# ELECTRONIC INDUSTRIES

Beginning next month (January, 1947) and reflecting current growth and specialization in the electronic arts, the editorial contents of Electronic Industries will be enlarged and divided into two specialized and separate magazines, with names and fields as follows:—

## TELE·TECH

*Continuing the TELE-communications TECHnical Section of Electronic Industries*

**Radio, AM, FM**
**Television, Facsimile**
**Transmitters, Receivers**
**Police, Aviation**
**Railroad, Radar**
**Design, Operation**

## ELECTRONIC INDUSTRIES & INSTRUMENTATION

*Continuing the Industrial-Application Features of Electronic Industries*

**Measuring, Recording**
**Control, Regulation**
**Detection, Protection**
**Processing, Treating**
**Energy Supplies**
**Design, Production**

Each of the new specialized magazines will serve its own important groups of readers with completeness impossible in the former paper.

Enlarged editorial staffs and increased reading pages will permit new standards of editorial value and service for the individual reader.

For further detailed information, including subscription arrangements and general publishing plans, see pages 18 and 19 of this issue.

*O. H. Caldwell, M. Clements*
Publishers

CALDWELL-CLEMENTS, INC.


**EVERYTHING YOU WANT TO KNOW ABOUT ELECTRICAL CONTACTS**

# The First Book of Its Kind . . .

## *Competent, Complete!*

***A Summary of Contents***

- Fundamentals of Electrical Contacts
- Selection of Contact Materials
- Contact Design, Assembly Methods and Maintenance
- The Automotive Battery Ignition Systems
- Contacts for Low Voltage Type Voltage and Current Regulators
- Contact Materials in Circuit Breakers
- Sliding Contacts
- Fundamentals of Electricity for Contact Applications
- Miscellaneous Tables — Engineering Data

Until recently there was very little published information on electrical contacts. What information existed was scattered in magazine articles and in two obscure books published abroad.

Now comes the first "encyclopedia" on the subject—a volume so comprehensive that it includes the latest there is to know about contact design, construction, application and materials . . . so completely up-to-date that it includes theories that have yet to be established, opinions that have yet to be proved. This is because the subject, even at this late date, has many controversial aspects.

Five years in the writing, the Mallory Contact Data Book belongs in every engineering library. Its combination of scientific facts, observations, first-hand experiences cannot be duplicated anywhere else. To recognized engineers writing on company letterhead, the book is free. To others, it is available at our printing cost—$2.50. *The Contact Data Book is still another example of Mallory's desire to provide helpful material for those who have a professional interest in the fields we serve.*

P. R. MALLORY & CO. Inc.

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

# ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

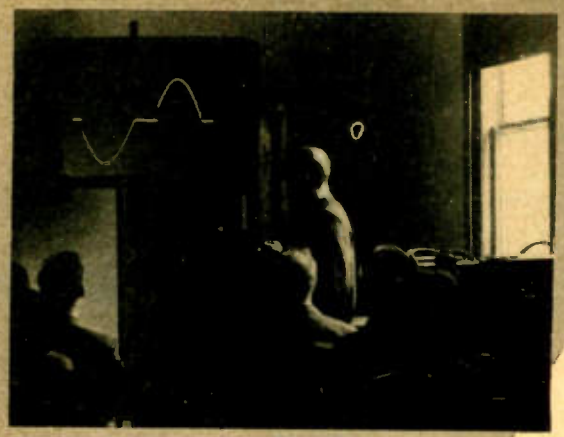

## Editorial Contents

**DECEMBER, 1946**




**CALDWELL-CLEMENTS, INC. — TEL. PLAZA 3-1340 — 480 LEXINGTON AVE., NEW YORK 17, N. Y.**

**BRANCH OFFICES**—Chicago 6, R. Y. Fitzpatrick, 201 N. Wells St., RAN 9225; Cleveland 14, D. J. O'Rourke, Citizens Bldg., 850 Euclid Ave., Main 8270; Los Angeles 5, The Robert W. Walker Co., 684 So. Lafayette Park Pl., Drexel 4388; San Francisco, 68 Post St., Sutter 5568.

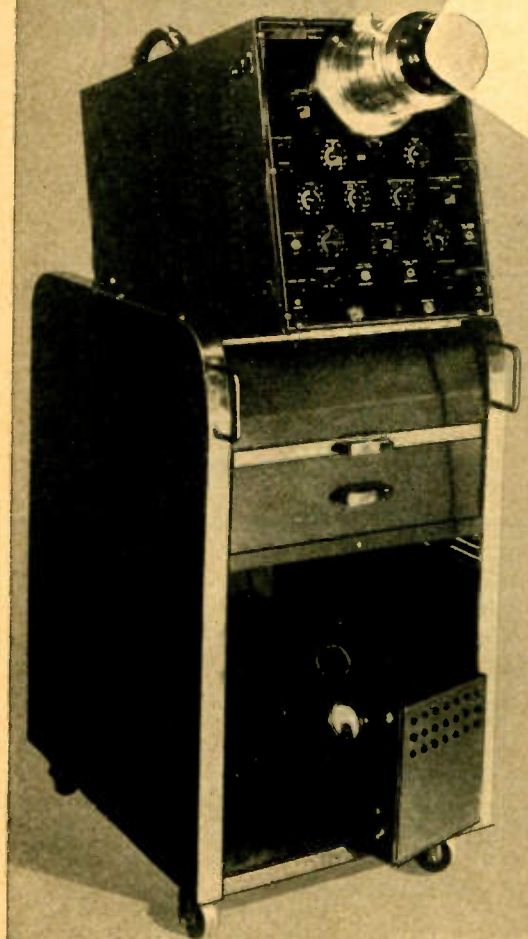


When projection lenses are available, you can project the oscillogram in a *well-lighted* room with *perfect* visibility, as in this unretouched photograph. Note open window.

# PHOTOGRAPHS, PROJECTIONS, HIGH-SPEED TRANSIENTS ARE *Clear*

if it's a

## DU MONT Type 247-A CATHODE-RAY OSCILLOGRAPH





Modified from the Type 247, this new Du Mont Type 247-A is such a startling success that phenomena hitherto totally invisible can now be *easily* seen. Such modification extends the range of the instrument tremendously in the field of transient studies or high-speed photographic applications.

The modification utilizes the new Type 5RP Cathode-Ray Tube operable at voltages up to 30 KV, producing sufficient brilliance for direct projection, if required.

Other features are: automatic beam blanking; choice of single or continuous sweep; sweep rates available from .5 cps to 50,000 cps; Z-axis amplifier with choice of output polarity; soundly engineered electrical and mechanical design.

***Further details on request.***

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# DEPENDABILITY
## UNDER ALL OPERATING CONDITIONS

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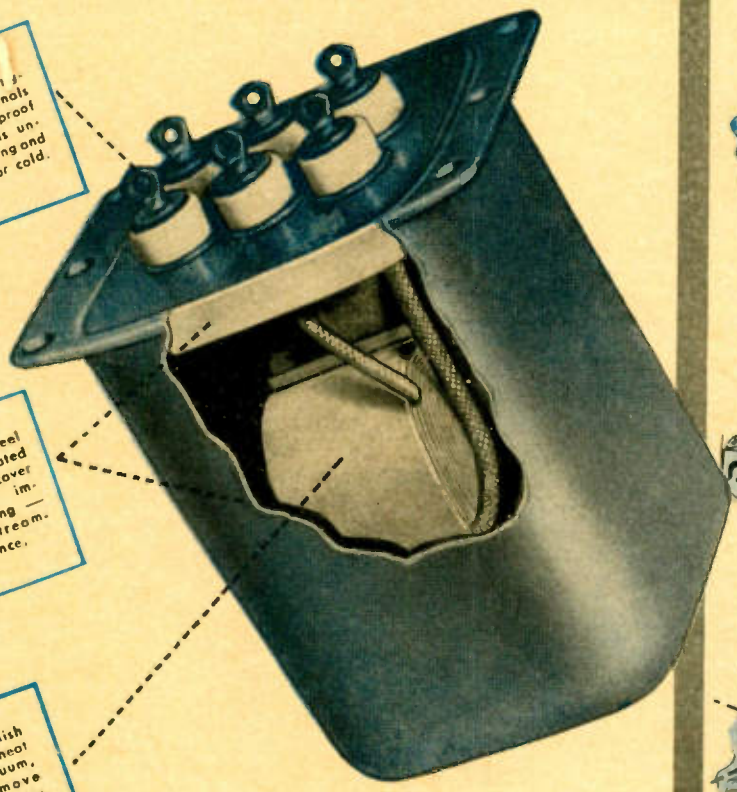
## CHICAGO TRANSFORMERS
## *Sealed in Steel*

Exclusive C. T. bushit gasket seal at terminals is permanently proof against moisture, is unimpaired by soldering and by climatic heat or cold.

Seamless drawn steel case and C. T.-innovated "Deep-Seal" base cover provide a strong, impenetrable housing — rust-proofed, streamlined in appearance.

Coil is wax and varnish impregnated under heat and alternating vacuum, pressure, to remove moisture, prevent its reentrance during assembly of unit.



***Sealed*** AGAINST ATMOSPHERIC MOISTURE AND INDUSTRIAL FUMES

THUS ***Sealed*** AGAINST CORROSION OF COPPER COIL WINDINGS

STAY ***Sealed*** IN EXTREMES OF HEAT AND COLD!

*FITTED TO THE APPLICATIONS WHERE COMPONENT DEPENDABILITY IS ESSENTIAL TO*

*Avoid*

~~COSTLY MAINTENANCE~~
~~LOSS OF LIFE~~
~~DISRUPTION OF A VITAL SERVICE~~

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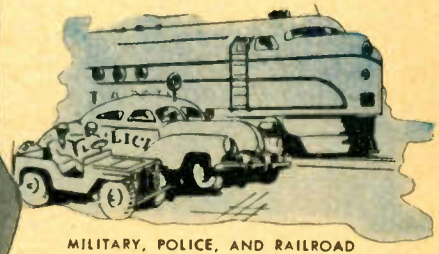
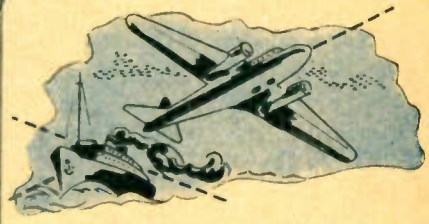
FIXED, MOBILE, & SATELLITE EQUIPMENT



MILITARY, POLICE, AND RAILROAD COMMUNICATIONS



ELECTRONIC NAVIGATIONAL AIDS FOR SHIPS AND AIRLINES

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★ In these and many other transformer applications, economy, as well as efficiency, is best served by Chicago Transformer's *Sealed in Steel* construction.

Let its assurance of long-lasting transformer reliability help make your electronic product free of component replacements and expensive servicing regardless of adverse operating conditions.

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**In the Magnavox Speaker Laboratory**—*all the apparatus needed for the development and production of quality loud-speakers.*

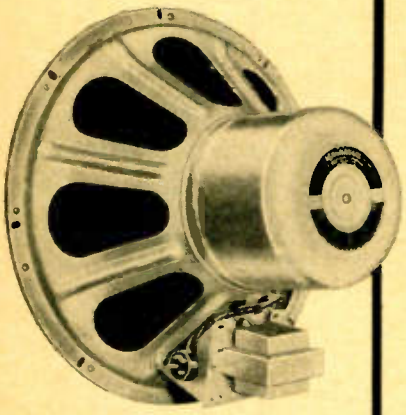
## At your service...at Magnavox

### All the facilities of modern radio science and engineering

SIX acres of modern plant and equipment, our staff of trained engineers and designers, plus 35 years of experience, research and development—all are at your command for producing the finest loud-speakers, capacitors and other component parts.

Magnavox quality and performance are long established as the highest standard in radio. The oldest and largest manufacturer of loud-speakers, Magnavox has achieved a breadth of experience and knowledge so complete, so accurate, that your specifications are met *exactly.*

Magnavox designers and engineers stand ready to apply their developments to any of your component problems. When you need component parts, specify Magnavox—specialists in quantity production of quality components for the manufacturing trade. The Magnavox Company, Components Division, Fort Wayne 4, Indiana.



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**—over 160 models**

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**has served the radio industry for over 30 years**

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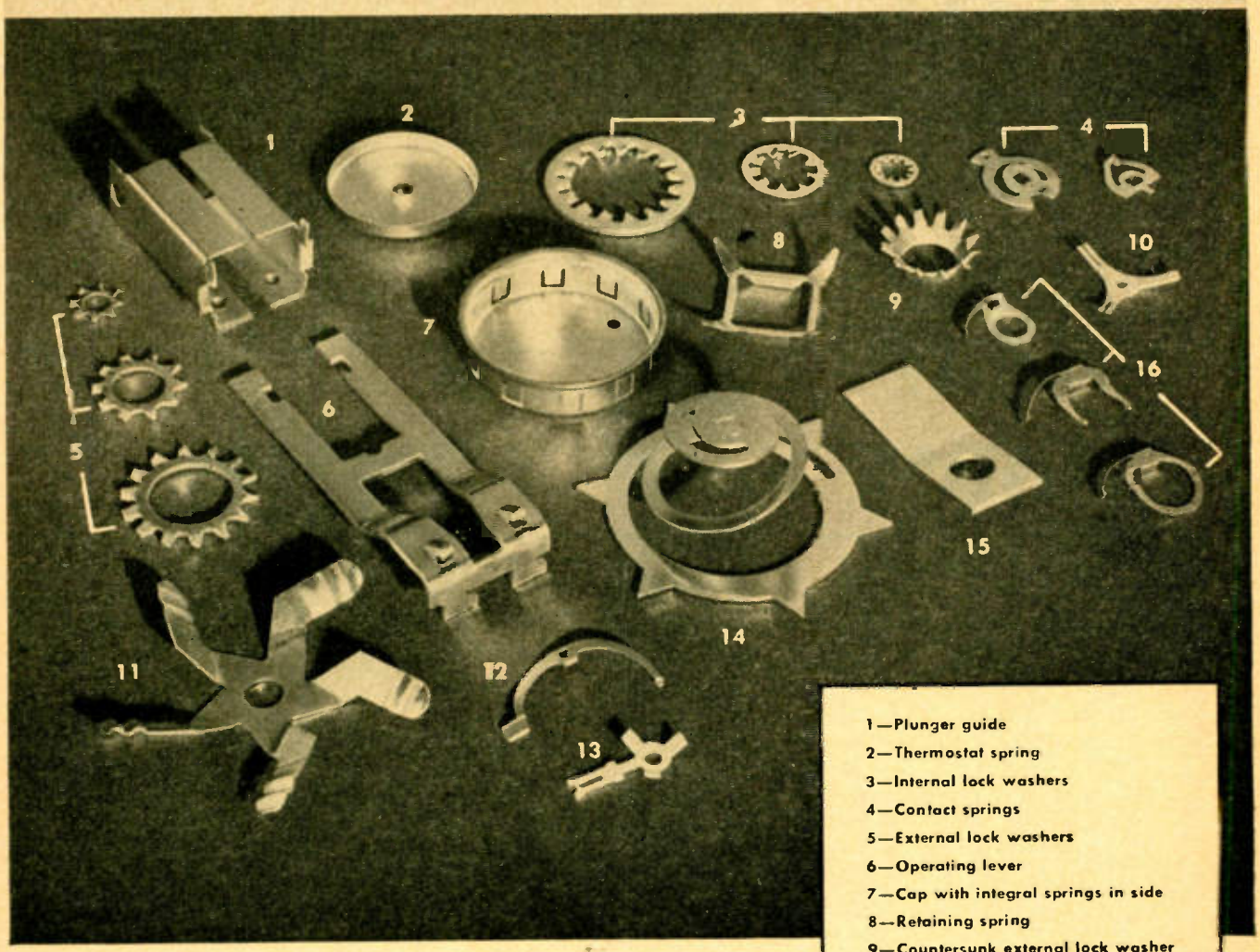


1—Plunger guide
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3—Internal lock washers
4—Contact springs
5—External lock washers
6—Operating lever
7—Cap with integral springs in side
8—Retaining spring
9—Countersunk external lock washer
10—Pressure spring for capacitor
11—Five-contact spring
12—Contact spring for radio part
13—Pressure spring and terminal
14—Involute spring
15—Contact point for solenoid
16—Contact springs
*—made of Phosphor Bronze strip supplied by Revere*

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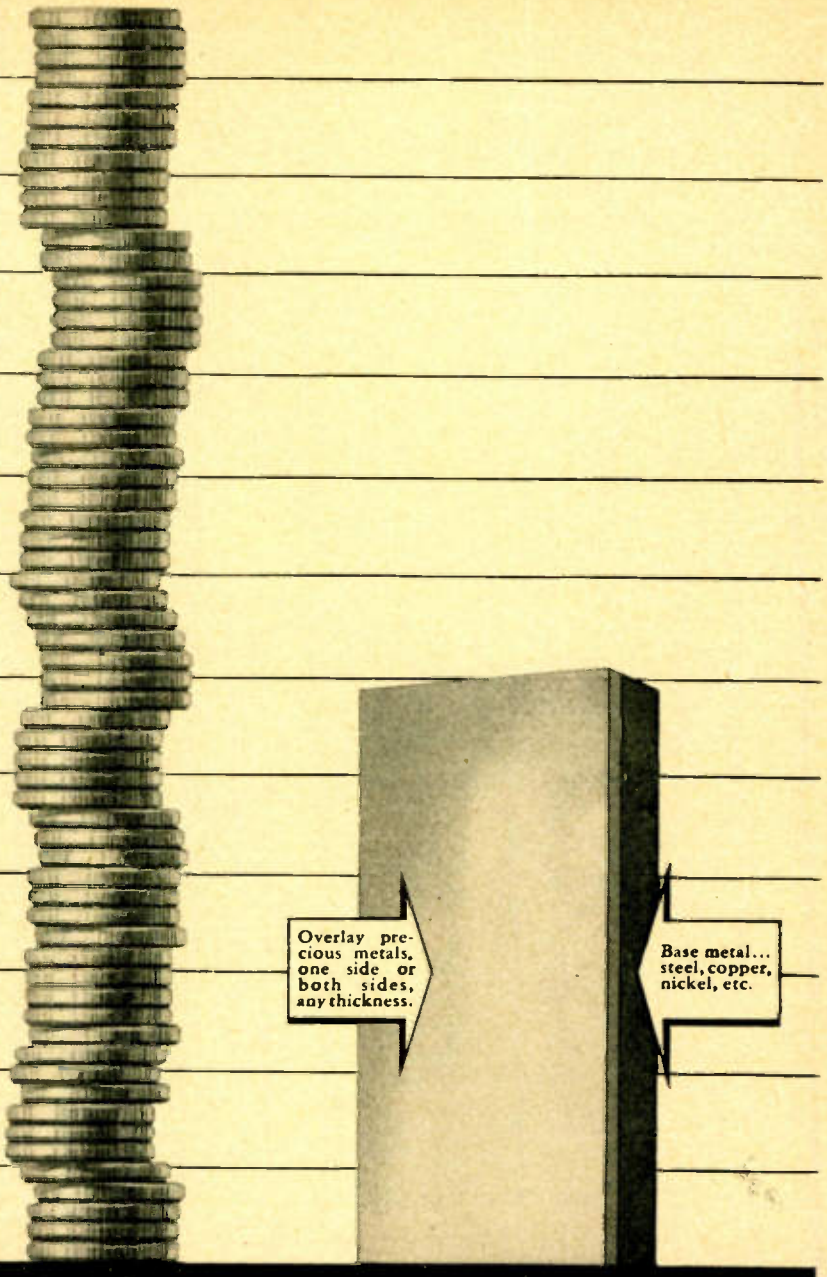


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## protects against shock and strain
## ...in products or plant equipment

If it's a *rugged* material you want to protect your products or plant equipment against shock and strain —you're sure of getting it in tough, durable National Vulcanized Fibre!

One of the strongest materials per unit weight known, this versatile, hard vulcanized fibre can "take it" in every way. Resilient and light in weight (about half that of aluminum), it has outstanding impact, tensile and dielectric strength . . . is extremely resistant to wear and abrasion . . . and is machined and formed easily, economically. You get all this and toughness, too, in National Vulcanized Fibre.

To be sure of improved performance for your products or plant equipment, let a trained National engineer show you how this rugged material can be readily adapted to your production. Write for information.

Trunks must be built to "take" the hard knocks to which they're subjected. That's why so many of them —including U. S. Army foot lockers —are made of *rugged* National Vulcanized Trunk Fibre.

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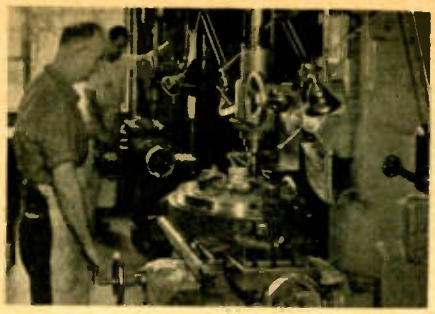


Light from two Dazors converges at the critical point of work on a precision jig boring machine (Omar Tool & Machine Co.).

With Dazor light of the desired quantity and quality directed (without waste) where needed, this operator makes her Singer sing.

The Dazor and a Remington Rand Bookkeeping Machine here team up for the speed and accuracy demanded in modern accounting.

# *Lighting .. Individually Fitted..* DAZOR ALONE *Floats!*


Pan American Airways technician overhauling a Flux Gate Compass.

YOU think of a *floating* object as something which moves, glides or drifts in any direction with effortless ease . . . a mental picture which fits perfectly the freedom of movement you find in a Dazor *Floating* Lamp.

With the Dazor you can concentrate glareless, shadowless light of high intensity on any horizontal or vertical work area. With the tips of your fingers you *float* it where needed—fit it to your seeing needs. When positioned, the lamp is firmly and automatically held in suspension by a patented enclosed spring force. It *stays put* without locking, tightening or "friction" holding. Dazor alone *floats!*

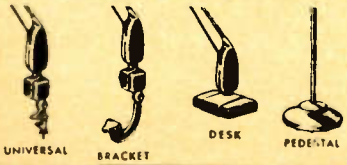
In your plant and office are vital tasks which demand fast, accurate, comfortable seeing: Drafting, design engineering, precise machining, fine assembly, inspection, tests, repairs, accounting and bookkeeping . . . where specialized Dazor lighting will help increase and improve work output —save you money.

**Phone Your Dazor Distributor**

. . . for any additional information desired. A better idea, ask him to demonstrate the advantages of Dazor lighting under actual working conditions. For your distributor's name, if unknown to you, write to the Dazor Manufacturing Corp., 4483 Duncan Ave., St. Louis 10, Mo.

IN CANADA address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ont.

CHOICE OF 4 BASES

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FLUORESCENT *and* INCANDESCENT

# VOLTMETERS for EVERY RF NEED

Permanent accuracy, high stability and high impedance input! You get all three with each of these three voltmeters. Suitable for laboratory, test bench or production line! Each has a frequency and voltage range adaptable to your particular needs . . . sturdy construction; easy-to-read meter scales!

## STANDARD ELECTRONIC VOLTMETER MODEL VM-27A

**Technical Specifications**

**RANGE:** 0.1 to 100 volts in five ranges a-c and d-c. (1, 3, 10, 30 and 100 volts full scale.)

**ACCURACY:** 2 percent of full scale on all ranges, on sinusoidal voltages.

**CALIBRATION:** Calibrated to read 0.707 of peak on a-c voltage, hence r.m.s. of a sinusoidal wave.

**FREQUENCY RANGE:** 20 cycles to over 100 megacycles with full accuracy from 50 cycles to 50 megacycles.

**INPUT IMPEDANCE:** d-c input 7 megohms, a-c input 4 megohms at audio frequencies and at radio frequencies equivalent to a capacity of 5 micro-microfarads having a power factor of 0.5%.

**POWER SUPPLY:** 105 to 125 volts 50-60 cycles at 30 watts.

**TUBES:** One 6H6 in probe, two matched 6J5GT and one 6X5GT rectifier.

**DIMENSIONS:** 8 x 8 x 8, probe, 2 inches diameter by 4 long.

**WEIGHT:** 11 lbs. less probe.

**PRICE:** $150.00 net, F.O.B. Flushing, N. Y.

## MODEL VM-27-ZC

Same as Model VM-27A but with means for setting meter to mid-scale on d-c.

**PRICE:** $155.00 net, F.O.B. Flushing, N. Y.

WRITE FOR DESCRIPTIVE BULLETINS

## HIGH FREQUENCY ELECTRONIC VOLTMETER MODEL 32

**Technical Specifications**

**RANGE:** 0.3 to 300 volts r-f in five ranges (3, 10, 30, 100 and 300 volts full scale).

**ACCURACY:** 5 percent of full scale on all ranges, on sinusoidal voltages.

**FREQUENCY RANGE:** 500 kilocycles to 500 megacycles.

**INPUT IMPEDANCE:** 0.5 to 1 micro-microfarad at a Q of about 200. (Steatite top.)

**POWER SUPPLY:** 115 volts 50-60 cycles at 30 watts.

**TUBES:** One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.

**DIMENSIONS:** 5½ x 9½ x 9½.

**WEIGHT:** 8 lbs.

**PRICE:** $99.50 F.O.B. Flushing, N. Y. (net)

*BULLETIN AVAILABLE*

## HIGH VOLTAGE ELECTRONIC VOLTMETER MODEL 31

**Technical Specifications**

**RANGE:** 10 to 10,000 volts r-f in five ranges (100, 300, 1000, 3000 and 10,000 volts full scale).

**ACCURACY:** 5 percent of full scale on all ranges, on sinusoidal voltages.

**FREQUENCY RANGE:** 100 kilocycles to 100 megacycles.

**INPUT IMPEDANCE:** Approximately 1 micro-microfarad at a Q of over 500.

**POWER SUPPLY:** 115 volts 50-60 cycles at 30 watts.

**TUBES:** One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.

**DIMENSIONS:** 5½ x 9½ x 9½.

**WEIGHT:** 8 lbs.

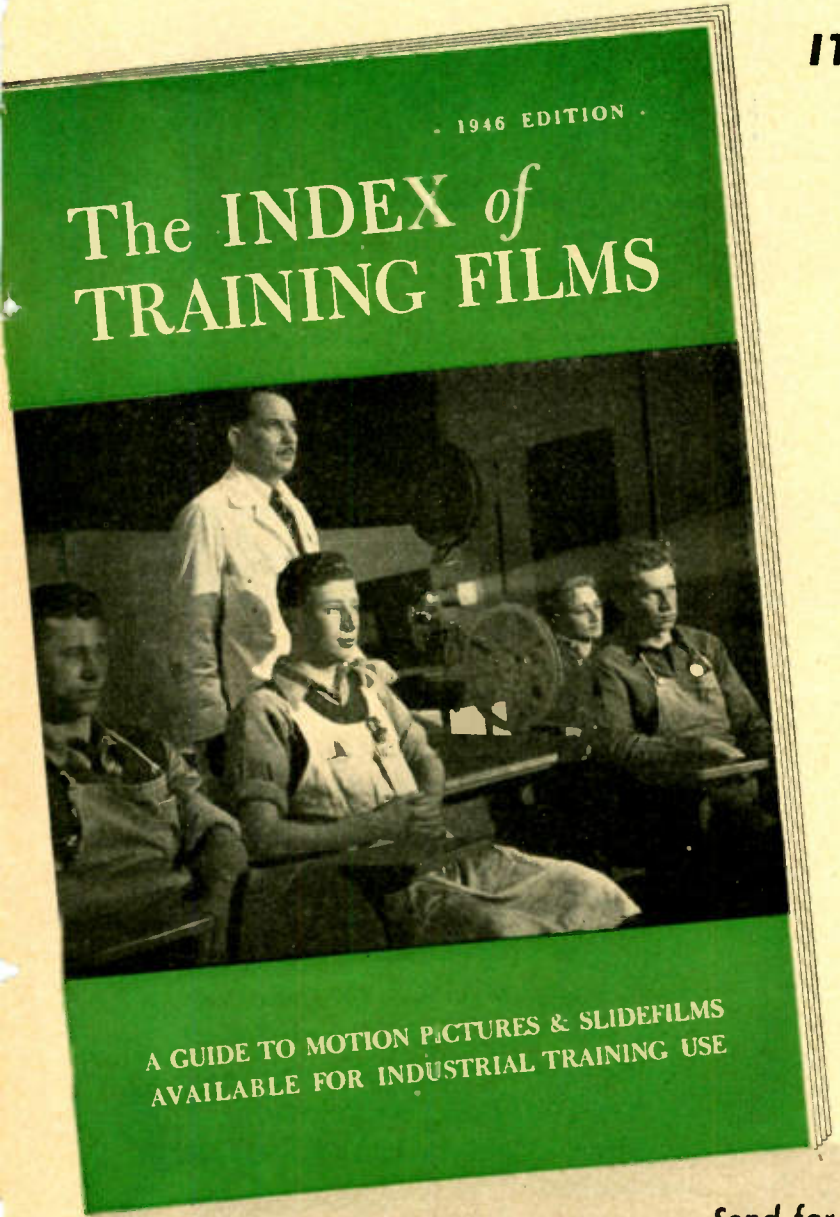
**PRICE:** $99.50 net, F.O.B. Flushing, N. Y.

*BULLETIN AVAILABLE*

**ALFRED W. BARBER LABORATORIES** ★ 34-08 FRANCIS LEWIS BLVD. FLUSHING • NEW YORK

Kodak

# This New Book Lists 155 Films for Training ELECTRONICS WORKERS




## IT TELLS YOU

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- **which films are free**
- **which you can rent or buy**
- **where to get them**

With this book as a guide, you can instruct your workers easily . . . inexpensively . . . *effectively*. Thousands of large and small plants, maintenance and service shops are using it to get excellent training films now available from private industry, government bureaus, and film distributors.

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All of them are described for you in this informative 104-page book, along with about 1500 films on other industrial subjects.

It also tells you where to get the films you want and the purchase or rental cost if any. Get a copy of "The Index of Training Films" for reference. It's free. Just write to . . .

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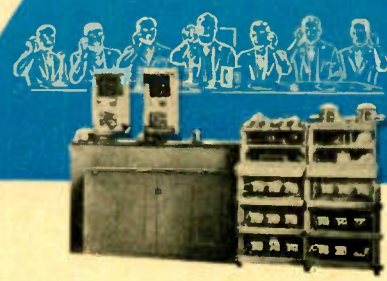
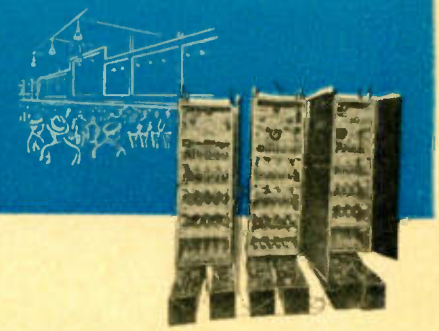
# Why this team stands



**1914.** World's first vacuum tube repeater amplifier; designed by Bell Telephone scientists and made by Western Electric for transcontinental telephony, was the start of modern electronic communications.



**1919.** These Western Electric amplifiers powered the mightiest sound system of its day, used at New York's "Victory Way" Celebration after World War I. There were 113 loudspeakers in the system.

WHEN Bell Telephone scientists designed and Western Electric manufactured the first vacuum tube repeater amplifier back in 1914, they opened a vast new frontier of communications and sound distribution. Up to that time, telephone communications—both by wire and radio—could cover only limited distances and produce relatively low volumes.

For more than 30 years, this team has produced ever better amplifiers for almost every use—long distance wire and radio telephony, radio broadcasting, sound distribution systems, mobile radio, sound motion pictures, disc recording, acoustic instruments and radar.

Equipped with unexcelled tools of research, experience, skill and manufacturing facilities, the Bell Laboratories-Western Electric team will continue to design and build amplifiers outstanding in quality, efficiency and dependable performance.

**— QUALITY COUNTS —**

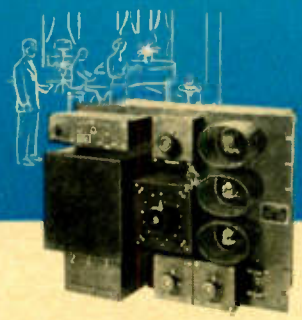
**BELL TELEPHONE LABORATORIES**

*World's largest organization devoted exclusively to research and development in all phases of electrical communications.*

**Western Electric**

*Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.*

# for *Quality* in Amplifiers

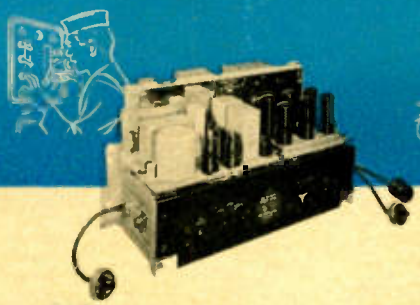


**1922.** The Western Electric 8A was the first commercial broadcasting amplifier. Today, 24 years later, same of these 8A's are still in use. This long life speaks volumes for the quality built into them.

**1928.** This ac operated amplifier, one of the first made, reduced maintenance costs and did away with cumbersame batteries and charging equipment. It was used to record some of the earliest sound motion pictures.

**1934.** Western Electric was an early leader in making compression type amplifiers to enable higher speech intensity between noise level and overload point. This equipment was used in overseas radiotelephony.

**1946.** The brand new 124H and J amplifiers for wired music and public address systems are small and light weight, yet deliver 20 watts. They are setting new standards of quality for music reproduction.



**1942.** This compact and powerful unit for battle announce systems is typical of Western Electric amplifiers designed during the war. It operated dependably when mounted a few feet from the largest guns.

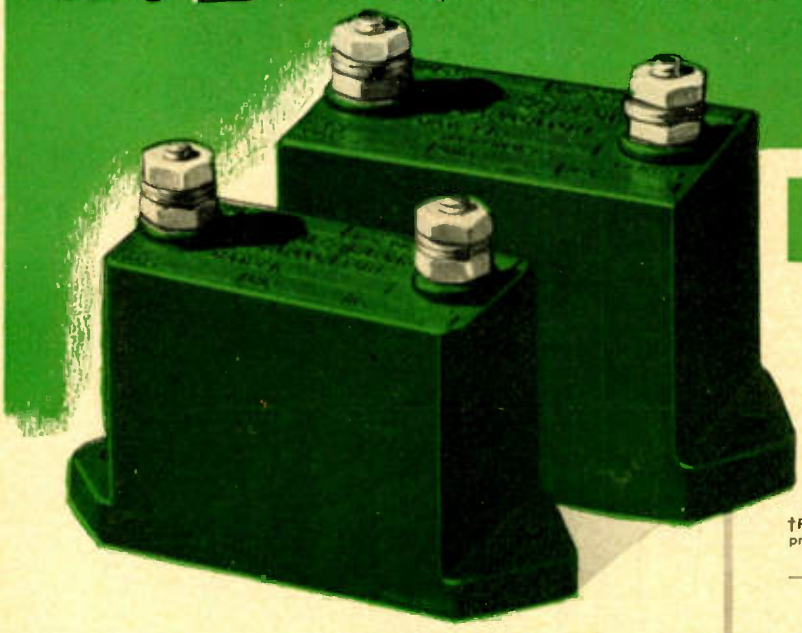
**1938.** Negative feedback is another of Bell Laboratories' many contributions to amplifier design—now in general use. This amplifier for disc recording was able to supply as much as 50 db of feedback.

**1946.** The 1126C is the latest design of Western Electric's popular level governing amplifiers. In operation it acts as a program-operated gain control to prevent overmodulation in AM or FM broadcasting. It immediately reduces gain when an instantaneous peak exceeds a predetermined level, slowly restores it when the peak is passed.

Distributed by GraybaR

OFFICES IN 95 PRINCIPAL CITIES

# G.E. OFFERS
# Lectrofilm Capacitors
# at New Low Prices!



## . . . Permits Use of Larger MUF Sizes in R-F Circuit Design without Cost Penalty

Here's a capacitor price reduction that really means something to circuit designers: *G-E offers all listed ratings of case-style 65 Lectrofilm* blocking and by-pass capacitors at one new price, approximately half of the previous level. Similarly, all listed ratings of case 70 designs are offered at one new, low price!*

This means that you no longer have to place cost ahead of good circuit design. It means that you now have complete freedom to use either *high* or *low* capacities in R-F blocking and by-pass applications—without paying a premium for higher capacity!

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.*

Write for Bulletin GEA-4295A, *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

*Reg. U.S. Pat. Off.

**NEW LOW PRICES OF G-E LECTROFILM CAPACITORS†**

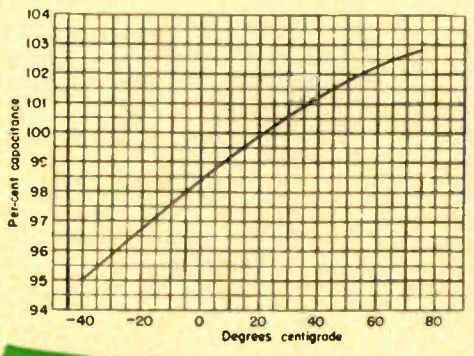
| | | | | | Cap Muf | Rated D-c Voltage |
|---|---|---|---|---|---|---|
| Quantity | 1 to 9 | 10 to 99 | 100 to 999 | 1000 or more | .0001 | 3000 |
| Case 65 | | | | | .001 | 3000 |
| | | | | | .01 | 1000 |
| Net Price | 6.50 | 4.90 | 3.90 | 3.25 | .1 | 500 |
| Quantity | 1 to 9 | 10 to 99 | 100 to 999 | 1000 or more | .0001 | 5000 |
| Case 70 | | | | | .001 | 5000 |
| | | | | | .01 | 2000 |
| Net Price | 8.45 | 5.85 | 4.55 | 4.25 | .1 | 750 |

†Prices to manufacturers purchasing Lectrofilm Capacitors for use with their product will be supplied on inquiry.

**RATINGS AT HIGH TEMPERATURE**

| Ratings are based on 25 C ambient temperatures. For other ambient temperatures the following derating factors must be used: | Ambient Temp. C | Per Cent Rated D-c Volt. | Per Cent Rated Superimposed RMS Sine Wave Current |
|---|---|---|---|
| | 25 | 100 | 100 |
| | 30 | 99 | 95 |
| | 35 | 98 | 85 |
| | 40 | 97 | 80 |
| | 45 | 96 | 75 |
| | 50 | 95 | 70 |
| | 55 | 94 | 60 |
| | 60 | 93 | 50 |
| | 65 | 92 | 45 |
| | 70 | 91 | 35 |
| | 75 | 90 | 15 |

**Good Capacitance-temperature Characteristics at low cost**




*G-E Lectrofilm Capacitors for Radio and Industrial Electronic Equipment*

**GENERAL ELECTRIC**

407-115-5700

## *Plastics where plastics belong*

*The tip insulators on this welding electrode holder are excellent examples of the use of technical plastics where plastics belong . . . using resistance to heat and impact and electrical insulating properties. Synthane (our type of plastics) qualifies well for this job. Glass base laminated resists heat and impact fatigue, insulates and wears well. For these reasons and others, Synthane finds its way into an army of applications requiring electrical, chemical, mechanical or combined specifications.*


*If you have a use for Synthane, let us help you before you design. Perhaps we can save you time and trouble with design, materials or completely fabricated parts. Write for the complete catalog of Synthane Plastics and their applications today. Synthane Corporation, 12 River Road, Oaks, Penna.*

**SYNTHANE**

***where Synthane belongs***

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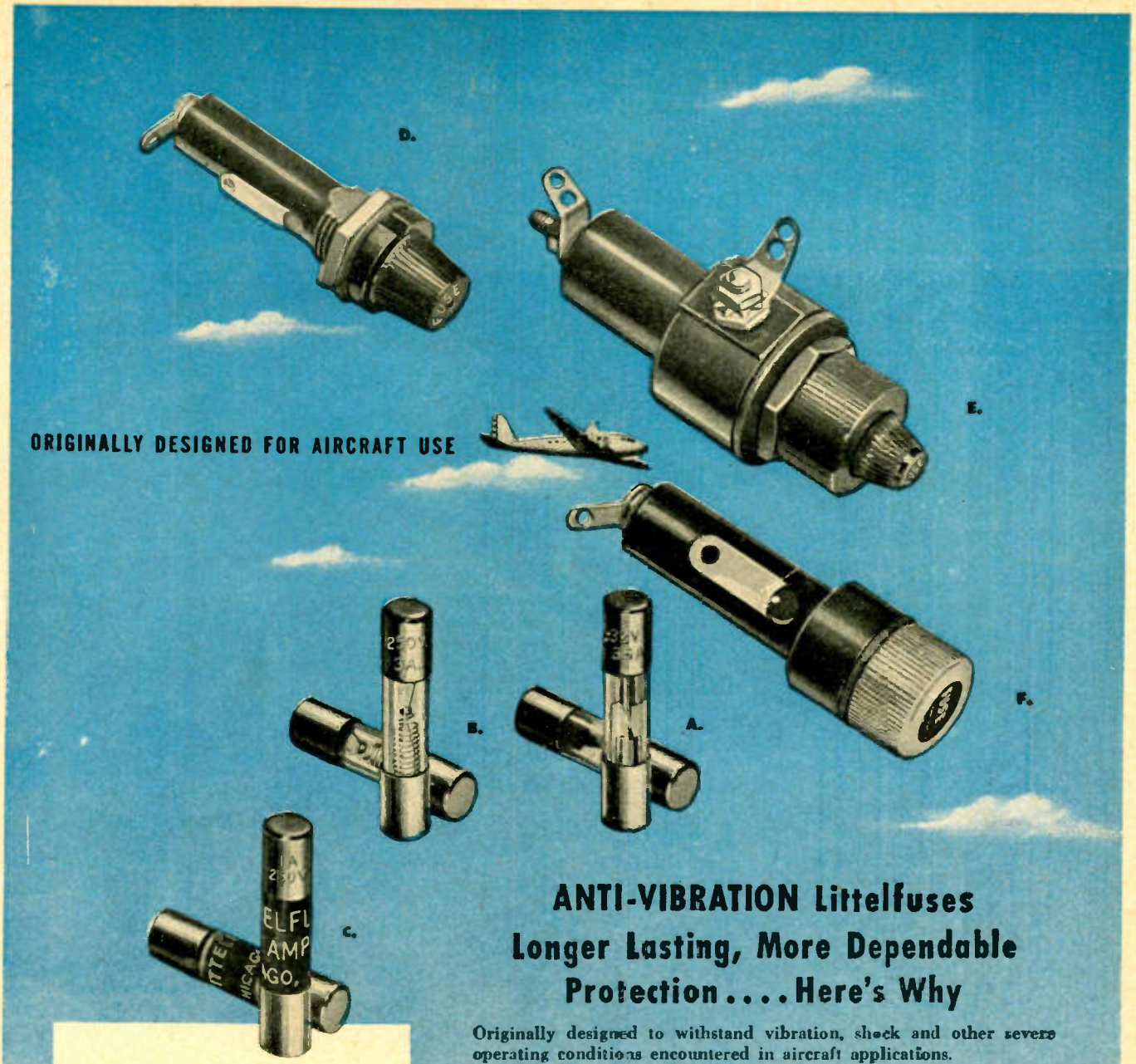
FABRICATED PARTS · MOLDED · MACERATED · MOLDED-LAMINATED




**ORIGINALLY DESIGNED FOR AIRCRAFT USE**

# ANTI-VIBRATION Littelfuses Longer Lasting, More Dependable Protection....Here's Why

Originally designed to withstand vibration, shock and other severe operating conditions encountered in aircraft applications.

Spring-and-Link element (5-ampere and lower) provides special protection for the delicate fuse element, offsets vibration. Short fusing section is soldered to beryllium copper spring as shown in illustration "B" above.

Mechanically depolarized elements, with 90 degree twist, are more responsive to vibration from any direction and are used in larger amperages, as shown in illustration "A" above. Special "gooseneck" formation at one end of fuse element prevents crystallization and cracking at the fusion point.

Complete assortment of ratings for small motors, relays and all industrial applications in which medium or high time lag protection coupled with anti-vibration and shock resistance qualities are major factors. In all such applications they will give you longer lasting, more dependable, more economical protection.

For complete information and prices on these and other Littelfuse quality products, send for Catalog No. 9 . . . just off the press.

**A.** 4 AG Littelfuse Series 411 Fuses. 10 to 40-ampere sizes for use on 32 volts or less. Glass enclosed.

**B.** 4 AG "Slo-Blo" Littelfuse Series 413 Fuses. 1 to 3-ampere sizes for use on 250 volts or less, and a 5-ampere size for use on 32 volts or less. Glass enclosed.

**C.** 4 AB Littelfuse Series 414 Fuses. 1 to 3-ampere sizes for use on 250 volts or less, 5 to 15-ampere sizes for use on 115 volts or less, and 20 to 40-ampere sizes for use on 32 volts or less. Bakelite enclosed, shatter-proof construction.

**D.** Finger Operated Fuse Extractor Post. A quick, safe and simple way of mounting and changing 4AG fuses. For front-panel mounting.

**E.** Pressurized, Finger Operated Fuse Extractor Post. Similar to above except for use at high altitudes in pressurized aircraft cabins, etc.

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*For other Fuses, Mountings and Accessories send for Catalog No. 9*

**LITTELFUSE** *Incorporated*

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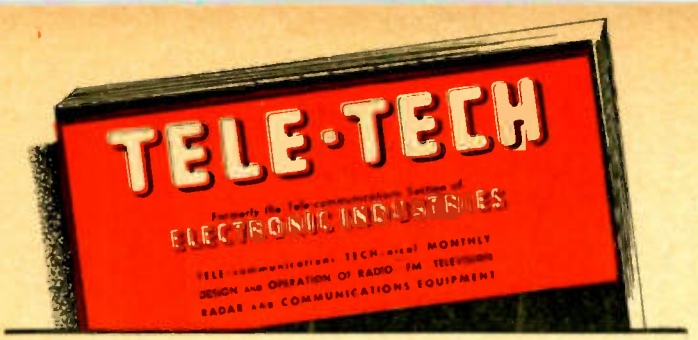
FIRST IN CIRCUIT PROTECTION

NITE-T-LITE · SWITCH-LITE · IGNITION-FRITZ · NEON INDICATORS · SWITCHES · CIRCUIT BREAKERS · FUSES, MOUNTINGS AND ACCESSORIES




**TELE-TECH**, devoted to TELE-Communications TECHnics in design, manufacture and operation, will be the largest technical magazine in the tele-communications field – largest in number of editorial pages, in editorial coverage of tele-communications subjects and in volume of tele-communications advertising.

**AN IMPORTANT**
**FOR PAID SUBSCRIBERS OF**
**CONCERNING NEW**
**TO BEGIN WITH**

Beginning with January, the publishers of ELECTRONIC INDUSTRIES will provide two new services in place of the present one.

For the rapidly expanding communications field, there will be TELE-TECH, a standard size monthly magazine, to cover all engineering phases of tele-communications–design, manufacture and operation.

For the industrial electronic field, there will

# THE ELECTRONIC INDUSTRIES

PROGRESS in electronic engineering and at points of specification has long been developing along two well-defined lines. It took the war and the first year of reconversion to emphasize the trend, but the fundamental character of the situation has long been clear, as revealed in various analyses and studies, in field contacts by ELECTRONIC INDUSTRIES editors and in reader service and subscription check-ups and correspondence.

There is a sharp and unmistakable division of interest between communication engineering and industrial electronic engineering, which alert publishers must recognize as an opportunity to better serve the fields in which they are engaged.

There is little in common between (1) the highly technical thinking and activities of responsible individuals in the field of communications and (2) the down-to-earth product development, plant operations and equipment specifications work of those who have shown such resourcefulness throughout all industry to give electronic equipment a job to do. Their problems differ, their methods are at variance and so also are their use and acceptance of many words. The engineering excellence and circuit complexities of the trained electronic engineer are often quite lost upon the man who is more interested in knowing how he can use electronic apparatus as an aid to production or a means of control.

### *Doing Something About It*

As a result, January 1947 brings to direct accomplishment two long-planned and carefully organized contributions to immediate and future progress in the electronic fields, by Caldwell-Clements, Inc. These will be TELE-TECH and ELECTRONIC INDUSTRIES & INSTRUMENTATION, replacing with specialized effectiveness the present limited, one-paper coverage of a dual-interest field.

### *Two Groups of Readers*

There are approximately 17,000 highly-trained, technically-minded radio and electronic engineers responsible for the development, design, manufacture and operation of tele-communications equipment – radio, broadcasting, FM, television, microwave, radar, aircraft, railroad, military, etc. Their activities will reflect a billion dollar market in 1947. For them, TELE-TECH has been editorially tailored for a complete coverage of TELE- communications TECHnics as applied to:

- broadcasting, whether AM, FM or shortwave
- television, as black-white and color proceed
- railroad radio for safety and speed with efficiency
- aviation navigation, safety and traffic
- recording and sound fields
- point-to-point commercial systems
- marine navigation and safety
- facsimile services
- personalized, mobile communications
- police and public safety facilities
- parts and components relating to all of these

TELE-TECH will be published monthly at a subscription rate of $3.00 for two years. It will be keyed, in coverage, in writing, in editing and in typography to the electronic interests of highly trained technical minds. It will not straddle, it will not compromise. In recognition of the global aspects of tele-communications, its circulation will include foreign manufacturers and broadcasters. Also government laboratories engaged in research and development of tele-communications for the military in the United States and similar laboratories in Latin American countries.

**CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, NEW YORK 17, N. Y., PLaza 3-1340**

CHICAGO 6 . . . . . 201 North Wells Street, RANdolph 9225
CLEVELAND 14 . . . . . 1210 Citizens Building, MAin 8270
LOS ANGELES 5 . . . . . 684 South Lafayette Park Place, DRexel 4388
SAN FRANCISCO 4 . . . . . 68 Post Street, SUtter 5568

## ANNOUNCEMENT
## ELECTRONIC INDUSTRIES
## PUBLISHING PLANS
## JANUARY ISSUES

be ELECTRONIC INDUSTRIES & INSTRUMENTATION, new in format and tempo, bringing to the production men of industry every important development, product or method to pace the extension of newer electronic ways to new industrial opportunities.

Here are the basic reasons why this important step has been taken at this time. Here are the ways in which readers will benefit and the overall progress in electronic fields will be advanced.


ELECTRONIC INDUSTRIES & INSTRUMENTATION, a new type of industrial magazine to serve design and production men who are responsible for industrial electronic methods. Pre-publication advertising contracts indicate that this magazine will set a new record for rapid growth and advertising returns.

# IN 1947 TWO SEPARATE GROUPS OF READERS TWO SPECIALIZED MAGAZINES

ELECTRONIC INDUSTRIES & INSTRUMENTATION, based upon an editorial concept and program new to industrial publishing, will be of the tabloid size and will combine the best-tested features of standard-size publications with the visibility, vitality, display, speed-up and news emphasis that is associated with the "new-product" type of paper. It will cover each month all that is timely and significant in electronic applications throughout all industry where typical uses are induction and dielectric heating, power conversion, precipitation, welding control and timing, photocell uses, x-rays for detection and test, motor speed controls and supersonic processing.

Specifically there will be:

- reviews of high spots in technical progress
- feature articles descriptive of how electronic methods are applied and with what results
- digest of feature articles appearing currently in 150 industrial magazines
- double page color charts of basic electronic data
- new products, materials, component parts and sub-assemblies
- new publications, bulletins and catalog announcements
- new books
- ABC stories of the principles upon which electronic methods are based
- product index
- "tubes on the job" shorts
- association news

ELECTRONIC INDUSTRIES & INSTRUMENTATION will have a circulation of 25,000 key men in industry whose decisions or recommendations result in the specification of electronic methods or components in the design, operation or installation of industrial equipment. Subscription, $3.00 for 2 years.

### *As To Present Subscribers*

So clear and sharp will be the line between the character of the reader services rendered by TELE-TECH and ELECTRONIC INDUSTRIES & INSTRUMENTATION that individuals receiving one will not require the other.

Present subscribers to ELECTRONIC INDUSTRIES are being carefully classified and, beginning with the distribution of the January issues, each individual according to his primary interests and activities, will receive that paper best suited to his electronic informational needs.

As all paid subscribers of ELECTRONIC INDUSTRIES are identified on our records by title and function, there is slight chance of error in determining which one of the two publications will better serve any given reader. However, if a subscriber's interest has shifted from tele-communications to industrial applications (or vice versa) and the other of the two publications is desired, please write to us stating your present activities and interests.

Simultaneously with the mailing of the January issues, each subscriber will receive a personal letter from the publisher stating the manner in which the subscription will be handled or extended.

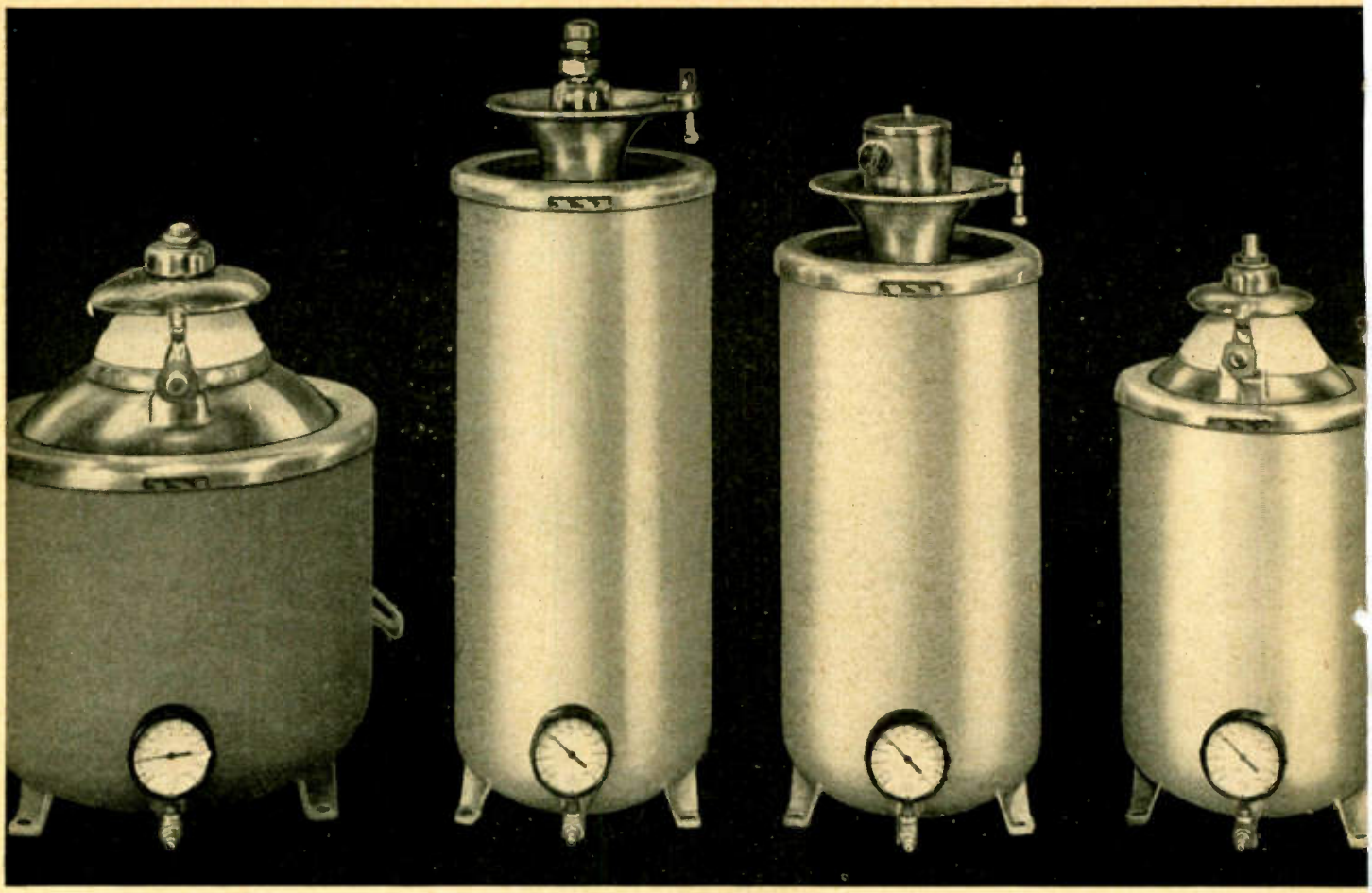
### *Advertisers Will Benefit*

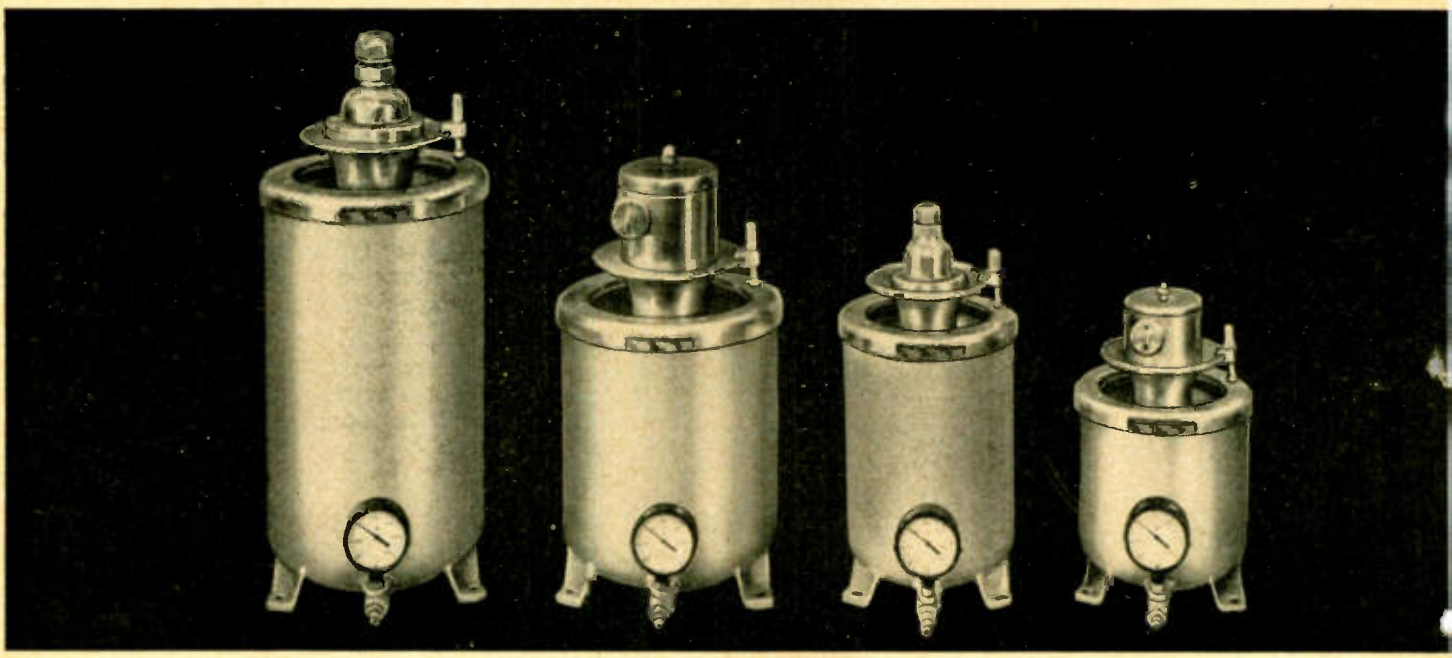
Just as readers will gain through the specialized editorial service rendered by the two magazines, so will advertisers benefit too. With such a carefully screened, nonduplicating, nonextraneous readership there is created a selective publishing service for a selected audience. For the advertiser this means a more precise and productive coverage of the market. Either or both papers may be used.

It is with pleasure that O. H. Caldwell and M. Clements, after 25 years of outstanding service to the electrical, radio and electronic industries take this significant step to advance electronic activities.

