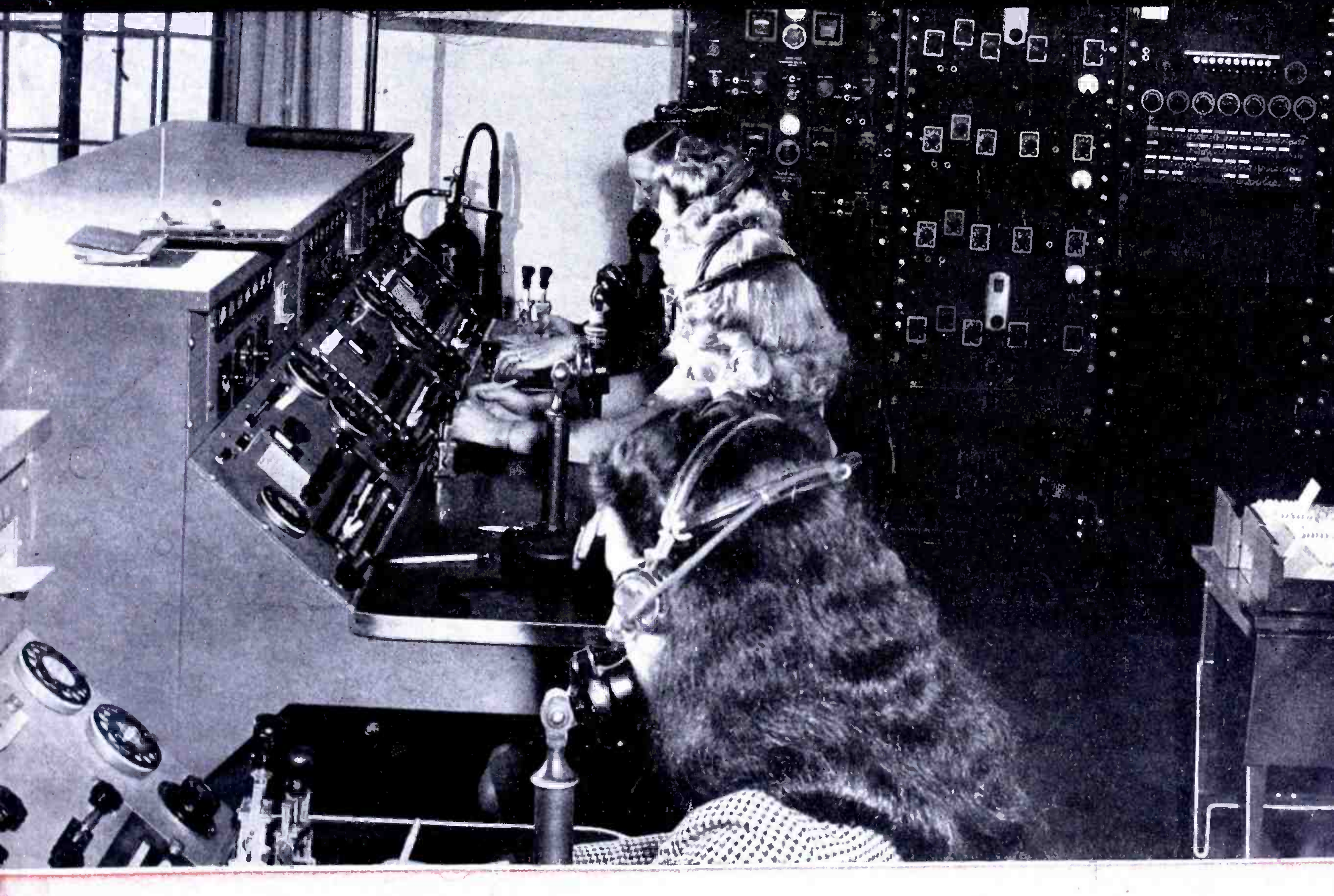
# COMMUNICATIONS



OCTOBER

★ RADIO ENGINEERING
★ THE RADIO PROXIMITY FUSE
★ TUNED P-A NEUTRALIZING CAPACITOR DESIGN
★ AERONAUTICAL COMMUNICATIONS
★ PULSE-AMPLIFIER COUPLING
★ TELEVISION ENGINEERING

1945

# Microphones Engineered by Electro-Voice

Answer Everyday Sound Problems

***Maximum Intelligibility Under Extreme Noise***

Hand-Held, close-talking single button carbon *DIFFERENTIAL microphone for all speech transmission in any noisy, windy, wet or extremely hot or cold locations. Cancels out background noise. Articulation is at least 97% under quiet conditions, and 88% under a 115 db noise field.

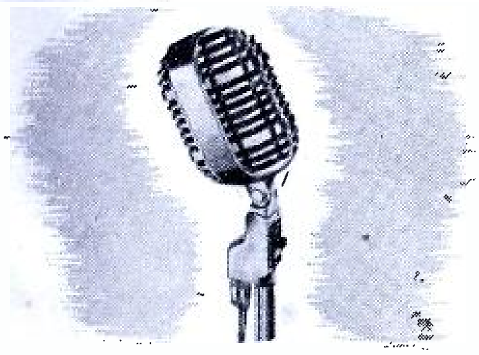
Model 205-S. List Price........$25

**Patent No. 2,350,010*

***Higher Articulation with Less Fatigue***

Moving coil, hand-held Dynamic microphone for high fidelity speech transmission. Uniform response, free from peaks, in the useful frequencies gives higher articulation, provides more usable power level, and is less fatiguing to the listener. For outdoor or indoor use.

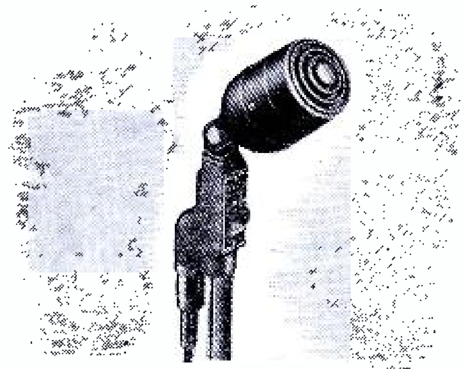
Model 600-D. Dynamic. List. $27.50
Model 210-S. Carbon. List.. $17.50



***Poly-Directional with Adjustable Polar Pattern***

The versatile high fidelity Cardak is readily adjustable to reduce any combination of reflected sound. Cuts reverberation or random noise pick-up . . . minimizes acoustic feedback. For broadcasting, recording, public address, communications.

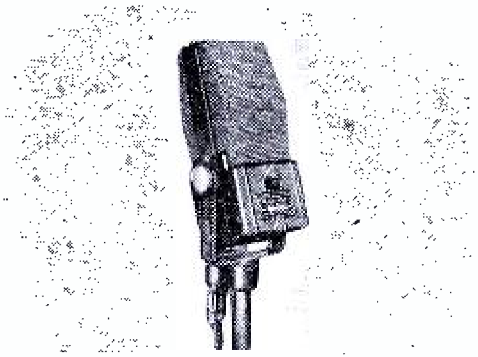
Model 725—Cardak I. List....$55
Model 730—Cardak II. List....$75



***General-Purpose Dynamic for Voice and Music***

Widely used because of its dependable all-around performance. Excellent frequency response for both indoor and outdoor speech and music pick-up. Rugged, small size, light weight. High output. Suitable for public address, dispatching, paging, recording and remote broadcast.

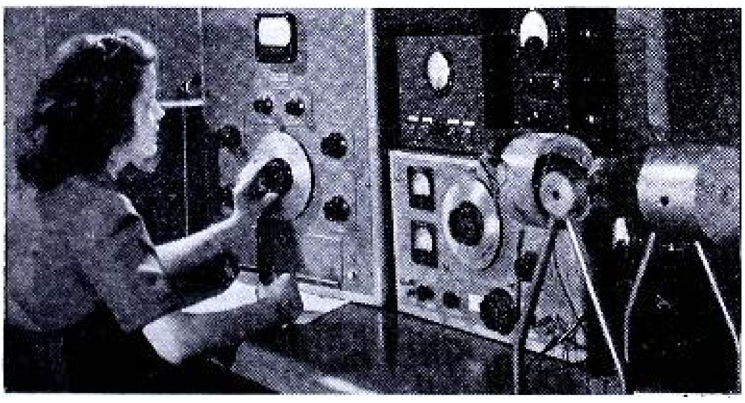
Model 630-C. List Price........$30



***Velocity High Fidelity Bi-Directional Sound Pick-Up***

Wide, flat frequency response, bi-directional polar pattern, high fidelity characteristics, wide-angle front pick-up, and pick-up range make it ideal for solo, orchestra, or chorus, for single speaker or groups. For indoor P.A., broadcasting, recording.

Model V-1-C. List Price........$30
Model V-2. List Price.......$37.50
Model V-3. List Price..........$50



***Corner of E-V "Lab"***

One of our Quality-Control units used in testing close-talking microphones. Harmonic distortion, frequency response, positional response (for carbons) level, etc., are carefully analyzed. Calibration is effected by Bell Laboratory standards and our own reciprocity checks.

**SEND FOR COMPLETE CATALOG**

Gives valuable data on Electro-Voice Microphones for communications, public address, broadcasting and recording. Includes helpful Reference Level Conversion Chart.

***Authorized Distributors Everywhere***

*No finer choice than* **Electro-Voice MICROPHONES**

*GUARANTEE*

The E-V models shown here are guaranteed forever against defects in workmanship and material.

**ELECTRO-VOICE, INC., 1239 South Bend Ave., South Bend 24, Indiana ★ *Export Division:* 13 East 40th St., New York 16, N. Y., U. S. A.—Cables: Arlab**

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...

RESEARCH APPEARS TO HAVE BECOME an influential factor in many reconversion programs in a variety of industries, particularly *communications*. Formerly relegated to a minor activity of a few, research today finds itself not only the prime project of substantial staffs, but as a favored asset by management. While the war accented the progressive advantages of research, prewar research had also demonstrated its long-term value. Many of the fundamental concepts established during peacetime served as the bases of innumerable successful wartime projects.

In the halls of Congress, research has also become a featured topic of discussion. A number of bills before the House provide for specialized governmental research programs to increase our world scientific leadership.

Aware that the usual commercial requisites interfere with pure research progress, many industries have removed these barriers and initiated extremely flexible long-term programs . . . programs that will afford unusually wide-scope research activity.

During a recent debate in Washington on the value of research to government and industry a leading government communications specialist said: "Research is a sound investment in the future."

Sound comment!

THE PAST MONTHS HAVE FOUND EVERYONE IN RAILROAD RADIO communications extremely active. Dozens of plans have now become actual installations throughout the country.

According to R. A. Clark, Jr., railroad radio specialist of Chicago, it appears as if around 40,000 fixed, mobile and portable stations may be installed by the roads during the next few years. This estimate covers equipment for engines, cabooses, passenger cars and fixed stations. These data are predicated on the present rolling stock, which is expected to increase, and which should, therefore, increase the number of required communications units.

Frequencies tested recently have ranged from 30 to 2,000 mc. Tests on 2,000 mc using f-m have been very encouraging. According to Mr. Clark, operation at this high frequency was found to be very satisfactory regardless of the territory, and that included operation through an extremely long tunnel.

It's a general consensus that railroad-radio communications development will now proceed at an accelerated pace and many railroads will install equipment as fast as it can be made available and as quickly as FCC assigns the necessary frequencies.—L. W.

**OCTOBER, 1945**

**VOLUME 25 NUMBER 10**

### COVER ILLUSTRATION

Control room of the Great Lakes radiotelephone system at Lorain, Ohio. (*Courtesy R. C. Hakanson*)



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# SYLVANIA NEWS

## ELECTRONIC EQUIPMENT EDITION

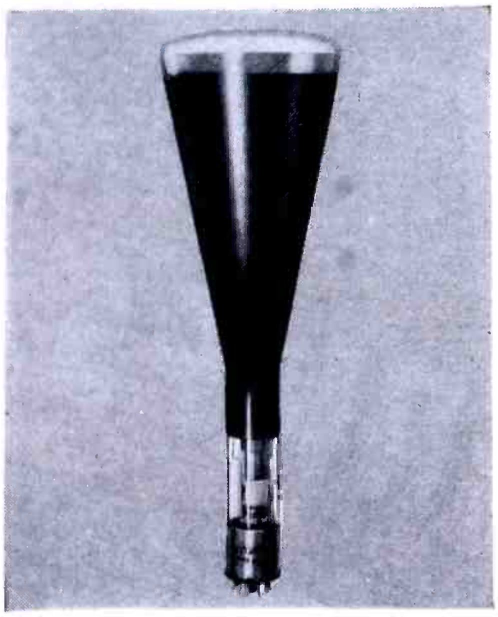
OCT. *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

## SYLVANIA CATHODE RAY TUBES NOW AVAILABLE

### *Ready for New Television Sets To Be Produced*

Sylvania Electric announces the welcome news that cathode ray tubes are once more available for the manufacturers of television sets.

Constant research in this field, combined with wide experience in large-



*Sylvania Electric precision-built cathode ray tube now available to television set manufacturers.*

scale production to meet war requirements, has placed Sylvania in a position to manufacture these tubes to a much higher standard than ever before.

This is an important factor to manufacturers of television receivers whose "plans" are rapidly becoming realities.

Check today with Sylvania Electric Products Inc., Emporium, Pa.

# MANY MANUFACTURERS TO USE ELECTRICALLY SUPERIOR TUBE

### *Sylvania Lock-In Radio Tube Ideal For FM, Television, Radar*

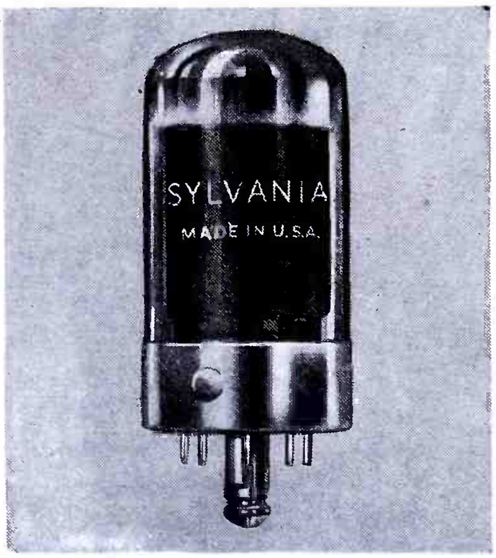
With the increasing trend toward higher frequencies—as shown by recent FCC decision assigning FM the band between 88 and 106 megacycles—set manufacturers will tend, more than ever, to use a tube ideally suited to the adoption of these very high frequencies.

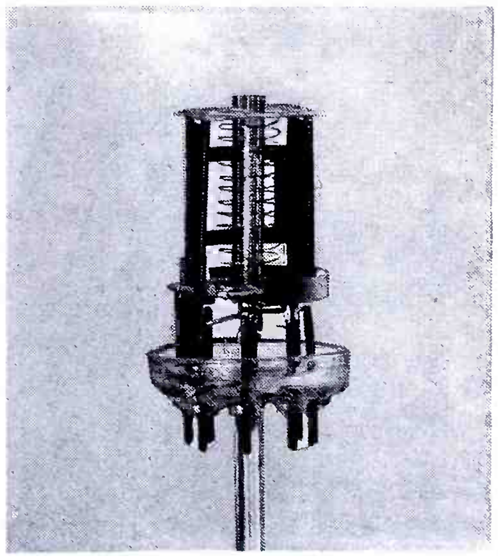
The Sylvania Lock-In is *known* to be electrically and mechanically superior to any tube made.

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

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

Today, set manufacturers considering the many developments in the field of communications, are looking to the Sylvania Lock-In Tube as a perfect electronic unit—the tube built to handle ultra-high frequencies.



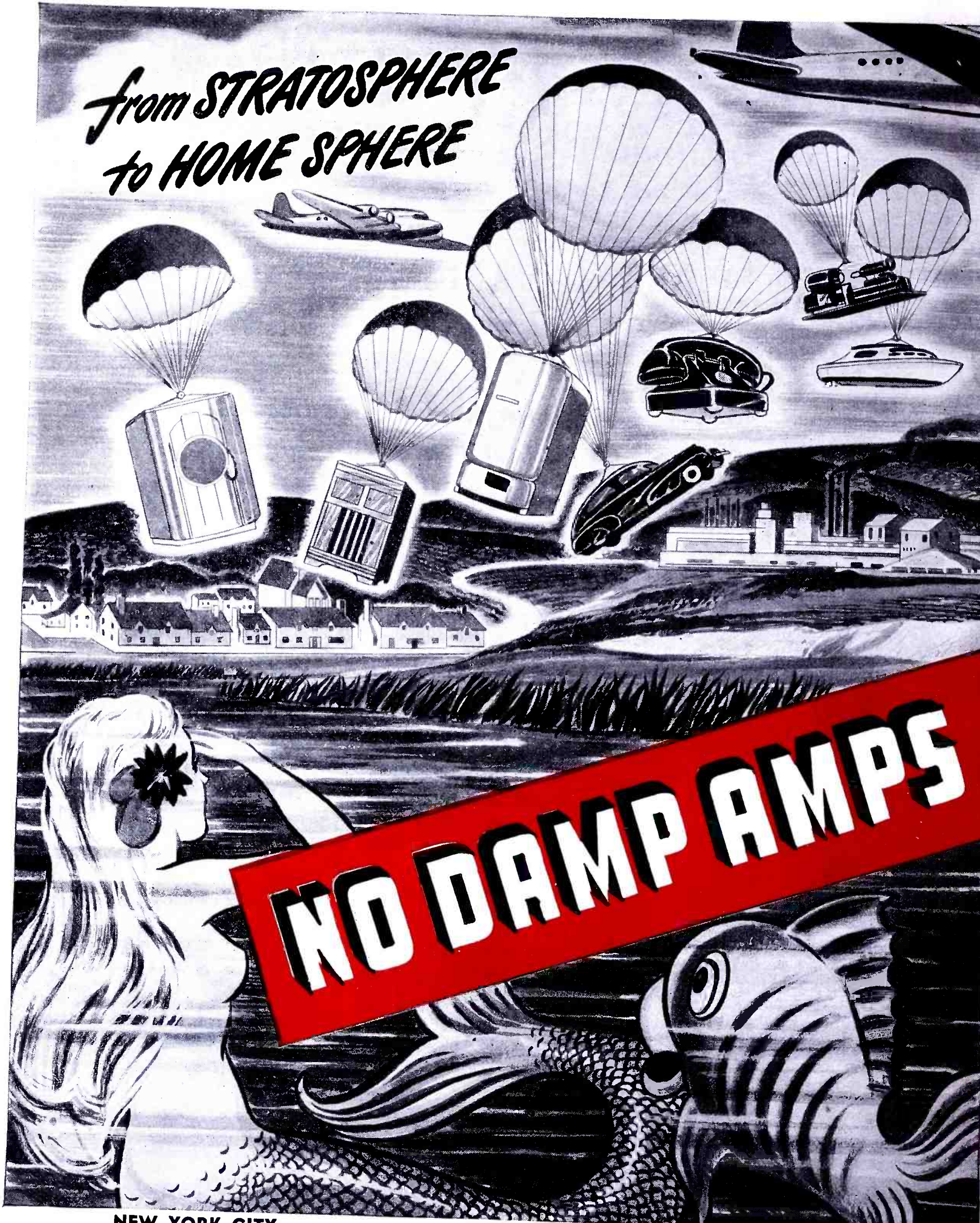



*The Sylvania Lock-In Tube showing construction—electrical and mechanical—that makes it superior to any tube made.*

# SYLVANIA ELECTRIC

**Emporium, Pa.**

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


from STRATOSPHERE
to HOME SPHERE
NO DAMP AMPS

# Now it's here

# FUSITE HermetiCan


FUSITE HermetiCan* open — ready for simple, sanitary can-sealing operation.

FUSITE HermetiCan* closed—sealed tight without use of heat.

**TO SPEEDILY—THRIFTILY—**
**PERFECTLY SEAL ELECTRICAL COMPONENTS!**

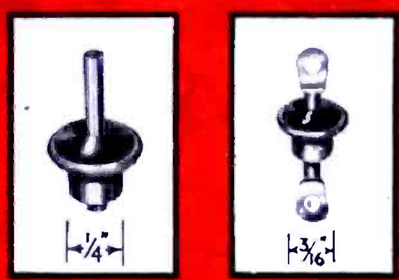
**WITH FUSITE SEALS**

**PEACEWORK** . . . means mass production of better products at less cost for more people. How to do it at a profit? Consider, then, FUSITE Hermetic Terminals . . . and especially the new FUSITE HermetiCan*. It hermetically seals, without heat. It is done with a "can-sealer" (manual or automatic) as used in quantity production sanitary food-canning. It's fast . . . simple . . . thrifty. It works to perfection. It's the new and better way to hermetically seal transformers . . . relays . . . condensers . . . rectifiers . . . switches. The HermetiCan* is a FUSITE original. Wide range of can sizes. Any number of terminals . . . from one to nine or combinations, thereof. FUSITE terminals are now available in two different styles: (1) Hollow Tube; (2) Flattened and Pierced. Single terminals as low as 3½¢ each in quantity. We invite your inquiry via letter or the coupon below.

**AS LOW AS 3½¢ EACH**

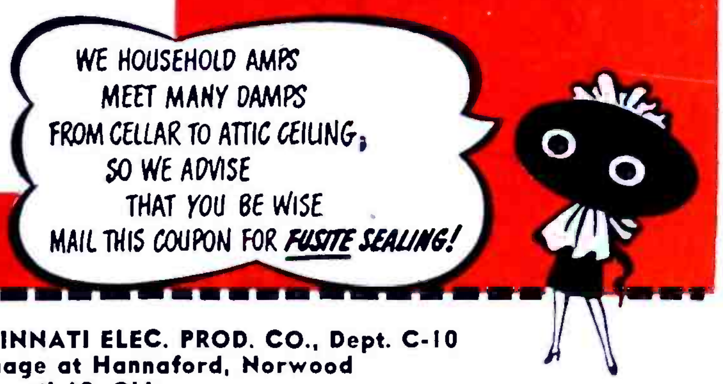
*HermetiCan is a registered trade name.

SHOWN ACTUAL SIZE




**No. 108 HT** (Hollow Tube Terminal)

**No. 106 FP** (Flattened and Pierced ends)




GLASS TO METAL

**FUSITE**

**HERMETIC TERMINALS**



**CINCINNATI ELEC. PROD. CO., Dept. C-10**
**Carthage at Hannaford, Norwood**
**Cincinnati 12, Ohio.**

Please send FUSITE literature and samples as indicated below:
Single FUSITES ( ) Multiple FUSITES ( ) FUSITE HermetiCan* ( )
I am interested in the possibilities for hermetically sealing..........

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(Name or kind of product)
Any information you may have on this will be appreciated.
My Name is..........
(Please Print)
My Position is..........
For..........
(Name of Company)
Whose Address is..........
City.......... Zone.......... State..........

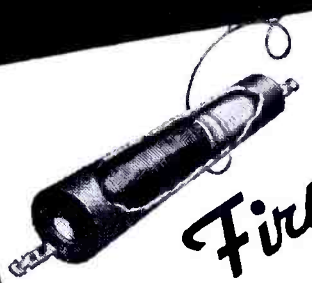
# ONE STANDARD TYPE

## does the job...

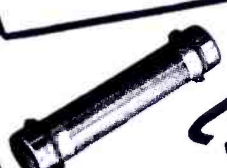
**NEW** type end seal for extra humidity protection.

WOUND WITH CERAMIC INSULATED WIRE 1000° C. HEAT-PROOF!

**NEW** glazed ceramic shell to withstand thermal shock, humidity and corrosive conditions.



*First* with resistors wound with ceramic-insulated wire.



*First* with glass-to-metal sealed resistors.

*First* and still exclusive with MEGO-MAX, the high-resistance, high-voltage resistors.

*and First* with the EXTRA humidity protection features for STANDARD resistors described above.

## ..in ANY climate!

No more "special orders" to obtain suitable resistors to withstand the extreme thermal and humidity conditions to which your product may be subjected in many parts of the world! STANDARD Sprague Koolohm Wire-Wound Resistors now incorporate these extra protection features — and this means that you can count on STANDARD Sprague Koolohms for maximum dependability in ANY climate, ANYwhere on the face of the globe. Write for new catalog of Sprague Koolohm wire-wound types for every requirement.

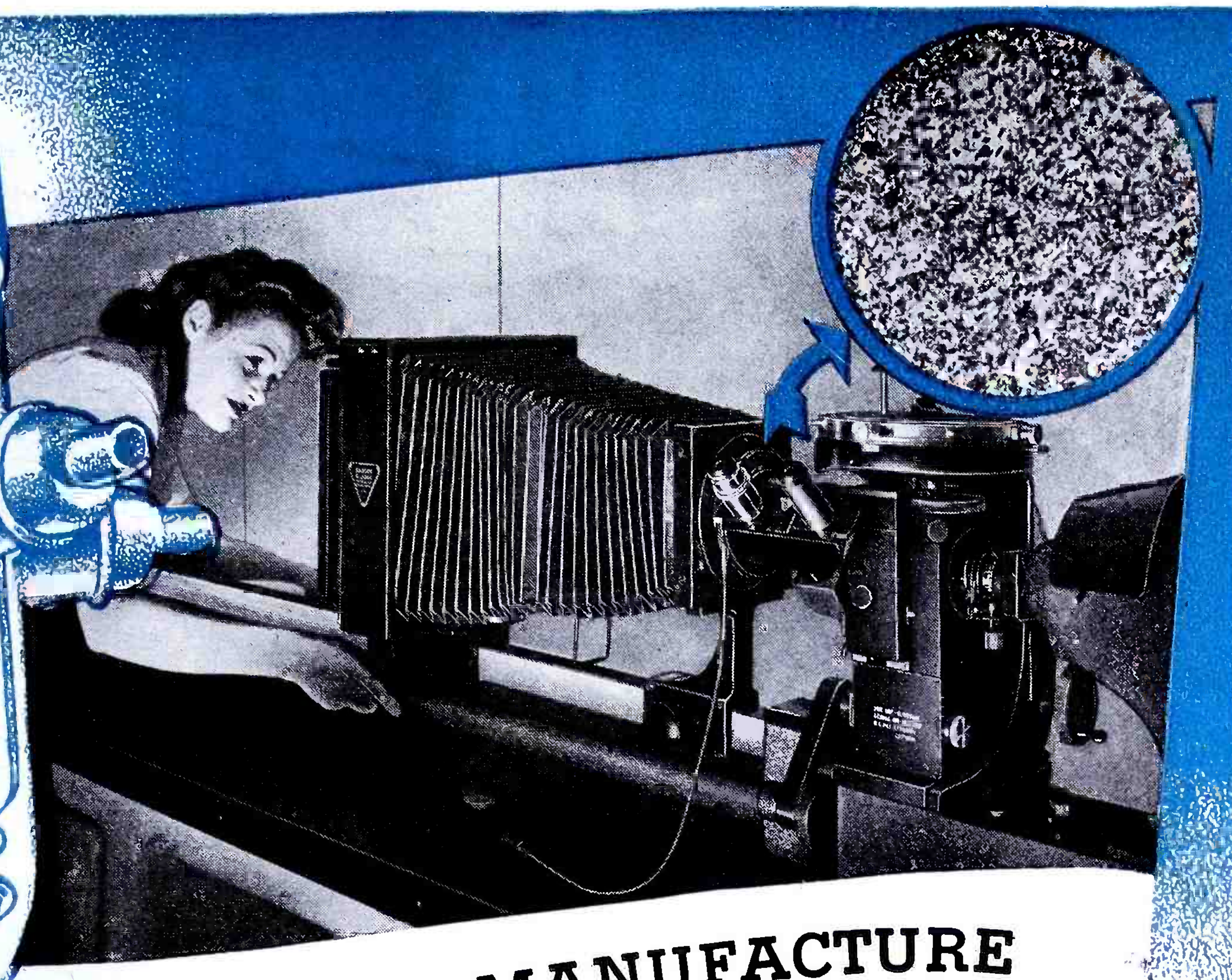
ARMY E NAVY

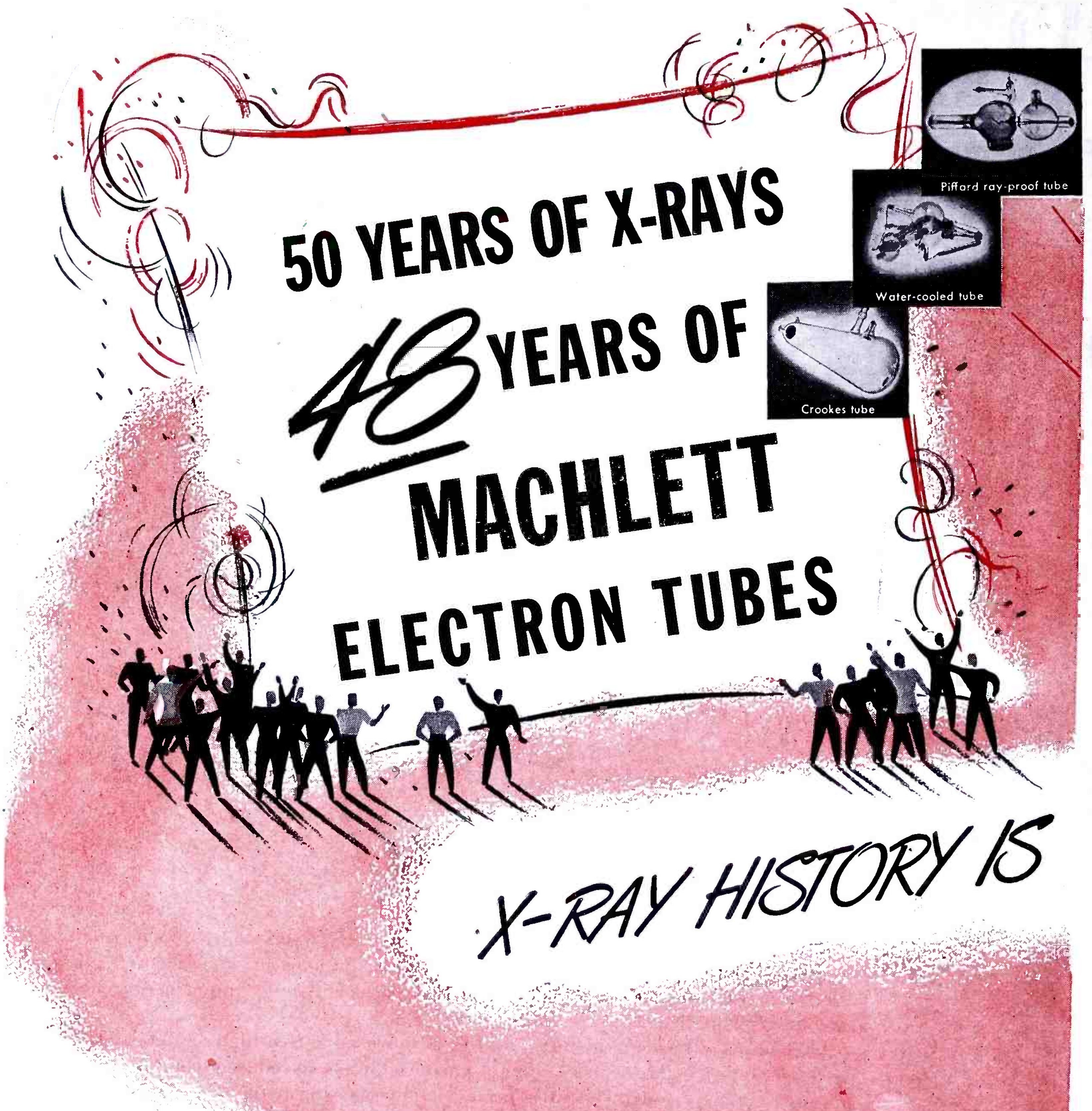
**SPRAGUE KOOLOHM**

TRADEMARK REGISTERED U.S. PAT. OFF.

**WIRE-WOUND RESISTORS**

**SPRAGUE ELECTRIC COMPANY,** Resistor Division, North Adams, Mass.



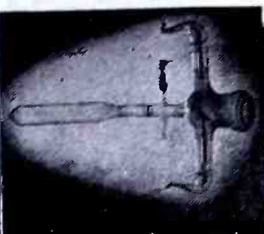


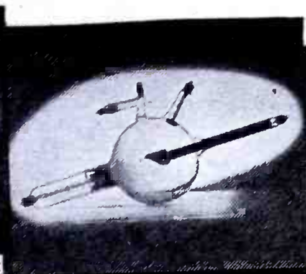

IT WAS 50 YEARS AGO, on November 8, 1895, that scientific investigation led Roentgen to the discovery of X-rays. In this semi-centennial year we honor his work, and the work of the pioneers who, sometimes at the sacrifice of their own lives, developed the theory and practice of a science that today means so much to all mankind.

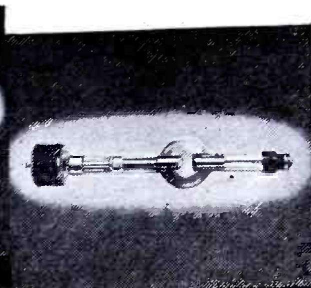
Very soon after Roentgen publicly announced his discovery in 1896, Robert H. Machlett made the first practical American X-ray tube. Quickly he improved his techniques, creating a whole series of "firsts" such as the first ray-proof tube, the first cooled by water, the first for contact therapy. The organization he founded carries on his principle of constant research, improvement and initiative, and has many other firsts to its credit, culminating in the amazing and unique 2,000,000-volt, direct current, sealed-off, precision X-ray tube.

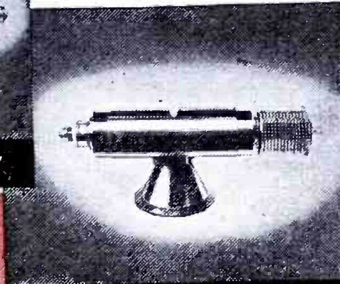
To a large extent, X-ray history is Machlett history, a history of service to mankind. Today, Machlett tubes are in use by doctors, hospitals, laboratories and factories in many parts of the world, saving lives, inspecting products, performing delicate analyses, expanding man's knowledge, serving with unmatched exactitude and economy. For the future, Machlett's talents will create other and still more valuable applications, for Machlett never stands still, is always creative, improving its tubes, developing new ones for old and new services.

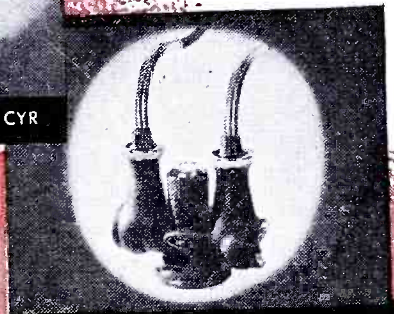
In addition to X-ray tubes for all purposes, we also make oscillators, amplifiers and rectifiers for radio and industrial uses, all to the same high (and unmatched) standards to which our X-ray tubes are held. It will pay you to buy Machlett tubes. For information as to the available types, write Machlett Laboratories, Inc., Springdale, Connecticut.

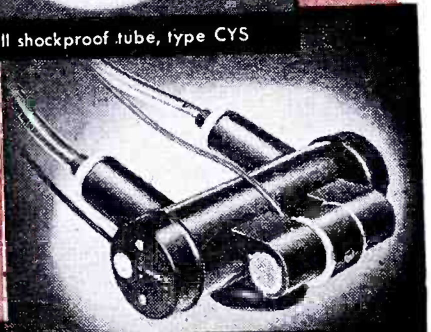

Cornell contact therapy tube

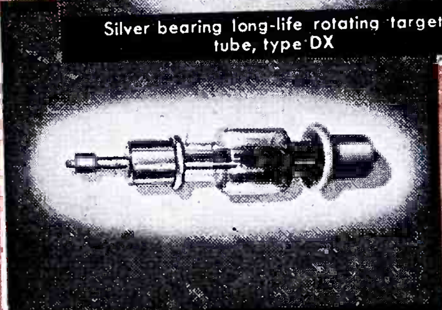

Transformer tube

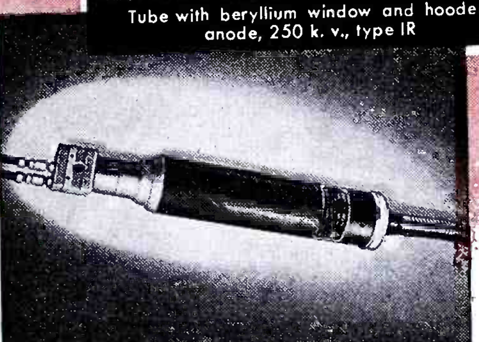

Pyrex heavy anode bulb tube, type MR


Compact ray-proof tube, type CYR


Small shockproof tube, type CYS


Silver bearing long-life rotating target tube, type DX


Tube with beryllium window and hooded anode, 250 k. v., type IR


Tube with vacuum-tight beryllium window in envelope—the Diffraction Tube

# first MACHLETT HISTORY!

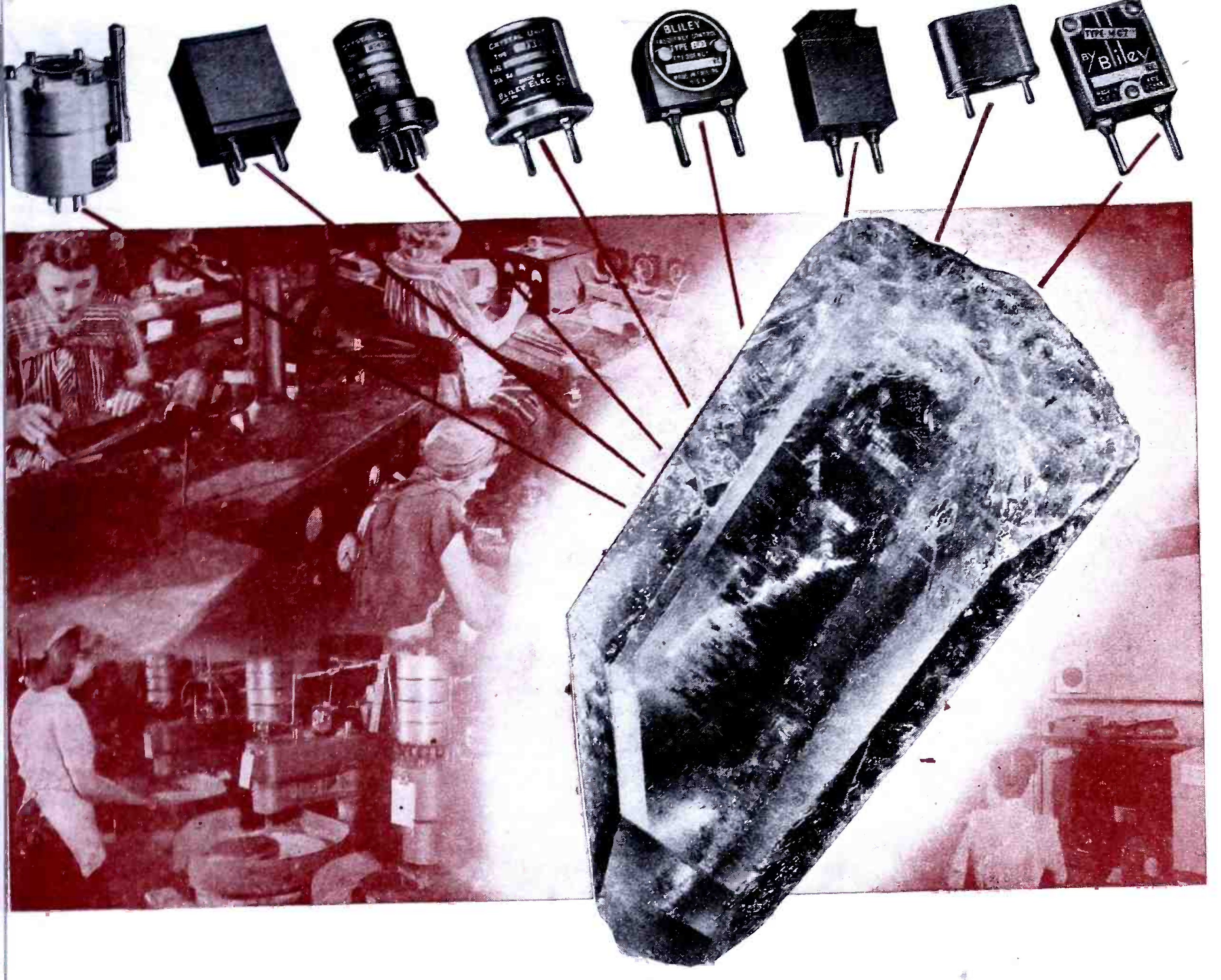
## From the Beginning

"When in 1895 Professor Roentgen announced his discovery, Machlett was immediately interested and began experiments to reproduce the results of Roentgen. He was ideally equipped for such work, for just at that time he had perfected a mercury pump capable of producing a very high vacuum. He attacked the difficult task and before many days had passed, succeeded in producing the first X-ray tube in this country."—I. S. Hirsch, *Radiology* 8:254, 1927.


2,000,000 volt direct current precision radiographic tube, type VM

MACHLETT

APPLIES TO RADIO AND INDUSTRIAL USES ITS 48 YEARS OF ELECTRON-TUBE EXPERIENCE




*You name the application . . .*

# BLILEY has the crystals

Post VJ Day production of Bliley acid etched* crystals for FM receivers, Aircraft and Marine radios, Railroad communications equipment and many other applications is proceeding with the same skill and efficiency that marked our wartime operations.

Substantial quantities of these crystals are in the hands of foresighted manufacturers who planned in advance with Bliley engineers for frequency stabilization in their postwar models.

Now, more than ever before, you need the versatile experience of Bliley engineers and craftsmen gained through more than 15 years of quartz crystal engineering exclusively. Whether your requirements are one crystal or a million, you can be sure of top quality—top design—and top performance—in Bliley crystals.

*Another star has been added. Our 5th citation for outstanding achievement in producing materials essential to the war effort.*

* * *

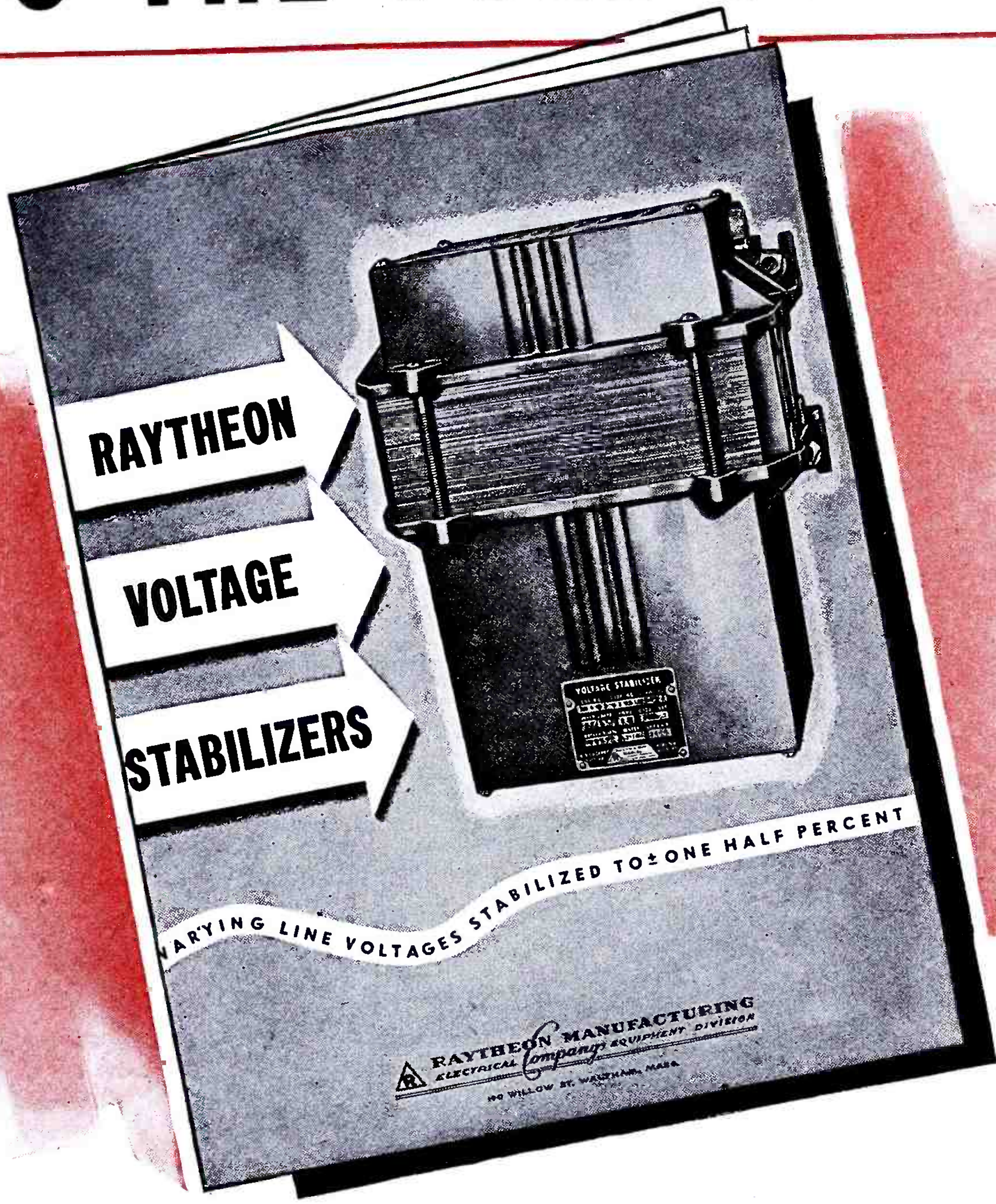
**Acid etching quartz crystals to frequency is a patented Bliley process.*

**Bliley CRYSTALS**

**Radio Engineers—write for temporary Bulletin CM-26**

**BLILEY ELECTRIC COMPANY • UNION STATION BUILDING ERIE, PENNSYLVANIA**

# HERE'S THE FULL STORY




# SEND FOR IT TODAY . . .

IN A DETAILED, 8-page bulletin now available, Raytheon Manufacturing Company tells the complete story about the dependable Raytheon Voltage Stabilizers. These trouble-free magnetic-type units . . . with no moving parts to get out of order . . . stabilize AC from ordinary voltage sources to within plus or minus a half percent, throughout their full rating.

