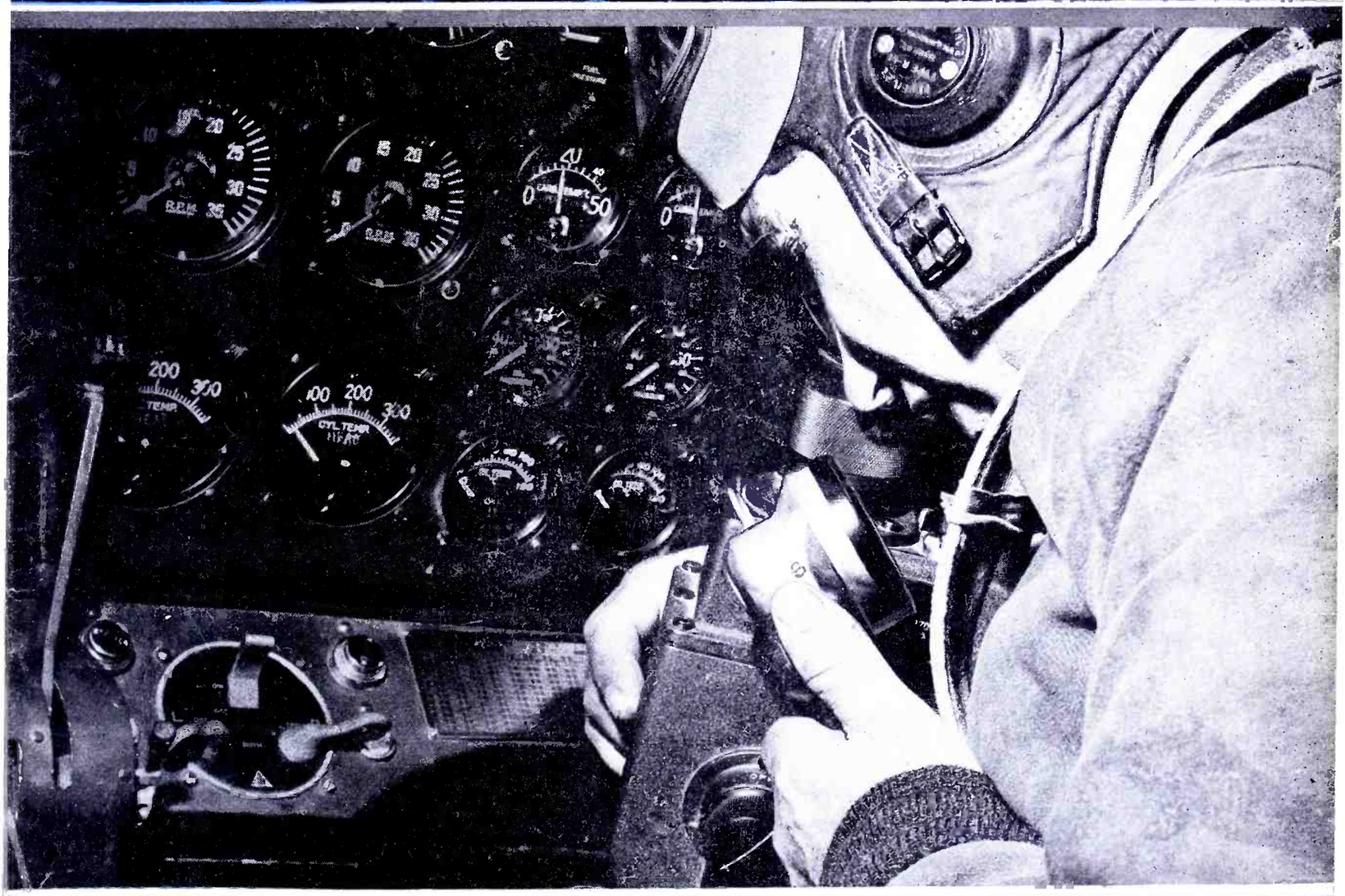
COMMUNICATIONS



APRIL

★ RADIO ENGINEERING
★ CONTROL-ROOM EXPANSION IN WARTIME
★ FREQUENCY CONVERSION CIRCUITS
★ AERONAUTICAL COMMUNICATIONS
★ MEASURING Q WITH OSCILLOSCOPE
★ TELEVISION ENGINEERING

1945

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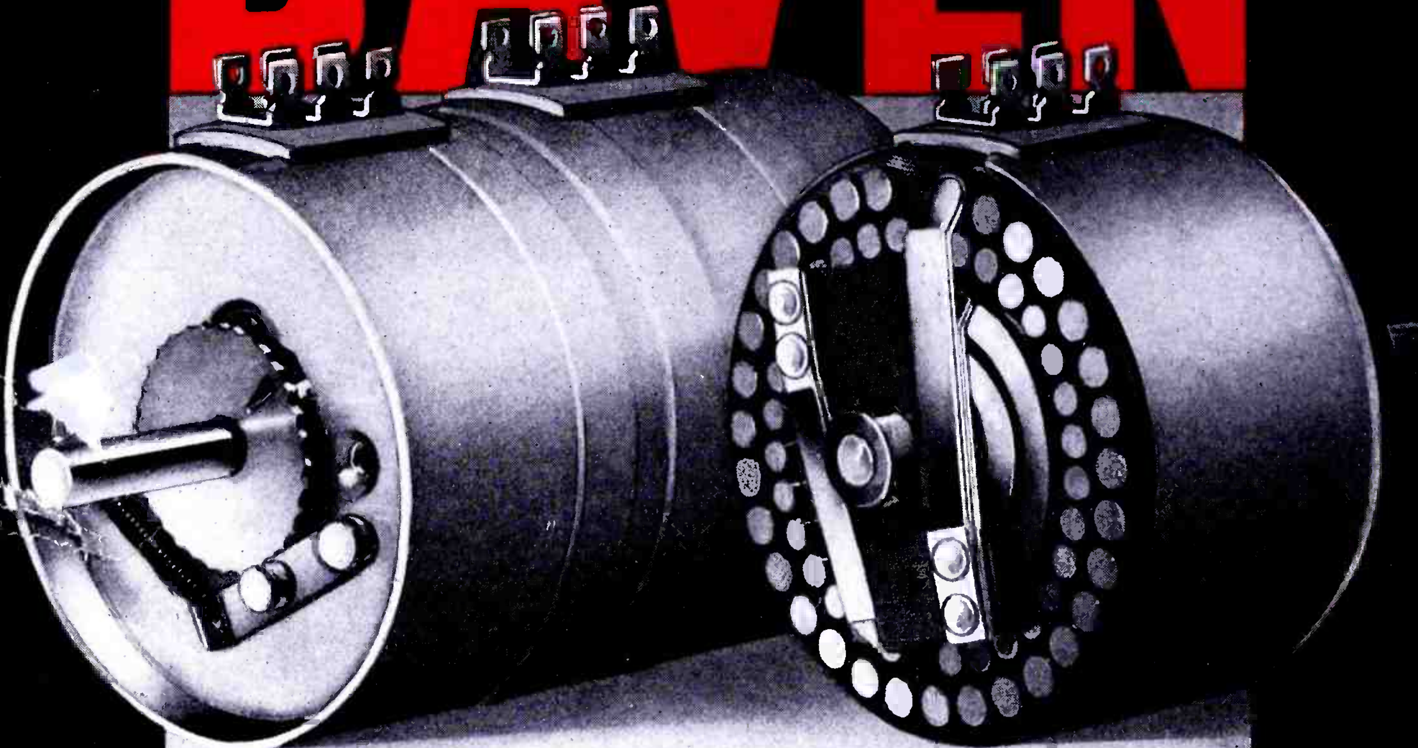
DAVEN



30 to 60 DAY DELIVERY
ON ATTENUATORS

We've progressed a long way from those early war days when, regrettably, deliveries were too often a hope and a promise. While we're not yet back to the luxury of filling many orders from the shelf, present production schedules assure prompt Daven Attenuator deliveries. Some standard models are available in small quantities for almost immediate shipment. 30 to 60 day delivery may be had on average quantities of most standard type Attenuators and many special types not requiring new engineering. Write for details on your specific requirements.

THE **DAVEN** COMPANY
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

NEW FEATURES OF DAVEN ATTENUATORS

NEW DETENT GEAR: Large gear and roller mounted in recessed front end of cover, separate from resistive network, gives accurate indexing.

CERTAIN STOP: Extrusions of detent gear and steel attenuator cover form sturdy stop to rotation, eliminating rotor-hub strain of previous method.

IMPROVED SHIELDING: Sturdy, snug-fitting steel cover affords superb electrical and dust shielding, and greater all-around ruggedness.

CAPTIVE TERMINAL BOARD: [illegible]

ANTI-FUNGUS TREATED: [illegible]

SILVER ALLOY CONTACTS: [illegible]

SEPARABLE COUPLINGS: [illegible]

SUPPORT THE RED CROSS ROLL CALL IN MARCH

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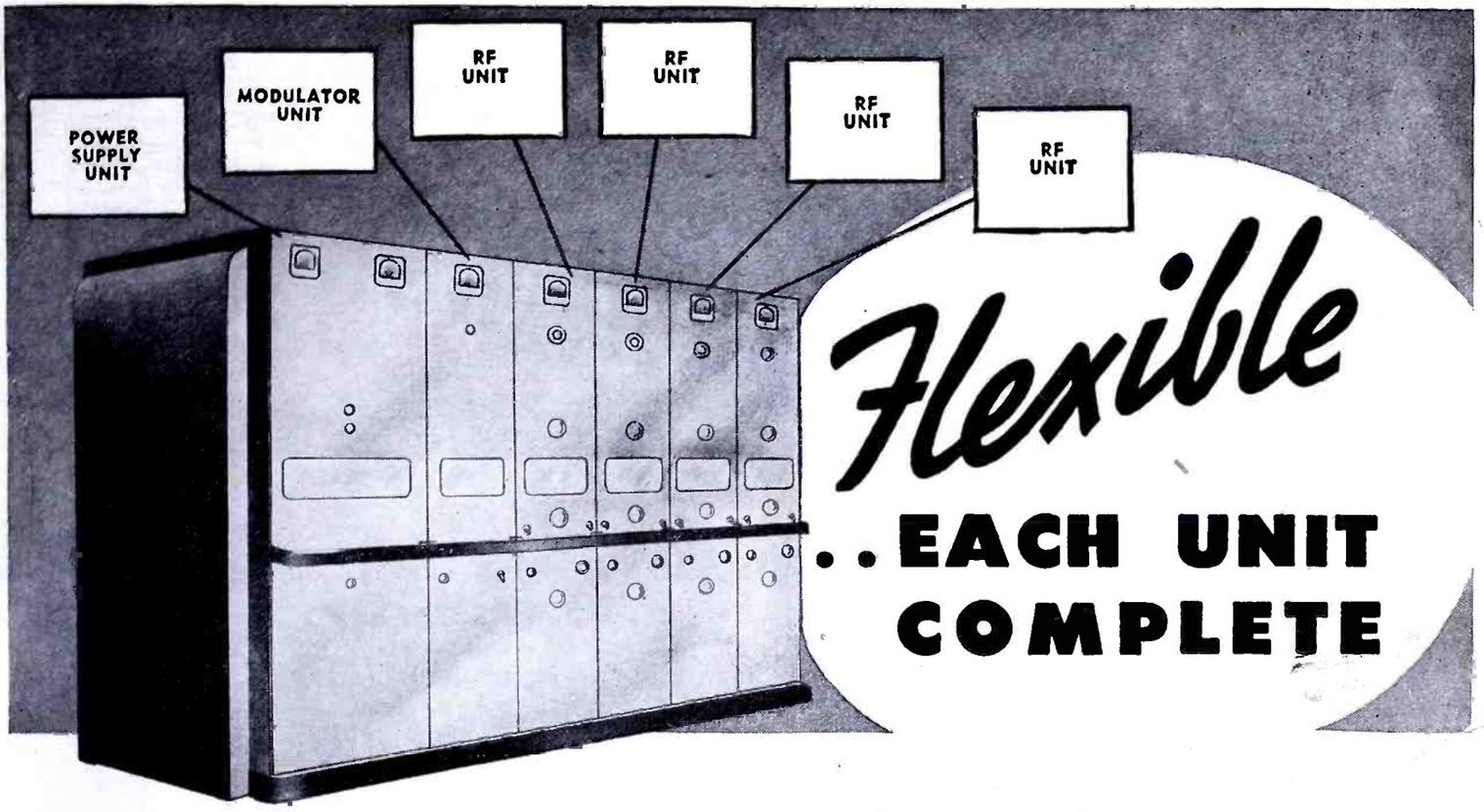

Flexible

..EACH UNIT COMPLETE

NEW SERIES CT-3000

MULTIPLE UNIT GROUND STATION TRANSMITTER

Flexibility is an outstanding feature of the CT-3000 series transmitter. Its design provides for the expanding requirements of a station and offers operational advantages. A station may consist initially only of a power supply, a modulator and one RF unit, being later enlarged by addition of RF units as needed. In operation, simultaneous transmission over several channels is available.

For airway and airport service, this newly designed product of RADIO RECEPTOR engineers and craftsmen represents the most advanced practice. This transmitter is intended for use at an airport for communication between ground and plane, or between two airports of an airway system for both long distance and local communication.

OPERATING CHARACTERISTICS

The transmitter assembly is composed of individual units, one for each RF channel, one for each modulator, and one for the rectifier power supply unit. The RF and modulator units are interwired and connected to operate from the common rectifier power supply unit.

FREQUENCY RANGE—2 to 20 mc. RF units are supplied with coils and capacitors to operate at a single specified frequency and output load. Components are available for operation on any other frequency and output load impedance within the limits specified.

POWER OUTPUT—2.5 KW continuous, 3 KW intermittent service.

FREQUENCY CONTROL—Low temperature coefficient crystal control at a sub-multiple of output frequency.

RF LOAD IMPEDANCES—Grounded or balanced transmission line loads—50-700 ohms. Loading inductor or series condenser available on special order for working directly into reactive antenna.

TYPE OF TRANSMISSION—A-1 (CW Unmodulated telegraph), up to four simultaneous channels: or A-3 (telephone Modulated carrier), up to two simultaneous channels.

MODULATION—High level modulation of RF power amplifier by means of Class B audio modulator.

NOISE LEVEL—Carrier noise 40 db. below 100% modulation.

KEYING—High speed (200 words per minute) electronic keying standard. Slow speed keying of oscillator available on special order.

POWER SUPPLY REQUIREMENTS—230 volts 50/60 cycles, 3 phase.

Also available in output powers of 1 and 5 KW. Circular on request.

ARMY E NAVY

RADIO RECEPTOR COMPANY, Inc.

251 WEST 19th STREET **NEW YORK 11, N.Y.**

Engineers and Manufacturers of Airway and Airport Radio Equipment

SINCE 1922 IN RADIO AND ELECTRONICS

www.americanradiohistory.com

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

We See...

THE ACCELERATED TREND TOWARD RADIO as the dominant medium of world-wide *communications* has provoked intense Congressional interest. Congressional committees have heard testimony on the flexibility of radio, its economical forms of operation and its speed of transmission. Currently a subcommittee of the Senate Committee on Interstate Commerce is conducting hearings on international communications to determine its global applications, frequency assignments, and particularly means of operation and control.

Press groups who have become extremely interested in the art and its application to news transmissions, are seeking extra channels and independent control for their activity. They emphasize that modern needs for high speed; multiple-address press; voice, photo and facsimile transmission; and direct circuits to various parts of the world, demand a global radio communications system that will enjoy all the privileges of the free American press.

THE INCREASED USE OF U-H-F AND S-H-F radio circuits for commercial traffic has also prompted many unusual projects. Western Union, for instance, is planning the installation of 2,000 to 11,372-mc radio links between Camden and New York to study traffic control. In their application to the FCC, they said that . . . "Information now available leads us to believe that radio-relay systems, operating in the u-h-f and s-h-f ranges, will provide very reliable transmission at a cost which will make it economically practical to use them between the major traffic centers throughout the country."

NEARLY 50% OF THE NATION'S STATIONS are operating on low-power today, according to data prepared by the FCC. There are 406 stations using 250 watts, unlimited; 12 with 250 watts, limited; 5 with 250 watts, sharing time; 11 with 100 watts night, 250 watts day, unlimited; and 1 with 200 watts, limited time.

Most plan to use increased power as soon as possible!

THE ALL-IMPORTANT RADIO TECHNICAL COMMISSION FOR AERONAUTICS has initiated an intensely thorough research program. Three major technical committees have already been appointed. These committees will study airborne navigation and communication; ground navigation and communication; and test procedures and standards. Dr. J. H. Dellinger of the Bureau of Standards, is chairman of the Commission.

Significant progress is in the offing for *aeronautical communications*. THE IRE BUILDING FUND needs your support. We urge you to contribute now.—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.

APRIL, 1945

VOLUME 25 NUMBER 4

COVER ILLUSTRATION

Interphone communications system on a combat plane. (*Courtesy Western Electric*)

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

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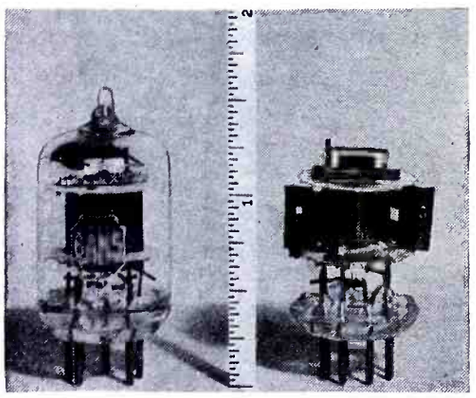
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

APRIL — *Published in the Interests of Better Sight and Sound* — 1945

Miniature Pentode Designed for Use In UHF Circuits

Tube Type 6AK5, a new addition to Sylvania Electric's line, is a miniature sharp cut-off pentode in the short bulb, and is especially suitable for use in ultra high



frequency equipment. Small size and high efficiency make it useful in portable equipment.

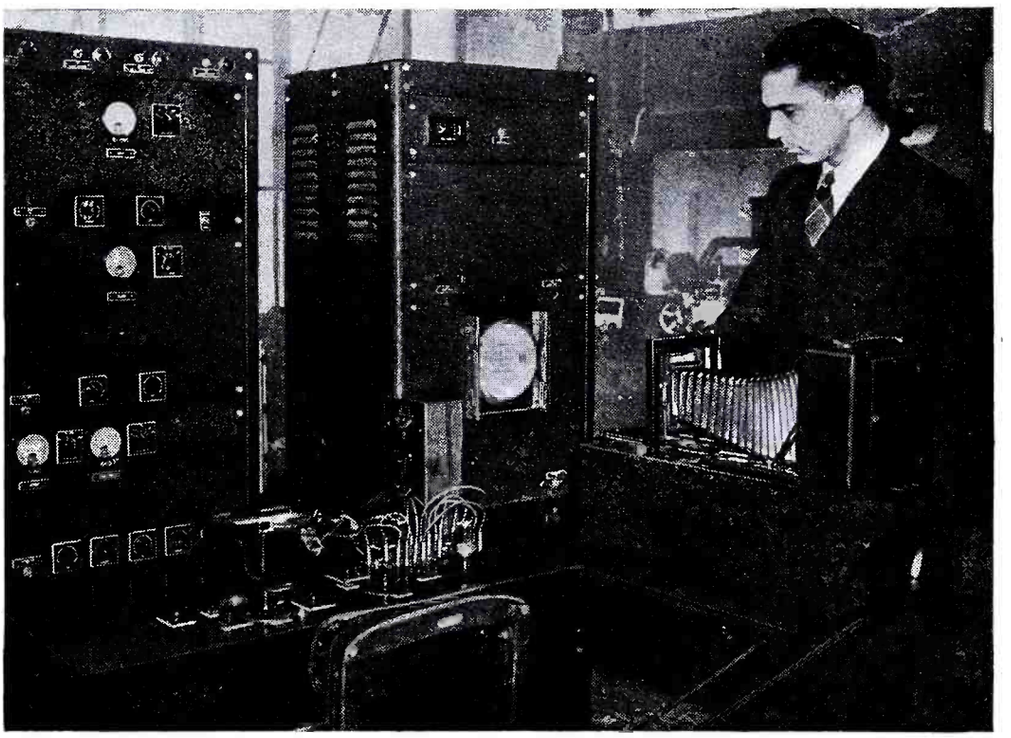
Full technical information may be obtained from Sylvania Electric.

SYLVESTER SURVEY

"Would you say your postwar radio choice would be the large console type or the smaller, table-top model?"

Oscillographic Technique Traces Tube Performance in New Regions

Method Devised by Sylvania Electric Throws New Light on Characteristics



The measurement of tube characteristics in regions where previous test methods were inapplicable has been made possible through the development, by Sylvania Electric, of a new procedure, based on photographing an oscillographic trace.

EARLIER METHODS

Formerly, tube characteristics were taken by a point-by-point method. This was extremely slow, and had the still greater disadvantage that it could be used only in those parts of the characteristics where the tube would not be damaged by continuous operation. In many recent applications, characteristics must be known in regions where a plate or grid would vaporize if left on for even a second.

PHOTOGRAPHIC RECORDING

The new technique permits taking of characteristics in these regions. The oscillographic trace of the characteristics is shown on a special Sylvania 7-inch cathode ray tube, and may be photographed.

Improved tubes and circuits are expected to result from the use of the new method, equipment for which was built in Sylvania Electric's Commercial Engineering Laboratory.

SYLVANIA ELECTRIC

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.

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

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How many places can you use this VERSATILE CERAMIC?

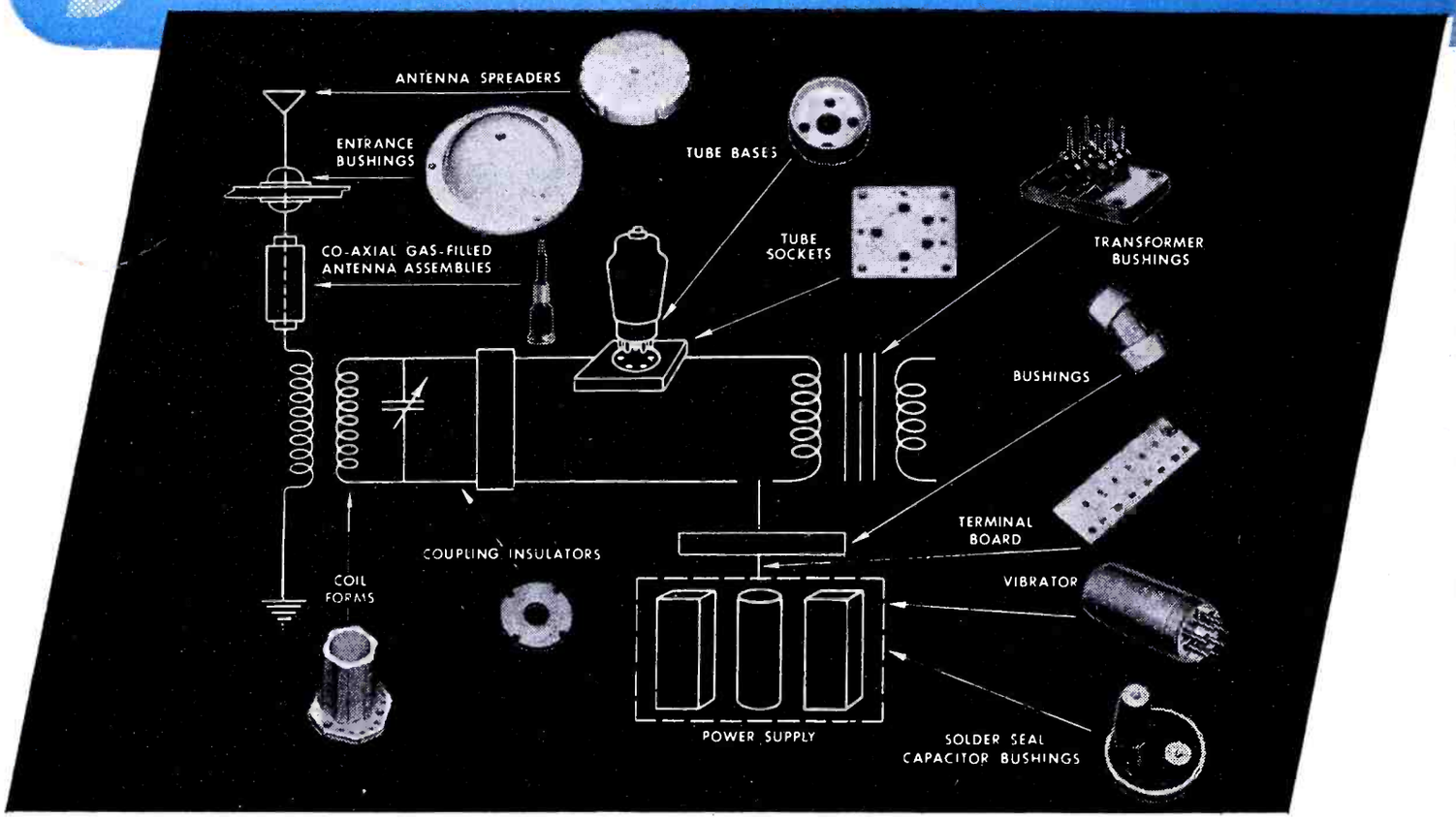

Illustration from Westinghouse book B-3244

NEW HIGH-STRENGTH ZIRCON PRESTITE IMPROVES INSULATION ON EVERY TYPE OF COMMUNICATIONS PRODUCT

This new, strong Zircon Prestite created by Westinghouse brings many advantages to designers and manufacturers of every type and size of communications equipment.

Zircon Prestite is a low-loss ceramic with exceptionally high resistance to thermal and mechanical shock (see table). Combined with the exclusive Westinghouse Solder-Seal process, it provides a gas-tight hermetic seal that excludes dirt, moisture and corrosive atmospheres permanently and maintains dielectric characteristics of enclosed gases regardless of temperature, humidity and pressure cycles.

Your nearest Westinghouse office can give you complete information on the many uses of this versatile Zircon Prestite for modern communications and electronics equipment. Or write Westinghouse Electric & Mfg. Co., P.O. Box 868, Pittsburgh 30, Pa. J-94660

How ZIRCON PRESTITE compares

Property	*Zircon Prestite	High-Tension Porcelain
Specific Gravity	3.68	2.4
Water Absorption in %	0.00	0.00
Dye Penetration	None	None
**Linear Coeff. of Thermal Expansion (20 to 700 deg C) per deg C	4.9 x 10-6	5.3 x 10-6
Tensile Strength, lbs per sq in	12,700	5,000
Compressive Strength, lbs per sq in	90,000	48,000
Transverse Strength, lbs per sq in	25,000	11,000
Impact Resistance (modified Charpy method) in gm per sq cm	17,800	6,000

*Approved as L-4 material by the Army-Navy Electronics Standards Agency.
**This is one of the characteristics that gives Zircon Prestite its remarkable thermal shock properties and warrants comparison with other low-loss, high-frequency ceramic materials.

Westinghouse

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. . . one of many Westinghouse contributions to improve electronic and communication design

Zircon Prestite is just one of many Westinghouse developments to improve modern electronic and communications design.

Weight reduction, high altitude and humidity resistance, greater strength and sensitive measurement are typical of the problems solved by these new Westinghouse developments.

Here is a quick check list of these important products . . . what they are, where to use them, what they will do. Like Zircon Prestite, each possesses characteristics giving designers greater freedom in design.

Your nearest Westinghouse office can give complete data on any of these exceptional communications products. Ask for the book number shown in parentheses on each item.

A QUICK CHECK LIST OF WESTINGHOUSE COMMUNICATIONS PRODUCTS

Hipersil . . .

Hipersil cores—made of new electrical steel with 1/3 greater flux-carrying capacity—eliminate time-wasting stacking of tissue-thin core laminations by hand. Available in 3 types for low to very high frequencies, pre-assembled Hipersil cores are delivered in two ready-to-assemble pieces for each core. (B-3223-A)

Dynamotors . . .

Smooth, functional design gives Westinghouse dynamotors high flexibility for radio equipment where space is precious. Lightweight and compact, these long-lived dynamotors are supplied for input ratings from 12 to 28 volts. (B-3242)

Capacitors . . .

Light weight, small volume and high reliability are advantages of Westinghouse Inerteen Capacitors for d-c service at 400 to 250,000 volts. Aluminum foil electrodes, noninflammable Inerteen and Westinghouse Solder-Sealing give these capacitors outstanding performance values. (B-3300)

Insulating Materials . . .

Westinghouse "Tuffernell" Insulating Materials will supply the *right* grade needed for numberless communications jobs. Backed by more than 50 years of field tests, these materials are adequately tested and proved for every application. (B-3322)

Electronic Tubes . . .

Uniform, trouble-free, long-life service of electronics equipment depends to a high degree on the tube itself. Westinghouse electronic tubes are made with complete quality control in every stage of production for the complete Westinghouse line . . . Pliotrons, Kenotrons, Phototubes, Thyratrons and Ignitrons.

Instruments . . .

Westinghouse instruments range in sizes and types from miniature panel instruments to 4-foot boiler room indicators for all types of mountings—round, wide-flange; round, narrow-flange; rectangular; and American War Standard. (B-3283)

EQUIPMENT FOR THE COMMUNICATIONS INDUSTRY

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Portrait of a man who no longer cares about the cigarette shortage, the meat shortage...or gas shortage!

It's just a question of time when all shortages will be replaced by plenty —thanks to this boy and to millions like him.

Give them a helping hand.
Buy Bonds — Donate Blood.

We, the management and employees alike, at Kenyon, are building better transformers than we ever built before — and building them faster for the armed forces

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc.

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NEW YORK, U. S. A.

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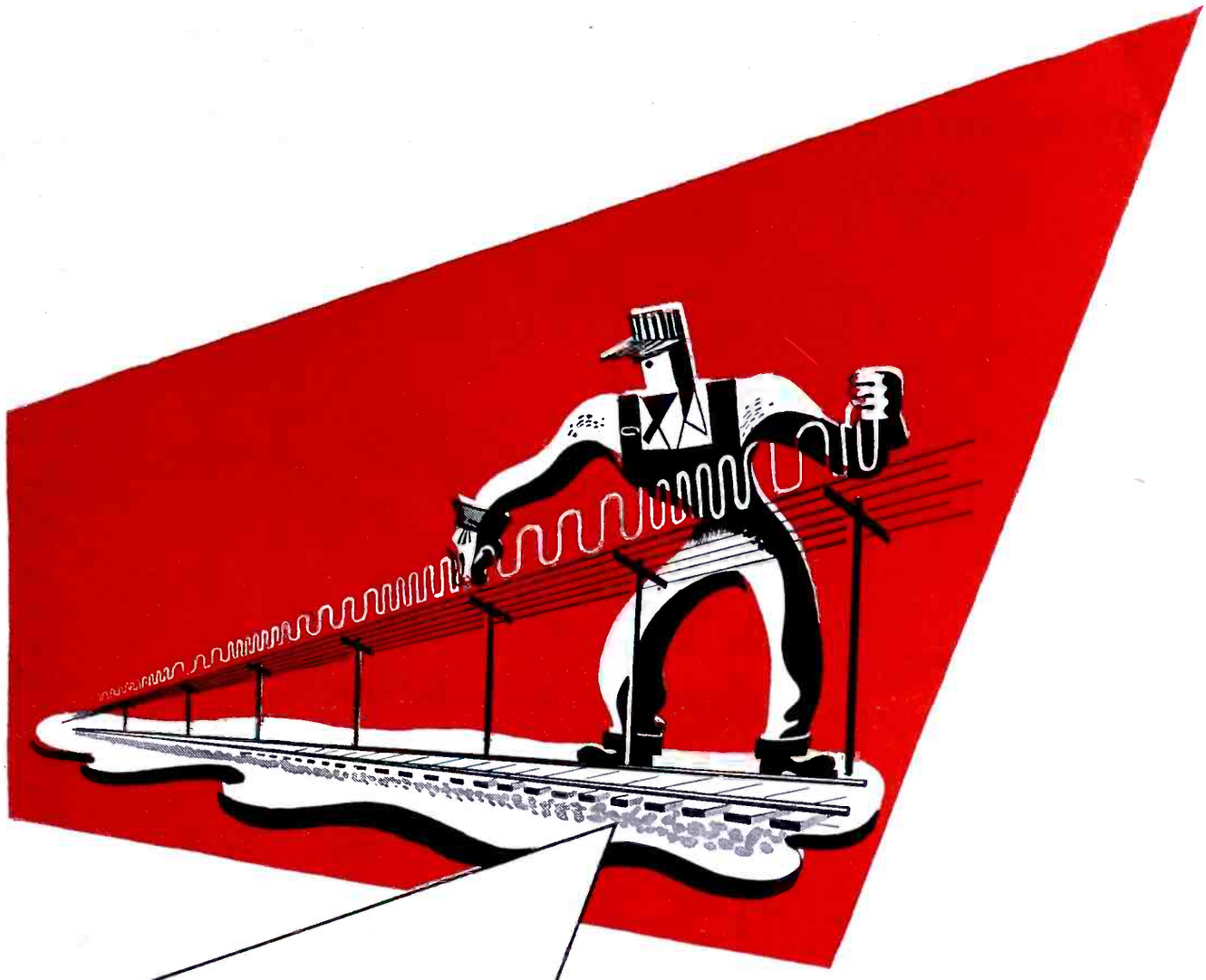

FM carrier induction

Adapting the principles of radio to train communication is a simple matter—up to a point. Standard space radio equipment will do in a pinch. But railroads necessarily demand more than adaptations. A coordinated system, for one thing; reliability of performance for another; and the privacy of wire lines. **Aireon** engineers tackled the problem and came up with an FM carrier-current system that makes use of the wayside wires. Communication with trains is established by inductive means. Performance is of telephonic quality. Equipment and operating costs are self liquidating. The first **Aireon** FM carrier induction system was installed on the Kansas City Southern Railway, where it is in daily operation. Similar installations have been made on other railroads. All have proved their dependability. Creative engineering of this nature has contributed to the steady growth of **Aireon** in the electronics field. Behind it is a type of thinking that gets things done. We'll show you what we mean any time you say.

Aireon

MANUFACTURING CORPORATION

Formerly *AIRCRAFT ACCESSORIES CORPORATION*

Radio and Electronics • Engineered Power Controls

NEW YORK • CHICAGO • KANSAS CITY • BURBANK

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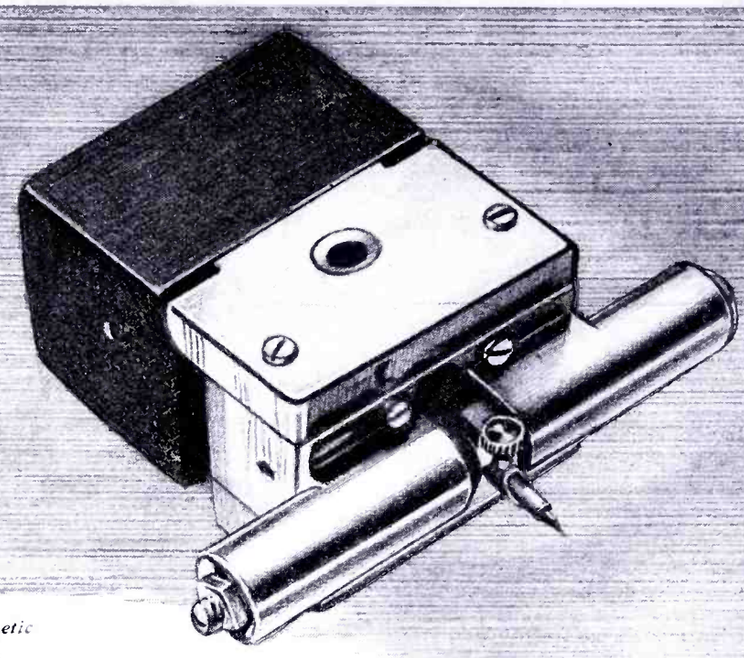
SOUND EQUIPMENT – *precisionized* – mechanically and electronically – *for finer performa*



No. 541 Magnetic Cutterhead

Fairchild Portable Recorder

Freedom from Distortion . . . *less than 1% at 400 cycles*

Laboratory tests measure a distortion freedom of less than 1% when a 400-cycle note is recorded . . . with a Fairchild No. 541 Magnetic Cutterhead . . . at a level of + 18db (reference .006 watts) to produce a stylus velocity of 2.5 inches per second.

Exceptional design and precision skill has produced a magnetic cutterhead that successfully damps the moving armature — through the use of unusually long cushion blocks and a positive means of adjusting and maintaining the armature in correct balance.

The result is the long sought *correct bass response* that remains free from distortion while producing the finest possible full volume recordings up to 8,000 cycles.

When mounted in a Fairchild adapter, the No. 541 Magnetic Cutterhead also provides a sapphire advance ball on swivel mount that permits instant change from "in-out" "out-in" cut direction . . . a micrometer-threaded screw contr of cut depth . . . and an easily accessible screw adjustme of the cutting stylus angle.

Standard with the No. 539 Fairchild Recorder, the ou standing performance and operating qualities of the No. 54 Magnetic Cutterhead are now available to all owners earlier Fairchild portable models and many other typ of recorders.

Descriptive and priority data are available. Address *Ne York Office:* 475 - 10th Avenue, New York 18; *Plant:* 88-0 Van Wyck Boulevard, Jamaica 1, N. Y.

Fairchild CAMERA AND INSTRUMENT CORPORATION

SOUND EQUIPMENT

www.americanradiohistory.com

MF-66 Glass base material is ready! Material, facilities and techniques are at last available for the production in quantity of the new Formica grade which is superior to all other grades in low losses at high frequencies. This material, created to extend the useful working range of laminated plastics, is ready for prompt shipment to high priority customers.

THESE ARE ITS CHARACTERISTICS:

MECHANICAL STRENGTH
(average values)

TENSILE (non-directional)	FLEXURAL (flatwise)	COMPRESSIVE (flatwise)
10,000 P.S.I.	14,000 P.S.I.	42,000 P.S.I.

WATER ABSORPTION
(average values)
24 HRS. IMMERSION AT 25°C
SAMPLE: 3" x 1" x 1/8"
0.15%

DIELECTRIC STRENGTH
(average values)
SHORT TIME METHOD
1/16" SHEET
450 V.P.M.

DIELECTRIC PROPERTIES
(average values)

POWER FACTOR			DIELECTRIC CONSTANT		
1 kc.	1 mc.	30 mc.	1 kc.	1 mc.	30 mc.
.015	.011	.018	4.9	4.7	4.6

Grade MF-66 is recommended for radio and radar coil forms, antenna bases, terminal strips and molded parts.

Fungus resistance of MF-66 is outstanding due to the absence of cellulose. The material is readily machinable to close tolerances into strong, shock-resisting insulating parts. Its low water absorption insures high electrical and dimensional stability in humid climates. Ask for quotations!

THE FORMICA INSULATION COMPANY
4635 Spring Grove Ave., Cincinnati 32, Ohio

FORMICA

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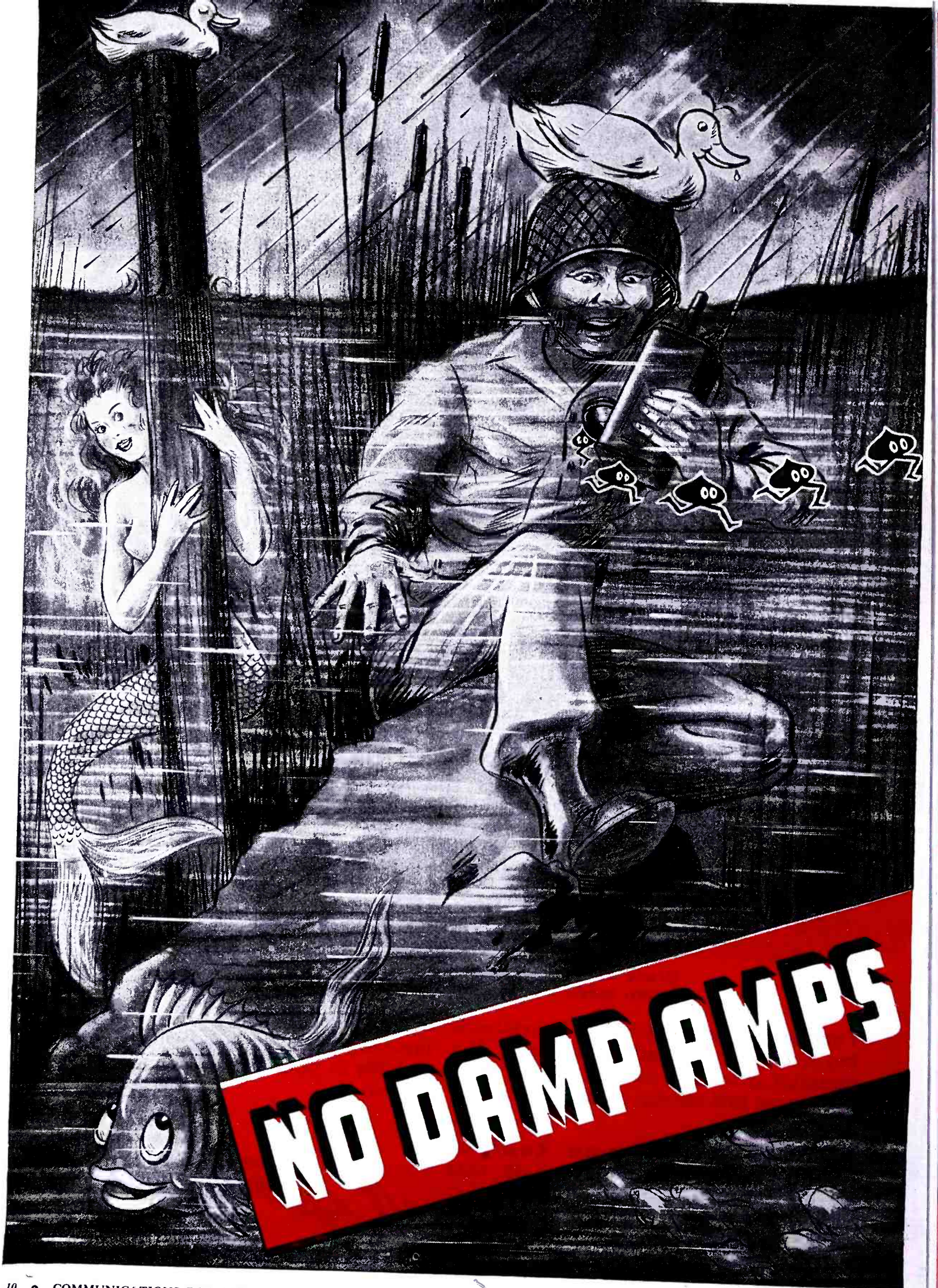

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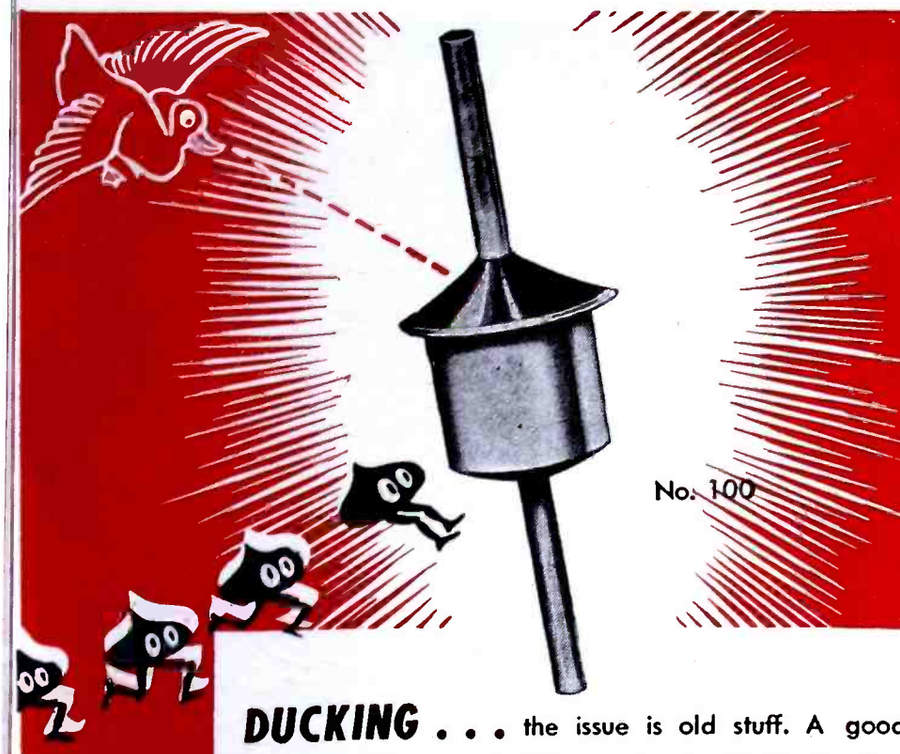


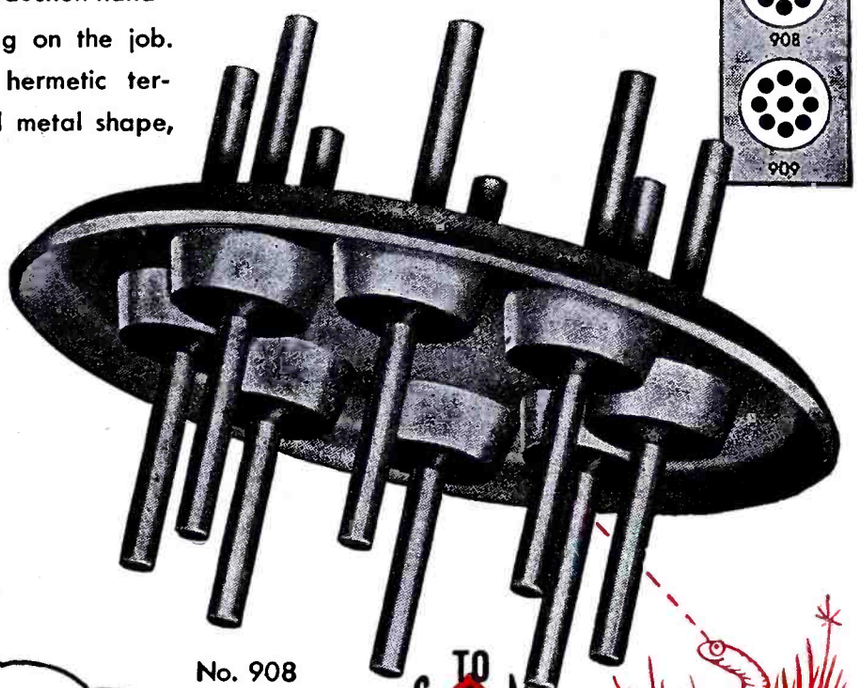
Fusite terminal panel used as cover for container. A single sealing operation.

Hole punched and adapter socket formed to receive Fusite terminal panel.

No. 100

No. 100 SINGLE FLANGE DIAMETER 5/16" (App.)	700 SERIES 1" DIAMETER (.952)	900 SERIES 1¼" DIAMETER (1.235)
INSERTS IN ⊙ 3/16" HOLE	702	902
	703	903
	704	904
	705	905
	706	906
	707	907
		908
		909

DUCKING . . . the issue is old stuff. A good ducking can spell *finis* for electronic equipment. When moisture wades in, the best transformer, coil, relay fold up. Protect them with **FUSITE** Hermetic Terminals. **FUSITE** keeps out the wet and seals in the dry. No damp amps are the positive result, regardless of outside atmospheric conditions. Time, place and temperature can be discounted. This means dependable performance. **FUSITES** pass the tough thermal shock test of dry ice to boiling water. They withstand production handling in your plant and manhandling on the job. **FUSITE** is an inorganic-insulated, hermetic terminal interfused within a reinforced metal shape, all in one piece. One and only one sealing operation is required to provide a perfect hermetic seal. **FUSITE** saves parts and labor, downs costs, ups production and helps to guarantee the performance of your electronic component parts. Look for this mark FUSITE stamped in every seal. It is your guarantee of "proved performance." Write for samples on your business letterhead.



No. 908

WITH FUSITE SEALS

A "GI" AMP,
OUT ON A PRANK,
IS GOOD FOR NOTHING-REALLY!
WET MAKES HIM HIGH,
SO KEEP HIM DRY,
"MP"-WITH *FUSITE SEALING!*

GLASS TO METAL

FUSITE

HERMETIC TERMINALS

NO DAMP AMPS!

CINCINNATI ELECTRIC PRODUCTS COMPANY

CARTHAGE AT HANNAFORD, NORWOOD,
CINCINNATI 12, OHIO

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www.americanradiohistory.com

WARD LEONARD ANNOUNCES

A NEW RELAY

This plug-in relay is a modification of a popular Ward Leonard type now used in small radio transmitters, aircraft control circuits and for similar applications. It is enclosed in a dust-proof cylindrical metal case (2 1/16" x 3⅛") rigidly supported against shock and fitted with standard octal base. Operates on standard voltages up to 115 V., AC and DC. Double pole, double throw contacts. Write for price list and further particulars

WARD LEONARD ELECTRIC CO.

Radio and Electronic Distributor Division

ARMY E NAVY

53 WEST JACKSON BLVD., CHICAGO, ILL.

WL **WARD LEONARD**
ACCEPTED MEASURE OF QUALITY

RESISTORS
RHEOSTATS
RELAYS

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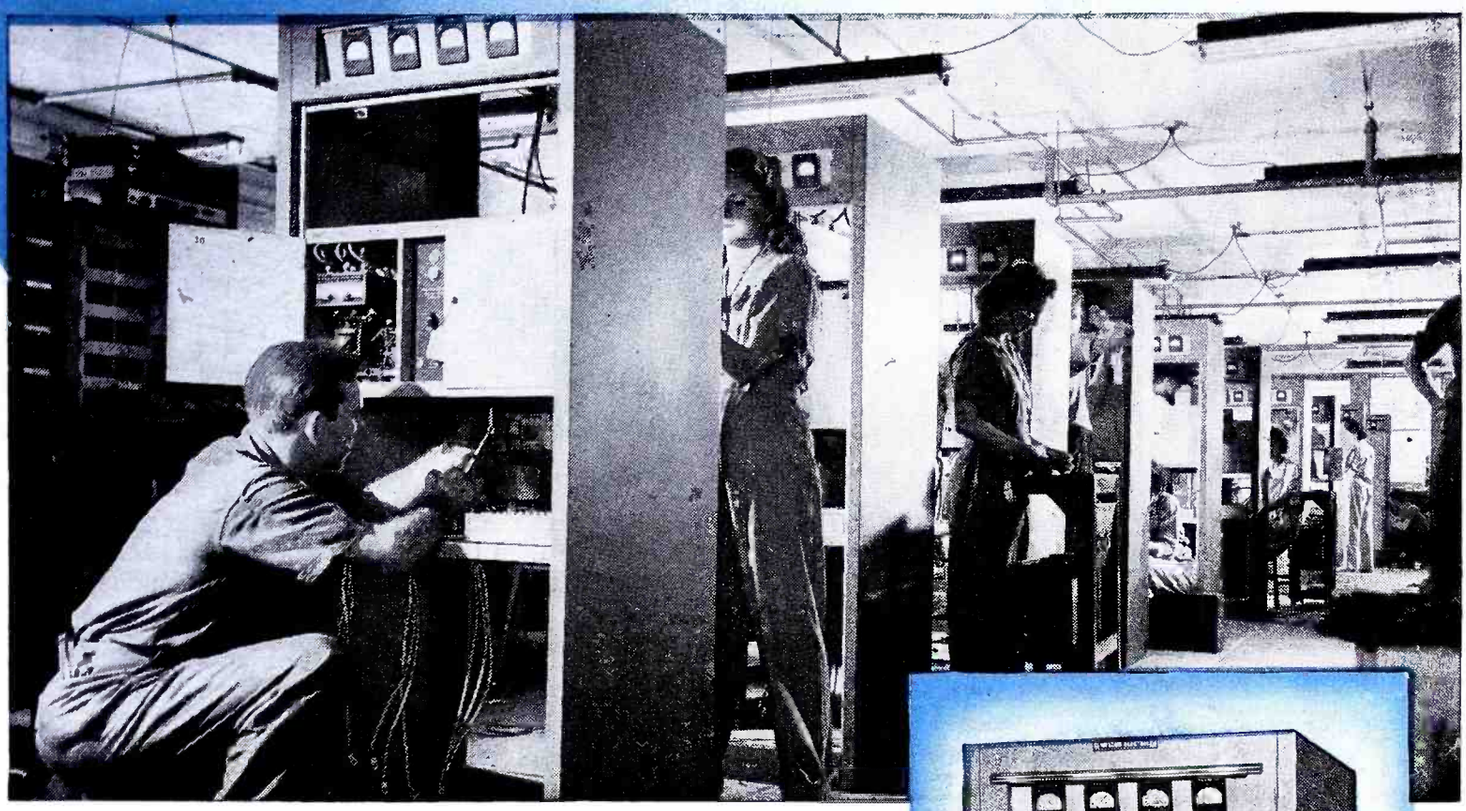
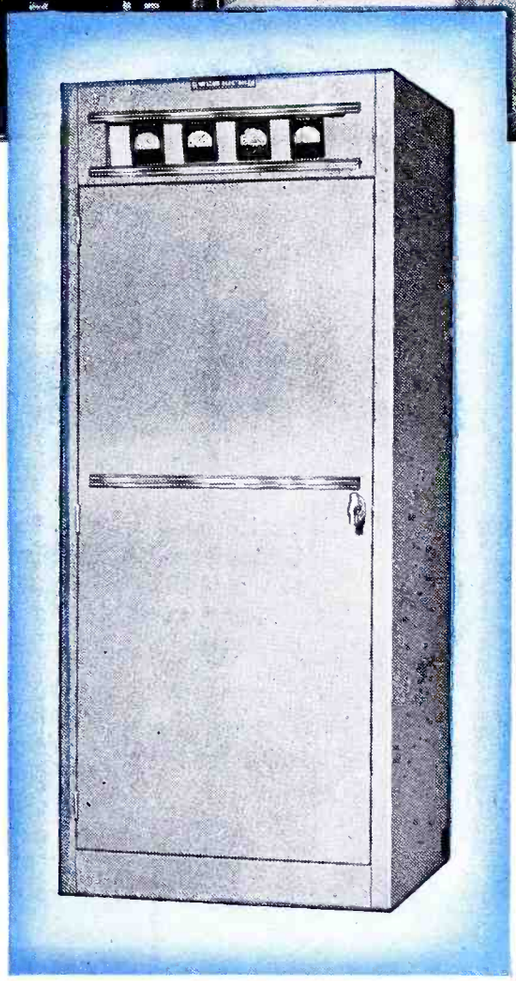
"Line Production" Experience IN RADIO MANUFACTURING



From Wilcox's war experience, as one of the largest manufacturers of radio communications equipment, has come many new products . . . a completely modern mass production factory . . . a trained engineering staff . . . plans and the knowledge needed for both war and peacetime products of highest quality. Look to Wilcox for leadership in radio communications equipment!



Model 50A Modulator — The 1600 watt 50A Modulator, shown at right, may be used for transmitter modulation, or high-powered audio needs.

WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

FOURTEENTH AND CHESTNUT — KANSAS CITY, MISSOURI

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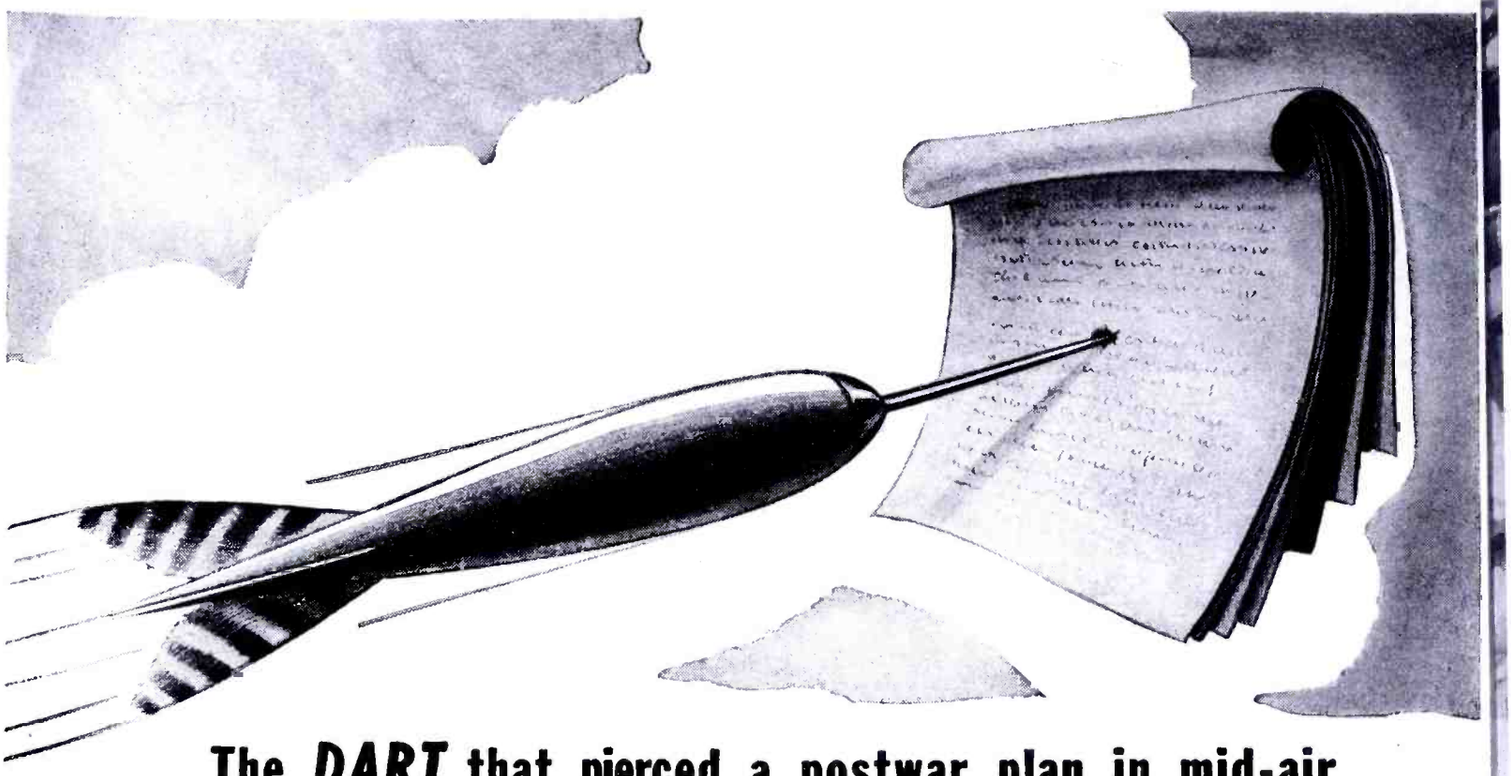

The *DART* that pierced a postwar plan in mid-air

Coming in to work on the bus each morning, the man read his newspaper. This morning was no exception. And he smiled to himself as he read the headlines. *Americans Hammering Germany from the West . . . Russians Closing In from the East.* That sounded good. The war would soon be over . . .

As he put away his topcoat and hat, the feeling of satisfaction clung to him. ". . . well, soon as we lick Germany . . ." and he mentally surveyed his own postwar plan.

Even at noontime, when the people of the plant were to be addressed by a young veteran just back from the Pacific, the man was still optimistic. He listened attentively to the stories of brave men and strange lands.

- The khaki-clad youth told his audience about the islands and the jungles and the mountains . . . about fighting and living conditions.
- Calmly, he spoke of the basic nature of the Japanese . . . how they are taught that it is an honor to die for the Emperor . . . and why few Japanese soldiers have ever surrendered.
- And he told of the resentment among many of the men in the Pacific area about the feeling at home that the war would be over—as soon as Germany was defeated. If that was so, why did hell break loose around them every day?

To the man who had smiled at the headlines that morning, these words were the dart that pierced his postwar plans in mid-air. Of course, he had always been conscious of the fact that we were fighting Japan. But that seemed a matter of cleaning up details . . . and good old MacArthur would take care of them. But now, he wasn't so sure. And he began to think. There was more to go, he reflected solemnly, much more to go . . .

There are many people like this man . . . people who are tempted to forget that Germany's defeat won't mean the end of the war. Military authorities predict that the fight with Japan will be a long, painful struggle . . . perhaps more costly than any we have yet experienced. This, then, is no time for rejoicing. Final victory will be a hard-earned commodity purchased only by consistent working, fighting, sacrificing.

ARHCo — ARMCO PRODUCTS

American Radio Hardware Co., Inc.

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MANUFACTURERS OF SHORT WAVE · TELEVISION · RADIO · SOUND EQUIPMENT

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Cathode Ray Tubes For War and Post-War

AMONG the many types of tubes produced by North American Philips for war purposes is the 5-inch cathode ray tube illustrated here. The problem with this type tube was to produce it in volume with evenly coated screens having no pinholes or other defects.

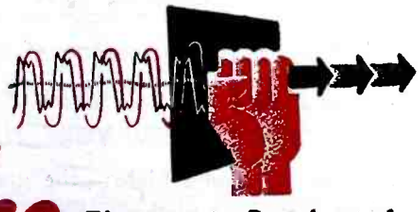
The ability to produce, in volume, NORELCO cathode ray tubes that meet rigid specifications, is the result of experience gained by an organization with a background of over half a century of research and development in the electrical field.

Although NORELCO tubes now go to our armed forces, a list of tube types we are especially equipped to produce will be sent on request.

North American Philips will have post-war facilities available for the development and production of tubes for projection television; also amplifier, transmitting, rectifier and special purpose tubes.

Write today for interesting booklet on "How and Why Cathode Ray Tubes Work" and the brochure describing the background of North American Philips in the science of electronics.

• *When in New York, be sure to visit our Industrial Electronics Showroom.*



Norelco Reg. U.S. Pat. Off.

Electronic Products by

OTHER PRODUCTS: Quartz Oscillator Plates; Searchray (Industrial X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Tungsten and Molybdenum Products; Fine Wire; Diamond Dies.

NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. E-4, 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Div.); Lewiston, Me. (Elmet Div).

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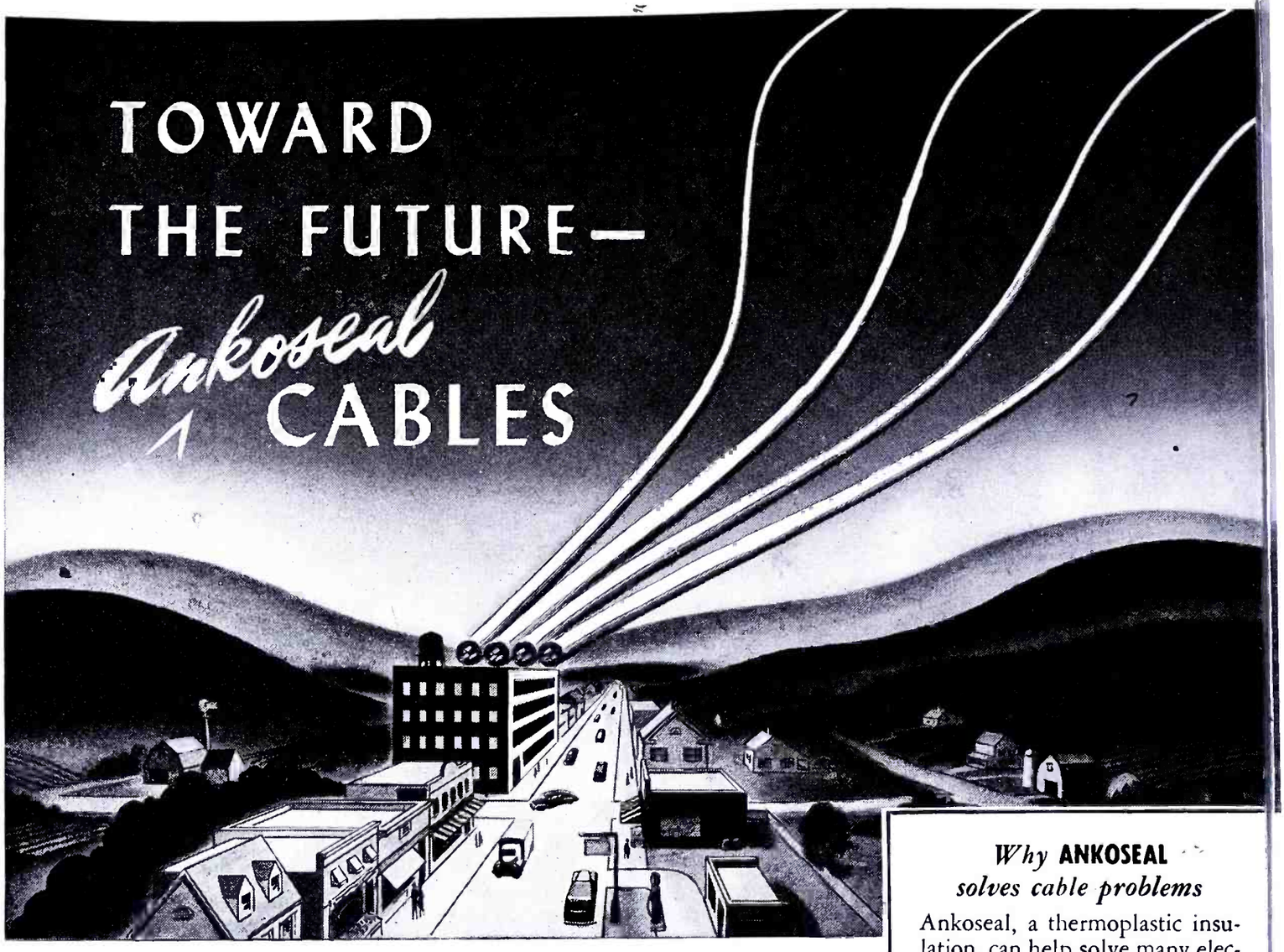

COMMUNICATION—WITHOUT-WIRES—the keynote of the nation's ability to wage modern war—has brought in its train a great paradox: A need for *more and different cables*. And the same needs will extend into the post-war world.

In the solution of the current problems that this need has raised, we at Ansonia, in all modesty, have played no small part. Ankoseal polyvinyl and polyethylene cables have been designed to meet the particular needs of our Army and Navy — needs which, of course, must remain secret, but which involve using *engineering techniques* in the solution of the problems they present.

To other government agencies requiring "fussy" cable jobs, Ansonia offers the "Yankee ingenuity" which has enabled this organization to meet these requirements—accurately and on time. And to business men now and in the post-war world, Ansonia, through its Ankoseal thermoplastic cables, offers the same ability to meet similar problems to their satisfaction.

Why ANKOSEAL *solves cable problems*

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio fields. Ankoseal cables are the result of extensive laboratory research at Ansonia—the same laboratories apply engineering technique in the solution of cable problems of all types.

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

A Wholly-Owned Subsidiary of

NOMA ELECTRIC CORPORATION

GENERAL OFFICES • NEW YORK, N. Y.

—In peacetime makers of the famous Noma Lights—the greatest name in decorative lighting. Now, manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

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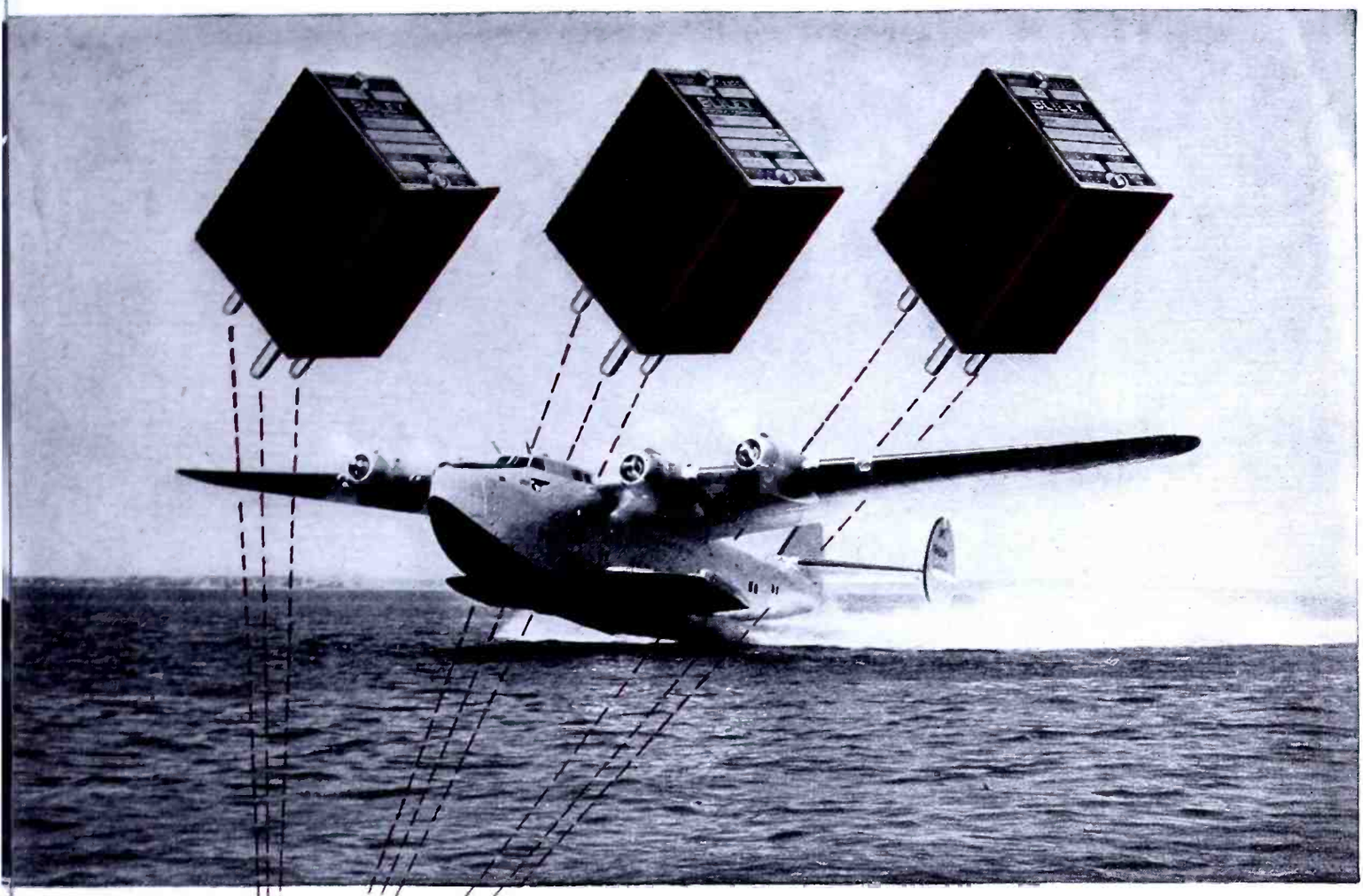
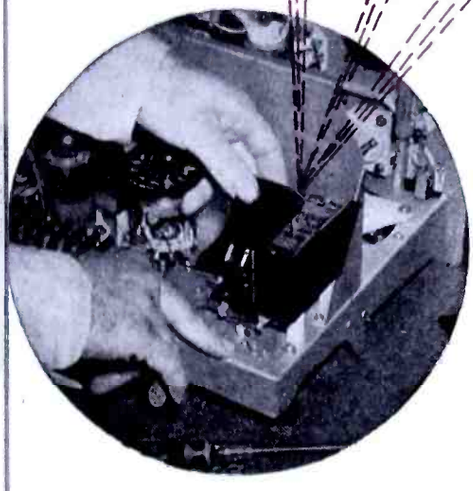


BLILEY CRYSTALS, of course, fly with Pan America



Bliley *acid etched** crystals persistently show up wherever there is an important communications job to be done such as the combination two-way telephone and telegraph and range finder systems of Pan American World Airways. In peace and in war Bliley crystals have flown millions of world-wide miles with their famous Clippers.

Bliley crystals are pre-conditioned for just such rugged assignments. In the Bliley Electric Company plant there is a large section where Bliley *acid etched** crystals receive their pedigree. Here each crystal gets "the works". Its activity and frequency are *proved* under tough laboratory created service conditions of altitude, humidity, temperature, immersion, shock and vibration.

But licking tough assignments is a tradition with Bliley engineers and craftsmen. This background of research and skill has been responsible for the distinguished record of Bliley Crystals in every field of radio communication. Whatever your crystal problem may be—specify Bliley.

✩ *A new star has been added*

ARMY E NAVY

Bliley CRYSTALS

✣ ✣ ✣

**Acid etching quartz crystals to frequency is a patented Bliley process. United States Patent No. 2,364,501*

Do more than before . . .
buy extra War Bonds

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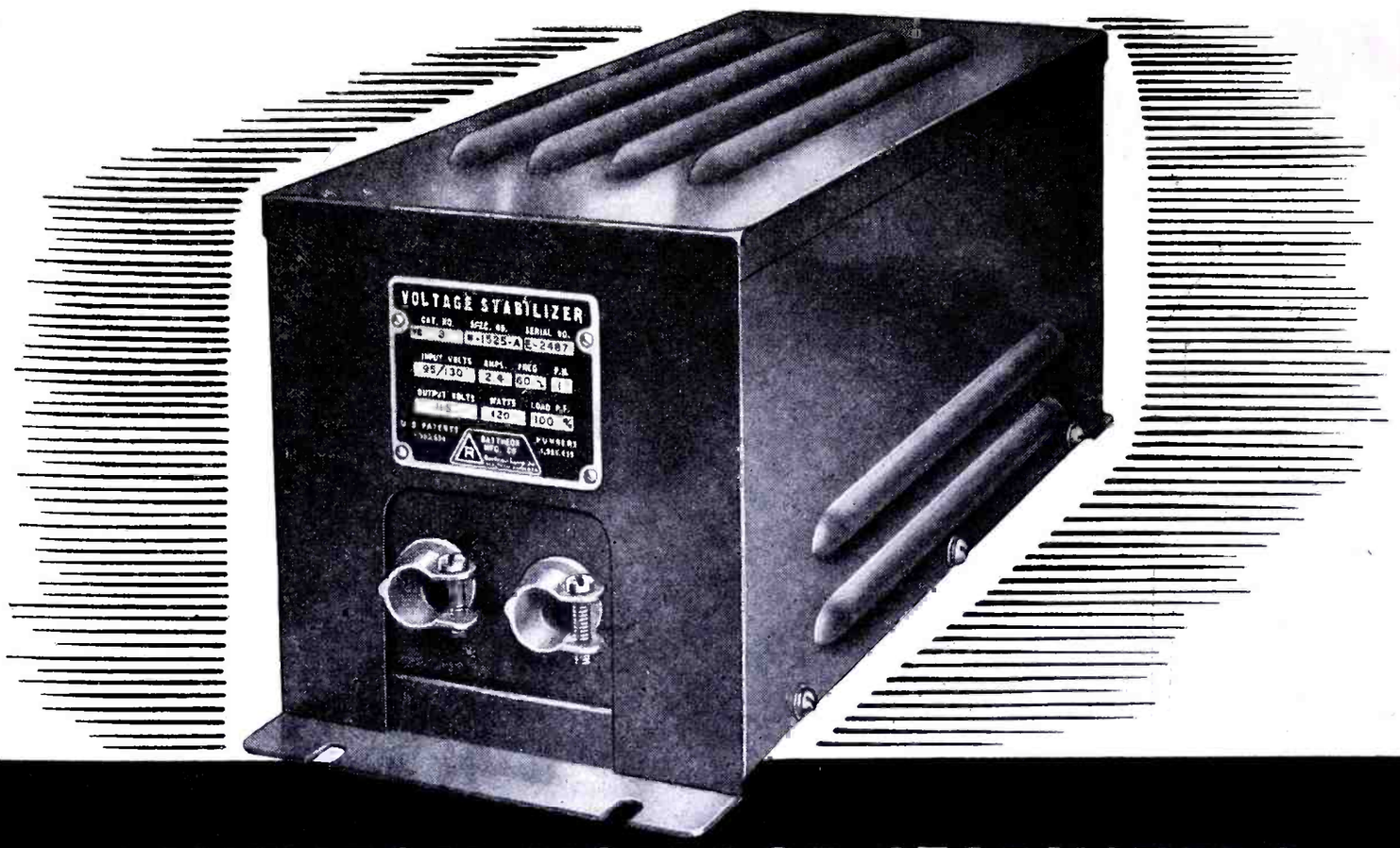


RAYTHEON VOLTAGE STABILIZERS

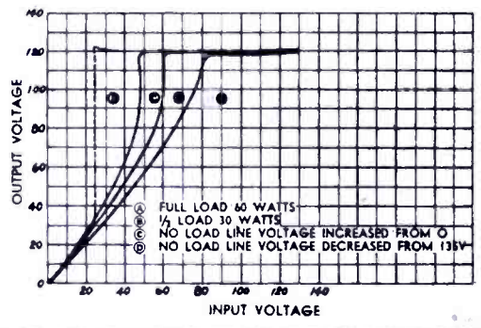
Provide Stabilized Voltage ±½% WITHIN 2 CYCLES

All precision as well as other types of electrical equipment requires steady, uniform voltage for accurate operation. Raytheon Voltage Stabilizers meet this need by providing accurately controlled voltage to ±½% of 1%.

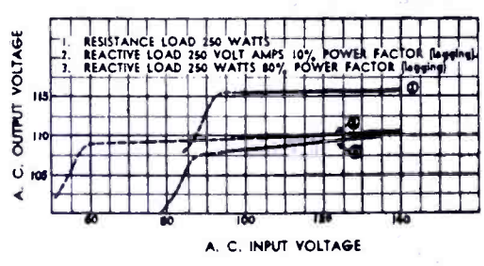
Entirely automatic in operation, the Raytheon Voltage Stabilizer requires no maintenance, no adjustments. Simply incorporate it into new products or equipment already in use and it will take care of itself providing uniformly stabilized voltage.

Raytheon Voltage Stabilizers provide these advantages: Stabilize voltage at any load within their ratings . . . Hold constant varying AC input voltage to ±½ of 1% — within 2 cycles . . . Control wide AC input variation — 95 to 130 volts. Write for Bulletin DL48-537. It gives the complete story.

INPUT VS. OUTPUT VOLTAGE
(Type VR 2)



OUTPUT VS. INPUT VOLTAGE
(Type VR 4)



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

RAYTHEON
MANUFACTURING COMPANY
Electrical Equipment Division
190 WILLOW STREET, WALTHAM, MASS.

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.

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NOW Your Fire Department can have its own Motorola Radiotelephone System

Fire Alarm Headquarters, Boston, Mass.
Supt. A. L. O'Banion. Chief Operator J. E. Laughlin.
Radio Supervisor J. E. McCarron.

FCC and WPB O-K 3-way Radio for Fire Stations

Fire departments serving over 150,000 people are now being licensed by the FCC to operate their own radio stations. Your Fire Department may now have its own license and operate on its own wave length distinct from that of the Police.

ANOTHER MOTOROLA FIRST

Boston Fire Department Radio System

The Fire Department of Boston, Massachusetts, is now operating its own radio station, WEY, consisting of one central control station and 33 mobile units. This means that the Fire Chief at Fire Alarm Headquarters is in instant touch by radiotelephone with his Division and District Chiefs whose cars are equipped with Motorola F-M two way radiotelephone units.

This is another notable Motorola Radio *First* in addition to the famous "Handie Talkie," an exclusive development of Motorola engineers, now being used by our front line infantry.

The Motorola "Handie Talkie" will be available for Emergency, Fire and Police use as soon as obligations to the armed forces have been completely fulfilled. In the meantime, you can get started on the radiotelephone system for your fire department.

WRITE *today for full details*

GALVIN MFG. CORPORATION · CHICAGO 51

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Let there be Music

THE VALUE OF MUSIC...

to America during this war can never be fully measured. At the U. S. O., in the jungle, in the factory and in the home, music has been a vital factor as a builder of morale and unity.

Brush is proud of its many contributions in the field of acoustics; notable among these is the Brush PL-20 pick-up. Its proven superiority in reproduction, its delicate but sturdy construction make it the leader in the field.

Write today for descriptive literature on the Brush PL-20 Crystal Phonograph Pickup.

THE BRUSH DEVELOPMENT COMPANY

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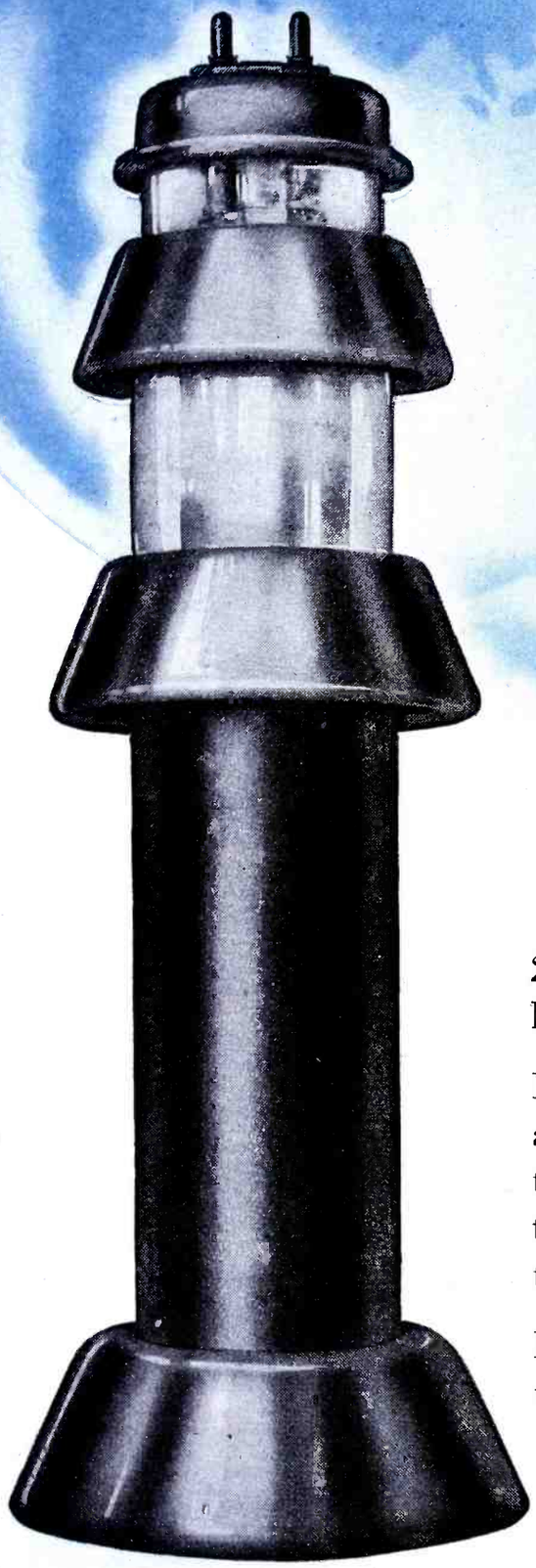

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HIGH FREQUENCY HEATING

INTERNATIONAL BROADCAST

FM

The Most Powerful High-Frequency Tube

200 Kilowatts—developed especially for high-power, high-frequency broadcast and industrial applications.

Into this development has gone all the knowledge and experience of the tube-building art that make the name Federal stand for dependability — a reputation earned by more than 35 years of service in the electronics field.

Federal tubes are built for long life . . . produced with all the care and precision of fine craftsmanship.

Federal always has made better tubes.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

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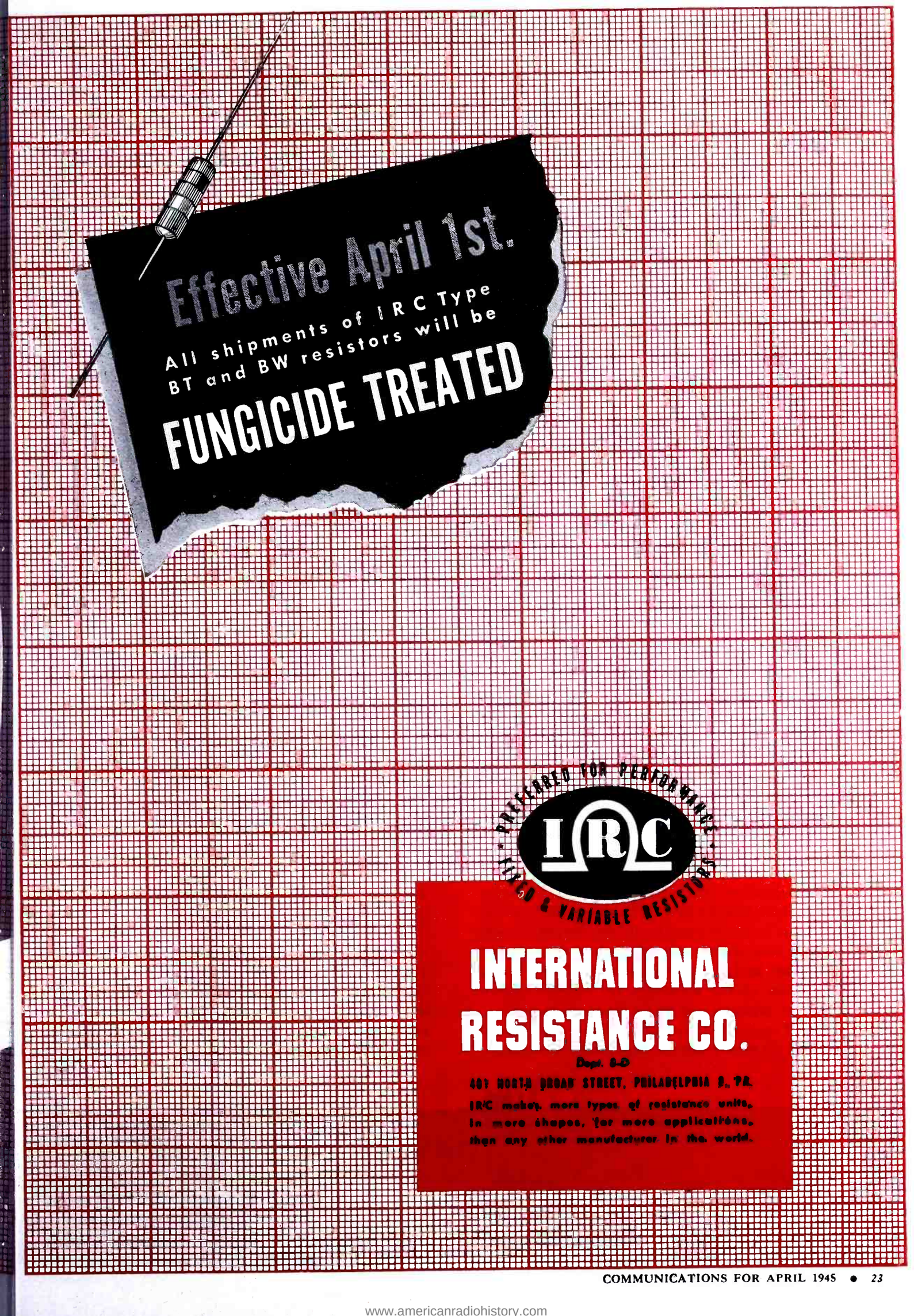

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• The reproducer unit in this loud speaker was especially developed by JENSEN for use in the intercom systems in navy vessels. It reproduces speech clearly and sharply through high levels of noise. Ruggedly built, it withstands extreme shock and vibration, and is weatherproof against severe weather exposure conditions, dust and smoke . . . Like all JENSEN military models, this speaker is built around the most powerful permanent magnet material ever developed, ALNICO 5, as all JENSEN PM Speakers will be when conditions permit.

Now being introduced for the intercom systems on trains, and specifically designed for that purpose, this particular model has many possibilities for use wherever a heavy, rugged speaker with clear, sharp speech reproduction is needed. Write for complete engineering data on this speaker. Samples can be furnished on proper priority.

Jensen
SPEAKERS WITH ALNICO 5

Specialists in Design and Manufacture of Acoustic Equipment

JENSEN RADIO MANUFACTURING COMPANY, 6601 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

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STRUTHERS-DUNN

INC.

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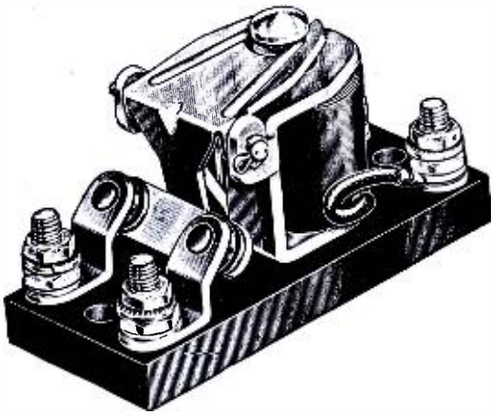
TYPES OF



RELAYS

Each available in countless coil combinations

1321 ARCH STREET, PHILADELPHIA 7, PA.

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND
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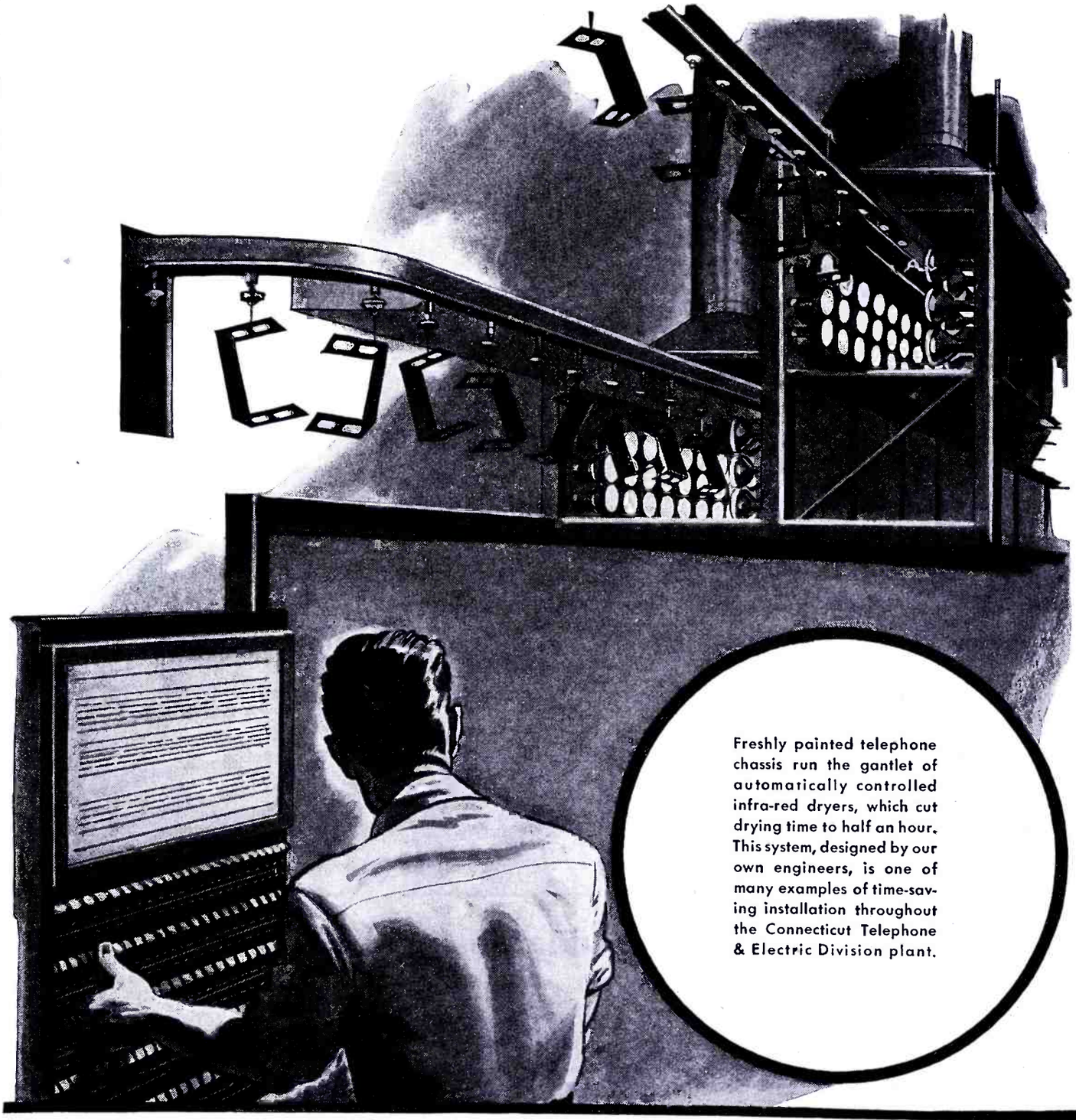
"DO NOT SQUANDER TIME"

. . . Benjamin Franklin

At Connecticut Telephone and Electric Division, production is unhurried, as it must be to maintain accuracy and quality in precision electrical and electronic manufacturing. We substitute *time-saving* methods for *hustle and bustle*. This has enabled us to keep abreast of the ever-increasing need for military communicating equipment of uniform dependability.

After the war, you will very likely use electrical equipment, electronic devices, or communicating systems made at Connecticut Telephone and Electric Division . . . Or you may be one of the many manufacturers who will use our engineering and manufacturing facilities in connection with your own products . . . In either case, our time-saving methods will be your gain, measured by the important standards of uniform high precision, and speed of filling your orders.



Freshly painted telephone chassis run the gantlet of automatically controlled infra-red dryers, which cut drying time to half an hour. This system, designed by our own engineers, is one of many examples of time-saving installation throughout the Connecticut Telephone & Electric Division plant.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT

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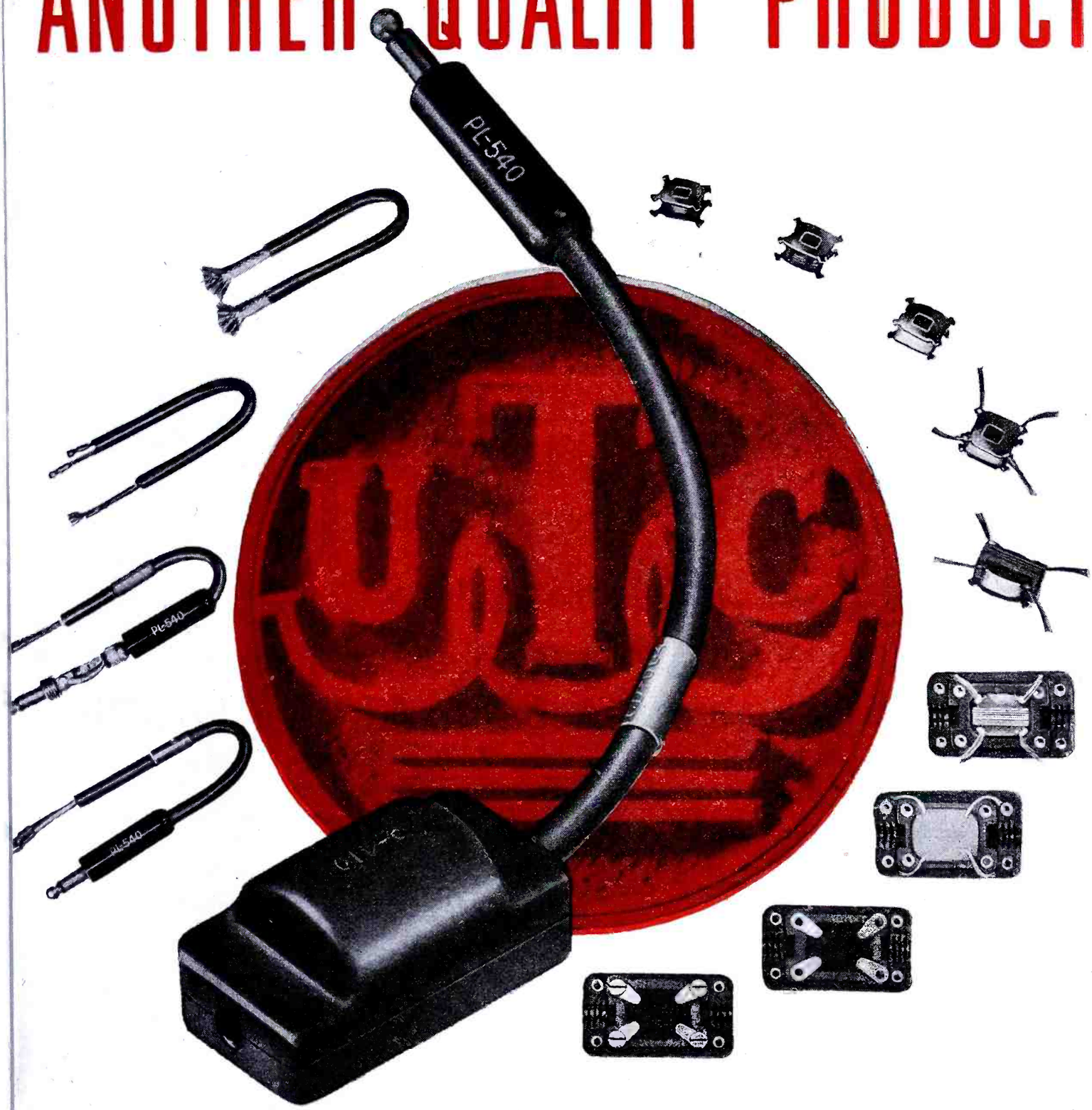
ANOTHER QUALITY PRODUCT



CD-604, CD-605 TRANSFORMER-CORD SETS

UTC production facilities for these Signal Corps headset adapters permit acceptance of additional quantity orders for quick delivery. Also available in hermetic construction.

ALL PLANTS

May we cooperate with you on design savings for your applications...war or postwar?

United Transformer Corp.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

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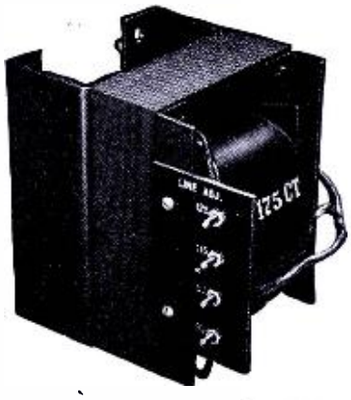
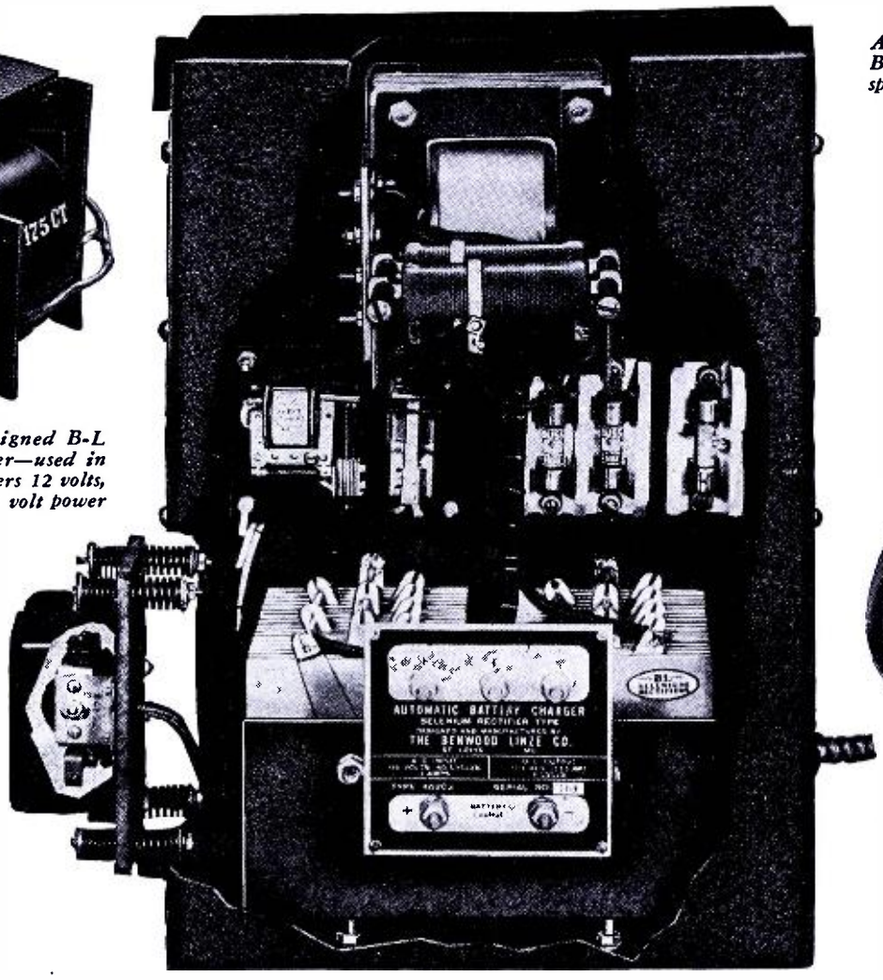
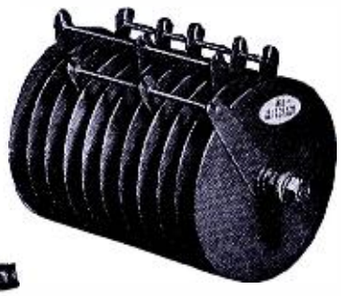


Above—Specially designed B-L heavy duty transformer—used in battery charger. Delivers 12 volts, stepped down from 115 volt power supply.



At left—Another example of B-L Battery Charger designed to meet specific needs.



Above—Specially designed B-L Selenium Rectifier converts AC to DC in the Battery Charger.

This B-L Battery Charger was designed to meet special need in Airport Fire Truck

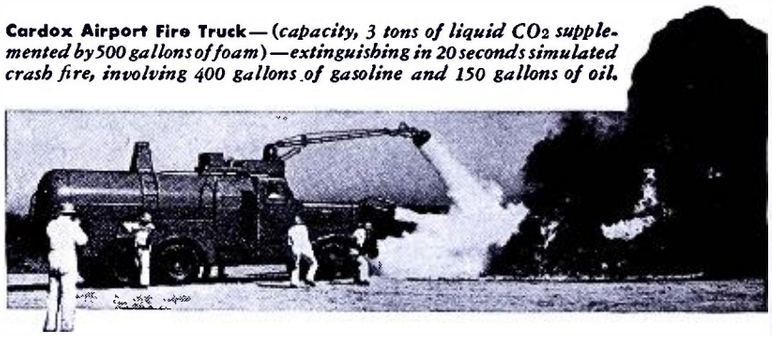
It maintains a 12 volt, 6 cell heavy-duty storage battery, which is a component part of the fire truck shown at the right, and furnishes power for mechanical operation of the booms directing the mass carbon dioxide discharge.

Since the nozzles must be directed to the proper position in extinguishing a fire, reliability of the mechanical drive, including the battery, is very important.

The battery is kept fully charged at all times by means of a trickle charge supplied by this B-L Charger. When the truck returns after use, the charger provides a 12 ampere rate for rapid recharging and automatically reduces to the trickle rate when battery charge reaches a predetermined value. The battery is thus fully recharged within a short period of time and maintained at full charge. The operation of this charger is fully automatic and it requires no attention.

The charger is mounted in the body of the truck and is of rugged construction, capable of withstanding severe shocks such as those encountered in operating mobile equipment over rough terrain. It is provided with a B-L selenium rectifier comprising two stacks, a heavy-duty B-L transformer, relays for automatic charge rate control and adjustable pre-set resistors. The entire equipment is housed in a heavy gauge steel cabinet.

Cardox Airport Fire Truck—*(capacity, 3 tons of liquid CO_2 supplemented by 500 gallons of foam)—extinguishing in 20 seconds simulated crash fire, involving 400 gallons of gasoline and 150 gallons of oil.*



Have You a Conversion Problem?

Twenty-five years of B-L specialized skill in AC-DC conversion problems is available to you. We are designers of Selenium and Copper Sulphide Rectifiers, Battery Chargers, and DC Power Supplies for practically every requirement. We invite your inquiries—address Dept. E.

SELENIUM **B L ELECTRICAL RECTIFIERS** **COPPER SULPHIDE**

THE BENWOOD LINZE COMPANY

1815 Locust Street • • • St. Louis 3, Mo.

DESIGNERS AND MANUFACTURERS OF SELENIUM AND COPPER SULPHIDE RECTIFIERS, BATTERY CHARGERS, AND D. C. POWER SUPPLIES FOR PRACTICALLY EVERY REQUIREMENT.

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AMPHENOL *Offers*

The Most Complete Line of U. H. F. Cables and Connectors.

Approved R-G CABLES *with Characteristics and Dimensions*

A-N NO.	NOMINAL IMPEDENCE	NOMINAL MMFD.FT.	CONDUCTOR WIRE SIZE	O.D. OF DIELECTRIC	INNER SHIELD	OUTER SHIELD	JACKET MATERIAL	JACKET O.D.	ARMOR MAX. O.D.
RG-5/U	53.5	28	16	.185	COPPER	COPPER	BLACK VINYL	.332	
	78.								
RG-7/U	97.5		7-21	.285				.420	
RG-8/U			7-21 SILVER*	.280	SILVER*			.405	.475
RG-9/U		29			COPPER			.405	
RG-		29							
	75	20							
U	75.	2							
13/U	74.								
RG-14/U	52.								
RG-15/U	76.								
RG-17/U	52.								
RG-18/U	52.								
RG-21/U	53.								
RG-22/U	95.								
RG-29/U	53.5								
					SILVER*	COPPER		POLYETHYLENE‡	.250 MAX
					TINNED				
					ED	TINNED	POLYETHYLENE‡		.20 MA
							BLACK VINYL		.6
							BLACK VINYL		
								BLACK VINYL	
			22CW	.146	COPPER			BLACK VINYL	
			22CW	.146*	COPPER				
						TINNED	POLYETHYLENE‡		

In the production of polyethylene dielectric cables Amphenol ranks first. This is the solid, flexible dielectric which was developed by the Army, Navy and Air Corps for wartime electronic use. Amphenol lists thirty-two sizes and types approved by the Army and Navy and most satisfactory results are obtained thru the use of Amphenol low-loss connectors designed specifically for these cables.

Complete assembly components may be obtained from Amphenol. For manufacturers using U.H.F. cables and connectors in quantity there is a definite advantage in having them assembled by Amphenol's highly expert Cable Assembly Department. This assures accurate and skilled workmanship and a definite saving of materials and labor.

Your request for Catalog D will bring you the latest information on high frequency cables and connectors. Complete information on Amphenol assembled units will be furnished on request.

Depend upon AMPHENOL *Quality*

U.H.F. Cables and Connectors
Conduit Fittings
Connectors (A-N, U.H.F., British)
Cable Assemblies
Radio Parts
Plastics for Industry

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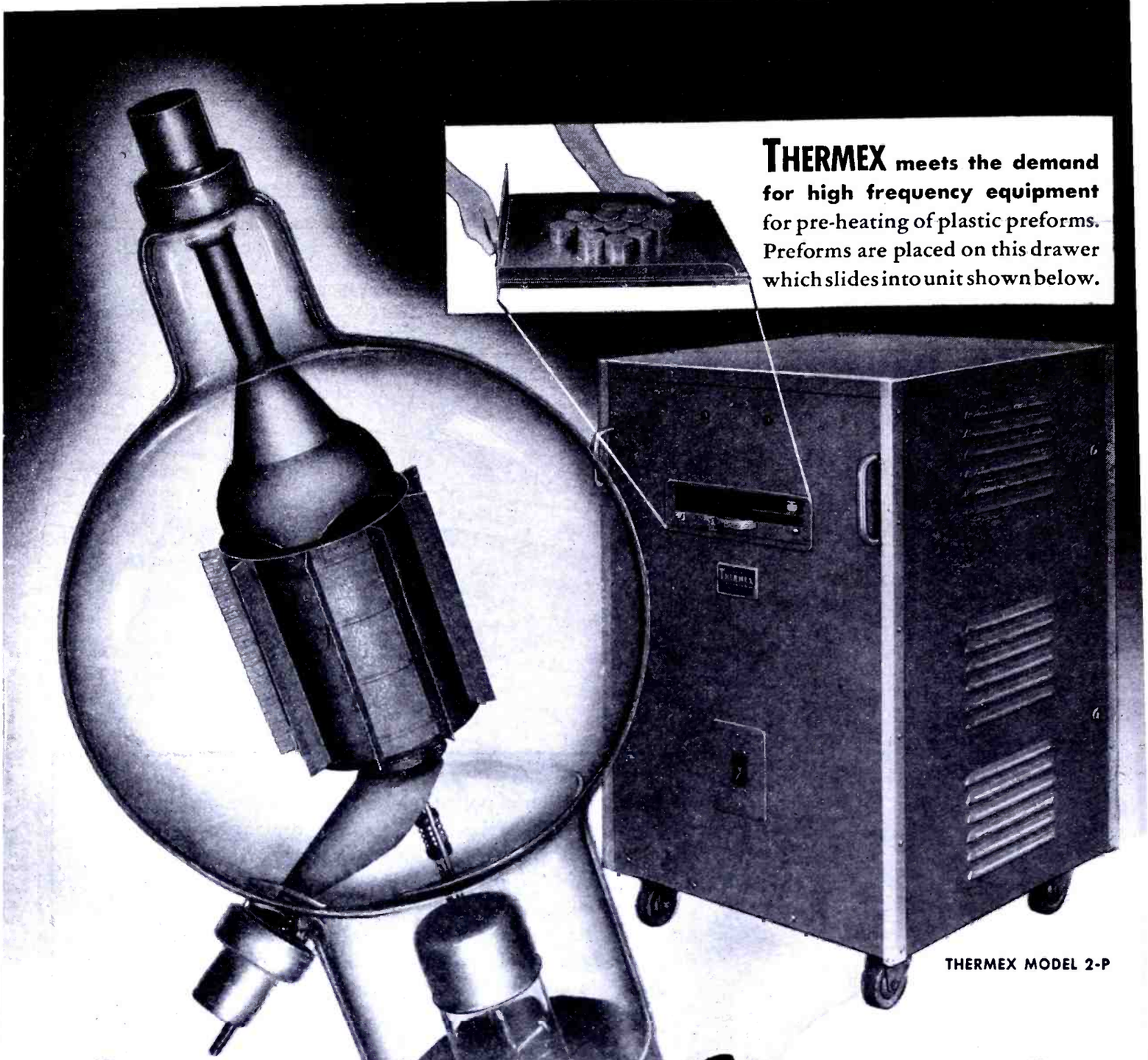

THERMEX meets the demand for high frequency equipment for pre-heating of plastic preforms. Preforms are placed on this drawer which slides into unit shown below.

THERMEX MODEL 2-P

Of course it uses Eimac tubes

This compact Thermex unit measures 28 inches by 28 inches, stands 47 inches high, and weighs only 614 pounds. It is a practical and flexible piece of equipment with built-in heating cabinet and removable 12 inch by 15 inch drawer-electrode.

Being completely automatic, there is nothing to do but plug this Thermex in and load and unload the preform drawer. No dials, no tuning, not even a button to push. Closing the preform drawer all the way in, turns on the high frequency power and timer. At the end of the prescribed time, which may be anywhere from 5 to 10 seconds up to 2 minutes, the red indicating light goes out, the operator removes the tray and unloads the preforms into the mold cavities.

The Thermex Model No. 2-P, which is illustrated, operates at a frequency of 25 to 30 megacycles using 230 volt 60 cycle single phase current. It has an output in excess of 3400 BTUs per hour, and it uses a pair of Eimac 450-TH tubes. The use of electronic heating has increased production for many plastic manufacturers who have been leaders in utilizing the science of electronics.

The Thermex Division of the Girdler Corporation of Louisville, Ky., is a leader in supplying equipment for this and other industrial applications. It's natural that Eimac tubes are used, since these tubes are first choice of leading electronic engineers throughout the world.