## CALDWELL-CLEMENTS PUBLISHING SERVICES

TELE-TECH • ELECTRONIC INDUSTRIES & INSTRUMENTATION • RADIO & TELEVISION RETAILING
ELECTRONIC ENGINEERING HANDBOOK • TELE-COMMUNICATION ENGINEERS' INSTRUMENT MANUAL
ANNUAL ELECTRONIC ENGINEERING DIRECTORY • RADAR • ELECTRONIC CONTROL HANDBOOK
RADIO-APPLIANCE PROFIT MANUAL • REPRESENTATIVES REGISTER • DISTRIBUTION—AREAS & QUOTAS





# Lapp

# CAPACITANCE

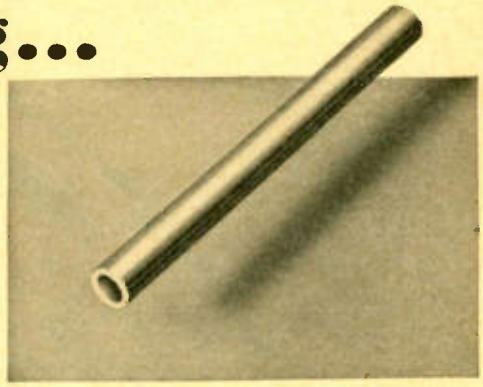
## LAPP GAS-FILLED CONDENSERS FOR HIGH POWER, HIGH CURRENT CIRCUITS

Designed particularly to the requirements of electronic power sources for radio broadcast, induction heating, and other high current applications, Lapp Gas-Filled Condensers offer a soundness of design and construction that spells *dependable performance*. No "warm up" is required; there is no change of capacitance with change in temperature. Losses are lower than in solid-dielectric circuits—power consumption is reduced. The dielectric is an inert gas, which precludes possibility of deterioration or puncture. Variable, adjustable, and fixed units are available, in power ratings up to 60 Kv peak, current to 500 amperes R.M.S. Your inquiry is solicited.

Lapp

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

# When men in Electronics talk of Tubing...



## they mean *Superior*

## and, of course Nickel tubing

**NICKEL**

**TO CATHODE SLEEVE SPECIFICATIONS IN SEAMLESS OR LOCKSEAM***

**Other Industries too have come to know about Nickel and Superior now supplies this extraordinary metal day in and day out**

**Ask Superior Tube Company for information on Seamless and Weldrawn* Nickel**

THE BIGGER NAME IN SMALL TUBING *Superior*

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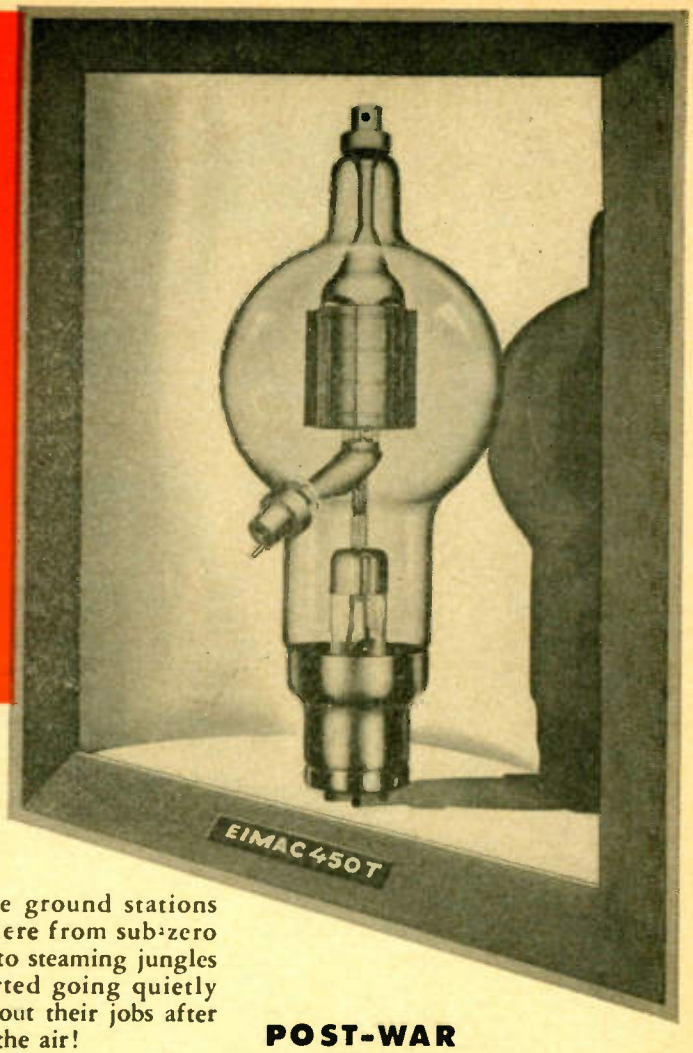
# FOR AN HONORED PLACE IN THE HALL OF FAME

Perhaps no other single transmitting tube has such a great and rightful claim to fame as has the Eimac 450T triode.

This tube, one of the original members of the Eimac family, has consistently established records for plus performance in some of the world's most gruelling applications.

Long before the war the Eimac 450T established a high standard of dependability and performance in the ground stations of leading commercial airlines. Because of their outstanding dependability and inherently superior capabilities, these tubes were snapped up for wartime duty in many vital applications.

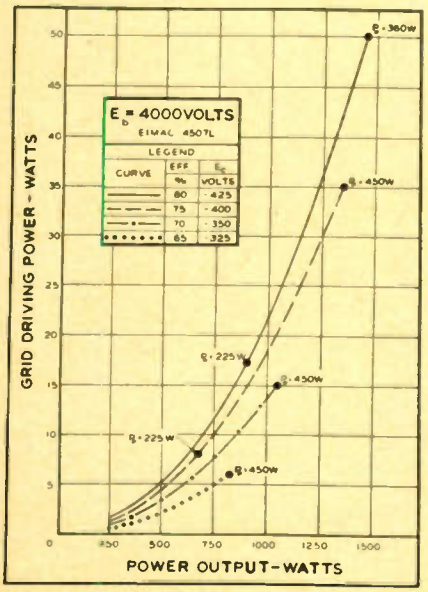



## UNUSUAL VERSATILITY

The Eimac 450T is perfectly suited to a wide variety of uses as a modulator, oscillator, or amplifier. It is available as a high-mu (450TH) or low-mu (450TL) type. In every capacity, the Eimac 450T is tops in its power range; stable, rugged, and above all, proven over years of successful use.

## LONG DEPENDABLE LIFE

When the first Eimac 450T's were installed in several major broadcasting stations, operators consistently reported better than 15,000 hours of service, top-notch performance. They were astounded to see such a compact tube do a giant's job. Eimac 450T's in airline ground stations located everywhere from sub-zero mountain passes to steaming jungles have been reported going quietly and efficiently about their jobs after 20,000 hours on the air!




## PERFORMANCE PLUS

Performance is, after all, the ultimate criterion of electron tubes. The unusual capabilities and low interelectrode capacitances of the Eimac 450T are two of the reasons for its widespread use in 1 Kw to 5 Kw stations at frequencies up to 60 Mc. And even at frequencies up to 150 Mc, the 450T triode will provide a useful output.

## HIGH POWER-GAIN

In a class B audio amplifier, a pair of Eimac 450TL's will provide 2200 watts plate power output with a driving power of but 15 watts! Or, in a class-C application, a *single* Eimac 450TL will provide an r-f plate power output of 1800 watts with but 42 watts driving power.

## POST-WAR IMPROVEMENTS

The 450T, proven before war and during war, stands today as a greater tube than ever before. Post-war developments, the result of steady, intensive research in Eimac's laboratory, has brought to today's 450T new electrodes for higher thermionic efficiencies and even longer life.

With these facts in mind, it's easy to see why the Eimac 450T is accepted over any other triode of like rating. This veteran tube has stood the acid test of time and rugged duty around the world. Today a still better 450T awaits your order. Inquire!

**EITEL-McCULLOUGH, INC.**
1305E San Mateo Ave., San Bruno, Calif.
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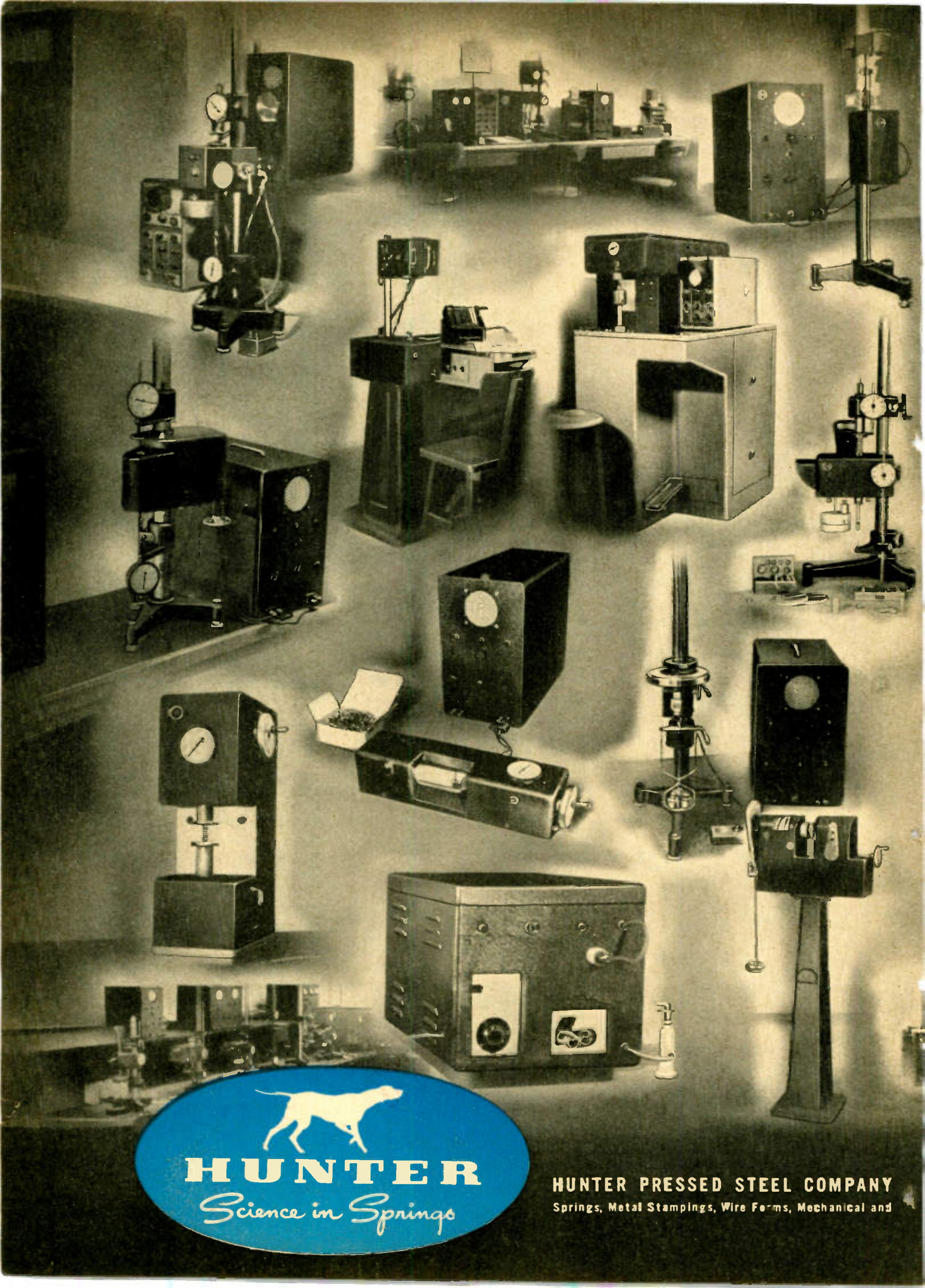
*Follow the Leaders to* Eimac TUBES

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT




HUNTER PRESSED STEEL COMPANY

Springs, Metal Stampings, Wire Forms, Mechanical and

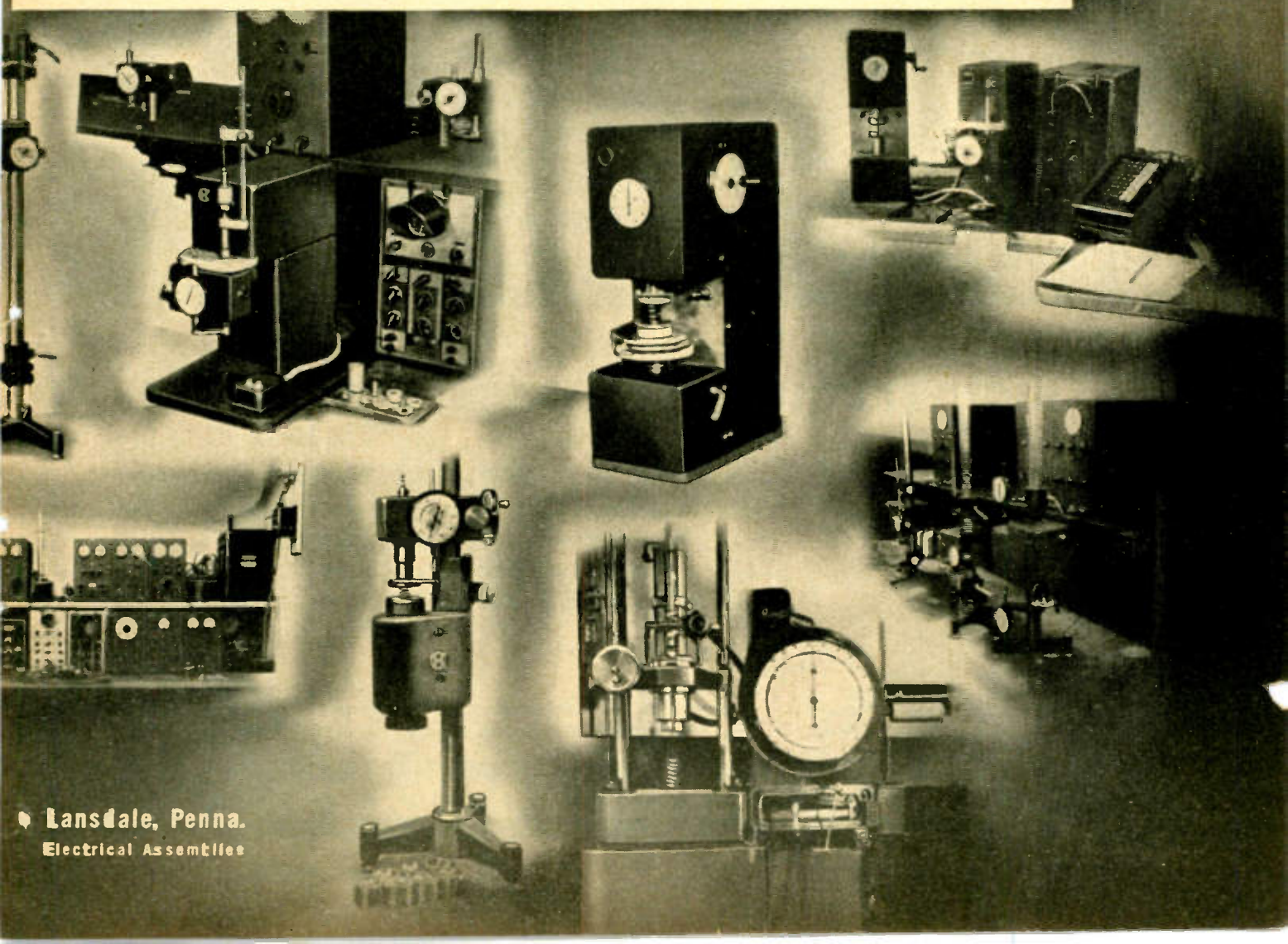
# All this to test Springs?

PEOPLE who follow our advertisements or pop in on us at Lansdale often say, "Why so much equipment just to test a spring?" Good question!

Making and testing a few springs is one thing. Making and testing hundreds, thousands or millions of springs is something else again. A very different something else if you want the kind of springs that can breeze by close specifications.

In order to implement our statistical control of quality (so effective in insuring better springs) . . . in order to give you springs that really meet tolerances and to *know that we know* they are right . . . we found it necessary to conceive, design and then even to build our own testing machines.

We show you a few of the machines on these two pages, some mechanical, some electronically operated.



Lansdale, Penna.
Electrical Assemblies

# LOW INHERENT INDUCTANCE

## SANGAMO
## *Silvered Mica Button*
## CAPACITORS

## PARTICULARLY USEFUL IN HIGH FREQUENCY BY-PASS APPLICATIONS

- Silvered Micas
- Receiving Micas
- Transmitting Micas
- Silvered Mica Buttons
- Transmitting Oil-Filled
- Ballast Capacitors (Paper)
- MOLDED Paper Tubulars
- Bathtub (Oil or Wax-Filled)
- Diaclor (A Paper Transmitting)
- Motor Starting, for A. C. and D. C.
- Metal-Encased Tubulars (Paper)
- Mineral Oil (For E Characteristics)
- Tubular Transmitting (Diaclor, Paper)
- Tubular Transmitting (Oil-Filled paper)

Sangamo SILVERED MICA BUTTON Capacitors are available in a wide variety of styles and sizes . . . When space is at a premium, solve your problem by using Sangamo SILVERED MICA BUTTONS.

Write for the new Sangamo Capacitor Catalog, and check your requirements against the Sangamo Line.

**SANGAMO ELECTRIC COMPANY** SPRINGFIELD ILLINOIS

# when specifications say...

# CAATC

## specify BLILEY CRYSTALS

AMERICAN AIRLINES PHOTO

In air carrier aircraft the seal of airworthiness is CAATC . . . Civil Aeronautics Administration Type Certification. The Bliley crystal units, shown on this page, are available with CAATC when specified.

The prime requisite for airworthiness is reliability. Each Bliley crystal, whether standard or CAATC, is rigidly tested for reliable performance. Frequency stability, precision and activity are proven for all conditions of temperature, moisture and vibration covered by the specifications that govern.

Engineers everywhere rely on Bliley "techniquality" for the answer to their frequency control problems. When you specify Bliley crystals you automatically include the creative engineering and production talent that has pioneered in frequency control for over fifteen years.

Write for Bulletin 27

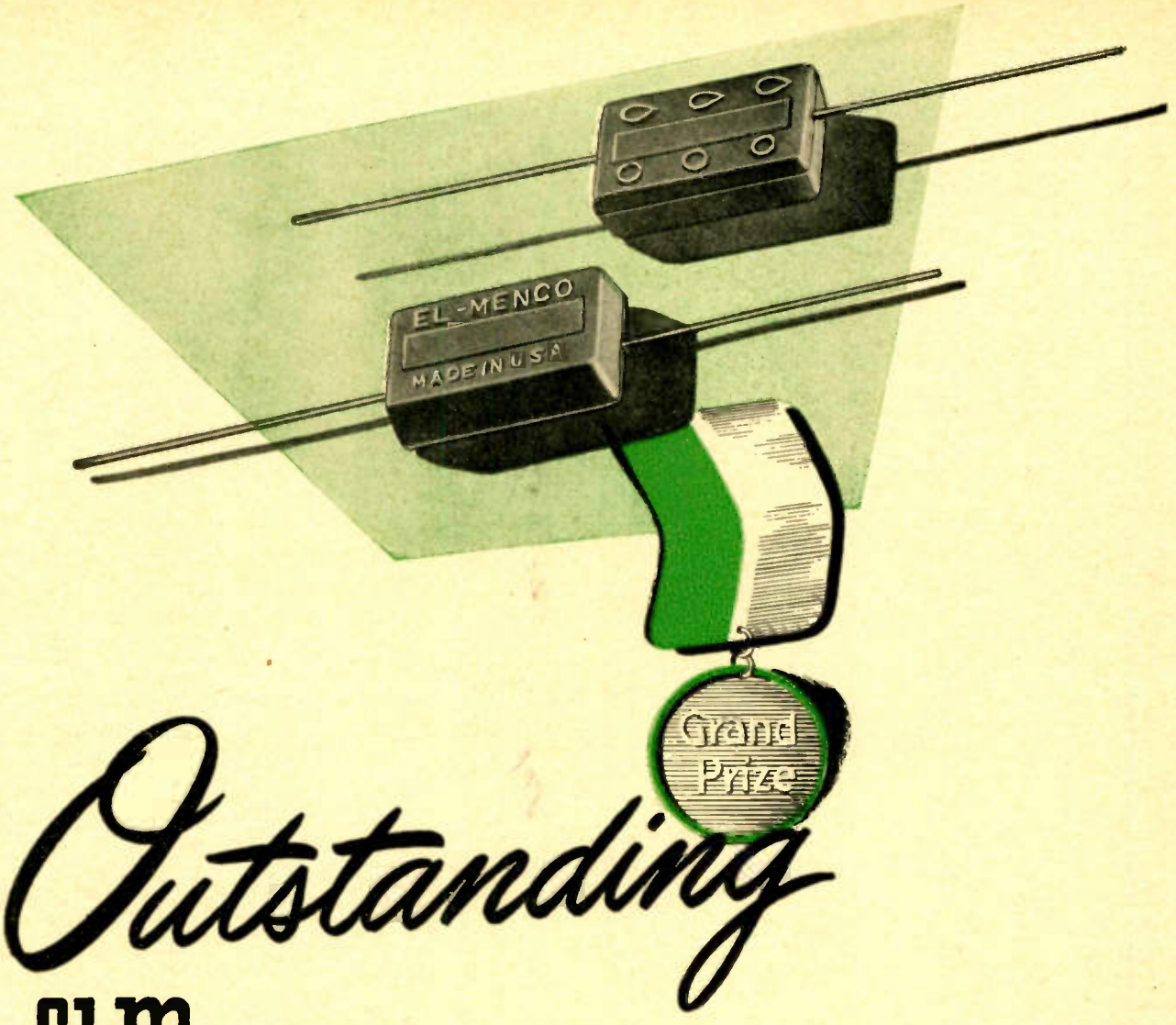
2000—11000KC
TYPE SR5—CAATC No. 363

3000—11000KC
TYPE MC9—CAATC NO. 362

2000—5000KC
TYPE AR4W—CAATC NO. 360
TYPE AR5W—CAATC NO. 361

**Bliley CRYSTALS**

BLILEY ELECTRIC COMPANY · UNION STATION BUILDING, ERIE, PENNSYLVANIA




# *Outstanding*

## El-Menco CAPACITORS are known and recognized for their high quality and absolute dependability throughout the entire field of electronic equipment manufacturing.

Constantly improved to meet changing standards, El-Menco Capacitors can be installed with the certain knowledge that they are the latest and best development in the capacitor industry. Electronic equipment manufacturers are invited to write for a new catalog.

THE ELECTRO MOTIVE MANUFACTURING CO., INC.
*Willimantic, Connecticut*

ARMY NAVY

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

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

# 10,000,000,000 OHMS

## for leakage resistance measurements at low potentials


**WILL INDICATE:**

**Insulation Properties**

**Leakage Resistance**

**Conductivity of Insulating Materials**

**Leakage due to moisture absorption and surface moisture**

## ★WESTON (MODEL 799) INSULATION TESTER

● A compact, one-hand operated insulation tester . . . range .1 to 10,000 megohms . . . easily read scale . . . test potential less than 50 volts d-c. Ideal for testing electrical components, devices, materials, and new and existing installations. Details from the WESTON representative near you, or write for bulletin.

# Weston *Instruments*

**Weston Electrical Instrument Corp., 666 Frelinghuysen Ave., Newark 5, New Jersey.**

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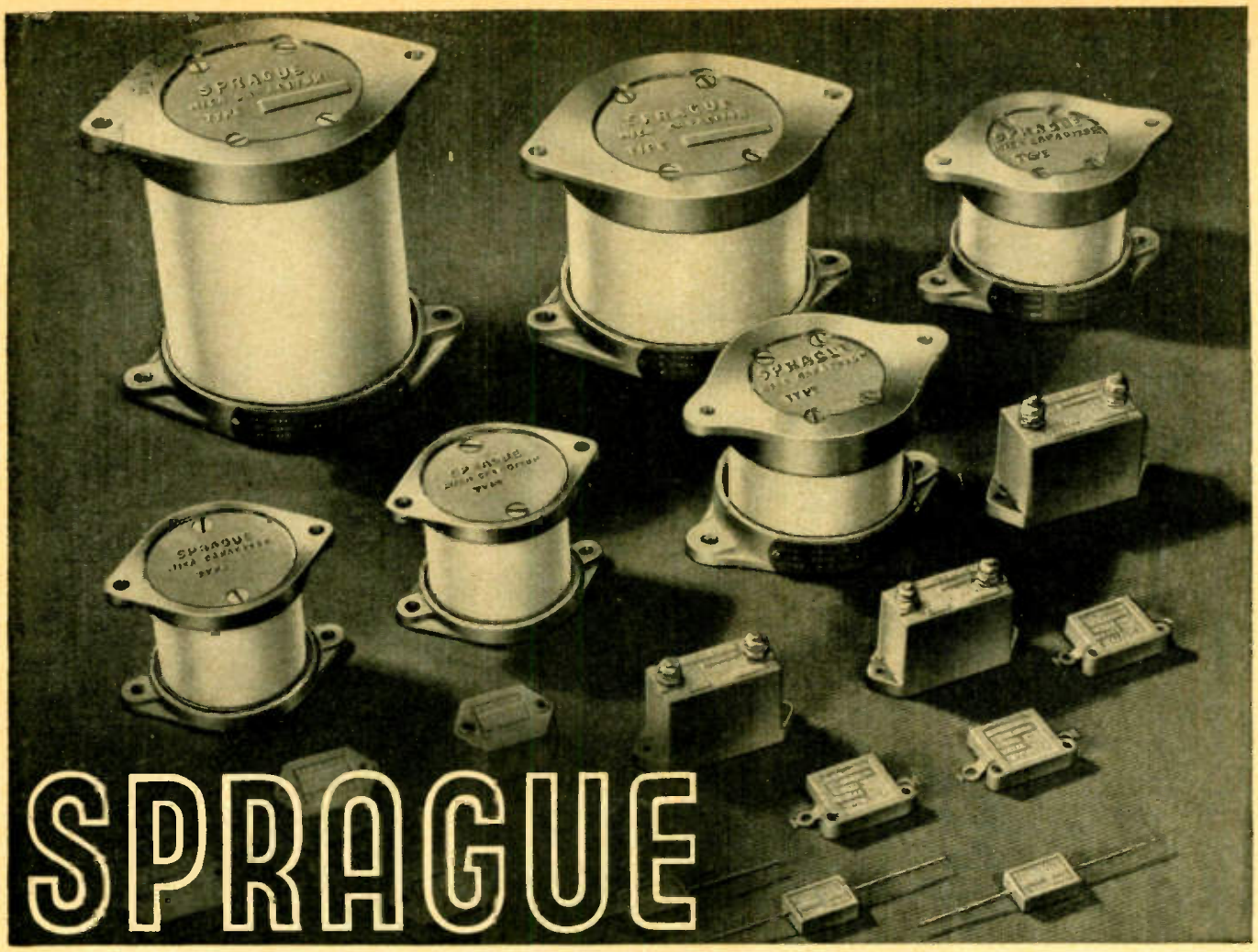



# MICA CAPACITORS . . .

*Standard and Special Types to Meet Practically Any Requirement*

THE full advantages of up-to-the-minute engineering are incorporated in the war proven line of Sprague Mica Capacitors covering molded, molded-case potted and ceramic-case potted types for almost any need. If one of the many standard types does not meet your requirements Sprague engineers will welcome the opportunity to cooperate in the design of special types for out-of-the-ordinary uses.



## WRITE FOR CATALOG 30

Contains data on all standard Sprague Mica Capacitors and outlines the many special types that can be engineered and produced as required.

**SPRAGUE ELECTRIC COMPANY**

NORTH ADAMS, MASS.


# TURNER
## MICROPHONES

*The Famous Turner No. 22*

### A *CERTIFIED* UNIT FOR EVERY JOB

Whatever your need for accurate pickup and clear, sharp reproduction of voice, music or sound, there is a Turner Microphone especially adapted to your requirements. The complete Turner Line of precision units includes both crystal and dynamic microphones for every communications purpose. Engineered to faithfully reproduce desired sound without distortions and built to stand up and deliver under difficult operating conditions, each unit is tested and ***Certified*** before leaving the factory assuring maximum dependability. For utmost in performance plus modern, eye appealing style Turn to Microphones by Turner.

Write for Free illustrated literature describing all Turner Microphones for specific and general use. Turner engineers will be glad to offer you impartial suggestions in helping you choose the right unit for your particular purpose.

**New *Turner Colortone* Microphones**

***Colorful beauty with accent on performance. New crystal and dynamic microphones in a choice of brilliant color finishes. See them at your dealer.***

## THE TURNER COMPANY

**904 17th Street N. E., Cedar Rapids, Iowa**

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 Co.*

**TURN TO TURNER FOR THE FINEST IN ELECTRONIC EQUIPMENT**

# The New EDISON Thermal Relay...

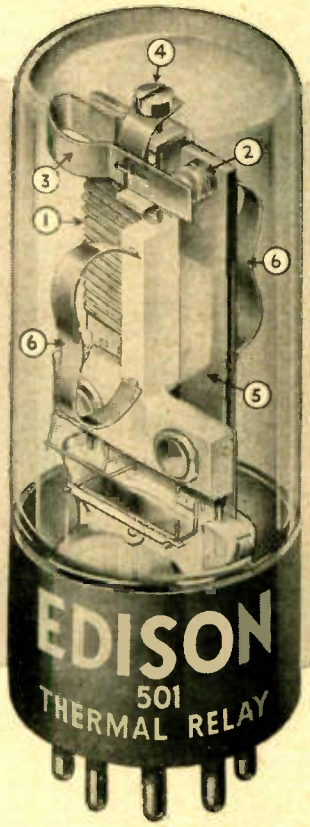
## *Here's how it works*

**1 ELECTRICAL HEATER**
(5 watts nominal up to 150 volts AC/DC) deflects bi-metal to actuate contacts.

**2 CONTACTS**
are rated at 6 amperes at 250 volts AC or 450 volts DC; under some conditions, s.p.s.t. normally open or closed.

**3 MOVING CONTACT ARM**
carried by heated bi-metal is a preloaded spring, which applies full contact pressure immediately after making. Action absolutely noiseless.

**4 FACTORY-ADJUSTED SCREW**
sets contact spacing for desired operating time—5 seconds to 8 minutes.




**5 COMPENSATING BI-METAL**
maintains pre-set contact spacing and relay timing, regardless of ambient temperature.

**6 "E" SPRINGS**
braced between sturdy ceramic support and glass tube make assembly shock proof.

- **HERMETICALLY SEALED**
in glass envelope, relay is tamper-proof, fully protected from dust, dirt, corrosion, or contact with outside air, with operation independent of altitude.
- **ARC-QUENCHING ATMOSPHERE**
guarantees absolute minimum of contact fouling, pitting, or transfer; permits equal AC and DC ratings.
- **STANDARD RADIO TUBE BASE**
4-pin or octal.

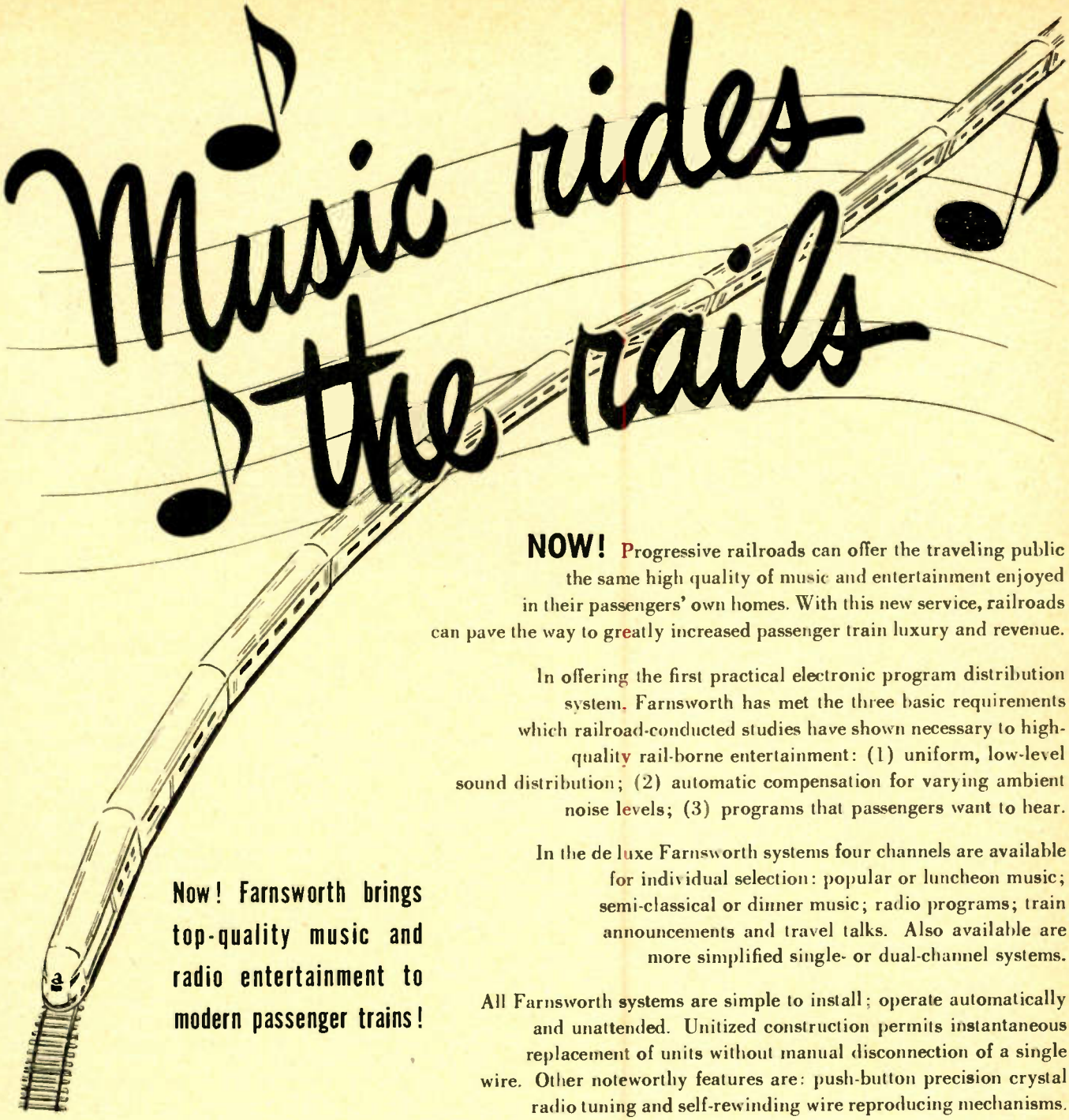
## What can this new thermal relay do for you?

It protects vacuum tubes by delaying plate voltage until cathodes are hot. But delay or timing is only one of its many uses. For instance it indicates or controls over- and under-current or voltage. The EDISON Thermal Relay carries relatively heavy AC or DC loads and prevents chatter when actuated by delicate controls. It can do dozens of other jobs better and more cheaply than any other type of relay.

AN **EDISON** CONTROL

**The services of Edison engineers**
are available to assist you in working out your particular problems. A letter giving as much data as possible on the proposed use will receive prompt attention. Instrument Division, Thomas A. Edison, Incorporated, 52 Lakeside Avenue, West Orange, New Jersey.

# Music rides the rails



**Now! Farnsworth brings top-quality music and radio entertainment to modern passenger trains!**

**NOW!** Progressive railroads can offer the traveling public the same high quality of music and entertainment enjoyed in their passengers' own homes. With this new service, railroads can pave the way to greatly increased passenger train luxury and revenue.

In offering the first practical electronic program distribution system, Farnsworth has met the three basic requirements which railroad-conducted studies have shown necessary to high-quality rail-borne entertainment: (1) uniform, low-level sound distribution; (2) automatic compensation for varying ambient noise levels; (3) programs that passengers want to hear.

In the de luxe Farnsworth systems four channels are available for individual selection: popular or luncheon music; semi-classical or dinner music; radio programs; train announcements and travel talks. Also available are more simplified single- or dual-channel systems.

All Farnsworth systems are simple to install; operate automatically and unattended. Unitized construction permits instantaneous replacement of units without manual disconnection of a single wire. Other noteworthy features are: push-button precision crystal radio tuning and self-rewinding wire reproducing mechanisms.

Farnsworth Passenger Program Distribution Systems have been engineered by the same laboratories that gave the world its finest instrument for musical reproduction — The Capehart.

Farnsworth Television & Radio Corp., Dept. EI-12, Fort Wayne 1, Indiana.

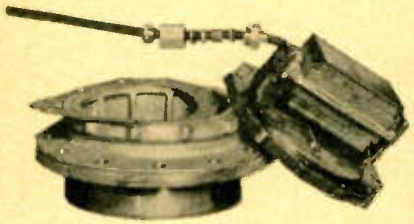
---

*Farnsworth*

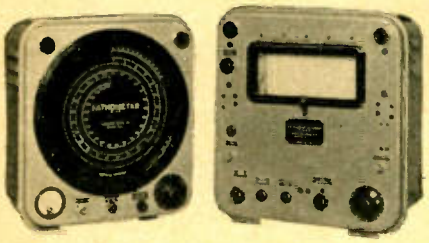
*Television · Radio · Phonograph-Radio*

Farnsworth Radio and Television Receivers and Transmitters • Aircraft Radio Equipment • Farnsworth Television Tubes • Halstead Mobile Communications and Traffic Control Systems for Rail and Highway • The Farnsworth Phonograph-Radio • The Capehart • The Panamuse by Capehart

# METAL PLATES that serve a steady diet of sound



*One of the two oscillators that are the key parts of every Fathometer. Here, the oscillating unit has been tipped back out of its casing to show how the stack of Nickel lamination plates is mounted.*



*Both an indicating dial and recorder can be used with the Fathometer. Other components include an amplifier and a driver.*

## The FATHOMETER†—the first practical application of "Sonar"—utilizes the magnetostriction of Nickel

One of the most practical uses of sonar is the Fathometer, manufactured by the Submarine Signal Co., Boston, Mass.

The Fathometer generates sonic vibrations, throws them at the bottom, and then listens for their echoes. With a Fathometer you can map the ocean floor . . . locate fish . . . safeguard navigation.

Like many other adaptations of sonar, the Fathometer depends upon Nickel to send and receive the sonic vibrations. Heart of each oscillator is a stack of thin Nickel plates, laced together with a winding of wire.

### HOW THE FATHOMETER WORKS

When current is passed through these windings, a magnetic field is created. *That's when the magneticstrictive property of Nickel goes to work!*

For under the influence of magnetic force, Nickel contracts, returning to its original length when the field goes dead. In a fluctuating field, the resulting vibrations are powerful enough to produce an echo from the ocean floor.

When the sonic waves bounce back to the Fathometer, a second oscillator (acting as a receiver) goes through the same cycle in reverse to convert sound into electrical impulses. Other components then time the lag between transmission and echo, registering the depth on an indicator.

### WHY NICKEL WAS CHOSEN

Nickel is used in sonar because it contracts more than any other commercial metal, contracting 32 units of length for every 1,000,000.

Magnetostriction is just one of the specialized properties obtainable with Nickel. When specifying metals for electronic or electrical use always consider Nickel and the INCO Nickel Alloys. They are strong, tough, rustless, corrosion-resistant and thermally durable.

†Trademark registered by Submarine Signal Company

**THE INTERNATIONAL NICKEL COMPANY, INC.**
67 WALL STREET, NEW YORK 5, N. Y.

Nickel

**NICKEL (INCO TRADE MARK) ALLOYS**

MONEL® • "K" MONEL® • "S" MONEL® • "R" MONEL® • "KR" MONEL® • INCONEL® • NICKEL • "L" NICKEL® • "Z" NICKEL®
®Reg. U.S. Pat. Off.

GUARDIAN RELAYS FOR EVERY CONTROL NEED

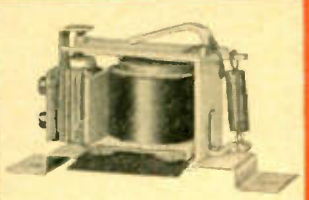
# Guardian Relays for Home Heating

The Republic Radiant Gas Burner, product of Autogas Company—Chicago, is designed to produce "Gradient-Heet" control in place of the usual intermittent On and Off operation. To accomplish this, a bi-metal thermostat containing two sets of contacts is wired in series with a Guardian 120 Relay. When both sets of contacts are closed, a maximum flow of gas passes thru the control unit. As room temperature rises a fractional degree, the thermostatic bi-metal blade opens one set of contacts, deenergizes the Guardian 120 Relay holding coil. This action opens a pilot valve, permits a portion of input gas to be routed to a regulating chamber and automatically diminishes the flow of fuel to the burner. Should the room temperature continue to increase, the second set of thermostatic contacts opens up to close the input gas supply completely. However, should the room temperature decrease at this intermediate point, the Guardian 120 Relay closes the pilot valve to allow a maximum flow of gas to the burner. In this application, Guardian's standard Series 120 Relay has been quickly converted to a "special" unit for better performance, price, and delivery. Whatever your control need, Guardian is ready with a Relay, Switch, Solenoid, Magnetic Contactor or complete control assembly.

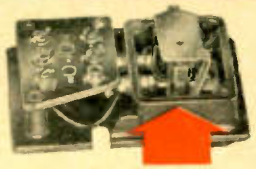
**GUARDIAN ELECTRIC**

1622-P W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY



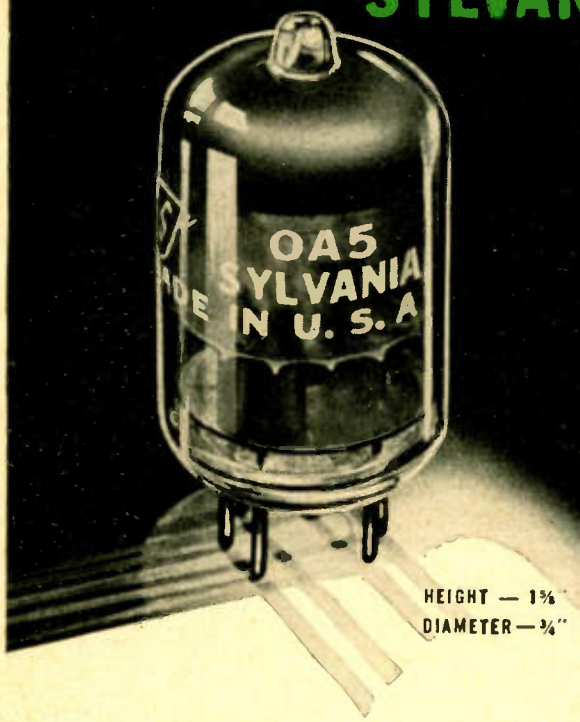
GUARDIAN'S SERIES 120 RELAY



. . . AS ADAPTED FOR CONTROL OF THE REPUBLIC GAS HEATER

# TRIGGERTUBE...

## SYLVANIA'S NEWEST




## —made specifically for electronic relay applications...

HERE'S a new 5-element, inert-gas filled, internally triggered cold cathode relay tube designed for operation up to 1000 volts on the anode, with a positive pulse on the control or trigger grid—a tube made specifically for triggering.

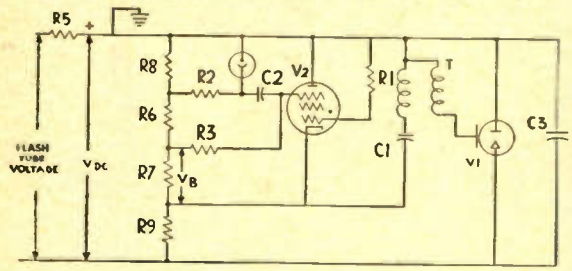
Its cathode structure is similar to that utilized in the well-known 1D21, SN4 type strobotron tubes which are mostly used for stroboscopic applications. This cathode design is characterized by its ability to furnish extremely high instantaneous peak currents—hundreds of amperes.

However, the design of the new Triggertube varies in that the delay time—time required to initiate the arc—as well as the deionization time, is greatly reduced as compared with previous triggering tubes. In addition, since this tube has been especially designed for trigger applications—applications which do not utilize the light flashes produced by the arc—it can be ideally utilized wherever stable characteristics and low switch current are important.

For example: electronic flash equipment in which externally triggered flash tubes can be readily controlled by a hand trip switch, built-in shutter synchronizing switches, or by a photocell.

Write address below for full specifications.

### PHOTOCELL TRIPPING CIRCUIT FOR ELECTRONIC FLASH TUBE




| | | |
|---|---|---|
| $R_1$ | Keep-alive current limiting resistor | 20 megohms |
| $R_2$ | Phototube resistor | 0.25 megohm |
| $R_3$ | Grid current limiting resistor | 10 megohms |
| $R_5$ | Power supply limiting resistor | |
| $R_6$, $R_7$, $R_8$, $R_9$ | Phototube and Triggertube voltage divider | |
| $C_1$ | Anode discharge condenser | 0.25 μfd. |
| $C_2$ | Trigger grid condenser | 0.01 μfd. |
| $C_3$ | Flash tube condenser | |
| T | Ignition coil condenser | |
| $V_B$ | Trigger grid bias voltage | |
| $V_1$ | Flash tube type R4330 | |
| $V_2$ | Type OA5 Triggertube | |

The OA5 is licensed under the tube patents of Edgerton, Germeshausen and Grier, but no license is implied under their circuit patents.

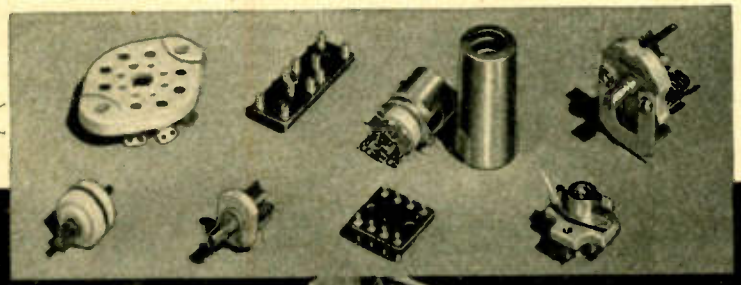
# SYLVANIA ELECTRIC

*Electronics Division . . . 500 Fifth Avenue, New York 18, N. Y.*

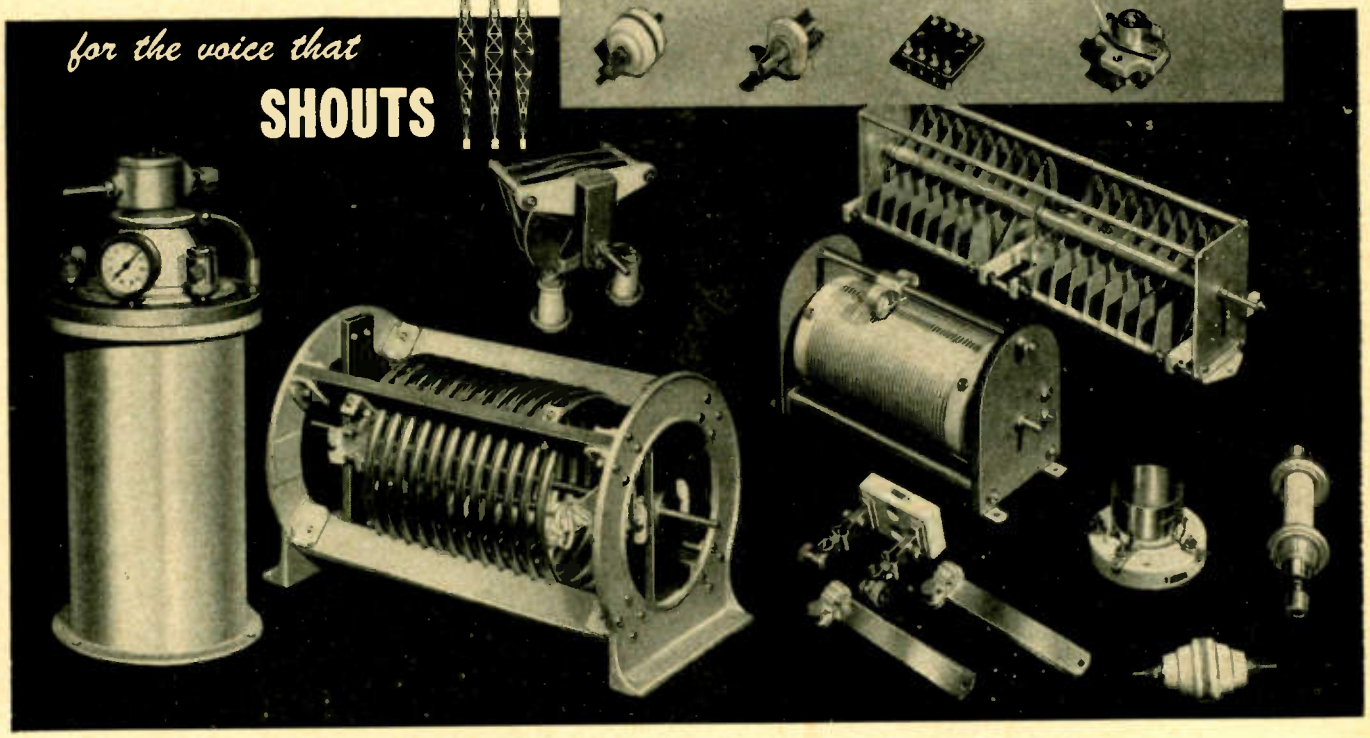
MAKERS OF ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

# JOHNSON COMPONENTS

*for the voice that* WHISPERS



*for the voice that*
**SHOUTS**



If you design or build electronic equipment no smaller than a handy-talkie, no larger than a 50 KW transmitter there are JOHNSON components "your size." Many of the small parts above find application in circuits operating at battery voltages. The miniature socket for instance is a modification of a predecessor that floated down over Europe in a handy-talkie with the paratroopers. They're catalog items with the exception of the terminal boards which typify JOHNSON ability to manufacture special assemblies quickly, easily and economically. The miniature condenser is an inch and half overall, has .015" spacing, 12 mmf. maximum and 3 mmf. minimum capacity. On the large side of the condenser family are the pressurized nitrogen-dielectric condensers offering RMS voltage ratings to 30,000 V capacities to 10,000 mmf., and highest capacity to mounting space ratios. Similar comparisons might be made with the other JOHNSON components.

Between the large and small above there's a big JOHNSON line from which to choose. Check the list below for parts you need. You'll find them carefully designed, skillfully manufactured. For more information write department O today.

*Johnson Products Include*

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

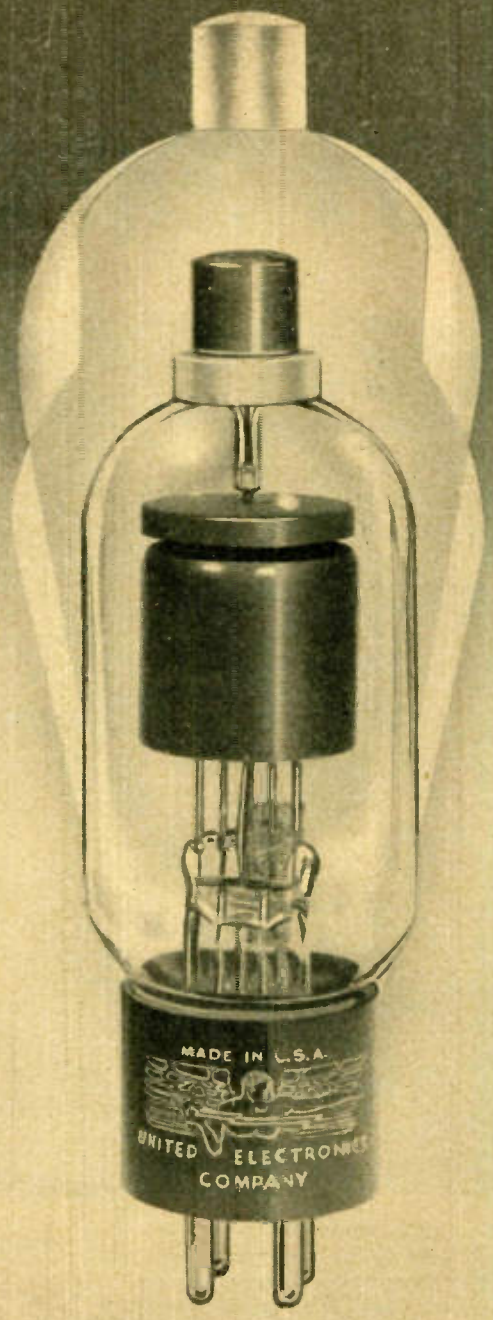
**JOHNSON**
*a famous name in Radio*

E. F. JOHNSON CO., WASECA, MINNESOTA

# 50% smaller
# SAME POWER

## New UNITED Z-225
## Mercury Rectifier

- *Saves Power Supply Space*
- *Solves Temperature Problems*




**$1.95 ea.**

*866-866A silhouettes and new Z-225 shown actual size.*

| | |
|---|---|
| Filament Rating | 2.5 Volts—5 amps. |
| Voltage Drop | 10-15 Volts |
| Condensed Mercury Temperature —Range | 25 to 60 C. |
| Supply Frequency up to | 150 cycles |
| Max. Peak Inverse Voltage | 10,000 |
| Max. Peak Plate Current | 1.0 amp. |
| Average Plate Current | .25 amp. |

A compact version of the type 866-A with identical characteristics and ratings, UNITED Z-225 is the exclusive solution for power supply problems wherever space and weight factors are of importance. Overall clearance dimensions considered, it occupies less than ½ the cubic space required for types 866-866A and permits good engineering practice rather than space limitations to govern circuit selection.

In contrast with tubes into which mercury is "dumped," the UNITED Z-225 is entirely free of excess mercury. Casual examination will reveal little or no mercury. Wherever 866-866A tubes are crowded and operating under poor temperature conditions the use of the Z-225 is indicated. In such cases it permits greater space for free circulation of air and consequently cooler operation.

Type Z-225 is another outstanding development of UNITED ELECTRONICS COMPANY—notable producers of mercury rectifiers and graphite anode tubes with the famous "Isolated Getter Trap."

## UNITED ELECTRONICS CO.

NEWARK, 2 NEW JERSEY

*Transmitting Tubes EXCLUSIVELY Since 1934*

# MODERNIZE YOUR PRODUCT *at Low Cost*

## WITH THESE INEXPENSIVE, HIGHLY ADAPTABLE SWITCHES

Up-to-the-minute switches add efficiency to the electrical product, that means greater sales appeal to the ultimate consumer. Stackpole line, slide, and rotary-action switches are highly adaptable to the individual needs of a wide variety of electrical equipment and cost but little. Eighteen standard units include 3-position types and 1-, 2-, 3-, and 4-pole switches with or without spring return, detent, covers and other optional features. Each can be adapted mechanically or electrically to meet a wide variety of specific requirements.

**OTHER STACKPOLE PRODUCTS**

Brushes and Contacts
Carbon Regulator Discs
Bearings—Pipe
Anodes and Electrodes
Packing, Piston and Seal Rings
Welding Carbons, etc.

**WRITE FOR ELECTRONIC COMPONENTS CATALOG**
. . . for complete details on Stackpole Switches, also Fixed and Variable Resistors, and molded iron cores.

**STACKPOLE CARBON COMPANY, St. Marys, Pa.**


# STACKPOLE

# SOLITE*

## NEW AND SMALLER PAPER CAPACITORS


## *Solar announces*

**SOLITE*** **Metallized Paper Capacitors**

Truly revolutionary are these miniature capacitors, one-third to one-fourth the size of conventional paper tubulars. *SOLITE** ... latest triumph of war research ... new in every way—made by an entirely new process—introduces a new concept of compactness to electronic product designers, a new idea of installation ease. Ask for *SOLITE* details.

Solar Manufacturing Corporation, 285 Madison Avenue, New York 17, N. Y.

© 1959

*Trade Mark

Solite Capacitors are fully protected by U. S. letters patent and patents pending.

SOLAR

**SOLAR CAPACITORS**
**"Quality Above All"**

# ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.


### *Absurd Power Restrictions*

Several times we have called attention to the absurd restrictions on the power of broadcasting stations, from which the industry and public continues to suffer.

Carrying this point into some actual figures, let us estimate the powers now commonly required to serve say a million people—250,000 homes:

| | |
|---|---|
| Electricity ..... | 2,500,000 kw |
| Automobile engines ... | 12,500,000 kw |
| Radio broadcasting ... | 50 kw |

Amazing as this comparison is, the fact remains that multiplying broadcasting powers even ten-fold or 100-fold would instantly put an end to interference from practically all natural and man-made static. Home receivers would be simplified and cheapened. And tremendously improved reception would be supplied the public.

### *DeForest Invented Tube Just 40 Years Ago*

This month marks the 40th anniversary of the invention of the three-element "audion" by Dr. Lee deForest. For actually, it was during December, 1906, that the first triode was produced and tested in the attic lab in the old Parker Building, 4th Ave. and 19th Street, New York City. But the famous patent application was not filed until Jan. 29, 1907.

Frank E. Butler, then as now, closely associated with Dr. deForest, explains the five-week delay as resulting from "Doc's" characteristic generosity of heart. After the tube was invented, Butler had gone out West to get married, and "Doc" had previously promised the young couple he would "show them New York".

Unannounced, the Butlers landed in town just as deForest and his attorney had completed drawing up the patent specifications, although the inventor had only enough cash on hand for the Patent Office fee. But, that the honeymooners be not disappointed, deForest quickly gathered up the precious patent-fee money and started out with the Butlers on a round of theatres, restaurants and the old Hippodrome. Available cash was soon used up, and no more was forthcoming for weeks.

And that is the hitherto unpublished story of why the filing of the "audion" patent application was delayed five weeks because of the inventor's big heart and small bank account.

### *Speedy Electronic Computation*

Industrial companies are now making extensive use of electronic computing machines. An unusual example was the enlistment of the M.I.T. differential analyzer to compute the proper curvature of some refractory-brick furnace arches. The object was to have all resultant forces tangent to the arch faces, so that no mortar would be needed!

The M.I.T. machine is particularly suited for helping industry because its various connections and shaft settings can be made in a few minutes by insertion of a new punched tape in the control apparatus.

### *Cosmic Static on TV*

Some years ago, the radio short-wave radiation coming from the center of our Milky Way Galaxy, was broadcast over a national network by your editor, in collaboration with Karl Jansky, of Bell Labs., discoverer of this celestial static.

Now it turns out that these same cosmic emanations from the Milky Way actually can increase the "noise" received by a television receiver. On 60 mc a good television receiver, that is, one that has a noise factor of not more than 4 db when measured in the laboratory and under conditions where cosmic radiations can cause no disturbance, will have an increased noise output of 9 db to 12 db when connected to a normal antenna. This noise output varies with the earth's sidereal rotation (about 23 hours and 56 minutes), the diurnal peak coinciding with the passing of the Milky Way overhead.


*For Detailed Information on Our New* ***See Pages 18 and 19***


## EXPANDED SERVICE FOR ELECTRONIC READERS

● As announced on our front cover, the editorial service of *Electronic Industries* beginning next month, January, will be expanded into two specialized monthly magazines: 1. "TELE-TECH", continuing the TELE-communications TECHnical section of the parent publication, and 2. "Electronic Industries & Instrumentation", covering industrial applications and factory electronics.

On pages 18 and 19 of this issue, we present full details of the new plan. There you will also want to read about the subscription arrangements which the publishers are making to supply each reader with an expanded editorial service best suited to his own special needs.

# Z-METER

***Basic laboratory instrument which opens up a new and important field in electrical and electroacoustic measurements***

Fig. 1 — The type 310-A Z-Angle meter is self-contained in a small portable cabinet, including ac operated power supply, visual balancing and phase meter, impedance standards, and source for two common test frequencies

**By L. E. PACKARD**

Technology Instrument Corp., 1058 Main St., Waltham, Mass.

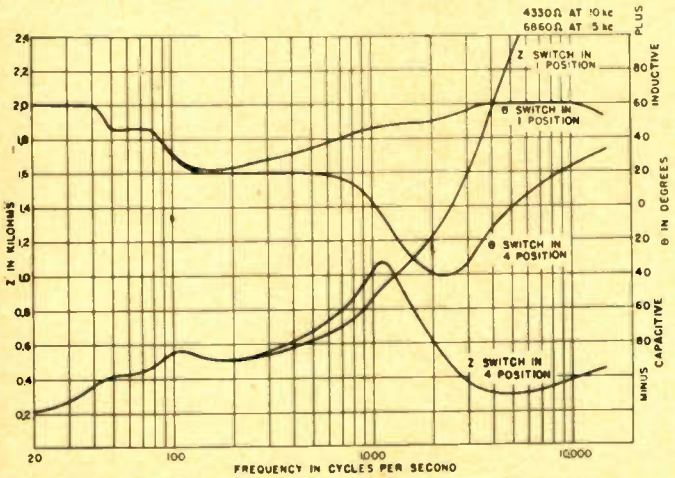
● Audio frequency measurements on communications circuits and units such as microphones, lines, transformers and speakers require the determination of complex impedances, usually at low phase angles, for which ordinary general-purpose bridges are not particularly adaptable. The simpler two-voltmeter method of measuring impedance gives no indication of phase angle and is subject to serious errors resulting from the residual reactances involved in a hastily made set-up. Equipment has therefore been developed, giving for the first time the convenience and simplicity of the common two-voltmeter measurements, with the accuracy at both low and high phase angles of elaborate and costly bridges. Furthermore, the instrument is direct reading in the units most generally useful to the communications engineer, namely, ohms impedance and degrees phase angle, and unlike most ac bridge circuits, the readings are completely independent of frequency.