The bulletin includes such useful information as electronic applications, performance features, principles of operation, operating characteristics, graphs, specifications of the three immediately available designs, cased, uncased, and endbell, and a price list.

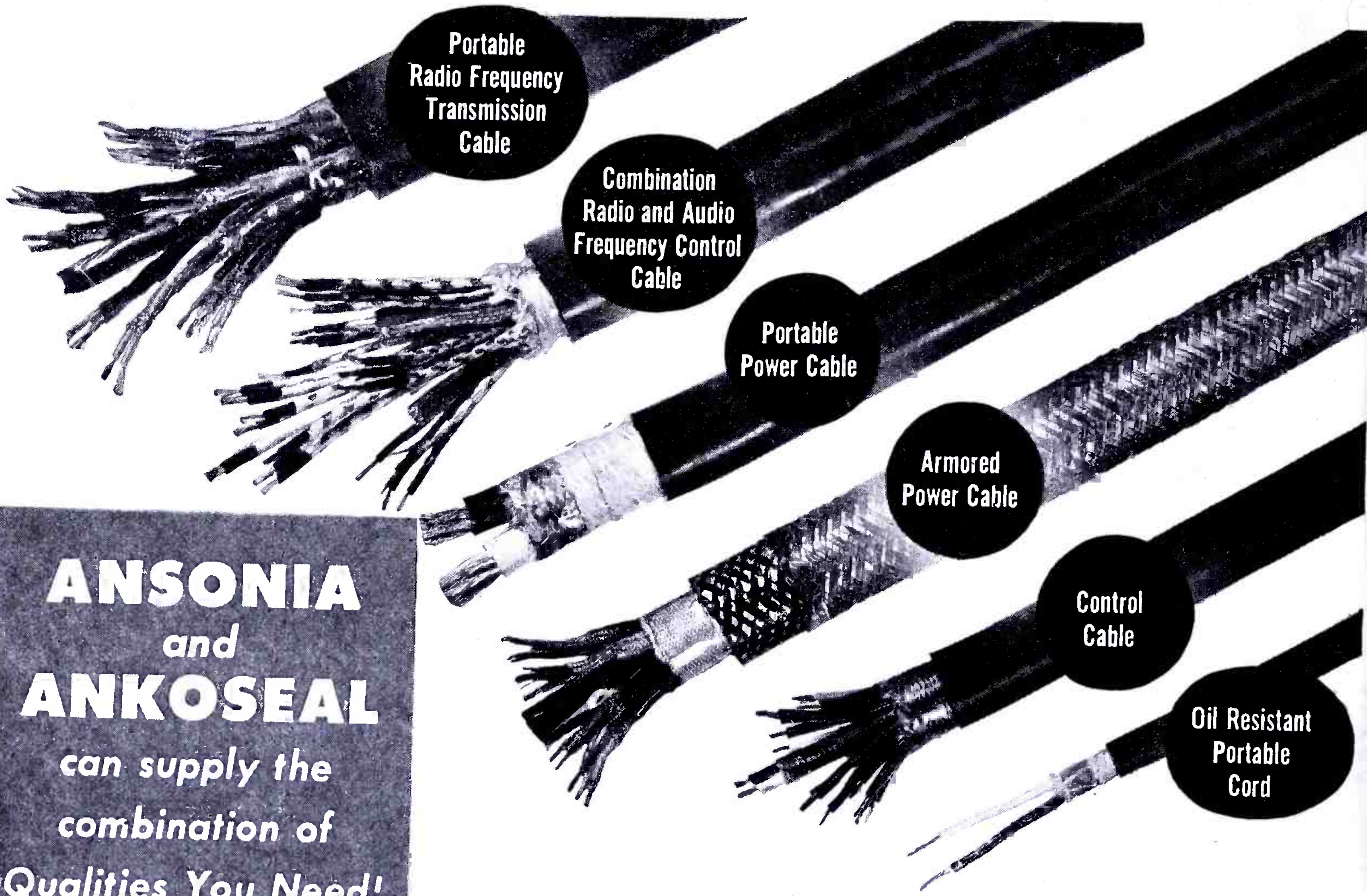
We urge you to send for your copy promptly. Ask for Bulletin DL48-537, and address your request to Raytheon Manufacturing Company, Electrical Equipment Division, Waltham 54, Mass.

**RAYTHEON**
MANUFACTURING COMPANY
WALTHAM 54, MASS.

ELECTRICAL EQUIPMENT DIVISION

*Excellence in Electronics*

# WHAT DO YOU WANT IN A CABLE?




**ANSONIA and ANKOSEAL can supply the combination of Qualities You Need!**

To do your job and do it right, you need cable with certain characteristics. Three or four or more factors—heat resistance, dielectric strength, flexibility and durability, for instance—must be satisfied in the *one* cable. You *can* settle for less—but when a cable fails, it's *your reputation* that suffers.

At Ansonia, electrical cable is engineered to meet *all* necessary requirements as far as that is possible. And, thanks to ANKOSEAL, a remarkable thermoplastic insulation, our engineers are usually able to combine in one cable all the qualities you need.

Simply tell us what you *want* in a cable—we'll design and produce it. It won't be the cheapest cable—but *it will be right!* The difference will result in longer life and better performance.

We'll be glad to describe in detail what Ansonia can offer you in the form of *job-engineered* cable. Write now for fuller information.

### *Why* ANKOSEAL *solves cable problems*

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

**THE ANSONIA ELECTRICAL COMPANY**

*Specializing in "Ankoseal" a Thermoplastic Insulation*

ANSONIA • CONNECTICUT

ARMY E NAVY

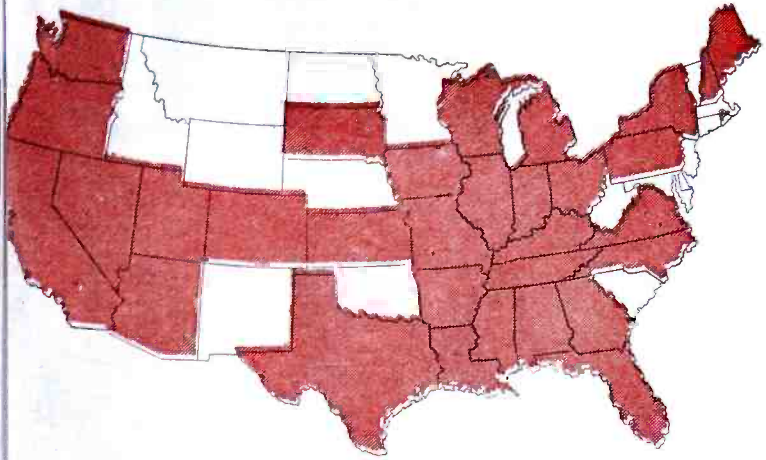
*A Wholly-Owned Subsidiary of*

**NOMA ELECTRIC CORPORATION**

GENERAL OFFICES • NEW YORK, N. Y.

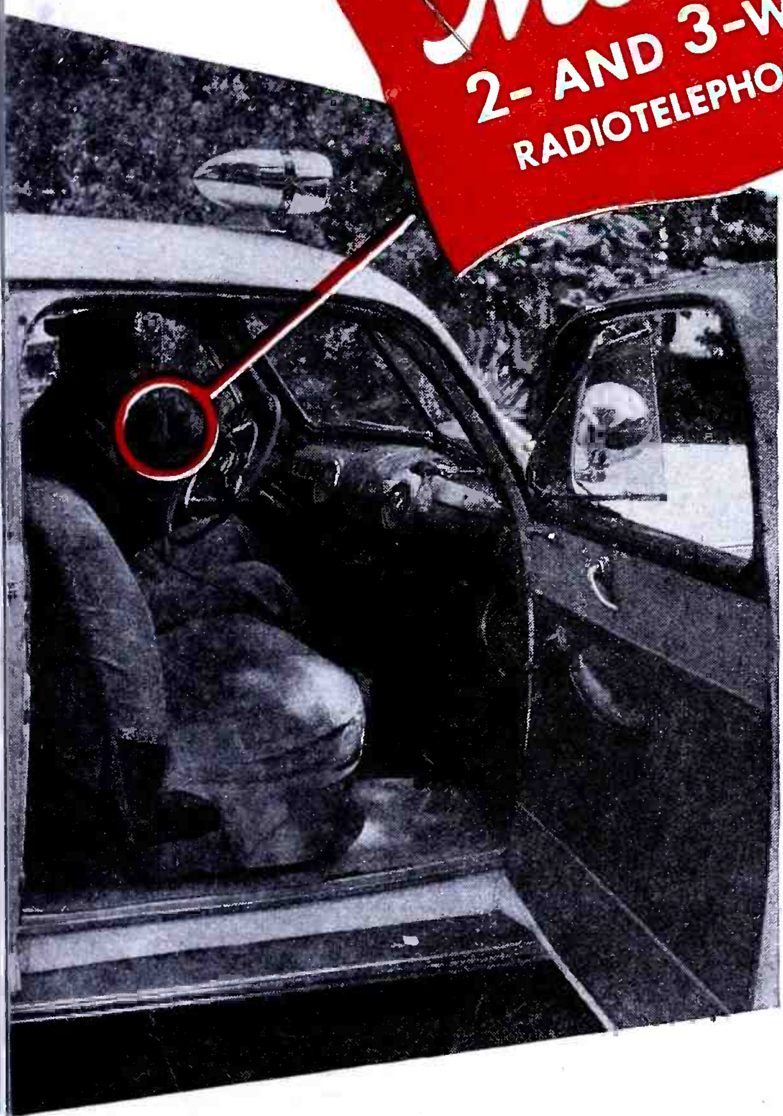
Makers of the famous Noma Lights—the greatest name in decorative lighting. Manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

# Highway Police of



# 36* STATES NOW USE—

## Motorola
## 2- AND 3-WAY F-M RADIOTELEPHONE SYSTEMS



From coast to coast the swing is overwhelmingly to Motorola. Police of 36 states and over 1000 communities now depend on Motorola F-M Radiotelephone for emergency communication. There *must* be a reason . . .

**1. SIMPLICITY**—It doesn't take an electronic technician to operate a Motorola Radiotelephone. Any man on your force can use it *without special training.*

**2. EFFICIENCY**—Motorola Radiotelephone has range and power, enabling patrols to maintain contact with the control station at distances up to 50 miles.

**3. RELIABILITY**—The Motorola Radiotelephone is made by the makers of the battle-tough "Handie Talkie" and "Walkie Talkie". You couldn't ask for a better guarantee that your radiotelephone will always deliver!

The terrain of the area you service may present a particular problem, but Motorola engineers can solve it. Write today—we will be glad to submit specific recommendations—without obligation, of course.

*Including Washington, D. C., Hawaii and Panama.

**FREE!** Write for detailed Motorola Radiotelephone Directory covering more than 1000 Motorola two and three way F-M systems now operating in United States, Canal Zone and Hawaii.

**GALVIN MFG. CORPORATION • CHICAGO 51**

COMMUNICATIONS AND ELECTRONICS DIVISION

F-M & A-M HOME RADIO • AUTO RADIO • PHONOGRAPHS • TELEVISION • AIRCRAFT RADIO • POLICE RADIO • RADAR • MILITARY RADIO

# STANDARD CRYSTALS

*Announcing*

STANDARD'S MIDGET crystal unit, now on a production basis.

STANDARD brings you, as an answer to your frequency control problem, the MIDGET. A precision crystal to your specifications in a holder that's radically different* — designed to fit *minimum* space requirements. Furthermore, the cost is attractive.

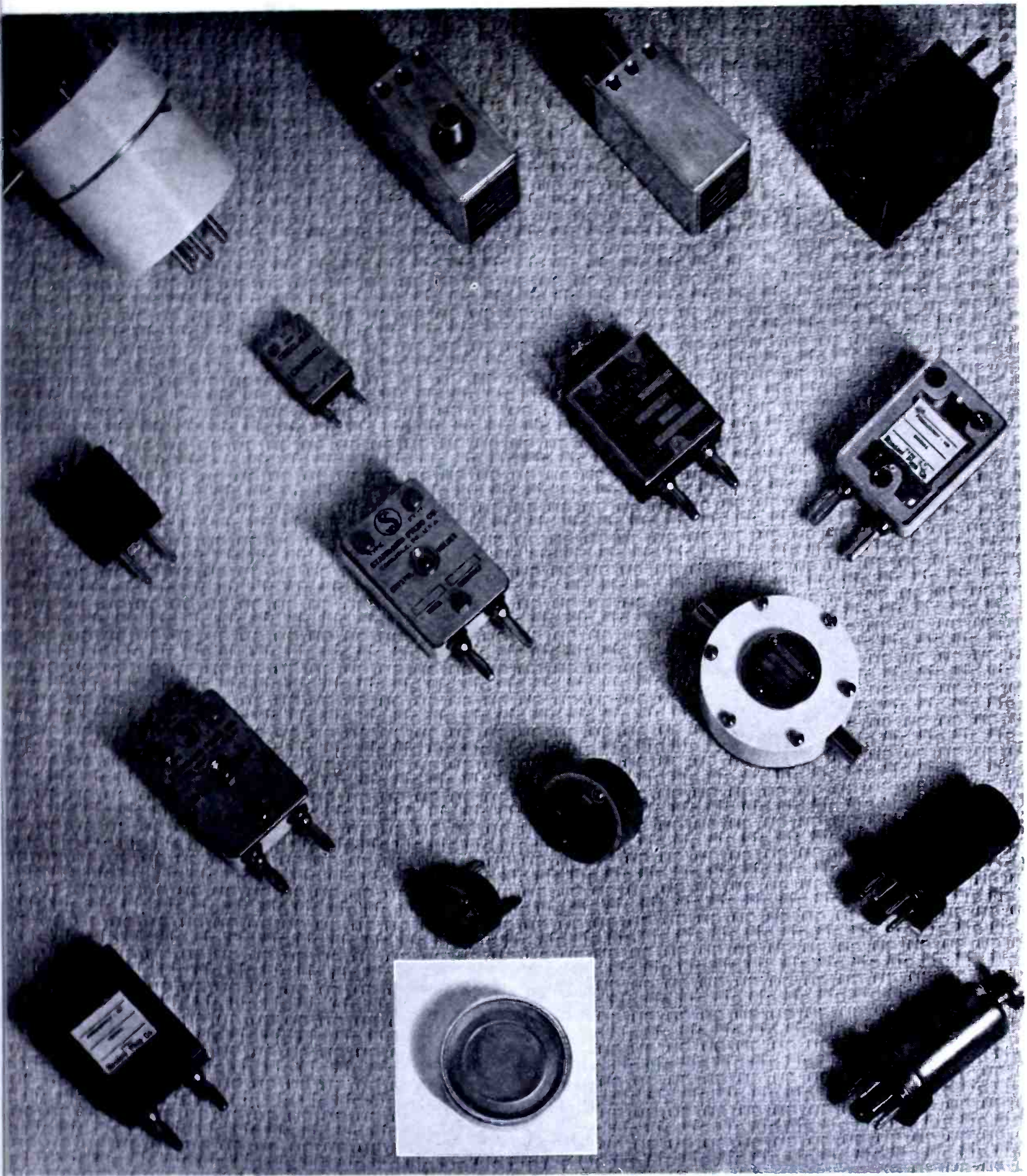
The MIDGET is a real triumph of that skill and knowledge gained through our years of research, development and production experience. We have furnished the armed forces millions of crystal units—NOW we welcome the opportunity to supply *your* requirements.

STANDARD'S engineering staff is at your command. *Write, wire* or *phone* us your frequency control problems.

For general AIRLINE, POLICE, BROADCAST, AIRCRAFT, AMATEUR and COMMERCIAL uses we make a complete line of crystals in standard or special holders. *Send for new catalog just coming off the press.* We take this opportunity to greet our old customers in these fields and to solicit their continued business.

* Refers to designs of holders.

In the inset (opposite page) the new STANDARD MIDGET is reproduced in actual size. The background pictures popular types in the STANDARD line.



# STANDARD PIEZO COMPANY

Established 1936

Quartz Crystals and Frequency Control Equipment

*Office and Development Laboratory*

CARLISLE, PA., P. O. BOX 164

SCRANTON, PA. CARLISLE, PA.

# AEROVOX "Know-How"

Aerovox "Know-How" in action: Chief Engineer Stanley Green (center) with Joseph L. Collins (Electrolytics), Louis Kahn (Assistant Chief Engineer) and Samuel Heyman (Production Manager) working out the capacitance problem of a customer from the application blueprints.

## ...can save you untold time, expense, trouble

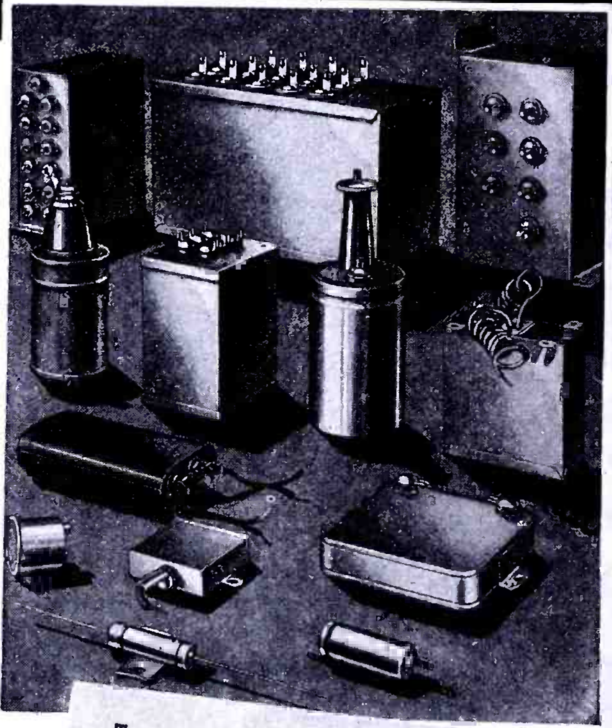
● Ingenuity, imagination, versatility, adaptability, coupled with sound engineering practice, add up to Aerovox "Know-How."

Of course Aerovox has an outstanding line of *standard* capacitors—paper, oil, electrolytic, mica and low-loss ultra-high-frequency types. A wide range of requirements are met with such a variety of listings. But Aerovox can also meet most extraordinary needs with *special* types that do not have to be billed at usual special prices. Here's why:

A tremendous variety of cans, terminals, insulators, mountings and production processes at the disposal of Aerovox engineers enables Aerovox to make up special types quickly, readily, inexpensively. So:

Bear in mind Aerovox "Know-How"—and save untold time, expense, trouble.

● ***Try us on that capacitance problem.***



Typical "special" capacitors assembled from standard Aerovox parts, indicating the wide variety of cans, terminals, insulators and mountings.

**AEROVOX Capacitors**

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 13 E. 40 ST., NEW YORK 16, N. Y. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

# New Pilotless Plane?

## BACK IN 1939 PACIFIC DIVISION HAD ALREADY FLOWN THIS RADIO CONTROLLED AIRPLANE

This portable 100 watt transmitter was used to control the plane. "Ground Pilot" sat in the truck body.

ix years ago we did it the hard way. Month after month at an isolated camp n the Mojave Desert Pacific Division radio engineers collaborated with ockheed engineers to perfect electronic controls and the aerodynamic haracteristics of one of the first airplanes to fly by radio direction alone.

he operations were part of a special Army project and, in all, six airplanes f Lockheed design were successfully flown. In light of the tremendous trides Pacific Division radio engineers have made since those early days, it s interesting to know that this first radio control receiver had to provide imultaneous operations of *thirteen* controls—for the elevator, rudder, -position throttle, altitude, airspeed, counter, camera and parachute release.

he success of these early, complicated experiments have given Pacific ivision a six-year lead in the development of numerous types of VHF ontrol and communication equipment. We would like the opportunity o demonstrate how these modern controls may solve your problems, too.

Taken from movie film, this shows an actual take off. Note perfect flight altitude for this critical operation.

Trailing smoke made observation easier. The 80 h.p. plane, comparable to a single-seater, had speed of 105 m.p.h.



**Pacific Division**
**Bendix Aviation Corporation**
11679 Sherman Way, No. Hollywood, Calif.

VHF COMMUNICATION SYSTEMS

PRODUCT OF Bendix AVIATION CORPORATION

**OPERATING SIX VHF EXPERIMENTAL STATIONS**

# NEW INSTANT-HEATING BEAM TETRODE
# Ruggedized 2E25
## FOR MOBILE OPERATION


Developed for Signal Corps portable, nobile, or emergency communications quipment, the 2E25 r.f. beam tetrode is asy on the battery. The thoriated tungten filament permits simultaneous appliation of filament and plate potentials. Precious battery power is conserved during tandby periods.

Completely shielded for r.f., the 2E25 reuires no neutralization even at its maxinum frequency of 100 megacycles. Other eatures are: low-loss octal base, plate conection to top cap, filament potential centered at 6.0 volts, and extremely rugged onstruction.

Consider the advantages of the 2E25 as an nstant-heating replacement for the 6V6GT r 6L6G in older equipment, or for use in nodern equipment such as the new Kaar nobile FM set illustrated. Remember, the ersatility of the 2E25 beam tetrode simlifies the spares problem; this one type an power a whole transmitter—R.F. and A.F. Order your engineering samples today.

### HYTRON 2E25

**Instant-Heating 15-Watt R.F. Beam Tetrode**

**TENTATIVE ELECTRICAL DATA**

| | |
|---|---|
| Filament Potential | 6.0 ± 5% ac or dc volts |
| Filament Current | 0.80 amp. |
| Plate Potential | 450 max. dc volts |
| Screen Potential | 250 max. dc volts |
| Grid Potential | −125 max. dc volts |
| Plate Current | 75 max. dc ma. |
| Plate Dissipation | 15 max. watts |
| Screen Dissipation | 4 max. watts |
| Grid Driving Power (Class C) | 0.5 watt approx. |
| Power Output (Class C) | 20 watts |

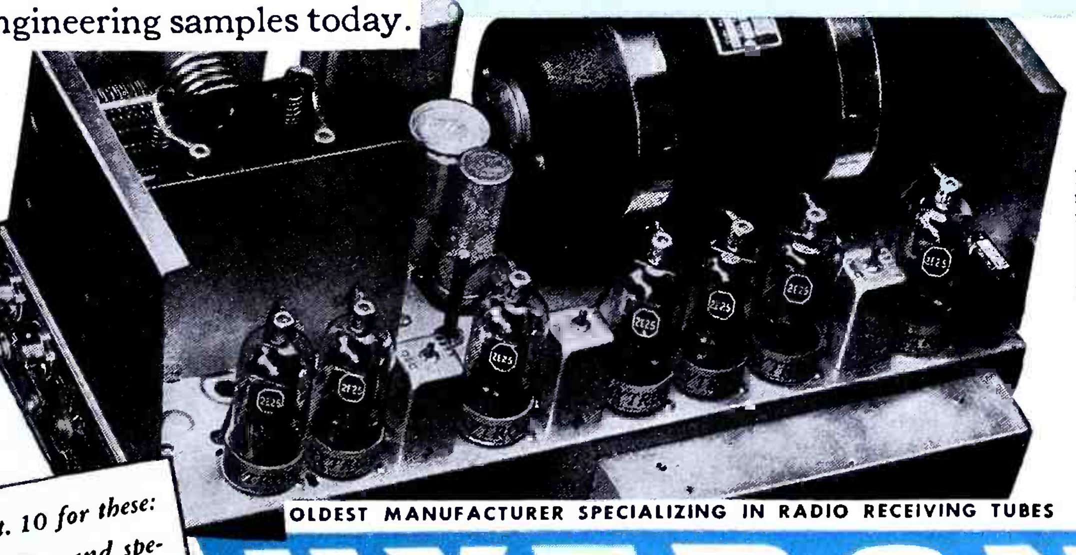
**AVERAGE DIRECT INTERELECTRODE CAPACITANCES**

| | |
|---|---|
| Grid to Plate (with external shielding) | 0.18 max. mmfd |
| Input | 8.5 mmfd |
| Output | 6.0 mmfd |

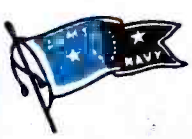
**MECHANICAL DATA**

| | |
|---|---|
| Maximum Overall Length | 4 3/16 inches |
| Maximum Diameter | 1 7/16 inches |
| Bulb | T-11 |
| Cap | Small metal |
| Base | 7-pin med. short shell low-loss octal |

**The New 2E25 Supersedes and Replaces the HY65**



New instant-heating mobile FM transmitter developed by Kaar Engineering Co. uses 7 Hytron 2E25 and 2 Hytron HY69 or HY1269.




***WRITE TODAY** to Dept. 10 for these: New Hytron transmitting and special purpose tube catalog; 21 x 17 inch sheet illustrating Step-by-Step Assembly of Typical Hytron Tube.*

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

# HYTRON
## RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

# WE SPECIALIZE IN "Specials"

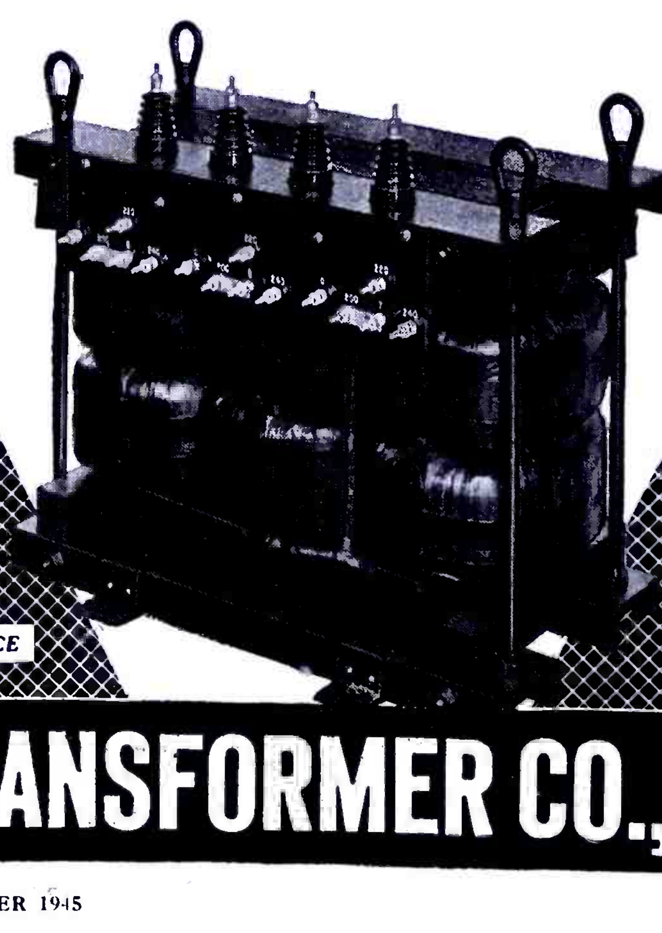
**FOR NEARLY 20 YEARS,** the Kenyon Transformer Company has done an outstanding job of satisfying the demand of large manufacturers for "special units" to fit exactly their most critical needs, with the same care that other manufacturers could provide items of their standard catalog lines.

**THIS ACHIEVEMENT** is a tribute to the skillful engineering ability of the Kenyon Pioneers who have maintained a leading place in the development of outstanding transformer equipment.

**WE INVITE INQUIRIES** from manufacturers of electronic and other types of equipment, and from industrial and commercial users of transformers.

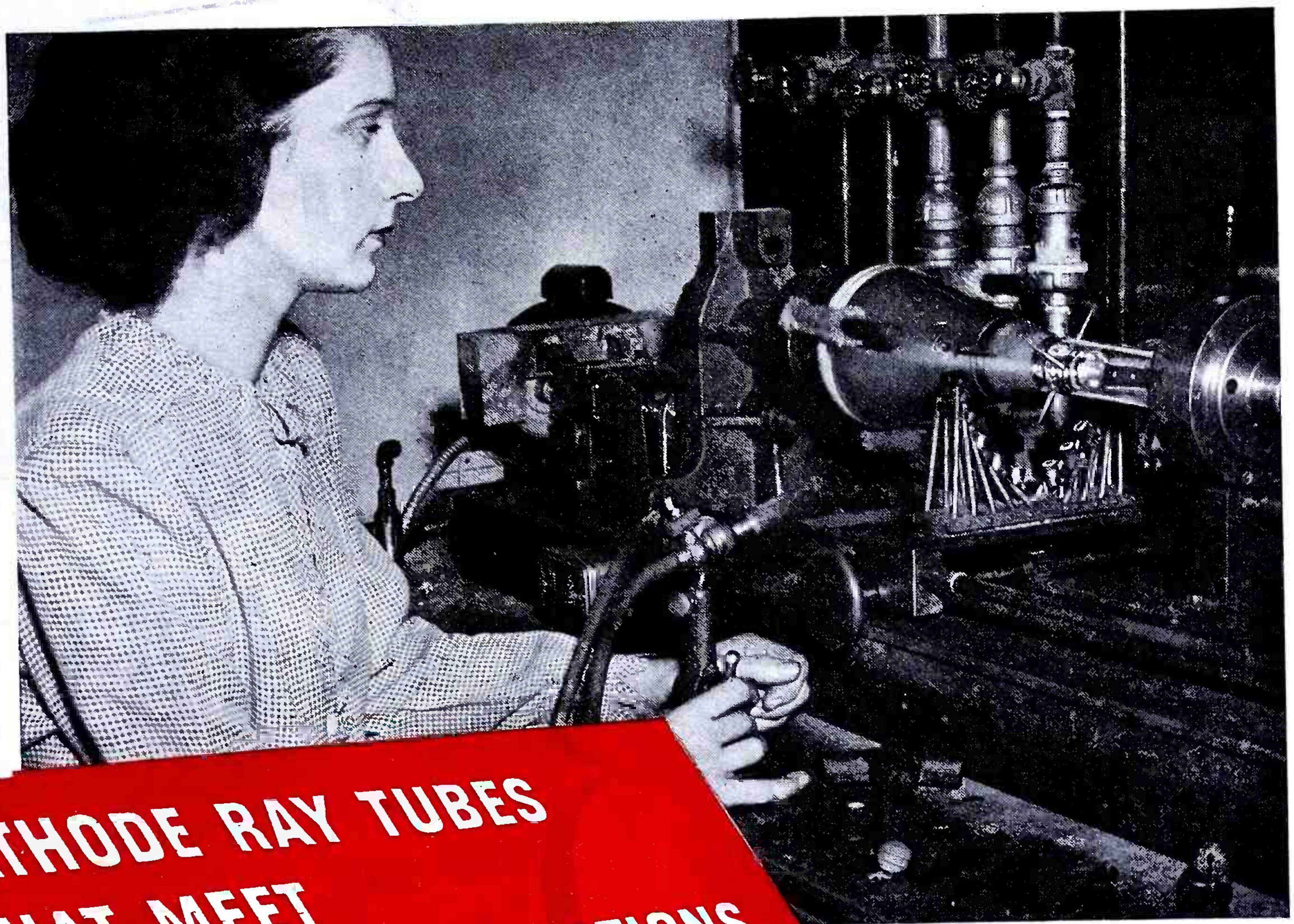
**KENYON PREDICTS** that the small additional cost of "specials" will be more than offset by the superior product—streamlined to fit each manufacturer's requirement.

*Inquiries invited — write for our new 1945* ***ILLUSTRATED CATALOG.***



*THE MARK OF* *EXCELLENCE*

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



# CATHODE RAY TUBES THAT MEET EXACTING SPECIFICATIONS

NORTH AMERICAN PHILIPS is one of the few manufacturers of electronic tubes endowed with the skill and experience required for the mass production of the 5JPl and similar cathode ray tubes.

The deflection-plate terminals of these tubes are brought out at the neck of the glass envelope to provide higher insulation and lower lead capacitance at very high frequencies.

In the manufacturing procedure the tubes are cracked at the neck, the deflection-plate leads bent out, and the envelope sections rejoined on a glass-sealing lathe, as illustrated. During this operation the tubes are maintained at a high temperature to prevent the formation of water vapor on the fluorescent screens.

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

The facilities which North American Philips has applied to the manufacture of electronic tubes during the war are now available for the postwar production of cathode ray tubes for direct viewing and projection television.

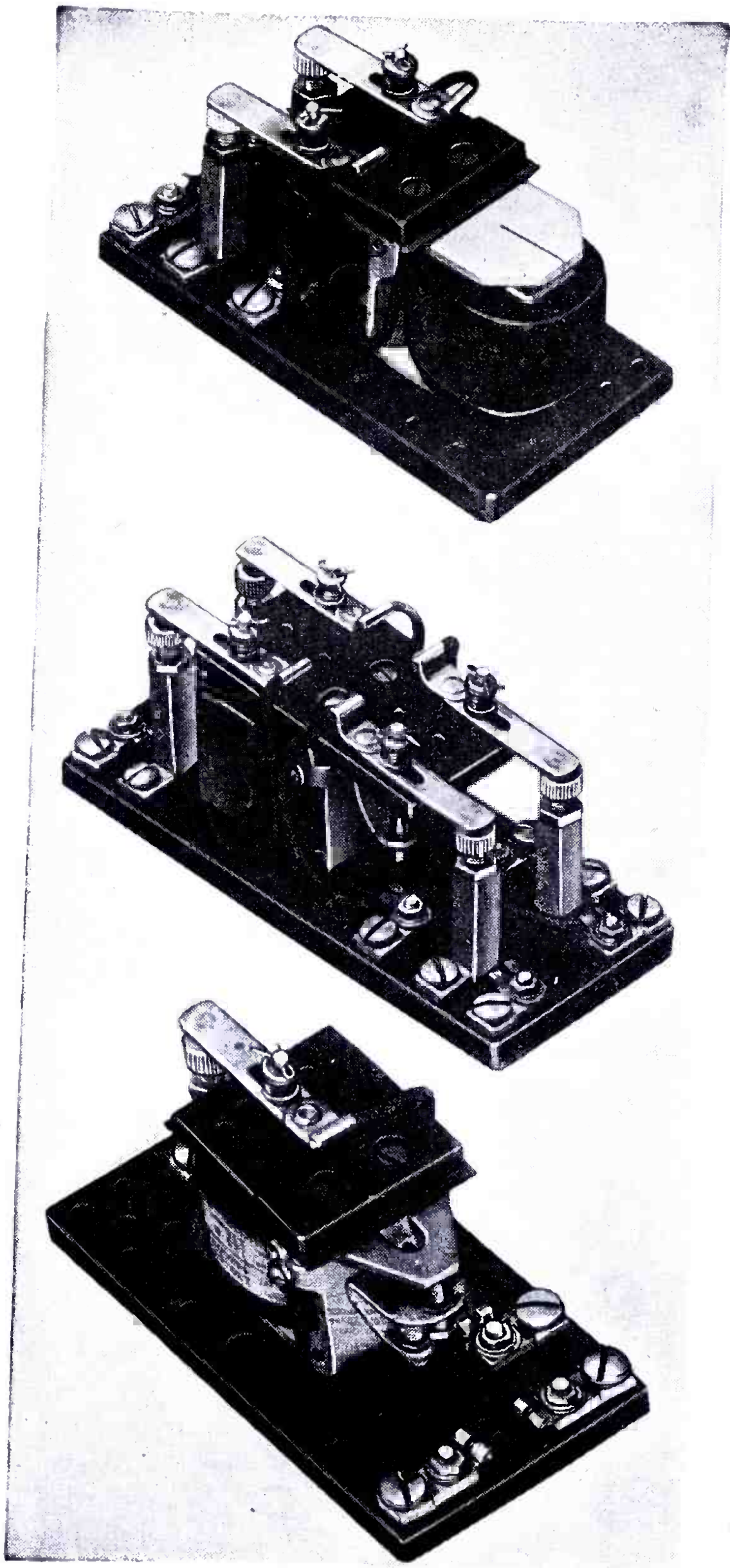
Write today for interesting booklet on "How and Why Cathode-Ray Tubes Work."

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

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

**Norelco** Reg. U. S. Pat. Off. *Electronic Products by* **NORTH AMERICAN PHILIPS COMPANY, INC.**

Dept. E-10, 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N.Y.; Mount Vernon, N.Y. (Metalix Div.); Lewiston, Me. (Elmet Div.)



# HEAVY DUTY RELAYS

Relays No. 130 are available for radio, electronic and industrial applications. Heavy duty contacts. One to four poles with wide variety of contact arrangements. Molded phenolic bases. New catalog gives complete data. Write for your copy now.

## WARD LEONARD ELECTRIC CO.

*Radio and Electronic Distributor Division*

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ACCEPTED MEASURE OF QUALITY

***RESISTORS***
***RHEOSTATS***
***RELAYS***

# 3 OUTSTANDING FEATURES OF THE NEW EIMAC 4-125A TETRODE

## 1 LOW DRIVING POWER

With but 2.5 watts driving power, the 4-125A will deliver 375 watts output at frequencies as high as 120 Mc. The low driving power requirement has been achieved without the use of excessive secondary emission. The control grid is specially processed to reduce both primary and secondary emission.

## 2 HIGH FREQUENCY PERFORMANCE

The Eimac 4-125A will deliver 200 watts output at 250 Mc. The performance curves below show the relationship between driving power and power output at frequencies up to 250 Mc.

## 3 LOW GRID-PLATE CAPACITANCE

The grid-plate capacitance of the 4-125A is only *0.03 uufd.* This low value allows operation up to 100 Mc. without neutralization. Stability is further assured by the special grid processing which reduces secondary emission.

A technical bulletin on Eimac 4-125A Power Tetrode contains full specifications and detailed discussion of the tube's characteristics, circuit diagrams and constant current curves. Write for your copy today.

*The Eimac 4-125A is the first of many new Eimac tubes that are on the way. Watch for future announcements.*

### ELECTRICAL CHARACTERISTICS

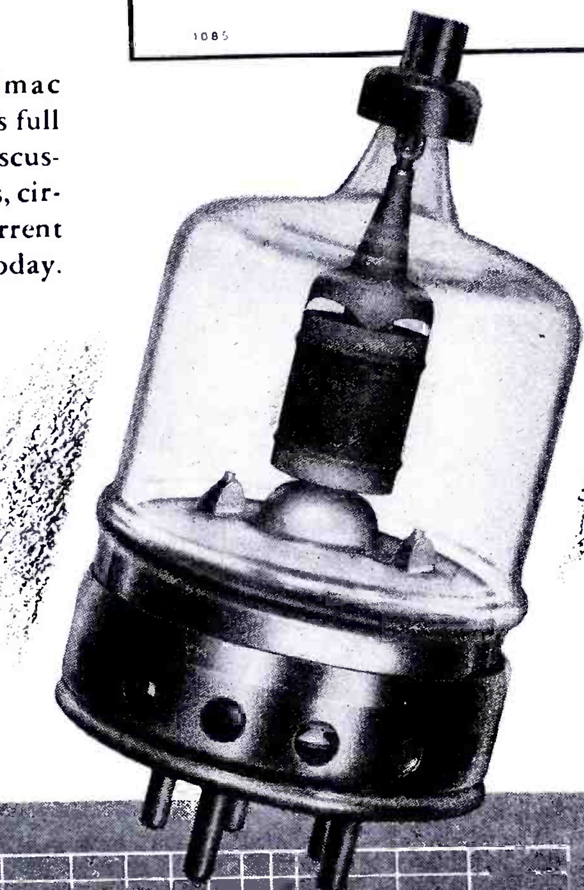
Filament: Thoriated Tungsten

| | |
|---|---|
| Voltage | 5.0 volts |
| Current | 6.2 amperes |
| Plate Dissipation (Maximum) | 125 watts |

Direct Interelectrode Capacitances (Average)

| | |
|---|---|
| Grid-Plate (Without shielding, base grounded) | 0.03 *uufd.* |
| Input | 10.3 *uufd.* |
| Output | 3.0 *uufd.* |
| Transconductance ($i_B$ = 50 ma., $E_B$ = 2500 v., $E_{C2}$ = 400 v.) | 2450 *umhos* |

1085



FOLLOW THE LEADERS TO

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

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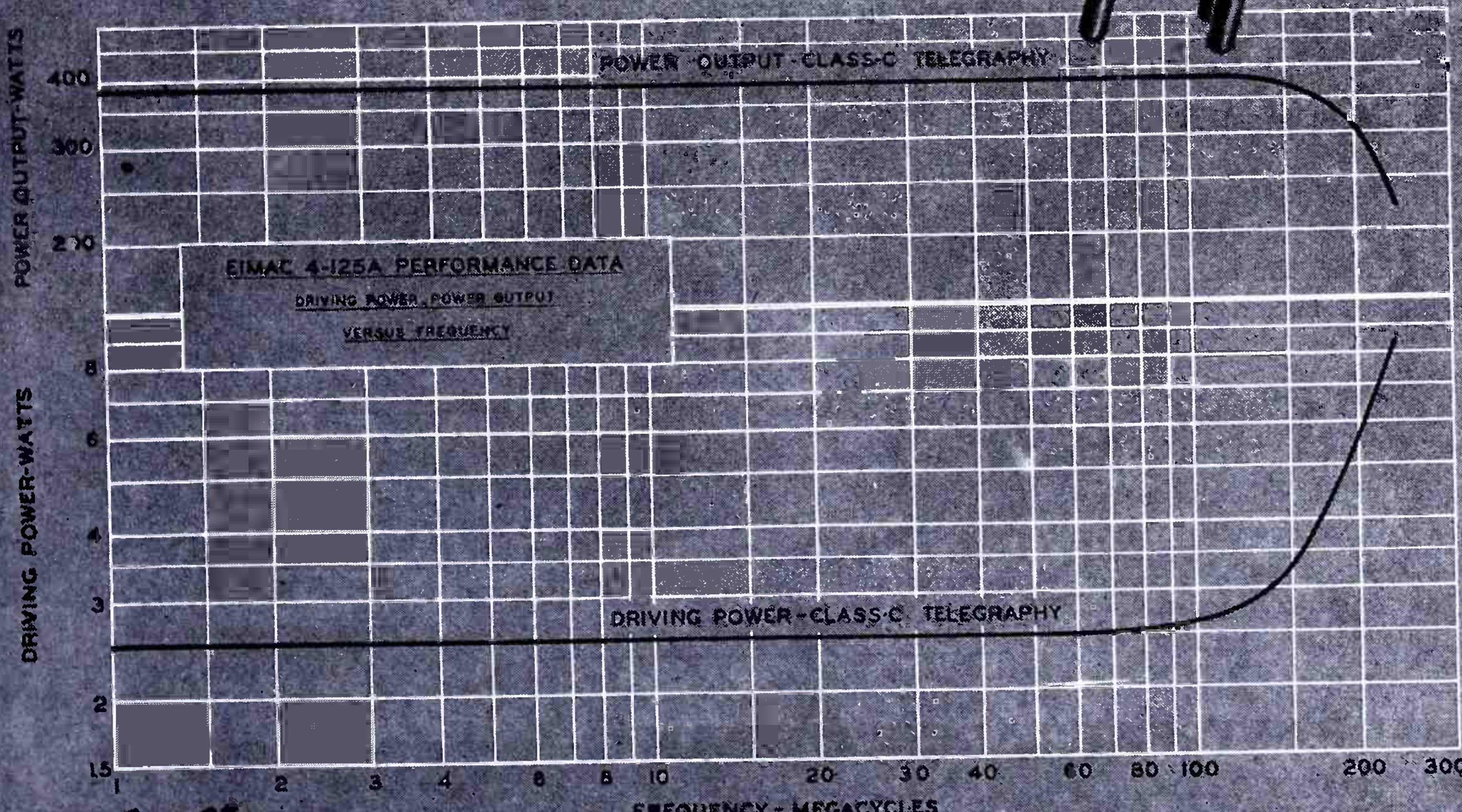
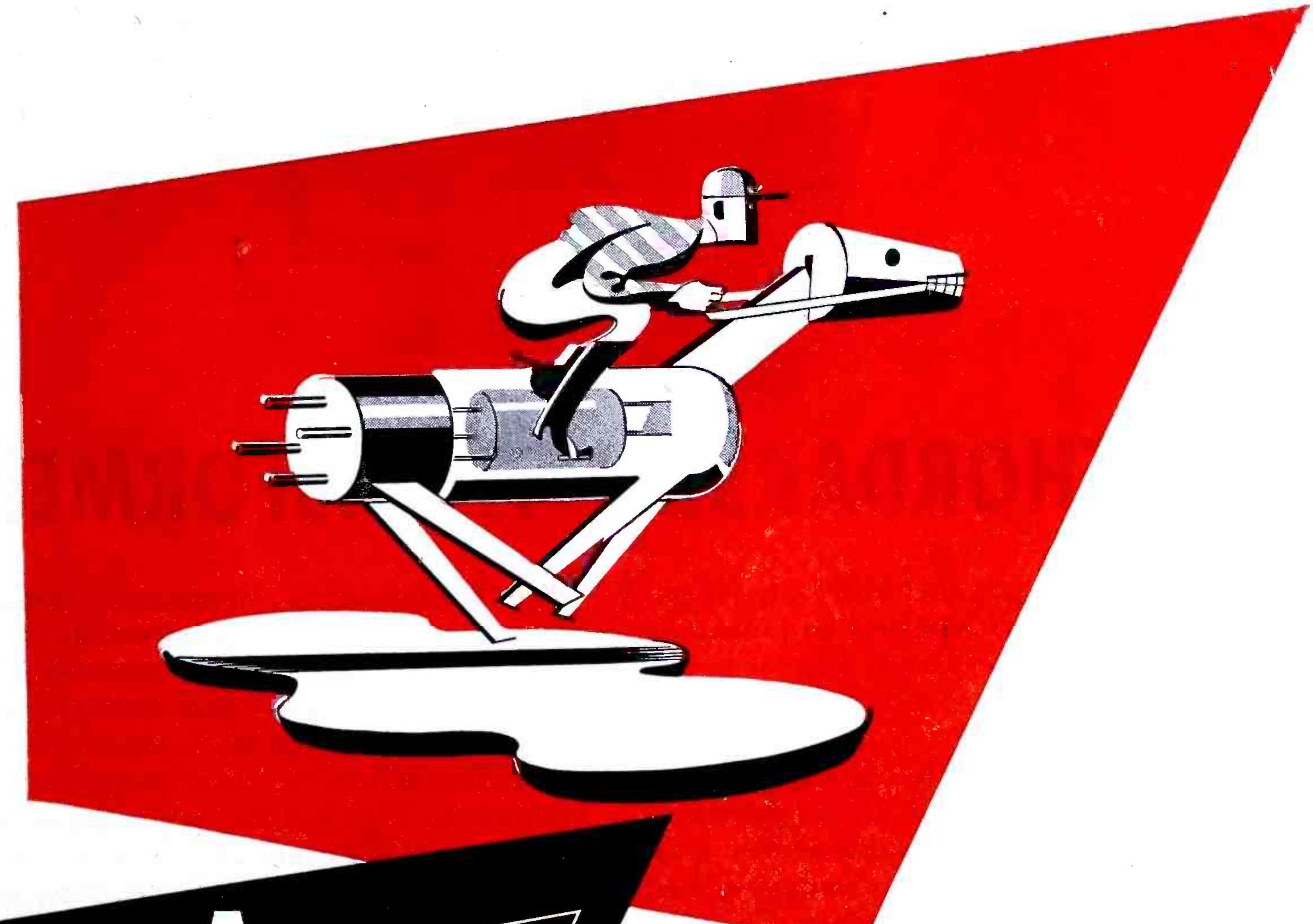
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U. S. A.




