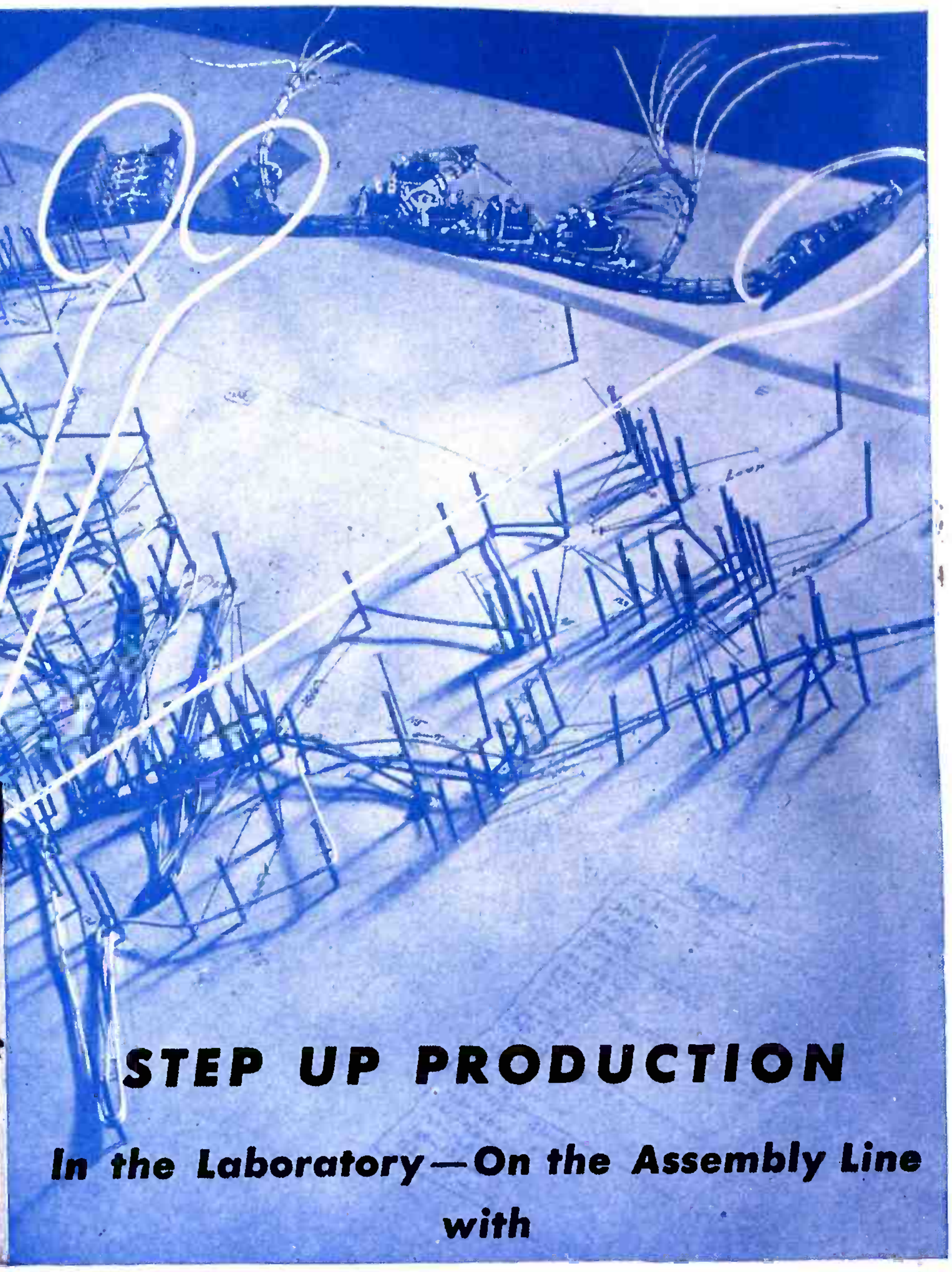
# COMMUNICATIONS

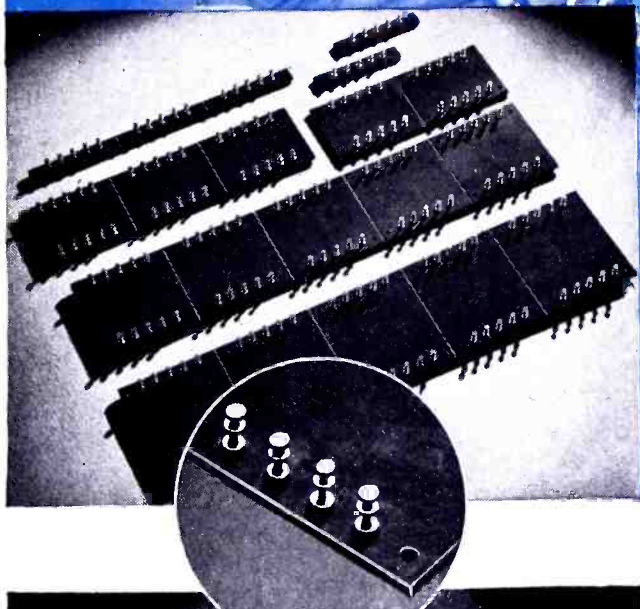


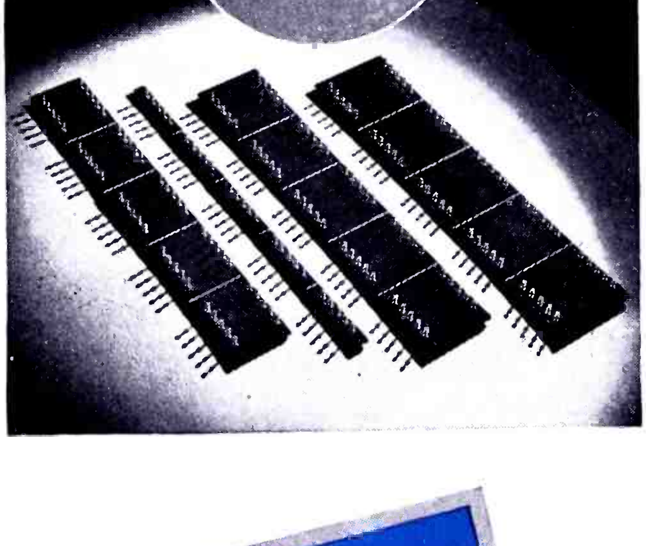
AUGUST

★ RADIO ENGINEERING
★ INSTRUMENT CALIBRATION IN V-T PRODUCTION
★ RESONANT SPEAKER-ENCLOSURE DESIGN
★ AERONAUTICAL COMMUNICATIONS
★ RADAR IN U. S. AND BRITAIN
★ TELEVISION ENGINEERING

1945







# STEP UP PRODUCTION

**In the Laboratory—On the Assembly Line**
**with**

## C.T.C. *All-Set* TERMINAL BOARDS

No more time-wasting board cutting, drilling and lug mounting when you have C.T.C. All-Set Terminal Boards on hand. They're furnished completely assembled with any size C.T.C. Turret Terminal Lug in four widths, ½"; 2" (*lug row spacing 1½"*); 2½" (*lug row spacing 2"*); 3" (*lug row spacing 2½"*) to fit all standard resistors and condensers. Select proper width board and go to work.

C.T.C. All-Set Terminal Boards are made of 3/32", 1/8" and 3/16" linen bakelite only and come in five-section boards which can be broken into fifths by bending on a scribed line. They may be ordered in sets of the four widths, or in lots of six or multiples of six in any single width. Extra lugs and stand-offs are supplied.

*For complete information on these new, money-saving All-Set Terminal Boards, write for C.T.C. Catalog Number 100.*

CTC

**CAMBRIDGE THERMIONIC CORPORATION**
442 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

# *We See...*

THE POSTWAR ERA HAS COME AT LAST. Many thanks are due to the men and women in the communications industry for their excellent work during the war. Their efforts played an important role in bringing World War II to a close.

With the backlog of a host of unusual military developments and our ambitious postwar projects, radio communications is destined to play a major role in peacetime world planning.

The rapidity of the release of important wartime developments for peacetime programs will of course be quite a governing factor in development and production. Analyzing this problem, FCC Commissioner E. K. Jett said, in an exclusive statement to COMMUNICATIONS:

"On entering the peacetime era our thoughts and efforts must be directed primarily to the needs of the American public. The public has been led to believe that many improvements will be made in communications, including the licensing of new services such as television, f-m, facsimile, urban and highway mobile, citizens radio and many others. However, many of the wartime developments are still classified as secret or confidential, and there has been no opportunity for industry as a whole to consider them with a view to adopting uniform standards. Since it is of the utmost importance that the design of equipment be as nearly perfect as the present state of development of the art will permit, I hope that a way will be found to declassify and release such technical information as promptly as may be possible."

When these accumulated developments are released and peacetime projects are accordingly accelerated, we will see quite a striking array of equipment and components.

Broadcasting activities should rise to new heights during the months to come. Records indicate that over 100 television stations, 500 f-m stations and close to 200 new a-m stations are scheduled for construction very soon. Relay networks will also play an important role. Commenting on this fact, Dr. C. B. Joliffe, of RCA, says that it is not fantastic to imagine long telephone and telegraph lines being replaced by relay towers from coast to coast.

The release of radar has also highlighted communications contribution during the past few years. Its application to air and sea piloting will revolutionize the art of navigation. The U. S. Merchant Marine has already indicated that it will install radar control on their ships. And the CAA have also certified the use of radar. Out at the CAA experimental station at Indianapolis, ten carloads of radar were recently delivered. The equipment will be used to increase safety factors particularly in zones of traffic saturation.

Communications has quite a job on hand. But, as during the war, we know that the job will be well done. . . . L. W.


# COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
Member of Audit Bureau of Circulations.

**AUGUST, 1945**

**VOLUME 25 NUMBER 8**


**COVER ILLUSTRATION**

Invasion loudspeaker system used to broadcast troop, weapon and supply instructions in large invasion areas.
*(Courtesy Western Electric)*

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# SYLVANIA NEWS
## ELECTRONIC EQUIPMENT EDITION

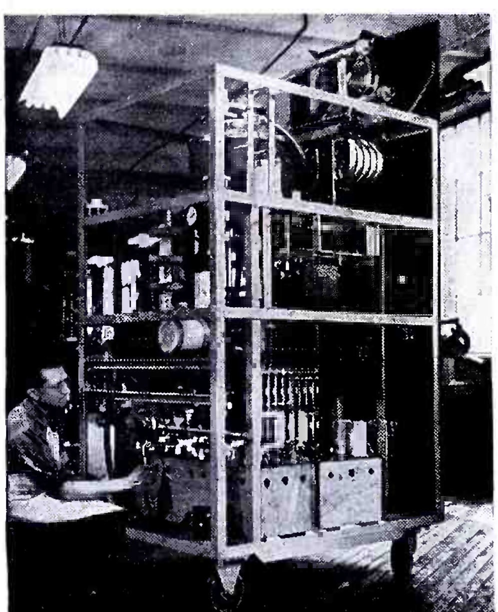
AUGUST *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

## HIGH FREQUENCY INDUCTION FURNACE USED IN TUBE PLANT

The bombarder or high frequency induction furnace pictured below is another example of high-precision, modern equipment manufactured at Sylvania Electric's plant in Williamsport, Pa.

### Flexible in Application

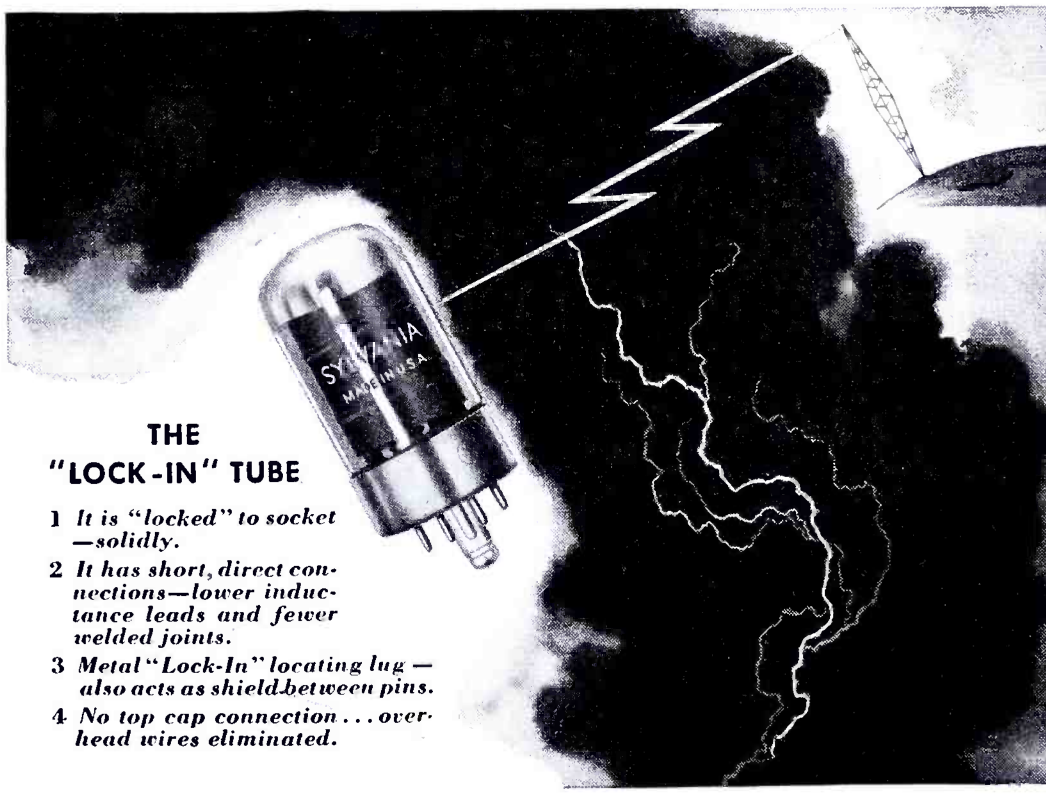
Used in all radio tube plants where exhaust machines operate, this essential apparatus may also be adapted for use in practically any application that requires high frequency induction heating by the connection of the proper heating coils. Its rated input is 25KVA, uses Type 207 tube as oscillator, frequency about 300KC.



*High frequency induction furnace used in all radio tube plants where exhaust machines operate. Made by Sylvania Electric at Williamsport, Pa.*

## LOCK-IN TUBES PERFECTLY IN LINE WITH RECENT FCC DECISION

### *High Frequency Sets (FM) Will Get Benefit of Tubes' Electrical Superiority*




Sylvania Electric's revolutionary type of radio tube — the Lock-In — is so mechanically stronger and electrically more efficient that it takes in its stride the recent FCC decision assigning to frequency modulation the band between 88 and 106 megacycles. The basic electrical advantages of the Lock-In construction are ideally suited to the adoption of higher frequencies.

Mechanically it is more rugged because support rods are stronger and thicker—there are fewer welded joints and no soldered joints—the lock-in lug is metal not molded plastic—the elements are prevented from warping and weaving.

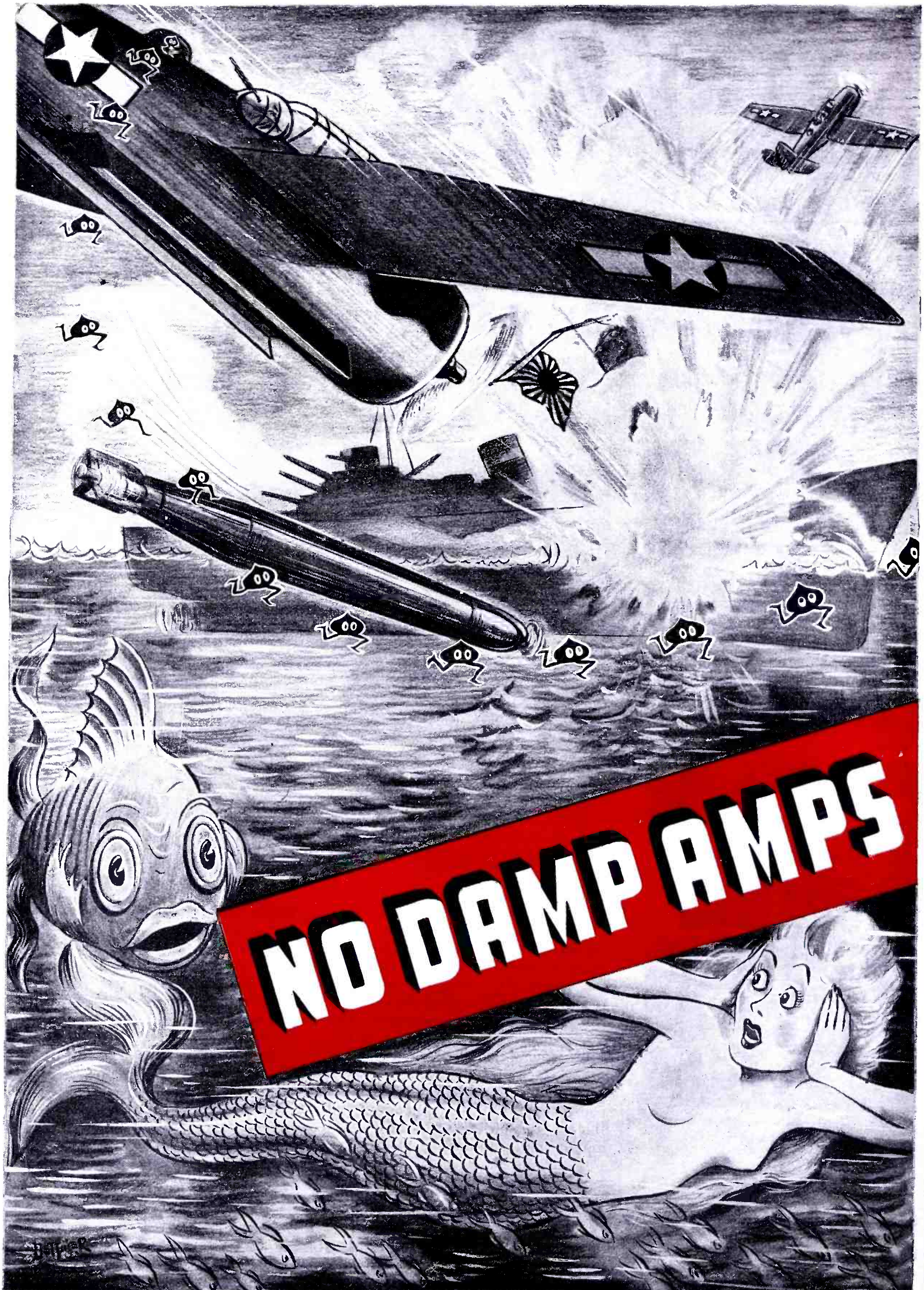
Electrically, it is more efficient because the element leads are brought directly down through the low loss glass header to become sturdy socket pins—reducing lead inductance—and interelement capacity.

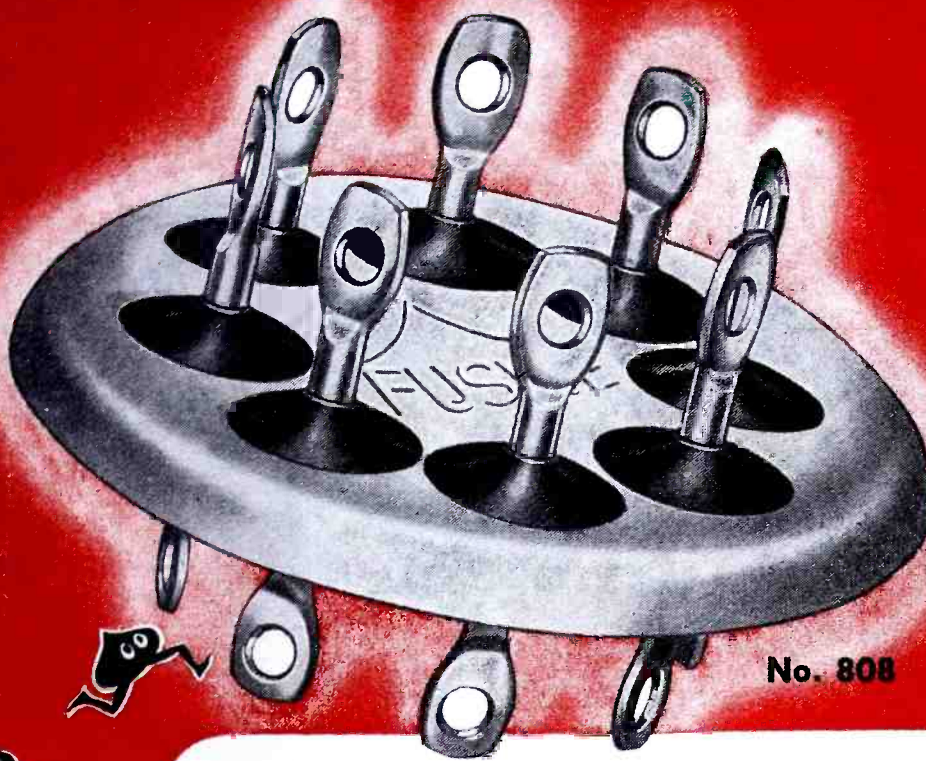
Today, the many special features of the Sylvania Lock-In Tube are even more up-to-date than when they were introduced in 1938—a fact of increasing importance when considering the numerous postwar developments in the field of communications.

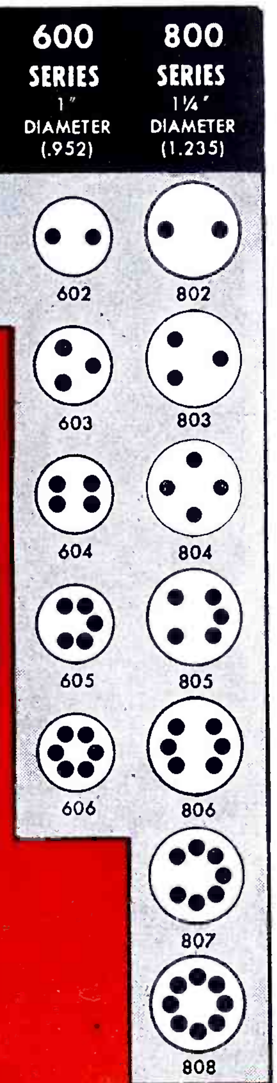
# SYLVANIA ELECTRIC

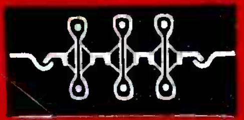
*Emporium, Pa.*

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

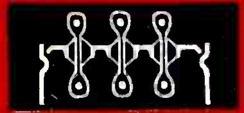

NO DAMP AMPS



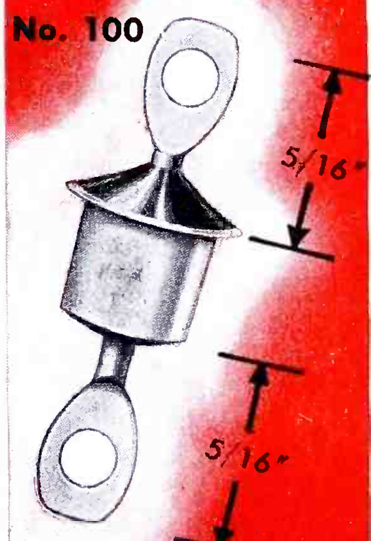
Hole punched and adapter socket formed to receive multi-terminal panels.



Fusite multi-terminal panel used as cover for container. A single sealing operation.

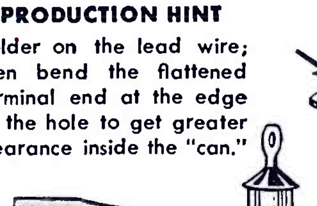
**FINISH . . .** means "to end". It also means "to bestow the last required labor upon; complete; perfect." Just so with the new *fused* electro-tin finish on **FUSITE** Hermetic Terminals. Microscopically, ordinary electro-tin finish looks like this ▒ **FUSITE's** *fused* electro-tin finish is like this ■ There are no pin-point holes in the finish where oxidation can start to work. **FUSITE's** new and proved *fused* electro-tin finish provides even, uniform protection. It is the completely satisfactory finish to the completely satisfactory hermetic seal . . . **FUSITE** . . . which satisfactorily stands the latest J-A-N tests. **FUSITE's** electrical properties have been bettered, too! Whereas a test of 500 megs, on electrical leakage, was formerly considered satisfactory, the new **FUSITE** now tests close to infinity. Leakage across the glass insulation is almost nil. This mark FUSITE is your assurance of the ultimate in hermetic terminals . . . for your war products of today; for your "peace-work" of tomorrow.

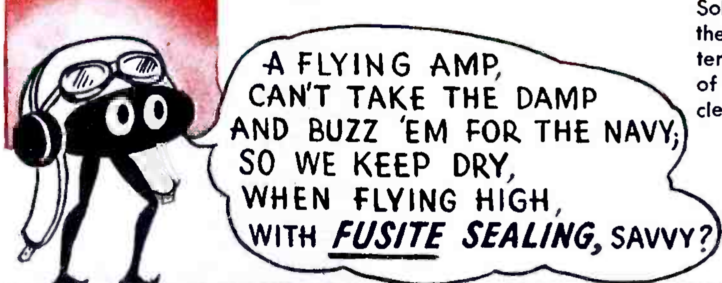
**WITH FUSITE SEALS**




**PRODUCTION HINT**

Solder on the lead wire; then bend the flattened terminal end at the edge of the hole to get greater clearance inside the "can."





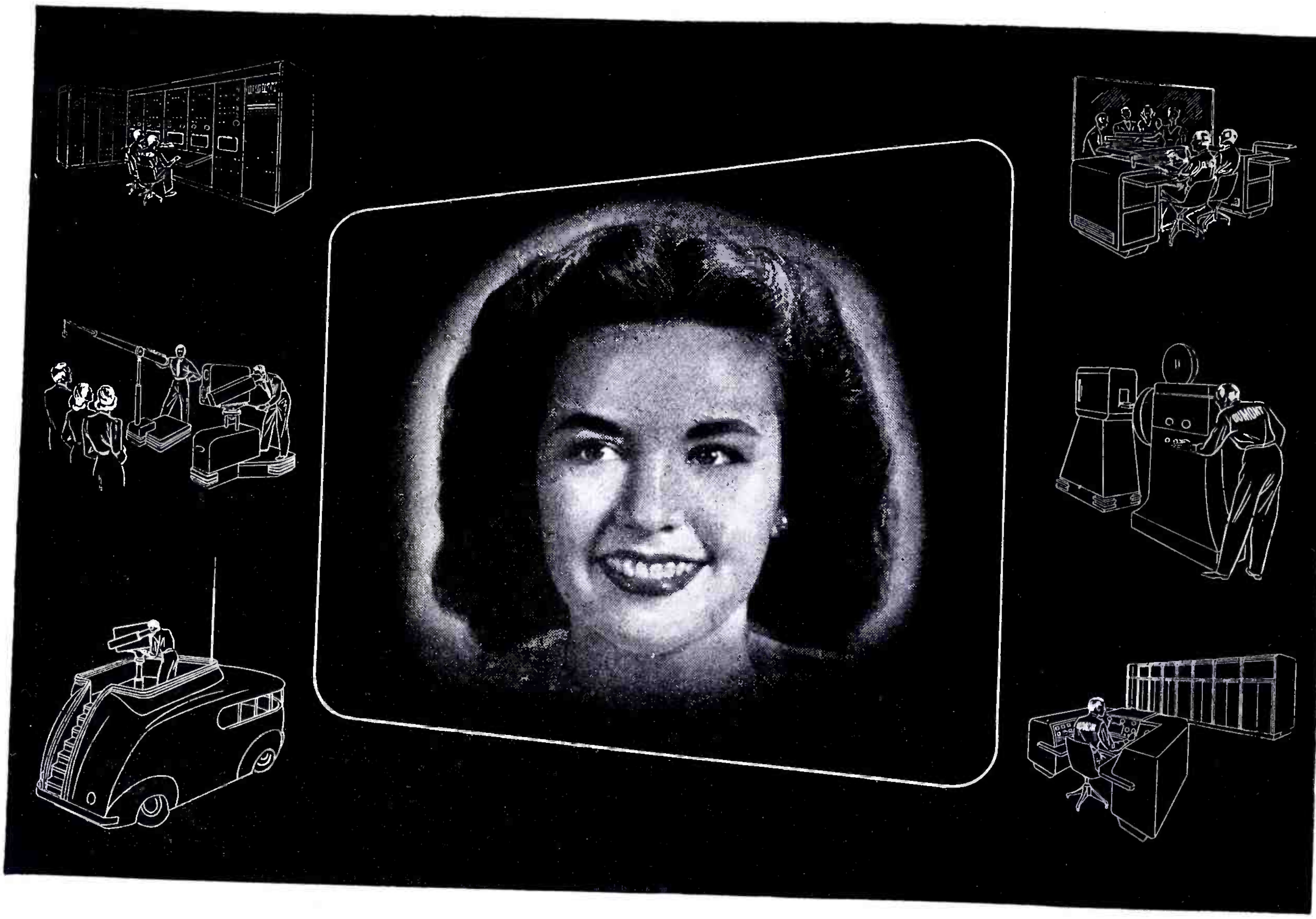


**HERMETIC TERMINALS**

***NO DAMP AMPS!***

**CINCINNATI ELECTRIC PRODUCTS COMPANY**

CARTHAGE AT HANNAFORD, NORWOOD
CINCINNATI 12, OHIO



# DuMONT—FOR THE TOOLS OF TELEVISION

**PROOF OF THE PUDDING!** DuMont has designed and built *more* television stations than any other company. DuMont-built stations, every week, are demonstrating the high efficiency, rugged dependability and low operating cost of DuMont-engineered equipment.

DuMont's simplified precision control—the dominant keynote of *all* DuMont design—is brilliantly exemplified in the tools of television featured above. These postwar designs incorporate all the flexibility and refinements dictated by more than 4 years of continuous and increasingly elaborate experimentation by hundreds of program producers.

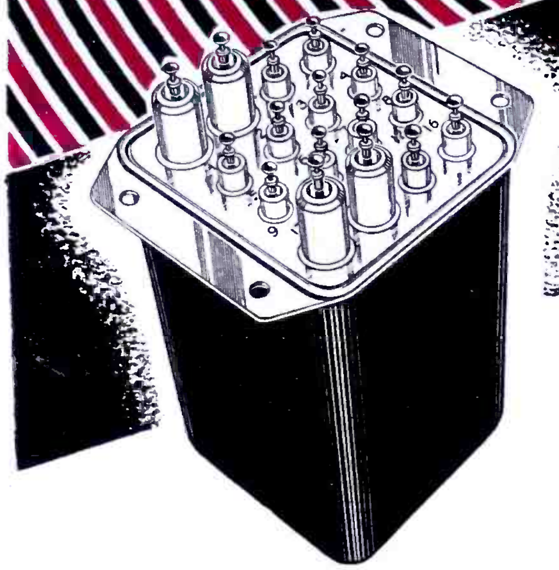
DuMont's Station WABD, New York, has pioneered a pattern for commercial television that you can make your own whenever you choose to study it. And DuMont's Equipment Reservation Plan insures early peacetime delivery of your equipment and competent training of your personnel. *Television is our business!*



**DUMONT** *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

# Call on Kyle Engineers



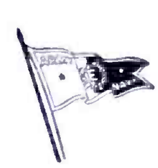
## For transformers designed to your own specifications

Postwar plans are under way. The sensational development in the use of electronic power will soon be converted to building products for home and industrial use, for transportation, communications, agriculture—for almost every service of modern living.

Kyle experience in building transformers for war can serve you well. Kyle's many years in developing and manufacturing electric power distribution equipment established their reputation for sound, practical engineering.

Based on their knowledge of the latest trends in the fields of radio communication, radar detection, and electronic controls, Kyle engineers will build the transformers you need to meet your exact specifications. These precisely built, dependable, small transformers are hermetically sealed to function perfectly under extreme conditions of climate and altitude.

Call on Kyle engineers to work with you on your own transformer requirements.



**KYLE CORPORATION**

SOUTH MILWAUKEE, WISCONSIN

# Answers to your Questions about the SHURE "556" *Super-Cardioid Broadcast Dynamic*

**Q.** *What is meant by Super-Cardioid?*

**Answer:** Super-Cardioid is an improvement on the cardioid (heart-shaped) pickup pattern, which makes it even more unidirectional. "Super-Cardioid" reduces pickup of random noises by 73% as compared to 67% for the Cardioid, and yet has a wide pickup angle across the front.

**Q.** *To accomplish this, is it necessary to have two Microphones in a single case?*

**Answer:** No. The Shure "556" is designed according to the "Uniphase" principle, a patented Shure development which makes it possible to obtain the "Super-Cardioid" pattern in a single compact, rugged unit.

**Q.** *Over what range does the Shure "556" give quality reproduction?*

**Answer:** The Shure "556" provides a high degree of directivity, both horizontally and vertically over a wide frequency range from 40 to 10,000 cycles.

**Q.** *Does the Shure "556" reduce feedback?*

**Answer:** Yes! Reflected sounds and "spill-over" from loud speakers entering from the rear are cancelled out within the Microphone.

**Q.** *Can the Shure "556" be used outdoors?*

**Answer:** Yes. It is insensitive to wind and will withstand heat and humidity. The low impedance models may be used at practically unlimited distances from the amplifier.

**Q.** *Can the Shure "556" be used for Studio Broadcasting?*

**Answer:** More than 750 Radio Broadcast Stations in the United States and Canada use the Shure "556" in their studios. Because it can be placed with its back to the wall without picking up reflected sounds or echoes, it facilitates Microphone placement.

*Model 556A for 35-50 Ohm circuits—*
*LIST PRICE $75*

*Model 556B for 200-600 Ohm circuits—*
*LIST PRICE $75*

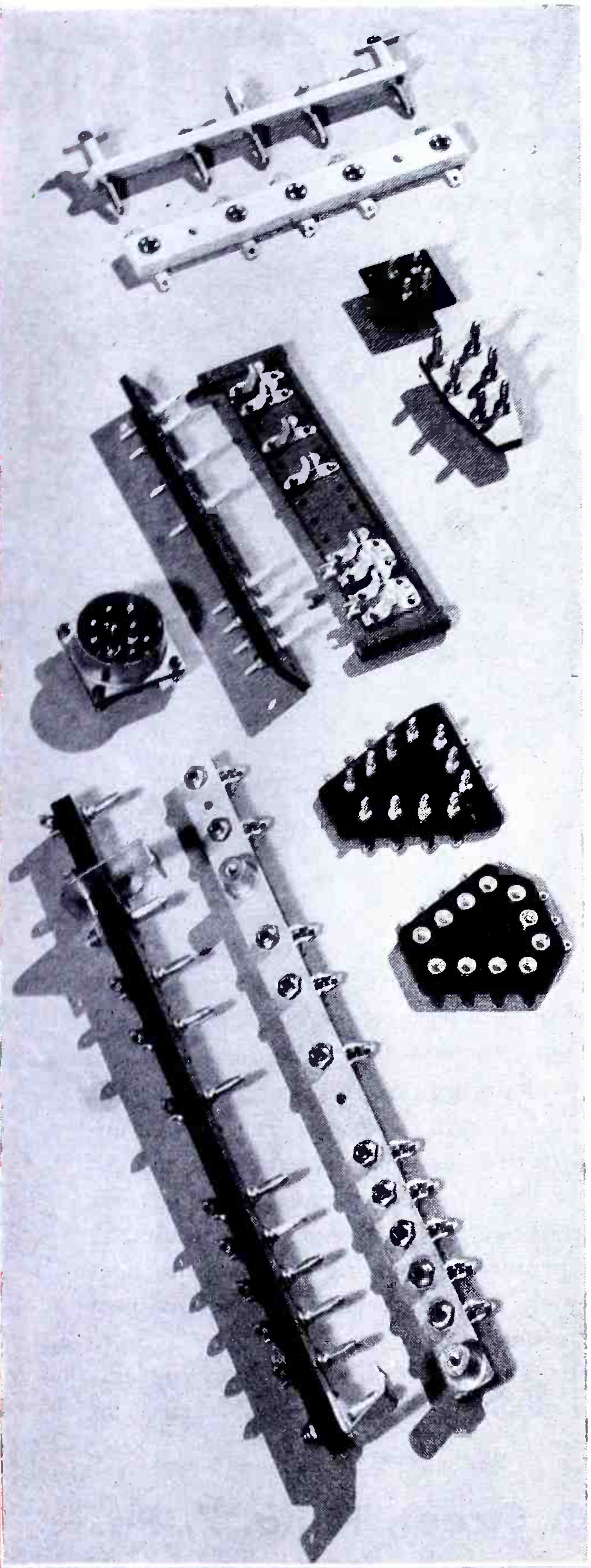
**SHURE BROTHERS**

*Designers and Manufacturers of Microphones and Acoustic Devices*

**225 West Huron Street, Chicago 10, Illinois**

**CABLE ADDRESS: SHURE MICRO**

SHURE MICROPHONES

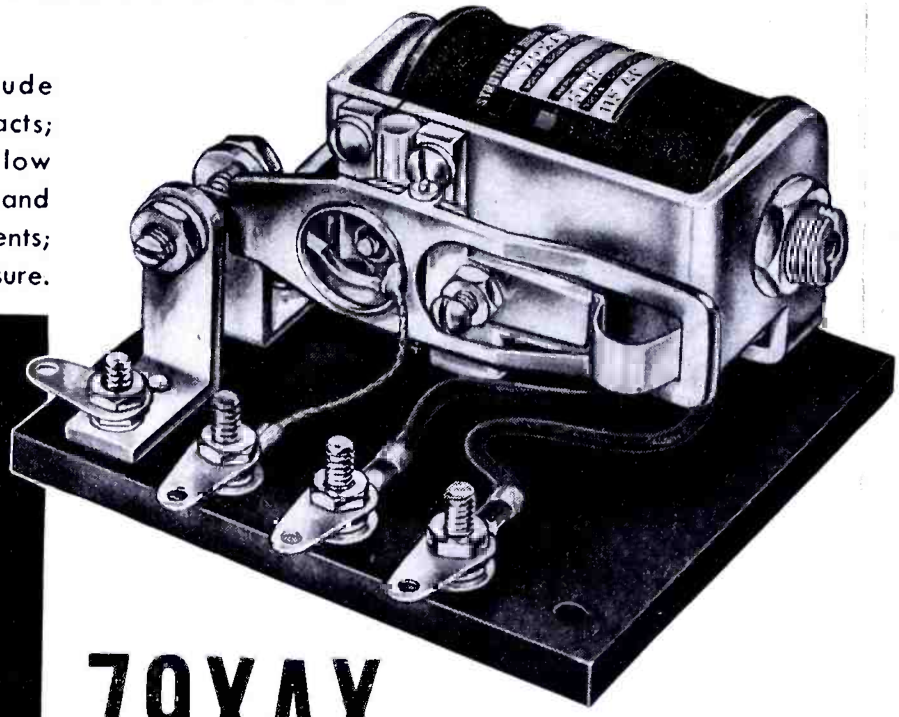


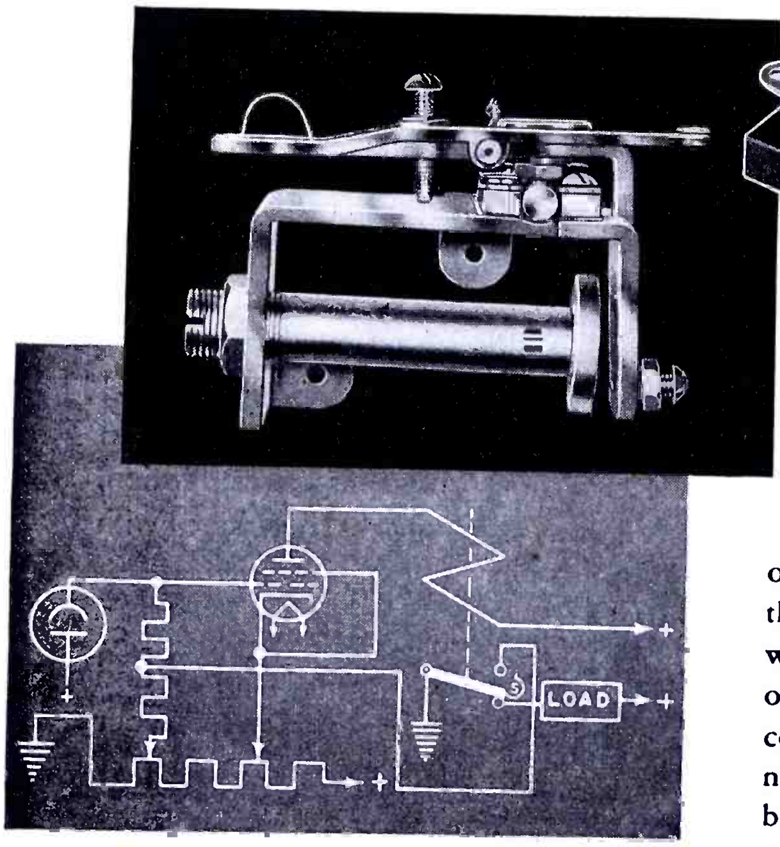


# POSITIVE SNAP ACTION

## 0.02 WATT SENSITIVITY

**SIMPLIFIED CONSTRUCTION** . . . Features include snap action contacts; high sensitivity; low operating power; statically balanced armature and contact assembly; six easily accessible adjustments; good contact wipe and stable contact pressure.






A typical vacuum tube application. A slight increase in plate current closes the relay, thus increasing negative bias on the amplifier tube so that plate current through the relay coil immediately decreases to a point close to the release value for the relay. Thus, any slight decrease in light falling on the photo cell will reduce plate current sufficiently to return relay contacts to normal position.

## 79XAX

Struthers-Dunn Type 79XAX snap action d-c operated relay is a positive acting sensitive unit that finds a wide variety of applications in circuits with slowly changing control currents. Erratic operation and varying contact resistance encountered with ordinary sensitive relays are eliminated. Applications for this popular relay cover a broad range of use from vacuum tube circuits, to overcurrent protection, pulsing circuits, and uses where extremely close differential or sensitivity of operation is required.

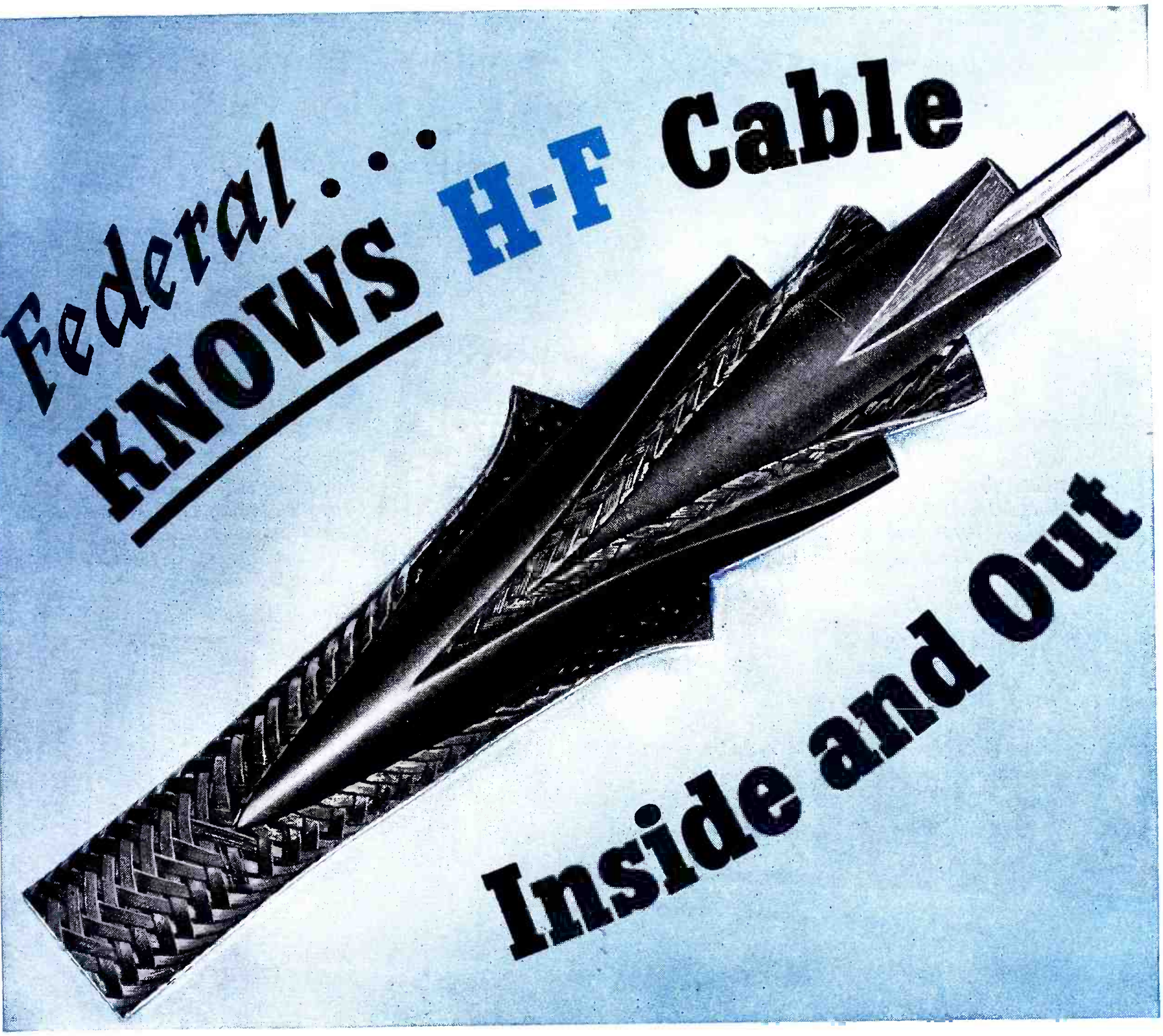
*WRITE* for Data Bulletin 79XAX giving full construction details and outlining a variety of suggested uses.

**STRUTHERS-DUNN, Inc., 1321 Arch Street, Phila. 7, Pa.**

# STRUTHERS-DUNN

## 5,312 RELAY TYPES

*DISTRICT ENGINEERING OFFICES:* ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO




From inner conductor to outer covering . . . Federal really knows high-frequency transmission lines.

And this knowledge was not easily won. As the pioneer in the field Federal not only developed over 80% of all h-f cable types in use today . . . but developed most of the equipment needed to test them.

Attenuation, high-voltage, dielectric and balance testing equipment, velocity of propagation, braid-resistance and electrical length meters . . . were all Federal-*engineered* to fit specific requirements.

That's why it's logical to turn to the acknowledged leader in the field for the finest in h-f cables, specialty-engineered harnesses and cable assemblies.

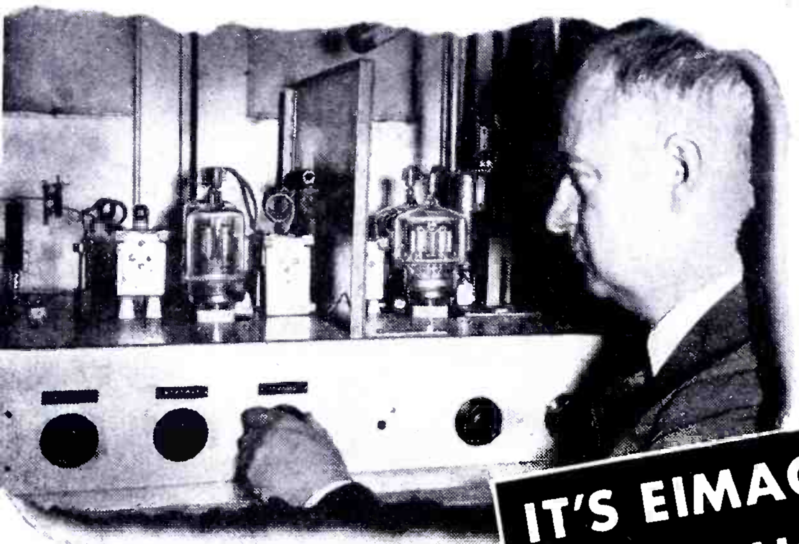
Where requirements are critical . . . for transmission lines with special characteristics . . . for custom-built and engineered harnesses and cable assemblies . . . take your high-frequency transmission problems to Federal.