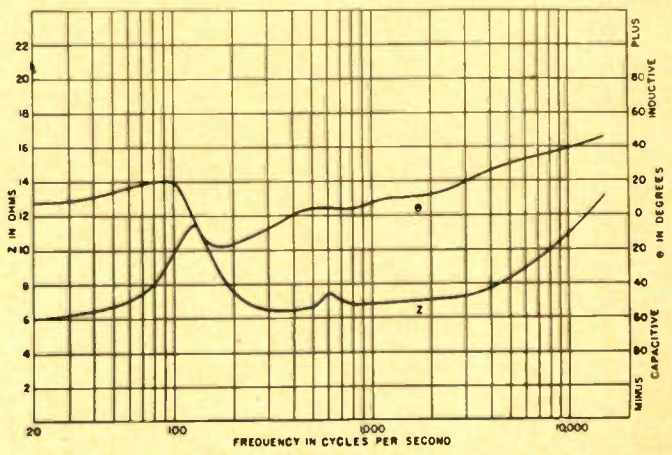
A specially shielded and balanced input transformer renders negligible the usual effects of stray capacitance and coupling to a degree impossible when separate units are assembled for impedance measurements.

As a typical illustration of the type of data which can be easily and quickly obtained, Fig. 2 shows the impedance and phase angle characteristics of a typical coaxial loudspeaker incorporating a cross-over filter network. Curve A represents the characteristic of the low frequency unit alone. It is generally typical of direct radiator loudspeakers, but with more inductance in the voice coil than is common for speakers which must handle the high frequencies as well as the low.

When the tweeter and associated cross-over network are connected into the circuit, the over-all impedance characteristic is as shown by curve B. Both curves show the wide variation possible in the impedance of a loudspeaker system. Such a system is normally intended to provide design-objective frequency response when operated from a particular impedance. Here it is important that the speaker be operated from the proper impedance, for a correct overall frequency characteristic. Otherwise wide variations in impedance will cause equivalent wide variations in the frequency re-

Fig. 2—Impedance and phase angle characteristics of a typical coaxial loudspeaker with and without cross-over network, with and without cross-over filter network and tweeter. (Curve A marked "Z, switch in 1 position". Curve B marked "Z, switch in 4 position".) Fig. 3—Impedance and phase angle function of single-unit direct-radiator loudspeaker



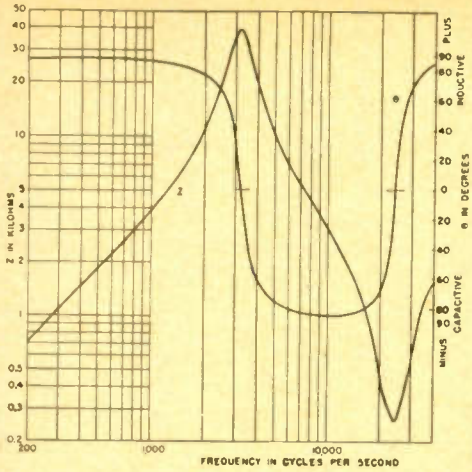



Fig. 4—Impedance and phase angle function of audio-frequency bridge isolating transformer with primary and secondary open circuited

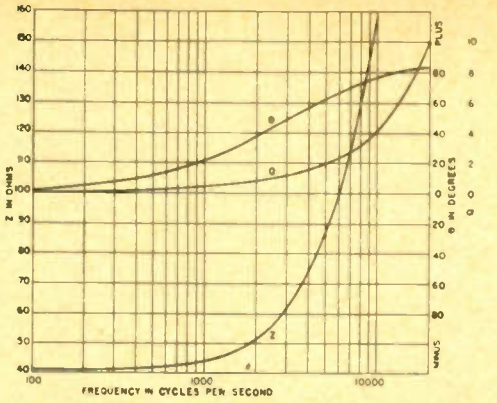



Fig. 5—Curves showing variation of impedance, phase angle and storage coefficient Q of rf choke

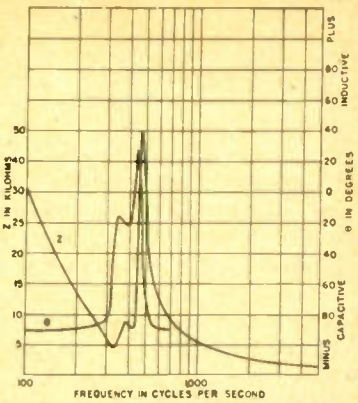



Fig. 6—Impedance and phase angle function of 6000-ohm band pass filter, terminated in 6000 ohms

sponse characteristic. For example (curve B), if the speaker were operated from an extremely high impedance, such as an output circuit containing pentodes or beam power tubes without inverse feedback, the response would be greatly exaggerated in the region of 1000 cycles.

The phase angle characteristics of the loudspeaker indicate how much of the available electrical power is actually converted into other forms of energy. Obviously a high reactive impedance will limit both the amount of power which can be drawn from the source, and the percentage which can be converted to useful energy. A low phase angle over the important frequency ranges tends to indicate a higher degree of efficiency than a high phase angle.

As to the problem of non-linear distortion, many power amplifiers particularly those with high impedance output tubes and no feedback, are extremely critical with respect to load impedance. A brief examination of tube handbook curves for load impedance distortion will quickly indicate this effect, which is still further exaggerated by impedances having high phase angles.

Only by knowing fully the impedance and phase angle characteristics of the loudspeaker is it possible to know whether or not many types of amplifiers will provide sufficiently distortion-free performance. The poor quality of many so-called high fidelity systems can often be attributed to the fact that test measurements were made with a dummy resistance load, with the loudspeaker added later.

Distortion measurements on a power amplifier operating into a fixed resistance load generally are quite useless in determining actual performance with a loudspeaker. The same applies to practically any amplifier operating into a network which does not represent a pure resistive impedance or which may have wide variations in impedance and phase angle with frequency because of electrical or mechanical resonances.

In another example, Fig. 3, the impedance and phase angle characteristic of a wide-range single-unit direct-radiator loudspeaker do not exhibit as great variations in impedance as those shown in Fig 2. However, the high and low frequency impedances still vary sufficiently from the average to necessitate careful matching to an amplifier for best results. The curves shown in Figs. 2 and 3 both represent relatively high priced, high grade speakers. With lower grade units, the effect of mismatching may often be even more serious.

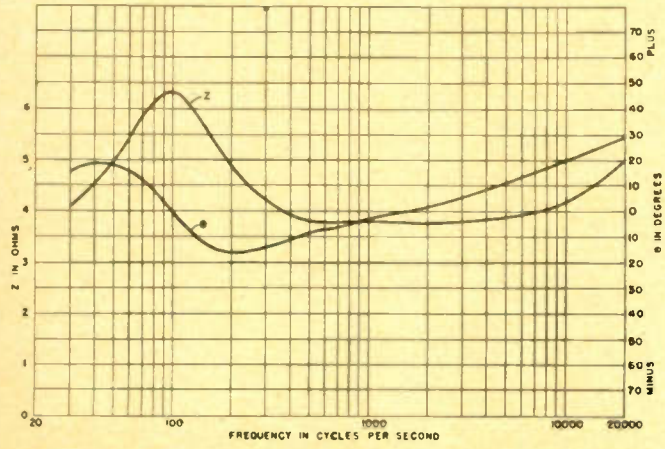
Other interesting examples of the various applications of the Z-Angle meter are the impedance and phase angle functions of a bridge isolating transformer, Fig. 4, an rf choke, Fig. 5, a band-pass filter, Fig. 6, and a microphone, Fig. 7. These examples exhibit wide variations of Z and $\theta$ with frequency, variations which are important both from a design and application point of view.

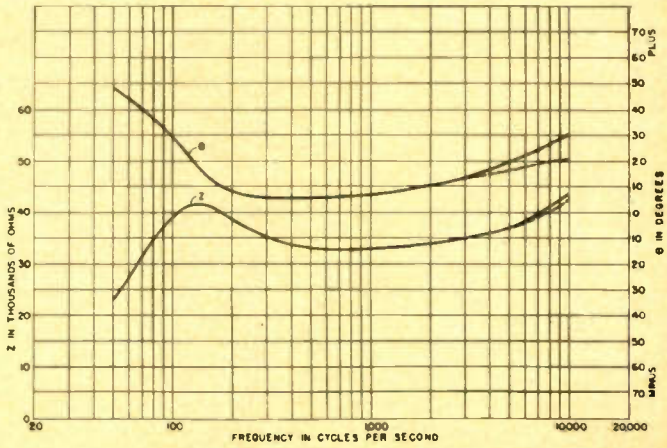
### *R, L and C measurements*

The range of the Z-Angle meter in impedance is essentially from 0.5 to 100,000 ohms and phase angle from +90° through 0 to —90° (L through R to C) over a frequency range of 30 to 20,000 cps (Fig. 8).

The range of the instrument is as follows: R—0.5 to 100,000 ohms, L—5 microhenries to 500 henries, C—0.0012 to 10,000 microfarads.

Fig. 7a—Impedance and phase angle function of microphone. Fig. 7b—Impedance and phase angle function of microphone with matching transformer



Readings of impedance and phase angle are obtained directly from the instrument, but these can be readily converted to values in henries and microfarads by simple relations, Fig. 9.

The dissipation factor D of capacitors and the storage coefficient Q of inductors are frequently desired, and since D is related to the phase angle $\theta$ as the cotangent of the angle $\theta$ and Q, the tangent of $\theta$, supplementary scales are provided on the meter so as to provide direct readings of D and Q, with the following ranges: D—direct reading from 0.1 to 10, and Q—direct reading from 10 to 0.1.

These extremely wide ranges of R, L, C, D and Q makes the Z-Angle meter far more versatile than widely used single-frequency universal bridges.

### Basic circuit

The circuit used in the Z-Angle meter is derived from the common two-voltmeter or voltmeter-ammeter method of measuring impedance. Here in a series circuit, the voltage drop across a known resistance is compared with the voltage drop across an unknown impedance when the same current is passed through both, as in Fig. 10. A direct measure of impedance is obtained in terms of the standard resistance by adjusting the variable resistance standard until the two voltage drops are the same. This is equivalent also to the voltmeter-ammeter method, since the voltage drop across the standard resistance is proportional to this current.

It has become customary in many laboratories to set up this circuit when needed, using standard laboratory oscillators, decade resistance boxes and vacuum tube voltmeters. When absolute accuracy is not too important, this procedure is acceptable. However, as is always the case when miscellaneous laboratory parts are assembled in this way, errors due to residuals

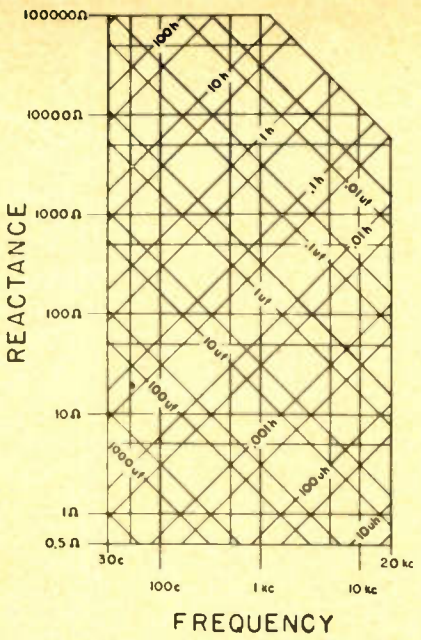



Fig. 8—Showing the magnitudes of impedance and frequency ranges covered by instrument

within the basic circuit elements, stray capacitance, extraneous pick-up and coupling between the leads are not analyzed, hence, there is good reason for questioning the accuracy of the final answer. A detailed analysis of error in even the simplest of circuits is something that requires a great deal of time and thought, and in most laboratories time does not allow for proper consideration of such problems.

### Phase angle

Furthermore, the basic two-voltmeter method gives no information regarding the phase angle of the unknown impedance, a serious shortcoming, because in the majority of the examples cited above, the impedance is not sufficiently defined without a knowledge of its phase angle.

Various circuits are used to obtain this information, but because of the complications involved and the difficulty of obtaining quantitative information in the desired

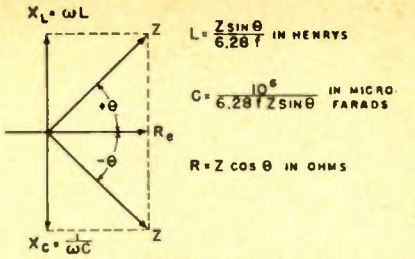



Fig. 9—Vector diagram and formulae showing relation of R, L and C to Z and $\theta$

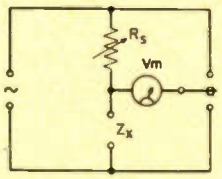



Fig. 10—Two-voltmeter method of measuring impedance

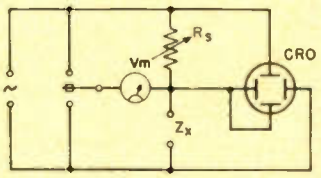
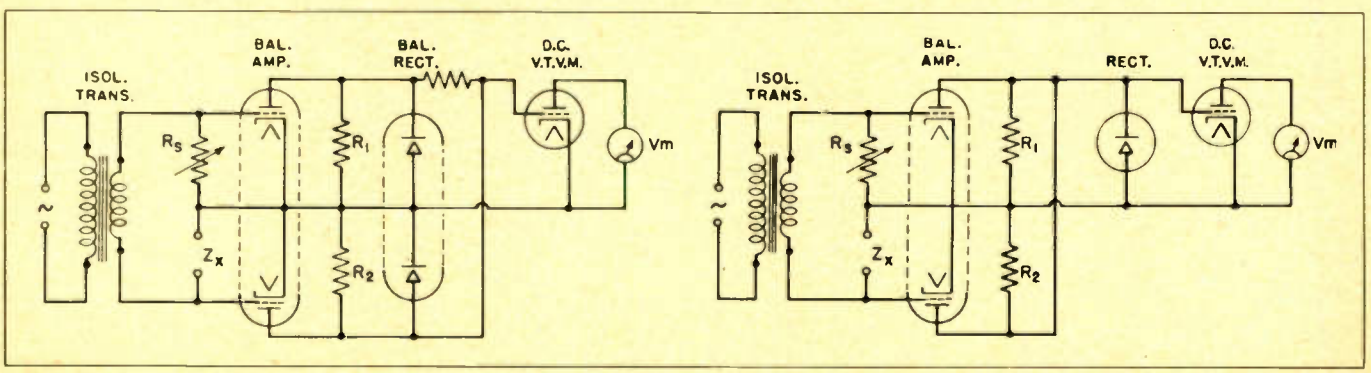



Fig. 11—Method of observing the phase angle of an unknown impedance through use of cathode-ray oscilloscope

units but generally they are not resorted to. Perhaps the most common method is the use of a cathode ray oscilloscope in the simplified circuit shown in Fig. 11. Such an arrangement will show departure from zero degrees phase angle by the change of a linear pattern into an elliptical or circular pattern on the screen of the oscilloscope. However, this method leaves much to be desired when quantitative measurements are involved.

In place of the voltmeter and switching circuit, a balanced amplifier and vacuum tube voltmeter combination is used in the Z-Angle meter for comparing the two voltage drops, providing considerable improvement as to the ease, accuracy and rapidity with which a balance may be obtained. It provides

Fig. 12—Simplied diagram showing balanced amplifier and rectifier assembly used in Z-Angle meter for impedance measurement. Fig. 13—Simplified diagram showing method of phase angle measurement used in Z-Angle meter



a null balancing method rather than comparing two voltages by alternately impressing them on an indicating meter. The circuit used for impedance measurements is shown schematically in Fig. 12.

The isolating transformer serves to isolate the measuring circuit from the oscillator, and the balanced amplifier, rectifier and vacuum tube voltmeter combined indicate the impedance balance by comparing the algebraic sum of the rectified voltages from the balanced amplifier. The vacuum tube voltmeter is designed to indicate a balance at midscale, and meter deflections on either side of the balance point indicate the direction of the unbalance. This not only increases the ease of operation but provides for production test applications a direct indication of whether the unknown is "High" or "Low".

The magnitude of the deflection indicates the amount of unbalance, and if desired a special percentage deviation scale may be used, the range of which may be used without the necessity of special adjustments over the entire frequency and impedance range of the instrument. The percentage deviation range of the meter is approximately from —30 to +20% with essentially uniform subdivisions. With production applications in mind, it is interesting to compare the production testing features of this circuit with the performance of conventional ac bridges and null detectors, the latter varying widely in sensitivity with bridge setting and providing no direct indication of direction of deviation.

The impedance balance is accomplished by the adjustment of a single dial, which not only simplifies the balancing procedure but makes impossible a condition of "sliding balance" which is frequently encountered when measuring a low Q inductor or capacitor with an ac bridge.

### *Direct indication*

The phase angle, storage coefficient Q or dissipation factor D is read directly on the meter by simply altering the circuit with the switches provided, so that the rectifier and vacuum tube voltmeter respond to the vector sum of the voltages appearing across the output of the balanced amplifier. The vector sum of these voltages is a measure of the relative phase difference between the voltage across the standard and the voltage across the unknown when the same current is passed through both. The circuit as arranged for phase angle measurements is as shown in Fig. 13.

A measure of the vector sum of the outputs of the balanced amplifier is accomplished by connecting the plate load resistors ($R_1$ and $R_2$) in parallel and impressing the resulting voltage across the rectifier and vacuum tube voltmeter combination. The magnitude of the voltages across $R_s$ and $Z_x$ are equal because such is the requirement for the impedance balance which is always made prior to the phase angle measurement. Fig. 14 shows the operation of the circuit on a vector diagram. When $Z_x$ is a pure resistance and when the voltages appearing across the grids and plates to ac ground are 180° out of phase with each other and the resultant voltage is zero, hence no deflection is obtained on the phase angle meter. With either a pure inductive or capacitive reactance as $Z_x$, the phase difference betwen the voltages appearing on the plates and grids are 90° out of phase and a resulting voltage which produces full scale meter deflection is obtained.

When measuring a network having unknown characteristics, it is also necessary to know the sign of the phase angle, that is, whether the impedance is made up of inductive or capacitive reactance. This is done by shunting a capacitor across the standard resistor so as to produce a shift of known direction in $E_{r_s}$ vector, which will produce a change in the magnitude of the resultant $E\theta$ vector hence a change in phase angle meter deflection (Fig. 15).

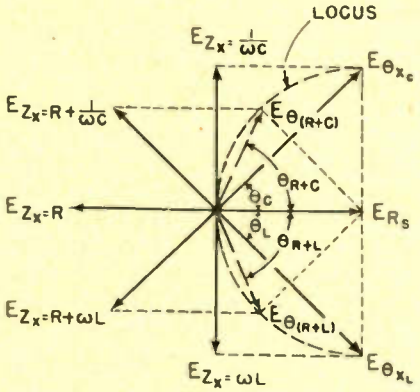



Fig. 14—Locus of vector sum of voltages producing phase angle readings as Z varies from pure R to pure + or — reactance, the latter two producing 90° or full scale meter reading. Impedance balance which precedes phase angle measurements insures equal magnitude of all impedance and resistance voltage vectors

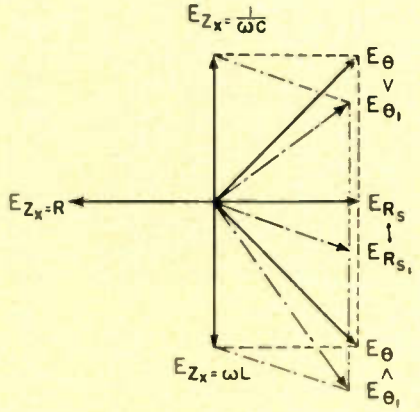


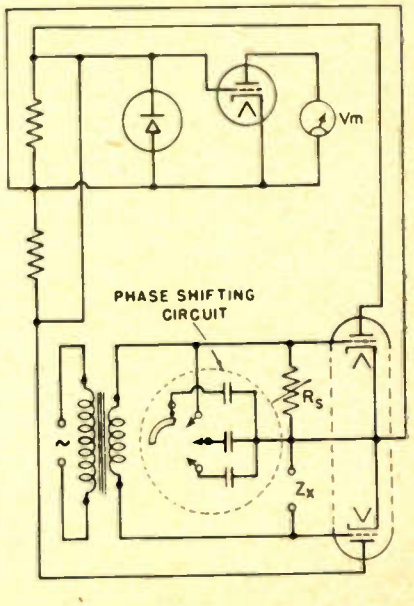

Fig. 15—Method of determining the sign of the phase angle

### *Reactance check*

The shift in the $E_{r_s}$ vector to $E_{r_{s1}}$ produces a change in the magnitude of the resultant vectors, an increase when measuring an impedance with inductive impedance and a decrease when measuring a capacitive impedance. The effect of this is an upswing of the meter pointer when depressing the "reactance check" button for (+) inductive impedance and a downswing for (—) capacitive impedance.

Because of the instrument's wide impedance and frequency range, three capacitors of different magnitudes are actually used in the instrument for this purpose and are connected into the circuit one after the other by means of a special low capacity push-button switch. Fig. 16, which is the same as Fig. 13 with the addition of this phase shifting circuit, shows schematically the circuit with which the indication of phase angle sign is obtained.

Fig. 16—Manner of selectively including capacitors of three values



# ELECTRONIC FORUM

***Second National Conference divides attention of engineers between instrumentation, wave propagation and industrial uses***

● The program of the second National Electronics Conference held in Chicago at the Edgewater Beach Hotel, September 25 to 28, again drew a nationwide audience. This heavily-attended forum on electronic research, development and application brought out much discussion on all phases of the art. Its appeal was not only to the technically-minded electronic engineer engaged in apparatus and circuit development but also to the engineering executives responsible for guidance and future decisions in their fields.

The Conference was under the guidance of a joint committee sponsored by the Illinois Inst. of Tech., Northwestern Univ. and the U. of Illinois and the local sections of the IRE and the AIEE with cooperation from the Chicago Technical Societies Council.

The forum was opened by an address "Electronics of the Future" by Dr. E. V. Condon (Director, Natl. Bu. Stan.) calling attention to the major fields of industrial activity where electronic methods provide the fundamental principles: radar, loran, television, HF heating, instrumentation and control, mathematical computing devices, mass spectrometers, and new approaches to the study of many new physical phenomena. His review of accomplishments in these fields disclosed that some of these "sidelines" of tube application, are developing to such an extent that they are even now taking a place along the older, mature branches of the electronic art: communication, power rectification and heavy-current control systems. His talk also made it evident that the newer electronic applications are standing on their own feet, with all phases from fundamental research to final installation of the equipment being handled.

During most of the four technical sessions, five groups of papers were presented simultaneously. The subject of electronic instrumentation was accorded three sessions, television and wave propagation, each two sessions, while the subjects of infrared and microwave systems, spectroscopy and medical uses, industrial applications, air navigation systems, theoretical developments, HF heating, radio relay systems, FM, recording, microwave generators, mobile radio communication methods and nuclear physics occupied one session each, with from three to five papers per session.

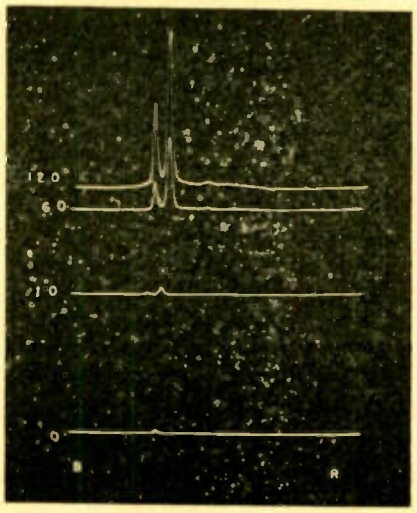



Fig. 2—Spectral analysis of mercury arc lamp after burning 10, 60 and 120 sec.

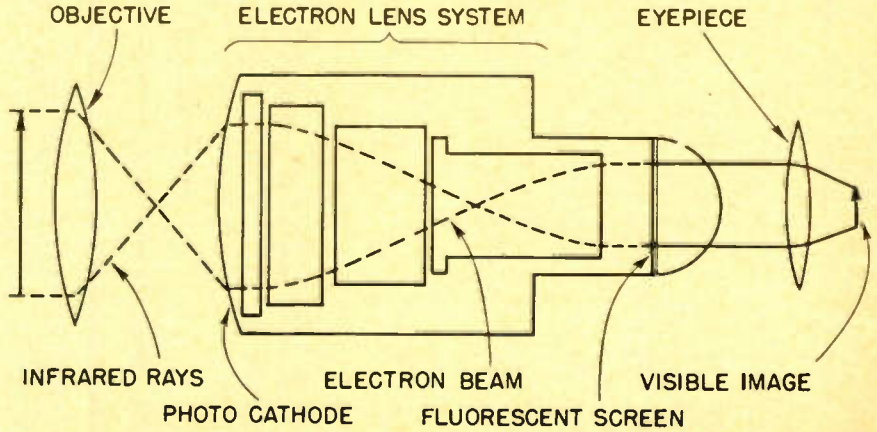
It is not feasible in this brief review to cover all the individual papers, even those highlighted by an unusually large attendance, but a few general notes on random papers will indicate the scope of the program (which, by the way, will be completely covered in the Conference Committees' own Proceedings).

During the session on infrared communication systems, details of war developments were described by W. S. Huxford, for modulating the "light" beam by mechanical optical and electronic methods. The systems of signal modulation of light—flux density changes (intensity), polarization variations, and frequency (color) changes were compared. Following this, methods for detecting optically-transmitted communication signals were described by R. J. Cashman. The infrared-sensitive compounds of thallous sulfide and lead sulfide in special cells were found particularly useful. Models of American and German infrared signalling equipment were demonstrated. Many of these used some variation of the principle shown in Fig. 1.

### *Recording spectrograph*

A cathode ray spectrograph was described by Feldt and Berkley (DuMont), which produces complete spectral distribution curves of an illumination source (or similar tests) at the rate of 250 complete spectra per second. The spectrogram is presented on a cathode-ray tube, as shown in Fig. 2. Here the intensity of a mercury arc lamp is shown just after the current

Fig. 1—Basic principle upon which many models of infrared signalling equipment is arranged



# COVERS WIDE FIELD

was turned on (lower curve) and after burning for 10, 60 and 120 seconds after the start (as indicated). The blue and red ends of the spectrum are indicated at the bottom. Continuous recording is possible.

Among the interesting new devices disclosed in the television field, the electrostatic Image Dissector described by Salinger (Farnsworth) showed the use of electrostatic rather than magnetic deflection for scanning (retaining magnetic field focusing, however), in a new form of dissector tube, Fig. 3. The scanning generators are connected by means of a voltage distribution bridge circuit to a circular disposed group of wires (12 in the present tube) inside the tube (only two of which are shown in Fig. 3). The two scanning voltages are applied in different proportions to these wires. The bridge circuit used (Fig. 4) has the connection points to the 12 wires in the "squirrel cage" indicated by numbers.

### *Microwave heating*

Future possibilities of using microwaves in high frequency heating were imaginatively handled by T. P. Kinn and J. Marcum (Westinghouse). Such possible schemes as the passing of bundles of textile filaments continuously through the center of a waveguide carrying microwave power were illustrated by simple drawings designed to stimulate the imagination. One scheme of particular interest for use in a tire factory was a design for curing automobile tires by rotating them inside a large waveguide. Before any of these schemes actually can be used, the development of sufficiently powerful sources at microwave frequencies must be an accomplished fact.

Seven months' intensive exploration of transmission characteristics in the high frequency television band has shown the validity of the selection of these frequencies for this service, according to W. B. Lodge (CBS). He commented on the problem that field intensity contour maps do not reflect the wide variations in signal with frequencies above 30 mc which may occur at times within a relatively few feet. To this end, a new system of obtaining field data and of analyzing and projecting this data so as to provide a quantitative measure of service rendered is being developed and tested.

The use of powdered iron in television deflecting circuits was described by A. W. Friend (RCA-Victor), wherein the problem of the horizontal deflection of electron beams in television systems

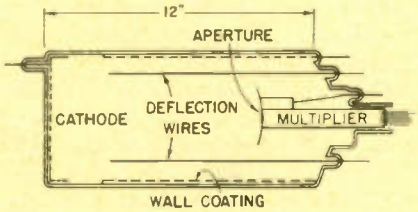



Fig. 3—New form of dissector tube

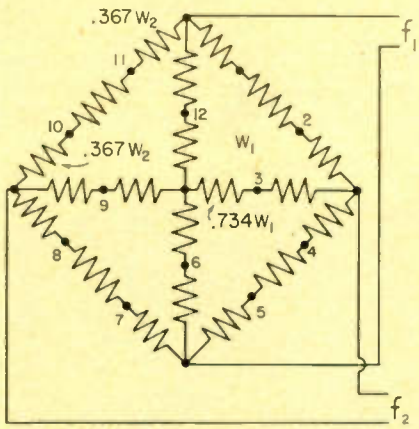



Fig. 4—Voltage distribution network used with new electrostatic image dissector tube

has been aided by the use of transformer and yoke cores molded from powdered iron materials especially compounded for these applications. Low cost materials (special sponge iron) have been developed to produce effective ac permeabilities of between 40 and 250.

### *Selective attenuation*

A demonstration and description of a new system for the reduction of background noise in the reproduction of music from records was given by H. H. Scott (Technology Instruments). By the use of "gate circuits" a system is achieved which is selective with respect to the type of applied signal and consequently tends to automatically attenuate the frequency response characteristics in accordance with certain types of signals while reproducing other types without substantial modification. A system was developed which will transmit with a high degree of fidelity those types of signals normally encountered in vocal and orchestral music, while at the same time discriminating against the usual types of background noise such as needle scratch and motor rumble. This system maintains a balanced dynamic range between lows and highs as was evidenced during demonstrations.

A new concept of the basic theory of the design of television viewing tubes was presented by R. G. E. Hutter (Sylvania Electric Products). This paper disclosed a new mathematical approach to the design of improved electron optical systems for controlling the quality of television images, providing a more complete and useful basis for cathode ray tube design by the elimination of these cut-and-try methods and the reduction of error. The new theory follows the shorter iconal method. Two experimental aids were used, an electrolytic tank and a magnetic field measuring device, to determine the important field design factors needed.

### *Radioactivity in diagnosis*

A valuable application of nuclear physics research deals with the use of radioactive materials in clinical diagnosis and medical therapy, the subject of a paper by J. T. Wilson (Allis Chalmers). It was shown how it is possible to induce artificial radioactivity by means of bombardment with neutrons, alpha particles, protons, and gamma radiation. The use of carbon$^{14}$ and hydrogen$^{3}$ is important in tracer work. The use of such radioactive materials in medical therapy in the clinics of several of our leading medical research institutions was summarized, such as the use of radio-phosphorus and radio-iodine for clinical diagnosis and biological tracer applications.

New laboratory problems connected with communication and industry developments have started new trends in cathode-ray oscillograph design according to the paper by W. L. Gaines (Bell Tel. Labs.). Modern testing requires readily accessible attenuators, delay networks and amplifiers that

(*Continued on page* 111)

# SATURABLE REACTORS

**By W. D. COCKRELL,**
Industrial Engineering Division
General Electric Co., Schenectady, N. Y.

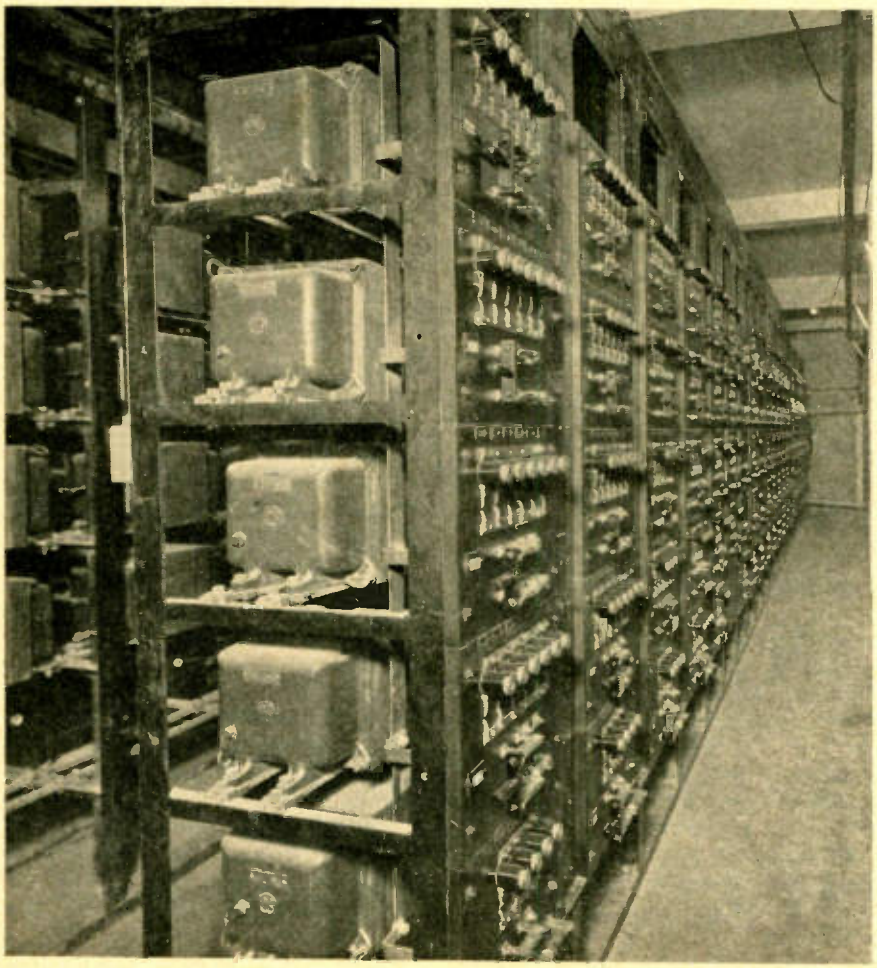
***The theory, application and selection of power control reactors utilizing magnetic saturation effects***

● The usual method of controlling either dc or ac power, putting a rheostat in series with the load, is fairly satisfactory but incurs a considerable loss of energy in heat. In the case of ac, the rheostat may be replaced by a variable reactance with greatly increased efficiency. At power frequencies, for practical reasons, this reactance is almost always inductive. Wattage losses are minimized, although the power factor of the circuit may be lowered.

The effect of a variable inductive reactor may be changed in a number of ways, as in Fig. 1: A, by mechanical motion in altering the position of an iron core in a solenoid, (which, because of the rapidly changing magnetic structure, is apt to be quite noisy) or in B, the inductance is adjusted by altering the number of turns on a coil by steps, giving a non-continuous adjustment. Also, when large amounts of power are to be controlled, heavy currents must be made and broken and the contactor required becomes expensive and its maintenance must be considered. The two coil reactor, shown at C provides interesting possibilities. It is simply a transformer in which the reactive or resistive load in the secondary reflects back an impedance into the primary circuits. One form of seam welding control uses high voltage thyratrons to short-circuit the secondary winding, thereby switching a high current flow in the primary circuit.

Another form of double coil reactor is called a saturable reactor. As the flux in an iron core increases past a certain point, called the "saturation point", the iron becomes less and less efficient, until, for extreme magnetic overload, the iron is no more effective than the air it replaced.

Fig. 5—A large bank of saturable reactors in a theatre-lighting installation



### *Permeability curve*

If we look at a curve of the ability of the iron to store energy (which we call the "permeability curve") (Fig. 8) against the magnetizing effect, we find that it first rises very fast and then bends over with a rather sharp knee at the point of saturation. From this point on the efficiency falls off quite rapidly.

Normally, iron-core reactors are designed so that they will always operate below the knee of the magnetization curve in the unsaturated portion. By shifting the operation point from the low end to the part of the curve above the knee, the inductive effect will be much smaller, and hence the current will be proportionally larger. This is done electrically, by "preloading" the magnetic field path by a coil supplied with direct current which establishes continuous unidirectional flux in the core. After the core has been preloaded, that is, the energy has been transferred from the electric to the magnetic form, it may be maintained with very little loss, limited mostly to the resistance loss in the dc coil.

# for AUTOMATIC CONTROL

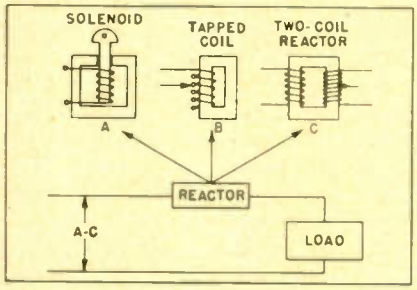



Fig. 1—Variable inductive reactors

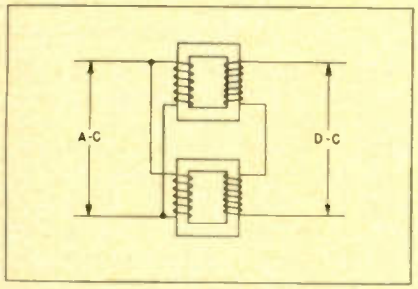



Fig. 2—Two reactor units in a balanced circuit

But when the ac energy is superimposed it finds that the magnetic path already is saturated and hence is much less efficient in inducing a voltage to hold back the current flow. Thus a larger alternating current is permitted to flow to the controlled load.

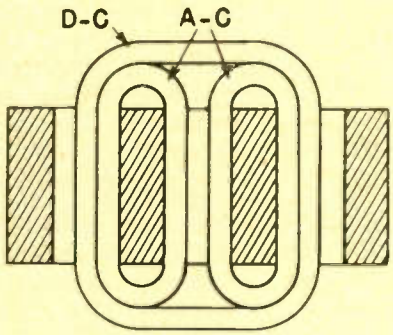
This is a simple principle upon which the saturable reactor works. We simply preload the magnetic path with a dc flux so that the superimposed ac will find its path already saturated and will have less impedance to its flow. By regulating the dc, we thus regulate the ac power flow to the connected load.*

### *Reactor Principles*

In its simplest form, a saturable reactor is composed of a closed iron core, on one side of which is wound the ac winding, and on the other side is the winding carrying the dc for saturation. This is a workable device and has been used, but it has one very obvious disadvantage. We have here, in effect, an ac transformer, with, as is usually the case, many more turns on the dc winding than on the ac winding. A very high ac voltage will be induced in the dc winding. Since it is the direct current only that determines the preloading or saturation, we might ignore this induced ac voltage and hold the direct current flow constant by means of an external inductance in the dc circuit. But the dc winding and external inductance must be insulated for the high voltage.

Another solution might be to place a large capacitor across the dc winding terminals. Furthermore, we must saturate the iron core sufficiently to prevent even the maximum reverse alternating current from demagnetizing it.

But rather than go to these extremes, it has been found much more desirable to split either the ac or dc coil into two parts in order that this transformer action will be balanced and cancelled. One way to do this is to provide two complete transformer units so that the ac windings are acting together and the dc windings are opposed as in Fig. 2. In this way, although the high voltages appear across the individual dc coils, the outgoing terminals should show no ac voltage. This type of construction makes possible the use of some of the new oriented-grain magnetic material such as cold rolled silicon steel, and is used to some extent at the present time. The maximum voltage present may be reduced by splitting the dc coils into sections and balancing the individual sections.



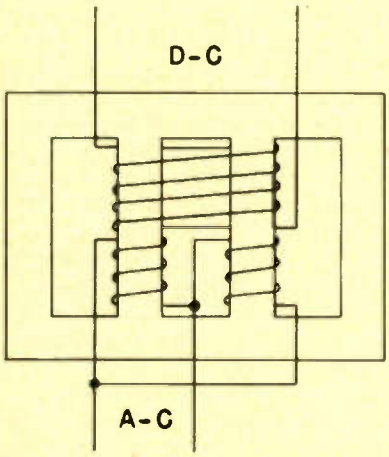




Fig. 4—The four-legged core saturable reactor

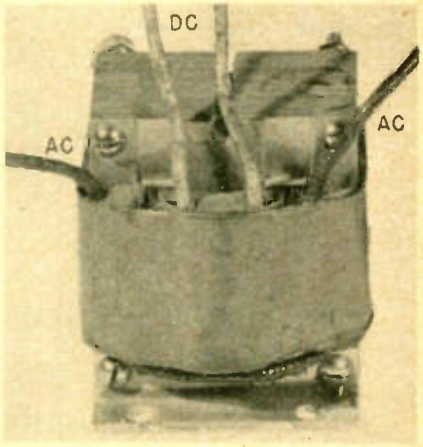



Fig. 3—The three-legged core saturable reactor

However, the solution which many find to be more desirable is that of balancing the magnetic forces rather than balancing the electrical forces. This is done by the correct design of the magnetic paths and the proper relation of the ac and dc coils to them. Let us consider first the simple form of three-legged reactor which can be built on standard transformer punchings. In this form, the ac winding is split into two parts and is placed on the outside legs whereas the dc winding encloses the center leg. Fig. 3 shows a small three-legged unit.

### *Control method*

Here the alternating current flowing in one coil at any instant produces a magnetic effect which tends to drive a flux around the outside path in the same direction as the second ac coil. However, in the center leg the magnetizing effects of the two ac coils are opposed and hence no transformer action can take place in the dc coil.

When the dc winding is energized, its constant flux flows through the center leg, out and down through each of the outside legs, and returns again to the center. When the ac flux is now superimposed on this dc flux, it finds the path saturated and the impedance low.

*The quantitative design of a saturable reactor has been covered by H. Holubow in the March 1945 issue of Electronic Industries.

Since the ac flux path through the iron core is now not much better than that through air, much of the ac magnetic flux is spread into the air outside of the core and hence we have considerable stray flux. The effect of this stray flux

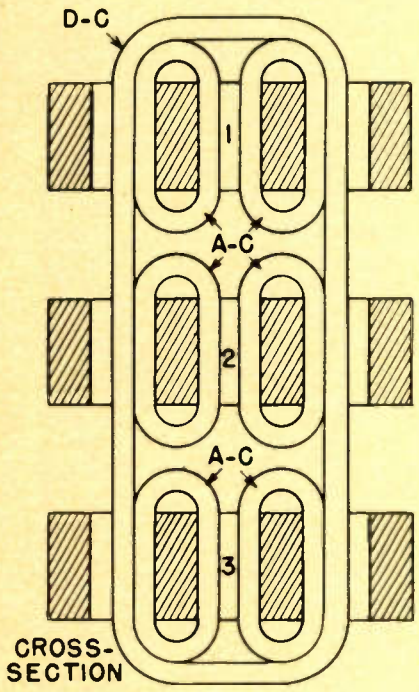



Fig. 6—A three-phase unit saturable reactor

on neighboring circuits is one of the disadvantages of this type of reactor.

The 4-legged reactor, as seen in Fig. 4, has ac coils wound on the two center legs and the dc coil wound over both. This makes a very efficient form of reactor since the ac and dc leakage magnetic flux is kept to a minimum. Also, the outside legs act as a magnetic shield for the device and there is very little stray field outside of the unit, thus making it possible to install a number of such reactors in a small space without interference. This is quite often necessary in large installations, such as might be required for multiple laboratory furnaces, a bank of process motors, or the many lighting circuits required in a theatre-lighting installation, such as Fig. 5.

Practically all of the power-type saturable reactors from ½ kva up to 75 kva rating are built with the four-legged construction.

### *Three-phase reactors*

If an application of saturable reactors to three-phase power load is required, three separate reactors can be used with the dc windings in series, or a composite reactor may be constructed, using three sets of cores and ac windings and with a single elongated dc winding surrounding all three cores. A cross-section of this type is shown in Fig. 6.

The question whether the halves into which the windings have been divided should be connected in series or in parallel also deserves serious attention. In those systems which use the divided dc winding, the halves must be connected in series, for in a parallel connection of the dc windings the induced ac voltage would be additive, and the heavy short-circuit currents flowing would neutralize the magnetic effect. On the other hand, in the ac winding we do have the choice of whether the halves will be connected in series or in parallel. The two types of connections are shown in Fig. 7.

With the series connection arrangement the ac voltage must be applied to force the current through both the series coils. If we assume the dc saturation to be equal to that of the peak ac magnetic flux, it will be seen that for one coil the ac flux will add and thus find a saturated condition, but in the other coil the ac flux will subtract from the dc and hence will find an unsaturated path and high impedance.

The reverse is true when the ac voltage reverses. Thus, for each half wave, when the dc saturation is equal to the ac value, we have still one half of the impedance remaining. If we are to rid ourselves of this remaining impedance, we must apply double the amount of dc to obtain a saturation which cannot be neutralized even by the maximum ac reverse current. So, for a series ac winding approximately twice the dc ampere turns are needed for the full saturation effect.

Let us next consider the action of the parallel ac windings. Here when the dc presaturation flux is equal to the peak ac value, we find that one path will now have low reactance as the ac flux is superimposed and most of the alternating current for this half wave will tend to flow through this half of the ac winding. On the other half cycle, the other ac winding is saturated. When the dc is removed, we again have the full reactance of each winding and the alternating current is held to its minimum value.

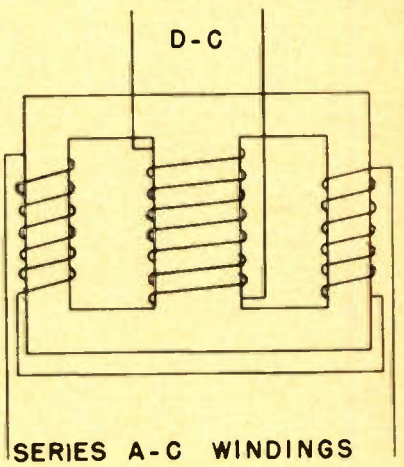
Under unsaturated conditions, coils in parallel, with a lower reactance will now handle twice the current so that the kva and the dc power required for saturation are unchanged. We have exchanged unsaturated reactive impedance for a larger current rating. When the ac coils are in parallel, they form a closed-circuit loop which tends to trap some of the magnetic energy when a change in saturation is desired. This slows down the control action of the reactor.

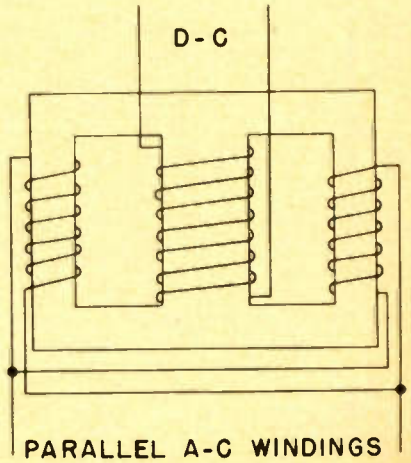
To sum up: for control operation where small power is involved, and maximum speed of action is desired, the series ac connection is often found; however, for large power installations where the currents are greater and the required impedances are lower, the parallel ac windings are most often used.

### *Reactor operation*

Perhaps we can understand the operation of the saturable reactor best by reviewing Fig. 8, a magnetizing curve for the core material. Although only one side of the complete magnetizing curve is shown, the reactor is so built that the action is always symmetrical and both halves of the ac wave are treated exactly alike. With no saturation, the reactor is designed to

Fig. 7—The three-legged saturable reactor



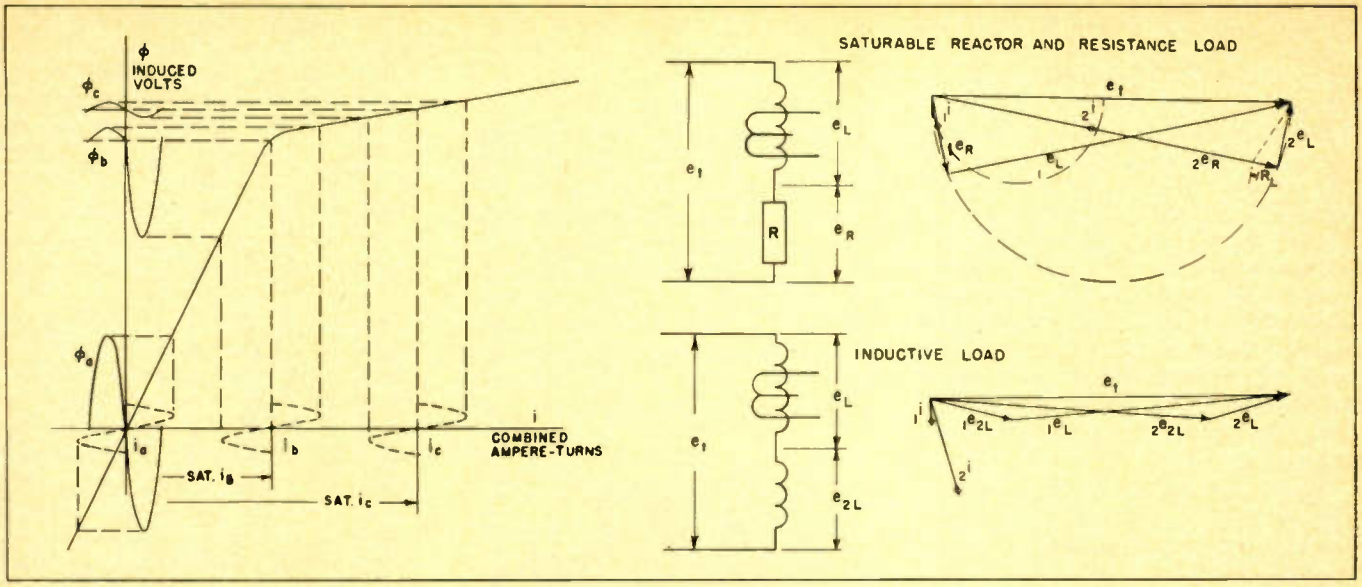



Fig. 8—The effect of close saturation

Fig. 9—The vector relations for a resistance load and an inductive load

work within its saturation region and thus operates as any other iron-core reactor, as in condition A. If a sine-wave alternating current flows, a sine-wave ac voltage is induced.

At the other extreme, at C, if the reactor is fully saturated, the ac voltage is again associated with a fairly smooth sine-shaped alternating-current wave of much larger magnitude. However, it is in the midrange condition where the combination of ac and dc flux move on both sides of the saturation knee that the most interesting results are obtained. The shape of the current wave here may look quite odd but it is easily worked out by a step-by-step method, remembering always that as the saturation increases, the current for a given voltage will be larger.

It can be seen that the current through the load and through the reactor has a very pronounced third harmonic. This distorted wave shape at midrange is a very important factor in determining whether a saturable reactor will be suitable for a particular application.

The actual shape of the wave and the percentage of third harmonic depends much on the steepness of the magnetization curve, the sharpness of the knee, core hysteresis effect, and on the characteristics of the connected load. Capacitors and other forms of filtering on the input side may be used to minimize the third harmonic which might otherwise be fed back into the power supply.

The commonest load controlled by a saturable reactor is a resistive load such as a heating element or incandescent lamp. An inductance, instead of absorbing energy, permits current to flow out of phase with the applied voltage or, as we say, with a 90-deg lagging power factor. If it is connected in series with the resistive load, which absorbs the electric energy directly as heat and thus consumes a current in phase with the voltage across it, we find that the voltage across the reactor cannot be subtracted directly from the supply voltage, but must be done vectorially as in Fig. 9. The path of two vectors at 90 deg with each other appears as a semicircle with the supply voltage as the diameter. This permits us to see at a glance the practical range over which the load can be controlled.

### *Reactor drop*

To obtain full voltage across the load, it would be necessary to have zero voltage across the reactor. This is obviously impossible, but if we will content ourselves with 95% of the total voltage across the resistance load, we see that we do not need to limit our reactor drop to 5%, but to the vectorial quantity which is 31% of the applied voltage. This is quite easy to obtain. However, we must not forget that there is also a small resistance loss within the ac winding of the reactor, and this too must be subtracted from our load voltage.

On the other hand, at the low-current end, if we attempt to cut the input voltage to the load down to 10%, it is necessary to increase the impedance of the reactor to hold back a voltage equal to 99% of the supply voltage. This is more difficult to do.

The load considered here was the resistive type in which the electric energy was changed to heat, or, perhaps, absorbed in some chemical process or in a rectifier. Sometimes, however, we wish to use the saturable reactor to supply power to a fairly high inductive load such as a motor or an ac magnet. In this case it is necessary to add the voltage vectors almost in a straight line as shown in Fig. 9, and it is thus necessary either to be content with a smaller portion of the total voltage applied to the load or to design our reactor for greater saturation in order that its minimum impedance may be made smaller. For this reason, the control of an inductive load is not usually as efficient as the control of the resistive load described above.

A practical design of reactor will control the resistance load about as follows: With no saturation, about 8% of the line voltage will appear across the load. At full saturation, about 96% of the line voltage appears across the load. Under such conditions the power ratio, that is, the ratio of dc power necessary for excitation to the ac power controlled, ranges from 25 times at ½ kva (that is, 1/25th of 500 or 20 watts dc required for saturation) to a power ratio of 111 or 135 watts dc for a 15-kva reactor.

On the other hand, if the reactor can be designed so that only 90% of the voltage need appear across the load, only about 40% of this dc will be required for saturation and the power ratio goes up 2½ times. In other words, only 8 watts dc would be required for the ½-kva reactor.

When the reactor is unsaturated, the circuit current is low and although the power factor is also quite low, perhaps only 5%, the ad-

ditional lagging kva in the system is negligible. When the reactor is fully saturated, the largest current occurs but the power factor has now risen perhaps to 97% as the power is consumed by the resistance load. If the installation is large enough and a partial load is common, it may be desirable to compensate for some of the lagging power factor by the use of capacitors connected across the line. These capacitors also have the effect, as we mentioned previously, of preventing the higher harmonics from being fed back into the power supply.

Since, in addition to the dc winding losses, we have only the copper losses in the ac winding and some core losses due to the hysteresis in the iron, our efficiency is quite high. Even at 10% saturation it has risen to 85%, and at 20% saturation it is up to 95%. Above 40% saturation, the efficiency remains at approximately 98%.

In a similar manner, the power factor has risen to better than 50% with 20% saturation and is 85% at 40% saturation, rising to better than 95-97% for values greater than 60% saturation.

The physical size of a saturable reactor is comparable to a standard two-winding single-phase transformer of equivalent rating. For example, power reactors from ½ to 5 kva use a four-legged punching approximately 8 in. by 10 in. About 1 in. of stacking is required for each kva. A larger size punching, 11 in. by 14 in., used on the 5 to 30 kva sizes, uses about 1 in. of stacking for each 2 kva. Control reactors for tube grid circuits may be much smaller, as the one in Fig. 3.

### *Control element*

Larger sizes up to 75 kva usually are made from standard L and flat punchings. The largest size reactors, having parallel ac windings, may have a time constant of perhaps three seconds in response. They are used principally for the control of electric furnaces and other large thermal loads in which fast response is not necessary.

As a control element in electric or electronic circuits, the saturable reactor offers many advantages.

First, it provides control in an ac circuit by means of a direct current. Control in the opposite sense, that is, the control of dc from ac circuits is comparatively simple, since much of our dc power is obtained from ac by means of electronic or dry-plate rectifiers or motor-generator sets. But the saturable reactor is one of the few means by which an ac circuit can be controlled directly by dc.

Second, the saturable reactor provides a means of insulating the dc control from the ac circuit. In this respect it has the advantage over electronic circuits in which a dc voltage is used to change the tube grid bias. The insulation between control and power circuits often permits considerable savings over the extra components required in other types of control.

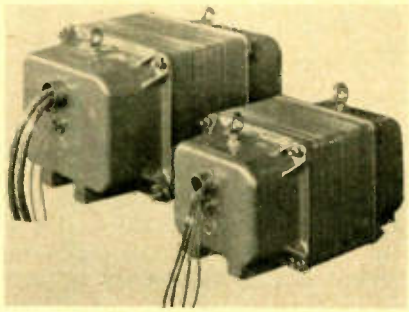


Fig. 10—Power saturable reactors

Third, since the control is through the magnetic path, we are able to vary the volts and amperes in both of our dc and ac circuits as desired so long as the proper power ratio is maintained.

Fourth, and perhaps most important of all, we are able to obtain a large power ratio or amplification between the dc used for control and the ac power which is controlled.

A possible form of control uses two saturable reactors with ac windings connected opposed so that the fundamental component of ac is balanced out and only the second harmonics left to be amplified as an indication of the dc saturating current. However, there are few of this type of control in commercial service. Perhaps the most widely known use of this type of operation is that of the "Flux-gate compass" and the "Magnesyn" form of remote-indicating equipment. These use the earth's magnetic field and that of a permanent magnet respectively for saturation.

Perhaps the simplest method for obtaining dc for saturation is by the use of dry-plate rectifiers operated from the ac bus. Since the power required is usually small, a resistance-type potentiometer may be used or one of the small autotransformers of the "Variac" type. In other cases, the necessary dc can often be obtained or rectified from the process to be controlled.

Saturable reactors have been made small enough and sensitive enough to be operated from such a dc source as thermocouples and blocking-layer photocells. But in attempting to operate the reactors from such small amounts of power, there are two important effects which may interfere with proper action. The first is the effect of stray fields, even the earth's magnetic field, which may cause false results at these low flux densities unless proper shielding and protection is provided. The second is the effect of residual magnetism present in all iron, and especially noticeable when low magnetizing forces are to be considered.

Saturable reactors are often used as the connecting link between a vacuum tube or pliotron amplifier and a thyratron output stage. For such service the small receiving-type tubes are quite capable of supplying the required dc saturation current. Since the interelectrode space within the tube acts as a high resistance, the dc circuit has fast response. This is especially true for pentode tubes which have an extremely high effective resistance for changes in current. In these circuits, it is sometimes necessary to supply a protective resistance or Thyrite in parallel with the dc coil to prevent damage due to rapid energy release.

A simple form of pliotron excitation is that of Fig. 14, which shows the circuit used with photoelectric input for controlling a fractional-horsepower motor which winds wire at a constant tension.

In Fig. 15 two pilotrons in a cathode-follower, or "long-tailed-pair" circuit, are used with two saturable

Fig. 12—A circuit for indicating lights

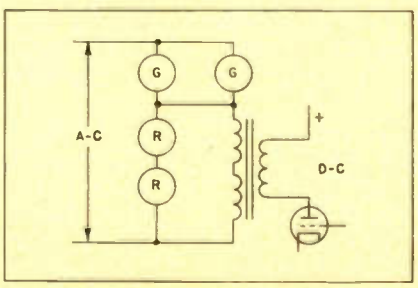
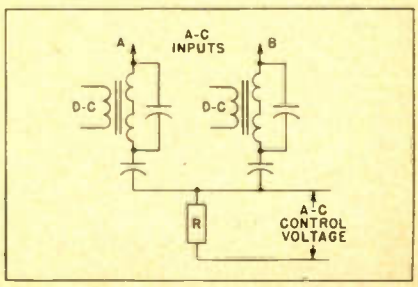



Fig. 13—Multiple feed to a common pilot



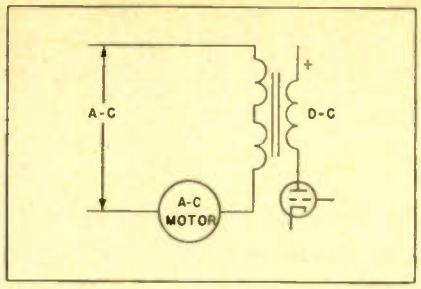



Fig. 14—Simple vacuum tube and saturable reactor control of fractional-hp motor

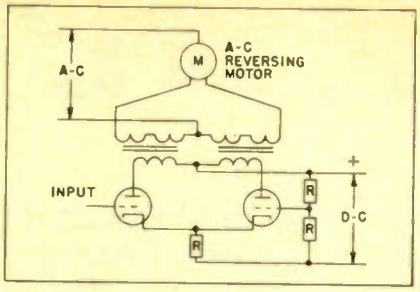



Fig. 15—The "long-tailed pair" and two reactors for reversing motor control

reactors to provide reversing control in a simple servo or follow-up control.

