COMMUNICATIONS

FEBRUARY

★ RADIO ENGINEERING
★ WAR CORRESPONDENT'S RECORDER
★ IMPEDANCE BRIDGE SWITCHING
★ AERONAUTICAL COMMUNICATIONS
★ REPORT ON IRE WINTER MEETING
★ TELEVISION ENGINEERING

1945

DAVEN

ATTENUATION NETWORKS

Series 690

DAVEN Series 690 Attenuation Networks comprise 20 models, designed for general laboratory and production testing at audio frequency levels. DAVEN plug-in type Fixed Attenuators are employed for matching source and load impedances with the base impedance of the network. A high degree of flexibility is thus achieved with an absence of mis-match, reflection loss and switching noises.

MODEL VARIATIONS

- 2 MOUNTINGS: Portable and Rack Type
- 3 BASE IMPEDANCES: 500, 600 and 135 ohms
- 2 CIRCUITS: "T" and Balanced "H"*
- 2 RANGES: 0-110DB, steps of 1DB (2 dials)
  0-111DB, steps of 0.1DB (3 dials)

*Balanced "H" type may be used as an unbalanced network of one-half the base impedance.

OTHER SPECIFICATIONS

ACCURACY: Resistors calibrated within ±1%

PLUG-IN PADS: Octal tube base, panel mounting, in wide range of impedances and losses.

FREQUENCY RANGE: 0-17,000 c.p.s.; at higher frequencies, slight reduction in accuracy.

OPERATION LEVEL: +20DB (0.6w) maximum input.

SIZE: 2 dial portable: 5"x10"x5"; 3 dial portable 6"x11½"x5"; rack: 3½"x19".

Daven Attenuation Standards, types 740 and 742 (resistor accuracy ±½%), are designed for applications requiring greater accuracy. See your DAVEN Catalog or write for details.

PORTABLE TYPES

"T"	BAL "H"	DB RANGE	BASE Z
T-690-A	H-690-B	0-110	500
T-690-C	H-690-D	0-110	600
T-692	H-692	0-111	500
T-693	H-693	0-111	600
T-694	H-694	0-111	135

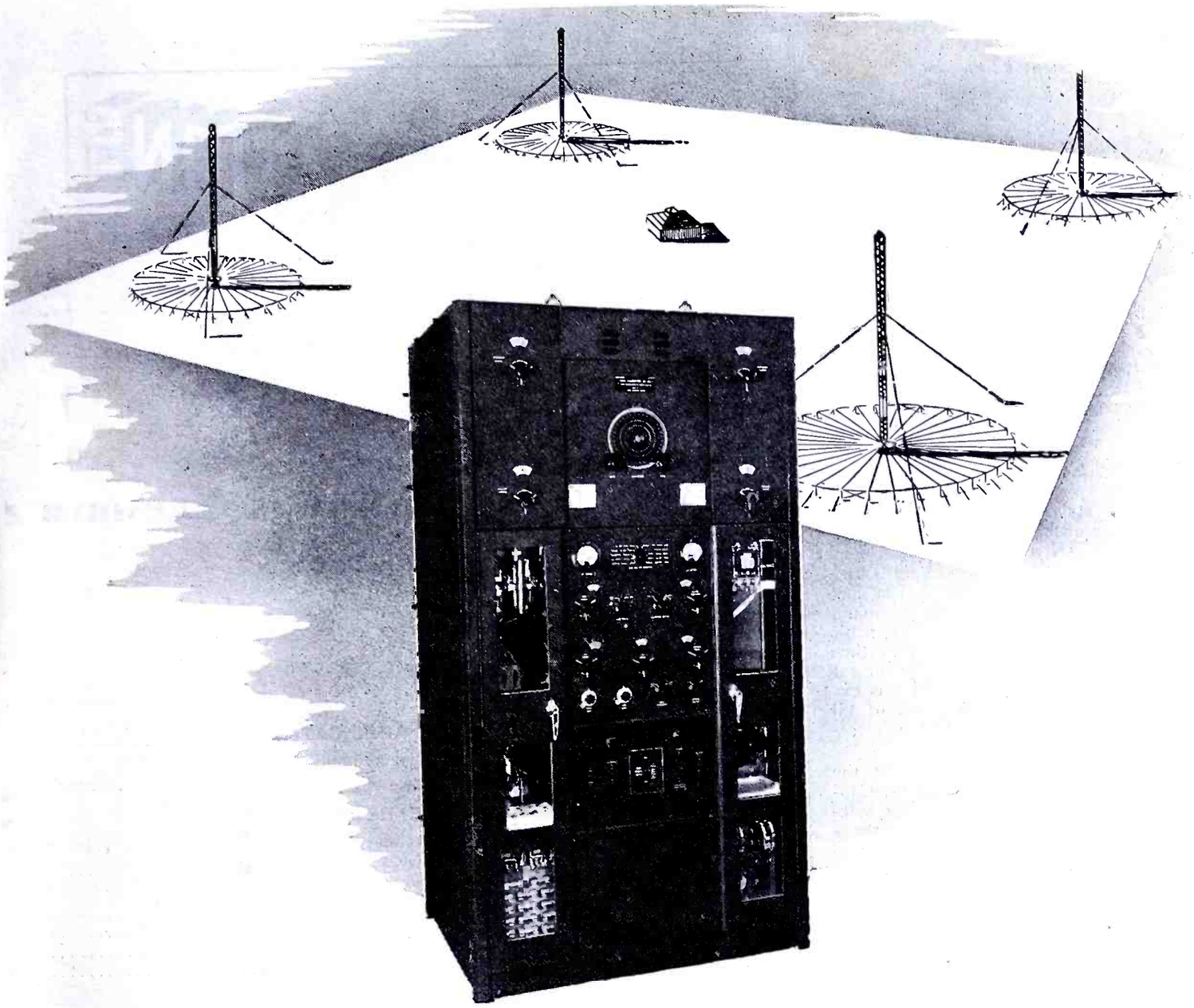
RACK TYPES

"T"	BAL "H"	DB RANGE	BASE Z
T-690-AR	H-690-BR	0-110	500
T-690-CR	H-690-DR	0-110	600
T-692-R	H-692-R	0-111	500
T-693-R	H-693-R	0-111	600
T-694-R	H-694-R	0-111	135

THE DAVEN COMPANY

191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

YOU CAN MAKE NO GREATER PERSONAL CONTRIBUTION TO THE WAR EFFORT THAN TO DONATE A PINT OF YOUR BLOOD TO THE RED CROSS



PIONEERS

Ground-to-Air Navigation and Communications Systems and Airport Traffic Controls

RADIO RECEPTOR was one of the first in the world to design, develop and produce radio ground equipment for the safety, comfort and efficiency of air travel and transportation. Our specialized experiences have been extensively employed in airports and air highways around the globe where RADIO RECEPTOR equipment is preferred for dependability, service, long life and ease of maintenance.

RADIO RECEPTOR engineers do a complete job! Facilities for entire installations, ***anywhere***, are afforded to municipalities and private air fields. Tropical installations receive special attention. RADIO RECEPTOR service engineers make periodic check-ups, and provide special emergency service, all over the United States. We are always glad to cooperate with engineers, consultants and local contractors in the construction and layout of any airport—large or small.

Partial List
RADIO RECEPTOR Installations:

Floyd Bennett Field—Brooklyn, N. Y.
LaGuardia Airport—New York, N. Y.
Washington National Airport—Washington, D. C.
DuPont Airport—Wilmington, Del.
St. Joseph's Airport—South Bend, Ind.
State of Pa. Range & Marker Beacons
Trans-Canada Airways
Important Airports of Soviet Russia
U. S. Army Airports All Over the World

Plan Now! **We are prepared to quote on complete airport traffic control installations and ground-to-air navigation and communications systems.**

Write for our free non-technical booklet, "HIGHWAYS OF THE AIR", Address, Dept C-2

ARMY E NAVY

RADIO RECEPTOR COMPANY, Inc.
251 WEST 19th STREET **NEW YORK 11, N. Y.**
SINCE 1922 IN RADIO AND ELECTRONICS

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

COMMUNICATIONS

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

We See...

A NAVAL RESEARCH AND DEVELOPMENT PROGRAM for *communications* that will provide for striking advancements in the art is in the offing, according to Captain J. B. Dow, USN, Director of Electronics of the Bureau of Ships. Speaking before the winter meeting of the AIEE and IRE, he said that he hoped a minimum of $25,000,000 a year would be made available to the Navy during peacetime for radio, radar and sonar development and research. He declared that this extensive program has the support of all the chiefs of the bureaus and the Secretary of the Navy.

Analyzing the substantial interest the Navy has taken in communications, Captain Dow said that approximately $80,000,000 will be spent this year for research and development, while prior to 1942 less than $4,000,000 yearly had been spent for this work. He also pointed out that over $1,300,000,000 of communications equipment was delivered in 1944 to the Navy, whereas in 1941 only about $48,000,000 had been spent for communications equipment.

Even components have been placed in the Naval analysis group. Captain Dow disclosed that a component testing laboratory costing close to $1,000,000 is now being established at the Naval Research Laboratory. This unusual laboratory will not be disbanded in peacetime, but instead enlarged, if possible, for increased analysis and development work, according to Captain Dow.

Discussing the enormous quantities of equipment used by the Navy, Captain Dow said that since December 7, 1941, some 300,000 complete equipments, each consisting of from 2 to 15 major units of equipment (receiver and transmitter), have been installed in over 38,000 vessels and landing craft.

The United States radio communications industry has ripped up all records of development and production, declared Captain Dow. And in the postwar era, he said that we look forward to new communications industry triumphs.

THAT BRILLIANT SCIENTIST to whom all industry is indebted for his invaluable contributions—*Dr. Ernst F. W. Alexanderson*—has been significantly honored by two celebrated scientific societies. He has received the Edison medal of 1944 from the AIEE and the Cedergren gold medal from the American Society of Swedish Engineers.

Honors well earned!—L. W.

FEBRUARY, 1945

VOLUME 25 NUMBER 2

COVER ILLUSTRATION

Cathode bombardment analysis at the Westinghouse research laboratories

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

BRYAN S. DAVIS, President — PAUL S. WEIL, General Manager
F. WALEN, Secretary — A. GOEBEL, Circulation Manager

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SYLVANIA NEWS

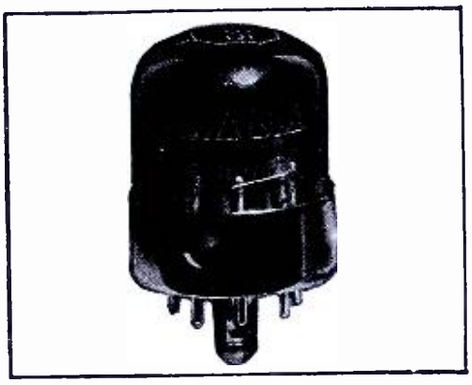
ELECTRONIC EQUIPMENT EDITION

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

Type 1AB5 Used as Mixer, RF Amplifier At 50Mc. and Above

Sylvania Electric's 1AB5 tube is a filament type pentode for use as a mixer or RF amplifier in circuits requiring a tube of greater mutual conductance than the 1LN5.

The 1AB5 is especially designed for operation at frequencies of 50Mc. and



higher. Its combination of characteristics results in higher effective input resistance at these frequencies.

The tube has an 8-pin base of the Lock-In type, and a Short T-9 bulb. It is designed to operate on a filament voltage of 1.2. Full technical data are available from Sylvania Electric.

DID YOU KNOW...

That new long, small diameter fluorescent lamps soon to be placed in production at Sylvania Electric will be of the instant starting type? Using no starters, they will need less maintenance.

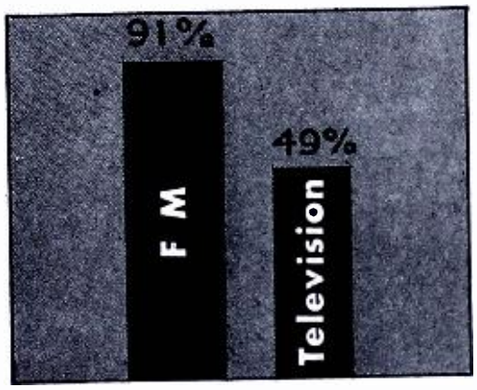
★ ★ ★

That the taking of tube characteristics by photographing an oscilloscopic trace permits the measurement of tube performance which could not otherwise be obtained? This is the method used in the Sylvania Laboratories.

Set-Owners Place FM First in Sylvania Survey of Radio Sets

91% of Consumers Interviewed Say They Want This Feature in Postwar Receivers

Preliminary reports of the nationwide survey being conducted by Sylvania Electric indicate a high degree of interest in frequency modulation. Of the thousands of set-owners who have been personally interviewed, 91% have indicated their desire to have FM incorporated in their postwar receivers. 70% said that they were willing to pay an additional sum in order to get this feature.



Graph shows percentages of set-owners stating that they want FM and television in their postwar sets.

Television, while also a subject of considerable interest, ranked behind FM in the tabulation of survey results. 49% of those interviewed stated that they wanted television reception after the war. The same percentage indicated their willingness to pay extra for it.

INFLUENCE OF COST

As a guide to set manufacturers in their postwar planning, the Sylvania survey is also eliciting information on the amounts which consumers would be willing to pay in order to have FM and television. The results of this phase of the survey will be published in subsequent issues of SYLVANIA NEWS.

"Would you be willing to go as high as $300 to have FM and television included in your radio set?"

SURVEY CONTINUES

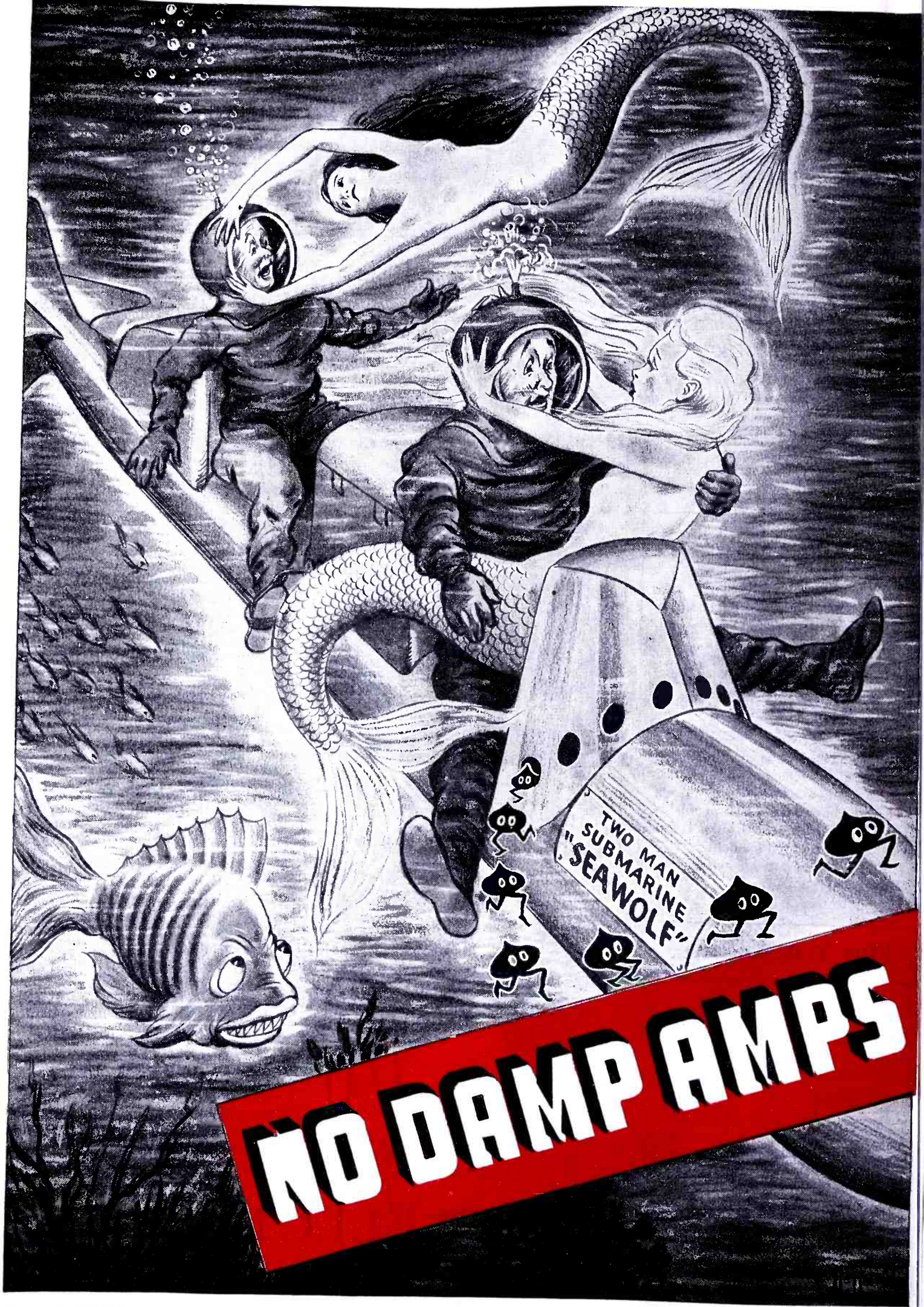
While the analysis of the results of personal interviews is going on, Sylvania Electric is continuing its survey, and broadening its scope, through the medium of a series of questionnaire-type advertisements appearing in leading national magazines.

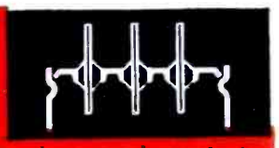
The purpose of these advertisements is to gather additional information on consumer preferences and interest, not only in various types of radio and television receivers, but also in the possibility of using electronic devices in their homes.

SYLVANIA ELECTRIC

SYLVANIA ELECTRIC PRODUCTS INC., *Radio Division,* Emporium, Pa.

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





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

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

700 SERIES 1" DIAMETER (.952)	900 SERIES 1¼" DIAMETER (1.235)
702	902
703	903
704	904
705	905
706	906
707	907
	908
	909

INTERFERENCE . . . can spoil any pick-up. Electronic equipment can't operate satisfactorily with outside interference, either. The best transformer, coil or relay washes out when moisture wades in. That's the "why" for **FUSITE** hermetic seals. They keep out the wet outside by sealing in the dry inside. No damp amps are the positive result. In the lab, **FUSITES** pass the tough thermal shock test of dry ice to boiling water. In your plant, they can and do stand production handling . . . and later, on-the-job manhandling. **FUSITE** is the only glass-insulated, multi-terminal panel interfused within a reinforced metal shape, all in one piece. This means that one and only one sealing operation is required to provide a perfect hermetic seal. It all adds up to this . . . parts and labor saved, costs downed, production upped and performance guaranteed, regardless of time, place or temperature. Write for samples on your business letterhead. A four-page illustrated file-folder, telling all about **FUSITE** and its many applications, is also yours for the asking.

WITH FUSITE SEALS

I'M MISTER AMP,
THE 'LECTRIC SCAMP,
FOR WHOM DAMPNESS HAS THAT FEELING;
BUT WHEN I'M DRY,
I'M REALLY HIGH,
AND I GO FOR *FUSITE SEALING!*

CINCINNATI ELECTRIC PRODUCTS COMPANY

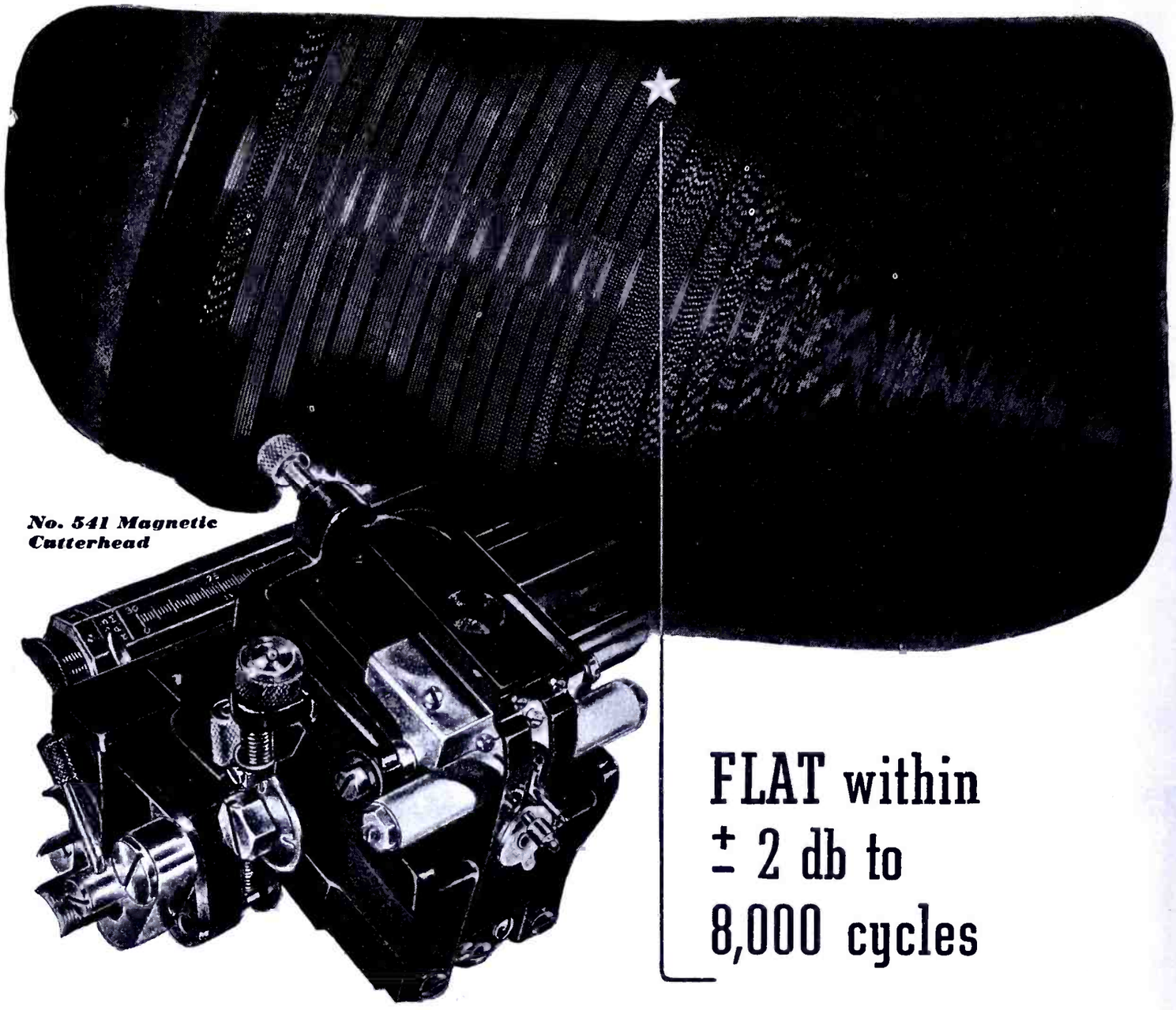
CARTHAGE AT HANNAFORD, NORWOOD,
CINCINNATI 12, OHIO

GLASS TO METAL

FUSITE

HERMETIC TERMINALS

NO DAMP AMPS!



No. 541 Magnetic Cutterhead

FLAT within ± 2 db to 8,000 cycles

Reproduced above is an actual photograph of a "light" method frequency pattern. The inside, the wide midway and the outside band are 1,000 cycle reference bands. Starting at 1,500 cycles, at the midway reference band, the succeeding outward bands increase by 500 cycle increments to 8,000 cycles.

Measurements by standard formula will show that all variations in frequency strength are within ± 2 db.

Narrowing frequency bands, from 1,000 down to 50 cycles in the bass, indicate a controlled power decrease — by means of a "network" in the electrical circuit of the Fairchild Magnetic Cutterhead.

Standard playbacks, in turn, increase these lowered frequency strengths by like amounts. This artificial equalizing prevents wide amplitudes in the bass and results in a flat playback.

Controlled freedom from distortion up to 8,000 cycles permits the Fairchild Magnetic Cutterhead to provide the finest possible full volume recordings of today's 6 to 7,000 cycle AM and higher cycle FM broadcasts.

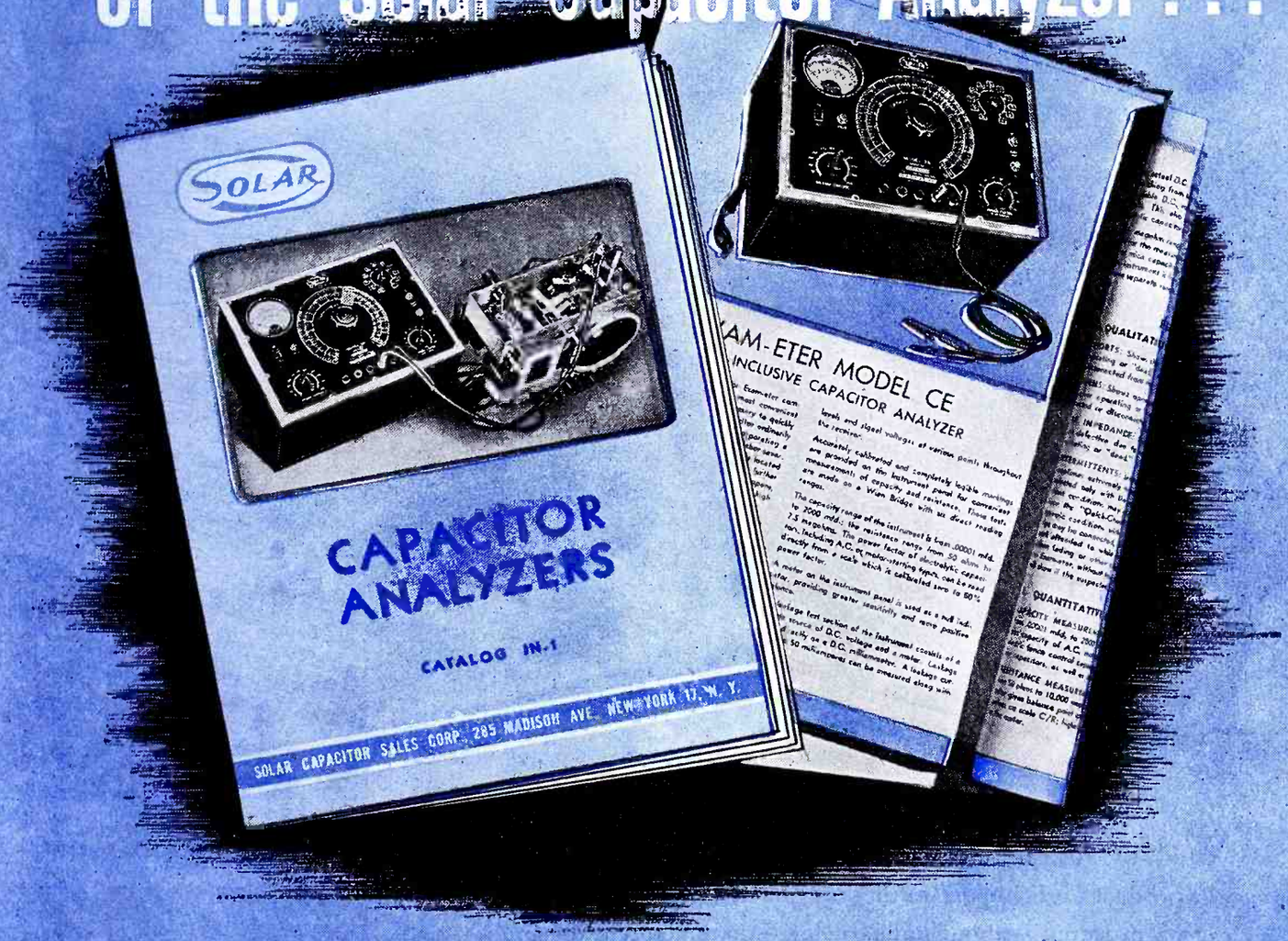
Standard with the No. 539 Fairchild Recorder, the No. 541 Magnetic Cutterhead can easily be adapted to earlier Fairchild models and many other types of recorders.

Descriptive and priority data are available. Address *New York Office:* 475 - 10th Avenue,, New York 18; *Plant:* 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

SOUND EQUIPMENT

Fairchild **CAMERA AND INSTRUMENT CORPORATION**

CHECK on this "QUICK-CHECK" Feature of the Solar Capacitor Analyzer . . .



THE SOLAR MODEL CE Capacitor Exam-eter speedily locates common defects in capacitors without disconnecting condensers—often eliminating further tests. This saving of time and labor is accomplished by the unique Solar "QUICK-CHECK" feature.

In this *single* instrument are combined the simplest, most convenient methods for examining the true condition of every capacitor in ordinary use . . . shorts, opens, intermittents, high R.F. impedance and high power factor.

***Catalog IN-1* illustrates and describes features of all models. Send for your copy today.**

SOLAR

ARMY E NAVY

Solar Mfg. Co.

ANOTHER HELPFUL SOLAR SERVICE

SOLAR CAPACITOR SALES CORP.
285 Madison Avenue, New York 17, N. Y.

Please send me a copy of Catalog IN-1 on Solar CAPACITOR ANALYZERS.

*Name*_____

*Title*_____

*Company Name*_____

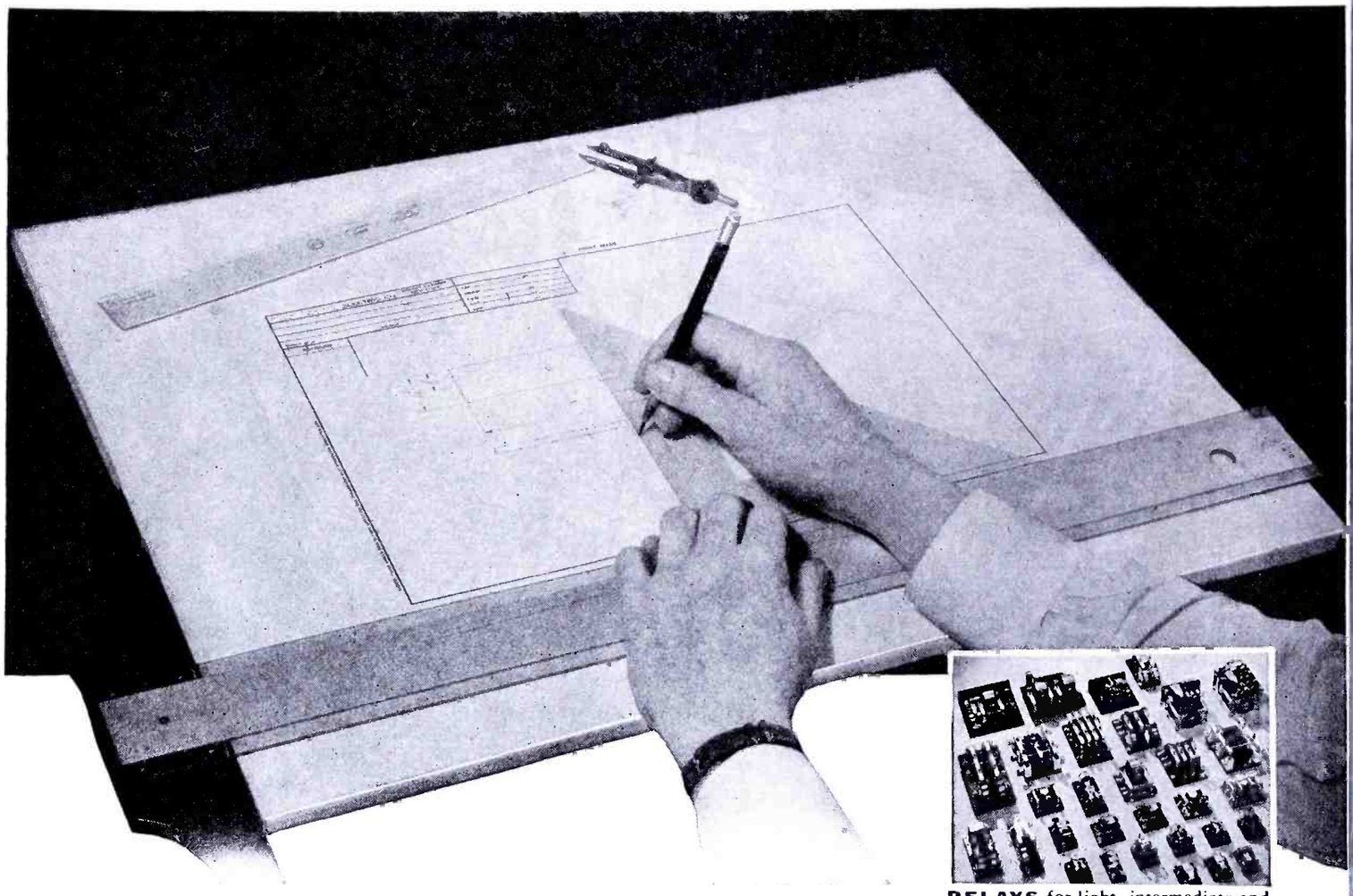
*Street Address*_____

*City*_____ *State*_____

SEND THIS COUPON IN—TODAY

7756

CONTROLS FOR POSTWAR PRODUCTS



RELAYS for light, intermediate and heavy duty, sensitive, transfer, time delay, antenna changeover, break-in and latch-in operation.

RESISTORS that withstand heat, moisture, vibration and other adverse conditions. Wide range of types, ratings, terminals and enclosures.

RHEOSTATS that include the widest range of sizes, types and current ratings from the tiny ring types for radio to huge industrial assemblies.

With the rush to catch the earliest possible markets with postwar products, it is important that they be designed with units that can be procured without undue delay. Manufacturers of equipment requiring electric controls will find Ward Leonard Relays, Resistors and Rheostats readily available without "time-out" for redesigning. Facilities at Ward Leonard used to produce products for war purposes required little or no conversion. To serve postwar markets, they will likewise require a minimum of reconversion. Make your selection from the Ward Leonard Line. Let us send you bulletins describing controls of interest to you.

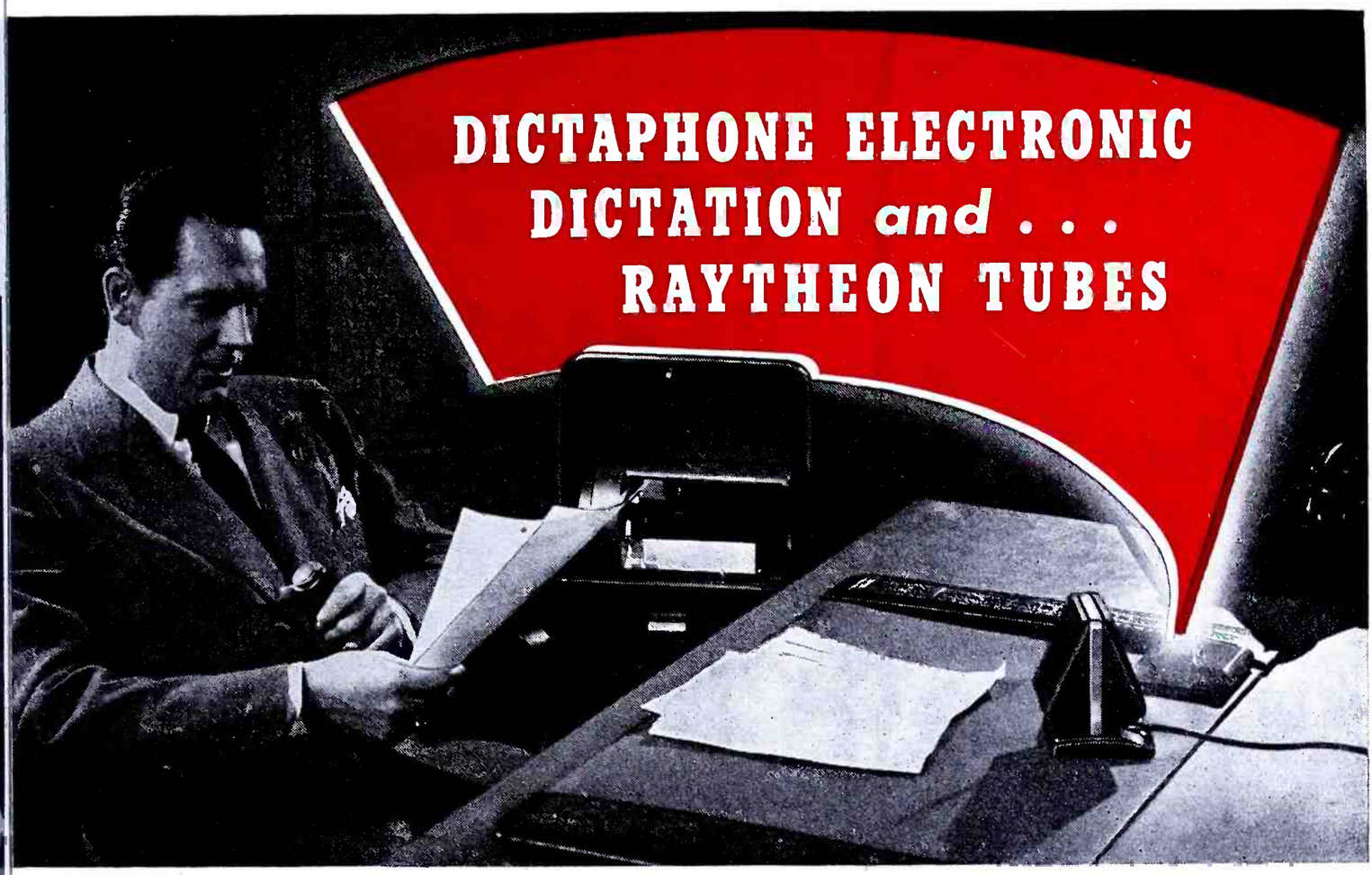
WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

ARMY E NAVY

Electric control (WL) *devices since 1892.*

WARD LEONARD ELECTRIC COMPANY · 75 SOUTH ST. · MOUNT VERNON, N. Y.



DICTAPHONE ELECTRONIC DICTATION *and* . . . RAYTHEON TUBES

● If you're a radio serviceman or engineer, you'll appreciate the ingenuity and development work which produced this new Dictaphone Electronic Dictating Machine which is available for essential uses. And if you're a busy executive, as well, you'll praise it as an aid to getting things done more easily, more quickly and more conveniently. Not only does it record dictation, but over-the-desk conversations and both ends of phone-calls too!

Raytheon high-fidelity tubes used in this remarkable new machine consistently deliver clear, realistic reproduction and give long, dependable performance...just as they will in the future for this and an infinite variety of other electronic devices.

When peace comes, Raytheon tubes will be more readily available. And they'll be even finer than Raytheon's pre-war tubes, for their design and construction will have been proved by the toughest test of all—the acid test of battlefront performance. We can promise, too, if you're a serviceman or dealer, that the Raytheon tube line will be the most *beneficial* line for you to handle. After Victory it will pay you to switch to Raytheon high-fidelity tubes!

• • •

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

Raytheon Manufacturing Company

RADIO RECEIVING TUBE DIVISION

Newton, Massachusetts • Los Angeles
New York • Chicago • Atlanta

Listen to "MEET YOUR NAVY" Every Saturday Night ENTIRE BLUE NETWORK Coast-to-Coast 181 Stations

RAYTHEON

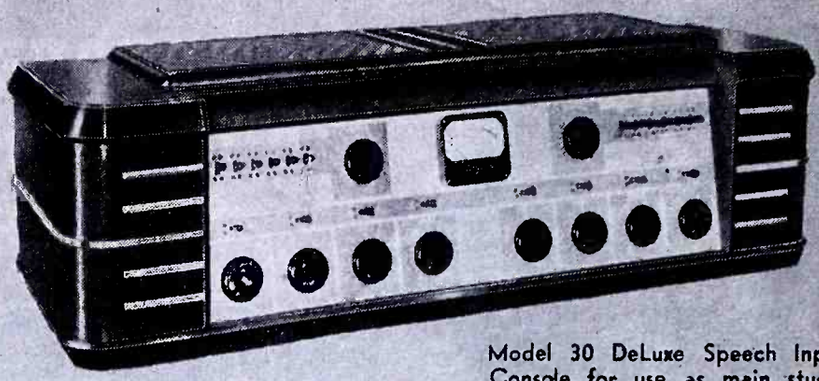
High Fidelity

ELECTRONIC AND RADIO TUBES

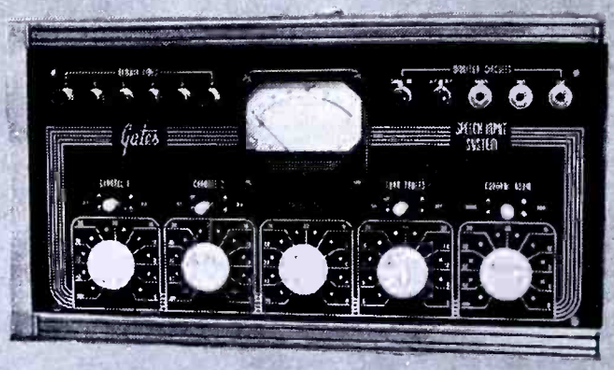
All Four Divisions Have Been Awarded Army-Navy "E" with Stars

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

Only Gates Offers You This Choice of SPEECH INPUT CONSOLES



Model 30 DeLuxe Speech Input Console for use as main studio control unit for stations up to 50,000 watts.



Model 51 CS Studioette Speech Input Console for smaller stations and sub-studio operation.

● Here are two popular examples of how Gates equipment is *engineered for efficiency and economy* to meet the requirements of every type of station. These two popular studio control units meet every demand for use as a main studio control unit, as sub studio control equipment, for auditorium pick-ups and for large broadcasts such as symphonies, conventions, etc. You'll find these Gates units in service all over the world . . . time-proved by dependable service in more than 100 U. S. broadcasting stations ranging from 250 to 50,000 watts.

THE MODEL 30 CONSOLE is streamline-designed for real showmanship by one of America's leading industrial designers, and carefully engineered to combine these important features:

- *FM frequency response*
- *5 complete pre-amplifiers*
- *Dual program and monitoring amplifiers instantly interchangeable*
- *All circuits controlled by keys (no push-buttons employed)*
- *Illuminated VU meter*
- *Massive modernistic appearance*

THE MODEL 51-CS STUDIOETTE is a junior size of the Model 30, substantially lower in price and ideally suited for the moderate-size station, where quality control equipment with the following features is desired:

- *FM frequency response*
- *High gain and low distortion*
- *Accommodates 5 microphones, of which any 3 may be mixed simultaneously*
- *Has 6 remote positions*
- *Complete cueing, monitoring and muting facilities*
- *Attractive 3 color finish*

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.

Ask About Our Priority Plan for Prompt Delivery When Gates Equipment Is Again Available.

Gates

RADIO COMPANY, Quincy, Illinois, U. S. A.

Manufacturers of Radio Broadcast Transmitters, Speech Equipment, Antenna Tuning and Phaser Units, Amplifiers, Remote Equipment, Broadcast Station and Transmitter Accessories

Among all the miracles that have been talked about for a great and glorious postwar era, here is one thing on which you can *really* count: JENSEN Speakers will be built around the wartime developed **ALNICO 5** ¶ JENSEN naturally pioneered in the use of this remarkable new magnet material which weighs only a fraction of other magnetic alloys of equal strength. Thus JENSEN postwar speakers with **ALNICO 5** will be lighter and more compact, but still as highly efficient and rugged as ever. ¶ JENSEN military loud speakers are now using **ALNICO 5** in great quantities. And as soon as conditions permit, **ALNICO 5** will become a feature of JENSEN PM Speakers.

Jensen
SPEAKERS WITH
ALNICO 5

Specialists in Design and Manufacture of Acoustic Equipment

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

Fire News of Top Importance!

FCC and WPB okay 3-way Radio for Fire Stations

Federal Communications Com-
en banc today approved
s to the Rules Govern
Radio Servic-
ns

Motorola installs 3-Way Citywide F-M Radio System in Boston, Massachusetts

Now You Can Bring Your Fire Fighting Equipment Up-to-Date

Think what it means to have instant communication with your firemen and equipment at all times—in fire stations, "on the way", and fighting the fire at the scene. What such communication means in conserving lives, property, personnel and equipment!

All these advantages you get with a Motorola Fire Fighters' radiotelephone system like Boston installed. The system is modelled after the famous Motorola police radiotelephone system so successfully used by State Police, County Sheriffs and City Police in many States, hundreds of Counties, Cities and Villages throughout the United States and the Canal Zone.

Full Information

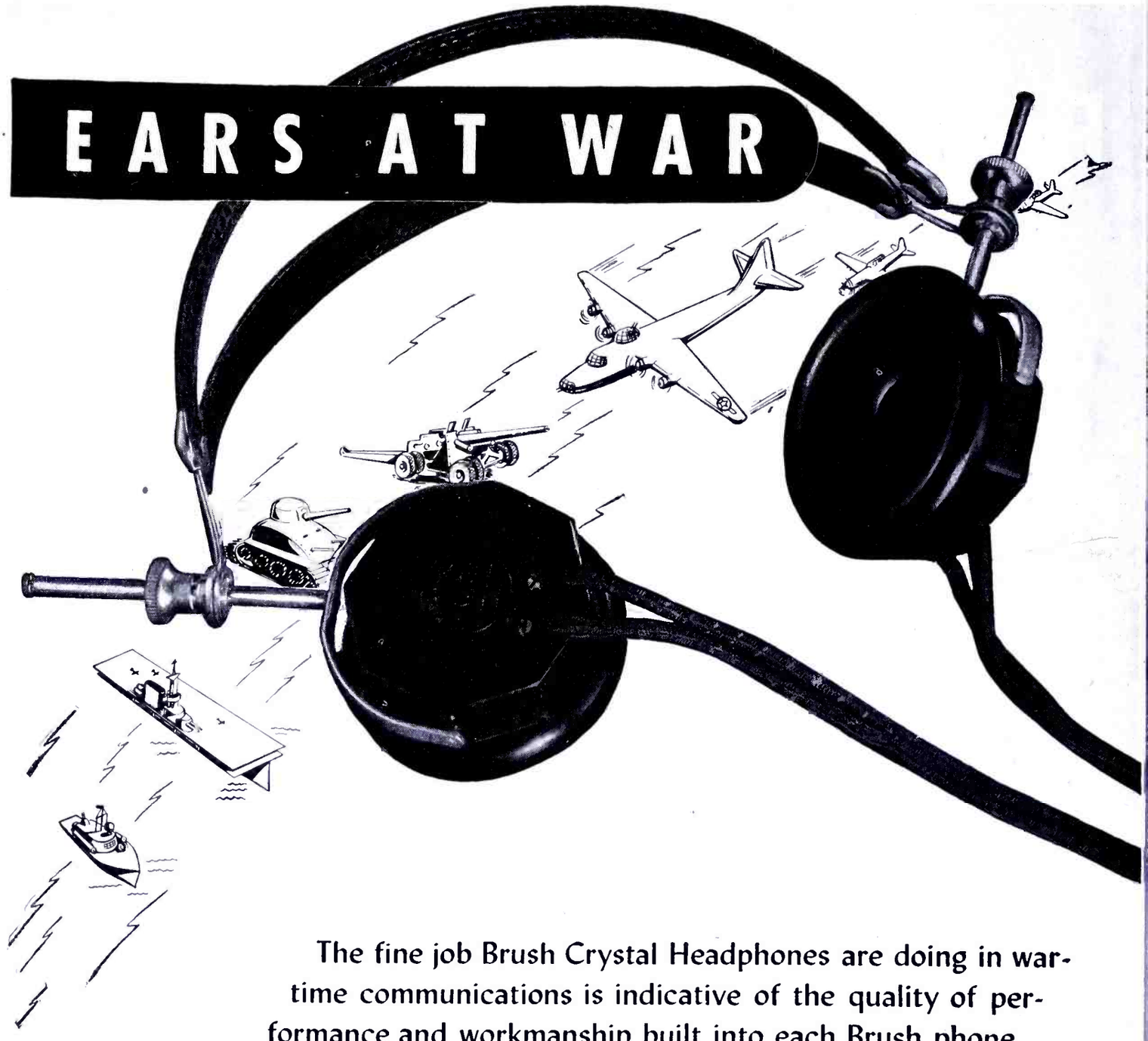
All you want to know—the radiotelephone system best for your community, all about the forms and applications—you can obtain quickly and without obligation. Just write today to the Motorola Division, Galvin Manufacturing Corporation, Chicago 51, Illinois.