Eimac TUBES THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

# Aireon rides again

OUR spirited steed is not only fast but well-gaited. We curled our lasso around the neck of "Electronics" a long time ago and with our strong personality, and kind treatment, turned it into our pet horse. It took a lot of skull work, a lot of smart engineering, but it worked out. Now our stable has 28 red hot electronic devices that should interest you. How about hitching your chariot to our fast-stepping organization, giving **Aireon** its head in helping solve your electronic problems?



**Aireon**

**MANUFACTURING CORPORATION**

Radio and Electronics • Engineer Power Controls

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# TESTIMONIAL TO PERFORMANCE!


# . . . THORDARSON TRANSFORMERS

The quality of a product and its performance over the years can best be judged by the repeat orders received. Repeat orders mean one thing above everything else . . . *customer satisfaction!*

For over 50 years, *Thordarson* has supplied transformers and other electronic products constantly to many of the most prominent manufacturers in industry. Yes, *Thordarson* has always enjoyed a large repeat order business.

At *Thordarson* . . . continuous research, progressive design and engineering are responsible for the development of the excellent transformers that have earned for *Thordarson* this reputation for fine performance.

Try *Thordarson* for your transformer requirements. Then you, too, will know why the many long-time users of *Thordarson* show their approval by repeat orders. New sales and distribution policies make *Thordarson* products available to everyone, everywhere.

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ARMY E NAVY

ORIGINATORS OF TRU—FIDELITY AMPLIFIERS

**THORDARSON**

*ELECTRIC MANUFACTURING DIVISION*

MAGUIRE INDUSTRIES, INCORPORATED

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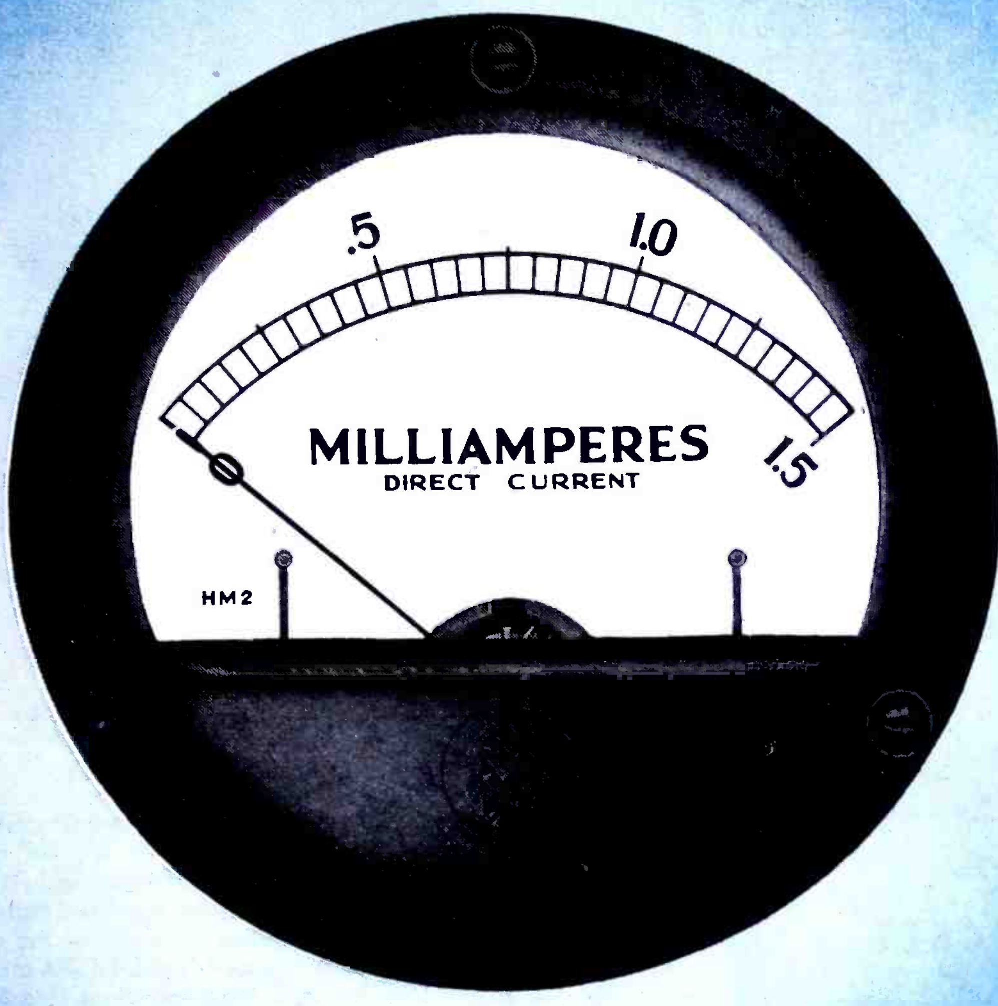
## FOR ALL CIVILIAN USE...




## ......AT NO MORE COST THAN STANDARD UNSEALED INSTRUMENTS

***Marion Glass-to-Metal Truly Hermetically Sealed 2½" and 3½" Electrical Indicating Instruments***

**IMPROVED PRODUCT • APPEARANCE • PERFORMANCE • SALABILITY**

***Write for our 12-page brochure***

**MARION ELECTRICAL INSTRUMENT CO.**

MANCHESTER, NEW HAMPSHIRE

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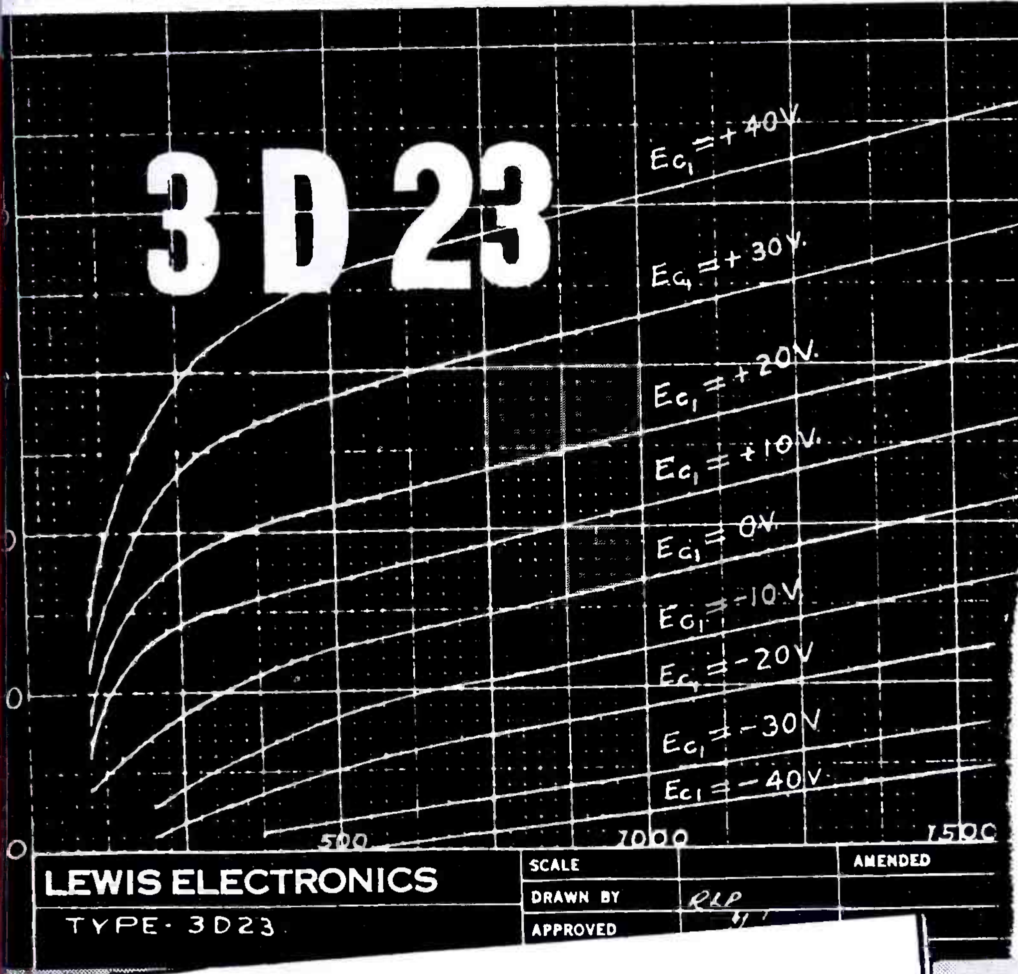
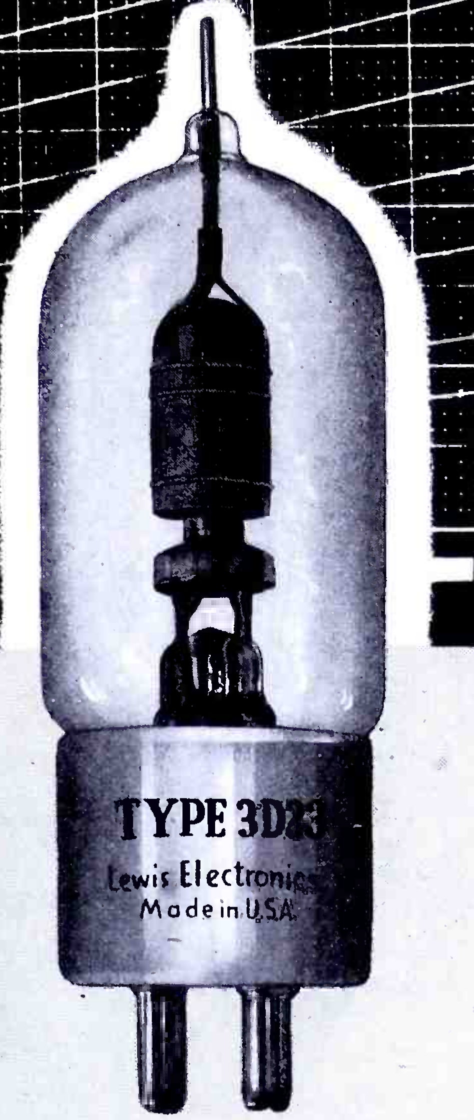



## 3D23 ... A NEW TETRODE FOR FIXED OR MOBILE OPERATION

| | |
|---|---|
| Filament Voltage . . . | 6.3 AC or DC Volts |
| Filament Current . . . . . . | 3.0 Amperes |
| Amplification Factor . . . . . . . . . | 65 |
| Mutual Conductance . . . . . . . . | 2750 |
| Plate Dissipation . . . . . . . . . | 35 Watts |
| Medium 4 Pin Ceramic Base | |
| Maximum Power Output . . . . . | 130 Watts |
| Approximate Driving Power . . . . | 4.5 Watts |

*Inter-Electrode Capacities:*

| | |
|---|---|
| Input to Plate . . . . . . . . . | .2 MMFD |
| Input, 6.5 MMFD — | Output, 1.8 MMFD |

*Frequency Limits as Power Amplifier:*

| | |
|---|---|
| Full Power Input . . . . . . . . | 250 MCS |
| Half Power Input . . . . . . . . . | 400 MCS |

LICENSED UNDER R. C. A. PATENTS

List Price $10.

*Catalog sheets and tubes ready for distribution!*

### *Lewis at Los Gatos*

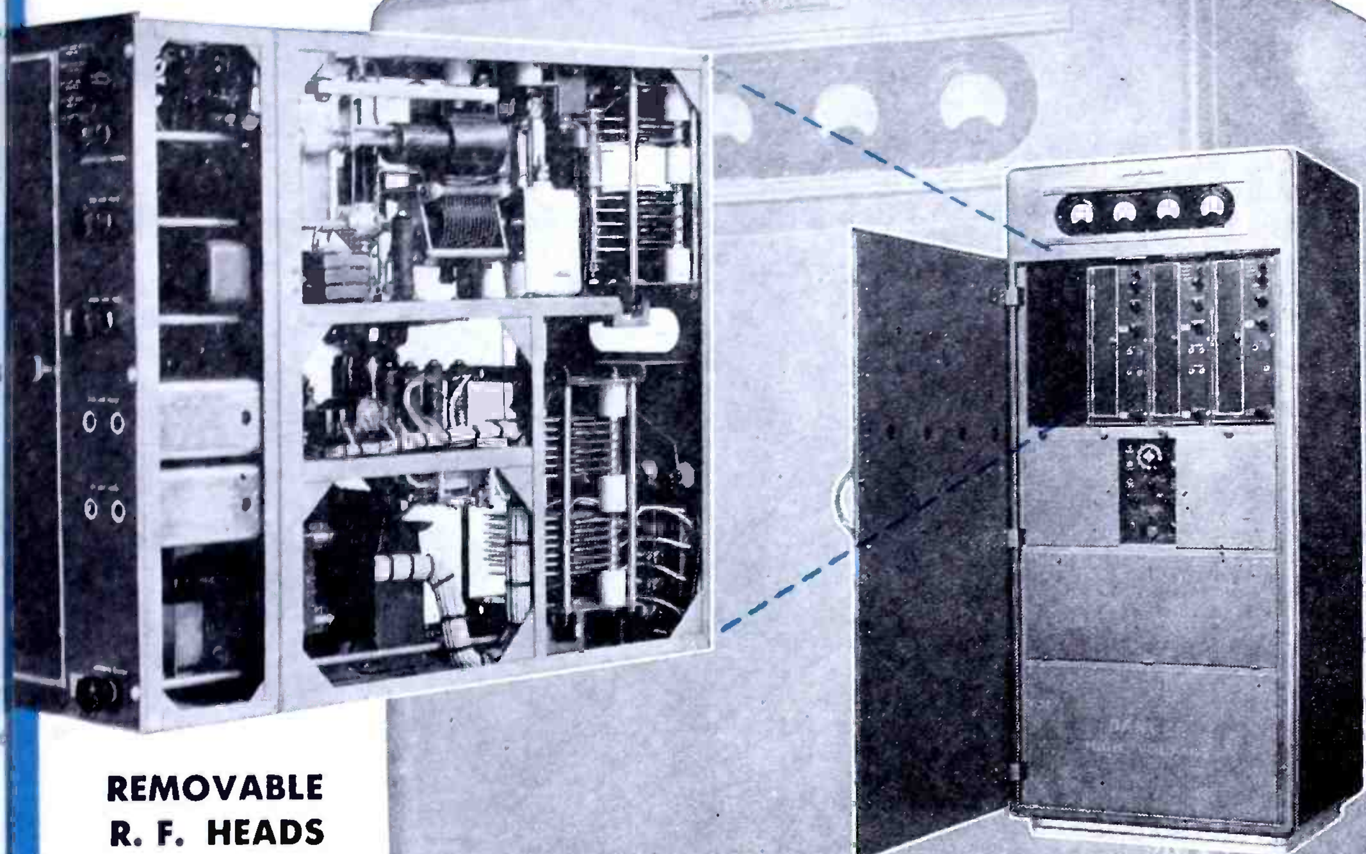
A manufacturing organization . . . the pride of an entire community . . . with an electronic engineering background of 20 years experience! *Plus* a war-born performance record of meeting huge production demands and exacting technical requirements—on time and economically!

EQUIPPED and READY to produce YOUR TUBES under YOUR BRAND name!

# Lewis ★ ELECTRONICS

LOS GATOS · CALIFORNIA

# *Wilcox Type 99A Transmitter*



**REMOVABLE R. F. HEADS**

All radio frequency circuits are included in the 2—20 Mc. R.F. head shown above. All connections to the transmitter cabinet are by means of plugs and receptacles.

A medium power transmitter, designed particularly for aeronautical service. Equally adaptable to other fixed services. Check these features for their application to your communication problems:

★ Four transmitting channels, in the following frequency ranges:
125—525 Kc. Low Frequency.
2— 20 Mc. High Frequency.
100—160 Mc. Very High Frequency.
Other frequencies by special order.

★ Simultaneous channel operation, in following maximum combinations:
3 Channels telegraph.
2 Channels telephone.
1 Channel telephone, 2 Channels telegraph.

★ Complete remote control by a single telephone pair per operator.

★ 400 Watt plus carrier power.

★ Low first cost. Removable radio frequency heads are your protection against frequency obsolesence.

★ Reliability backed by two years of engineering research, one year of actual field operation.

★ Available with all-steel, or wood pre-fabricated transmitter house complete with primary power, antenna, and ventilation fittings.

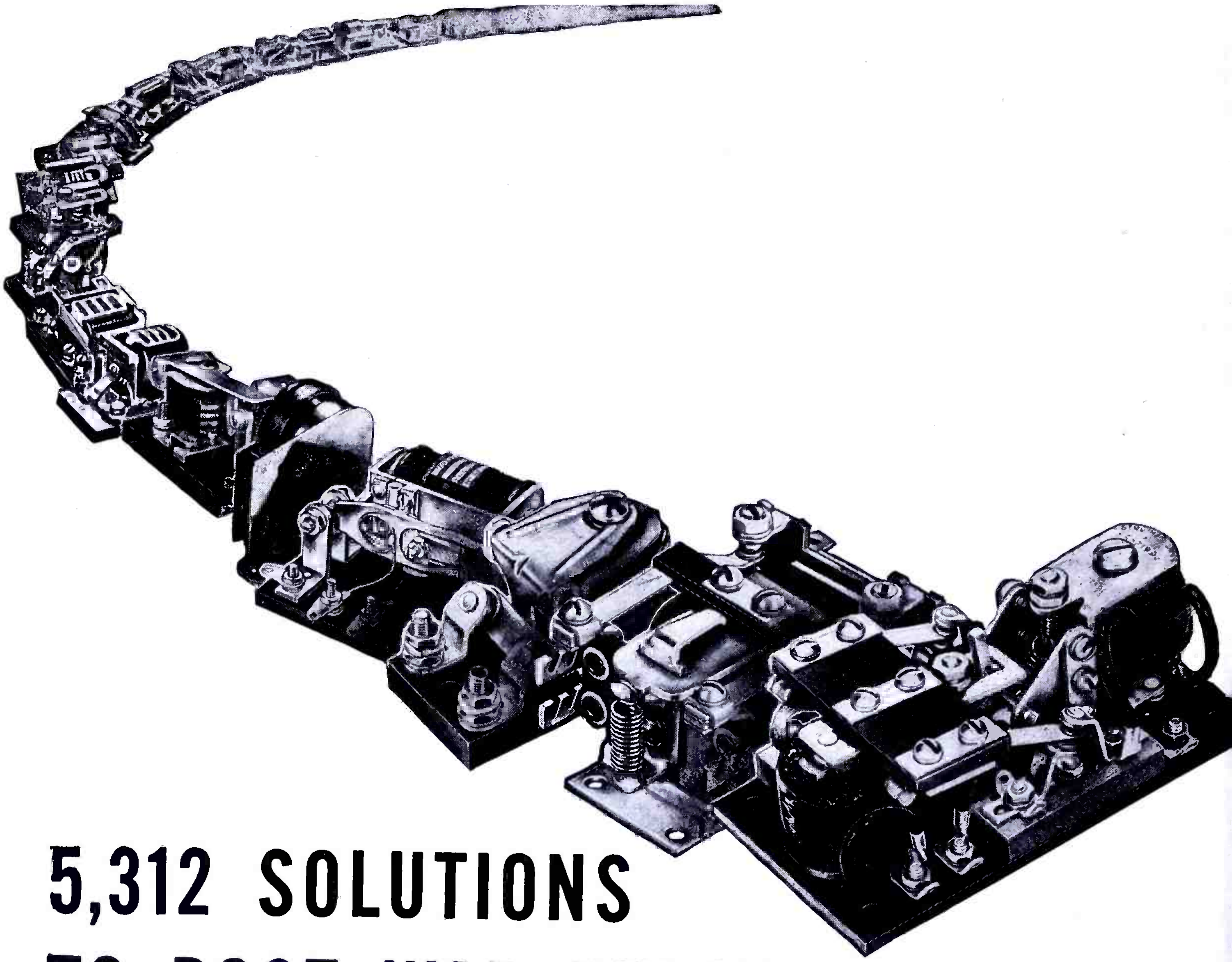
★ Not a "post-war plan," but a field-tested transmitter now in production.

*An inquiry on your letterhead outlining your requirements will bring you complete data.*

**WILCOX ELECTRIC COMPANY, INC.**

*Manufacturers of Radio Equipment*

**Fourteenth and Chestnut Kansas City, Missouri**



# 5,312 SOLUTIONS TO POST WAR RELAY PROBLEMS

Fit the relay to the job!

To make this readily possible, Struthers-Dunn offers 5,312 *standard* types, each available in countless design adaptations to fit your needs *exactly.* These include thousands of styles, shapes, sizes and ratings in a-c types, as well as hundreds more of the most modern d-c types including those capable of withstanding the rigors of war equipment usage.

Beyond the standard Struthers-Dunn types, at your service, are the full facilities of a large, specialized organization which, for 22 years, has concentrated exclusively on "tailoring" relays and timers to specific applications and requirements.

STRUTHERS-DUNN, INC., 1321 Arch Street, Philadelphia 7, Pa.

# STRUTHERS-DUNN

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# IN TELEVISION DUMONT SETS THE PACE!

**DUMONT'S JOHN WANAMAKER TELEVISION STUDIO, STATION WABD**
*Regular Television broadcasts will begin about December 1, 1945*

DuMONT TELEVISION engineers, who have designed and built more television stations than any other company, will soon complete the world's largest television installation. They are now transforming more than 500,000 cu. ft. of the great John Wanamaker store in New York into the first "Television City."

The largest studio (50′ x 60′ with a 50′ ceiling) boasts 4 cameras—the first studio to be so well equipped. A balcony accommodates 700 spectators and a rear glass wall of the control room permits sightseers to watch rehearsals and broadcasts. Two other "live talent" studios are equipped with 3 and 2 cameras each. Several cameras are mounted on a new type dolly providing extreme ranges of elevation and camera angle. A telecine studio has projectors for both 16 mm. and 35 mm. film.

DuMont Television broadcasting equipment embodies all the flexibility and refinements accruing from more than 4 years of continuous and increasingly elaborate programming experimentation. Simplified precision control—the keynote of DuMont design—assures high efficiency and rugged dependability at low operating cost. DuMont leadership means adequate training of your technical personnel, and the finest craftsmanship for the least outlay.



**DUMONT** *Precision Electronics and Television*

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# For Foxhole Conditions

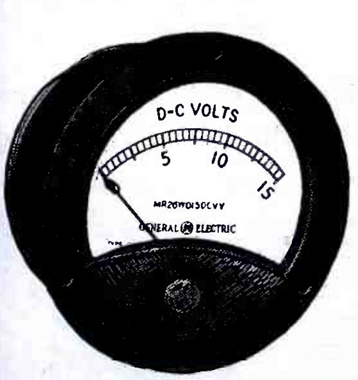
# A HERMETICALLY SEALED PANEL INSTRUMENT with 5 *Important Features*

LOW, damp, wet holes protect lives, but cause equipment to rust, corrode, and fall apart. Where there is no cover, rain, dew, and fog soak into equipment—until, even in direct sunlight, it doesn't dry out for weeks.

To protect the sensitive element from fungus growth and the rapid deterioration caused by these conditions, our engineers developed a unique, hermetically sealed enclosure for this 2½-inch G-E panel instrument. Complete sealing, easy field servicing, accurate combat-proved element, and sturdy construction make this a superior instrument. It is designed to meet tentative Signal Corps Specification 71-3159, and is available for direct-current (DW-61) or radio-frequency (DW-62) service.

This new hermetic enclosure is another example of the way G-E measurement engineers have been, for nearly fifty years, overcoming difficulties in the design and application of precision instruments. There are many other recent G-E accomplishments, typical of which are the new 1½-inch instruments, the internal-pivot element, and new magnetic alloys.

For more complete information on this hermetically sealed instrument, ask the nearest G-E office for Booklet GEA-4429, or write to General Electric Company, Schenectady 5, N. Y.

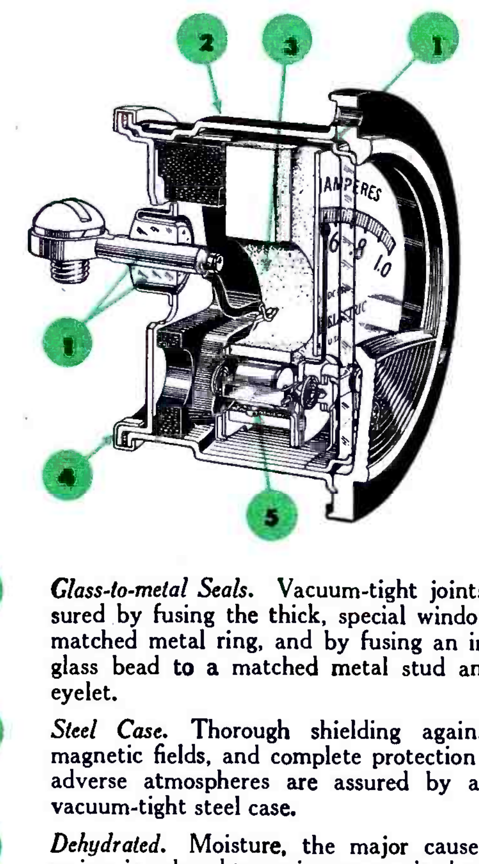



**HEADQUARTERS FOR ELECTRICAL MEASUREMENT**

**Buy all the BONDS you can—and *keep all you buy***

**GENERAL ELECTRIC**

602-84-6200




1. *Glass-to-metal Seals.* Vacuum-tight joints are assured by fusing the thick, special window into a matched metal ring, and by fusing an insulating glass bead to a matched metal stud and metal eyelet.
2. *Steel Case.* Thorough shielding against stray magnetic fields, and complete protection from all adverse atmospheres are assured by a strong, vacuum-tight steel case.
3. *Dehydrated.* Moisture, the major cause of corrosion, is reduced to a minute quantity by a special dehydration process.
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5. *Internal-pivot Element.* High resistance to shock, fast response, and compactness are inherent in the internal-pivot-element construction—a design which has had a fine record of performance throughout the war.

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| | | **HK-854L** | 450 watts (Low Mu) |
| **HK-54** | 50 watts | **HK-854H** | 450 watts (High Mu) |
| **HK-254** | 100 watts | **HK-1054L** | 750 watts |
| **HK-354C** | 150 watts (Low Mu) | **HK-1554** | 1000 watts |
| **HK-354E** | 150 watts (High Mu) | **HK-3054** | 1500 watts |

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|---|---|---|
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| **HK-354D** | Triode, Medium Mu | HK-354C or E<br>HK-454L or H |
| **HK-354F** | Triode, High Mu | HK-354E |
| **HK-257A** | Beam Pentode | HK-257B |
| **HK-153** | High Vacuum Rectifier, inverse peak volts, 5000 | HK-253 |
| **HK-54S** | Triode. Same as HK-54 except fil. current is 3.35 instead of 5 amps. | HK-54 |
| **HK-2054A** | Triode | |
| **HK-2054B** | Triode | |



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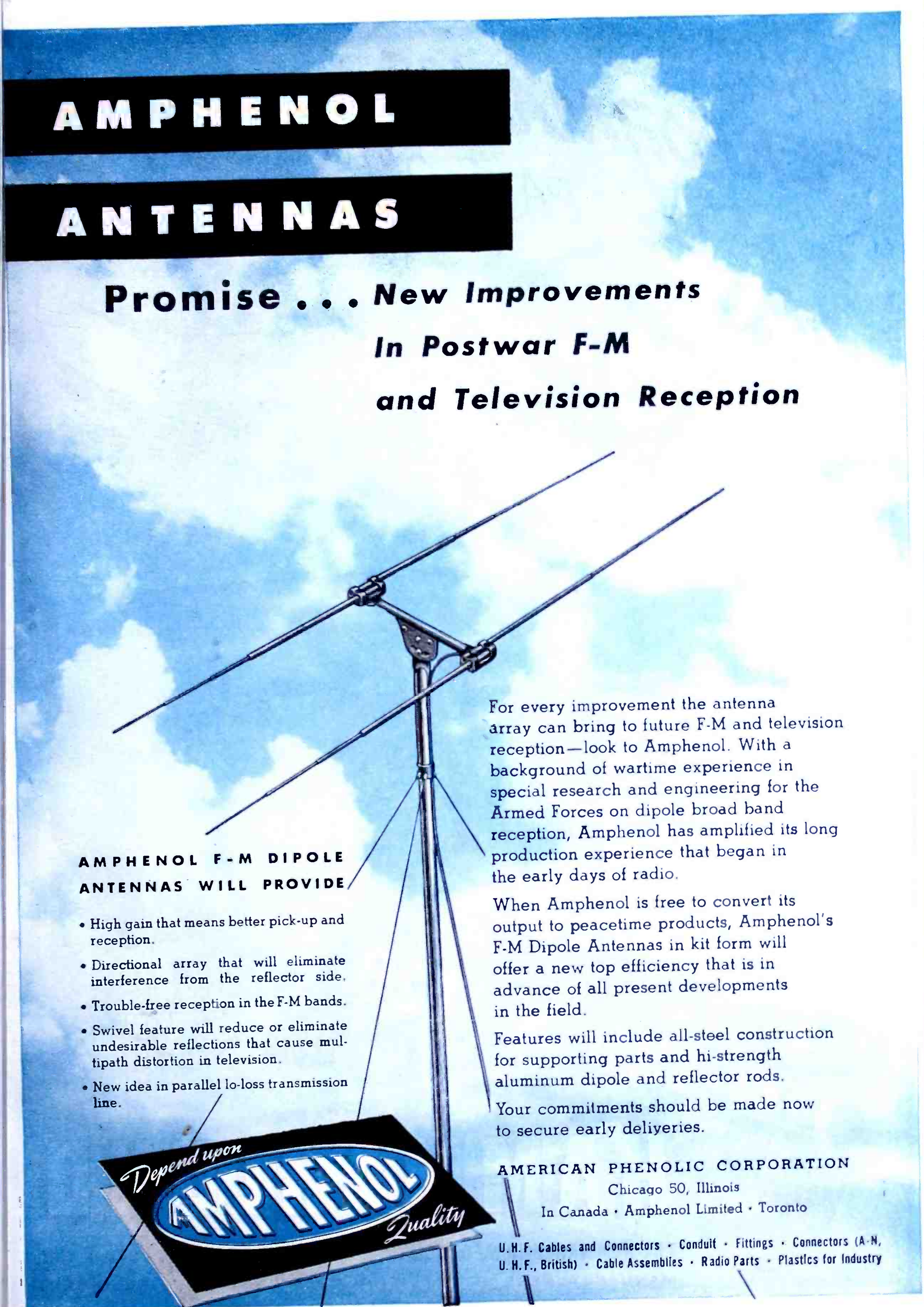
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LEWIS WINNER, Editor

★ ★ OCTOBER, 1945 ★ ★

# THE RADIO PROXIMITY FUZE

## Tiny Receiver-Transmitter Units in Noses of Bombs, Rockets and Shells Activate Explosive Charges Bursting Projectiles When in the Proximity of a Target

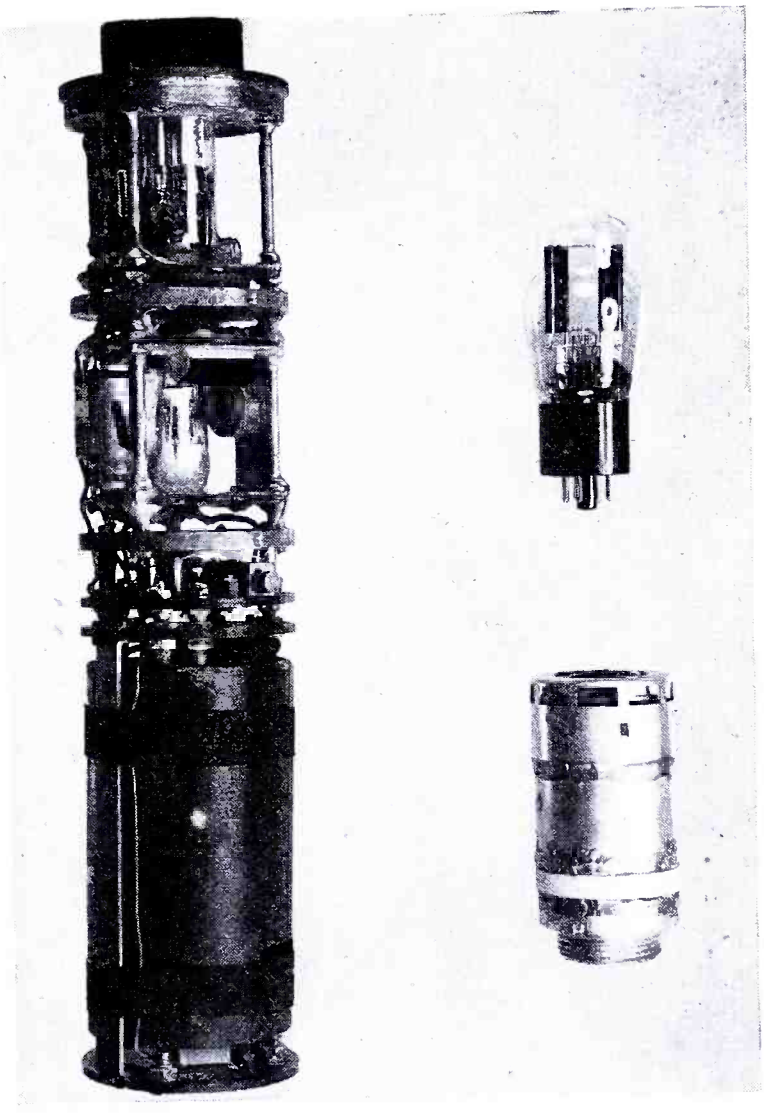


Figure 1

The first successful radio proximity fuze in the world, tested at the Navy Dahlgren Proving Grounds by National Bureau of Standards scientists on February 12, 1941, less than two months after initiation of the development. It was attached to the tail of a bomb and trailed a whip-like antenna. Beside it is shown the later-developed miniature mortar radio proximity fuze and, for size comparison, a conventional radio receiver tube.

*(Courtesy National Bureau of Standards)*

**by RALPH G. PETERS**

RECENTLY the Army and Navy revealed that a radio-proximity or VT fuze had been developed and used in the noses of bombs, rockets and shells. The fuze has been cited as one of the most important weapons of war ever conceived, its role in bringing the war to an end being compared to that of the atom bomb.

These radio units were identified as proximity fuzes because they burst when in the proximity of a target. The official name, *VT*, which means variable time, was applied because the device is a form of a time fuze which automatically adjusts its time of function to provide a burst at just the right time to give maximum damage to the target.

The fuze operates as a miniature sending and receiving station. When the projectile is released, this station begins to send out a continuous r-f signal, not a short pulse as in radar. As the projectile approaches its target, the signal is reflected back and operates to detonate the explosive charge.

The basic components of the fuze are: (*1*)—miniature *rugged* vacuum tubes, (in the shell application the tubes must be strong enough to stand the tremendous stresses of being shot from a gun . . . 20,000 G), as essential elements of simple electrical circuits; (*2*)—a miniature rugged battery or generator to provide electrical power, and (*3*)—safety devices to prevent operation of the fuze until it had travelled a safe distance.

An oscillator generates the r-f signal. When a target is approached, part of the radiated signal is reflected back to the fuze and an impulse is set up in the fuze by the interaction of the radiated and returned signals.

This impulse is amplified by an a-f amplifier in the fuze and is fed to a thyratron tube which serves as a switch to initiate the detonation of the projectile.

The detonation of the projectile is accomplished by an electrical detonator much like a dynamite cap. When the thyratron is triggered by the impulse generated by approach to a target, it causes enough electric current to pass through the electrical detonator to make it explode. This explosion sets off an auxiliary explosive charge, or booster, carried in the fuze, which in turn detonates the explosive filling in the projectile.

In addition to the primary elements of the fuze, there are also included safety devices which prevent operation of the fuze until it has travelled a minimum safe distance. Some models of the fuze also contain a *self-destruction* switch which acts to detonate the projectile beyond the target if it has passed the target without coming close enough to function.

### Fuze Operation Analysis

In Figure 3 we have a block diagram

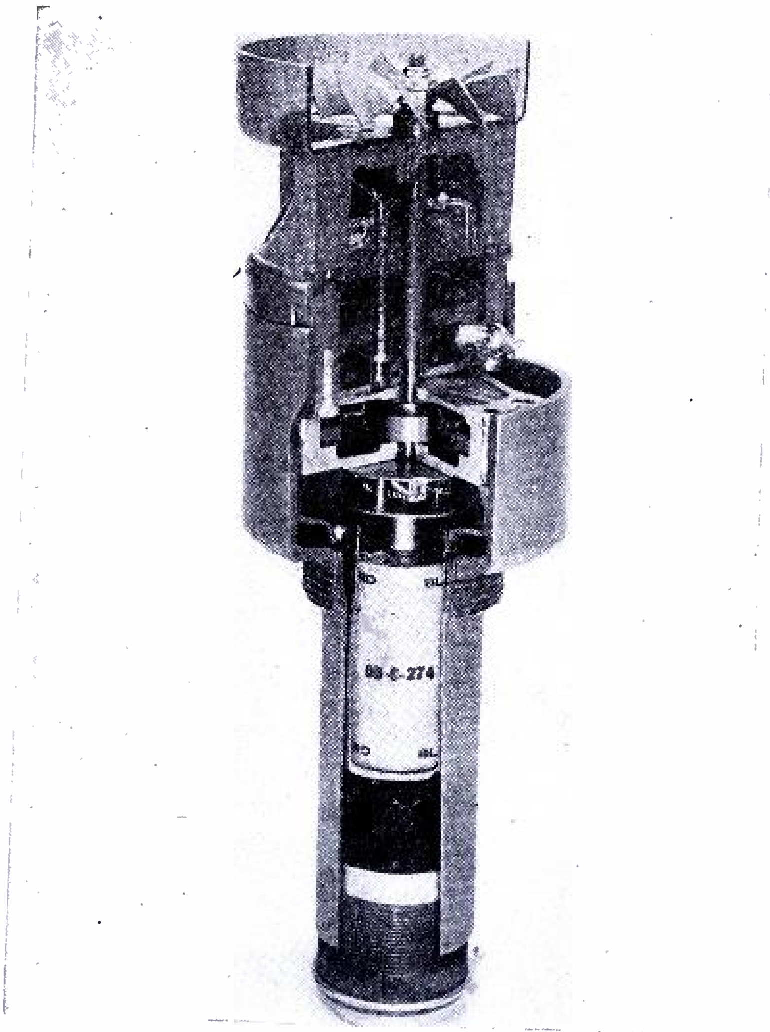


Figure 2

Cut-away view of ring-type bomb fuze developed by National Bureau of Standards. View shows transmitter-receiver located in compartment directly below propeller. Generator is visible at center. Part immediately below generator is a gear train and below that is the firing unit; white section just below center of fuze. Below firing unit is detonator compartment and below that, the booster charge.

This fuze was used in bombing of Iwo Jima, Italy, Japan, Germany, etc.

*(Courtesy National Bureau of Standards.)*

which illustrates the basic pattern of fuze operation.

In use safety devices complete the electrical circuits and line up a powder train shortly after the projectile is set in motion. Within a fraction of a second the tubes warm up and the transmitter excites the antenna which may be the bomb or shell itself or a small auxiliary conductor. The outward radiation moves away from the projectile until it encounters some reflector obstacle, perhaps an airplane, buzz bomb, or the ground below. The radiation is reradiated or reflected by the obstacle and part of it returns to the projectile. But if the projectile is moving with respect to its target (as generally happens) the returning radiation has a slightly different frequency because of the Doppler effect, Figure 4.

