers will be glad to tell you which miniature to use and advise you as to circuits. You know they are not in the radio set business so you can talk to them freely. Why don't you write 'em?"



**TUNG-SOL**

*vibration-tested*

**ELECTRON TUBES**

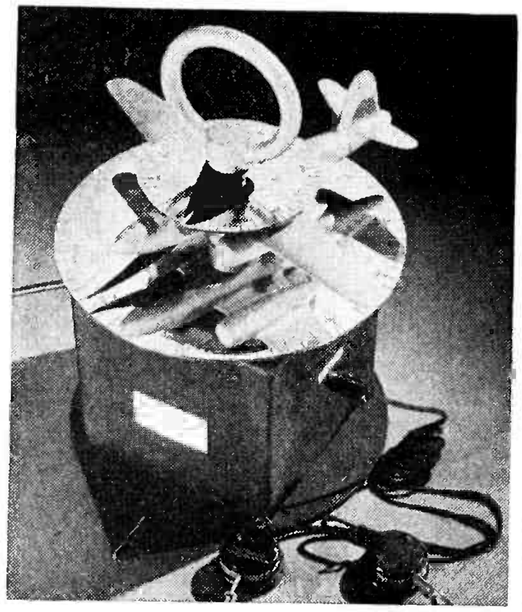
TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

Sales Offices: Atlanta • Chicago • Dallas • Denver • Detroit • Los Angeles • New York

*Also Manufacturers of Miniature Incandescent Lamps, All-Glass Sealed Beam Headlight Lamps and Current Intermittors* ing beam pentode is particularly adaptable to mobile equipment. It has 18 watts output at 165 mc. Complete details are given in a 5-page bulletin E-126.

### Loop Radio Compass Trainer (36)

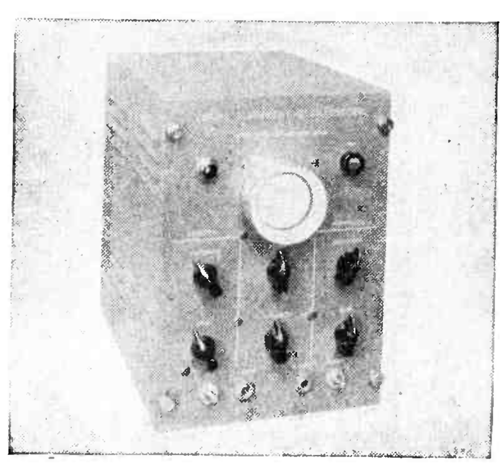
MOTO RADIO CO., 5732 Baum Blvd., Pittsburgh 6, Pa. Details of the device illustrated have just been released by the Army. It demonstrates visually and aurally how positions of a radio station and an



airplane in relation to the North magnetic pole and the setting of the radio loop antenna combine to indicate a bearing from airplane to station. All of the elements are movable in order to set up different problems.

### Visual Alignment Oscilloscope (37)

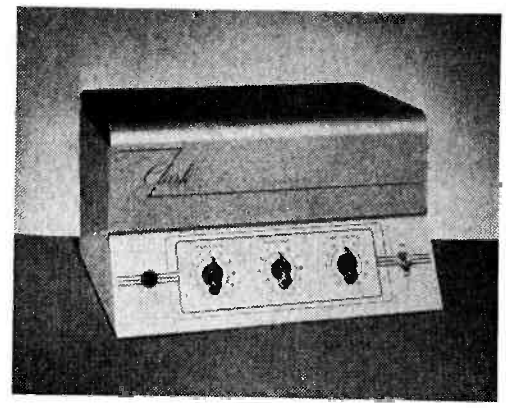
HARVEY RADIO Laboratories, Inc., 439A Concord Ave., Cambridge 38, Mass. The Model 188TS visual alignment oscilloscope has been designed for use with the 204TS and 205TS signal generators. Although



usual focus, intensity and centering controls are provided as well as vertical and horizontal amplifiers, no internal sweep is necessary since that is included in the signal generator with which the equipment is used.

### P-A Amplifier (38)

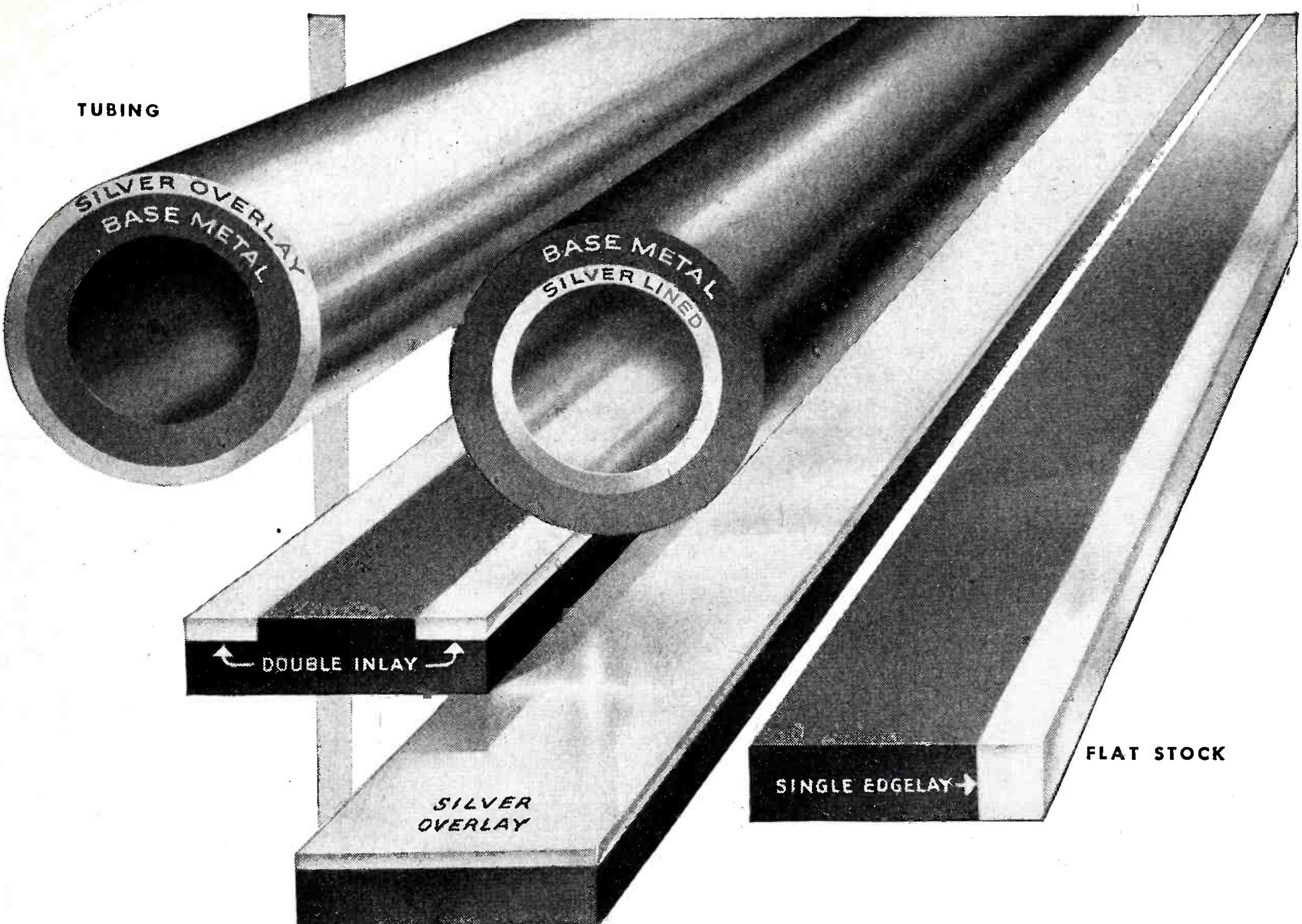
CLARK RADIO EQUIPMENT Corp., 4636 Ravenswood Ave., Chicago 40, Ill. The Model PA-10a 10-watt public address amplifier has a virtually flat response from 50 to 10,000

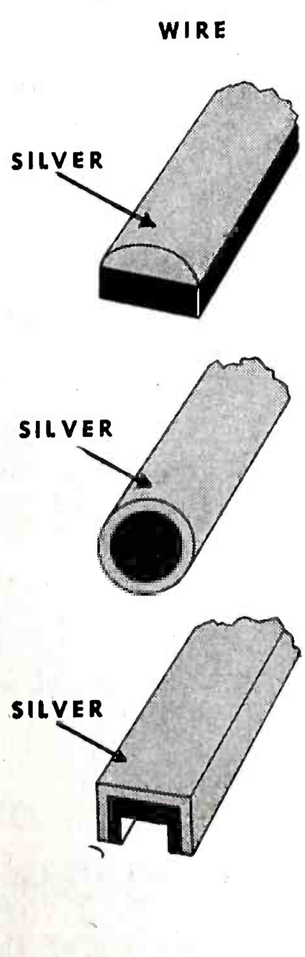


cycles and less than 3 percent harmonic distortion at maximum power. Hum is 60 db down. Two half-megohm inputs are provided. Output is tapped for 4, 8, 16, and 500 ohms impedance. Further information is given in Bulletin 134.

### Television Waveform Oscillograph (39)

ALLEN B. DUMONT Laboratories, Inc., 2 Main Ave., Passaic, N. J. The Type 280 oscillograph is made up of four units, each on a standard panel and chassis for relay-rack mounting. It has been designed for accurately determining duration and shape of various

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## *Laminated Metals*

### Give You Silver ONLY Where You Need It

A thin layer of silver, or other precious metal, permanently bonded to a heavier, inexpensive base metal...that's General Plate Laminated Metals. It means that you get all the advantages of precious metals yet costs are much less . . . especially important today with the high cost of silver.

General Plate Laminated Metals are available in sheet, tube and wire in a wide range of shapes and sizes. There's flat stock, precious metal covered one side or both sides — edgelay or inlay. Tubing, precious metal lined, covered or both. Wire — round, oval, square or any odd shape.

General Plate Laminated Metals give you such advantages as high corrosion resistance, better electrical conductivity, better spring properties, ease of fabrication, more strength and best of all at low cost.

No matter what you manufacture or plan to build, General Plate Laminated Metals will fit into your design picture. Engineers are available for consultation and will help you on your particular problems.

**GENERAL PLATE DIVISION**

*of Metals and Controls Corporation*

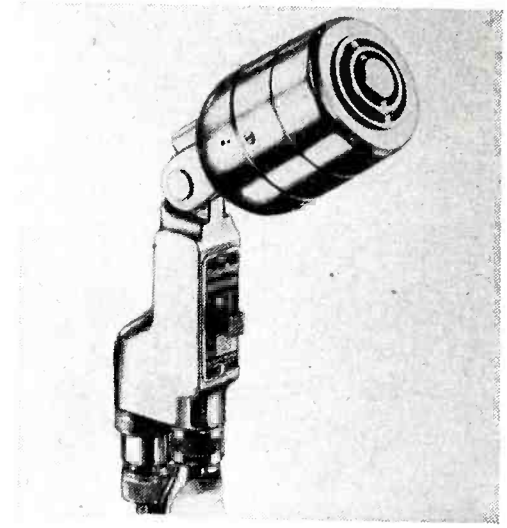
50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Pittsburgh, Pa.

**ATTLEBORO, MASSACHUSETTS**

waveforms in the composite television signal and the character of the picture-signal video in conjunction with transmitter operation according to FCC standards.

### Dynamic Mike (40)

ELECTRO-VOICE, Inc., Buchanan, Mich. The Model 630 dynamic mi-



crophone now provides frequency response that is substantially flat from 40 to 9,000 cps. Output level is 53 db below 1 volt per dyne per sq cm, open circuit. The new Acoustalloy diaphragm withstands high humidity, extremes of temperature, corrosive effects of salt air, and severe mechanical shocks. Complete information is given in Catalog No. 101.

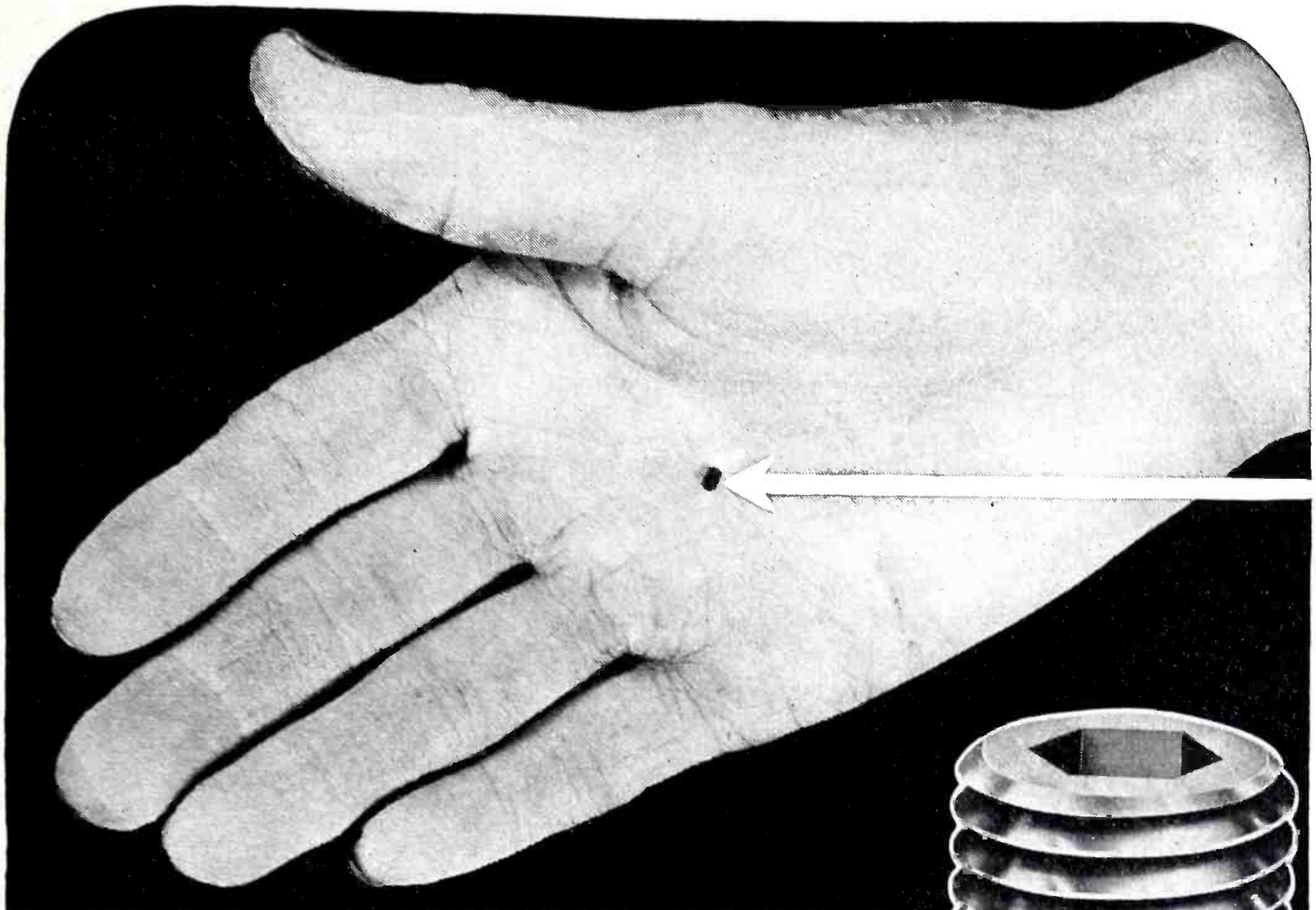
### High-Energy Cell (41)

NATIONAL CARBON Co., Inc., New N. Y. Improved chemical mixture used in new flashlight cells has

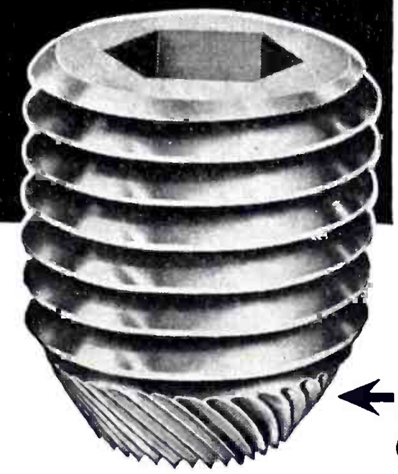

doubled the capacity with no increase in size. The cell illustrated contains 10, 890 foot-pounds of energy, weighs 3 1/3 ounces and delivers 1½ volts.

### Rotating Beam Antenna (42)

KINGS ELECTRONICS, Inc., 372 Classon Ave., Brooklyn 5, N. Y. The Roto Beam antenna covers all the television bands and rotates clock-



This extremely small "Unbrako" Socket Set Screw is a full-fledged "Unbrako" SELF-LOCKER - knurled cup point and all.



Pat'd and Pats. Pend.

←KNURLED CUP POINT

Reg. U. S. Pat. Off.