First let us consider those systems in which the saturable reactor forms a part of the control chain and does not itself control the output power or in which the output from the saturable-reactor circuit network is only a few watts.

One of the simplest saturable-reactor circuits is that shown in Fig. 12, which has been used for the operation of tuning-indicator lights on radios. It consists essentially of two red lamps in series and two green lamps in parallel with a saturable reactor in parallel with the red lamps. When the reactor is unsaturated, the major part of the applied voltage appears across the red lamps, lighting them brilliantly. However, as the reactor is saturated by current from the circuit, the red lamps are shunted by the low reactor impedance and the green lamps are lit. This is a possible indicating circuit for many processes which vary with the dc power signals.

In large theatre-lighting installations, it is often desirable to fade smoothly the lighting effects from one scene into another. In addition, in some installations as many as five scenes can be preset in advance, then selected and brought forth smoothly by fading. A circuit to do this is shown in Fig. 13. The voltage across the common resistor R is the reference or pilot voltage which determines the light intensity of one circuit. The control power is fed to this resistor from each of the reactors in turn as it is saturated. Although the reactor impedance in the saturated and unsaturated conditions may have a ratio of as much as 20 or 30 to 1, this ratio may be increased many times by the proper use of series and parallel resonance between the reactor impedance and that of series and parallel capacitors.

This same system is, of course, applicable to other forms of control in which the output must be blended smoothly from a number of different control points.

### *Regenerative reactors*

Although the power ratio between the controlling dc and the ac power is large, even greater ratios can be obtained by rectifying a small amount of the ac output and connecting it in parallel with the dc control power. By careful adjustment of this feedback power, most of the dc required for saturation can be supplied in this manner, and the control dc circuit then needs supply only the small remainder. Or in some cases, more-than-sufficient dc can be supplied so that a "lock-in" action takes place.

Once a small amount of saturation power has been applied to the

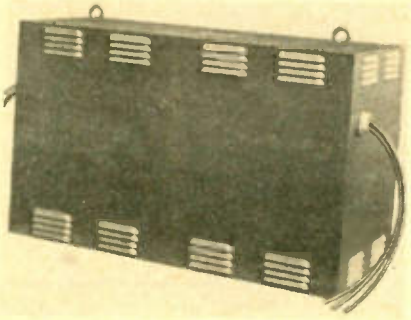


Fig. 11—Larger saturable reactor up to 75 kva

dc control winding, the process continues on to full saturation due to the dc feedback. In this case, in order to reverse the action, the control dc must be reversed so that its magnetizing action opposes that of the feedback and thus starts the desaturating cycle. This circuit provides a very definite snapaction which may be desirable for large magnets and contactors. For example, for large contactors, control power would be needed only when the contactor is being picked up or dropped out.

In conclusion, a saturable reactor provides a wide range of control with smooth adjustment over the entire range. It is very efficient even at light loads. It is a compact, sturdy unit having no moving parts to wear and making no more noise than the ordinary single-phase transformer. The voltage drop in the reactor at full saturation can be made small, permitting 95% or more of the voltage to be applied to the load.

The dc control power required is small and can be obtained from any reasonable combination of current and voltage as available. The control current can readily be obtained from tube amplifiers. The control and power circuits are electrically separate. Finally because of the efficient operation of both the reactor and the small amount of control power needed, both the control and power elements are quite small and easily located.

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# THE BLOCK SYSTEM

***Modeled on railroad block signalling practice, system using interrogation and reply pulse technics promises to provide automatic safety on airways***

• Airlines are threatened with choking on their own speed! Flying 3 to 7 miles per minute, planes not only need lots of elbow room, but need some automatic danger indication even along their normal travel routes to keep from colliding. And it must be remembered that collisions are possible from six directions in a cubic medium!

An interesting development promising to solve this problem is the block system of control proposed by the General Railway Signal Co. and based on principles of railway block control.

In brief, the idea is to set up on the ground interrogator controllers at intervals along an airway beacon. These can be located anywhere and their distance apart can be regulated by the traffic density along the route. Each ground station blocks out for itself a cylinder possibly 30 miles in diameter and of unlimited height. It proceeds to send out pulses to interrogate any airplane within this cylinder and to obtain a response which it records (Fig. 1). During the entire time the airplane is in this cylindrical block its movement and altitude are known and recorded by the ground station and any other airplane, provided it is properly equipped, would receive a danger signal if it attempted to fly into the same block at the same altitude.

### *Pulses used*

As in television technic, the ground station sends out first a synchronizing pulse. After an interval of 1,000 microseconds the first interrogation pulse is sent out. This pulse is designed to interrogate airplanes at the 1,000 ft. level. After another 1,000 microseconds the second pulse is sent out to interrogate planes at the 2,000-ft. level. This process is repeated for as many altitudes as desired, say 16, so that an entire interrogation sequence for up to 16,000 feet takes place in 18,000 microseconds and then repeats (Fig. 2).

The airplane is equipped with a transponder controlled by an altimeter. If the plane is at 1,000 feet, the altimeter regulates the transponder so that it will be operative only for pulses received more than 1,000 but less than 2,000 microseconds after the synchronizing pulse. Thus at the 1,000-ft. altitude the plane will only give responses to the first interrogation pulse.

Likewise the ground station receiver which gathers in the replies from the airplanes is equipped with a gate circuit which opens after the interrogation pulse and closes after a predetermined time so that planes too distant will not be heard. For example if a 30-mile diameter block is being controlled, the gate would remain open for 161 microseconds, the time needed for a signal to travel out 15 miles, trigger the airplane transponder and be sent back to the ground station. Any signal received later than this would be coming from a more distant plane and would not affect the ground station receiving set.

It is obvious that the information obtained in this way must be properly organized and presented to the pilots of planes in the block, arriving and departing.

Suppose 3 adjacent blocks—A, B and C (Fig. 3). Assume planes in A and B. The fact that block C is unoccupied must be sent from the C to the B ground station

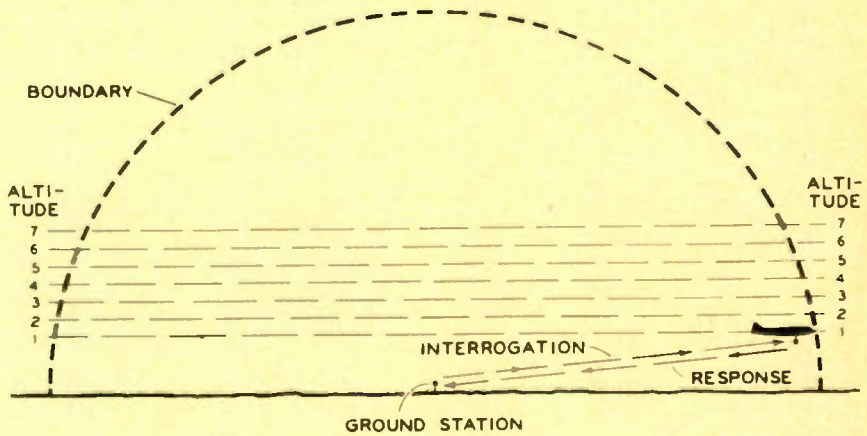
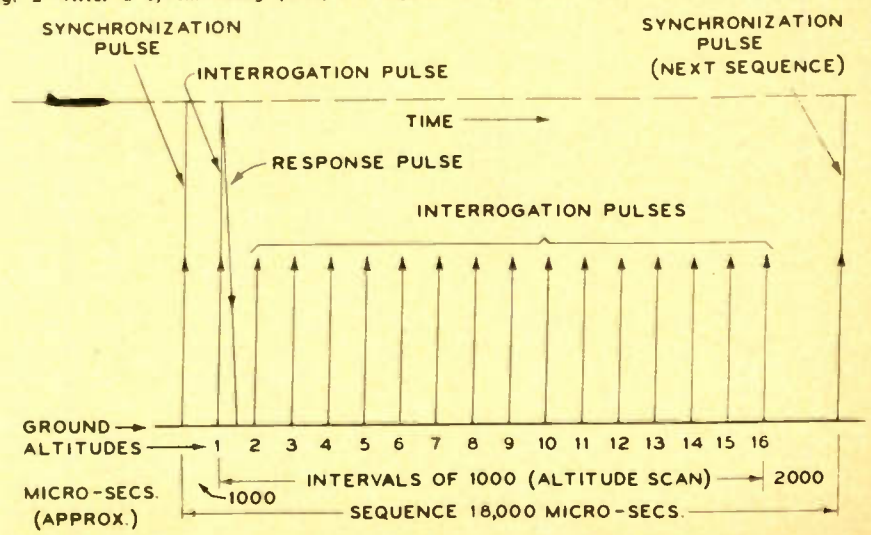



Fig. 1—Time sharing is used to interrogate planes by altitudes

Fig. 2—After a synchronizing pulse, interrogation pulses occur at 1000 microsecond intervals



# FOR AIRWAY CONTROL

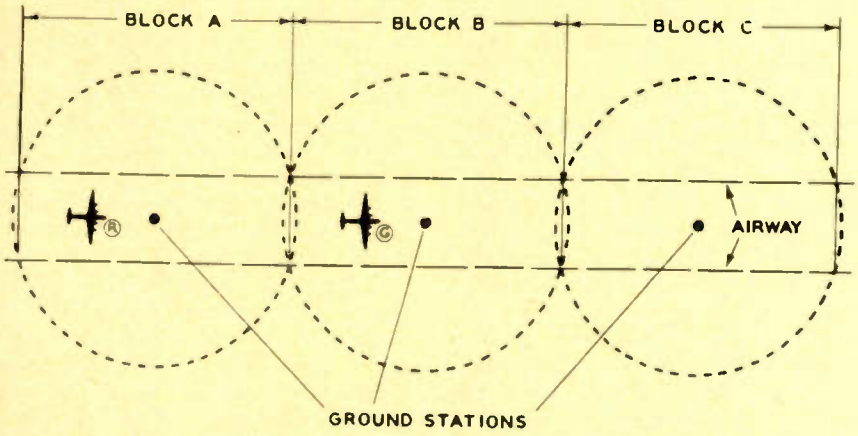



Fig. 3—Disposition of ground stations along an airway to create separate blocks

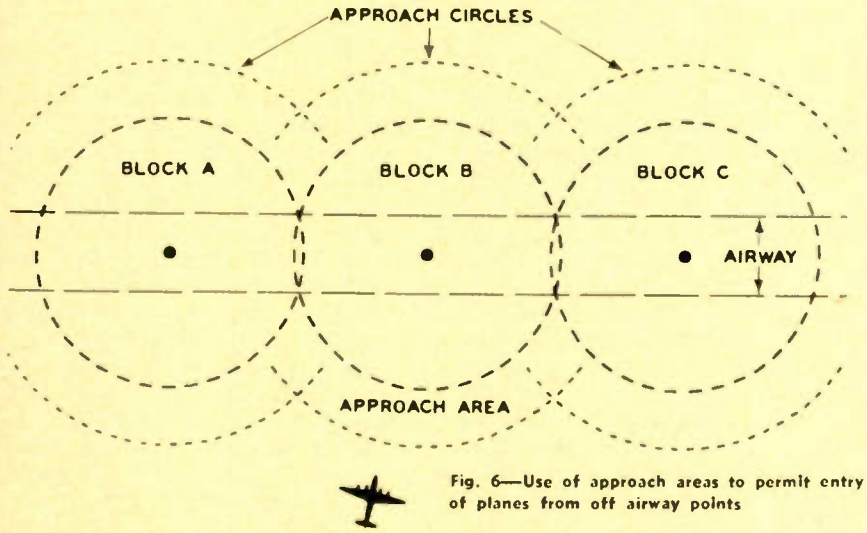



Fig. 6—Use of approach areas to permit entry of planes from off airway points

either by wire or radio link and transmitted from B to planes under its temporary control. Plane B will receive this information by means of a green light in the cockpit meaning "proceed". Plane A on the other hand will have a red signal because plane B is in the next consecutive block.

This system called "two indication signalling" may be extended to "three indication signalling" by providing for a yellow warning signal when an obstructing plane is still two blocks away.

In addition to providing clearance warning on a given level, it is necessary to have a scheme for clearance up and down when a plane wishes to ascend or descend. It is clear that if a plane in block B wishes to ascend from 5,000 to 6,000 feet, blocks A, B and C should all be clear at 6,000 feet (Fig. 4). This is because the plane may move upward entirely in block B or go into C. Furthermore another plane may be moving from A to B.

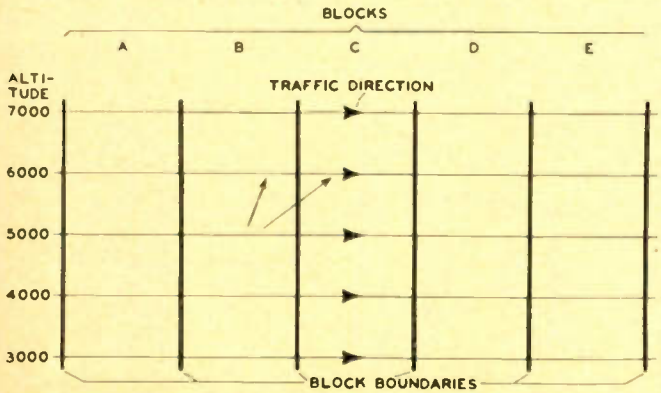
To find out the status of these blocks the pilot pushes a button and if all is clear receives a signal in the form of an illuminated green arrow marked "ascent" together with the green cruising signal. The system further provides that if Block C ahead is not clear either at 5,000 or 6,000 ft. the green arrow will show together with a red cruising signal. This indicates restricted ascent to be completed entirely in Block B. Furthermore the ground station reserves the B 6,000 ft. level for the plane in question by giving all other planes approaching that block and level a red signal. Movement of the ascending plane to the desired level automatically cancels this reserve signal. But if the ascending pilot changes his mind about climbing he can "cancel" his "reservation" by pushing a "cancel" button.

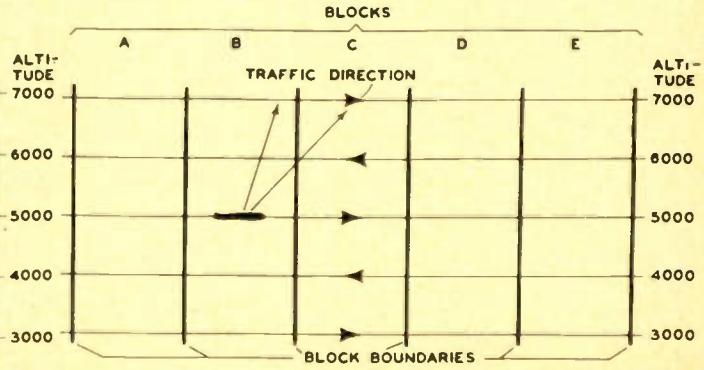
If alternate altitudes of an airway carry traffic in opposite directions the pilot would not wish to ascend to 6,000 ft. from 5,000 ft. but would go on to 7,000 ft. The principles of operation would be exactly similar, however, though more complicated as more altitudes would have to be explored (Fig. 5).

Furthermore the system lends itself to ground instructions to flying planes since an ascent or descent signal could be caused to appear to a designated pilot by ground control.

To provide for entry to the air-

Fig. 4—Clearances required for altitude change when traffic is all in one direction and, Fig. 5—when in 2 directions



way from the side an extended diameter cylindrical block is designated as an approach area (Fig. 6). As an approaching pilot flies toward a ground station, say B, he has displayed before him the condition of Blocks A and B by an ap-

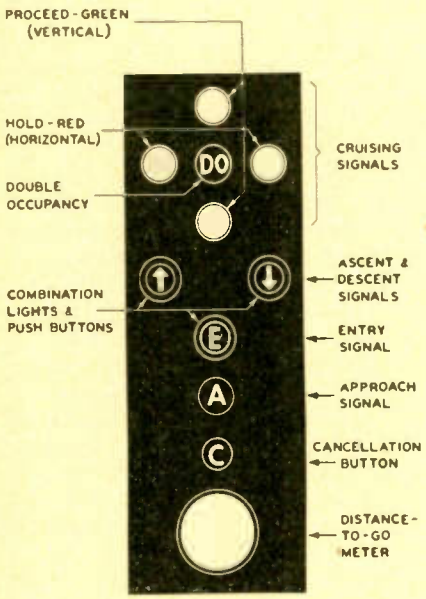



Fig. 7—The cockpit signal

proach signal. Of course he has to tune to the airway frequency to receive this. Should he wish to enter he pushes an entry button thereby requesting permission to enter. When he is in the approach area such request will be answered by a grant or a refusal as conditions warrant. Entry authorization locks out any other entry. The pilot may also "look at" other altitudes.

Now that the basic principles have been explained it is necessary to consider how to prevent confusion along an airway due to pulses from several ground stations being heard in one plane. This is done by having adjacent ground stations send out synchronizing pulses of different widths. Block A for example will have a short pulse, B a long one, C again a short one and so on. The pulse first received then, be it long or short, will control the plane signals, causing them to answer to the nearer ground station (Fig. 8).

### *Code signals*

Furthermore, since it is necessary to send instructions such as "Proceed", "Hold", "Ascent", "Descent", "Entry", "Double Occupancy" (of one block), it is advisable to form a code. This can be done by using four signal sequences each 18,000 microseconds long such as were described earlier to form a complete "Signal Cycle" 72,000 microseconds long. With a four digit code like this it is possible to transmit fifteen different signals.

To effectuate this system six different pulse widths are used. The first four are used respectively in the four signal sequences which constitute a signal cycle. Thus pulse width 1 always appears in sequence 1 and so on. In addition pulse width 5 is used for checking and 6 as a blank. As a result sequence 1 could have in it pulse widths 1 or 6, sequence 2 could have 2 or 6, etc. The apparatus on the airplane is equipped with five relays each of which responds to a pulse of given width. Pulse width 1 will energize relay 1R. Pulse width 2 will pick up relay 2R. However, pulse width 6 will not. Hence if code 1 consisting of the ordered group of pulses 1, 6, 6, 6 is received in the plane only relay 1R will be actuated.

The effect of having relay 1R energized is to cause the plane transponder to radiate a response pulse of width to energize ground relay 1RP.

On the ground there are four code origin relays 1P, 2P, 3P and 4P. Also there are four response relays 1RP, 2RP, 3RP and 4RP.

The general scheme of operation is that a pulse originating on the ground must cause the plane to repeat the correct pulse. If this happens for each code pulse a check pulse is sent from the ground to close a check relay on the plane.

In sequence 2, since code origin relay 2P on the ground is not energized, the ground radiates blank pulse 6. This does not pick up plane relay 2R. The transponder then does not radiate the proper pulse to pick up ground relay 2RP. The connections are arranged so that circuits are closed only if the code origin relay P and its associated response relay RP are both actuated or both left de-energized. This is then a check circuit. If the circuit is in correct working order current flows through the various ground relay contacts causing the ground station to send out check pulse 5 of characteristic width. This energizes check relay 5R on the plane thereby finally completing the circuit to light the desired signal.

An important advantage of this system is that it can have superimposed upon it a central traffic control which would be in a position to make such changes in the indications being given to planes as seemed warranted in the light of any special conditions which might exist.

It is even possible to extend the system to provide for flying along multiple lateral traffic lanes at a single altitude. Thus along an east-west airway, Fig. 9, eastbound traffic would be flying south of and westbound traffic north of the line of beacons. To do this it would be only necessary to assign two interrogation channels for each altitude and to provide planes with a means for switching to either group of channels according to direction of flight.

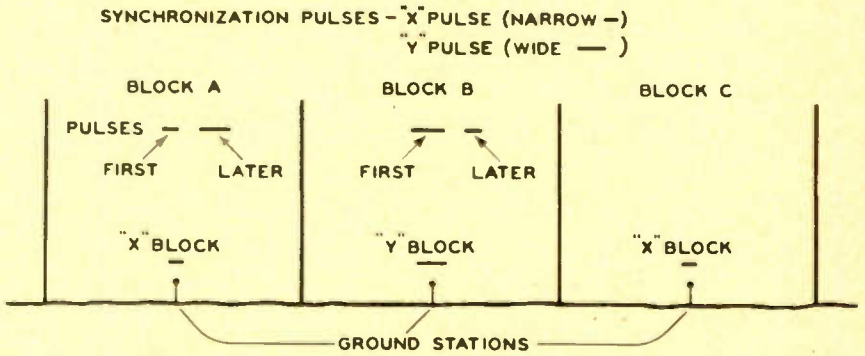
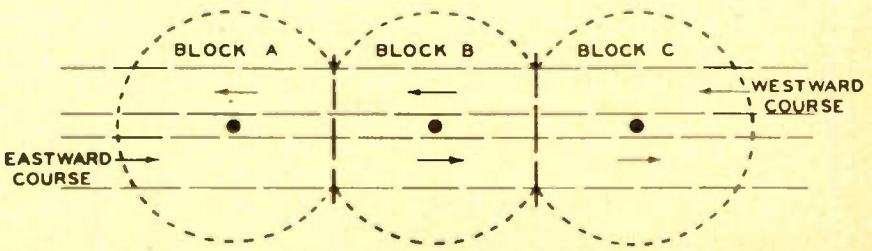



Fig. 8—Long and short pulse technics used in alternate blocks

Fig. 9—Multiple airways at the same elevation



# BROAD BAND TUBE

***Traveling wave design multiplies bandwidth by 80, gives tremendous gain***

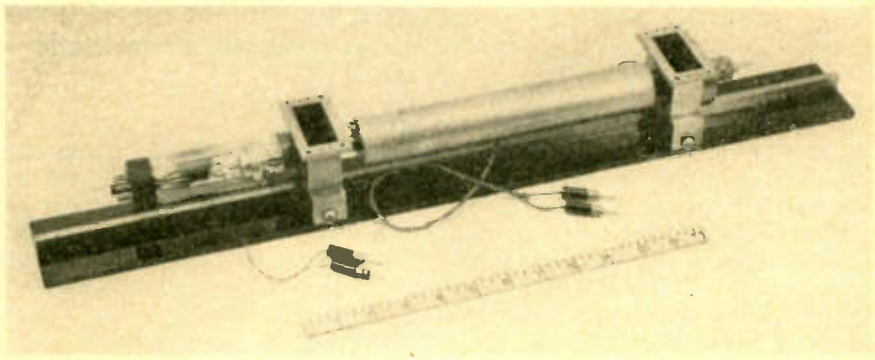


Fig. 2—Experimental model of beam traveling wave tube showing waveguide connections

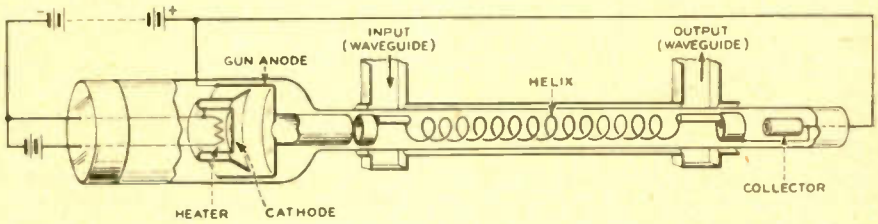



Fig. 1—Cross-section of the tube showing arrangement of the various elements

• The recent development by Bell Telephone Laboratories of the beam traveling-wave tube, described briefly in ELECTRONIC INDUSTRIES for August, promises to provide unprecedentedly high gain with a bandwidth about eighty times as great as has been practicable with other microwave tubes. Further, the nature of this new tube is such that the band can be broadened even more without sacrificing gain.

In the beam traveling-wave amplifier electrons are accelerated from a hot cathode by a high-voltage electrode and shoot down the axis of the tube in a narrow beam. No grids are used. Surrounding the electron beam for nearly a foot of its length down the tube there is a closely wound helix of wire which carries the signal current. This current produces alternating electric and magnetic fields or waves, and as the wire itself is roughly thirteen times as long as the wound spiral, the signal wave travels down the tube about one-thirteenth as fast as light. The electron stream travels through the helix a little faster than the wave.

Since the signal wave at any instant is alternately positive and negative along the tube axis, electrons meet both retarding and accelerating forces in their progress down the tube. Due to the fact that the speed of the electrons is greater than that of the waves and due to the bunching of electrons caused by the waves there is a net positive transfer of energy from the electrons to the waves. Hence the wave amplitude is increased.

In the present amplifier two waveguides, one carrying the weak input signal and the other the amplified output signal, are fitted around the tube near the ends of the helix. At each end, the helix is fastened to a metal collar inside the tube, and short straight sections between the collars and the helix act as antennas to couple the helix to the guides. This arrangement is indicated diagrammatically in Fig. 1, while Fig. 2 shows a complete beam traveling-wave amplifier.

Besides the tube and the two waveguide connections, two coils which can be seen in Fig. 2 are required in forming the electron flow into a narrow beam and in guiding it down the tube. The electrodes surrounding the cathode are so shaped as to send the electrons into the tube in nearly parallel paths. The narrow coil just to the left of the input waveguide in Fig. 2 provides a final adjustment before the beam enters the helix, and the long coil covering the tube between the two waveguides keeps the beam from spreading in its passage through the helix.

The construction of the experimental tube can be seen more clearly in Fig. 3, which shows enlarged views of the two ends. Four slender ceramic rods which run the length of the tube between the helix and the inner surface of the glass hold the helix accurately cen-

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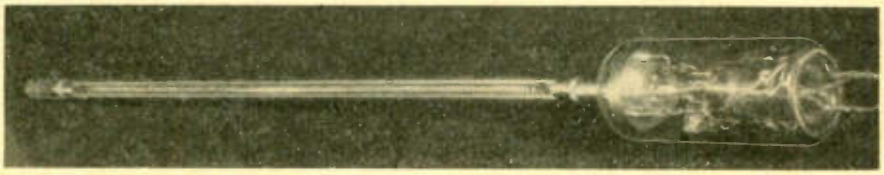
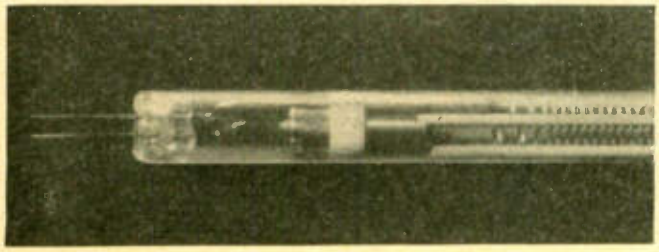
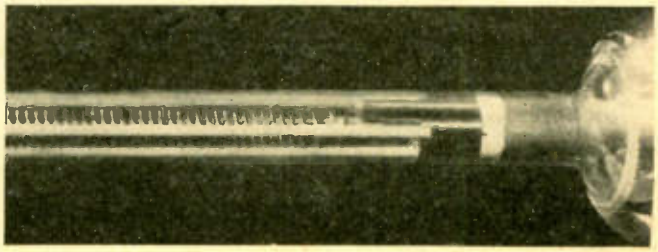


Fig. 3—Above, the complete tube; below, at each end the helix is attached to a projection from a metal ring that acts as an antenna. Input end at right and output at the left





# RCA REVEALS FIRST

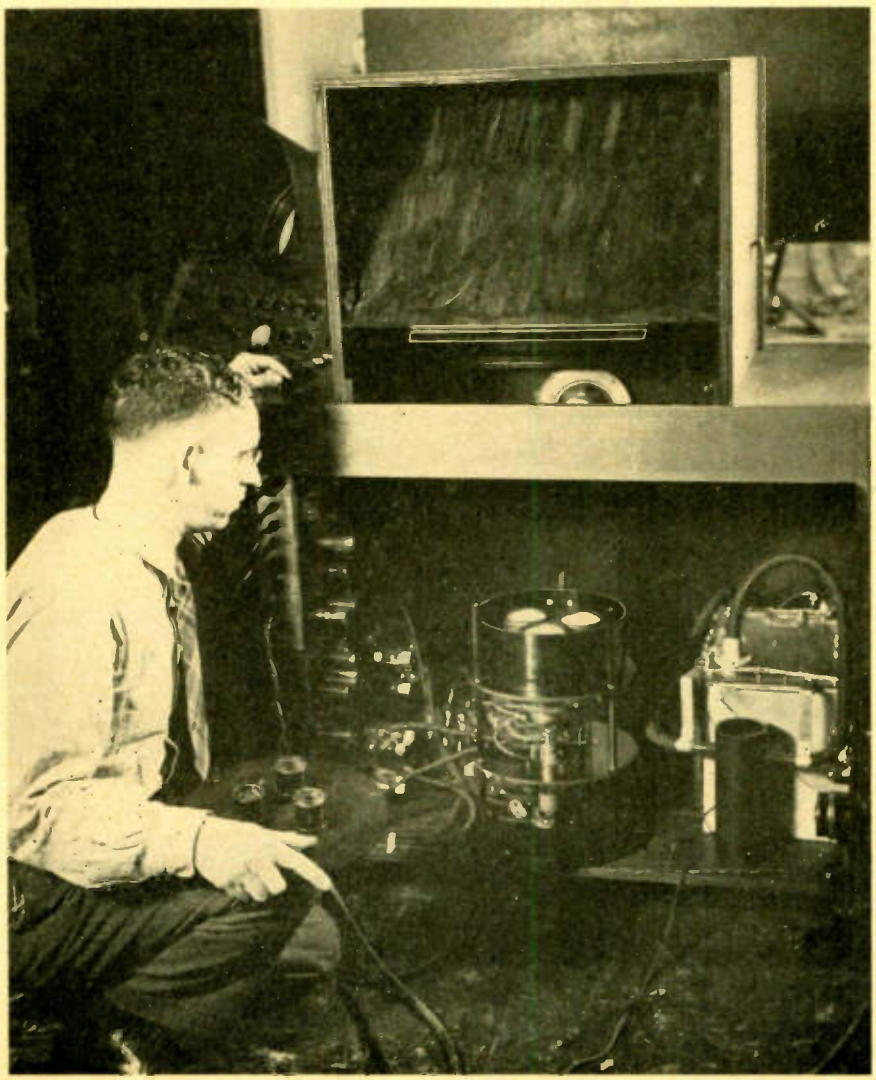
***Three continuous color signals within 16 mc band are received on Trinoscope and projected into one picture***

• At a demonstration on October 30, held for the benefit of press representatives and members of the broadcasting industry at Princeton Laboratories of the Radio Corporation of America, electronic color television was unwrapt for the first time as a practical system.

The color transmission systems proposed heretofore have been based on dividing the picture to be sent on a time basis and sending first its blue image then its green image and finally its red image, this sequence being endlessly repeated. In the Radio Corporation of America system all three colors are sent simultaneously and are therefore present all the time. A number of obvious advantages of this system can immediately be mentioned. Among them are tripling of the light available, impossibility of color breakup during rapid movement, increase in available picture size and the practical possibility of making black and white receivers useful on color signals.

At the transmitting end the system comprises an electronic cathode ray tube of about 5 in. face diameter as a light source. This is a tube with an aluminized phosphor face excited by 30 kv to give as much light as possible. A regular scanning raster is made to appear on the face. In front of this is placed the picture to be transmitted and beyond that there are focusing lenses with a system of partial color selective mirrors to split the light into three parts. The three light fractions, filtered by red, blue and green filters, respectively, are impressed on three phototubes thereby modulating AC carriers. The 3 modulated waves are then sent simultaneously side by side over a 16 mc bandwidth.

Rear view of RCA electronic color television receiver, with the Trinoscope projection assembly in the lower part of the cabinet. Its three 3-in. kinescopes receive signals representing red, blue and green images and project them optically through filters as a composite picture on a 15-20 in. screen



### *Color Separation*

At the receiving end each of the three color modulations is used separately to excite a cathode ray tube of about 3½ in. face diameter. Light from these 3 tubes is focused again through the proper red, blue and green filters and condensing lenses onto a 15 x 20 in. translucent screen where the colored picture appears.

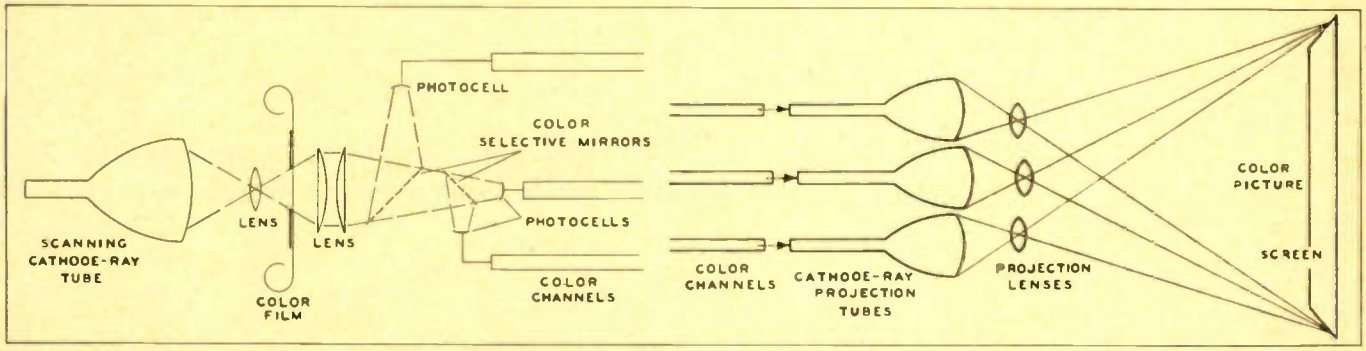
An ordinary black and white receiver can be tuned to receive the green image thereby rendering the picture in monochrome. This is possible inasmuch as the standard 525 lines, 30 frames per second scanning rate is used.

Due to the wide transmission band required it will be necessary to transmit in the 480 to 920 mc region and therefore a converter will have to be purchased by owners of black and white sets to bring this frequency down within the range of their tuning capabilities.

The picture resulting from this system is in excellent register and the color range is very wide. In the demonstration there was no color separation or fringing.

It was stated by Mr. E. W. Engstrom, director of research that the system had only just been finished and considerably more work would have to be done on obtaining better resolution and color balance.

# ELECTRONIC COLOR TV




Manner in which the color picture is divided into three colors by means of color selective mirrors, transmitted on three carriers simultaneously and combined at the receiver for optical projection on the screen as a composite color picture. Tuning to green channel only will operate black and white set

However, he felt that there were no problems which could not be worked out in this system and that they were going ahead with its development in complete confidence that its possibilities were unlimited.

David Sarnoff, President of the Radio Corporation of America emphasized that the production of colored electronic television without mechanical rotating parts was as great an advance as was the cathode ray tube over the rotary scanning disc for black and white television. He felt therefore, he said, that the difference between mechanical rotating color television and electronic color television such as was demonstrated was the difference between there being no color television service and actual public color television.

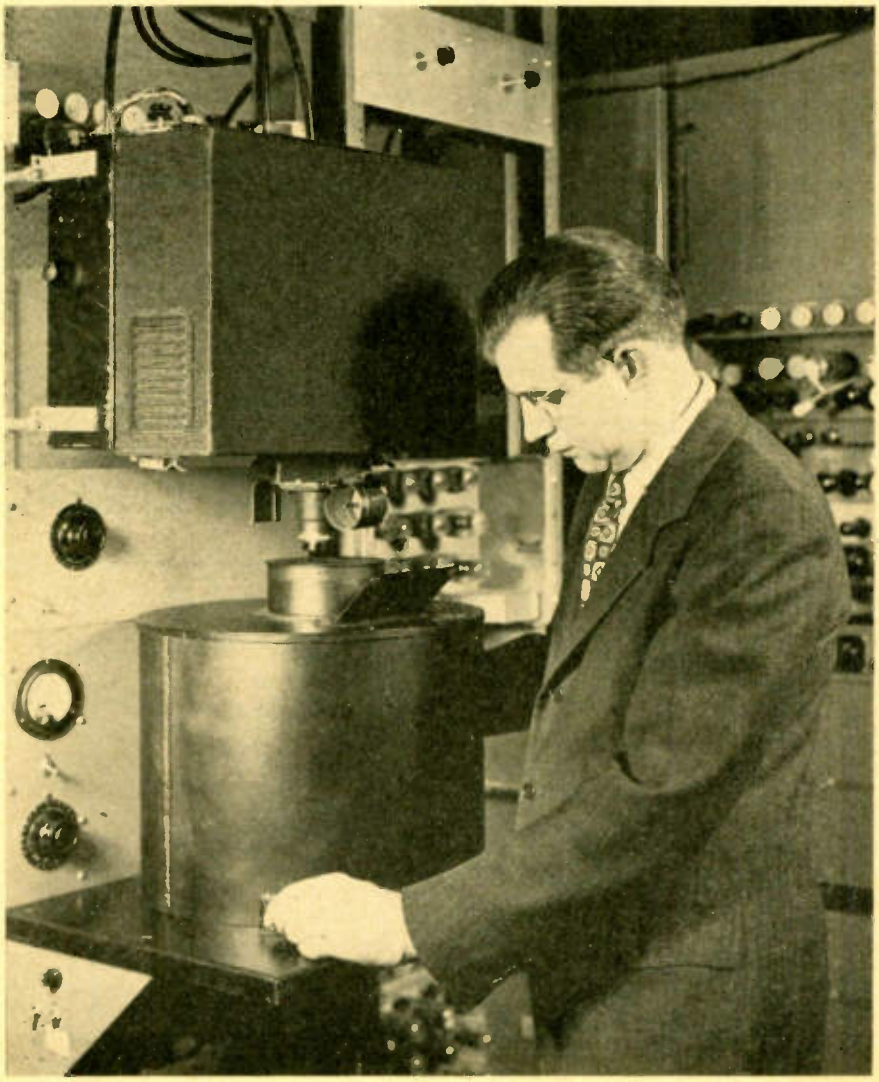
After slides had been demonstrated, a colored moving picture, an old Disney film, was run through and gave excellent results. Here again C. B. Jolliffe, executive vice-president, and E. W. Engstrom, vice-president and director of research, emphasized that considerable more development work was in the immediate offing.

Mr. Sarnoff said that "The new RCA electronic color television system will be available to the entire radio industry. The development is so important in contributing to television leadership for our country that we have decided to demonstrate it publicly as apparatus becomes available for each successive step. We begin with the current demonstration in which still pictures are used, but which sufficiently establishes the basic principle; it will be followed by the transmission and reception of color pictures in motion, then outdoor scenes and finally electronic color television on large-size theatre screens."

Dr. Jolliffe disclosed that the RCA timetable for future demonstrations of color television is divided into five stages, the first of which featured still pictures televised from color slides on a large screen 15 x 20 in. The remaining

(*Continued on page* 103)

The electronic color television camera uses a high-voltage kinescope as a light source. Image of the slide in natural colors is separated into the electrical equivalent of component colors by means of a system of mirrors and photocells in the top unit of the assembly



# BETTERING OUTPUT

By LOUIS DOLINKO
United Electronic Co., Newark, N. J.

***Engineering considerations involved in improving performance through use of getter traps and graphite anodes***

● The amount of power delivered by a transmitting tube for any class of service depends, in large measure, upon the ability of the anode to dissipate safely the heat created during operation. Recent war-inspired development of electronic equipment has prompted marked improvement in power tube operation, output and life. Much credit for this advance must be given to the use of graphite as an anode material. Previously established output and dissipation ratings have been increased by as much as 300%.

The relatively large mass of graphite anodes has offered problems in degasification and processing technics which were not present for metal anodes. Marked improvement in graphite anode transmitting tube performance and processing is a result of two fairly recent developments, the "isolated getter trap" and zirconium coating of the anode.

The isolated getter trap (patent pending) consists, in its conventional form, of a glass tube 7/8 in. long and approximately 3/8 in. in diameter into which the molybdenum flag with attached getter cup is introduced. Each end of the flag is welded to a nickel shield and the shields fit snugly over the ends of the glass tube. Each shield has a single vent and the molybdenum flag is placed so that the getter material faces in a direction opposite to the vents. (See Fig. 1)

The advantages of the getter trap are:

1. Radio frequency losses resulting from conductive getter deposit on the bulb are reduced to a minimum. Hence, increases in tube power output and efficiency result. Furthermore, local overheating of the glass bulb and stem which may lead to bulb puncture and stem-press electrolysis is, in the main, avoided.

2. Decreased values of interelectrode capacitances result from the absence of a conductive getter deposit on the bulb. This permits use of full tube ratings at higher frequencies or alternately allows increased ratings for a given operating frequency.

3. More stable interelectrode capacitance values are attained. In conventional transmitting tubes the amount of conductive getter deposit on the bulb varies with tube operating temperature and affects the values of the inter-electrode capacitances. The use of the getter trap leads to increased stability of these capacitances which in turn furthers frequency stability and great constancy of tube characteristics.

4. The non-contamination of internal tube parts leads to a decrease in primary emission from active getter particles deposited on the plate and grid; also a decrease in secondary emission, which may be caused by the pollution of the plate and grid surfaces.

5. High-frequency flashing of the getter material may be controlled by visual examination of the amount of getter in the trap and by attendant heat adjustment.

The new getter structure has yielded interesting results as regards (a) increased power output for specific operating conditions; and (b) greater uniformity of power output for production runs.

Tubes with the new getter structure were compared with others of conventional getter structure with the following results:

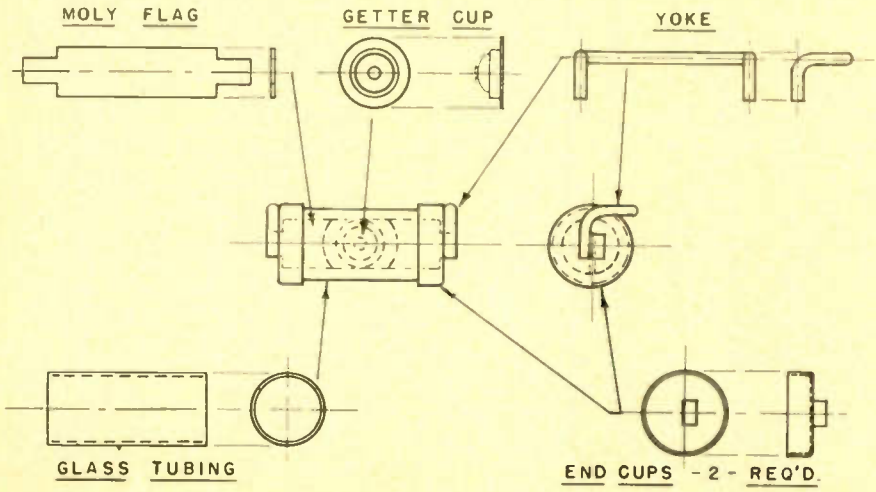
| | With Getter Trap | With Conventional Structure | Gain |
|---|---|---|---|
| Average Antenna Power Output | 270 Watts | 255 Watts | 5.9% |
| Percent Deviation from Mean | .27% | 1.70% | 1.43% |

Operating Conditions—Tube Type HV-18: $E_f$ = 10 Vdc; $E_p$ = 2000 Vdc; $I_p$ = 200 ma; $I_g$ = 25 ma; F = 15 mc.

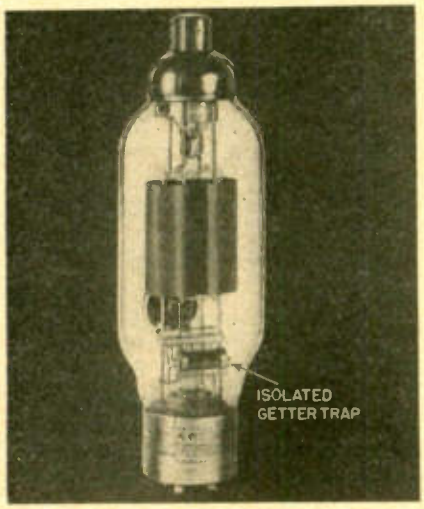
With a rise in operating frequency the difference between the old and new structures becomes more marked. For this particular tube type, at an operating frequency of 30 mc, gains of 20% in power output are usual.

HV-18 tubes with both old and new getter structures were life tested at 800 watts input—a very high rating for this type. Tubes with the old getter structure exhibited life of a few minutes before collapsed bulbs and other defects appeared. Tubes with the new structure gave satisfactory life through a continued test of 500 hours' duration.

Fig. 1—Construction of the getter trap in which getter material faces in direction opposite vent



# FROM POWER TUBES




General appearance of tube showing location of the getter trap and its method of mounting

Heretofore it has not been practical to use a graphite anode in very high frequency transmitting tubes because of the nature of conventional getter assemblies which tend to waste radio frequency power in the metallic getter deposit. The isolated getter trap, however, eliminates this disadvantage and allows the use of graphite anodes in these tubes.

### *Anode materials*

Anode materials for high quality tubes must meet stringent requirements. The choice of such material is, in general, dictated by the following criteria:

1. The material must permit ready and thorough degasification procedures.
2. Low coefficients of thermal expansion are essential for maintenance of shape, uniformity of characteristics, and constancy of interelectrode capacitances. The expansion of the material must be free from discontinuities or structural transformations which may cause warping.
3. Thermal conductivity must be high in order that hot spots and back emissions be avoided.
4. High radiation emissivity is needed so that sufficient heat is radiated to keep the anode temperature low.
5. The vapor pressure at the outgassing temperature should be sufficiently low to prevent deposition upon the bulb and associated tube parts.
6. The material must permit manufacture to close dimensional tolerances and must be sufficiently strong to withstand processing and handling during assembly. The strength at high temperatures should suffice to maintain alignment and prevent deformation during processing and use.

The considerations enumerated above are an integral part of the tube design and performance. Graphite, as a power tube anode material, may now be evaluated in terms of these considerations.

### *Thermal expansion*

During the exhaust of power tubes, vacuum tube generators are used to heat anodes considerably above normal operating temperatures — occluded gases are thus driven from the various tube parts. At these high temperatures, a low coefficient of linear expansion is of prime importance if warping of the anode material is to be prevented. Such warping, of course, may also occur if the power tube is overloaded during operation.

Warping changes the relative positions of the electrodes, thus affecting the tube operating characteristics, the interelectrode capacitances, and indirectly, the operating frequency.

Graphite has a lower linear coefficient of expansion (see Table 1)

TABLE 1

LINEAR COEFFICIENTS OF EXPANSION

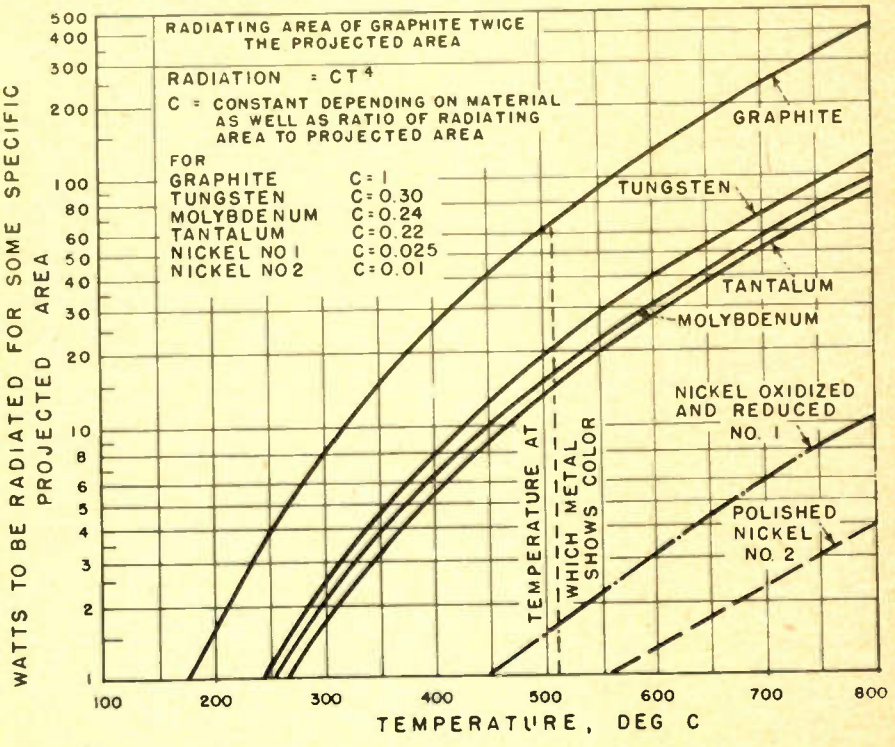
| | |
|---|---|
| Graphite | 2-2.8 x $10^{-6}$ per °C. |
| Molybdenum | 4.0 x $10^{-6}$ per °C. |
| Tantalum | 7.0 x $10^{-6}$ per °C. |

than any other power tube anode material and since no softening point for graphite exists, these anodes will not warp. Also since graphite does not melt or flow, fused spots or holes in the anode are avoided. This freedom from mechanical displacement of tube elements allows the manufacture of closely matched tubes.

### *Radiation emissivity*

As previously stated, the power-handling ability of an electronic tube is a function of the heat dissipated during operation. High heat radiation is perhaps one of

Fig. 2—Heat dissipating properties of graphite as compared with a number of other materials



the most critical requirements of an anode material. Fig. 2 depicts the heat dissipating abilities of some anode materials. At 510°C., the temperature at which these anodes begin to show a red color, a graphite anode would dissipate 70 watts as compared to 16 watts for molybdenum, and 14 watts for tantalum. At 600°C., a graphite anode would dissipate 130 watts as compared to 31 watts for molybdenum and 28 watts for tantalum.

Hence, to get dissipation values which are sufficiently high, molybdenum and tantalum anodes must operate at higher temperatures than graphite. Even at 800°C., molybdenum would only dissipate 98 watts and tantalum 90 watts for the specific projected area under consideration.

A low vapor pressure in an anode material is extremely desirable in order to reduce deposit of conductive coating on the bulb and insulators during exhausting as well as in normal operation. The vapor pressure of graphite is $360 \times 10^{+12}$ mm of mercury at 1000°C. This is an average value which varies with different types of graphite. It lies between the vapor pressure values of tungsten and molybdenum and is comparable to the vapor pressure of tantalum.

### *Thermal conductivity*

The high thermal conductivity of graphite coupled with its relatively large mass insures quick and uniform distribution of heat through the anode. Hence, hot spots and resultant warping and fusing of the anode material, as well as overheating of associated tube parts with consequent gassing, are prevented. The greater mass of a graphite anode is also effective in allowing the anode to withstand severe overloads.

Comparative values of thermal conductivity for some anode materials are given below:

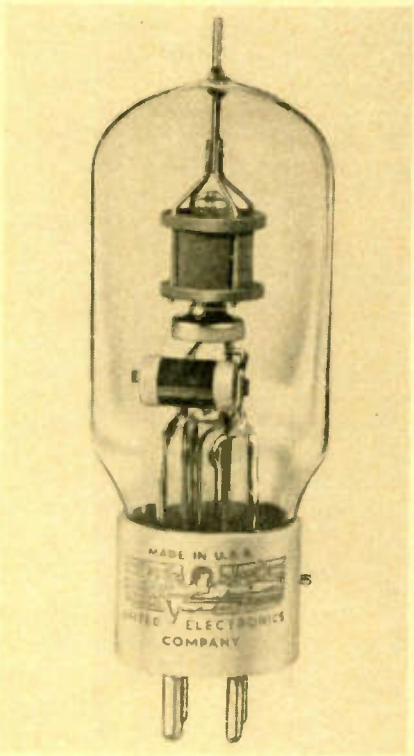
TABLE 2
THERMAL CONDUCTIVITY
(CAL/CM SEC °C)

| | |
|---|---|
| Graphite (solid) | .315 at 20° C.<br>.337 at 390° C.<br>.286 at 20-1000° C. |
| Molybdenum | .35 at 20° C.<br>.236 at 1000° C. |
| Tantalum | .130 at 20° C.<br>.174 at 1430° C.<br>.186 at 1630° C. |

Ease and efficiency of anode outgassing is of extreme importance. The anode must not liberate any appreciable amount of gas during normal operation. Gas in a tube leads to ionization (evidenced by a bluish-purple or pink glow), lowered negative space charge, increased anode current, higher anode temperature, and finally, liberation of still more gas. The emission obtainable from thoriated tungsten filaments is readily poisoned by small amounts of oxygen and by the sputtering or bombarding action of positive ions. This is especially true of the heavier gases, such as mercury, which will destroy emission much more readily than the lighter gases such as hydrogen.

TABLE 3

| | Graphite | Molybdenum | Tantalum |
|---|---|---|---|
| Melting Point (°C.) | 3674 (sublimes) | 2620 | 2850 |
| Tube Processing Temperature (°C.) | (pre-heated 1600-2100) 1000-1200 | 1500-1700 | 2000 |
| Normal Operating Temperature (°C.) | 500-600 | 700 | 800-900 |




Another type of graphite anode construction such as is used in tubes for high frequencies

In connection with tube degasification, three temperature levels are involved, namely, the melting point, processing temperature, and operating temperature. Adequate temperature differentials must exist between these levels if high power rating and safe tube operation is to be attained.

Graphite, when degassed at 2150° C., will yield no further gases even if subsequently heated to a higher temperature. It is interesting to note that a graphite anode that has been completely degassed will absorb only a small fraction of the original gas content when stored under proper conditions. It has been found that no gas is evolved by graphite at 1000° C. if it has been previously degassed at 1300° C.

Norton and Marshall[5] studied evolution of gases from a sample of carbon which had been hydrogen fired and then vacuum fired. It was found that the gas evolved in the range 1700° to 2200° C. was predominantly nitrogen, while at lower temperaatures, hydrogen and carbon monoxide were the chief gases given off.

### *Outgassing methods*

Graphite anodes are often hydrogen baked at 1000° C. or above in order to accelerate the subsequent outgassing procedure and to prevent oxidation during the exhaust process. The large volume and porosity of graphite indicates that more gas must be removed from it than from molybdenum or tantalum.

It is interesting to note, however, that exhaust schedules and times for both graphite and molybdenum are quite similar. Dur-

(*Continued on page* 104)

Life tests indicate that graphite anodes become harder during operation

TYPE: V-70-D
No. CB-7

| Test Readings After Total Hours Indicated | 0 | 16 | 32 | 77 | 134 | 179 | 242 | 338 | 385 | 403 | 573 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hours | | | | | | | | | | | |
| Emission Voltage | 6.7 | 6.7 | 6.6 | 6.6 | 6.6 | 6.5 | 6.5 | 6.6 | 6.6 | 6.6 | 6.6 |
| Gas Current (Microamperes) | 1.4 | 1.1 | 0.6 | 0.6 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

Conditions of Operation
Frequency—10 mc
Plate Voltage—1750 Vdc
Plate Current—175 ma per tube
Grid Current—25 ma, dc, per tube

Push-Pull Oscillator
Input per Tube—306 watts
Power Output—226 watts
Plate Dissipation—80 watts

# ENGINEERS STUDY TV

***New transmitters, studio equipment and receivers feature record attendance at second TBA conference***

• Keyed to the slogan "Television —It's Here", Television Broadcasters Association, Inc., wound up its second annual conference and exhibition after two days at the Waldorf-Astoria in New York on October 11 with a record registration of about 800, which is a couple of hundred more than registered for the first conference held in December 1941. Over 1200 attended the annual banquet and heard Paul Raibourn, vice-president of Paramount Pictures, Inc., present TBA's Awards of Merit for engineering achievements and programming progress. Before and after the dinner, delegates and guests packed the exhibition where the wares of an even dozen exhibitors were spread out.

For the most part the conference devoted itself to programming, which is understandable when it is considered that TBA, formed in December 1943 with ten charter members now has close to fifty film companies, advertising agencies, manufacturers, educators and a dozen major broadcasters on its membership roster. Ralph B. Austrian was general chairman of the conference.

From an engineering point of view, interest centered largely in the exhibition, which uncovered some new equipment for transmission, for studio control, for remote operation and for better use of film. In addition there were several newly developed home television receivers though none disclosed the use of anything radically new in the way of circuit design or the utilization of components.

For the better use of film, RCA's Victor Division had on hand a special television film camera and a 16 mm television film projector; General Electric had in operation its new pulsed-light movie projector which will be available for both 16 and 35 mm film.

Precise electronic timing of illumination and camera tube scanning of movie film frames is a feature of the GE projector, which requires no shutter. A capillary tube mercury lamp (GE # AH-6) delivers light pulses that are controlled by signals from the television station's synchronizing pulse generator thus being timed with the sweeps of the television camera tube. The pictures are projected onto the mosaic during the blanking intervals.

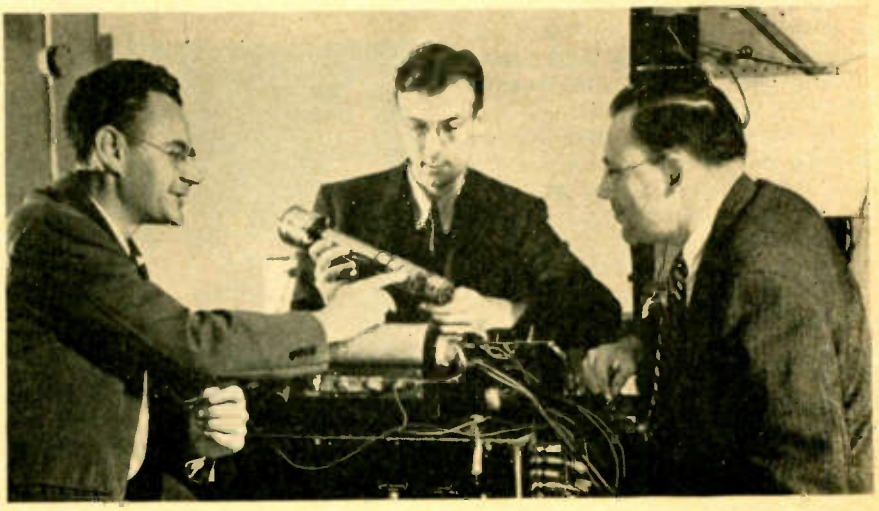
The capillary lamp is operated at about 10 amperes during each pulse of operation (500 microseconds every 1/60 second). The lamp, an optical system consisting of reflector and condensing lens which direct the light through the film, and an electronic pulse generator are packaged together and mounted on a standard projector pedestal in place of the conventional arc lamp or other light source.


Eliminating the shutter, GE's pulsed light film projector is electronically synchronized

The rest of the mechanism is similar to that used in present-day television movie projectors, except for the elimination of shutters and associated gearing, shafts and guards. Strict requirements of motor phasing ordinarily encountered in television movie projection are materially relaxed because the illumination of the film is not governed by a mechanical shutter which must be carefully aligned with the scanning circuits of the television system.

In network operations, the new GE projector will allow comprehensive switching without difficulty. Wide tolerance on phase of the film-drive mechanism will permit simple methods to be used for making the projector follow the station synchronizing. It will not be necessary to dictate the phase and frequency of the synchronizing signals

Top engineering award of TBA was given to these three engineers who together fathered the Image orthicon tube. They are Dr. Albert Rose, Dr. Paul K. Weimer and Dr. Harold B. Law, of RCA Labs



which govern the whole television system.

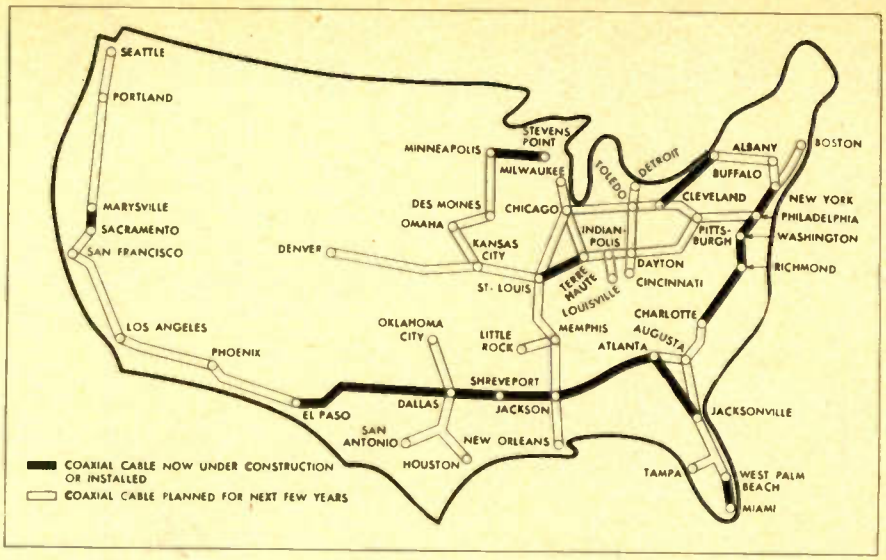
In addition to its new film camera and projector, RCA also had in operation production models of their Image-orthicon television camera and associated portable control and monitoring equipment. Also shown and demonstrated, in addition to the various components of the field camera sets were RCA's new monoscope camera, used for introducing titles and other still pictures into regular field pickup transmissions as well as for testing equipment in telecasting studios and television receiver manufacturing plants, and RCA microwave radio relay equipment. The latter, consisting in the main of a hook-shaped waveguide backed by a parabolic reflector, is used to beam a program from field location-to-studio or studio-to-transmitter.

