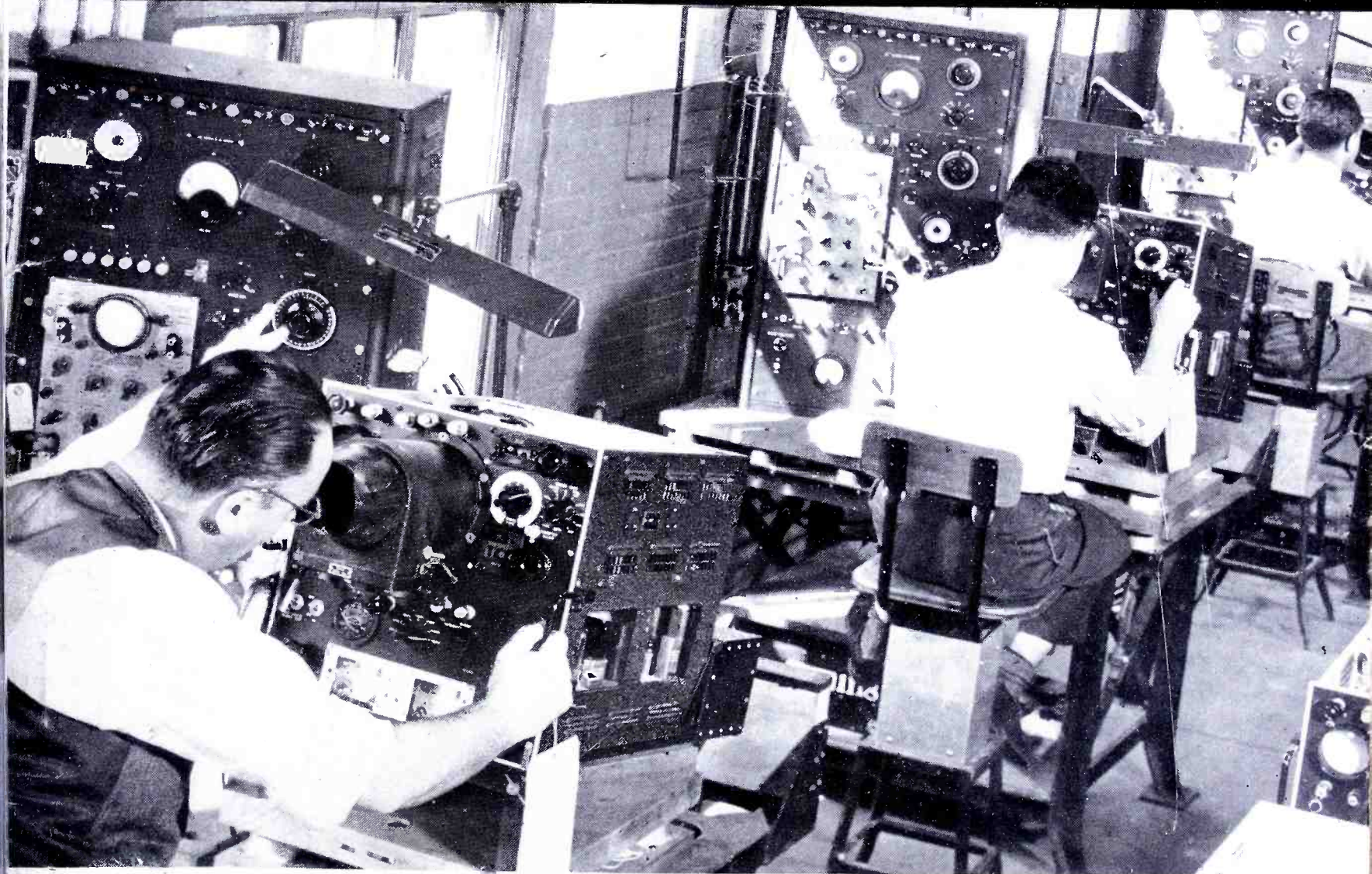


COMMUNICATIONS



SEPTEMBER

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

1945

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.

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Amperex Type 889 Transmitting Tube. Filament voltage, 11 volts. Filament current, 125 amperes. Amplification factor, 21. Direct interelectrode capacitance: grid to plate, 17.8 μf ; grid to filament, 19.5 μf ; plate to filament, 2.5 μf . 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 μf ; grid to filament, 19.5 μf ; plate to filament, 2.5 μf . List price, \$325.00.

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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 sys-

tems 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.

Pal C. Langevin
PRESIDENT

The Langevin Company

INCORPORATED

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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 catapulted 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 WEAJ 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.
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SEPTEMBER, 1945

VOLUME 25 NUMBER 9

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Radar unit test room. (Courtesy Western Electric)

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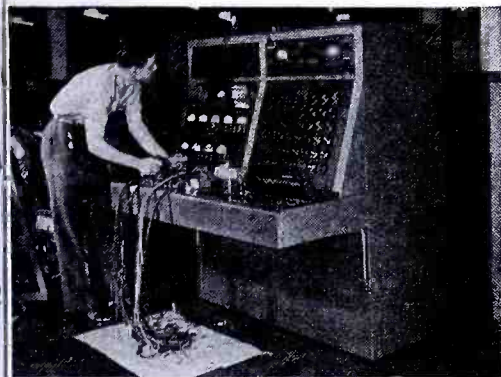
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

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

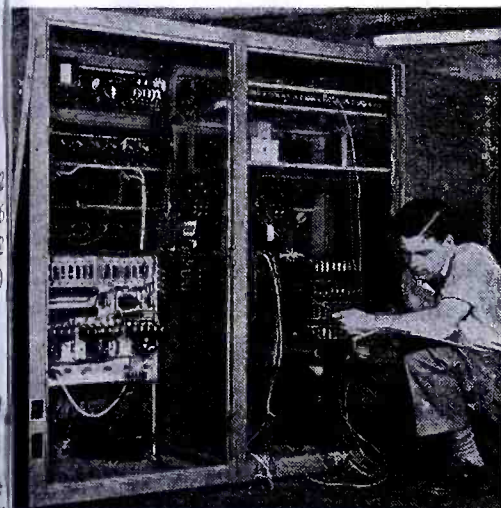
UNIVERSAL TEST UNIT CHECKS RADIO TUBES —ELECTRONIC DEVICES

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

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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.

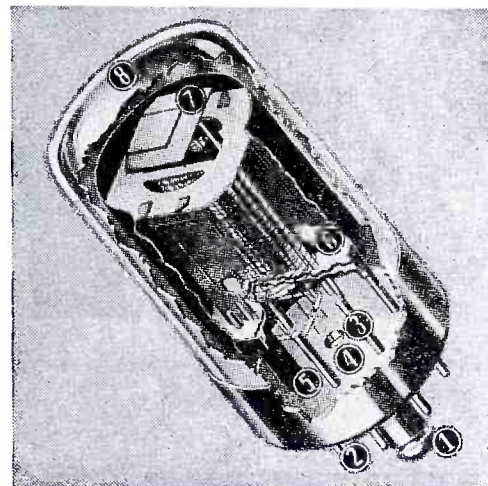
Not Limited In Use

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.*



9 POINTS OF MERIT

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- 2 No soldered connections . . . all welded for greater durability.
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- 8 No top cap connection . . . overhead wires eliminated.
- 9 Reduced overall height . . . space saving.

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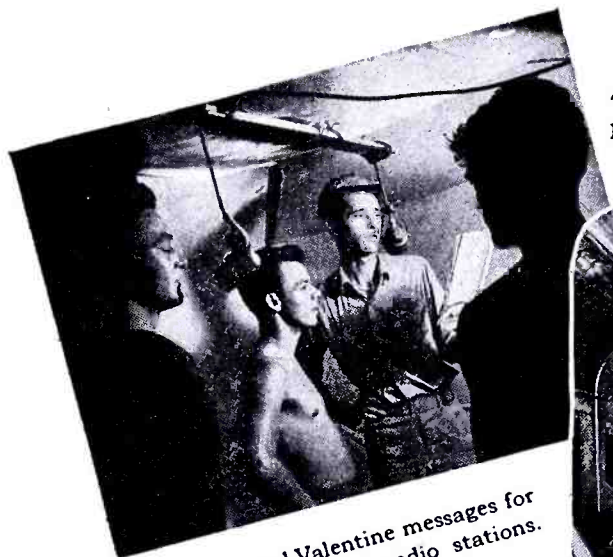
SYLVANIA ELECTRIC

Emporium, Pa.