Follow the leaders to

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

EITEL-McCULLOUGH, Inc.
985 San Mateo Avenue, San Bruno, California
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, California, U. S. A.

Eimac has received 7 ARMY-NAVY "E" AWARDS for production efficiency • San Bruno 5, Salt Lake City 2

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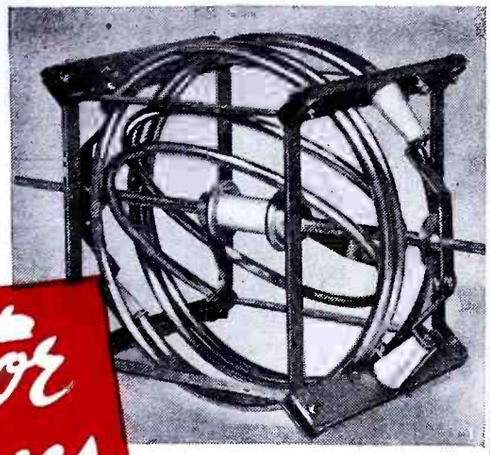
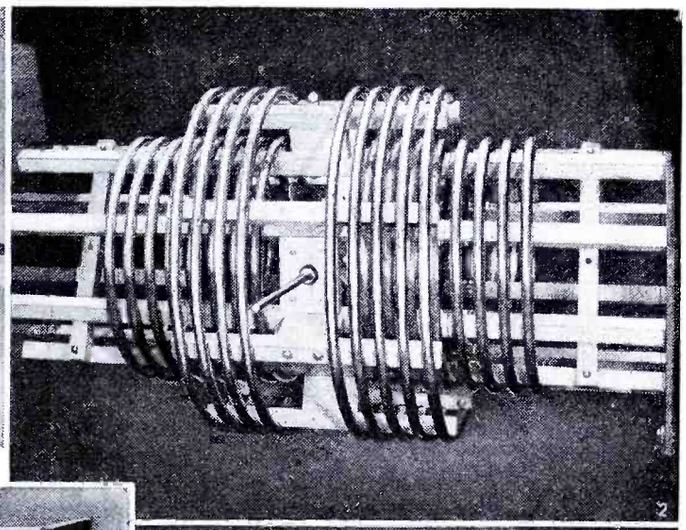
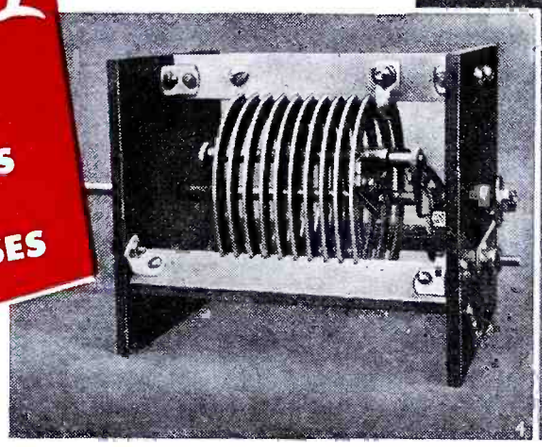
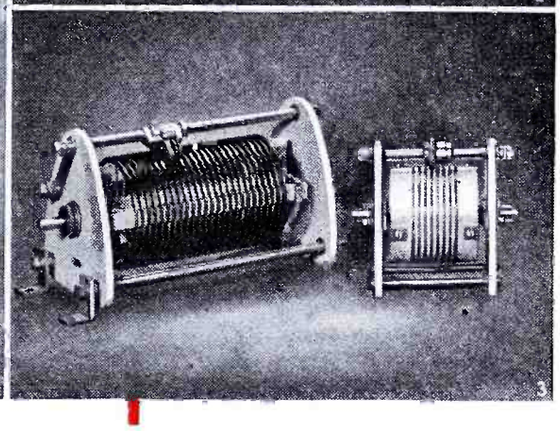




Inductor Designs

for RADIO TRANSMITTERS and INDUSTRIAL USES





When you need an inductor for any purpose consult Johnson Engineers. Their files will probably contain a design tor your required inductor, but if not, they can design one and make it to do your particular job.

Inductor design is quite a special study and no one conductor, no one insulator, no one type of construction is suitable for every requirement. Johnson may select a copper tubing conductor to handle high currents in one design, while edgewise strip is selected in another because of its narrow width and the ability to get a greater inductance in the same length. Other conductors are available too, such as solid wire, litz wire, flat strip, square Bars and special shapes, some plated, some polished and lacquered according to their use. In order to make contact to the conductor and bring off taps Johnson has produced a complete line of clips and connectors for use on fixed taps as well as sliders and rollers for continuously variable taps.

Insulation requirements vary. While steatite or mycalex may be used for low losses in a certain high frequency coil, plastics may be better for another because they stand more mechanical shock. Production facilities at Johnson provide for working any insulating material so the best one or the best combination, can always be selected to fit the special job.

Johnson inductors are designed and built for efficient operation and they have high Q. Some are fixed and some are variable. Some designs require special features such as rounded parts to minimize corona discharges at high voltages, water cooling, variation of inductance or variation of coupling.

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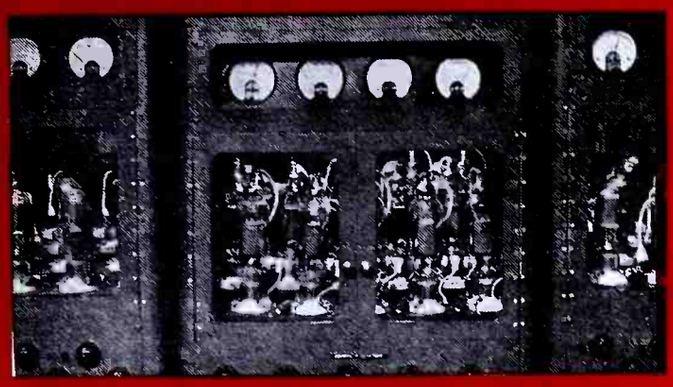
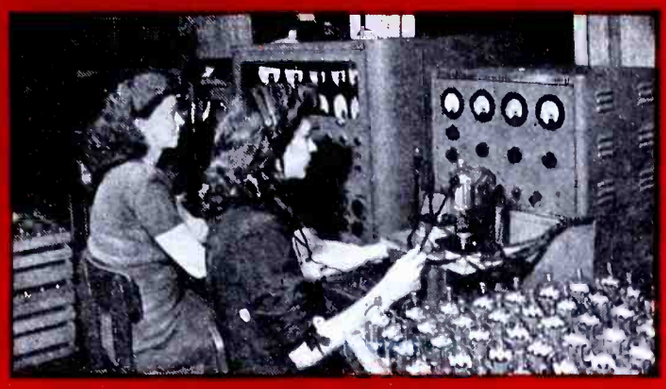


*QST-1—Life testing is an important Quality Standard test at United. It is a strictly observed procedure whereby life expectancy is controlled in "run-of-production" tubes.



QST-2—A unique test is applied to every United tube to assure noise-free operation.

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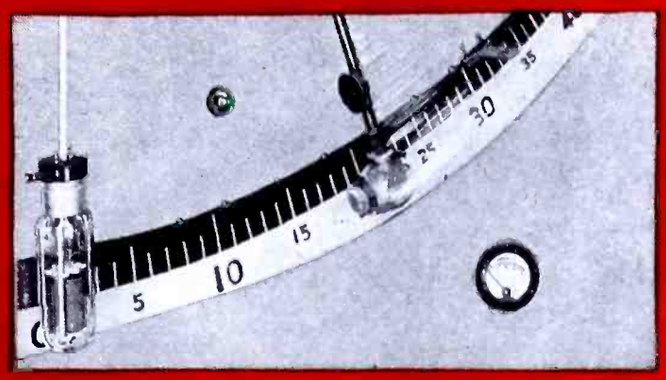

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Brilliant United craftsmanship is steadfastly verified and maintained by skillful and vigilant testing—truly representative of daily production. For this reason every United tube must pass through a series of critical examinations that do not permit any defects, no matter how minute they may be, to escape unnoticed.

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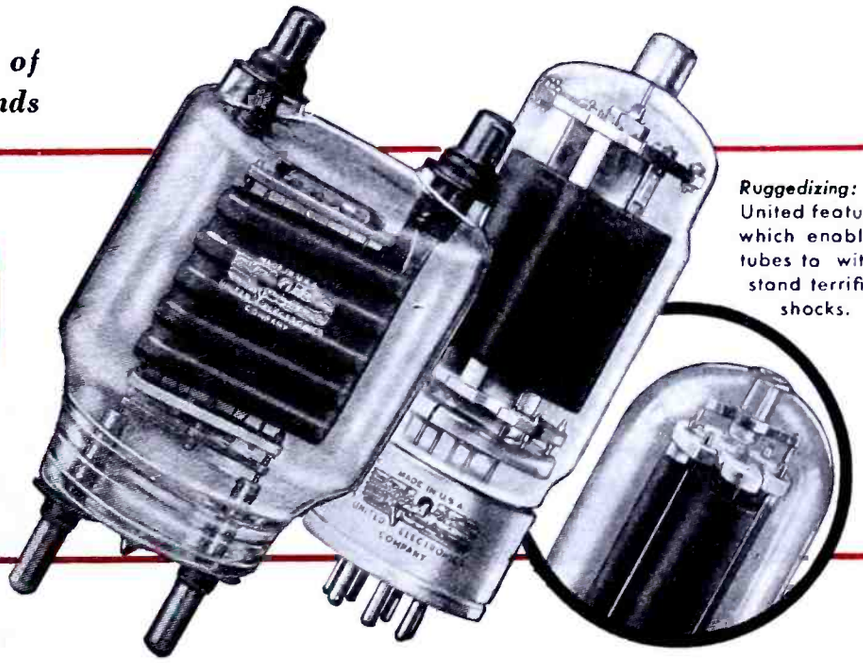

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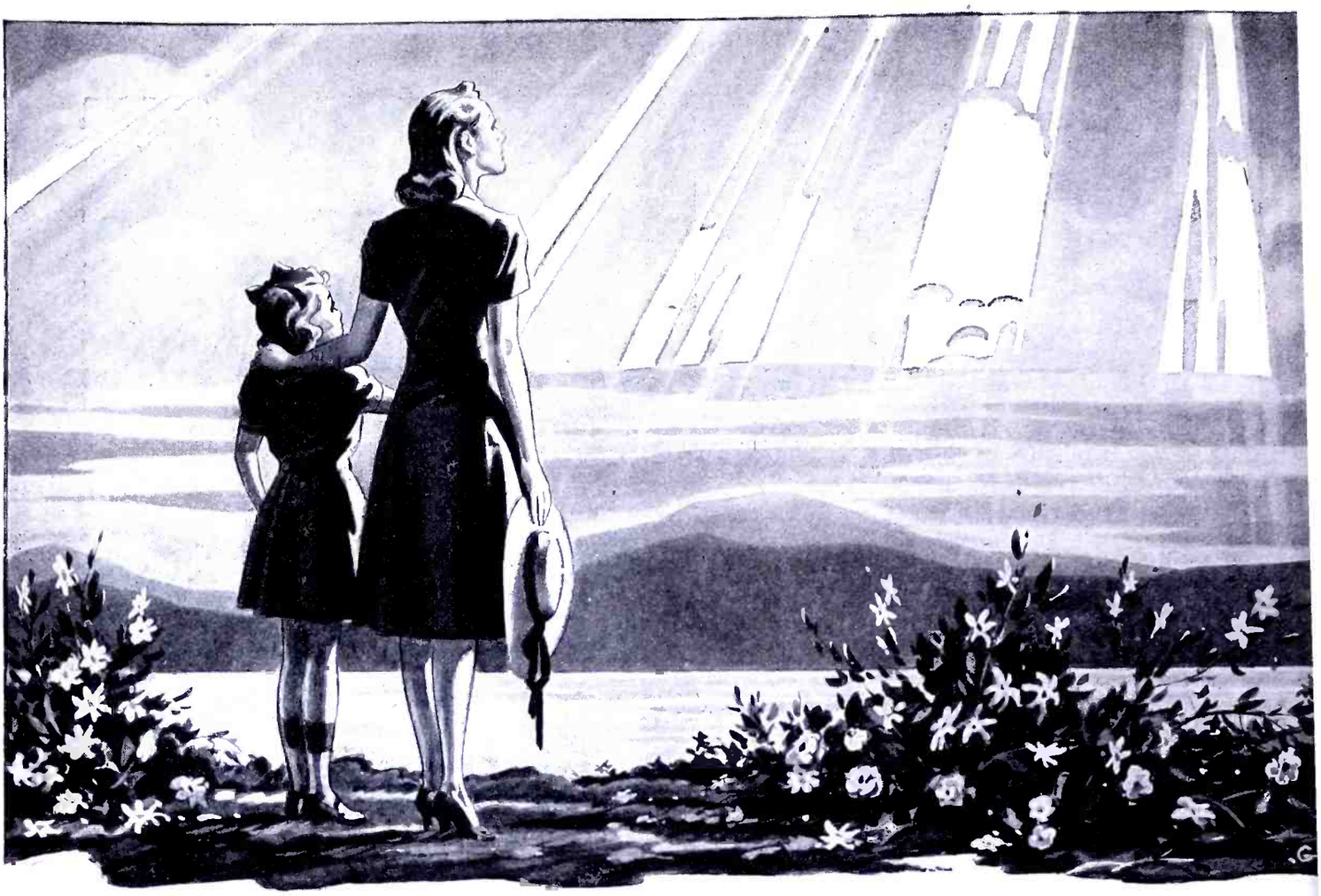

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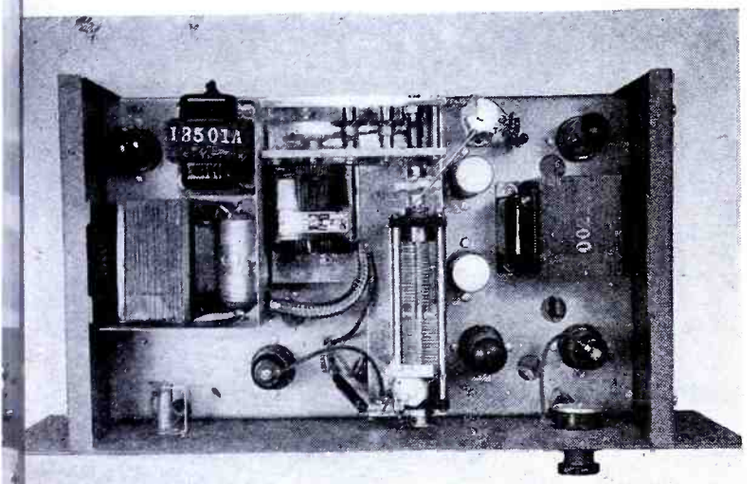
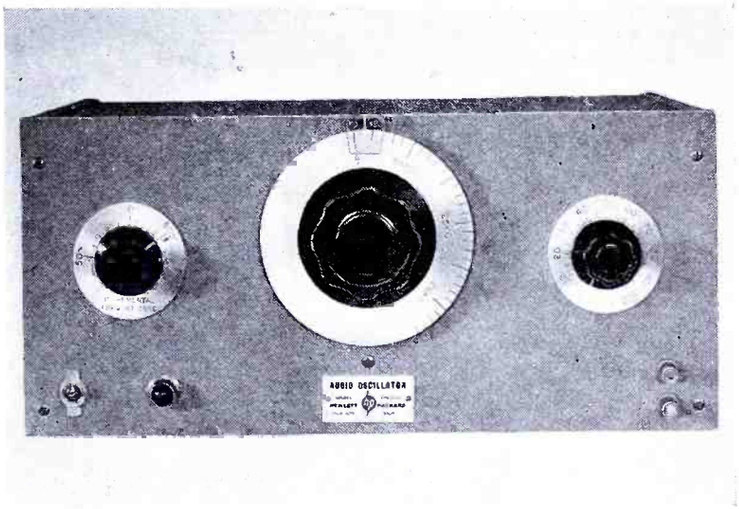
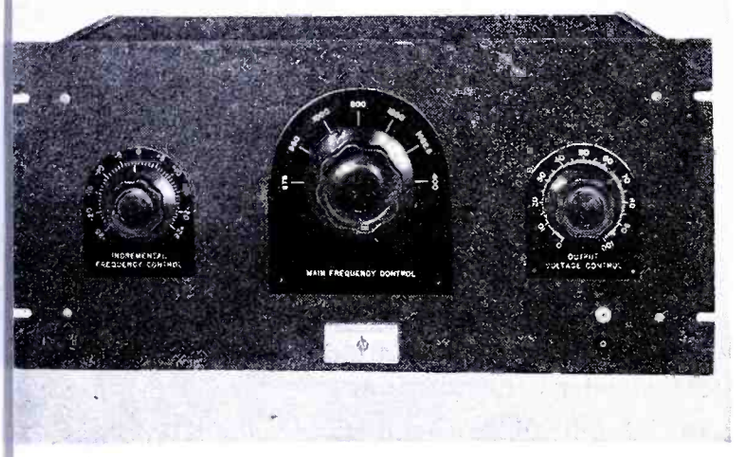
EXAMPLES OF -*hp*- ENGINEERING TO SOLVE SPECIAL PROBLEMS



his instrument automatically varies the output frequency rom 1000 cps to 3000 cps and back to 1000 cps once each econd. It's another example of a special oscillator on which nformation has not been restricted during the war.



This special unit was developed to supply a readily adjusted frequency between 24 and 26 kc, and is now in use testing secret devices for the war effort. To give an accurate incremental variation of the frequency, a separate control was provided.



o facilitate rapid production tests for a prominent western dio manufacturer, this special oscillator was designed and onstructed. Seven fixed audio frequencies are instantly obained by means of a single control knob. Small incremental ariations of frequency are controlled by another knob.

The Hewlett-Packard organization has had wide experience in the development of special equipment for laboratory and production work where specific and exacting problems are encountered. The answer quite often requires only an adaptation of a standard -*hp*- instrument, but in some cases new instruments are developed for the particular problem. Today all of the standard -*hp*- instruments are confined to war work. However, -*hp*- engineering facilities are at your service to assist in solving your individual problem. A letter will bring further information without obligation.

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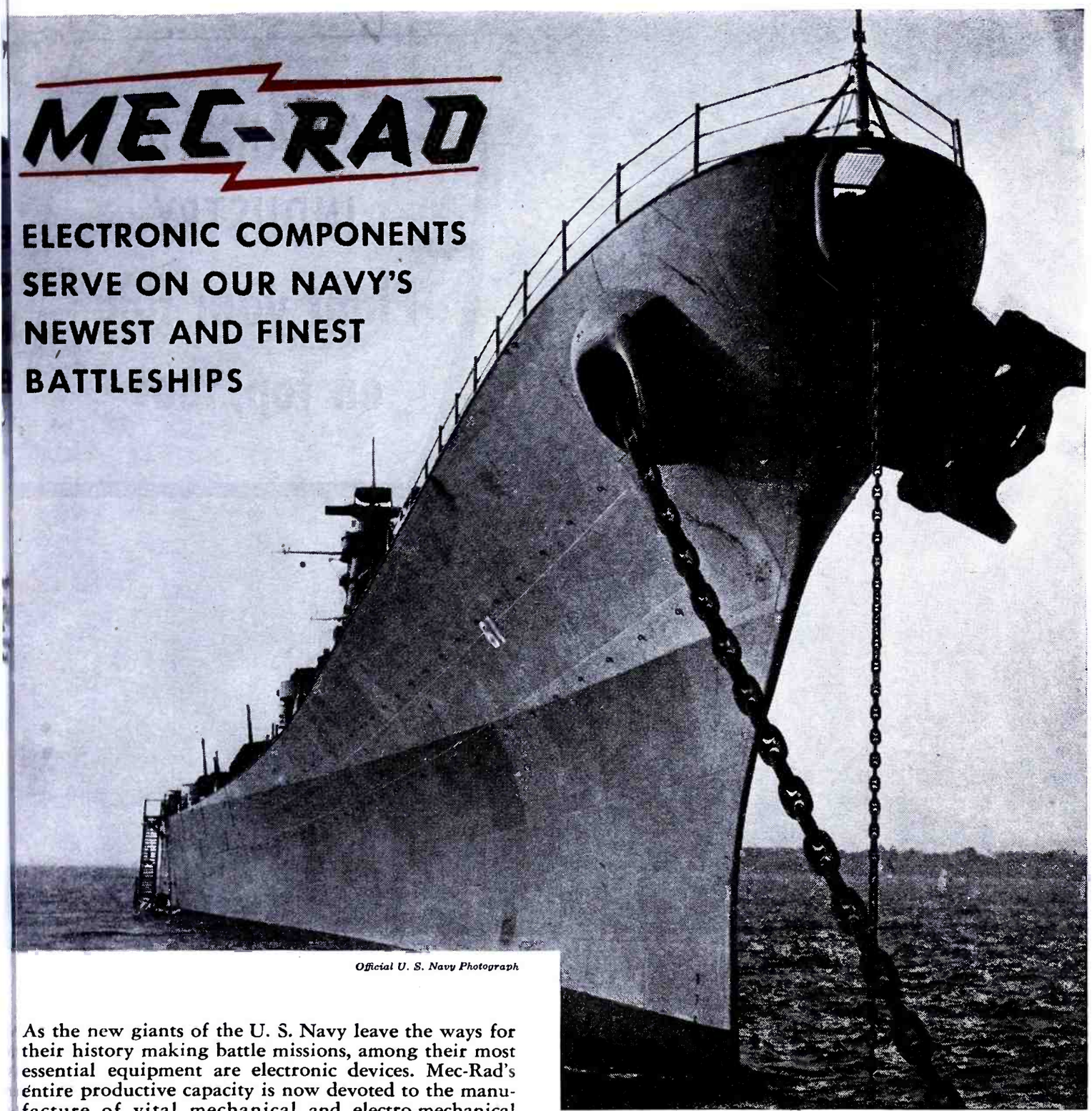

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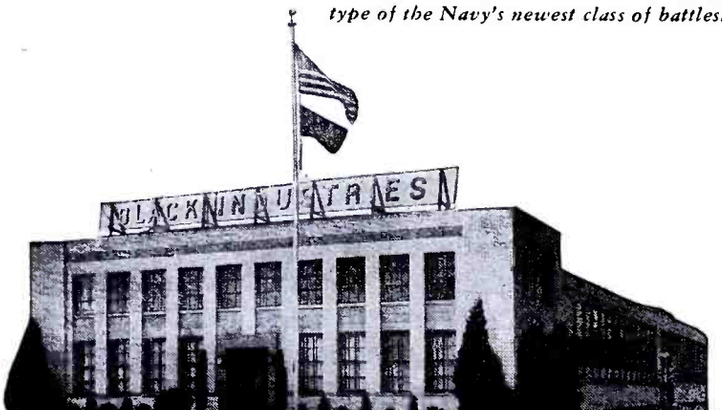

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★

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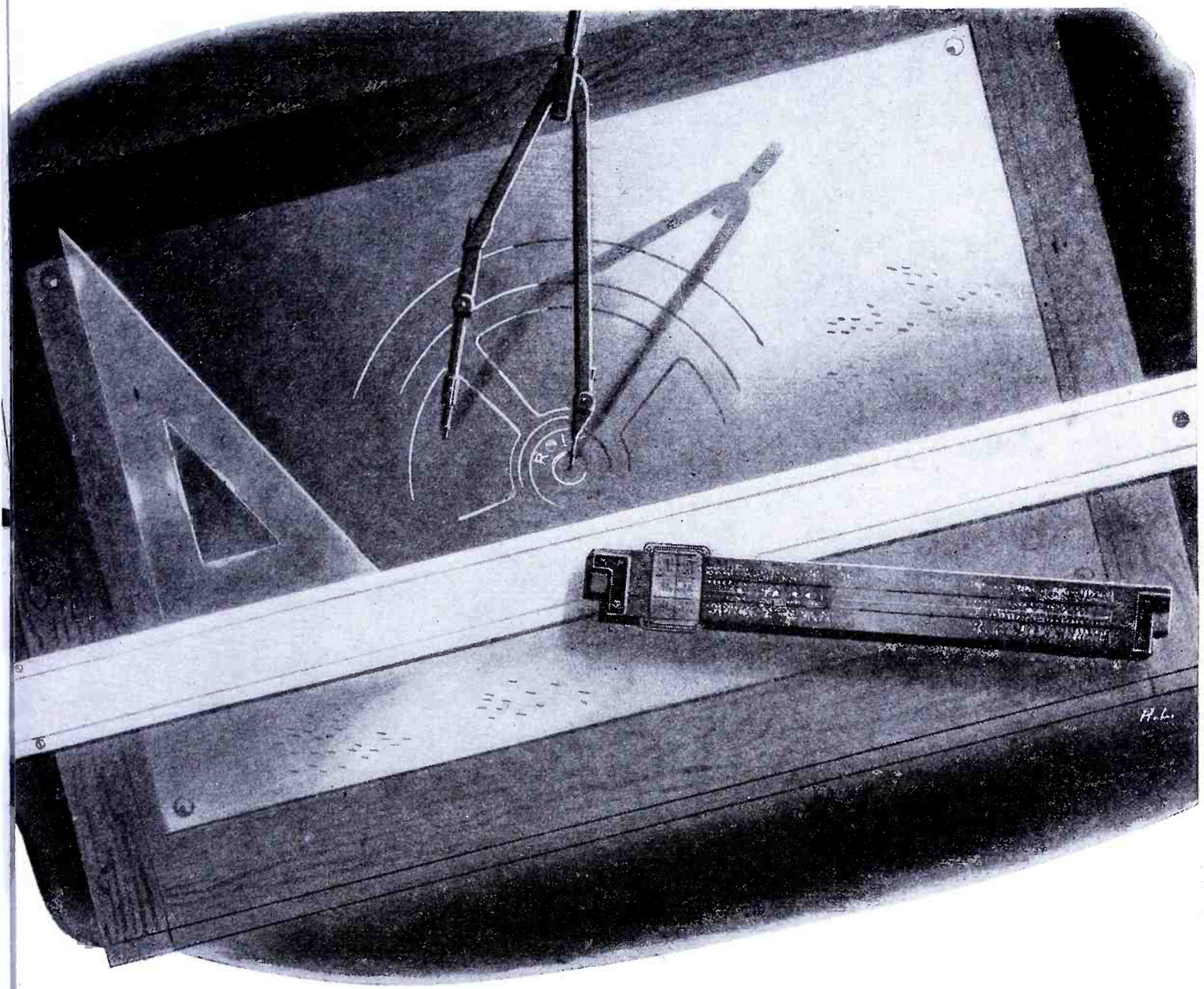

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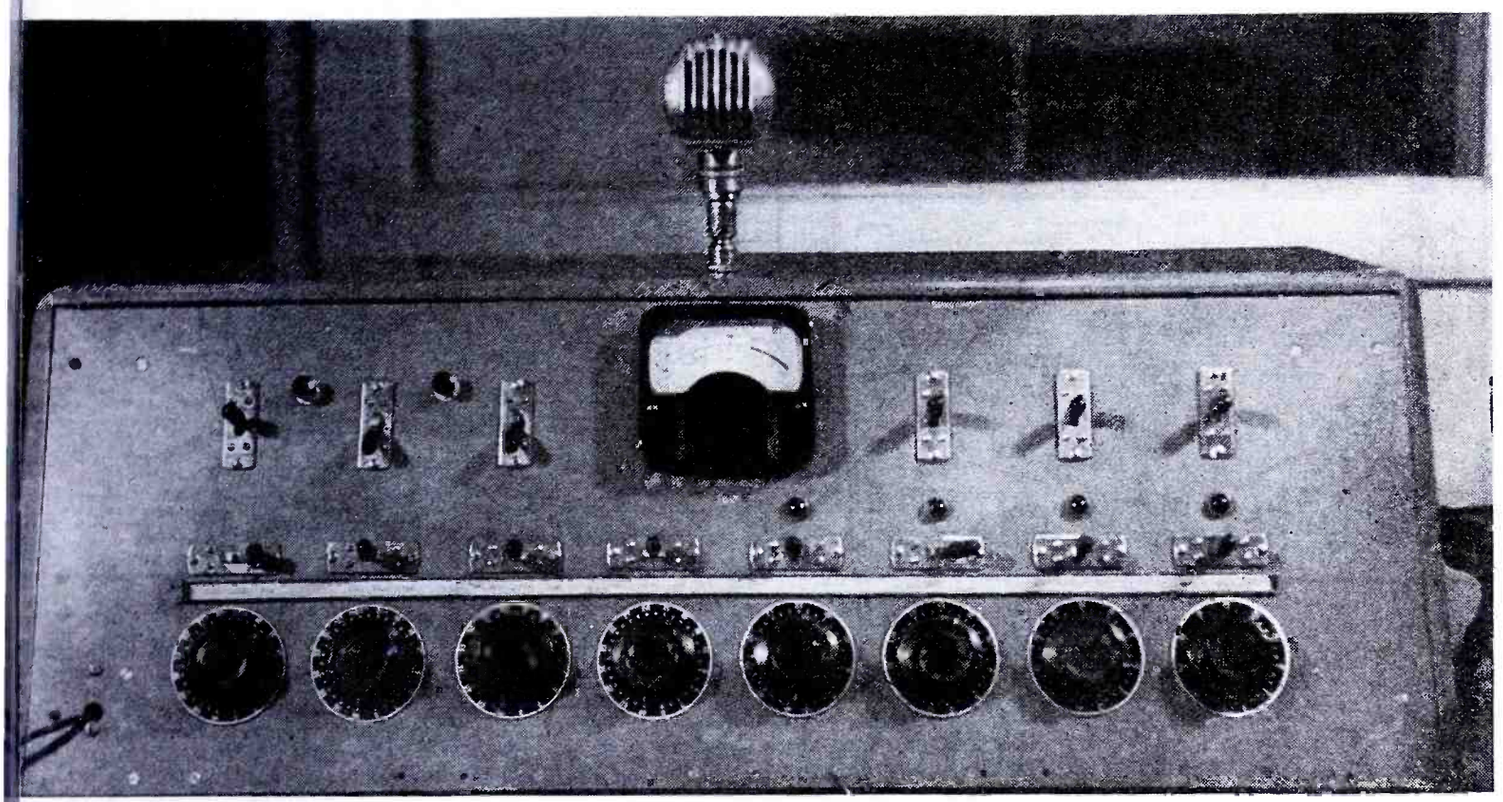

STUDIO FACILITY EXPANSION

Using Spare Parts and Converted Equipment

by LAWRENCE A. REILLY

Chief Engineer, WSPR

THE descriptive OWI slogan . . . *"Patch it up; wear it out; make it do; go without,"* . . . has erved as the basic engineering pro-ram of all of our broadcasting sta-ons, since Dec. 7, 1941. At some ations the program presented a vari-y of knotty problems. In many in-ances the difficulties increased as the ionths went by, particularly where xpanded operations required enlarged ngineering facilities. The latter was ie problem we faced in 1942.

In 1936 we received our license to perate as a limited-time local station. conomics demanded a minimum of quipment. In 1942 we became a net-work affiliate of the Blue system, requiring full-time operation. The control-room setup was far from adequate for this added service. A new layout was necessary but priority regulations made it impossible to buy new equipment. And the MRO rating didn't help much either.

That meant a rearrangement of equipment on hand. An inventory of equipment in use, spare parts in the bins and what could be legally purchased indicated the possibility of a flexible three-channel system that would last for the duration and perhaps past that period, too. The system that resulted from this plan is shown in Figure 1.

Four factors governed the system requirements. They were: (*1*)—Technical reliability and sound design; (*2*)—Simultaneous use of three channels; (*3*) — Patchcord-less routine operation; and (*4*)—Simplicity of operation for inexperienced wartime personnel.

Although a few later additions have been made since WPB authorized the $500.00 maximum single-project purchase, the setup has remained the same for almost three years.

Naturally, some substitutions were necessary. These included a masonite

Illustration above shows modified WSPR mixer panel-console. Keys, top row, left to right: recording amplifier input; monitor amplifier *1* input; monitor amplifier *2* input; push-to-talk buttons between these keys. Bottom row, eight mixers with associated key switches for *air-audition*. Left to right: network, nemo, turntable *1* and *2*, and four microphones.

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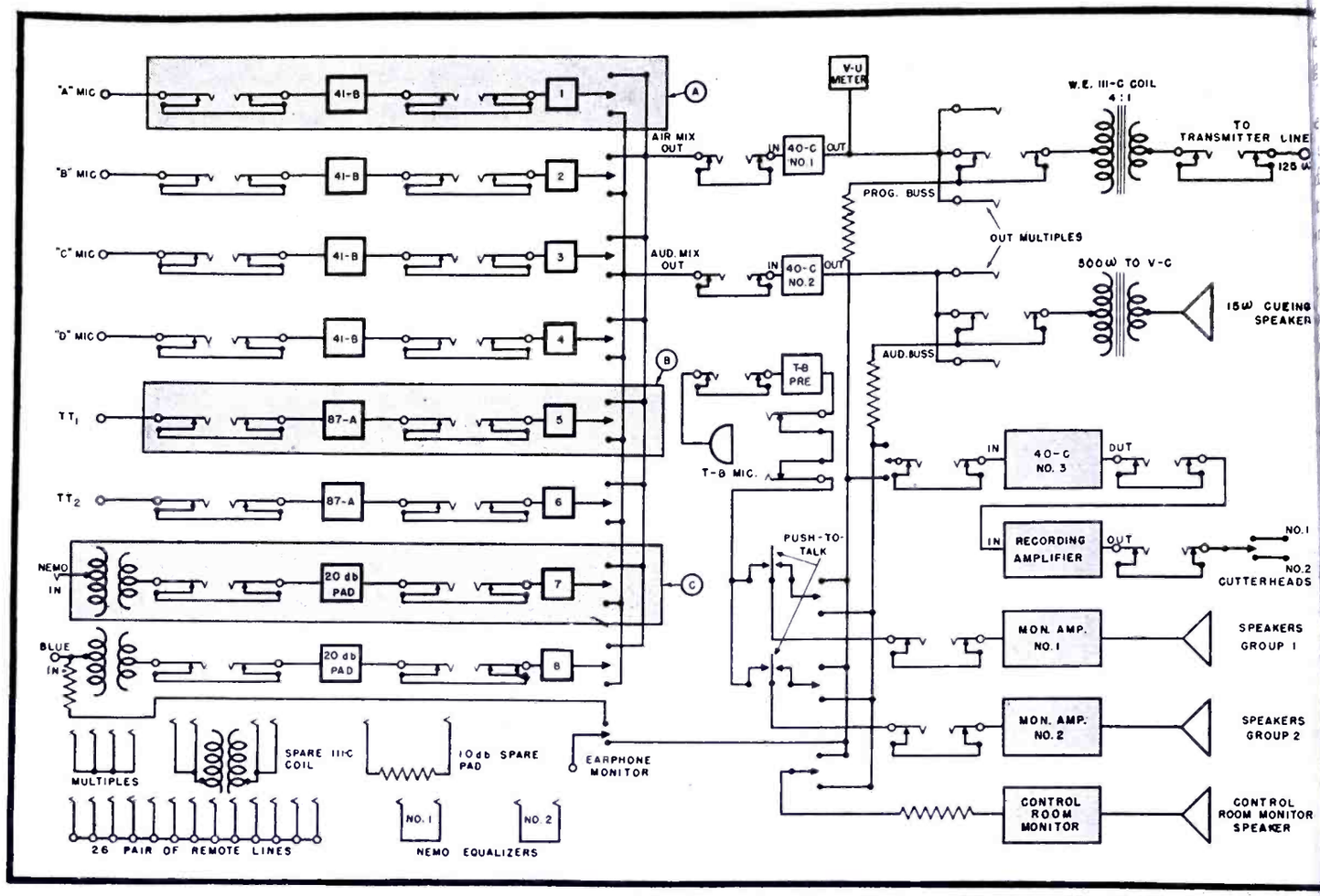


panel for the mixers and a wooden console cabinet. These should be supplanted by aluminum as soon as possible.

We decided to use an eight-position mixer. This appeared to fulfill our needs and was not too awkward to handle. Experience indicated that when the control operator has more than eight faders to manipulate, confusion results. The eye can easily encompass eight, however.

The eight positions (from right to left in page 41 illustration) are: Microphones *1*, *2*, *3* and *4*; turntables *1* and *2*; remote pickup; and network. Of course, by patching, any desired

Figure 1

Block diagram of the WSPR mixer-amplifier. Detailed design of sections *A*, *B* and *C*, appear in Figures 2, 3 and 4.

combination can be had, but that procedure is rarely necessary.

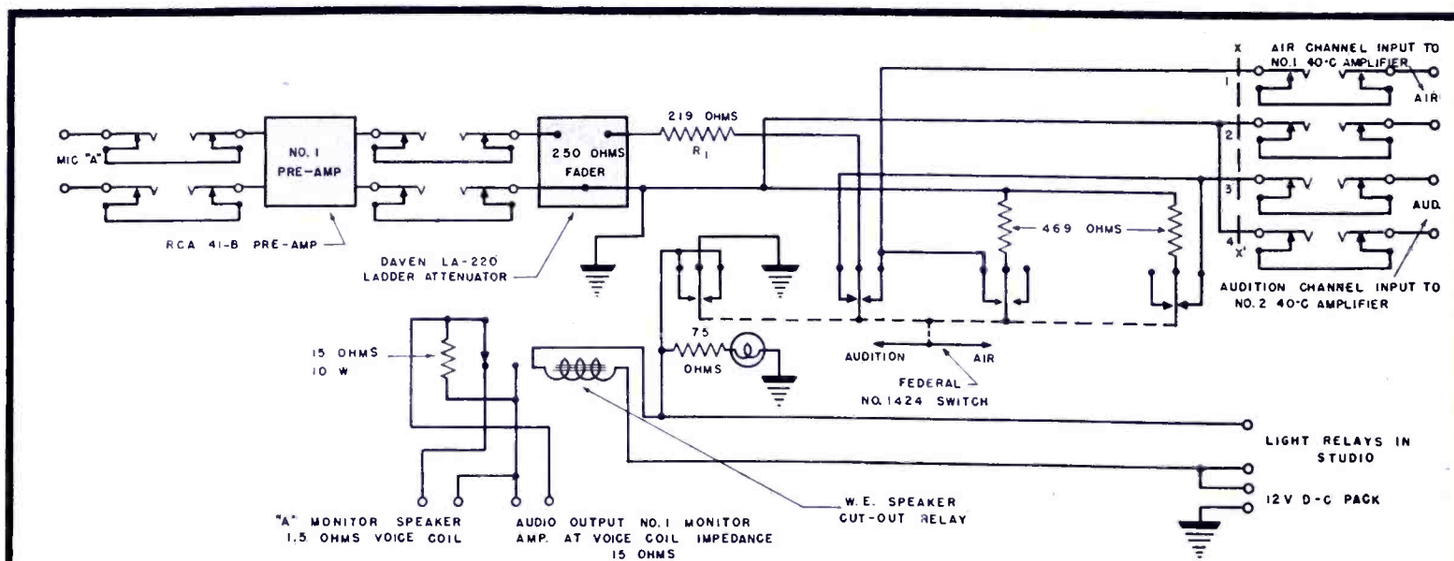
Each microphone has an RCA-41-B two-step pre-amplifier while each turntable has an RCA 87-B two-step booster-amplifier. Thus, the level delivered to the mixer from microphones and turntables is about —30 db, Figure 5. This requires a 20-db drop between the incoming network and remote lines, before their respective faders.

Figure 2

Details of *A* microphone mixer circuit. Mixers A, B, C and D are identical.

Unbalanced Ladder Attenuators

Unbalanced ladder attenuators are used; to permit their use with one side of each grounded, a parallel mixer is used. It was found essential to have but one point of grounding and all audio circuit grounds fed to this common point. The faders have a resistance of 250 ohms (Daven LA-220). Each fader goes to a multi-pole switch. The switches are Federal 1424 type having 12 *springs*. Although in some positions a few of the springs are unused, it seemed wise to standardize on



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12-contact switch to provide for addition of signalling or interlock circuits at some later date.

To avoid feedback from monitor speakers to microphones, we provided a speaker cutout relay that operated before the microphone was inserted into the system. By bending the springs on the key switches one way or the other it is possible to secure any desired sequence of opened or closed position. The springs connecting the 59-ohm dummy resistors were bent so as to be normally closed when the switch is in neutral and open individually when thrown to air or audition, Figure 2. These resistors maintain the correct input load conditions at all times.

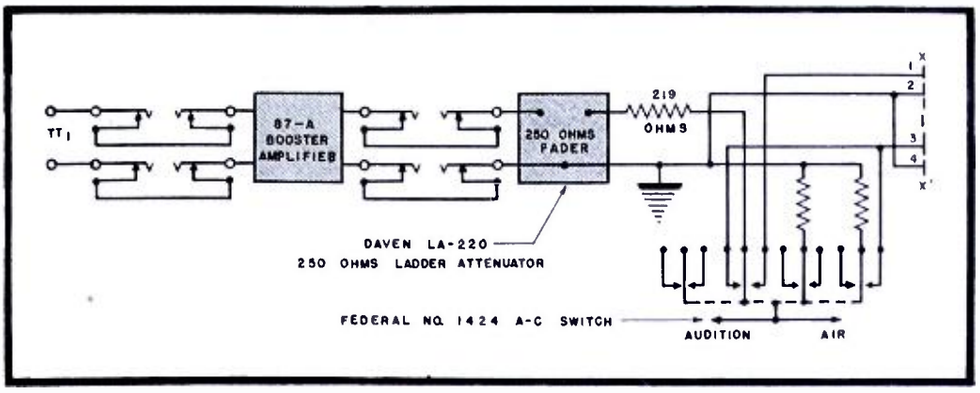
Computation of Mixer Constants

We applied the equations of Slaymaker (*Broadcast News*, March 1940) to find the values for the series resistor, R_1, and the proper terminating impedance, Z_2, for the eight-position mixer with 250-ohm inputs, Figure 6. The 59-ohm value indicated that a special mixing transformer would be necessary to match the output impedance of the mixers to the input of the program amplifier at 250/500 ohms. Since it was impossible to buy such a custom-built item, an alternate method was introduced.

We selected the split primary input transformer of a RCA 40-C amplifier (RT-248). By unsoldering and reconnecting as shown in Figure 7, we secured a primary resistance value of 62½ ohms. Feeding a 59-ohm source to a 62½-ohm load did not introduce any mismatch problems. Frequency response runs (Figure 8) proved that. No 219-ohm resistors were available, however. However, a search of the bins with an ohmmeter provided several 5% tolerance ½-watt carbon units of that value. We located 469-ohm dummy load resistors by the *bin-search* method too. These resistors are switched in when the keys are in neutral.

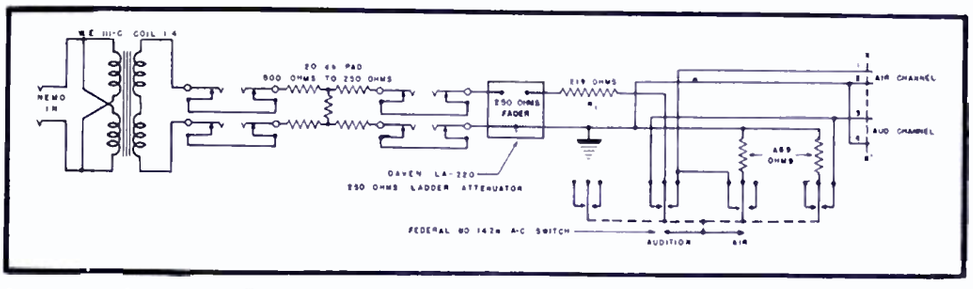
Normaling Jacks

All inputs and outputs to each component are connected through normaling jacks to permit substitution and flexibility. For regular operation, however, no patching is used for channel *1* (*air*) or channel *2* (*audition*). Channel *1* feeds the transmitter at 0 *db* over a 1½-mile line, equalized to 8,000 cycles, but good to 10,000. The *2* channel is identical in every way up to its output. A small p-m speaker, with narrow frequency range, is kept across channel *2* for cueing purposes, and for monitoring auditions without



interfering with aural monitoring of channel *1* on the large control-room speaker. To prevent confusion when the speakers are used simultaneously, a marked difference in tone quality between the regular monitor and the small cueing speaker is provided.

The second channel, which can be used to feed the transmitter in an emergency, serves as an audition channel for feeding any of the offices or monitor speakers in any studio as well as



the control room. It is used also to record one program while another is on the air.

The third channel is generally used to record network programs for delayed broadcast without interfering with the full use of channels *1* and *2*. The recording amplifier is normally bridged across the output of channel *3*.

To drive the cutting heads, a power amplifier had to be built of available parts. Since the amplifier would bridge a program source at about 0

Figures 3 (above) and 4 (below)

Figure 3, details of unit *B*; turntable *1* pickup mixer circuit. Circuit *2* is identical to *1*. Figure 4, details of *C* unit; mixer circuits for nemo and the Blue network. Both these circuits are identical.

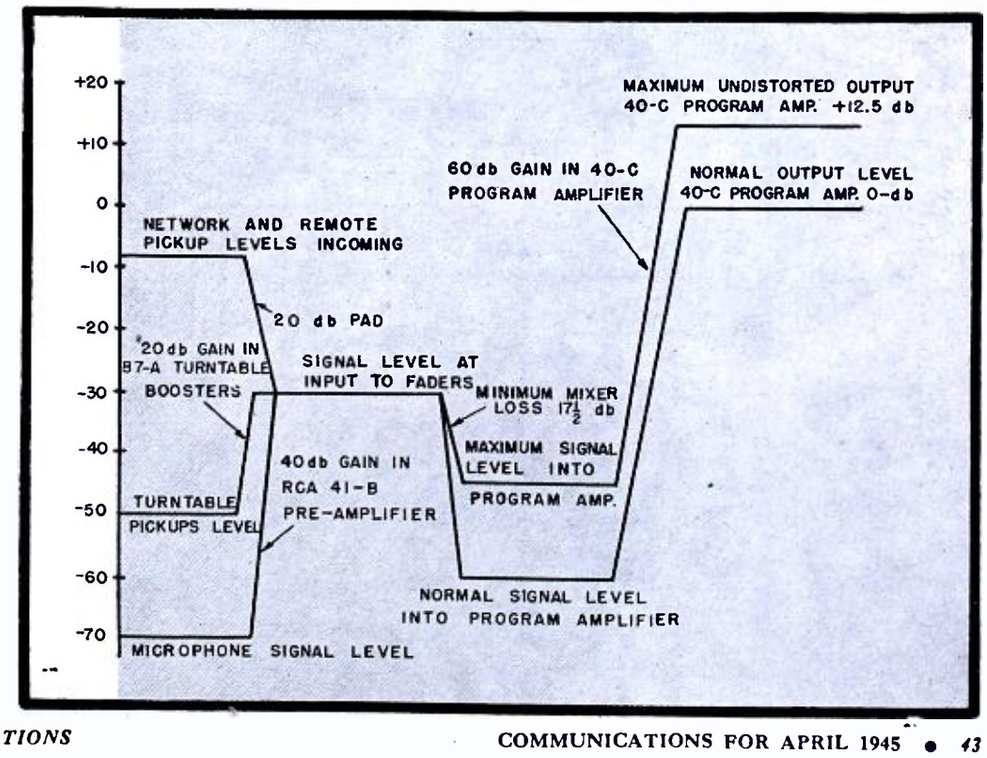


Figure 5

The signal level chart for the modified WSPR studio facilities.

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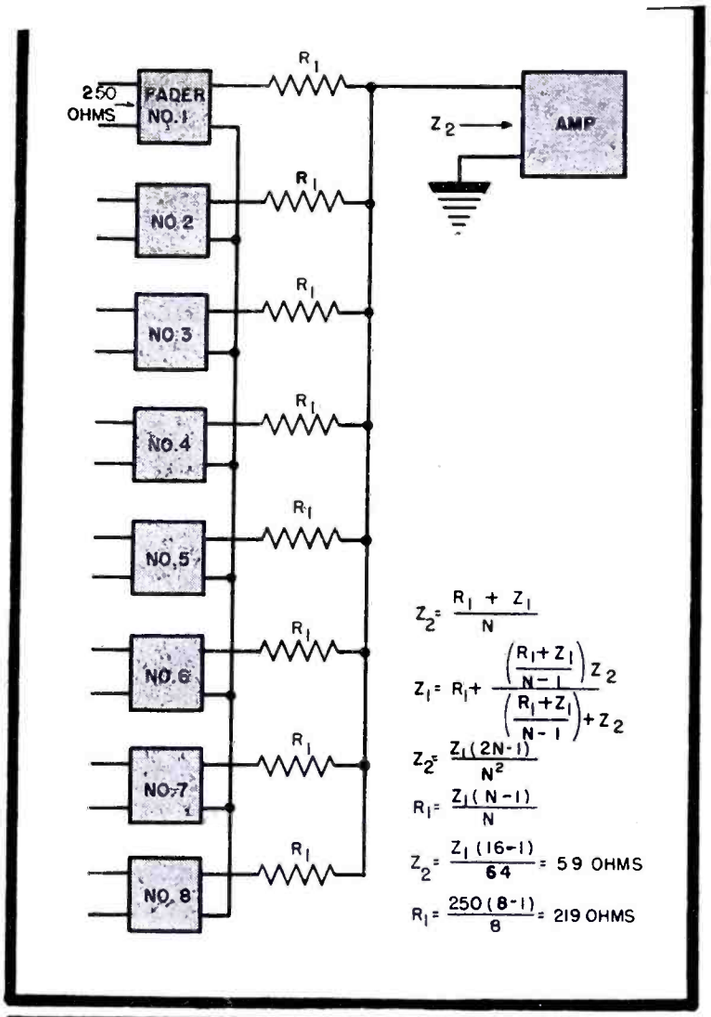

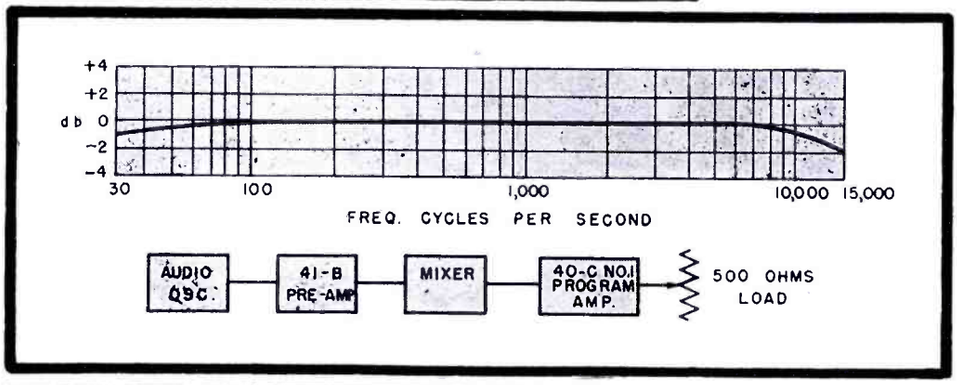

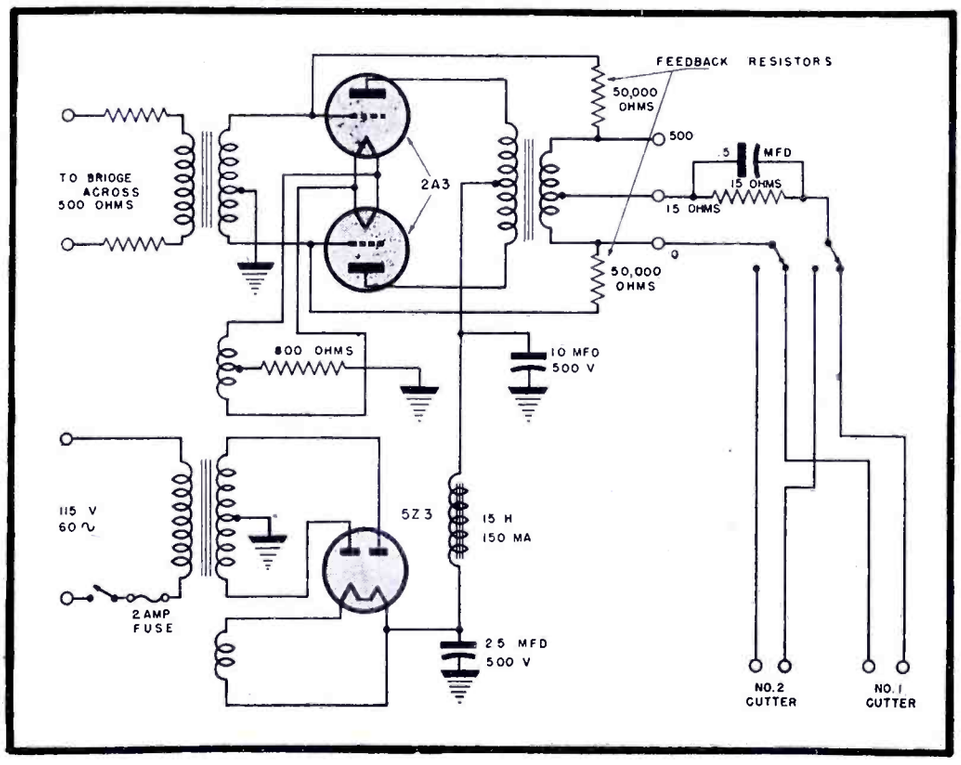

Figures 6 (left), 8 (below), 9 (bottom)

Figure 6. fundamental parallel mixer - circuit for 8 to 250-ohm sources. Figure 8, the overall response of the WSPR amplifier system. Figure 9. single-stage recording amplifier.

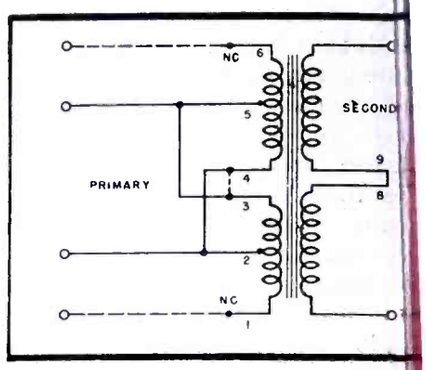

Figure 7

Input connections to program and auditio plifier transformers. The dotted line indic normal 500-ohm input; solid line as altere approximately 59 ohms, with jumper from removed.

level (12½ milliwatts at 500 oh we used but one stage, Figure 9. 2A3 tubes were selected for their G_m and good damping factor. Th important since the cutterhead i dance will vary almost 10 to 1 their useful audio range. Low quency deemphasis is provided by *RC* circuit in the output. In additi a small degree of inverse feedb (about 5 db) helps to equalize cu response peaks and dips.

To accommodate our increased cording work a separate record shop is now under construction. T will house two rim-drive turntab with improved cutterheads. Wh ready, it will supplement, not repla the present facilities.

Talkback to any studio or oth point in the building equipped with monitor speaker is provided by a d namic microphone located atop t console. Two push-buttons located the upper left of the console are co nected so that when the first is push the input to monitor amplifier *1* lifted, and the microphone is connect across it. When the second button pushed, the input-to-monitor amplifi *2* is lifted and the talkback microphon appears across it. Both buttons ma be depressed to provide talkback to a points for studio paging. Of cours any studio that may be on the air ha its speaker cutout and is inoperativ for talkback while in use. To obtai sufficient level a single stage pre amplifier had to be provided in th talkback circuit. It is labelled *TB-pr* in the diagram.

Speaker cutout relays and warning or signalling lights as well as the indi cator lights on the console are operated by a 12-volt, 5-ampere d-c pack with a dry-disc rectifier. A 2,000-mfd, 15 volt capacitor prevents hum being fed into audio circuits. The induction field around this pack proved a very serious matter. We therefore oriented the pack to minimize hum pickup in all input circuits.

