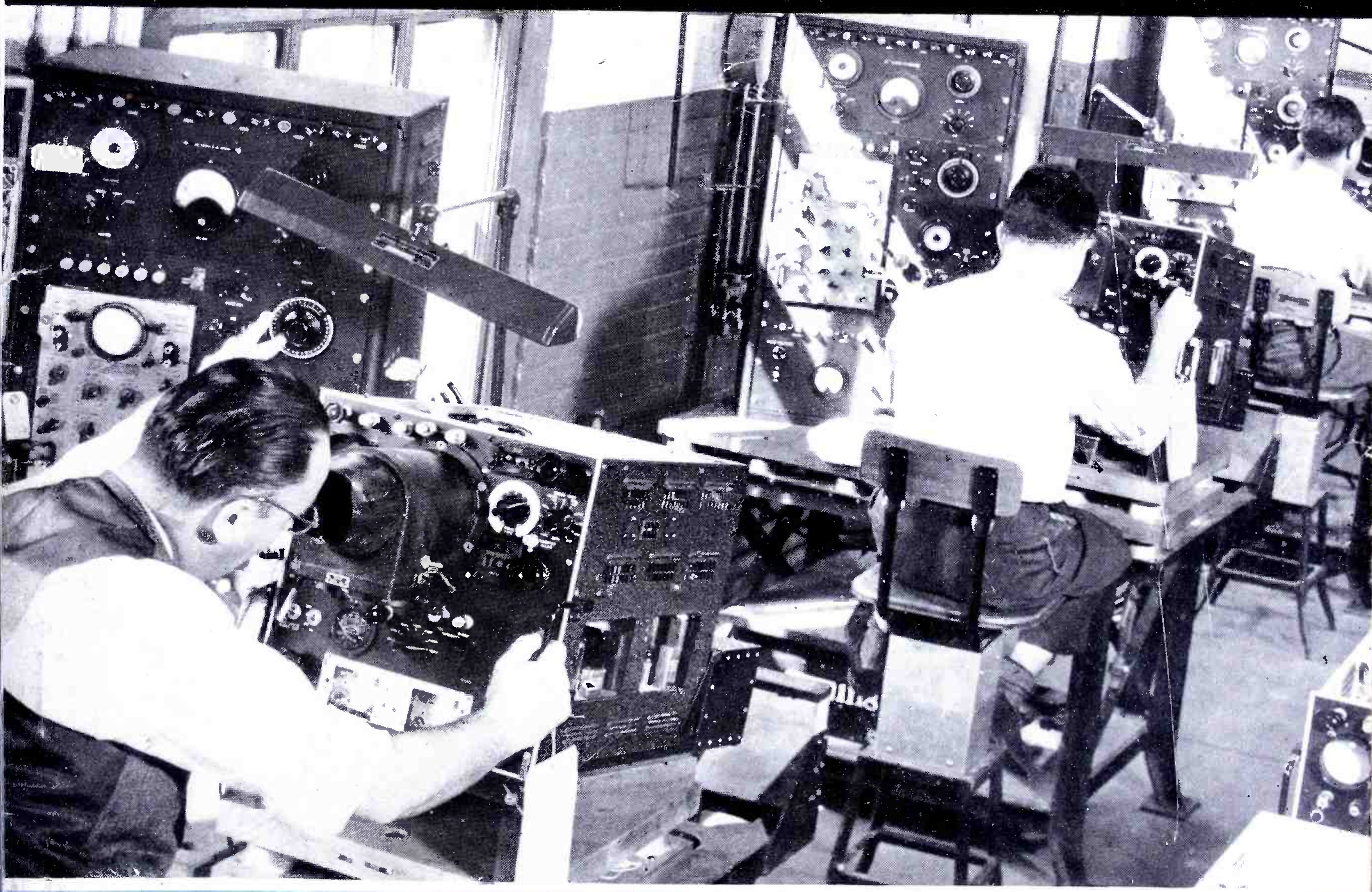
COMMUNICATIONS



SEPTEMBER 1945

★ RADIO ENGINEERING
★ AIRLINE F-M SYSTEM
★ COIL Q AND FILTER PERFORMANCE
★ AERONAUTICAL COMMUNICATIONS
★ TRANSMITTER POWER-INCREASE METHODS
★ TELEVISION ENGINEERING

THE AMPEREXTRA FACTOR IN DIELECTRIC HEATING

Dielectric heating has revolutionized the processing of plastics, textiles, rubber, drugs, foods, wood, paper and many other products. For dielectric heating equipment Amperex has originated a number of electronic tube types especially suited for use as oscillators at high frequencies. Dependable operation and reserve capacity are the **Amperextra Factor** in this group of tubes — a Factor which will increase in importance in the highly competitive postwar years when goods must be delivered better, cheaper—and on time.

"WON'T GO CUCKOO"

. . . that is how one electronic heat generator manufacturer describes Amperex tubes. If your equipment is right, Amperex Special Application Engineering will help you make it better. Dependable operation is assured, replacements minimized, and greater value per dollar expended may be anticipated.

THE AMPEREX SPECIAL APPLICATION ENGINEERING DEPARTMENT

. . . Amperex Special Application Engineers have nothing to sell. Their job is to work with you on the development of new equipment or the improvement of present products. Their time and knowledge is yours for the asking, without charge or obligation.

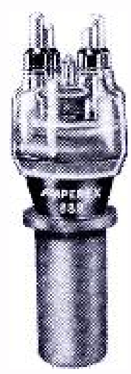
RESERVE CAPACITY

. . . the measure of tube life is in the reserve capacity of the tube. Because of novel design, Amperex high frequency tubes may be used at plate voltages and plate power inputs sufficiently high to allow power outputs at maximum rated watts per tube.

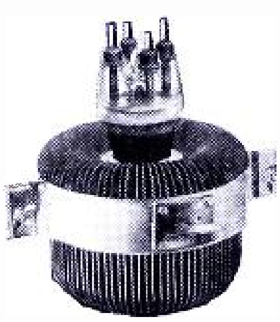
AMPEREX TUBES . . .

. . . for dielectric heating applications are available in 25 different types, operating with remarkable efficiencies at frequencies ranging from 20 to 120 megacycles. Write for the Amperex catalog.

Amperex Type 235-R Transmitting Tube. Filament voltage, 14.5-15.0 volts. Filament current, 39.0 amperes. Amplification factor, 14.0. Grid to plate transconductance at 500 ma., 6500 micromhos. Direct interelectrode capacitance: grid to plate, 9.0 μμf; grid to filament, 10.0 μμf; plate to filament, 1.5 μμf. List price, $125.00.



Amperex Type 889 Transmitting Tube. Filament voltage, 11 volts. Filament current, 125 amperes. Amplification factor, 21. Direct interelectrode capacitance: grid to plate, 17.8 μμf; grid to filament, 19.5 μμf; plate to filament, 2.5 μμf. List price, $175.00.



Amperex Type 889-R Transmitting Tube. Filament voltage, 11 volts. Filament current, 125 amperes. Amplification factor, 21. Direct interelectrode capacitance: grid to plate, 20.7 μμf; grid to filament, 19.5 μμf; plate to filament, 2.5 μμf. List price, $325.00.

AMPEREX

. . . the high performance tube

Many standard types of Amperex tubes are now available through leading radio equipment distributors

AMPEREX ELECTRONIC CORPORATION

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Canadian Distributor: Rogers Majestic Ltd. • 622 Fleet Street West, Toronto

HOLD ON TO THE WAR BONDS YOU HAVE — AND KEEP BUYING MORE

To Our Friends and Customers

The Langevin Company Inc. believes its customers are entitled to a statement of the company's future plans. The entire life of the company has been spent in the audio frequency field. *It intends to remain in that field.*

Due to its war effort, its facilities, experience and personnel have been increased. It will continue to develop, design and manufacture—to better than FM standards—sound and broadcast speech input equipment.

Its products will continue to include quality transformers and quality amplifiers, ranging from the smallest unit to especially-engineered speech input systems for the large broadcast stations. Much of this equipment is now in production; some in development—some between development and production.

To our old customers, the above is sufficient. To those who may be interested in becoming customers—we are 23 years old, all our equipment carries the Union Label and is fully licensed under A.T.&T. patents.

PRESIDENT

The Langevin Company
INCORPORATED
SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK	SAN FRANCISCO	LOS ANGELES
37 W. 65 St., 23	1050 Howard St., 3	1000 N. Seward St., 38

LEWIS WINNER, Editor
F. WALEN, Assistant Editor

We See...

WITH THE DISCLOSURE of the VT radio proximity fuze by the Army and Navy recently, we learned of a development that introduces many unique receiver and transmitter concepts . . . concepts that involve unusually miniature designs. For in this shell fuze, which contains a 3- or 5-tube receiver-transmitter, we find 1/4" x 1" triodes, pentodes and other tube types and allied components and power supplies that will withstand the terrific shock of 20,000 G, occupying but a few inches in diameter and thickness, and providing fool-proof service whether fired from a gun or catapulated by rocket action. While at the present many of the details of the ingenious circuit and component designs are still under secure control and thus not available for immediate commercial application, the success of this small-unit project has alerted everyone to its unusual possibilities. The new concepts displayed will serve as a basis of thought and practice in many future commercial developments.

THE FCC RELEASE of the new f-m power and frequency assignments for existing f-m stations and the corresponding request that equipment tests begin December 1, has prompted a varied reaction among engineers and station owners. Those in favor of the rulings say that the program accelerates f-m activity and assures prospective new-receiver owners of transmissions on the new frequencies. Others, however, say that it will be difficult to revamp the transmitters for these new frequencies in the short time allotted.

Fortunately the engineering standards have at long last been issued. The release of these data will simplify many problems of design. However, careful development and construction demands exacting study, and that's quite a time-consuming process. Thus the December 1 deadline still appears to be too close for all of the final design decisions.

The new frequencies and powers will not only require revamped or new transmitters but revamped or new antennas. In some instances the change-over will be simple while in others it will be quite involved, requiring completely new installations. For instance, the new order brings considerable power reductions for many of the stations located in the larger cities over installed or ultimate powers previously planned. The f-m station of WEAF in New York has been assigned a radiated power of 1.6 kw because of its high antenna height of 1,258 feet. This compares with the Baton Rouge station WBRL with a 20-kw power and an antenna height of 500 feet. This poses interesting problems for the stations with high locations. Thus a station with a lower antenna height and higher power may lay down a stronger signal within the 1 millivolt contour than the lower powered station using a high antenna. Problems to be studied will include signal-to-noise ratio and desired-to-undesired signal ratios due to tropospheric or sporadic E interference from other stations; the station with a high antenna may be at somewhat of a disadvantage in this respect.

With the foregoing problems to solve, television striking ahead, too, and a-m transmitter and antenna renovation and construction also on the calendar, there'll be plenty of round-the-clock activities for the *Communications* man for many, many months.—L. W.

COMMUNICATIONS

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

SEPTEMBER, 1945

VOLUME 25 NUMBER 9

COVER ILLUSTRATION

Radar unit test room. (*Courtesy Western Electric*)

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

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PAUL S. WEIL, Vice Pres.-Gen. Mgr. **A. GOEBEL, Circulation Mgr.**

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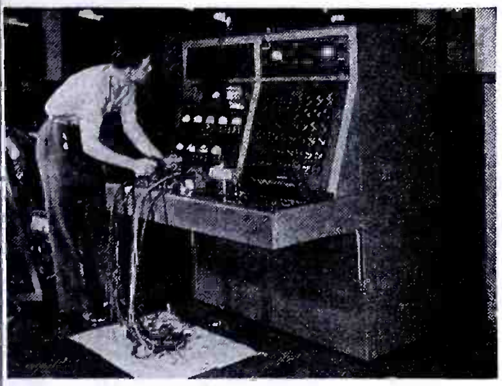
SYLVANIA NEWS
ELECTRONIC EQUIPMENT EDITION

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

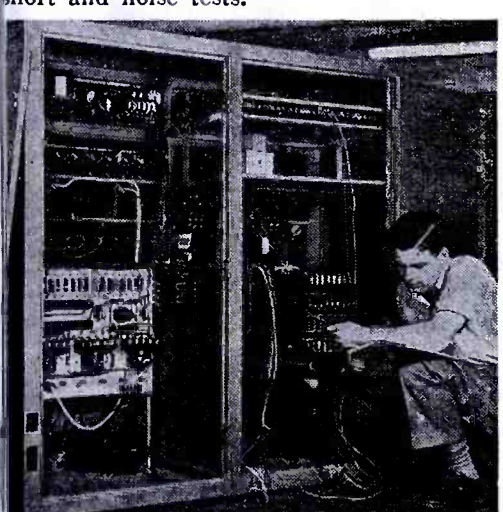
UNIVERSAL TEST UNIT CHECKS RADIO TUBES —ELECTRONIC DEVICES

Another essential electronic apparatus manufactured by the Industrial Apparatus Division of Sylvania Electric at Williamsport, Pa., is shown in accompanying photographs.



Above is the front view of the Universal Test Unit that preheats all tubes except rectifier, short tests all tubes (each element separately), noise tests RF and AF tests, static tests all tubes for all characteristics except plate resistance and amplification factor, dynamic tests mutual conductance, gain and power output at 400 cycles.

In addition, it may be adapted to test many other types of electronic devices by simply changing a small socket adaptor, and can be equipped with automatic tappers for short and noise tests.



Rear view Universal Test Unit

HIGH FREQUENCY TUBE ALSO BEST FOR ALL RADIOS

"Lock-In" Not Only Ideal For FM, Television, But Better For Other Type Sets

An outstanding advantage of Sylvania Electric's advanced type radio tube—the Lock-In—is its perfect suitability for *any* class radio set—portable battery, farm battery, household, automobile, marine or aircraft.

Not Limited In Use

Although the basic electrical and mechanical advantages of the Lock-In construction are right in step with the continuing trend of the industry toward higher frequencies, these exceptional qualities do not limit the tube's applicability.

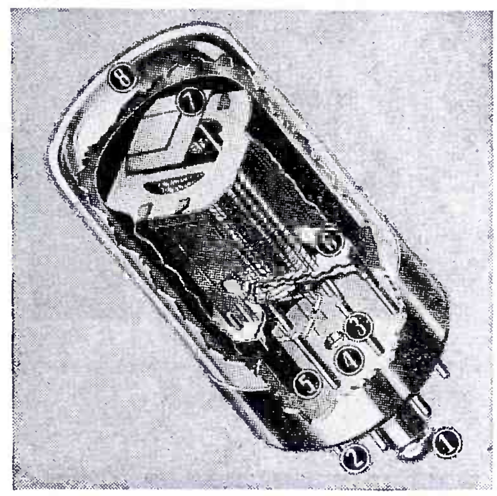
Set Performance Improved

On the contrary, this superiority is reflected in the better performance attained in all sets employing Sylvania Lock-In Tubes.

Write today for further information. *Sylvania Electric Products Inc., Emporium, Pa.*

REMEMBER THIS EMBLEM

IT STANDS FOR HONORABLE SERVICE TO OUR COUNTRY



9 POINTS OF MERIT

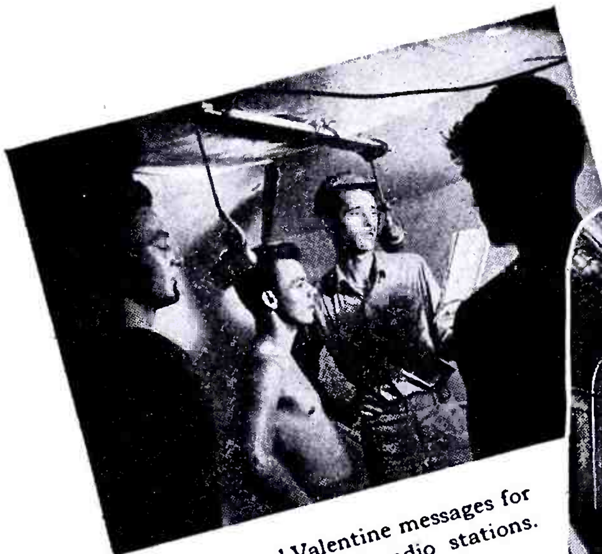
1. Lock-In locating plug . . . also acts as shield between pins.
2. No soldered connections . . . all welded for greater durability.
3. Short, direct connections . . . fewer welded joints — less loss.
4. All-glass header . . . better spacing of lead wires.
5. No glass flare . . . unobstructed space for internal shielding.
6. Improved mount support . . . ruggedly mounted on all sides.
7. Getter located on top . . . shorts eliminated by separation of getter material from leads.
8. No top cap connection . . . overhead wires eliminated.
9. Reduced overall height . . . space saving.

SYLVANIA ELECTRIC

Emporium, Pa.

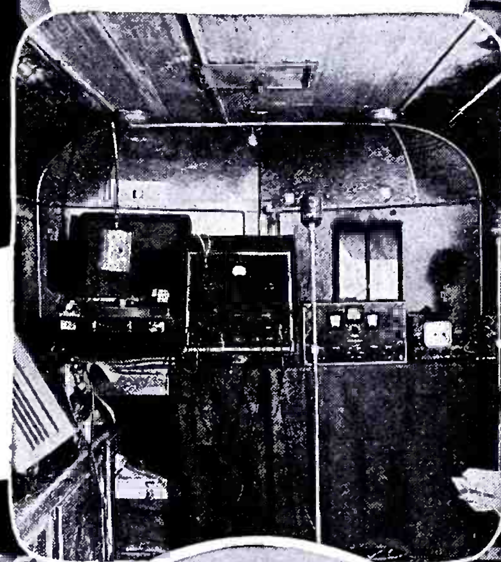
MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

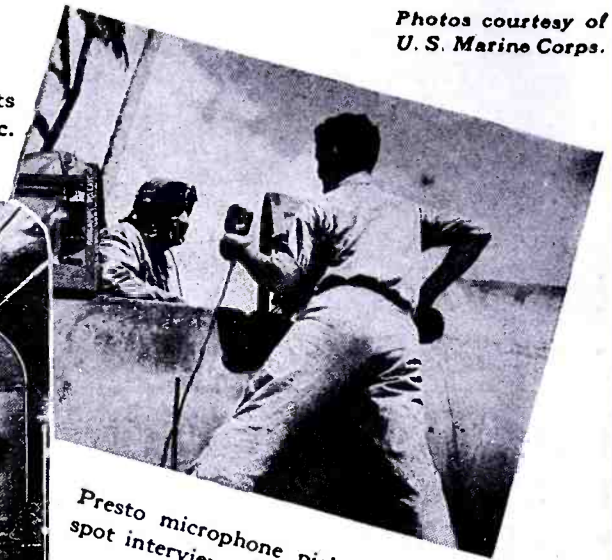
Photos courtesy of U. S. Marine Corps.



Marines record Valentine messages for broadcast over U. S. radio stations.

Trailer-studio houses and transports Presto equipment in South Pacific.





Presto microphone picks up on-the-spot interview with fighter pilot.

Presto transcribes battle experiences during Bougainville offensive.

THIS IS WHY YOU HAVEN'T BEEN ABLE TO GET A PRESTO RECORDER

Because Presto equipment has been right there in the front lines with G.I. Joe... to support his strategy with actual combat transcriptions... to support his morale with recorded messages of his voice for the folks back home... and to give America a permanent, unprecedented sound document of a world-at-war.

South Pacific natives serenade U. S. listeners via Presto recordings.

Presto recordings carry Marines' greetings to their families at home.

At the front, Presto is standard equipment with the Armed Services.

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Walter P. Downs Ltd., in Canada

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

ALL NEW – incorporating new techniques, new circuits, new tubes.

NEW TRANSMITTERS . . . with impressive high fidelity, low harmonic distortion, low hum level . . . with outputs of 1, 3, 10 and 50 kilowatts . . . plus ample operating safeguards.

The basic unit is the exciter, generating 250 watts of RF power. Its design permits adding power units as desired . . . at any time . . . in selected steps that make possible the different outputs.

NEW ANTENNAS . . . of two or more loops with two or more half-wave elements, are factory tuned for easy installation. Standard coaxial lines feed them.

NEW POWER TUBES . . . highly efficient, incorporate notable Federal achievements in design and production. They assure long, dependable performance in FM broadcasting.

Look to Federal for the finest in FM equipment.

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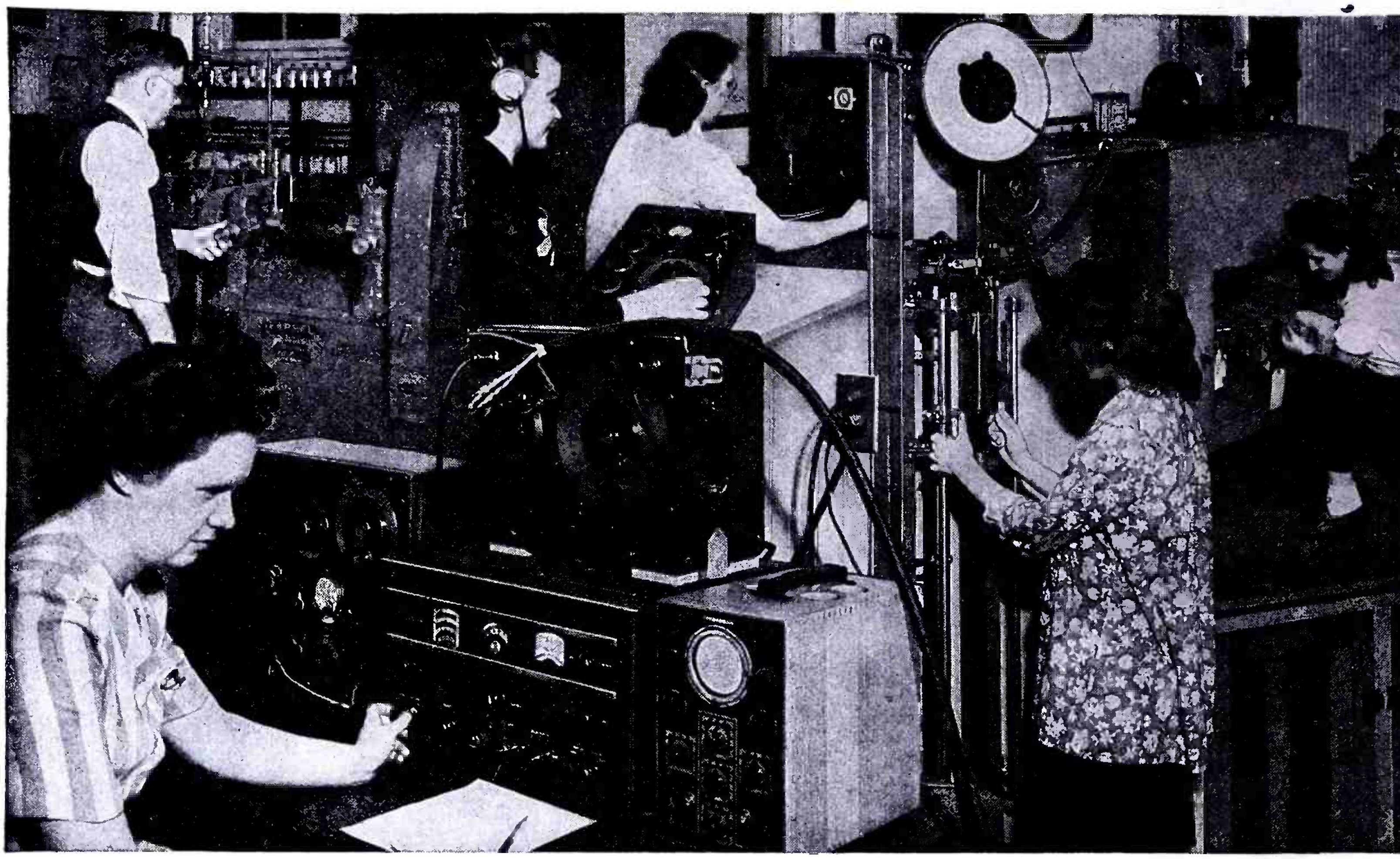


This Laboratory Can Help Solve

YOUR CABLE PROBLEMS

PICTURED above is a composite view of some of the test equipment in daily use at The Ansonia Electrical Company Laboratories.

This equipment and the personnel, both laboratory and engineering, are constantly on the job controlling production quality of our many specialty cables for Government and industry uses.

These facilities have helped get many special Army and Navy multiconductor cables into production. Some of these cables had never been made before. Some were just too tough for many to handle. Some were conventional cables but their performance characteristics using thermoplastic insulation were either unknown or unproved. After extensive research and careful analysis in our laboratories several types of Ankoseal were developed and successfully applied on these various cables.

Today the electrical values and physical characteristics of many types of Ankoseal are known and proved. They are serving over wide temperature ranges and in varied electrical applications all over the world.

The laboratory and engineering personnel, the test equipment, the manufacturing resources of The Ansonia Electrical Company stand ready to help solve your special cable requirements.

Call on us. We'll gladly assist you.

Why ANKOSEAL *solves cable problems*

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

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

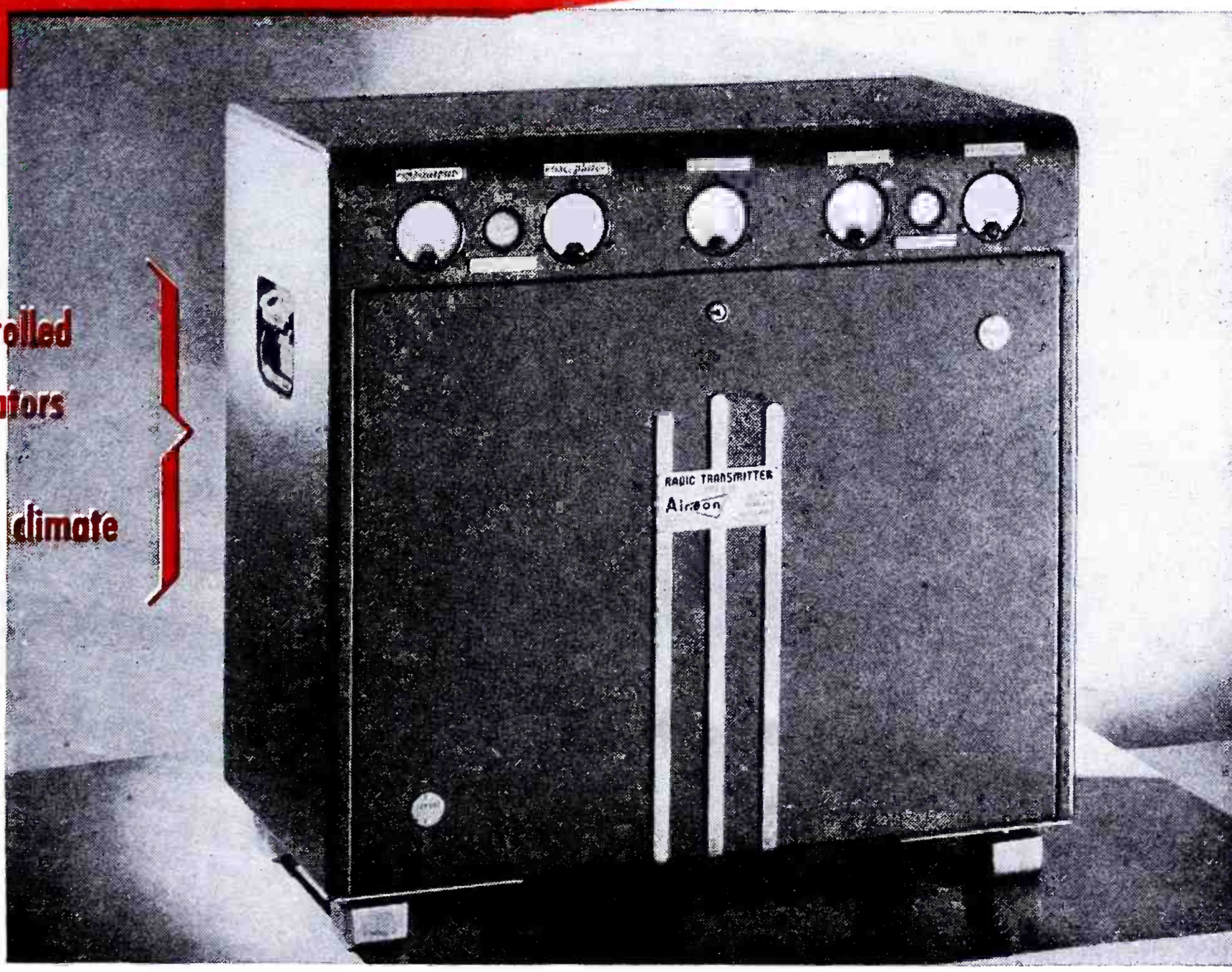
A Wholly-Owned Subsidiary of

NOMA ELECTRIC CORPORATION

GENERAL OFFICES • NEW YORK, N. Y.

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.

NOW—The answer to radio communication for small airports



Push-button controlled

Experienced operators unnecessary

Designed for any climate

The new Aireon Type 574A Radiophone Transmitter mounted in welded steel cabinet measuring only 22" wide x 22" high x 14" deep. Also available in standard relay rack mounting.

The Aireon Type 574A Radiophone Transmitter is a completely self-contained, automatically operated unit specifically designed to meet the requirements of the small airport. Rated at 50 watts output, and readily portable, it also makes an ideal emergency transmitter or, by the addition of a low-frequency channel, a control tower transmitter.

The transmitter can be operated by third class personnel, as all tuning adjustments and components are safely covered by a locked front door. Control circuit design renders the actual operation extremely simple. Channel selection is accomplished with mechanically interlocked push buttons. The unit can be remotely controlled up to distances of 10 to 25 miles over an ordinary telephone circuit.

Though eleven tubes are used, they are confined to *three* readily obtainable types. This avoids the necessity of carrying a large supply of tubes in service stock. Electrical components conform to recognized standards such as ASA and JAN.

Special consideration has been given to insure satisfactory operation in tropical climates by protecting components against moisture. Each of the five chassis can be quickly unplugged and removed from the cabinet without the use of tools, thus simplifying servicing.

The Type 574A Transmitter is equipped with two frequency channels for alternate operation — 200 to 400 kilocycles and 2.0 to 16.0 megacycles. Single channel, fixed-tuned companion receivers are also available.

Write today for descriptive literature, prices and delivery dates.

Aireon MANUFACTURING CORPORATION

Radio and Electronics • Engineered Power Controls

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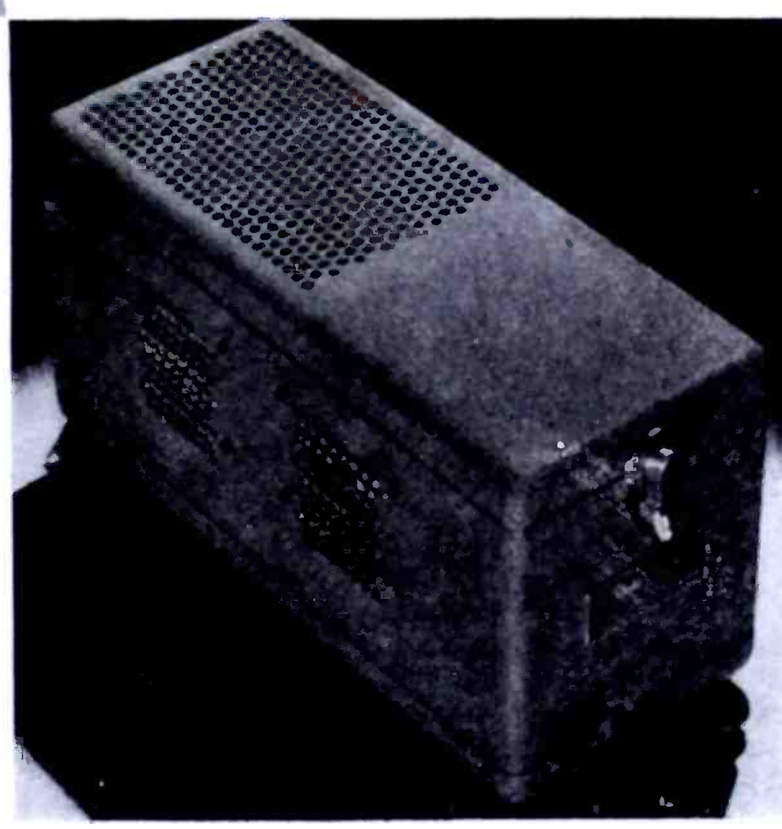
KANSAS CITY • BURBANK

an open and shut case of finer craftsmanship

When you bring us your sheet metal fabrication problems, you hire 20 years of *specialized* experience in serving the highly individual needs of manufacturers of electrical, radio, electronic and mechanical apparatus. Our long history in this exacting specialty is one of intimate knowledge, and assures post-war permanence.

At your service are our 65,000 square feet of floor space . . . hundreds of skilled craftsmen . . . large stores of stock dies to save you money. Try us for chassis, panels, cabinets, racks, housings.

ANY SIZE . . . ANY METAL . . . ANY GAUGE . . . ANY FINISH



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Custom Craftsmen in Sheet Metal

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ARMY E NAVY

You can use the NEW VOLTOHMYST for checking FM Discriminator Alignment

(A ZERO-CENTER-INDICATOR IS INCORPORATED FOR THIS PURPOSE)

—and you can also use the 195-A Voltohmyst

As an ELECTRONIC D-C VOLTMETER

Measures d-c Voltage to 1000 volts in six ranges—has high resistance input of 10 megohms constant on all ranges—plus isolation resistor in probe for dynamic socket voltage readings—polarity turnover switch eliminates confusion in reversing test leads—positive and negative indications are individually calibrated.

As an ELECTRONIC OHMMETER

Measures Resistance up to 1000 megohms with internal source of only 3 volts—six resistance ranges indicating from .1 ohm with shielded cable—zero resetting unnecessary with change of range—all ranges are indicated on "OHMS" scale.

As an ELECTRONIC A-C VOLTMETER

Measures a-c Voltage to 1000 volts r.m.s. in six ranges—with clear linear scale—Binding Jack with locking pin plug prevents accidental ground lead disconnection—meter protected against accidental burn-out.

As an ELECTRONIC A-F VOLTMETER

Measures a-f and Supersonic Voltage up to 100 volts with a range of 20 to 100,000 cycles—internal self-balancing diode—produces linear reading at any frequency.

As an ELECTRONIC OUTPUTMETER

Measures Decibels based on a-f voltage—calibrated in Volume Units for direct reading across 600 ohm audio circuits with standard zero level of 1 milliwatt.

The New Model Of The Famous RCA Junior Voltohmyst Incorporates Several New Features Including:

A diode for a-c measurements (flat 20 cycles to 100 kilocycles); linear a-c scale for all ranges; new plastic meter case with one-piece crystal-clear transparent front (no glass to break or loosen); and a shielded a-c cable and probe.

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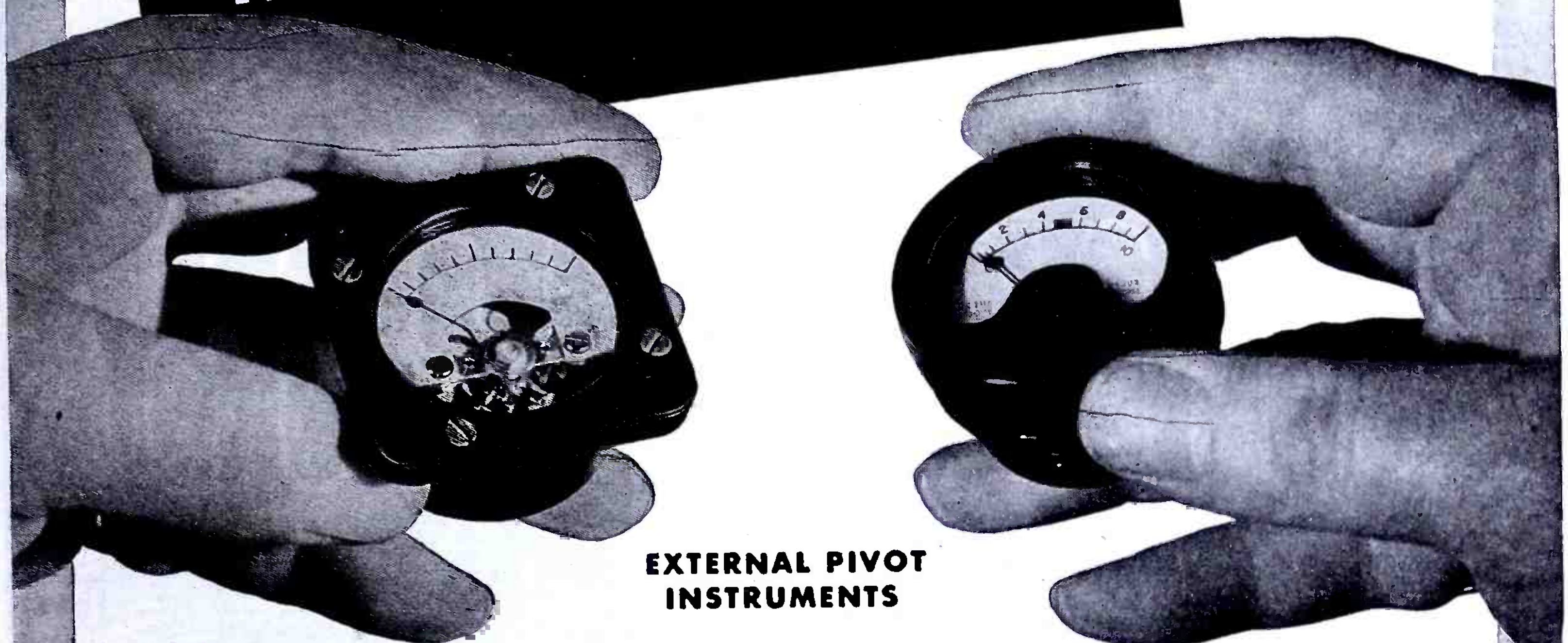
Meet TWO LITTLE METERS THAT DO A GREAT BIG JOB!



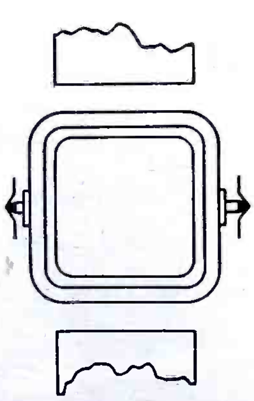
EXTERNAL PIVOT INSTRUMENTS

1½" Square Model 112

Measuring only 1¾" square by 25/32" deep, the 112 is capable of performing a full-scale task in a variety of applications. Made with the precision of all DeJUR larger instruments. It can be immersed in water at a depth of 30 feet for seven days without harm to mechanism. Movement built to forthcoming JAN-I-6 specification for 1½ inch instruments. Quickly and easily installed. Additional information upon request.

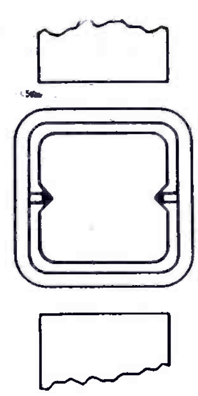
1½" Round Model 120

Another good friend to know. It also is capable of doing a man-sized job in many applications where space is at a minimum. Performs with high efficiency. Uses basically the same carefully designed components as large DeJUR instruments. Built with fine precision. Entirely self-contained, with built-in resistors and shunts. Also, immersion-proof throughout. Conforms to forthcoming JAN-I-6 specifications for 1½ inch instruments. Write for catalog.



External Pivots

EXTERNAL PIVOTS—used in the design of DeJUR 1½ inch Meters provide greater accuracy in mounting the moving element between the jewel bearings. For this reason internal pivots are not used in DeJur instruments.



Internal Pivots

DeJUR engineers are prepared to work with you on special models of DeJUR Products for your present and postwar applications.

DeJUR AMSCO CORPORATION

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Transformer Specialists . . .

Thordarson's tradition of quality provides the underlying reason for its past half-century of progressive leadership in the specialized manufacture of dependable transformers, components and other electronic devices. This same tradition, upheld through every phase of *Thordarson* design, engineering and manufacturing is your guarantee of the finest transformers for requirements of Tomorrow . . . and years to come. With confidence . . . gained by this ability to produce quality merchandise and coupled with novel sales policies . . . *Thordarson* looks forward to supplying the expanding demands of the radio and electronic industries.

500 WEST HURON ST., CHICAGO, ILL.

ARMY E NAVY

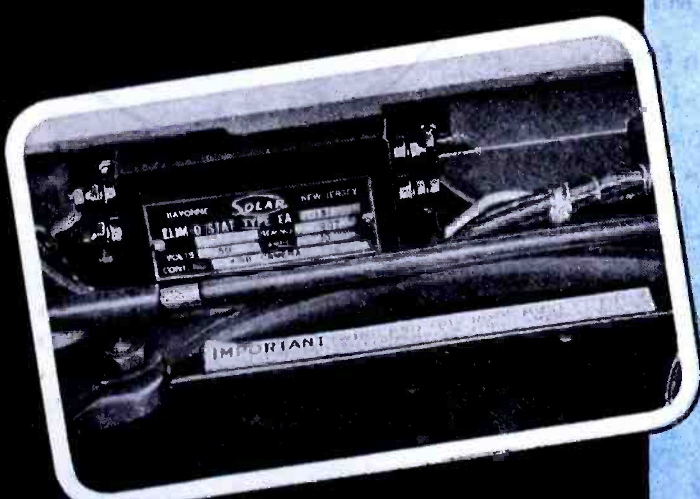
ORIGINATORS OF TRUE-FIDELITY AMPLIFIERS

THORDARSON

ELECTRIC MANUFACTURING DIVISION

MAGUIRE INDUSTRIES, INCORPORATED


THE EYES
HAVE IT


SOLAR
ELIM-O-STAT TYPE EA
IMPORTANT

AMPHENOL offers
WIDEST SELECTION OF APPROVED R-G CABLES
Immediate Delivery
Amphenol's government approved "Coax" and "Twinax" R-G Cables today represent the maximum in types available from a single manufacturer—a definite advantage. There is usually a size for every normal requirement. But "special" needs too are promptly met. They embody the same widely experienced engineering, high quality materials and dependable production that have made Amphenol products famous the world over. And you can have immediate delivery on most Amphenol Cable types. So depend on Amphenol for any high frequency cable requirements. Catalog Section D brings you detailed technical data and helpful illustrations.
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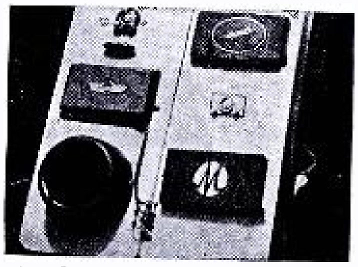
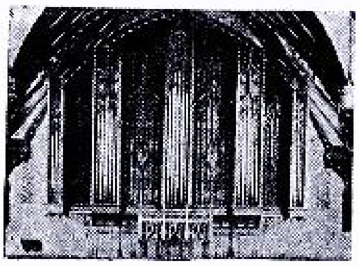
Depend upon AMPHENOL Quality
U.H.F. Cables and Connectors
Connectors (A-N, U.H.F., British).
Plastics for Industry

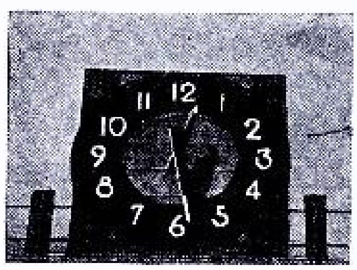
B-L METALLIC RECTIFIERS SINCE 1923

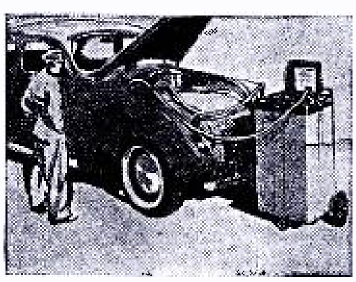
SELENIUM
COPPER SULPHIDE

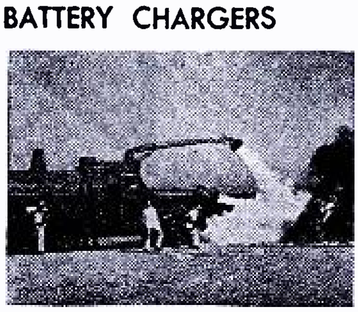
A few B-L Rectifier applications are illustrated below:

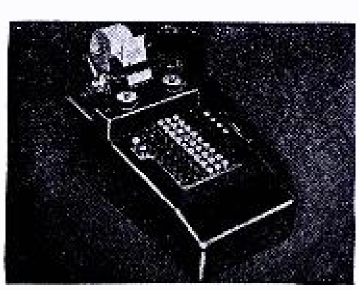

AUTO RADIOS

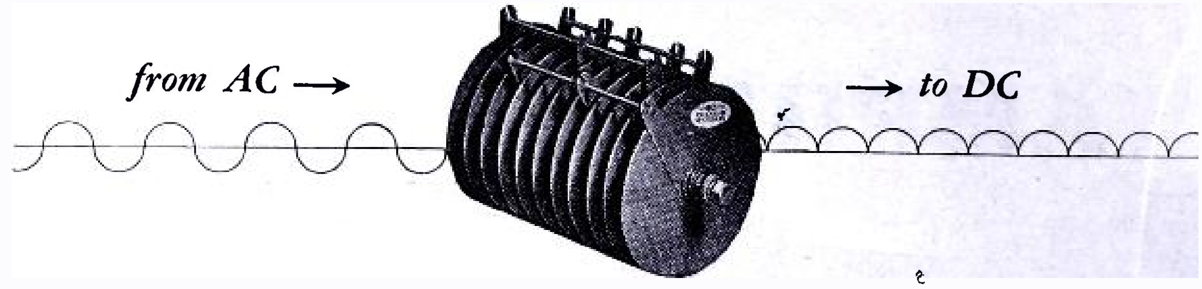

PIPE ORGANS


CLOCKS


BATTERY CHARGERS


FIRE TRUCKS


BUSINESS MACHINES



B-L METALLIC ELECTRICAL RECTIFIERS (SELENIUM COPPER SULPHIDE)

offer you these advantages:

They are COMPACT
For a given power output the space required by metallic rectifiers is very small.

They are SILENT
B-L Rectifiers are silent in operation and have no moving parts.

They are DEPENDABLE
Dependability is assured by their simple and rugged construction, in which no glass bulbs, filaments, or other fragile parts are employed.

They are TROUBLE-FREE
Regular maintenance and attention are unnecessary.

They are RUGGED
B-L Rectifiers are rugged and will withstand heavy overloads for short periods of time.

They are ADAPTABLE
B-L Rectifiers are adaptable for power outputs from Milliwatts to Kilowatts.

Many rectifier applications, heretofore considered impractical, have been devised by B-L Engineers. It is more than likely that they can be of assistance in solving your problems of converting AC current to DC . . . Write for Copper-Sulphide Bulletin R38-e — or for Selenium Bulletin R41-e.

THE BENWOOD-LINZE COMPANY
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Designers and Manufacturers of Selenium and Copper Sulphide Rectifiers, Battery Chargers, and DC Power Supplies for practically every requirement.

COLLINS 32RA RADIO TRANSMITTER*

A deservedly popular 50 watter

THE COLLINS 32RA* was introduced in 1939 as a quality designed, quality built radio communication transmitter, broadly adapted to most applications within its power and frequency scope.

It, or its d-c version—the 32RB†—was immediately put into service by airlines for control towers, by oil pipelines for emergency systems, by fishing companies for fleet control, and by other widely different types of industrial users.

It was found to be rugged, simple to operate, easy to service, and so thoroughly and universally satisfactory that a rising commercial demand was halted only by the war. During the entire war the Armed Forces have employed thousands of these transmitters. A typical use has been that of control towers on air training fields throughout the country.

Of the several up-to-the-minute transmitters which Collins has ready for its civilian customers as Government requirements are cut back, this one represents a type of which limited quantities are now being manufactured for essential civilian uses. If you would like specifications and design data, write us for new, illustrated bulletin. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

ARMY E NAVY

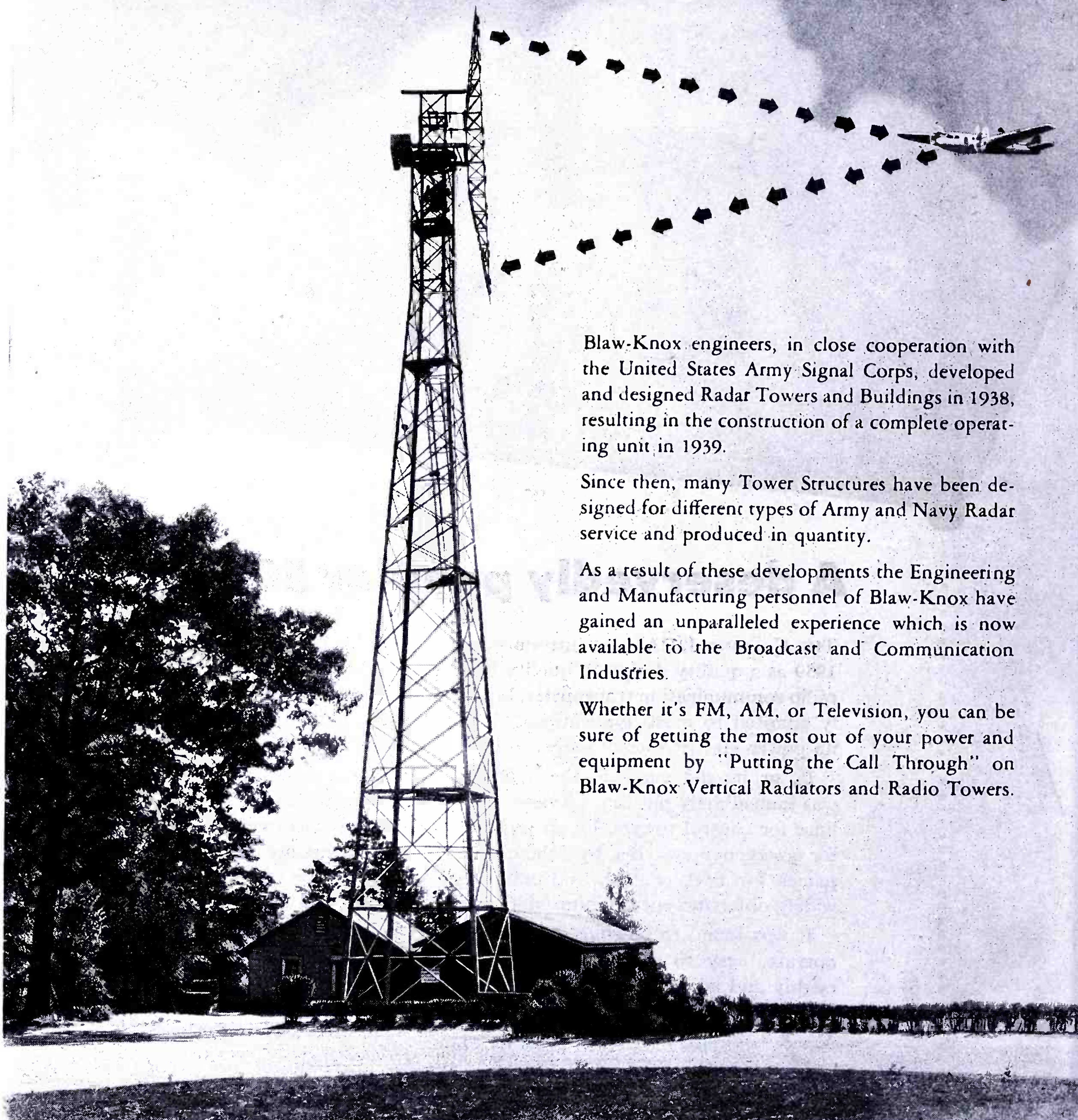
*COLLINS 32RA—Power source: 115 *volts alternating current*. Power output, 50 watts phone; 75 watts CW. Frequency range, 1.5 to 15 mc. Four frequencies instantly selected by panel control.

†COLLINS 32RB—Power source: 12, 24, 32 or 110 volts *direct current*. Dynamotor, self contained. Otherwise identical with 32RA.

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

RADAR

is not new to the Blaw-Knox Company



Blaw-Knox engineers, in close cooperation with the United States Army Signal Corps, developed and designed Radar Towers and Buildings in 1938, resulting in the construction of a complete operating unit in 1939.

Since then, many Tower Structures have been designed for different types of Army and Navy Radar service and produced in quantity.

As a result of these developments the Engineering and Manufacturing personnel of Blaw-Knox have gained an unparalleled experience which is now available to the Broadcast and Communication Industries.

