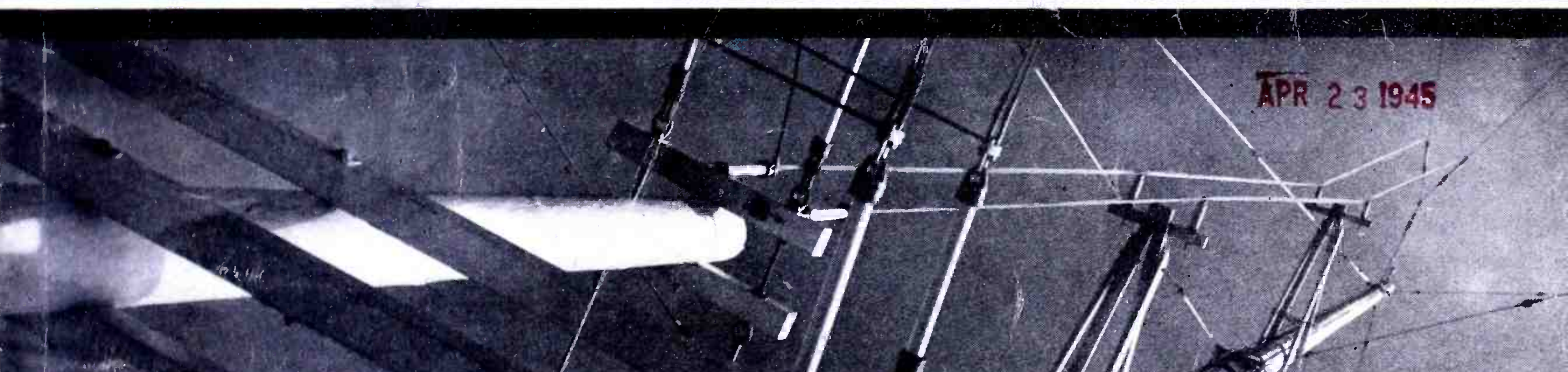
COMMUNICATIONS



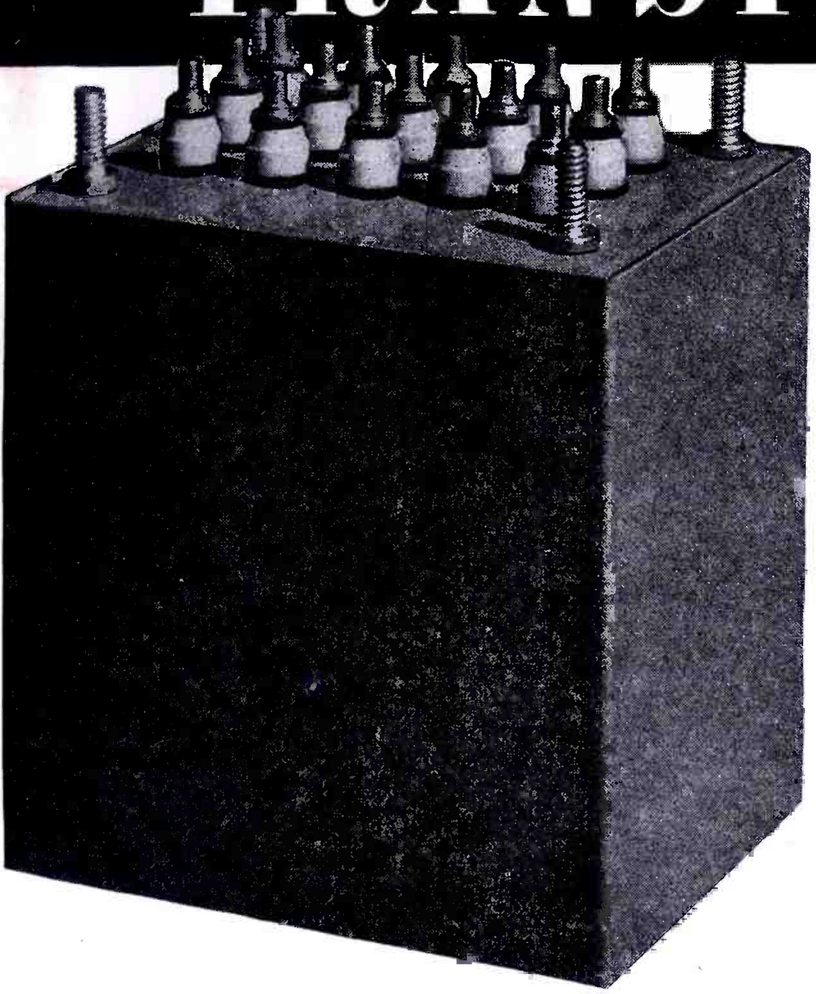
MARCH

- ★ RADIO ENGINEERING
- ★ FILTER ANALYSES
- ★ PLATE-LOADED AMPLIFIERS
- ★ AERONAUTICAL COMMUNICATIONS
- ★ V-H-F ANTENNA COUPLING CIRCUITS
- ★ TELEVISION ENGINEERING

1945


TRANSMITTING
Amperex
TUBE
ZB-3200

Hermetically Sealed TRANSFORMERS



Illustrated at left is a Langevin Hermi-Lock hermetically sealed transformer. Case must be destroyed before interior of unit can be reached. Hermi-Lock provides extensive safety factor for combat use.

The failure of a hermetically sealed transformer is largely due to the fact that solder is depended upon for a mechanical union as well as the hermetic seal. Solder having a low tensile strength is readily fractured by thermal action, vibration or shock, and the seal broken; with failure a probability.

LANGEVIN hermetically sealed transformers employ the unique *Hermi-Lock construction which provides a positive mechanical union between body, cover and bottom, the solder being simply the sealing agent. The result is a dependable unit with little chance of failure under simultaneously adverse conditions.

Your inquiry for transformers of all types up to 5 KVA are solicited.

* Trade Mark Registered

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St.

LOS ANGELES
1000 N. Seward St., 38

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

We See...

SIGNIFICANT PROGRESS IN AERONAUTICAL COMMUNICATIONS V-H-F developments has prompted a complete revision of the radio-range system in this country. The methods evolved have been so effective that more than half of the present 37,000 miles of airways are scheduled to have v-h-f ranges (112-118 mc) by July, 1946. Eight v-h-f two-course visual, two-course aural ranges are already in operation between New York and Chicago. Ranges are being extended west from Chicago. These should be ready within the next few months. And during the summer construction on v-h-f ranges on the Atlantic-Boston and San Diego-Bellingham routes will begin.

Discussing the v-h-f trend, in Dayton, Ohio, recently, Thomas B. Bourne, CAA Federal Airways director, said that v-h-f will serve airport traffic control for the flying plane and field control for taxiing and parking instructions. The ranges between 118 and 132 mc are scheduled for use here.

The postwar era will find v-h-f systems providing an invaluable service to the private pilot, indicated Mr. Bourne. These pilots will be served by receivers that will cover the 108 to 132-mc band without interruption, either by push button or tuneable control to provide navigational guidance along the airways and instrument approaches, and all of the essential two-way communications while enroute and while landing and taking off. While the projected plans involve complex problems—problems that are a challenge to engineering ability—everyone is certain that the challenge will be met quickly by the alert communications industry.

MILLIONS ARE STILL WITHOUT DAY OR NIGHT broadcast service because of station spacing and clear-channel problems, stated FCC Chairman Paul Porter recently. He pointed out that approximately 38.5 per cent (10,000,000 people) of the areas in the country are outside the daytime service range of any standard broadcast station. At night the condition is worse, he indicated, for nearly 57 per cent are outside of the nighttime primary service area.

Discussing the gravity of this situation, Mr. Porter pointed out that it is imperative that radio service be provided to these areas. He hoped that a thorough analysis of the clear-channel problem by the FCC and industry and subsequent solutions will insure a nationwide radio service . . . a service that will provide coverage for the entire nation and not just a small part!—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.

MARCH, 1945

VOLUME 25 NUMBER 3

COVER ILLUSTRATION

View of rhombic antenna system designed for 200-kw operation at new OWI-CBS international transmitter at Delano, California.
(Courtesy CBS)

Published Monthly by the Bryan Davis Publishing Co., Inc.

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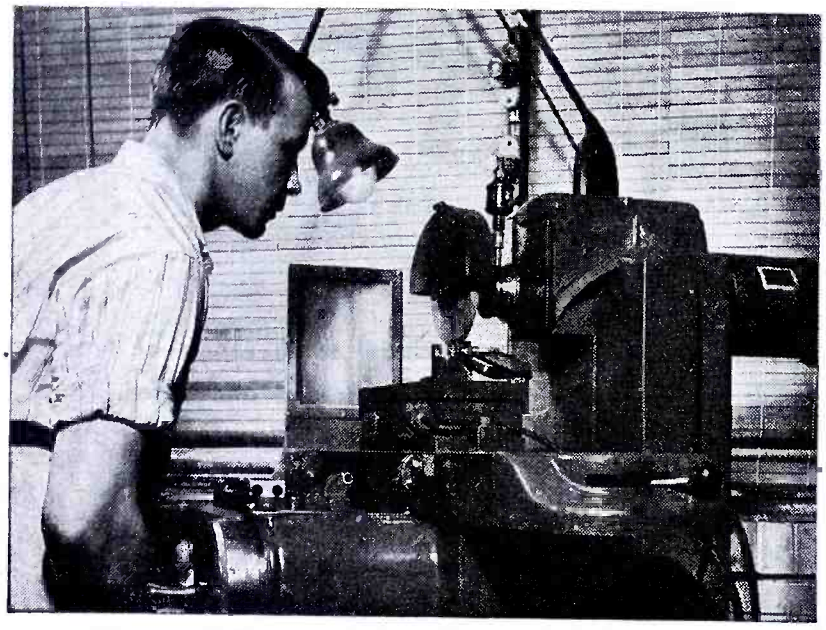
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

MARCH *Published in the Interests of Better Sight and Sound* 1945

Well-Equipped Sylvania Plant Makes Own Small Parts to Assure Top Quality in Radio Tubes



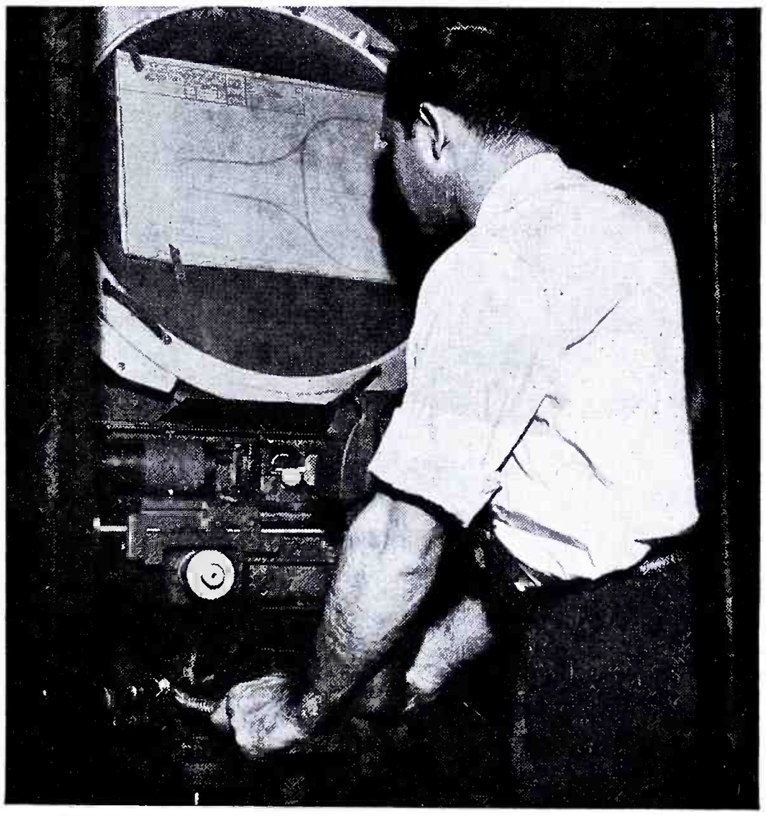
Many of the special tools required for turning out small tube parts are tailor-made right at Sylvania's Emporium plant.

To insure that all Sylvania-made radio tubes will be of the very best quality, the well equipped tube plant in Emporium, Pennsylvania, provides extensive facilities for making over 8500 of the delicate small parts that go into Sylvania tubes.

Each month over 600 million small parts are turned out. In making these intricate parts, Sylvania craftsmen work with a variety of metals such as tungsten, steel, copper, phosphor bronze, beryllium copper and tantalum.

The Emporium staff includes highly skilled production engineers, tool and design men, and expert tube makers.

By a sampling method, watchful Sylvania inspectors carefully study each batch of small parts for detailed perfection.



Tiny tube parts are magnified and their outlines superimposed on scale drawings to insure meeting the extremely close dimensional tolerances required.

SYLVANIA ELECTRIC

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, ACCESSORIES; INCANDESCENT LAMPS

If you want the job done right —

A group of Hytron engineers decided in 1938 that to get those ideal tubes for "ham" radio — they must build them themselves. Combining years of experience in tube manufacture with exact knowledge of the tube characteristics desired, they went to work.

First they concentrated their efforts. Low and medium power types were most needed by the majority of hams. Hytron was equipped to make them. Gradually the engineers translated ideals into a comprehensive line—v-h-f triodes and pentodes, low and medium mu triodes, instant-heating r.f. beam tetrodes, and sub-miniatures.

Hams themselves, the engineers knew their brain children would be given the works. They built the tubes rugged; rated them conservatively. And did the amateur go for them! The v-h-f types — HY75, HY114B, HY615 — soon became accepted standards. Today's WERS operators use them almost exclusively.

Performance in the proving ground of amateur radio was the proof of the pudding. You will find Hytron transmitting and special purpose tubes in war and civilian jobs of all kinds. Like the BANTAM GT and BANTAM JR., they are popular because they are built right for the job.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION

ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

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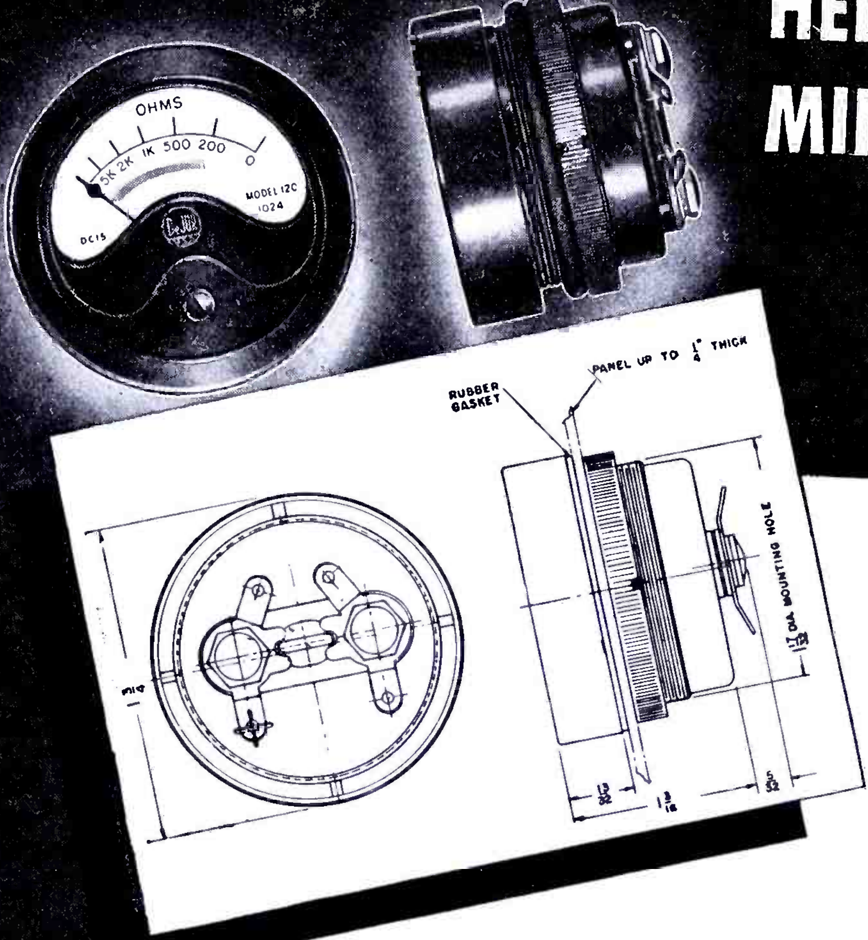
HERMETICALLY SEALED* MINIATURE 1½" METER

(MODEL 120)



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Ideal Component for All Small Equipment

- The smallest meter available, yet capable of performing a full-scale task in a variety of applications.
- Hermetically sealed, it can be immersed in water for as many as seven days without harm to its mechanism.
- The case, as well as the glass, is completely waterproof—thus, if the glass breaks, water still cannot penetrate.
- Since the equipment in which this meter is used must also sustain immersion, terminal studs are waterproof sealed.
- Supplied with the Model 120 is a waterproof gasket for mounting the instrument flange to the panel.
- Quickly and easily installed—only one hole—no drilling, no screws necessary—just tighten on with a ring.
- Ideal for all small equipment—present or postwar. Write for complete specifications and prices.

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AMPHENOL

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Navy No. / Army No. RG-

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Date

Production No.

Spools

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CAPACITANCE

CHARACTERISTIC IMPEDANCE

CAPACITANCE UNBALANCE

COLD BEND TEST

DIMENSIONAL

CONTINUITY

U. S. Government Inspector

AFFIDAVIT

This is to certify that the above information and test results are true and accurate to the best of my knowledge and belief.

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SEAL

*At Amphenol all U.H.F. Cable is thoroly inspected and must bear affidavit of test approval before shipment.

Extra significance is attached to the whole idea of *Quality* when it applies to electronic equipment. High-frequency currents make special demands of a technical nature that go far beyond the standards of good material and high quality workmanship.

Such requirements are a familiar story to Amphenol, one of the pioneers and leaders in the low-loss transmission equipment field. Amphenol makes the most complete line of both solid dielectric flexible U.H.F. Cables and U.H.F. Connectors and they are now being produced in tremendous volume.

Actually Amphenol's own tests and inspections go beyond required performance and tolerances. Amphenol tests for *outstanding quality* assure dependable performance under the most difficult of conditions.

Depend upon **AMPHENOL** *Quality*

U.H.F. Cables and Connectors
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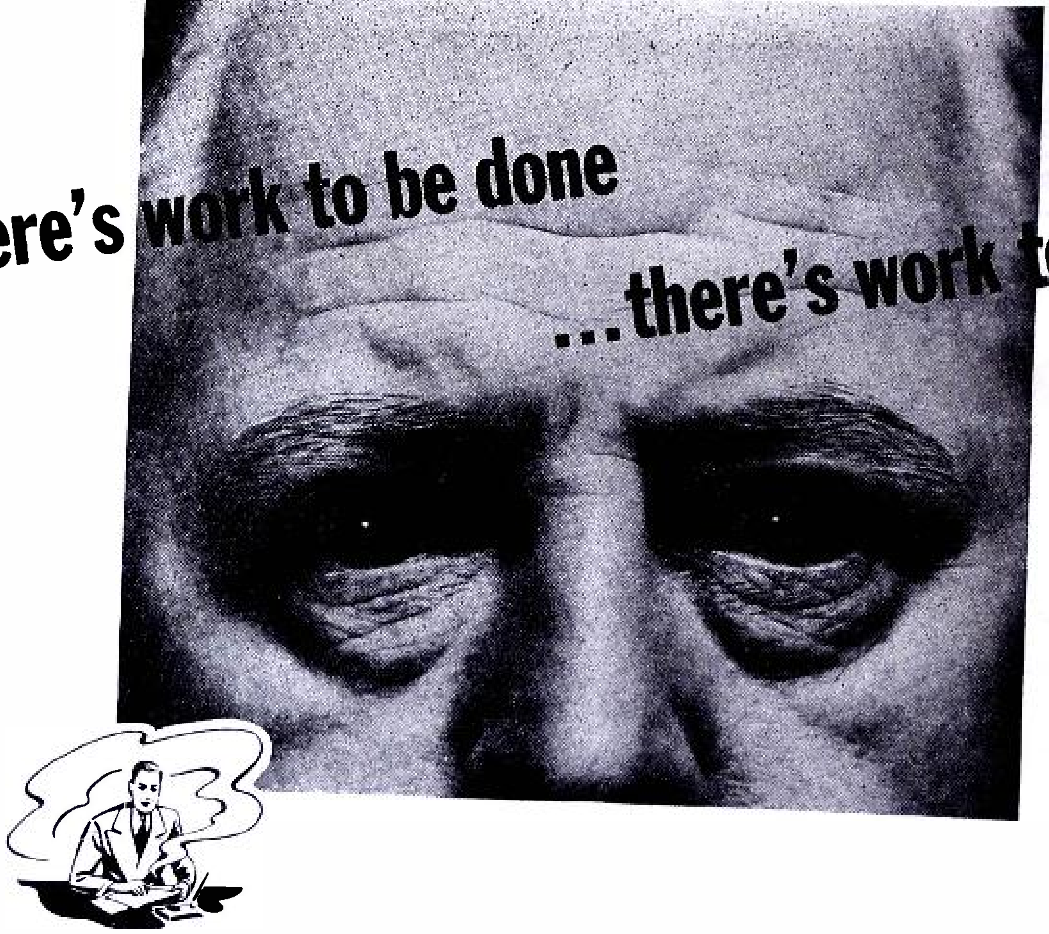
Amphenol U.H.F. Coax Cables with Amphenol Low-Loss Connectors.

...there's work to be done

...there's work to be done



The man behind the desk watched the smoke from his cigarette rise slowly in graceful patterns and then thin out. Through his crowded mind, the words throbbed again and again—there's work to be done . . . there's work to be done . . .

His job as production manager of the plant had always been tough. But never, before the war, had there been the personal urgency in his work that existed now—an urgency that was not for mere personal gain. No, there was a bigger reason.

Somewhere far away . . . it was impossible to imagine just where . . . there were three sons whose very existence depended, in part, on such things as the equipment his plant was turning out.

> There was Doug, a radioman in the Navy, now probably with the task force that was harassing Tokyo . . .
>
> And Ted, so proud of his Signal Corps, was in France plodding over the terrain stringing his precious telephone wires behind him . . .
>
> And Mitchel, the baby of the family and a bomber pilot, his whereabouts were still a big question mark in the man's mind...

All three were depending upon him. Suddenly, the man straightened up. This was no way to produce! This was no way to get the goods to the fighting fronts! As Doug and Ted and Mitchel had remarked as they went their respective ways—there's work to be done.

Yes, there's work to be done . . . lots and lots of work before this war is finally and completely over. It is not the personal assignment of Doug or Ted or Mitchel or this man, their father. It is an assignment that all Americans must continue to share. It is an assignment demanding faster, greater production . . . more purchases of bonds . . . more donations of blood . . . more conservation of paper and scrap and other critical materials. It is an assignment that demands continued total mobilization, continued cooperative effort to finish the work there is yet to be done.

ARHCO RADIO PRODUCTS

American Radio Hardware Co., Inc.
152 MACQUESTEN PARKWAY SOUTH • MT. VERNON, NEW YORK
MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

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JOHNSON *for*
HIGH POWER COMPONENTS

To meet the need for a light-weight, high-capacity, high-voltage tank condenser for transmitter applications, Johnson engineers developed a new type of condenser. The unit illustrated has a capacity of 1200 mmf. at a peak voltage of 40,000 volts at 2 megacycles. Nearly any combination of capacity and voltage ratings may be had. The capacity may be varied in the field by removing plates or altering spacing.

The plates are made of fabricated sheet steel, heavily copper plated and enamelled. Rounded edges increase the breakdown voltages. Vertical tie rods of copper tubing furnish good conductivity between plates. Plates are secured to the upright supports with aluminum castings.

A protective gap is incorporated in the condenser to protect the plates from damage in case of excessive voltages or surges. The mounting base is welded channel iron, which forms a strong support. A very convenient mounting for the tank inductance is formed by the two cross beams at the top of the condenser.

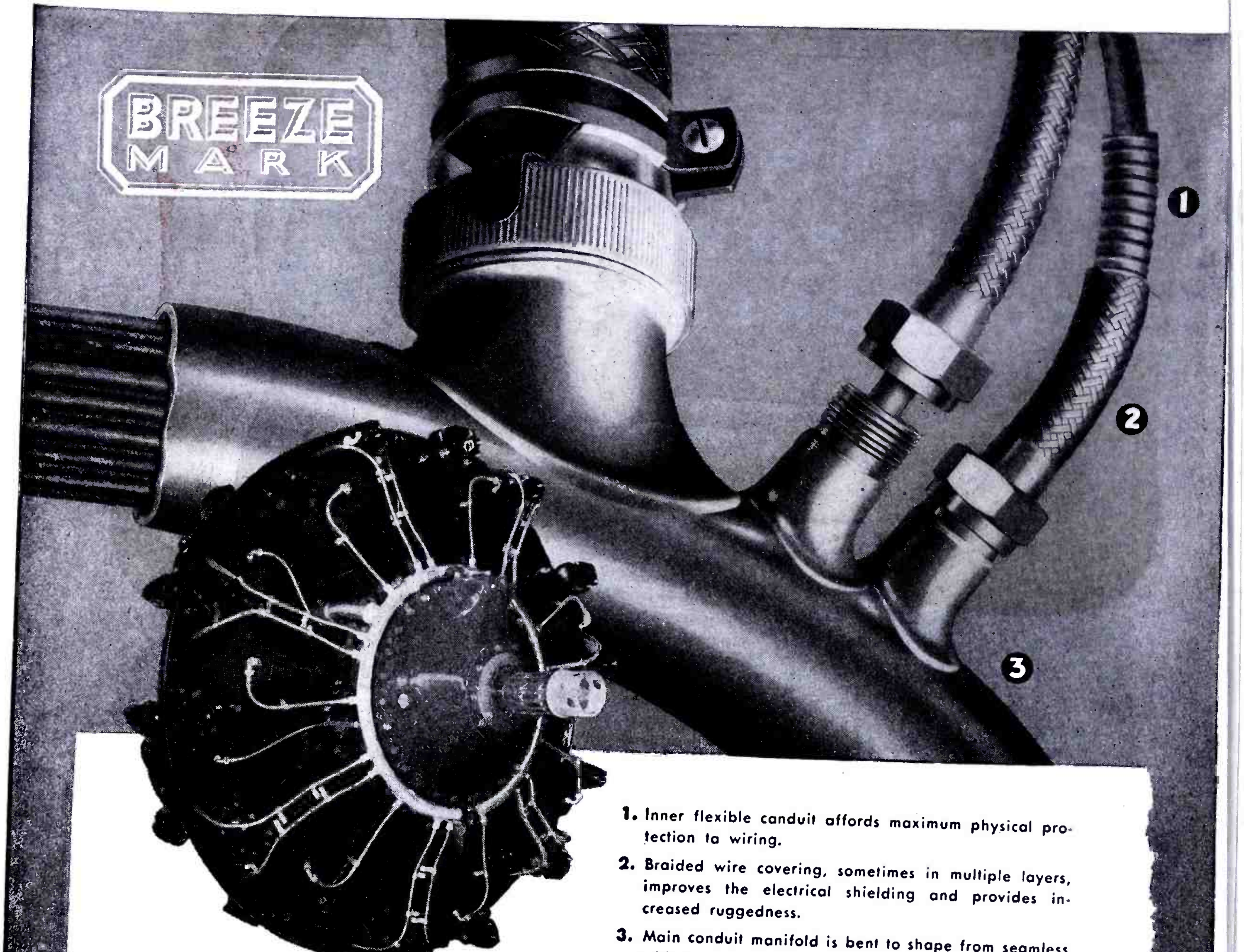
This condenser will find wide application in high power equipment because of its compact and efficient construction.

Ask for Catalog No. 968E

Other JOHNSON Products for High Power • • • • • **INDUCTORS**, variable & fixed• **TRANSMISSION LINE EQUIPMENT**• **SOCKETS**• **SWITCHES**• **COUPLINGS**• **CHOKES** • **ANTENNA PHASING UNITS**• **GAS-FILLED CONDENSERS**• **CONTACTORS INSULATORS**

JOHNSON
a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA



1. Inner flexible conduit affords maximum physical protection to wiring.
2. Braided wire covering, sometimes in multiple layers, improves the electrical shielding and provides increased ruggedness.
3. Main conduit manifold is bent to shape from seamless tubing.

Electrically Sealed Circuits

WITH BREEZE RADIO IGNITION SHIELDING

The Breeze Radio Ignition Shielding which equips the modern aircraft engine is the product of extensive laboratory test and research.

Effective shielding calls for a metal case of high conductivity around possible sources of radio interference, designed to lead off high frequency impulses to the ground and prevent their radiation. Each installation must be custom engineered to meet the needs of the problems involved.

Breeze Shielding is designed for ruggedness, resistance to vibration, and maximum isolation of high frequency interference. Each wire of the braided cover must be positively soldered at each connection, inner conduit must be tight to avoid electrical leakage, and fittings must be precision-machined for close fit and uniform pressure of contact faces.

New shielding problems presented by the rapid advance in the science of radio communication and television are constantly being solved by Breeze engineering. A background of many years experience in shielding automotive, aircraft, marine and commercial engines has made Breeze America's headquarters for Radio Ignition Shielding.

Breeze BREEZE MARK
CORPORATIONS, INC.
Newark, New Jersey

The Greeks gave us a word for it . . . now we give it to *you*

WHEN Sperry first developed its velocity-modulated, ultra-high-frequency tube, the word "KLYSTRON" was registered as the name of the new device.

This name — from the Greek, as coined by scientists of Stanford University — is an apt description of the bunching of electrons between spaced grids within the tube.

"Klystron" is a good name. So good, that it has come into widespread use as the handy way to designate *any* tube of its general type, whether a Sperry product or not.

This is perfectly understandable. For the technical description of a Klystron-type tube is unwieldy, whether in written specifications, in conversation, or in instructing members of the Armed Forces in the operation of devices employing such tubes.

These conditions have prompted many requests from standardization agencies — including those of the Army and Navy — for unrestricted use of the name Klystron. In the public interest, Sperry has been glad to comply with these requests . . .

From now on, the name KLYSTRON belongs to the public, and may be used by anyone as the designation for velocity-modulated tubes of any manufacture.

Sperry will, of course, continue to make the many types of Klystrons it now produces, and to develop new ones.

On request, information about Klystrons will be sent, subject to military restrictions.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

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"My Make-Believe Ballroom Needs Transcription Equipment That's Really Rugged!"

Martin Block

"That's why our installation is PRESTO"

"Our PRESTO transcription turntables get a real workout here at WNEW," says Martin Block, popular announcer and director of the *Make-Believe Ballroom* program. "We keep them running almost continuously throughout the day. And they're giving the same fine, clear reproduction today that they gave when we installed them years ago. As an announcer, that means a lot to me. It's a nice feeling to know that my transcribed show is getting out 'in good voice!'"

From users of PRESTO equipment all over the country comes the same story: "It's rugged, it's dependable, it stands the gaff!" The increased use of transcribed material in wartime broadcasting has placed a heavy burden on all recording and playback equipment. PRESTO users—including many of the major broadcasting stations—have found that their equipment is handling the job with ease. That's because PRESTO devices are products of integrity—built to do *more* than will ever be expected of them.

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

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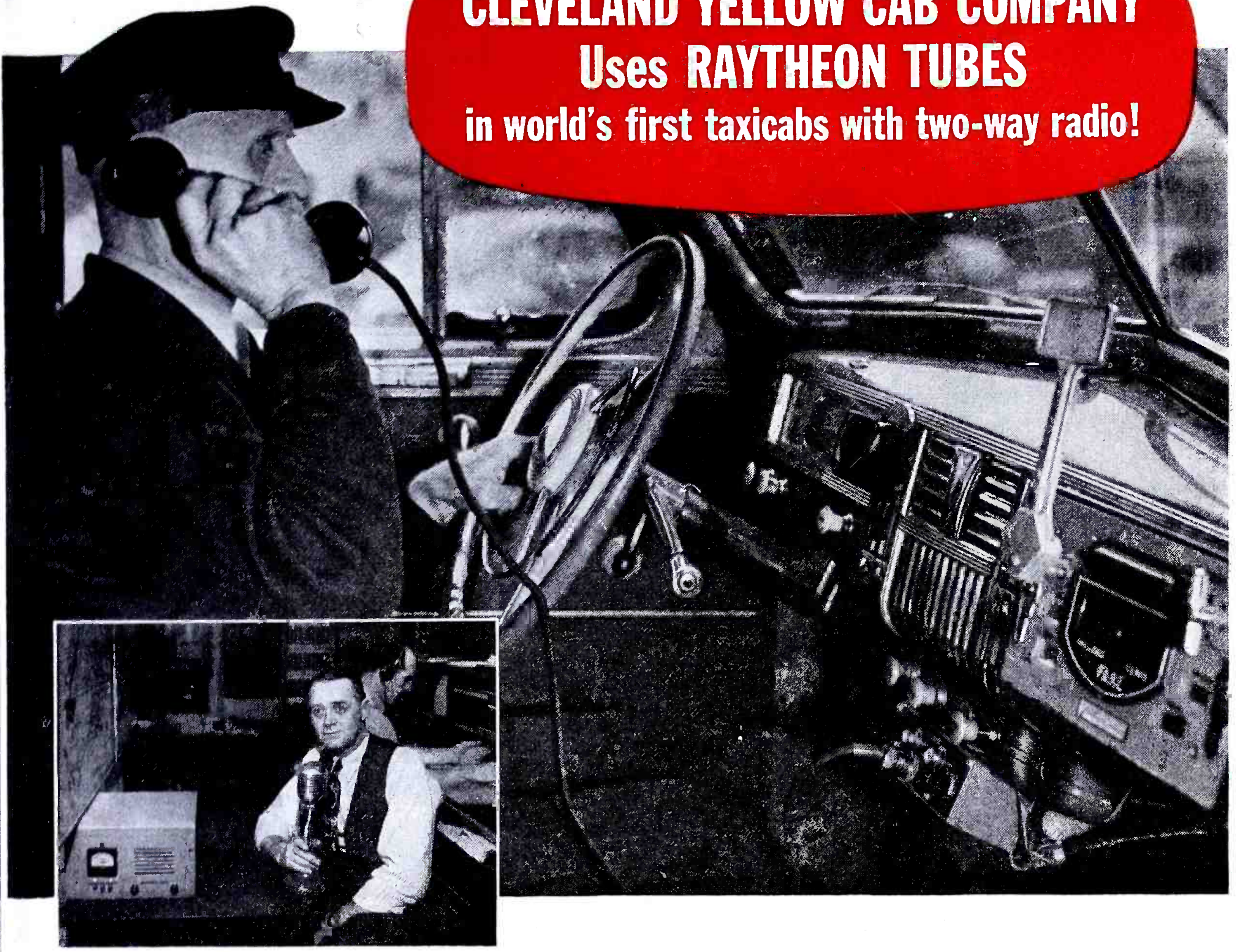
Walter P. Downs Ltd., in Canada

CLEVELAND YELLOW CAB COMPANY Uses RAYTHEON TUBES in world's first taxicabs with two-way radio!



The eyes of the nation's transportation industry are on Cleveland these days, for it is there that the world's first taxicabs equipped with two-way radio are being demonstrated by the Cleveland Yellow Cab Company.

Officials say that dispatching has proved so much more efficient that future fleets similarly equipped will eliminate millions of miles of wasteful "dead" cruising. And they also report that Raytheon High-Fidelity Tubes, used in both transmitter and receivers, provide clear, dependable reception — even in the tunnels under Cleveland's Terminal Tower.

This application of Raytheon Tubes is just one of many being planned for the postwar period by progressive manufacturers in the electronics field.

If you are a radio service dealer, you, too, should realize that Raytheon's combined prewar and wartime tube experience will result in even *better* tubes for all uses. Keep an eye on Raytheon . . . and watch for a Raytheon merchandising program that will help you be more successful, in the peacetime years ahead, than you've ever been before!

• • •

Increased turnover and profits . . . easier stock control . . . better tubes at lower inventory cost . . . these are benefits which you may enjoy as a result of the Raytheon standardized tube type program, which is part of our continued planning for the future.

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Every Saturday Night
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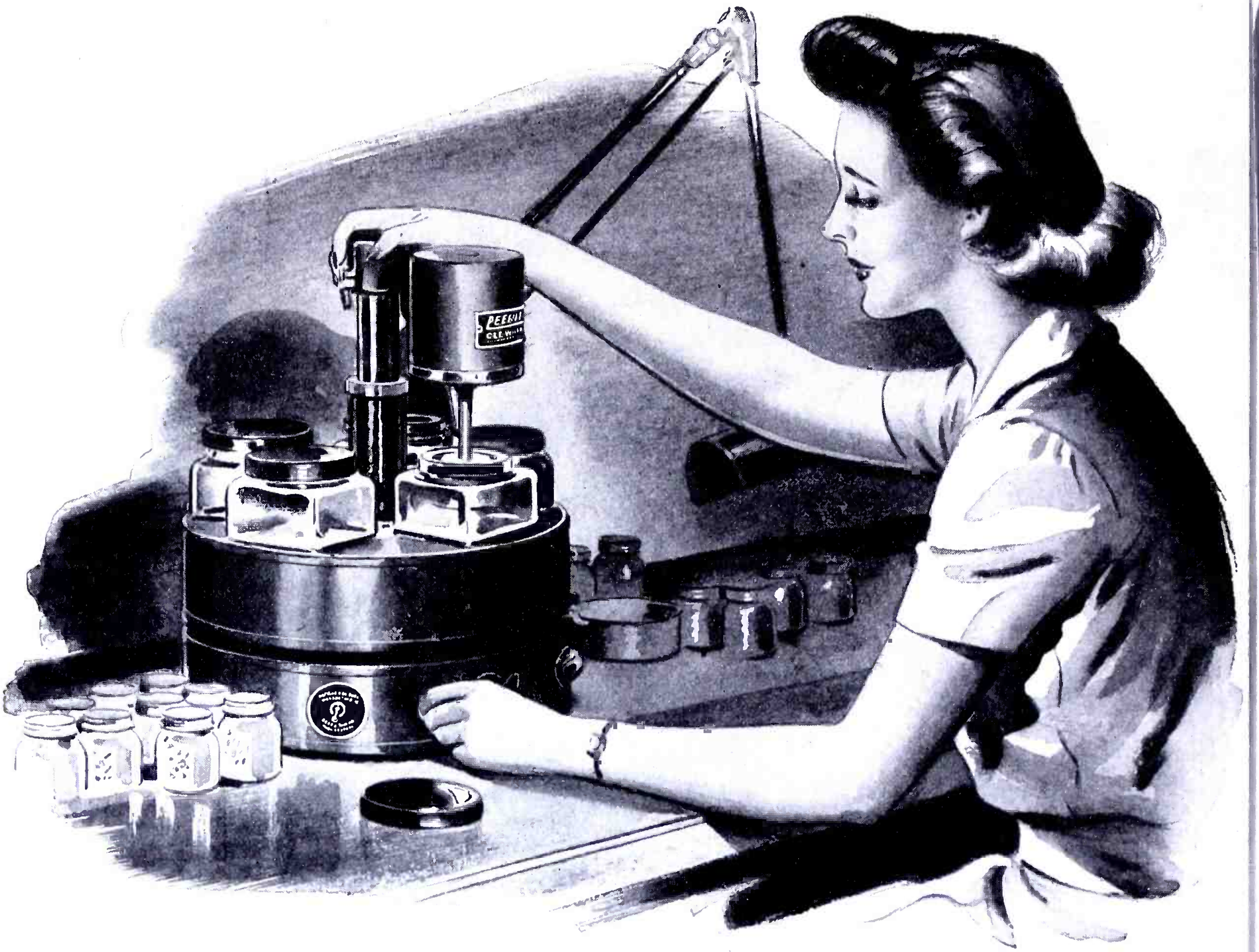
Have Been Awarded
Army-Navy "E"
With Stars

RAYTHEON
High Fidelity
ELECTRONIC AND RADIO TUBES

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS



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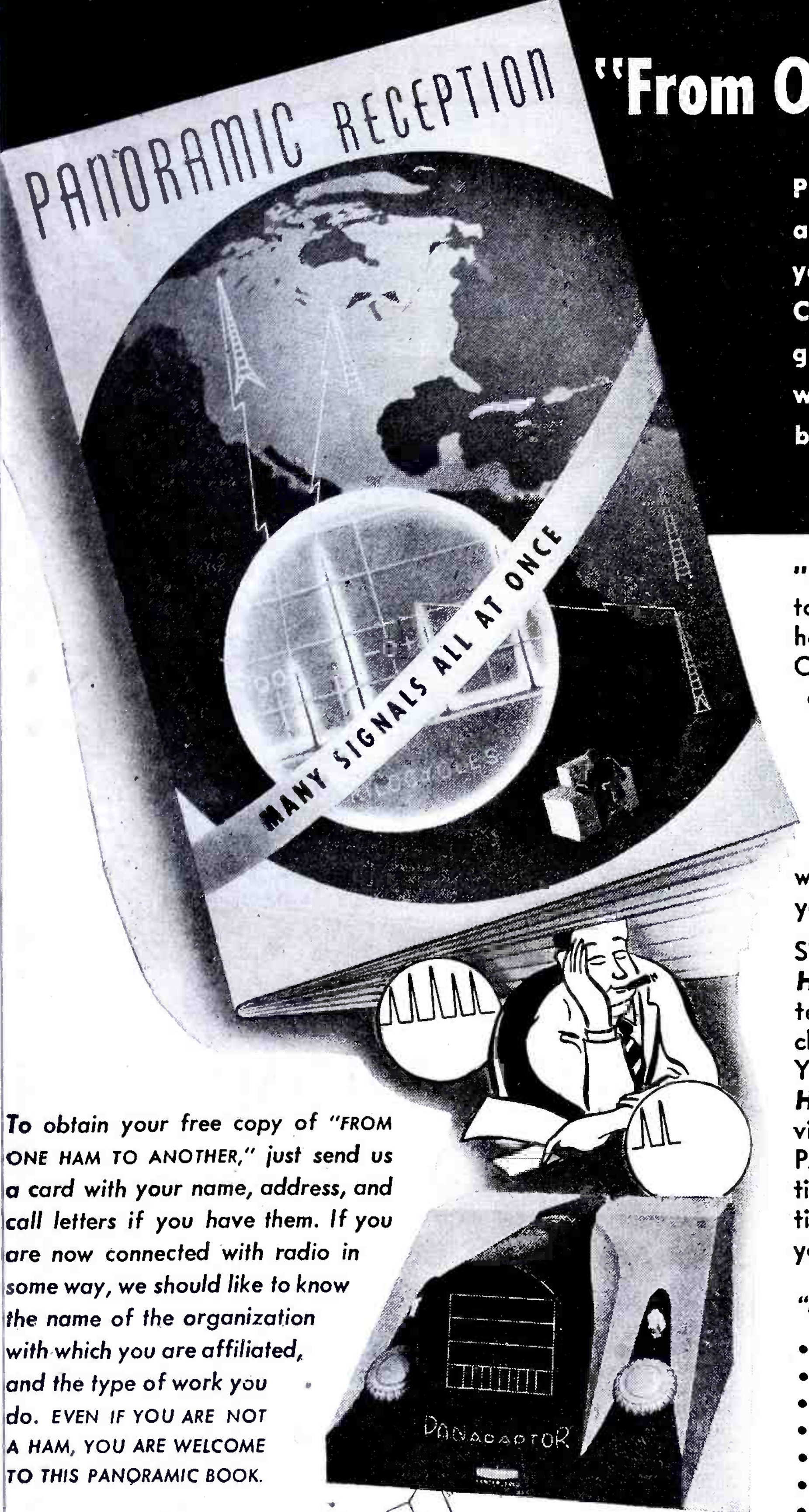
PANORAMIC'S

FASCINATING, NEW BOOK FOR AMATEUR RADIO OPERATORS!



"From One Ham to Another"

Packed full of brand new information on amateur radio operation! Shows how you can solve many of your problems! Completely explains, in your own language, the PANORAMIC Technique, and what it will mean to you when you get back to your rig!

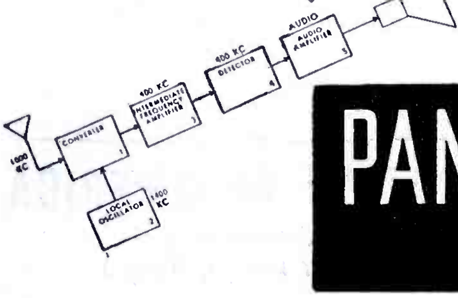
"From One Ham to Another" tells you how to get the most out of your rig. It shows you how you can have even more satisfactory QSO's with your friends all over the world. In detail it describes the problems that confront amateur radio operators . . . and proposes solutions. For example, after you have read ***"From One Ham to Another,"*** you will know how to reduce the number of missed signals, how to determine quickly which frequencies are free, how to step up your efficiency.

Simple and pleasant to read, ***"From One Ham to Another"*** is written for the ham in terms you use. And you will be amused by the clever cartoons that illustrate it throughout. You will want to file and keep ***"From One Ham to Another"*** for the new ideas it provides. You will learn about the role that the PANADAPTOR will play in future ham operations. You'll be thrilled by the stories of wartime applications of this technique. Send for your free copy today!

***"From One Ham to Another"* discusses such subjects as:**

- **Watching for CQ's**
- **Answers to CQ's**
- **Operation of nets**
- **Choosing a spot in the band for your xmtr**
- **Helping your brother ham**
- **Reading signal strength**
- **Logging the frequencies of your friends**
- **And many other topics of great interest**

To obtain your free copy of "FROM ONE HAM TO ANOTHER," just send us a card with your name, address, and call letters if you have them. If you are now connected with radio in some way, we should like to know the name of the organization with which you are affiliated, and the type of work you do. EVEN IF YOU ARE NOT A HAM, YOU ARE WELCOME TO THIS PANORAMIC BOOK.



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A complete, compact test-bench in a single unit!

...the new RCA 170-A AUDIO CHANALYST

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97-6136-110

● With the 170-A you can systematically test any sound system completely for failure to operate, weak output, interrupted operation, and distorted or noisy output.

● You can check the presence, absence, or character of a signal throughout its path—from source to load.

● You can check gains or losses, measure component values, and test the voltages of any item supporting or controlling the signal.

● You can narrow down poor performance to its cause, and locate the defective part in an amazingly short time.

● You can use it to solve signal-interruption problems by multi-channel monitoring.

● In an emergency, you can use the RCA Audio Chanalyst to substitute for defective amplifiers by bridging the signal through it, and thus around the defect.

BUY MORE WAR BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

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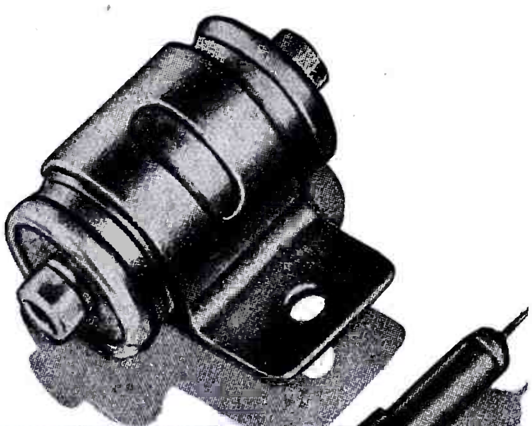
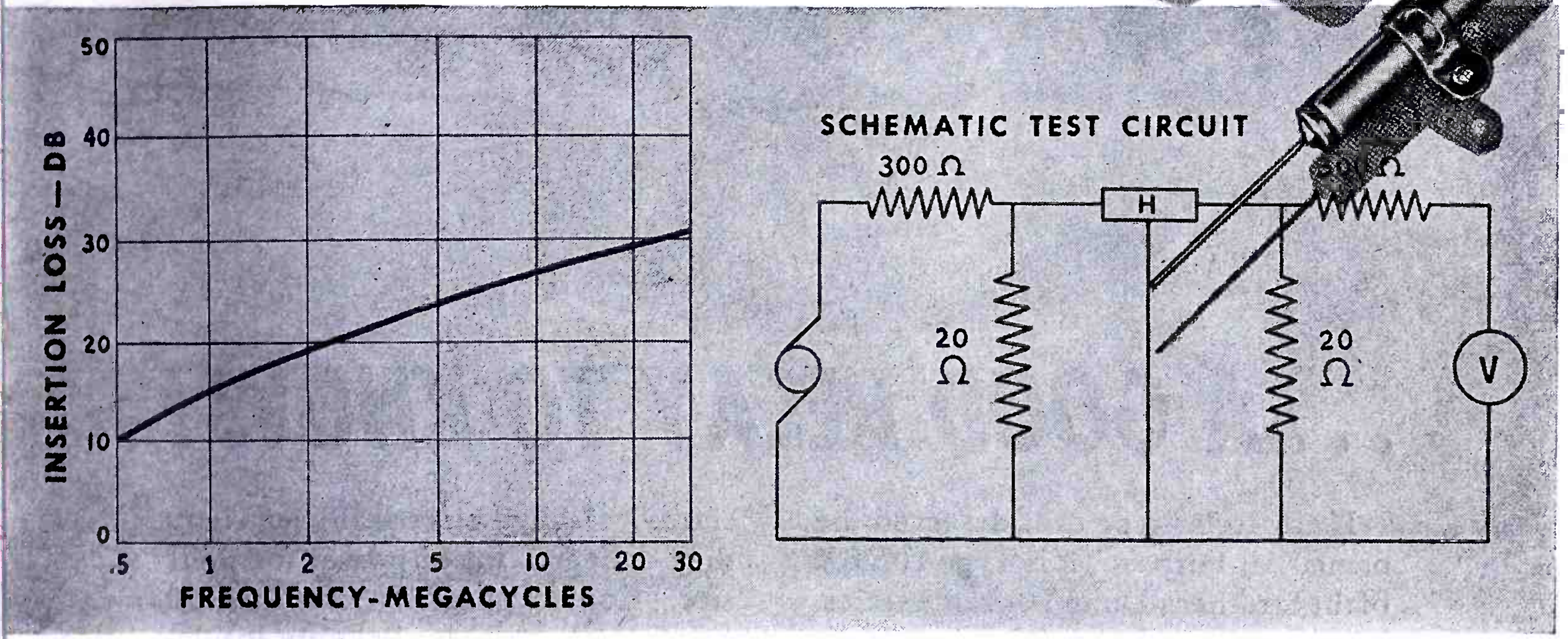
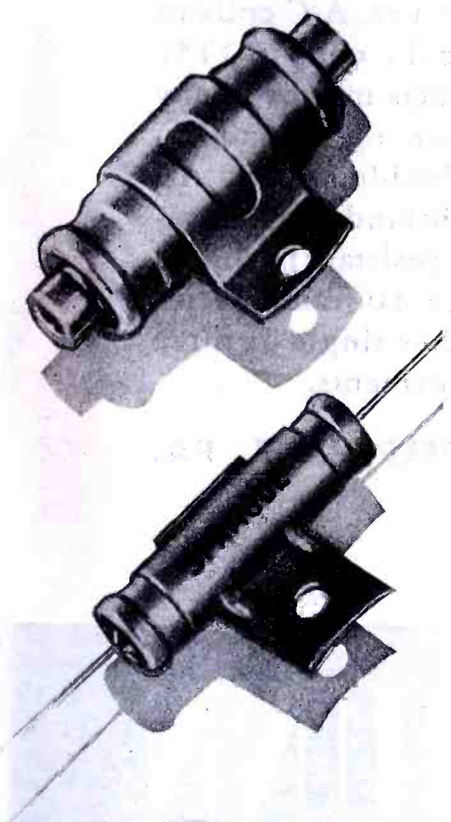
SPRAGUE HYPASS CAPACITORS





Curve showing insertion loss of a Sprague HYPASS Capacitor.

The Solution to "WHAT TO DO WITH ANTI-RESONANT FREQUENCIES?"



Conventional methods of getting rid of vibrator "hash" usually call for the use of a by-pass capacitor, shunted by a mica capacitor. This system, however, has at least one anti-resonant frequency. Of course the engineer juggles his constants so that this anti-resonant frequency comes where it causes the least trouble—BUT, in today's all-wave devices, there just isn't any such place!

The New Sprague Method is simply to utilize the Sprague HYPASS Capacitor. Technically, this is a 3-terminal network which, at low frequencies, "looks" like a capacitor in respect to its capacity, voltage rating, and size. At high frequencies—well, the above diagram tells the story. Although accurate measurements of their performance at the very high end of the spectrum are difficult to obtain as yet, qualitative indications show that HYPASS units do the job at 100 megacycles and more—so much so that, if you have a "hash" problem, we'd welcome an opportunity to stack them against it.