If $f$ is the frequency of the radiation from the fuze which moves toward the target with velocity $v$, the frequency of the wave striking the reflector is $f + \frac{v}{\lambda}$. The target reradiates at this frequency and the fuze moves through this radiation picking up a reflected wave with a frequency $f + \frac{2v}{\lambda}$. A suitable detector then separates out the beat or difference frequency $\frac{2v}{\lambda}$. Moreover, as the fuze gets closer to the target the reflected wave gets stronger and the difference frequency component gets larger. When it gets large enough and changes in the proper manner, the fuze circuit functions and explodes the charge.

An equivalent concept can be applied, if we think of the reflector as changing the input impedance to the antenna. Let us suppose the antenna carries a current $I$; it will set up an electric field at the reflector which is proportional to $I$. A certain fraction of this field will be reflected back to the fuze giving a reflected field proportional also to $I$. This reflected field will induce a voltage $v$ in the antenna proportional to its strength, finally resulting in voltage induced in the antenna which is proportional to $I$ and theref appearing like an impedance.

The presence of the reflector is t equivalent to an added impedance in antenna circuit. Each time the path tween the fuze and target is shortened $\lambda/2$, the over-all path is changed by $\lambda$ a the phase angle of the impedance vec changes by one cycle.

Thus we may express the additio impedance due to the reflector in the fo

$$Z = a\,e^{j}\left(\frac{4\pi r}{\lambda} + \Phi\right)$$

where $\Phi$ is an arbitrary phase factor ta ing account of changes of phase at refle tion. Now if $r$ changes so that

$$r = vt$$

where $v$ is the component of project velocity toward the target then

$$Z = a\,e^{j}\left(\frac{4\pi vt}{\lambda} + \Phi\right)$$

which is of the form

$$Z = a\,e^{j}\,(wt + \Phi)$$

if we say $w = 2\,v/\lambda$ thus getting the san Doppler frequency as before. In the terms the fuze problem becomes a simp one. If we call $Z_o$ the input impedance the antenna in free space, then in the pre ence of a reflector

$$Z = Z_o + a\,e^{j}\left(\frac{4\pi vt}{\lambda} + \Phi\right)$$

and the problem is simply to design a cir cuit to respond to this change in antenn impedance.

The VT fuze uses the same antenna fo transmission and reception. Thus th radition pattern f ($\Theta$) is used twice an we have a directivity pattern $f^2$ ($\Theta$), giv ing the sensitivity of the device in vari ous directions, $\Theta$. This means that th ampliture $a$ contains $f^2$ ($\Theta$) as a factor

In Figure 5 appears an extremely sim plified drawing of the variation of th amplitude $a$ and the resistance componen of Z, $Z_r$, as a VT-fuzed projectile passe an airplane.

In the figure $P$ is the closest distance o approach and $r$ the distance to the target Now

$$r^2 = x^2 + P^2$$

$$\frac{dr}{dt} = v = \frac{x\,dx}{r\,dt} = \sin\Theta\,V$$

and the antenna impedance is of the form

$$Z = Z_o + a\,e^{j}\left(\frac{4\pi V\sin\Theta}{\lambda} + \Phi\right)$$

showing that the frequency is $2\ V/\lambda$ at large distances dropping to zero momentarily when $x = o$ and rising again when the projectile passes beyond the plane. The amplitude $a$ is small at large distances, gets large at the center, and falls again when the projectile passes.

The dotted curves in this figure, indicating the impedance changes, show at every instant the antenna impedance. If the projectile moves rapidly through the interacting region, the changes in impedance are rapid; if it moves slowly the changes are slow.

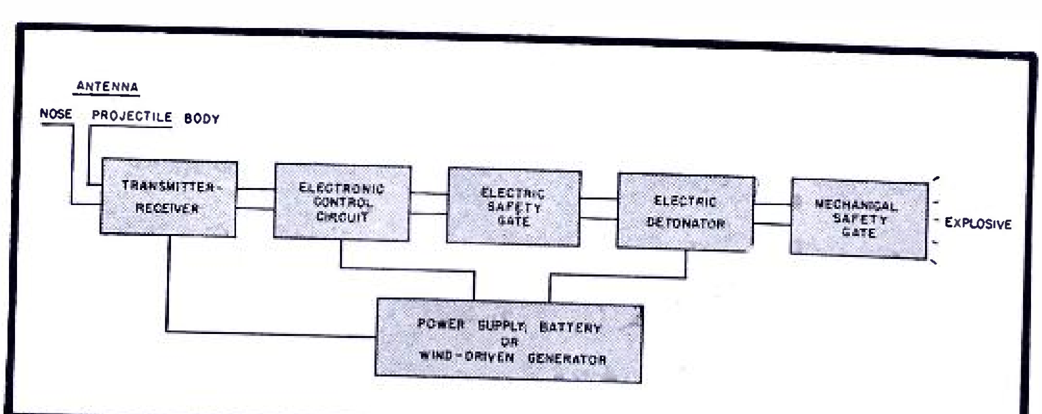
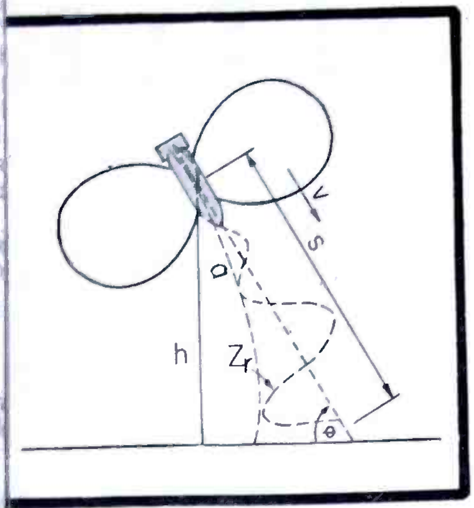


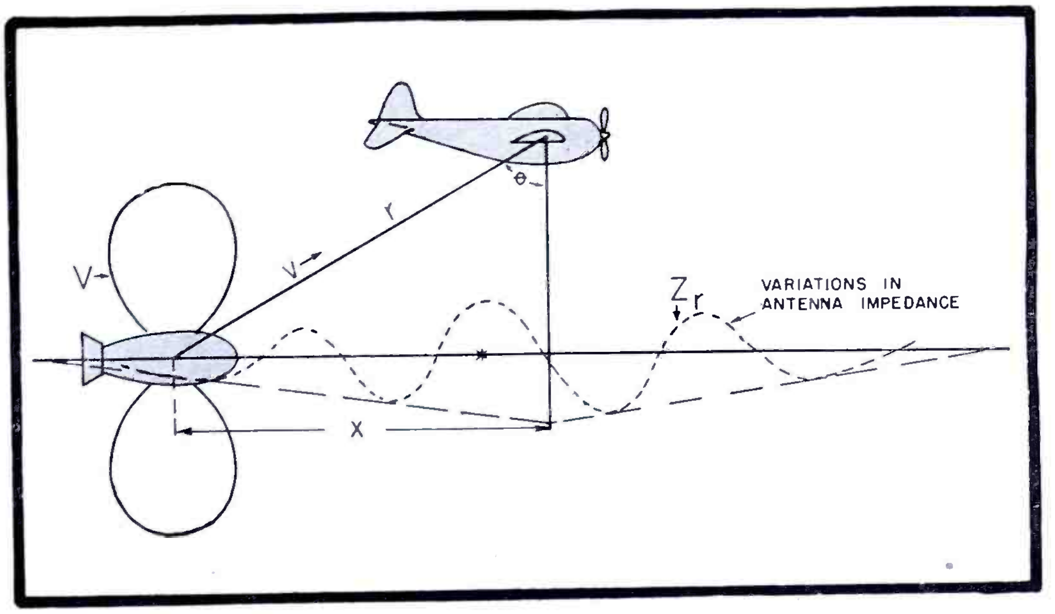

Figure 3

Block diagram showing sequence of operation in radio proximity fuze.



*MILITARY SUB-MINIATURE RECEIVER-TRANSMITTER DEVELOPMENT*




The problem is to get the burst (* in ure) to occur shortly before the protile reaches point $x = o$ to take account the forward motion of the fragments ported by the projectile motion.

When the projectile is used for function on approach to ground as in a bomb, distance to the target, in this case a t plane of large extent, is the vertical ight $h$, Figure 6.

In this figure $h = s \sin \Theta$ and

$$v = \frac{ds}{dt} \sin \Theta = V \sin \Theta$$

d the appropriate antenna impedance is

$$Z = Z_o + a e^j \left( \frac{4 \pi V \sin \Theta}{\lambda} + \Phi \right)$$

in the previous case. In Figure 6, the npedance amplitude $a$ and resistance mponent $Z_r$ have been plotted as dotted rves along the trajectory. In this case, e angle $\Theta$ and V are almost constant er the last few hundred feet of travel here the reflection becomes appreciable that the ripple frequency w is constant d $a$ grows as the height decreases.

In designing the circuit, the optimum mage height had to be considered carelly. The circuit had to be designed so at a burst was obtained about 50′ to 5′ above the ground.

It will be immediately evident from the gure that when the projectile approaches steep angles, the radiation toward the round is small, whereas at small angles, e radiation directed toward the ground large. Thus, the burst will be higher r small approach angles and lower for rge approach angles. Later designs vercame this difficulty. In the bomb aplication, for example, a radiation pattern with maximum sensitivity directly off

(*Continued on page* 92)

Figures 4 (below left). 5 (above right) and 6 (above left)

**Figure 4 illustrates reflection of radio waves from target. Figure 5 shows the variation in antenna impedance as a radio-fuzed rocket passes by plane. In Figure 6, we see the variation in antenna impedance as a radio-fuzed bomb or artillery projectile approaches ground.**

*(Patterns shown in Figures 5 and 6 are sensitivity patterns. In Figure 5, the vertical line or closest distance of approach to target is P.)*

Figures 7, 8, 9 (right, top to bottom)

**Figure 7. Artist's conception of region of sensitivity of radio-fuzed rocket approaching airplane.**

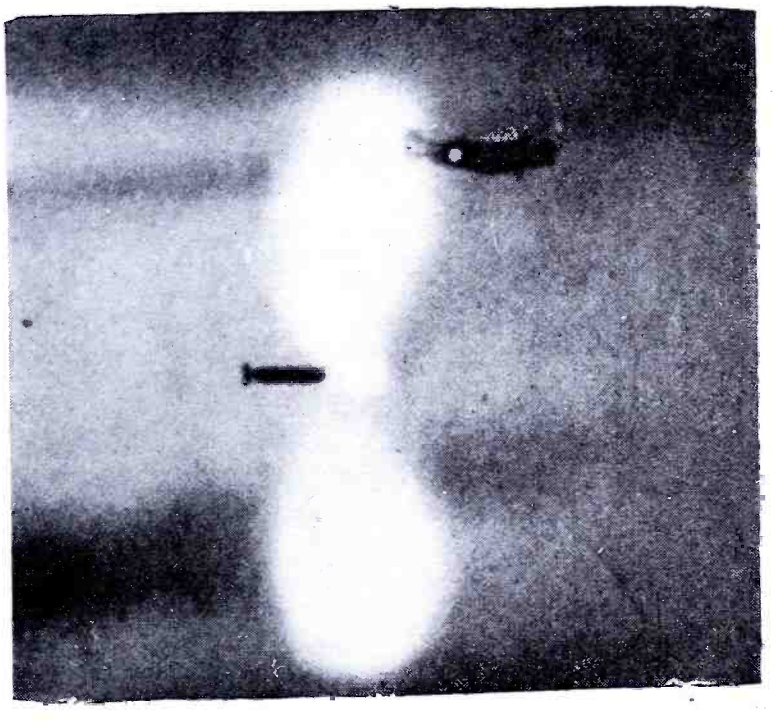
*(Official War Department photo.)*

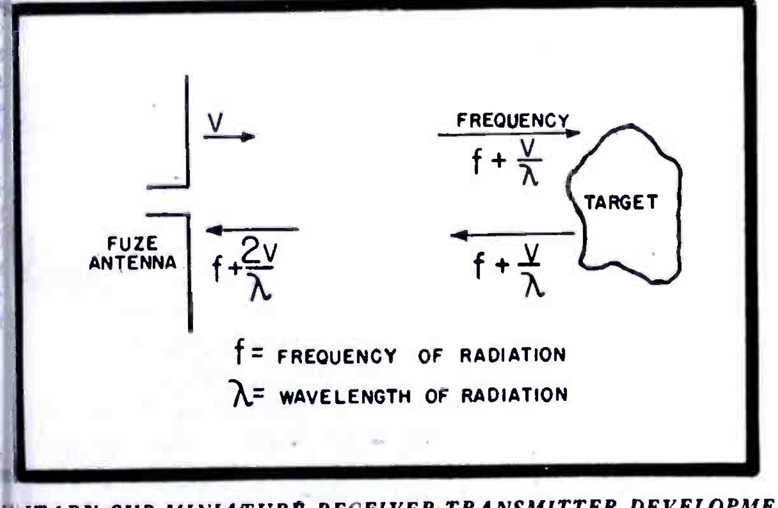
**Figure 8. Bar type VT-fuze developed by National Bureau of Standards inserted in nose of 500-pound bomb.**

*(Courtesy National Bureau of Standards.)*

**Figure 9. Army fighter plane carrying steel tubes used to launch rockets.**

*(Official War Department photo.)*



# A 9-SPEAKER BATTLE-


**by H. W. DUFFIELD**

**Engineer, Radio Division**

**Western Electric Co.**

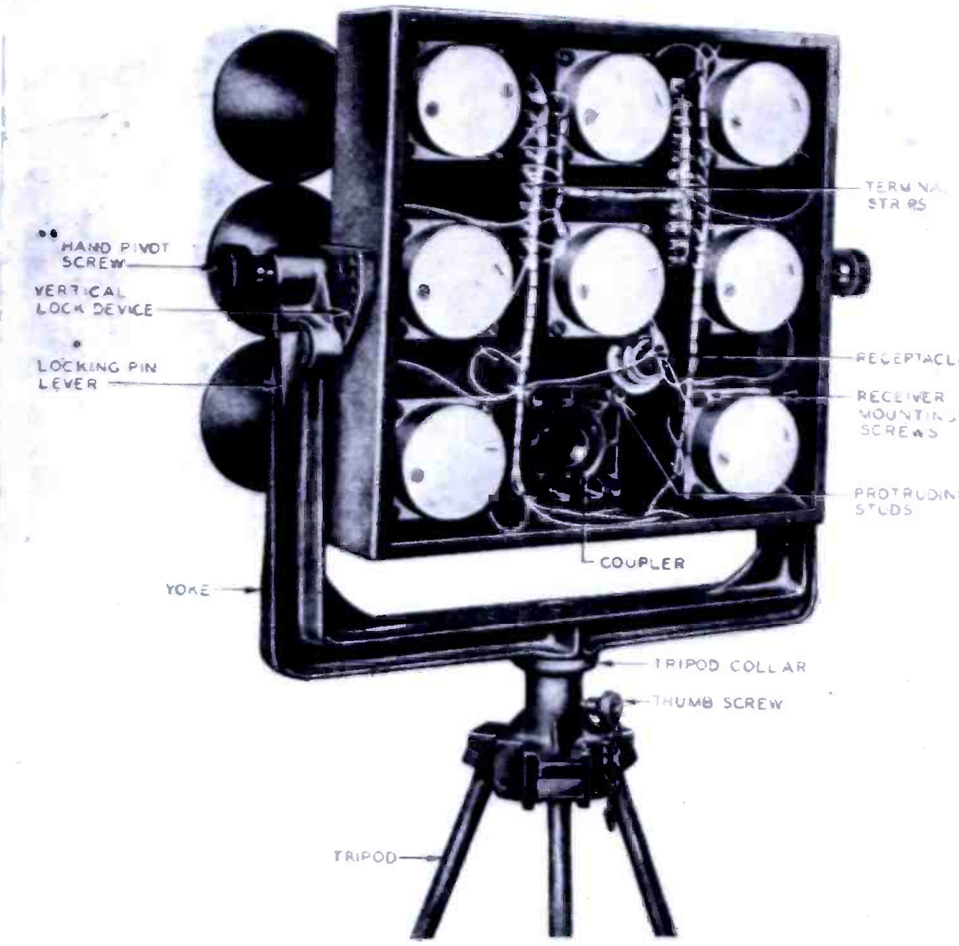




Figure 1

Nine-speaker assembly of the high-gain announcing system.

WHEN the Navy's amphibious forces recently stormed the beaches at Iwo Jima and Okinawa, a 9-speaker high-level, high-gain announcing system was used to carry instructions for beach activities and landings of men and equipment.

### System's Power

The system's frequency response rises from about 250 to 500 cycles and then is reasonably flat at 6,000 cycles at which point it decreases. It is capable of creating a sound level of about 116 db above the reference level of 0.000204 dyne per square cm, at a distance of 30′ from the loudspeaker. The major part of the energy is radiated through a cone of 50°.

The amplifier unit consists of two sections, a preliminary amplifier and a power amplifier.

The preliminary amplifier is a four-stage unit employing two resistance-coupled stages, two resistance-coupled push-pull stages with transformer coupling between the second and third stage. The push-pull operation with inverse feedback employed in the last two stages stabilizes its operation and insures low distortion. When transformer-coupled to the power amplifier, this unit is capable of delivering approximately 10 watts (200 volts) to a resistance load of 4,000 ohms (simulating the maximum load presented to the amplifier by the power amplifier during normal operation) connected across the output terminals. An input voltage of approximately 0.0015 volt connected across the appropriate input terminals will produce full output.

An electric eye, visible to the operator through a gasketed window in the carrying case, indicates the degree of full power from the power amplifier during operation.

The preliminary amplifier is supplied with two input circuits designed to match either a magnetic-type or a carbon-type microphone. A gain con-

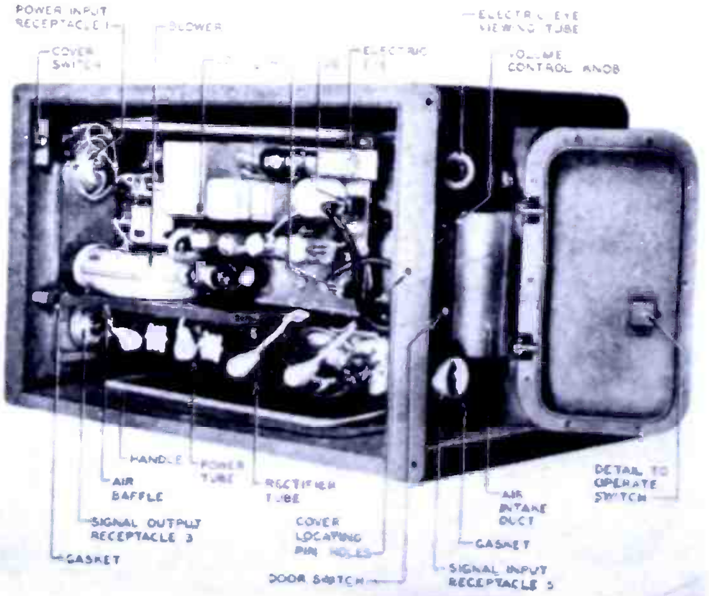



Figure 2

Amplifier unit used with the nine-speaker announcer. The unit consists of two sections; preliminary amplifier and power amplifier. See opposite page for diagram.

# ANNOUNCING SYSTEM

## Used During Invasion of Iwo Jima and Okinawa

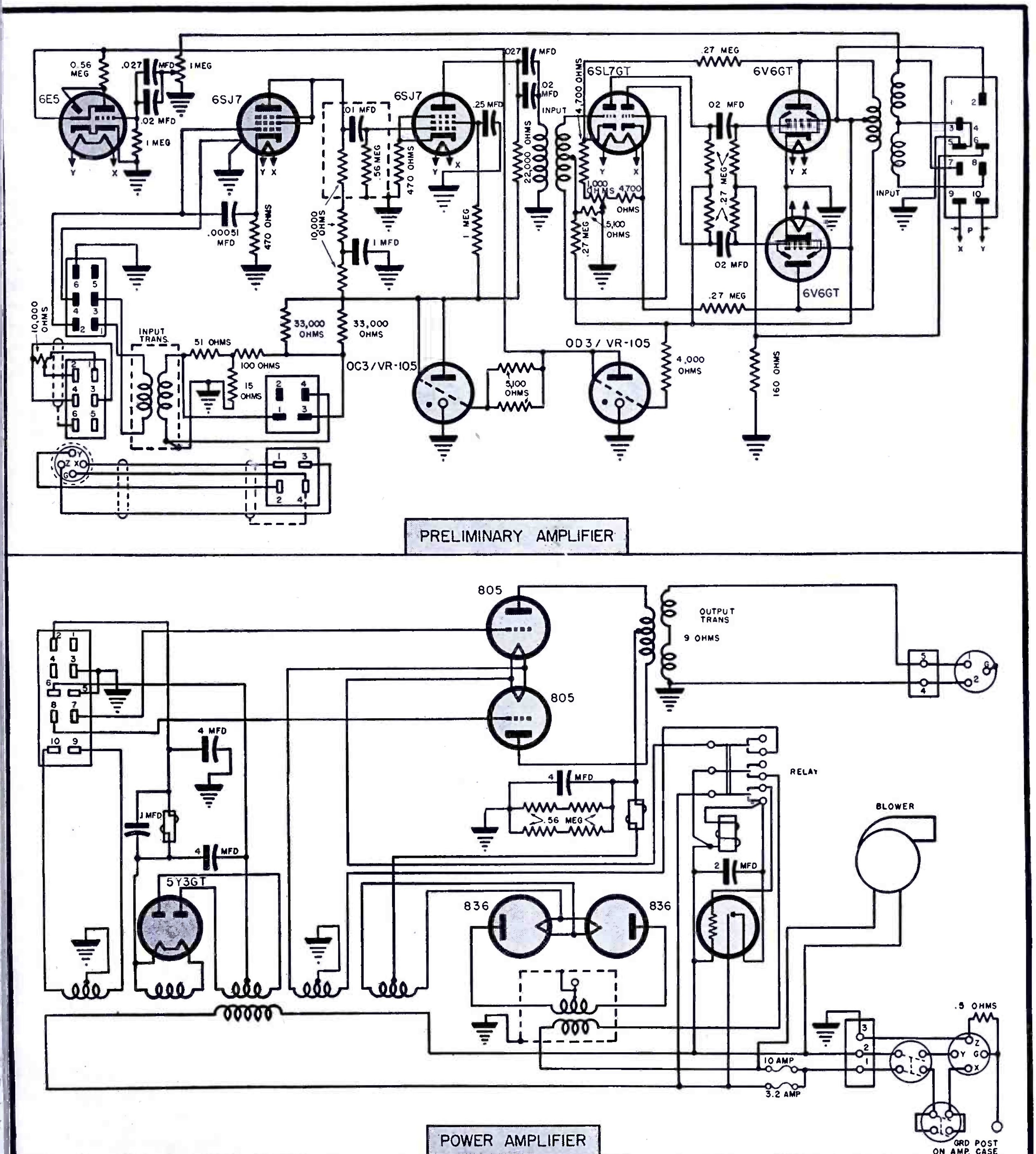



Figure 3
Circuit diagrams of the preliminary and power amplifiers.

Figure 4

Units that make up the battle - announcing system: (left to right) engineer alternator set, amplifier, magnetic-type microphone being used by operator, and nine-speaker unit.

trol, which is easily accessible, provides a continuous gain adjustment common to both input circuits.

#### Power Amplifier

The power amplifier consists of a two-tube, single push-pull stage transformer coupled to the output. The unit includes a self-contained power pack which, also provides filament, plate and screen currents to the preliminary amplifier. To protect the rectifier tubes from possible damage, a thermostatically-operated time delay relay is provided. A separate rectifier tube is furnished for the preliminary-amplifier branch and is connected in the normal manner directly to the main a-c power supply. When the amplifier is in operation, the thermostatically-operated relay closes the winding of the electromagnetic relay. Thus, the operation of this relay closes both the filament and plate circuits of the power amplifier. Therefore whenever the unit is subjected to the vibrations and shock of modern battle, the lockup relay will insure the unit against the opening of the power supply to the filament and plates of the power amplifier.

The amplifier unit will deliver 250 watts to an impedance load of 9 ohms, with normal voice input.

The loudspeaker unit consists of a group assembly of nine dynamic-type receivers and horns mounted on a common metal panel. In the receiver the moving coil, which moves in a p-m field, is rigidly attached to a phenolic diaphragm. Added features consist of blast valves to protect the receivers from powerful gun blasts and as a precaution against heavy tropical rains the receivers are equipped with special drainage slots.

#### Speaker Setup

The nine receivers and horns are wired as three parallel groups of three receivers in series. Each receiver has a d-c resistance of approximately 5.5 ohms. Thus each group of receivers in series has a resistance of about 17 ohms, and the resistance of the three parallel groups connected to the receptacle will range between 5 and 6 ohms. Due to the motion of the diaphragms the reproducer presents an impedance load of 9 ohms to the output of the amplifier.

During operation the loudspeaker unit is attached to a metal yoke, all of which is then mounted on a tripod assembly.

By swinging the speaker unit on its yoke supports, it is possible to point it up or down through an angle of 110°. A lever-operated pin located on one side of the yoke serves to hold the speaker unit in any desired vertical position. It is also possible to point the speakers in any horizontal direction by swiveling the yoke on the tripod. A thumbscrew in the tripod collar serves to key the yoke to the tripod and clamps the speaker in any selected horizontal position. The legs of the tripod are adjustable in length from 40″ to 57″. The speaker unit, less the mount, when placed in its metal carrying case weighs approximately 145 pounds, including the case.

The microphone ordinarily used is of the magnetic-type (sound powered) equipped with a push-to-talk button switch, a feedback reduction attachment, and a chest plate and neck strap.

Because of the high output characteristic of the loudspeakers, the feedback reduction attachment is introduced to permit relatively close operation of the microphone with respect to the loudspeakers without causing the system to *sing*. The microphone is watertight and its cartridge is constructed to offer protection from gun blasts. It is equipped with a 50′ cable attached to a weatherproof plug which connects to the input of the amplifier.

Power for the operation of the system is supplied by an engine alternator set. The set is a portable, integral gasoline-engine-driven electric power plant designed to supply a-c continuously and is rated at 1.67 kva and 0.9 power factor. The engine is a single-cylinder, air-cooled, 2-cycle vertical type, governed for 3600 rpm. It is equipped with a flywheel-type magneto which is mounted as a complete assembly on the end of the intake valve shaft. The fuel tank, which holds one gallon, sufficient for 1½ hours operation, is mounted under the engine. Fuel is forced to an adjustable-jet type carburetor by crankcase pressure. The engine and alternator are completely shielded against radio interference. In addition filters are wired to the output of the alternator to suppress extraneous r-f noise. Starting of the engine may be done either manually by means of a rope or electrically by a 24-volt storage battery.

The power set, which is shock mounted in a metal watertight carrying case, weighs approximately 210 pounds including the case.

All operating units are tropicalized. The system has functioned satisfactorily in rain, mud and snow in temperatures ranging from −40° to +130° F.

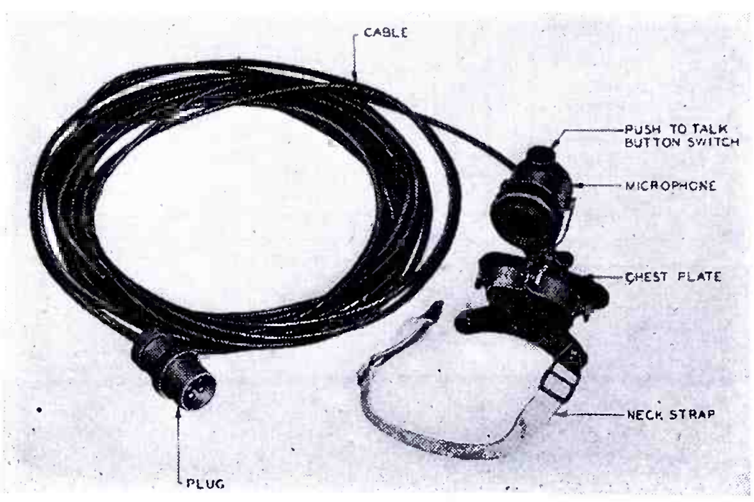
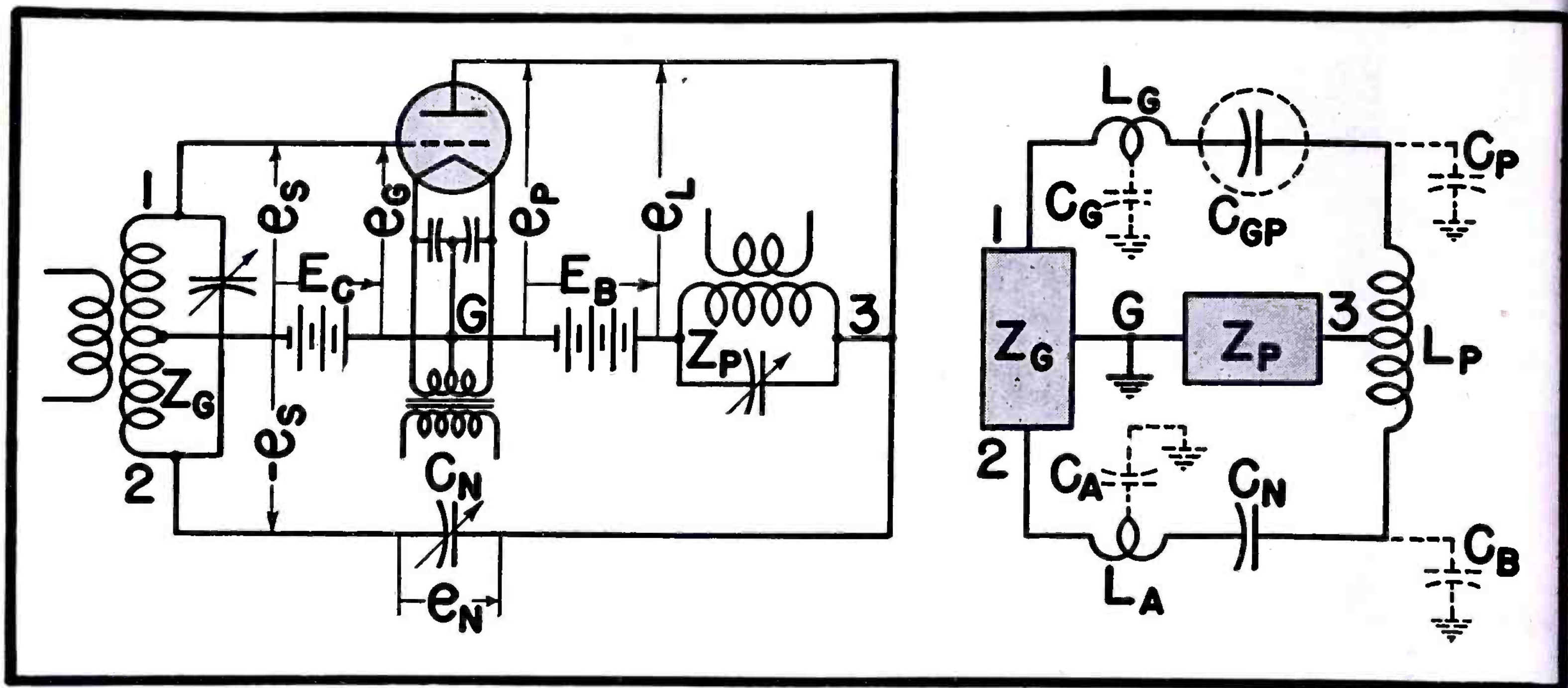



Figure 5

Magnetic-type microphone used with announcing system. It is fitted to metal chest plate with neck strap.




# ROLE OF THE NEUTRALIZING CAPACITOR IN TUNED POWER AMPLIFIERS

THE purpose of neutralization is to prevent oscillations at the natural frequency of the tuned circuits in r-f power amplifiers employing triodes with cathode at ground potential. In the absence of neutralization these oscillations are produced by power supplied to the tuned-grid circuit from the plate-tuned circuit through the grid-plate capacitance of the tubes and all incidental wiring and other capacitance in parallel with it.

There are several well known neutralization methods.[1] Two, Rice neutralization and Hazeltine neutralization[2] or their combination known as

by WILSON PRITCHETT
Radio Engineer
E. F. Johnson Company

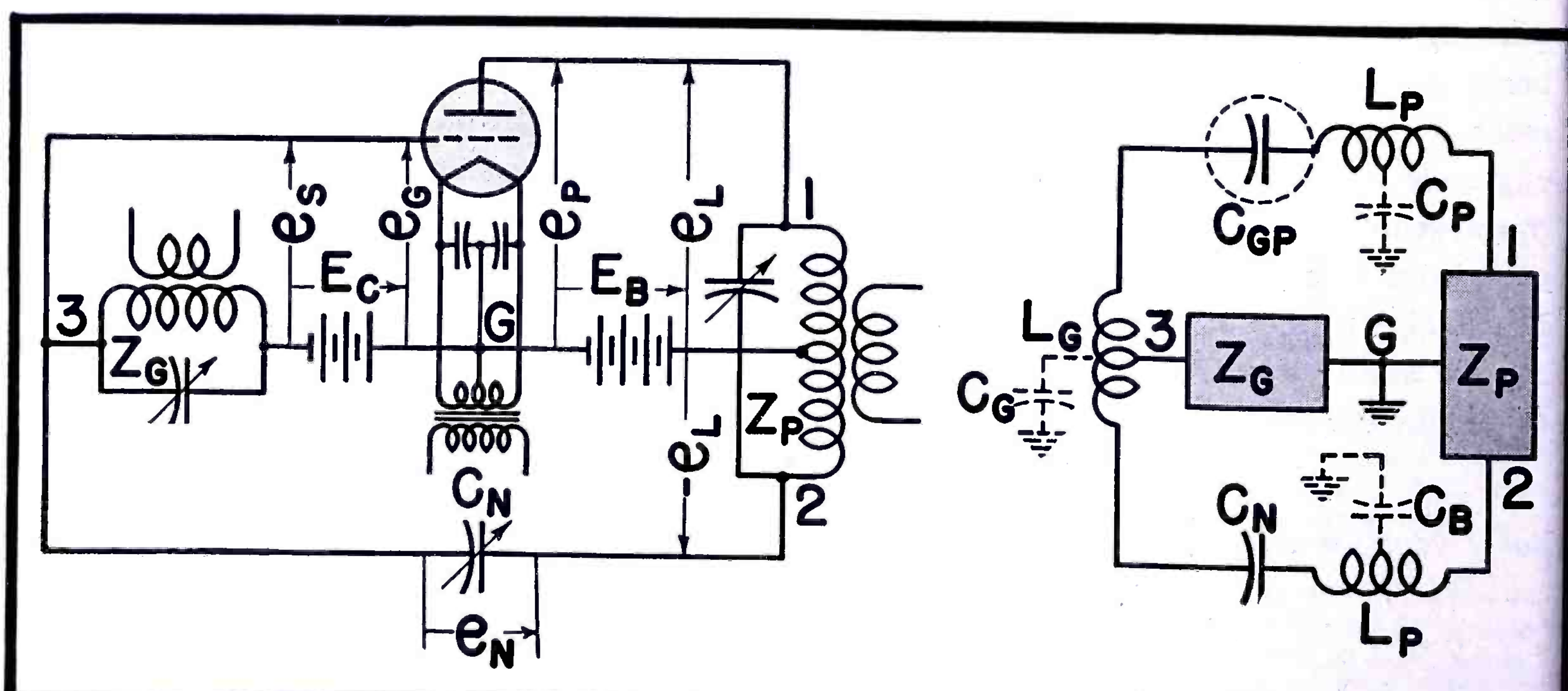
cross-neutralization in push-pull amplifiers, have a distinct advantage of being useful over a wide frequency range. This paper analyzes the function of the neutralizing capacitor in these circuits with the emphasis on the principles of wide-band neutralization.[3]

Figures 1 (above) and 2 (below)
Figure 1*a* (left). Schematic circuit of a tuned r-f power amplifier with Rice neutralization. The neutralizing circuit of 1*a* appears in 1*b* (right). Figure 2*a* (left) shows the schematic circuit of a tuned r-f power amplifier with Hazeltine neutralization. In *b* (right) we have the neutralizing circuit of *a*.

### Wide-Band Neutralization Circuits

Radio-frequency amplifiers having a single tube or group of parallel tubes make use of either a balanced tuned-

[1] *The Radio Amateur's Handbook*, ARRL, West Hartford, Conn.
[2] Terman, F. E., *Radio Engineering*, Sec. Ed., pp 321-2, McGraw-Hill Book Company, Inc.; 1937.
[3] Terman, F. E., *Radio Engineers' Handbook*, pp 501-2, McGraw-Hill Book Company, Inc.; 1943.



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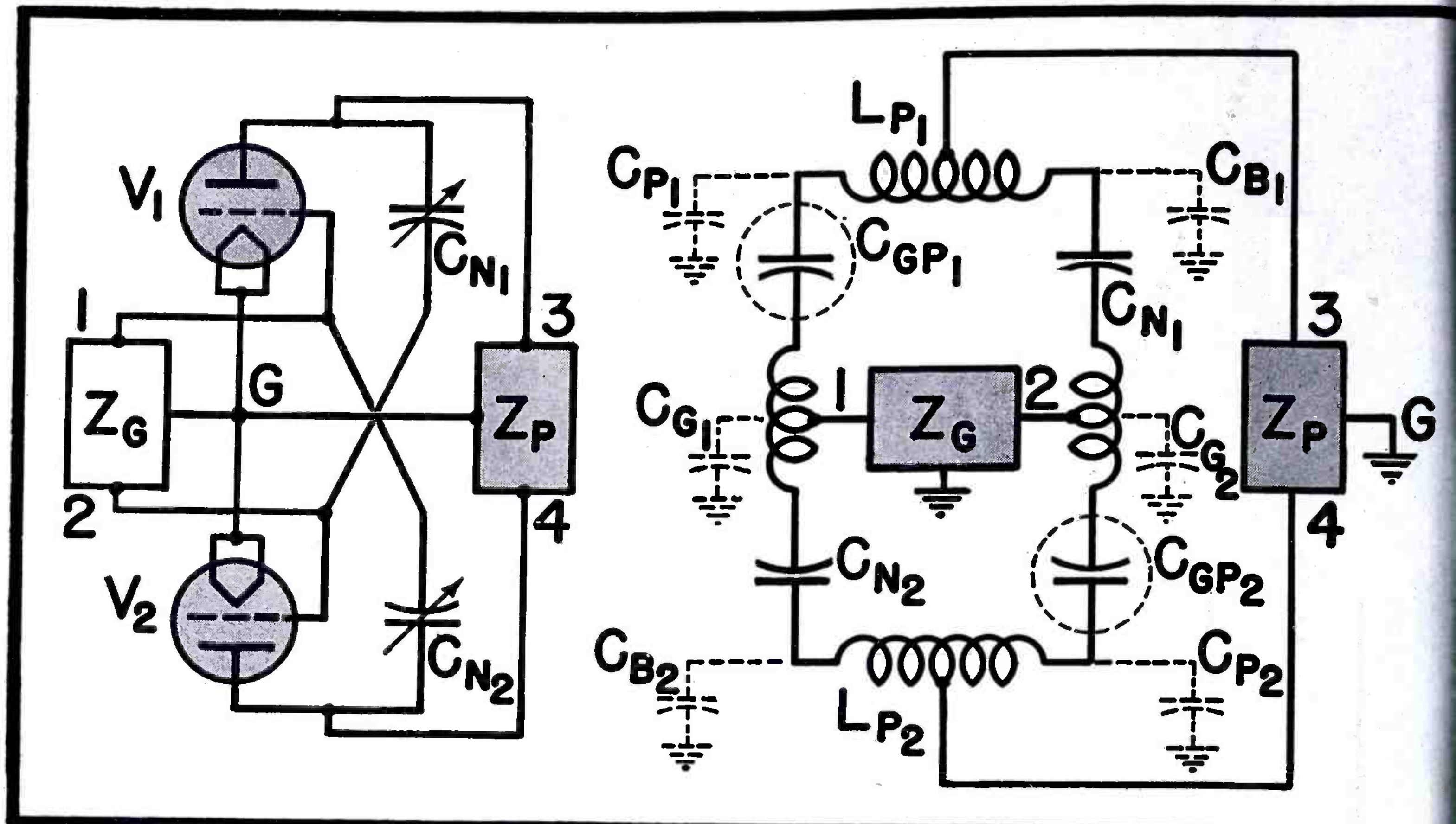


**Figure 3**
In *a* (left) appears a simplified schematic circuit of a push-pull tuned r-f power amplifier with cross neutralization. In *b* (right) appears the neutralizing circuit.

grid circuit or a balanced tuned-plate circuit to supply the neutralizing voltage. Schematic circuits of these are shown in Figures 1*a* and 2*a*.

Pull-pull amplifiers having both grid and plate circuits balanced supply the neutralizing voltages automatically as shown in the simplified circuit sketch of Figure 3*a*.

### Neutralizing Capacitor Voltages

Since the neutralizing capacitor voltages are the same for both the push-pull and the single-ended types of amplifiers for a given supply and tuned circuit voltage, we shall limit our voltage considerations to circuits of the latter type.

The circuits of Figures 1*a* and 2*a* referred to supply the direct currents to the tube through the inductors. Neither chokes nor blocking capacitors are used. This condition subjects the neutralizing capacitor to the greatest possible voltage.

We are familiar with the 180° relationship between the sinusoidal voltages on the grid and on the plate.[4] Since the supply voltages are in series with them, we see from the directions of the voltages in the diagrams that the crest value of the neutralizing capacitor voltage,

$$E_N = E_B + E_C + E_L - E_S \qquad (1)$$

Where: $E_L$ and $E_S$ are the crest values of the sinusoidal voltages $e_L$ and $e_S$ respectively. Therefore the neutralizing capacitor in this instance must withstand almost twice the plate supply voltage.

The use of grid or plate blocking capacitors or both may reduce the needed voltage rating. In the case of a blocking capacitor between one side of the neutralizing capacitor and the grid,[5] the rating is less by the amount of the bias voltage

$$E'_N = E_B + E_L - E_S \qquad (2)$$

In the case of a plate blocking capacitor,[6] the direct plate voltage, $E_B$, is removed, and

$$E''_N = E_C + E_L - E_S \qquad (3)$$

Circuits taking advantage of both blocking capacitors[7] have

$$E'''_N = E_L - E_S \qquad (4)$$

In plate-modulated amplifiers for 100% amplitude modulation conditions, the voltage, $E_B$, changes with modulation between a very low value and one that is nearly twice the direct-supply voltage. During the time that $E_B$ is largest, $E_L$ assumes a magnitude twice its unmodulated value. Although plate-modulated amplifiers nearly always use a considerable portion of grid leak bias, the change of $E_C$ with modulation is insignificant as far as the rating of the neutralizing capacitor is concerned.

Applying these facts to equation 1 we find that without blocking capacitors the voltage rating of the neutralizing capacitor must be approximately four times the plate supply voltage for high level modulation. The respective ratings needed for the other three cases are also almost doubled.

Further consideration of Figures 1*a* and 2*a* is needed to determine the voltage ratings of the insulators supporting the two electrodes comprising the neutralizing capacitor. Assuming that the electrodes of the capacitor are supported from a grounded part of the amplifier, we notice that the insulator supporting the grid electrode must withstand a crest voltage of

$$E_{GN} = E_C + E_S \qquad (5)$$

and that the insulator supporting the plate electrode must withstand a crest voltage of

$$E_{PN} = E_B + E_L \qquad (6)$$

This shows us that the insulator supporting the plate electrode must provide the same order of insulation that is found at the plate of the tube. The requirements of the grid electrode insulator, on the other hand, are moderate.

Use of blocking capacitors, again, eases the crest voltage burden. These remove the direct voltage from the corresponding supporting insulator.

### Neutralizing Circuits of Single-Ended Amplifiers

The circuits of Figures 1*a* and 2*a*

[4] See reference 2, page 314.

[5] Everitt, W. L., *Communication Engineer,* Fig. 32?a, p 552, McGraw-Hill Book Company, Inc.; 1937.

[6] Brainerd, Koehler, Reich, and Woodruff, *Ultra - High - Frequency Techniques,* Fig. 3-58, p. 165, D. Van Nostrand Company, Inc.; 1942.

[7] Everitt, W. L., *loc. cit,* Fig. 329b.