Whether it's FM, AM, or Television, you can be sure of getting the most out of your power and equipment by "Putting the Call Through" on Blaw-Knox Vertical Radiators and Radio Towers.

BLAW-KNOX

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
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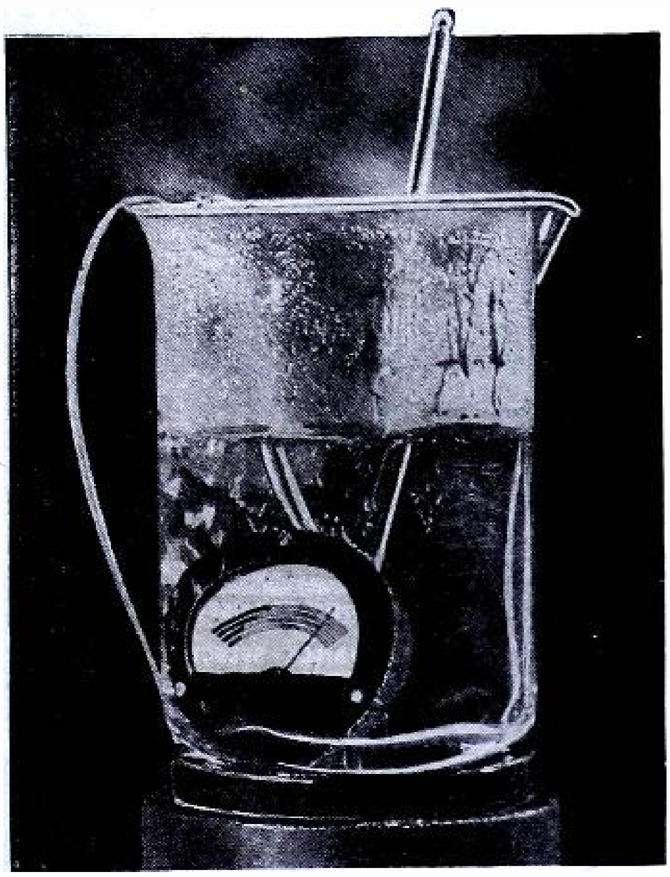


We weren't satisfied to test our hermetically sealed instruments for temperature, humidity and salt spray individually — we went whole hog and combined the three conditions in a beaker of boiling brine. This test, which really exacts more from an instrument than is normally necessary, was conducted for two weeks without failure or permanent error in excess of 1%. The maximum zero shift was .75%, the current sensitivity plus .5% — and the instrument showed no moisture penetration and no leaks as was evidenced by further production vacuum checking.

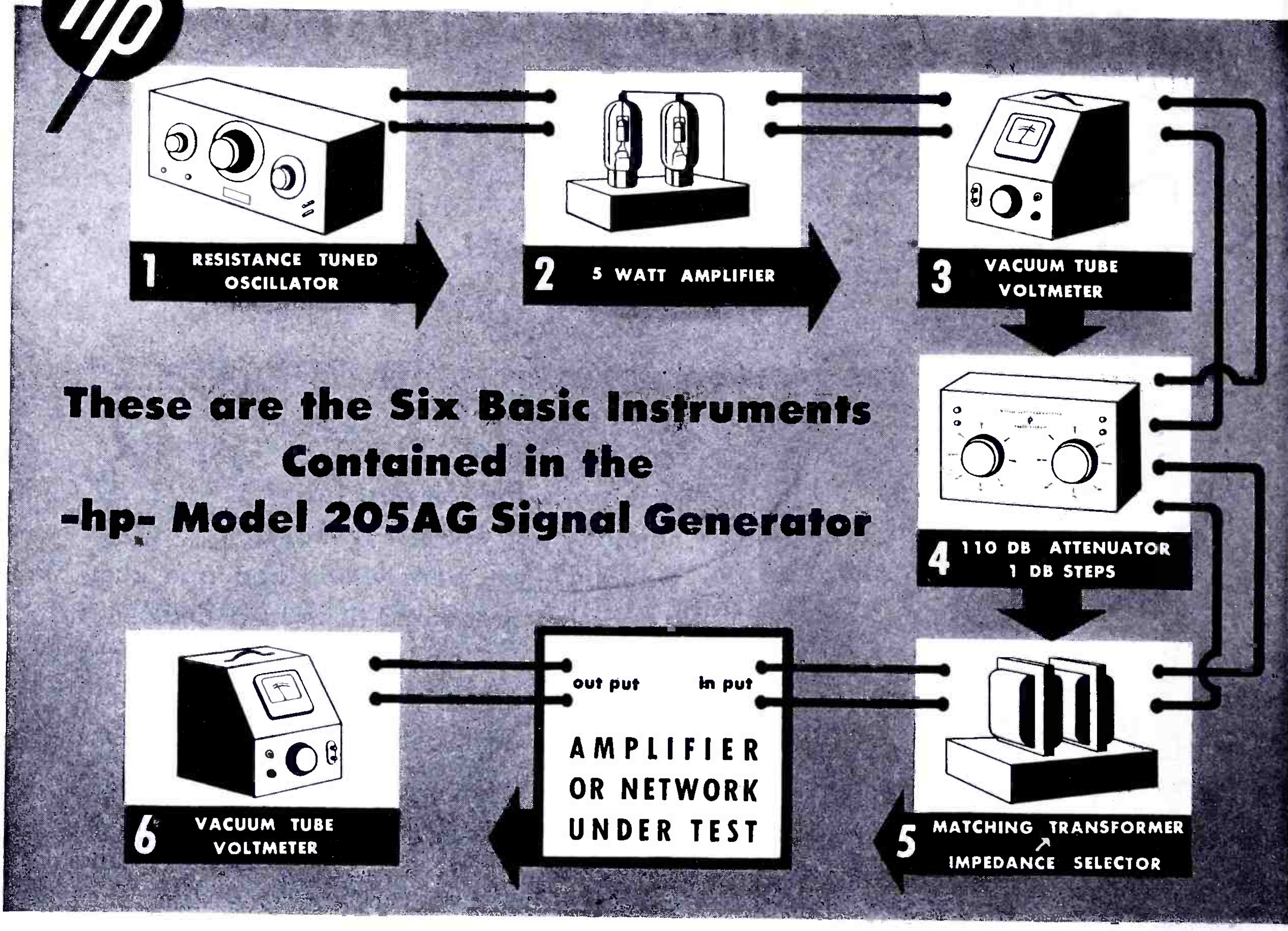
What may be "unfair" in a test of Marion hermetically sealed instruments is only fair to their users. Whether you're a manufacturer or a consumer, our tests serve to prove the quality and dependability of our instruments. They are an assurance that when these "hermetics" are installed in any equipment, and used in any part of the world, their trouble-free performance will be sustained. Remember — Marion glass — to — metal hermetically sealed instruments are positively interchangeable, and cost no more than standard conventional types. Write for our 12-page brochure.

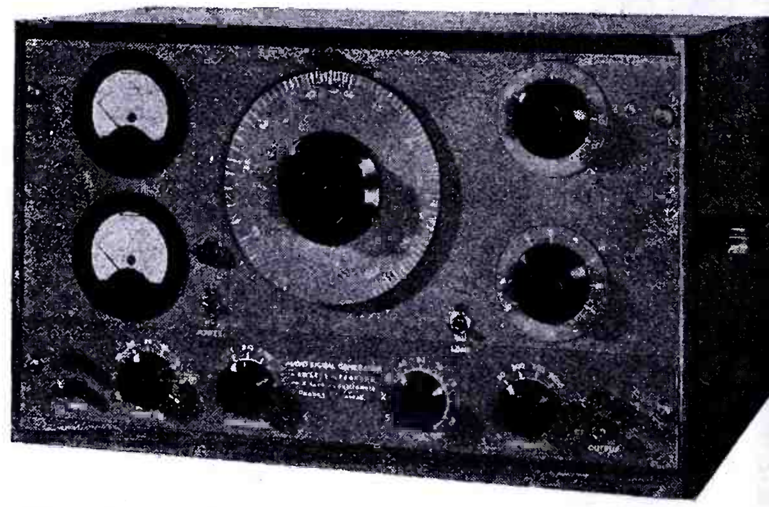
Marion Glass-to-Metal Truly Hermetically Sealed 2½" and 3½" Electrical Indicating Instruments

MARION ELECTRICAL INSTRUMENT CO.
MANCHESTER, NEW HAMPSHIRE

WHAT CAN MARION "HERMETICS" DO FOR ME? WRITE—WE'LL SUPPLY THE ANSWER

LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY





In order to reduce the task of making gain measurements to the most simple routine possible, *-hp-* engineers assemble all the necessary instruments into a single compact unit. To make amplifier gain measurements, it is necessary only that the operator connect input and output leads to the binding posts provided.

Any desired frequency within the range of 20 to 20,000 cps is made available by the resistance-tuned audio oscillator. Such frequencies are developed at any desired voltage between 150 volts and 50 micro-volts.

There are two vacuum tube voltmeters provided, one to measure input and the second to measure output. The input meter has a range of minus 5 db to plus 49 db, with an input impedance of 5000 ohms.

The output impedance can be instantly changed to the commonly used impedances of 50, 200, 500 and 5000 ohms which is very convenient for matching various types of networks. Furthermore, these impedances are balanced to ground and center tapped. The Model 205AG will supply 5 watts output with less than 1% distortion.

The *-hp-* Model 205AG, providing as it does the six basic instruments in a convenient unit, saves much valuable time in making audio frequency measurements. Its accuracy and versatility, coupled with the extreme ease with which measurements can be accomplished, make it an asset to any electronic laboratory or production line. Ask for more complete information. No obligation, of course.

HEWLETT-PACKARD COMPANY

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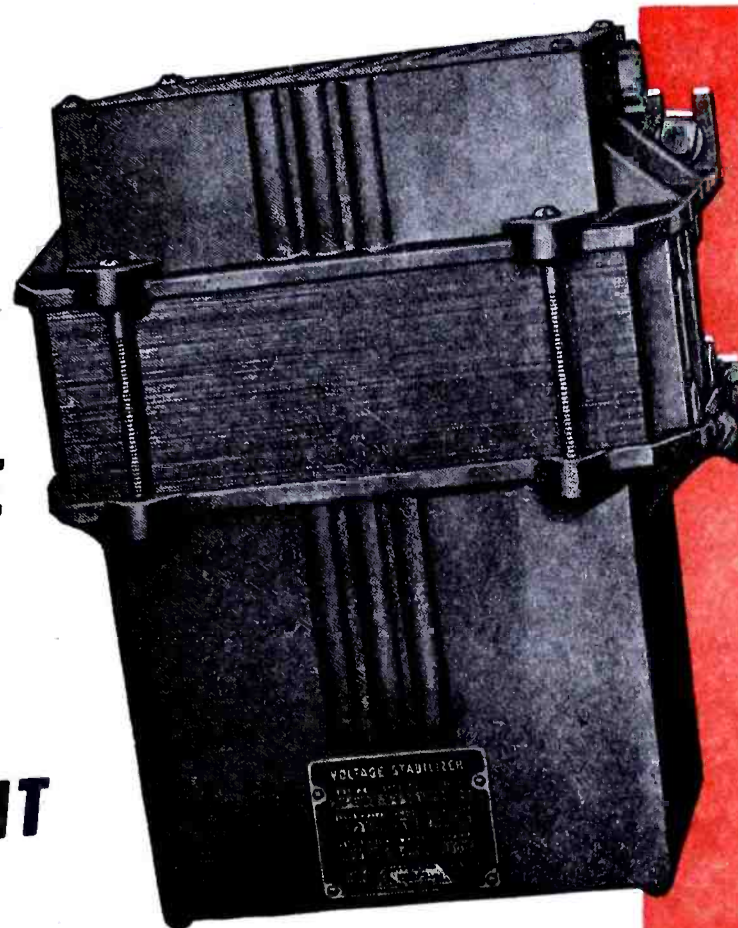
Square Wave Generators · *Audio Frequency Oscillators* · *Signal Generators* · *Vacuum Tube Voltmeters* · *Electronic Tachometers* · *Attenuators* · *Noise and Distortion Analyzers* · *Wave Analyzers* · *Frequency Meters* · *Frequency Standards*



Step Up THE ACCURACY OF YOUR OPERATING EQUIPMENT with *Raytheon Voltage Stabilizers*

LINE VOLTAGE may vary between 95 and 130 volts. If not stabilized at the input side of your equipment, this variation can cause highly inaccurate performance.

Get a close-up of the kind of performance your equipment can deliver when teamed with a magnetic-type Raytheon Voltage Stabilizer. Inquire now.

Raytheon Voltage Stabilizers are at work in such varied fields as:

RADIO • TELEVISION • COMMUNICATIONS • RADAR • MOTION PICTURES • SOUND RECORDING • ELECTRONIC DEVICES • CONSTANT SPEED MOTORS • PRODUCTION MACHINERY • SIGNAL SYSTEMS • X-RAY EQUIPMENT TESTING AND LABORATORY EQUIPMENT

Write today for Stabilizer Bulletin DL48-537. Get the story complete.

- ★ **Control of output voltage to within ±½%.**
- ★ **Stabilization at any load within rated capacities from 95-130 V.**
- ★ **Quick response. Stabilizes varying input voltage within 1/20 second.**
- ★ **Entirely automatic. No moving parts. No maintenance. No adjustments.**
- ★ **Won't overheat. Temperature rise is within 55° C.**

RAYTHEON
MANUFACTURING COMPANY
WALTHAM 54, MASS.

ELECTRICAL EQUIPMENT DIVISION
Excellence in Electronics

TOUGH JOBS WANTED

Final operation in assembly of a 110-volt radio control unit. Metal and plastic parts made by Remler.

Telephone Type Plugs

Signal Corps • Navy Specifications

PLUG NUMBER	NUMBER CONTACTS	TYPE SLEEVE	SEE NOTE
PL47	2	Long	
PL54	2	Short	1
PL55	2	Long	2
PL55K	2	Shoulder	
PL68	3	Long	3
PL124	2	Short	1
PL125	2	Long	2
PL155	2	Off Set	2
PL354	2	Short	1
PL540	2	Short	1
B-180207	2	(Lock-Nut)	2
CAU-49109	2	Long	2
CRL-49007A	3	Long	3
NAF-1136-1	2	Long	2
NAF-212938-1	3	Long	3
NAF-215285-2	2	Short	1

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

OTHER DESIGNS TO ORDER

FOR TWENTY-SEVEN YEARS Remler has been favorably known as an electronic engineering organization composed of a closely knit group of specialists, qualified by training and experience to produce radio, electronic components and complete sound equipment • In the near future Remler facilities will again be available for the mass production of electronic components in metal and plastics and the custom production of radio, sound transmitting and amplifying equipment.

Inquiries invited, write—

REMLER COMPANY, LTD. • 2101 Bryant St. • San Francisco, 10, Calif.

REMLER

SINCE 1918

Announcing & Communication Equipment

No Brass Hats Here-- JUST BRASS TACKS!

GATES RADIO CO.

OURS is a moderate-sized, compact organization in which everyone from the chief executives to the kid who runs the blue print machine is dedicated to just one purpose. That purpose—to design and build efficient, dependable Radio Transmitting Equipment—our exclusive specialty.

We have been at it successfully since 1922—long enough to gain genuine, practical know-how in every phase of the business. That experience, plus engineering ability and precision workmanship, add up to the kind of Equipment which appeals to Engineers and Station Managers alike.

Let us tell you more about GATES Transmitting Equipment—and about the GATES Priority System for Prompt Post-War Delivery! Write today!

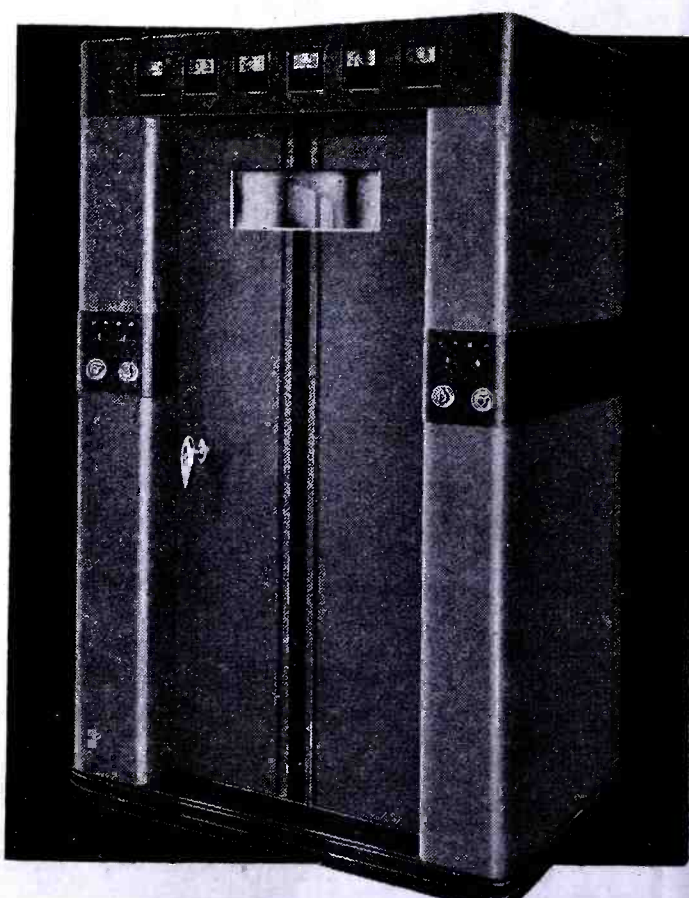
GATES RADIO CO. • QUINCY, ILLINOIS

GATES ONE KILOWATT BROADCAST TRANSMITTER

This new Transmitter, utilizing many wartime developments, will meet the exacting demands of peacetime broadcasting. Its proven dependability—plus its modern, streamlined appearance—fit it perfectly into tomorrow's Radio Station. Accurately engineered, with all parts conveniently accessible. The pressure-type cabinet keeps out dust and helps assure cool operation. High fidelity performance.

Detailed bulletin on the GATES 1 KW Transmitter will soon be available.

GATES *is now in full production on civilian equipment and can make prompt delivery on many popular items.*



GATES RADIO CO. QUINCY, ILLINOIS

EXCLUSIVE MANUFACTURERS OF RADIO TRANSMITTING EQUIPMENT SINCE 1922

WHY CHOOSE UTC?

FOR WAR AND POSTWAR COMPONENTS

1 – UTC IS THE LARGEST TRANSFORMER SUPPLIER TO THE COMMUNICATIONS INDUSTRY.

2 – THE SCOPE OF UTC PRODUCTS IS THE WIDEST IN THE INDUSTRY.

3 – UTC ENGINEERING LEADERSHIP IN THE INDUSTRY IS ACCEPTED . . . WE DESIGN TO YOUR NEEDS.

4 – THE QUALITY OF UTC PRODUCTS IS HIGHER THAN EVER.

5 – THE DEPENDABILITY OF UTC PRODUCTS IS BACKED BY MANY YEARS OF EXPERIENCE. UTC IS NOT A WAR BABY.

6 – UNEXCELLED PRODUCTION FACILITIES MAKE UTC'S PRICES RIGHT AND DELIVERIES ON TIME.

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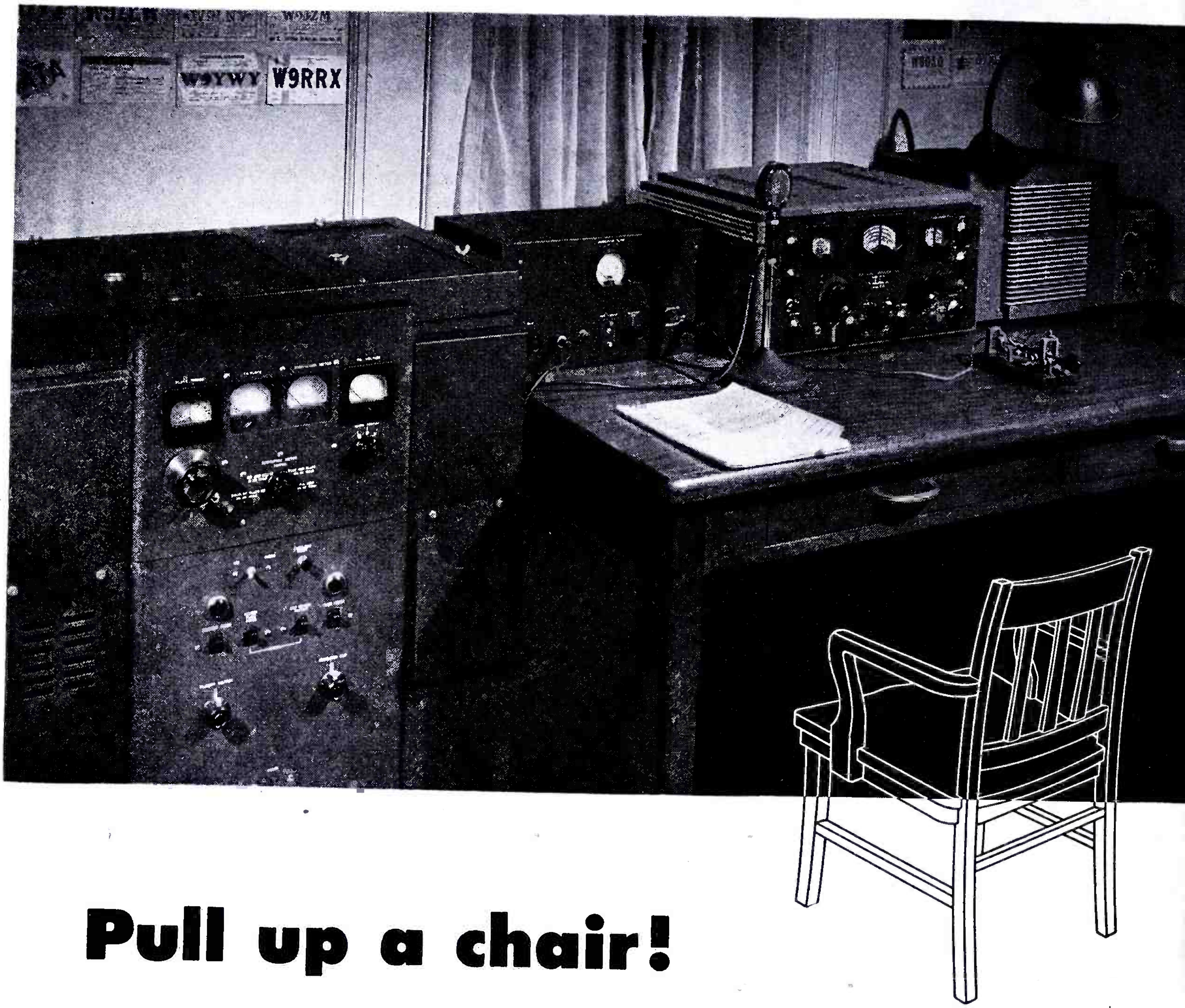
ARMY NAVY ALL PLANTS

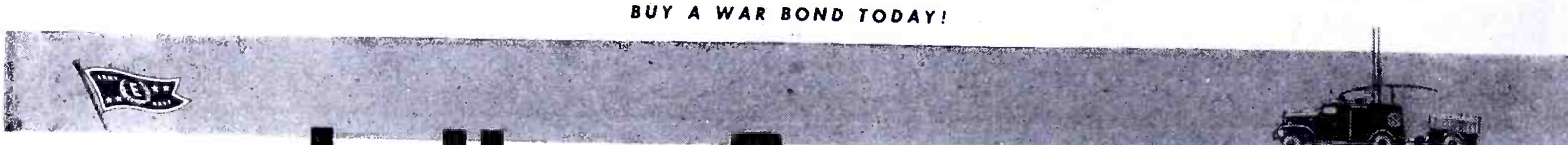


Pull up a chair!

Get a ringside seat at the ideal ham shack of tomorrow. The above picture was made at Hallicrafters Ham Shack on the Boulevard, in Chicago. But no picture can represent, no artist can paint what Hallicrafters has in store for the amateurs when the demands of war production are relaxed. Rugged, dependable, sensitive high frequency transmitters and receivers — like the HT-4 which went to war as the famous mobile radio station SCR-299 and the SX-28A, the great communications receiver — belong in the postwar picture of your ideal ham shack. Hallicrafters equipment has been constantly refined and developed under the fire of war. In peace it will come closer than ever to meeting the exacting requirements of the radio amateur who has played such a prominent part in the progress of all radio and who assumed such a valuable role in war communications.

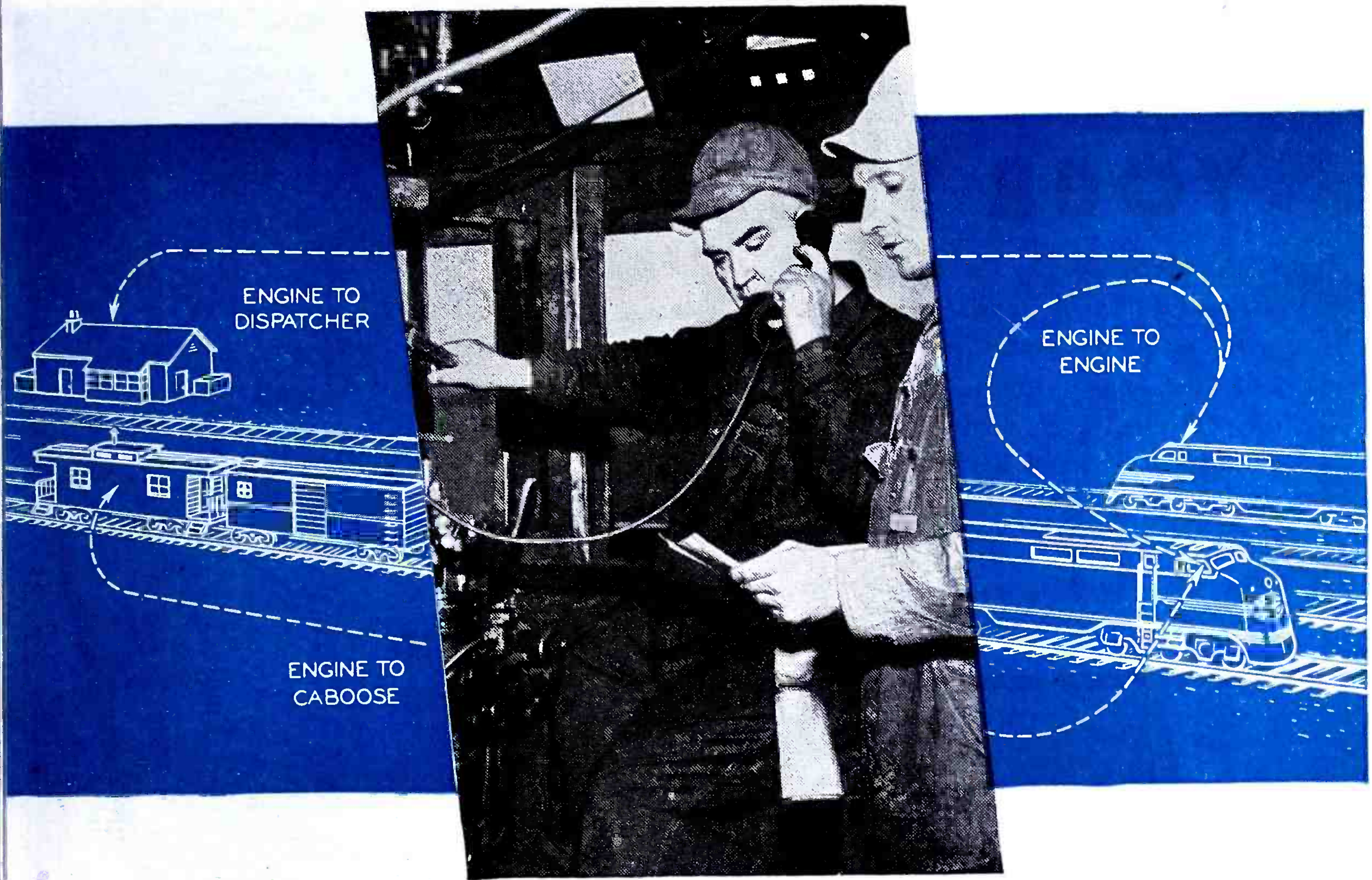
Even now you can "pull up a chair" in your ideal ham shack by sending for Hallicrafters 1945 Catalog . . . a fascinating piece of ham literature . . . detailed specifications on more than 20 models that are helping to win the radio war. Specify Catalog S-36A.

BUY A WAR BOND TODAY!



hallicrafters RADIO

THE HALLICRAFTERS CO., WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT, CHICAGO 16, U. S. A.



The basic starting point in designing transportation communications equipment is CONSTANT VOLTAGE

With a calculated operating voltage, communications equipment can be designed to operate superbly in the laboratory.

But what happens when this equipment gets into the field where voltages may vary as much as 30% from the laboratory standard? Signals become indistinct and garbled and the life of costly tubes may be prematurely shortened.

The communications equipment now being designed to provide greater safety, greater efficiency in the operation of our rail, sea, air, bus and truck transportation cannot fulfill this function if it is to rely on uncertain supply voltages. Constant voltage here is a "must".

SOLA Constant Voltage Transformers specially designed for communications equipment have been widely and successfully used before and during this war. They are the starting point in the basic design of much of the equipment now being planned for the major developments that are coming. Have you planned them into your equipment?

Consultation *now* with SOLA engineers means better communications for the future. SOLA Constant Voltage Transformers are available in standard designs in capacities from 10VA to 15KVA. Or special units can be designed to meet any requirements. SOLA Constant Voltage Transformers require no supervision or manual adjustments. No networks or moving parts to get out of order. They protect both themselves and the equipment against short circuit. They are a practical and economical solution to ever present voltage problems.

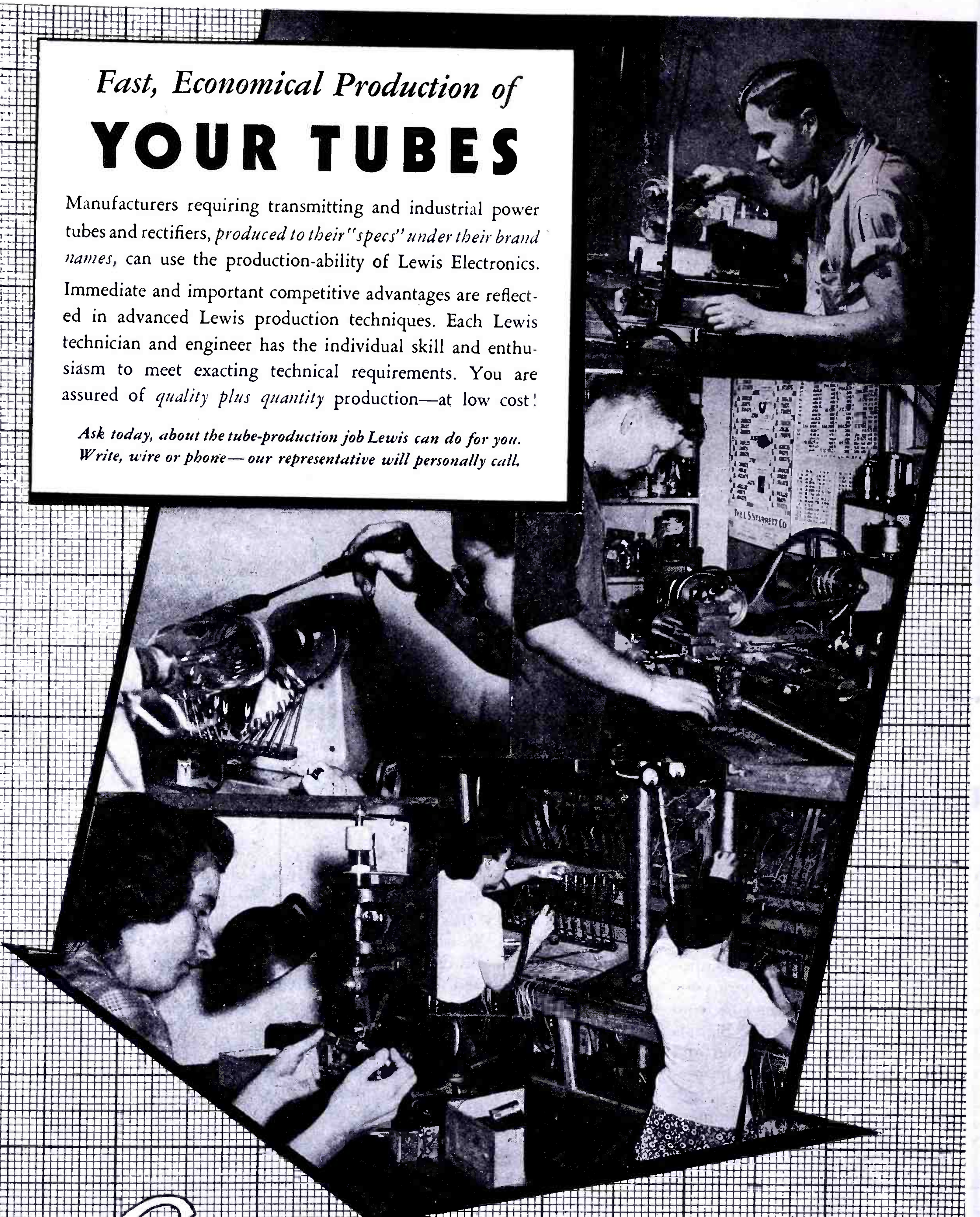
SOLA Constant Voltage Transformers

To Manufacturers:

Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.

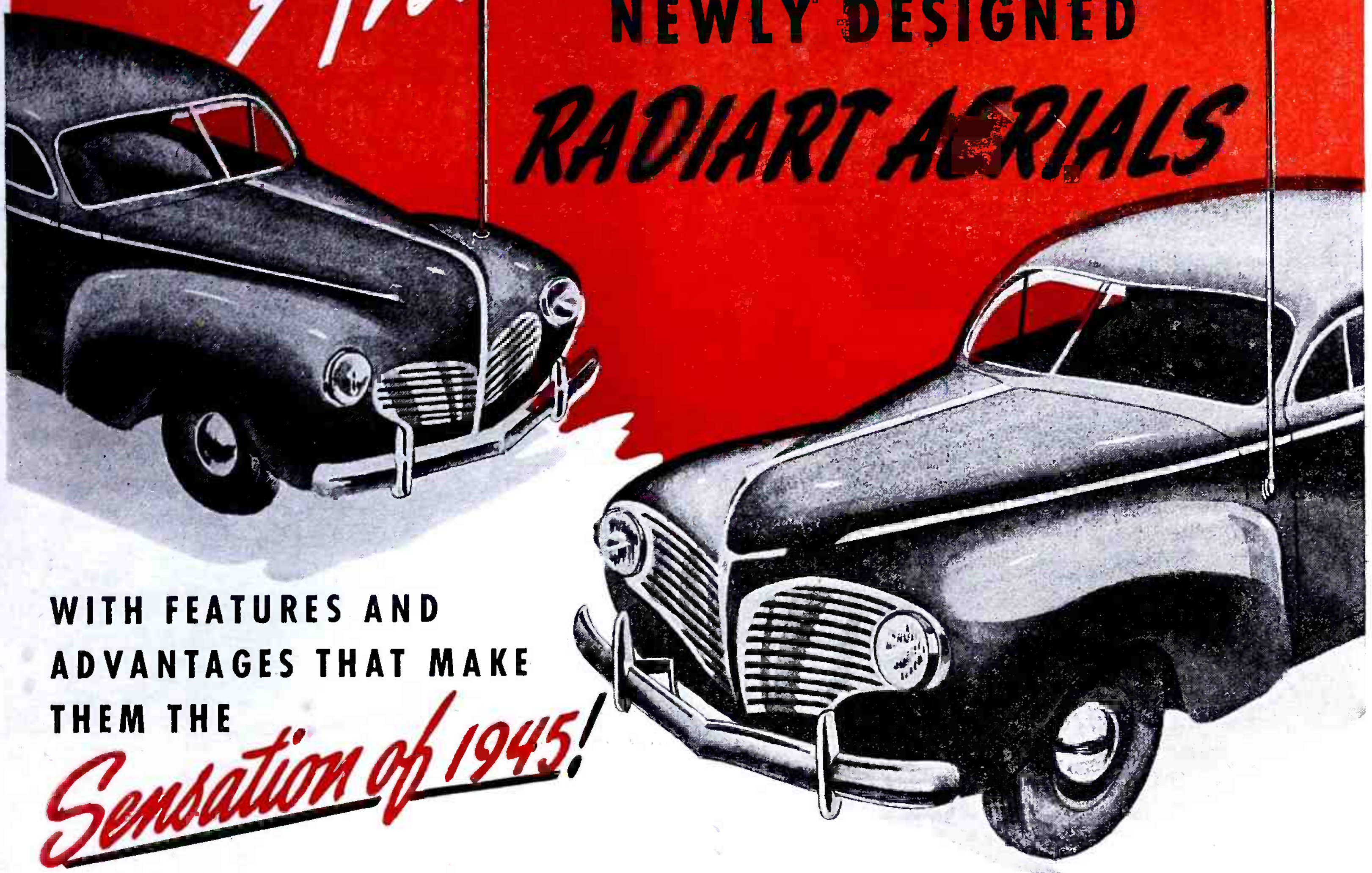
Ask for Bulletin ECV-102

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • etc. **SOLA ELECTRIC COMPANY, 2525 Clybourn Avenue, Chicago 14, Illinois**



Announcing...

NEWLY DESIGNED RADIART AERIALS



WITH FEATURES AND ADVANTAGES THAT MAKE THEM THE

Sensation of 1945!

This new RADIART Line is complete — 3 and 4 Section Models — to fit all cars — all angles — cowl, fender and under hood types — with waterproofed leads of new design featuring lowest capacity — high efficiency construction — with combination pin and bayonet fittings.

All models are made with only highest quality Admiralty brass tubing and stainless steel top section — thereby providing the maximum in elastic load limit consistent with the utmost in strength and rigidity.

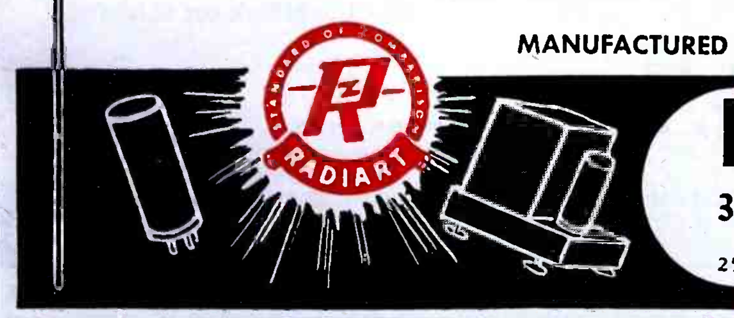
Newly designed method of mounting provides simplest form of one man installation — Mounting is completely waterproofed and impossible to short to the body.

And including those well known RADIART Features of the "Static" muffler magic ring and the permanent all-metal anti-rattler.

★ Check these RADIART advantages and features against all other aerial specifications and you will understand why RADIART AERIALS HAVE ALWAYS BEEN THE STANDARD OF COMPARISON.

Ask your distributor about deliveries of these new models.

MANUFACTURED BY THE MAKERS OF *RADIART* EXACT DUPLICATE VIBRATORS



Radiart Corporation

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Export Division
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Canadian Office
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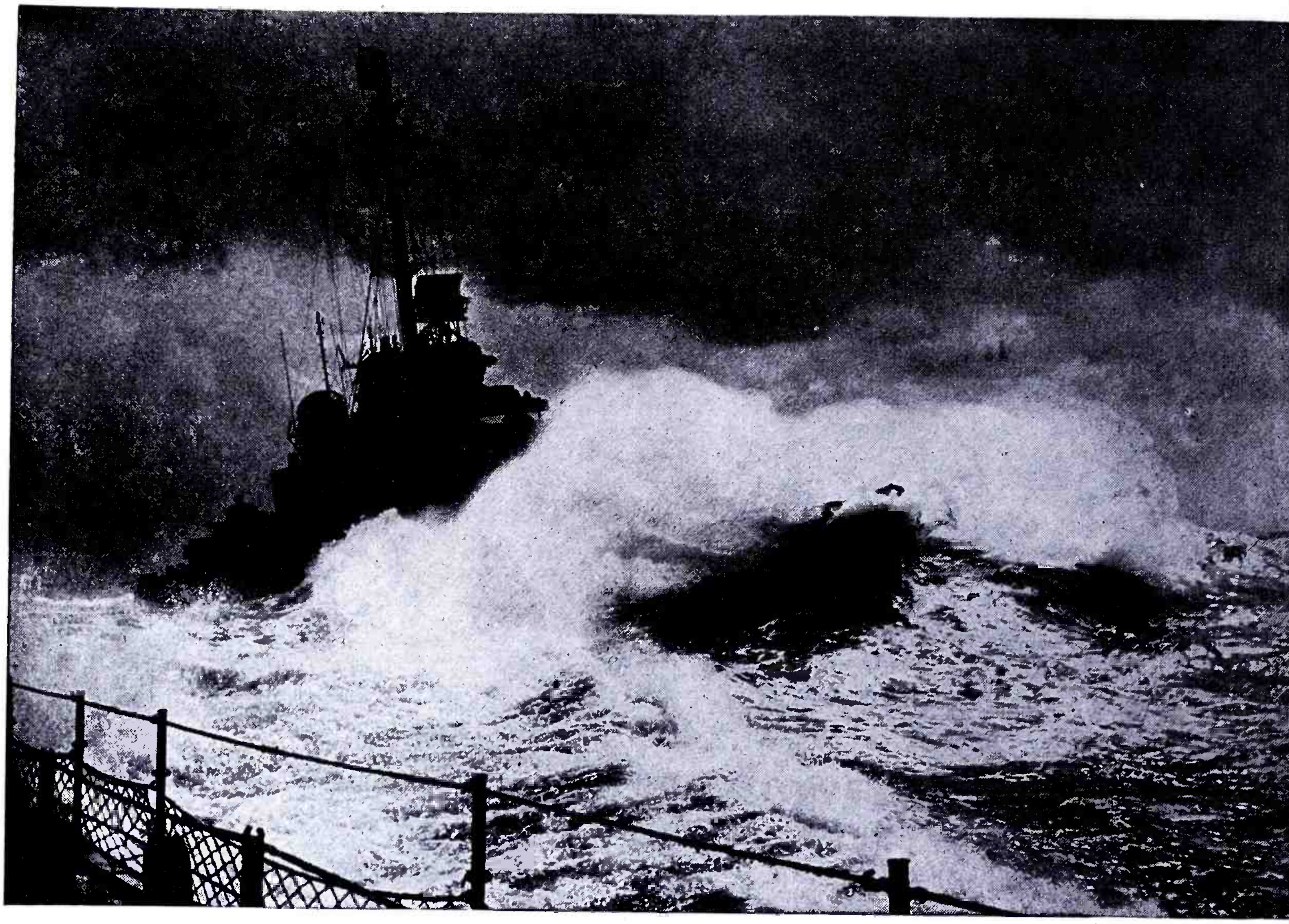
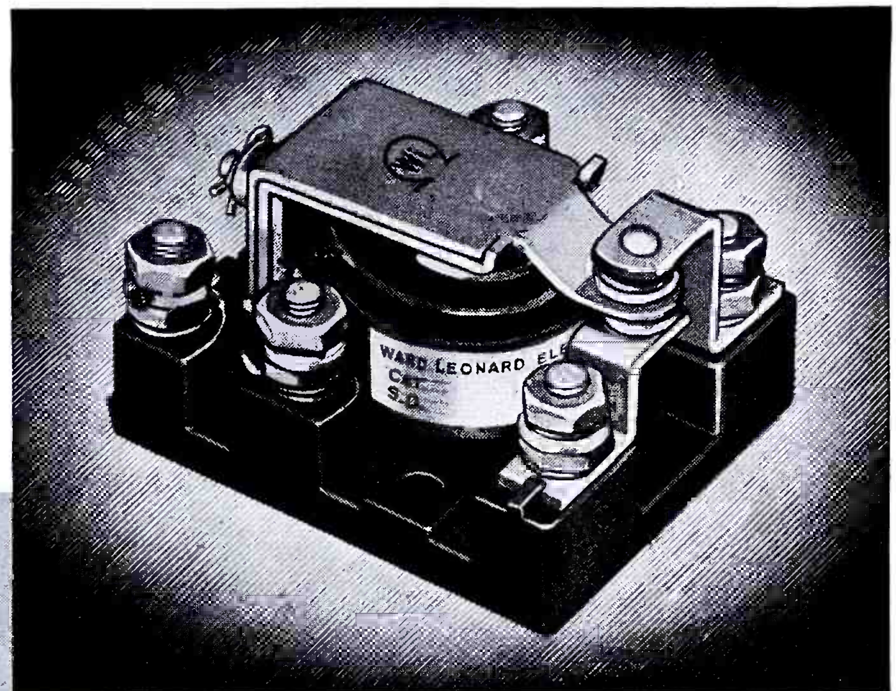
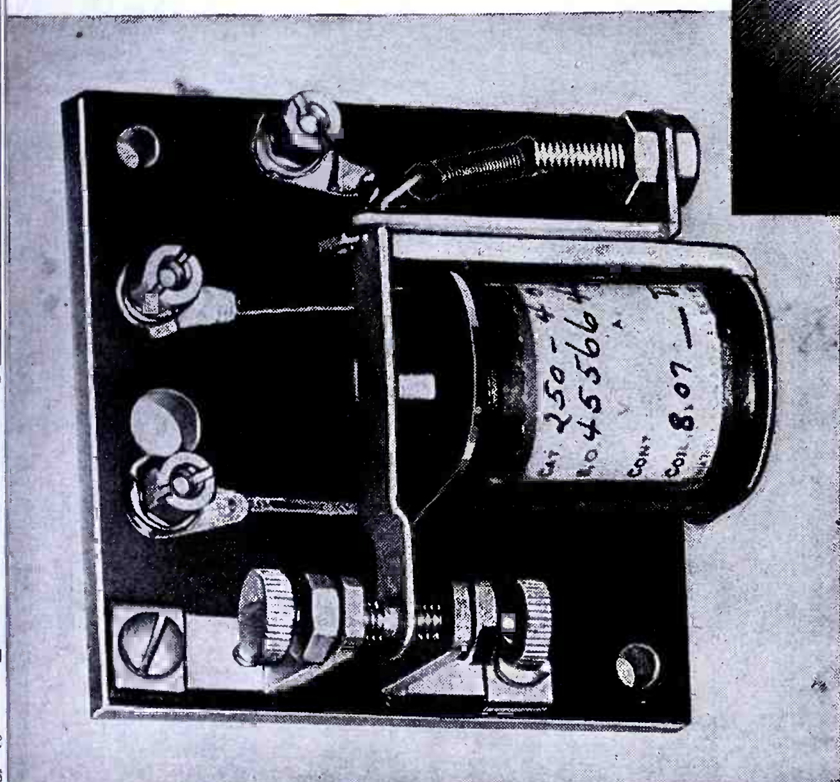


2 NEW RELAYS

Here are two of the new types of Ward Leonard Relays that are being made available to the trade through Radio and Electronic Parts Distributors.





BULLETIN 105 RELAY is useful for controlling small transmitters, public address systems, compressors, and similar devices.

Sturdily built on a molded phenolic base.

Compact in size, Single Pole unit measures 1⅞" wide x 1 15/32" long x 1½" high; Double Pole unit measures 2½" wide x 2¾" long x 1¾" high.

Single Pole or Double Pole contacts.

Available for A.C. or D.C. operation.

•

BULLETIN 250 RELAY will operate on minute fluctuations of current, and is easily adjustable to meet circuit or application requirements. It is available for operation on either A.C. or D.C.

New catalogs giving complete data on Bulletin 250 Relays and Bulletin 105 Relays are available. Write for your copy now.

WARD LEONARD ELECTRIC CO.

ARMY E NAVY

Radio and Electronic Distributor Division

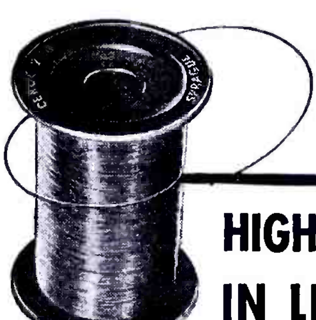
53 WEST JACKSON BLVD., CHICAGO, ILL.

WL WARD LEONARD
ACCEPTED MEASURE OF QUALITY

RESISTORS
RHEOSTATS
RELAYS

THEY'LL HELP YOU BUY AND USE CAPACITORS . . . EFFICIENTLY!

Up-to-the-minute CAPACITOR and APPLICATION DATA



HIGHER POWER IN LESS SPACE

with this new 200° C. Class C Insulation

Manufacture coils, transformers, or similar wire wound devices? Then you owe it to yourself to investigate the tremendous possibilities of *CEROC 200—the Sprague inorganic, non-inflammable wire insulation that permits continuous operation to 200° C.

Write for Bulletin 505

A lot of time and effort has gone into making these new Sprague Catalogs invaluable guides to modern Capacitor selection and use for all who buy or use Capacitors.

CATALOG 10 brings you up-to-the-minute data on time tested *Sprague Dry Electrolytic* types for practically any application. *CATALOG 20* does the same relative to the most modern line of *Paper Dielectric Capacitor* types on the market today. A copy of either or both will gladly be sent on request.

Write Today!

SPRAGUE ELECTRIC COMPANY • North Adams, Mass.

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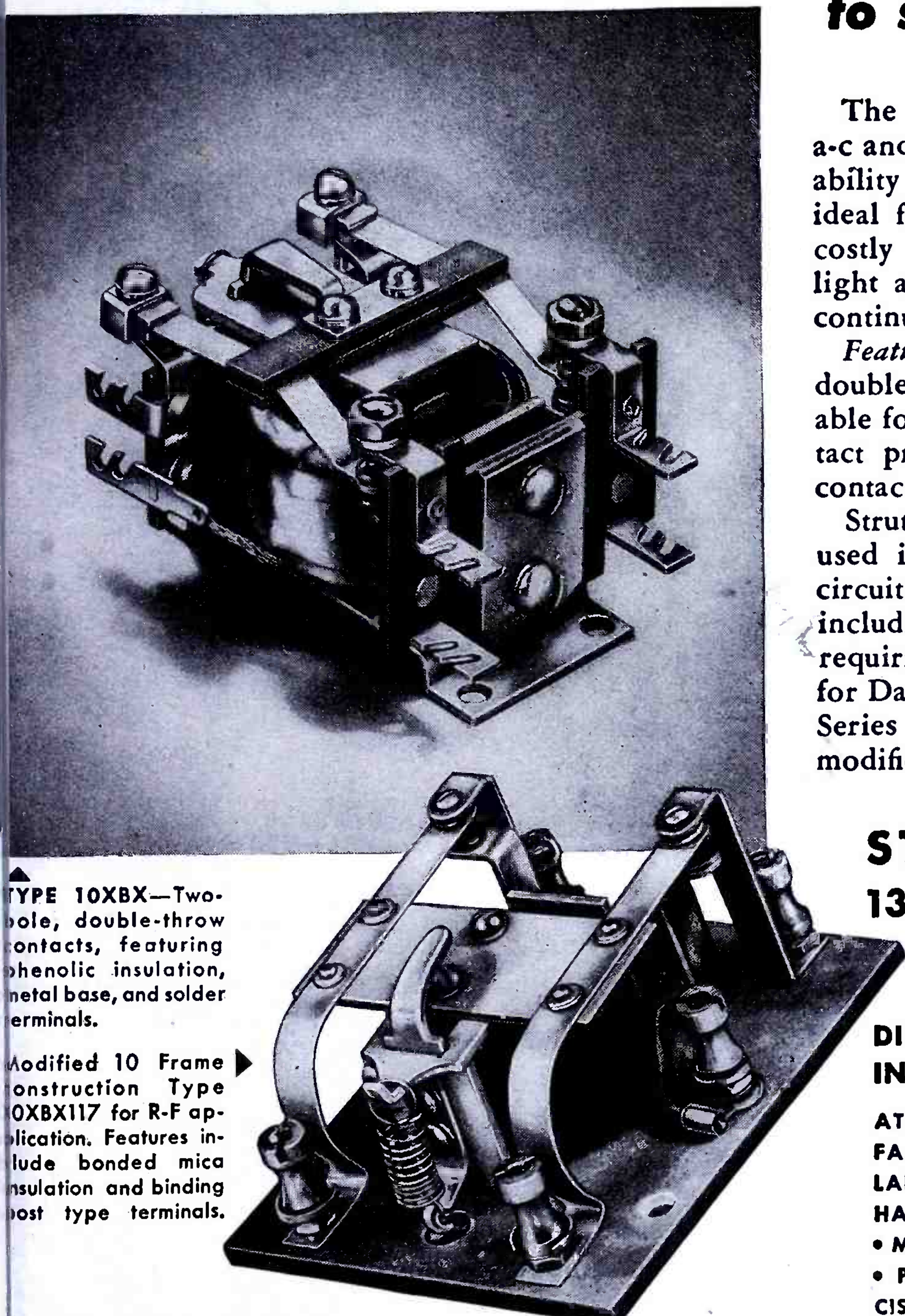
CAPACITORS—*KOOLOHM RESISTORS

A STANDARD RELAY FOR DOZENS OF SPECIAL APPLICATIONS

. . . requiring a compact light weight unit that handles plenty of power and is highly resistant to shock and vibration



TYPE 10XBX—Two-
ole, double-throw
ontacts, featuring
henolic insulation,
etal base, and solder
erminals.