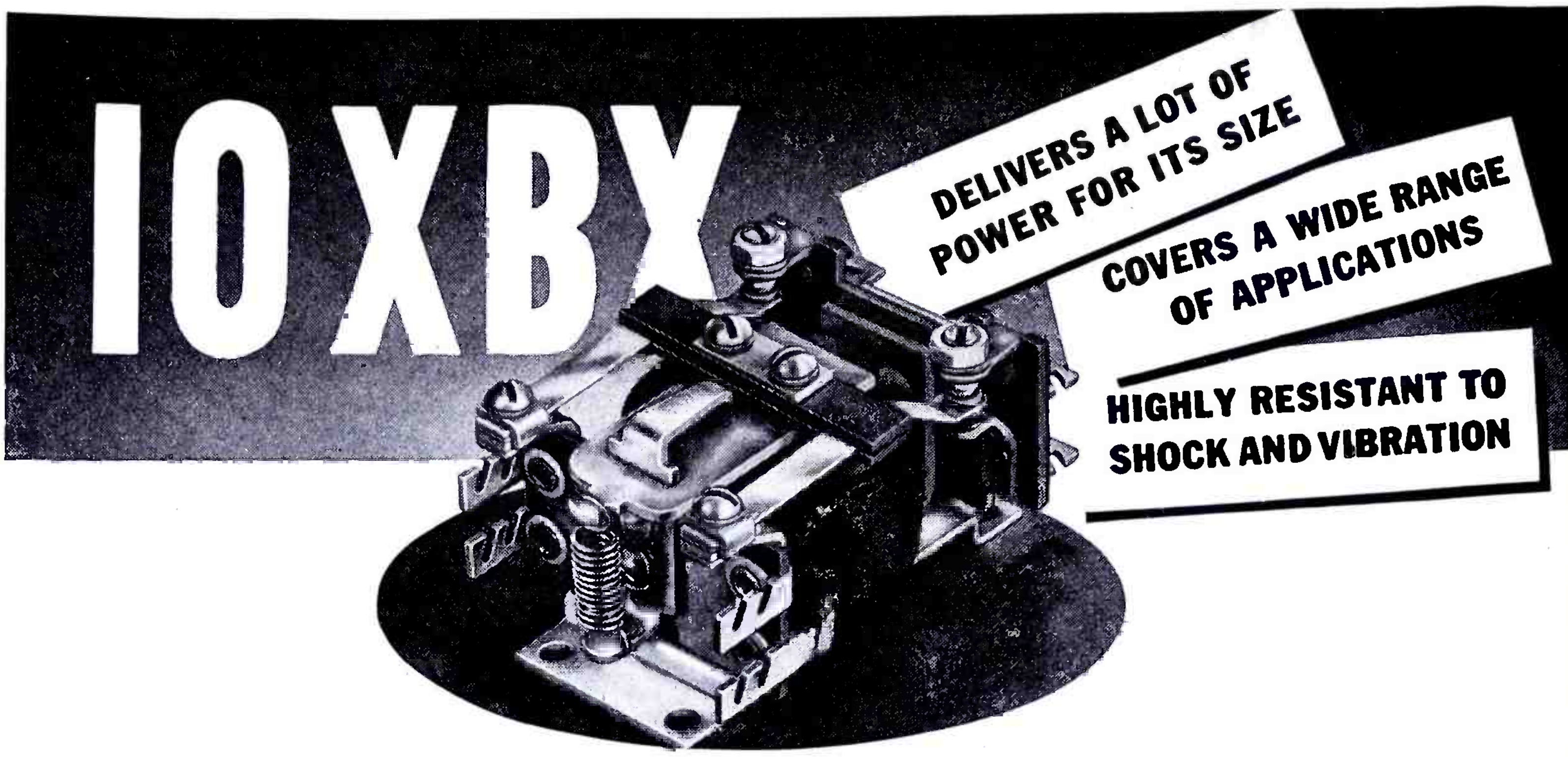
SPRAGUE ELECTRIC COMPANY, *North Adams, Mass.*
(Formerly Sprague Specialties Co.)

*T. M. REG. U. S. PAT. OFFICE

SPRAGUE

ARMY E NAVY

CAPACITORS — *KOOLOHM RESISTORS



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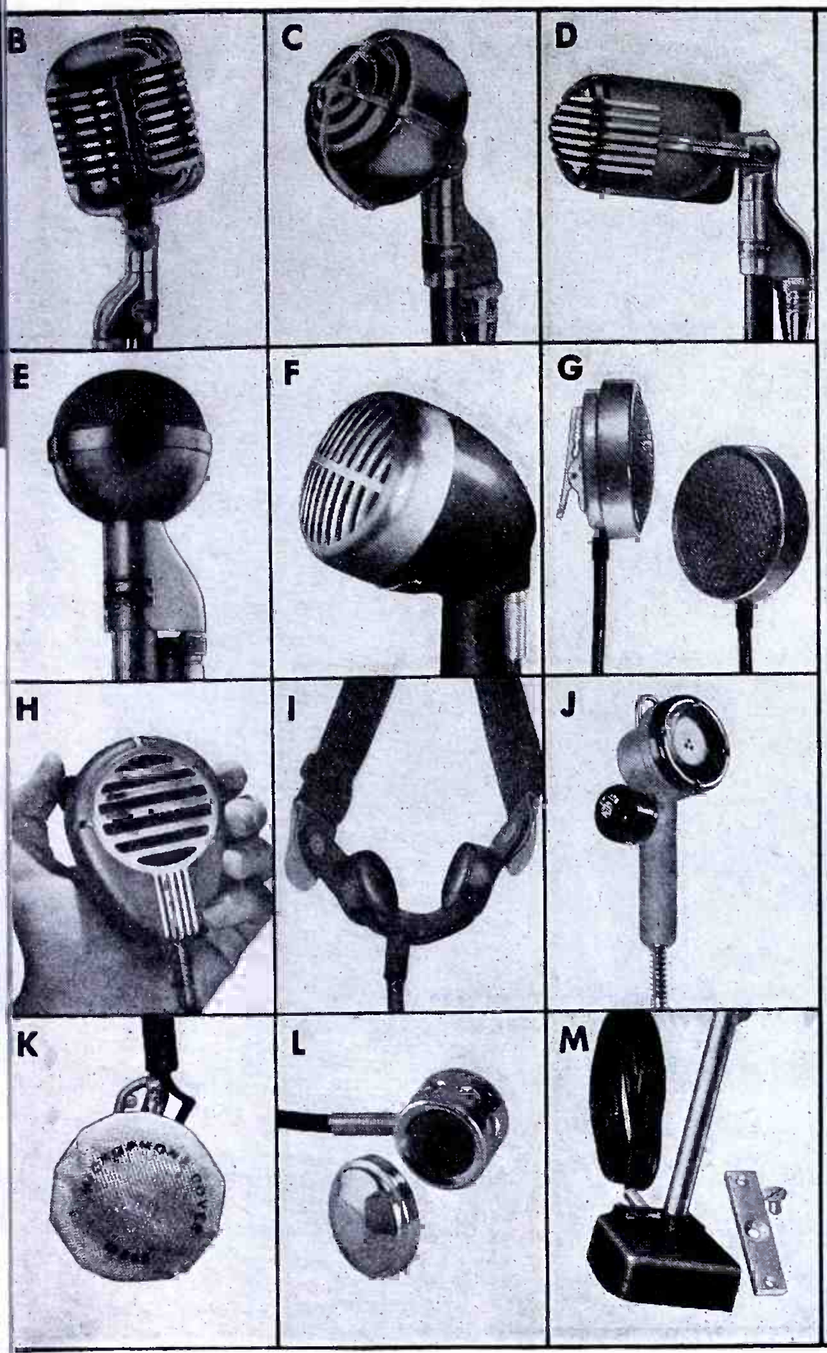

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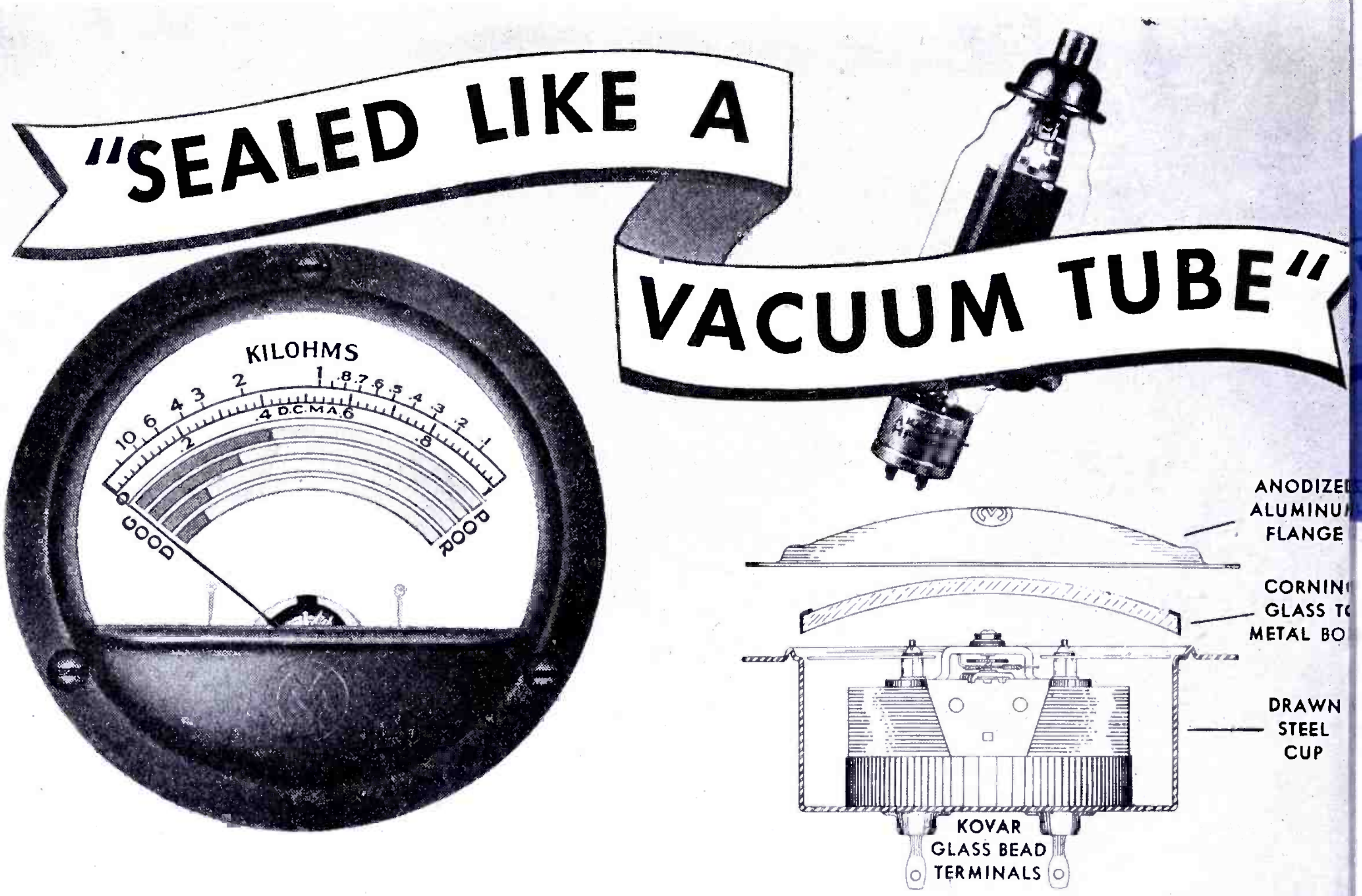

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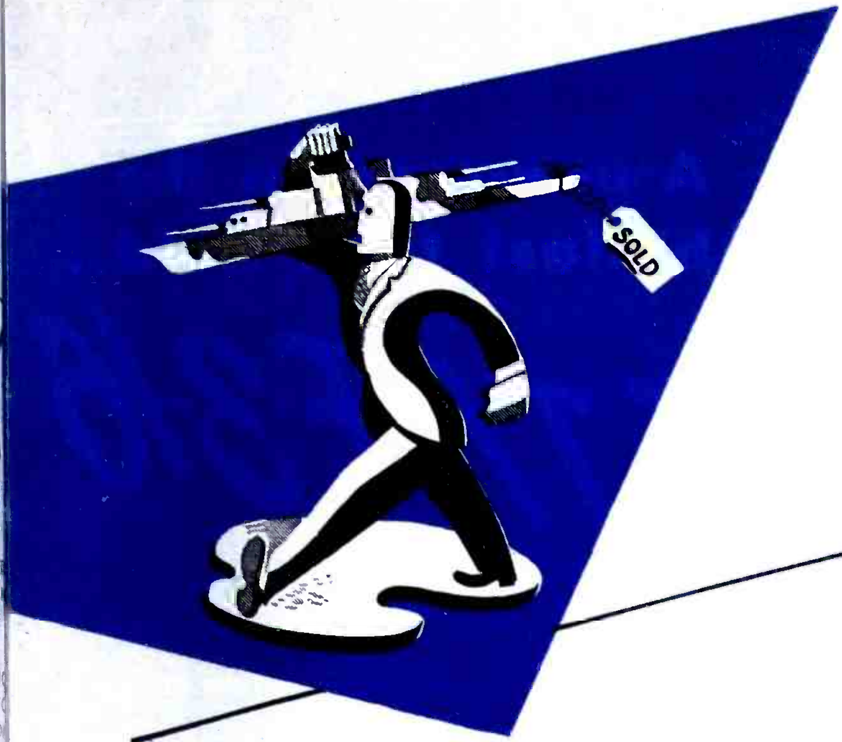

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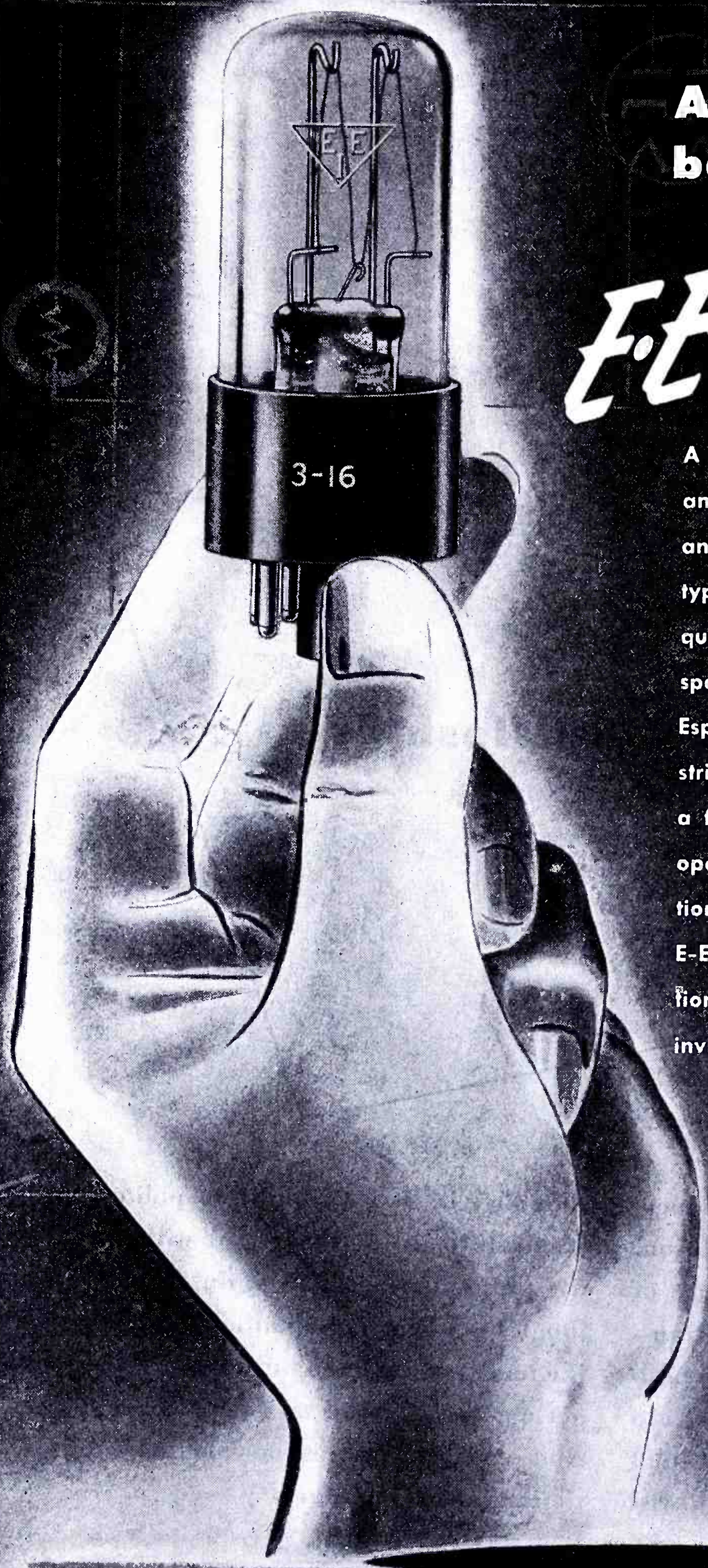

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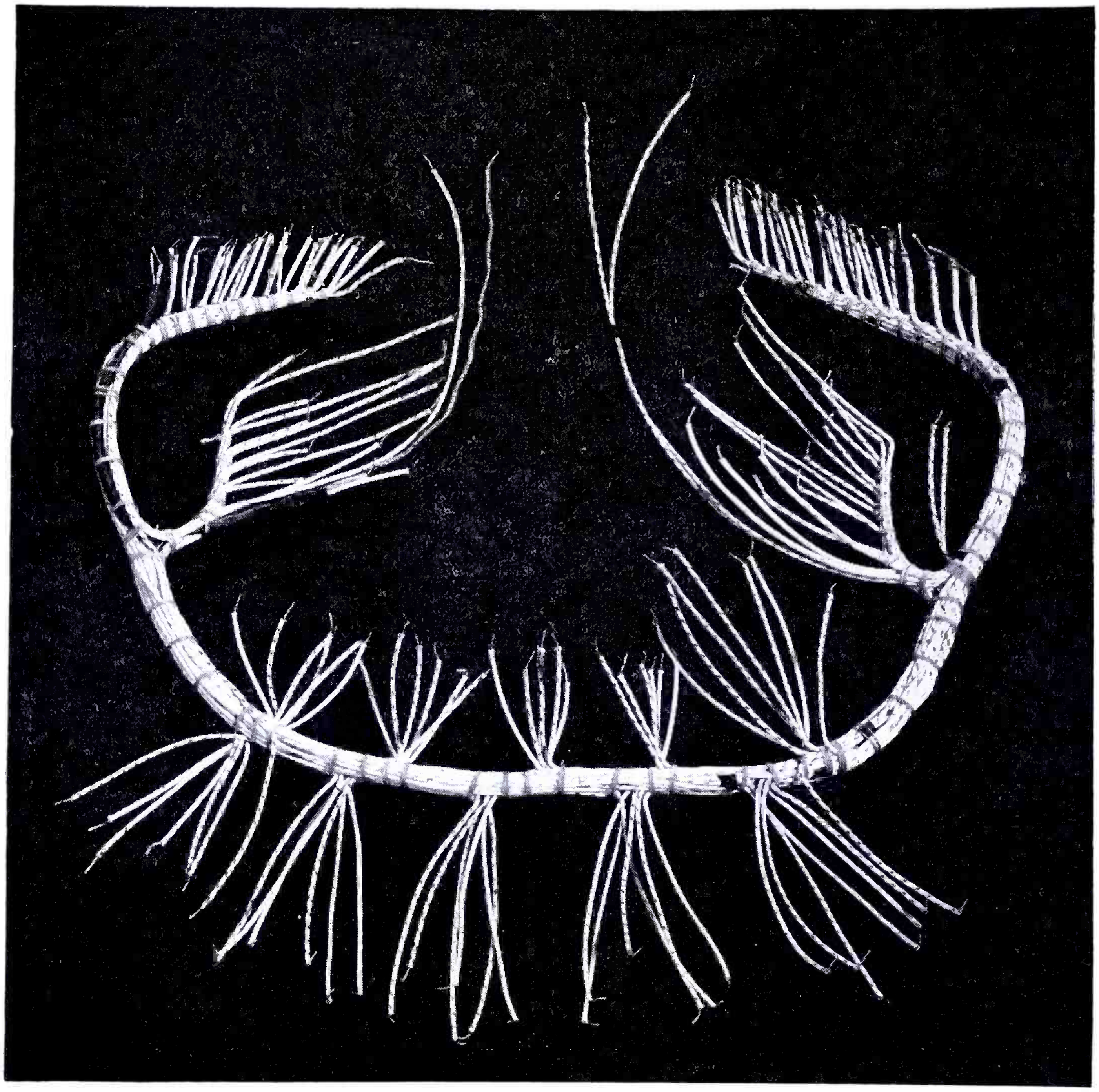

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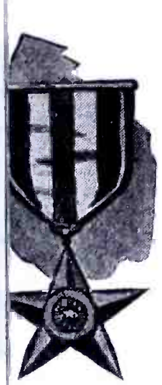

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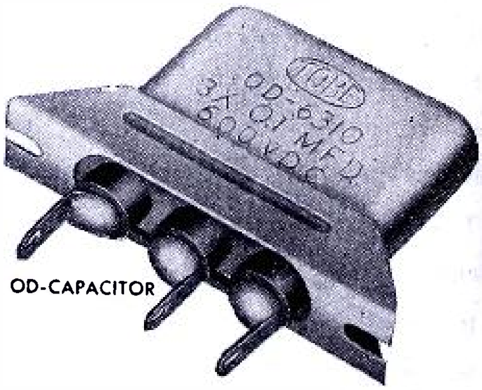

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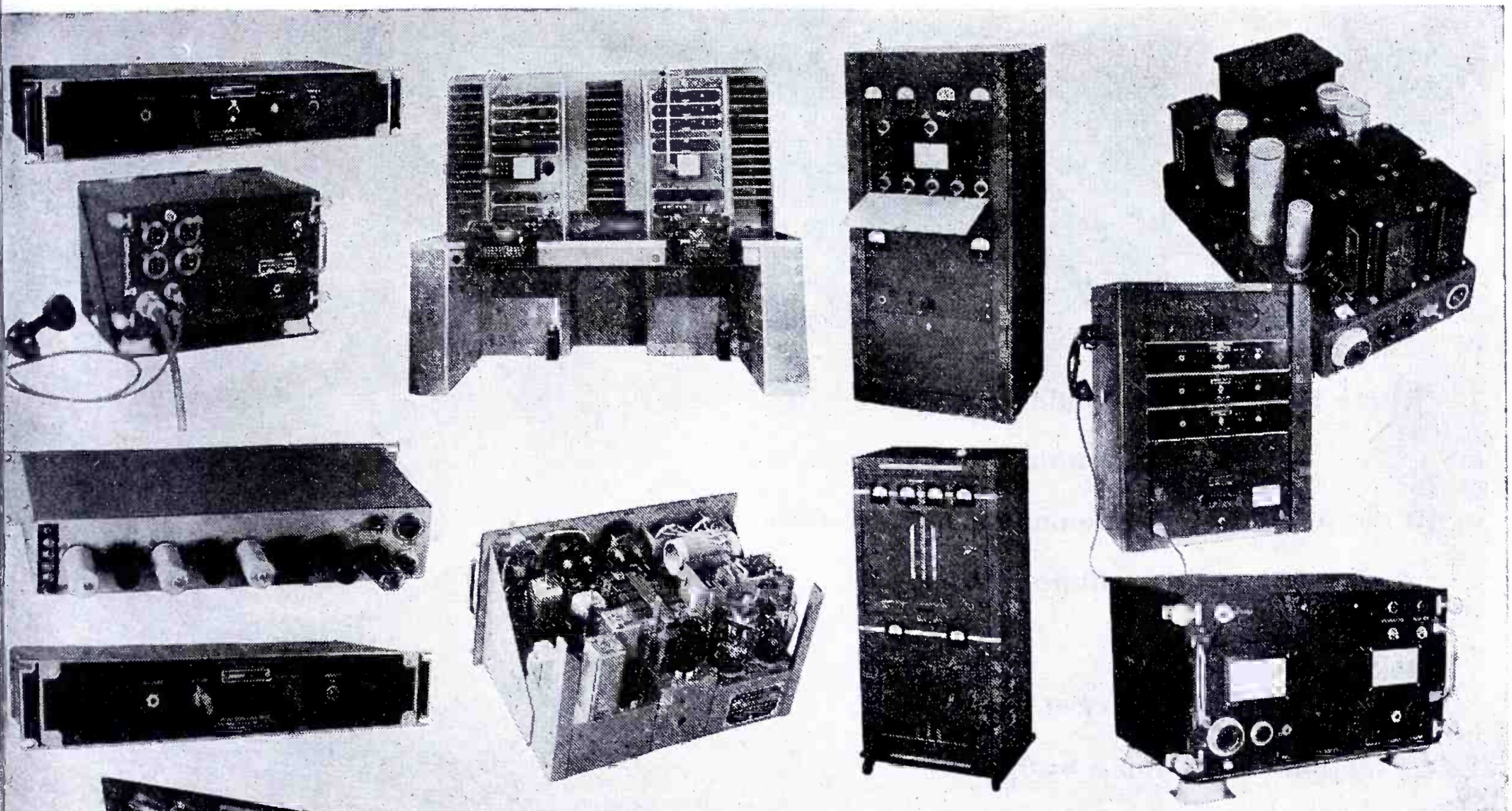

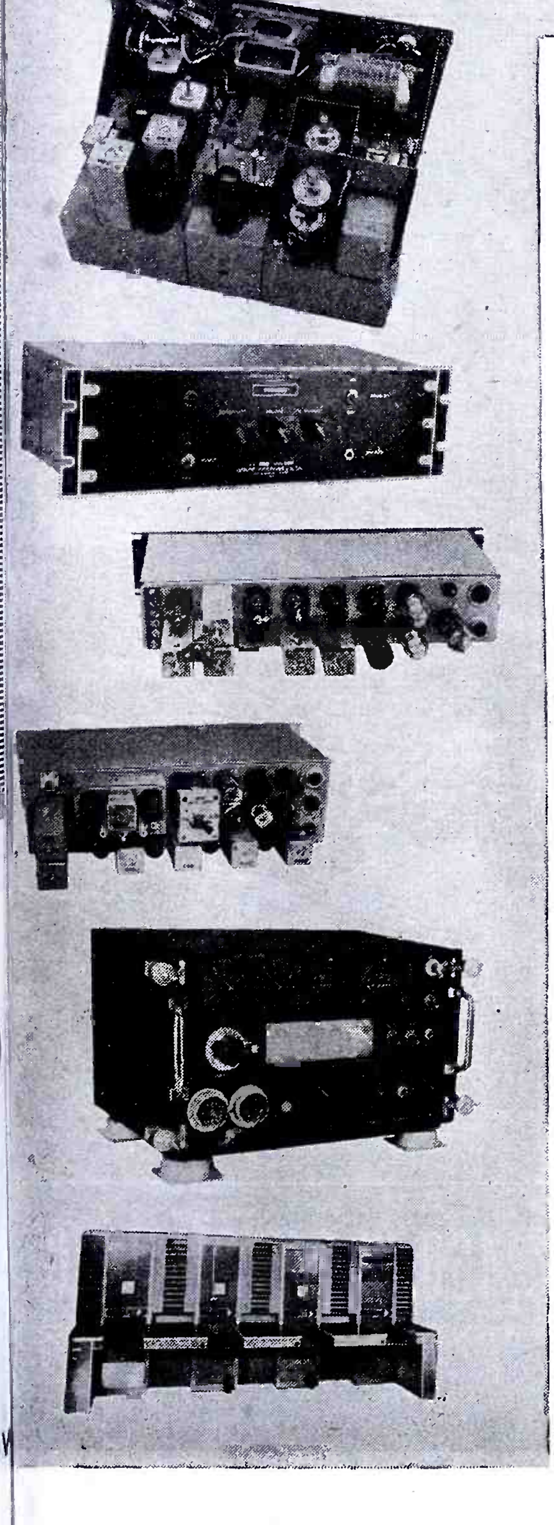

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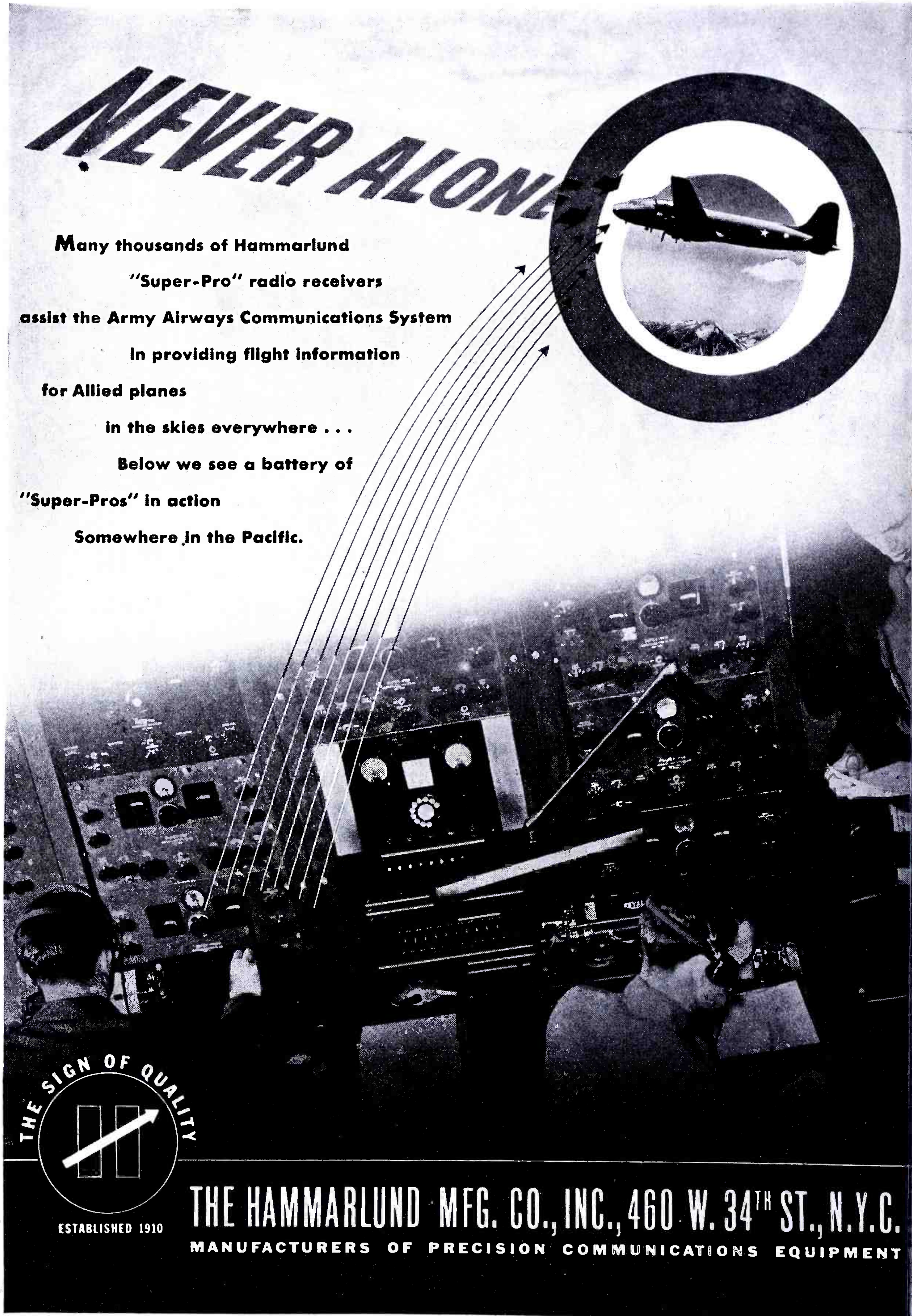
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LEWIS WINNER, Editor

* * MARCH, 1945 * *

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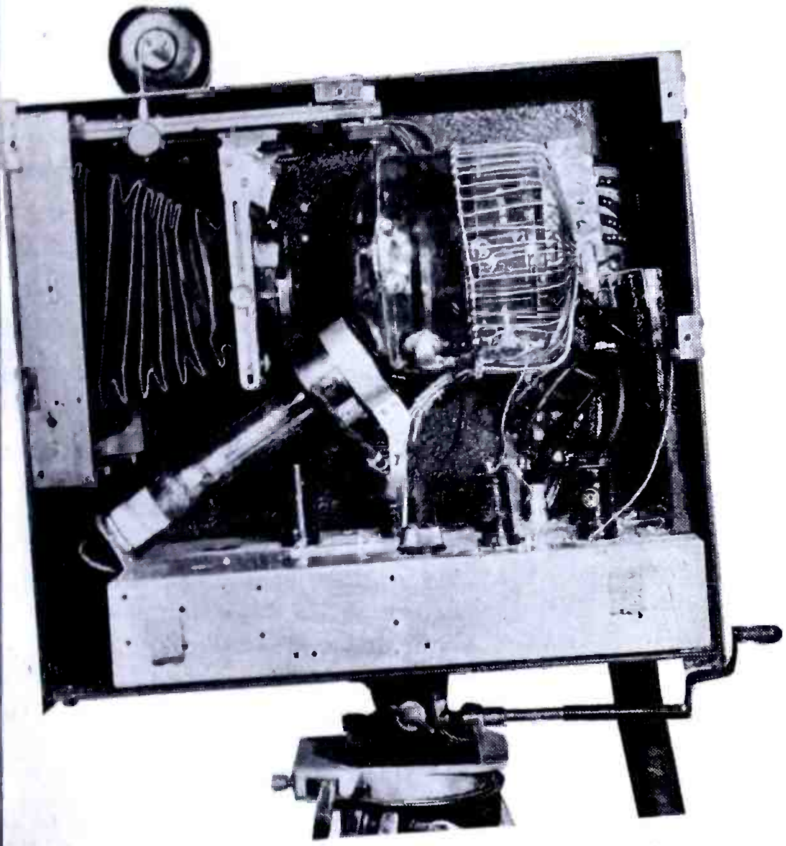

Figure 1 (*a*)
Camera, iconoscope and pre-amplifier.

by ALBERT PREISMAN
Consulting Engineer
Capitol Radio Engineering Institute

N the course of building television studio equipment in our laboratories for use in the school, several teresting circuit modifications were cluded.

The original, operative system was nproved to take advantage of the wer standards of 525 lines-per-pic- re. The synchronizing generator d already been altered, and it reained to widen the video amplifier ndwidths to 6 mc, and to improve e linearity of the deflection genera- rs.

The equipment was designed to cilitate instruction. However, the sign format was essentially the same a commercial station. Most of the its are being built in duplicate. They ll then be further broken down into parate items for laboratory use. In this way, the students will be able to perform individual experiments without throwing the rack equipment out of adjustment. The latter can then be employed to instruct the students in operational technique.

The basic layout of the system is shown in Figure 1 (*b*). A switch enables either the monoscope or the iconoscope chain to be connected to the transmitter line. The video mixing and line amplifier has high gain, and amplifies the incoming signal to a level sufficient to drive the monitor picture tube directly, particularly since the latter is located physically close to it. A simple connecting wire (*no coaxial cable*) connects the amplified output directly to the grid of the picture tube. Since the capacity of the wire to ground is low, the gain of the last stage can be kept high. Further, since the level of the signal is high, any noise signal picked up has negligible effect upon the picture.

Monoscope Pre-Amplifier

The monoscope is coupled to its two-stage pre-amplifier through a video coupling circuit having an 1800-ohm resistor. While this is low, the output of the monoscope is sufficiently high to give a satisfactorily high signal-to-noise ratio, and the coupling impedance has a flat response up to 6 mc. One stage having a gain of about six is employed, followed by a cathode-coupled stage to feed a 70-ohm coaxial line which is terminated at the video mixing amplifier.

The cathode-coupled stage, Figure 2,

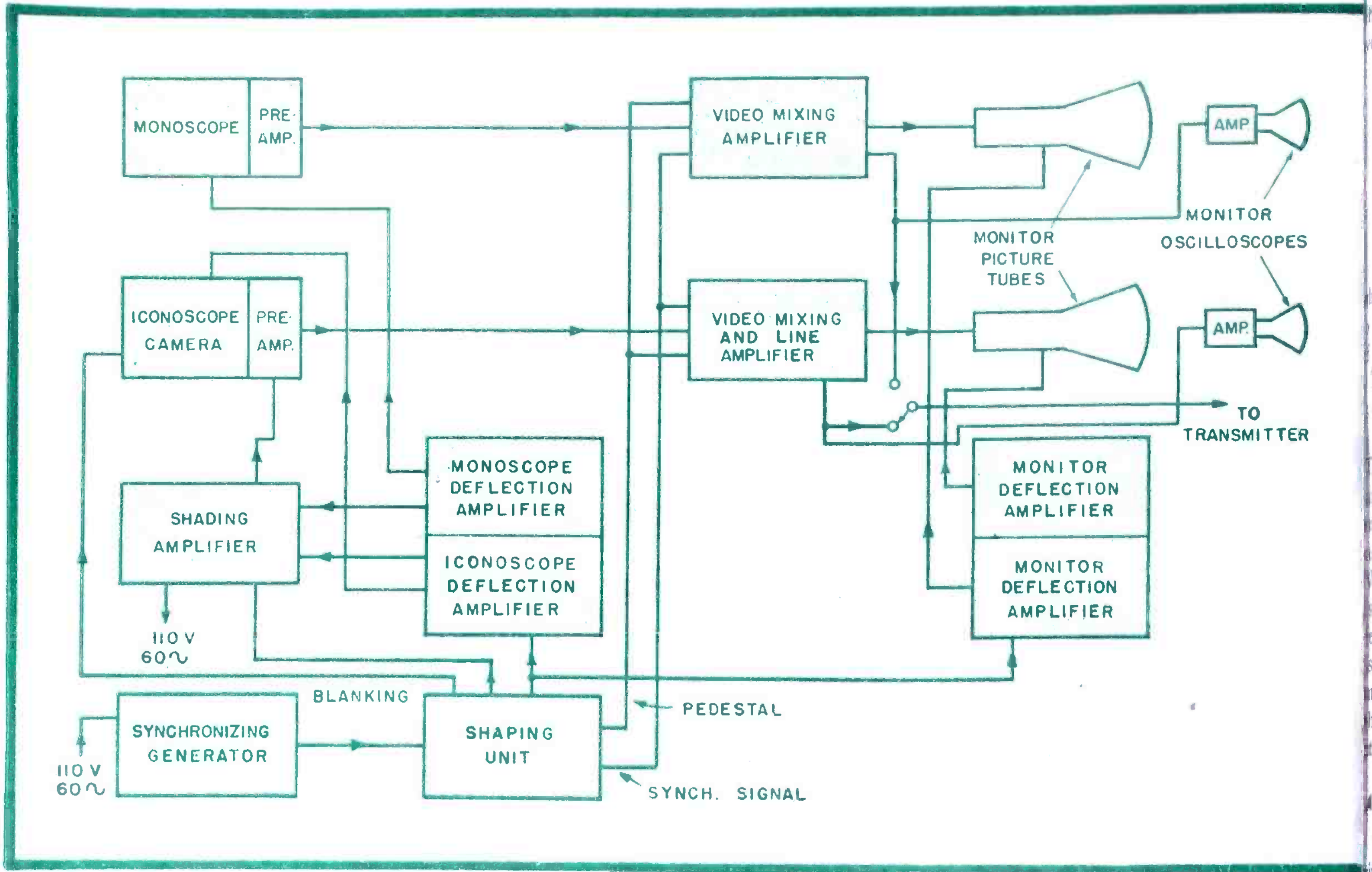

Figure 1 (b)
Block diagram of system.

is of interest. When the coaxial cable with its 70-ohm termination (at the video mixing amplifier) is connected to the cathode-coupled stage, the cathode-bias resistance is only about 70 ohms, instead of the 140 ohms specified for proper bias (2 volts). To bring the bias up to 2 volts, a 25,000-ohm bleeder resistance is connected between the cathode and the + 300 volt terminal to increase the voltage drop across the 70 ohms to the required value. At the same time the 25,000-ohm resistor constitutes a negligible shunt (in conjunction with the power supply) across the 70-ohm resistor as far as the video signal is concerned. This seemed to be the simplest of several possible methods to accomplish the same result. Figure 3 shows the monoscope unit, with the shield cover removed.

Camera Details

The iconoscope pre-amplifier consists of four video stages, because the signal level is lower than that of the monoscope. The last stage is also a cathode stage to feed the coaxial cable leading to the video mixing and line amplifier. A 10,000-ohm coupling resistor is used between the iconoscope signal plate and the first video stage and the shading signals are mixed i at this point. Also vertical and horizontal blanking impulses are fed to th grid of the iconoscope, although th horizontal blanking impulses can b eliminated if desired. The camera, together with the iconoscope and it pre-amplifier, are shown in Fig. 1 (*a*)

The Video Stages

The video stages are mainly of th shunt M-derived type, Figure 4. Thi circuit looks like an ordinary shunt peaking stage in that it employs R and the peaking coil L, but in additio has a small condenser C shunting L This circuit has been described in previous issue of COMMUNICATIONS and also elsewhere.[2] While C coul consist of the distributed capacity o the peaking coil by winding the latte in several layers so as to build this u to the proper value, it was felt tha better control could be had by windin the coil as a single-layer solenoi whose distributed capacity is abou 1 mmfd, and then placing a sma trimmer condenser in parallel with and adjusting it to the proper value.

For a conservative design, as mentioned in the article in COMMUNICATIONS, the values of L, C, and R i

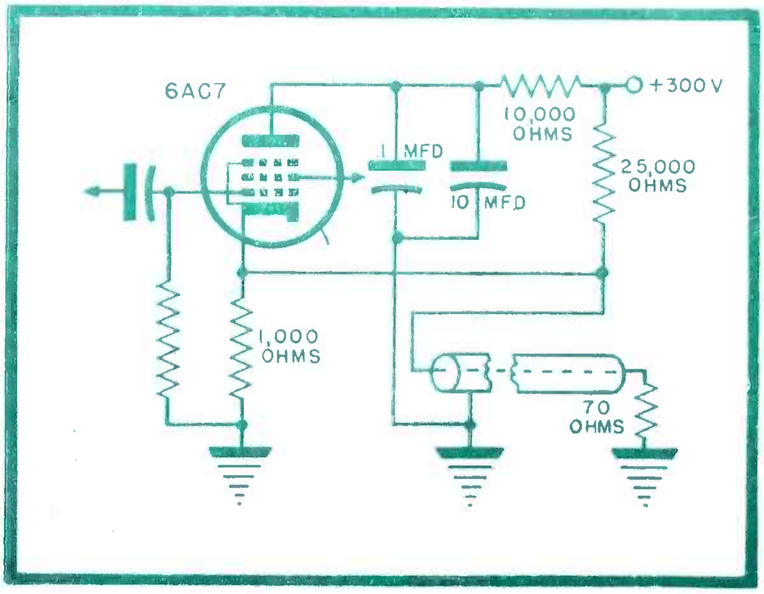

Figure 2

Cathode-follower stage.

---

[1] A. Preisman, *High Frequency Response Video Amplifiers*, COMMUNICATIONS; Decemb 1942 and January 1943.

[2] See, for instance, A. B. Bereskin, *Improv High Frequency Compensation for Wide-Ba Amplifiers*, Proc. IRE; October 1944.

rms of the total capacity C_t of the o tubes involved are

$$\left.\begin{aligned} L &= \frac{.49}{\omega_h^2 C_t} \\ C &= 0.354\, C_t \\ R &= \frac{1.085}{\omega_h C_t} \end{aligned}\right\} (1)$$

iere $\omega_h/2\pi$ is the highest frequency which flat amplification within 2% the low-frequency value is desired. The resonant frequency of *L* and C_t $\omega_r/2\pi$, and

$$\omega_h = 0.7\, \omega_r \qquad (2)$$

hus, if $\omega_h/2\pi$ is to be 6 mc, then *L* ıd C_t must resonate to $6/.7 = 8.57$ c. This can be used as a means of ljusting *L* to the desired value. 'here single tubes are employed, C_t about 25 mmfd; where two tubes ed a third, as in a mixing stage, C_t about 34 mmfd. These values were easured on a *Q*-meter, and include e *hot* input capacity of the following age.

djustment of a Video Stage

To adjust *L* to the proper value iven by equations *1* and *2*, the *Q*-eter can be employed. As an alterative L can be adjusted in the amifier stage itself. To do this, we ave to short out the resistor in series ith *L*. Thus *L* and C_t form a simple arallel resonant circuit. Then the eaking coil in the next stage is shortl out and the normal plate load restor (about 1000 ohms) is shunted ith a 200-ohm resistor. The stage is ow flat without peaking over a range 8 mc or more, and is of low imedance. As such, its frequency reponse is not affected when a vacuumibe voltmeter is connected across it; acts as a buffer stage, whereas if the icuum-tube voltmeter were connected irectly across the stage under test, its ipacity would affect the adjustment that stage. If the following stage is the cathode-coupled type, it will inction directly as a buffer stage. ven though the gain of the buffer age is less than unity, the amplificaon of the preceding stage compenates for this and permits a sizeable eading on the voltmeter.

A suitable signal generator is conected to the grid of the stage under st, and the frequency varied. At the equency where the voltmeter gives large deflection, *L* and C_t are in arallel resonance. An excess number turns on *L* is used so that it will esonate with C_t below the desired freuency $\omega_r/2\pi$. Then turns are stripped f from *L* until it resonates just at ie above frequency.

For some reason, our tests indicated that the value of *L* so obtained is somewhat less than that determined on the *Q*-meter. The distributed capacity of *L* could not explain this discrepancy as its order of magnitude is too small. It is believed that others have noticed this too. In our work, we preferred using the value of *L* determined by the *Q*-meter. This gave a satisfactory frequency response curve.

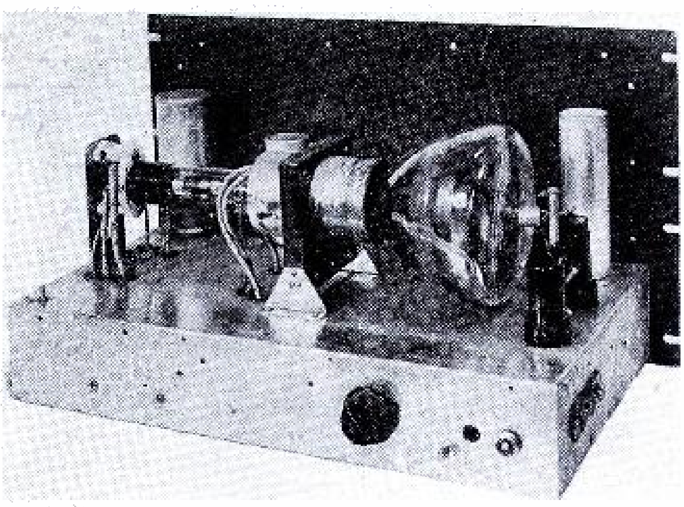

Figure 3

The monoscope unit.

The value of *C* is determined by resonating *L* on the *Q*-meter with the latter's condenser set at any convenient value and at any suitable frequency, then reducing the *Q*-meter capacity by the above value of *C*, adding the trimmer, and finally adjusting the latter until resonance is reestablished. The value of *C*, however, is not critical.

The response curve determined by equations *1* and *2* is one that drops gradually from its value at ω_h, here 6 mc. This insures that when many stages are employed, no *bumps* in the overall response will be encountered, and echoes will be avoided.

Video Mixing and Line Amplifier

The video mixing and line amplifier is shown in Figure 5. The first stage has a volume (contrast) control in the form of a screen-grid potentiometer. The only objection to this type of volume control is that as the screen grid potential is varied, especially if this is done rapidly, the d-c component of the plate current changes as well as the G_m and hence amplification of the stage. As a result, not only does the amplitude of the video signal change, but a surge owing to the change in d-c component occurs, which produces a resultant flicker on the screen. However, this type of volume control is convenient and free of frequency variation with change in setting, and furthermore, can be located remote from the amplifier, if desired.

The second stage is a mixer stage. Here the pedestal is mixed with the video signal for subsequent clipping in the following stage. There is nothing unusual about this stage, except possibly the elimination of a coupling condenser to the grid of the tube amplifying the pedestal. While some variation of the bias may occur with the change in the setting of the input volume control potentiometer, the ped-

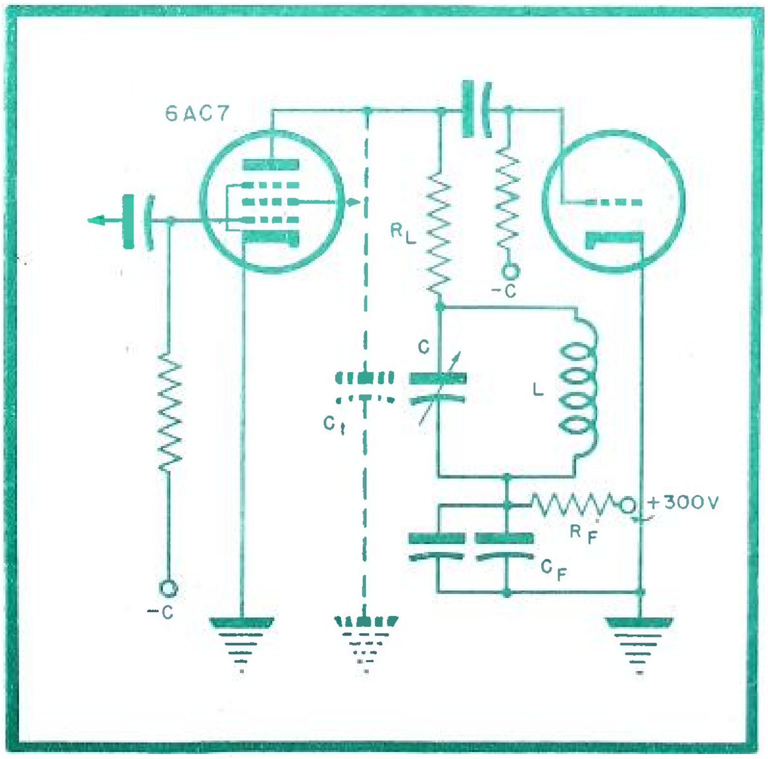

Figure 4

Shunt *M*-derived type of video stage used in system.

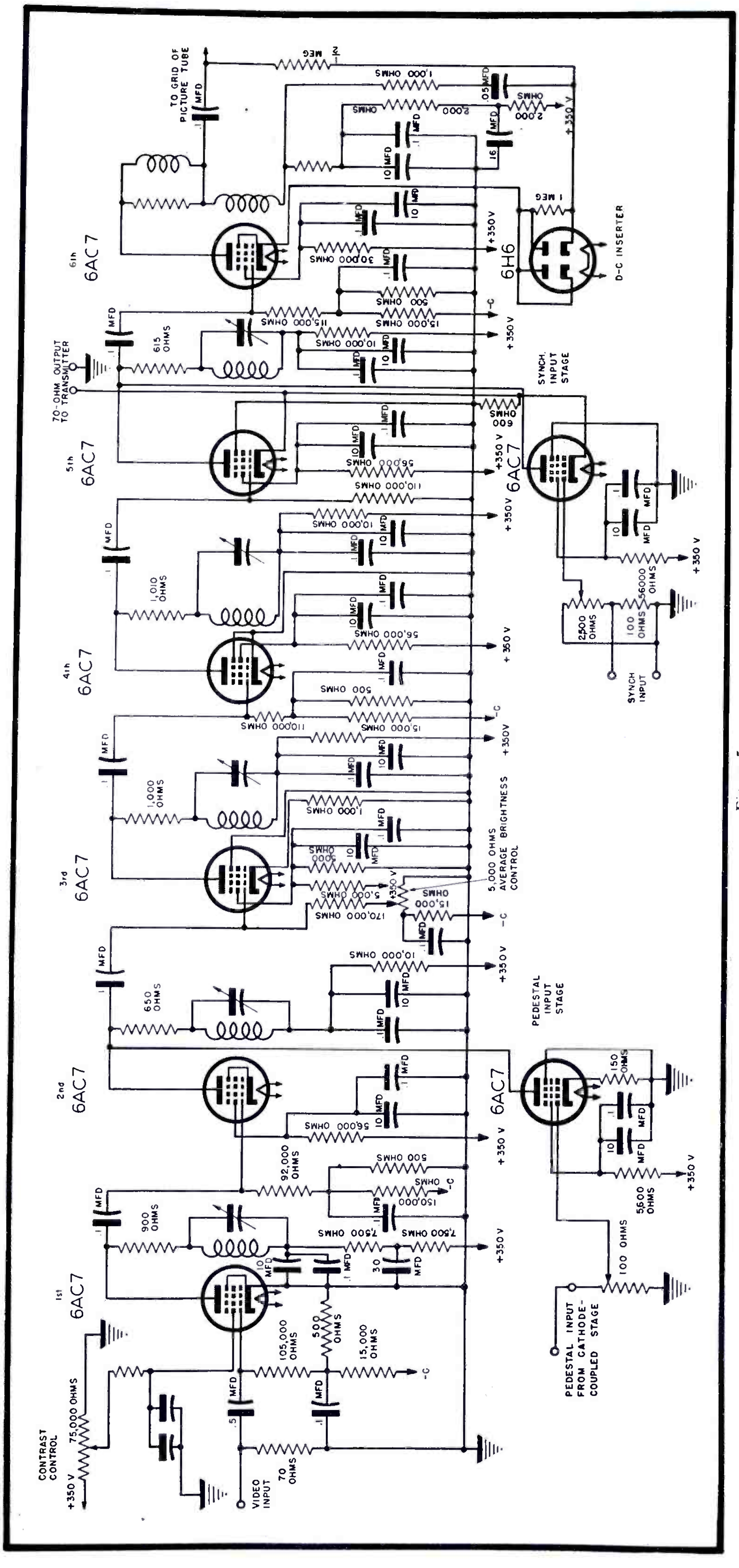

Figure 5

Video mixing and line amplifier. All resistance values as measured. Plate load resistors determined by h-f response; grid resistors by l-f response. Filter resistors not critical. Minus C = —50 v obtained from well-filtered but unregulated power supply.

estal is of sufficient amplitude to be clipped anyway, so that the change of bias is of no particular consequence. Also such a change is small owing to the cathode self-bias resistor. While this resistor reduces the gain of the stage, this is also unimportant because more than sufficient pedestal amplitude is available at this point.