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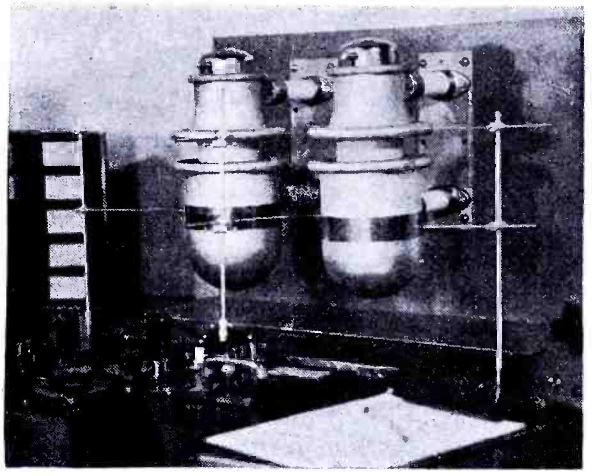


Figure 4

Neutralizing capacitors mounted for measurement. Dimensions and mounting data: Diameter of lower electrode, 6⅛"; overall height of capacitor, 15¾"; spacing upper and lower lips, 1¼"; insulator length, 6"; separation vertical centerlines of capacitors, 10" lower cup above table, 3¼". Measurement data appear in Figure 5.

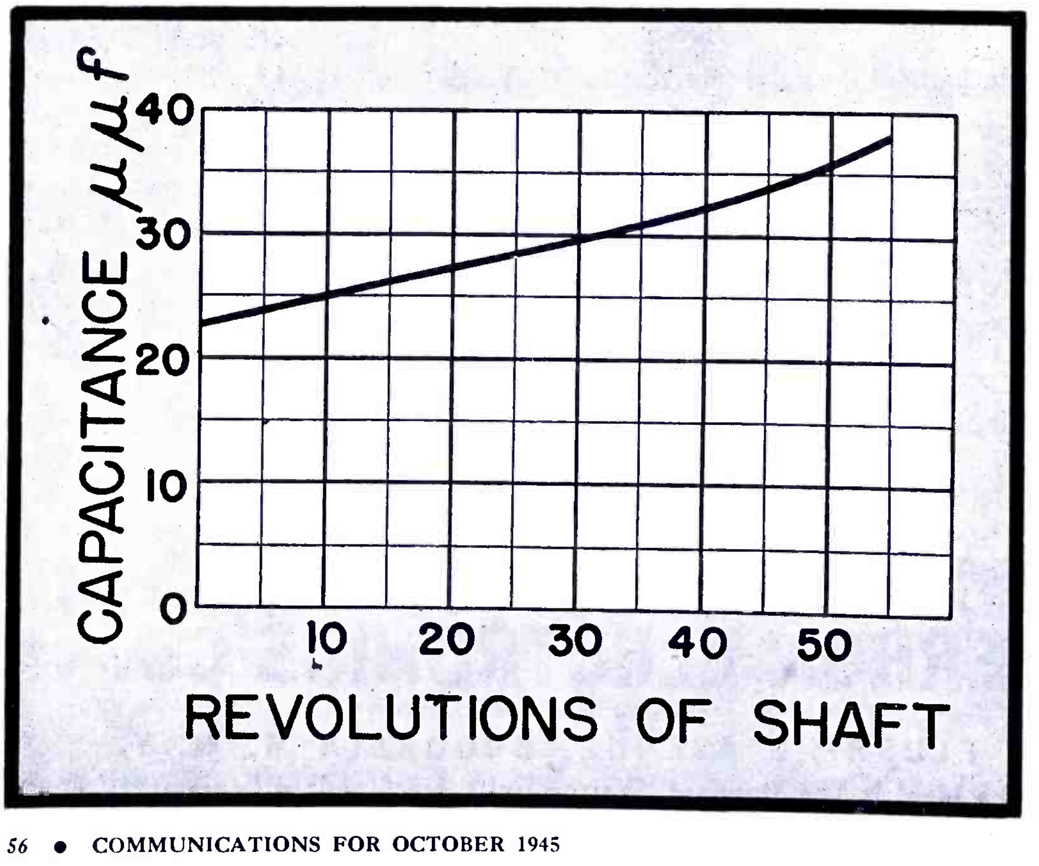
were drawn to simplify the transition from the schematic to the respective neutralizing circuit of Figures 1*b* and 2*b*. These neutralizing circuits were drawn in the familiar form of the bridge circuit showing conditions for zero coupling between grid- and plate-tuned circuits through tube and stray capacitances of the system. Coupling due to mutual inductance of the grid and plate inductors varies with frequency and in practical construction of amplifiers is intentionally made small.

In Figure 1*b* the stray capacitance to ground of the plate, $C_P$, has been separated from that of the plate side of the neutralizing condenser, $C_B$, and in Figure 2*b* the capacitance of the grid to ground has been lumped with that of the grid side of the neutralizing capacitor and of the wiring. This difference in procedure was due to the fact that the wiring inductance in the plate side of the neutralizing circuit is frequently made appreciably greater than the wiring inductance in the grid side of the neutralizing circuit to prevent the occurrence of certain types of high-frequency parasitic oscillations.[3]

For ideal conditions of balance in the neutralizing circuits just considered we may make several observations. The grid tuned circuit, $Z_G$, together with the stray capacitances of the wiring, the grid of the tube, and the grid side of the neutralizing capacitor to ground of Figure 1*b* shall remain balanced to ground over the frequency range necessary. A similar situation shall hold with regard to the plate tuned circuit, $Z_P$, and the capacitances $C_P$ and $C_B$ of Figure 2*b*. The inductance of the plate wiring to the neutralizing capacitor shall be center-tapped at point *3* and $C_P$ shall equal $C_B$ in Figure 1*b*. A similar situation shall hold for the grid wiring to the neutralizing condenser in Figure 2*b*. And finally, the capacitances, $C_N$ and $C_{GP}$, shall be equal.

Figure 5

Direct capacitance variation of neutralizing capacitors of Figure 4. Data on incidental capacitances in mmfd: Upper electrode to ground, 7.7; lower electrode to ground, 13.7; between upper electrodes, 1.8; between lower electrodes, 2.5; between one upper and opposite lower electrode, 0.4. Spark-over at 2 megacycles, 40 kilovolts peak.




#### *Neutralizing Circuit of Push-Pull Amplifier*

We are now ready to carry over to the neutralizing circuit of the push-pull amplifier the same principles observed in the case of the neutralizing circuits of the single-ended amplifier.

Figures 3*a* and 3*b* show a simplified schematic diagram of the push-pull t-r-f amplifier employing identical tubes and the corresponding neutralizing circuit. The plate lead inductances have been made larger than the grid-lead inductances and the stray capacitances to ground separated on the plate sides of the circuit, as before, for the single-ended amplifier.

The ideal conditions for balance and consequent zero coupling between $Z_P$ and $Z_G$ through the grid-plate and stray capacitances of the circuit may be observed at once. The grid- and plate-tuned circuits together with the attached wiring and electrodes shall remain balanced to ground over the frequency range necessary. The plate lead inductances shall be center-tapped and the capacitances, $C_{P_1}$, $C_{P_2}$, $C_{B_1}$ and $C_{B_2}$ shall be equal. And finally, the capacitances, $C_{GP_1}$, $C_{GP_2}$, $C_{N_1}$, and $C_{N_2}$ shall be equal. This shows us that the basic requirements for balance are in general the same as those for the single-ended amplifier.

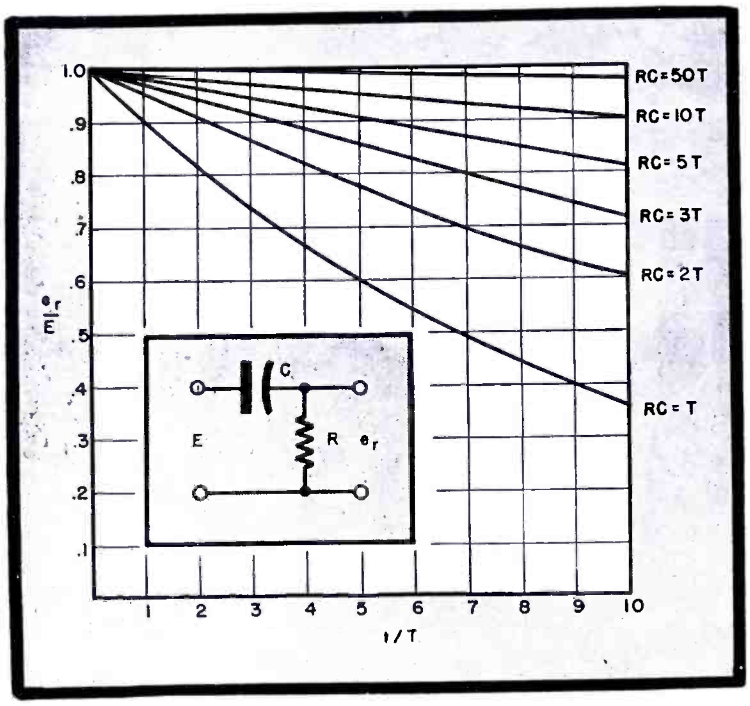
Since the neutralizing circuit is a balanced bridge and the capacitances of the circuit themselves small, it would seem that the circuit as a whole is sensitive to a small change in any capacitance. This is found to be the case in the actual neutralizing process of an amplifier.

#### *Neutralizing Capacitors*

The influence of the various direct and stray capacitances of the neutralizing capacitors upon the amplifier and its neutralizing circuit will now be examined, as we refer again to Figure 3*b*. Only the direct capacitance, $C_N$, between the electrodes of the neutralizing capacitor contributes to the neutralizing process. The stray capacitance to ground of the electrode of the neutralizing capacitor connected to the plate circuit of the amplifier shunts the half of the plate circuit to which it is connected. The stray capacitance to ground of the electrode of the neutralizing capacitor connected to the grid circuit of the amplifier

(*Continued on page* 82)

[3]The theory and technique of this method of capacitance measurement will appear in an early issue of COMMUNICATIONS.




# An Analysis of a Method of Calculating the Response of RC Amplifier Coupling Circuits to Pulse Voltages

Figures 1 (insert) and 2

Figure 1. Resistance-capacity network for low-frequency response. Figure 2. Response of RC network to square pulse; *T* represents width of pulse.

# PULSE AMPLIFIER COUPLING

by SIDNEY MOSKOWITZ
Engineer
Federal Telecommunications Laboratories

IN pulse-amplifier design it is important to correctly proportion interstage-coupling components to maintain flat tops on amplified pulses. In a method recently evolved, it has been found possible to select values of grid resistance and coupling capacity to support pulses of any given width and repetition rate. This method may be applied to amplifiers that do not require low-frequency compensation because of sufficiently high pulse rate resulting in small physically realizable coupling components. Where compensation is required, the amount can be determined from a knowledge of the pulse response of the coupling network used.

This method is based on the fact that if a step voltage, *E*, is applied to a capacitor and resistance in series, as in Figure 1, the voltage across the resistance, $e_r$, is given as

$$e_r = E\,\varepsilon^{-t/RC}$$

where *t* is the time measured from the beginning of the step.

For small values of *t* compared to *RC*, this equation may be written as

$$e_r = (1 - t/RC)\,E$$

Values of $e_r$ versus *t* have been plotted in Figure 2 for several values of *RC*. On this graph, *T* represents the width of a pulse.

By inspection of the curves, a time constant can be selected to give the required minimum rate of decrease in pulse amplitude over its duration.

The foregoing may be related to bandwidth by applying the fact that the frequency at which the sinusoidal response of an *RC*-coupled amplifier drops 3 db is given by

$$f_o = \frac{1}{2\pi RC}$$

To be exact, the resistance comprising the *RC* coupling should be taken as the grid resistance in series with the parallel combination of plate-load and plate resistance. However, in most video designs, the latter are negligible.

Figure 2 shows that the fractional falling off of the pulse top (d/A) is equal to the reciprocal of the factor *X* by which the pulse width is multiplied to give the *RC* time constant. This is true when *RC* is *10T* or greater. For example: When *RC* is equal to *20T*, the pulse top will decay to 1/20 of the pulse amplitude.

### Example

Let us find the time constant of the coupling required to pass pulses as shown in Figure 3. We may write

$$RC = XT_2$$

From the foregoing discussion and since the coupling cannot pass a d-c component,

$$d = (1/X)KA$$

where

$$K = T_1/T_2$$

then $X = KA/d$.

Let us assume that $T_1/T_2 = .1$ and d/A is to be made 5%. Then $X = .1/.05 = 2$. Hence, $RC = 2T_2$.

If $RC = 2T_2$ is then used for the positive pulse top, *RC* will equal $20T_1$. The positive top will therefore fall to 1/20A or 5%. It can be seen that the top and bottom parts of the pulse decay by the same percentage.

The above calculation is made for a single *RC* coupling. If couplings for a multistage linear amplifier are being designed, the effect of each coupling must be taken into account. For such a case, it may prove simpler to consider sinusoidal frequency response. The amplifier should then be designed

(*Continued on page* 88)

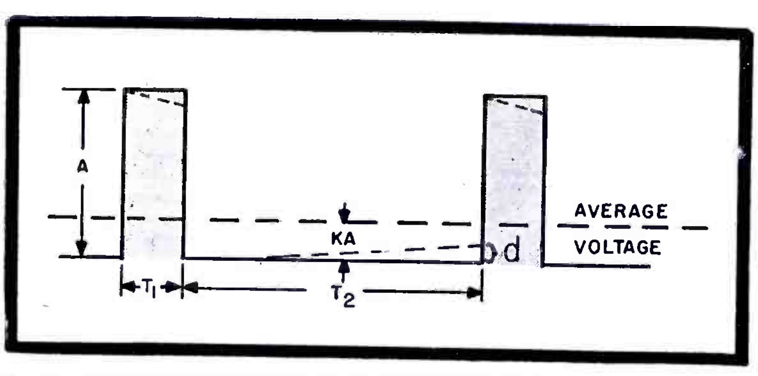



Figure 3

The time constant of coupling required to pass pulses shown can be secured by the method offered in this paper; see discussion under *Example*.

# THE CBC H-F GLOBAL

by R. D. CAHOON
Senior Engineer
International Service
Canadian Broadcasting Corp.

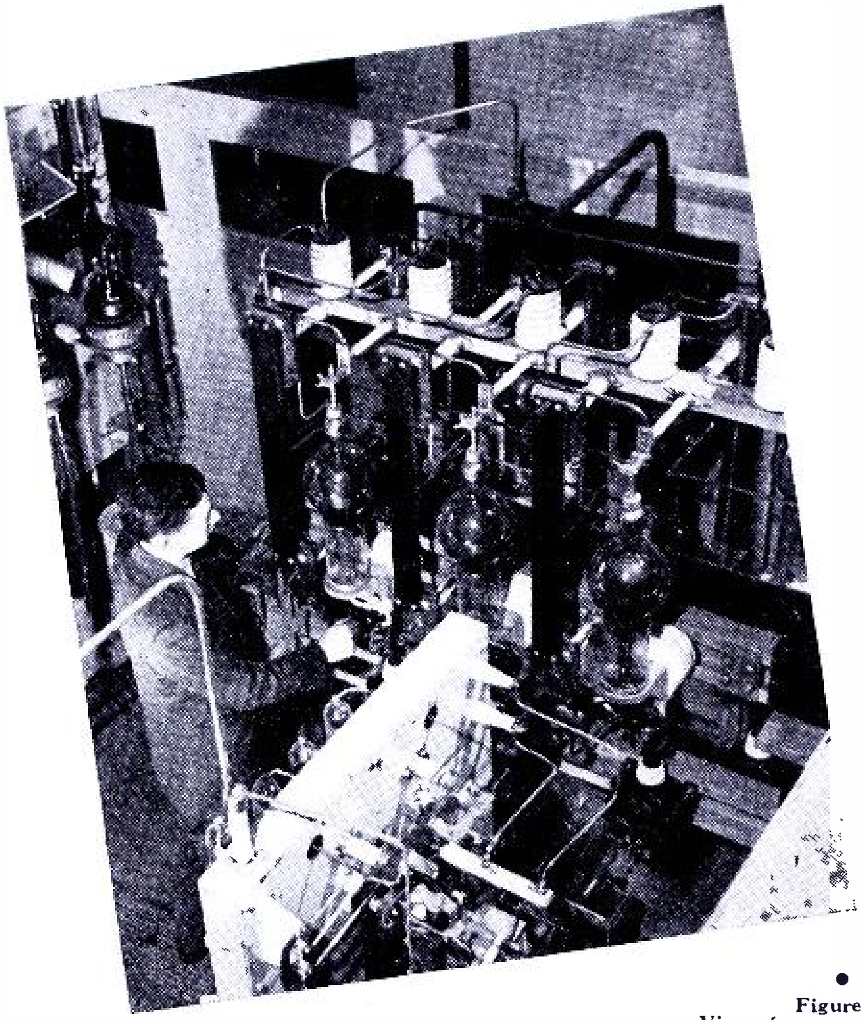


Figure 1
View of power-supply system for 50-kw transmitters.

DECEMBER 19th, 1944 will always be an eventful day for us, for on that day our two 50-kw 6- to 22-mc global transmitters went on the air. While long-distance broadcasting on h-f is not new, we had planned a system capable of broadcasting to nearly any spot on the globe, and that was quite an order.

We had to consider ionization and its effects. The variable nature of the ionosphere prompted the use of different frequencies at different times of the day. The type of antennas selected required a separate curtain array for each frequency in the International band, in each direction chosen; five antenna systems in each of three major directions. Incidentally two-hop transmission is required for transmission to Europe for most of the frequencies used.

Another very important factor affecting the ionosphere that we had to consider was the earth's magnetism. Since the earth is a magnet of a variable nature, its effect on the ionosphere is also variable. Unfortunately for Canada the centre of the earth's magnet, the north magnetic pole, is within Canada's territorial boundaries, in fact, located on Boothia Peninsula, north and west of the Hudson's Bay. When the earth's magnetism comes to an unstable varying condition, we have those annoying magnetic storms. During these periods, the ionosphere becomes very disturbed, particularly at the magnetic poles, with decreasing disturbance further from these poles, and unpredictable results. Signals may fade badly or disappear entirely depending on the severity of the storm and on the proximity to the magnetic poles of the ionosphere areas where the electromagnetic waves are refracted.

For Canada, h-f service to Great Britain and Europe was originally the most important circuit. It was therefore necessary to examine Canada very carefully for the most suitable location for the transmitters to avoid, as far as possible, transmission through ionosphere disturbed by magnetic storms. From published literature of various communications circuits, we found an interesting analysis that was made in 1934 by K. A. MacKinnon, then with the CBC. From this study it was concluded that best transmissions to England could be made from the extreme South East coast of Nova Scotia. An actual improvement of from 6 to 8 db was predicted over transmission from Montreal. But even this was not considered conclusive enough, and it was decided that experimental tests should be carried out to prove the point.

The BBC h-f service was then in operation and since transmission and reception are reciprocal, it was decided to make some extended quantitative measurements on reception of BBC at Ottawa and at or near Halifax, Nova Scotia. These experiments were carried out by the writer in April and May, 1941. The tests ran for a month on frequencies in five of the international h-f bands. It was thought advisable to check transmis-

| Frequency (mc) | Time of Day E.D.T | Average µv/m Ottawa | Average µv/m Halifax | Gain (db) |
|---|---|---|---|---|
| 15.14 | 1130 | 56.3 | 118.1 | 6.28 |
| 17.81 | 1130 | 64.3 | 131.1 | 6.2 |
| 15.14 | 1400 | 18.5 | 78.2 | 12.5 |
| 11.75 | 1900 | 221.0 | 649. | 9.37 |
| 9.58 | 2115 | 447.0 | 1112.0 | 7.36 |
| 6.11 | 2215 | 227 | 446. | 4.12 |
| | | Average | | 7.64 |

Figure 2
Results of tests on BBC signal strength and fading at Halifax and Ottawa.

ons at all useful times of day on the ptimum frequencies used at these articular times. Quantitative meas-rements were made of the field rengths at each location on dupli-ite sets of measuring equipment nder identical conditions. Graphic harts were kept of these results.

Furthermore, qualitative tests were ade possible on the various types f programmes, by having the pro-rammes transcribed at both points by lentical equipments, right from the ntenna to the discs used. This ex-edient was extremely effective in nowing up the effects of fading, par-icularly during periods of extreme agnetic storms.

The results (Figure 2) of these tests greed remarkably close to the pre-icted results on signal strength and lso definitely proved that fading con-itions were better at Halifax, fur-her from the zone of maximum dis-irbance.

Comparison of the transcriptions irther verified our contentions. Of 26 sets of recordings, we found that e results were:

| | |
|---|---|
| etter in Halifax | 103 |
| qual | 17 |
| etter in Ottawa | 6 |

The results were conclusively in avor of transmission to the most east-n part of Canada, to avoid a path hrough the more disturbed iono-phere. We then had to select a site uitable from practical considerations, roximity to power, proximity to tele-hone lines, suitable land and ground onductivity, etc. The site of our BA transmitter was the obvious an-wer. All the necessary requirements ere there and in addition there would e the economy of joint operation of -f transmitters with the CBA broad-asting transmitter.

### Antennas

One of the major decisions to be ade was on the type of antenna sys-em to be used. We attempted to pro-ide the best possible antenna system egardless of cost and structural dif-culties. This policy proved to be a ise one in the results obtained. In general study of the problem of orld coverage, it was decided that ontinuous service to all countries and nguages was decidedly out of the uestion, and we therefore attempted o provide listening service during the aximum listening hours in general.

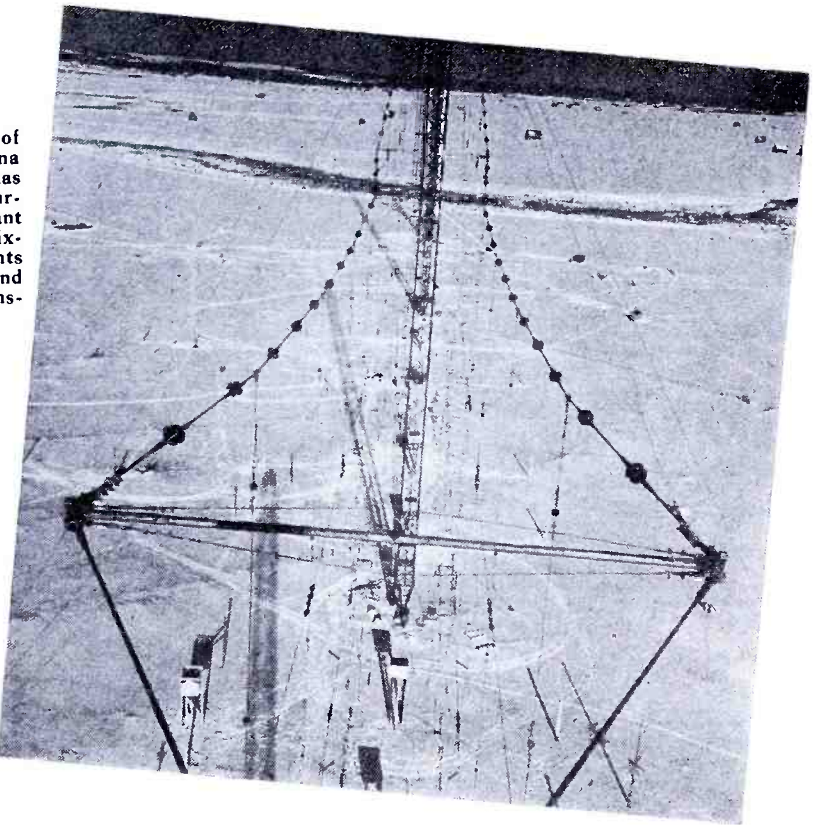


**Figure 3**
**Aerial view of one of the 380′ beam antenna towers. The antennas are multi-element curtains of the resonant type composed of sixteen half-wave elements properly phased and driven by two transmission lines.**

From an azimuthal map centered on Sackville, New Brunswick, we found that it was possible to cover nearly all major continents of the globe with three antenna systems which were reversible and which could have the direction slightly altered in a system known as slewing.

The antennas chosen were actually multi-element curtains of the resonant type composed of sixteen half-wave elements properly phased and driven by two transmission lines. Behind each element was an identical element

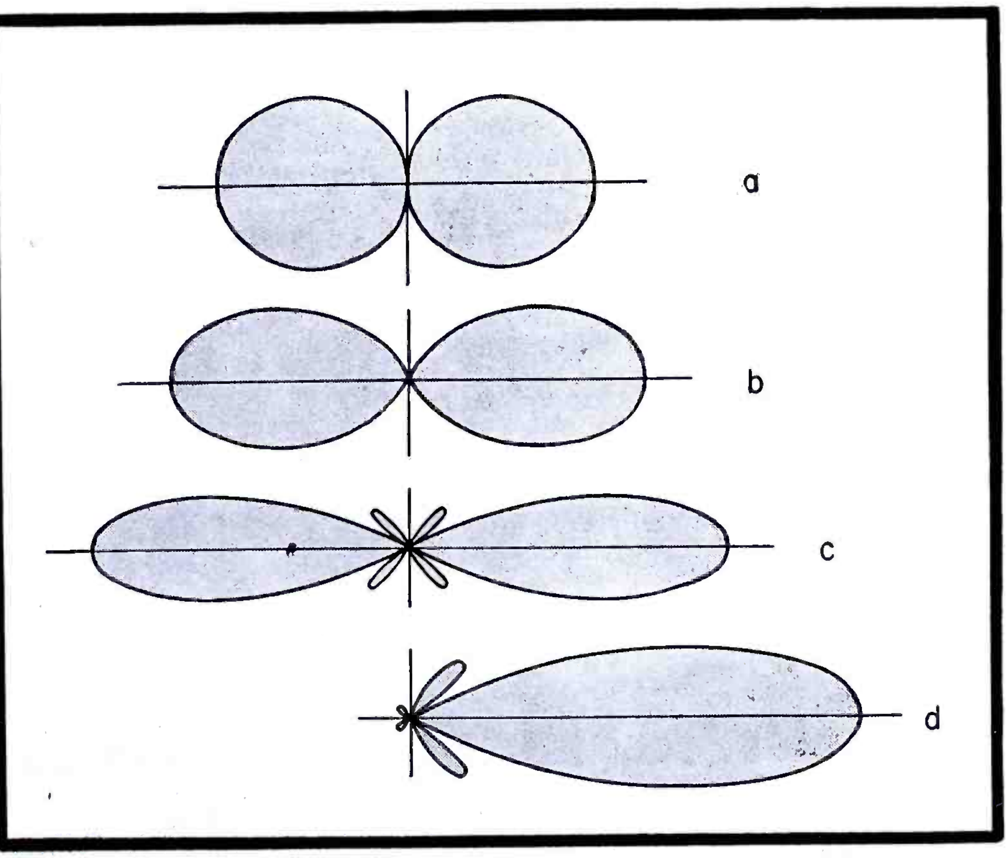



**Figure 4**
**Horizontal polar diagrams of radiating systems of one, two and four-element half-wave antennas: *a* represents one half-wave element; *b*, two half-wave elements; *c*, four half-wave elements; and *d*, four half-wave elements plus reflector (rear lobe eliminated by reflector).**

## CBC TRANSMITTERS

(*Continued from page* 61)

spaced a quarter wavelength, acting as a reflector properly phased and connected by two more transmission lines properly stubbed.

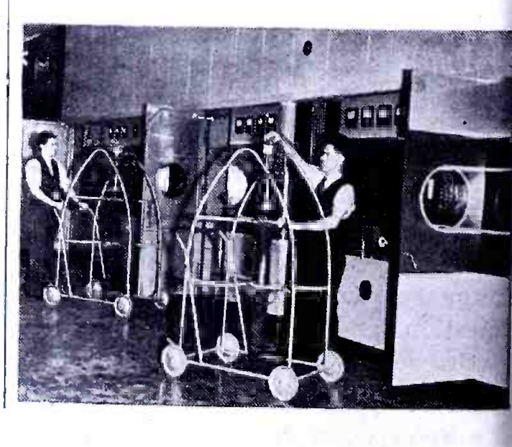
Figure 4 *a*, *b* and *c* shows the horizontal polar diagram of radiating systems of *1*, *2* and *4*-element half-wave antennas. These illustrate the important concentration of energy by the use of a multi-element system. Similarly stacking the elements in a vertical plane concentrates the energy in the vertical plane. The effect of the reflectors in eliminating the back lobe and strengthening the forward lobe is illustrated in *d*. Because of the time differences, it is very unlikely that transmission in opposite directions from the same antenna will ever be required. Thus the inclusion of the reflectors with provision for reversing shows an increased signal strength in either direction at the time of day required.

The slewing of the beam is accomplished quite simply by delaying the phase in one-half of the curtain. This is done by adding in an additional length of transmission line and is controlled from the antenna switching room by remote control.

The so-called medium gain arrays are mostly two frequency antennas with only two elements in height but four elements long. This results in less gain because of less vertical concentration.

In Figure 8 (see page 86) appears a tabulation of the fundamental characteristics of all the antennas. This shows increased signal strengths afforded by using antennas four elements high by four wide, giving us a gain of 21.5 db. Reducing to four horizontal elements and two vertical elements reduces the gain to 15.3 db when the lower element is one wavlength above ground and 12.6 db when the lower element is only a half wave above ground. The problem of this point is, of course, an economic one as it becomes expensive to erect antenna

Figure 5
Tube racks designed to move 100-kw tubes from storage vault to panel.



structures high enough to accommodate four elements at 6 megacycles where the wavelength is approximately 150'.

### Transmitters

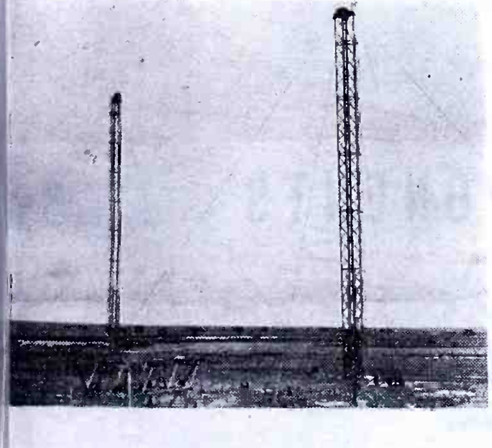
Specifications for the transmitter called for an output power, at least 50 kw, capable of full modulation. The six international bands between 6- and 22-mc had to be covered. Frequency response was ± 1.5 db from 50 to 8,000 cycles and ± 2 db between 30 and 10,000 cps. Other required features were: Frequency stability, .005%; audio distortion, less than 5% rms total harmonic content; and carrier noise, 60 db below 100% modulation.

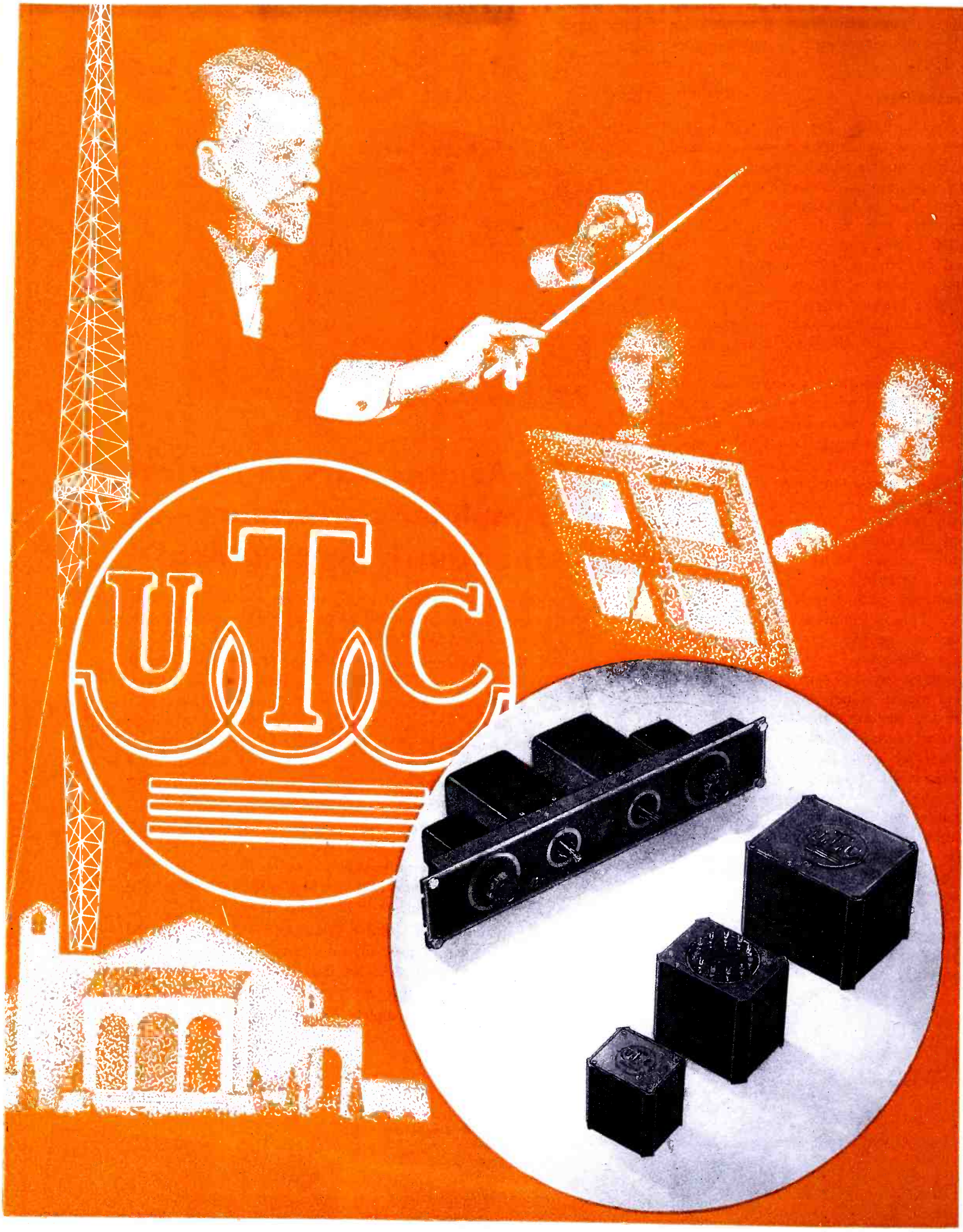
The transmitters were installed by RCA. (A simplified schematic of the circuit is shown in Figure 7.) This is a straight-forward class *C* plate-modulated transmitter, high-level modulated in the final stage by class *B* modulators. The tubes are air cooled with the exception of the final stage and the modulator tubes which are water cooled 880's. The oscillator works at half frequency and is a conventional plate-tuned crystal oscillator. This is followed by an 802 buffer doubler feeding into push-pull 828's operating class *C*. In the second stage we have two 810's in push-pull cross-neutralized inductively coupled to the third power-amplifier stage (827R radiation-cooled beam pentode). For simplicity and stability these tubes were neutralized and drove directly the final stage 880's in push-pull cross-neutralized inductively coupled to the output circuit. This stage operates class *C* with an efficiency of approximately 75% over the entire frequency range.

The audio amplifier is quite conventional and is push-pull throughout. To reduce audio phase shift over a feed-back loop, the third audio stage

(*Continued on page* 65)

**Figure 6**
**Two of the four antenna towers used at the Sackville N. B. station of CBC.**



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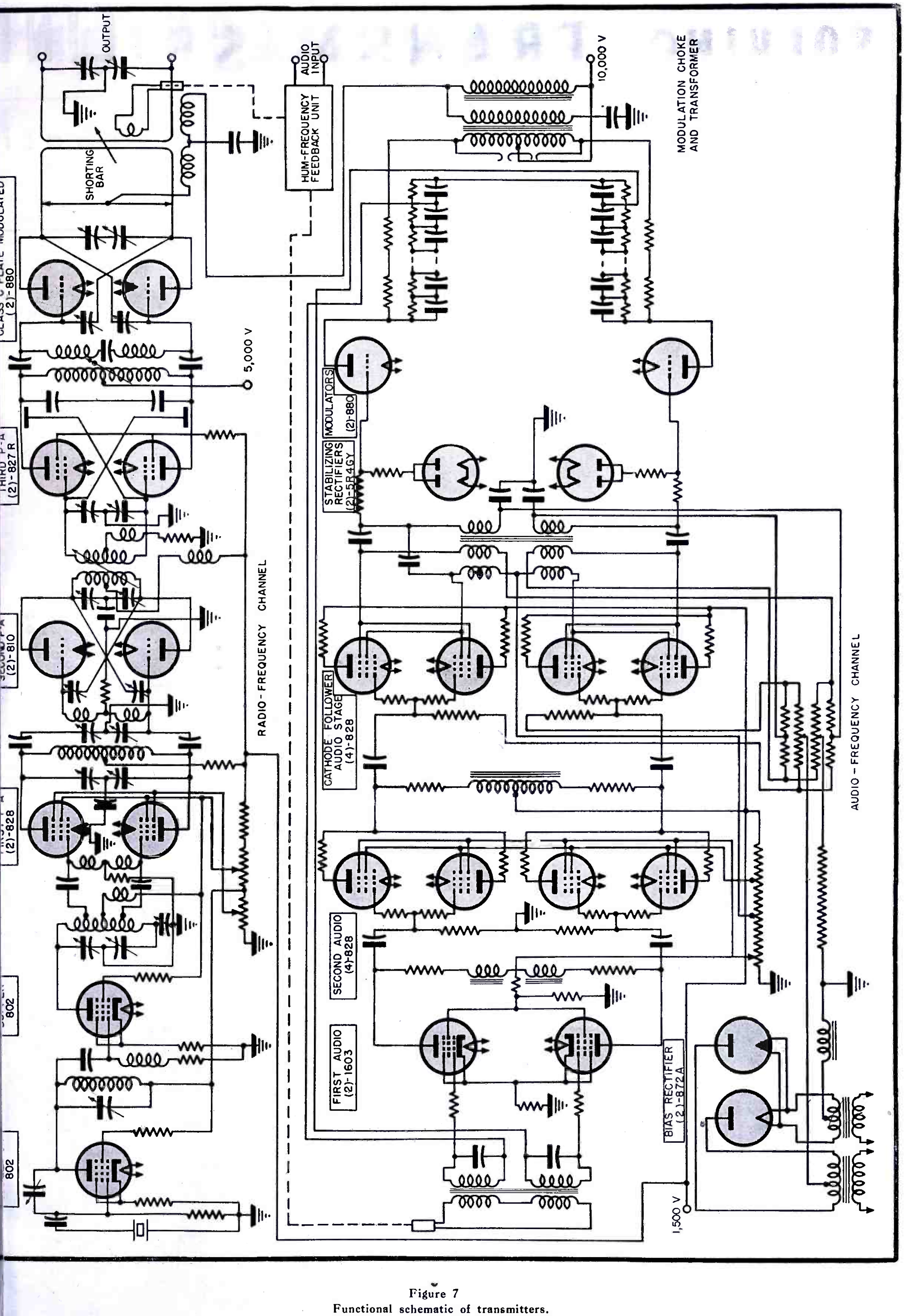



Figure 7
**Functional schematic of transmitters.**



(Continued on page 85)

# SOLVING TRANSMISSION LINE

## With Charts of Complex Hyperboli Tanh and Coth

IN calculations of long transmission lines having appreciable attenuation the complex hyperbolic functions tanh and coth $(\alpha + j\beta)$ are frequently used. Although these values can be computed directly from tables of real hyperbolic and circular trigometric functions, such computations are rather tedious. Values can be found more readily from charts. Accordingly the charts shown in Figures 1 and 2 were developed and found to be quite handy for transmission line work.

The values of the tanh of the complex angle $(\alpha + j\beta)$ are also complex and are shown on the charts as the rectangular coordinates u ± jv. Values of α are shown by the arcs centering on the horizontal axis. Values of β are shown in degrees by the arcs centering on the vertical axis (in plain figures for tanh). In the range 0°-90° the corresponding values of $v$ are positive. To permit a larger scale the same arcs are used for the values in the range 90°-180° where the corresponding values of $v$ are negative. Since the values in the lower corner of Figure 1 were too crowded for accurate reading, an enlargement of this section was prepared, Figure 2.

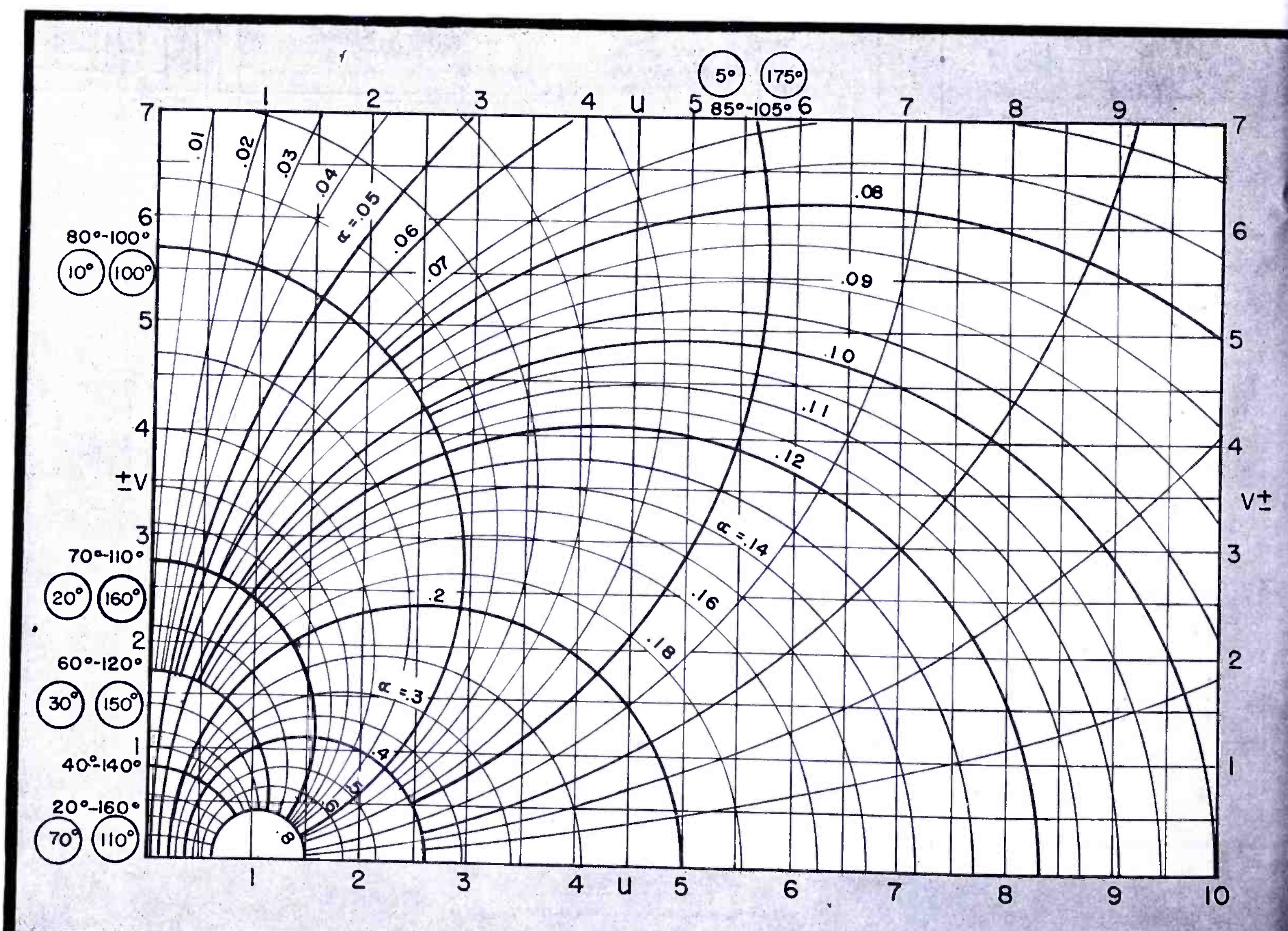
The same charts are used to evaluate the functions of coth $(\alpha + j\beta$ since

$\coth(\alpha + j\beta) = \tanh[\alpha + j(\beta + \pi/2)$

For coth the β arcs are changed fro the values for tanh functions, and a shown by the italicized values, th *85°* in the text and circled values i Figures. The β arc values correspon ing to the coth functions are obtaine by adding 90° to the tanh β arc valu between 0° and 90° and subtractin 90° between 90° and 180°. The value of $v$ corresponding to coth $(\alpha + j\beta)$ i the range 0°-90° are negative, and i the range 90°-180° positive. Fo either tanh or coth functions all value recur at intervals of 180°. Therefor to obtain functions of values over 180 it is necessary to subtract $n$ (180°), a required, to obtain values between 0 and 180°.