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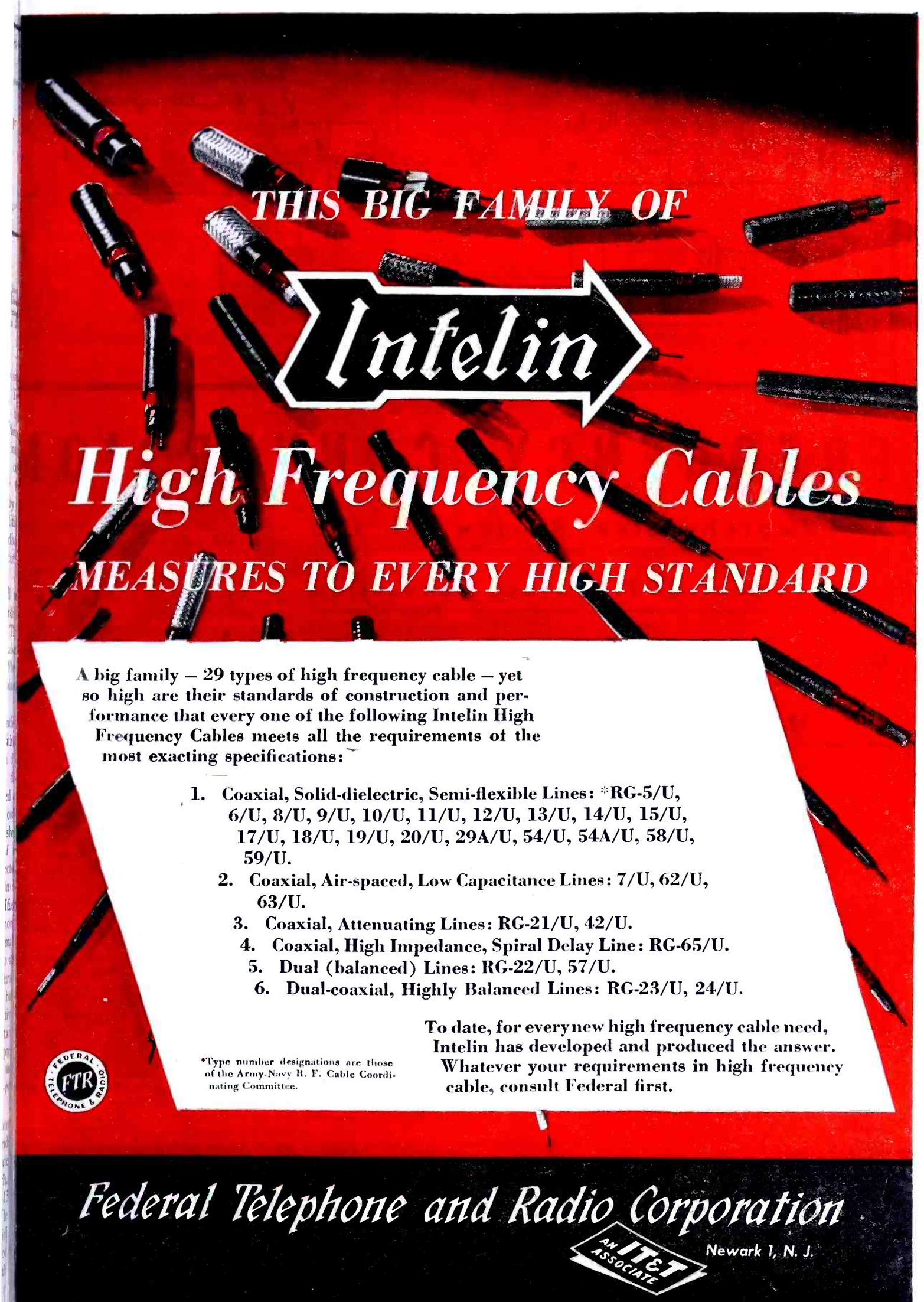

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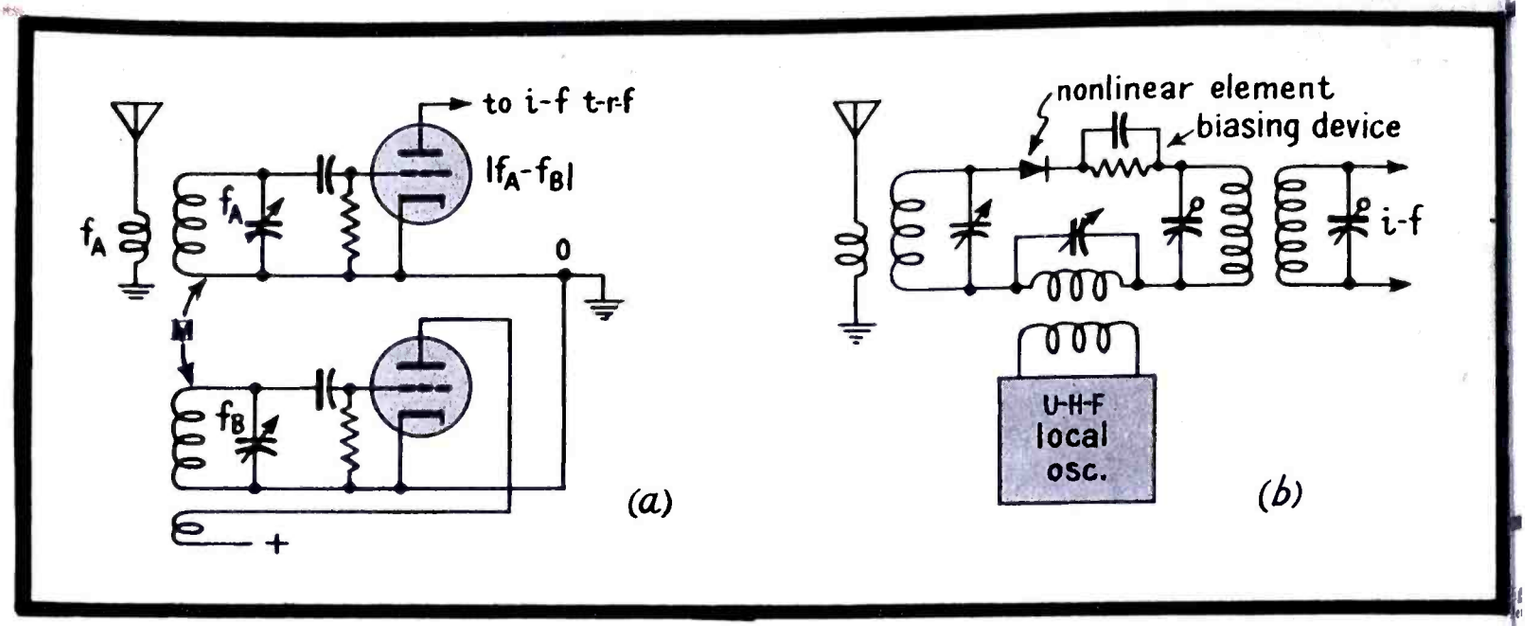

FREQUENCY CONVERSION

A Comprehensive Review of the Development of Frequency Conversion Circuits, Citing the Progress Made Here and in Europe

[PART ONE OF A TWO-PART PAPER]

by HARRY STOCKMAN

Cruft Laboratory, Harvard University

THE first application of frequency conversion, known to the writer, was made in radio transmission circuits. If two waves, differing by a low frequency, were transmitted at different points and then received at a third point on a nonlinear-circuit-element receiver, the difference frequency became audible in a properly connected telephone. A patent covering this idea was filed in 1901 by R. A. Fessenden (an American engineer). He not only used a system in which both waves were produced outside of the receiver, but later described a system in which one of the waves was produced inside the receiver. With the latter arrangement he was able to vary the pitch of the audible difference-frequency tone produced by the dots and dashes in code transmission; a great improvement. As a nonlinear circuit element Fessenden utilized an iron-core inductance.[1]

The latter system used by Fessenden laid the foundation for so-called *heterodyne receiver circuits,* which soon became of great importance. The word *heterodyne* is derived from the Greek *Heteros* (other, external) and *Dynamis* (power), and supposedly illustrates that the weak incoming signal is reinforced from another source; the locally produced wave. In code receivers of today the source of this wave is known as the *continuous-wave oscillator,* c-w-o, and the audible difference-frequency component is referred to as the *beat,* and its frequency as the *beat frequency.* (Unfortunately the continuous-wave oscillator is sometimes called *beat-frequency oscillator,* b-f-o; a misleading term, which describes a particular type of laboratory equipment and should not be used in connection with code receivers).

The heterodyne-type receivers described were of interest for code reception only. During the decade preceding World War 1 this type of receiver was gradually improved and equipped with a crystal rectifier as nonlineal element. Although such a receiver does not have any element that functions as a detector, just a frequency changer, it is not representative for frequency conversion circuits of the type to be discussed in this paper, and will not be further considered.

Developments Prior to 1920

In 1904 A. Fleming invented the diode, to be followed in 1907 by the Lee de Forest triode. Both these tubes were used in heterodyne-type code receivers, the triode as a continuous-wave oscillator in 1913, following the inventions of regenerative circuits by E. H. Armstrong, Lee de Forest, G. Arco, A. Meissner, and others. Toward the end of 1913 H. G. Round invented the single-tube heterodyne receiver, which later under the name *autodyne* became widely used as a superheterodyne type of circuit.

Before further developments are discussed, let us briefly recapitulate the evolution of the vacuum tube, and follow through the tube developments up to the present time. In 1913 Langmuir introduced the double-grid or *space-charge grid* tube (in England known as the bi-grid tube). This tube could do most of what the triode was able to do, however, with very much reduced plate-voltage. Around 1919 W. Schottky invented the *screen grid* as a means of increasing the power efficiency of low-frequency output power tubes, such as loudspeaker tubes, It is well known that the Schottky tetrode failed to give the improvement aimed at, principally because of secondary emission, causing a dip in the plate-current versus plate-voltage curve. Several years later a third so-called pentode or suppressor grid was introduced, which created a strong bucking field between itself and the plate, preventing electrons released at the plate from escaping from this electrode, caus-

Although any electrical or mechanical device that changes the frequency of a given alternating quantity may be referred to as a frequency changer or frequency converter, the term, in this paper, is restricted to electrical communication devices only.

[1] A. T. Witts, *The Superheterodyne Receiver,* Pitman and Sons, London; 1942.

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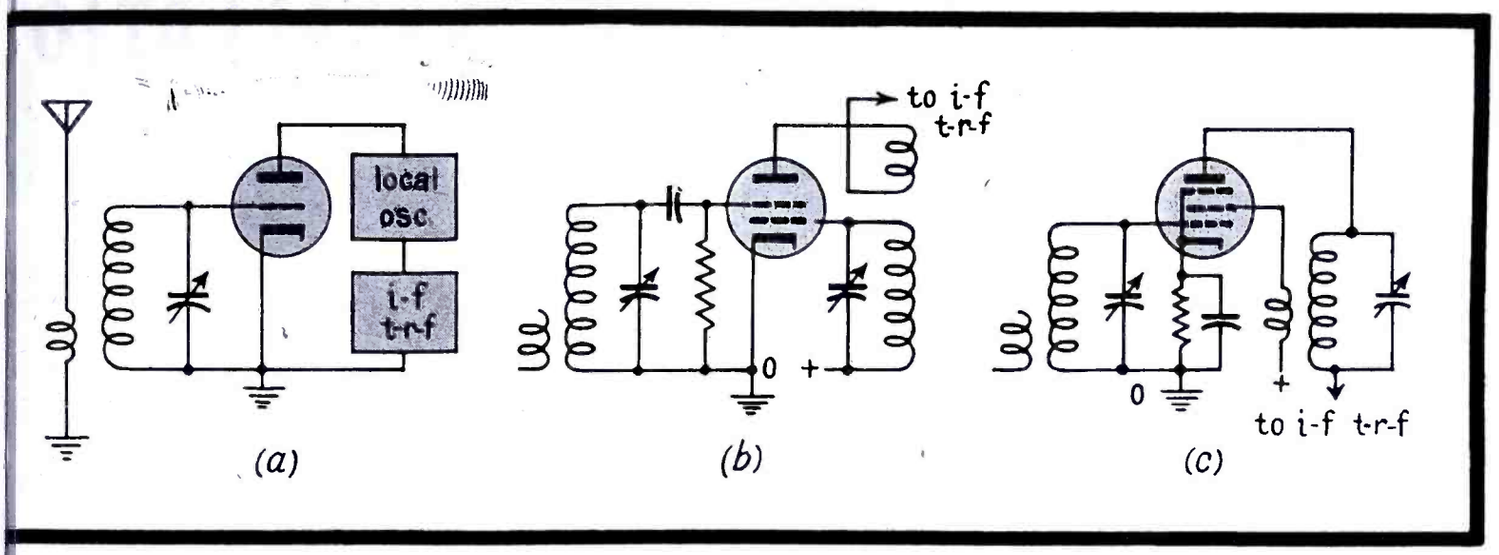


Figures 1 (page 46, left) **and 2** (above)

gure 1, circuit coupling as employed in the first superheterodynes (*a*), and (*b*) in more modern u-h-f receivers, where the signal and oscillator ments may have the form of resonant lines or cavity resonators. Figure 2, developments leading up to electron-coupling: ultradyne (*a*), double-grid converter tube (*b*), and h-f pentode converter tube (*c*).

CIRCUIT DEVELOPMENT

g undesirable plate current variations. he Philips Company in Eindhoven, olland, has received much credit for e invention of the low-frequency out-t pentode.

During the developments just described e tube design had been vastly improved many other respects as well. The gh-temperature receiving tube was re-aced by the dull-emitter tube around 25, so that three to six tubes could be iven with the cathode power that was eviously required for one. (This be-me a factor in favor of the super-terodyne, as this circuit required a rge number of tubes). Between 1925 d 1930 indirectly-heated tubes became mmonly used in all except battery-op-ated receivers, and this brought about veral changes in circuits employing bes. Cathode coupling, for example, uld be used with advantage (cathode jection in mixer tubes), and individual thode bias employed, making the tube ages more independent and thus im-roving stability.

During the time when the European be manufacturers concentrated on 1-f tput pentodes, with Philips in Holland ading many phases of the research ork, the American manufacturers arned to appreciate the advantage of e pentode for high-frequency amplifi-cation as well. Even if there were early attempts in Europe to replace the commonly used h-f tetrodes with pentodes, America must be credited with the general adoption of the h-f pentode on a large commercial scale. For several years it was common to find European and American receivers built more or less the same way, the former, however, employing tetrodes and the latter pentodes in the high-frequency stages. Around 1930 there was a definite trend toward high-frequency pentodes even in Europe and a few years later the high-frequency tetrode ceased to be of importance for the set manufacturers. (The introduction of screen-grid tubes had for the superheterodyne receiver just the opposite effect to the one caused by the introduction of the dull-emitter tube; it delayed its development. The necessity for frequency changing in an early stage of the receiver became less acute when stable amplification could be obtained on the incoming frequency and without the necessity for neutralization circuits).

The different trends in development on both sides of the Atlantic must be placed against a background of beliefs of the early stages. Schottky himself, when inventing his loudspeaker tetrode, did not, as it seems, believe that this tube contributed stability to high-frequency circuits.* (There are reasons to believe that the later appreciation of screen-grid tubes in high-frequency circuits was partly due to the early work of radio amateurs, who tried everything not knowing if it was supposed to work or not).

Figure 3

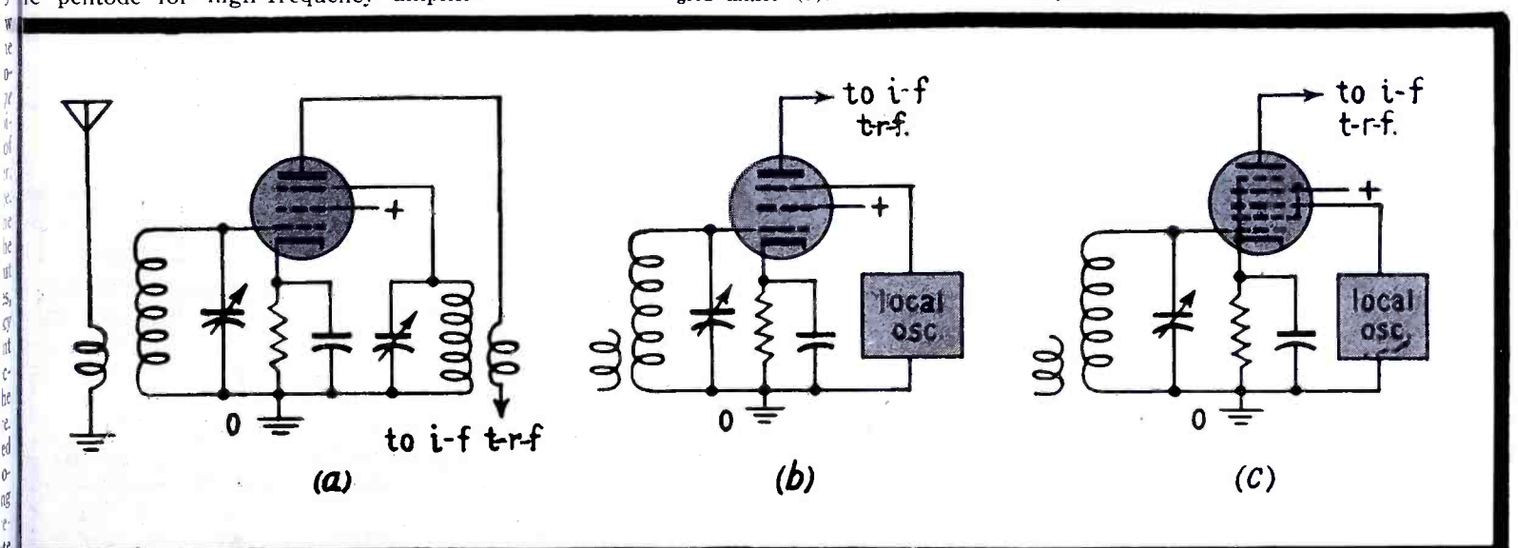
Developments of electron-coupled converters: improved type of h-f pentode converter tube (*a*), h-f pentode mixer tube (*b*), and modern pentagrid mixer (*c*).

The Superheterodyne

Before discussing tubes with more than five electrodes, let us turn back to the development of frequency conversion circuits prior to 1920. At the end of the first World War there appeared a new type of radio receiver; the superheterodyne. The fundamental parts of the

(*Continued on page* 88)

*W. Schottky: *Uber Hochvakuumverstärker*, III Teil, Archiv für Elektrotechnik, pp. 299-328; *Band VIII* 1919. In this paper the following statement is of particular interest: "In the question of *freedom from whistling* (prevention of self-excitation of the amplifier circuit) the screen-grid tubes (Schutznetröhren) with correctly chosen transformers and proper electrostatic shielding (Schutz) do not differ from the other tubes; this question, which initially produced many difficulties in the art, now only plays a subordinated role."



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(PART TWO OF A TWO-PART PAPER)

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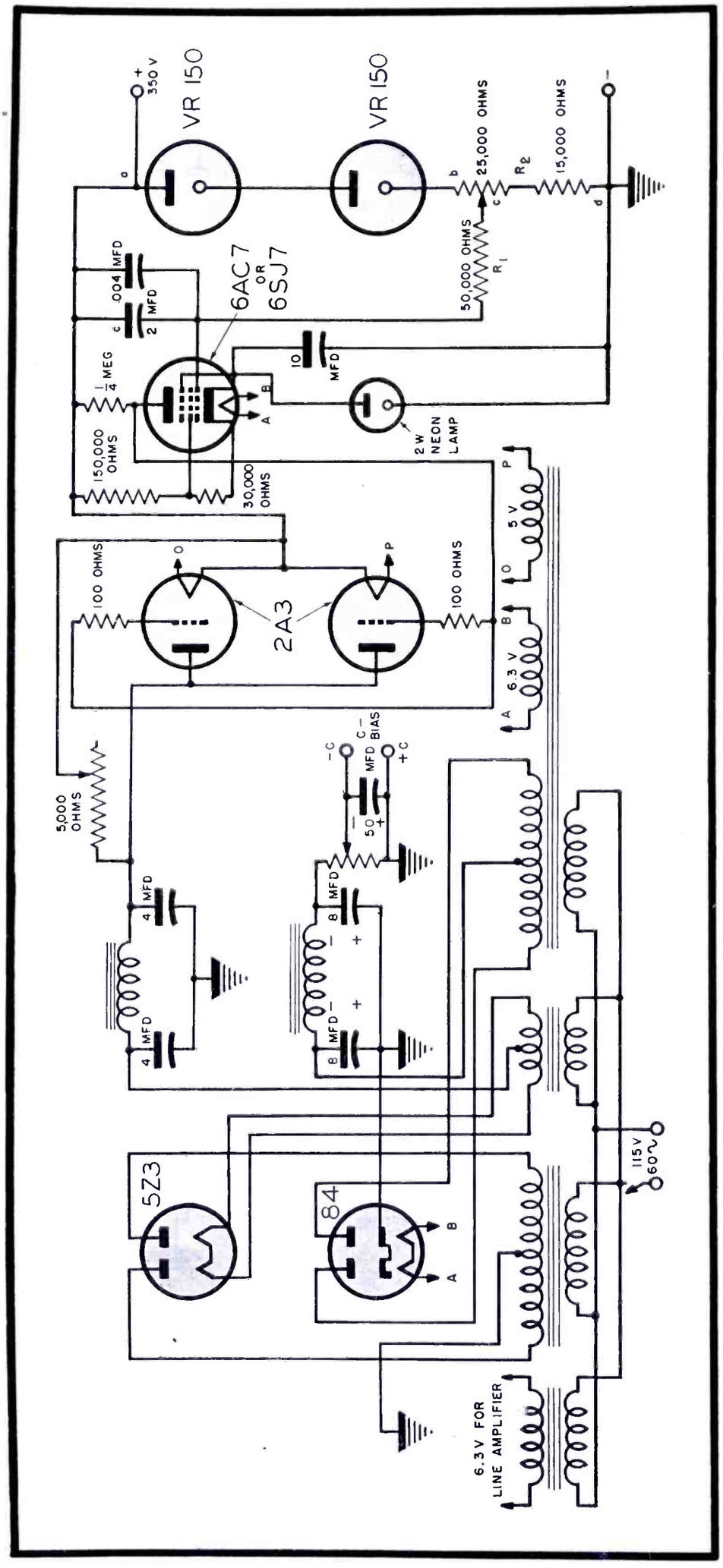
Consulting Engineer

Capitol Radio Engineering Institute



THE regulated power unit bu tor the installation is shown Figure 7. Two gas tubes are series with potentiometer R_2. The gr of the single amplifier tube is connec ed to the arm of R_2; the cathode of th tube is held above ground by a thir gas tube, as shown. Two 2A3 tubes i parallel function as the series rheosta

Suppose for any reason point changes its potential relative to poi *d* by an amount $\triangle E$. Since the tw gas tubes maintain a constant voltag between points *a* and *b*, point changes its potential relative to *d* b the same amount $\triangle E$. If the poten tiometer arm is set at point *b*, then th grid of the amplifier tube receives voltage change $\triangle E$ relative to th cathode, since the latter is held at fixed voltage above ground by its ga tube. Thus the voltage change $\triangle$ is transmitted full strength to the am plifier.

Suppose, however, that the poten tiometer arm is half-way down be tween *b* and *d*. Then the potentia change between the arm (point *c*) an ground (point *d*) is only half of $\triangle E$ or the amplified tube receives onl half of the output voltage change.

One can regard the amplifier tub and the two rheostat tubes as a two stage d-c amplifier whose output is fe back degeneratively to the input. Th forward gain of the amplifier may b denoted by α, and the feedback by β

Figure 7

The regulated power unit, with two gas typ tubes, VR150, in series with potentiometer R

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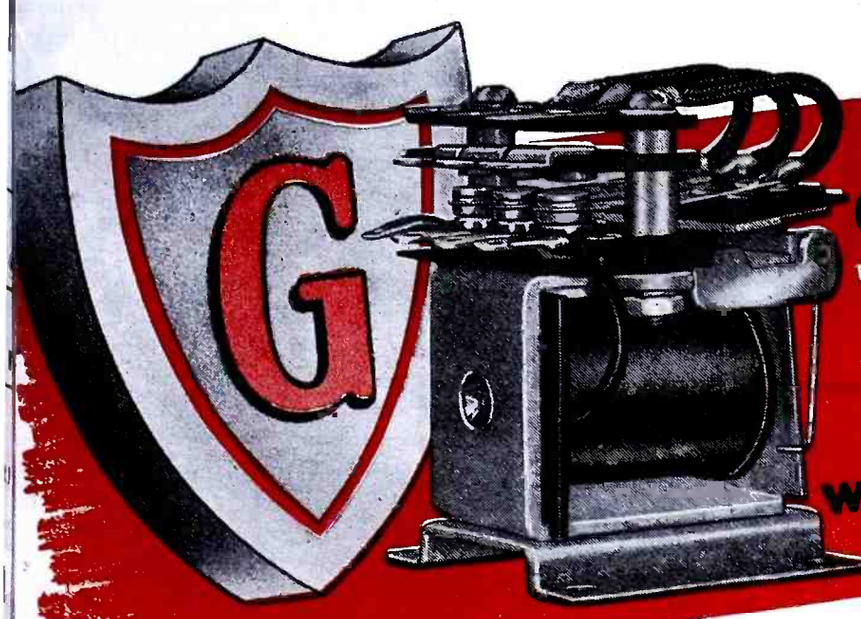

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VARIATIONS OF THE SERIES 345 RELAY

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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.

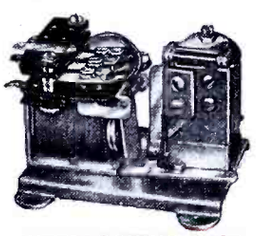
TIME DELAY—On D.C. coils a time delay of 0.25 seconds on release or 0.06 second on attract may be achieved through the use of copper slugs which require these time intervals for saturation or de-energizing depending on whether they are used on the heel or head of the coil.

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

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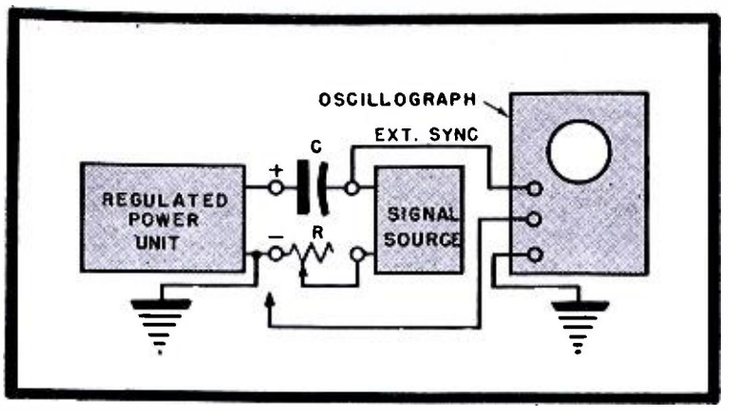


Figure 8

Suggested method of testing regulated power supply with c-r-o and audio oscillator signal source.

where β represents the fraction of the output voltage change ($\triangle E$) fed back to the grid of the first tube.

If c is at b, then β is a maximum (unity), whereas if c is close to d, β is near zero. Maximum regulating effect is obtained when α and β are a maximum. The value of α is fixed by the tubes and circuit employed. The value of β is determined by the voltage developed by the rectifier, the regulated output voltage desired, and the number of gas tubes employed and their voltages.

If maximum output voltage is desired, c must be moved down close to d. This biases the amplifier tube to the greatest extent, reduces its plate current and hence the drop in its plate resistor, and thereby reduces the bias on the series-rheostat tubes. They can therefore pass the desired current with less (plate) voltage drop, thus affording maximum output voltage.

At the same time, however, β is reduced because c is farthest from b. To increase β, it is therefore advisable either to increase the input voltage from the rectifier or to increase the voltage drop across the gas regulator tubes. The latter are normally available in voltages of 150, 135, 105, 75 and 60 volts (the latter is a special neon tube). These can be readily placed in series in any combination. The regulator tube in series with the cathode can also be chosen in the above voltages. It is thus often possible to bring point b close to the cathode in potential even at the highest output voltage desired, say 300 volts, so that the grid can be operated three-quarters of the way up the potentiometer or higher.

A further aid is to employ an R-C combination in the grid circuit. This acts to keep the grid close to point a as far as quick changes in the output voltage are concerned; i.e., it also acts to increase β for a-c variations in the output voltage.

Tests made on the regulated power units indicated, however, that values of C greater than 2 mfd and R_1 greater than 50,000 ohms did not improve the regulation appreciably, at least as far as line voltage surges are concerned. The higher the product R_1C is, the better is this combination able to cope with low-frequency voltage changes. However, if the gas regulator tube combination is suitably chosen, it, too, can cope with slow voltage variations, and probably masks the effect of R_1C. In passing it should be noted that C should have low leakage and this factor in itself limits the value of R_1C. Also, some tubes, like the 6AC7, cannot have more than about 100,000-ohms resistance in the grid circuit unless the tube is self-biased.

Measurement of Internal Resistance

The regulated power unit should be able to cope with line voltage surges to reduce *picture bounce* to a minimum. It should also have as low an output impedance as possible, especially for low frequencies, to minimize the possibility of motor-boating. The output impedance should be considerably less than 1 ohm.

A suggested method of testing for this is to connect up a test circuit, Figure 8. First the output bypass condenser across the output terminals of the regulated power unit should be disconnected if it is desired to test the electronic regulating unit alone. A fairly high-gain oscilloscope should be employed for good sensitivity. The signal source may be any kind of audio oscillator, and should preferably be set to a farly low frequency, somewhere in the neighborhood of 60 cps, although tests can be made at various frequencies.

The blocking condenser C should be fairly large; the larger the better, and the output voltage of the signal source should also be as large as possible, for good sensitivity. The rheostat R should be low, on the order of a few ohms. A filament rheostat is suitable.

Test Unit Application

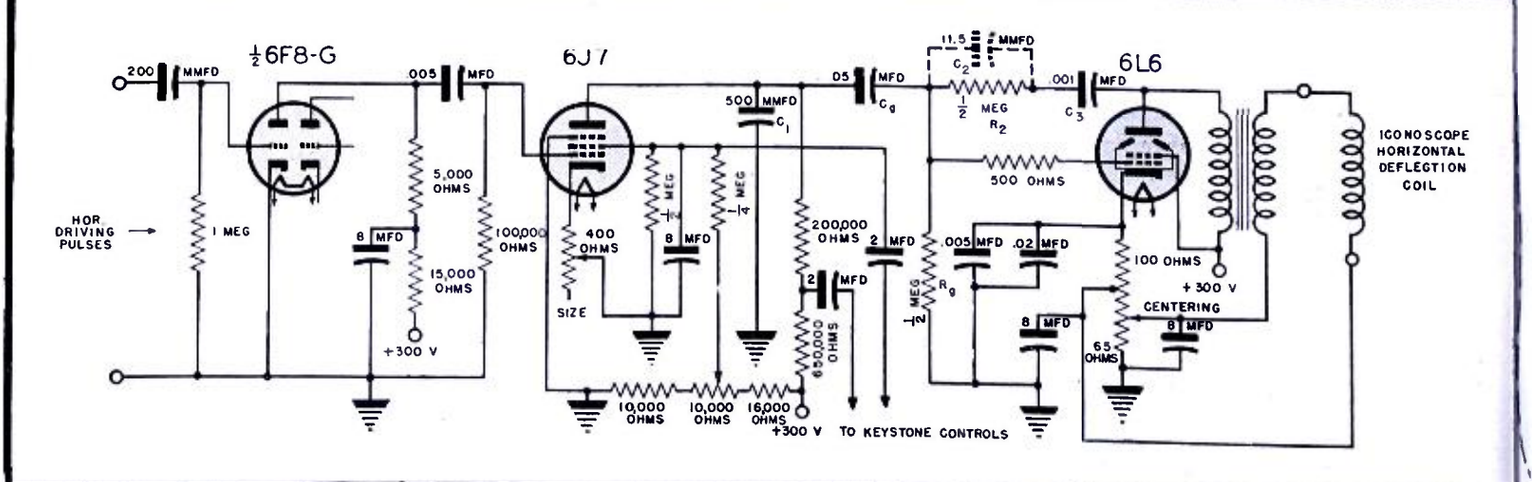
In operation, a signal is impressed upon the regulated power unit and the rheostat in series. The *high* lead of the oscilloscope is connected to $B+$ and then to the *high* side of R, and R adjusted until the signal voltage across it, as observed on the oscilloscope, is equal to that across the regulated power supply. R is then removed from the circuit and its resistance measured on an ohmmeter or preferably on a *Wheatstone* bridge. The value measured is the internal impedance of the regulated power supply.

Often with the test components available, all that can be observed is that no appreciable indication is obtained on the oscilloscope when connected across the power supply, or when connected across R, if the latter is made much less than an ohm. One

(*Continued on page* 66)

Figure 9

Iconoscope horizontal deflection generator circuit.



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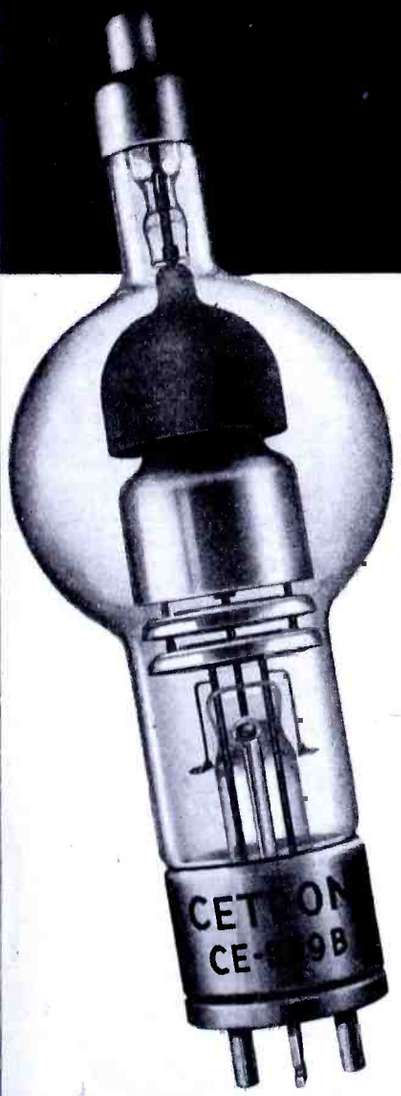

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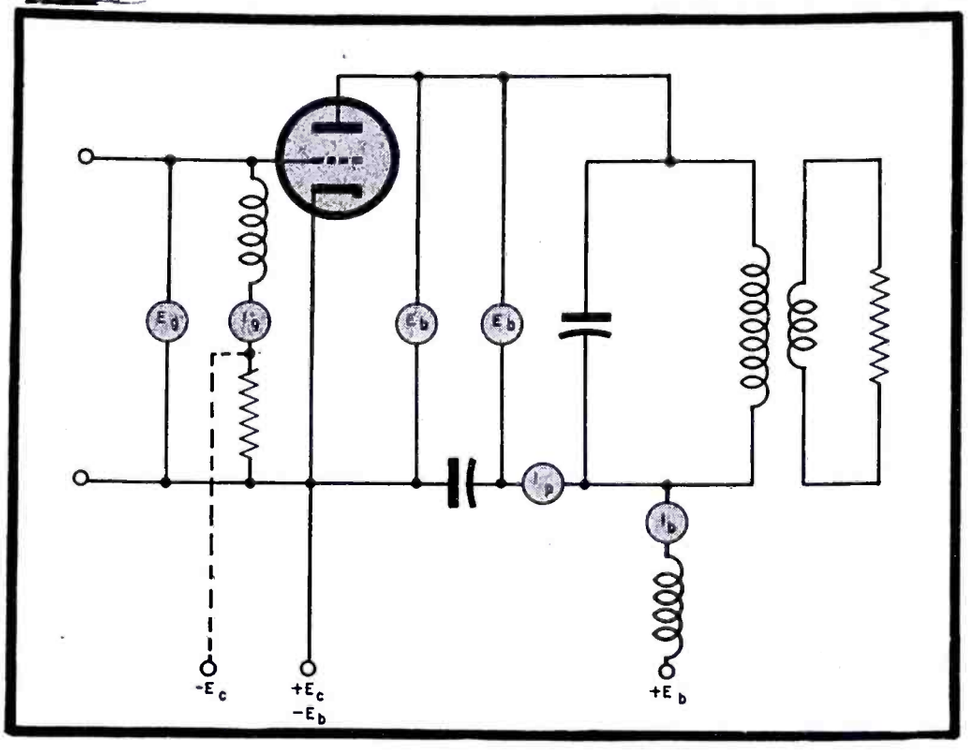

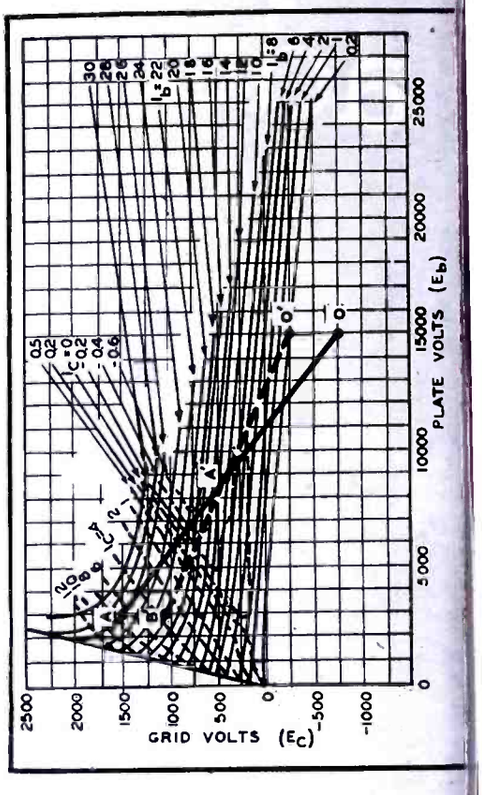

Figures 1 (above) and 2 (right)

Figure 1 illustrates a typical class *C* amplifier circuit. Various voltages and currents are indicated. In Figure 2 we have the average constant-current characteristcs of an 898 used in the graphical analysis of class C amplifiers, in this paper.

EXTERNAL-ANODE TRIODES

CHARACTERISTICS AND APPLICATIONS

Analysis Of Applications in Class C, Class B R-F and A-F Amplifiers, and High-Power Oscillators

[PART FOUR OF A FOUR-PART PAPER]

by A. JAMES EBEL
Chief Engineer WILL
Assistant Professor of Electrical Engineering,
University of Illinois

IN the design of equipment utilizing external-anode triodes, the output requirement of the equipment is usually the determining factor. Second in importance is availability of standard equipment to meet the design requirements, and third is the cost factor, which must be balanced against expected results. Fundamental applications of these tubes are in class *C* amplifiers, class *B* radio-frequency and audio-frequency amplifiers, and high-power oscillators. It is beyond the scope of this paper to discuss completely the design procedure for each of these applications. For the engineer who is interested in complete design data, a complete bibliography has been prepared.* It is rather our purpose to touch on the design procedure for each application so that the operating engineer may have some insight into the source of operating constants.

Because the class *C* amplifier design procedure may be made the basis for other design applications it will be considered first. A typical circuit diagram of a class *C* amplifier with the various voltages and currents indicated is shown in Figure 1. There are a number of methods of approach in the design of class *C* amplifiers. In general the more approximate the design procedure the simpler it becomes. The method of Terman[1] represents perhaps the best compromise between absolute accuracy of results and ease of application. It can often be used to arrive at the constants needed in the more exact analysis to be described. In dealing with design problems it is often expedient to use a simple approximate solution and then to get the accurate data and the final design from trimming up a model constructed according to the approximate design. In the case of external-anode triodes however, the cost of constructing a model is so great that the design must be accurate enough to allow for exact specification of the equipment which is to be used.

Therefore the method of analysis developed by Mouromtseff[2] will be

[1] F. E. Terman and W. C. Roake, *Calculation and Design of Class C Amplifiers*, Proc. IRE, pp. 620-632; April, 1936.

[2] I. E. Mouromtseff and H. N. Kozanowski, *Analysis of The Operation of Vacuum Tubes As Class C Amplifiers*, Pro. IRE, pp. 752-778; July, 1935.

*See conclusion of paper.

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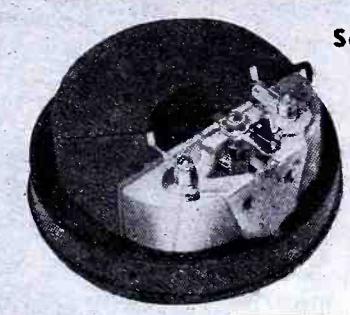

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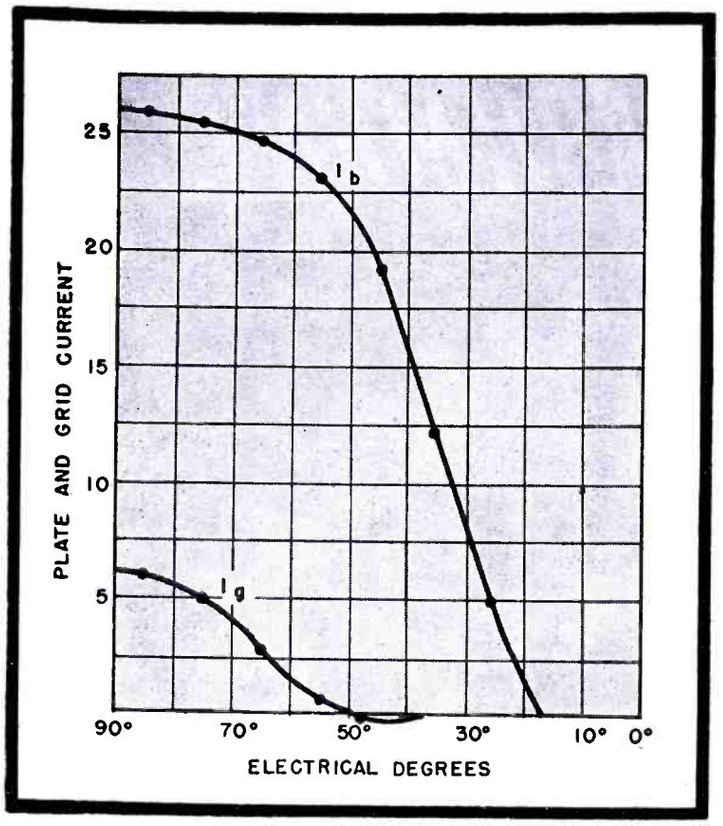

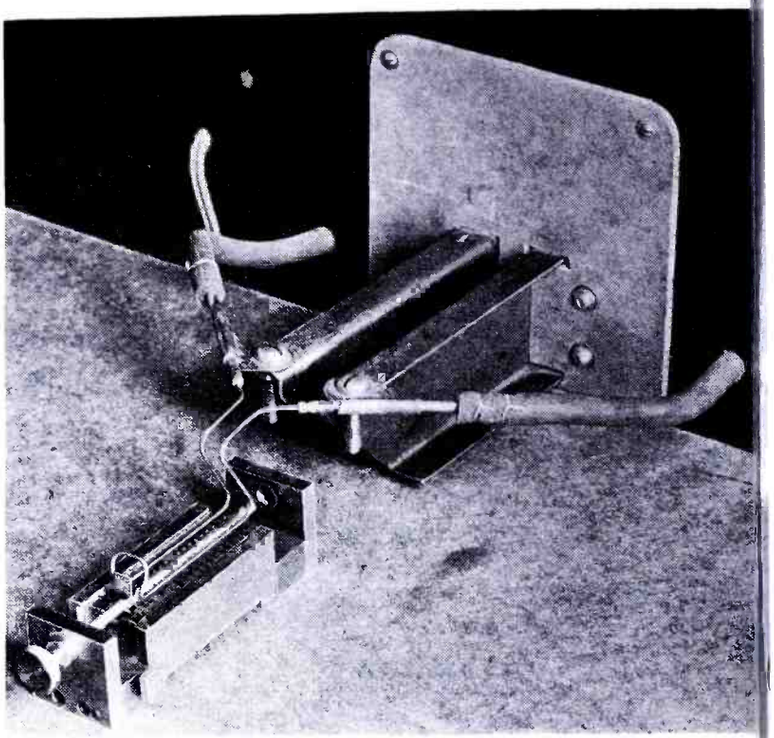

Figures 3 (left) and 4 (above)
Figure 3, a plate-current-time curve. Figure 4, an r-f heat application in variable condenser construction.
(*Courtesy FTR*)

used here in the analysis of class *C* amplifiers and will be modified for application to class *B* r-f amplifiers and oscillators. This is a graphical analysis which uses constant-current characteristics for a vacuum tube, such as those shown in Figure 2. The fundamental drawback to the application of this method is that it requires a series of successive approximations before the exact result may be achieved. It is a cut and try method on paper instead of in the laboratory.

There are certain fundamental facts concerning the operation of a class *C* amplifier which will serve as guide posts to the engineer in constructing load lines on the constant-current curves and which will reduce the number of attempts necessary before the best solution is attained. It is known, for example, that the minimum plate-voltage swing must not dip below the maximum grid-voltage swing. Also it is generally known that the proper bias will be in the vicinity of twice cutoff basis. The required output will, after a few trials, also specify the plate voltage swing which will be necessary. Finally the available d-c plate voltage will be a determining factor.

The load line *OA* in the Figure was drawn from an operating plate voltage of 15,000 volts and grid bias of 750 volts (point *O*) to a minimum plate voltage of 3,000 volts and an assumed positive grid swing of 1,500 volts. In order to plot a plate current-time curve such as shown in Figure 3, it is necessary to divide this line into segments which are proportional to the sine of the electrical angle at which the current is to be taken off. In this example the points shown correspond to angles of *5, 15, 25, 35, 45, 55, 65, 75, 85,* and *95°*. These angles were selected since they represented the mid-points of each 10° segment of the curve in Figure 3. Therefore the values taken off may be tabulated directly, as in *Table I,* without the necessity of plotting the curve mentioned above. A sine scale[3] will greatly facilitate the division of the load line according to the sines of the angles.

If the currents taken off at these points are multiplied by the angle at which they are taken off, as illustrated in *Table I,* and if the sums of these tabulations are divided by *18* (twice the *9* intervals to consider a full wave) the direct plate current, I_b, and the alternating plate current I_p may be determined. The power output is given by

$$P_o = I_p E_p \qquad (1)$$

or $P_o = 6.33 \times 12{,}000 = 75.96$ kw

The power input is given by

$$P_i = I_b E_b \qquad (2)$$

or $P_i = 7.43 \times 15{,}000 = 112.35$ kw

Then the efficiency is

$$n = \frac{P_o}{P_i} = \frac{75.96}{112.35} = 68\% \qquad (3)$$

The load impedance is determined by

$$R_L = \frac{E_p^2}{2P_o} = \frac{E_p}{2I_p} = \frac{12{,}000}{2 \times 6.33} = 948 \text{ ohms} \qquad (4)$$

Taking off the values of grid current

(*Continued on page* 56)

[3] *Handbook of Tube Operation,* Federal Telephone and Radio Corporation, p. 27.

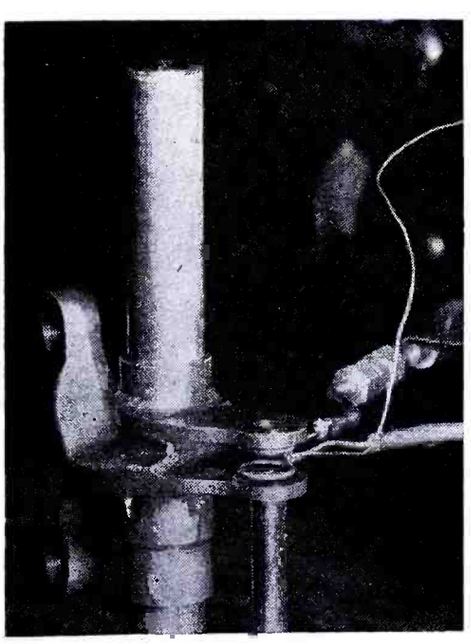

Figure 5
R-f heating for surface-hardening application using self-quench oscillator.
(*Courtesy FTR*)

Mid-Ordinate Angle	Indicated Current	Current x Sine of Angle
85°	25.8	25.8
75°	25.5	24.5
65°	24.5	22.3
55°	23.0	18.8
45°	19.0	13.4
35°	12.0	6.9
25°	5.0	2.3
15°	0.0	0.0
5°	0.0	0.0
	134.8	114.0
	$I_b = \frac{134.8}{18} = 7.49$	$I_p = \frac{114.0}{18} = 6.33$

Table I

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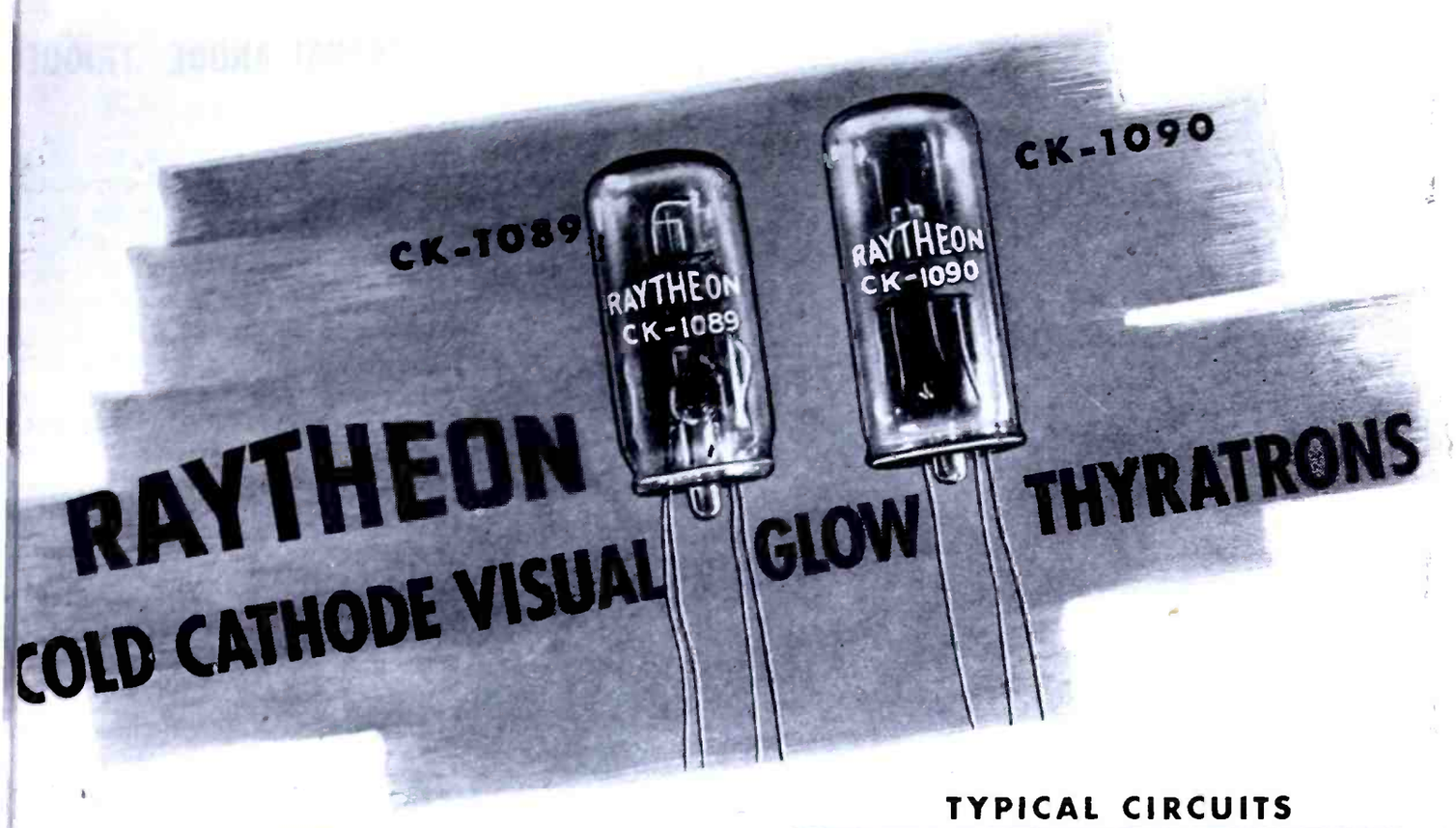

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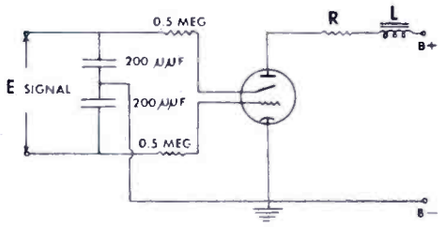
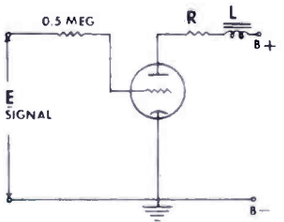
TYPICAL CIRCUITS

CK-1089



CK-1090



R = Current limiting resistance. L = Relay coil if used.

SPECIFICATIONS OF CK-1089 AND CK-1090

Minimum Peak Anode Breakdown Voltage (No Signal)	225 volts
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Peak Positive Starter-Anode Breakdown Voltage Starter Electrode to Cathode on CK-1090	170 max. volts
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EXTERNAL-ANODE TRIODE

(*Continued from page* 54)

along the same load line and at t marked intervals, the grid-current-tim curve is determined, as shown in Fi ure 3, and the tabulation shown *Table II* is made. From this the gr current, I_g, can be determined as show and the grid driving power, P_g, a the bias loss, P_c, are calculated as fo lows:

$P_g = I_g E_g = .81 \times 2{,}250 = 1{,}822.5$ w (5

$P_c = I_g E_c = .81 \times 750 = 607.5$ w (6

These operations have provided set of operating constants for an 8 water-cooled tube. An examinatio of these constants shows that:

(*1*)—The power output, maximu plate current, plate dissipatio and grid losses are within th prescribed limits.

(*2*)—The efficiency is too low for u modulated operation.

(3)—The load resistance is low.

Before making another attempt th calculations should be examined wit the view of determining the directio of change which will become neces sary. A study of *Table I* will sho that if the angle of flow of the curren is less the efficiency will be higher This indicates a higher value of bia and will also necessitate more grid driving voltage. To increase the loa resistance it will be necessary to in crease the plate-voltage swing or th grid swing or both. With this infor mation available another attempt ma be made. Since this is an illustratio to indicate procedure and not to arriv at any final designs, we shall omit ad ditional steps that can be applied t probe the problem.

If the design problem involves a modulated class *C* amplifier, we ma determine a new operating point b applying the rule stating that . . . a 100% modulation the plate voltag will be double the carrier value and th bias value will either remain the sam with fixed bias or vary downward wit grid-leak bias. The analysis by *Mou romtseff* and *Kozanowski* effectively illustrates the design of modulated am plifiers. From the above discussion i is apparent that some of the approxi mate methods will be helpful in deter-

Mid-Ordinate Angle	Indicated Current
85°	6.0
75°	5.0
65°	2.8
55°	.7
	14.5

$$I_g = \frac{14.5}{18} = .81$$

Table II

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nining preliminary data for use in the xact analysis.

The recent development in r-f heating as an industrial tool and the number of successful applications in connection with war industries have rewakened the interest in the high-power oscillator-design problem. Whether the application is one of inductive heating or one of dielectric eating the oscillator-design problem emains the same. Roughly stated, the enerator must deliver a specified mount of power to the application circuit, which may be a low- or a high-mpedance load. The requirement of requency stability is not important. The overall stability of the generator s most important, however, if it is to ive reliable service in industrial applications. The efficiency of the unit hould be as high as possible. Figures 4 and 5 shows some r-f heating applications.

The design of the high-power oscillator is essentially a class *C* amplifier lesign problem with the addition of leveral other factors which tend to omplicate the design procedure. Figure 6 shows the circuit diagram of a ommercial r-f heating power generator. From the theory of oscillator peration it is known that the grid ias, generally grid-leak, depends on he excitation. The excitation in turn lepends on the output of the oscillator ince a part of the output is fed back o the grid to produce the excitation. With increasing output producing ever ncreasing input, the output will rise till the mode of the amplifier operation s such that a further increase in excitation voltage will produce no increase in output voltage. This is the equilibrium point for the operation of the oscillator and is a function of the tube characteristics, grid-leak resistance, applied plate voltage, circuit losses, and feedback factor. With this *which came first—the chicken or the egg* situation facing the designer, it will be necessary to assume certain values which may have to be modified later in accordance with the results of the calculations.