The third stage is the clipper stag This employs variable *C*-bias as t method of adjusting the clipping lev This has the objection that the gain the stage decreases as the bias is i creased, so that the signal shrinks one attempts to clip the pedestal dow to just above the black level. This h been obviated to some extent by sta ilizing the screen voltage. As will noted from Figure 6, a fixed pote tiometer or voltage divider circuit employed for the screen supply inste of a series resistor. The bleeder cu rent is appreciably greater than t screen current, so that variation of t latter produces less variation of t screen voltage and hence of the G_m the tube than would be produced by series screen resistor. A further ite to be noted is the 1000-ohm catho resistor. This furnishes an appreci ble amount of inverse feedback a straightens the dynamic characteristi thereby minimizing the *saturating* the blacks in the picture.

The fourth stage is a straight an plifier stage that also reverses th polarity of the signal. It can then b mixed with the synchronizing sign in the following stage in the corre polarity. (The synchronizing sign comes out of the *shaping unit* with i peaks to the negative.)

The fifth stage is also a mixin stage. Here the synchronizing sign is added to the pedestal and pictu components to complete the video signal. At the same time output is o tained for a coaxial feed to the mo ulating amplifier in the transmitte This is accomplished by employing common cathode as well as a comm plate resistor. Thus mixing occu both in the common cathode resistor well as in the common plate resisto The cathode resistor is only 70 oh *when the coaxial cable is connecte* Since the d-c components of both tub flow in it, the proper bias of —2 vol is obtained without the need for add tional bleeder current. While th cathode resistor reduces the gain, suf cient stages are provided to meet th overall gain requirements. Incidenta ly, as in the pedestal stage, no cou ling condenser is employed for th synchronizing input stage.

The sixth and last stage is of th high-gain type, and employs a com bination of series and shunt peaking This is of the type described in th RCA tube manual. However, th stage described there is for a *4* instea of a *6*-megacycle bandwidth. The r sponse is easily extended by reducin the inductances to $(4/6)^2 = 4/9$ of th

(*Continued on page 60*)

Announcing

A MINIATURE OSCILLOGRAPH

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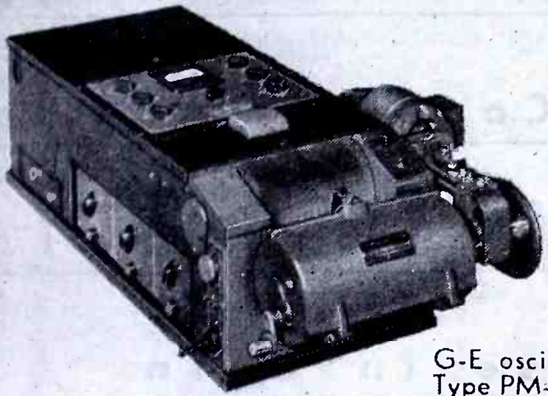
SIZE: $4\frac{1}{2}$ by $4\frac{1}{2}$ by 14 inches



G-E oscillograph, Type PM-10, set up for tests with magazine film holder, driving head, and a-c motor unit

THIS 6-ELEMENT OSCILLOGRAPH was developed for use where light weight and small size are essential. It's easily portable, to obtain "on the spot" photographic records of the characteristics or the performance of many machines and devices. Records simultaneous variations of six rapidly changing phenomena. Type PM-17; net price, $850 up. Write today for leaflet GEA-4331.

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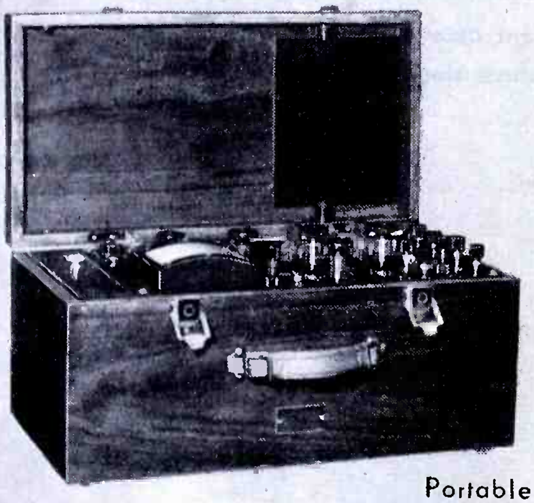

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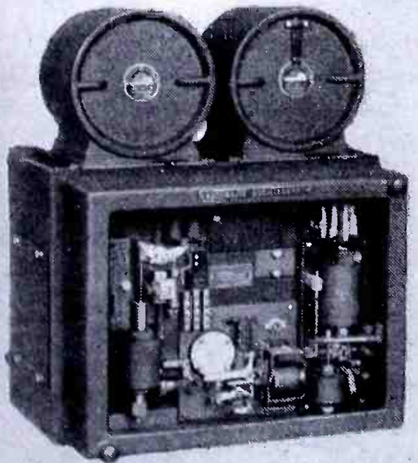
TYPE PM-12—Anyone can operate it. For work in the field, in the laboratory, or in the classroom. For either visual indications or taking oscillograms of current and voltage waves. Originally developed for school use, industry has found this 2-element portable especially valuable for observing or recording welding current. Net price, $665.



Automatic oscillograph, Type PM-13. Starts recording one-quarter cycle after disturbance occurs

TYPE PM-13—Entirely automatic. Can take as many as 100 oscillograms of transients and surges without attention. Particularly useful for determining the sequence of relay and breaker operation and the effect on system stability. Net price, $2125.

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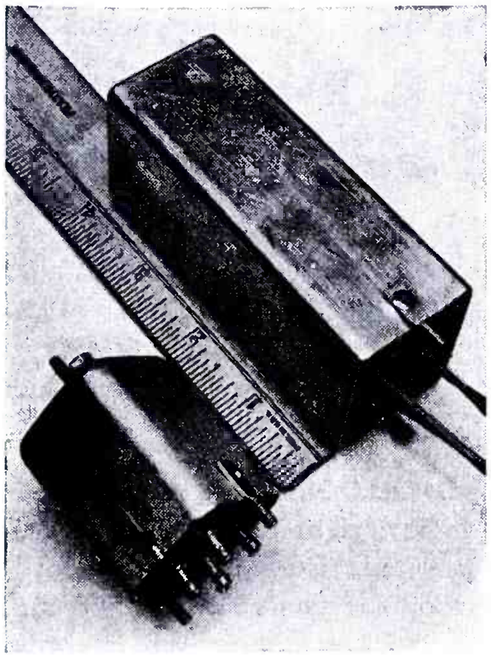
AN IMPROVED ANTENN COUPLING CIRCUI FOR 30-40 M

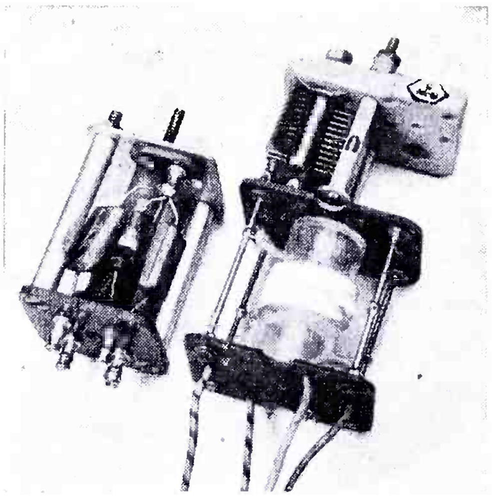
Permeability-Tuned Pi-Typ Of Antenna Coupling Applie To Secure Substantia Increase in Gain

by H. J. KAYNER
Assistant Chief Engineer
Doolittle Radio, Inc.



Figures 1 (above) and 2 (below)

Figure 1, external views of two types of antenna coil assemblies analyzed in this paper; smaller unit is the permeability-tuned type. In Figure 2 we have internal views of the two antenna coupling units.



It has been general practice to use a low-impedance primary, tuned-secondary transformer for an antenna coupling device in most receivers in the 30 to 40-mc range, and reasonably good results have been obtained. Recent developments have indicated that the permeability-tuned *pi* type of antenna coupling offers higher gains.

The usual unit and the permeability-tuned compact *pi* types are shown in Figure 1. Inside views of the units appear in Figure 2. It might be pointed out before the design parameters are investigated, that permeability-tuned antennas have been used in broadcast automobile sets years ago, but the conditions for matching are greatly different.

In Figure 3*a*, we have the usual notation of a low impedance primary, tuned secondary circuit. The equivalent circuit of Figure 3*b* may be obtained by a transformation; including the primary resistance R_1 in the source resistance R_s as R'_s, and the tube input resistance R_G in the resistance of the secondary R_2 as R'_2.

The transfer impedance Z'_2 is given by the following expression

$$Z'_2 = \frac{Z_pZ_s - Z^2_m}{Z_m}$$

since $E_2 = \frac{E}{Z'_2} \cdot \frac{1}{J\omega C_2} = \frac{EZ_m}{Z_p\,Z_s - Z^2_m} \cdot \frac{1}{J\omega C_2}$

The gain $G = \frac{E_2}{E}$

where E_2 is the voltage across C_2

or $G = \frac{Z_m}{Z_pZ_s - Z^2_m} \cdot \frac{1}{J\omega C_2}$

Now Z_m is, in this instance $= J\omega M$

and $Z_p = R'_s + J\omega\,L'_1$

$$Z_2 = R'_2 + J\left(\omega L_2 - \frac{1}{\omega C}\right)$$

At resonance $Z_2 = R'_2$

Substituting

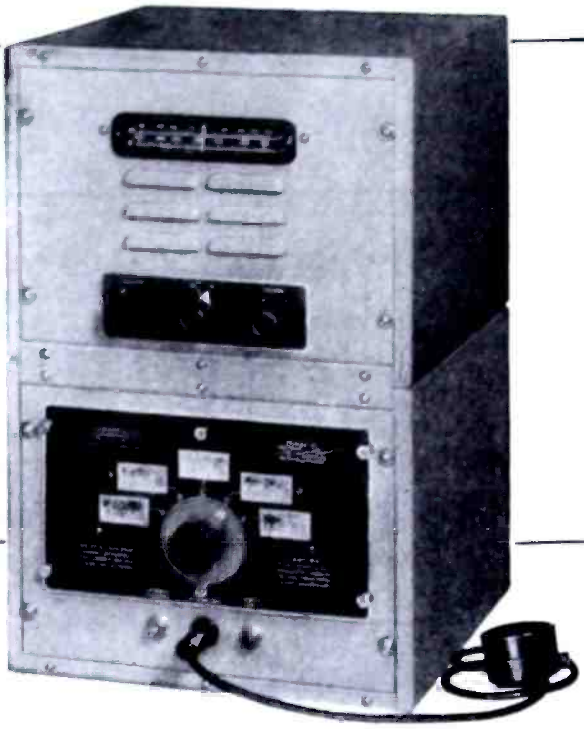
$$G = \frac{J\omega M \cdot \frac{1}{J\omega C_2}}{(R'_s + J\omega L'_1)\,(R'_2) - (J\omega M)^2}$$

But, since $J\omega L'_1$ is usually ab 2% of R_s it may be dropped from equation and not appreciably affect accuracy; then

$$G = \frac{\frac{\omega M}{\omega C_2}}{R'_sR'_2 + (\omega M)^2}$$

KAAR 50 and 100 WATT INSTANT HEATING

MOBILE OR FIXED RADIOTELEPHONES



A new series of KAAR radiotelephones, offering improved performance and greater convenience, is now available to police and fire departments, public utilities, sheriffs' offices, railroads, the forestry service, and similar users of radiotelephone communication. Designed with the needs of these services in mind, this series provides instant heating tubes, single channel or five channel operation, and crystal controlled or tunable receivers. Notice how compact this equipment is, and how it is immediately accessible for tuning or servicing, although the cabinet itself may be permanently secured to a shelf, wall, vehicle, or vessel.

SERIES 46 • 50 WATT KAAR RADIOTELEPHONE

A five channel transmitter with power output of 50 watts. All five channels are independently tuned, and any one may be instantly selected by turning a knob on the front panel. Standard frequency range is from 1600 to 6000 Kc. Furnished with companion tunable or fixed tuned crystal-controlled receiver as desired. Power supply (8"x 8"x 17") is a separate unit, interconnected by a 12-foot cable. Available for operation on 117 volts 60 cycle A. C., 12, 32 and 110 volts D. C.

SERIES 96 • 100 WATT KAAR RADIOTELEPHONE

(NOT ILLUSTRATED)

Five channel instant-heating transmitter, with an output of 100 watts and having a standard frequency range from 1600 to 6000 Kc. The companion receiver may be of the tunable or fixed tuned crystal-controlled type as desired. R. F. ammeter and plate milliammeter are mounted on front panel. This 100 watt radiotelephone, including transmitter and receiver, is only 19½" high, 22" wide, 14¾" deep. Furnished with separate power supply (8" high, 16" wide, and 17" deep). Available for operation on 117 volt 60 cycle A.C., 32 or 110 volt D.C. circuits.

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. . . and you will get a **KAAR 46!**

★ **INSTANT HEATING TUBES...** Stand-by current is zero — yet there is no waiting for tubes to warm up before sending a message! Reduces drain on batteries . . . extremely important in mobile or marine operation.

★ **FIVE CHANNEL TRANSMISSION...** Any one of five channels from 1600 to 6000 Kc can be instantly selected by turning the large knob on the panel.

★ **CARRY ONLY 1 SPARE TUBE...** For simplicity of replacement there is only one type of tube used in these Kaar transmitters. (For 117 volt AC operation, 5R4GY rectifier tubes are also employed.)

★ **REMOVABLE PANEL...** By removing six finger-tight lugs, the front panel of the transmitter may be lifted away, exposing all tuning controls. This allows complete tune-up to be made in a short time without moving the set.

★ **SIMPLE TO SERVICE...** When four screws are released, transmitter slides out like a letter file to simplify tube replacement.

★ **FITS MOST ANYWHERE...** Transmitter may be placed above or below the receiver, or on either side of it. Transmitter and receiver units are each 10" high, 13" wide, 13" deep. This equipment is easy to install.

★ **REASONABLY PRICED...** Although Kaar instant-heating radiotelephones offer all these features for convenience and simplicity, they are competitively priced. Your inquiries are cordially invited.

KAAR ENGINEERING CO.

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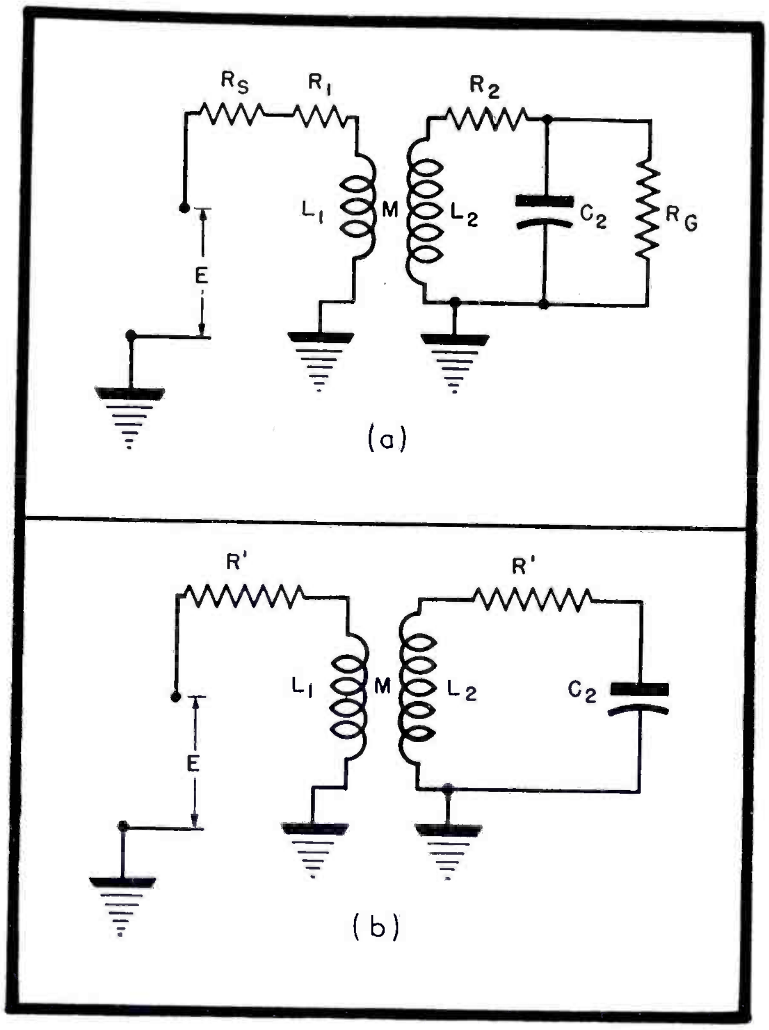

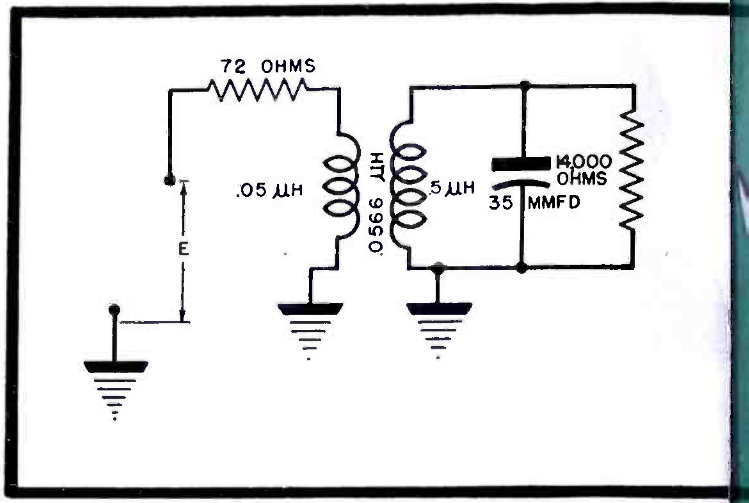

●

Figure 3 (left) and 4 (above)

Figure 3, (*a*), circuit of a low-impedance primary, tuned-secondary antenna transformer. In (*b*), we have the equivalent circuit of (*a*) when transformed by the method described in the paper. Input resistor identity should read R′s; output, R′₂. Figure 4, the original circuit values used in the calculation of antenna gain of an inductively-coupled antenna circuit.

●

Also at resonance $\frac{1}{\omega C_2} = \omega L_2$ and dividing by R'_2

$$G = \frac{\omega M Q'_2}{R'_s + \frac{(\omega M)^2}{R'_2}}$$

where $$Q'_2 = \frac{\omega L_2}{R'_2}$$

For the conditions of maximum gain we differentiate the above equation using *G* as the dependent variable and *M* as the independent variable, and equate the numerator to zero; then

$$0 = R'_s + \frac{(\omega M)^2}{R'_2} - \frac{2(\omega M)^2}{R'_2}$$

or $$R'_s = \frac{(\omega M)^2}{R'_2}$$

If the reactive components are replaced the more general equation is

$$Z_p = \frac{(\omega M)^2}{Z_s}$$

This is only useful in noting that the secondary will be detuned slightly to compensate for the residual inductance of the primary. As indicated, this will not usually affect the gain equation more than about 2% and is omitted to simplify the result.

Now let us take the actual values of a commercial antenna transformer which is given in Figure 4.

$$F = 35 \text{ mc}$$

R_G is calculated from the RCA application note on *Tube Input Conductance*, for a 6SJ7, as follows:

$$\frac{1}{R_G} = .3\,F + .05\,F^2 = 10.5 + .05 \times 35^2$$

or $$R_G = \frac{1}{71.75} \cdot 10^6 = 14{,}000 \text{ ohms.}$$

$$Q_2 = 80 \text{ (without the tube loading)}$$

$$L_2 = .5 \text{ microhenry or } J\omega L_2 = J112$$

$$C_2 = 40 \text{ mmfd or } \frac{1}{J\omega C_2} = -J112$$

The anti-resonant impedance $= Q_2\omega L_2 = 112 \times 80 = 8960$ ohms.

Since this impedance is shunted by R_G the effective or resulting impedance is their combination. That is,

$$Q'_2\omega L_2 = \frac{Q_2\omega L_2 \cdot R_G}{Q_2\omega L_2 + R_G} = \frac{8960 \cdot 14{,}000}{23{,}760}$$
$$= 5200 \text{ ohms;}$$

then $$Q'_2 = \frac{5200}{112} = 46$$

(with primary loading, $Q''_2 = Q'_2/2$

and $$R'_2 = \frac{112}{50} \;\; 2.42 \text{ ohms}$$

Choosing a value of $\omega M = \sqrt{R'_s \cdot R'_2}$ where R'_s is the usual concentric line impedance of 72 ohms, and R'_2 is 2.4 ohms

$$\omega M = \sqrt{2.42 \times 72} = 13.1 \text{ ohms}$$

Substituting

$$G = \frac{46 \times 13.1}{72 + \frac{174}{2.42}} = 4.2 \text{ times}$$

Actual tests indicated a gain of 4.6 times which means that the value chosen were close to those used abov but the value of R_G must be highe than the 14,000 ohms calculated. I might be pointed out that the expression used was given for 250 volts a the plate and 100 volts at the scree of a 6SJ7 tube. Here, however, onl 75 volts of screen, and 180 volts c plate potential were used. Because c this and data obtained from othe measurements, R_G is estimated to b nearly 25,000 ohms.

Recalculating the gain

$$G = \frac{13.1 \times 59}{72 + \frac{174}{1.9}} = 4.7 \text{ times}$$

which provides much closer agreement with the measurements made.

Now let us look at the problem fro the general viewpoint of power transfer. This is definitely a passive ne work connected between two termina ing impedances R_s and R_G with th generator voltage *E* connected i series with R_s. When an ideal transformer is used, the value of R_G i changed to $\frac{R_G}{n^2}$ where *n* is the voltag or turns ratio, and when $n = \sqrt{\frac{R_G}{R_s}}$ the maximum power is transferre This is equal to $\frac{E^2}{4R_s}$ which is a fa miliar expression, Figure 8 (see pag 44).

A very important relationship whic is not usually noted, is that the valu of the secondary voltage is nE/2 sinc

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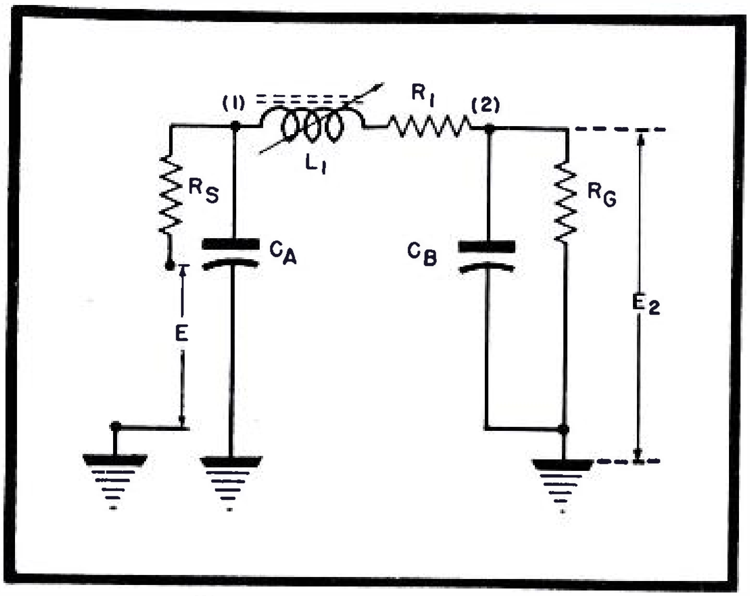

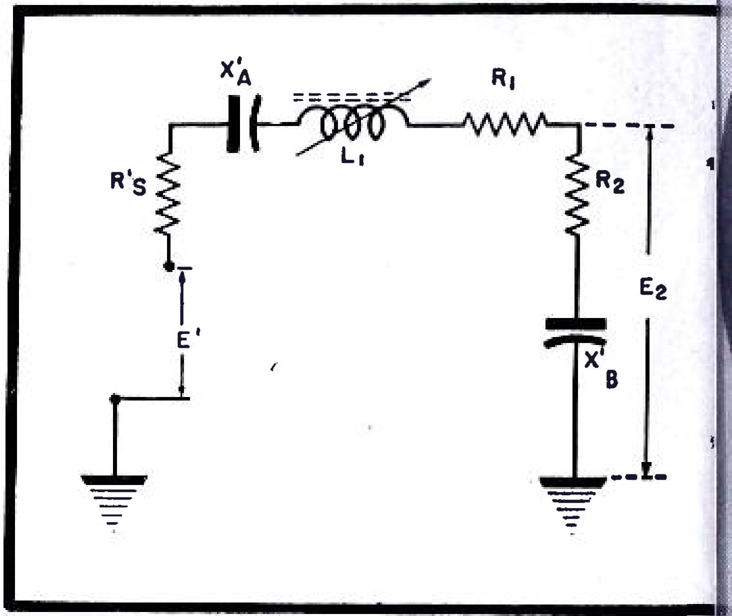

Figure 5 (above) and 6 (right)
Figure 5, representation of a *pi* type of antenna coupling circuit using permeability tuning. Figure 6, modification of *pi* type of antenna coupling circuit by method described in paper.

the primary voltage is E/2 because its reflected impedance is the same as the series generator impedance. Then the maximum voltage transfer is

$$\frac{E_2}{E} = G = \frac{\frac{n\,E}{2}}{E} = \frac{n}{2}$$

but $$n = \sqrt{R_G/R_s}$$

$$G_{max} = \tfrac{1}{2}\sqrt{R_G/R_s}$$

We can then say that if a network were made up of pure reactances, the maximum voltage gain would be (using $R_s = 72$ and $R_G = 25{,}000$),

$$G = \tfrac{1}{2}\sqrt{25000/72} = 9.3$$

Thus it is easily seen that the conditions are greatly different at these frequencies than at say the center of the broadcast band which is approximately 1 megacycle. The value of the input grid resistance,

$$R_G = \frac{1}{.3 + .05} \times 10^6 = 2.85 \text{ megohms}$$

The maximum gain would then be, disregarding effective *Q* and assuming pure reactances originally, and a standard antenna of 400 ohms

$$G_{max} = \tfrac{1}{2}\sqrt{2.8 \times 10^6/400} = 41.5 \text{ times}$$

Using a *pi* type of antenna coupling circuit, employing permeability tuning, gains of 22 times have been measured as referred to previously, in certain automobile receivers. This type of circuit using variable air condensers was successfully employed in equipment up to 120 megacycles. Here the tube used was a 9003, with an input conductance at 100 mc of

$$Y_G = 0. + .005 \times 100^2 = 50 \times 10^{-6}$$

$$\text{or } R_G = 20{,}000 \text{ ohms}$$

The gain was found to be approximately 5 times which was a little more than twice the inductively coupled circuit previously used. Thus it was thought worthwhile to investigate the possibilities of this arrangement in the 30- to 40-mc band.

Pi Network Coupling Circuit

Let us now consider the use of the *pi* type of network whose input and output circuits will be placed between the same source and load resistances. The first condition that must be met is the value of L_1, which is equival
to *M* by the following equation

$$\omega L_1 \leqq \sqrt{R_s\, R_G}$$

Thus, ωL_1 must be less than $\sqrt{72 \times 14,}$

= 1000 nearly, (at 35

This would permit the use of a c
of more than 4 microhenries, but
capacity to tune the circuit would b
total of 5 mmfd. Since circuit
pacity and grid capacities do not ha
good power factors and are consider
unstable, it is advisable to use capac
values of 10 mmfd or more. Also
was found difficult to maintain a hi
value of *Q* if the space factor of
turns is reduced, since the windi
length is fixed.

The usual *pi* network as shown
Figure 5 was first considered.
means for calculating the gain is
as straightforward as in the case
the inductively coupled circuit pre
ously analyzed. The method used w
the reduction of the circuit in Fig
5 to that of Figure 6 by the use
Thevenin's Theorem. To arrive
this result, the circuit in Figure 5
considered broken at *1* and *2*. Th
points are then calculated for
equivalent series values taken first
1 toward the source, and toward
load at *2*.

At point *1*, $Z'_1 = R'_s - j\,X'_a$

$$= R_s\left[\frac{X^2_a}{R^2_s + X^2_a}\right] - JX_a\left[\frac{R^2_s}{R^2_s + X^2}\right.$$

To simplify the calculations and f
the effect of the magnitude of
various parameters on the resulti
gain, let $R_s = nX_a$, and substitute i
the bracket quantities.

The above expression becomes

$$'_s - j\,X_a = R_s\left[\frac{1}{n^2 + 1}\right] - JX_a\left[\frac{n^2}{n^2 +}\right.$$

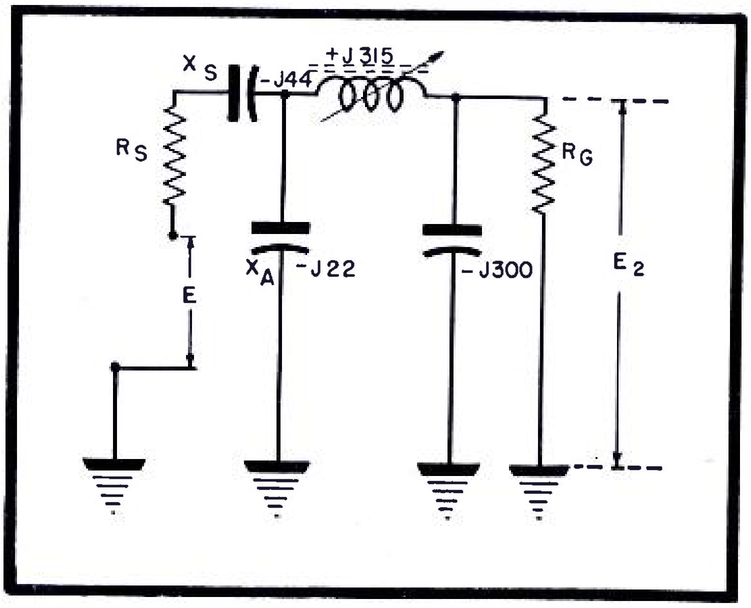

Figure 7

Final arrangement of the original circuit of Figure 5, with values used.

These are the reasons Heintz and Kaufman endorses

TUBE STANDARDIZATION

ANDARDIZATION IS A
ARTIME NECESSITY

Colonel C. C. Irwin, commanding officer of the
gnal Corps Standards Agency, recently stated that
majority of Signal Corps contractors are heartily
operating with the standardization program
onsored by his agency to the end that approved
mponent parts and materials are used wherever
ssible in equipment supplied to the Signal Corps.
"However, there are some," Colonel Irwin said,
ortunately only a few, who view this program as
attempt to put an unsound theory into practice.
ch is, of course, not the case. Standardization is
ally necessary, not only to relieve bottlenecks in
oduction and distribution; to facilitate mainte-
nce by providing interchangeability of parts; but
ore important, to reduce equipment failures in
e field.

"There is no theory in a Gold Star.

"If the reasons behind the laconic phrases 'killed
action,' 'missing,' and 'plane failed to return'
uld be explained, it is quite probable that equip-
ent failures would bulk large among the reasons.

"It is not expected that the use of approved
andard component parts will eliminate equipment
ilures, but it most certainly will reduce them."

QUALLY ADVANTAGEOUS IN
HE POSTWAR PERIOD

Joint Army and Navy Specifications ("Jan-1A
ecs") have already established standards of elec-
ical similarity and physical dimensions for vacuum
bes. Heintz and Kaufman will voluntarily con-
nue to apply these engineering standards to post-
ar Gammatrons as the benefits are so obvious that
e believe the designers of communications equip-
ent will insist upon their continuation:

1. Standardization of specifications will facilitate
quipment design and production, since it assures the designer that there will be no physical or electrical changes made in the tube type he has selected. Often such changes have necessitated extensive redesign of equipment.

2. It will assure performance where performance is vital... in air transport and marine communications, in navigation and direction finding.

3. By establishing rigid electrical and physical requirements and tests, tube failures will be materially reduced. Such failures often reflect on the manufacturer of equipment, and must be guarded against just as carefully in peacetime as in war.

STANDARDIZATION DOES NOT LIMIT NEW DESIGN

Standardization of the specifications for current Gammatron tube types will not restrict the development of additional types to meet future needs. (Next month we will list here the Gammatron tubes which will be available indefinitely under our voluntary standardization program.)

Have you written for data on the HK-257B (JAN. 4E27)?

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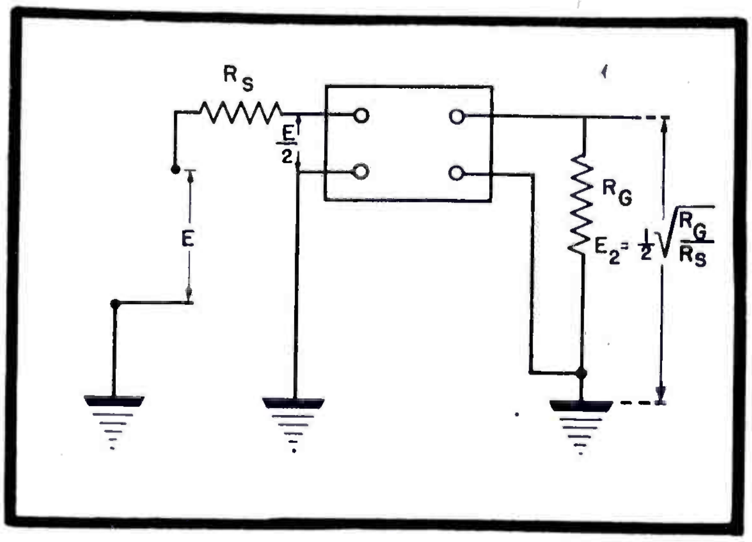

Figure 8

Generalized block diagram of a passive network used as an impedance-matching device.

At point *2* it may be shown that,

$$Z_2 = X^2_B - jX_B$$

with an accuracy of ½%, or better when

$$\frac{R_G}{X_B} \geqq 14.$$

(Using the values in the previous example for R_s and R_G with a value of L_1 of J270 or 1.22 microhenries at 35 mc.)

The capacities shown as C_a and C_B have values of reactance X_a and X_B which may be calculated from formulas given by Everitt in his book, *Communication Engineering*, p. 236.

$$X_a = \frac{-R_s X_L}{R_s \pm \sqrt{R_s R_G - X^2_L}}$$

$$X_B = \frac{-R_g X_L}{R_g \pm \sqrt{R_g R_s - X^2_L}}$$

The value of the radical

$$\sqrt{R_s R_G - X^2_L} = \sqrt{10^6 - 72{,}900}$$

$$= 960 \text{ closely}$$

$$X_a = \frac{-72 \times J\,270}{72 + 960} = -J19$$

$$= 250 \text{ mmfd, nearly}$$

$$X_B = \frac{-14000 \times J\,270}{14000 + 960} = -J255$$

$$= 18 \text{ mmfd}$$

Substituting these values in t previous transformation equation v may obtain the circuit of Figure 6 e cept for the value of R_1 and E′, t new generator voltage. If we ta *Q* of the coil to be 110 which easily obtained with the iron core, t value of R_1 is 2.75 ohms.

The new generator voltage E′ equal to the open circuit voltage acro X_a, and the current through it is

$$I_1 = \frac{E}{R_s - JX_a}$$

$$E' = -JX_a I_1 = \frac{-EJX_a}{R_s - JX_a}$$

$$= E\,(-JX_a)\,\frac{(R_s + JX_a)}{(R^2_s + X^2_a)}$$

and its absolute magnitude is

$$E' = \frac{E\sqrt{X^2_a}\,\sqrt{R^2_s + X^2_a}}{R^2_s + X^2_a}$$

Again using the substitution $R_s = nX$

$$E' = \frac{E}{\sqrt{n^2 + 1}}$$

We can now easily calculate th values of all the parameters in th equivalent circuit of Figure 6. Th value of E_2 is taken to be the *I* drop across X_B since R_2 is negligib in comparison. Then the gain will b

$$G = \frac{E_2}{E} = \frac{I'X_B}{E};$$

(*Continued on page* 68)

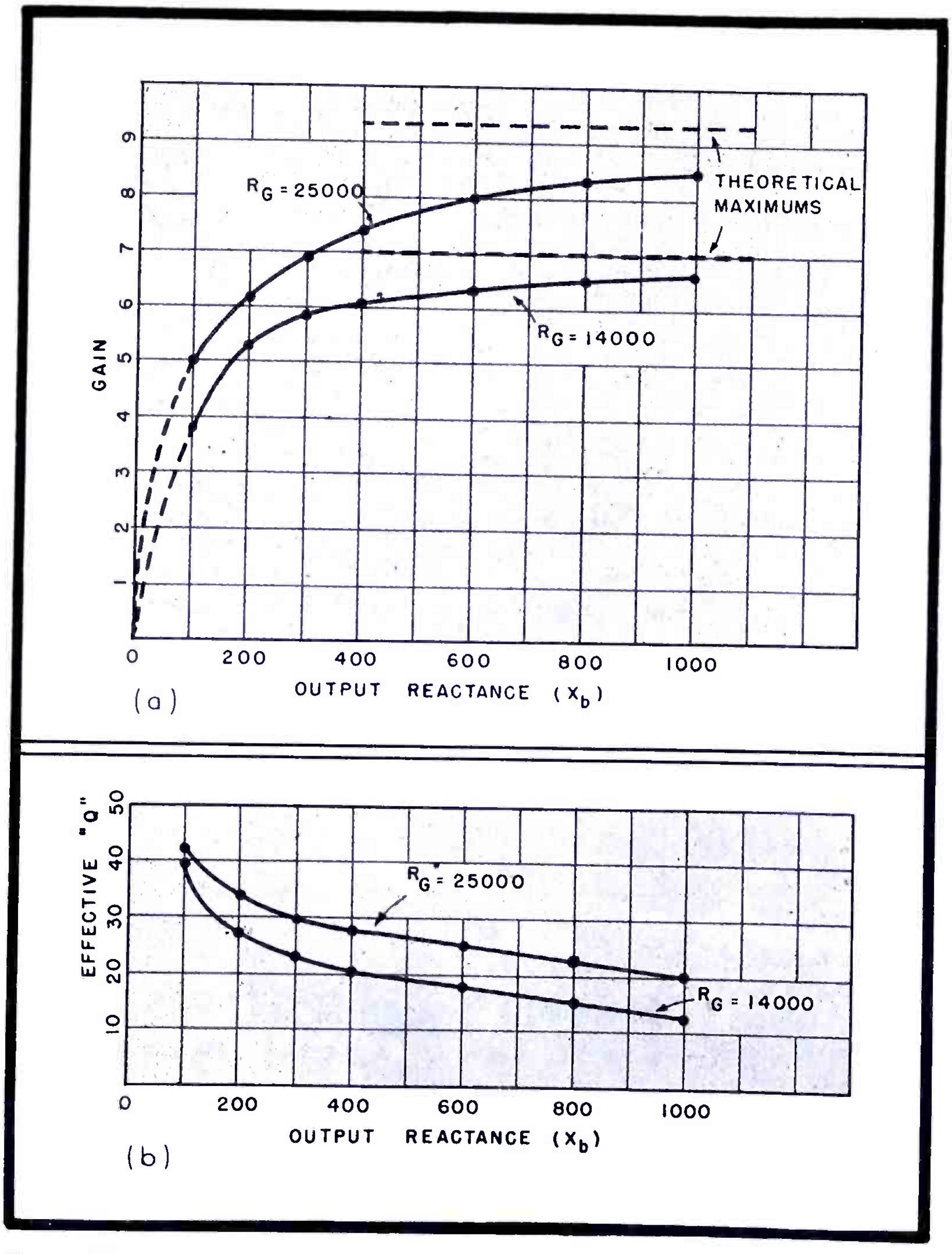

Figure 9

Graphical representation of the effect c varying the reactance of the output cor denser on gain and resultant *Q*. In (*a*) w have the voltage gain of a *pi* type of ar tenna coupling circuit linked to a 72-oh concentric line, working into a 6SJ7 at 3 mc. At (*b*) we have the effective *Q* for th above circuit.

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DESIGN OF BROAD-BAN
AIRCRAFT ANTENNA SYSTEMS

by F. D. BENNETT, P. D. COLEMA
and A. S. MEIER, Captain Air Corps

Special Projects Laboratory
of
Aircraft Radio Laboratories
Wright Field, Dayton, Ohio

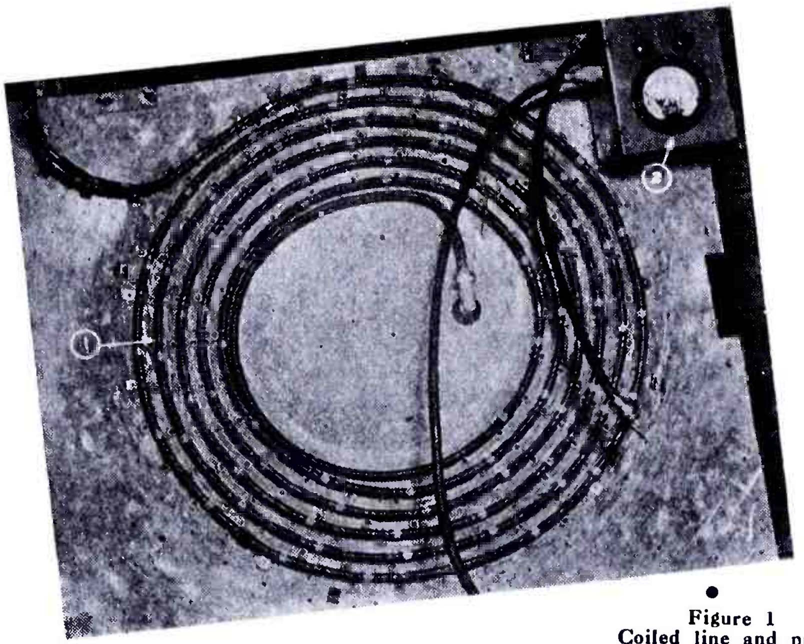

Figure 1
Coiled line and probe assembly; *1*, coiled line; *2*, probe box.

BECAUSE of the irregular ground offered to an antenna by the metallic surface of an aircraft and because of the large dimensions of the antennas necessary in the 10-100 mc range, the design of low-frequency aircraft antennas is of necessity based on experimental measurement of antenna impedance and experimental methods of increasing antenna bandwidth. In the analyses offered in this paper, three problems are considered. They are (*1*)—the consideration of methods of measuring aircraft antenna impedances on the ground and in flight, (*2*)—methods of increasing antenna bandwidth through the use of reactance networks called matching sections and (*3*)—methods used in the selection and design of broad-band wire antennas.

Part I—A Coiled Line for 10-80 mc Impedance Measurement

In an attempt to provide a method of impedance measurement on aircraft during flight a compact, rugged system has been developed based on the standing wave line principles. This apparatus is insensitive to noise, vibration and small electrical disturbances such as obtain during fight conditions.

The system as shown in Figure 1 consists of a coiled line of 50-ohm commercial cable which acts as the counterpart of the slotted lines common to laboratory practice at higher frequencies, together with a probe cable and meter box which is the counterpart of the sensitive crystal or bolometer probes used with the high-frequency slotted lines. The coiled line is mounted rigidly on an aluminum grounding sheet and is punctured with probe holes at 5-cm intervals so that the voltage standing wave on the line may be measured. The probe consists of a probe tip connected to a half wavelength cable which leads to a parallel resonant circuit inside the meter box. A second resonant circuit coupled to the first contains the 0-125 ma thermocouple meter from which relative voltages are taken. Adjustment of the first tuned circuit enables a high impedance to be presented across the probe tips in order to achieve minimum distortion of the standing wave, while adjustment of the second circuit controls the meter current. The line is energized by a continuous wave of 10-watts power so that the amount of energy absorbed by the probe is a negligible fraction of the whole. A further advantage lies in the fact that working with this high level of power minimizes the effect of stray electrical disturbances due to ignition or oth radio equipment on the plane.

In taking data it is necessary to tain three maximum and three mi mum values of the voltage standi wave in order to secure enough formation to be able to calculate terminating impedance correctly. cause the 50-ohm cable, although lo loss, nevertheless has appreciable tenuation, it is found that the maxi and minima increase appreciably the observations are made furt from the termination. It can be prov that for low loss cable the envelo of the maximum and minimum val are the two lines

$$y_1 = \alpha(A-B)x + (A+B)$$
$$|E|_{max} \text{ envelope}$$

$$y_2 = \alpha(A+B)x + (A-B)$$
$$|E|_{min} \text{ envelope}$$

whose intercepts enable calculation the standing-wave ratio

$$\rho = \frac{|E|_{max}}{|E|_{min}} = \frac{A+B}{A-B}$$

In these equations *A* and *B* are real magnitudes of the incident reflected travelling waves on the li α is the attenuation in nepers/me and *x* is the distance along the

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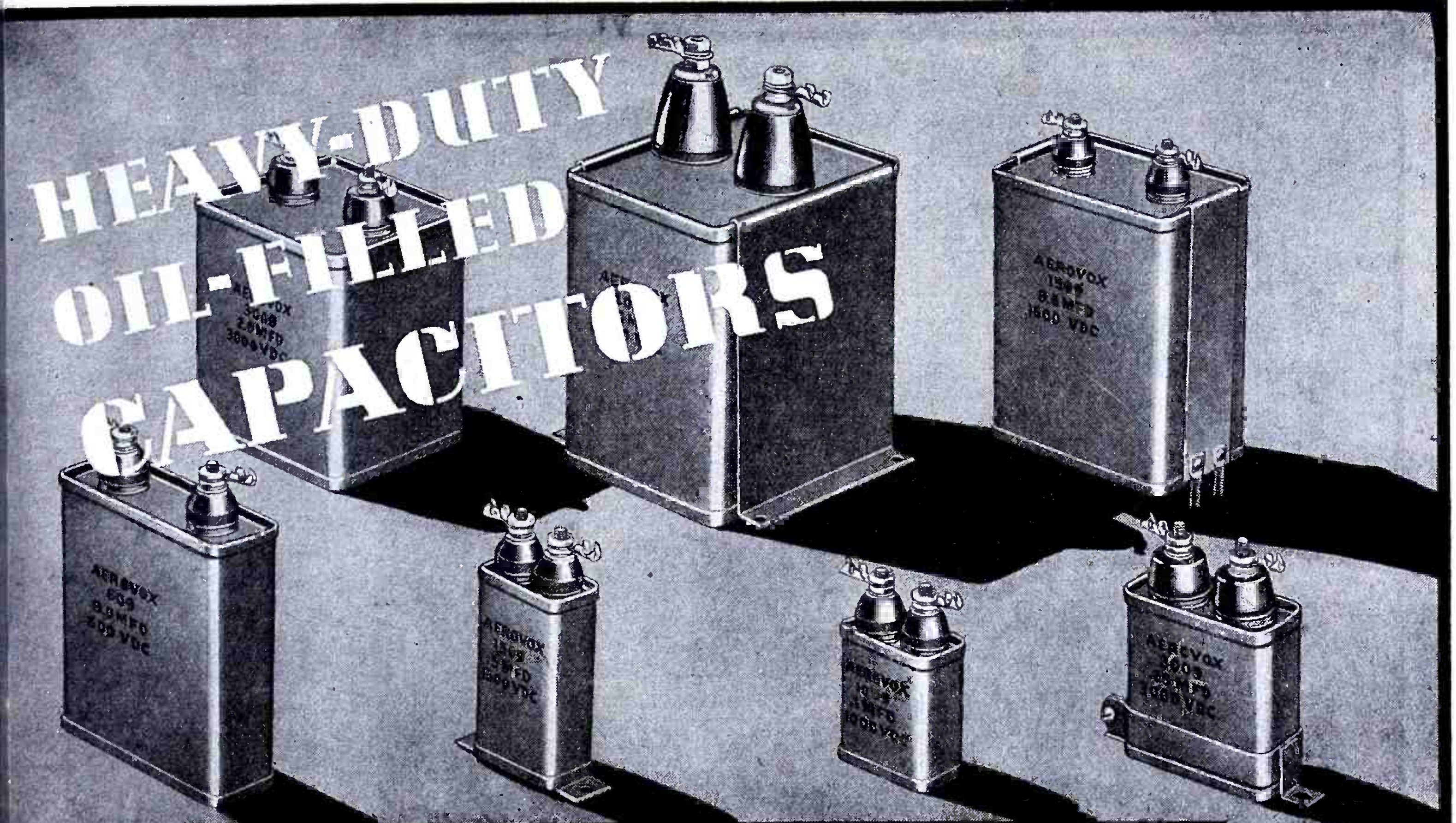

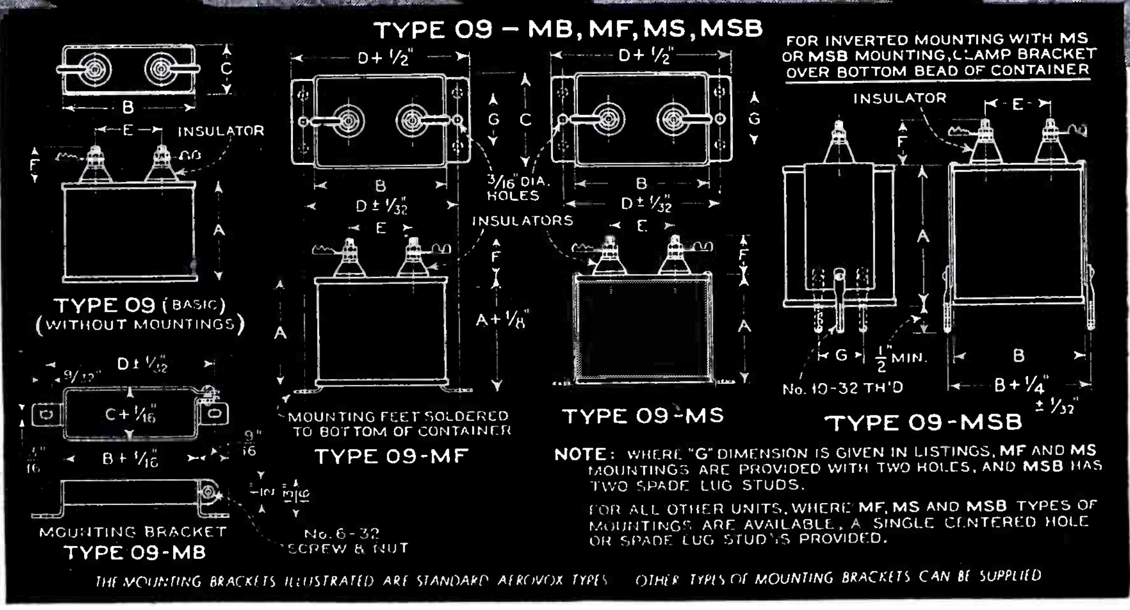

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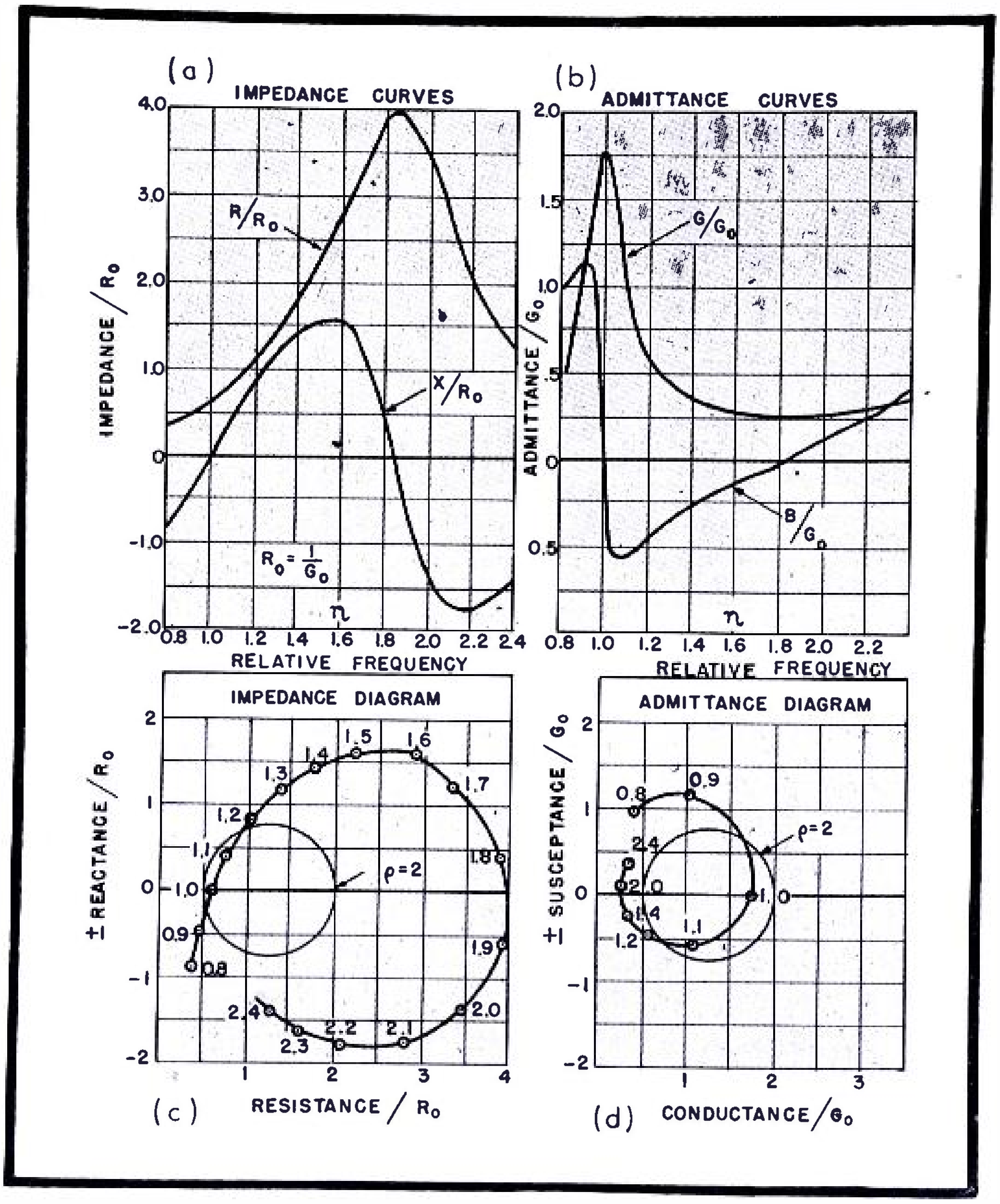

Figure 2

Antenna impedance diagrams useful in matc section analysis.

measured positively from the termination.