● **Motorola who developed the "Handie Talkie" will make them available for Emergency Fire and Police use as soon as obligations to our armed forces have been completely fulfilled.**

GALVIN MFG. CORPORATION • CHICAGO 51

F-M RADIO • AUTOMATIC PHONOGRAPHS • TELEVISION • F-M POLICE RADIO • RADAR • MILITARY RADIO COMMUNICATIONS

EARS AT WAR



The fine job Brush Crystal Headphones are doing in wartime communications is indicative of the quality of performance and workmanship built into each Brush phone.

Features of Brush Crystal Headphones are—

- **Wider range—clarity at all frequencies from 100 to 10,000 c. p. s.**
- **High impedance—ideal for multiple installations.**
- **BIMORPH* crystal drive element.**
- **High sensitivity.**
- **Light weight, rugged, shock-proof construction.**

*Trade Mark Reg. U. S. Pat. Office

THE BRUSH DEVELOPMENT COMPANY

3503 PERKINS AVENUE • CLEVELAND 14, OHIO

AMPHENOL

Under All Conditions

CONTRIBUTES TO RELIABLE COMMUNICATIONS

Man's isolation under adverse conditions has ended with recent radio developments which overcome the trying conditions of air and sea transportation. This means rising above all conditions of interference. Among the things that have made this possible is Amphenol *current transmission equipment* that will carry the high frequencies without appreciable loss.

The name "Amphenol" on high frequency cables means the best of polyethylene insulated cable—cable that is sold under affidavit of exacting tests and inspections. "Amphenol" on low-loss connectors means the minimum of loss in tight fitting, secure holding connections. On both it means transmission equipment that will do its part toward providing the clearest possible transmission and reception of communications even under adverse conditions.

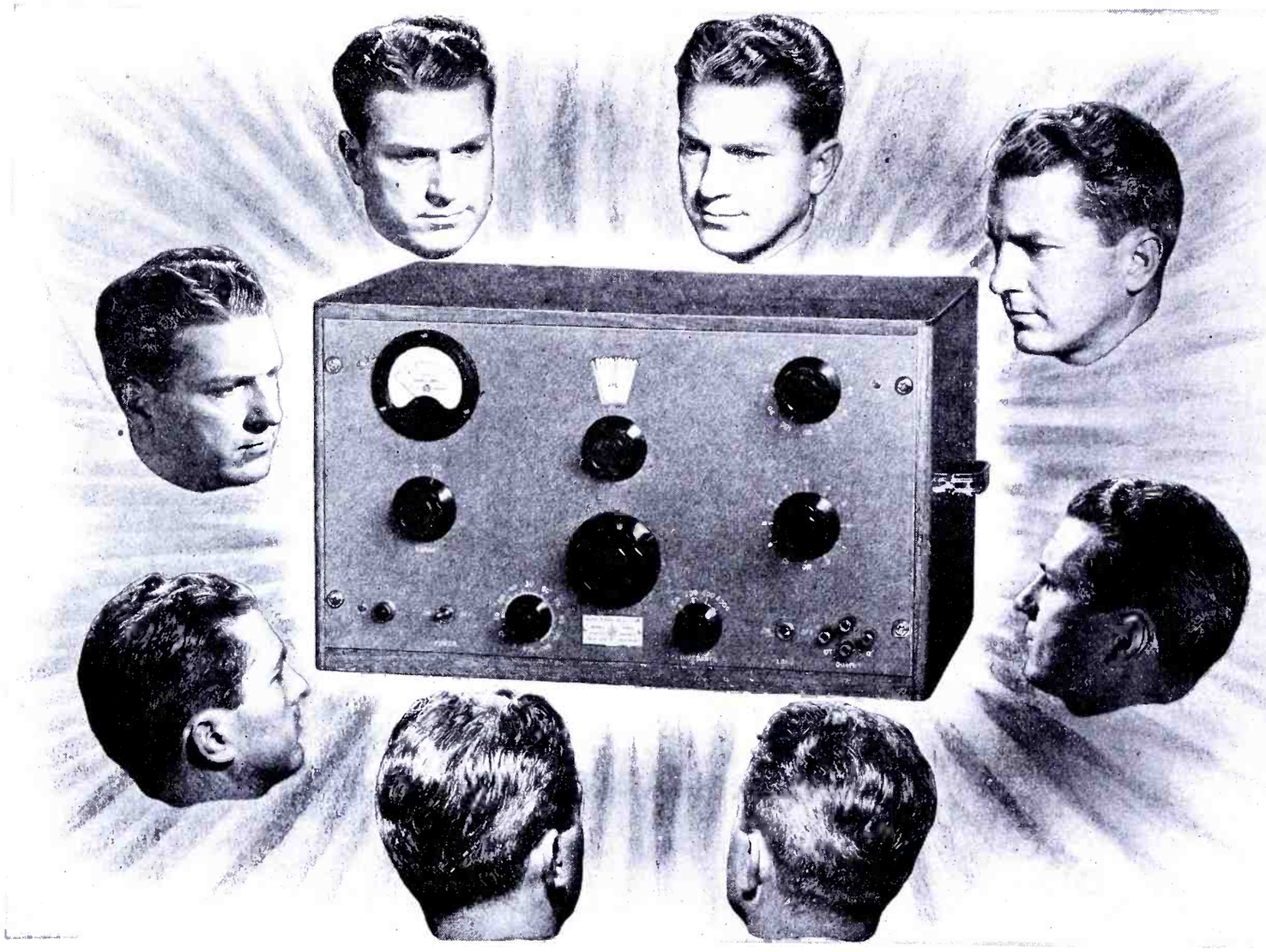
AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada—Amphenol, Limited—Toronto

Depend upon AMPHENOL *Quality*

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

YOU ARE LOOKING AT
ANOTHER NEW-*hp*-INSTRUMENT

...a signal generator for use below 100 kc



This new -*hp*- Audio Signal Generator embodies many new features which are very desirable. Outstanding among these is the new main frequency dial which enables the engineer to make extremely accurate settings. Parallax is completely void and the vernier adjustment is smooth and positive. A spring loaded gear drive, built on a heavy cast frame, maintains accuracy of settings. The Model 205-AH consists of an -*hp*- Resistance-Tuned Audio Oscillator, an output meter, an impedance matching system and an attenuator set. The frequency range is from 1 kc to 100 kc, maximum power output is 5 watts, the hum level is at least 65 db below output voltage and the frequency response is ±1 db from 10 kc reference. The output attenuator provides 0 to 110 db in 1 db steps, while the output meter is calibrated directly in volts at 500 ohms and in db above 1 milliwatt level.

A limited number of preliminary specification sheets are ready for engineers who write immediately.

HEWLETT-PACKARD COMPANY

980 **BOX 980 E STATION A • PALO ALTO, CALIFORNIA**

CANADIAN OFFICE: 560 KING STREET WEST, TORONTO 2

they said

it couldn't

be done . . .

and again . . .

THEY SAID

IT COULDN'T

BE DONE . . .

Hytron's telescoping of receiving tubes to BANTAM GT size was at first considered impracticable. Development of the BANTAM JR. was another impossibility to be proved possible. This first sub-miniature was a tiny tube whose diameter was about that of your little finger — and it was a pentode at that! As a production tube it just didn't seem to make sense.

Encouraged by hearing-aid manufacturers eager to gain the additional sensitivity of the vacuum tube, Hytron sweated it out for two long years. Operators were trained to assemble the minute parts under magnifying glasses. A simple reversal of the conventional stem made baseless tubes possible. Problems of obtaining suitable vacuum with such small bulbs, were licked.

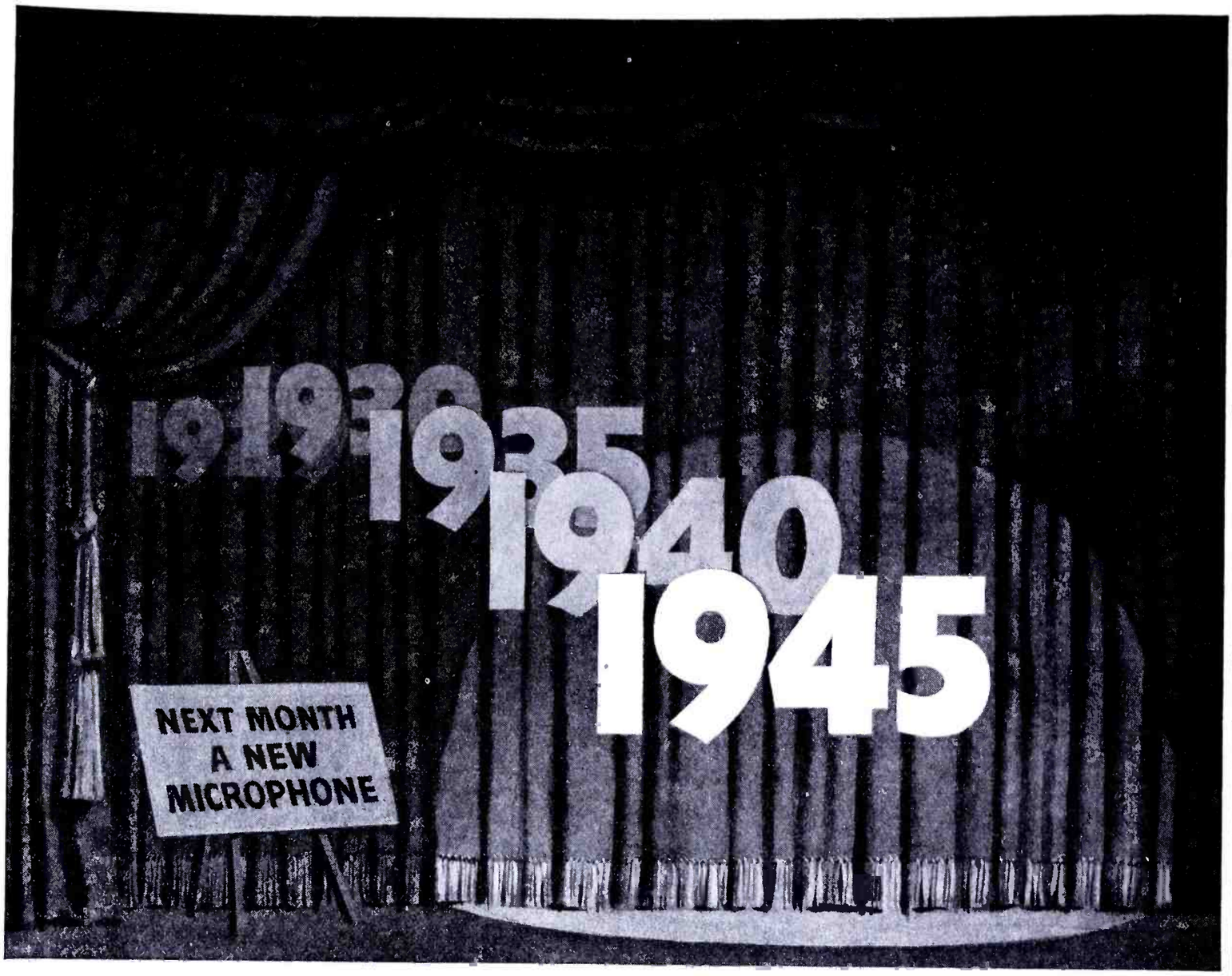
Finally in 1938, Hytron introduced the first successful sub-miniature. Tiny but rugged despite a hair-like filament and a diminutive mount structure, its low current drain and compactness made the BANTAM JR. a natural for all kinds of portable equipment, hearing aids, and military electronic devices. After the war, watch for even smaller and better Hytron subminiatures.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

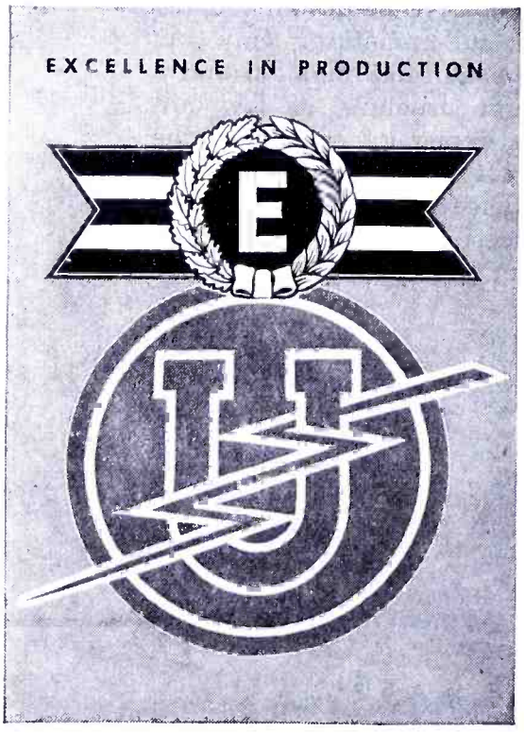
HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

BUY ANOTHER WAR BOND



A NEW STAR IN THE ELECTRONIC FIELD



The stage is set for something new in Universal's line of products. Next month will bring the appearance of a new microphone to meet markets made by present and postwar demands. This will be the first microphone of its kind offered by Universal since the War. Universal has, since before Pearl Harbor, been manufacturing microphones and electronic voice communication components for the U. S. Army Signal Corps.

We are still pleased to manufacture all the microphones our fighting men require and we are pleased to make a new microphone to fill their and essential home front needs.

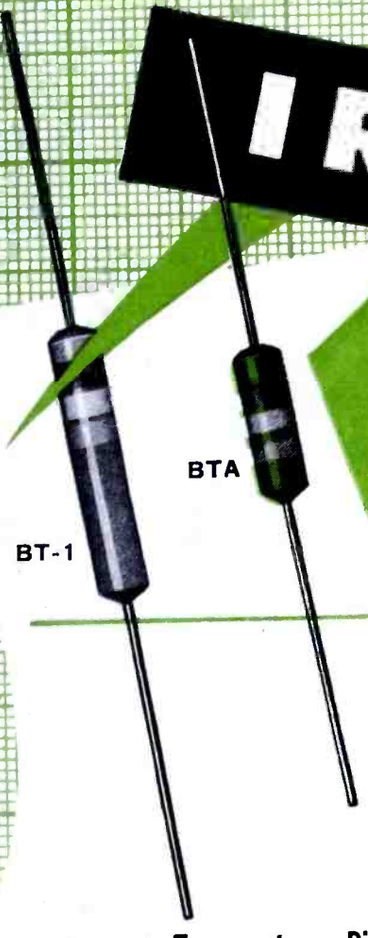
← **Emblems of quality in war production**

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

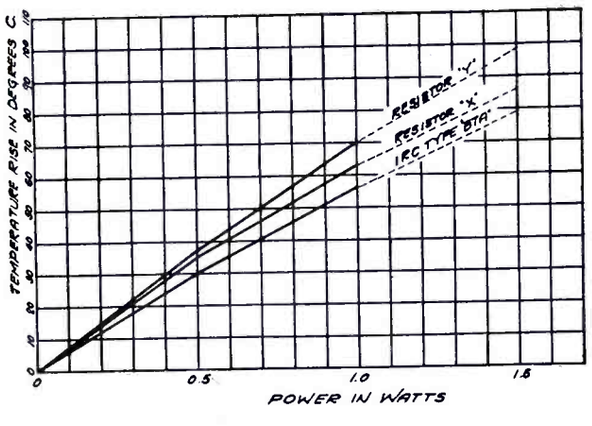
FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

NO. 3 IN THE IRC NEW PRODUCT PARADE

IRC is ready with...



THE NEW BTA RESISTOR



Lowest Temperature Rise

Like all BT Resistors, the operating temperature of the new BTA is *lower* than other resistors of comparative size!

Only the extreme pressure of essential war production has delayed our release of this small one-watt AWS RC 30 type *insulated* resistor. You'll find the BTA insulated resistor a worthy and important addition to the BT family. Built to meet American War Standards specifications, the BTA is only 0.718 inches long and 0.250 inches in diameter. Wattage rating, 1 Watt at 40° C ambient. Voltage rating, 500 volts. Minimum range, 330 ohms. Maximum range, Standard: 20 megohms.

Write today for comprehensive bulletin containing engineering data and charts.

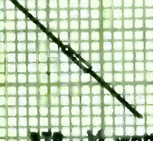
ENGINEERED FOR PERFORMANCE • FIXED & VARIABLE RESISTORS • IRC

INTERNATIONAL RESISTANCE CO.

DEPT. 8-B 401 NORTH BROAD STREET PHILADELPHIA 8, PA.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

AN 3155 Resistor



BTR—½ watt Insulated Resistor

BTA—1 watt Insulated Resistor

COMING....COMING....COMING....COMING....

A STATEMENT OF POLICY TO THE EQUIPMENT MANUFACTURER CONCERNING *Gammatron Tubes*

WE at Heintz and Kaufman Ltd. believe that equipment manufacturers, many of whom are making their long-range plans now, will be interested in the policies for the standardization and stabilization of tube types which have been established for Gammatrons. These policies merit consideration when designing equipment either for military or civilian use.

Practically all tubes now sold to the Government must conform to specifications covering electrical standards and physical dimensions.

We are heartily in favor of the Signal Corps and Bureau of Ships joint standardization of electronic component parts. The good work of the Radio Manufacturers Association likewise deserves the highest commendation. We believe that the Joint Army and Navy Specifications for Vacuum Tubes ("JAN specs") will be accepted voluntarily by tube manufacturers as post-war commercial standards, since they offer many advantages to the equipment manufacturer.

All H&K Gammatrons when again manufactured for commercial use will conform to the rigid physical and electrical specifications now required by "JAN specs."

Thus when you design equipment around Gammatron tubes you can be sure that neither electrical nor physical changes in these tubes will make redesign of equipment necessary, or replacement difficult.

We plan to tell you more about our standardization and development policies in future advertisements. So please be on the watch for them each month.

BUY WAR BONDS

HEINTZ AND KAUFMAN LTD.

SOUTH SAN FRANCISCO • CALIFORNIA

Gammatron Tubes

Recent Progress

HAS MADE AVAILABLE TO FORMICA:

- **Better Fibre Bases Such as Glass**
- **Better Resins**
- **Better Production Methods**
- **Better and More Accurate Test Information**

FORMICA'S service to the electrical engineer and the electrical manufacturer, under the pressure of war research, has improved more rapidly during the past few years than usual.

New fibre bases such as glass have made possible high frequency insulation of excellent quality—comparable for many purposes to ceramics—which can be readily machined—which is easily workable in production.

New resins such as melomine have intensified the useful qualities of many Formica grades.

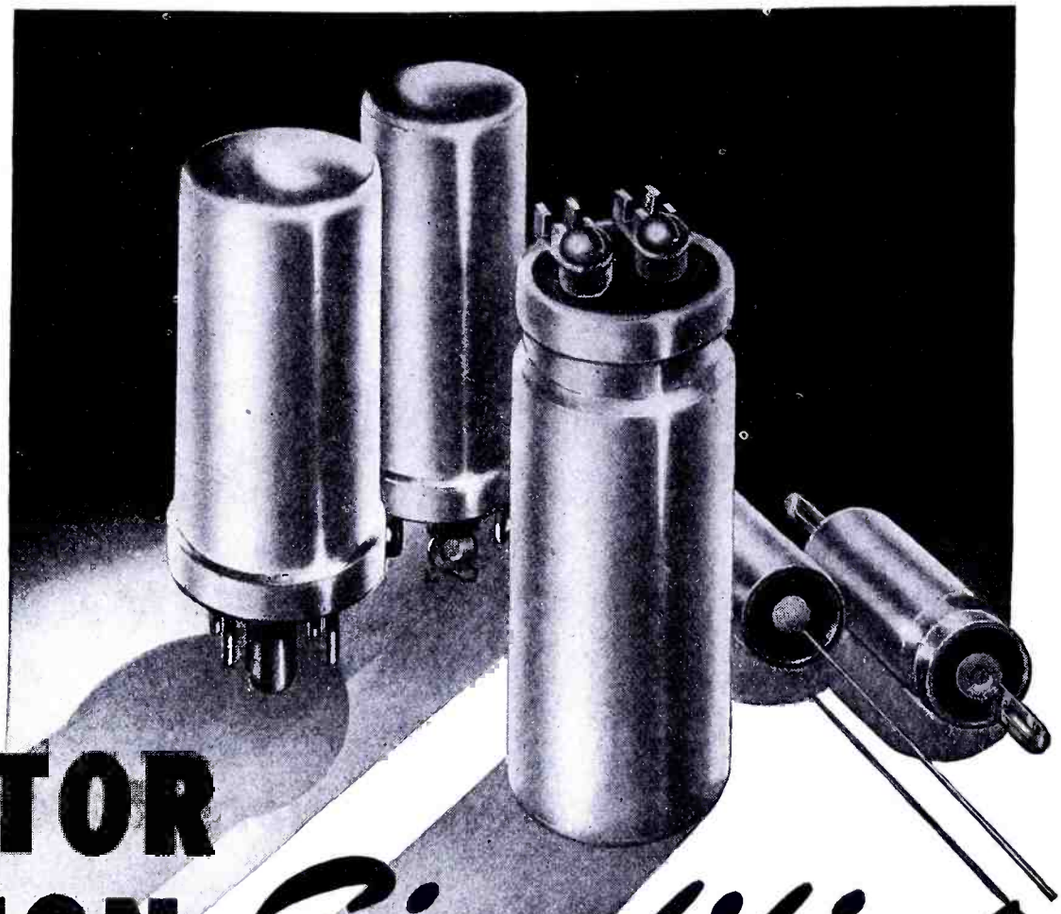
Infra-red treating machines, electronic heat for curing thick sections, new types of tube rolling machines, are features of newly developed equipment that make possible better quality in greater volume.

A large investment in the most modern testing equipment has enabled the Formica laboratory to give more accurate, detailed and valuable answers to the engineer's questions regarding the exact physical and chemical characteristics of the material.

Why not make use of this exceptional equipment for service? Send in your inquiries.

FORMICA

THE FORMICA INSULATION CO. • 4635 SPRING GROVE AVE. • CINCINNATI 32, OHIO



CAPACITOR SELECTION *Simplified*

Probably no type of Electrical-Electronic component affords a greater variety of selection for a given application than capacitors. Probably no component is more susceptible to design changes to accommodate given conditions. Moreover, nowhere has engineering been moving faster in developing new types, improving old types and, in general, changing past conceptions of Capacitor usage.

That's why proper Capacitor selection is no casual matter—and this, in turn, is why we make the following recommendation to Capacitor users:

Write today for a supply of Sprague Capacitor Sample Request Forms. Then, as Capacitor applications arise, send full data to Sprague engineers on these forms. Let Sprague consider all factors involved—both in the light of long, specialized experience, and of the latest Capacitor developments or adaptations which Sprague engineering may have to offer.

It takes no longer to buy Capacitors on this basis. Such service makes them cost no more—and it frequently means important savings, increased efficiency on your production line, and greater dependability for your product.

SPRAGUE CAPACITOR TYPES

Dry Electrolytics Paper—Mica
Power Factor Correction
High Voltage Networks
*Vitamin Q Capacitors
Radio Noise Suppression
Filters, etc., etc.

SPRAGUE RESISTOR TYPES

*Koolohm Wire-Wound Power
Hermetically-sealed Wire Wounds
Bobbin Types
Voltage Divider Sections
Precision Meter Multipliers, etc.

*T. Ms. Reg. U. S. Pat. Off.

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

ARMY E NAVY

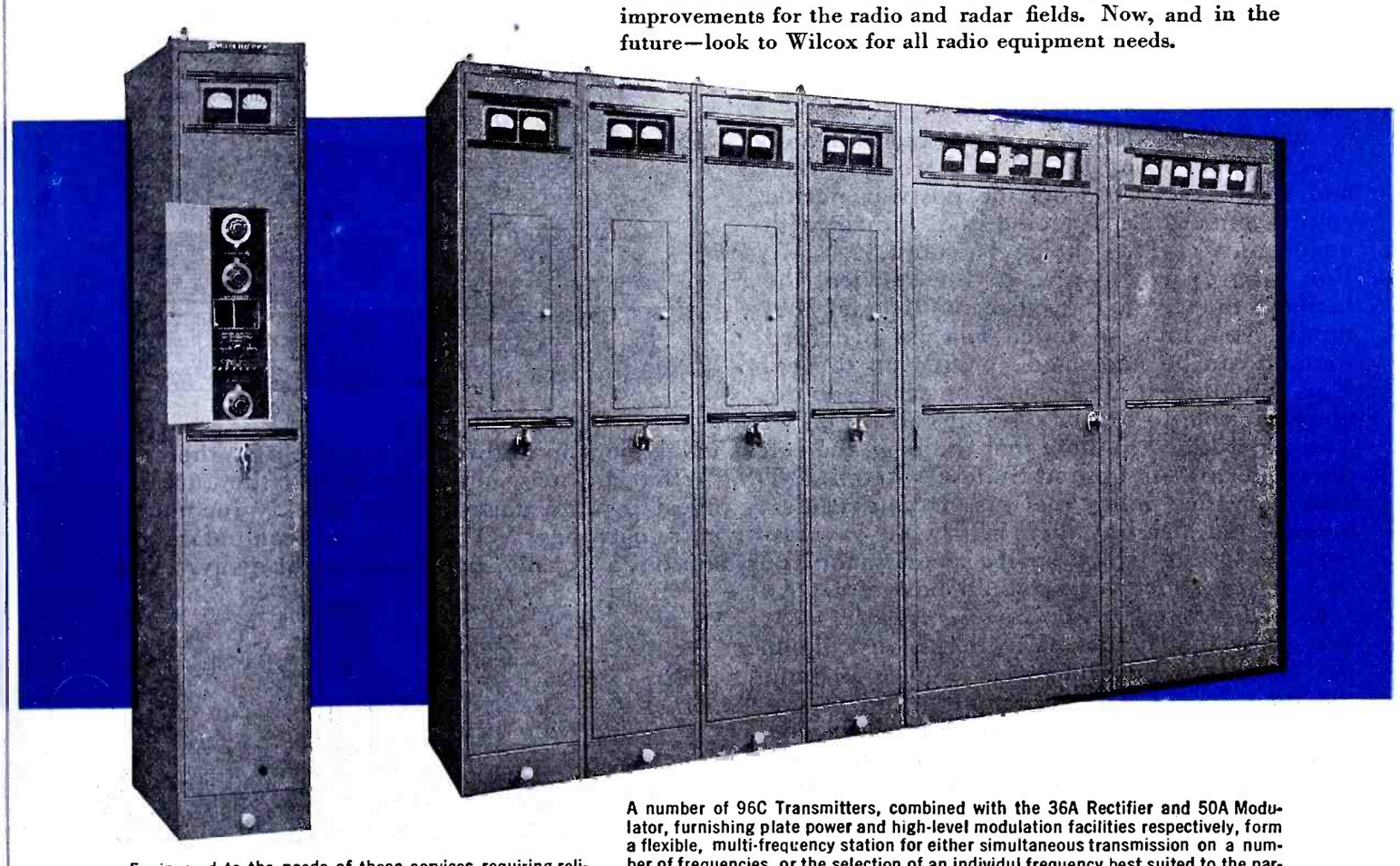
SPRAGUE

CAPACITORS — *KOOLOHM RESISTORS

Look to Wilcox for Quality

. . . IN RADIO COMMUNICATIONS EQUIPMENT

For many years, the quality of Wilcox communications apparatus has been relied upon by broadcasting stations, commercial airlines and governmental agencies. Throughout the United States and over the world flight schedules have been accurately and safely maintained through use of Wilcox ground and aircraft transmitters, receivers and control equipment. From the urgency and new demands of war have been developed many Wilcox improvements for the radio and radar fields. Now, and in the future—look to Wilcox for all radio equipment needs.



Engineered to the needs of those services requiring reliable radio communinications, the Wilcox Electric Company 96C equipment represents an advanced stage of design in the field of medium frequency, medium power transmitters. Each unit is a complete, fixed-frequency 2.5 KW RF transmitter, for either telegraph or telephone operation in the range of 2-20 MC.

A number of 96C Transmitters, combined with the 36A Rectifier and 50A Modulator, furnishing plate power and high-level modulation facilities respectively, form a flexible, multi-frequency station for either simultaneous transmission on a number of frequencies, or the selection of an individul frequency best suited to the particular communication problem. The use of an individual channel for each frequency avoids the complications of frequency shifting mechanisms.

WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

Fourteenth and Chestnut **Kansas City, Mo.**

After Victory... WHAT?

When Victory is ours, and Peace returns to the land . . . will YOU be snug in your own paid-for home—with security against illness, provision for retirement, education for your children—all ASSURED BY BONDS?

Or will you be one of those "too busy" people who "meant to buy Bonds tomorrow"? Who find themselves entering the postwar period empty-handed . . . facing the future with uncertainty? The choice is yours.

For, wherever you are, in the service, the factory, the farm, the office, YOU and that family you love so much *can* be provided for—or can be neglected . . . it's up to *you*. Yes, actually! It all depends on what *you* do. On what you do *before* the war's over; on what you do, in fact, TODAY!

You must know by now that the best, the safest investment in the world—the one with the most liberal terms—is United States WAR BONDS. What you may not know is that they are the best insurance policy there is. If you regularly invest a percentage of your weekly income in bonds—and also buy them with your savings or extra earnings, NOW—you can accumulate that very Nest Egg which spells security for your family . . . easily, painlessly, right away. And, in just ten short years, you'll have *4 DOLLARS FOR EVERY 3 you invest!*

We guess that makes War Bonds just about the best darn buy there is. You're helping the boys to come home sooner—and you're *insuring* a bright, safe future for those you love. *When you invest in Bonds, the full faith and credit of the United States Government is behind that future of yours!*

THE MARK OF EXCELLENCE

If You Believe in America . . . BUY BONDS!

Here at Kenyon, we're proud to play our small role on the stage of a BIG war. That's why EVERY Kenyon transformer used by our fighting forces throughout the world reflects only the highest precision craftsmanship. Kenyon workers are doing their share—bringing Victory closer by turning out top quality transformers *uninterruptedly—and as fast as possible!*

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

After ADOLPH and TOJO are Q·R·T

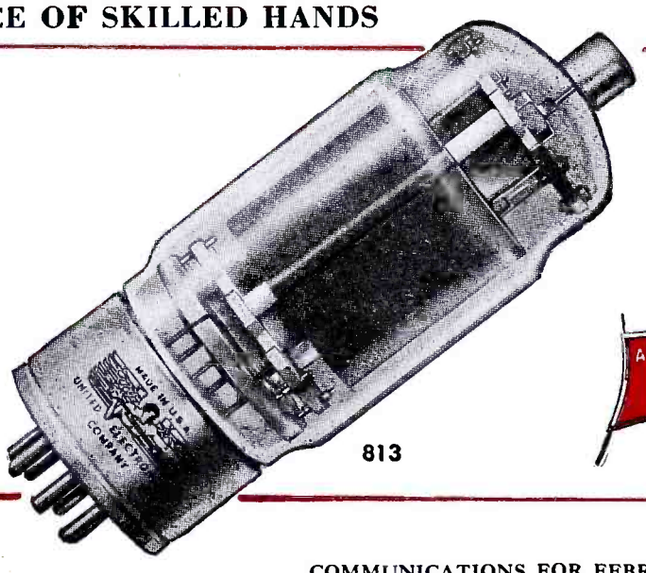
The rig he left behind is due for a big change when GI Joe comes home. War experience has been an "eye opener" for him. From chassis to sky wire many pre-war Ham outfits will undergo a major alteration and amazing technical advances will be put into practice. Stimulated by training and experience gained in the armed services thousands of new enthusiasts will swell the ranks of amateur radio.

When the gang goes back on the air again, CQ'ing, SS or DX; UNITED will be ready to serve the Amateur with war-perfected Transmitting Tubes.

Since 1934 UNITED has specialized in engineering, designing and building Transmitting Tubes that set the Quality Standard for the entire Radio Industry. When performance counts UNITED Tubes provide a maximum of electronic efficiency—plus a long and dependable life. Accept nothing less than UNITED quality for your own tube requirements.

Order direct or from your electronic parts jobber.

MASTERPIECE OF SKILLED HANDS



813

ARMY E NAVY

UNITED

ELECTRONICS COMPANY

NEWARK, 2 NEW JERSEY

Transmitting Tubes EXCLUSIVELY Since 1934

Our Navy's PT Boats are driving the war home to the enemy at high speed. They're shooting straight to the mark! They're demonstrating the power of American ingenuity and industry to the Jap war lords!

Eastern is serving on board these scrappy, hard-hitting PT Boats. Eastern equipment helps them carry out each assignment—swiftly and surely. Amplifiers, only a few short years ago, were thought of mainly in connection with sound systems. Today, they are an important part of many essential war instruments.

Eastern is proud to utilize its engineering and production facilities in the war effort . . . certain that its war-time experience will result in better-than-ever post-war sound and electronic equipment. Until the victory is won, Eastern will continue to devote all its resources to the design and manufacture of war equipment. To aid the war effort, our engineers are available for consultation on any amplification problem you may have.

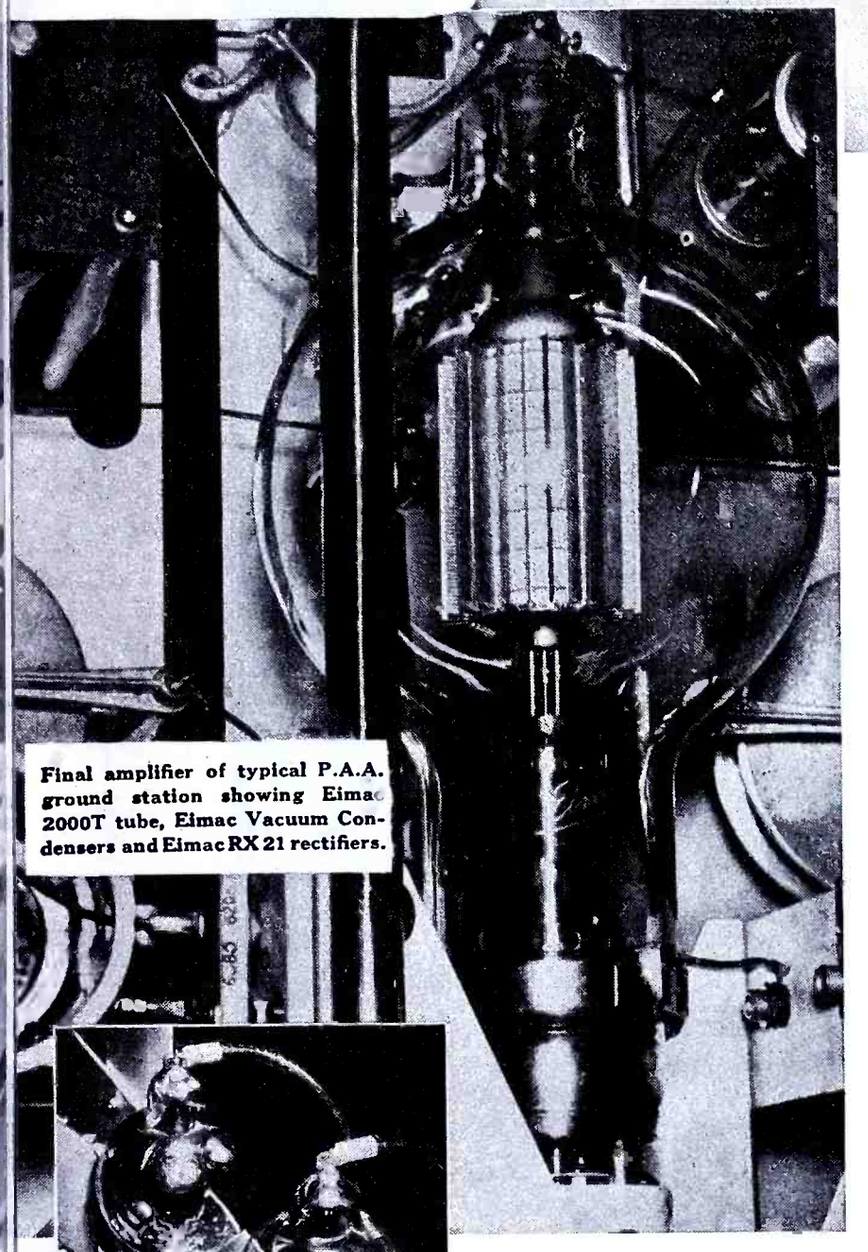
On request, we shall be glad to forward brochure containing the first of a series of articles covering technical phases of interest on sound amplification prepared by our engineering staff. Ask for Brochure 2-G.

EASTERN AMPLIFIER CORPORATION
794 East 140th Street, New York 54, N. Y.

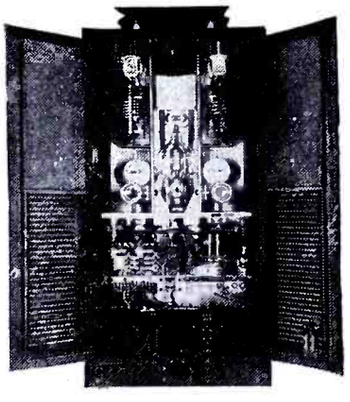
EASTERN AMPLIFIERS

PAN AMERICAN USES EIMAC TUBES

Pan American World Airways, which has done so much to advance the war-time goals of the nation, has just announced a plan for a new service to South America. Employing a fleet of stratosphere planes, carrying 108 passengers, flying at more than three hundred miles an hour, Pan American proposes to take travelers from New York to Rio de Janiero in less than twenty hours instead of the present sixty-six hours, charging $175 for the trip, as against the current rate of $491.



Final amplifier of typical P.A.A. ground station showing Eimac 2000T tube, Eimac Vacuum Condensers and Eimac RX 21 rectifiers.



Pan American Airways and all its associated and affiliated companies, which comprise the P. A. A. World System, have been using Eimac tubes in the key sockets of all ground stations for a number of years.

Because of the extensive operations of Pan American World Airways, these tubes have been subjected to about every test possible — altitudes; ground level; extremely cold climates and high temperatures found at the equator; conditions of high and low humidity; and in some instances, when new bases are being built, perhaps somewhat trying power conditions. The high regard which P. A. A. engineers have for Eimac tubes is clearly evidenced by their continued and more extensive use, as the years roll by.

The fact that Eimac tubes are the number one favorite of the commercial airlines is important evidence to substantiate the oft repeated statement that "Eimac tubes are first choice of leading electronic engineers throughout the world."

Follow the leaders to

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

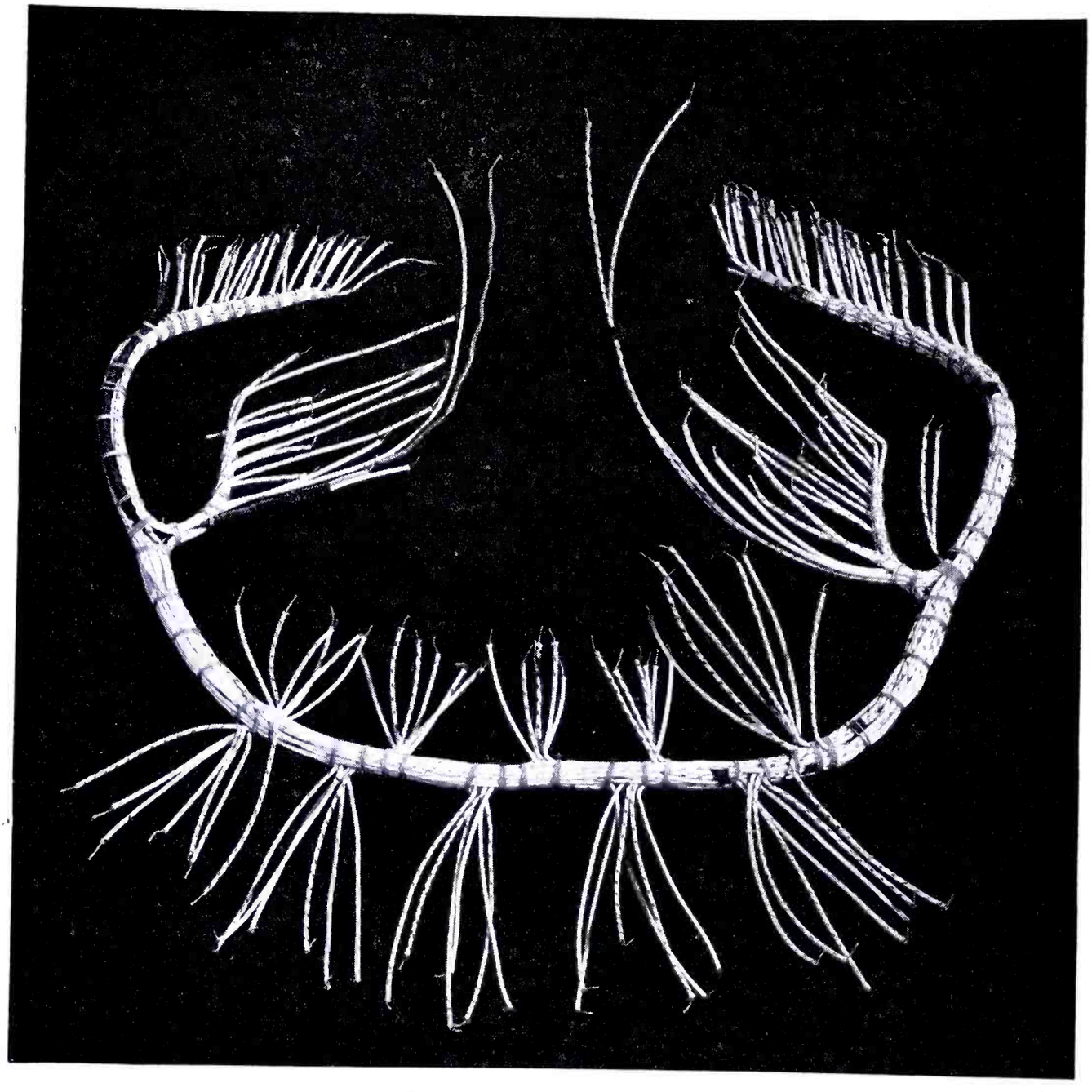
Write for your copy of Electronic Telesis—a 64 page booklet fully illustrated—covering fundamentals of Electronics and many of its important applications. Written in layman's language.

EITEL-McCULLOUGH, INC., 947 San Mateo Ave., SAN BRUNO, CALIF.

PLANTS LOCATED AT: SAN BRUNO, CALIFORNIA AND SALT LAKE CITY, UTAH

Export Agents: FRAZAR & HANSEN, 301 Clay Street, San Francisco, California, U. S. A.

A HEAVY WIRING HARNESS
by a Wire Manufacturer



helps solve your manpower problem

Use Lenz Laced Wiring Harnesses, constructed of approved types of color coded insulation to speed up your assembly operations, and release *manpower* for other work on the assembly line.

The Lenz organization, manufacturers of radio and instrument hookup, has the experienced personnel that can produce these harnesses with meticulous care and regard for precision, to meet your exact specifications.

Quotations will be gladly furnished on receipt of sketch and specifications.

LENZ

IN BUSINESS SINCE 1904

LENZ ELECTRIC MANUFACTURING CO.

1751 North Western Avenue • Chicago 47, Illinois

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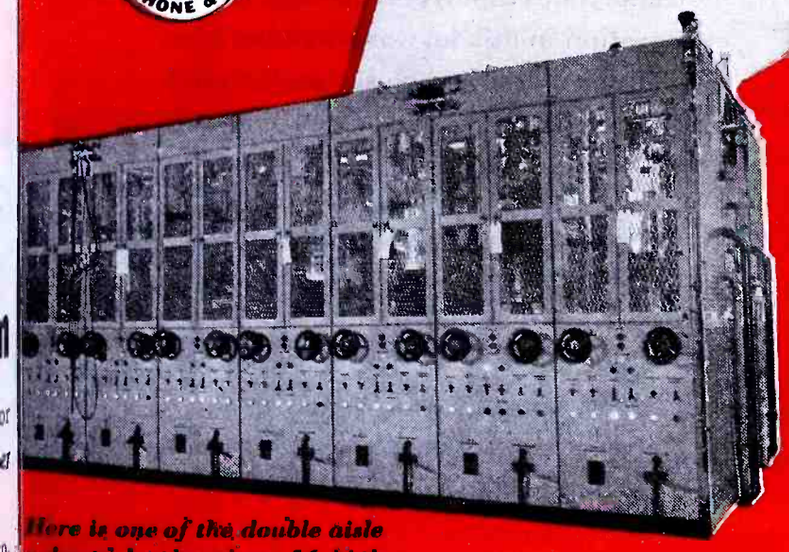
Federal Tubes...

come CLOSER to the

PERFECT VACUUM



Here is one of the double aisle exhaust banks where 16 high power tubes can be exhausted at one time, each with individual control.

Always in the forefront of tube research and development, Federal makes another advance and now has added exhaust units of entirely new and original design to its production equipment.

This latest Federal achievement produces a tube that is substantially closer to the perfect vacuum—a tube with greater efficiency and longer life.

Arranged in banks of eight and operated with identical control equipment, these units exhaust uniformly every size of Federal tube—assuring a consistent and high standard of quality.

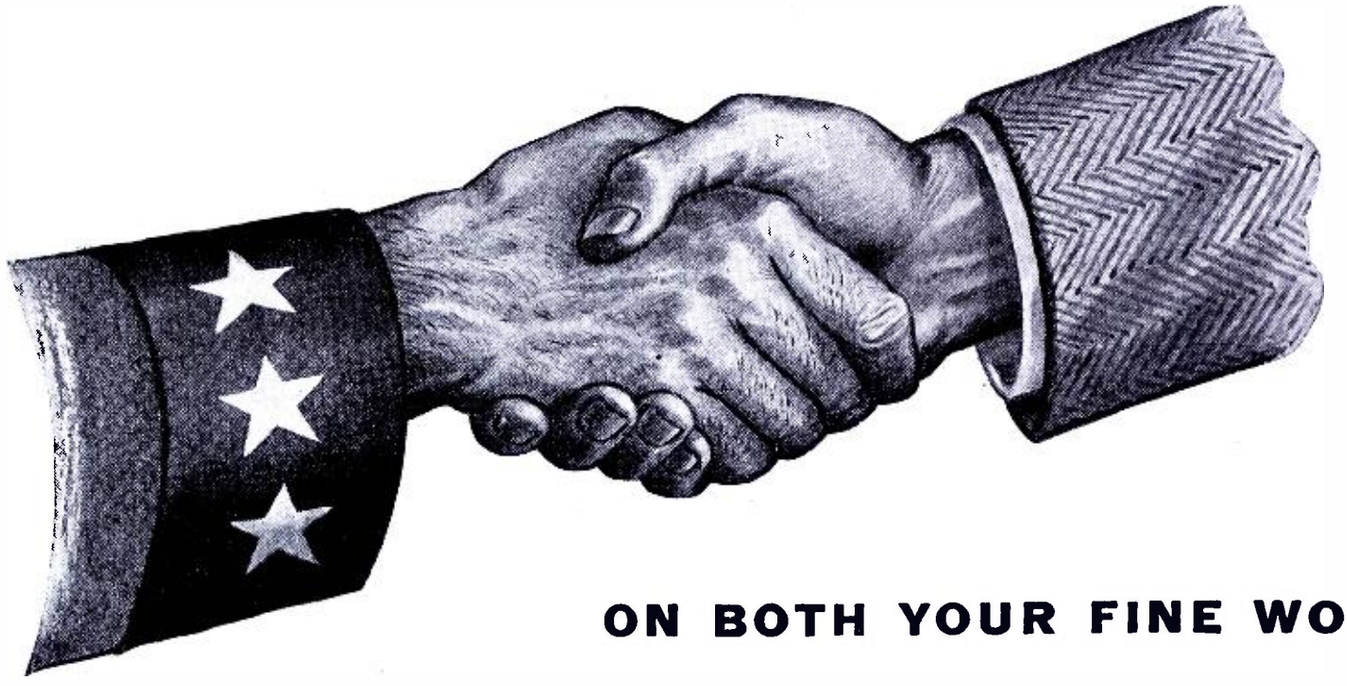
For any communication and industrial power tube need, turn to Federal now—test its reputation that "Federal always has made better tubes."