FEDERAL TELEPHONE & RADIO — FTR

**Federal Telephone and Radio Corporation**

AN IT&T ASSOCIATE

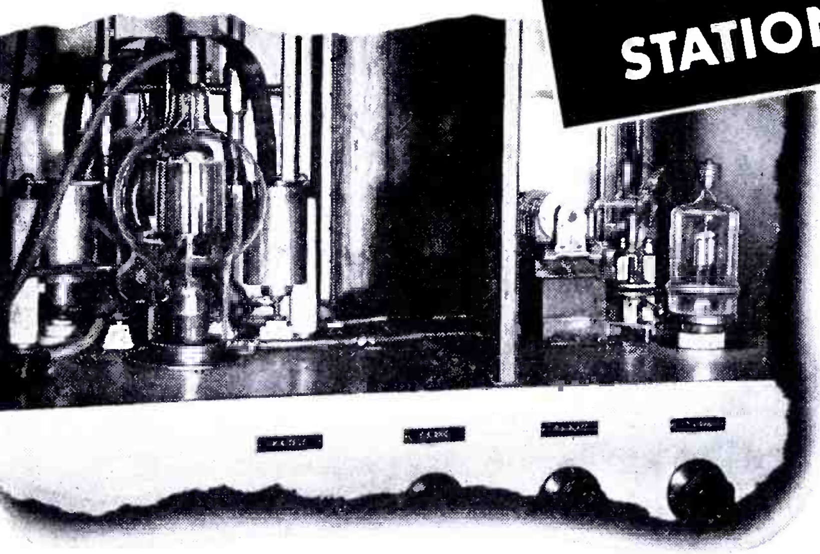
Newark 1, N. J.



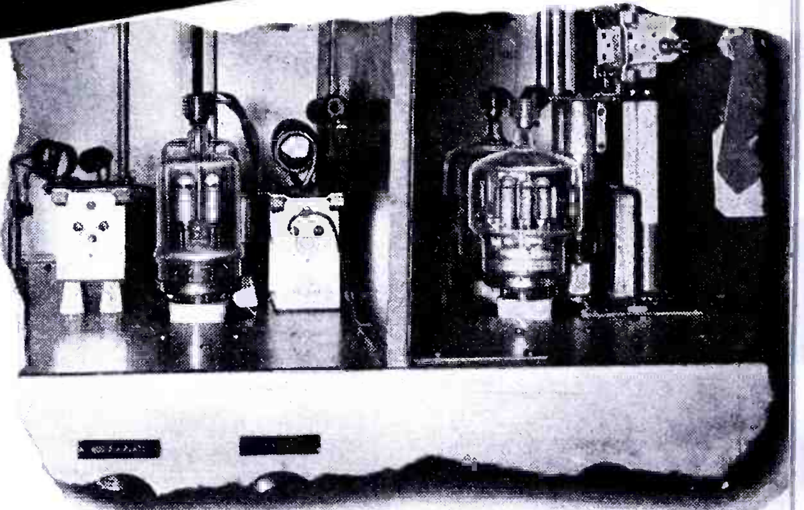
# IT'S EIMAC AGAIN! FIRST CHOICE FOR THE KEY SOCKETS AT TELEVISION STATION WBKB

*A. H. Brolly . . . Chief Engineer of Television Station WBKB, Chicago, adjusts the grid circuit of the Eimac 304-TL's in the Class B linear stage of the video transmitter.*

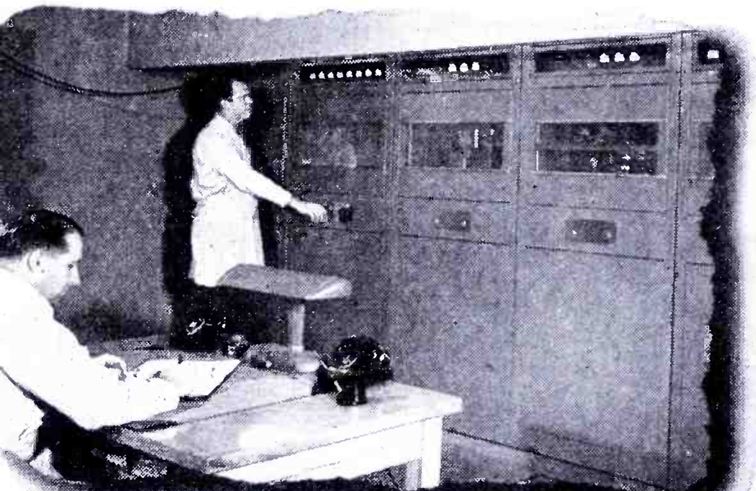
*Mr. Brolly calls attention to the Eimac 1000-T's in the final stage of the Audio FM Transmitter which operates at 65.75 megacycles. It is a very stable amplifier of good efficiency.*



*The video transmitter operates at 61.25 megacycles; peak power output is 4 KW which provides a television service throughout metropolitan Chicago and reaches suburbs out to 35 miles or more.*



*Eimac 152-T's are used in the modulated stage and 304-T's in the first Class B linear amplifier of the video transmitter.*



*E. F. Cawthon and W. R. Brock are operating the station which has been broadcasting television programs with the present equipment since 1942 and began operation on a commercial schedule in October, 1943.*

Grid modulation is employed at WBKB and a broad band of frequencies must be passed in all stages following the modulated amplifier. Multiple-tuned resistance loaded coupling circuits are used between stages.

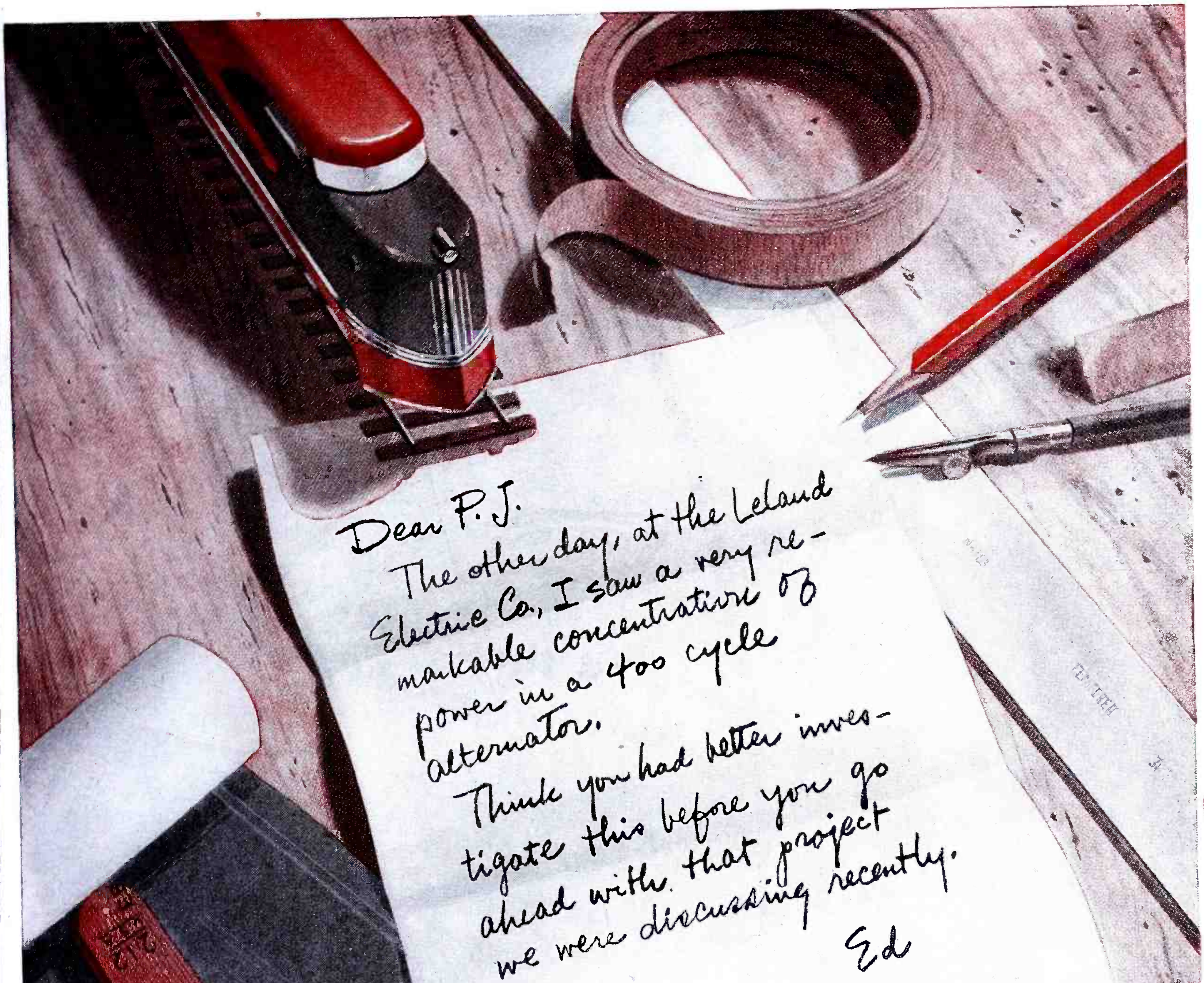
Performance, stability, dependability are good reasons why Eimac tubes are to be found in the key sockets of the outstanding new developments in Electronics. Balaban & Katz, owners of television station WBKB of Chicago, offer potent confirmation of the fact that Eimac tubes are first choice of leading Electronic Engineers the world over.

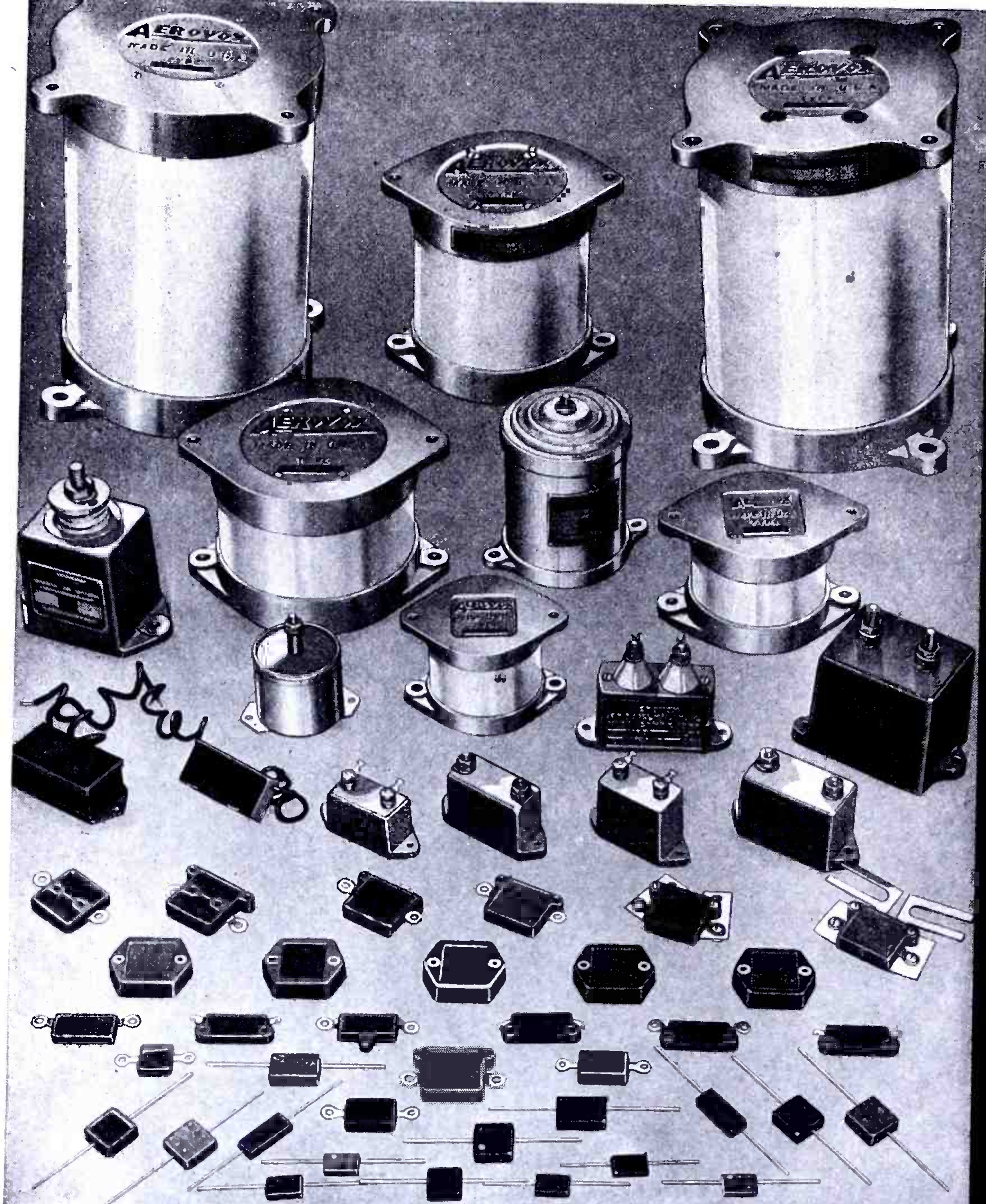
**FOLLOW THE LEADERS TO**

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

**ELECTRONIC TELESIS**—*fully illustrated. Send for a copy now. The Science of Electronics written in simple language. You'll find it of valuable assistance in explaining electronics to the layman. No obligation.*

**EITEL-McCULLOUGH, INC., 1032 San Mateo Ave., San Bruno, Cali**
**Plants located at: San Bruno, California and Salt Lake City, Uta**
Export Agents: Frazar & Hansen
301 Clay Street, San Francisco 11, California, U.S.A.


Dear P. J.
The other day, at the Leland Electric Co., I saw a very remarkable concentration of power in a 400 cycle alternator.
Think you had better investigate this before you go ahead with that project we were discussing recently.
Ed
if it calls for
CREATIVE ELECTRICAL
ENGINEERING...
call for Leland!



# Radio Out of a Hat!

## 88 DAYS FROM DRAFTING BOARD TO FLIGHT LINE

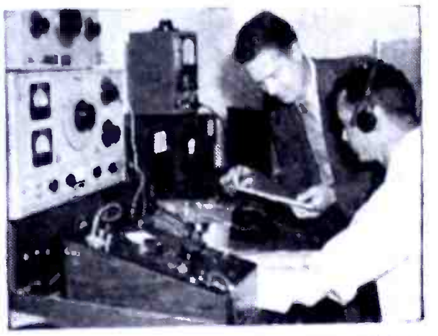
Germany stunned the world in '39 with their *blitzkrieg*. At exactly the same time another *blitzkrieg* was quietly being made by the Canadians in this country. They needed airplanes and radio communication equipment—fast.

The airplanes they got...and the radios. There were less than 90 days left when Pacific Division got the go ahead for transmitters and interphone equipment that had not even been designed.

In 88 days Pacific Division designed—developed—and delivered a quantity of 100-watt master oscillator transmitters for low and high frequency...amplifiers for the interphone...and engineered and installed these and all other radio equipment in the Canadian airplanes.

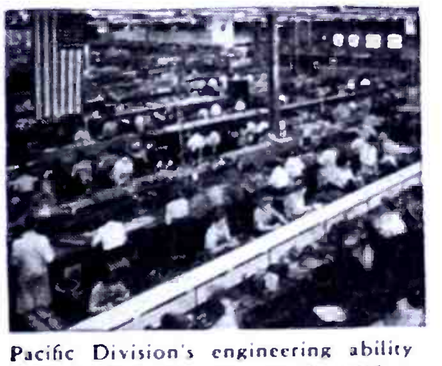
We at Pacific Division would rather not accept any more orders that we have to pull out of a hat. But we are open for business, especially VHF Communication Systems in which we specialize, that demands experience, ability and resourcefulness. Your inquiries are invited.





A new interpretation of simplified VHF, scheduled for early announcement, is the latest development of the company's radio engineering laboratory.

Quality in quantity is the keynote of all Pacific Division manufacturing processes.



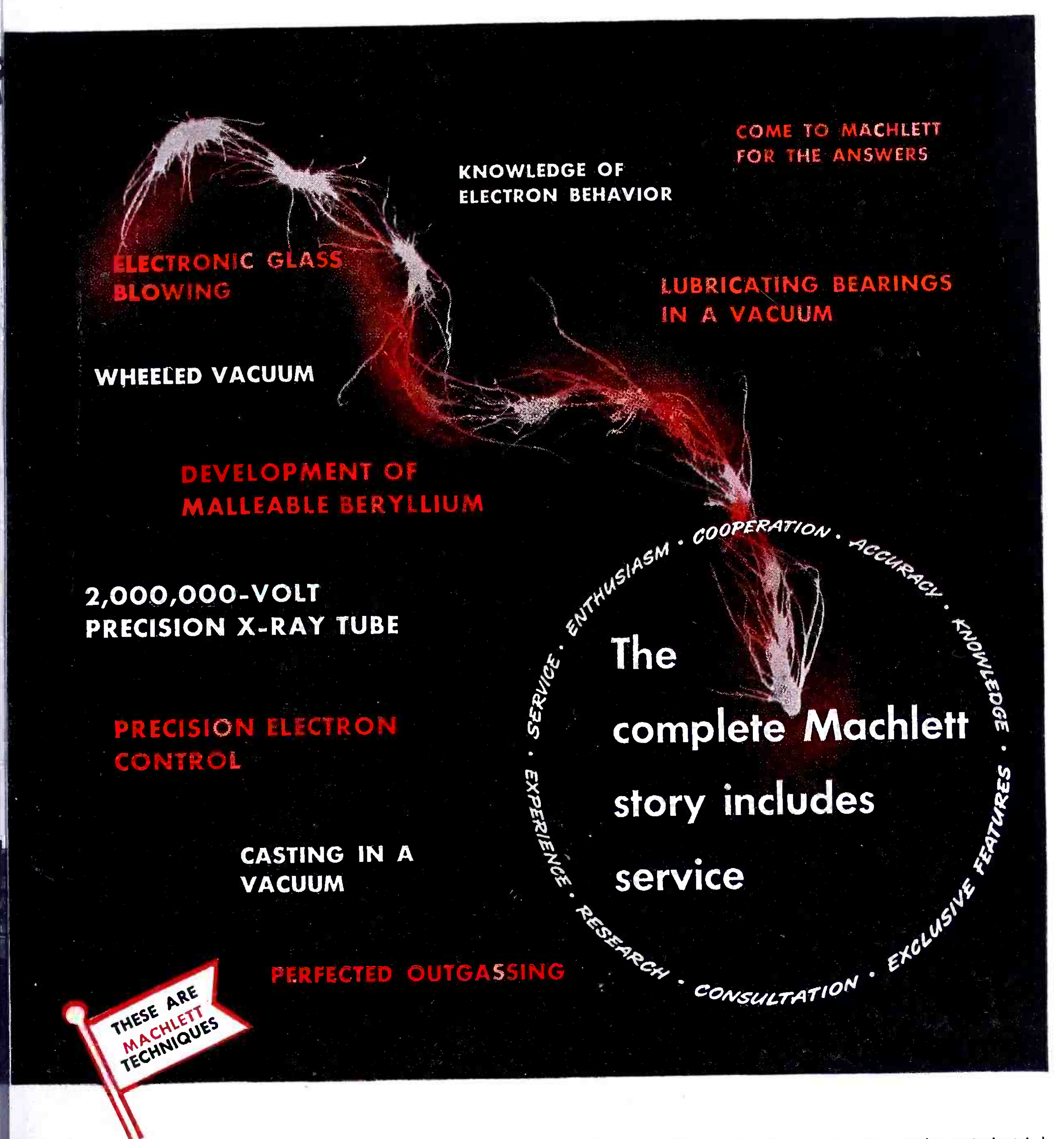
Pacific Division's engineering ability is matched by its outstanding production facilities. Here future VHF equipment will be manufactured in volume.

**Pacific Division**
**Bendix Aviation Corporation**
NORTH HOLLYWOOD 7, CALIF.

VHF COMMUNICATION SYSTEMS

PRODUCT OF Bendix AVIATION CORPORATION

**OPERATING SIX VHF EXPERIMENTAL STATIONS**




The above ten Machlett techniques reflect only a part of one side of this organization — that of technical capability.

It takes much more than even the highest techniques to make a business great. There is also required a thorough knowledge of customers' requirements, and that conscientious, painstaking, continuing meeting of them called "service."

Just as there is the most intimate relationship between an electron tube and the equipment with which it is connected, so there is a close and constant contact with our customers. With them we are never in competition, and thus we may be, and often are, called upon to do design and development work, to live with tube and equipment problems, and cooperate in solving them. We often follow through all the way to the ultimate users, to make certain of their satisfaction and see that conditions of use are such as to assure optimum results and economy. It is a long-established Machlett practice not merely to accept but to seek out every opportunity to serve. Thus, Machlett customers obtain much more than the best possible tubes.

When you need a medical or industrial X-ray tube, or a radio or industrial oscillator, amplifier or rectifier, it will pay you to choose a Machlett. Write for information as to available types, identifying the associated equipment and nature of use. Machlett Laboratories, Inc., Springdale, Connecticut.

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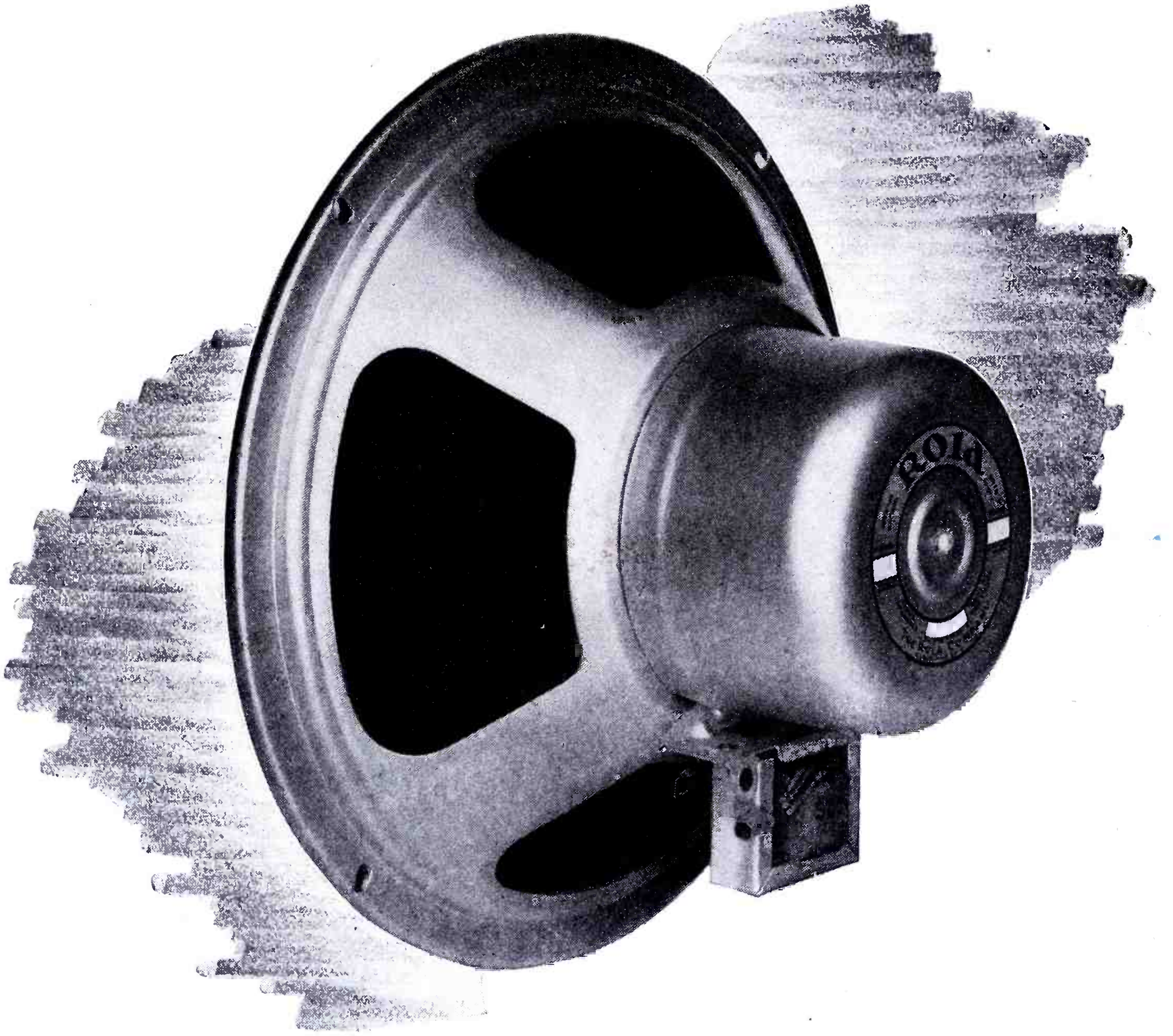
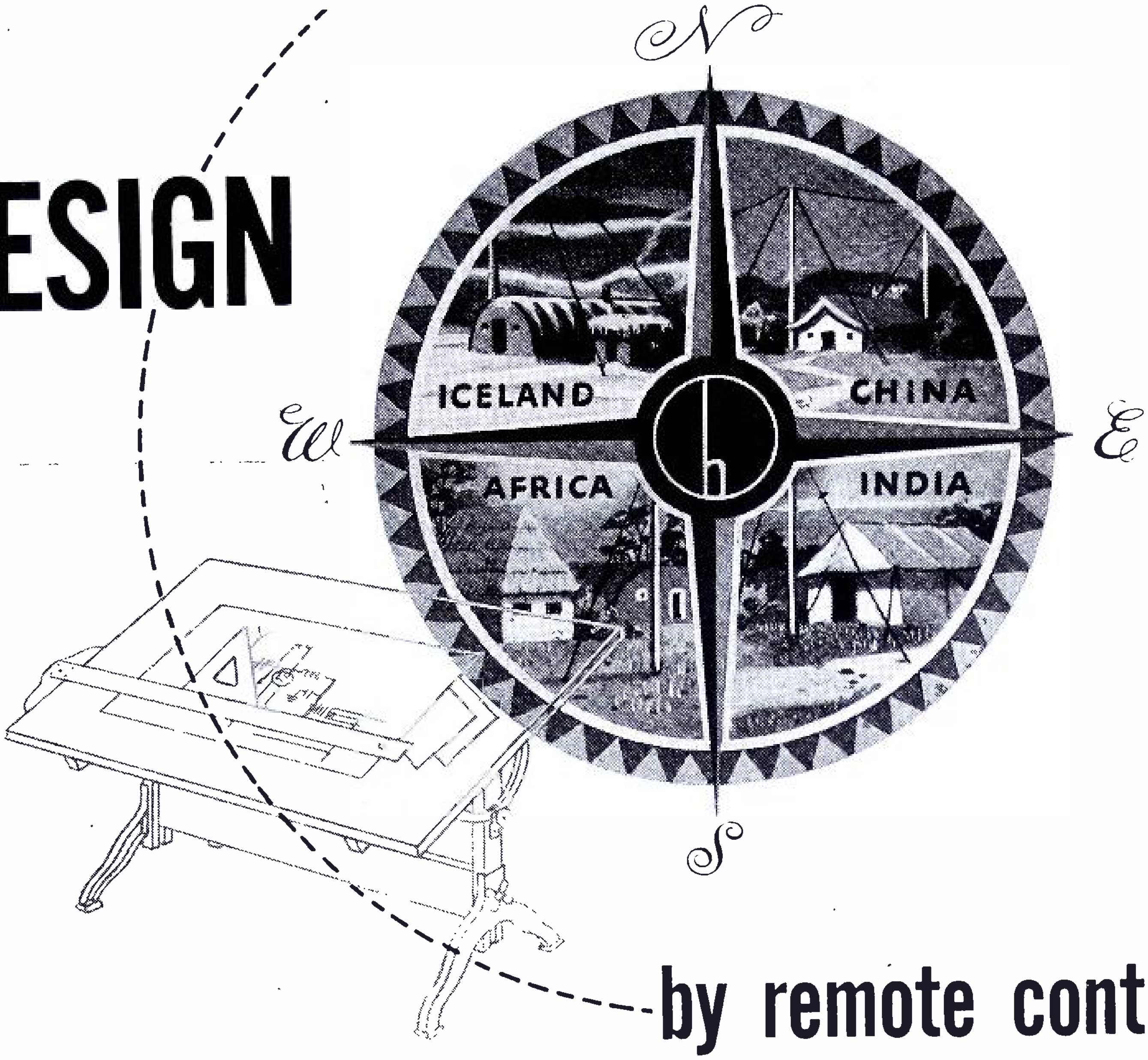


# DESIGN

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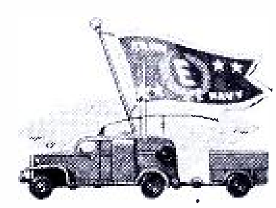

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# QUICK CHECK LIST OF SOME WESTINGHOUSE COMMUNICATIONS PRODUCTS

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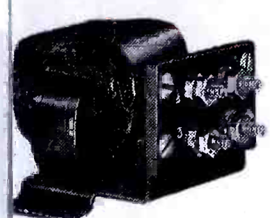
### ipersil Cores . . .



Ready - to - assemble Hipersil cores have ⅓ greater flux-carrying capacity and eliminate time-wasting stacking of tissue-thin laminations by hand. (B-3223-A)

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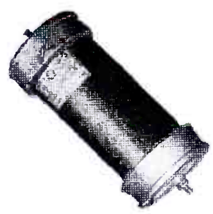

Light weight, small volume and high reliability are features of Inerteen Capacitors for d-c service at 400 to 250,000 volts. Inerteen—the liquid dielectric is noninflammable . . . nonexplosive. (B-3300)

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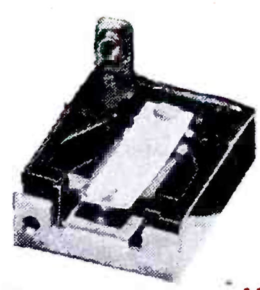

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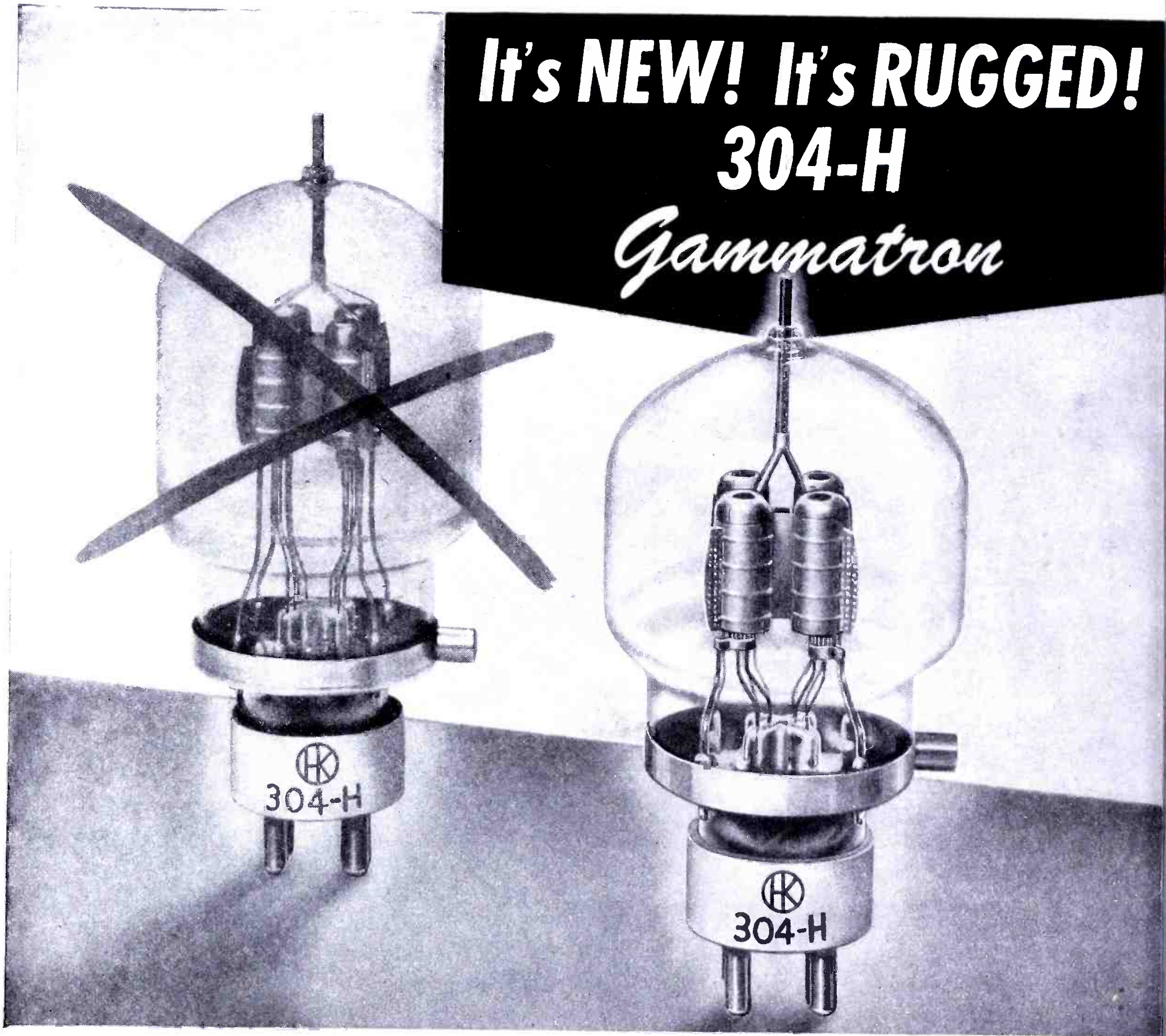


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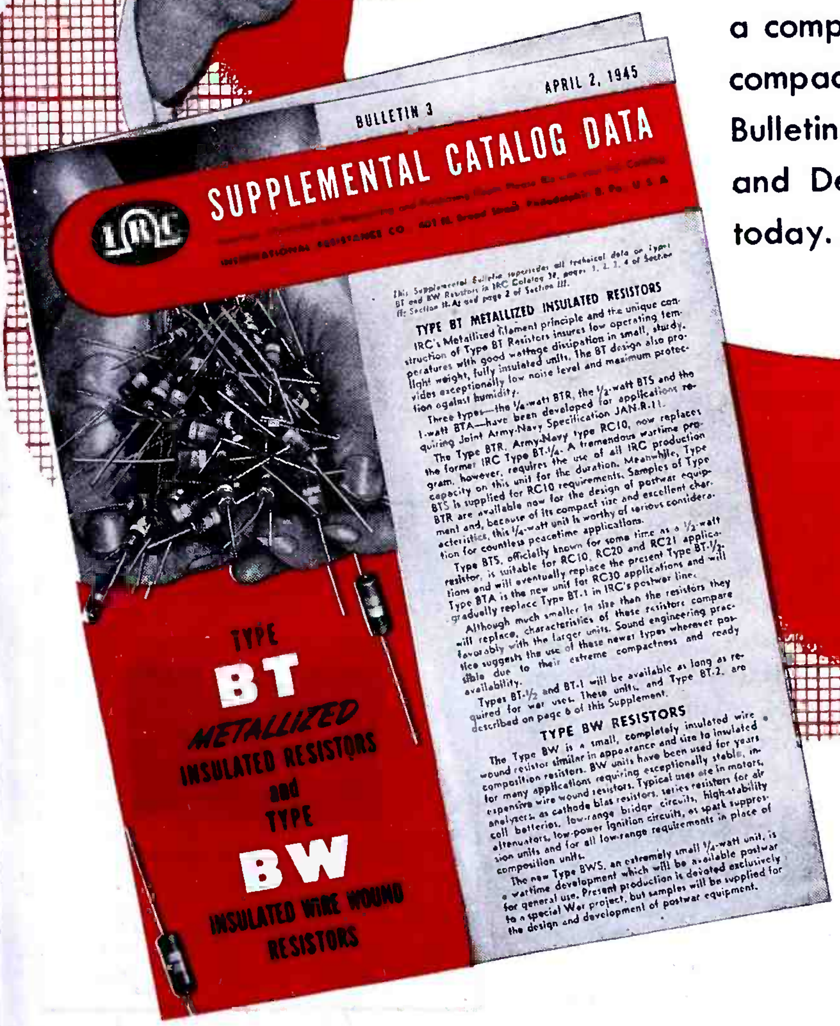


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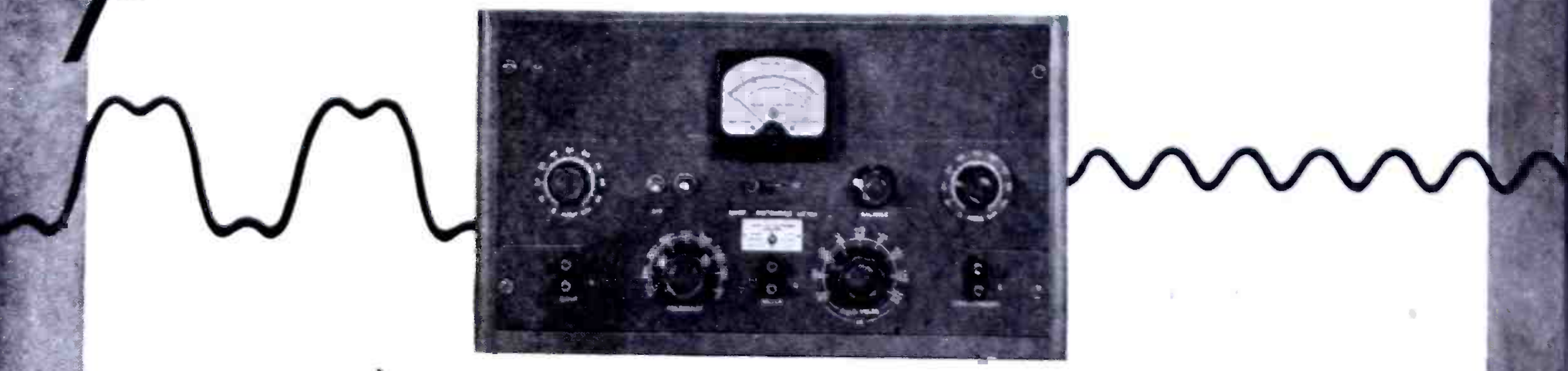
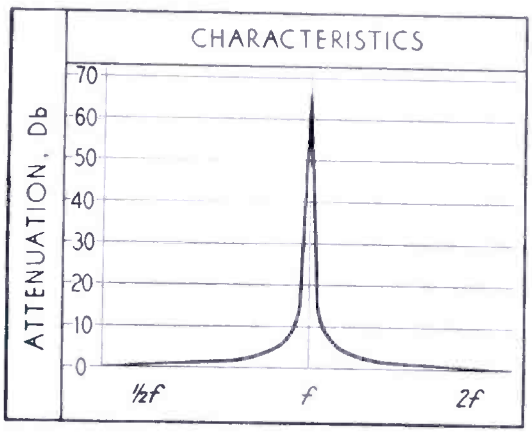


# This instrument separates harmonics from a desired frequency

By eliminating the fundamental frequency, this instrument permits accurate measurement of noise, distortion and the harmonics of the wave. At balance its fundamental circuit has almost infinite attenuation at a single frequency and other frequencies are passed with little or no attenuation.



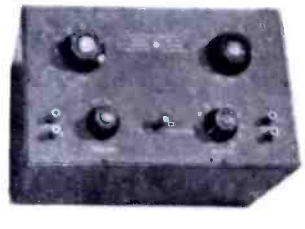

As shown in the chart: the attenuation at the 2nd harmonic (2F) would be in the order of 1/2 db while at the resonant frequency it would be infinite—from 60 to 70 db in practical circuits making it possible to measure distortions as low as 0.1%.

The *-hp-* Model 325B Noise and Distortion Analyzer is really a combination of three separate elements: a frequency elimination circuit, a stabilized 20 db amplifier and a vacuum tube voltmeter, any one of which may be used individually. The amplifier employs inverse feedback and is very stable . . . accuracy is independent of line voltage and tube characteristics. Because the input is to the grid of the amplifier and is equivalent to 200,000 ohms, it will not load down the circuit being measured. The sensitivity of the vacuum tube voltmeter in combination with the amplifier is such that hum may be measured directly and voltage measured as low as .0005.

The *-hp-* Model 325B covers the audio frequency spectrum, supplying frequencies of 30 cps, 50 cps, 100 cps, 400 cps, 1000 cps, 5000 cps, 7500 cps, 10,000 cps and 15,000 cps within ± 5%. These frequencies cover FCC recommendations for checking FM as well as AM broadcast. The meter scale is calibrated in volts and in dbs.

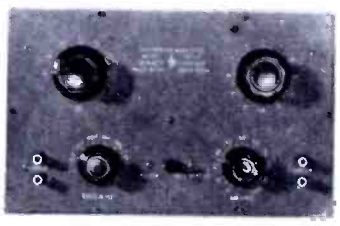
The *-hp-* Model 325B in combination with *-hp-* 200 series Audio Oscillators provides equipment to make most laboratory AF measurements including distortion, power, gain and frequency response. Write for complete information now.

## OTHER *-hp-* INSTRUMENTS



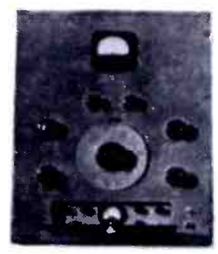
**Distortion Analyzer**

The Model 320A consists of two fundamental elimination circuits, 400 cps and 5000 cps, together with a calibrated attenuator reading in decibels.



**Distortion Analyzer**

The Model 320B consists of six fundamental elimination circuits, 50, 100, 400, 1000, 5000 and 7500 cps, together with a calibrated attenuator reading in decibels.



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## Signal Corps • Navy Specifications

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|---|---|---|---|
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| PL54 | 2 | Short | 1 |
| PL55 | 2 | Long | 2 |
| PL55K | 2 | Shoulder | |
| PL68 | 3 | Long | 3 |
| PL124 | 2 | Short | 1 |
| PL125 | 2 | Long | 2 |
| PL155 | 2 | Off Set | 2 |
| PL354 | 2 | Short | 1 |
| PL540 | 2 | Short | 1 |
| B-180207 | 2 | (Lock-Nut) | 2 |
| CAU-49109 | 2 | Long | 2 |
| CRL-49007A | 3 | Long | 3 |
| NAF-1136-1 | 2 | Long | 2 |
| NAF-212938-1 | 3 | Long | 3 |
| NAF-215285-2 | 2 | Short | 1 |

*Note 1 — Interchangeable with others Note 1.*
*Note 2 — Interchangeable with others Note 2.*
*Note 3 — Interchangeable with others Note 3.*

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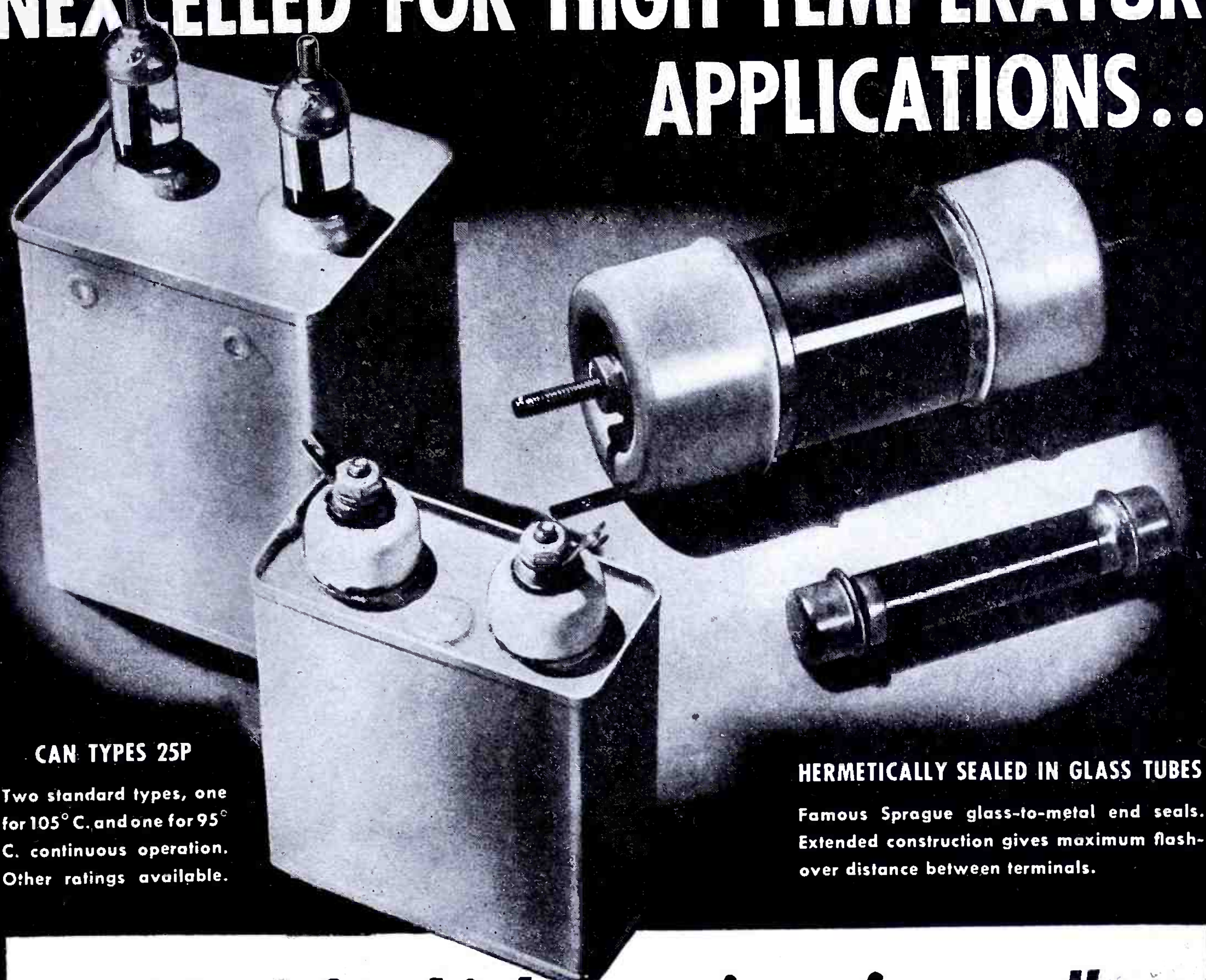

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Famous Sprague glass-to-metal end seals. Extended construction gives maximum flash-over distance between terminals.

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Sprague Capacitors impregnated with the exclusive VITAMIN Q impregnant make possible the use of much smaller units—with a substantial safety margin—on numerous high-voltage, high temperature applications ranging from transmitting to television. Where high temperature is not a factor, their unique characteristics assure materially higher capacity ratings for a given size.

Type 25 P VITAMIN Q Capacitors operate satisfactorily at thousands of volts at ambient temperature as high as 115° C. Insulation resistance at room temperature is *more than 20,000 megohms per microfarad.* Throughout the temperature range of + 115° C. to — 40° C. they retain all virtues of conventional oil-impregnated capacitors.