Ordinarily for s-w-r greater than *1.5* the distance of the first minimum from the end of the line may be obtained by drawing horizontal chords through the first trough and obtaining the intersection of the bisector of the chords with the voltage curve; however for lower s-w-r a correction is necessary due to attenuation and may be obtained by constructing the chords parallel to the lower tangent line in (*1*).

Comparison of coiled line measurement with those of a 916-A r-f bridge indicates that the working accuracy of the coiled line is about ± 5%. This estimate is borne out by the fact that successful matching section design within this limit of error has been repeatedly accomplished.

By modifying the probe arrangement to use a high-impedance vacuum-tube voltmeter and an adjustable length of line for probe tuning, this coiled line system has been used successfully up to 200 mc.

Part II—Impedance Matching

To obtain maximum power transfer it is desirable to terminate a feed line in its characteristic impedance. While this may be easily done with a π or T reactance network for a single frequency, the problem is more difficult over a range of frequencies through which the antenna load impedance may vary by large amounts from the characteristic impedance R_o of the line. To overcome these difficulties a technique has been devised employing both graphical and analytical means to give a clear over-all picture to the solution to the problem.

In Figure *2* typical antenna curves are depicted on the four types of diagrams most useful to this type of analysis, viz., impedance-frequency and admittance-frequency curves, the impedance diagram in the complex plane and the admittance diagram in the complex plane. Here relative frequency η has been plotted where η is taken to be *1* at the first resonant frequency for the antenna.

In work of this sort it is desirable to adopt some convention for expressing the bandwidth of an antenna. As a s-w-r on the feed line of *2* or less indicates that 89% or more of the transmitted power is being expended in the load and as most transmitters perform very well into s a load, it has been decided in work to regard as satisfactory antenna impedances which give s-w-r of *2* or less on the feed l The problem of matching then comes one of trying to obtain maximum amount of antenna curv represented on the admittance or pedance diagram within the ρ : circle. It is then of interest to st the geometrical effect on the ante of various simple reactance eleme and combinations of reactance ments. Before proceeding with study we shall define bandwidth of antenna as $\frac{\eta_2 - \eta_1}{\eta_1} \times 100$ where is the frequency at which the pedance curve enters the $\rho = 2$ ci and η_1 is the frequency at which leaves.

From inspection of Figure 2 may see that the addition of se inductive or capacitive reactance ments will have the effect of rotat the *impedance* diagram up or do while adding capacitive or induct elements in parallel will have a sim effect on the *admittance* diagr Short line elements or lumped circ elements may be used to produce th effects; in any particular instance choice will depend on the freque range and size of matching section lowed.

Series quarter-wave lines have well known effect of transposing h impedance waves to low and low pedance to high. These are very u ful elements in completing a match where a condenser or coil has b used to *set up* the curve for quarter-wave line.

Figure 3 represents the admittan frequency and admittance diagrams a resonant antenna. The applicat of a shorted λ/4 stub in parallel w the antenna impedance (or a paral resonant lumped element circuit) depicted in these figures. The ef of the parallel stub is to cancel susc tance with the result that the curv *collapsed* into the $\rho = 2$ circle shown in the admittance diagram. will be observed that the points to left of the .5 abscissa in the admitta diagram cannot be brought into

(*Continued on page 70*)


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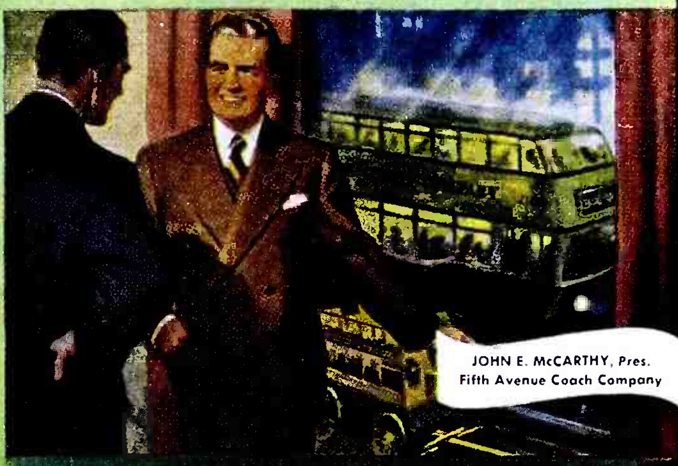
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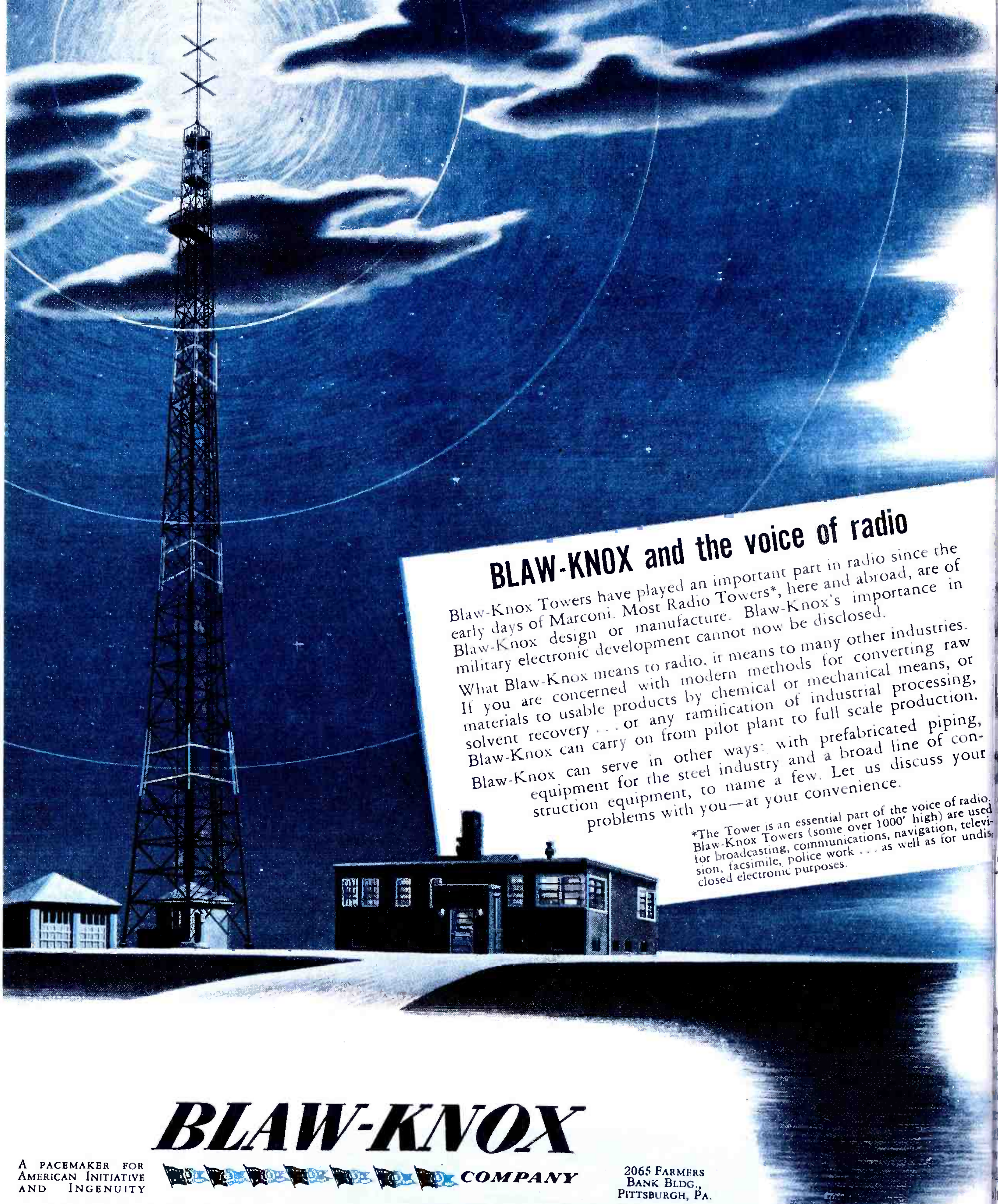

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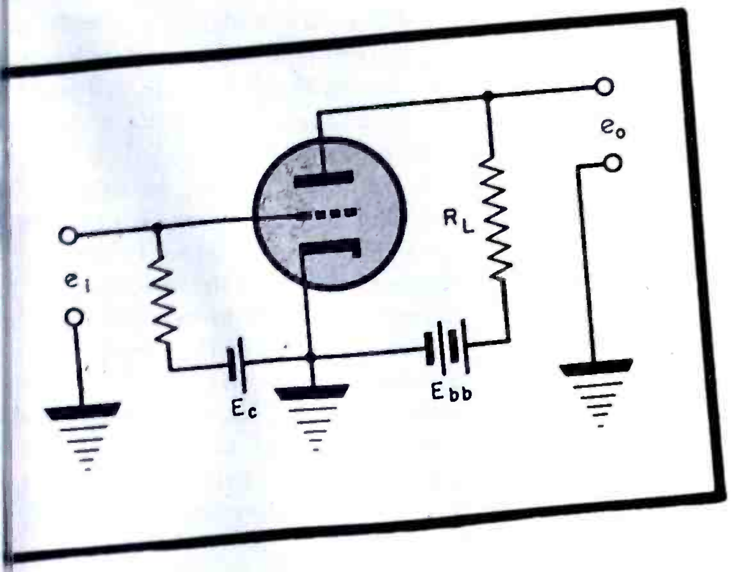

Figure 1 (left)
Circuit for plate-loaded amplifier.

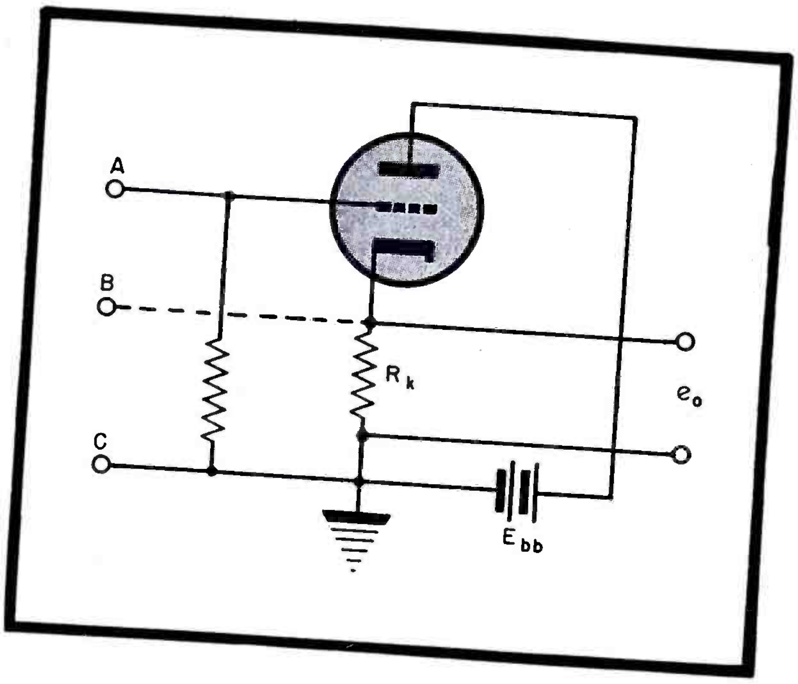

Figure 2 (right)
Cathode-follower circuit.

ATHODE FOLLOWERS ND LOW-IMPEDANCE LATE-LOADED AMPLIFIERS

n Analysis of the Relative Merits of These Circuits

by **SIDNEY MOSKOWITZ**
Radio Engineer
Federal Telephone and Radio Laboratories

BECAUSE of the interest in the design of wideband amplifiers for use with oscillographs and ision circuits, the analysis of the *ode follower* has become the sub- of widespread discussion. The ode follower is characterized by output impedance, high-input im- nce, wide-frequency response, age gain less than unity and low output voltage to ground. As a lt, the circuit may be applied as a o-frequency power amplifier, or dance transformer. The use of a -loaded amplifier as a low im- nce coupling stage, although ob- s, has not had as widespread ap- tion. Yet, it allows many of the ntages of the cathode follower to obtained, plus decoupling and e reversing characteristics which are not obtained with the former.

This paper will outline the design factors of the cathode follower, and compare the results with those of the plate-loaded amplifier.

The symbols used may be defined as follows:

μ	Tube amplification factor
R_p	Tube plate resistance
R_L	Plate-load resistance
G_m	Tube transconductance or μ/R_p
R_k	Cathode-load resistance
e_i	Input-signal voltage
e_o	Output voltage
E_c	Grid-bias voltage
i_p	Instantaneous plate current
i_c	Instantaneous cathode current
I_b	Average plate current
I_s	Average screen-grid current

$$A \quad \frac{\mu R_L}{R_p + R_L} \text{ for plate-loaded amplifier}$$

$$A \quad \frac{\mu R_k}{R_k + R_p} \text{ for cathode follower}$$

Voltage Gain

The voltage gain of a plate-loaded amplifier, as in Figure 1, is

$$\frac{e_o}{e_i} = A = \mu \frac{R_L}{R_L + R_p} \qquad (1)$$

If the tube is a pentode (high-amplification factor and high plate resistance), equation *1* becomes

$$A = G_m R_L \qquad (2)$$

Although the gain of the plate-loaded amplifier is here given a positive value, in reality, the output voltage is opposite in sign to the input voltage. The plate-loaded amplifier, therefore inverts the signal voltage. If the signal is a sinusoidal voltage, this effect would correspond to a phase shift of 180°.

When the output voltage of Figure 1 is fed back to the input, the net grid to cathode voltage for alternating currents is $e_i - e_o$. From the theory of

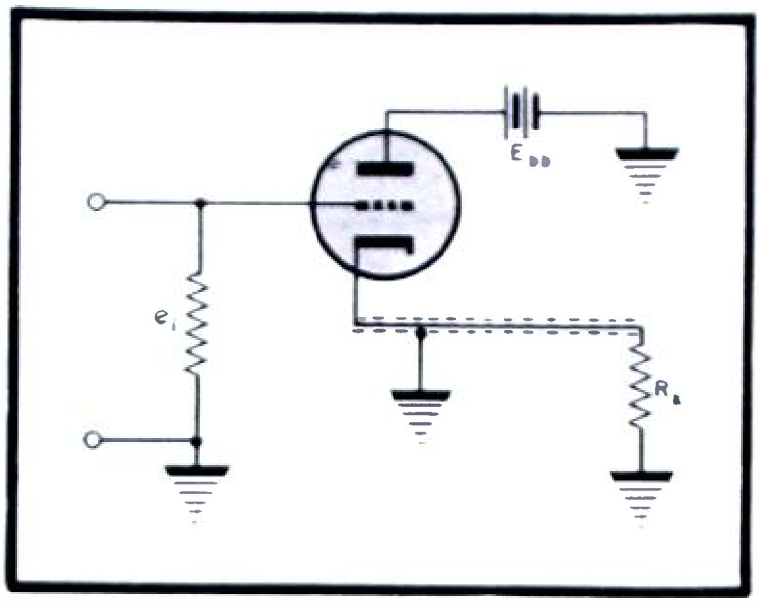

Figure 3

Load connected to cathode follower by means of a coaxial cable.

the inverse feedback amplifier, the gain of such an arrangement is

$$A = \frac{A}{1 - \beta A}$$

where β is the ratio of feedback voltage to total output voltage. In the above β = −1. Therefore,

$$A = \frac{A}{1 + A} \qquad (3)$$

The circuit of a cathode follower is shown in Figure 2. It can be seen that this circuit follows the above analysis. That is, if it is assumed that the input voltage is fed into points *A* and *B*, analysis will show that the gain is given by equation *1*. If the input voltage is fed to point *A* and *C*, as it is usually done, the altered gain is given by equation *3*.

It then is permissible to analyze the cathode follower by taking the gain for the plate-loaded amplifier having the same loading and substituting it in equation *3*. If this is done, it will be found that for resistance load the gain of the cathode follower is

$$A' = \frac{\mu R_k}{(\mu + 1) R_k + R_p} \qquad (4)$$

For a pentode this may be written as

$$A' = \frac{G_m R_k}{1 + G_m R_k} \qquad (5)$$

Output Impedance

The output impedance of the plate-loaded amplifier consists of the load resistance in shunt with the tube plate resistance. Or,

$$Z_o = \frac{R_p R_L}{R_p + R_L} \qquad (6)$$

The output impedance of the cathode follower is given as the load resistance in shunt with a resistance represented by $R_p/1 + \mu$

$$\text{or} \quad Z'_o = \frac{R_p R_k}{(1 + \mu) R_k + R_p} \qquad (7)$$

For a pentode, equation *6* becomes

$$Z_o = R_L \qquad (8)$$

and equation *7* becomes

$$Z' = \frac{R_k}{1 + G_m R_k} \qquad (9)$$

Examination of these equations shows that the gain can be written as

$$A = G_m Z_o \qquad (10)$$

$$A' = G_m Z'_o \qquad (11)$$

Comparing equations *10* and *11* we note that if $Z_o = Z'_o$ then the gain of the plate-loaded amplifier is equal to that of the cathode follower and is less than unity.

It is well to point out that whereas the output impedance of the plate-loaded amplifier is fairly constant, the output impedance of a cathode follower may not be fixed at any one value at all times. As stated above the cathode-follower output impedance is equal to R_k in shunt with $1/G_m$ (approximately). The transconductance of a tube is a function of plate current and will therefore vary with the instantaneous input signal voltage. Since $1/G_m$ is a controlling factor of output impedance, the output impedance may vary with signal voltage. For example, if the input signal voltage reaches such a negative value that plate current ceases to flow, G_m becomes zero and as a result, the instantaneous output impedance becomes equal to R_k. Therefore, if the signal voltage swings from cut-off to some positive value, an abrupt change in output impedance will be encountered. On the positive portion of the cycle, the output impedance will be a low value equal to that given by equation *7* and on the negative portion it will be a higher value equal to R_k. This variation of the output impedance may have a marked effect on the frequency response of the circuit.

Output Voltage

Although the voltage gains of the cathode follower and the plate-loa amplifier are equal for equal out impedance the maximum voltage t can be obtained from the cathode f lower is greater. Let us assume t both circuits are operated so that g current never flows. In other wor the grid voltage never swings positi If the output voltage is small w respect to the plate voltage, we m assume the plate-to-cathode voltage constant. Hence, the maximum pl current in the two types of circu will be equal when each grid cathode voltage is zero. If we c this value of current, mi_p, then the cathode follower,

$$\text{peak } e_o = mi_p R_k$$

and for the plate-loaded amplifier,

$$\text{peak } e_o = mi_p R_L$$

For equal output impedances, of the cathode follower is greater th R_L of the plate loaded amplifier. T above equations, therefore, indic that the peak output voltage obtaina is greater when a cathode follower used. Since the gains of the two c cuits are equal, the greater out voltage is obtained by applying higher input signal voltage.

In the plate-loaded amplifier, maximum current will flow wh $e_i - E_c = 0$. However, for the cath follower, the net grid-to-cathode vo age is $(e_i - E_c - e_o)$. Since $e_o = A'$ we have, for the cathode follower,

$$\text{peak } e_i = \frac{E_c}{1 - A'} \qquad (1$$

for maximum plate current.

This equation shows that an exce ingly high input voltage would be quired to make the grid-to-cath voltage zero when the voltage gain the cathode follower is close to un In practice, the grid-to-cathode vo age may become zero because of pl current saturation before the in voltage reaches a value given by eq tion *12*. A still greater input volt than that causing saturation w cause grid current to flow.

The cathode follower delivers output voltage with less distort than that introduced by its analog plated-loaded amplifier. The ratio distortion introduced by the cath follower to that introduced by a pla loaded amplifier having the same l and output voltage, is

$$\text{Distortion ratio} = \frac{1}{1 + A}$$

A comparison of distortion int duced by a cathode follower and pla loaded amplifier having the same g and output impedance cannot be m

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directly: However, a fair approximation of the improvement in linearity of the cathode follower can be obtained from the above equation.

Power Output

The cathode follower is commonly used as a power amplifier of signals whose frequency components may vary from low audio frequencies to several megacycles. When used as a power amplifier, the load resistance, R_k, of Figure 2 represents the load itself and the output power is dissipated therein. In many applications, the cathode follower is connected to the load by means of a cable, Figure 3. For wide-band circuits, the cable would be coaxial, terminated in its characteristic impedance. To obtain the maximum power transfer, therefore, the output impedance of the cathode follower should be equal to the input impedance of the cable. If the cable is terminated properly, the output impedance of the cathode follower would be made equal to the characteristic impedance of the cable.

The output impedance would then be only $1/G_m$. Control of the output impedance can be obtained to some extent by control of the d-c operating points of the tube, but is generally obtained by choice of the type of tube to be used.

For example, if the output impedance desired is 100 ohms, a 6AG7 tube whose G_m is listed as 11,000 micromhos might be used, provided the power output obtained is satisfactory.

The maximum power obtainable from either a cathode follower or a plate-loaded amplifier is a function of the current capacity of the tube. As stated above, if no grid current is drawn, the maximum voltage obtained is the product of the load impedance and the cathode current that flows when the grid-to-cathode voltage becomes zero. The peak output power would then be (for resistance load)

$$m\,p_o = (m\,i_c)^2 R_k \qquad (13)$$

If we were to consider the analagous plate-loaded amplifier (one having a matched load fed through a cable as in Figure 4), the total load impedance presented to the amplifier would be ½ the actual power load. Hence, since the load is equal to the tube output impedance, the peak power obtainable is one-quarter of that obtained from the same tube used as a cathode follower.

The problem of coupling the load to the plate-loaded amplifier is another factor to be taken into consideration. Any cable connecting the load to the amplifier would be at a high voltage above ground. This difficulty could be overcome by using a decoupling condenser. However, if low frequencies are involved, the large size of the condenser would be a drawback.

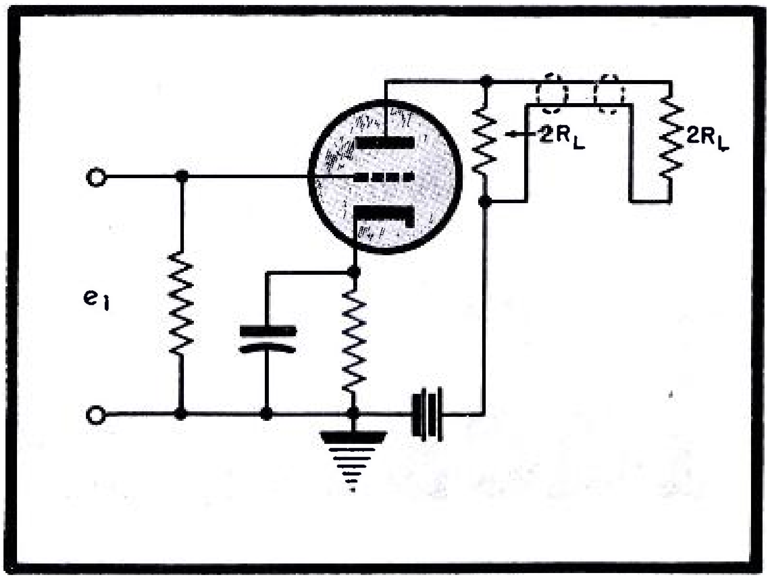


Figure 4

Load connected to plate-loaded amplifier by means of a cable.

Bias Voltage

In the plate-loaded amplifier, the grid-bias voltage may be obtained by means of a fixed voltage, such as a battery or power supply, or by means of a bypassed-cathode resistor. The most common form of biasing method is the use of the cathode resistor. The value of the resistor to be used is calculated by the equation

$$R_c = \frac{E_c}{I_b + I_s} \qquad (14)$$

A bypass condenser is then chosen so that the proper frequency and phase response is obtained.

In the cathode follower, the bias voltage may be obtained either partly or entirely from the d-c voltage developed across the cathode load itself. The bias voltage required depends c the type of operation desired.

Several methods of obtaining gr bias for the cathode follower ai shown in Figure 5. In Figure *5a* tl bias voltage is obtained from the d voltage developed across the cathoc resistor R_c. The value of R_c can l calculated from equation *14*. This ci cuit may be used as a voltage devi having a low output impedance. F such an application, the value of I is calculated from equation *14*. R_k then fixed at a value giving the prop output impedance. This output imp dance consists of R_c, R_k and $R_p/1 +$ in parallel.

In some applications, R_k may be tl power load connected to the cathoc follower by means of a cable. Tl output impedance feeding the load R_c shunted by the tube impedan $R_p/1 + \mu$. The resistor R_c and tl value of $R_p/1 + \mu$ (or approximate $1/G_m$) are chosen so that the prop grid bias and output impedance a obtained.

In Figure *5b* the bias volta is developed across the load, R_k. Sin the load, R_k, is fixed by consider tion of output impedance, there ca be no control of the bias vol age. If the bias voltage develop by R_k is too low, it may be increas by adding a bypassed series resist as shown in Figure *5c*. The capaci is chosen so that the proper low fr quency response is obtained. Tl value of R_c may then be calculat from

$$R_c = \frac{E_c}{I_b + I_s} - R_k$$

In applications where the d-c vo age across R_k may be too high, t method of Figure *5d* may be used. this circuit, E_c is the voltage d veloped across R_c. R_c may then calculated from equation *14*. noted in a later section, the input i pedance of this circuit is higher th the value of grid return resistance.

A variation of the circuit of Figu *5d* is shown in Figure *5e*. Here, may be calculated from equation Note its similarity to divider n works in inverse feedback systems.

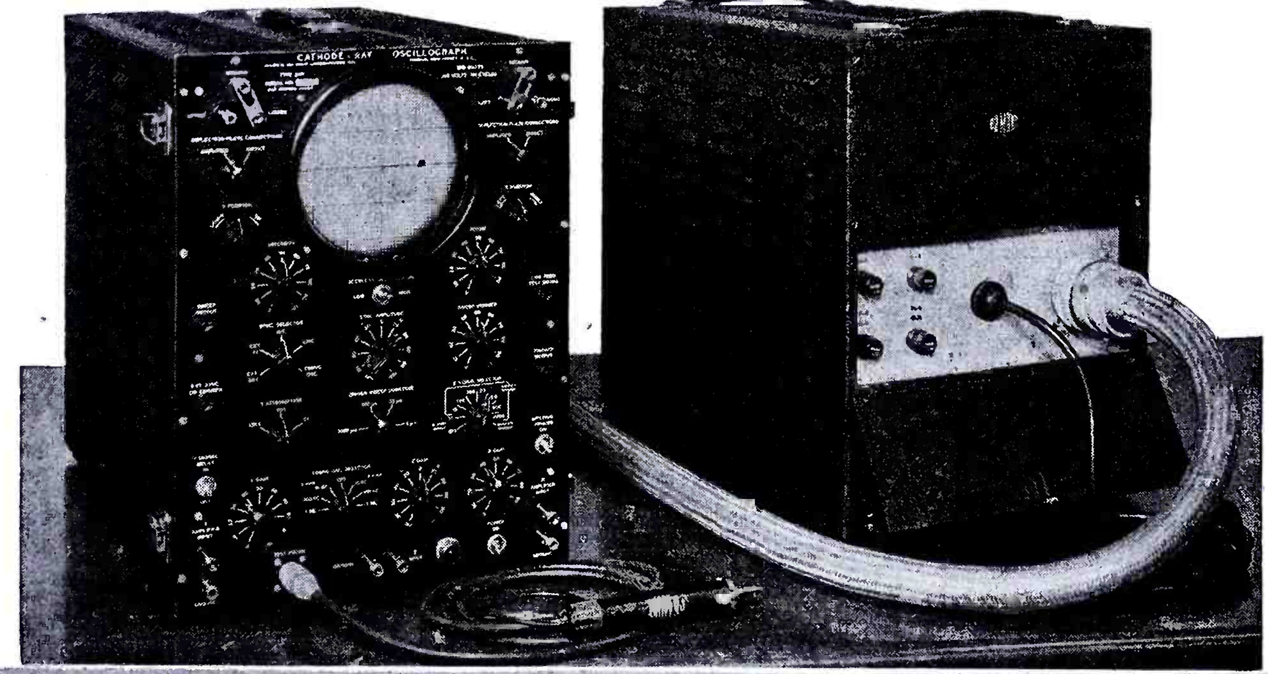
When the load resistance R_k Figure *5b* is chosen to obtain a quired value of output impedance gain, it may be necessary to check t bias voltage developed to insure a c rect point of operation. The bias vo age may be calculated as follows:

Draw the customary load line the plate characteristic curves cor sponding to the cathode-load resista and plate supply voltage. Assume value of plate current I_b and calcul E_c = assumed $I_b \times R_k$. The int

CIRCUIT ANALY

To facilitate the study of microsecond pulses containing frequency components as high as ten megacycles . . .

New! TYPE 248 DuMONT Oscillograph



Wide band vertical axis amplifier usable to 10 MC.

4000 volts accelerating potential applied to cathode-ray tube, allowing observation of fast-writing-rate phenomena.

Extremely flexible time-base generator to display signals which heretofore required special sweep circuits.

Delay network in vertical channel, permitting observation of entire wave shape of short duration phenomena.

Useful timing oscillator for quantitative analysis.

Trigger output signal useful for "synchroscope" applications.

Optional low capacitance probe input to vertical amplifier.

Convenient mechanical design which permits placing separate power supply on floor or shelf beneath lab bench.

Storage space for all cables provided in power unit.

Design is such that modifications to standard specs. can be accommodated to special order in the following respects: (1) Driven sweep durations; (2) Marker oscillator frequencies; (3) Trigger pulse rates.

Both metal cabinets, with carrying handles, measure 14"x 18"x 21" deep. Power supply weighs 80 lbs. Oscillograph, 30 lbs. Units connected by 6-foot shielded cable. Standard A-N connectors used.

➧ Still another DuMont "first". Incorporating the most advanced features, this latest oscillograph is now available at moderate cost as a standard commercial instrument. It will be especially welcomed by the investigator heretofore restricted in his work by the inadequate performance or the prohibitive cost of existing equipment.

Type 248 is a portable instrument. Two units facilitate handling and installation. Either transient or recurrent phenomena can be displayed. Also accommodates phenomena of inconstant repetition rate. The leading edge of short pulses is not obliterated. The accelerating potential applied to the cathode-ray tube is great enough to permit study of extremely short pulses with low repetition rates, usually observed only with specialized and costly oscillographic equipment. Timing markers are available for quantitative or calibration purposes.

In short, this instrument removes the very noticeable deficiencies in commercial test equipment performance brought to light by recent advances in electronic technique. And it is equally useful as a general-purpose or as a production-test instrument.

➧ **Write for Literature . . .**

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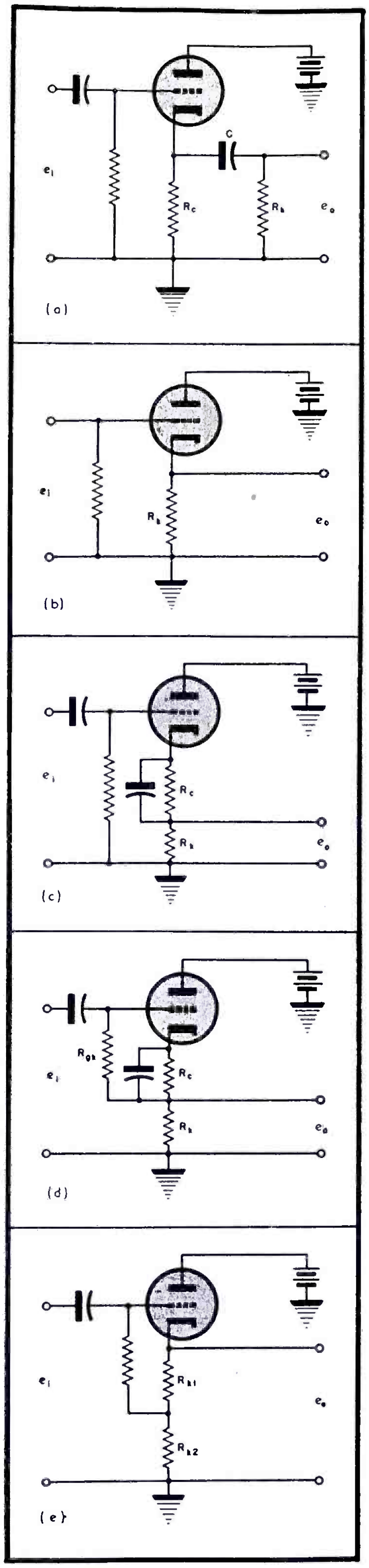

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Figure 5
Methods of obtaining grid bias for cathode followers.

•

section of the grid curve for this value of E_c and the load line gives an actual plate current, I_b, that would flow if this E_c actually existed. Assume two or more values of I_b and follow the above procedure. Then plot the assumed value of plate current versus the actual value of plate current to the same scale. A line drawn at an angle of 45° passing through the origin will intersect the current curve at the actual current that will flow in the circuit. The product of this value of I_b and R_k gives the bias voltage that will be obtained.

Frequency Response

The cathode follower and plate-loaded amplifier have thus far been treated as pure resistance devices. Whereas this may be true at low frequencies, at the higher frequencies the effects of the internal capacities of the tube and the capacities added by the associated load and wiring must be taken into account. It will then be found that the voltage gain of both types of circuits will decrease at higher frequencies. The complete circuits of the cathode follower and plate loaded amplifier including all capacities are shown in Figure 6. The load circuit of Figure 6*a* may be considered as consisting of R_L shunted by C_{pk} and C_L. It then can be shown by simple analysis that the vector voltage gain of the plate-loaded amplifier may be written as

$$\overline{A} = \frac{A}{\sqrt{1 + (f/f_o)^2}} \underline{|-\theta} \qquad (15)$$

where f is the frequency at which the gain is to be calculated, and f_o is the frequency at which the load resistance is equal to the shunt capacitive reactance and is equal to

$$\frac{1}{2\,\pi\,R_L\,(C_{pk} + C_L)}$$

A is defined by equation *1*

$$\theta = \tan^{-1}\frac{f}{f_o} \qquad (16)$$

The magnitude of the gain is

$$A/\sqrt{1 + (f/f_o)^2}$$

and the phase shift introduced by the amplifier is given by equation *16*. The magnitude of the gain may also be written as

$$|\,\overline{A}\,| = A\cos\theta \qquad (17)$$

Equations *16* and *17*, which are surprisingly simple in form, may be used to calculate the gain of a plate-loaded amplifier at frequencies where circuit capacities are not negligible.

From the above results, the frequency response of the cathode fo

lower may be easily derived.

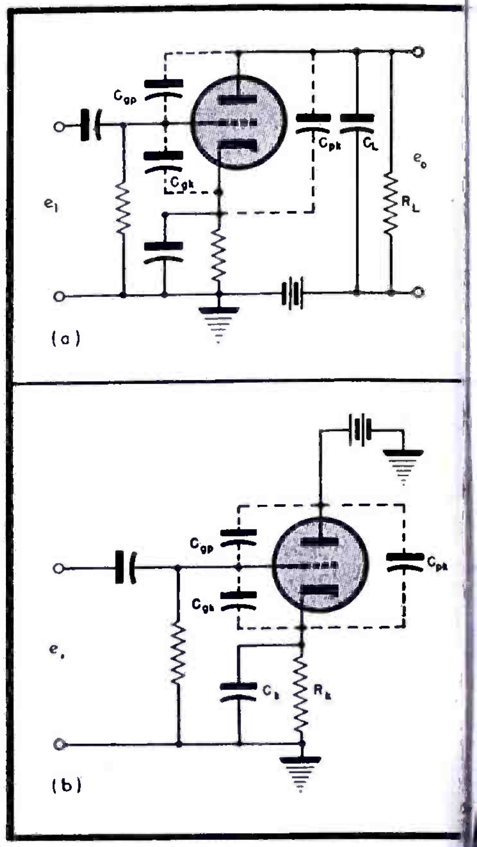

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Figure 6
In (*a*) we have the complete circuit of plate-loaded amplifier, including tube int electrode and load capacities. In (*b*) have a complete cathode-follower circ with tube interelectrode and load capaciti

•

If equation *15* is substituted in equ tion *3* the vector gain of the catho follower is obtained and is

$$\overline{A'} = \frac{A'}{\sqrt{1 + [f/f_o\,(1 + A)]^2}} \underline{|-\phi}$$ (1

$$\phi = \tan^{-1}\frac{f}{f_o\,(1 + A)}$$ (1

$$\text{where}\quad f_o = \frac{1}{2\,\pi\,R_k\,(C_k + C_{pk})}$$

Again, the magnitude of the ga may be simply written as

$$|\,\overline{A'}\,| = A'\cos\phi$$ (2

It can readily be seen from equ tions *16* and *17* that the gain of plated-loaded amplifier will fall to 70 of its low frequency value (half-pow point) and the phase shift will be 4 when $f = f_o$ (when the load resistan is equal to the shunt capacitive rea tance). However, equations *19* a *20* show that the gain of the catho follower will drop to 70% and t phase shift will be 45° wh $f = f_o\,(1 + A)$. For the same loa ing, therefore, the bandwidth of t circuit has been increased by the fa tor $(1 + A)$.

At the higher frequencies, the o

(*Continued on page 92*)

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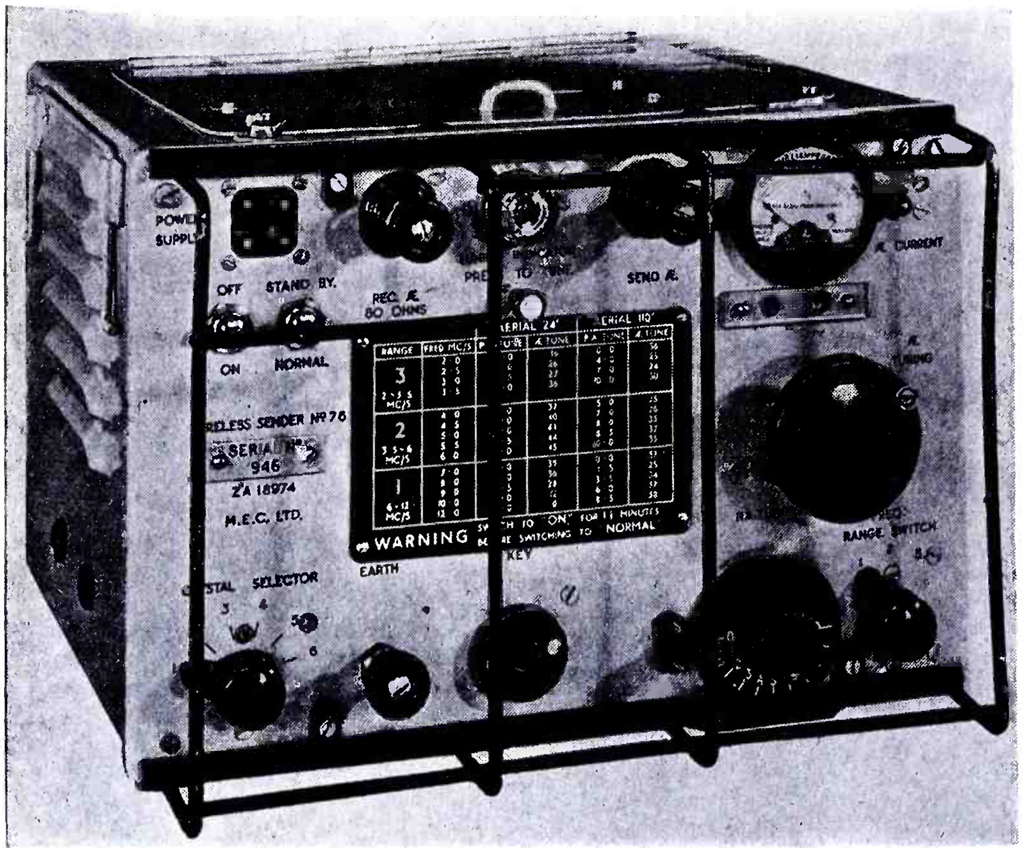

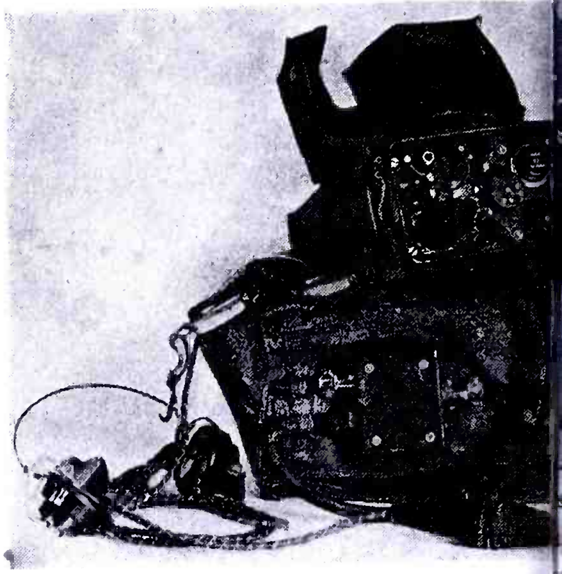

At left, type *76* transmitter designed for Commando operations. The unit has a power of 20 watts. Operates on the 2 to 12-mc bands. Below, type *46* transceiver that is crystal-controlled on three spot frequencies in the 3.4-4.3, 5-6, 6.4-7.6 or 7.9-9.1 mc bands. Four tubes are used in a superhet receiver; three in the 1.5-watt transmitter.

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BRITISH ARMY COMMUNICATIONS' EQUIPMENT DEVELOPMENTS

by CAPT. ANDREW REID

of the Signal's Directorate
Britain's War Office

THE recent removal of certain security restrictions in Britain has made it possible for the first time to review in some detail the development and tactical uses of the radio communications equipment used by the British Army.

The vast scale of Britain's military radio equipment, that has proved so necessary in modern mobile warfare, could not have been achieved without considerable help from the United States under Lend-Lease arrangements. This help has not been confined to the supply of U. S. Signal Corps equipment (such as radio station SCR 399 and wavemeter SCR 211), but has included the granting of facilities to manufacture in the U. S. A. equipment of basically British design such as the *19* model radio set, which appeared almost overnight as a result of experience in France in 1940 when it became evident that a small, robust and reliable set was needed in every tank. Canada has also made an invaluable contribution to production of this among other sets, as well as producing others of her own design.

The *19* model is really three sets in one: an h-f transmitter for working over distances of up to 15 miles, a small v-h-f set for local communications among troops of tanks, and an intercommunication amplifier for internal communication between members of the tank crew.

The British Army has no equivalent of the American walkie-talkie. The nearest approach is a small pack set known as *38*. This is carried on the chest and used for platoon and patrol work. A slightly larger set with range up to 5 miles is the *18* or the *48* which is its U. S.-manufactured equivalent. For sets used in forward areas the trend is toward crystal-control. These sets are easier to operate and thus ideal for the infantry and other non-signals personnel whose training in radio is necessarily brief and superficial. The *46* set, for instance, is operated entirely by switches. At brigade level and above, all sets are operated by Royal Signals personnel who, although trained to fight, are first and foremost radio men. Their training allows more complex equipment to be used. The *22* model is the most versatile of the Royal Signals sets. It is used as a vehicle set, air observation set, for man-pack and mule pack, and is among those dropped by parachute—with tubes in position—for use by airborne forces.

Certain types have been developed for special purposes outside the ordinary range of communications. Most popular of these has been the *76*, originally designed for Commando formations and other troops likely to be working in isolated bodies, cut off from parent formations or bases. The *76* is small, light and sturdy and yet has sufficient power to provide efficient communications over 250 to 300 miles. This set was used on the Normandy beaches and in the recent operations by the British First Airborne Division in Holland to provide rear link communications to the United Kingdom.

As a result of the very mobile operations in the Middle East the need arose for a mobile model providing reliable radio contact over distances of up to 100 miles. For this purpose the high-power model *12* and later *53* were designed (250-watts transmitter power). The equipment is used in the large command vehicles, armored and unarmored, with which the headquarters of every British corps, division and brigade are equipped today.

The introduction of such high-power transmitters at field headquarters resulted at first in considerable interference with other lower-powered transmitters and a *major headache* in frequency allotment. That these difficulties have been largely overcome by skillful allotment of frequencies was shown by reports from Normandy where there was a greater congestion of radio stations than is likely to occur again.

•

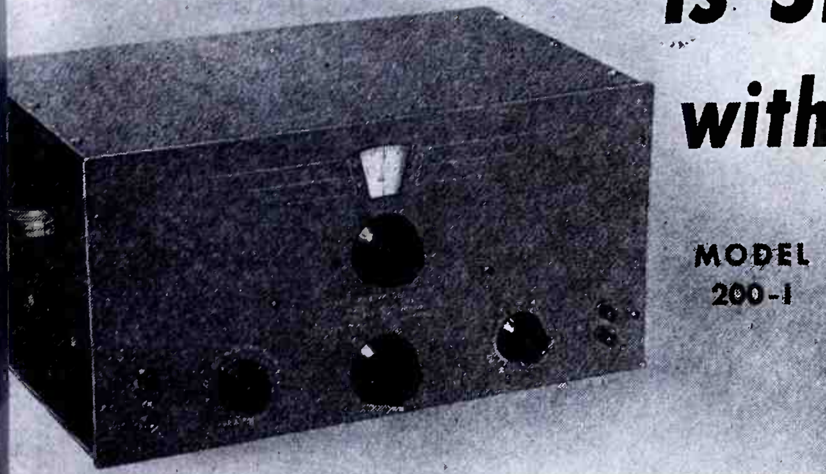
Technical Data

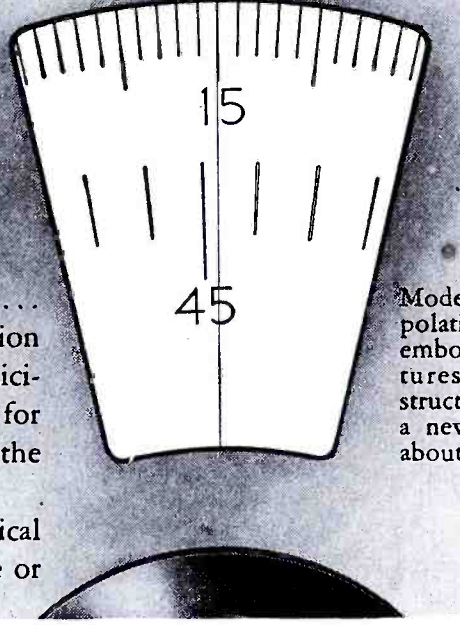
BY H. W. BARNARD

TO link a platoon with its company, not more than two miles away, the British Army has a 5-tube transceiver 9" x 6½" x 4", weighing 6 pounds excluding combined filament and plate dry battery. It is known as the *38*. As

(Continued on page 91)

LIFETIME of SPLIT-HAIR ACCURACY
is Standard Equipment
with Every -hp- Instrument





Model 200-I is a new interpolation oscillator which embodies many new features. New, rugged construction, new circuit and a new accurate dial. Ask about it.

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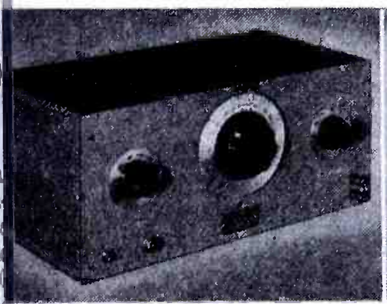
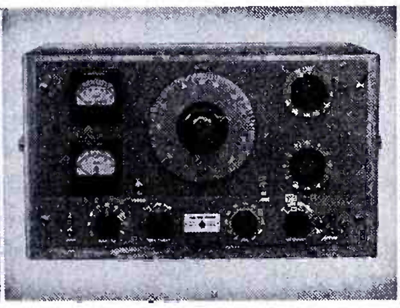
king every important test and measurement *with insured accuracy* in the
dio frequency field.

A few of these instruments are illustrated below . . . complete technical
ormation will be sent on request. For special applications, a note or
etch outlining your problem will receive prompt attention.



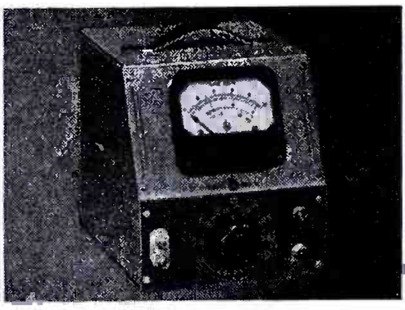
RESISTANCE-TUNED AUDIO OSCILLATORS

quire no zero setting...several models
ilable to cover frequency ranges from
ps to 200 kc.



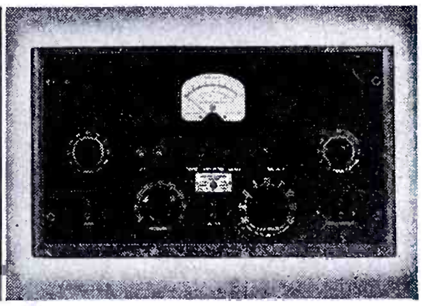
AUDIO SIGNAL GENERATORS

Three models—205-A, 205-AG, 205-AH—provide frequency ranges from 20 cps to 100 kc.



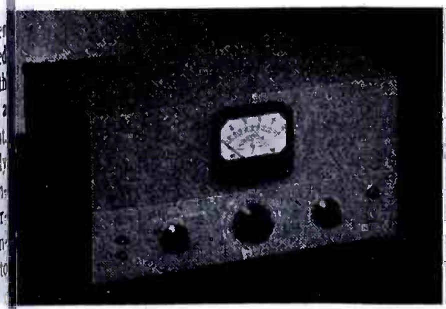
VACUUM TUBE VOLTMETERS

Make accurate voltage measurements from 1 cycle to 1 megacycle, cover nine ranges, (.03 volts to 300 volts) with full scale sensitivity.



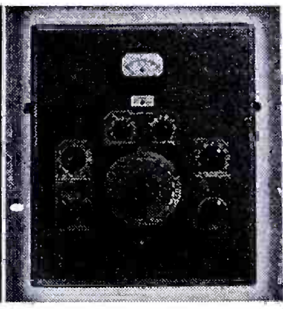
DISTORTION ANALYZERS

Three models available—320-A, 320-B and 325-B—to provide frequency coverage from 30 cps to 15 kc. Model 325-B incorporates a vacuum tube voltmeter.



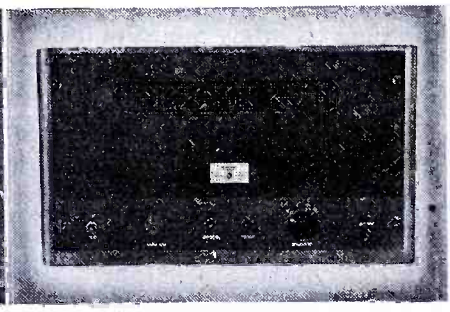
LECTRONIC FREQUENCY METER

e Model 500-A is designed to mea-
e the frequency of an alternating
ltage from 10 cps to 50 kc. Overall
curacy is ± 2% of full scale value.



HARMONIC WAVE ANALYZER

Measures individual components of a complex wave over a frequency range of 30 to 16,000 cps. The selectivity can be varied continuously, making the analyzer adaptable to a wide variety of measurements.



FREQUENCY STANDARDS

The Model 100-B supplies standard frequencies of 100, 1,000, 10,000 and 100,000 cps, all of which are available simultaneously.

ATTENUATOR AND VOLTAGE DIVIDERS

The Model 350-A consists of a 10 db and a 100 db bridged-T attenuator, providing a total of 110 db attenuation. variable in 1 db steps. Other attenuators and voltage dividers can be quickly supplied.