# THESE UNBRAKO SELF-LOCKERS

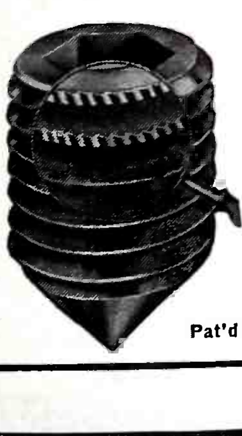
## are as alike as two peas in a pod

Each is a perfect replica of the other, from the internal wrenching feature that facilitates compact designs to the knurled cup point that makes these "Unbrako" Socket Set Screws SELF-LOCKERS, whose knurled points dig-in and stay dug—even when subjected to the most chattering vibration. Yet, they can be easily backed-out with a wrench and used OVER and OVER AGAIN.

Write for your copy of the "Unbrako" Catalog of Socket Screw Products.

**"Unbrako" and "Hallowell" Products are sold entirely through Industrial Distributors.**

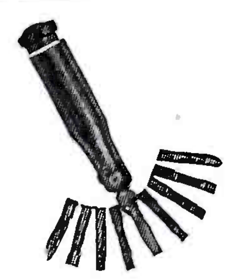
Knurling of Socket Screws originated with "Unbrako" in 1934.



The "Unbrako" Socket Set Screw with the Knurled Swaged Threads is a SELF-LOCKER, too, for use with Flat, Oval, Cone, Half- and Full- Dog Points. Cut shows cone point.

Pat'd and Pats. Pend.

The "Unbrako" Socket Head Cap Screw is a time-saver. Its knurled head provides a slip- and fumble-proof grip, even though the fingers and head be ever so oily, therefore, it can be screwed-in faster and farther before it becomes necessary to use a wrench.



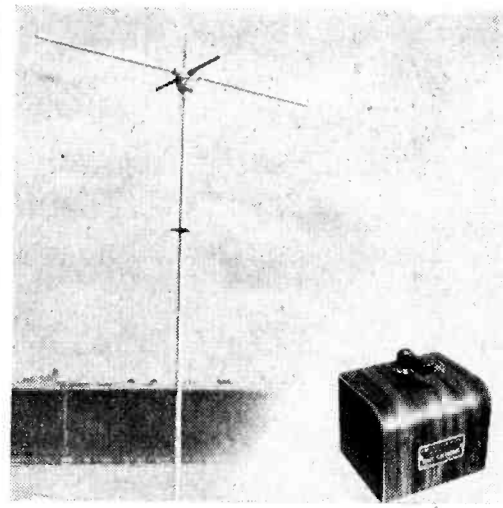
You can't screw socket screws in or out without a hex socket wrench, so why not get our No. 25 or No. 50 "Hallowell" Hollow Handle Key Kit which contains most all hex bits.

Kits: Pats. Pend.

*OVER 44 YEARS IN BUSINESS*

# STANDARD PRESSED STEEL CO.

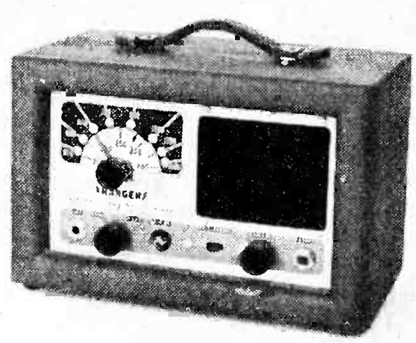
JENKINTOWN, PENNA., BOX 596 • BRANCHES: BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO



wise or counter-clockwise in a complete 360 degree circle. It is operated by a 24-volt motor, which is controlled by a double-pole, double-throw switch located in the control box at the receiver.

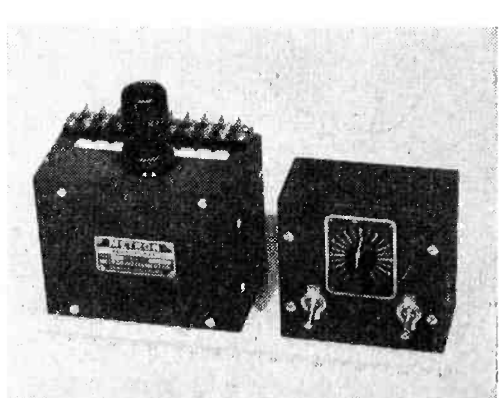
### Broadcast and Beacon Portable (43)

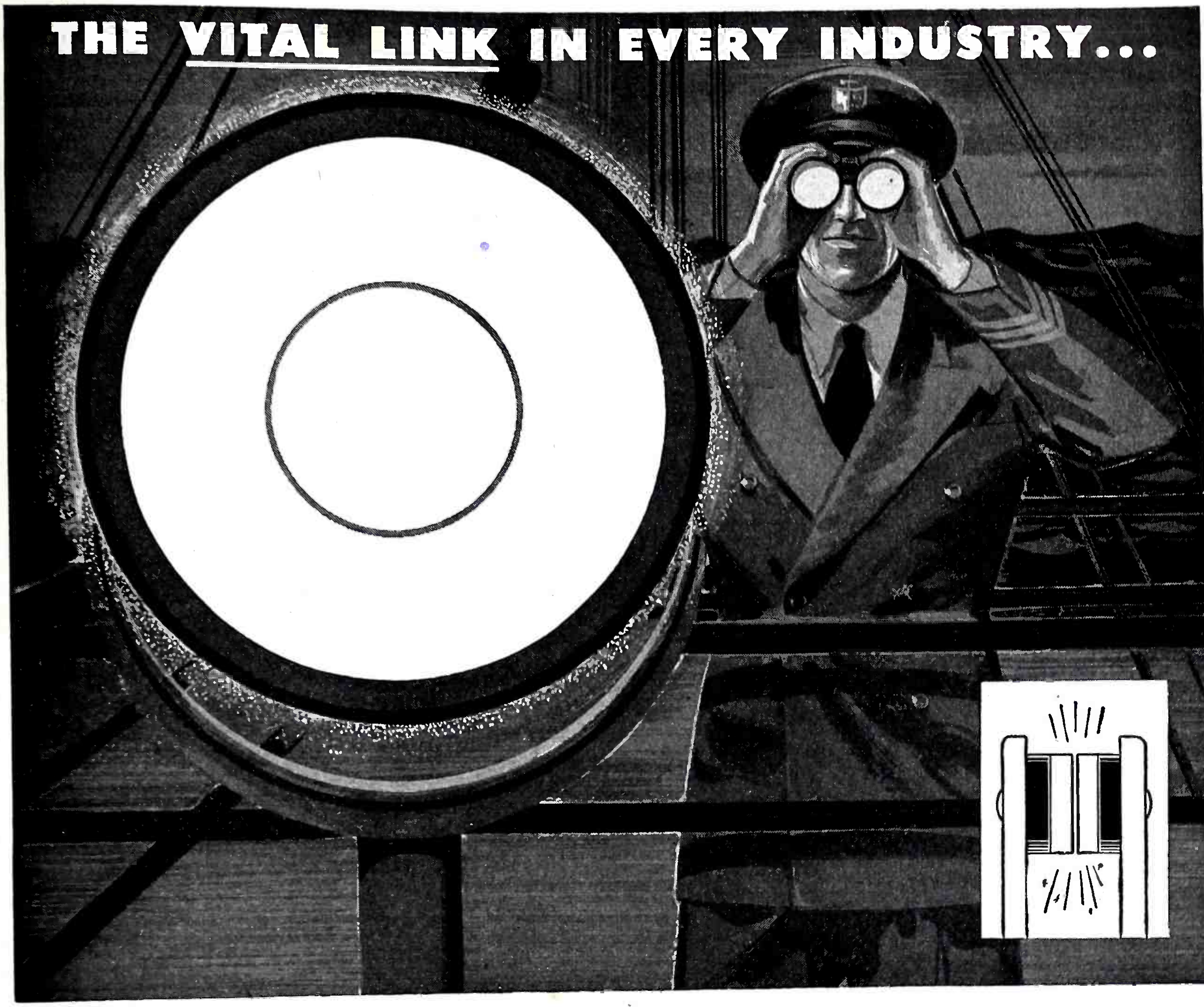
ELECTRONIC SPECIALTY CO., Los Angeles, Calif. The Ranger Model 118 is a portable a-c or d-c receiver covering the broadcast band and frequencies between 195 and 410 kc. Batteries can be recharged while the receiver is operating from a-c or d-c. A built-in loop gives bearings within two degrees. The complete equipment weighs 7½ pounds.



### Welding Timer (44)

METRON Instrument Co., 432 Lincoln St., Denver 9, Colo. One tube



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**WILCO PRODUCTS INCLUDE:**

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Silver - Platinum - Tungsten - Alloys
Sintered Powder Metal

**THERMOSTATIC BIMETAL**
All temperature ranges, deflection rates and electrical resistivities.

**SILVER CLAD STEEL**
**JACKETED WIRE**
Silver on Steel, Copper, Invar or other combinations requested.

**ROLLED GOLD PLATE AND WIRE**

**NI-SPAN C***
New Constant Modulus Alloy

**SPECIAL MATERIALS**

*Reg. Trade Mark, The International Nickel Co., Inc.

WILCO

## *They keep the power flowing!*

In applications where life itself may be involved, as well as in every-day industrial applications, WILCO CONTACTS assure a steady, uninterrupted flow of power. WILCO CONTACTS function dependably in every range of frequency operations by bringing to each operation requisite ductility, hardness, density, freedom from sticking, low metal transfer, high conductivity and arc-resistance.

● You, too, can depend on WILCO CONTACTS to keep the power flowing in your products through the matchless qualities provided by exclusive WILCO processes. WILCO engineers will gladly help you select from a great variety of available WILCO contact materials the particular contacts suited to your needs—or develop new alloys for special purposes.

**THE H. A. WILSON COMPANY**

105 Chestnut Street, Newark 5, N. J. • *Branch Offices:* Chicago, Detroit, Los Angeles, Providence

**SPECIALISTS FOR 30 YEARS IN THE MANUFACTURE OF THERMOMETALS • ELECTRICAL CONTACTS • PRECIOUS METAL BIMETALLIC PRODUCTS**

and two relays are employed to obtain timing intervals from 1/60 second up to several minutes in one of several continuously variable ranges. Adjustments by steps or fixed intervals are also available. Accuracy is high and is substantially unaffected by wide variations in line voltage or temperature.

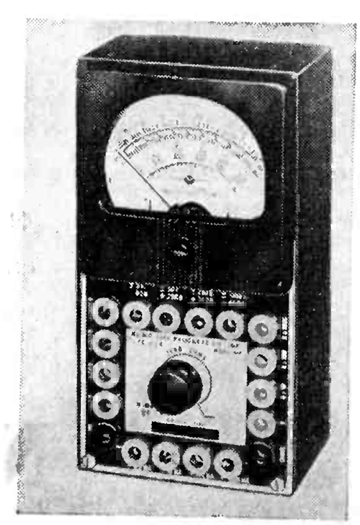
### High Frequency Voltmeter (45)

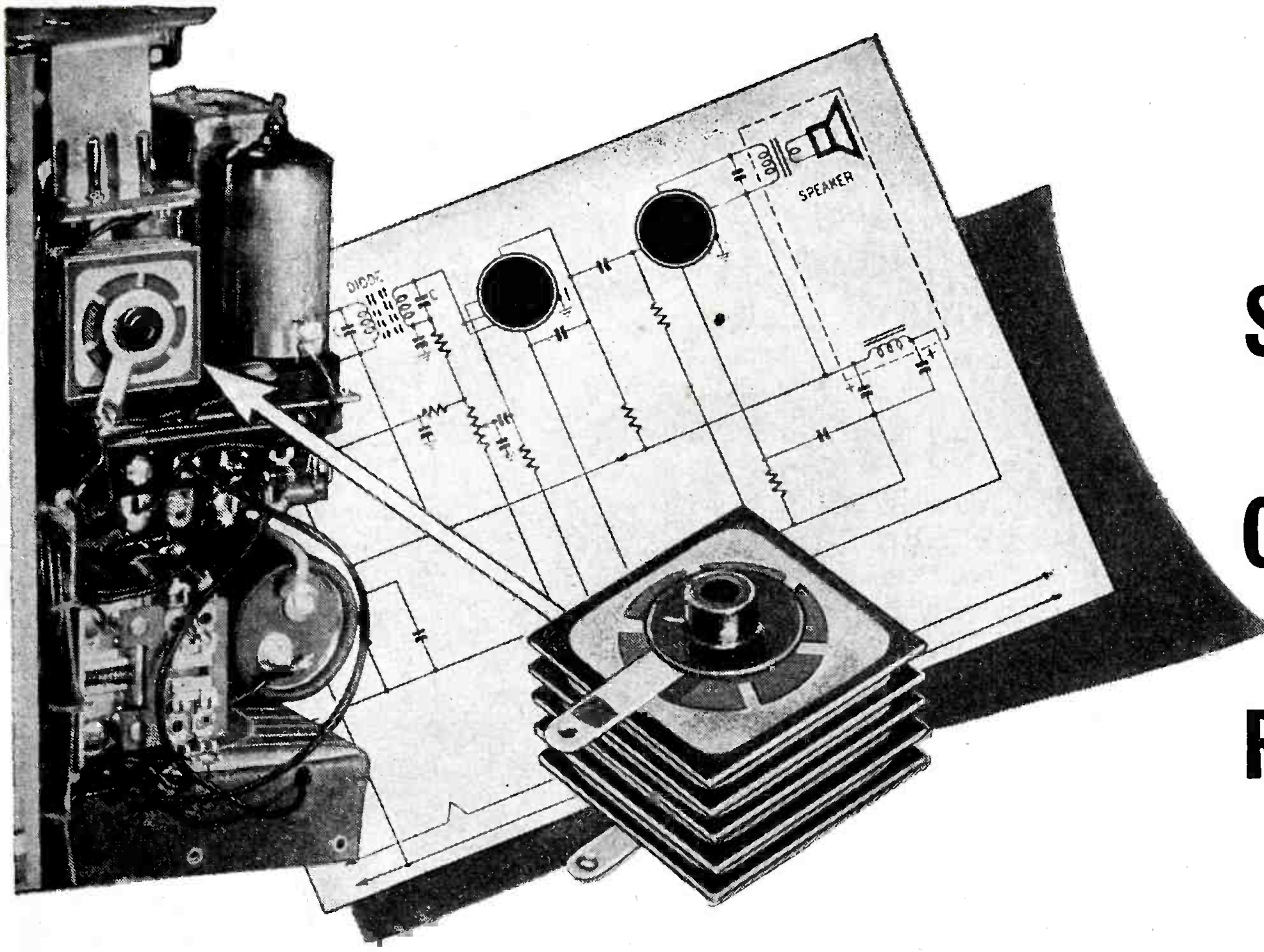
Alfred W. Barber Labs., 34-14 Francis Lewis Blvd., Flushing, N. Y. The Model 32 electronic voltmeter has a radio-frequency probe


with an input capacitance of 0.75 micromicrofarad, making possible measurements up to 500 megacycles. It measures 0.3 to 300 volts r-f in five ranges. The instrument operates from 115 volts and weighs 8 pounds.

### Multitester (46)

Radio City Products Co., Inc., 127 West 26th St., New York 1, N. Y. The model 449A meter has a d-c






# SIMPLE

# COMPACT

# RELIABLE

# NEW G-E SELENIUM RECTIFIER FOR USE IN A-C/D-C TYPE RECEIVERS

This new selenium rectifier, *less than one inch long* and only one inch square, offers builders of portable radios a new way to cut manufacturing costs and to build a better product.

Here are some of the advantages you gain when you incorporate it in your designs:

**SAVES SPACE** — Can be mounted in places where a rectifier tube and socket won't fit. Radio cabinets can be made smaller when this new selenium rectifier is used.

**CUTS INSTALLATION COST** — No socket or filament circuit is necessary. Only two soldering operations and a minimum of mounting hardware are required.

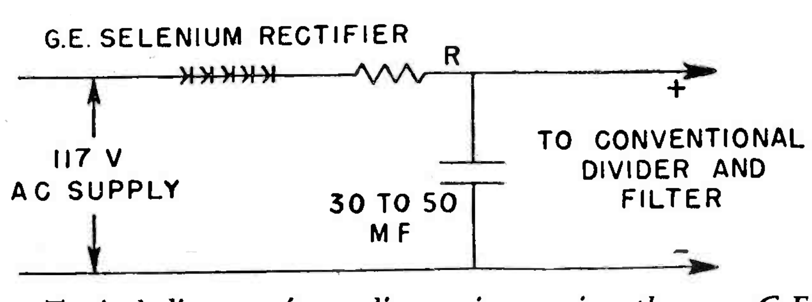
**AMPLE CURRENT CAPACITY** — Designed to withstand safely the inverse peak voltages obtained when rectifying (half-wave) 110-125 volts, rms, and feeding into a capacitor as required in various radio circuits.

**RATINGS BASED ON END USE** — In designing the G-E rectifiers, consideration was given to the temperatures usually encountered within the cabinet of a small radio receiver. Ratings are based on ambient temperatures of 50C to 60C, which experience indicates to be the usual operating conditions.

G-E selenium rectifiers are given a coating of moisture-resistant varnish as a protection against humidity and dampness.

The construction of G-E rectifiers provides constant and uniform spring contact pressure on the cells, regardless of temperature variations.

For information that will help you make efficient use of G-E selenium rectifiers in your designs, write Section A61-531, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.