Two other new RCA products were the special television film camera and the 16 mm television film projector. The camera, which contains an iconoscope and associated circuits, provides a means of obtaining picture signals from either 16 mm or 35 mm positive or negative motion picture film. The projector is designed to throw images from 16 mm film on the mosaic of the iconoscope at the rate required to match current television scanning standards, and can accommodate up to 2000 feet of film without replacing reels.

### *Demountable camera*

The new RCA Image-orthicon camera is arranged to be demounted and set up again for movement to and from a field location. The body of the camera consists of two units, the lower unit housing the Image orthicon pickup tube and video amplifier circuits and controls, while the upper unit houses an electronic view finder which enables the operator to see on a small kinescope the exact picture he is picking up and transmitting. The two units fit together when set up for operation.

The camera has a four-position lens turret which will accommodate any standard lenses and permit almost instantaneous change. The lens turret control on the back of the camera permits the operator to change from one lens to another of a different focal length and refocus in less than one second. A specially designed lightweight telephoto lens also can be fitted into the lens turret when it is desirable to locate the camera at some distance from the action.




**Bringing television network shows nearer, AT&T is rapidly expanding its coaxial cable facilities**

RCA receivers demonstrated included seven and 10-in. direct view television sight and sound table models, showing pictures 23 and 52 sq. in. in size respectively; a console with a 10-in. direct-view television receiver, standard broadcast, FM and shortwave radio plus Victrola with automatic record changer; a large-screen projection model television console showing a 15 x 20 in. picture in combination with standard broadcast, FM and shortwave radio.

The 10-in. table model will be the first of the RCA Victor television receivers offered the public. It goes on public sale in selected stores in commercial television markets in November.

DuMont, in addition to a complete television studio set-up including two cameras and all necessary monitoring and measuring equipment, also staged an extensive exhibit of receivers ranging from large console models built around the company's 20 in. direct view tube, to several smaller models in which 12 and 15 in. tubes are used. All DuMont receivers, it is understood, are to match a 75-ohm input so as to allow the use of coaxial cable feeder and a new type of antenna engineered especially for the purpose by Dielectric Products, Inc., Jersey City. The antenna itself was illustrated and described on page 96 in the November issue of Electronic Industries.

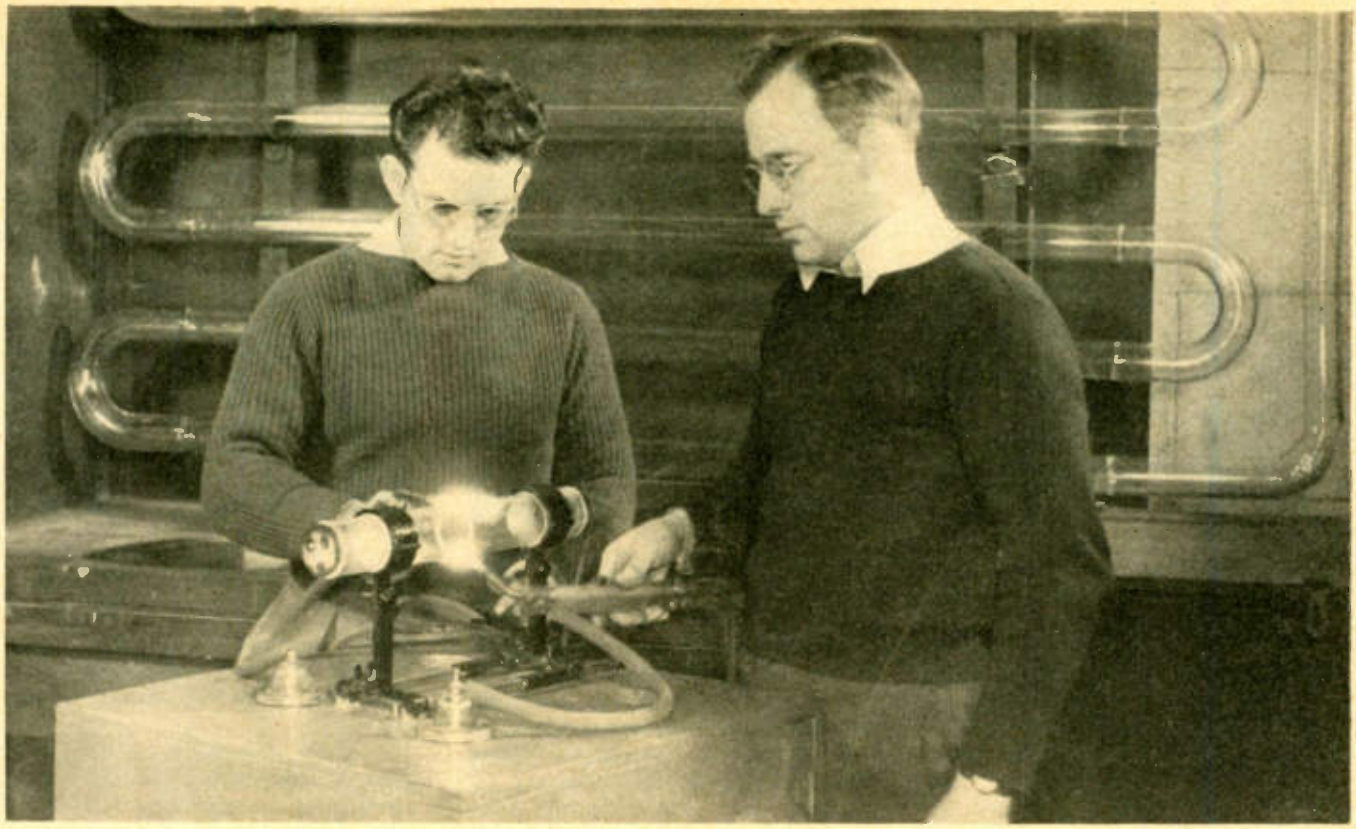
**GE's new TV camera and one-man hydraulically operated dolly is lighter, more flexible in use**

### *Inductive tuning*

DuMont also exhibited working models of its Inputuner, embodying the Mallory-Ware inductuner covering all channels in both FM and television bands from 44 to 216 mc. Tuning is continuous, without the need for any form of switching.

Farnsworth Television and Radio Corp., during the past year has developed a new line of home receivers ranging from table models to television-phonograph-radio combinations, and development work is now being carried forward on a projection-type console. In addition, transmitting and studio equipment are slated for early production. Included in the exhibit were these models: a metal cabinet table set with a 10-in. semi-flat viewing tube, covering all channels and with provision for later addition of an AM adaptor for standard broadcast; a wood cabinet table model quite similar to the other, both to sell for between $250 and $300; a direct-view console which incorporates standard broadcast and has a 10-in. tube; a low-boy combination console with standard broadcast and a record changer; a deluxe console

(*Continued on page* 110)



Combining flame heating and HF current in the fabrication of glass pipeline and heat exchanger, a section of which is shown in the background

# HF GLASS WORKING

By E. M. GUYER,
Research Laboratories
Corning Glass Works, Corning, N. Y.

***Electronic heating alone and in combination with flame simplify production and extend conventional limitations***

• The glass maker has recourse to a new art of electrical glass working which transcends, in many important ways, the limitations of the older flame art. These novel electrical methods are the result of several years of experiment in the research laboratories of the Corning Glass Works over wide frequency bands with different types of electrical power sources and control equipment.*

Glass, with proper handling, can be welded with electric currents or heated and melted in high frequency electric fields with many of the benefits and advantages which these new electronic tools are demonstrating in the metal and plastic industries.

An outstanding example is afforded by current demands for giant television tubes. The glass eyes of television have grown, recently, so big as to tax the art of the glass maker. With tube diameters measured in feet instead of inches, superior optical quality has been achieved by pressing the large funnels and viewing panels separately and then sealing them together to form a vacuum tight envelope. The sealing operation must be accomplished without distortion of the glass parts or loss of accurately controlled dimensions.

At the present time this operation is being performed successfully by means of the newly developed electrical methods which not only provide distortionless welding together of the parts but permit the high melting temperature low expansion borosilicate glasses to be worked even more easily than soft glasses can be worked with conventional gas burners.

To see clearly just why these electrical heating methods are desirable, how they operate and what advantages they possess over flame heating in the sealing of television tubes and many other glass products we must first consider three different types of electrical heating.

In electrical glassworking the

*U. S. Patents 2,306,054, 2,389,360, 2,394,051.

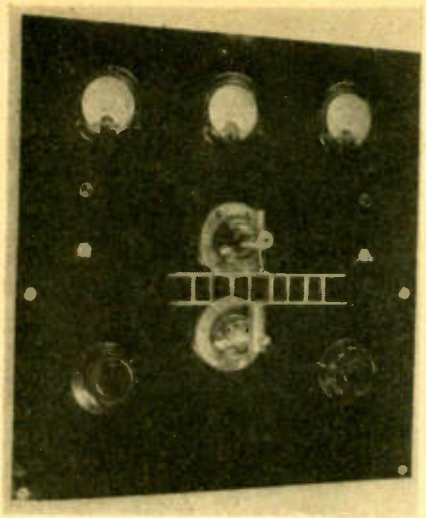


Fig. 1—Condenser electrode system for HF dielectric loss heating of industrial glass

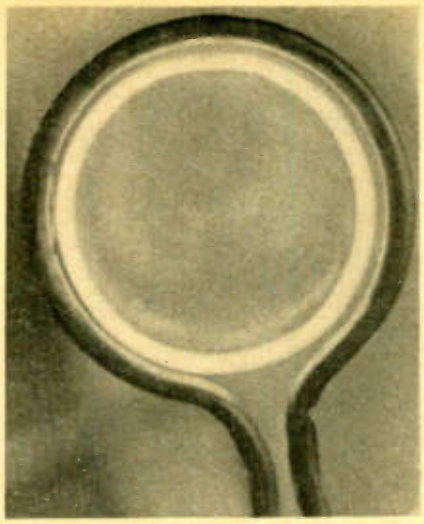


Fig. 2—Showing use of encircling electrode in glass fabrication by HF induction method

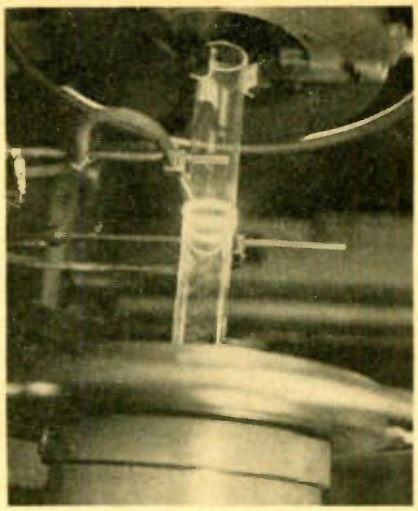


Fig. 3—Use of a high frequency glass sealing lathe utilizing an electrode cross-fire

glass is heated by transformation of electrical energy into heat within the glass. Electrical energy is transmitted into the glass by one or more of the three basic methods—high frequency dielectric loss heating, high frequency induction heating, and electrical conduction heating.

Selection of a particular type or combination of the basic types is governed by the range of temperature required, the shape of the article and kind of glass to be heated, and by the exact nature of the operation to be performed.

Since glass at low temperatures is a dielectric it can be heated by high frequency dielectric loss heating up to temperatures where its electrical resistivity is too low for efficient matching to high impedance wave generators (Fig. 1). Once the glass has become a high resistance electrical conductor, however, it generally is more efficient to switch to electric conduction heating to attain the much higher temperatures necessary for melting. Here again, however, the resistance variation calls for special treatment of the power supply system to maintain efficient operation and close control of heating rate. When its resistance is finally low enough, the glass can be rapidly heated and melted by high frequency induction like any other electrical conductor. (Fig. 2.)

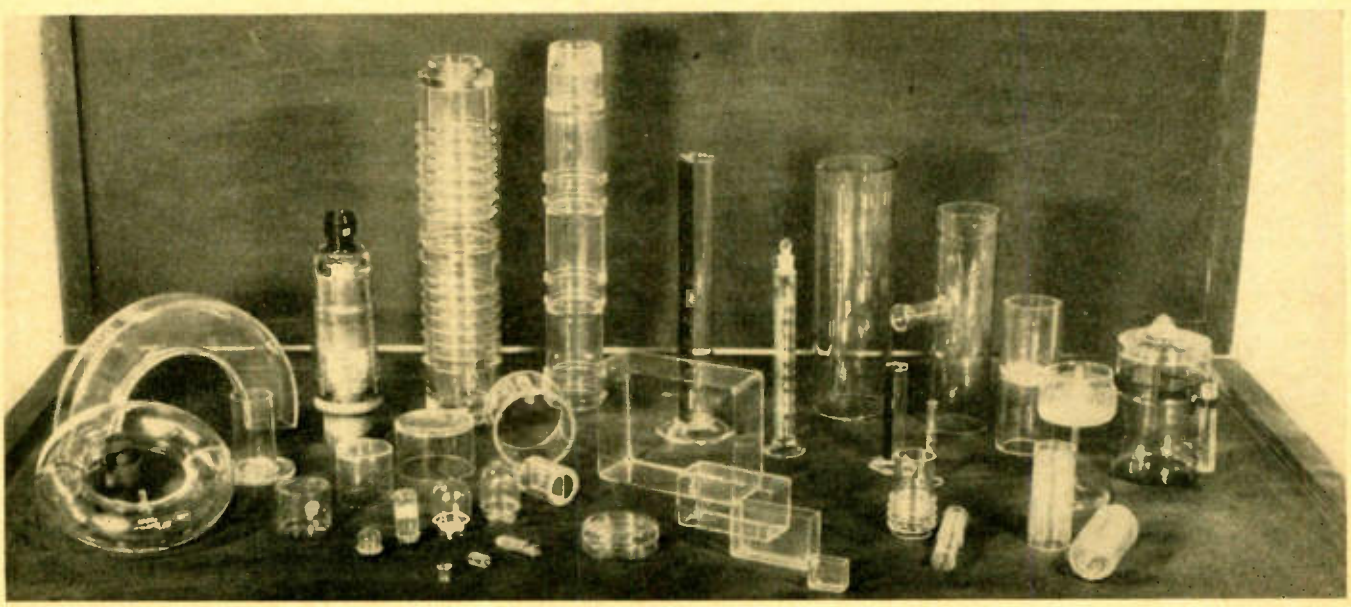
Another system of electrical glassworking which has proved very effective in certain applications operates by means of a so-called electrical-cross-fire (Fig. 3). No condenser plates are necessary with this system since the electrodes consist of electrically conducting pin points of flame. These little flames serve a threefold purpose:

1. They preheat a restricted region of the glass until it becomes electrically conducting although still far below glassworking temperature.

2. They accurately guide the high frequency electrical discharge from the burner tip to the preheated conducting path on the glass thus serving as flexible non-sticking brushes or power leads.

3. Their proximity to the glass determines to a certain degree the load resistance since they are connected in series and thus motion to or from the glass serves as a rheostat regulating current flow and hence heating rate. As they impinge on the glass surface even

Fig. 5—Glassware ranging from 25 lb. lightning arrestors and heat resistant glass fuse bushings to miniature glass cells all produced by electrical sealing



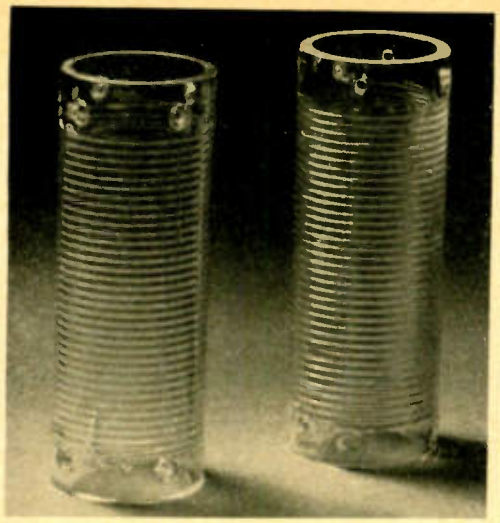


Fig. 4—Glass coil forms for radio use showing locations of ten electrically punched holes

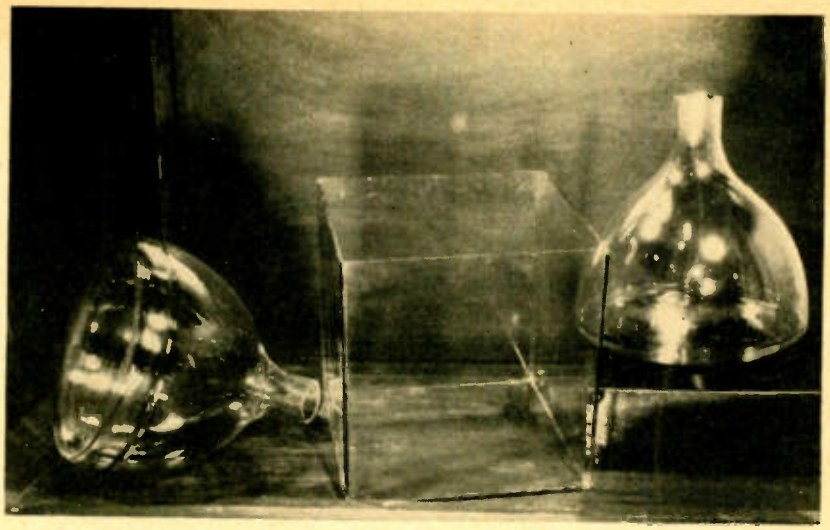


Fig. 6—Two examples of large glass products that have been fabricated with HF heating equipment—a large square glass box and two modern type 20-inch face television tubes

their resistance losses contribute to glass heating.

Once electrical conduction has been established through the glass the operator has at his disposal exact electronic control of the heating rate by virtue of variable oscillator and impedance matching network parameters of the HF power supply.

Among many possible applications of electrical glassworking under investigation at Corning two distinct types of operation have already graduated from the experimental laboratory and are now established in actual production practice — high frequency hole punching and high frequency electric glass welding.

Because of its rapid rate of increase in viscosity as it starts to cool, glass—even very hot glass—is hard to perforate. The same properties which permit glass to be drawn into rods and tubes hundreds of feet in length manifest themselves when an attempt is made to poke a hole through a body of hot glass. By heating a molten path through the glass with high frequency current, however, a smooth surfaced hole can be formed more easily and in much less time than by conventional grinding operations. A machine tool not unlike a giant ticket punch is used to pierce the fluid glass in the highly localized electrical melting zone.

Fig. 4 illustrates a recent development in electronic glassware made possible by the new process. The low dielectric losses of these two different types of glass coil forms enable them to meet the exacting requirements of stable high Q inductor service in the ultra-high-frequency wavebands. Ten electrically punched holes locate mounting screws and anchor winding terminals in one type while a ¾ in. diameter hole punched in the end of the other facilitates mounting.

### *Electrical glassworking*

High frequency electrical glass welding has been in actual production operation for a period of five years with several of the original machines still turning out ware twenty-four hours a day. These products include articles formerly manufactured by conventional methods and new glass products developed with the aid of the electrical methods. All of these would be more difficult and costly, or, in some cases, impossible to produce without electric heating.

The varied glassware illustrated in Fig. 5 ranging from 25 lb. lightning arrestors and heat resistant glass fuse bushings to miniature glass cells was all of it produced on either hand operated electrical sealing lathes or on rotary automatic machines. In Fig. 6 the large glass box and 20-in. diameter television tubes are likewise products of electrical sealing.

In certain operations electrical methods actually eliminate the necessity of using costly machines in welding operations. Accurately synchronized rotary leads sometimes can be replaced by relatively simple and inexpensive jigs and fixtures to support the glass parts.

A striking example of this process is the high-frequency-wave welded "all-glass" pipeline, a new product of electrical glassworking. Simple portable equipment makes possible for the first time the rapid installation, repair and servicing of "all-glass" lines of any length desired in plant or out-of-door locations.

Although the new electrical methods can be applied wherever conventional gas operations are now used, the cost of high frequency equipment necessitates intelligent selection of work where optimum benefits are derived from the special features of the electronic process.

Some of the advantages of electrical glassworking demonstrated by laboratory experiment and production practice may be summarized briefly as follows:

1. Electrical glassworking transcends the limitations of conventional methods with regard to size and shape and composition. Work is not restricted to articles in forms which can be mounted conveniently on rotating heads. Neither is it limited to glasses with low melting temperatures.

2. Electrical seals are stronger due to favorable temperature distribution.

3. Rejection losses are reduced by more accurate control of temperature and exact repetition of critical processes.

4. Sharp localization of heat prevents overheating of other parts in close proximity to the melting zone.

5. Electrical methods are free from injurious loss of volatile glass constituents and deleterious reactions with products of combustion.

6. Electric heating provides deep penetration into thick sections of hard glasses, resulting in faster melting speeds.

Thus in operations where heating and melting time are significant factors, production costs can be cut by the adoption of electrical glassworking methods.

# STUDIO CONTROL UNIT

**By N. J. PETERSON**
Transmitter Division
General Electric Co., Syracuse, N. Y.

***Single cabinet for desk mounting contains all controls and amplifiers for one or two studios and announce booth***

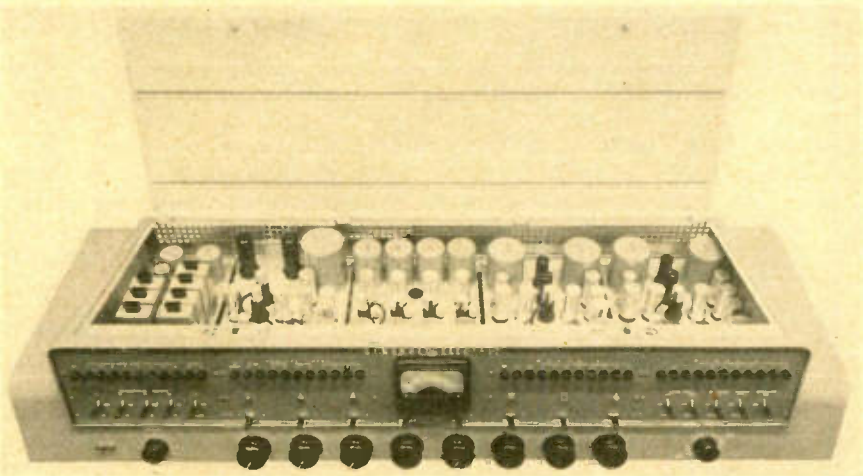
• With the present rapid expansion of the broadcasting industry, and with new FCC engineering standards for FM, there is a need for new high quality equipment in broadcast studios. The consolette, type BC-L-A, will be the answer to most requirements for a studio control unit for both AM and FM broadcasting.

The single cabinet, for mounting on a standard desk, contains all of the controls and amplifiers needed for operation of either one or two studios plus an announce or transcription booth. Facilities are included for monitoring, cueing, and "talkback," in addition to the main functions of controlling microphones, transcription turntables, and remote lines.

The simplified block diagram shows how the various components are connected to make a complete audio system. By the use of switches in the preamplifier input circuits, four microphones can be accommodated in each studio. The input to one of the preamplifiers also can be switched to either an announce booth or a control room microphone.

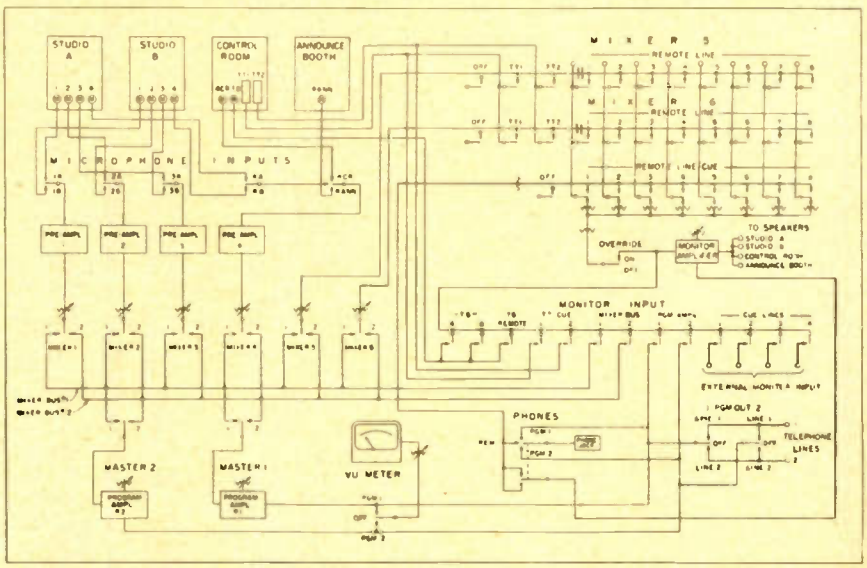
The preamplifier outputs are connected to four of the mixers, mixers 5 and 6 being used for transcription turntable and remote line inputs. A push-button assembly is used for selection of inputs to mixers 5 and 6, which can be any one of the two turntables or eight remote line circuits. The push-buttons are mechanically interlocked so that only one button can be used at a time. The six mixers can be switched to either of two mixer buses, and by the use of input switches on the two program amplifiers, it is possible to select either mixer bus for either program channel.

The use of two program channels means that in case of an emergency, the program can be switched instantly to the second channel without loss of program time. Or, if desired, the program can be fed into two transmitters (perhaps FM and AM), with complete isolation furnished by the separate program amplifiers. At other times, the No. 2 channel can be used for auditioning while No. 1 channel is "on the air." In special cases, where several microphones are being used, both channels can be connected to the same outgoing line, without mismatch, and one of the master gain controls can be used for fading three orchestra microphones simultaneously while an announcement is made on a microphone controlled by the other master gain. This is done without affecting the mixer settings.



The consolette has been engineered and built for maximum accessibility. Hinged top cover raised

Simplified block diagram showing how components are connected to make complete audio system



The front panel, which is sloped to give best visibility, contains the gain controls, switches, and visual monitor (VU meter). The placement of these parts has been given particular attention to provide operating ease. A new improved type of push-button switch is used for high level audio switching and standard lever keys for low-level and output switching. The VU meter, which is illuminated, has an external multiplier which can set the 100% point on the scale for +4, +8, +12, or +16 VU. A switch on the panel transfers the VU meter to either of the line outputs.

Approximate audio levels in the consolette for normal operation are shown on the chart. Before entering the mixers, the microphone level is raised 30 db. by the preamplifiers. Then, in order to compensate for the mixer loss of approximately 26 db., a booster stage is used in the program amplifier, ahead of the master gain control. This arrangement gives desired operating flexibility with optimum performance characteristics.

The master gain controls of the program channels are placed between the first (booster) and second stage of the program amplifier. For normal operating conditions, the master gain is set so that the program amplifier, including the booster stage, increases the mixer bus level by approximately 70 db. This results in an output of +8 VU, (including loss of 6 db. output pad) which is the normal level for feeding telephone lines. At this output level, the distortion is less than 1% rms, 50 to 15,000 cycles.

Transcription turntables are connected directly to the mixer buses in the consolette. In order to obtain the proper level from most transcription pickups, it is necessary to use an external preamplifier having at least 30 db. gain. Quite often, this amplifier is located in the turntable cabinet. Remote line imputs have built-in isolation transformers and the remote line level is decreased with 29 db. pads, before connection is made to the mixer bus.

### *Frequency response*

The most critical parts of the amplifier circuits are the audio transformers. In order to obtain low distortion and uniform frequency response from 50 to 15,000 cycles, it was necessary for the transformer designers to work very closely with circuit designers in order to develop the special transformers required. Special alloy shields and windings are used to obtain the low noise levels required. Amplifiers have been designed so that overloads do not occur during conditions of unusually high microphone output levels. Low noise level tubes, such as the type 1620, are used for highest performance.

The 10-watt monitoring amplifier will operate four loudspeakers and has sufficient gain so that the talkback microphone, which operates through the monitoring amplifier, does not require a preamplifier. The volume control for this amplifier is mounted on the panel. Usually, an exceptionally high quality monitoring loudspeaker is located in the control room for accurate aural monitoring and wall speakers are used in the studios.

If additional loudspeakers are required for sponsor booths, reception foyer, and offices, it is necessary to have additional monitoring amplifiers. The headphone jack, which is on the panel, can be switched to either line output or to the incoming remote lines. This jack accommodates either single or double plugs.

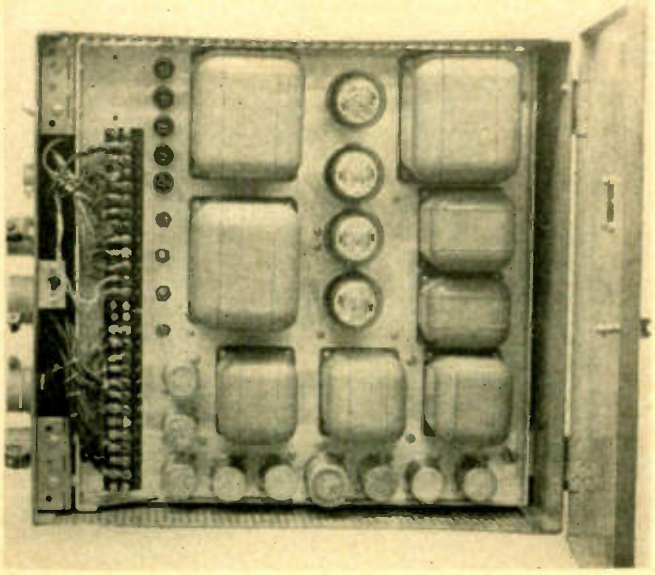
Cueing operations are handled with push-button switches which connect the input and output of the monitoring amplifier to the desired circuits. Any of the remote lines can be cued by selecting the proper push-button. The input of the monitoring amplifier can be switched to the outgoing program channels, mixer buses, transcription turntables, or several external cue inputs. The external cue could be from master control, station monitor, or other special sources. An over-ride switch makes it possible for a remote operator to "call-in" on the monitoring loudspeaker in the control room for tests before a broadcast. This eliminates the need for a special order-wire.

All microphones and loudspeakers are interlocked so that acoustic feedback will not occur at any time. For example, when the operator wishes to talk into studio "A" he simply presses the button marked "TALKBACK A." This automatically disconnects the control room loudspeaker and prevents feedback. The circuit is arranged so that it is not possible to talk back to a studio which is on the air.

The power supply for the consolette is a separate wall-mounted unit. This unit contains four rectifier circuits—individual rectifiers for each of the two program amplifiers, the monitoring amplifier, and the relay circuits. Preamplifier power is obtained from either of the program amplifier power supplies. This arrangement provides maximum reliability. The relay rectifier will furnish power to operate external "on-air" and audition light relays. These relays are controlled by circuits in the consolette.

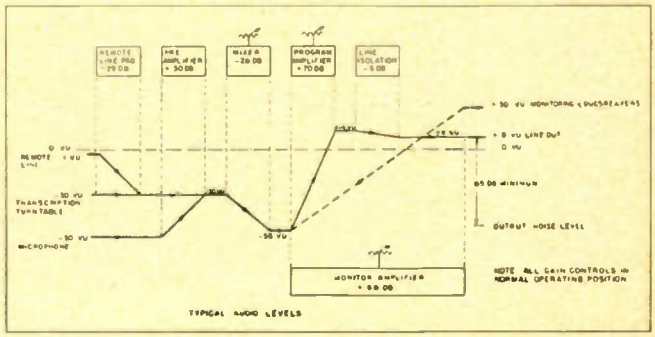
Installation of the equipment is

(*Continued on page* 109)



Power supply for the unit is mounted in a separate cabinet wall

Approximate audio levels in consolette for normal broadcast operation



# REMOTE AMPLIFIER for

By PAUL WULFSBERG,
Project Engineer,
Collins Radio Co., Cedar Rapids, Ia.

***Design of a four channel and master self-contained unit for operation on both AC and batteries***

• The design of a remote amplifier for broadcast service involves many interesting problems, some of which are rather unique in audio amplifier design. In most cases programs are sent via telephone lines to the main studios. In some cases, however, a radio link is used. The remote amplifier thus must serve the same purposes as the regular studio console. Light weight, and maximum operating flexibility are required and the fidelity of the amplifier must be comparable to regular studio equipment.

In order to achieve reasonable economy of space and low battery drain, low level mixing generally is used. With new type faders, noise caused during adjustment of volume level is negligible. By use of T type faders very low insertion loss is possible in a four channel system. Four channels and master are adequate for nearly all remote broadcasts.

Since microphones average —60 to —70 db an overall gain of 90 db is adequate for the remote amplifier and allows a moderate reserve of gain which is sometimes useful. An output level of +10VU is normally adequate for all remote pickups.

From an operational standpoint, the remote amplifier and its power supplies should all be contained in one case, thus eliminating battery and ac power supply boxes and the accompanying cables for interconnecting the units.

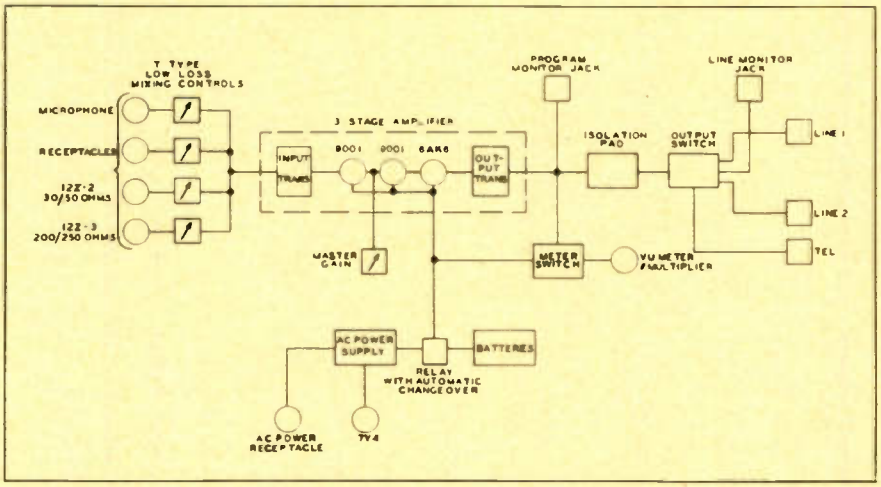



Fig. 4—Block diagram of Collins 12Z amplifier showing automatic AC-battery changeover

The amplifier should provide for either ac or battery operation and automatic cutover from ac to batteries is very desirable to give program protection in case of power line failure. With the above objectives in mind, the design of a new broadcast remote amplifier was undertaken.

The first problem considered in the design was the choice of tubes.

Fig. 1—Front view of complete amplifier unit in its case


Fig. 2—Rear view of the amplifier with the case removed

# BROADCAST SERVICE

Since the gain required is 90 db, the total gain of the amplifier, exclusive of the input transformer, needs to be 65 to 70 db. Since the output stage normally has a large step down ratio in the transformer, its net gain is very low, being perhaps only 6 or 8 db. This leaves at least 60 db of amplification to be developed in the preamplifiers. The use of pentodes allows this gain to be realized in only two stages.

Since the preamplifier circuit requires cathode-type tubes for ac operation, the 6.3 volt series is the obvious choice. There are a number of sharp cutoff pentodes in this group which require only 0.150 ampere filament current. Some of the tubes considered were 6W7-G, 7C7, 7AG7 and the 9001 in the miniature series.

The 9001 tube, which is very nearly identical in characteristics to the 6J7 type generally used, was chosen for the preamplifier stages because it is smaller in size than the other types.

Several tubes of low drain characteristics are available which might be used for the output stage. The types 6C4, 6G6G and 6AK6 all have 0.150 ampere filaments. The 6AK6 is a miniature version of the older 6G6G, which is a pentode type tube similar to a 6F6 but having reduced ratings. The 6AK6 (triode connected) was found to be more satisfactory than the 6C4 triode because of lower amplification factor and plate impedance.

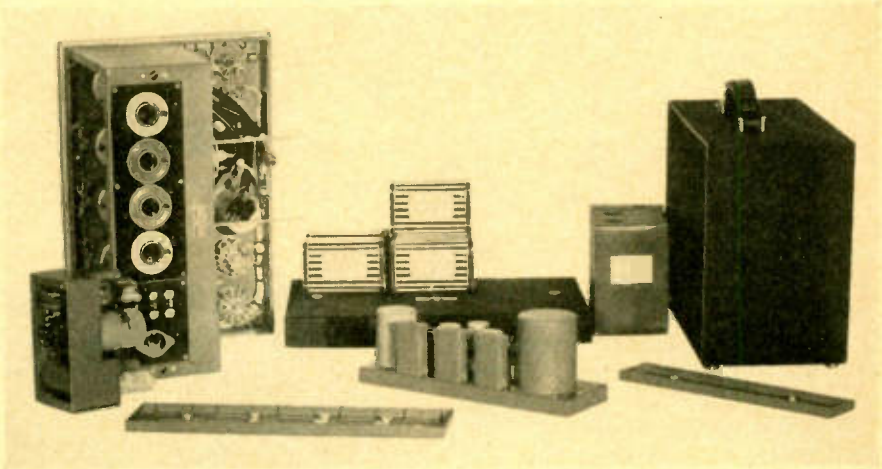


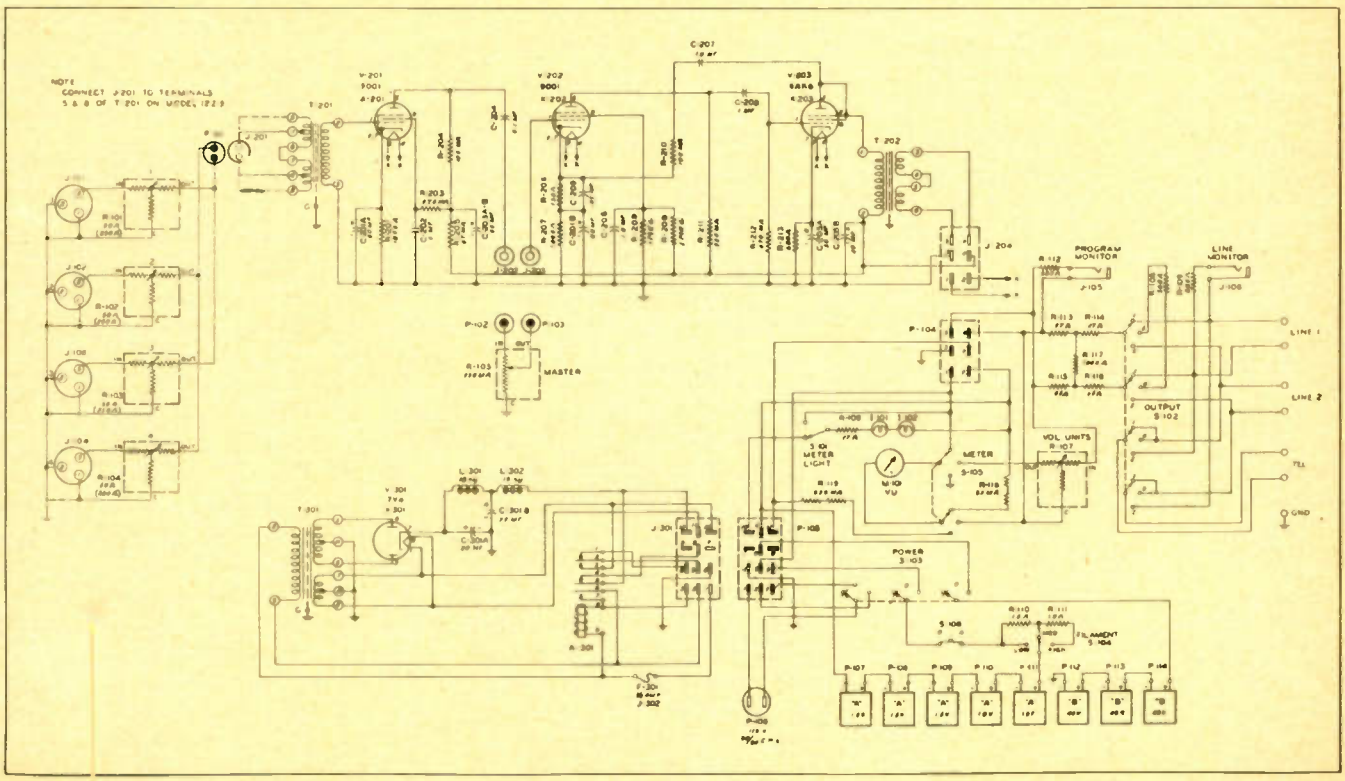
Fig. 3—View of the disassembled unit showing compact design and accessibility

The design of the output amplifier brought up several problems. The distortion was not to exceed 1% for typical operating levels (+8 to +10 dbm) at all frequencies. This requirement is easy to meet in the mid-frequency range, but becomes more difficult at frequencies of 100 cycles and below, and at frequencies of 5,000 cycles and above. Inverse feedback seemed a logical method for reducing this distortion.

The 6AK6 was tried as a pen-

(*Continued on page 97*)

Fig. 5—Complete wiring diagram of the amplifier which provides for master gain and for mixing four input channels



# MAGNETIC CONTROL

**By C. R. KNIGHT**
General Electric Co., Schenectady, N. Y.

***External field used instead of conventional grid to regulate plate current in new industrial high vacuum tube***

• Although control of electron current flow in a vacuum tube by a magnetic field was described first by Dr. A. W. Hull of the General Electric Co. in 1921,[1] comparatively little practical use of this principle was made until tubes of this type were developed for the generation of extremely high frequencies.

The simplest form of magnetically controlled tube, wherein the flow of anode current is controlled by a magnetic field, can be shown to occupy a logical place in the industrial electronics field. Although there are inherent power losses in a magnetic coil, compared with the negligible power required to control a negative-grid tube, a device of this sort can perform certain functions better and more economically than the conventional types of electron tubes.

At some time or another most designers have wished for a "dc transformer" or a simple means of combining the outputs of several unrelated sources into a single amplification system. Basic limitations of conventional tubes are reached when very low frequency or direct-current voltages of about 1 volt or less are to be amplified.

The magnetically controlled tube circumvents the difficulties encountered in the conventional types by utilizing the magnetic field available when a current flows in a conductor, thus the action of the tube is essentially independent of voltage available for the control. In addition, since control is completely through the magnetic field, complete isolation of the controlling circuit from the anode circuit of the tube is possible. This is not the case in direct-current amplifiers using conventional types.


Fig. 1 (above)—Type 2B23 diode, showing standard intermediate-shell octal construction

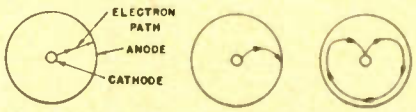
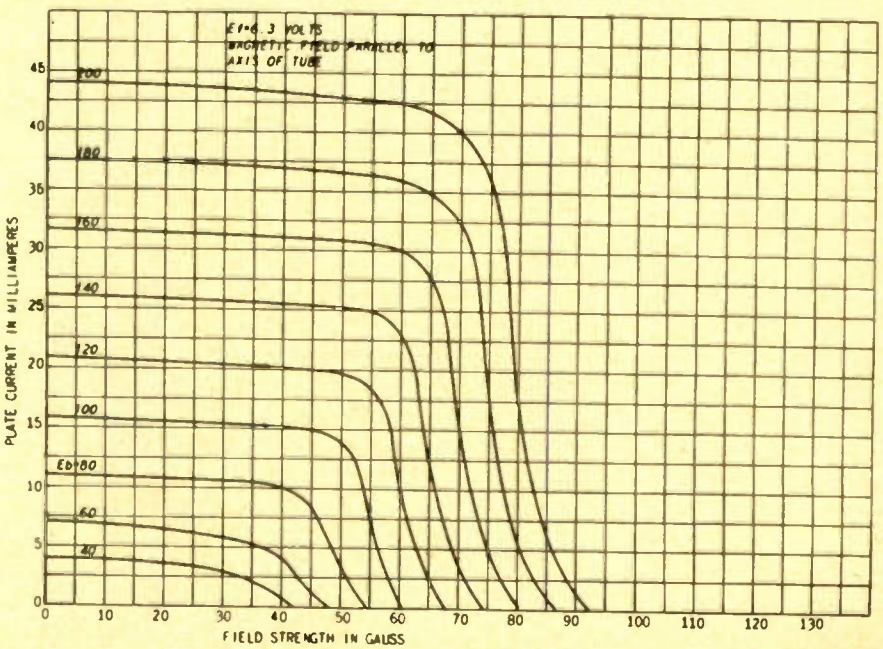



Fig. 2-A, B & C (above)—Effect of magnetic field on electron trajectory in the type 2B23

The recently announced type 2B23 is a diode in which anode current is controlled by a magnetic field, as in Fig. 2. In the absence of such a field, electrons will follow straight radial paths from the cathode to the anode, as shown in Fig. 2A. As the magnetic field is increased, the electrons are deflected from the straight path on a radius of curvature, as in Fig. 2B, which is a function of the magnetic field strength and the anode voltage. Further increase in the magnetic field strength will return the electrons to the cathode, resulting in anode current cut-off, as in Fig. 2C. As field strength is increased the anode current remains substantially constant up to a certain point, then decreases rapidly to zero, as shown in Fig. 3.

The basic circuit for the application of the Type 2B23 is shown in Fig. 4. A magnetic bias field is supplied by the current in $L_2$ suf-

Fig. 3—Anode current vs. field strength for the type 2B23 at various values of anode voltages




1. Hull, A. W., "The Magnetron," Journal of the A.I.E.E., Vol. 40, pp. 715-23, September, 1921.

   Hull, A. W., "The Axially Controlled Magnetron," Journal of the A.I.E.E., Vol. 42, pp. 1013-18, June, 1923.

   Hull, A. W., "The Effect of a Uniform Magnetic Feld on the Motion of Electrons Between Coaxial Cylinders," Physics Review, Vol. 18, No. 2, pp. 31-57, 1921.

# OF ANODE CURRENT

ficient to bring the anode current to the desired operating point. The signal field coil $L_1$ can be on the same coil form as $L_2$. The load resistance may be placed either in the anode circuit, as shown, or in the cathode circuit, as the application demands, although in the latter case care must be used to see that the heater-cathode voltage is not excessive.

The circuit of Fig. 5 illustrates an adaptation of the basic circuit to perform the functions of a voltage-control amplifier and a current-limit amplifier in an electronic motor-control circuit, where the output is connected through a suitable circuit to the control element of thyratrons or other devices which are supplying armature power.

Assume that a decrease in this output voltage increases the power supplied to the armature. With no current in $L_1$, tube $V_1$ is conducting a maximum plate current. The variable resistance $R_4$ is adjusted so that the cathode of $V_4$ is at a potential somewhat more positive than the anode; therefore, $V_4$ will not be conducting under this condition. The actual setting of $R_4$ will depend upon the maximum armature current involved. At an instant of time immediately after the closing of the armature circuit,

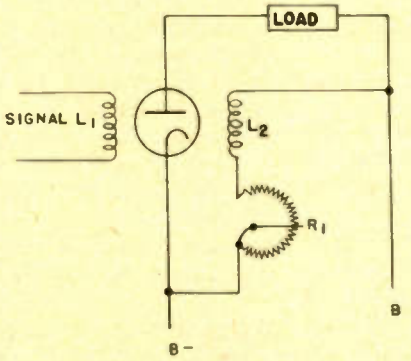



Fig. 4—Basic magnetic control circuit

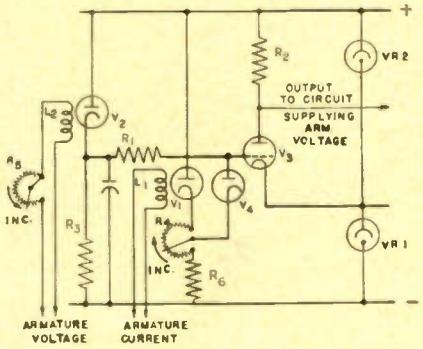



Fig. 5—Motor control circuit using type 2B23

the field on $V_2$ is zero and $V_2$ is conducting a maximum plate current.

This anode current, through $R_3$, produces a maximum grid potential on $V_3$, which in turn produces a minimum output voltage, whereupon the circuit supplying the armature tends to supply maximum power. At this instant the motor has not started to turn, and its effective resistance is very low. The armature current will rise rapidly until the field supplied to $V_1$ is increased sufficiently to limit current in $R_4$ and $R_6$ to a point where $V_4$ conducts current. Anode current in $V_4$ tends to lower the grid potential of $V_3$, which in turn limits the armature power supplied, thereby limiting the starting current.

As the motor comes up to speed, its effective resistance increases. Since constant current is being supplied, the armature voltage rises until the field supplied to $V_2$ by $L_2$ is sufficient to reduce anode current in $V_2$, causing increased output voltage from $V_3$ and resulting regulatory action on the arma-

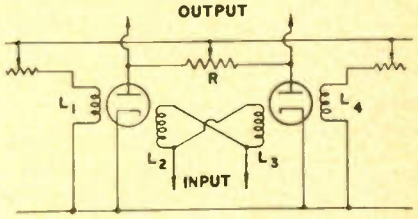


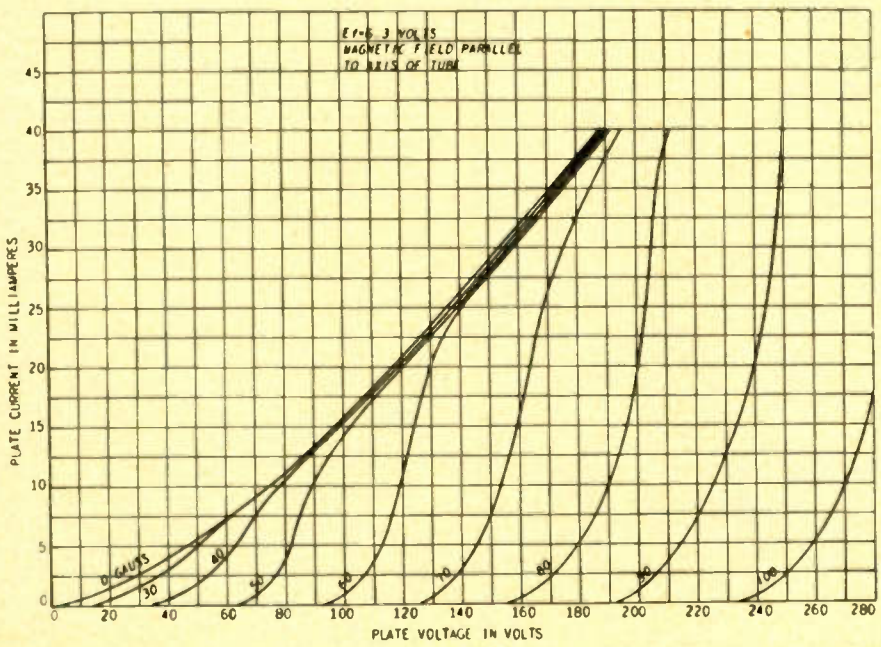

Fig. 6—A stable control circuit using two diodes

ture voltage. The voltage at which this regulation occurs is determined by the setting of $R_5$.

In applications requiring greater stability than that provided by the basic circuit of Fig. 4, a combination of two tubes in the manner shown in Fig. 6 can be used. Here the bias field is supplied by the identical coils $L_1$ and $L_4$. The signal is fed into coils $L_2$ and $L_3$ as shown. Any drift in the bias field strength due to heating up of the bias coils causes an identical anode current change in both tubes. These anode currents flowing through the balance resistor R result in zero net voltage across the extremities of the resistance R. Similarly, any change in tube anode currents due to heater voltage variation in the tubes is almost identical and will cause no change in the net voltage across R. However, when signal voltage is applied to the signal coils, the signal in $L_2$ adds to the field of $L_1$, causing a decrease in anode current in $V_1$ and the signal cur-

(Continued on page 108)

Fig. 7—Family of anode characteristics when field strength is held at various constant levels



# TUBES ON THE JOB

### *Dynamic Balancing*

The difficult feat of dynamic balancing of long rotors, where usually a tendency exists for the ends to act independently, is accomplished by the Dynograph balancer, developed by the R. B. Annis Co., Indianapolis, Ind. The Dynograph is a precision electronic device for locating and measuring the two separate components—on each end of the rotor—of dynamic unbalance with a sensitivity as high as one part in one hundred thousand.

The amount and position of unbalance in rotating parts is determined by a single trace on a cathode ray tube. The mechanical vibrations are picked up by flexibly mounted lightweight bearings which vibrate synchronously with the rotation. After conversion to electrical pulses, and amplification, the amount of unbalance is measured directly by the vertical height of the trace on the cr-tube scale.

The two components of dynamic unbalance are separated either by alternate mechanical locking pivots positioned opposite the planes of correction or by adjustment of the vibration pickup units to anode position along a parallel vibration bar. Position of the unbalance is determined by the relative position of an impulse peak on the trace line created by a photoelectric scanning head which projects a focused beam of light onto the work. An identifying spot on the rotor modulates the amount of reflected light reaching the phototube, thus producing a reference peak on the vertical trace line. Rotor speed ranging from 500 to 50,000 rpm can be handled by the Dynograph.

### *Electronic Control For Projector Arcs*

A more precise and reliable method of maintaining a constant arc gap in motion picture projection lamps has been developed by the Forest Mfg. Corp., Newark, N. J., through the use of a pulse generator and a solenoid driven carbon feed system.

A thyratron, operating on 110 volt ac, furnishes impulses to a solenoid to advance both positive and negative carbons at any desired speed. This is done through the action of the solenoid plunger on a pawl which rotates a ratchet gear to turn a worm screw attached to the carrier. The impulses can be set by a control adjustment knob on the generator to values between 20 and 120 per minute.

Since the rate of carbon consumption is very nearly constant, a constant feeding speed of the carrier unit, when properly adjusted to the rate of carbon consumption, will maintain the desired arc gap setting. The control adjustment dial is graduated in amperage, since carbon consumption varies with the arc amperage; and the feeding speed can be set at the exact point required by the arc current.

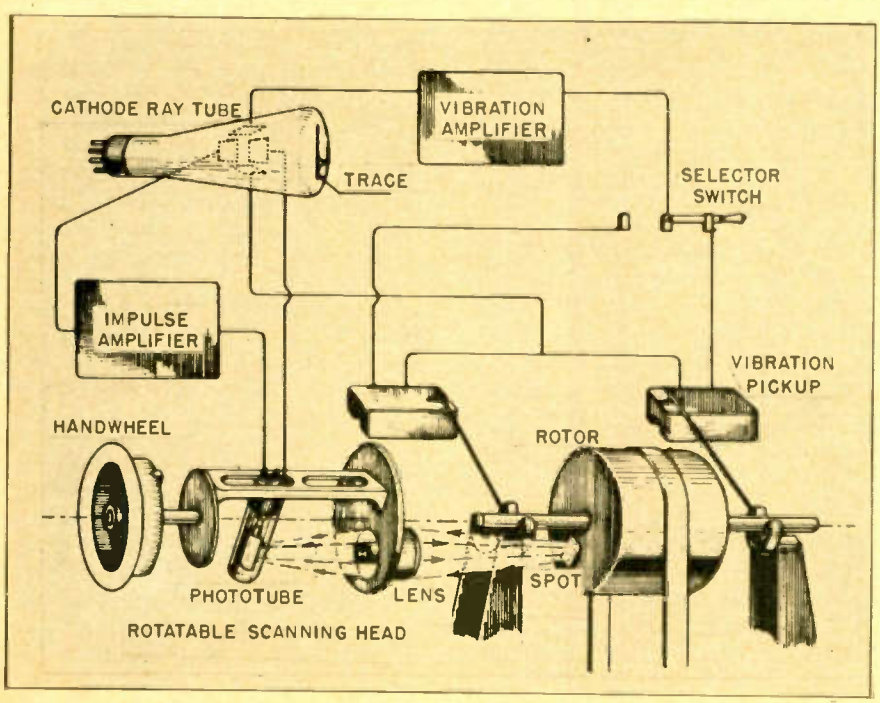
### *Radio Translator System for Audiences*

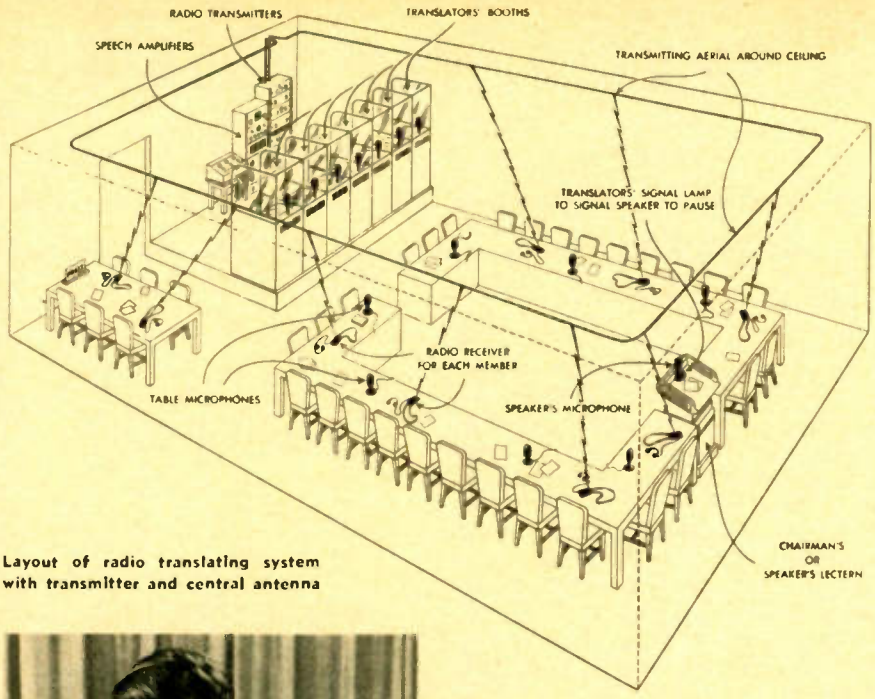
A portable, lightweight radio receiver, used in conjunction with a new system for broadcasting speech translations, permits individual members of an audience to move freely about the auditorium while hearing the speech translations in any one of seven different languages.

A new development of the International Business Machines Corp., the set measures 1⅝ by 4⅛ by 5½ in. high, and weighs only 1½ lbs. The circuit is built around three multifunction tubes, similar to the midget tube developed during the war for the proximity shell fuse. They provide two stages of rf amplification, diode detector with automatic volume control, and pentode output to earphones. The antenna is permanently embedded in a shoulder strap which supports the portable receiver. The set is provided with an on-off switch, a channel switch with which a listener selects the language channel he wants, and a volume control knob.

In the operation of this translator system, the speaker's words are broadcast within the room, picked up by the interpreters in booths at the rear of the auditorium, and translated into several different languages, amplified and re-broadcast to the audience. Eight broadcasting channels are used; a common channel over which all speeches are broadcast to the interpreters and seven language channels.

Schematic diagram of the Dynograph balancer shows the separation of the unbalance components at each end of the rotor to facilitate separate study at the screen of the CRT






Layout of radio translating system with transmitter and central antenna

Any one of seven language channels may be selected with this "camera-sized" receiver

The several transmitters, one for each language channel and the common channel are low power, crystal controlled, and operate at 12.5 kc intervals on band of 100-187.5 kc. The use of low frequency carriers eliminates reflections and fading of signals, and produces a more uniform field throughout the auditorium than can be obtained with higher frequencies. Also, interference with or from existing radio services is eliminated.

The transmitters are all coupled to a single wire loop antenna, placed in the ceiling around the auditorium. Thus all the listeners are located within the field of the loop, and receive maximum signal strength with a minimum of transmission power. Since the field strength outside the loop drops off rapidly, transmission is localized to the participating audience, and the low power used eliminates the need for a radio station license.