If a class *C* dynamic characteristic such as shown in Figure 7 is available for an amplifier operating with a given value of grid-leak resistance, the oscillator-design problem becomes a very simple one. Such a characteristic can be determined experimentally in any class *C* amplifier by varying the excitation voltage and measuring the a-c output current. As mentioned before, this experimental procedure might become very expensive if the high-power equipment is not available. The other alternative is to plot such a character-

(*Continued on page* 86)

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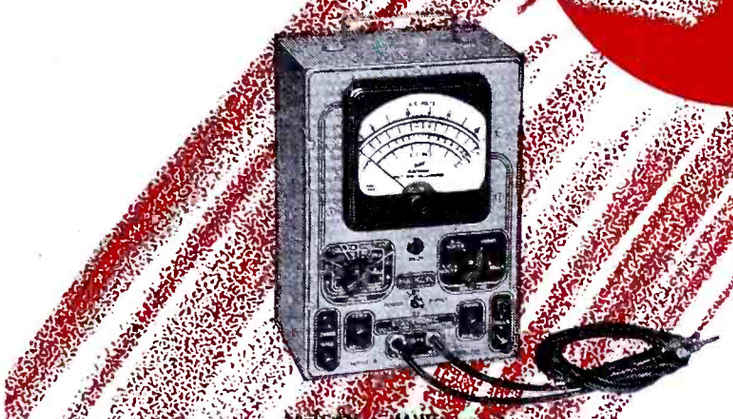

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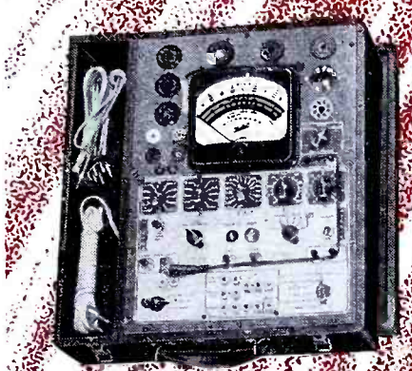

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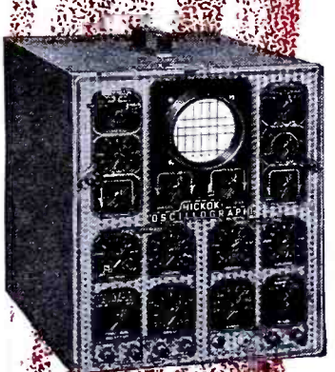

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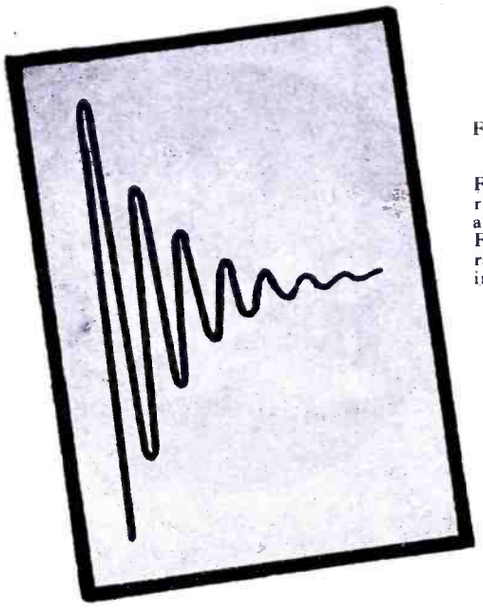
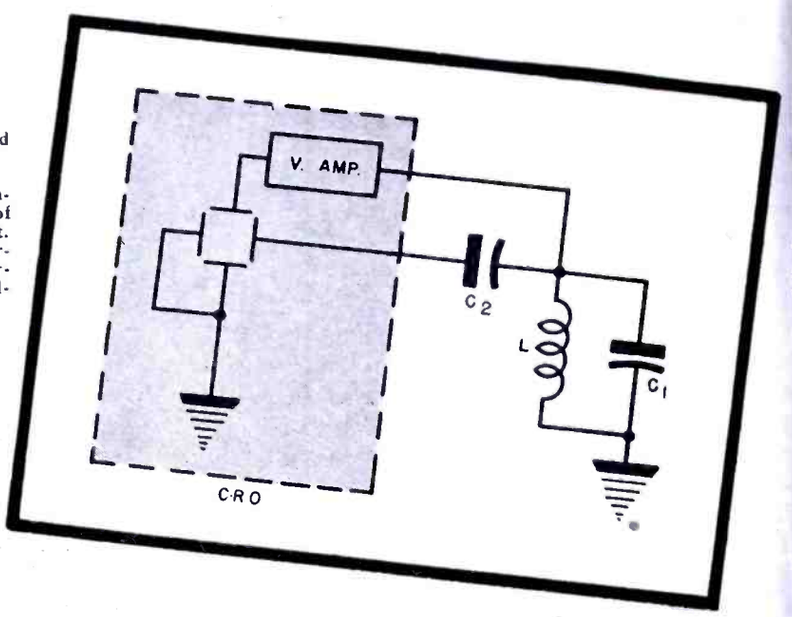


Figures 1 (left) and 2 (right)

Figure 1, the logarithmic decay curve of an oscillating circuit. Figure 2, circuit arrangement for measuring Q on the oscilloscope.



MEASURING Q WITH THE C-R OSCILLOSCOPE

by ROBERT C. PAINE

INDUCTORS used in radio communications circuits are not pure inductance, but consist partially of resistance. This subjects an oscillating current, passing through an inductor, to a loss of energy, in the wire and in the surrounding material immersed in its field. With the aid of a cathode-ray oscilloscope it is possible to apply this circuit phenomenon to measure the resistance of an inductor.

In this method the inductor forms a part of an oscillating circuit to which a pulse of energy is supplied, creating oscillations which are allowed to die out gradually due to the loss of energy. This is shown in the logarithmic voltage curve of Figure 1, where the height of each cycle is successively lower than its predecessor by a constant ratio. The logarithm of this ratio to the natural base Ξ is known as the logarithmic decrement, d. This measure of efficiency was commonly used in the days of radio when operations depended on oscillating spark discharges which gradually died out in this manner. It is related to the present commonly used figure of merit $Q = (\omega L/R)$ by the expression $Q = \pi/d$. The curve of Figure 1 can be readily formed on the screen of an oscilloscope and the ratio of height of

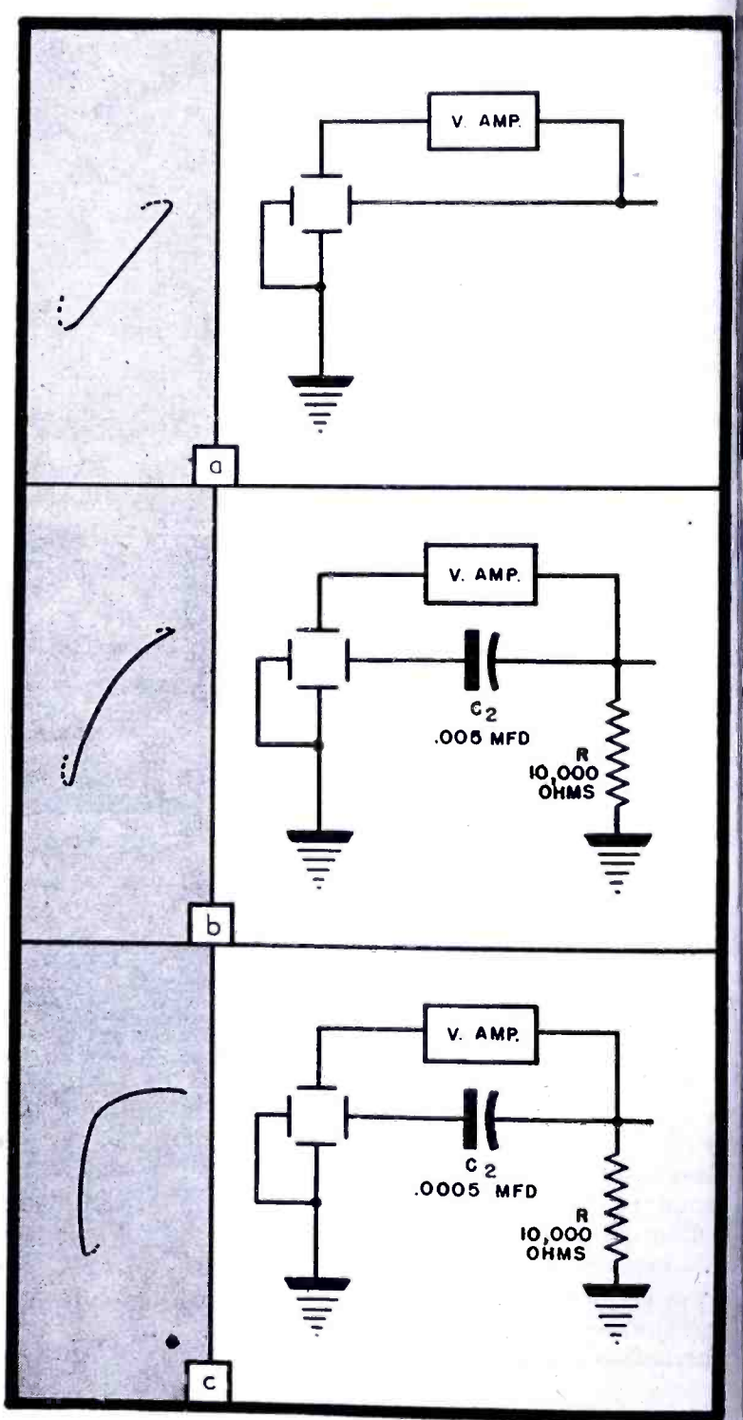


Figure 3

How a sharp pulse can be obtained from the c-r-o sweep voltage by differentiation. In *a*, the vertical amplifier is connected directly to the horizontal sweep voltage producing a diagonal line, one cycle of the saw-toothed wave. In *b*, the coupling is through C_2. Resonant impedance of oscillating circuit is represented by R. In *c*, we see how the saw-toothed wave is differentiated, creating single sharp pulse during return sweep.

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59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

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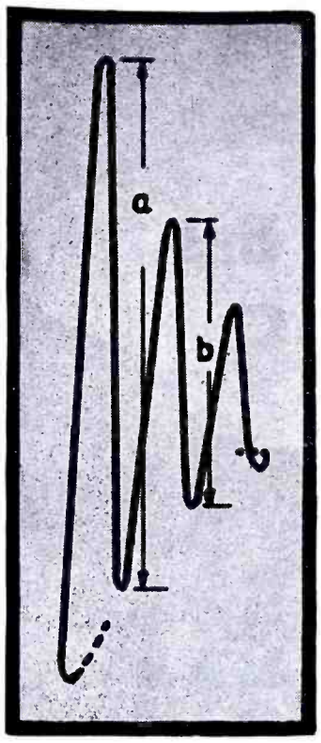

Figure 4
Oscillation curve of a 22.5-mh coil at 1,000 cycles as seen on the oscilloscope screen. $Q = 1.364/\log (a/b)$

successive peaks, r, found by direct measurement with a scale. The value of $d = (\log_{10} r/\log_{10} \xi) = (\log_{10} r/.4343)$ and $Q = .4343\ \pi/(\log_{10} r) = 1.364/(\log_{10} r)$.

The sharp pulse of voltage necessary to excite oscillations in the tuned coil is derived from the saw-toothed wave of the oscilloscope sweep circuit by means of a differentiating circuit arrangement. The circuit arrangement is shown in Figure 2, where the condenser C_2 is connected at some convenient point for tapping the horizontal sweep voltage. The condenser C_1 is selected to tune the inductor under test. L, to any frequency that is desired and can be satisfactorily observed.

The effect of the differentiating circuit is shown in Figure 3. In (a) the vertical amplifier is connected directly to the horizontal sweep voltage producing a diagonal line, one cycle of the saw-toothed wave, on the oscilloscope screen. In (b) the coupling is through condenser C_2 and the resonant impedance of the oscillating circuit is represented by a resistor, R. The saw-tooth wave is then modified as shown When used in measuring Q, C_2 has a relatively high impedance as shown in Figure 3(c), and the saw-toothed wave is differentiated, creating a single sharp pulse during the return sweep. This is represented on the screen by the thin vertical line. In the figures shown here the sweep frequency is about 6,000 cycles, and the vertical amplifier gain has been adjusted to keep the figures at about the same height. Due to the small size of C_2 in measuring Q (about .5% of C_1), its effect on the oscillating circuit is slight after the first pulse. Generally the losses in condenser C_1 can be considered negligible compared to the losses in the inductor, L, so that the net Q measured is that of the coil, provided the input impedance of the vertical amplifier is sufficiently high.

To illustrate the application of this method, let us consider an air-core coil which measures, on an a-c bridge, 22.5 millihenries with a Q of 5.6, at 1,000 cycles. This coil is tuned with a 1-mfd condenser to a frequency of about 1,000 cycles and coupled to the sweep circuit with a .006-mfd condenser. The oscilloscope then is adjusted to produce the curve shown in Figure 4. To determine Q from this figure it is convenient to measure the height of the curve from peak-to-peak, as at a and b. For the first few cycles, the ratio of these values is not greatly different from the ratio of the vertical height of the peaks which should be measured for greatest accuracy. For this case, using a decimal or millimeter scale, a is found as *85* and b as *47*, equal to a ratio of *1.8*. The value of Q then equals 1.364/(log 1.8) or 5.34; a fairly good check for this method, derived from the formula $Q = \dfrac{.4343\ \pi}{\log_{10} r}$.

The inductance of a coil can also be checked by this method, considering the capacity of the condenser used to tune it and the frequency at which the circuit oscillates. The sweep frequency is known approximately from a calibration of the sweep controls, or more accurately by a check of the oscilloscope against a calibrated audio oscillator; the oscillation frequency equals the product of the sweep frequency and the number of oscillation cycles appearing on the screen.

Testing an iron-core choke coil shunted by a .004-mfd condenser, two complete cycles appeared at a sweep frequency of 500 cycles, equivalent to an oscillation frequency of 1,000 cycles. This is calculated to correspond to 6.5 henries and the Q is computed from the figure on the screen as 5.2. This same coil when checked on an a-c bridge at 1,000 cycles showed an inductance of 8.2 henries and a Q of 3 apparently a poor check. Howeve when measured on the bridge at lower level of voltage, a value of 7 henries and a Q of 4.9 was foun showing that the apparent discrepan in this case was probably due to t low energy level in the oscilloscop test.

Application at Lower R-F

The oscilloscope method is applica ble to coils at the lower radio freque cies within the limits of capability the oscilloscope amplifier and swee circuits. For higher values of Q measurement may be made on oscilla tions several cycles apart to obtain be ter accuracy. Then the value of obtained by the formula provide should be multiplied by the differenc in the numbered cycles. For exampl if measurements were made on th second and sixth cycles, then the valu of Q found in this manner would b multiplied by *4*.

Figure 5(a) represents a check o an r-f coil of *4* millihenries, resonate to a frequency of approximately 65 k by a .0015-mfd condenser. A couplin condenser, C_2, of *10* mmfd is used her and the sweep frequency is about 7,50 cycles. The same test is made in Fig ure 5(b) with the sweep frequency somewhat increased to change the phase between the first and last oscilla tion cycles in such a way that a res onant effect takes place, causing the voltage remaining in the condenser after the last oscillation to add to the voltage of the first oscillation and increase the amplitude. These figures are to the same scale and no change has been made in the gain of the vertical amplifier. The Q for this coil is found by measuring the height of the second and sixth cycles; 52/34 = 1.53. The logarithm of this value is .183 and $Q = (4)1.364/.183 = 30$.

This method of measuring Q is not as accurate as some other methods, but it is very convenient for a quick comparison of unknown coils. It also has the fascination of tieing old to new methods and is useful for instruction in basic principles.

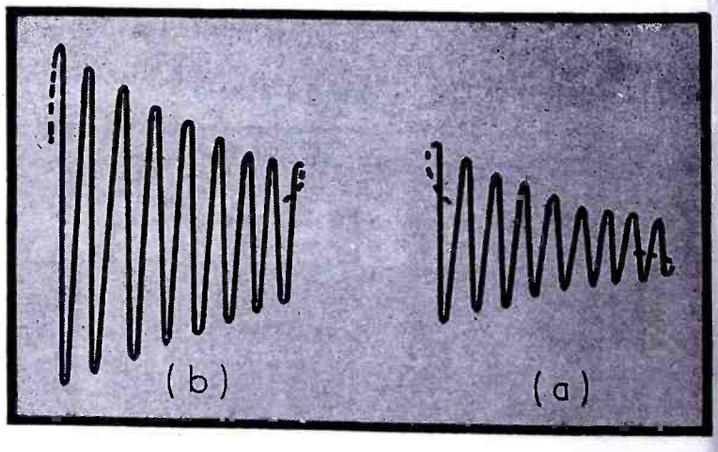

Figure 5
Oscillation curves of 4-mh coil at 65 kc.

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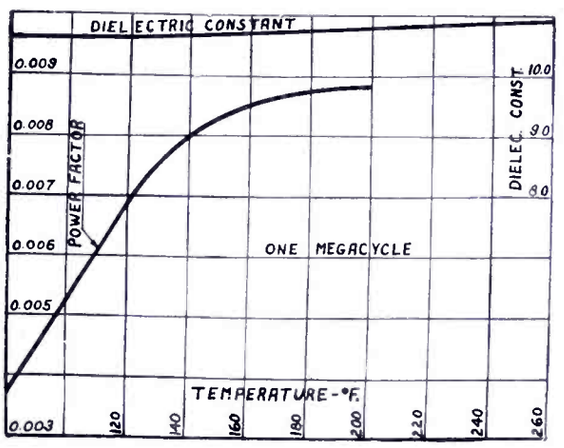

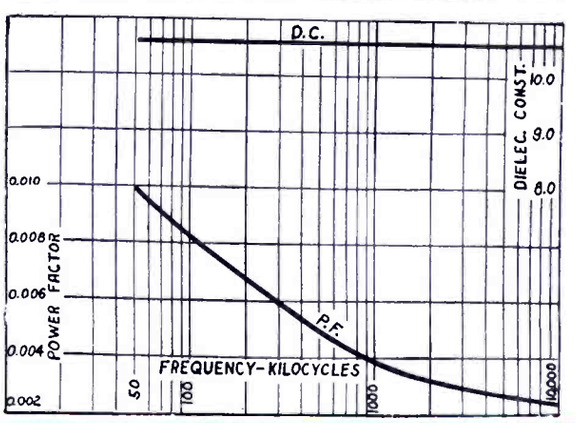

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FILTER ANALYSIS AND DESIGN

[PART TWO OF A TWO-PART PAPER]

by C. E. SKRODER

Asst. Prof. Electrical Engineering
University of Illinois

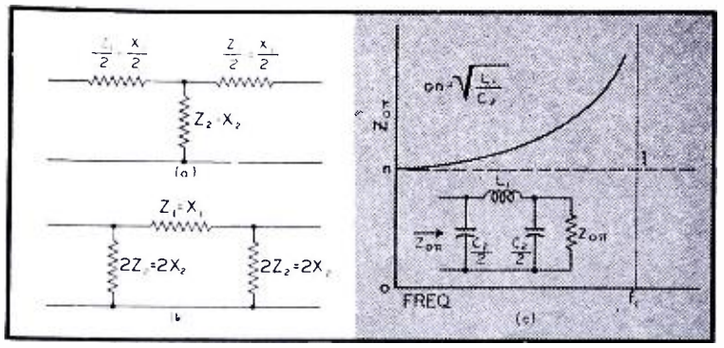


Figure 26
In (*a*) and (*b*) are shown T and π networks having the same values of X_1 and X_2. In (*c*) is shown graph of characteristic versus frequency in transmission band for low-pass, prototype, filter section of π configuration.

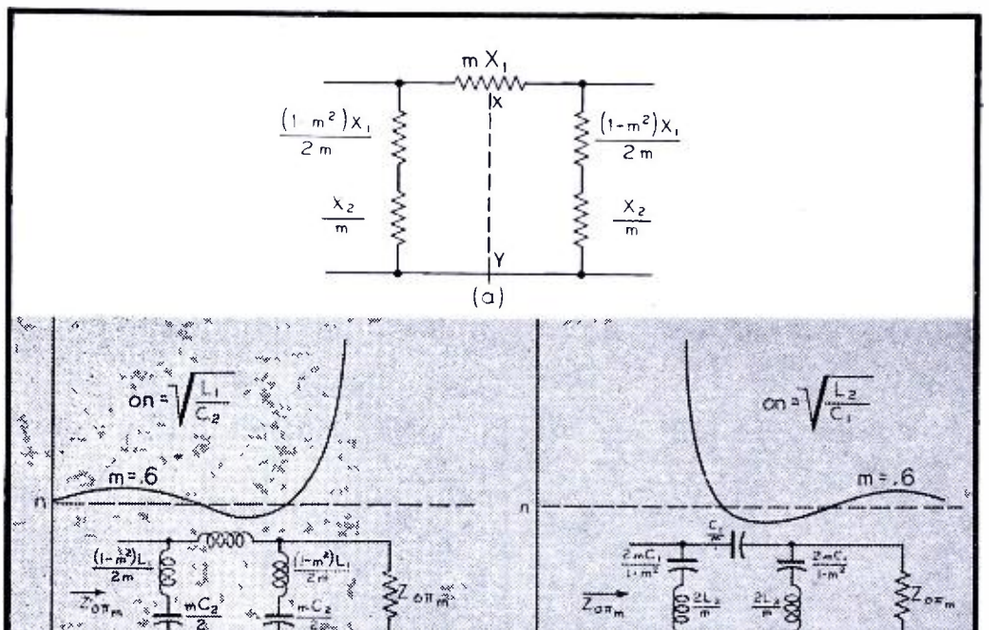


Figure 27
(*a*)—Generalized *m*-derived filter section of π configuration. (*b*)—Characteristic impedance versus frequency of low-pass, *m*-derived filter of π configuration. (*c*)—Characteristic impedance versus frequency of high-pass, *m*-derived filter of π configuration.

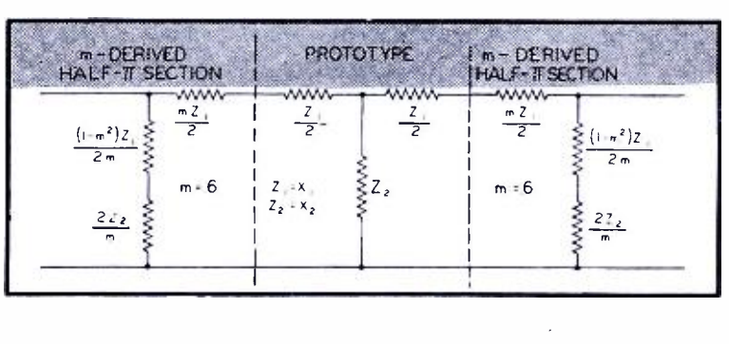
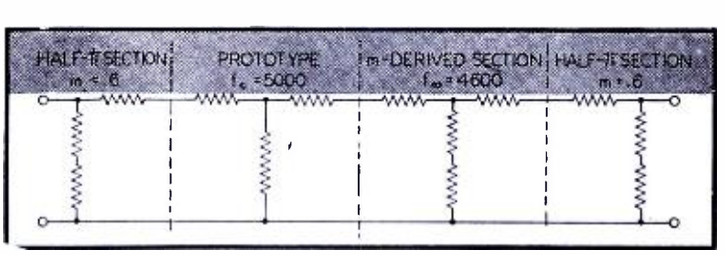


Figure 28
Prototype filter section terminated at each end with half-π, *m*-derived section.



Schematic of filter network.

THE networks discussed in the initi installment are of the *T* configur tion. Networks of π configurati can be constructed. If the relationships i dicated in Figures 26a and 26b are mai tained, the cut-off frequency will be t same in both, as well as the attenuati characteristic. The characteristic impe ance, however, will not be the same. Th can be seen by comparing Figures 2 and 26c. These figures show the variati of characteristic impedance of low-pa filters of *T* and π configurations respe tively as a function of frequency.

M-Derived Filters

Particular cases of filters of π confi uration which are of interest and impo tance are those of the *m*-derived typ The general circuit for these is shown Figure 27a. When *m* is chosen as .6 (c close to .6) the characteristic impedan of this network is nearly consta throughout the transmission band. Th is illustrated in *b* and *c* of the Figur While this Figure shows the curves characteristic impedance for the high-pa and the low-pass filters, the effect using *m* equal to .6 on filters of a classifications when made up as π se tions in accordance with Figure 27a, to cause the characteristic impedance t remain constant throughout nearly t entire transmission band. Hence, if th terminating impedance is known to b constant, regardless of frequency, the *m* derived filter of π configuration, usin *m* equal to .6, should be used.

Composite Filters

When such a π configuration is used i connection with a prototype section t form a composite filter, it is usually cus tomary to cut the π section at *xy*, Figur 27a, and attach one of the halves, calle a half-π section, to one end of the proto type and the other half to the other en This is illustrated in Figure 28. Such filter would have the advantage of near constant characteristic impedance through out its transmission range; but *m* bein fixed at .6, the frequency of infinite at tenuation f_∞ may not occur at the mos desirable frequency. If this is an im portant matter, another *m*-derived sectio of T configuration and having infinite at tenuation at the desired frequency can b added in cascade with the other *T* sectio or sections already included.

Sample Design

Let us assume that a high-pass com posite filter is to be designed, and the fol

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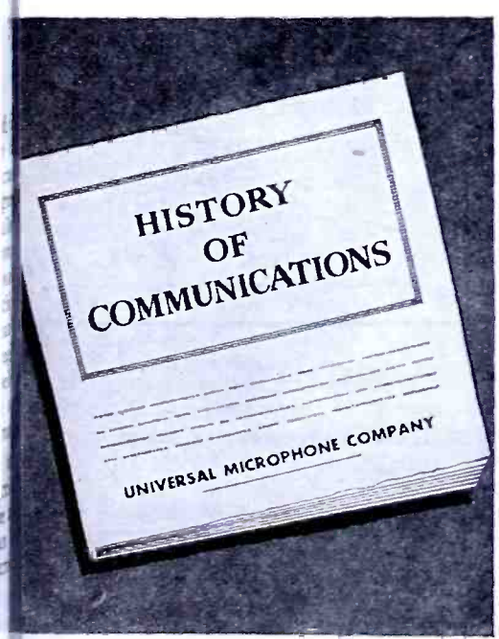

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(Continued from page 62)

lowing characteristics are available: cut off frequency, $f_c = 5000$ cycles; frequency of infinite attenuation, $f_\infty = 4600$ cycles; constant load impedance, $R = 600$ ohms.

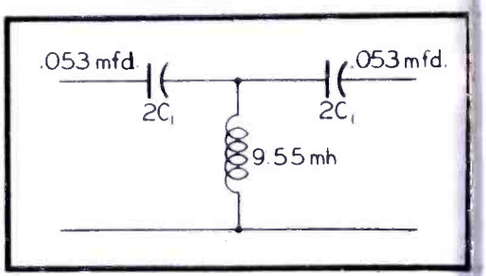
To obtain satisfactory attenuation at the lower frequencies in the attenuation band, a prototype section should be used. to obtain infinite attenuation at 4600 cycles requires the use of an m-derived section with the proper value of m. Since the load impedance is constant, the filter should have terminating half-π sections of the m-derived type with $m = .6$.

Prototype Design (From Figure 8)

$$L_2 = \frac{R}{4\pi f_c} = \frac{600}{4\pi \times 5000} = 9.55 \text{ mh}$$

$$C_1 = \frac{1}{4\pi f_c R} = \frac{1}{4\pi \times 5000 \times 600}$$

$$= .0265 \text{ mfd}$$



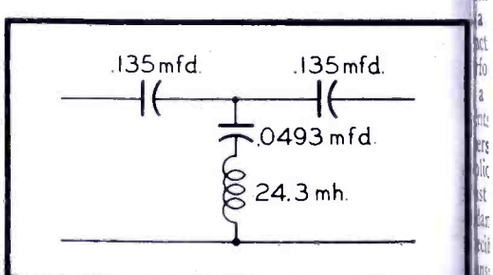
Design of m-derived section f_∞ = 4600 cycles (From Figure 11)

$$m = \sqrt{1 - \frac{(f_\infty)^2}{(f_c)^2}} = \sqrt{1 - \frac{(4600)^2}{(5000)^2}} = .393$$

$$\frac{2C_1}{m} = \frac{2 \times .0265 \text{ mfd}}{.393} = .135 \text{ mfd}$$

$$\frac{4mC_1}{1 - m^2} = \frac{4 \times .393 \times .0265 \text{ mfd}}{1 - .393^2} = .0493 \text{ mfd}$$

$$\frac{L_2}{m} = \frac{9.55 \text{ mh}}{.393} = 24.3 \text{ mh}$$



Design of half-π section for m = .6

$$\frac{2C_1}{m} = \frac{2 \times .0265 \text{ mfd}}{.6} = .0884 \text{ mfd}$$

$$\frac{2mC_1}{1 - m^2} = \frac{2 \times .6 \times .0265 \text{ mfd}}{1 - .6^2} = .0496 \text{ mfd}$$

$$\frac{2L_2}{m} = \frac{2 \times 9.55 \text{ mh}}{.6} = 31.85 \text{ mh}$$

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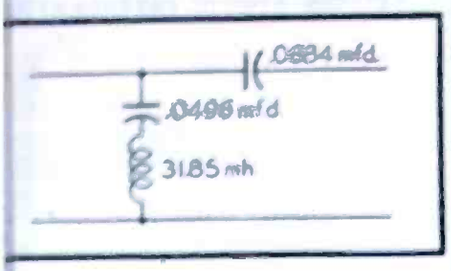
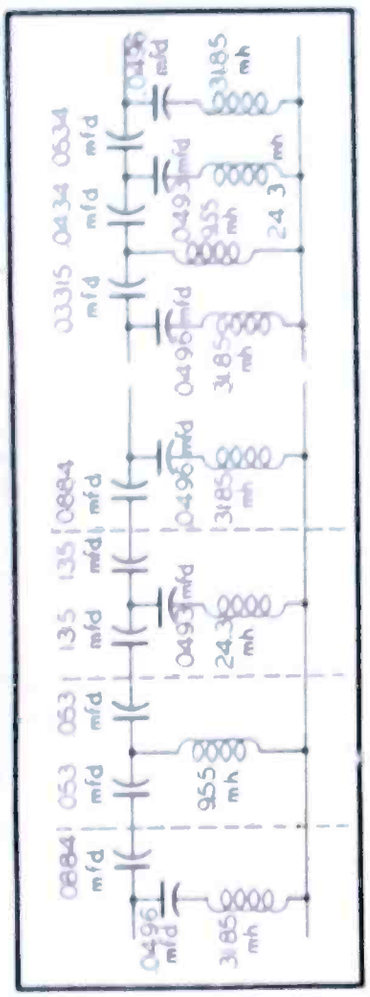
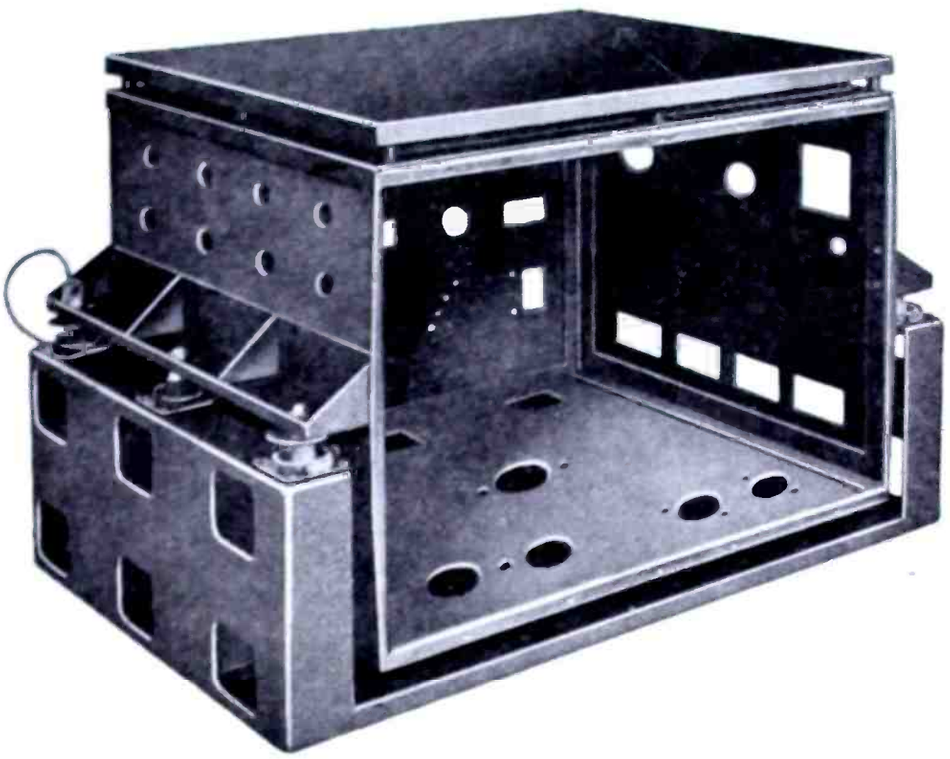




rom the foregoing the impression may gained that the design of filters is so involved and complicated as it ht first have been thought. However, n filters are to be designed to operate a communications system and in con- ction with other equipment, and the formance of the communication system a whole must fulfill specified require- nts, we find that the design of such rs is not too simple a project. In such lications the requirements that a filter t fulfill, in addition to the proper im- ance and cut-off frequency, include ified maximum dissipation in the smission range, the number of db rease in attenuation that must take e in a specified number of cycles in vicinity of cut-off, and specified mini- n *db* attenuation at specified frequen- in the attenuation band. These are a few of the requirements that must met.

The fundamentals which have been ered in this treatment of filter net- rks are those upon which the general ject of filters is based. The formulas n and the design principles discussed be used as a basis for the design and nstruction of filters, the performance of ch should prove satisfactory for gen- use.

SHEET METAL FABRICATION



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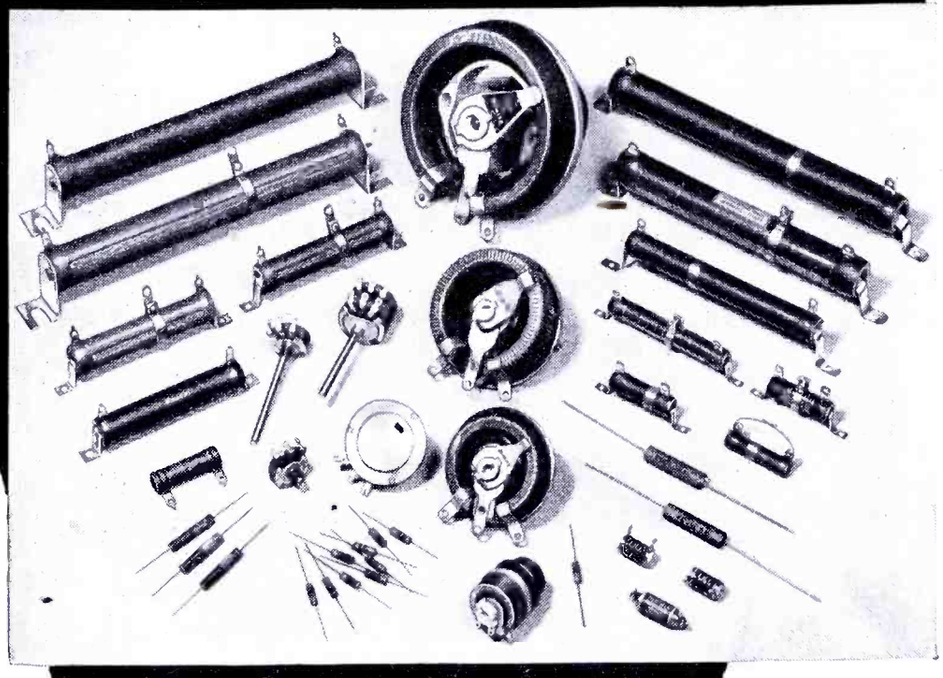

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TELEVISION STUDIO INSTALLATIO

(*Continued from page* 50)

can then at least be sure that the re ulated power supply has a very lo internal impedance and will probab be satisfactory for use with a vid amplifier.

Deflection Generator

A final point to note is the icon scope horizontal deflection generato The rapid return stroke in the case horizontal deflection tends to set th yoke and output transformer into osci lations; the resonant circuit is repre sented by the total reflected inductanc and the distributed capacity of th windings, as presented to the tube.

One method of *squelching* thes damped oscillations that occur durin the forward stroke is to use a sel biased diode across the primary of th output transformer. The diode auto matically becomes conductive durin the forward stroke and damps out thes oscillations. A diode with a sufficient ly high perveance is therefore indi cated.

Another method, employed by th English, is to use a tuned trap circui to absorb these oscillations. Som questions may be raised as to its effec tiveness when large deflection current are to be handled, as in the case o American tubes that do not have constricted portion at the end of th neck for the deflection yoke.

A third method is to use the outpu tube as the damping means. The aver age triode, if used, does not have sufficiently low r_p to make the circui critically damped. However, if in verse voltage feedback is employed, th apparent r_p can be reduced to a valu sufficiently low to accomplish this re sult, even if a pentode tube is em ployed.

One simple method has been sug gested by Goldmark.* A resistance an a suitably large blocking condenser ar connected between the plate and gri of the output tube. The latter is 6L6 beam power tube of high r_p, bu the feedback reduces this to a suitabl low value. Although more saw-toot excitation is required because of th inverse feedback, such increased ex citation is readily available.

The circuit is shown in Figure 9, in solid lines (page 50). The first tube, to the left, merely amplifies the rectangular pulses coming in on the coaxial line. The second tube from the left is known

(*Continued on page* 74)

*P. C. Goldmark, E. R. Piore, J. M. Hollywood, T. H. Chambers, and J. J. Reeves, *Color Television—Part II*, Proc. IRE; Sept. 1943.

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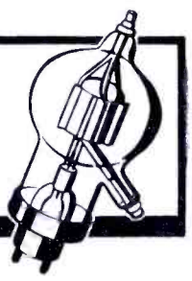

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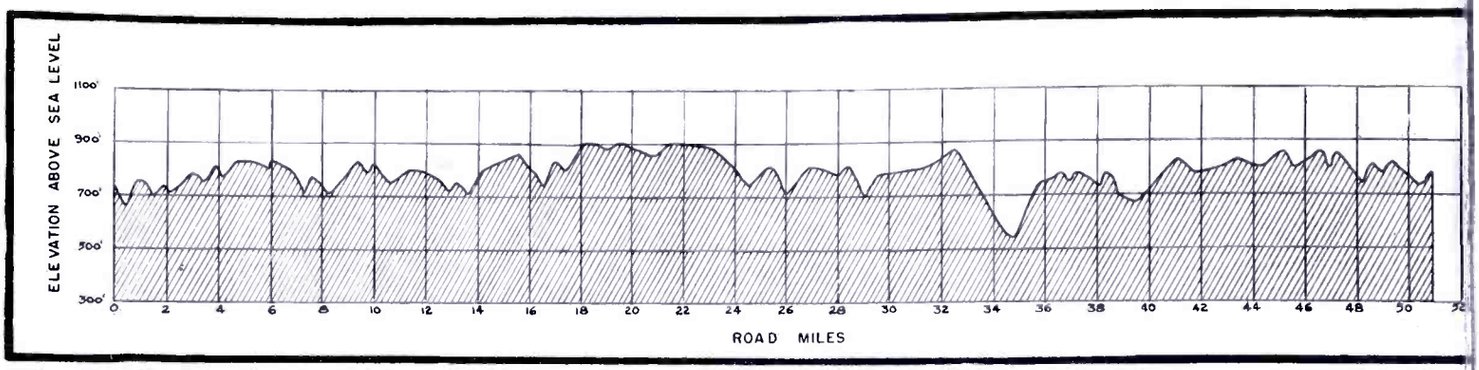


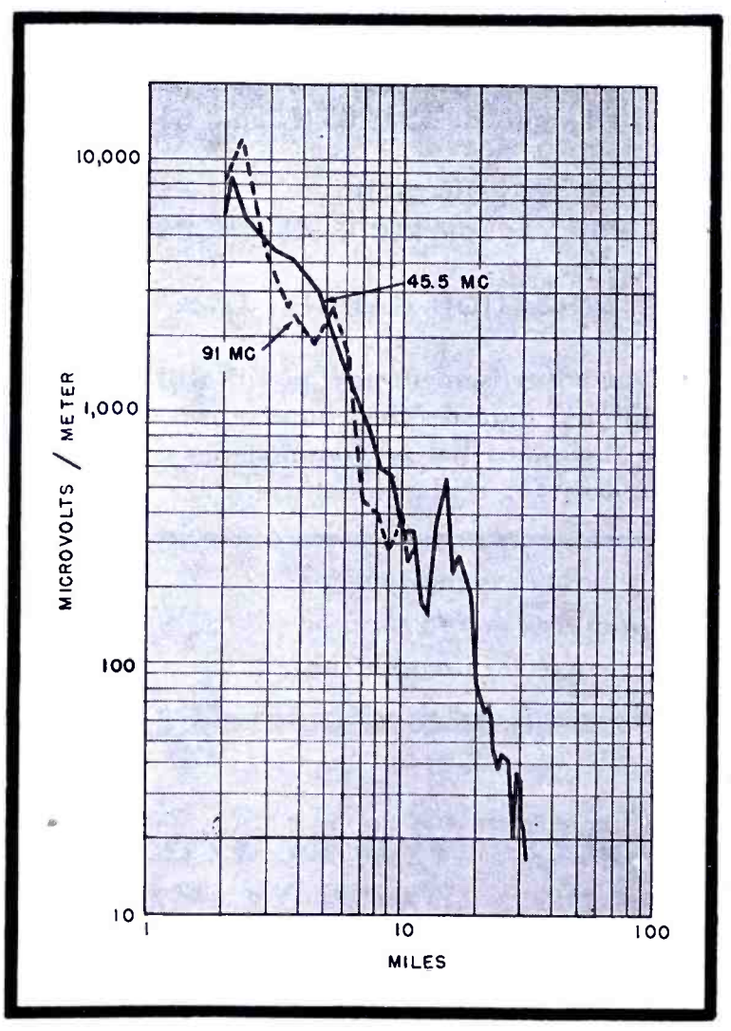
Road elevations along east radial. Country in this area is of the rolling type with 100-foot hills located approximately every mile or tw

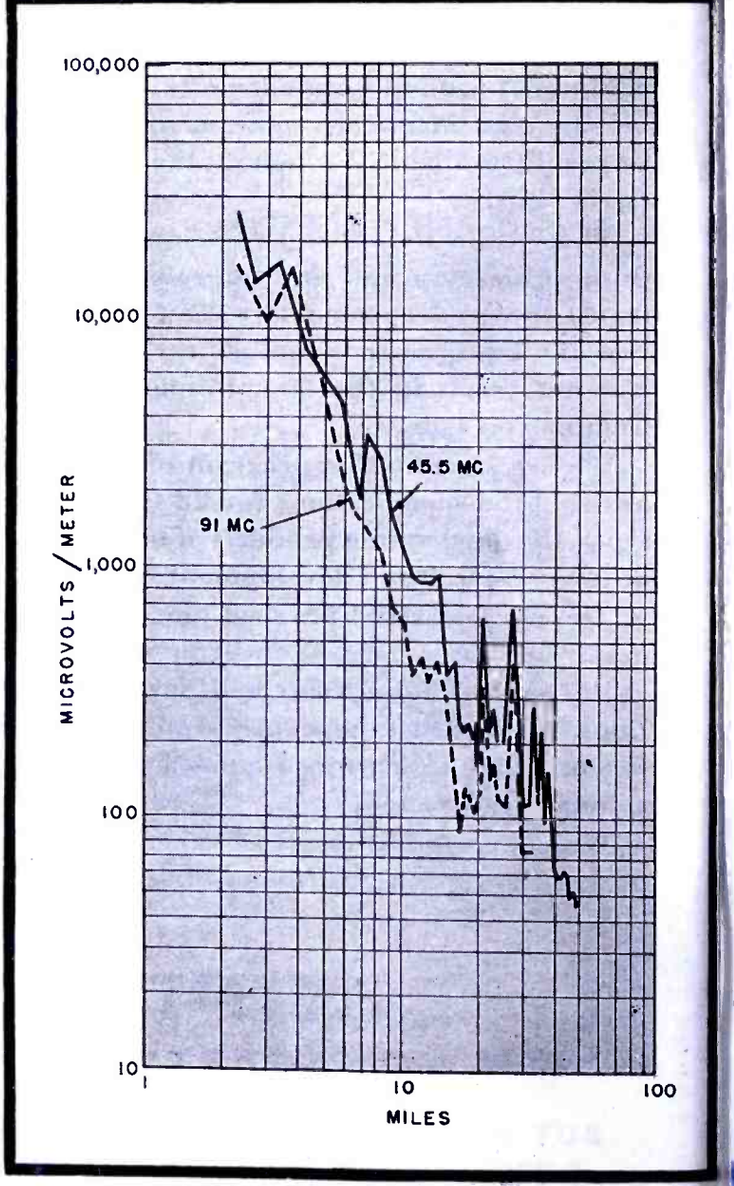
45.5 AND 91-MC FIELD INTENSITY TESTS

by RALPH G. PETERS

A MOST interesting series of v-h-f field tests were conducted during the month of February by FCC engineers, with Ralph J. Renton of the engineering department in charge. The tests were conducted in the rolling country of Louisville, Kentucky on 45.5 and 91 mc, using WHAS transmitters with inputs 1300 and 250 watts respectively, wit no modulation, and vertical half-wav and horizontal half-wave 100′ to 66 antennas. The plotted results, Figure

Figures 1 (below) and 2 (right)
Figure 1, plot results for east radial; 660′ transmitting antenna height; polarization, vertical; 7′ receiving antenna height; power, 1 kw. Figure 2, west radial results with conditions identical to east radial.





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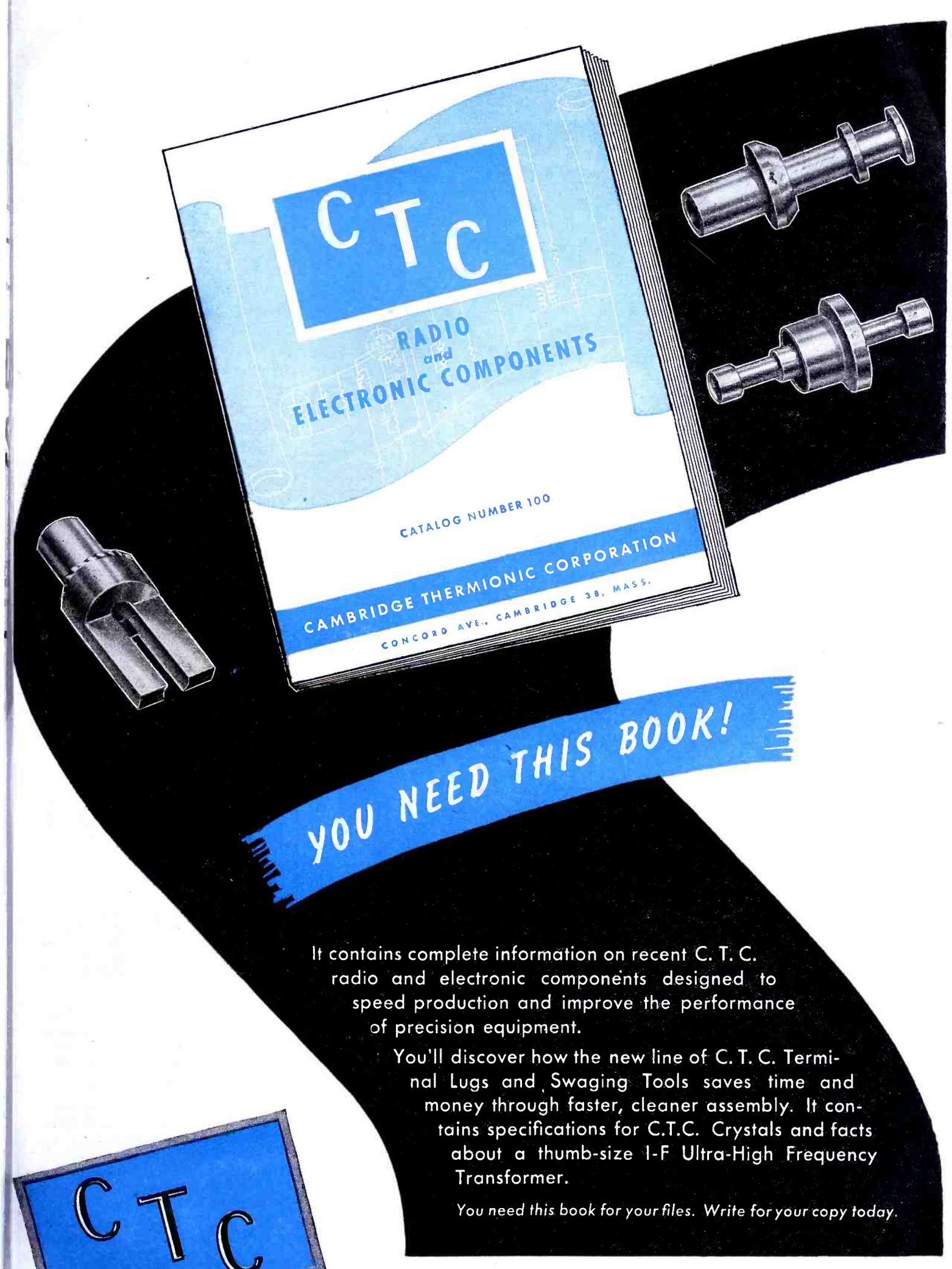

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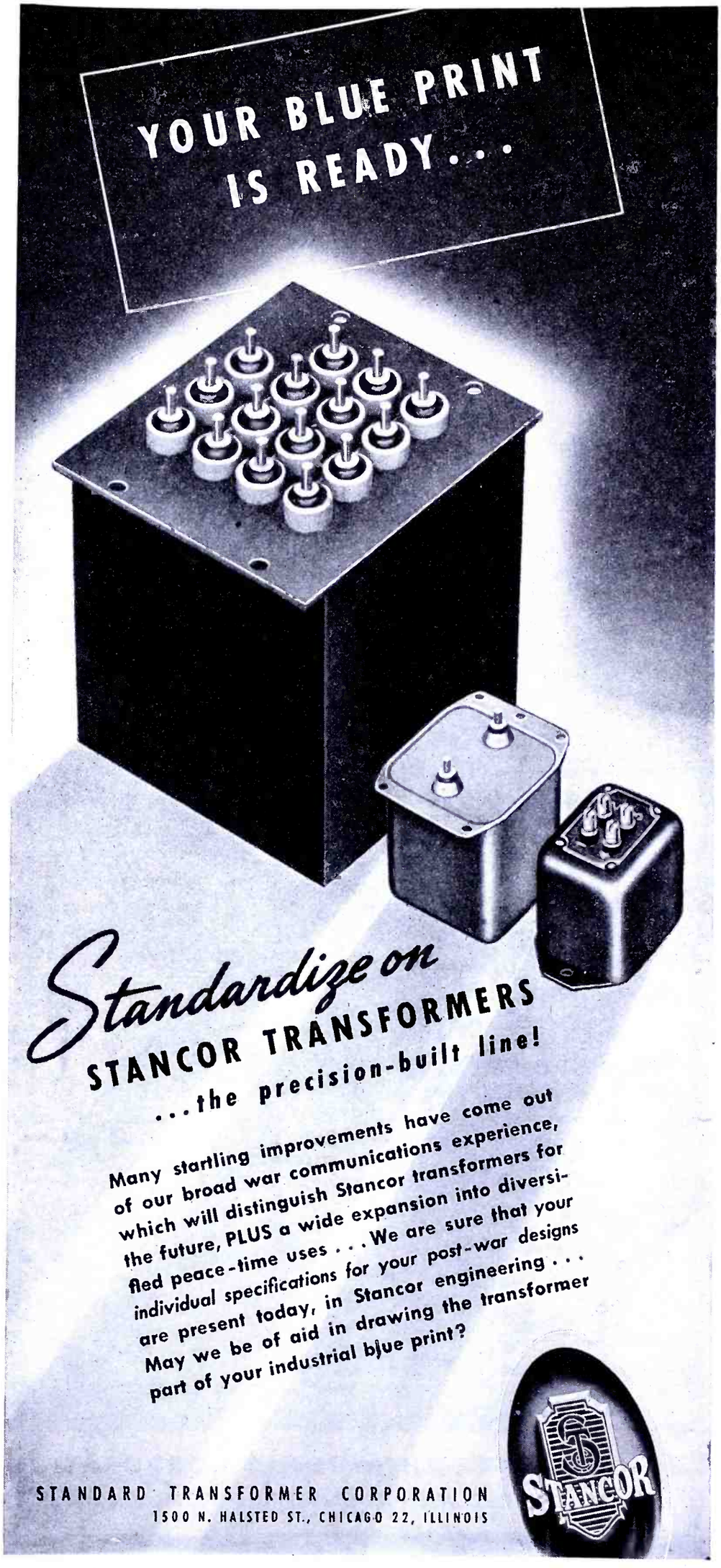

1 to 4, were offered to the FCC du ing the February-March hearings i Washington to aid in assigning f- and television frequencies.

Renton's Analysis

Discussing the tests, Mr. Rento said: "The horizontal antennas wer oriented to provide a maximum signa in the direction of the radials. Th radials chosen for the test were ap proximately due east and due west c the transmitter. The east radial con sisted, for the most part, of rollin country with 100 foot hills locate approximately every mile or two There were a few valleys with drop of approximately 200′ and at Frank fort, Kentucky, a drop of 400′ in miles.

"The terrain of the west radial wa relatively smooth for the first 2(miles; however the city of Louisvill is centered at about 19 to 20 mile from the transmitter. A slight hump was noticed at 22.5 miles. This was caused by the bridge over the Ohio River. At 28 miles the terrain is quite rugged.