Modified 10 Frame
onstruction Type
0XBX117 for R-F ap-
lication. Features in-
lude bonded mica
nsulation and binding
ost type terminals.

The design flexibility of Struthers-Dunn 10 Frame a-c and d-c relays coupled with their proven dependability under adverse operating conditions make them ideal for many applications usually requiring more costly special types. 10 Frame Relays are small and light and particularly built to withstand shock and continuous vibration.

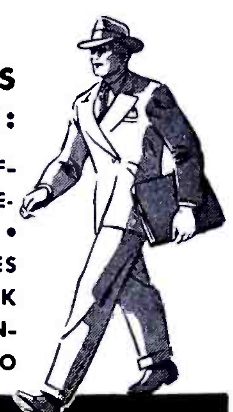
Features include: — One- to four-pole, single- and double-throw contact arrangements; insulations suitable for power or radio-frequency circuits; high contact pressures and plenty of "follow-up" for long contact life.

Struthers-Dunn #10 Frame Relays are currently used in many Radar, Radio, and Communications circuits for shipboard, aircraft and general use, including a wide variety of industrial installations requiring extra quality and plus performance. Write for Data Sheet 10-000 describing the 10-Frame Relay Series and outlining a few of the many available modifications.

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

DISTRICT ENGINEERING OFFICES IN THESE CITIES TO SERVE YOU:

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



STRUTHERS-DUNN

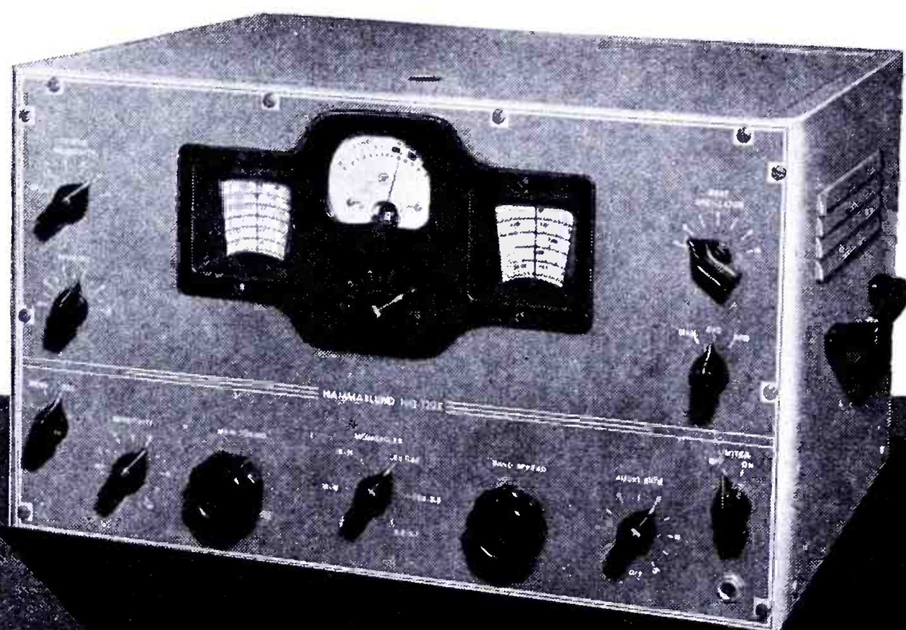
5,312 RELAY TYPES

NEW!!

"HQ-129-X"

$129.00* AMATEUR NET

LESS SPEAKER



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WRITE TODAY

A postcard will bring description of this outstanding new receiver.

FINEST LOW COST RECEIVER

By all measurement this is unquestionably one of the greatest values ever offered to amateurs . . . Here is "ham" communication at its best, streamlined for highest performance at a modest cost . . . WRITE TODAY. Send card for descriptive folder.

HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N. Y.

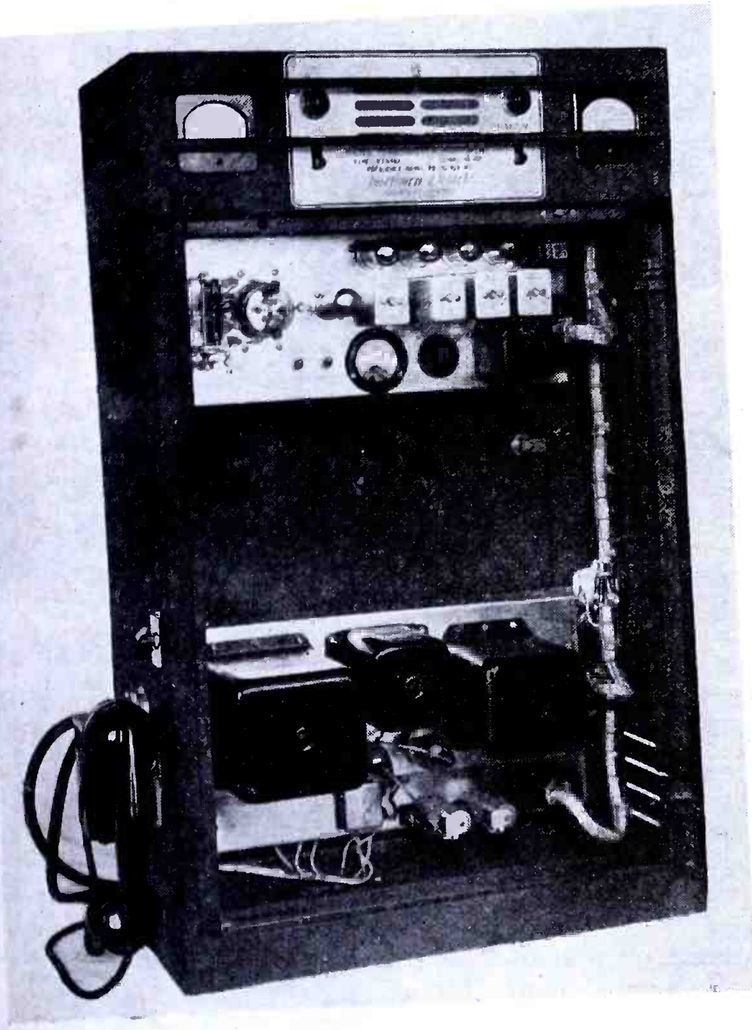
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

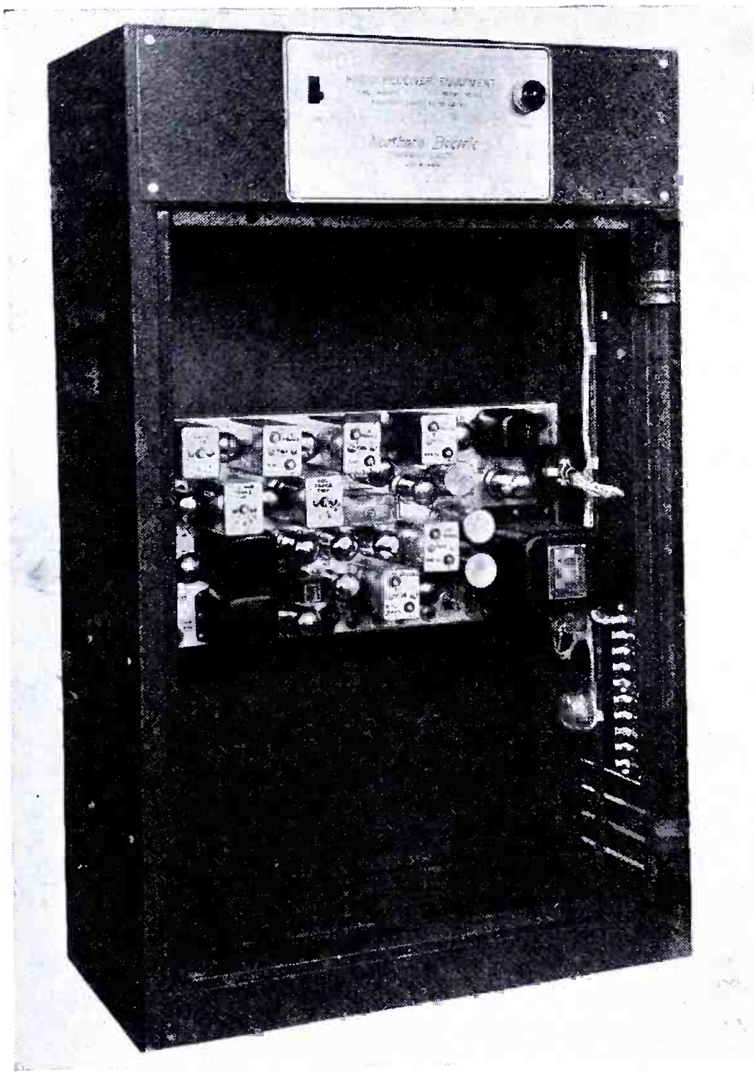
COMMUNICATIONS

LEWIS WINNER, Editor

* * SEPTEMBER, 1945 * *

Figures 1 (below) and 2 (right)
In Figure 1 we have an interior view of the Trans-Canada f-m transmitter unit. Figure 2 shows the receiver. (*Courtesy Northern Electric Co., Ltd.*)





AIRLINE V-H-F F-M SYSTEM

Trans-Canada Air Lines Network Links West Coast Island Airports To East Coast Airport Stations

by T. W. HALL

Supervisor of Ground Maintenance, Trans-Canada Air Lines

THE importance of rapid and uninterrupted point-to-point communication in the day-to-day operation of an air transport company can best be appreciated if we consider that the commodity being sold is speed. For every flight, accurate information affecting the plane's safe and efficient conduct must be conveyed to stations along the route flown and this traffic must of course precede the flight to its destination. And, in contrast to other forms of transportation where the traveler may usually purchase a ticket upon application to a ticket agent, the airline agent must first determine whether space is available on the flight in question. In order that the public may be served rapidly in this respect it is necessary to maintain accurate central

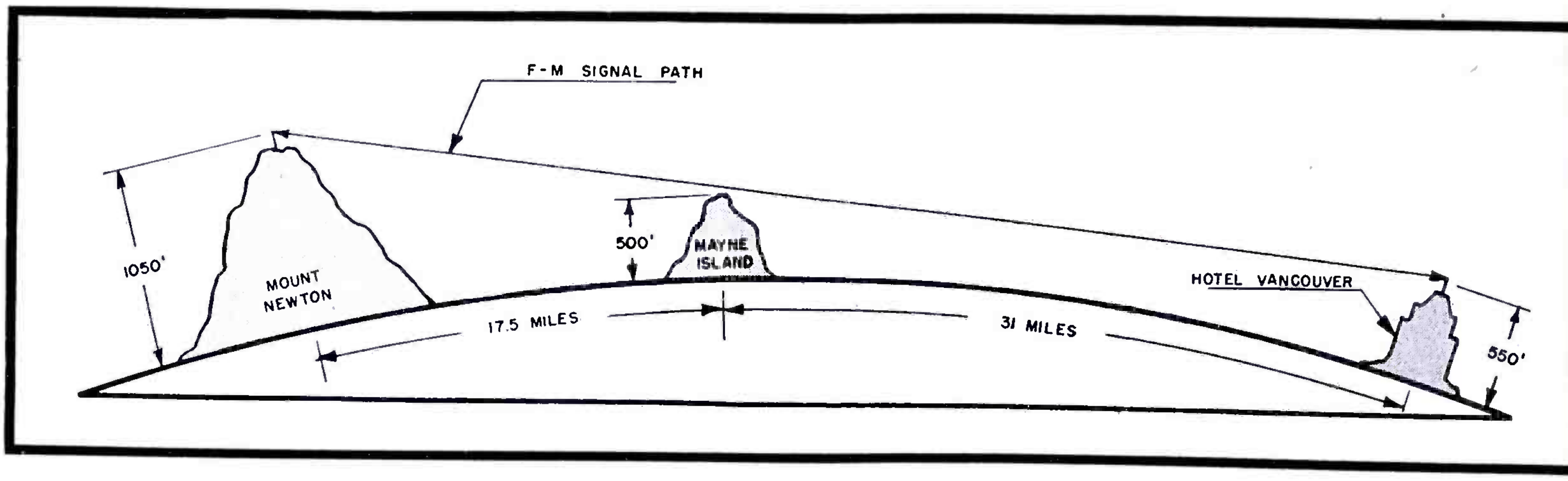


Figure 3
Antenna heights and signal paths between eastern and western terminals of the airline system.

records of seat sales and reservations throughout the system. A volume of communications traffic is involved in compiling these records alone. Approximately 10,000 messages are filed daily for space records, flight and other pertinent air-transport operations.

Land-line teleprinter circuits formed the backbone of our network until last year when we decided to extend our transcontinental service to Vancouver Island. Since wire circuits across the Straits of Georgia were not available, we decided to try radio. After an unsuccessful attempt to span this route by means of h-f circuits, a v-h-f network was tried. This was very successful and today we operate a full duplex, 73.5/95 mc f-m circuit feeding four TCA offices.

In the selection of station sites it was of course first necessary to insure an unobstructed signal path. At the same time economic considerations dictated the importance of locating the stations where they would be easily accessible the year round and in reasonable proximity to the control offices and to power outlets, with a view to minimizing initial installation and recurring maintenance costs.

Maps of the coastal area showing twenty-five foot contour intervals were studied carefully and from them profile sketches were made of a number of alternate signal paths. Although the distance involved is roughly 48 miles, largely over salt water, these sketches showed that considerable height would be required at the terminals due to the presence of a number of islands in the Straits rising as high as 700′.

A 48.5-mile signal path between the sites was finally selected. Preliminary calculations gave 90 μv/m as the signal strength which could be expected over this path, based on the use of vertical half-wave coaxial antennas. This figure was encouraging as the erection of directional arrays at the Vancouver site would have proved extremely difficult.

At the eastern terminal, the twenty-second floor of the Hotel Vancouver was selected. Two ornamental masts 20′ in height appeared to be *tailor made* for accommodation of the two antennas and by placing the transmitting and receiving racks immediately below them feeder losses were kept to a low value, the distance to each antenna being about 60′. The height of the antennas above mean sea level is approximately 550′.

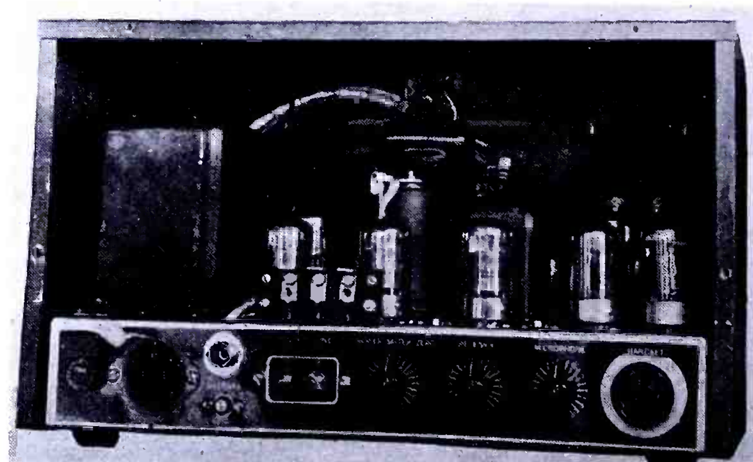
At the western terminal, we selected the top of Mount Newton, with an elevation of 1000′, a-m-s. The transmitter and receiver were separately housed and two 90′ masts were erected as closely as possible to the equipment, again to minimize feeder losses. Although an all-weather road to a public park about 100′ below the summit provided a means of access to this site, it was necessary to construct power and control lines from the airport, a distance of five miles. The antennas are of telescoping construction and were adjusted for the frequencies used before erection, which offered no serious difficulties, although at the Hotel Vancouver we did have to enlist the services of a steeplejack due to the hazard involved. The feeders are solid dielectric coaxial cable having a loss of approximately 1.8 db per 100′.

The equipment was supplied by Northern Electric of Montreal, Canada. The original design of the control circuits permitted simplex push-to-talk operation only and a number of modifications were made to adapt them to duplex operation.

The transmitter operates in the range of 70 to 100 mc, the transmitting frequency at Vancouver being 95.5 mc. and at Mount Newton 73.5 mc. The output is 50 watts into a 70-ohm load. The output is frequency modulated to a deviation of ±15 kc, this being accomplished by phase shift of a crystal oscillator operating at 1/32 of the carrier frequency.

The circuit employed to produce phase shift is somewhat novel. One

Figures 4 (left) and 5 (below)
Figure 4 shows remote control unit used in network system; meter at left indicates carrier, meter at right, line level. Rear of control unit appears in Figure 5. *(Courtesy Northern Electric Co., Ltd.)*



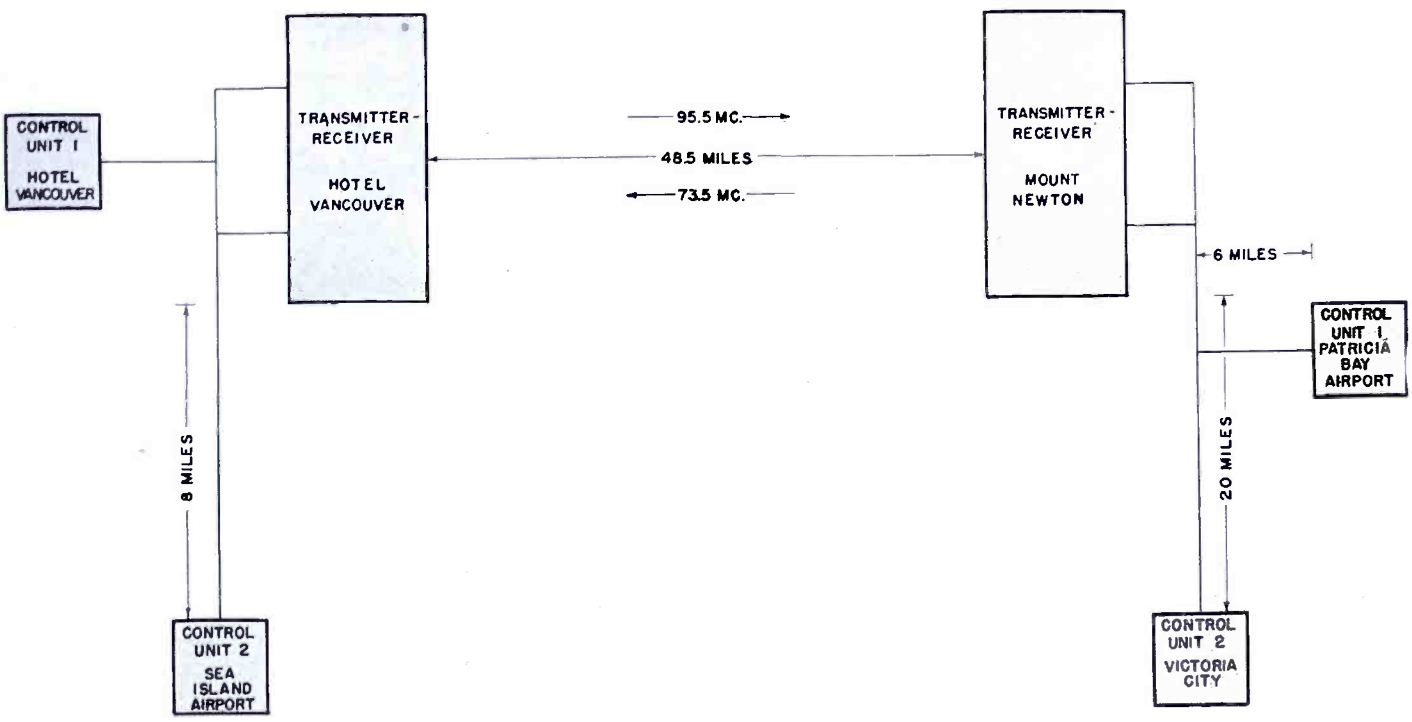


Figure 6
Control facility setup at airport and city traffic control quarters.

half of a twin triode 7F7 comprises the crystal oscillator, the crystal being connected between grid and plate in a modified Pierce circuit. The other half of the 7F7 is used as the phase modulator, the output of the oscillator section being coupled into its grid. The phase modulator's plate circuit is tuned to the fundamental oscillator frequency and r-f energy is fed from the grid circuit in two ways, one due to the direct grid-plate capacity and the other to the tube amplification. The degeneration resulting from the unbypassed cathode resistor maintains these two voltages at approximately equal values and somewhat less than 180° out of phase. The bias on the grid of the phase-modulator section is then varied at an a-f rate causing the amplified voltage across the plate tank to vary in a similar manner. The result is a current through the output inductance which varies in phase and frequency. To obtain a frequency deviation of 15 kc at the carrier frequency the output of the modulator is then multiplied by a factor of 32, this being accomplished through a frequency quadrupler stage employing a 7W7 tube and three frequency-doubler stages using 7C5 tubes. The output of the third doubler at the carrier frequency is coupled to the grids of an 815 power amplifier operated push-pull class *C*.

The receiver covers the same frequency range as the transmitter and employs fifteen tubes in a triple-conversion supreheterodyne circuit. The signal frequency (95.5 mc at Mount Newton, 73.5 mc at Vancouver) is converted to the first i-f by heterodyning it with the amplified 8th harmonic of a crystal-controlled oscillator giving resultants of 45.75 mc and 33.25 mc respectively. The same heterodyning voltage is used to obtain the second frequency conversion, resulting in a second intermediate frequency of 5 mc. After passing through one stage of amplification at the second i-f, the signal is fed to the third converter, a triode heptode, utilizing the triode section as a crystal-controlled oscillator at a frequency of 5456 kc, providing a third i-f of 456 kc. The signal is then passed through two limiting stages. Essentially perfect limiting action is obtained, the first limiter and preceding stages being designed so that saturation occurs with a signal input to the receiver of one microvolt. The second limiter stage is followed by a conventional Foster-Seeley discriminator. An extremely efficient squelch circuit is employed, its sensitivity being such that a signal of .1 microvolt will render the receiver operative.

The mainland station is controlled from the TCA traffic office on the lobby floor of the Hotel Vancouver and from the airport office at Sea Island, a distance of eight miles from the hotel. The island station is controlled from the airport office at Patricia Bay, a distance of six miles and the traffic office in midtown Victoria, a distance of 20 miles from Mount Newton. Two pair of lines from each control station are required to carry the control and audio circuits and since these were leased lines forming part of commercial telephone cables, particular attention was paid to the matter of line termination and balance to avoid cross-talk interference with other services. Each line is terminated in standard, 1 : 1 impedance ratio Western Electric repeating coils, the center taps being utilized in phantom for d-c control of the transmitters.

Each of the control offices is supplied with a compact desk mounting control unit comprising a two-stage amplifier to bring the microphone output of a standard hang-up handset to the level required for modulation of the transmitter, a single-stage amplifier to raise the output of the receiver line to loudspeaker level, and a power supply which, in addition to providing plate and filament power for the amplifiers also supplies 50 volts d-c for operation of the carrier-control relays. The control units at the Sea Island and Victoria offices which feed the longest lines are so arranged as to correctly terminate the latter while the

(*Continued on page* 90)

STEPPING UP TRANSMITTER

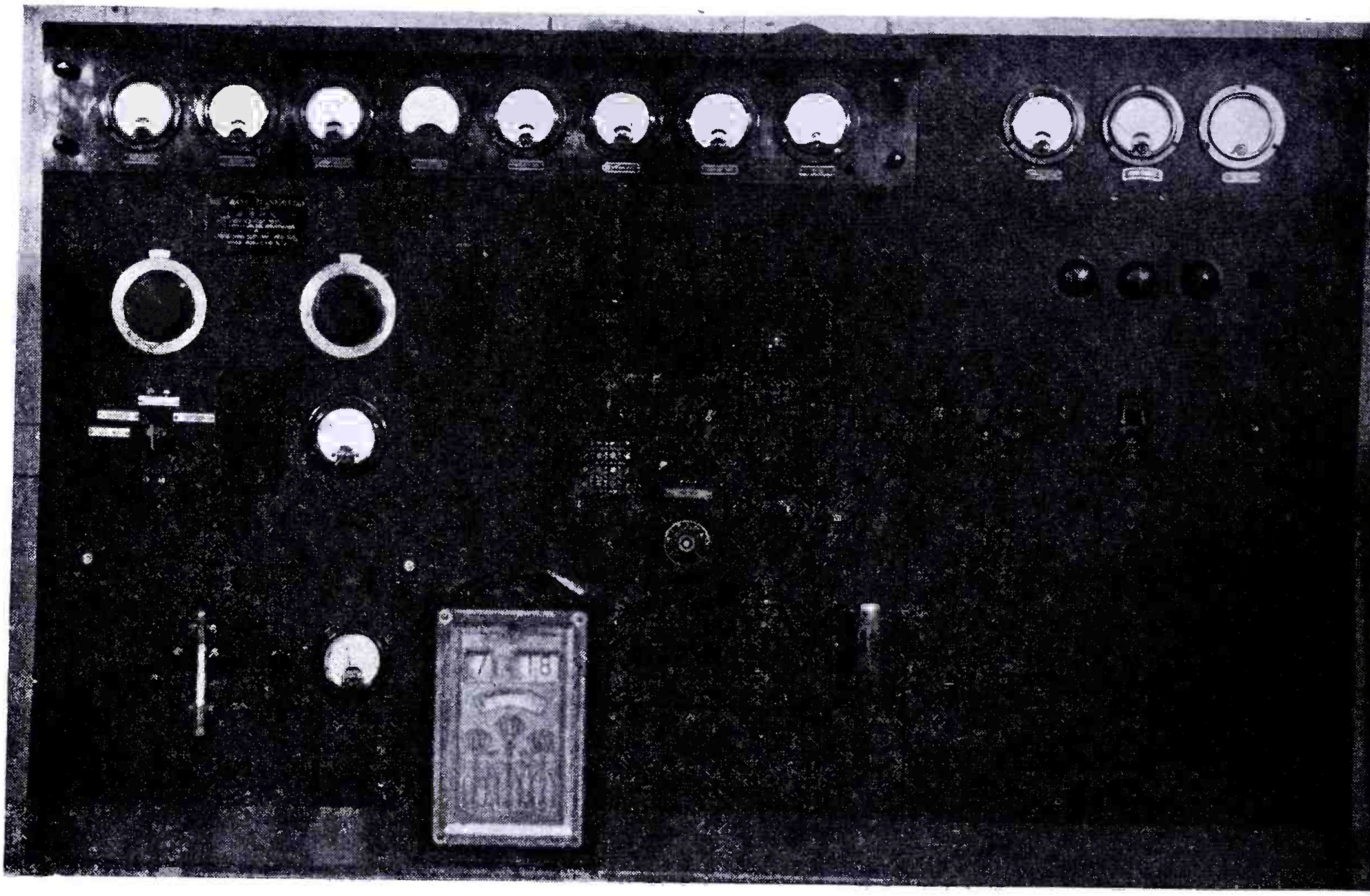


Figure 1
Composite revamped 1-kw transmitter. Final amplifier with HF-200 tubes are behind upper grill.

IN 1941, just prior to Pearl Harbor, we were scheduled to increase WSPR's power from 500 watts to 1 kilowatt. Our program called for a modification of the 500-watt unit, which was about 5 years old. This conversion was to be effected by using larger rating final amplifier tubes, modulators and increasing power handling capacities of certain components.

Fortunately, generous design of most of the original parts proved helpful in lessening the number of items that would have had to be scrapped and replaced. Some refinements, not incorporated in the original design seemed desirable too.

After a canvass of available tubes to replace the eight 75-watt type 203A's in the final amplifier, and the four 203A's in the modulator we chose the HF-200. The HF-200, rated at 125 watts by the FCC, could use the 203A socket. Thus the required eight tubes could be substituted in the same sockets. And, since the characteristics were not too dissimilar, the circuit changes were minimized.

An entirely new 1,750-volt power supply had to be built. In addition a new modulation transformer of increased rating was required. We were able to locate this and several other parts in a foreign country and import them under license. The necessary larger tank capacitors, meters, relays, etc., were obtained through the help of the *NAB Swap Bulletin*. Disassembled high-power ham equipment also came in handy, yielding a few high-voltage standoff insulators, sockets for the new rectifier, meters and relays.

Just when it appeared as if we would be able to proceed with construction, the FCC adopted its *Memorandum Opinion* which forbid the *use* of criti-

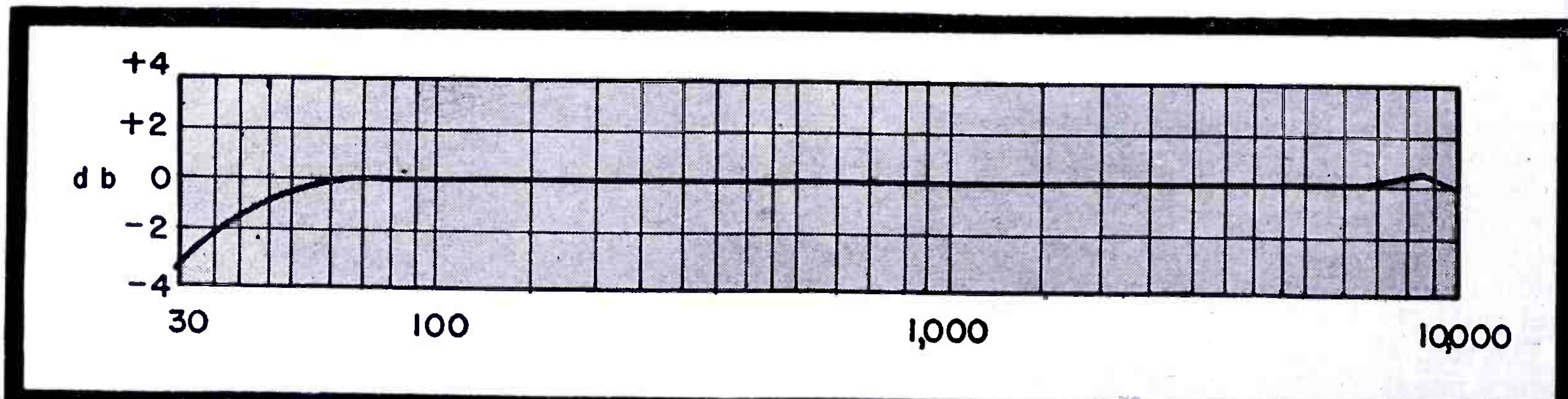


Figure 2
Frequency response plot of modified transmitter; carrier hum is more than 50 db below 100% modulation.

POWER FROM 500-W TO 1-KW

While Maintaining a Daily 17-Hour On-the-Air Schedule

by LAWRENCE A. REILLY

Chief Engineer, WSPR

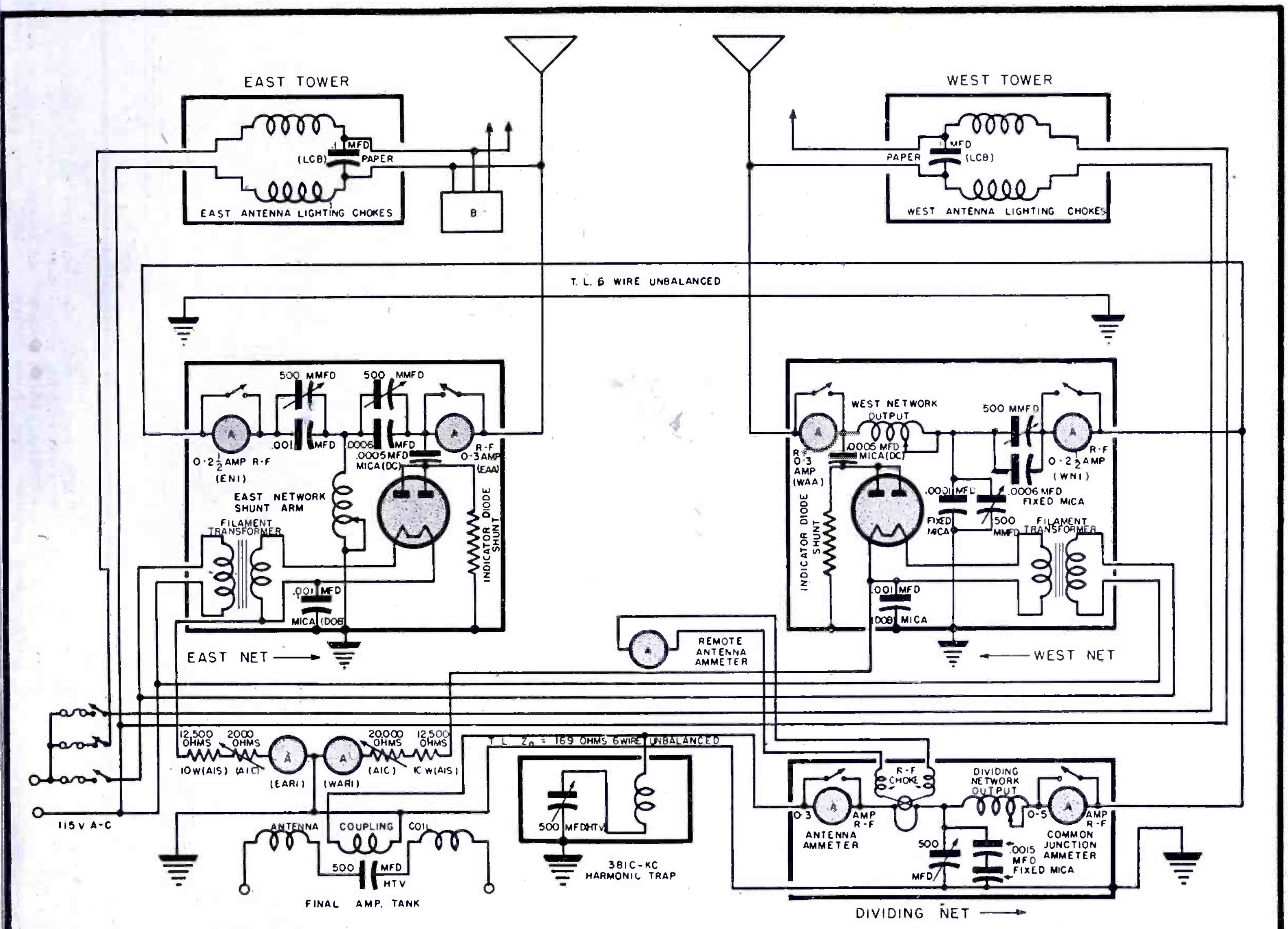


Figure 3
Antenna system at WSPR. WNI, west network input ammeter; WAA, west antenna ammeter; ENI, east network input ammeter; EAA, east antenna ammeter; WARI, west antenna remote indicator; EARI, east antenna remote indicator; AIS, antenna indicator series resistors; AIC, antenna indicator calibrating rheostats; DC, diode coupling capacitors; DOB, diode output bypass capacitors; HTV, harmonic trap variable capacitor; LCB, lightning-choke bypass capacitor.

cal materials for new construction. By its provisions, even with the necessary material already on hand, the construction could not be authorized. Thus we had to shelve our plans until April 18, 1944 when we received word that the restrictions had been lifted and we could proceed with our alterations.

Because the transmitter must remain on the air from 7 a.m. to midnight, all work had to be done during the *off-air* hours. That meant going to work on section by section, taking one section per night and getting it back in order again in time for sign-on in the morning. Roughly, if work began at midnight, dismantling had to be completed by about 3 a.m. and reassembly begun. Thus, only about one half the *off-air* time was available for construction, the remainder of the time being required for reassembly and test.

The first unit assembled was the 1,750-volt power supply. Then the HF-200 modulators were hooked up to the new, larger, modulation transformer and tested. In the next step the HF-200's were placed into the final amplifier, the associated circuits adjusted and placed in operation, but only on 500-watts power output. The final steps called for the installation of the power-change relay, meters, and the miscellaneous items. This work was completed in about ten nights.

Where a 2,000-v capacitor replaced a 1,000-v unit, of like capacitance, the 1,000-v capacitor was passed on down to some place in the circuit to replace

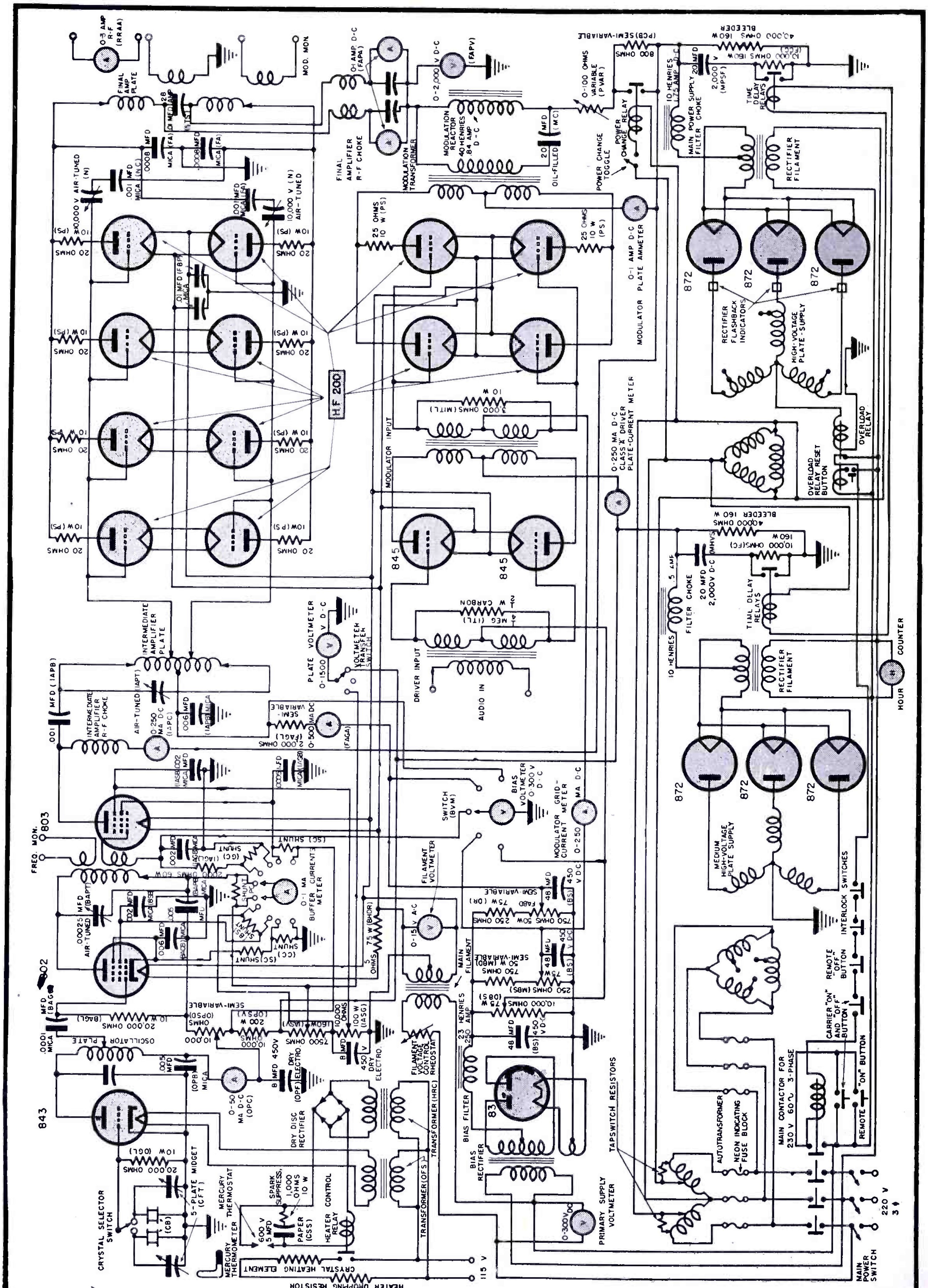


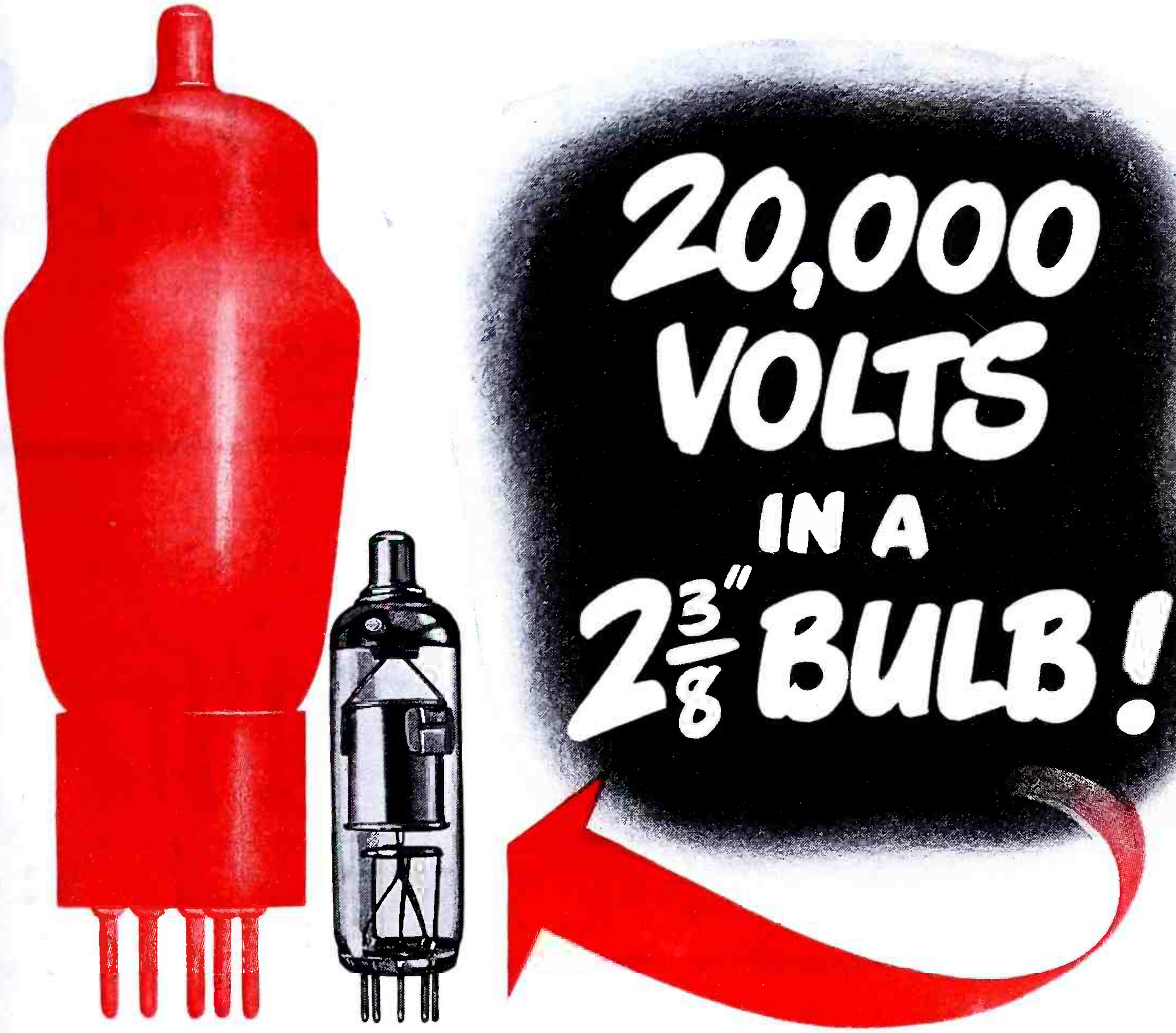
Figure 4

Complete revamped transmitter at WSPR. RRAA, remote reading antenna ammeter; FAPA, final amplifier plate ammeter; FAPV, final amplifier plate voltmeter; FAGA, final amplifier grid-current ammeter; IAPC, intermediate amplifier plate-current meter; OPC, oscillator plate-current meter; STS, split-tank series capacitor; FA, final amplifier tank capacitor; N, neutralizing capacitor; FBP, filament bypass capacitor; IAPT, intermediate amplifier air-tuned plate-tank tuning capacitor; IAPB, intermediate amplifier plate bypass capacitor; IASB, intermediate amplifier screen bypass capacitor; IAGB, intermediate amplifier grid-leak bypass capacitor; BAPB, buffer amplifier plate bypass capacitor; BAPT, buffer amplifier plate-tank tuning capacitor; BACB, buffer amplifier cathode-bias capacitor; BAGC, buffer amplifier grid-coupling capacitor; and OPF, oscillator plate-supply. [*Additional identity data will appear in October* COMMUNICATIONS.]

a 500-v unit. Thus, a minimum of new parts were used. Similarly, a 1,000-ma meter replaced a 500-ma meter, and this one was handed down to 250-ma circuit, etc.

The schematic of the transmitter appears in Figure 4. One of the transmitter features provides for the use of eight low-power tubes in push-pull-parallel in the final amplifier and four similar tubes in the modulator. Experience has shown that this practice minimizes the variety of spare tubes that must be carried on hand, and thus

(*Continued on page* 89)



ANOTHER "FIRST" BY NATIONAL UNION RESEARCH LABORATORIES

AN example of how war-time research by National Union engineers is helping to lay the foundation for vastly improved post-war Television, FM and radio reception, is this new half wave high vacuum rectifier—the NU 1Z2.

Here is a miniature with the voltage handling capabilities heretofore possible only in full size tubes. For a high voltage rectified supply in the operation of radar and television equipment, the NU 1Z2 saves space—operates with increased efficiency—is exceptionally rugged. Its low filament power consumption suggests many new fields in circuit design and application.

The NU 1Z2 joins a notable group of original electron tube developments by National Union Research Laboratories. For progress through research—count on National Union.

National Union 1Z2 High Voltage Rectifier

Inverse peak anode voltage-max.	20,000 volts
Peak anode Current	10 ma.
DC Output Current	2 ma.
Filament Voltage	1.5 volts
Filament Current	300 ma.

The NU 1Z2 is designed to withstand shocks in excess of 500 G's.

Maximum overall length	2.70"
Maximum seated height	2.37"
Maximum diameter	.75"
Bulb	T5½
Base Miniature Button	7 pin
Mounting position	Any

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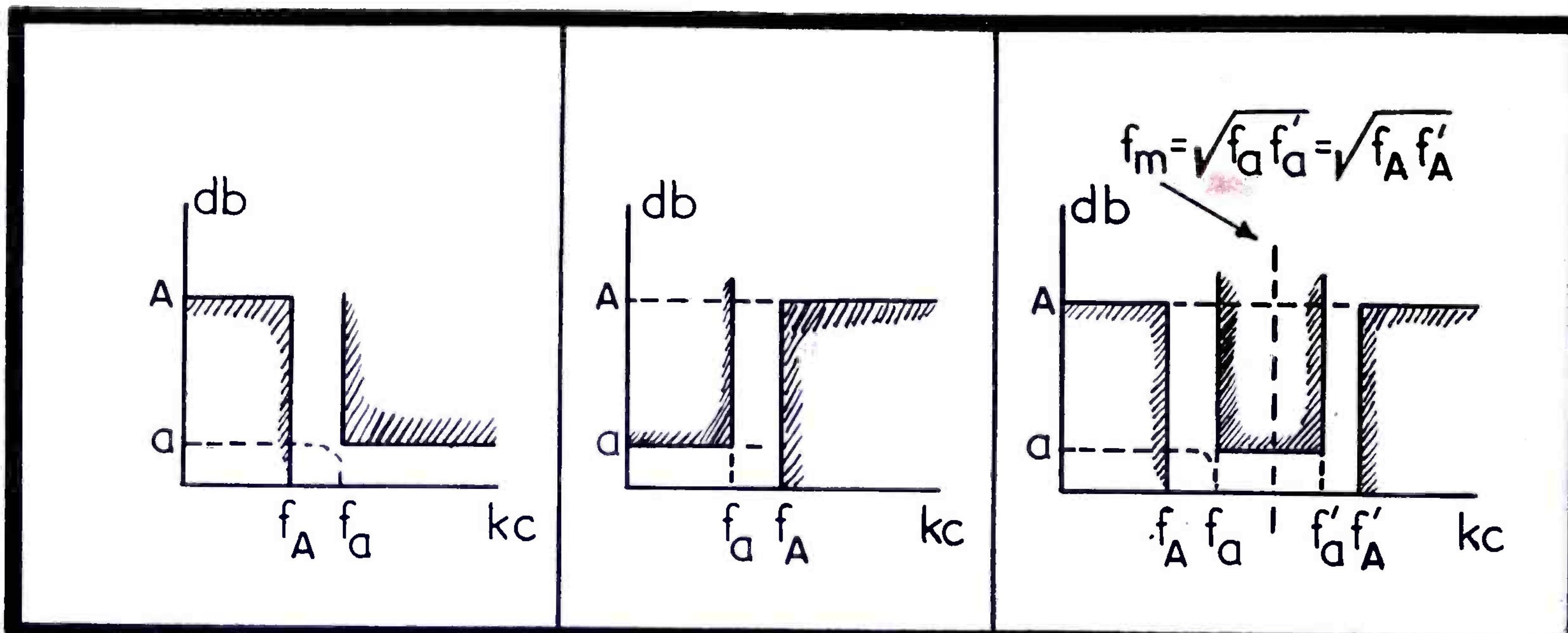
EFFECT OF COIL Q

Analysis Offers Universal Charts, Valid For Dissipative Filters, to Permit Rapid Selection of Required Filter Values



by **PAUL SELGIN**

Research Engineer

Farnsworth Television and Radio Corp.

IN a previous paper[1] the design of a multi-section filter was carried through with the help of new parameters, permitting the use of labor-saving universal charts and simplifying calculations.

The procedure, consisting of six steps, resulted in values of inductance and capacitance for the elements (coils and capacitors) of the complete assembled filter. However, the figure of merit, or Q of the coils remained unspecified. This information is necessary if the attenuation introduced by the filter in the *pass* band is a critical item in the desired performance. This attenuation (a in Figure 1) is largely controlled by the Q of the elements. In practice, the Q of capacitors is so high, unless their quality is very poor, that its value is not controlling and only the Q of coils needs to be considered.

Rather than try to compute the lowest permissible Q for the coils of each section, we will assume that the designer has at his disposal several types which can be held to specified minimum Q values, as for example: type A (Q of 200 or over); type B (Q of 100 or over); type C (Q of 50 or over). There is no objection, from a technical standpoint, to the use of the best obtainable coils in all cases, but of course this may be poor economy.

Formulas are available in the literature[2] for computing the effects of dissipation; but this computation becomes excessively unwieldy in all but the simplest cases when several sections are involved. Such elaborate computations add so much to the engineering cost that the resulting economy is largely nullified. It is the purpose of this paper to overcome this difficulty by the use of universal charts upon which the desired values may be read directly with sufficient accuracy for all practical purposes.

Such charts cannot possibly be based upon the parameters of conventional filter theory. A new set of parameters and a new variable, all of which have the same form, were introduced in the paper previously mentioned. They are:

The *frequency number n*, a variable depending on frequency of the form:

$$n = \frac{1}{4\pi^2 f^2} \text{ (for high-pass filters)}$$

$$n = 4\pi^2 f^2 \text{ (for low-pass filters)}$$

$$n = \left(\frac{f}{f_m} - \frac{f_m}{f}\right)^2 \text{ (for symmetrical band-pass filters; } f_m = \text{midband frequency)}$$

The *filter number F*, a parameter equal to the value taken by n when the *cut-off* frequency of the filter (or either of the two cut-off frequencies) is put in place of the generic frequency; and

The *section number S*, a parameter equal to the value taken by n when the *frequency of peak attenuation* for the section (or either one of two such frequencies) is put in place of the generic frequency.