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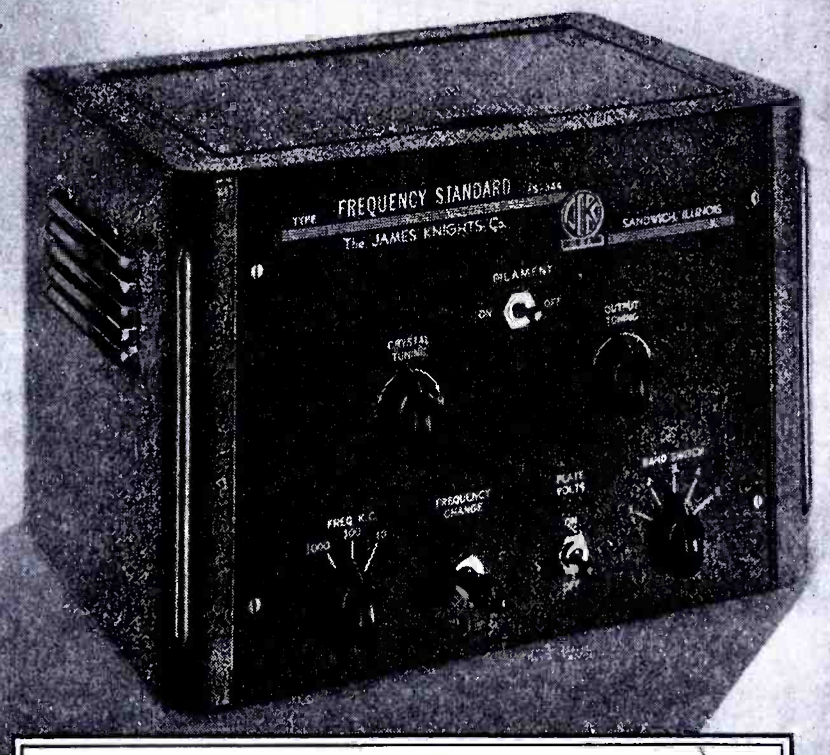


TELEVISION

(Continued from page 36)

value specified in the manual, and l
reducing the resistance by 4/6 of t
value specified. This stage, howeve
is critical in its adjustments for o
taining a flat response, and for avoi
ing echoes in the picture, but it is pe
fectly stable in operation.

Elimination of Oscillation

The amplifier was at all times stal
at high frequencies, but gave troul
because of low-frequency oscillatio
(motor-boating). High-frequency st
bility was obtained by providing
shielded compartment for each stag
and allowing the coupling condens
between stages to project half-w
into each stage through a hole in t
shield wall. As a further precauti
we kept the input and the output c
cuits as far apart as possible with
the compartment. Low stage capac
is promoted by keeping the plate le
plate resistor, and the top end of t
peaking coil and trimmer condens
as far away from the chassis a
grounded components, such as bypa
condensers, as possible.

Low frequency oscillations we
more difficult to eliminate. The pro
lem was solved by following two lin
of attack. One was to improve t
performance of the regulated pow
supply, and this will be discussed su
sequently. The other was to use
two-section *R-C* filter in the first a
in the last stages.

In the first stage, the two-secti
R-C filter is represented by the 30- a
the 10-mfd condensers and the t
7500-ohm resistors connected betwe
the bottom end of the peaking coil a
the power supply. In the last sta
the 16- and the 10-mfd condensers a
two 2000-ohm resistors serve this pu
pose.

The use of a two-section *R-C* fil
is quite common in audio amplifie
but is not noted, as a general rule, in
video amplifier, possibly because it
feared that the low-frequency respon
will be adversely affected by such
circuit. This is not the case, howev
If the filter resistors are large in va
compared to the reactance of the fil

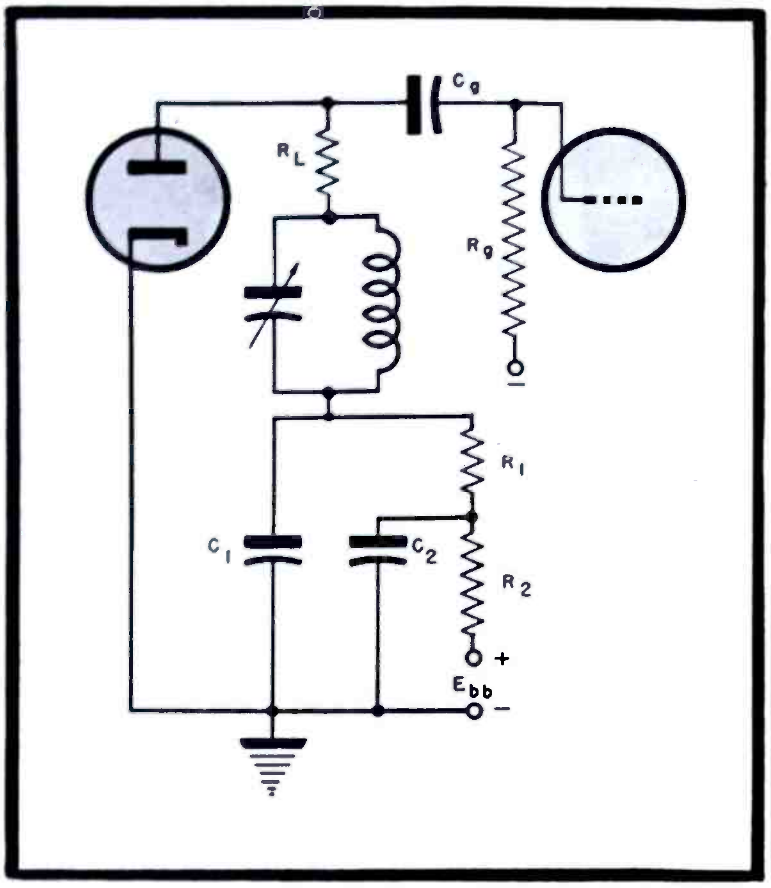


Figure 6

rcuit used to analyze e l-f response proper- of a two-section C filter. If R_1 and are high compared the reactance of C_1 d C_2, then the bot- m of R_1 is essen- lly at a-c ground po- tial because of C_2, gardless of its con- ction to B+ through R_2.

ndensers at the lowest frequency ider consideration, then the adjust- ents are exactly the same as for a ngle section filter.

ircuit Analysis

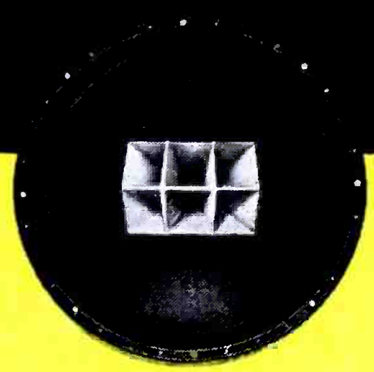
An examination of Figure 6 clarifies is point. If R_1 and R_2 are high com- red to the reactance of C_1 and C_2, en the bottom end of R_1 is essentially a-c ground potential because of C_2, gardless of its connection to B+ rough R_2. In other words, C_2 may regarded as shorting out R_2 and the ternal impedance of the *B* supply. ence, for proper low-frequency re- onse, the time constants C_1R_L and R_g are adjusted for equality, just if R_2 and C_2 were not present.

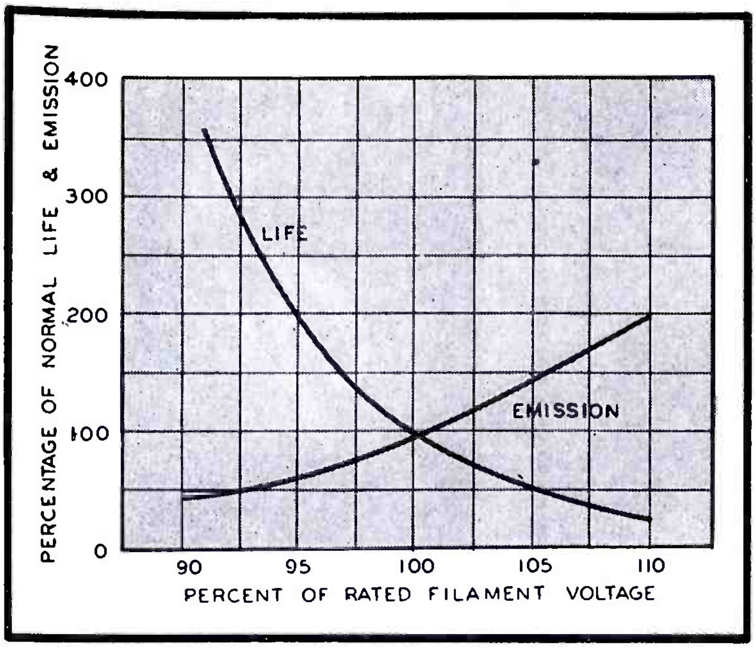
This elementary analysis appears equate for the adjustment of the ge. At the same time, the two-section filter in general affords more de-coupling of the stage from the other stages than does a single-section filter employing the same total amount of capacity and resistance.

Even Stages

It may appear strange that an even number of stages are involved, but there may be a phase shift in the regulated power unit as well as in the amplifier that causes the motor-boating between the first and sixth stage. At any rate, the use of a two-section filter in these stages eliminated this difficulty, and such treatment for any other combination of stages did not.

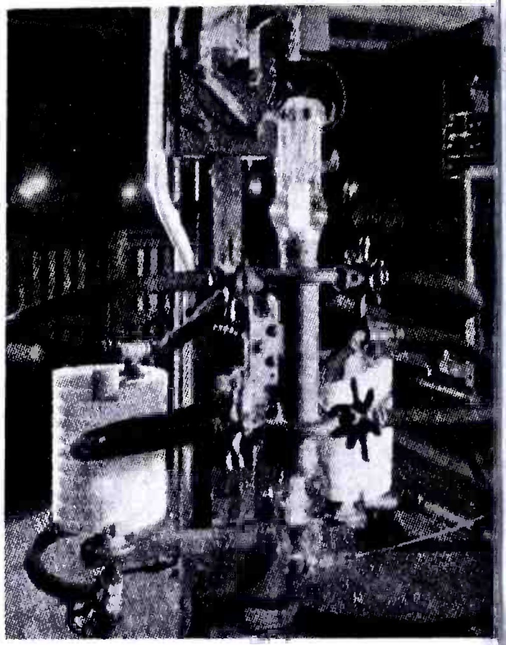
[*To Be Concluded in April* COMMUNICATIONS]





Left, relationship between tungsten filament temperature and length of life. This Figure (6), presented in first part of paper, is analyzed further in this installment. Right, water coils used in testing 100-kw tubes.

(*Courtesy Lapp*)



EXTERNAL-ANODE TRIODES

CHARACTERISTICS AND APPLICATIONS

[*PART THREE OF A FOUR-PART PAPER*]

by A. JAMES EBEL

Chief Engineer WILL
Ass't Prof. Electrical Engineering
University of Illinois

WITH the construction and operational characteristics of the external-anode triode well in mind, it is prudent to consider certain maintenance and operation procedures that will tend to prolong tube life and give more efficient, trouble-free service. Proper operation and maintenance pays rich dividends in lower tube replacement costs, fewer expensive outages, and conservation of critical materials.

The proper care of the tube begins with its installation. It is essential of course to install vertically, and in the proper water jacket or airflow duct. Yet there are other installation factors which are just as important. The glass envelope of the tube should be protected from any mechanical damage incurred by filament, grid or external leads falling down and striking the glass. In water-cooled installations, thought should be given to the possibility of water damage to components in case of leaks or breaks in the water system. In air-cooled installations, we must remember that the heat from the tube will raise the ambient temperature around all the components which are mounted above the tube and in the air stream. This in effect lowers the power ratings of these components.

A fool-proof type of interlock system should be installed in connection with either type of tube; one which will not allow the potentials to be applied in improper sequence and which will interrupt all of the potentials when the cooling flow drops below a safe limit. Double protection is obtained if thermal protection is combined with the flow interlock. It is possible for a tube to overheat with the proper flow, in cases of excessive scale formation on water-cooled anodes and of excessively high air intake temperature in forced air cooling systems.

In the discussion of the characteristics of the filament, grid and anode of an external-anode triode, many facts which should govern the operation of these tubes were discussed and need only be reviewed here. In the operation of the filament the starting cycle should provide for gradual heating and limitation of initial current surge to twice normal current. It is also desirable to provide for gradual cooling of the filament to prevent the thermal shock which occurs with sudden removal of filament potential. During the operation period close control of the filament voltage is essential. It should be maintained at as low a value as possible in keeping with the emission requirements of the circuit. The increased life obtainable with lower filament voltage was shown in Figure 6 of the first part of this paper, and is presented again for further study. From this plot it may be seen that a 5% reduction in filament voltage results in doubling the life of the emitter whereas a 10% reduction will increase the life four times. The pure tungsten filament used in these tubes cannot be damaged by operation in the region of voltage saturation. In the case of some of the larger tubes increased life is obtained when the filament voltage is reduced to 80% of normal during standby periods of lengths up to 12 hours. The evaporation thus becomes negligible and the starting strains on the filament are prevented. In the smaller type tubes the voltage must be completely removed if the standby period is longer than two hours.

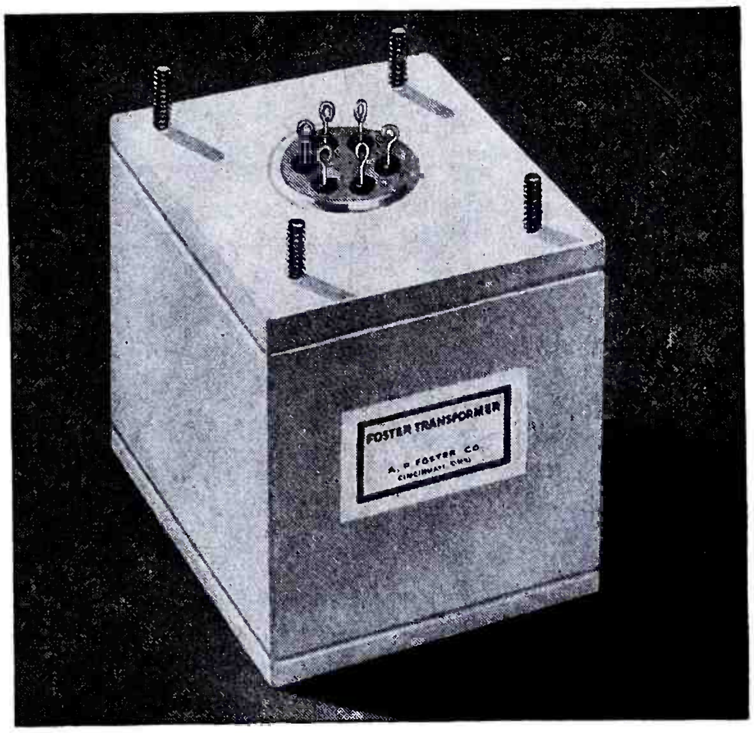
The maximum grid current ratings of large tubes should be rigorously observed since excessive grid heating leads to operational instability. It i also important, at the higher frequencies, to avoid localized heating at the grid seal. Such heating is often due to improper circuit adjustment.

The anode cooling systems for either water or forced air cooled tubes must be carefully watched during operation and in the start and stop periods. When setting the equipment using the tubes into operation the operator should check the operation of the air or water-flow interlocks. If the closing of the interlock is sluggish and not positive when the pump or blowe starts rotating, borderline operation i indicated and maintenance is require at the first opportunity. The outle water temperature should never ex

(*Continued on page 94*)

PERFORMANCE

in a tiny package



It had to be small, this new MULTIPLE CHANNEL BAND PASS FILTER, because it's destined to do a special military job. **FOSTER** designed and is building it, meeting the high performance standard required, kept it light in weight, and sealed it in a case that measures only **2¾ x 2¾ x 3¼"**!

Terminals are sealed in VITROSEAL, a basic advance in transformer manufacture, exclusive with Foster. VITROSEAL terminals are fused uniformly, simultaneously, into the metal, in multiple. The job is neat, fast, economical. The seal is sure and extremely resistant to vibration and thermal shock.

In the past 12 months Foster Engineers have solved more than 1000 individual transformer problems, designing and building entirely new units or "upping" the performance of units already in use.

If you manufacture electrical and electronic equipment, it may well be worth your while to address your special transformer inquiries to Foster.

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BAUMAN & BLUZAT	2753 WEST NORTH AVENUE	CHICAGO 47, ILL.	TELEPHONE: HUMBOLT 6809-10-11-12

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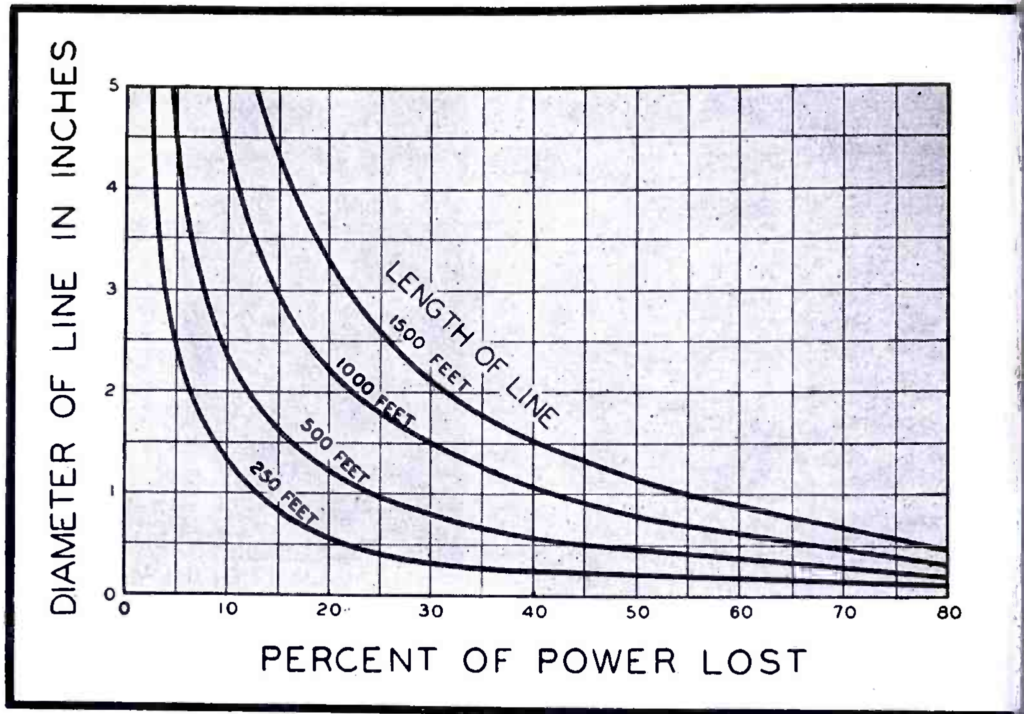
APPROXIMATE LOSSES FOR VARIOUS SIZES OF CONCENTRIC TRANSMISSION LINES AT 46 M

by WILFRED H. WOOD

Chief Engineer WMBG

LOSSES vary considerably with different types and kinds of concentric transmission lines at 46 megacycles. These losses depend upon the kind of materials and construction of the insulators used as well as the number used. It is also dependent on the copper used. Usually, these losses are expressed in decibels per 1,000 feet. It is, however, sometimes necessary to know the losses in power expressed in percent of power lost rather than in decibels. This is particularly true in calculating estimated coverages. These data are also useful in filling in the FCC application forms for f-m and television installations, which ask for percent of power loss.

To facilitate the preparation of these data, a set of curves offering approximate losses for various sizes of concentric transmission lines at 46 mc were prepared. They appear in the figure at the right. These curves do not represent any individual make of line, but rather an average of losses of several makes. The actual losses may be greater or less than shown.



A VOLUME LEVEL CONTROL FOR AUDITION AMPLIFIERS

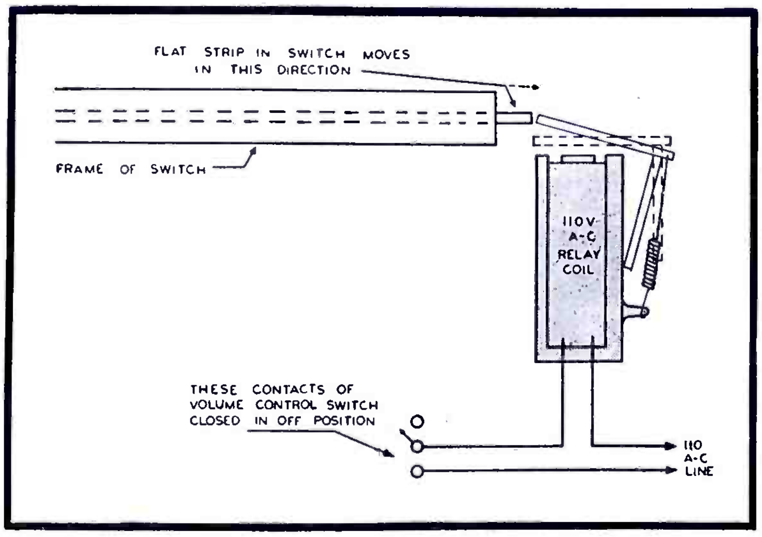
by HARRY E. ADAMS

Chief Engineer WIBC

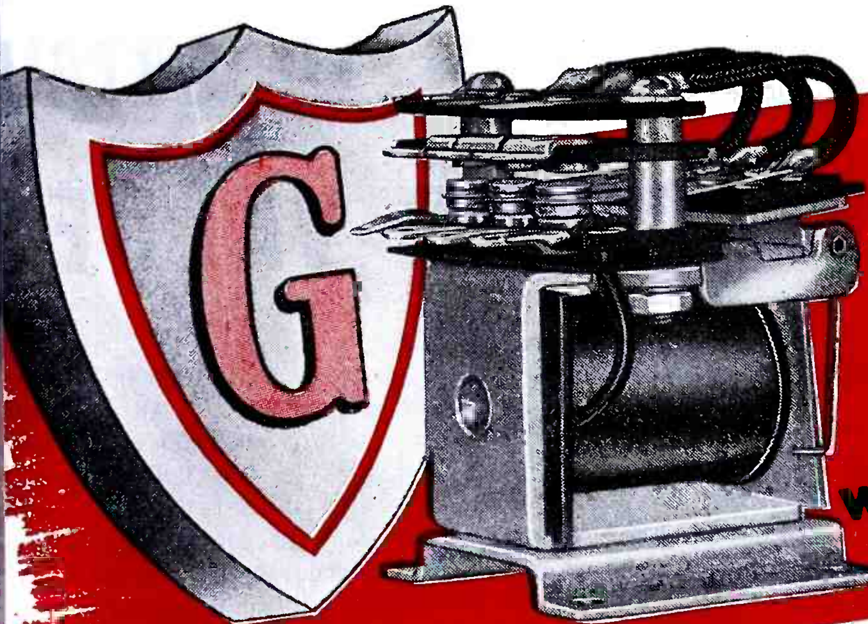
THE use of push-button selector switches for connecting audition speaker-amplifiers across various lines, a frequent studio and office practice, often presents an annoying problem. The casual user of such equipment, being non-technical will often turn the volume high, if he finds the line in use to be dead. He will then push the button he desires withou first reducing the volume, resulting i a loud blast of sound which is quit annoying to anyone nearby.

Seeking a solution, we developed a arrangement that provided a reduc tion of the volume to zero before an change in the push-buttons could b made.

In this method, the coil and arma ture from a 110-volt a-c relay wa added to the push-button assembly s as to provide a positive electrical loc Since any change in the push-butto setting causes the flat strip throug the push-button switch to move, an change is prevented by the armatur unless its coil is energized to swing out of the way. The addition of spst switch to the volume contr makes it impossible to operate th push-buttons until the control is fir turned to *off* position, thus energizin the coil.



Setup of the push-button assembly that provides a positive electrical lock.



GUARDIAN Series 345

RELAY

a "Basic Design" with many variations

meets special applications

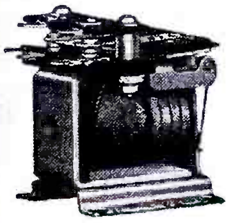
saves time . . . saves tooling . . . speeds delivery!

If your application requires a specially designed relay Guardian engineers can be of great help to you. But, as a result of their wide experience in designing "specials" they have evolved a standard design so flexible that it is now specified in numerous applications that would ordinarily require a specially designed unit. Perhaps you can use it in your "special" application . . . with a saving in money and delivery time. This unusually flexible relay is the SERIES 345. Its chief features are the large coil winding area, numerous contact combinations, the non-binding pin type armature hinge pin, its resistance to shock and vibration, and an ability to operate in extremes of temperature. It is now being used in aircraft, radio, and other exacting applications to insure dependable performance.

STANDARD SERIES 345—The ample coil winding area of the SERIES 345 gives you a wide range of windings for various voltages and currents. Coil winding area is approximately .75 cubic inches. Average power required is 3.56 watts with three pole, double throw contacts of 12½ amp. capacity. Coils are available for either A.C. or D.C. operation.

The maximum switch capacity of the Standard Series 345 is three pole, double throw. Contacts are rated at 12½ amperes at 110 volts, 60 cycles, non-inductive A.C. Moving contacts are attached to but insulated from the armature by a bakelite plate. Terminals are solder lugs. Weight is 6½ ounces.

VARIATIONS OF THE SERIES 345 RELAY



TIME DELAY

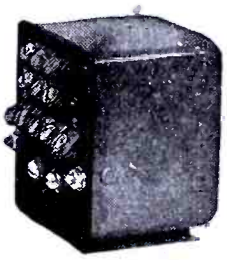
WINDING—Multi-wound coils are available for operation on two or more circuits. Or coil may be wound to operate on the discharge of a 3 mfd. condenser.

CONTACTS—Normal switch capacity is three pole, double throw; maximum switch capacity may be up to six pole double throw with 12½ amp. contacts, or any variation of contact combinations within this range, including the operation of contacts in sequence. The flexibility of the contact springs may be increased through the use of coil spring rivets.

TIME DELAY—On D.C. coils a time delay of 0.25 seconds on release or 0.06 second on attract may be achieved through the use of copper slugs which require these time intervals for saturation or de-energizing depending on whether they are used on the heel or head of the coil.

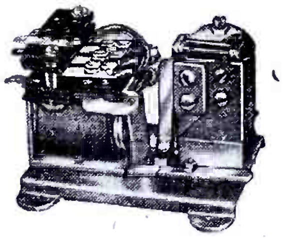
DUST COVER—For applications where this relay may be subject to injury or in atmosphere where dust may be present in sufficient quantity to impede operation, the SERIES 345 may be equipped with a metal dustproof cover.

SCREW TERMINALS—Screw type terminals are optional for applications where terminals must be disconnected occasionally or where solder lug terminals are not otherwise practical.



DUST COVER

INTERLOCKING—Here the series 340 a-c relay is coupled with the d-c coil of a series 405 short telephone type relay in an overload application. Under normal conditions the series 340 contacts are mechanically held in a closed position. Normal current flows through the series 405 coil and then through the series 340 contacts to the circuit for which overload protection is desired. Excessive current, however, energizes the series 405 coil, releasing the locking arrangement and breaking the series 340 contacts. Push button control resets to normal but is ineffective if current is still excessive.



INTERLOCKING UNIT

SERIES 345 RELAY DATA

Normal Volts	Minimum Volts	Normal M.A.	Minimum M.A.	Coil Resist.	Normal Wattage
6	4.8	600	480	10	3.56
12	9.8	300	245	40	3.56
24	18	148	111	162	3.56
32	25.6	112	89	287	3 56
115	92	31	25	3720	3.56

Minimum operating wattage........................2.3

If you will write us about your relay problems our engineers will be glad to make recommendations which may save you time and money. Should you desire a quotation, please mention quantity.

GUARDIAN ELECTRIC

1610-C W. WALNUT STREET
CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

COMBINING COMPONENTS TO OBTAIN EXACT SPECIFICATION VALUES

DURING wartime it is usually quite difficult to procure many circuit components in their exact determined values. For instance, it may be necessary to obtain a resistor of exactly 1,422 ohms, as was the writer's trying experience several years ago while working on a critical hum phasing circuit. It also may be necessary to set up a permanent equalizer on a broadcast loop with exactly 168 ohms in the equalizer resistance. Similarly, in filter design, some non-standard capacitance such as .263 mfd or .0839 mfd may be required in the final result. Obviously these are not *stock* items, and so it therefore becomes necessary to combine parts which are easily procurable or items normally carried on hand to provide these values. It has been the usual practice to series-connect resistances in such a manner as to make the composite result the sum of all the resistances in the chain. In like manner, all condensers have been connected in parallel to make the result the sum of all condensers. The reciprocal combination, however, appears to offer the best method of obtaining complex values. While the procedure is nothing new, it has been very seldom used.

Resistance

In combining resistances, the parallel connection is preferable because it is very easy to adjust the final resistance of the combination and compensate for any discrepancy in the component resistances, and allow for the resistance loss in the wiring if necessary, by properly selecting the final resistance value. Incidentally, such adjustments are not readily possible with the series-connection method. From the relationship

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\ldots.$$

we note that each resistance is considered as a conductance and that the overall conductance is the sum of the individual conductances. In a great number of cases, a two-resistor combination will be found which will equal the accuracy of ordinary measuring apparatus. However it is possible to carry this accuracy to *any known extreme* with a three-resistor combina-

by RAYMOND P. AYLOR, JR.

Formerly Chief Eng. WGH
Now with Maritime Commission

tion. In making the initial selection and for comparison purposes, or where the accuracy desired does not exceed three parts in one thousand, a slide rule is sufficiently accurate. Beyond this, a book of six-place tables will be required. When it becomes necessary to use a three-resistance combination, either because extreme accuracy is required or because of inability to suitably match two resistances to the requirement, it is advisable to select the two resistances of such value as to give a result not over 1% greater than the final resistance desired. Then it is possible to make a precise adjustment to the exact overall value with the third resistance. In other words, the third resistance is used merely as a vernier or fine adjustment to eliminate the 1% error.

For example, suppose we desire a resistance of exactly 1422 ohms. We find a conductance of 1/1422 mho or .000703235 mho is required (sixth place accuracy). Consulting a book of tables, we look for a combination of two stock resistances whose reciprocals (conductances) added, come closest to the desired reciprocal or conductance. We find 2,500 ohms listed as .0004 mho, 3,300 ohms listed as .0003030 mho conductance, which, added is the reciprocal of 1,422.4 ohms. Also, it would have been possible to have *used 1,500 ohms* (0.000666666 mho) in parallel with 27,500 ohms (.000036363 mho), which would have given the same result. Either selection would give an accuracy of better than three parts in ten thousand. At this point, it is advisable to check the wiring resistance and the accuracy of the resistors selected before making the final correction with the third parallel resistor. We now have the combination to the degree of precision, where, by adding thousands of ohms in the third parallel resistance, we can change the overall result in terms of microhms. We note the additional conductance which must be added to the combination by subtracting the conductance which gave us 1,422.4 ohms from the conductance sought. In this case, we need 0.0000002047 mh added conductance. An additiona stock resistor, 5,000,000 ohms, has conductance of 0.0000002 mho. B making this third resistance variabl within very narrow limits, we ca carry the accuracy beyond the limit o the tables or to the degree of precisio of any known standard.

In less critical applications, such a in setting up an equalizer resistance extreme accuracy is not required and two-resistor combination can easily b found which will suffice. For instance in obtaining 168 ohms resistance, w would try 200 ohms (.005 mho) in par-allel with 1,050 ohms (0.00095238 mho) which, added, provides 0.00595238 mh conductance or exactly 168 ohms resistance.

Capacitance

While the series connection of condensers requires more space it is to be preferred because it allows the final adjustment to be made within very narrow limits, and for ordinary accuracy imposes the requirement of precise calibration on only one of the units, in contrast with the high required accuracy of all units if connected in parallel. The relationship between series condensers is similar to the relation between parallel resistances; the reciprocal of the equivalent capacitance of a number of condensers in series is equal to the sum of the reciprocals of the capacitances of the individual condensers, as shown by

$$\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\ldots.$$

From the above, it is seen that it is less costly to use only two capacitance elements in the series connection. Taking economic factors into consideration, it seems advisable to select a precision *stock* value of capacitance about 20% greater than the final capacitance required, then adjust the final combination with a relatively large and inexpensive condenser which acts as the second element. This adjustment can be made in fairly large steps, which will vary the final overall capacitance in very small units.

Suppose we wish to obtain a ca-

(*Continued on page 97*)

RAYTHEON VOLTAGE STABILIZERS

CONTROL VARYING LINE VOLTAGES

TO 115 VOLTS ± ½%

Ordinary A.C. line voltages as taken from supply mains often vary as much as from 95 to 130 volts. This impairs the precision operation of electrical equipment.

A Raytheon Voltage Stabilizer, built into new products or incorporated into equipment already in use, overcomes the disadvantage of fluctuating voltages by providing an accurately controlled source of power to ±½%.

Here's what a Raytheon Stabilizer does—stabilizes varying input voltage from 95 to 130 volts to 115 volts ±½% within 2 cycles.

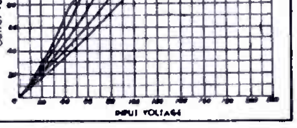
Raytheon Voltage Stabilizers are entirely automatic. They require no adjustments or repeated maintenance. No moving parts assure long life. Write for bulletin DL 48–537.

EFFECT OF VARIABLE FREQUENCY

Since partial resonance is a requisite design feature, these devices are sensitive to frequency changes. The output voltage will vary in the same direction and 1.4 times the percentage change in frequency, over a range of 5% of the normal frequency.

Stabilization, however, will be within ±½% at the output voltage which is established by the frequency.

TYPE VR 2
INPUT VS OUTPUT VOLTAGE
FOR VARIOUS FREQUENCIES



ne in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the Blue Network. Consult your local newspaper for time and station

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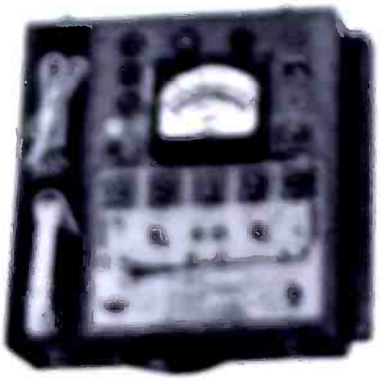
The coveted Army-Navy "E," for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 16,000 men and women are producing for VICTORY.

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.



ANTENNA COUPLING

(Continued from page [illegible])

[illegible] to plot the gain for different values of [illegible] in the previous equation, [illegible] coupling [illegible] into the equation, the value of [illegible] must be disregarded when [illegible] is greater than 0.8 [illegible] has been calculated but [illegible] by noting that

[illegible]

We first calculate the value of M with an approximate value of λ_0 and compare its corrected value from the last equation. This usually requires one extra calculation but it is quickly determined, Figure 9.

The new value of λ_0 may then be found and the resulting Q (which corresponds to $Q_e/2$ as used in the previous example) is plotted against the values of λ_0 used. Immediately, we can see that the gain improvement

slight after 300 or 400 ohms of re-
tance.

The measured value of gain was ain found to be higher than the cal- lated value which substantiates the e of R_0 as 25,000. Another curve is lotted with the new value of R_0 which ows close agreement with the mea- red value.

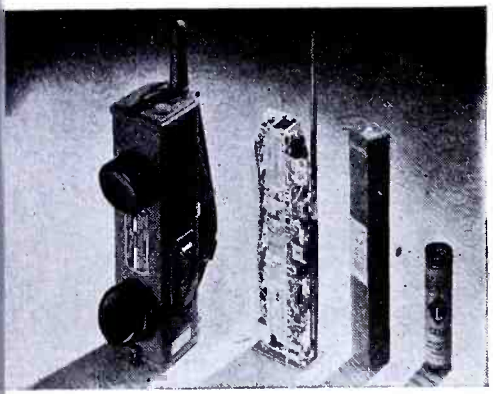
The final arrangement of the cir- it is shown in Figure 7. A value f – J300 was used for the output ndenser because it was thought ad- isable to maintain the higher *Q* value t a slightly lower gain. In this ar- ngement

$$M = (n^2 + (K + 1)^2)$$

here K is the ratio of X_s/X_o, and *n* as used previously. This gave a ain as indicated on the upper curve f 7 times. One further modification as used. We returned the output con- enser to the cathode of the tube, re- ulting in a gain of slightly over 8 imes. However, since the improve- ent may change from set to set due o variation in cathode bypassing it as not used in the general equation. s a conclusion therefore, it will al- ays be possible to get the values of ain shown in the upper curve or a lightly higher value if the output ondenser is returned to the cathode.

•

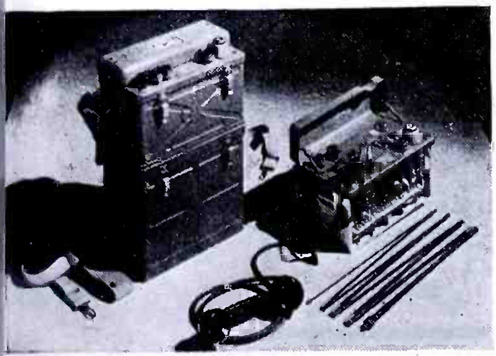
HANDIE AND WALKIE-TALKIES

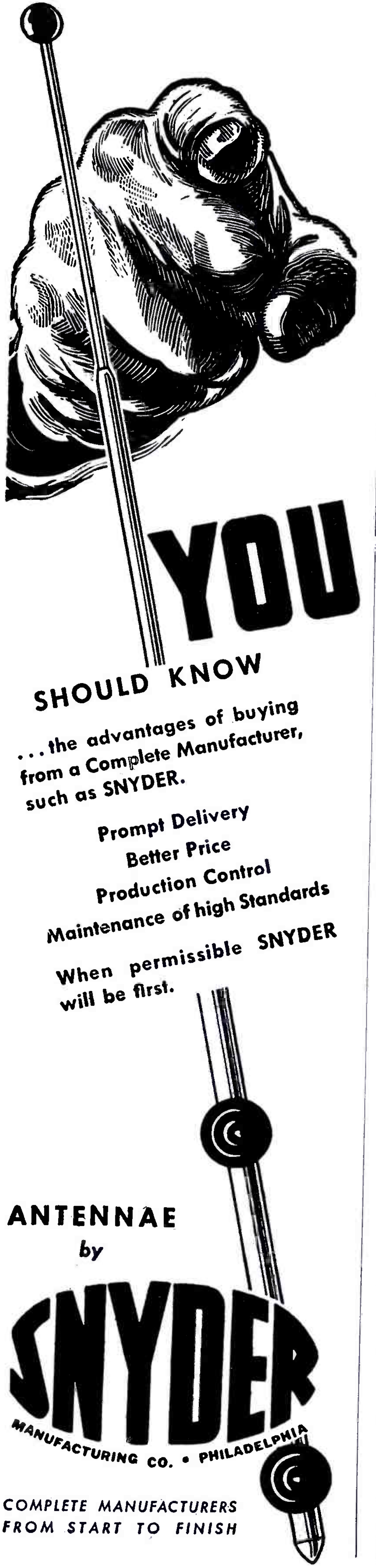


(*Courtesy Motorola*)

bove, the handie-talkie, 3"x3"x12". Below he walkie-talkie, which is about 17" high, 2" wide and 7" thick. The handie-talkie eighs a little over 5 pounds, while the alkie-talkie unit weighs about 35 pounds.

•





BROAD-BAND AIRCRAFT ANTENNA

(*Continued from page 48*)

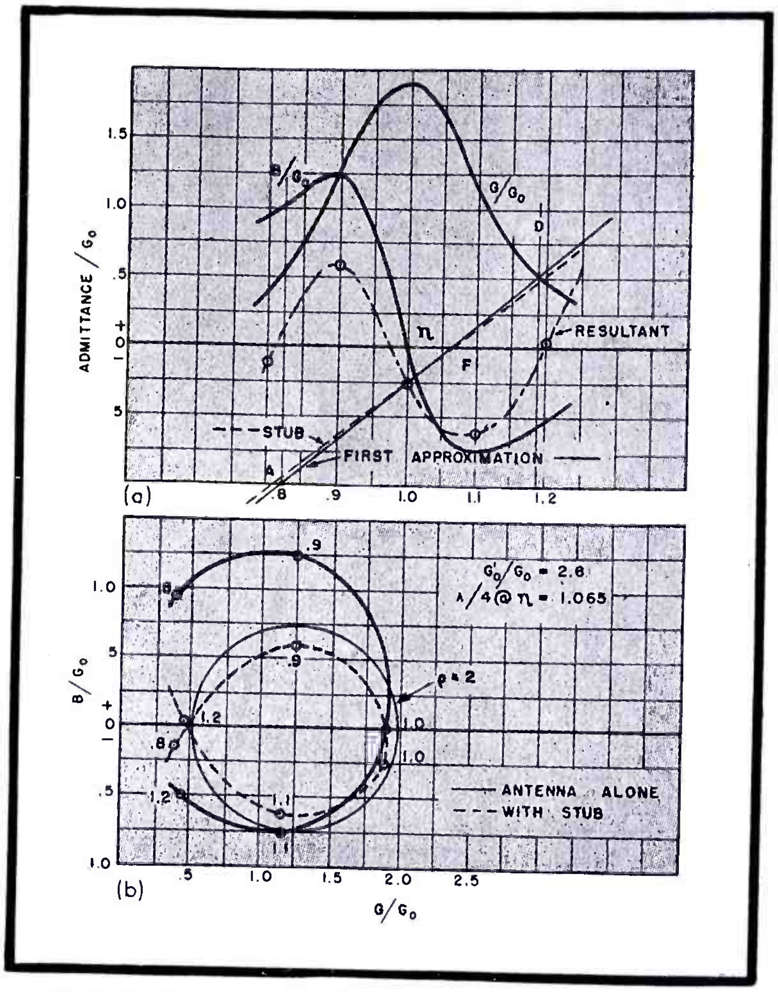


Figure 3

Application of sh quarter-wave stub matching a reson antenna.

$\rho = 2$ circle by any cancelling of susceptance. This line on the admittance diagram or its corresponding ordinate on the admittance-frequency curve then defines the maximum bandwidth to be expected. This bandwidth is realized if the curve falls within the $\rho = 2$ circle when these limiting points are tied on the $B/G_o = 0$ line of th admittance diagram.

The method of calculation of th parallel λ/4 stub may be seen fro the upper curve of Figure 2. Th B/G_o values corresponding to $\frac{G}{G_o} = 0.$

(*Continued on page 88*)

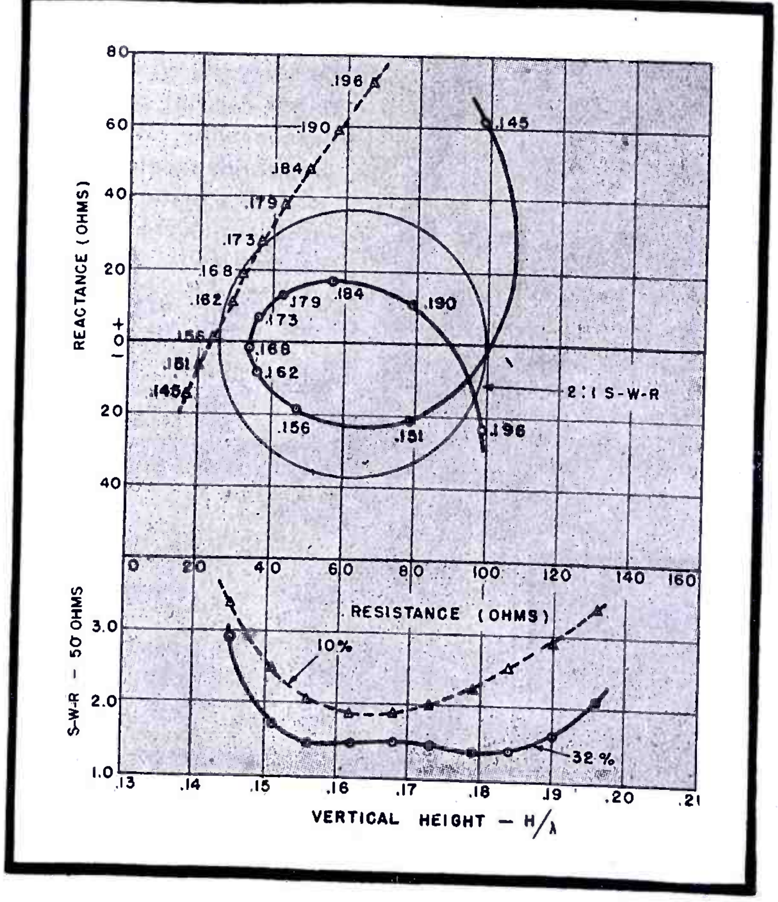
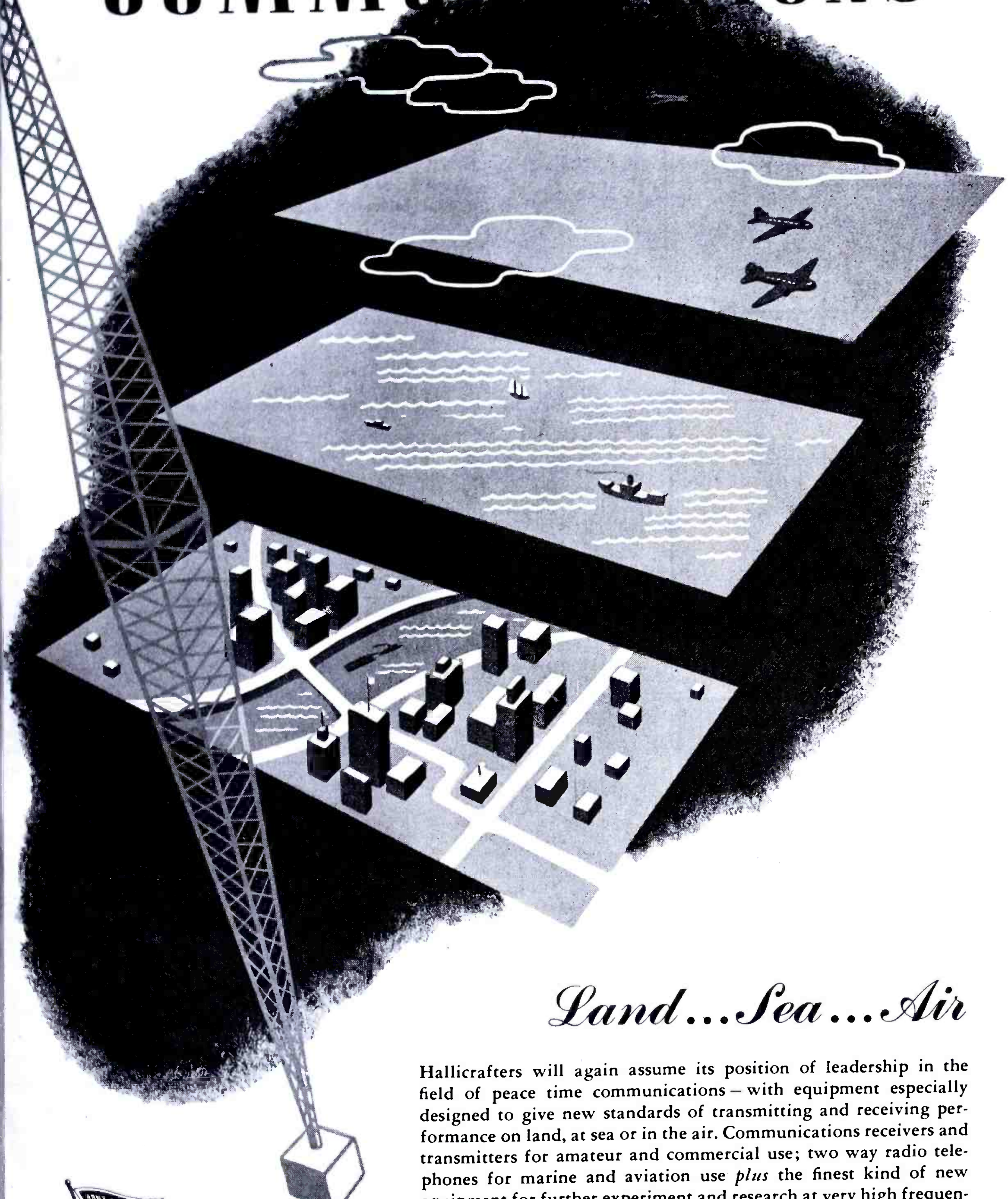


Figure 4

Two-element matching section analysis fo three-wire fan antenn Triangles represent unmatched antenna impedance; circles represent antenna wit matching section.

COMMUNICATIONS



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Hallicrafters will again assume its position of leadership in the field of peace time communications – with equipment especially designed to give new standards of transmitting and receiving performance on land, at sea or in the air. Communications receivers and transmitters for amateur and commercial use; two way radio telephones for marine and aviation use *plus* the finest kind of new equipment for further experiment and research at very high frequencies will all be included in Hallicrafters postwar production plans.

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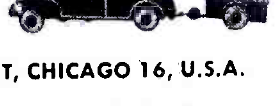


THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U.S.A.

FILTER ANALYSI AND DESIG

by C. E. SKRODER

Assistant Professor of Electrical Engineering

University of Illinois

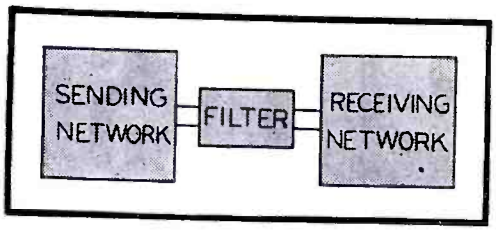


Figure 1
Filter section inserted between sending and receiving networks.

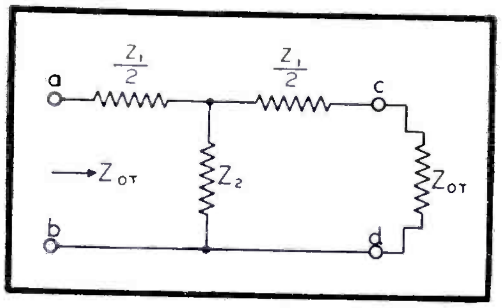


Figure 2
Filter section of simplest configuration terminated in its characteristic impedance.

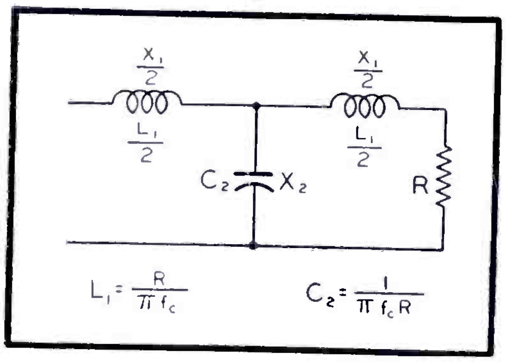


Figure 3
Low-pass, prototype, filter section.

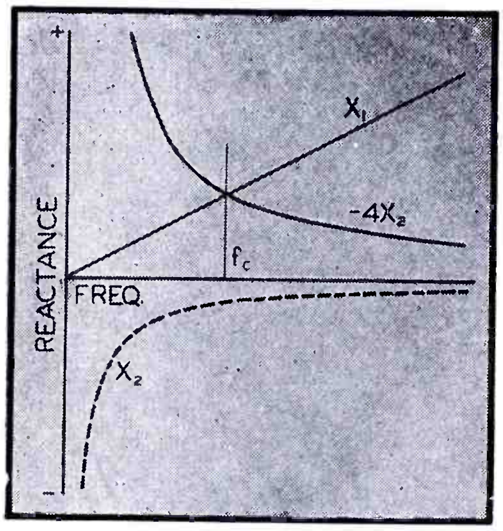


Figure 4
Graphs of reactance versus frequency for elements of a low-pass, prototype, filter section.

THE subject of filters is one that covers a field so extensive that it might, itself, well be considered a special branch of electrical engineering. The types of filters are numerous, and the complexity increases as the performance demands become more exacting. To cover adequately the subject of filters would require a manuscript of hundreds of pages. This brief discussion will therefore be confined to the fundamental principles of filter operation as embodied in the most simple filter networks operating under ideal conditions.

The term filter, as used in this paper, applies to a passive network. This is a network which does not contain any source of energy such as a generator, battery, vacuum tubes, etc., having two input terminals and two output terminals, and which is inserted between a sending network and a receiving network for the purpose of excluding from the receiving network, by means of excessive attenuation, currents of certain frequencies emanating from the sending network; currents of all other frequencies being passed through the filter without attenuation. See Figure 1.

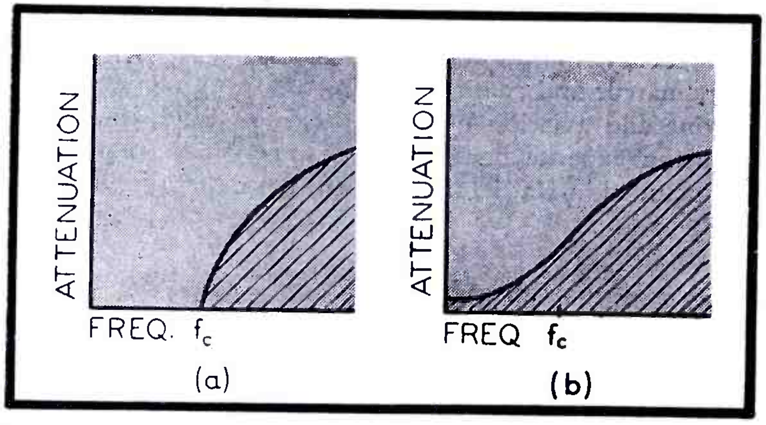
The simplest form that a filter can take is that of the *T* network *abcd*, shown in Figure 2. In this network Z_1 is the total series impedance, one-half of this being placed on each side of the shunt branch, the impedance of which is Z_2. Such a network is said to be symmetrical. In general, filter networks are found to consist of one or more symmetrical *T* or π networks connected in cascade.