*Typical diagram for radio receivers using the new G-E selenium rectifier. A ballast resistor "R" is usually provided to limit the output voltage of the rectifier to that required by the particular circuit. The value of "R" is usually between 25 and 50 ohms, but may be modified to meet any particular circuit requirements.*

**GENERAL ELECTRIC**

sensitivity of 5,000 ohms per volt. The Germanium crystal rectifier permits a-c measurements from 30 cps to 50 kc. Batteries are self-contained. The price is $24.50.

## Literature

(47)
**Electronic Tube Guide.** Westinghouse Electric Corp., Bloomfield, N. J. Catalog 86-020 has been revised effective Mar. 1. In it are described rectifying, amplifying, generating, controlling and phototubes indexed according to these functions.

(48)
**Iron Powders.** General Aniline and Film Corp., Special Products Div., 270 Park Ave., New York 17, N. Y. A 31-page booklet describes the characteristics of carbonyl iron powders, gives formulas, a bibliography of papers and a glossary.

(49)
**Instrument Catalog.** Industrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J. Catalog 10 contains 15 illustrated pages that describe the complete line of industrial testing equipment, including bridges, conductivity apparatus, capacitance and resistance decades.

(50)
**Radioactive Counters.** Radiation Counter Labs., 1451 East 57th St., Chicago 37, Ill. Data sheet No. 3 is a 6-page folder describing a line of Geiger, mica-window, beta and gamma counters. A glossary of terminology is included.

(51)
**Lock Washers.** Shakeproof, Inc., 2501 North Keeler Ave., Chicago 39, Ill. A slick-paper brochure pictures many applications of lock washers and parts engineered to gain their advantage without increasing assembly costs.

(52)
**Technical Reprints.** North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y., is offering leaflets containing reprints from

articles that have appeared in trade magazines. The subjects include X-ray diffraction, cathode-ray tube life tests, quality control, and technical publicity for engineers.

(53)
**Power and Transmitting Tubes.** Electronic Enterprises, Inc., 65 Seventh Ave., Newark, N. J. Rectifiers, vacuum capacitors, oscillator and amplifier tubes are all listed in a loose-leaf catalog that has recently been printed.

(54)
**Beam Pentode.** Hytron Radio and Electronics Corp., Salem, Mass. The type 2E30 is an instant-heating 10-watt miniature beam pentode for a-f and r-f service. Circuit diagrams as well as tube characteristics are listed in Bulletin E-120.

(55)
**Special Products.** The Electrodyne Co., 899 Boylston St., Boston 15, Mass. "Electrodyne Products and Services" is the title of a booklet that lists many special electronic devices, many of them used in experiments in sensory psychology and physiology.

(56)
**Plastic Materials Table.** Shaw Insulator Co., 160 Coit St., Irvington 11, N. J. General properties and uses for molded plastics materials are given compactly on two sides of a single sheet. All of the common materials are included together with typical applications.

(57)
**Grinding Mill Controls.** Mosher Electronic Controls, 130 West 42nd St., New York 18, N. Y. Keeping a grinder motor operating within 5 percent of rated capacity at all times is easy with the electronic feed regulators described in a brochure now offered.

(58)
**Plug-In Amplifiers.** The Langevin Co., Inc., 37 West 65th St., New York 23, N. Y. A new 4-page, 2-color catalog folder gives the details of booster and monitor amplifiers that can be plugged into a rack mounted assembly. The equip-

ment has been standardized so that only two types of tubes are used in two types of amplifiers for all general audio purposes.

(59)

**Insulating Materials.** Mitchell-Rand Insulation Co., 51 Murray St., New York 7, N. Y. The electrical insulating material guide book recently issued includes everything from sleevings to fish paper as well as the latest price list.

(60)

**Rotary Actuator.** Radio Condenser Co., Camden, N. J. The Rotenoid device, described in a 4-page brochure, maintains an almost constant torque over 180 degrees rotation.

(61)

**Selenium Rectifiers.** Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J. has just issued a new catalog of standard selenium rectifier equipments. Information on rectifier stacks is not given but may be obtained in a separate catalog.

(62)

**Voltage Regulators.** Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn., have just turned out a 16-page catalog describing the principles of operation and technical specifications of electronically-controlled regulators and Nobatrons.

(63)

**Automatic Engine Control.** Synchro-Start Products, Inc., 1046 West Fullerton Ave., Chicago 14, Ill. F-m stations in remote locations often rely upon an auxiliary power plant for power and tower lights in the event of failure of exposed power lines. The almost human action of the apparatus described in a bulletin can be applied to any auxiliary power or pumping installation.

(64)

**New Parts Catalog.** National Co., Inc., Malden, Mass. Catalog 700 lists the line of parts, complete oscilloscopes and receivers available


Available in popular sizes and ranges for switchboard and panel requirements; including DC, AC (power frequencies and radio frequencies) rectifier types, and DB meters. Ask your local WESTON representative for full details, or write ...Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

**WESTON**
*Panel Instruments*

for experimenters, amateurs, and design engineers.

**Stroboscope.** Universal Microphone Co., Inglewood, Calif. Four circles divided for checking accurate speed of 78 and 33⅓ rpm turntables under 25, 50, or 60 cycle light are printed on a single 6-inch cardboard disc. Send 10¢ direct to the manufacturer for this item.

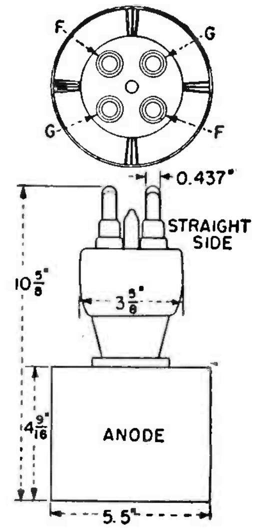
## Tube Registry

**The information furnished by the RMA Data Bureau has been abridged and only the more significant dimensions are given.**

### Type 5549

Triode, forced air cooled, filament type.

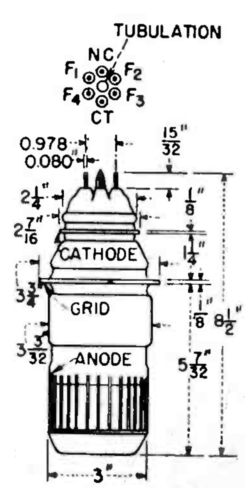
$E_f = 12.6$ v
$I_f = 56$ amp
$\mu = 23$
$C_{in} = 22.3$ $\mu\mu$f
$C_{out} = 2.6$ $\mu\mu$f
${}_gC_p = 18.0$ $\mu\mu$f
$E_b = 8{,}500$ v (max)
$I_b = 1.25$ amp (max)
$E_c = -1{,}000$ v (max)
$I_c = 0.25$ amp (max)
$W_p = 4$ kw




### Type 6C23

Triode uhf pulse power amplifier and oscillator, heater type, forced air cooled. Maximum ratings up to 600 mc. At $I_b$, 18 amp and $E_c$, $-50$ v, $\mu$ is 14.

$E_f = 7.0$ v
$I_f = 26$ amp
$C_{in} = 36.4$ $\mu\mu$f
$C_{out} = 1.8$ $\mu\mu$f
${}_gC_p' = 21.4$ $\mu\mu$f




As a plate modulated Class-C pulse

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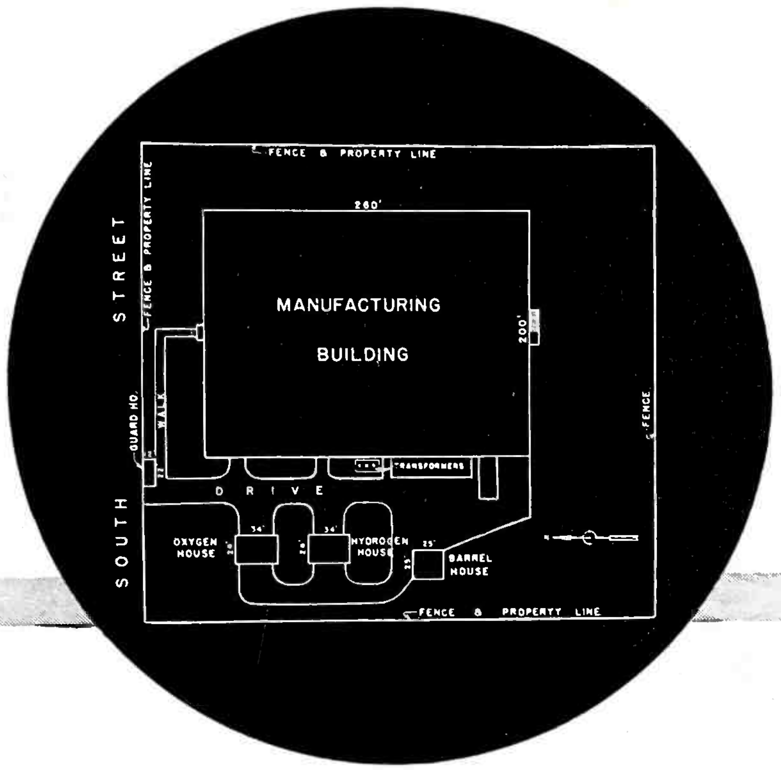


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Sealed proposals, in duplicate, for purchase or lease of Plancor 636 will be received by the War Assets Administration Regional Office, named below, until 2:00 P.M. (M.S.T.), May 15, 1947, at which place and time all proposals will be publicly opened and read.

Credit terms for the purchase of this property may be arranged. Information on how to prepare and submit a proposal may be obtained from any War Assets Administration Regional Office. Reference to this facility by name of lessee is for identification only, and has no connection with the lessee's own facilities. War Assets Administration reserves the right to reject any or all proposals.

For detailed information about Plancor 636, address War Assets Administration, Washington 25, D.C., or the Regional Office shown below. In submitting proposals, address:

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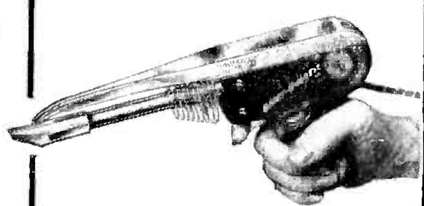

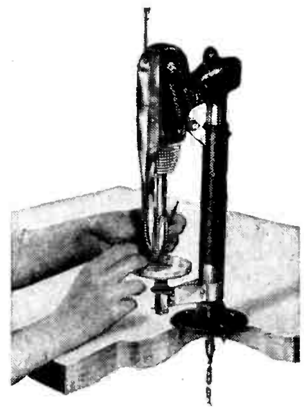

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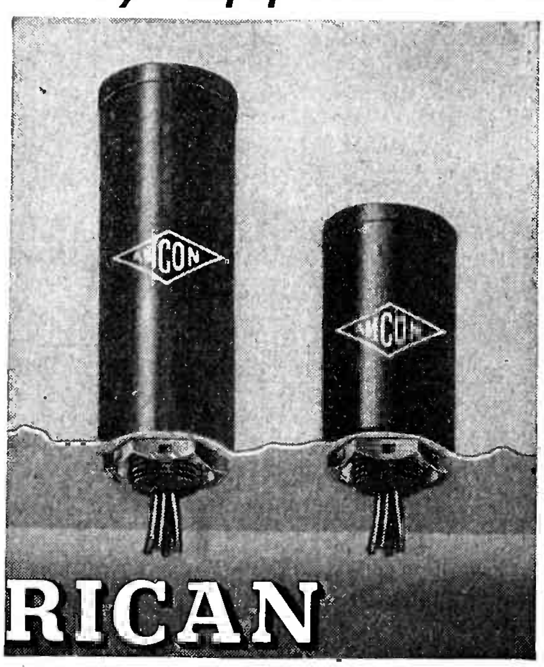


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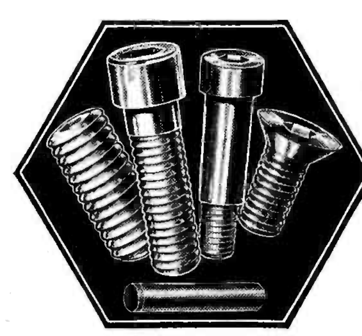
*Stock sizes from No. 4 to 3/4" diameter; 1/4" to 3" length.*

Order of your local ALLEN Distributor, — or ask him for samples for try-out.



**THE ALLEN MFG. COMPANY**
HARTFORD, CONNECTICUT, U. S. A.

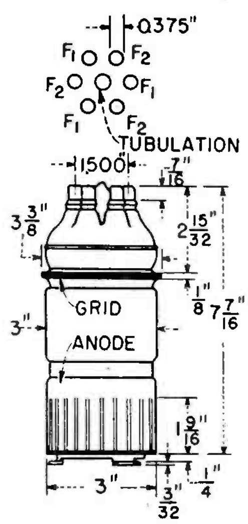
oscillator, 10 $\mu$sec pulse, maximum ratings:

$E_b$ = 15 kv
$I_b$ = 0.1 amp (average)
$I_b$ = 100 amp (peak)
$E_c$ = −2 kv
$I_c$ = 0.01 amp (average)
$W_p$ = 1 kw

### Type 8C22

Triode uhf pulse power amplifier and oscillator, filament type, forced air cooled. At $I_b$, 15 amp and $E_c$,—100 v, $\mu$ is 9. Maximum ratings up to 600 mc.

$E_f$ = 4.1 v
$I_f$ = 320 ± 24 amp
$C_{in}$ = 19.5 $\mu\mu$f
$C_{out}$ = 0.98 $\mu\mu$f
$_gC_p$ = 8.3 $\mu\mu$f



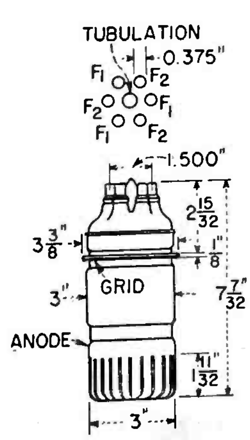

As a plate modulated Class-C pulse oscillator, 5 $\mu$sec pulse, maximum ratings:

$E_b$ = 25 kv
$I_b$ = 25 ma (average)
$E_c$ = −4 kv
$I_c$ = 10 ma (average)
$I_b$ = 50 amp (peak)
$W_p$ = 600 watts

### Type 8C23

Triode uhf pulse power amplifier and oscillator, filament type, forced air cooled. Maximum ratings up to 600 mc. At $I_b$, 28 amp and $E_c$, −100 v, $\mu$ is 9.

$E_f$ = 4.1 v
$I_f$ = 320 ± 24 amp
$C_{in}$ = 23.7 $\mu\mu$f
$C_{out}$ = 1.57 $\mu\mu$f
$_gC_p$ = 13.7 $\mu\mu$f




As a plate modulated Class-B os-

cillator, 5 $\mu$sec pulse, maximum ratings:

$E_b$ = 21 kv
$I_b$ = 25 ma (average)
$I_b$ = 50 amp (peak)
$E_c$ = −4 kv
$I_c$ = 10 ma
$W_p$ = 500 watts

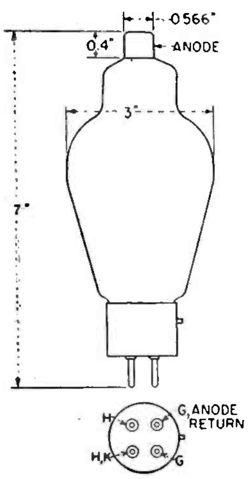
## Type 5559 (Revised)

Triode mercury thyratron, heater type; ionization time 10 microseconds; deionization time 1 millisecond; mercury temperature 40 to 80 C.

$E_f$ = 5 v
$I_f$ = 4.5 amp
$E_{drop}$ = 16 v
$C_{in}$ = 10 $\mu\mu$f
${}_gC_p$ = 2.5 $\mu\mu$f
$E_b$ = $E_{inv}$ = 1,000 v
$I_b$ = 15 amp (peak)
$I_b$ = 2.5 amp (average 15 sec)

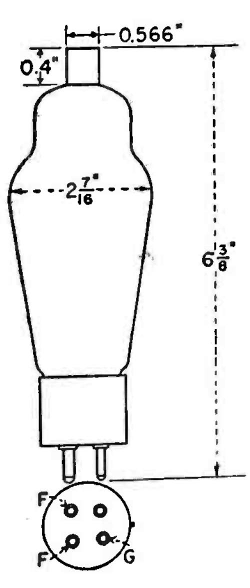
Control:

| $E_b$ | $E_c$ |
|---|---|
| 60 v | 0 v |
| 100 v | −1.75 v |
| 1,000 v | −6.50 v |




## Type 5557

Triode mercury thyratron, filament type; heating time 5 seconds; ionization time 10 microseconds; deionization time 1 millisecond; mercury temperature 40 to 80 C. Maximum ratings up to 150 cps.




$E_f$ = 2.5 v
$I_f$ = 5 amp
$E_{drop}$ = 16 v
${}_gC_p$ = 2.5 $\mu\mu$f
${}_gC_k$ = 7 $\mu\mu$f
$E_{inv}$ = 5,000 v (max)
$E_{fwd}$ = 2,500 v (max)
$I_b$ = 1 amp (inst)
$I_b$ = 0.5 (15 sec average)

Control:

| $E_b$ | $E_{c1}$ |
|---|---|
| 40 v | 0 v |
| 100 v | −2.25 v |
| 1,000 v | −6.5 v |

(continued from p 152)

most of it has been in the laboratory or under controlled conditions.