Our problem now consists in expressing, first analytically and then graphically, the *attenuation* and *phase shift* of any given filter section in terms of the above quantities. As to the *type* of filter we will restrict ourselves to the three standard *derived* types discussed in the preceding paper, which include the *prototypes* as particular cases. Relatively few filtering

[1]COMMUNICATIONS: July 1945.
[2]T. E. Shea, *Transmission Networks and Wave Filters*, page 315.

Figure 1 (above)
Attenuation characteristics of high-pass filters (left), low-pass filters (center), and band-pass filters (right).

N FILTER PERFORMANCE

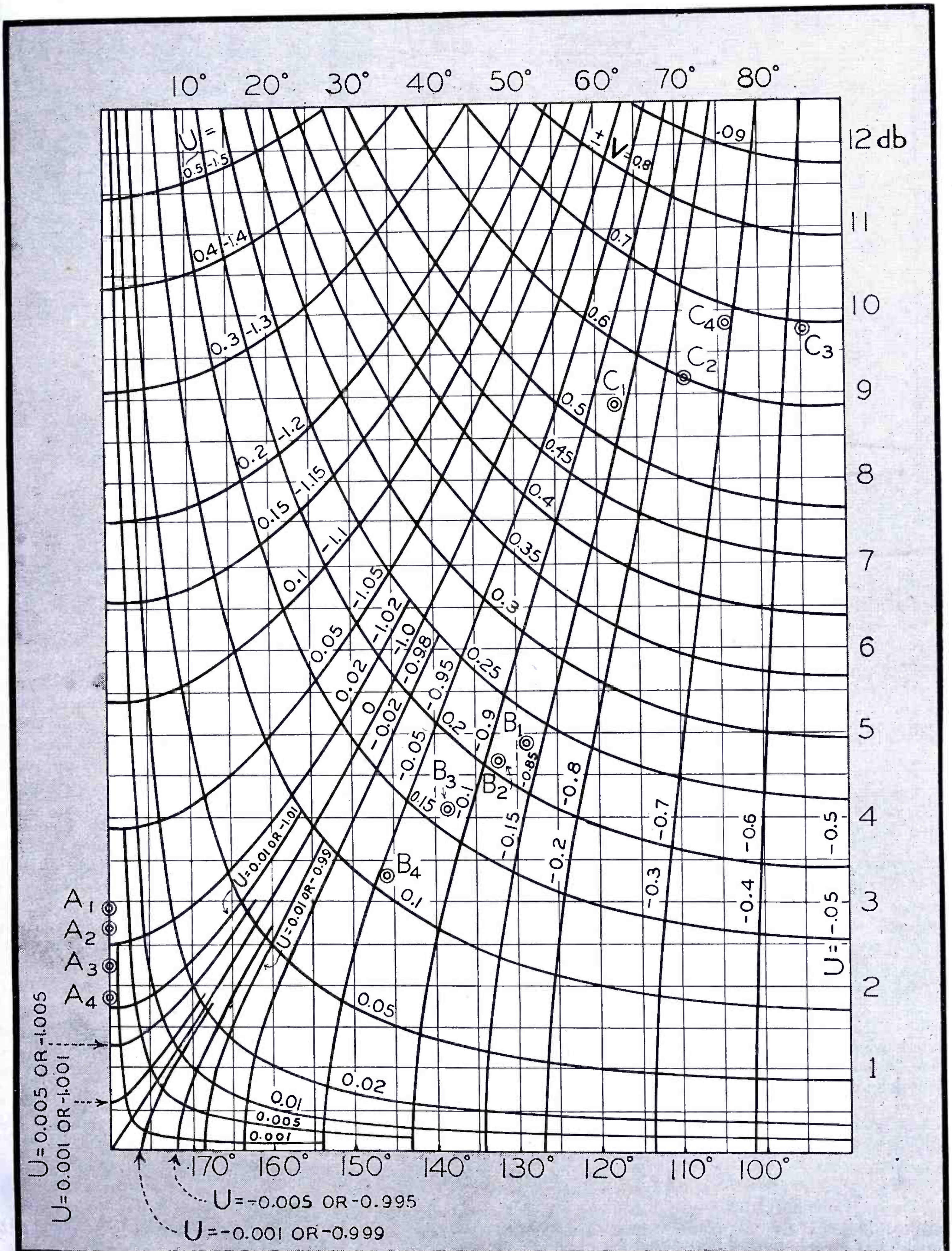


Figure 2

Chart for obtaining attenuation and phase shift from values of U and V. Points A, B and C apply to a typical filter structure (not, however, that given as example in the text).

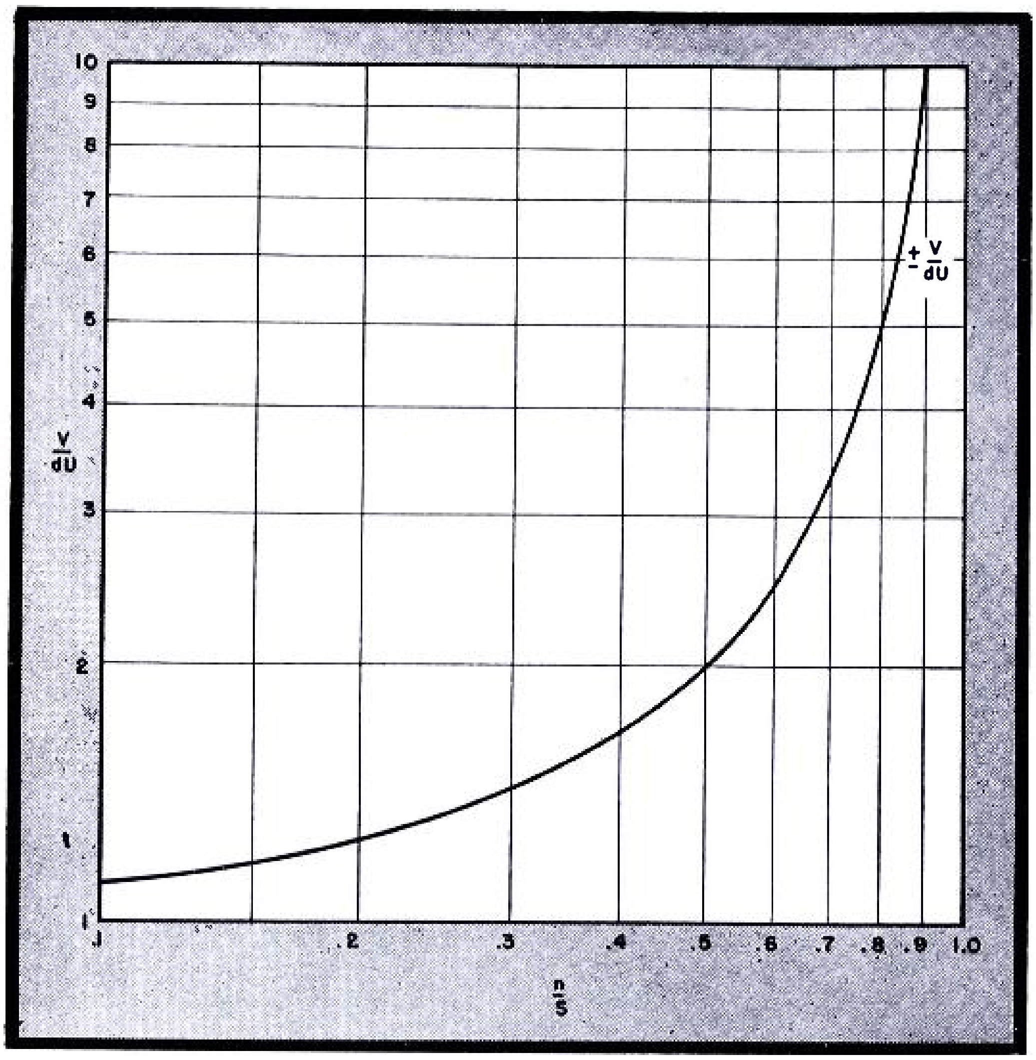


Figure 3

Values of $\frac{V}{du}$ for dissipative low and high-pass filter sections. (*Use + sign for low-pass.*)

problems lie outside the scope of these standard types.

Both attenuation α and shift phase β are given by the transfer constant, which for a *T* or π network has the value

$$\theta = \alpha + j\beta = \log_e \frac{\sqrt{1+P}+\sqrt{P}}{\sqrt{1+P}-\sqrt{P}}$$

where α is in nepers (1 nep = 8.68 db), β in radians, and P is equal to

$$P = Z\,Y$$

Z is the series impedance and *Y* the shunt admittance of the basic L section, two of which, depending on the method of their junction, can form either a *T* or π section. *P* is generally a complex number, and therefore may be written as

$$P = U + jV$$

A relationship between *U* and *V* on one side, α and β on the other, is established by a family of orthogonal lines or map such as that of Figure 2. Given values of *U* and *V*, the reader will obtain on this chart attenuations in decibels and phase angles in degrees. Other charts for the same purpose may be found in the literature, but some of these are very inaccurate at the points where they are most frequently used, a disadvantage which appears to be overcome by the arrangement of Figure 2.

We have now reduced the problem to the determination of *U* and *V*. This involves some tedious algebra, and due to space limitations we must ask the reader to take the results for granted.* If we assume no dissipation (infinite *Q*, or perfectly reactive elements), *V* is zero in all cases and *U* has the value

$$U = \frac{n/F - n/S}{n/S - 1} \quad (1)$$

This value is common to all three types (high, low and band-pass). When dissipation is present the expressions for *U* and *V* become more complicated. Some of the complication may be removed by neglecting the quantity d^2 or $1/Q^2$ when it appears as a summation term.

It should be noted here that *d*, the dissipation factor, is often used in place of *Q*, of which it is the reciprocal, for two reasons: First, it eliminates confusion due to the fact that *Q* is often used with a different meaning; and second, it is more convenient analytically.

The only disadvantage is its fractional value. In practical daily use it is easier to say *a Q of 100*, than *a d of .01*. When discussing networks it is customary to use *d* in the equations.

Assuming reasonably high values of *Q* the omission of d^2 does not appear to be a serious error. This is true with certain exceptions; at the frequencies of peak attenuation, for instance, the term d^2 becomes the controlling factor on the value of *V*, and at mid-band frequency (for band-pass filters) this term controls *U*. But these are *singular points* in the function *U* + *jV*, and the value of the function at these points is not critical. Except for these points and their immediate neighborhood, d^2 may safely be omitted. When this is done, *U* is found to retain the value given by equation *1* and *V* becomes

$$V = \pm\, dU \frac{1}{n/S - 1} \quad (2)$$

(*for high and low-pass filters; use + for low-pass*)

$$V = \pm\, dU \frac{\frac{2(n+S)+nS}{n-S} - \sqrt{S+4}}{\sqrt{n(S+4)}} \quad (3)$$

(*for symmetrical band-pass filters; use + for frequencies above mid-band*)

The value of d (1/Q) is assumed to be common to all the coils of the filter section. This is common practice whenever possible, but there may be cases when the differences in inductance for the various coils are so great as to cause appreciable differences in the *Q* values. In such cases the lowest *Q* should be used to be safe.

We see from equation *2* that a single curve will give values of ± V/dU in terms of n/S for both high- and low-pass filters. This curve appears on Figure 3. A family of curves is needed to represent equation *3*. This consists of plots of ±V/dU against *n* for fixed values of S, and is shown on Figure 4. (See page 106).

Equations *2* and *3*, and Figures 3 and 4, apply to the *derived types*, but they include prototypes as limiting cases. For prototypes, S becomes infinity[3], hence equation *2* becomes

$$V = \pm\, dU \quad (4)$$

(*use + for high-pass; — for low-pass prototype sections*)

and equation *3* becomes

$$V = \pm \frac{dU}{\sqrt{n}} \quad (5)$$

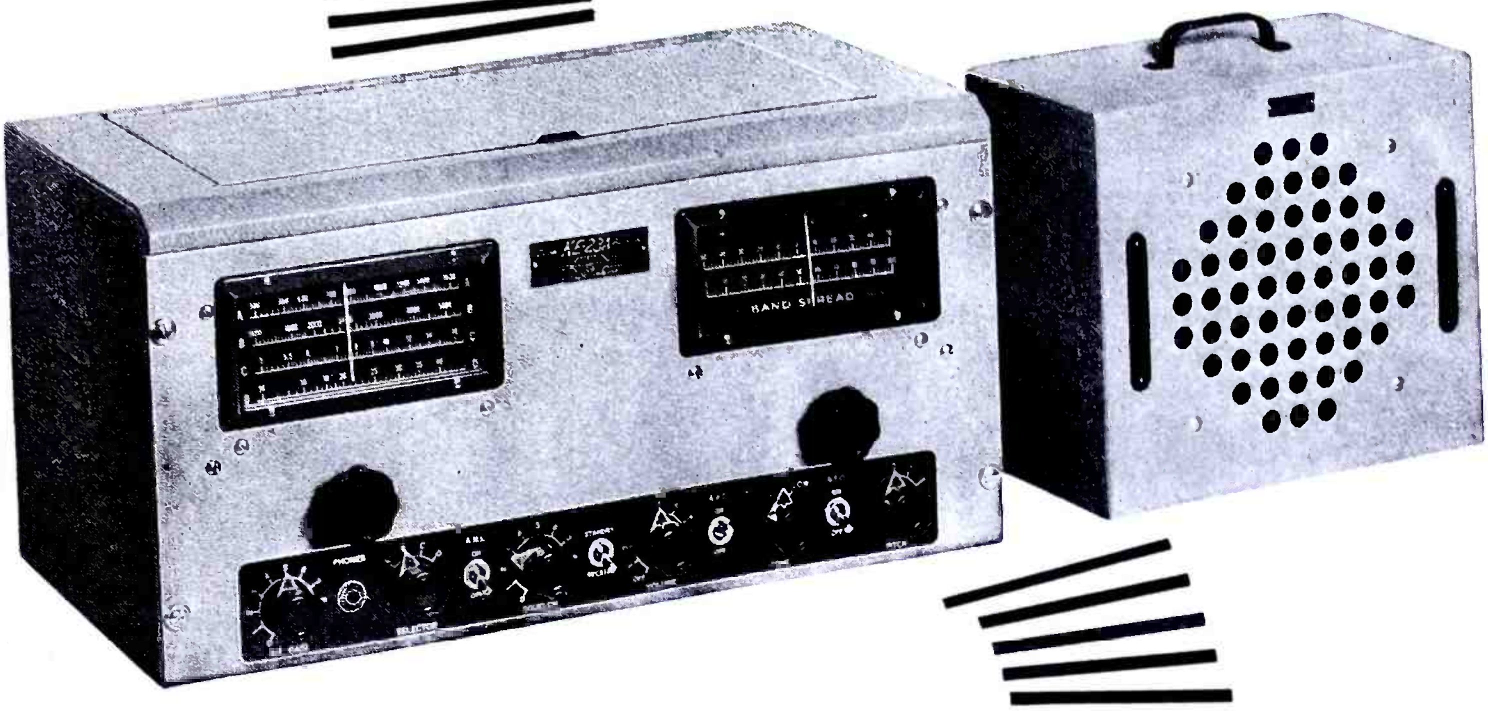
(*use + for frequencies below midband in symmetrical band-pass prototype sections*)

These values are so simple that no

(*Continued on page* 105)

*Derivations are available upon request.

UP TO 42 Mc



DOWN TO 500 Kc

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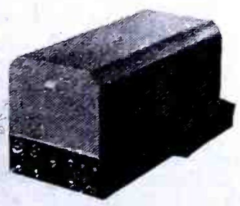

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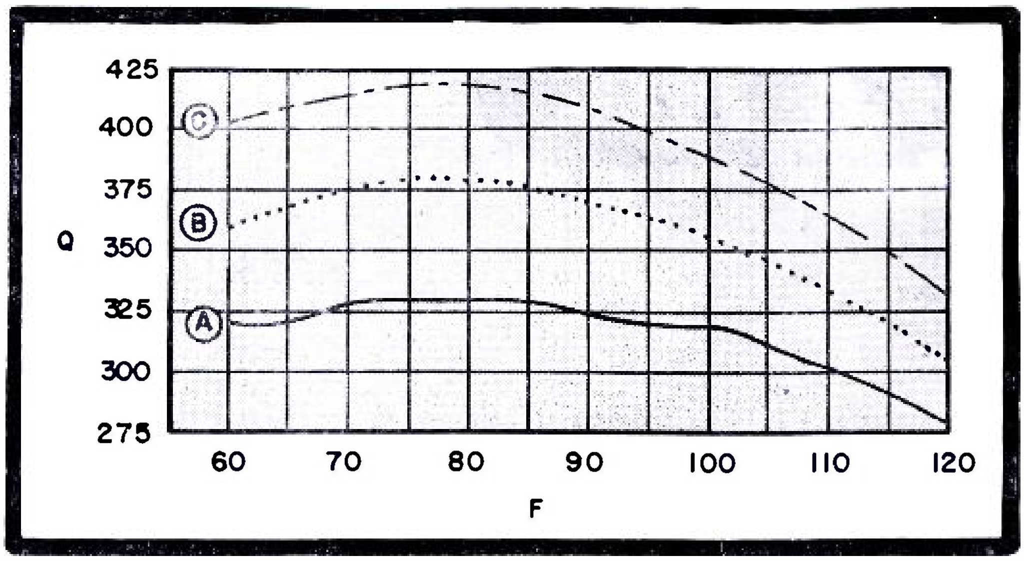


Figure 1

Q response curve for coils wound on a ¾" forı 3 turns, wound 4 turns-per-inch, over the fr quency range of 60–120 mc. Curve *A* is f No. 16 wire, curve *B* for No. 14, and curve for No. 10 wire. *Q* improves rapidly with ı increase in wire size.

COIL DESIGN FOR

by ART H. MEYERSON

New York Fire Department Radio Laboratory

THE design of coils for use in the 60 to 120-mc frequency spectrum presents an expanded version of the problems encountered at lower frequencies. The two characteristics in which most interest centers are the frequency stability of the coil and its *Q*. Reasonable physical dimensions, and adaptability to circuit design are also important, but are secondary considerations.

While frequency stability requirements are not as stringent at 100 mc as they are at 1000 kc, when gauged in terms of per cent of frequency they are found to be more restrictive. For this reason, coil design for the higher frequencies must be considered in terms of zero-temperature coefficient.

In addition, the *Q* must be as good, and preferably better than for lower frequency coils, if any appreciable stage gain is to be realized. Increased loading effect of tubes and other circuit components, must be overcome to some extent in the associated *LC* circuit. Because of these considerations, a series of experiments were undertaken to determine if any particular form of coil shape was better fitted for use at higher frequencies than the standard type.

The tests were conducted with Boonton 170A Q meter. All mann and shapes of coils were tried. Mat rial which had been gathered prev ously for standard coil forms* wa used as a guide in the determinatio of what standards to set and wha course to pursue.

These previous experiments ha shown that for standard coil form wound on lucite and polystyren forms, highest *Q* was obtained wit large diameter wires spaced slightl better than the wire diameter and coil lengths of about .8". Also, *Q* in creased with coil diameter. For exan ple, for size *10* wire, .102" diamete greatest *Q* was realized at a windin pitch of 4 to 5 turns-per-inch, with to 5 turns used.

However, in the design of coils fo use at higher frequencies, the value inductance must be kept quite sma so that a large value of tuning ca pacitance may be used to minimize th effect of tube loading capacitanc Again, for large value inductance slight changes in inductance val accompanying temperature variatio would cause large frequency devi tions. One solution to variation inductance value with temperature, ha been the use of tuning condensers wi negative-temperature coefficients. How ever, this method has been found u

*COMMUNICATIONS; April and May, 1944.

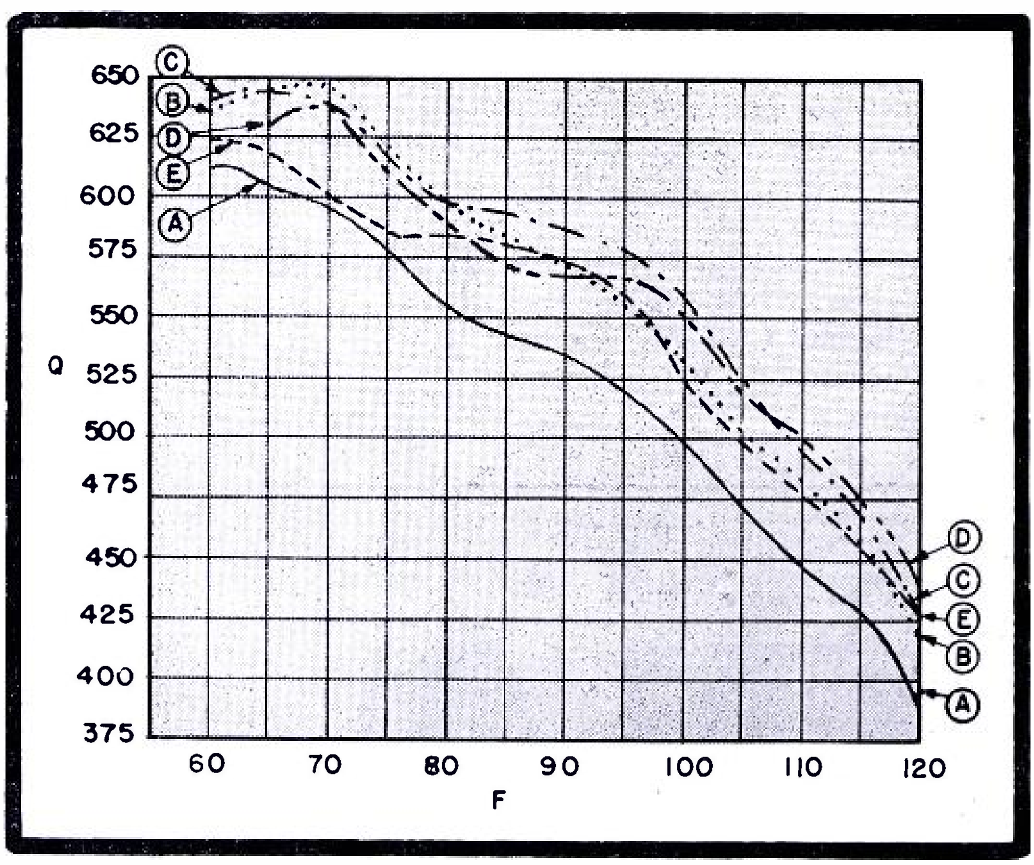
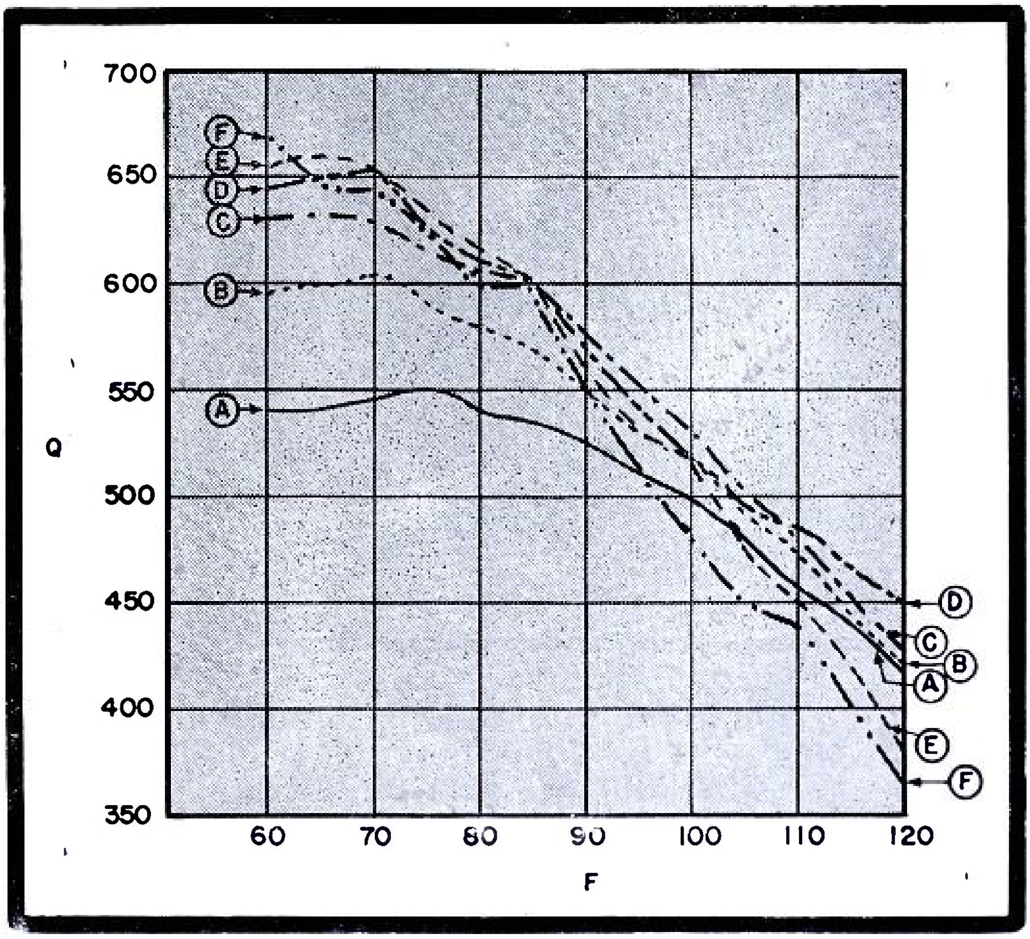


Figure 2a

Q response curves for 3" strap-type coils, co structed of No. 16 gage copper sheet, over frequency range of 60–120 mc. Curves *A* to represent, respectively, ¼", ⅜", ½", ⅝" a ¾" strap widths. Optimum over-all results obtained with ⅜" to ½" widths.

Figure 2b

[Co]mparison of Q of strap-type coils constructed [of] varying widths and diameters, of identical [ind]uctance. Curves A to E represent, respec[tive]ly, widths of ¼", ⅜", ½", ⅝", ¾" and 1".



V-H-F

[sa]tisfactory. The temperature source [ma]y not affect the coil and condenser [at] the same time. In one oscillator [ci]rcuit tested, using the previous setup, [th]e frequency would first decrease, and [th]en start to rise after a few minutes of [co]pper were used. The improvement in [tempe]rature coils as well as condensers [of]fer the better solution.

Initially experiments were conducted [to] determine what coil shapes produced [th]e highest Q. Standard coil forms [we]re tried, using the data gathered at [lo]wer frequencies. Since the value of [in]ductance was limited by tube input [ca]pacitance, the maximum inductance [pe]rmissable was arbitrarily set at less [th]an .2 µh. This would permit tuning [to] 120 mc with a 10-mmfd capacitor.

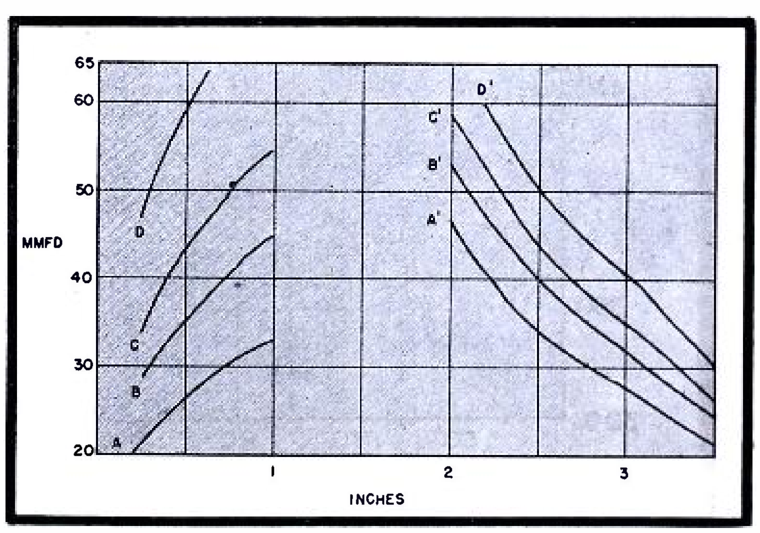
Previous experiments had indicated [th]at Q increased most rapidly with [wi]re size. The next most important [in]fluence was coil diameter, and last [we]re number of turns and turns-per-[in]ch. Setting 2 to 3 turns as a minimum [fo]r optimum turn design, the largest [pe]rmissable diameter for the coil form [fo]r an inductance of .2 µh was found [to] be .75". In Figure 1 we see the effect of wire size on coil Q; note that the Q increases rapidly with wire size.

Since wire size exerted a greater influence on Q than number of turns, the next step was to determine the relative influence of form diameter as against number of turns. For this experiment, flat metal bands of 16-gage copper were used. The improvement in Q is shown graphically in Figure 2a,b. Figure 2a shows the Q curve of strap type coils of 3" diameter, varying in width from ¼" to ¾" for the 60 to 120-mc frequency range. Figure 2b shows the Q curve of strap type coils of varying width and diameter, whose inductance value has been kept constant at .12 µh. Optimum results above 100 mc were obtained at strap widths of ⅜" to ½" diameter. Increasing the strap width lowered the highest frequency at which greatest Q was realized.

Several other experiments were conducted to determine the effects of various mechanical influences on coil Q. One experiment involved the use of coils made from straps with the grain of the metal running vertically to the direction of bend, and horizontally. No difference in either Q or inductance value was found to exist. Another experiment involved the stamping out of holes in the flat strip. These holes would be necessary for mounting and circuit connection. A flat strip, ½" wide, and of 3⅛" diameter was used, into which ¼" holes were stamped. For one hole, no appreciable reduction in Q was noted. Increasing the number of holes to 11 decreased the Q about 7%. The number of holes was increased by steps of 2 from 1 to 11 and it was noted that the Q decreased proportionately. However, one peculiarity was noted. If the holes were equally spaced, the Q did not decline as rapidly as when they were spaced indiscriminately. Also, the in-

Figure 3

[Th]is graph indicates the increase or decrease in inductance with an increase in [dim]ensions of strap-type coils at 80 mc. Curves A, B, C and D show the [res]pective decrease in inductance caused by an increase in strap width for [3½]", 3", 2½" and 2" diameter straps. Note that the decrease in inductance [is] more rapid for smaller diameter straps. Curves A', B', C' and D' show the [res]pective increases in inductance for ¼", ⅜", ½" and ¾" wide straps, with increase in diameter. Note that all four curves are almost identical.



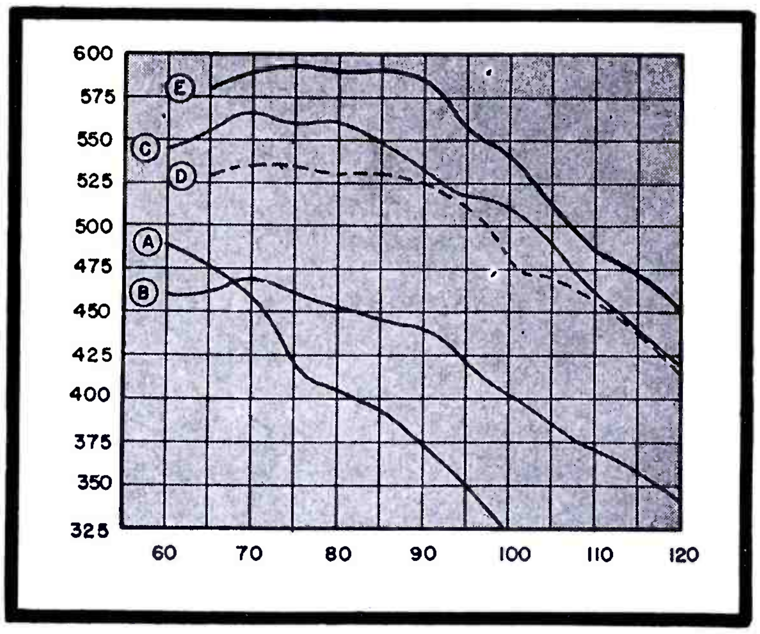
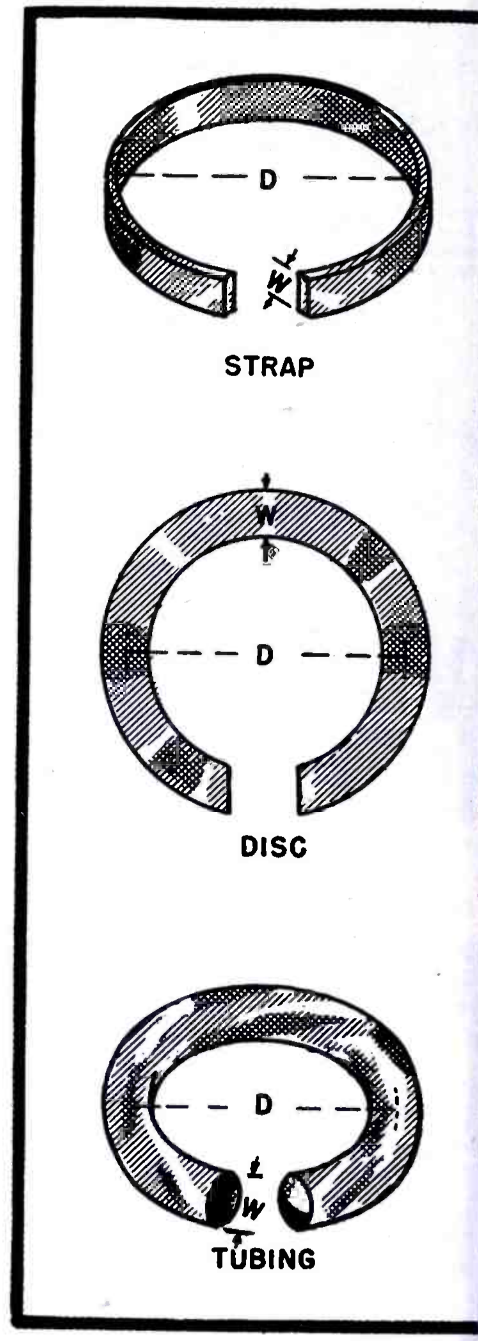
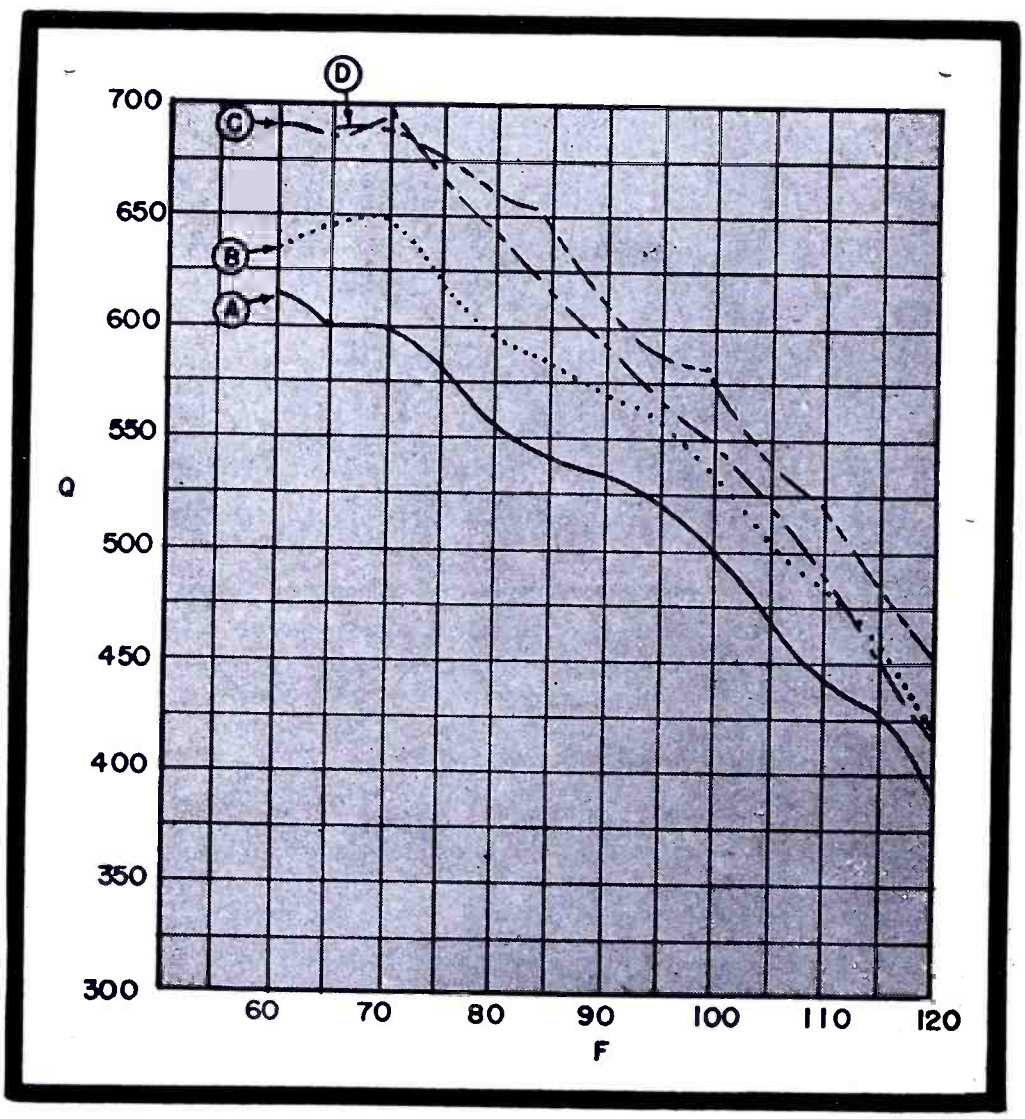


Figure 4
Comparative Q readings for five different types of coil construction. Curve A is for 3 turns of No. 10 wire on a 1" form, wound 4 turns per inch; curve B, 2½" loop of No. 10 wire; curve C, 2½" diameter strap coil; curve D, 2½" diameter disc-type coil; curve E, 2½" diameter tubing coil.



Figures 5 (below) and 6 (right)
Figure 5 shows the Q characteristics for both tubing- and flat-type coils. Curves A and B are for ¼" and ⅜" wide strap-type coils, respectively, of 3" diameter. Curves C and D are for 3" tubing-type coils of 3" diameter, and, respectively, ¼" and ⅜" widths. It will be noted that tubing is superior to strap-type coils in Q, and that Q increases more rapidly for strap-type coils with an increase in width. However, at the upper end of the frequency spectrum, the characteristic Q of all four coil types is so close that no real advantage exists for tubing types. Figure 6 illustrates the three types of coils used in determining v-h-f coil Q.



ductance value increased slightly wi an increase in the number of hole varying from .119 µh for no holes, .121 µh for 11 holes.

The next step was to determine th frequency stability of the coil shap For this purpose, the graph shown Figure 3 was drawn. The abscissa w plotted in inches, and the ordinate mmfd. Curves A, B, C, and D demon strate the increase in capacitan necessary to compensate for an in crease in strap width, for various co diameters. Curves A', to E' show th decrease in capacitance necessary compensate for an increase in co diameter for various width coils. N attempt was made to keep these curv absolutely accurate. However, for pu poses of observation, they are su ficiently correct. Since both sets curves are drawn to the same bas any variation in either width, or di meter may be compared.

Small-Width Coils

It will be noted that curves A' t

(*Continued on page* 82)

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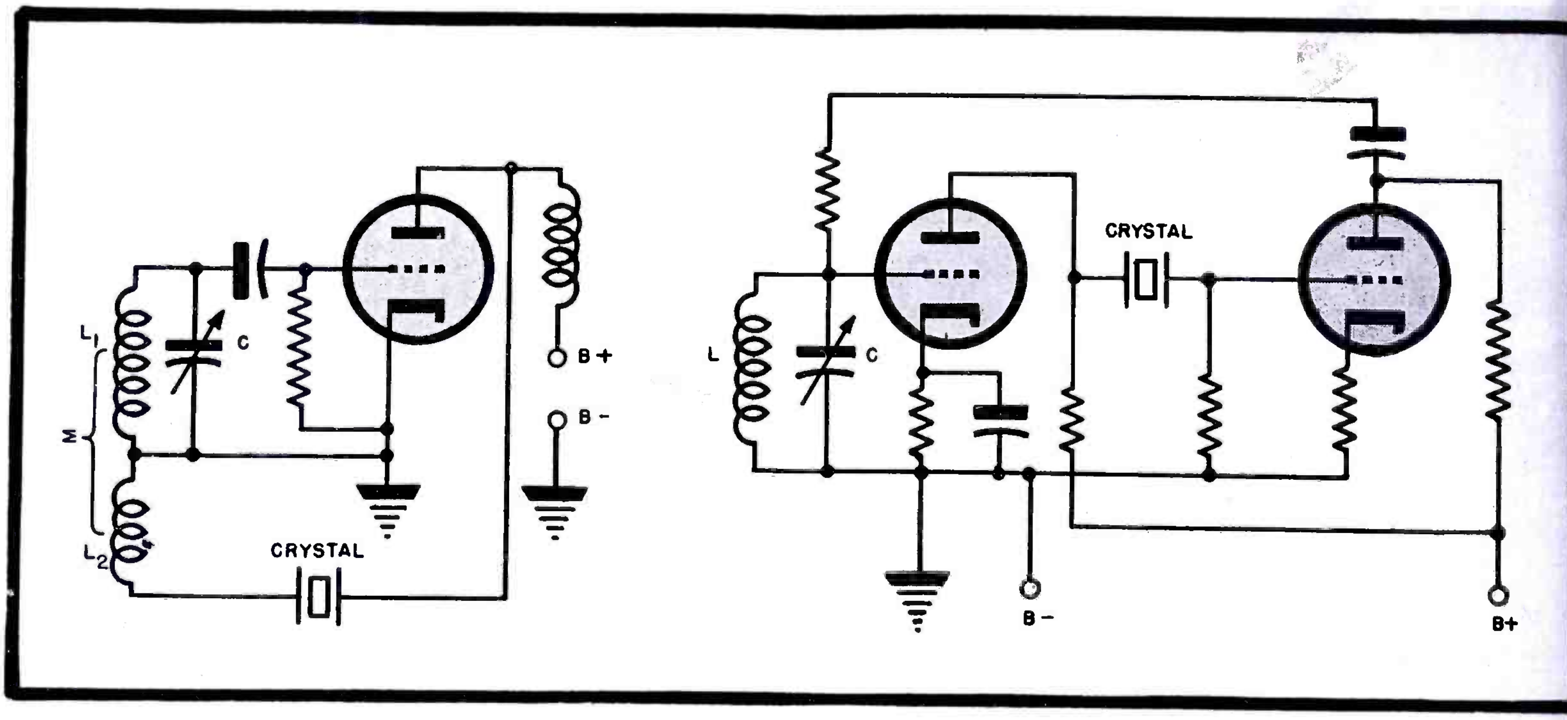

CRYSTAL OSCILLATORS IN F-M AND TELEVISION

An Analysis of Some Crystal Plate Cuts and Their Applications in V-H-F Receivers

by SIDNEY X. SHORE

Consulting Engineer

[*Part Two of a Series*]

THE crystal-oscillator plate may exhibit two different but fairly closely spaced frequencies of oscillation depending upon the circuit employed with the crystal.

The crystal may oscillate at its series resonant frequency, where its impedance is shown as a resistive component when the crystal is placed in series with a feedback path in the oscillator. This frequency is slightly lower than the parallel resonant, or antiresonant, frequency of oscillation of the crystal that prevails when the crystal is placed in parallel with an effective negative resistance. In Figure 1 we have two circuits illustrating oscillation of the crystal at its series-resonant frequency. The circuit at the left is simply the grid-tuned plate-tickler coil with the crystal in series with the tickler. At the right is a two-tube feedback amplifier, resistance coupled, with the crystal acting as the coupling element between the first and second stages.

Figure 3 shows the analogue of the t-p-t-g oscillator with a parallel resonant crystal connected from grid to cathode in place of the *LC* circuit. Two negative resistance oscillators are shown in Figure 2; at left, the dynatron, and at right the transitron, each circuit driving a crystal to oscillation at its parallel-resonant frequency. Incidentally, a series of experiments showed that the transitron was a remarkably stable medium for crystal oscillator plates.

One of the criticisms of crystal-controlled oscillators is that its Q is so high that one cannot change the frequency of the oscillator sufficiently by external means to make it useful as a continuous tuning device. In the main that is true, for crystals will be most useful in spot-frequency tuning, predetermined and preset. However, in double-superheterodyne circuits the second, or even the first, oscillator may be crystal controlled, and this oscillator may be on a fixed frequency over the entire range of the tuning dial.

In reviewing crystal-circuit patents we found a U. S. patent (2,224,700) covering a crystal with a continuously variable frequency, issued to John

Figure 1 (above)

Crystals may be resonated at series-resonant frequency in circuits shown above.

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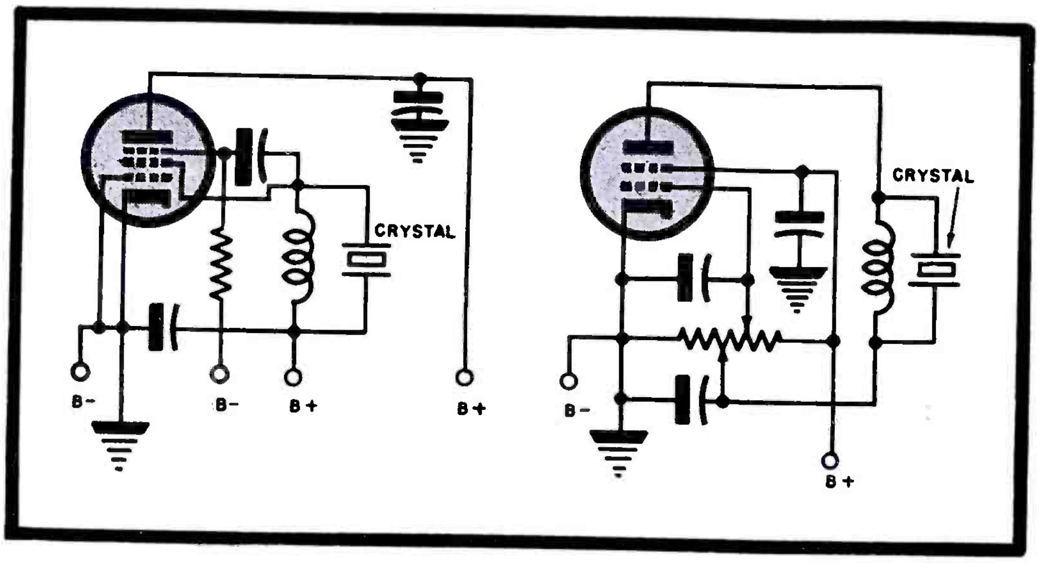
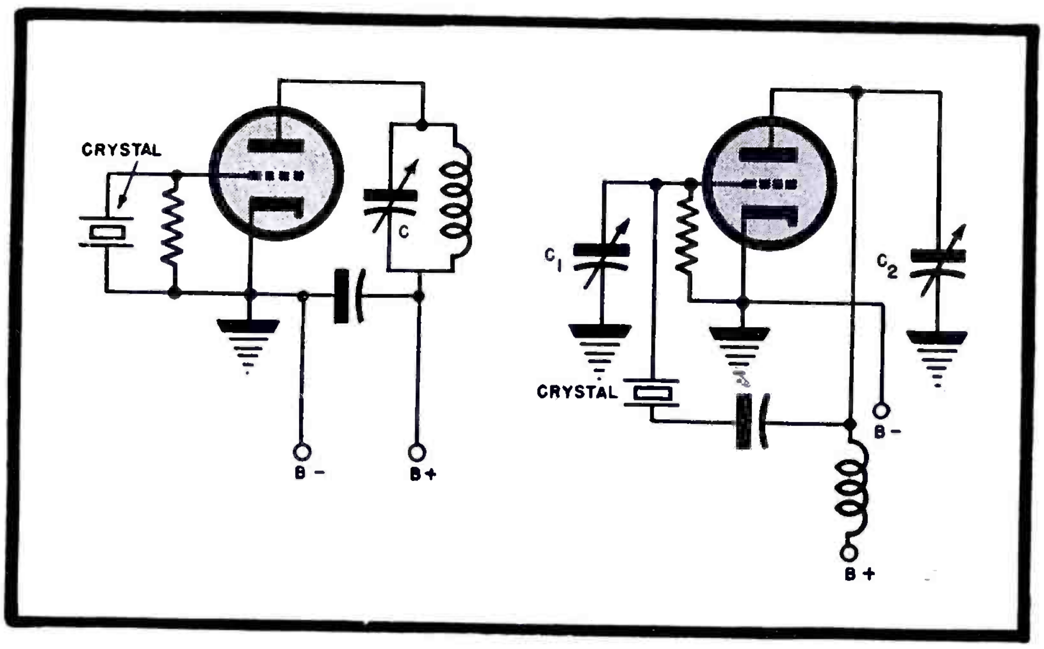


Figure 2 (above)
Crystals may be resonated in negative-transconductance type circuits: Left, transitron oscillator, crystal-controlled; right, dynatron oscillator, crystal-controlled.



Figures 3 (left) and 4 (right)
Figure 3. Crystal analogue of the t-p-t-g oscillator circuit. This circuit is also useful in exciting crystals at low odd orders of mechanical harmonic oscillation. Figure 4. Pierce-type crystal oscillator, the analogue of the self-excited Colpittis or ultraaudion oscillator.

Wolfskill of the Bliley Co. While this is a fairly complicated crystal to manufacture, it does allow tuning over a frequency range of several hundred kilocycles. One of the disadvantages of this crystal is that its temperature coefficient of frequency varies as its frequency of oscillation varies, making its frequency stability a variable factor. However, it would be possible to design a crystal which would provide variable frequency characteristics without a variable temperature coefficient of frequency for different frequencies. This type of crystal would be quite difficult to manufacture and its cost would be high. However we were faced with many more complex problems in the early days of crystal production. Because of these problems crystals were priced as high as \$20 some 5 years ago. Now design solutions have cut costs down, way down, so that some types may sell for as little as twenty-five cents.

To illustrate the use of a crystal oscillator in a broadcast receiver, let us study a typical receiver with a standard i-f of 455 kc. Using the station WABC as an example, having a carrier frequency of 880 kc, we find that the local oscillator frequency should be 1,335 kc. An *AT*-cut crystal having a thickness of approximately 0.050" will oscillate at 1,335 kc. If such a crystal were used in a Pierce oscillator, Figure 4, and the r-f stages were tuned to 880 kc, we would pick up WABC, and the frequency stability of the receiver would be of the order of less than 2 parts-per-million per degree C and per-volt change on the plate of the oscillator tube. It is possible to build a pushbutton receiver using *AT*-cut crystals in this fashion to cover the entire broadcast spectrum. For manual or dial tuning the Pierce oscillator can be operated with an *LC* combination in place of the crystal and it will function well as an ultraudion oscillator.