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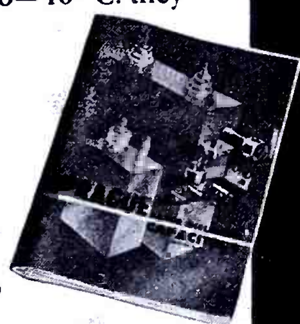

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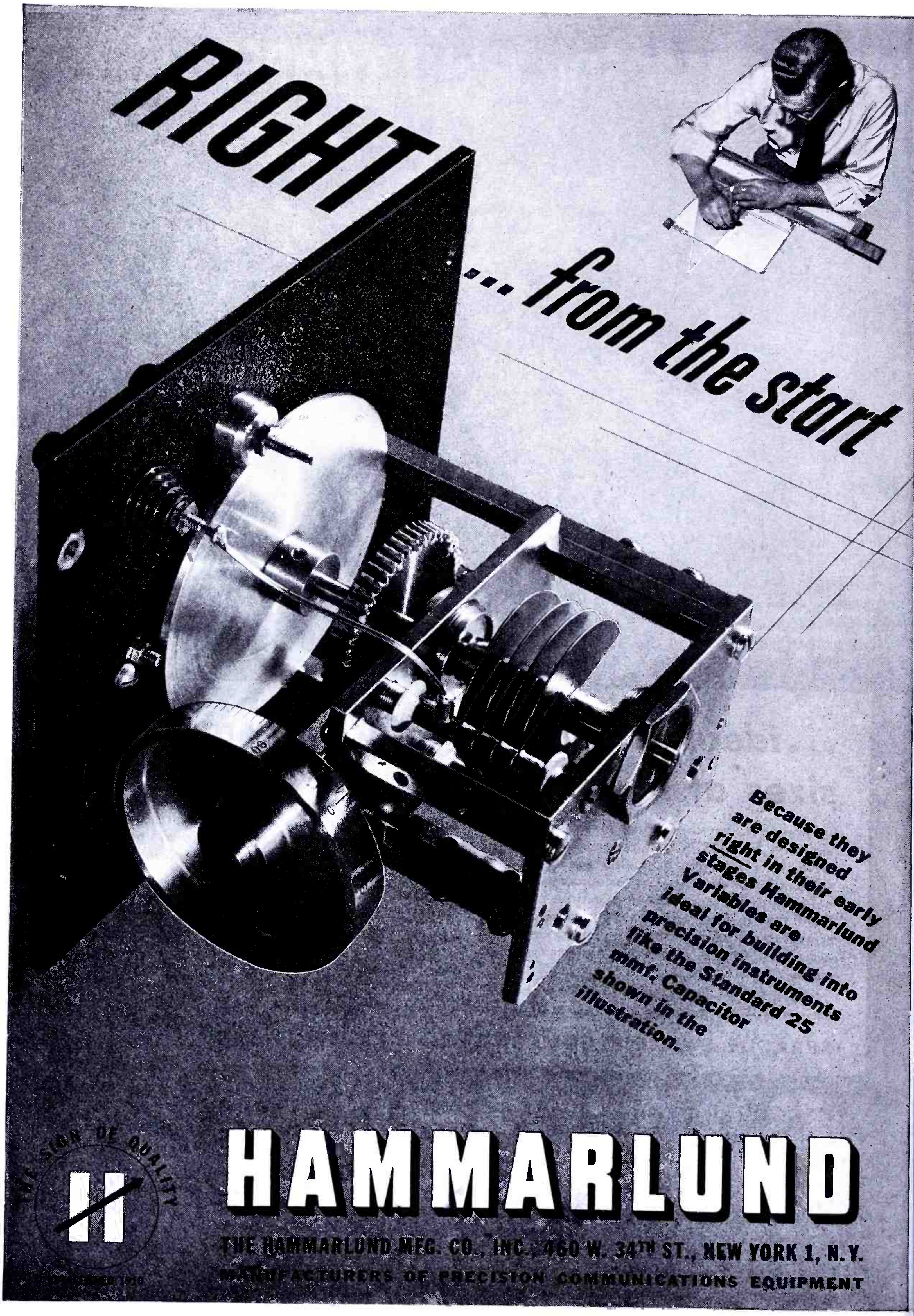
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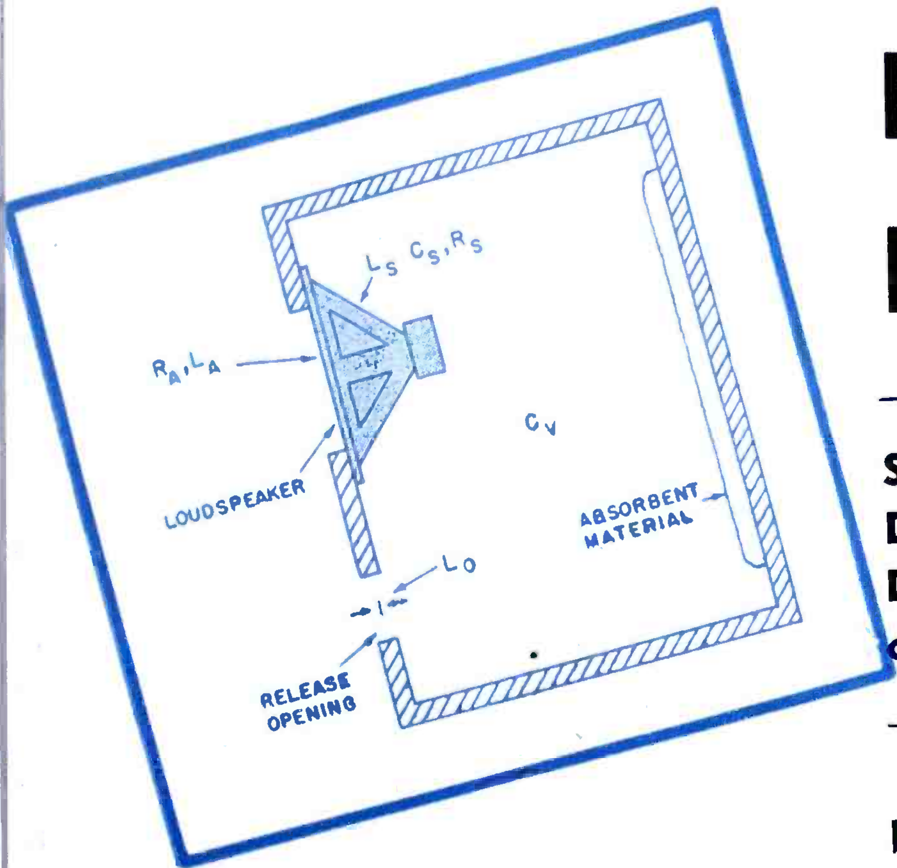
COMMUNICATIONS

LEWIS WINNER, Editor

AUGUST, 1945

# RESONANT LOUDSPEAKER ENCLOSURE DESIGN




## Simplified Procedure to Determine the Proper Dimensioning for Vented or Reflex Enclosures

by SGT. FREDERICK W. SMITH, JR.

U. S. Army Signal Corps

Figure 1
Cross section of a resonant-loudspeaker enclosure.

THE resonant type of loudspeaker enclosure is commonly encountered in a high-fidelity reproducing or monitoring system and is described commercially as a vented, tuned or reflex enclosure. Its construction is shown in Figure 1 and consists of a cabinet completely enclosed except for a *release* opening or vent of any shape located near the loudspeaker opening.

The electro-acoustical equivalent of such an arrangement is shown in Figure 2. $L_s$, $C_s$ and $R_s$ are constants due to the loudspeaker diaphragm mass compliance and damping, while $R_a$ and $L_a$ represent the effects of the air loading on the exterior side of the loudspeaker diaphragm. $C_v$ represents the acoustical capacitance of the enclosed volume of air coupled to the interior side of the loudspeaker (Figure 1), while the acoustical inertance, $L_o$, shunting $C_v$, is the result of the mass of air contained in the release opening. This opening is usually constructed to equal in area the radiating surface of the loudspeaker diaphragm as originally specified by Thuras.[1]

The improvements in low-frequency response obtained through the addition of the tuned circuit, $C_v$ and $L_o$, to the system have been described previously,[2,3] and will be only briefly discussed here.

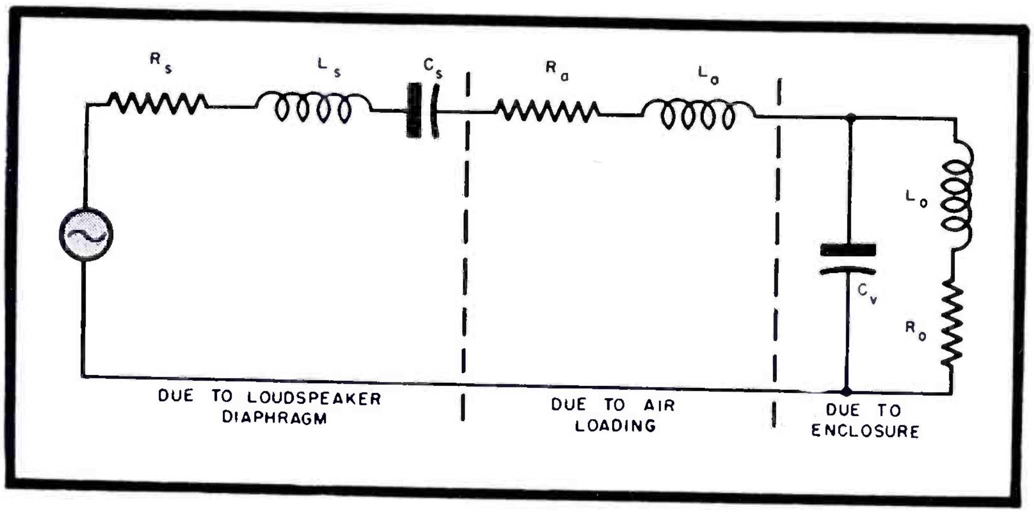
$C_v$ and $L_o$ are proportioned to resonate at the same point as the effective mass and compliance of the loudspeaker diaphragm, reducing the peak in diaphragm excursions and the output directly radiated which normally occurs at this point. Also, since the phase difference between the volume currents in $L_o$ and those generated at the immediate rear of the loudspeaker may be as much as 180°, the

*The views expressed in this paper are solely those of the writer and do not reflect the opinion of, or constitute a verification by, the U. S. Army Signal Corps.*

[1] A. L. Thuras, *Sound Translating Device*, Pat. 1,869,178; July, 1932.

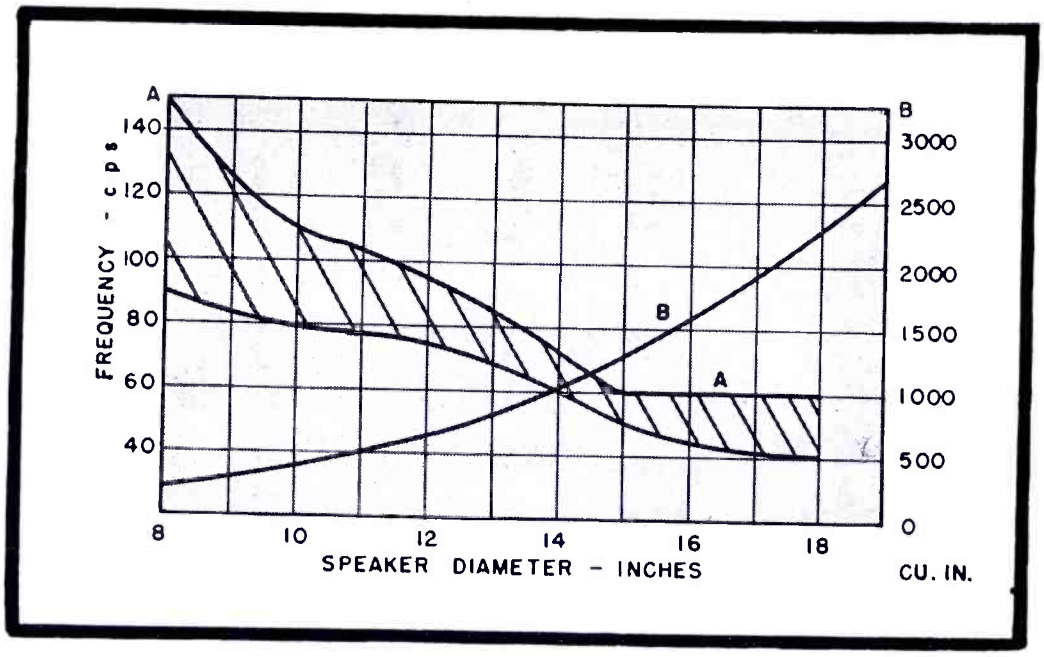
[2] Carson, Chittick, Cole and Perry, *New Features in Broadcast Receiver Design*, RCA Review; July 1937.

[3] H. F. Olson, *Elements of Acoustical Engineering* (Acoustic Phase Inverter; ch. 7, 11), D. Van Nostrand.



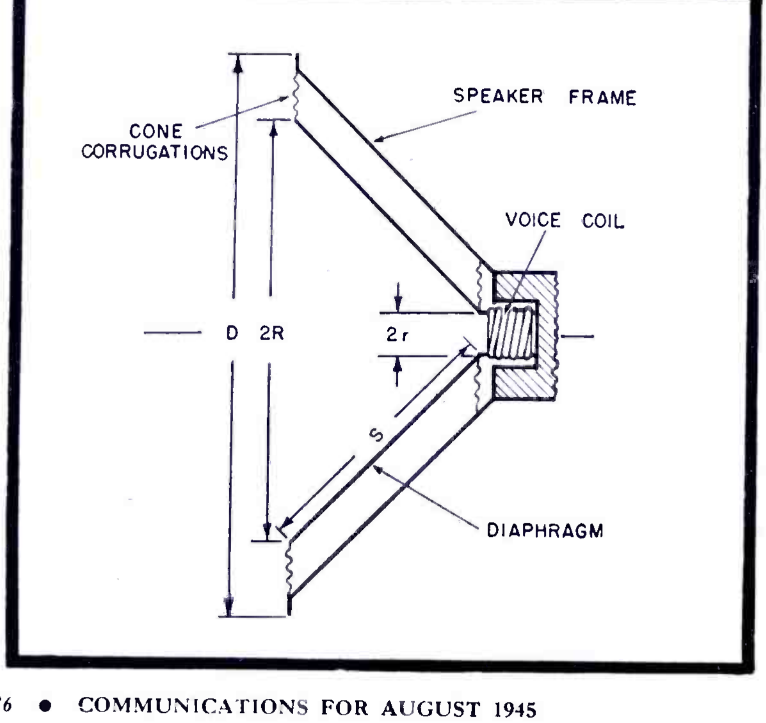

Figures 2 (above) and 3 (below)

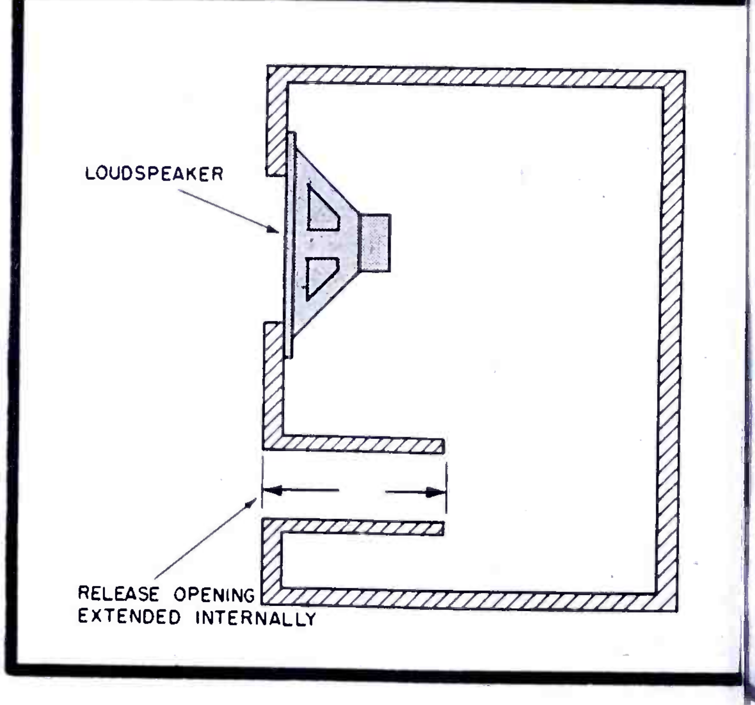
Figure 2. Equivalent circuit of a resonant-loudspeaker enclosure. Figure 3. Resonant frequencies and displaced volumes for loudspeakers of various sizes. Curve *A* represents the frequency range in cps; curve *B*, the volume displaced in cubic inches.




Figures 4 (left, below) and 5 (right, below)

Figure 4. Loudspeaker dimensions, *S*, *R* and *r*. *D*, nominal loudspeaker diameter; *R*, actual radius of diaphragm in inches; *S*, slant height of diaphragm in inches; and *r*, voice coil radius in inches. Figure 5. Enclosure with extended release opening.




sound issuing from the release openi will reenforce that directly radiated.

Subsidiary series resonances b tween the effective reactances of t loudspeaker diaphragm and the e closure elements may also occur sin $L_s$ and $C_s$ combined will be inducti above their resonant frequency wh the combination of $C_v$ and $L_o$ will capacitive. All of these factors te to level and extend the response such an enclosure in the range belo 150 cps.

A primary design consideratio therefore, is a knowledge of the lou speaker resonant frequency which necessary to properly resonate the e closure. Figure 3 shows the usu range of resonant frequencies e countered in loudspeakers of variou sizes. The exact value may either b measured or obtained from the man facturer.

A second consideration is the are required for the release opening. A mentioned above, this is made equal t the actual radiating area of the lou speaker so that

$$\text{Release opening area} = \pi S(R + r) \quad (1$$

where: S = slant height of the lou speaker diaphragm
r = voice coil radius
R = radius of diaphragm

*S* is measured from the voice co to the corrugations at the edge o the loudspeaker cone, while *R* is mea sured from the loudspeaker axis to th same point as is shown in Figure 4 2R will be considerably less than th nominal diameter of the speaker.

The initial enclosure volume, V

[4]C. E. Hoekstra, *Vented Loudspeaker Encl sures*, Electronics; March, 1940.

[5]H. F. Olson, *Elements of Acoustical Eng neering*, (Inertance Of An Open Pipe Wit Large Flanges, ch. 5, 11).

obtained by equating the expressions r the reactances of $C_v$ and $L_o$, which e equal at resonance, and solving r $V_c$, as originally proposed by Hoekra.[4]

As will be shown later, this initial olume must be modified before $V_t$, e final enclosure volume, and consequently the enclosure dimensions are etermined.

Thus, the capacitive reactance of e enclosed volume is

$$X_{cv} = \frac{\rho c^2}{\omega V_c} \quad (2)$$

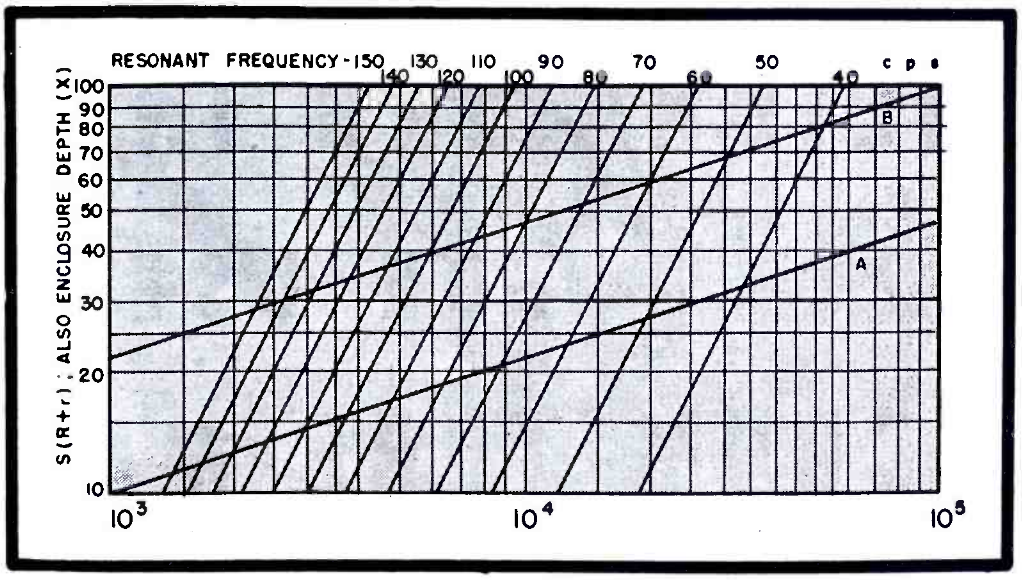
Where: $V_c$ = the initial enclosure volume
$\rho$ = density of the medium
c = velocity of sound in the medium
$\omega = 2\pi f$
f = loudspeaker resonant frequency

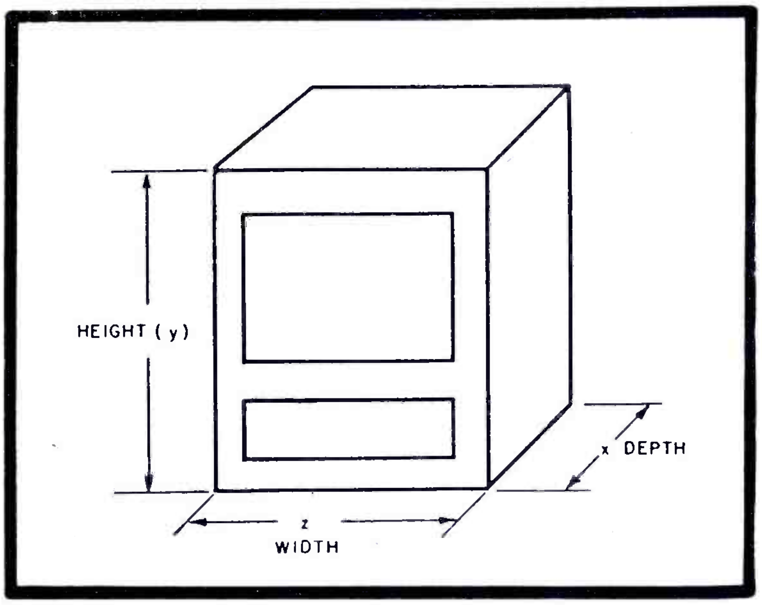
nd the reactance of the mass of air the release opening is[5]

$$X_{Lo} = \left[\frac{\omega\rho}{\pi (R')^4 k^3}\right] K_1(2kR') + \frac{\rho l \omega}{\pi (R')^2} \quad (3)$$

Where: $l$ = release opening length
$\rho$ = density of medium
$\omega = 2\pi f$
f = loudspeaker resonant frequency

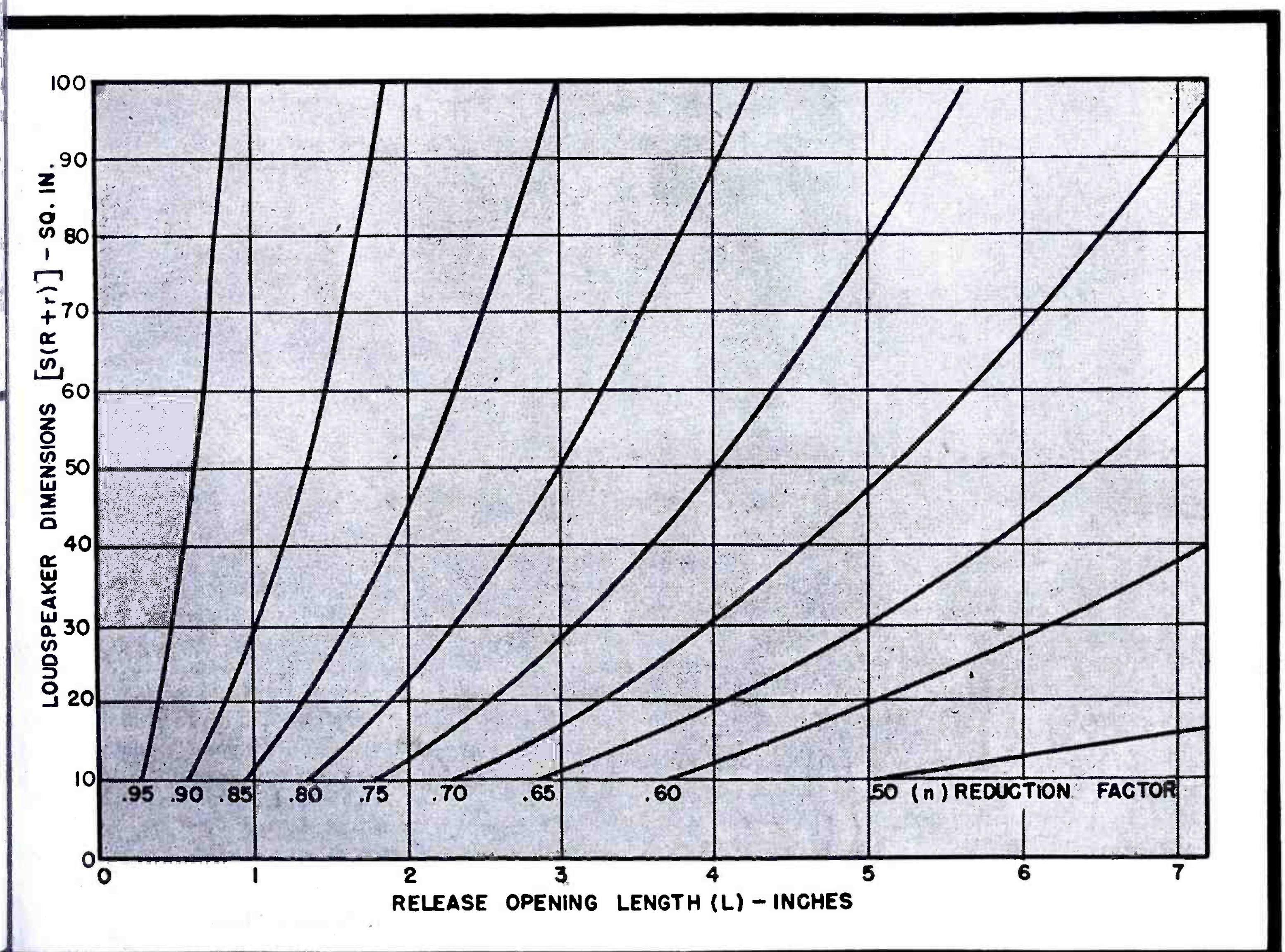
(*Continued on page 77*)



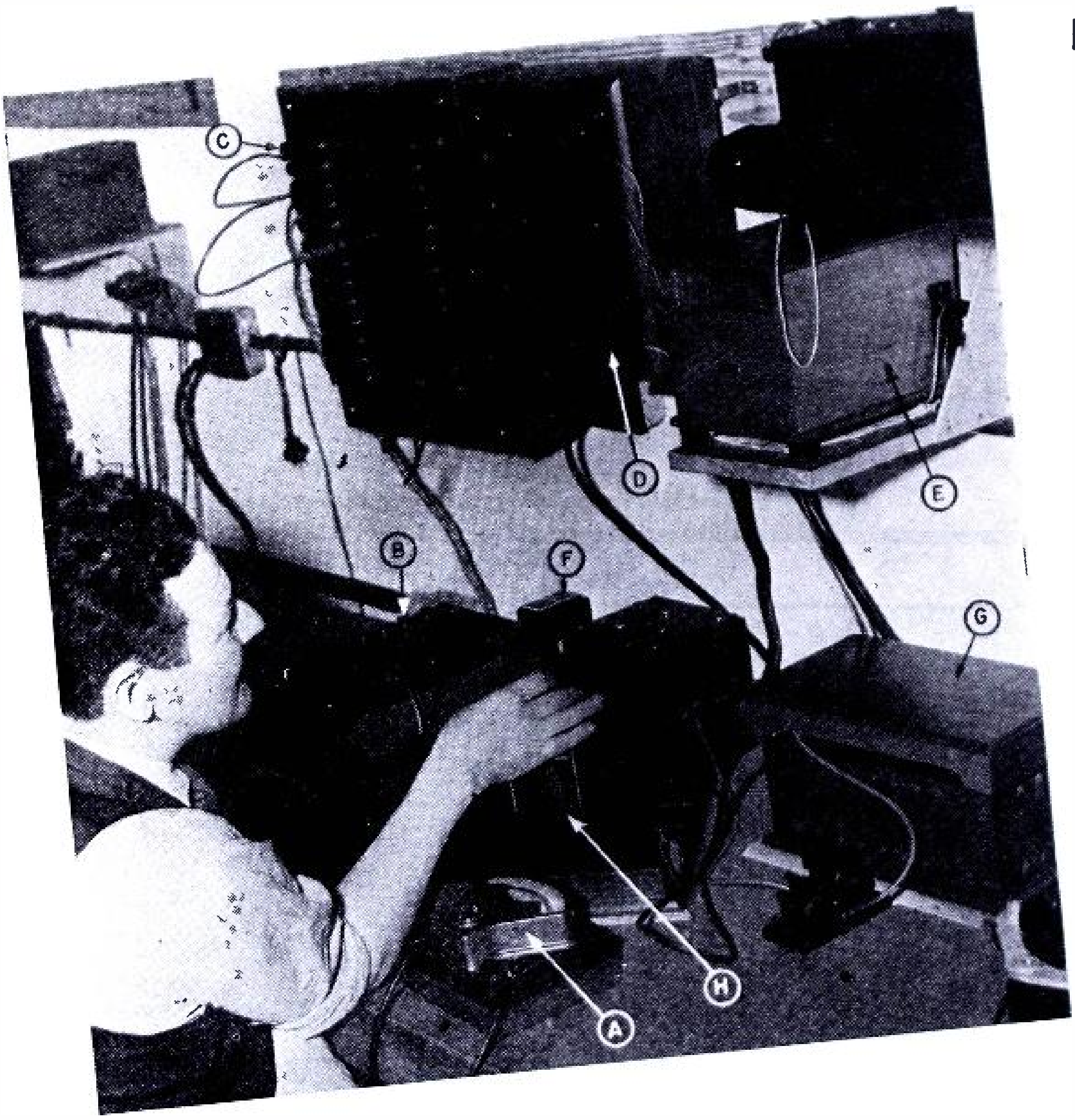




Figures 6 (right), 7 (above) and 8 (below)

Figure 6. Dimensions determined from the end volume, $V_t$. Figure 7. Required enclosure volume $V_c$ form various loudspeaker dimensions; also depth of enclosure (*x*) versus $V_t/ab$ (curves *A* and *B*); *S* (*R* + *r*), square inches; *x*, depth in inches; $V_c$, cubic inches. Figure 8. Volume reduction (*n*) due to release opening length (*l*) for various loudspeaker dimensions.



# CALIBRATING INSTRUMENTS FOR USE IN VACUUM-TUBE MANUFACTURE





by EUGENE GODDESS

Special Projects Engineer
In Charge of Quality

North American Philips Co., Inc.


Figure 1

Primary equipment used to calibrate a secondary standard meter for mass tube production tests. *A*, voltmeter being calibrated; *B*, voltbox; *C*, fixed resistor; *D*, variable resistor; *E*, galvanometer; *F*, standard cell; *G*, current box; and *H*, potentiometer.

IN mass production of vacuum tubes the problem of measuring attributes which determine the product's characteristics is quite complex, since a number of instruments are often used simultaneously.

For example, in measuring the light output of a c-r tube, the meters involved are: (*a*)—microammeter (for measurement of photovoltaic current); (*b*)—grid voltmeter; (*c*) — heater voltmeter; (*d*)—heater-current meter; (*e*)—first-anode voltmeter; (*f*)—second-anode voltmeter; and (*g*) third-anode voltmeter (in accelerator type tubes).

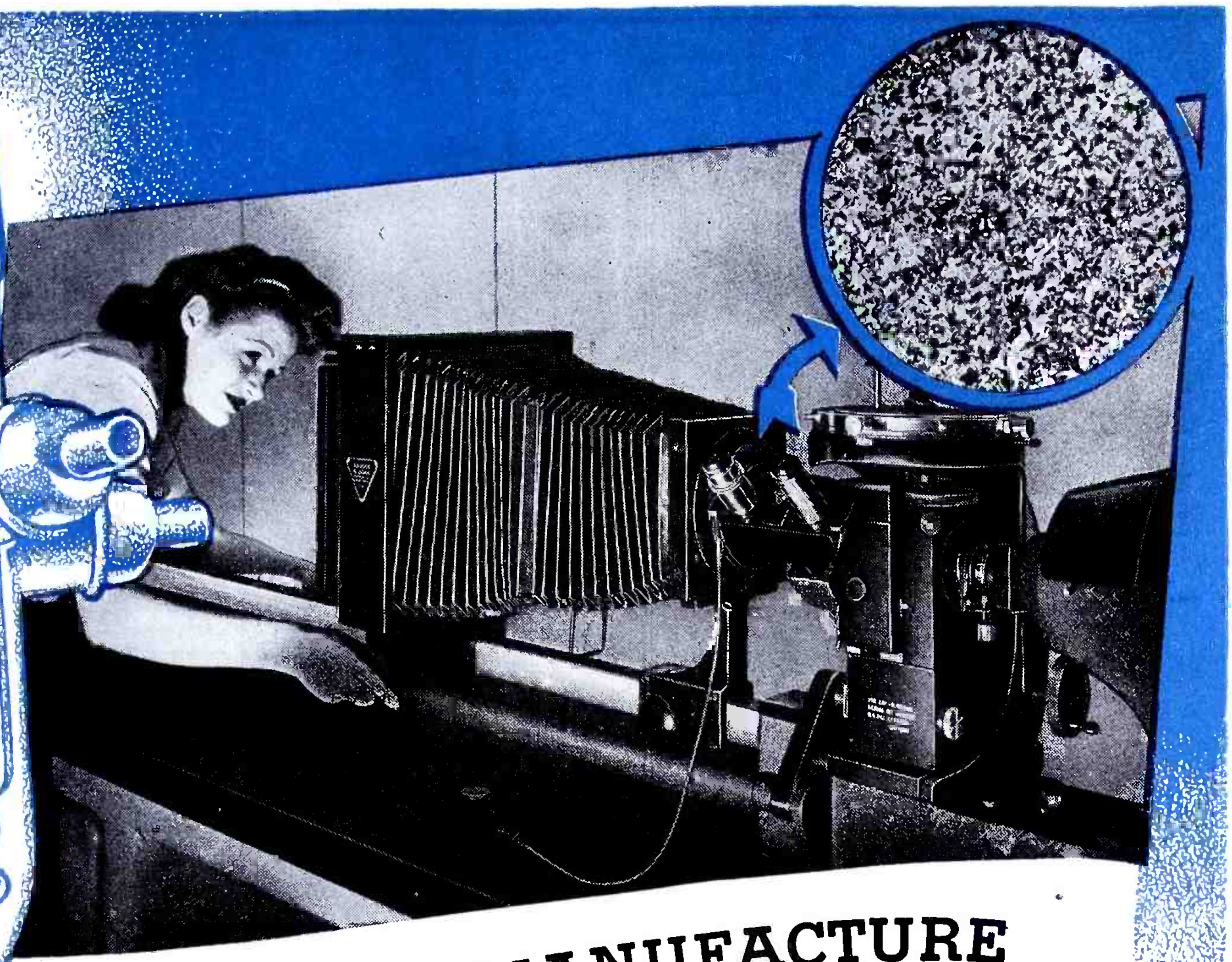
Accuracy of measurement, therefore, depends on the accuracy of calibration of the test-set meters. Improperly calibrated meters can cause:

(a)—Good tubes to be rejected.
(b)—Bad tubes to be accepted.
(c)—Quality to be indeterminate.

The usual procedure is to have a set of portable standard meters which are used to calibrate the test-set meters. These portable (or working) standards are calibrated by comparison to a set of secondary standards which are kept in a fixed position in the meter laboratory. The secondary standards are calibrated directly against primary standards consisting of a standard cell and a calibrated potentiometer. Primary equipment used to calibrate a secondary standard meter is shown in Figure 1, and in Figure 2 we have the circuit diagram for the precision equipment.

### Use of Primary Standards

A number of batteries (emf in Fig-



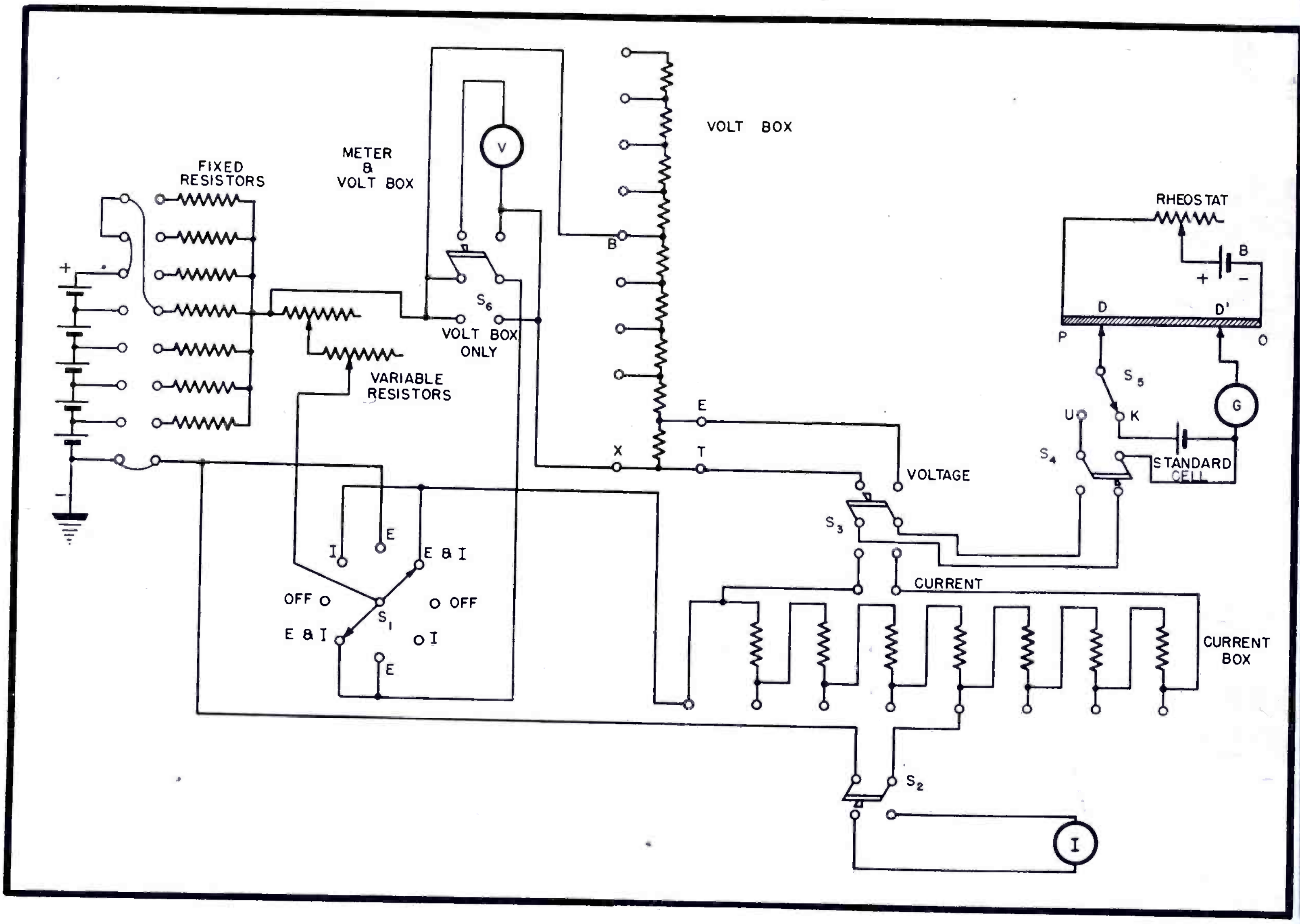



Figure 2
Instrument setup use in calibration of precision equipment. $S_2$ must be closed for simultaneous measurement of *E* and *I*.

ure 2) act as a source of potential which is placed across a network composed of fixed and variable resistors.

If a current meter is to be standardized the current through the resistors is placed through meter *I*, by means of suitable switches, $S_1$ and $S_2$, and through a precision fixed resistor in form of a current box. A known fraction of the voltage drop in the current box is then placed across the potentiometer using switch $S_3$ in the current position, closing switch $S_4$, and placing switch $S_5$ in position *U*.

#### Standardizing Voltmeter

If a voltmeter is to be standardized, the potential across the variable resistor is placed across the meter *V* and a voltbox by closing switch $S_6$ as indicated. A fraction of the voltage across the voltbox is then placed across the potentiometer by placing switch $S_3$ in the voltage position, closing switch $S_4$, and placing switch $S_5$ in position *U*.

A potentiometer, as indicated by the line *PO* in Figure 2, is a conductor of uniform resistance per-unit-length. Connected in series through a rheostat, battery *B* causes a steady current to flow through *PO* and the voltage drop is a direct function of length.

#### Standard Cell Application

Standard cell, *SC*, is connected across *DD* through a sensitive galvanometer, *G*, so its current flows opposite to the working current from battery *B*. The rheostat is varied to make the battery, *B*, current just equal to the *standard-cell* current as shown by a galvanometer null indication, thereby standardizing the working current. To compare an unknown voltage to that of the standard cell, the unknown voltage is switched into the circuit by moving switch $S_5$ from *K* to *U*. The potentiometer is then reset for a galvanometer null reading by varying the distance *DD*.

In practice, the distance *DD* is set to an ohmic resistance 1,000 times the potential of the standard cell as certified by its manufacturer.

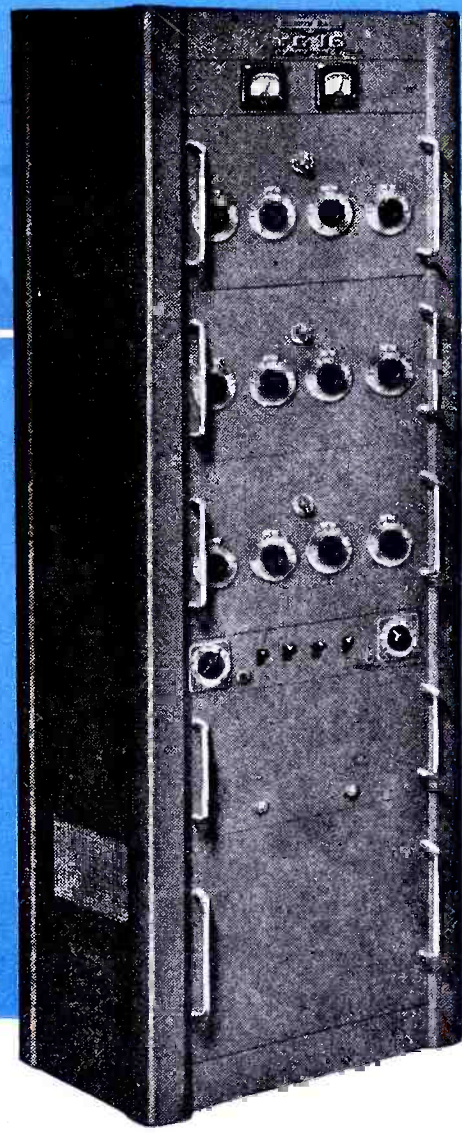
Since each division of *DD* represents a potential difference of 1 millivolt, once the distance *DD* has been set to a galvanometer null, the unknown is read directly in millivolts.

Suppose it is necessary to calibrate a 0 — 500 volt voltmeter, *V*, at its 350-volt deflection. The meter is connected in parallel with the voltbox, across a variable supply and sufficient voltage is applied to deflect the meter to read some given amount, i.e., 300, 350, 400 volts, etc. The question then is: What is the true voltage across the meter which makes it deflect to read 350 volts?

#### True Voltages

To answer this question, a known proportion of the voltage across the voltbox (i.e., across the meter) at *BX* is fed to the terminals marked *ET*. Suppose the fraction is 1/500 of *BX*, and suppose the voltage fraction is measured on the potentiometer *PO* as 694 millivolts. Consequently the voltage across the voltbox is 500 (.694) = 347 volts. In other words, the meter required 347 volts for a deflection of 350 volts on its scale, and hence is calibrated at this one point of its scale. Comparison of secondary standards should be made with the primary standards at least once every two weeks.

# THOROUGHBRED — j.g.



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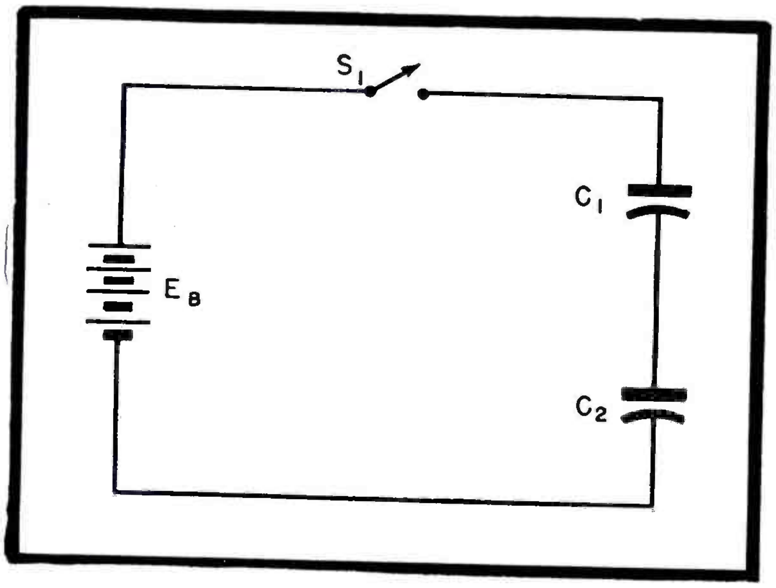



## An Analysis of a Pulse Counting Circui Which is Not Limite by Pulse Repetition Rate

# ELECTRONIC COUNTING

**by MAX WEBER**

IN television and the allied arts, a need often arises for a circuit which will enable pulses to be counted, or which will have an output whose frequency is some fraction of the input frequency. This need makes itself apparent in television equipment (for marker *pips*), and frequency meters, navigational aids, and many other types of electronic equipment.

The counting of pulses may be accomplished by feeding them to a circuit which will have one output pulse every time a certain number of input pulses has been impressed. The number of pulses and frequency of pulses which can be counted by a circuit of this type will be limited. Instability of operation usually results if attempts are made to count too many pulses at once. Although this would appear to be quite a handicap, actually this obstacle is quite easily overcome by using several counting circuits in cascade, if necessary. Clearly, the final number of pulses counted is the product of the numbers which were counted by each circuit. For example, if each circuit gives one output pulse for each ten input pulses, and only four such stages are used, the final stage will have one output for each 10,000 original input pulses.

Figure 2 is a schematic representation of the counting circuit to be analyzed in this paper*. Should the input signal be of insufficient amplitude to produce satisfactory results, one or more stages of amplification shoul be used prior to the introduction o the signal to the circuit.

Figures 1 (above) and 2 (below)
Figure 1. Charging of condensers in series. Figure 2. Electronic counting circuit with blocking oscillator for output stage.

*An interesting discussion of this circuit was presented by A. V. Bedford and J. P. Smith, *A Precision Television Synchronizing Signal Generator*, RCA Review; July, 1940.

The operation of the counting cir cuit will be seen to depend upon th charging of condensers in series. I will therefore be necessary to reviev briefly a circuit, such as Figure 1 which shows two condensers $C_1$ an $C_2$ placed in series across a source o potential $E_B$.