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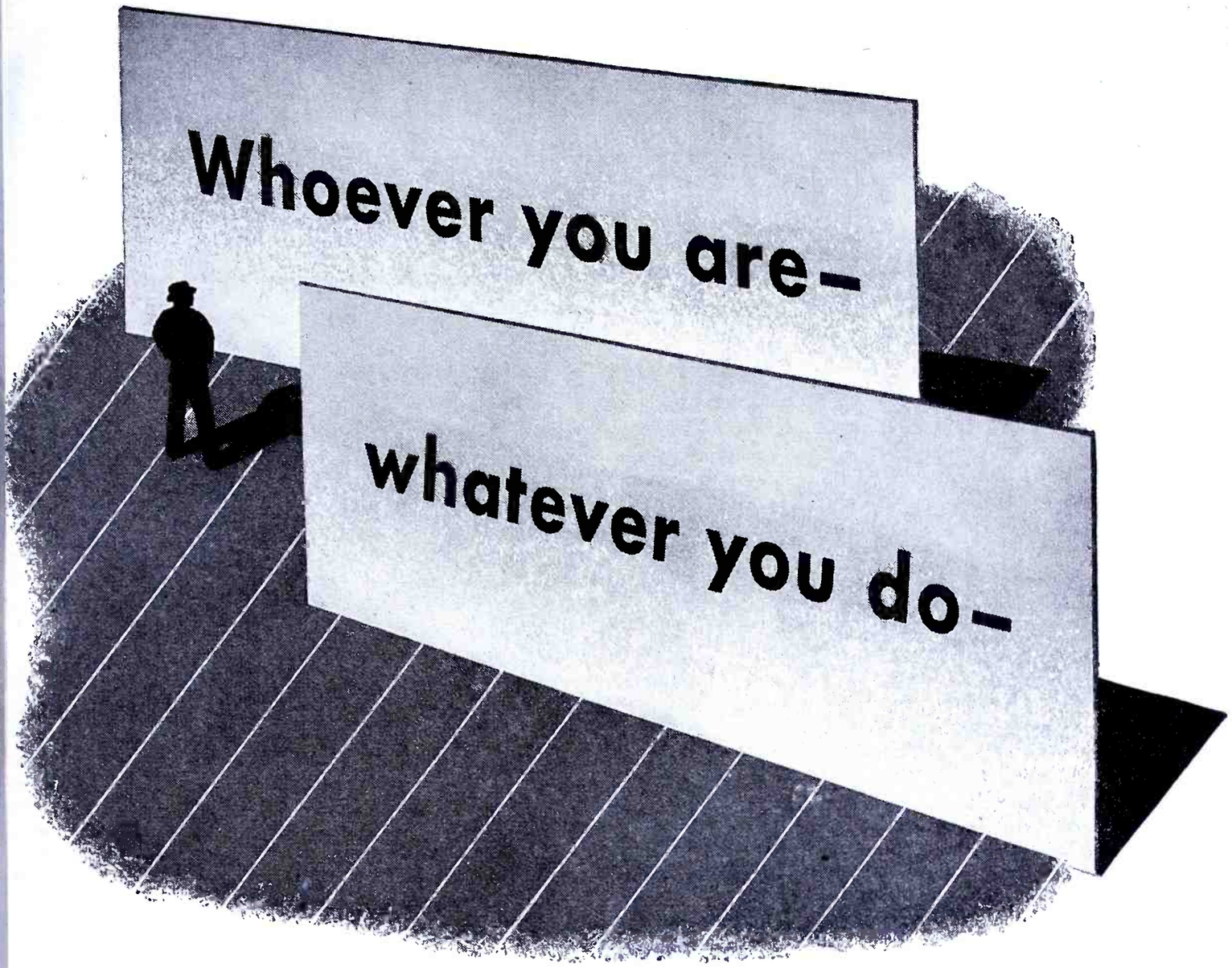

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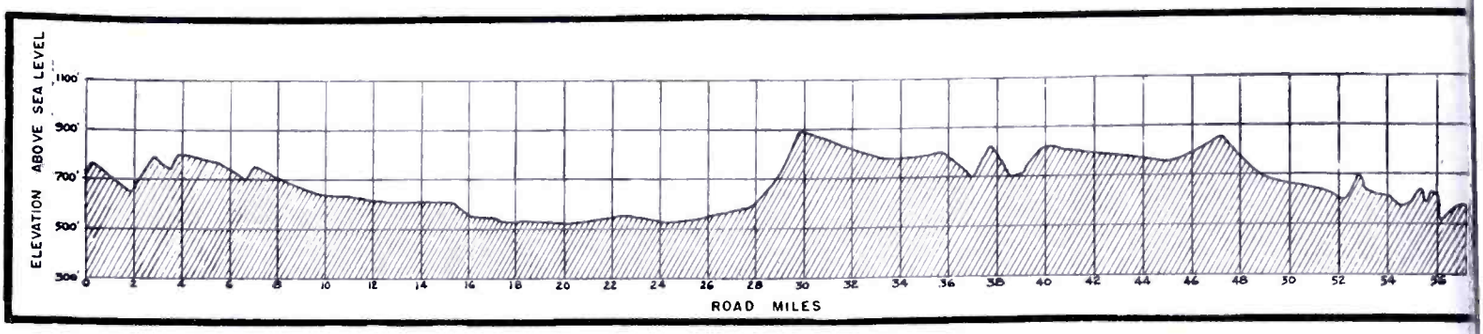


Road elevations along west radial. This terrain is relatively smooth for the first 26 miles; from 28 miles on, terrain is quite rugged.

were made with an RCA model 301A meter installed in a Pontiac coupe. The instrument was arranged to actuate a model AW, 5-ma Esterline Angus recorder. The recorder chart feed mechanism was driven by the car speedometer cable at a chart speed of exactly 5" per mile.

Plot Methods

"Each mile (or less) of the chart was analyzed for *the value of field exceeding* 50% *of the distance*. This value of field obtained was corrected for 1-kw radiated power and plotted as a single point on the field intensity versus distance-curve sheet.

"In order to obtain radiated power by the most direct means it was necessary to determine the plate input power to the final stage, compensate for final stage efficiency, and subtract coaxial-cable loss and transmission line standing-wave loss. The plate input to the final was measured by d-c meters.

Transmitter Efficiency

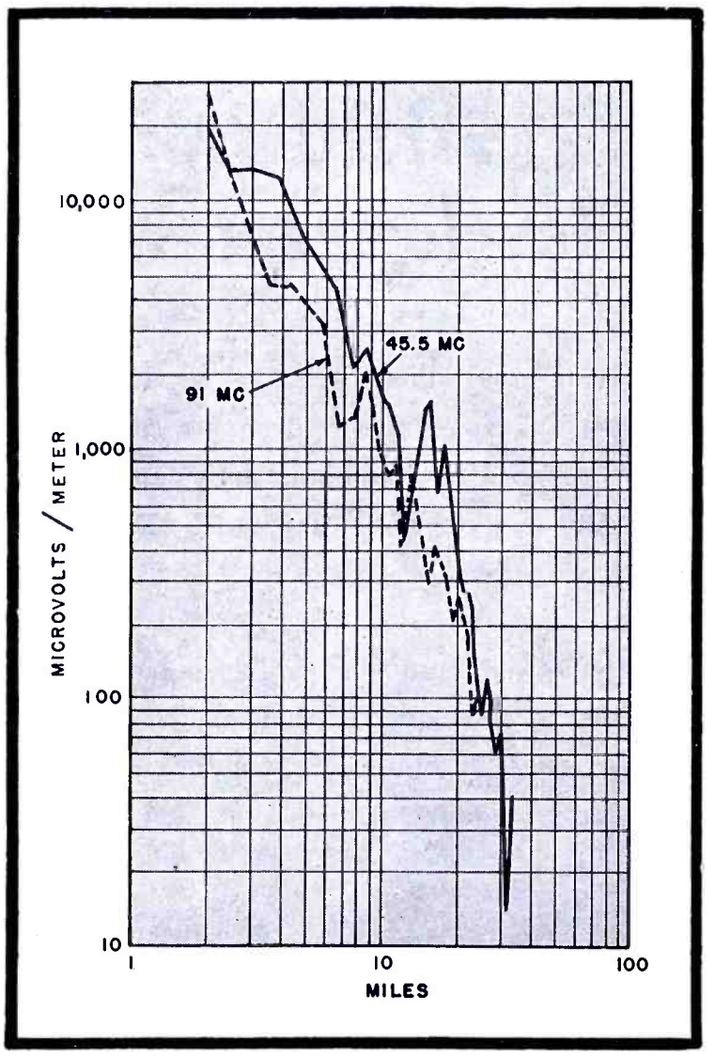
"The efficiency for both the 45.5 and 91-mc transmitter was determined by the staff of WHAS previous to this survey as 50%. The determination was made by a dummy-antenna load. The antennas were fed through copper coaxial cable, 7/8" outside diameter and 1/4" inside conductor diameter. The loss for this line was determined from tables as 2.1 db per 1000' for 45.5 mc and 3 db per 1000' for 91 mc. An additional 20% transmission line loss due to standing waves was determined by the WHAS staff previous to this survey.

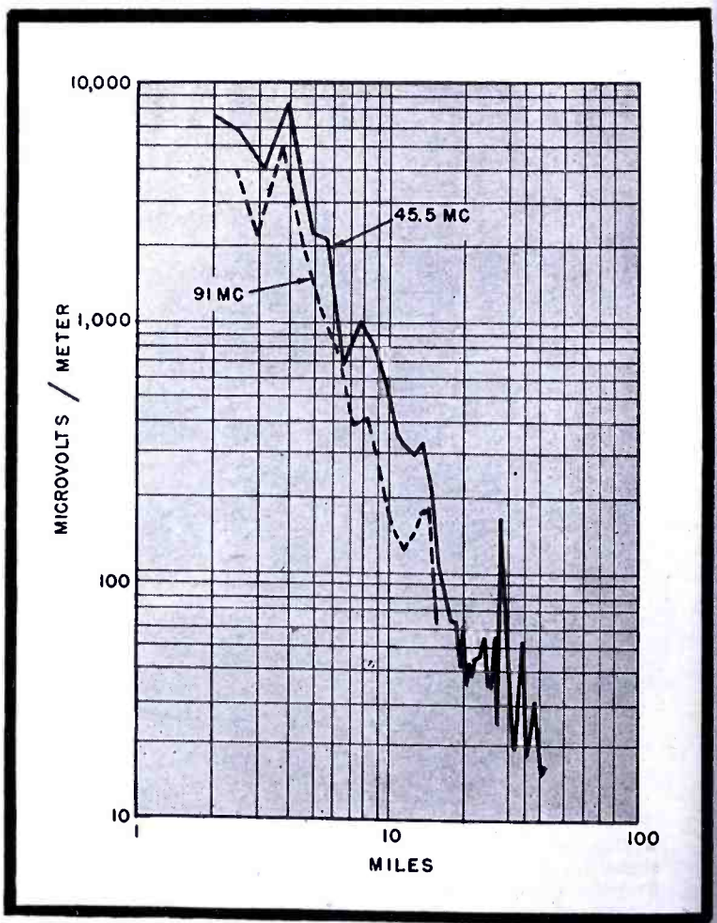
"It is believed that the power-correction factors used were reasonable; however any variation of true power radiated over that calculated will move the 91 and 45.5 curves up or down essentially the same amount. The change would be slight even with a considerable error in calculated power because the field intensity varies as the square root of the power ratio.

"Receiving antenna heights were 7' for vertical polarization and 10' for horizontal polarization. In order to properly interpret the curves for broadcast reception the plotted values should be modified by a suitable height-gain corection factor for reference to the standardized 30' receiving antenna height."

Figures 3 (left) and 4 (below)

Figure 3, east radial tests with 100' transmitting antenna and 7' receiving antenna. Figure 4, west radial tests; conditions same as east radial tests; polarization, vertical; power, 1 kw.





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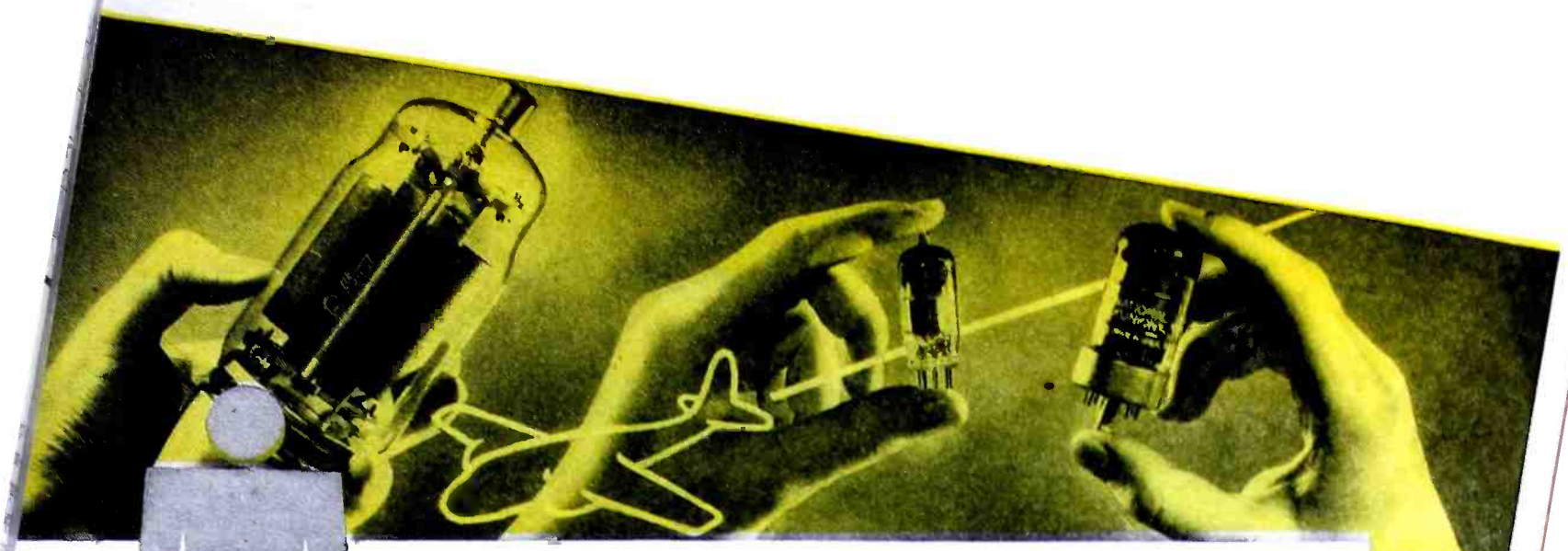

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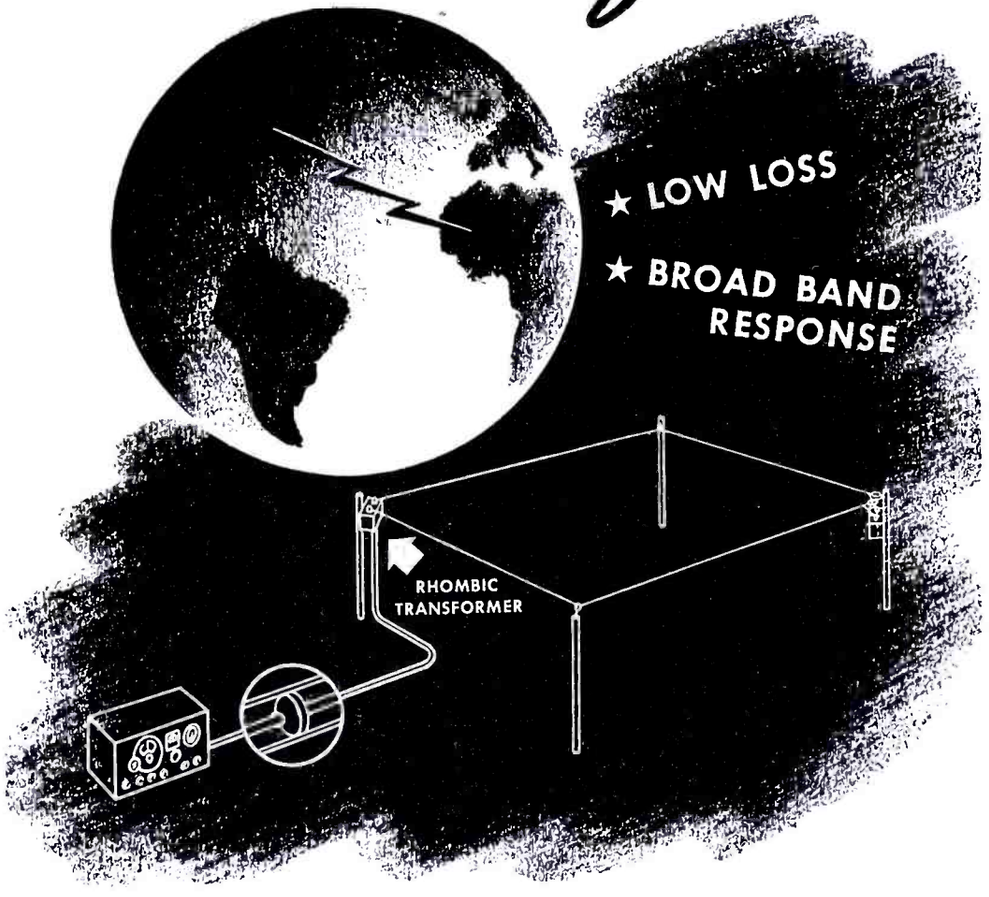
ANDREW
Rhombic Transformers



FOR TRANSOCEANIC RADIO COMMUNICATION

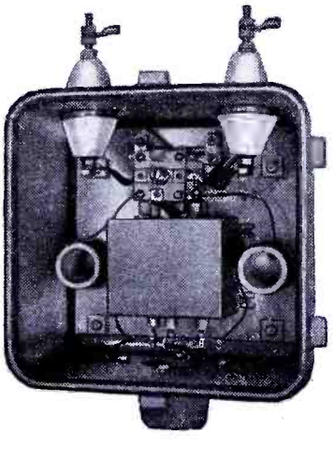
★ You need *quality* equipment for reliable, uninterrupted radio communication across oceans and continents. That is why radio engineers specify ANDREW antenna coupling transformers and coaxial transmission lines when designing rhombic antenna systems.

For highest efficiency and most successful rhombic antenna operation, the antenna coupling circuit must have a broad frequency response and low loss. To meet these requirements, ANDREW engineers have developed the type 8646 rhombic antenna coupling transformer, illustrated below, to assure fullest utilization of the advantages of the rhombic type antenna. Losses are less than 2 decibels over a frequency range from 4 to 22 megacycles.

Type 8646 unit transforms the 700 ohm balanced impedance of the antenna to match the 70 ohm unbalanced impedance of the line. Unusually broad band response is achieved by using tightly coupled transformer elements with powdered iron cores of high permeability. This unit is contained in a weatherproof housing which may be mounted close to antenna terminals.

Transformer unit 8646 is another expression of the superior design and careful engineering that has made ANDREW CO. the leader in the field of radio transmission equipment.

WRITE FOR BULLETIN NO. 31 giving complete information on this new radio communication unit.



ANDREW

ANDREW CO.
363 EAST 75th STREET
CHICAGO 19, ILLINOIS

TELEVISION STUDIO INSTALLATIO

(*Continued from page 66*)

as the discharge tube. Its grid is fe the rectangular pulses from the fir tube, and these pulses key in the tub (otherwise biased beyond cutoff dur ing the other alternation). When th tube is keyed in, it discharges cor denser C_1, which otherwise charge through R_1 from the *B* supply. Th voltage across C_1 is therefore of saw tooth shape of predetermined forwar and return strokes.

This voltage is used to drive th 6L6 tube, which in turn passes a saw tooth current through the deflectio yoke via the output transformer. Th voltage developed across the yoke and hence reflected back to the tube is approximately rectangular in shape if the current through the yoke is saw tooth in shape. Some of the voltag across the primary of the output trans former is fed back via C_3 and R_2 t the grid circuit, thereby reducing th r_p of the tube to a sufficiently low valu to damp out any oscillations that migh occur in the output transformer an yoke. C_3 is made large enough (abou .001 mfd) so that its reactance is neg ligible to the a-c voltage developed. I merely blocks the high d-c voltage from the grid of the tube.

The percentage of the voltage fed back depends upon the relative magnitudes of R_2 as compared to that of the impedance between the grid and ground. Ordinarily this feedback circuit as described is satisfactory. In the case of the iconoscope deflection amplifier, difficulty was experienced in damping out the oscillations. This may have been due to the fact that the iron-core iconoscope deflection yoke had too low an impedance for the standard output transformer (RCA #9836) available at the present time.

Feedback-Ratio Control

An inspection of Figure 9 reveals that the impedance between the grid and ground is R_g, paralleled by the series combination of C_g and C_1. (It may be assumed that R_1 is a negligible shunt across C_1 at the frequencies involved.) Hence the impedance between the grid and ground decreases as the frequency goes up, whereas R_2 remains constant in magnitude. This in turn means that the feedback ratio is less for the harmonics in the rectangular wave across the primary of the output transformer than it is for the fundamental component.

It was therefore felt that a more nearly equal amount of feedback to all

(*Continued on page 76*)

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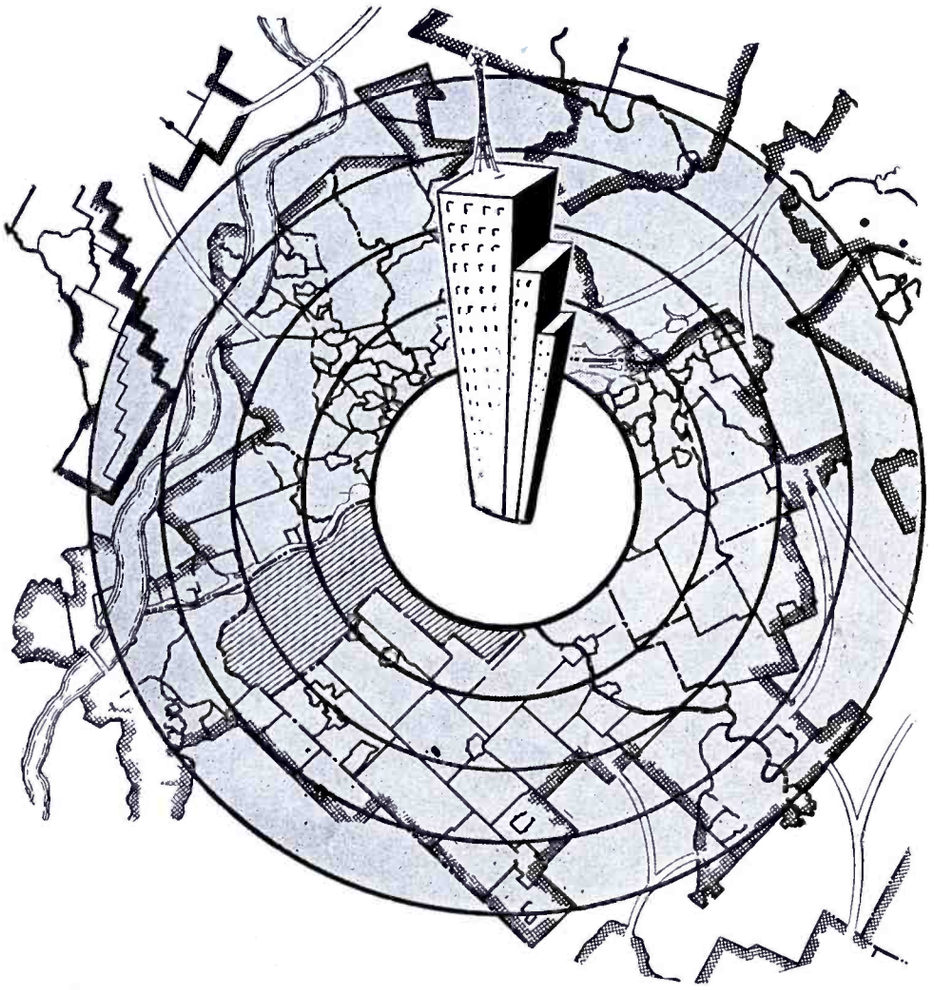

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DuMont-engineered telecasting equipment has rugged dependability and practical flexibility; will be designed for economical operation and is realistically priced. These facts have been spectacularly demonstrated by more than 4 years' continuous operation in 3 of the nation's 9 Television stations.

Furthermore, a pattern for profitable station design, management and programming has been set at DuMont's pioneer station, WABD New York . . . a pattern and backlog of Television "know-how" which is available to prospective station owners. Call, write or telegraph today.

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components of the wave could be obtained if R_2 was shunted by the proper size of condenser, C_2, shown in dotted lines. Presumably, best results would be obtained if the impedance of both parts of the feedback circuit were made of the same kind; i.e., if the time constants C_2R_2 and $R_gC_gC_1/(C_g+C_1)$ were made equal.

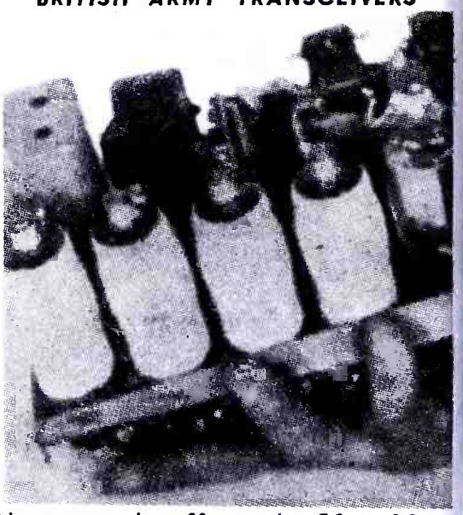
Adjustments were made experimentally, by varying C_2. When the optimum value was employed, the ripples in the longer flat portion of the rectangular voltage wave were practically eliminated, and satisfactory horizontal deflection was obtained. Similar benefits were obtained for the horizontal deflection circuits of the monoscope and the picture tube, although these were fairly satisfactory even if R_2 alone was employed.

Credits

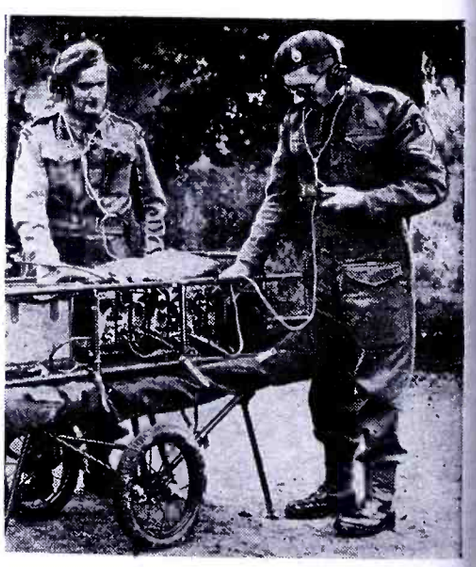
The writer wishes to express his appreciation for the help and cooperation afforded by P. D. Wickre, CREI instructor in television, and to E. H. Rietzke, president of Capitol Radio Engineering Institute, under whose direction this work proceeded.

•

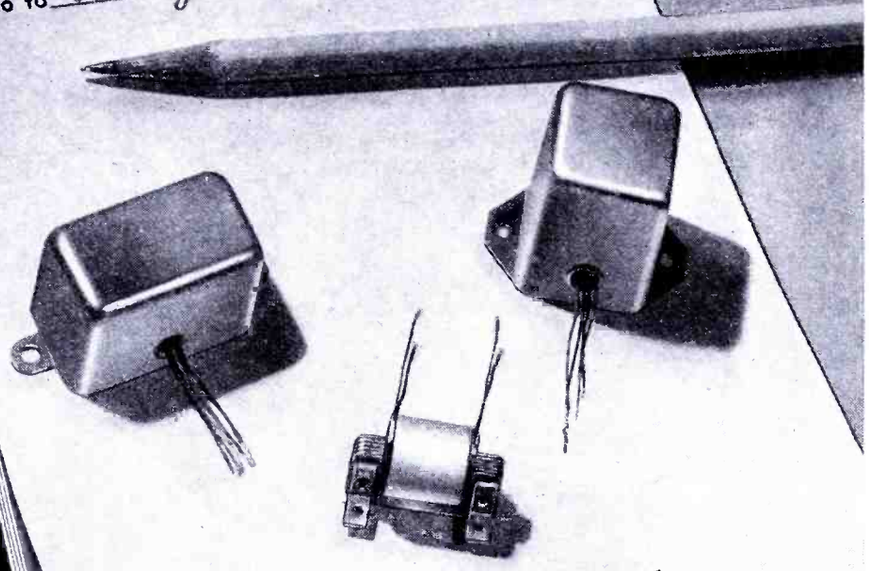
BRITISH ARMY TRANSCEIVERS



Above, transceiver *38*, covering 7.3 to 8.9 mc. Output is .2 watt. Below, model *22*, with frequency range of 2 to 8 mc, in handcart used during amphibious operations.
(British Official Photos; Crown Copyright Reserved)



Memo to Design Engineers—



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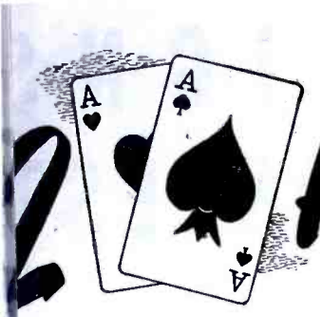
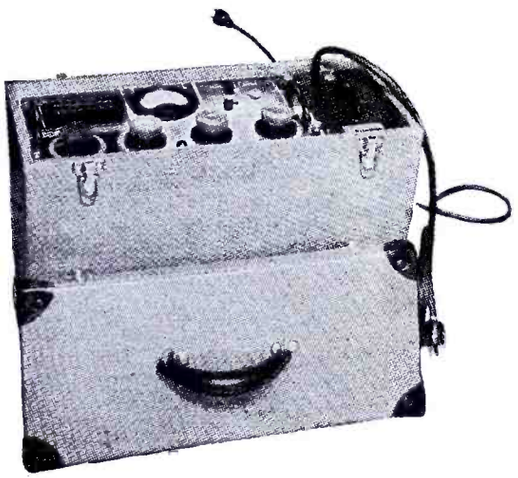


2 ACES...that are JACKS "of all trades!"

A FAMOUS PAIR



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● **The Gates Remote Conditioner for single microphone remote pick ups, A.C. operated.**

Gates

Remote Pick-Up Amplifiers

This famous pair is truly "a Jack of all trades" . . . for they have been "Aces" in doing an outstanding job of remote broadcasting from Maine to Pango Pango—from Macy's windows to Montana's mountains—from Sandlot ball games to World Series—from Presidents to Prime Ministers. For more than a decade Gates Remote Amplifiers have served broadcasters for every need and purpose. From year to year they have been modernized, but in efficient performance they still remain the same in name, type number and service.

Here's what one broadcaster writes about his Gates DYNAMOTE: "—My Gates Dynamote is so much superior to my studio speech system quality, that I have discarded my studio equipment until new equipment can be obtained."

Another wrote: "—I am using my Gates Dynamote as standard for overall frequency response for the entire transmitting plant."

This, plus the fact that Gates Remote Conditioners are used in nearly every U. S. broadcast station for single mike pick-ups, is proof that this famous pair has been engineered for efficiency and economy. This is why Gates Remote Amplifiers are now in use in every theatre of war, bringing to America's loud speakers the war events from the place where history's biggest news is taking place!

Wartime restrictions do not allow the sale of new broadcasting equipment without priority, therefore, this equipment is presented merely to acquaint you with Gates' current developments.

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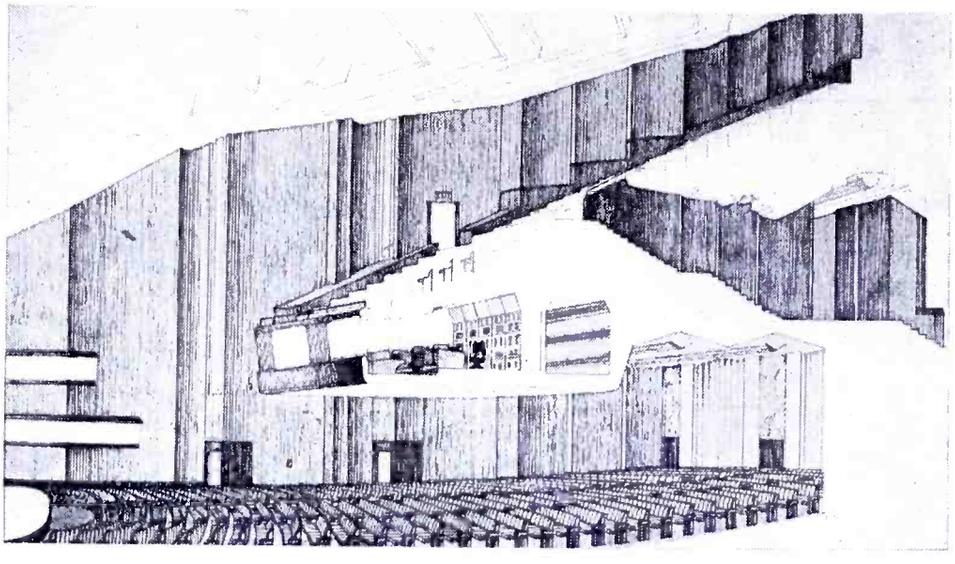
FIRST PRIZE DESIGNS IN WGN AIR THEATRE CONTEST



by
ARTHUR FREDERICK ADAMS
and
WILLIAM F. CLARK

•

Cross-sectional view of the proposed WGN radio-television studio theater designed by Arthur Frederick Adams and William F. Clark, winners of the $10,000 contest. The large stage measures 94' in width and is 70' deep. Large control booth for video broadcasting is located under the balcony.

•

IN designing the new WGN theatre we provided for all postwar developments in materials, air conditioning, lighting, television, f-m and improvements in the present type of broadcasting.

In addition we included new methods of accommodating scenery, properties, sponsors' products, sound effects, musical equipment and other miscellaneous items.

As all utilities, such as steam, water, gas, sewer, electricity, are obtainable from the main plant of the Tribune Tower or the adjoining streets, it was decided to eliminate the boiler room on the lower level, together with chimney or stack for the entire building. This will eliminate noise and provide more space for storage of properties, scenery sets.

Competition specifications called for a large studio theatre of 2,000 seats and smaller studio theatre with 600 seats. The problem was com-

(*Continued on page* 80)

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with quality first . . . . to last.

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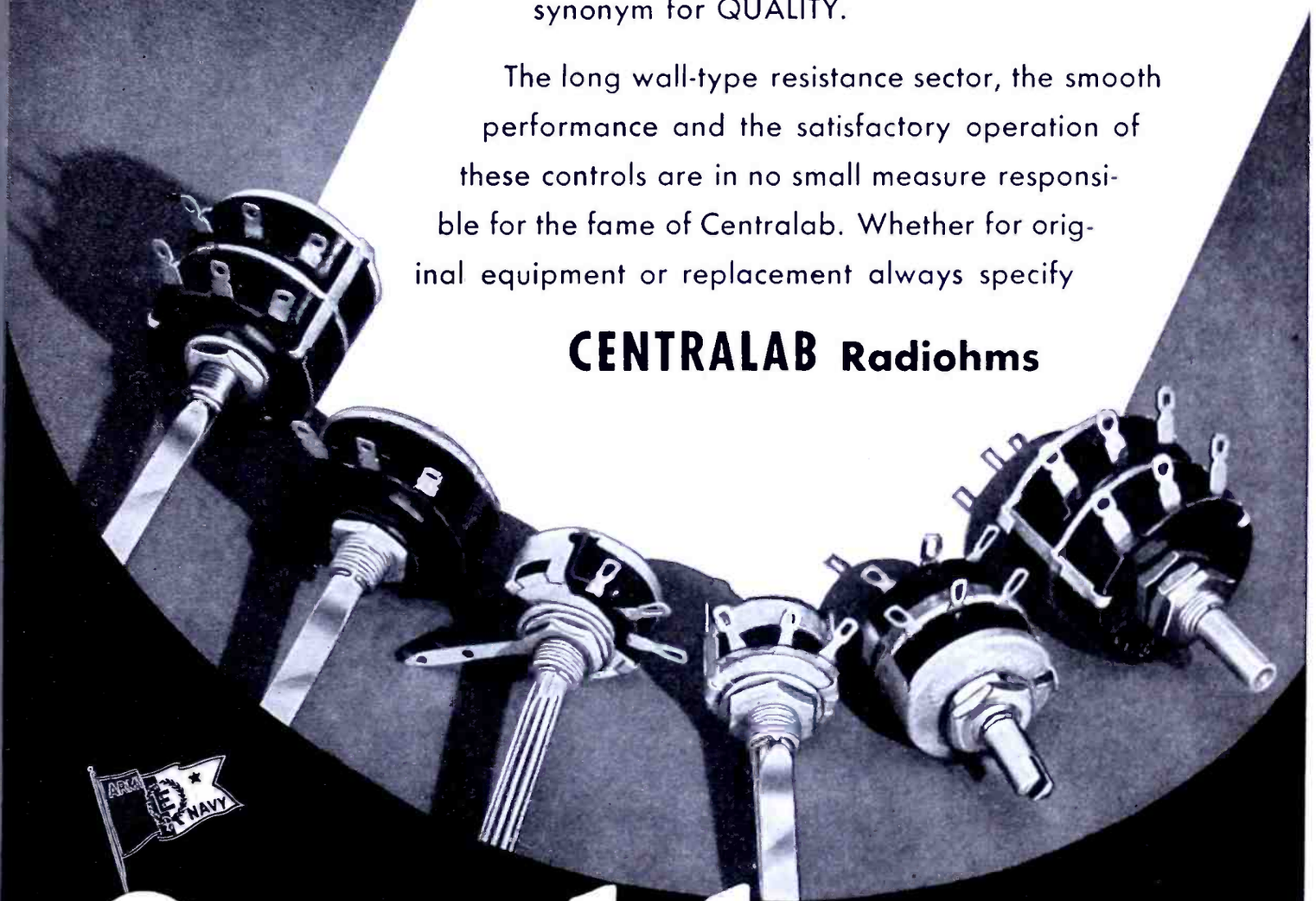

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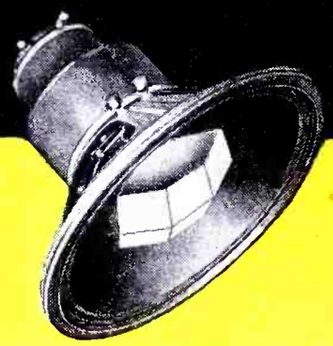
IN SOUND



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WGN AIR THEATRE

(*Continued from page 78*)

paratively simple for the smaller studio theatre since broadcasting and transcribed television programs from films were assumed as the type of entertainment to be used. The larger studio offered many problems, for we assumed the presentation of large-scale productions such as light and grand opera, or grand opera with costumes and full scenery, or *live-talent* shows with television and motion pictures, or transcribed television.

Television Problems

Televising *live-talent* programs requires a relatively large stage area, which must be acoustically treated, soundproofed, air conditioned, wired for equipment, and otherwise constructed in a very special way. We have found that two or more studios are required for such production, to provide for rehearsals, with scenery setups to be left in place; the actors and action shifting from one studio to another. The movie industry uses fixed sets, and practical television experience points in the same direction. Shifting from scene to scene must be completed in a fraction of a second and *noiselessly*. Thus moving stages did not seem to be practical.

This trend of thought, due to space requirements, could not be applied to this problem. So we have reversed the idea. Instead of the usual painted fixed sets for background scenes, we propose projected background scenes using plastic fireproof curtains lowered from the top of the studio stage. Rear projectors with wide angle lenses can be used, thus eliminating moving or shifting of scenery and cutting down noise.

Scenery Provisions

The design calls for mobile, folding scenery for backgrounds of sets easily and noiselessly moved and stored, remaining fixed during the televisioning by cameras. These properties, sponsors' products, with or without secondary backgrounds, are to be placed on five hydraulic operated lifts to be raised from lower level to the stage at the proper time for rehearsals and previews. The use of 3 cameras, operated separately or simultaneously, is planned. Staggering programs between the large and small stages and other studios on the upper floors, should provide sufficient time to re-

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set the television studio stage for a different television show following the first one placed on the air.

Stage Size

Competition data prescribed that 200 musicians and actors would occupy the stage. Present television cameras have a rather narrow angle of view so that for wide scenes, they must be located rather far away. With this as a yard stick of measurement, we set the length at approximately 100′, the width at approximately 70′. The higher the studio stage, the more easily the correct acoustics can be maintained. Also, it is necessary to allow for lights and other fixtures, back drops and scenery flats. The height should be approximately 50′.

Audience Problems

Elimination of audience space appears to be the trend in television studio design. The desirability of such provision is an open question. Most do agree that television programs are not as well adapted to audience viewings as are audio programs. Cameras and camera men, lights, etc., obstruct the view of the audience.

Seating Arrangements

In this design, we have provided 2,000 seats arranged so that the audience can view part of the actual activities of television behind the scenes and the remaining part from the screen above.

The other facilities, such as the control booth, film projection room, are located under the balcony. This provides a wide stage view by the program director and the short throw for projectors to the screen on the stage.

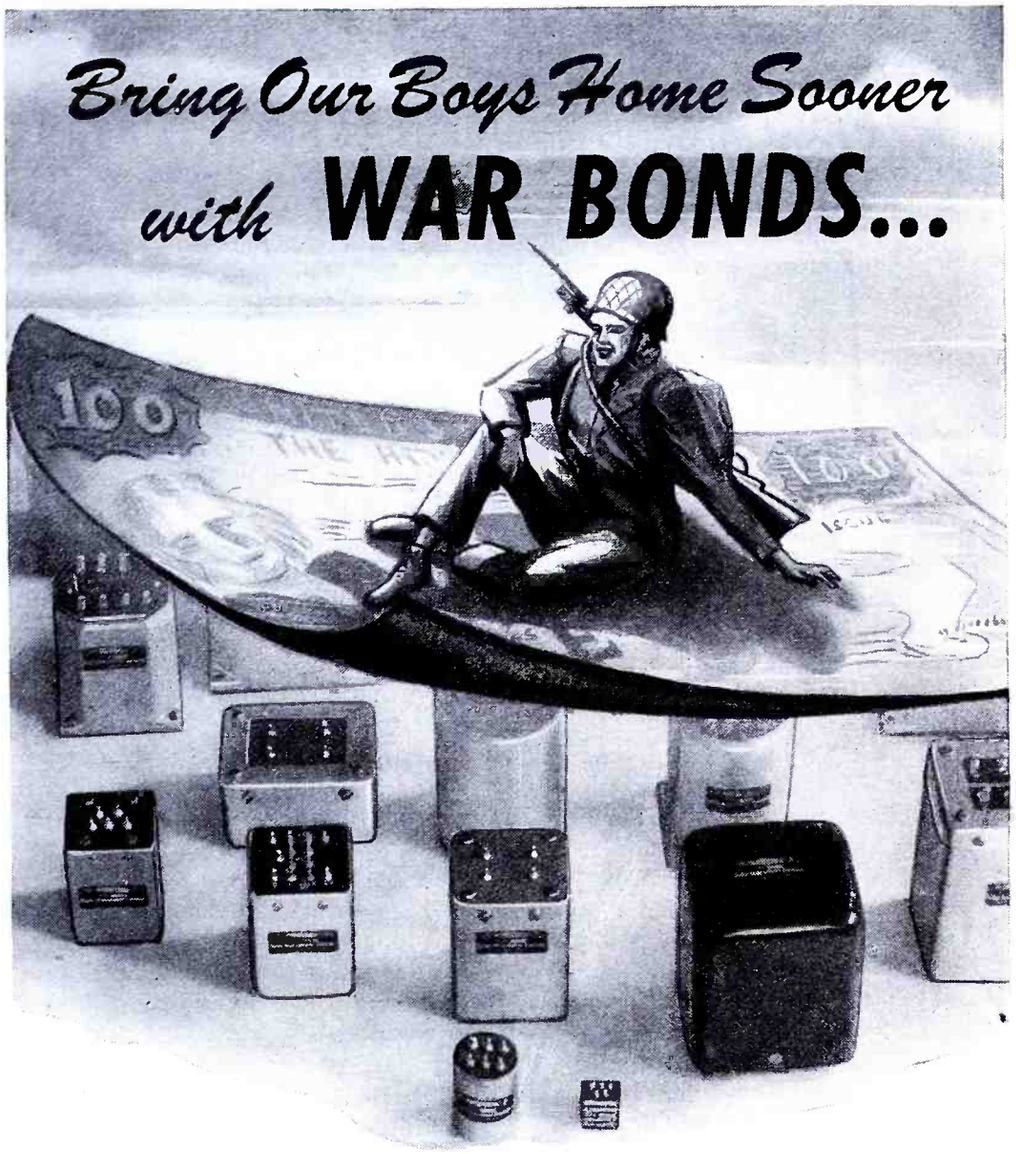
Television Control Booth

In the television control booth we have proposed the placement of the monitor console for previewing the pictures; 3 cameras on dollys are located on stage. The program director, and video and audio console operator overlook the monitor console in this room. All camera operators will be under the control of those in this booth via earphones. Another member of the staff will control the lighting of the overhead lights.

Projection Room

Adjacent to this control booth, we plan to have the projection room and

(*Continued on page* 84)



It's squarely up to us at home to finance the weapons of war as well as to build them. This is America's challenge. Here at ADC, we are exerting our energies to produce the finest communication components — and invest in as many War Bonds as possible. Believing that most Americans share our thoughts, we ask you to join us in this pledge — "Let us all continue purchasing War Bonds to the limit and bring our boys home sooner to a peaceful and economically sound country".

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Audio Development Co.

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VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

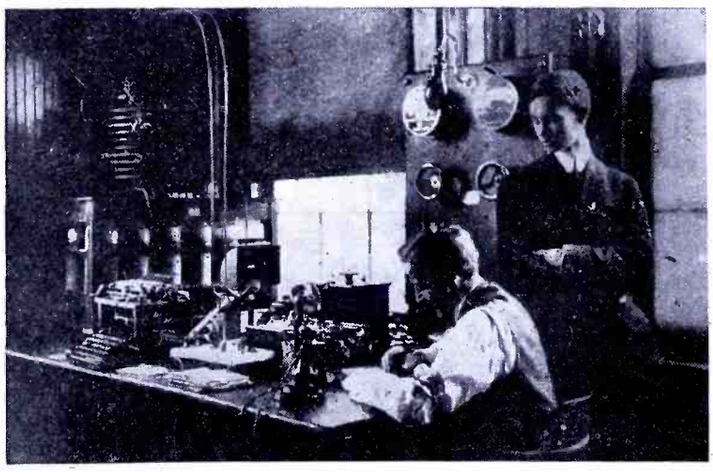
Personals

LIFE member Charles W. Horn, a veteran member of the Naval Reserve was recently promoted to the grade of Captain. He will continue his post as an assistant to the Director of Naval Communications, VWOA honorary member Rear Admiral Joseph R. Redman. Formerly director of development and research with NBC, Captain Horn plans to enter the Latin-American radio field after V-Day. . . . There is at least one former professional wireless operator among the FCC Commissioners, E. K. Jett. Mr. Jett, who was formerly FCC chief engineer, is a pioneer wirelessman. We were pleased to have him with us at our twentieth anniversary cruise. . . . Congratulations to our *number one* life member, Brig. General David Sarnoff, who was awarded a special citation at the recent *One World* dinner in New York for his outstanding contributions to international good-will through the medium of wireless communications. . . . Honorary member William S. Paley, formerly president of the Columbia Broadcasting System, was recently commissioned a Colonel in the Army of the United States on the staff of General Eisenhower. Congratulations, Colonel Paley. . . . Current events indicate why life member Lt. Comdr. V. H. C. Eberlin, with the Aircraft Carrier Task force now attacking Japanese home islands, is too busy to keep us informed of latest developments. When the next lull comes, and that doesn't appear probable for quite a while, we should like to have a bit of news, VHC. Good luck. . . . On March 5, 1945, the 38th anniversary of the reception of Dr. de Forest's first broadcast by life member A. F. "Steve" Wallis, the program was dramatized over WLIB, a station in the city where a *"tree grows."* "Steve" was interviewed by Tom Kennedy, radio editor of the New York *Times*. At the time of reception Comdr. Wallis was a wireless operator at the New York Navy Yard, in Brooklyn. . . . We mourn the loss of pioneer wirelessman Arthur Nilson, president of the Nilson Radio School. Our sincere sympathies to his family. . . . Honorary member Neville Miller, former president of NAB and for almost a year with UNRRA in the Balkan theatre, will return to the United States shortly. Mr. Miller has always been most cooperative in VWOA activities. Welcome home, NM. . . . Veteran member Edwin W. Lovejoy was promoted to the rank of full Commander in the Naval Reserve as of the first of the year and transferred to the Philadelphia Navy Yard from the West Coast. Congratulations Commander Lovejoy. Let's hear from you more often. . . . Our grateful appreciation to George H. Clark for his splendid contributions to the twentieth anniversary year book, a 124-page brochure with a complete history of VWOA from then 'til now. A dollar to us at headquarters to cover cost of packaging and mailing will bring you a copy. . . . From Rear Admiral Joseph R. Redman, Director of Naval Communications, we have received a congratulatory message saying: "I do wish to take this opportunity to extend my good wishes to the association as well as my desire to see your organization grow and prosper during the next twenty years." Thank you, Admiral Redman. . . . A most interesting note has come in from honorary president Dr. Lee de Forest. He says in part: "Don't let it happen, Bill, as it has usually in the past, that, having extorted from me my annual address before the VWOA banquet, you desist from any further letter writing until the next crisis shall arrive next January." Sincere and heartfelt thanks for your grand message, Doc. . . . "Bill" Simon continues to do a grand job as treasurer and executive secretary of VWOA. His efforts in connection with our twentieth anniversary were particularly commendable. . . . Our congratulations to life member C. J. Pannill, Radiomarine president, and our many VWOA members in the company on receiving a fourth star for their Army-Navy "E" flag. . . . Ted McElroy has shipped out as a radio operator on a merchant ship. He says that there's a shortage of key pounders and he is happy to be able to pitch in and lend a hand. A round of applause to you, Ted, for your splendid spirit!

•

Perpetual Calendar

VETERAN member Lt. Comdr. Willard E. Edwards, U. S. N. R., has during his spare moments in the Pacific theatre of war developed a new perpetual calendar. It has won wide acclaim in civil and military circles. Even the Congressional Record discusses it in a concurrent resolution . . . "requesting that the President, at the conference for the conclusion of treaties of peace terminating the present war, urge upon the nations of the world represented at such conference the adoption of the *Edwards perpetual calendar.*" We found the new calendar most interesting. Its adoption would provide that all anniversaries fall on the same day of the week every year, the first month of each quarter begin on Monday, the second month of each quarter on Wednesday and the third month of each quarter on Friday, perpetually.



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The United Wireless Telegraph Company (De Forest) station *BH* in Quincy, Mass., May, 1911. The station, covering the Boston district, was operated by Art. A. Stockellburg, "Sy", (seated) and Ken Richardson, "R", (standing).

•

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BACK THE ATTACK -- BUY MORE WAR BONDS

WGN AIR THEATRE

(*Continued from page* 81)

camera room. The projection roo will be of fireproof construction wi separate means for ventilation direct to the outside. There will be one slid projector for stills and two 35-m and two 16-mm projectors. The pi ture will be projected through a opening in the wall to the require number of cameras.

R-F Control Room

The r-f, a-f, etc., control rooms serv ing the large and small studio theatre will be centralized around the maste control room.

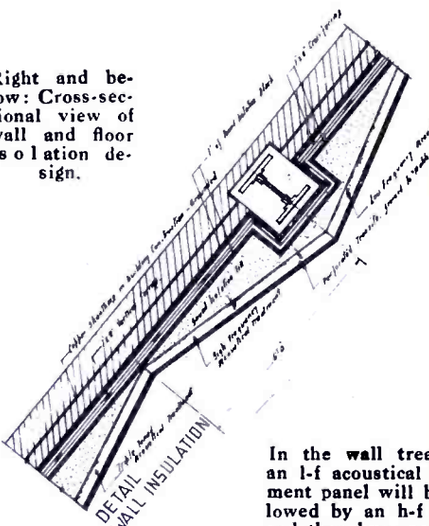
Acoustics

In the acoustics of the large studi stage, where scenes will vary from in timate living room shots to large ex teriors, a control of reverberation ha been included so that the studio can b very *dead* for exteriors and *live* enough for the illusion of *interiors*. For th audience area the walls, ceiling an rear of auditoriums will be acousti cally treated with perforated transite backed by rock wool.

Outside Noise Control

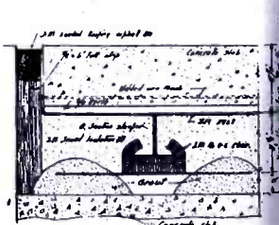
Sound isolation of the floors an walls for the ground floor and part of the lower level have been provide to shut out the noise of the traffic lake steamers and switch engines.

Right and below: Cross-sectional view of wall and floor isolation design.



In the wall treatm an l-f acoustical tre ment panel will be f lowed by an h-f pa and then by a panel triple - tuned frequer characteristics. T h sequence repeats throughout.

Felt and sound insulation material of J-M type are proposed in the floor isolation design.



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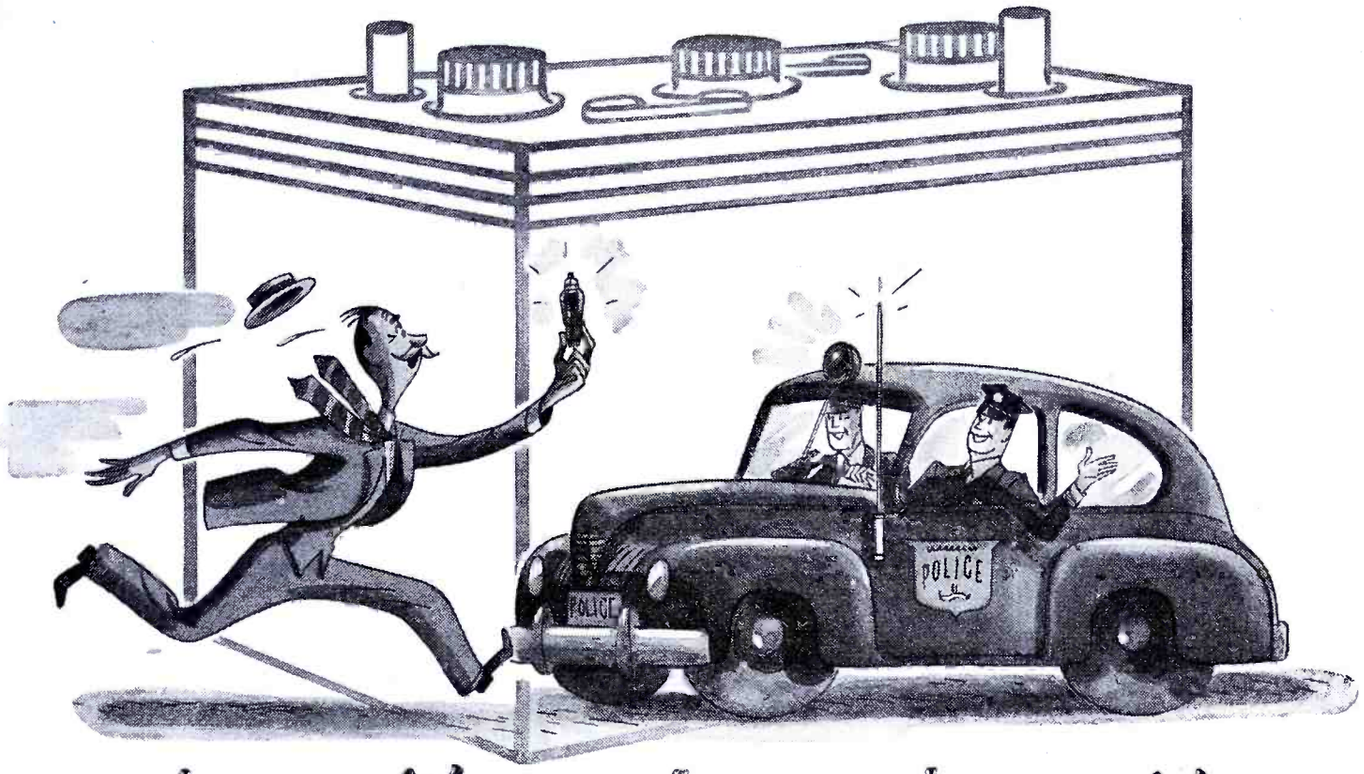

HY1269 HY31Z HY65 HY69 HY1231Z

In mobile operation, the battery is the kingpin. Two-way police radio takes it out of the battery twenty-four hours a day. Conservation of battery power during stand-by periods is mandatory.

Instant-heating Hytron tubes with thoriated tungsten filaments came to the rescue of police radio. Only when on duty, does police radio equipment draw power when Hytron tubes are used. Filament and plate power go on together.

And that's not all. The Hytron HY31Z, HY65, HY69, HY1231Z, and HY1269 are rugged. HY65 performance in two-way motorcycle police radio has proved this. Including 12-volt filament tubes for marine applications, Hytron's instant-heating line is versatile. Concentration is on the R. F. beam tetrode — work horse of transmitting tubes — but also included is the HY31Z twin triode for Class B. One type can power a whole transmitter — R. F. and A. F. — thus simplifying the spares problem (e.g., Kaar Engineering transmitters built around the HY69).

Wartime uses are bringing additions to the Hytron instant-heating line. Watch for future announcements.