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

CONGRATULATIONS...



ON BOTH YOUR FINE WORK

AND FORESIGHT ON THE PAYROLL SAVINGS PLAN

IN your wholehearted support of the Payroll Savings Plan, you are doing far more than backing the most valid system of war financing—and building a powerful dam against the onrush of dangerous inflationary dollars.

By encouraging the all-out participation of your employees in this greatest of all savings plans, you are helping to create a sound economy for post war days.

With this same plan, you are assisting working America to build a mainstay against the inroads of unemployment and want—to save for homes, educational advantages and old age comforts!

You and your employees, through *mutual* cooperation in this forward-looking plan, are gaining a new and closer understanding—the cornerstone of a firmer, *mutually* profitable relationship!

National benefits, too, follow the "All Out" effort you are making! The prosperity of our United States rests on the economic stability of both management and labor. Your Payroll Savings Plan is working constructively toward the assurance of both!

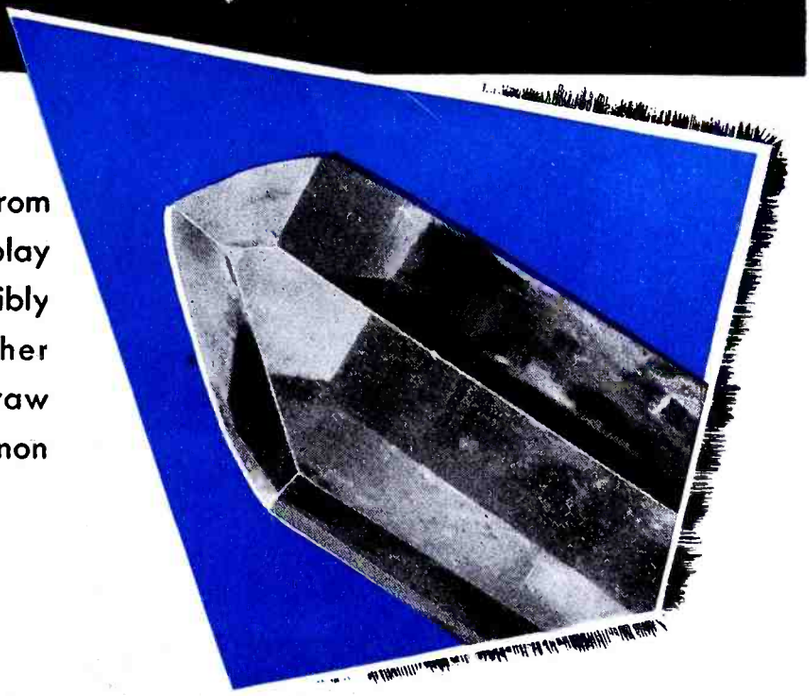
The Treasury Department acknowledges with appreciation the publication of this message by

COMMUNICATIONS

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council*

TELICON

CRYSTALS



The raw product comes from Brazil. As a result of interplay of elements — over possibly millions of years — Mother Nature endowed the raw quartz with the phenomenon of PIEZO-ELECTRICITY

Crystals were applied, before the war, on a small scale mainly in transmitters and in supersonic television. Today, the crystal is the ***heart*** *of all communications equipment of the armed forces. Crystals are used in the air, on the ground, on the sea and under water.*

American inventive ingenuity made possible a mass production technique which enabled this probably youngest of all industries . . . to produce tens of millions of this critical component.

Crystals of all types . . . for frequency control or for supersonic applications . . . plated or pressure mounted . . . in hermetically sealed or in plain holders . . . are manufactured — in two most up-to-date plants — by TELICON Corporation.

SUPERSONICS ★ RADIO ★ ELECTRONICS

TELEVISION

FOLLOWING VICTORY

TELICON Corporation

305 E. 63rd St. NEW YORK 21, N. Y.

COMMUNICATIONS

LEWIS WINNER, Editor

• • FEBRUARY, 1945 • •

Figure 2 (above)
The BBC recording unit at the war front.

Figure 1 (below)
Closeup of the BBC war correspondent's front-line recorder.

A WAR CORRESPONDENT'S RECORDER AT BBC

by W. J. LLOYD and D. E. L. SHORTER

London, England

FOR front-line reporting by BBC war correspondents, a simplified lightweight disc-type recording unit has been developed. Adjustments have been reduced to a minimum.

Although these requirements are fulfilled in some measure by various types of tape recorders, it is a bit difficult to make use of portions of the recorded material without returning the whole drum of tape to its base. Further, the editing of tape recording is rather a laborious process. For these reasons it was decided to record on 10" aluminum discs (coated with cellulose nitrate).

As the equipment was primarily intended for speech only, advantage was taken of the restricted frequency range of sound to be used. It was not necessary to adhere to the normal high-fidelity recording standards, as long as a high degree of intelligibility was maintained.

To operate the recorder, only a few simple operations are necessary. After placing a disc on the turntable, and moving the cutter arm to a suitable position over the disc, the microphone is removed from a clip in the lid:

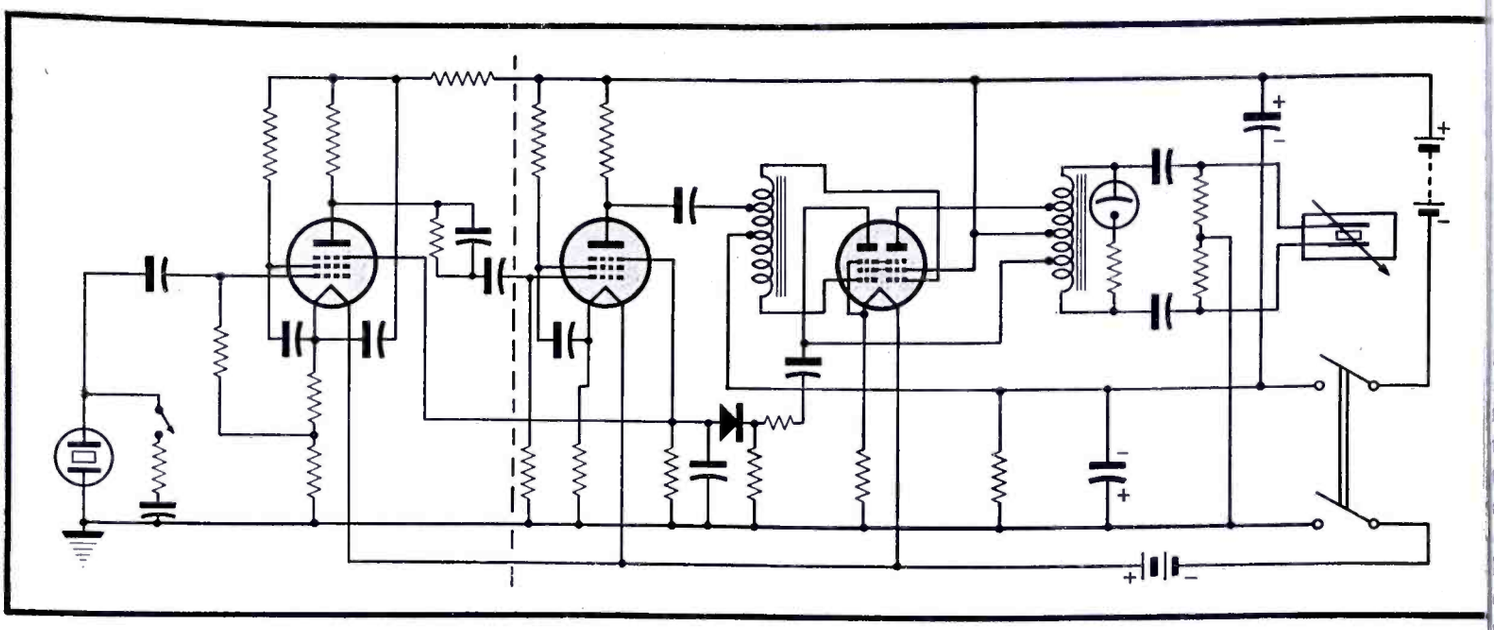


Figure 3
Three-stage amplifier circuit using low consumption pentodes in the first two stages, and a quiescent push-pull pentode in stage three.

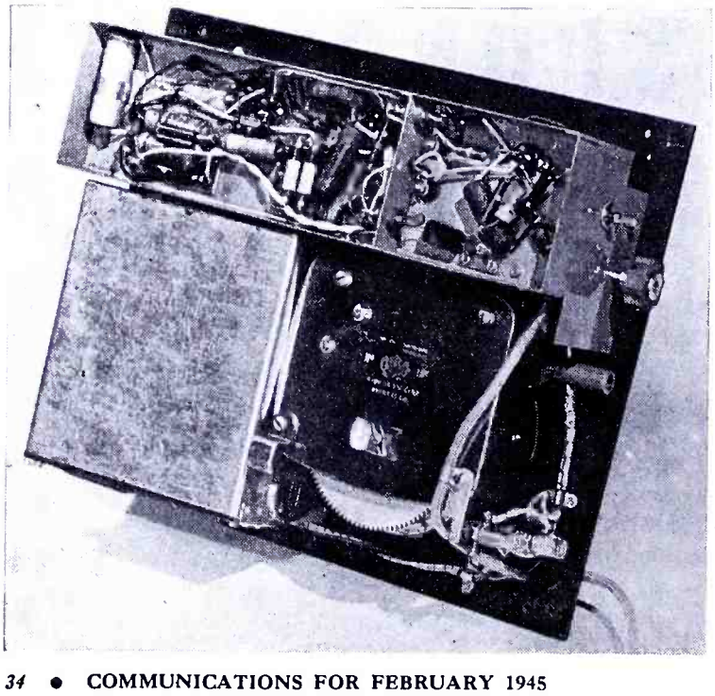
this lid can then be closed for protection from rain or debris. A motor is then wound and a single motor knob is turned. An amplifier switch is then snapped on, cutter-head is lowered and the commentary can begin. A warning light indicates that about 15 seconds remain before recording will be completed. When this 15-second period expires, an automatic trip shuts off the recorder. To interrupt recording, a *stop* button can be depressed. Three minutes of talk are provided on the disc, a period which has been found long enough for most dispatches from the front.

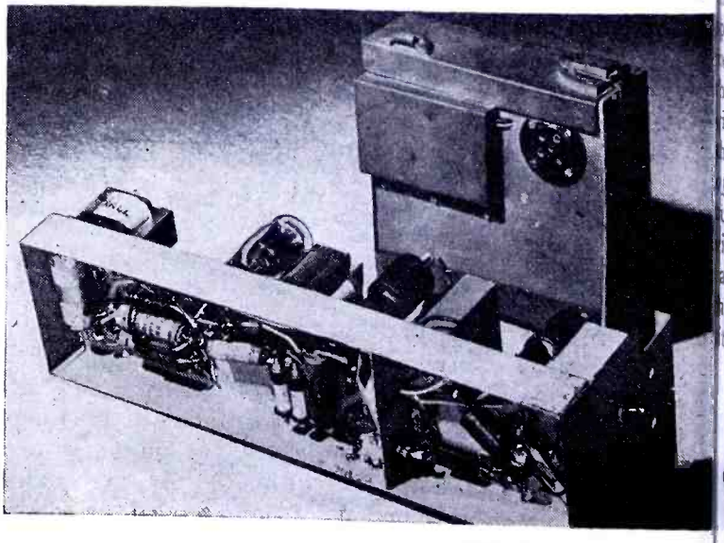
In view of the weight of the recorder, it was necessary to judge the weight of the allied equipment which has to be carried by the correspondents. A man can normally carry thirty-five pounds with reasonable ease for a moderate distance, but if the weight is increased to fifty pounds considerable difficulty would be experienced in carrying it for even short distances under active service conditions. After completing our recorder model, we found it, the batteries, and 12 discs to weigh 42 pounds. This has been reduced to 40 pounds. The shape of the case, as well as its weight, makes a great deal of difference to the ease with which it may be carried. The best practicable proportions were found to be 16″ x 13″ x 10″.

The unit's lightness and small size make it ideal for recording in aircraft.

A spring motor was found to be the only satisfactory drive for the turntable, since an electrically powered motor required batteries which added too much weight to the project. No commercial phonograph motor was found capable of supplying the torque necessary to overcome the drag of approximately 10 ounce-inches imposed by the recording cutter. (The standard phonograph record drag is about 4 ounce-inches). It was therefore necessary to experiment with various mechanical systems. In the early experiments a commercial clockwork unit was used; the spring barrel was modified to include the two springs in parallel, instead of the normal series link. This provided about twice the normal torque at the expense of running time. Since, however, the motor was designed to replay three 12″ records without rewinding, there was still ample time for recording on a 10″ disc. With this information as a basis of design, we then approached a manufacturer. With his aid we secured a special motor capable of maintaining three and a half times the normal torque for approximately 250 revolutions of the turntable, which at the standard rate of 78 rpm, corresponds to a recording time of about 3 minutes. The normal type of handle was unsuitable as it had to be removed after each recording *session*. A new handle was developed therefore, this one folded back into a recess when carrying.

A pivoting arm method of tracking the head across the disc was decided upon to replace the parallel tracking





Figures 4 (left) and 5 (below)
Figure 4, underside view of recorder. Figure 5, amplifier and battery box.

system. Originally a leadscrew drive was adopted using an *O.B.A.* standard thread, but later this was improved to a buttress thread having the core diameter and pitch of a 5/16" Whitworth standard. The leadscrew is driven by a spring-loaded rubber-faced disc and wheel at right angles from one of the motor layshafts.

The form of the knife-edge to engage with the leadscrew necessitated some experiment as the leadscrew formed a chord to the arc of travel of the cutter-arm. This blade is fixed to the end of a leaf spring, the other end of which is attached to the lower end of a pillar, which forms a bearing in a base attached to the motor board. The cutterarm is carried on two pivots mounted on the top end of the pillar, and also rests on a slide which can be moved vertically in order to raise and lower the cutter-head by a cam on the control shaft.

Figure 5 shows some of the detail of the control mechanism. The control knob has a free wheel device inside which permits the shaft to be turned in a clockwise direction only. Fixed on the shaft are three cams and a spring. The first cam in the *off* position holds the governor pad of the motor hard on to the friction disc, preventing rotation. When the shaft is turned through 180° to the *on* position, the cam actuates the spring leaves of two micro-switches which close the battery circuits, thus switching on the amplifier. (There is no appreciable delay in warming up). The action of turning the shaft clockwise winds up a spring which stores energy for returning the shaft to the *off* position when released. The shaft is held in the *on* position by a second cam which has a pin engaging with a slot in it. The pin is carried on a trip lever which may be moved out of engagement either manually by depressing a button on the control panel, or automatically, when the cutter head reaches the inside of the record. Automatic tripping is effected by a leaf spring, connected with the tracking mechanism, pushing against the end of the trip lever. An initial tension is given to the return spring to insure the mechanism returning fully to the *off* position. A third cam raises the cutter head by means of the slide previously mentioned. The spring arm carrying the knife edge passes over this cam, which, when in the *off* position, disengages the tracking mecha-

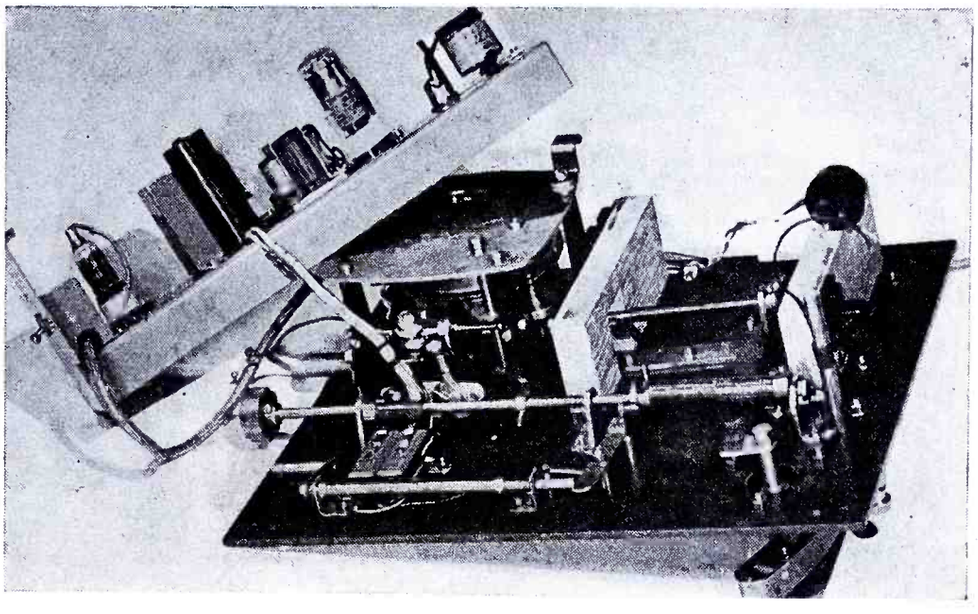


Figure 6
Underside view, with amplifier removed.

nism. The red warning lamp, which is operated from the amplifier batteries, lights up the instant the spring arm makes contact with the trip lever.

A light and sensitive cutter head is necessary. Various phonograph pickup assemblies were tried as cutter heads. A piezoelectric type was finally adopted. The crystal holder is designed to give the replay needle the large trailing angle necessary for the reproduction of discs. When used for recording, however, this angle is far too great and in order to obtain the correct degree of trail, the shank of the cutter is bent. Sapphire-tipped cutters were used, they were found to last longer than steel cutters, although careful handling is essential. To accomodate emergencies, six spares are supplied with the unit. The inclined axis of rotation of the stylus, coupled with the bending of the sapphire shank, results in a complex mode of vibration of the sapphire tip. Any distortion introduced by this effect, however, is negligible for the present purpose.

A unit method of construction was adopted to facilitate the servicing of the equipment in the field. Any one of the three main units, motor, amplifier, or battery box, can be replaced if faulty with the aid of simple tools and returned to base for service.

Plastics were used freely in the design, but, in some cases such as the cams, metal reinforcement was found necessary. The motor board is of plasticised linen, and the various units are mounted on it.

The motor board is fixed by four wing nuts to a strip metal frame, resiliently mounted inside the wooden case. Wood was chosen for the case to save weight. Metal reinforcements are fitted to each corner on the outside, while further strength is given by corner brackets holding the resilient mountings.

Electrical Equipment

Two types of microphone have been used with this equipment. One of these

(*Continued on page* 68)

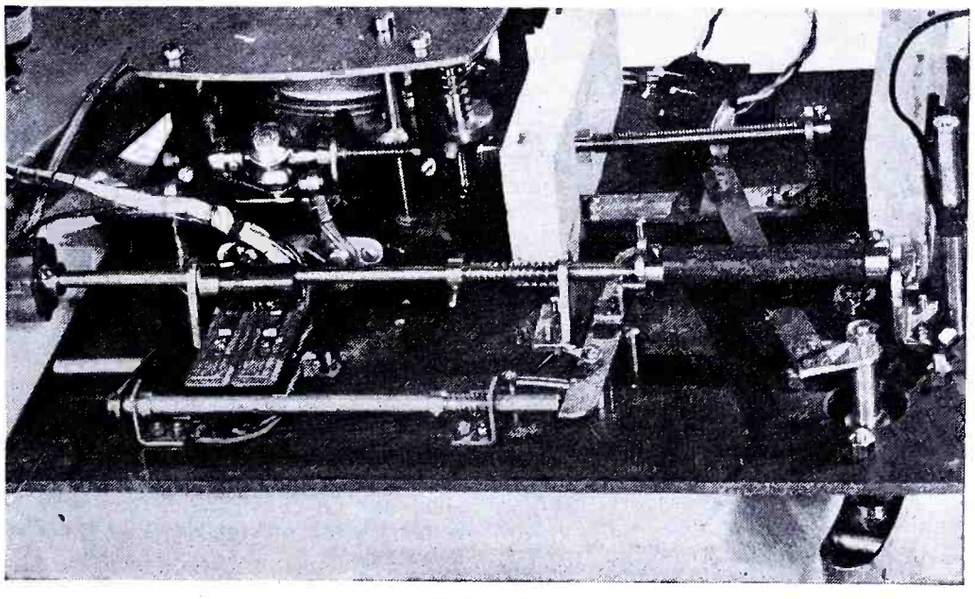
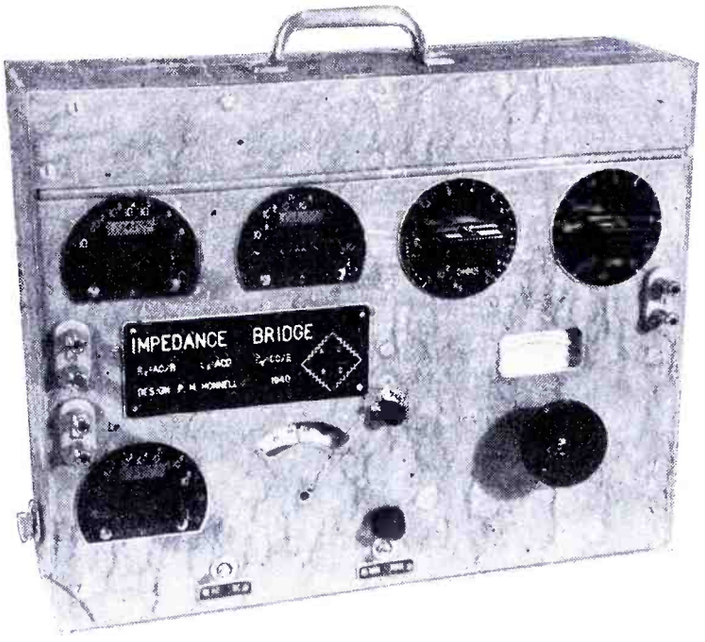
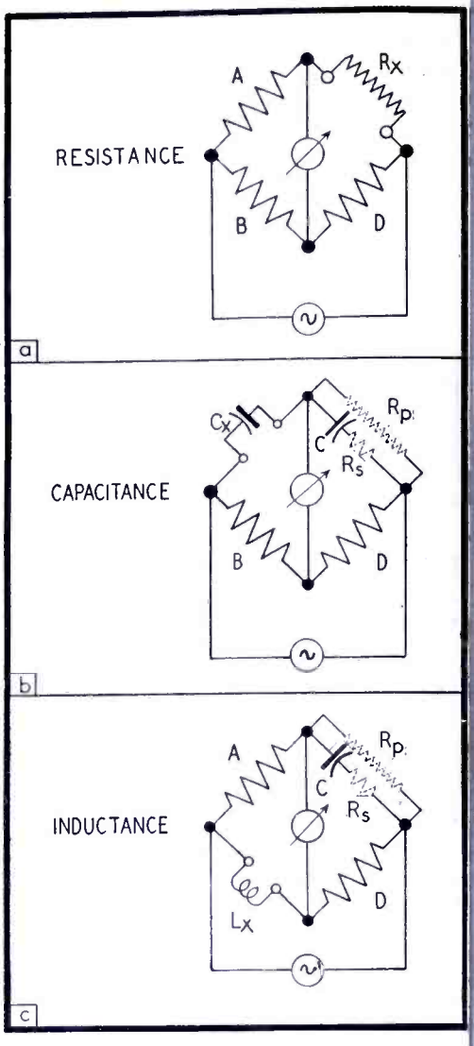


Figure 7
Closeup of the recorder control mechanism.





Figures 1 (right) and 1*a* (left)

Figure 1, basic bridge networks for measurement of resistance, capacitance and inductance. Figure 1*a*, the completed general-purpose bridge.

A GENERAL-PURPOSE IMPEDANCE BRIDGE SIMPLIFIED SWITCHING CIRCUIT

by P. M. HONNELL

Lt. Col., Signal Corps

U. S. Military Academy

THE usefulness of the general-purpose impedance bridge for routine laboratory measurements at audio frequencies is well known. Although its accuracy is generally not as high as that of specialized bridges designed for the measurement of specific circuit parameters, the compactness, versatility, and reasonable cost of the general-purpose bridge far outweighs this limitation.

The general-purpose bridge is in reality three bridges in one since it must provide networks for the measurement of resistance, capacitance, and inductance. Three basic bridge networks suitable for these measurements are shown in Figure 1. To reduce the number of component parts of the impedance bridge to a minimum, it is apparent that some means must be provided for switching between these three basic bridge circuits. Although the literature is replete with descriptions of bridge circuits, there are few references to suitable methods of achieving this end.

This paper describes a simplified circuit which does not require complicated or special switches to change from one bridge circuit to the other.

The Circuit

The complete bridge circuit is shown in Figure 2. It comprises two adjustable resistive arms A and B; an adjustable capacitive arm C; and a continuously variable resistive arm D. The variable resistances R_s and R_p are provided for balancing the loss components of capacitors and inductors under measurement. The shielded transformer isolates the output circuit electrostatically from the bridge circuit. The remaining jacks, binding posts, switches and shields ar self-explanatory. The following para graphs outline the operating procedure for specific parameter measurement with this bridge circuit.

The opinions expressed in this paper must not be construed in any way as reflecting the official views of the War Department.

Resistance Measurements

For d-c resistance measurements, th a-c/d-c switch is thrown to d-c, and a appropriate value of battery applied t the input jack of the bridge. The micro ammeter is used for indicating the d balance, the sensitivity switch being use to protect the instrument during the in itial stages of the balancing adjustment The unknown resistor is connected to th R_x binding posts; adjacent decade switc C is set on $\boxed{R_x}$; A and B arms set a suitable value (by trial, if necessary and continuously variable arm D a justed until the bridge is balanced.

For a-c resistance measurements, th battery is replaced by an oscillator of th desired frequency and 1 to 10 volts ou put; the a-c/d-c switch is thrown to a and a pair of headphones or an ampl fier with an output meter is connected

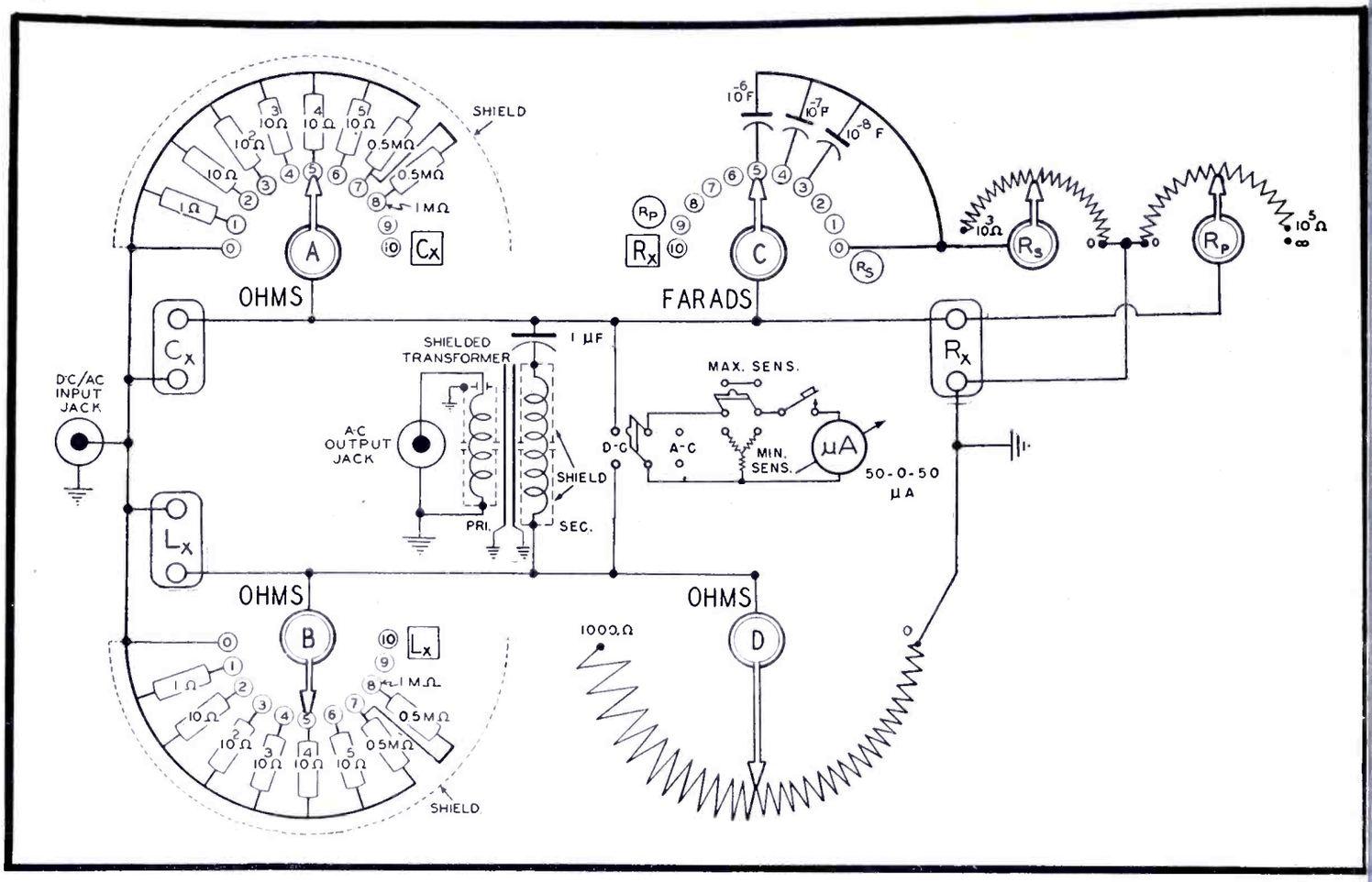


Figure 2
The simplified circuit for the general-purpose bridge.

the output jack for indication of balance. The bridge arm settings are the same as for d-c measurements.

Capacitance Measurements

For capacitance measurements, the unknown capacitor is connected to the C_x binding posts; decade switch *A* adjacent to these posts is set on C_x; decade capacitance *C* is set on 10^{-6}, 10^{-7} or 10^{-8} farads; decade *B* on a resistance value (by trial if necessary); and the continuously variable arm *D* is adjusted for balance.

The loss component of the unknown is balanced by either the variable resistor R_s (for capacitors with low losses) *or* the variable resistor R_p (for capacitors with high losses). For some conditions, either resistor may be used and a balance still obtained.

Inductance Measurements

Inductors are measured by connecting them to the L_x binding posts; setting the adjacent *B* decade switch on L_x; and using appropriate values of the *A* and *C* decades. Balance is obtained by varying the *D* arm. The coil losses are balanced by either the R_s *or* R_p variable resistors (for low-loss and high-loss coils, respectively).

Summary of Settings

Only the decade switches are required for switching between the three bridge circuits shown in Figure 1. This greatly simplifies circuit wiring, and minimizes sources of errors due to stray inductive and capacitive couplings between the bridge arms since such stray couplings are thereby kept to a low value.

A summary of the foregoing settings of the bridge arms for the various parameter measurements, together with the corresponding bridge networks appears in *Table I*. Due to the symmetrical physical arrangement of the bridge (Figure 2), reference to this summary of settings becomes unnecessary after a few typical measurements have been made, since the proper settings are learned quickly.

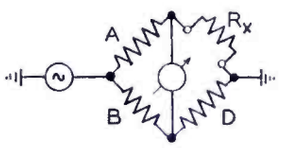
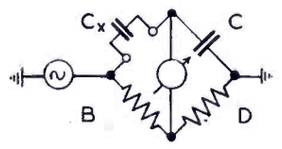
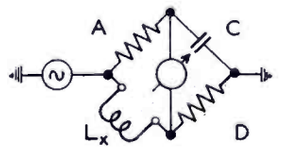
MEASUREMENT	BRIDGE ARM SETTINGS A	B	C	D	R_S	R_P	BRIDGE NETWORK
RESISTOR	OHMS	OHMS	R_x	OHMS	0	∞	
R_S	OHMS	OHMS	R_S	OHMS	OHMS	∞	
R_P	OHMS	OHMS	R_P	OHMS	0	OHMS	
CAPACITOR	C_x	OHMS	FARADS	OHMS	BALANCE FOR CAPACITOR LOSS WITH R_S OR R_P		
INDUCTOR	OHMS	L_x	FARADS	OHMS	BALANCE FOR INDUCTOR LOSS WITH R_S OR R_P		

Figure 3
Table I, with bridge arm settings for measurement of resistance, capacitance and inductance.

Numerical Results of Measurements

After the appropriate settings of the decade and variable arms have been made for null output, or balance of the bridge, substitution must be made in the proper equation of balance to obtain numerical values for the unknown parameters under test. These equations of balance are given in *Table II*, and apply to the corresponding three bridge networks which may be set up on the impedance bridge according to the method outlined in *Table I*. In many cases, this substitution in the balance equations can be completed mentally, since the *A*, *B* and *C* arms are in powers of ten, and the variable arm *D* is direct reading. (The equations in *Table II* are of course perfectly general, and apply to the corresponding bridge networks shown.)

Although the bridge is not quite direct reading in the sense that substitution in an equation is required, compensating advantages of this arrangement should not

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59	67	109	127	
60	68	112	149	

PLP		PLQ		PLS	
56	65	56	65	56	64
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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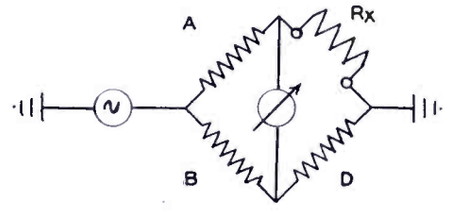
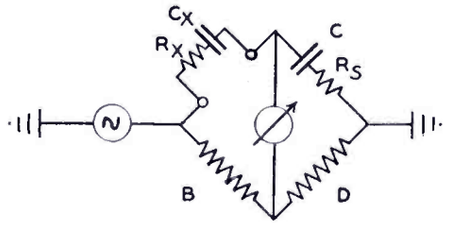
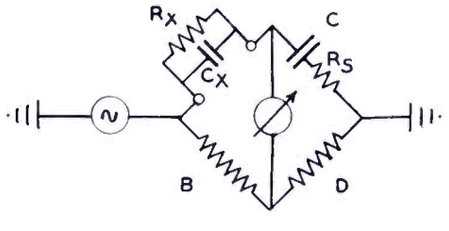
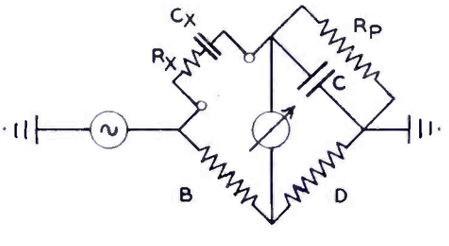
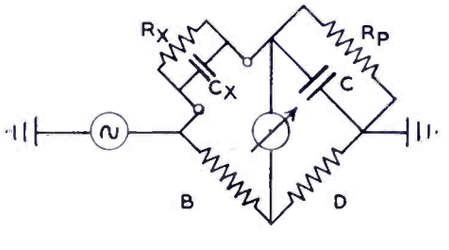
	PARAMETER	BRIDGE NETWORK	EQUATIONS OF BALANCE
(a)	RESISTOR		$R_X = \frac{A\,D}{B}$
(b)	CAPACITOR		$C_X = \frac{C\,D}{B}$ $R_X = \frac{B\,R_S}{D}$ $Q_X \equiv \frac{1}{\omega C_X R_X} = \frac{1}{\omega C R_S}$
(c)	CAPACITOR		$C_X = \frac{C\,D}{B} \cdot \frac{1}{1+(\omega C R_S)^2}$ $R_X = \frac{B\,R_S}{D} \cdot \frac{1+(\omega C R_S)^2}{(\omega C R_S)^2}$ $Q_X \equiv \omega C_X R_X = \frac{1}{\omega C R_S}$
(d)	CAPACITOR		$C_X = \frac{C\,D}{B} \cdot \frac{1+(\omega C R_P)^2}{(\omega C R_P)^2}$ $R_X = \frac{B\,R_P}{D} \cdot \frac{1}{1+(\omega C R_P)^2}$ $Q_X \equiv \frac{1}{\omega C_X R_X} = \omega C R_P$
(e)	CAPACITOR		$C_X = \frac{C\,D}{B}$ $R_X = \frac{B R_P}{D}$ $Q_X \equiv \omega C_X R_X = \omega C R_P$

Figure 4

Table II, with equations of balance for resistor and capacitor measurements.

be overlooked: Since the ratio arms are adjustable, the range of the bridge is very great, particularly as to loss balance over the frequency range of the bridge; the bridge arms may be adjusted for greatest sensitivity or ease of balance, depending upon the magnitude of the parameter under test; and finally, but not the least important, it is possible to compute both the equivalent series *and* parallel combination of inductors or capacitors under test and their loss components, thus providing great versatility to the measurements.

Equations of Balance

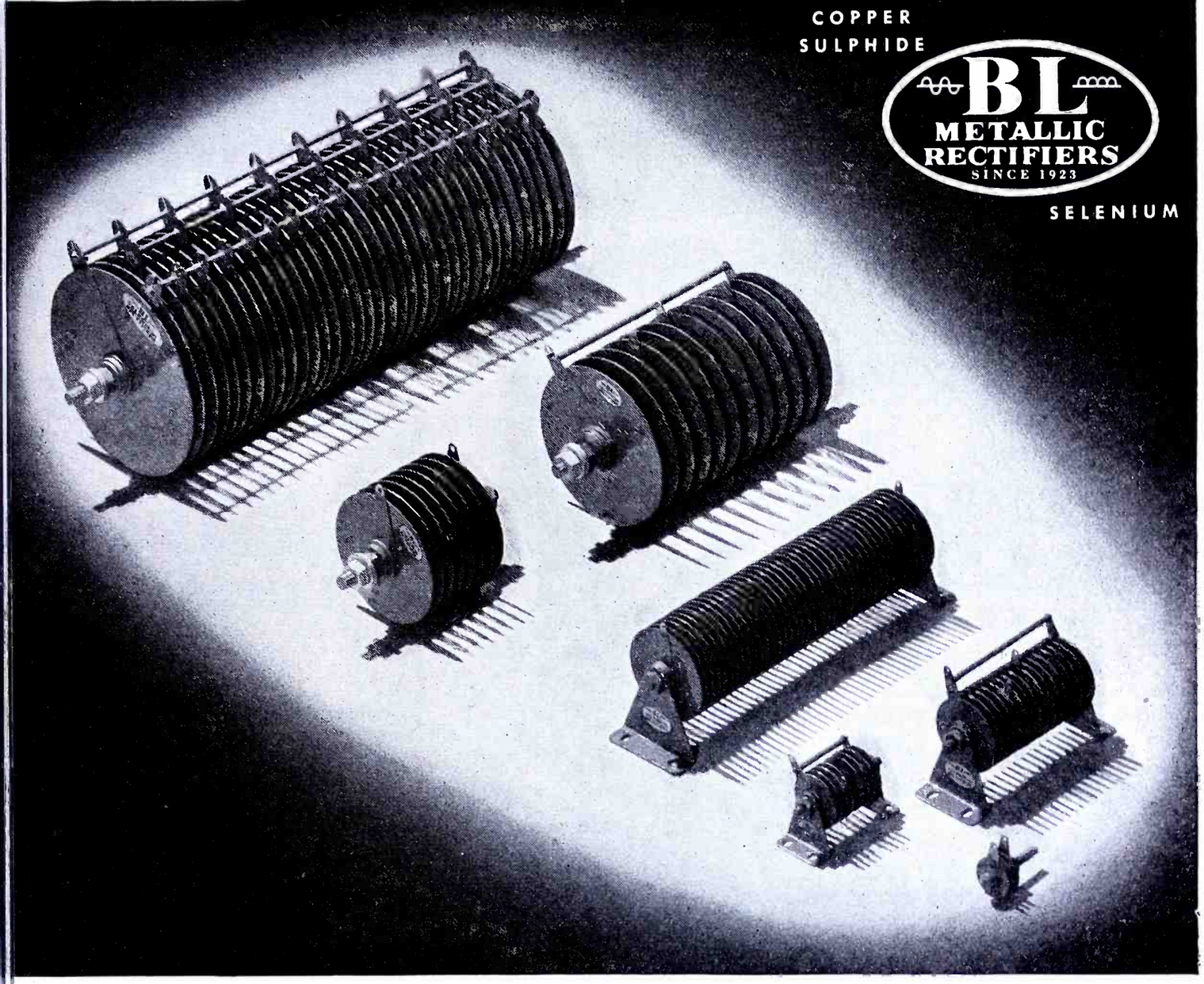
Since a capacitor with losses may be considered either as a capacitance and resistance in series, or a capacitance and resistance in parallel, and since these combinations may be balanced on the general-purpose bridge with either the resistance R_s in series (or the resistance R_p in parallel) with the bridge capacitance standard arm C there are four different combinations possible for this measurement. Thus, there are four capacitance bridge equations of balance. Likewise, there are four possible equations of balance for inductor measurements. Fortunately, there is only one resistance bridge equation, making a total of nine equations of balance. These bridge circuits and their exact equations of balance, together with the expressions for the Q_x of the parameter under measurement, are listed in *Table II* (*a*) to (*i*).

Resistance Bridge

In *Table II* (*a*), we have the *Wheatstone bridge* equation of balance for R_x that is applicable to both direct and alternating current measurement of resistance. (It is, in fact, possible to place a battery and oscillator in series to the input jack thus facilitating a quick change from d-c to a-c resistance measurements when this is desired.)

Capacitance Bridges

The *series resistance* bridge appears in (*b*) of *Table II*. Here an unknown capacitance C_x and resistance R_x in series (or a capacitor with losses represented in this manner) are balanced with the resistance R_s in series with the standard capacitance arm C. Note that the testing frequency is absent from the balance equations for C_x and R_x, although of course present in the expression for Q_x. Since R_s varies from a nominal maximum value to zero ohms, this circuit is usually most



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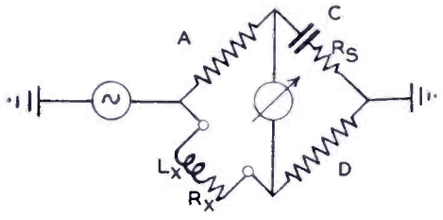
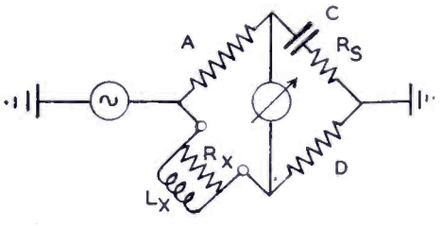
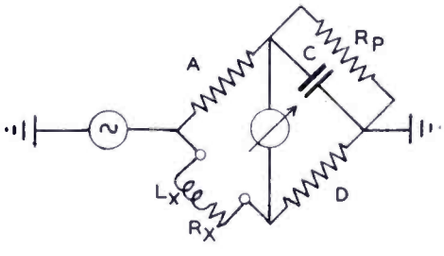
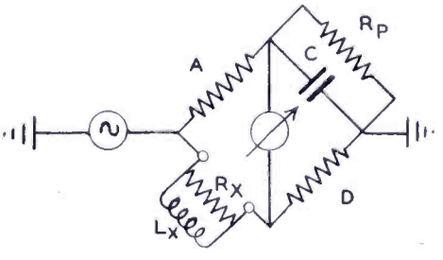
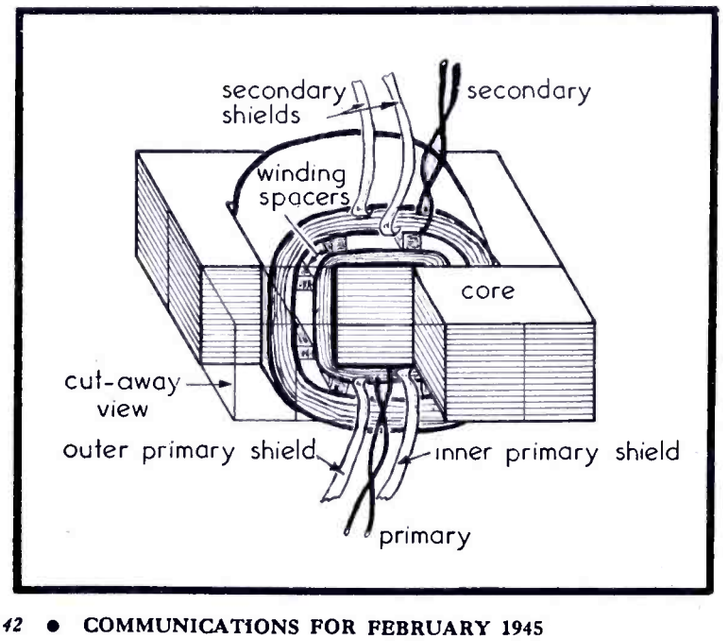
	PARAMETER	BRIDGE NETWORK	EQUATIONS OF BALANCE
(f)	INDUCTOR		$L_X = A\,C\,D\,\frac{1}{1+(\omega C R_S)^2}$ $R_X = \frac{A\,D}{R_S}\cdot\frac{(\omega C R_S)^2}{1+(\omega C R_S)^2}$ $Q_X \equiv \frac{\omega L_X}{R_X} = \frac{1}{\omega C R_S}$
(g)	INDUCTOR		$L_X = A\,C\,D$ $R_X = \frac{A\,D}{R_S}$ $Q_X \equiv \frac{R_X}{\omega L_X} = \frac{1}{\omega C R_S}$
(h)	INDUCTOR		$L_X = A\,C\,D$ $R_X = \frac{A\,D}{R_P}$ $Q_X \equiv \frac{\omega L_X}{R_X} = \omega C R_P$
(i)	INDUCTOR		$L_X = A\,C\,D\,\frac{1+(\omega C R_P)^2}{(\omega C R_P)^2}$ $R_X = \frac{A\,D}{R_P}\cdot[1+(\omega C R_P)^2]$ $Q_X \equiv \frac{R_X}{\omega L_X} = \omega C R_P$

advantageous for high Q_x measurements.

The *Wien*[1] *bridge* is given in (*c*) of *Table II*. Here an unknown capacitance C_x and resistance R_x in parallel (or a capacitor with losses represented in this manner) are balanced by the same impedance-bridge circuit as in (*b*). That is, the resistance R_s in series with the standard capacitance arm *C* provides the loss balance. Note that there are now frequency terms present in the balance equations. As in (*b*), this arrangement is most suitable for high Q_x measurements. If $Q_x > 10$, then the equation for C_x in (*b*) may be used with less than 1% error; that is, the frequency term in C_x is then inappreciable. It is, however, of importance in the equation for R_x.

In (*d*) of *Table II* we have an inversion of the *Wien bridge*, where an unknown series combination of a capacitance C_x and resistance R_x are balanced with the resistance R_p in shunt with the standard capacitance arm *C*. Frequency terms appear in the equations for balance. Since the resistance R_p is variable from a nominal maximum value to zero ohms, the circuit is best adapted to low values of Q_x, in which case the frequency term becomes important in the equation for C_x, and unimportant in R_x.

The *parallel resistance* bridge is presented in (*e*) of the *Table*. No terms involving frequency appear in the balance equations for C_x and R_x; and it is likewise most suitable for low Q_x values.



Figures 5 (above) and 6 (left)

Figure 5, Table II with equations of balance for inductor measurements with general-purpose bridge. Figure 6, the shielded bridge transformer.

Inductance Bridges

The well-known *Hay* bridge for the measurement of inductors appears in (*f*) of *Table II*. Here the unknown consists of an inductance L_x in series with a

(*Continued on page* 81)

[1]It is interesting to note that although the literature calls the circuits in (*b*) and (*c*) *series resistance* and the *Wien bridges*, respectively, the actual physical devices in both circuits may be *the same* general purpose bridge arms and unknown capacitor with losses.