When switch $S_1$ is closed, the bat tery voltage $E_B$ appears across C and $C_2$. If the potential which finally appears across $C_1$ and $C_2$ be called E and $E_2$ respectively, it is apparent tha

$$E_B = E_1 + E_2 \quad (1)$$

The relationship between the charg and the voltage in a condenser is

$$Q = CE$$

where $Q$ is measured in coulombs, C in farads and $E$ in volts. Since C and $C_2$ are in series,

$$Q_1 = Q_2 = C_1 E_1 = C_2 E_2$$

$$\text{or } E_1 = \frac{C_2 E_2}{C_1} \quad (2)$$

Substituting equation 2 in equation

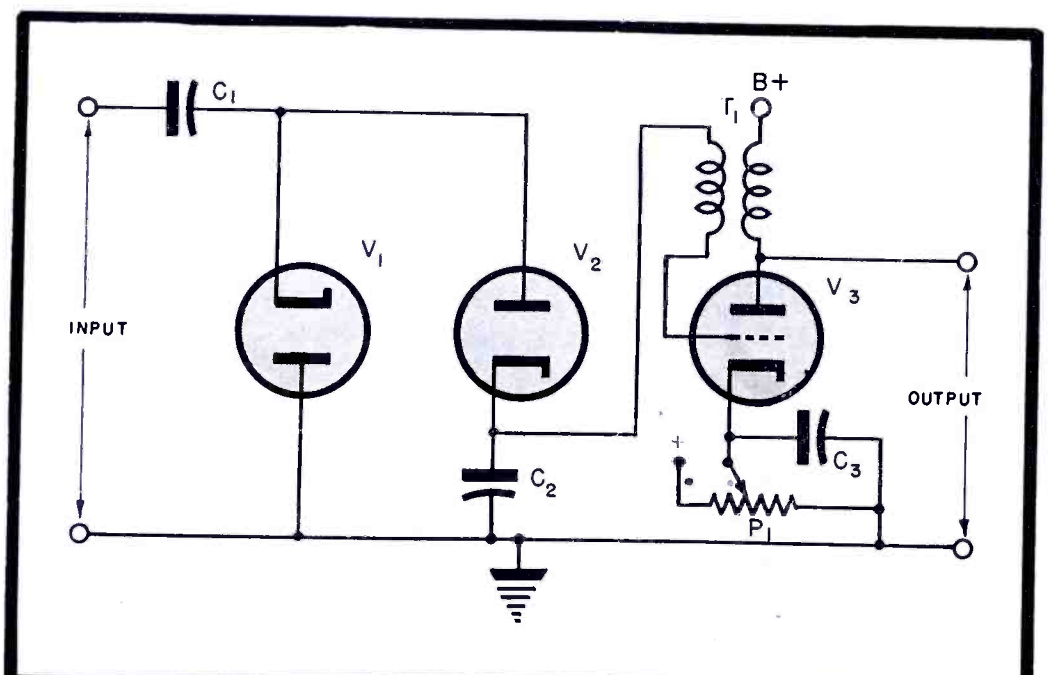
$$E_B = \frac{C_2 E_2}{C_1} + E_2 = E_2\left(\frac{C_2 + C_1}{C_1}\right)$$

$$\text{or } E_2 = E_B\left(\frac{C_1}{C_2 + C_1}\right) \quad (3)$$

$$\text{Similarly } E_1 = E_B\left(\frac{C_2}{C_2 + C_1}\right) \quad (4)$$

From equations 3 and 4, it may be seen that the voltage across either

(*Continued on page 44*)



*From Metal Fabrication to Finished Unit . . .*

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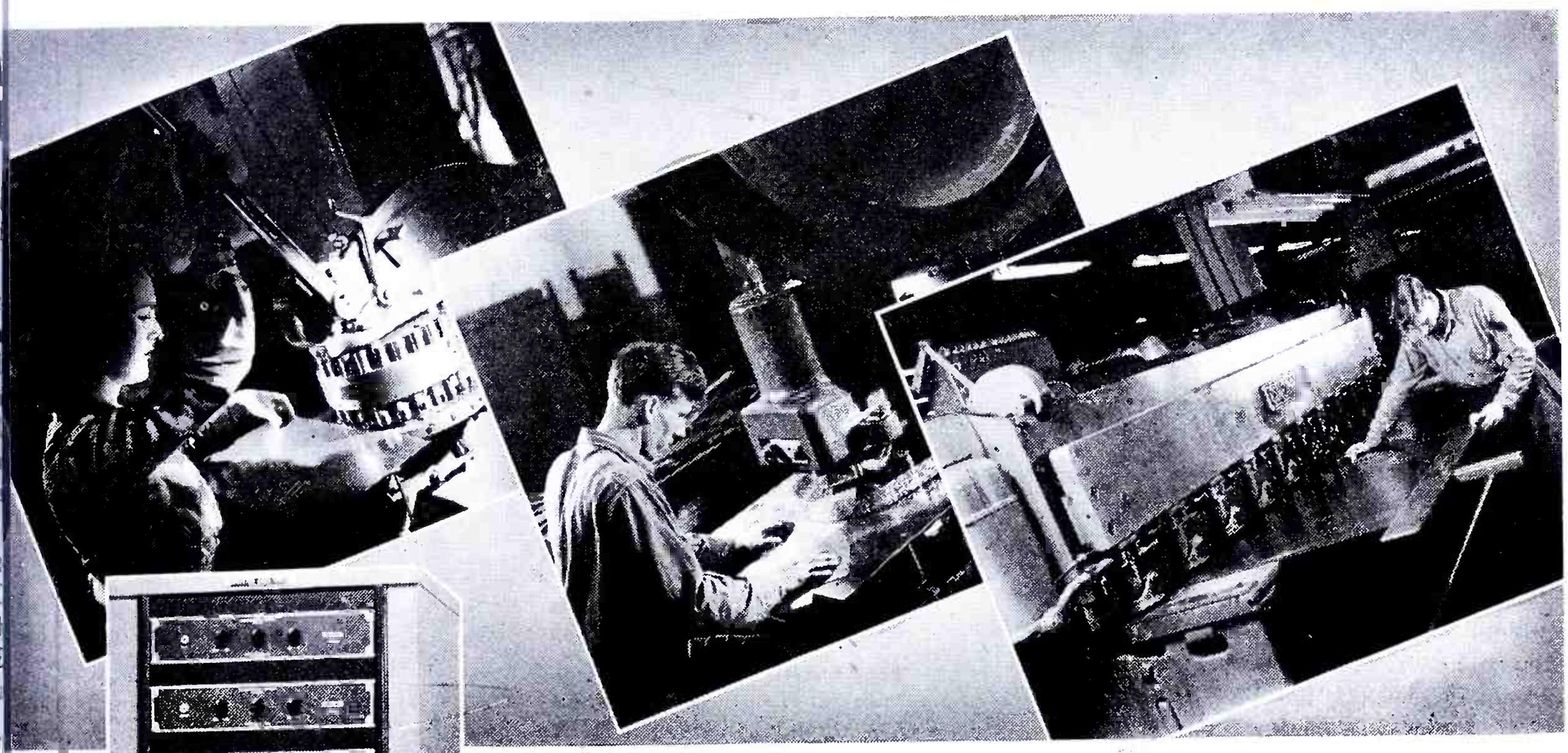

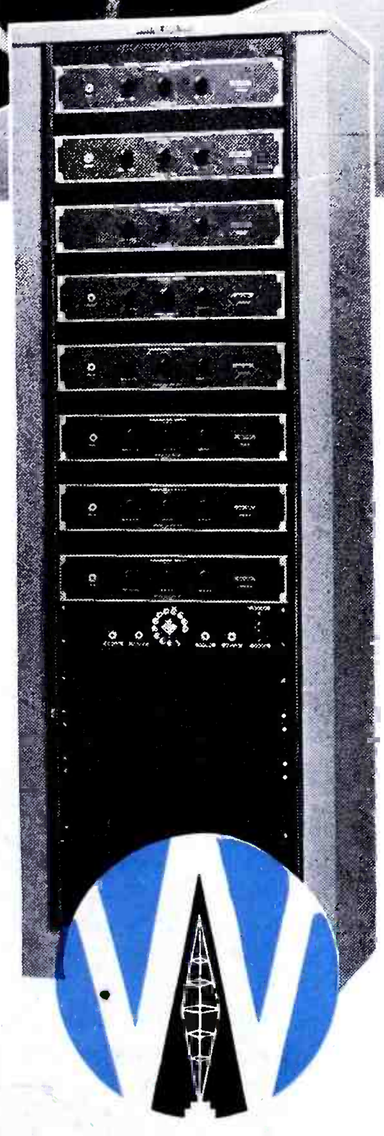

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*Manufacturers of Radio Equipment*

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# ELECTRONIC COUNTER

(*Continued from page 42*)

condenser varies inversely with the size of the condenser, since these equations could be written as

$$E_2 = E_B \times \frac{1}{C_2}\frac{C_1 C_2}{C_1 + C_2}\Big) \qquad (3a)$$

$$E_1 = E_B \times \frac{1}{C_1}\frac{C_1 C_2}{C_1 + C_2}\Big) \qquad (4a)$$

Consider now the circuit to be used for a counting device, or a frequency divider, as shown in Figure 2.

The actual portion of the circuit which does the counting consists of tubes $V_1$ and $V_2$, and condensers $C_1$ and $C_2$. It is therefore this portion upon which most of the emphasis will be placed during this discussion. The remainder of the circuit is an ordinary blocking oscillator, one function of which is to provide a discharge path for $C_2$. The necessity for providing some discharge path for $C_2$ will be shown after an explanation of the theory of operation of this circuit has been presented. The blocking oscillator is a simple and frequently used output stage for this type of counting circuit, although many other devices have been used successfully for the same purpose.

The circuit shown is a simplified one which includes only the principal components. Values are not given since they will depend upon the frequencies involved. Relative values of condensers $C_1$ and $C_2$ will depend upon the number of pulses the circuit is intended to count. Further in the discussion it will be shown that a definite ratio exists between the value of $C_1$ and that of $C_2$. The selection of the vacuum tubes to be used is optional. It is suggested, however, that one tube such as the 6H6 be used for $V_1$ and $V_2$. The setting of $P_1$ must be such that $V_3$ is biased below cut-off.

Let us assume that the input to this circuit is a square wave having some definite pulse repetition rate, as shown in the first part of Figure 4.

It is not necessary that the input be a square wave. This circuit will operate efficiently if the input is a sine wave or some other wave which is quite regular in nature; and, even if the input waveform is quite irregular in shape or repetition rate, satisfactory counting is possible. One of the advantages of using this circuit is that it will be able to count pulses regardless of their irregularity of shape or repetition rate. However, in order to simplify the explanation and the resultant wave shapes, the input here ll be assumed to be a square wave th a constant repetition rate.

Let us consider the condition of $C_1$ d $C_2$ after one cycle of the square ive has passed. It will be noted it on the positive half-cycle $V_2$ is le to conduct (since the plate is posi- e with respect to the cathode) and and $C_2$ are then in series with each ner across the input voltage. On e negative half-cycle, however, $V_1$ the tube which is capable of passing rrent and $C_1$ is the only effective pacitance then across the input volt- e (ignoring any stray capacitance interelectrode capacitance in $V_1$).

After the positive half of the cycle is passed, $C_1$ and $C_2$ will both be iarged through $V_2$ as shown in Fig- e *3a*. When the negative half of the cle is applied, $C_1$ will discharge (or iarge in the opposite direction) rough $V_1$. $C_2$ will remain charged it was previously. Figure *3b* shows e condition of $C_1$ and $C_2$ when the egative peak of the applied signal is passed. It will be noted that e charge on $C_2$ has not changed. he cathode of $V_2$ is positive with re- ect to the plate so that this tube can- ot conduct to allow a path of dis- iarge for $C_2$. After one cycle of the oplied signal has passed, the voltage ross $C_2$ may be represented as

$$= E_M\left(\frac{C_1}{C_1 + C_2}\right) = r\,E_M \qquad (5)$$

here $E_M$ is the peak of the applied oltage, and $r$ is the ratio of

$C_1$ to $(C_1 + C_2)$.

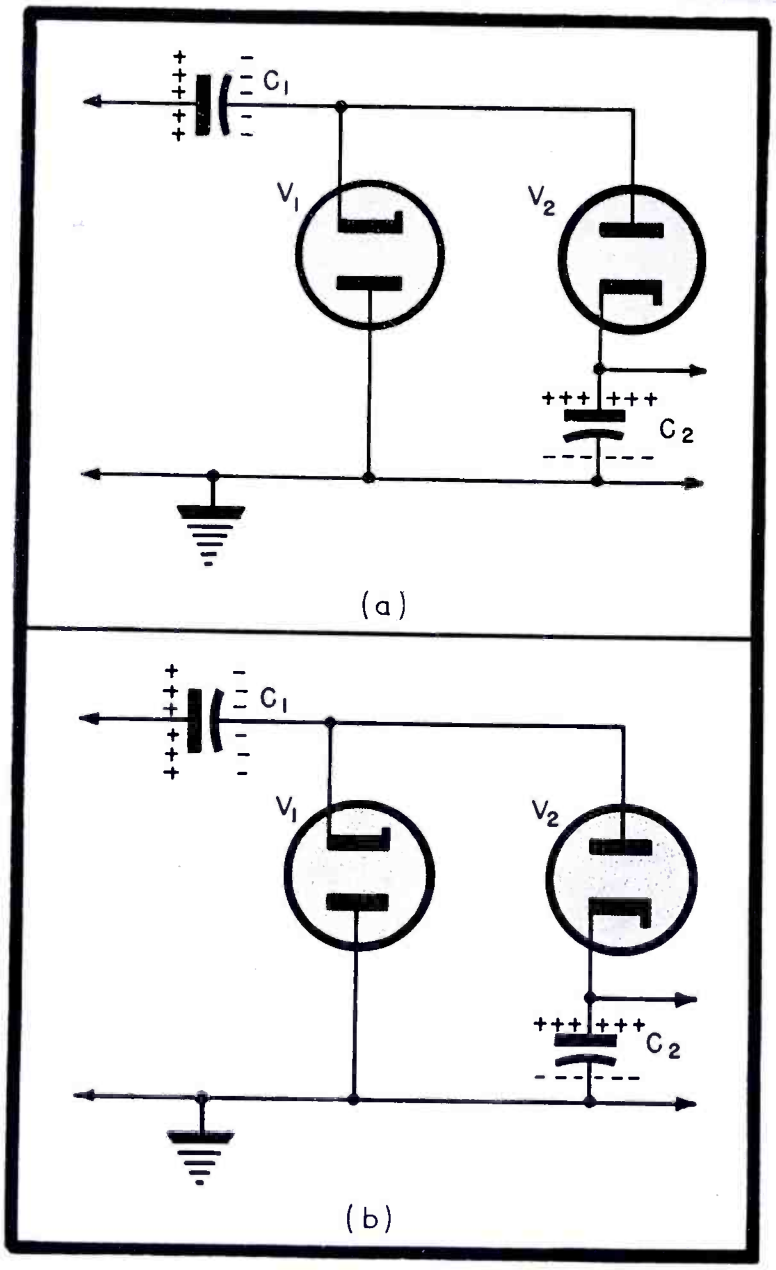
This equation is not quite exact, s we have failed to consider the oltage across $V_2$. However, the volt- ge across the diode will be quite nall, and consideration of it would nnecessarily complicate the discus on without increasing the accuracy the calculations appreciably.

### lultiple Cycle Effects

Equation *5* expressed the voltage cross $C_2$ after the first cycle (or ulse) of the applied voltage has assed. It will be of value to deter- nine what voltage exists across $C_2$ fter the application to this circuit of ny given number of cycles. This may e achieved by determining the voltage resent after the passage of two or hree cycles, and then arriving at a eneral equation which will be ap licable for any number of cycles.

When the second cycle of the in oming signal is applied, $C_1$ has dis- harged, but the voltage shown in

(*Continued on page* 46)




**Figures 3 (left), and 4 (below)**

**Figure 3. Condition of condensers $C_1$ and $C_2$: (*a*), after positive portion of applied signal; (*b*), after negative portion of applied signal. Figure 4. Theoretical wave-shape relationships.**

equation *5* is still present across C
The actual peak voltage now im
pressed on the circuit will be

$$E_M - E_1 = E_M - r\,E_M \quad (6$$

The voltage present across $C_2$ afte
the second cycle of the incoming sig
nal has passed will be the sum of th
voltage given by equation *5* and a por
tion of the impressed voltage show
in equation *6*. This may be expresse
as

$$E_2 = E_1 + (E_M - E_1)\,r \quad (7$$

or, substituting equation *5* in equa
tion *7*,

$$E_2 = r\,E_M + r\,E_M - r^2\,E_M$$

$$E_2 = E_M\,(2r - r^2) \quad (8$$

This may also be written as

$$E_2 = E_M\,[1 - (1 - r)^2] \quad (9$$

The reason for using the form of equa
tion *9* for equation *8* will be apparen
shortly.

When the third cycle of the incom
ing signal has been applied, the volt
age then appearing across $C_2$ will b
the sum of $E_2$ and a portion of th
difference between $E_M$ and $E_2$. Thi
may be expressed as

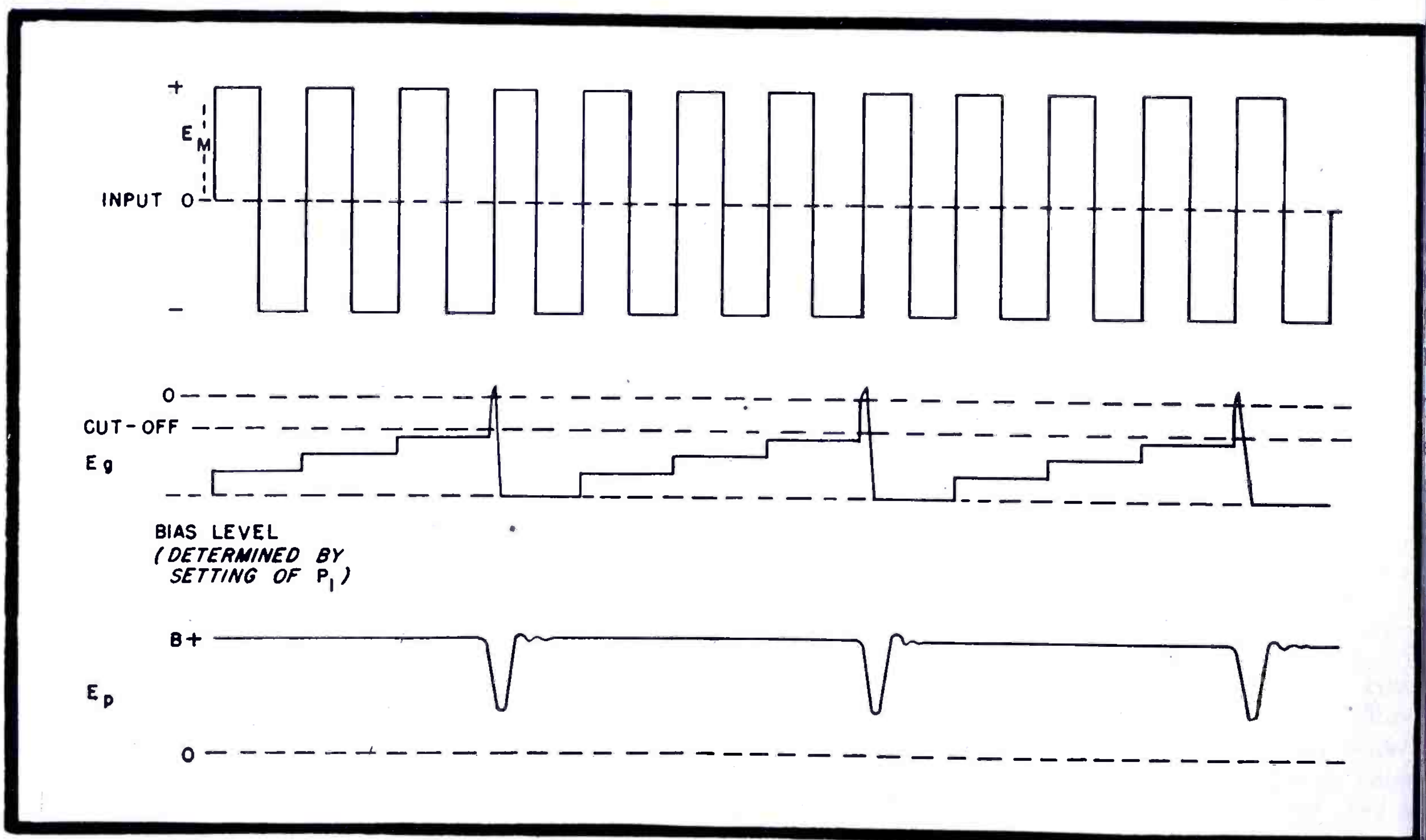
$$E_3 = E_2 + r\,(E_M - E_2)$$
$$= E_M\,[1 - (1 - r)^2] + r\,\{E_M - E_M\,[1 - (1 - r)^2]$$
$$= E_M\,[1 - (1 - r)^2 + r\,(1 - r)^2]$$
$$= E_M\,[1 - (1 - r)^2\,(1 - r)\,]$$

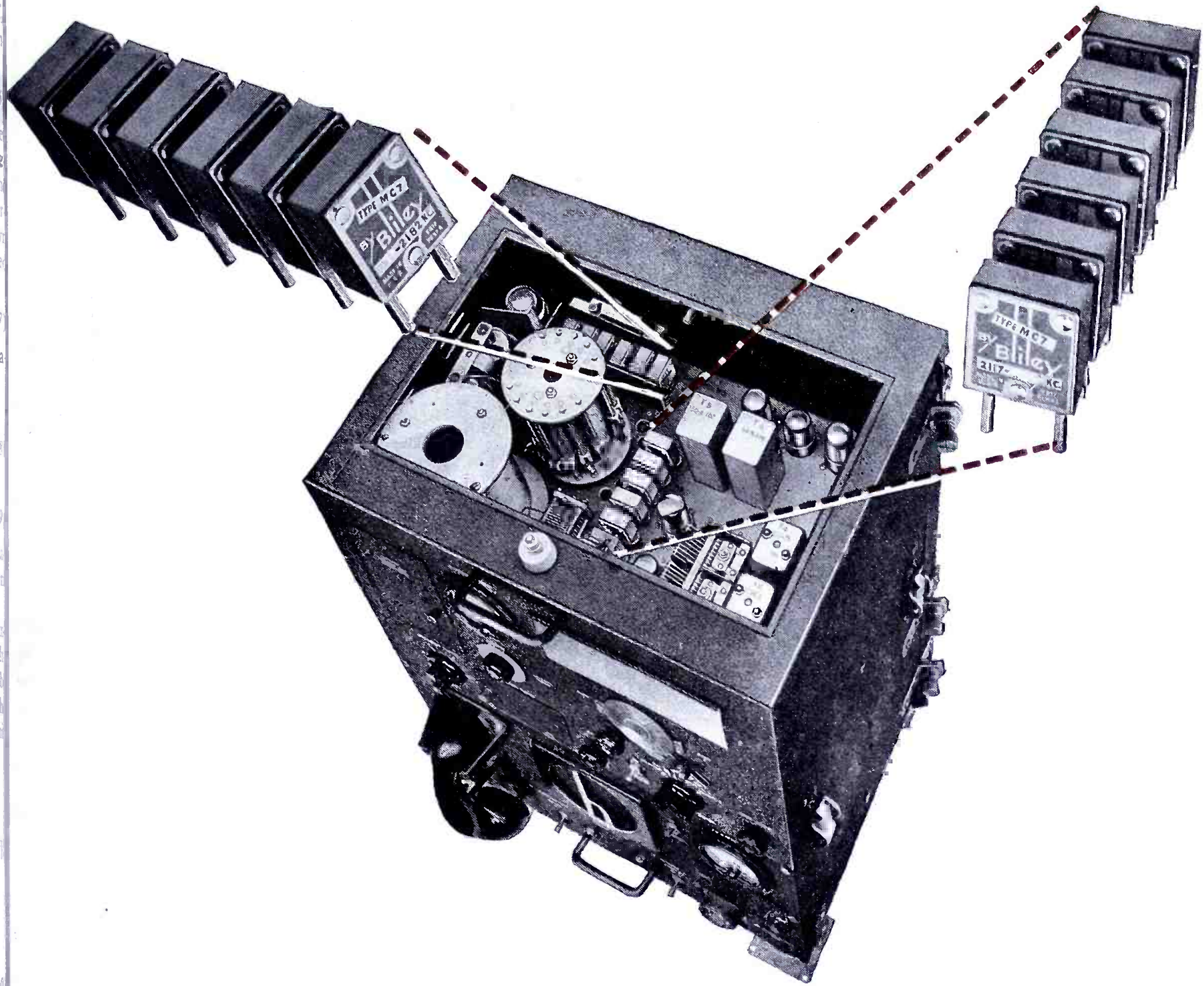
or

$$E_3 = E_M\,[1 - (1 - r)^3] \quad (10$$

From equations *5*, *9* and *10* the gen

(*Continued on page 79*)



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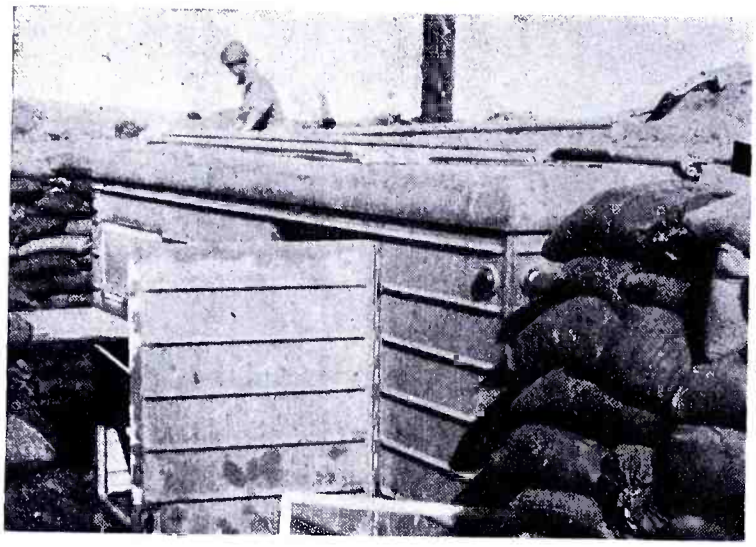


Figures 1 (right) and 2 (left)
Figure 1. First CAA tower at Tinghawk-Sakan. Contacts equaled those of busy metropolitan field. Figure 2. Mobile receiver trailer and antenna pole buried in volcanic ash on Iwo.

# MAINTENANCE OF THE AACS WARTIME RADIO CIRCUITS

## AACS Communications Men Kept Complex Systems On-the-Air In Spite of Air Raids and Shell Fire

by CPL. MARK WEAVER

Headquarters AACS, AAF
Asheville, N. C.

A HOST of unusual experiences have been recorded by the AACS communications men during their missions around the world . . . experiences that reveal the alertness and ingenuity applied to keep our communications circuits *on the air*.

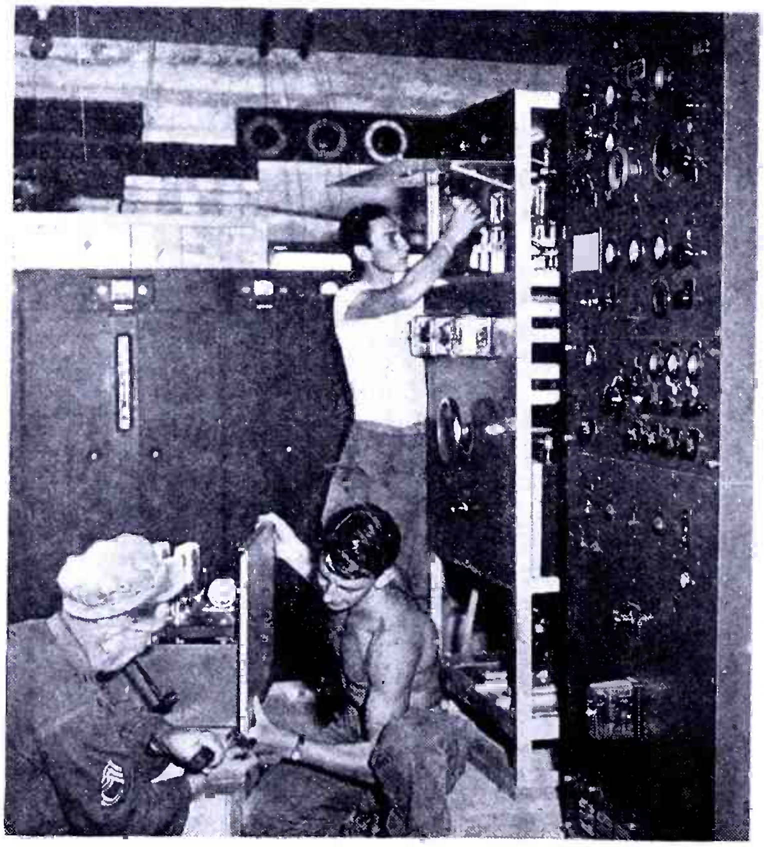
On Iwo Jima antenna poles and other communications necessities were put into operation under direct fire from Jap lines less than a mile away. At Myitkyina, Burma, moving with the advancing Allied troops, AACS men were constantly shelled by artillery. The airstrip was a sort or no-man's-land; ripped apart by both armies. But in spite of air raids and shell fire, air communications on all fronts hit the air on schedule.

During the few months since the taking of Iwo Jima B-29 pilots have had many occasions to mentally thank the fighting men who fought on that pin-point bit of volcanic ash. They have been expressive in appreciation of the communications set-up there.

### C-47 Incident

Quick thinking and "spur of the

(*Continued on page* 81)



Figures 3 (left) and 4 (below)
Figure 3. Applying finishing touches on 10-kw transmitters at AACS' Miami master radioteletype weather broadcast station, WYI. Figure 4. Repairing Jap bombed transmitter building in China. AACS men repaired both radio equipment and building in a matter of hours.

# CRYSTAL OSCILLATORS IN F-M AN[D] TELEVISION

by SIDNEY X. SHORE
Consulting Engineer

*[Part One of a Series]*

WITH circuit simplification a[nd] the use of a minimum [of] tubes major requisites [of] most superheterodyne oscillators, st[a]bility has become increasingly im[-]portant, particularly at v-h-f. An[d] with the new fm/television allocation[s] the veryhigh frequencies are sche[d]uled to become as important as th[e] m-f broadcast band.

The general practise in designin[g] wide-band f-m i-f systems is to mak[e] its response reasonably flat over [a] range of 200 kc to avoid the dange[r] of clipping one of the sidebands [of] the modulated signal, especially [...]

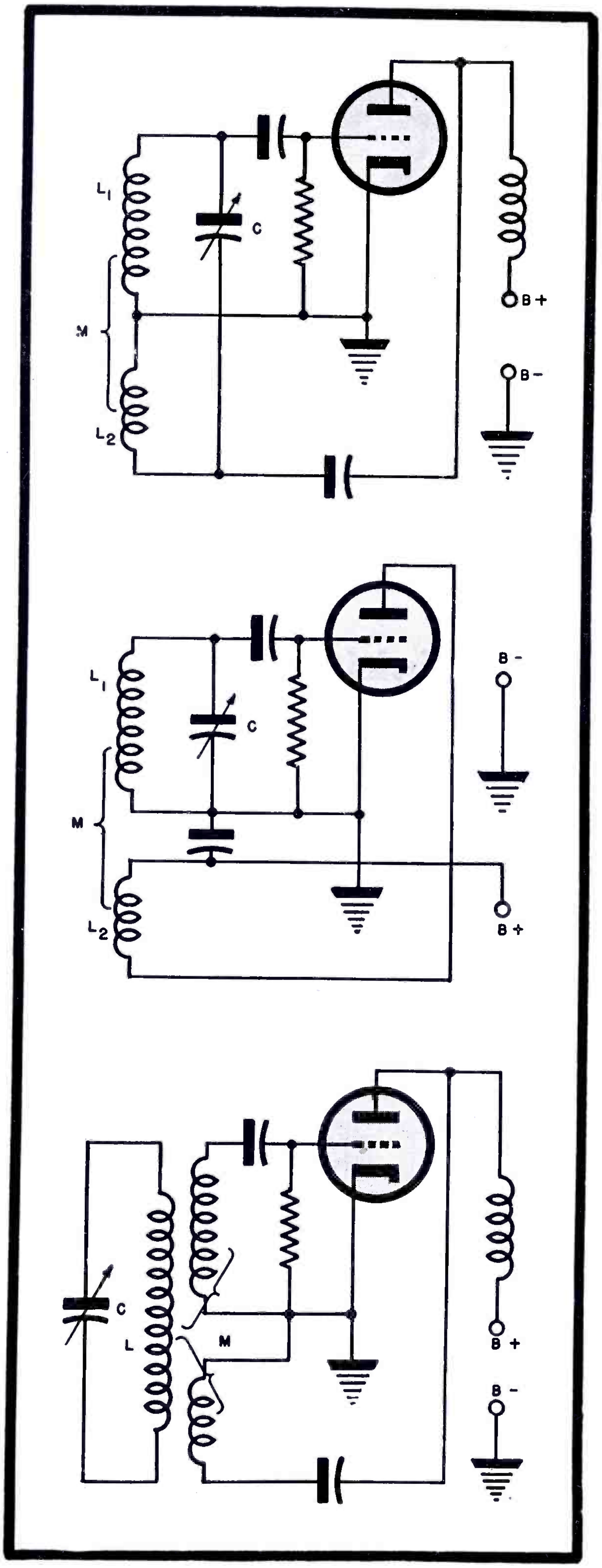
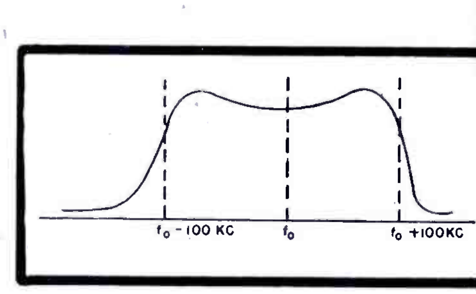
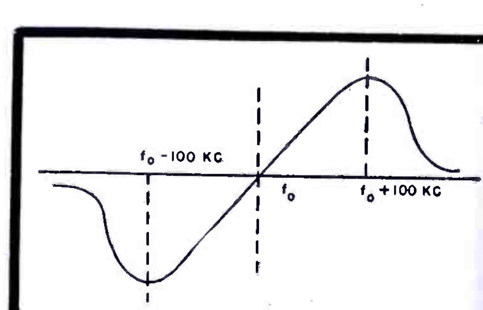
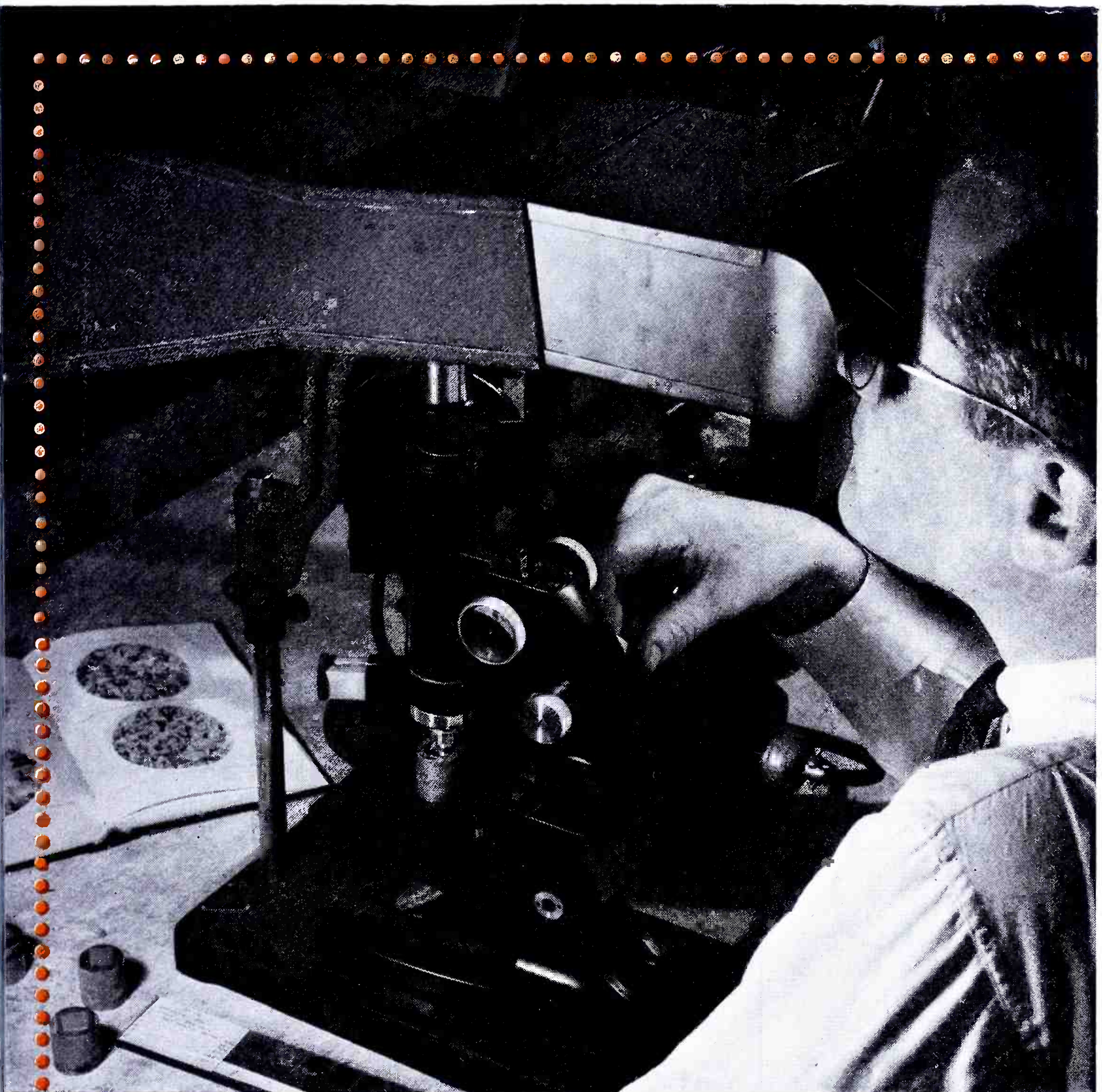



Figure 3
Inductively - coupled feedback oscillators (self-excited): At top, Hartley; center, plate-tickler; bottom, Meissner. Hartley and plate-tickler coil oscillators appear in most superheterodynes. These systems use lumped inductances and capacitances in combination with distributed capacitances and inductances associated with wiring, tubes and other components to establish oscillator frequency.




Figures 1 (above) and 2 (below)
Figure 1. The i-f resonance characteristic at th[e] limiter of an f-m receiver. In Figure 2 appea[rs] the f-m discriminator characteristic; $f_0$ repr[e]sents the beat between resting carrier frequen[cy] of station and local oscillator in the receive[r].





Investigating the grain structure of a metallurgical subject, magnified 585 times.

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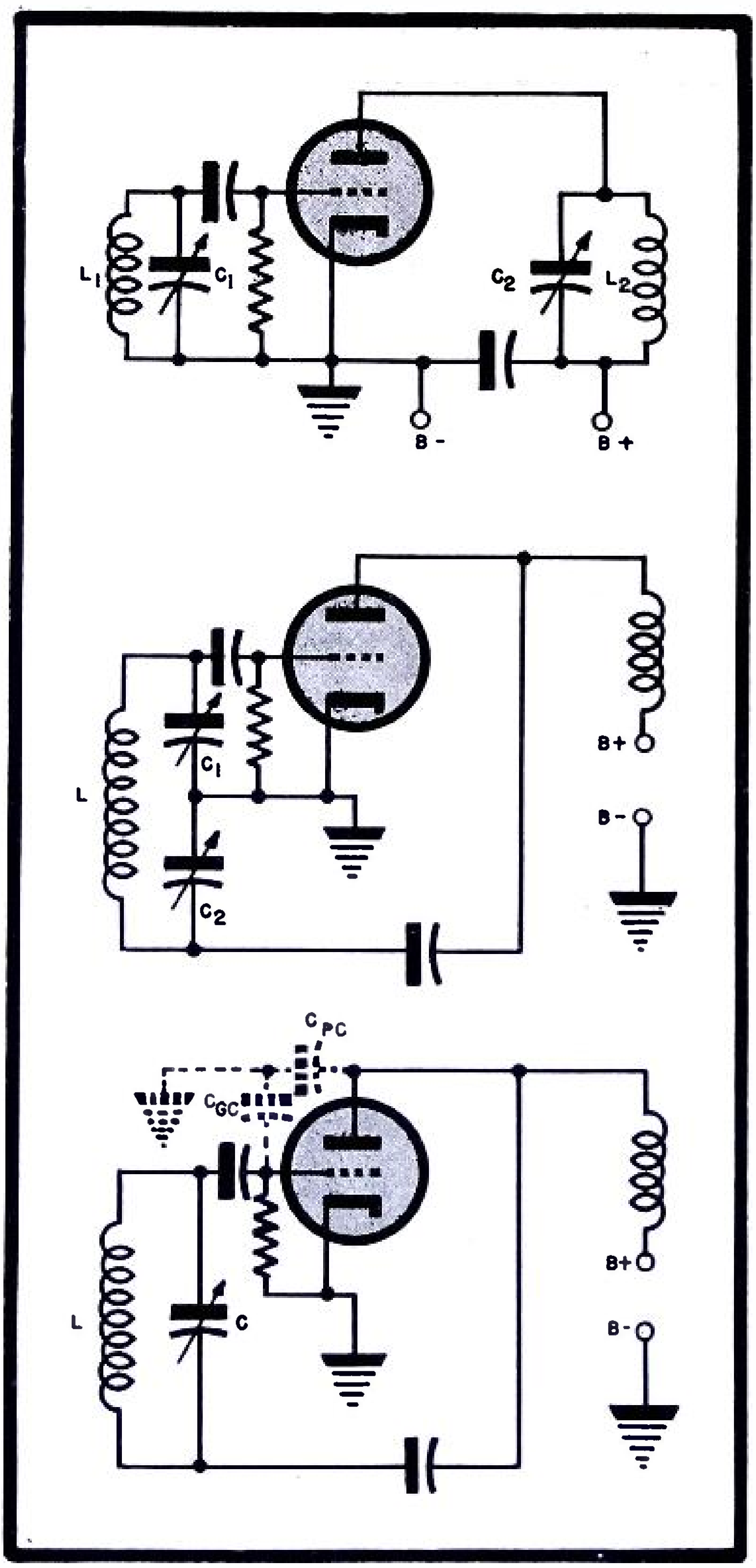
. IN RADIO COMMUNICATIONS, IT'S . . . COLLINS




Three types of capacity-coupled feedback (self-excited) oscillators: top, tuned-plate-tuned-grid; center, Colpitts; bottom, ultraudion. In the t-p-t-g oscillator, the plate-grid capacity serves as the feedback path. The Colpitts circuit secures feedback via the proper sizes and ratio of $C_1$ and $C_2$. In the ultraudion circuit, the grid-cathode and plate-cathode capacitances are used in similar fashion as $C_1$ and $C_2$ in the Colpitts for proper phase feedback. Only one coil and capacitance are needed in the oscillating circuit and since no d-c must pass through coil, the lumped *LC* circuit can be replaced by a crystal. The resulting circuit is known as one form of the Pierce oscillator.

high-modulation levels, because of local oscillator drift. This widening of the pass band of the i-f is done at some expense of gain of the i-f system. If the pass band of the i-f system were able to accommodate a large oscillator drift, the discriminator characteristic, which departs from linearity just beyond the 150-kc pass band, will cause the highly modulated signals to become distorted as the detector voltage departs from proportionality to frequency deviation.

In Figure 1, we have the i-f resonance characteristic at the limiter of an f-m receiver; Figure 2 illustrates the discriminator characteristic, $f_o$ represents the beat between the resting carrier frequency of the station and the local oscillator in the receiver. For the purposes of illustration let us assume that the resting carrier frequency of the broadcast station is 100 mc, and that the local oscilliator frequency for this dial setting is 85 mc. The beat frequency or i-f will then be 15 mc. The width of the modulation band of a 100% modulated f-m signal would be 150 kc according to the present system.*

Of course, as long as there is enough voltage at the limiter grid to saturate the limiter there will be no deleterious effect due to this i-f clipping. At high-modulation levels, where this effect would occur, any increase in noise due to lessened limiter effectiveness would be masked somewhat by the high audio level but this effect is definitely present.

*A deviation in oscillator frequency of .03% will result in an $F_0$ beat of 25 kc.

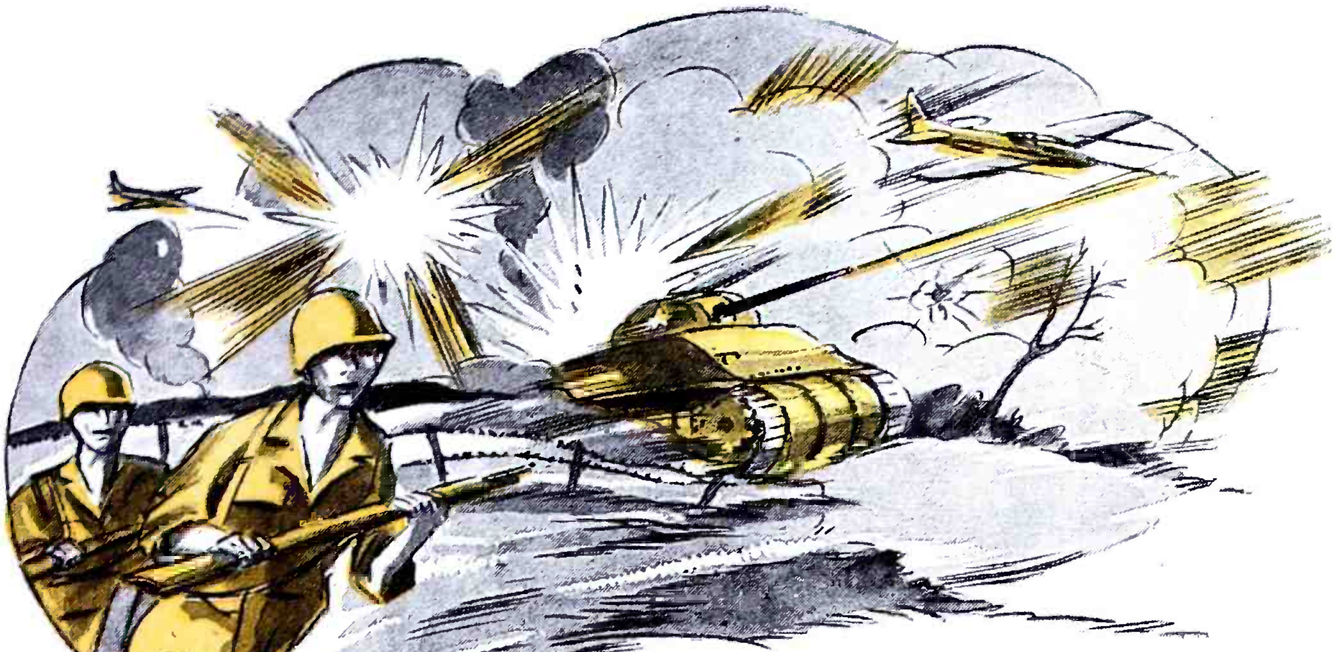
It is obvious therefore that the need for oscillator stability is greater than ever before. In a television receiver, local oscillator drift will result in the same effects, just described on the sound channel and in image distortions on the video channel. At frequencies above 30 mc oscillator instability and drift may be eliminated in great measure by the use of low-temperature coefficient quartz crystals and suitably designed oscillator circuits.