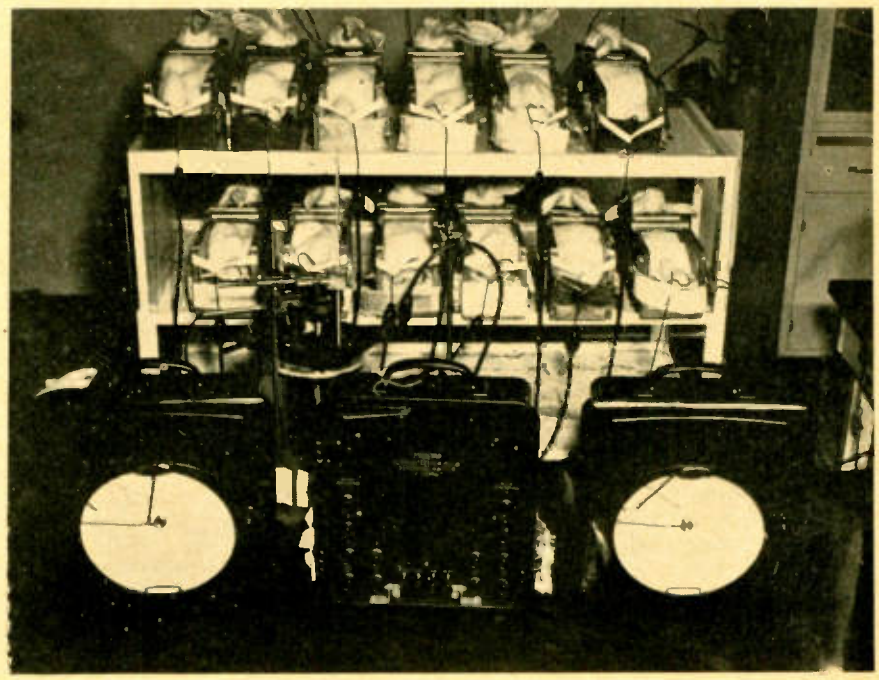
## *Fever Measurements*

A unique use of Dynalog temperature instruments has been found in the measurement of pyrogen content (the temperature raise produced in organic bodies) of penicillin, streptomycin and other infusion fluids. Every batch of these chemicals must pass exact standards of the Food & Drug Administration for pyrogen content before being released for human use.

The test for pyrogen content usually is conducted by inoculating some of the fluid into the veins of an ear of a rabbit. The animal's temperature is then recorded four times in four hours, the maximum allowable temperature rise being below 0.6° C.

In order to reduce the manual operations necessary in recording temperature readings of a large group of test animals, Edison-Splitdorf Corp., West Orange, N. J., and Foxboro Co., Foxboro, Mass., jointly have developed an automatic indicating-recording fever thermometer for rectal use. By use of the equipment including a Foxboro scanning switch and the indicating fever thermometers—based on the well-known Dynalog instruments—12 rabbits are kept under test at the same time. Readings are automatically recorded on standard graph paper. The recording indicator uses a voltage unbalance circuit for control and is accurate to within 0.1°C. A unique feature of the Dynalog electronic circuit is the comparison of the bridge unbalance to a standard frequency which is also supplied to the Wheatstone bridge. Thus balance control, detection of direction of unbalance and detection of amount of unbalance are accomplished in one tube. No mechanical multiplication is needed. The fever bulbs are two in. long, ⅛ in. wide, and are made of silver, which is gold plated to resist corrosion. They are left in place for the entire test period.

A group of twelve rabbits is tested periodically for temperature rise by means of specially designed fever bulbs in conjunction with Foxboro Dynalog instruments and a scanning switch



# SURVEY of WIDE READING

***Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad***

## Properties of Mixed Dielectrics

R. Vieweg and Th. Gast, Institute fuer technische Physik, Technische Hochschule, Darmstadt (Zeitschrift fuer technische Physik, Berlin, 1943, No. 3, pp. 56 to 62).

To establish the dielectric constant $\epsilon$ of powders or fibers the dielectric constant $\epsilon_m$ of a mixture of the powder or fiber with another dielectric of known dielectric constant $\epsilon^1$ can be measured and the dielectric constant $\epsilon$ computed from $\epsilon_m$ and $\epsilon^1$. The dielectric constant $\epsilon_m$ of the mixture depends on the dielectric constants $\epsilon$ and $\epsilon^1$ of the components, their respective volumes, and the size and shape of the particles making up the mixture; in extreme cases, the equivalent capacitance is a parallel or series connection, respectively, of the two components.

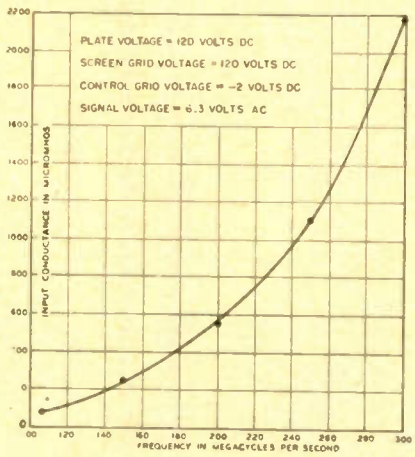
In the present article experiments are described where air is being used as the known dielectric and the dielectric constant of the air varied by application of varying pressure. A self-balancing bridge circuit was designed for the registration of the capacitance-pressure curves. Curves presenting the change in the dielectric constant of the mixture and of pure air, respectively, with variation in pressure were taken. These data permit the evaluation of $\epsilon$ by formulas given in the article.

## Design and Performance of the 6AK5 Tube

G. T. Ford (The Bell System Technical Journal, July 1946, pp. 385 to 407)

The Western Electric 6AK5 tube, intended for the broadband IF amplifiers of radar receivers, is designed for high transconductance, low capacitances, high input resistance, and good noise figure, indicating the desirability of close grid-cathode spacing, fine grid wires, short lead wires, small elements and large cathode emission. Attention is given particularly to the effect of the various electrode spacings on the band merit (bandwidth times mid-band amplification factor for resonant frequency); it decreases rapidly with increasing cathode-grid spacing. A 0.089 mm spacing was decided on, resulting in a band merit of 117 for the 6AK5. Grid-screen and suppressor-plate distances have less influence on tube performance; larger values seem to improve the band merit; values of 0.32 mm and 1.62 mm respectively were chosen. The control-grid pitch is 0.0127 mm, and the wire size 0.0010 in. Cathode lead inductance is estimated at 0.02 micro-henry, the mutual conductance is given as $5 \times 10^{-3}$ mhos, and the grid-cathode capacitance is $4 \times 10^{-12}$ farad.

The curve represents the average value of the input conductance as



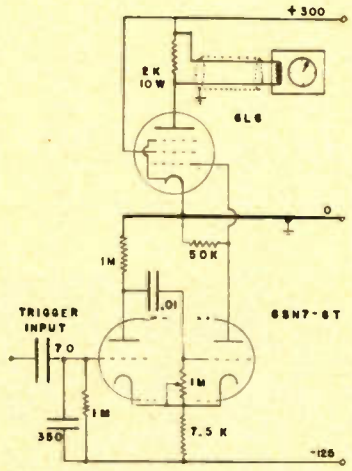

Input conductance of 6AK5 tube as function of frequency (Naval Research Laboratory)

a function of frequency for six 6AK5 tubes as tested by the Naval Research Laboratory. Approximate computations indicate that at an operating frequency of 250 mc the input conductance is largely due to the cathode lead inductance while the transit time effect contributes only a small fraction.

## Pulse Recorder

B. E. Watt (The Review of Scientific Instruments, September 1946, pp. 338 to 342)

The high speed pulse recording circuit shown in the diagram may




be used to operate a Ceno low impedance mechanical counter at more than 130 counts per second. The two sections of the 6SN7-GT operate as a gate generator, the 6L6 as current amplifier. Details of circuit operation are given.

## Electrostatic Field of Electron Beam

F. Borgnis, I. Physikalisches Institut der Universitaet in Graz, Austria (Annalen der Physik, Berlin, Vol. 43, No. 5, pp. 616 to 629)

The electrostatic potential and field distribution inside and outside a circular cylindrical electron beam—traversing the space between two conducting planes A and B which are at equal potential—is studied. The problem arose in connection with the investigation

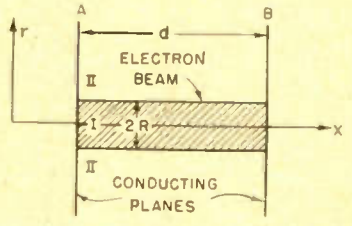



Fig. 1—Set-up of problem under consideration

of the space charge effect on the focussing properties of a density-modulated electron beam. A general solution, assuming the density to be a known function of x, the direction of electron travel, ex-

clusively, is found; the expressions for the field components, which involve fast converging series of Bessel functions, are derived.

Simplification of the problem by assuming a constant electron density throughout the beam, which is warranted for fast traveling electrons, permits numerical evaluation. The lines of force, illustrated in the second figure for a

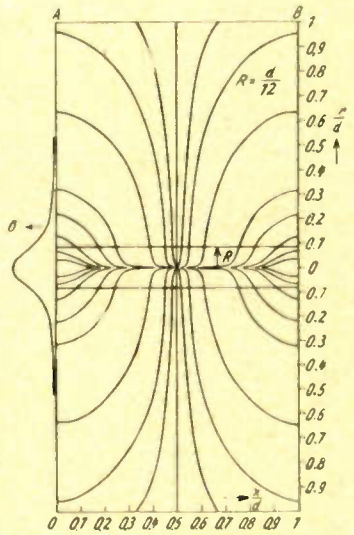



Fig. 2—Electrostatic lines of force due to constant density electron beam

ratio of beam radius to beam length R/d = 1/12, and the electric field intensities along the axis, illustrated in the third figure with R/d as parameter, were computed in this way. R/d equal to infinity corresponds to the case where the space between the plans A and B is completely filled with evenly distributed space charge.

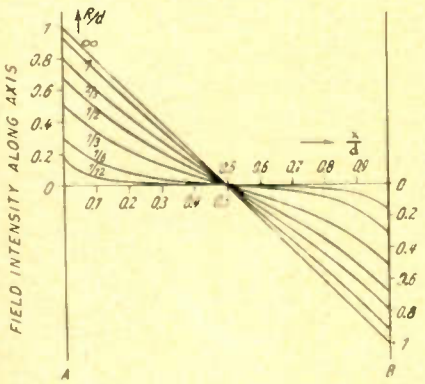



Fig. 3—Field intensity along axis of constant density electron beam

From Fig. 2, it can be seen that there is only an axial field component at the beam axis which is zero at the mid point, while strong radial fields prevail at a distance from the beam axis, particularly in the center region. $\sigma$ indicates the charge density on the electrode. The reduction in the field strength caused by space charge with a reduction in beam radius is clearly demonstrated in Fig. 3.

The special cases of a point charge and of a space charge cylinder situated inside a metal cylinder are considered.

## Mathematics of Paraboloidal Reflectors

E. Pinney (Journal of Mathematics and Physics, February 1946, pp. 49 to 79)

Radiation within a paraboloidal reflector follows the laws of geometrical optics only if the reflector diameter is large compared with the wavelength. Considerable deviations from the computed results are observed at diameters of ten to fifteen wavelengths and it is therefore indicated to derive more accurate formulas. The article is concerned with the properties of Laguerre's function and Laguerre's polynomial which constitute solutions of the scalar wave equation in paraboloidal coordinates and therefore are essential to the mathematics appropriate to describe the electromagnetic field within a paraboloidal reflector.

## Oxide Coated Cathodes

J. P. Blewett, E. A. Coomes, A. Elsenstein, A. Fineman and A. Elsenstein (Journal of Applied Physics, August, 1946, pp. 643 to 668).

A series of articles entitled "Oxide Coated Cathode Literature, 1940-1945", "Pulsed Properties of Oxide Cathodes", "Study of Oxide Cathodes by X-Ray Diffraction Methods", and "Studies of the Interface of Oxide Coated Cathodes" by the authors mentioned above, respectively, reports recent research on the properties and theory of oxide coated cathodes. Particularly the behavior at pulsed operation is studied. It appears that a layer model is best suited to explain the observed phenomena. In this model a crystalline blocking layer interface separates the base metal from the semi-conducting oxide which is covered by a surface layer.

## Matching Load to Tube Oscillator

R. E. Burgess (Wireless Engineer, London, September 1946, pp. 237 to 240)

A tube oscillator is a non-linear power source. Therefore, conventional network theorems do not apply and special formulas had to be derived to investigate its operating characteristics, particularly power transfer to a resistive load.

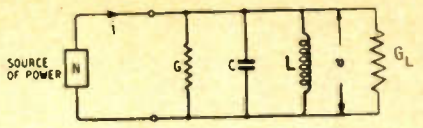



Fig. 1—Schematic of tube oscillator and load

The circuit considered (Fig. 1) consists of a negative conductance element, N, and the oscillatory circuit incorporating conductance, G, capacitance, C, and inductance, L. It is assumed that the current-voltage characteristics of the negative conductance element, N, have the form:

$$i = -av + bv^{2n+1} ,$$

where i is the current, v the voltage, a and b are constants, and n is a positive integer. From the second figure, which illustrates the

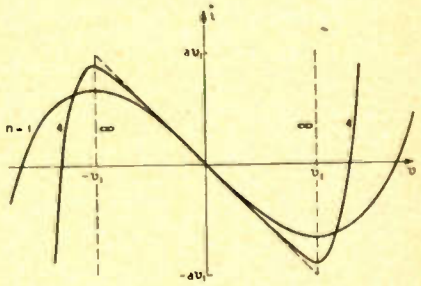



Fig. 2—Voltage-current characteristics of nonlinear element N

characteristics for different values of the parameter, n, it will be seen that a for practical purposes sufficient variety of current-voltage characteristics is covered by this formula. The two turning values, $v_1$ of v, for which the current assumes a maximum or minimum, respectively, are given by:

$$v_1 = \pm \left( \frac{1}{2n+1} \cdot \frac{a}{b} \right)^{1/2n} .$$

For the calculation of the amplitude and power relationships it was assumed that the potential difference, v, across the oscillatory circuit is a pure sine wave

$$v = A \sin \omega_0 t .$$

Then it can be shown that the amplitude A will be equal to

$$A = v_1 \left( \frac{2n+1}{F_n} \cdot \frac{a - G}{a} \right)^{1/2n} ,$$

where $F_n$

$$F_n = \frac{3 \cdot 5 \cdot \ldots \cdot (2n+1)}{4 \cdot 6 \cdot \ldots \cdot (2n+2)} .$$

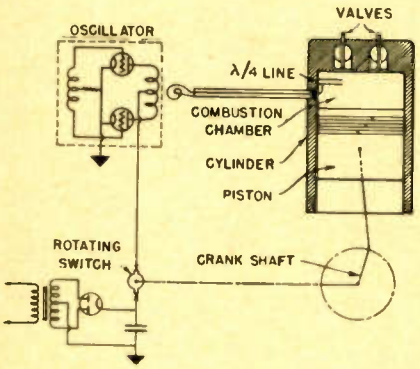
In the limiting case of G = O the

(Continued on page 108)

# NEW PATENTS ISSUED

### *Ignition System*

A resonant system is provided inside the combustion chamber of an internal combustion engine. High frequency energy is supplied to the resonator by an oscillator, which is synchronized with the operation of the engine so that discharge of the resonant system occurs at the top of the compression stroke at which instant the rotating switch will be closed.




The resonant system comprises a quarter-wave line fed near the shorted end next to the combustion chamber wall. Discharge takes place at the voltage antinode across the open end of the line. Alternatively the combustion chamber may be formed as a resonant cavity at the instant of maximum compression and the discharge take place between two metal parts protuding from the movable piston and the opposing wall of the combustion chamber, respectively. Energy is supplied to the resonant chamber by a coupling loop fed by the high frequency oscillator.—W. W. Eitel, Eitel-McCullough, Inc., (F) Oct. 11, 1943, (I) June 25, 1946, No. 2,402,539.

### *Bomb Steering Mechanism*

The bomb or projectile the path of flight of which is to be controlled from a plane is equipped with two reversible motors for left-right and up-down steering, respectively. A tube and relay circuit is so connected as to rotate one of the motors in either direction in response to a specified audio frequency. Four resonant circuits responsive to four different audio frequencies are provided for the four desired operations, respectively. A fifth frequency and corresponding relay may be included for secrecy.

It is further proposed to steer the vertical course and the horizontal course from separate airplanes flying in suitable paths for observing vertical and horizontal deviations from the desired bomb path. Each airplane is equipped with apparatus permitting horizontal and vertical control; however, only one of these controls may be in operation in each plane. To obviate interference of two carriers simultaneously received by the bomb antenna, the signals from one plane may be referred to the other plane and both signals used to modulate one carrier simultaneously.

M. G. Clay, (F) February 4, 1942, (I) March 26, 1946, No. 2,397,088.

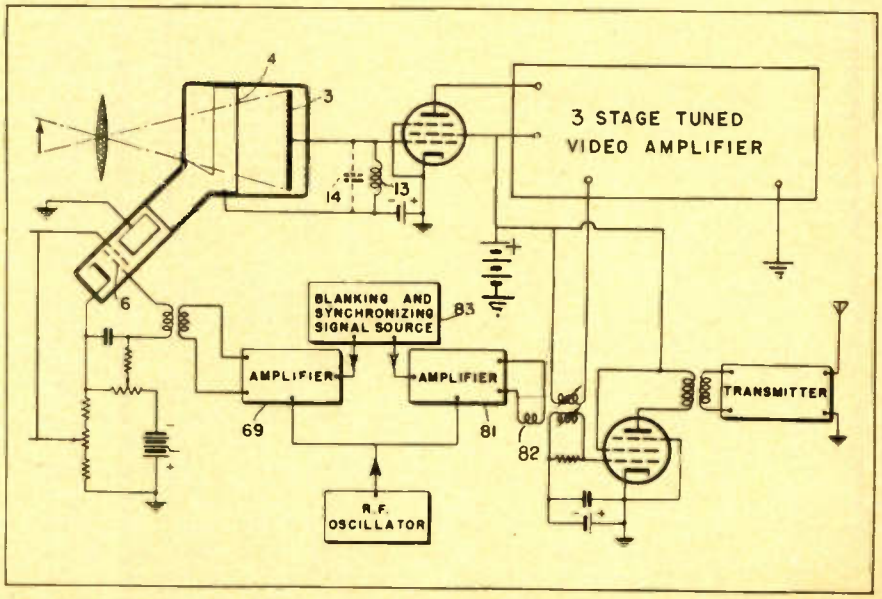
### *Iconoscope Generating AM RF Carrier*

According to the present invention, the electron beam intensity is modulated by a radio frequency voltage applied to control grid 6. Consequently the iconoscope output will consist of a radio frequency carrier, the amplitude of which is modulated by the picture signal. An advantage of the system is that the dc picture component corresponding to the mean picture brightness is generated and amplified simultaneously with the ac component obviating the necessity for a separate dc restoring device. Only a small percentage—10% at the most—modulation is secured, however, so that to increase the modulation amplitude, a tuned, wideband video amplifier is inserted between the iconoscope output circuit and the transmitter. Inductance 13 and capacitance 14, representing the capacitance between the signal plate 3 and the collector anode 4 are tuned to resonance at the carrier frequency. Resonant circuits alternately tuned to the carrier and to the limiting upper side band frequency provide coupling between the video amplifier stages so that a bandpass characteristic is obtained. The unmodulated portion of the carrier is eliminated by operating one stage as a class C amplifier. During retrace intervals the electron beam is suppressed and a synchronizing signal supplied to the transmitter via transformer coil 82, while during scanning the synchronizing signal is blocked, amplifiers 69 and 81 being operative at alternate time intervals.—L. F. Mayle, Farnsworth Television and Radio Corp., (F) January 10, 1944, (I) May 28, 1946, No. 2,401,010.

### *Split-Anode UHF Oscillator*

In the split anode oscillator (see figure on p. 105) the circumferential lengths of the anode segments are an odd multiple of one-half wavelength. These anode segments define inductances while the gaps between them define capacitances. The oscillation frequency generated by the tube depends on the circumferential dimension of the anode segments and no external, tuned circuit with associated losses is needed.

(*Continued on page* 105)



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# NEWS OF THE INDUSTRY

### *IRE Show Moves To Grand Central*

Location of the 1947 Radio Engineering Show to be staged by IRE has been changed. The show is to be held in Grand Central Palace instead of the 17th Regiment Armory, which it outgrew. There will be no change in the dates which remain March 3 to 7. The change in location, which makes available a great deal more space than the Armory provided, permits the addition of some 25 manufacturers to the list of exhibitors. At the same time Grand Central Palace is more accessible from the Hotel Commodore where Convention sessions will be held.

### *Power Show Promises Electronic Applications*

It is expected that the 17th national exposition of Power and Mechanical Engineering scheduled for New York's Grand Central Palace during the week of December 2 through December 7 will hold much of interest for electronic engineers. There are to be nearly 400 exhibits, many of them featuring various forms of electronic control. Exhibit classifications cover the subjects of power generation, conversion, distribution and application to productive machines and equipment.

### *To Promote Teleran*

For the better development and promotion of Teleran, new air navigation system, Radio Corp. of America has brought together a special engineering group which will be headed by Dr. Douglas Ewing as chief Teleran engineer. Included in the group are P. J. Herbst at Camden, and Dr. Irving Wolff at Princeton. Dr. Ewing formerly was assistant director of MIT's Radiation Laboratory. Coordination of the development plan will be under the general direction of Loren F. Jones who is manager of research and development projects for RCA.

### *Hughes Drops FM and TV*

Howard Hughes, noted aviation engineer, is out of TV and FM. He asked the FCC to withdraw his applications for FM and television stations at Los Angeles. The request was granted.

### NEW IRE PRESIDENT

Dr. W. G. R. Baker, vice president of General Electric, and newly elected president of IRE

### *Baker Heads IRE*

Dr. W. R. G. Baker, president of General Electric Co. in charge of electronics, has been elected president of the Institute of Radio Engineers. He succeeds Frederick B. Llewellyn of Bell Telephone Laboratories.

Noel Ashbridge, deputy director-general of the British Broadcasting Co. was elected vice president. Three new directors are Murray G. Crosby, consulting engineer of the Paul Godley Co., Upper Montclair, N. J.; Raymond F. Guy, radio facilities engineer, National Broadcasting Co.; and Raymond A. Heising, patent engineer, Bell Telephone Laboratories.

### *NAB Hears of Future BC Expansion fom Jett*

While most of the sessions attended by the 2,000 delegates to the Chicago convention of the National Association of Broadcasters, Oct. 21 to 24, were taken up with commercial and administrative topics of advertising policies, programming, audience measurements and FCC relations, engineers present took part in enlightening discussion of FM, pulsetime modulation, and facsimile.

Elaborate apparatus exhibits presented by the manufacturers particularly featured television equipment, in addition to AM, FM, and facsimile. All convention sessions were televised by Chicago Station WBKB and RCA, under the direction of Capt. W. C. Eddy.

Radical changes which broadcasting faces, were outlined by Commissioner E. K. Jett, who forecast that wireline networks may disappear and every service may be shifted in the spectrum. Pulse-time modulation technics, while not available for present AM and FM systems, may provide broadcast-station interconnections, when applied to microwave frequencies.

Microwave relays at 3700 to 13,000 mc, declared commissioner Jett, may prove more efficient than wirelines or coaxial cables, for distribution of AM, FM, television and facsimile programs of high technical quality.

Jett also forecast increased tube sizes on frequencies below 1,000 mc, reaching up to units of 50 kw per tube. Resonant-cavity magnetrons, he said, are efficient at frequencies

### *Conventions and Meetings Ahead*

**67th Annual Meeting of the American Society of Mechanical Engineers**—Hotel Pennsylvania, New York City, December 2-6.

**17th National Exposition of Power and Mechanical Engineering**—Grand Central Palace, New York City, December 2-7.

**American Society for X-Ray and Electron Diffraction** — Winter meeting University of Pittsburgh. Dec. 5, 6, 7. (Dr. S. S. Sidhu, University of Pittsburgh.) Joint Meeting with E.M.S.A.

**Electron Microscope Society of America**—Winter meeting, Mellon Institute of Industrial Research, Pittsburgh, Pa. December 5, 6, 7. (Dr. Earl A. Gulbransen, Westinghouse Research Laboratories, East Pittsburgh, Pa.) Joint meeting with A.S.X.R.E.D.

**Materials Handling Exposition**—Public Auditorium, Cleveland, Ohio, January 14-17, 1947.

**Electrical Engineering Exposition**—71 st Regiment Armory, New York, January 27 to 31, 1947.

**7th International Heating and Ventilating Exposition** — Lakeside Hall, Cleveland, Ohio, January 27-31 concurrently with the **53rd Annual Meeting of the American Society of Heating and Ventilating Engrs.**

**American Society for Testing Materials**—Spring Meeting—Benjamin Franklin Hotel, Philadelphia, Pa., February 24-28, 1947.

**Institute of Radio Engineers**—Annual Meeting (Commodore Hotel) and Show (Grand Central Palace), New York, March 3-7.

ranging from 600 to 10,000 mc, and will provide the basis for many postwar circuits.

FCC Chairman Denny, in a panel discussion, reasserted that the FM allocation at 88 to 108 mc is final, implying that the FM low band may soon be abandoned, despite the large number of sets in operation and still being built with low-band FM tuning. Papers of engineering interest presented during the sessions included: "FM Transmitter and Receiver Status", Dr. W. R. G. Baker, General Electric Co.; "FM Station Engineering", T. A. M. Craven, Cowles Broadcasting Stations; "Facsimile Broadcasting", Capt. W. G. H. Finch, Finch Telecommunications, Inc.; "Facsimile and the Broadcaster", John V. L. Hogan, Radio Inventions, Inc.

### *Kinzel Again Heads Engineering Foundation*

Dr. A. B. Kinzel has been re-elected chairman of the Engineering Foundation. He is vice-president of the Union Carbide and Carbon Research Laboratories, Inc., and of the Electro Metallurgical Co. and is an internationally known metallurgist. Other officers elected were: Vice-chairman, Dr. L. W. Chubb, director of the Westinghouse Research Laboratories; Dr. Edwin H. Colpitts, formerly vice-president of the Bell Telephone Laboratories; Secretary, John H. R. Arms.

The Engineering Foundation is one of the departments of the United Engineering Trustees, Inc., a corporation which was set up jointly by the four national engineering Founder Societies with an aggregate membership of over 88,000. These are: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

### *Buffalo Gets FM*

At least two Buffalo, New York stations will take to the air shortly with FM. WBEN and WBNY anticipate program service this month and in January respectively.

WBEN will use a 3 kw Federal Telephone & Radio FM transmitter and a square loop antenna mounted on top of the Hotel Statler, according to Chief Engineer Kingsley. All studio amplifier equipment has now been replaced by high

(*Continued on page* 118)

# WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau** ★ ★ ★

**EFFECT OF REPUBLICAN VICTORY ON FCC**—Since the FCC is a special province in Washington of the electronics-radio industry, the fate of the Commission in the face of a Republican-controlled Senate and House is important in view of the promised economy axe-wielding. But there is felt to be little real chance of any House investigation of the FCC. Actually, little industry support of such a move is in the offing. Due to the fact that the present Commission, under the leadership of Acting Chairman Denny, and with such an able engineering associate as Commissioner Jett, is functioning more efficiently, and more in the interest of the communications-broadcasting industries than ever before, the FCC could come away from a Congressional microscope with a record of real accomplishment, especially in regard to its engineering functions.

**PARED APPROPRIATIONS**—Previous aim of FCC to secure an increased allotment of funds of the tremendous rise in its work—some 430,000 applications for stations, amateur and operator licenses since the end of the war—appears pretty much doomed. But the Commission is going to make a strong presentation before the House and Senate Appropriations Committees for retention of its present funds. No one can predict at this time, before the beginning of Congress, how its attempt will come out, but, if the Republican victors do desire to retain essential government activities, necessary to the proper functioning of the broadcasting and communications services, its chances are fairly good. Following are some of the reasons why the FCC is going to contend with Congress for what it considers legitimate functions.

**WORLD CONFERENCES**—Frequency Allocation Division of FCC under Captain Paul Miles, Navy veteran, will be occupied day and night in formulating the United States position, together with industry experts, for the coming frequency allocations parley, then the world telecommunications conference and finally the meeting on high-frequency radiocommunications and short-wave broadcasting. The FCC staff experts work with the State Department, Army, Navy, and CAA and their planning is carried on with the full cooperation and participation by the communications-broadcasting-radio manufacturing industries.

**FERTILE FIELD IN MOBILE SERVICES** — Manufacturers, who have entered the mobile radiotelephone field, will some day find real gold in "them thar hills". This service is just starting towards its fruition and the FCC figures prove it. There have been 26,000 land and mobile stations granted to date by the Commission with thousands coming in daily. But, due to equipment manufacturing difficulties, there are comparatively few units in actual operation. Telephone companies, buses, trucks, taxicabs and other large vehicular users are all showing their intense interest. To illustrate the "gold", FCC recently granted two Pacific Coast taxicab companies stations which will cost $1,500,000. Next problem will be on overcrowding assigned frequencies and rising possibilities of interference.

**AVIATION SAFETY AIDS**—PICAO studies which were held in November at Montreal, following the demonstration of aviation radio-radar-electronic navigation and traffic control aids at Indianapolis, were most significant for U.S. manufacturing industry. If American systems are generally adopted as the world standard, there is the potentiality of a billion dollar market during the next decade in the United States alone and possibly another billion throughout the rest of the world. Standards of global systems, it is proposed by PICAO, are to prevail for next five years at least. Most important development at PICAO sessions was indication that the operating standards and frequency plan of the U.S. Radio Technical Commission for Aeronautics should be the basic foundation for the world aviation radio navigation aids blueprint.

**SEA SAFETY PRESENTS BIG FIELD**—Establishment of a government-industry advisory and policy organization for marine navigation radio-radar-electronic aids to map out the best systems of radar, loran and shoran particularly, similar to the Radio Technical Commission for Aeronautics, has been proposed in the highest U.S. government quarters. FCC has created a Special Marine Safety Survey Group to make a comprehensive survey of radio communications and radio aids to aid safety of life and property at sea. The view is that a separate Marine Radio Safety sea conference should follow the world telecommunications conference, slated to be staged in this country next July.

**SHOALS AHEAD**—Ever since the settlement of the dispute with GE and Westinghouse, labor troubles in the radio-electronics manufacturing industry have been quite dormant. But authoritative observers in Washington felt, as this issue went to press, union unrest was simmering in view of the rising cost of living and added impetus was given by the strikes in the maritime and other major industries.

*National Press Building*
*Washington, D. C.*

*ROLAND C. DAVIES*
*Washington Editor*

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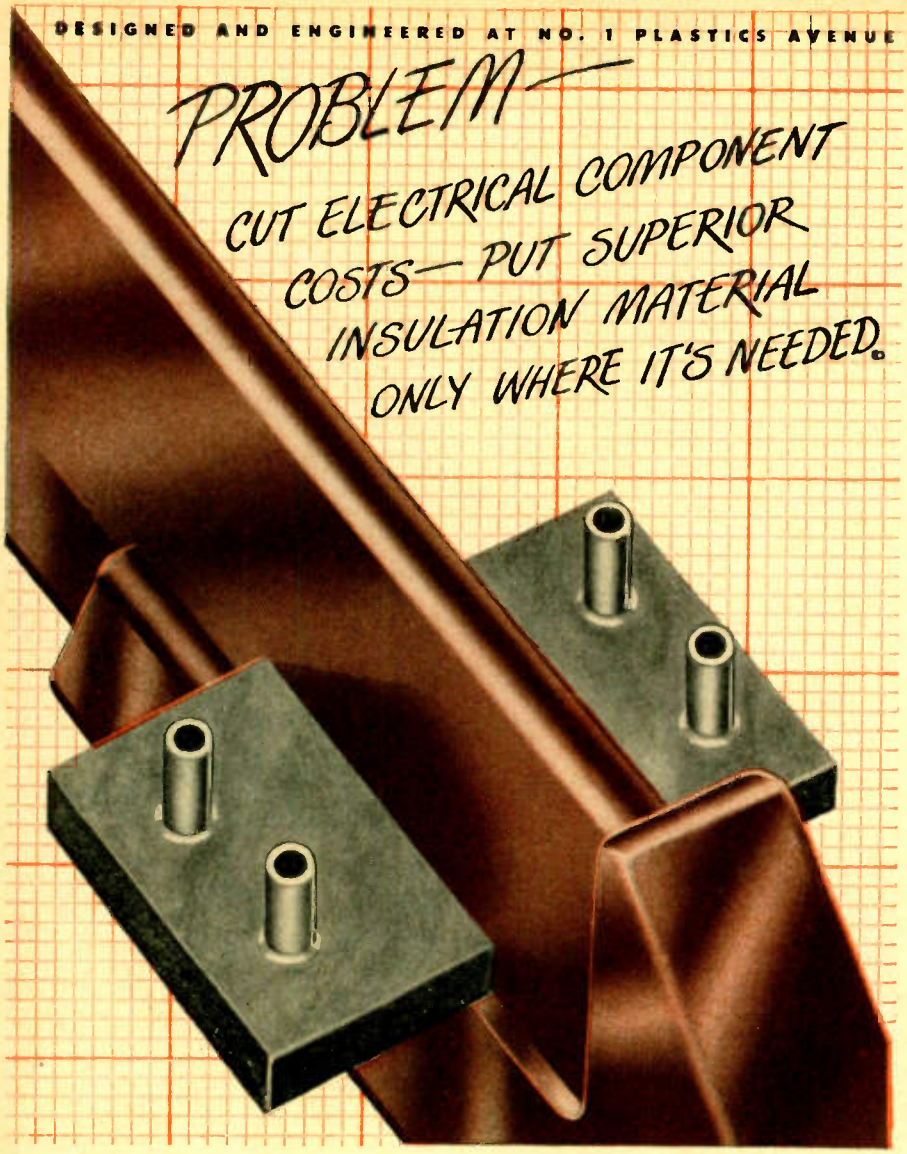


# G-E MYCALEX—the insulator that can be bonded in an insulator

● This rectangular piece of G-E mycalex plays a vital part in the cutouts that protect street lighting circuits from overloads. The design of the cutout calls for insulation material with a superior combination of properties that can be molded as an insert into a less expensive red phenolic plastics part. To meet these requirements, G-E mycalex was selected—a compound of glass and mica that withstands the frequent voltage stresses of the application and stays resistant to heat, moisture, and arcing.

Metal studs are firmly molded into the G-E mycalex, and the G-E mycalex insert itself is securely anchored in the phenolic plastic. New and improved designs for electrical components are possible with these two unique features. And in many cases, lower costs are an additional result.

General Electric engineers will be glad to advise you on the uses of G-E mycalex—will mold parts to your own design. Learn the full story of this unique insulating material by sending for our new bulletin—"G-E Mycalex." Write to Section T-16, Plastics Divisions, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.

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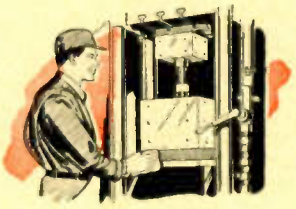
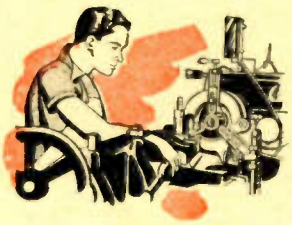
You may order fabrication of sample G-E mycalex parts at surprisingly low cost. Test them yourself in your own equipment. Then, if you decide to specify G-E mycalex, your design can be converted to a molding process which permits speedy and economical production runs.



MOLDING SERVICE



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*Samples Supplied on Request*

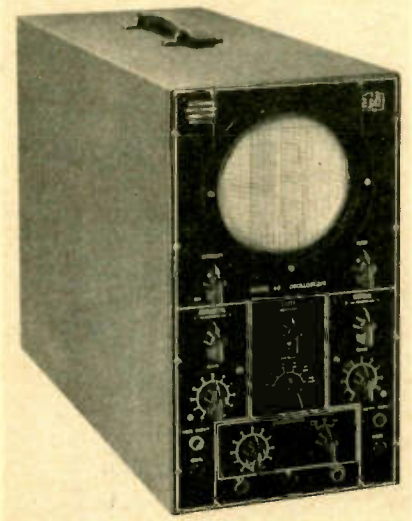
MYCALEX

# GENERAL ELECTRIC

CD46-M16

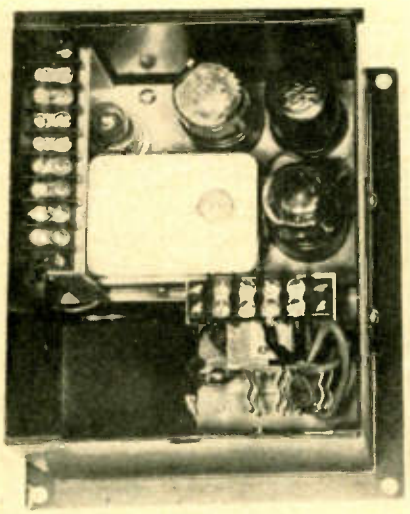
# ELECTRONIC PRODUCTS

***Parts, components, materials the manufacturers offer***



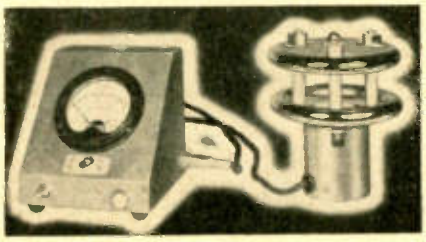
### CR Oscilloscope

Model 49 cathode ray oscilloscope is a new version with improved linearity of sweep, synchronization control and excellent square wave response. Five tubes are used for vertical and horizontal amplification, for the sweep oscillator and for rectification. Frequency response ranges from 10 cycles to 300 kc, the sweep range being from 10 cycles to 60 kc in 4 steps. Deflection sensitivity of the unit is 1 volt rms per in. **Electronic Development Laboratory, 2655 W. 19th St., Chicago 8, Ill.**—Electronic Industries



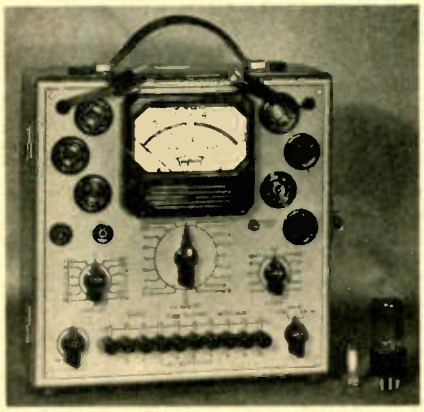
### Overheating Protector

The Ashcroft thermal protector is an electric limit switch actuated by a thermocouple to protect equipment and materials against excessive temperatures. The limit temperature may be chosen with an accuracy of 2% in the available ranges of 100° F to 1000° F, or from 800° F to 2000° F. The protector will "fail safe" for the conditions of excessive temperature, burning or breaking of thermocouple, tube failure or power supply failure. **Manning, Maxwell & Moore, Bridgeport, Conn.**—Electronic Industries



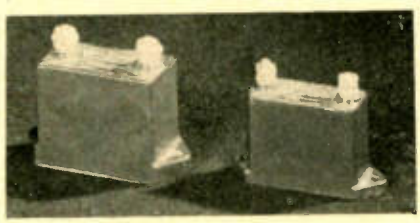
### RF Voltmeter

An rf voltmeter, which measures directly the potential between the applicator electrodes of dielectric heating installations, consists of a coupler connected to the high voltage electrode, and an indicating unit. The indicator incorporates a small rectifier and a sensitive meter calibrated in two ranges from 0 to 5 and 0 to 25 kilovolts. The coupler is a voltage divider with built-in acorn tube for rf rectification. The instrument has a frequency range from 5 to 60 mc and is for operation on 115 volt, 60 cycle, ac. **Electronic Apparatus, Radio Corp. of America, Camden, N. J.**—Electronic Industries



### Tube Tester

Model 2425 tube tester reads transconductance directly by a simple measurement directly proportional to $G_m$ of the tube. "Short" and "open" tests of every tube element as well as gas tests are provided for. There is no possibility for grid overloading. **The Triplett Electrical Instrument Co., Bluffton, Ohio.**—Electronic Industries

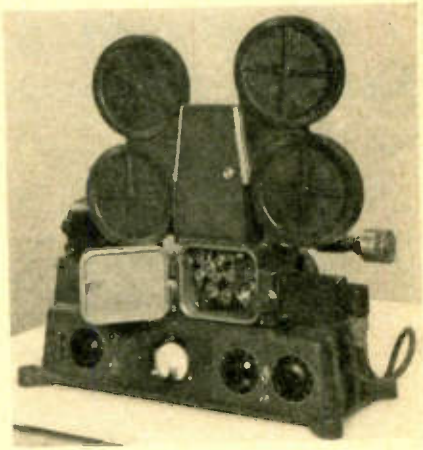


### Plastic Cased Capacitors

Lectrofilm capacitors suitable for rf blocking and by-pass applications are now available in low-loss plastic cases. In case style 65 four ratings are listed from .0001 mfd at 3000 volts dc to .1 mfd at 500 v. dc. In case style 70 four ratings are available from .0001 mfd at 5000 v. to .1 mfd at 750 v. dc. **General Electric Co., Schenectady 5, N. Y.**—Electronic Industries

### Vacuum Tube Voltmeter

Type 1800-A vacuum tube voltmeter, which supersedes Type 726-A, but is smaller and lighter, reads dc from .01 to 150 volts and ac from .1 to 150 volts. Frequency correction curves for resonance and transit time effects are supplied up to 500 mc. For relative voltage indication the instrument may be used up to 2500 mc. Zero setting is the same for all ranges. Input resistance for low frequencies is 25 megohms, for dc 10 megohms or open grid. Rated accuracy is ± 2%. The regulated power supply consumes 25 watts on 100 to 130 volts, 50 to 60 cycles, ac. **General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.**—Electronic Industries

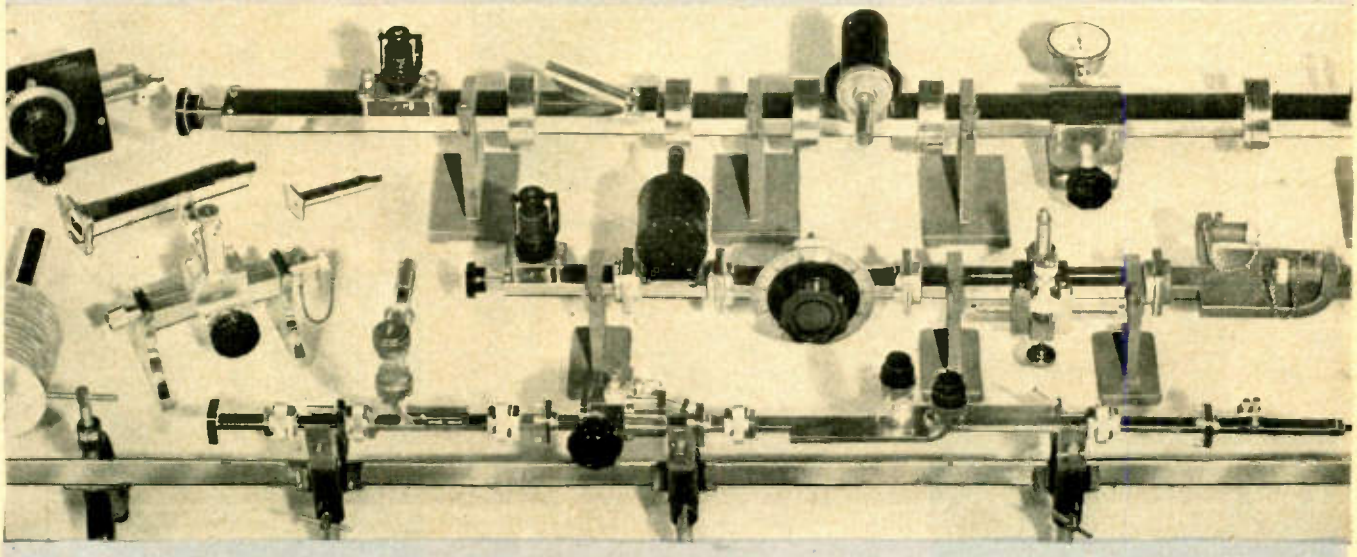


### Sound Recorder

A sound-on-film recorder and reproducer utilizes standard motion picture film in 16, 35 or 50 mm sizes and permits printing of unlimited quantities of the master recording in a daylight printer, which is part of the equipment. Six separate sound tracks may be recorded on 16 mm film, the recording time being approx. 17 minutes on a 100 ft. roll. Audio frequencies up to 10,000 cycles can be recorded with the equipment, which weighs less than 100 lbs. **Electronic Chemical Eng. Co., 443 So. La Cienega, Los Angeles 36, Cal.**—Electronic Industries

# 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.

DE MORNAY BUDD

EQUIPMENT FOR 97% OF ALL RADAR SETS

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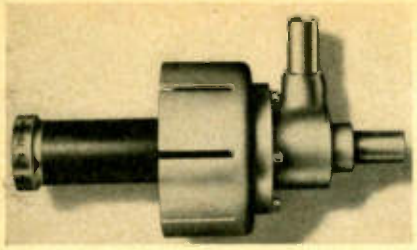
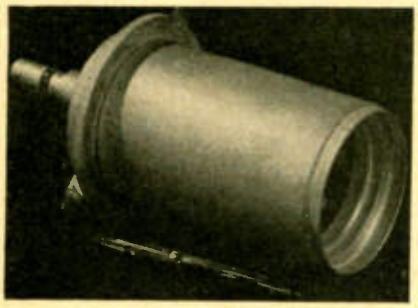


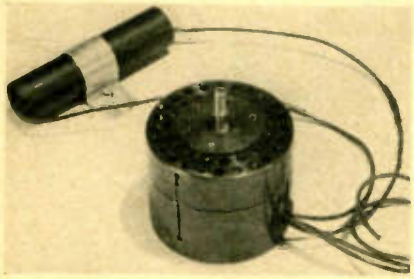
### Water Cooled Resistor

For television, FM, and dielectric heating applications a liquid cooled, high frequency high power resistor is now being offered. Inside the type LP resistor a high velocity stream of water flows in a spiral path against the resistance film, the cooling action being adjustable by means of interchangeable intake nozzles to suit local water pressure and power dissipation up to 5 KW. The resistance film is less than .001 in. thick and has an active length less than one-quarter wavelength at fm and television frequencies. LP resistors are available in values of 35 to 1500 ohms with a standard tolerance of ±15%. The resistance elements are interchangeable. The unit may be mounted directly on the end of a coaxial line. **International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.**—Electronic Industries



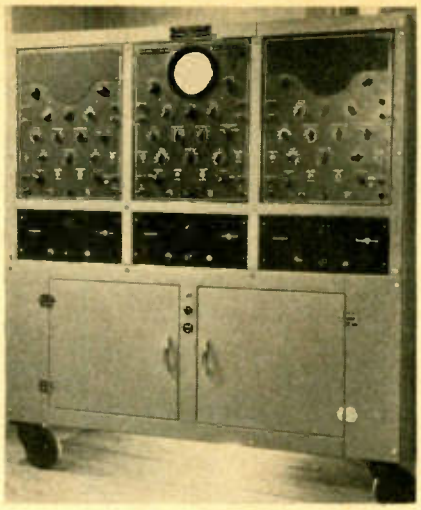
### High Power Magnetron

A new magnetron furnishes 5 kw of continuous power output for use as cw oscillator operating on 1050 mc. The tube has a range of efficiency from 60 to 65% at max. power output and permits heating in a cavity or enclosure making it efficient for plastics and industrial heating applications. Cathode terminals and water connections may be turned in any direction. The anode is watercooled, the cathode a tungsten filament. **Electronics Dept., General Electric Co., Thompson Rd., Syracuse, N. Y.**—Electronic Industries



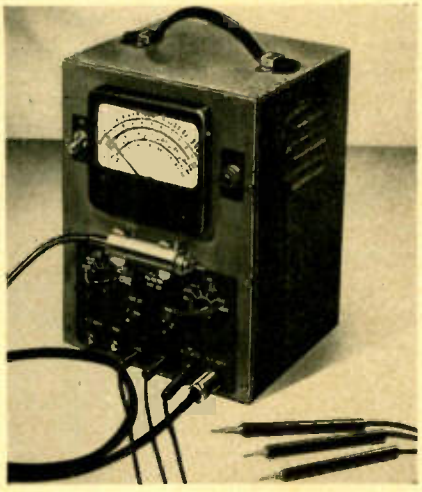
### Synchronous Motor

A single-phase synchronous capacitor motor based on a new principle has been designed for use on record changers, wire and tape recorders, timers, etc. Weighing but 18 oz. the 3,600 rpm motor has a max. output of 2.4 watts, a starting torque of .75 oz. in., running torque of .9 oz. in. at 117 volts, and a low magnetic leakage field. The unit is for operation on 117 volt, 60 cycle, ac. **Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.**—Electronic Industries



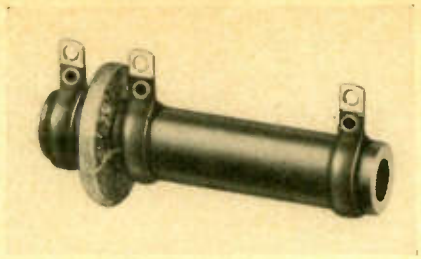
### Three-channel Oscilloscope

To utilize their new triple-gun cathode ray tube (type 5Z3P11), three type 247 oscilloscopes have been assembled to permit simultaneous display of three phenomena on a single screen. Switching facilities provide for independent use of three vertical, three horizontal and three intensity modulation amplifiers, or any of these circuits may be connected in parallel if desired. All twelve deflection plates, as well as the three second anodes, are accessible for direct connection to signal sources. Characteristics of each channel are identical to those of the Dumont type 247 oscilloscope. The type E-3G47-S1 equipment is supplied with a General Radio 35 mm. oscilloscope camera for recording traces at speeds from 5 to 35 ft. /sec. **Electronic Tube Corp., 1200 E. Mermaid Ave., Chestnut Hill, Phila. 18, Pa.**—Electronic Industries



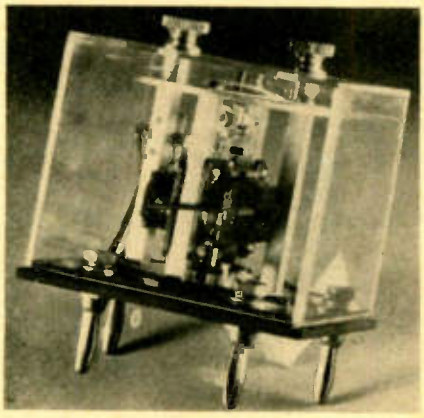
### Electronic Circuit Tester

The first test instrument to use type 1247 proximity fuse type tube in a midget probe for signal tracing, the type 134 Polymeter provides an unusually wide range of electrical measurements for radio, FM, TV, and industrial electronic equipment operating on frequencies up to 300 mc. The instrument has a balanced amplifier circuit practically independent of line voltage and permits correct zero setting for all ranges by preset factory adjustments. Measurements include 0-1000 V. dc in 6 ranges, 0-300 V. ac in four ranges for af to 15 kc and for rf from 10 kc to 300 mc., 0-10 amps. current in 7 ranges, and 0-1000 megohms resistance in 6 ranges. The Polymeter is rated at 30 watts input at 105-125 volts, 50-60 cycles, ac. **Sylvania Electric Products, 500 Fifth Ave., New York 18, N. Y.**—Electronic Industries



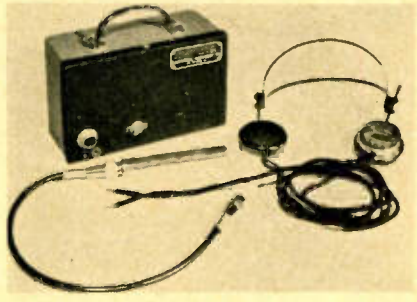
### Video Coupler

A new television component, the video-coupler, has been designed to couple the video amplifier to the picture tube in television receivers. It is a three-terminal network, and combines three units in one assembly, including two peaking inductances and the load resistor. Convenient to use, it saves unnecessary procurement, handling, and variations incidental to the three individual parts it can replace. Accurate and consistent electrical characteristics are insured. **P. R. Mallory & Co., Inc., Mallory Bldg., Indianapolis, Ind.**—Electronic Industries



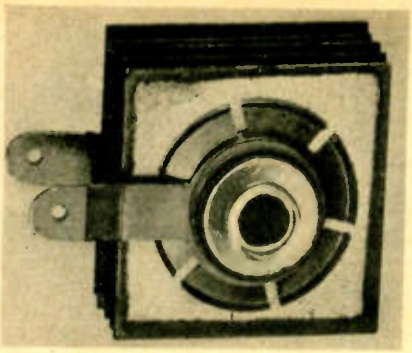
### Frequency Selective Relay

A torsional type frequency selective relay for the control of a number of operations in variable sequence from a remote location has been designed to have high stability over a wide range of ambient temperature and pressure conditions. The oscillating member of the relay consists of a pair of astatically balanced magnets suspended on a main shaft. An arrangement series of torsional relays is available covering the frequency band of 10 to 20 cycles, the frequency being adjustable within the limits of ± ½ cps. Contact capacity of the relays is .05 amp. and max. contact voltage is 100. **Wallace & Tiernan, Inc., Belleville 9, N. J.**—Electronic Industries



### Radioactivity Detector

For outdoor field service or for laboratory radioactivity studies model 5A radioactivity detector fills the need of a small, portable, lightweight instrument with self-contained batteries. The instrument proper, weighing 4¾ lbs, contains all auxiliary amplifying apparatus, and an oscillator to provide 1000 volts operating potential from miniature "B" bateries for the Geiger-Mueller counter tube. **Geophysical Instrument Co., Key Blvd. and Nash St., Arlington, Va.**—Electronic Industries

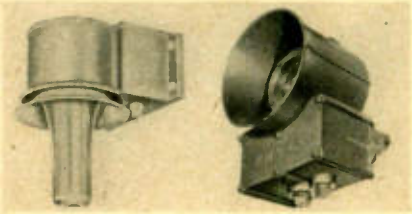


### *Selenium Rectifier*

A miniature five plate selenium rectifier, the 5M1, has been designed to replace such rectifier tubes as 25Z5, 35Z5, 117Z6 and others in ac-dc battery portable radio receivers, console radios and vibrator power supplies. Radio equipment using this rectifier starts instantly, as no warmup time is required. Only one in. by one in. and occupying less than one cubic in. of space, the rectifier is to be used with 25 ohm series resistor and maximum capacitance of 40 mfd. Maximum continuous current is 100 milliamperes at an ambient temperature of 35 degrees C. **Radio Receptor Co., Inc., 251 West 19 St., N. Y. 11, N. Y.**—Electronic Industries

### *Appliance Temperature Tester*

A new appliance temperature tester has been designed for use by appliance servicemen in the home, and for laboratory technicians and contractors. The unit checks operating temperatures of all types of refrigeration, and covers quick-freeze and deep-freeze temperatures as low as minus 100 degrees F. It also tests oven temperatures of gas and electric ranges. Four cold zones and two heat zones can be measured at one time by turning a switch to proper bulb and thermocouple positions. **J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.**—Electronic Industries



### *Explosion Proof Speakers*

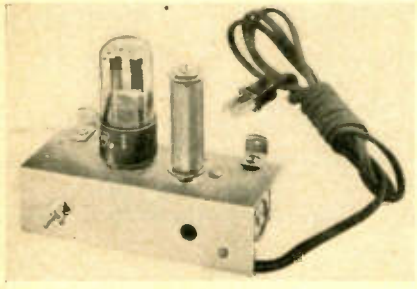
Two new submergence and explosion proof loudspeakers, Model MSR and Model MM-2TC are available for extreme operating conditions of dust, spray, humidity, shock or under water service. Model MSR consists of a reflex air column horn, a radial deflector for 360° dispersion, and a hermetically sealed housing with a driver unit providing 15 watts output in the range from 250 to 6000 cycles. Model MM-2TC is a directional speaker consisting of a reflex air column horn and sealed housing with high capacity driver unit, having output characteristics similar to model MSR. **University Loudspeakers, 225 Varick St., New York 14.**—Electronic Industries

### Magnetic Recorder

A magnetic recording-reproducing machine using a ¼ in. wide magnetic coated paper tape, complete with driving units, amplifier, speaker, and crystal microphone permits a recording time of 30 minutes on one reel. Frequency response of the unit is from 100 to 5,000 cps, signal-to-noise ratio approx. 40 db. The recordings are permanent. **Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio.**—Electronic Industries

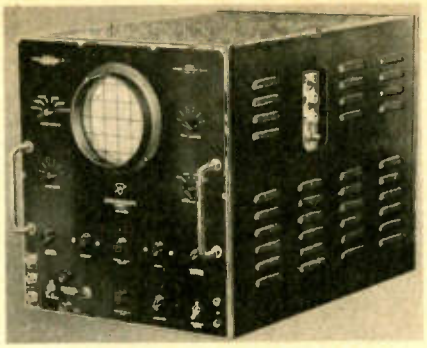
### Electronic Galvanometer

For the measurement of dc and low frequency ac voltage in the microvolt range a new contact modulated amplifier has been designed to replace suspension type galvanometers in circuits having between 5 and 100,000 ohms resistance. The equipment has a faster response than sensitive galvanometers, is not subject to vibration, and is suitable for actuating recorders, relays or dc motors. The amplifier uses a breaker to interrupt the input current, converts it to an 80 cycle ac voltage, and after amplification, rectifies the output synchronously. The unit is available for 6 volt battery operation or for 110 volts, 60 cycles, ac. **The Perkin-Elmer Corp., Glenbrook, Conn.**—Electronic Industries



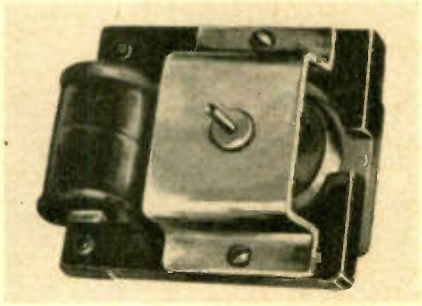
### Phono Oscillator

Any record player or automatic record changer may be linked to a standard broadcast reeciver over a distance of 50 ft. by means of this phono oscillator which uses a 12SL7 tube. The unit is 2 in. wide, 5¼ in. long, and 4¼ in. high. The oscillator is permeability tuned to 600 kc, but may be adjusted anywhere in the range from 550 to 1550 kc. **D & M Mfg. Co., 51 Lincoln Ave., Midland Park, N. J.**—Electronic Industries



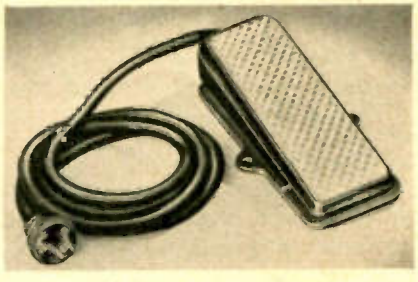
### Waveform Analyzer

The synchroscope is designed for the visual examination of shape, amplitude, and duration of pulsed waveforms in television, pulse time modulation, sonic depth finders, geophysical exploration, etc. The instrument includes a 5 in. tube, a trigger generator for synchronization, and adjustable time delay phasing circuits. Space is provided for addition of a video amplifier and rf envelope viewer. Sweep speeds range from .01 to 5 in. per microsecond, and may be delayed up to 90 microseconds. Repetition frequencies from 500 to 5000 p.p.s. are provided. The instrument consumes 200 watts at 105-125 volts, 50-60 cycles, ac. **Electronics Div., Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18.**—Electronic Industries



### Miniature Motor

A miniature motor of the self-starting, permanent magnet type, can operate on as little as 30 milliwatts power in applications where a limited source of power is a factor. The dc motor will work in any position and is designed to start in only one direction, regardless of polarity reversal. To meet individual requirements the motors are manufactured with a number of bearing designs, and different field coil windings for operation on a variety of specific voltages. The illustrated model 2000-2 weighs 2¼ oz.—**Alnl Corp., 10 E. 52 St., New York 22.**—Electronic Industries



### Foot Switch

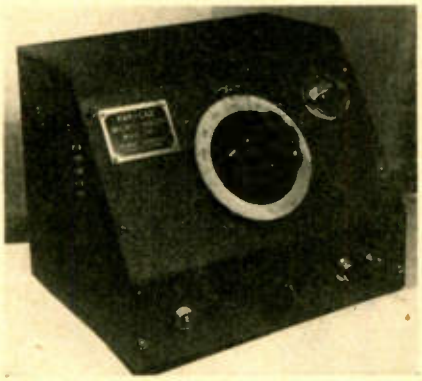
Made especially for equipment requiring reliable control of power with complete freedom of the operator's hands, this foot-operated switch for series circuits is made of cast aluminum. Power handling capacity is 1000 watts at voltages up to 220 ac or 32 dc, non-inductive loads. Switch mechanism is snap action type, and can be supplied SPST or SPDT, either normally open or normally closed. **Electronic Controls, Inc., 44 Summer Ave., Newark, N. J.**—Electronic Industries

### Capacitor Housing

A general utility housing for motor-starting capacitors accommodates the standard 1⅝ x 3¼ in. unit without any auxiliary caps or brackets. The housing, made of heavy-gage metal, completely covers and protects the capacitor and terminal assembly, and fits the motor frame contour. It provides a rugged, shock-proof installation. **Aerovox Corp., New Bedford, Mass.**—Electronic Industries

### Range System

A tunable VHF receiver for operation on omnidirectional airways range systems is available for airline flight tests on the New York-Chicago omnidirectional range. The experimental receiver covers the range from 108 to 135 mc and includes a converter, indicating units, and other circuits necessary for flight operations and phase-comparison localizer installations. **Aircraft Radio Corp., Boonton, N. J.**—Electronic Industries



### Wiring Capacity Meter

Model 401A Micro-Miker will measure shunt capacity in vacuum tube amplifiers directly without disconnecting the load resistor or disturbing the circuit. Input and output capacities of vacuum tubes and stray capacity between wiring and chassis also may be measured by direct substitution in a parallel resonant circuit at a frequency between 2.5 and 3.5 mc. The instrument consists of an rf oscillator coupled to a tuned detector with a tuning eye to indicate resonance. The capacity bridge provides a range from 0 to 230 mmfd on a semilogarithmic scale. Four tubes are used. **Kalbfell Labs., 1076 Morena Blvd., San Diego 10, Cal.**—Electronic Industries


The Collins 18S-1 Aircraft Transmitter-Receiver

# Reliable Aircraft Communication for Commercial and Executive Planes


The Collins 180K-1 Antenna Loading Unit

Commercial airlines and owners of executive type planes have found that the Collins 18S-1 gives them the dependable long range communication they want. They are able to establish and maintain firm contact with ground stations, even under adverse conditions.