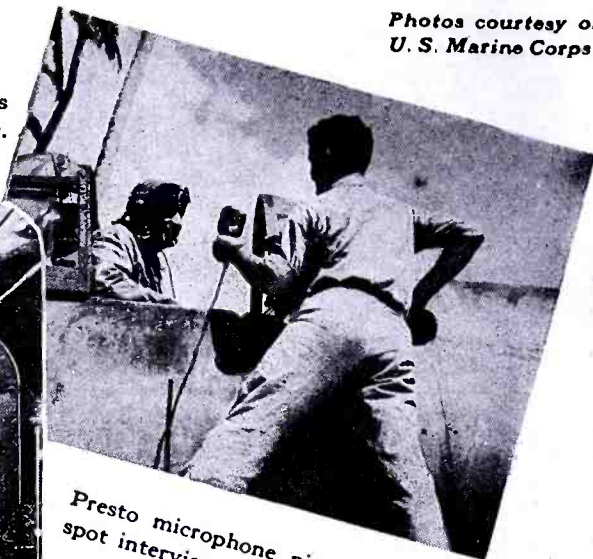
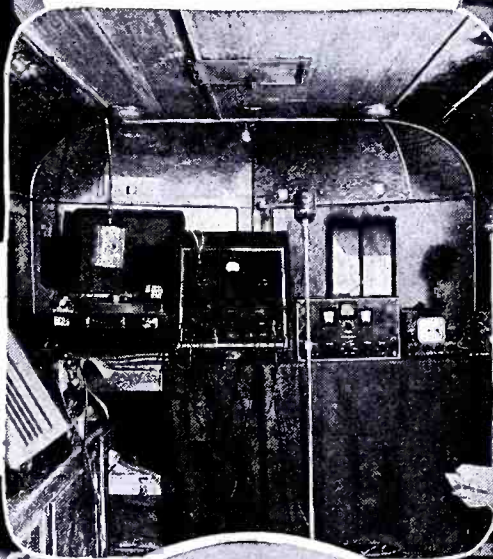
MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS
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Photos courtesy of
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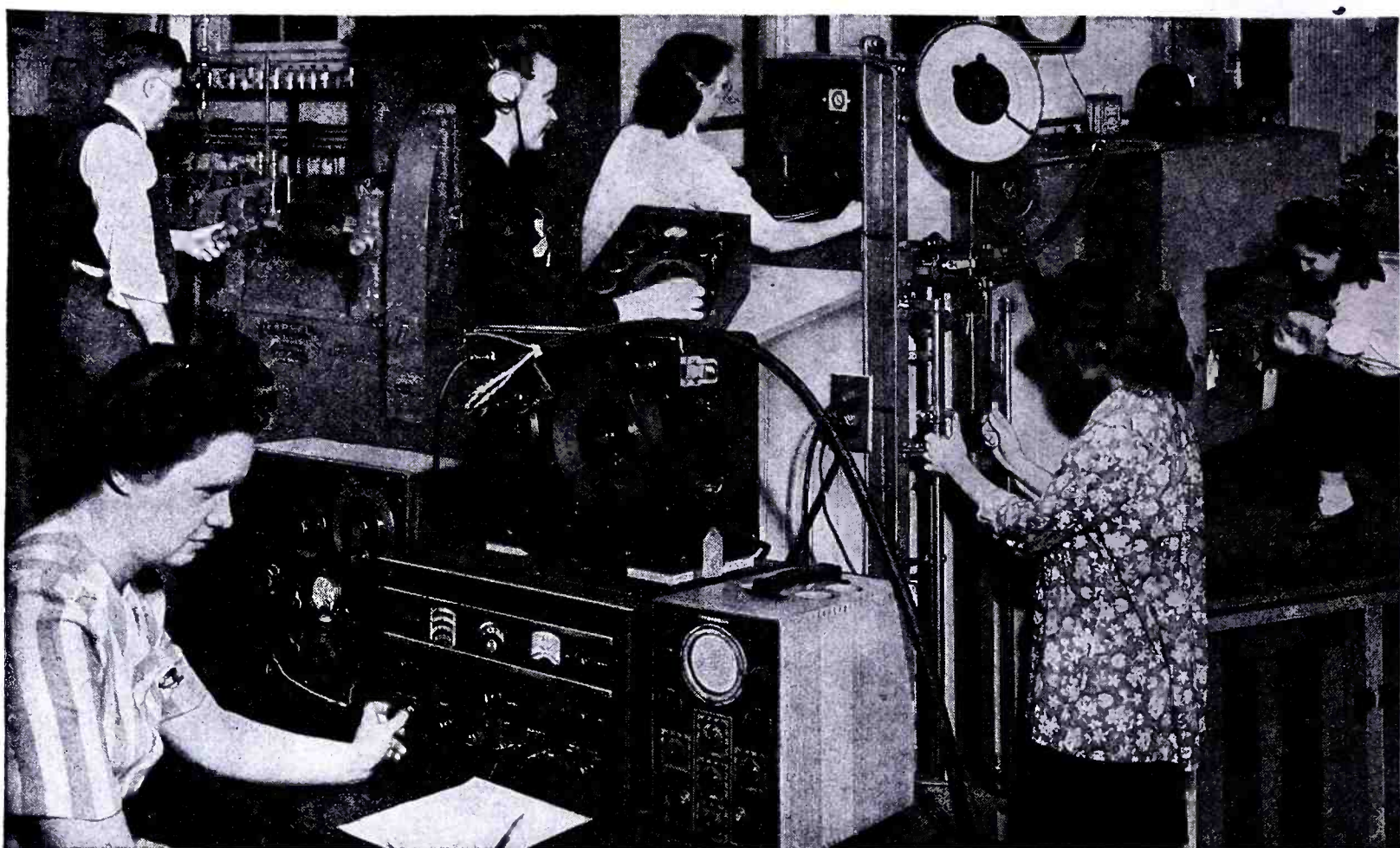
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solves cable problems

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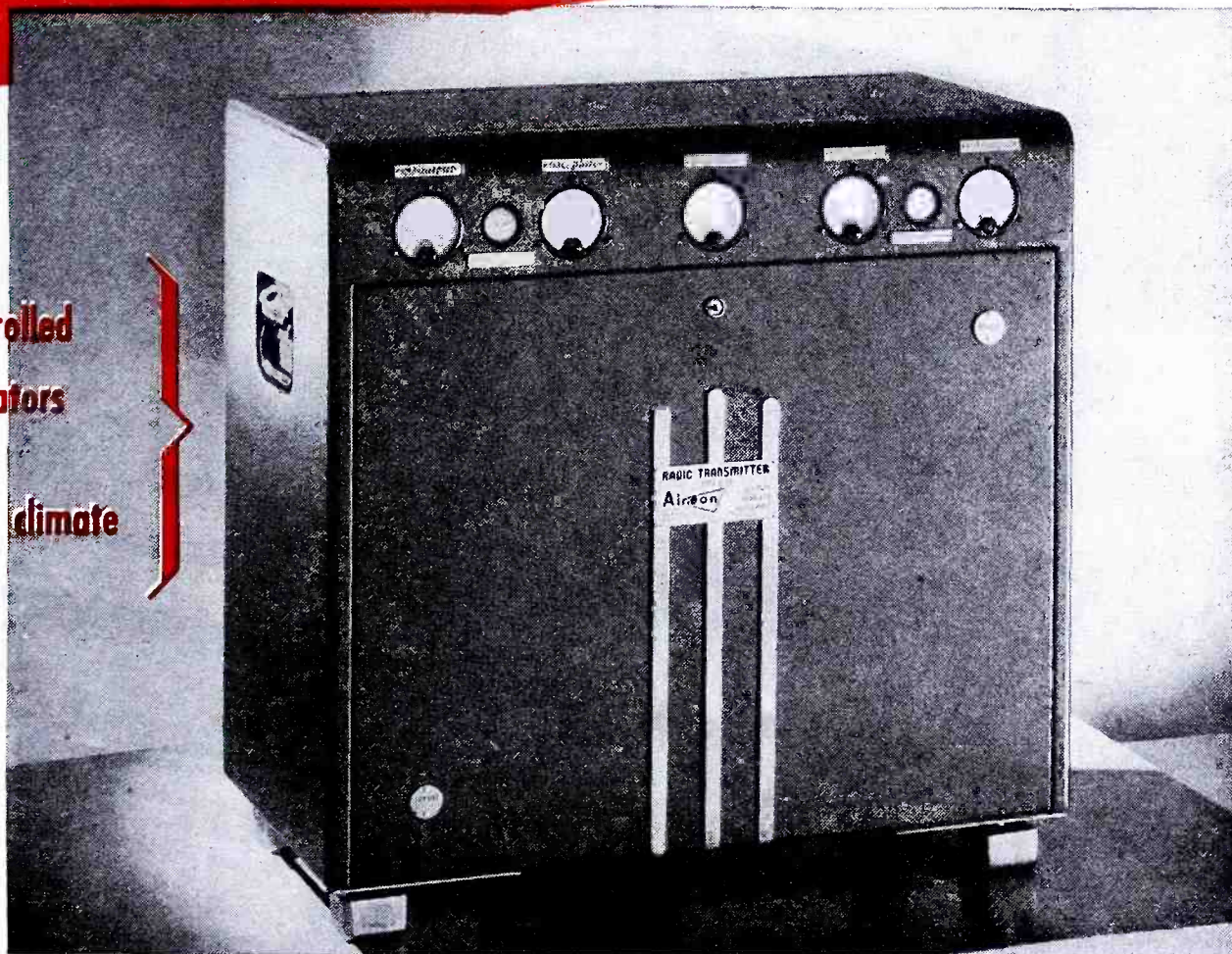
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NOW—The answer to radio communication for small airports

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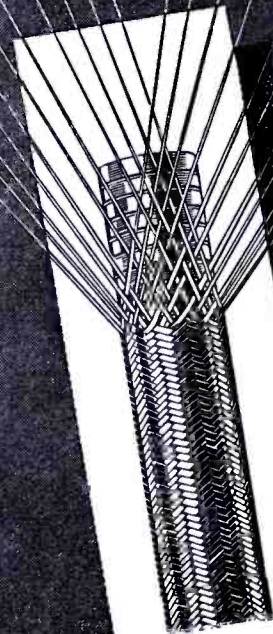
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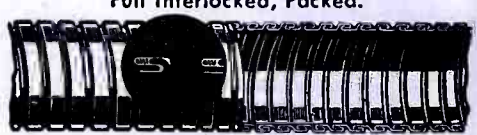
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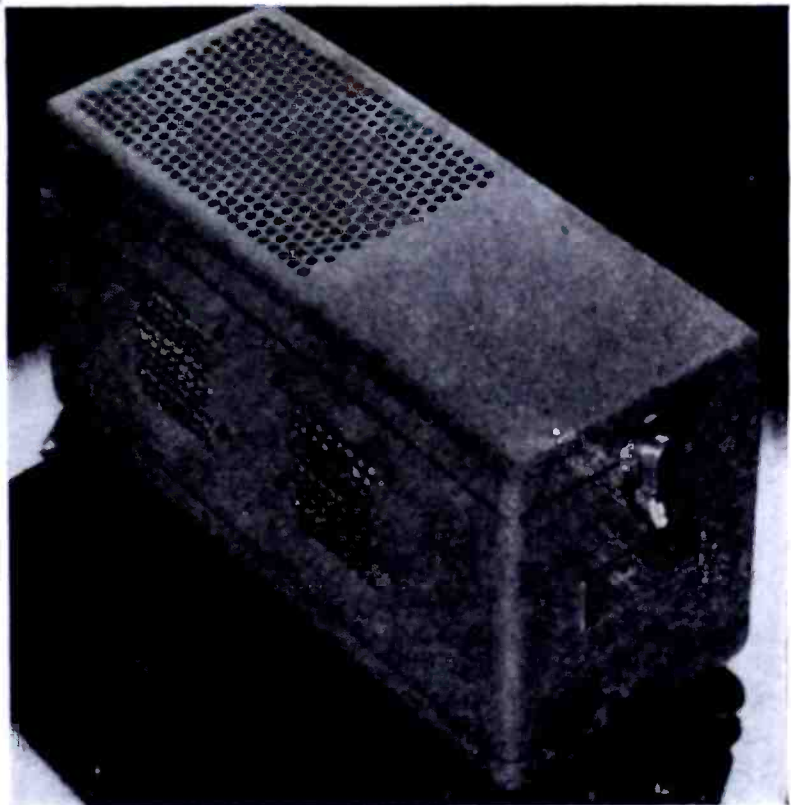