In the discussion of fundamental filter theory, the assumption is made that the filter is terminated in its characteristic impedance (defined in the following paragraph) ; that is, the impedance of the ceiving network is equal to the charact istic impedance of the filter section. T is the ideal condition, which is rarely e fully realized in actual practice. As result, the actual performance of a fil never comes up to that indicated by theoretical consideration. Experience h shown how actual filter performance h fallen short of that of the ideal filter, a since filter design formulas are bas upon ideal conditions, a background of e perience is required if these formulas a to be used in designing filters to full given performance requirements.

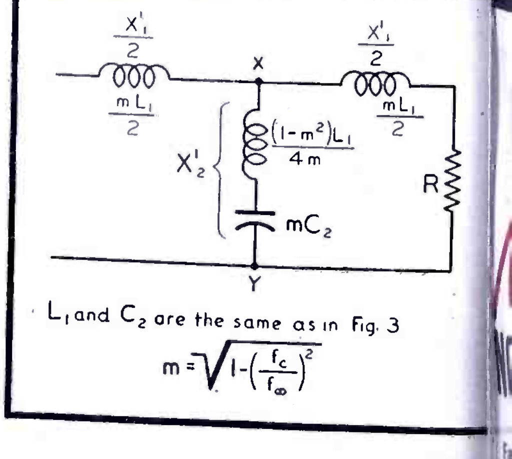
In this discussion it will be assum that the filter network is terminated wi its characteristic impedance at all tim Characteristic impedance of a fou terminal impedance, a network with tv input and two output terminals, is usual defined as the input impedance of an i finite number of such networks connect in cascade. A mathematical analysis w show that the characteristic impedan may also be defined as that impedan which, when connected to the outp terminals of the network, will cause t input impedance of the network to the same as the impedance connected the output terminals. This is illustrat in Figure 2. If this network is solv for Z_{OT}, the characteristic impedance, is found that

$$Z_{OT} = \sqrt{Z_1Z_2 + \frac{Z^2_1}{4}}$$

A further consideration of the netwo of Figure 2 will show that if Z_1 and are pure reactances but opposite in typ



Figures 5 (left) and 6 (right)
Figure 5, attenuation vesus frequency in low-pass, prototype, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_1/C_2}$. Figure 6, low-pass, *m*-derived filter section.



Four steps ahead in Crystal Manufacture

Raw quartz, properly oriented, on its way to the high-speed cutting machines

NORTH AMERICAN PHILIPS research and engineering have contributed to four developments that have advanced the art of crystal processing. Each has solved at least one problem in the mass production of quartz oscillator plates to meet the rigid demands of war equipment.

- ***Q-Lap:*** An exclusive North American Philips development, this high-speed machine automatically grinds crystal blanks parallel to close tolerances, ready for further production operations.
- ***Utilization of Unfaced Quartz:*** By developing in 1943 a method of utilizing unfaced quartz, previously very difficult and costly to use, North American Philips materially increased the available supply of quartz in the nation's limited wartime stock pile.
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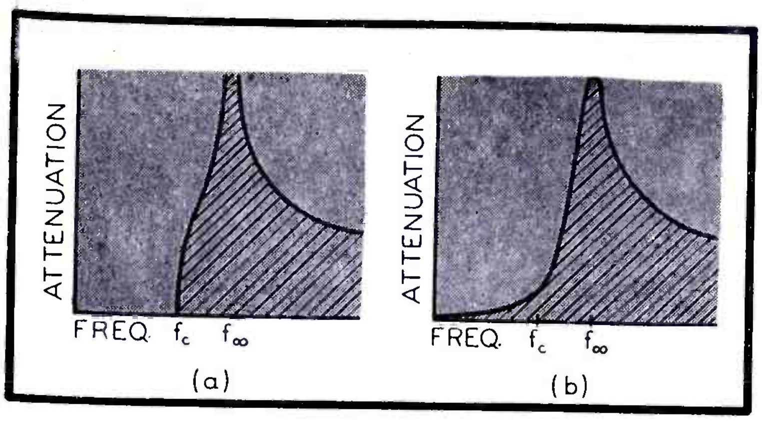
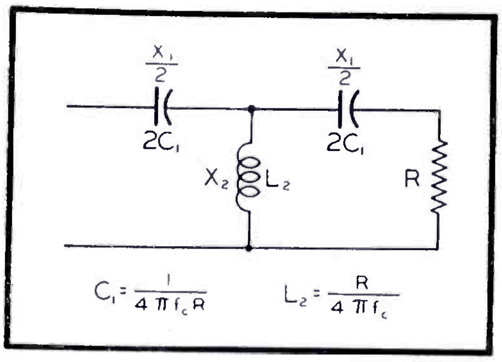
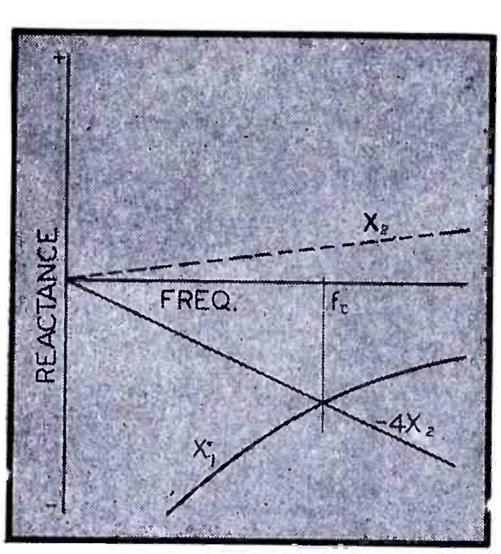


Figure 7
Attenuation versus frequency in low-pass *m*-derived, filter section: (*a*) no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_1/C_2}$.





Figures 8 (left) and 9 (left, below)
Figure 8, high-pass, prototype, filter section. Figure 9, graphs of reactance versus frequency for elements of a high-pass, prototype, filter section.

$Z_1 = X_1$, an inductive reactance, and $Z_2 = X_2$, a capacitive reactance or vice versa, there will be no current attenuation in the network for all frequencies in that range within which

$$\frac{X_1}{4X_2} \text{ lies between } 0 \text{ and } -1$$

$$\text{or} \qquad \frac{X_1}{-4X_2} \text{ lies between } 0 \text{ and } 1 \qquad (1)$$

Such a range of frequencies is called the transmission band. In the equation the minus sign indicates that X_1 and X_2 are to be opposite in type as stated above. For all frequencies for which $X_1/-4X_2$ does not have values between *0* and *1*, there will be attenuation. This band of frequencies is called the attenuation band.

The characteristic impedance is pure resistance at all frequencies within th transmission band, but is pure reactanc at all other frequencies.

Low-Pass Filters

In Figure 3 is shown a *T* network i which X_1 and X_2 are pure reactances an of opposite types. The frequency limit between which there will be no attenuation are those for which, referring t equation *1*, $X_1/-4X_2 = 0$, which is satisfied when $X_1 = 0$ or $X_2 = \infty$, and whe $X_1/-4X_2 = 1$, which is satisfied whe X_1 is equal to $-4X_2$. By plottin the reactance curves for X_1 and X with frequency as abscissa, a graph i obtained from which one may readily determine the range of frequencies withi which the filter network will transmi currents without attenuation. Such graph is shown in Figure 4. In this grap X_1 and $-4X_2$ are designated and show in solid lines while X_2, from whic $-4X_2$ is calculated, is shown as a dotte line. Since X_1 is an inductance, its reactance is positive. The shunt branc element X_2 being a condenser, its reactance is negative and is plotted below the horizontal axis. The quantity -4X must then be positive and is plotted abov the horizontal axis. A study of thes curves shows that at zero frequency X is zero and X_2 is infinite; hence, this frequency must be one of the frequency limits of the transmission band as indicate by equation *1*. At some frequency f_c $X_1 = -4X_2$; and at this frequenc $X_1/-4X_2 = 1$, which is the other limiting condition for the transmission band Furthermore, inspection of the grap shows that for all frequencies between 0 and f_c, $X_1/-4X_2$ has values between (and *1*. In this range of frequencies equation *1* is fulfilled and there will be no attenuation. For all other frequencies, al frequencies greater than f_c, $X_1/-4X_2$ is greater than *1*, and for these frequencies there will be attenuation. The network of Figure 3 is, accordingly, that of a low-pass filter, passing currents of low frequencies and attenuating those of high frequencies, the cut-off frequency being f_c

High-Pass Filters

If in the network of Figure 3 the inductances $L_1/2$ are replaced by condensers of equal capacitances, and C_2 is replaced by an inductance, the network of Figure 8, a high-pass filter, is obtained. It would be logical to conclude that such a network is also a filter since the series reactance X_1 is of the opposite type to that of the shunt branch X_2. The type of filter and the transmission band can be readily ascertained by drawing the reactance curves for X_1 and X_2, as shown in Figure 9. From these curves it is seen that at infinite frequency X_1 is zero, while X_2 is infinite. Hence, at infinite

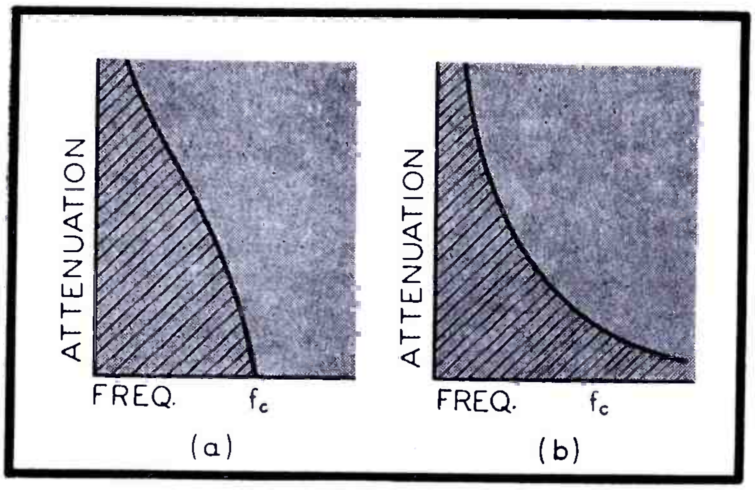
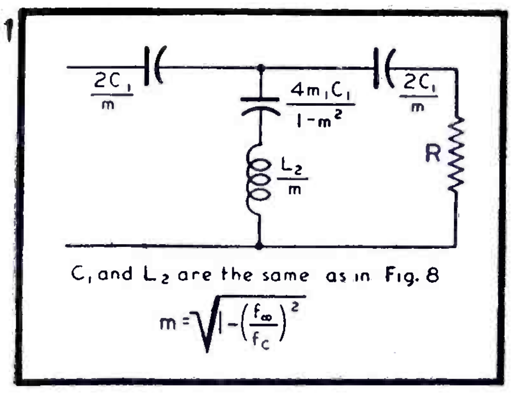
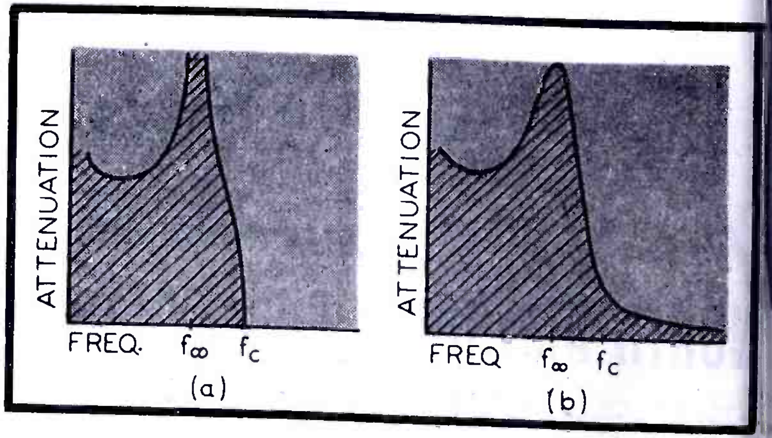


Figure 10
Attenuation versus frequency in high-pass, prototype, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_2/C_1}$.





Figures 11 (left) and 12 (right)
Figure 11, high-pass, *m*-derived, filter section. Figure 12, attenuation versus frequency in high-pass, *m*-derived, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_2/C_1}$.

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FILTERS

(*Continued from page* 74)

frequency $X_1/-4X_2$ is zero, and one of the limiting values of equation *1* is satisfied. At frequency f_c, the curves of X_1 and $-4X_2$ intersect, X_1 is equal to $-4X_2$, so $X_1/-4X_2$ is equal to *1* at this frequency. Frequency f_c is, accordingly, the frequency at which the other limit indicated in equation 1 is satisfied. At all frequencies greater than f_c, the graph indicates that X_1 is less than $-4X_2$ and that both X_1 and $-4X_2$ are positive. At all frequencies between f_c and infinite frequency, $X_1/-4X_2$ has values between *0* and *1*. There will, accordingly, be no attenuation in this band of frequencies. For all frequencies less than f_c, the graph shows that X_1 is greater than $-4X_2$. For all these frequencies, $X_1/-4X_2$ will be greater than *1* and attenuation will take place. The network of Figure 8 will, accordingly, transmit currents of all frequencies greater than f_c without attenuation, while currents of all frequencies less than f_c will be attenuated.

Band-Pass Filters

In Figure 13 is shown a network in which X_1 consists of a capacitance and inductance in series, and X_2 of a capacitance and inductance in parallel. Whether this network will act as a filter can be determined by again drawing the reactance curves, as was done for the low-pass and high-pass filter networks. These reactance curves are shown in Figure 14. Since both X_1 and X_2 consist of inductance and capacitance, each has a re nant frequency. Let it be assumed t the constants of X_1 and X_2 are so cho that the resonant frequency of X_1 is same as the anti-resonant frequency X_2. In the figure this frequency is in cated by f_r. That resonance occurs X_1 and anti-resonance in X_2 at this f quency is indicated by the fact that being the reactance of a series circuit, zero at this frequency and X_2, being reactance of a parallel circuit, is infin at this same frequency.

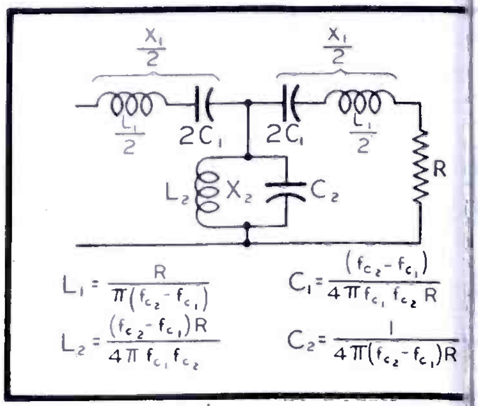

Figure 13
Band-pass, prototype, filter section.

At frequencies f_{c_1} and f_{c_2}, $X_1 = -4$ and $X_1/-4X_2 = 1$. These two frequenc will be two of the limiting frequencies the transmission band. From f_{c_1} to $X_1/-4X_2$ has values between *0* and *1* a hence, no attenuation will take place this range of frequencies. At f_r, t reactance of the shunt branch X_2 is finite and that of X_1 is zero; obviou there can be no attenuation at this f quency. In the range of frequencies fr f_r to f_{c_2}, X_1 is less than $-4X_2$. Therefo between f_r and f_{c_2}, $X_1/-4X_2$ has val between *0* and *1* so there will be no tenuation in this range. At all f quencies less than f_{c_1} and greater th f_{c_2}, X_1 is greater than $-4X_2$, the ra of X_1 to $-4X_2$ is greater than *1*, a there will be attenuation at any frequen less than f_c and greater than f_{c_2}. Or currents in the band of frequencies tween f_{c_1} and f_{c_2} are transmitted with attenuation. The network of Figure is therefore a band-pass filter.

Band-Elimination Filters

Figure 18 shows a series branch X_1 th consists of inductance and capacitance parallel. The shunt branch X_2 consists inductance and capacitance in series. in this network, X_1 and X_2 are so signed that X_1 is anti-resonant and is resonant at the same frequency, t reactance curves of X_1 and $-4X_2$ are shown in Figure 19. That X_1 and are resonant at the same frequency is here again indicated by the fact th X_1 is infinite and X_2 is zero at this fr quency.

At f_{c_1} and f_{c_2}, $X_1 = -4X_2$ a $X_1/-4X_2 = 1$. For all frequencies bel f_{c_1}, X_1 is less than $-4X_2$ and $X_1/-4$ has values between *0* and *1*. Currents these frequencies will, accordingly, transmitted without attenuation. For

(*Continued on page* 78)

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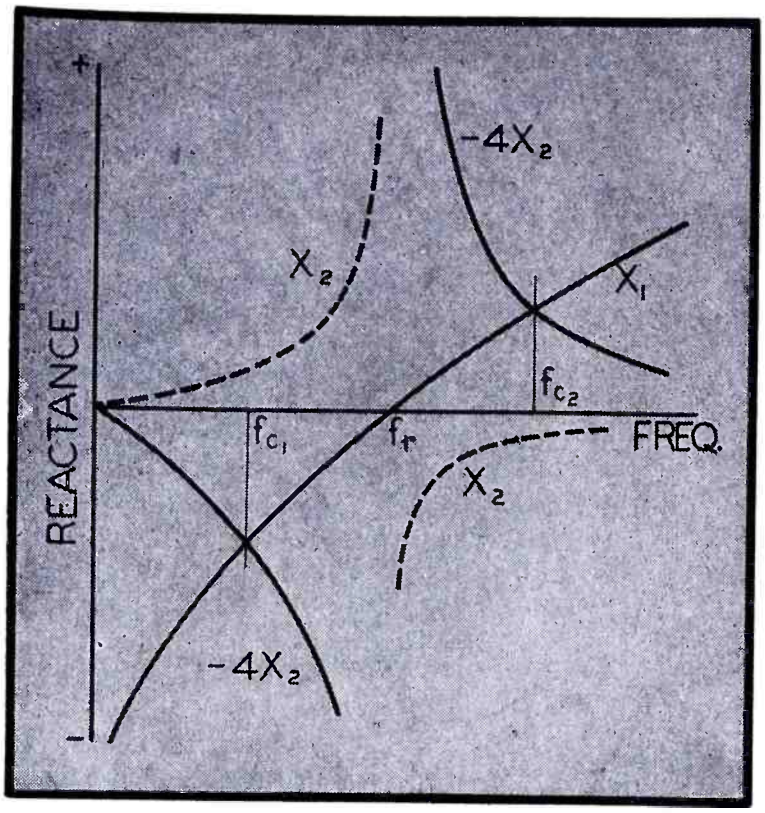

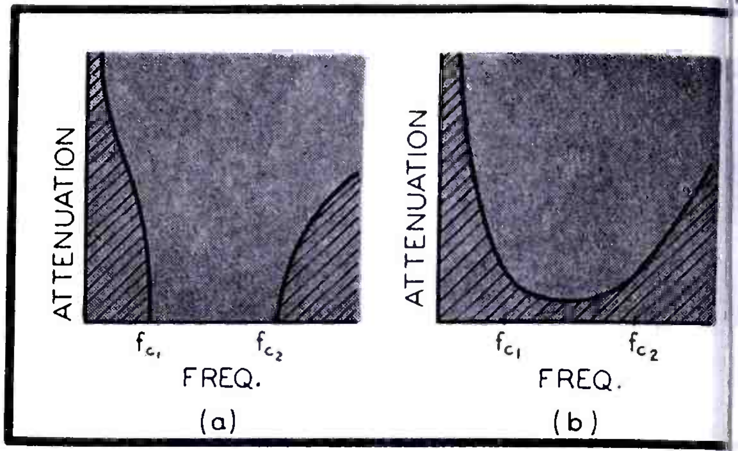

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Figures 14 (left) and 15 (above)

Figure 14, graphs of reactance versus frequency for elements of a band-pass, prototype, filter section. Figure 15, attenuation versus frequency in band-pass, prototype, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_1/C_1}$.

●

(*Continued from page* 76)

frequencies above f_{c_2}, X_1 is also less than $-4X_2$, and for these frequencies $X_1/-4X_2$ again has values between *0* and *1*. So currents of all frequencies greater than f_{c_2} will also be transmitted without attenuation. For all frequencies between f_{c_1} and f_{c_2}, X_1 is greater than $-4X_2$ and $X_1/-4X_2$ is greater than *1*. There will, accordingly, be attenuation in the network at all frequencies between f_{c_1} and f_{c_2}. Since only the currents of frequencies between f_{c_1} and f_c are attenuated, the network of Figure 22 would tend to eliminate currents in this band of frequencies from its output. For this reason, this type of filter is known as a band-elimination filter.

The four networks, Figures 3, 8, and 18, discussed up to this point are four basic filter networks from whi other more elaborate and complex fil sections are derived. These basic n works are called the prototypes.

Attenuation Characteristics

In the foregoing discussion the assum tion has been made that the filter n work is terminated at all frequencies wi an impedance equal to the characterist impedance of the filter network. For t low-pass filter of Figure 3, this chara teristic impedance is pure resistance the unattenuated or transmission rang but it is not constant. In the transmi sion band it varies in the manner inc cated by the curve nf_c in Figure 23 its value in the vicinity of zero frequen being $\sqrt{L_1/C_2}$. If the termination in pedance could change with frequency an identical manner, then the attenuati characteristic for this filter would be shown in Figure 5*a*, there being no a tenuation up to the cut-off frequency. Th shaded portion indicates attenuation. actice, however, the impedance co nected to the output terminals of the se tion would, more often than not, be resistance of fixed value. The best th could be done would be to so design th filter that $\sqrt{L_1/C_2}$ is equal to the resi tance of the receiving network. In Figu 23*a* the load impedance is represented b line *nl*. At some frequency f′ the tw curves *nl* and nf_c draw away from eac other quite appreciably. The effect is cause an appreciable reflection loss at a

(*Continued on page* 80)

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Figure 16

Band-pass, *m*-derived, filter section.

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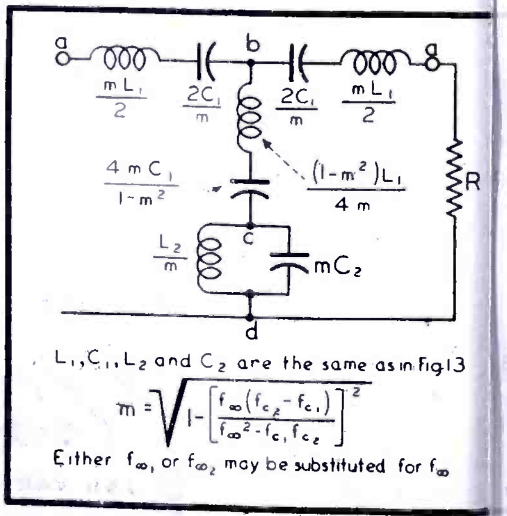

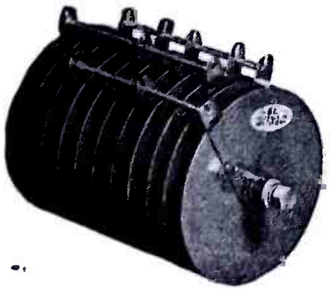

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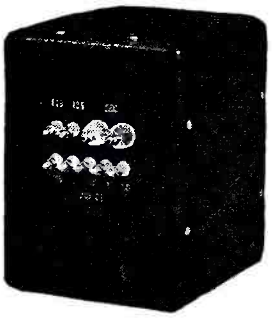

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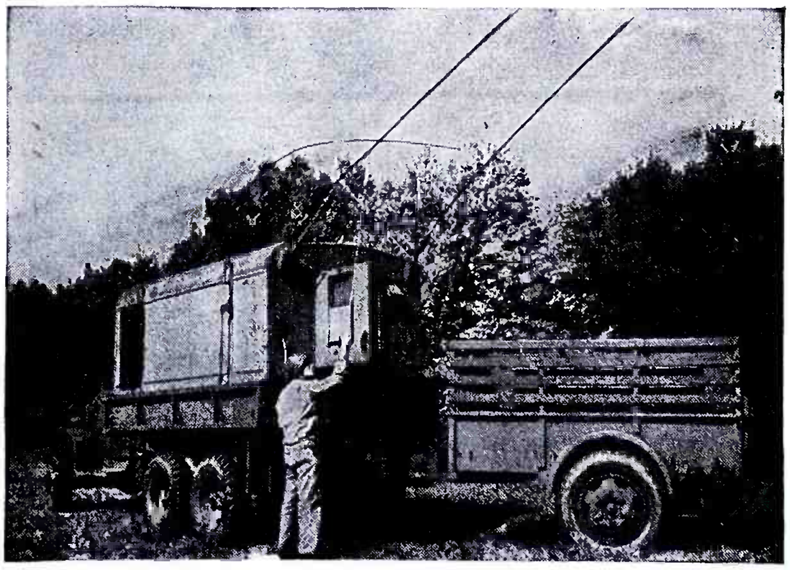

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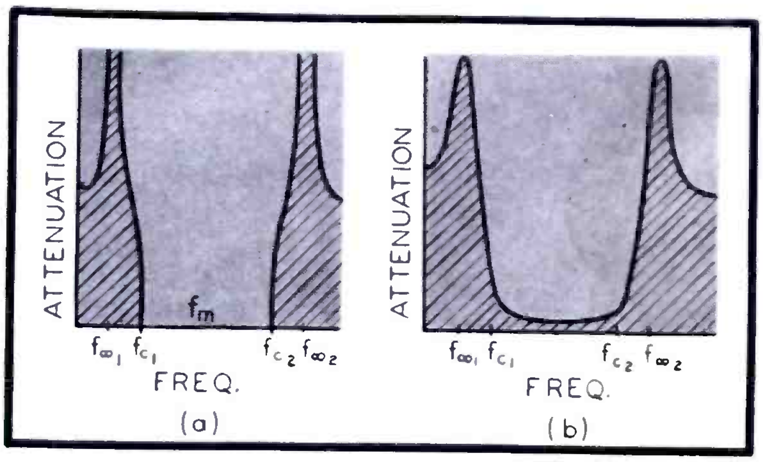

Figure 17
Attenuation versus frequency in band-pass, *m*-derived, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_1/C_2}$.

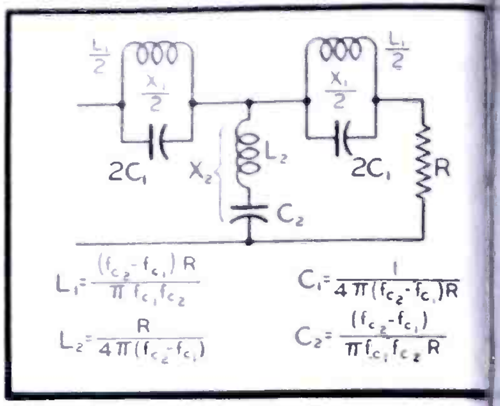

Figure 18
Band-elimination, prototype, filter section.

frequencies above some such frequency as f′, and attenuation actually exists at frequencies less than f_c. Because of this reflection loss and because the coils have some resistance, the actual attenuation characteristic of the low-pass filter would be something like that shown in Figure 5b.

The attenuation characteristics of the prototypes of the other types of filters, both for the ideal termination and approximately as realized in practice, are shown in *a* and *b*, respectively, of Figures 10, 15, and 20.

Derived Filters

It is quite obvious from a consideration of the attenuation characteristics of the prototypes that the cut-off is not very sharp; that is, attenuation does not begin abruptly, nor does it increase sharply. The prototypes or basic filter networks therefore do not, alone, make very good filters. Whether the prototype would prove satisfactory depends upon the requirements of the job to which the filte is to be applied. However, there ar modifications that can be made and filter can be derived having much sharper cut off. The prototype must first be designe because the constants of the modified type are determined from those of the prot types. These modified types, being de rived from the prototypes, are known derived filters.

Let us consider the circuit of Figure For all frequencies less than that at whic X_2' is resonant, the impedance of con denser C_2 would predominate, the re actance X_2' would be capacitive, and th equivalent circuit would be similar t that of Figure 3. It would be expected the that the circuit of Figure 6 would be have like a low-pass filter with a cut-of frequency below the resonant frequenc of the shunt branch X_2'. By proper de sign, circuits of Figures 3 and 6 can b made to have the same characteristic im pedance and also the same value of cut off frequency f_c. The shunt branch o the network of Figure 6, however, will b resonant at some frequency f_∞ greater than f_c. The impedance of the shun branch at resonant frequency is zero. Thi is equivalent to a short circuit at *xy*, an no current can be delivered to the receiv ing network represented by *R*. Attenua tion at this frequency f_∞ is, accordingly infinite. This is indicated on the attenua tion characteristic shown in Figure 7*a* As shown in this Figure, the cut-off fo this derived type is sharper than for th prototype of Figure 3, whose attenuatio characteristic is shown in Figure 5 However, the derived filter has the dis advantage that as the frequency is in creased beyond f_∞, the attenuation de creases, and it becomes less effective a a filter.

The network of Figure 11 is derive from its high-pass prototype of Figure 8 As would be concluded from an inspectio of this derived network, its shunt branc is resonant at some frequency f_∞ les than the cut-off frequency f_c. At thi resonant frequency the attenuation is in finite. This is indicated on the attenua tion characteristic shown in Figure 12a As in the case of the derived filter of th loss-pass type, this filter has sharper cut off than its prototype, but the attenuatio decreases as the frequency is lowere from f_∞, and it is less effective at th lower frequencies than is its prototype.

From the prototypes of the band-pas and band elimination filters, whose cir cuits are shown in Figures 13 and 18 re spectively, new filters of the same classi fications may be derived, the shun branches of which are resonant at severa

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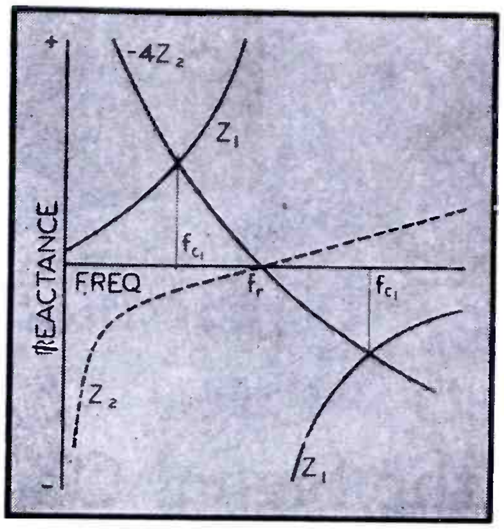
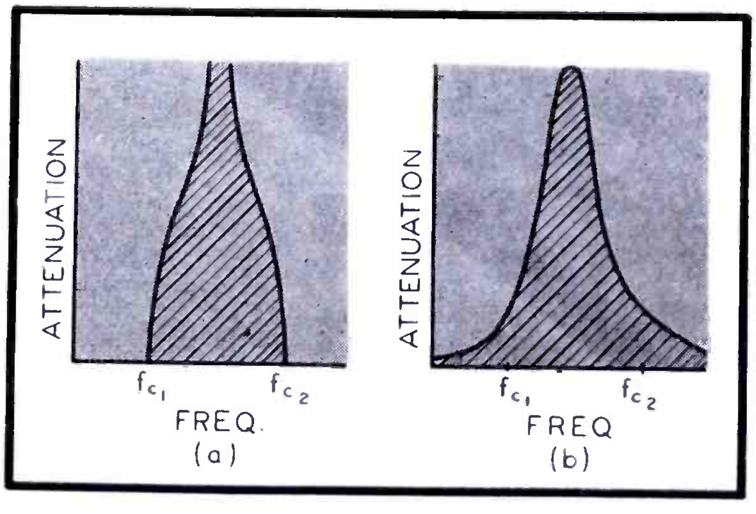
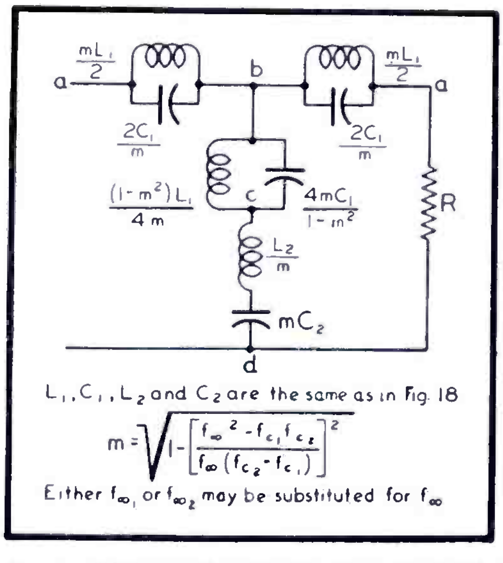


Figure 19 (above, left)
Graphs of reactance versus frequency for elements of a band-elimination, prototype, filter section.





Figures 20 (above, left) and 21 (left)
Figure 20, attenuation versus frequency in band-elimination, prototype, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies. (*b*) in practical section terminated in $R = \sqrt{L_1/C_2}$. Figure 21, band-elimination, *m*-derived, filter section.

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(*Continued from page* 80)

frequencies. These derived types are shown in Figures 16 and 21, and their attenuation characteristics are shown in Figures 17 and 22. These attenuation characteristics show the increase in sharpness of cut-off resulting from resonance occuring at frequencies f_{∞_1} and f_{∞_2}. In both of these filters, Figures 16 and 21, the shunt branches are similar in configuration. The band-pass filter of Figure 16 must be designed so the portions *ab* and *bc* are resonant, and portion *cd* antiresonant at a single frequency f_m, the mid-frequency. The band-elimination filter in Figure 21 must be so designed that the portions *ab* and *bc* are antiresonant and portion *cd* is resonant at a single frequency f_m. With these conditions fulfilled, series resonance will take place in branch *bd* in each case at some frequency f_{∞_1} less than and some frequency f_{∞_2} greater than the mid-fr quency, as indicated by the attenuatio characteristics in Figures 17 and 22. A these characteristics show, increase sharpness of cut-off has been realized b this modification of the prototype.

As has been pointed out, these modifie types are derived from the prototype and there is a definite relation betwee the constants of the two types. The r lationships for each classification a given in Figures 6, 11, 16 and 21. T prototypes must therefore be design first and the inductance and capacitan values determined before the constants the derived types can be determined.

Composite Filters

Both the prototype and the derived ty have disadvantages. The prototype lac sharpness of cut-off; while in the a tenuation band of the derived type, t attenuation decreases as the departu from the frequency of infinite attenuati becomes greater. The advantages of bo of these types can be realized by using o of each connected in cascade, forming two section filter. Such a filter is show in Figure 24a. The network in this figu consists of the prototype and the deriv type of low-pass filter. The attenuati characteristic of this filter is shown in of the figure, the dotted line showing t attenuation characteristic of the prot type alone. The attenuation in this co posite filter at any frequency is the su of the attenuation in the prototype secti and that in the derived section. A fai satisfactory filter results. As the pe formance demands become more exacti more sections may be added. Howev since it is physically impossible to co struct a filter without dissipation, the is a limit beyond which added effectiv ness is counter-balanced by increas power losses in the filter.

Although the composite filter discuss here is of the low-pass type, it should obvious that composite filters can just well be constructed in the high-pass, ban pass and band-elimination types.

Design

Before work on the design of a fil of a particular classification is start certain data must be known. These a the impedance or resistance of the rece ing network into which the filter is work and the frequency or frequencies which attenuation is to begin . . . t cut-off frequency f_c in the high-pass low-pass filter and the cut-off frequenc f_{c_1} and f_{c_2} in the case of the band-pass band-elimination filter.

The equation from which the values L_1 and C_2 are determined for the lo pass filter of Figure 3 are easily

(*Continued on page* 84)

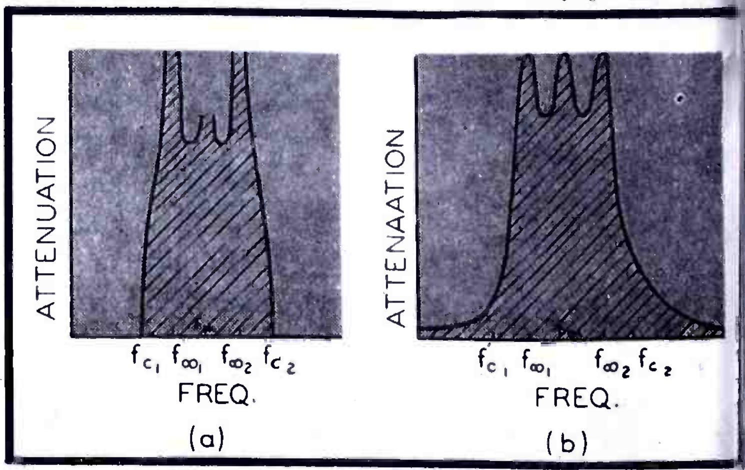
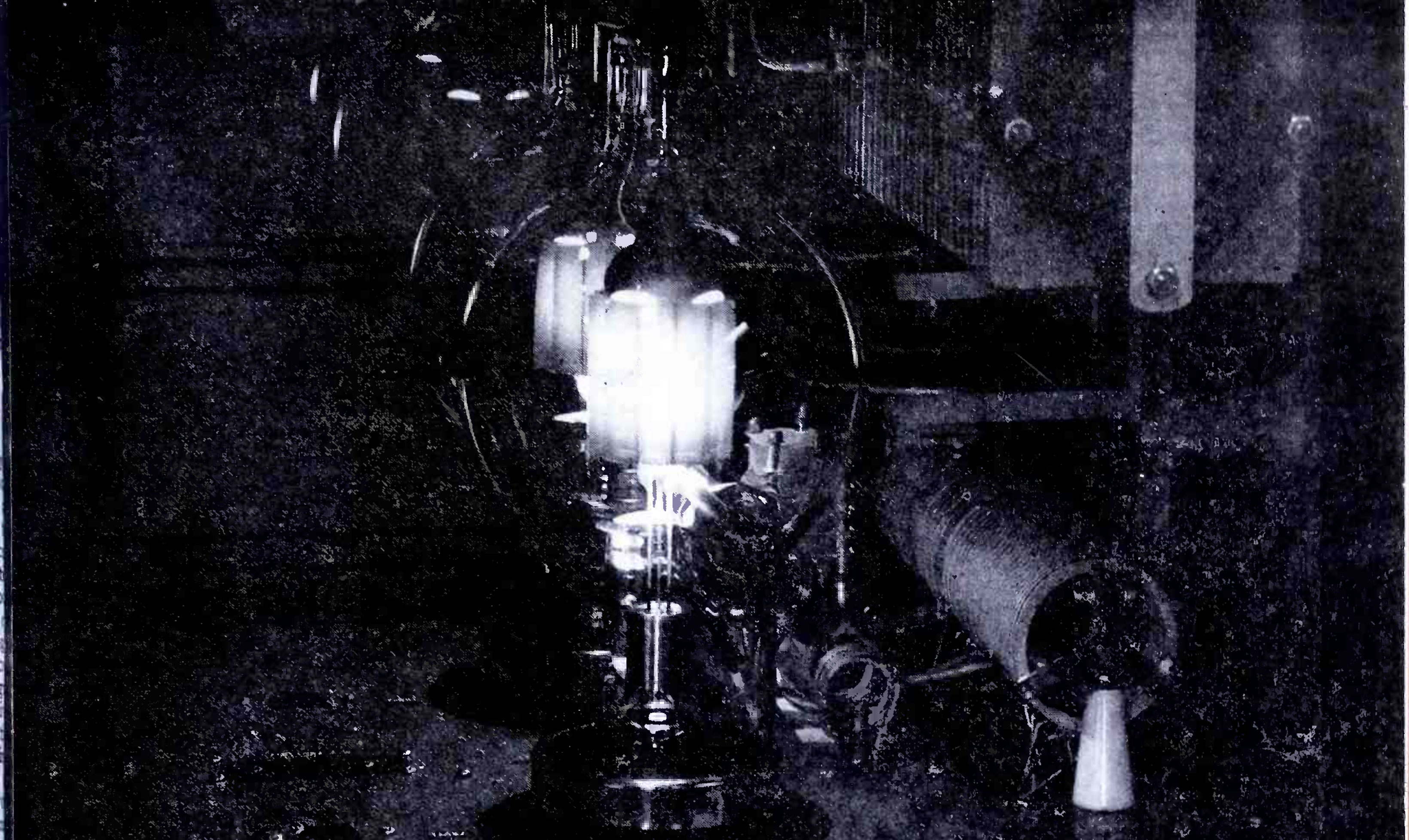
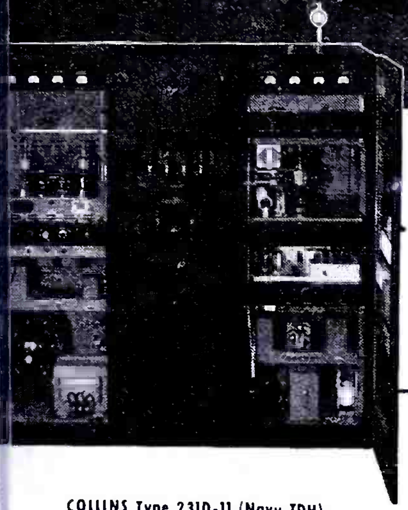


Figure 22

Attenuation versus frequency in band-elimination, *m*-derived, filter section: (*a*) in no-loss section terminated in its characteristic impedance at all frequencies, (*b*) in practical section terminated in $R = \sqrt{L_1/C_2}$.





COLLINS Type 231D-11 (Navy TDH)
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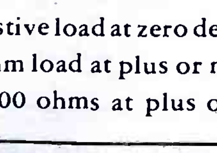
Mr. F. M. Davis, General Manager of the Collins Engineering Division, says: "Eimac tubes have been found to be reliable, rugged and capable of withstanding the severe overloads encountered during equipment tests, without damage." Statements like this, coming from such men as Mr. Davis, offer proof that Eimac tubes are first choice of leading engineers throughout the world.



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(*Continued from page* 82)

veloped. Referring to the reactanc curves for this filter, Figure 4, it wi be noted that at the cut-off frequency f

$$X_1 = -4X_2, \qquad (2$$

but at this frequency

$$X_1 = j2\pi f_c L_1$$

and

$$X_2 = -j\,\frac{1}{2\pi f_c C_2}$$

or

$$-4X_2 = j\,\frac{2}{\pi f_c C_2}$$

Substituting these values of X_1 a $-4X_2$ in equation *2*, there results

$$L_1 C_2 = \frac{1}{\pi^2 f_c{}^2}$$

Now referring to Figure 23, it is ev dent that the best that could be done an attempt to make the load impedan and the characteristic impedance of t filter network approximately the same to have *R*, the receiving network res tance, equal to $\sqrt{L_1/C_2}$; that is

$$\sqrt{\frac{L_1}{C_2}} = R$$

There are now available two independ equations, each in L_1 and C_2. These equ tions may be solved simultaneously, a the values of L_1 and C_2 determined terms of known quantities. From th equations

$$L_1 = \frac{R}{\pi f_c}$$

$$C_2 = \frac{1}{\pi f_c R}$$

The equations for the constants for high-pass prototype can be derived i very similar manner. In determining equations for the constants for the ba pass and band-elimination protypes, mathematical developments, while difficult, are considerably more invol and complex. Design formulas for e type of filter are given directly be the figure of the filter to which t apply. For example, the equations the determination of the constants for prototype band-pass filter are shown rectly below Figure 13.

Thus far, the discussion relating to sign formulas has concerned the pr types only. Since the derived type is tained from the prototype, there must definite relations between the const of the prototype and those of the der type. These relationships are fu mentally the same for all classes of fil of the *T*-type configuration, such as been treated in this discussion, and shown in Figure 25. This Figure is

(*Continued on page* 88)

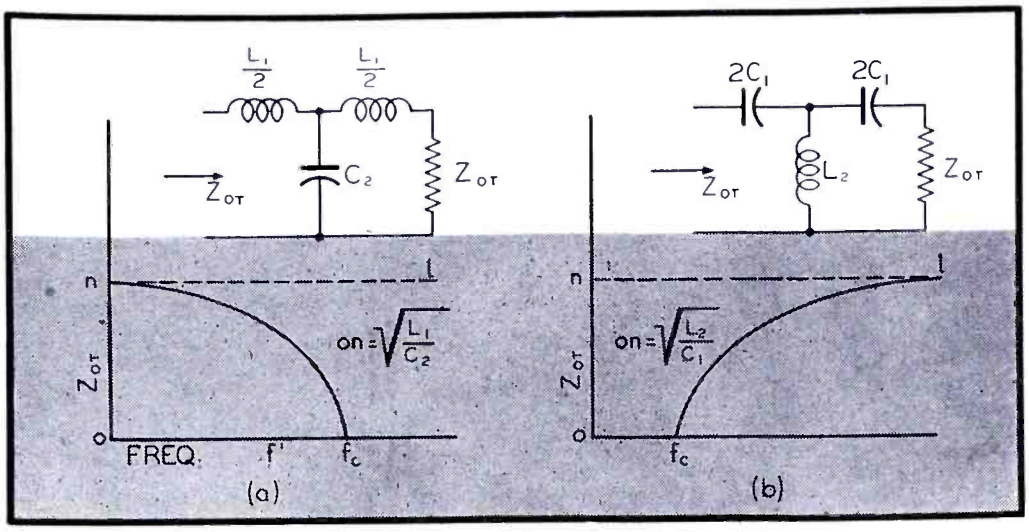

Figure 23 (above)
Graph of variation of characteristic impedance versus frequency in the transmission band of prototype filter of T-configuration.

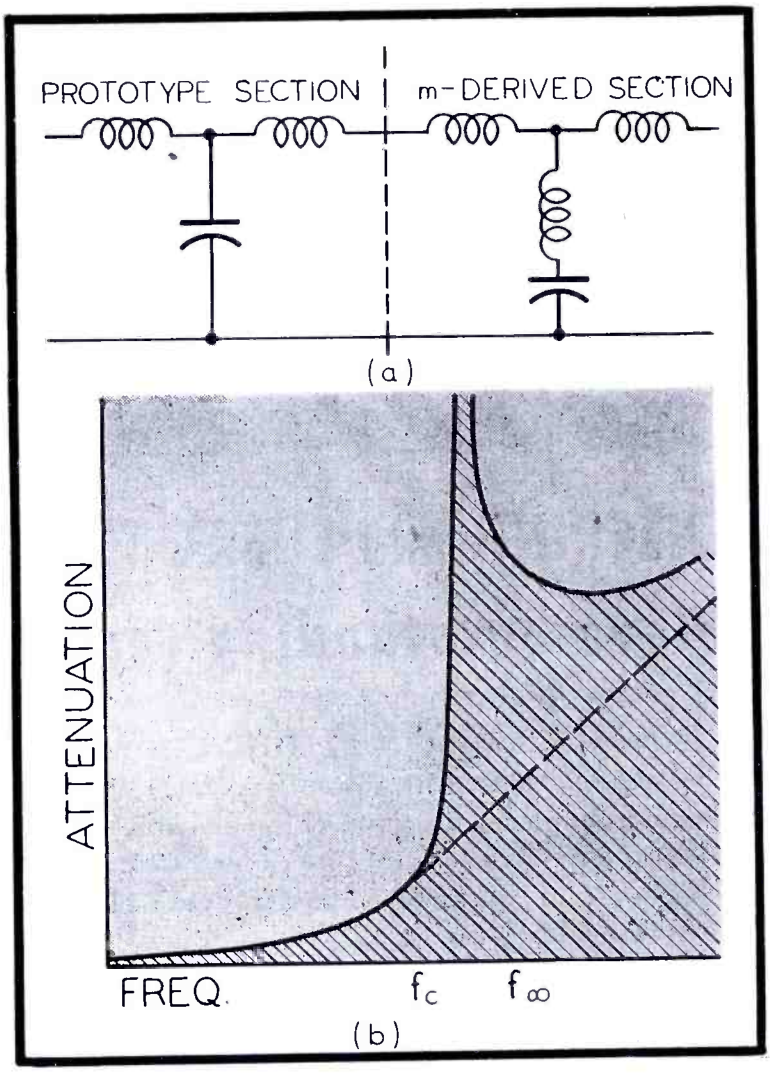

Figure 24 (left)
(*a*) Low-pass, composite filter consisting of a prototype section and an *m*-derived section. (*b*) Attenuation versus frequency in composite filter terminated in $R = \sqrt{L_1/C_2}$.

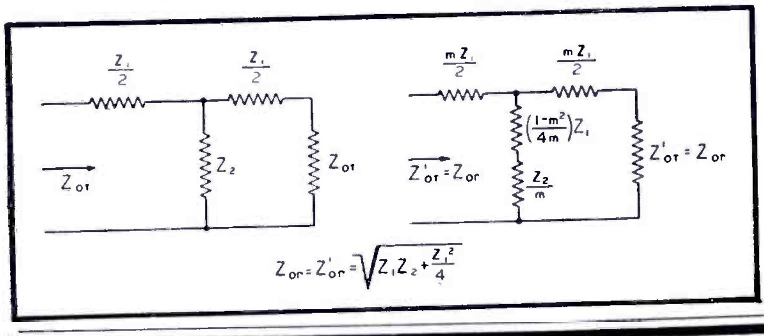

Figure 25
Generalized section of an *m*-derived filter section, showing the relationships between the elemnts of this section and its prototype.

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59	67	59	67	59	65
60	74	60	74	60	74
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VWOA VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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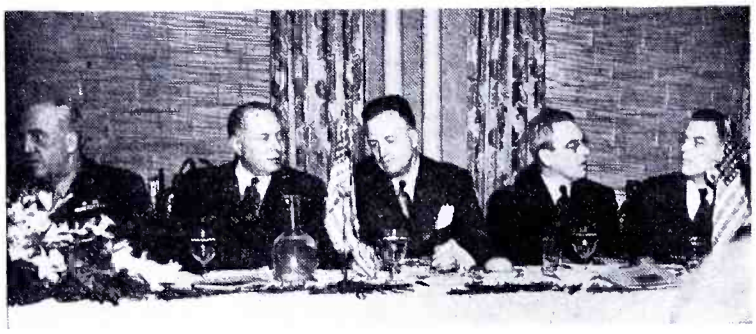


At the VWOA banquet. Left view, left to right: Major Gen. Frank Stoner, Brig. Gen. David Sarnoff, Jack Popelle, Orrin Dunlap, Jr., and E. K. Jett. Right view, left to right: R. Morris Pierce, Brig. Gen. H. M. McClelland, Major Gen. H. C. Ingles, and W. J. McGonigle.

Dinner-Cruise Awards

AMONG the awards made at the VWOA twentieth anniversary dinner-cruise were Certificates of Merit to Peter Podell, James V. Maresca and Sam Schneider for their efforts in founding the association.

A posthumous certificate was presented to William Fitzpatrick and was accepted by his brother Joseph Fitzpatrick.

A Marconi Memorial Medal of Merit was presented to William J. McGonigle, VWOA president in recognition of his devotion to the association. He was bulletin editor in 1930; secretary and director, 1933 through 1936; and has been president and director since 1937. The medal was presented to Mr. McGonigle by Brigadier General "Dave" Sarnoff, first VWOA life members.

Broadcasts

THE dinner-cruise ceremonies were broadcast for an hour over f-m station WBAM, affiliate of WOR-Mutual. Musical salutes to each of our armed services and the United Nations by Ted McElroy's eighteen-piece employees' orchestra were a feature of the broadcasts.

Presentation of the Marconi Memorial Service Award Plaque to J. R. Poppele, president of Television Broadcasters Association, was broadcast over WEAF and the NBC network. Presentations of the Marconi Memorial Medal of Achievement to Dr. Allen B. Du Mont; Marconi Memorial Medal of Service to R. Morris Pierce and Marconi Memorial Medal of History to Orrin E. Dunlap, Jr., were also broadcast over the NBC network.

Dinner-Cruise Speakers

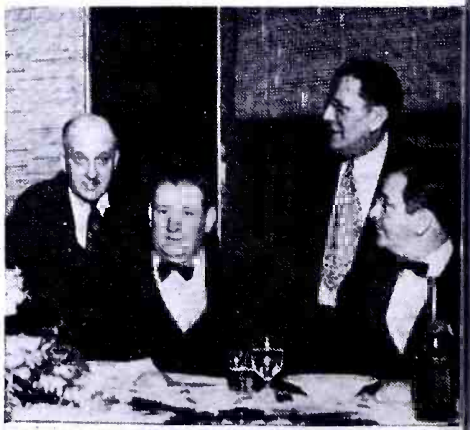
FRANCIS COLT DE WOLF, chief of the Telecommunications Division of the Department of State, presented an intriguing message at the banquet. He predicted a radio world with an expanded spectrum and minimum interference functioning as the great trunk lines, aide by a vast network of secondary co axial cables and land lines that woul systematize the whole world to provid twenty-four-hour service to any poi on earth.

He foresaw the possibility of senc ing telegrams and other messages b means of a 'quarter-in-the-slot' radi and facsimile system that would spa continents and oceans. He envisione also the establishment of a world-wi uniform rate for such messages. Po sibly six to eight channels on a sing frequency might be used, he said.

He stated that in our future worl written messages will be sent by fa simile and charges will be based o the square inches, or preferably squa millimeters. We shall avoid all po sibility of error in transmission, said. He added that we also anticipa the day when, at our breakfast table every man will find his favorite new paper whether it be from New Yor London, Paris or Rio de Janiero.

IN a talk by Major General H. Ingles, members of the VWO were told that their familiari with the science has provided an i sight into the untold potentialities th lie ahead.

Below, guests at the VWOA banquet. Left view, left to right: E. H. Rietzke, Ludwig Arnson, Arthur Lynch. Center view, Dr. Allen B. DuMont. Right view, left to right: B. G. Seutter, Ted McElroy, J. W. Chaplin, and W. J. Halligan.