*Picture Brightness and Contrast*

"The brightness with which a picture can be produced on a television screen is one of the most important performance characteristics of a television receiver. If inadequate brilliance is produced, the house must be darkened in much the same way as a movie theater in order to be able to see the picture. This seriously restricts the usefulness of television in the home because most people will find it very difficult to make their rooms sufficiently dark during the daytime for satisfactory viewing under these conditions and quite inconvenient to black out their homes at night. Hence, receivers must be developed capable of operating satisfactorily in rooms with normal illumination.

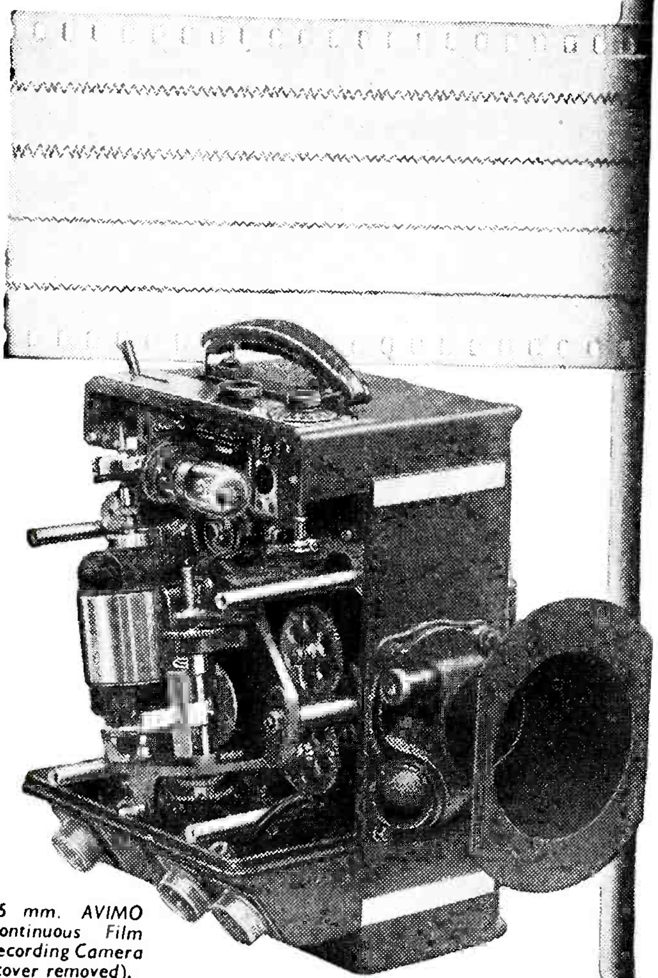
"Dr. Peter C. Goldmark, testifying for Columbia Broadcasting System, stated that Columbia had developed a receiver in its laboratory which was capable of producing 22 foot lamberts of illumination. However, at the hearing in New York, none of its receivers developed more than 15 foot lamberts. In contrast, Allen B. DuMont Laboratories, Inc., demonstrated black and white direct-view receivers that produced an average highlight brightness as high as 750 foot lamberts and Philco Radio Corporation displayed a projection type, of receiver which produced an average highlight brightness of approximately 35 foot lamberts.

"Expert witnesses for DuMont and other companies testified that in their opinion the brightness of the Columbia picture was not adequate for home use. Dr. Goldmark maintained that it was adequate and that any greater brightness would be uncomfortable to the eyes. The demonstration was not an effective medium for resolving this conflict in testimony.

*Flicker*

"In the case of television as in the case of motion pictures, an increase in brightness of the picture (without an increase in frame rate) accentuates observable flicker. It is this factor which

4 Oscillograph traces on 70 mm. paper.



35 mm. AVIMO Continuous Film Recording Camera (cover removed).

9016E

## RECORDING TRANSIENT PHENOMENA

The behaviour of moving parts under actual working conditions may be studied by means of standard commercial oscillographs, which translate mechanical or electrical variations into evanescent traces on a fluorescent screen. Avimo cameras record these traces on continuous film or paper, so that they may be subsequently checked, examined, and measured. Write for Publication C3, giving full details of AVIMO Cameras including types with built-in cathode ray tubes.

AVIMO

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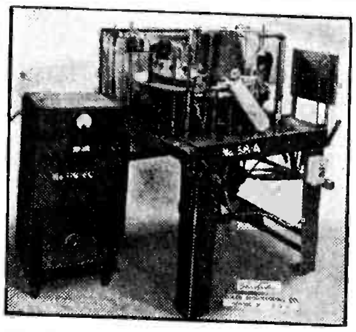
## ELECTRONIC TUBE EQUIPMENT



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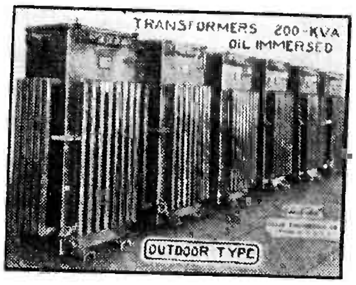
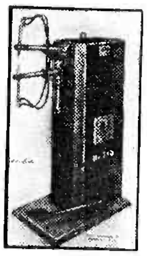



Sizes ¼ To 250 KVA



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FOR ALL PURPOSES
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Neon Sign Units
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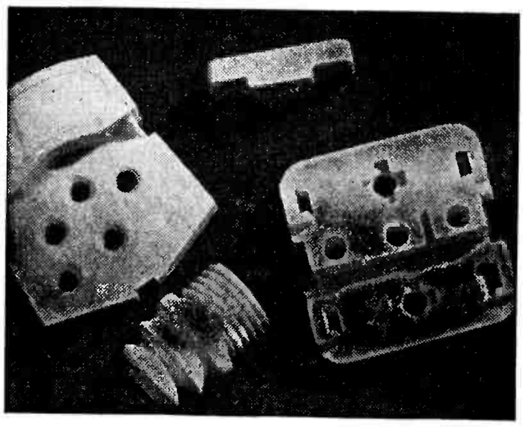

## *Lavite* STEATITE CERAMIC

**Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body**

| | |
|---|---|
| Compressive Strength | 96,000 lbs. per square inch |
| Tensile Strength | 7,200 lbs. per square inch |
| Flexural Strength | 10,500 lbs. per square inch |
| Modulus of Rupture | 20,000 lbs. per square inch |
| Dielectric Strength | 235 volts per mil |
| Dielectric Constant | 6.42 } Frequency of 1 megacycle |
| Loss Factor | 2.90 } |
| Power Factor | .446 } |
| Bulk Specific Gravity | 2.664% |
| Density (from above gravity) | 0.096 lbs. per cubic inch |
| Hardness (Mohr scale) | 7.0 |
| Softening temperature | 2,350°F |
| Linear Coefficient of Expansion | 8.13x10—6 |
| Moisture Absorption (ASTM D-116-42-A) | 0.009% |

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

*We will gladly supply samples for testing.*

**D. M. STEWARD MFG. COMPANY**

*Main Office & Works: Chattanooga, Tenn.*
*Needham, Mass. Chicago Los Angeles*

operates as a serious stumbling block in the path of increasing the brightness of the Columbia picture.

"There is not agreement on the record as to whether there would be any flicker in the Columbia picture if a brightness of 20 foot lamberts is achieved. However, as the brightness is increased, and the frame rate remains constant, there would no doubt be an increased tendency to flicker. . . . If we use the testimony of Columbia's own witnesses, flicker becomes apparent at 23 foot lamberts and begins to be objectionable at 52 foot lamberts.

*Possible Solutions*

"An answer to this problem of brightness and flicker might be found in a higher frame rate; with a higher frame rate additional brightness is possible without flicker. The difficulty with this solution is that Columbia has specifically stated that it is opposed to a higher frame rate.

"Another possible solution was suggested by Dr. Goldmark. He testified that it was possible to increase brightness without changing the frame rate and still avoid flicker. This could be done, he stated, by employing tubes with a slow decay phosphor. Dr. Goldmark admitted that such tubes have not yet been developed. Moreover, RCA testified that it had experimented with such tubes and had found them to be very complicated. Witness for DuMont testified that that company had also conducted experiments with tubes having slow decay phosphor but found them objectionable. Apparently such tubes resulted in objectionable trails being left on the face of the tube.

"In summary, the Commission is unable to conclude from the evidence that the brightness of the Columbia picture is adequate for home use under normal circumstances or that it can achieve such brightness without encountering objectionable flicker. In the absence of more convincing evidence on the point, the Commission is of the opinion that on the point of brightness and flicker alone, the risk of approving the Columbia standards at this time is that color television might be forced to limp along with a picture that is not sufficiently bright for general home use or is subject to objectionable flicker.

*Increasing Frame Rate*

"An increase in frame rate would mean additional channel width.... The wider the band, the fewer television channels that can be accommodated. With 16-mc channels, only 27 television channels can be provided for between 480 and 920 mc. There is some doubt as to whether this number is adequate to provide a truly nationwide competitive television system. Any diminution in the number of available channels will make the task even more difficult. Moreover, at the hearing in Princeton, RCA demonstrated a simultaneous television system which employed a frame rate of 30 per second and yet could be accommodated within a 12.5-mc band. This system is as yet too untested to be able to predict whether it will prove practicable, or whether it results in degrading television performance.

"In the second place, an increase in frame rate poses some very difficult mechanical problems. The higher the frame rate, the faster must be the revolution of the mechanical color wheel. An increase in frame rate from 24 to 30 per second would require an equivalent increase in the speed of the color wheel from 1,440 rpm to 1,800 rpm. (Frame rate as used here means the number of times per second that each individual picture is seen in all of the colors.)

*Screen Size*

"At the hearing Columbia demonstrated a receiver with a 7-inch direct viewing tube. A lens with magnifying characteristics was used in front of the tube so as to give an apparent size of a 10-inch screen. This lens, however, has since been discarded by Columbia because it is subject to specular reflection from lights and windows and severely restricts the viewing angle at which the picture can be seen.

"It is obvious that color television will not be wholly satisfactory unless larger viewing screens can be built. At the present time

there are 20-inch direct viewing tubes for monochrome television. Incorporating a viewing tube of that dimension into the Columbia color television system involves some difficult problems. With a 7-inch viewing tube the mechanical color wheel has a diameter of approximately 16 inches. For a 20-inch tube the diameter would be 42 inches. This would impose severe limitations on receiver cabinet design.

*Decision of Commission*

"The Commission is of the opinion, for the reasons which have been discussed, that the petition of Columbia Broadcasting System should be denied. In reaching this decision, the Commission does not desire to minimize in any way the advances that have been made in the development of color television. On the contrary, the Commission is of the opinion that Columbia Broadcasting System, Dr. Goldmark, and the people who have worked under him are to be commended for their continuing interest in the field and for the great strides that they have made in this field in so short a period. The Commission, however, cannot escape the conclusion that many of the fundamentals of a color television system have not been adequately field tested and that need exists for further experimentation along the lines noted above. It is hoped that all persons with a true interest in the future of color television will continue their experimentation in this field in the hope that a satisfactory system can be developed and demonstrated at the earliest possible date."

## Tube Sales Data

A NEW statistical service, providing for the first time a complete record of electron tube sales, is announced by the Radio Manufacturers Association and the National Electrical Manufacturers Association.

The NEMA Statistical Department will carry out the joint activity, which covers the sales by manufacturers of all tubes except radio receiving (reported by

RMA), x-ray, and battery-charging types. Questionnaires will be sent to all members of both trade associations who manufacture electron tubes, as well as to all known tube manufacturers in the industry who do not belong to either association. The data will be compiled on a quarterly basis beginning with January 1, 1947, and an overall report will be prepared for 1946.

The new service includes the following classifications of nonreceiving tube types: 1—rectifiers, high-vacuum; 2—triodes and multigrid high-vacuum types with external anode; 3—triodes and multigrid high-vacuum types with internal anode; 4—gas or vapor rectifiers, including pool tubes; 5—grid, ignitor, and other gas or vapor control tubes; 6—phototubes; 7—television receiver cathode-ray tubes; 8—all other types of cathode-ray and camera pickup tubes; 9—velocity-modulated tubes, magnetrons, gaps, and TR boxes; 10—miscellaneous types including voltage regulator, ballast, vacuum capacitors, vacuum switches, vacuum gage tubes, etc.

### FCC Personnel Changes

COMMODORE Edward M. Webster, retired chief of communications of the U. S. Coast Guard, has been named by President Truman to fill the vacancy on the Federal Communications Commission, and the appointment has been confirmed by the Senate. This brings the Commission up to its full strength of seven members for the first time since the resignation of Paul A. Porter. Commodore Webster joined the engineering department of the FCC in 1934 after over 25 years of active service in the Coast Guard, and was made acting assistant chief engineer in 1938. During World War II he was recalled to active duty, and after the war became director of telecommunications for the National Federation of American Shipping.

The Commission also announced that it was accepting with regret the resignation of chief engineer George P. Adair, who plans to open offices as a radio engineering consultant. His position will be

filled by George E. Sterling, assistant chief engineer.

### Papers Needed for Chicago Electronics Conference

PAPERS are now being sought for possible presentation at the 1947 National Electronics Conference, to be held at the Edgewater Beach Hotel, Chicago, on November 3, 4, and 5. A wide range of subjects will be included at this Conference, covering essentially research, development, and application in the field of electronics and closely allied fields. A limited number of survey papers, giving a general overall picture of highly specialized fields, will also be included.

Those interested in submitting such material should send a 100 to 200-word abstract to Dr. G. H. Fett, University of Illinois, Urbana, Illinois, to reach him by June 1, 1947. Accepted papers must not be published elsewhere before the Conference. It is expected that papers which are presented at the Conference will be published in the "Proceedings of the National Electronics Conference."

Officers elected to serve for the coming year in connection with this national forum on electronic developments and their applications are as follows:

Chairman of the board of directors—W. O. Swinyard, Hazeltine Electronics, Inc.

President—A. B. Bronwell, Northwestern University.

Executive vice-president—W. L. Everitt, University of Illinois.

Vice-president in charge of program—G. H. Fett, University of Illinois.

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Vice-president in charge of publicity—H. S. Renne, Radio-Electronic Engineering.

Vice-president in charge of publications—T. J. Higgins, Illinois Institute of Technology.

Secretary—R. E. Beam, Northwestern University.

Treasurer—E. H. Schulz, Armour Research Foundation.

Chairman, exhibits committee—O. D. Westerberg, Commonwealth Edison Co.

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### Radar Association Formed

FORMER Navy and Marine officers who worked out applications of radar in air and surface navigation and traffic control during World War II have organized the Association of Electronic Reserve

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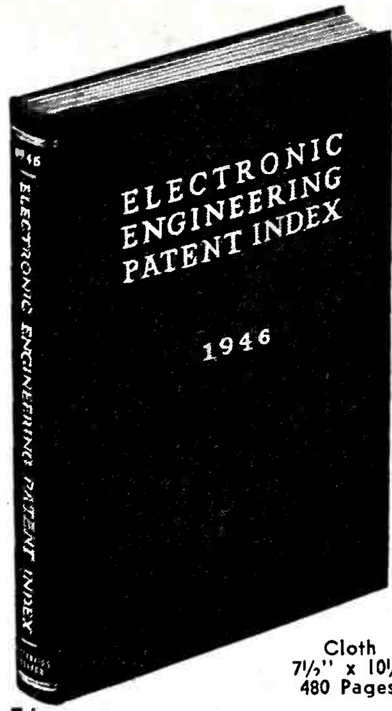


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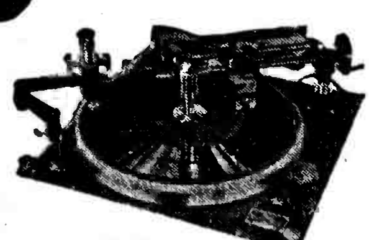

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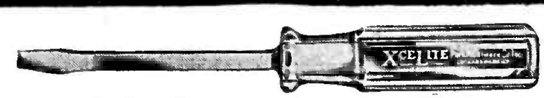


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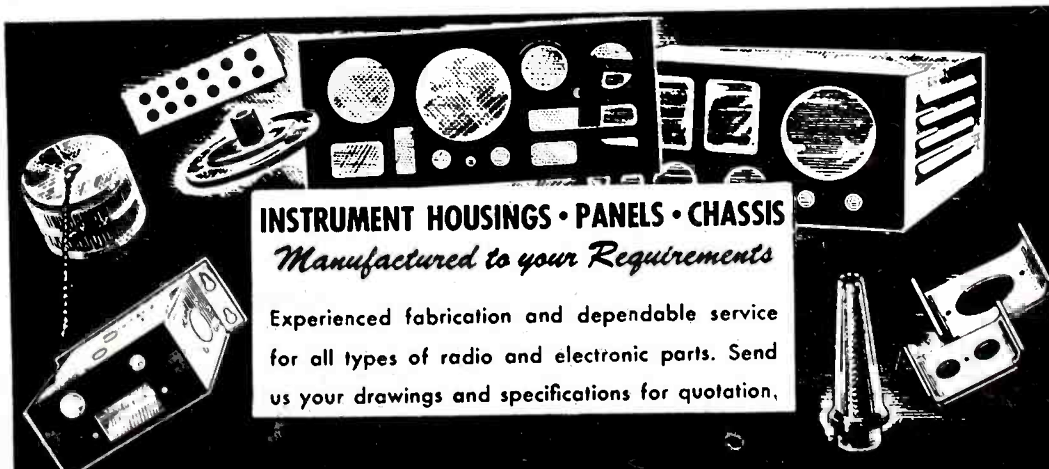

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## Cincinnati IRE Conference

PAPERS to be presented at the one-day television technical conference sponsored by the Cincinnati Section of the Institute of Radio Engineers on May 3, 1947 in the Engineering Society Building include:

Antennas for Television Reception, by A. Alford, consulting engineer.