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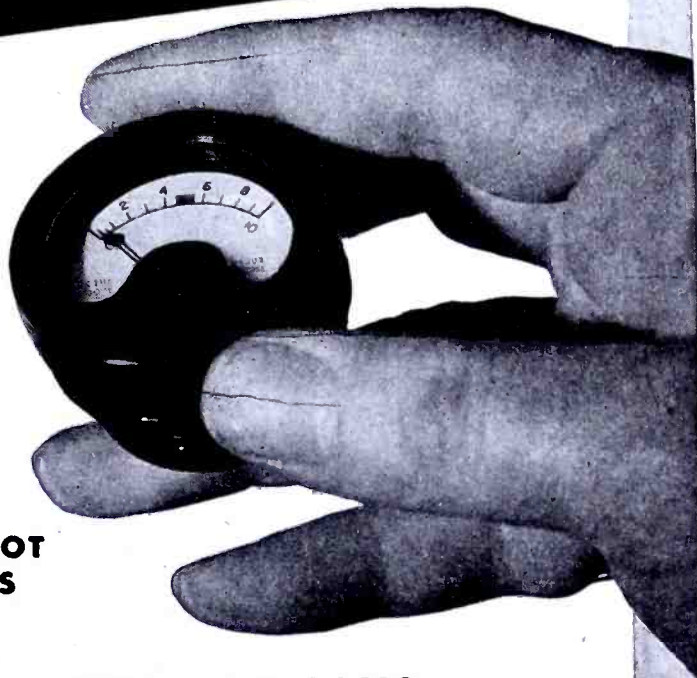
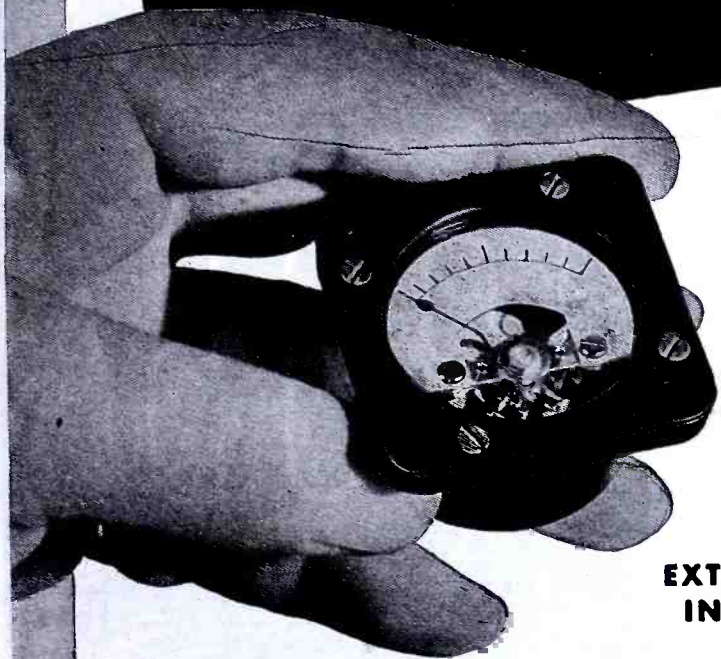
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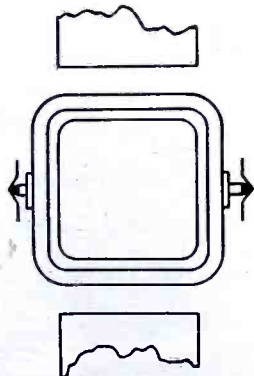
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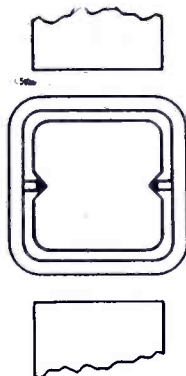
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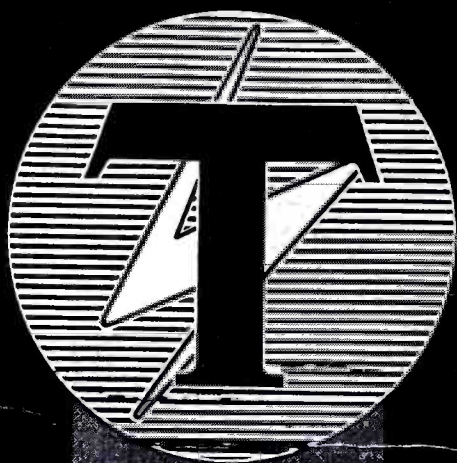
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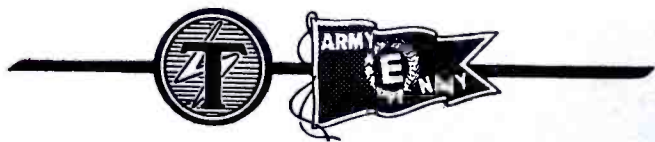
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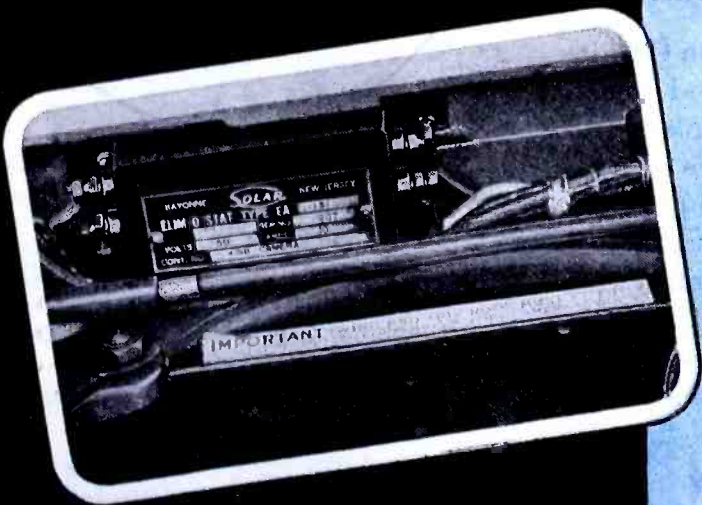
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Quick as a wink the Fairchild Night Owl Camera records enemy movements intended to be hidden by darkness. Quick as a flash the radio of the photo-reconnaissance plane keeps touch with its base — and clearly — for Solar Elim-O-Stats are part of the electronic equipment of these highly perfected cameras. This is but one of many instances where Solar Elim-O-Stats are being used to absorb local interference and keep speech channels free. Let Solar advise you on radio-noise suppression.

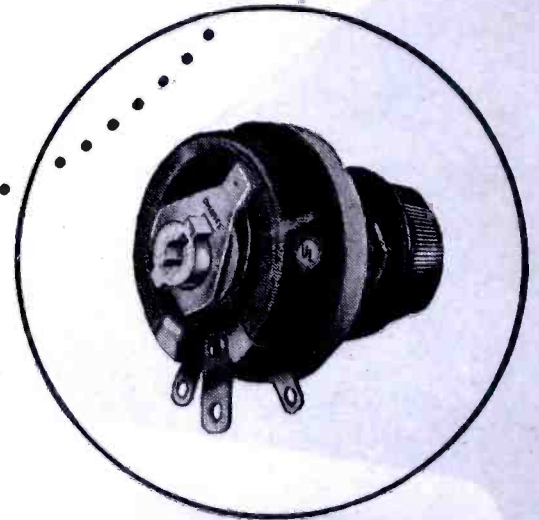
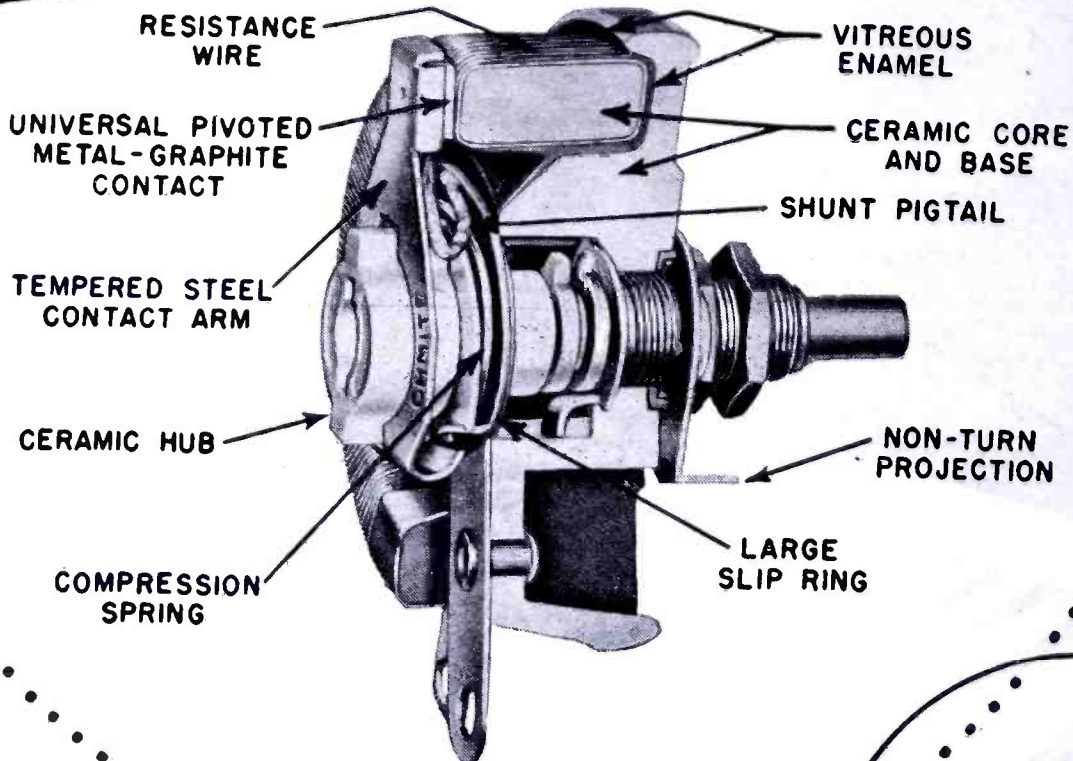