Postwar crystals will probably be silver plated, or perhaps even copper plated, and molded in a simple plastic

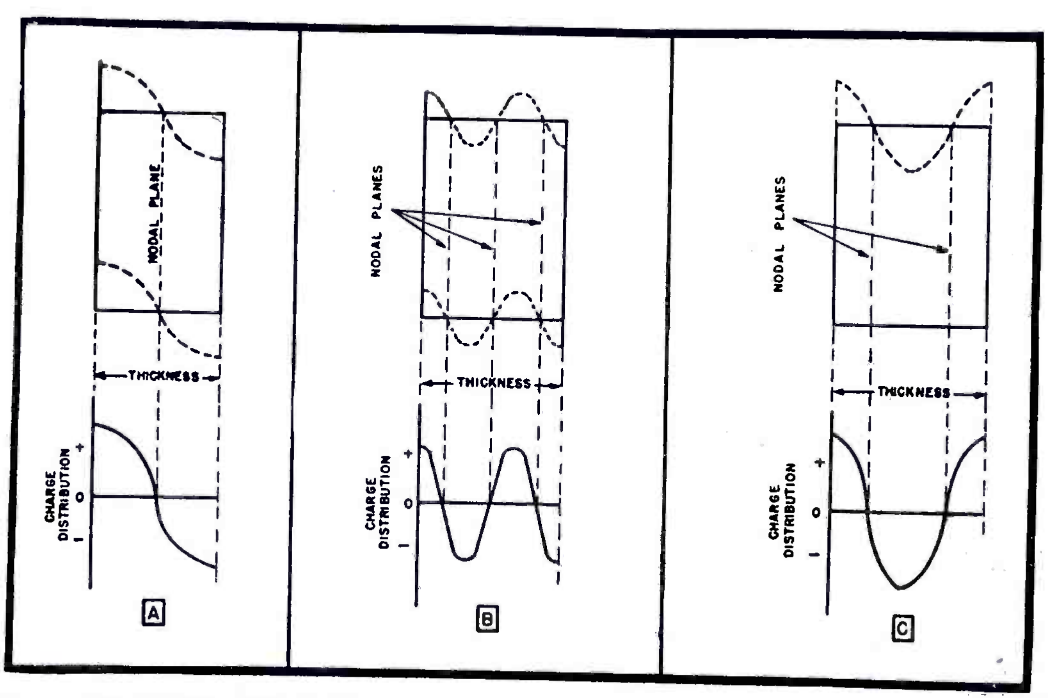
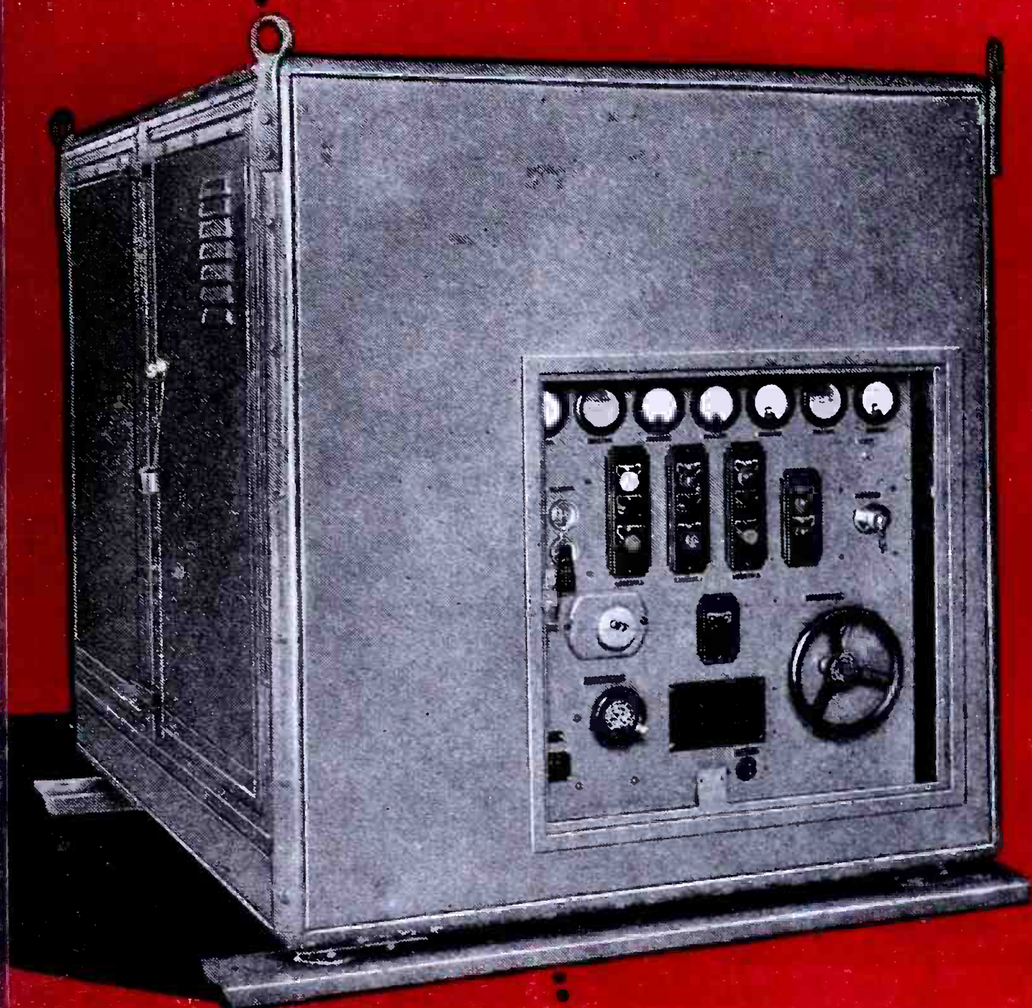


Figure 3a
Diagrams illustrating the motion of planes parallel to the major faces of a thickness-shear oscillator plate in fundamental (*A*), second (*C*) and third (*B*) harmonic modes. Note, in the second (and all even) harmonic modes no voltage is developed across the two faces because the charge developed has the same polarity and magnitude.



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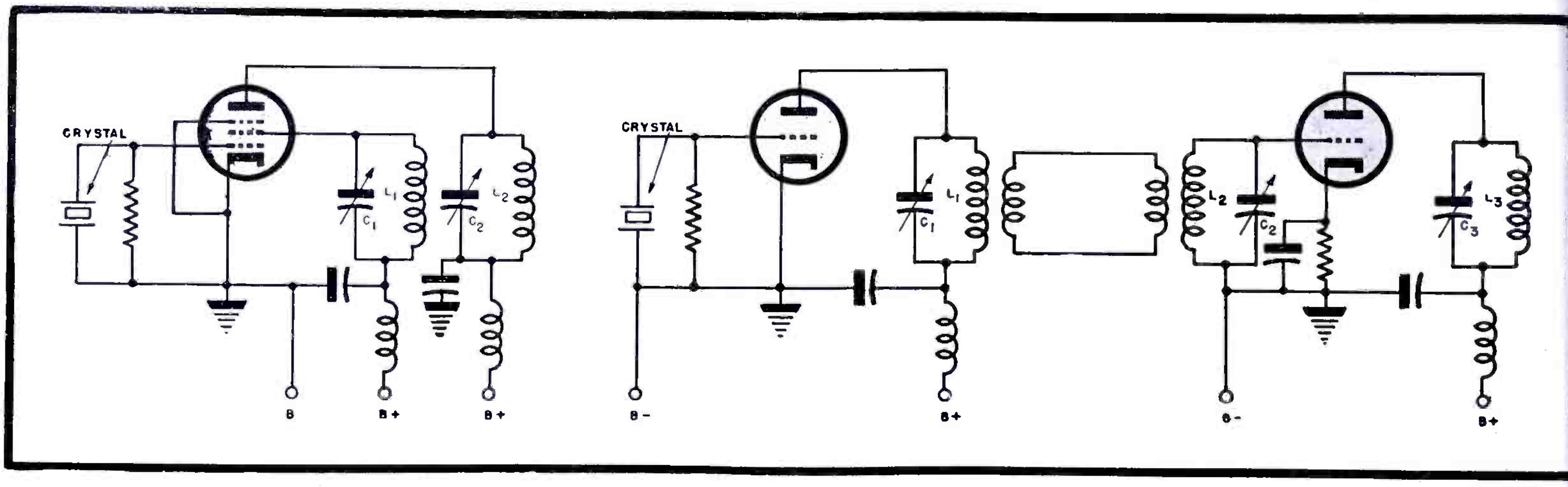


Figure 5

At left we have an electron-coupled crystal oscillator capable of frequency multiplication and harmonic operation. A two-stage frequency multiplier, m-o-p-a type for harmonic operation, is shown at right.

holder resembling a mica condenser and no larger in size.

Stable pre-tuned crystal oscillators are ideal for television receivers. Thus receivers can be tuned by pushbuttons to select any one of the six television channels. There is no need for a tunable local oscillator in the superheterodyne television receiver.

The frequency spectrum of the television stations does complicate the problem of crystal control. For instance, we have to consider crystal thickness at these higher frequencies. Since the quartz crystal is a mechanical resonator, its frequency of vibration is a function of a dimension, and the frequency is inversely proportional to the particular dimension involved. In high-frequency oscillators, usually the thickness-shear type, the frequency-controlling dimension is the thickness of the crystal plate. For the two most common zero-frequency-temperature coefficient plates used at high frequencies, the *BT* and the *AT*, the product of *frequency* and *thickness* is constant; for the *BT* it is approximately equal to 99.8, for the *AT* approximately 66.7. Thus it may be seen that the *BT* crystal plate is mechanically more suitable for use at higher frequencies because its thickness is about 50% greater than *AT* crystal at the same frequency. Because the *BT* crystal is cut at a greater angle with respect to the optical axis of the mother quartz than the *AT* crystal, 49° as compared with 35°, the piezoelectric activity of the *BT* is less than that of the *AT*. It is more difficult to excite a *BT* crystal than it is to excite an *AT* crystal.

Therefore, if in a television receiver we were to assume that the i-f were 11 mc, the local-oscillator frequency of the ordinary superheterodyne receiver would range from about 36 mc to 74 mc, if the local oscillator is on the low side of the signal, or from 58 mc to 106 mc if the local oscillator is on the high side of the signal. (Six local oscillator frequencies would be required, one for each television channel, as recently allocated by the F. C. C.) These are fairly high frequencies for crystal oscillators vibrating in a fundamental thickness-shear mode. The thickness of a *BT*-type crystal for 36 mc, for example, would be about 0.0028", obviously a fragile slice of quartz (less than the thickness of this sheet of paper). For a fundamental-mode 106-mc oscillator the *BT* crystal would be less than .001" thick. Thicknesses of corresponding frequencies of an *AT* crystal would be about 30% less than for the *BT* crystal. Exciting the crystal so that it will vibrate at some harmonic of its fundamental provides an effective solution as we shall see in the next few paragraphs.

Local oscillators of the *LC* variety have been commonplace at these frequencies in the prewar f-m receivers. However many of these commercial f-m receivers had a considerable amount of frequency drift, especially during the first 10 to 20 minutes of warm-up time. In the f-m receiver, objectionable as the drift might be, manual tuning can be introduced for some readjustment. In television receivers, such manual control will not be practical. Thus precise stability control will be essential.

The m-o-p-a system might be employed with a stable low-frequency *LC* oscillator. Either an electron-coupled oscillator with the output tuned to the required harmonic of the oscillation circuit, or a two-stage frequency multiplier may be used. The crystal analogues are shown in Fig. 5. The disadvantages of this method of deriving the high frequency for a local oscillator outweigh the advantages gained in the construction of a low-frequency stable oscillator. Undesired harmonics of the low-frequency oscillator might beat with nearby signals to be picked up by the receiver as interference, to cite one example.

If an *LC* oscillator were to be used, it would be prudent to consider all design factors necessary for maximum stability at the fundamental frequency and to build a single tube v-h-f oscillator accordingly.

In another method to secure mixing of the signal with the local oscillator we could apply one-half of the nor-

Figure 6

Conventional type of superheterodyne arrangement for the f-m bands, using a 10-mc i-f system. Crystal control by use of harmonic crystals for push-button tuning is easily applied.

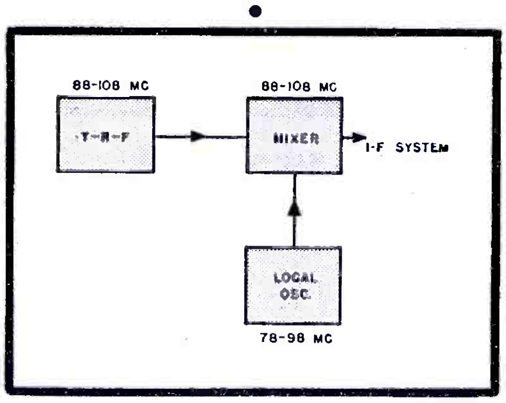
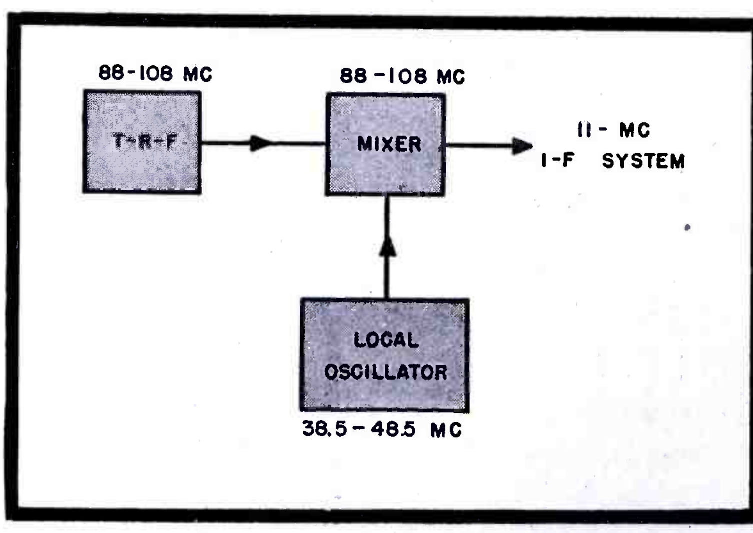
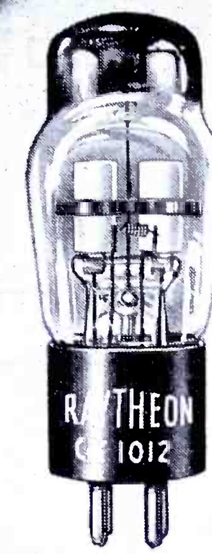


Figure 6a

Superheterodyne system employing an 11-mc i-f where the injected local oscillator frequency is one-half the usually used frequency. The second harmonic of the local oscillator beats with signal to develop the i-f of 11 mc.





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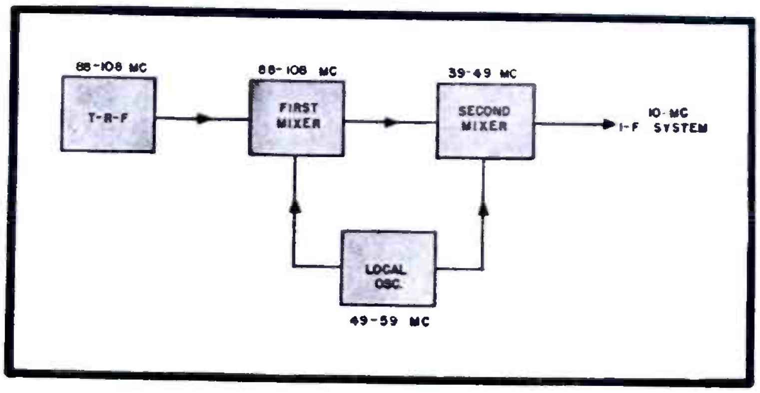
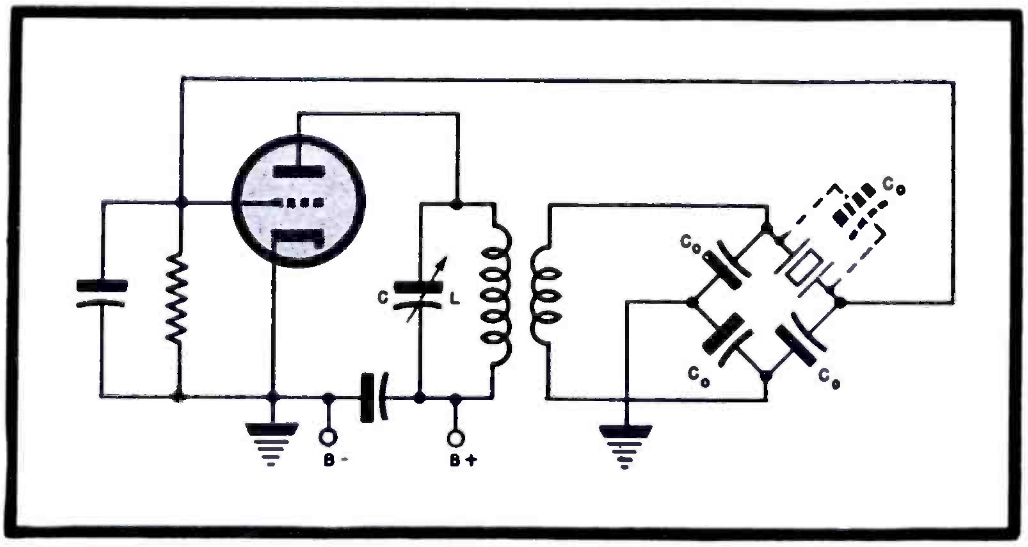


Figures 7 (left) and 8 (below)

Figure 7. Double superheterodyne arrangement utilizing a single local oscillator to develop both beat frequencies. Figure 8. Bridge-type circuit used to neutralize effective shunt capacity of the crystal, thereby allowing excitation of the crystal at high odd-orders of harmonic oscillation.



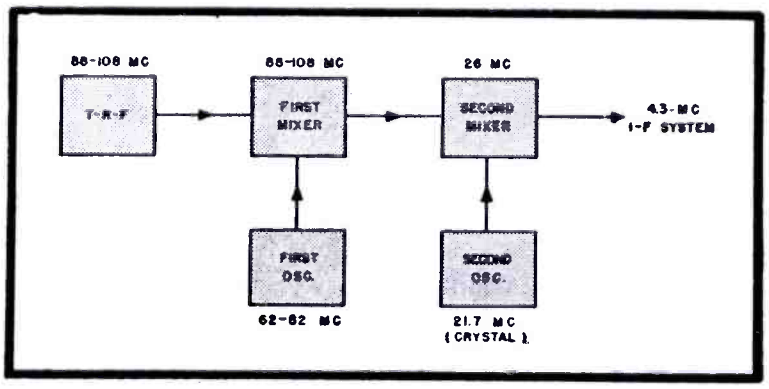


Figure 9

Double superheterodyne system for f-m reception employing the 4.3-mc i-f system. The second oscillator here may be fixed-tuned by a low-harmonic order crystal.

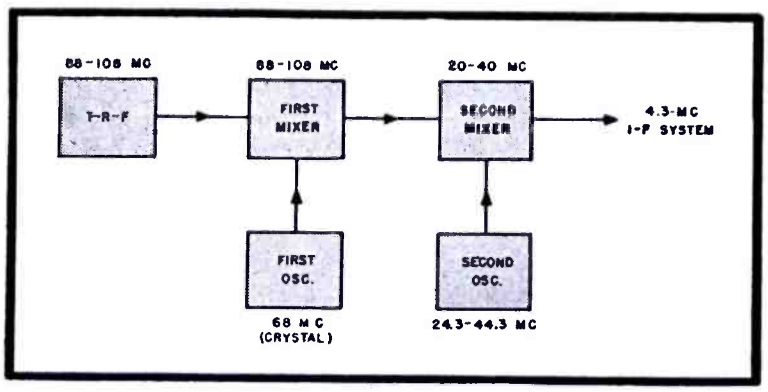


Figure 10

Double superhetero- with the fixed-frequency first oscillator crystal-controlled.

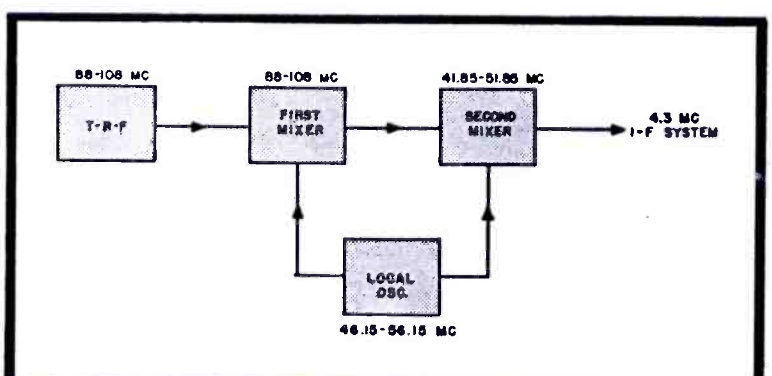


Figure 11

Double superheterodyne employing a 4.3-mc i-f system, as in pre-war f-m receivers, with a common local oscillator to produce both i-f beats.

mally used high-frequency of a local oscillator into the mixer stage. The signal would beat with the second harmonic of the local oscillator frequency to deliver the proper intermediate frequency to the i-f system. The conversion transconductance for this means of mixing may be lower than for fundamental mixing, but the improvement in oscillator stability and the high efficiency of the mixer as an amplifier at the lower oscillator frequency may well offset this other disadvantage. Figure 6*B* illustrates this case (Figure 6*A* shows the normal lineup in a superheterodyne built to receive the new f-m band).

As we pointed out earlier, the quartz crystal can be applied to v-h-f if we excite the crystal so that it will vibrate at some harmonic of its fundamental mode of vibration. The thickness for this fundamental mode must be high enough to be sturdy and readily manufactured. For example, if a *BT* crystal about 0.0138″ thick having a fundamental thickness-shear frequency of vibration of 7.2 mc were to be excited so that it would vibrate mechanically at the fifth harmonic of its fundamental the resonant frequency of the voltage developed across its faces would be 36 mc. Such a crystal might be made to oscillate in the crystal analogue of the t-p-t-g oscillator illustrated in Figure 3. If the plate tank circuit were tuned to 36 mc and a fundamental 7.2-mc crystal in the grid circuit had little enough shunt capacity so that at 36 mc the crystal showed an inductive reactance to the amplifier, the crystal could oscillate at 36 mc. (In vibrating high frequency thickness-shear quartz oscillator plates at harmonics of the fundamental frequency, only odd harmonics may be excited in a v-t oscillator because a crystal vibrating in this mode at even harmonics has a zero resultant voltage developed across its faces. Opposite faces must move in opposite directions in order to develop a voltage across the faces. For even harmonic vibrations the opposite faces must move in the same direction and the crystal will not be excited. See Figure 3*A*.)

The *AT*-cut crystal is easier to excite than the *BT*-cut in the same oscillator for similar frequencies. As a harmonic oscillator in the simple circuit of Figure 3, an *AT*-crystal plate may be excited up to its seventh mechanical harmonic, and in this respect is more desirable than the *BT*.

With the *AT*-cut crystal as well as with the *BT*-cut crystal, therefore, the order of harmonic which may be excited in the normal type of oscillator is limited by the shunt capacity of the crystal. And the highest frequency

(*Continued on page 85*)

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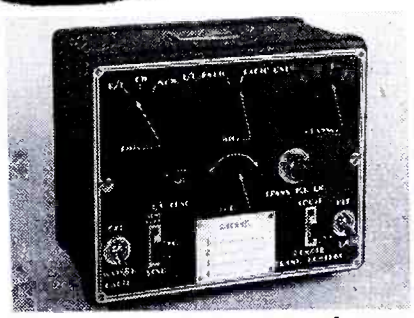
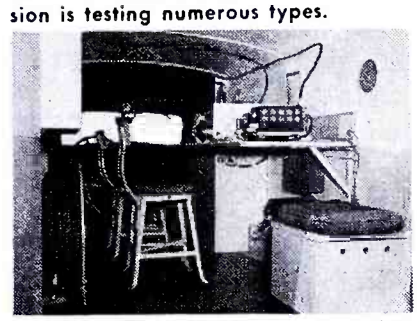


This control unit was one of many pieces of equipment built for intercommunication in British airplanes.

To determine most efficient antenna for VHF communication Pacific Division is testing numerous types.



Interior of Pacific Division's mobile laboratory used in VHF communication development program.

Pacific Division
Bendix Aviation Corporation
11600 SHERMAN WAY, North Hollywood, Calif.
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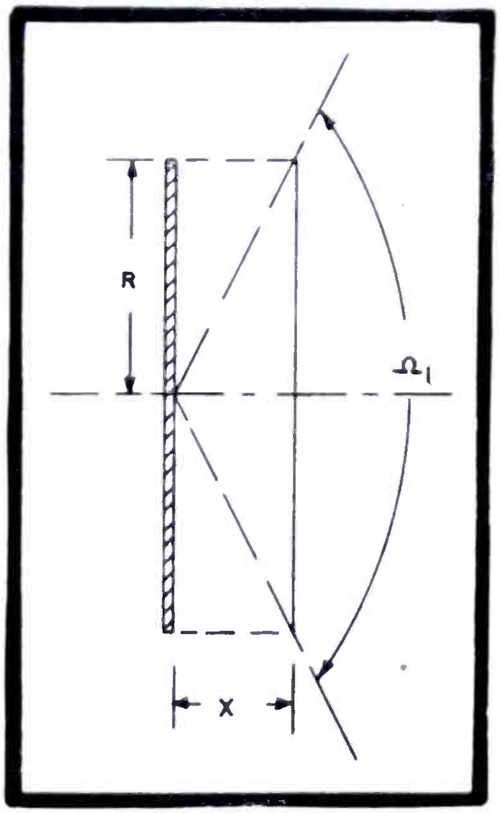
VHF COMMUNICATION SYSTEMS

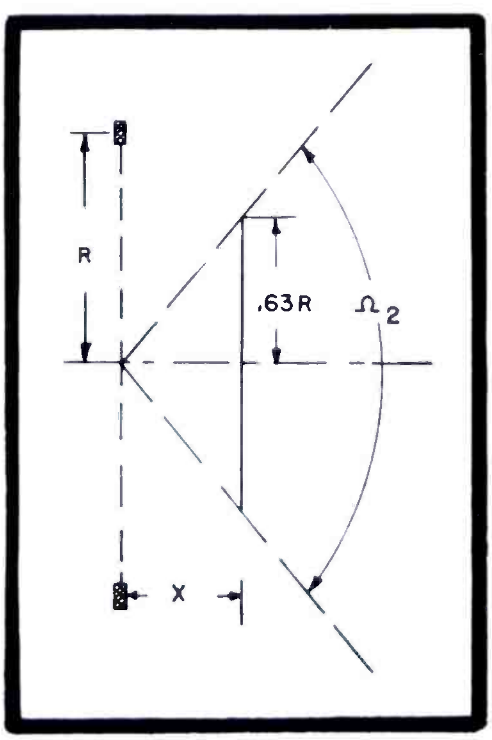
PRODUCT OF Bendix

OPERATING SIX VHF EXPERIMENTAL STATIONS

ACOUSTIC FEEDBACK REDUCTION



Figures 1 (above) and 2 (below)
Figure 1 illustrates the divergence of a sound beam from a piston radiator at $\lambda = D_m = 2R$. Figure 2 shows the divergence of a sound beam from a ring radiator at $\lambda = D_m = 2R$.



THE increased directivity of an annular horn mouth is quite a useful feature, but the increased margin against acoustic feedback thus gained is still not sufficient for satisfactory operation of higher-power electric-megaphone systems. In the development of a system of this type,[1] an acoustic pressure output requirement of about three times that of the original megaphone was set as a design point. Such a requirement demanded a corresponding increase in the acoustic feedback loss. Hence other means were sought to further sharpen the directivity pattern and thus reduce sound radiated to the rear of the horn. One method which furthered this object was based on an attempt to partially focus or converge the radiated sound toward the central axis. The hypothesis used was considerably overdrawn, as the wavelengths of the radiation were of the same order of magnitude as the physical dimensions involved. However, as a net advantage resulted, the method of arriving at this solution may be of interest.

Let us first consider a piston radiator of radius R. Assuming that the theory of high frequency radiation from a piston, as developed by Crandall,[2] is still applicable where R is comparable to the wavelength λ of the frequencies we are interested in, then it can be further assumed that the radiation from the piston is substantially plane for a distance

$$X = R^2/\lambda$$

as shown in Figure 1.

Crandall calls X the critical distance defined by

$$X = m^2\lambda, \quad \text{where} \quad m\lambda = R$$

this distance being the point to which the beam of radiation is parallel to the normal axis. Beyond this point, the beam diverges, the angle of divergence being roughly the angle subtended by the piston at the point X. In other words, beyond X, the beam diverges at this angle, shown as Ω_1 in Figure 1.

Now returning to the previous discussion concerning the relative sharpness of radiation from a ring versus a piston, it was developed that the increased sharpness of the ring pattern was equivalent to proportionately greater radiation in the forward direction, from sources of the same strength. This has been worked out by Massa[3] and shown in graphical form for various ratios of diameter to wavelength. Selecting a frequency at which the advantage of the ring over the piston is about 4 db, i.e., $\lambda = D_m = 2R$, and assuming Crandall's theory for the piston can be applied in a similar manner as above, then at the same distance $X = R^2/\lambda$ the area embracing the same intensity as that from the piston is

$$A_R = \frac{A_P}{\text{antilog}_{10}\,(4/10)}$$

$$= A_P/2.5$$

Then $\quad D_R = D_P/\sqrt{2.5} = .63\,D_P$

That is to say, the circular area in front of the ring at the distance X containing the same portion of the total radiation as the area of radius R from the piston, has a smaller radius in the proportion shown. If the solid angle Ω_2 containing the cone of rays is now taken as that subtended by this area (A_R) from the center of the plane of radiation, it is found to be smaller than Ω_1 for the piston Figure 2. Therefore the cone of rays containing the major portion of the radiated sound is narrower from the ring than from the piston. Hence the radiation from the former is of proportionately greater intensity in the forward direction, and less energy is radiated to the rear.

At the lower frequencies, it can be seen from the relation $X = R^2/\lambda$ that these solid angles are relatively large. This is illustrated in Figure 3 where $\lambda = 24''$ ($f = 500$ cycles approximately), $D = 12''$, so $X = 1\frac{1}{2}''$ only. In addition, the increased directivity of the ring over the piston is based on the assumption that the ring is thin. Therefore if a definite limitation of say 10″ to 12″ is placed on the diameter of the ring, the area of the

[1]Project initiated by writer at Powers Electronic and Communication Co., Glen Cove, New York.

[2]Crandall, *Theory of Vibrating Systems and Sound*, D. Van Nostrand.

[3]Massa, *Acoustic Design Charts*, Blakiston

**This is a continuation of the analysis of electric megaphones which appeared in the July issue of* COMMUNICATIONS, *in which the factors involved in developing a high-power electric megaphone system with a practical margin against acoustic feedback, are considered further.*

BY INCREASED DIRECTIVITY IN ELECTRIC MEGAPHONES*

by ARTHUR J. SANIAL

Chief Engineer
Atlas Sound Corporation

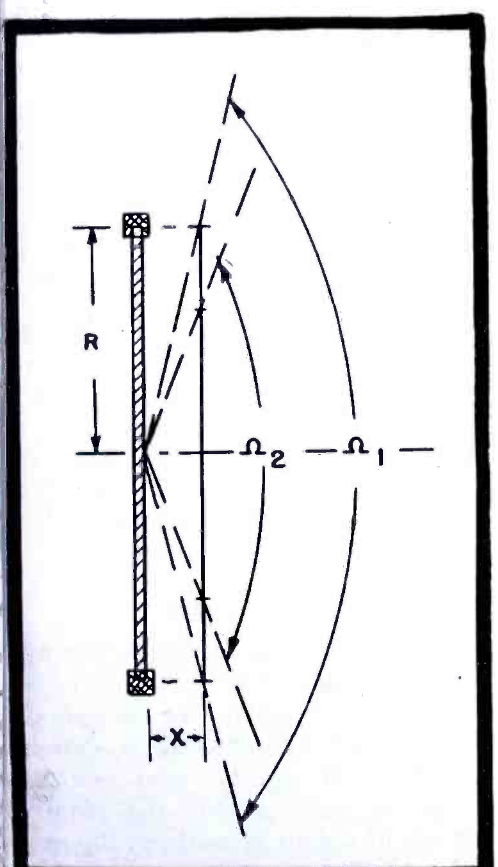
nnular mouth will be relatively small. At the lower frequencies this will reduce the transfer efficiency to the atmosphere.

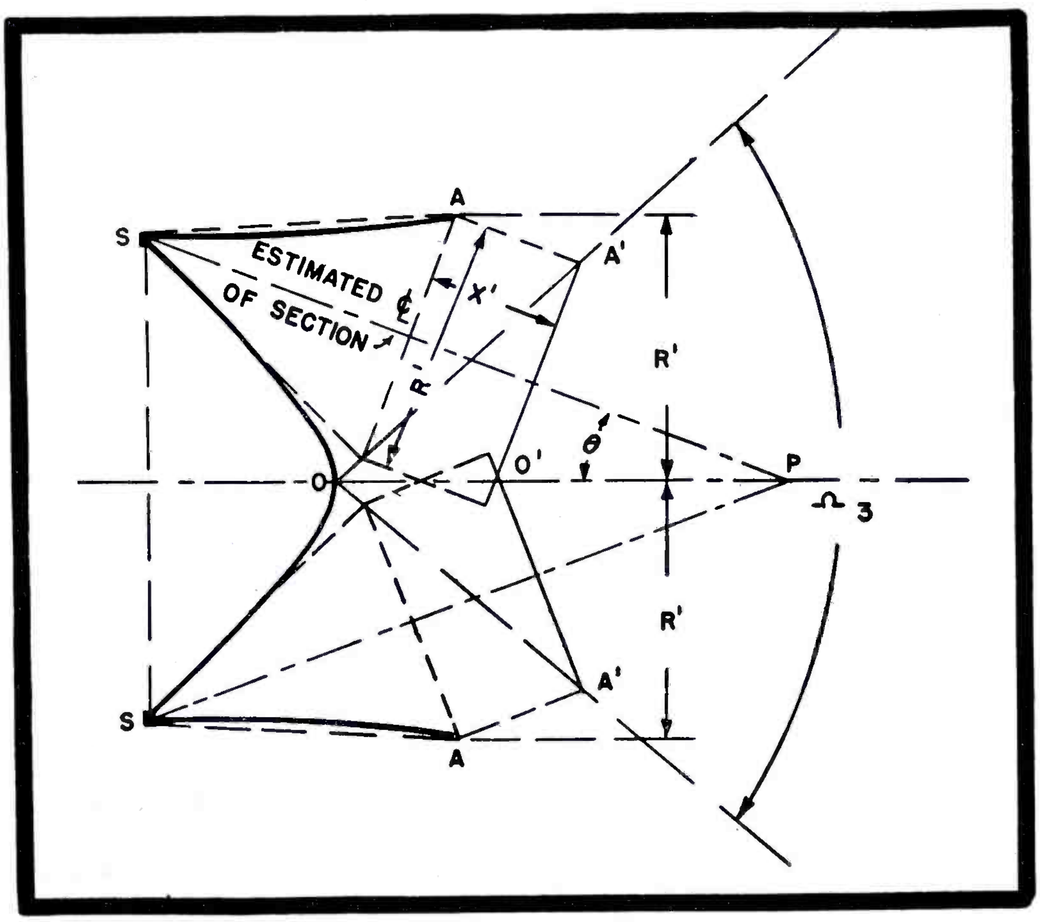
The next step, then, is to look into the possibility of terminating the ring radiator with an annular horn of flaring cross-section. The purpose is to present a more favorable impedance match to the atmosphere comparable to that of a circular horn mouth of the same diameter, and at the same time, tend to keep the divergence of the cone of sound, around the normal axis, small. Figure 4 shows a cross section of a ring exit with such a possible horn, the latter composed of an outer horn or bell and an inner plug. Hypothetical axes drawn normal to the plane of the exit of any section of the added horn, indicate that the sound waves have a tendency, at least, to converge toward the main central axis at an angle Θ.

It seems logical that the beam of sound in the plane of any half section of the added horn (*ASO*) will remain parallel to the axes of the section (*SP*) to a point $X^1 = (R^1)^2/\lambda$. This will produce a surface of revolution described by the line A^1O^1 based on the same reasoning as applied to the imaginary plane at a distance $X = R^2/\lambda$ in front of the piston, to which the sound beam remained parallel. We can then take Ω_3 as the angle of divergence, i.e., the solid angle subtended by the surface $A^1O^1A^1$ from the point *O*. The smaller angle of divergence (cp to Ω_2 Figure 2) indicates that an improvement in concentration is possible. In fact it may be even greater than this elementary graphical analysis indicates, for inasmuch as the surface $A^1O^1A^1$ is not a plane, the beam of sound may not actually tend to diverge until some other point between O^1 and *P* is reached. At any rate, some data taken

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

Figure 3 illustrates the comparative divergence of sound beams at a lower frequency from a piston (Ω_1) and a ring (Ω_2) . . . ($\lambda = 2\ D_m = 4R$). In Figure 4 we have a method of graphically approximating the divergence of a sound beam (Ω_3) from a ring radiator terminated by a short horn to converge the beam toward the axis for λ 2R′.





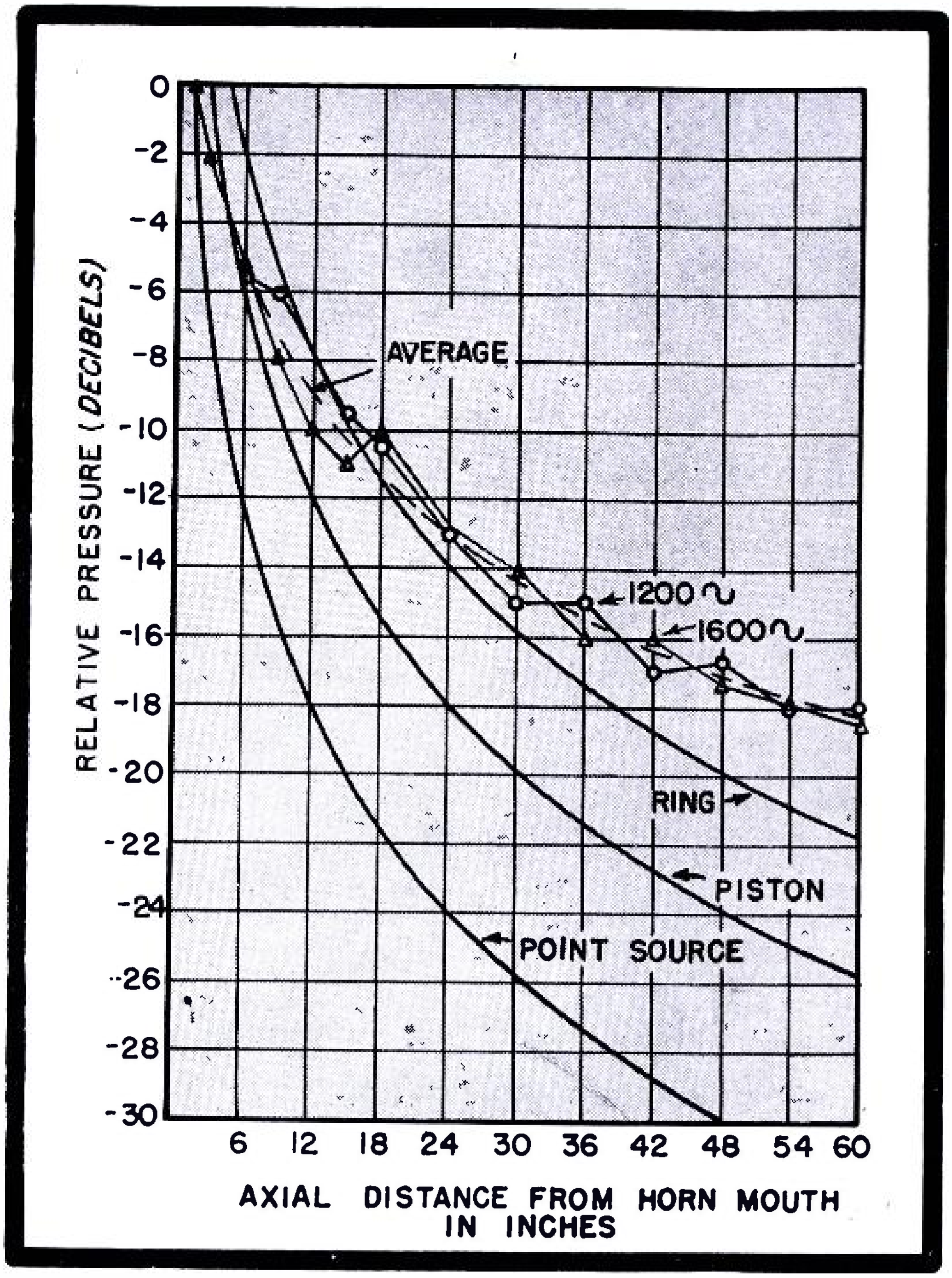


Figure 5

Comparative output versus distance from a source of given strength when the source is a point, a piston, a ring and a ring with special horn termination, where D = λ approximately for the latter three.

on a horn built with a mouth of this shape (at λ = Dm approximately), shows the tendency to maintain an appreciable proportion of the sound around the normal axis for some distance. In Figure 5 we have the result of measurements of output pressure, in db below maximum, versus distance on the central axis of the horn at two frequencies, 1200 and 1600 cycles. There are also plotted three smooth curves, the lower *A* representing the theoretical variation of pressure with distance on the axis from a point source at 1½″ (equal to the strength of the megaphone output at this point). Similarly, *B* is the inverse square low curve for a source 6 db stronger representing the increase to be expected from a piston, D = λ in size. Curve *C* is a similar curve 4 db greater than the piston at a given distance, and represents the theoretical increase to be expected from a thin ring radiator over a piston of the same diameter.[3] It can be seen that the pressure output of the horn does not fall off as rapidly with distance as the inverse square law curves, but at 60″ is more than 7 db better than the output of a piston of the same diameter, and about 3 db better than a ring. This indicates that the advantage of the ring radiator is not only retained at these frequencies, i.e., in the region of 1500 cycles, in spite of the added horn, but the sound is even less divergent than from a ring or annular mouth. This would seem to verify the result of the previous hypothesis, that the sound beam tends to converge toward the central axis for some distance, with this design.

Comparing this to the illustrative example given previously (Figure 9), in which the megaphone had a circular mouth, then with a horn designed as above instead, an increase of 7 db on the axis can be considered as an equivalent increase in the feedback margin. It will be recalled that in this previous example, the value of 100 bars output pressure at 4′ could not be obtained without feedback under the conditions of input pressure and theoretical feedback loss assumed. The feedback loss in this case was taken as 22 db at 2000 cycles. If we wish to find the maximum output on the same basis for the region of 1500 cycles, we can safely use a feedback loss of 17 db, on the bases of lower discrimination due to the horn directivity, as the frequency is lowered. We find the pressure output for 28 bars input from

$$20 \log_{10} (PH/PM) = 17$$

$$PH/PM = 7.07$$

or $PH = 7.07 \times 28 = 198$ bars at 1′

Thus at 4′, $PH = 49\frac{1}{2}$ bars.

The original megaphone system, in which the megaphone was similar to the above, had frequencies below about 700 cycles practically cut out. The rise in response between 700 and 1500 cycles was such that only about 2 db additional feedback margin was required to prevent feedback at the lower frequencies. With 2 db less gain then, the output pressure would be expected to be correspondingly less, other conditions remaining the same as above, or

$$PH = \frac{49\frac{1}{2}}{\log^{-1}(2/20)} = 40 \text{ bars (approximately)}$$

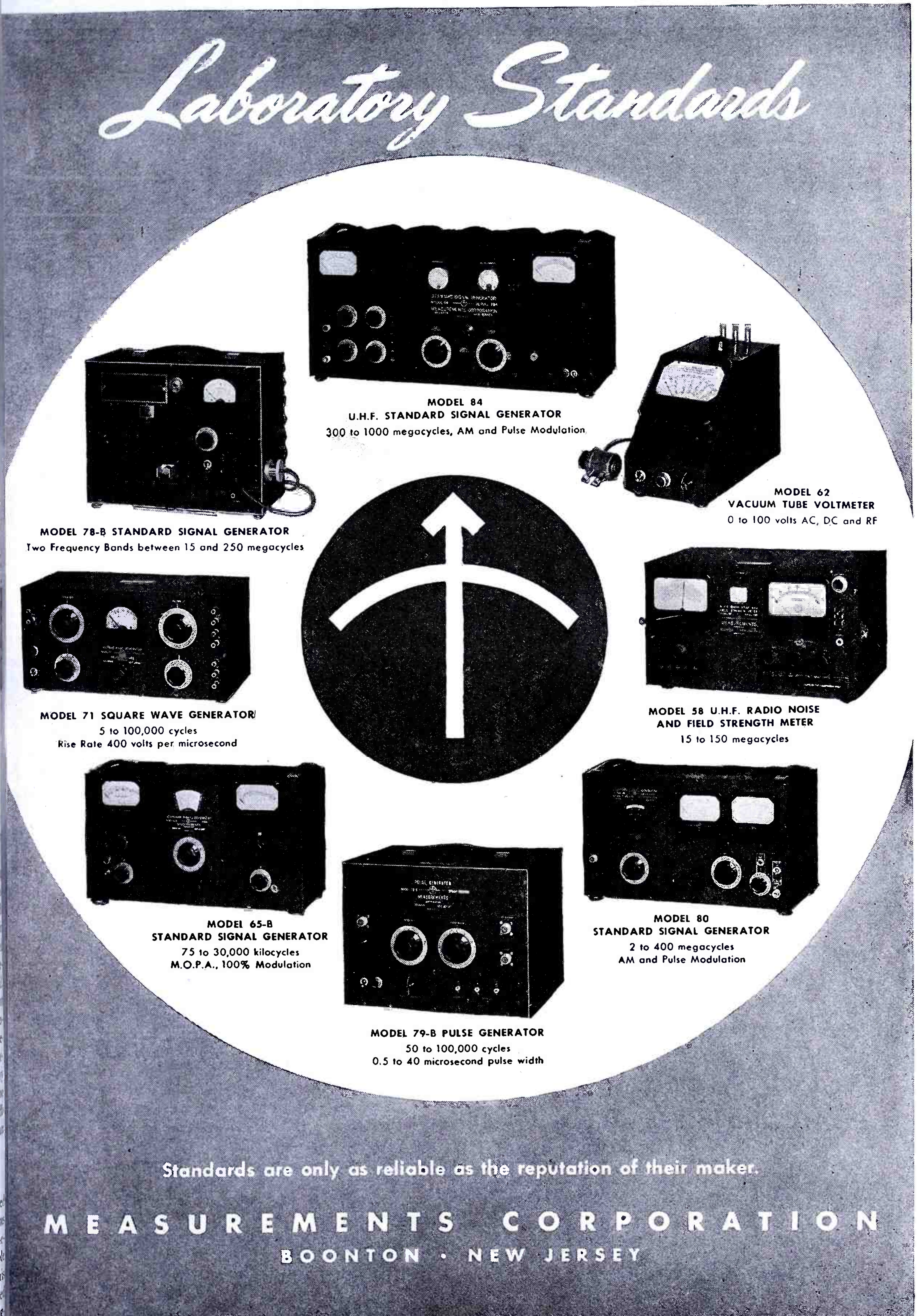
This was the figure cited previously for the original megaphone system output.

Thus a megaphone incorporating the improvements in design referred to above, effecting approximately 7 db increase in the feedback margin in the 1500 cycle region, can be expected to produce an output pressure correspondingly greater than the original. Of course, the amplifier equipment must be capable of handling the increased power necessary, and the reduced feedback margin at lower frequencies must be compensated by equalization, or other means, in the system. The pressure ratio for 7 db is 2.24; thus the pressure output can be increased to

$$49\frac{1}{2} \times 2.24 = 111 \text{ bars}$$

This pressure is actually obtained with a megaphone of such dimensions and with the special horn design described, when coupled to a suitable amplifier. It can be seen that this brings us very near to the required tripling of output pressure of the original megaphone system.

[3]Massa, Loc. Cit.


Laboratory Standards
MODEL 84
U.H.F. STANDARD SIGNAL GENERATOR
300 to 1000 megacycles, AM and Pulse Modulation
MODEL 78-B STANDARD SIGNAL GENERATOR
Two Frequency Bands between 15 and 250 megacycles
MODEL 62
VACUUM TUBE VOLTMETER
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MODEL 71 SQUARE WAVE GENERATOR
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Rise Rate 400 volts per microsecond
MODEL 58 U.H.F. RADIO NOISE
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Personals

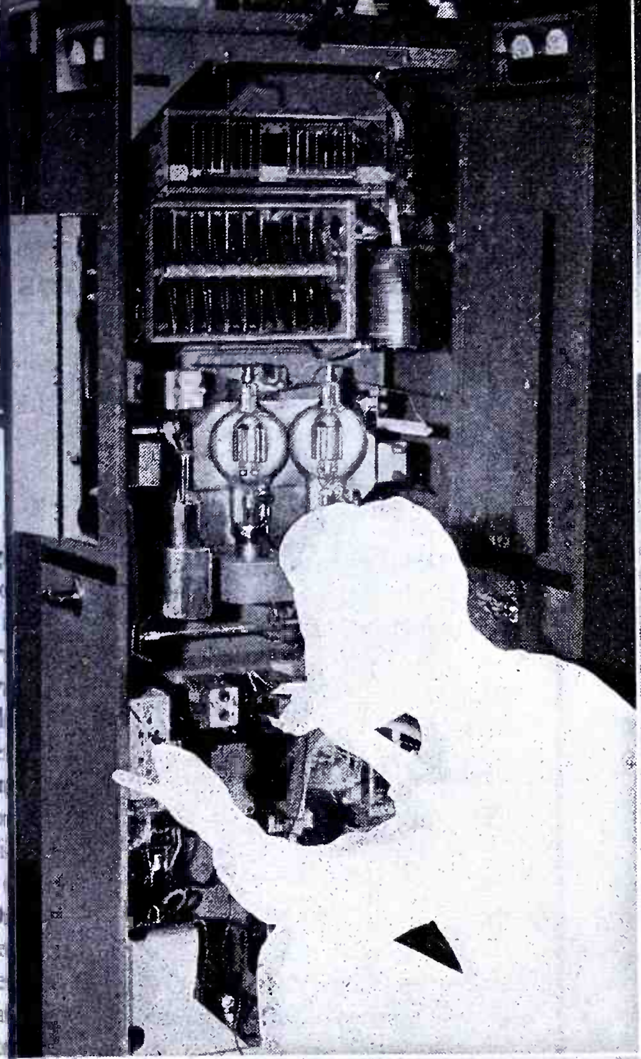
M. C. LOPEZ is now stationed in Dixon, Calif. . . . Col. R. Woolverton, U. S. A. Signal Corps. (Ret.), is one of the more active members in the San Francisco chapter. . . . It has been many months since we have heard from T. M. Stevens, a director of VWOA in the early days and a life member for many years. . . . Cyrus T. Reed, sales engineering head of Hallicrafters is a recent new member. . . . Lt. Comdr. A. F. Van Dyck, life member is still on active duty with the Navy in Washington. Like Haraden Pratt, Comdr. Van Dyck is another former professional wireless operator, who served as president of IRE. . . . S. W. Fenton, formerly of the Mackay organization in San Francisco is now with the I. T. & T. office in Washington. . . . J. A. Balch, formerly of the Honolulu chapter of VWOA is also in Washington. . . . Dr. F. A. Kolster, life member, of radio compass fame, is busy in Washington. . . . A hearty welcome to new-member George E. Sterling, assistant chief engineer of the Federal Communications Commission. George is a real oldtimer. He did a grand job with FCC's RID. . . . W. S. Wilson, VWOA resident agent in Delaware, was a Major in the U. S. Army Air Corps stationed in India when last heard from. . . . The complete story of the experiences of veteran member L. H. Marshall, who was torpedoed, will be revealed in an early issue. . . . "Bill" Beakes, chairman of the board of Tropical Radio and a VWOA life member continues to enjoy boating down Miami way in semi-retirement. Many happy days, "Bill." . . . Wm. D. Kelly is now chief operator of WFBR in Baltimore. . . . Wm. T. Freeland, of Freeland and Olschner, a member of our New Orleans chapter, was in New York recently and had lunch with some of the boys. . . . Robert V. Howley, honorary member, president of the Tropical Radio Telegraph Company, was recently elected chairman of the radio committee of the American Federation of Shipping. . . . D. W. Rentzel,

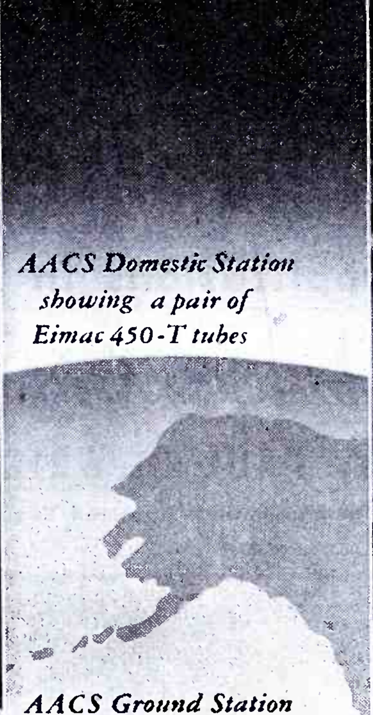
G. E. Sterling, assistant chief engineer of the FCC, who has become a VWOA member.

president of the Aeronautical Radio Company in Washington, has become a VWOA member. Welcome. . . . Harry Cornell, radio supervisor for the Standard Oil Company, is another veteran who recently joined our ranks. Besides being a veteran operator Mr. Cornell also holds a master's license. . . . E. A. Nicholas, president of Farnsworth Television and VWOA life member, is one of the three members of IRE who will supervise the IRE Building Fund use. . . . Commander H. D. Kaulback is now located in Bethesda, Md. . . . J. McWilliams Stone, life member has been traveling all over the country in behalf of Operadio of which he is president. . . . M. L. MacAdam of the Boston chapter is special consultant to the World Broadcasting System. . . . D. A. Myer is doing his bit at WBZ, Boston, at the controls. . . . J. Smith Dodge is back at WNAC-WAAB, Squantum, Mass., after a period of active duty as a Lieut. in the Navy. . . . A recent new member from Longmeadow, Mass., is veteran wirelessman Monte Cohen. . . . Benj. Wolf, who has been a member of VWOA almost from the beginning, is now in charge of the FCC Grand Island Monitoring Station in Nebraska. . . . Lt. Col. W. S. Marks, Jr., is now stationed at the Camp Coles Signal Laboratory at Red Bank, N. J.