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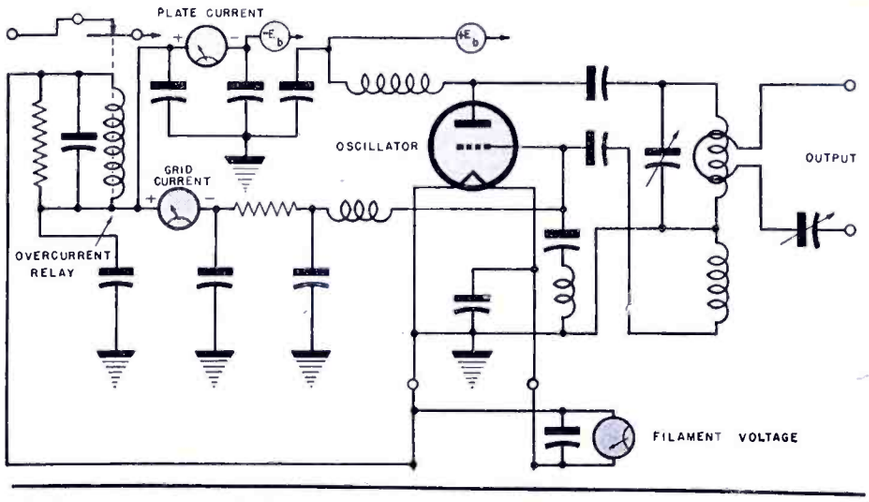

Figure 6
Circuit of commercial r-f heating power generator. Power output is 25-kw.
(*Courtesy FTR*)

EXTERNAL-ANODE TRIODE

(*Continued from page 57*)

istic from the constant-current pla characteristics, remembering that aft an assumed value of grid bias is tak it will have to be altered when t exact value of the d-c grid current h been determined. Several successi analyses will have to be completed f each point on the dynamic characte istic, an extremely tedious job.

A feedback line which shows th ratio between the grid-excitation vo age fed back and the a-c component the plate current will intersect the dy namic characteristic at a point *P*. Th intersection determines the upper lim of the operating line of the oscillato The plate voltage is known, so that th lower limit of the operating line ca be determined from the a-c componen of the plate current corresponding t the operating point *P*. The effect o greater feedback is shown by the dot ted line on the dynamic characteristic A feedback value which is too smal for oscillation is indicated by th dashed line on this characteristic.

A complete analysis of the operat ing constants of the oscillator can now be taken from the operating line which has been drawn on the constant-current characteristics. The grid circuit becomes part of the load of the oscillator; hence the load impedance and the output power must be modified accordingly. The power used in the grid circuit must be subtracted from the output power, and consequently it will not be possible to obtain as high efficiencies with oscillator circuits as with equivalent class *C* circuits. It should also be noticed that the analysis assumes that the grid voltage is exactly 180° out of phase with the plate voltage. Any departure from this condition will tend to reduce the efficiency of the oscillator. Because of the number of dependent parameters in the oscillator design, the results are never as accurate as in the design of amplifiers using the same tubes.

The class *B* linear amplifier is passing out of general usage in favor of more efficient amplifiers for modulated waves.[4] There are a number of elec-

[4] W. H. Doherty, *A New High Efficiency Power Amplifier For Modulated Waves*, Proc. IRE, p. 1163; Sept., 1936.

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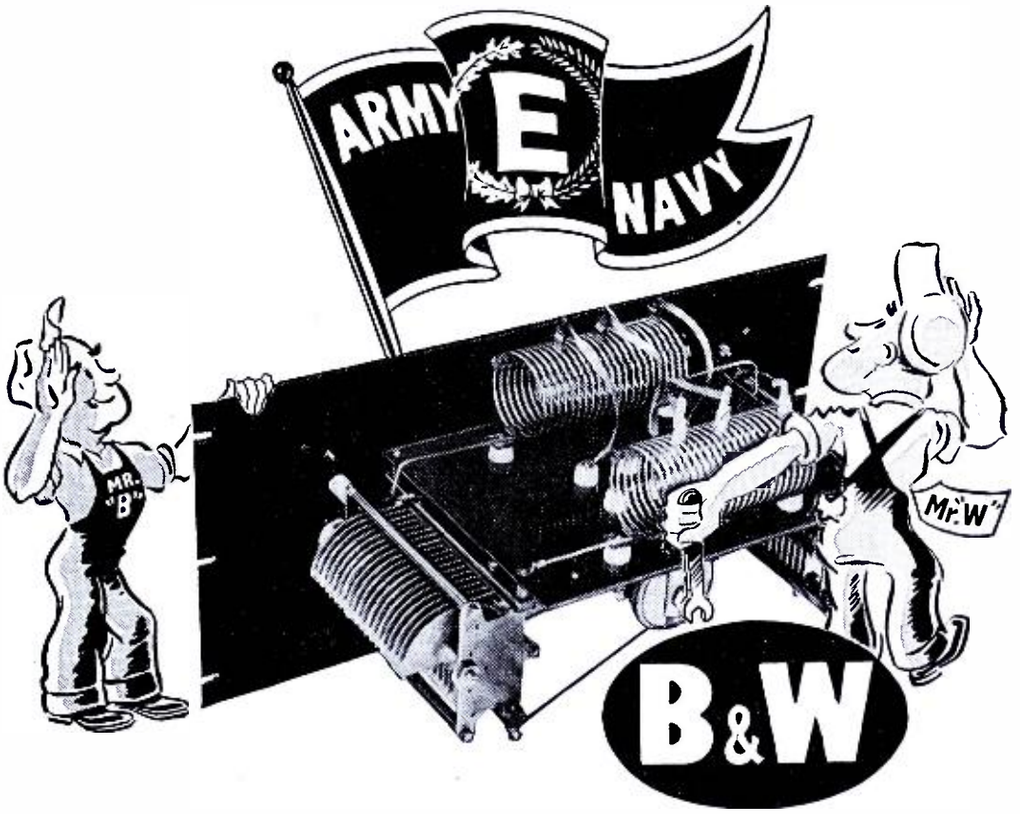
nic units in use at present employ- g this type of amplification, so its de- n will be considered briefly. Re- ring to Figure 2, the line *O A'B'* resents the dynamic characteristic class *B* operation. We know that this type of operation the plate cur- t with no excitation is very nearly o, and that with excitation the cur- t flows over a half cycle. Also that h full modulation the grid excitation l the plate swing doubles in value. ce any distortion will be due to op- tion in the range of saturation, it is irable to carry out the design for crest modulation condition, illus- ted by the line *O'B'*. The analysis followed in a manner identical with t of the class *C* amplifier. The plate ltage swing and the grid excitation e then halved and the operation ng the path *O'A'* is analyzed. The ernating component of the plate cur- nt at carrier level should be com- red with the crest value for the re- ired two-to-one relationship. The wer output at carrier level should be actly one-fourth of the peak power, d the load should be the same. If ese conditions are not met, a new est line will have to be established d another set of calculations carried t.

It will be noted that the efficiency at rrier level is very low compared with e efficiency at full modulation. This akness of the linear amplifier is cor- cted in the *Doherty* amplifier, where carrier tube and a crest tube are ed, so that they both operate at high iciency. A proper analysis of the eration of this amplifier cannot be ade in a survey paper of this type. rther information on operation and sign of these amplifiers should be tained from source materials.[4, 5]

The high-power high-level modu- ted transmitters have been made pos- ble by the development of class *B* a-f mplifiers which produce large output wers with low distortion. While e design of these amplifiers pose any interesting problems, there is no lequate short cut in the design which ill give operating characteristics and rves from which distortion might be lculated. Yet it is possible to *rough ut* a class *B* design using the plate naracteristics of the tube. Figure 8 ows the circuit diagram of a class *B* -f amplifier with the voltages and cur- nts indicated. On the plate charac- ristics (Figure 9), a trial load-line erected with a slope which is the ciprocal of the load resistance. The oint *O* is determined by the operating

(*Continued on page* 102)

[5] *Handbook of Tube Operation*, Federal Tele- hone and Radio Corporation; p. 31.



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FREQUENCY CONVERSION CIRCUITS

(*Continued from page* 47)

superheterodyne circuit were actually at hand early during the first World War, and *the invention of the superheterodyne was merely a matter of putting together these parts in a particular order for a particular purpose.* The parts referred to were local oscillators, nonlinear tube circuits, (such as grid-leak detectors) and various types of tube amplifiers. The superheterodyne circuit was consecutively approached by several people, some of whom came very close to the final idea. Most of the activity concerning the superheterodyne circuit, with the invention just hanging in the air, was shown in France at the end of the first World War. Here L. Levy, concerned with the problem of reducing interference due to reception of undesired transmission and static, designed in 1917 a *noise-free* code receiver, in which a local oscillator was employed to heterodyne with the incoming wave. The ultra-acoustical beats could, if necessary be amplified (in what is now known as the i-f amplifier) and then passed on to the detector and acted upon by the continuous-wave oscillator to become audible. Levy's receiver was probably the first outline of the modern *code-reception* superheterodyne of today.

Another approach was made by E. L. Chaffee (present director of Cruft Laboratory) and J. H. Hammond, who du ing the first World War were worki on a transmission system for secret co munication. This transmission syste was demonstrated to the various alli officials in France. The main differen between the Chaffee-Hammond system a the conventional superheterodyne is th in the former system, the frequency no mally supplied by the first local oscillat is supplied from the transmitter. It mu be realized that both Levy, and Chaff and Hammond approached the idea of t superheterodyne from specific angles a with specific aims in mind. Even if t possibility of using the receivers f telephone (later broadcast) reception w evident to them, this solution was not interest as they were following up line which at that time were of more im portance.

In simultaneous research work W Schottky of Siemens, Berlin, designe special types of receivers for high sens tivity and selectivity, free from disturb ances caused by undesirable signals. I 1918 Schottky filed a patent on a re ceiver, in which the incoming wave wa converted to a wave of lower frequency which was then amplified and detected This was at least in principle a straight forward superheterodyne, and it could b used for any type of signal. It had the features of high sensitivity and selectivity because of i-f amplification. However, gone so far, Schottky left the receiver in an undeveloped state, probably not realizing its future possibilities.

Major E. H. Armstrong's Developmen

If Schottky was unable to see the value of the circuit for telephone reception, what later became broadcast reception, there was a man in France who had this ability; and this is where the name of E. H. Armstrong enters into the development of the superheterodyne type of receiver. (Naturally, due to the war, there was no connection between the research work carried out in Germany and that carried out in France). Armstrong apparently knew that much more gain and better selectivity could be obtained in long-wave amplifiers than in medium-wave amplifiers, and further that in general, amplifiers with a very limited frequency range were superior to amplifiers with a wide range. He built a long-wave receiver with fixed tuning, and to receive medium-wave stations he employed the already known technique of heterodyning, putting a frequency changer between the antenna and the long-wave receiver. Armstrong's patent application, although filed in 1918,* was later than Schottky's. Armstrong claimed in his patent the use of multiple frequency conversion.

In this discussion we are only interested in the superheterodyne receiver from the point of view of its frequency converter, and the following treatment will be centered on the converter stage rather than upon the superheterodyne as a receiver.

Developments Prior to 1930

The original superheterodyne employed *circuit-coupling* with its main disadvantages of direct *interaction* and *radiation*. The direct interaction involved mutual

*French patent 50 15 11, December 30, 1918.

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ng effects, and synchronization (pull-
. Frequently the mixer circuit em-
ed a grid-leak detector, and the de-
r circuit was just the same thing re-
ed, as here another grid leak detec-
was employed.* The local oscillator
a simple triode circuit, inductively or
citively coupled to the mixer cir-
The first superheterodynes em-
ed converter stages with one tube as
er and the other tube as local oscil-
, but considerable efforts were being
from the beginning, to reduce the
ber of tubes in the converter stage
two to one. Thus it became desir-
to have a tube that performed the
ns of mixing and oscillations simul-
ously. One circuit already available
a the Round's autodyne. His circuit
several disadvantages, for example
ification loss due to detuning;
isadvantage that grew worse as
intermediate frequency became
er and higher during the de-
er's effort to get rid of image in-
rence. (The autodyne came back
orarily around 1930, when the short-
e bands were made available to the
o-listening world. These autodyne
ivers were then, for some time, op-
ed with relatively low i-f values and
efore had negligible detuning). The
uirements on converter stages free
n *pulling* effects and radiation con-
uted in making the autodyne less
ular.

ther circuits were comparatively free
n some of the shortcomings of the
odyne. H. W. Houck in his *Har-
ic Heterodyne* of 1923 eliminated the
ning losses because he operated the
l oscillator at half the required fre-
ncy and utilized its second harmonic
mixing. It is interesting to realize
many design problems of these
's are the same ones we now en-
nter in the design of modern centi-
er-wave converters, which of neces-
employ circuit coupling; see Figure 1.

Tropadyne

ne circuit, widely appreciated by
o amateurs, was the *tropadyne,* em-
ring a sort of balanced tuned circuit
prevent direct interaction and radia-
, as well as detuning loss. Another
ular circuit was the *ultradyne.*

here were other circuits as well, but
e single input mixers soon faded in
ortance in competition with a new
of circuit; the double-input mixer.
early form of this circuit employed
ble-grid tubes in which the first grid
as a space-charge grid. Schottky
loyed the double-grid tube in circuits,
re both grids acted as control grids,
his main objective was probably not
er action. Later in 1917 and 1918
lack of enthusiasm for the screen-
d tube as a high-frequency amplifier
vented him from successfully apply-
it in circuits, where the screen grids
e operated at a frequency different to
one on the signal grid. It was there-
e natural that few attempts were
g made during the first eight or ten
rs of superheterodyne developments
employ screen-grid tubes in the con-

(*Continued on page* 90)

*The fact that a detector circuit was employed
mixer led many to believe that the mixer
e performed detection, and thus call the
er stage "first detector". Although correct
the original circuit, this term now creates
fusion and should not be used.

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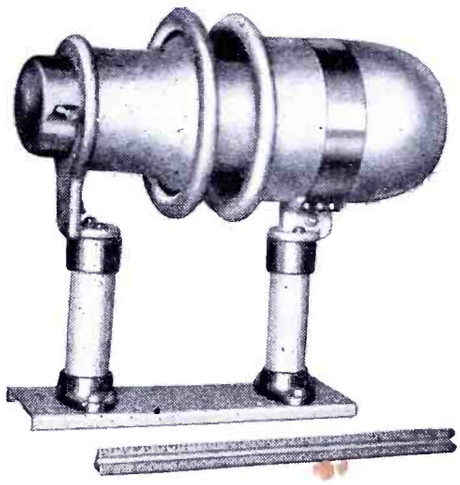

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FREQUENCY CONVERSION

(*Continued from page 89*)

verter stage. The set manufacturers (and a great number of radio amateurs) actually used the much less suitable double-grid tube, at least in Europe. This tube was connected with the second grid and the space-charge grid as an oscillator-grid or vice versa. The oscillator circuit employed one of the grids as oscillator grid and had a feed-back coil in the plate circuit. The outstanding disadvantage of the double-grid tube as a converter tube was the direct interaction (via the capacitance between the control grids), whistles due to intensive harmonic generation, radiation, and low conversion gain. Although a standard circuit with separate oscillator may have had still more direct interaction and radiation, it was often preferable from the point of view of stage gain. It must be realized that the double-grid tube had to compete not only with the original Armstrong superheterodyne mixer tube, but with more modern circuits, in some cases having the oscillator voltage injected into the cathode circuit rather than into the grid circuit—a great step forward.

Although in the years before 1930, the double-grid tube gained a temporary, although weak, position, it was gradually losing ground in competition with h-f tetrodes and pentodes. No doubt the original aim in employing h-f tetrodes and pentodes was the same as in employing double-grid tubes; to get rid of the separate local oscillator. However, circuits with h-f pentodes as *mixers* came in frequent use as well, one factor in favor of the high pentode being its stability under all tuning conditions. The advantages of circuits employing a separate oscillator thus became more generally appreciated, especially when cathode injection was employed. These latter circuits with screen-grid type tubes and cathode injection became very popular and marked a distinct step forward in converter stage design. In America, where high-frequency pentodes were in common use earlier than in Europe, several good *converter tube* circuits developed, too.

Pentodes in Converters

Because most pentodes available in Europe around 1925-1927 were loudspeaker pentodes, these tubes came to be used to some extent in converter stages, although because of considerable electrode capacitance they were not well fitted for high-frequency operation. In 1928 the writer tried a circuit employing a loudspeaker pentode with the suppressor grid utilized as part of the local oscillator circuit, and with no intentional circuit-coupling between signal and oscillator circuits. Experiments of this sort were probably carried out much earlier by tube and set manufacturers. The circuits developed were of interest as early attempts of modern mixer and converter designs, although there was little conscious effort made to achieve so-called electron-coupling and avoid circuit-coupling.

Electron-Coupled Mixers

The radical change from old to new ideas occurred around 1930 and was characterized by the gradual acceptance of *electron-coupled mixer and converter tubes.* Up to this time most converter stages operated in accordance with the principle that the signal and oscillator voltages were first added (linearly mixed), whereafter the sum was applied to the nonlinear mixer element. A square-law device as mixer gives a simple example on how the intermediate frequency was produced in such a setup. If the oscillator voltage $e_B = E_{B\,max} \cos Bt$ is injected in series with the signal voltage $e_A = E_{A\,max} \cos At$, the output current i contains the component

$$i = k\,(e_A + e_B)^2 = k\,(E_{A\,max} \cos At + E_{B\,max} \cos Bt)^2 = \ldots + \tfrac{1}{2} k\, E_{A\,max}\, E_{B\,max} \cos (A - B)t, \quad (1)$$

which is the component utilized as the i-f component in standard superheterodyne receiver design.

The Ultradyne

It is here of interest to investigate some of the previously mentioned circuits to see if they would operate satisfactorily, or maybe better, if the circuit coupling were removed. A circuit of special interest in this respect is the previously mentioned *ultradyne,* Figure 2a; once popular among radio amateurs. The mixer tube has a *separate electrode for each one of the two waves to be mixed,* but one of these electrodes, the plate, as well serves as output electrode (the mixer tube operates with zero-plate bias and is therefore stable for all tuning conditions). If the triode were free from electrode capacitance, and undesirable space-charge and stray couplings are of negligible effect, then no energy

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l be transferred from the local os-ator to the antenna circuit and there-e no radiation will prevail. The early es sometimes had a considerable elec-de capacitance as well as other de-ts, but the *ultradyne* was still superior the conventional superheterodyne, as iation, mutual tuning effects and syn-onization were much reduced. Thus *ultradyne* became used for short-ve reception in 1927. It is of interest quote a well-known technical writer o described the possibilities of the *adyne* circuit.[2] This quotation is of at interest since it proves that the sibility of achieving improved electron pling by means of screen-grid tubes s known to set designers in Europe 1927-28. As we will see it took the nufacturers five years to proceed from king about the possible use of electron king screen-grid tubes to actually pting screen-grid tubes on a com-rcial basis. The quotation, in free nslation states: ". . . Already by using riode of small electrode capacitance, oscillation energy transferred to the enna becomes very small. It is in s respect still better to use a screen-d tube. The use of a screen-grid tube however, only successful when the t of the circuit is so designed and eened that high-frequency energy can-reach the antenna circuit via any er path. . . ." It is remarkable that 1927-28 *ultradyne* circuit was used in ctice all the way down to 10 meters. e main difficulty in extending the ge into the *useless* region below 10 ters was the failure of the local oscil-or to maintain proper operation.

uble-Grid Tubes

Another example of electron-coupling king in combination with unavoidable cuit coupling is provided by the previ-ly mentioned double-grid tube, used to e extent around 1925-1930. If this e is utilized with a separate oscillator il is assumed to have negligible capaci-ce coupling between the grids, as well negligible undesirable space-charge ef-ts, it would still perform its action as frequency converter. This is because signal circuit is coupled via the elec-n stream to the plate circuit, and in-dependently the oscillator grid is coupled the same electron stream to the plate cuit. The reasons for the mixing ac-n were not understood too well in the inning. It was graually realized that en if each grid in the idealized tube l a straight characteristic within the gion of operation, so that, seen from particular grid under static condi-n the tube was entirely linear, an i-f mponent of considerable amplitude was veloped in the plate circuit. The fact t the tube could operate without rec-fication puzzled some early investigators nd still puzzles many students). Today know that this condition exists be-se of the so-called *gate-effect*.

ectron Coupling

In everyday parlance, an amplifier or cillator tube, in which one control-grid cuit is coupled via the electron stream ly to the plate circuit (or other simi-r output electrode circuit) is said to be erated with *electron coupling*. The

(*Continued on page* 92)

[2] M. V. Ardenne, Empfang auf kurzen Wellen, thgiesser and Diesing, Berlin; 1928.

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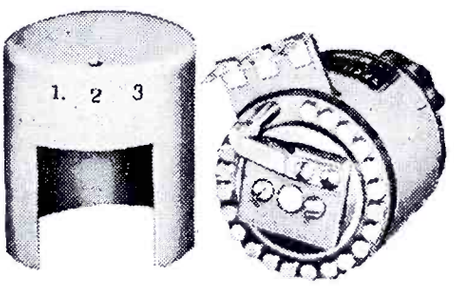

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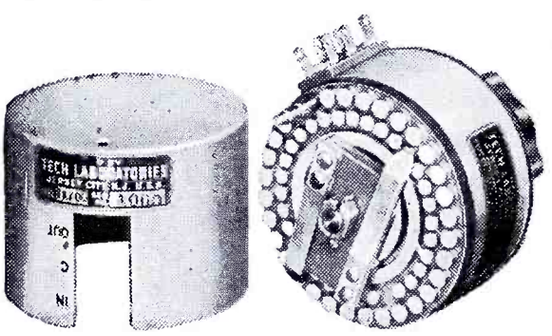

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FREQUENCY CONVERSION CIRCUITS

(*Continued from page* 91)

word *only* implies that circuit coupling and undesirable space-charge coupling has been reduced to become of negligible importance by means of suitable screen-grid design and suitable electrode potentials. In mixer and converter tubes the term *electron coupling* requires that both the signal grid circuit and the oscillator grid circuit be coupled to the plate circuit, as mentioned previously. (There is no generally accepted definition on what is meant by *electron coupling;* the above formulations reflect the opinion of the writer rather than any accepted definitions).

Although the action of the early double-grid tubes to a considerable extent did depend upon electron coupling, circuit-coupling effects were often predominant. Converter circuits of the type shown in Figure 2*b* therefore showed little improvement over the original superheterodyne circuits as they gave strong direct interaction and radiation.

Screen-Grid Tube Applications

The gradual change-over in 1925-1930 to screen-grid type tubes considerably improved the double-input type of mixer and converter tubes. Thus in the mixer circuit shown in Figure 3*a*, the signal circuit at least was electron-coupled the plate circuit. This type of cir became very popular, as it was qu free from direct interaction and radiati The circuit in Figure 3*b* shows an tempt toward electron coupling of bl signal and oscillator circuits to the pl circuit. The operation of this tube a mixer tube is therefore essentially to electron coupling. The circuit Figure 3*c* is developed toward practica complete electron coupling, a fourth g being employed to provide screening the oscillator grid from the plate, that at least in principle true electr coupling is obtained. For various r sons this type of tube was manufactu with a fifth grid, a pentode or suppres grid, which is not actually necessary obtaining electron coupling. It co tributes, however, to the operation of tube, as it improves the screening a increases the plate resistance, the lat result contributing to less damping the following i-f circuit. Tubes w five grids may also be used as *converti* tubes, in which the two electrodes close to the cathode are utilized as oscillat grid and oscillator plate. Electron cou ling exists as the signal control grid h a screen-grid on each side. Strict speaking the circuit in Figure 3*c* belon to a period following 1930, and this ty of tube, specially built for electron cou ling, will therefore be further discuss later in the paper.

Superheterodynes and Oscillator Applications

The foregoing discussion must not lea to the opinion that most superheterodyne were built with converter tubes durin the early developments. The origin design with a separate oscillator was th one in most common use, and the vario improvements in tubes were utilized i both mixer and converter tube circuits a they appeared. A separate oscillator ca generally be built with better character istics than a *built-in* oscillator. A stag that has to perform mixing only can b made to operate better than a stage tha must also incorporate an oscillato The method used to introduce the oscilla tor voltage to the mixing part of the sys tem can generally be chosen to better ad vantage with a separate oscillator tha with a *built-in* oscillator. All this i especially true when the operation is ex tended toward higher frequencies.

•

G.E. AIRCRAFT TWO-WAY UNITS

Personal plane 18-pound 12-watt two-way G.E. equipment with a plug-in type instrument panel on display at the recent Airport Development Clinic in New York. At right, Philip G. Caldwell, sales manager of G.E. aircraft and marine division, with W. T. Piper, president of the Piper Aircraft Corporation.

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NEWS BRIEFS

COMMUNICATIONS JOINS TBA

COMMUNICATIONS has become an affiliate member of the Television Broadcasters Association, Inc. Lewis Winner, editor, will represent COMMUNICATIONS at TBA meetings.

* * *

AYRES PROMOTED BY TWA

Ralph C. Ayres has been appointed system superintendent of communications for Transcontinental and Western Air, Inc. He will also retain his post as chief radio engineer. Mr. Ayres replaces Gordon A. O'Reilly, who will become vice president and general manager of Aeronautical Radio Incorporated of America, Washington, D. C.
Mr. Ayres has been with TWA since 1937.

* * *

ILLINOIS TECH RECEIVES $15,000 GRANT FROM OHMITE

The Illinois Institute of Technology has received $15,000 from the Ohmite Manufacturing Company to be used for the establishment of a laboratory for the precision measurement of electrical and magnetic quantities.
The gift came through David T. Siegel, president of Ohmite and a trustee of Illinois Tech. It represents the initial contribution for equipping what will be known as the Ohmite Laboratory for Precision Measurements.
The laboratory's ultimate goal is to provide precision electrical measurements for the Chicago area approaching in accuracy those of the Bureau of Standards in Washington, D. C. The lab will be located at the Armour Research Foundation of Illinois Institute of Technology and will be developed under the direction of Prof. E. H. Schulz, supervisor of electrical engineering laboratories, and L. W. Matsch, supervisor of electrical engineering at the Armour Research Foundation.

* * *

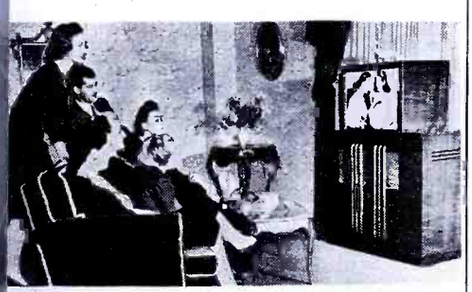
MAGUIRE INDUSTRIES BUYS THORDARSON

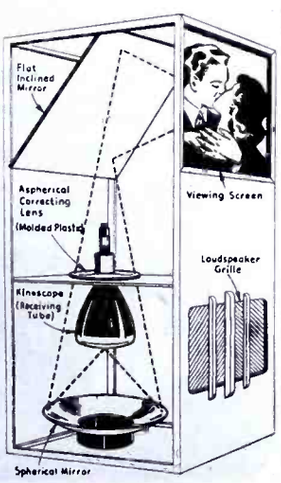
The Thordarson Electric Manufacturing Company of Chicago has been purchased by Maguire Industries.
Russell Maguire has been elected a director and president of Thordarson to succeed Jackson Burgess, who has resigned. Bartlett Winkham and Eugene D. Powers, directors of Maguire Industries, have also been added

(*Continued on page* 94)

* * *

LARGE-SCREEN HOME TELEVISION





Reflective television system recently demonstrated by RCA. Translucent plastic viewing screen is 11½" x 16". Voltage of 27,000 is applied to 5" c-r tube.

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STRENGTH

There's satisfaction in buying antennae from Snyder. There's solidity to the organization—there's quality to their products—there's a definite price advantage. Make your next order to Snyder.

ANTENNAE
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MANUFACTURING CO. • PHILADELPHIA

COMPLETE MANUFACTURERS FROM START TO FINISH

NEWS BRIEFS

(Continued from page 93)

to the board. The Thordarson company will continue to operate as a separate entity. Plans of the new management include a resumption of the manufacture of transformers for radio equipment.

* * *

BEN MILLER JOINS UTC AS S-M

Ben Miller has been appointed general sales manager of United Transformer Corporation, 150 Varick St., New York 13, N. Y. Samuel L. Baraf has taken over the merchandising activities as director of sales and merchandising.

Mr. Baraf will have complete charge of surveying present-day and potential industrial markets and planning for large scale distribution.

Mr. Miller was formerly with Meissner Mfg. Corp. as sales manager.

S. L. Baraf Ben Miller

* * *

FTR U-H-F AND TELEVISION NOMOGRAPHS

A series of 25 nomographs for use in u-h-f work have been issued by the Federal Telephone and Radio Corporation of Newark, N. J.

Six of the charts have been developed for design of double and triple tuned band-pass circuits in the v-h-f and u-h-f ranges.

Two of the nomographs cover series and shunt-peaking methods of range extension in wide-band amplifiers, while other charts relate to impedance characteristics in various types of transmission lines, including single wires in troughs and in square outer conductors; balanced two-wire and concentric lines, air-spaced, and with solid dielectric; quarter-wave matching sections, and sending-end impedance in uniform lines. There are also nomographs for transmission-line lengths, cut-off frequencies in circular wave-guides, u-h-f path lengths and optical line-of-sight distances, deflection sensitivities of cathode-ray tubes, modulation percentages from oscillograms, reduction in gain caused by feedback, and dissipation of power in water-cooled devices.

* * *

J. R. BEEBE OPENS TRANSFORMER COMPANY

J. R. Beebe, formerly with Thordarson, is now owner of Premier Electronic Products, Inc., 4849 North Western Avenue, Chicago 25, Illinois. The company will produce transformers.

Mr. Beebe said that Premier will be equipped to produce critical oil-filled and hermetically sealed units.

* * *

SIGNAL CORPS DEVELOPS MORALE RECEIVER

The Signal Corps has completed development and standardization of a battery a-c/d-c 1500-500 kc/3.5-19 mc receiver to be used for morale and recreational purposes.

A built-in loudspeaker and headset jacks accompany the receiver.

The receiver will not be issued for use in

LT. CMDR. BRENGLE WINS NAVY AWARD

Lieutenant Commander Ralph T. Brengle, U.S.N.R., receiving Secretary of Navy ribbon which accompanied letter of commendation from Vice Admiral H. Kent Hewitt, U.S.N., Commander U. S. Eighth Fleet, citing outstanding performance while serving on staff of Commander of Eighth Fleet.

JONES 2400 SERIES PLUGS and SOCKETS

P-2406-CCT

S-2406-SB

A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically the entire length.

The Contacts on both Plugs and Sockets are mounted in recessed pockets greatly increasing leakage distance, increasing voltage rating. Molded BM 12 Bakelite insulation. Plug and Socket contacts are silver plated. The finished appearance of this series will add considerably to your equipment.

The 2400 Series are interchangeable with all units of the corresponding No. 400 Series.

Send today for general catalog No. 1 listing and illustrating our complete line of Plugs, Sockets and Terminal Strips.

HOWARD B. JONES COMPANY
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Marine Radio Telephone Equipment

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country except as specifically prescribed the War Department.

* * *

CHINSON, TOPEKA AND NTA FE TO STUDY R.R. RADIO

FCC has granted the Atchison, Topeka, Santa Fe Railway Company permission install two experimental class 2 portable portable-mobile radio stations to study types of v-h-f antenna systems, control s, and radio transmitters and receivers ed on railroad rights-of-way and rolling k.

e analysis will cover application to end- nd of trains; two-way train-to-train; two- yard-to-trains, engines or cabooses; two- dispatch-to-trains, engines or cabooses; way brakeman or flagman-to-train, engines abooses; and fixed station-to-fixed station g the right-of-way.

e FCC says that radio equipment proposed these stations will be loaned by the Aireon ufacturing Corporation, Kansas City, sas, for a period of three months.

equencies to be used will be assigned by chief engineer; power 10 watts; A3 emis- ; composite, type experimental equipment; mited hours of operation.

ese stations are to be used for experimental o communications along the Santa Fe Rail- System between Chicago and Galveston, between Chicago, Los Angeles and San ncisco.

* * *

TATIC APPOINTS RUSSELL C.-VA. REP

nk B. Russell of 5043 Marvine Road, xel Hill, Pa., has been appointed sales esentative of The Astatic Corporation in District of Columbia and Virginia.

* * *

W. FORSTER DEAD

bert W. Forster, advertising manager of stern Electric Company, died suddenly re- ly.

* * *

G. H. BROWN GIVES C. OF A. TALK

lication of r-f techniques used in the manu- ure of penicillin was discussed by Dr. rge H. Brown, research division head for smitters at RCA Labs at the April ting of The Radio Club of America in emeyer Hall, Columbia University.

r. Brown discussed r-f equipment and hods for dehydrating certain pharmaceutical erials which are sensitive to high tempera- s. This method involves a system for entrating the material in bulk. The con- rate is then measured into final con- ers where it is conditioned by means of o-frequency power.

* * *

' AWARDS

Army-Navy "E" has been awarded to the er Company, 1255 S. Michigan Ave., Chi- , Ill.

e Hicksville plant of Press Wireless has ived its second white star.

ourth white stars have been won by iomarine Corporation of America, Federal ufacturing and Engineering Company, and ler Company, Ltd.

e Ansonia Electrical Company has re- ed a white star for its "E" flag.

xecutone, Inc., N. Y. City, has been rded an "E" flag.

Muter "E" award: Les Muter, president; l Pfohl, vice president; Col. C. L. Ford- U.S.M.C.; Commander C. O. Triebel, U.S.N.

* * *

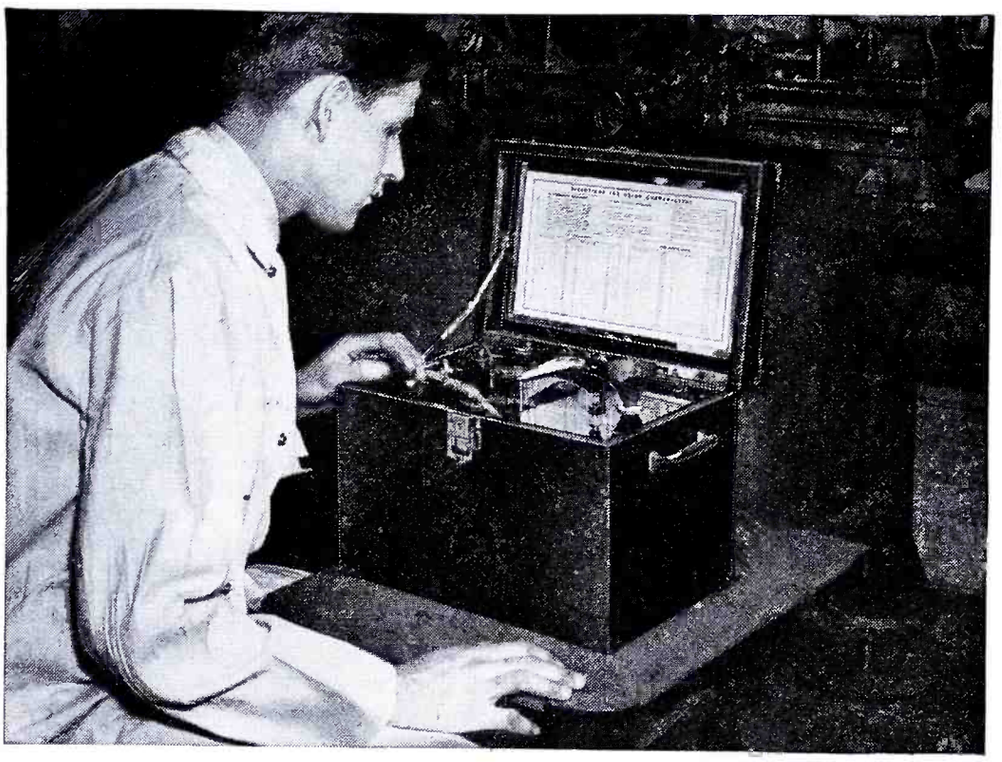
. SKOW JOINS SYNTHANE

Norman A. Skow has ben appointed ctor of research, Synthane Corporation.

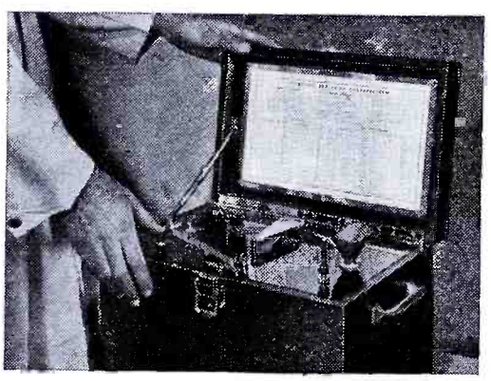
(*Continued on page* 96)

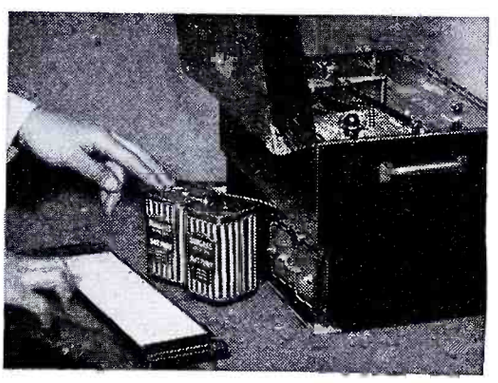
PORTABLE POWER PROBLEMS

THIS MONTH—FISHER CARBANALYZER



TIME-SAVING carbon content analyses of steel samples—from molten metal to report—take only five minutes with the portable, *battery-powered* Carbanalyzer, produced by the Fisher Scientific Company. Leading steel firms employing open hearth or electric furnaces quickly make carbon determinations of each steel batch, achieving close control of quality.





CARBANALYZER, powered by Burgess Industrial Batteries, operates over a range of .05% to 1.50% carbon content and is sensitive to a change of ± .005%. The power requirements of modern control and test instruments are fully met by Burgess Industrial Batteries—the standard of quality for all commercial uses. The types you require may not be immediately available today since industrial battery production is greatly reduced by urgent war needs.

Burgess Battery Company, Freeport, Illinois

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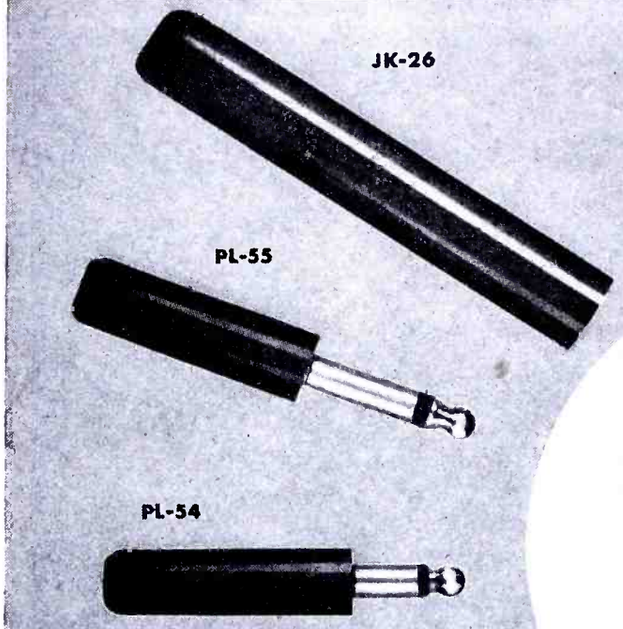

America's largest producer of JK-26 jacks. All models built to strict Signal Corps specifications.

Experience for Sale!

Amalgamated Radio, pioneers in the field, maintain experimental and development laboratories for post-war radio and television equipment. Our components are completely engineered in a self-contained factory equipped with tools of our own design. Years of specialized experience assure high quality products at low cost. *Inquiries are invited.*

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Featuring new materials and designs, the new Nemco Crystal Holders have easily *passed every test to which they have been subjected by the Signal Corps. and crystal manufacturers.*

Nemco Holders are designed to prevent deterioration of the crystal by repelling water vapor under tropical conditions.

Because we *specialize in the manufacture of Crystal Holders exclusively,* we can give you the quality and service to help speed your production.

Write for samples and prices; also request quotations on your requirements for imprinting holders with metallic ink.

New NEMCO N5X in No. 6105 and 592 may be obtained in all types of FT-243 Holders.

NATIONAL ELECTRONIC MANUFACTURING CORP.

22-78 STEINWAY ST., LONG ISLAND CITY, N. Y.

NEWS BRIEFS

(*Continued from page* 95)

Oaks, Pa. He was formerly with Bakelite Corporation.

* * *

MINNESOTA MINING TAPE CATALOG

A 24-page catalog covering insulating tape has been published by the Minnesota Mining and Manufacturing Company, St. Paul 6, Minn. Featured is a chart with a resume of the relative properties of 18 different types of scotch tape. Data offered include type of backing, tensile strength, thickness and characteristics such as stretch, adhesion, insulation, dielectric strength, electrolytic corrosion-factor, chemical stability, electrolyte content and melting point. Samples of each tape are also provided.

* * *

MECK MOVES CHICAGO OFFICE

John Meck Industries, Inc., Plymouth, Indiana, have moved their Chicago expediting office to 35 East Wacker Drive. Fred Arnold is manager of the office.

* * *

DR. L. P. SMITH NOW RCA LABS ASSOCIATE RESEARCH DIRECTOR

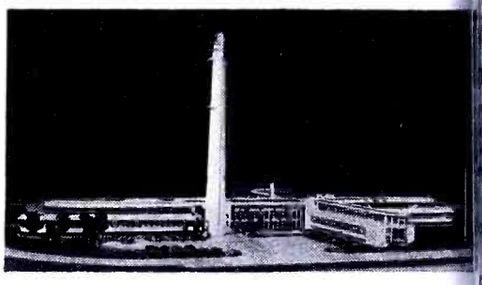
Dr. Lloyd Preston Smith, professor of physics at Cornell University, has been appointed associate research director of RCA Laboratories, Princeton, N. J. Dr. Smith's appointment fills a vacancy caused by the death last July of B. J. Thompson. Since February 1941, Dr. Smith has been associated with RCA Laboratories as a research consultant.

* * *

I. T. & T. FORMS TELECOMMUNICATIONS LAB. CORP.

A $2,000,000 corporation, the International Telecommunication Laboratories, Inc., has been formed by I.T.&T.

E. M. Deloraine, general director of Federal Telephone and Radio Laboratories, New York, will be president. Other officers elected were Harold H. Buttner and Douglas B. Baker, vice presidents; Paul F. Swantee, comptroller; O. C. Buchanan, treasurer, and C. Douglas Webb, secretary. The laboratories will concentrate upon initiating inventions, developing them, and providing an interchange of information on postwar activities among I.T.&T. laboratories, and manufacturing and communication subsidiaries.



Left, E. M. Deloraine. Above, model of the Federal Telephone and Radio Corporation research laboratories, now under construction in Nutley, N. J., which will serve as headquarters of International Telecommunication Laboratories, Inc., when completed.

* * *

RAYTHEON TO INSTALL WEST COAST RELAY SYSTEM

A microwave relay system to be installed on mountain peaks on the West Coast is being planned by Raytheon Manufacturing Co.

The system is said to augment the Western link of a microwave communications project revealed recently.

Raytheon has asked the FCC for permission to build experimental stations on Mt. Adams in Washington; Mt. Shasta, Mt. Lassen, Mt. Tamalpais, Mt. Whitney and Mt. San Gorgonio in California; Wheeler Park in Nevada; Kings Peak in Utah and Grays Peak in Colorado. These mountain peaks range in height from 3,000 to 15,000 feet.

Raytheon has requested channels on 30.66, 39.55, 90, 200, 400, 900, 1,900, 4,000, 6,000, 10,000, 16,000 and 26,000 megacycles.

The system contemplates automatically op-

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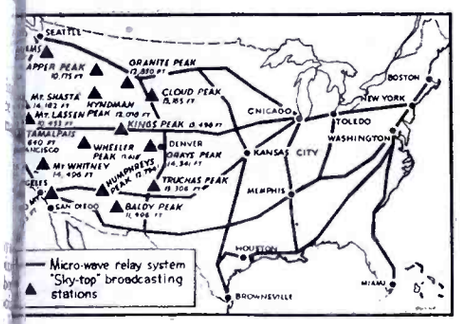
ted relay stations every 30 to 45 miles ween terminal points. Raytheon says that system will be effective along a path from to 25 miles on each side of a solid line m, or a total coverage of from 30 to 50 es in width.

ervices planned by Raytheon include: omatic warning for airplane pilots; simi- protection for ships against rocks, shoals, collision, and for railroad trains and high- vehicles against collision; printing of spapers by radio facsimile; high definition vision and motion pictures; portable trans- ting units for newspaper services; warn- s of impending floods, breaking of reser- s, forest fires, train wrecks and other sters.

oseph Pierson, former president of Press eless, Inc., is in charge of Raytheon's munications division.



* * *

TROLA AND ROHR RCRAFT MERGE

hr Aircraft Corporation and International trola Corporation have agreed on a pro- al for exchange of stock interests and participate in a postwar manufacturing gram in the aviation, radio and automobile ustries.

ohr has its plants on the Pacific Coast. ed H. Rohr is president and general man- er of Rohr Aircraft, and C. Russell Feld- nn is president and board chairman of trola.

* * *

ARCO ANTENNA SHOWROOM

rco Steel Construction Company of Eliza- h, New Jersey, have announced a field show- m where various types of Harco radio ers and masts will be on view. Antenna- er erection demonstrations will be provided. urs are allotted by appointment.

* * *

E F-M DEBATE DATA AVAILABLE

e discussion of the position of f-m in the ctrum, which took place at a special ses- n of the IRE Winter Technical Meeting s been transcribed and is now available m IRE, 330 West 42nd Street, N. Y. 18, N. Y. he transcription contains thirty mimeo- aphed pages and is priced at three dollars copy, postage prepaid.

* * *

OFFSTEIN RETURNS TO ATR

er more than three years of military serv- , Captain Albert Goffstein has returned the American Television & Radio Co., Paul, Minnesota, to resume his post as neral manager and chief engineer.

* * *

ONCORD RADIO CATALOG

68-page catalog listing condensers, resistors, ansformers, tools, testers, tubes, and other sential components and equipment has been leased by Concord Radio Corporation, 901 . Jackson Boulevard, Chicago 7, Illinois, d 265 Peachtree Street, Atlanta 3, Georgia.

* * *

DMIRAL HOOPER RECEIVES RANKLIN INSTITUTE AWARD

ear Admiral S. C. Hooper, USN (Ret), has

(Continued on page 98)

There's a TURNER Microphone REPRESENTATIVE Near you

HELPING SOLVE MICROPHONE PROBLEMS IS HIS BUSINESS!

The Turner Company is proud of its thoroughly experienced staff of representatives. This competent group is qualified in every field of microphone application. These men are ready to study your electronic communications problems NOW. You are invited to call in your nearest Turner Representative for expert advice and suggestions in selecting the right microphone for your purpose. He is at your service whether you need job lots or single units. Call him today!

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The TURNER Company
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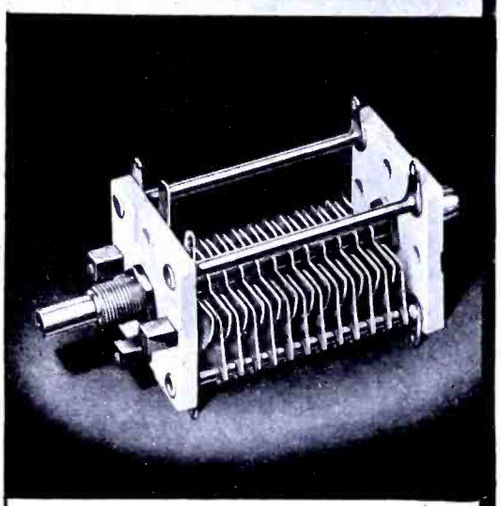
Application



The 23000 Series Variable Air Capacitors

"Designed for Application," double bearings, steatite end plates, cadmium or silver plated brass plates. Single or double section. .020" or .060" air gap. End plate size: 1 7/16 x 1½. Rotor plate radius: 19/32". Shaft lock, rear shaft extension, special mounting brackets, etc., to meet your requirements.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

NEWS BRIEFS

(Continued from page 97)

received the Elliott Cresson Medal for 1945. It was presented to him at the annual medal day ceremonies of the Franklin Institute in Franklin Hall, Philadelphia, Penna.

Admiral Hooper is the first Navy man ever to receive this award offered for "his pioneering leadership and practical utilization of discoveries in the field of radio for the United States Navy."

* * *

654 NOW IN NAB

Thirty-one more broadcasting stations have been admitted to NAB membership during the past three months, bringing the total membership to 654. Of these, 635 are a-m stations.

Frequency modulation, television, and networks round out the total of 654, with 37 associates representing equipment manufacturers, station representatives, transcription companies and market research organizations.

* * *

W. A. ONORATO BECOMES GENERAL DRY BATTERY PRES.

Walter A. Onorato has been elected president of General Dry Batteries, Inc., Cleveland, Ohio, and of General Dry Batteries of Canada, Ltd. He succeeds C. P. Diebel, founder of the company, who died in January.

* * *

SHOFSTALL NAMED G.E. RECEIVER DESIGNING ENGINEER

N. F. Shofstall has been appointed designing engineer of the receiver division of G. E. Headquarters will be at Bridgeport, Conn.

* * *

DR. LEROY D. WELD NOW WITH TURNER

Dr. Leroy D. Weld, professor of physics at Coe College, has joined the Turner Company, Cedar Rapids, Iowa, as director of research. Dr. Weld had been conducting part-time research for the Turner Company previously.

* * *

KARET OF UTAH ON WESTERN SPEAKING TOUR

Robert M. Karet, sales manager of the wholesale and sound divisions of Utah Radio Products Corp., 820 North Orleans St., Chicago, demonstrated and described the Utah wire recorder at jobber meetings in many Western cities, during a recent three-week tour.

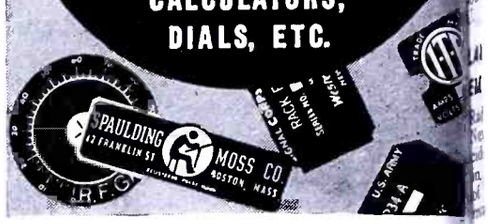
* * *

SPRAGUE PAPER CAPACITOR CATALOG

A 56-page, catalog, 20, covering paper dielectric capacitors has been issued by the Sprague Electric Company, North Adams, Mass.

Included in the catalog are details and dimensions for Sprague cardboard and metal tubular types, bathtub types, large and small rectangular units, ylindrical container units, hermetically-sealed types, ignition capacitors, screw-mounted types, radio-interference suppression filters, donut-shaped capacitors, 3-terminal network types, fluorescent lamp capacitors, paper dielectric capacitors for a-c applications, etc. Also included are data on Sprague energy storage capacitors for welding, flash-photography, and similar uses; vitamin Q capacitors for high temperature uses, including the hermetically sealed units in glass

Plastic
NAME PLATES
SCALES, GAUGES, CHARTS, CALCULATORS, DIALS, ETC.



- Impervious to moisture, grease, oils, acids, alkalis.
- Printing guaranteed not to wash or rub off.
- Non-inflammable, non-corrosive plastic.
- Printed and laminated vinylite and cellulose acetate.

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Cobalt • Chrome • Tungsten
Stamped, Formed or Cast.
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Also: LAMINATIONS for output transformers of highest permeability. Standard stocks in a wide range of sizes for Audio, Choke, Output and Power Transformers. Write for dimension sheet. . . . TOOLS . . . DIES . . . STAMPINGS . . . . HEAT TREATING.
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bes; glass-to-metal seals for many types of apacitors, and Koolohm resistors.

* * *

YLVANIA TO OPEN ARIETTA, OHIO, PLANT

lvania Electric Products, Inc., now have a w plant at Marietta, Ohio. W. H. Lamb ll serve as plant manager and Edward wis will be resident general manager.

* * *

M.C. NAMES BECKER AND COHN O COVER CALIFORNIA

e Universal Microphone Co., Inglewood, l., have appointed Herbert Becker factory presentative for northern California, Fresno d north, with headquarters in Burlingame. S. H. Cohn, of Los Angeles, will cover uthern California, south of Fresno for M. C.

* * *

AFAYETTE RADIO ADOPTS MPLOYEES GROUP INSURANCE

adio Wire Television Inc., 100 Sixth Avenue, ew York City, have instituted a group ac- dent and life insurance plan for all workers, effect since January 18, 1945. The cost this insurance will be paid wholly by the anagement.

* * *

YLVANIA PROMOTES DON MITCHELL

on G. Mitchell, vice president in charge of ales, Sylvania Electric Products, Inc., was ected to the board of trustees recently.

* * *

HANSEN WINS IRE AWARD

Dr. W. W. Hansen research engineer at Sperry Gyroscope was recently awarded the Morris N. Liebmann memorial prize by the IRE . . . "for the application of magnetic theory to radiation, antennas, resonators, and electron bunching; and for the development of prac- tical microwave equipment and technique."

* * *

BENWOOD LINZE OPENS N. Y. OFFICE

The Benwood Linze Electrical Manufacturing Company, St. Louis, Mo., have opened a New York office at 420 Lexington Avenue. H. S. Dahl will be in charge.

* * *

OMBERG BECOMES BENDIX RESEARCH HEAD

Arthur C. Omberg has been named chief research engineer of the Bendix Radio division. Mr. Omberg was formerly assistant chief of the operational research branch of the U. S. Army Signal Corps.

Dr. Harold Goldberg, formerly senior engineer with the Stromberg-Carlson Company, has also joined Bendix as a research engineer.

Harold Detrick has been appointed chief engineer of the Bendix home radio unit. Charles P. Geyh has joined the home radio division as

(*Continued on page* 100)

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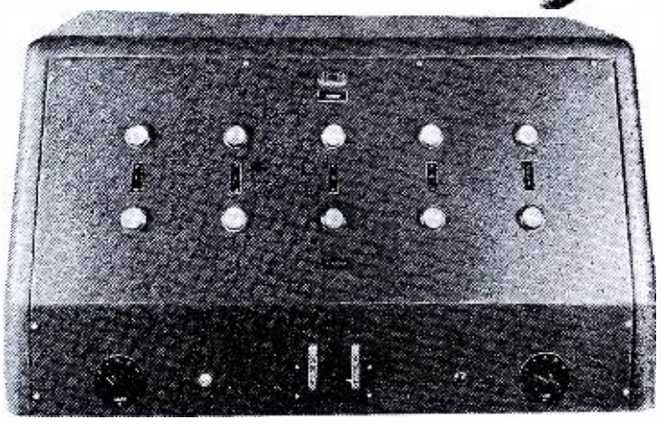

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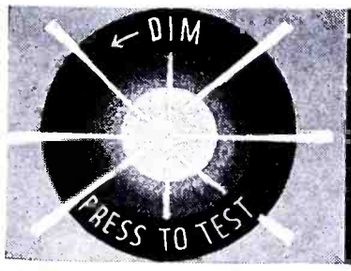

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NEWS BRIEFS

(*Continued from page 99*)

a cabinet design and production engineer.

Mr. Detrick formerly was chief engineer o the General Instrument Corporation.

A. C. Omberg

H. Goldberg

* * *

SHAEFFER BECOMES U.M.C. DESIGNER

Norbert Shaeffer has joined the Universal Microphone Co., Inglewood, Cal., as an industrial design engineer.

The D-20 microphone, first Universal product since Pearl Harbor, is the first model created by Mr. Shaeffer.

* * *

STOELTING TIMER BULLETIN

A 4-page electric timer bulletin, 1100, has been released by the industrial division of the C. H. Stoelting Company, 424-P North Homan Avenue, Chicago 24, Illinois.

The new bulletin describes table model stop clocks, wall model stop clocks, precision chronoscopes, combination timers and impulse counters, stop watch controllers, and spring wound x-ray timers.