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A TOTAL OF NINE
ARMY-NAVY EXCELLENCE AWARDS

SOLAR MANUFACTURING CORP.
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Ⓢ 8013

Why **OHMITE** Rheostats GIVE SMOOTHER, CLOSER CONTROL



DESIGNED AND BUILT TO WITHSTAND SHOCK • VIBRATION • HEAT • COLD • HUMIDITY

In critical applications, engineers know they can rely on Ohmite design. Construction is compact . . . all ceramic and metal. The wire is wound on a solid ceramic core, locked in place and insulated by special Ohmite vitreous enamel. Each turn of wire is a separate resistance step. Self-lubricating metal-graphite contact brush rides on a large, flat surface . . . insures perfect contact, prevents wear on the wire. Tempered steel contact arm assures uniform pressure at all times. High strength ceramic hub insulates shaft and bushing. These are just some of the Ohmite rheostat features that provide permanently smoother, closer control.

OHMITE MANUFACTURING COMPANY
4869 Flournoy Street • Chicago 44, U. S. A.

Ohmite Rheostats are extensively used in all types of applications . . . military and industrial. Widest range of types and sizes, in stock and special units, for every need . . . 10 models ranging from 25 to 1000 watts, from 1-9/16" to 12" diameter. Ohmite engineers are glad to assist you.

Write on company letterhead for helpful Catalog and Engineering Manual No. 40.

BUY MORE
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Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES

And now . . .

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410

PRECISION-MOLDED

**Newest and Greatest Advancement
in Low Loss Insulation**

Just as sound advanced motion pictures and as television is advancing radio, so the new improved MOLDED MYCALEX will advance the cause of electronic engineers who seek ever-higher standards in insulating materials.

New and exclusive methods of MYCALEX CORPORATION now enable us to mold MYCALEX to far more exacting specifications . . . closer tolerances, with metal inserts molded in and other refinements.

Our technique affords a virtually endless variety of irregular shapes that compare with molded plastics for smoothness and precision. Yet MYCALEX offers so much more in electrical and physical advantages.

For example: greater strength and dimensional stability, freedom from cold flow, freedom from carbonization, imperviousness to moisture and gases . . . ability to withstand temperatures beyond 400 C.

Investigate the new uses and applications of this remarkable new advancement in MYCALEX. Get the facts about MYCALEX 410.



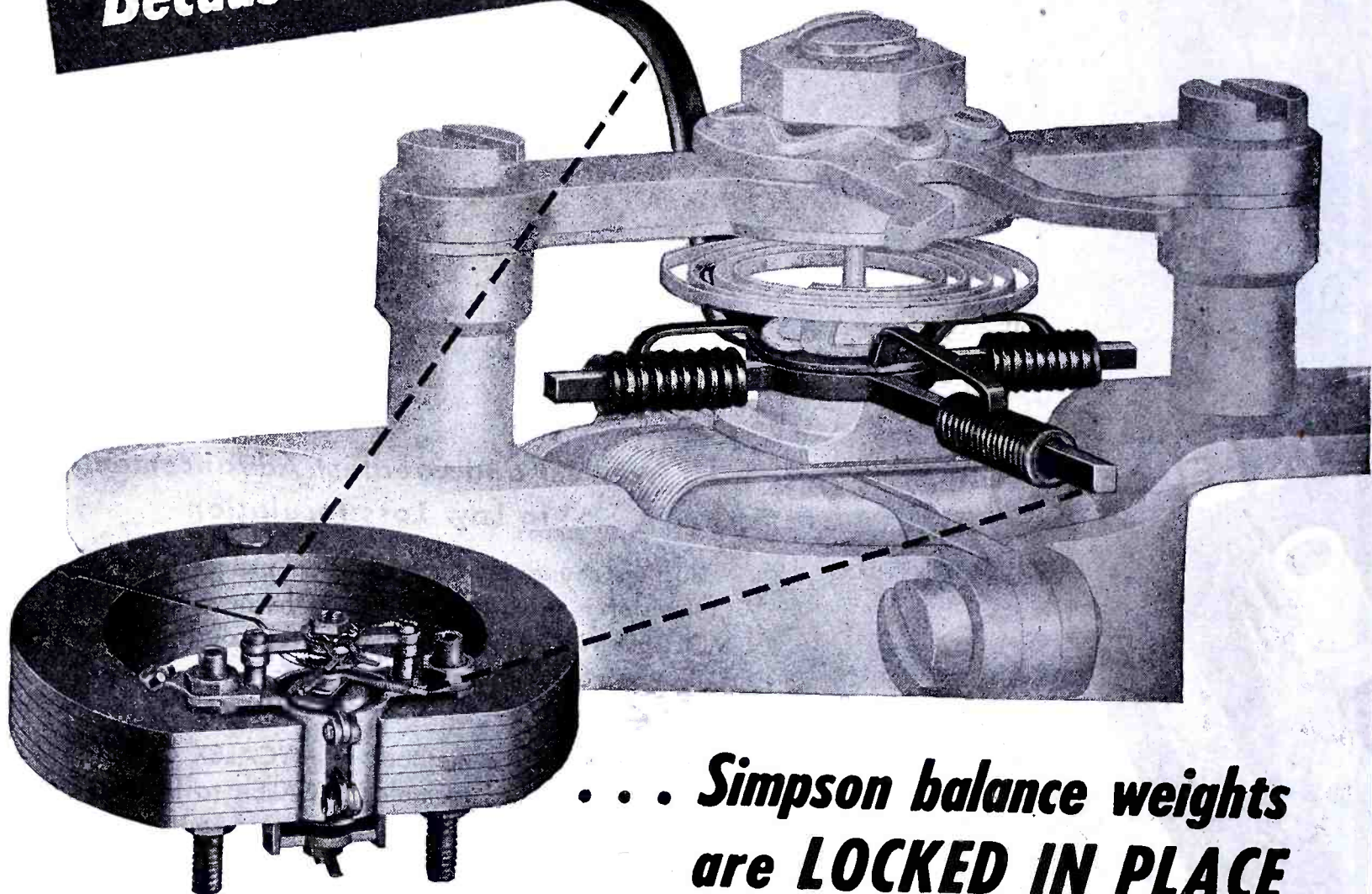
MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J.

Executive Offices, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Because Accuracy Hangs in the Balance



... Simpson balance weights are LOCKED IN PLACE

PERHAPS it's the smaller details, like these balance weights, that best illustrate the value of Simpson's 35 years of experience.

Though only tiny coils of wire, these balance weights have an important function—to offset the weight of the pointer so the moving assembly will swing in perfect balance. If the instrument is to stay accurate, they must stay in place.

So Simpson has devised a method of locking these balance weights in position. This construction not only defeats vibration and shock, it per-

mits even greater initial accuracy and makes possible faster, more efficient production.

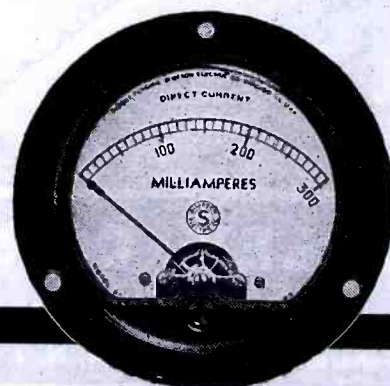
Such refinements come from a greater knowledge of the problems of instrument manufacture, and a greater fund of practical experience which can be applied to their solution. This is the simple reason Simpson Instruments are writing such an outstanding service record in posts of vital responsibility. This, too, is your guarantee of the ablest translation of today's advances in tomorrow's instruments.

SIMPSON ELECTRIC COMPANY
5200-5218 Kinzie St., Chicago 44, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory



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.

AMERICAN PHENOLIC CORPORATION

Chicago 50, Illinois

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Depend upon

AMPHENOL

Quality

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

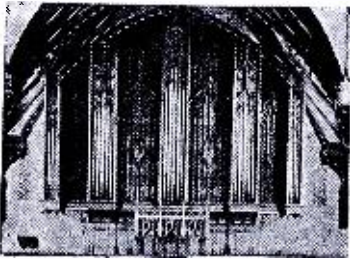


SELENIUM COPPER SULPHIDE

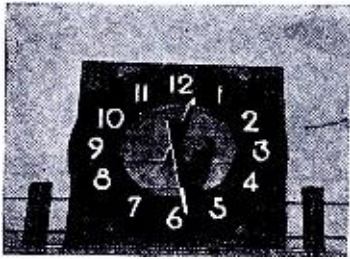
A few B-L Rectifier applications are illustrated below:



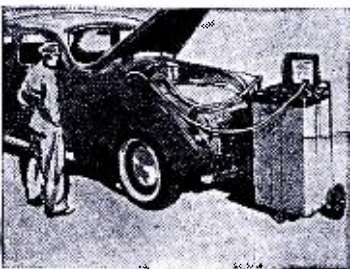
AUTO RADIOS



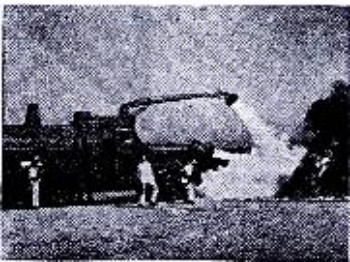
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BATTERY CHARGERS



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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.