. . . Paul F. Godley, life member, i expanding his consulting radio-engi neering organization. . . . Clarenc Seid, a former wireless operator, i a practicing attorney in Brooklyn N. Y. . . . E. K. Price is at the Nava Air Station at Floyd Bennett Field Brooklyn, N. Y. . . . D. Carruther and J. T. Maloney have been lendin a hand at the Radio Supervisor office of the War Shipping Adminis tration during the recent illness o VWOA director C. D. Guthrie. Ou best wishes to CD for his complet recovery soon. . . . VWOA member V. Ladeveze and R. S. Henery ar members of the RCA Communication staff at Rocky Point L. I. . . . Car Coleman, radio supervisor of Arnessen Electric Company, has become a VWOA member. . . . C. S. Ander son, who did so much to insure th editorial excellence of many *Yea Books* is now living in retirement i New Jersey. Good health, CSA. . . Benjamin Titow is now manager o the RCAC office in the Chrysle Building, New York. . . . E. J. Simon one of the earliest wireless pioneer in America, recently joined us. Mr Simon was one of the first co-worker of Dr. de Forest. . . . It is now Lt Comdr. Edw. Bennett, USNR at Nor folk, Va. . . . Veteran member V. A Kamin is now Lt. Col. Kamin. . . Lt. Fred T. Bowen has been a Cincpac Advance Headquarters fo some time. . . . George Street, chair man of the Honolulu chapter o VWOA, is manager of RCA Commu nications in Hawaii . . . Life Membe Capt. C. H. Maddox, USN, a sub marine expert, has been working ou of Pearl Harbor for over a year. . . Lt. Col. R. L. Duncan, who as RI director signed "Bill" McGonigle' graduation certificate, is with the VI Bomber Command in the Pacific. Let hear from you "Rudy." . . . John C Ashton, who applied at N A H for *Certificate of Skill* way back in th early 1900's, when George Clark wa the certifier of skill, is now assistan to the vice president of Majesti Radio and Television Corporation. . .

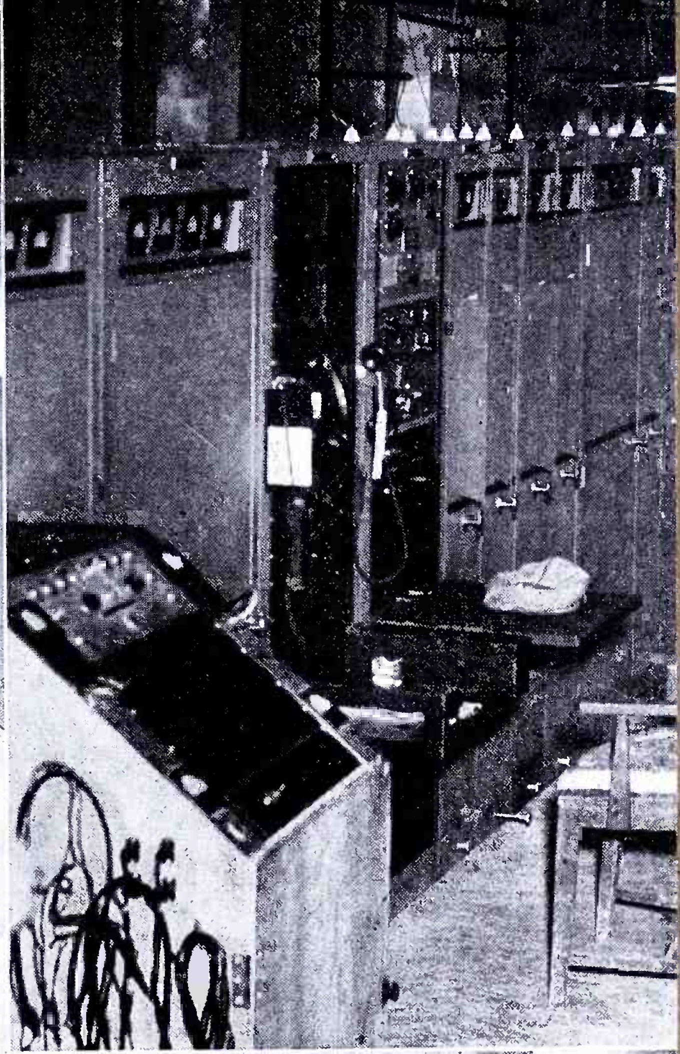
(*Continued on page* 81)





AACS Domestic Station showing a pair of Eimac 450-T tubes

AACS Ground Station China-Burma-India Theatre



AACS* BLAZES THE TRAIL FOR SAFE FUTURE WORLD AIR TRANSPORTATION

AACS Station on an island in South Pacific

World-wide aviation communications are an established fact today. Almost overnight a great radio network has been created. The actual physical difficulties involved were great enough, to say nothing of the variety of extreme operating conditions encountered and overcome. Needless to say, the equipment employed must be dependable, both from a standpoint of construction and performance capability.

The establishment of radio ground stations on every continent and in fifty-two different countries...overcoming the widest extremes in operating and climatic conditions (from 40 degrees below zero to 140 degrees above)...stations in jungles ...in deserts...in mountains and towns...and to have these stations constantly operating at near peak levels is a tribute to the equipment employed. On this page are shown three AACS Stations located at widely separated spots on the globe.

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**A. A. C. S. (Army Airways Communications System)*

RESISTIVE ATTENUATORS,

An Analysis of Their Applications in Mixer and Fader Systems

[*Part Eight of a Series*]

by PAUL B. WRIGHT

Communications Research Engineer

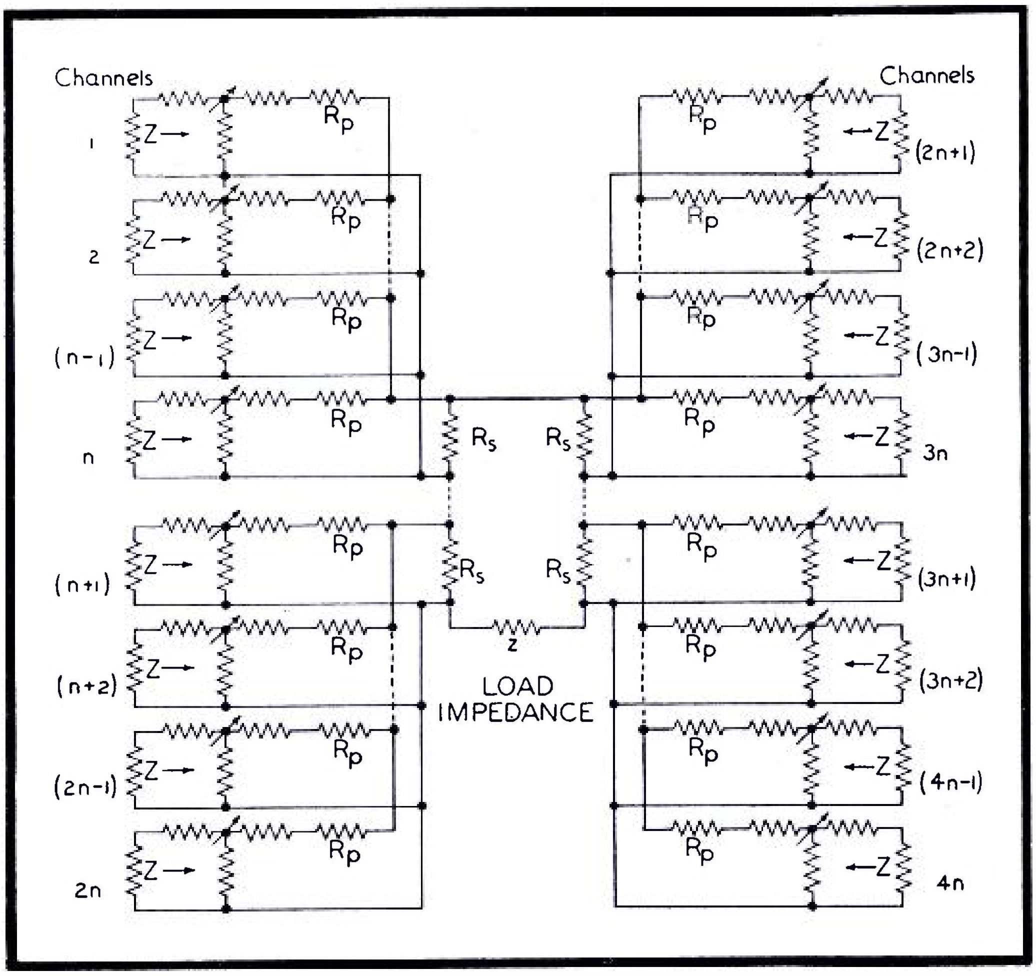


Figure 8
Parallel-series system of mixer and faders with the necessary compensating series and shunt resistances required to match all impedances at their respective junctions.

ALTHOUGH equations *20* to *25* give the individual system parameters, they are not in the proper form for the combined systems of series and parallel groups, but the required forms may be obtained from them. Taking the equations in pairs and dividing, term by term, of . . . first, *20* and *23*; then *21* and *24*, and finally, *22* and *25*, we obtain, respectively, the equations

$$\frac{R'_s}{R'_p} = \frac{2C_s}{G_p} = \frac{2\coth\Theta_s}{\sinh 2\Theta_p} = \frac{n_s(2n_p-1)}{n_p(n_s-1)(n_p-1)} = \frac{R_s}{R_p}\frac{z_p}{z_s} \qquad (26)$$

$$\frac{R'_s}{R'_p} = \frac{2g\,s^2_s}{C_p s^2_p} = \frac{2s^2_s\,\mathrm{csch}\,2\Theta_s}{s^2_p\tanh\Theta_p} = \frac{s^2_s}{s^2_p}\cdot\frac{n_p(2n_s-1)}{n_s(n_p-1)(n_s-1)} = \frac{R_s}{R_p}\frac{z_p}{z_s} \qquad (27)$$

and

$$\frac{s^2_s}{s^2_p} = \frac{E_s}{E_p} = \frac{\cosh^2\Theta_s}{\cosh^2\Theta_p} = \frac{n^2_s}{n^2_p}\cdot\frac{2n_p-1}{2n_s-1} = \frac{z_p}{z_s} = s^2 \qquad (28)$$

When the number of groups in parallel equals the number of fader channels connected in series, $n_p = n_s = n$; $\Theta_p = \Theta_s = \frac{1}{2}\Theta$, and $z_p = z_s = z$. This is a particularly advantageous condition, for this permits using faders and mixers having a common impedance level, or the input and output impedances of the system are all identically equal. Hence, it has become common practice to use two channels in series and two groups of these connected in parallel, giving a total of four channels. This is generally sufficient for most of the applications in the average station. However, when more channels are required in a given system, they may be readily built out for the proper impedance levels by making use of the previously derived equations for the compensating resistances required. For this special case or condition, equations *26* to *28* reduce to simple forms; *26* and *27* become the identities

$$\frac{R'_s}{R'_p} = \frac{2n-1}{(n-1)^2} = \mathrm{csch}^2\,\Theta = p = \frac{R_s}{R_p} \qquad (29)$$

while *28* reduces to the condition

$$\frac{s^2_p}{s^2_s} = \frac{z_s}{z_p} = 1 \qquad (30)$$

From equations *20* and *28*, the compensating resistance which should be placed in shunt with each series-connected fader channel output is

$$R_s = z_p\frac{n^2_p(2n_s-1)}{n_s(2n_p-1)(n_s-1)} \qquad (31)$$

while the compensating resistance which should be placed in series with each series-connected fader channel group is found by using equations *23* and *28*, giving

$$R_p = z_s\frac{n^2_s}{n_p}\,\frac{n_p-1}{2n_s-1} \qquad (32)$$

Equations *31* and *32* may be written in terms of the hyperbolic functions of a real variable by making use of the pairs of equations *21* and *25*, and *22* and *24*, becoming respectively

$$R_s = 2z_p\,\mathrm{csch}\,2\Theta_s\cosh^2\Theta_p = 2z_pE_pg_s \qquad (33)$$

and

$$R_p = z_s\cosh^2\Theta_s\tanh\Theta_p = C_pE_sz_s \qquad (34)$$

When the number of series groups in parallel is equal to the number of series-connected channels, $n_s = n_p = n$; $\Theta_p = \Theta_s = \Theta/2$, and $z_s = z_p = z$. For this special condition, equations *33* and *34* become

$$R_s = z\coth\frac{\Theta}{2} = dz \qquad (35)$$

and

$$R_p = \frac{z}{2}\sinh\Theta = \frac{1}{2}Az \qquad (36)$$

Insertion Loss of a Series-Parallel Mixer System

The insertion loss caused by a series-connected mixer and fader system between input and output impe-

PADS AND NETWORKS

ances of z_s and Z, or by a parallel-onnected system having input and utput impedances of z_p and Z was nown to be equal to

$$b = 10 \text{ Log}_{10} (2n-1) \qquad (12)$$

y using proper subscripts for the eries and the parallel portions of the eries-parallel mixer network, from quation (*12*), the losses caused by hese portions may be written directly ithout further appeal to circuit heory as

$$b_s = 10 \text{ Log}_{10} (2n_s - 1) \qquad (37)$$

or the series-connected fader chan-els, and

$$b_p = 10 \text{ Log}_{10} (2n_p - 1) \qquad (38)$$

or the parallel groups of series-con-ected channels.

The total loss of the system is the um of the losses incurred by the eries-parallel connections, and is the um of the losses given by equations 7 and *38*. The loss of a series-parallel mixer and fader system is, herefore,

$$db = db_s + db_p$$
$$= 10 \text{ Log}_{10} ((2n_s - 1)(2n_p - 1)) \qquad (39)$$

When the number of parallel groups quals the number of series-connected hannels in each group, $n_s = n_p = n$. Equation *39* then becomes

$$db = 10 \text{ Log}_{10} (2n-1)^2 \qquad (40a)$$

or

$$db = 20 \text{ Log}_{10} (2n-1) \qquad (40b)$$

These equations give the insertion oss which will be incurred from the nput of any single channel to the common output load of the complete ystem of faders, compensating re-sistances and mixers with the faders and mixers turned to zero loss. If

In last month's discussion, the series-connected fader and the parallel-connected fader systems were considered, together with an analysis of their performance expressed both algebraically and in terms of the hyperbolic functions of a real variable. In this installment, the series-parallel-connected fader system discussion is continued and equations describing the complete behavior of this type network system are developed. This is followed by further analytical work dealing with the parallel-series-connected fader and mixer system and several lesser known systems which are quite useful to use. These are the *multiple bridge* and the *lattice network* systems which may be utilized to advantage for some applications. All of the equations which are derived are shown in the algebraical, hyperbolical and symbolical forms. The key chart which was presented earlier in this series may be used to great advantage when checking the definitions of the symbols used which are not specifically defined in the text. This procedure also may be directly applied to the hyperbolic equations shown. It is of course necessary to take into account that, in general, subscripts are used in most of the equations in the text while the key chart does not have any subscripts. This does not, however, alter the fundamental forms nor their definitions in terms of the propagation function, theta. To avoid the necessity for extensive interpolation of the hyperbolic function tables to find the correct numerical values for the various functions used throughout the text, a series of tables providing all of the functions required is presented.

these do not have zero insertion losses, whatever their loss, it must be added to that obtained by equations *40*.

Parallel-Series Mixer and Fader Systems

For systems of this type, we have the general arrangement of connections as shown in Figure 8. The equivalences of the system are shown in two steps, on a unit basis, by Figures *9* and *10*. As explained in previous analyses, the faders have been assumed to have been removed from the equivalent structure or turned to a position of zero insertion loss.

As in the series-parallel mixer and fader system, by assignment of proper subscripts, use may be made of the previously developed equations for the series and the parallel mixer and fader systems. For this purpose, let us consider n_p sources or fader channels connected in parallel and n_s such groups then connected in series. The normal parallel-fader output impedance, z_p becomes the new source for the series group impedance, z_s; hence $z_p = z_s = z$. The individual channel input impedances are Z_p and the common output impedance is Z_s. From the previously developed equations for the series and the parallel types of fader and mixer systems, we may, by application of the proper subscripts, formulate the equations for the parallel-series type of system. Thus, from equations *16* and *17*, which are

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

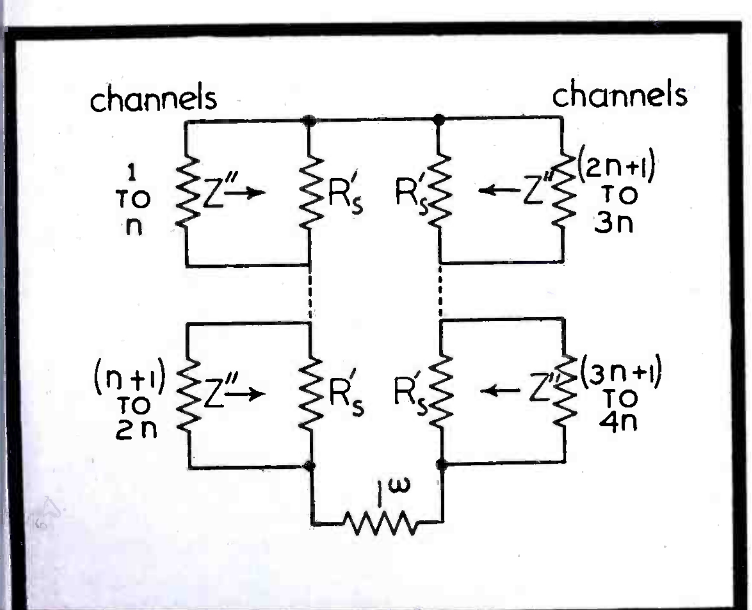
$$s^2 = Z/z = n^2/(2n-1) = E = \cosh^2 \theta \qquad (17a)$$

and

$$s = B = \cosh \theta \qquad (17b)$$

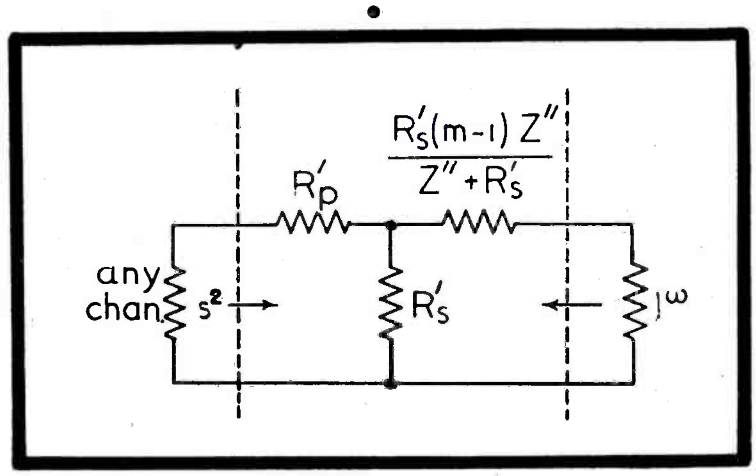
we may write the unit equations as

(*Continued on page* 71)



Figures 9 (left) and 10 (below)

Figure 9. One stage in the reduction of Figure 8 to an equivalent unit basis with faders removed. $Z'' = (R'_p + 1)/n$. $R'_p = R_p/z_p$.
Figure 10. Final transformation of Figure 8 to an equivalent unit channel basis. $R'_s = R_s/z_s$.



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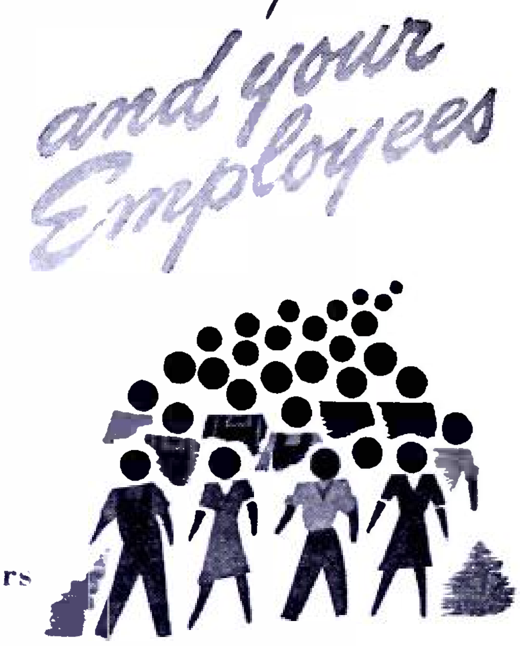

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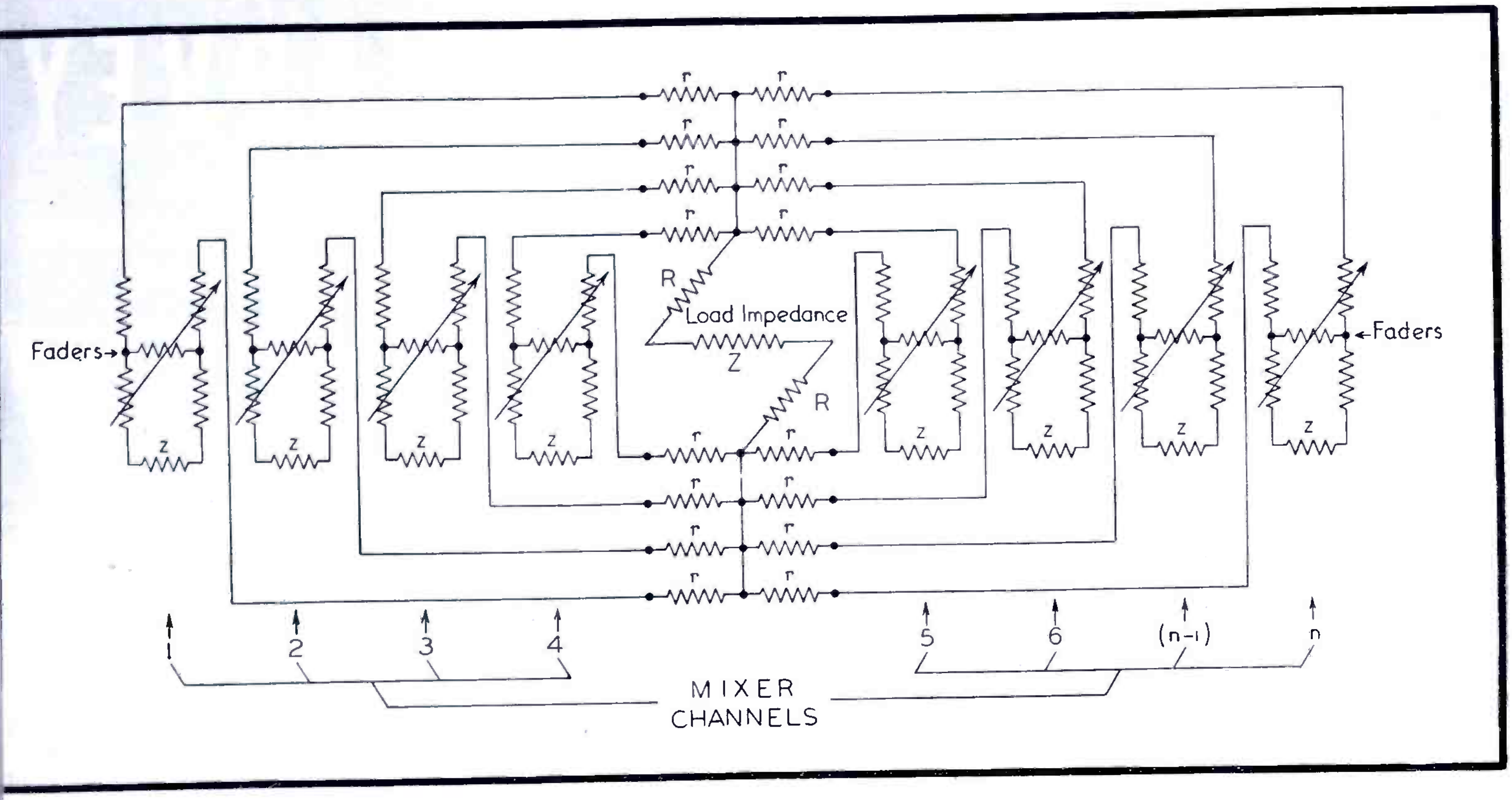
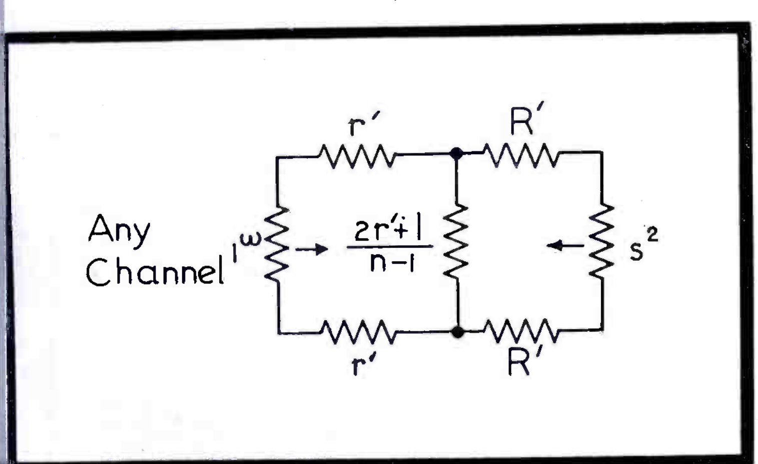
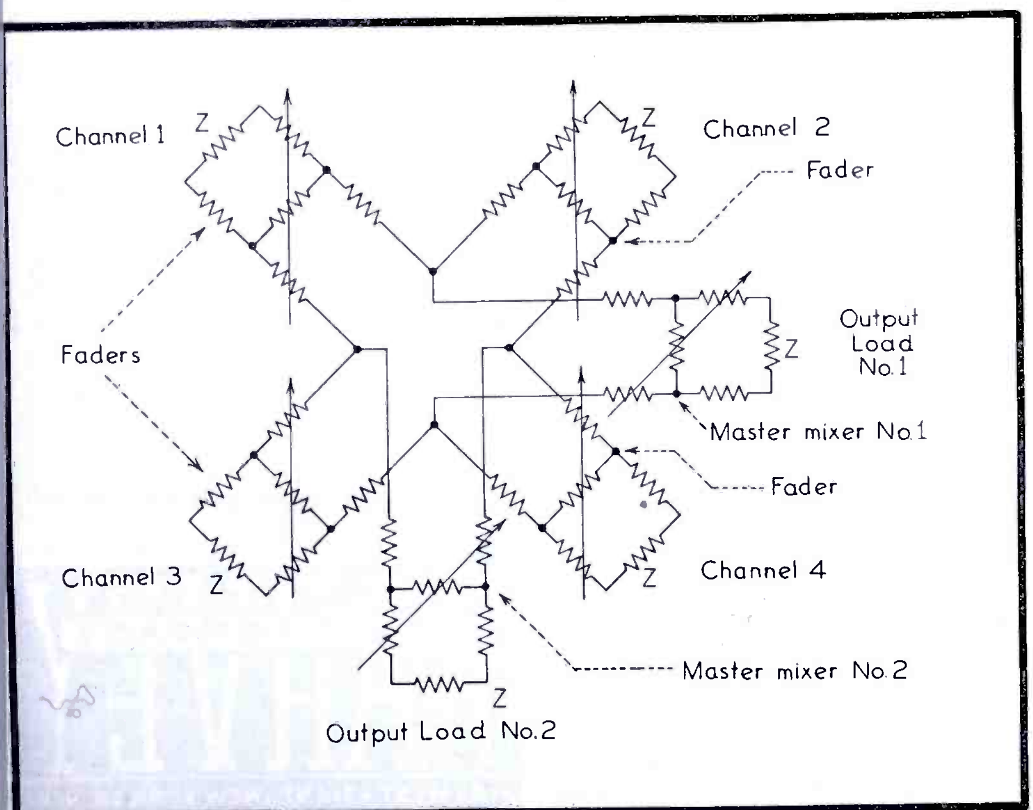




Figures 11 (above), 12 (left) and 13 (below)
Figure 11. An *n*-channel system of mixer and faders in balanced form. **Figure 12.** A single-channel representation of Figure 11 with the faders set for zero insertion loss. **Figure 13.** A lattice-type bridge system of mixers and faders, consisting of four input-fader channels with two mixer outputs.



$$R'_p = \frac{n_p(n_p-1)}{2n_p-1} = \frac{1}{2}\sinh 2\Theta_p = \frac{1}{2}G = \frac{R_p}{z_p} \qquad (41)$$

or

$$R'_p = s^2_p\,\frac{n_p-1}{n_p} = s_p\sinh\Theta_p = A_p s_p = \frac{R_p}{z_p} \qquad (42)$$

and

$$s^2_p = \frac{n^2_p}{2n_p-1} = \cosh^2\Theta_p = E_p = \frac{Z_p}{z} \qquad (43)$$

for the parallel-connected fader channels, and

$$R'_s = \frac{n_s}{n_s-1} = \coth\Theta_s = c_s = \frac{R_s}{z_s} \qquad (44)$$

or

$$R'_s = s^2_s\,\frac{2n_s-1}{n_s(n_s-1)} = 2s^2_s\,\operatorname{csch} 2\Theta_s = 2g_s s^2_s = \frac{R_s}{z_s} \qquad (45)$$

and

$$s^2_s = \frac{n^2_s}{2n_s-1} = \cosh^2\Theta_s = E_s = \frac{Z_s}{z} \qquad (46)$$

From the pairs of equations . . . *41* and *44*; *42* and *45*, and *43* and *46* . . . the ratios of the various parameters of the network may be obtained. These result in the equations

$$\frac{R'_p}{R'_s} = \frac{n_p}{n_s}\cdot\frac{(n_p-1)(n_s-1)}{2n_p-1} = \frac{\sinh 2\Theta_p}{2\coth\Theta_s}$$

RESISTIVE NETWORKS

(*Continued from page 71*)

$$= \frac{G_p}{2c_s} = \frac{R_p}{R_s}\cdot\frac{z_s}{z_p} = \frac{R_p}{R_s} \qquad (47)$$

or

$$\frac{R'_p}{R'_s} = \frac{s_p^2}{s_s^2}\cdot\frac{n_s(n_s-1)(n_p-1)}{n_p(2n_s-1)}$$

$$= \frac{s_p \sinh\Theta_p}{2s_s^2 \operatorname{csch} 2\Theta_s} = \frac{A_p s_p}{2g_s s_s^2} = \frac{R_p}{R_s}\frac{z_s}{z_p} = \frac{R_p}{R_s} \qquad (48)$$

and

$$\frac{s_p^2}{s_s^2} = \frac{n_p^2}{n_s^2}\frac{2n_s-1}{2n_p-1} = \frac{\cosh^2\Theta_p}{\cosh^2\Theta_s} = \frac{E_p}{E_s} = \frac{Z_p}{Z_s} \qquad (49)$$

When the number of groups in series equals the number of channels parallel-connected in each group, $n_s = n_p = n$, $\Theta_s = \Theta_p = \Theta/2$, and $Z_p = Z_s = Z$. For this condition, all mixers and faders are made equal in their image impedances and all inputs and the output of the system are connected to the same value of impedance. This is an especially convenient relationship and an important one to remember as its use greatly simplifies the design work involved in both the parallel-series and the series-parallel systems. Applying this condition to equations *47* and *48*, we have the identities

$$\frac{R'_p}{R'_s} = \frac{(n-1)^2}{2n-1} = \sinh^2\Theta = P = \frac{R_p}{R_s} \qquad (50)$$

and from *49*, the relationships of

$$\frac{s_p^2}{s_s^2} = \frac{Z_p}{Z_s} = 1 \qquad (51)$$

From equations *42* and *49*, the compensating resistance which should be placed in series with each parallel-connected fader channel output is

$$R_p = Z_s\frac{n_p(2n_s-1)(n_p-1)}{n_s^2(2n_p-1)} \qquad (52)$$

while the compensating resistance which should be placed in shunt with each parallel-connected fader channel group is found by using equations *45* and *49*, resulting in

$$R_s = Z_p\frac{n_s(2n_p-1)}{n_p^2(n_s-1)} \qquad (53)$$

In terms of the hyperbolic functions of a real variable, equations *52* and *53* may be written, using equations *41* and *46*, as

$$R_p = \frac{1}{2}Z_s \sinh 2\Theta_p \operatorname{sech}^2\Theta_s = \frac{1}{2}Z_s G_p e_s \qquad (54)$$

nd

$$_{s} = Z_p \operatorname{sech}^2 \Theta_p \coth \Theta_s = c_s e_p Z_p \quad (55)$$

When $n_s = n_p = n$; $\Theta_p = \Theta_s = \Theta/2$, nd $Z_s = Z_p = Z$, equations *54* and *5* become

$$_{p} = Z \tanh \frac{\Theta}{2} = DZ \quad (56)$$

nd

$$_{s} = 2 Z \operatorname{csch} \Theta = 2 a Z \quad (57)$$

nsertion Loss of a Parallel-Series lixer System

The losses for each section and roup of this type of mixer system aay be written directly from equaons *37* and *38*. Their sum results 1 equation *39* which is the total loss f the system from any single channel nput to the output of the system. For 1e special condition of $n_s = n_p = n$, he loss is given by equations *40*. Ience, the insertion loss of the seriesarallel and the parallel-series sysems is equal, and are both given by quations *38* to *40* inclusive.

ables for Fader and Mixer System esign

Values of the compensating resisances required for the series, parallel, eries-parallel and parallel-series types f mixers are available from the tables ffered in this installment. The ratios f the terminating impedances as well s the ratios of the compensating reistances are given so that the deigner may determine quickly whether r not any set of conditions or relaionships between the network paraneters and the terminating impelances are either possible or practicable. A table of insertion losses acompanies each type of mixer conidered. These tables show directly he losses which will be incurred hrough the use of any given type nixer for any desired combination of eries or parallel connections. These ables will minimize the amount of vork otherwise necessary in interolating the required values of inserion losses and the further interpolaion of the untabulated hyperbolic unctions. This is because the number f channels is an integral number and herefore only certain and definite osses are permissible if good matchng of impedances at the various network junctions is to be obtained.

Multiple Bridge Mixer and Fader Systems

The method of connecting a multiple bridge mixer is shown in Figure 11; its equivalent circuit on a single channel basis appears in Figure 12. By comparison of Figure 12 with the

(*Continued on page 74*)

No. of Parallel Groups in Series	PARALLEL-SERIES MIXER No. of Channels in Parallel: 2	3	4	5	6	7	8	9	10	Network Elements and Impedance Terminations
	$G_p e_s/2$									
2	0.50000	0.90000	1.28571	1.66667	2.04545	2.42308	2.80000	3.17647	3.55263	
3	.37037	.66666	0.95237	1.23455	1.51514	1.79485	2.07405	2.35291	2.63155	
4	.29166	.52500	.75000	.97222	1.19318	1.41346	1.63333	1.85294	2.07237	
5	.2400	.43200	.61714	.80000	0.98182	1.16308	1.34400	1.52470	1.70526	
6	.20370	.36666	.52380	.67900	.83333	0.98716	1.14072	1.29409	1.44737	
7	.17687	.31837	.45481	.58958	.72358	.85714	0.99049	1.12366	1.25673	
8	.15625	.28125	.40178	.52082	.63919	.75719	.87500	0.99262	1.11017	$R_p = \frac{1}{2} G_p e_s Z_s$
9	.13992	.25185	.35979	.46639	.57240	.67807	.78355	.88889	0.99415	
10	.12667	.22800	.32571	.42222	.51818	.61385	.70933	.80470	.90000	
	$c_s e_p$									
2	1.50000	1.11111	0.87500	0.72000	0.61110	0.52062	0.46874	0.41976	0.38000	
3	1.12500	0.83333	.65625	.54000	.45832	.39796	.35156	.31482	.28500	
4	1.00000	.74074	.58333	.48000	.40740	.35375	.31249	.27984	.25333	
5	0.93750	.69444	.54687	.45000	.38194	.35164	.29296	.26235	.23750	
6	.90000	.66666	.52500	.43200	.36667	.31837	.28124	.25186	.22800	
7	.87500	.64815	.51042	.42000	.35647	.30952	.27343	.24486	.22167	
8	.85714	.63492	.50000	.41143	.34920	.30321	.26786	.23986	.21714	$R_s = c_s e_p Z_p$
9	.84375	.62500	.49219	.40500	.34374	.29847	.26367	.23611	.21375	
10	.83333	.61728	.48611	.40000	.33950	.29479	.26041	.23320	.21111	
	Z_p/Z_s									
2	1.00000	1.35000	1.71428	2.08333	2.45454	2.82693	3.20000	3.57353	3.94737	
3	0.74074	1.00000	1.26983	1.54319	1.81817	2.09400	2.37035	2.64702	2.92394	
4	.58332	0.78750	1.00000	1.21527	1.43182	1.64904	1.86667	2.08456	2.30263	
5	.48000	.64800	0.82285	1.00000	1.17818	1.35693	1.53600	1.71529	1.89473	
6	.40740	.55000	.69840	0.84875	1.00000	1.15169	1.30368	1.45585	1.60816	$\frac{Z_p}{Z_s} = \frac{E_p}{E_s}$
7	.35374	.47755	.60641	.73697	0.86830	1.00000	1.13200	1.26412	1.39637	
8	.31250	.42187	.53571	.65102	.76703	0.88339	1.00000	1.11670	1.23352	
9	.27984	.37778	.47972	.58300	.68688	.79109	0.89549	1.00000	1.10463	
10	.25334	.34200	.43428	.52778	.62182	.71616	.81066	0.90529	1.00000	
	R_p/R_s									
2	0.33333	0.60000	0.85714	1.11111	1.36363	1.61539	1.86667	2.11765	2.36842	
3	.44444	.80000	1.14284	1.48146	1.81817	2.15382	2.48886	2.82394	3.15786	
4	.50000	.90000	1.28572	1.66667	2.04546	2.42308	2.80000	3.17648	3.55264	
5	.53333	.96000	1.37142	1.77778	2.18182	2.58462	2.98667	3.38822	3.78947	
6	.55555	1.00000	1.42855	1.85182	2.27273	2.69225	3.11105	3.52934	3.94737	
7	.57143	1.02859	1.46940	1.90482	2.33775	2.76926	3.20000	3.63033	4.06026	
8	.58333	1.05000	1.50000	1.94437	2.38628	2.82681	3.26663	3.70574	4.14459	$\frac{R_p}{R_s} = \frac{1}{2} G_p C_s$
9	.59260	1.06667	1.52382	1.97535	2.42429	2.87185	3.31858	3.76472	4.21062	
10	.60000	1.08000	1.54284	2.00000	2.45454	2.90771	3.36000	3.81174	4.26316	

Requirements and Definitions

$\frac{1}{2} G_p = \frac{1}{2} \sinh 2\theta_p = \frac{n_p (n_p - 1)}{2 n_p - 1}$

$e_s = \operatorname{sech}^2 \theta_s = \frac{2 n_s - 1}{n_s^2}$

Z_s = mixer output impedance

R_p = compensating resistance to place in series with each fader output channel

$c_s = \coth \theta_s = \frac{n_s}{n_s - 1}$

$e_p = \operatorname{sech}^2 \theta_p = \frac{2n_s - 1}{n_p^2}$

Z_p = fader input impedance

R_s = compensating resistance to place in shunt with each group of channels

$Z_p = \cosh^2 \theta_p = z \frac{n_p^2}{2 n_p - 1}$

$Z_s = z \cosh^2 \theta_s = z \frac{n_s^2}{2 n_s - 1}$

z = Output impedance of each parallel fader group

$E_p = \cosh^2 \theta_p$; $E_s = \cosh^2 \theta_s$

$R_p = \frac{1}{2} z \sinh 2\theta_p = z \frac{n_p (n_p - 1)}{2 n_p - 1}$

$R_s = z \coth \theta_s = z \frac{n_s}{n_s - 1}$

$G_p = \sinh 2\theta_p$

$C_s = \tanh \theta_s$

$\theta_s = \frac{1}{2} \operatorname{Log}_\epsilon (2n_s - 1)$

$\theta_p = \frac{1}{2} \operatorname{Log}_\epsilon (2n_p - 1)$

The values of the compensating resistances required to provide proper impedance matching at all junctions of the parallel-series fader and mixer system.

T-network configuration and design data presented by Figure 1 in *Part III*[1], the element values may be written directly by inspection, resulting in the equations

$$R = (cZ - ay)/2$$
$$= (Z \coth \theta - (Zz)^{1/2} \operatorname{csch} \theta)/2 \qquad (58)$$

and

$$r = (cz - ay)/2$$
$$= (z \coth \theta - (Zz)^{1/2} \operatorname{csch} \theta) \qquad (59)$$

From the key chart, the hyperbolic functions may be transformed into algebraic expressions in terms of *k*, the loss function. The loss function for the *T* network is

$$k = s\left(1 + \frac{v + z}{w}\right) \qquad (60)$$

Making the substitutions indicated by comparison of the figures mentioned above, v=2r and w=(2r+z)/(n – 1) into *60*, the loss function for the multiple bridge mixer is obtained as

$$k = ns \qquad (61)$$

No. of Series Groups in Parallel	SERIES-PARALLEL MIXER No. of Channels in Series 2	3	4	5	6	7	8	9	10	Network Elements and Impedance Terminations
					$2g_s E_p$					
2	2.00000	1.11111	0.77778	0.60000	0.48889	0.41270	0.35714	0.31481	0.28148	
3	2.70000	1.50000	1.05000	.81000	.66000	.55715	.48215	.42500	.38000	
4	3.42865	1.90476	1.33333	1.02857	.83810	.70748	.61226	.53968	.48254	
5	4.16667	2.31481	1.62038	1,25000	1.01852	.85979	.74405	.65587	.58642	
6	4.90918	2.72727	1.90913	1.47275	1.20000	1.01300	.87664	.77274	.69091	
7	5.65387	3,15000	2.19872	1.69612	1.38202	1.16667	1.00960	.88995	.79572	
8	6.40000	3.55555	2.48892	1.92000	1.56448	1.32067	1.14286	1.00741	.90076	$R_s = 2g_s E_p z_p$
9	7.14694	3.97062	2.77940	2.14412	1.74703	1.47477	1.27624	1.12500	1.00588	
10	7.89474	4.38596	3.07022	2.36843	1.92983	1.62906	1.40978	1.24270	1.11111	
					$C_p E_s$					
2	0.66667	0.90600	1.14286	1.38889	1.63639	1.88459	2.13338	2.38231	2.63158	
3	.88889	1,20000	1.52381	1.85185	2.18188	2.51282	2.84444	3.17647	3.50877	
4	1.00000	1.35000	1.71430	2.08333	2.45459	2.82686	3.20010	3.57347	3.94742	
5	1.06667	1.44000	1.82859	2.22222	2.61821	2.84382	3.41343	3.81176	4.21053	
6	1.11111	1.55555	1.90476	2.31481	2.72727	3.14100	3.55568	3.97046	4.38596	$R_p = C_p E_s z_s$
7	1.14286	1.54285	1.95917	2.38095	2.80528	3.23077	3.65724	4.08397	4.51121	
8	1.16667	1.57500	2.00000	2.43055	2.86369	3.29800	3.73333	4.06910	4.60533	
9	1.18518	1.60000	2.03174	2.46914	2.90907	3.35042	3.79261	4.23529	4.67836	
10	1.20000	1.62000	2.05715	2.50000	2.94550	3.39224	3.84000	4.28816	4.73684	
					z_s/z_p					
2	1.00000	0.74074	0.58332	0.48000	0.40740	0.35374	0.31250	0.27984	0.25334	
3	1.35000	1.00000	.78750	.64800	.55000	.47755	.42187	.37778	.34200	
4	1.71428	1.26983	1.00000	.82285	.69840	.60641	.53571	.47972	.43428	
5	2.08333	1.54319	1.21527	1.00000	.84875	.73697	.65102	.58300	.52778	
6	2.45454	1.81817	1.43182	1.17818	1.00000	.86830	.76703	.68688	.62182	$\frac{z_s}{z_p} = \frac{E_p}{E_s}$
7	2.82693	2.09400	1.64904	1.35693	1.15169	1.00000	.88339	.79109	.71616	
8	3.20000	2.37035	1.86667	1.53600	1.30368	1.13200	1.00000	.89549	.81066	
9	3.57353	2.64702	2.08456	1.71529	1.45585	1.26412	1.11670	1.00000	.90529	
10	3.94737	2.92394	2.30263	1.89473	1.60816	1.39637	1.23352	1.10463	1.00000	
					R_p/R_s					
2	0.33333	0.44444	0.50000	0.53333	0.55555	0.57143	0.58333	0.59260	0.60000	
3	.60000	.80000	.90000	.96000	1.00000	1.02859	1.05000	1.06667	1.08000	
4	.85714	1.14284	1.28572	1.37142	1.42855	1.46940	1.50000	1.52382	1.54284	
5	1.11111	1.48146	1.66667	1.77778	1.85182	1.90482	1.94437	1.97535	2.00000	
6	1.36363	1.81817	2.04546	2.18182	2.27273	2.33775	2.38628	2.42429	2.45454	$\frac{R_p}{R_s} = \frac{1}{2} C_p C_s$
7	1.61539	2.15382	2.42308	2.58462	2.69225	2.76926	2.82681	2.87185	2.90771	
8	1.86667	2.48886	2.80000	2.98667	3.11105	3.20000	3.26663	3.31858	3.36000	
9	2.11765	2.82349	3.17648	3.38822	3.52934	3.63033	3.70574	3.76472	3.81174	
10	2.36842	3.15786	3.55264	3.78947	3.94737	4.06026	4.14459	4.21062	4.26316	

Requirements and Definitions

$2g_s = 2\,\text{csch}\,2\Theta_s = \frac{2n_s - 1}{n_s(n_s - 1)}$

$E_p = \cosh^2\Theta_p = \frac{n_p^2}{2n_p - 1}$

z_p = mixer output impedance

R_s = compensating resistance to place in shunt with each fader output channel

$C_p = \tanh\Theta_p = \frac{n_p - 1}{n_p}$

$E_s = \cosh^2\Theta_s = \frac{n_s^2}{2n_s - 1}$

z_s = fader input impedance

R_p = compensating resistance to place in series with each group of channels

$z_s = Z\,\text{sech}^2\Theta_s = Z\frac{2n_s - 1}{n_s^2}$

$z_p = Z\,\text{sech}^2\Theta_p = Z\frac{2n_p - 1}{n_p^2}$

$\frac{z_s}{z_p} = \frac{\cosh^2\Theta_p}{\cosh^2\Theta_s}$

Z = Output impedance of each series fader group

$E_p = \cosh^2\Theta_p$; $E_s = \cosh^2\Theta_s$

$R_p = \frac{1}{2} z_p \sinh 2\Theta_p = z_p\frac{n_p(n_p - 1)}{2n_p - 1}$

$R_s = z_s \coth\Theta_s = z_s\frac{n_s}{n_s - 1}$

$G_p = \sinh 2\Theta_p$

$C_s = \tanh\Theta_s$

$\Theta_s = \frac{1}{2}\text{Log}_\epsilon(2n_s - 1)$

$\Theta_p = \frac{1}{2}\text{Log}_\epsilon(2n_p - 1)$

Values of the compensating resistances required to provide proper impedance matching at all junctions of the series-parallel fader and mixer system.

here k is equal to or greater than nity, n is the number of fader channels and s is equal by definition to he square root of the ratio Z/z taken ositively and equal to or greater than nity.

The algebraic form of equation *58* nd *59* as found from the defining key chart substitutions yield the forms of

$$R = \frac{1}{2}\left(Z\frac{k^2+1}{k^2-1} - (Zz)^{1/2}\frac{2k}{k^2-1}\right) \qquad (62)$$

and

$$r = \frac{1}{2}\left(z\frac{k^2+1}{k^2-1} - (Zz)^{1/2}\frac{2k}{k^2-1}\right) \qquad (63)$$

Substituting *61* into *62* and *63*, the element values for the multiple bridg-

[1]COMMUNICATIONS; January 1945.

RESISTIVE NETWORKS

(*Continued from page 75*)

ing type of mixer system are obtained in terms of the number of channels and the fader and mixer image impedances, as

$$R = Z\left(\frac{n^2s^2 + 1 - 2n}{2\,(n^2s^2 - 1)}\right) \qquad (64)$$

and

$$r = z\left(\frac{n^2s^2 + 1 - 2ns^2}{2\,(n^2s^2 - 1)}\right) \qquad (65)$$

For the special case of equal fader and mixer impedances, $s = 1$, or $Z = z$, and the equations for the element values reduce to the identities of

$$R = r = Dz = z \tanh\frac{\theta}{2}$$

$$= z\frac{k-1}{k+1} = z\frac{n-1}{n+1} \qquad (66)$$

Transmission Loss of the Multiple Bridge Mixer

From the definition of the power transmission loss for the *T* network of

$$db = 10 \operatorname{Log}_{10} k^2 \qquad (67)$$

by using *61*, the power transmission loss in decibels of the multiple bridge mixer from the input of any fader channel to the common output of the mixer may be written

$$db = 20 \operatorname{Log}_{10} (ns) \qquad (68)$$

which becomes simply

$$db = 20 \operatorname{Log}_{10} n \qquad (69)$$

when the input and output image impedances are made equal to each other.

Complete tabulations for the element values and the loss of the multiple-bridge network were given in a previous paper, and should be consulted for more detailed information.

Lattice Fader and Mixer Systems

An arrangement for a special case of the generalized lattice network as used for a mixer system is shown in Figure 13. The equivalent structure on a single channel basis appears in Figure 14.

The image impedance of each channel is found readily by using *Bartlett's Theorem* which was described and illustrated in *Part I*[3] Briefly, for a symmetrical network such as the equivalent one of Figure 14, the image impedance may be found by taking the positive square root of the product of the short- and open-circuited impedances of the bisected

[2]Communications; September, 1943.
[3]Communications; August, 1944.

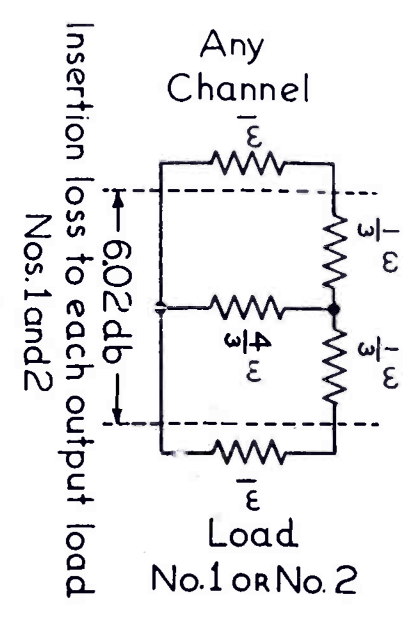


Figure 14
An individual channel representation of Figure 13 (*see page 71*).

etwork as viewed from either end of the normal network. For Figure 14, this gives

$$\frac{1}{3}Z\left(\frac{1}{3}Z+\frac{4}{3}Z\right)=Z \qquad (70)$$

Insertion Loss for Lattice Fader and Mixer Systems

By comparison of Figure 14 with Figure 1 of the charts given in *Part II*, the loss of the *T* network is

$$b = 20\ \mathrm{Log}_{10}\left(1+\frac{v+z}{w}\right)$$

$$= 20\ \mathrm{Log}_{10}\left(1+\frac{\frac{Z}{3}+Z}{4Z/3}\right) = 6.02 \qquad (71)$$

This is the insertion loss, and in this case is also the power transmission loss from the input of any single channel of the system to any of the four loads if two inputs are used, or to any one of three loads if three loads are used. It should be noted that in the latter case one of the input sources is always a load for one of the two remaining sources. This mixer system is an excellent one to use for talk-back systems as well as for selective systems in which it may be desired to feed two separates sources into a common system without mixing of the two sources at their inputs but at the same time permitting the delivering of signal energy to a common output, as well as providing transmission in the opposite direction. This is because each channel has a conjugate impedance, and the conjugate transmission paths give high (theoretically, infinite) losses between any two such conjugate impedances.