* * *

ELECTRO-VOICE CATALOG

A 36-page catalog, featuring a simplified reference level conversion chart for microphone rating standardization use has been released by the Electro-Voice Corporation, 1239 South Bend Ave., South Bend 24, Indiana.

Poly-directional, dynamic, velocity and carbon microphones are described with applications, specifications, diagrams, etc. Basic operating principles of microphones are also offered.

* * *

N. A. PHILIPS C-R BOOKLET

A 16-page illustrated c-r booklet entitled "How and Why Cathode-Ray Tubes Work" has been released by North American Philips Company, Inc., 100 East 42nd Street, New York. The data in the booklet is reprinted from the July, September, October and November, 1944, issues of COMMUNICATIONS.

J. R. Beers, development engineer, is the author of the series of papers which cover early history, mathematical concepts, present-day problems; c-r tube manufacturing problems; testing of c-r tubes, and special c-r tube designs. The latter discussion covers

●

FAREWELL BANQUET FOR AEROVOX OFFICIALS

Left to right: Sam Siegel, retiring vice president, and Mrs. Siegel; W. Myron Owen, new president; Mrs. Charles Golenpaul; S. I. Cole, retiring president; Charles Golenpaul, sales manager; Mrs. Emanuel Cohen, wife of Colonel Cohen, former stockholder and company official; Stanley Green, new vice president and chief engineer; Frank Siegel and Austin C. Lescarboura.

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hs systems, color filters and three-color reens.

* * *

DW CORNING VARNISH DATA

4-page folder describing the properties of 993 silicone varnish and outlining the ommended procedures of application to the ulation of electrical equipment, has been eased by Dow Corning Corporation, P. O. x 592, Midland, Michigan.

* * *

ERITT AT CEDAR RAPIDS E MEETING

W. L. Everitt, president of the IRE, spoke ently before the newly organized Cedar pids section. He discussed wartime devel- ment of electronics.

Frank M. Davis of Collins Radio was elected airman of the chapter. Professor L. A. are, University of Iowa, was named vice airman; John A. Green, Collins Radio, ame secretary-treasurer.

* * *

AMMARLUND CAPACITOR OCHURE

32-page booklet describing variable capaci- design and production has been issued the Hammarlund Manufacturing Company, ., 460 West 34th Street, New York 1, N. Y. variety of capacitors are discussed and ustrated.

* * *

E. BULLETINS

vo bulletins describing push-button units, ector switches and indicating lights (GEA- 4), and thickness gages (GEA-4363) have en released by G. E.

* * *

INLAYSON NOW ANADIAN MARCONI G-M

uart M. Finlayson has been appointed neral manager of Canadian Marconi Com- ny. He succeeds R. M. Brophy, who re- ntly resigned.

* * *

UTOMATIC MICA TRIMMER ATALOG

12-page catalog discussing mica compres- on trimmers has been released by Automatic anufacturing Corporation, 900 Passaic Ave- e, East Newark, New Jersey.

Specifications, capacity curves and outline awings are offered.

* * *

EONARD OF PHILIPS GIVES IRE TALK

A. Leonard, technical commercial man- er of the quartz crystal division of North merican Philips Company, Inc., New York, esented a paper on quartz crystals before e Rochester, N. Y., section of IRE recently.

* * *

.M.C. HOUSE ORGAN OW A MONTHLY

Micro Topics," house organ of Universal icrophone Co., Inglewood, Cal., will here- ter be published monthly.

The jobbers' edition of the paper, previously sued at frequent intervals, will be discon- nued and the news merged with factory tes and personnel items. A new feature will an engineering section for sound men. Tech- cal data will be furnished by a committee cluding James L. Fouch, president; Les Will- rd, chief engineer, and Jack Hall, production anager.

•

TLANTA REPS VISIT ASTATIC PLANT

. Hollingsworth (second from left) and Lou till (second from right), Atlanta, Georgia rep- esentatives of Astatic Corporation, during a isit to new plant and offices at Conneaut, Ohio, ith W. J. Doyle, sales manager of manufactur- g division; Ray T. Schottenberg, sales manager f jobber division, and F. H. Woodworth, president (from left to right).

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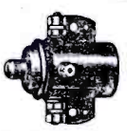

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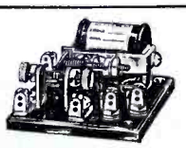

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EXTERNAL-ANODE TRIODES

(Continued from page 87)

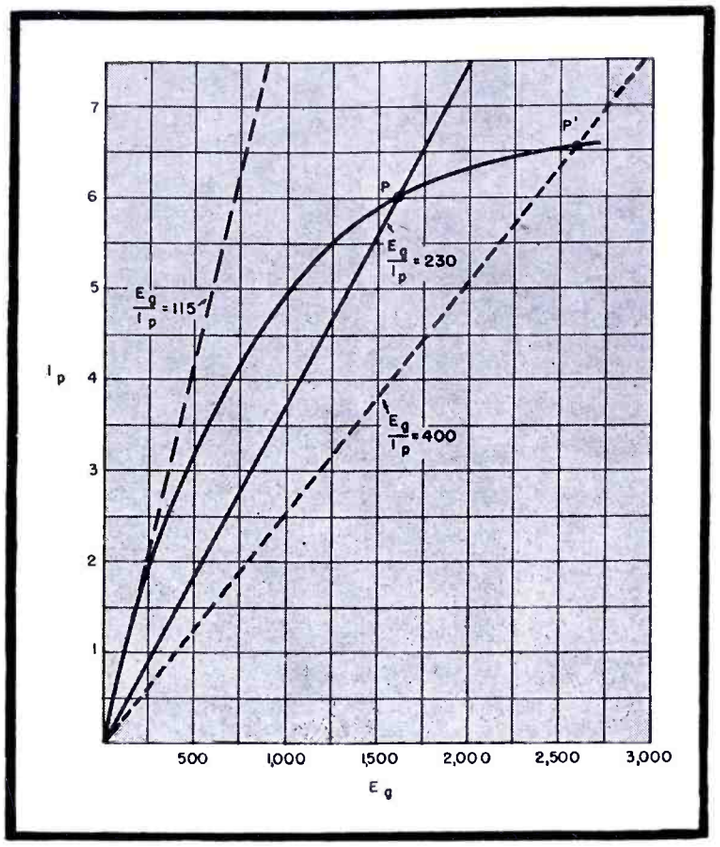

Figure 7
Class *C* dynamic characteristics, where the grid-leak resistance has a given value. Feedback line, which shows the ratio between grid-excitation voltage fed back and a-c component of plate current, will intersect dynamic characteristics at point *P*. This intersection determines upper limit of operating line of oscillator.

plate voltage and the grid bias necessary to reduce the no-signal plate current to a near zero value. The other end of the load line will be determined by distortion considerations. For simplicity the value first selected will be such that the maximum grid voltage

(Continued on page 104)

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

Radiomen!

CREI Offers Another Interesting Technical Discussion on Uses of THE CATHODE RAY OSCILLOSCOPE

Sent Free on Request

Readers of this column each month have been hearty in their praise of the interesting technical articles written each month by the CREI Director of Engineering Texts, Mr. Albert Preisman. These articles appear in our popular monthly paper, the "CREI NEWS."

In the May issue of the "CREI NEWS," Mr. Preisman has prepared a relatively elementary, but highly practical discussion of some of the many uses of the Cathode Ray Oscilloscope. Many men in the armed forces have had occasion to employ Cathode Ray Oscilloscope in special, and usually secret, military devices. Many have written to CREI and requested that some of the ordinary uses of the Oscilloscope be described—particularly some of the features that are not generally discussed in text books. The forthcoming article aims to meet this request and it is felt that a large number of radiomen will want to read it.

If you are not already on the mailing list to receive the "CREI NEWS," write at once to the address below and ask for your free copy of the May issue which includes the article on the Oscilloscope. All subsequent issues will be sent to you regularly without charge . . . and, of course, without obligation.

The subject of "Cathode Ray Oscilloscopes" is but one of many that are being constantly revised and added to CREI lessons by A. Preisman, Director of Engineering Texts, under the personal supervision of CREI President, E. H. Rietzke. CREI home study courses are of college calibre for the professional engineer and technician who recognizes CREI training as a proven program for personal advancement in the field of Radio-Electronics. Complete details of the home study courses sent on request. . . . *Ask for 36-page booklet.*

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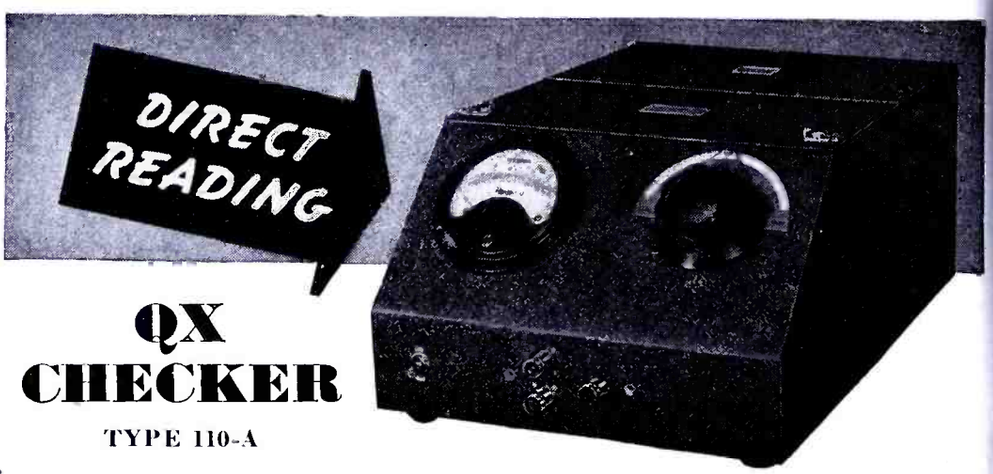

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MEMO:

Too busy this month, making Variatems for the war effort, to write copy for ads.

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Art Davis

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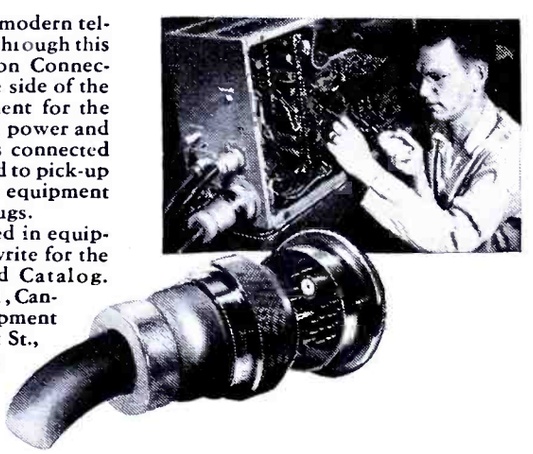

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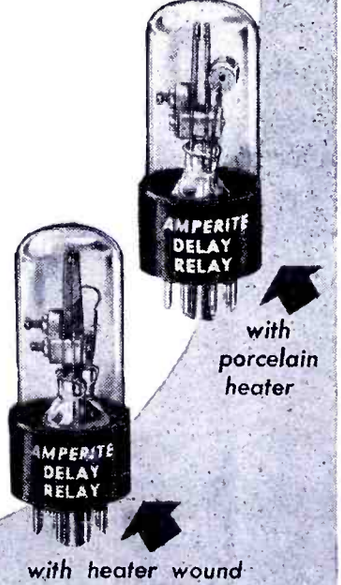

with porcelain heater

with heater wound directly on blade

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EXTERNAL-ANODE TRIODES

(*Continued from page* 102)

does not approach the minimum plat voltage.

It will be noted that this diagram holds for only one tube, so that som of the values obtained will have to b doubled to take into account the two tube class *B* operation. The plat swing E_p is taken from the load line a follows

$$E_p = E_b - E_{b\,min} = 15{,}000 - 5{,}000 = 10{,}000 \text{ v} \quad (7)$$

The power output for 2 tubes is then given by

$$P_o = \frac{1}{2} I_{b\,max} E_p = \frac{1}{2} \times 25 \times 10{,}000 = 125 \text{ kw} \quad (8)$$

The average plate current per tube is

$$I_b = \frac{I_{b\,max}}{\pi} = \frac{25}{3.14} = 7.96 \text{ a} \quad (9)$$

and the power input for 2 tubes is determined from

$$P_i = 2 I_b E_b = 2 \times 7.96 \times 10{,}000 = 159.2 \text{ kw} \quad (10)$$

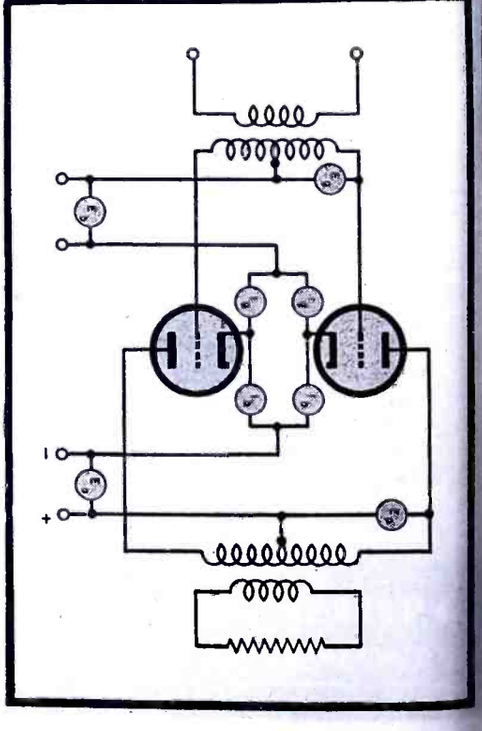
The load resistance per tube is that used in establishing the slope of the load line. The total plate-to-plate load resistance is four times this value. The grid driving power is taken from the static grid characteristic. The maximum grid current, 2 amperes, is taken off the grid characteristics (Figure

•

Figure 8.

Circuit of a class *B* a-f amplifier, with voltages and currents indicated.

•



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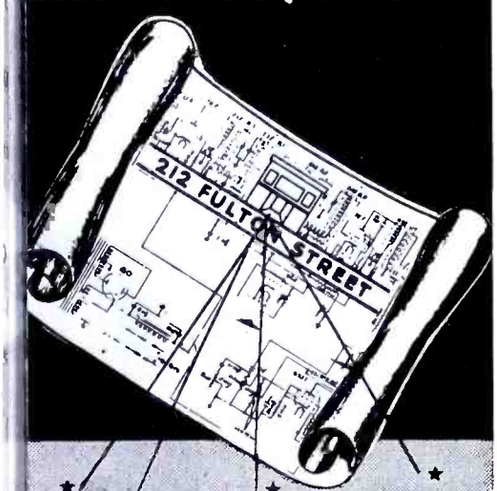

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9), at a point that corresponds with the values of E_g (*max*) and E_p (*min*). Then the driving power for 2 tubes becomes

$$P_g = \frac{2}{5} I_{g\,max} E_g = \frac{2}{5} \times 2 \times 1{,}500 = 1{,}200 \text{ w} \qquad (11)$$

This is the power that must be supplied by the driver.

This design trial can be analyzed for available output, efficiency, and operating constants. If the required conditions are not met, then another load line should be selected and the procedure repeated. In order to determine the distortion in any of these designs, it is necessary to plot composite characteristics so that the operation in the vicinity of zero plate current may be checked. If a dynamic-transfer characteristic is plotted for the two tubes, then the distortion may be analyzed by any of the multi-point analysis methods.

The constant current curves can be used for the analysis of these amplifiers and the graphical results will be a little more complete and accurate, but the procedure is tedious and should not be attempted where other methods are available.

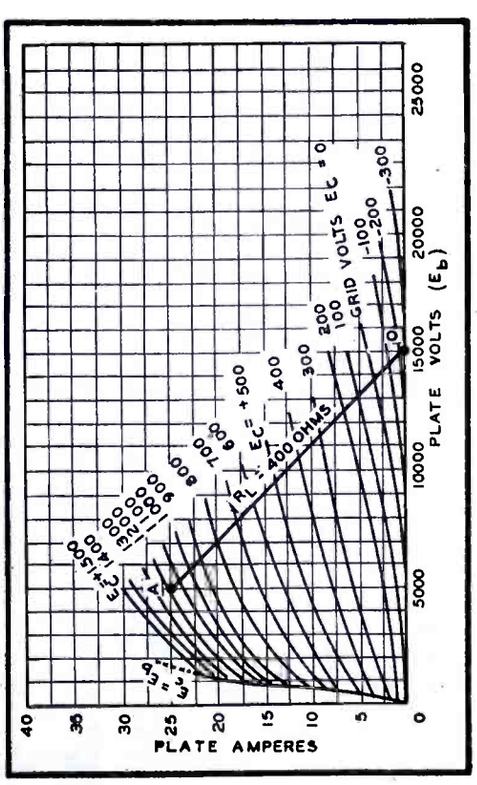
Very little has been said about circuit components used in connection with external-anode triodes or about the actual circuit design. Very often the analysis of the tube operation specifies the circuit design which must be used. While the dissipative circuit determines the final load value, it is necessary to design transformation cir-

(*Continued on page* 106)

●

Figure 9

Average plate characteristics of 898. Point *O* is determined by the operating plate voltage and grid bias necessary to reduce the no-signal plate current to a near-zero value. Other end of line is determined by distortion considerations.



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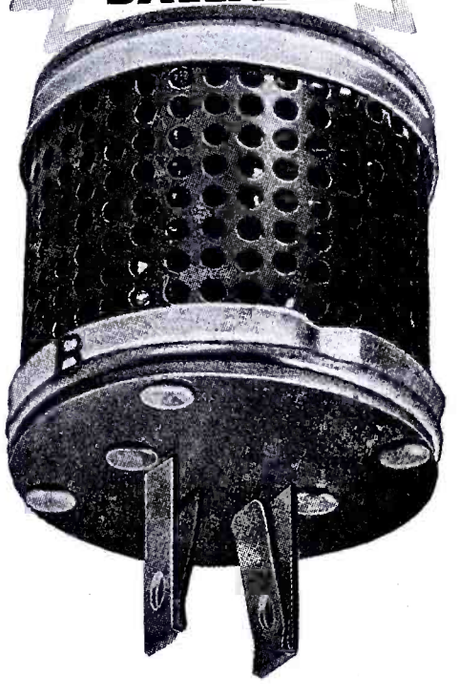

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PULSE WIDTH: continuously variable 0.5 to 40 microseconds.

OUTPUT VOLTAGE: Approximately 150 volts positive.

OUTPUT IMPEDANCE: 6Y6G cathode follower with 1000 ohm load.

R. F. MODULATOR: Built-in carrier modulator applies pulse modulation to any r.f. carrier below 100 mc.

MISCELLANEOUS: Displaced sync output, individually calibrated frequency and pulse width dials, 117 volt, 40-60 cycles operation, size 14"x10"x10", wt. 31 lbs.

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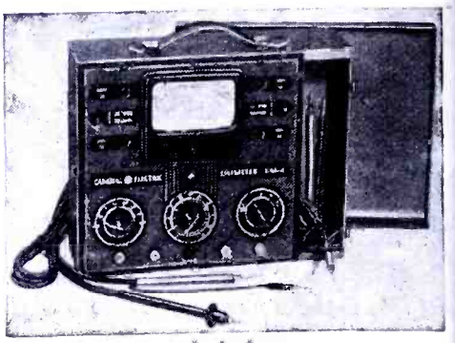
THE INDUSTRY OFFERS . . .

G.E. MULTIRANGE INSTRUMENTS

A multirange instrument, type UM-4 unimeter, with d-c ranges from 100 microamperes to 10 amperes in six steps and resistance ranges from 3,000 ohms to ten megohms in five steps, has been announced by G. E.

On d-c, the unit operates from 0 to 10,000 volts at 20,000 ohms-per-volt. On a-c it ranges from 0 to 10,000 volts at approximately 5,000 ohms-per-volt.



BENDIX CRYSTAL TRANSMITTER

An a-m eight-channel, mobile-service transmitter for the 100-156 mc band, using one

•

EXTERNAL-ANODE TRIODES

(*Continued from page* 105)

cuits which will make the proper load impedance appear at the plate circuit of the tube. Thus the problem of designing tank circuits is one of load transformation, and selection, since many harmonic frequencies appear in the plate current wave, and only the fundamental component is desired.

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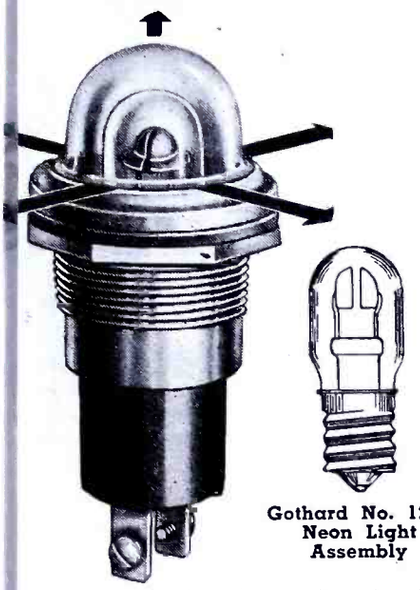

Gothard No. 1216 Neon Light Assembly

Gothard has established a policy for the approval of all leading Pilot Light Assemblies in the Gothard Line to meet the ever increasing demand for approved component parts. This feature, plus such Gothard developments as rigid non-short terminals, generally higher standards in light dispersion, and special engineering service for unusual requirements is your guarantee of maximum efficiency and lasting quality in every Gothard Assembly.

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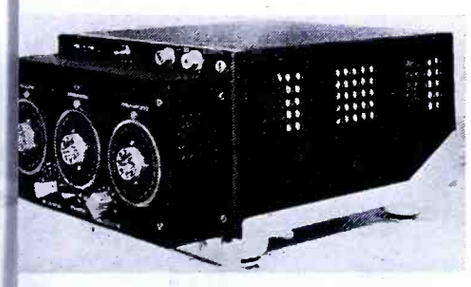
Cables—Simontrice, New York

(*Continued from page* 106)



Crystal has been developed by the Bendix Radio division of Bendix Aviation Corporation. Model uses a three-dial, eight-channel, automatic shifter. Manufacturer says that the number of dials can be varied on the basic design from one to ten, and as high as sixteen channels could ultimately be incorporated into design.

The transmitter designed by R. B. Edwards of the division's transmitter engineering department, can also be secured for f-m operation.

* * *

MALLORY DRY BATTERIES

A tropical dry battery that is said to provide four to six times the operating life of a normal battery has been developed by Samuel Ruben, in association with P. R. Mallory and Co., Inc., for the Signal Corps. The dry cell is said to have a high shelf life, and will stand high temperatures. Individual cells are hermetically sealed.

The cells are said to have a flat discharge characteristic.

According to Mallory, the new cell, within rated current range, possesses the same ampere hours' service life whether the battery is operated intermittently or continuously. Under normal conditions no recovery time is required.

Licenses already have been granted by Mallory to Ray-O-Vac, Magnavox Corporation and Sprague Electric Company.

Data released by the War Department state that the new batteries (BA-38-R) have seventy-two cells that can be packed in a space less than 1' long and slightly less than 1½" wide. Each battery weighs not quite 2 pounds and has a nominal voltage of 93.6. The battery, containing mercuric oxide, contains layers of zinc and paper, especially impregnated and arranged in a spiral like a jelly roll. A zinc pellet at the top of the can, but separated from the can by an insulator, serves as the negative pole. The cell uses a steel can which serves as the positive pole but does not enter into the reaction of the cell. A fluid metal, mercury or quicksilver, is the prime component.

* * *

MARION 2½" AND 3½" METERS

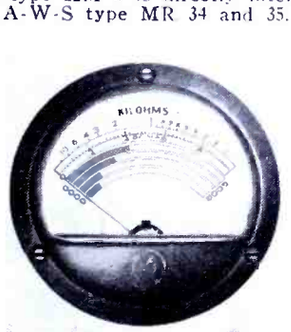
Meters of 2½" and 3½" (d-c) size that are said to be completely hermetically sealed have been produced by Marion Electrical Instrument Company, Manchester, New Hampshire.

Meter mechanism is built into a protective cup-like frame, with glass cover sealed to the metal rim. Window sealing process was developed in cooperation with the engineers of the Corning Glass Company.

Use of magnetic shielding is said to provide panel interchangeability without affecting calibration. For extra r-f shielding, the instrument can be supplied silver plated.

Silver-clad beryllium copper hair springs are said to reduce zero shift at all temperatures. Standard Kovar glass-head type terminals.

Built to A-W-S standards; type HM 2 is directly interchangeable with A-W-S type MR 24 and 25, type HM 3 is directly interchangeable with A-W-S type MR 34 and 35.



* * *

E.E.I. RECTIFIERS

High-voltage rectifiers, type 3B 27, with a peak inverse voltage of 8500 have been produced by Electronic Enterprises, Inc., 65-67 Seventh Avenue, Newark 4, N. J.

Peak plate current is 0.6 ampere, and

(*Continued on page* 108)

for ULTRA-HIGH FREQUENCY *functions*

● This Aerovox Type 1865 capacitor is designed for ultra-high-frequency radio power equipment such as television and FM transmitters. Especially recommended for fixed tuning, by-passing, blocking, coupling, neutralizing and antenna-series capacitance.

Losses are extremely low, due to highly refined sulphur dielectric used. Corona losses are avoided by the unique design, grounded case, and insulated terminal. Type 1865 (illustrated) has cast aluminum case; steatite insulator supports terminal. Lower-cost Type 1860 has aluminum can; mica disc insulator for terminal. Ratings up to 10,000 test volts effective. .00001 to .000125 mfd.

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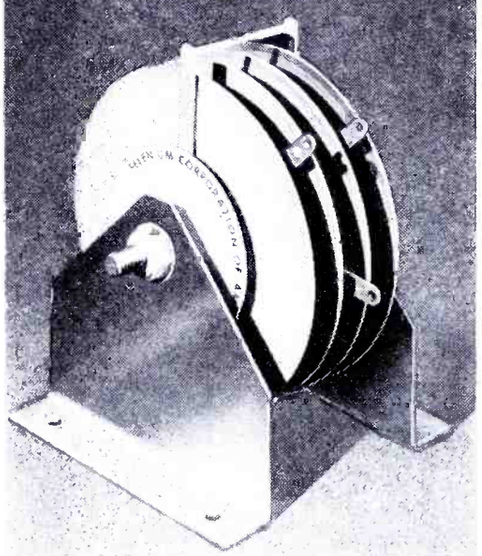

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THE INDUSTRY OFFERS . . .—

(*Continued from page* 107)

an average plate current of .150 ampere. Four tubes in full bridge are said to deliver 5415 d-c volts to filter, with 6000 volts total input. Filament draws 5.0 amperes at 2.5 volts. Base is medium four-pin bayonet.

* * *

TALK-A-PHONE POWER BOOSTERS

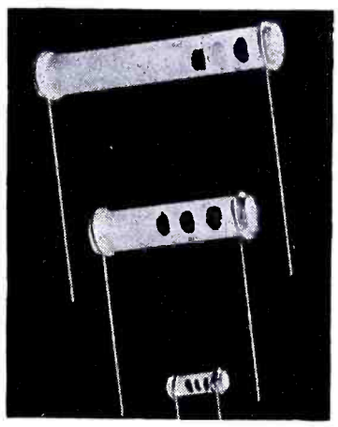
A 15-watt amplifier, for inter-communication power booster application has been announced by Talk-A-Phone Mfg. Co., 1512 So. Pulaski Rd., Chcago 23, Illinois.

* * *

MICAMOLD FIXED CERAMIC DIELECTRICS

Fixed ceramic capacitors conforming to joint Jan-C-20 specifications are now in production at Micamold Radio Corporation, 1087 Flushing Avenue, Brooklyn 6, N. Y.

Available in preferred temperature coefficients for any capacity under designations CC20, CC25, CC30, CC35, CC40 and CC45.



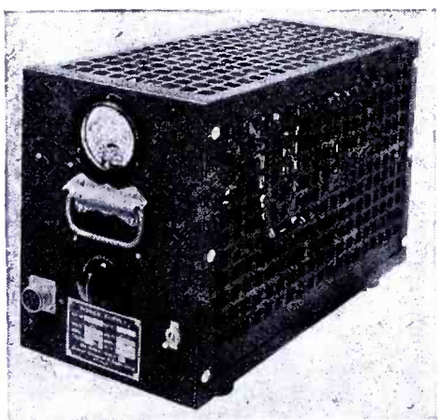
* * *

FTR REGULATED POWER SUPPLIES

A selenium rectifier unit, FTR-3128-S, providing d-c power up to 10 amperes, continuous duty, between 22 and 30 volts, has been announced by Federal Telephone and Radio Corporation.

Output voltage is said to be automatically held constant within ±0.5 volt regardless of load variation from 0 to 10 amperes, or a-c line voltage fluctuations of 105 to 125 volts. Ripple voltage is said to be limited to approximately 5%.

Unit has 0-30 scale d-c voltmeter, and d-c output terminals on the front panel. An 8-foot rubber-covered cord with metal sheathed plug is provided for a-c input connection. Weighs approximately 74 pounds. Cabinet, 11¼"x8"x16". For single, phase a-c input of 115 volts, 58 to 62 cycles.



* * *

G.E. SIGNAL GENERATORS

Two signal generators, SG-2A and SG-3A, one to provide a signal source only, the other to make possible calibrated output readings, have been announced by G. E.

The SG-2A generator covers 100 kc to 32 mc in five bands which are selected on the front panel. Modulation of the unit, 30% deep, in accordance with the IRE recommendations for receiver testing, is effected by the constant current method on the plate of the oscillator tube.

The SG-3A is said to permit directly calibrated readings of r-f output, with subdivided readings of signals of 0.5 to 100,000 microvolts, at all frequencies from 100 kc to 32 mc. By

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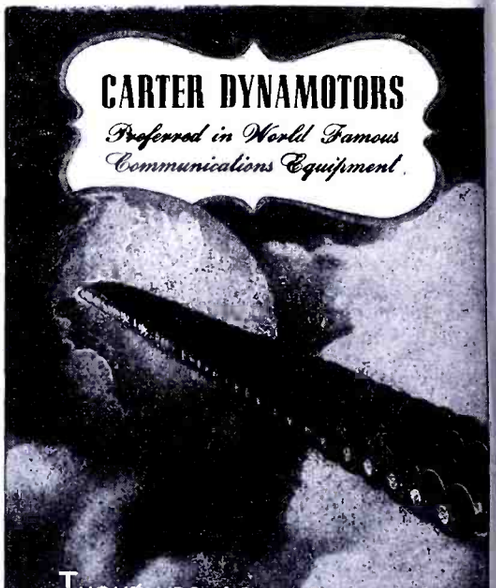

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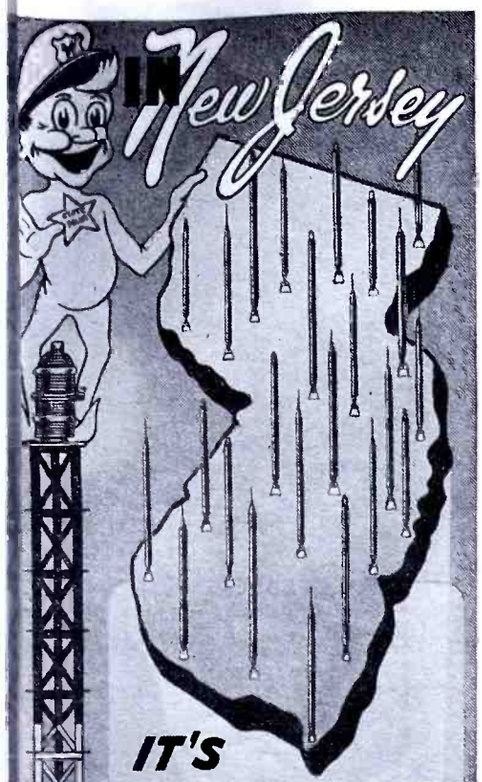

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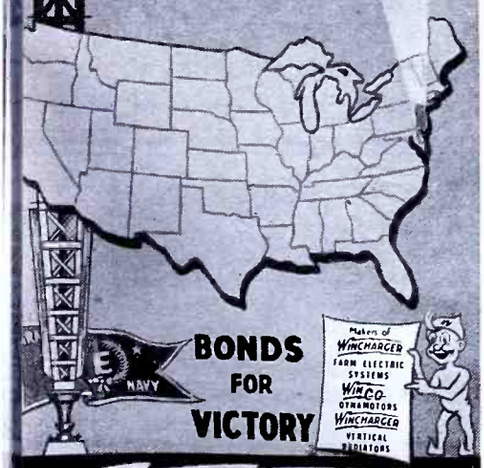

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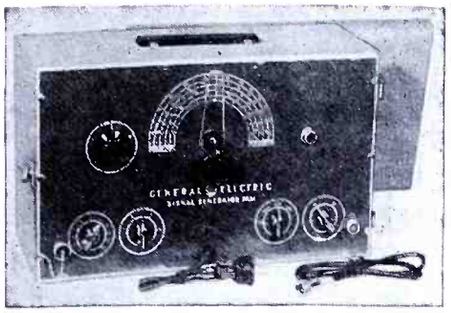
using second harmonics, signals up to 64 mc are available.

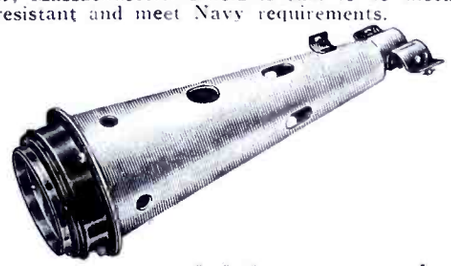
A vacuum-tube voltmeter monitors the output of the modulated oscillator to the attenuator.



* * *

FIVE-INCH C-R TUBE SHIELD

A shield for 5" cathode-ray tubes, Maco J 583 p, constructed of .025" mu-metal, hydrogen annealed at 1100° C has been developed by Metallic Arts Co., 243 Broadway, Cambridge 39, Massachusetts. Shield is said to be shock-resistant and meet Navy requirements.



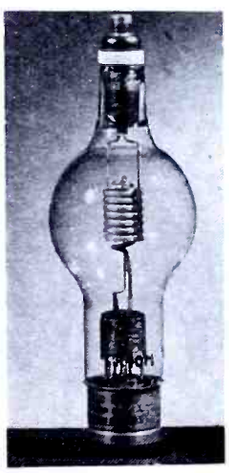
* * *

TAYLOR HIGH-VACUUM RECTIFIERS

A high-vacuum, half-wave rectifier, TR-40M, equipped with a 4-pin jumbo (50-watt) base and using Nonex glass has been announced by Taylor Tubes, Inc., 2312 Wabansia Avenue, Chicago, Illinois.

Filament is thoriated tungsten. Plate lead is at top, and filament leads are brought out to pins 2 and 4.

Filament power, 5 volts at 10.5 amperes. Peak forward voltage, 25,000. Peak inverse voltage, 60,000. Average plate current, .25 ampere. Size, 9⅞"x3⅛".



* * *

G.E. SPEAKERS

A super loudspeaker that is said to carry speech for three miles under average weather conditions has been developed by G.E. Under been heard up to 18 miles. Works on less ideal conditions the speaker is claimed to have than 25 watts of power. Portable with gas driven generator, or can be plugged into 110 or 220 a-c line.

* * *

NEMCO CRYSTAL HOLDERS

Crystal holders are now being produced by the

(*Continued on page* 110)

10,000
PARTS

Ten thousand different
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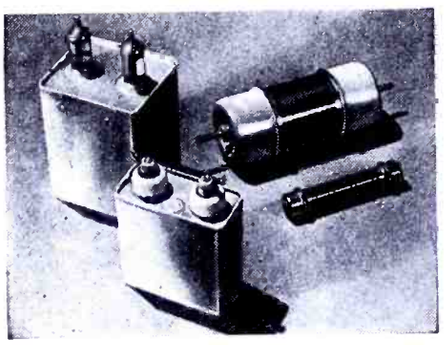
National Electronic Manufacturing Corporation, 22-78 Steinway St., Long Island City, N. Y.

Illustrated is the N5X in 6105 and 592 which may be obtained in all types of FT-243 holders.

* * *

SPRAGUE HIGH-VOLTAGE CAPACITORS

Capacitors utilizing an oil-impregnant, vitamin Q, that are said to operate satisfactorily at thousands of volts at ambient temperatures as high as 105° C have been announced by the



Sprague Electric Company, North Adams, Mass. The impregnant, developed by Sprague, affords the production of hermetically sealed

THE INDUSTRY OFFERS . . .—

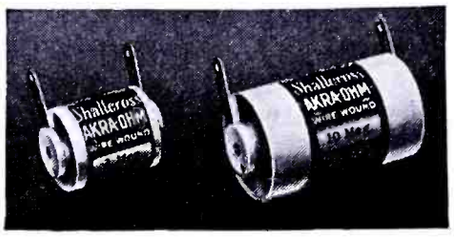
(*Continued from page* 109)

capacitors in rectangular metal containers for 95° C and 105° C continuous operation, and in d-c rated voltages from 1,000 to 16,000. Other types include type 45P hermetically sealed in glass shells with metal end caps.

* * *

SHALLCROSS HERMETICALLY SEALED RESISTORS

Hermetically-sealed wire-wound resistors (patent applied for), 1100 series, constructed without glass, without the use of "floating" or



stud-locked resistance elements, and without ferrule terminals or caps, are now being produced by Shallcross Manufacturing Co., Collingdale, Penna.

Resistors are layer wound with noninductive pie windings. Utilize standard mounting facilities. At present available in two designs and in all resistance values from 1000 ohms to 10 megohms.

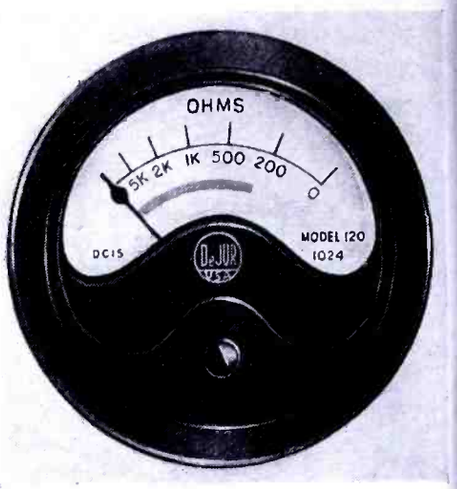
Both the resistance form and the protective shell are of ceramic. The resistance winding element and outer shell are said to be an intergal unit.

* * *

DEJUR-AMSCO MINIATURE METERS

A hermetically-sealed, ring-mounted miniature 1½" meter, model 120, has been announced by DeJur-Amsco Corp., Northern Blvd. and 45th Street, Long Island City 1, New York.

Instrument range may be mounted on ⅛" to ¼" panels. A waterproof gasket is supplied for sealing to the panel. Available in a wide variety of ranges including highly sensitive microammeter or microvoltmeter requirements. Built to A-S-A specifications.



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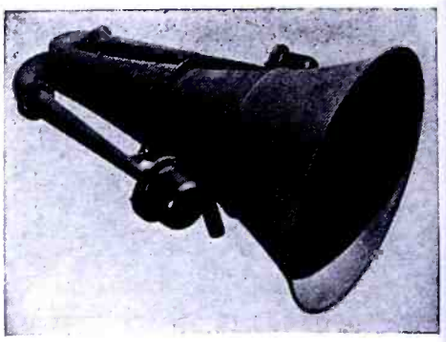
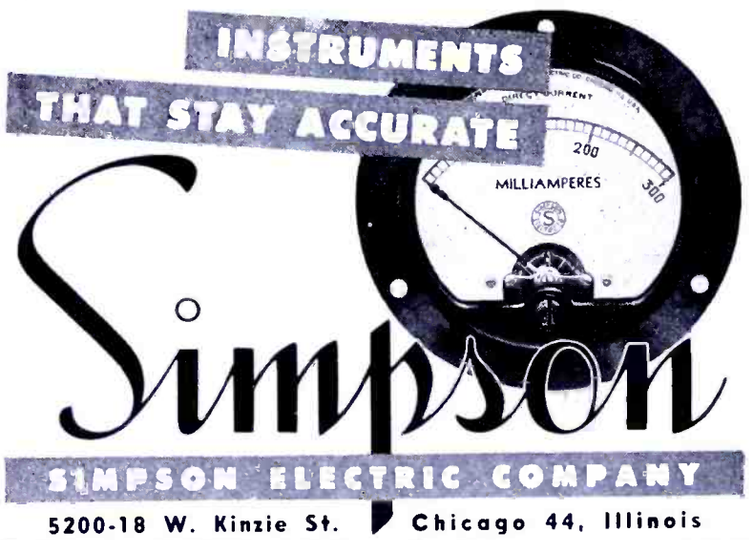
LANGEVIN SPEAKERS

An exponential speaker horn, 24A, that has a bell diameter of 25" has been produced by the Langevin Company, 37 W. 65th St., New



York 23. Over-all length, 38"; over-all width 26". Frequency response is said to be 110 to 6500 cps.

Receiver attachments are available for cou-



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MODEL 504-A

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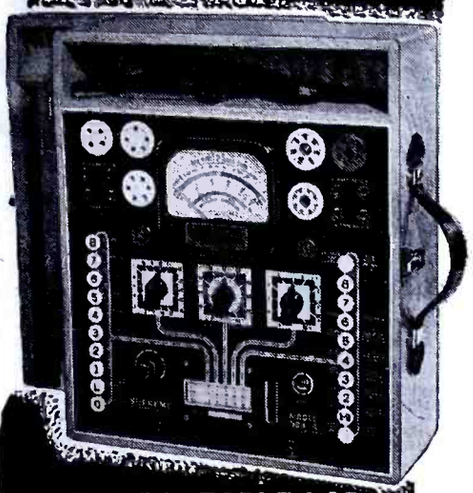

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★ Operation as simple as ABC. Multisection push-button switches do all work. Simply "follow the arrows" for tube checking. No roaming test leads for the multimeter.

★ Open face wide scale 4¼-inch rugged meter built especially for this tester—500 microampere sensitivity.

★ Each AC and DC range individually calibrated.

★ Professional appearance. Solid golden oak carrying case.

★ Guaranteed Rectifier.

SPECIFICATIONS

DC MICROAMPERES:
0-500

DC MILLIAMPERES:
0-2.5-10-50-250

DC AMPERES
0-1-10

DC VOLTS—1000 OHMS PER VOLT:
0-5-25-100-250-500-1000-2500

AC VOLTS
0-5-10-50-250-1000

OUTPUT VOLTS:
0-5-10-50-250-1000

OHMMETER:
0-200-2000-20,000 OHMS
0-2-20 MEGOHMS

BATTERY TEST:
Check Dry Portable "A" and "B" Batteries Under Load

CONDENSER CHECK:
Electrolytics checked on English Reading Scale at Rated voltages of 25-50-100-200-250-300-450 volts.

TUBE TESTER:
Emission type with noise test, floating filaments, easy chart operation. Checks all receiving type tubes.

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115 volts 60 cycle. Special voltage and frequency upon request.

SUPREME

SUPREME INSTRUMENTS CORP.
Greenwood, Miss., U.S.A.

pling two or four driver units and making the horn capable of maximum inputs of 50 and 100 watts.

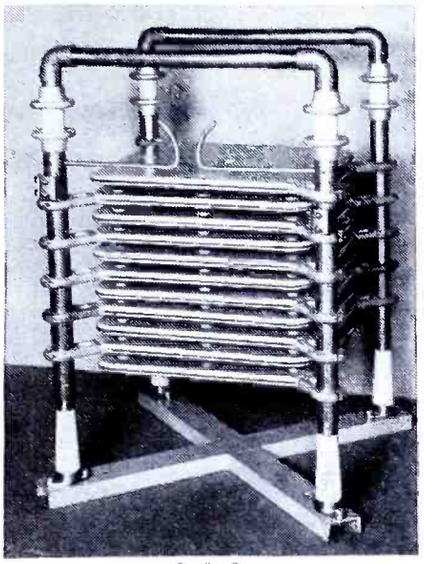
* * *

JOHNSON HIGH-POWER CAPACITORS

High-power, high-capacity capacitors in various spacings up to 1½", have been announced by the E. F. Johnson Company, Waseca, Minnesota. For a spacing of 1", the breakdown rating is said to be 45,000 peak volts at 2 megacycles.

Condenser plates, 18" square, are made of fabricated sheet metal. Frame rods are 1⅝" copper tubing, and are fitted with heavy strap connectors capable of carrying a high current. A tank coil may be mounted on top of the condenser and supported by the cross pieces.

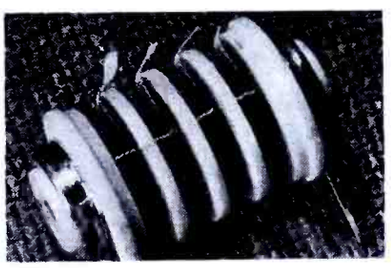
A protective gap is built into the condenser for flash-over protection. Top steatite insulators have corona shields. Condenser illustrated has a capacity of 1200 mmfd and is 40" high.



* * *

MEPCO WIRE-WOUND RESISTORS

Wire-wound impregnated resistors are now being produced by Madison Electrical Products Corporation, Madison, N. J. Twenty types are said to be available. Windings of resistors are insulated by cellulose acetate tape before impregnation.



* * *

U.M.C. D20 DYNAMIC MICROPHONES

Four models of the dynamic response microphones, D20, have been announced by Universal Microphone Co., Inglewood, California.

Mounted on micro-adjust swivel. Unit may be positioned througout a 60° angle.

Designed for use in indoors and outdoors with a frequency range of 50 to 8000 cycles at −54 db as referred to one volt per bar.

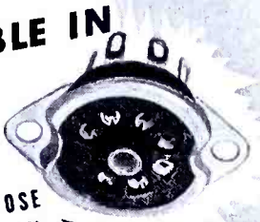
Standard ⅝"-27 thread stand coupling. Dimensions: 2⅝" wide 3" high, 3¼" deep; shipping weight, 3¾ pounds.

Available in 50, 200, 500, and 40,000-ohm types.

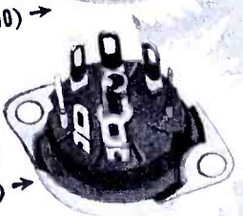
EBY

SADDLE TYPE MINIATURE TUBE SOCKETS

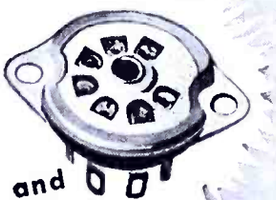
AVAILABLE IN



GENERAL PURPOSE PHENOLIC (EBY #8100) →



LOW LOSS PHENOLIC (EBY #8082) →



STEATITE (EBY #8083) →

The castings and beryllium copper contacts are identical with JAN S-28 Types SO 10M and SO 10C except that the shield base is replaced with a saddle. These EBY sockets meet the need for quality replacement of sockets of the saddle type. Write today for prices and samples.

LONG LIFE CONTACTS

The self-aligning beryllium copper contacts have been especially designed and Micro-processed to assure constant, even pressure on all parts of the socket pin without fatigue in contacts after continuous use.

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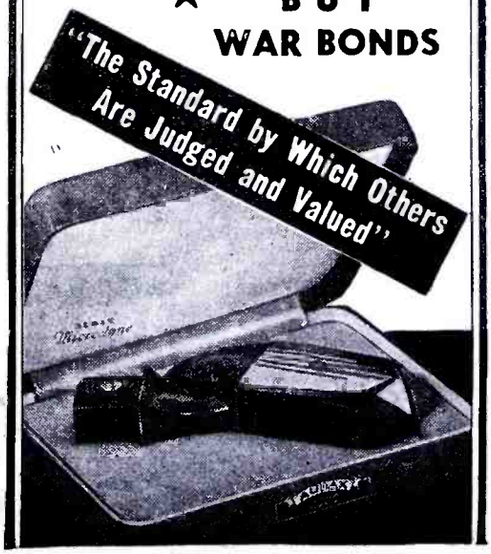

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COMMUNICATIONS—APRIL, 1945*

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

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IN A BUTTERFLY CIRCUIT

$$L = 2.12r\left(\ln\frac{36r}{t+w} - 2\right) \text{ centimeters}$$

If you haven't seen these plates before, you may think them the futuristic effort of a designer on the day after the night before. Actually they represent some of the steps in the development of an entirely new circuit for ultra-high-frequency use.

The problem of designing a compact ultra-high-frequency circuit with a large and continuously-adjustable range, and with no sliding contacts, is a difficult one.

Transmission lines, with none of these desirable features, have been used widely in the past. They offer numerous mechanical difficulties, very precise machine work being required to obtain acceptable accuracy. In addition, very often they are too large to be incorporated in many instruments.

The new circuits, developed by General Radio, are for obvious reasons called Butterfly Circuits. They have no sliding contacts, afford a tuning ratio of about 4 to 1, are very compact, can be designed for a satisfactory value of Q, and are mechanically comparatively simple.

The design of Butterfly Circuits is described in detail in the October 1944 issue of the G-R *Experimenter*. If you haven't seen a copy, we'd like to send you one.

ARMY E NAVY

WRITE FOR BULLETIN 916

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

NEW YORK CHICAGO LOS ANGELES

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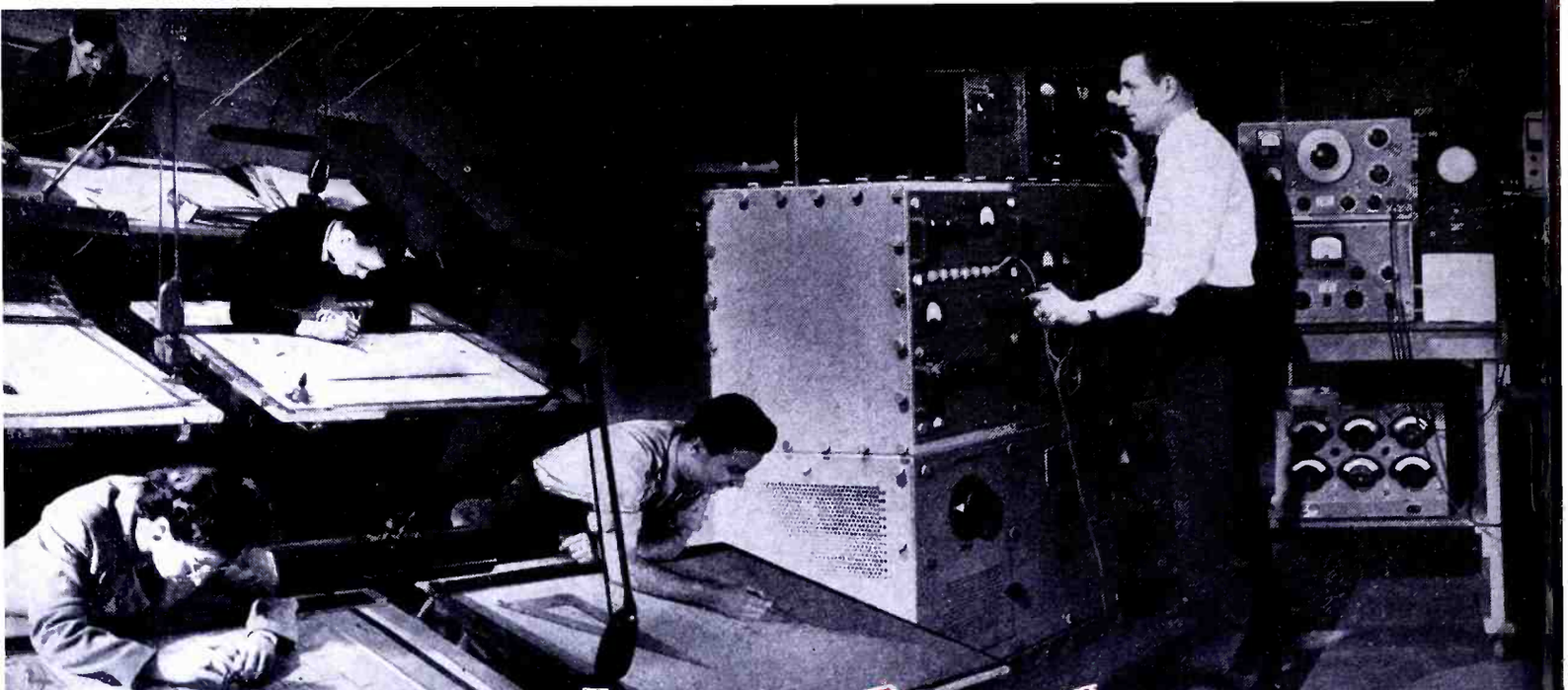

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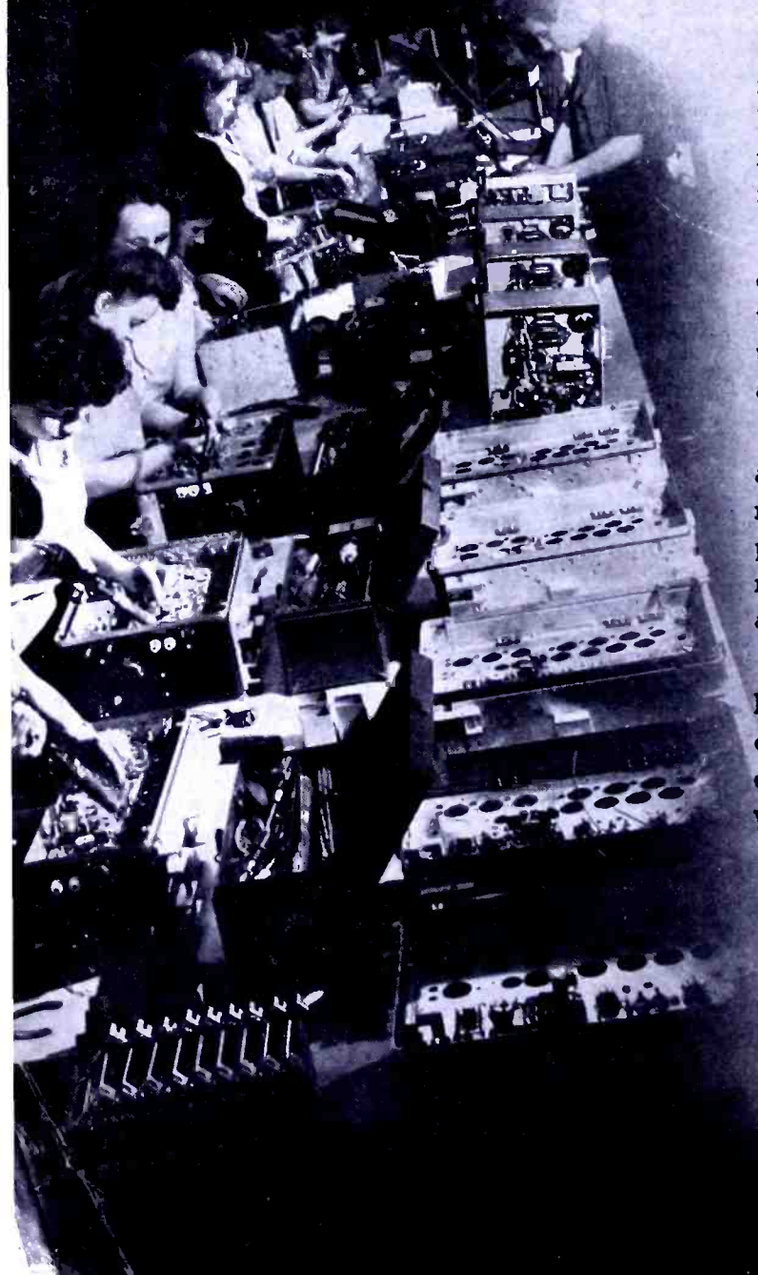

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In these ever broadening fields, Temco engineers are contributing heavily in the application of electronics to the manifold demands of war. Restrictions do not permit us to describe these achievements now but we can speak about the engineers who made them possible.

Underlying these accomplishments are the versatility and the vision of a closely knit organization of pioneering minds—rich in ideas—mature in judgement. Keeping pace with progress in radio research, they are constantly meeting the challenge of many new and diversified assignments.

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