A New Approach to Television Input Circuits, by Paul F. G. Holst of Crosley Corp.

I-F Television Amplifier Design, by Stuart Seeley of RCA.

Television Receiver Synchronizing Circuits, by R. W. Sanders of Farnsworth Television and Radio Corp.

Cathode-Ray-Tube Screens in Contact With Metal, by C. S. Szegho of Rauland Corp.

Reflective and Refractive Optics for Projection Television Receivers, by G. K. Schnable of Rauland Corp.

Interconnecting Facilities for Television Broadcasting, by W. E. Bloecker of A. T. & T. Co.

The Future of Color in Television, by Donald G. Fink of ELECTRONICS.

Space will be provided for exhibits. A number of interesting demonstrations are planned, including that of the Crosley Broadcasting Corporation television transmitter, which will be in operation on channel 4 for the duration of the conference. Additional information can be obtained from E. J. H. Bussard, The Crosley Corp., 1729 Arlington, Cincinnati, Ohio.

## MEETINGS

APRIL 28-MAY 9: International Merchant Marine Radio Aids to Navigation meetings; first week at Hotel Roosevelt, New York City; second week on three ships working out of New London, Conn.

MAY 3: IRE spring technical conference in Cincinnati, featuring television papers and exhibits; information—E. J. H. Bussard, The Crosley Corp., Cincinnati.

MAY 4-8: National Electrical Wholesalers Association meeting, Traymore Hotel, Atlantic City, N. J.

MAY 6-10: National Plastic Exposition, sponsored by The Society of the Plastics Industry, in the Coliseum, Chicago.

MAY 13-16: 1947 Conference and Show by Radio Parts and Electronics Equipment Shows, Inc., Chicago.

MAY 17: New England Radio Engineering

Meeting of North Atlantic Region of IRE; six technical papers, luncheon, and banquet at Continental Hotel, Cambridge, Mass.

MAY 21-24: ASME Oil and Gas Power 19th National Conference, Cleveland, Ohio.

MAY 26-27: Annual meeting, 3rd NAB district, Lord Baltimore Hotel, Baltimore, Md.

MAY 26-29: ASME Aviation Meeting, Los Angeles, Calif.

MAY 27: Metal Powder Association annual spring meeting, Waldorf-Astoria Hotel.

JUNE 10-13: RMA annual convention, Stevens Hotel, Chicago.

JUNE 12-13: ASME Wood Industries National Conference, Madison, Wis.

JUNE 16-19: ASME semiannual meeting, Stevens Hotel, Chicago.

SEPT. 1-4: ASME fall meeting, Hotel Utah, Salt Lake City.

SEPT. 8-12: Second Annual Conference and Exhibit of The Instrument Society of America, at Stevens Hotel, Chicago.

OCT. 6-8: ASME Petroleum Mechanical Engineering Conference, Houston, Texas.

OCT. 21-25: Pacific Chemical Exposition, San Francisco Civic Auditorium.

## BUSINESS NEWS

GENERAL ELECTRIC purchased from WAA for $851,000 the radio receiving tube plant that it operated during the war at Tell City, Indiana.

ELECTRA VOICE CORP. purchased from WAA for $781,000 the radio receiving tube plant operated by G-E during the war at Bowling Green, Ky.

INDUSTRIAL TELEVISION, INC., has been newly established in Nutley, N. J. to design, manufacture, and install television equipment and other electronic devices.

AMERICAN RELAY & CONTROLS, INC., Chicago, has acquired all assets of the Chicago division of Allied Control Co., Inc.

GOTHARD MANUFACTURING CO. has been purchased by the E. F. Johnson Co., Waseca, Minn.

ENGINEERING CONTROLS, INC. is the new name of Pacific Enterprise Products Co., Los Angeles, Cal.

FARNSWORTH TELEVISION & RADIO CORP. has doubled the space available for manufacturing operations at its Fort Wayne, Indiana plant, and now has all research and engineering activities at this plant.

AIRCRAFT RADIO CORP., Boonton, N. J. announces delivery of ten of the newly-developed vhf omnidirectional range radio receiving systems to CAA for installation in

CAA's fleet of regional inspection aircraft.

RADIO ENGINEERING Co., 8 State St., New York City, offers a complete engineering service for small receiver manufacturers.

AMERICAN WATERWAYS OPERATORS, INC., has set up a special radar committee to study standardization of radar equipment and navigation aids on the rivers.

## PERSONNEL

R. O. WHITESELL, formerly chief engineer of the rectifier division of P. R. Mallory Co., is now a partner in the sales engineering firm of Engineering Products, Indianapolis, Ind.

JOHN A. HIPPLE has been appointed chief of the Atomic Physics Section at the National Bureau of Standards, where he will direct research in ionization and separation of molecules by electron impact and will design and supervise construction of new mass spectrometers to be used in measuring masses of elements and their isotopes. He comes directly from Westinghouse Research Laboratories.

J. A. Hipple

J. J. Mellon

J. J. MELLON is now chief engineer of Allen-Bradley Co., Milwaukee, Wisc., replacing Gustav O. Wilms who will continue to serve the company on a consulting engineering basis while in semi-retirement spending his winters in Florida.

GARRARD MOUNTJOY, former president of Electronic Corporation of America, has been appointed chief radio engineer of Stromberg-Carlson Co.

DONALD MACGREGOR, formerly executive vice-president of Webster-Chicago Corp., has joined Zenith Radio Corporation in Chicago as

vice-president in charge of production.

M. J. GROSS, with G-E since 1928, has been made vice-president in charge of engineering at General Electric X-Ray Corp., Chicago.

M. J. Gross

V. K. Zworykin

VLADIMIR K. ZWORYKIN, director of electronic research at RCA's Princeton laboratories, was awarded the Franklin Institute's Potts medal for his invention of the iconoscope and kinescope. Dr. Zworykin was recently elected vice-president and technical consultant of the RCA Laboratories Division, and is now developing electronic computing equipment for use in weather prediction and weather control.

ELMER P. GERTSCH becomes general works manager for the five plants of Hoffman Radio Corp. in Los Angeles.

ARTHUR J. SANIAL has resigned as chief engineer of Atlas Sound Corp. to devote full time to consulting engineering work in the field of sound systems.

SAMUEL BERMAN, research engineer with Waugh Laboratories Division, received the Longstreth Medal, annual new-inventions award of The Franklin Institute, for development of a metal locator used in surgery. Distribution and sale of the instrument is being handled by General Electric X-Corp., with Waugh Laboratories continuing its manufacture.

CARL S. ROYS has been appointed professor of electrical engineering at Syracuse University. He previously held a similar position at Illinois Institute of Technology, and was active in organizing and managing the Ohmite Laboratory of Precision Measurements of the Armour Research Foundation.

# NEW BOOKS

## Speedlights

By ARTHUR PALME. *American Photographic Publishing Co., Boston, Mass.* 1946, 128 *pages, price* $2.50.

IN THIS small book the author, well known in the photographic literature for his articles on the subject, performs the distinctive service of answering nearly all the questions photographers are now asking about those flashlights which can be fired more than once, thanks to the marvel of electronics.

There is the history, going back to Fox Talbot and his spark techniques, of the improvements worked by Mach and Boys and finally to the modernization of the whole principle by Edgerton in 1928. There are descriptions of commercial equipment available at the time the book was written; there are many pictures made by various exponents of the high-speed flash and data on how these pictures were made; there are circuit diagrams and pages on home assembly, a chapter on the synchronization problem—and, quite properly, a warning that 2,000 volts is a lethal amount of electrical pressure no matter who touches it.

This is a good little book, giving a lot of data on a most timely subject.—K.H.

## Fundamentals of Industrial Electronic Circuits

By WALTHER RICHTER. *McGraw-Hill Book Company, Inc., New York, 1947, 569 pages, $4.50.*

THIS new addition to the growing list of books dealing with electronic fundamentals suffers in only one respect according to this reviewer—its title is slightly misleading. It deals not exclusively with circuits useful in industrial processes, as one might suppose, but with many circuits which are useful to all electronic engineers whether their chief interest is industrial control or communication. In other words, the "industrial" aspect of the title should not prevent a nonindustrial engineer from being interested in the book.

The author, who is not unknown to readers of Electronics, has an easy style. He uses many mechanical analogies. The number of

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mathematical equations he includes is practically zero, and he has a vast proficiency in making clear the basic functioning of complex arrangements of tubes and components. His use of problems at the end of each chapter and the inclusion of numerous bibliographies situated near the text to which they apply are important and useful adjuncts.

The 27 chapters deal with such fundamentals as circuit theorems; mutual and self inductance, capacitance and combinations thereof; nonlinear conductors; amplifiers; timing circuits; bucking or compensating circuits; cathode followers; tube wattmeters; tuned circuits; beat-frequency and relaxation oscillators; phototubes and optical systems for them.

The meticulous yet clear explanations of the basic circuits and of their design features, leavened by the occasional light touch, make this a book which is strongly recommended.—K.H.

## Russian-English Technical and Chemical Dictionary

By LUDMILLA IGNATIEV CALLAHAM. *John Wiley & Sons, Inc., New York, 1947, 794 pages, $10.00.*

INTENDED chiefly for English-speaking chemists and chemical engineers with a fair knowledge of Russian, this monumental work also provides comprehensive coverage of electrical engineering and other fields, and includes the more frequently used terms in aviation, radio, physics, mathematics, and other pure sciences. An introduction orients the reader in most efficient usage of the dictionary, and lists common Russian technical word endings.—J.M.

## Television Receiving Equipment

By W. T. COCKING. *Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S. E. 1, England, Second Edition, 1947, 380 pages, 12/6d plus 5 d postage.*

ALMOST 50 additional pages covering important improvements in television receiving techniques developed during and since the war in England have been added in this

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second edition of a book written specifically for television technicians. The author is editor of Wireless Engineer. The chapter on electromagnetic deflection has been greatly expanded since this system is now almost universally employed in England. Though British television standards differ slightly from those in the United States, circuits and techniques are so similar that American technicians will find much valuable information in this book.—J.M.

## The Theory of Mathematical Machines

By FRANCIS J. MURRAY, *Associate Professor of Mathematics, Columbia University. King's Crown Press (Division of Columbia University Press), New York, N. Y., 1947, 116 pages, $3.00.*

THOSE engaged in construction of continuous calculating devices, differential analyzers, and digital calculators will find this comprehensive discussion of the basic principles of such devices invaluable. Fundamental requirements are considered, and mechanical and electronic approaches are taken up one by one. Perhaps a third of the book is devoted to the electronic circuitry of calculators.

Reproduction is directly from typed copy and the author's original sketches, with excellent clarity, using two-column makeup on 8½ x 11-inch pages. The format was chosen to make scholarly material such as this available at minimum cost. —J.M.

## Automatic Telephone Practice

By HARRY E. HERSHEY. *Technical Publications, Whitewater, Kansas, Fifth Edition,* 132 *pages,* $4.00.

THE LARGE pages of the volume conveniently display all phases of the Strowger step-by-step telephone system. The treatment includes discussions of general principles, historical aspects, circuit kinks (some of which have been designed for nontelephone use), and circuits. Any engineer interested in remote control or telemetering will profit from a review of the sections dealing with relays and stepping devices.

In addition, the reader is treated to a whole chapter on morals, besides frequent interjections of autobiographical bits, diatribes against newspaper men, and the theological gem, "Christus Victor". It is a tossup whether the collector of literary curiosa or the student of automatic switching will get the greatest value from the book.—A.A. MCK.

## Commercial Broadcasting Pioneer

By WILLIAM PECK BANNING. *Harvard University Press, Cambridge* 38, *Mass.*, 1946, 308 *pages*, $3.50.

FOR THOSE who listened to the first WNAC-WEAF network broadcast on a crystal set or thrilled to voices from across the continent over a loudspeaker during one of the first transcontinental hookups, this book is rich and satisfying. The subtitle, "The WEAF Experiment, 1922-1926", appropriately defines the contents. The author, as a former assistant vice-president of the American Telephone & Telegraph Co., was admirably placed to evaluate the great role played by the Telephone company as a builder and supplier of all types of broadcast equipment, custodian of the networks, and operator of its own stations.—A.A.MCK.

## Concise Chemical and Technical Dictionary

EDITED BY H. BENNETT. *Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947, 1055 pages, $10.00.*

APPROXIMATELY 50,000 definitions covering every field are included, with major emphasis on chemical and nucleonic terms. Thousands of trade-name products in the plastic, rubber, pharmaceutical, and chemical fields are listed with their chemical compositions and properties. Opening sections cover the nomenclature of organic chemistry, names and formulas of radicals, pronunciation of chemical words, and abbreviations used, while an appendix gives many useful tables and an addenda of new terms. A valuable reference for anyone concerned with applications of electronics to the chemical field. —J.M.

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EXPERIENCED BROADCAST and radio communication engineer, age 29, with 4½ years experience in development and testing of VHF communication equipment and systems. Desire responsible position in FM, standard broadcast or, communications installation. No objection to overseas assignment. PW-329, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

BRAZILIAN, 29, ambitious, with more than ten years of experience in radio field being more than four in aircraft radio. Knowledge of English and romance languages. Look for position in Export Department, Sales Engineering in Latin America, training people for radio maintenance in Latin America, or Advertising Agency. P. O. Box 6753, Towson, Maryland.

ELECTRICAL ENGINEER (B.S.E.) 5 years manufacturing experience including 3 years product engineer on UHF metal vacuum tubes for large manufacturer in mid-west and east. Experienced with induction heating, electronic controls, welders, vacuum pumps, testing and tube fabrication. Presently employed, 27, married one child. Interested in sales or application engineering. PW-330, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

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ANYTHING within reason that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

## ATTENTION ENGINEERS

**Experienced engineers with Bachelor's, Master's, or Doctor's degrees in Electrical Engineering, Communications, Radio, Physics, Mathematics. At least two years experience in design and development of radar and television systems, electronics navigational systems, automatic computors, servomechanisms, etc., required. Specialists in High Frequency transmitters, receivers, antennas, aircraft electronic components particularly desired. Starting salary commensurate with experience. Exceptional opportunity for the right men. Write**

**McDONNELL AIRCRAFT CORPORATION**

**Lambert—St. Louis Municipal Airport, Box 516, St. Louis (21) Missouri**

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Experienced senior electrical and mechanical project engineers needed for responsible positions in development and production of A.M., F.M., television receivers and components. Opportunity for advancement. State qualifications in application to:

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**145 Palisade Street**
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*Reply giving full details to*

**Personnel Manager**
**BENDIX RADIO**
**Division of Bendix Aviation Corporation**
**Baltimore 4, Maryland**

## JR ENGINEER AVAILABLE

*BEE Cooper Union June 1947*

*Married Age 28*

Major in Coast Artillery. Five years army experience. Staff and administrative duty. Harvard and MIT Radar Course

**WILLIAM HOLLANDER**
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Leading midwest designer and manufacturer of broadcast stations, radio communication and navigation equipment, amateur radio equipment, and industrial control devices, has excellent opportunity for able, experienced editor for its own technical publication. Will also handle articles regarding our equipment and advanced research for the electronic, broadcast, aviation and amateur press. Please write fully regarding background, experience, age and salary. Samples of your work will be helpful in first letter. Address

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520 North Michigan Ave., Chicago 11, Ill.

## FACTORY ENGINEER

**We have an opening in our factory engineering division for an outstanding man. This position requires experienced background of at least 5 years engineering work on factory problems relating to receiving tubes manufacture. An engineering degree would be helpful but the primary requirements of the position are the experience and the ability to successfully solve every-day problems encountered in the manufacture of receiving tubes.**

*Apply by letter to Personnel Dept.*

**NATIONAL UNION RADIO CORPORATION**
**Lansdale, Pa.**

**ADDITIONAL EMPLOYMENT ADVERTISEMENTS ON PAGE 287**

## ELECTRONIC ENGINEER

***DEVELOPMENT LABORATORY***

An experienced man to serve as project engineer in the development of RF test equipment.

Good opportunity for person with 10 years or more electronic experience.

Salary commensurate with ability. Replies held in confidence, please include resume.

*Dr. J. Downsborough*

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**Boonton, N. J.**

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**American Firms desirous to extend their activity to Belgium, are invited to contact with**

**SOCIETE INDUSTRIELLE ALFA**
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**BRUSSELS**

*Oldest importer of American radio, electrical and electronic material.*

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Han. 5226
361 Atlantic Ave., Boston, Mass.