Electronic Fader and Mixer Systems

For controlling the level of signals transmitted by electronic means through the use of vacuum tubes a simple voltage dividing device is usually employed, Figure 15. The mixing of several channels may be accomplished in a number of ways. However, the most common are by transformer coupling using multiple windings, or by resistance-divider networks which also act as plate circuit loading resistances. Here, again, a wide variety of connections are possible which will serve satisfactorily for average quality public-address systems or program services. Hence, only the grid input voltage divider will be considered as its design may readily be determined by consideration of the

(*Continued on page 78*)

RESISTIVE NETWORKS

(Continued from page 77)

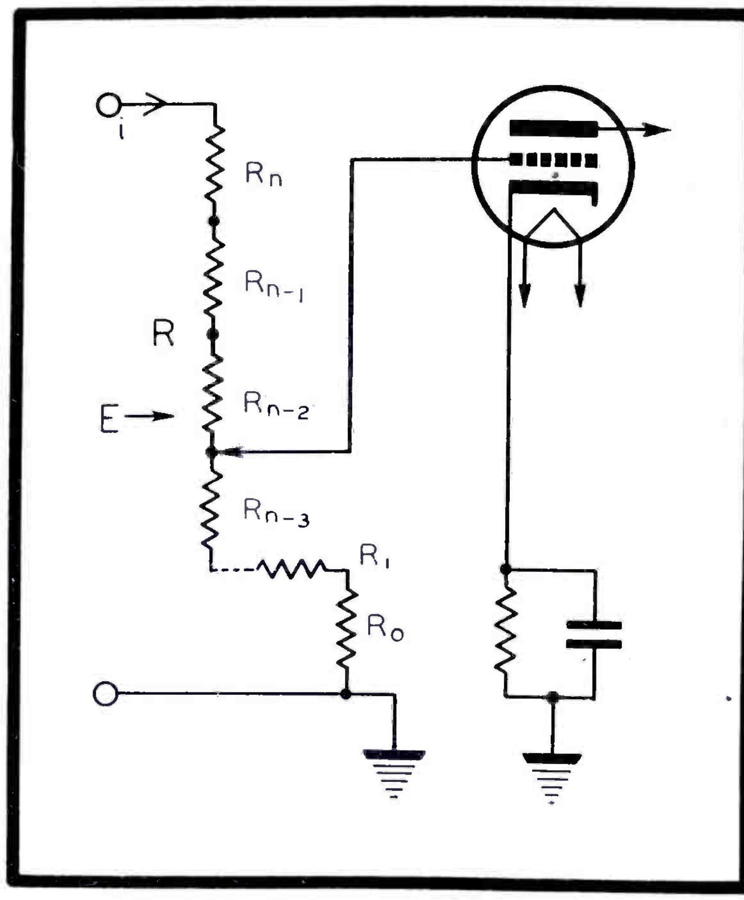


Figure 15
An electronic fader or volume control which may be either a step-by-step unit calibrated in db per step or a continuously variable one calibrated in db per degree of rotation.

requirements of the total loss and the total resistance at the grid input. A detailed treatment of this type gain control was presented in a previous article[4] and only the final design results will be utilized here.

The reference resistance which will give the minimum gain required, other than zero, is

$$R_o = R/k_t = Rr_t \qquad (72)$$

where: R is the total input grid resistance of the potentiometer or gain control, or in this case, the fader; k_t is the loss function which corresponds to minimum gain or maximum loss, and r_t is simply the reciprocal of the loss function, k_t.

The values of the individual step resistances, R_1, R_2, R_3, etc., are obtained from the recurrence formula,

$$R_n = R_o\,(k_s^{\,n} - k_s^{\,n-1}) \qquad (73)$$

where: k_s is the loss function corresponding to the loss-per-step in the case of step-by-step attenuators or faders and n is the step number as counted from the position of maximum loss, and numbering from one to (infinity, theoretically) the highest number required to give maximum gain or minimum loss of the channel. In the case of continuously variable potentiometers, the variation in loss may

[4]Communications; October, 1943.

be taken in terms of degrees per decibel which will give a non-uniform spacing in the case of linear resistance potentiometers and appreciably linear in the case of properly tapered resistances. The latter are of course to be preferred since the decibel is a logarithmic unit. By making use of the *Tables of Hyperbolic Functions of a Real Variable* presented in *Part II*, and noting that the *k* corresponding to any given step is found from the *db* column by taking *n* times the number of *db* required per step. For example, if the loss-per-step were given as 2 db and the resistance desired were the fourth or R_4, $k^n_a = 2.51189$ as found on the row for 8 db; $k_a^{n-1} = 1.99526$ as found on the row for 6 db. From equation *73*, therefore, the value of $R_n = 0.51663 \times R_o$. If the total loss of the fader were to be 49 db before finally turning the adjustment knob to the position of infinite loss, and the total grid input resistor were to be 500,000 ohms, from (72) and the table, $R_o = 500{,}000 \times 0.01 = 5{,}000$ ohms. Any other values of required losses and resistances may readily be calculated in a similar manner.

[*See page* 80 *for Parallel-Series or Series-Parallel Mixer Table.*]

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ELECTRIC ALARM CLOCK SWITCH

Electric alarm clock with a switch unit rated up to 1650 watts, that will time and control household appliances, announced by Warren Telechron Company, Ashland, Mass. The unit is known as the Selector.

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GIANT MARS PLANE ANTENNAS

Multiple antenna system used on the new Glenn Martin "Hawaii Mars," recently built for the Naval Air Transport Service.

RESISTIVE NETWORKS

(Continued from page 79)

PARALLEL-SERIES OR SERIES-PARALLEL MIXERS
No. of Channels in Parallel, or in Series

Insertion Loss in Decibels

No. of groups in Series or in Parallel	2	3	4	5	6	7	8	9	10
2	9.54	11.76	13.22	14.31	15.18	15.91	16.53	17.08	17.56
3	11.76	13.98	15.44	16.53	17.40	18.13	18.75	19.29	19.78
4	13.22	15.44	16.90	17.99	18.86	19.59	20.21	20.76	21.24
5	14.31	16.53	17.99	19.08	19.96	20.68	21.30	21.85	22.33
6	15.18	17.40	18.86	19.96	20.83	21.55	22.17	22.72	23.20
7	15.91	18.13	19.59	20.68	21.55	22.28	22.90	23.44	23.93
8	16.53	18.75	20.21	21.30	22.17	22.90	23.52	24.06	24.55
9	17.08	19.29	20.76	21.85	22.72	23.44	24.06	24.60	25.09
10	17.56	19.78	21.24	22.33	23.20	23.93	24.55	25.09	25.57

Requirements and Definitions

Channels in parallel are used with groups in series, and channels in series are used with groups in parallel.

The insertion loss in db $= 10 \log_{10}[(2n_s - 1)(2n_p - 1)]$

n_s = No. channels in series
n_p = No. channels in parallel

The table at the left gives the insertion loss of any channel of either the parallel-series or the series-parallel fader and mixer system. For simple series or parallel mixers, one half of the diagonal values as read from upper left to lower right will give the insertion loss.

VWOA NEWS

(Continued from page 66)

. . . Lieut. (JG) R. B. Wood, USNR, is now assistant to the Radio Materiel Officer at the Norfolk Navy Yard. . . . I. Vermilya, one of the earliest of oldtimers, is now at WNBH at New Bedford, Mass. . . . Army Radio oldtimer, 1st Lt. Wilbur C. Roberts, when last heard from, was detailed to a Communications Squadron (AACS). . . . Lawrence E. Grant secured a commercial ticket in 1930 serving aboard fishing trawlers. He then went to WDRC, Hartford, Conn. When we entered the war he joined the War Department as a Radio Engineer. Later he became a radio instructor at the Enlisted Reserve School, Teachers College, Boston. He is now at the Radio Research Laboratory, Harvard University. . . . A Flight Radio Officer in the Air Transport Command; Flight Radio Inspector in the Naval Air Transport Service; Radio Officer in the Merchant Marine together with miscellaneous other radio service . . . that's the record of veteran Bert Green. . . . W. Jennings is now Chief Radioman in a Coast Guard Unit out of San Francisco. . . . Willard B. Edwards, N. O. B. Radio Officer, of Edwards perpetual calendar fame, was stationed in the Midway Islands when last reported. . . . A note of appreciation from "Doc" Forsyth at Snug Harbor for some pipes and tobacco sent him by VWOA. Drop him a note at Sailor's Snug Harbor, Staten Island, N. Y. He is totally blind, now. . . . Arch MacIntyre, formerly a field engineer with Altec, ERPI and RCA recently returned to his home in Tampa, Fla. . . . Sid Doroff is doing a fine job for VWOA among CAA personnel. . . . Jack Scanlin, one of the real oldtimers, is now living up in Saugerties, N. Y. . . . Marvin Sumner is now operating at the Coast Guard station at Chesterland, Ohio. . . . Lorentz A. Morrow, who was first licensed in 1922, is now a Lt. Comdr., USNR, at Lake Forest, Ill. . . . 1st Lt. John F. Hill was recently transferred to a tank destroyer battalion of the U. S. Army. He saw service as a commercial operator aboard the S.S. Gypsum in 1936, followed by the S.S. Robin Hood and various other vessels of the Merchant Marine and since 1941 has been a member of the U. S. Army assigned to communications. . . . John M. Jeffords who sailed on the Robert E. Lee in 1928, then on Tropical Radio ships and in 1937 joined International Sound Photos, has, for the past five years, served as a vocational high school teacher of radio communications.

V-H-F COIL DESIGN

(*Continued from page* 52)

D′ respond almost equally to increases in diameter, as measured in mmfd; also, the curves are steeper as the diameter decreases. At the same time the compensation for this change, as shown by the curves *A* to *D*, increases with a reduction in coil diameter. In addition, each of the latter curves is steeper for smaller widths. Therefore, small width coils have greater frequency stability, through greater compensation.

Since the graph of Figure 3 cannot be used for exact computation, some of the results taken directly from the data are offered.

Copper Strap Coils

For example, let us take a strap coil of ½″ width and 3″ diameter. We note that any expansion due to temperature will affect both the width and the diameter proportionately. An increase in length of 10%, due to temperature, will effect an increase in diameter of 10%, as well as a 10% increase in width. At 80 mc a

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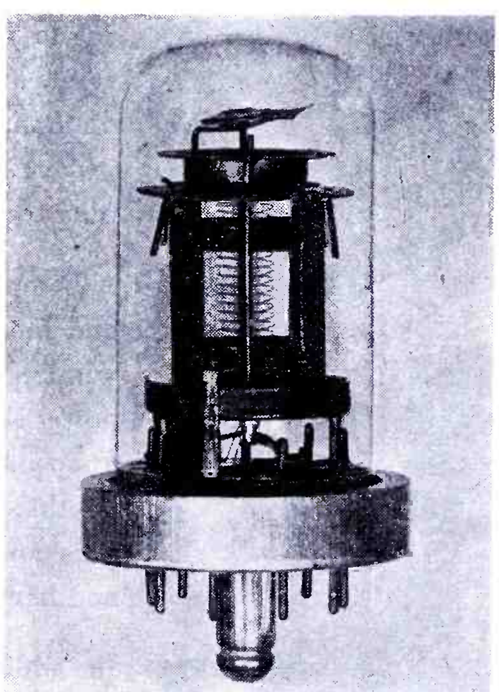
SYLVANIA RADAR TUBE



British radar type tube, VR-91, of lock-in type construction, produced by Sylvania for the British military.

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10% increase in diameter is equal to a capacitance of 5.22 mmfd; a 10% increase in width is equal to a capacitive decrease of 1.2-mmfd. or a net increase or 4.02 mmfd. This would be responsible for a very definite frequency decrease with temperature rise. An equal inductance made with ¼-wide copper strap and 2½" diameter would decrease in frequency the equivalent of 3.54 mmfd. for an 10% increase in diameter and width at 80 mc. In general, an increase in the width of the strap decreases the frequency stability of the coil.

Copper Tubing Tests

The next series of experiments were conducted with copper tubing in place of flat strips. Several points were noted. For coils of equal diameter, the value of inductance increased more rapidly with a decrease in tubing diameter than for flat strips. In addition, a 3" coil constructed of ¼" tubing had less inductance than a strap coil made with ¼" wide copper. It was therefore reasoned that the secondary dimension of the coil, or its thickness might have some additional compensating effect that may increase the temperature stability of the coil.

Disc Type Coils

To determine the effect of the secondary dimension on both coil *Q* and stability, flat, disc-type coils were constructed of 16 gage copper. The results, compared with strap type coils, were found to be quite dissimilar.

Frequency Stability

The frequency stability of the flat-disc type, as compared with the strap type, was found to be better. For example, a 10% increase in dimensions for a 2½" diameter, ¼" wide disc-type coil, at 80 mc, is equal to an 8.4% change in inductance. This compares with 10.4% for a strap-type coil, of the same dimensions, and 9.5% for a similar coil made of tubing. Therefore, disc-type construction can be said to improve the stability of the coil.

Q Tests

Checks on wire type coils showed the following results. A 2½" diameter loop of No. 10 wire showed an increase in inductance of 8.4% for a 10% dimensional increase. However, the *Q* was considerably reduced. A coil constructed of No. 10 wire on a 1" form, 3 turns wound 4 turns per inch, had a 16% increase in induc-

(*Continued on page* 84)

V-H-F COIL DESIGN

(*Continued from page* 83)

tance for a 10% dimensional increase. The comparative Q for all these type coils is shown in Figure 4. Disc-type coils were difficult to construct and it was felt that if they were stamped out of copper sheet instead of using shears, which caused a slightly irregular edge, the Q would compare more favorably with either strap- or tubing-type coils. We note from the curves that a single turn loop made of No. 10 wire has a much better Q characteristic than a coil-wound type.

A portion of the various charts collected for this paper appears in Figure 7. The results shown are typical of those obtained for increases or decreases in parameters.

Figure 7
Chart data for flat-, disc- and tubing-type coils; Q = direct reading; C = tuning capacity in mmfd.

2½" Diameter—¼" Stock

F	FLAT		DISC		TUBING	
MC	Q	C	Q	C	Q	C
60	545	61.0	...	...	...	...
65	555	51.9	530	55.2	580	64.5
70	565	44.8	535	47.6	590	55.1
75	560	38.7	535	41.2	595	47.9
80	560	34.0	530	36.2	590	42.0
85	545	30.0	530	32.0	590	37.0
90	530	26.5	525	28.5	585	33.0
95	515	23.5	510	25.3	555	29.5
100	510	21.2	475	23.0	540	26.5
105	490	19.1	470	20.8	505	24.0
110	460	17.3	455	18.9	485	21.9
115	440	15.8	440	17.0	475	19.9
120	420	14.1	415	15.4	450	18.0

3" Diameter—¼" Stock

F	FLAT		DISC		TUBING	
MC	Q	C	Q	C	Q	C
60	615	51.0	580	50.1	660	58.1
65	600	43.5	585	42.6	665	49.5
70	600	37.2	580	36.5	660	42.4
75	580	32.2	560	31.9	625	36.8
80	555	28.1	560	27.8	605	32.1
85	540	25.0	550	24.3	595	28.1
90	535	22.0	530	21.7	590	25.0
95	520	19.8	500	19.1	540	22.2
100	500	17.5	450	17.2	520	20.0
105	470	15.9	430	15.5	470	18.0
110	445	14.3	400	14.0	445	16.1
115	430	13.0	370	12.6	415	14.8
120	390	11.8	340	11.2	400	13.1

2½" Diameter—⅜" Stock

F	FLAT		DISC		TUBING	
MC	Q	C	Q	C	Q	C
60	...	...	...	...	...	...
65	595	59.6	545	64.2	...	...
70	600	51.4	550	55.1	625	61.4
75	600	44.5	545	48.0	610	53.1
80	605	39.0	550	42.0	605	46.8
85	585	34.5	550	37.1	615	41.0
90	575	30.6	545	33.0	605	36.5
95	560	27.3	525	29.7	585	32.9
100	550	24.5	500	26.6	570	29.5
105	530	22.1	495	24.0	535	26.8
110	505	20.1	480	22.0	505	24.1
115	475	18.1	465	20.0	490	22.0
120	460	16.5	440	18.0	475	20.0

3" Diameter—⅜" Stock

F	FLAT		DISC		TUBING	
MC	Q	C	Q	C	Q	C
60	635	58.0	600	56.8	...	...
65	645	49.5	610	48.1	660	56.5
70	650	42.5	610	41.4	665	49.1
75	620	37.0	590	36.0	625	42.5
80	595	32.3	580	31.4	610	37.2
85	585	27.3	575	28.8	615	32.9
90	570	25.0	560	24.5	600	29.0
95	560	22.4	525	22.0	560	25.9
100	535	20.1	480	19.8	540	23.0
105	505	18.0	470	17.8	490	21.0
110	485	16.4	460	16.0	460	18.8
115	460	15.0	425	14.3	440	17.0
120	420	13.4	390	13.0	415	15.3

Conclusion

Even though an improvement in both Q and frequency was obtained by the use of disc-type coils, it was felt that better results could be obtained by the use of other type coil shapes. With this in mind, further experiments were conducted. The results obtained with loop-type coils were found to hold for coils of any shape, that is disc type construction offered the best solution for coil construction problems, both as to Q and stability. In addition, once a size had been determined, they were easy to construct, and lent themselves to mechanical installation. The results of these experiments, together with checks made under actual operating conditions, will be presented in another paper.

V-H-F OSCILLATORS

(*Continued from page* 60)

attainable for a satisfactory commercial crystal used this way is limited by the minimum safely reproducable thickness. A frequency of about 40 to 50 mc probably represents the highest practical figure. If a broad frequency spectrum extending beyond 40 to 50 mc is to be covered, one simple possibility would be the use of a circuit such as Figure 5, where the crystal is resonated at its fifth or seventh mechanical harmonic by L_1 and C_1. By electron coupling, the output circuit L_2 and C_2 is resonated at a multiple of the mechanical harmonic. With a 5-mc *AT*-cut crystal operated at its fifth mechanical harmonic and multiplied four times in the output circuit the output frequency would be 100 mc. It should be remembered that a *BT*- or an *AT*-type crystal oscillating at a mechanical harmonic frequency will possess the same frequency-temperature coefficient as the fundamental oscillation.

Bridge Circuits

One of the most interesting solutions to the high-frequency stable-crystal oscillator requirement is the bridge circuit oscillator, Figure 8. The crystal forms one leg of a reactance bridge which is used to neutralize the shunt capacity of the crystal so that it may show a positive reactance at the natural frequency of oscillation, either fundamental or harmonic. I. E. Fair of Bell Laboratories has patented[4] a simple crystal-holder design which includes the neutralizing capacitors C_o as an integral part of the holder for this circuit. The *LC* circuit is used to resonate the crystal at the proper harmonic frequency as desired and the same crystal may be resonated at various harmonics merely by changing *L* or *C* or both.

Increased Q

With this system, the useable frequency range of a low-temperature coefficient crystal is greatly extended. It is interesting to note that the *Q* of the same crystal oscillating at a mechanical harmonic is increased over its value at the fundamental frequency of vibration. The increase may be of the order of ten times or more depending upon the particular crystal and the care with which it has been fabricated.

The use of this type of bridge circuit for v-h-f oscillator control may

(*Continued on page* 86)

V-H-F OSCILLATORS

(*Continued from page* 85)

result in an initial increased cost. However, with mass production techniques and with ingenious designs the overall cost of such a frequency controlling device should be considerably lower than an equivalent stable self-excited or *LC* oscillator.

Use of Harmonics

It may be possible also to lessen the cost of such crystal-controlled oscillators in receivers by using the same crystal oscillating at different harmonics to tune different stations. For example, in an 11-mc i-f system, the local oscillator frequencies on the low side of each of the six television channels would be, respectively, 36, 46, 52, 58, 68, and 74 mc. Now, a 4-mc *AT*-cut crystal used in a bridge circuit would oscillate at 36 mc, its ninth harmonic; at 52 mc, its thirteenth harmonic; and at 68 mc, its seventeenth harmonic. It is only necessary to readjust either *L* or *C* to resonate the crystal at the desired harmonic. In push-button practice the circuit connections would be obvious, and simple. Thus this 4-mc crystal would serve three channels.

Filter-Attenuation Control

If the t-a system of television transmission were used it might be possible to broaden the i-f system slightly and utilize the same crystal for more than one channel even if the odd integral harmonics do not fall exactly in place in the frequency spectrum. However, with the r-a system of carrier and vestigial sideband attenuation the television carrier frequency must fall in the same place within the i-f pass band to derive proper filter and attenuation characteristics.

Stability Factors

For the f-m and facsimile channels the problem of stable frequency control is, in many ways, similar to that for television. Because there will be many more channels in the f-m band than in the television band the number of pushbuttons required will be increased. Manual tuning has been used almost exclusively heretofore, but at channels of double the former frequencies local oscillator stability will become more important.

Consumers became wary of pushbutton receivers because drifting made the pushbuttons useless. The simplicity and effectiveness of pushbutton operation will have to be stressed in educational campaigns, particularly those promoting f-m where tuning accuracy is very essential to good quality. Crystal controlled oscillators appear to offer the solution to this problem.

Crystal or LC-Control

Here, as in television, we should have one pushbutton for each station to be received. The problem of using the same crystal oscillating at different harmonic orders for different stations will be more easily resolved if the channels are uniformly spaced within the frequency spectrum. For manual tuning of an f-m receiver the bridge circuit of Figure 8 can be simply converted into an *LC* oscillator. Thus an f-m receiver can be crystal controlled or *LC* controlled using this same oscillator.

V-H-F Receiver Design Problems

Many problems are encountered in v-h-f receiver design. High gain, wide-band circuits, and high-image frequency rejection is desirable, yet difficult to attain. The various requirements for good receiver design seem to contradict each other in execution. Generally, the gain of an i-f system, for example, is inversely proportional to the frequency used and to the bandwidth of the system. High i-f's are desirable to minimize interference. Wide-band circuits are necessary of course in television and wide-band f-m systems.

Double Superheterodynes

The double superheterodyne system will undoubtedly be used in many television and f-m receivers. In Figure 9 we have one such form of design with four-ganged tuned circuits used in conjunction with a crystal-controlled second local oscillator to feed a conventional 4.3 i-f system. We note from this diagram that two additional tubes will be necessary as compared with the normal prewar f-m receiver using a tuned r-f stage preceding the mixer. The frequency of the second oscillator must not interfere with any tuning position of the r-f system. A very simple harmonic oscillator circuit may be used for this control.

Fixed Oscillators

In Figure 10 we find that the first local oscillator is fixed and four-ganged tuned stages are still required. The i-f system is the same as that used in Figure 9 to minimize the variable factors. This circuit would probably be less desirable than the preceding one largely because the fixed crystal oscillator is at a much higher frequency. A compensating item is the fact that it is easier to build a stable fixed frequency oscillator than it is to build a stable variable frequency oscillator at v-h-f. With crystal control throughout, the circuit in Figure 10 might be more desirable because the variable frequency oscillator operates at a much lower frequency and simpler circuits might be employed in its design.

Mixing Local Oscillator

Another interesting circuit possibility for a double superheterodyne is indicated in Figure 11, where the same local oscillator is mixed to create both beat frequencies. To determine the frequency of this common local oscillator we apply equations *1* and *2*.

$$\text{l-o} = \text{r-f} - \text{i-f}_1 \quad (1)$$
$$\text{l-o} = \text{i-f}_2 + \text{i-f}_1 \quad (2)$$

where *l-o* means *common local oscil-*

(*Continued on page* 88)

V-H-F OSCILLATORS

(*Continued from page 87*)

lator frequency; r-f, frequency of the incoming signal; i-f_1, first i-f or the beat between the incoming r-f signal and l-o; and i-f_2, frequency of the second i-f or the main i-f system through the discriminator.

It is not necessarily recommended that an i-f system of 4.3 mc be used, but such a system did provide a simple setup for experimentation with the double superhet at the newly allocated f-m frequencies.

Converters

Of course the present f-m receivers may be used in conjunction with a converter system as a double superhet. The procedure is indicated in Figure 12. A frequency of 40 mc for i-f_2 was designated because it is available on prewar f-m receivers and it is somewhat removed from the lowest frequency postwar television channel.

References

[1] I. Koga, *Characteristics of Piezo-Electric Quartz Oscillators,* IRE Proc.; November, 1930

[2] F. B. Llewellyn, *Constant Frequency Oscillations,* IRE Proc.; December, 1931

[3] K. A. McKinnon, *Crystal Controlled Dynatron,* IRE Proc.; November, 1932.

[4] I. E. Fair, *Crystal Controlled Oscillator for Ultra-High Frequencies,* U. S. Patent 2,260,707; October 28, 1941

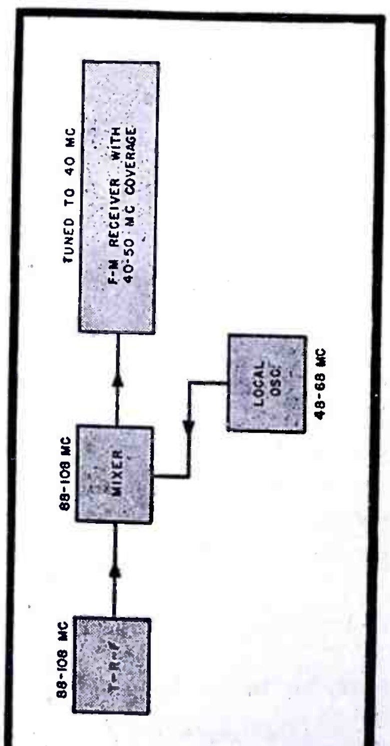
[5] W. P. Mason and I. E. Fair, *A New Direct Crystal-Controlled Oscillator for Ultra-Short Wave Frequencies,* IRE Proc.; October, 1942

[6] W. P. Mason, *Negative Transconductance Tube Oscillator,* U. S. Patent 2,332,102; October 19, 1943.

[7] I. E. Fair, *Piezo-Electric Crystals in Oscillator Circuits,* Bell System Tech. Journal; April, 1945.

Figure 12

Frequency converter method which may be used with a prewar f-m receiver to provide, in effect, double-superheterodyne operation.



INCREASING TRANSMITTER POWER

(*Continued from page* 44)

minimizes replacements. In addition, the failure of one tube in the final need not cause an outage. Operation can continue until sign-off with only a tolerable degree of plate current unbalance.

Parasitics

Parasitics are avoided by 10-ohm resistors in the plate circuits.

Increasing Tube Life

Several years ago we found that the charging current to the power supply filter capacitors in the 500-watt transmitter was so high that the life of rectifier tubes were affected. Often fuses would blow on starting. We installed 10,000-ohm resistors in series with each bank of capacitors and through these the capacitors were charged. Time delay relays were inserted so that 10 seconds later the resistors would be shorted out of the circuit.

Reducing Power at Sunset

To drop power to 500 watts at local sunset a relay is used. This cuts in sufficient resistance in series with the final amplifier plate supply to drop the voltage 30%. The relay is remotely controlled from the operating position. Simultaneously, audio input to the transmitter is reduced manually 3 db. Ultimately it is intended to make this automatic, using a fixed 3-db pad and a relay.

Monitor Meter

To check modulation, a monitor output meter, and an overmodulation flash-lamp are mounted on the operating desk for constant visibility. Full modulation at 1,000 watts requires an audio input of +27 vu; 500 watts, +24 vu.

Frequency response of the transmitter itself is substantially flat from below 30 cycles to beyond 10,000 cycles, with carrier hum more than 50 db below 100% modulation. A frequency response run appears in Figure 3.

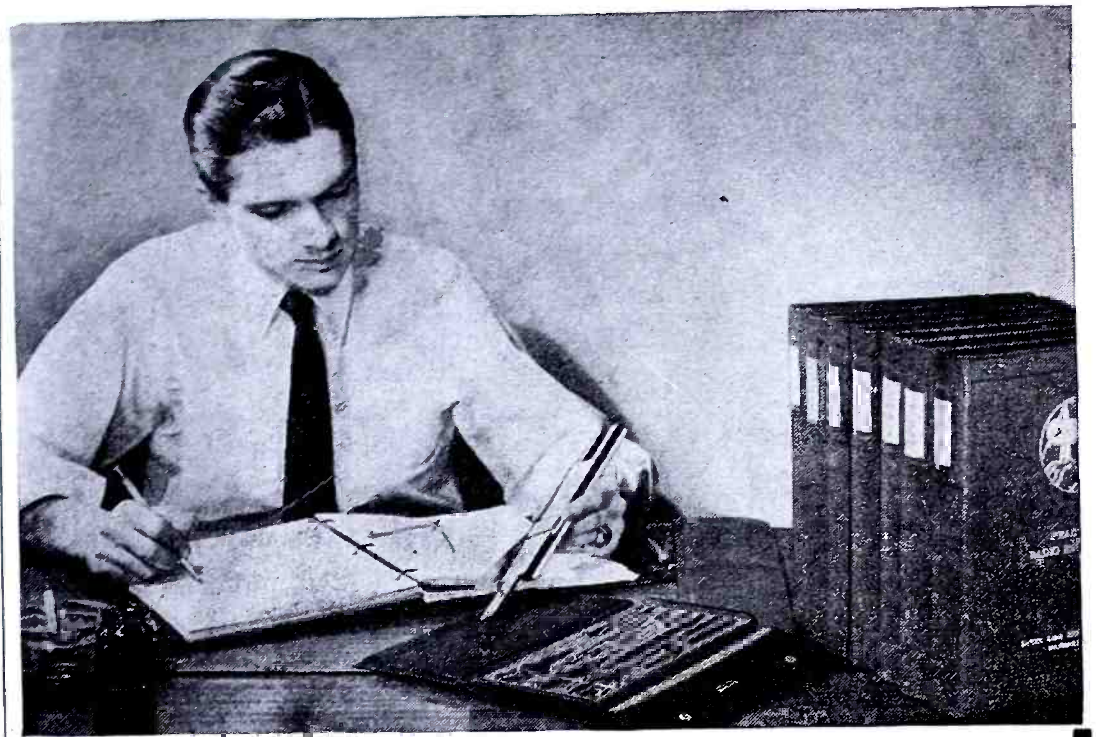
Power Consumption

Total power consumption of the transmitter alone, from the 220 volt 3 φ supply is 5 kva for 100% modulation.

Antenna System

The antenna system, shown in Figure 2, was designed to transmit the equiv-

(*Continued on page* 90)



INCREASING TRANSMITTER POWER

(*Continued from page* 89)

alent of 500 watts east and west, and 2 kw, north and south. It consists of two elements, spaced 120°, excited in phase. They are fed from a six-wire, unbalanced transmission line having a surge impedance of 169 ohms.

Harmonics

A serious third harmonic on 3810 kc is suppressed in a simple series-resonant trap at the input on the transmission line.

Two-Phase Networks

The length of line feeding the east radiator is 120° electrical, and the lag in current caused is compensated in the two-phase shift networks. The sum of the lead in the east net, plus the lag in the west net is equivalent to 120°, bringing the currents at the bases into phase.

Remote Indicators

Remote reading antenna current indicators, using diode tube rectifiers are mounted on the operating desk; each has a screw-driver adjusting series resistor for calibrating purposes. Actually these rectifiers measure the r-f rms voltage to ground at the base of the vertical radiators. This can be assumed proportional to base current as long as antenna resistance remains constant. Some seasonal variation in antenna resistance is experienced, but it is not unusual. Long dry spells are accompanied by a rise in antenna resistance and a drop in antenna current for a given power.

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AIRLINE F-M

(*Continued from page* 41)

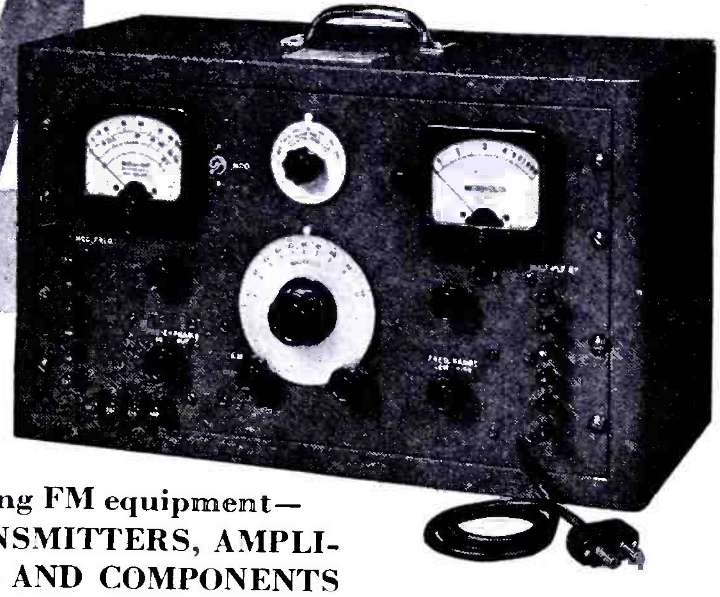
remaining two control units form a parallel bridging load of 10,000 ohms so that the termination is not affected appreciably. A signal lamp on the front panel indicates to each operator when the circuit is in use by the associated control station, thus preventing unnecessary interference. It is possible, however, to operate both associated control stations simultaneously, thus permitting any operator to break in with priority traffic if desired. The panel also contains a meter, calibrated in decibels above 6 milliwatts, which may be switched from the transmitter ine to the receiver line to facilitate nitial line level adjustments and to ssist the operator in maintaining the orrect speech level. Normally this neter is across the output of the mirophone amplifier. A loudspeaker nounted on the front panel is used for alling purposes only and is maintained t sufficiently high level to be heard ny place within the office concerned. mmediately upon receiving a call, it s merely necessary for the operator to ift the handset from its hook to establish contact. The control units were riginally wired for carrier control by neans of the *push-to-talk* button on he handset. However, inasmuch as his system operates full duplex, the operation was simplified somewhat by lisconnecting this feature and connecting two formerly unused contacts on the hang-up switch so that the carier control relays are operated upon emoval of the handset.

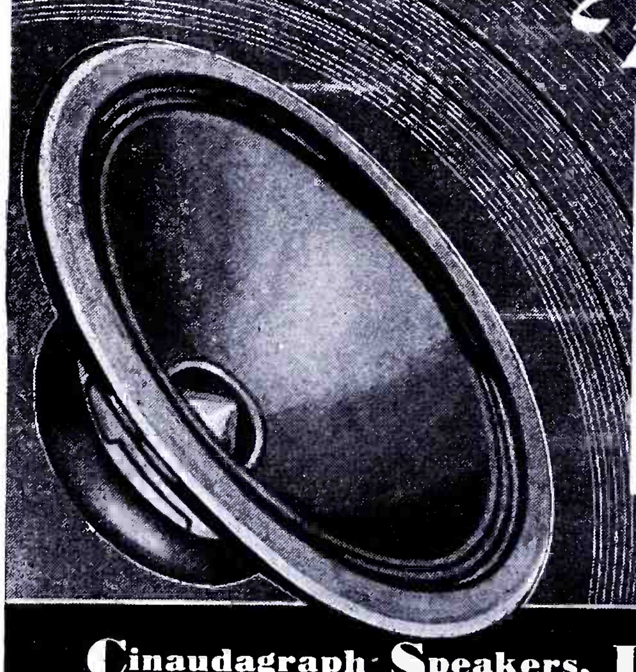
nstallation and Maintenance

Installation of the equipment proved o be relatively straightforward and no problems of any significance were encountered. The measured signal strength proved to be somewhat lower than the calculated value and this was attributed to grazing loss where the signal path crosses Mayne Island in the Straits. The signal strength at both terminals is more than adequate, the results obtained in eighteen months of operation being completely satisfactory in every respect. Aside from visits by a maintenance technician at six-month intervals the equipment has been unattended and the only interruption experienced was due to control line failure. The routine check procedure consists of thorough cleaning of the cabinets and chassis, checking the adjustment and condition of the carrier control relays, checking and recording meter readings and replacement of low emission tubes where required.

V-H-F Features

It has been well demonstrated that this circuit is capable of handling a large volume of communications traffic more efficiently than a wire printer or h-f circuit and the operating costs are substantially lower by comparison. Another important advantage lies in the fact that control of the equipment is extremely simple, permitting the assignment of sales and clerical personnel to its operation. Similar systems will certainly play an important part in the postwar expansion of airline communication facilities for which plans are now being formulated.





NEWS BRIEFS

MORE F-M CHANNELS TO NORTHEASTERN AREA

The two-megacycle channel between 106 and 108 mc, initially reserved for facsimile, has been allocated to f-m stations in the Northeastern section section or area 1. This band, however, will continue to be available for facsimile in the rest of the country and facsimile will also have 10 mc between 470 and 480 mc.

The Northeastern section will be able to have at least as many metropolitan f-m stations as there are existing stations (whether high or low power) plus as many as 50 per cent more in most communities. Sixty channels are allocated for metropolitan stations having in general 20,000 watts power and a 500-foot antenna. In addition, this section will have 20 channels for community stations, with the main studio located in the center of the city served and limited to 250 watts power and a 250-foot antenna.

Preliminary studies by the FCC indicate that under this plan all listeners in the Northeastern area, whether urban or rural, will have the opportunity of a choice of at least several f-m stations, with many listeners a choice of a dozen or more. The Commission intends to scrutinize closely the licensing of stations in this area to make sure that this result is achieved.

The remainder of the nation will have 70 f-m channels, 10 for community stations and 60 for metropolitan and rural stations. The metropolitan stations in this area are designed primarily to render service to a single metropolitan district or a principal city, and to the surrounding rural area.

* * *

CAPT. FINCH RETURNS TO FINCH TELECOMMUNICATIONS

Captain W. G. H. Finch, USNR, has returned to inactive duty at his own request, to assume the presidency of Finch Telecommunications, Inc., Passaic and Clifton, N. J. He will also direct construction of f-m station WGHF, New York, within the next few months.

* * *

100-BUS RADIO SERVICE PLANNED BY INTERCITY BUS RADIO

The Intercity Bus Radio, Inc. a division of the National Association of Motor Bus Operators, has filed an application with FCC to equip up to 100 intercity buses with a two-way 34-44-mc f-m radio communications system and to operate

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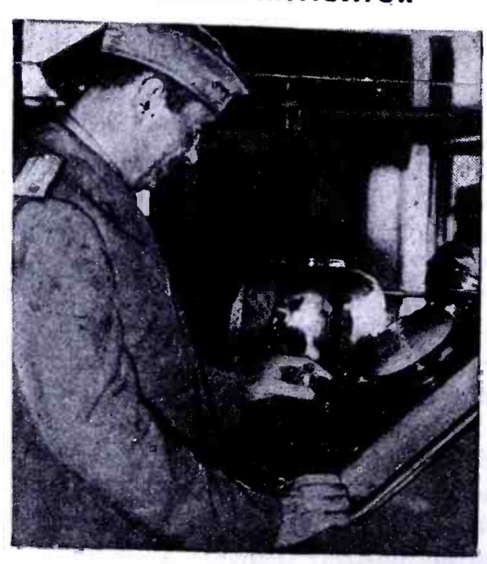
ELECTRONIC NAVIGATOR



Rear Admiral H. L. Vickery, USN, Commissioner USMC, with G.E. radar aboard "American Mariner" that reveals obstacles in ship's path. Range is said to be 30 miles.

central control transmitter. The Greyhound rporation in cooperation with several other ercity bus lines running into Chicago, will rticipate in the project. The system is ex-cted to begin operations around November.

The tentative plans, which are expected to d to the development of a nationwide system two-way radio on highway buses, provide the operation of a 250-watt central trans-tter in the Chicago Loop. Negotiations are derway for this installation atop the Board of ade Building.

The buses will be equipped with 50-watt nsmitters, combined with receivers. Grey-und plans to install the radio sets on buses four of its lines—Pennsylvania, Central, rthland and Illinois—running into Chicago.

n addition, three relay receiving stations will located in outlying sections of Chicago. ese stations will serve to pick up messages m buses on the highways for automatic relay land wires to the main control points of the rious operating companies in Chicago. While 250-watt central transmitter should be able reach buses on the highways as far distant 75 miles, low power of the bus transmitter d static interference of the Chicago Loop may t always permit clear reception except through remotely-operated relay stations. Antennas these relay stations may therefore be in-lled atop the large gas storage tanks that nge the city.

The development of the project is under the ection of Frank W. Walker, formerly chief lio engineer of the Michigan State Police, o recently joined Greyhound as communica-ns engineer.

* * *

OHN WANAMAKER TO INSTALL ELEVISION STUDIOS IN N. Y. STORE

llen B. DuMont Laboratories, Inc., will install ree television studios in the main New York re of John Wanamaker. The studios will be erated in conjunction with DuMont television tion WABD, New York.

The installation will include one giant studio x 60′ with a 50′ ceiling, two smaller studios, elecine room housing television cameras, and ilities for art work, property storage, dress-g rooms and accommodations for live audi-ces.

The large studio will be equipped with four meras, two of which are to be mounted on xible dollies.

* * *

APT. GEO. F. SCHECKLEN NAMED P AND G-M OF RADIOMARINE

ptain George F. Shecklen, USNR, has been cted vice president and general manager d also a director of the Radiomarine Corpora-n of America. Before entering the Navy on ive duty in December, 1941, Captain Scheck-was commercial manager of RCA Communi-ions, Inc.

* * *

CC APPROVES A. T. & T. COAXIAL ABLE EXTENSION

new coaxial link, extending from Meridian, ss., to Shreveport, La., with 6 coaxials be-een Meridian and Jackson, Miss., a distance about 99 miles, and 8 coaxials between Jack-n, Miss., and Shreveport, La., a distance of out 240 miles, was approved recently by the C.

The units of the transcontinental coaxial route eady completed are: New York, N. Y.,-Phil-elphia, Pa., 2 coaxial-unit cable, 90 miles; iladelphia, Pa.,-Baltimore, Md., 6 coaxial-unit ble, 100 miles; Baltimore, Md.,-Washington, C., 4 coaxial-unit cable, 43 miles.

With the current approval the number of les of the proposed project approved by the mmission totals 1,482. With additional con-uction proposed by the company to complete route of Los Angeles, the total route miles l be 3,287.

* * *

BS U-H-F TELEVISION UNIT TO GO CHRYSLER BLDG., NEW YORK

e Columbia Broadcasting System expects to tall their 485-mc color television transmitter

(*Continued on page* 94)

NEWS BRIEFS

(*Continued from page 93*)

on the seventy-first floor of the Chrysler Building in December.

A coaxial cable carrying a 10-mc signal will connect the transmitter to the laboratories at 485 Madison Avenue via the studios in Grand Central Terminal, 15 Vanderbilt Avenue.

* * *

CONCORD RADIO SOUND CATALOGS

Two folders presenting listings of available-now sound equipment units and sound accessories have been published by the Concord Radio Corporation, 901 W. Jackson Boulevard, Chicago 7, Illinois.

Described are amplifiers, intercommunication systems, recording equipment, and accessories.

* * *

GEN. C. O. BICKELHAUPT BECOMES A. T. & T. SECRETARY

Brigadier General Carroll O. Bickelhaupt has been elected secretary of the American Telephone and Telegraph Company. He succeeds Robert H. Strahan, who has resigned because of ill health.

General Bickelhaupt was vice president of A. T. & T. in August, 1941, when he left on military leave of absence.

* * *

L. C. F. HORLE NOW RMA ENG. DEPT. CHIEF ENGINEER

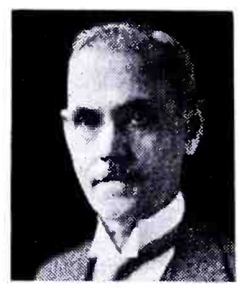
Lawrence C. F. Horle has been appointed chief engineer of the engineering department of the Radio Manufacturers Association.

Mr. Horle will be responsible for the management of the department, including the RMA data bureau.

* * *

OSCAR HAMMARLUND DEAD

Oscar Hammarlund, founder of the Hammarlund Manufacturing Company, Inc., of New York, N. Y., died recently.



* * *

L. J. CHATTEN APPOINTED PHILIPS V-P AND GENL. COMMERCIAL MGR.

Louis J. Chatten, former director of the WPB Radio and Radar Division, has been appointed vice president and general commercial manager of North American Philips Company, Inc.

* * *

AIREON OPENS SAN FRANCISCO OFFICE

Aireon Manufacturing Corporation has opened an office in the Kohl Building in San Francisco.

Jack Kaufman, formerly president of Heintz and Kaufman, Limited, has been named head of the office.

* * *

RCA PROMOTIONS

Lieut. Commander Wayne Mason, USCG, has been appointed assistant manager of the New

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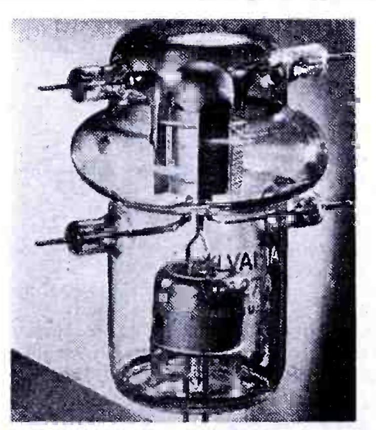
POWER MEASUREMENT LAMP



Power measurement lamp for measurement of power output at frequencies up to 900 mc developed by Sylvania Electric Products, Inc., Emporium, Pa. Lamps measure outputs ranging between .05 and 25 watts. Accuracies are said to be within 5% or less.

'ork office of the RCA Frequency Bureau, 60 roadStreet. He will direct RCA frequency llocation and station license activities.

Louis Martin has been named manager of the pplication engineering section of the RCA tube ivision. He will be in charge of the field apication engineering group.

Richard A. Glidewell is now sound products ales manager of the RCA International divion; Lucien Begin has become technical conultant on RCA film recording.

Hubert H. Kronen has been elected vice presient and general manager of RCA Victor Radio, A., Radio Corporation of American Brazilian ubsidiary with headquarters in Rio de Janeiro. J. Chisholm has been named sales manager f the radio and appliances department, the osition previously held by Mr. Kronen.

C. E. Welsher has been appointed field superisor in the electronic apparatus section of the CA Service Company.

E. T. Brown has been named theatre service eld supervisor for the Chicago district of the CA Service Company.

Lawrence B. Morris has resigned from the RCA ictor division of RCA. He was formerly vice resident and general counsel and recently direcor of labor relations.

* * *

'E" AWARDS

ohn E. Fast & Company, Chicago, received ne Army and Navy "E" pennant recently.

A second white "E" flag star was awarded the Insuline Corporation of America, New 'ork.

The McElroy Manufacturing Corporation, Boson, Mass., won their third white star for their E" flag recently.

* * *

. S. McCOMB, ACRO ELECTRIC, DIES

ohn S. McComb, Acro Electric Company, leveland, died recently.

* * *

VESTINGHOUSE NAMES LANDELLS COMMUNICATIONS ENGINEER

oseph H. Landells has been appointed comunications application engineer at San Fransco for Westinghouse Electric.

Mr. Landells will be responsible for coverage the communications industry and radio broadasting stations throughout the San Francisco ay area.

* * *

. & O. TO INSTALL -H-F RADIO SYSTEM

v-h-f (156-162 mc) radio-telephone system will on be installed in the B. & O. yard at New astle, Pa., by Bendix. It will be used to facilite the operation of the freight-car classificaon yard at that point.

The equipment will consist of a fixed radio ansmitter and receiver, and mobile transmitterceiving units installed on switching engines. hree main control points will be installed so at the yard office may be in constant comunication with the crews in charge of engines vitching the trains.

* * *

. C. FELT JOINS MERTRAN AS AD MAN

eorge G. Felt has been appointed advertising d sales promotion manager of the American ansformer Company, Newark, N. J. During e war, Mr. Felt directed personnel relation tivities in the Paterson plant of Wright Aeroutical.

* * *

. E. FULTON BECOMES RCAC UPERVISOR OF TRAFFIC OPERATIONS

arold E. Fulton has been appointed superisor of traffic operations of RCA Communicaons, Inc. Mr. Fulton was formerly superinndent of the central radio office, New York. N. R. Cherrigan, district manager of RCAC San Francisco, will move to New York to place Mr. Fulton, and Harry E. Austin, disict commercial manager, San Francisco, will cceed Mr. Cherrigan as district manager in at city.

F. Wilhelm, assistant district manager, San ancisco, has joined the administrative divi-

(*Continued on page* 96)

NEWS BRIEFS

(*Continued from page* 95)

sion of the traffic department in New York. James F. Waples, formerly assistant superintendent of RCAC at Manila, P. I., will succeed Mr. Wilhelm in San Francisco.

* * *

FOUR NEW REPS ANNOUNCED BY WEBSTER-CHICAGO

S. K. MacDonald, Lee Maynard, G. G. Willison and V. O. Jensen have been appointed manufacturers representatives by Webster-Chicago Corporation.

Mr. MacDonald will cover Philadelphia-Pittsburgh-Washington. His office will be at the Liberty Trust Building, Broad and Arch Streets, Philadelphia 7, Pa. Lee Maynard, 139 North Central, Clayton 5, Missouri, will cover St. Louis. G. G. Willison, West Building, Houston, Texas, will cover Texas and Verner O. Jensen, 2616 Second Avenue, Seattle 1, Washington, will cover the Pacific Northwest.

S. S. Egert, 27 Park Place, N. Y. City, will continue to represent Webster-Chicago in the metropolitan New York area.

* * *

PHILIPS SPECTROMETER BOOKLET

A 12-page booklet, *Engineering-Design Development of X-Ray Spectrometer*, has been released by North American Philips Company, Inc., 100 East 42nd Street, New York.

The text was written by J. S. Buhler, technical-commercial manager, and covers the basic design principles involved in the Geiger-counter X-ray spectrometer.

* * *

CLAY CRANE HEADS AIREON ADVERTISING

Clay Crane has been appointed director of public relations and advertising of the Aireon Manufacturing Corporation.

Mr. Crane, who spent 37 months in the Santo Tomas prison camp near Manila, was cited recently "for fortitude and courage which contributed materially to the success of the Philippine campaign."

For two years prior to the outbreak of hostilities in the Pacific, Mr. Crane lived in Manila, serving as a staff member of the National City Bank of New York.

* * *

COL. ALLSOPP HONORED BY ARMY

Colonel Clinton B. Allsopp, vice president of the International Telephone and Telegraph Corporation, recently received the Legion of Merit for performing "exceptionally outstanding services" while serving in the office of the Chief Signal Officer of the United States Army.

* * *

HUGH KNOWLES ELECTED ACOUSTICAL SOCIETY PRESIDENT

Hugh S. Knowles, vice president and chief engineer of the Jensen Radio Manufacturing Company, was recently elected president of th Acoustical Society of America.

Mr. Knowles was also recently honored b the Fellowship Award of the Institute of Radi Engineers for his *outstanding contribution* *acoustics.*

* * *

EMERSON RADIO BUYS RADIO SPEAKERS, INC.

Emerson Radio & Phonograph Corporation ac quired 100 per cent of the authorized and issue capital stock of Radio Speakers, Inc., Chicag Ill., recently.

Henry C. Forster has resigned as preside and director of the company. Mr. Forster wi remain with the company as consultant. Ma Abrams has been elected president of the co poration and Morton E. Ornitz has become vi president and treasurer. George S. Holly re mains as vice president in charge of enginee ing and production.

* * *

WESTINGHOUSE PROMOTIONS

A. C. Monteith has been named assistant ma ager of headquarters engineering and direct of education of the Westinghouse Electric Co poration.

R. H. McMann, former procurement contr director of the Republic Aviation Corporatio has been appointed Eastern district manager the Westinghouse home radio division.

Mr. McMann will be located at 40 Wa Street, N. Y. City, and serve all of New E gland, New York and northern New Jersey.