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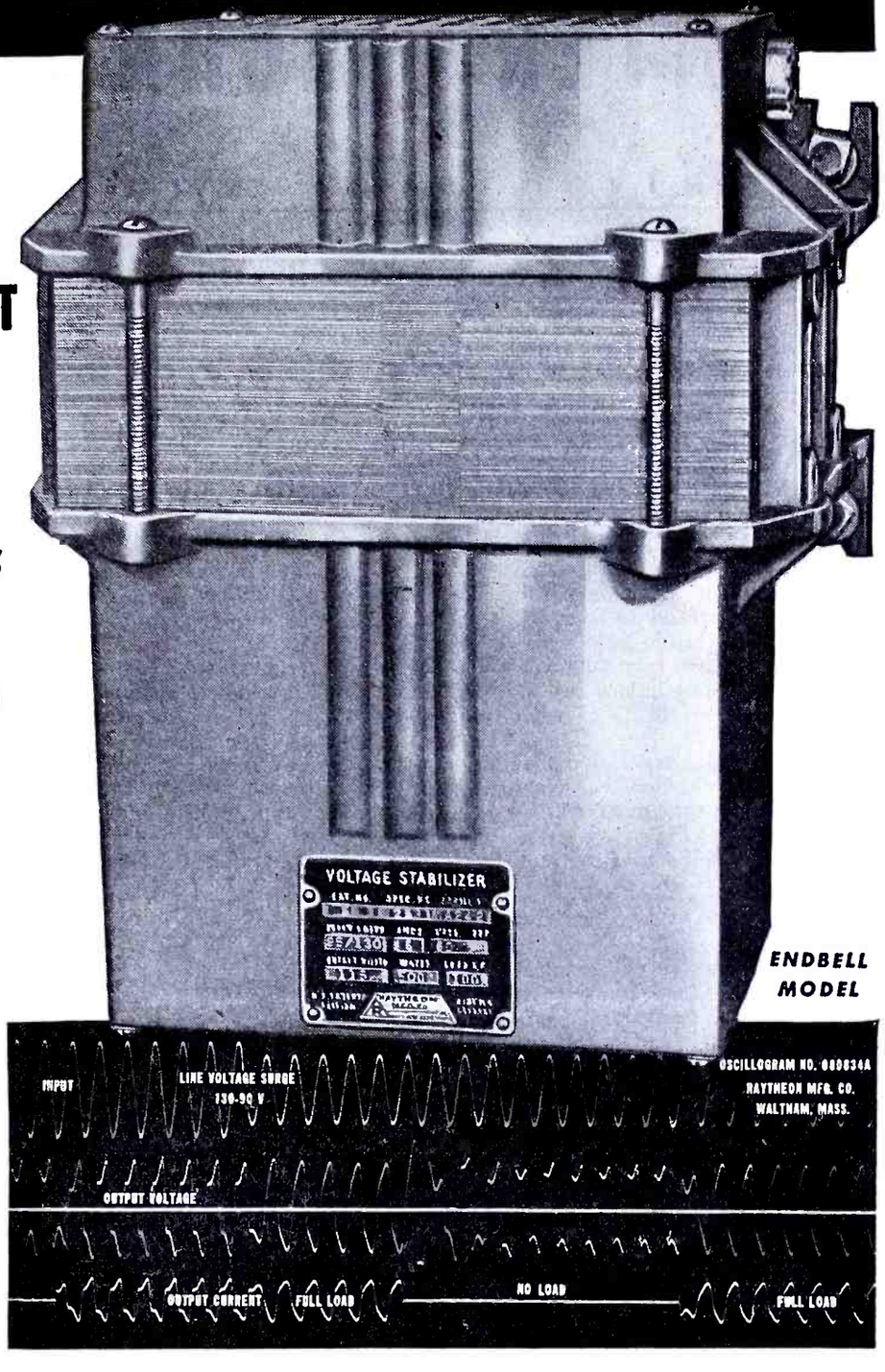

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Burrows and Decino; and Murdock

INSTRUMENT APPROACH AND LANDING SYSTEMS

by LEWIS WINNER
Editor

A REVIEW of the history of aeronautical instrument landing development and an analysis of the principal features and standards of the system which have been adopted, was offered by Lieutenant-Colonel F. L. Moseley of the Air Technical Service Command, Wright Field.

Colonel Moseley stated that instrument landing development work actually began in 1928 under the auspices of the Guggenheim fund.

He revealed that three general classes of systems have been developed . . . compass guiding station (*Hegenberger*); glide path-localizer-marker (Bureau of Standards, Bendix, Air Track, Sperry, Navy, present AAF systems, Lorenz); and talk-down methods, involving radio location of the aircraft and issuance of necessary corrective instructions to the pilot by radio communications.

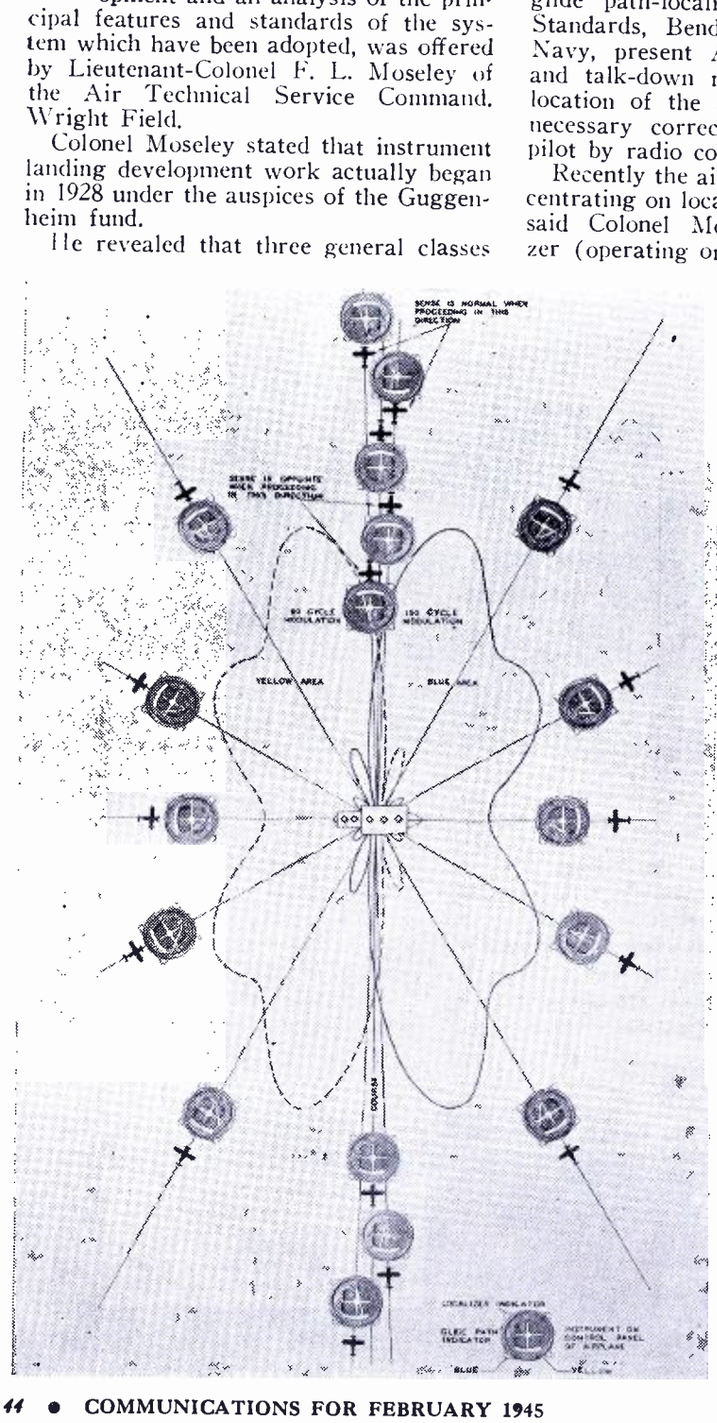
Recently the air services have been concentrating on localizer-glide path-markers, said Colonel Moseley. Here a localizer (operating on 110 mc) gives runway guidance, markers check distance fro the runway, and a straight line glide pa (operating on 300 mc) controls desce to visual contact.

Describing the localizer, Colonel Mos ley said that it divides the area arou the field into a right hand (designat blue) and a left hand (designated yellow portion, providing a sharp course li down the runway between the blue a yellow halves of the area. There are s radio-frequency channels used to perm simultaneous operation of a number facilities in congested areas.

The glide path provides a straight li of descent beginning about 20 miles fro the field, said Colonel Moseley. For th purpose, three radio-frequency channe are provided, suitably paired with the s localizer channels through a commo channel selector switch in the aircraft.

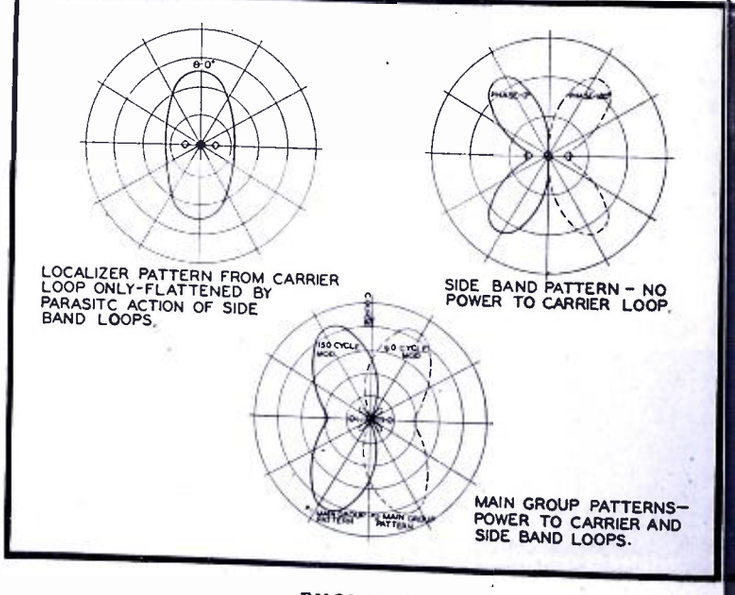
Colonel Moseley pointed out that mark ers are located at 4½ miles, one mil and at zero distance from the edge the field. He said that each mark comprises a low power 75-megacycle ton modulated transmitter emitting a to and keyed at a rate associated with i location.

A single frequency fixed-tuned receive in the plane receives the marker signal This receiver is fitted with an outpu relay connected to a marker light o the instrument panel. Colonel Mosele said that newer models of the receiver include an audio output channel providin the pilot with an audible indication



Figures 1 (left) and 2 (below)

Figure 1, fundamental radiation pattern of a localizer. On-course line is defined as a condition of equality between two patterns modulated at 90 and 150 cycles respectively. Figure 2, loop patterns. Upper left, *a*, basic circular loop pattern; right, *b*, cloverleaf pattern; and center below, *c*, final pattern, the sum of two patterns.



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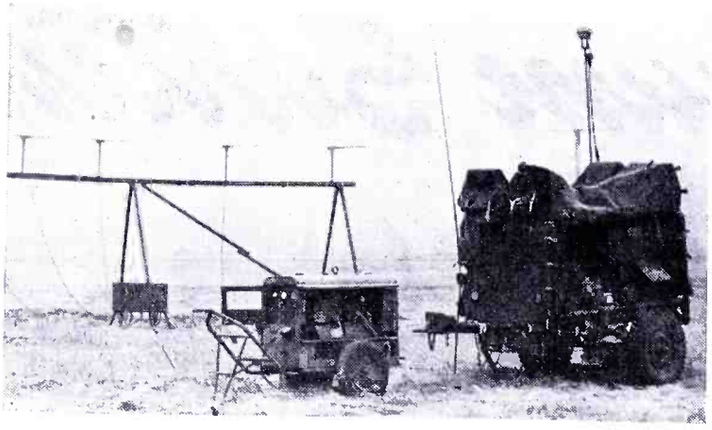
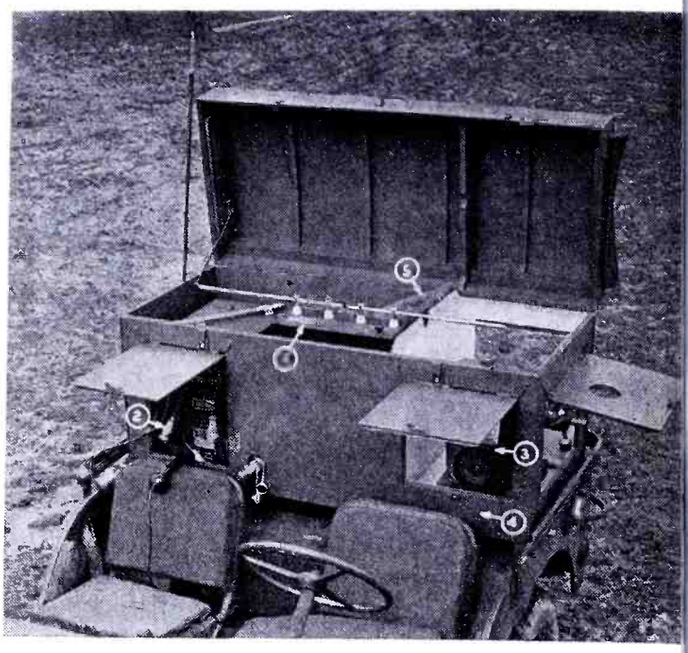




Figures 3 (above, left) and 4 (right)

Figure 3, localizer equipment that can be shipped by air. Figure 4, marker transmitter in a jeep.

his position with respect to the markers along the localizer course.

Discussing the glide-path indicator Colonel Moseley said that it has an alarm circuit which keeps the needle at full scale *fly-up* position whenever the glide-path signal is not being received. This feature, he said, prevents the pilot from flying with his needle perfectly centered on a non-existent and therefore highly dangerous path.

In Figure 1 appears the fundamental radiation pattern of the localizer. Explaining this pattern, Colonel Moseley said that the on-course line is defined by a condition of equality between two patterns modulated at 90 and 150 cycles respectively. These frequencies are separated by filtering and rectified differentially to produce a zero center type of indication.

In the localizer system, said the Colonel, an unmodulated transmitter feeds through a balanced line to an r-f bridge where the power is divided and fed to a pair of lines which form a part of a mechanical modulator system. A pair of paddle wheels are driven by a synchronous motor, he said. These alternately tune and detune circuits which are closely coupled to the pair of transmission lines and thus vary the r-f power transmitted by them. One paddle wheel carries three blades, the other, five, producing modulation frequencies of 90 and 150 cycles respectively, on the lines feeding to the output bridge, he explained. Thus each modulated line contains carrier and carrier plus and minus the modulation frequency. In addition, he said, the output bridge is connected so as to cancel out the carrier voltages on the two modulator lines, feeding the remaining sidebands to the two outer loops of the basic three-loop antenna array.

Analyzing the center loop signal, he said that the presence of the two outer loops modifies the basically circular loop pattern to the dumbell shape, as shown in Figure 2*a* (the carrier and sideband pattern).

In Figure 2*b*, we have a cloverleaf pattern produced by two outer loops, radiating sidebands only, being separated approximately 165°. In Figure 2*c*, we see the final pattern, the sum of the two patterns. Colonel Moseley said that increased pattern sharpness is obtained by the use of additional pairs of loops spaced out at the sides of the array and radiating suitably reduced amounts of sideband power.

Recently developed localizer equipment designed for transportation by air appears in Figure 3. Colonel Moseley said that when this equipment is dismantled it can be mounted in two trailers of a size suitable for shipment in cargo-type aircraft. The antenna system in this localizer uses balanced V-type dipoles backed up by parasitic V reflectors. Colonel Moseley said that the overall pattern produced by this equipment is of the two-course type with the rear course suppressed approximately eight db below the front course.

Describing the marker transmitters Colonel Moseley said that they are installed in a waterproof housing which is, mounted on the rear of a jeep, Figure 4. Here we have a small gasoline engine power supply, and a marker transmitter of approximately ½ watt provided. This unit is provided with a control switch marked *Boundary-Middle-Outer* which permits the operator to select the modulation frequency and keying rate associated with each of the marker positions, explained Colonel Moseley.

Colonel Moseley pointed out that for control and supervision, all units of the portable system are connected together and to the control tower through a group of low-power f-m receivers. These are similar to those used for cars, and can be operated off either dry batteries or a generator and battery circuit of a car.

In the localizer receiver we have six-channel crystal controlled sup heterodyne of approximately two mic volt sensitivity, said Colonel Mosel Describing the receiver, he said that includes an automatic volume cont which holds the output constant to wit 1 db over an approximate range of to 100,000 μv input. He said that t output system of this receiver is divid into two parts, one of which is a norm audio output stage feeding through volume control to headphone terminal the other output circuit comprises filte for separation of the 90- and 150-cyc course modulation frequencies. The filt outputs, he explained, are connected to pair of balanced bridge-type copper oxi rectifiers (varistors) which form a pa of a differential rectifier system. H pointed out that when the plane is the localizer course equal amounts signal modulated at 90 and 150 cycles a received; the net output from the balanc rectifier system is zero and the pilot indicator reads *on course*.

The glide-path receiver has three-cha nels and operates directly from the ai plane's 24-volt system, said Colon Moseley. A visual indicator circuit sul stantially identical to that used in th localizer receiver is provided here.

Describing the alarm system (Figure 5), Colonel Moseley said that is possib for a pilot flying the glide path to cente his plane accurately on the path and the during descent have the glide path trans mitter go off the air for some accidenta reason. Such an occurrence would no take the glide path needle off center an thus the pilot would believe that he following a safe descent path. To avoi this, the alarm system was devised. I this system some d-c is taken from a 24 volt supply and fed through the cros pointer indicator so as to drive the glid path needle to the top of the scale, sai Colonel Moseley. The alarm current i controlled by a sharp cut-off amplifie tube, he explained. And, he said, the con trol voltage for this tube is taken fror

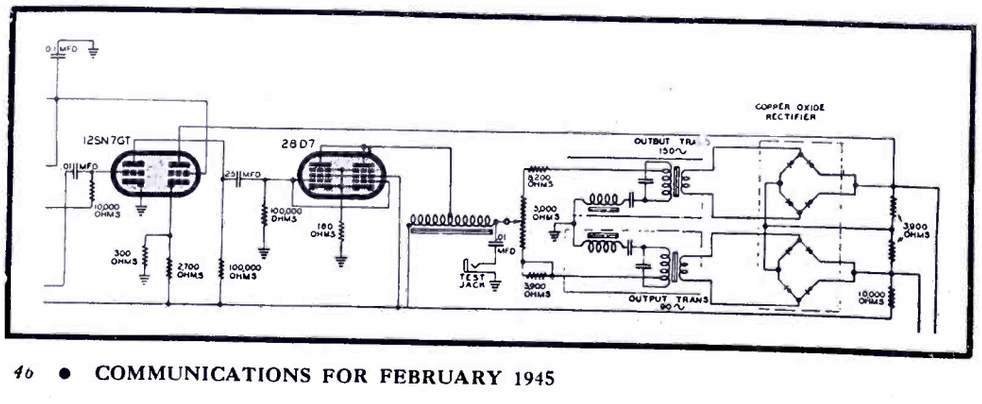
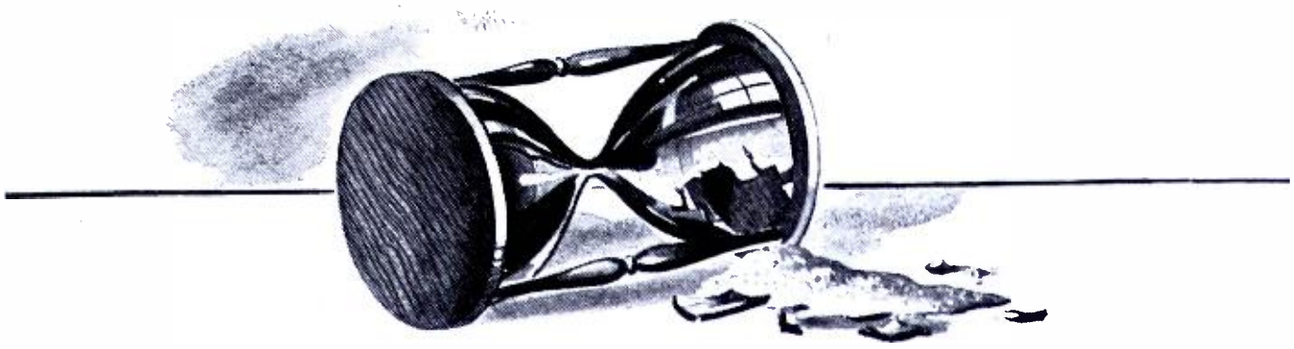


Figure 5

The alarm system circuit that alerts the glide path circuit should the transmitter go off the air

The lost minute....



Once upon a time in a war plant, there was a man whose diligence was exceeded by none. But, as the headlines became more encouraging, he became casual and, at times, negligent. It was during one of these interludes that he lost a minute. It had escaped unobtrusively, and was gone forever.

But the memory of that minute haunted him day and night . . . so constantly, in fact, that he decided to search for it, to try to reclaim it. And so, in his spare hours, he rode around the world upon a cloud fashioned of thoughts. He tried to trace Time's path through all the countries on the face of the globe.

That was how he happened to be with the Allied assault forces that landed at H-Hour, D-Day on one of the South Pacific islands. He saw how men fighting desperately for a beachhead make each minute count.

That was how he happened to be in an American Field Hospital on the German front when the momentary action of a surgeon saved the life of a GI.

That was how he happened to be in an English village when a buzz-bomb instantly demolished a home.

That was how he happened to see new men born and old men die—all in just one short minute.

After seeing the grotesque, the wonderful, the prosaic things that happen all over the world in one minute—the minute which might have been the one he lost—this man made a resolution.

He resolved that if one minute could be so important to so many people he would fill each of his minutes with sixty seconds, of work—work to help end the war sooner. Never, until peace-time, he vowed, would he again indulge in the luxury of wasting time. . . .

During this war, all of us have lost essential time . . . but not all of us have been as deeply impressed by our loss. Let us call a halt to waste . . . now! Let us stay on the job—geared to an all-out war-time schedule. Let us support all home front activities. Let us give unselfishly of our time, our energy and our money until the world is wrapped in the security of permanent peace.

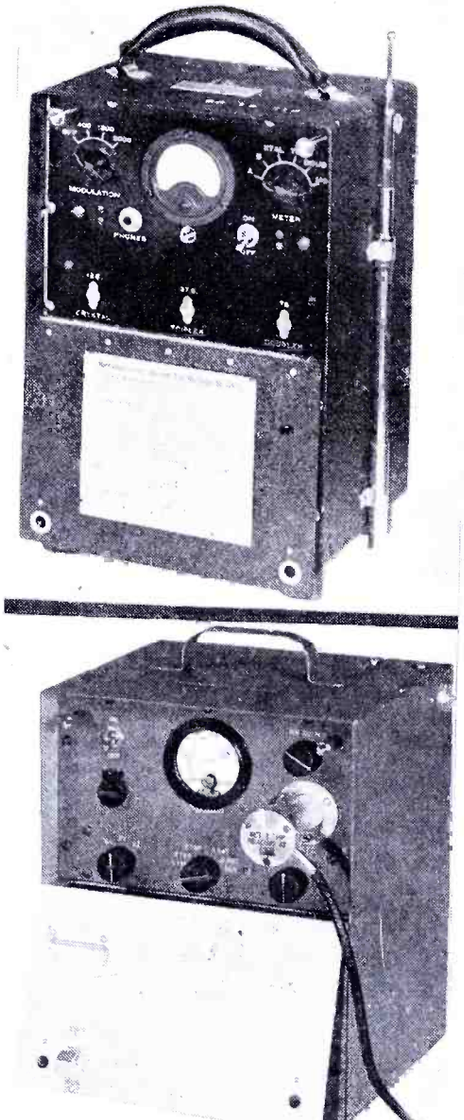


Figure 6
Assortment of test equipment used to service and maintain instrument landing equipment.

the avc line. The circuit is so adjusted during production that the alarm will indicate failure when the receiver input drops below approximately 50 μv.

Several units of test equipment have been designed to service and maintain the instrument landing equipment. Some of these are shown in Figure 6. The test equipment includes a battery powered buzzer type test set which emits a 90 and 150-cycle modulated radio-frequency signal for flight line checking of the complete airborne system.

Colonel Moseley said that a crystal controlled portable oscillator also has been provided for sensitivity measurement of the installed glide-path receiver to check for correctness of alarm indicator setting.

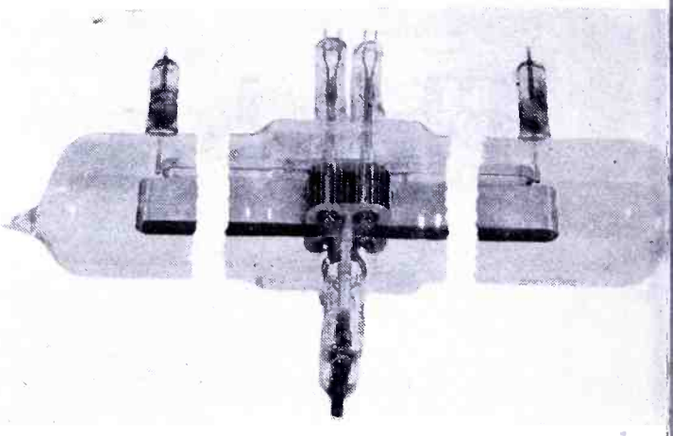


Figure 7
The push-pull-triode transmitter tube described by J. E. Gorham of the Signal Corps Ground Agency, Asbury Park, N. J.

SELF CONTAINED TRIODE TRANSMITTER

AN unusual tube, used as a push-pull triode transmitter for 200 to 700 mc, was described by J. E. Gorham of the Signal Corps Ground Signal Agency, Asbury Park. Major H. A. Zahl and G. F. Rouse of the same agency were co-authors of the paper.

In Figure 7 appears a general view of the tube. The two vertical parallel rods at the top of the tube form a balanced line output circuit which is coupled directly to the plate circuit. The points at which the rods are attached to the loop are points of moderately high r-f impedance when the tube is oscillating. The parallel transmission line thus serves in a rough way as a stepdown transformer and simultaneously makes the point at which the external output is attached, a point of reduced r-f voltage and a point of reduced impedance. Mr. Gorham said that the first property is of considerable value in reducing the tendency towards r-f corona at the junction point where there may be an appreciable discontinuity. The second property, he said, is of value in designing a matching circuit to connect the tube to a 50-ohm concentric line, such as is often used to transmit power in this frequency band.

The uppermost loop is the plate loop, and is connected directly to the anodes in such a way as to simultaneously reduce the problem of connecting the oscillating circuit to the plates, and by virtue of the flat surface of the loop, increase the effective radiating surface and power dissipation of the plates. The plate loop, made up of two U sections, serves to maintain the symmetry of the circuit, and of course each of the two U sections in effect resonates with half of the interelement capacities. Thus, explained Mr. Gorham, for a given half loop length and set of interelement capacities the tube may be made to oscillate at a higher frequency than if only one half loop was used.

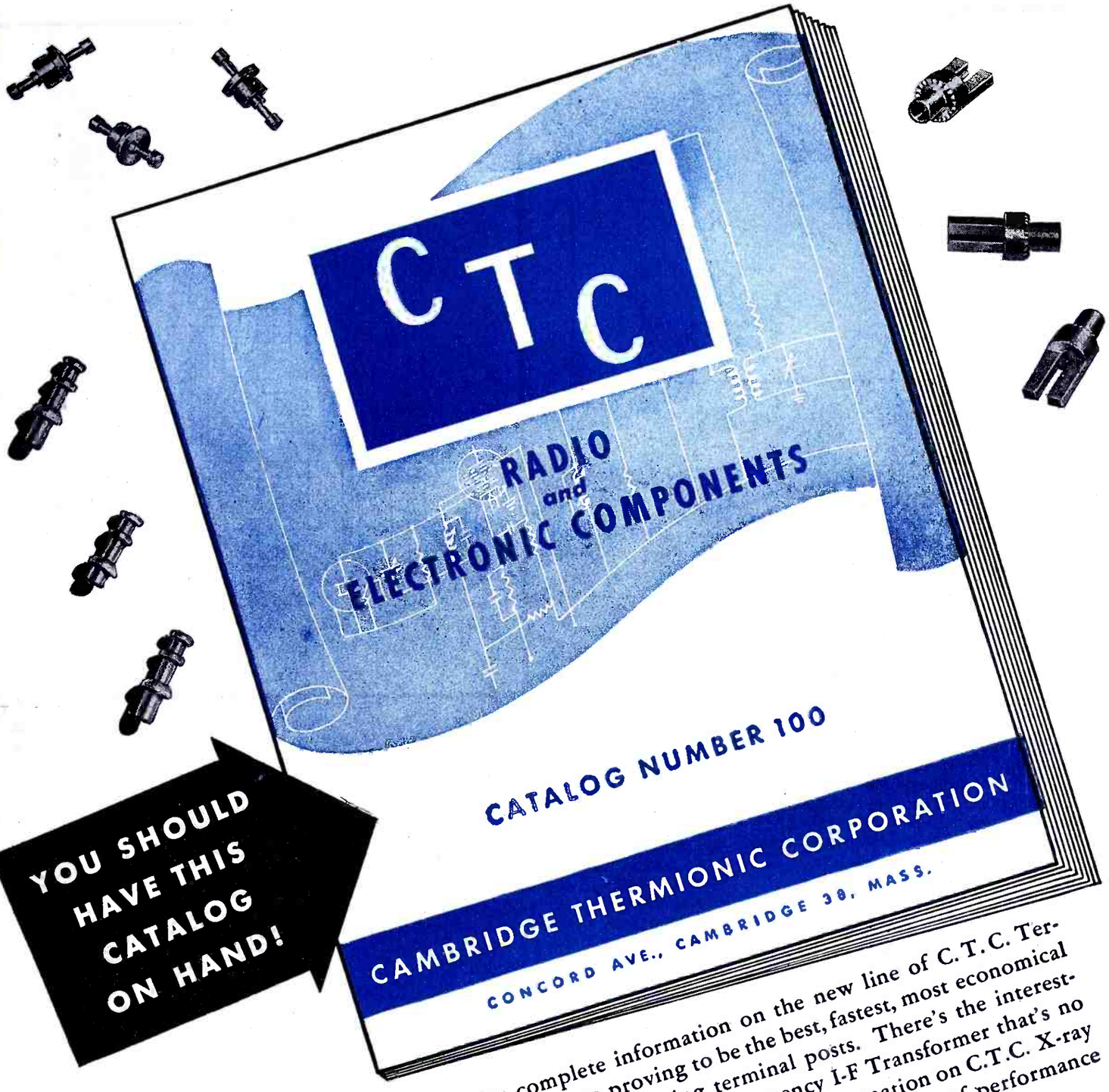
The lower loop is the grid loop. Its primary purpose is to obtain grid driving power from the plate circuit. It has been found that relatively little of the power dissipated in the grid cages is conducted along the grid wires to the external loop, and therefore, it can have less radiating surface than the plate loop. Mr. Gorham said that in normal operation the anodes are run at a red heat, and the filaments are run at a somewhat higher temperature than is usually used. This results in having the grid cages located between two very hot elemen They are therefore very sensitive to g contamination and subsequent blocki during oscillation. Under such conditic when plain tantalum wire is used in t cages the tube becomes sufficiently co taminated to be inoperative in about hours, declared Mr. Gorham. This d ficulty was overcome by the use of Eim "X" grid cages, revealed Mr. Gorham.

Analyzing the oscillator, Mr. Gorha said that if the oscillator is used witho a shield, about 80% of the power outp obtainable with a shield is realized. general, he said, the shielding fou most successful consists of a rectangul metal box with a central transverse she which serves to hold the tube. It is al necessary to separate the cavity contai ing the filament line from the cavi containing the tube and output circu This latter cavity has been designed act as an r-f choke at the end of t concentric line, and thus accomplish t transition from the balanced output the tube to unbalanced concentric tran mission line. Mr. Gorham stated that t filament line cavity serves primarily contain the radiation, but its shape al determines the distribution of standin waves at the point where the filamer pins are sealed through the glass envelop

Mr. Gorham said that although t optimum output is obtained at a definit frequency determined by the geometry the elements inside the envelope, the have observed that the filament line ma be used to shift the operating frequenc over a bandwidth of 30 megacycles be tween half power points. Mr. Gorham in dicated that this feature is of considerabl importance in allowing some tolerano in manufacturing, and in adapting th tube to several different types of r-f cir cuits.

EXALTED-CARRIER A-M AND P-M RECEPTION

METHODS of eliminating harmoni distortion due to carrier fading i amplitude- and phase-modulate reception were offered in a paper by Mur ray G. Crosby, consulting engineer. Mr Crosby said that distortion is eliminate by filtering the carrier and recombinin it with the signal at a raised or exalte level, or by recombining in a type o detector which inherently eliminates th carrier-fading distortion. He pointed ou that this fading is common in medium frequency broadcasting at the regio where the sky wave and ground wav are approximately of equal strength a night, from 50 to 150 miles from the transmitter. And in h-f transmission where the ionosphere is depended upo



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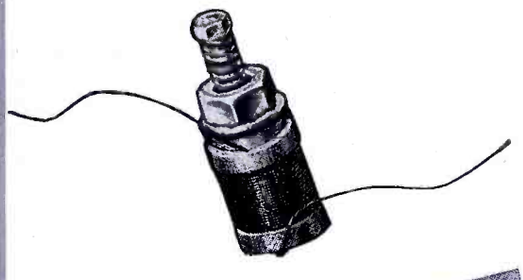

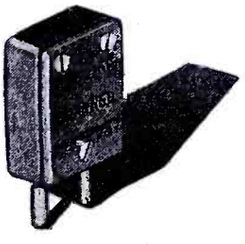

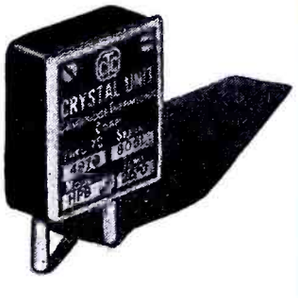

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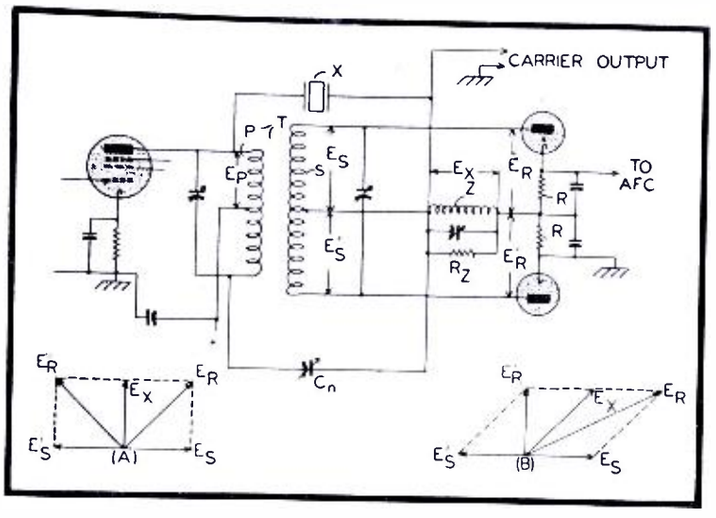

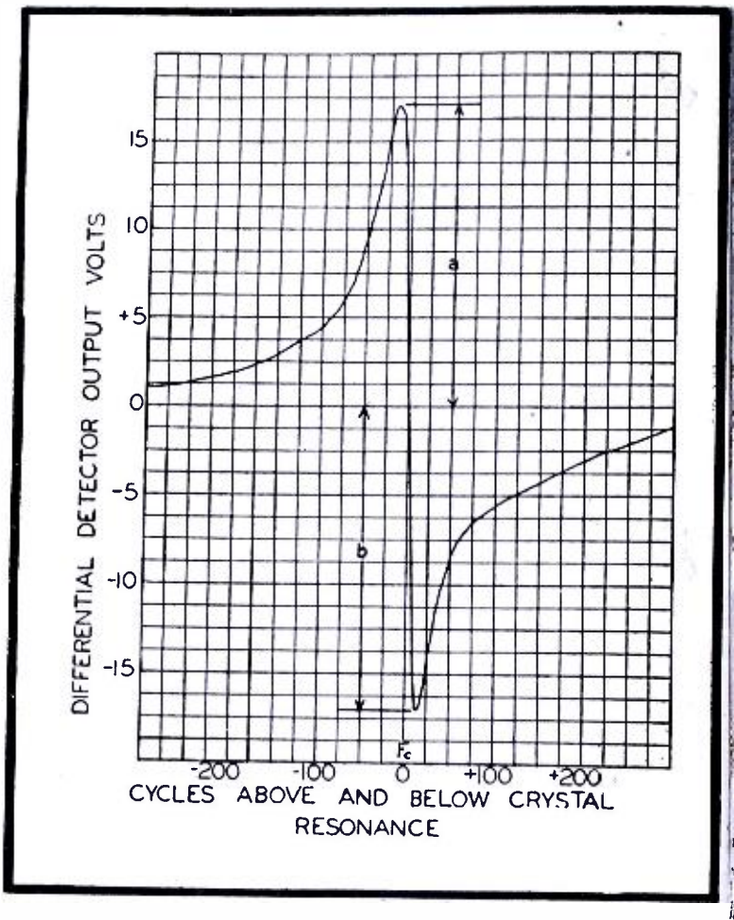

Figures 8 (left, above) and 9 (right)
Figure 8, carrier filter and automatic-frequency-control discriminator circuit, described by Murray Crosby. Figure 9, automatic-frequency-control detector output characteristics.

for transmission, he said that carrier fading is practically always present.

In an exalted-carrier receiver, we have a conventional double-superheterodyne receiver. The i-f output of this receiver is divided into two branches. One of these branches feeds a recombining detector fed from the second i-f, while the other branch feeds a carrier filter and an afc discriminator which seperates the carrier from the side bands. The filtered carrier is fed to a carrier limiter which maintains the carrier amplitude at a constant value. Then, explained Mr. Crosby, the filtered and limited carrier is recombined with the unfiltered signal at a phase determined by a phase adjuster. The resulting combined signal is detected by detectors and fed to an a-f amplifier.

The afc discriminator uses the same crystal filter for both the carrier filter and the frequency discriminator, said Mr. Crosby. Thus, he explained, careful synchronization isn't necessary, for we do not have separate crystal filters or other separate afc circuits.

A form of the carrier filter and afc discriminator circuit is shown in Figure 8. A crystal filter of the type commonly used in communications-type receivers serves as the carrier filter, said Mr. Crosby. Carrier filter output is also combined with the unfiltered energy in proper phase so as to form a sharp frequency discriminator similar to the phase-shift type of discriminator used in frequency-modulation reception, he explained. The crystal X is fed by the mid-tapped primary P which also furnishes opposite-phase voltage to condenser C_n for neutralizing the electrode capacity of the crystal holder. The output of the carrier filter, explained Mr. Crosby, appears across tuned circuit Z which is normally tuned to the crystal frequency. This output is tapped at this point to provide pure carrier for recombination with the signal, he stated.

How the crystal output combines with the secondary voltages from transformer T, is shown in A of Figure 8. Mr. Crosby said that the primary voltage E_p, is not shifted in phase by the crystal filter since the crystal is operated at series resonance and Z is tuned to resonance. Hence, he said, the phase of E_x is the same as that of E_p; the secondary voltage of E_s and E_s', are shifted to 90° with respect to the primary voltage, by the phase shift inherent in tuned-transformer T.

Continuing this analysis, Mr. Crosby said: "For the in-tune condition shown in A, the resultant voltages E_r and E_r' are equal in amplitude at the detector inputs. The voltage rectified by the diodes and appearing on the differentially-connected diode resistors R and R' will therefore balance so that the automatic-frequency-control output potential is zero. When the carrier frequency is out of tune with the crystal, the phase of the crystal output is shifted so that vector B is produced. For this condition, the resultant voltages fed to the differential detectors are out of balance so that a difference voltage appears across the diode resistors. This voltage is positive or negative depending upon the direction of the frequency shift. The result is a frequency discriminator as shown in Figure 9, which has its mid point at the filtered carrier frequency, F_c, and has a sensitivity in accordance with the selectivity of the crystal filter." (Figure 9 is an actual characteristic taken on an experimental exalted-carrier receiver.)

Mr. Crosby said that the primary object to be accomplished by the recombination and detection of the filtered carrier and unfiltered signal is that of eliminating the distortion brought about by overmodulation that results from carrier fading. Feeding the carrier to a single diode detector with the amplitude of the carrier exalted with respect to the unfiltered signal, is one method of affecting the result, he said. He pointed out that this reduces the effective percentage of modulation fed to the detector so that the carrier may fade to a greater depth before overmodulation occurs. In other types of detectors, he said, the distortion products are either balanced out or are not generated.

In Figure 10, we have a circuit for combining the filtered carrier and unfiltered signal for detection on a single diode. Tube A may function as either a carrier amplifier or limiter, but it will be assumed to be an amplifier for this discussion.

Mr. Crosby said that for phase modulation detection with the single diode, the only change required is a shift in the phase of combination between the unfiltered carrier and the filtered carrier. The phase difference is switched from the zero-degree relation proper for amplitude-modulation detection to a 90° or 270° phase difference.

A circuit for balanced diode detection appears in Figure 11. Here diodes C and D have their outputs connected differentially so that their outputs cancel if the

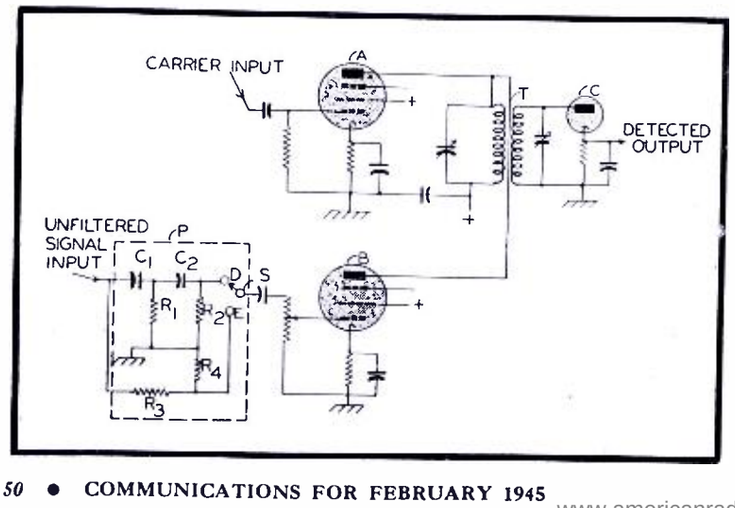

Figure 10
Single diode detector circuit analyzed by Mr. Crosby.

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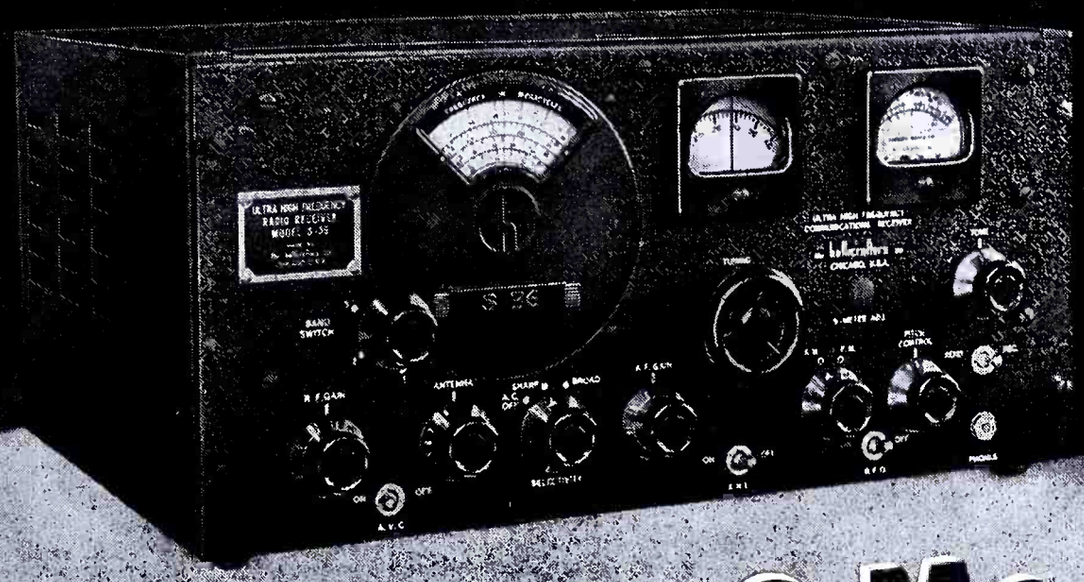

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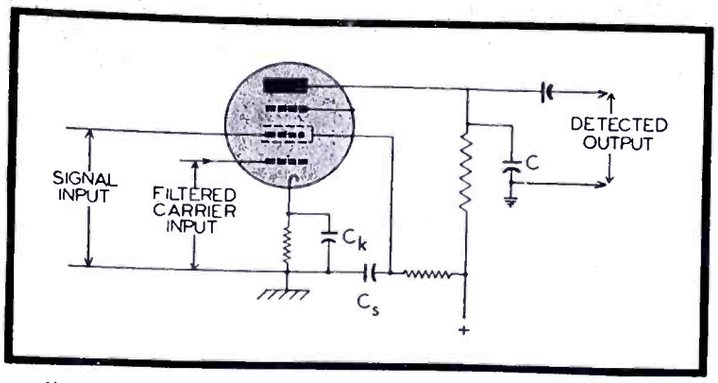
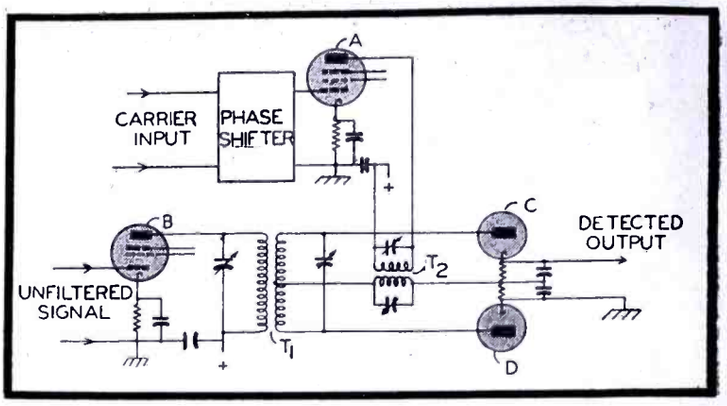




Figures 11 (right) and 12 (left)
Figure 11, balanced diode detector circuit. Figure 12, multi-grid detector system.

amplitude envelopes on their input waves are in phase. Accordingly, said Mr. Crosby, if input is present from either the carrier channel or the unfiltered-signal channel alone, there is no output except that due to unbalance.

Mr. Crosby explained that balanced-diode detection has its greatest advantage in phase-modulation reception; the balanced circuit cancels second harmonic distortion that is introduced when the carrier fades. Thus, he said a greater degree of carrier fading for a given degree of carrier exaltation, can be tolerated.

Discussing selectivity, Mr. Crosby said that the use of exalted-carrier detection produces the equivalent of an increase in the selectivity of the receiver.

The improvement in adjacent-channel selectivity for diode detection is equal to $4X^2$ where X is the degree of carrier exaltation, he said. This selectivity improvement however, he explained, is only effective on the modulation component of the undesired signal.

With multi-grid detection, the output is proportional to the product of the two signals on the grids, explained Mr. Crosby.

To obtain a figure of merit describing the improvement effected by the carrier exaltation, Mr. Crosby made some observations wherein the number of faults marring program reception were counted to determine the relative number of faults per minute; a fault was counted each time some sort of fading distortion occurred which would be classified as undesirable. International broadcast signals in the 15, 11, and 9 megacycle bands were used. The results appear in the table below:

Antenna	*Unexalted faults/min.*	*Exalted faults/min.*	*Unexalted faults/min. / Exalted faults/min.*
A.....	3.35	1.17	2.86
B.....	2.29	0.71	4.2
A and B Diversity..	2.2	0.43	5.1

Mr. Crosby explained that the application of exalted-carrier detection increases the receiver output volume variations that normally accompany selective fading. He said that when the carrier fades the avc system, which is actuated by the carrier energy, operates to increase the gain of the receiver and thereby raises the level of the sidebands fed to the detector. This, he explained, produces an abnormally high percentage of modulation at the detector input so that the output volume is higher than normal. The usual result is a burst of volume in the receiver output. Such an effect is present with unexalted-carrier detection, Mr. Crosby pointed out, but the volume burst is usually a burst consisting of the type of distorted output which is produced when the carrier fades.