**Figure 1**

Chart of tanh $(\alpha + j\beta) = u \pm jv$, or coth $(\alpha + j\beta°) = u \pm jv$. For tanh values in the 0°-90° range, $v$ is positive; in the range of 0°-180°, $v$ is negative. For coth values in 0°-90° range, $v$ is negative; in the range of 90°-180°, $v$ is positive. $[B_1° = (B° + 90°)]$.



# PROBLEMS

**by ROBERT C. PAINE**

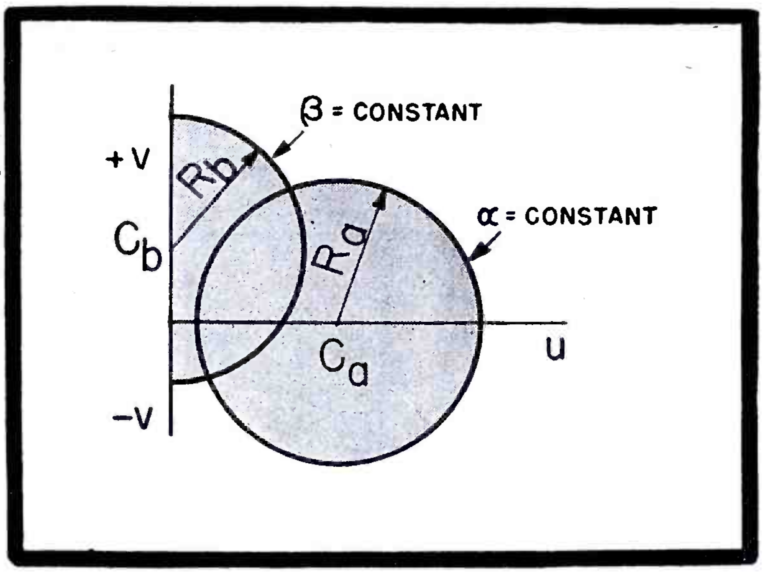



Figure 3
Plot showing that the curves are constant and are circular arcs.

***amples***

***(1)*** Required: Input impedance of line short circuited or open circuited the terminal; line is 4.167 wavegths long and has a characteristic pedance, $Z_o$, of 600 ohms and a tal attenuation of 4.34 db (when operly terminated).

These values are equivalent to a t propagation characteristic of $+ j\beta = .5 + j1500°$ which will be und on the chart at $.5 + j\,[1500°$ $3(180°)]$ or $.5 + j60°$. In Figure 2 nh of this value is found as $u + jv$ $1.12 + j\,.83$. The short-circuited put impedance

$$Z_{sc} = Z_o \tanh(\alpha + j\beta).$$

this case

$$Z_{sc} = 600\,(1.12 + j\,.83) = 672 + j\,498;$$

open-circuit impedance of a line,

$$Z_{oc} = Z_o \coth(\alpha + j\beta).$$

r the given line this value correonds to

th $(.5 \pm j\,60°)$ or $u - jv = .57 - j\,.43$ and the input impedance

$$Z_{oc} = 600\,(.57 - j\,.43) = 342 - j\,258.$$

***(2)*** Required: Propagation characteristic of a given line by input impedance measurements made at one end.

These are made as

$$Z_{sc} = 1200^{\omega}\,\underline{|+15°}$$

with the distance end short circuited, and

$$Z_{op} = 300^{\omega}\,\underline{|-15°}$$

with the distant end open. Since

$$Z_{sc} = Z_o \tanh(\alpha + j\beta)$$

and

$$Z_{oc} = Z_o \coth(\alpha + j\beta), \qquad Z_o = \sqrt{Z_{sc} Z_{oc}}$$

and

$$\tanh(\alpha + j\beta) = \sqrt{Z_{sc}/Z_{oc}},$$

or

$$(\alpha + j\beta) = \tanh^{-1}\sqrt{Z_{sc}/Z_{oc}}.$$

Then

$$Z_o = \sqrt{(1200^{\omega}\,\underline{|+15°})\,(300^{\omega}\,\underline{|-15°})} = 600^{\omega}\,\underline{|\,0°}$$

and

$$\tanh(\alpha + j\beta) = \sqrt{(1200^{\omega}\,\underline{|+15°})/300^{\omega}\,\underline{|-15°}} = 2\,\underline{|+15°}$$

(*Continued on page* 89)

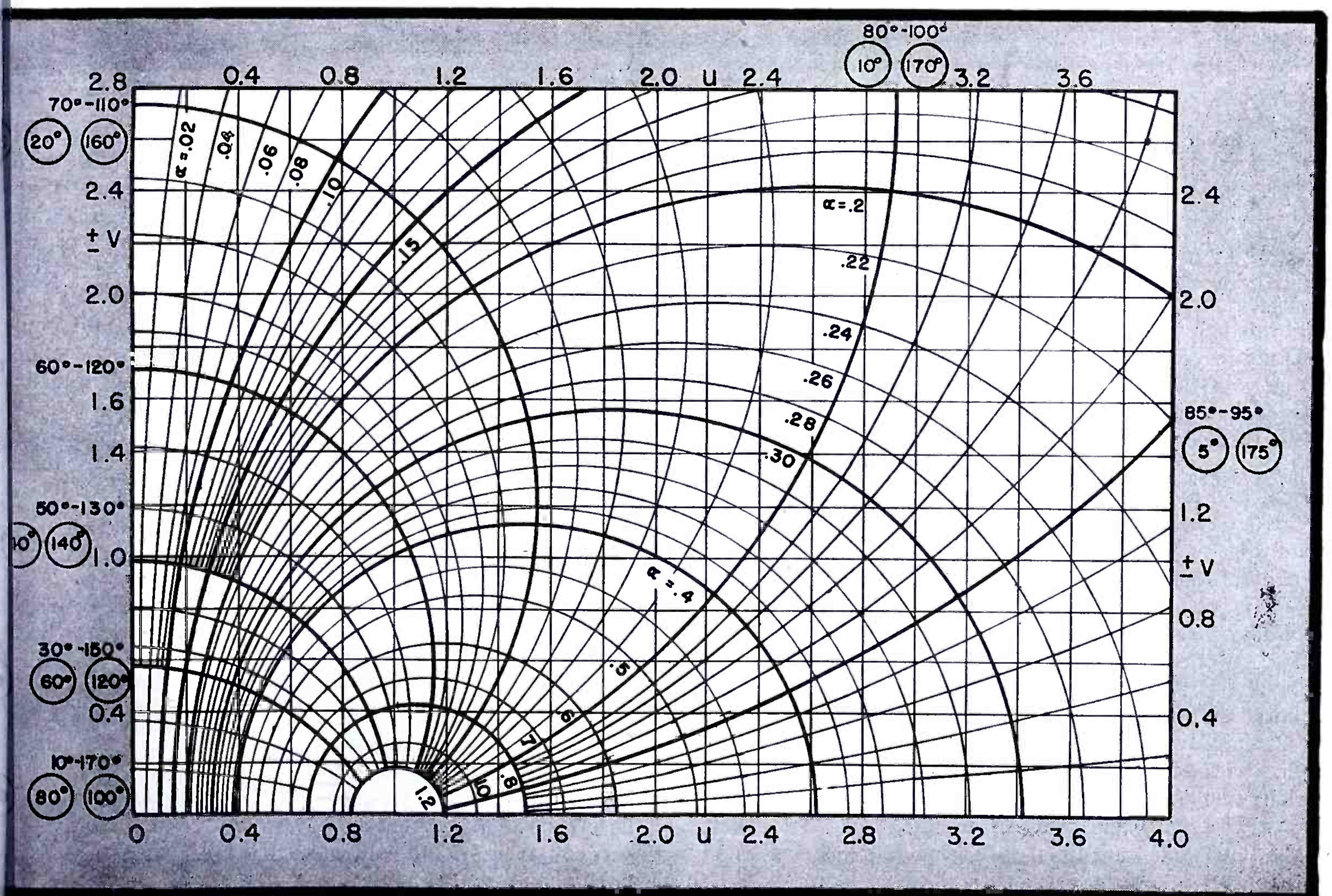



Figure 2
Enlargement of a section of chart, shown in Figure 1, for the higher values of $\alpha$.

# N. Y. NAVY YARD'S QUIET ROOM

by **WILLIS M. REES**
**Acoustical Specialist**
**Owens-Corning**
**Fiberglas Corporation**

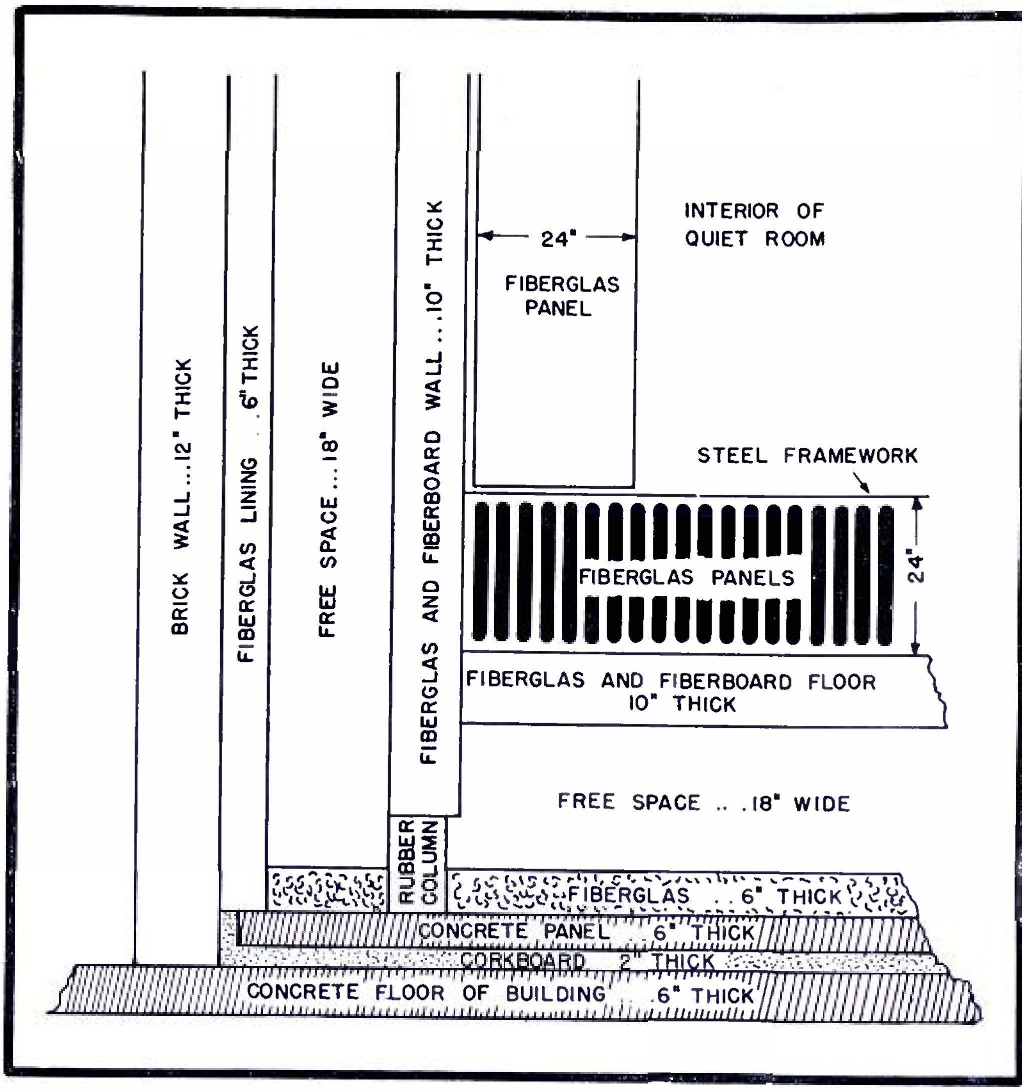



Figure 1

Cross-sectional view of construction of the quiet room in the N. Y. Navy Yard in Brooklyn.

THE New York Navy Yard in Brooklyn, features one of the quietest spaces in the world, a specially designed *silent* 16′ × 26′ × 12′ high room in which ship microphones, telephones, loudspeakers and other communications devices can be calibrated for level and fidelity.

Designed for as low as 4 cps and for a noise level of 24 db, the usual range of frequencies for which the room is used is between 200 and 20,000 cps. The noise level is less than 20 db, and at most freqguencies is in the order of 15 db; 4 cps is approximately 16 cycles below the lower limit of audible sound, while a noise level of 15 db is just above the threshold of audibility.

The quiet room is all but completely isolated from the rest of the Material Laboratory building and is enclosed in a second room, 30′ × 40′, and 25′ high, with brick walls 12″ thick which rest on a 6″-thick concrete floor. The walls and concrete ceiling of the outer room are lined with fiberglas 6″ thick, held in place with wire mesh. To break the symmetry of any standing sound waves, the walls are built so that no two of them are parallel. Between the outer room and the quiet room there is a free space of 18″.

The function of the outer room is to exclude outside noise, whereas the quiet room itself is designed so that sound waves generated within it will be absorbed instead of being reflected back from the walls, floor and ceiling to distort the pattern when calibrating equipment.

To exclude all vibration created by outside noise or due to other causes, the steel skeleton of the quiet room is supported on 14 rubber columns, 8″ square and 14″ high when compressed 1⅛″ by the weight of the room which is approximately 20 tons. The rubber columns, which provide the only contact between the quiet room and the rest of the building, rest on a 6″-thick monolithic concrete panel poured on 2″-thick corkboard laid on the concrete floor of the building. Fiberglas, 6″ thick, is laid on the concrete panel.

### Walls, Ceiling and Floor

The walls, ceiling and floor of the quiet room consist of four layers. On the outside is a 1″ thick perforated fiberboard, 4″ of fiberglas, 1″-thick perforated fiberboard, and a 4″-thick lining of fiberglas held in place by wire mesh. Panels of fiberglas, covered with cheesecloth, are hung, with the longer axis running vertically, all around the walls, reaching from top to bottom. The panels are 4″ thick and 24″ from front to back. There are approximately 2″ of space between each panel.

### Suspended Panels

Similar panels, with the longer axis running horizontally, are suspended from the ceiling and are projected vertically from the quiet room floor. Above these latter panels is a steel framework which, when covered with sections of metal grill, provides a means of walking about the quiet room. All of the metal grill sections, except those which may be needed to support instruments, are removed during testing periods. It is unnecessary for anyone to be in the room during the testing periods, since all tests are conducted by remote control.

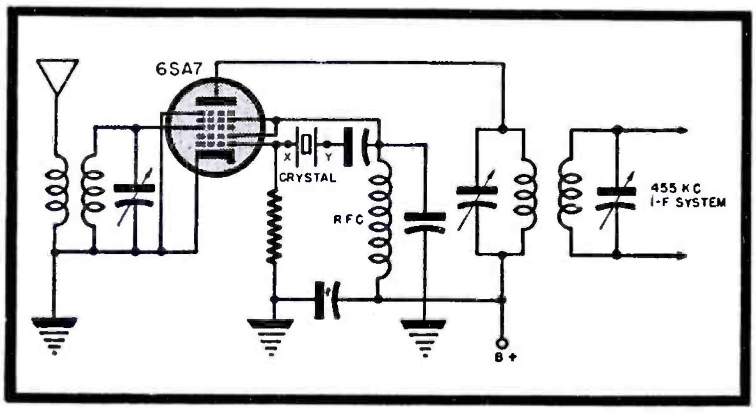
### Fiberglas Construction

The fiberglas material employed consists of fine, interlaced glass fibers treated with a thermosetting resin to provide permanence of form. Its average density is 2½ pounds per cubic foot. Tests made in accordance with methods prescribed by the Acoustical Materials Association show that a 1″ thickness of the material has a noise reduction factor of 0.60 at 550 cycles.

Figures 1 (below) and 2 (right)

Figure 1. A *Pierce*-type crystal oscillator circuit used in an a-m broadcast and short-wave receiver. Figure 2. Chart showing frequency relationships for each of the first six television channels.

| Channel | Channel Frequency (MC) | Sound Channel Resting Frequency | Video Carrier Frequency | Local Oscillator Frequency | One-half Oscillator Frequency | Fundamental Crystal Frequency | Harmonic Order of Crystal |
|---|---|---|---|---|---|---|---|
| 1....... | 44-50 | 49.75 | 45.25 | 27.50 | 13.75 | 4.583 | 3rd |
| 2....... | 54-60 | 59.75 | 55.25 | 37.50 | 18.75 | 6.25 | 3rd |
| 3....... | 60-66 | 65.75 | 61.25 | 43.50 | 21.75 | 4.35 | 5th |
| 4....... | 66-72 | 71.75 | 67.25 | 49.50 | 24.75 | 4.95 | 5th |
| 5....... | 76-82 | 81.75 | 77.25 | 59.50 | 29.75 | 5.95 | 5th |
| 6....... | 82-88 | 87.75 | 83.25 | 65.50 | 32.75 | 6.55 | 5th |




## A Discussion of Crystal Oscillator-Mixer Circuits For the Standard Broadcast Bands and the New F-M/Television V-H-F Channels

# CRYSTAL-CONTROLLED RECEIVERS FOR A-M, F-M AND TELEVISION

by SIDNEY X. SHORE

Consulting Engineer

[ *Part Three of a Series* ]

WITH the recent announcement by RMA of the approved f-m i-f of 10.7 mc and the unanimous proposal of 22.25 mc for the i-f sound channel of television receivers, it is now possible to analyze the quantitative design features of the oscillator sections of these receivers.

In a-m design, we have 455 kc as the i-f for broadcast and s-w receivers, a standard i-f for years. In Figure 1 we have a push-button crystal-oscillator circuit used as the local oscillator of an a-m b-c/s-w receiver. The circuit is the *Pierce* type discussed in previous papers and also described as a Colpitts or ultraudion. Several crystals and one end of the manual-tuning *LC* circuit could be connected together at point *x*. The switching could then be effected at point *y* by a push button, rotary, or dial type of selector switch.

The crystals required are high-frequency thickness-shear type oscillators covering a 995 to 2,055-kc range and having a low temperature-frequency coefficient. It is simple to utilize higher-frequency crystals in the oscillator to select stations in the short-wave bands. The station selector switch must of course control all tuned r-f circuits. The Pierce-type circuit makes it unnecessary to tune the oscillator to resonance at the crystal frequency. For different communities it is only necessary to slip the proper crystals into place to tune to the desired channels.

If manual tuning is desired, an *LC* circuit may be switched in to replace the crystal, and tuned as usual.

Crystal oscillator circuits for television receivers are somewhat more complicated. These systems will usually require at least one tuned *LC* circuit. Limiting the requirement to *only*

(*Continued on page* 106)

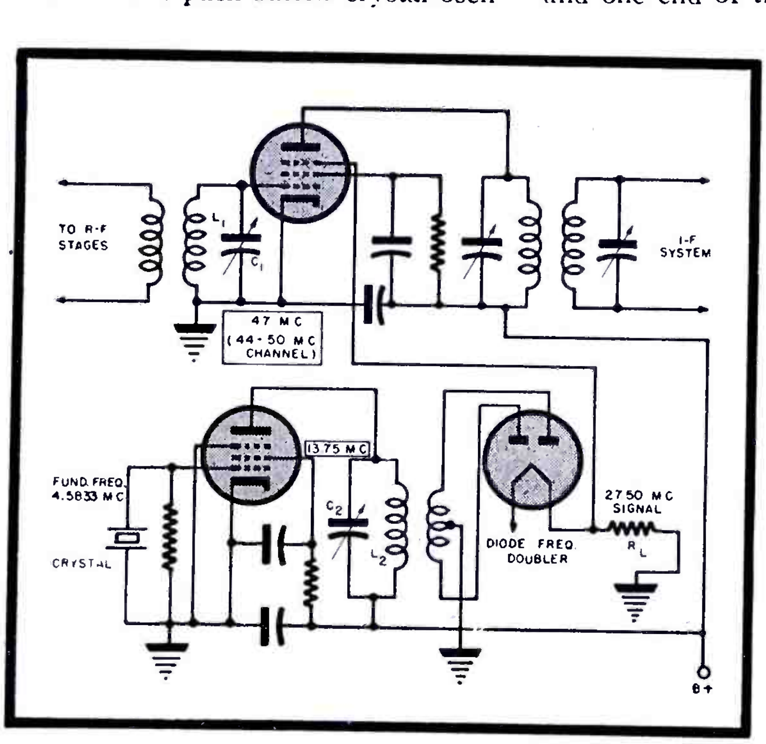
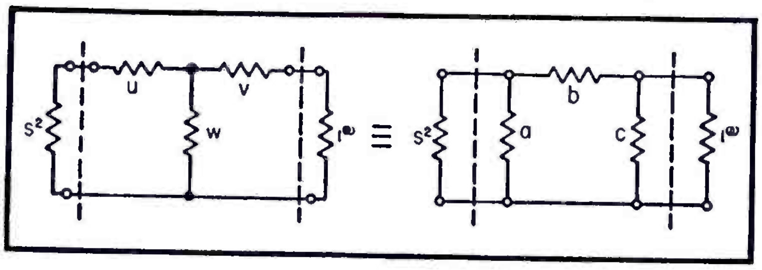
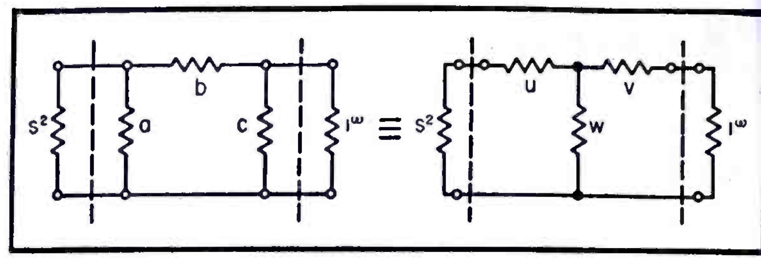



Figure 3

Circuit of mixer and local oscillator to tune to television channel *1*, using an oscillator generating ½ desired frequency and a diode-frequency doubler.




Figures 1 (left above) and 2 (right above)

Figure 1. A normalized $T$-to-$\pi$ network transformation, where: $s^2 = 1.333$, $u = 1.044$, $v = 0.696$, $w = 0.348$, $a = 1.915$, $b = 3.830$, and $c = 1.276$ ohms.
Figure 2. A normalized $\pi$-to-$T$ network transformation, where: $s^2 = s^2$, $a = 3.39$, $b = 2.71$, $c = 1.35$, $u = 1.23$, $v = 0.49$ and $w = 0.62$ ohms.

# RESISTIVE ATTENUATORS, PADS AND NETWORKS

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

[*Part Nine of a Series*]


by PAUL B. WRIGHT

Communications Research Engineer



**The preceding papers in this series on purely resistive types of networks gave the general philosophy involved in their design. Charts and tables were prepared to expedite computations of the elements of the network. The form of presentation of the charts and tables also was arranged to permit the complete and rapid determination of the performance of the networks in terms of their image impedances, insertion and transmission losses. Use was made of a symbolical method whereby most mathematical expressions were compressed into quite simple forms. These forms were then shown to be directly convertible into hyperbolical, algebraical and exponential expressions and were compactly arranged in a *key chart* which served to define all of the relationships between the various forms.**

**In this installment, the last of the series on networks of the purely resistive type, a few examples have been chosen from an infinity of those possible. These examples may be considered representative of those which would be most probable in practical design work. The examples are given directly in terms of the nomenclature used throughout the text, the key chart and the figures of the various charts.**


THE $T$ to $\pi$ transformation results in the equivalence shown in Figure 1. The equations of the transformation are

$$a = \Phi/v \qquad (1)$$

$$b = \Phi/w \qquad (2)$$

and

$$c = \Phi/u \qquad (3)$$

where

$$\Phi = uv + uw + vw.$$

For unit values of $u = 1.044$, $v = 0.696$ and $w = 0.348$ ohms for the $T$ network, application of equations *1*, *2* and *3*, respectively, give $a = 1.915$, $b = 3.830$ and $c = 1.276$ ohms respectively. The terminations are $s^2 = 1.333$ ohms and unity, but need not be unless it is desired to match the network image impedances. The terminations given are on a unit image-impedance basis.

### $\pi$ to $T$ Transformations

The $\pi$ to $T$ transformation results in the equivalence shown, on a unit matched image-impedance basis, in Figure 2. The equations of the transformation are

$$u = ab/\Delta \qquad (4)$$

$$v = bc/\Delta \qquad (5)$$

and

$$w = ac/\Delta \qquad (6)$$

where $\Delta = a + b + c$. For $a = 3.39$, $b = 2.71$ and $c = 1.35$ ohms, *4*, *5* and *6* give the resultant $T$ as $u = 1.23$, $v = 0.49$ and $w = 0.62$ ohms.

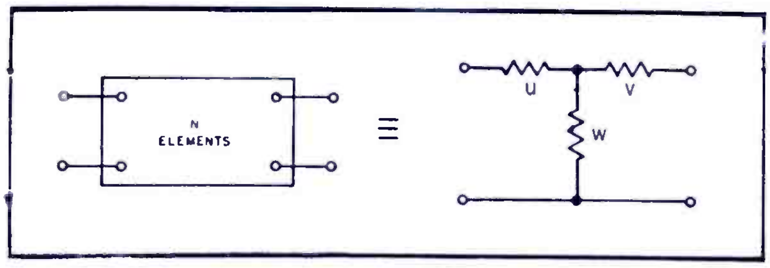
### Equivalent T of N Elements

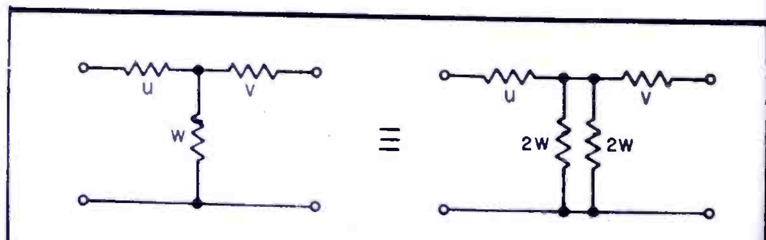
The equivalent $T$ network of any complicated arrangement of purely resistive elements may be found by calculation from three independent measurements upon the network. These measurements may be either two open-circuit measurements from the two ends plus one short-circuited measurement, or alternatively, two short and one open-circuited measurement. Assuming that the first of these two

(*Continued on page* 76)

Figures 3 (below left) and 4 (below right)

Figure 3. An equivalent $T$ network of one having $N$ elements providing open-circuited measurements, $Z_{01} = Z_{02} = 1{,}000$ ohms and short-circuited-measurement of $Z_{s1} = 360$ ohms; $u = v = 200$, $w = 800$ ohms. Figure 4. An application of *Bartlett's bisection theorem* applied to the equivalent $T$ of Figure 3. The image impedance = 600 ohms.



### Personals

LEROY BREMER, for many years an energetic VWOA representative, as secretary of the Los Angeles-Hollywood chapter, is back at his civilian activities after 5 years of service with the U. S. Maritime Service.

LB was a Lieutenant (Senior Grade) in the U. S. M. S. He traveled some 700,000 miles covering all theatres of operations, participating in thirty-three invasions. He was wounded three times, on Saipan, Palau and in Manila.

LB has received the Combat Bar; Defense Bar; Philippine Defense Ribbon; Philippine Liberation Ribbon; Middle East War-Zone Bar; Atlantic War-Zone Bar; Pacific War-Zone Bar; the Presidential Unit Citation and a Personal Citation from General of the Army Douglas MacArthur.

A note from LB states that he'd like to act as L.A. secretary again. With LB doing the spadework, Doc de Forest as a most active participant and Hal Styles as chairman, we are certain that the L.A. chapter will again become preeminent in VWOA affairs.

Congratulations, LB on your outstanding war record and all good wishes for continued success in your civilian work, and in VWOA affairs.

WE understand Commander Fred Muller is now stationed at Norfolk. . . . Our twenty-first birthday party at the Hotel Astor on Saturday evening, February 16, 1946, will be *a victory celebration*. . . . J. F. Rigby, life member and personnel director of RCA Communications, recently completed 25 years of RCAC service. An interesting biographical sketch of JFR appears in *RCAC Relay*, authored by his older daughter. . . . We're glad to hear that director C. D. Guthrie is up and around again. We look forward to seeing him at our meetings. . . . Congratulations to E. H. Price, an enthusiastic VWOA member, upon his recent election as vice president of the Mackay Radio and Telegraph Company. . . . It's now Major General H. M. McClelland, the Air Communications Officer of the Army Air Forces. Congratulations. . . . Old-timer R. K. Davis, long with Tropical Radio, has resigned to enter business at Fort Plain, N. Y. Good luck. . . . Lloyd C. Nunn, one of our most faithful members, has completed 33 years of service with RCAC. He is a senior operator at RCAC. . . . The Fall meeting of VWOA at the 77th Division Club on October 25, 1945, was attended by many old-timers. . . . We are anxious to obtain wartime heroic act details of radiomen in all branches of the services as well as in civilian pursuits. Please send them **in** to headquarters with photos if possib**le.** . . . George Street, chairman of our Honolulu chapter continues to be quite active in wireless affairs out Wakiki way. . . . R. H. Pheysey, who received a VWOA testimonial scroll recently is now with United Fruit Company. For years he was with Tropical Radio. . . . Col. Thompson H. Mitchell, vice president and general manager of RCAC, was at the recent communications conference in Rio. . . . Congratulations to Captain George F. Shecklen, U. S. N. R., upon his recent election as vice president and general manager and a director of the Radiomarine Corporation of America. Captain Shecklen, a 33-year veteran of radio, graduated from the Philadelphia School of Wireless Telegraphy in 1912, subsequently serving as wireless officer aboard merchant vessels for three years. Progressing through various assignments in radio—shore station operation, sales commercial representative — Captain Shecklen was instrumental in setting up communications facilities of RCAC throughout the Far East. Commercial manager of RCAC at the time of his call to active duty, he served as Communications Officer in the Third Naval District, New York. He then went on a special mission to South America for the State Department. In 1944 he was transferred to the staff of the Commander-in-Chief of the U. S. Pacific Fleet. He served for fifteen months at Pearl Harbor and in the Western Carolines. . . . W. F. Aufenanger, life member, is an outstanding member of the executives bowling team at RMCA. Washington chapter chairman F. P. Guthrie, a pioneer wirelessman, was recently elected an assistant vice president of RCAC. Many thanks FPG for the splendid work you've done for VWOA in the Nation's capital. . . . In the Navy in 1923 for four years, then the Coast Guard from 1929 to 1934 and back to the Navy from 1937 until the present, now serving as an Aviation Chief Radioman, is the record of William Shaw Nagata. . . . Frank D. Pizzuti, formerly radio officer on the S.S. Caddo, now senior engineer at Airadio, Stamford, Conn.

George Clark, VWOA secretary, who prepared a historical chapter on radio pioneers for the souvenir brochure distributed at the recent radio pioneers' dinner in New York City.

### Pioneers Honored

PIONEERS of the wireless art were honored at a recent dinner held in the grand ballroom of the Hotel Commodore, under the auspices of the IRE, VWOA, ARRL and the RC of A.

One of the features of the evening was a souvenir brochure containing the intriguing history of the pioneering personalities and their developments, prepared by our own George Clark. George, who is now secretary and director of the VWOA and one of the original VWOA incorporators, was a charter member of the Wireless Institute, predecessor to the IRE. He is also a charter member of the IRE and was the first Chief Radio Aid to the U. S. Navy. Congratulations to a grand old wireless pioneer.

# RESISTIVE NETWORKS

*(Continued from page 72)*

sets of measurements is chosen, the equations for the elements are

$$u = Z_{01} - w \qquad (7)$$

$$v = Z_{02} - w \qquad (8)$$

$$w = (Z_{02}(Z_{01} - Z_{s1}))^{1/2} \qquad (9)$$

If the open-circuited measurements each equal 1,000 ohms and the short-circuited measurement from one end is found to be 360 ohms, use of equations *7, 8* and *9* give the equivalent *T* shown in Figure 3, with $u = v = 200$ and $w = 800$ ohms. If $Z_{01}$ and $Z_{02}$ were unequal, the equivalent *T* would be an asymmetrical network with *u* and *v* unequal also.

### Bartlett's Theorem

An application of *Bartlett's theorem* is shown in Figure 4. To determine the image impedance of the network of Figure 3, and find if the terminations shown in figure are correct for proper match of impedances, the network is bisected as shown. The square root of the open and short-circuited impedances of the bisected network will give the image impedances of any symmetrical network. The equations for the open circiuted and short circuited conditions are, respectively,

$$Z_{OC} = Z \coth \frac{\Theta}{2} \qquad (10)$$

and

$$Z_{SC} = Z \tanh \frac{\Theta}{2} \qquad (11)$$

Since the hyperbolic coth and tanh of the half angle subtended by the network half are reciprocal functions, from *10* and *11*, the above statement follows. For Figure 4, the open-circuited bisected network gives 200 + 1600 = 1800 ohms and the short-circuited condition gives, simply, 200 ohms. The square root of their product equals 600 ohms. Hence, the termination as shown is the correct one for image operation or matching.

### Series-Insertion Network

Let us assume that we should like to know the effect of inserting a given resistance between any two impedances having a ratio of four to one, hence, $s^2 = 4$. Referring to Figure 5*a*, with *u* equal to 2 ohms, the insertion loss as found from the equation

$$\text{db} = 20 \text{ Log}_{10} \left( 1 + \frac{u}{s^2 + 1} \right) \qquad (12)$$

is found to be 2.92 db. This is the loss that would be obtained with the series resistance connected into the circuit over that which would result if it were missing or short circuited.

Conversely, if the loss is caused by an inserted facility between these same impedance terminations, the unknown network element is given by the equation

$$u = N\,(s^2 + 1) \qquad (12)$$

From the first table given in the series, *N* is given by interpolation as 0.40, hence $u = 0.4(4 + 1) = 2.0$ ohms as the value of the inserted resistance.

### Shunt-Insertion Network

Figure 5*b* shows a shunt of 2 ohms placed across the terminations of 5*a* instead of in series. The equations for loss and element value are

$$\text{db} = 20 \text{ Log}_{10} \left( 1 + \frac{1}{w}\,\frac{s^2}{s^2 + 1} \right) \qquad (13)$$

and

$$w = n \frac{s^2}{s^2 + 1} \qquad (14)$$

with $w = 2$ ohms; the loss in this case happens to be identical to that of the series case, or 2.92 db. Were the loss given as 2.92 db instead, with the same terminations, the element value $w = 0.8 \times 2.5 = 2.0$ ohms. The interpolated value of $n = 2.5$ as found from the first chart, or may be secured by taking the reciprocal of *N* from the series case.

### Series and Shunt Insertion Network

In Figure 5*c* appears a series and shunt insertion network; Figures 5*a* and 5*b* are merely special cases of this more general network. The equation for the loss of this network when inserted between any given facilities is

$$\text{db} = 20 \text{ Log}_{10} \left( 1 + \frac{u + v}{s^2 + 1} + \frac{(u + s^2)\,(v + 1)}{w\,(s^2 + 1)} \right) \qquad (1$$

If the unit values of the elements are $u = 1$, $v = 4$ and $w = 2$ ohms respectively, the insertion loss for an impedance-termination ratio of $s^2 = 4$ is 13.3 db. The elements cannot be found uniquely in terms of the loss function since an infinite variety of elements can give the same insertion loss in this case.

### L Taper, Series Matched

This type of network, Figure 6*a*, is matched on its series-end only. The power transmission loss for this network is given by the expression

$$\text{db} = 20 \text{ Log}_{10}\,(s(1 + 1/w)) \qquad (1$$

and the network element values by

$$v = s(s - r) \qquad (1$$

and

$$w = sr/(1 - rs) \qquad (1$$

For $s^2 = 4$, $v = 3.5$ and $w = 1$ ohm, the transmission loss is 12.04. Conversely, if the loss were given as 12.04 and the terminations as shown, the element values from *17* and *18* by use of the first table, $v = 2\,(2 - .25) = 3.5$ and $w = (2 \times 0.25)/(1 - (2 \times 40.25)) =$

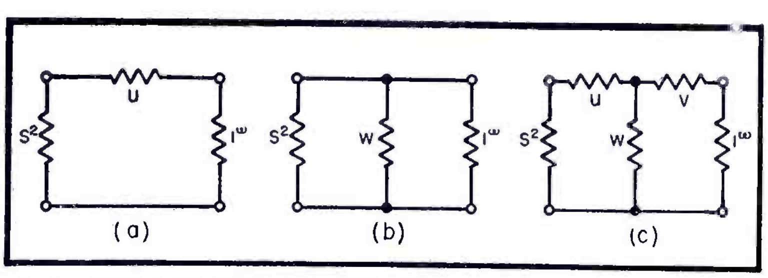
### L Taper, Shunt Matched

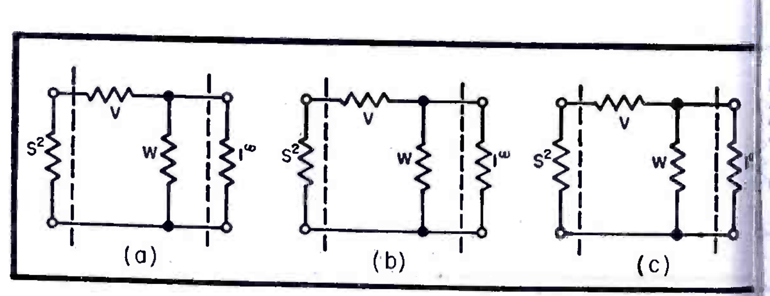
Figure 6 illustrates an *L*-taper pad or attenuator matched on its shunt end only. With $s^2 = 2$, $v = 1$ and $w =$ 1.5 ohms, the loss and element equations are given by

$$\text{db} = 20 \text{ Log}_{10}\,(s(1 + v/s^2)) \qquad (1$$

Figures 5 (below left) and 6 (below right)

Figure 5*a*, *b* and *c*. Insertion losses of these networks on a normalized or unit basis give for: (*a*) 2.92 db with $s^2 = 4$, $u = 2$ ohms; (*b*) 2.92 db with $s^2 = 4$, $w = 2$ ohms; (*c*) 13.3 db with $u = 1$, $v = 4$, $w = 2$, $s^2 = 4$ ohms. Note that these networks *are not matched* by image impedances. Figure 6*a*, *b* and *c*. Transmission losses of these *L*-taper networks on a normalized basis give for: (*a*) 12.04 db with $s^2 = 4$, $v = 3.5$, $w = 1$ ohm, matched at series end only; (*b*) 6.52 db with $s^2 = 2$, $v = 1$, $w = 1.5$ ohms, matched at shunt end only; (*c*) 11.5 db with $s^2 = 4.05$, $v = 3.5$, $w = 1.15$ ohms, matched at both ends of the network.



$$v = s(k - s) \quad (20)$$

and

$$w = s/(s - r) \quad (21)$$

The transmission loss is 6.52 db. Conversely, were the loss given and the element values desired, equations *20* and *21* with the interpolated value of $k$ and $r$ from the first table of this series would result in $v = (2)^{1/2} (2.121 - 1.414 = 1$ ohm, and $w = 1.414 / (1.414 - 0.471) = 1.5$ ohms.

### L Taper, Series and Shunt Matched

This is a minimum-loss network, Figure 6*c*. It is matched by its image impedances at both ends. Their ratio must be equal to or greater than unity with the larger impedance connected to the series end of the network.

The ratio which it is possible to match and build the network with positive elements is given by column $E$ in the second table of the series. If the minimum loss pad desired is 11.5 db, the ratio of terminating image impedances must be 4.049. The unit elements required to give this loss are given by the equations

$$v = As \quad (22)$$

and

$$w = as \quad (23)$$

From table *two* of the series, the element values are therefore,

$$v = 1.746 \times 2.01 = 3.51 \text{ ohms}$$
$$\text{and } w = 0.573 \times 2.01 = 1.154 \text{ ohms} \quad (24)$$

### T-Network Design

Usually, the loss desired for the network and the impedances between which is is to operate are given as data from which the element values can be obtained. When the terminations are equal and the network is connected at its terminal ends by equal image impedances, particularly simple forms of the equations result. If a pad or attenuator having a transmission loss of 10 db is to be designed for given ratios of the image impedances, it is necessary to first determine the maximum ratio which can be used and still result in physically realizable elements. This ratio is given by the hyperbolic cosine-squared function which is designated symbolically as $E$. It will be noted that any ratio up to a maximum of 3.025 can be satisfactorily used and will give positive elements. Let us assume that the ratio of terminating impedances is $2.0 = s^2$, and that the loss is 10.0 db. The equations for the element values on a unit basis are

$$u = cs^2 - w \quad (25)$$

(*Continued on page* 78)

# RESISTIVE NETWORKS

(Continued from page 77)

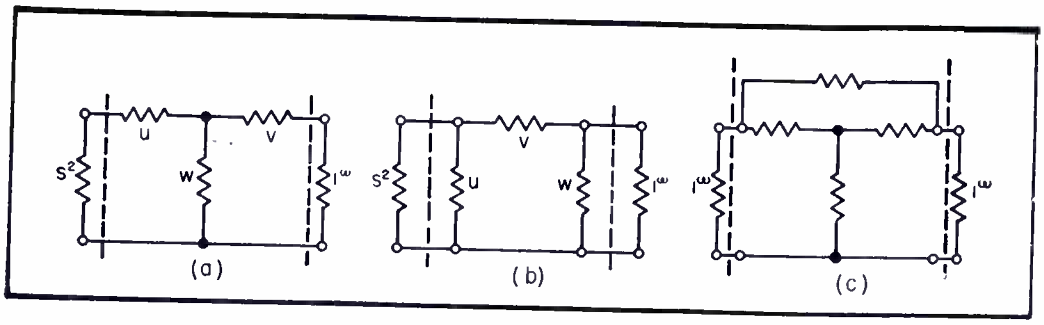



Figure 7
Transmission losses of these networks (T, π and bridged-T respectively operating between image impedances on a unit basis give for: (a) 10.0 db with $s^2 = 2.0$, $u = 1.448$, $v = 0.226$, $w = 0.996$ ohms; (b) 15 db with $s^2 = 4$, $u = 12.1$, $v = 5.446$, $w = 1.132$ ohms; (c) 5 db with $v = 0.778$ and $w = 1.285$ ohms.

$$v = c - w \tag{26}$$

and

$$w = as \tag{27}$$

From the above data and the second table of the series, the element values required are $u = [(2 \times 1.222) - (1.414 \times 0.703)] = 1.448$ ohms, $v = (1.222 - 0.996) = 0.226$ ohm and $w = 1.414 \times 0.703 = 0.996$ ohm. These values are shown in Figure 7b.

When, however, the image impedances are equal, $s^2 = 1$ and the equations 25 to 27 simplify to

$$u = v = D \tag{28}$$

and

$$w = a \tag{29}$$

For a 10-db pad, the unit values are then read directly, without any calculation, whatever, from table *two* of the series, and give respectively, $u = 0.519$ ohm $= v$ and $w = 0.703$ ohm. To place the unit values on any desired impedance level basis other than unit ohm at the small terminating impedance end of the network, it is only necessary to multiply all element values and both terminations by the smaller of the two terminations if different, or by the common value if terminations are equal.

Since the loss of the unit network is given by the equation

$$db = 20 \operatorname{Log}_{10} \left( s\left(1 + \frac{v+1}{w}\right) \right) \tag{30}$$

for the general *T* and the same without the *s* factor when the network is symmetrical with equal-terminating impedances, a means is readily available to determine the transmission loss of any such network when operated between its image impedances. If we assume that the network whose loss is desired is that of Figure 1, then equation 30 applied gives 16.62 db.

### π-Network Design

The π-network design may be obtained by first designing a *T*-network and then using the *T*-to-π transformation. However, the more direct method using the equations shown in the charts together, with the hyperbolic functions from the second table of this series is preferable when available. The equations for the element values on a unit basis are

$$u = s^2/(c - as) \tag{31}$$

$$v = As \tag{32}$$

and

$$w = s/(cs - a) \tag{33}$$

(Note that the formula for the unit value of $u$ was inadvertently omitted in the chart, but may be obtained as in 31 by dividing both sides of the equation for $u$ on a full-impedance basis by $z$, the smaller of the terminating image impedances.) Let us assume that the network is to operate between unequal-terminating impedances having a ratio of $s^2 = 4$, and a transmission loss of 15 db is desired. The element values are therefore, $u = 4/[(1.065 - (0.367 \times 2)] = 12.1$, $v = 2.723 \times 2 = 5.446$ and $w = 2/[(1.065 \times 2) - 0.367)] = 1.132$ ohms respectively, Figure 7b.