The 18S-1 delivers more than 100 watts of power on any of twenty crystal controlled frequencies. The receiver section, of superheterodyne design, also has twenty crystal controlled frequencies. Frequency range is 2.7-12.0 mc. After the equipment has been pretuned to desired channels, all frequency selection is automatic. Remote control is provided.

A single 1½ ATR unit cabinet contains the transmitter, receiver, and dynamotor power supply. The receiver operates directly from the 28 volt d-c power source. Weight, including shock-mount, is 60 pounds.

**Other models:**

**The 18S-2** *includes CW facilities.*

**The 18S-3** *includes CW facilities and has a frequency range of 2.7 to 18.0 megacycles.*

The 180K-1 antenna loading unit efficiently transfers the power output from an 18S to any standard commercial fixed antenna. Remote controlled, pretuned operation for ten channels is provided. Nominal input impedance is 50 ohms. Weight 12 pounds. Size 12" w, 7½" h, 10½" d.

**IN RADIO COMMUNICATIONS, IT'S . . .**

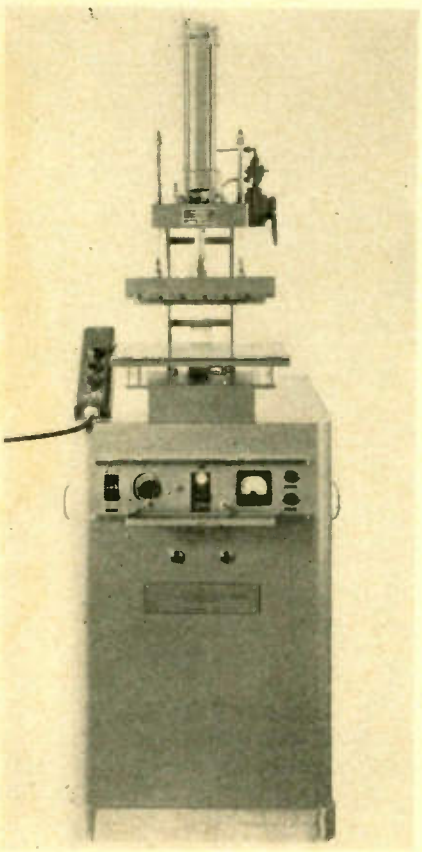
**COLLINS**

**COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA**

11 West 42nd Street, New York 18, N. Y. • 458 South Spring Street, Los Angeles 13, California

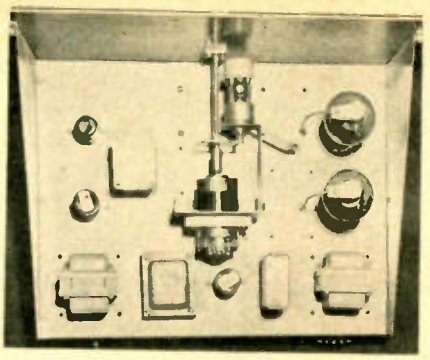
### Mobile FM Equipment

Comco model 210, a mobile VHF transmitter-receiver for use in taxicabs, police, etc., operates in the 152-162 mc band and uses crystal controlled narrow swing FM. Transmitter and receiver are on the same chassis; the power supply, containing a 600-volt dynamotor, is separate. The receiver is a dual conversion, crystal controlled superheterodyne with 17 tubes with a stand-by drain of 3.8 amps. Either single channel or dual frequency operation is possible. The illustrated "Taxicab Package" contains all items necessary for complete installation. **Communications Co., 300 Greco Ave., P.O. drawer 6250, Coral Gables, Florida.**—Electronic Industries



### Dielectric Sealer

Type K-3-S Thermatron 2½ kw dielectric sealer is suitable for sealing, welding or bonding thermoplastic sheets and has been especially designed for mounting type 4 sealing press on the unit and operating it by foot controls. The unit utilizes a frequency of 27.4 mc, provides a heat output of 8,550 BTU per hour, and is equipped with long-life, external anode tubes. It operates on 220 volts, 60 cycle, single phase, ac. **Thermatron Div., Radio Receptor Co., Inc., 251 West 19 St., New York 11.**—Electronic Industries



### Follow-up System

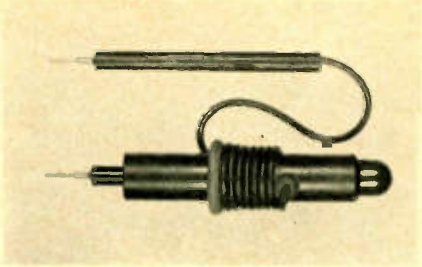
A new servo follow-up system has been developed for use where accuracy is desired in remote control, motor positioning, gaging of liquid levels and similar applications. The system has an output torque of 96 in.-ounces, and can be ordered for special uses in order to control up to ½ hp motors. Maximum following speed is approximately 50 rpm, and it has the high positioning accuracy of .027%. The system can also be used in reverse direction to control mechanical movement remotely in any application where a theoretical perfect long flexible shaft without backlash requiring inappreciable torque would be satisfactory. **Electronic Associates, Inc., 61 Brighton Ave., Long Branch, N. J.**—Electronic Industries

### Amateur Receiver

The Collins 75A receiver has 14 tubes in a double conversion circuit with 1 rf and 3 IF stages to provide 2.5 watts output into 500 or 4 ohm loads with an rf input signal of 1 microvolt and a signal to noise ratio of 10 db. Straight line coverage of the 80, 40, 20, 15, 11 and 10 meter bands is obtained by a new system of permeability tuning. Image rejection is a minimum of 50 db; bandwidth is variable by use of crystal filter controls in five steps from 4 kc to 200 cycles at 6 db down. The receiver operates on 115 v., 50/60 cycles, ac. **Collins Radio Co., Cedar Rapids, Iowa.**—Electronic Industries


### Resonant Relay

A resonant relay, which can be used for electronic applications without an auxiliary relay, has a vibrating reed mechanism adjusted to respond to a narrow band of frequencies (260-320 cps) and to reject all others. In electronic uses, the grid of a thyratron is triggered directly from the vibrating contacts of the resonant relay. A small amount of energy received by the relay at its resonant frequency causes the contacts to vibrate. When the relay operates, the current from the power supply is delivered to the circuit to be controlled in pulses at the resonant frequency of the relay. **Stevens-Arnold Co., 22 Elkins St., South Boston, Mass.**—Electronic Industries



### Test Lamp

A filament test lamp and voltage indicator is available in two models from 100 volts to 600 volts for use on ac or dc circuits to locate grounds, open circuits, blown fuses, etc. Variation in light glow indicates approximate voltage. The lamp is equipped with a number of safety provisions to eliminate shock and breakage hazards.—**Holub Industries, Inc., Sycamore, Ill.**—Electronic Industries

### Process Operation Recorder

The number and length of operations and processes, such as the turning on and off of electric motors, electric furnaces, etc., may be determined with an operation recorder which will indicate and record up to 25 operations per minute. Operations may be recorded from 12 hours to seven days on renewable charts, the total number being totalized on an electric counter. The recorder will operate from any contacting device suitable for operation on low (6 V.) voltage. The device is especially useful to record processes and operations of industrial machines at a central location. **Instrument Laboratory Inc., 926-34 Elliot Ave. West, Seattle 99, Wash.**—Electronic Industries

### Frequency Monitor

A combination FM frequency deviation and modulation meter permits measurement of ±15 kc carrier frequency deviation and 20 kc modulation each side of center frequency on 1 to 4 channels in the 152 to 162 mc band. The instrument has an accuracy of ± .0015% with readings possible to .0003%. All crystals are temperature controlled, and each instrument is individually calibrated. **Doolittle Radio Inc., 7421 S. Loomis Blvd., Chicago, Ill.**—Electronic Industries

### *Dial Graduation*

The Linotone process is a new method of precision engraving for the production of graduating dials or scales with an accuracy usually only possible with costly machine tools. Precision on circular dials is ±1 minute of arc at 3 in. of radius. In place of tools and dies a highly precise master is used, permitting great flexibility and even changes in design during production. Being particularly suitable for high quality-low volume work, the process is applicable to aluminum, brass, steel, and plastics without regard to the surface contour. Tolerance is less than 1/1000 in. in all dimensio s. **Linotone Corp., Div. Mergenthaler Linotype Co., 536 W. 35th St., New York 1.**—Electronic Industries

### *Volt-Ohmmeter*

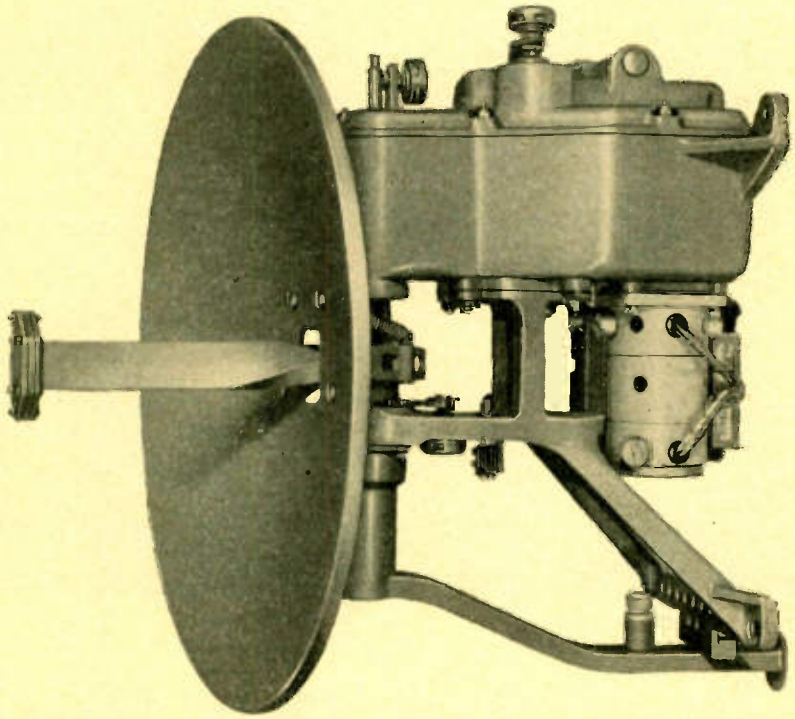
The advanced model WV-75A of the VoltOhmist uses a special diode probe for measurement of peak-to-peak voltages up to 250 mc. The instrument comprises a vhf voltmeter, an audio, ac and dc voltmeter, ohmmeter and fm indicator. Ac and dc voltages may be read up to 1000 volts, resistance measurements may be made from 0 to 1,000 megohms in six ranges. A specirl protective electronic circuit prevents burning out the meter. **RCA Victor Div., Radio Corp. of America, Camden, N. J.**—Electronic Industries

### *Expanding Arbor*

Certain machining processes may be speeded up through the use of this expanding arbor on secondary operations where work-piece is held by the inside diameter. Its design permits chucking and unchucking work-piece without stopping the spindle when used on a screw machine or lathe with standard collet. Since expansion is accurate, concentricity is maintained with the collet. Made in sizes from ⅜ in. to 1 in., at 1/64 in. intervals, an entire range is accommodated with three collet sizes. **Asco Corp., 874 East 140th St., Cleveland, O.**—Electronic Industries

(*Continued on page* 127)

# AIRBORNE RADAR ANTENNA TYPE AN/APS-4



During the war air search operations for the location of surface vessels, and for mapping, were of paramount importance in attaining victory. The need was successfully met by the development of the AN/APS-4 Airborne Radar Antenna, which was used on our bombers, land-based planes and carrier-based fighters.

DALMO VICTOR'S superior design of the AN/APS-4 Antenna was among the foremost contributions in the outstanding performance of this equipment.

DALMO VICTOR is developing and producing micro-wave equipment to be applied to peace-time uses. We solicit inquiries from electronic engineers, aircraft companies—from all who may be interested.

## LIGHT WEIGHT SIMPLICITY LONG LIFE!

*These are the features which distinguish the success of the DALMO VICTOR -designed and -developed AN/APS-4 Airborne Radar Antenna.*

•

Typical of component parts combining these features are the Main Gear Drive and Gear Housing illustrated here.

MAIN GEAR HOUSING

*Light Weight!*

The AN/APS-4 Antenna weighs less than 13 pounds! Quantity production was accomplished through good basic design, incorporating magnesium castings, aluminum reflectors, and snap retaining rings.

MAIN GEAR DRIVE

*Simplicity!*

Simplicity is the keynote in all DALMO VICTOR airborne radar antenna designs. In the AN/APS-4 Antenna, simple direct drives and gearing with a minimum of moving parts were used.

•

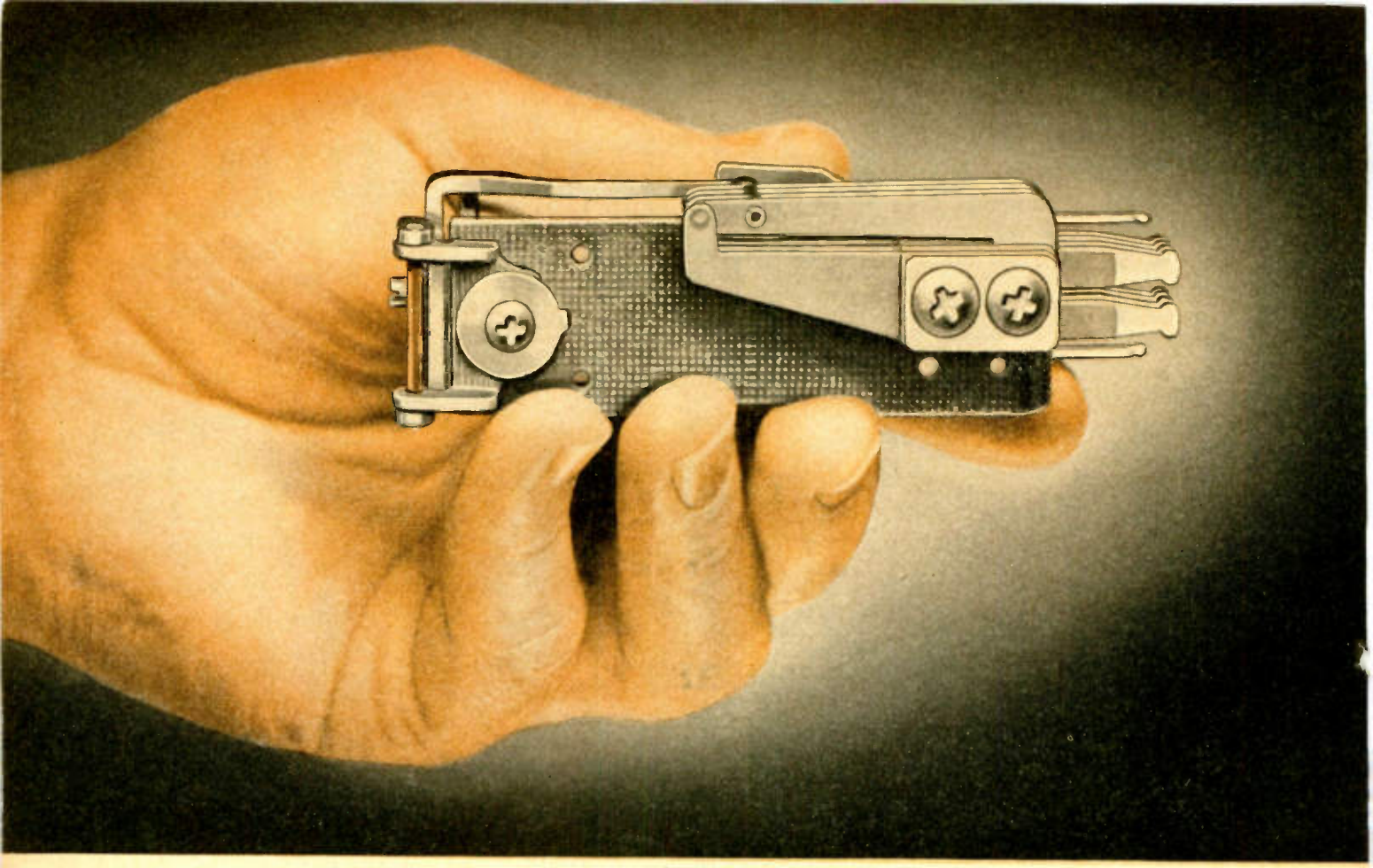
*Long Life!*

The AN/APS-4 Antenna, built for the U.S. Navy, has an operating life of 2000 hours before major repairs —the equivalent of approximately 600,000 scheduled miles of "Constellation" flying.

DALMO VICTOR

*Manufacturers*

SAN CARLOS, CALIFORNIA



# Relays Are Our Business!

● Every effort of the Clare organization is directed toward the production of carefully designed relays, well manufactured from high quality materials, precisely adjusted for perfect operation.

Clare "custom-building" gives the flexibility of design and construction that meets your most exacting new requirements . . . allows you to design freely and rely on the skill of Clare engineers to give you the unusual, new and improved features to fit your purpose.

Where inches and ounces count, Clare gives you compact construction to fit modern streamlined design. Is your need for more efficient operation, greater ability to withstand vibration, new and different electrical characteristics? Clare engineers are ready to "custom-build" just the relay for the job.

Clare "custom-building" is a method of construction. It permits choice of a wide range of contact ratings . . . five different contact forms or any combination of them . . . either flat or hemispherical contacts which may be of rare metals or special alloys.

Clare Relays are built for applications where precise performance, long life, and dependability are prime requisites. Thousands of users attest to the value of Clare Relays and the Clare "Custom-Built" principle.

Clare sales engineers are located in principal cities to help you with your relay problems, show you how Clare "Custom-Built" Multiple Contact Relays are the effective answer to modern design problems. Send for the Clare Engineering Data Book today. Address C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable address: CLARELAY. In Canada: Canadian Line Material, Ltd., Toronto 13.

# CLARE RELAYS

**"Custom-Built" Multiple Contact Relays for Electrical and Industrial Use**

## REMOTE AMPLIFIER

(*Continued from page 71*)

tode with feedback looped to the interstage cathode. As has always been true in the past, the writer found that a tube as a pentode with feedback does not give the quality that the same tube will as a triode with somewhat less feedback. It was also noted that the greater the applied feedback, the more critical the design of the transformer becomes.

After some investigating, it was found that the 6AK6 connected as a triode would easily give +17 dbm (50 milliwatts) output with 135 volts on the plate and a drain of 11 milliamperes. Using 6 to 8 db of feedback, the 1,000 cycle distortion at this point was only 1.0%.

After checking the output stage, the overall gain was further considered. In the input circuit, four T type faders in series parallel give a 6 db loss. The microphone transformer, having a 50,000 ohm output impedance, gives a voltage gain of 26 db when the secondary is unterminated as is customary in preamplifiers. This gives a net voltage gain of 20 db going into the preamplifier stage.

It was found that approximately 40 db gain is the maximum available from the 9001 tube if the plate load is to be held to 100,000 ohms maximum. The remaining voltage gain required (30 db) was found to be easily obtainable from the last two stages including the feedback circuit.

### *Battery power*

The next problem considered was that of the battery power supply. The required voltages are 6.3 volts at 0.45 amperes and 135 volts at 12 milliamperes. After much consideration, the following conclusions were reached for the battery requirements:

(a) Dry batteries are the cheapest and easiest to handle for both filament and plate voltages.

(b) Dry batteries give the best life and performance as filament batteries if figured at a cell voltage of approximately 1.25 volts each.

(c) Five cells in series plus a small rheostat is the best choice for the filament supply.

The batteries chosen for the filament were the Burgess type 4F. This type is made by at least ten different manufacturers and is very low in price. The plate supply batteries chosen were Eveready

(*Continued on page 101*)

## every time we do this stunt—

# A Manufacturer Cuts His Production Costs!

Bending over backwards for our customers is part of C-D's service. Actually though, designing a special type capacitor may not be so strenuous a job for us. Not because your capacitor problem is a breeze. It simply comes easier to us, than to most other manufacturers, to bend ourselves to specialized tasks.

For, in the course of designing and manufacturing over ¼ of a million different types of capacitors, our engineers have gathered a wealth of information, experience, or call it "know-how" that speeds the solution to every problem they handle. And the sooner your requirements are met . . . the more perfect the design — the greater are your savings. Typically, of the many problems C-D engineers have successfully licked are the capacitor types shown below.

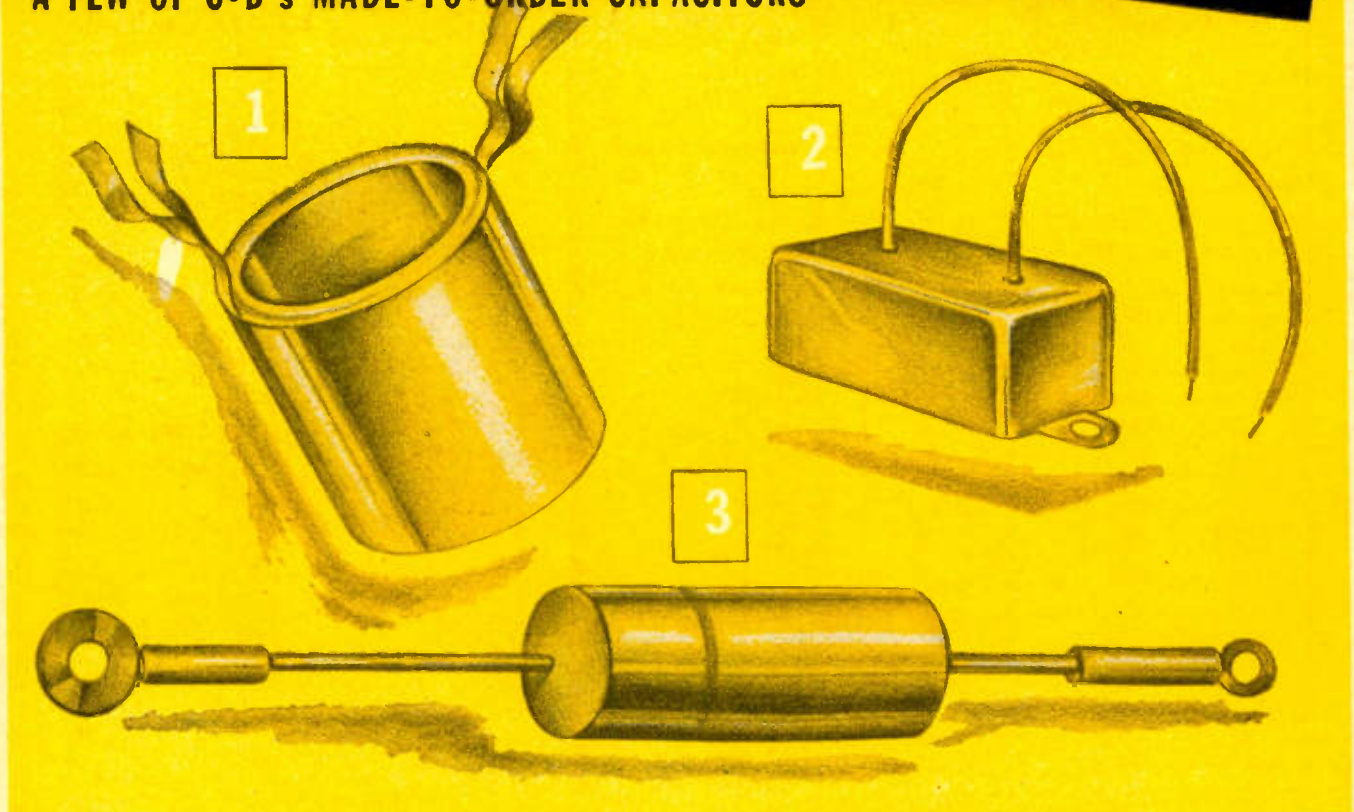
If your plans call for anything in capacitors, consult with our engineers. Catalog of standard types available on request.

Cornell - Dubilier Electric Corporation, South Plainfield, New Jersey. Five other plants in New Bedford, Providence, Worcester and Brookline.

**CORNELL-DUBILIER**
world's largest manufacturer of
**CAPACITORS**

**MICA • DYKANOL • PAPER • ELECTROLYTIC CAPACITORS**

### A FEW OF C-D's MADE-TO-ORDER CAPACITORS




**CAPACITOR #1.** This capacitor unit was designed for a manufacturer of motors. Mounts directly on motor shaft.

**CAPACITOR #2.** Designed for spark suppressor applications in home appliance equipment. An inexpensive dependable unit for competitively priced mixers, juicers, grinders, etc.

**CAPACITOR #3.** Standard paper tubular capacitor adapted for automobile ammeter, oil pump, radio noise filter applications, etc.

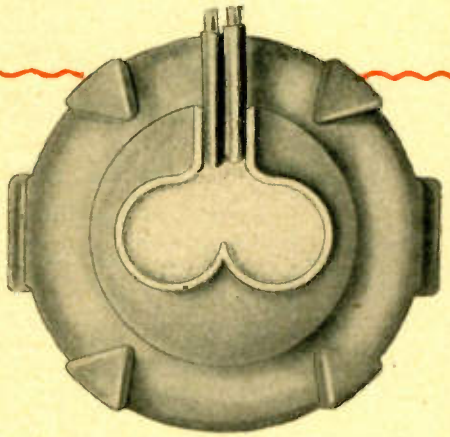

# Fibron #5373
## flexible plastic tubing

Here is another application where this improved Irvington formulation . . . Fibron #5373 . . . solves an electrical insulation problem involving high temperatures. Hot cement, used to seal the #5373-covered heating elements, has no effect on the flexibility of this unusual plastic. When the heater is in use, the tubing withstands continuous operating temperatures as high as 85° C. #5373 possesses the electrical, mechanical, and chemical properties which distinguish all Fibron tubings. Some of these are:

| | |
|---|---|
| Dielectric Strength (.020" wall) wet | 1000 V.P.M. |
| dry | 1000 V.P.M. |
| Tensile Strength, P. S. I. | 3000 |
| Life at 105° C. | 2000 hours |

Fibron #5373 tubing is available in all standard B & S wire gauge sizes, in six brilliant colors, in heavy wall thicknesses if required—in 36" lengths, coils, or cut pieces.

Test this unusual product now. Generous samples and additional technical information gladly sent on request.



*Approved by Underwriters' Laboratories for this application

Short lengths of Fibron #5373 are used to protect the conductor leads on the heating element of the Electra-Serve, manufactured by Electrical Industries, Inc., Newark, N. J. This bottom view of the unit shows where the hot cement seals over the #5373 insulation. Withstanding this heat and high operating temperatures, #5373 tubing retains its flexibility and high dielectric strength.

**IRVINGTON** *Varnish and Insulator Company* IRVINGTON 11, NEW JERSEY, U.S.A.

***Authorized distributors in:*** BALTIMORE · BLUEFIELD, W. VA. · BOSTON · CHARLOTTE · CHICAGO · CLEVELAND · DALLAS · DENVER · LOS ANGELES · MINNEAPOLIS NEW HARTFORD, N. Y. · NEW YORK · NEW ORLEANS · PHILADELPHIA · PITTSBURGH · ST. LOUIS · SAN FRANCISCO · SEATTLE · HAMILTON, ONT., CANADA

type 482. This type is also made by many manufacturers and has high performance compared to its weight. Its price is low and it has a desirable space factor for this particular design. The life expectancy for the filament batteries is 50 to 55 hours and that of the plate batteries 100 to 125 hours.

The requirements for the ac operated power supply raised several problems. The power supply, in addition to being light and small, was required to operate within a few inches of a high gain preamplifier. This, of course, meant that very good hum shielding was necessary and also required that the ripple on the plate voltage had to be very low.

In order to avoid having more than one filament winding on the power transformer, the decision was made to use a cathode type rectifier tube with 6.3 volt filament. The choice of the rectifier tube to meet this requirement was between the 6X5, the 7Y4, and the 6ZY5-G. These are all 6.3 volt type tubes with well insulated cathodes. The 6ZY5-G tube has the lowest filament drain (0.3 amperes) but because it is a rather large tube, the 7Y4 was chosen. It has a filament drain of only 0.5 amperes.

The power transformer, requiring only 15 watts of power, was housed in a mu-metal microphone transformer hum shield. This same type shield was used to shield the cutover relay which was ac operated for the sake of power supply economy.

The power supply in its final form weighed 3 lbs. complete and was designed as a plug-in unit. The plate voltage ripple is 100 db below the output voltage of 150 volts.

### *Switching arrangement*

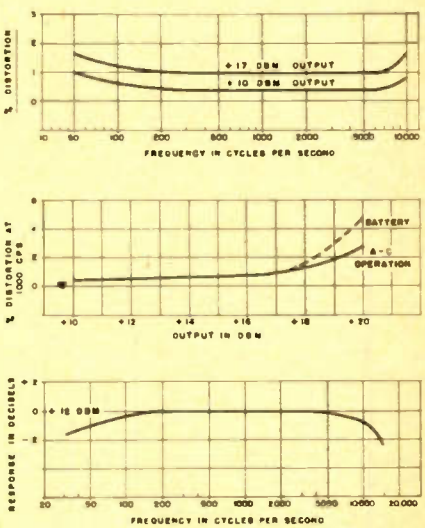
Provision is made in the output circuit for two remote lines and a telephone subset which is used for communication with the master control room. The output control switch provides switching the amplifier output from line No. 1 to line No. 2 in case of line trouble. The center switch position is provided for a cue circuit where only one remote line is used. In this position, only the line monitoring headphones is connected across the line. This means that there is no unnecessary loss of level of the cue signals at the amplifier end of the circuit. This is important, especially where the line loss is considerable.

(*Continued on page* 102)

In order to prevent the amplifier being left on when the front cover is closed, a small interlock switch is provided to open the filament circuit. A 3 db isolation pad is provided in the output circuit to give improved line matching.

The VU meter is the illuminated Weston type 862 and has an on-off switch to economize on battery drain when needed. When the switch is in the off position and the amplifier on ac power, loss of meter illumination indicates loss of ac power. A meter selector switch is provided for checking filament and plate batteries.

The final performance characteristics obtained in the design of the remote amplifier are as follows.




**Figs. 6, 7 and 8—Distortion and frequency response curves of the complete amplifier**

The distortion and frequency response characteristics are shown in Figs. (6), (7) and (8).

Gain: 92 db.

Frequency response: ±1 db from 30 to 12,000 cps.

Output level: +17 dbm maximum (50 milliwatts).

Distortion: 1% or less at all frequencies with output level of +10 dbm or less.

Noise level: 60 db or more (unweighted) below program level with input level of —60 dbm.

Power consumption: 15 watts on a-c operation.

Battery life: Filament batteries 50 hours. Plate batteries 100 hours.

Weight: 40 lb. complete with batteries.

Size: 14½ in. wide, 11½ in. high and 8¼ in. deep.

Where ac operation alone is required, the batteries may be omitted, thereby reducing the weight to only 28 lb. All structural members of the amplifier are aluminum.

## ELECTRONIC COLOR TV

(*Continued from page 59*)

stages in the timetable of laboratory demonstrations of electronic color television were outlined as follows: *Motion picture films* within 3 months; *Live-action studio scenes* by the middle of 1947; *Outdoor action scenes* by the latter part of 1947; *Large-screen theatre-size pictures* in 1948.

"RCA scientists and engineers have a complete plan for this schedule and our laboratory tests reveal that this is practicable," added Dr. Jolliffe. "We need only time to produce the necessary equipment such as cameras and tubes, so that a demonstration can be made in approximately one year, that will include all five stages at the same time, that is, the complete range of universal all-electronic color television—in motion, indoors and outdoors."

## BROAD BEAM TUBE

(*Continued from page 57*)

tered in the envelope. The ends of these rods are held in four slots placed ninety degrees apart in the metal collars to which the helix is connected. The connection of the helix to each collar is made at the end of a narrow projecting finger which acts as an antenna in coupling the helix to the waveguide. Thus, the ends of the helix are fastened to the high voltage ends of two antennas.

Near the input end of the helix where the electron stream is shot in as a smooth unvarying flow, the signal level remains nearly constant for a short distance. In this region the signal acts on the electron stream, gradually producing fluctuations in velocity and density. Then, when these fluctuations become large enough, the electron stream begins to give up energy to the electric field, and finally there is a long region in which the signal increases the same number of db for each inch of travel.

### *Merit Expands*

Considerable expansion has been started by the Merit Coil & Transformer Corp., Chicago, and will approximately double the present capacity of the plant. The company manufactures transformers for the electronic and electrical industries. Headquarters are at 4427 North Clark Street.

## BETTERING OUTPUT

*(Continued from page 62)*

ing exhaust, the primary application of external bombardment causes an onrush of gas from the anode with consequent flashing or ionization. If precautions are not taken, blackened or smudged bulbs may result. Usual procedure is to apply the external bombardment slowly and to discontinue the application of rf energy during flashing. Subsequent bombardment of the anode to white heat 1000°-1200° C. is then possible with no bulb discoloration. Alternatively, Faraday shields may be used to prevent flashing or ionization.

The use of high velocity, large volume, air blowers is conventional to prevent sucked-in or collapsed bulbs. Wherever possible, it is preferred that carburization of thoriated tungsten be instituted before mounting the graphite anode; otherwise the anode will tend to adsorb the heavy hydrocarbon gases and lengthen the exhaust time.

Evidence exists that graphite anodes exert a gettering action and adsorb gases. Mantell[3] gives comprehensive data on the adsorbent qualities of carbon while Dunoyer[1] discusses the gettering action of charcoal at various temperatures. Life test data for graphite anode tubes show a definite improvement in emission which may be attributed to the clean-up action of the graphite. The utility of such gettering action is of value where extremely high, short-time peak loads are encountered.

### *Zirconium coating*

Many power tube failures may be traced to emission troubles which result from poor vacuum in the tube. The use of zirconium-coated graphite anodes to maintain a high degree of vacuum increases the life expectancy of power tubes and greatly accelerates the exhaust processing. Zirconium is particularly well adapted for "clean-up" of an electronic tube because of its high adsorptive power, low vapor pressure, poor electron emission, and also because of the negligible electrical leakage values introduced.

Zirconium hydride may also be used for anode coating purposes since it is the same as gas-free zirconium, but with 1.5 to 2% of hydrogen added. This hydrogen is evolved when the temperature of the hydride reaches 300° C. and above.

Zirconium, properly processed for tube manufacture, is an adsorbent of large area, the adsorption varying with the surface condition. Zirconium powder mixed with a suitable binder is sprayed on the graphite anode and heated in vacuum to 1000° C. or above, at which temperature the zirconium adheres firmly to the anode, with the probable formation of zirconium carbide. The latter is a very hard, gray colored crystalline mass. The heat radiation from the surface is amost as high as from a perfect black body.

The binders most commonly used consist of a dilute solution of nitrocelluose in amyl acetate or of a silica sol—zirconium suspension developed by the Bell Telephone Laboratories.

Zirconium is highly reactive at elevated temperatures, combining readily with all but the rare gases, the optimum temperature range for gettering action by zirconium being 400°-600°. Properly processed zirconium will act as a continuous getter in a vacuum tube at temperatures of 200° C. and above. Zirconium coated graphite anodes, which are designed to operate between 500° C. and 600° C. are, therefore, very well suited for the optimum gettering properties of zirconium. Commercial tube production experience tends to corroborate the above data.

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1. Dunoyer, L.—Vacuum Practice, G. Bell and Sons Ltd., 1926.
2. Hukagawa, S. and Nambo, J.—Adsorption Properties of Metallic Zirconium for Gases and Its Applications to Electron Tubes, ETJ Vol. 5, No. 2, February, 1941.
3. Mantell, C. L.—Industrial Carbon, 2nd Edition—D. Van Nostrand Co.—1946.
4. Marsden, C. P. Jr.—Thermionic Emission in Transmitting Tubes—Electronics December 1938.
5. Norton, F. J.and Marshall, A. L.—Trans. Am. Inst. Mining Met. Engrs., Inst. Metals Div., 156, 351 (1944).
6. Rogers, A. N.—Use of Zirconium in the Vacuum Tube—Preprint 88-19, The Electrochemical Society.
7. Spitzer, E. E.—The Application of Graphite as an Anode Material to High Vacuum Transmitting Tubes, Proc. I.R.E., August, 1933.
8. Spitzer, E. E.—Anode Materials for High Vacuum Tubes, Electrical Engineering, November, 1935.

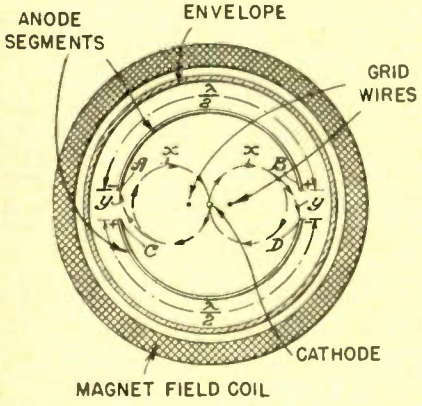
## *Aluminum Solder*

The Aluminum Solder Corp., which will manufacture and distribute solder developed in Switzerland during the war, has been formed in New York and will headquarter in the Reeves International Building, 10 East 52nd Street. Head of the new company is Hazard E. Reeves.

## PATENTS

(*Continued from page 78*)

Oscillations take place in the circumferential direction along the anode segments, one edge being positively charged at the instant the other edge is negatively charged, as indicated by the plus and minus signs in the drawing.



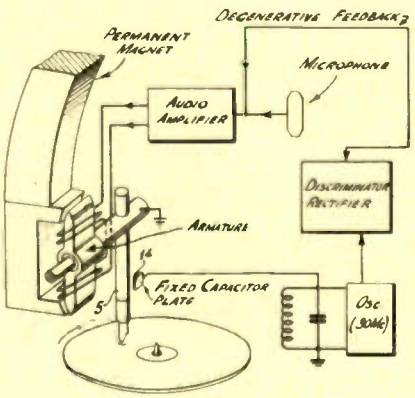

Negatively biased grid wires are arranged to prevent electron emission in certain directions. Interaction of the axial magnetic field, the grid wires, and anode potentials determines the electron paths which will follow the dashed lines x or y depending on the instantaneous potentials at the tips of the anode segments. The electrons will strike or come close to the instantaneously negative anode tips (A and D) when the adjacent tips (C and B) are at high positive potentials; however, the electrons will take paths x further away from tips A and D when tips C and B assume lower potentials. Electrons in no instance strike anode segment tips B or C. This explains how high frequency fluctuations in potential between adjacent capacitively-coupled anode tips influence the electron paths in such a manner that their action on the potential of the anode tips increases the initial potential fluctuations. The varying magnetic field generated by the changing current in the anode segments may also influence the electron paths.

Assuming the gap between the adjacent anode tips to be of the order of .25 cm, and a pulsed applied anode potential of 25,000 volts, the electrons will reach a velocity of $9 \times 10^9$ cm/sec and will traverse the region near the anode structure in approximately $1 \cdot 11 \times 10^{-10}$ sec; as this time interval should not exceed one-tenth of a cycle, the oscillation frequency may be 900 megacycles. Output may be obtained by electromagnetically coupling a loop or open-ended capacitors to one or both of the anode segments. The oscillator can also radiate energy directly and may for this purpose be mounted in front of a reflector.

An alternative to the grid wires is the coating of the cathode with electron-emissive material on opposite sides only. A further modification of the oscillator structure provides three or more evenly spaced anode segments of equal circumferential length. To prevent overheating and wear of anode segment tips A and D by impinging electrons, these tips may be made of a larger cross-section than the remaining portion of the anode segments.—C. W. Hansell, RCA, (F) July 25, 1941, (I) June 18, 1946. No. 2,402,397.

### *Negative Feedback Recorder*

The capacitance variations between the grounded, moving stylus holder 5 and the fixed capacitor plate 14 control the resonant frequency of the tank circuit of the high frequency (for instance, 30 mc) oscillator; its output, upon discrimination, serves to provide negative feedback voltage for the driving audio amplifier. It is an advantage of this system that no coupling is present between the audio frequency driving coils and the high frequency feedback circuit so that shielding is not required. Similar results can be obtained by using a fixed-frequency oscillator

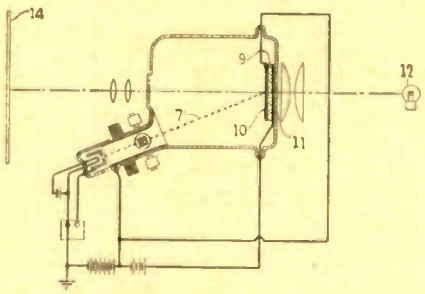



and shifting the discriminator characteristic by suitably inserting the varying capacitance in the discriminator circuit. Both effects may be combined to give double output voltage amplitudes by using two fixed capacitor plates in a balanced system where the oscillator frequency and the discriminator characteristic are changed in opposite directions in response to the displacements of the stylus. Various shapes and ways of arranging and mounting the fixed capacitor plate are suggested; it may, for instance, be secured to the permanent magnet if isolation is assured.—H. E. Roys, RCA, (F) September 13, 1943, (I) May 28, 1946, No. 2,400,953.

### *Television Receiver Screen*

If certain ionic crystals which are normally transparent to visible

light are struck by a beam of cathode-rays, X-rays, or by light of suitable wavelength, a deposit of opaque material called opacity centers is created in the crystal, the degree of opacity depending on the intensity of the incident radiation. The opaque deposit can also be destroyed by the same type of rays, the degree of destruction in a given time interval depending on the intensity of the rays and on the density of the deposit already formed. Disappearance of the opaque deposit can be achieved, alternatively, by positioning the crystal in an electrical field at a suitable temperature, in which case the deposit moves across the crystal towards the positive pole where it disappears leaving the crystal substantially transparent.




A single flat crystal, a mosaic of small crystals, or a microcrystalline structure of this type substance may be used in the screen of a television receiver. Electron beam 7, which is intensity-modulated by the picture signal, scans screen 9, causing its opacity to assume values corresponding to the picture signal. The electric field strength between electrodes 10 and 11 as well as the screen temperature are adjusted to make the deposit move across the crystal at such a speed as to arrive at electrode 11 and disappear exactly after completion of one frame scanning period. It is then replaced by a new opacity center starting from electrode 10. Light source 12 will cause a picture to appear on screen 14.

The picture repetition frequency in this system can be much lower than with conventional reception methods, since the picture brillance is held constant during the complete frame scanning period and no flicker occurs. The minimum repetition frequency is determined only by the requirements of the eye to perceive continuous movement, and may be approximately 17 to 20 frames per second. Consequently, the frequency band width necessary to transmit the signal is less than in conventional systems.

Alternatively the opacity center may be removed by a different intensity electron beam or by an electromagnetic radiation of specified wavelength. The extinguishing spot is moved across the screen and is closely followed by the modulated spot which produces the opacity so that the opacity again persists throughout a complete frame scanning period.

A. H. Rosenthal, Scophony Corp. of America, (F) Sept. 21, 1943, (I) March 19, 1946, Re. 22,734.

### *Aircraft Landing System*

It is proposed to combine on a cathode-ray tube screen indications derived from radio signals received on the plane and indications derived from gyroscopic apparatus installed in the plane, to inform the pilot of the position and orientation of the plane. For example, a three spot pattern may be produced on the screen similar to the image observed if three light sources are viewed which are located at the point where the plane is supposed to make contact with the ground and at two points located equal distances to the right and left, respectively, of one point on the aircraft approach path.

W. M. Hall, Research Corp., (F) December 10, 1938, (I) May 14, 1946, No. 2,400,232.

### *Largest Taxi Project Approved by FCC*

The largest taxicab radiotelephone project yet to come before the FCC, the Yellow Cab Co.'s application for land stations at Los Angeles and San Francisco to communicate with a total of 1600 cabs, has been approved by the FCC. The experimental class 2 stations will use 152.27 mc, operating with 60 watts.

Ten other taxi companies in different sections of the country have recently obtained FCC approval of radiotelephone projects. They were: Greyhound Cab Co. (Baltimore); Yellow Cab Co. (National City, Cal.); Hickey Cab Co. (Bridgeport, Conn.); Libertyville, Ill. Cab Co.; Checker Cab Co. (Milwaukee); Lyndhurst, N. J. Cab Service; Yellow Cab and Checker Cos. (Albuquerque, N. M.); Valley Cottage, N. Y. Cab Co.; City Cab Co. (Falls City, Nebr.); and Yellow and Checker Co. (Flint, Mich.). Each company applied for one land and from three to 200 mobile units.

At the same time the commission granted the application of Dr. George Weems, practicing physician of Huntington, Md., for a land station and a mobile unit for his own use in furnishing medical service. The commission reports the grant is the first for an individual user of mobile service.

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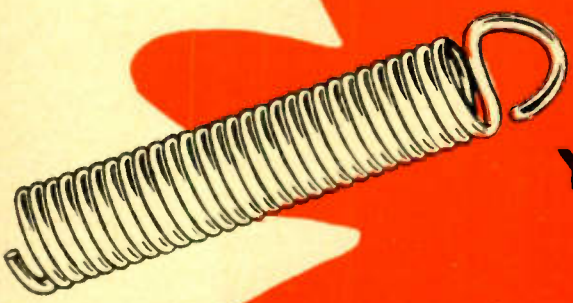

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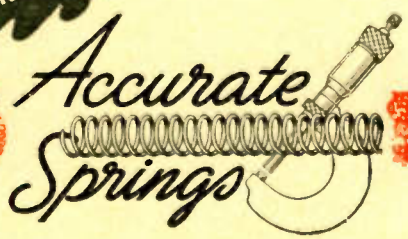


*Wire Forms • Stampings*

## WIDE READING

*(Continued from page 77)*

amplitude A has its maximum possible value $A_0$.

$$A_0 = v_1 \left(\frac{2n+1}{F_n}\right)^{1/2n}$$

which decreases from $2v_1$ at n = 1 to 1.44 $v_1$ at n = 4 and tends to $v_1$ as n tends to infinity. Variation of

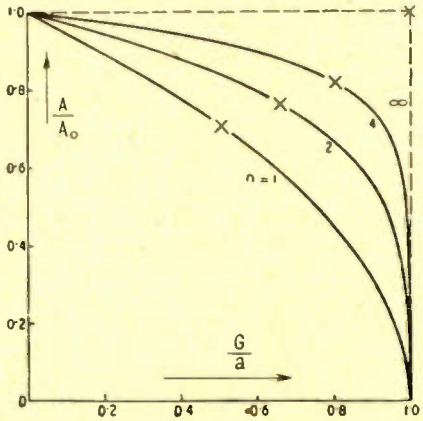


Fig. 3—Relative amplitude as function of load

the relative amplitude $A/A_0$ with load for n = 1, 2, 4 and infinity is illustrated in Fig. 3.

The power

$$P = \tfrac{1}{2} v_1^2 G \left[\frac{2n+1}{F_n}\,\frac{a-G}{a}\right]^{1/n}$$

dissipated in the circuit reaches a maximum value of

$$P_{max} = \tfrac{1}{2} v_1^2 a \cdot \frac{4n}{n+1}\left(\frac{n!^2}{2n!}\right)^{1/n}$$

when the circuit conductance G has its optimum value

$$G_{opt} = \frac{n}{n+1} \cdot a$$

The term following the multiplication dot in the expression for $P_{max}$ varies very little with n: it is unity for n equal to 1 and n equal to infinity, and it reaches a maximum of 1.103 for n equal to six. Therefore, the maximum power available from the negative conductance, N, is approximately equal to that which would be expended in a conductance of value a by a sinusoidal oscillation of amplitude $v_1$.

If an external load, $G_L$, is connected to the oscillator it must be substituted for the intrinsic conductance, G, of the oscillator, while the negative conductance, a, may be changed to a′ = a-G to include the intrinsic conductance of the oscillating current. With these changes, the formulas for P, $G_{opt}$ and $P_{max}$ will describe the transfer of power to the external load $G_L$.

Fig. 4 illustrates the dependence of $P/P_{max}$ on the ratio $G_L/a'$ (load conductance $G_L$ to negative conductance a minus oscillatory circuit conductance G) with four values of n as parameter. The curves dem-

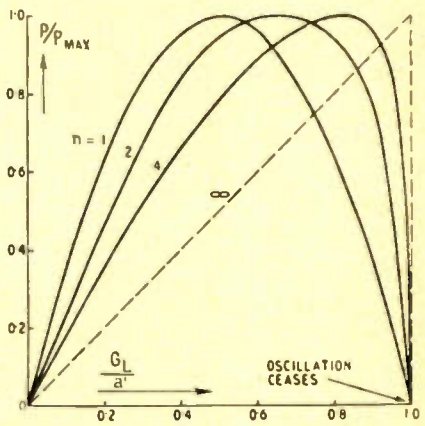


Fig. 4—Dependence of power output on load

onstrate the faster decline of power output with deviation of $G_L/a'$ from its optimum values, n/(n+1), compared with the behavior of a linear power source.

The response of the oscillator to a small external electromotive force of different frequency (shot noise, received signal in heterodyne operation, or side-bands in amplitude-modulated operation) is treated. Formulas for the amplitudes of the self-maintained and of the forced oscillations are evaluated.

## MAGNETIC CONTROL

*(Continued from page 73)*

rent in $L_3$ bucks the field in $L_4$, causing an increase in the anode current of $V_2$. These unbalanced anode currents then cause a net output voltage to appear across R.

The circuit details are essentially those of providing an efficient field coil. The coil dimensions, dependent largely on the size of the tube itself, are those of a solenoid 3″ long with an inner diameter of about 1 5/16″. They are usually simple air-core coils, although soft-iron shields can be used over the coils for magnetic shielding. Such shields increase sensitivity about 50%. Though for a uniform field over the entire axial length of the cathode and anode, a coil of about 3″ in length is required, shorter coils may be used to produce remote cut-off effects in the tube. The anode of the tube should be centered axially in the coil. When more than one control coil is used on a tube, the coils should be concentric.

## CONTROL UNIT

*(Continued from page 69)*

relatively simple because the consolette is practically complete in itself. Interconnections between consolette, power supply, microphones, and other external equipment should be made in conduit. Power circuits should be separated from audio circuits, and it is desirable to have the high level and low level audio circuits in individual conduits. The conduit can enter the consolette from either the rear or bottom of the cabinet.

Ease of maintenance is obtained by using a hinged top cover and hinged chassis. Opening the top cover gives access to plug-in capacitors, tubes, push-button switches, and relays. When the entire chassis is thrown back, most of the wiring is accessible. Also, in this position, the mixers and lever switches may be serviced. A rotary switch on the panel is provided for checking the condition of tubes. The VU meter is connected into the cathode bias circuits of the tubes for this test, and the reading obtained gives an indication of the tube condition.

The consolette weighs approximately 180 lbs., and may be placed on a standard desk. The power unit weighs 75 lbs. and is 17 in. high by 17 in. wide, by 8 in. deep.

The chief purpose of the consolette is for control of broadcast studios, but the equipment is flexible enough for other uses, such as in recording studios. In a large broadcast studio installation, a consolette can be used for each studio control booth, all units feeding into the master control equipment.

### *Press Wireless Moves Engineering*

The Engineering Division of Press Wireless Mfg. Corp., a subsidiary of Press Wireless, Inc., is being moved from its present Long Island City, N. Y., location to the company's factory in Hicksville on Long Island. The move has been made to expedite production. The executive and sales offices will remain at 1475 Broadway, New York City.

### *Industrial Ovens*

Industrial Oven Engineering Co., Cleveland, Ohio, has shortened its corporate style to Industrial Ovens, Inc. The company has recently occupied a new plant at 13825 Triskett Road. Industrial heating and processing equipment are the specialties of the organization.

## ENGINEERS STUDY TV

(*Continued from page 64*)

combination including both standard broadcast and FM and a record changer, the viewing tube being a 10-in. semi-flat model.

Farnsworth also exhibited its tunable, rotatable dipole antenna which is electrically rotated by remote control so as to permit best signal pickup. Dipole arms may be lengthened or shortened for tuning purposes. A price of $62.50 has been put on the equipment.

General Electric exhibited several receivers including a large screen Schmidt projection model. In addition, there was revealed a new studio camera of unusually compact design, mounted on a pedestal which permits the camera to be raised and lowered hydraulically under the control of pedals. The camera has a four-lens turret and an optical viewfinder.

Sonora Radio and Television Corp. exhibited three receivers, one a console type with a 9-in. tube and the other two being table models, one having a 5-in. tube and the other a 9-in. tube.

Giving no hint of large-scale production soon to be inaugurated in its new two and a quarter million dollar plant, Philco exhibited no new receivers, the only model on view being a pre-war model equipped with a 14-in. direct view tube. Exhibitions for distributors, which will reveal a complete line of receivers, including table and console models, direct view and projection types, are scheduled for early Fall.

### *Network carriers*

A glimpse of what may be television's future, when programs can be carried over coast-to-coast networks was furnished by the American Telephone & Telegraph Company's exhibit. Transmission of television programs over different types of facilities, such as radio relay, coaxial cable and telephone wires, were demonstrated. Programs were fed to the Bell System exhibit over a microwave channel across mid-town New York from the Long Distance building to the Waldorf-Astoria.

The coaxial program of the Bell System was illustrated by a large map, showing what has already been installed or is under construction, and what is planned for the next few years. These coaxial cables are installed primarily for urgently-needed telephone circuits. With special additional equipment, however, they can carry television programs.

The Bell System's first microwave radio relay system, to be completed in 1947, between New York and Boston, was illustrated at the exhibit by a diorama. An intermediate station, similar to the seven located on mountain tops along this route, was featured. Initially each of these stations, which are, on the average, about twenty-five miles apart, will be equipped for two-way transmission with complete spare facilities. A four thousand mc antenna of the type to be used along this microwave channel, was on view.

Two television monitoring receivers were in operation, fed over television transmission facilities furnished by the Bell System and so arranged that they could pick up programs from different broadcasters. In operation was the actual video amplifier used to feed the television programs to the receivers on display. This amplifier is the same type as those used at intervals of about one mile on ordinary telephone wires to make them suitable for carrying television images.

In addition to the Intra-Video System, Telicon engineers revealed push button television channel selector sets. A table model, the "Ten", featuring AM and FM radio in addition to offering 6 by 8 in. picture images will retail for approximately $425. The "Two Foot" projection Telicon, giving home movie size pictures will include AM and FM as well as an automatic record changer. It is custom built and will sell for $2,640. Prices for the "Fifteen", 15 in. tube receiver and the "Twenty", 20 in. tube receiver will be $1,450. and $2,100. respectively.

TBA's top engineering honor went to the three engineers who worked together to perfect RCA's Image-orthicon tube. Thus "for the outstanding technical contribution to television", the Award was given to Dr. Albert Rose, Dr. Harold Bell Law and Dr. Paul Kessler Weimer, all of RCA Laboratories, Princeton, N. J.

### *Rotom to Thermador*

Thermador Electrical Mfg. Co., 5119 District Boulevard, Los Angeles, has taken over the Rotom Mfg. Co., Alhambra, California. The Rotom company has long manufactured fractional horsepower motors and will continue to do so in its Alhambra plant.

## ELECTRONIC FORUM

(*Continued from page 47*)

are capable of handling transient wave forms. The convenience of precision single-excursion sweeps with a high ratio of operate restore time was mentioned. Accessory circuits such as lockout, sweep delay and timing circuits have been found to be essential for some purposes. Methods for designing a laboratory instrument capable of handling fast rising pulses as well as slower wave forms were discussed.

Applications of the Pressuregraph (an electronic instrument for indicating static or dynamic pressures in internal combustion engines, pumps or any device which is subject to pressure variations) were described by A. Crossley (Electro-Products Labs.). The use of a diaphragm producing a change in capacitance in a bridge circuit, causes modulation of a high frequency carrier. The modulated wave is amplified and visualized on an oscillograph. This system provides means whereby a static pressure calibration will suffice for both static and dynamic observations. The negligible inertia of the diaphragm permits true studies of transient pressures, such as met with in injection pumps, oil lines or other hydraulic or gas systems subject to unusually fast pressure variations.

### *Microwave relays*

In a paper "A Microwave Relay Communication System" by G. G. Gerlach (RCA-Victor), the experimental results obtained with a 4000-mc relay system connecting New York and Philadelphia were described. This system has a frequency modulated subcarrier which in turn is used to frequency modulate the final carrier. Demodulation to the sub-carrier frequency is carried out at the relay stations. Similar microwave relay equipment will be installed by (Western Union) in a circuit connecting New York, Washington and Pittsburgh.

"Ignitron Converters for Induction Heating" by R. J. Ballard and J. L. Boyer (Westinghouse) described a new type of converter used with vacuum tube oscillator, particularly suited for heat treating, which makes it possible to supply this entire field of induction heating and melting with power from electronic equipment. A new circuit, is used, called the cycloinverter in which three phase, sixty cycle power is converted to single phase power at a higher frequency by means of a single conversion.

# PERSONNEL

**Dr. Ladislaus Marton**, known for his work in developing the electron microscope, has been appointed principal physicist in the electronics section of the National Bureau of Standards, Washington, D. C. Dr. Marton joins the bureau from the faculty of Stanford University, where he was associate professor of physics and head of the division of electron optics.

Dr. L. Marton

Dr. H. K. Skramstad

**Dr. H. K. Skramstad** has been appointed chief of the guided missiles section of the National Bureau of Standards, Washington, D. C. He joined the bureau in 1935 as a physicist in the aerodynamics section, and during the war worked on the development of the BAT, a radar-guided bomb.

**Dr. B. J. Miller** has been appointed chief of the recently organized guided missile electronics section of the National Bureau of Standards. The section is concerned with the electronic and servo-mechanism phases of guided missiles, research and development of which is the primary responsibility of the Bureau's guided missile section. As a physicist in the Ordnance Development Division of the Bureau, Dr. Miller played an active part in research phases of the radio proximity fuse.

**Eugene Somoff** has been appointed to the newly created post of technical service engineer at the American Standards Association, New York. During the war he served as a Russian translator for the Army, and was administrative assistant in the translation unit of the Air Service Command, Fairfield, O.

**Joseph Collins** has been appointed chief engineer of the Aerovox Corp., New Bedford, Mass. He was head of the electrolytic engineering division at Aerovox since 1938, and prior to that time was in charge of electrolytic engineering at Sprague Electric Co.

**Leslie G. Thomas** has been elected vice-president in charge of manufacturing of the Solar Mfg. Corp., New York, and will supervise production at the company's plants in Chicago, Bayonne and North Bergen. Recently he was vice-president and works manager of the International Resistance Co., Philadelphia. **Don Corson,** former sales manager of the power division of Aerovox Corp., has been appointed manager of the special products division at Solar. Corson was also sales manager of the power factor division at Cornell-Dubilier Electric Corp.

Leslie G. Thomas

Don Corson

**F. Ellis Johnson** has been appointed head of educational activities at the Hanford Engineer Works, Richland, Washington. He was formerly dean of the colleges of engineering both at the University of Missouri and the University of Wisconsin. Hanford Engineer Works, organized by DuPont for the development of atomic energy, has been recently taken over by General Electric Co.