He said that volume bursts can be removed by the application of audio volume-limiting techniques used on the program level fed to broadcast transmitters.

REFLEX OSCILLATORS

A QUALITATIVE analysis of some of the properties of reflex oscillators was offered by J. R. Pierce of Bell Telephone Laboratories.

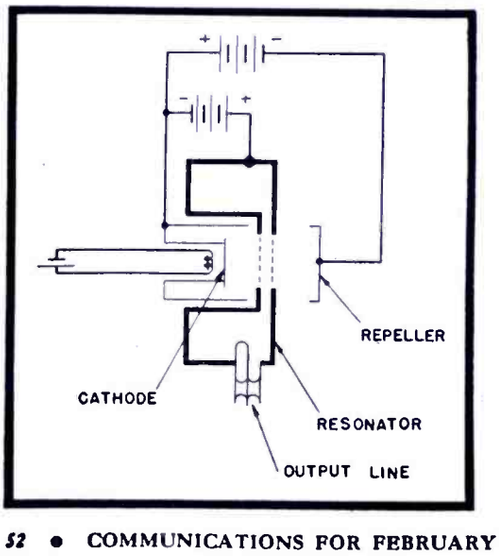
Mr. Pierce stated that a reflex oscillator is a form of a h-f long transit time tube which has distinct advantages as a low power source. It may be light in weight, need have no magnetic focusing field, and may be made to operate at comparatively low voltages, he explained. It may serve as a beating oscillator in double-detection receivers or a frequency-modulated oscillator in low power transmitters. While its efficiency is not too great, explained Mr. Pierce, this need not be a handicap in some applications.

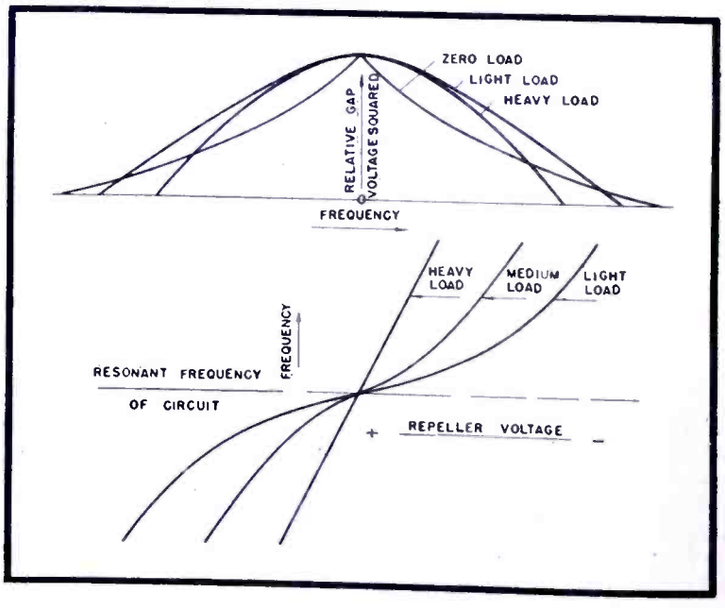
In Figure 13, we have a reflex oscillator. In operation, an electron stream from the cathode passes through the longitudinal radio-frequency field in the *gap* between two grids, where the stream is *velocity modulated*, then into a retarding field produced by a *repeller* electrode where the beam becomes *bunched*. The bunched stream returns across the gap, exciting the resonant circuit or *resonator*.

Mr. Pierce stated that reflex oscillators exhibit electronic tuning. That is, the frequency of oscillation can be changed by a substantial amount, usually several tens of megacycles, by varying the voltage of the repeller electrode. He explained that for moderate loads the total electronic tuning frequency range between half power and half power is not much affected by loading; for very heavy loads it is decreased. The rate of change of frequency with voltage is faster the heavier the load. Figure 14 shows some theoretical curves of relative power versus frequency and of frequency versus repeller voltage. Mr. Pierce said that measured curves are very similar in shape. He pointed out, too, that frequency may also be affected by resonator voltage.

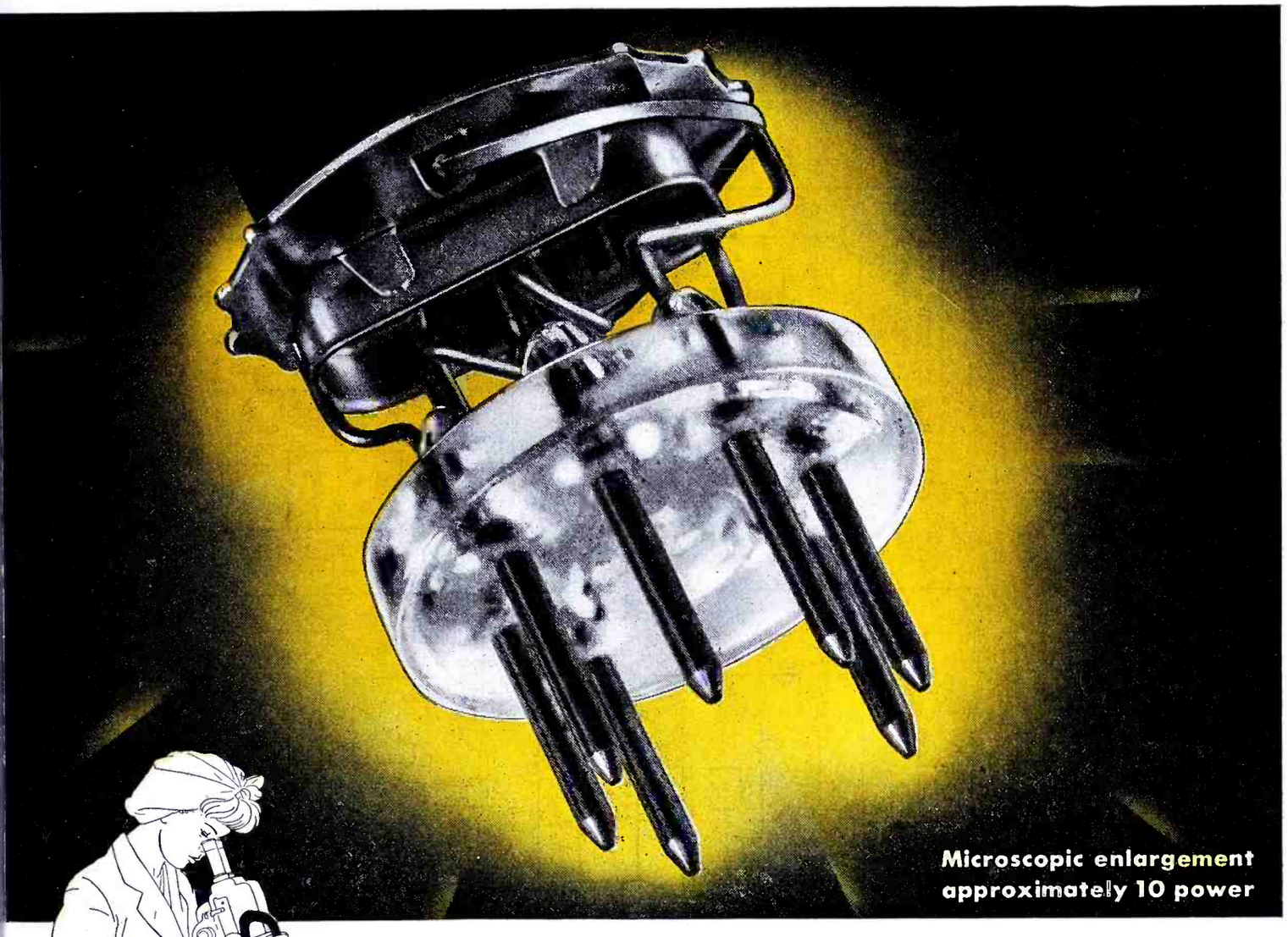
Mr. Pierce stated that since frequency of oscillation may be influenced by the load coupled to an oscillator, a reactive load coupled to the resonant circuit changes the resonant frequency of that circuit and hence the frequency of oscillation.

In reflex oscillators, we have another sort of frequency change with load. The frequency versus repeller voltage diagrams of Figure 14 explain this point. To





Figures 13 (left) and 14 (right)
Figure 13, a modern reflex oscillator. Figure 14, theoretical curves of relative power versus frequency and of frequency versus repeller voltage.



Science on the Production Line

Commonly you think of the microscope as a scientific laboratory instrument. But at National Union, these days, you will find it even more extensively used, as a *production* machine, insuring microscopic precision step by step through many processes of manufacture.

With the aid of microscopes, National Union workers accurately check almost invisibly small parts. They *see* to it that welds are sound, clearances are exact and the structure is mechanically perfect. In the photograph above for example, a N. U. 6AG5 miniature tube mount, no higher than your thumb nail is enlarged approximately 10 times, to permit minute examination of important structural factors. Enlargements up to 500 times—making a hair on your head look as tall as a tree—are just as readily obtained, when needed. Moreover, this tube, assembled from 31 individual parts, must pass 40 individual inspections, in addition to thorough examination under the microscope.

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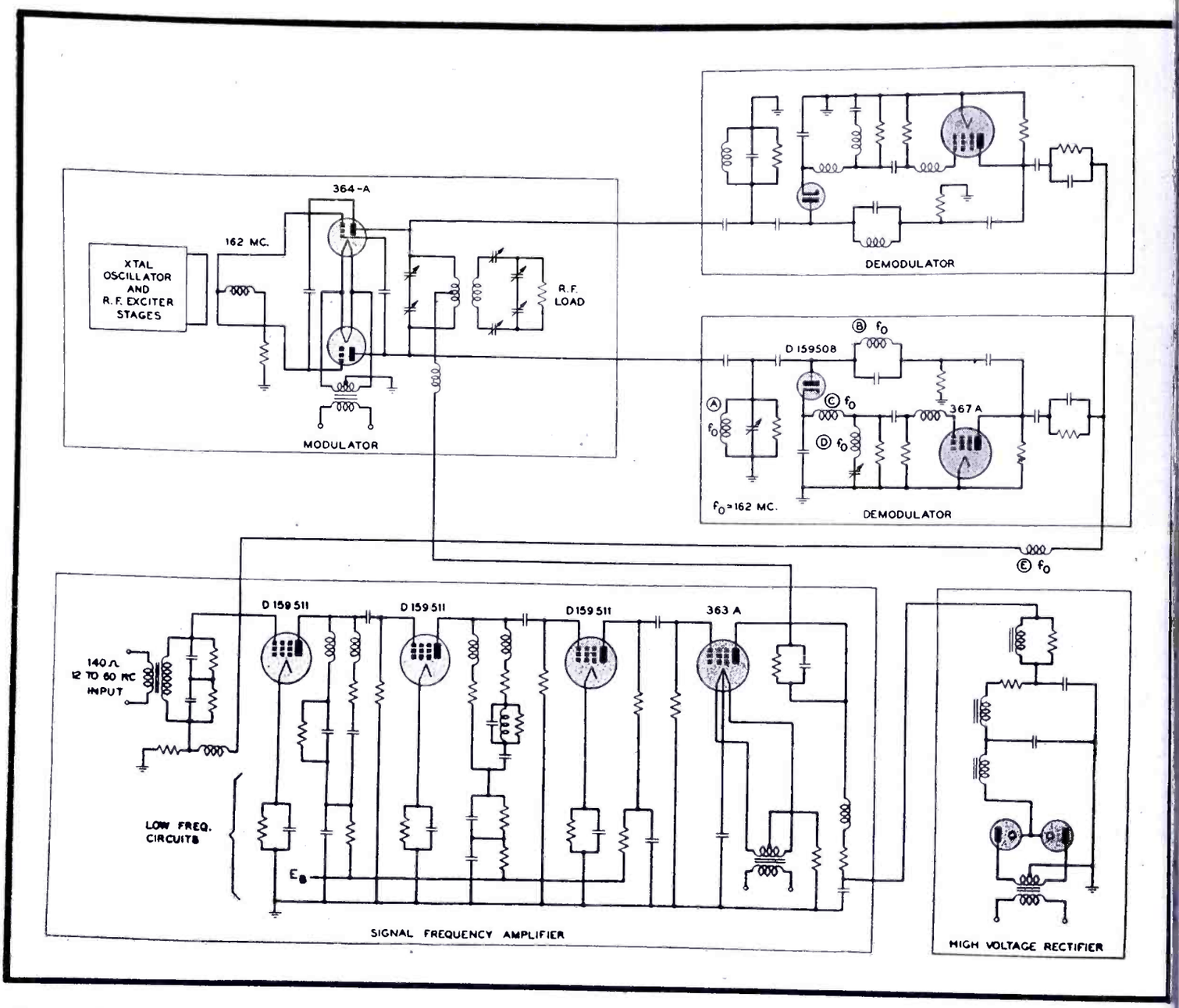


illustrate let us imagine that the oscillator is operating off circuit resonance by means of electronic tuning, stated Mr. Pierce. (Such operation is represented by a point away from the common intersection of the frequency versus repeller voltage curves.) Thus it may be seen, he said, that if the repeller voltage is kept constant and if the circuit conductance is changed, that is, the load is changed in purely resistive sense, not changing the resonant frequency of the resonant circuit, the frequency of oscillation will change in shifting to a new frequency versus repeller voltage curve.

Mr. Pierce also explained that the nature of the load is important as well as its impedance at a given frequency. For instance, he said, coupling a reflex oscillator tightly to a high Q resonant circuit makes the variation of frequency with repeller voltage less rapid and may result in other undesirable effects.

•

MULTIPLEX SYSTEMS

THE requirements of an u-h-f multiplex system and how they were met by employing a sufficient amount of envelope feedback, were discussed by Charles R. Burrows of Bell Telephone Labs and Alfred Decino, formerly of the Labs.

•

Figure 15
Schematic of a multiplex transmitter discussed by Charles R. Burrows of Bell Telephone Laboratories.

•

Three types of distortion were analyzed. These were:

(*1*)—Non-linear distortion resulting from deviations of the overall input-output amplitude characteristic from a straight line.

(*2*)—Distortion resulting from deviations of the gain-frequency characteristic from symmetry and the phase-frequency characteristic from skew-symmetry.

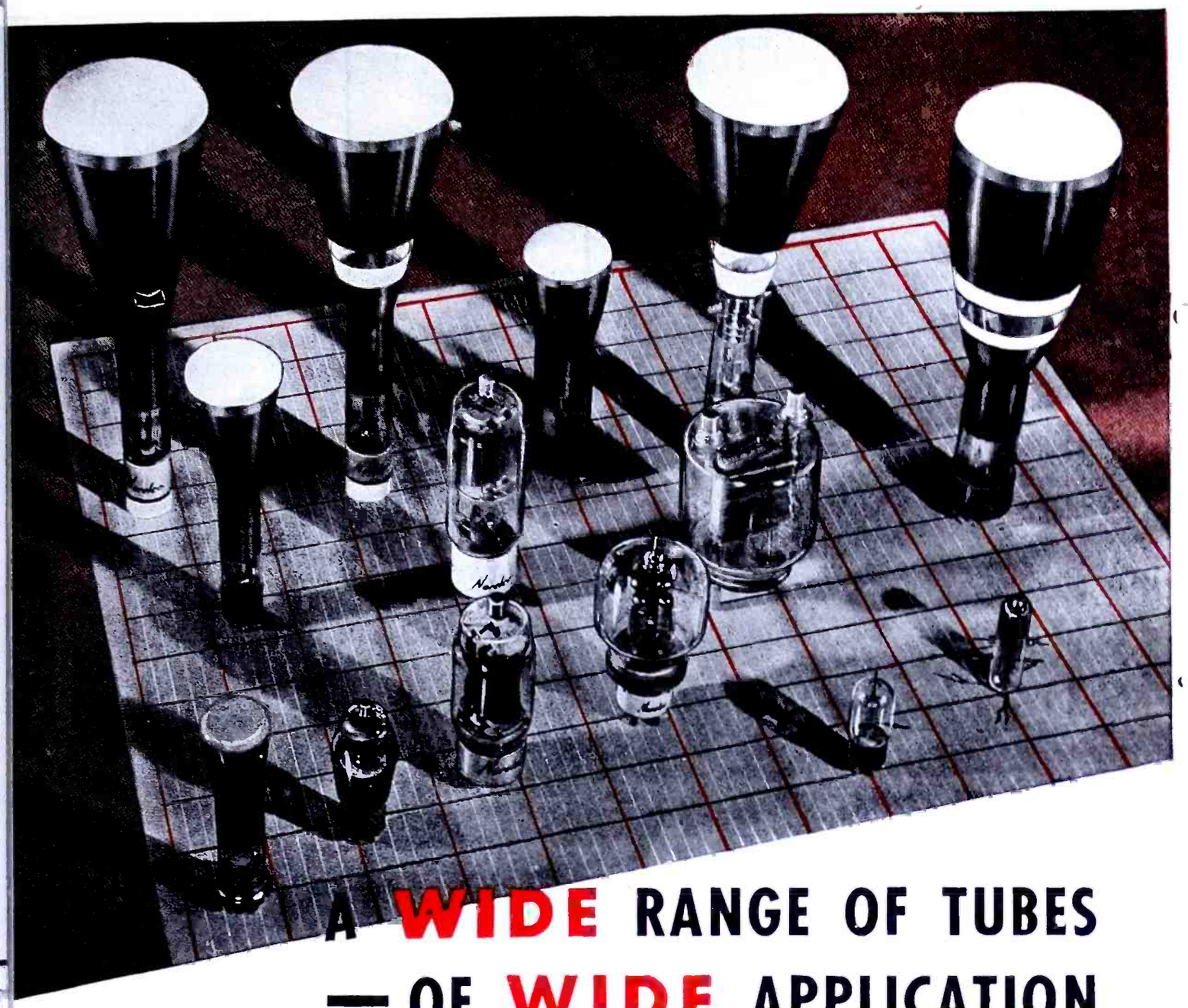
(*3*)—Generation and detection of parasitic phase modulation.

The schematic of a transmitter that meets these requirements appears in Figure 15. R-f drive is obtained from a crystal-controlled oscillator and a harmonic generator chain. This is applied to the grids of a bridge-neutralized push-pull modulated power amplifier. There are 12-speech channels in the type K frequency range from 12 to 60 kc. These, said Mr. Burrows, are applied to the input of the signal frequency amplifier. The output of this amplifier is used to plate-modulate the bridge-neutralized r-f power amplifier. Part of the modulated output of this amplifier is picked up, demodulated, and fed back to the input of the signal frequency amplifier.

Since the demodulator is in the B circuit any distortion produced by it appears in the output of the transmitter. This is reduced to a satisfactory value by applying local feedback to the diode demodulator.

The main feedback amplifier based on Bode's design, appears in Figure 16. Here a fixed gain margin is provided at frequencies from f_1 to f_2 at which the phase is unfavorable and singing would result if the gain were greater than unity. A fixed phase margin is provided at frequencies for which the gain is greater than unity and an unfavorable phase would result in singing. In the design of a commercial transmitter, Mr. Burrows pointed out that it is necessary to have these margins to allow for variations in the manufacture of tubes and the circuit elements. A gain margin of 10 db is provided. This allows the use of tubes whose transconductances are greater than their design value by this amount. No decrease in the transconductance of the tubes can produce singing.

A phase margin of 30° is provided to allow for variations in tube capacities and the electrical constants of the circuit elements. It is also desirable to provide more feedback than is necessary to limit



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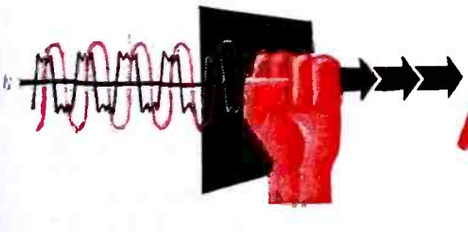

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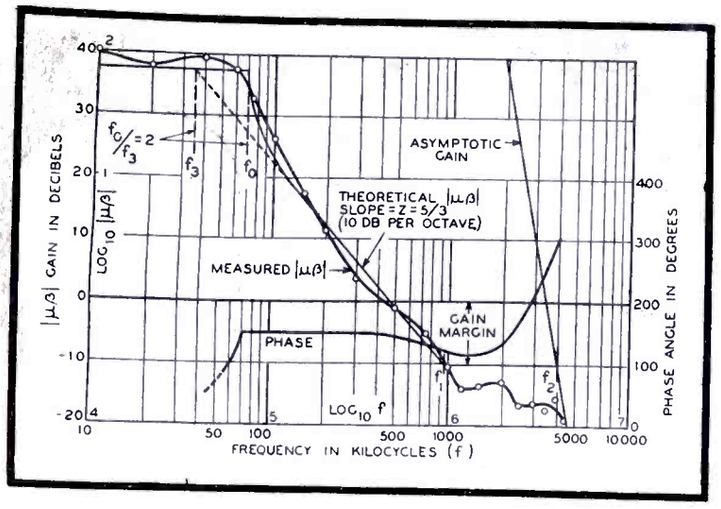


Figure 16 (above)
Plot for main feedback multiplex amplifier design, based on Bode's work. Desired design appears on the heavy curve; circles show the measured values.

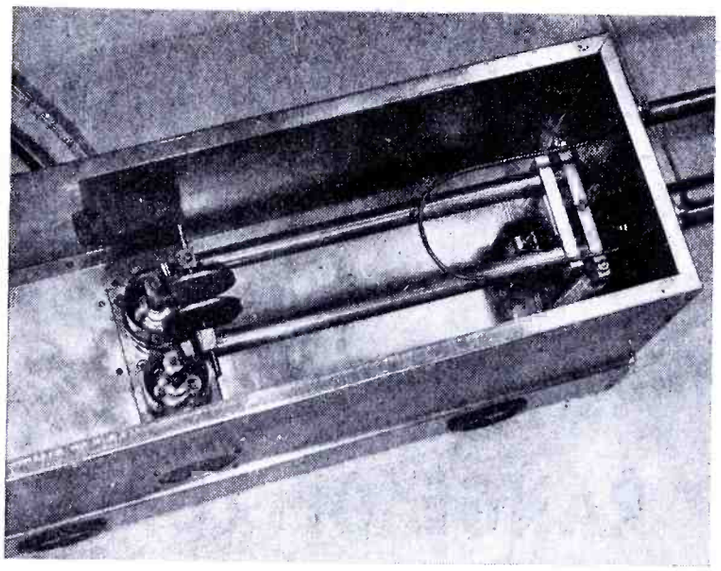
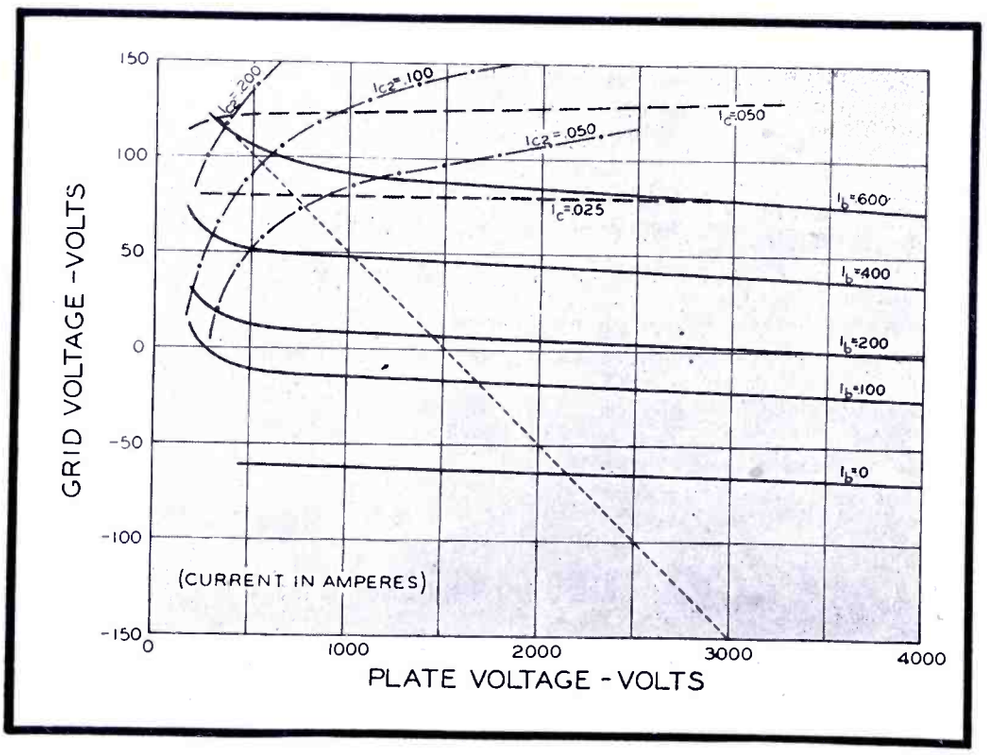


Figure 18 (left)
The v-h-f tetrode, described by Clayton E. Murdock, in a 100-mc 750-watt test amplifier. No neutralizing circuit was used in this test unit.

Figure 19 (below)
Constant-current characteristics of tube described by Mr. Murdock. Short dashes (operating line) illustrate a 3,000-volt, 500 watt input, 75% efficiency operating condition.



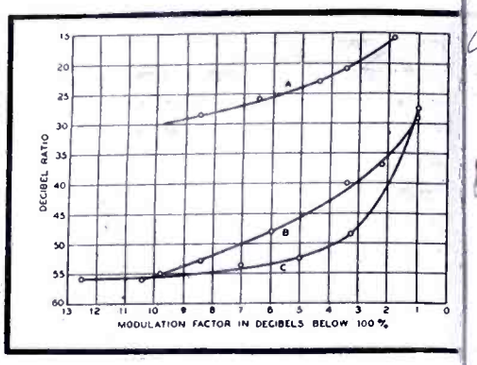


Figure 17 (right)
Overall distortion of multiplex transmitter. Ordinate shows ratio of fundamental to second harmonic distortion.

the non-linear distortion to the desire value. In this transmitter 10 db of feed back were provided in addition to tha necessary to meet distortion requirements This allowed the aging of the tubes t the point where their combined trans conductance was less than the desig value by this amount before it was neces sary to replace them. The heavy curv of Figure 16 gives the desired desig the circles the measured values.

The overall distortion of the transmitte is shown in Figure 17. The ordinat shows the ratio of fundamental to secon harmonic distortion. Curve *A* is for th transmitter without feedback; *B* show the improvement with a high-level linea detector in the feedback network, while C shows the results with local feedback i the beta circuit.

V-H-F TETRODES

MEDIUM-POWER transmitting tetrodes which in a conventional push-pull arrangement can deliver as much as 750 watts at 120 mc were described by Clayton E. Murdock of the Eitel-McCullough Laboratory.

Mr. Murdock said that the tube, known as the Eimac 4-125A, has a plate-to-grid capacitance of 0.03 mmfd, while the input and output capacitances measure 10.5 mmfd and 3 mmfd, respectively. He said that lead inductance has been kept to a minimum in the tube through the use of a *dish* type stem and short, heavy leads. And to hold the screen grid at ground r-f potential, two screen leads have been provided, he stated. The seated height of the tube is 4⅜".

The tube can be operated without neutralization and with full output at frequencies as high as 100 mc, said Mr. Murdock. Above this frequency, a slight amount of neutralization is required, he said, but full power output may be obtained up to 120 mc.

The tube uses a 32-watt thoriated tungsten filament, and tantalum control grid and tantalum screen-grid supported by their leads from a dish-type stem. The plate, which is also of tantalum, is supported by a single lead from the top of the envelope. A large shield structure, which serves to join the screen grid to its supporting leads, separates the tube into two section, explained Mr. Murdock.

Describing applications, Mr. Murdock said that two typical test rf amplifier units were built. One amplifier unit, which served for several relatively low-frequency tests at 14 mc was completely contained in a cabinet measuring 15" by 11" by 9", he said. This unit, which employed two tubes, was capable of handling an input power of 1000 watts at a plate efficiency of 75%, explained Mr. Mur-

(*Continued on page* 84)

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TELEVISION RELAYS*

by H. B. FANCHER

Engineering Section

Transmitter Division

General Electric

[*From testimony presented at the FCC allocation hearings.]

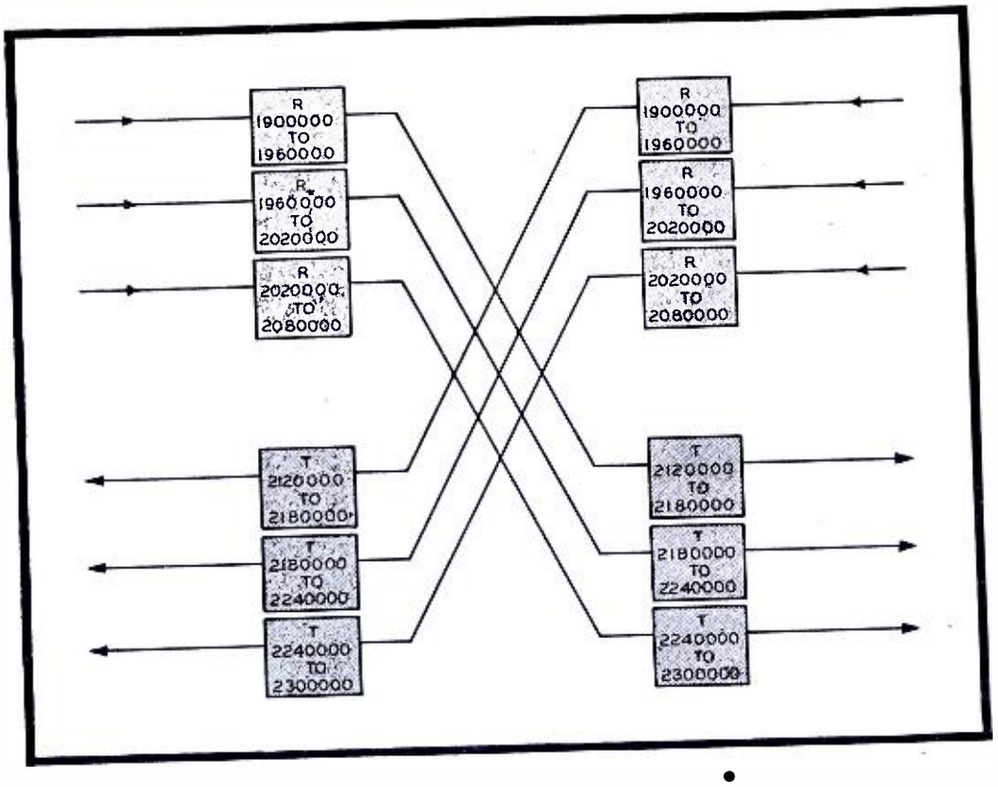

Figure 1
A typical 3-channel, two-way television relay-station system.

THE choice of frequencies, bandwidth requirements, and type of modulation for relay systems are determined to a large extent by the type of service to be transmitted as well as equipment available at the present state of the art. It is obvious that if any great amount of relaying is to be done frequencies in the microwave region are required. In this region there are a relatively large number of megacycles available and reasonably sized directive antennas can be built to restrict the radiated energy to a narrow beam.

The service which requires the largest bandwidth seems to be a high definition or color television system. One such proposed system needs 9.75 mc video modulation. If a relay channel is to be built to accommodate such a system, then it is desirable to use the same band to transmit a multiplex system of other services which in themselves do not require such bandwidth. This is an ultimate goal and experimental equipment would start with the 4.5 mc required by a standard television signal or an equivalent amount of multiplexed service. These services would include f-m broadcast channels, business machine channels, facsimile channels, or voice communications.

To start such a system in the immediate future, the carrier frequencies employed will undoubtedly be limited by available tubes, all of which are classified. We are proposing to experiment with such a system in the 2000-mc region with equipment which will deliver approximately 10 watts into an antenna system with a 6° beam. Undoubtedly higher frequencies will eventually supplant this link. At present it is not possible to produce any appreciable amount of power which can be modulated at higher frequencies although tubes to do this are in the research stage.

The determination of modulation to be employed is based on the required signal-to-noise ratio and the limitation of vacuum tubes available. There appear to be fundamental difficulties associated with amplitude modulation at frequencies where transit time in the tube is appreciable. The phase modulation produced in the modulated stage, either by plate or grid modulation, gives an intolerable amount of frequency modulation in the output, even though the carrier be crystal controlled. Frequency modulation at low level is fairly straight forward and amplifiers are available to give reasonable power in the 2000-mc region. F-m is also better with respect to immunity from interference and gives a better signal-to-noise ratio. It is also a more efficient way to multiplex.

With f-m, and modulating frequencies up to 10 mc, the required channel widths can be determined. If a swing ratio of 2 to 2½ is employed, the total band is 40 to 50 mc. Frequency stability in the order of ±.05% (± 1 mc at 2000) does not add materially to the bandwidth requirements. So for a block of frequencies to give a single 2-way channel, 60-mc spacing probably gives sufficient guard bands. The rejection of the adjacent channel interference is obtained both by receiver i-f selectivity and limiter action.

To produce a relay system we plan to use 2-channel assignments for a single 2-way circuit. The frequencies will be staggered (Figure 1), so that a single frequency would be used at a given relay point to receive both from the North and from the South. A single different frequency is used for the North and South transmitters at the same location. This means that the front-to-back ratios of the antennas will have to be good enough to keep the North-bound signal out of the South-bound receiver at any relay point. This is a less stringent requirement than if the signal were fed through on the same frequency, but does not require any more space in the spectrum.

Highly directive antennas with beams in the order of 6° are planned. These will employ either parabolas or horns to obtain the required directivity. At 30 miles, which is the average

(Continued on page 69)

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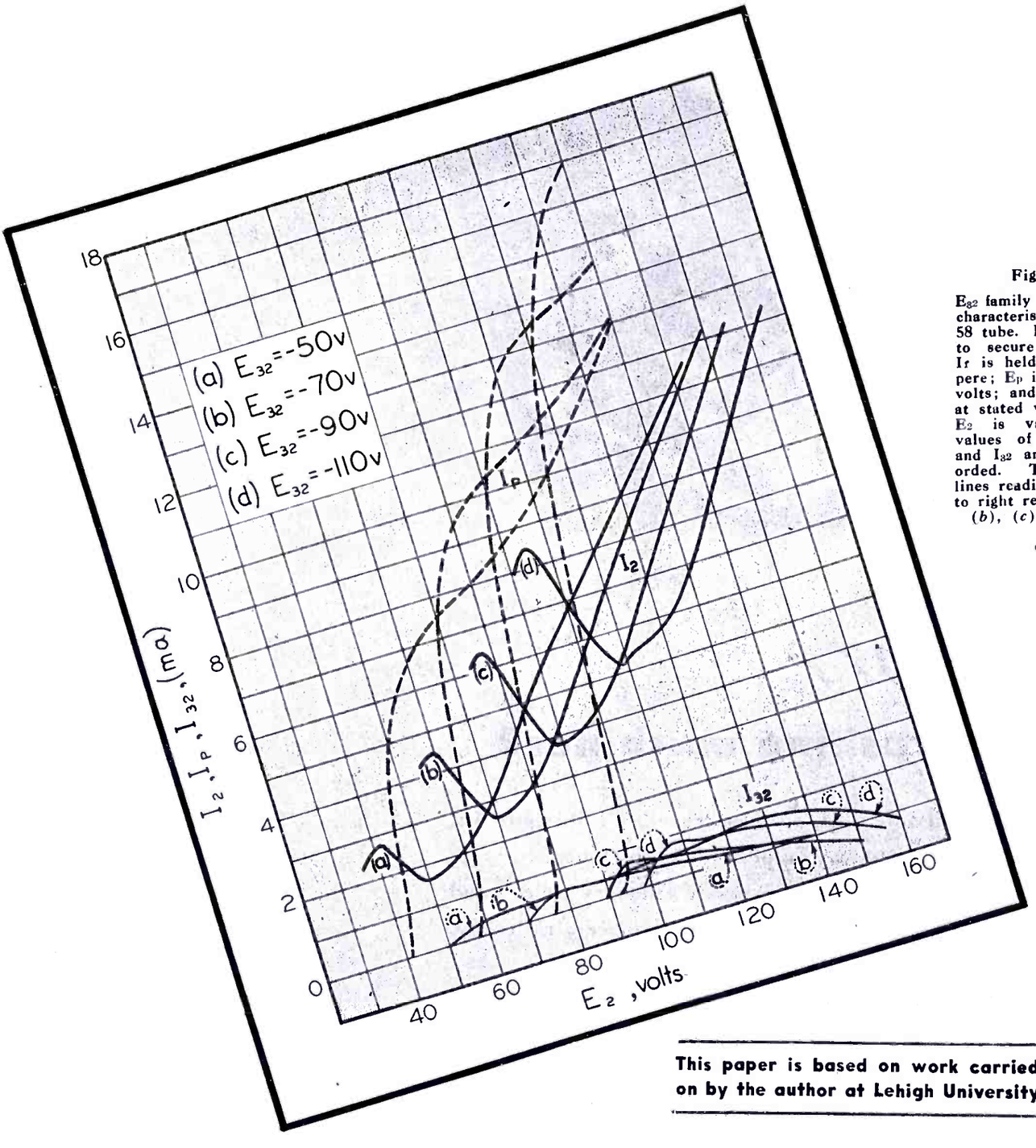

Figure 1

E_{g2} family of transitron characteristics for a 58 tube. Method used to secure this plot: I_f is held at 1.0 ampere; E_p is held at 22 volts; and E_{32} is held at stated value. Then E_2 is varied. The values of E_2, I_2, I_p and I_{32} are then recorded. The dashed lines reading from left to right represent (a), (b), (c) and (d).

This paper is based on work carried on by the author at Lehigh University

SUPPLY VOLTAGE EFFECT ON TRANSITRON PERFORMANCE

by CLEDO BRUNETTI

Chief, Production Engineering Section, National Bureau of Standards, Washington, D. C.

Formerly Assistant Professor of Electrical Engineering, Lehigh University

IN the June, 1944 issue of COMMUNICATIONS,[1] a series of families of current-voltage characteristics were presented for several of the more common types of tubes used as transitrons. The manner in which the performance of a transitron oscillator[2] under specified conditions may be determined by an inspection of the characteristics, was also described. The essential factor to be observed is that in order for oscillations to occur, the resonant impedance of the tuned circuit, L/RC, must equal or exceed the reciprocal of the slope of the characteristic at the operating point*. Once oscillation sets in, the amplitude increases until the average negativ

[1]Cledo Brunetti, *Characteristics of the Transitron Oscillator*, COMMUNICATIONS; June, 194

[2]Cledo Brunetti, *The Transitron Oscillato* Proc. IRE, Vol. 27, pp. 88-90; February, 193

*L and R are the inductance and resistanc of the coil in henries and ohms, respectivel C is the capacitance in farads of the co denser in parallel with the coil. R is assume small compared with L/RC.

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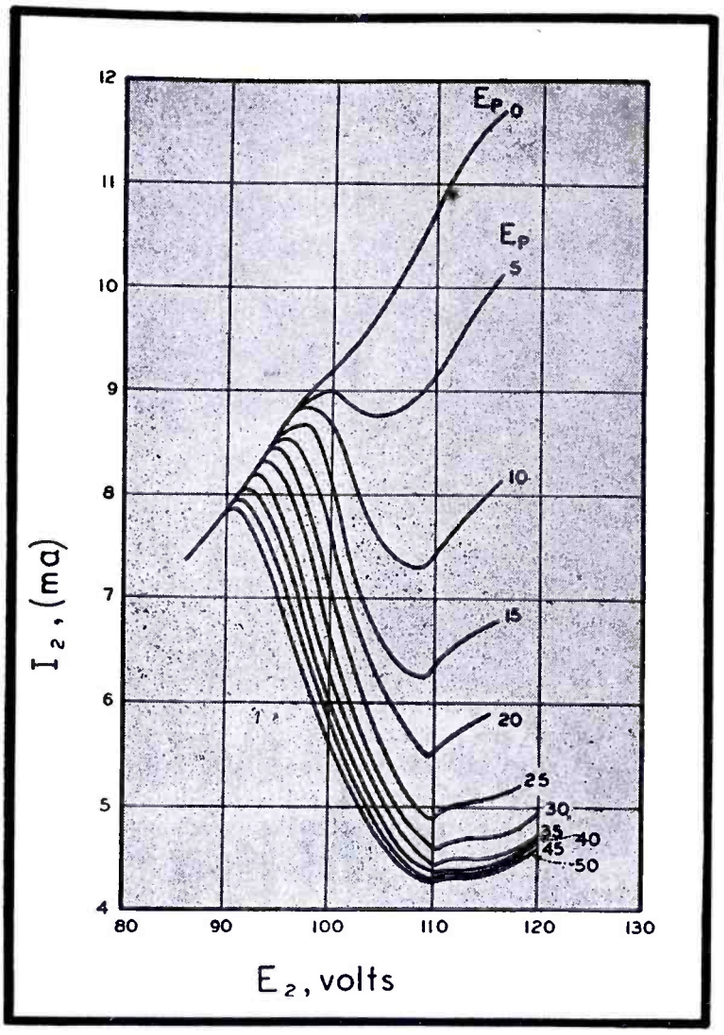

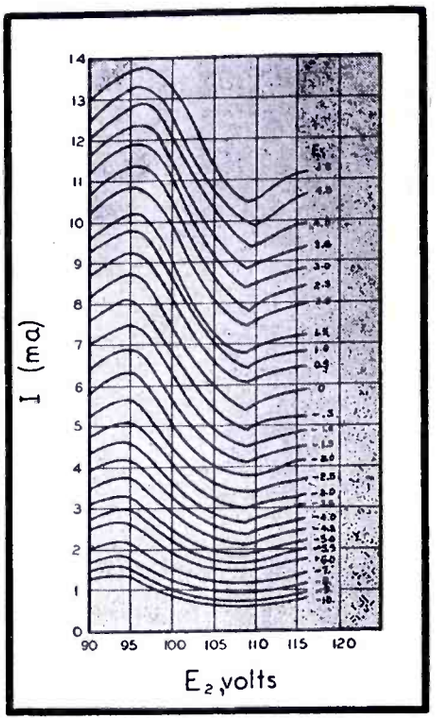

Figures 2 (left) and 3 (right)
Figure 2, the E_P family of transitron characteristics for a 58 tube. To secure these values, I_f is held at 1.0 ampere; E_1 is held at zero; E_{32} is held at 110 volts; and E_P is held at stated value. E_2 is varied, and E_2 and I_2 are recorded. Figure 3, the E_1 family of characteristics for a 58. To secure this plot, E_1 is held at stated value; E_{32} is held at —110 volts; I_f is held at 1.0 ampere; and E_P is held to 20 volts. E_2 is varied, and E_2 and I_2 are recorded.

resistance presented by the transitron equals the resonant tuned circuit impedance. If the latter exceeds the reciprocal of the slope at the operating point by a sufficient margin, the oscillations may swing over the bends of the characteristic. The influence of the bends is such as to apply a dynamic braking action to the amplitude thus preventing it from increasing indefinitely. The sharper the bends, the greater the control of amplitudes. On the other hand, in general, the longer the negative sloped portion of the characteristic, the greater the amplitude of oscillation.

In order to understand more fully the mechanism of operation of the transitron, it is of value to present an additional set of characteristics showing how the d-c supply voltages control the performance. These characteristics are contained in Figures 1, 2, and 3, which were obtained with the aid of the circuit of Figure 4. In Figure 1, three families of characteristics are plotted, plate current, I_p, anode current I_2, and transfer current I_{32}. It will be seen that as the blocking voltage E_{32} is increased, the anode-current negative-resistance characteristics increase in magnitude. In these curves the plate voltage is held fixed. In oscillator practice, where a condenser is used in place of E_{32} to couple grid *2* back to grid *3*, the anode voltage, E_2, is set at the value corresponding to the center of the negative sloped portion of the characteristic selected. The same curves apply as shown in Figures 1, *2*, and 3. In oscillator design, therefore, increasing E_2 will allow larger amplitude of oscillation and, because of the steeper slope at the operating point,** will allow oscillations to persist over a wider range of values of L/RC. This means that if the frequency is varied by means of the condenser C, oscillations will be sustained over a wider range of frequencies.

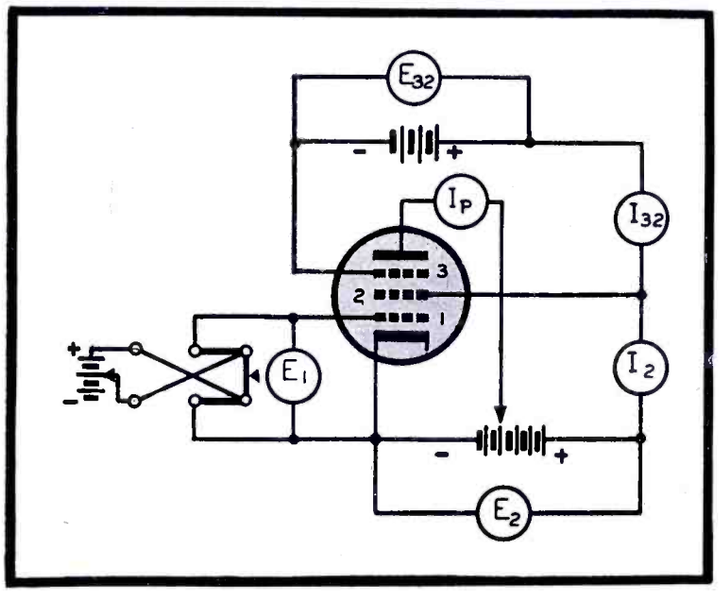

Figure 4
Circuit used to obtain transitron characteristics.

An interesting feature of this circuit, revealed by Figure 1, is that no current flows to the plate until the anode voltage reaches a value corresponding to the upper bend of the negative-resistance (or I_2) characteristic; also for small values of anode voltage no current flows in the transfer circuit (I_{32}) until the lower bend of the characteristic is reached. For larger values of E_2 some transfer current begins to flow before the lower bend in I_2 is reached. This has the effect of rounding out the lower bend and is generally not of importance except in cases where the transitron is used as a trigger circuit[3].

In Figure 2 the effect of varying the plate voltage is shown. For low values of plate voltage, the negative slope at the center of the characteristic decreases and with it the length of the

**The center of the negative sloped portion of the characteristic.

[3]O. S. Puckle, *Time Bases*, John Wiley & Sons; 1943.

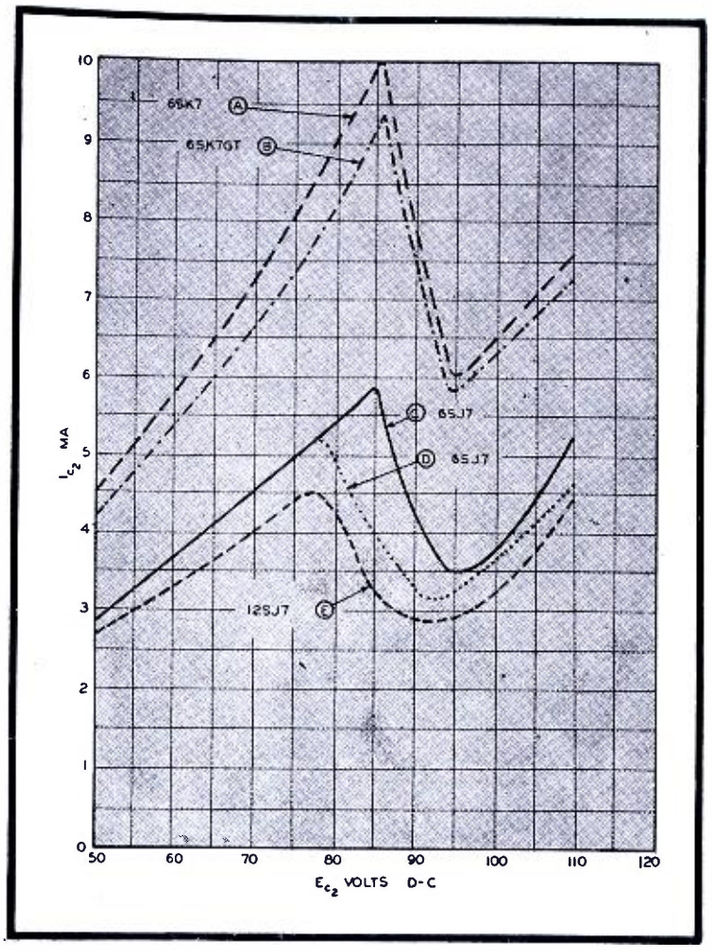

Figure 5 (*Kohler data*)

Transitron static characteristics for 6J7, 12SJ7, 6SK7 and 6SK7GT. *$E_{c\ 3-2}$ equals — 100 volts d-c; E_{c1} equals 0, and E_b equals 22 volts d-c. (*Grid *3* is biased — 100 volts with respect to grid *2* for all points on curve.) (*B*), (*B*) and (*C*) tests were made on August 8, 5, and 10, 1944, respectively. (*D*) test was made in September, 1942, while (*E*) test was made in March, 1941.

negative sloped portion. In practice this means the oscillator will have a more limited range of frequencies and lower amplitude of oscillation, respectively, assuming condenser tuning is employed. It is also seen that for the conditions stated, no practical advantage is gained in increasing the plate voltage beyond 35 or 40 volts. Up to this point, however, an increase in plate voltage will be followed by an increase in amplitude of oscillation and because of the steeper slope at the center of the characteristic, a wider operating range of L/RC will be made effective. If the voltage on the plate is reduced to zero, the negative resistance characteristic disappears completely and the oscillator ceases to function. The variation of amplitude with plate voltage suggests the possibility of plate-modulating the transitron oscillator. This method has been used with some success, limited only by the fact that the impedance presented by the plate circuit to the source of modulating voltage is not linear.