The loss for this network in terms of the image impedances and the element values is given by the expression

$$db = 20 \operatorname{Log}_{10} \left(1 + v + \frac{v}{w}\right) \Big/ s \tag{34}$$

on a unit basis.

Were the element values obtained above substituted into equation 34, the loss obtained would be found to be 15 db.

In the special case of equal-terminating impedances, this network also may be designed by direct inspection of the second table in the series and the simplified equations of

$$u = w = d \tag{35}$$

and

$$v = A \tag{36}$$

For a 10-db pad, on a unit basis, $u = 1.925 = w$ and $v = 1.423$ ohms. It may be noted that these values are simply the reciprocal function of equations 28 and 29 for the *T* network; hence the general rule that for symmetrical networks of the *T* and π configurations, the reciprocal of the series-*T*, arms give the shunt-π arms and the reciprocal of the shunt-*T* arm gives the series-π arm. When the π-element values are given for a symmetrical network, the converse relationship is used to find the equivalent *T* configuration.

### Bridged-T Network Design

This type network is one of the most

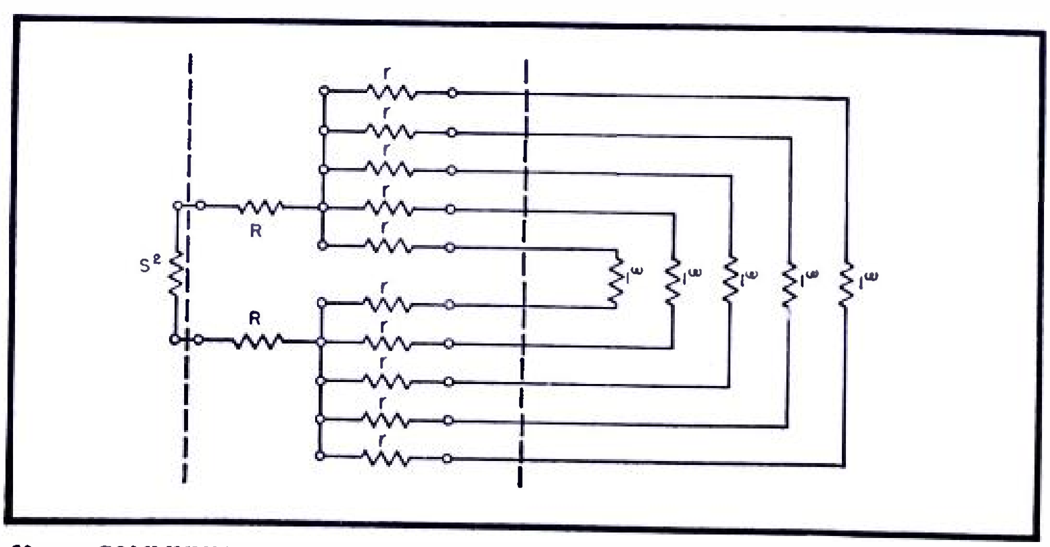



Figure 8
An application of a multiple-bridging normalized network of five branch outlets. Transmission loss is 20 db; $R = 1.838$, $r = 0.308$ and $s^2 = 4.0$ ohms.

ul of all of the standard configura-
s of symmetrical form. It is shown
Figure 7c on the unit or so-called
nalized basis. The design equa-
s for the series and shunt arms
simple forms and the network
be designed by inspection of the
table of the series and the equa-
s

$$N \quad (37)$$

$$n \quad (38)$$

, for example, a 5-db pad is de-
d, the values of the elements from
table are found to be $0.778 = v$,
series arm and $w = 1.285$ ohms
the shunt arm. All other values
he unit elements are given directly
er the columns $N$ and its re-
ocal, $n$. The product of the series
shunt element values by *37* and
equals unity and the functions are
inverse to each other with re-
ct to the unit termination.
'he loss function may be expressed
several ways as shown by the
rts. The most convenient of these
be used to obtain the transmission
of

$$= 20 \operatorname{Log}_{10} (1 + v) \quad (39)$$

us assume that $v = 4.623$ ohms.
n from *39* and the first table giv-
values of $k$, the loss is found as
db.

### tiple-Bridge-Network Design

'his type of bridging network is
ely a building-out network which
series resistances so adjusted that
any given number of outlets
lged onto the circuit and for any
o of input and load-impedances
e will be no reflections of energy
urring at the network junction
nections. The configuration is
wn in Figure *8*. If all load im-
ances are not equal they may be
le so by means of either trans-
mers or minimum-loss type pads.
unequal input and load im-
ances, the building-out series re-
ances $R$ and $r$ will be unequal,
le for equal input and output ter-
ations of the network $R = r$.
ce the number of branches which
be connected in multiple to this
work is always integral and never a
tional or decimal number, the
function progresses in discrete
ounts depending upon the number
bridging outlets and the ratio of the
ut and output terminations. The
on a power transmission basis
n the input to the network to any
of the equal outlets is

$$= 20 \operatorname{Log}_{10} n_m s \quad (40)$$

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# RESISTIVE NETWORKS

(*Continued from page* 79)

while the element values are respectively equal to

$$R = \frac{1}{2}(cs^2 - as) \qquad (41)$$

and

$$r = \frac{1}{2}(c - as) \qquad (42)$$

For a 4:1 ratio of input and output impedances with five branches connected, the transmission loss by equation *40* and the *k* column of the first table of the series 20 db. From *41* and *42* with table *two* of the series, $R = [(4 \times 1.02) - (2 \times 0.202)]/2 = 1.838$ ohms and $r = (1.02 - 2 \times 0.202) = 0.308$ ohm for the unit building out values. For equal terminations, $s = 1$ and the equations *41* and *42* become identities. Equations *40*, *41* and *42* become, respectively

$$db = 20 \, Log_{10} \, n_m \qquad (43)$$

and

$$R = r = D/2 \qquad (44)$$

For five outlets, the loss becomes equal to 13.98 db and the element values equal to 0.333 ohm each.

### Lattice-Network Design

This type of network is a more general one than any of the previously discussed standard configurations of networks. Since, however, in this generalized form, it is essentially an unbalanced structure with respect to the ground plane, and further, since it is uneconomical of elements, it is not expected to have but little practical application in this form. The equations which determine its performance were given in the second set of charts in this series. The symmetrical form of the lattice has, however, great usage both in the direct-lattice arrangement of elements and in the transformed applications of it; hence it will be the only one used for an example of the use of the charts and tables.

The design equations become simple

**Figure 9**

**A symmetrical lattice network on a unit basis having a transmission loss of 8 db, in which $t = w = 0.4305$, $u = v = 2.323$, $s^2 = 1$ ohm.**

for the case assuming that $u = v$ and $t = w$. The element values are

$$u = v = d \tag{43}$$

and

$$t = w = D \tag{44}$$

For a given loss, these are respectively the same values obtained for the shunt arms of the symmetrical $\pi$ and the series arms of the symmetrical $T$ network. In this case, the terminations of the network equal unity, and the unit elements may be obtained directly by inspection of the second table of this series. For an 8-db transmission loss, the element values are $u = v = 2.323$ ohms and $t = w = 0.4305$ ohm. The network is shown in Figure 9.

The transmission loss of this symmetrical network is found in terms of the elements by the equation

$$db = 20 \operatorname{Log}_{10} \left( (v+w+2)/(v-w) \right) \tag{45}$$

The correctness of this may be checked by substituting the values of $v$ and $w$ just obtained into the equation. This gives an accurate check and shows that the loss is 8 db for $w = 0.4305$ and $v = 2.323$ ohms.

### Bridged-T to Lattice-Network Transformation

Application of *Bartlett's-bisection theorem* to the symmetrical bridged-$T$ network of Figure 10*a* results in the symmetrical lattice network of Figure 10*b*. The open-circuited bisected half of 10*a* gives $[(1 + (2 \times 1.285)] = 3.570$ ohms for the shunt arms of Figure 10*b*, while the short-circuited bisected half of 10*a* gives 1 ohm in parallel with 0.778/2 ohm, resulting in 0.280 for the series arm of the lattice network shown in Figure 10*b*. The values of the bridged-$T$ were chosen from Figure 7*c* which was designed to have a loss of 5db. Hence, if the transformation given in Figures 10*a* and *b* is correct, the values obtained for the lattice should agree with those which would be obtained by the lattice design equations 43 and 44 for a loss of 5 db. Using the second table of the series as a check, it is found that columns *d* and *D* for 5 db give identically the results obtained by *Bartlett's theorem.*

### Ladder-Network Design

An example, carried out in detail, was presented in the discussion relating to these networks. It is believed that no further information would be

(*Continued on page* 106)

## NEUTRALIZING CAPACITORS

(*Continued from page* 56)

shunts the half of the grid circuit to which it is connected. The direct capacitance between corresponding electrodes of the neutralizing capacitors in the push-pull circuit shunts the entire plate- or grid-tuned circuit to which the corresponding electrodes is connected. The direct capacitance between the plate electrode of one neutralizing capacitor and the grid electrode of the other neutralizing capacitor is effectively added to the grid-plate capacitance of the tube between them.

Although the theory of the measurement of the direct and stray capacitances in a multi-electrode system, such as we see in the four electrodes of the two neutralizing capacitors and ground just considered, is beyond the scope of this paper,[8] data on the results of such measurements are included.

In Figure 4 appear a pair of neutralizing capacitors designed for use in high-power amplifiers.[9] They are mounted on a grounded panel and placed near a capacitance bridge for measurement. The object of the mounting used was to simulate conditions of direct and stray capacitance that may be found in practice and to afford an opportunity to secure capacitance data for a specific set of conditions which can be used for making estimates under different mounting conditions.

The table top was covered with a heavy copper sheet grounded to the bridge. Rugged probe supports were erected on the high terminal of the capacitance bridge and upon the table top for connecting the electrodes of the neutralizing capacitors either to the high terminal of the bridge or to ground. A precision capacitor is shown to the right of the bridge in the well in the table. The parallel substitution method was used at a frequency sufficiently low to insure that the inductance and resistance of the probes produced negligible error in the measurements.

The graph of Figure 5 gives the variation of the direct capacitance, $C_N$ of one of the neutralizing capacitors in Figure 4. The drive shaft for producing the capacitance variation is shown projecting out the front of the upper electrode and may be located readily in any of eight positions. Only the inner electrode moves, and the capacitance range may be changed by resetting the lower cup. The dimensions of the capacitors and their ounting data are supplied in the ption of Figure 4. The direct and ray capacitances are given in Figure Incidentally the crest spark-over ltage for the capacitor and support-g insulators was the same and is in-uded in Figure 5.[10] Since the ex-rnal parts of neither electrode moves ith shaft rotation, all capacitances her than $C_N$ remain unchanged roughout the variation shown in gure 5.

### sign of Neutralizing Capacitors

The general principles covered so r point to several factors influenc-g the design of neutralizing capaci-rs. We may divide these factors to two groups; first those concerned ith general circuit problems, and cond, those concerned with voltage tings of the neutralizing capacitors d their supporting and drive coup-g insulators.

Those factors concerned with the rcuit of the amplifier are affected ost by the capacitances of the neu-alizing capacitor.

()—To secure complete neutralization the capacitance $C_N$ must be capable of being made equal to the effective grid-plate capacitance of the tubes with which it is to be used.

()—To prevent detuning or unbalancing, or both, of the grid- or plate-tuned circuit and to prevent changing the effective grid-plate capacitance to be neutralized, neither the direct capacitances between like and unlike electrodes of opposite condensers nor their capacitances to ground should change perceptibly with adjustment of $C_N$.

()—To insure constancy of adjustment the supporting members should be rugged and the drive mechanism free from backlash.

)—To prevent overshooting the proper adjustment of $C_N$ during adjustment the variation of capacitance should be capable of fine control.

()—To provide symmetry enhancing the capacitive balance of the circuit the capacitance to ground of the electrodes should approximate those of the corresponding electrodes of the tubes with

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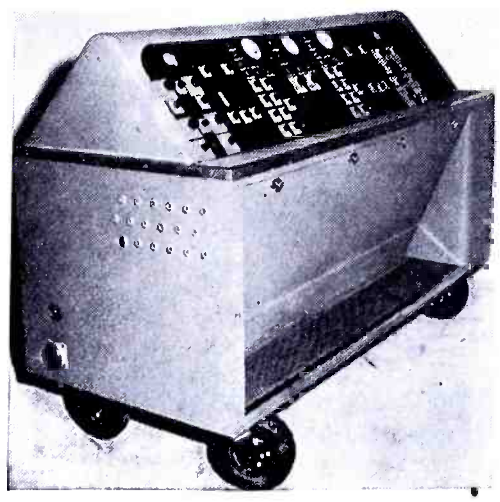
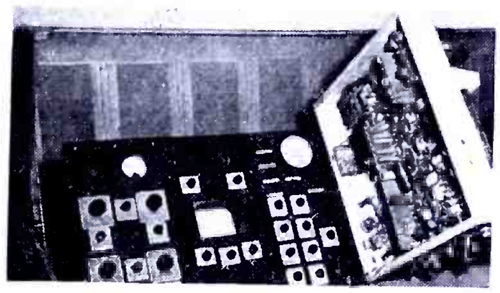
[9]These capacitors were designed by W. Olander, chief engineer, E. F. hnson Company, in 1944.

[10]The voltage measurements were de by B. W. Griffith, radio engi-er, E. F. Johnson Co.

[11]See reference 2, page 395.



Mobile television control system, *Telemobile*, designed by Klaus Landsberg, director of television at W6XYZ, the Paramount station in Hollywood. The unit combines all the control equipment necessary for operation of two television cameras, including the synchronizing pulse generator, sweep signal generator, power supplies and monitoring units.





## NEUTRALIZING CAPACITOR

(*Continued from page* 83)

which they are to be used.

(*6*)—To maintain equality between the two neutralizing capacitors used with identical tubes and balanced circuits in a push-pull amplifier provision should be made for positive ganging of the drive controls when desired.

(*7*)—To provide flexibility in choice of circuit layout to secure balance and symmetry in push-pull amplifiers provision should be made for convenient electrical and mechanical connections.

Those factors concerned with the voltage ratings of the neutralizing capacitor and its associated parts are problems in high-voltage insulation at r-f in which a constant component of voltage may be present.

The spacing and radii of curvature of the parts exposed to air are largely determined by the total peak voltage involved. These voltages have been given in equations *1, 2, 3,* and *4* and their modifications mentioned fo high-level modulation.

The rating of the solid insulatio on the other hand may be influence greatly at the higher frequencie where uneven or excessive heatin due to the alternating component ma cause failure well below the spark over voltage. Equations *5* and *6* giv first the constant component and sec ond the crest value of the alternatin component of the voltages. The effec tive value of the tuned-plate circui voltage in high-level modulated ampli fiers depends upon the character o the modulation and has a maximun value of one and one-half times th unmodulated value.[11]

The importance of any one or com bination of the factors mentione depends upon the amplifier in whicl the neutralizing capacitors are to b used. For example the direct an stray capacitances will be greater i amplifiers built where space is at premium. Any capacitance unbalanc or dissymetry becomes more signifi cant in high-frequency amplifiers.

## CBC TRANSMITTERS

(*Continued from page* 65)

was a cathode follower circuit. This has the advantage of a low impedance driving the final class *B* stage as well as providing low audio-phase shift. Under certain operating conditions the grid characteristic of the 880 has a negative impedance resulting in a dynatron action taking place. This dynatron oscillation is damped out in this circuit by means of small rectifier tubes connected from grid to ground with a series resistor. The action of this circuit is to allow current to flow when the grid potentials are positive, the condition under which dynatroning occurs. This effectively provides a positive resistance in parallel with the negative resistance when required.

Three separate rectifiers are provided to supply plate power. The first provides 1500 volts from two 872A rectifiers. The second provides 5000 volts for the driver stage from a full-wave bridge rectifier using four 872A's. A final and modulator power supply provides 10,000 volts supplied by a three-phase full rectifier using six 857B's with a spare tube continuously heated up, capable of insertion when required to replace any of the six in use. A special overall hum-frequency feed-back amplifier is used to reduce noise at power line frequency.

The design and installation was further complicated by two extremely important problems, namely, grounding and shielding. Without paying particular attention to these two items, extreme difficulty can be expected from low-level audio stages picking up and rectifying power from the antennas, in extremely concentrated fields. The main principle involved in grounding was to be sure that all metallic parts of building and internal fittings were carefully grounded at one point only and that ground loops particularly were avoided. All low-level audio equipment in studio booths was protected from high radio fields by complete double shielding. This policy proved its worth in reduction of interference problems.

In the mechanical design and layout of equipment special precautions were taken to facilitate maintenance and to insure safety to equipment and personnel during operation. This is an extremely desirable feature as continuity of service is important and is only possible by easy access to all component parts. Safety to personnel and equipment is a fundamental prerequisite and requires careful design

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of control circuits and relays and grounding.

The transmitters may be started manually with individual switches or can be started automatically from a master switch through proper delay relays and contactors.

### *Studio and Program Methods*

To insure maximum flexibility at transmitter point, all program circuits from studios, recording room and transmitters are terminated in a master control position. This position is equipped with a six-channel pre-set type control console. Monitoring and testing facilities and an automatic telephone system were also provided. This permitted centralizing of supervision and co-ordination of all incoming programs. However, it was not practical to consider programing this station from Sackville where special linguists were required for various languages and countries to be covered. We therefore established a studio point at Montreal, 600 miles away, requiring 600-mile program circuits between studios and transmitters. This studio point consists of mainly three studios, and control rooms, recording room, master control and the necessary offices and facilities for the production staffs. Montreal was chosen as the



| Antenna System | Frequency (mc) | Bearing of Beam | Number of Horizontal Elements | Number of Vertical Stacks | Height of Lower Elements Above Ground (wavelengths) | Beam Width (degrees) | Beam Gain (in db) | Slewing Angle (degrees) | Vertical Radiation Angle (degrees) |
|---|---|---|---|---|---|---|---|---|---|
| European | 17 | N60°E | 4 | 4 | 1 | 35 | 21.5 | 10 ± | 7.5 |
| | 15 | N60°E | 4 | 4 | 1 | 35 | 21.5 | 10 ± | 7.5 |
| | 11 | N60°E | 4 | 4 | 1 | 35 | 21.5 | 10 ± | 7.5 |
| | 9 | N60°E | 4 | 4 | 1 | 35 | 21.5 | 10 ± | 7.5 |
| | 6 | N60°E | 4 | 3 | 1 | 35 | 19.5 | 10 ± | 9 |
| African | 15–17 | N97°E | 4 | 2 | 1 | 35 | 15.3 | 13 ± | 11 |
| | 9–11 | N97°E | 4 | 2 | 1 | 35 | 15.3 | 13 ± | 11 |
| | 6 | N97°E | 4 | 2 | ½ | 35 | 12.6 | 13 ± | 17.5 |
| South American | 15–17 | N171°E | 4 | 2 | 1 | 35 | 15.3 | 13 ± | 11 |
| | 9–11 | N171°E | 4 | 2 | 1 | 35 | 15.3 | 13 ± | 11 |
| | 6 | N171°E | 4 | 2 | ½ | 35 | 12.6 | 13 ± | 17.5 |

Figures 8 (above) and 9 (right)

Figure 8. A tabulation of the fundamental characteristics of all the antennas used at the CBC plant. Figure 9. At one of the control consoles.

ntre for this studio point because of
comopolitan nature and because of
program talent available.

### udio Construction

The three studios were constructed accordance with our standards for oustic performance. They are small, ended mainly for talk and announce dios. The control consoles are pro-ed with two microphone positions, ee turntable positions and four line sitions with the necessary monitor-r and cueing facilities. Several spe-l features are incorporated in this uipment for our specific needs such First, automatic starting of turn-les when turntable position key-itch is thrown on; second, remote ntrol of microphones by news an-uncers and station announcers.

### cording Room

In the recording room are installed ee double channels with provision expansion. These recorders are mposite units made to provide the gh performance needed. Installed in s room as well are two reference orders. These are low quality ma-nes using an embossing process on n. Their purpose is to keep an ac-rate record of everything trans-tted outside the country and are rticularly required to meet censor-p requirements.

### rformance

To provide good rebroadcast cover-e to any spot on the globe is cer-nly an ambitious aspiration. How-er, from our Sackville station we e to provide good service to sev-l continents, namely, Europe, South nerica and Africa, with somewhat erior service to the Antipodes.

Measurements made by the BBC on 15-mc transmission gave us aver-e signal strengths of 400 $\mu$v/m peak-500. This is an improvement of m 6 to 8 db over most other sta-ns, which is very worthwhile par-ularly in times of magnetic dis-bances.

### antitative Tests

Continuous quantitative tests have en made since our opening broadcast th more than satisfying results. gnal strengths have held up, pos-ly increased; conditions of fading ve improved and interference from ner stations and from atmospheric tic have been almost nil. On the mc band we have experienced a le interference from other stations. 235 hours of transmissions, 196 urs have been satisfactory for re-badcast quality in England.

## PULSE AMPLIFIER COUPLING

(*Continued from page* 58)

to have an overall low frequency response such that the frequency at which the response falls to 3 db below the mid-frequency response is

$$f_o = \frac{1}{2\pi X T}$$

In the preceding example and with a repetition rate of 5,000-pulses per second, the low frequency half power point ($f_o$) is 400 cps.

### Sinusoidal Frequency Response

The foregoing procedure may be reversed and used to find the sinusoidal frequency response of a given amplifier. We note, however, that the method must assume that the low-frequency response is affected only by resistance capacity networks as of Figure 1. The effect of cathode- and screed-grid circuits may be neglected if sufficient bypassing has been used.

### Applying Method

The method consists of applying a symmetrical square wave ($T_1 = T_2$) of variable frequency to the input of the amplifier. The output is observed on an oscillograph which is known to have good low frequency pulse response. The square-wave frequency is then varied until the tops of the output pulses decay by a measurable amount, such as 10%. The factor $X$ is then equal to 0.1. Furthermore, the width of the pulse $T$ is equal to 1/2F, where $F$ is the square wave frequency. Hence,

$$f_o = \frac{1}{0.4\pi F}$$

The response of the amplifier at any other frequency, $f$, within the low frequency region may be obtained from the relation

$$\text{relative gain} = \cos \tan^{-1} \frac{f_o}{f}$$

The phase shift at the frequency, $f$, may also be obtained from the relation

$$\tan\theta = \frac{f_o}{f}$$

The advantage of this method is that only one measurement is necessary, whereas a determination of amplifier frequency response by means of applying sinusoidal input requires measurements at several frequencies.

## [T]RANSMISSION LINES

(*Continued from page* 67)

in rectangular coordinates

$$u + jv = 1.93 + j\,.518.$$

Figure 2 this value corresponds to

$$\alpha + j\beta = .515 + j\,80.5\,n\ (180^\circ)$$

ually the length of the line in wave-gths is known approximately; for given line it is between one-half one full wavelength. Thus the uired value of β is

$$180^\circ + 80.5^\circ = 260.5^\circ$$

The curves for the charts were de-ed from the formula for tanh $(\alpha + j\beta)$ $(\sinh\alpha\cosh\alpha + j\sin\beta\cos\beta)/$ $sh^2\alpha\cos^2\beta + \sinh^2\alpha\sin^2\beta) =$ jv. From this equation it can be wn by an involved process that the ation for a curve of constant value α, Figure 3, is $(u - 1/\tanh 2\alpha)^2 + v^2$ $1/\sinh\alpha)^2$. This is the equation of ircle in rectangular coordinates in ich the abscissa for the center, $= \coth 2\alpha$, and the radius, $= 1/\sinh 2\alpha$. Similarly, the equa-n for the curve of constant value of $u^2 + (v + \cot 2\beta)^2 = (1/\sin 2\beta)^2$ ich is also the equation of a circle which the ordinate for the center, $= -\cot 2\beta$ and the radius $R_0$ $/\sin 2\beta$. Since coth $(\alpha + j\beta)$ is al to tanh $[\alpha + j(\beta + 90^\circ)]$, the h function can also be represented the same curves.

### [Plo]tting Similar Curves

Similar curves can be readily plotted m the equations given, by using es of values of real hyperbolic and ular trigonometric functions avail-e in many handbooks. Problems ch do not fall within the ranges wn by these charts can be solved by rts drawn for special ranges as re-red.

The curves of Figures 1 and 2 are e similar to those of line impedance sus the standing wave ratio, Q, wavelength.[1] The curves of angu-values β are similar to the curves φ and for low values of α, the con-nt α curves nearly coincide with the curves when these are given in ues of $1/Q$.

### [Ref]erences


Robert C. Paine, *Graphical Solu-n of Voltage and Current Distribu-n and Impedance of Tranmission es,* IRE Proc., pp. 686-695; Nov. 4.

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. C. Slater, *Microwave Transmis-n*; McGraw Hill Book Co.

# NEWS BRIEFS

## PROGRAM FOR THE 1945 ROCHESTER FALL MEETING

**[RMA Eng. Dept. and the IRE]**

*The Sheraton Hotel*
*Rochester, New York*
*November 12 and 13, 1945*

### MONDAY, NOVEMBER 12

*9:30 A.M.* Technical Session (W. L. Everitt presiding)
*A Coaxial Modification of the Butterfly Circuit;* E. E. Gross, General Radio Company
*The Radio Proximity Fuze;* H. Trotter, Jr., Eastman Kodak Co.
*Proximity Fuze Tubes;* R. M. Wise, Sylvania Electric Products, Inc.

*2:00 P.M.* Technical Session (J. E. Brown presiding)
*Microwave Radar;* Donald G. Fink, McGraw-Hill
*High Quality Sound Recording on Magnetic Wire;* L. C. Holmes, Stromberg-Carlson Company

*8:15 P.M.* General Session (George Town presiding)
*The Aurora and Geomagnetism;* C. W. Gartlein, Department of Physics, Cornell University

### TUESDAY, NOVEMBER 13

*9:30 A.M.* Technical Session (R. A. Hackbush presiding)
*Recent Developments in Converter Tubes;* W. A. Harris and R. F. Dunn, RCA.
*Industry Standardization Work in Television;* D. B. Smith, Philco Corporation
*War Influence on Acoustic Trends;* Hugh S. Knowles, Jensen Radio Manufacturing Company
*Germanium Crystals;* Edward Cornelius, Sylvania Electric Products, Inc.

*2:00 P.M.* Technical Session (L. M. Clement presiding)
*Television—A Review of Technical Status;* E. W. Engstrom, RCA Laboratories
*Comments on Existing Television Systems from a Measurement Viewpoint;* Jerry Minter, Measurements Corp.

*6:30 P.M.* Stag Banquet (R. M. Brophy, toastmaster)
*The Future of Radar;* L. A. DuBridge, Radiation Laboratory, Massachusetts Institute of Technology

* * *

## RCA TO CONDUCT WIDE-BAND TESTS

RCA has received FCC construction permits and licenses for four new experimental class 2 portable stations to develop and test a system of wide-band, multi-channel radiocommunication, and to conduct other related experimental operations. In addition to observation on equipment performance, propagation on s-h-f will be studied under actual operating conditions. Analyses will cover horizon and beyond horizon transmission path capabilities, diurnal, atmospheric and other influences on the communication ranges; characteristics during magnetic disturbances and lightning storms; seasonal variations in propagation wi particular reference to refraction effects.

The terminal stations will be located initial on the Market Street National Bank Buildi in Philadelphia, Pa., or on top of the RC building in Camden, N. J.; and on the Co tinental Bank Building, 30 Broad Street, Ne York City. The intermediate relay statio will be located in Bordentown, N. J., and Te mile Run, N. J.

* * *

## UNIVERSITY OF CHICAGO TO RUN STRATOSPHERE F-M TESTS

The University of Chicago Cosmic Ray Labor tory has received a license for an experiment f-m portable mobile station aboard a free balloo within a 350-mile radius of Chicago. The co posite type transmitter will be installed on free balloon to obtain scientific information r garding the nature of penetrating radiatio in the stratosphere.

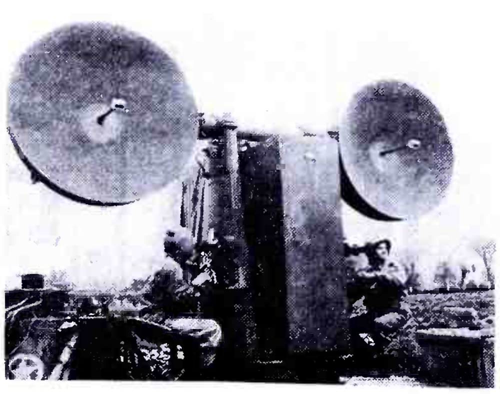
* * *

## UNITED AIR LINES TO SPEND MILLIONS FOR AERO COMMUNICATIONS AIDS

United Air Lines will spend approximate $10,000,000 for the purchase, development a



## RADAR IN NEW HEBRIDES AND ITALY



Radar near an anti-aircraft emplacement at Magnano, Italy.

A radar installation in a sandbagged revetme on Espiritu Santos, New Hebrides. Unit sho at left and above was known as the *Mick Mouse* because of the shape of its antennas.

*(Photos courtesy U. S. Signal Corps.)*

aptation of a variety of aeronautical communications aids.

Developments proposed include airway traffic monitors, operating on the radar principle; automatic position recorders; radio-impulse devices; automatic landing devices; facsimile, etc.

* * *

### CKSTEIN JOINS ECHOPHONE

ul H. Eckstein has been appointed sales manager of the Echophone division of Hallicrafters.

Mr. Eckstein was formerly with Westinghouse Electric as assistant sales manager of radio receiver division.

* * *

### J. LARKIN NOW NATIONAL D. ENG. MANAGER

lliam J. Larkin has been named engineering manager of the National Radio Company, Mal-, Mass.

Mr. Larkin was formerly chief mechanical ineer.

* * *

### OMMUNICATION PARTS EXPANDS

mmunication Parts has moved to a new nt at 1101 North Paulina Street, Chicago.

* * *

### E WINTER MEETING IN JAN. 1946

Institute of Radio Engineers will hold its ual winter technical meeting at the As- Hotel in New York, January 23 to 26, 1946. ward J. Content is chairman of the meeting mittee.

ustin Bailey, Howard Frazier, William B. ge, Stuart L. Bailey, George W. Bailey and abeth Lehmann have been appointed general committeemen.

ub-committee chairmen in charge of various vities are: Frank Marx, arrangements; C. Lewis, banquet; H. F. Scarr, exhibits; mond F. Guy, finance; Will Whitmore, licity; A. E. Harrison, papers; Dorman D. sel, printed program; Harold P. Westman, stration; Don H. Miller, special features; rge B. Hoadley, sections committee activi- and William H. Crew, technical committee activities.

* * *

### RMAN ELECTED EM CHAIRMAN

. Berman, general sales manager of Shure thers, Chicago, was elected chairman of Association of Electronic Parts and Equipt Manufacturers recently.

y S. Laird, vice president of Ohmite Mfg. was elected vice chairman, and H. A.

(*Continued on page* 95)

•

### ANTI-FUNGUS TREATMENT

ting a chassis with a lacquer containing a ted fungicide at the RCA plant in Camden.

# RADIO PROXIMITY FUZE

(*Continued from page 47*)

the nose was achieved. In the anti-aircraft shell and rocket applications it was necessary to study the sensitivity problem carefully so that the fuzes could function reliably against aircraft for values up to 70'; thus the aircraft's area of activity could be magnified and the chance of hitting enemy aircraft increased several fold.

VT fuzes were produced for use on bombs, shells, rockets, and were in production for mortar shells as the war ended.

The developments were started by the O. S. R. D. on its own account and at the independent request of the Army and Navy. The work was divided, because of different technical problems, into fuzes of two classifications; those which would be applied to bombs and rockets (non-rotating projectiles) and those for shells (rotating projectiles). The nerve centers of these two development programs were located, respectively, at the Applied Physics Laboratory, Johns Hopkins University and the National Bureau of Standards. On the part of the services, the Bureau of Ordnance, Navy Department, was the responsible organization for the Navy project, charged with monitoring the developmental program and producing the fuzes for distribution to all services; the Office, Chief of Ordnance, and the Office, Chief Signal Officer, operated similarly for the Army.

While the basic principle of the fuze was quite simple as already shown, the technical problems were enormous. Special sub-miniature tubes were developed which were capable of withstanding the terrific acceleration of being fired from a gun or mortar and microphonically stable enough to function properly in the presence of strong vibration set up by the rotating generator and the projectile screaming through the air at supersonic velocity. Miniature components were developed and the whole assembly continually reduced in size. The mortar fuze, smallest of the family, could be placed inside an ordinary half-pint cream bottle with almost an inch to spare in length.

The problem of power supply was a serious one. In the shell fuze a special storage battery had to be developed. The electrolyte was provided by a capsule which broke when the projectile was fired. The electrolyte was distributed by the rotation of the shell in flight.

To meet the wider temperature requirements for air-borne rockets and bombs needed by the Army and Navy arms a



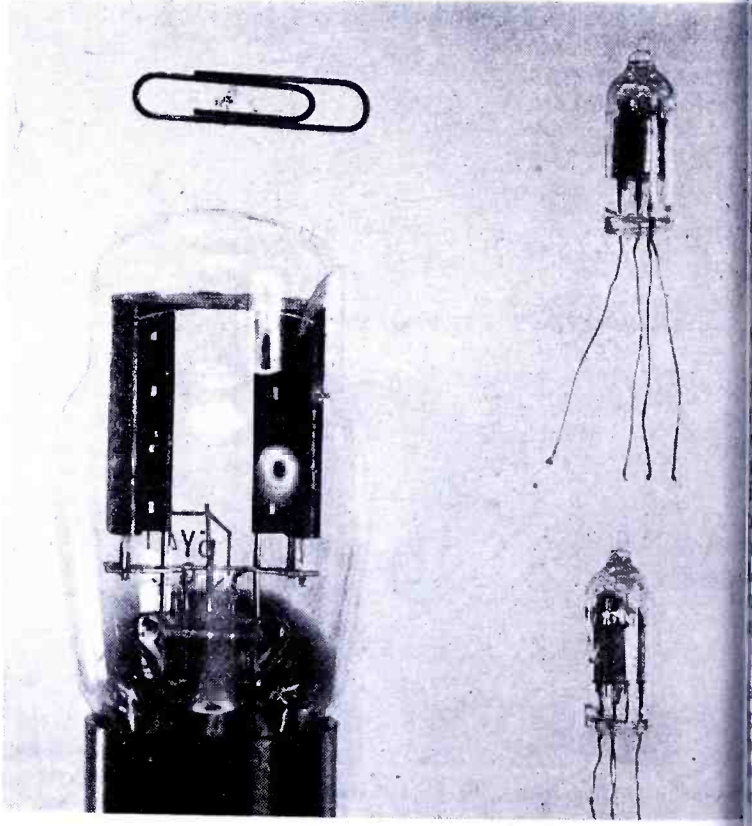


**Figure 10**
**Comparison of radio tubes used in VT fuze with standard radio tube.**

(*Courtesy National Bureau of Standards*)

wind-driven generator was developed.
s was powered by the air stream
und the projectile and ran at the tre-
dous speed of 30,000 to 40,000 rpm.
generator turned out to be more com-
t than a battery and was used to power
fuze for the tiny 81-mm mortar shell.
well as for rocket and bomb fuzes.

he enemy was by no means unaware
the utility of such a device and the
y of his efforts to produce similar
es is interesting and enlightening.

ince the end of hostilities we have
ned that the Germans were trying to
e fuzes working on identical princi-
. In fact the start was made nearly
years before our own and yet a suc-
ful model was never achieved for com-
use.

he enemy made the serious mistake of
great diversification of effort. At one
e the Nazis were working on forty
erent methods of getting proximity
es. Each project was given to a small
up and knowledge of the other similar
vities or results was rigidly restricted.
le progress was made on any of these
elopments.

he initial military successes of the
hrmacht led to a second great mistake;
thought the war was won and all de-
opment was curtailed. Our growing
power convinced them of this error and
ve development was resumed on some
lve methods involving radio, sound,
t, light and electrostatic fields. The
gram was still diversified and com-
tmentalized.

s if this were not enough another
nder was made. The Nazi engineers
e convinced that it was impossible
build a vacuum tube that would with-
nd 20,000 G and still operate normally.
nsequently, their projects for shell
es did not stress the radio method,
they never tackled a fuze for the tiny
rtar.

n contrast the engineers and physicists
his country spent a short time of care-
preliminary experimentation on the
ious possible methods including many
those tried by the enemy. They dis-
ded all but two, the photoelectric and
io types, and concentrated on those.
er a short period of intense competi-
n, the radio device proved superior and
activity was devoted to it.

When the enemy finally felt the impact
these new fuzes, he was working on so
ny types, not including the one that hit
n, that there was great confusion as to
w the American unit was made. There
as yet no clear evidence that he suc-
ded in completely unravelling the mys-
y.

On our own side, after about two years
intensive effort, backed by the tre-
ndous technical experience of our own
ustry with its vacuum-tube production
acity, fuzes were in production and
ilable. The fear of giving the infor-
tion to the enemy for use against our
craft kept the use of the fuzes confined
Naval activities on the high seas, until
later stages of the war when it became
ar that even if the enemy had the in-
mation, he would not have time to
it.

Large stock piles were built up in the
ious over-seas theatres of combat
inst the day when a general release of
fuze secret would be made. The first
of VT fuzes *over land* resulted when
i-aircraft types were employed in the

(*Continued on page* 94)

# RADIO PROXIMITY FUZE

(*Continued from page 93*)

defense of London against the buzz-bombs. This operation, however, was carried out in secret to protect our allied air offensive. The general release for all types of VT fuzes was finally set for Christmas Day, 1944. By this time sufficient quantities of fuzes were available just behind the front lines to allow their employment to continue after it had once started. The Germans, however, began their Ardennes offensive on the 15th of December and the fuzes were immediately released for the Battle of the Bulge.

### Increased Use of Fuzes

Employment of VT fuzes then spread rapidly to all theatres of combat throughout the world. Reports have flooded into Washington of the uniformly successful results. Right up to VJ-Day, VT fuzes were used in enormous quantities by tactical and strategic bombers, by assault fighters firing rockets, by anti-aircraft and artillery gunners and by the fighter-bombers of the carrier fleets.

### VT-Fuze Production

The quantities of VT fuzes employed in combat continually increased throughout this period, and since no definite end of the war could be predicted, production of all types of VT fuzes kept pace with the mounting usage. At the conclusion of the war almost one-third of the radio industry was engaged in the production of VT fuzes.

### Credits


COMMUNICATIONS acknowledges the assistance of the following members of the *VT Fuze Team* in preparing this paper:

Army: Captain J. F. Teas

Navy: Lieutenant Neil Dilley

National Bureau of Standards: Mr. Harry Diamond, Dr. Cledo Brunetti, Dr. Robert Huntoon

Johns Hopkins University—Applied Physics Laboratory: Dr. Allen Hynek



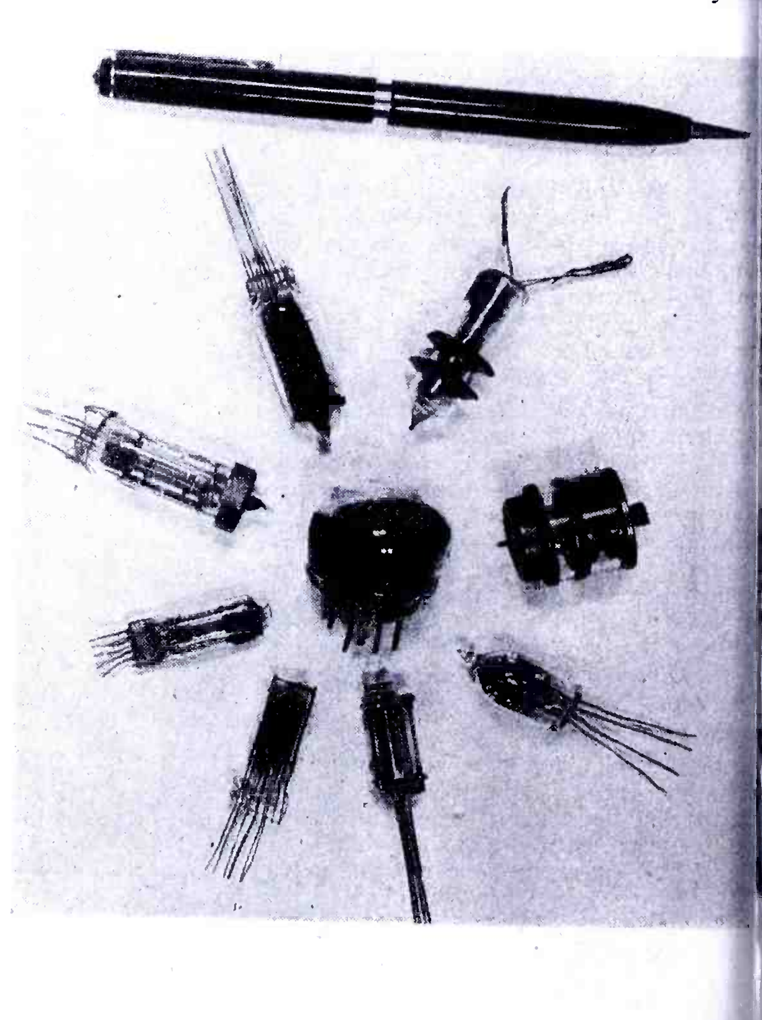



**Figure 11**
Display of tiny radio tubes used in production of VT fuze.
(*Official Navy photo*)

## NEWS BRIEFS

(*Continued from page* 91)

Staniland, treasurer of Quam-Nichols Co., was amed treasurer.

J. A. Berman

* * *

### MAJOR F. D. LANGSTROTH NOW CHIEF OF ELECTRON TUBE STAFF

lajor Frank D. Langstroth has been named hief of the Electron Tube Staff of the Army lectronics Standards Agency.

He was formerly a commercial engineer for ie radio division of Sylvania.

* * *

### IEELY ENTERPRISES EXPANDS

Iorman B. Neely Enterprises have moved to a ew building at 7442 Melrose Avenue, Hollyood, California. The company represents Iewlett-Packard Company, Kaar Engineering ompany, Presto Recording Corporation, Radio ngineering Laboratories, Inc., Sensitive Rearch Instrument Company and the Webster lectric Company.

* * *

### IORHAN TO EXPORT OR MARION INSTRUMENT

orhan Exporting Company, 458 Broadway, ew York City, have been appointed excluve export agents to all countries in the orld, except Canada, for Marion Electrical strument Company, Manchester, New Hampire.

* * *

### R. McELROY TO DISTRIBUTE ALLICRAFTERS SETS IN BOSTON

R. McElroy, president of the McElroy anufacturing Company, 82 Brookline Avenue,

(*Continued on page* 96)

### G.E. ELECTRONICS PARK

odel of $10,000,000 electronics park planned by G.E. for the Syracuse, N. Y., area.

# NEWS BRIEFS

(*Continued from page* 95)

Boston, has opened a distributor unit in Boston to sell Hallicrafters equipment.

* * *

### BUSES INSTALL G.E. F-M UNITS

The Washington, Virginia and Maryland Coach Company recently installed a G.E. two-way f-m system on one of their buses to test its effectiveness in improving bus service and in public emergencies. Tests will be conducted between the bus operator and the company's headquarters in Arlington, Va.


* * *

### BROOKLYN POLY E.E. PROGRAM TO FEATURE S-H-F STUDY

The Polytechnic Institute of Brooklyn, N. Y., has revised its electrical engineering curriculum to include a series of courses on microwave techniques, based on wartime developments.

The revised curriculum will include recent developments in ultrahigh frequencies in their application to f-m and television, theory and design of antennas, and electron optics covering the design of electron focusing systems.

* * *

### FARNSWORTH OFFICERS REELECTED

E. A. Nicholas was reelected president of the Farnsworth Television & Radio Corporation, Fort Wayne, Ind., at a meeting held recently. Other officers reelected include: E. H. Vogel, vice president in charge of sales; Edwin M. Martin, vice president and secretary; B. Ray Cummings, vice president in charge of engineering; J. P. Rogers, vice president and treasurer; Paul H. Hartmann, assistant treasurer, and Fred A. Barr, assistant secretary.

Philo T. Farnsworth has resigned as a vice president but will continue as a director. He will also continue his research work for Farnsworth at his laboratory in Fryeburg, Me.

* * *

### CRYSTAL RESEARCH LAB CATALOG

An 8-page catalog covering crystal development activities and products has been released by the Crystal Research Laboratories, Inc., 29 Allyn Street, Hartford 3, Connecticut.

Illustrations and descriptions of different types of crystals manufactured are presented. Shown, too, are the various steps involved in production of the raw quartz to the finished crystal.