GOVT. SURPLUS

## OBJECTIVE LENSES

2¾" O.D. 15" focal length
NEW — ACHROMATIC — COATED — IN PEDESTAL MOUNT $15.00 ea.
EYE PIECES — WRITE FOR PRICES

**F. W. BALLANTYNE** **Point Pleasant**
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20,000#—SILICON TRANSFORMER STRIP .011 x 2¾" x Coils—AA GRADE—OXIDE FINISH—58-72 TYPE PRICE—10¢ lb. FOB. NEW YORK CITY.

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1000 only available for immediate shipment subject to prior sale at $55.00 per hundred. Original packaging—Guaranteed perfect.

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FS-316, Electronics
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## *SURPLUS EQUIPMENT SALES*

**Constant impedance type N connectors**

| | | | |
|---|---|---|---|
| UG21U | 75¢ | UG27U | $1.00 |
| UG24U | 75¢ | UG29U | $1.00 |
| UG25U | 75¢ | UG30U | $1.00 |
| UG58U | 75¢ | UG83U | $1.00 |
| | M359 | 50¢ | |

½ ft.-2 ft. length of RG11U cable with PL259 connectors at each end, $1.00.

*Microwave Generator TS155A/UP, range 2700-2900 megacycles, pulse modulated 120-2000 pps, variable pulse width and delay, Thermistor bridge, R.F. power meter for internal and external metering, 9 tubes 25" x 15¼"d. 12½"h, complete with connectors, cables and adapters, new $160.00.

Oil filled capacitors:
.05 mfd 2500 WVDC G.E. Pyranol 26F160.... .75
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.15 mfd 4000 WVDC G.E. Pyranol 25F279....1.50
.25 mfd 4000 WVDC Sprague P-9717.........1.00
2 mfd 4000 WVDC G.E. Pyranol 23F47......5.00
.5-.5 mfd 5000 WVDC G.E. Pyranol 26F729...4.00
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1 mfd 15000 WVDC G.E. Pyranol 14F263...25.00

Radar Receiver BC 1068 A, 150-210 megacycles, permeability tuning individual tuning for the r.f. stages, bandwidth 4 mc, 115 volts 60 cps, 14 tubes, $35.00

3" cathode ray scope, radar indicator ID-93/APG-13A complete with 3BPI and 10 tubes, 110 v. 400 cps, new $25.00

Silver button mica feed thru capacitors, threaded, 500 mmfd 500 volts dc 15c each

Westinghouse 3½" meter, 0-1 ma. white scale reading 0-350 volts $4.00

Landing Indicator meter, 2 meter movements, 210 microamps each, Westinghouse CAY222316, $5.00

***Write for Bulletin***

**ELECTRO IMPULSE LABS.**
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**BEST QUALITY, USED ELECTRON TUBE MACHINERY**

Equipment for the manufacture of all kinds of electron tubes, radio tubes, incandescent lamps, neon tubes, photo electric cells, X-ray tubes, etc.

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***Also complete design and fabrication of servo amplifiers and systems.***

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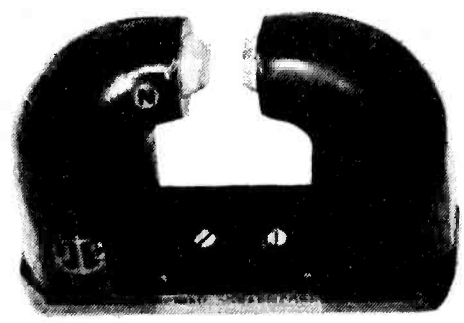
# MAGNETS

**for magnetrons**



| | |
|---|---|
| *Center field strength* | *4800 gauss* (approx) |
| Pole face diameter | 0.75" |
| Pole face spacing | 0.635" |
| Overall dimensions | 2½"x5½"x7½ |
| Net weight | 14 lbs. |

- Individually calibrated.
- Supplied with keeper block.
- Individually packed in original sealed cartons.
- Made by CINAUDAGRAPH

**List price......$36.00**

**Stock No. In lots of 10....$5.00 ea.**
**UMM-48 In lots of 100.... 4.25 ea.**
F.O.B. Corona, New York

**DUBIN ELECTRONICS CO.**
**103-02 Northern Blvd., Corona, N. Y.**
Tel: Illinois 8-3132 Wire: Dublectron N. Y.

***Special Values***

## Panel & Portable Meters

D. C. Microammeters: 50-100-200-500 microamps. High Resistance Voltmeters Vacuum Thermo-Couple Meters 3½" & 4½" Round & Rectangular

**Multirange Portables:**
readings from 10 microamps. full scale

**Precision Electrical Instrument Co.**
146 Grand Street New York 13, N. Y.

*A Battery-operated*

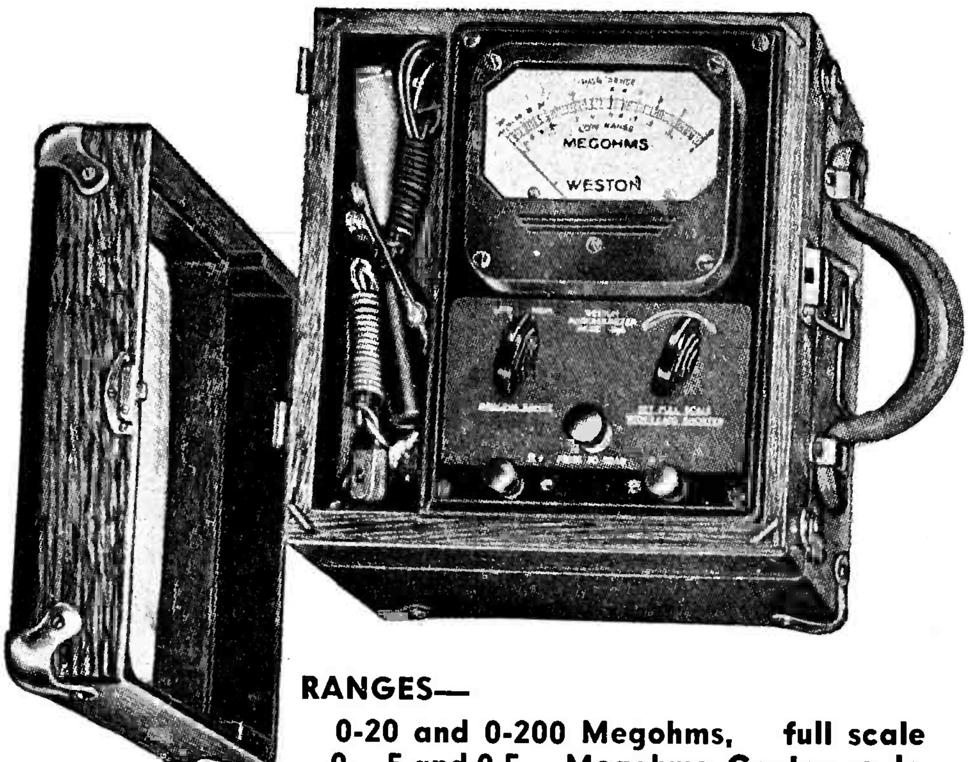
# INSULATION TESTER!!

## 200 MEGOHMS

**At a Test Potential of**

## 500 VOLTS D. C.

**Supplied by built-in battery and vibrator power supply.**




**RANGES—**

**0-20 and 0-200 Megohms, full scale**
**0- .5 and 0-5 Megohms, Center scale**

This unit was designed for the Navy to operate off eight 67½ volt batteries which provided a test potential of 350 to 500 Volts.

The original units have been modified slightly to operate off 2 inexpensive, (approximately 80¢) internal #6 standard 1½ volt dry cells and a vibrator power supply which provides a test potential of 500 volts. The use of the vibrator power supply eliminates the high replacement costs (approximately $18.00) of the 67½ volt batteries.

- **NO HAND CRANKING**—The 500 volt potential is made instantly available by simply pressing a panel switch.
- **DIRECT READING**—All calibrations printed in large easy-to-read type enabling exact determination of leakages from 0 to 200 megohms.
- **PORTABLE**—Enclosed in a rugged hardwood carrying case 8⅜" x 9⅛" x 8" deep with removable cover.
- **METER MOVEMENT**—A Weston Model 801 4½" Rect. 0-50 microampere meter guarantees extremely accurate readings on all ranges.

**SURPLUS — NEW — GUARANTEED**

*Complete with leads, instructions, internal power supply, etc. Ready to use.*

**NET $39.50**

**All prices F.O.B., N. Y.—25% Deposit required on C.O.D.'s. Orders accepted from rated concerns on open account Net 30 days.**

# SURPLUS NEW METERS

### MICROAMMETERS

W. E., 3½", concentric style, 0-200 microamp .......... $4.00

G. E., DO-41, 3½", 0-500 microamp mvt. scale 20 K. V., comp with paper V-O-M.A. scale .......... $4.95

### D. C. MILLIAMMETERS

W. H., RX-35, 3½" square, 0-1 M.A., 55 ohms, internal resistance, complete with paper V-O-M.A. scale .......... $4.95

G. E., DW-41, 2½", 1 M.A. .......... $3.95

### D. C. KILOVOLT METER

W. H., NX-35, 3½", 1.5 K. V. complete with 1000 r/v ext prec resist .... $6.95

### D. C. AMMETER

Triplett, 3½", 0-15 Amps .......... $4.00

### RADIO FREQUENCY AMMETERS

Weston 425, 3½", 120 M.A.R.F. .... $8.50

Westinghouse, NT-35, 3½", 3 A.R.F. $5.50

Simpson, 2½", 3 Amp., expanded at lower part of scale .......... $3.50

### A. C. VOLTMETERS

G. E., AO-22, 3½", 150 volt ....... $5.50

W. H., NA-35, 3½", 15 volt ....... $3.95

W. H., NA-35, 3½", 150 volt ...... $5.50

Weston, 476, 3½", 300 volt ........ $8.00

G. E., AO-22, 3½", 500 volt ...... $12.00

### SPECIAL METERS

Weston, 301, Type 61 Decibel Meter, 3½", — 10 to + 6, 6 M. W. 600 Ohms; High speed type .29 — .35 Sec. to final reading. Complete with external wire wound precision resistors to extend the range to any or all of the following ranges:

| | |
|---|---|
| — 20 to + 16 DB | — 50 to + 46 DB |
| — 30 to + 26 DB | — 60 to + 56 DB |
| — 40 to + 36 DB | — 70 to + 66 DB |

List Price = $31.00 ... Your cost ... $9.50

Weston, 301, Type 21 Standard Decibel Meter, 3½", round flush bakelite case, — 10 to + 6, 6 M. W., 600 ohms; General Purpose type 0.5 — 0.7 Second to final reading, 45-62% overthrow, 5000 ohm internal resistance at ODB .. $8.50

**All meters are in round flush bakelite case with white scale unless otherwise specified.**

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# MARITIME SWITCHBOARD

**338 Canal Street - - - Worth 4-8217 - - - New York 13, New York**

# New Surplus Relays & Contactors

All in original manufacturers cartons

### 1000

- 110 volt, 60 cycle
- Cutler Hammer Type 619 unmounted contactors
- 4 pole, 25 amp., 600 volt normally open contactors
- Has one normally open and one normally closed pilot contacts to be used for pilot light or push button control

**$3.95 Each**

### 500

- Same as above but one normally open pilot contact

**$3.75 Each**

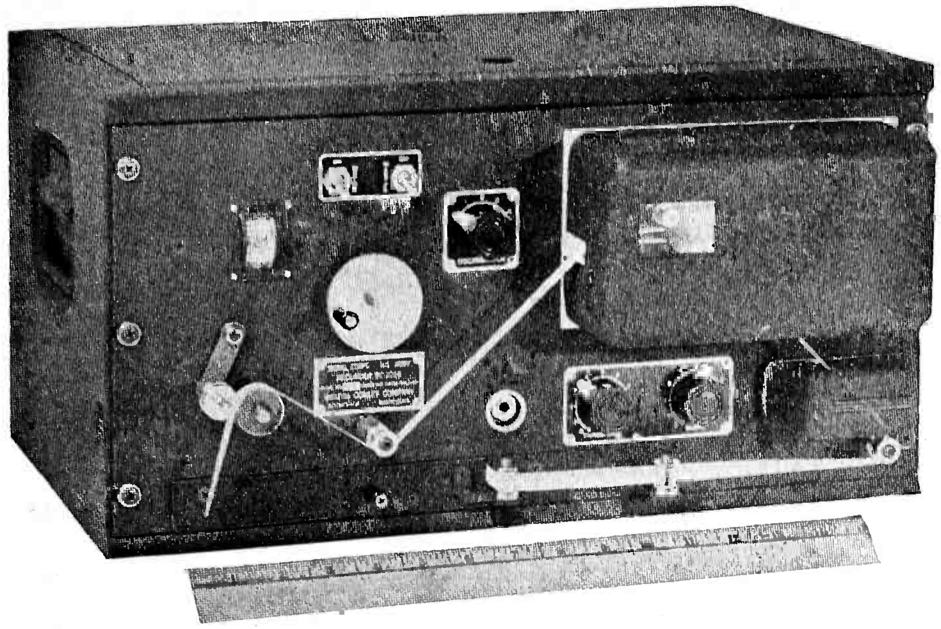
### 350

- 110 volt, 60 cycle A.C.
- 2 pole, 100 ampere normally open contactor
- Manufactured by Monitor Controller
- Mounted on ¾" panel 19"x14"
- Has one large auxiliary contact which was used to close high voltage condenser bleeder circuit when contactor was opened
- Has one normally open and one normally closed auxiliary contacts for pilot light or push button control circuits
- Panel contains 1-single pole, 200 ampere, 250 volt fuse clip
- Also 2-30 ampere, 125 volt, fuse clips for pilot circuits

**$4.95 Each**

**SPECIAL DISCOUNTS FOR QUANTITY PURCHASES**

# CODE RECORDER BC-1016



- **GENERAL**—Designed for ink recording of standard code signals at speeds up to 400 words per minute on a ⅜" paper tape. Made by Waters Conley Company, Rochester, Minnesota.
- **APPLICATION**—a) Designed primarily to be connected to the output circuit of a radio receiver. Operates on a signal from 0.15 to 50 volts, usually connected directly across the speaker voice coil so that signals may be heard as well as automatically recorded. Frequency response 500 to 5000 cycles per second.
  b) Direct Keying recording from an automatic keyer or from a hand key to record messages for code practice, etc.
  c) Can be operated from a telephone line which carries the radio signals to the recorder from a remote location.
- **POWER SUPPLY**—Operates on 117, 170, 210 or 240 volt 50-60 cycle alternating current or within 10% of those voltages.
- **POWER CONSUMPTION**—Approximately 140 watts operating; approximately 85 watts in standby.
- **COMPONENTS**—Fully equipped and assembled. Just connect to voice coil of the speaker on your receiver (or to a key for code practice) and plug into your power line.
  Contains the following:
  - Bodine variable speed drive motor with fan
  - Three pens (use Higgins "Eternal Black" ink)
  - Power Cord
  - Technical manual with instructions and wiring diagrams
  - 5 Spools of tape (1000' spools) These five spools can record up to 20,000 foot of message if necessary (extra tape available from radio supply houses)
  - Amplification—bridge circuit with the following tubes 1 6SJ-7, 1 6SN-7, 2 5U4-G, 1 6H6, 3 6L6

Complete ready to use in Steel Cabinet 10¼" high 19¼" wide x 14⅝" deep; wt. 80 lbs. Designed to fit any standard 19" rack. Height is 8⅜" and wt. 65 lbs. when cabinet is removed for rack mounting.