In lower cost receivers where i-f systems may be peaked as much as possible to realize maximum gain with minimum tubes and circuits oscillator stability is particularly important if good quality is desired over a period of time at a single dial setting. Instability of oscillator components has resulted in the abandonment of push-button systems by the majority of manufacturers. Crystal-controlled oscillators offer the simplest solution to this problem.

In the high-fidelity a-m broadcast receiver oscillator instability can mar reproduction, unless the i-f system will pass a band considerably wider than the minimum required. But then interference from adjacent-channel stations becomes a serious problem.

Oscillator stability is exceedingly important in portable mobile equipment. Automobile radios should certainly be equipped with push-buttons to avoid dial twisting and fishing for signals while driving. And timing a-m and particularly f-m sets by ear without some visual resonance indicator prompts mistuning and resultant poor quality. Of course a visual tuning indicator in an automobile would be a hazard to driving safety. Therefore push buttons become a *must* in design. Under the grueling riding conditions with the attendant severe vibration and temperature changes oscillator stability again becomes a circuit necessity. The need for stable oscillators in marine equipment is also increasing. For marine operations and for other point-to-point applications where several spot frequencies may be used almost exclusively a stabilized crystal-controlled oscillator is the solution.

For single side-band transmission and suppressed carrier transmission extreme oscillator stability and accurate reinsertion of the proper carrier frequency are of paramount importance. To conserve space in the frequency spectrum as the need for more transmitters grows the art may



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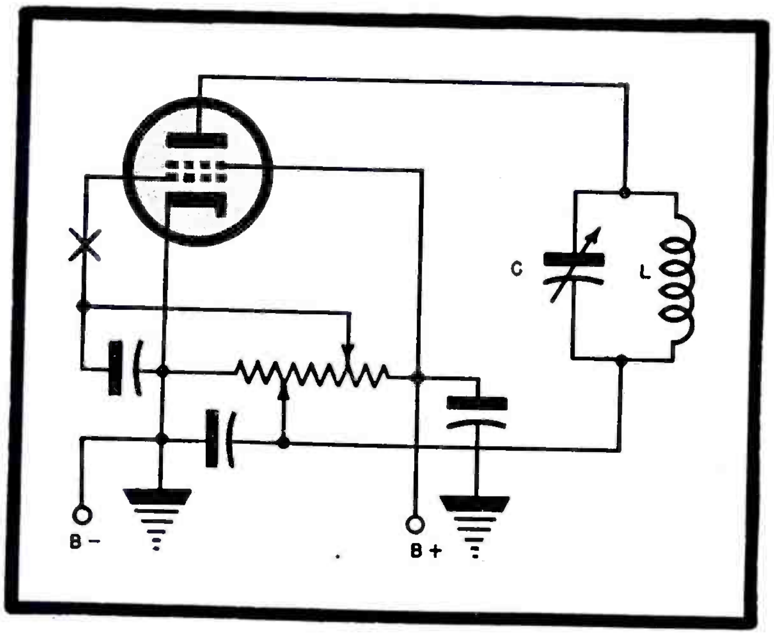



**Figure 5**
The dynatron oscillator circuit. An additional resonant circuit may be inserted at point *X*. The oscillator will oscillate at the resonant frequency of both resonant circuits.

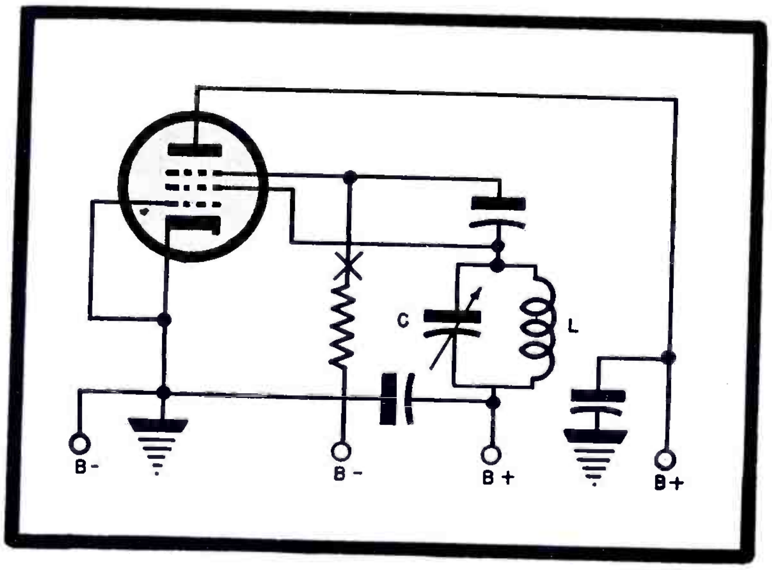



**Figure 6**
The transitron oscillator. Both the transitron and dynatron are negative-resistance oscillators. The transitron is much more stable than the dynatron. An additional resonant circuit may also be inserted at point *X*.

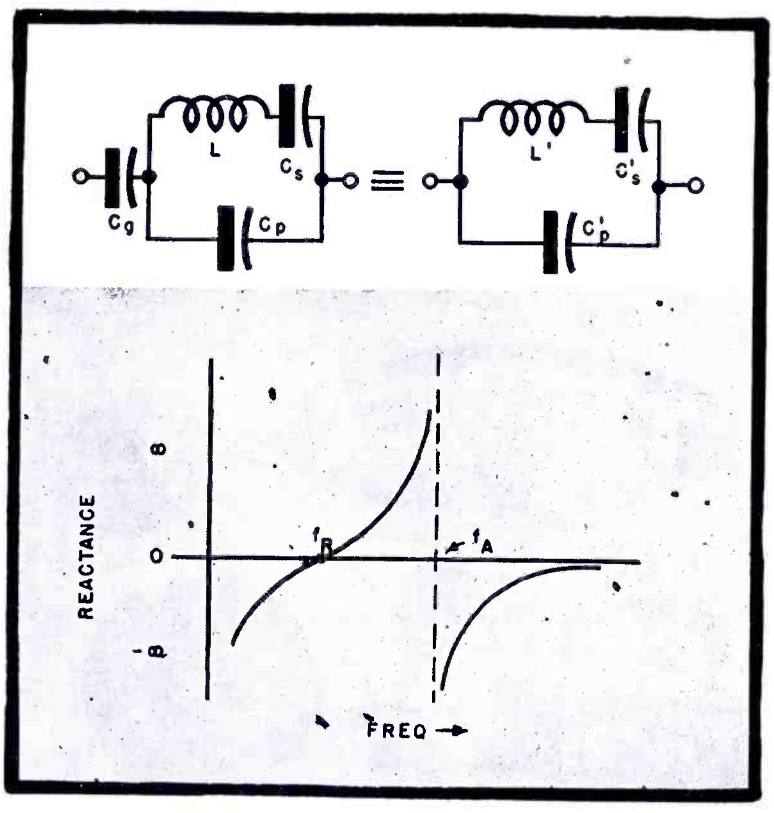



**Figure 7**
The equivalent circuit of a quartz crystal in an air-gap mounting. It will be seen that the crystal plate can be excited to resonate or oscillate over a narrow band of frequencies, depending upon the associated circuit elements; resonant frequency, $f_R$, is the series-resonant frequency and is a function of the equivalent *L* and *C* of the crystal element. Antiresonant frequency, $r_A$, is the parallel-resonant frequency.

turn toward these means for savir frequencies, and also power.

At present the magnetically- or i ductively-coupled feedback oscillato (*Hartley and plate-tickler coil*) a used in most superheterodynes.

The *Meissner* oscillator is not use in receivers because it requires more complicated coil and its efficienc is no better than the previously mer tioned types. These oscillators us lumped inductances and capacitance in combination with distributed ca pacitances and inductances associate with the wiring, tubes and other com ponent parts to establish the oscilla tion frequency.

Other types of self excited oscilla tors utilize capacity-coupled feedback Figure 4. The t-p-t-g oscillator util izes the plate-grid capacity as th feedback path. The *Colpitts* circui accomplishes feedback by the prope sizes and ratio of $C_1$ and $C_2$. Th *ultraudion* is an interesting circuit i that it utilizes the grid-cathode an plate-cathode capacitances in a simila fashion as $C_1$ and $C_2$ are used in th *Colpitts* circuit for proper phase feed back. In requires only one coil an capacitance in the oscillating circuit and since no d-c must pass througl the coil it is a simple matter to re place the lumped *LC* circuit by a quartz crystal. The resulting circui is known as one form of the *Pierce* circuit (Patent #2,112,863, issued to George W. Pierce). This interchangeability of lumped *LC* with a quartz crystal provides an ideal arrangement for most types of low-frequency or broadcast band push-button receivers.

Other types of oscillator circuits requiring only a single coil and condenser in the *LC* section are those utilizing negative resistance. In figure 5 we have the *dynatron* as disclosed in 1917 by Dr. Albert W. Hull. Figure 6 shows the *transitron* circuit, a much more stable type of oscillator than the dynatron and capable of many interesting effects.

All of the self-excited oscillators shown utilize a shunt *LC* circuit to determine the frequency of oscillation. A bridge type of oscillator circuit, which has been used to increase stability of self-excited oscillators, utilizes a series resonant *LC* circuit which is effectively in series with the feedback leg of the circuit. At series resonance of the *LC* combination maximum feedback occurs and oscillations are started.

It is possible to demonstrate analytically and graphically that there are many causes of oscillator instability.[1]

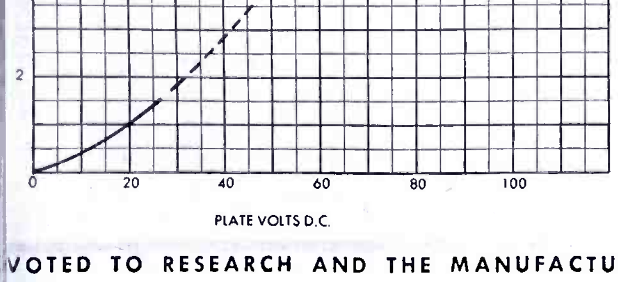
The general expression for the fre-

(*Continued on page* 83)


**Electrical Characteristics of Type 2B25**

| | |
|---|---|
| Filament Voltage (AC or DC) | 1.4 volts |
| Filament Current | .110 amps. |
| Maximum Peak Inverse Voltage | 2800 volts |
| Maximum Peak Plate Current | 9.0 ma |
| Maximum Average Plate Current | 1.5 ma |

TYPE 2B25
AVERAGE CHARACTERISTICS




A recent development for the expanding Raytheon miniature tube line is the type 2B25 high-voltage, high-vacuum rectifier. This tube requires approximately 0.15 watts filament power, yet can deliver 1000V DC at 1.5 ma.

These characteristics make it applicable to various forms of electronic equipment in which its small size and rugged construction may be very desirable features. Furthermore, with proper precautions, the low filament power can easily be supplied from an oscillator if it is desired to rectify low radio frequency to obtain direct current power within the 2B25 voltage and current ratings. Plate and filament potentials can be turned on simultaneously without damage and heating is practically instantaneous—thus making this tube suitable for intermittent usage.

Other possible applications include operation as the rectifier in battery vibrator power supplies designed to supply the high voltage DC for small portable cathode ray oscilloscopes or special test equipment.

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# SKIN EFFECT IN ROUND CONDUCTORS

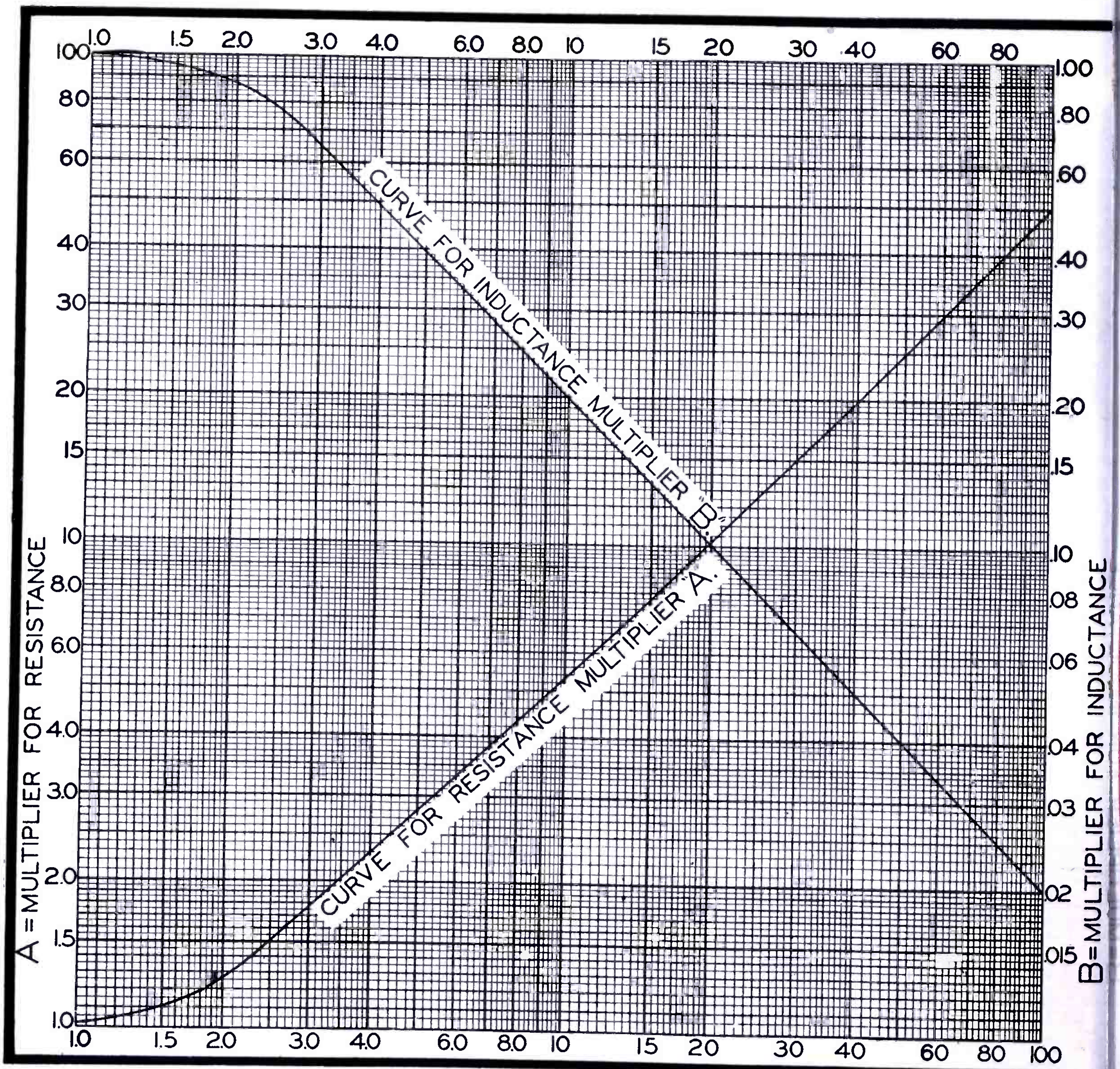
by W. B. SHEPPERD

Army-Northwest Airlines
On Leave, E. E. Dept., North Dakota Agricultural College

Many papers offering skin-effect calculations have been published, giving both empirical solutions covering a limited range, and rigorous solutions. However, having occasion to present this topic to a group of war-time trainees in radio work, the writer was unable to find any method that was lucid and simple enough to be used by technicians of limited mathematical training and which at the same time was reasonably accurate over a wide range. The simplified formulas used in power-line work are correct only for comparatively low frequency, while the high-frequency formulas are inaccurate except where depth of penetration is slight.

To present to the trainees a method of calculating skin effect that would be simple and dependable, the method described in this paper was developed. Where the conductor is copper, only conductor diameter and frequency need be known to determine the increase i

(*Continued on page* 60)




Skin effect curves. $K = 6.08\, d \sqrt{f}$ for copper; $7.98 \sqrt{\frac{\mu f}{\rho}}$ for any conductor; d = conductor, diameter inches; $\mu$ = permeability, air = 1; f = frequency, kc; $\rho$ = resistivity, microhm per cm cube. (*Copyright, W. P. Shepperd*)

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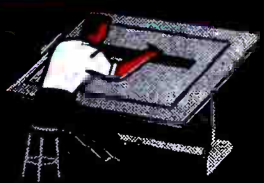

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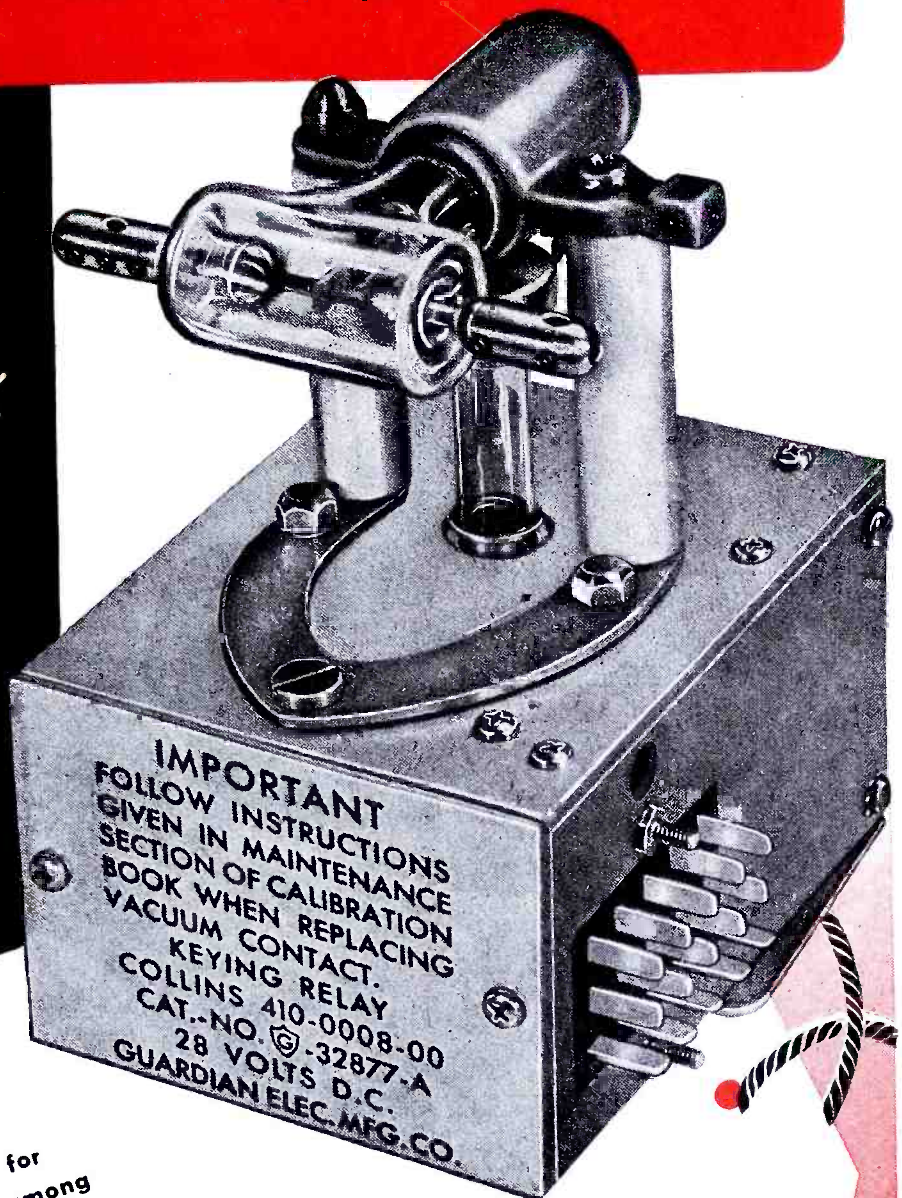


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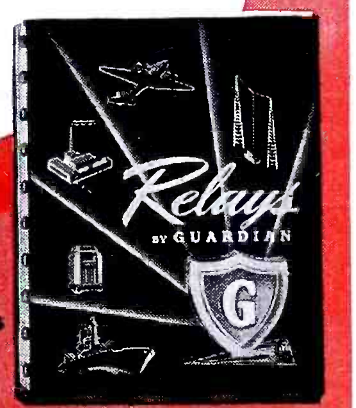


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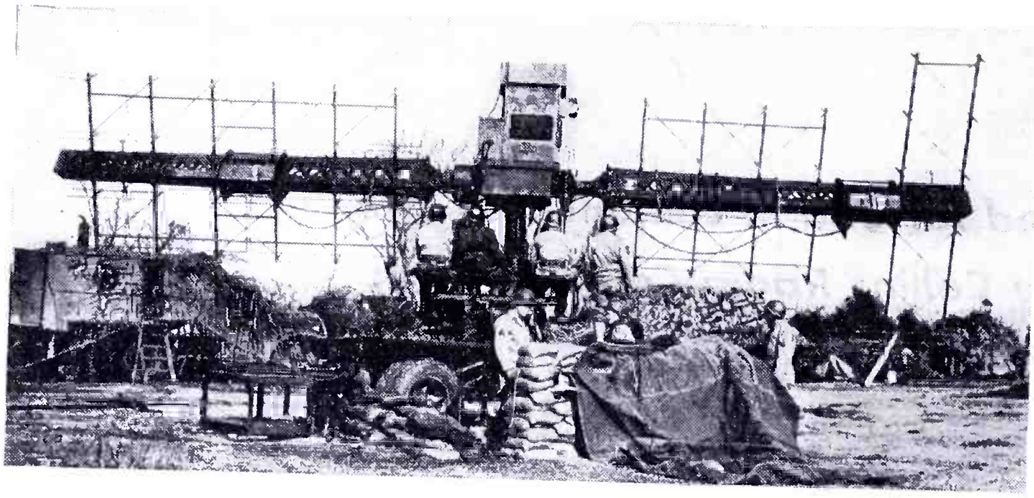
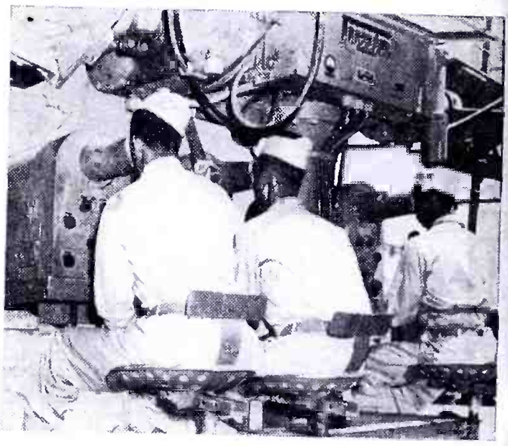
# RADAR IN U.S.



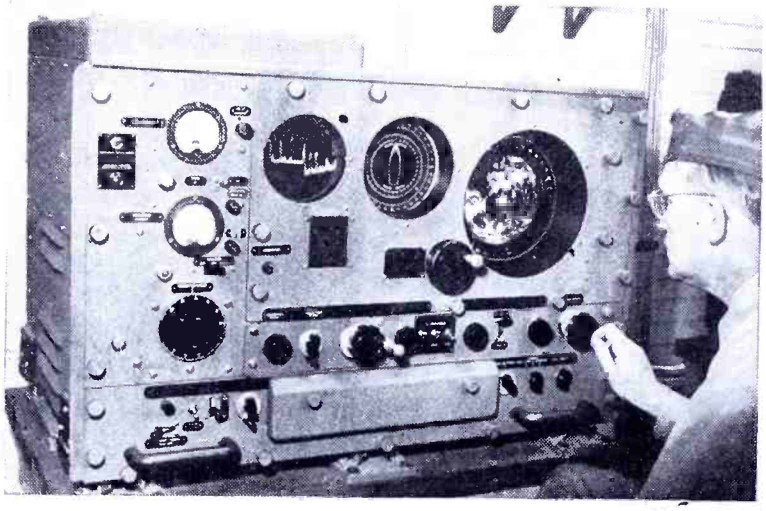
Above, U. S. SCR-268 mobile trailer-mounted radar in action at Nettuno, Italy. This unit, for use by antiaircraft batteries to help them locate, track and shoot down enemy planes, has a range of 40,000 yards.

(*Courtesy U. S. Signal Corps*)

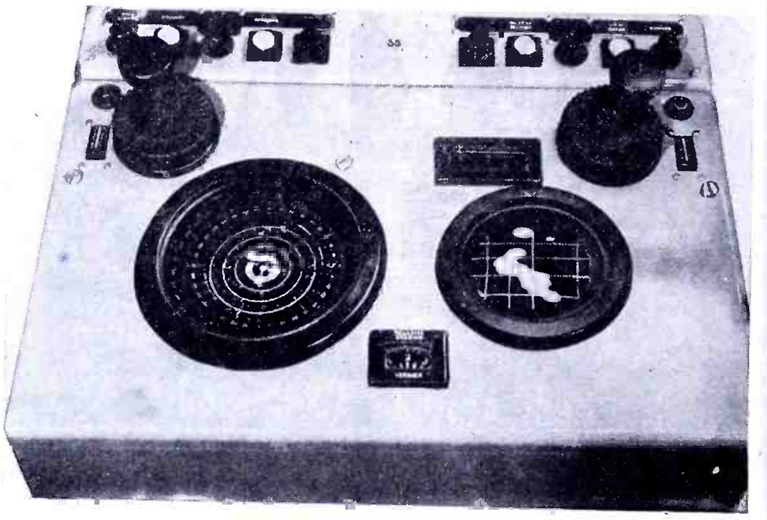


Above, SCR-268 radar on the alert; studying the scopes to pinpoint the approach of an enemy plane. One man calls off the target's altitude to gunners while another gives its distance or range. The third observes the enemy's direction relative to the instrument.

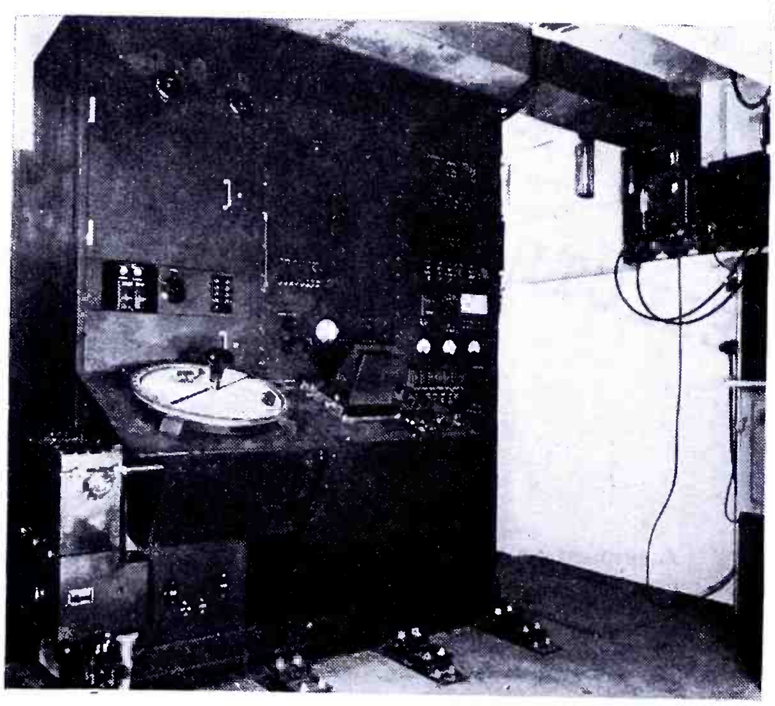
(*Courtesy U. S. Signal Corps*)

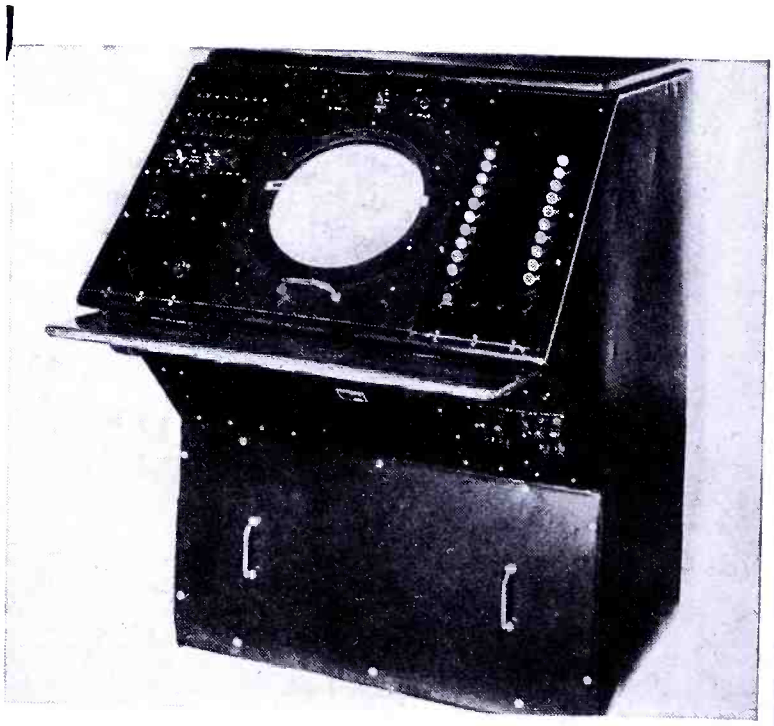


Above, SG radar indicator, used by the U. S. Navy, showing operator obtaining accurate range and bearing of target. (*Courtesy Raytheon*) Below, interior of British radar receiver car with mobile unit used overseas. Unit can be set up in a few days after arrival at site. Antenna masts are 108'. (*British Official Photo*)

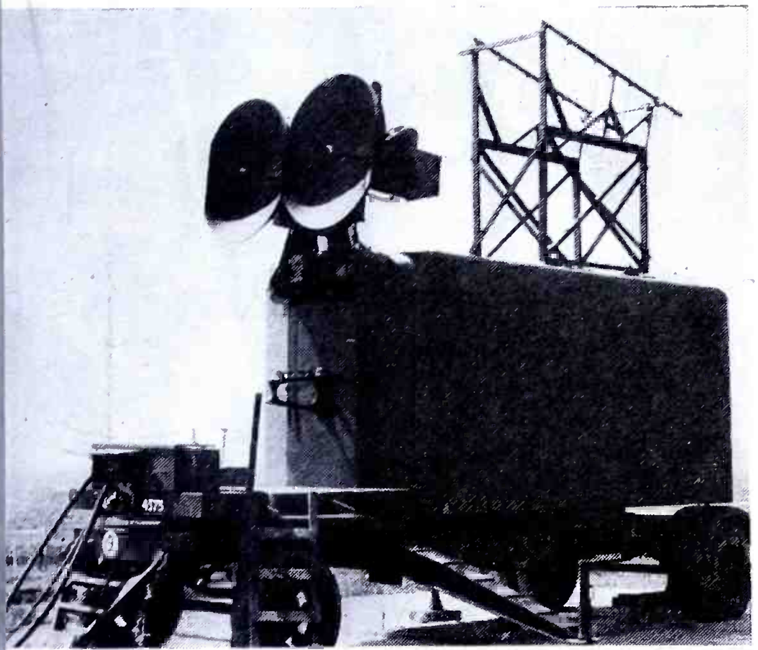


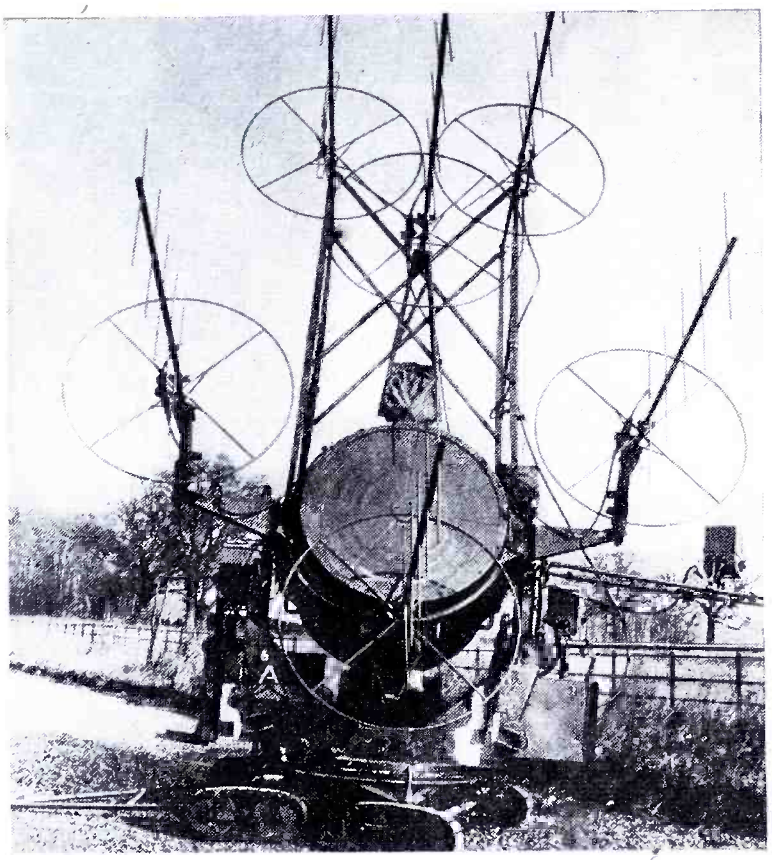
Above, radar repeater used by the U. S. Navy. Unit repeats information from master SG system. (*Courtesy Raytheon*) Below, console interception height finder at a British ground-controlled interception radar station. (*British Official Photo*)





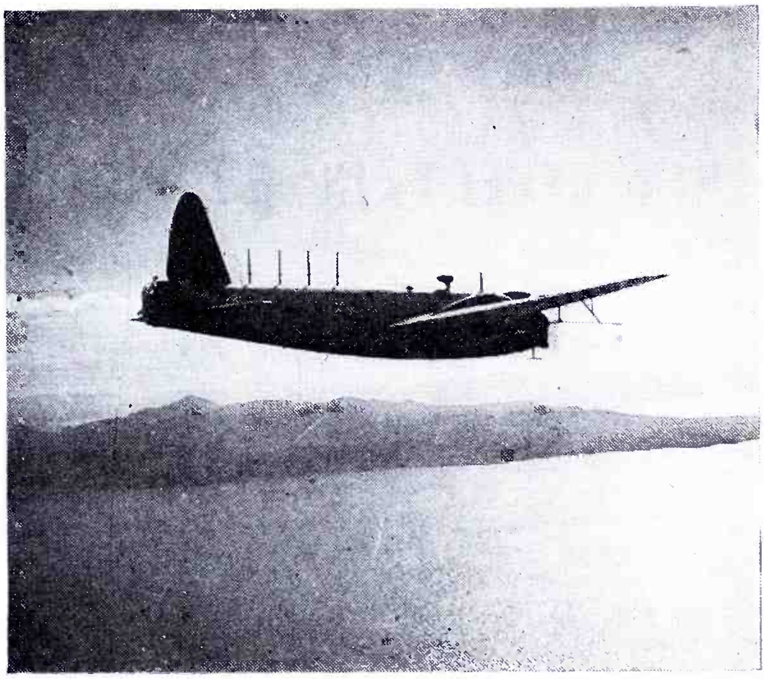
# AND GREAT BRITAIN





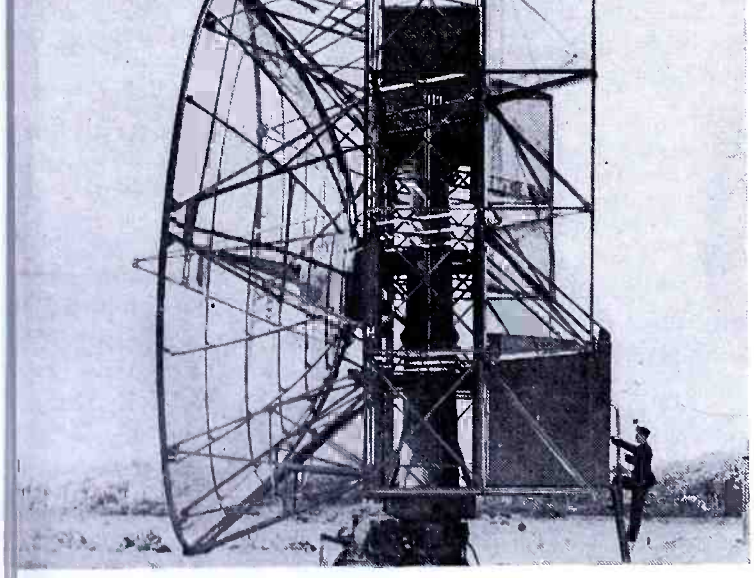
Above, British mobile radar equipment used in connection with the defense of the Orkney Islands. Above right, British radar-controlled searchlight used extensively during the flying bomb attacks. Right, a Royal Air Force Wellington with external radar devices. Below, British fighter direction antenna system which comprises a final GCI (ground controlled interception) structure and rotation gear on which is mounted a thirty-feet diameter paraboloid which gives greater discrimination on aircraft track. It is used mainly for offensive operations. The cabin mounted on the antenna structure houses both the transmitter and receiver.

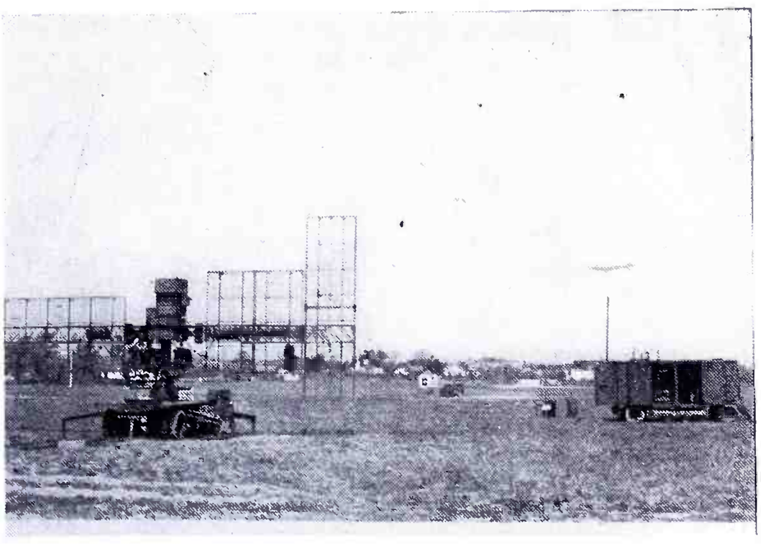
*(All photos, British Official)*



Below, right, magnesium model radar.

*(Courtesy U. S. Signal Corps)*





# SKIN EFFECT IN ROUND CONDUCTORS

(*Continued from page* 56)

resistance due to skin effect. For other materials a formula involving resistivity and permeability is given. From this result the curves give a multiplier to be applied to the d-c resistance and inductance of the wire. All theoretical considerations have been omitted from these instructions.

The basis for the curves is the solution by Bessel functions.[1] The following analysis shows the derivation of the curves.

Symbols used in the development are:

- $\delta$ = Depth of penetration of current in flat conductor of infinite depth. This is depth at which the current density becomes $1/\epsilon$ times its value at the surface.
- $r_o$ = Outside radius of the conductor.
- $f$ = Frequency, cycles per sec.
- $\mu$ = Permeability, air = 1.00.
- $\rho$ = Resistivity.
- $R_s$ = Skin resistance; resistance at frequency $f$ of unit width × length of conductor of infinite depth.
- $R_o$ = D-c resistance of conductor.
- $R_f$ = Resistance of conductor at frequency $f$.
- $L_o$ = Internal inductance at low frequency or d-c.
- $L_f$ = Internal inductance at high frequency.
- $d$ = Diameter of conductor.
- $K$ = Abiscissa used in curves.
- $q = r_o/\delta$ used in calculating curves.

Depth of penetration in a flat plate conductor of unlimited area is found to be:

$$\delta = \frac{1}{2\pi\sqrt{\frac{\mu f}{\rho} \times 10^{-9}}} \text{ cm} = \frac{1}{2\pi}\sqrt{\frac{\rho}{\mu f \times 10^{-9}}}$$

(cm depth, where $f$ is cycles per second, $\rho$ is ohms per cm cube, and $\mu$ is permeability referred to air as unity).

For copper, $\mu = 1$, $\rho = 1.724 \times 10^{-6}$;

$$\delta = \frac{1}{2\pi}\sqrt{\frac{1.724 \times 10^{-6}}{1 \times f \times 10^{-9}}} = 6.608$$

$$\sqrt{\frac{1}{f}} \text{ cm depth}$$

The numeric $R_o/\delta$, the ratio of conductor radius to depth of penetration, appears in the equations for high-frequency resistance, in the form of the independent variable

$$q = \sqrt{2}\frac{r_o}{\delta}$$

Because it was a bit more convenient in plotting, $r_o/\delta$, rather than $q$, was used as the abscissa in constructing the curves, and under the name of $K$, $r_o/\delta$ is the calculated value used for entering the curves. $K$ is developed as follows:

$$\frac{r_o}{\delta} = \frac{d}{2}\left[2\pi\sqrt{\frac{\mu f}{\rho} \times 10^{-9}}\right]$$

$$= \pi d \sqrt{\frac{\mu f}{\rho} \times 10^{-9}}$$

where $d$ is centimeters diameter, $\rho$ ohm/cm cube, and $f$ is cycles per second.

$$= \pi d \sqrt{\frac{\mu f}{10^3 \rho}} \quad \text{where } \rho \text{ is microhm/cm cube}$$

$$= \pi d \sqrt{\frac{\mu f}{\rho}} \quad \text{where } f \text{ is kilocycles}$$

$$K = 7.98\, d \sqrt{\frac{\mu f}{\rho}} \quad \text{where } d \text{ is inches diameter}$$

This form of $K$ is used because it is derived from properties expressed in the common handbook units used in this country.

Where the conductor is copper, $K$ is still further simplified by substituting the permeability 1.000 and resistivity 1.724 microhm/cm cube:

$$K = 7.98\, d \sqrt{\frac{1.000\, f}{1.724}} = 6.08\, d\sqrt{f}$$

with $d$ in inches and $f$ in kilocycles.

Equations upon which the curves are based give the ratio of the resistance and the internal inductance of the conductor at frequency of $f$ kilocycles to the low-frequency or d-c resistance and inductance. Inductance due to the magnetic field outside the conductor is, of course, unaffected; the inductance to which the formula and curve apply is that due to the magnetic field inside the conductor. The equations in terms of $q$ are:

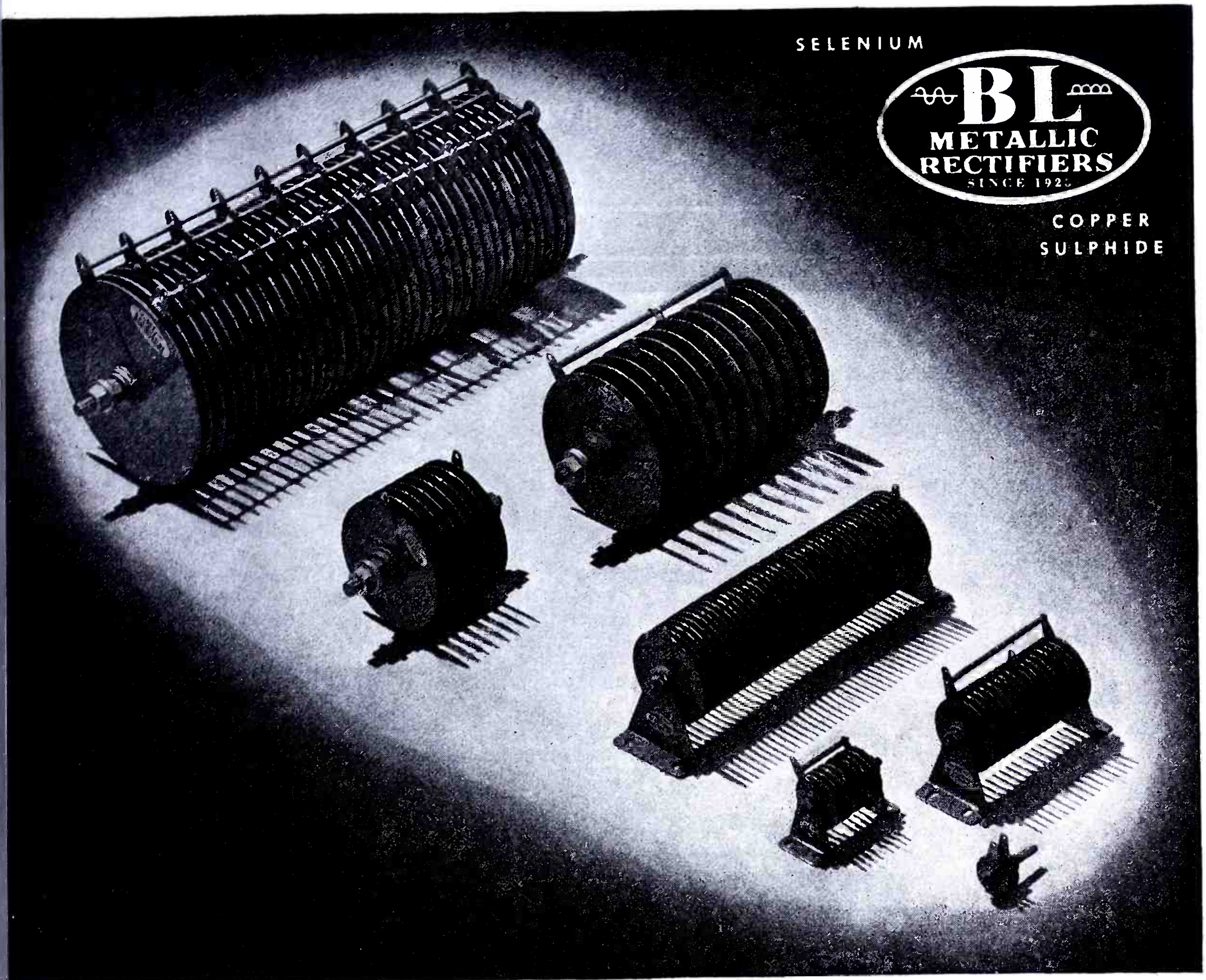
$$\frac{R_f}{R_o} = \frac{q}{2}\left[\frac{\text{Ber}\, q\, \text{Bei}'\, q - \text{Bei}\, q\, \text{Ber}'\, q}{(\text{Ber}'\, q)^2 + (\text{Bei}'\, q)^2}\right]$$

$$\frac{L_f}{L_o} = \frac{4}{q}\left[\frac{\text{Ber}\, q\, \text{Ber}'\, q + \text{Bei}\, q\, \text{Bei}'\, q}{(\text{Ber}'\, q)^2 + (\text{Bei}'\, q)^2}\right]$$

In these equations Ber $q$ and Bei $q$ are the real and imaginary Bessel functions of the argument $q$, and Ber' $q$ and Bei' $q$ are the first derivatives of these functions. The values were obtained from tables by H. B. Dwight (Vol. 58, *Transactions of the AIEE*). All calculations were carried out to four significant figures to make the

(*Continued on page* 87)

[1]J. R. Whinnery, *Electronics*: February, 1942

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VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary

**Personals**

WE have just received a war story of a radio man's heroism that we believe will be one of the greatest ever recorded. It's the story of Forrest Vosler, a sergeant who received the Congressional Medal of Honor from the late President Roosevelt.