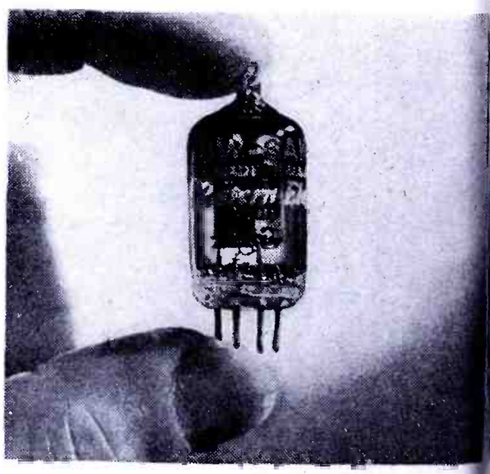
* * *

### J. M. LANG NOW G.E. KEN-RAD DIVISION MANAGER

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

●

### MINIATURE PENTODE



Tiny W. E. 6AK5 pentode, 1½" high and ¾" in diameter developed for h-f application.

ent, with headquarters at Owensboro, Ky. Lang will be in charge of the operations E. Ken-Rad plants in Owensboro, Ky., untingburg, Ind. He will also be respon- or the management of government-owned tube plants at Bowling Green, Ky., and ity, Ind.

Lang succeeds C. J. Hollatz, who has be- consultant.

* * *

### . COLEMAN BECOMES ASST. CTOR OF RCA VICTOR NEERING DIV.

Coleman has been appointed assistant di- of engineering for the RCA Victor divi-

C. Batsel has succeeded Mr. Coleman as ngineer of engineering products.

Coleman will make his headquarters at n, N. J.

Batsel was formerly chief engineer at Victor, Indianapolis, Ind.

* * *

### . BALCOM APPOINTED JUDGE

F. Balcom, vice president and treasurer vania Electric Products, Inc., has been ted Associate Judge of Cameron County lso president of the Emporium Trust ny, filling two vacancies caused by the of B. G. Erskine, chairman of the board ne of the founders of Sylvania.

* * *

### D MOVES TO TELEVISION FREQUENCY

nt television station WABD has begun vamp their transmitter and shift from r channel 4 (78 to 84 mc) to new channel to 82 mc). Permission for the move was d recently by the FCC.

* * *

### RELAY EXHIBIT AT NKLIN INSTITUTE

s and timers produced by Struthers- Inc., Philadelphia, were presented in lustrial exhibit staged under the auspices Franklin Institute.

exhibit portrayed the development of for both wartime and peace uses.

* * *

### L KUCH OPENS AD OFFICE

L. Kuch, former advertising and sales tion manager of Aerovox Corporation, pened an advertising and sales office at lympia Building, New Bedford, Mass.

* * *

### EL AUTO-ANTENNA DATA

age folder describing cowl-and-fender-type ntennas has been released by Radel Man- uring Company, 6300 Euclid Avenue, and 3, Ohio.

* * *

### SHOCK HAZARD BOOKLET

page booklet entitled *Measurement of ic Shock Hazard in Radio Equipment* t. Karl S. Geiges, U.S.N.R., has been hed by the Underwriters Laboratories, 161 Sixth Avenue, N. Y. 13, N. Y. pared while the author was an associate er at the laboratories, the discussion

(*Continued on page* 98)

●

### RANSMITTER STUDY BY NAVY STUDENTS

students of Iowa State College studying s transmitters during a recent tour of the plant.

## NEWS BRIEFS

(*Continued from page 97*)

covers: Electric shock hazard (threshol perception, *let-go* currents, fatal currents, l of measurement); body resistance; shock ards (chassis, external circuit connec vacuum tubes); methods of measuring hazard (electrodynamometer instrument, mocouple instrument, rectifier instrument, uum-tube voltmeter); development of uring equipment (diode-peak meter, ac-c d-c measurements, open circuit voltage urement); specifications (voltage of circuit, circuit potentials, leakage current).

* * *

### CAPT. NEISLAR RETURNS TO MAGNAVOX

Captain Jerre Neislar has returned to Magnavox Company as sales representati the southwestern district.

During his Army Air Force service, Ca Neislar was Commanding Officer of an base squadron in the South Pacific, an the procurement section of the Army Te cal Service Command at Wright Field.

* * *

### C. J. HOLLATZ JOINS RAYTHEON

Carl J. Hollatz, former manager of the E Rad division of G.E., has joined Rayth Manufacturing Co. in an executive capacit

* * *

### BOUCHERON RETURNS TO FARNSWORTH

Captain Pierre H. Boucheron, USNR, has b appointed director of public relations for Farnsworth Television & Radio Corporat Fort Wayne, Indiana.

Before being called to active duty in 19 Captain Boucheron was sales manager.

* * *

### HYTRON CATALOG

An 8-page catalog with data on transmitt and special-purpose-tubes has been publish by Hytron Radio and Electronics Corp., Lafayette Street, Salem, Mass. Discussed u-h-f triodes, pentodes, r-f beam tetrod

●

### AT NEW HALLICRAFTERS SITE

**William J. Halligan, president of Hallicraft at steam shovel controls on the new site Hallicrafters at Kostner and 5th Avenue, Chic J. J. Frendreis, secretary and treasurer, at ri**

acorns, rectifiers and voltage rectifiers. A rating and operations chart and a group of base diagrams are also offered.

* * *

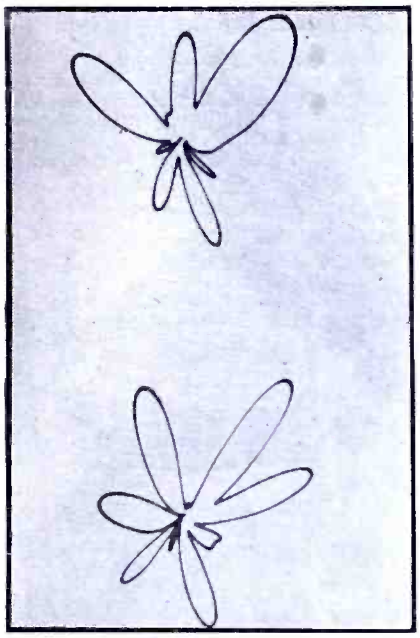
### BENDIX ANTENNA AND COMPASS BULLETINS

An 8-page bulletin describing the MN-31 automatic radio compass and a 4-page bulletin covering the MS-105A v-h-f broad band antenna, have been released by Bendix Radio, Baltimore 4, Maryland. Both bulletins offer construction and performance data.

•

### AUTOMATIC ANTENNA ANALYZER

Above, electronic antenna-tower position computing device, the *Antennalyzer*, developed at RCA Laboratories. Below, radiation pattern equation expressed in terms of polar coordinates. The *Antennalyzer* changes the resultant graph from rectangular to polar coordinates by the flip of a switch.



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### SOUND-PROOFED POLICE RADIO ROOM

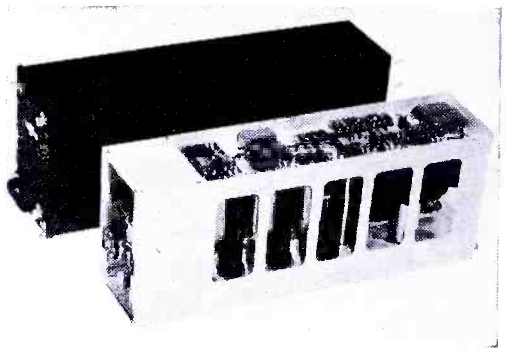
Interior of the sound-proofed 14' x 14' x 9½' high radio operations room, using Fiberglas acoustical board on the walls and ceiling, at police headquarters, Newark, Ohio.

# THE INDUSTRY OFFERS . . . —

### COLLINS AIRCRAFT COMMUNICATIONS RECEIVER

A crystal-controlled, light-weight aircraft communications receiver, 51K-1, using the autotune for selecting channels has been developed by the Collins Radio Company, Cedar Rapids, Iowa.

Receiver offers ten preselected frequencies for reception anywhere within the range of 2.4 to 18 megacycles. The maximum time required for the autotune to change channels is said to be 2 seconds. Fits into ½ ATR unit, and weighs less than 20 pounds. Operates from a 24-volt d-c source; 12-volt model optional.



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### TRIPLETT TUBE TESTER

A tube tester offering tube-value tests, short and open element tests and a transconductance comparison check for matching tubes, has been announced by The Triplett Electrical Instrument Co., Bluffton, Ohio.

Features three-position lever switching, and multi-color scale.

Size, 10" x 10" x 5¾".

* * *

### FTR SEALED-IN-GLASS SELENIUM RECTIFIERS AND IRON-CORE MAGNETIC COMPONENTS

High-voltage selenium rectifier stacks, hermetically sealed in cartridge-fuse type glass, have been developed by Federal Telephone and Radio Corporation, 200 Mount Pleasant Avenue, Newark 2, New Jersey.

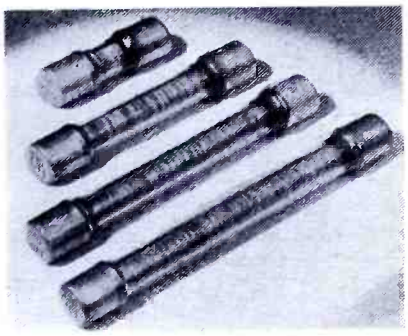
Contact is made through small heavy silver-plated ferrules at each end of the glass tube; ferrules permit mounting in 30-ampere fuse clips, unpolarized or polarized.

Especially designed for operation in high ambient temperatures. Rectifiers are available in several tube lengths and in various voltages up to 4,000.

Iron core magnetic components, custom built to meet specific requirements, have also been announced by Federal Telephone and Radio Corporation.

Available with power ratings ranging from milliwatts to kilowatts. Components can be provided in any of the basic types of construction—open, frame, semi-enclosed, enclosed and hermetically sealed. Various terminal types can be supplied, including standard nut-fasteners and solder-type binding posts with porcelain bases.

Hermetically-sealed units utilize either compression bushings on porcelain bases, or glass-to-metal fusion seals in one piece covers.



FTR Selenium Rectifiers

* * *

### EIMAC TETRODES

Tetrodes with a maximum plate dissipation rating of 250 watts, type 4-250A, have been announced by Eitel-McCullough, Inc., San Bruno, California.

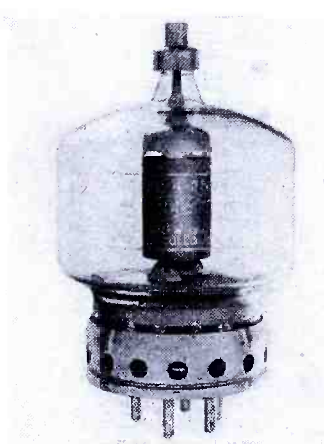
Preliminary class-C amplifier data indicates that at 3,000 plate volts a single 4-250A provides a power output of 650 watts with a driving power of less than 3 watts. Eimac engineers state that low grid-plate capacitance (.11 mmfd) eliminates neutralization below 40 mc.

Filament (thoriated tungsten) voltage, 5.0; current, 14.5 amperes.

Direct interelectrode capacitances (average): Grid-plate, .11 mmfd; input, 12.7 mmfd; output, 4.6 mmfd.

Maximum plate current, 350 ma.

Base, 5-pin metal shell; length, 6.38"; diameter, 3.56".



### DIAL LOCKS

Dial locks especially applicable for use on mobile equipment to accurately maintain tuning adjustments, are now available from The Radio Craftsmen, 1341-3 South Michigan Avenue, Chicago 5, Illinois.

Accommodates a wide range of dial thicknesses. Made of 21-gage spring brass, nickel plated.

* * *

### ALDEN TELEVISION-TUBE CONNECTOR

A television tube connector, 208FTSC, permitting leads to be brought off the side of the

(Continued on page 102)

DIALCO FOR POST-WAR PILOT LIGHTS

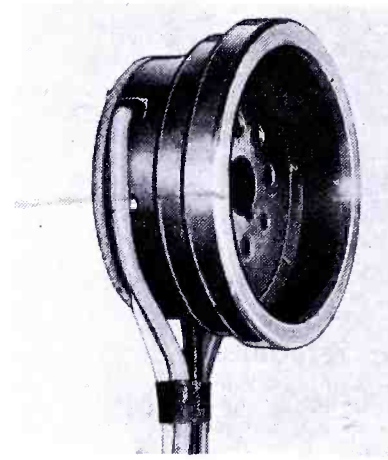


# THE INDUSTRY OFFERS . . . —

(*Continued from page* 101)

connector at any point has been developed by Alden Products Company, 117 North Main Street, Brockton 64, Massachusetts.

Provision has been made for a long leakage path between contacts, strain relief on the leads and a skirt to prevent possibility of touching the pronts of the tube while they are *hot*.



* * *

## ANDREW FOLDED UNIPOLE ANTENNAS

Folded unipole antennas for transmitting and receiving from 30 to 40 mc and for powers up to 5,000 watts, have been designed by Andrew Company, 363 E. 75th Street, Chicago 19, Illinois.

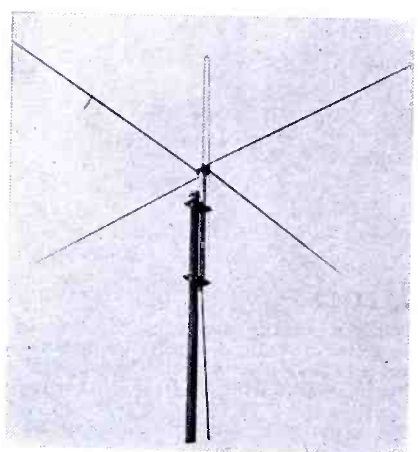
*Slide-trombone* calibration is said to permit adjustment for any frequency between 30 and 40 mc, using only a wrench. Provides a non-reactive impedance with a resistive component varying between 62 and 75 ohms.

Andrew engineers say that there is no standing wave on the line with this antenna.

Bandwidth is said to be never less than 400-kc wide for a standing wave ratio of 1.2 : 1.

May be used with 70-ohm coaxial cable, solid dielectric or beaded, up to 7/8" diameter.

Lightning hazard said to be minimized by grounded vertical element. Weight, 15 pounds.



* * *

## RADIO RECEPTOR COMPANY SELENIUM RECTIFIERS

Selenium rectifiers featuring aluminum plates and hermetical sealing have been announced by

Receptor Company, Inc., 251 West 19th
, New York City.
s offered have capacities of from 25 mils
hundreds of amperes.

* * *

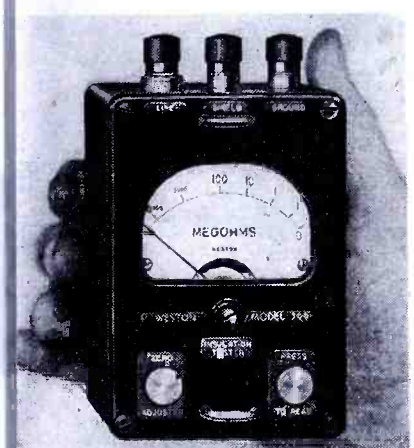
### NER PLASTIC MICROPHONES

pse acetate plastic housings, in a variety
ors, for crystal and dynamic microphones,
been announced by the Turner Company,
Rapids, Iowa.
ies will be known as *Colortone;* first allot-
will be made in orange, green, yellow and
r.

* * *

### TON DIRECT-READING ULATION TESTER

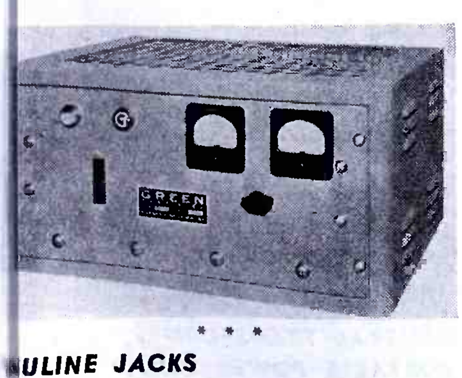
t-reading insulation-measuring instruments,
799, affording a single range for .1 to 10,000
hms, with the 10,000 mark at 8% of the
length, have been produced by Weston
ical Instrument Corporation, 617 Freling-
n Avenue, Newark 5, New Jersey.
circuit has a test potential of less than
ts d-c. An electrical guard circuit is pro-
for elimination of surface leakages when
g cables.
, 5⅝" x 3¼" x 4⅞".




* * *

### EEN STABILIZED RECTIFIERS

lized rectifier units, TRX, have been de-
ed by the W. Green Electric Co., Inc., 130
Street, New York City.
en engineers say that the load current
be varied between zero and maximum at
lemand frequency, with negligible variation
rminal voltage.
er features include non-resonant filter, op-
l output ranges—110-120, 150-160 volts, mod-
r 1-, 2-, 4- and 7-ampere capacity.




* * *

### ULINE JACKS

eries of midget-sized jacks have been de-
(*Continued on page* 104)

# THE INDUSTRY OFFERS . . .

(*Continued from page* 103)

signed by the Insuline Corporation of America.

There are three models: Single closed-circuit, single open-circuit, and a three-way microphone type.

Features incorporated include arched spring members and interlocked component parts.

* * *

### REINER VACUUM-TUBE VOLTMETER AND AMPLIFIER

A vacuum-tube voltmeter, 451, and amplifier, 101, offering 25 millivolts a-c on the lowest range, 1,000 volts on the highest range, 10 cps to 700 mc frequency range, and a 7-mmfd input capacity has been announced by Reiner Electronics Co., Inc., 152 West 25th Street, New York 1, N. Y.

Ranges: A-c volts, 0-.025-.1-.25, (with amplifier) . . . 2.5-10-25-100-250-1,000; d-c volts, 0-2.5-10-25-100-250-1,000; d-c current, 0-2.5-10-25-100-250-1,000 ma; ohms, 1 ohm to 1,000 megohms; a-c frequency range, 10 to 5,000 cps, (with amplifier) 50 cps to 700 megacycles. D-c volt, ohm and current accuracy said to be 2% on full scale. A-c volt accuracy said to be 2% for 50 cps to 50 mc; a-c frequency, entire range accuracy, said to be 5%. Weight, 20 pounds. Size, 10¾" x 9" x 8".

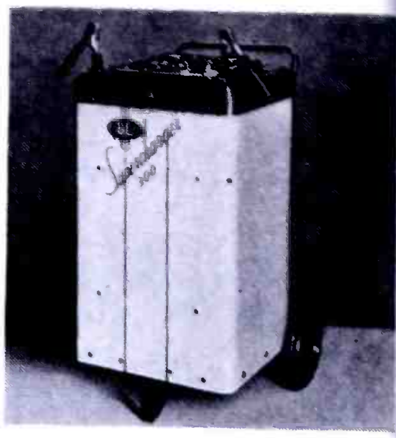
* * *

### B-L BATTERY CHARGERS

Battery chargers, *Fast Battery Superchargers*, providing charging in about 20 minutes, have been announced by the Benwood-Linze Company, St. Louis.

Overload circuit breakers on d-c lines protect the charger from excessive power loads as a result of shortages or defects in the batteries being charged. Conversion from the a-c source to d-c for charging is obtained by a B-L selenium rectifier.

Weight, 130 pounds. Two chargers are available . . . one to operate from 100-valt, 60-c a-c; the other from 220-volt, 60-cycle a-c.



* * *

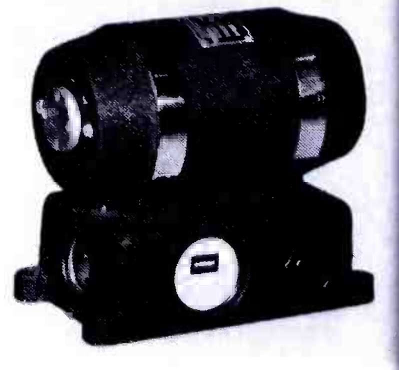
### CARTER FREQUENCY CONTROLLED CONVERTERS

Frequency-controlled d-c to a-c rotary c verters have been developed by Carter M Company, 1608 Milwaukee Avenue, Chic Illinois.

Designed with the frequency control in base and a vibration reed-type meter to v ally indicate the frequency of the output.

In 110-120-volt d-c to 117-volt a-c models, o put can be controlled within ±10 volts at cycles, over ±10-volt d-c fluctuation.

Models can be supplied with input volta ranging from 6 through 64 for battery conv sion and also 110-120 volts d-c for line c version. Wattage ranges are from 40 thro 250, continuous duty.



* * *

### NATIONAL UNION IONIZATION GAGE

A high-vacuum ionization gage has been veloped by the research laboratories of Natio Union Radio Corporation, 15 Washington Str Newark 2, New Jersey.

The gage, NU-R1038, is said to be capable recording pressures below one billionth of atmosphere.

The sensitivity is said to be 1 microamp per 1.0 × $10^{-5}$ mms of mercury; conversion f tor is 10.

The tubes are equipped with flexible leads connection to the ionization gage circuit wh may be any one of a number of standard form

Filament voltage, 3; filament current, 2 a peres; ion collector voltage, —13; shield pote tial, —13; electron collector voltage, 200; el tron collector current, 20 ma.

Overall length (not including leads), appro mately 5"; length of bulb (not including exha tube), approximately 3"; length of exhaust tu approximately 2"; bulb style, T-11; maxim diameter, approximately 1⁷⁄₁₆"; length of lea (flexible), approximately 2".

The gage may be cleaned up for the measu ment of high vacuua either by electron bo bardment from the filament or by inducti heating of the plates. The first of these me ods is useful initially since it serves not only degas the gage parts but also to activate t filament. It is recommended that the bombar ing voltage be in the region between 300 a 400 which will give approximately 30 watts p plate, heating them red hot.

* * *

### GENERAL TRANSFORMER PORTABLE POWER UNITS

Portable power supplies for 4-, 5-, or 6-tube 1½-volt battery farm or portables, operating of 105-125-volt, 50-60-cycle lines, have been announced by General Transformer Corporation, 1250 West Van Buren Street, Chicago 7, Illinois.

Provides *A* . . . 1.5 at 200 ma, 1.35 v at 250 ma, 1.55 v at 300 ma, and 1.35 at 350 ma; *B* . . 90 v at 13 ma, and 101 v at 8.5 ma.

Two-section *A* filter, composed of three high-capacity capacitors, and two oversized iron core chokes; *B* filter has two high-capacity capacitors and an oversized choke.

Universal sockets for battery plugs.

Size, 2⅛" x 4½" x 6¾"; shipping weight, 5 pounds.

* * *

### RADIART AUTO ANTENNAS

An auto antenna, model *De Luxe CF*, with two short, one long and one wedge, adapter insulators to fit curved or straight cowls and fenders have been announced by The Radiart Corp., Cleveland, Ohio.

Rod assembly has a top rod of stainless steel. Tubular sections are of antimonial admiralty brass. Leads are *plastic-loom*, said to be impervious to moisture. Inner conductor is covered by polyethelene tubing.

* * *

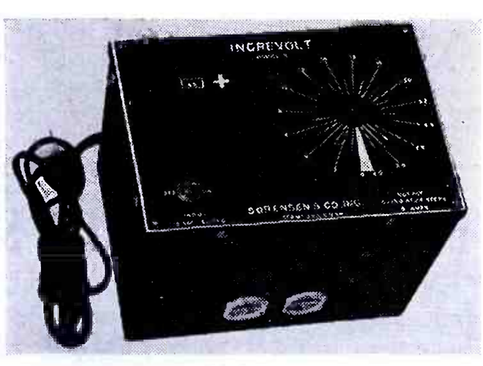
### SORENSON VOLTAGE CONTROLS

Adjustable a-c voltage controls, *Increvolt*, for adjustment to any desired voltage between 0 and 130 to within .1 volt have been developed by Sorenson and Co., Inc., 375 Fairfield Avenue, Stamford, Conn.

Control has *burnout* protection; uses automatic Klixon.

Available in two models: Model 5, 5 amperes, 0-130 volts; model 15, 15 amperes, 0-130 volts.

One control provides output voltages from 0 to 100 in 25-volt steps; another controls 0-30 volts, and .1-volt increments.




* * *

### PRECISION BOBBIN COIL FORMS

Die-formed bobbin coil forms for speaker field coils have been produced by Precision Paper Tube Company, 2023 W. Charleston St., Chicago 47.

The form comes in one-piece assembly, ready to go on mandrel of coil winding machine.

Coil base shaped by die in one-piece from spirally wound, heat-treated dielectric materials.

# RESISTIVE NETWORKS

(*Continued from page* 81)

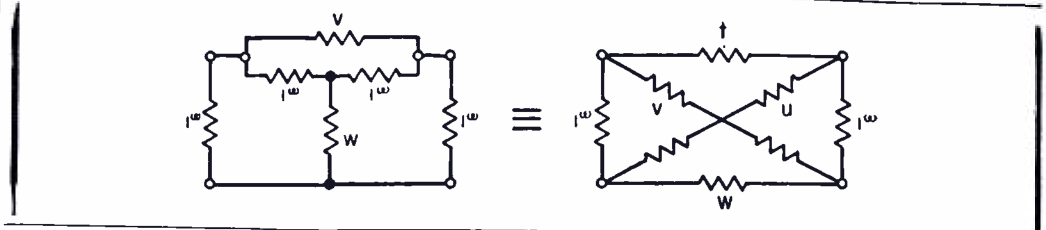



Figure 10

An application of Bartlett's theorem to transform a bridged-*T* to an equivalent lattice network: (*a*, left) 5 db loss with $v = 0.778$, $w = 1.285$ ohms; (*b*, right) 5 db with $t = w = 0.280$, $u = v = 3.570$ ohms on a unit basis.

added by citing a second example of the use of design equations.

The compensating resistance required for building out the faders to give a proper match of impedance as viewed from the load end of the mixer system is given on a unit basis by the compact expression

$$R = c \qquad (46)$$

and the insertion loss of each channel from input to common load exclusive of fader insertion losses is

$$db = 10\,\mathrm{Log}_{10}\,(2n - 1) \qquad (47)$$

In this system as well as in all other mixer systems, *n* is the number of channels and hence cannot be other than an integral number. This means that the loss of mixing systems in general varies in discrete steps or intervals. For a two-channels system, the loss by *47* is 4.77 db. From *46* and the second table of the series, R = 2.00, as shown by Figure *11*.

### Parallel-Mixer Systems Design

This system for four channels is shown in Figure 12. The insertion loss is identical with that of an equal number of series-connected channels, and is given by equations *47*. The element value required to compensate or build out the impedances of the faders so that the load is properly matched is

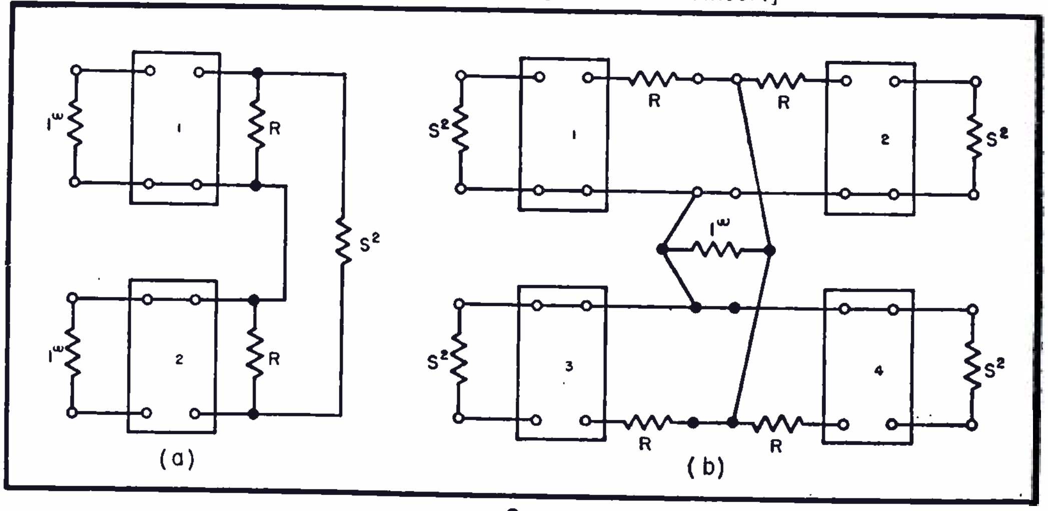
$$R = G/2 \qquad (48)$$

From the *third* table of the series, the value of *G* may be obtained, or from the table which appeared with the mixer section of this series, *G/2* may be found directly without interpolation. The loss caused by insertion of the compensating resistances for four channels is 8.45 db. The value of the unit-compensating resistance is 1.714 ohms. The ratio of the source to load impedance is given by column *E* of the *second* table of the series for the parallel mixer and also for the series mixer when the ratio is taken of load-to-source for the number of db-insertion loss as given by equation *47*.

[*Notes on Series-Parallel and Parallel-Series Mixer System Design will appear in November.*]

Figures 11 (below left) and 12 (below right)

Figure 11. A series mixer and fader system of two channels. On a unit basis, the loss of each channel = 4.77 db, $s^2 = 1.333$, R = 2.0 ohms. Figure 12. A 4-channel parallel mixer and fader system on a unit basis. Each channel loss = 8.45 db, $s^2 = 2.285$, R = 1.714 ohms.




# CRYSTAL-CONTROLLED RECEIVERS

(*Continued from page* 70)

one tuned circuit, would be a desirable feature.

In Figure 2 are the six low-frequency television channels with their related sound and video frequencies, plus the local oscillator, one-half local oscillator and fundamental crystal frequencies and crystal harmonics required for a proposed system. Harmonic oscillator operation is projected where the crystal is excited to oscillate at a mechanical harmonic by the *LC* circuit in the plate of a conventional t-p-t-g type of oscillator. The fifth

*Resting frequency of an F-M transmitter refers to the unmodulated transmitted *carrier* frequency.

onic is the highest order of harmonic required.

example of the recommended circuit used is illustrated in Figure 3. It be noted that the local oscillator a 4.583 mc crystal vibrating at its harmonic because $L_2$ and $C_2$ are to 13.75 mc. To inject a signal 50 mc into the mixer to beat with esting* sound channel frequency 75 mc for the i-f of 22.25 mc, a ave rectifier duo-diode has been as a frequency doubler. Resonant t $L_1$ $C_1$ has been tuned to the frequency of the channel, 47 mc.

his circuit it is necessary to use witch sections to switch the oscil- from channel to channel. Both als and $L_2$ $C_2$ must be switched for ent frequencies. However, there tuned frequency multipliers with onal tuned circuits.

diode frequency doubler has found to be a fairly efficient cir- nd simplifies the controls a great

circuit application which is also ble and fairly simple eliminates iode-frequency doubler and oscil- he crystal at its proper mechani- armonic to equal the required oscillator frequency directly. This crystal bridge circuit. It ... harmonic crystals mounted in e-type holders. These holders usu- have four terminals for the diag- of the bridge. Figure 4 shows a t of this type applied to a tele- receiver tuned to channel *1*.

illator switching in this applica- lso requires two switch sections itch crystal holders and also the rcuit, which is tuned to resonate desired harmonic of the crystal.

se crystal holders are precision- devices and therefore are some- costly. To reduce this cost the t shown in Figure 5 could be d.

his circuit the group of oscillator crystals is connected in parallel, e entire group is connected to one arm of the bridge. The ca- s, $C_n$, in the other arms of the are chosen to effectively cancel tal shunt capacity across the crys- nnected in parallel.

w, if *L* and *C* are tuned to reso- t a frequency which is an odd nic of the fundamental of any the shunted crystals, that crystal be excited to oscillate at that nical harmonic frequency. This d of local-oscillator frequency l would eliminate one switch sec- n the selector switch. Thus the

(*Continued on page* 109)



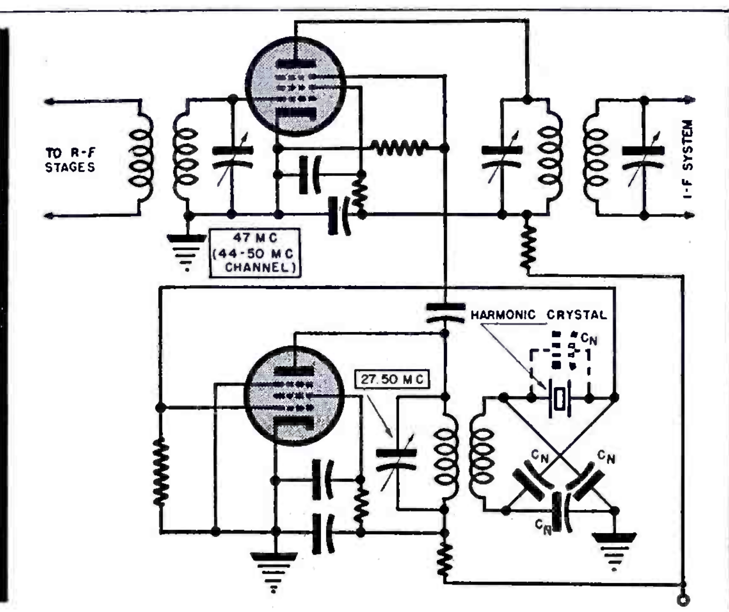



**Figure 4**
Television receiver mixer and local oscillator stages using a bridge-circuit oscillator generating a mechanical harmonic frequency of a low-frequency fundamental crystal plate.

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## …STAL-CONTROLLED RECEIVERS

(*Continued from page* 107)

…ls would not require switching. …the *LC* circuit would be switched …e required local-oscillator fre…y so that the switch mechanism …l be quite simple. Cheaper crys…lders would be usable and only …t of bridge balancing condensers, …cted externally to the shunted …l holders, would be required.

…oratory experiments to determine …timate practicability of this sys…e now being completed. Results …presented in a subsequent paper.

…different i-f sound channel, 21.75 …ere used, we would find quite an …ting result. The local-oscillator …ncy relationships are such that a …fundamental crystal when oper…n its seventh, eleventh, and fif… harmonics would oscillate at the … frequency to tune the first, third …fth television channels respec… The total number of crystals …ed to tune the six channels would …uced to four *instead of six*. Thus … be seen that with another choice …and possibly an allocation of tele… channels adjacent to each other …rystal might be suitable to tune …nnels.

…h the proposed RMA television …nd channel of 22.25 mc the first …urth television channels may be … with a 5.5-mc crystal tuned to …te at its fifth and ninth harmonics …tively. Therefore the six chan…ay be tuned with five crystals.

…ure 6 shows the harmonic order …rious fundamental crystal fre…es which equal the six oscillator …ncies required to tune the tele… channels. For parallel crystal …ion it is desirable to choose crys…aving fundamental frequencies …at odd harmonics of a particular …l, other than the one required for that crystal operation, will not fall too close to the frequency of operation of the others.

Television receivers covering these six channels and utilizing the RMA standard will not derive any particular benefit from a double-superheterodyne circuit application.

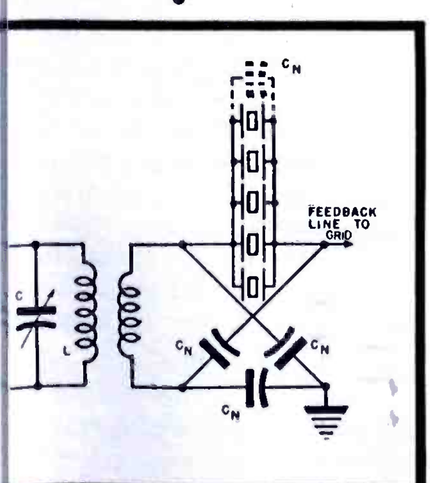
If the television i-f were to be used in f-m receivers, the circuits described would simply be extended to cover the 88- to 108-mc frequency spectrum. With the RMA adopted i-f of 10.7 mc the problems may be altered a bit. The same circuits, however, may still be applied with appropriate local-oscillator frequency modifications.

With higher oscillator frequencies the double superheterodyne system could utilize two separately-controlled local oscillators, the first variable in frequency and the second fixed in frequency and both crystal controlled. The second oscillator and second mixer may be combined in one tube such as the 6K8. The r-f stages and first local oscillator could utilize the miniature type tubes effectively, since they are more suitable for v-h-f operation.

The second local oscillator operates at 22 mc and uses a simple third or

(*Continued on page* 110)

**Figure 5**
**…ental bridge circuit with a number of … in parallel, used similarly to the oscillator shown in Figure 4.**



# CRYSTAL-CONTROLLED RECEIVERS

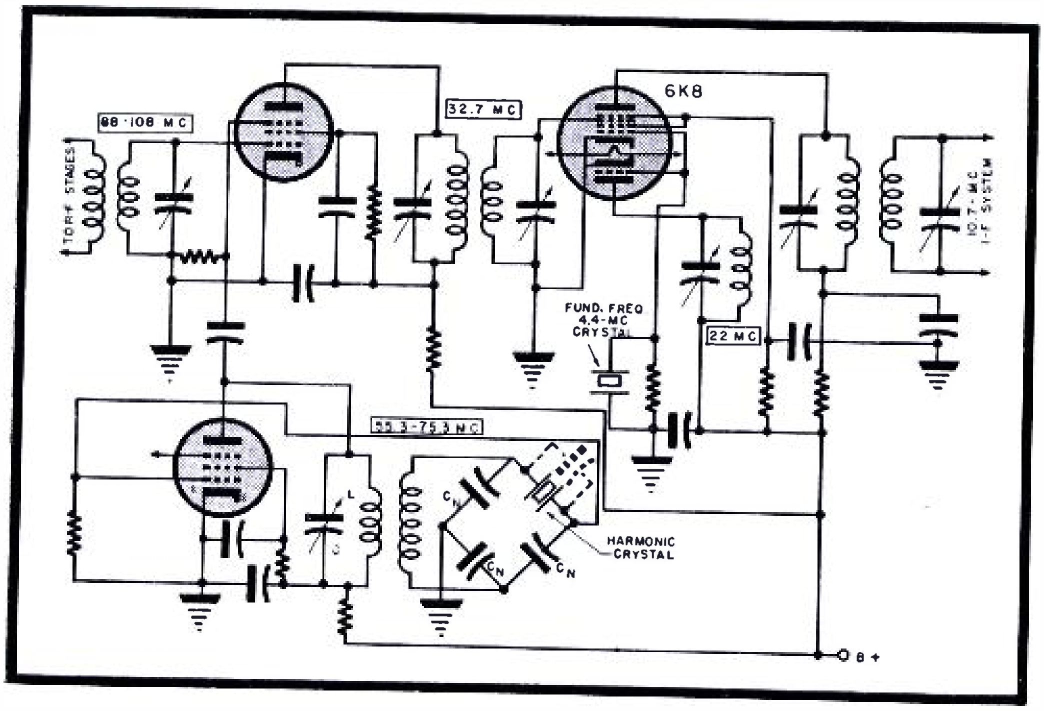
(*Continued from page* 109)

fifth harmonic crystal operating in a fixed tuned t-p-t-g type circuit.

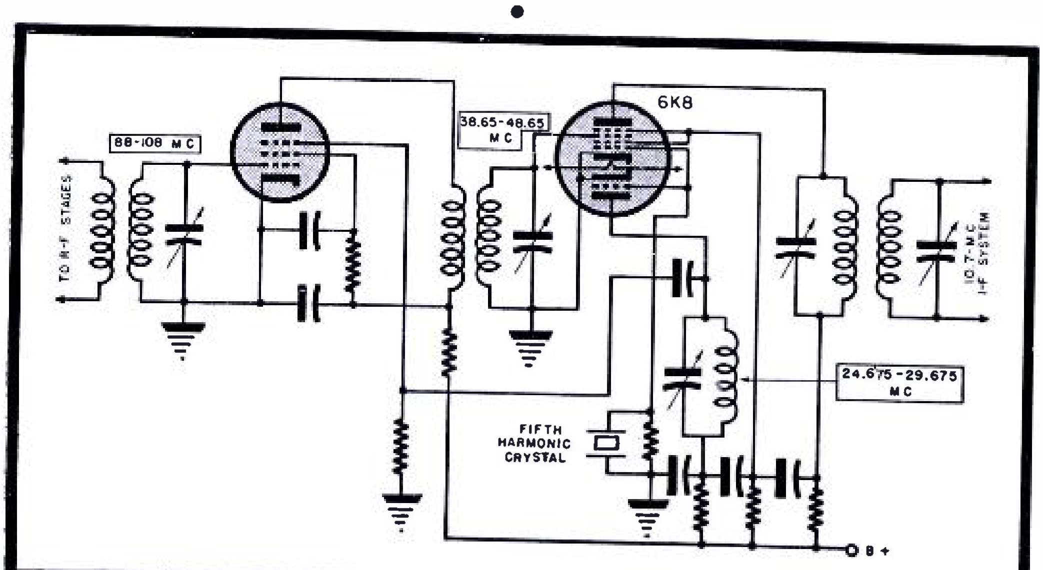
The first local oscillator would have to deliver a signal with a frequency range of 55.3 to 75.3 mc to the first mixer to provide a first i-f of 32.7 mc. This frequency range could be covered with bridge-circuit harmonic crystals

| Harmonic Order | 27.50 mc | 37.50 mc | 43.50 mc | 49.50 mc | 59.50 mc | 65.50 mc |
|---|---|---|---|---|---|---|
| 3......... | 9.1666 | 12.5 | 14.5 | 16.5 | 19.8333 | 21.8333 |
| 5......... | 5.5 | 7.5 | 8.7 | 9.9 | 11.9 | 13.1 |
| 7......... | 3.9286 | 5.3571 | 6.2143 | 7.0714 | 8.5 | 9.3571 |
| 9......... | 3.0555 | 4.1666 | 4.8333 | 5.5 | 6.6111 | 7.2777 |
| 11......... | 2.5 | 3.4091 | 3.9545 | 4.5 | 5.4091 | 5.9555 |
| 13......... | 2.1154 | 2.8845 | 3.3462 | 3.8077 | 4.5777 | 5.0385 |
| 15......... | 1.8333 | 2.5 | 2.9 | 3.3 | 3.9666 | 4.3666 |
| 17......... | 1.6176 | 2.2059 | 2.5618 | 2.9118 | 3.5 | 3.8529 |
| 19......... | 1.4474 | 1.9737 | 2.2942 | 2.6053 | 3.1316 | 3.4474 |

Figure 6 (above)
Listing of the local-oscillator frequency for each of the six television channels and odd sub-harmonics of each channel used to determine fundamental frequency of a mechanical-harmonic crystal-oscillator plate.




Figures 7 (above) and 8 (below)
Figure 7. Mixers and local oscillators of a crystal-controlled double-superhet f-m receiver covering 88-108 mc. Figure 8. A double superheterodyne f-m receiver using a common local oscillator to beat with the r-f signal and also the first i-f signal to deliver a 10.7 mc second i-f signal to the i-f system.




operating at the proper harmoni deliver the required oscillator quency directly. Figure 7 shows circuit application.

The use of one crystal to de local-oscillator frequencies for diffe f-m station channels is quite feas and will certainly bear investiga from both lowered cost and gre simplicity possibilities.

A double superheterodyne cir which uses a single local oscillato beat for both i-f's is shown in Fig 8. We note that referring to Figur one tube has been eliminated. An crease of one tuning control of a r nant circuit, is also shown. The type of tube may be used as a combi tion second mixer and common l oscillator because the frequen passed through the tube are compa tively low. This type of tube will as efficient as it was in the old 42-50-mc band f-m receivers.

The common local-oscillator quency range is 49.35 to 59.35 mc. actual frequency injected to mix w the r-f signal and first i-f is one-h of the oscillator frequencies mention and maximum conversion transcond tance will not be realized. The os lator circuit is of the t-p-t-g type usi fifth harmonic crystals having fun mental frequencies ranging from 4.9 mc to 5.935 mc. The second i-f variable in frequency from 38.65 to 48.65 mc. The local-oscillator f quencies and the first i-f frequenc may be interchanged if desired.

Harmonic crystals are precisi ground devices and require care control in manufacture. It is reaso able to expect, therefore, that the c of these crystals will be higher th that for those designed for a-m sets.

Generally, a-m tuning crystals n have a fairly low figure of merit still operate satisfactorily to deve enough oscillator voltage for pro conversion transconductance. Crys used in experimental a-m receiv have been tested and found to hav frequency drift of 70 to 200 cycles o an 80° C temperature range when t ing the broadcast band.

The evaluation and the adoption one of the many circuit possibilities crystal-controlled tuning of receiv must be governed by the following co siderations: (*1*)—Simplicity and s bility of circuits; (*2*)—ease of adju ment; (*3*)—cost of manufacture; ( —cost of component parts; and (*5*) cost of replacements and repairs.

It is believed that the crystal-con trolled local oscillator would simpli spot tuning stability problems, and f applications such as television, i adoption becomes almost mandatory.

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