**Milton Lauer** has been appointed to the newly created post of product manager of the radio tube division, Sylvania Electric Products, Inc., Emporium, Pa. For one year during the war he served as chief of the production scheduling and distribution unit, electron tube section, radio and radar branch of the WPB in Washington.

Milton Lauer

Ray C. Bierman

**Ray C. Bierman,** formerly chief engineer with Permoflux Corp., has joined the staff of Webster-Chicago Corp., Chicago, as senior electrical engineer. Bierman was previously a broadcast engineer with NBC and ABC.

**Dause L. Bibby** has been promoted to manager of manufacturing, engineering and research at the Poughkeepsie, N. Y., plant of International Business Machines Corp. Previously he was executive assistant at the company's Endicott, N. Y., plant.

**Paul K. Povlsen** has been made assistant to the president of the Galvin Mfg. Corp., Chicago. He was formerly vice-president in charge of production and engineering for the J. I. Case Co., Racine, Wis.

**Jerome R. Steen,** formerly associated with General Electric Co., has been appointed director of quality control for the lamp, fixture, wire products, tungsten and chemicals, radio tube and electronic divisions of Sylvania Electric Products, Inc., Emporium, Pa. Joining Sylvania in 1931, he was appointed manager of the quality control engineering department, radio tube division, in 1944.

Jerome R. Steen

Samuel Lubin

**Samuel Lubin** has joined the field engineering department of Sprague Electric Co., North Adams, Mass., and will locate in Washington, D. C., where he will be in charge of contacts with all government agencies and laboratories including the Navy department, Signal and Air Corps, and the departments of the Interior, Commerce, and Agriculture. He was formerly with the new development section of the Technical Standards division of R.E.A.

**Wells Davis** has joined the staff of Battelle Institute, Columbus, O., where he will be engaged in electronics research. He was associated with the department of electrical engineering at Ohio State University for the past seven years, and prior to that was an engineer with GE.

**Robert M. Bennett, Jr.,** has been appointed chief engineer of the St. Louis Microphone Co., St. Louis. While in the service, Bennett was stationed at the Radiation Laboratory of M.I.T., doing engineering work.

**James L. Middlebrooks**, who was appointed director of engineering of the National Association of Broadcasters in June, has been appointed chief facilities engineer for the American Broadcasting Co., New York.

**Ben Adler**, former chief facilities engineer at the American Broadcasting Co., has been elected vice-president in charge of engineering of the Transmitter Equipment Mfg. Co., Inc., New York. Adler holds patents on geophysical methods, a large screen television projection system and a synchronizing system, and in 1942 was appointed manager of test and measuring equipment section for RCA.

Ben Adler

Edwin Moran

**Edwin Moran** has been appointed to head the industrial and commercial activities of Honovia Chemical and Mfg. Co., Newark, N. J. He was formerly vice president of Sperti, Inc.

**Alois W. Graf**, chairman of the Chicago section of the Institute of Radio Engineers, has opened an office in Chicago for the practice of law in patent and trade-mark cases. Graf is a member of the executive committee of the Illinois Engineering Council, and is active in the Chicago Technical Societies Council.

**Dr. Ralph Galbraith,** contributing author of "Principles of Radar," has been appointed professor of electrical engineering and chairman of the department at Syracuse University, Syracuse, N. Y. Galbraith, who is a member of the A.I.E.E., will succeed Professor Charles Henderson, who has relinquished the chairmanship due to ill health.

**Louis Gerard Pacent,** president of Pacent Engineering Corp. and a well known consulting engineer, has been appointed a member of the Board of Examiners of the American Institute of Electrical Engineers. Pacent, who is a fellow of the A.I.E.E. and the I.R.E., will represent the radio engineering profession in his new capacity.

# NEW BOOKS

### *Reference Data for Radio Engineers*

2nd Edition. Published by Federal Telephone and Radio Corp., New York, 1946. $2.00, 336 pages.

The second edition of this reference book for research, development, production, operation, and education of electronic technics, brings up to date the chapters on microwaves through declassification of war developments, and presents much additional data along with all the material of the first edition. The manual has been compiled by the editorial staff of Electrical Communication, the technical Journal of the I.T.&T. The arrangement of the book remains unchanged.

General information, tables on "Engineering and Material Data" are followed by chapters on "Audio and Radio Design" and "Rectifiers and Filters." A chapter on "Iron-core Transformers and Reactors", describing power transformer design has been added. The theory of vacuum tubes and design methods for amplifiers are discussed in detail. Data on cathode ray tubes has been expanded.

A new chapter on room acoustics presents the more important considerations and tables on reverberation and required power levels for PA equipment. Wire transmission and rf transmission lines are treated in detail. The revised waveguide chapter includes equations for rectangular and cylindrical guides as well as illustrations of field distribution patterns. The material on radio propagation and radio noise has also been revised. Mathematical expressions and tables are given for antennas and arrays. Electronic integration and differentiation, relaxation oscillators, and Fouvier analysis of common wave forms are contained in a chapter on non-sinusoidal wave forms. Mathematical formulas and tables are included in the remaining chapters of the book.

### *Heaviside's Electric Circuit Theory*

By H. J. Josephs. Published 1946. Chemical Publishing Co. of N. Y. Inc., New York. 115 pages.

This monograph is based on an "Out-of-Hours" course of lectures delivered by the author at the Post

Office Research Station in Great Britain. The scheme adopted is to base electrical circuit theory on a far reaching theorem reconstructed from scattered papers of Heaviside and called by the author "Heaviside's Last Theorem."

The introductory paragraph describes the breakdown of the classical method for finding the transient and steady-state solutions of involved circuits and indicates the advantages of Heaviside's scheme.

There follow chapters on the expansion theorem, ladder networks, Heaviside's last theorem, Carson's integral equations, the establishment of operational formulas and a discussion of transmission lines and the application of modern theories of integration to the solution of circuit problems. The book is tion.

### *Radio's Conquest of Space*

**By Donald McNichol. Published by Murray Hill Books, Inc. New York 16, N. Y. 1946. $4.00. 374 Pages with many photographs and sketches.**

Although this pioneer radio engineer-historian disclaims any attempt to romanticize the history of radio, this "prosaic" record of achievement by the more than 500 experimenters, whose efforts have been identified by name, and of the hundreds of items that make up the science of radio, cannot help being more interesting than the ordinary romance. The author by his first hand contact with many of those whose contributions are listed, has assembled an authentic record of a fifty year active development period, following a couple of hundred years of more or less isolated events. He has used a style and approach to the subject that denotes good judgment in analyzing the development of items that had so many claimants for the "who done it" honors. The art is admirably covered, especially the earlier fundamentals, but even a few of the recent wartime developments are mentioned. While this book is not an engineering design treatise, its availability to numerous wartime research groups might have called attention to several earlier principles which, all but forgotten, were reinvented again. It is good reading for all—the old-timers who were in the game before 1941 and the newcomers who can thus easily get the background of this most interesting art.

### *Capacitors, Their Use in Electronic Circuits*

**By M. Brotherton, Bell Tel. Laboratories. Published by Van Nostrand Co. Inc., New York, N. Y. 1946. 107 + VI Pages. 32 Illustrations. $3.00.**

Designers of electronic systems so often are concerned with the "important" components of a circuit that they disregard the routine items—such as the selection of the most suitable capacitor types. When it is recalled that such tactics have resulted in the general opinion among servicemen that capacitors should be checked first after circuits fail, it is refreshing to come upon this little manual written in such an interesting style, which shows that "defective capacitors are rarely traceable to limitations of the capacitor art per se. The responsibility usually lies with ignorance carelessness or an uneducated sense of economy".

Characteristics under steady dc and ac loads are described; followed by a review of the features of all common types. A final chapter on "Twenty Keys to the Right Capacitor" provides excellent reading for all designers.

## NEWS OF INDUSTRY

(*Continued from page* 81)

quality amplifiers designed to take full advantage of the high fidelity characteristics inherent in FM. WBEN will broadcast on a frequency of 92.1 mc. At the present time, WBEN's plans are that no FM programs will be a duplication of the AM broadcasts.

WBNY, another pioneer of FM in Buffalo, expects to initiate FM service shortly after the first of the year. Station manager Albertson, anticipates an FM coverage of approximately 12,000 square miles. The FM transmitter is a General Electric 10 kw set feeding a 6 bay turnstyle antenna with a total elevation of about 2,000 ft. above sea level.

### *Wheelco in Indiana*

In order to better serve Indiana, western Ohio and Kentucky territories, Wheelco Instruments Co., Chicago, has established a district service office in Indianapolis at 107 So. Capitol Ave. The office will be under the direction of John E. Anderson. The Indianapolis office will control a sub-office in the Temple Bar Building at Cincinnati. It will be under the direction of L. A. Wallingford.

# This Is Good News!

## . . . our greatly increased production on Simpson Model 260 makes it available to you NOW at your jobber's

The Simpson 260 is easily the world's most popular set tester for television and radio servicing. You cannot touch its precision, its useful ranges, or its sensitivity in any other instrument selling for the same price or even substantially more.

It has been a long time since we have been able to produce enough 260's to meet the demand, because the 260 has consistently out-sold every other remotely similar test instrument. The reason is simple: it out-performs and out-values them all. Simpson advanced engineering and unyielding standards of quality and precision manufacture enable it to *stay* accurate under conditions ordinary instruments cannot survive.

Incidentally—production on other Simpson instruments is clearing, too. We feel confident that it will not be long before you can buy those Simpson instruments you have waited for.

Ask your jobber for the Simpson 260—he has it now!

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**SIMPSON 260, HIGH SENSITIVITY SET TESTER FOR TELEVISION AND RADIO SERVICING**

*Ranges to 5000 Volts—Both A.C. and D.C.*
*20,000 Ohms per Volt D.C.*
*1000 Ohms per Volt A.C.*

At 20,000 ohms per volt, this instrument is far more sensitive than any other instrument even approaching its price and quality. The practically negligible current consumption assures remarkably accurate full scale voltage readings. Current readings as low as 1 microampere and up to 500 milliamperes are available.

Resistance readings are equally dependable. Tests up to 10 megohms and as low as ½ ohm can be made. With this super sensitive instrument you can measure automatic frequency control diode balancing circuits, grid currents of oscillator tubes and power tube, bias of power detectors, automatic volume control diode currents, rectified radio frequency current, high-mu triode plate voltage and a wide range of unusual conditions which cannot be checked by ordinary servicing instruments. Ranges of Model 260 are shown below.

Price, complete with test leads ..... $38.95
Carrying case ..... 5.55

| Volts D.C. (At 20,000 ohms per volt) | Volts A.C. (At 1,000 ohms per volt) | Output |
|---|---|---|
| 2.5 | 2.5 | 2.5 V. |
| 10 | 10 | 10 V. |
| 50 | 50 | 50 V. |
| 250 | 250 | 250 V. |
| 1000 | 1000 | 1000 V. |
| 5000 | 5000 | 5000 V. |

| Milli-amperes D.C. | Micro-amperes | Ohms | |
|---|---|---|---|
| 10 | 100 | 0-1000 | (12 ohms center) |
| 100 | | 0-100,000 | (1200 ohms center) |
| 500 | | 0-10 Megohms | (120,000 ohms center) |

(5 Decibel ranges: —10 to +52 DB)

***ASK YOUR JOBBER***

# Model 2450
## ELECTRONIC TESTER

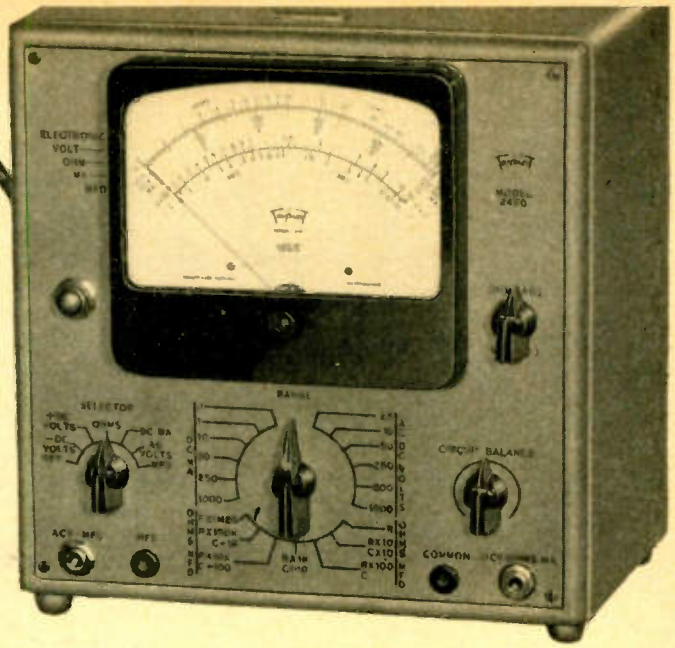
★

**There's never been a tester like this!**

Here's a tester with dual voltage regulation of the power supply DC output (positive and negative), with line variation from 90 to 130 Volts. That means calibration that stays "on the nose"! That means *broader service* from a tester that looks as good as the vastly improved service it provides. This model includes our Hi-Precision Resistor which outmodes older types.

HIGHLIGHTS—42 ranges: DC and AC. Volts: 0-2.5-10-50-250-500-1000 • DC MILLIAMPS: 0-0.1-1.0-10-50-250-1000 • OHMS: 0-1000-10,000-100,000 • MEGOHMS: 0-1-10-100-1000 • CAPACITY IN MFD: 0-.005-.05-.5-5-50 • LOAD IMPEDANCE: 51 megohms on DC Volts • CIRCUIT LOADING: Low frequencies. Circuit loading equal to 8 megohms shunted by 35 mmfd. High frequency circuit loading equal to 8 megohms shunted by 5 mmfd.

*Detailed catalog sheets on request.*



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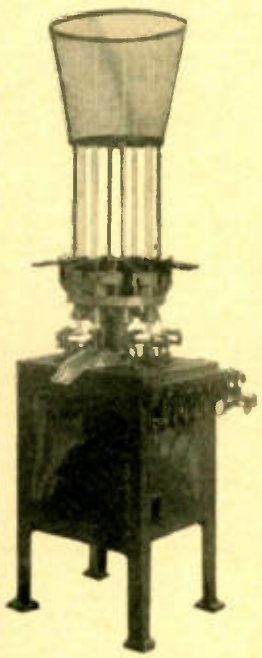

**EIGHT HEAD HOT-CUT FLARE MACHINE**

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Automatic throughout.

Can be synchronized with automatic Stem machine.

Accommodates eight full lengths of glass tubing.

Cuts off and flares in one operation.

Production 1250 flares per hour.

Made in two sizes: *Miniature machine,* for miniature flares and fluorescent starters, and *Standard machine* for standard size lamps, fluorescent and radio tubes.

Range of *Standard Machine:*

| | |
|---|---|
| Glass tubing | 35 to 42 gauge |
| Length of flares | 5 mm to 80 mm |
| Forms flares up to | 47 mm diameter |
| Net weight | 1500 pounds |
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### *Diathermy at 3,000 Mc*

The FCC has concluded tests on a Raytheon diathermy machine which operates in the 3,000 megacycle band, and the Commission is working with Raytheon on the question of where to place such high frequency diathermy apparatus in the spectrum. Top FCC engineering officials stated that Raytheon was giving its whole-hearted cooperation on the experiments with the diathermy apparatus to avoid all possible interference to radar operations in that microwave band. In addition, the Navy is now testing the machine in relation to possible interference with radar installations and air navigation systems.

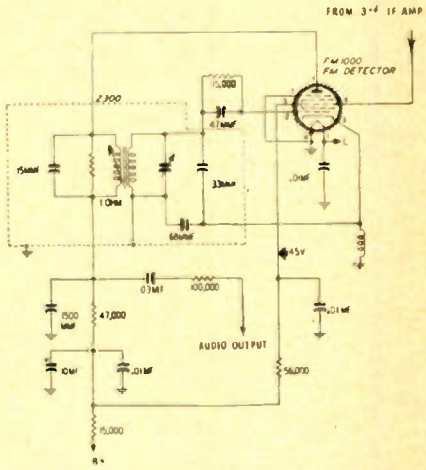
### *Minute Man Expands*

Bernard Shereff and Jack H. Scheinmann have recently purchased all the stock of Minute Man Products, Inc., 309 East 22 St., New York 10, N. Y. The firm has been engaged almost exclusively in the production of chassis, brackets, and all metal parts for the radio manufacturing field, will expand their facilities.

### *Bradley Circuit Single Stage FM*

A new single-stage FM detector developed by the Philco Laboratories represents the result of a research program to design a carrier wave detector highly responsive to carrier frequency deviation and insensitive to variations in carrier amplitude. The new Bradley circuit represents a more direct way of converting carrier frequency deviations into audio voltage than the conventional multi-stage discriminator limiter system. The practical application of the detector makes use of a new heptode tube designated as the Philco FM 1000 which embodies improved interlectrode shielding, high transconductance and sharp cutoff characteristics. The detector is also designed to have improved discrimination characteristics against unwanted carrier frequencies. Laboratory tests have shown that the Bradley circuit provides greater attenuation of unwanted signals than the conventional circuit. Compared with a discriminator system using a double limiter, the new detector has been shown to attenuate same channel interference twice as effectively and adjacent channel interference three times as effectively.

The essential portions of the circuit are the heptode and two resonant circuits mutually coupled and tuned to the intermediate frequency. One resonant circuit is connected in the plate lead and is coupled reactively to the second resonant circuit so as to produce frequency modulation in accordance with variations in the plate current. The other resonant circuit is connected between one control grid (No. 1) and the cathode comprising an oscillator operating class C and producing short pulses of space current. The incoming signal is fed to the other control grid (No. 3) and varies the amplitude of the space current in accordance with the carrier frequency deviations. The net result is that the oscillator frequency tends to follow the carrier frequency and in fact approaches a constant phase relationship when the carrier frequency is steady. This phase difference corresponds to a particular steady state plate current. When the carrier frequency is changed, a new phase relationship between oscillator and carrier causes a corresponding linear change of mean plate current. The mean plate current, therefore, bears the desired linear relationship with the deviations of the incoming carrier frequency. [The plate resonant circuit is highly damped to prevent any carrier amplitude variations being coupled into the oscillator tuned circuit; this makes the detector insensitive to amplitude modulation.] The audio output is taken from the plate circuit through an RC combination.




Fundamental Bradley circuit as used by Philco in FM receivers has new heptode tube

# NEW BULLETINS

### *Transmitting Tube Manual*

Whether it be lighthouse tubes, phasitrons, or standard transmitting tubes the Transmitting Tube Manual compiled by the Electronics Dept., General Electric Co., Schenectady, N. Y., will be a valuable aid to electronic engineers and designers in selecting the proper tube for a particular application. The compendium, supplied in a sturdy binder, is prepared in loose leaf form and arranged in sections with tabbed dividers for ease of adding new or revised data. A table of contents and a "Quick Selection Chart" aid in rapidly locating specific tube information. A separate application section includes definitions, classes of operation, typical applications, and notes on maintenance and operation. The main part of the manual gives technical information, descriptions, ratings, and curves on some 95 types of vacuum capacitors and switches, lighthouse triodes, phasitrons, triodes, beam power tubes, pentodes, mercury vapor and high vacuum rectifiers. Some of the more popular applications of each of these tubes are listed. The back of the manual contains an "Interchangeability Chart" for comparison with other tube types, as well as complete socket and base information.

### *FM Transmission Lines*

Bulletin 42 containing complete technical information on FM transmission lines and the new 51.5 ohm coaxial lines for FM and TV is being distributed by Andrew Co., 363 E. 75 St., Chicago 19. Complete solderless installations are possible with these lines. The 16-pg. pamphlet contains charts of length- vs. efficiency for a variety of lines and diameters, as well as power ratings, attenuation data and constructional information. The back of the booklet describes dry air equipment and automatic dehydrators for use on coaxial lines.

### *Power Generators*

A 10 pg. booklet entitled "Generating AC Electric Power" describes generating plants, independent generators, high frequency generators, rotary converters, and dc battery chargers manufactured by Kato Engineering Co., Mankato, Minn. Technical descriptions, specifications, illustrations and prizes are included in the catalog.



### *Sound Absorption*

"K" Felt, a combination of kapok and other selected fibers designed for sound absorption and thermal insulation, is discussed in Data Sheet No. 3, which has been published by the American Felt Co., Glenville, Conn. This booklet explains fundamental principles of acoustic treatment, including formulas necessary for working out felt requirements, along with sample problems. Tables in this data sheet provide all necessary information for computing insulation requirements for any installation.

### *Precision Resistors*

All types of vitreous enameled resistors are shown in the 8-pg. catalog 10-T, released by Model Engineering & Mfg., Inc., Huntington, Ind. Old parts numbers of the Tru-Ohm units, originally assigned by the Utah Radio Products Co., have been retained, and the listing has been simplified for easy location of any resistor and its full electrical and physical characteristics. Special non-inductive units and ferrule types are included. A complementary line of resistor mounting hardware also is shown.

### *Development Specialists*

Gerald N. Hanson, who has been engineering manager of the Sperry-Gyroscope Co.'s electronic products unit, has formed Hanson-Gorrill-Brian, Inc., to function as research, development and design specialists for products and special machinery. Associated with Hanson are W. Stanley Brian, inventor, who has seen service with such companies as General Motors, General Electric, Ken-Rad Tube and Lamp Corp., Grigsby Grunow Co., of which he was chief engineer, and the Arcturus Radio Co.; W. Sterling Gorrill, who was a research physicist for seven years with Sperry where he did outstanding work on servo-mechanisms, radar, computing devices, gyro stabilization, and infra-red detecting systems. The new organization will have headquarters at Meadow Lane in Glen Cove, N. Y.

### *Reporters Cover UN Opening Via Television*

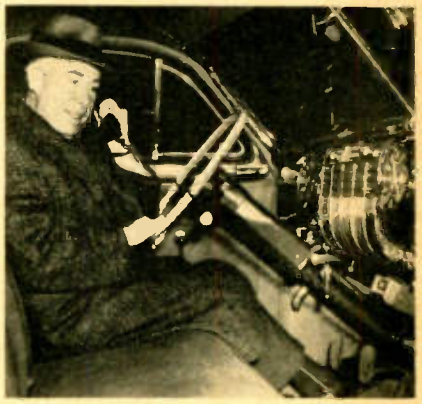
Press headquarters at the recent United Nations General Assembly in New York was outfitted with television receivers, to enable reporters who could not get accommodations in the assembly room to get a first hand view of the proceedings via television. RCA Victor division of the Radio Corp. of America supplied image orthicon cameras to pick up the action, RCA receivers were tuned to the sessions, and NBC cameramen operated the equipment.

Newsmen made good use of a similar television service at the opening sessions of the UN Security Council at Hunter College, last spring. At that time, more than one half of the 700 reporters turned to RCA television for detailed coverage of the meetings. Many expressed a preference for this type of coverage, since it allows close ups of UN personalities.

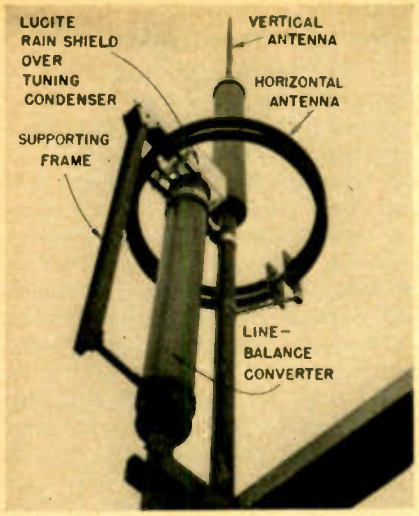
### *Multicore Moves*

Multicore Solder Corp. has occupied larger quarters at 315 Broadway, New York. The company distributes an resin multicore solder in wire form with three cores of non-corrosive flux. The solder is a British product made by Multicore Solders, Ltd., in England for whom the American company is exclusive sales representative.

### PRESIDENT GALVIN AT MIKE



Paul V. Galvin, president and founder of the Galvin Mfg. Corp., makers of Motorola equipment initiating commercial radiotelephone service in the Chicago area. Motorola 152-162 mc frequency-modulated equipment with its 30-watt crystal-controlled mobile transmitter and companion crystal-controlled receiver together with a selective calling system are fitted in the trunk of the automobile. The central station transmitter of the Illinois Bell Telephone System's mobile service system is a Motorola 152-162 mc 250-watt central station transmitter unit.




### *Propose Circular Polarization for FM*

An extensive series of tests on circular polarization was recently made by the United Broadcasting Co., owners of WHK, WHKB, WHKC, WHKK in the Cleveland area. As a result this group is recommending the adoption of circular polarization as the standard for FM and TV broadcasting stations. They point out that the propagation characteristics are quite similar to vertical and horizontal polarizations and in addition circularly polarized receiving antenna give the best results because they intercept all propagated energy, and automatically take care of changes from true vertical or horizontal polarizations. In addition radiations can be received on horizontal, vertical or inclined antennas.

### *Theatre Television*

Technical equipment now being developed for theatre television will make it possible for theatres to become the amusement and cultural centers of every neighborhood, according to Ralph Austrian, president of the RKO Television Corp. Austrian made this prediction before a meeting of the Society of Motion Picture Engineers held recently.

### *Tele for Communication*

"Television will the most powerful communication tool of them all," stated Charles R. Denny, Jr., acting chairman of the FCC, at a meeting of NAB's recent Chicago convention. Speaking for the commission, he stressed the communication aspects of television, and stated that video would not be simply a luxury entertainment service.

### *Stereoscopic Effect Coincidental Color TV*

● While the recent color TV demonstrations may not have convinced a sufficient number of engineers that certain details of the systems presently proposed should be the final word, it did a remarkable job of focusing attention on the possibilities of a good system and on the public acceptance of the value and importance of color. The demonstration indicated further that delays in the development of a final set of color system standards can not be permitted by industry. Many developmental programs that had been lagging during recent years were enlarged thereafter and numerous other basic system possibilities are being studied.

One proposal of interest, made by Harry Lubcke, Director of Television for the Don Lee Television System in Hollywood is the basis for an intensive research program under a special color license grant by the FCC on a 35 mc band at a requested carrier frequency of 585 megacycles. Lubcke plans to combine stereoscopic (three-dimensional) images with color, moving thereby immediately to the problem which ultimately will need to be tackled by television engineers. He feels that an early review of this matter is important in view of the possibilities which exist for correlation and interleaving of standards requirements.

Initially, a simultaneous system using stationary filters rather than a sequential system, is contemplated. Registration difficulties are anticipated, although since the same waveforms can be used on multiple tubes only mechanical precision problems appear to be of consequence. Voltage variations and non-linearity affect each simultaneous channel equally and consequently have little or no discernible effect.

The stereoscopic effect will be provided without the use of special viewing spectacles or other appliances by the observer. Binaural sound, the stereophonic system, also will be provided and would be injected into the waveband between the portions used for video energy. Binaural sound has been found to provide remarkable improvements in making television realistic.

### FCC Approves Five Mobile Projects

Four mobile telephone projects of three Bell System companies and one independent company have been approved by the FCC. One was the Texas highway mobile telephone system of the Southwestern Bell which comprises 16 land stations, the same number of auxiliary test stations, and 325 mobile units. The Illinois Bell received sanction of an additional link in the Chicago-St. Louis highway mobile system with land and test stations at Champaign and Rockford, Ill., with 400 mobile units. Indiana Bell was granted one land and one auxiliary and 25 mobile units. The Upstate Telephone Corp. of New York received approval for two land stations at Mohawk and Johnston, N. Y., and 20 mobile units.

### Carter Enlarges

Carter Motor Co., long a manufacturer of dynamotors and other types of rotary converters has relocated in its own building at 2644 N. Maplewood Avenue, Chicago. The new building provides more than four times the previous floor area.

### G-E Scientist Honored

Victor H. Fraenckel, scientist at the General Electric Research Laboratory, was awarded the medal of freedom, a special civilian award of the War Department. According to the citation, Fraenckel served as special adviser on radio and radar counter-measures under the Commanding General, U. S. Strategic Air Forces in Europe. "He formulated many of the operational policies and technics which greatly contributed to the effectiveness of the radio counter-measures program in our strategic air effort."

### Contact Arms

Under license arrangement with the Western Electric Co., the D. E. Makepeace Co., Attleboro, Mass., has undertaken the manufacture of bar contact tape. The company plans to supply the tape alone, to attach the tape to arms supplied by other manufacturers, or to provide complete assemblies of arms with tape attached. Tapes are supplied in various metals and as bimetallic forms in which precious metals may be combined with palladium and palladium alloys on nickel.

### Audience Records Home Entertainment

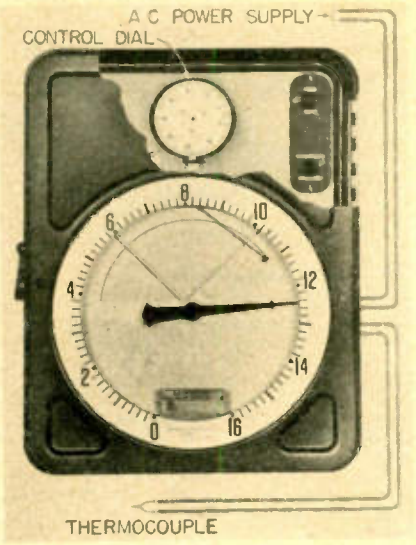
C. P. Jaeger has been elected vice-president in charge of manufacture and sales of Audience Records, Inc., a new corporation uniting leading radio and motion picture stars as director-stockholders for production of record albums. H. Paul Warwick is president and Norman Merrill is vice-president in charge of recording. Albums are to feature complete home entertainment programs, produced with music and full casts before studio audiences in Hollywood and New York. Corporation offices are at 230 Park Avenue, New York, and 6331 Hollywood Boulevard, Hollywood, Calif.

### Triad Transformers

Triad Transformer Mfg. Co. has been formed in Los Angeles and has taken over the inventory and equipment of the Electronic Components Co. L. W. Howard is head of the new company and associated with him is O. D. Perry. The company will specialize in transformers for the radio, aviation and other electronic fields. Headquarters have been established at 423 N. Western Avenue.

## ELECTRONIC PRODUCTS

(*Continued from page 93*)




### *Potentiometer-Pyrometer*

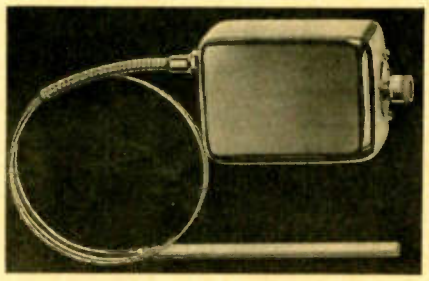
An electronic potentiometer-pyrometer which has no moving or vibrating parts records one or two temperatures on a 12 in. diam. chart and indicates on a 29 in. bold scale. The instrument operates from a thermocouple or any dc source with a minimum variation of 10 millivolts for full scale. The dc potential is balanced against a conventional potentiometer circuit with dc-ac converter being used in conjunction with an electronic detector to measure the unbalance. **Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.**—Electronic Industries


### *Transmitting Tube*

Designed for the medium power field or for high power audio applications the type T 300 transmitting tube has greater peak emission and longer life than the HF-300, KU-23, and the DR-300, for which it may be substituted. Having a carbon plate the tube will provide 600 watts output in class C telegraphy with a driving power of approximately 20 watts, and a mixmum plate dissipation of 200 watts. Filament voltage is 11 V. at 6 amps., max. plate voltage is 3000, and the amplification factor is given as 23. **Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago, Ill.**—Electronic Industries

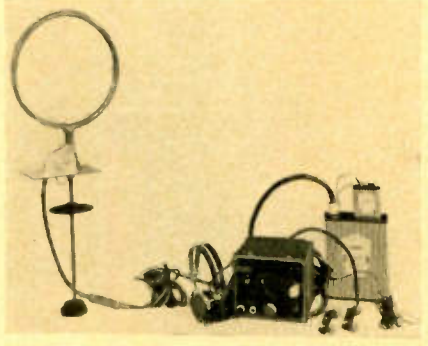
### *Voltage Regulator*

Designed for aircraft use and general industrial applications the model D-500 ac voltage regulator uses lightweight transformers and is hermetically sealed to withstand an ambient temperature range of —55° to +70° C. The unit has input voltage range from 95 to 125 volts, output from 110 to 120 V. with a frequency range from 360 to 500 cps. Within a load range from 50 to 500 VA regulation accuracy is 0.5% and harmonic distortion less than 5%. Transient recovery time of the regulator is approximately 4 cycles. **Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.**—Electronic Industries



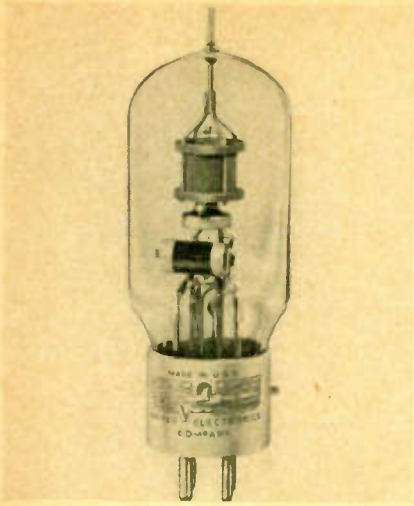
### *Thermostat*

For industrial applications requiring control of temperatures over narrowly calibrated ranges, type O Thermostat of the remote bulb type, may be used for all liquids or gases non-injurious to brass, or for metal to metal applications. The assembly consists of a liquid-filled copper thermal assembly which actuates a remote snap-action switch. It may be adjusted in increments of 120° or 250° F in the range from —120° to 600° F. Four different bulb types are available. **United Electric Controls Co., 69-71 A Street, Boston 27, Mass.**—Electronic Industries



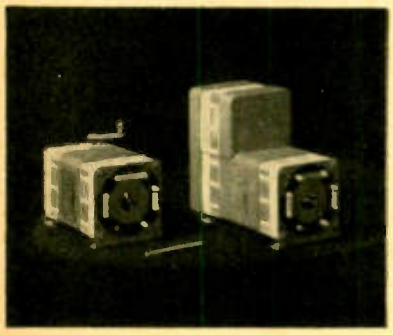
### *Radio Range Receiver*

This postwar aviation range receiver and aural-null loop combination incorporates new circuits and components, which make possible greater selectivity and clearer reception. The unit, known as the AMRL-1, is composed of a directly controlled radio range receiver powered by dry cell batteries; manually operated aural-null rotable loop; headphones and shock mounts; etc. Receiver covers the 195-405 kc range, and has provision for interphone communications. **Lear, Inc., Grand Rapids, Mich.**



### Graphite Anode Beam Tube

Designed to surmount the disadvantage of short service life in high temperature anode tubes, the type 5562 VHF tetrode with its graphite anode and isolated getter trap is one of the smallest commercial graphite anode tubes and has low operating temperature. With a filament voltage of 6.3 at 3 amps., the tube has an amplification factor of 60, transconductance of 2500 micromhos, and is good up to 120 mc for maximum ratings. As Class C rf amplifier it will provide 60 watts output with a driving power of 2 watts.—**United Electronics Co., 42 Spring St., Newark 2, N. J.**



### Induction Voltage Regulators

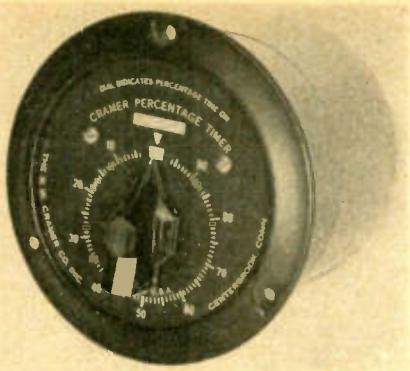
The 300 and 600 VA Inductrols have been added to the line of dry-type induction voltage regulators. The units are available either hand or motor operated for providing a variable output voltage from a constant supply, or "automatic" for maintaining a regulated output voltage from a varying supply voltage. **The Transformer Div. of General Electric, Schenectady, N. Y.**—Electronic Industries

### Geiger-Mueller Counter

Built for industrial research or the physical laboratory Model 337 Geiger-Mueller Counter registers and counts radioactive impulses, utilizing a scale of 64 with provision for switching to a scale of 8, if desired. The impulse register, shock-mounted and insulated, is contained within the instrument. Power supply is ac operated and continuously variable from 0 to 2000 volts. Front panel controls include switching of power, reset, start and stop counting, panel light indication, and aural monitoring with volume control adjustment.—**Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.**—Electronic Industries

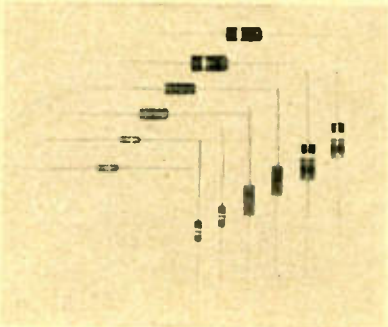
### Etchtool & Demagnetizer

Adapted to deep etching on polished surfaces, this combination etchtool and demagnetizer has a tungsten marking point. The point will permanently mark the hardest steel, stainless steel and steel alloys. It is not necessary to cut down writing speed to increase marking depth, as depth is automatically controlled. Has 5 ft. cable, which is detachable. Three other marking points, elkonite, copper and carbon, are available. As a demagnetizer, it will demagnetize tools that have been in contact with a magnetic chuck, and will perform either of its two operations without a setup delay. **Luma Electric Equipment Co., 1106 Dorr St., Toledo 1, Ohio.**—Electronic Industries



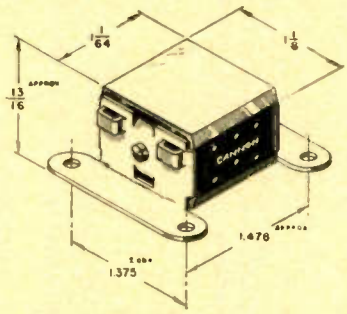

### Percentage Timer

Type PE percentage timer for use on ac automatically controls the percentage of time of opening or closing any electrical circuit out of a definite length of time, and is useful for regulation of ovens, furnaces, blowers, pumps, etc. The timer consists essentially of a self-starting synchronous motor which drives a positive snap acting switch mechanism rated at 250 watt incandescent lamp load. It is available in 12 speeds ranging from one revolution in 15 seconds through one in 24 hrs. Standard dials are calibrated in steps of 1% from 4% to 96%. **R. W. Cramer Company, Inc., Centerbrook, Conn.**



### Composition Resistors

Composition resistors capable of operation at full rating in ambient temperatures up to 70° are available in standard RMA resistance values for ½, 1, and 2 watts. An RMS voltage of 350, 500, or 1000 volts may be applied continuously to the ½, 1, and 2 watt units respectively. The resistors will withstand high humidity and have excellent stability. **Specialty Div., Wolf Street Plant, General Electric Co., Syracuse, N. Y.**

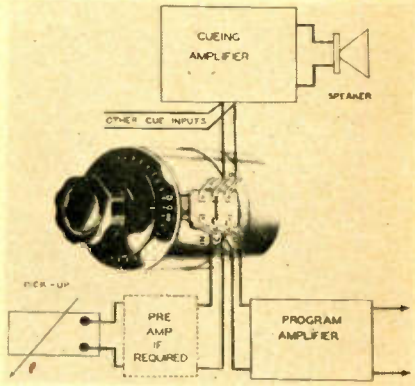



### Terminal Block

Designed for aircraft, radio, and other equipment carrying many low amperage circuits the type Y6 terminal block is a compact and flexible terminal disconnect device, molded of phenolic. The basic unit is a six-socket contact block with foot brackets, to which additional units may be added vertically or horizontally by means of side brackets and top interlocking strips. Contacts are made of silver-plated brass and accommodate No. 16 AWG wire for 5-amp. circuits.—**Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Cal.**

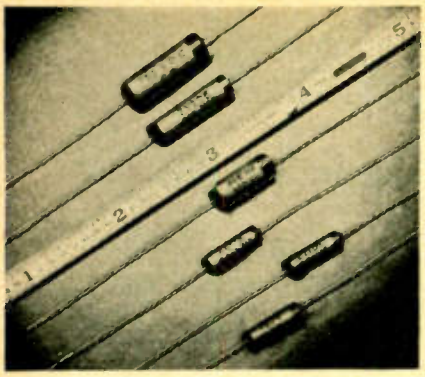
### Transmitting Tubes

Two new transmitting tubes are available. Forced-air-cooled, Type GL-5518, designed for use as class C rf amplifier and oscillator, is adapted for grounded-grid circuit applications. A pair of tubes have a power output of 12.9 kw at a dc plate voltage of 6,000. Type GL-5C24 for class A and class $AB_1$ af amplifier and modulator service has a mu of 8, and will provide 55 watts output for a peak af grid voltage of 150 and plate voltage of 1,500 volts.—**Tube Div., Electronic Dept., General Electric Co., Schenectady, N. Y.**



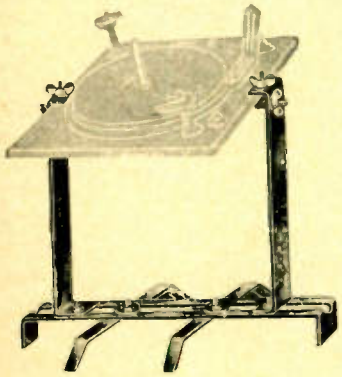

### Built-in Cueing Control

Direct cueing controls, which have a wide application in broadcast stations, recording stations, wire music service and the sound film industry, are now built in on this line of attenuators. The control transfers program material to a separate cueing amplifier, and eliminates the need for additional switching devices. Provision is made at the extreme attenuation position for connecting the incoming signal to a cue circuit before fading in the signal. A lug on the terminal board is provided for connection to the cueing system. **Daven Co., 191 Central Ave., Newark 4, N. J.**—Electronic Industries



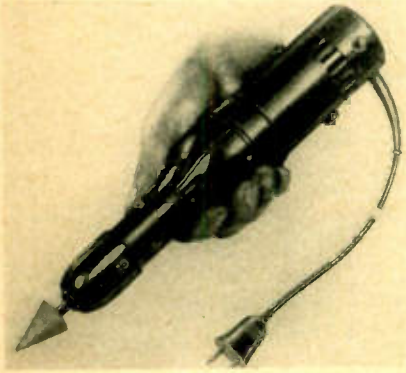
### *Midget Capacitors*

Planned for application in portable tranceivers and radios, pocket meters and hearing aids, these midget capacitors have 2 in. unbreakable leads. Standard ZY units are ¾ In. in length and from 3/16 to 1 1/32 in. in diameter. Values range from .0001 mfd to .006 mfd at 600 v dc. .002 to .02 mfd at 400 v., .004 to .02 at 200 v., and .01 to .05 mfd at 150 volts. ZZ units are available in a range from .0001 mfd to .01 mfd at 150 vdc. **Cornell-Dubilier Electric Corp., South Plainfield, N. J.**



### *Turntable Stand*

Record changers may be supported in any convenient position on this phono turntable stand which is adjustable, about 15 in. above the work bench. Pivoted clamps permit the record changer to rotate for easy accessibility. **General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.**—Electronic Industries



### *Electric Handtool*

The new Precise-40 electric handtool and portable grinder has 1/5 hp and speeds to 40,000 rpm for grinding, milling, drilling, finishing, and polishing of metals, plastics, and glass. The tool set includes a precision quill fitted with a No. 0 Morse taper, a Jacob's chuck for small arbors, and special spindles to extend the quill length. The tool may be used alone or mounted in a vise, lathe, or milling machine. Accessories for special uses are also available. **Precise Products Co., 1328-30 Clark St., Racine, Wis.**—Electronic Industries

### *Lightweight Battery*

A new 45 volt B battery of the Mini-Max type having only half the weight and size of pre-war models has been developed for use with electronic industrial test equipment, portable amplifiers, etc. The reduction in size and weight is made possible by printing the carbon electrode in a thin layer on the zinc plate. The battery weighs 4 lbs. 4 oz. and displaces only 76.6 cu. in. **National Carbon Co., Inc., 30 E. 42nd St., New York.**—Electronic Industries

### *Miniature Magnetic Receiver*

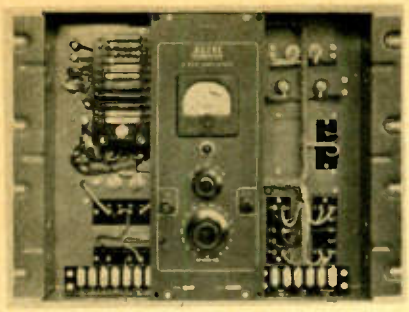
The Telex magnetic receivers for hearing aids and similar use provide high fidelity and clarity under extreme atmospheric conditions, being operative from —30° to ± 160° F. Weighing less than ½ oz. they have a sensitivity of 18 dyns per $cm^2$ for 10 microwatts input and an impedance of 128 ohms per receiver. **Electro-Acoustic Div., Telex, Inc., Minneapolis, Minn.**

# ANNUAL INDEX

## To Electronic Industries for 1946

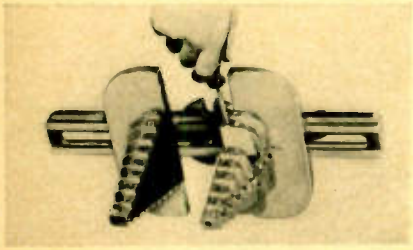
**The Annual Index has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page.**

ABS—Abstract NPI—New Patents Issued SWR—Survey of Wide Reading TOJ—Tubes on the Job



### *High Quality Amplifier*

Designed primarily as a high power recording amplifier using preemphasis and outside-inside equalization, the A-255 amplifier provides a maximum gain of 65 db with frequency response uniform within 1 db from 20-20,000 cycles. A 6SJ7 pentode operating a 6V6 as phase inverter to drive a pair of 807 tubes provides 40 watts output with 8% intermodulation—approx. 2% tot. harmonic distortion. The output transformer is tapped for 10 and 20 ohm loads. The unit operates on 105 to 130 volts, 50-60 cycles, ac, and consumes 200 w. **Altec Lansing Corp., 1161 North Vine St., Hollywood 38, Cal.**—Electronic Industries



### *Concentric Winding Head*

Considerable savings in production time are possible through this winding head designed for the production of concentric coils for many types and sizes of single phase motors, from a coil for a 1/20th hp, 24-slot 6-pole stator to coils for a 3 hp, 36-slot 2-pole stator, the latter 7 coils to a group. It comprises nine pairs of segments, large to small sizes, eight of them adjustable by means of a screw. By referring to an accompanying chart, operators can set segments to the proper dimensions without removing the head. Thus it can save many hours formerly wasted in set-up time, and also eliminates the problem of labeling and storing many sets of forms. **Continental Electric Co., 650 N. Prairie Ave., Hawthorne, Calif.**—Electronic Industries

### *DC Voltmeters*

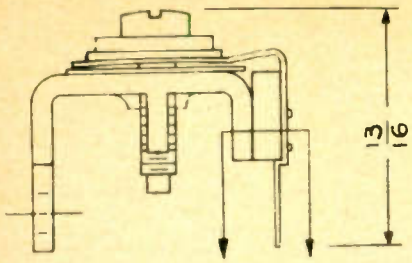
Type 501-F multi-voltmeter will measure dc voltages from 1 milli-volt to 1000 volts in eleven overlapping ranges with an accuracy of ½%. Sensitivity of the instrument is 10,000 ohms per volt, the max. current drain being 100 microamps. on any range at full scale. All resistances are wire-wound. An increased sensitivity of 100,000 ohms per volt with a current drain of 10 microamps. is available in the type 501G which in all other respects is similar to type 501F. **Rawson Electrical Instrument Co., 116 Potter St., Cambridge, Mass.**—Electronic Industries

### *Adds Radiophone*

Wilcox Electric Co., Kansas City, Mo., has formed a new Telephone Division, which will produce a combination radio and automatic dial telephone exchange. This combination will use telephone for short distances, and radio for point to point communications. Another unit combines telephone communication with a public address system. By dialing a specified number, any phone in the system automatically becomes a microphone, and the entire organization can be addressed. John H. Van Horn, who joined the company in September, will be chief engineer of the new division. He was with the Automatic Electric Co., Chicago, as a design and project engineer from 1939 to 1942.

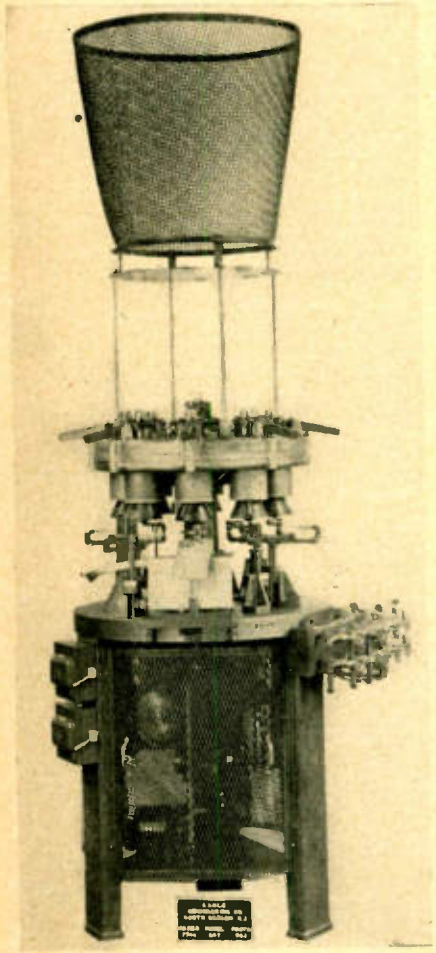
### *Asco Enlarges*

The Asco Corp., Cleveland is occupying a new and larger building at 17702 Waterloo Road, Cleveland. The company manufactures mechanical and electrical components and has been doing business from 874 E. 140th Street, Cleveland. The move will provide additional production facilities.




### *Mica Trimmer Capacitors*

Designed to meet all normal coil requirements for radio and electronic uses, five mica trimmer capacitors having a combined range from 5 to 370 mmfd are available for antenna, rf, or oscillator trimmers, or for use as neutralizing or balancing capacitors. The units are made of high grade India ruby mica, and are not affected by variations in humidity and altitude. They have a minimum Q of 200 at 1000 kc, the leakage resistance being better than 2,000 megohms at 300 volts dc. Screw adjustment of the trimmers is very smooth and remains permanently set. **Lear, Inc., Grand Rapids, Mich.**—Electronic Industries

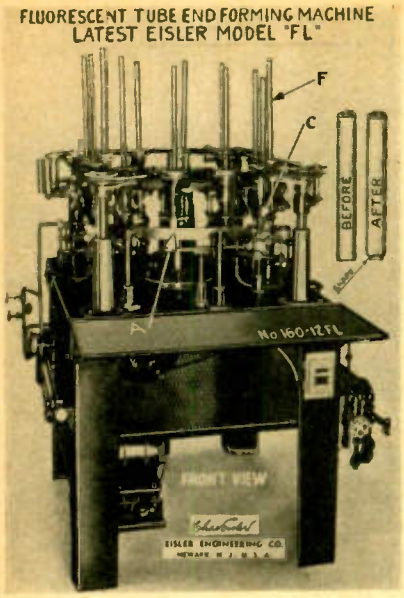


### *Hot Cut Flare Machine*

An automatic high speed hot cut flare machine designed for the production of glass parts in tube manufacture will handle soft or hard glass with a speed of 2400 per hour on ordinary flares. The unit can accommodate tubing diameters from ¼ to 1⅛ in. and flare diameters up to 1¾ in., the max. length being 3 in. Eight heads with removable jaws are provided. An automatic tubing cutting machine and a bulb and ampule blowing machine are built on the same chassis and will handle the same tubing sizes. The tubing is blown into moulds, and the bulbs or ampules are automatically cut off. **Kahle Engineering Co., 1307.09 Seventh St., North Bergen, N. J.**


### *Flash Tube*

Type R-4340 electronic flash tube provides a peak output of 48 million lumens for color, and black and white photography uses. Spectral characteristics are almost flat between 4000 and 7000 angstroms giving it daylight quality. The tube is suitable for capacitor discharge circuits and will give a flash of 1/5000 second duration by discharge of a 120 mfd capacitor at 2500 volts. Tube life is rated at more than 10,000 flashes with a max. repetition rate of four times per minute. **Sylvania Electric Products Inc., 500 Fifth Ave., New York 18.**—Electronic Industries

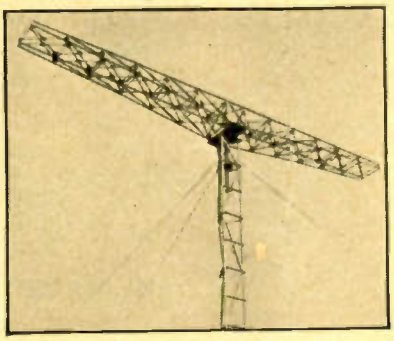



### Tube Forming Machine

A machine for shaping the ends of fluorsecent tubes consists essentially of twelve chucks and a barrel cam which moves the chucks from station to station. The machine, powered by a ½ hp motor is fully automatic; it is necessary only to invert the tubes after one end has been shaped. The chucks can hold sizes from 1 in. to 2⅛ in. O.D., and from 700 to 900 tubes an hour may be handled. Fuels used for heating the tubes are gas, air, and oxygen. **Eisler Engineering Co., Dept. 34, 743 South 13th St., Newark 3, N. J.**—Electronic Industries

### Current Transformers

Two current transformers for meter, relay, and control device applications have been developed for various laboratory uses. One, the JKL-3, is rated 5,000 volts, 1200 amperes, and is designed to withstand full-wave impulse tests at 60 kv in accordance with ASA standards. The other, the JKL-4 is rated 8700 volts, 1200 to 4000 amperes, and will withstand full-wave impulse tests at 75 kv. Both the JKL-3 for 2400- and 4800-volt lines, and the JKL-4 for 7200-volt lines, have been designed for accurate metering over the normal current range up to 100% of rating, and for relay operation up to 20 times rated current. **General Electric Co., Schenectady 5, N. Y.**—Electronic Industries



### Rotary Beam Antenna

The Trylon rotary beam antenna support is intended for a 4-element, 20 meter array for amateur use. The support is constructed of lightweight stainless steel, is designed to withstand wind and icing conditions, and may be erected with a screwdriver. Ball bearing design provides full 360° traverse actuated by manual or motor drive. **Wind Turbine Co., Tower and Antenna Div., West Chester, Pa.**—Electronic Industries

## VI ELECTRONICS IN INDUSTRIES



## VII CIRCUIT ARRANGEMENTS and DESIGNS

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## ELECTRONIC ENGINEERING HANDBOOK

Written and published as a day-in day-out working tool for engineers interested in electronic applications in the industrial and communication fields. Edited by Ralph R. Batcher and William Maulic, this book contains the writings of the foremost men in the particular phases of electronics covered by the book. Yet its messages are presented in a manner easily understood by any engineer with a basic knowledge of electrical principles.

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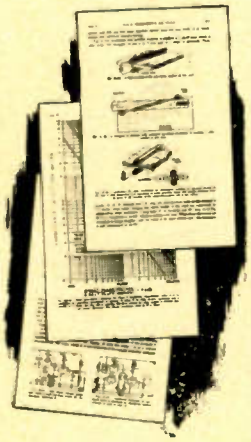

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- *Low Frequency Amplifiers*
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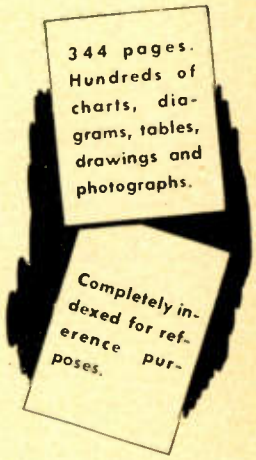


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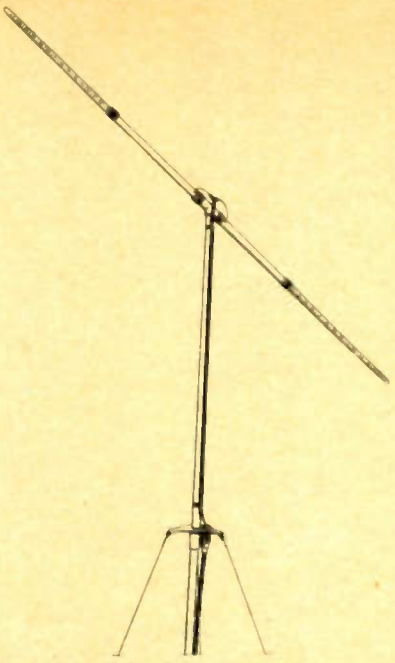
### *R-F Amplifier Tubes*

Designed to replace bulkier or obsolescent tubes, such as the 6D6, 6U7G, 6K7, 6SK7, etc., these miniature cathode type rf amplifier tubes are the electrical equivalent of the 6SK7 and 12SK7. Designated as the 6BD6 and the 12BD6, they enable manufacturers to use standard IF transformers at a considerable saving in production costs. Special features include: remote cut-off characteristics, zero-bias operation without cathode resistors, and proper operating characteristics with or without series screen-dropping resistor. **Raytheon Mfg. Co., Newton, Mass.**—Electronic Industries



### *Tunable Dipole*

A new television and FM dipole has been designed to help eliminate ghosts and weak reception on certain stations in low areas. The dipole arms are adjustable, and the adjustable feature consists of an uhf element that is calibrated from 1.0 to 21.5 in half steps. A broad band of frequencies can be covered including black and white or color television, FM, glide paths, airport controls, etc. **Kings Electronics, 372 Classon Ave., Brooklyn 5, N. Y.**

### *Volt-Ammeter*

A clip-on volt-ammeter consisting of a current transformer and 2½ in. dial rectifier type instrument provides five current ranges from 0 to 1000 amps. and two voltage ranges from 0 to 600 volts with an accuracy of 3% full scale. For current measurements the core is opened and the instrument is clipped over a single core cable or other current-carrying conductor. Range can be extended downwards by looping the conductor twice or more through the core aperture. Sensitivity on voltage ranges is approx. 333 ohms per volt. **Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20.**—Electronic Industries

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## *Advertisers, December 1946*



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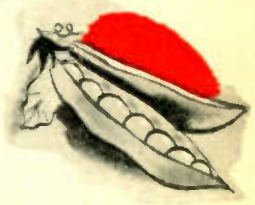

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# RCA-1P42

## —a tiny high-vacuum phototube with unusual possibilities


**FEATURES**

- Can be used in close y confined space
- Head-on structure permits close spacing e in banks
- Excellent sensitivity—single amplifier stage cient for many relay services
- Smooth end terminal permits pin-jack mou
- High-vacuum insures high stability

**RATINGS AND CHARACTERISTICS**

**MAXIMUM RATINGS, ABSOLUTE VALU**

Anode-Supply Voltage (DC or Peak AC) . . . 150 max. Volts
Cathode-Current Density . . . 14 max. Microamp/s
Average Cathode Current* . . 0.4 max. Microampere
Ambient Temperature . . . . . 75 max. °C

**CHARACTERISTICS:**

Maximum Dark Current at 150 volts . . . 0.005 Microampe
Sensitivity:
At 4200 Angstrams . . . . . 0.020 Microamp/
Luminous** . . . . . 25 Microamp/l

**MINIMUM CIRCUIT VALUES:**

DC Load Resistance . . . . . 1 Megohm

*On basis of the use of a sensitive cathode ar in diameter.

**Given for conditions where a Mazda project operated at a filament color temperature of 2 used as a light source. With daylight, the several times higher; with light from a high arc, many times higher.

THE RCA-1P42 high-vacuum phototube opens up entirely new fields of application to the design engineer—particularly for control purposes where space limitation is a prime consideration. Its extremely small size, combined with the unique "head-on" construction, permits exceedingly close spacing of the tubes in banks for controlling a large number of circuits, or the use of a single tube in closely confined quarters.

The semi-transparent cathode surface on the glass window in the large end of the 1P42 is sensitive to light sources predominating in blue radiation, and has negligible sensitivity to infrared radiation. The tube has an S-4 spectral response and maximum response at a wavelength of 4200 Angstroms.

The RCA-1P42 is especially designed for compact services such as the control of complex business-machine operations. It is also applicable to small equipment for sound-film reproduction.

A technical bulletin on the RCA-1P42 is available on request. RCA tube application engineers will be glad to work with you in adapting this or any other RCA tube types to your equipment designs. Address RCA, Commercial Engineering, Section D-7L, Harrison, N. J.

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