From official records we learned that Vosler was wounded in the legs and almost completely paralyzed from the waist down, while on a flying fortress mission over Bremen. His radio equipment destroyed, he relieved the tail gunner who had also been hit; he fired the tail gun until hit again. This time he was struck in the shoulders and face and was blinded. Crawling back to the radio compartment he made frantic efforts to repair his radio gear. The fortress was losing altitude rapidly and S O S was imperative if any of the crew were to be rescued. Unable to see, and by sense of touch alone, he repaired the radio and sent the distress call.

With the ship losing altitude, it was necessary to throw everything overboard. As the pilot struggled to reach th English Channel, the plane dipped lower and lower, and it appeared as though the lightened fortress would drop in the sea. Vosler then made the appeal, now so famous in the Air Corps. He asked that he be thrown out to further lighten the stricken plane. His crewmates refused. The ship fell into the English Channel and shortly thereafter, the blinded Vosler heard a fellow crewmate floundering in the water. He slipped off the wing and felt around for him and pulled him back to the wing, holding him until they were rescued.

Today, Vosler, who is but 21, is back on the job. Despite the handicap of having lost one eye and having only ten per cent vision in the other he is at the controls of WSYR in Syracuse, N. Y., and he is also studying at Syracuse University.

We of VWOA salute *hero* Forrest B. Vosler!

Forrest B. Vosler, winner of the Congressional Medal of Honor, at his post as control operator at WSYR, Syracuse, N. Y.

THE *scroll of appreciation* awarded by VWOA to each of the co-founders of VWOA will be presented to co-founder Gilson Van der Veer Willets, chairman of our San Francisco chapter at a meeting in San Francisco. The presentation will be made by Arthur A. Isbell, a former VWOA director and recently recipient of the VWOA Marconi Memorial Wireless Pioneer Medal.

The inscription on the scroll reads: "To a pioneer who visualized a fraternal organization of Old-Time Wireless Operators; who translated these early hopes and dreams into practical realization; who gave advice and assistance as to plans and personnel; who offered full devotion to creating and developing the order; who served in major roles during the early and later meetings of the organization; and to whom, in greater part, the association owes its present place in the radio field, the officers of the *Veteran Wireless Operators Association* hereby present this permanent record of appreciation."

Congratulations, GVW.

WE were delighted to hear that the aircraft carrier Hornet returned to the West coast recently, after quite a Pacific theatre battle. For, besides the other five members of the crew aboard, was our own life member, Lt. Comdr. V. H. C. Eberlin, Air Communications Officer on the staff of Admiral Sample. We should get some real stories from *"Ebbie"* when they can be told. . . . Our hearty congratulations to Commodore E. M. Webster on his recent elevation to that rank by President Truman. Commodore Webster is the first communications officer in the Coast Guard. Commodore Webster was more recently Assistant Chief Engineer of the Federal Communications Commission. . . . Glad to welcome George Clark back after a vacation in New Hampshire. He should be in good shape for his usual fine contributions to our 1946 Year Book. . . . Remember, *February 16, 1946* at the Hotel Astor, VWOA comes of age. Yes, it will be our twenty-first birthday party and we are mighty proud of the splendid strides we have made in this comparatively short period. With the war in the Pacific now a thing of the past we plan to have a gala *dinner-cruise*. . . . Our sincerest wishes to life member Haraden Pratt, vice president and chief engineer of All-America Cables and Radio Corporation, and other I.T.T. affiliates, upon his recent election as chairman of the Radio Technical Planning Board. A former professional wireless operator, Mr. Pratt has come up the hard way. . . . We understand that VWOA director, Commander Fred Muller, will be returning to this country, before this issue reaches you. If he does, there's a homecoming party waiting. Welcome home, Commander FM. . . . Hearty congratulations to Dr. Lee de Forest, honorary president of VWOA, who celebrated his seventy-odd birthday during August. We look forward to having *Doc* as a guest of honor at our "coming of age" party in February. Keep it in mind, *Doc*. See you then. . . . Commander G. L. Graveson has recently been overseas on a special communications assignment. . . . VWOA director "Steve" Wallis and Mrs. Wallis recently returned from a vacation on Long Island . . . . Remember we want photos and items for this page. Send them in, we'll do any rewriting necessary.

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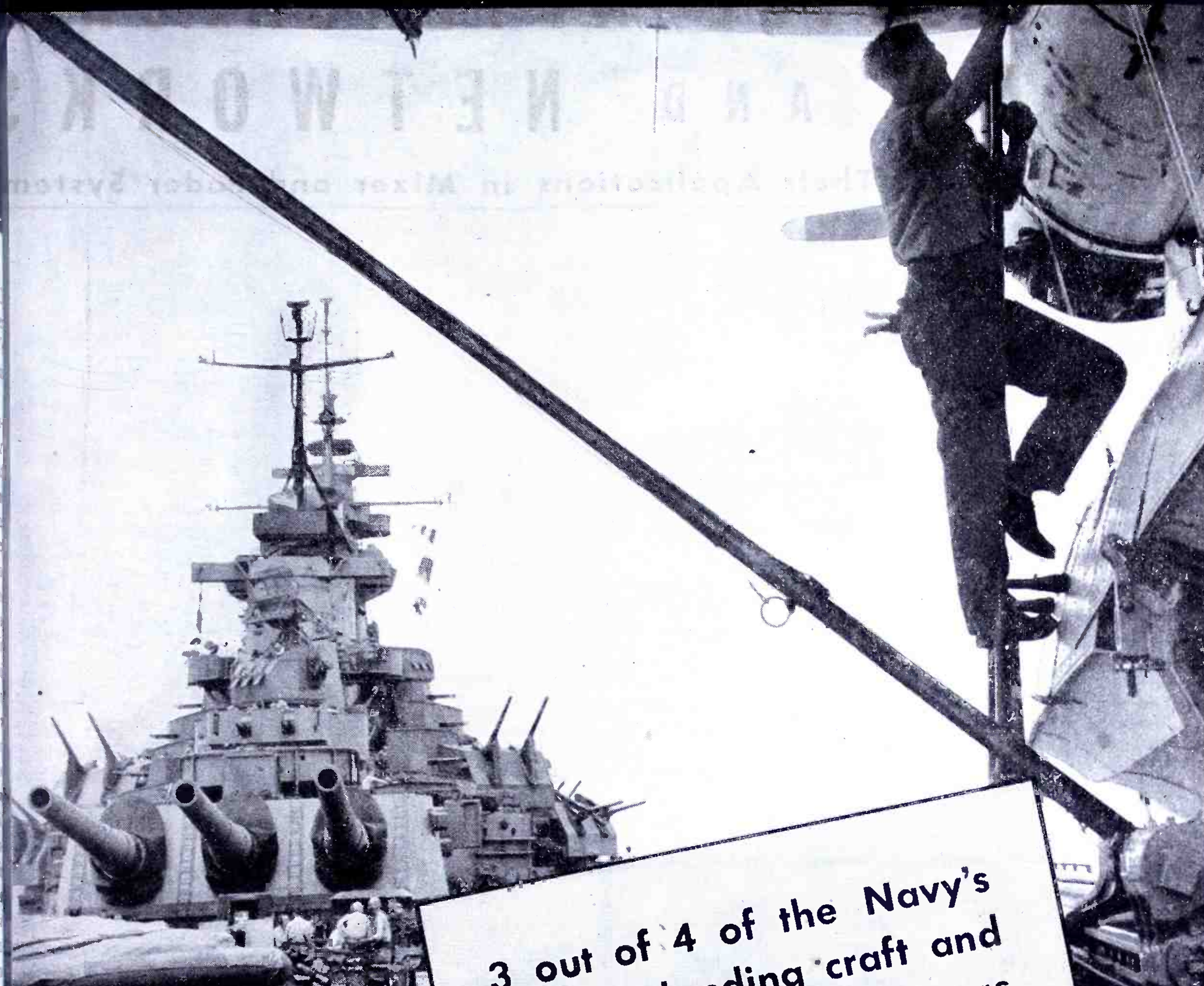

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# RESISTIVE ATTENUATORS, PADS AND NETWORKS

## An Analysis of Their Applications in Mixer and Fader Systems

**[*Part Seven of A Series*]**

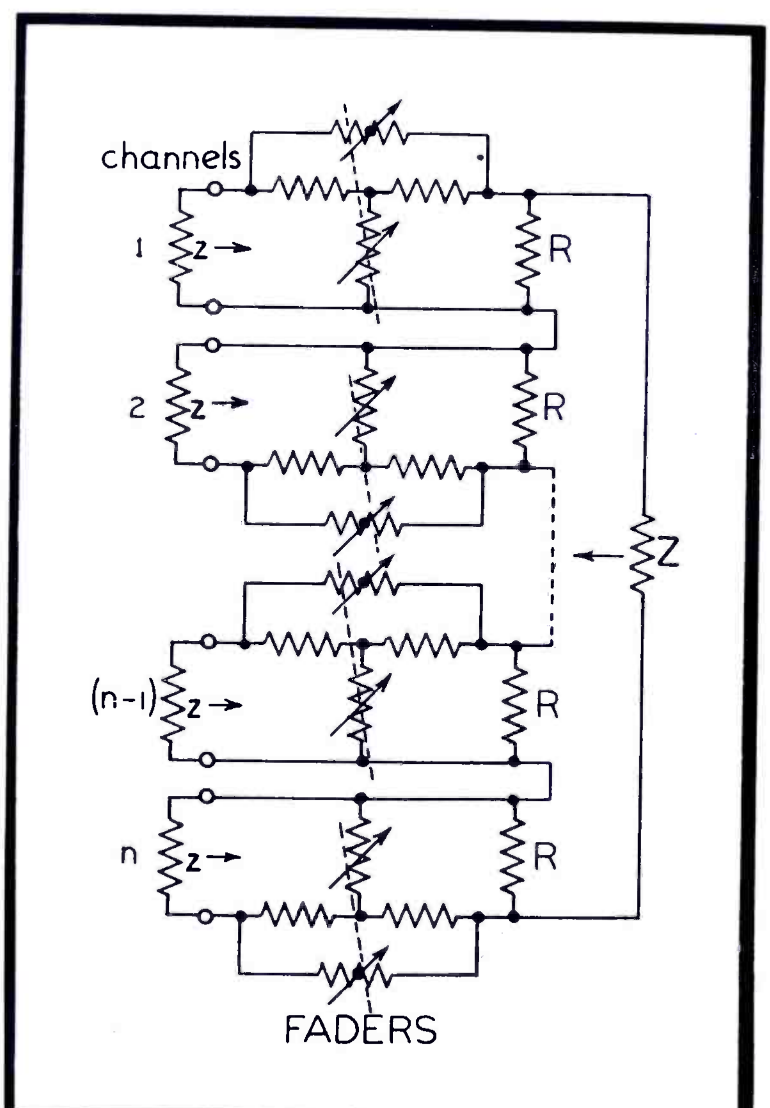
**by PAUL B. WRIGHT**

**Communications Research Engineer**

To avoid reflections of energy which occur at the junctions of two impedances of different magnitudes and to assure complete independence of operation for each channel of a mixer and fader system, it is essential that all impedances be matched to a reasonable degree of precision. The exact degree of mismatch permissible at any junction will depend upon the amount of loss that happens to be connected into each fader or mixer channel. To avoid the uncertainties of the reactions taking place between channels, with varying degrees of mismatching for a multitude of different loss and impedance combinations, it has become customary and expedient from a practical engineering point of view to specify that the deviations from nominal values of impedance shall not exceed plus or minus some certain percentage of the nominal values. These are determined by the requirements of a particular installation. For a high-fidelity broadcasting system, the im pedance deviations would naturall and of necessity have to be less tha those which would be permissible fo a common public address system. Fo the former, resistor values used a components of the mixer and fade networks would normally be specifie to an accuracy of ±1% from nomina design requirements, while for th latter system, accuracy limits of ±5% to 20% would be quite satisfactory Hence, in choosing a fader or mixe for a particular application, carefu consideration should be given to th magnitude of distortion and interac tion which may be allowed in th fader system and the mixer to whicl it is connected. This implies that whe either building or selecting a mixer o fader network, too much attentio need not be paid to obtaining abso lute accuracy in elements; for suc accuracy increases the time require for adjustment and their consequen final cost. If, for example, a 5% t 10% deviation is permissible in th resistance of the elements to assur given or required limits in impedanc or insertion loss, there is little poin in striving for 1% or .1% simply be cause it is possible to get it with suffi ciently applied persistence.

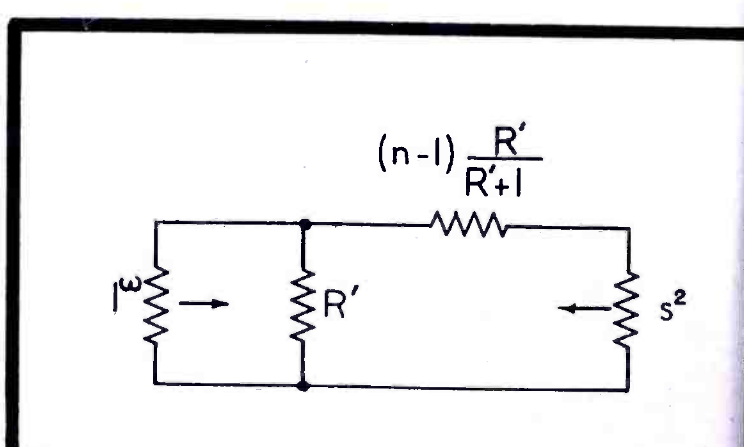
In the prepartion of the *tables o hyperbolic functions of a real variable* the variable requirements for engi neering accuracy were anticipated b calculating the tables so that the great est errors were on the order of a fev parts per hundred thousand through out the majority of the ranges an functions. This order of accurac

**The use of hyperbolic functions for the design and solution of problems involving mixer and fader systems are discussed in this installment. This procedure has been made possible through compression of formulas and their simplification by applying the charts and tables presented earlier in the resistive network papers.**




**Figures 1 (left) and 2 (below)**

**Figure 1. A series-connected fader and mixer system of *n* channels with compensating resistances to maintain constant impedance relationships at all junctions of the network system. Figure 2. A representation of *Figure 1* on a normalized or unit channel equivalent basis, with faders removed. R′ = R/z.**



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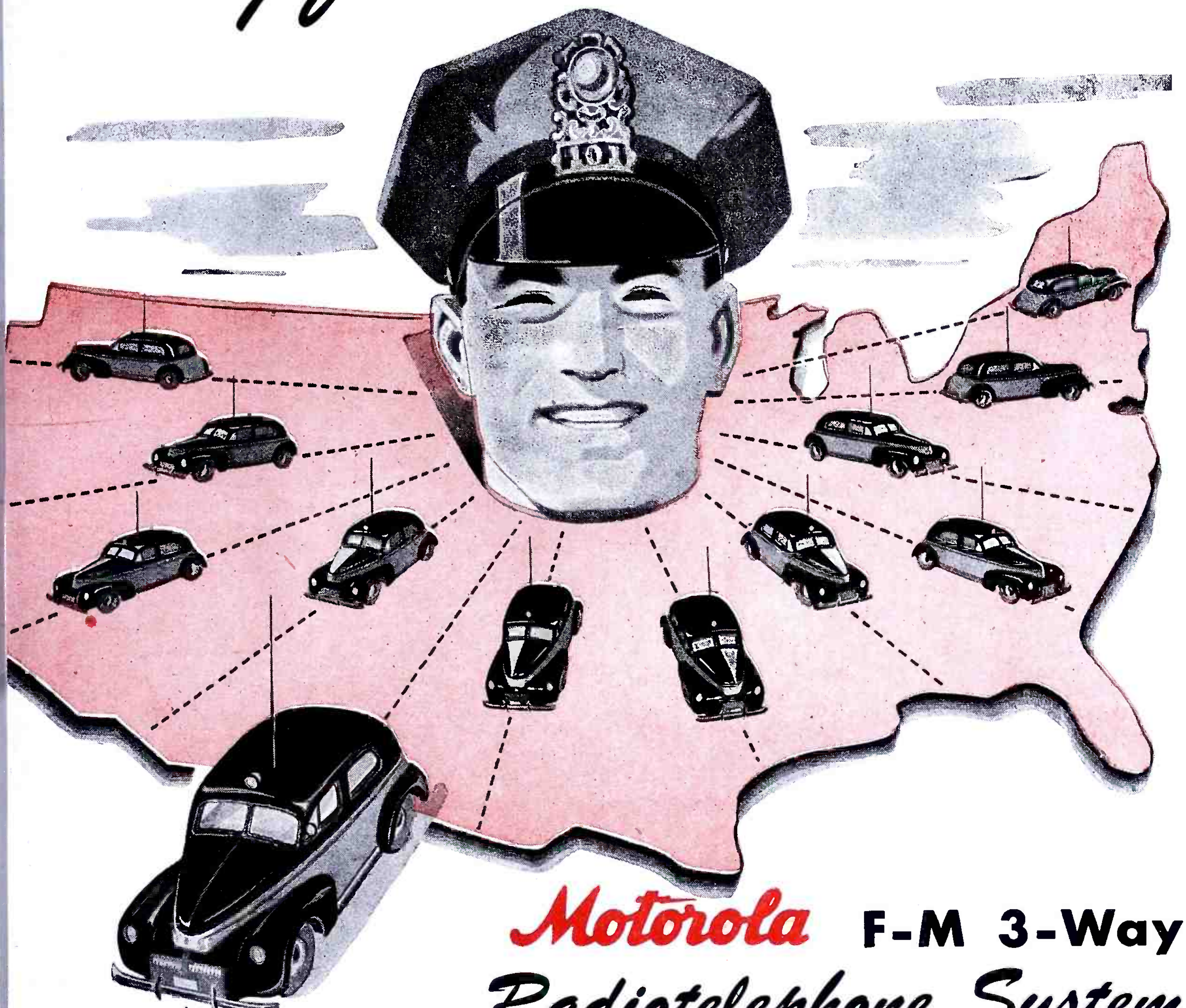

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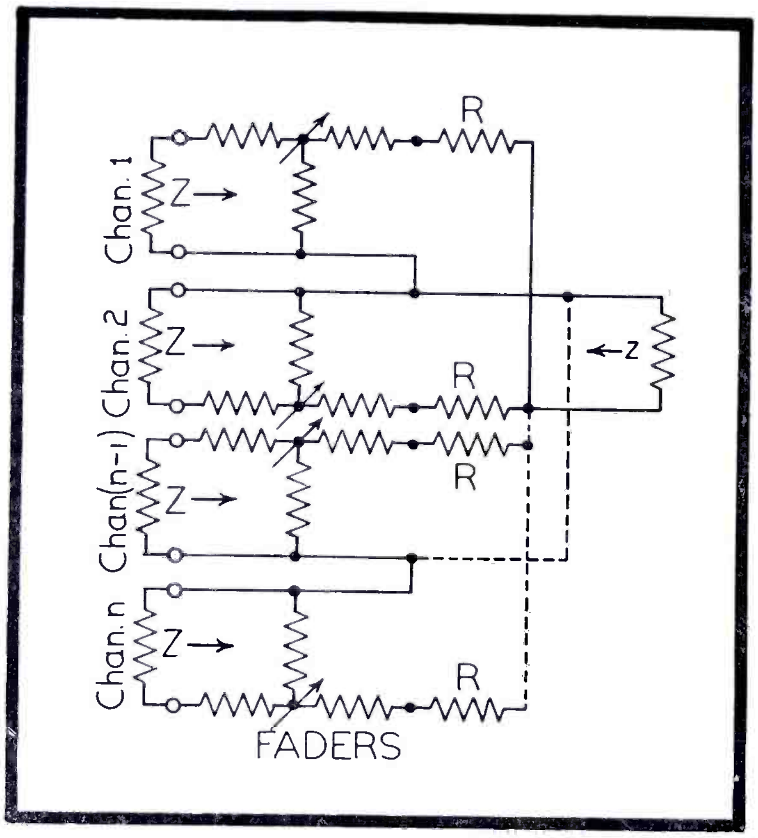


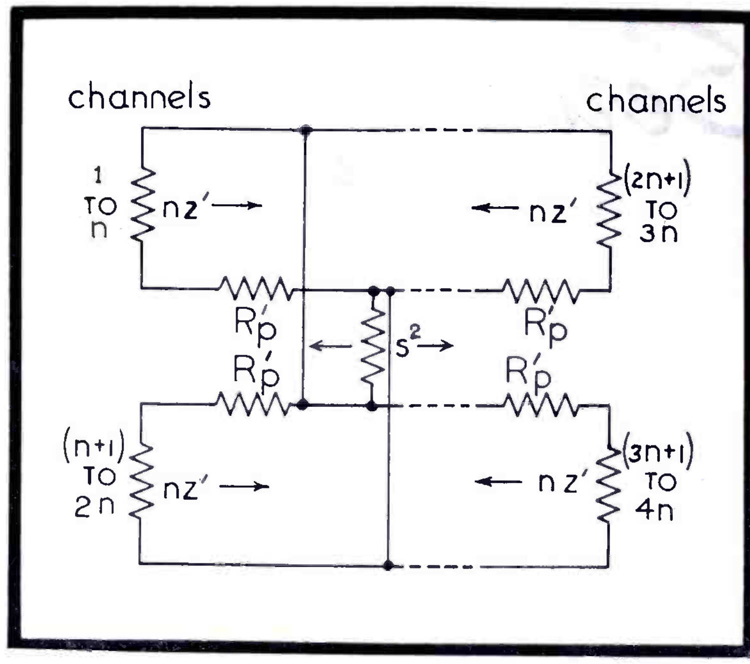


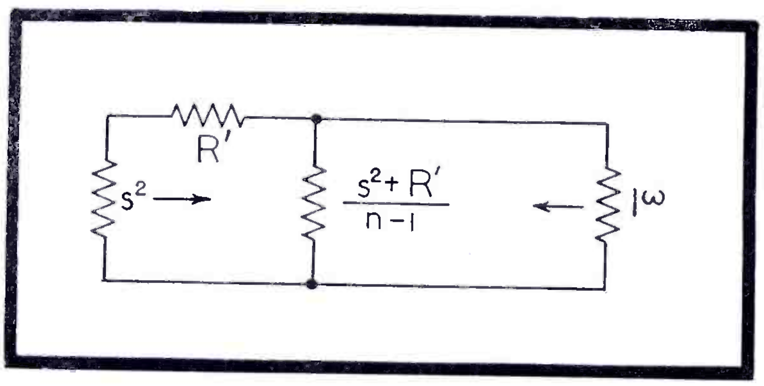


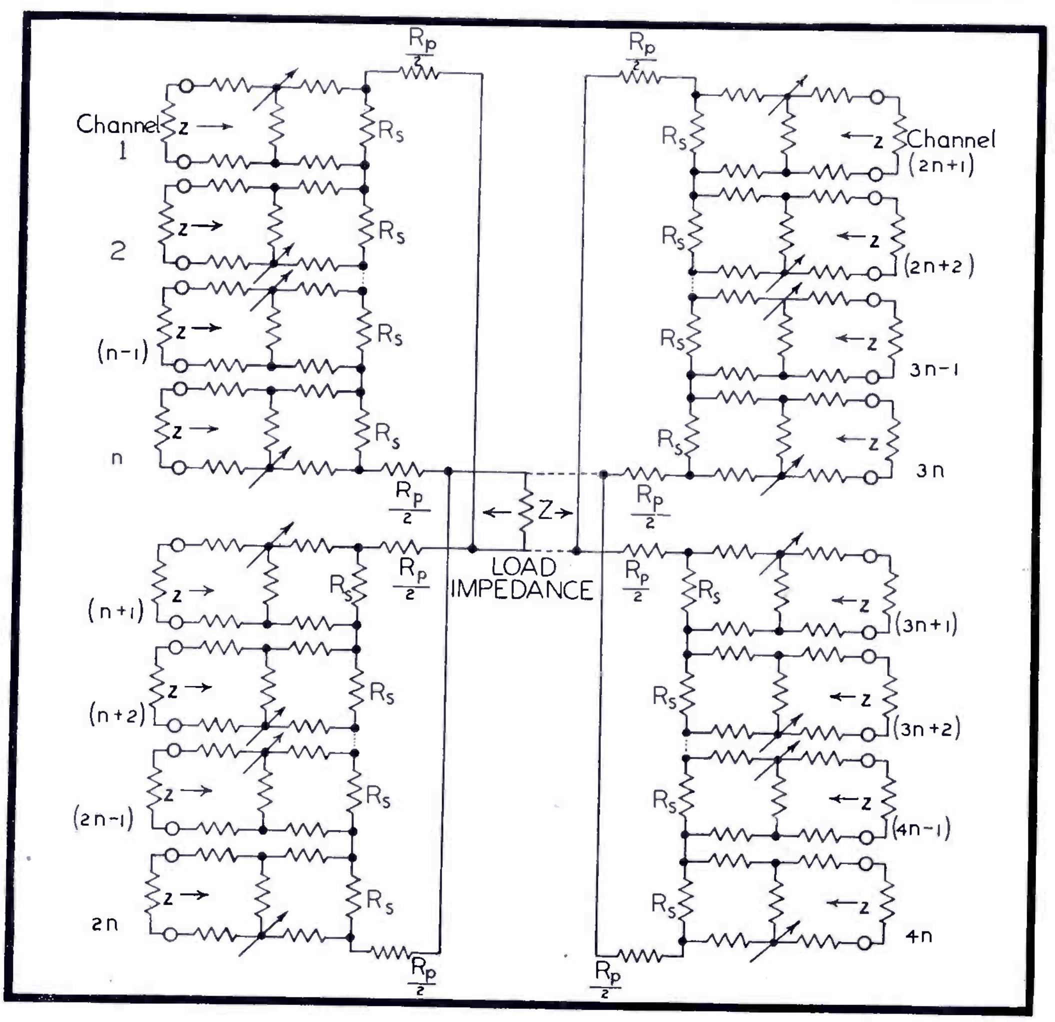


**Figures 3 (top, left), 4 (left), 5 (below, left) and 6 (above, right)**

**Figure 3.** A parallel-connected mixer and fader system of $n$ channels with compensating resistances required to maintain a match of impedances at all junctions of the network system. **Figure 4.** The equivalent of *Figure* 3 on a unit channel basis with faders removed. $R' = R/z$. **Figure 5.** A series-parallel system of mixer and faders with the necessary compensating shunt and series resistances required to match all impedances at their respective junctions. **Figure 6.** One stage in the reduction of *Figure* 5 to an equivalent unit basis with faders removed.

$z' = R'_s/(R'_s + 1)$.

was adhered to to permit the highest degree of precision possible in the design of quality equipment. For equipment not requiring this degree of accuracy, the tabulated figures may be rounded off as desired. For example, if slide rule accuracy is desired, three significant figures are sufficient for a ten-inch rule and three or four for a twenty-inch rule, depending, of course, upon the sections of the scales being used. If higher order accuracy is necessary, arithmetic, logarithms or a calculating machine may be used as desired by the calculator.

In the straightforward design of mixers and faders, the input-to-output network impedance ratios obtained for many designs will frequently be found to be of inconvenient values that cannot be realized readily by the common impedances of connecting equipment normally available from commercial companies, without special and expensive design. To circumvent this difficulty, a simple and inexpensive expedient frequently resorted to is to use matching or building-out methods, or both, if necessary. The building-out methods usually consist of adding resistance either in series or shunt as needed to either build up the terminating impedance to match the network-image impedance, or to step down the network image impedance to match the terminating-network impedance. The additional insertion losses and the element values required for the system may be calculated by using Figures *1* to *4* of the charts given in Part *II*[1]. Matching methods require the use of a dissymmetrical network, usually of the minimum loss type. This will generally be a network of the *L* taper (*case III type*).[1] The losses and ele-

(*Continued on page* 68)

[1]October, 1944, COMMUNICATIONS.


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## RESISTIVE NETWORKS

(*Continued from page 66*)

ferent types of systems are shown by Figures 1 to 7 as well as the equivalent circuits on an individual channel basis using normalized network configurations. These are configurations which are placed upon a unit basis referred to $z$, the smaller of the terminating impedances. The larger of the terminations is referred to with the upper case letter, $Z$. For example, to match mixer and fader network impedances which are series connected, it is necessary to place a shunt resistor across each fader output, while for a parallel system, it is necessary to build out each fader output with a series resistor so that each fader and mixer unit will be properly terminated. The series-parallel and the parallel-series systems use combinations of both series and shunt resistors to match the impedances of the connected units. The series-parallel system will utilize shunt resistors for the series-connected faders, and series resistors for the paralleled groups of series connected faders. The parallel-series system will have series resistors for the parallel connected faders, and shunt resistors for the series-connected groups of parallel connected faders.

### Other Mixer and Fader Networks

Other types of mixers which are particularly useful for many applications, but are not as well known as the types mentioned above are of the multiple bridge, and the lattice type configurations respectively.[2, 3, 4]

As most commonly used, mixer and fader systems are connected so that a fader network is placed in each channel to control the level of the signal from that input, while the mixer proper is generally termed a master mixer and is connected on its input side by the combined outputs of all faders, and on its output side by a load such as a line or amplifier.

### Series-Parallel Mixer and Fader Systems

For these mixers it is convenient to make direct usage of the previously developed theory and tables prepared for the series and the parallel mixer and fader systems. To be as practicable as possible with the least loss in generality of treatment, these systems will be assumed to be arranged as per Figure 5. This Figure shows $n$ fader channels connected in series per group

[2]November 1943; COMMUNICATIONS.
[3]December, 1943; COMMUNICATIONS.
[4]September, 1943; COMMUNICATIONS.

d *m* groups connected in parallel. ne series-connected faders each have shunt compensating resistor and the rallel-connected groups of series-nnected faders each have a series mpensating resistor. The complete t of series-parallel-connected faders e then connected to the master mixer ntrol network. By means of the aster mixer unit, the signal or proam level of all faders may be simulneously regulated. Individual faders e used to regulate the level of the gnal or program material being fed to the master mixer from each annel of the system. Although, sically, this network is no more mplex than those of simpler conguration, some assistance in visalizing the performance of a single annel is gained by making the unit uivalence representation in two eps as shown by Figures *6* and *7*, inead of in one step as was done for e simpler configurations.

Since, in general, the number of eder networks connected in series ill not be equal to the number of ich groups connected in parallel, the doption of suitable subscripts to the ements and terminating impedances essential for analysis purposes. For eries-connected mixers in a group, ne lower case letter *s* will be used, nd for parallel-connected groups of ich mixers, the lower case letter *p* ill be used. These will bear no relaonship whatever to the letters used n the symbolical notation adopted nroughout this series of papers on urely resistive networks.

The networks comprising the faders re of one of the standard types. hese are the *T*, $\pi$, *bridged-T* or *dder* configurations. The master nixer is usually one of the *T* or the type networks. The Figures which how the equivalent channel repreentation on a unit basis in all cases ave the fader networks removed or urned to the zero insertion loss posiion. If, for example, faders are used which do not have zero insertion loss, uch as the ladder networks disussed in *Part V*,[5] it will be necessary o add this insertion loss to that of the ndividual channel loss as found asuming the fader network to be removed from the circuit.

The equations which govern the design of the elements of the various types of mixer and fader system networks are given by the analytical development from the straightforward electric circuit theory considerations which follow. The algebraic forms are interchangeable with those of the hyperbolic functions by means of suitable transformations. The inser-

(*Continued on page* 70)

# RESISTIVE NETWORKS

(*Continued from page 69*)

tion losses are shown to be functions of the image-impedance ratios of the networks and these, in turn, are by analogy with *L*-taper networks of *case III* further shown to be functions of the number of channels of which the system under consideration is composed.

### *Series Mixer and Fader Systems*

The method of connecting faders and their associated mixer, generally known as a master mixer, is shown, for a series-connected system, in Figure 1. In Figure 2 we have the equivalent network represented on a unit basis for any single channel. For this Figure, the fader networks are removed from the circuit for purposes of analysis, since each of the channels are assumed to feed into the network at the network image impedance level. Further, the master mixer may also be removed since it is assumed to operate between its image impedances. The only effect of the re-insertion of these networks into the equivalent circuit configuration is to add either an insertion loss or a variable loss dependent upon the setting of the inserted networks. The total loss is then the sum of the component losses taken algebraically. The losses are expressed in terms of decibels below some arbitrary zero reference. The references most commonly used are those of either 1 milliwatt dissipated by 600 ohms, or 6 milliwatts dissipated by 500 ohms. The difference in level between these two references at their zero indications, as read by volume indicators, is 7.78 db.

Referring to Figure 2, the image impedances on a unit basis are

$$1 = \frac{R'\left(s^2 + (n-1)\dfrac{R'}{R'+1}\right)}{R' + s^2 + (n-1)\dfrac{R'}{R'+1}} \qquad (1)$$

and

$$s^2 = nR'/(R'+1) \qquad (2)$$

where: $s^2 = Z/z \geqq 1$, the ratio of normal mixer image impedance to that of the source or input image impedances of the series system; $R' = R/z$, the unit shunt compensating resistance; and $n$ = the number of channels which are to be connected in series in the complete system.

If equation *2* is used in equation *1*, first to eliminate $s^2$, and then to elim-

[6]July, 1945; Communications.

ate R′, the equations resulting are

$$' = n/(n-1) \qquad (3)$$

r the shunt resistance to add across ch fader network, and

$$= Z/z = n^2/(2n-1) \qquad (4)$$

r the ratio of the image impedances the system.

By observation of equation *3* and *4* this equivalent unit network and at of the *L*-taper network shown as *se III* in Figure 12 of *Part III*, the uations relating the hyperbolic funcons and the number of channels of e series system may be written by spection as

$$' = n/(n-1) = as = s \operatorname{csch} \Theta \qquad (5)$$

nd

$$= Z/z = n^2/(2n-1) = E = \cosh^2 \Theta \qquad (6)$$

rom *6*, $s = \cosh \Theta$. Hence, *5* may be ritten in the alternative form of

$$' = s \operatorname{csch} \Theta = \cosh \Theta \operatorname{csch} \Theta$$
$$= \cosh \Theta / \sinh \Theta = \coth \Theta = c \qquad (7)$$

n these equations, $\Theta = \cosh^{-1} s =$ .115129 × No. (db) insertion loss f the network. The symbolical forms sed throughout this part and the reainder of the paper are defined comletely by the key sheet presented in art IV[6].

One additional form of equation reting to the shunt-compensating reistance, in terms of the image imedance terminations ratio and the umber of channels of the network ystem, is given by dividing equation by *6*, term by term, and solving for ′. This equation is

$$' = s^2(2n-1)/(n(n-1)) \qquad (8)$$

To place all terminations and elenents of the network system upon a ull impedance basis, it is only necesary to multiply each side of the equaons above by *z*, the smaller of the wo terminating impedances.

### nsertion Loss of a Series-Connected Iixer System

The insertion loss of a series mixer ystem may conveniently be found rom the equation given in Figure 12 f the chart in *Part II* and by use f equations *5* and *6* of this paper. he equation supplied is in terms of ransmission loss, but this is identical vith the insertion loss in this case ince it is a minimum loss network. Therefore the loss of each channel aken on either an insertion or a ower transmission loss basis is iven by

$$lb = 20 \operatorname{Log}_{10} (s + \sqrt{s^2 - 1}) \qquad (9)$$

vhich becomes by use of equations 5

[6]May, 1945; COMMUNICATIONS.

(*Continued on page* 72)

# RESISTIVE NETWORKS

(*Continued from page 71*)

and $\theta$,

$$db = 20 \text{ Log}_{10}\left(\frac{n}{(2n-1)^{1/2}} + \sqrt{\frac{n^2}{2n-1} - 1}\right) \quad (10)$$

$$= 20 \text{ Log}_{10}(2n-1)^{1/2} \quad (11)$$

$$= 10 \text{ Log}_{10}(2n-1) = 10 \text{ Log}_{10} k^2 \quad (12)$$

where: $k^2$ is defined as equal to the power ratio taken equal to or greater than unity.

From 12,

$$k^2 = 2n - 1 \quad (13a)$$

or

$$k = (2n-1)^{1/2} \quad (13b)$$

from which,

$$n = (k^2 + 1)/2 \quad (14)$$

By definition, $k = \varepsilon^{\theta}$, and therefore equation *14* may be written in the form

$$n = (\varepsilon^{2\theta} + 1)/2 \quad (15)$$

This form substituted into any of the formulas given in terms of $n$ will give the exponential forms, from which, by definition, the hyperbolic forms may be written as given above.

### Parallel Mixer and Fader Systems

The method used for connecting parallel faders and their associated master mixer control network is shown by Figure 3. In this system, the compensating resistance is used to build out each fader channel so that no mismatching of impedances will occur at any junction of the network system. The equivalent network representation of the parallel-connected system is shown, on a unit basis for any single channel, by Figure 4. In this Figure, as in that for the single channel of the series system, the fader networks have been removed from the system for purposes of simplifying the analytical expressions for the parameters of the system. The remarks regarding the effect of the reinsertion of the series faders into the network upon the losses of the system taken upon an overall basis are equally applicable here and also for all other types of faders and mixer systems discussed in this paper.

By making use of Figure 12, *Part II,* it may be observed that the equations for the *L* taper, *case III* network element values shown in that chart, are reciprocal to each other in ns of the hyperbolic portions of the ations. By comparing Figure 4 this paper with that figure, the ations for element values and the o of the terminating image impances may be written directly in ns of the hyperbolic functions. rther, these in turn may be written terms of the number of channels m the equations derived for the ies-connected system. This proure enables us to write, for the t compensating resistance to use in ies with each fader, the equation

$$= s^2 (n-1)/n = As = s \sinh \Theta \qquad (16)$$

$$Z/z = n^2/(2n-1) = E = \cosh^2 \Theta \qquad (17a)$$

d

$$B = \cosh \Theta \qquad (17b)$$

erefore *16* becomes

$$= s^2 (n-1)/n = \sinh \Theta \cosh \Theta$$
$$= \tfrac{1}{2} \sinh 2\Theta = \tfrac{1}{2} G \qquad (18)$$

bstituting equation *17a* into *16*, the npensating resistance may be writ- directly as a function of the numr of channels only, thus

$$= \frac{n(n-1)}{2n-1} = \tfrac{1}{2} \sinh 2\Theta$$
$$= s^2 \tanh \Theta = Cs^2 \qquad (19)$$

By multiplying each side of equans *16* to *19* by *z*, the smaller of the minating impedances, the paraters of the network will then be exessed on a full instead of a unit imdance or normalized basis.

### ertion Loss of a Parallel-nnected Mixer System

Since the equivalent circuit of the stem shown in Figure 4 is exactly same as that of the series type stem shown in Figure 2 as far as form is concerned, and also since is an *L*-taper network of *case III*, th both ends terminated in its age impedances, the loss equations the series system given by equans *9* to *15* apply directly for the rallel system also. The significant ference is one merely of designation. e designation of the impedance ratio the series cases applied to the ratio load to source impedances, while in parallel case, the impedance ratio plies to the ratio of any one of the urce impedances to the load imdance. Therefore, with this difence in designation only, all of the ss equations for parallel-connected ixers and faders are identical in ery respect to those derived for the ries-connected faders and mixers, d hence it will be unnecessary to peat them here.

### ries-Parallel Mixer and Fader Systems

For these mixers it is convenient to

(*Continued on page 74*)

## RESISTIVE NETWORKS

(*Continued from page 73*)

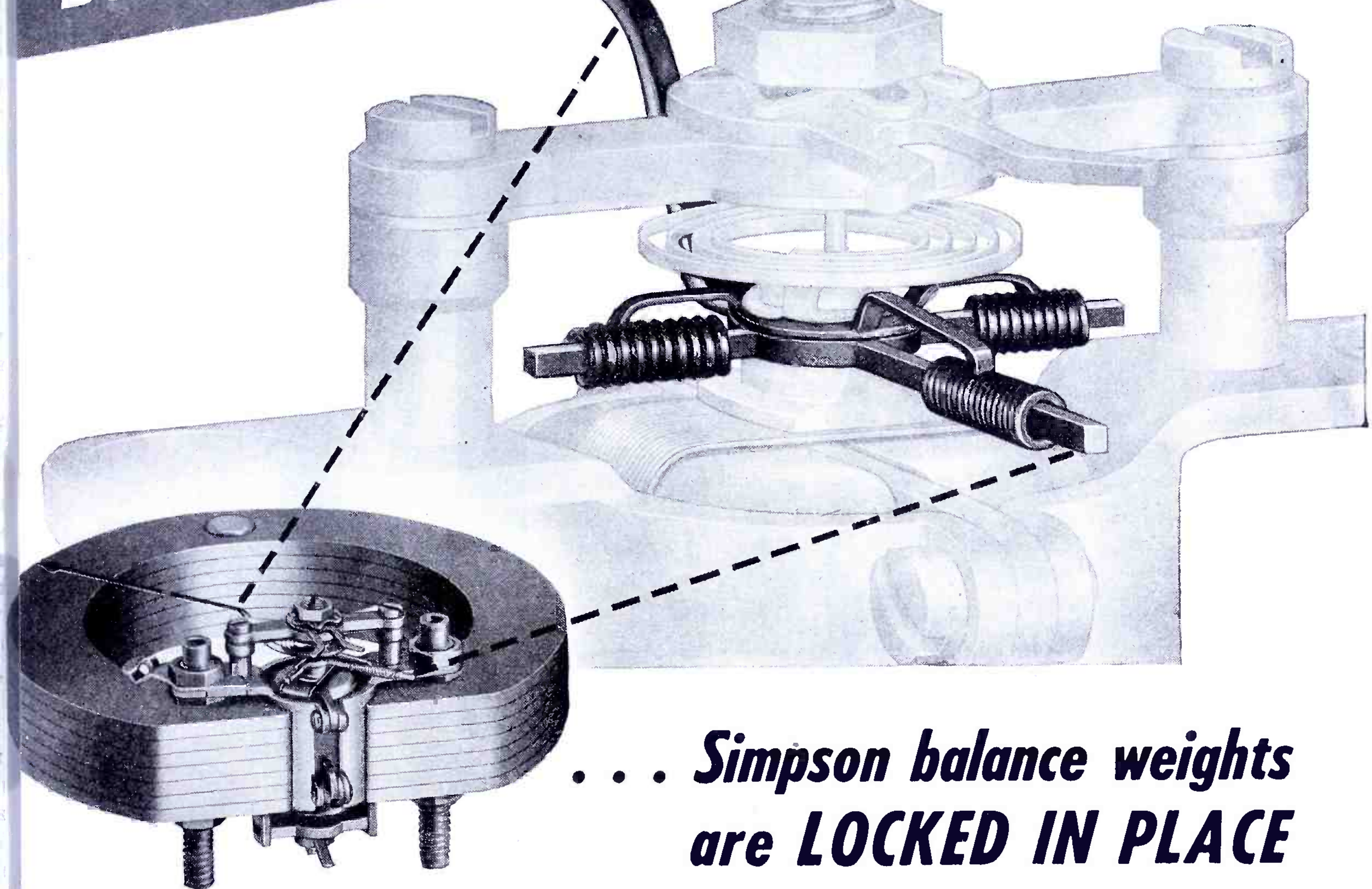
make direct usage of the previously developed theory and tables prepared for the series and the parallel mixer and fader systems. To be as practicable as possible with the least loss in generality of treatment, these systems will be assumed to be arranged as per Figure 5. This Figure shows $n$ fader channels connected in series per group and $n$ groups connected in parallel. The series-connected faders each have a shunt compensating resistor and the parallel-connected groups of series-connected faders each have a series compensating resistor. The complete set of series-parallel-connected faders are then connected to the master mixer control network. By means of the master mixer unit, the signal or program level of all faders may be simultaneously regulated. Individual faders are used to regulate the level of the signal or program material being fed into the master mixer from each channel of the system. Although, basically, this network is no more complex than those of simpler configuration, some assistance in visualizing the performance of a single channel is gained by making the unit equivalence representation in two steps as shown by Figures *6* and *7*, instead of in one step as was done for the simpler configurations.

Since, in general, the number of fader networks connected in series will not be equal to the number of such groups connected in parallel, the adoption of suitable subscripts to the elements and terminating impedances is essential for analysis purposes. For series-connected mixers in a group, the lower case letter $s$ will be used, and for parallel-connected groups of such mixers, the lower case letter $p$ will be used. These will bear no relationship whatever to the letters used in the symbolical notation adopted throughout this series of papers on purely resistive networks.

Let us consider $n_s$ sources of program material originating in or from lines, loops, turntables, microphones or amplifiers connected in series and $n_p$ such groups connected in parallel. The normal series mixer system output image impedance becomes the new parallel-mixer system input image impedance. Figure 7 shows a single channel on a unit basis. The input image impedance of each fader channel is $z_s$ ohms and the output image impedance of the $m$-paralleled groups of series mixers is $z_p$. The output image impedance of each series-connected fader system is $Z_s$ ohms and the input image impedance of each

(*Continued on page 76*)

# Because Accuracy Hangs in the Balance



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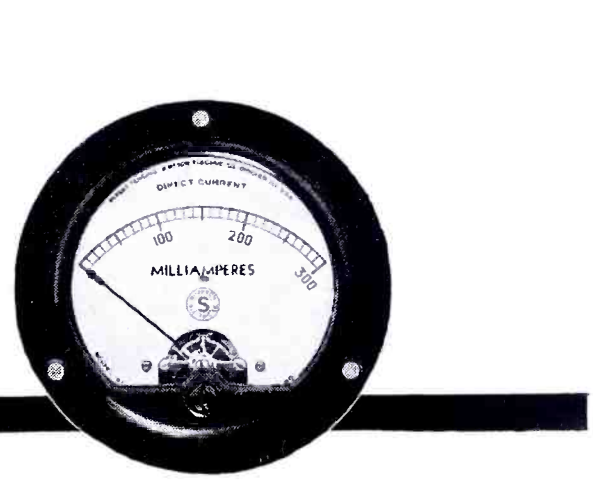


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# RESISTIVE NETWORKS

(*Continued from page 74*)

parallel group of series-connected system is $Z_p$. But, to have a proper impedance match at their junctions, these must be equal to each other. Hence, $Z_s = Z_p = Z$.

The equations of the series and the paralleled groups may, with their associated subscripts, be written directly from the derivations which were derived for the series and for the parallel mixer and fader systems.