Figure 3 shows how the characteristic may be controlled by varying the bias on grid *1*. As this quantity is made more negative, the slope decreases until gradually the sharp negative resistance characteristic is lost. This property is made use of to control automatically the amplitude of oscillation[2] as follows:

A portion of the output voltage is rectified by means of a simple diode circuit and fed back in negative polarity to grid *1*. The d-c voltage on grid 1 is then proportional to the amplitude of the oscillation voltages. If (following a change in L/RC as the oscillator frequency is varied, e.g., by changing *L* or *C*) the amplitude tends to change, the negative bias on grid *1* will also change. The latter produces the required change in average negative resistance to meet the change in L/RC and the necessity for swinging up past the bends of the characteristic is removed. By proper adjustment the amplitude may be restricted to oscillation over the linear negative portion of the characteristic and maintained fairly constant. In this case very good waveform will also be maintained and in addition, good frequency stability with respect to variation in d-c supply voltages.

The possibility of modulating the amplitude of the transitron oscillator by means of a voltage inserted in the circuit of grid *1* is also apparent and has been employed in various applications. However, unless care is exercised in selecting and maintaining the operating point at a linear part of the characteristic, poor frequency stability may result.

The practice of varying the negative slope of the characteristic by means of the bias on grid *1* has been employed by experimenters[4] in measuring the effective resistance of coils. One of the simpler methods is as follows: A coil of known inductance *L* and unknown resistance *R* is connected in parallel with a standard condenser *C* of a known value and the combination substituted in place of the meter, I_2, in Figure 4. The voltages E_2, E_{c_1}, and E_{c_2} are chosen so as to place the operating point approximately at the center of the negative sloped portion of the characteristic. The negative bias on grid *1* is now reduced until oscillations set in. At this stage L/RC is equal to the negative reciprocal of the slope at the operating point. The latter is obtained either from the static characteristic such as shown in Figure 3 or measured dynamically[5]. From this identity, the value of *R* is computed.

[4] I. Iinuma, *A Method of Measuring the Radio-Frequency Resistance of an Oscillatory Circuit*, Proc. IRE, Vol. 18, pp. 537-543; March 1930; also *Resonant Impedance and Effective Series Resistance of High Frequency Parallel Resonant Circuits*, Proc. IRE, Vol. 19, pp. 467-478; March 1931.

[5] Cledo Brunetti, *The Classification of Average Negative Resistance with Extensions of its Use*, Proc. IRE, Vol. 25, No. 12, pp. 1595-1616; December 1937.

R-F Pentodes as Transitron Oscillators

by E. KOHLER

Commercial Engineering
Ken-Rad Division
Electronics Dep't., General Electric

PUBLICATION of Cledo Brunetti's fine paper entitled *Characteristics of the Transitron Oscillator in* COMMUNICATIONS, June 1944, brings to mind certain facts which may not be generally known. We feel it is in order to point out that the tube parameters which yield the negative resistance characteristic employed in the *transitron oscillator* are not standardized. It is impractical to consider that this characteristic can now be standardized for existing types at this stage of tube production history. If a *transitron oscillator* tube with rated characteristics is needed we shall have to select one suitable type and *standardize the negative resistance characteristic under a new type number.*

One example came to our attention wherein a new production lot of one manufacturer's type 6SJ7 failed 100% to oscillate in a *transitron* circuit. They were good type 6SJ7 tubes, but a minor change in the suppressor grid design which was expedient to tube production and which in no way affected the rated characteristics of the tubes made them unsuitable in that equipment. When this possibility is extended to all tube manufacturers none of whom control the negative resistance characteristic the problem of interchangeability could become chaotic.

To illustrate this probability all available production dates and makes of types 6SJ7 and 6SK7 to be found in our laboratory were investigated for *transitron*

(*Continued on page 78*)

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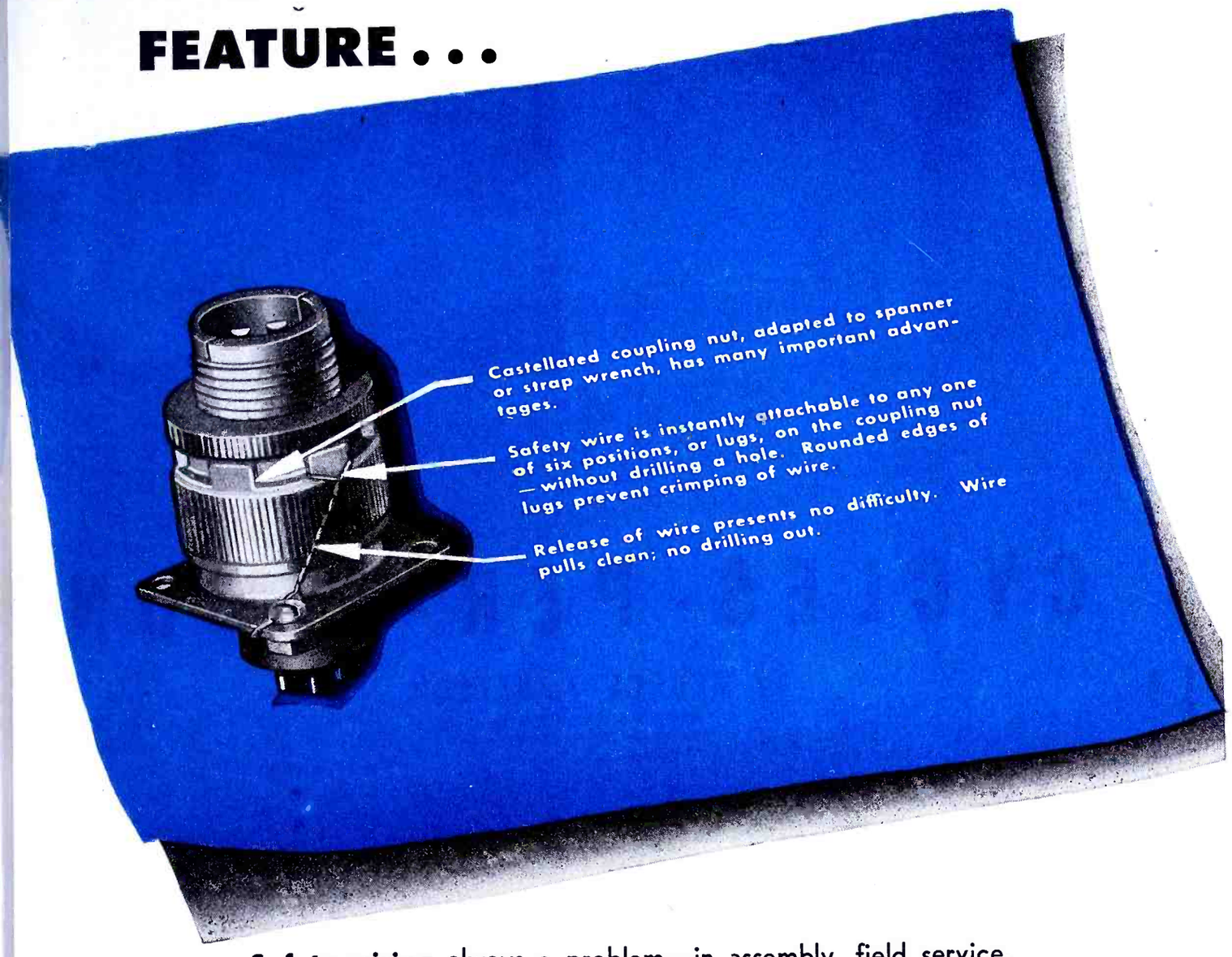

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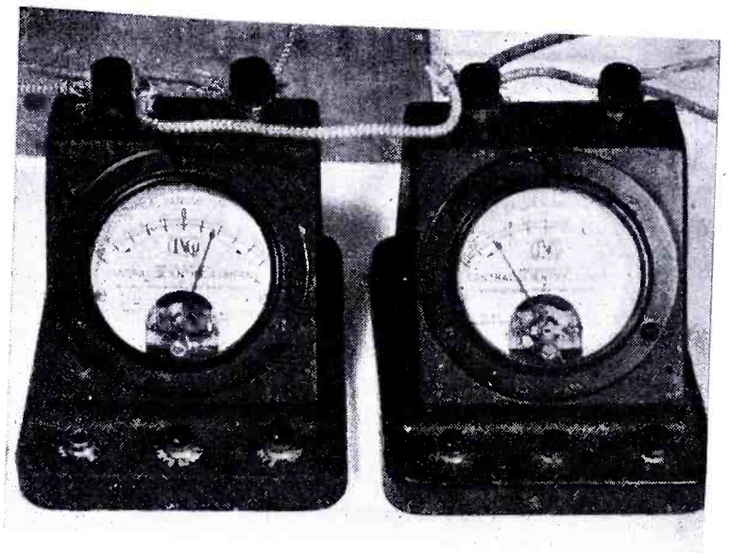
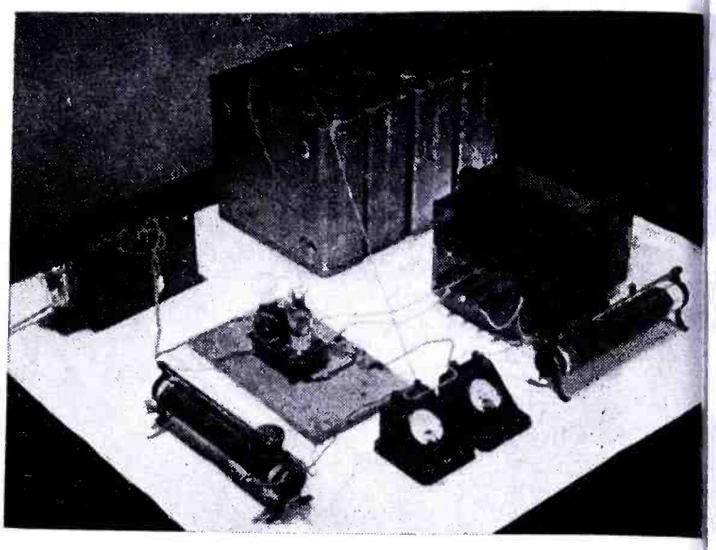




Left, galvanometers used in low-frequency demonstration oscillator. Galvanometer at left is in the condenser branch, while one at right is in inductance section of tuned circuit. Wire linking meters is common point between capacitive and inductive branches of tuned circuit. Right, layout of oscillator. Large condensers in background comprise the "variable condenser," and the large power transformer is used as the inductance.

3 CYCLES-PER-SECOND

by GEORGE J. NELSON
Department of Physics
Southern Junior College
Collegedale, Tenn.

DURING our ESMWT courses, it was necessary to study the behavior of the various elements of a low-frequency vacuum-tube oscillator under dynamic conditions.

We selected a standard Hartley oscillator with one modification to accommodate a low frequency of 3 cps. The positive side of the power supply was connected directly to the plate of the tube so that no high voltage appeared on the inductance, eliminating the usual grid blocking condenser. Obviously, to pass any appreciable quantity of energy at three-cycles-per second a substantial capacitance would be necessary. Whatever capacitance is available is needed for the tuned circuit and is not to be obscured as coupling capacitance.

The first demonstration was made with a galvanometer connected to the low voltage winding of the transformer used for the inductance. When current flows into the circuit the galvanometer needle first flutters, and, then as the oscillation builds up the swinging of the needle increases to maximum. We thus noted that alternating current was present. The needle will swing to one side and then to the other. The frequency is determined by counting the swings of the needle for a period of time measured by a stop-watch. By connecting and disconnecting condensers the frequency can be changed.

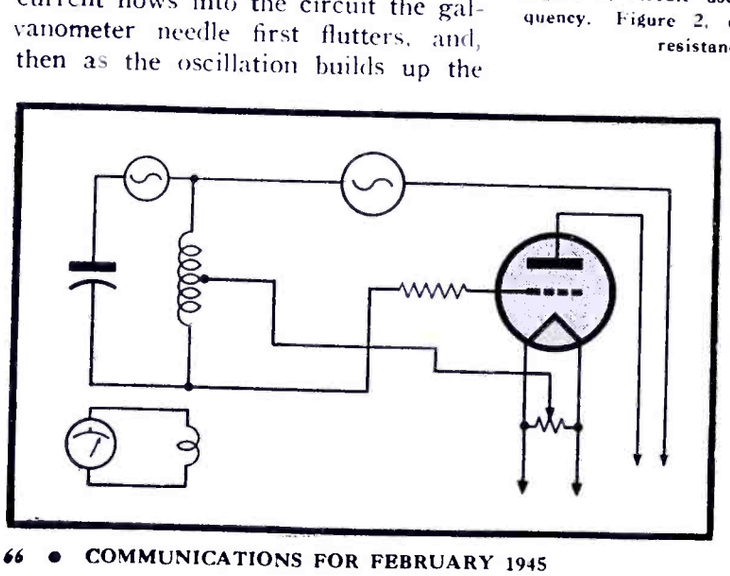
A lamp, in series with the plate, also aids in the study. For in action it blinks on and off. This indicates that the oscillator draws current over part of the cycle and rests the other part. This point is referred to when the class *C* amplifiers are studied. A small lamp in series with the condenser bank carries the circulating current between the condensers and the inductance and blinks at a rate twice that of the larger lamp in the plate circuit. This smaller lamp lights up regardless of the direction of the current and therefore indicates the charge and discharge of the condenser.

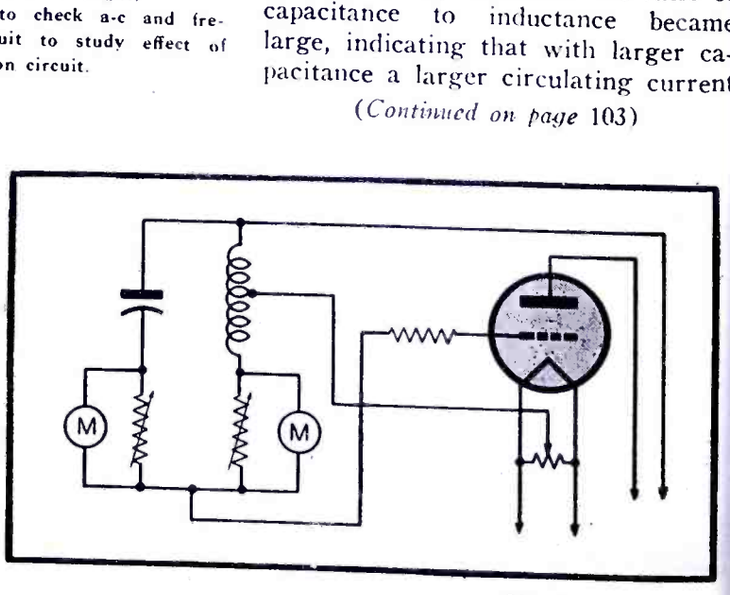
By disconnecting one condenser at a time the frequency increases. The galvanometer will indicate frequencies up to about ten-per-second but with diminishing deflection. We are thus able to note directly the effect of tuning with a variable condenser. In addition, we can study the effect of using less inductance. To do this we only have to move the connections to the lower voltage taps on the transformer.

With the small lamp in series with the condensers, we observed that it flashed brightly whenever the ratio of capacitance to inductance became large, indicating that with larger capacitance a larger circulating current

(*Continued on page* 103)

Figures 1 (left) and 2 (right)
Figure 1, circuit used to check a-c and frequency. Figure 2, circuit to study effect of resistance on circuit.





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WAR CORRESPONDENT'S RECORDER

(*Continued from page 35*)

has a diaphragm-operated piezoelectric movement and is mounted on a clip which can be attached to any convenient point of support. The sensitivity of this microphone is sufficient for the recording of speech at distances up to about two yards, thus allowing the commentator a certain freedom of movement. The other microphone has a special ribbon-velocity element designed to avoid pickup of external noise. Noise elimination is provided by taking advantage of the change in frequency response with distance, a characteristic of this type of microphone. Held close to the commentator's mouth, it enables clear speech to be recorded in the presence of deafening noise such as is encountered, for example, inside an aircraft.

Low-consumption pentodes are used in the first two stages and a small quiescent push-pull pentode is used in the third stage. The whole unit consumes only 0.3 ampere at 3 volts and from 8 to 12 milliamperes at 100 volts. Power is derived from dry batteries which are housed in a light metal cassette, fitted with a plug and socket connection. Each set of batteries lasts long enough for the recording of some 40 discs, after which the casette is readily replaced by another and returned to base for refitting.

Since the commentator cannot be expected to operate a gain control while he is speaking, an automatic regulating circuit is provided. With this method speech is neither lost in the surface noise, nor distorted by overloading of the amplifier or disc. To this end, a portion of the output from the last stage is rectified and smoothed to produce negative bias for the suppressor grids of the first two stages. The reduction in amplifier gain for loud signals then keeps the recorded level within reasonable limits. As soon as an intense signal ceases, however, the rectified bias voltage is removed by the discharging of the smoothing condenser through a leak. Thus the full gain of the amplifier is restor leaving the equipment ready to d with any weaker signals that may f low. It would be possible in this w to control automatically the full d namic range of the recorded sound that, for example, the voice of t commentator standing at 4′ from t microphone would be recorded nearly the same level as it would if he were to hold the instrument 4″ from his mouth. If this were do however, the full gain necessary f the recording of distant speech wou be present during every pause, so th all kinds of unimportant noises wou appear highly magnified, between se tences, perhaps even between word This surging up and down of th background noises is quite unpleasan and may actually mar the intelligibi ity of the speech. Therefore it w necessary to control this volum range. An attenuator was adopted fo this purpose. This consists, for th piezoelectric microphone, shown in th circuit diagram, of a condenser-resis tance shunt of such value as to reduc the voltage across the terminals to on tenth (by 20 db). This shunt i switched into circuit whenever th microphone is to be used at close quar ters. Thus it is possible to keep withi

olerable limits the range of volume nd any background noises.

A small neon lamp connected across he amplifier output flickers when the evel on the disc is sufficient for good ecording.

The movement of the lightweight utter head is, as previously mentioned, a converted piezoelectric phonograph pick-up, fitted with a sapphire-tipped stylus and with the tone arm modified to allow for the application of the pressure necessary to obtain the correct depth of cut on the cellulose disc. The effect upon the frequency response of the amplifier of the capacitive load presented by the cutter head to the output tube, is compensated by appropriate corrections between the first and second stages.

We are indebted to the research laboratories of the BBC, where this equipment was developed, for data and illustrations used in this paper.

•

TELEVISION

(*Continued from page* 58)

distance between relay points, the antenna beam diameter is slightly over 3 miles so that duplication of the same frequency along parallel routes would have to be carefully considered in the individual cases to avoid interference. At the intermediate points, locations might be found with sufficient separation, but at terminal locations, such as New York City or Washington this would probably not be possible. Thus the same frequency could be used only once in a given direction. The actual operation of a relay system with regard to interference from other relay circuits on the same frequency requires field tests. The theoretical gain and front-to-back ratio of antennas can be measured in the laboratory, but an actual system is needed to tell whether local reflections or anomalous propagation will be appreciable.

To be commercially feasible, relay points, many of which will be located in relatively inaccessible places, must be designed for unattended operation. They should include suitable means for turning them off and on and removing them from the air in case of improper operation, such as deviation from frequency or antenna directivity requirements. To insure continuity of service, tubes with a long and predictable life will be required as well as standby units which can be remotely switched into the circuit.

EXTERNAL ANODE TRIODES

CHARACTERISTICS AND APPLICATIONS

[PART TWO OF A FOUR-PART PAPER]

by A. JAMES EBEL

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

BECAUSE the life expectancy varies so greatly with small voltage fluctuations, it is also important to maintain a constant supply voltage. If the filament is operated from a d-c source of supply, the usual procedure of regular filament polarity reversal should be rigorously followed, to assure even evaporation of the filament. As the filament evaporates, the diameter becomes less and the resistance greater. If the evaporation is uneven, as it always becomes before final failure, a hot spot develops which hastens the melting of the filament in that spot. Even before actual failure, uneven evaporation makes the filament mechanically weaker and therefore more susceptible to damage from mechanical shock.

Besides mechanical shock, often an important factor in shortening the life of a tube, there are two other important sources of stress to be considered in tube design and operation. These are electrostatic and electromagnetic stresses. Electrostatic forces are important when the interelement potential difference is in the order of 20 kv or greater. This condition is reached only in high-voltage, high-vacuum rectifiers because the grid filament voltage in the external-anode triode seldom becomes greater than a few thousand volts.

Electromagnetic forces are much more important, however. An analysis of the forces on the filament strands when carrying high current[7] shows that the deflection of strand is proportional to the one-fourth power of its length and is dependent on the phase of the currents in adjacent strands. In the case of direct-current operation or single-phase operation with the currents flowing in opposite directions in adjacent strands, the tangential force approaches zero and the radial force is negligible. In multi-phase operation, the phase sequence must progress uniformly around the structure to achieve low tangential forces. Often filament structures do not lend themselves to such operation, so that the best possible configuration and phase pattern must be selected with a mechanical structure that will keep stresses within safe limits.

Since successful multi-phase operation is predicated on an optimum strand current-phase relationship, it is important to operate all tubes in accordance with filament connections recommended by the manufacturer and to provide adequate protection against phase unbalances. In the case of very large tubes some sort of phase balance detector should be employed which will operate when one phase drops below 10% of the value of the others. Differential current relays are useful for this application.

One authority[8] has recommended that all multi-strand filaments be operated single phase. He points out that it is difficult to maintain phase balance with multi-phase operation and that the hum level is only increased in the order of one

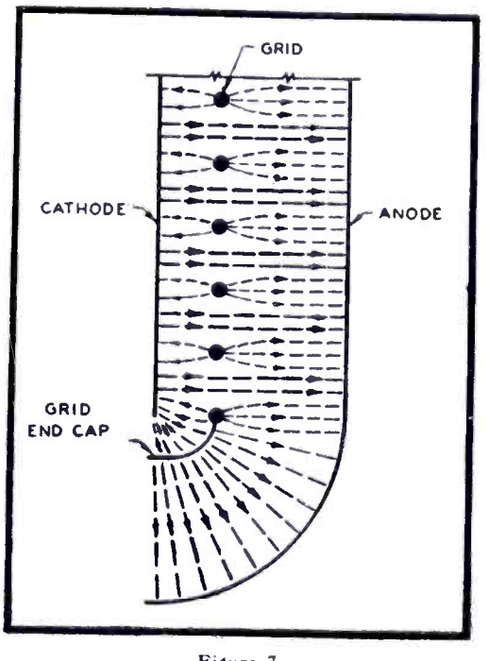


Figure 7
Approximate field distribution for a vacuum tube with negative bias voltage less than cutoff.

db by single-phase operation. Since the hum in the case of multi-phase operation is in the audible range, the actual hum may be greater if weighted for audibility.

Before taking up in detail the anode characteristics of the external-anode vacuum tube and its associated cooling system, a word should be said about the source of heat in the tube anode. The kinetic energy of each electron striking the plate of a tube is given up in the form of heat. Though the mass of the individual electron is very small, its velocity is high because of the high plate potentials normally employed in such tubes. For every ampere of current flowing in the plate circuit, 10^{19} of these high-velocity impacts occur every second. Thus it may be seen that the power dissipated in the form of heat at the anode may reach very large values. The power input to a vacuum tube circuit may be expressed as

$$P_i = I_{ba}E_{ba} + I_{ba}E_{rb} + \frac{1}{T}\int_0^T i_{pa}e_{pa}dt + \frac{1}{T}\int_0^T i_{pa}e_{rb}dt \quad (3)$$

where I_{ba} is the average plate current.

E_{ba} is the average plate voltage.

i_{pa} is the instantaneous plate current measured relative to I_{ba}.

e_{pa} is the instantaneous plate voltage measured relative to E_{ba}.

e_{rb} is the instantaneous voltage across the load.

r_b is the load resistance.

E_{rb} is the d-c voltage drop across the load resistance.

It may be seen from inspection of *3* that the first and third terms represent tube power relations, while the second and fourth terms represent power in the load. The first term is the power dissipated in the tube. In the third term, the voltage and current are out of phase, so that this power is actually deducted from the dissipation within the tube represented by the first term. The fourth term shows that the load voltage and the current are in phase, so that the power deducted from the dissipation appears in the load as useful output. The second term represents losses in the load and in general is negligible. The efficiency of a vacuum tube delivering power to a load is the ratio of the useful power output to the total power input, which is generally the ratio of the fourth term in *3* to the whole right side of the equation. Thus it may be seen that the classification of tubes as 5-kw or 50-kw tubes is somewhat meaningless unless the type of application and circuit efficiencies are known.

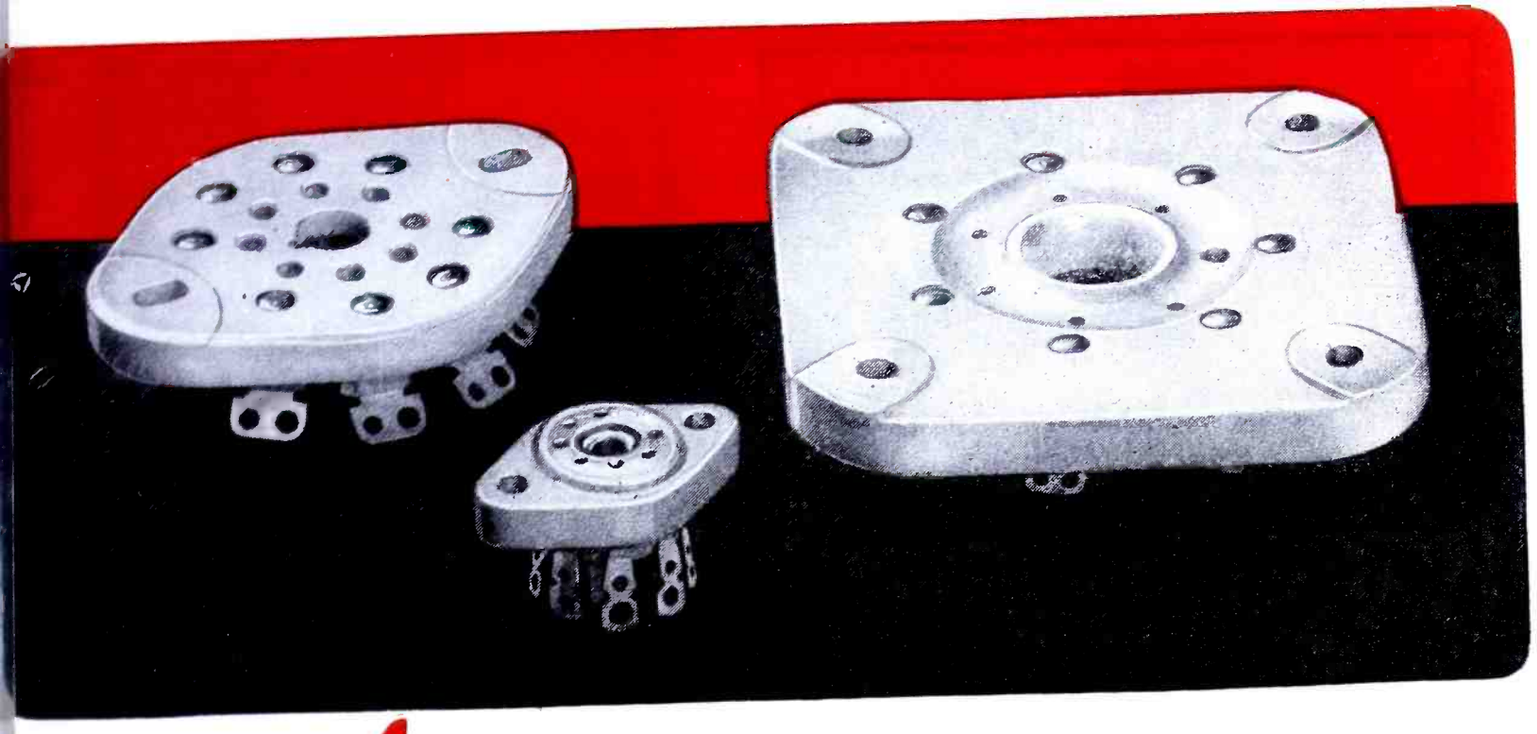
The heat generated by electron impact develops on the inside surface of the anode and flows radially outward to the outer surface of the anode. The rate of flow, from the laws of heat conduction, is given by:

$$Q = \frac{K\,(t_2 - t_1)\,A}{d} \quad (4)$$

where Q is the rate of heat transfer,
K is the thermal coefficient of the material,
t_2 and t_1 are the temperatures of the inner and outer surfaces,
A is the cross-sectional area normal to heat flow, and
d is the thickness.

If the rate of heat generation exceeds the rate of outward flow, the temperature of the inside of the anode will rise. As the temperature rises, the temperature difference increases and the rate of outward flow increases until equilibrium temperature is reached, where the rate of flow equals the rate of generation.

The above statement postulates that the heat flowing to the outer surfaces of the anode is carried away as fast as it is generated; in other words, that the cooling system is functioning properly. In water-cooled tubes the heat is transferred to the water stream and thereby carried away to cooling mechanisms; whereas in the forced-air cooled tubes the air stream carries away the heat. While considera-



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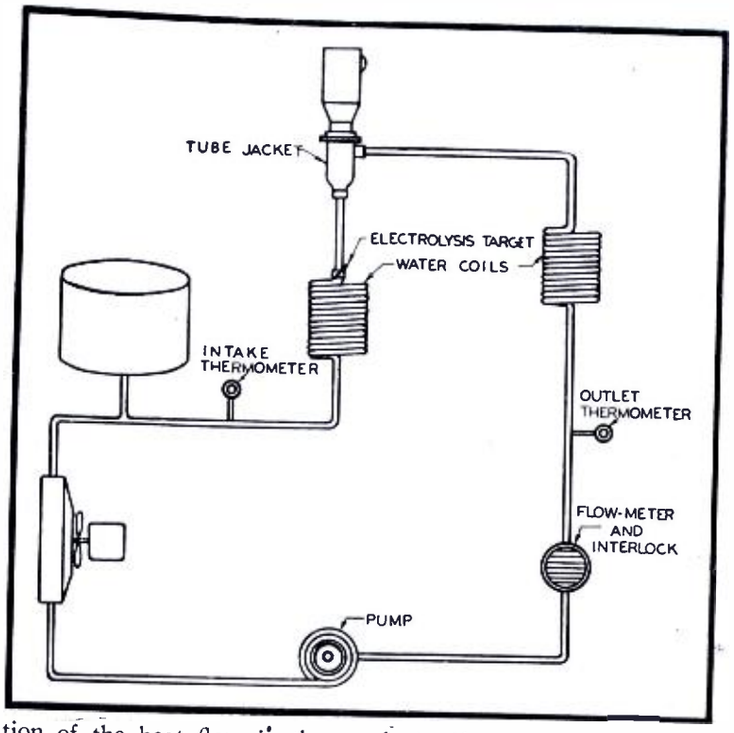

Figure 8

Fundamental components of the hydraulic system of a water-cooled transmitter or an h-f heating generator.

tion of the heat flow in the anode itself is rather simple when an even heat generation is assumed, in actual practice it is very complex because of the focusing effect of the grid.[9] Figure 7 shows the approximate field distribution for a vacuum tube with negative bias voltage less than cutoff. From this it may be seen that the maximum number of electron impacts will occur between the grid wires and the vertical grid stays, and that these wires will cast a shadow on the anode surface. Since the grid voltage varies from cutoff to high positive values in many types of operation, this shadow is not as well defined as the diagram in Figure 7 indicates, but rather varies throughout the entire operating cycle. Even so, there is an uneven distribution of heat which complicates the cooling picture, since lateral flow takes place according to equation *4*, along the anode between the hot spots. At the same time there will be a greater transfer of heat to the cooling agent at these hot spots.

The water-cooled tube presents many interesting thermal and hydraulic problems. The work of Mouromtseff[10] and the pamphlet *Tubes*[11] on this subject are classic and should be consulted for a complete study of the cooling problems. It has been shown that the cooling of such a tube depends on several operational factors as well as on a number of design factors. The rate of cooling increases with the water velocity and depends critically on water temperature. These are two factors which the operator can control. The rate of heat transfer is actually less with cold water because of an increase in viscosity of the liquid. On the other hand the allowable temperature rise is greater in cold water so that the maximum operational temperature lies in the relatively wide range between these two extremes.

Of the design factors, the spacing between the anode and the water jacket is probably most important. The smaller this spacing the higher becomes the velocity of the cooling stream for a given rate of flow. The optimum spacing has been found to be in the order of .02" for a tube with a 1.5" anode diameter.[12] Such small spacing would not allow for any scale formation, however, so that in practice this spacing is approximately .09". Other design factors such as grid and grid stay placement with respect to the cathode wires will have an effect on cooling, since they affect focusing and the formation of temperature differentials on the anode surface. The ratio of the cathode length to the total length of the anode also has an effect, since some of the heat will be conducted to those parts of the tube that do not have electrons impinging directly upon them, as they are out of the normal field between cathode and anode.

The formation of scale, because of its low conductivity, is very detrimental to the cooling of the anode. An examination of equation *4* will show that for a given rate of flow the temperature difference must be greater if a material of lower conductivity is used. Thus for a given water temperature rise in the cooling system, the actual anode temperature must be much higher with a scale formation.

The dissipation limit for a water-cooled tube is indicated by a singing which accompanies the formation of steam at the anode. A certain amount of hiss or sing can be tolerated, since the minute bubbles of steam are washed away in the turbulent flow of the cooling liquid. If the steam is formed faster than it is washed away, however, overheating may easily take place, the rate of scale formation will increase, and there is a possibility of gassing within the tube.

Although the direct cooling agent is water in water-cooled tubes, the final dissipation of the heat must be into the air. This is accomplished in a radiator blower system or in a cooling pond with the aid of evaporation. Figure 8 illustrates the fundamental components of the hydraulic system of a water-cooled transmitter or h-f heating generator. A closed system is used because of the necessity of employing distilled or very pure water to keep down the leakage current through the water stream. The pump must be of such capacity that it will develop the proper rate or flow in a circuit with the hydraulic resistance offered by the tube water jacket. It may take as much as 50 pounds pressure to force the water through the insulation coils and the tube jacket. This also leads to the interesting fact that the water pressure within the jacket itself may be high enough to raise the boiling point of the water as much as 30% and accounts for temperature indications in water-cooled tubes above 100°C without the accompanying sing.

It is desirable for the operator to be able to calculate the total dissipation of heat into the water by the water-cooled tubes from the indications of the input and output temperature indicators and the flow meter. Assuming that the specific heat of water remains constant over the temperature ranges encountered in the cooling systems, the power dissipated into the water stream is given by

$$P = 264\,R(T_o - T_i) \qquad (5)$$

where R is the rate of flow in gallons per minute,

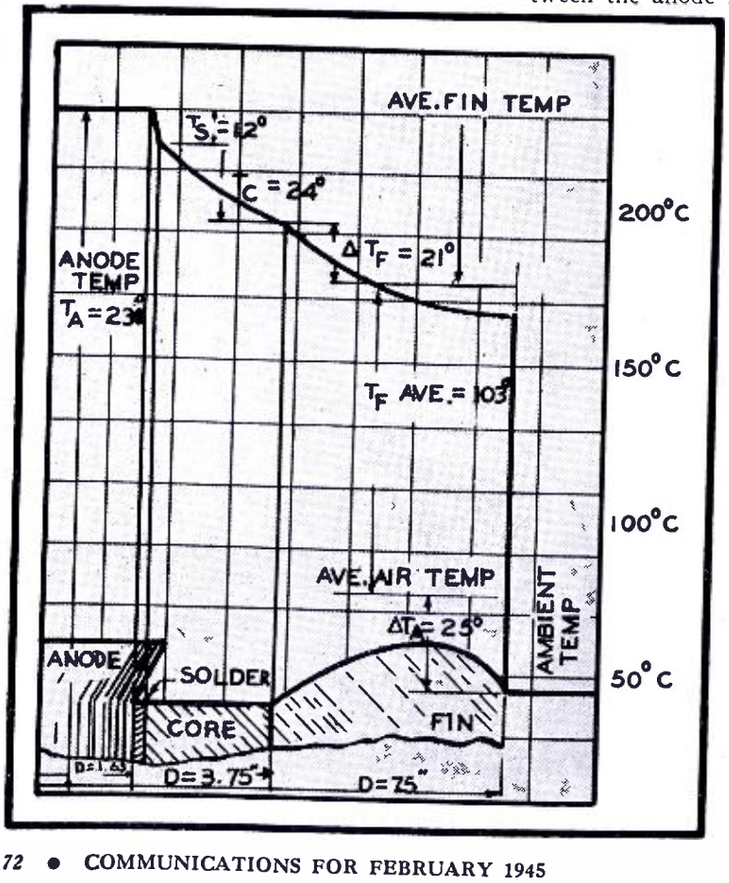

Figure 9

Cross section diagram of an air-cooled tube with the temperature gradients superimposed.

(*Continued on page 74*)

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EXTERNAL ANODE TRIODES

(*Continued from page 72*)

T_i is the input temperature,
T_o is the output temperature, and
P the power in watts.

Input and output thermometers at the cooling devices would show the exact reverse indications except for whatever heat loss there would be in the connecting pipes between the tube and the cooling unit. The cooling in a radiator is proportional to the difference between radiator temperature and air temperature, the air velocity and the cooling area. From the above analysis it may be seen how the equilibrium temperature in a water-cooled system is reached. The temperature of the water is raised in proportion to the amount of heat dissipation in the tube. The inlet temperature will rise till the average temperature in the cooling unit is enough above ambient temperature to effect a rate of heat dissipation equal to that of the tube less connecting circuit losses. It is the duty of the operator to watch these various factors for indications of improper functioning, which can be readily noted in any departure from the regular operation explained above.

Distilled water is recommended in all cases of water-cooled tube operation because the shortened life of such an expensive item as an external-anode vacuum tube will cost much more than pure water. The additional possibility of interruption of service due to too much scale formation or excessive hydrolysis is also to be considered. Even with distilled water there are always some impurities that go into solution as the warm water passes through a considerable length of pipe or rubber hose, and fixtures such as pumps, radiators, and metering devices.

In the forced-air cooled tube the cooling process is much simpler and in some ways more efficient, even though a forced-aid cooled tube cannot handle as much dissipation as a water-cooled tube of the same size. Much good information has been published recently [13, 14, 15] on this subject and should be consulted. Figure 9 shows a cross-section diagram of an air-cooled tube with the temperature gradients superimposed. The slope of any of the temperature gradient curves is dependent upon the heat conductivity of the material and the rate of cooling. The heavy copper core surrounding the anode facilitates the longitudinal and circular flow of heat so that the effect of grid focusing is neutralized and the cooling is evenly distributed.

The amount of power dissipation an air-cooled external-anode tube can handle is proportional to the average temperature difference between the fins and the air stream, the rate heat is transferred from the fins to the air stream per unit area per degree, and the total effective area. It may be seen that all of these factors, except possibly the first, are design factors and are out of the operator's control. The dissipation in the final analysis is limited by the maximum safe temperature the anode can reach. This is limited by the melting point of the solder that affects the thermal contact between anode and cooler and by the point at which gas will be driven from the anode. Tin solder will begin to soften at approximately 180° C, whereas a well evacuated

e will not liberate excessively till 250° reached; so that the cooling limit in tubes in current use is limited by solder melting point. The temperature 150° recommended by most manufacers represents a margin of safety below melting point, although some tubes h higher melting-point solder run as h as 200° C.

The temperature of the incoming air important, since for a given rate of t transfer to the air the allowable dissation is a function of the incoming air perature. While the ambient temature is out of the operator's control, per installation and care in operation l keep the air at the blower intake m rising in temperature very much ve the ambient. So often in installans where forced-air sealed tubes are d, the hot air is exhausted into the m, and a separate exhaust fan or the lding circulating system is depended on for the hot air removal. This leads the recirculation of the hot air through cooling system because the air path istances are such as to short-circuit exhaust system.

The velocity of the air stream controls rate of heat transfer to the air stream. e only limit is the point where obtionable whistling takes place, or where installed fan capacity has to be so at to create the pressure necessary to tain the desired velocity that commerl units cannot be employed. The core d cooling fin radii bear a definite relanship to each other for optimum cool, as do the number and thickness of fins. These factors along with some eresting possibilities for construction air-cooled tubes of equal dissipation to ter-cooled tubes are taken up in the erences indicated in the foregoing ct.

The tube may be installed in an inlated socket that forms the air duct m an individual blower or mounted a shelf that forms part of the air flow cuit in the equipment with one comon blower and individual duct control air to each unit or cubicle. The hot is generally exhausted outside but can used to heat the building. A similar ating adaptation may be made with ter-cooled tube units.

A note on the heating effect of a piece high power electronic equipment might appropriate. If, for example, the piece equipment is a 5-kw radio transmitter th a power input of 25 kw, all but the wer lost as electromagnetic radiation available in the form of heat. This eans that with the exception of the kw carrier power and whatver addinal power is added to the carrier by odulation (approximately 2.5 kw maxium) the power input can be used for ating purposes. If the amount of heat kilowatts-per-hour available is conrted to btu and the heat loss for the ilding structure is known for the varis outside temperatures, then the suitality of the equipment as a heat source n be gauged. Added to this is, of course, e problem of heat distribution which an installational problem and should considered in the initial installation of e equipment.

The *flash arc* (sometimes called *arc ack*) is an instantaneous breakdown ithin the tube that allows reverse curnt flow. In external-anode vacuum tubes constitutes one of the chief sources of

(*Continued on page* 76)

EXTERNAL ANODE TRIODES

(Continued from page 75)

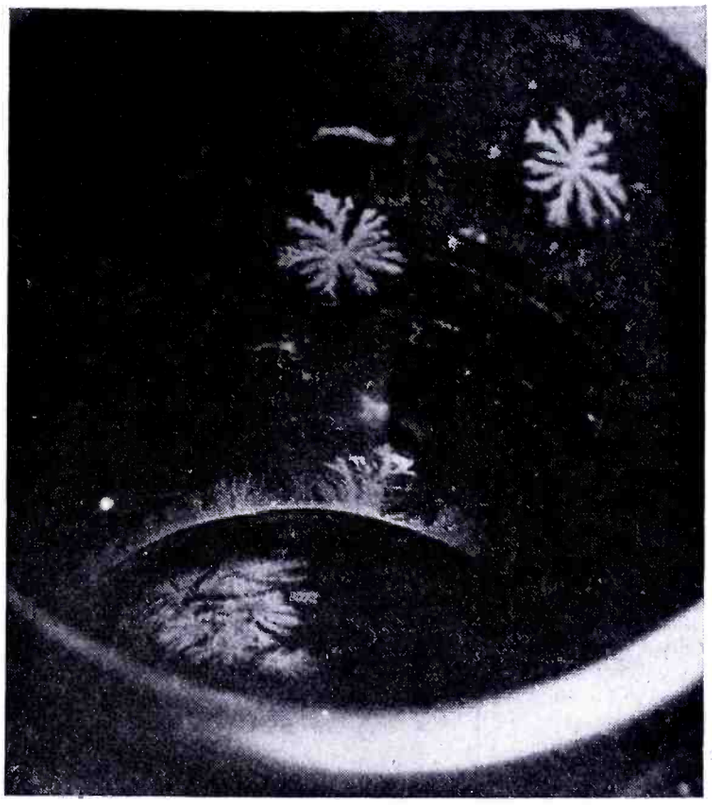


Figure 10
Characteristic flash markings on inside of a high-power water-cooled tube. Careful maintenance procedure aids in reducing number of flash arcs in any given operational situation.

interruption of operation and tube failure. While with improved manufacture technique the incidence of such arcs is reduced, yet they remain a major problem for the design and operating engineer. They are generally identified by a sharp ping within the tube and interruption of the plate circuit by the d-c overload relay. Because of the intense light from the tungsten filament it is impossible to see the arc take place, and often even the ping is obscured by the normal operating noises of the tube. If sufficient energy is available at the plate supply, there will be a high current d-c follow-up arc, which is a sustained arc and will be destructive in the tube. The prevention of these power arcs is within the power of the design and operation engineers.