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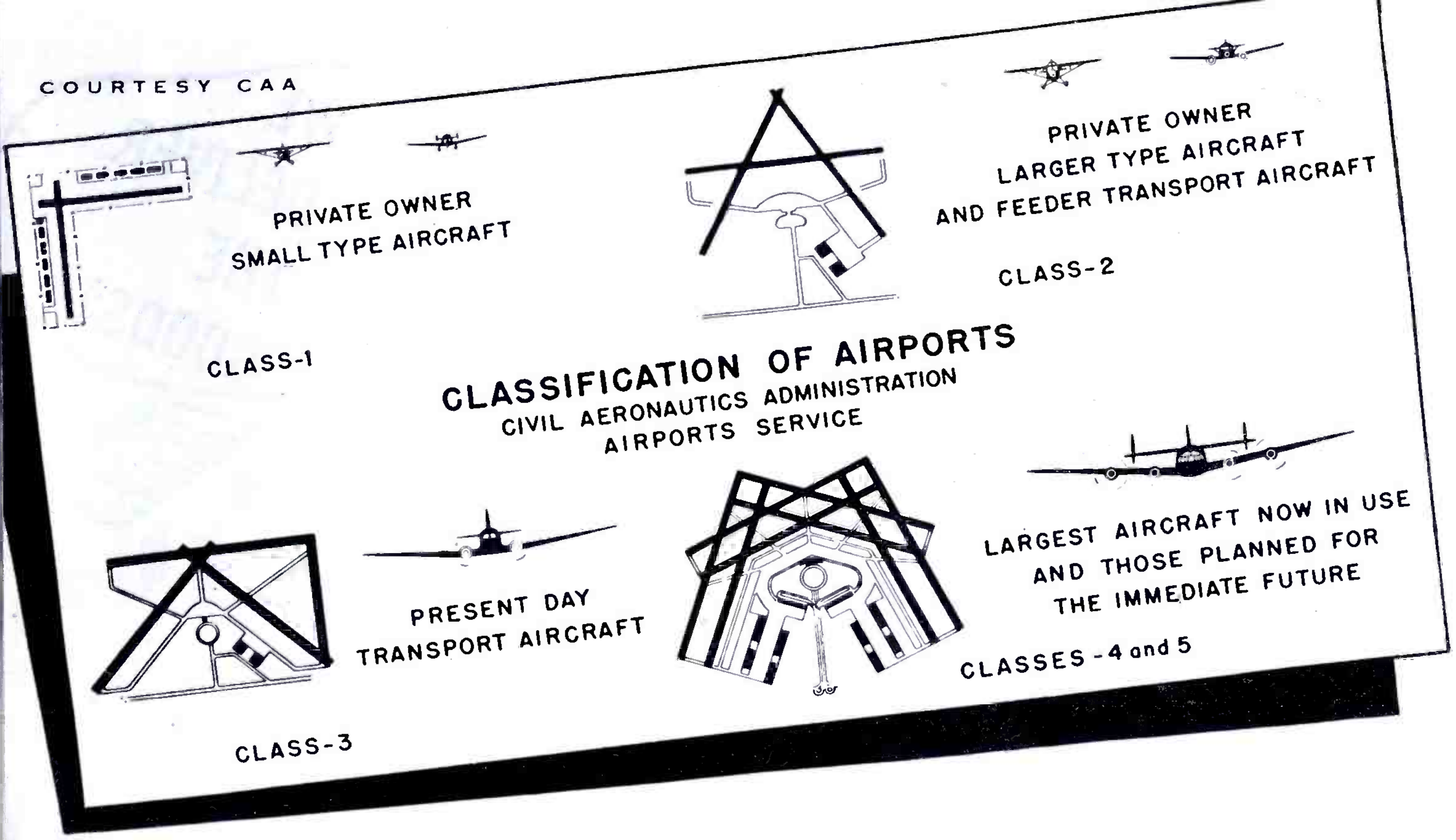

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FILTER ANALYSIS

(*Continued from page* 84)

fectly general. The impedances Z_1 and Z_2 are X_1 and X_2, respectively, of the prototypes and, hence, may take numerous forms, the forms they take determining the class of filter, high-pass, low-pass, etc. As a specific case, Figures 3 and 6 show the relationship between the constants of the prototype and the derived type as obtained by the application of the general relations indicated in Figure 25.

The derived type is usually referred to as the m-derived filter because of the prevalence of the constant *m* in the relationships shown. The value of *m* determines the frequency or frequencies at which infinite attenuation occurs, or in other words, determines f_∞. The constant *m* must always be positive and less than *one*. When *m* is unity, the derived type resolves into the prototype. This can be easily verified by substituting unity for *m* in Figure 25. As *m* decreases in value and approaches zero, the frequency f_∞ approaches the cut-off frequency.

The value of *m* is determined from the values of f_c and f_∞ in the low-pass and high-pass filters and from f_{c_1}, f_{c_2}, and f_{∞_1} or f_{∞_2} in the band-pass and band-elimination filters. Before a design is started the values of these frequencies would, of course, be known and would be determined by the requirements of the job to which the resulting filter is to be applied. The relationships between *m* and these frequencies are shown along with the design formulas for each of the various filter types in Figures 6, 11, 16 and 21.

[*To Be Concluded in April* COMMUNICATIONS]

●

BROAD-BAND ANTENNAS

(*Continued from page* 70)

are laid off on their respective ordinates but with opposite sign. The line *AD* constructed through these two points represents accurately the susceptance of the desired parallel λ/4 stub. From the intersection with the η axis the resonant frequency of the stub may be calculated, from the slope of the line the characteristic impedance may be obtained.

Space does not permit the discussion of the effect of series half-wave lines nor the results to be expected with two-element networks employing all combinations possible. A two element network will be demonstrated in the concluding part of this discussion.

In general it is easier to match high impedance (or anti-resonant) antennas than low impedance antennas; however, good results may be obtained on resonant antennas through proper choice of elements.

It is usually better in two or more element networks to use the first elements to position the impedance curve in the complex plane so that the ad-on of the final element achieves maximum bandwidth.

t III—The Broad-Band Fan Antenna

t low frequencies resonant an- na dimensions are of the same er as aircraft dimensions so that unting of a suitable radiating device es difficult problems to the an- na designer. If in addition it is cified that the antenna be broad d and yet offer negligible wind g, the problem seems nearly im- sible at first glance. This is so ause conventional broad-band an- na design at very-high frequencies resulted in expanding the physical of the ordinary quarter-wave radi- r into cone or cylindrical shape. h an expedient is obviously im- ctical at frequencies from 10-100 where such techniques would re- in sheet metal antennas 3-30 feet h, that would be difficult to mount l too large to fly safely. For these sons the investigation of multi-wire ennas was undertaken with the end view of simulating a large metallic face by means of a few small wires ving negligible wind drag.

Experiments with a two-wire *V* enna demonstrated that consider- e flattening of the resistance and re- ance curves over a band of fre- ncies is possible by use of flare gle between the wires of 50–65°. ove this angle only very slight im- vement could be obtained. Appli- ion of matching techniques to the antenna indicated that increases in dwidth from 8% unmatched to % with matching section were pos- le. As applications requiring ater bandwidths than this were cessary further investigation was de.

t was found that addition of a wire joining the two *V* wires to ke a *fan* antenna greatly improved impedance characteristics obtained. dition of more wires to produce 3-, and 5-wire fans likewise achieved provement although here it was n that the increment in going from o 5 wires is considerably less than t in going from 3 to 4. It was ickly apparent that a 3- or 4-wire n represented the optimum antenna this type from the standpoint of sirable physical and electrical char- teristics. Figure 5 shows a 3-wire n mounted on the tail of a B-24. The res have been exaggerated in the otograph in order to see them at l. As may be seen a compact in- nspicuous structure is possible. avorable impedance characteristics

(*Continued on page* 90)

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(*Continued from page* 89)

have been obtained through use of several wires; favorable pattern characteristics can be obtained by orientation of the mounting. In this instance it was desired to direct the pattern downward. The small size of the antenna wires and insulators insures almost negligible wind drag at present day aircraft speeds; so design specifications can be successfully met with this type of fan antenna.

Figure 4 shows the matching section analysis of a three-wire fan similar to the one depicted in Figure 5. Here the original antenna curve represented by the dashed curve lies slightly to the left of optimum position in the $\rho = 2$ circle. Addition of a series condenser has the effect of translating the curve downward into a more favorable position in the circle, then addition of a $\lambda/4$ shorted stub in parallel collapses the curve into the $\rho = 2$ circle with attendant increase in bandwidth. Inspection of the s-w-r curve shows that the initial bandwidth of 10% has been increased to 32% by matching.

For applications requiring greater bandwidth, addition of another wire to make a 4-wire fan and adjustment of the lengths to position the antenna curve favorably in the complex plane have led to bandwidths as high as 19% unmatched and 45% when matched with a suitable network.

The techniques of antenna design described in this part coupled with the measurement and matching techniques of parts *I* and *II* constituted a powerful method of attack to low-frequency aircraft antenna problems. The method is not necessarily limited to low frequencies; and, in fact, has been successfully applied at much higher frequencies.

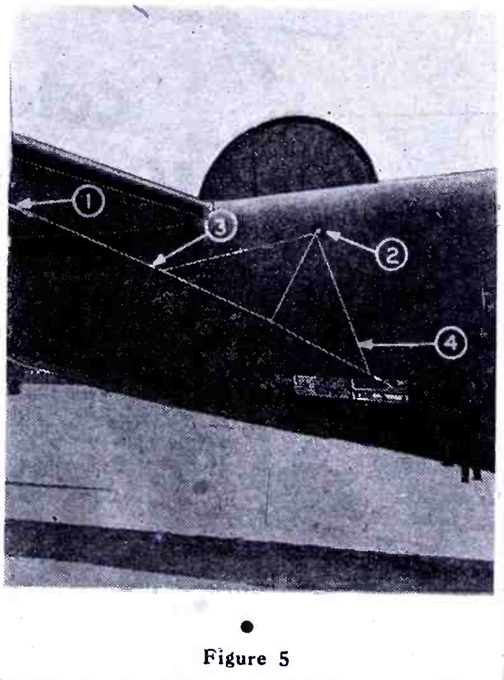
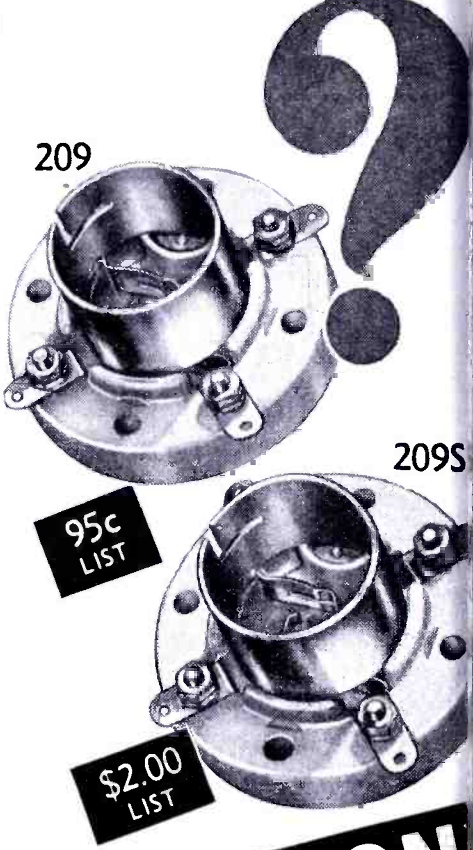


Figure 5

Three-wire fan antenna on B-24: *1*, spring tension unit; *2*, insulator leadin; *3*, insulator; *4*, wire. (Wires have been accentuated in illustration to improve visibility.)



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(*Continued from page* 58)

ceiver it operates as a four-tube super- with one r-f stage, separate local os- tor, mixer, and i-f/a-f reflex ampli- with a metal rectifier for detection automatic gain control.

or transmission the local oscillator is employed as the master oscillator the i-f/a-f reflex amplifier as the ulation amplifier, followed by the er amplifier.

he set has a frequency coverage of 1 7.3 to 8.9 mc. An i-f of 285 kc is l. With a 4' rod antenna its range is e-quarters of a mile. The transmit- power is .2 watt. Throat microphones used.

nother model that has proved quite tive is the *18*. This is a six-tube -pack transmitter-receiver which is l primarily for 'phone communication veen company and battalion headquar- Later models of this set also pro- for c-w operation.

he set is self-contained and housed in se 11" x 10" x 17". Its weight, in- ing harness and battle battery, is 32 nds. When using a 10' rod an- a the two-tube transmitter with a er of .25 watt and frequency cover- of 6 to 9 mc, has a range of over five s. Changeover from send to receive ffected by the switch in the micro- ne.

his model, which is carried on the c, has an antenna socket on the side of case rotatable through 90°. Thus the antenna can be maintained in a ver- l position even when the wearer is g prone. Incidentally this set is not nded to be operated by the wearer but a second person. The receiver is a r-tube superheterodyne.

Iodel *46*, used by infantrymen and rated entirely by switches, is crystal trolled on three spot frequencies. se frequencies fall in either the 3.4 to 5 to 6, 6.4 to 7.6 or 7.9 to 9.1 mc ds, and are pre-selected by plug-in s.

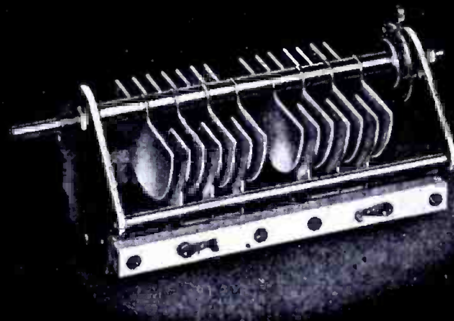
he superhet receiving section of this tube transceiver employs four tubes; riode-pentode frequency changer, two stages, diode detector and avc, and put reflexed into the second i-f stage. intermediate frequency is 1,550 kc.

oth the local and master oscillators he three-tube 1.5-watt transmitter are tal controlled. The modulator tube riven by a triode microphone ampli- which can also be used to modulate graphic transmissions.

he transceiver uses a 9' sectional rod nna with which it has an effective light range of some ten miles. De- ned primarily for beach operations, re it is employed for ship-to-shore munications, it weighs 24 pounds com- e with battery, which is carried in a arate haversack.

ecause of its use in combined opera- s the set has been rendered as water- of as is practicable. A rubber sheath ses over the six-pin plug and socket the operating panel connecting the bat- , 'phones and throat microphone to set. On the 7" x 4" panel, which is the top of the set when in the operat- position on the wearer's chest, are a ss-button send-receive switch, three- nnel frequency-selector and on-off tch, three-channel frequency-selector on-off switch with visual indica-

(*Continued on page* 94)



CATHODE FOLLOWERS AND PLATE-LOADED AMPLIFIERS

(*Continued from page* 56)

put impedance of the cathode follower should be calculated from

$$Z'_o = \frac{R_k}{\sqrt{(1+A)^2 + (f/f_o)^2}} \qquad (21)$$

rather than by equation *7*.

Input Admittance

It is a familiar fact that the input admittance of a plate-loaded amplifier is affected by the load circuit through the grid-to-plate capacity of the tube. If we visualize the input admittance as a resistance shunted by a capacity we may state:

$$\text{input resistance} = \frac{1}{2\pi f C_{gp} A \sin\theta} \qquad (22)$$

and

$$\text{input capacity} = C_{gk} + C_{gp}(1 + A\cos\theta) \qquad (23)$$

The net input resistance consists of the result of equation *22* in parallel with the actual grid return resistance. We note therefore from the above equations that the input admittance increases with frequency and gain.

The input admittance of a cathode follower (for capacitive load) consisting of a resistance and capacity component may be given as

$$\text{input resistance} = -\frac{(1+A)^2 + (f/f_o)^2}{2\pi (f/f_o)^2 C_{gk} G_m R_k} \qquad (24)$$

and

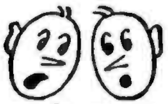
$$\text{input capacity} = C_{gk}\frac{(1+A) + (f/f_o)^2}{(1+A)^2 + (f/f_o)^2} + C_{gp} \qquad (25)$$

At low frequencies $\left(\text{when } \frac{f}{f_o} << 1\right)$ the effect of the grid-to-cathode capacity is reduced to $C_{gk}/1 + A$.

The resistance R′ is in shunt with the existing grid-return resistance. The effect of the grid resistor may be made small by returning it to the cathode instead of ground as shown in Figure *4d*. The equivalent grid-ground resistance is then

$$\text{equivalent } R_g = \frac{R_{gk}}{1 - A'}$$

The effective grid-to-ground resistance may therefore be made much higher than the actual grid-to-ground resistance. This result gives the cathode follower a great advantage over the plate-loaded amplifier. The cathode follower may be designed to



ve a low loading effect on the input nal circuit.

Equation 24 indicates that the re- cted input resistance is negative. is effect sometimes causes oscilla- ns to be set up if any inductance sts in the input circuit. This con- ion may be prevented by adding a all series resistor of the order of) ohms between input and grid.

The equations given in this paper ould prove of aid in designing hode-follower devices. It should be nted out, however, that in some plications, the constant-output im- ance and higher gain of the plate- ded amplifier may favor its use.

As an example of the calculations olved in designing a plate-loaded plifier or a cathode follower as a -impedance output device let us nsider the following problem:

A low output impedance is desired a source of sinusoidal voltage, so t loading will not cause an ex- ssive variation in output voltage. e output impedance should be of the ler of 100 ohms and the gain of the tput device may not be less than .7. If we were to design a cathode lower having these characteristics, circuit might appear as in Figure .

The output impedance is approxi- tely

$$= \frac{R_k}{1 + G_m R_k} = 100. \text{ (from equation 9)}$$

d the gain is

$$= \frac{G_m R_k}{1 + G_m R_k} = 0.7 \text{ (from equation 5)}$$

Solving these equations, we obtain

$$R_k = 333 \text{ ohms}$$

d

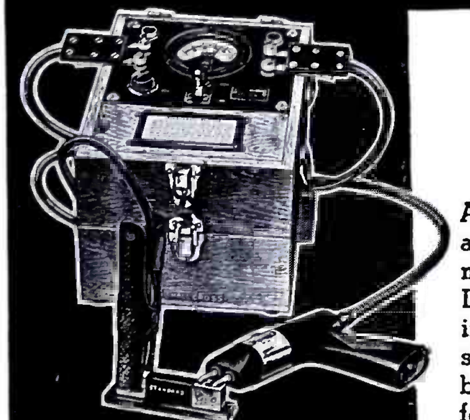
$$G_m = 7000 \text{ micromhos}$$

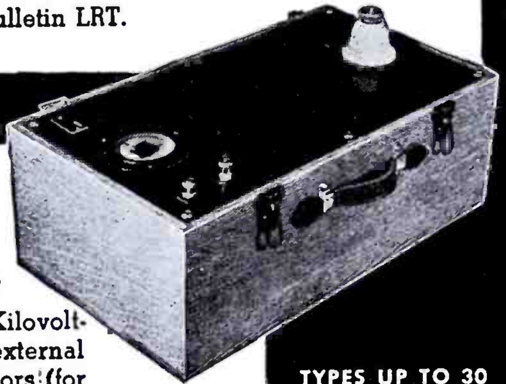
A pentode such as the 6AC7 or G7 would have the required trans- nductance and could be used as the thode follower.

If we were to use the same tube above as a plate-loaded amplifier, e circuit would appear as in Fig- e 1. To obtain an output impedance ual to 100 ohms, it is only necessary make R_L equal to 100 ohms. The in of the circuit will be equal to since we have shown that for equal tput impedance the gain of the plate- aded amplifier is equal to that of e cathode follower.

As far as the foregoing calculations e concerned, there is no obvious dif- rence between the results obtained om the two circuits. Furthermore,

(*Continued on page* 94)





BRITISH COMMUNICATIONS

(*Continued from page* 91)

tor, vernier tuning control, antenna socket and six-way socket.

Although these pack sets are rugged and can be employed for stationary operation, their range is such that their uses are somewhat limited. It is obvious, therefore, that commanders would demand the erection of stations providing greater range as far forward as possible. One such model is the general purpose transceiver, *22*, which can be transported in a variety of ways.

The receiving section of the *22* is a seven-tube superhet employing one r-f stage, separate local oscillator, mixer, two i-f stages, diode detector and pentode output.

When used for transmission two of the receiving tubes are used for the modulator which incorporates automatic control of drive and modulation. A combined master-oscillator frequency-doubler feeds three pentodes in push-pull in the output stage.

The set has a frequency coverage of from 2 to 8 mc.

●

CATHODE FOLLOWERS

(*Continued from page* 93)

if the output capacities of both devices are approximately equal, the bandwidth of each device will be the same.

If high input resistance, low input capacity and low distortion are desired in our illustrative case, the use of the cathode follower would prove advantageous. It should therefore be kept in mind that in many applications, the advantages of the cathode follower over the plate-loaded amplifier may be debatable.

●

EXTERNAL-ANODE TRIODES

(*Continued from page* 62)

ceed 70° in water-cooled triodes. Any hissing at lower water temperatures indicates localized heating and boiling, which should receive the immediate attention of the maintenance engineer. In the forced-air cooled tubes, a temperature rise above the normal operating temperature should be investigated. A careful check of operating temperatures compared with the ambient temperature logged over a period of time will give valuable information for the determination of the limits of the normal temperature range.

While many overheating troubles may be traced to the improper functioning of the cooling system, often the trouble is actually in the electrical circuit the tube is driving. It is possible for the efficiency of a circuit using high-power external-anode tubes to drop without noticeable change in anode voltage or current. Such decreased efficiency will show up in increased heating. Properly adjusted loads and close overload protecon will go a long way in insuring ng tube life.

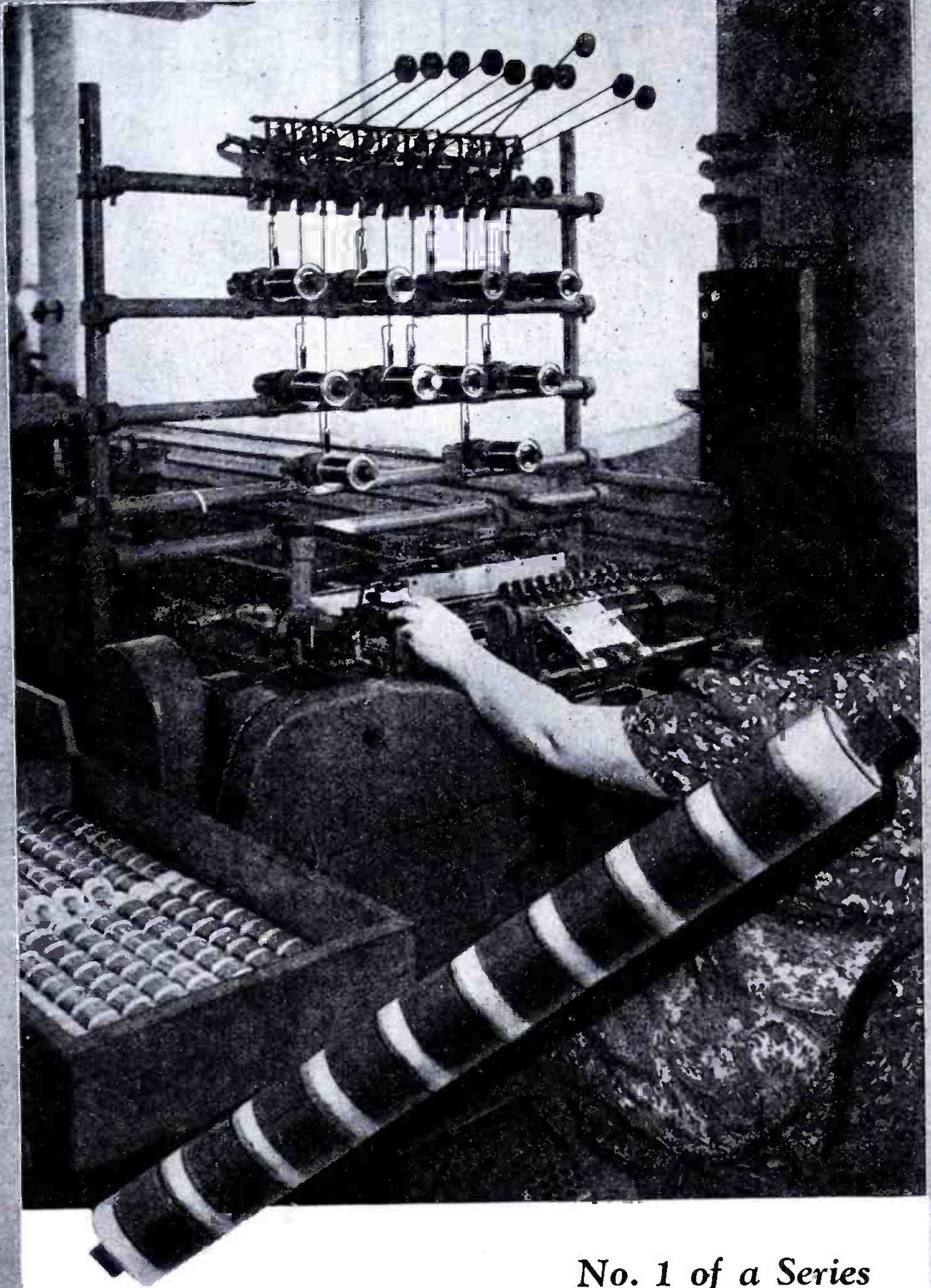
The largest weight of responsibility r the long life and trouble-free serv- e of high power tubes falls on the aintenance engineer. Radio broad- asting over a period of years has as- mbled and trained a large force of ficient maintenance men, who by eir careful scrutiny of all factors hich may lead to tube failure, have ken a place among the most valu- ble members of their station staffs. n the field of industrial applications these tubes the same development ust take place, and industrial main- nance men will do well to study the chniques developed by these broad- ast maintenance engineers.

The water system for high power ubes requires all the attention that ny piece of rotating equipment nor- ally requires; and in addition there the necessity for keeping the sys- m clean, removing scale from the node, maintaining adequate electroly- s targets, and maintaining proper peration of the water flow interlock ystem. The problem of cleaning the cale off the tube anodes has been the ubject of much discussion. Charles I. Singer[4], one of the country's foremost maintenance authorities, recommends the removal of scale without emoving the tubes from their sockets ecause of the great danger of me- hanical damage to the brittle tungsten lament and the hanging electrode upports. To accomplish this type of leaning, about two pounds of tri-so- ium phosphate are added to the cool- ng water and the system is flushed or one hour with the filaments on nd with a water temperature of 140°. The system must be thoroughly lushed before final refilling with pure vater.

Other authorities recommend the emoval of the tubes so that the scale ondition may be observed and the leaning be adequately done. A 20% olution of hydrochloric acid is gen- rally used with a soft applicator. Here again the tube must be carefully insed to remove all traces of acid be- ore replacing in the socket. Extra are must be taken to prevent any type of mechanical jarring to the tube dur- ng the cleaning process.

Both methods of cleaning have their dvantages and disadvantages, and he maintenance engineer must base is choice on many factors which are peculiar to his own installation. It has been the experience of the author that as long as the tubes can be cleaned in the socket sufficiently so that the tube temperature does not rise or excessive hissing does not take

(*Continued on page* 96)



(Continued from page 95)

place, they should not be removed; but at the first indication that the cleaning is not complete, the tubes must be removed for cleaning. This system also has a major drawback. It is possible (with faulty observation) to get a localized scale formation which makes the removal of the tube very difficult without damage or excessive loss of time during a tube change emergency. The use of absolutely pure water gives one of the best means of insurance against scale troubles. Distilled water should be used wherever possible. If other water must be used, the hardness must be kept below 10 grains per gallon.

Regular observation of the electrolysis target and frequent replacements will do much to protect the other metal parts of the tube socket water connections with the insulating column. The operation of the interlock should be checked against the flow meter for freedom of movement and for accuracy. A regular check should also be made of the operation of the plate overload relays to assure proper adjustment and fast action.

The problem of exuded gas within the tube and of flash arcs was discussed earlier in this paper. Keeping spare tubes gas free while not in operation becomes a major maintenance problem. It is possible to keep tubes in good condition by rotating them so that the spares see a week's service every three months. Operation at normal anode potential tends to clean them up sufficiently in this period of time. This requires frequent handling of the tubes, however, and in the case of some of the larger tubes it may be very detrimental. Having duplicate sockets for the tubes right in the equipment so that the spare may be inserted in the circuit by relay switching is by far the best solution to the problem. The tube may be put into operation for short periods at frequent intervals to keep it gas free. A tube that has been on the shelf for a long period of time should be placed in service with reducd anode potential. In an hour or so the potential may gradually be raised to its full value. If the tube should flash arc at any potential as this is being increased, the potential should be reducd slightly for a short period and again gradually increased until full voltage is obtained.

Good maintenance is based on a complete knowledge of the equipment being maintained, enough experience with the equipment to recognize its operating idiosyncrasies, and patience to regard every minor irregularity of operation as an important indication that trouble is in the offing.

OMBINING COMPONENTS

(Continued from page 66)

citance of .263 mfd, reciprocal of ich is 3.80228. By selecting the st series element from an accurate *ck* size of .3 mfd, reciprocal 3.33333 ix places), we can now determine e second element is .46895. Reenter- ove, we find that the reciprocal of e second element is .46995. Reenter- g the tables, we find the result to be tween 2.1 and 2.2 mfd. In all prob- ility, there will be a slight correction r stray capacitances, ground capac- , etc. For this reason, we list re- ltant overall capacitance obtained ith several different values for this cond capacitance:

	Total reciprocal	*Overall capacitance*
0 mfd	3.83333	0.2609 mfd
1 mfd	3.80952	0.2625 mfd
2 mfd	3.78788	0.2640 mfd

rom this, while adjusting the second ement, we observe that a change of mfd produces a change of only ightly greater than .001 mfd in the nal result. Thus, for any average egree of precision, it is necessary only have the first element of high ac- uracy. Since the requirements are ss severe on the second element, two r more relatively inexpensive con- ensers could be connected in parallel form this second element, giving a uch closer result.

Of course, if precision condensers re used throughout, it would be pos- ible to carry the accuracy to six places r whatever standard required, as hown in the method of obtaining ex- ct values of resistance, since the re- iprocal rule applies to either function.

As indicated, the method is very lexible and quite practical for applica- ion in cases requiring a high degree f precision. Probably the results ob- ained could have as easily been worked ut by graphical means, but there is a ertain amount of error in the inter- retation of any graph. In the initial steps, before referring to the tables, it s very convenient to utilize the *D* and *D1* scales of the slide rule, mentally dding the reciprocals. Thus, we can entatively set up several possible com- binations for consideration, letting such factors as cost and space deter- mine the final choice. With a slide rule alone it is possible to set up a combination with much less than 1% final error. This method is not pre- sented merely as a wartime substitute, because the problems involved might just as well be encountered at any time.

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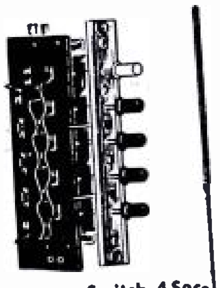

Push Button Switch, 4 Sections, each 8 pull double throw, with release button as illustrated.
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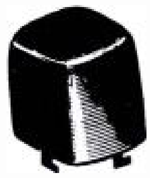

Full Wave Vibrator Transformer, 6 Volts. Imput—250 Volts. 60 MA. Output C.T.
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I. R. C. type CS Dual Potentiometer 2500 ohm and 25 ohm.
5B2007
Specially priced, **49¢**

Cornell-Dubilier type TJL6040, 4 mfd. 600 volt DC wkg. oil filled condenser.
5B3015
Specially priced, **$1.49**

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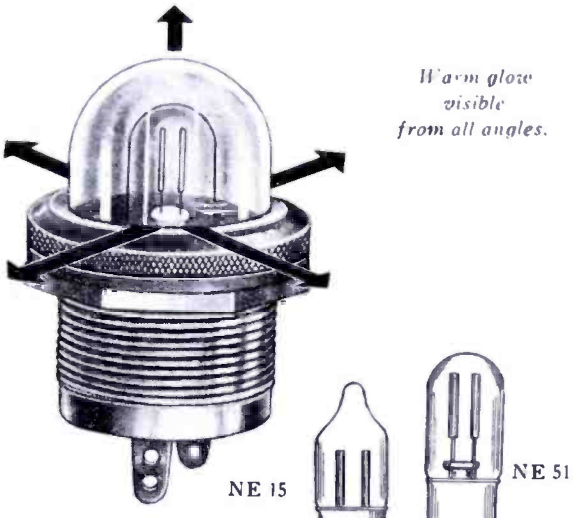


NEWS BRIEFS

STANDARD FREQUENCY BROADCAST SERVICE EXTENDED

Effective February, 1945 broadcasting of standard frequencies and standard time interval from WWV near Washington, D. C. ha been extended by broadcasting 15-megacycl signals at night as well as in the daytime.

The service is continuous at all times day an night, from 10-kilowatt radio transmitters except on 2500 kilocycles per second where kilowatt is used. The services include: (1 standard radio frequencies, (2) standard tim intervals accurately synchronized with basi time signals, (3) standard audio frequencies and (4) standard musical pitch, 440 cycles pe second, corresponding to A above middle C.

* * *

G. L. TAYLOR BUYS MIDLAND SCHOOLS

G. L. Taylor, president and active head of Midland Radio and Television Schools, Inc., has acquired full control of the schools from KMBC. Under the new ownership the school name will be changed to Central Radio & Television Schools, Inc., the Midland name being retained by Midland Broadcasting Company, owners and operators of KMBC.

Mr. Taylor has resigned from KMBC as vice president in charge of technical development.

Robin D. Compton has been named technical director of Midland Broadcasting.

* * *

TBA FORMS ENGINEERING COMMITTEE

A TBA engineering committee has been formed by F. J. Bingley, chief television engineer of Philco and a member of the TBA board of directors.

Serving on the committee are: W. J. Purcell, G. E.; Dr. Thomas T. Goldsmith, Jr., Du Mont Laboratories; David B. Smith, Philco; O. B. Hanson, NBC; Robert Shelby, NBC (alternate); E. A. Hayes, Hughes Productions; George Lewis, Federal Telephone and Radio Corporation; Harry Lubcke, Don Lee; and H. L. Blatterman, Earle C. Anthony, Inc.

* * *

TOM JOYCE RESIGNS FROM RCA

Tom Joyce, general manager of the radio, phonograph and television department of the RCA Victor Division of the Radio Corporation of America, at Camden, N. J. announced his resignation recently.

* * *

ASA SOUND LEVEL METER STANDARDS

A new American standard for sound level meters has been approved by the American Standards Association.

The new standard supersedes a tentative standard originally issued in 1936.

Among the improvements over the tentative standard are the inclusion of design objective and tolerance curves for flat response-frequency characteristics of sound level meters and slight revisions in the previously agreed-on

●

NAVY P-A BOOTH

Lt.(jg) Charles Colledge, U.S.N.R., formerly of NBC, at controls of broadcast and p-a system displayed at the recent Navy electronic exhibit in Chicago.

ves for 40 and 70 decibel equal loudness ours.

opies of the new standard, Z24.3-1944, may obtained from the American Standards As- ation, 70 East 45th Street, New York 17, Y., at 25 cents per copy.

* * *

A-NEMA STANDARDS AGENCY

ew agency, the Joint Electronic Tube En- ering Council (JETEC), for the standard- on of tubes, has been established jointly by A and the National Electrical Manufac- rs. The agency will handle standardiza- of all electronic tubes; transmitting, re- ng, industrial and non-industrial. Present standards will not be changed.

e agency will have a policy committee isting of Dr. W. R. G. Baker, director of RMA engineering department, and presi- A. C. Streamer of NEMA. It will op- e through the RMA data bureau, of which C. F. Horle is manager. There will be a EC engineering council, with four mem- , two each from RMA and NEMA, which issue tube standards. The four members he council are: O. W. Pike, G.E., chair- ; J. R. Steen, Sylvania Electric Products, ; A. Senauke, Amperex Electronic Cor- ion, and D. D. Knowles, Westinghouse.

* * *

MORE JOIN RMA

new members have been admitted to the A. They are: American Coil & Engineer- Co., Chicago. Illinois; Chicago Condenser oration, Chicago, Illinois; Electrical Re- nce Corporation, Franklinville, N. Y.; son Industries, Chicago, Illinois; Measure- ts Corporation, Boonton, New Jersey; Min- Corporation of America, New York, N. Y.; . Seeburg Corporation, Chicago. Ill.; Sher- Electronics Company, Brooklyn, N. Y.; S. Television Mfg. Corp., New York, N. Y., The Zell Company, New York, N. Y.

* * *

HN F. RIDER NOW LT. COL.

n F. Rider has been promoted to Lieuten- Colonel.

om June 1, 1942 to November 17, 1943, nel Rider was stationed at the Southern al Corps School, Camp Murphy, Fla. Here organized and became the director of the ining Literature Division. Transferred to Monmouth he organized the Radar Liter- e Section at the Signal Corps Publication ncy. Colonel Rider was subsequently ad- ced to Executive Officer of the Agency is at present Deputy Director in charge ll operations of the Agency.

* * *

MURDO SILVER OPENS PLANT

engineering and manufacturing company, McMurdo Silver Company, has been ned by McMurdo Silver in Hartford, Conn. ivities will cover primarily sale of amateur s, kits and special equipment and consulting ineering.

r. Silver was formerly with Grenby Mfg. as vice president in charge of radio and tronics.

* * *

VIS NAMED GALVIN AUTO DIO CHIEF ENGINEER

Davis has been appointed chief engineer he auto radio division of the Galvin Manu- uring Corporation. Gus L. Mydlil has be- e assistant chief engineer.

J. Davis

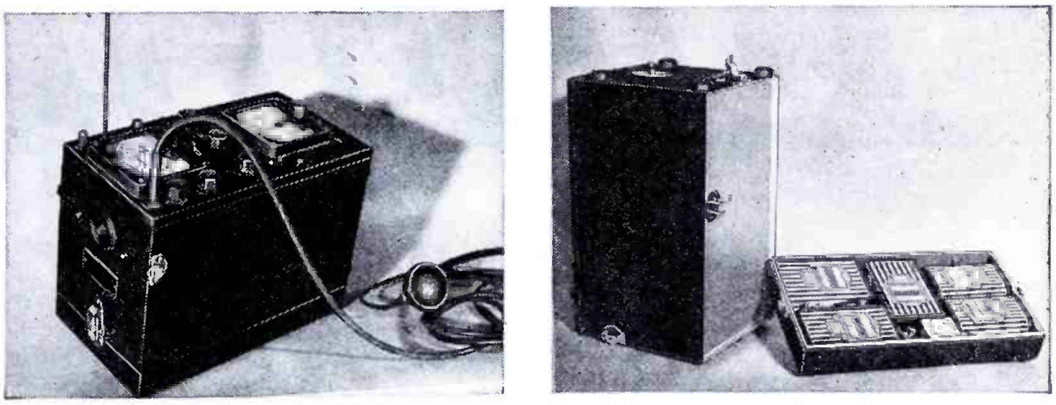
G. L. Mydlil

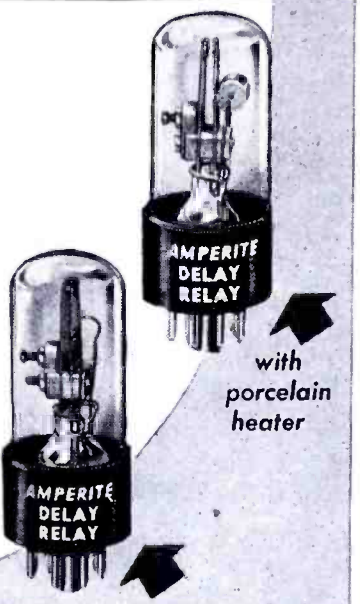
* * *

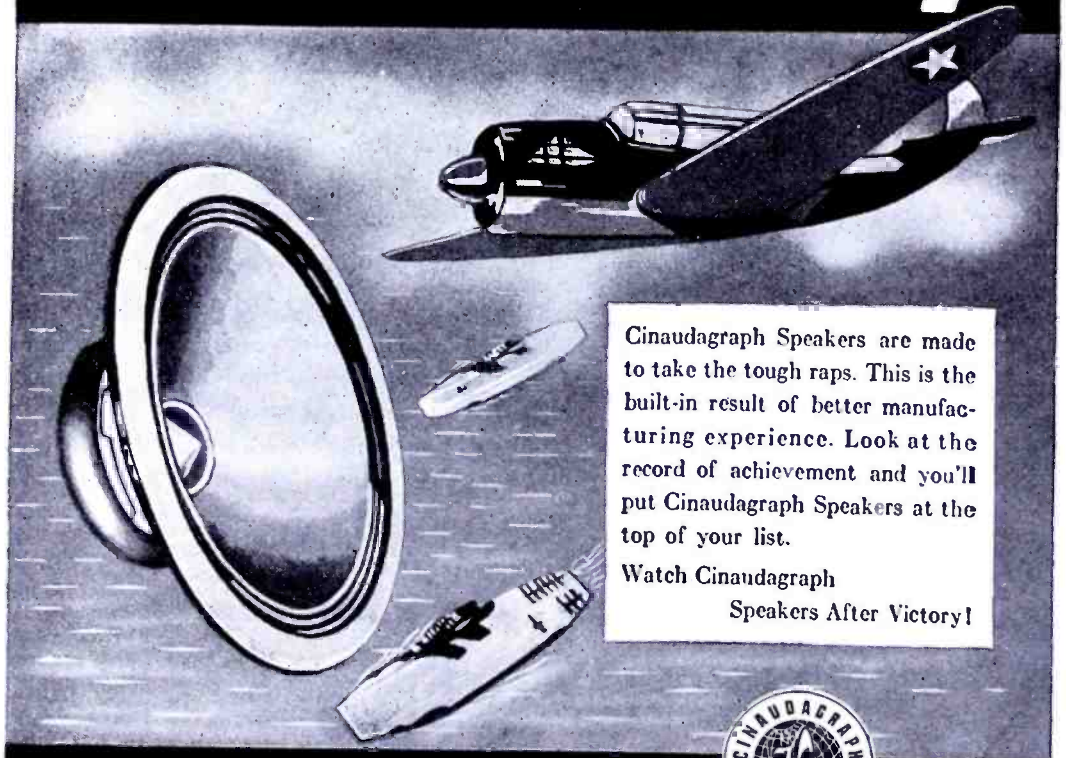
M. MARTIN NOW FARNSWORTH V-P

yin M. Martin has been appointed vice-

(*Continued on page* 100)







NEWS BRIEFS

(*Continued from page 99*)

president and secretary of the Farnswor Television & Radio Corporation. Mr. Mart has been with Farnsworth as secretary a counsel since 1939.

* * *

WEBSTER PRODUCTS SOLD TO WEBSTER-CHICAGO CORP.

Webster-Chicago Corporation, 5622 Bloomin dale Avenue, Chicago, has purchased Wel ster Products, 3825 West Armitage Avenu Chicago. The former Webster Products o ganization and facilities will be retained inta and will operate as the electronics division Webster-Chicago Corporation. Personnel at t parent company also remains unchanged.

The electronics division is now manufa turing dynamotors and voltage regulators. F peacetime production, the new division will r sume manufacture of Webster record changer The Bloomingdale plant of Webster-Chicag will continue to specialize in the design an fabrication of laminations for motors and tran formers.

R. F. Blash, president of Webster-Chicago.

* * *

W. W. MARTIN NOW AIREON ASSISTANT AD MAN

William W. Martin has been named assistan to the director of advertising of the Aireo Manufacturing Corporation. Mr. Martin formerly was an airline pilot with Transcontinental and Western Air, Inc., and Mid-Continent Airlines.

* * *

UNGAR NAME CHANGE

The corporate name of Harry A. Ungar, Inc. has been changed to Ungar Electric Tools Inc. Factory and offices are at 615 Ducommu Street, Los Angeles, California.

* * *

C. B. JOLLIFFE NAMED RCA LAB HEAD

Dr. C. B. Jolliffe, chief engineer of the RC Victor division, has been elected vice presi dent of Radio Corporation of America i

●

C-R TUBE RECORD AT WCAE

(*Courtesy RCA*)

Chief Engineer James Schultz of WCAE (left with the cathode-ray tube, which has given mor than 50,000 hours of service in program monitoring.

rge of RCA Laboratories. Dr. Jolliffe suc-ds Otto S. Schairer, who has become a ff vice president of RCA. Mr. Schairer will consultant and advisor on research, develop-nt, patents, trademarks and licenses.

• • •

LLICRAFTER'S EXPORT IT MOVES

e export division of Hallicrafters Company moved to 1791 Howard street, Chicago. nuel Ortiz, Jr., is manager of the division.

M. Ortiz, Jr.

• • •

UNGER BECOMES TAYLOR BE ADVISORY S-M

L. Munger, formerly sales and advertising nager of Taylor Tubes, Inc., 2312 Wabansia e., Chicago, Illinois has become advisory es manager.

r. Munger will now also handle war surplus ninistration for another company. Head-rters will be maintained at Taylor Tubes.

• • •

DUSTRIAL INSTRUMENT DATA

bulletin describing direct-indicating com-ison bridges, capacity and resistance limit dges, resistance and capacitance decades, eatstone bridges, voltage breakdown test and test fixtures, Kelvin bridges, megohm dges, megohmmeters and conductivity ap-ratus has been published by Industrial In-uments, Inc., 17 Pollock Ave., Jersey City, J.

• • •

AFFER NOW STANCOR TROIT REP.

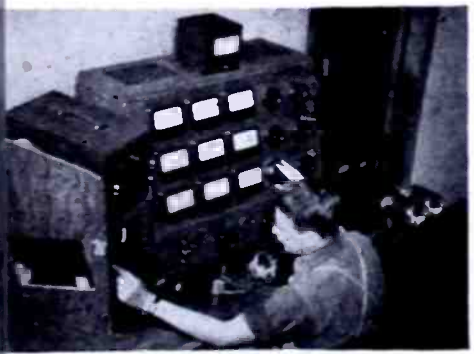
nt Shaffer has been appointed representa-e for the jobber and industrial divisions of ndard Transformer Corporation in the De-it area, with offices at 6432 Cass Avenue.

• • •

RTER MOTOR DESIGNS DYNAMOTOR ODUCTION TEST CONSOLE

test console placing all units under actual any operating condition, has been de-oped by the Carter Motor Company, 1608 waukee Avenue, Chicago, Illinois.

he console consists of a wide-range meter el, marine receiver, twin oscillographs and et of storage batteries together with suit-e outlets for 115 volts a-c and d-c.



• • •

H. BUTTNER RECEIVES E HONORS

H. Buttner, vice president and a director Federal Telephone and Radio Corporation.

(Continued on page 102)

H. H. Buttner

NEWS BRIEFS

(*Continued from page* 101)

has been awarded a fellowship in the Institute of Radio Engineers in recognition of his contributions to the advancement of international communications. The honor was bestowed at the recent IRE winter meeting.

• • •

DOHERTY JOINS MARION INSTRUMENT

Ellis E. Doherty has been appointed Director of purchasing and expediting of the Marion Electrical Instrument Company, Manchester, New Hampshire.

Mr. Doherty was formerly with the War Department Signal Corps production office in Boston, as a field expeditor and consultant.

• • •

STEVENS INSTITUTE HONORS MACHLETT

Raymond R. Machlett, president of Machlett Laboratories, Inc., Springdale, Connecticut, received the honor award medallion of Stevens Institute of Technology, at an alumni dinner of the Institute in New York recently.

• • •

EMERSON MARKHAM NAMED TBA DIRECTOR

Emerson Markham, manager of television at General Electric, has been named a director of the TBA, succeeding Robert L. Gibson, who resigned recently.

• • •

U. M. C. MICROPHONE DATA

A bulletin, 1458, describing the D-20 series of dynamic microphones, has been published by Universal Microphone Co., Inglewood, Cal.

• • •

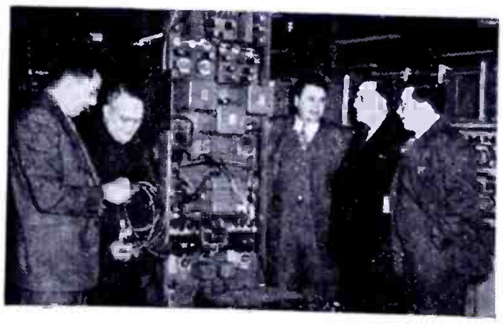
AEROVOX OFFICIALS HONOR COLE, COHEN AND SIEGEL

S. I. Cole, retiring president, and Samuel Siegel, retiring vice president, were feted by their Aerovox associates at a banquet held in New Bedford recently. Colonel Emanuel Cohen, U. S. Signal Corps Reserve, third member of the original owners and management, was represented by Mrs. Cohen.

Recordings of vocal tributes of thirty-two

•

ROCK ISLAND R.R. RADIO UNIT



Rock Island radio equipment described recently before the Collins Radio technical association and the AIEE in Iowa. With unit above are, left to right: F. M. Davis, director of research and development, Collins; T. A. Hunter, director of oscillator development, Collins; A. E. Ganzert and E. A. Dahl of Rock Island.

ociates of Mr. Cole and Mr. Siegel were sented.
Ir. Cole announced his retirement as general nager.

* * *

RTWRIGHT TO REPRESENT CARTER

M. Cartwright & Son, 1276 Peabody Ave- , Memphis, Tenn., have been named Ten- see representatives by Carter Motor Com- y, 1608 Milwaukee Avenue, Chicago, Illinois.

* * *

E. LICENSES KNIGHTS CO.

James Knights Company, Sandwich, Illi- , have received a license from the West- Electric Company to manufacture elec- ic equipment under W.E. patents.
ouis Cunz has been appointed chief pro- tion supervisor of the quartz cutting de- tment. John Ernst has become chief pro- tion supervisor of crystal finishing.

* * *

IPHENOL CABLE CATALOG

enty-six types of RG cables and companion -f connectors are described in section *D* of atalog released by American Phenolic Cor- ation, 1830 South 54th Avenue, Chicago 50, nois.

* * *

E BREEN JOINS U.M.C.

e Breen has become sales manager for the iversal Microphone Co., Inglewood Cal. He s formerly western division sales manager the El Monte, California plant of Littelfuse,

* * *

DE NIKE APPOINTED N. U. ISTRIBUTOR DIV. S-M

DeNike who has been director of public ations of National Union Radio Corporation s been named sales manager of the distribu- division.

* * *

S. HAYS NOW OPA CONSULTANT

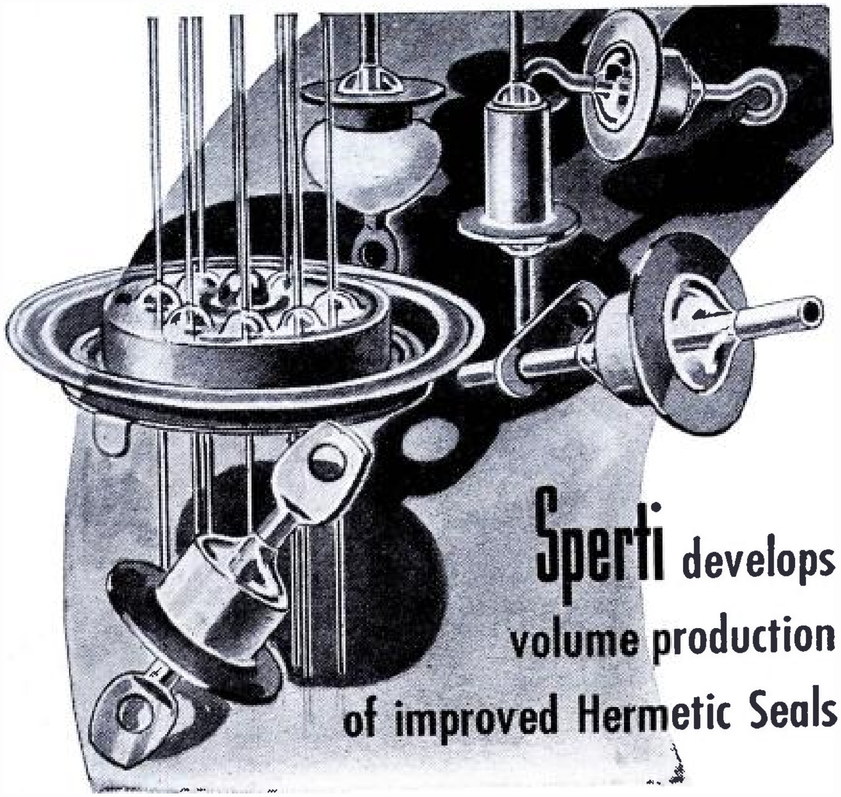
rman S. Hays, manager of field service gineering at Philco, has been appointed a nsultant to the Service Trades Price Branch the OPA.
Mr. Hays, who will serve on a part time sis, will advise OPA's national office chiefly matters relating to radio and household ap- ance repairs.

* * *

MA CANCELS ANNUAL JUNE SHOW

e annual industry war conference, RMA embership meetings and tentative Parts Trade ow, scheduled next June at Chicago, all ve been cancelled because of the government avel restrictions. There will be an RMA

(*Continued on page* 104)



NEWS BRIEFS

(*Continued from page* 103)

convention by mail, through proxies. Th only meetings next June at the Stevens Hote will be of the association's board of director and the executive committees of its five divisions, with new directors elected by mai proxies.