* * *

WUNDERLICH JOINS FTR

Norman Wunderlich has been appointed exec tive sales director of radio equipment and a lied products for the Federal Telephone an Radio Corporation, Newark, N. J. Mr. Wu

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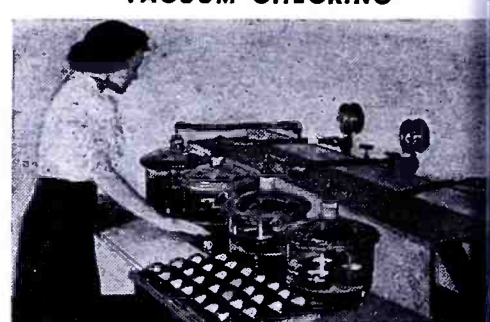
VACUUM CHECKING



Vacuum checking units used to check sealing glass-to-metal 2½" and 3½" hermetically seal instruments, developed by Marion Electrical I strument Co., Manchester, New Hampshi Instruments are submerged in glass jars, partial filled with alcohol. A vacuum of 25" is dra in accordance with Jan. 1-6 spec. During t production checkers watch for air bubbles whi would indicate imperfect sealing. Spot checks f a period of four hours are made in a 29" vacuu

ch was formerly manager of the communi-ns and electronic division of the Galvin ufacturing Corporation.
his new post Mr. Wunderlich will direct sales sections embracing broadcast equip-e, industrial electronics, rectifier equip-e, aerial navigation, mobile radio equipment, components.

* * *

TES EXPANDS

Gates Radio Company, Quincy, Ill., has d to larger quarters in a new building. Specialty Distributing Company will rep-t Gates in the Southeast: Atlanta, Geor-Chattanooga, Tennessee; Savannah, Geor-and Macon, Georgia. The Houston Radio y Company of Houston, Texas, has been nted Southcentral distributors in Texas, iana and Mississippi.

* * *

. WINNE NAMED HEAD G.E. ENGINEERING

y A. Winne, vice president in charge of eering for the G. E. apparatus department, been appointed vice president in charge of eering policy for the entire company.
nest E. Johnson, assistant engineer of the nautics and marine engineering division, eeds Mr. Winne.

* * *

. MORROW BECOMES RME G-S-M

Cmdr. L. A. Morrow, USN, has joined Mfg. Engineers, Inc., Peoria, Illinois, as engineer and general sales manager. Cmdr. ow was officer-in-charge of stations NCN NHL in the Southwest Pacific theatre.

* * *

RCO NAME CHANGE

o Steel Construction Co., Inc., 1180 East d Street, Elizabeth, N. J., will hereafter be n as Harco Tower, Inc.

* * *

FERSON-TRAVIS TO MAKE MARINE, CRAFT, MOBILE AND FIXED UNITS

rson-Travis,, N. Y., will soon begin the ar production of marine, aircraft, mobile fixed station equipment.
rine equipment will include a 10-watt radio-one, with four crystal controlled trans-ng and receiving channels; 25-watt radio-one, with five crystal controlled trans-ng and receiving channels; 75-watt radio-one, with ten crystal controlled transmit-and receiving channels; direction finder, a high-gain top-loaded antenna.
jected aircraft units include a 2-watt light-transmitter-receiver; and 15-watt cabin transmitter-receiver.
bile and fixed station equipment planned des a 30-watt, f-m transmitter and re-r for police, fire and general mobile and radio communications service; a high gain oaded vehicular antenna; and a 15 tube all-purpose communications receiver, covering 540 kc to 32 mc in five bands.

* * *

J. J. COLBERT NOW REEVES-ELY CRYSTAL DIVISION MANAGER

J. J. Colbert has been appointed manager of the crystal division of Reeves-Ely Laboratories, Inc., New York City.
Mr. Colbert was formerly with Western Electric, in charge of the production engineering of quartz crystals at the Clifton, N. J., plant.

* * *

E. P. TOAL NAMED G.E. RECEIVER S-M

E. P. Toal has been appointed sales manager of G.E. standard radio receivers. Mr. Toal will be located at the Bridgeport, Conn., plant.

* * *

KELSEY GOES TO HALLICRAFTERS

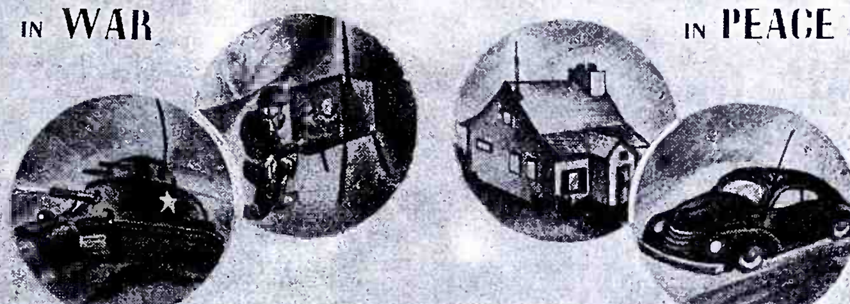
Lester L. Kelsey has been elected vice president of the Hallicrafters Company, Chicago, and general manager of the Echophone division.
Mr. Kelsey was formerly assistant to the president of the Belmont Radio Corporation. Prior to the Belmont post he was general manager of the radio division of Stewart-Warner.

* * *

FRANCIS SMITH BECOMES ROLA CHIEF ENGINEER

Francis B. Smith has been named chief engineer of The Rola Company, Inc., Cleveland, Ohio.
Mr. Smith was formerly in charge of audio-

(*Continued on page* 98)



NEWS BRIEFS

(*Continued from page 97*)

frequency and acoustics at Zenith Radio Corporation, Chicago.

Previously he was with the Hammond Instrument Company, Chicago, as a member of the engineering staff.

* * *

OPERADIO APPOINTMENTS

W. Bert Knight, president of the W. Bert Knight Company, 908 Venice Boulevard, Los Angeles, has been appointed sales representative for Operadio loudspeakers in southern California and Arizona.

C. H. Carey has joined the staff of Operadio as a sales engineer for the Michigan-Ohio territory.

* * *

SNOW BECOMES LEAR RADIO AD MAN

Homer Morgan Snow has been appointed advertising and public relations director of the radio division of Lear, Incorporated. Mr. Snow will be located in New York at 1860 Broadway.

* * *

AIREON ACQUIRES OXFORD-TARTAK

Aireon Manufacturing Corporation has purchased for $400,000 cash, 100 per cent of the stock of the Oxford-Tartak Company and the Cinaudagraph Corporation of Chicago, Ill.

Aireon has also purchased the entire assets of the Midco Tool & Supply Company of Oklahoma City.

* * *

TECHNICAL APPARATUS CAPACITANCE METER DATA

A 4-page folder describing a capacitance meter, model 37B, has been released by the Technical Apparatus Company, 1171 Tremont Street, Boston 20, Mass. Application and constructional details are presented.

* * *

BENDIX EXPRESSOR-AMPLIFIER LEAFLET

A 4-page leaflet describing an expressor-limiter, model MT-93, has been prepared by Bendix Radio, Baltimore, Maryland. Design and application data are offered.

* * *

COL. DIXON NOW I. T. & T. V-P

Colonel George P. Dixon, who was Chief of Air Communications for the U. S. Air Forces in the European Theatre of Operations, was recently elected a vice president of the In national Telephone and Telegraph Corporat

* * *

NORAN E. KERSTA RETURNS TO N

Noran E. Kersta, former manager of the N television department, recently discharged f the U. S. Marine Corps, has returned to network's television department in an execu capacity.

* * *

HOLLIDAY-HATHAWAY TO COVER NEW ENGLAND FOR CARTER

Holliday-Hathaway Sales Company, 176 Fed Street, Boston 10, Massachusetts, have been pointed Carter Motor Company representat in Massachusetts, Maine, Vermont, Rhode land, Connecticut and New Hampshire.

* * *

JOHNSON TO HANDLE MAGUIRE EXPORTS AND IMPORTS

Harold E. Johnson has been named manag director of Maguire Internacional, S.A., a d sion of Maguire Industries, Inc., in Mexico Central America.

The unit will export the radio phonogra of its Meissner division, portable radios record changers, railroad, aviation and ma communications, equipment, and other r products.

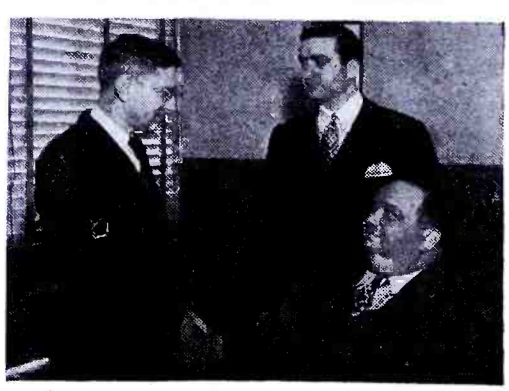
* * *

JENSEN LOUDSPEAKER MONOGRA

The fifth in a series of monographs enti *Horn Type Loudspeakers* has been publis by the technical service department of

●

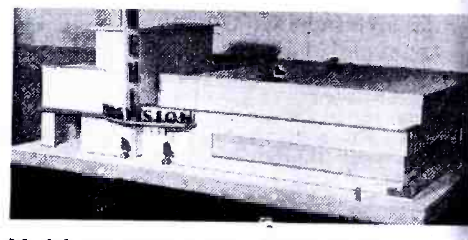
DR. SIMON JOINS GUTHMAN



Dr. Alfred W. Simon (left), who recently joined the E. T. Guthman & Co. research and engineering department. Seated, Edwin I. Guthman, president; right, Gene M. Keyes of sales department.

●

MODEL TELEVISION STATION



Model television station (6' square) prepared Allen B. DuMont Laboratories, Inc., for exh tion at the Stratford Theatre, Toledo, Ohio, conjunction with the "Toledo Tomorrow" exp tion. Model has a removable roof to show detail the control room, transmitter, two stud talent rooms, stock rooms, office space clients' rooms.

n Radio Manufacturing Company, 6601 S. nie Avenue; Chicago 38, Ill. Data covers transmission and propagation, horn ac- horn shape, high-frequency horns, re- e-frequency characteristics, patterns, etc.

* * *

. HENNING NAMED WOOD-LINZE SECRETARY

C. Henning, Jr., sales manager of the ood-Linze Company, St. Louis, has been d secretary.

* * *

IER TO REPRESENT HERINGTON ON WEST COAST

t Hetherington & Son, Inc., Sharon Hill, has opened an office at 5607 W. Adams Los Angeles, California. Sales activities e under the direction of C. E. Fisher, for- with the Glenn L. Martin Company, Bal- e, Md.

* * *

CANIZED RUBBER COMPANY IE CHANGE

Vulcanized Rubber Company, New York and Morrisville, Pennsylvania, has ed its name to Vulcanized Rubber and cs Company.

* * *

LEE TO INSTALL W TELEVISION TRANSMITTER

-kw television transmitter is being built he Don Lee television and broadcasting ns by G.E.

west-coast network has filed with the for permission to install the transmitter

NEWS BRIEFS

(*Continued from page 98*)

5,800 feet above sea-level on Mt. Wilson outside Hollywood, Calif.

W6XAO will be used as a relay station and studio site after the new transmitter is installed.

* * *

IRC SUPPLEMENTAL RESISTOR CATALOG

An 8-page supplemental catalog bulletin, No. 3, describing BT metallized insulated resistors and BW insulated wire-wound resistors, has been released by the International Resistance Company, 401 North Broad Street, Philadelphia, Pa.

* * *

G.E. VACUUM SWITCH AND CAPACITOR DATA

A 4-page bulletin covering vacuum switches and a 2-page release describing vacuum capacitors have been released by G.E. Rating and application data are presented.

* * *

MAGUIRE RR RADIO BROCHURE

A 20-page booklet on railroad radio communications has been released by the electronics division of Maguire Industries, Inc., 1437 Railroad Avenue, Bridgeport, Connecticut. Some of the subjects covered are: Yard communications, end-to-end radio, inter-train communications, train-to-wayside station, and remote control.

* * *

ALTEC LANSING PROMOTIONS

E. O. Wilschke, until recently McKinley plant manager of Altec Lansing Corporation, has been named assistant to the vice president, Altec Service Corporation, New York.

A. Fiore, former director of the Los Angeles electronics division, has been promoted to plant manager.

A. K. Davis, previously assistant director of the Los Angeles electronics division, is now director.

E. P. Grigsby, formerly field representative for Gilfillan Bros., Los Angeles, has been appointed special Altec Lansing Corporation representative.

* * *

STACKPOLE CONTACT DATA

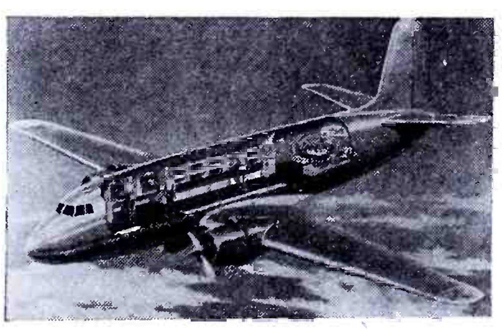
A 36-page electrical contact catalog and data book, No. 12, has been issued by the Stackpole Carbon Co., St. Marys, Pa. Presented are data on contact materials with notes on the applications of each type; materials; contact types, shapes, and sizes; methods of attaching contacts; contact metal compositions, welding and brazing tips, etc.

* * *

PIEZO MANUFACTURING CORP. TO MAKE PIEZOELECTRIC CORP. REMOTE CONTROLS

The Piezo Manufacturing Corporation, 110 East 42nd Street, New York 17, New York, has become exclusive manufacturer of remote control equipment formerly manufactured by Piezoelectric Corporation. The successor company will continue to sell remote control joints, assemblies and related accessories throughout the United States and Canada.

F-M/TELEVISION STRATOVISION PLANE



All-metal, low-wing monoplanes, almost as large as the B-29, but weighing only one-third as much, that have been proposed for the Westinghouse f-m/television sky relay broadcasting system. Two planes would be in the air at all times at each location; one broadcasting, the other standing by to take over in event of emergencies. Planes would cruise at 150 mph. Quarters would be provided for a flight crew of three and six technicians.

THE INDUSTRY OFFERS . . .

G.E. CAPACITANCE VOLTAGE DIVIDERS

Capacitance voltage dividers for voltage measurement and wave-form observation of high-frequency voltages, from 15,000- to 50-000-volt peak, have been announced by G. E. Dividers may be obtained with two independent voltage ratios of any desired value, for simultaneous pulse measurement and wave-form observation.

Connected to a high-potential, high-frequency circuit, the capacitance voltage dividers provide one or two step-down ratios, reducing the voltage to a suitably low value for connection to a voltage measuring device, an oscillograph, or both.

Units consist essentially of a high-voltage, ceramic bushing, which constitutes a low value of capacitance, in series with one or more standard, molded-type lectrofilm capacitors, assembled in a hermetically-sealed tank. The units can be supplied with either microphone-type cable leads, having suitable screw-in terminals, or with connectors for the attachment of coaxial cable.

* * *

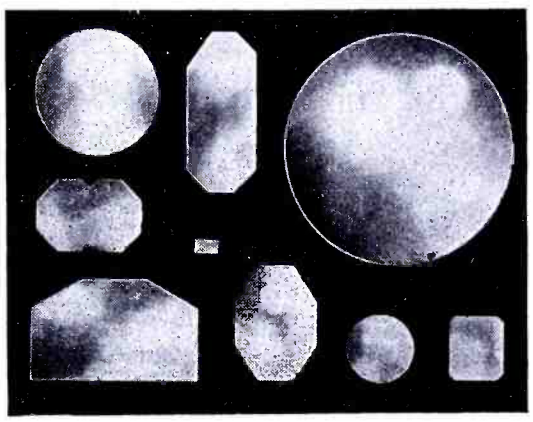
ZENITH OPTICAL MIRRORS AND REFLECTORS

Methods of producing, to specifications, front or rear surface mirrors for precision instruments and electronic equipment, have been developed by the Zenith Optical Laboratory, 123 W. 64th St., New York 23, N. Y.

The reflecting surface of these mirrors is said to be produced by new techniques in the thermal evaporation of metals under vacuum.

Where unusually high reflectivity is needed, a special aluminum alloy is used. Mirrors can also be supplied in gold, silver, and various other metals to meet specific requirements.

Mirrors are said to have permanent reflectivity characteristics. Aluminum alloy mirrors are said to be particularly useful because their reflectivity curve is virtually a straight line from the infra-red to the ultra-violet.

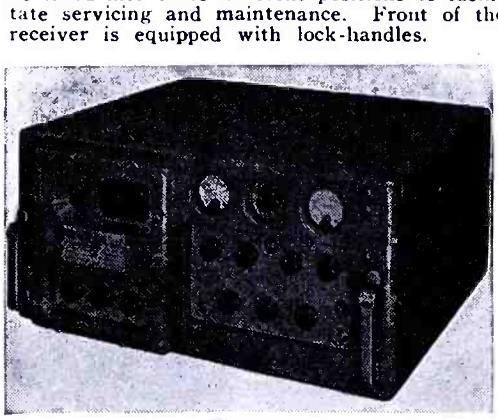


* * *

NATIONAL U-H-F RECEIVER

An u-h-f receiver for U. S. Navy fleet and shore-station use has been announced by the National Radio Company, Malden, Mass.

The set is mounted on a drawer-slide and can be tilted into three different positions to facilitate servicing and maintenance. Front of the receiver is equipped with lock-handles.



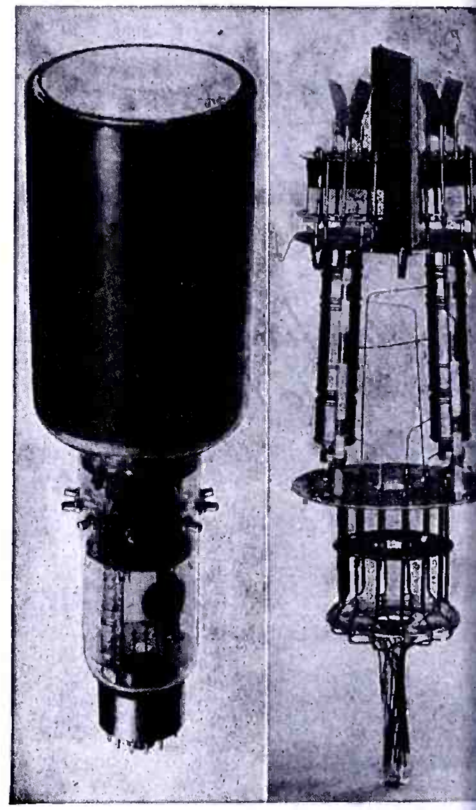
* * *

DUMONT DOUBLE-BEAM TUBE

A double-beam c-r tube, 5SP, with two guns in a single glass envelope, both aimed at or converging on the single screen for simultaneous and superimposed traces, has been announced by Allen B. Du Mont Laboratories, Inc., Passaic, N. J.

Heretofore simultaneous comparison of two phenomena could be accomplished either using two separate tubes or oscillographs plac side by side, or by using an electronic switch present first one phenomenon and then other on the same tube screen in rapid succ sion.

The two guns are contained in a 5" envelo Independent control of the X, Y and Z a functions for each beam are provided. Defl tion plate leads are brought out through glass envelope wall. Second-anode leads also brought out through the envelope wall. standard Army-Navy diheptal 12-pin base the standard socket. The electrode volta ratings are similar to those of the Army-Na preferred type 5CP1. Constant connectors electrode leads are supplied with the tube.



* * *

GOODRICH PLASTICS

One of a series of thermosetting resins, Kristo formed by polymerizing liquid monomer in t presence of a suitable catalyst, and suitable lenses, h-f insulators and lamination, has be developed by the B. F. Goodrich Chemical Co pany, Cleveland.

Kriston monomer is a somewhat visco water-clear, anhydrous liquid having a speci gravity of 1.25 which can be cast in sim molds. It sets to a hard, heat-resistant pla tic. No water or other volatile products a said to be released during the polymerizati facilitating the preparation of dense, non-poro articles.

Kriston polymer is said to have a refract index of about 1.57. The material can be ma into a water-clear plastic or made in a w range of colors which can be transpare translucent or opaque.

* * *

STANDARD PIEZO MIDGET CRYSTALS

Midget crystal units measuring approximat 5/8" in diameter for 1/4" blank and 7/8" for 3/8" blank (thickness of holder with crys mounted, about 1/8") have been announced Standard Piezo Company, West Louther a Cedar Streets, Carlisle, Penna.

* * *

TRIPLETT VOLT-OHM-MILLIAMMETE

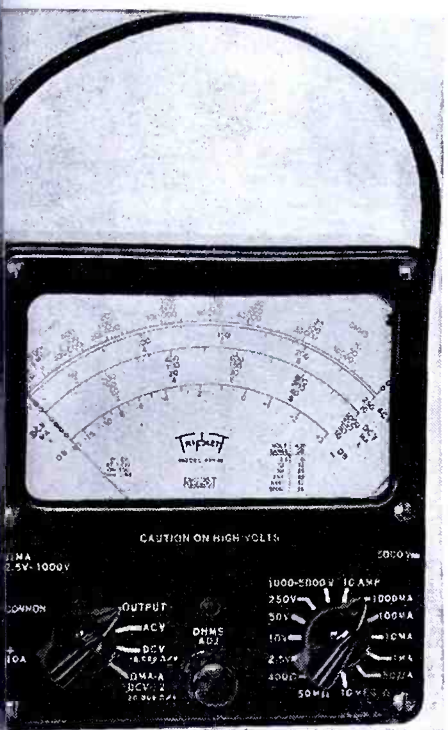
A volt-ohm-milliammeter, 62 5-N, with du sensitivity d-c voltage ranges (10,000 and 20, ohms-per-volt) has been produced by the Tr lett Electrical Company, Bluffton, Ohio.

Ranges are: 0-1.25-5-25-125-500-2,500 d-c vol at 20,000 ohms-per-volt; and 0-2.5-10-50-250-1,0 5,000 d-c volts, at 10,000 ohms-per-volt. A voltage ranges: 0-2.5-10-50-250-1,000-5,000, 10,000 ohms-per-volt.

Current ranges: 0-50 d-c microamperes; 0 10-100-1,000 d-c milliamperes; and 0-10 d-c a peres, at 250 mv.

Resistance ranges: 0-400 ohms (60 at cent

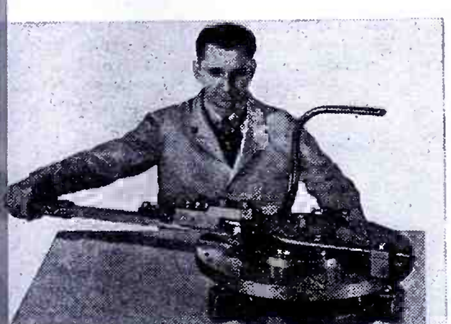
); 0-50,000 ohms (300 at center scale); 0-10 ›hms (60,000 ohms at center scale).
·ect reading output level decibel ranges: to +3, +15, +29, +43, +55, +69 db. A enser is in series with a-c volt ranges for ıt readings.
icating instrument is 6"; 5" scale. Black, ›d case, 6" x 5½" x 2½".



* * *

CRO BENDERS

cro benders, featuring Torrington roller ıgs have been produced by the O'Neil- Mfg. Co., Minneapolis 15, Minn.
larger No. 2 and 3 size benders have ng control levers which reverses forming ıon of the bender nose.

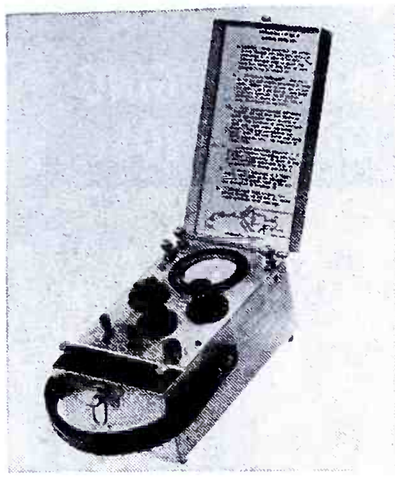


* * *

SON LINEMAN'S BRIDGE

eman's bridge to measure the resistance res as well as the unbalance between two has been developed by Nilsson Electrical atory, Inc., 103 Lafayette Street, New 13, N. Y. Reading on loop can be changed unbalance reading by throwing a switch hanging the position of three decade dials. Switching arrangement also designates which wire is of the higher resistance.

The range of measurement is up to 111 ohms in steps of .1 ohm. Accuracy is said to be ¼ of 1%. Galvanometer, Weston 375, has a sensitivity of approximately 22 microamperes per division for 30 divisions. Batteries are standard 1½-volt flashlight cells.



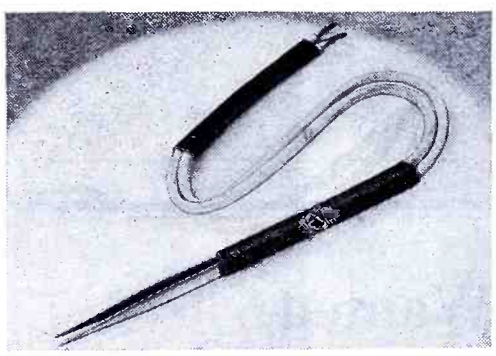
* * *

BESCO SPOT-WELDING TWEEZERS

Spot welding tweezers have been announced by the New Jersey Jewelers' Supply, 280 Plane Street, Newark 2, N. J.

Has a pair of insulated, forged, copper tweezers with plastic covered, flexible, copper leads terminating in a pair of lugs which connect in place of regular welding electrodes. Developed originally to weld radio tube wires .003" o-d.

Operates on from ½ to 1 kva on 10 amperes. Used with a timer which cuts the current and times the length of the weld.



* * *

FTR F-M BROADCAST EQUIPMENT

A line of f-m broadcast transmitters and antennas, with outputs ranging from 250 watts to 50 kilowatts, has been announced by Federal Telephone and Radio Corporation, Newark, N. J.

The transmitters are of the multi-unit design. The basic unit of the transmitter is an exciter which generates initial r-f power; in itself, a complete 250-watt transmitter. In this unit are included the f-m system, center frequency stabilization system, and the r-f multiplier and output stages. The 250-watt output of the exciter unit is stepped up to 1, 3, 10, or 50 kw by a power amplifier unit or series of such units. The antenna arrays are fed by standard coax-

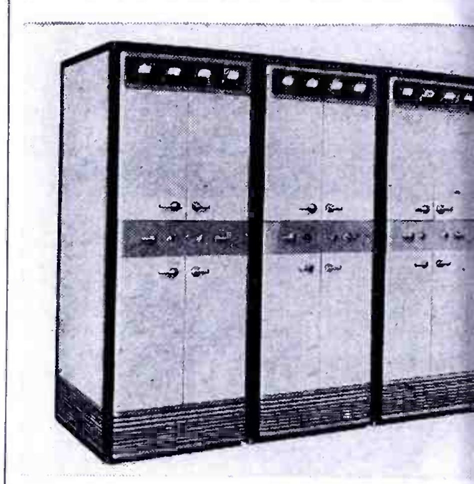
(*Continued on page 102*)

THE INDUSTRY OFFERS . . .

(*Continued from page* 101)

ial lines, combining high power gains with r critical tuning, and consist of from 1 to 1 more loops, each embodying two or more h wave elements. The arrays are factory-tu for easy installation.

Center frequency stability is obtained b phase discriminator in the basic unit w locks the center frequency to the crystal o lator frequency. Negative feedback is use the last power stage of the exciter.



* * *

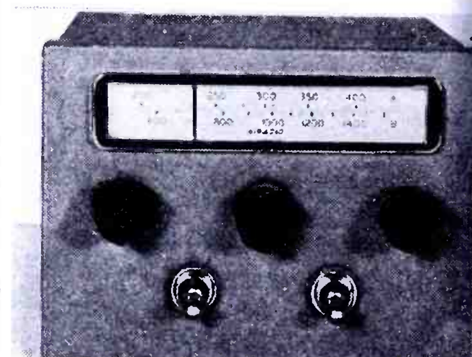
G. E. SMALL CAPACITORS

Small capacitors with removable moun brackets have been announced by G. E. Bra ets can be obtained with all small, rectangu case capacitors for use in either a-c or d-c plications, and can be clamped over either top or bottom flange of the case permitting unit to be mounted in an upright or inve position.

* * *

AIRADIO PRIVATE AIRCRAFT RECEIVER-TRANSMITTER

A lightweight two-band two-way receiver-tra mitter for private aircraft has been develo by Airadio, Incorporated, Stamford, Conne cut. The set offers standard plane-to-gro communication, radio range, weather broadc and standard broadcast reception, as well interphone between pilot and passengers. incorporated in receiver is a radio-range fil



* * *

HEXACON SOLDERING IRONS

Electric soldering irons for operation off 1 24-volt batteries have been announced by Hexacon Electric Company, 173 W. Clay A nue, Roselle Park, New Jersey.

Irons are available in 100- or 200-watt si All irons are supplied with either 6' or 12' co and with the conventional plug cap or batt clips.

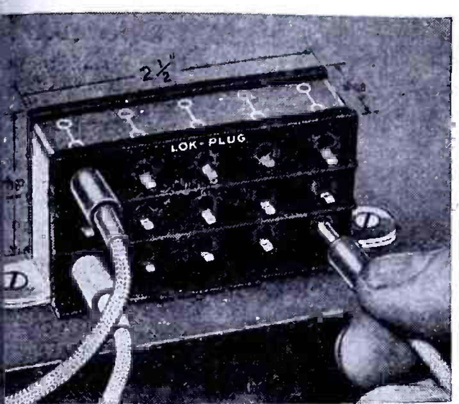
* * *

BUCHANAN PLUG CONNECTOR

A plug connector, with multiple-fingered spr inserts that are said to provide uniform p sure on long-wiping contacts, has been de oped by Buchanan Research Laboratories, For commercial wire sizes No. 26 through 10, these connectors are manufactured and by Buchanan Electrical Products Co., Inc. West Jersey St., Elizabeth, N. J., and by Pe Union Electrical Corporation, Erie, Pa.

Known as Lok-Plug Connectors, they are f nished for surface or flush mounting; availa for snap-on installations.

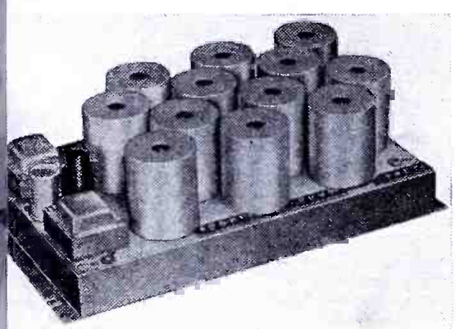
To facilitate circuit identification, insulat ves are available in six solid colors and in y color combinations.



* * *

DREW ANTENNA TUNING UNIT

antenna tuning unit, 760, for coupling a e antenna into a number of receivers, or a ber of antennas into a single receiver, has developed by Andrew Company, Chicago ll. Containing six r-f amplifiers with an ciated power supply, each amplifier stage is unit has low-impedance input and output its. These circuits may be series connected se with a single antenna or receiver.



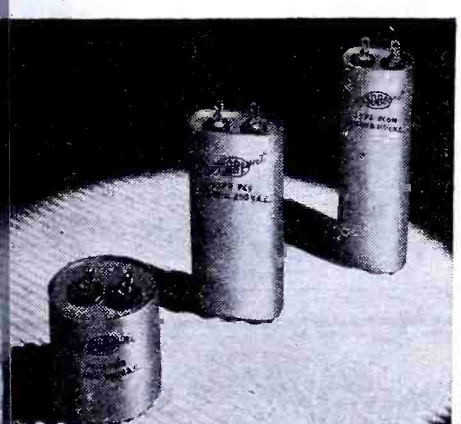
* * *

E DEUTSCHMANN POWER CTOR CORRECTION CAPACITORS

npregnated, oil-filled capacitors for fluores- lamp service, have been announced by the Deutschmann Corporation, Canton, Mass. ined in hermetically sealed metal cases; egnated and filled with pure mineral oil. ating temperatures range from —67° to ° F.

-tight terminals are insulated with phen- bushings and provided with tinned copper ring lugs.

ailable sizes include capacitances from 2.0 25 mfd and working voltages from 165 a-c 0 a-c. The standard capacitance tolerance + 20%.



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R. U-H-F HETERODYNE QUENCY METER

ttery-operated 10-3,000-mc heterodyne fre- cy meter, type 720-A, has been produced e General Radio Company, 275 Massachu- Ave., Cambridge 39, Mass.

internal oscillator covers a frequency of 100-200 megacycles. For frequencies 100 megacycles harmonics of the un- n frequency are made to produce beats the internal oscillator. For frequencies 200 megacycles, harmonics of the internal ator produce beats with the unknown fre- y.

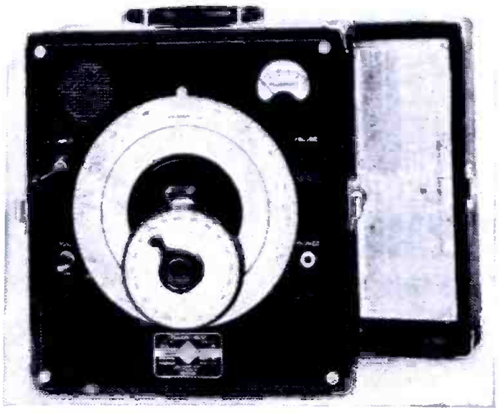
internal oscillator uses the butterfly cir- in which capacitance and inductance are

(Continued on page 104)

varied simultaneously. No sliding contacts are used in this circuit and no current is carried by the bearings.

The detector is a silicon crystal. A three-stage audio amplifier is included, having an effective bandwidth of 50 kc. The output of the amplifier operates a panel meter and a built-in loudspeaker. A jack is provided for head telephones.

Dimensions: 12½" x 13½" x 10½" overall; panel, 10¾" x 11¾".



* * *

U.M.C. MIKE STANDS

A microphone floor stand (26"-64"), model A63, using three upright sections, with knurled adjustment collars, has been announced by Universal Microphone Co., Inglewood, Cal. It can be used with any microphone that has ⅝"-27 thread.

* * *

AMERTRAN VACUUM-OIL IMPREGNATED HERMETICALLY-SEALED TRANSFORMERS

Vacuum-oil impregnated transformers are now being made by the American Transformer Company, 178 Emmet Street, Newark 5, N. J.

In the process a temperature of 230° F and an absolute pressure of 1 mm of mercury is applied.

In addition to vacuum-oil impregnation, cores and coils receive a vacuum-varnish treatment.

* * *

GREEN ELECTRIC TUBE LIFE-TEST EQUIPMENT

A life-test unit for triodes, simulating actual electrical operating conditions has been produced by Green Electric, 130 Cedar Street, New York 6, N. Y.

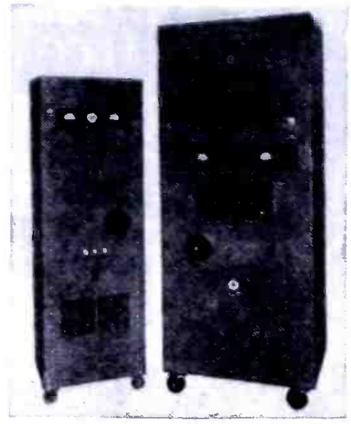
Up to 1¼ amperes to 2000 volts for plate supply to the tubes under test are provided by a plate rectifier. This unit is three-phase operated and includes a filter, continuously variable voltage control, time delay relay, door interlock safety switches, supervisory lamps, voltmeter, ammeter and interlock circuits for connection to the life-test cabinet. A running-time meter which indicates the duration of the life-test, is also included.

The life-test cabinet accommodates six triodes with total plate dissipation of over 2 kw. This unit incorporates continuously variable filament supply, a filament voltmeter, regulated grid supply, plate ammeter, circuit breaker, supervisory lamps, door safety switches and interlock circuits associated with the plate supply rectifier. The interlock circuits cut off plate supply if the grid bias fails, or if the access doors are opened.

THE INDUSTRY OFFERS . . . —

(*Continued from page* 103)

Since filament voltage, grid-bias voltage and the plate supply voltage are all variable, it is said to be possible to adapt the test unit for testing other types of tubes simply by changing the tube sockets.



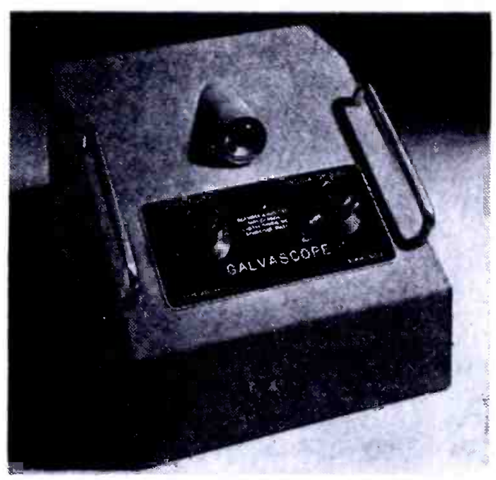
* * *

HARVEY RADIO ELECTRONIC GALVANOMETER

An electronic a-c galvanometer, the Galvascope, for a-c bridge balancing has been developed by Harvey Radio Laboratories, Inc., Cambridge, Mass. Employs a 6E5 tube as an indicator.

The Galvascope circuit consists of an a-c amplifier, signal rectifier, indicator, and a self-contained power supply. The operation of the device involves amplification of the 1,000-cycle bridge signal, followed by a rectification of the amplified signal and application to the indicator tube.

In the absence of signal, the eye of the indicator tube is closed or overlapped, depending upon the setting of an indicator bias control. When signal voltage is applied, the eye opens. As the bridge is brought into balance the signal decreases, and is indicated by closing of the eye. By proper manipulation of the controls, the eye is just closed (but not overlapped) at bala whereas slightly off balance the eye is ope a small angle.



* * *

A-M-P SOLDERLESS WIRING ADAPT

Knife-disconnect parts that are said to pe conversion of electrical assemblies to kn disconnect splicing terminals use, are b made by Aircraft-Marine Products, Inc., North Fourth Street, Harrisburg, Pa.

The pre-formed adapter member is inst in the assembly in the same manner as solder tab it replaces; however, it termin in a knife-disconnect end which accommod the knife-disconnect terminal. Connections disconnections are made by engaging terminal to the disconnect and by means knife-switch wiping action.

Adapters for vertical or horizontal conver for wire sizes from 22 to 10 are available.

* * *

PRECISION SCIENTIFIC IONIZATION GAGE

An ultra vacuum gage, E-31, for use with Televac "S" recorder, has been announced Precision Scientific Co., 1750 N. Spring Ave., Chicago 47, Ill.

Precision Scientific engineers say that v used with a moderately high-speed pum system, the gage actually outgasses i Filament is protected before and during o tion automatically in that current will not c filament before pressure of 1 micron has established and turns off automatically if p sure rises above 1 micron.

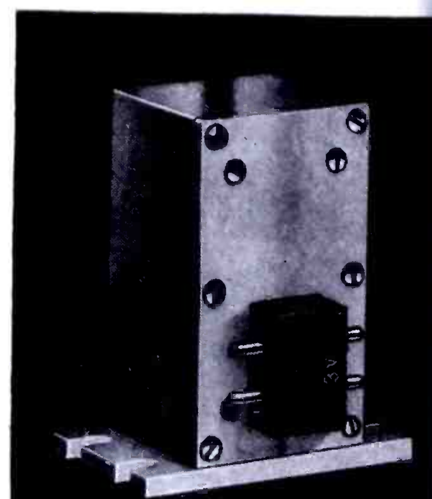
* * *

STATHAM ACCELEROMETERS

A series of accelerometers whose sensitive ment consists of unbonded strain sensitive ments has been developed by Statham Lab tories, 8222 Beverly Blvd., Los Angeles 36, fornia. Grid-form filaments are connected Wheatstone bridge circuit of which all arms are active. The bridge circuit is bala in assembly. There are four electrical minals, one at each corner of the bridge. small dry-cell battery is connected to tw them, and the other two are connected dire to a recording galvanometer.

The natural frequencies of these acc ometers vary from 100 to 1,000 cycles per ond, depending upon their acceleration ran The 12 G accelerometer has a natural frequ of 400 cps.

Weight is 2 ounces.



FILTER PERFORMANCE

(*Continued from page* 48)

harts are necessary, although Figure includes a plot for the prototype ase (*straight line*). To illustrate ne practical use of the charts, we will ıke up the filter of the preceding aper and determine what grade of oils (*A*, *B* or *C*) should be used in s construction.

xample

The specification for the filter in the receding paper included the followıg:

Maximum attenuation for the passınd

$$a = 2\ \text{db}$$

requency number for the boundary equencies of the pass-band, or *edge* equencies

$$n_a = 0.134$$

he filter number had the value

$$F = 0.1875$$

We are particularly interested in ıe edge frequencies, because if the tenuation requirement is met at ıese frequencies, we may be sure that is met throughout the pass-band. lementary considerations show that the attenuation introduced by disspation rises sharply as either cut-off frequency is approached, and is lowest at midband. We will therefore compute the attenuation only at the edge frequencies, for each type of coil, as a guide to our selection, although the charts may be used to cover the entire pass-band if desired.

*In a previous paper, July COMMUNICATIONS, atement . . . *for prototype sections, S = 0* ould read . . . for prototype sections, S = ∞.

1—Prototype section (S = ∞)

Using (*1*)

$$U_a = -n_a/F = -0.714$$

From (*5*)

$$V_a = \pm \frac{dU_a}{\sqrt{n_a}} = \mp d \times 1.95$$

For coils type A (*d = 1/200*)

$$V_a = \mp 0.00975$$

$\alpha = 0.2$ db (from Figure 2)

For coils type B (*d = 1/100*)

$$V_a = \mp 0.0195$$

$\alpha = 0.4$ db (from Figure 2)

For coils type C (*d = 1/50*)

$$V_a = \mp 0.039$$

$\alpha = 0.75$ db (from Figure 2)

2—Derived section 1 (S = 0.605)

From (*1*)

$$U_a = \frac{n_a/F - n_a/S}{n_a/S - 1} = -0.632$$

From chart (Figure 4)

$$\frac{V_a}{dU_a} = 7.0$$

$$V_a = d \times 0.632 \times 7 = d \times 4.42$$

Type A

$$V_a = 4.42/200 = 0.0221$$

From chart (Figure 2)

$\alpha = 0.4$ db

Type B

$$V_a = 4.42/100 = 0.0442$$

$\alpha = 0.8$ db

Type C

$$V_a = 4.42/50 = 0.0884$$

$\alpha = 1.51$ db

3—Terminal section (S = 0.358)

$$U_a = \frac{n_a/F - n_a/S}{n_a/S - 1} = -0.543$$

$$\frac{V_a}{dU_a} = 8.7$$

$$V_a = d \times 0.543 \times 8.7 = d \times 4.72$$

Type A

$$V_a = 4.72/200 = 0.0236$$

$\alpha = 0.4$ db

Type B

$$V_a = 4.72/100 = 0.0472$$

(*Continued on page* 106)

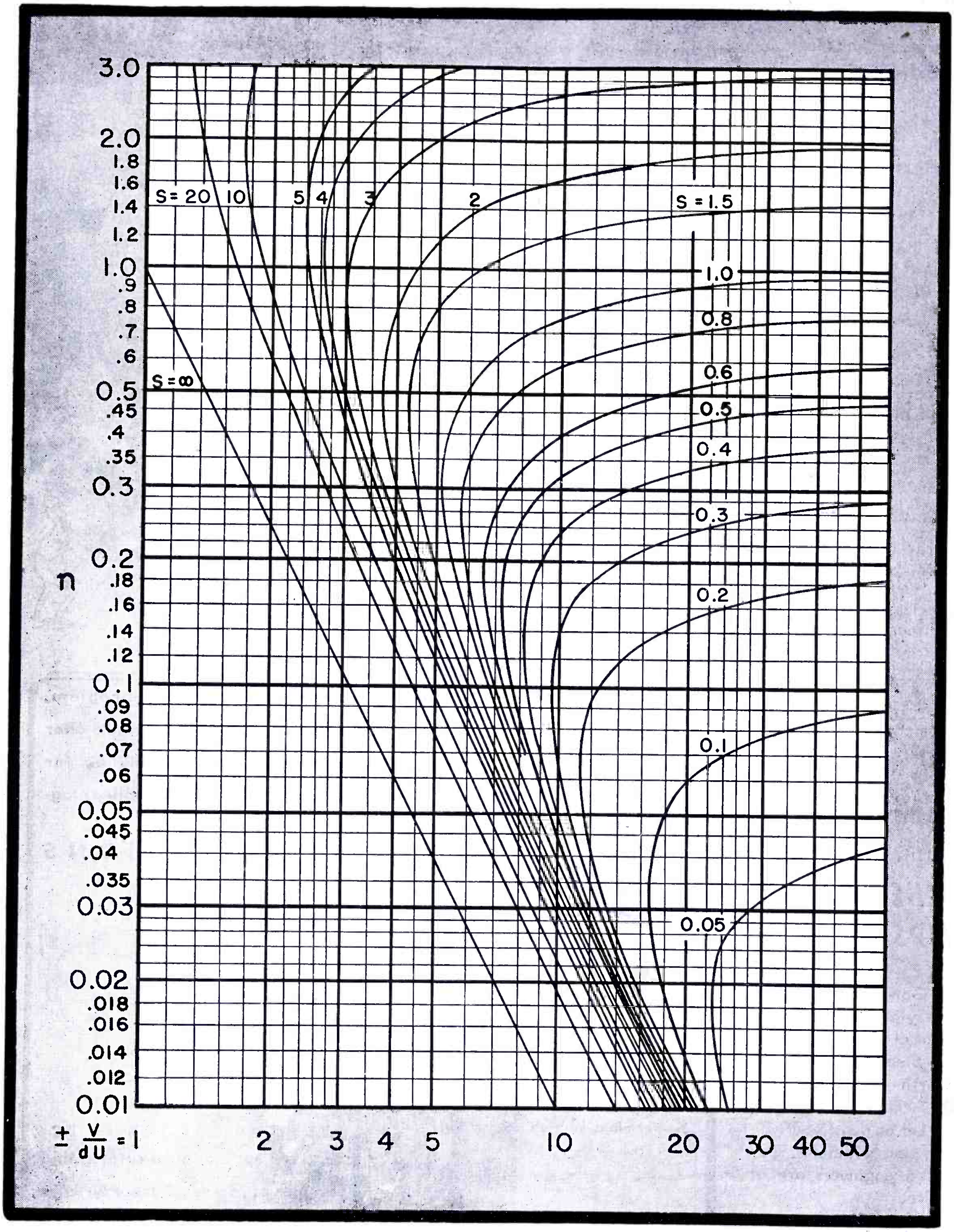


Figure 4 • Values of $\frac{V}{du}$ for dissipative band-pass filters.

$\alpha = 0.85$ db

Type C

$V_a = 4.72/50 = 0.0944$

$\alpha = 1.6$ db

4—Complete Filter

The attenuation for the complete filter at the *edge* frequencies may be obtained by adding the values found for each section. Thus, if coils *A* are used

$$\alpha_{total} = 0.2 + 0.4 + 0.4 = 1.0 \text{ db}$$

Using type *B*

$$\alpha_{total} = 0.4 + 0.8 + 0.85 = 2.05 \text{ db}$$

Using type *C*

$$\alpha_{total} = 0.75 + 1.51 + 1.6 = 3.86 \text{ db}$$

5—Conclusion

Since the permissible attenuation is a = 2 db, coils of type *B* with *Q* of 100, may be used. The computed attenuation with this type is 2.05 db, which is close enough to the desired value for all practical purposes.

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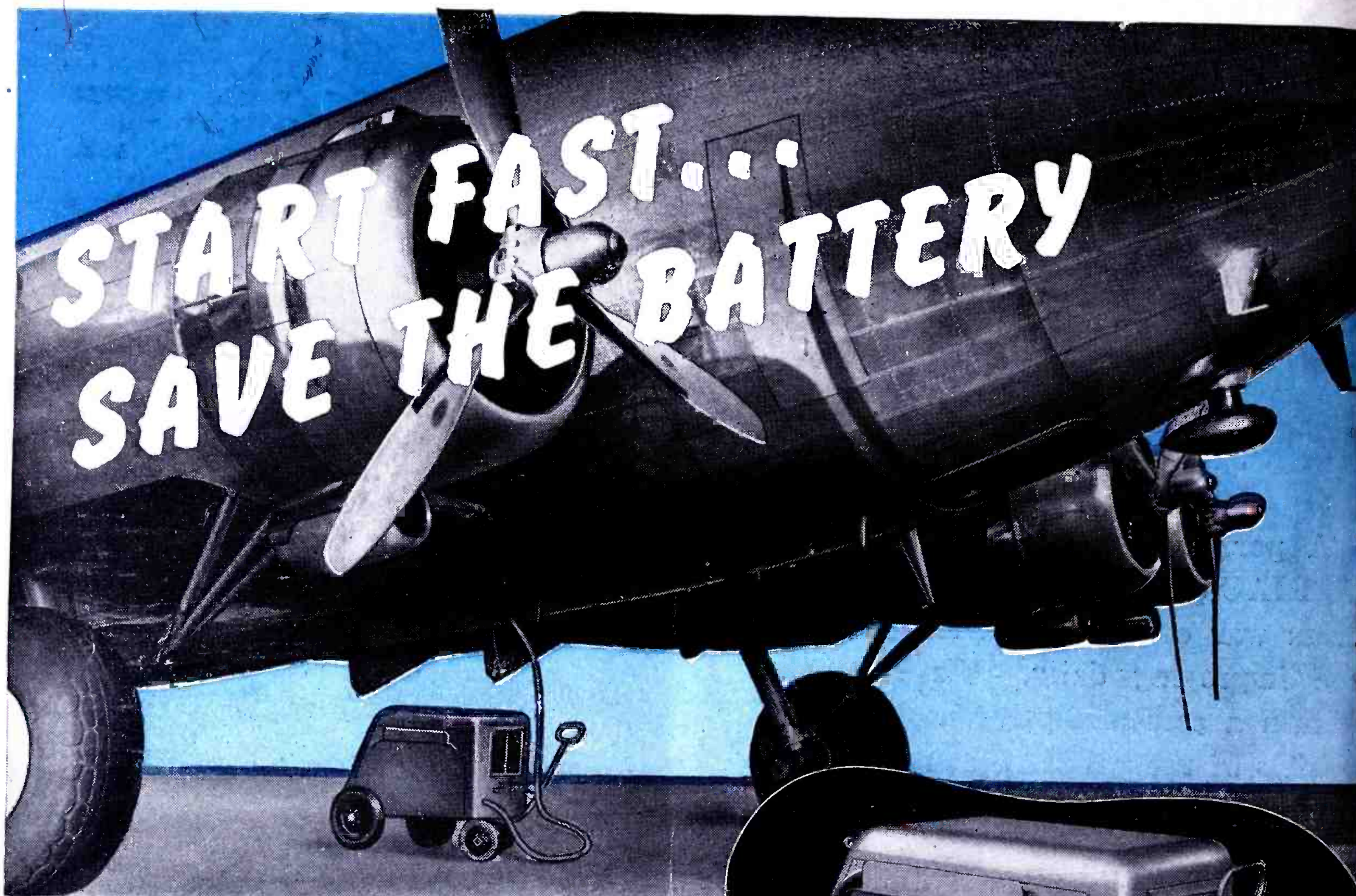

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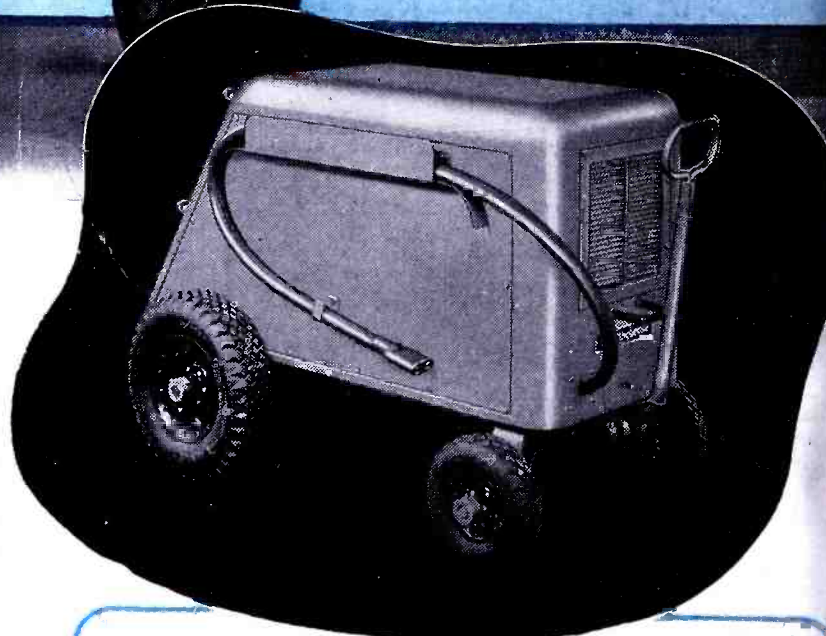

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