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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.



*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.

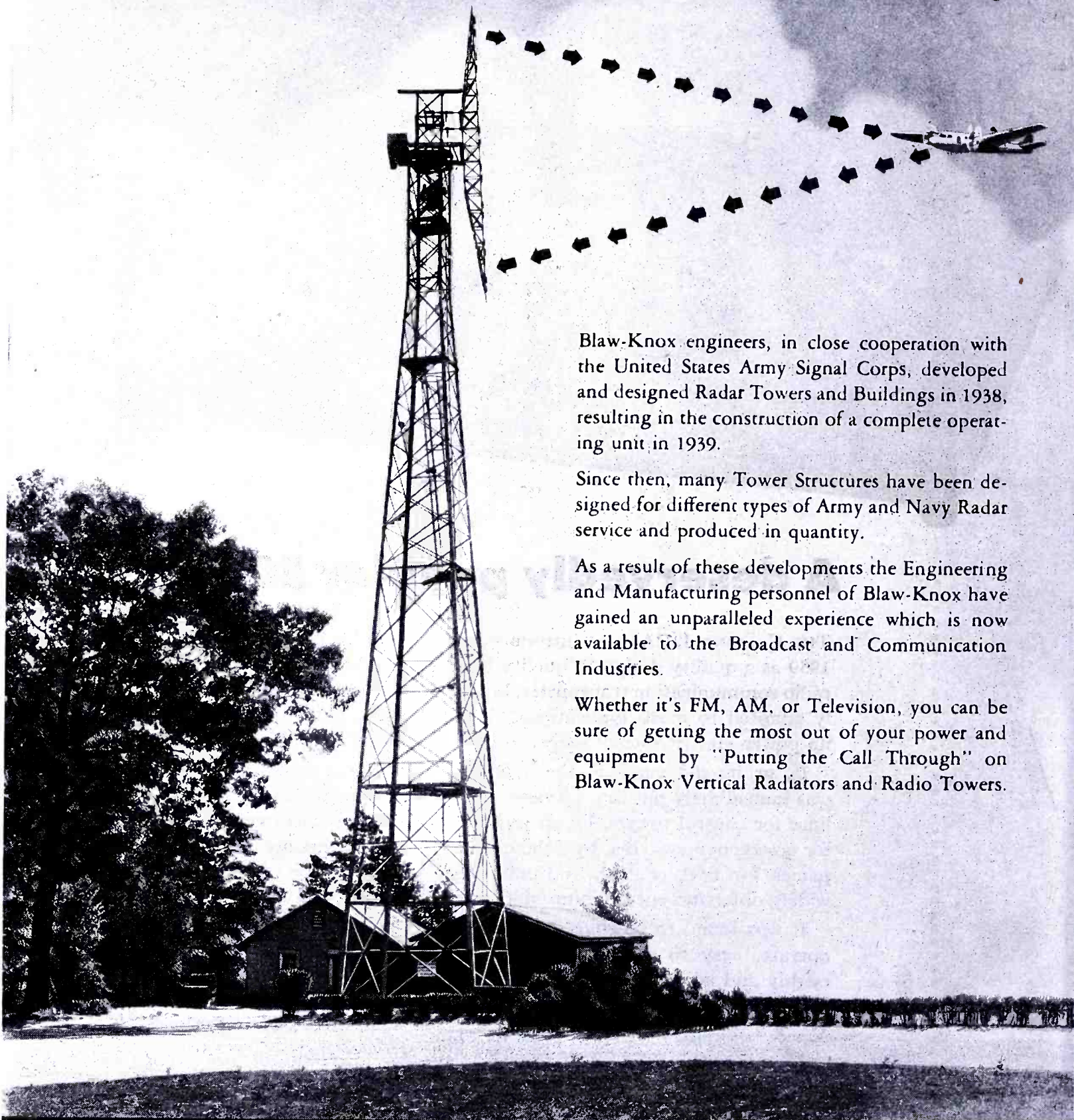
†COLLINS 32RB—Power source: 12, 24, 32 or 110 volts direct current. Dynamotor, self contained. Otherwise identical with 32RA.

IN RADIO COMMUNICATIONS, IT'S ...



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.

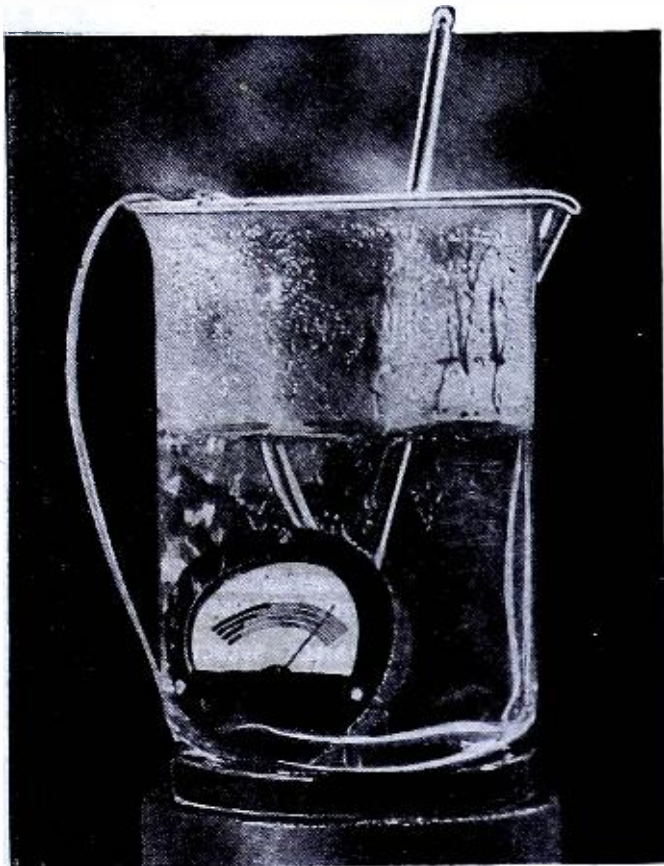
As a result of these developments the Engineering and Manufacturing personnel of Blaw-Knox have gained an unparalleled experience which is now available to the Broadcast and Communication Industries.

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.

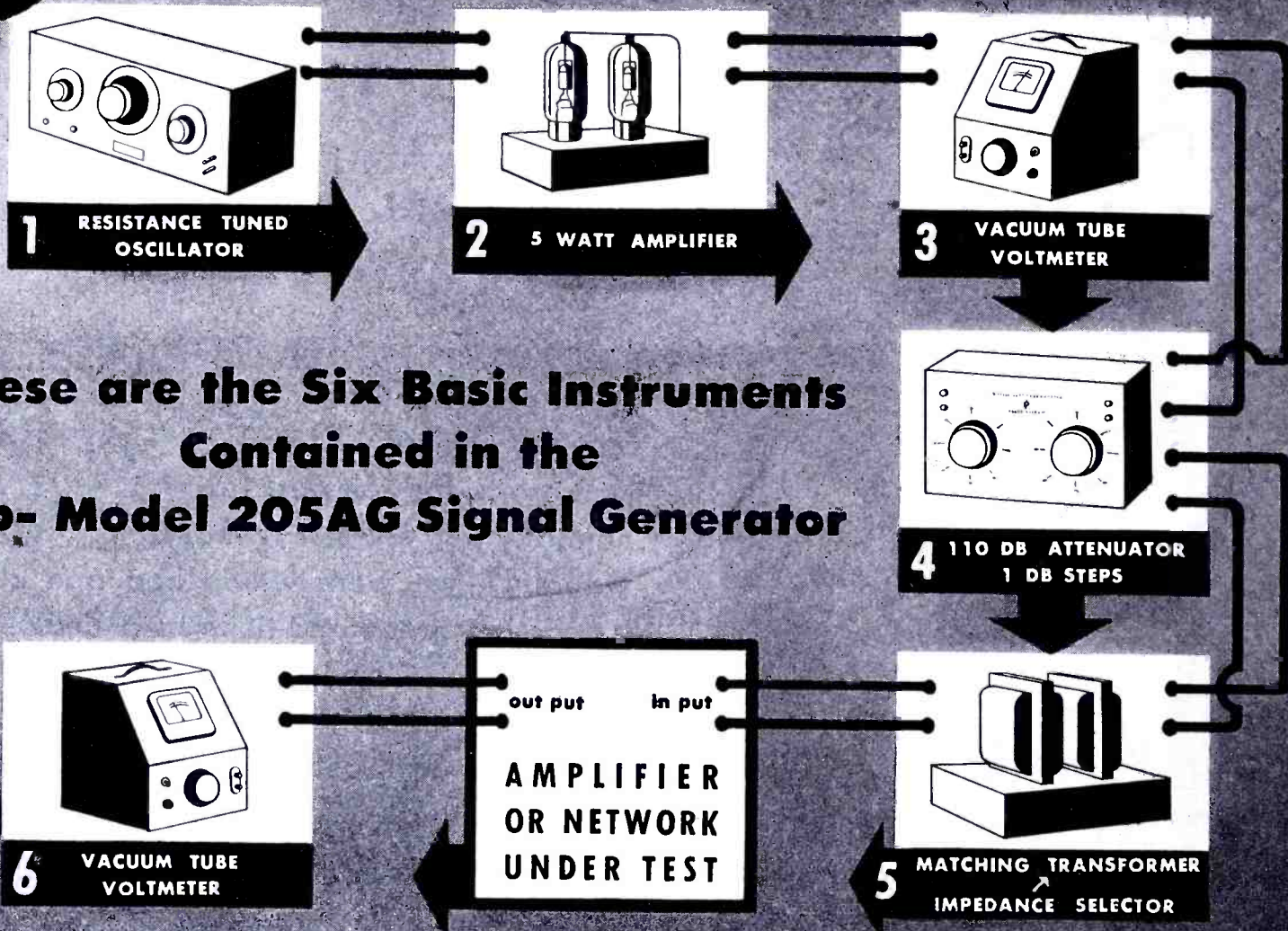
Marion Glass-to-Metal Truly Hermetically Sealed 2½" and 3½" Electrical Indicating Instruments