* * *

BENTON JOINS AMPHENOL ENG. STAFF

H. Z. Benton has been appointed to the engineering staff of American Phenolic Corporation, 1830 South 54th Avenue, Chicago 50, Illinois. He will be in charge of design and production on tube sockets, and will also supervise engineering and research on specialty antennas.

Mr. Benton was formerly chief engineer o Crowe Nameplate & Mfg. Co.

* * *

HYTRON NAME CHANGE

The Hytron Corporation, Salem, Mass., will hereafter be known as the Hytron Radio and Electronics Corporation.

At an officer's election, Bruce A. Coffin was named president and general manager; Lloyd H. Coffin, treasurer and chairman of the board of directors; Edgar M. Batchelder, executive vice president; and Charles F. Stromeyer, vice president and director of engineering.

* * *

R. RAMSEY HEADS U.M.C. SERVICE DEPT.

Robert Ramsey has been appointed manager of the service department of Universal Microphone Company, Inglewood, Calif.

* * *

E. L. BRAGDON GOES TO RCA DEPT. OF INFORMATION

E. L. Bragdon, formerly trade news editor of the National Broadcasting Company, has joined the staff of the department of information of RCA.

Before becoming associated with NBC in 1942, Mr. Bragdon was radio editor of the New York Sun, a position he had held since 1923.

* * *

J. KAUFMAN JOINS LEWIS ELECTRONICS

Jack Kaufman has been named vice president of Lewis Electronics, Los Gatos, California.

* * *

PREMAX ANTENNA CATALOG

A 24-page catalog describing tubular steel, aluminum and stainless steel antennas; monel, police and marine antennas; corulite elements; amateur installations; mountings and supports; and commercial installations has been released by Premax Products, Niagara Falls, N. Y. Cross-sectional diagrams and data on the various antenna types are also offered.

* * *

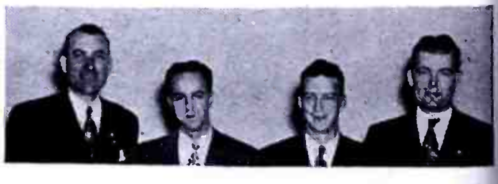
SPERTI OPENS N. Y. OFFICE

Sperti, Inc., now has a New York office at 714 Fifth Avenue. The headquarters, laboratories and manufacturing plant are in Cincinnati, Ohio.

George Stevens, formerly of the parent or-

●

WCEMA OFFICERS



Left to right: Herbert Becker (Eitel McCullough), secretary; Howard Thomas (Packard Bell), vice-president; Bud Bane (Technical Radio), president; and James Fouch (Universal Microphone), treasurer.

anization in Cincinnati, is directing the New ork office.

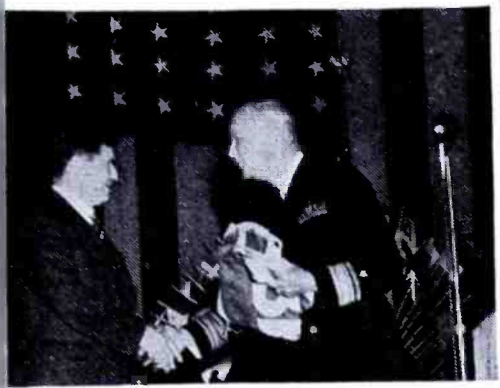
* * *

E" AWARDS

he Army-Navy "E" pennants have been warded to Barker & Williamson, Upper arby, Penna.; Pacific Sound Equipment Comany, Hollywood, Calif.; and Harvey-Wells lectronics, Inc., Southbridge, Mass.

A second white "E" flag star has been warded to the Formica Insulation Company, 20 Spring Grove Avenue, Cincinnati, Ohio.

Fourth white "E" flag stars have been won y Henry L. Crowley & Company, Inc., West range, N. J., and Edwards and Company, orwalk, Connecticut.



ohn M. Wells, president of Harvey-Wells, ccepting the "E" flag from Rear Admiral W. T. Cluverius, U.S.N.

* * *

SHALLCROSS HIGH-VOLTAGE TEST EQUIPMENT CATALOG

A six-page bulletin, F, describing several types of high voltage test equipment has been issued y the Shallcross Manufacturing Company, Collingdale, Penna.

Data covers portable kilovoltmeters suitable for use from 1 to 30 kilovolts; corona protected kilovoltmeters for measurements up to 200 kilovolts; separate kilovoltmeter multipliers, available for use with external meters for measurements from 1 to 30 kilovolts; and corona protected resistors, available separately for use with suitable meters to permit measurements of potentials up to 200 kilovolts.

* * *

N. A. PHILIPS CONDENSED CATALOG

An 8-page catalog describing all of the Norelco products has been announced by North American Philips Company, Inc., 100 East 42nd Street, New York.

Subjects covered include cathode-ray, transmitting, power and amplifier tubes; quartz crystal oscillator plates; searchray (x-ray) inspection units; geiger-counter x-ray spectrometer; film-type x-ray diffraction equipment; quartz crystal x-ray analysis unit; metallurgical products (tungsten and molybdenum powder, rod, sheet and wire, aluminum alloy, enameled copper, resistance, silver and gold-clad silver wire in fine sizes); and medical x-ray equipment (radiographic units, tables, tubes, tube stands and miscellaneous accessories).

* * *

MICA INSULATOR MANUAL

An 86-page manual with data, tables and values on sheet mica, built-up mica, laminated plastics, varnished cloth and tapes as well as miscellaneous insulating materials such as varnishes, twines and fiberglas, has been published by the Mica Insulator Company, 200 Varick Street, New York 14, New York.

The manual will be sent on request upon company letterhead.

* * *

BABKES BECOMES LEAR RADIO PURCHASING HEAD

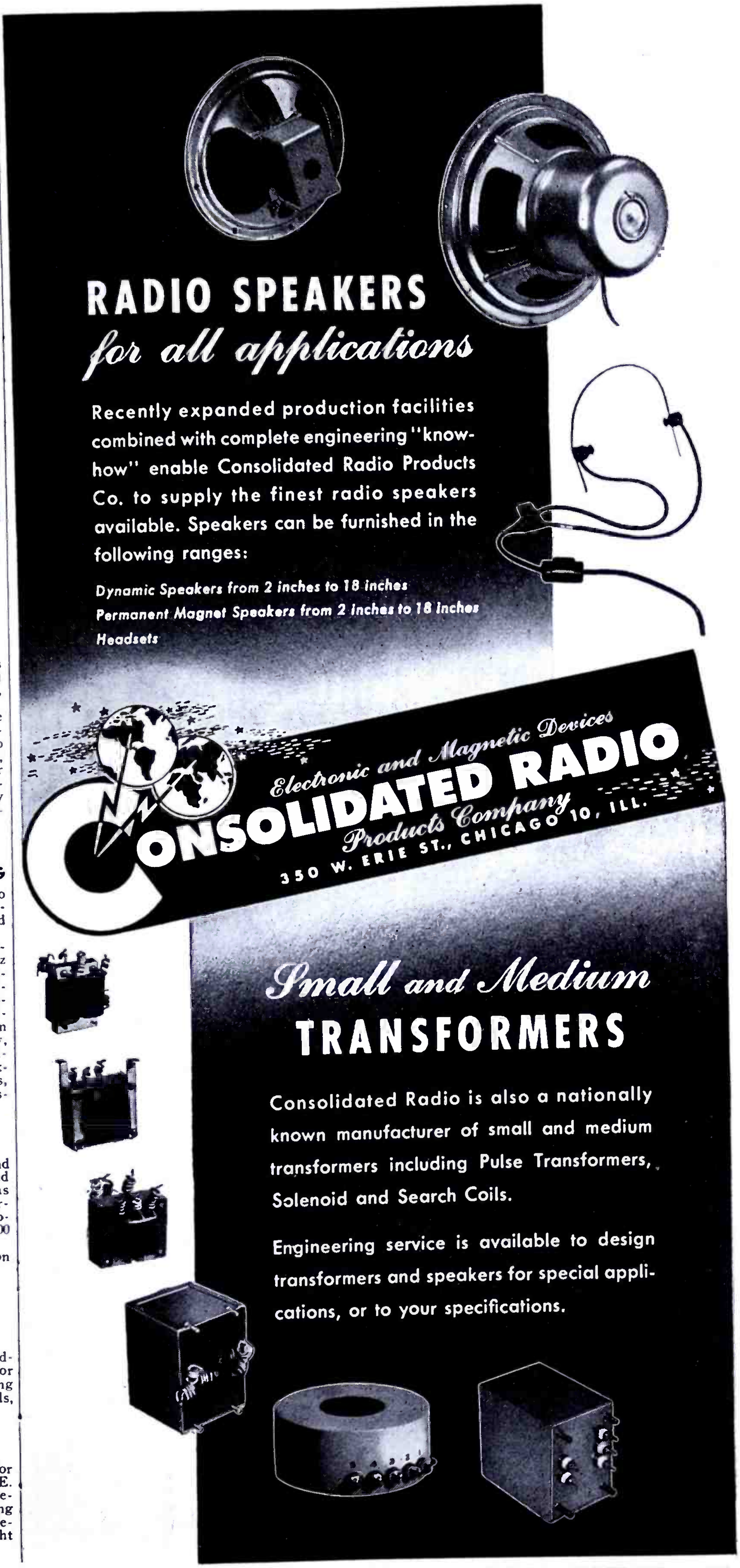
E. Joseph Babkes, formerly in charge of scheduling distribution of radio test equipment for the WPB, has been appointed radio purchasing agent for Lear, Incorporated, Grand Rapids, Michigan.

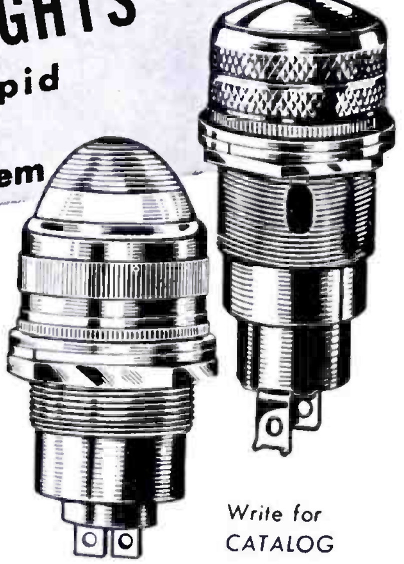
* * *

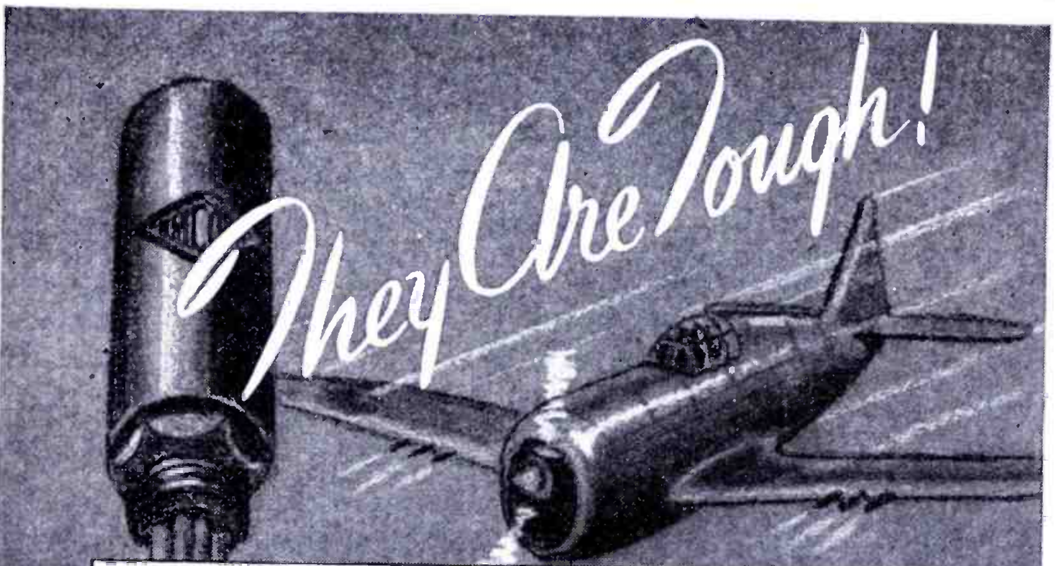
LINGO VERTICAL RADIATOR DATA

A brochure covering vertical radiators for broadcast stations has been issued by John E. Lingo & Son, Inc., 28 Street and Buren Avenue, Camden, New Jersey. Antenna supporting poles for other types of service are also described. Presented too are radiator height

(Continued on page 106)







NEWS BRIEFS

(*Continued from page* 105)

charts, with data on ground systems and FCC minimum radiator heights for all class stations throughout the standard broadcast band.

* * *

GULOW VARI-FORMER BULLETIN

A 4-page bulletin covering voltage regulating transformers has been published by the Gulow Corporation, 26 Waverly Place, New York, 3, N. Y.

* * *

HARVEY-WELLS BROCHURE

A 36-page "case book" describing the plant and personnel facilities of Harvey-Wells Electronics, Inc., Southbridge, Mass., has been just been released. Described are mobile, marine and ground transmitters and receivers, and aeronautical communications equipment.

* * *

JENSEN SPEECH MANUAL

The fourth in a series of monographs on loud speakers and frequency control, has been published by the Jensen Radio Manufacturing Company, 6601 South Laramie Avenue, Chicago, Ill. This latest release covers the effective reproduction of speech. Copies are priced at twenty-five cents and are available from the technical service department.

* * *

LEAR FACILITIES DATA

A 24-page booklet covering engineering and production facilities has been published by Lear, Inc., 1480 Buchanan Avenue, Grand Rapids 2, Michigan.

* * *

ANDREW COUPLING TRANSFORMER BULLETIN

A bulletin, 31, describing rhombic antenna coupling transformers, coaxial plugs and jacks has been released by Andrew Company, 363 East 75 Street, Chicago, Ill.

* * *

CAMBRIDGE THERMIONIC CATALOG

A 24-page catalog, 100, with data on C. T. C. terminal lugs, x-ray oriented crystals, u-h-f i-f transformers and pressure and hand swaging tools, has been released by Cambridge Thermionic Corporation, Concord Avenue, Cambridge 38, Massachusetts.

* * *

MYKROY MOLDING BULLETIN

A 12-page bulletin presenting a discussion of insulation and Mykroy glass-bonded mica ceramic 51 and its application to injecting molding, has been published by Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, New Jersey.

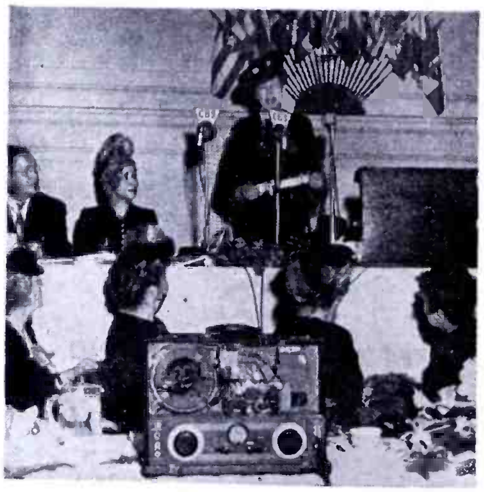
* * *

JONES CATALOG

A 32-page catalog, No. 14, describing multi-contact plugs and sockets, terminal strips, fuse mounts, etc., has been released by Howard B. Jones Company, 2460 W. George Street, Chicago 18.

* * *

NAB DINNER FILM-RECORDED



(*Courtesy Frederick Hart and Co.*)

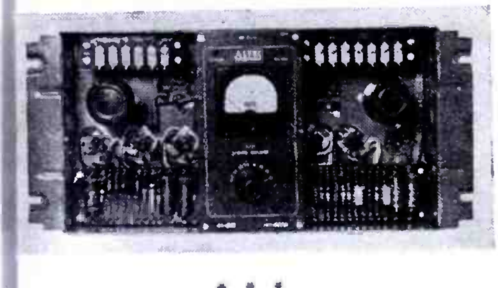
Recording talk of Mrs. F. D. Roosevelt, accepting scroll presented by Association of Women Directors of NAB as outstanding woman in broadcasting, on film recorder at a dinner in N. Y. City. Talk by FCC chairman Paul Porter (at extreme left in photo) was also film-recorded. Guests heard these talks and special women's program played back on film recorder.

THE INDUSTRY
OFFERS . . . —

LTEC LANSING LIMITER AMPLIFIER

5-watt limiting amplifier that is said to ave a 70 db gain and eliminates thumping d monkey chatter has been recently developed by Altec Lansing Corporation, 1210 Taft uilding, Hollywood, California.

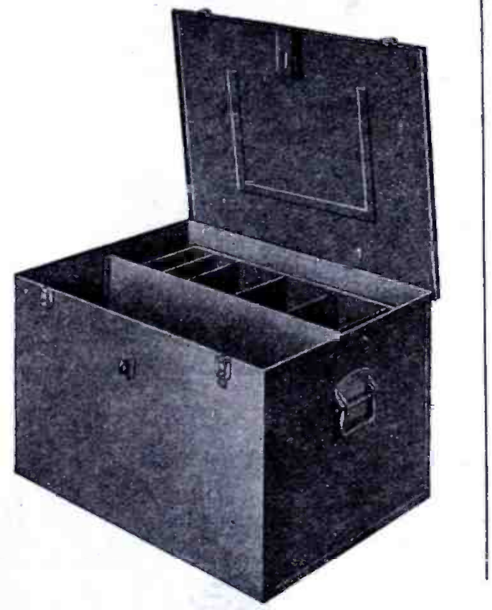
According to John K. Hilliard, chief engieer, the new amplifier permits a total input tenuation of 30 db in 1 db steps; provides ten-one compression beyond the limiting point; rmits a 5 to 6 db limiting action without beg apparent to the ear; permits limiting of to 15 to 20 db without distortion; provides valuable safety factor in high power radio d public address installations and effectively duces over-modulation without distortion. he new amplifier is said to have a freuency characteristic of ± 1 db over a 20 to ,000-cycle range. The unit is designed for lay rack mounting.



* * *

COLE SPARE PART BOXES

part parts boxes in 24 stock sizes are now vailable from Cole Steel Equipment Co., Inc., 9 Broadway, New York 13.



* * *

G. E. SILVER ALLOY BRAZING METHOD

method of brazing small round wires with iameters of 0.0226" to 0.049", using a mixure consisting of equal parts of filed silver older and borax flux, has been announced by . E.

In application, the end of one of the two wires to be brazed is either moistened or eated and then inserted in the container holdng the mixture. When a sufficient amount dheres to the wire, the two ends being razed are placed together and heated over a as flame until the alloy fuses them. If ormal heating is applied the joint will be ree of lumps and points, eliminating a finshing operation before the braze can be insulated.

In the conventional method of brazing these small wires a strip silver alloy and flux was used. This resulted in a loss of the silver both from drip at the braze and from an excess of brazing material at the point of contact. The method is said to save approximately 80% of the strip silver alloy.

* * *

I.C.E. VACUUM CONDENSERS

Vacuum type condensers in 10 to 100 mmfd capacity ranges are now being made by Industrial and Commercial Electronics, Belmont, California.

The condensers are available in steps of 1 mmfd, and said to be accurate within ±1 mmfd. Tolerances of tenths of 1 mmfd are also said to be available.

* * *

G. E. FLAME-RESISTANT PLASTIC

The development for the Navy of a fire-shock-resistant plastic has been announced by G. E.

Methods to produce the material were evolved by G. E. laboratory men, working with Dr. Howard W. Haggard of Yale University.

Asbestos is used as an inorganic filler in the plastic.

* * *

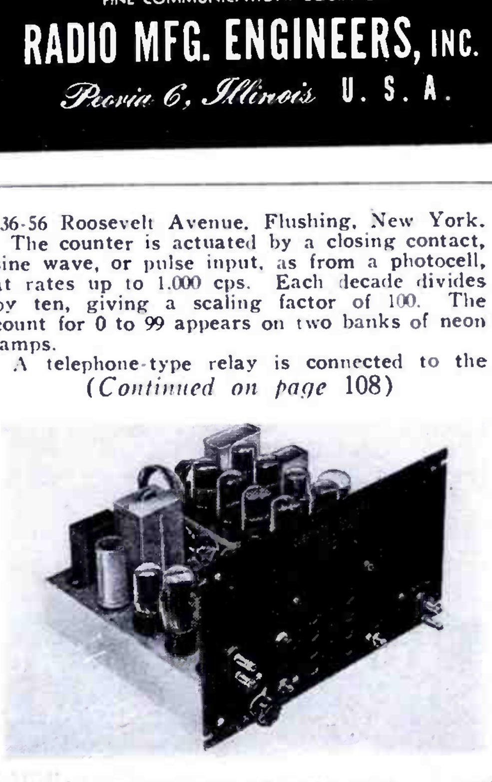
POTTER ELECTRONIC COUNTER

A two-decade electronic counter has been designed by The Potter Instrument Company, 136-56 Roosevelt Avenue, Flushing, New York.

The counter is actuated by a closing contact, sine wave, or pulse input, as from a photocell, at rates up to 1,000 cps. Each decade divides by ten, giving a scaling factor of 100. The count for 0 to 99 appears on two banks of neon lamps.

A telephone-type relay is connected to the

(*Continued on page* 108)



THE INDUSTRY OFFERS . . .

(Continued from page 107)

counter output and the contacts of this relay close once for each 100 input cycles. These contacts are connected to an output terminal. A conventional electro-mechanical counter may be connected to the output terminals to extend the count to as many places as desired.

Uses of the timer include application as an interval timer by connecting it through a switch to a known external frequency. When the switch is closed and opened, the unit will count the number of cycles of the known frequency that have passed in the closed-switch time interval, giving a reading in terms of the number of cycles of the known frequency. The 60-cycle line may be used as the known frequency.

The counter can be supplied with switches to make it predetermining. Uses a complement of 11 tubes. Operation is from a 60-cycle, 105 to 125 volt line. Weight, 25 pounds.

* * *

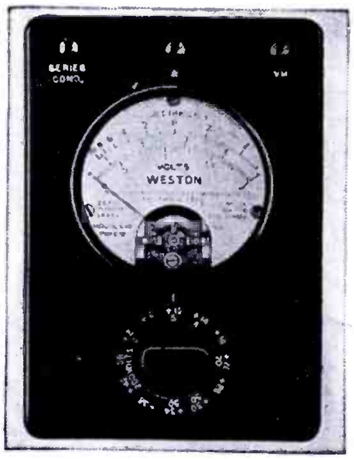
WESTON POWER LEVEL VOLTMETER—OUTPUT METER

A portable test unit, with a rectifier-type voltmeter which provides readings in decibels and in volts, has been produced by Weston Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey. Known as the 695, type 11, it is said to offer a-c voltage measurements in seven ranges from 2 to 200 volts full scale. Has a constant impedance of 20,000 ohms.

Eleven db ranges are provided, from —4 to +36 db at zero on the db scale. This provides a total spread at 55 db (scale: —10/0/+5).

A self-contained condenser, available through a separate pinjack, is provided for blocking d-c components. Calibrated for 500-ohm lines with a zero level of 6 milliwatts or 1.732 volts. Each instrument is supplied with a chart giving interpolation values on lines other than 500 ohms (from 5 to 10,000 ohms at 6 milliwatts zero level).

Dimensions: 5½"x3¼"x3⅛" approximately.



* * *

G-C INSTRUMENT KNOBS

Molded bakelite knobs, 1¼" o-d, are now available from General Cement Mfg. Co., Rockford, Illinois. Complete with ¼" brass insert and set screw. Over-all height, ⅞".

* * *

UTC LOW AND HIGH-PASS FILTERS

High-pass interstage and low-pass interstage filters, HPI and LPI, have been developed by United Transformer Co., 150 Varick Street, New York 13, N. Y.

The units are designed with a nominal impedance of 10,000 ohms. Loss at cutoff frequency is said to be less than 6 db. At .75 times cutoff or 1.5 cutoff frequency respectively, the attentuation is said to be 35 db, and at one-half or twice cutoff frequency respectively, the attenuation is 40 db.

The units employ a dual alloy magnetic shield which is said to reduce inductive pickup to 150 mv per gauss. The dimensions in hermetically sealed cases are 1½"x2½"x2½". Filters of the HRP and LPI type can be pplied for any cutoff frequency from 200 to ,000 cycles.

* * *

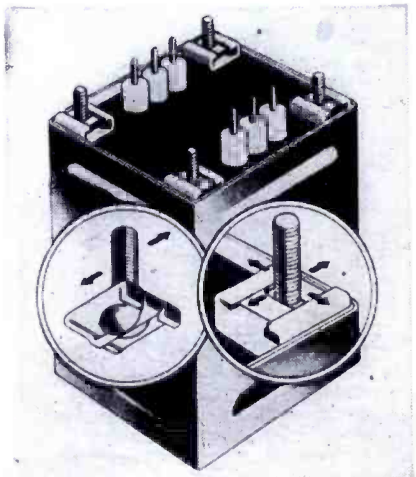
:CCO MOUNTING STUDS

elf-aligning, detachable mounting studs for ransformers have been developed by the lectronic Components Company, 423 N. Vestern Avenue, Los Angeles, Calif.

This feature is said to allow an actual tolrance that can exceed ¼" in mounting dihension.

Uses a clip arrangement, stamped from eavy gauge steel, cadmium plated, which is aid to prevent the stud from turning while it ermits centering in two directions. The stud an be moved (not bent) in four directions to lign with irregularly spaced holes and is relaceable in the field with any round head nachine screw available.

Transformers equipped with this mounting re available in 15 standard case sizes, either ermetically or non-hermetically sealed.



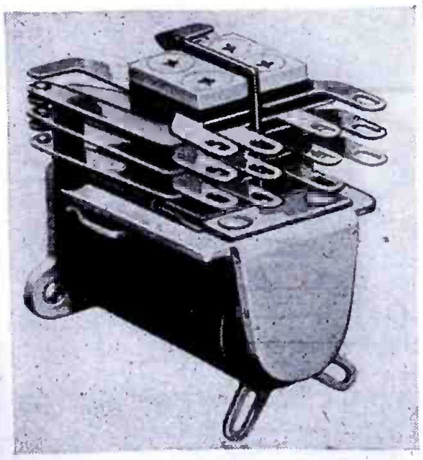
* * *

R-B-M LIGHTWEIGHT RELAY

A relay weighing 1¾ ounces, type 23000, has been designed by R-B-M Manufacturing Company, division of Essex Wire Corporation, Logansport. Indiana.

Specifications include 6 normally open contacts; contact rating, 3 amperes d-c non-inductive. Also available in other arrangements of normally open and normally closed contacts. Vibration resistance said to be up to 10 g's at 40,000 feet; temperature ranges, −65°

(*Continued on page* 110)



A Present and a Future for Experienced Design Engineers

The Collins Radio Company has always been a pioneering organization—an *engineer's* engineering and manufacturing outfit.

It was the pioneering urge that led us to introduce professional standards of design and performance in transmitters and receivers for radio hams in the early thirties . . .

To plan and build special radio equipment that stood up to the rough-and-tumble of Admiral Richard E. Byrd's second expedition to Little America . . .

To take high quality broadcast equipment out of the laboratory and make it economically practicable for any broadcasting station . . .

To meet the individual requirements of some of the great airlines with specially engineered communication equipment, including the ingenious Collins Autotune.

To be prepared on December 7, 1941, to go into production of airborne and ground based radio gear of highly advanced design for the Armed Forces—the result of research and development looking years ahead.

We are looking far ahead today in the field of high quality radio communication equipment. Our post-war plans, well advanced, offer a very substantial opportunity for additional junior and senior assistant design engineers with at least three years of practical mechanical design and drafting experience, and for design engineers with five to ten years of experience. Our work involves the production of small, intricate mechanical and electrical mechanisms.

This is a splendid opening for men and women who are able to make neat, accurate parts drawings with complete specifications, assembly drawings and layouts, who will assume responsibility, and who have knowledge of general standard shop and field practices.

Cedar Rapids is a human, wholesome city of about 65,000. People enjoy living here. And people enjoy working, without being distracted by weather variations, in the modern controlled-conditions Collins plant.

If you feel that you could fit happily and capably into this organization, write us fully. Tell us about your education, experience, age, desired compensation and draft status. W.M.C. regulations, of course, must apply.

Address E. H. Reinschmidt,
Superintendent of Design,
Collins Radio Company,
Cedar Rapids, Iowa.

www.americanradiohistory.com

THE INDUSTRY OFFERS . . . —

(*Continued from page* 109)

C to +85° C. Approximate dimensions, 2 1/16" long, 1½" high, ⅞" wide.

Magnet coil bobbin is of molded phenolic. This type of relay is also said to be available with heavy duty contacts rated at 10 amperes, 28 volts d-c non-inductive.

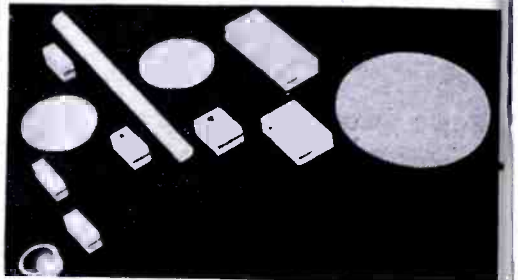
* * *

MYCALEX CERAMIC CAPACITOR DIELECTRIC

A selective range of dielectric constants, from 8 to 15 at one megacycle is said to be available with a ceramic capacitor dielectric, Mycalex series K, recently developed by Mycalex Corporation, Clifton, New Jersey.

The material is said to have been approved by Army and Navy (JAN 1-12) as Class H.

Available in thicknesses of ⅛" to 1" in 14"x 18" sheets; thicknesses down to 1/32" in smaller sheets, and 14" to 18" rods, ¼" to 1" in diameter.

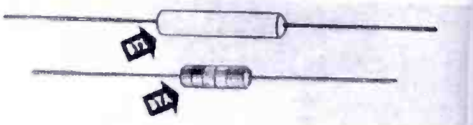


* * *

IRC 1-WATT INSULATED RESISTORS

Insulated 1-watt resistors, type BTA, designed particularly for applications requiring American War Standards' RC30 specifications, have been announced by International Resistance Company, 401 N. Broad Street, Philadelphia 8, Pa.

Resistor is .718" long by .250" in diameter. Has a wattage rating of 1-watt at 40° C ambient and a voltage rating of 500 volts. Minimum range is 330 ohms. Standard maximum range is 20 megohms. Higher ranges are available on special order.



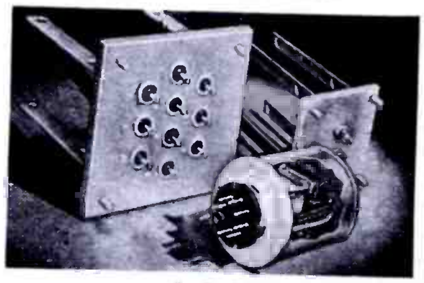
* * *

ETL SEALED HEADERS

Sealed headers and sealed mountings are now being produced by Electronic Testing Laboratories, Inc., 44 Summer Avenue, Newark 4, N. J.

Terminals used are glass bead type. Glass is annealed for strain elimination. Many standard high and low-voltage terminal types are said to be available for inclusion in the header assembly.

Either hermetically-sealed, ventilated or pressurized enclosures are supplied. Inert gas content may be provided if desired.



* * *

DI-ACRO RADIUS BRAKES

A radius brake for forming duraluminum, chrome molybdenum, spring tempered alloys, and various other low ductile materials has been produced by O'Neil-Irwin Manufacturing Company, Minneapolis 15, Minn.

Radii obtainable with standard forming plates: 0, 1/16", 3/32", ⅛", 5/32", 3/16"; maximum folding width, 12"; maximum full width folding capacity, 16-gauge steel plate; maximum degree of angular folding, 110°.

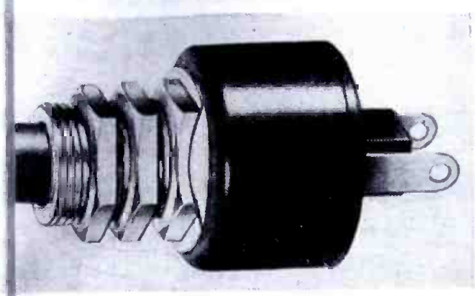
* * *

GRAYHILL SNAP-ACTION SWITCH

A ⅞"x1⅛" momentary push-button, snap-action tch, known as a snapit switch, has been ounced by Grayhill, 1 North Pulaski Road, cago 24, Illinois.

he phenolic body of the switch is round and mounted by a 3/8-32 bushing, 7/16" long. witch operates on a .0625" movement of the h button and carries a current rating of amperes at 115 volts a-c and 2 amperes at volts d-c.

ormally open, single-pole type is indicated a red push button, and a black push button cates a normally closed, single-pole switch.



* * *

CO RESONANCE METER

u-h-f resonance meter, type MW-70, has developed by Erco Radio Laboratories, , Hempstead, New York.

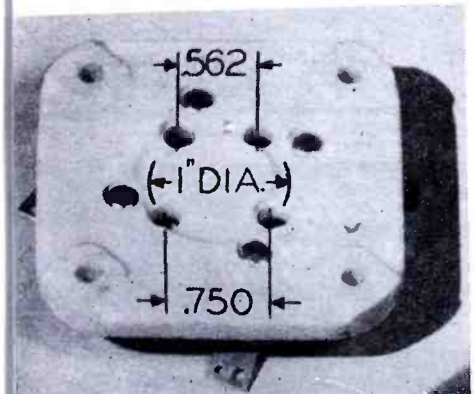
esigned around a high *Q* concentric res-nt chamber whose center conductor is made iable through the use of a rack and spur r. A small plug-in pick-up antenna is mum coupled to the center conductor. Rec-ation is obtained with a miniature crystal tridge and indication of resonance is di-tly shown on a d-c microammeter which is unted in the end of the housing.

* * *

OHNSON TRANSMITTING UBE SOCKETS

accommodate the new jumbo 4-prong bases 8008,BR6, GL146, SC22, GL152, GL159 and 169 tubes, E. F. Johnson Company, Waseca, nnesota, have produced a steatite socket, 244. asures 2⅝"x2⅝" and ¾" thick.

ne piece base construction is used with lded in bosses on top of socket, the bosses ng ground to present a flat mounting sur-e underneath a chassis. Cadmium-plated ss contacts with steel spring reinforce-nts are riveted to the ceramic base in such way that they can not turn.



* * *

ERMOFLUX MIDGET RANSFORMERS

31/32"x37/64"x7/16" transformer has been veloped by Permoflux Corporation, 4900 West and Avenue, Chicago 39, Illinois.

Transformers are said to have a uniform equency response from 100 to 8,000 cycles, 2 db. Can be made with windings to provide pedances as high as 200,000 ohms and, when ed as a choke coil, with inductive reactance as high as one megohm. They may be potted, shielded or hermetically sealed if desired

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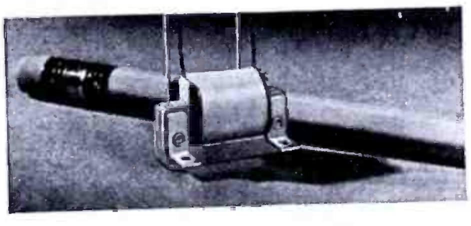


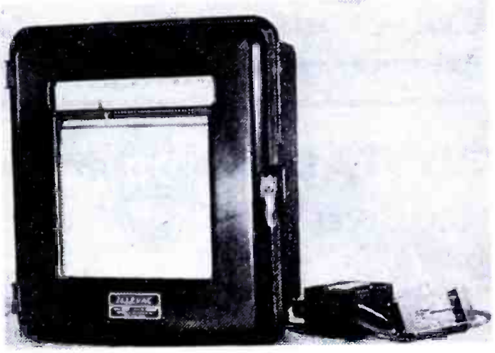
PRECISION SCIENTIFIC RECORDING UNITS

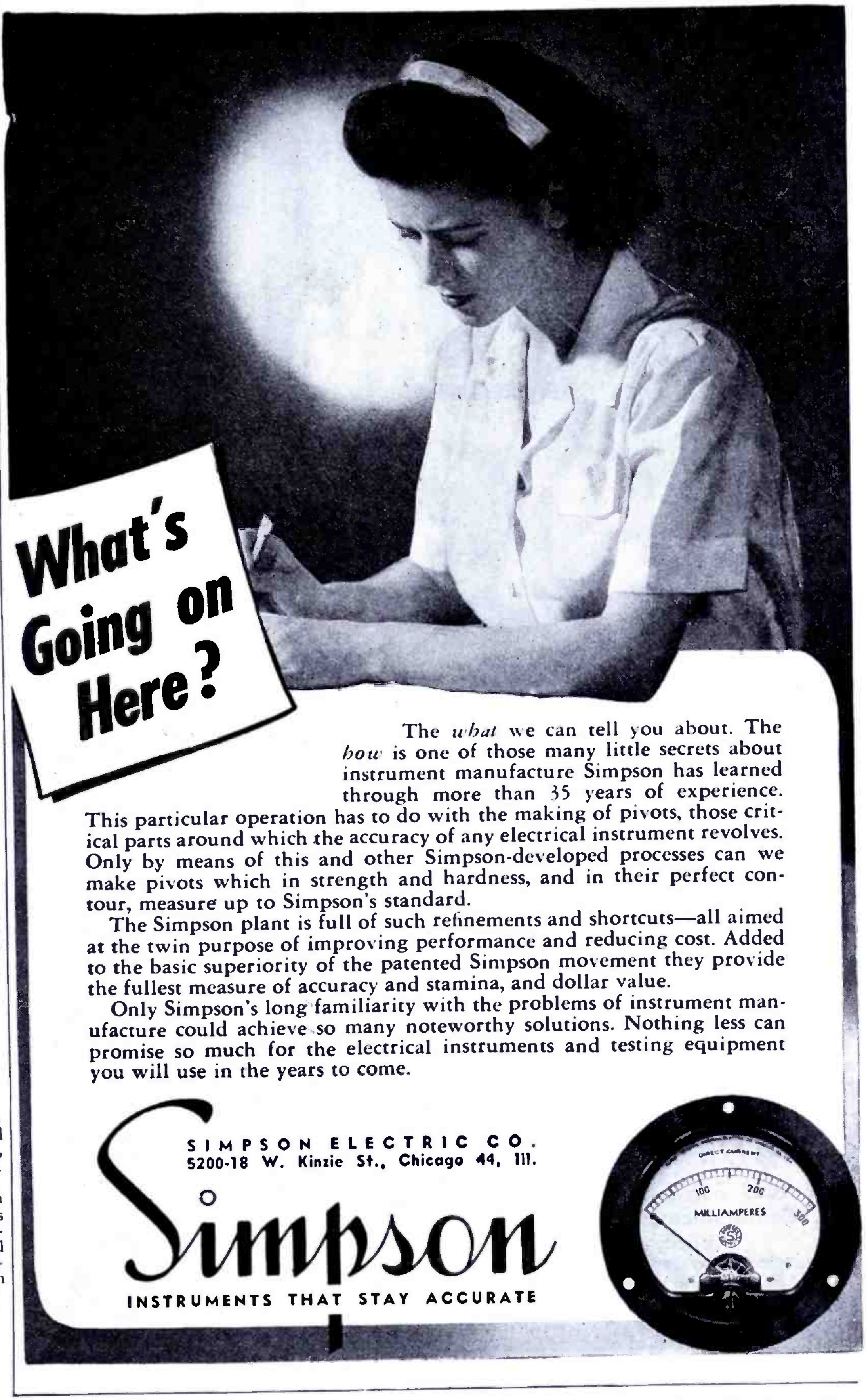
Micron recording instruments known as tele-vac, have just been announced by Precision Scientific Co., 1750 N. Springfield Avenue, Chicago 47, Illinois.

One type MR is said to have a range of 0-500 microns. Gauge is supplied with a special Leeds and Northrup micromax strip chart recorder calibrated directly in microns.

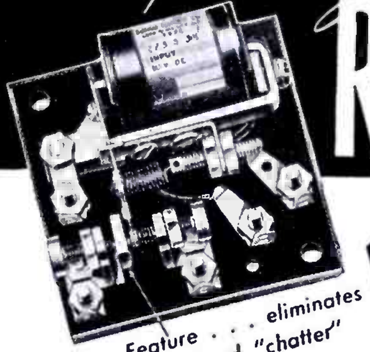
Another recorder, type S, is for ultra vacuum use. It has two ranges, 0 to 500 microns for pressures above 1 micron, and 0 to .4 microns, utilizing the 500 thermal gauge here. Accurate readings are said to be available down to 10^{-6} mm hg (.001 micron). The type S is also said to feature a safety circuit which makes it impossible to turn on the ionization gauge

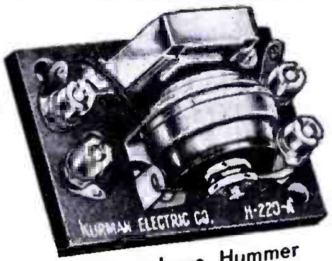
(*Continued on page* 113)





25 YEARS
Specialization in
RELAYS





New Feature . . . eliminates "bounce" and "chatter"

Microphone Hummer

Twenty-five years' experience in solving all types of Relay Problems . . . Complete facilities for Designing, Engineering, Manufacturing . . . Specialists in producing Relays of exceptional power and sensitivity for Aircraft, Intercommunications-Systems, Electronic Devices. Exclusive Kurman features provide greater dependability, longer life, more precise performance . . .

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Our highly trained staff of experts can assist you in the design, engineering, and sale of your product. We are equipped to help you create new, and improve old products; design informative labels; inject new ideas in your packaging and merchandising. We have had thirty years of experience in selling chain stores, department stores and jobbers—have an attractive showroom and office and experienced personnel skilled in checking competition. If you are interested in post-war sales volume and profits, write to:

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We are fully licensed to manufacture the complete BIRTCHER line of locking type, stainless steel tube clamps. Orders placed with us for prompt delivery using BIRTCHER part and identification numbers will be filled at prices as favorable as those to which you are accustomed. All clamps will be identical with those manufactured by the Birtcher Corporation.

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THE INDUSTRY OFFERS . . . —

(Continued from page 111)

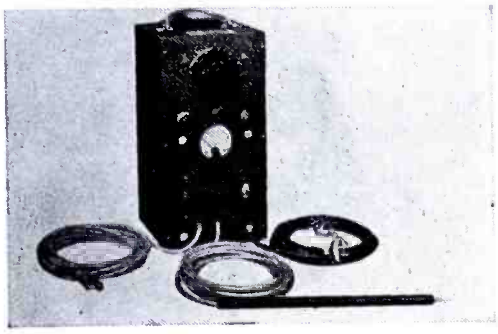
until a vacuum of 1 micron has been reached. Average life of ionization gauge is stated to be 3000 hours.

* * *

DIETZ SIGNAL INDICATOR

A 3-way signal indicator, the Teller, that is said to be continuously self-testing and shock resistant has been produced by Dietz Mfg. Co., 2310 South La Cienega Boulevard, Los Angeles, Calif.

Weight, installed, .64 ounce; voltage, 18-30 d-c; wattage, 1.2; temperature, −75° to +60° F; altitude, to 50,000 feet.

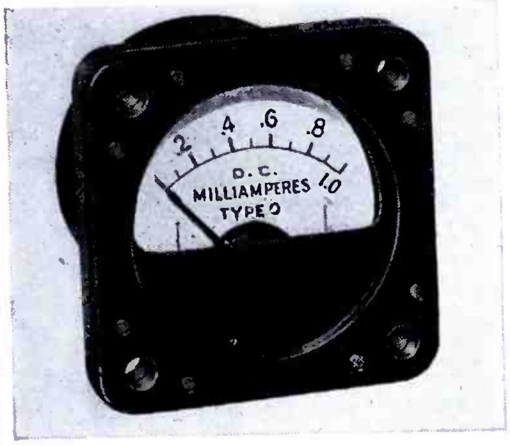


* * *

ROLLER-SMITH 1½" PANEL INSTRUMENTS

A group of 1½" electrical instruments has been developed by Roller-Smith, Bethlehem, Penna.

Available in d-c voltmeters, in all practical ranges above 50 millivolts, and in d-c ammeters in all practical ranges above 500 microamperes.



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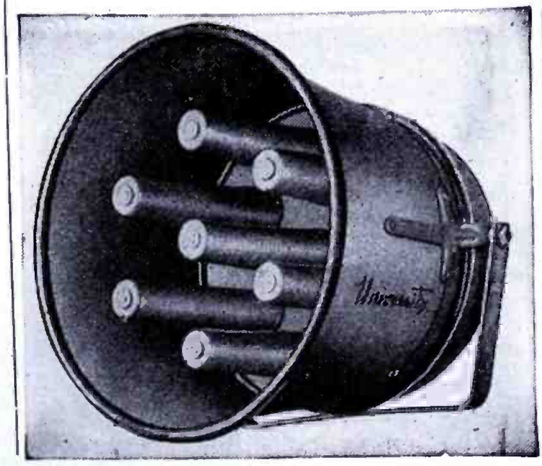
UNIVERSITY LABS MULTI-REFLEX SPEAKERS

Multi-reflex speakers, type AA7, with a capacity of 200 watts have been announced by University Laboratories, 225 Varick Street, N. Y. 14, N. Y.

Designed with 250-cycle low-frequency cutoff, Projector has 7 driver units that are said to be hermetically sealed, and shock and blast proof.



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STAINLESS STEEL - LOCKING TYPE

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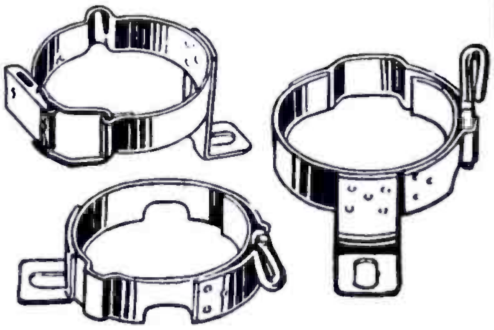
Where vibration is a problem, Birtcher Locking TUBE CLAMPS offer a foolproof, practical solution. For ALL types of tubes and similar plug-in components.

83 VARIATIONS



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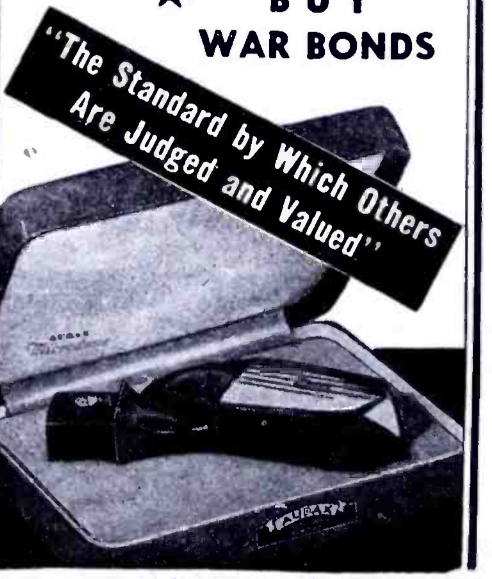

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS — MARCH, 1945*

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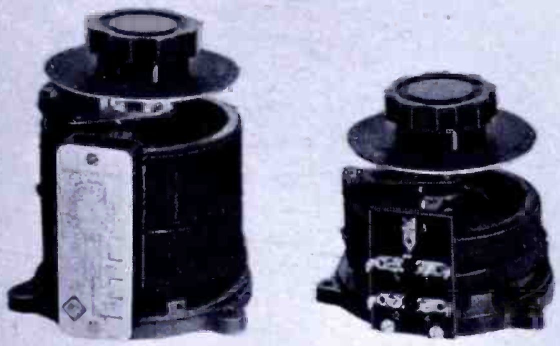
*Due to paper restrictions several advertising pages had to be omitted from this issue.

A NEW VARIAC FOR 400 TO 2600 CYCLES



200-CU 60~ NEW 60-AU 400-2600~

SAME POWER RATING

DESIGNED for an increasing number of applications requiring the control of power at frequencies higher than 60 cycles, this new VARIAC meets the need for a unit for frequencies between 400 and 2600 cycles. It is a companion to the widely used Type 200-A, having substantially the same power rating . . . 860 va; with a load current of 5 amperes, rated, and a maximum current of 7.5 amperes near zero and line voltages.

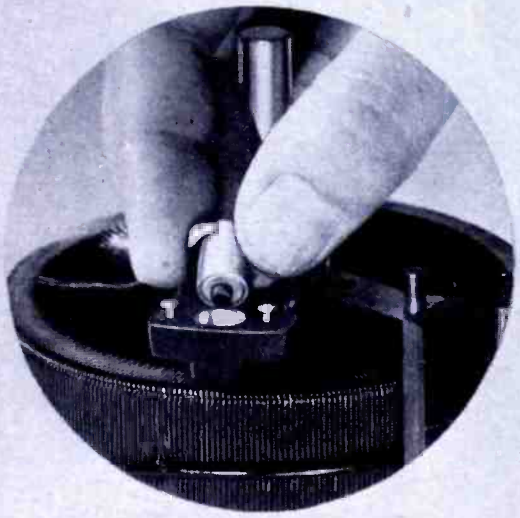
A number of new mechanical features are incorporated in the Type 60-A VARIAC. Included are:

- New unit brush construction requiring no tools for brush replacement and designed to prevent contact between brush holder and winding if the brush wears away.
- Positive rotor contact with NO pigtail.
- Combination screw and solder terminals.
- Fully insulated hollow steel shaft.
- Improved bearings, suitable for motor drive.

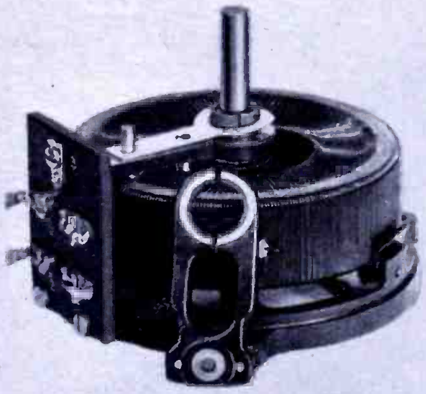
As seen in the photograph, the 60-A VARIAC is considerably smaller than its 60-cycle counterpart. The Type 60-AU is priced at $13.00 and the 60-AM at $15.00.

Because all VARIAC production is scheduled months in advance on high priority war orders for 60-cycle models, these new VARIACS are now available only in sample quantities.

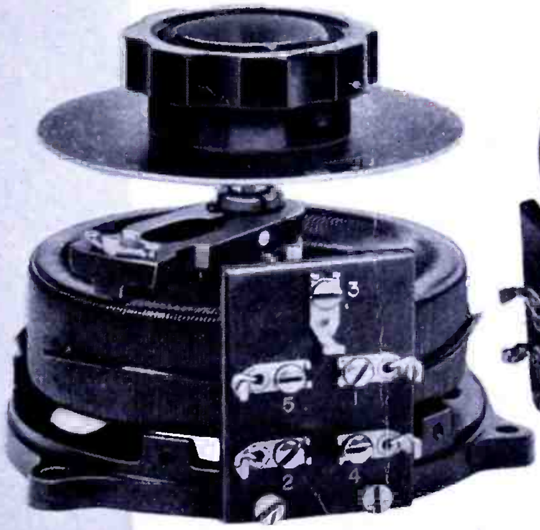
- WRITE FOR BULLETIN 924



UNIT BRUSH — REPLACED IN A FEW SECONDS



POSITIVE ROTOR CONTACT WITH NO PIGTAILS



TYPE 60-AU

TYPE 60-AM

VARIAC

MADE ONLY BY

GENERAL RADIO COMPANY

Cambridge 39, Mass.
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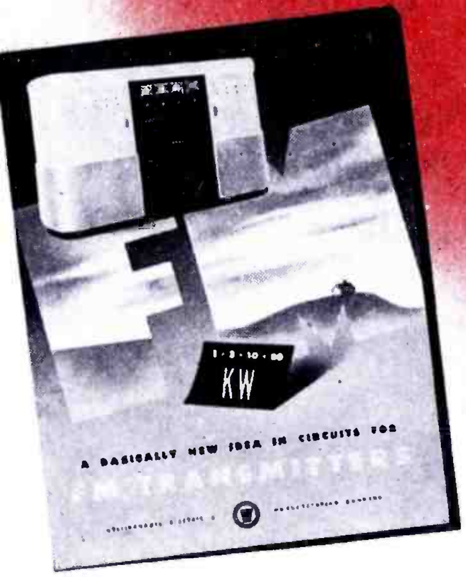
PLUS ALL THE EXTRAS OF SPECIAL WESTINGHOUSE RESEARCH FOR FM



1-3-10-50 KW

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Here in a smartly-styled package is a basically new approach to FM transmitter design . . . combined with all the performance extras of special Westinghouse research for frequency modulation.

Built in 1, 3, 10 and 50 kw ratings, this new design provides direct generation of the modulated carrier by a simple and straightforward circuit. Frequency corrections are independent of critical tuning. Distortion is low.*

Metal-plate rectifiers—first introduced by Westinghouse for high-voltage, high-current AM applications—virtually eliminate outages caused by rectifier (tube) failures. Space and cooling requirements are reduced, operating costs are lowered.

Your nearest Westinghouse office has complete details of this new triumph in FM transmitter design in booklet B-3529. Or write Westinghouse Electric & Manufacturing Company, Radio Division, Baltimore, Maryland.

J-08103

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* For harmonics up to 30 kc/s at ± 75 kc/s swing, distortion is less than 1.5% rms for modulating frequencies between 50 and 15,000 cps.