There is no final evidence as to what the actual cause of these flash arcs is, but the work of Gossling[16] and Mouromtseff[17] points very definitely to the liberation of gas within the tube as the main factor. Within the evacuated envelope of an external anode triode, the only mediums whereby conduction may be set up between plate and grid or plate and cathode are either electronic emission or ionization. Electronic emission is of four types; (*1*)—thermionic, (*2*)—high field, (*3*)—secondary, and (*4*)—photoelectric. Thermionic emission is out of the question because it has been shown that the plate surface cannot reach temperatures necessary for the initiation of such emission. Although secondary emission is common within these tubes, there seems to be no correlation between the incidence of flash arcs and secondary emission. Photoelectric emission might be caused by the soft x-rays generated by the bombardment of the anode by primary electrons of high velocity, but here again there is no definite correlation between the conditions giving rise to x-rays and flash arcs. High field emission from a smooth surface requires potential gradients far above those normally encountered within the tube. Any blistering or flaking

he anode surface would, however, rise to the conditions necessary and ient for formation of such an arc. is a rare possibility in the present of the tube manufacturing art. Thus ionization of gases present within tube is left as a cause of the flash Experimental introduction of small ities of gas into a tube has not given to the type of flash arcs normally d in hard vacuum tubes, so that it t simply a question of ionic conduc- It may be that gases condensed on cool surface of the anode, which is coolest element in the external anode , are suddenly released during opera- in such form that they give rise to field emission or disintergration of gas pocket and the formation of the ltant arc.

is a known fact that flash arcs are frequent in forced-air cooled tubes in water-cooled tubes. The anode of forced-air cooled tube is warmer and efore does not invite the condensation ases such as does the relatively cold r-cooled anode. The temperature dis- ition is of course also more even in air-cooled anode. This, plus the fact flash arcs seldom if ever occur in ation-cooled tubes, even with high- ntial gradients, indicates strongly condensed gases have some definite ct on the occurrence of the arcs.

igure 10 shows the characteristic arc markings on the inside of the le of a high power water-cooled uum tube. Much can be done in the of maintenance procedure to reduce number of flash arcs in any given rational situation, which will be dis- ed later. In the matter of desig it is rtant, if a destructive power arc is to follow the flash arc, that the d-c load protection in the circuit be fast sure. Furthermore, the condensers he circuit between the overload pro- on and the tube anode should be as ll as possible so that the energy stored not be sufficient to cause a destruc- power arc. This indicates that the e blocking condenser be as small as ible, and that push-pull operation is er in this respect than parallel opera- The plate choke should have enough uctance to prevent a rapid rise in cur- from the final filter condenser in the t of a flash arc.

econdary emission takes place to a ceable extent in all power tubes. As henomenon it occurs whenever elec- s impinge on a material with energy more than 10 volts. The maximum ssion takes place at electron energies he order of 600 volts, depending upon material. In the high-power triode, ndary emission from the anode is of importance since the anode in opera- very seldom becomes negative with ect to any of the other elements of tube. Even when the minimum plate age approaches the maximum grid age in certain types of operation, very of the secondary electrons have ugh energy to overcome the potential dient between the grid and the plate. here is considerable secondary emis- n from the grid, however, which pre- ts a very definite problem in tube de- n as well as in the application of the e. Figure 11 shows a typical grid racteristic of a high-power triode. negative slope of the curve as the ential increases indicates that the grid uit of this tube will present a negative

(*Continued on page* 106)

SUPPLY VOLTAGE EFFECT ON TRANSITRON PERFORMANCE

(*Continued from page 64*)

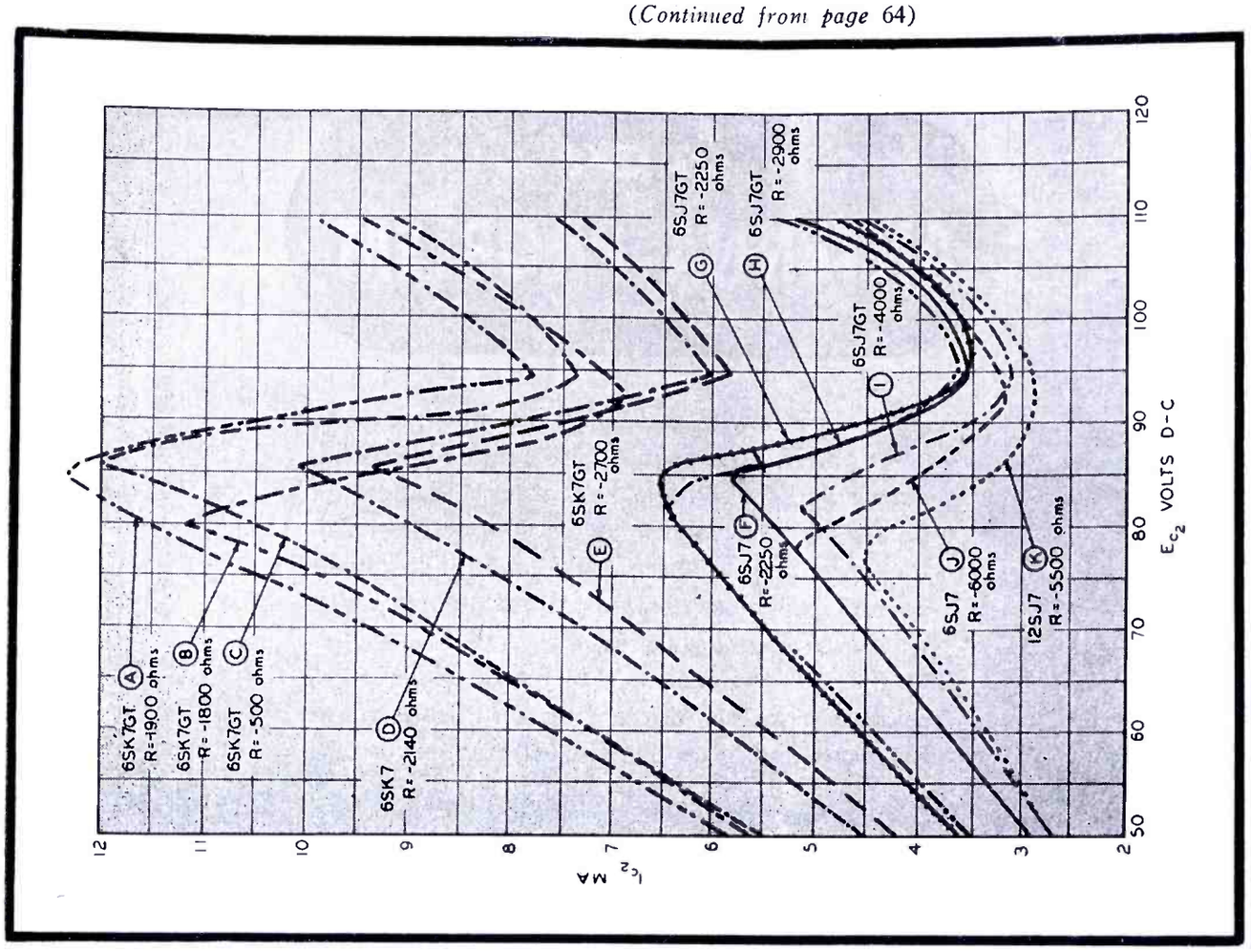


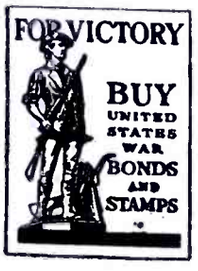
Figure 6

Transitron static characteristics secured Kohler. E_b equals volts; $*E_{c_{3-2}}$ equ —100 volts d-c; equals 0. (*Grid biased —100 v with respect to gri for all points on curv (*A*) test was made July, 1942; (*B*), S tember, 1940; (September, 1940; (*E*) *and* (*F*), Aug 3, 5 and 10, 19 (*G*), December, 19 (*H*), January, 19 (*I*), March, 1942; (September, 1942; a (*K*), March, 19 Negative resista shown for each tube minimum value cal lated from negat slope.

characteristics. Averages for four to six tubes of each make were made. The negative resistance at the *midpoint* of each characteristic for the 6SJ7 or 6SJ7GT varies from –2250 ohms for a 6SJ7 of our make of August 1944 and another manufacturer's tube of December 1942 to –5500 ohms for our 12SJ7 of March 1941. The curves show that a *transitron oscillator* circuit adjusted for oscillation at 82.5 volts E_{c_2} with our 6SJ7 of March 1941 or another tube of September 1942 could be inoperative at the same applied voltages with still another make tube of December 1942 or one of ours of August 1944.

The tube samples we happened to have do not illustrate exactly this state of affairs for the 6SK7 but there is no reason that the same range of variation could not be expected for the 6SK7 or any other pentode as we found for the 6SJ7. Dr. Brunetti's curves for the 6C6 and 57 (theoretically identical tubes except for heater rating) also tend to illustrate our point.

This analysis is not offered to deprecate the advantages and virtues of the *transitron oscillator*, but rather to point out the difficulties which might be expected with the use of standard tube types in transitron circuits with non-adjustable screen and bias voltages.



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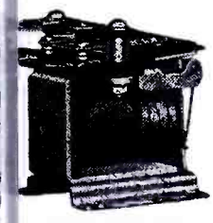
saves time . . . saves tooling . . . speeds delivery!

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

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

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

VARIATIONS OF THE SERIES 345 RELAY



TIME DELAY

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

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

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

INTERLOCKING UNIT

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—The SERIES 345 may be used in combination with various coils to achieve a mechanical interlock. One of the most recent developments is the use of the SERIES 345 in an overload application. Excessive current energizes the SERIES 345 coil. The armature is then mechanically locked in the energized position by an arm attached to a Series 405 coil and is held in the locked position until the Series 405 coil is energized by a push-button arrangement. If current through the Series 345 is still excessive, relay remains in locked position even though released by push-button control.

SERIES 345 RELAY DATA

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

Minimum operating wattage.....2.3

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

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MAY WE COOPERATE WITH YOU ON DESIGN SAVINGS FOR YOUR APPLICATION . . . WAR OR POSTWAR?

ARMY E NAVY

United Transformer Co.

BRIDGE SWITCHING

(*Continued from page* 42)

ance R_x (or an inductor considered as n a combination). This is balanced n a resistance R_s in series with the ndard capacitance arm C. The equa- s of balance include frequency terms. s circuit is most suitable to measure- nts of inductors of high Q_x since the stance R_s varies from a nominal ximum value to zero ohms. If $Q_x > 10$, n the expression for L_x is independent frequency to better than 1%; the ex- ssion for R_x is then largely dependent n a frequency term.

n (*g*) of the *Table* we have an un- ned bridge circuit that balances the allel combination of an unknown in- tance L_x and resistance R_x (or an uctor[2] considered as such a combina- n), with the resistance R_s in series h the standard capacitance arm C. e balance equations for L_x and R_x are ependent of frequency, and the bridge ost suitable to high Q_x measurements. The *Maxwell* bridge circuit for the asurement of inductance, with balance ations for L_x and R_x in series in- endent of frequency, appears in (*h*) the *Table*. The bridge is most suitable low Q_x measurements.

The last bridge circuit (*i*) in the *Table* an unnamed bridge circuit that meas- s the parallel combnation of L_x and The circuit is most suitable for low measurements, in which case the fre- ncy term is important in the equation L_x and not significant in the equation R_x.

Constructional Details

Since electrostatic shielding in an im- dance bridge is absolutely essential to proper operation, the device was as- bled in an aluminum cabinet, and very mmetrically arranged, with the bridge ms located as shown in Figure 2. Elec- omagnetic and electrostatic coupling tween the oscillator and the output cuit is reduced to a minimum by not cluding the oscillator within the bridge binet proper; and external connections these devices are made with shielded axial cords.

The decade resistors of the *A* and *B* ms of the bridge are IRC type WW-4, cept for the 1 and 10-ohm steps, which re non-inductively wound of manganin re. All resistances are within ½% of eir nominal values. An aluminum ield surrounds each decade resistance; ese electrostatic shields are connected the bridge as shown in Figure 2. The and R_p variable elements are General adio 471-A rheostats with scales cali- ated on a Wheatstone resistance bridge. he adjustable 1000-ohm *D* arm was nstructed on a frame similar to the eneral Radio 533-A rheostat, using an proximately logarithmically-shaped card ound with manganin wire to give a tal of 1000-ohms resistance. The rect reading scale of this variable resis- nce was very carefully hand calibrated ith a precision Wheatstone bridge.

The rather large mica capacitance tandards (which give the bridge its reat range) were constructed from thick

(*Continued on page* 84)

[2]Iron core reactors are very often best repre- nted by such parallel combinations of induct- nce and resistance, particularly in communica- on networks. See *Magnetic Circuits and Trans- rmers*, MIT Staff, page 197, John Wiley; 943.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

THE VWOA played host to a record attendance at its 20th anniversary dinner-cruise at the Hotel Astor in New York on February 17. Honored guests included Rear Admiral J. F. Farley, Assistant Chief of Coast Guard Operations; Major General H. C. Ingles, Chief Signal Officer of the U. S. Army; FCC Commissioner E. K. Jett; Major General Frank E. Stoner, Chief of Army Communications; Captain E. M. Webster, Chief of Coast Guard Communications; Brigadier General David Sarnoff, first life member VWOA; Colonel Thompson H. Mitchell, vice president and general manager RCA Communications; Haraden Pratt, vice president and chief engineer of Mackay Radio and Telegraph Company; George W. Bailey, president American Radio Relay League; T. R. McElroy and W. J. Halligan.

One of the highlights of the evening was a message from General Dwight D. Eisenhower. It had been forwarded to General Stoner for presentation at the dinner-cruise. The message read:

"I am duly appreciative of your invitation to me to be a guest of honor at the twentieth anniversary dinner of the Veteran Wireless Operators Association. I regret my inability to accept, but I am glad to testify to the great debt all of us owe to the signalmen in this theater of war. Signal communications are the indispensable servant of command; without them the effective control of a vast modern fighting force would be an impossibility. Signal personnel of this theater has, from the very beginning of the invasion, been characterized by a high order of skill, devotion to duty, and, in the forward areas, exemplary courage and fortitude."

STRIKING messages from Admiral King and Lt. General A. A. Vandegrift of the Marines were also presented.

General Vandegrift said in his salute to the VWOA:

"The great miracle-producing field of wireless communications has contributed vitally to the success of our armed forces. We are deeply grateful to, and proud of, the men who make these miracles possible—the men the VWOA represents.

"Close radio contact with our tactical support planes makes it possible for them to bomb and strafe enemy positions ringing the beach without danger to our own troops.

"With our guns ashore, radio makes it possible for spotter planes to pick out the smaller enemy emplacements and relay their location to our gunners.

"When we come out of the water to strive for a foothold on soil the enemy is fighting bitterly to hold, our separate landing units must coordinate their efforts with all possible precision. All manners of obstacles work against this, but obstacles are overcome and hard-hitting teamwork is maintained principally through the vital ties of wireless communications.

"This success results from our possession of superior equipment operated by courageous and efficient men.

"We are proud of our communications personnel. The entire communications field, to which I am pleased to commend them, can be proud of these men."

Admiral King declared in his message that widespread public acclaim has attended the miracle of modern communications equipment and its contribution to success in this war. He stated that perhaps too little has been said of the human element in war communications.

Paying tribute to radio operators he declared that. . . . "It is my wish to emphasize his fighting participation so that full recognition may be accorded the similarity and identity of purpose which exist between the communicator at his radio key and the gunner at his firing key—a similarity which reaches its full synthesis in modern combat."

Lt. Gen. A. A. Vandegrift, Commandant of the U. S. Marine Corps, who sent a special communications message to the 20th annual dinner-cruise of the VWOA.

Awards

THE Marconi Memorial Medal of Achievement was awarded to Dr. Allen B. Du Mont. . . . The Marconi Memorial Medal of Service went to R. Morris Pierce in recognition of his outstanding service to the cause of the United Nations in connection with the Italian Fleet and Luxembourg Radio incidents. . . . William J. McGonigle received a Marconi Medal of Brotherhood "in appreciation of earnest years of devotion to the growth and good of the association." . . . Orrin E. Dunlap, Jr. received the Marconi Memorial Medal of History. . . . A posthumous Scroll of Appreciation was awarded to William S. Fitzpatrick—*Pioneer in the wireless art—charter member and earliest worker in the founding of our Association.*

Honorary memberships were awarded to Major General Frank E. Stoner, Donald McNicol, former IRE president; Lawrence J. Dunn, Chief Radio Aide to the Chief Signal Officer of the Army; and Hugo Gernsback.

Life memberships were awarded to Henry Steinberg, a pioneer in wireless, now a manufacturers representative in New York; Paul Godley, consulting engineer and famous for his work in the trans-Atlantic tests for the *hams* way, way back; Louis G. Pacent, Sr., pioneer development engineer; and Lewis Winner, who has had as varied a career as any of us and is now editor of COMMUNICATIONS and editorial director of SERVICE.

IRE WINTER MEETING REPORT

(*Continued from page* 56)

dock. On several occasions the low-driving power requirements of the tube were demonstrated by driving the 14 m-c amplifier to its full rated 1000 watts input by means of a standard Meissner signal shifter. Mr. Murdock explained that the signal shifter consists merely of an oscillator-doubler unit, with a 6L6 as the output-doubler stage.

100-mc Tests

For tests at 100 mc and above, a unit utilizing linear grid and plate tank circuits was employed, Mr. Murdock pointed out. He said that there were no significant differences between the operation of the tubes at 14 and 100 mc. The driving power at 100 mc was found to be less than 5 watts per pair, he said, and there was no difficulty in obtaining a plate-circuit efficiency of 75%.

Filament voltage is 5 volts; current, 6.3 amperes.

[*Additional digests of IRE Winter Meeting papers will appear in the March issue of* COMMUNICATIONS.]

BRIDGE SWITCHING

(*Continued from page* 81)

mica sheets obtained from condensers formerly utilized in spark transmitters. By a tedious process, the high-voltage capacitors were torn down and reassembled with the mica sheets split to minimum thickness. This was found most easily accomplished by wetting the mica sheets, and starting a split with a razor blade. A magnifying glass was helpful on the eyes during this process. Once the split was made in a mica sheet, it was continued most readily by use of a smooth needle and immersion in water which greatly facilitated the separation of the mica laminations. It was, of course, necessary to thoroughly dry out the mica sheets by baking in an oven prior to their use. The condensers were assembled from alternate sheets of thin tin foil and mica, temporarily clamping each assembly from time to time and its total capacitance measured. Each capacitance was made a few per cent too large; then impregnated with beeswax compound, clamped while still warm, and allowed to cool. In order to adjust them to their respective nominal values, the completed condensers were placed in their separate mountings and their capacitances measured. These capacitances were high. A portion of one condenser sheet was then removed from each condenser, and reassembled and remeasured. After a few trials, the assembled condensers were finally adjusted to within the precision of measurement to the desired nominal values. All measurements were made by a substitution method, with a laboratory decade capacitor as the standard. The assembled general-purpose bridge was utilized as the measuring device, using an auxiliary condense in the C_x arm. Since a substitution method was used, the final capacitance adjustments were correct to within a per cent of the capacitance standard, which itself had a limit of error of 0.25%.

Shielded Transformer

The secret of the successful operation of an impedance bridge lies in the isolating transformer required to change from the balanced bridge arms back to a single-side or grounded condition.[3] The shielded transformer utilized in this bridge was constructed from a high-quality, shell-type 3:1 ratio a-f transformer. After disassembly, approximately one half of the inner part of the outer (or secondary) winding was removed, reducing the turns ratio of the transformer to approximately 1½:1. This left a gap between the two windings. A sheet of thin tin foil was wound around the outside and inside of each winding, leaving small overlaps with insulation between to prevent the formation of short-circuited turns. A lead was brought out from both the outer and inner shields of the two windings. These electrostatic shields must, of course, be insulated from each other and from the core. The transformer was then reassembled with small spacers between the windings, as shown in the cut-away view in Figure 6, and the entire device treated to a beeswax impregnation.

The shielded transformer eliminates the electrostatic coupling between the two windings; balances the stray-ground ca-

[3] See *Shielded Transformers for Impedance Bridges*, General Radio Experimenter, Vol. X, No. 5; October 1935.

ritances of the windings so as to shunt ually the *C* and *D* arms of the bridge; d reduces these shunting-ground ca- citances to a minimum. These con- ions thereby completely determine the nnections of the shields, which are de as shown in Figure 2.

The winding closest to the core, *pri- ary* in Figures 2 and 4, has the highest pacitance to ground, and is therefore ilized as the output winding; both electrostatic shields are connected to ound (the aluminum cabinet). The *ter* winding has a minimum capacitance ground, and is therefore connected to junctions of the *A-C* and *B-D* arms. he outer shield of this winding is con- cted to its outer winding terminal; e inner shield to the inner winding rminal. This outer winding is identi- d as *secondary* in Figures 2 and 4.

Finally, the primary and secondary nding terminals are shielded from each her by the transformer core which is so grounded to the aluminum cabinet, igure 4.

idge Accuracy

The only devices required to calibrate e bridge are a good Wheatstone d-c idge for measurement of the fixed and riable resistance arms of the bridge, d a precision standard of 1.0, 0.1 and 01-microfarads capacitance for calibra- on of the capacitance arm *C* of the idge.

If the highest accuracy is desired for easurement of R_x and Q_x of elements nder test, more exact values than those hich can be marked on the R_s and R_p ales are required. These more exact alues (to the full accuracy of the bridge) ay be obtained by measuring these antities on the general-purpose bridge self, as follows:

If R_s has been used for the loss com- onent balance, after the measurement as been made, disconnect the element nder measurement from the bridge nd turn the decade switches as shown *Table I;* decades *A, B* and *D* on ohms, nd decade *C* on (R_s). (It will be noted rom Figure 2 that this places R_s across he R_x binding posts.) Then balance he bridge for resistance in the usual anner.

The resistance R_p can likewise be de- rmined by setting the decade arm *C* on (R_p), and *A, B* and *D* on ohms as shown *Table I.* This measurement can be ade either on d-c or on a-c with sen- ibly the same results.

Since the arms of the general-purpose idge are accessible externally, all de- ade and variable resistances as well as he capacitance decades can be calibrated gainst standards from time to time and he corresponding exact values utilized n the balance equations given in *Table I,* if a maximum of accuracy is desired rom the bridge. This refinement is ardly justified, however, since the bridge ccuracy is practically limited by the recision of settings which is of the rder of 1%.

Considering the fact that no special recautions were taken in the construc- ion of the bridge except to choose com- onents within ½% of their nominal val- ues, the accuracy of the bridge is quite good. For d-c resistance measurements, the accuracy is within the precision of reading of the bridge, about 1%, except for the extreme ranges. For a-c resis-

(*Continued on page* 103)

NEWS BRIEFS

NAVY SEEKING NEW INVENTIONS

The Navy has turned over to the National Inventors Council, of which C. F. Kettering is chairman, several communications problems for industry solution. Solutions to the problems which appear below should be prepared in sketch and description form and sent to the National Inventors Council, Department of Commerce, Washington, D. C.

The problems are: (1) **A small portable field strength meter** about the size and weight of a walkie-talkie for rapid checking of radio field intensities in the vicinity of radio transmitting stations. The instrument must be simple to use and accurate within plus or minus 10%. Frequency range desired is 100 kc to 20,000 kc. The range of field intensities desired is from 10 to 1,000 millivolts per meter. (2) **Radio antennas** up to 300 feet in height that can be set up by unskilled ground crews. The efficiency of radio devices is often limited by the extreme difficulty of obtaining reasonable antenna heights quickly in the field. Very light alloys and special rigs for rapid erection by a ground crew without climbing are desired, in addition to ability to dismantle or collapse into packages not exceeding 20 feet in length. Insulated base vertical antennas are preferable but grounded base type could be used if the device had enough other advantages in the way of ease of erection and ruggedness. (3) **A precision twin-triode vacuum tube** with general characteristics of the current 6SN7 type having the following additional precision features:

1—After a fifteen minute warm-up, the gm of the two sides shall be equal over the normal operating range to within + 1%.

2—The tube shall be completely nonmicrophonic.

3—The above characteristics to be maintained over an ambient temperature range + 80°C to —40°C.

4—It would be possible to produce this tube by mass production methods with not more than 10% rejects.

Note—Tubes presently available in production permit excessive variation in grid-plate conductance in the separate halves of the tube.

* * *

NAB CONVENTION CALLED OFF

The National Association of Broadcastors has cancelled its annual convention which would normally be held in the late spring. NAB district meetings will continue to be held, provided they conform in all respects to the government's travel rulings.

* * *

1945 TUBE NEEDS UP 25%

Receiving tube requirements for 1945 will be about 25 per cent higher than the 12,000,000 a month required in 1944, according to WPB. To advise on any methods that may be necessary to achieve this increased production, a radio tube task committee has been created.

The committee indicated that existing manufacturing facilities, if fully utilized, are sufficient to increase production to the extent required, in spite of the fact that the lower schedules for 1944 were not quite met.

* * *

DR. TERMAN NOW STANFORD U. DEAN

Dr. Frederick E. Terman has been appointed dean of the Stanford University School of

●

MEASURING MOLECULE SIZE

Dr. Paul M. Doty, research associate at the Polytechnic Institute of Brooklyn, with the rayleighometer for determining the shape of molecules. Scattering of light principle is used.

gineering. He is, at present, head of the dio Research Laboratory at Cambridge, ssachusetts
Dr. Terman has been executive head of anford's department of electrical engineering ce 1937. In 1941, Dr. Terman served as esident of the Institute of Radio Engineers.

* * *

AIRNES BECOMES GALVIN OME RADIO CHIEF ENGINEER

m. E. Cairnes has been appointed chief gineer of the home radio division of Galvin anufacturing Corporation. Gus Wallin will assistant chief engineer of the same division.

W. E. Cairnes

G. Wallin

* * *

PB ISSUES 1945 CRITICAL ATERIAL REPORT

report submitted by the WPB to the FCC vering the requirements of the military for 45, states that aircraft, special and emer- ncy services and marine craft will receive e bulk of approvals for equipment for 1945. The report discloses that WPB is endeavor- g to equip all planes operating as common rriers with the necessary communication uipment. Some equipment may be available r other planes used in essential services. It is expected that more equipment will be ailable for special and emergency services. elease of such equipment is no longer re- ricted mainly to police systems, but it is w available to public utilities and other ers. The use of such equipment will often sult in increased efficiency and pay dividends the use of manpower. There may not, wever, be enough equipment to fulfill all quirements for essential public services and ar industries.

A number of boats are being made available fisheries. Where possible, these boats will e equipped from existing stocks of equipment. o equipment is contemplated for tugs, barges, c., or for fresh water fishing vessels.

In connection with broadcast station equip- ent the WPB has advised the Com- ission that: "Installation of new broadcast- g services will be reviewed with extreme re. All such applications received and show- g that the required equipment was on hand, ere approved until the latter part of Decem- er. The increasing problem of finding man- ower for war industries has made it neces- ary to consider the manpower needed to con- truct, operate and provide maintenance for dditional stations.

"It is not felt that the general premise that roadcasting is in the war interest' will longer uffice to support the use of manpower and aintenance materials for new stations. Ap- lications must be critically reviewed from the tandpoint of available manpower and the need or the service to contribute to the war effort. he use of manpower cannot be approved nless an actual contribution is to be made."

Certain types of changes in facilities may be ade without WPB approval. For instance, ew installations costing less than $500 may e made on shipboard without WPB approval. n general, any change not involving con-

(*Continued on page* 88)

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1,000,000 CRYSTALS

North American Philips Company employees with the millionth quartz crystal unit produced for the U. S. Army Signal Corps.

NEWS BRIEFS

(*Continued from page 87*)

struction work and costing less than $500, but not requiring the purchase of a transmitter or receiver, is allowable. This dollar limit is raised to $2,500 in the case of international point-to-point stations (which does not include international broadcasting). No radio operator may start construction which will cost more than a fixed amount unless he has WPB approval. In most cases, the limit is $200 for cost of materials, new equipment and labor.

* * *

McRAE RETURNS TO EASTERN AIR LINES

Colonel Don C. McRae has returned to Eastern Air Lines as superintendent of communications after serving in the armed forces since May, 1942.

Colonel McRae assisted in the coordination of airway communications along the North Atlantic air routes. He served in the American Defense Theatre and the European-African-Middle East Theatres.

* * *

H. P. SEGEL MOVES

Henry P. Segel Company has moved to 143 Newbury Street, Boston, Mass. Branch offices are at 474 Woodland Street, Hartford, Connecticut.

* * *

ELECTRO-VOICE SALES REPS MEET

Recently appointed sales representatives of Electro-Voice microphones, attended a three-day conference at the plant in South Bend, Indiana, several weeks ago.

Representing Electro-Voice at the conference were: Louis Burroughs, chief engineer; A. M. Wiggins, research engineer; Albert R. Kahn, president; R. W. Augustine, sales manager; and Robert E. Seikman, production manager.

Electro-Voice sales representatives at the conference were: Art Cerf and Joseph Marsey, Art Cerf & Co., New Jersey; J. P. Davenport, Michigan; C. L. Pugh, C.L. Pugh Co., Ohio; Maitland K. Smith, Georgia; M. D. Patterson, Texas; Maury E. Bettis, Missouri; Adolph Schwartz, New York; M. D. Ely, Southern California; W. C. Hitt, Northern California; George D. Norris, Washington; and L. A. de Barros, (export agent) Rock International, New York.

Louis Shappe, president of the Shappe-Wilkes Advertising Agency, New York, handling the Electro-Voice account also attended the conference. He declared that advertising must place special emphasis on technical literature designed to inform.

Seated, background: M. D. Patterson; Joe Marsey; Adolph Schwartz; Leo de Barros; Maury Bettis. Standing, background: Bob Seikman; Louis Burroughs; Albert Kahn. Seated, foreground: Richard Augustine; Maitland K. Smith; J. P. Davenport; Art Cerf; C. L. Pugh.

* * *

CAPT. DOW NOW DIRECTOR OF ELECTRONICS

Captain Jennings B. Dow, USN, has been named director of electronics for the Bureau of Ships. Captain Dow has for several years headed the radio division of the Bureau.

* * *

F. J. BINGLEY ELECTED TBA VICE-PRESIDENT

Frank J. Bingley, chief television engineer of the Philco Radio and Television Corporation,

elected vice president of the TBA to ceed Robert L. Gibson of G.E. Mr. Gibson, o was recently appointed advertising and s promotion manager of the chemical de- tment of the General Electric Company ted that his new post will take him out of ct television activity. The vacancy on the rd, caused by his resignation, has not been ed.

* * *

LLEY JOINS U. M. C.

nford Kelley has been appointed electro- hanical engineer at Universal Microphone . Inglewood, Cal. He was formerly with telfuse, Inc.

* * *

UALITY CONTROL RATING D CLAROSTAT

approved quality control rating has been arded for the third time, by the Army Air ces, to Clarostat Mfg., Co., Inc., Brooklyn, Y.

* * *

CK NOW WGL CHIEF ENGINEER

ward J. Beck had been made chief engineer Farnsworth's broadcasting division, including ir newly acquired station WGL.

Mr. Beck was formerly chief engineer of the stmoreland Broadcasting Company. He has n with Farnsworth since 1939. In 1942 he s appointed chief engineer of the Fort yne plant.

* * *

T. & T. F-M BOOKLET

12-page brochure covering wide-band trans- sion facilities has been released by the erican Telephone and Telegraph Company. booklet discloses that the Bell System ady is furnishing studio-transmitter links many f-m stations. These links transmit requency band of 15,000 cycles as specified the FCC. It was stated that present broad d carrier telephone facilities can readily be apted for 15,000-cycle program circuits, if de- d, by adding special terminal equipment.

nalyses in the booklet cover network prob- s. According to these data the Bell System l be able to furnish inter-city circuits of kind needed including 15,000-cycle circuits hey are required.

ell System engineers say, too, that if other ans than wire circuits should prove better, more economical for f-m program transmis- n, these systems will be used, citing as evi- ce A. T. & T.'s projected microwave radio- y system between New York and Boston.

* * *

CA THEATRE TELEVISION HANDBOOK

handbook, "Theatre Television Handbook for ojectionists" has been prepared by the RCA

(*Continued on page* 90)

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CMDR. WASSELL AT LEWYT PLANT

mmander Corydon M. Wassell, USNR, o "r. Wassell" fame, with Alex M. Lewyt, pres- nt of Lewyt Corporation, during a Navy and d Cross rally at the plant. Lewyt employees ard Dr. Wassell discuss communications' major role in the war.

NEWS BRIEFS

(*Continued from page 89*)

Service Company for theatre managers and projectionists.

Although the contents are primarily devoted to technical discussions of the reception and large-screen projection of television programs, several chapters deal with such non-technical subjects as television commercial possibilities, the handling of programs, and audience response.

Technical data covers a review of electrical fundamentals of video circuits, sweep and synchronizing circuits, and the operation of a television system. The theory and operation of diodes and rectifiers, voltage amplifiers, and limiters are also explained.

The book will be mailed without charge to theatre owners, managers, and projectionists upon request to the RCA Service Company, Inc., Camden, N. J.

* * *

WCEM ELECTS THOMAS PRESIDENT

Howard Thomas, general manager of Packard Bell Company, was elected president of the West Coast Electronics Manufacturers' Association at the recent annual meeting.

Other officers elected were: Lew Howard, Peerless Electrical Products Co., vice president; and James L. Fouch, president of Universal Microphone Co., treasurer.

A council which will include the officers, and former president H. L. Hoffman; Dave Marcus, manager of Electronic Specialty Co.; Frank Fisher, Radiation Products, Inc., and Ashford Wood, of Littelfuse, Inc., was also formed.

* * *

NORTH AMERICAN PHILIPS BULLETINS

Two booklets, covering the Norelco Geiger-Counter x-ray spectrometer and x-ray diffraction techniques, respectively, have been announced by North American Philips Company, Inc., 100 East 42nd Street, New York.

Under optimum conditions of resolution, an accuracy of ± 0.03 of a degree is said to be obtainable.

Included also are data on methods of operation, and specifications for the spectrometer proper, transformers, stabilizer, scaling unit, power supply, frequency meter, impulse counter, Geiger unit, and x-ray tube.

X-ray diffraction techniques and applications data appear in a 12-page booklet.

Diagrams, typical diffraction films, and several tabulations are supplied.

The booklet also catalogs specific problems that can be handled for alloys, asbestos, carbon, case hardening, cellulose, cold-rolled steel, dry cells and batteries, electric silicon steel, paper and parchment, plastic film, resin, resistance alloys, rubber, tungsten, waxes and waxed papers.

An 8-page folder titled "Some Problems Influencing the Drawing of Fine Wires" by H. P. Edinga, wire division manager, has also been released by North American Philips. It is a reprint of a technical paper presented before the annual meeting of the Wire Association at Pittsburgh.

The folder covers drawing problems particularly with respect to the cold-drawn types. Machines, labor, lubrication, diamond dies and production output are a few of the items mentioned in the discussion.

* * *

SCHWENKER JOINS BENWOOD LINZE

Jack F. Schwenker has been named manager of the new Chicago office of Benwood Linze

●

HANDIE TALKIE AT ROSE BOWL

(*Courtesy Motorola*)

Captain C. F. Morris (left) and Chief Neil F. Anderson of the Pasadena (California) police force directing traffic with a handie-talkie at the Rose Bowl game.

lectrical Manufacturing Company, St. Louis, Missouri. The Chicago address is 20 North Wacker Drive.

* * *

WRIGHT RETIRES FROM ELECTRIC SPECIALTY

John M. Wright, has retired as president of Electric Specialty Company, Stamford, Conn. David G. Shepherd succeeds Mr. Wright as president. W. H. Haines, sales manager, has been elected vice president and general sales manager.

* * *

T-B X-RAY FOLDER

An 8-page booklet with data on the postwar possibilities of x-ray and other scientific testing equipment has been published by Triplett & Barton, Inc., Burbank, Calif.

Issued to those making request on company letterhead.

* * *

OWEN NEW AEROVOX PRESIDENT

V. Myron Owen has become president of the Aerovox Corporation. Mr. Owen recently resigned the vice presidency of the Detroit Harvester Company, of which he remains a director. He is also a director of Duncan Electrical Mfg. Co., the Chicago Rivet & Machine Co., and the Seneca Falls Machine Co.

Associated with Mr. Owen is Stanley Green who is now vice president and chief engineer of Aerovox. Samuel I. Cole, retiring Aerovox president, remains as general manager. Samuel Siegel, who was vice president, remains with the company as director of purchases.

* * *

R. H. MAYER ADDRESSES THE CEDAR RAPIDS IRE

Rollins H. Mayer, chief engineer of The Turner Co., Cedar Rapids, Iowa, analyzed **The Noise Cancellation Differential Dynamic Microphone** at a recent meeting of the Cedar Rapids section of the Institute of Radio Engineers.

* * *

NAME CHANGE FOR TECKNA

The Teckna Plastic Company, 223-01 Northern

(*Continued on page 92*)

●

GEN. INGLES AT HALLICRAFTERS

Major General H. C. Ingles, Chief Signal Officer (right), during a visit to Hallicrafters. Left to right: Herbert Hartley, works manager, and William J. Halligan, president of Hallicrafters.

NEWS BRIEFS

(*Continued from page* 91)

Boulevard, Bayside, L. I., N. Y., fabricators of plastics, and product-engineers, has changed its name to the Teckna Company.

* * *

COMAR ELECTRIC CATALOG

A four-page circular describing relays, switches, condensers and coils has been released by Comar Electric Company, 2701 Belmont Ave., Chicago 18, Illinois.

* * *

GLENN-ROBERTS COMPANY MOVES

The Glenn-Roberts Company has moved to a new plant at 3100 East 10 Street, Oakland 1, California.

* * *

WILSON NOW PHILIPS CRYSTAL UNIT MANAGER

Wesley L. Wilson has been appointed commercial manager of the quartz crystal division of North American Philips Company, Inc.

* * *

NEWARK ELECTRIC OPENS N. Y. STORE

A New York City branch at 115 W. 45 St., has been announced by the Newark Electric Company, 323 W. Madison St., Chicago.

The new unit will be known as the Newark Electric Co., Inc., and will have as its president, Adolf Gross. For the duration, Mr. Gross continues as consultant to and purchasing agent for the ERSA. Stanley Cojala will be manager of the store, and Edward Cornfield will also participate in store activities.

Sam Poncher is president of the Chicago unit.

Sam Poncher

* * *

IT'S NOW BITTAN-NEVINS CO.

The D. R. Bittan Sales Company, 53 Park Place will hereafter be known as the Bittan-Nevins Co. Irvin Nevins and Dan R. Bittan are partners in the company.

* * *

MAGNAVOX OPENS CHICAGO OFFICE

The Magnavox Company has opened a Chicago office at 737 North Michigan Avenue, with Ray Olson in charge.

Telephone number of the new office is Delaware 1707.

* * *

J. W. CHAPLIN IN NEW PRESS WIRELESS POST

Joseph W. Chaplin has been named director of communications for Press Wireless, Inc. Mr. Chaplin succeeds D. K. deNeuf, who recently resigned. He is a former world champion telegrapher.

* * *

G. E. APPOINTMENTS

Howard K. Smith, formerly in the federal and marine divisions of the G. E. apparatus department, has been appointed assistant to A. A. Brandt, general sales manager.

J. M. Lang has been appointed assistant manager of the Ken-Rad division of G. E.

L. R. O'Brien and R. W. Metzner, former executives in the Ken-Rad Tube and Lamp Corporation, will serve as sales managers in the G. E. tube division.

Mr. O'Brien will be in charge of equipment tubes, and Mr. Metzner will be sales manager of replacement receiver tubes.

Claude J. Hendon has been appointed manager of sales in the G. E. tube division.

* * *

STEPHENS WINS HUDSON-AMERICAN PROMOTION

Henry A. Stephens has been appointed manager of Hudson American Corporation's newly created advertising and public relations division located at 331 Madison Avenue, New York.

* * *

OVER 600 MILLION RESISTORS SHIPPED IN 1944

The fixed and variable resistors industry shipped 398,361,000 resistor units valued at $35,066,000 in 1943 and 600,496,000 units valued at $48,000,682 in 1944, WPB revealed recently. The average cost per resistor ranged from

TECHNICAL NOTES

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

in August 1943, to 7.1c in January, 1945, eduction of 31 per cent.

* * *

ELEFSON AND JONES PROMOTED SYLVANIA

Dr Bennett S. Ellefson has been appointed sistant to the vice president in charge of neering, Sylvania Electric Products, Inc. office is located at Sylvania Center, Bay- Long Island.

alter R. Jones has been assigned to the ly created post of general engineering ager for radio receiving tubes at Sylvania. Jones was formerly manager of commercial neering.

Dr. B. S. Ellefson W. R. Jones

* * *

EE DISTRIBUTION FOR DIO ENGINEERS' DIGEST

Hudson American Corporation have announced that **The Radio Engineers' Digest** will after be distributed without charge.

* * *

NCHARGER BUYS TOMATIC RECORD PATENT

Benjamin patent (1,841,593) for automatic nograph record changers has been purased by the Wincharger Corporation, Sioux Y, Iowa.

he patent is said to basically cover drop e inter-mixing record changers, permitting ndling of either 10" or 12" records, or a nture of both sizes, without requiring any ustment.

* * *

BINSON JOINS ARHCO

Homer (Robby) Robinson has been appointed vice president and general sales manr of the American Radio Hardware Comy, Inc., 152-4 MacQuesten Parkway South, unt Vernon, New York.

r. Robinson was formerly with National on Radio Corp. as district manager, export advertising manager, and more recently eral sales manager.

* * *

E BEGINS BUILDING-FUND MPAIGN

Institute of Radio Engineers recently ugurated a campaign for the raising of ,000 for a building fund, in anticipation of war expansion of its service to the elec- ic and communication industries.

* * *

AR BUILDS AIRPORT RADIO SHOP

airport service station for aircraft radio just opened at the Grand Rapids, Michi- Municipal Airport, by Lear, Incorporated. Sagert is in charge.

he shop has two shielded testing rooms, for the service of all types of automatic ction finders only, and the other for the ing of aircraft receivers and transmitters.

* * *

AWARDS

Army-Navy "E" award has been won by mmercial Radio-Sound Corp., 570 Lexington enue, New York 22, N. Y. A. Lincoln Bush resident of the company.

rco Radio Laboratories, Inc., Hempstead,

(*Continued on page* 94)

NEWS BRIEFS

(*Continued from page* 93)

L. I., N. Y., has received a second star for their "E" pennant.

A third star has been added to the "E" flag of RCA Laboratories at Princeton, N. J.

A fourth white star has been awarded to the Bayonne, N. J., plant of the Solar Manufacturing Corp., and the Cambridge, Mass., plant of General Radio Company.

* * *

ROY S. KERCHER JOINS GRAYHILL

Roy S. Kercher has been named chief electrical engineer of Grayhill, La Grange, Illinois.

Mr. Kercher was formerly with the Furnas Electric Company.

* * *

JACK GEARTNER JOINS ECA

Jack Geartner has been appointed sales manager of the Electronic Corporation of America, 45 West 18 Street, New York.

Mr. Geartner was formerly assistant sales manager and advertising director of Emerson Radio & Phonograph Corp.

* * *

WESTON TEST INSTRUMENT DATA

An 8-page booklet covering an industrial circuit tester and other test instruments has been published by the Weston Electrical Instrument Corporation, Newark 5, New Jersey.

* * *

ROBINSON VIBRATION CONTROL BOOKLET

A 16-page booklet discussing vibration control has been published by Robinson Aviation, Inc., 730 Fifth Avenue, New York 19, N. Y.

Various types of Robinson shock mounts for instrument panels and equipment are described. Vibration absorption curves are also presented.

* * *

E-I SEALED TERMINAL LEAFLET

Hermetically-sealed terminals are described in a leaflet released by Electrical Industries, Inc., 42 Summer Avenue, Newark 2, N. J.

* * *

TELEX HEARING AID DATA

Hearing aid design, development and application, is analyzed in a 24-page booklet, released by Telex Products Company, Telex Park, Minneapolis, Minn.

* * *

UNITED ELECTRIC THERMOSTAT BULLETIN

A 4-page bulletin covering type K thermostats for control devices between —120° and 600°F has been published by the United Electric Controls Company, 69-71 A Street, Boston 27, Massachusetts.

* * *

B. J. THOMPSON DEAD

B. J. Thompson, associate research director of RCA Laboratories, was killed recently during flight in an Army plane in the Mediterranean area.

(*Continued on page* 104)

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AT EPEM LUNCHEON

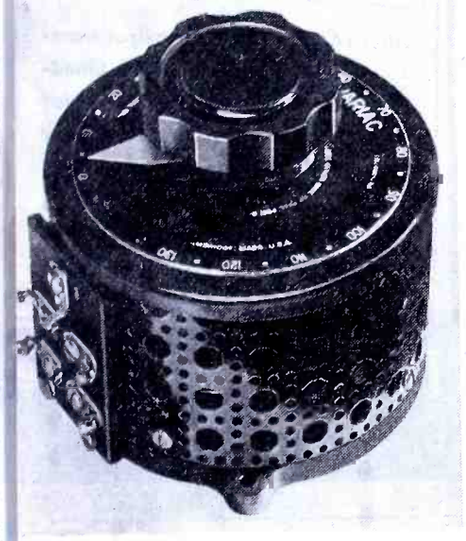
At a recent luncheon of the Electronic Parts and Equipment Manufacturers (formerly the Sales Managers Club, Western Division) in Chicago.

THE INDUSTRY OFFERS . . . —

. R. 400-CYCLE VARIAC

400-cycle, 5-ampere Variac, type 60-A, for -volt use, was recently developed by Gen- l Radio Company, 275 Massachusetts Ave- e, Cambridge 39, Mass. Rated nominally at cycles, can be used at any frequency be- een 400 and 2600 cycles. The rating is 860 t-amperes. Output voltages up to 135 volts obtainable with 115-volt input. A new e of brush and radiator construction is said be used so that brushes, when necessary, be changed in a few seconds.

Available either with or without case. The erall height is 4⅛"; overall diameter 5½". t weight is 3½ pounds cased; 3 pounds, 2 nces without case.



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.E. LICENSES TAYLOR TUBES

he General Electric Company has granted a ense to Taylor Tubes, Inc., 2312 Wabansia ve., Chicago, to manufacture grid-controlled ctifier tubes.

As a result of this license, Taylor has placed vo new tubes into immediate production. They e the TT-17 and the 873. The former is mparable to the GE-FG17 and the latter is 872A with an added grid control.

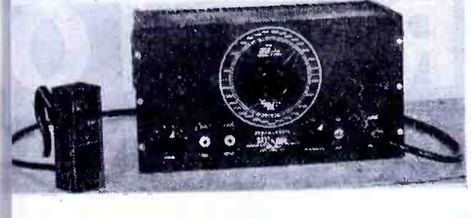
Specifications of the TT-17 are: Filament, 5-volts a-c at 5 amps; inverse peak plate ate volts, 5,000 volts d-c at 2 amperes; aver- ge plate current, ½ ampere; negative start- g grid voltage; mercury-vapor type; size, ¼"x2⅛"; small 4-pin ceramic base with fila- ent and grid connection to pins.

* * *

CML STROBOSCOPE

stroboscope that is said to permit studies of otary speeds from 600 to 600,000 rpm or vi- rations from 10 to 10,000 cps has been an- ounced by Communication Measurements aboratory, 120-24 Greenwich Street, New ork.

The model, 1200, uses a light source mounted a small probe at the end of a 5-foot flexible ible. Provision is made to operate the unit om external tuning fork or crystal standards. A light intensity control switch is also pro- ided. This enables the user to control both he intensity of the light and the duration of he pulse length.



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ASSOCIATED RESEARCH GROUND RESISTANCE TESTER

ow and high-ground electrical resistance test-

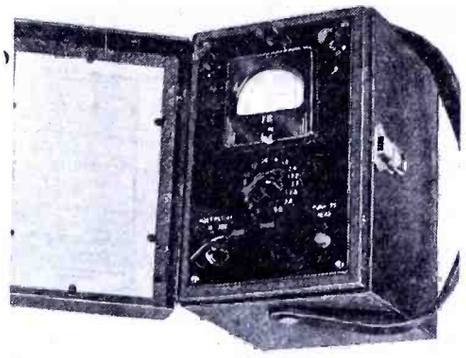
(*Continued on page* 96)

THE INDUSTRY OFFERS . . . —

(*Continued from page 95*)

ing is provided by a unit, the 255 Vibroground, manufactured by Associated Research, Incorporated, 231 South Green St., Chicago 7, Illinois.

Has four ranges 0-3, 0-30, 0-300,0-3000 ohms. Supplied with self-contained power supply which eliminates hand cranking. Direct readings are provided. Design is said to exclude strays from high potential networks, d-c ground currents, or any a-c commercial frequencies.



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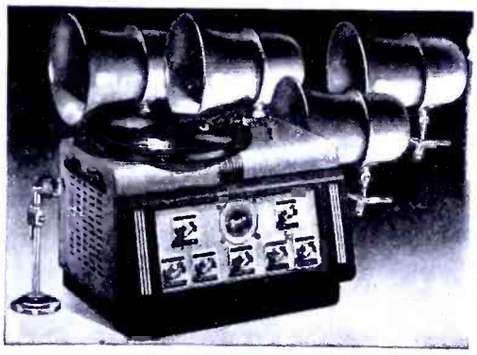
ALLIED 60-WATT P-A SYSTEMS

All-purpose 60 watt p-a systems have been announced by Allied Radio Corporation, 833 West Jackson Blvd., Chicago 7, Illinois.

Amplifier has four individually-controlled microphone channels, two individually-controlled phono channels, universal output for matching any arrangement of speakers, individual controls for high and low frequencies. Available separately or with any combination of speakers and microphones, depending upon individual requirements.



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THREE-INCH C-R TUBE SHIELD

A shield for 3" cathode-ray tubes, M-996a, has been developed by Metallic Arts Company, 243 Broadway, Cambridge 39, Massachusetts.

Shield is said to provide protection against vibration and shock with a shock absorbing cushion built into the clamp ring and by a gum rubber gasket around the tube face. Mechanical protection for the tube is provided by a transparent screen, available in either plain or colored lucite. The shield body, formed of Mu-metal, is cadmium plated, and has a blue-baked wrinkle outside finish.

• • •

S-D LATCH INTERLOCK RELAYS

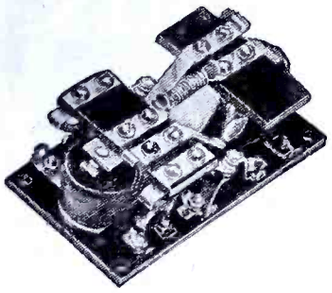
Two-coil relays 50XB□, are now available from Struthers-Dunn, Inc., 1321 Arch Street, Philadelphia 7, Pa.