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



LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY



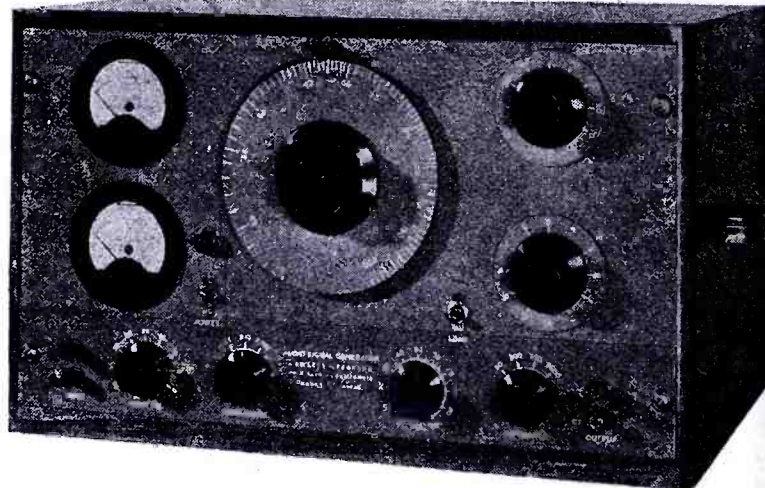
These are the Six Basic Instruments Contained in the -hp- Model 205AG Signal Generator

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

BOX 1046E STATION A • PALO ALTO, CALIFORNIA



Square Wave Generators
Attenuators

Audio Frequency Oscillators
Noise and Distortion Analyzers

Signal Generators
Wave Analyzers

Vacuum Tube Voltmeters
Frequency Meters

Electronic Tachometers
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 $\pm 1/2\%$.
- ★ 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.



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

A POSTWAR PROJECT FOR YOU...

SUPERSTANDARD RECEIVING TUBES

● Receiving tube design is often a compromise. Ruggedness, dependability, long life—the very qualities most desirable in industrial electronics and aviation—have often been sacrificed for reduced cost and power consumption in broadcast receivers. Low filament current may be poor economy in an industrial tube. A standard 6SJ7GT may be objectionably microphonic in sound equipment. Vibration, jars, shocks, and inadequate maintenance in the factory may play hob with a standard receiving tube.

SUPERSTANDARD—above standard; a term coined by Hytron for a standard receiving tube completely redesigned to give improved performance in special electronic applications

STANDARD — SPECIALLY SELECTED — NOW HYTRON PROPOSES SUPERSTANDARD

HYTRON IS CONVINCED: Standard receiving tubes are not right for special electronic applications. Special selection of standard tubes leads to embarrassing replacement problems—does not guarantee permanence of characteristics specially tested, long life, or suitability for operation at not-too-conservative maximum ratings. Hytron prewar ceramic-based low-loss GTX

tubes were but a step in the right direction. The Navy “ruggedized” tube program points the way. Complete redesign of many receiving tubes is mandatory. A tube listing at a dollar in electronic equipment costing thousands and controlling huge production lines is false economy which has already dealt industrial electronics many an unnecessary black eye.

MAY WE HAVE YOUR OPINION?

- 1 Do you agree that special selection merely results in replacement problems?
- 2 How many thousands of hours of life should **SUPERSTANDARD** tubes have?
- 3 What degree of vibration and shock should **SUPERSTANDARD** tubes be capable of withstanding?
- 4 For what characteristics not now tested should **SUPERSTANDARD** tubes be production tested?
- 5 Would you be willing to pay a premium price for **SUPERSTANDARD** tubes to attain trouble-free operation?
- 6 Should Hytron concentrate on developing **SUPERSTANDARD** tubes usable for many special purposes, and avoid trick and highly specialized tubes?
- 7 How closely should a **SUPERSTANDARD** tube adhere to fundamental characteristics of a standard receiving tube it supersedes?
- 8 Do you believe **SUPERSTANDARD** tubes should have special bases to avoid replacement by inferior standard receiving tubes?
- 9 Should **SUPERSTANDARD** tubes have new type numbers, or the old standard type numbers with a special suffix (e.g., 6SJ7GTS)?*
- 10 Have we omitted pertinent questions you believe important?

**NEMA and RMA are now working on type designation systems.*

The Hytron **SUPERSTANDARD** tube is as yet an idea—a postwar project for YOU. You who use the tubes can spark the program—can make it come to life. Hytron will put its postwar engineering drive behind the **SUPERSTANDARD** tube, if you will help. Let us know the improvements of specific characteristics your experience has proved desirable. Drop a line today to our Commercial Engineering Department.

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE





**No Brass Hats
Here --
JUST BRASSTACKS!**



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!

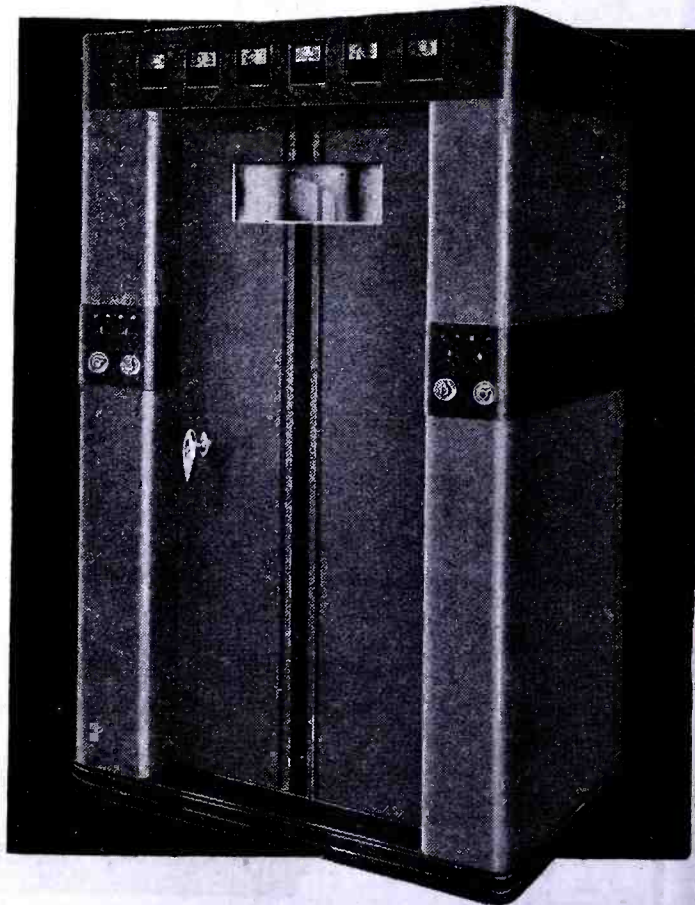
GATES RADIO CO. • QUINCY, ILLINOIS

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.*

United Transformer Corp.

150 VARICK STREET

EXPORT DIVISION: 13 EAST 40th STREET,

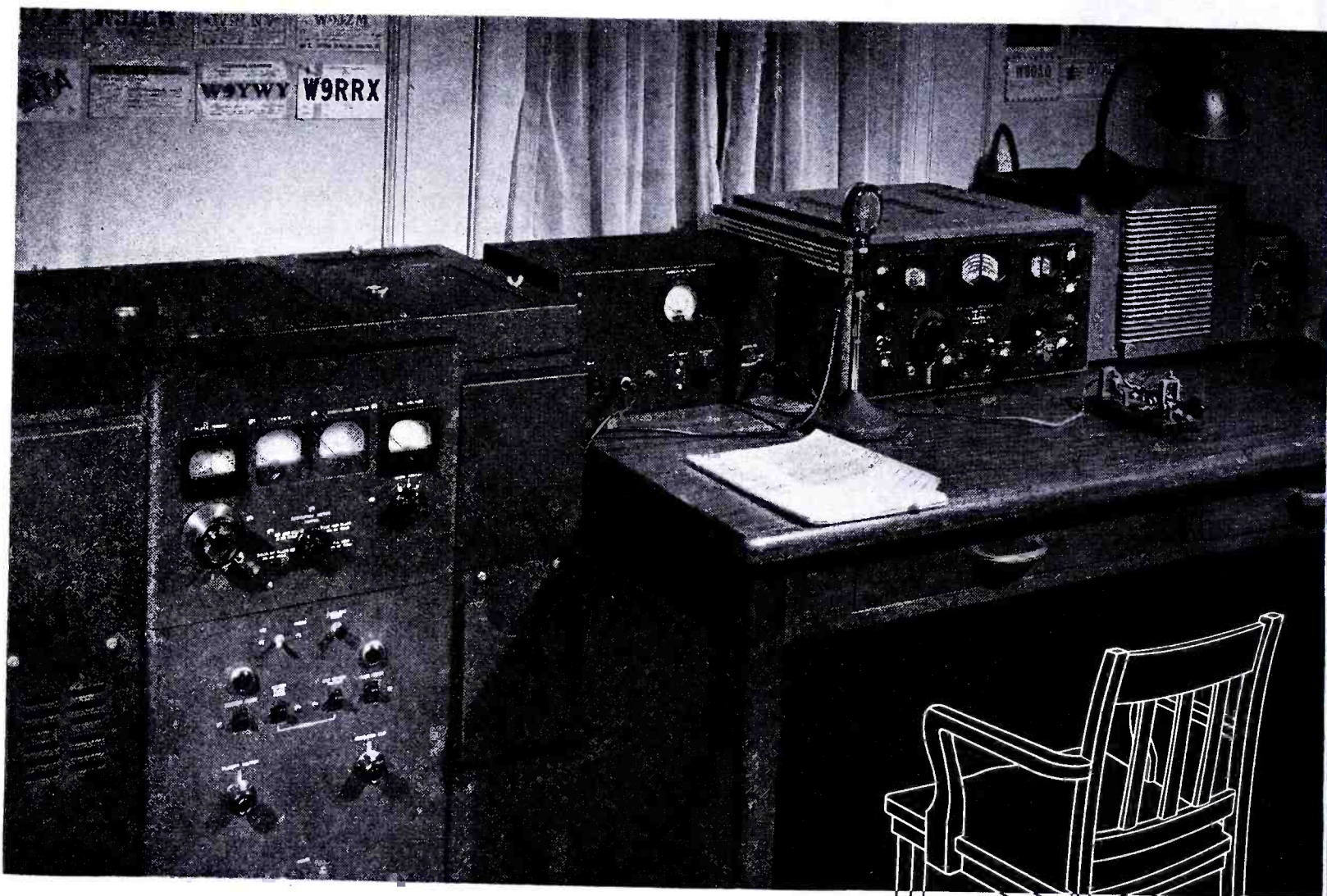
NEW YORK 13, N. Y.