**SURPLUS NEW GUARANTEED**

**NET $24.95**

All prices FOB, N. Y.—25% deposit required on C.O.D.'s. Orders accepted from rated concerns on open account Net 30 days

## MARITIME SWITCHBOARD

338 Canal Street - - - Worth 4-8217 - - - New York 13, New York

# "Communications"

**Specializes in Industrial Electronic — and Microwave Parts. We guarantee every item in this Ad to be to your complete satisfaction.**

## MICROWAVE PLUMBING

### 10 Centimeters

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|---|---|
| Sand Load—Waveguide section. App: 23" high with cooling fins (Dummy Ant.) | $35.00 |
| Wave Guide to Coax. with flange Gold plated 10 CM | 25.00 |
| Standing Wave Detector, rigid coax 58 ohm. | 5.00 |
| Coax rotary joint, with mounting plate | 8.00 |
| Wave guide (16 ft. lengths) per foot 10 CM | 2.00 |
| Heavy Flange for mounting wave guide | 2.00 |

### 3 CENTIMETERS

| | |
|---|---|
| Wave guide 90° bend E Plane. 18" long | $ 4.00 |
| Wave guide, 18" long S curve, cover to choke | 3.50 |
| Rotary coupler, wave guide in and out, choke to choke | 6.00 |
| Duplexer section using 1B24 | 10.00 |
| Wave guide 5 ft. lengths, per ft | 1.95 |

### 1.25 CENTIMETERS

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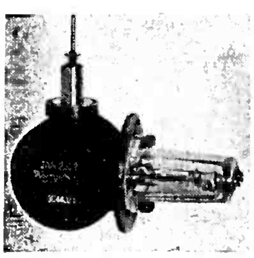
| T section choke to cover | $ 4.50 |
| Flexible section choke to choke | 3.00 |
| Mitered elbow and S section cover to choke | 3.50 |

## MAGNETRONS



2J32 (JAN.) is designed for 10 cm. operation. Rated at 300 kw peak pulse power. Complete information supplied. Brand new. The 2J32 is listed at $200. OUR PRICE ...$25.00
3J31 One cm. magnetron listed at $95.00. OUR PRICE ...$20.00
720 Magnetron value $200. Special ...$20.00

| | |
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| 2J38 (3245-3263 MCS) complete with magnet | 37.50 |
| 2J26 (10 CM) | 25.00 |

| | |
|---|---|
| Magnets for Magnetrons | 12.00 |
| KLYSTRON oscillator tubes 2K25/723 ab designed for 3 cm operation. New. With complete data. Listed at $38.00, reduced to | 7.75 |
| McNally Klystron 707B (10 CM) | 9.95 |
| Tunable Cavity for 707B | 3.50 |
| 30 mc oscillator-amplifier with 2 6AC7's. Uses 723ab, Waveguide input, xtal detector: | |
| With 6AC7's | 10.00 |
| With 6AC7's, 723ab and 1N21 | 16.50 |
| Thermistor Beads (D-170396), for use with UHF and Micro-Wave Equipment (List $7.00). In separate sealed containers | .95 |
| Thermistor Buttons D 168391 | .95 |
| Magnet for 3 centimeter magnetrons, incorporating a magnetron stabilizer cavity. Cinaudagraph Type UC 210 | 22.50 |
| W.E. Converter BC 437A | 19.00 |
| Parabolic Reflector—Ribbed—For operation in 3000-4000 MC Range. Made by Budd. Has Mounting Neck. New | 85.00 |
| Dipole—Can be used with above | 5.00 |

## SO RADAR

We have complete SO Radars—including Antenna, Transmitter—Receiver, Indicator, Motor—Generator Set, used, but in Good Condition, with a brand new antenna system ... $500
We also have the SO-9 New! in original crates complete with full set of spare parts—ready for installation.
A $20,000 Buy—Our Price ... $2,500

## RELAYS

### All types—all sizes

| | |
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| Edison Tube type sealed thermal relay. 45 to 60, second delay. 4 prong base. AC or DC | 2.95 |
| GE—Underload relay. Type CR2810-1265. High Amperage. Sturdy construction on ½" bakelite base | 1.50 |
| 6 V AC DPDT Dunco | 1.50 |
| 6 V AC DPST Dunco | 1.20 |
| Struthers Dunn 125V. DC relay—3 amp. Type ADBT 8. DPST Rugged on bakelite base | 1.50 |
| 115V/60c 10 amp rating, 1 contact SPST open, 1 contact closed DPDT. GE Type CR 2790 | 2.10 |
| DPST Telephone type, 1 contact open, 1 contact closed, rating 5 amps at 50 Volts | 1.05 |
| DPST 115V/60c | 1.25 |
| 12 or 28 Volt Relay Grab Bag. | |

Made by Leach, Kurman, Advance, etc.:

| | | |
|---|---|---|
| SPST | Ea. | .50 |
| DPDT | Ea. | .60 |
| TPTT | Ea. | .70 |

## PULSE TRANSFORMERS

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|---|---|
| GE Type K2450A. Will receive 13KV, 4 microsecond pulse on pri., secondary delivers 14 KV Peak power out 100KW | $15.00 |
| Hi Volt. Magnetron Input transformer W.E. #D-166173 with cooling fins | 12.00 |
| Raytheon UX 4298E—Pri. 4 KV, 1 microsecond Sec. 16 KV. 16 Amps. Fil. pri. 115V. 400 Cycle | 15.00 |
| W.E. Hi Volt input pulse Transformer #D 169271 | 9.95 |
| GE Radar pulse Tformer K2731 Diameter App. 11" vertical cooling fins | 19.50 |
| Ameritran Plate Tformers Type PF Pri. 115V/60c. Secondaries 38 V and 2.2 V, center tapped. Primary and secondaries tested 10,000 V | 12.00 |
| Utah Blocking oscillator transformer, 3 windings #9280 or 9318 ea. | .75 |

## MICROWAVE TEST PARTS

| | |
|---|---|
| Maguire Wavemeter (3 cm)—Vernier drive dial, and resonant cavity #1539TFX 21GA | $20.00 |
| 4 inch directional coupler, 20 Db drop. 3 Cm wave guide in and out, coax prob | 5.50 |
| 8" long directional coupler CU-90/UP-20Db drop has short right angle (10 Cm) | 5.50 |
| W.E. Signal Generator I-138 A (10 Cm) indicator is a 0 to 200 microammeter. Value $400—our price | 75.00 |

## HI VOLT COMPONENTS

| | |
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| ½ wave rectification transformer, 115V/60C. Sec. 3200 V. @ 150 mils. Kenyon | 7.25 |
| 2KVA Transformer and choke—115 V—50 to 70 cycle input, single phase. Output 17,000 V. @ 144 mils. CHOKE 4,000 H. @ current. DCR 4500 Ohms Dimensions, 26x29x13" Amertran | 74.50 |
| Sangamo Capacitor G-3 .006 mf. 10Kv list $87.50 | 17.50 |
| .1—.1 7000 V GE Pyranol Capacitor | 2.06 |
| 10-10-10 mf Synchro cap 90V/60C | 2.50 |
| .75 mf. 20,000 Vdc GE 14F136 | 22.00 |
| 1 mf. 5000 VDC oil, CD or GE | 4.50 |

400 Cycle Transformers all sizes at lowest prices. Most small Transformers at 50¢. Larger ones at proportionately low prices. Send us your approximate voltage and quantity requirements.

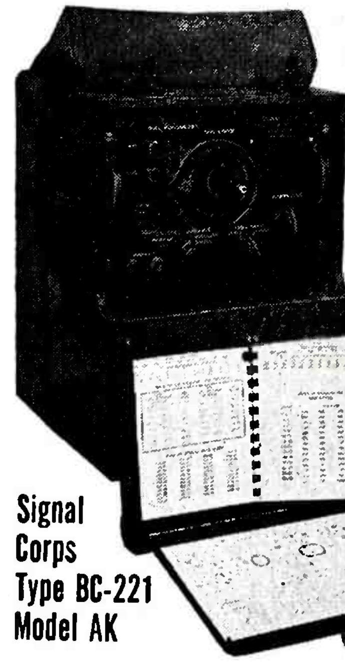
***All merchandise guaranteed. Mail orders promptly filled. All prices F.O.B. New York City. Send Money Order or Check. Shipping charges sent C.O.D. Send for our latest microwave flyer, also our complete parts catalog.***

## COMMUNICATIONS EQUIPMENT CO.

**131-E LIBERTY STREET NEW YORK CITY 7, N. Y.**

***Telephone WHitehall 4-7658***

# MAINTENANCE MEN! BROADCAST ENGINEERS!



Modulated FREQUENCY STANDARD

$79.50

Signal Corps Type BC-221 Model AK

**Complete with tubes, original crystal and calibration charts**

This is a stable, heterodyne frequency meter with fundamental ranges of 125-250 and 2000-4000 KC; checks up to 125th harmonic on high-grade receivers; internally modulated at 400 cycles; stability better than .005%; works on 110v. a-c, batteries, or vibrapack; sturdy wood case has carrying handle; drop front carries book of calibration charts. In excellent condition, this is a valuable tool for field and laboratory.

## Genuine MegΩMeter INSULATION TESTER

Brand New Government Surplus

Only $89.50

True ohmmeter with hand-driven 500-volt generator wholly self-contained in polished, black phenolic case . . . the accepted means for checking insulation resistance . . . direct reading to 1000 megohms . . . complete with wood carrying case, test leads, 21-page instruction book. Order today!

**The RADIO SHACK Corp.**

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167 E WASHINGTON ST., BOSTON, MASS., U.S.A.

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"TAB" SPECIAL 3 for $1.00 Precision Wire Wound Resistors IRC, SHALLCROSS, MEPCO, INST RES. Co., OHMITE FOR METERS, BRIDGES, AMPLIFIERS.

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SPRAGUE 10Meg TenKV MEGOMAX MFAI..$1.75
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DELCO APPLIANCE MOTOR PERMANENT MAGNET MINATURE TYPE #5069370 DC 27.5VOLT OP. BRAND NEW AN GOV'T INSPECTED 10000 RPM, SHAFT 1/8" Dia/½" long IDEAL FOR Experimenters, Industrialists Thousands of uses Laboratories, Schools, Colleges, Factories "SMALLEST MOTOR MANUFACTURED" 2" long x 1-⅛" x 1"W Operates on low current-Gov't Developed at high cost-Excellent for Trains, Toys small mechanical devices, camera shutters, Graphic recorders, blowers, foolproof in operation "TAB" SPECIAL ...$3.95
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DAVEN 13CKT Sw 2SPDT/3SPDT/SP3P HV .79
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RF Choke 1MH/300ma National 3 for........ .89
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2mfd/5500WVDC, WST INERTEEN........... 7.95
2mfd/12500WVDC WST .................. 25.00
1mfd/25000WVDC WST INERTEEN.......... 75.00
0.5mfd/600WVDC Bathtub, Five for........ .95
2mfd/600WVDC, TLA, Two for............. .79
0,5&0mfd/600WVDC, Bathtub, 5 for........ .95
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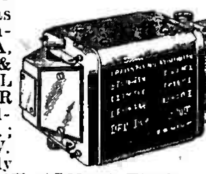

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3A4/75¢@; 6AL5/81¢@; 6SL7 each.......... 1.00
6C8/$1@; 6F7/$1@; 6K7/66¢@; 6K8 each.... .81

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TX-6 N.Y. Trans.—8000 ohm Pri., 880 ohm sec.—4-⅛" x 3" x 4-⅜" ½ 6½ lbs. $6.95

TC-9 Chicago Trans.—165 v. @ 125 a., 18 v. @ 1.5 a., 1 v. @ $1.25 a.
4¼" x 2-¾" x 3-⅛"—4½ lb. $1.49

TC-10 Pri. 115 v. AC—50—1200 cy per sec.—sec. 6.3 @ .6A—359 v. @ 70 Ma—65 v. @ 70 Ma—400 v. @ 10 Ma—5 v. @ 2A—6.3 @ 4 A—4" x 4" x 5½" 13 lb. $5.95

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TF-10 N.Y. Trans. Pri. 220 v. Sec. 6.4 v. @ .9 A—4" x 2-¾" x 3-⅜"—6½" lb. $3.95

TF-11 N.Y. Trans. Pri. 220 v. Sec. 5.07 v. @ 13.5 A—5¾" x 4" x 5-⅛"—13 lb. $4.25

TF-17 G.E. Pri. 115 v. Sec. Dual 54 @ .065 KVA—Insul. 12.5 KVA—5" x 7" x 8"—9½ lbs. $9.95

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TC-11 Raytheon—Pri. Tap for 105 v., 110 v., 115 v., 120 v., AC—Sec. 1000 v. CT—1000 v. @ 1.5 A—5 v. @ 5 A.—6.3 v. @ 12 A—10" x 11" x 10"—70 lbs. $35.00

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| 6K6 | .69 | HY69 | 1.65 | 5Y4G | .59 |
| 6K7 | .79 | HY615 | .89 | 5Z3 | .89 |
| 6K8 | 1.25 | V70D | 6.90 | 6X5 | .89 |
| 6L6 | 1.25 | 100TS/ VT127A | 3.00 | 25Z6 | .98 |
| 6L6G | 1.20 | | | 35Y4 | .99 |
| 6L7 | .98 | 2C26A | .75 | 35Z5 | .99 |
| 6R7 | .98 | 2C34 | 1.15 | 80 | .75 |
| 6SA7 | .90 | 2C40 | 2.60 | 83V | .98 |
| 6SC7 | .85 | 2J32 | 20.00 | 84 | .90 |
| 6SG7 | .98 | 2J33 | 20.00 | 117Z3 | 1.19 |
| 6SH7 | .65 | 2JB51 | 2.49 | 250R | 3.95 |
| 6SJ7GT | .69 | 2J56 | 20.00 | 815 | 2.25 |
| 6SK7 | .79 | 211 | 1.25 | 836 | 1.50 |
| 6SL7 | .89 | 217C | 7.50 | 866A | .75 |
| 6SN7GT | .69 | 3E29A/ 829B | 2.95 | 872A | 2.25 |
| 6SQ7 | .89 | | | 884 | .75 |
| 6SR7 | .89 | 304TH | 9.85 | 2050 | .90 |
| 6Q5 | .98 | 307A | 6.25 | 2051 | .90 |
| 6U5 | .98 | 4E27/257B | 6.49 | RK60 | 1.25 |
| 6U6 | .98 | 446A | 2.60 | RK72 | 3.50 |
| 6Y6GT | .99 | 6C4 | .64 | VR90 | .75 |
| 6Y6G | .89 | 703A | 1.49 | VR105 | .75 |
| 7F7 | 1.25 | 705A | 4.95 | VR150 | .75 |
| 12SA7GT | .99 | 715B | 4.95 | Z225 | 1.95 |
| 12SK7 | .89 | 800 | 2.25 | 2AP1 | 2.25 |
| 12SN7GT | .79 | 801A | 1.75 | 3AP1 | 3.45 |
| 12SQ7GT | .99 | 803 | 8.95 | 3BP1 | 2.95 |
| 12K8 | 1.25 | 805 | 3.75 | 5BP1 | 3.95 |
| 14B6 | .99 | 807 | .95 | 5BP4 | 5.45 |
| 28D7 | .75 | 808 | 2.95 | 5CP1 | 3.95 |
| 30 | .78 | 809 | 1.50 | 7BP7 | 7.95 |
| 34 | .98 | 810 | 2.49 | 7EP4 | 23.50 |
| 35L6 | .99 | 811 | 1.95 | 902 | 2.25 |
| 37 | .69 | 812H | 6.90 | 913 | 3. |

**NO MAIL ORDERS FOR LESS THAN $5.00**

All Tubes are guaranteed with exception of open filaments which are checked before they leave our warehouse. All tubes shipped via Rail Express.

## SELSYN MOTORS

Selsyn II-5 brass housing motors—have a variety of swell uses—ruggedly built—heavy torque & made to rigid Army specs. Made for use on 115 v. 60 cy AC. Ideal for remotely controlling your beam ant. & to tell just where it's pointed. Minimize guess work when pinpointing that beam—these motors will not only indicate but will also drive. Shipping wt. approx. 24 lbs. A steal at $12.90 pr.

## AMERTRAN VOLTAGE REGULATOR
### (TRANSTAT)

17.4 amps. maximum output 2 KVA single phase 115 v. 50 to 60 cy. 90 to 130 v. shipping weight 20 lbs.—a marvelous buy—First come, first served. $24.95.

Micro Switch—can be used on AC with ratings of 1200 watts up to 600 v. AC also for DC work—normally open-Die Cast—BZE-2RQ9TN—$1.25.

Blower 6 v. AC or DC hi speed blower made by John Oster. Rated at 5000 RPM—1.8 AMP—made for continuous duty—1⅛" overall diameter—1" blower output—1¼" blower intake—$5.95.

## METERS

MM 4—0-100 Ma—Model 301—Weston 3½"—$3.95
MM 10—0-1 amp. DC—Weston #301 3½"—$3.95
MM 12—0-50 Ma—Westinghouse NX35 3½"—$3.95
MM 14—0-150 Ma—Westinghouse 3½" NX 35—$3.95
MM 19—0-800 Ma—Western Elec. D-55050—3½" $3.95
MM 24—0-5 Ma—Westinghouse—style 1208685 2½"—$2.95
MM 27—0-1-Ma—De Jur—27 ohm DC Res. 2½"—$3.95
MM 29—0-200 Ma—Westinghouse—OX33 2½" $2.95
MM 33—0-1 Ma—McClintock—MD-300-1K 3½" $3.95
MM 34—0-50 Ma—G. E. Type DW 51 2½" $2.95
MM 36—50-0-50 Meter Face Calib.—End of Scale—to .5 ma. calibrated yds. per sec.—Western Electric—KS 8798 4½" $3.95
MR 5—0-2.5 RF Amps McClintock—MD 3001 3½" Panel Mount $3.95
MR 6—0-100 RF Ma G.E. DW 42—2½" $3.95
MR 7—0-100 DB Above 1 Microvolt—Model 25—3½" $5.49
MR 13—0-8 RF Amps DC Weston—Model 425AM—3½" $4.95
MZ 1—0-130 v. AC—25 to 125 cy—Weston #476VM—3½" $4.95
MZ 11—0-8 v. AC Weston #476—3½" $3.95
MV 4—0-3.5 KV DC Westinghouse 3½"—$3.95
MV 8—0-4 KV DC—Roller-Smith 3½"—$2.95
MV 10—0-50 DC Westinghouse—Model PW—Leatherett Case—4 x 3½" $1.95
MU 1—100-0-100 Simpson—2½"—$3.95
MQ 1—Ext. Res. for K.V. Meters—$1.00
V.T.V.M.—Model 450 #529—Reiner Elect.—Complete with Model 101 Amplifier, AC Probe & Leads—$119.95

## RELAYS

KR 4—Allied #KS5910—115 v. AC—DPDT $2.50
KR 5—Leach Type 1357—115 v. AC—DPDT $2.00
KR 6—Struther Dunn—115 v. AC—DPDT $1.65
KR 7—Betts & Betts—Keying Relay 30 v. DC—300 ohm coil DPDT Hermet. sealed. Fits Octal Socket. $1.98
KR 10—Allied #KS5910—115 v. AC 10 amp contacts TPDT $1.98
KR 11—Allied #KS5910—115 v. AC 4 PDT 10 A. contact $2.50
KR 12—Struther Dunn—115 v. AC—2 relays on one mount. SPDT & SPST 10 A. cont. $3.95
KR 13—Kurman Elect. #X1400 D.C. overload relay with AC reset coil 115 v. AC SPDT $4.95
KR 15—Sperry—Thermo Time Delay ADJ 15-45 Sec. 115 v. AC 60 cy SPDT—$3.50
KR 17—Leach—1177BF—115 v. AC Ceramic Insul. TPDT—$1.75
KR 18—Leach—#374—115 v. AC—DPST $ .98
KR 19—Struther Dunn—115 v. AC—4PST—30 Amp. Contact $5.95
KR 21—Wheelock Sig.—115 v. AC—5 Amp. Contacts DPDT—B3 x 4—$2.25
KR 22—G.E. #CR2790E105—115 v. AC or 230 AC Heavy Duty DPDT $4.95
KR 24—Adlake Mercury Time Delay Relay—#1040-80 normally opened .3 to 5 sec 115 AC $8.95
KR 25—Struther Dunn—115 v. AC 30 amp. contacts—DPST $4.95
KR 26—G.E. Instantaneous over current relay—Type PBC 2 amps @ 115 v. $24.95

300 ohm twinex—unaffected by moisture—will handle 3 kilowatts of R.F.—losses at 40 MC per 100 ft., are 3/10 DB. Best buy in the house at .08 per foot.