For the series-connected fader systems, the unit compensating resistan is

$$R'_s = c_s = \coth \theta_s = \frac{n_s}{n_s - 1} = \frac{R_s}{z_s} \quad (20)$$

or

$$R'_s = 2g_s s^2_s = 2s^2_s \operatorname{csch} 2\theta_s$$

$$= s^2_s \frac{2n_s - 1}{n_s(n_s - 1)} = \frac{R_s}{z_s} \quad (21)$$

and the ratio of the terminating i- pedances is

$$s^2_s = E_s = \cosh^2\theta_s = \frac{n^2_s}{2n_s - 1} = Z/z_s \quad (22)$$

For the paralleled series-connect groups, the unit compensating resi tance is

$$R'_p = G_p/2 = \sinh 2\theta_p/2$$

$$= \frac{n_p(n_p - 1)}{2n_p - 1} = \frac{R_p}{z_p} \quad (23)$$

or

$$R'_p = C_p s^2_p = s^2_p \tanh \theta_p$$

$$= s^2_p \frac{n_p - 1}{n_p} = \frac{R_p}{z_p} \quad (24)$$

and the ratio of the terminating im- pedances is

$$s^2_p = E_p = \cosh^2 \theta_p = \frac{n^2_p}{2n_p - 1} = Z/z_p \quad (25)$$

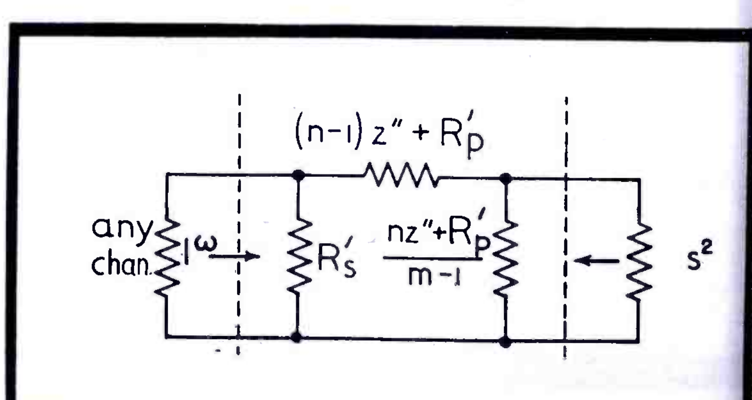
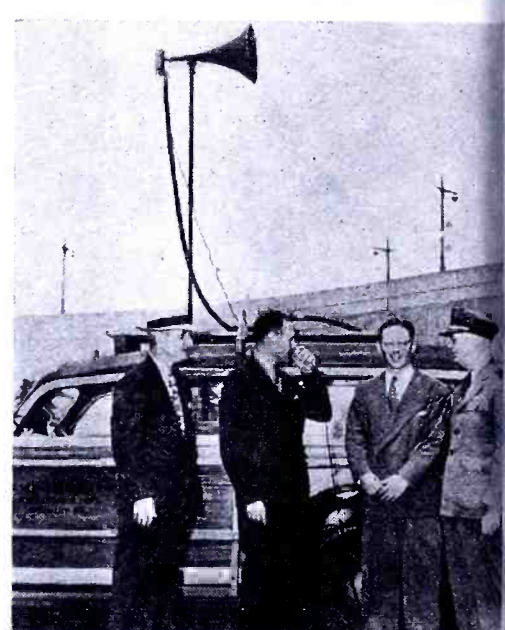



Figure 7

Final stage of the reduction of Figure 5 to an equivalent unit channel basis. $z'' = R'_s/(R'_s + 1) = z'$ and $R'_s = R_s/z$.

**HIGH POWER MARINE SPEAKER**



Howard Perdue of G.E. demonstrating marin loudspeaker at Randall Island stadium, Nev York, to Inspector Francis E. Burns, New Yorl Police Department; C. F. Gill, G.E., and Capt C. E. Merrill, U. S. Coast Guard (left to right)

(*Continued from page 37*)

$k = 2\pi/\lambda$
$\lambda$ = wavelength
$K_1$ = Bessel Function of the first order
$R'$ = radius of opening

A series which may be substituted f the factor $K_1(2kR')$ is[6]

$$K_1(2kR') = \frac{2}{\pi}\left[\frac{(2kR')^3}{3} - \frac{(2kR')^5}{3^2 \cdot 5} + \frac{(2kR')^7}{3^2 \cdot 5^2 \cdot 7} \ldots\ldots\right] \quad (4)$$

If $f$ remains less than 150 cps and is less than 25 cm, the second and ird terms of this series may be negcted with sufficient accuracy and uation *3* will reduce to

$$X_{Lo} = \frac{3.4\, f\, \rho}{R'} + \frac{2\, f\, l\, \rho}{(R')^2} \quad (5)$$

Equation *5* is derived for a circular ening of radius R'. In practice the elease opening will consist of an pening of any shape of which only e total area is fixed, so that

$$R' = [S(R + r)]^{1/2} \quad (6)$$

s this is the radius of a circular ening possessing an area equal to at required for the release opening.

Equating $X_{ev}$ and $X_{Lo}$ and substitutg for R', an expression for $V_c$ is tained

$$V_c = \frac{c^2 S (R + r)}{4\pi f^2 [l + 1.7 [S (R + r)]^{1/2}]} \quad (7)$$

sing 1185 feet-per-second as the elocity of sound, equation *7* reduces

$$V_c = \frac{9.47 \times 10^6 S (R + r)}{f^2 (.588 l + [S (R + r)]^{1/2})} \text{ cu. in.} \quad (8)$$

Where: $V_c$ = initial enclosure (volume, cubic inches)
$f$ = loudspeaker resonant frequency, cps
$l$ = release opening length, inches
S, R and r = loudspeaker dimensions, inches

As can be seen, a reduction in the required enclosure volume for any given set of conditions may be effected by increasing the length of the release opening, $l$; e.g., by extending

(*Continued on page 78*)

[6] H. F. Olson, op. cit., (Resistive and Reactive Loan On A Vibrating Piston, ch. 5. 7).

# RESONANT SPEAKER ENCLOSURES

(*Continued from page 77*)

it within the enclosure as shown in Figure 5. An estimation of the reduction possible in this manner can be gained from Figure 8 which indicates the volume ratio existing between enclosures possessing varying release opening lengths as compared to one having a length considerably less than 0.1".

It must be remembered that both the loudspeaker and the release opening if extended inward, will displace a volume which must be added to $V_c$. This will provide the final volume, $V_t$, from which the enclosure dimensions are evaluated. Figure 3 also indicates roughly the volumes displaced by loudspeakers of various diameters and may be used as a guide.

The dimensions of an enclosure of a given volume will depend on which ratios of height and width, to depth have the most satisfactory appearance. The volume of the enclosure, $V_t$, in Figure 6 is $xyz$, and since the dimensions $y$ and $z$, the height and width, are some multiple of the smallest dimension $x$, the depth, then

$$ax = y; \quad Bx = z$$

and

$$x, \text{ the depth} = \left[\frac{V_T}{ab}\right]^{1/3} \qquad (10)$$

Typical values for this type of enclosure are a = 1.85 and b = 2.45.

### Design Procedure

Figures 7 and 8 will facilitate design calculations. The procedure for their use is as follows:

($a$)—Determine the loudspeaker dimensions $S$, $R$, and $r$ and the loudspeaker resonant frequency, ($f$).

($b$)—Calculate $S(R + r)$.

($c$)—Using Figure 7, determine the initial volume $V_c$, from the values obtained in $a$ and $b$. For convenience these curves assume negligible values of ($l$).

($d$)—Select a release opening length ($l$), and find the corresponding reduction factor ($n$) in Figure 8 for the particular value of $S(R + r)$ used.

($e$)—Multiply $V_c$ by this reduction factor and add to it $V_d$, the volume displaced by the loudspeaker and other material to be mounted within the enclosure. The final volume, $V_t$, is this sum or

$$V_t = n\,V_c + V_d \qquad (11)$$

($f$)—Choose suitable height and width to depth ratios ($a$ and $b$) and calculate $V_t$/ab. Use Figure 6, curve $A$, to determine the smallest internal dimension $x$, (the width). If $V_t$/ab is less than 1000 cu. in., use curve $B$, dividing the horizontal scale by 100 and the vertical scale by 10. The remaining internal dimensions, the height and width, are then obtained from equation 7.

In actual construction, the required volume may be approximated, and the enclosure exactly tuned by varying the release opening area or length slightly, whichever is practicable. Mechanical resonance of the cabinet members can be avoided by using material of low elasticity while placement of sound absorbant on the inner walls of the enclosure particularly opposite the loudspeaker will help prevent hangover or echo effects.

Care must be taken in the installation of amplifying equipment within the same enclosure as the loudspeaker to prevent acoustical or mechanical feedback. To check on the quality of construction, a frequency run at the highest output level anticipated should be made and any sympathetic vibration observed should be damped out with further reenforcement.

(*Continued from page* 46)

al form of the voltage equation after e n-th cycle may therefore be de- ced and written as

$$= E_M [1 - (1-r)^n] \qquad (11)$$

This gives the voltage across $C_2$ er n cycles have been completed.

One method of justifying the logic equation *11* without a rigorous oof is to consider the result after extremely large number of cycles s passed. Since *r* is less than one, value of $(1-r)^n$ will approach zero *n* approaches infinity. Therefore, approaches the value of $E_M$. That the voltage across $C_2$ will continue increase with each cycle of the ap- ed signal but it may never exceed peak value of the applied voltage, d theoretically would require infinite ne to become equal to the peak value the applied voltage. For practi- l purposes, the voltage across $C_2$ ay be regarded as reaching the peak lue of the applied voltage in a finite ne. The time required will depend on the frequency of the applied sig- l and the relative capacities of the ndensers $C_1$ and $C_2$.

The practical application of this cir- it lies in its ability to function as counter of pulses, or as a frequency vider. Figure 4 illustrates the man- r in which this takes place.

The frequency of the output pulses ill be seen to be some fraction of e frequency of the input pulses. The rcuit has therefore *counted* the num- r of input pulses by indicating one tput pulse for a specific number of put pulses.

Further analysis of the grid voltage the triode tube, $V_3$, with respect to e cathode is necessary for complete nderstanding of the counting circuit's eration. The grid voltage ($E_g$) of $_3$ will be increasing by steps in ac- rdance with equation *11* just as the ltage across $C_2$ increases. Eventu- ly (unless $V_3$ is biased further below t-off than $E_M$, in which case the cir- it becomes inoperative), $E_g$ rises to e point where $V_3$ is able to pass rrent. The portion of the circuit volving this triode now functions as blocking oscillator which has just een triggered. Upon being triggered, e plate voltage ($E_P$) drops sharply, d the grid voltage rises sharply as own in Figure 4. It will be noted at $E_g$ rises well above the level it ould have reached if another *step* voltage had taken place. As a mat- r of fact, it is this condition which akes a blocking oscillator so appro- riate for use as the final stage of the ounter circuit. The grid voltage of

(*Continued on page* 80)

## ELECTRONIC COUNTER

(*Continued from page 79*)

$V_3$ is driven quite positive with respect to the cathode so that grid current flows and provides a discharge path for condenser $C_2$. Meanwhile condenser $C_3$ keeps the cathode potential of $V_3$ from rising rapidly when the tube begins its heavy conduction. This, too, is a necessary feature to the operation of the circuit. For, if the cathode potential is allowed to rise when $E_g$ rises, the grid may never go positive with respect to the cathode, in which case $C_2$ will not be able to discharge. Discharging of $C_2$ is necessary if the counter circuit is to count the same number of pulses each time. Any charge still on $C_2$ will act to decrease the bias on $V_3$ and decrease the number of pulses it will pass before being triggered again.

The setting of potentiometer $P_1$ determines how many pulses the circuit will count. In the case illustrated in Figure 4 the circuit is counting by fours. Should the bias on $V_3$ be increased to an amount slightly below the voltage resulting from a substitution of five for *n* in equation *11*, the circuit will then be counting by fives and the pulse recurrence frequency may then be said to have been divided by five.

It is recommended that this counting circuit not be used to count many more than ten pulses. Operation may become quite unstable when counting by too high a number is attempted. This is because each succeeding *step* in voltage is smaller than the preceding step. The amplitude of each step in voltage, since it is the difference between the voltages for two successive intervals of time, may be expressed as

$$S_n = E_n - E_{n-1} = E_M\,[1-(1-r)^n] - E_M\,[1-(1-r)^{n-1}]$$

$$= E_M\,[(1-r)^{n-1} - (1-r)^n]$$

or

$$S_n = r\,E_M\,(1-r)^{n-1} \qquad (12)$$

Since $(1-r)^{n-1}$ decreases as *n* increases, the size of the step decreases as an attempt is made to increase the number of pulses the circuit can count. When the difference in voltage becomes too small, any irregularities (such as a change in supply voltage) will change the counting of the circuit and cause its operation to be unstable. To allow the operation of the circuit to be as nearly stable as possible, the circuit components must be chosen with care, particularly condensers $C_1$ and $C_2$. The actual capacity of these condensers will depend upon the duration of the applied pulse. The narrower the pulse, the smaller must be the condensers. The relative capacity of the condens-

(*Continued on page 81*)

s, however, will not depend upon lse duration but upon the number of lses the circuit is intended to count, d condenser leakage. Usually, the

(*Continued on page* 97)

## ACS MAINTENANCE

(*Continued from page* 48)

ment" improvising mark the story k of a flight from a South Ameri- n city in an AAF C-47, many nths ago. Flying the Central nerican Hump to Albrook Field, nama, during a tropical storm, three ACS men, Major John Frizen, aster Sergeant Maddox, and Ser- ant—now Captain—H. F. Whelan, re forced down in a small clear- . Engine trouble was enough, but, add worry on worry, the radio uipment had burned out. Only jor repairs could put it in opera- n. Major Frizen and Sgt. Mad- x started out to hunt for some form human life. Albrook was about 150 les away through the jungle. helan stayed behind with the plane. ter some hours the Major and the rgeant returned. Near the clear- they heard the sound of airplane gines. They speculated, puzzled. their surprise they saw an Army nsport waiting for them when y reached the clearing. It had wn in from Albrook. "But how uld that be?" they asked.

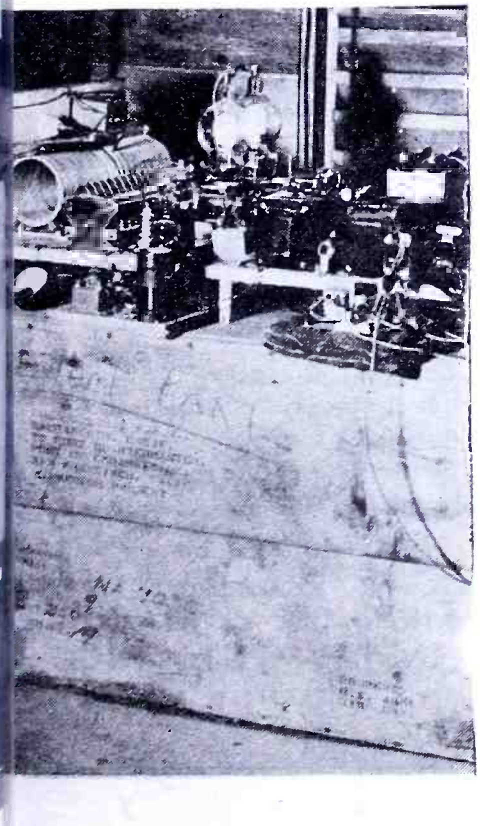
"I called the field and asked them send it," declared Whelan.

"How could you call the field on a ad transmitter?"

Whelan merely pointed. Frizen's

(*Continued on page* 82)

a South Pacific Base. Captured Jap spare ts were pressed into improvised transmitter vice for standby or emergency purposes by



## AACS MAINTENANCE

(*Continued from page* 81)

gaze took in the little Collins 40-watt rig carried as cargo. Whelan had hooked it to the emergency dynamotor in the plane, tied forty feet of twisted pair (telephone line) to the Collins for an antenna, used a parking rod as a ground, and the mike from the pilot's compartment.

"Got 'em the first time, too," he stated proudly. Frizen just grinned. Give a radio mechanic a tube and a few parts and he'll talk to Mars on it . . . thank God for that!

The AACS man's job is not always just repair. In the states and in rear-echelon units the main installation is put in and tested by AAF and Signal Corps engineers. However, when air communications were being rushed into operation along the north and south Atlantic routes to Europe, the AACS man did his share of installation. At that time there just weren't enough AAF and Signal Corps engineers to cover every job. The high priority given the work coupled with the time element permitted no waiting. Everyone had a job to do. Radio operators, typists, supply men, all worked under the supervision of the maintenance man. They put up a temporary station, but it worked. The engineers came along later and put in the permanent station.

In battle areas AACS moved in with combat troops on every invasion. Tactical teams assembled in a few hours the contact link so vital in the rapid expansion of Allied ground and air power. Radio range and homing beacon stations, air/ground installations, and control towers were placed along aerial warfronts.

The control tower on Saipan brought the first B-29s in from a Tokyo raid at the rate of one every 20 seconds . . . order out of chaos. The one installed at Tacloban airstrip on Leyte last Fall enabled over two hundred Naval planes, deprived of their carrier by Jap bombs, to land, refuel, and take off to fight again. Total time elapsed . . . 24 hours. Direction-finding stations, in the treacherous Hump area have saved countless planes and tons of cargo by giving the lost pilot his position and a safe route to fly. With the aid of air communications cargo planes have flown plasma into battle areas. On the return trip they haul the more seriously wounded to hospitals. Instrument-landing systems keep vital traffic moving in and out of airfields ven though the weather is zero-zero. The necessity of air communica-ons has been proved in the cauldron war. That's why joint air com-unications operated by AACS for e Army, Navy, and Marine pilots d been established in the Pacific. ACSPAC has proved its value in ordinated air operations. That's ny maintenance men sat shoulder to oulder with Marines, Seabees, AAF eathermen, and Joe Infantry in ery landing barge invasion. That's hy these radio operators, control wer men, clerks and radio mechanics ew the whine of a Jap sniper's bul-, and the whistling scream of shells. hey kept the circuits . . . on the air!

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## -M/TELEVISION OSCILLATORS

(*Continued from page* 54)

ency of oscillation of a vacuum tube d tuned-circuit oscillating system ually includes *L*, *C*, *R* the resistance *L*, $R_p$ the plate resistance of the be, and an element relating to the upling coefficient whether it be in-ctive or capacitive coupling. The and *C* include the distributed ca-cities and inductances of the leads d tube elements.

Variations in any of these para-eters will result in variations in fre-ency, whether these variations are pid or slow. For home receivers e most important sources of insta-ity are voltage variations, tempera-re variations, humidity changes and st old age with its attendant dust, hydration, corrosion, etc. In ap-ications where there is a great deal vibration, such as in portable mo-e use, we have another instability ctor, mechanical agitation and vi-ation of the component parts of the cillating circuit. With self-excited cillators a tube replacement may splace the resonant frequency of the cillating circuit because of slightly fferent characteristics from the re-aced tube. This frequency change ay be so great at v-h-f that the re-iver will no longer track properly d a loss in gain or sensitivity re-lts.

Voltage variations will cause $R_p$ vary, as well as variations in $R_L$ sulting from the reflection back into e resonant circuit of load variations e to the voltage changes.

Temperature changes cause most of e drift, especially in a v-h-f re-eiver during the first few minutes warming up. Coils expand slightly the temperature increases and erefore *L* varies. The dielectric

(*Continued on page* 84)

(*Continued from page 83*)


constant of capacitors varies with temperature; dielectric dimensions also vary with temperature changes. Tube capacities change with temperature changes, and these capacities often are in shunt or in series with the lumped *LC* circuits.

Attempts have been made to compensate for these temperature changes by the utilization of negative temperature capacitances in circuits where the average t-c of the capacitance is positive.

High-*Q* circuits help minimize the effects of voltage variations and load variations on the oscillator. At v-h-f resonant lines begin to approach the realm of reasonableness insofar as physical size is concerned. But even at 100 mc a ¼-wave resonant line would be about 9″ to 10″ long. Tuning a resonant line tank circuit would be a fairly complicated mechanical problem in a home receiver.

In magnetically-coupled feedback oscillators the coefficient of coupling is made very high to achieve maximum flux linkages and to eliminate stray fields with attendant phase shifts.

Llewellyn has demonstrated how, with suitable reactances in the grid and plate circuits of oscillators, it is possible to compensate quite well to eliminate frequency changes with voltage variations. But in the ordinary home receiver these may be fairly complicated additions because stability improvements generally are effective at only one frequency.

Electron-coupled oscillators and m-o-p-a systems may be utilized to improve stability, especially at v-h-f where the fundamental oscillator frequency may be made fairly low and the oscillator tube may be operated at reduced voltages in combination with a frequency multiplying amplifier.

The piezoelectric quartz crystal, perhaps the best stabilizing medium for an oscillator, has many advantages over lumped *LC* circuits. There are also disadvantages in specific amplifications.

The crystal is a very high *Q* mechanical oscillator or resonator. (Crystalline quartz is one of the most elastic bodies known, with an extremely low mechanical damping factor.)

As the crystal plate vibrates, charges are developed across two opposite faces and these charges are varied at the same rate that the crystal vibrates and compresses and decompresses. If these charges are zed and amplified the simple harric motion of the vibrating quartz tal plate is translated into a simple nonic variation of charge or volt- across two opposite faces. Bee of the high $Q$ of the crystal changes and voltage variations little effect on the resonant frecy and a high measure of sta- is realized.

is possible to cut a quartz crystal from the mother quartz so that frequency of vibration of the tal plate will be substantially inndent of temperature changes. is, for temperature changes of C the frequency variation can be tained to less than .015%. In certain types of cuts can main- constant frequency within .002% a temperature change of about to 75° C, more than the normal erature variation encountered in receivers and even in automosets.

he aging problems formerly asso- d with crystals have been subially eliminated. (A subsequent le will deal with the aging of tals, its manifestations and its ination, and will cite experimental illustrating the cure.)

he variation in frequency of pro- finished crystals has been found e less than .0005% over a period wo years. At 100 mc this would espond to a frequency change of than 500 cycles.

is possible to hermetically seal all quartz crystal to eliminate hu ty effects and inhibit temperature ations. The thermostatic control emperature is easily accomplished, in extremely small spaces. For nal receiver applications ambient erature changes will have negle effects on the frequency of lation and temperature control is cessary.

is possible to house a complete tal plate in a container about the of the postage stamp type coner. If necessary the space reed may be as much as one cubic . There are no inductive fields ving about and the physical placet of the crystal is less critical than placement of a coil in a resonant uit. For postwar applications the tal plate will almost certainly ire not more than one-half to one c inch of space in a receiver. For y high-frequency applications the tal will probably be molded in a tic container with two leads proing in much the same manner as stors, capacitors and fuses are now ufactured.

lass production techniques introed into the manufacture of

(*Continued on page* 86)

## F-M/TELEVISION OSCILLATORS

(*Continued from page* 85)

crystals as a result of wartime needs will reflect greatly lower prices. Automatic machinery has been developed for manufacturing crystals in huge quantities.

In general a crystal oscillator or resonator plate can be substituted as a circuit element in place of a lumped capacity and inductance. The equivalent circuit of a quartz crystal plate in an air gap mounting is illustrated in Figure 7. Note that the crystal plate can be excited to resonate or oscillate over a narrow band of frequencies, depending upon the associated circuits. The *resonant frequency*, $f_R$, is the series resonant frequency and is a function of the equivalent *L* and *C* of the crystal element itself. The *antiresonant frequency*, $f_A$, is the parallel resonant frequency, and is a function of the equivalent *L* and *C* of the crystal element itself and the dielectric capacity of the quartz in shunt with the equivalent *L* and *C*. The airgap capacity influences both the series and the parallel resonant frequencies. With plated crystals, the electrodes are deposited directly on the surface of the quartz and the effective air gap is negligible.

Plated crystals will probably be most widely used in radio receivers because of the potential simplicity of manufacturing processes for mass production, with consequent low cost.

#### Part II Data

The next installment will discuss the actual use and application of crystals and crystal circuits for both push-button spot-frequency tuning and for dial or continous-coverage tuning in radio receivers.

[1]F. E. Terman, *Radio Engineering;* McGraw-Hill.
K. R. Sturley, *Radio Receiver Design;* Wiley.
H. J. Reich, *Theory and Applications of Electron Tubes;* McGraw-Hill.

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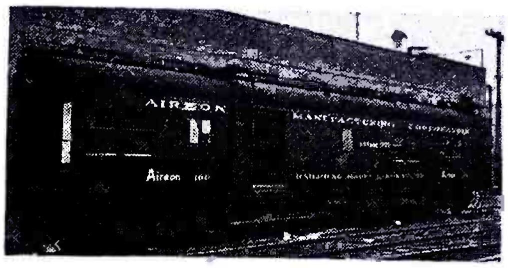
### RAILROAD RADIO LAB CAR




All-steel car equipped by Aireon with u-h-f *space* radio telephone units, and inductive, or *carrier* type equipment, for tests and demonstrations.

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## SKIN EFFECT

*(Continued from page 60)*

rves as accurate as their scale per-
ts.

At very-high frequencies the depth penetration of current becomes so ght that curvature of the conductor face is negligible. The conductor n shows conductivity proportional the circumference and to the depth penetration; that is, it behaves as it were a section of a flat con-ctor of infinite width. Resistance centimeter square of such a con-ctor is:

$$R_s = \frac{\rho}{\delta} = \rho\left[2\pi\sqrt{\frac{\mu f}{\rho} \times 10^{-9}}\right]$$

$$= 2\pi\sqrt{\rho\mu f\, 10^{-9}}$$

ohm per cm square

sistance per cm length of round nductor is then:

$$R_f = \frac{R_s}{\text{Area}} = \frac{R_s}{2\pi r_o} = \frac{\sqrt{\rho\mu f\, 10^{-9}}}{r_o}$$

ohm at extremely high frequency

sistance per cm length at low fre-ency or d-c is:

$$R_o = \frac{\rho}{\pi r_o^2}$$

atio of high-frequency resistance to c resistance is then:

$$\frac{R_f}{R_o} = \frac{\sqrt{\rho\mu f\, 10^{-9}}}{r_o} \times \frac{\pi r_o^2}{\rho}$$

$$= \pi r_o \sqrt{\frac{\mu f}{\rho} \times 10^{-9}}$$

$$= \pi \frac{d}{2} \sqrt{\frac{\mu f}{\rho} \times 10^{-9}}$$

it this is equal to $r_o/2\delta$. At high equency, therefore, the resistance tio is simply ½ *K*. It may be monstrated in a similar way that e inductance ratio at high fre-uency approaches the value

$$\frac{L_f}{L_o} = \frac{2}{K}$$

The curves extend to $K = 100$, at hich condition the exact value of sistance and reactance ratios differs less than 1% from the values K/2 d 2/K respectively. At the lower d of the curves, the skin effect cor-ctions are 2% for resistance and % for inductance. These curves erefore cover the entire range of lues for which skin effect computa-ons are difficult; if *K* is below 1.0 e correction is, for most purposes, egligibly small, and if *K* exceeds 0 the multiplier is K/2 for resis-nce and 2/K for inductance.

# BOOK TALK . . . .

## TRANSMISSION LINES, ANTENNAS AND WAVE GUIDES

***By Ronold W. P. King and Harry Rowe Mimno,* Associate Professors of Physics and Communication Engineering, Harvard University; and *Alexander H. Wing,* Electronics Lecturer, Harvard University . . . 338 pp . . . New York: McGraw Hill Book Co. . . . $3.50.**

This book is the outgrowth, with some additions, of preradar training lecture material presented at Cruft Laboratory, Harvard University.

The treatment is largely non-mathematical and is qualitative in aspect. There are four chapters, with a list of pertinent references at the end of each chapter. An excellent group of problems which are especially well chosen to test the ability of the student or reader, are also presented.

### Chapter I

Chapter I (by Dr. Wing) treats transmission lines from the conventional electric-circuit theory point of view and contains enough mathematics to emphasize the factors entering into their consideration. In the sections relating to the *skin effect,* several formulas based upon a *well-developed skin-effect* are offered.

### Chapter II

Chapter II (by Dr. King) deals with the complex subject of antennas and their coupling to the universe by a qualitative discussion in terms of electromagnetic theory. Ordinary electric-circuit theory is shown by several well chosen examples to give erroneous results which may, in some cases, lead to conclusions exactly opposed to those found by recourse to the more general electromagnetic theory. A number of well chosen graphs make up for the lack of extensive mathematical treatment. Colinear and parallel antenna arrays are well discussed and a table of the function *sin* $Nx/(N \sin x)$ is given to reduce the labor involved when making calculations of the array factor for $N$ parallel identical antennas having equal current amplitudes but differing progressively in phase by delta radians.

### Chapter III

Chapter III (also by Dr. King) is a sequel to the study of antennas in that the same general principles governing electric circuits having dimensions comparable with or greater than a wavelength are applied to circuits of a different type. These circu[its] utilize the ultrahigh-frequency [re]gions and are associated with [the] fact that their dimensions are of [the] same order of magnitude as the wa[ve]length. They are known by the ge[n]eral term of wave guides. A quali[ta]tive discussion coupled with a lar[ge] number of graphs showing the d[is]tribution of the electric and the ma[g]netic fields in several types of guid[es] help to formulate ideas of the mann[er] of propagation and the performan[ce] of these guides. Cavity resonato[rs] receive but two of the fifty-eight pag[es] in this chapter, but this should not [be] too surprising since most of the data had been restricted since befo[re] the outbreak of war.

Chapter IV (by Dr. Mimno) is [a] very general discussion on wa[ve] propagation to acquaint the stude[nt] with a few of the practical propagati[on] difficulties met with when attempti[ng] to place the theories into practice. Sk[ip] distances with time of day, night [and] season; sporadic ionosphere layer[s;] irregular reflections from objects suc[h] s buildings and mountains are each hown to contribute to variability in he propagation of these waves.

The physical points of view and the nalogies used throughout the text re invaluable factors to bridge the ap between an elementary readable xt and a highly mathematical reatise.

The treatment of material through-ut the book is scholarly and horough.

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## ELECTROMAGNETIC ENGINEERING *(Vol.1, Fundamentals)*

**y *Ronold W. P. King*, Associate Proessor of Physics and Communicaton ngineering, Harvard University . . . 68 pp . . . New York: McGraw Hill ook Co. . . . $6.00.**

This, the first of three volumes on he subject of *Electromagnetic Engineering*, is a systematic study of *fundamentals*.

To those who have never been exposed to the broad concepts of electromagnetic theory, the book will appear to be fairly complex. However, very effort has been made to simplify eading. For instance the author offers a compilation of nomenclature used throughout the text with explanatory data. A unique numbering system to identify equations and figures more rapidly is also used to simplify text study. The numbering system is excellent and merits consideration for more widespread adoption by other technical writers.

A working knowledge of calculus and complex algebra with some familiarity with elementary differential equations is essential for the reading of this work. Vector analysis is used throughout the text, but is introduced in terms of fundamental electromagnetic concepts rather than the more formal mathematical symbolism.

The Maxwell-Lorentz equations that define the electromagnetic field are shown first to consist of four simultaneous, partial differential equations of the first order. These are then transformed into the integral relations that are so often found to be more convenient in the solutions of problems. This is especially true when the boundary conditions are sufficiently simple, and when the problems are characterized by symmetry. The *skin effect* and internal impedance of various types of tubular conductors are dealt with by means of Bessel's functions.

An analysis of electric circuits is given, utilizing the concepts of electromagnetic theory. Circuits comprising the coaxial line, two-wire lines and

(*Continued on page* 91)

# NEWS BRIEFS

## GERMAN RADIO DEMOBILIZATION STUDY COMPLETED

A study of means for demobilizing German radio and electronic industries to prevent their use in a future war has been completed and a report has been filed with the Foreign Economic Administration.

The committee is headed by Ray C. Ellis, former Director of the WPB Radio & Radar Division and now a special consultant at Johns Hopkins University. Its membership includes Ralph Bown of Bell Laboratories and the Office of Scientific Research and Development; Louis J. Chatten, former director of WPB Radio & Radar unit; Capt. F. C. Layne, Chief of the Navy Electronics Division; Capt. Gilbert Myers, USN, secretary of the Joint Communications Board, and Brig. Gen. T. C. Rives, Deputy Air Communications Officer, AAF Headquarters.

* * *

## NOBLE IN NEW GALVIN POST

Daniel E. Noble has been appointed general manager of the communications and electronics division of Galvin Manufacturing Corporation, 4545 West Augusta Blvd., Chicago 51, Illinois. In his new position Dr. Noble will have direct authority over the engineering, sales and engineering production departments of the division. He will retain his present responsibilities as director of research.

* * *

## FINCH PROMOTED BY NAVY

W. G. H. Finch has been promoted to Captain, USNR.

Captain Finch formerly was assistant chief engineer of the FCC and in 1935 founded the Finch Laboratories of which he was president. He relinquished his post as president just prior to Pearl Harbor and volunteered for active duty with the United States Navy.

* * *

## MOUNTJOY TO HEAD LEAR RESEARCH ACTIVITIES

Garrard Mountjoy, who has been in charge of research and development work in the radio division of Lear, Incorporated, has been advanced to take charge of all research and development work in the New York laboratories of Lear. Richard A. Marsden, previously in charge of research activities, has resigned to devote his time as patent counsel, and will continue to act in that capacity for Lear.

* * *

## HENRY HUTCHINS BECOMES PRESIDENT OF JOHN MECK INDUSTRIES SALES CORP.

Henry Hutchins, former sales manager of National Union Radio Corp., has been elected president of John Meck Industries Sales Corporation, 35 East Wacker Drive, Chicago, Illinois. He will direct the national sales of Meck radios.

* * *

## FARNSWORTH ACQUIRES HALSTEAD TRAFFIC

Farnsworth Television & Radio Corporation has acquired all of the assets of Halstead Traffic Communications Corporation including patents relating to railway and highway radio communications.

William S. Halstead, president of the Halstead company, will serve Farnsworth as consulting engineer on radio communications equipment and traffic control as well as on other phases of electronics. John A. Curtis, vice-president of Halstead and chairman of its management committee, has been appointed manager of the Farnsworth communications division. Most of the key personnel of the Halstead organization, including members of the engineering staff, have been added to the Farnsworth staff.

Farnsworth will transfer Halstead laboratory and manufacturing facilities to its plant in Fort Wayne, Ind.

W. S. Halstead (above)
J. A. Curtis (right)

* * *

## N. Y. C. SCHOOLS TO TRY TELEVISION VIA NBC

Television programs prepared for classroom use will be transmitted to the junior high schools of New York City by WNBT. Arrangements were made by J. E. Wade, superintendent of schools, and John F. Royal, NBC vice-president in charge of television.

The first programs will cover science.

* * *

## MECK FORMS NEW P-A UNIT

A separate corporation, Audar, Inc., to manufacture and sell public address systems and audio amplifiers has been formed by John Meck Industries, Inc., Plymouth, Indiana.

The officers of the corporation are John S. Meck, president; E. W. Applebaum, treasurer

(*Continued on page* 92)

(Continued from page 89)

ar-wire lines and their associated aracteristic properties are given ex- sive and thorough treatment.

The book concludes with several ful appendices. These are: Vec- formulas and identities; tables of hyperbolic functions, cosh and h of one-half arc sinh h; Bessel's ctions; material constants, and di- nsions and units.

This book should become a refer- e work on the shelf of every en- eer who is either engaged in who expects to follow the field of ctromagnetic engineering.

•

## LTRA - HIGH - FREQUENCY ADIO ENGINEERING

**W. L. Emery, former Instructor of ctrical Engineering, Iowa State Col- e . . . 282 pp . . . New York: The cmillan Company . . . $3.25.**

In this book the author has attempted cover a vast field in relatively few ges, and the result is that the reader ains a very light exposure from a eat many subjects. Many of the cussions given could scarcely be stified on other grounds than gen- al information. For example, power pply filters, voltage doublers and ase discriminators each receive a agraph. Many other sections ttered throughout the book relating various techniques are all too agerly treated and are in a prac- al sense a mere acknowledgment of istence. Much of the text ma- ial is of the descriptive type fol- ved by a few equations which must taken entirely on faith. Deriva- ns are relatively few, but are as nple and direct as possible.

The deficiencies of the book as a t-book have been partially offset well chosen examples of problems ich follow the text material quite sely. These are supplemented by periments which the student can duct to confirm the results obtained m solving the problems, and to eck the statements and equations en in the text. An excellent list of erences is given at the conclusion each chapter which can be con- ted to fill in the gaps and to aug- nt the material presented. The ge number of references given con- bute greatly to the value of the book.

This text is literally a collection of tes and not a textbook in the cus- nary sense. From this viewpoint, book appears in true perspective d as such, it is recommended for dents and engineers.

# NEWS BRIEFS

(*Continued from page* 90)

and general manager; and Russell G. Eggo, secretary.

* * *

## SCOTT BARLOW JOINS SYLVANIA STAFF

Scott Barlow has been named editor of the Sylvania News, and assistant to H. G. Kronenwetter, advertising production manager of the radio tube division.

* * *

## PRATT NOW RTPB CHAIRMAN; FRAZIER VICE CHAIRMAN

Haraden Pratt, vice president and chief engineer of the American Cable and Radio Corporation, has been elected chairman of the Radio Technical Planning Board. He succeeds Dr. W. G. R. Baker of G. E.

Mr. Pratt is also vice president of Federal Telephone and Radio Corporation.

Howard S. Frazier, NAB director of engineering, has been named vice chairman. Will Baltin, TBA secretary-treasurer, is the new RTPB treasurer.

* * *

## DETROLA AND UTAH RADIO MERGE

A proposal to merge Utah Radio Products Company, Chicago, into International Detrola Corporation was approved recently.

Meetings of stockholders to vote on the proposal will be held soon.

* * *

## SURPLUS DATA

Approximately 3,000 items of Government-owned surplus property which the RFC handles as a disposal agency are listed in a booklet recently published, "How To Do Business With RFC."

* * *

## G. E. NAMES PETTIT TO NEW AD-SALES POST

L. E. Pettit has been named assistant to the general sales manager of the G. E. electronics department. He will coordinate advertising and sales promotion activities of the department.

* * *

## RAIBOURN HEADS 1945 TBA AWARDS COMMITTEE

Paul Raibourn, president of Television Productions, Inc., economist for Paramount Pictures and a director of TBA, has been appointed chairman of the TBA awards committee for 1945.

* * *

## J-B-T BULLETIN

A 4-page bulletin, VF-43-1C, describing vibrating reed frequency meters has been published by J-B-T Instruments, Inc., 441 Chapel Street, New Haven 8, Conn.

* * *

## F. X. RETTENMEYER JOINS FTR

Francis X. Rettenmeyer, formerly chief receiver engineer of RCA Victor, has been named chief components engineer of Federal Telephone and Radio Corporation.

* * *

## SYRACUSE U. TO INSTALL WIRED TELEVISION

Syracuse University will install a G. E. wired television system shortly after the war.

Equipment will be used to conduct various classroom teaching experiments, as well as teaching television programing and other techniques to students.

* * *

## F. G. GARDNER BECOMES U. M. C. GENERAL MANAGER

F. G. Gardner has been appointed general manager of Universal Microphone Co., Inglewood, Cal.

Mr. Gardner was formerly Los Angeles representative for the Federal Telegraph and Radio Corp.

* * *

## CARTER MOTOR BULLETIN

A 4-page bulletin, No. 445, describing generators, magmotors and other rotary equipment, has been published by the Carter Motor Company, 1608 Milwaukee Avenue, Chicago, Illinois.

* * *

## AMPEREX TUBE CHART

A tube interchangeability chart, 8½x11½, listing approximately 300 transmitting tube type numbers and their equivalent designation in Amperex tubes, has been released by Amperex Electronic Corporation, 25 Washington Street, Brooklyn 1, N. Y.

* * *

## G. E. INDUSTRIAL ELECTRONICS TRAINING COURSE

An industrial electronics talking slide-film training course has been announced by G. E. Organized for presentation in twelve sessions.

The introductory slidefilm, "Harnessing the Electron," illustrates applications of electronic ubes and their four fundamental uses, while he second film, "Electronic Tubes as Recti-iers," describes three important types of ectifiers, the kenotron, phanotron, and the gnitron. The grid control of electronic tubes discussed in the third film, and the fourth nd fifth cover the fundamentals of electricity. ix of the remaining films are devoted to hotoelectric and electronic relay systems, elec-ronic rectifier equipment, the thy-mo-trol rive, electronic heating in industry, and the ectronic control of a-c power, respectively.

* * *

### VINFIELD BECOMES WESTINGHOUSE HOME RADIO CHIEF ENGINEER

V. S. Winfield has been appointed chief engi-eer of the home radio division of Westing-ouse Electric Corporation.

Mr. Winfield was formerly with Colonial adio, Buffalo. During 1942-43 he served as onsulting engineer to the Ordnance Division Bell Aircraft specializing in electronic devices.

* * *

### MECTRON CORP. FORMED

A new electronic manufacturer, Mectron Cor-oration, Inc., has opened a plant in Lawrence, Mass. Anthony Lambo is vice president and eneral manager.

* * *

### WILLIS APPOINTED FCC COMMISSIONER

Ex-Governor William H. Wills, of Bennington, Vermont, recently became a member of the Federal Communications Commission, succeed-ng Norman S. Case.

He was appointed by President Truman on une 13, and was confirmed by the Senate on uly 12.

* * *

### SNODGRASS JOINS W. E. HEARING-AID DIV.

William E. Snodgrass, formerly executive vice-resident of the Dictograph Products Company, as joined Western Electric as general manager f the hearing-aid division.

* * *

### RCA SCHOLARSHIP PLAN

A scholarship plan providing for as many as een students to receive $600 yearly scholarships during the academic year 1945-1946, thirty dur-ng 1946-47, fifty during 1947-1948, and sixty each academic year thereafter, has been an-nounced by RCA. Those eligible will include ll students enrolled at universities to be elected by the RCA education committee.

On the committee are Dr. James Rowland Angell, president emeritus of Yale University and public service counselor of NBC, who is chairman; Gano Dunn, president of the J. G. White Engineering Company, president of Cooper Union and a director of RCA; Dr. C. B. Jolliffe, vice president in charge of RCA labor-atories, and F. H. Kirkpatrick, director of education and training, RCA Victor Division.

* * *

### KNOOP OF DU MONT PRESENTS C-R PAPER TO IRE

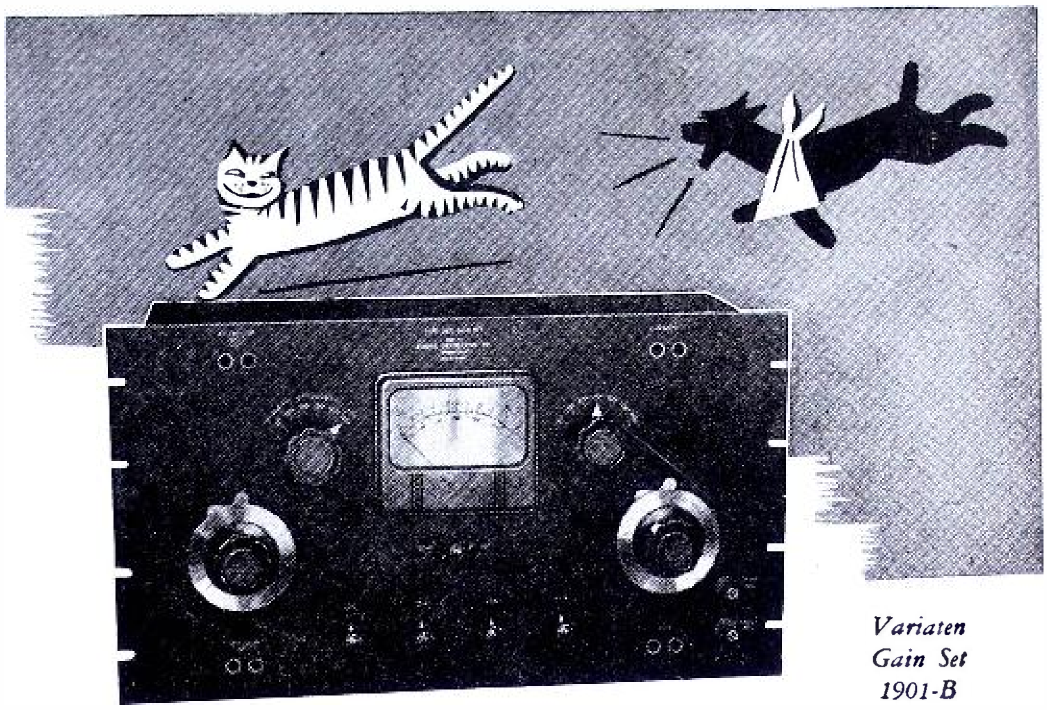
A paper covering the applications of the cathode-ray oscillograph was offered by Walter A. Knoop, Jr., of the engineering staff of Allen B. Du Mont Laboratories, Inc., before the Red Bank (N. J.) section of the IRE recently.

* * *

### ILLINOIS CENTRAL TO TEST R.R. RADIO

Space radio and induction systems for train and train-wayside station communications

(*Continued on page* 94)



# NEWS BRIEFS

(*Continued from page 93*)

will be tested soon on the western lines of the Illinois Central Railroad between Freeport, Ill., and Waterloo, Ia. Equipment has been furnished by Aireon Manufacturing Company. Tests will be under the supervision of P. B. Burley, Illinois Central electronics engineer.

* * *

## RALPH HORTON BECOMES PRESIDENT OF GREAT AMERICAN INDUSTRIES

Ralph Horton, New York City, has been elected president of Great American Industries, Inc., 70 Britannia Street, Meriden, Conn. He succeeds Harold W. Harwell, who resigned.

Mr. Horton will be located in the N. Y. City offices of Great American Industries at 247 Park Avenue. Frank W. Watts has been appointed general manager of the Connecticut Telephone & Electric Division in Meriden and the Rutland Electric Products Division in Rutland, Vermont.

* * *

## EASTERN AMPLIFIER CORP. CATALOG

A postwar catalog on amplifiers is being prepared by Eastern Amplifier Corporation, Bruckner Blvd. and 140th St., New York 54, N. Y.

* * *

## VANCE, FINN, ELLIOTT AND HAINES WIN RCA PROMOTIONS

Harold C. Vance has been appointed manager of the direct sales department of the RCA tube division. Mr. Vance will supervise the sales of all tube types to commercial broadcasters, air lines, police, educational institutions, and industrial users.

Mr. Vance joined RCA in 1930 as manager of commercial broadcast and police transmitter sales in the middle western states.

David J. Finn has been named manager of the renewal sales department of the RCA tube division.

Mr. Finn will be in charge of the sale of tubes, component and replacement parts sold through distributors and retailers.

Prior to his appointment, Mr. Finn was Chicago regional sales manager for RCA Victor.

Joseph B. Elliott has become general manager of the RCA Victor home instruments division.

Mr. Elliott will direct all activities connected with the design, engineering, production, distribution and sales of RCA Victor radios, television home receivers and Victrola phonographs.

Eugene F. Haines is now assistant treasurer of the Radio Corporation of America and manager of the RCA Victor treasury department.

Mr. Haines has been with RCA Victor and predecessor companies for 44 years.

D. J. Finn (above), H. C. Vance (above, right), J. B. Elliott (right).

* * *

## G. E. INDUSTRIAL ELECTRONIC TUBE MANUAL

A 412-page technical manual on electronic tubes for industry has been prepared by the G. E. tube division at Schenectady.

The manual, which sells for two dollars, features popular applications of ignitrons, phototubes, thyratrons, phanotrons and other electronic industrial tubes.

Copies of the manual may be purchased by writing electronics dept., 267-122.


* * *

## L. M. BRAUN TO HEAD ECA EXPORTS

Lawrence M. Braun has been named vice president in charge of the E. C. A. International Corporation. Mr. Braun has been with E. C. A. (Electronic Corporation of America) for thirteen years.

* * *

## FUNK TO REPRESENT PYROFERRIC

B. J. Funk has been named mid-western representative for the Pyroferric Company, New York City.

Headquarters will be at 565 W. Washington Street, Chicago.

* * *

## MUHLEMAN JOINS J. WALTER THOMPSON

M. L. Muhleman has joined the editorial staff of the trade and technical division of J. Walter Thompson Company.

* * *

## "E" AWARDS

Army-Navy "E" awards have been won by the Dobbs Ferry and Mount Vernon, N. Y., plants of North American Philips Company, Inc., and the Benwood-Linze Company and its affiliate, the B-L Electric Manufacturing Company of St. Louis, Missouri.

A second white star has been added to the "E" flags of the Burgess Battery Company, Freeport, Illinois, and the Aerovox Corporation's plants at New Bedford and Taunton, Mass.

Radio Receptor Co., Inc., New York, and the United Electronics Co., Newark, N. J., have won their third white "E" flag stars.

Another white star has been added to the "E" flag of the Commercial Radio-Sound Corp., New York.