NEW YORK 16, N. Y., CABLES: "ARLAB"



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.

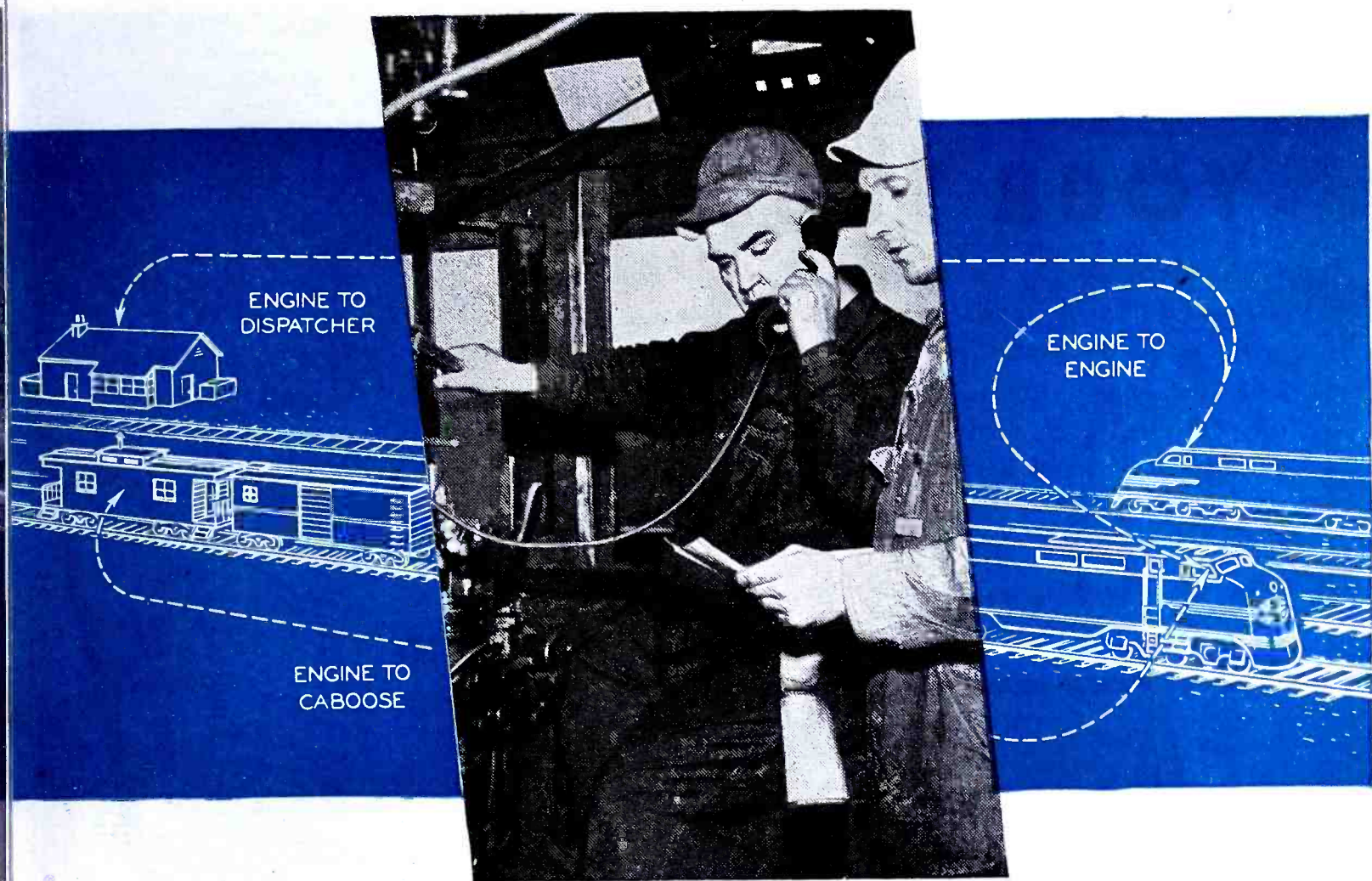
Even now you can "pull up a chair" in your ideal ham shack by sending for Hallicrafters 1945 Catalog . . . a fascinating piece of ham literature . . . detailed specifications on more than 20 models that are helping to win the radio war. Specify Catalog S-36A.

COPYRIGHT 1945 THE HALLICRAFTERS CO.

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 engi-

neers 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.

Constant Voltage Transformers SOLA

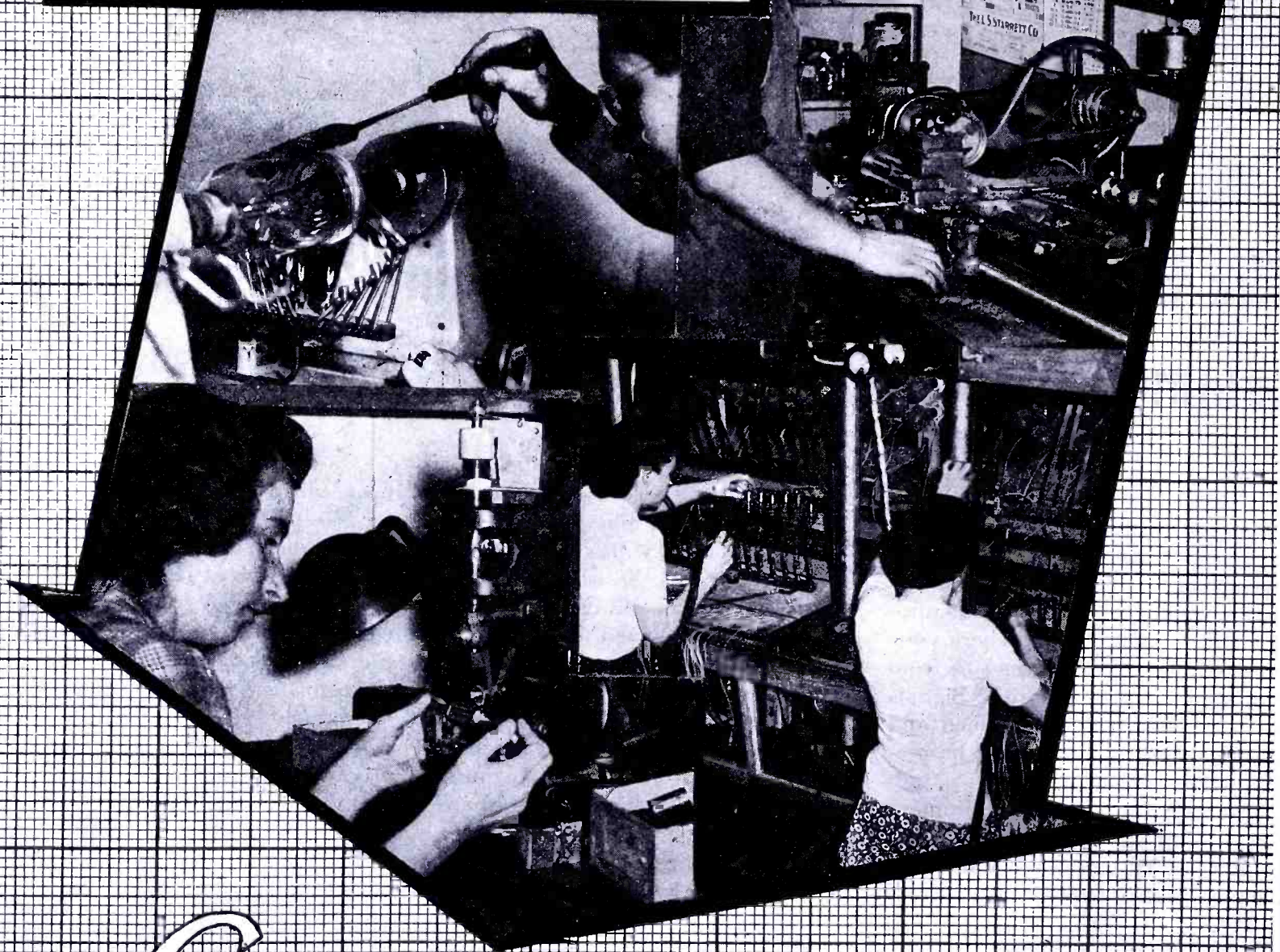
To Manufacturers:
Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.
Ask for Bulletin ECV-102 ●

Fast, Economical Production of
YOUR TUBES

Manufacturers requiring transmitting and industrial power tubes and rectifiers, *produced to their "specs" under their brand names*, can use the production-ability of Lewis Electronics.