Relays are said to use a positive interlock between two symmetrical operating elements which represents latch-in relay construction. This latch operates from a momentary impulse. Application of power to one coil latches the contacts into one position. Power then applied to the other coil throws the contacts into a latched-in second position. A third "matched"

position, for certain applications, can be obtained by energizing both coils simultaneously.

Relays are produced in ratings from 6 to 200 amperes or more, and with practically any desired contact arrangement. Standard types provide for two auxiliary contacts, one in each coil circuit. The use of auxiliary contacts makes it possible to obtain operation over wide ranges of voltages, a-c or d-c.

Size of one type of these relays, 50XBX103, having double-pole, double-throw main contacts, and rated at 6 amperes at 24v d-c is 3 7/16" long; 1 7/8" high; and 1 5/8" wide.



* * *

RCA AUDIO CHANALYST

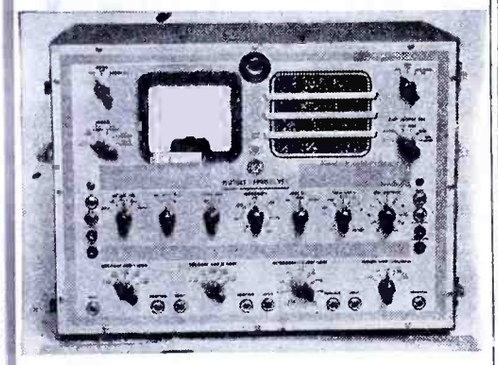
A new model of the audio chanalyst has been announced by the RCA Victor Division of RCA.

This model, 170A, is said to provide testing of any point of a sound system from microphone to speaker, serving in emergencies as a bridging unit to substitute for the defective section of an inoperative amplifier.

The chanalyst contains a calibrated high-gain amplifier useful for signal tracing, tube checking and gain measurements. It supplies its own test signal from a built-in beat-frequency oscillator, which can be operated by an internal auxiliary sweep circuit for checking multiple speaker installations.

The voltohmyst included as one of the channels is said to have been modified for flat, linear measurement of audio frequencies.

An impedance tester and a high-speed electronic indicator is also included.



* * *

AMPERITE DELAY RELAYS

A thermostatic metal-type delay relay with porcelain heater providing delays ranging from 1 to 120 seconds has been developed by Amperite Co., 561 Broadway, New York 12, N. Y.

Relay is also said to be compensated for ambient temperature changes from —40° to 110°F. Contact ratings up to 115 volts, 10 amperes, a-c. Hermetically sealed. Octal radio base. Circuits available are spst normally open; spst normally closed.

* * *

STACKPOLE INSULATED RESISTORS

Insulated resistors, type CM, available in 1/3-(RC-10); 1/2-(RC-21); and 1-watt (RC-30)

(*Continued on page* 98)

THE INDUSTRY OFFERS . . . —

(*Continued from page 97*)

sizes in all required ranges are now being produced by Stackpole Carbon Company, St. Marys, Pa.

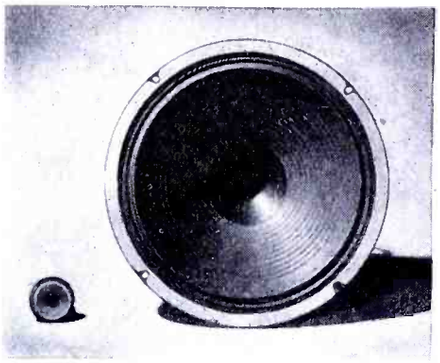
* * *

PERMOFLUX SPEAKERS

Loudspeakers in the 2" to 15" size have been announced by Permoflux Corporation, 4900 West Grand Avenue, Chicago 39, Illinois.

Speakers are said to be true dimensioned, with diaphragms graduated in ½" steps up to and including 7½" with other standard sizes up to 15". Speakers will provide power handling capacities from 1 to 20 watts, with acoustical output in 2-db steps.

Speakers are said to use a new magnetic alloy



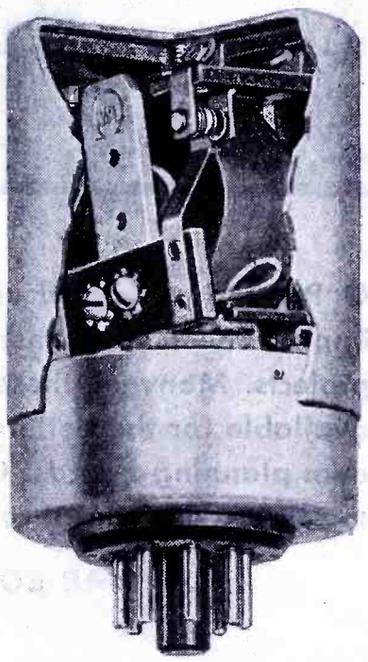
* * *

WARD LEONARD PLUG-IN ENCASED RELAY

A plug-in type relay enclosed in a metal can and fitted with a standard octal-plug base has been announced by Ward Leonard, Mt. Vernon, N. Y.

Relay mechanism is encased in a cylindrical metal housing 2 1/16" in diameter and 3⅛" high. It is said to be supported against shock by means of a key in the center of an insulating disc that fits in the top of the case.

Double-pole, double-throw contacts are rated 4 amperes at 115 volts, 60 cycles a-c and at 24 volts d-c, ½ ampere from 25 to 115 volts, d-c.



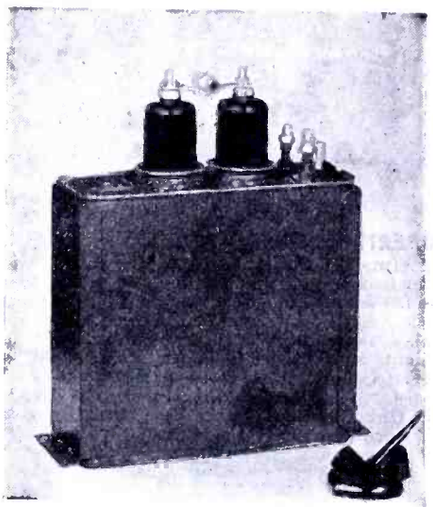
* * *

G.E. PARALLEL-PLATE CAPACITORS

High-frequency, water-cooled parallel-plate capacitors, for use in the resonant circuit, or tank circuit of high-frequency electronic oscillators have been announced by G. E. When connected in parallel with an inductance coil, this capacitor, type HFP, completes the resonant circuit which determines the frequency of the oscillator.

In this application the capacitors are operated at relatively high voltages and may be required to carry heavy currents continuously at frequencies up to several megacycles. Units are available in standard ratings ranging from 2000 volts, 0.025 mfd to 9000 volts, 0.0056 mfd.

Capacitors employ a synthetic dielectric liquid.



* * *

IDEAL COMMUTATOR UNIVERSAL CHUCKS

A 3-jaw chuck has been announced by the Ideal Commutator Dresser Company, 4025 Park Avenue, Sycamore, Illinois. Body is high tensile strength semi-steel. Rib construction. Scroll of alloy steel.

* * *

KIRKLAND SHALLOW-DEPTH INDICATING LIGHT

A shallow-depth indicating light with an overall depth behind the front of the panel to the extreme end of the insulation barrier of 1", has been announced by The H. R. Kirkland Company, Morristown, New Jersey. It is for single-hole mounting in a 1⅜" diameter holes in panels up to ¼" in thickness.

The exposed holding lip is of the hex nut type and 3/16" in thickness.

The molded bakelite socket is of the candelabra screw base type for use with the S6-120 volt tungsten lamp or the T4½ neon glow

lamp. A ¼" square insulation barrier separates the two 6/32 terminal screws. Known as the DE-659 D/E unit.

* * *

RCA THYRATRON 3D-22

A four-electrode thyratron, 3D-22, for use primarily in relay and grid-controlled rectifier applications, has been produced by the RCA Victor division of RCA. Conservatively rated to handle an average output current of 0.75 ampere in continuous operation.

Has a xenon-gas filling. Said to have a control characteristic essentially independent of ambient temperature throughout the range from −75 to +90°C.

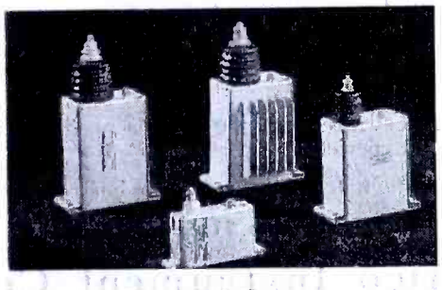
* * *

G.E. H-F PAPER-DIELECTRIC CAPACITORS

High-frequency .01-mfd paper-dielectric capacitors, available in ratings of 5,000 to 20,000 volts d-c, have been announced by G. E. Developed primarily for grid- and plate-blocking service in the electronic-oscillator circuits of high-frequency induction-heating equipments.

Internal kraft-paper and aluminum-foil assemblies are impregnated with a low-loss liquid dielectric, and hermetically sealed in rectangular metallic cases.

Units are supplied with removable footed-type brackets. The 20,000-volt rating unit is available in a plain case, or with cooling fins to permit a higher current-carrying capacity.



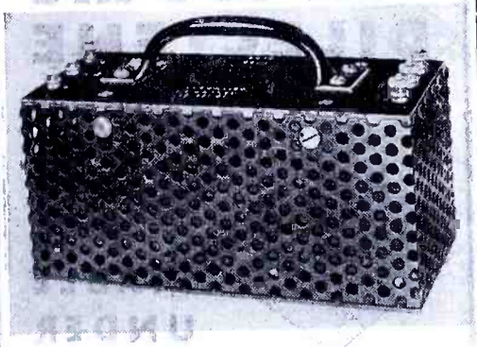
* * *

NYT ISOLATING TRANSFORMER

Isolating transformers wound for three-phase and applicable to single-phase circuits have been announced by New York Transformer Company, 26 Waverly Place, New York 3, N. Y.

Ratings are: 250 va, 115 volts, 1:1 ratio, 3-phase and frequency range of 60 to 400 cycles.

Transformer is 8½" long x 5½" high x 4" wide and weighs 16½ pounds.



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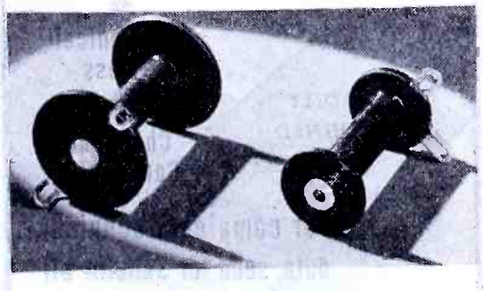
MOLDED BAKELITE ELECTRO-MAGNET CORES

A method of molding bakelite to electro-magnet cores has been developed by the R-B-M Manufacturing Company, division of Essex Wire Corporation, Logansport, Indiana.

The same method is also said to be used to mold coil terminals directly in the bobbins.



* * *

GULOW VARI-FORMERS

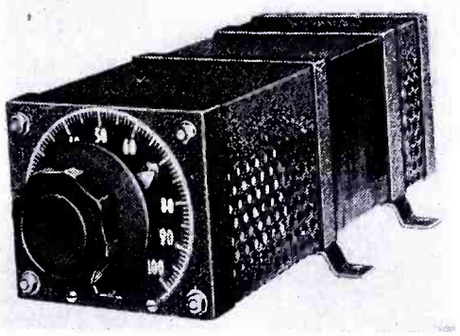
Auto transformer voltage regulation units wound for constant current or taper wound for current proportional to voltage have been developed by Gulow Corporation, 26 Waverly Place, New York. A self-aligning solid-silver

(*Continued on page* 100)

THE INDUSTRY OFFERS . . .

(Continued from page 99)

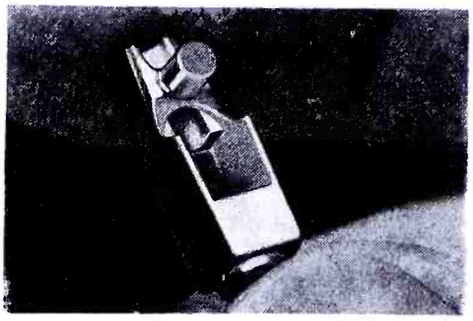
contact, fingertip controlled by a single knob switch, is said to provide small increment voltage change throughout the range of the device. No carbon brushes are used. Incremented increase is in the order of 0.75 volt or less. Windings are on shell type core, impregnated. Units are supplied either with autotransformer winding or separate windings for isolation of circuits. Available for one or three phase use with single control. Class A or B insulation optional.



* * *

FAIRCHILD MAGNESIUM STYLUS CHUCK

A magnesium casting, weighing .3734 gram, equivalent to .000823 pound to be used as a stylus chuck has been developed by the Fairchild Camera & Instrument Corporation, New York. This chuck which holds a cutterhead stylus, operates laterally at a frequency up to 10,000 cps in a Fairchild recorder. The chuck is said to offer substantial stiffness, considering the low mass of the part.



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IRC POWER WIRE-WOUND RESISTORS

Power wire-wound resistors, designed to fulfill Army-Navy specification JAN-R-26, have been announced by International Resistance Company, 401 N. Broad Street, Philadelphia 8, Pa. A completely sealed unit, known as the GRW, it is said to support a transverse load of as much as 100 pounds. Ferrules of the resistor are said to withstand a twisting torque of 80 inch-pounds.

All connections are welded. Pyrex glass enclosure tube is used. Pure lead is used for sealing between the ferrules and the pyrex glass enclosure. Melting point is said to be above the 275°C operating temperature of the resistor.

Seven standard sizes are now available. They correspond to Army-Navy types RW-10F to RW-16F, inclusive, and are identified as GRW-10 to GRW-16. Resistance values covered by these seven types are from 0.1 ohm to 46,000 ohms, with power ratings from 15 to 140 watts.

* * *

PLASTIC BLIND RIVET

A plastic blind rivet, Des-Rivet, that is said to permit one-man operation and blind fastening has been announced by the Plastic development division of the Victory Manufacturing Company, 1105 Fair Oaks Avenue, South Pasadena, California. The design is based on a wedging action and takes advantage of the flow characteristic of plastic materials under pressure.

Rivets are molded as one piece consisting of a head with plug attached by a thin breakaway section and a tapered shank split to form four tapered fingers.

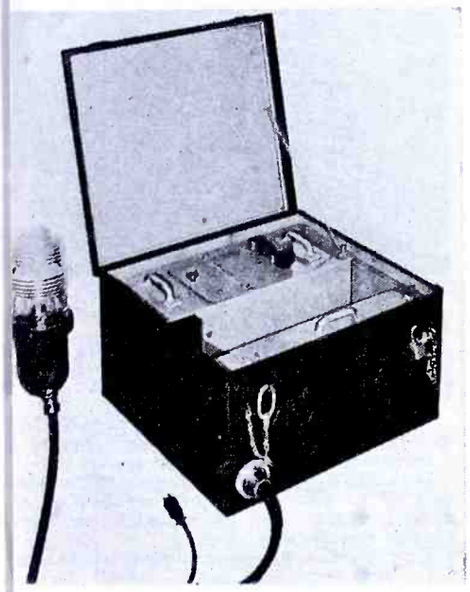
Rivet is applied by pressing the tapered fingers into a drilled hole. Taper on the outside diameter of the fingers reduces the inside diameter of the shank, the rivet and work being held in place by the pressure of the depressed fingers. Impact from the rivet gun, which may be manual or air operated, in-

antaneously shears the plug and drives it to the plastic shank until the plug is flush th both ends of the rivet, maintaining the ntour of the rivet head.
Wedge action of plug in tapered shank exnds the fingers against the walls of the illed hole and upsets the shank end of the vet.

* * *

LECTRONIC LABORATORIES PORTBLE FLASHING BEACON

lightweight portable flashing beacon has en developed by Electronic Laboratories, c., Indianapolis, Indiana. Operates from 0 volts, d-c or a-c. Has a vibrator power pply for converting to 2000 volts d-c. Elecnic has also designed this same equipment operate from 6, 12 or 24-volt storage batries. All connections are made with water oof plugs, and the carrying case itself is mpletely water proof. Lamp may be separely mounted on a pole if desired.
Light is said to be visible, under normal erating conditions, for at least 20 miles at ght.



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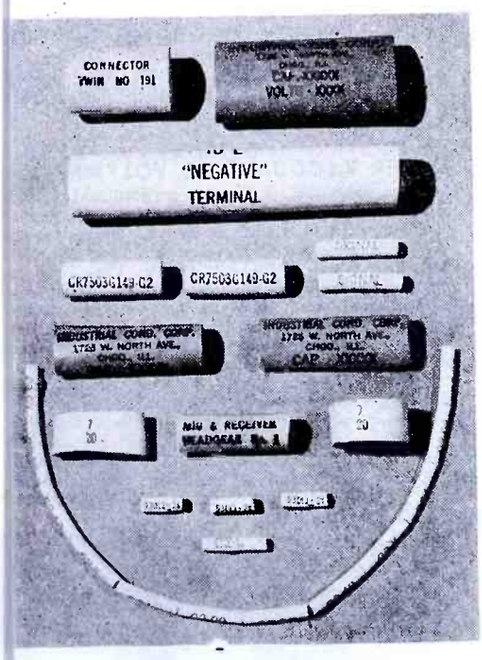
POLYVINYL EXTRUDED TUBING WIRE MARKERS

Turbo markers, made of polyvinyl extruded ubing, are now being produced by William Brand & Company, 276 Fourth Ave., New York, 10, N. Y.
The markers are available in all colors, as well as clear, transparent polyvinyl extruded ubes, with any desired location of imprinting, ircumferentially or longitudinally, in any liameter or length.



* * *

CARTER BATTERY-CHARGING HAND GENERATOR

A one-man hand generator delivering about 140-watts has been released by Carter Motor Company, 1608 Milwaukee Avenue, Chicago.

(*Continued on page* 102)

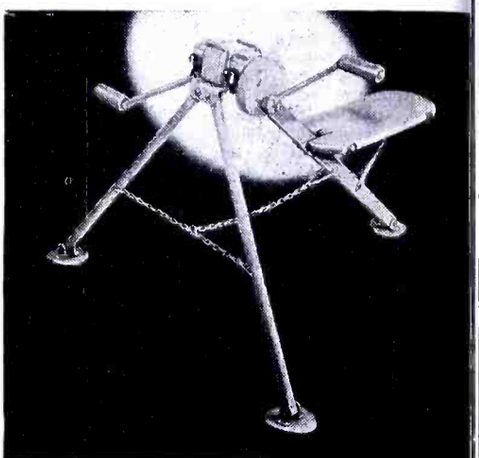
THE INDUSTRY OFFERS . . .

(*Continued from page* 101)

Provides 8 volts d-c at 5 amperes for charging batteries.

In operation, one man, seated on the seat which folds up when not in use, turns two cranks. Drive is by means of a gear train.

Generator is said to be moisture-proof. Shafts of the crank handles are sealed and unit is completely enclosed. Output is to two terminals to which the charging line is connected. A chain suspended between the legs prevents collapse when the unit is set up.



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LANGEVIN 102 AMPLIFIERS

Amplifiers, 102 series, that are said to meet wide-frequency range requirements have been developed by Langevin Company, Inc., 37 West 65th Street, New York.

The 102-A units have input impedances of 30/250; output impedance, 600 ohms; and a frequency response, 30/16000 cps, .5 db.

Type 102-B is a three-stage amplifier with a gain of 95 db. It employs input-stage electronic mixing, and is intended for public-address installations.

Type 102-C consists of a three-stage amplifier, fixed gain, adjustable, 75/85/95 db.

Type 102-D is a two-stage amplifier with an input impedance of 600 ohms and bridging; fixed gain, 600 ohms; input, 61 db.; bridging input, 45 db.

* * *

GLOBE PERMANENT MAGNET MOTORS

Two models of a Motor-Mite type motor with 5 and 7.5 watts intermittent service output have been announced by Globe Industries, Inc., 125 Sunrise Pl., Dayton 7, Ohio.

Input is 24 v. d-c. Free running—20,000 rpm speed; peak load—11,000 rpm. Temperature range is said to be —55° to +175° F. Heat rise said to be 45°C at rated load. Pole pieces are within closed magnetic circuit. End shields are brass and molded plastic. Dimensions: MM-1 style, diameter 1 3/16", length 1⅝"; MM-2, diameter 1 3/16", length 1⅜". Shaft: ⅛"x½"; available with any type extension. Weight: MM-1, 5 oz.; MM-2, 3¼ oz.

* * *

REINER VACUUM-TUBE VOLTMETER

A vacuum-tube volt-ohm-milliammeter, type 450, with a wide-frequency range a-c voltmeter which measures from 50 cps to 50 megacycles has been announced by Reiner Electronics Co., Inc., 152 West 25 Street, N. Y. City. Instrument has six d-c voltage ranges, with input capacitance that is said to be less than 2 micromicrofarads; input resistance 11 megohms, all ranges; d-c ranges from 50 microamperes to 1 ampere in six ranges.

Voltmeter has a single zero adjust for all a-c and d-c ranges.

The a-c voltage ranges are: 0-2.5-10-25-100-250. D-c voltage ranges are: 0-2.5-10-25-100-250-1,000. The d-c current ranges are: 0-2.5-10-25-100-250-1,000 milliamperes. Ohmmeter ranges are .1 ohm to 1,000 megohms; center scale resistance; 10, 10^1, 10^2, 10^3, 10^4, 10^5, 10^7 ohms.

BRIDGE SWITCHING

(*Continued from page* 85)

nce measurements, the accuracy from) ohms to 1,000 ohms is also 1%; below ohm and up to 100,000 ohms there is out a 5% error. The error in capaci- nce measurements is of the order of % in the range from 0.001 microfarad 1.0 microfarad; for inductance meas- ements the accuracy from 0.1 milli- nry to 1 henry is about 3%. These curacies are at 1000 cps; errors are out 3 times as great at 3,000 cycles.

These relatively useful accuracies are a large measure due to the fact that ere are a minimum of wiring connec- ons and no special switching devices introduce stray couplings in the bridge rcuit of Figure 2; the symmetrical ar- ngement of the bridge arms; and the ielded bridge transformer. A brief dis- ssion of the effects of residual com- onents on the accuracy of impedance ridges (entirely neglected in this bridge) as been discussed by Easton.[4]

[4]Ivan G. Easton. *Coil and Condenser Meas- rements*, COMMUNICATIONS, p. 21; September 943.

●

L-F OSCILLATOR

(*Continued from page* 66)

was obtained. This condition has a urther bearing on the function of the ircuit. Since these flashes are alter- nately bright and dim, we find an in- eresting condition; a loss of energy lue to the circulating current flowing hrough the resistance of the circuit, particularly during the time when the late circuit is not conducting current, for at this time the unit is *coasting*. This shows the necessity of high Q in the tuned circuit.

We studied the effect of resistance in the tuned circuit, demonstrated by inserting variable resistances in each branch, Figure 2. We used 2,000-ohm wire-wound laboratory type. The gal- vanometers were omitted temporarily. The resistances were connected at the grid end so that the system could be charged by the sudden flow of current when the power is turned on. The resistance of the inductance was about 200 ohms. However, when resistance is added, the amplitude of the energy in the tuned circuit is diminished. The lamp in the plate circuit will not flash as brightly as before and the *off* period is shorter. The critical resistance was also found by increasing the resistance until the oscillations could not be sus- tained. They died out slowly after being started by the *shock* of suddenly turn- ing the power on, after having been off for a moment. The critical re- sistance was found to be about 1,200 ohms. When the resistance was re-

(*Continued on page* 104)

(*Continued from page* 103)

duced below the critical value, the oscillator, which had been turned off for a moment, *built up* slowly, but at a much slower rate.

In analyzing the nonoscillating condition with this equipment, we found that although there was no circulating current, the plate circuit conducted current continuously with greater plate dissipation, with possible overload of the tube. This was due to the plate resistance which was the only load on the power supply in this condition.

Phase difference was also studied with the apparatus. In this operation, the resistors in the circuit were reduced to very low values and the galvanometers were connected so that the grid terminals went to the corresponding binding post of each galvanometer. In this way, if these instruments were connected across a d-c line, they would both swing to the same side, for they were really in parallel and connected with the same polarity toward the grid.

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NEWS BRIEFS

(*Continued from page* 94)

WESTINGHOUSE PROMOTIONS

Walter E. Benoit has been elected vice president of Westinghouse Radio Stations, Inc.

Robert E. Burrows is now manager of general radio sales, with offices in New York City. Mr. Burrows will be in charge of sales and promotion for the supply company.

Clinton R. Hanna, inventor of the tank-gun stabilizer, has been appointed associate director of the Westinghouse Research Laboratories.

* * *

G. E. APPLICATION TUBE FOLDER

A 4-page folder describing high-vacuum air-cooled and water-cooled tubes, mercury-vapor rectifiers, thyratrons, rectifiers, etc., has been released by G. E.

* * *

ANDREW CO. SOLVES WBEZ ANTENNA PROBLEM

The problem of coupling a 70-ohm unbalanced coaxial transmission line to a much smaller balanced impedance of the antenna, posed by E. H. Andresen, chief engineer of WBEZ, was solved by Andrew Company engineers recently. They constructed a quarter-wave impedance

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B-29 GUNNERY SYSTEM TELEVISED

Demonstration of the B-29 central gunnery control system being telecast over WRGB, Schenectady.

nsforming section with a concentric bazooka the balance conversion. Adjustments were de by varying the average dielectric con- nt in the resonant section.

* * *

AZE JOINS UNITED ELECTRONICS

hard H. Fraze, formerly assistant to the asurer of General Precision Instrument, has n named controller at the United Elec- mics Company, Newark.

* * *

CA APPOINTS C. W. TAYLOR ANAGER OF TUBE PARTS AND ACHINERY SALES

arles W. Taylor, development and manu- cturing engineer, has been named manager RCA tube parts and machinery sales. Mr. Taylor will be located at Harrison, N. J.

* * *

USTAFSON OF HALLICRAFTERS ONORED

vight E. Gustafson of Hallicrafters received diamond studded gold pin, the Chicago ibune war worker's award, for expediting ipments of parts.

* * *

EWA CANCELS PRING CONVENTION

ıe National Electrical Wholesalers Associa- on has called off its 37th annual convention heduled the week of April 22 at The Stevens, icago.

* * *

ROWN JOINS KELLY TRADING

chard I. Brown, formerly of Allen B. uMont Laboratories, Harrison Radio Corpo- tion and The U. S. Air Corps has been pointed manager of the electronics division Henry Kelly Trading Company, Inc.

* * *

IDNEY M. ROBARDS NEW RCA NFORMATION DEPARTMENT HEAD

dney M. Robards, has been appointed man- er of the information department of RCA. Mr. Robards joined RCA early in 1938, after rving as assistant editor of the press division NBC.

* * *

RAIN TO REPRESENT ENTINEL RADIO

J. Crain has been appointed Ohio represen- tive for Sentinel Radio. Mr. Crain will make s headquarters in Cleveland.

* * *

IUGUS OF A. T. & T. DEAD

. Zimmerman Hugus, assistant vice president the American Telephone and Telegraph ompany, died recently.

* * *

I. L. EDSALL NOW RCA TUBE AD MAN

oward Linn Edsall has been named advertis- g and sales promotion manager of the RCA be and equipment department. Mr. Edsall is a former licensed radio oper- or, and has also served as an instructor in dio and physics.

* * *

E FEVRE, CROSS AND OEHLSEN VIN STEWART-WARNER PROMOTIONS

rden LeFevre has been appointed vice-presi- nt and director of engineering of division ıe (alemite, instruments and radio) of the tewart-Warner Corporation. Fred R. Cross

(*Continued on page* 106)

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YACHTSMAN'S TELEPHONE GOES TO WAR

Midget W. E. 8-watt transmitter and receiver formerly used by small boat owners are now being used on Merchant Marine training ships.

NEWS BRIEFS

(*Continued from page* 105)

is now advertising manager and George W. Oehlsen, Jr. is the assistant director of engineering of division one.

Mr. LeFevre has been with Stewart-Warner since 1925.

* * *

H. R. MAAG NAMED RCA WESTERN REGIONAL MANAGER

Harold R. Maag has been appointed regional manager for the RCA West Coast area. His headquarters will be at RCA Victor's Hollywood offices, 1016 No. Sycamore Avenue.

* * *

K. McLEOD NOW WITH N.U.

Kenneth McLeod has joined the engineering staff of National Union Radio Corporation to take charge of electronic quality control.

Prior to joining National Union Mr. McLeod was at Columbia University as a research engineer.

* * *

CBS OWI DELANO, CALIFORNIA STATION ON AIR

The CBS Delano, California, h-f transmitters for OWI and CIAA use, went on the air recently. Two separate transmitters are now in operation, with a third transmitter scheduled to be installed early next year.

Broadcasts are beamed to the Orient for the Office of War Information and to South America by the Office of the Coordinator of Inter-American Affairs in San Francisco.

* * *

WESTINGHOUSE TO OPERATE KEX, PORTLAND, ORE.

Westinghouse Radio Stations, Inc., has taken over operation of KEX in Portland, Oregon. J. B. Conley, formerly manager of Westinghouse stations WOWO and WGL at Fort Wayne, Indiana, has become general manager of KEX.

EXTERNAL ANODE TRIODES

(*Continued from page* 77)

resistance element within the range of the negative slope. Such an element in a circuit may easily lead to oscillation of the dynatron type unless steps are taken to prevent it. One method often used in power-amplifier design is the inclusion of a dynatron rectifier in the grid circuit of the tube. This is essentially a half-wave rectifier that tends to restrict the reverse current flow. Grid loading often is sufficient. Even though oscillatory instability does not take place, the change in the grid characteristic often leads to high distortion when these tubes are used in audio amplification.

Secondary emission is not entirely detrimental, however, since it reduces the amount of driving power necessary in r-f amplifier considerations. Present-day manufacturing techniques have reduced secondary emission greatly by careful control of the materials that go into the tube. Low work function impurities are almost entirely eliminated. This is highly important if the published characteristics of the tube are to be attained in production, because secondary emission changes both the grid and plate characteristics.

Secondary emission may also take place from the non-conducting elements of the tube. If stray electrons become focused on a part of the envelope, the resultant secondary emission makes that spot positive, which increases the energy of the bombardment. If this action becomes cumulative, a hot spot may be formed that will melt the glass and cause a tube failure.

While the electrical characteristics of

external-anode triodes have been dissed in a general way, the actual electcal characteristics for a tube must be tained from the manufacturer before y design is attempted. Figure 12 shows assembly of the complete characterics of a well-known high-power watercled triode. The two filament characterics are of importance in the design of filament circuit, and the emission aracteristic gives important information out the tube output limitations. The id characteristics give valuable infortion for the design of a grid circuit any type of application. A careful dy of these characteristics and comrison between tubes will show the exnt of secondary emission to be expected the grid circuit.

The family of plate characteristics are portant for a number of design probns, especially those dealing with audio plifier design, since they may be used construct a composite characteristic for e analysis of push-pull amplifier along load line. The experienced engineer ay gather a great deal of information om a simple inspection of these curves.

approaching a new design, the probm of tube selection starts with eliminaon of a large number of available tubes om inspection of these characteristics fore any actual design calculations are arted.

The constant-current characteristics e probably the most valuable in the lution of high-power triode application sign problems. The erection of a load ne on these curves can give all the in-

(*Continued on page* 109)

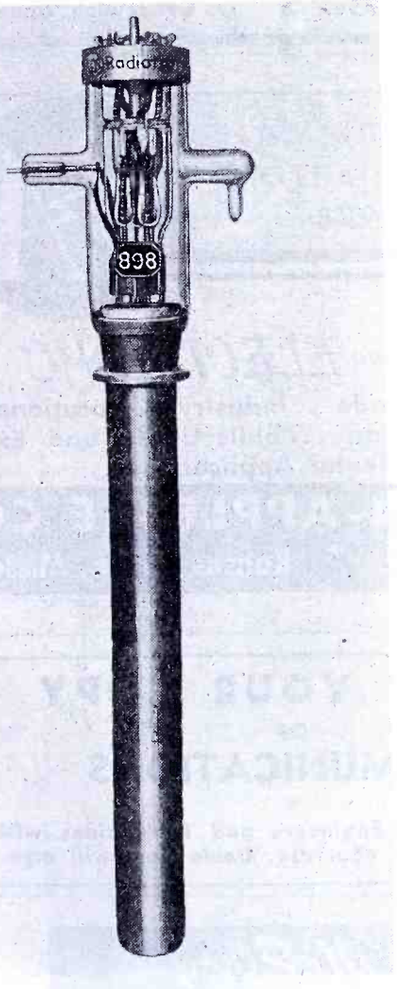

Figure 12
High power water-cooled triode whose characteristics appear in graphs on page 110.

XTERNAL ANODE TRIODES

(*Continued from page* 107)

rmation needed for design of both grid id plate circuit elements. All operating onditions can be determined graphically, id the design merit may be ascertained nmediately before beginning final devel-pmental construction of the equipment. consideration of the application of these irves to design problems will be taken p in a subsequent paper. The manufac-irers of these high-power triodes are ager to cooperate with the design en-ineer in furnishing complete character-tics as well as application notes on e tubes manufactured by them.

redits

The author wishes to express his ap-reciation to personnel in the vacuum-ube departments of the Federal Telephone nd Telegraph Corporation, General Elec-ic Company, Radio Corporation of merica, Amperex Electronic Corp., Vestinghouse Electric & Manufacturing ompany, and the Western Electric Com-any. Their assistance in preparation of hotographs and collection of the material as been invaluable. The author also ishes to express his gratitude to Pro-essor G. H. Fett, of the University of llinois, for his suggestions on the presen-ation of this material.

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(*Continued on page* 110)

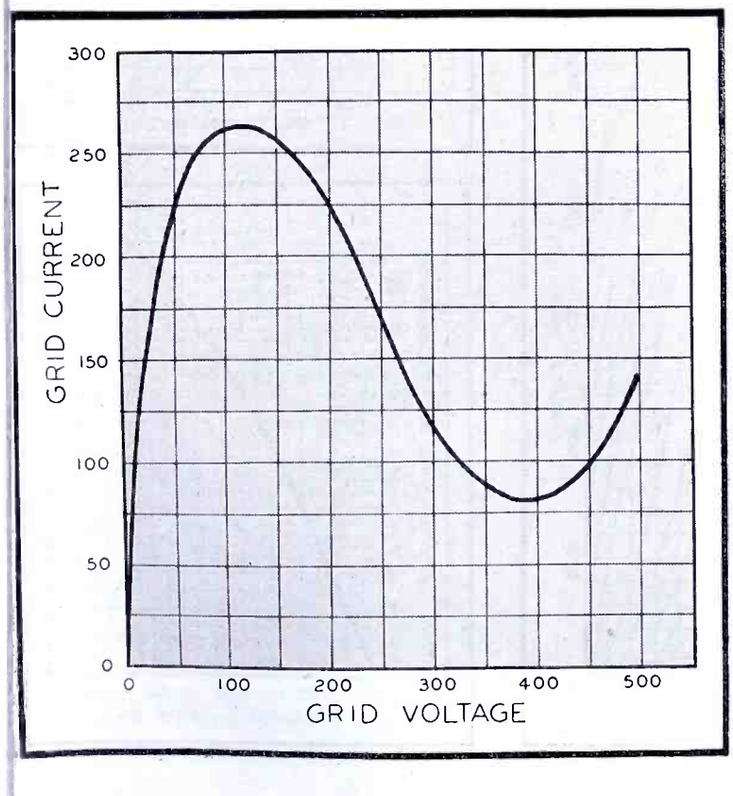

Figure 11

Typical grid characteristics of a high-power triode. Negative slope of curve as the potential increases indicates that the grid circuit will present a negative resistance element within the range of the negative slope.

EXTERNAL ANODE TRIODES

(*Continued from page* 109)

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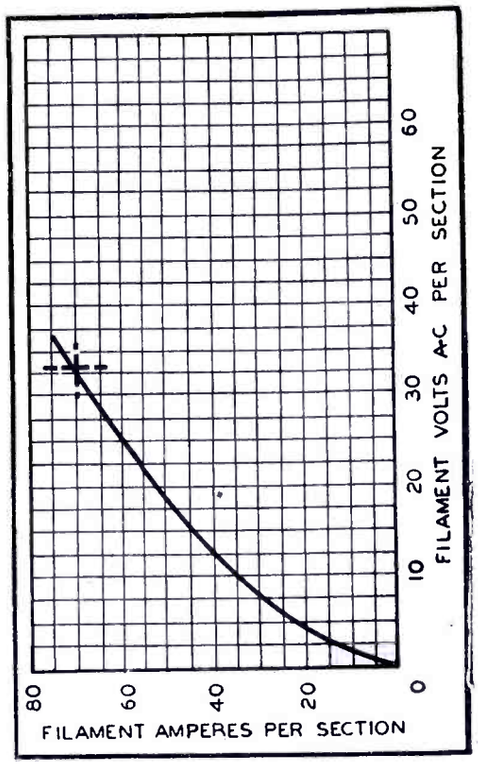
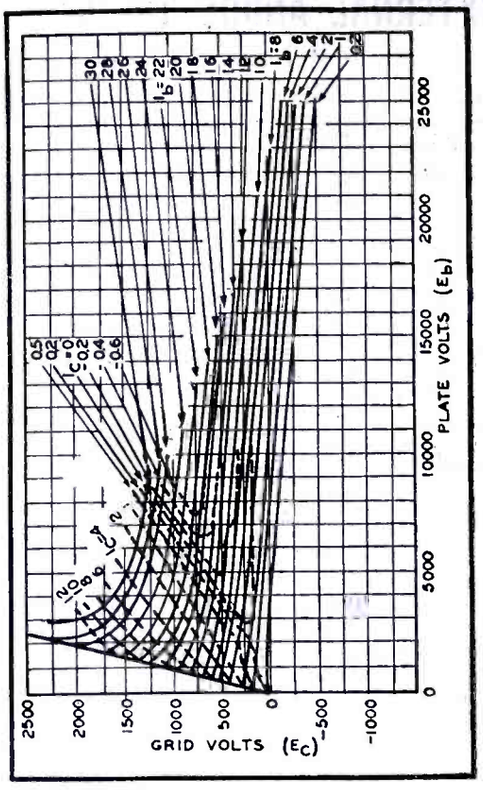




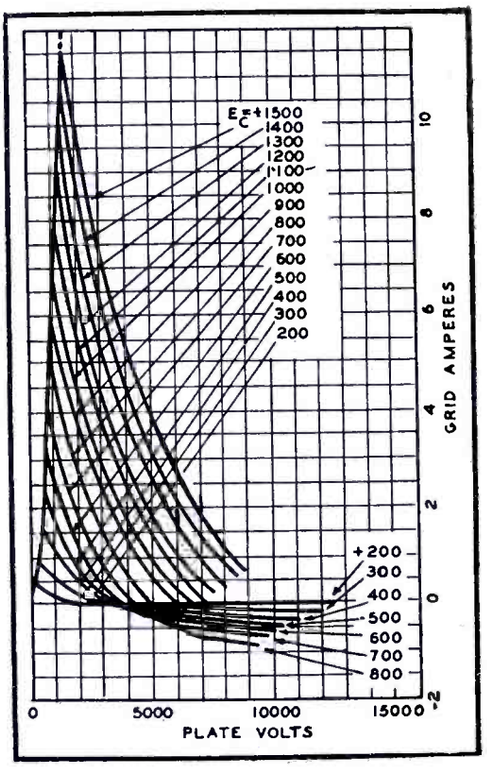
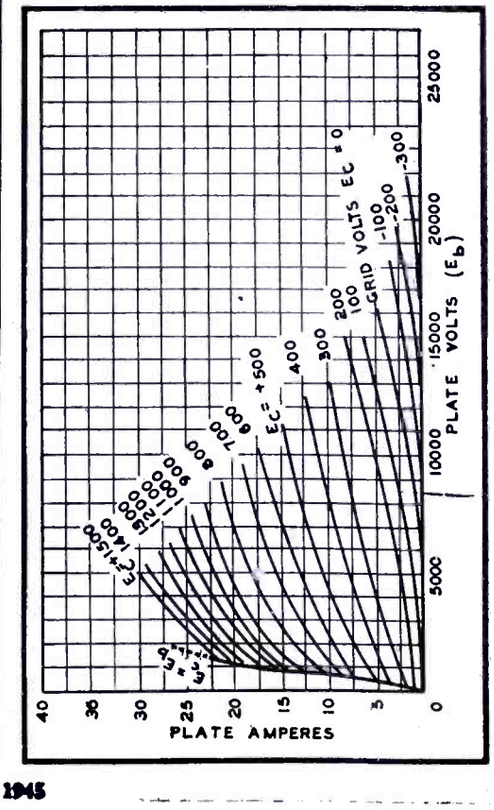
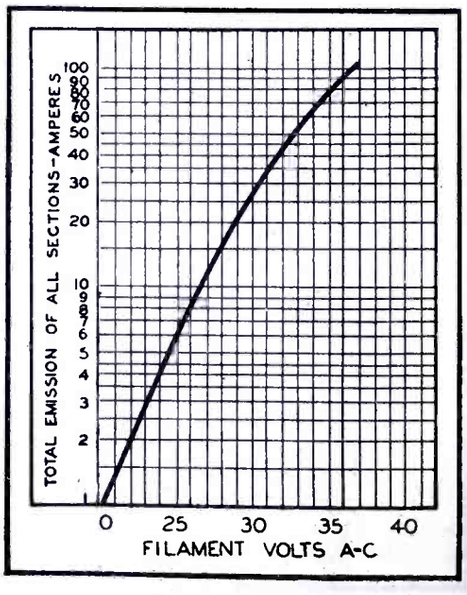
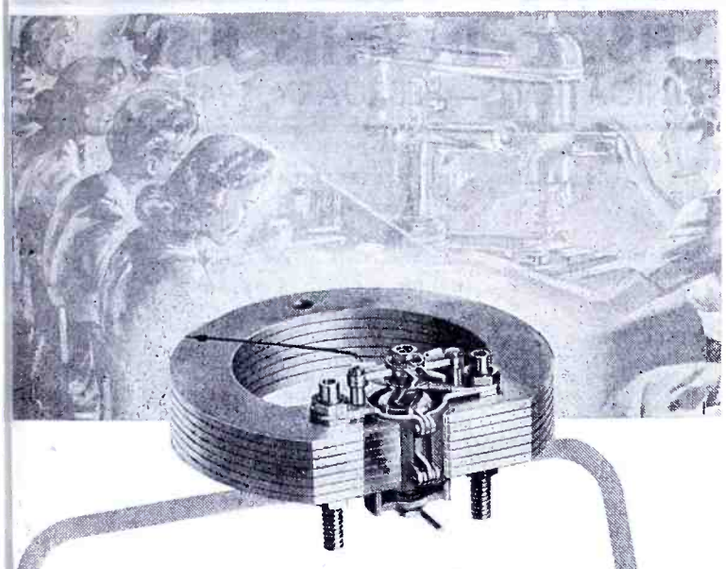


Figure 12 *a, b, c, d, e*

Above, (*a*), average filament characteristics of RCA 898; (*b*), below, average plate characteristics (Ef = 33 volts a-c, single phase excitation); (*c*), right top, average constant-current characteristics (Ef = 33 volts a-c, single phase excitation, Ic = grid amperes, Ib = plate amperes); (*d*), right center, typical characteristics (Ef = 33 volts a-c, single-phase excitation); (*e*), right bottom, average filament-emission characteristics (single-phase filament emission).







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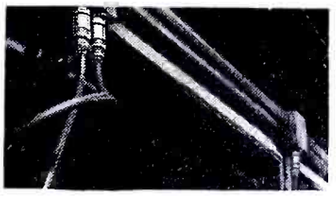

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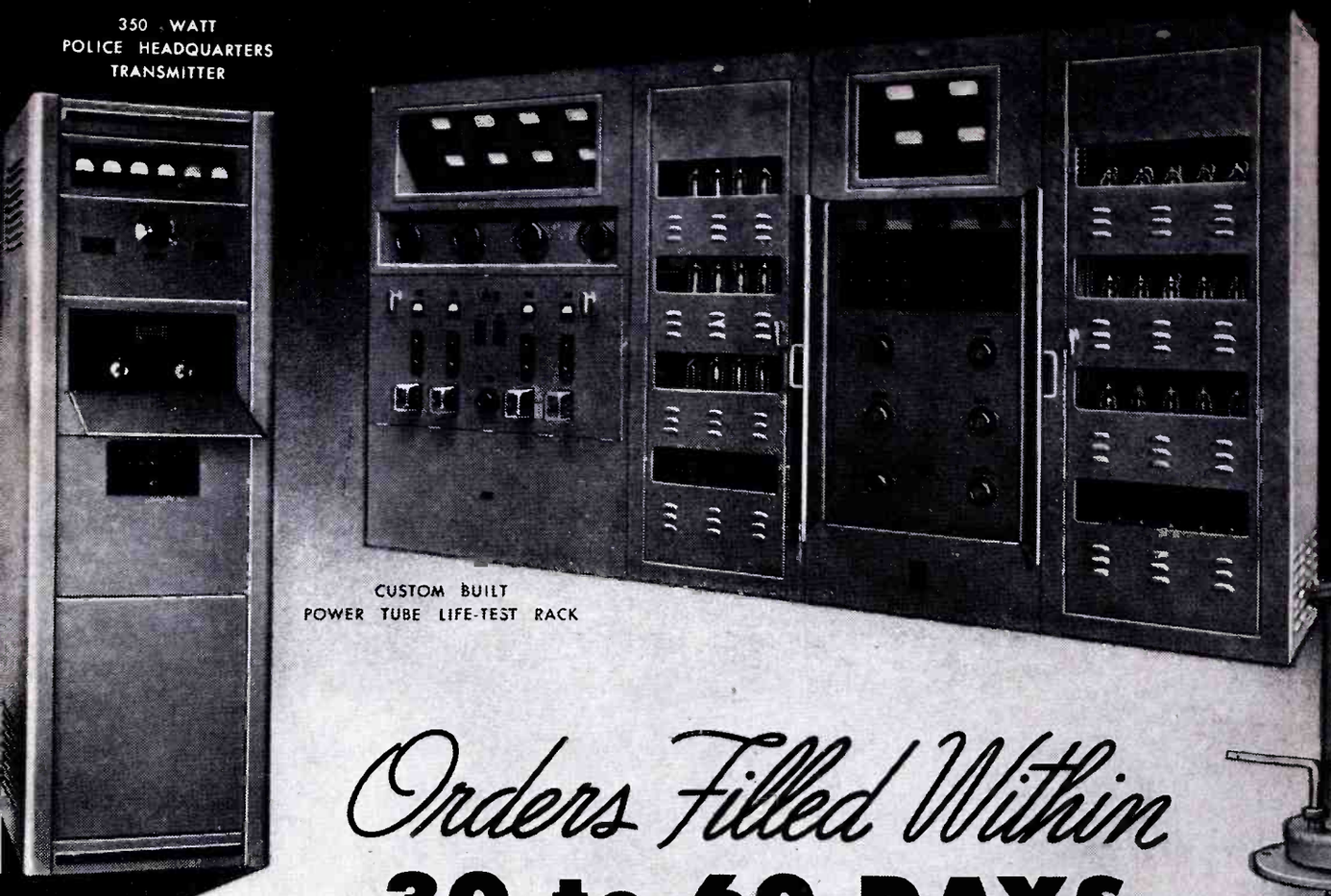

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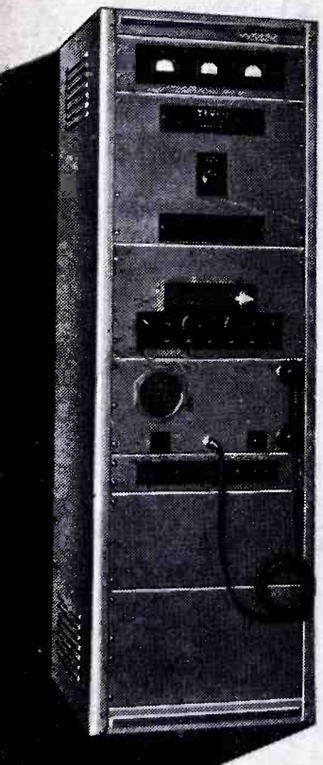

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