* * *

## IRC ENGINEERING CATALOG

A 4-page supplemental catalog data bulletin containing engineering and purchasing infor-

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## SYLVANIA EXECS HONOR GEN. McNARNEY

Frank A. and Walter E. Poor, director and president of Sylvania Electric Products, Inc., and General Joseph T. McNarney, Commander of the U. S. Army Forces in the Mediterranean, during a recent welcome-home celebration at Emporium, Pa.

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ation of grade 1, class 1 resistors (type RW power wire wound), has been published the International Resistance Company, 401 orth Broad Street, Philadelphia 8, Pa.

* * *

**ALSTROM INSTRUMENT CONTROL OARD CATALOG**

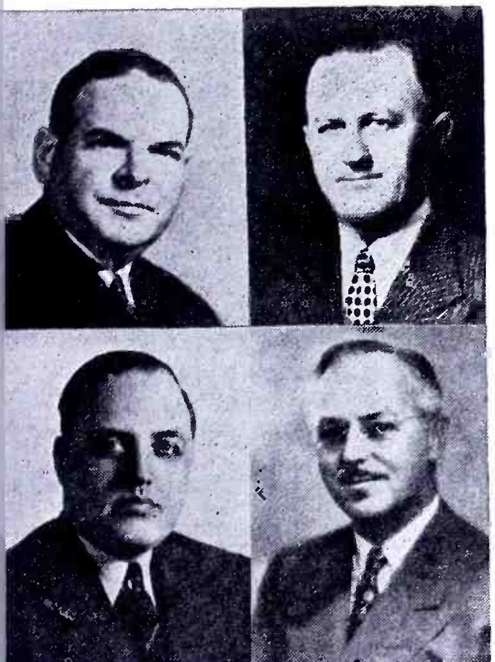
6-page catalog, No. 119, covering panel and ubicle installations, has been released by alstrom Company, panelboard department, 28 alstrom Court, Passaic, New Jersey.

* * *

**EVERS NOW ELECTRONIC ABORATORIES BOARD CHAIRMAN; ARSTANG, PRESIDENT**

orman R. Kevers, formerly president of the ectronic Laboratories, Inc., Indianapolis, has en elected chairman of the board. William . Garstang has been elected president; he was rmerly vice president and general manager. ree vice presidents were named: Walter E. eek, sales manager; Paul H. Frye, chief enneer; and Harry C. May, works production anager.

Four new manufacturer's representatives have so been announced by Electronic Laboratories. hey are: Harry B. Segar, Buffalo; Arthur ocke, New York City; S. K. McDonald, Philelphia; and J. Y. Schoonmaker, Dallas.



H. B. Segar (upper left), A. Rocke (upper right), S. K. McDonald (lower left), J. Y. Schoonmaker (lower right).

* * *

**A. D. WILLARD NOW NAB EXECUTIVE V-P**

A. D. Willard, Jr., has been elected to a newly-created office of executive vice president of the National Association of Broadcasters. Mr. Willard was manager of WBT, Charlotte, N. C.

* * *

**SCHOTTENBERG OF ASTATIC VISITS PHIL.-BALTIMORE JOBBERS**

Ray T. Schottenberg, sales manager of the obber division of The Astatic Corporation, Conneaut, Ohio, visited jobbers in Baltimore and Philadelphia recently. Frank B. Russell, district representative, accompanied Mr. Schottenberg.

* * *

**OLSON FLUORESCENT LIGHTING CATALOG**

A catalog featuring fluorescent fixtures has been prepared by Olson Radio Warehouse, 73 E. Mill Street, Akron 8, Ohio.

* * *

**LEWYT APPOINTS GREER ASS'T WORKS MANAGER**

Robert Greer has been named assistant to works manager Arnold M. Wolf, of the Lewyt Corporation, Brooklyn.

* * *

**J. J. FINN JOINS SHAPPE-WILKES**

James J. Finn, formerly president of the J. Finn Publishing Co., has become vice president

(*Continued on page 96*)

# NEWS BRIEFS

(*Continued from page* 95)

of Shappe-Wilkes, Inc., New York. He wi supervise merchandising and public relations.

* * *

## BROWNE HEADS CONCORD RADIO INDUSTRIAL DEPARTMENT

A new industrial department, under the direc tion of L. R. Browne, has been announced b Concord Radio Corporation, Chicago, Ill.

* * *

## WEBSTER-CHICAGO BOOKLET

A 20-page booklet covering "The Story of Web ster-Chicago" has been released by Webster Chicago, 3825 W. Armitage Ave., Chicago 4 Illinois.

* * *

## KNIGHTS OPENS CHICAGO OFFICE

The James Knights Company of Sandwich Illinois, has opened a Chicago office at 175 Wes Jackson Boulevard, headed by E. H. Aberdeen

* * *

## GALVIN NAMES GOEBEL ACTING FIELD SALES DIRECTOR

E. S. Goebel has been appointed acting directo of field sales in the communications and elec tronics division of Galvin Manufacturing Corp

Mr. Goebel succeeds Norman Wunderlich, wh resigned as sales manager.

* * *

## ALTEC LANSING DUPLEX SPEAKER BULLETIN

A 12-page brochure, offering an analysis o the duplex speaker and allied accessories, divid ing network, cabinets and amplifiers, has bee released by Altec Lansing Corporation, 121 Taft Building, Hollywood 28, Calif. Respons curves are also presented.

* * *

## DEHYDRATION DATA

A 4-page bulletin, describing chemical dehy drators and their application to communica tions installations in isolated exposed build ings, has been prepared by the H. J. Kaufma Company, 13215 Roselawn Avenue, Detroit Mich.

* * *

## MAGNAVOX CAPACITOR REFERENCE GUIDE

A 24-page capacitor reference manual has jus been released by The Magnavox Company, For Wayne, Indiana.

Offered are reference material for all stand ard sizes of Magnavox capacitors available, wit cross reference to standard production num bers. In addition, anode size factors, leakag limits and resistance limits are charted.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## ELECTRONIC COUNTER

(*Continued from page* 81)

circuit will be used to count a fixed number of pulses or a number that will vary slightly from some fixed number. Although the setting of $P_1$ will determine how many pulses the circuit will pass before it is triggered, the ratio of the sizes of $C_2$ and $C_1$ will help to determine the stability of operation of the circuit.

The degree of stability of the circuit depends upon the size of the *step* in voltage, as shown in equation *12*. The larger the step the less likely will be the possibility of any *drifting* or changing in counting. Obviously, then, maximum stability will be possible when $S_n$ is also a maximum. This condition exists when the derivative of $S_n$ with respect to $r$ is equal to zero. The derivative of $S_n$ is

$$\frac{dS_n}{dr} = \frac{d}{dr}[r E_M (1-r)^{n-1}]$$

$$= E_M [(1-r)^{n-1} - r(n-1)(1-r)^{n-2}]$$

or

$$\frac{dS_n}{dr} = E_M (1-r)^{n-2}(1-nr) \qquad (13)$$

Setting equation *13* equal to zero, two solutions present themselves. The first gives $r$ the value 1; the other gives $r$ the value $\frac{1}{n}$. Applying these solutions to our original definition of $r$, namely,

$$r = \frac{C_1}{C_2 + C_1}$$

it is seen that if $r$ is equal to 1, $C_2$ must be zero which is obviously an impractical solution. Using the other value of $r$, which was $\frac{1}{n}$,

$$\frac{1}{n} = \frac{C_1}{C_1 + C_2} \qquad (14)$$

Solving equation *14* results in

$$C_2 = (n-1)\,C_1 \qquad (15)$$

Equation *15* tells how large $C_2$ should be with respect to $C_1$ for maximum stability. Whenever the circuit suggested here is used, either as a counting device or as a frequency divider, the conclusion reached in equation *15* should be observed as closely as possible. This is especially true since there is bound to be some slight leakage in the condensers, and some variation in their indicated value, which will tend to make the circuit operate with some degree of inefficiency no matter how carefully the elements are chosen. Condensers $C_3$ and

(*Continued on page* 98)

## ELECTRONIC COUNTER

(*Continued from page 97*)

$C_2$ are the most important elements in the circuit. They should be of mica and well made to keep leakage down to a minimum.

A few unusual effects should have been apparent from a study of the waveshape for $E_p$ of the blocking oscillator circuit. Although the voltage dropped at first, it was probably noted that when it started to return to $B+$ again as the tube was cut off once more, $E_p$ actually rose above $B+$. This was due to the collapsing lines of force (within the inductance of the transformer) which tended to oppose any changes in the direction of current flow. It was probably also noted that oscillations continued after the output pulse. These oscillations were due to distributed capacitance (between the windings of $T_1$) which caused the secondary of $T_1$ to act as a tuned tank circuit. These oscillations dampen out very quickly and do not appreciably alter the operation of the circuit. Only the first pulse will be of sufficient amplitude to be of any practical use.

### *Constant Amplitude Pulses*

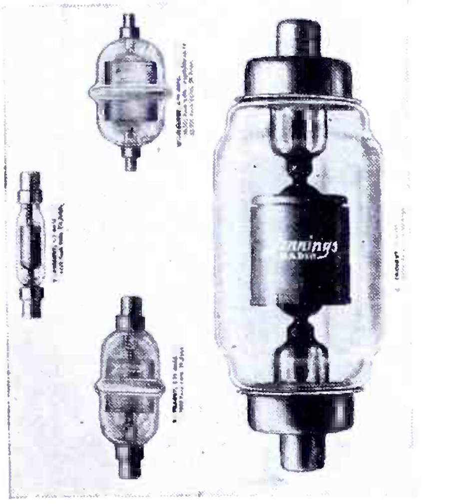
In this discussion the assumption has been made that the pulses being counted are of constant amplitude. However, should the input signal consist of pulses of varying amplitude, each pulse *step* will also be irregular in amplitude causing the blocking oscillator (or other pulse output device) to respond after a varying number of input pulses.

If the circuit described in this paper is to be used to count pulses of varying amplitude, it will be necessary to precede the counting circuit with a limiter stage whose function is to maintain the input pulses at a constant level. Several types of limiting circuits are suitable for this purpose, the most frequently used being the biased diode limiter and the saturated pentode limiter. Each type of limiter has its advantages and disadvantages but it will be found that, in general, the saturated pentode limiter is simpler and more satisfactory since it eliminates biasing requirements and provides some voltage gain. The principal disadvantage of the saturated pentode limiter is that the phase of the input pulse signal will be inverted and may require another amplifying stage prior to the input to the counter circuit. The phase inversion may be eliminated, if need be, by connecting the saturated pentode limiter as a cathode follower (in which case, this stage would no longer provide any voltage gain).

# THE INDUSTRY OFFERS . . . —

### JENNINGS HIGH-VACUUM CAPACITORS

Four high-vacuum capacitors ranging from 1 mmfd at 7½ amperes, 3,000 peak volts, to 250 mmfd at 60 amperes, 20,000 peak volts and a special high-power unit of 50,000 peak voltage, 60 amperes peak, have been announced by Jennings Radio Manufacturing Company, 1098 East Williams Street, San Jose, California.



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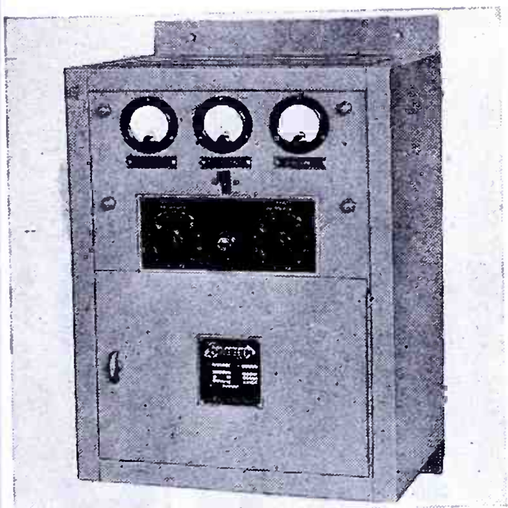
### FTR BATTERY CHARGERS

Automatic telephone selenium rectifier chargers, FTR-8,000-S, providing d-c outputs ranging from 2.4 to 16 amperes for from 12 to 60 cells, has been developed by Federal Telephone and Radio Corporation. Output voltage ranges from 2.1 volts per cell at high rate charge to a trickle volt charge of 2.25 volts per cell.

Battery potentials are said to be automatically maintained within selected limits by a voltage control relay circuit which varies the charge between high and trickle rates, both of which are adjustable. The unit is said to be designed to operate without automatic regulation if necessary, permitting the rate of charge to be adjusted manually when desired. An alarm circuit is provided to indicate failure of charger or battery circuits, both of which are equipped with fuse protection and overload switches.

For single phase, 60-cycles, 110, 130, 200, 220 and 250 volts.



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### ROGERS INSULATING BOARD

A non-cotton cellulose electrical insulating board, Durok, with a dielectric strtngth from 400 to 600 volts per mil, has been announced by Rogers Corporation, 9 Mill Street, Manchester, Conn.

Material is said to be neutral, since it is not chemically treated or sized; said to dry out with a short baking cycle and absorbs insulating varnish.

The material is made by laminating many thin, continuous layers while wet under high

(*Continued on page* 100)

(*Continued from page 99*)

pressure, without the use of adhesives or chemicals, then drying without any tension.

Stock sheet sizes are 36" x 48" and 36" x 24", with the grain direction parallel to the second dimension. Thicknesses now available are .015", .020", .025" and .030".

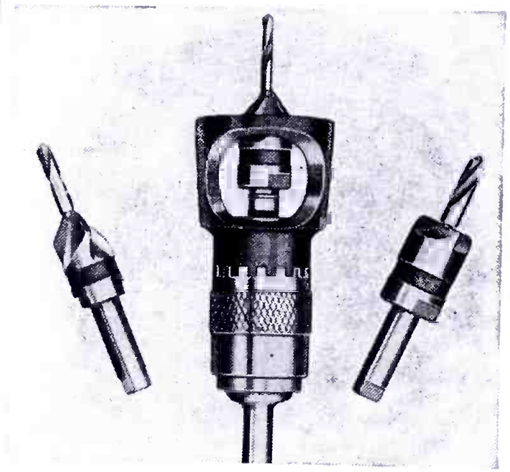
* * *

### AIRCRAFT TOOL DRILPILOT

A tool, Drilpilot, that is said to permit drilling and countersinking, drilling and spotfacing, or drilling and counterboring in one operation, has been announced by Aircraft Tools, Inc., 750 E. Gage Avenue, Los Angeles, California.

Body of drill is ⅝" long with a 9/16" flute length. Shank is .086 diameter and ⅝" long. Comes only in standard rivet sizes 40, 30, 21 and 10.

Used with standard angle drill adapters or angle drill attachments. Can be used in connection with replaceable shank countersink or replaceable shank spotfacer.



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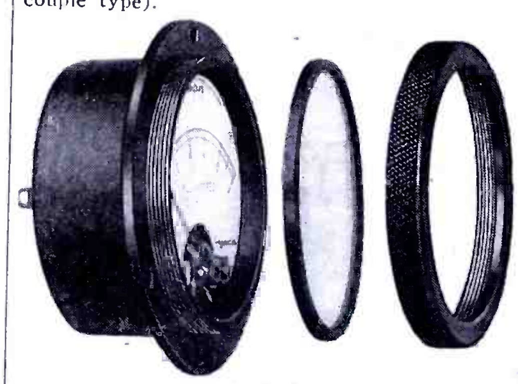
### TRIPLETT HERMETICALLY SEALED INSTRUMENTS

Panel flush mounting 1½", 2½", 3½" meters (a-c and d-c), hermetically sealed, have been produced by Triplett Electrical Instrument Co., Bluffton, Ohio.

Mechanisms are D'Arsonval d-c and repulsion moving iron a-c type, furnished in 2½" and 3½" seamless metal cases, 1½" in d-c only. Instruments have the same case sizes and conform in performance to JAN-1-6 specifications. They also comply with S.C. No. 71-3159 and A.C. 45A40327 specifications. Zero shift on the instrument is said to not exceed ±2%; accuracy, 2% of full scale.

Models 321-HS (3½") round, 221-HS (2½") round, and 127-HS (1½") square made in d-c voltmeters, ammeters, milliammeters and microammeters. Models 331-HS (3½") round and 231-HS (2½") round made in a-c voltmeters, ammeters and milliammeters. Models 341-HS (3½") round and 241-HS (2½") round available in r-f ammeters and milliammeters (a-c thermocouple type).



* * *

### ACA REGULATED POWER SUPPLIES

A series of saturable-reactor regulated-power supplies for applications requiring d-c voltages regulated to better than 5% from full load to no load, and having less than 1% ripple under full load conditions, has been announced by Amplifier Co. of America, 398 Broadway, New York 13, N. Y.

Units are available in 24 v ½ ampere, 24 v 2 ampere, 48 v 1¾ ampere, 48 v 5 ampere (combination 24 and 48 v 750 ma), 36 v 1 ampere, 110 v 8 ampere, 120 v 200 ma, 135 v ½ ampere, 250 v .4 ampere, and 500 v 200 ma.

Power packs may be furnished with built-in automatic voltage regulators to compensate for line voltage changes.

Power packs employing heavy-duty rectifier tubes are provided with built-in thermal time delay relays which apply plate supply voltage approximately 30 seconds after rectifier filaments are heated.

* * *

### BENDIX CRYSTAL AND HOLDER ASSEMBLY

Crystals, type mx-9, for 250-10,000 kc with tolerances of 0.01% at 20° for 250-1200 kc and .02% for 1200-10,000 kc, have been announced by Bendix Radio, Baltimore, Md.

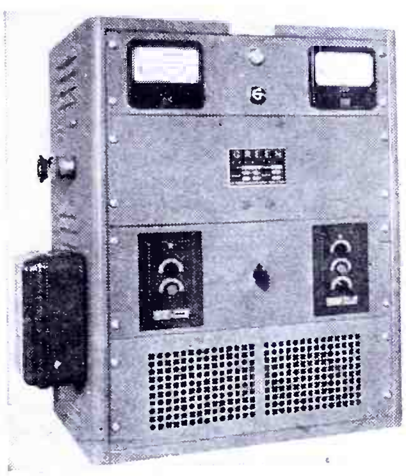
Bendix engineers say that crystals will operate satisfactorily at any air temperature between − 40 and + 55° C.

* * *

### GREEN LOW-VOLTAGE RECTIFIERS

Low-voltage stabilized high-current rectifiers rated at 200 amperes, voltage range zero to 3 volts, have been developed by Green Electric Co., 130 Cedar Street, New York City. Any voltage selected in range is said to be maintained to within 50 millivolts over load variation from zero to 200 amperes, and with line voltage variation of ± 10%.

Voltage stabilization system includes motor-driven powerstat and electronic pilot device.



* * *

### IDEAL COMMUTATOR SENSITIVE BALANCING WAYS

Balancing ways that use "scale type" bearings in a 10" size that are said to provide a sensitivity to .007 ounce inches has been announced by the Ideal Commutator Dresser Company, 4025 Park Avenue, Sycamore, Illinois. Bearings used in the 20" and 42" size are said to permit an accuracy in balancing to .009.

The work is carried on free turning discs. Discs are ground on outside diameters, and mounted on ground spindles.

Four sizes are available, 10", 20", 42" and 60" swing; 400, 1,000, and 5,000 pounds capacity, respectively.

* * *

### G.E. 1½" PANEL INSTRUMENTS

Two types of 1½" meters for d-c, r-f and a-f work, have been announced by G. E. One type DN-1, 2 and 3, has a watertight design for application where the equipment may be accidentally submerged in water, exposed to rain, or used in extremely humid climate. The other model, DN-4, 5 and 6, uses a conventional design for use in aircraft or for other service where the instrument will be protected from the elements.

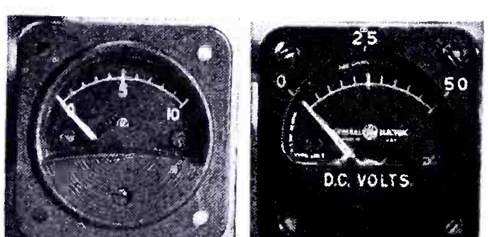
Both instruments have the same basic design

(*Continued on page* 102)

# THE INDUSTRY OFFERS . . . —

(*Continued from page* 101)

in utilizing an internal-pivot element combined with the permanent-magnet moving-coil construction. The pivots are mounted on the inside of the armature shell, instead of being secured to the outside of the armature winding.




* * *

### SCHRILLO COUNTERSINK

A micrometer adjustable countersink, model 6300, has been produced by Schrillo Aero Tool Engineering Company, 8715 Melrose Avenue, Los Angeles 46, California. Tool has a cutter capacity of ⅞" diameter. Cutters are driven off a 7/16"-20 threaded shank or a standard taper.

Features a self-lubricating bearing. Adjustments are made in increments of .001". Taper shank cutter style has a self-contained knock-out pin.

* * *

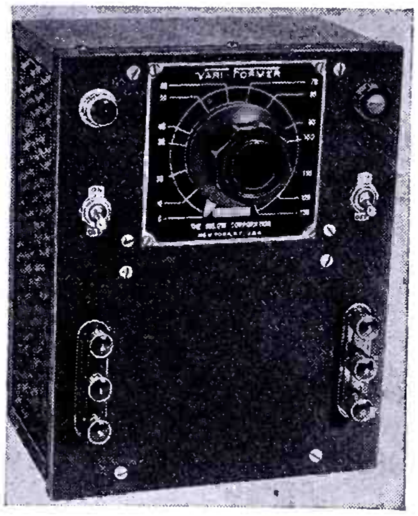
### GULOW ISOLATION VARI-FORMERS

Transformers, vari-formers type W, with primaries wound for 115 volts input and variable secondaries wound for an output of 0-130 volts, have been announced by Gulow Corporation, 26 Waverly Place, New York 3, N. Y. Units can be connected as autotransformers. Inputs of 115 or 220 volts can be applied and output ranges of 0-65 or 65-130 are obtainable with increments of 0-3 volts. Likewise output ranges of 0-130 or 115-245 with increments of 0.6 are possible.

Separate primary and variable secondary windings wound on the same core. Electro static shield between primary and secondary grounded to the core and brought out to a separate terminal.

Units with capacities of 500 va to 2,000 va are available. The 500 va measures 7" x 9" x 4½" deep; weight, 20 lbs. The 2,000 va measures 10" x 10" x 8" deep; weight, 50 pounds.

Unit illustrated is model LW 43 AX, capacity 600 va.

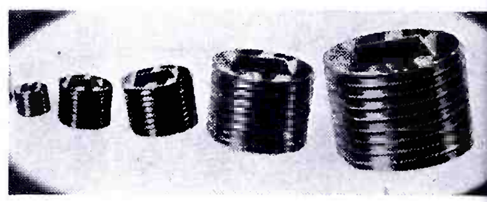



* * *

### AMERICAN MOLDED PLASTIC PIPE SEALS

Plastic pipe seals and thread protectors in countersunk pattern have been announced by American Molded Products Company, 1644 N. Honore Street, Chicago 22, Illinois.

Sizes available: ⅛", ¼", ⅜", ½", ¾". Fits commercial square bars of standard sizes.



* * *

### SKYWAY SPINTITE TORQUE TOOL

A tool, Tork-Tite, featuring torque limiting action and torque settings calibrated in inch ounces, has been announced by Skyway Precision Tool Co., 3217 Casitas Avenue, Los Angeles, Calif.

Presented in two models with either fixed or adjustable torque settings.

* * *

### MICA INSULATOR LAMICOID

A laminated plastic, Lamicoid, is now available in sheet form for post-forming, from the Mica Insulator Company, 200 Varick Street, New York 14, N. Y.

According to Mica Insulator, suitable molds and dies for post-forming stock can be made of hard wood, resin-bonded wood, metal forms, cast resin, kysite and similar materials.

The sheets measure 36"x42" and are made in thicknesses of 1/32" and over. The stock is available, in two types: E-527, for deep drawing and forming of intricate parts; and E-528, for ordinary forming and shallow drawing.

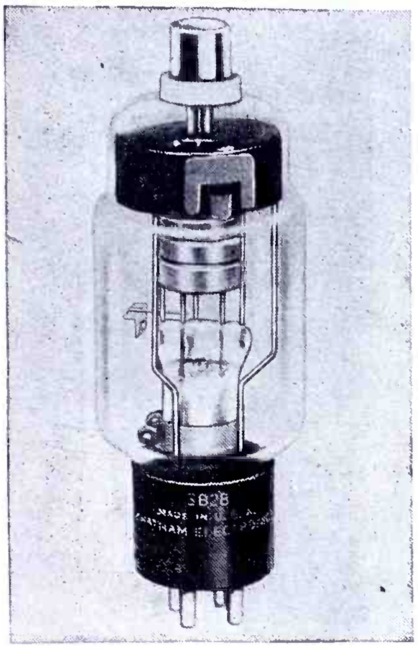
* * *

### CHATHAM ELECTRONICS XENON FILLED HIGH-VOLTAGE RECTIFIERS

High-voltage xenon-gas rectifiers that are said to feature high peak inverse voltage rating, constant voltage drop, heavy current capacity and a wide ambient temperature range have been produced by Chatham Electronics, 475 Washington Street, Newark 2, New Jersey. Tube operates through an ambient temperature range of — 75° C to + 90° C.

Characteristics (up to 150 cps): Filament voltage, 2.5 volts a-c; peak inverse voltage, 10,000 volts; peak anode current, 1 amp at 10,000 volts; peak anode current, 2 amp at 6,500 volts; average anode current, 250 ma at 10,000 volts; average anode current, 500 ma at 6,500 volts; maximum height, 6.38"; and maximum diameter, 2.07".

Characteristics (up to 500 cps): Peak inverse voltage, 6,500 volts; peak anode current, 2 amp; and average anode current, 500 ma.



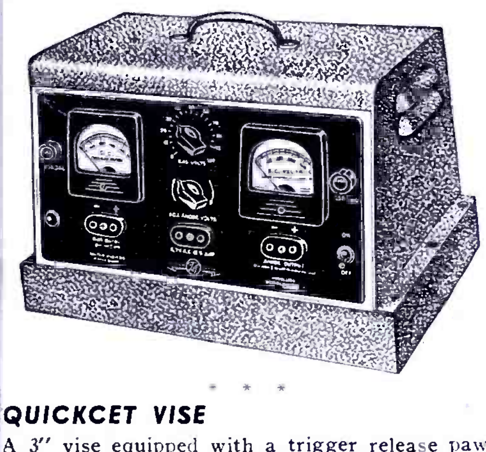
* * *

### TECH APPARATUS SELF-REGULATING POWER PACKS

A power pack, 1220 EB, providing two voltage-regulated d-c outputs covering the ranges commonly used for anode and bias voltages has been announced by Technical Apparatus, 1171 Tremont Street, Boston 20, Mass.

High-voltage output is continuously adjustable from zero to 400 volts. Voltage is said to be automatically held at its initial setting under load variation from zero to full current. Maximum current output on the anode supply is 250 ma; maximum power output, 40 watts. Regulated bias voltage is continuously adjustable from — 160 volts to 0 at maximum current of 2 ma.

Instrument contained in a steel housing 13" by 11" by 9".



* * *

### QUICKCET VISE

A 3" vise equipped with a trigger release pawl with ¾" of thread which holds a screw under spring tension has been announced by Grand Specialties Co., Grand Avenue at Troy, Chicago 22, Ill.

Vise known as Quickcet, is said to open instantly to full 3" by pressure of thumb or finger on trigger release after tension has been eased by a turn of a looseproof handle.

* * *

### INDUSTRIAL INSTRUMENT RESISTANCE LIMIT BRIDGES

A resistance-limit bridge (modified Wheatstone) to check resistors between 1 ohm and 3 megohms, working to ±.1% has been announced by Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J. Known as model LB-3, this bridge has high and low limit dials covering a range of ±11% in .1% steps, and uses a sensitive built-in galvanometer to provide for high and low indication, respectively. In the normal operating position the zero on the galvanometer scale acts as a reference point.

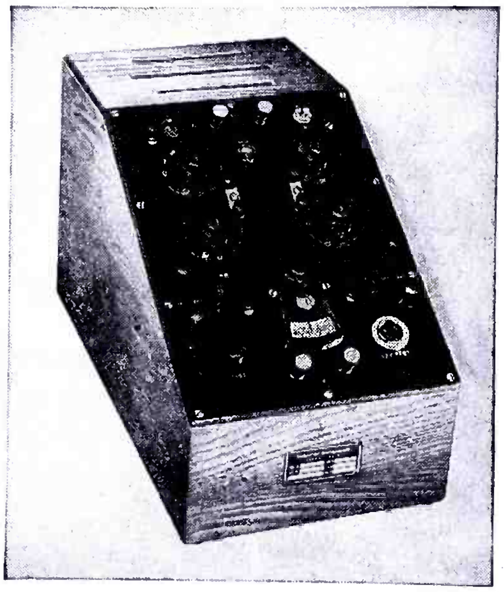
For most measurements the galvanometer and internal 3 volts d-c source will be found satisfactory. For measurement of resistors above several thousand ohms and particularly

*(Continued on page 104)*

## THE INDUSTRY OFFERS . . . —

(*Continued from page* 103)

when the resistance range is increased above 1 megohm, an external battery is recommended. For low-resistance measurements particularly below 10 ohms, a more sensitive external galvanometer may be desirable, although most measurements between 1 and 10 ohms may be satisfactorily made by using an external 1½-volt battery.

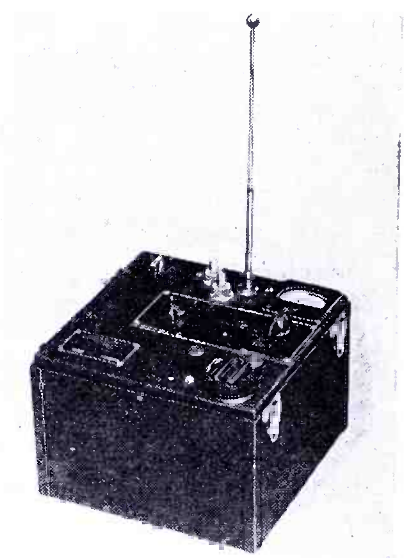


* * *

### ANDREW H-F AIRCRAFT OSCILLATOR

A portable, battery-operated oscillator, type 291, for checking h-f aircraft receivers has been announced by Andrew Company, Chicago 19, Illinois.

Instrument has a frequency range from 49 to 154 mc with modulation frequencies of 70, 90, 400, 1,300, and 3,000 cycles. Contains a collapsible antenna and two coaxial terminals for low- and high-level outputs.



* * *

### ELECTRONIC MEASUREMENT POWER SUPPLIES

A power supply with continuously variable voltage, 0-325 volts d-c at 125 ma without switching, has been announced by Electronic Measurements Company, 10 West Front Street, Red Bank, N. J.

Regulation of unit, model 200-B, is said to be within 1% for voltages between 20-325 volts from no load to full load; within 2% at 10 volts from no load to full load. Hum voltage is said to be less than 10 millivolts including noise.

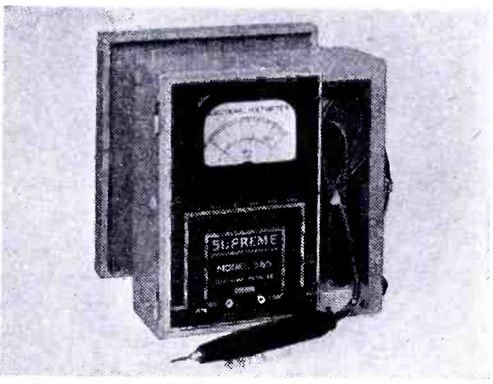
* * *

### SUPREME V-T VOLTMETER

A vacuum-tube voltmeter, model 565, has been announced by Supreme Instruments Corporation, Greenwood, Miss.

R-f probe uses miniature h-f diode; said to be applicable from 50 cycles to 50 mc. D-c voltage circuits have shielded leads; each lead has a 20-megohm isolating resistor which also acts as part of the multiplier resistors; high input impedance of 80 megohms on 1-volt range and 40 megohms on 500-volt range. Balanced bridge circuit uses nearly 100% degenerative feedback.

D-c voltage ranges of 0-1, 0-2.5, 0-10, 0-100, 0-250, and 0-500, and a-c voltage ranges of 0-1, 0-2.5, 0-10, 0-100, and 0-250 provided by means of push-buttons.

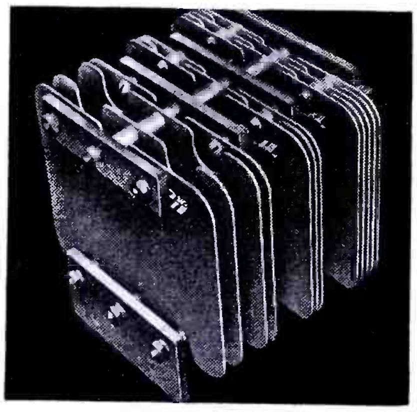


* * *

### TECHRAD CAPACITORS

One-to-four section capacitors with capacities of 20, 40, 120 and 230 mmfd, have been produced by Technical Radio Company, 275 Ninth St., San Francisco. Overall dimensions of capacitor are 5⅜″ × 5¼″. Designed originally for the output section of a pi-network.

Typical spacing is .080″. Capacitors can be supplied with spacing to .220″. Aluminum plates and spacers. Brass mounting feet. Universal type of construction.



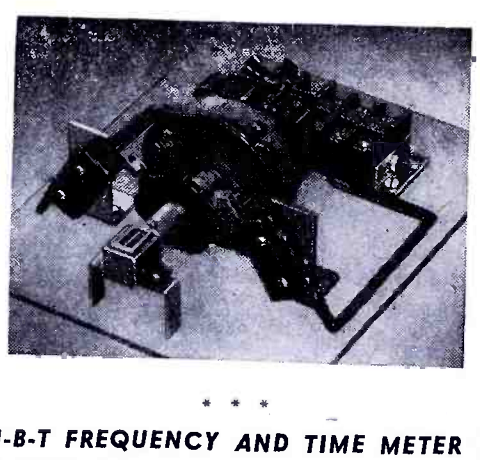
* * *

### B/W TIMING CONTACTORS

A timing contactor for testing solenoids, relays, etc., has been developed by B/W Controller Corporation, Birmingham, Michigan.

The contactor consists of a synchronous motor, available in various speeds, and two micro switches operated by a cam disc fastened to the motor shaft.

Terminals are provided for wire connections. Two switches are standard equipment so that two tests can be run at the same time. The counter, for short runs, is optional. Unit is portable. All items are mounted on a steel back plate and enclosed in a 9″x12″x4″ sheet metal case.



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### J-B-T FREQUENCY AND TIME METER

A combined frequency meter and elapsed time meter, 31-FE, has been developed by J-B-T Instruments, Inc., New Haven, Conn.

Frequency or speed is said to be indicated to an accuracy of ±0.3% by a bank of 5 reeds calibrated in single cycle steps from 58 to 62 cycles. The running time meter is driven by a synchronous motor, and indicates elapsed time in hours and tenths.

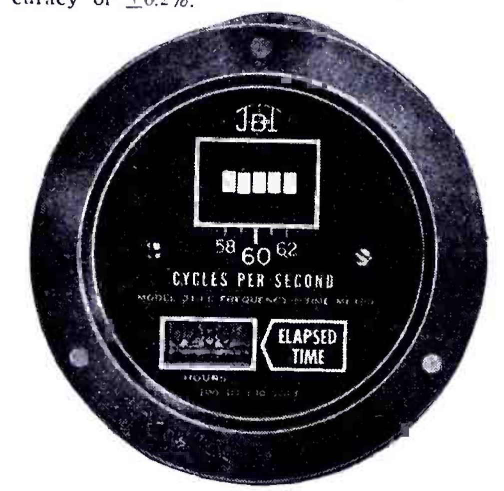
Operates on 110 volts, and is also available for 48 to 52 cycles and in half-cycle steps for

(*Continued on page* 106)

# THE INDUSTRY OFFERS . . . —

(*Continued from page* 104)

59 to 61 cycles and 49 to 51 cycles, with accuracy of ±0.2%.

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### BAKELITE LOW-LOSS PLASTICS

A low-loss phenolic mica-filled plastic molding material, BM-16981, that is said to be especially suitable in high-frequency circuits, has been developed by the Bakelite Corporation, 300 Madison Avenue, New York 17, N. Y.

The volume resistivity of the plastic is said to have remained high in a recent test decreasing from 1 x $10^9$ megohms to 1.6 x $10^5$ megohms. The plastic was immersed for 3,600 hours in 50° C water during the test. At 1 megacycle, the power factor was 0.055.

* * *

### OPERADIO DUAL AMPLIFIERS

A 40-watt dual amplifier, the Soundcaster, designed for either plant broadcasting or public address service, has been announced by Operadio Manufacturing Company, St. Charles, Illinois. Three models are available.

The basic Soundcaster, 1335, is for continuous use. Model 531 incorporates a two-speed, manually-operated, record player for 10" and 12" commercial recordings, or 16" transcriptions. Model 530 features an automatic record-changing mechanism for either twelve 10" or ten 12" recordings.

Weighs approximately 45 pounds.

* * *

### STANDARD MOLDING PLASTIC BOXES

Plastic transparent boxes designed to hold V-mail films and other similar objects have been developed by Standard Molding of Dayton, Ohio.

* * *

### FAIRCHILD WIRE-WOUND POTENTIOMETERS

A non-linear, wire-wound, potentiometer has been announced by the Fairchild Camera and Instrument Corporation, New York.

Fairchild engineers say that tolerances of ½% or better have been consistently reached for certain curves.

The potentiometer was developed for use in bridge T attenuators in a Fairchild airborne electronic computing gunsight. At present, one standard size, with a 1⅞" outside diameter is available. The model now in manufacture can be used singly or stacked; it has been banked to 18 on one shaft. Linear units are also available.

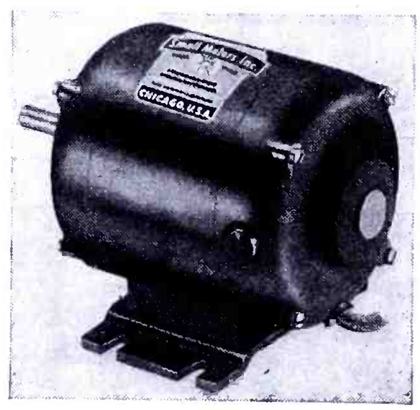
* * *

### S-M FRACTIONAL H-P MOTORS

An a-c/d-c fractional h-p motor, SM-4, has been developed by Small Motors, Inc., 1308 Elston Avenue, Chicago 22.

The motor's rating is from 1/50 to 1/10 horsepower. It is 3 5/16" in diameter, 4 3/16" long; height with base is 3⅞".

It is made to order at speeds from 2,000 to 10,000 rpm with precision oil bearings, and from 10,000 to 20,000 rpm with oilless sleeve bearings. Made in shunt and series windings for d-c, and universal for a-c/d-c.

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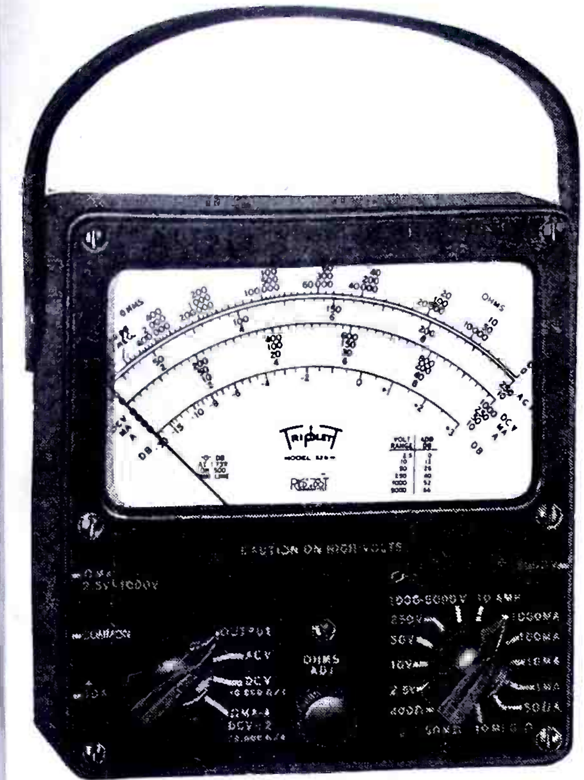
### G.E. B-F AUDIO OSCILLATORS

Beat-frequency audio oscillators, type AO-2, using full vision and making possible direct calibration, have been announced by G.E. Unit provides a sine wave, and continuous variable frequency from 25 to 15,000 cps.

A 6E5 electron-ray tube is used to indicate zero beat while adjusting the panel control knob to obtain the proper relationship between the two high-frequency oscillators. Maximum output is 120 milliwatts on a cathode-follower type output impedance coupling circuit.



## Long Scale, Wide Range Volt-Ohm-Milliammeter

DOUBLE SENSITIVITY
D.C. VOLT RANGES

0-1.25-5-25-125-500-2500 Volts, at 20,000 ohms per volt for greater accuracy on Television and other high resistance D.C. circuits.

0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

A.C. VOLT RANGES

0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

OHM-MEGOHMS

0-400 ohms (60 ohms center scale)
0-50,000 ohms (300 ohms center scale)

DIRECT READING OUTPUT LEVEL DECIBEL RANGES

— 30 to +3, +15, +29, +43, +55, +69 DB

TEMPERATURE COMPENSATED CIRCUIT FOR ALL CURRENT RANGES
D.C. MICROAMPERES

0-50 Microamperes, at 250 M.V.

D.C. MILLIAMPERES

0-1-10-100-1000 Milliamperes, at 250 M.V.

D.C. AMPERES

0-10 Amperes, at 250 M.V.

OUTPUT READINGS

Condenser in series with A.C. Volts for output readings.

ATTRACTIVE COMPACT CASE

Size: 2½" x 5½". A readily portable, completely insulated, black, molded case, with strap handle. A suitable black, leather carrying case (No. 629) also available, with strap handle.

LONG 5" SCALE ARC

For greater reading accuracy on the Triplett RED •DOT Lifetime Guaranteed meter.

SIMPLIFIED SWITCHING CIRCUIT

Greater ease in changing ranges.

**HERE'S THAT NEW TRIPLETT 625-N**

STANDARDS ARE SET BY TRIPLETT

# Triplett

**ELECTRICAL INSTRUMENT CO.** BLUFFTON, OHIO

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## RESISTORS, RHEOSTATS and RELAYS

hold top place in War Equipment, Now and in Peacetime Products of the Future.

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DANDY SIXTEEN PIECE UNIVERSAL MIDGET TOOL SET: Midget Pliers, Diagonal Cutters, Four Midget End Wrenches, Needle-nose Pliers, Screwholder, Six Punches & Chisel, Round File, Midget Crescent Wrench, $14.85. Remit today. Catalogue Free With Order.

**UNIVERSAL TOOL COMPANY, 1527 Grand, C.
KANSAS CITY 8, MISSOURI**

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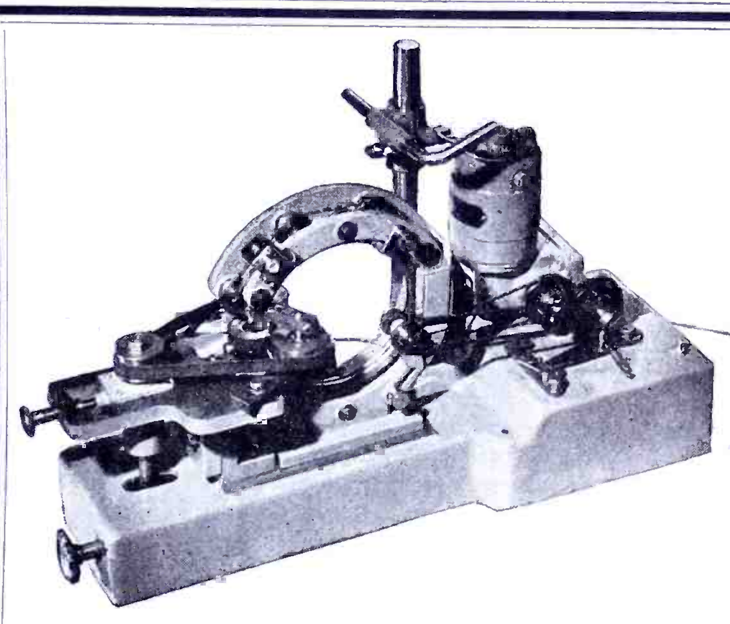

# A NEW WINDER

For making Toroidal Coils
On small cores with fine wire

*Larger Machines Available*

**Mico Instrument Co.**

88 TROWBRIDGE STREET, CAMBRIDGE, MASS.

# ADVERTISERS IN THIS ISSUE

## COMMUNICATIONS — AUGUST, 1945

# Post-War Broadcast Equipment—by G-R

● TWO of the first civilian products to come out of war research at General Radio are a broadcast station Modulation Monitor and a new Distortion & Noise Meter. These instruments have the latest circuits and new designs. Just as soon as we are out of war production these and other instruments for the broadcast station will be available again. Included will be a Frequency Deviation Meter, an F-M Monitor, a H-F Frequency Meter and Monitor, several Oscillators and other instruments. We are NOT in production on any of these now; however, information on several are available now. Brief descriptions are given below:


**TYPE 1931-A AMPLITUDE MODULATION MONITOR**

For program-level monitoring and for measuring transmitter audio-frequency response. Requires only 0.5 watt r-f input; carrier frequency range of 0.5 to 60 Mc; distortion is less than 0.1%; 600-ohm audio output circuit for audible monitoring; provides continuous indication of modulation percentage on either positive or negative peaks with a high-speed meter which reads both percentage modulation and decibels; measures carrier amplitude shift when modulation is applied; carrier envelope output available for distortion measurements; flashing lamp furnishes instantaneous indication of any modulation peaks exceeding any predetermined value between 0 and 100% on negative peaks. Approximate price: $220.00

**TYPE 1932-A DISTORTION & NOISE METER**

For measuring a-f distortion, noise and hum levels. Equally useful in the broadcast station, the development laboratory and the production line. Continuously adjustable from 50 to 15,000 cycles, fundamental, for distortion measurements and 30 to 45,000 cycles for noise and VU measurements; distortion ranges are full-scale for 0.3%, 1%, 3%, 10% or 30% with overall accuracy for each range of ±5% of full scale ±0.1% distortion; range for carrier noise extends to 80 db below 100% modulation or 80 db below a-f signal of zero VU level; no interlocking controls, only one tuning control plus small trimmer. Approximate price: $350.00

**● WRITE FOR COMPLETE DESCRIPTION AND SPECIFICATIONS**

**GENERAL RADIO COMPANY** Cambridge 39, Massachusetts

90 West St., New York 6   920 S. Michigan Ave., Chicago 5   1000 N. Seward St., Los Angeles 38

# Place your Electronic Problem before these Temco Engineers

From left to right: S. L. Sack, J. C. Cardon, Morton Kahn, E. E. Baker, E. E. Horrocks, H. H. MacAdams

● Accomplished Radio and Electronic Engineers sit at this Temco Table and by combining their engineering and inventive abilities, they have produced numerous new electronic devices.

From Radar to Chronaximeters, they have designed and manufactured electronic equipment which reflects and incorporates great technical achievements. Backed by a very flexible and efficient manufacturing organization, they are one of the best equipped staffs of Engineers to consult regarding problems involving electronic equipment.

No matter how complicated your problem may appear, a Temco-engineered device can provide the answer. The Temco Table, therefore, is the best place for such problems. For proof, ask us to show you what we have accomplished for others. Write for facts today.

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**TRANSMITTER EQUIPMENT MFG. CO., INC.**
**345 Hudson Street • New York 14, N. Y.**