75,000 ohm bleeder, 200 watts Ohmite—Special..$1.65
50,000 ohm bleeder, 100 watts I.R.C.—100 watts.. .89

## G. E. INTERLOCK SWITCH

Hi-voltage is lethal—protect yourself and family—this switch automatically shuts off Hi-volt. circuits while adjustments are being made—low pressure—hi current capacity, positive action. Silver plated contacts. $2.49 pr.

Continuity Checker—Neon type—in black metal box 3-⅝" x 5" x 3½" complete with leads & AC Cords—$2.50.

R F INDICATOR PROBE Z601—has a fixed xtal (VHF) type and a pick up coil. Coax lead, coax connector at end. Probe has 4" bakelite handle. Used with a 0-1 Ma. meter across it. For checking R.F. in lines, neutralizing finals, etc. $1.98.

## COMPLETE LINE OF TELEVISION COMPONENTS

### MAGNETIC DEFLECTION YOKES]

| Cat. No. | Defl. Angle | Horiz. Ind. | Vert. Ind. | | Overall | Price |
|---|---|---|---|---|---|---|
| DY-1S | 55° | 5 mh. | 19 mh. | | 2⅝" | $9.60 |
| DY-2L | 40° | 5 mh. | 22 mh. | | 3 1/16" | $10.50 |
| DY-4L | 40° | 1.5 mh. | 45 mh. | For use in RCA TRK-120 and similar Television Receivers | 3 1/16" | $10.50 |

### SHIELDED BLOCKING OSCILLATOR TRANSFORMERS

| Cat. No. | USE | Price |
|---|---|---|
| Ot-103H | Horizontal Oscillator (15,750 cycles) | $4.75 |
| Ot-104V | Vertical Oscillator (60 cycles) | 3.95 |

### YOKE MATCHING TRANSFORMERS

| Cat. No. | USE | Price |
|---|---|---|
| Yt-111H | Horizontal | $22.50 |
| Yt-113H | Horizontal | 9.60 |
| Yt-112V | Vertical | 9.60 |

### BLOCKING OSCILLATOR TRANSFORMERS
Open Construction

| Cat No. | USE | Price |
|---|---|---|
| OT-101H | Horizontal Oscillator (15,750 cycles) | $3.25 |
| OT-102V | Vertical Oscillator (60 cycles) | 2.50 |

**PURCHASING AGENTS AND ENGRS. GET ON OUR MAILING LIST**

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**All Prices f.o.b. N. Y. C.**


**ECONOMICAL**—K-TRANS cost less to purchase—less to use.

**EFFICIENT**—K-TRANS will duplicate or exceed the performance of your present i.f. transformers.

**STABLE**—Permeability tuning, magnetic shielding of windings, silver mica condensers combine to give a stability never before obtainable in a standard commercial i.f. Transformer.

**VERSATILE**—Four models of K-TRAN meet all 455 KC requirements. Also available for 262 K.C., and 10.7 M.C. for F.M. receivers.

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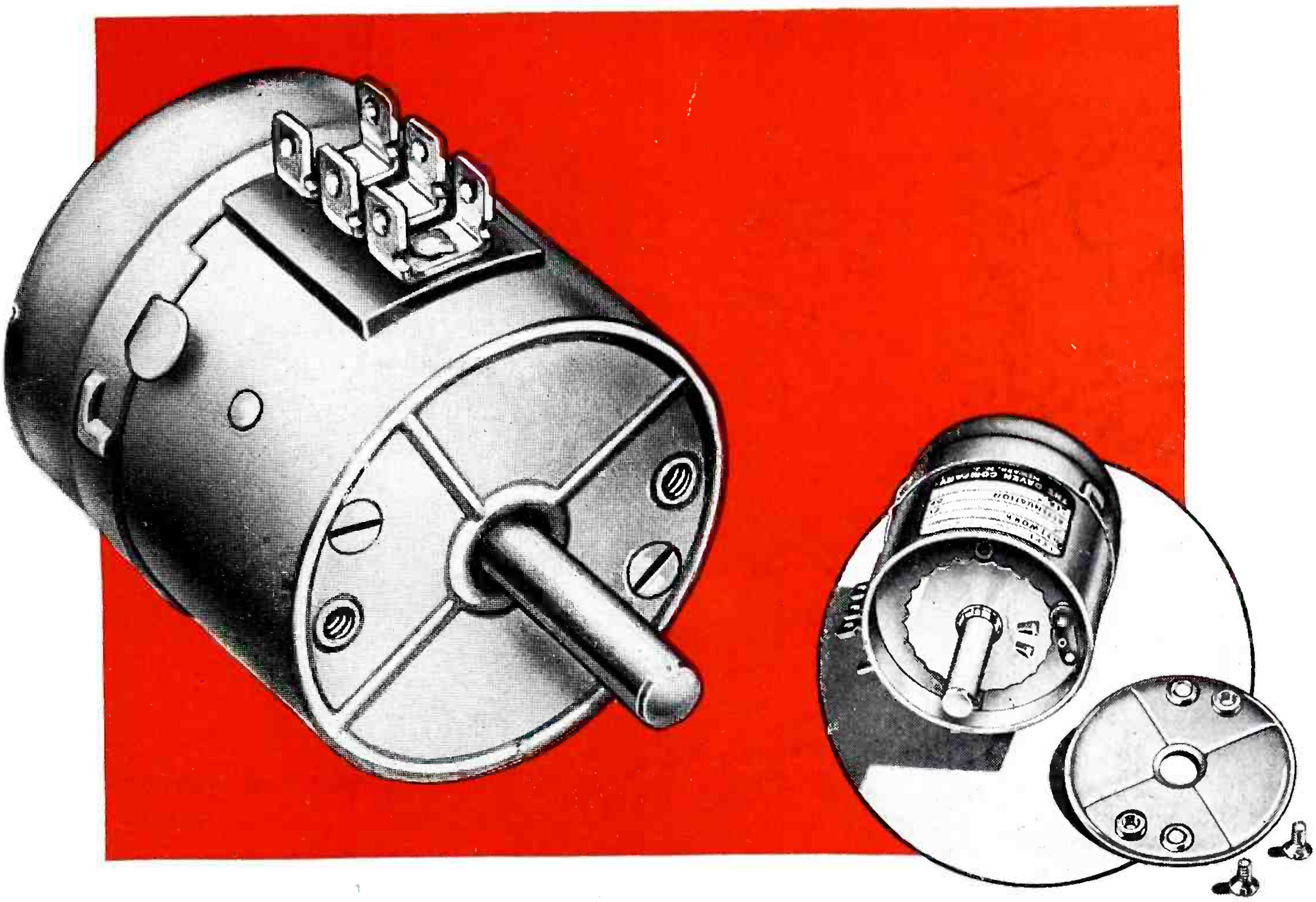
900 PASSAIC AVE. EAST NEWARK, N. J.

# INDEX TO ADVERTISERS

# INDEX TO ADVERTISERS

# DAVEN ENGINEERING

## AGAIN BRINGS YOU A NEW AND *Better* ATTENUATOR

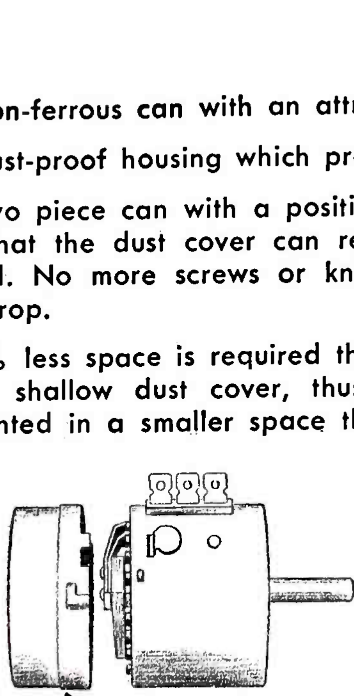


**In keeping with our policy of continually improving our products, we have developed a new and better design for the mechanical construction* of our attenuators. In addition to improved standard features, the latest Daven units offer a choice of mountings and an optional ground lug. Dimensions of the new type attenuators make them interchangeable with preceding models.**

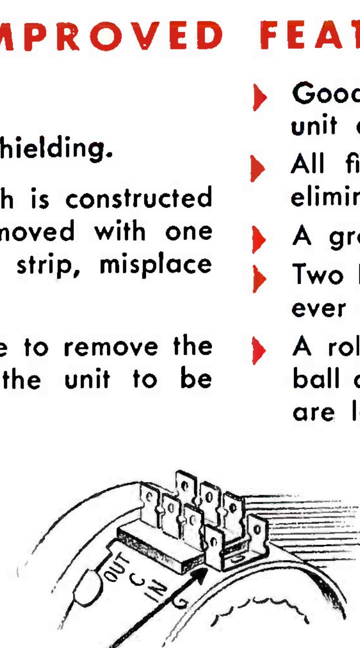
**Patent Pending.*

### IMPROVED FEATURES

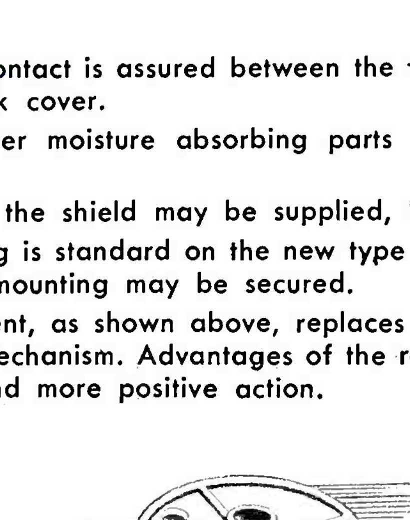
- A non-ferrous can with an attractive finish.
- A dust-proof housing which provides total shielding.
- A two piece can with a positive lock, which is constructed so that the dust cover can readily be removed with one hand. No more screws or knurled nuts to strip, misplace or drop.
- 50% less space is required than heretofore to remove the new shallow dust cover, thus permitting the unit to be mounted in a smaller space than formerly.
- Good electrical contact is assured between the front of the unit and the back cover.
- All fibre and other moisture absorbing parts have been eliminated.
- A ground lug on the shield may be supplied, if required.
- Two hole mounting is standard on the new type units, however single hole mounting may be secured.
- A roller type detent, as shown above, replaces the former ball and spring mechanism. Advantages of the roller detent are longer life and more positive action.



SHALLOW COVER




GROUND LUG



SINGLE HOLE MTG.

*May we suggest, when purchasing speech input equipment, that you specify* **DAVEN CONTROLS.**

**THE DAVEN CO.**

**191 CENTRAL AVENUE**
**NEWARK 4, NEW JERSEY**

# *ANNOUNCING...* RCA blue-sensitive Gas Phototubes

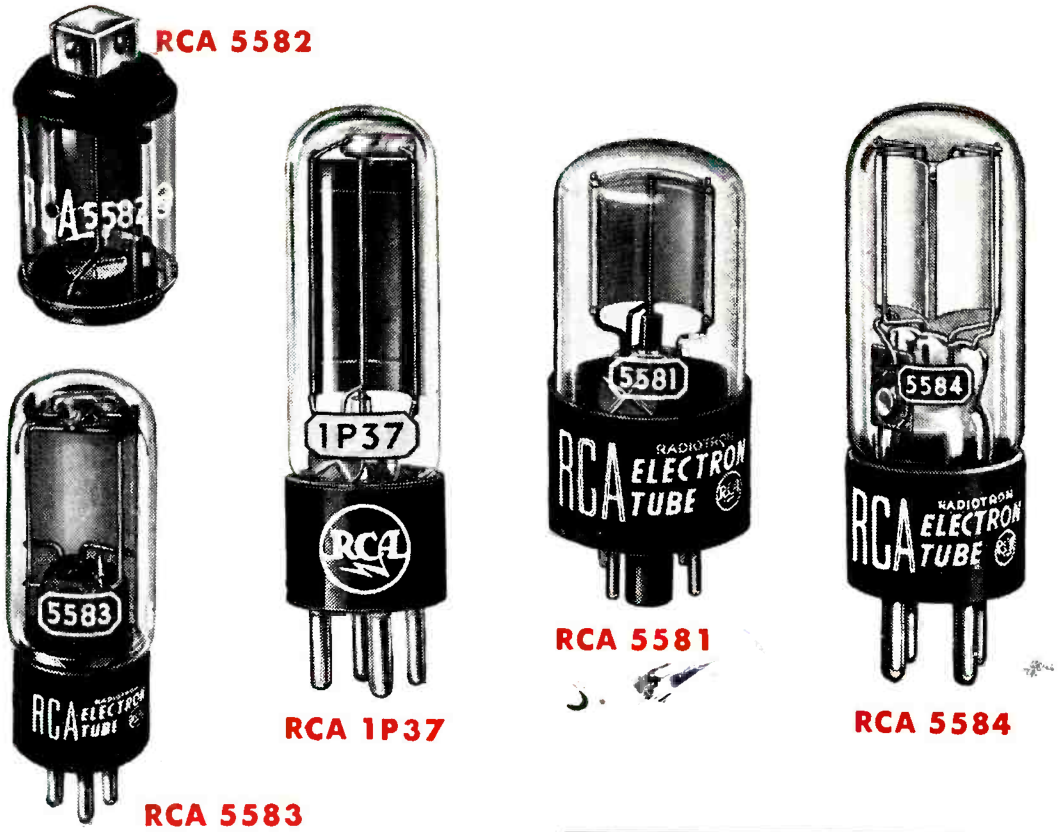



**TABLE OF COMPARABLE TYPES**

| NEW TYPES S-4 RESPONSE | INTERCHANGEABILITY | OLDER TYPES S-I RESPONSE |
|---|---|---|
| 5581 | | 930 |
| 5582 | The new RCA types are inter- | 921 |
| 5583 | changeable with these earlier | 927 |
| 5584 | types. In some cases, minor | 920 |
| 1P37 | circuit changes are necessary | 868,918 |

## Feature high sensitivity to blue radiation, no response to infrared, and high signal-to-noise ratio

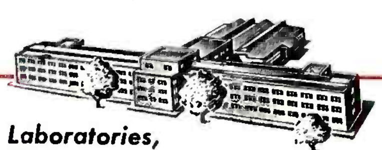
These five new phototubes represent another important tube development initiated by RCA with the introduction of the 1P37. They have the advantage of combining the S-4 response with gas amplification. Thus, the tubes offer exceptional sensitivity to blue radiation, no response to infrared, and a high signal-to-noise ratio.

The five types illustrated are especially valuable in sound reproduction from a dye-image sound track because of the total absence of masking of the modulation by infrared transmission. They are equally attractive for industrial applications involving measurement and color control where infrared radiation might mask the desired signal.

RCA 1P37, 5581, 5582, 5583, and 5584 Gas Phototubes have a maximum response at a wavelength of 4000 Angstroms and a maximum gas amplification factor of 5.5.

Each of the five new types has comparable luminous sensitivity, anode characteristics, and structure to the older type having S-1 response. They may therefore be used interchangeably with the earlier types with minor circuit changes.

RCA Tube Application Engineers will be pleased to offer their services toward the use of these or other RCA tube types in your equipment. Meanwhile, send for the new Bulletin CRPS-102 covering the technical data on the complete line of RCA Cathode Ray, Phototube, and Special Types. Address all inquiries to Commercial Engineering, Section R-40E, Harrison, N. J.



*RCA Laboratories, Princeton, N. J.*

**THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA**

***TUBE DEPARTMENT***

***RADIO CORPORATION of AMERICA***

***HARRISON, N. J.***