Immediate and important competitive advantages are reflected in advanced Lewis production techniques. Each Lewis technician and engineer has the individual skill and enthusiasm to meet exacting technical requirements. You are assured of *quality plus quantity* production—at low cost!

*Ask today, about the tube-production job Lewis can do for you.
Write, wire or phone — our representative will personally call.*



Lewis



ELECTRONICS

LOS GATOS • CALIFORNIA

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.

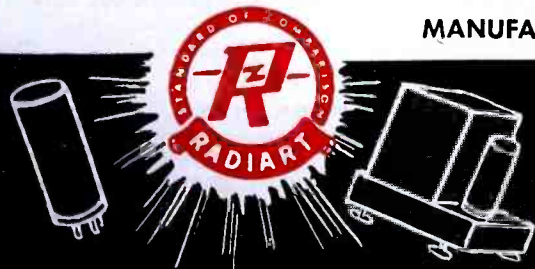
Newly designed method of mounting provides simplest form of one man installation — Mounting is completely waterproofed and impossible to short to the body.

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



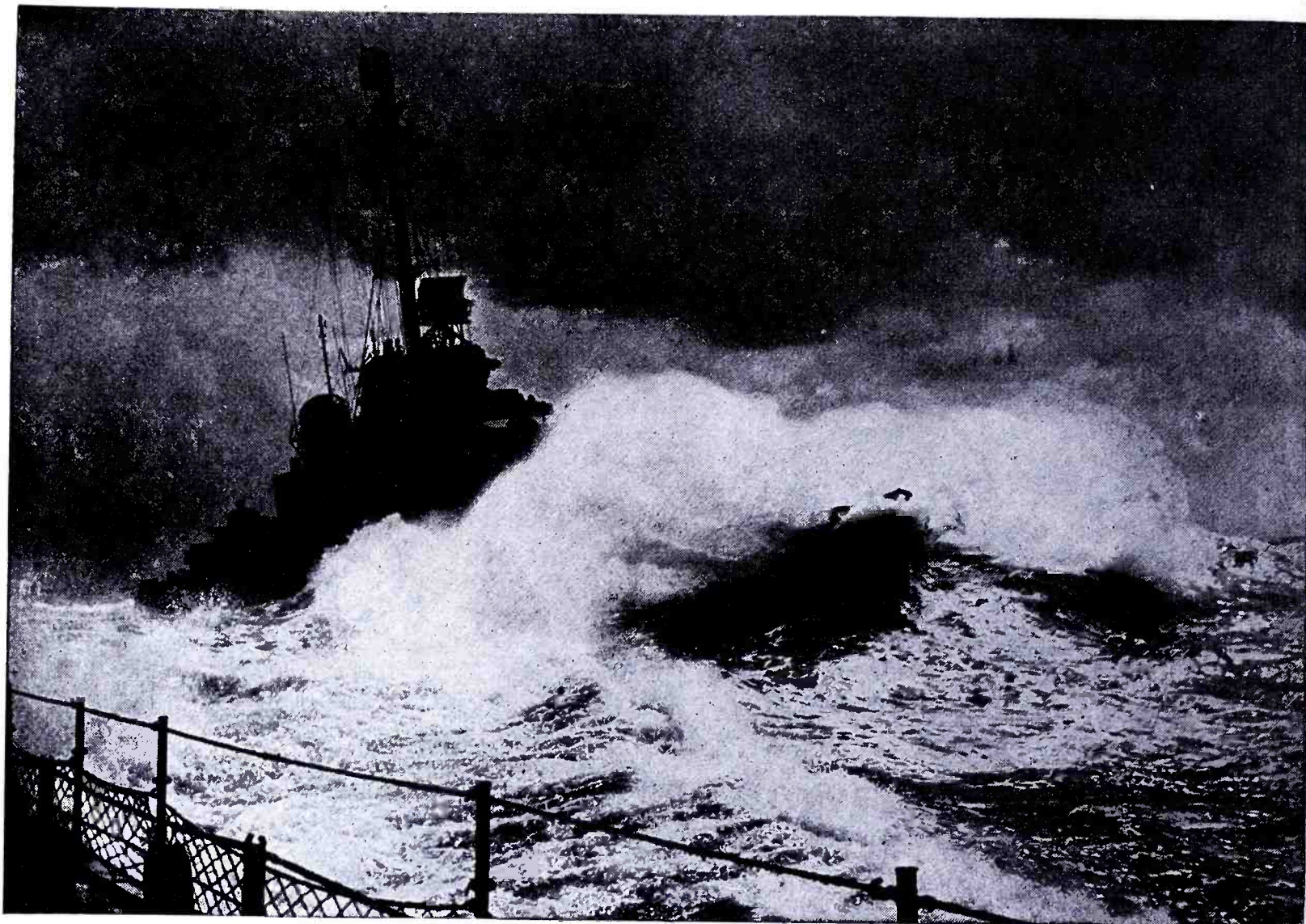
Radiart Corporation

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Export Division
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OFFICIAL U. S. NAVY PHOTO

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More than one sailor has said, "It's a helluva place to fight a war!"

That's a miracle of understatement when you know the Pacific as well as the U. S. Navy knows it.

They know how many thousands of miles you have to go before you reach the fighting fronts.

They know there's almost continual rain and bad weather to hamper operations after you get there.

And they know there are no good ports!

Think of the thousands of ships, and the millions of tons of supplies it takes to keep our fighting forces moving toward Japan.

Imagine, if you can, the problem of handling those ships and supplies with no port facilities.

There are no giant cargo cranes... no miles of docks and warehouses... nothing but beaches, and human backs, and a refusal to call any job impossible.

Remember, too:

It takes 3 ships to do the supply job in the Pacific that 1 ship can do in the Atlantic.

It takes 6 to 11 tons of supplies to put a man on the Pacific battleline, and another ton per month to keep him supplied.

It takes a supply vessel, under ideal

conditions, half a year to make one round trip.

Add up those facts, multiply by the number of sailors, soldiers, and marines for whom the Navy is responsible.

Maybe you'll begin to realize what "no ports" can mean in the rough, tough waters of the Pacific.

Maybe you'll see that we have *two* reasons to be proud of the U. S. Navy. *First*, the way they've sunk the enemy's ships.

Second, the way they sail *your* ships... taking the worst the Pacific can hand them... but keeping the supply lines open... keeping the attack *on schedule!*

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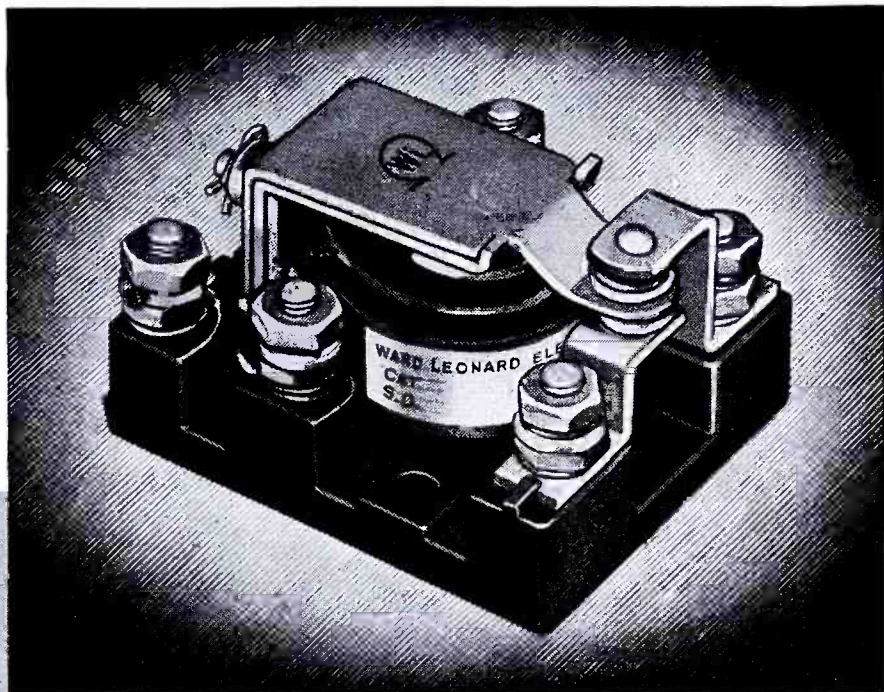
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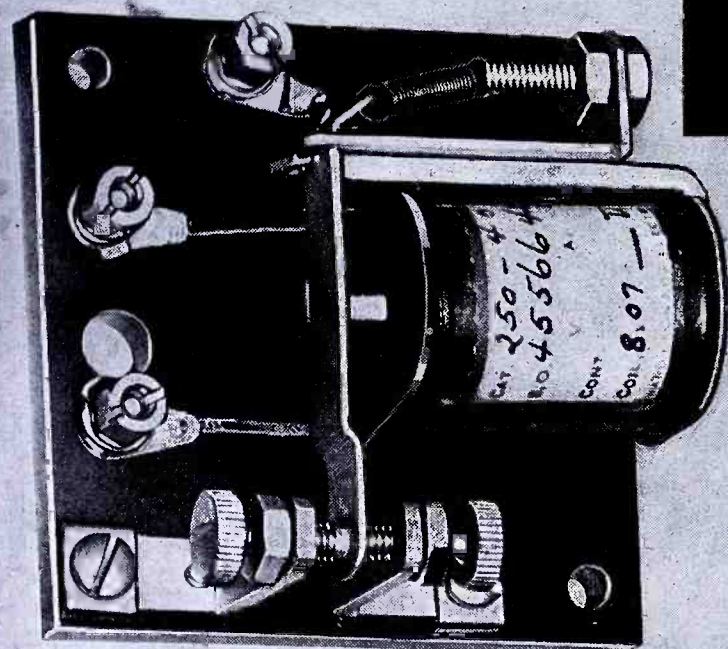
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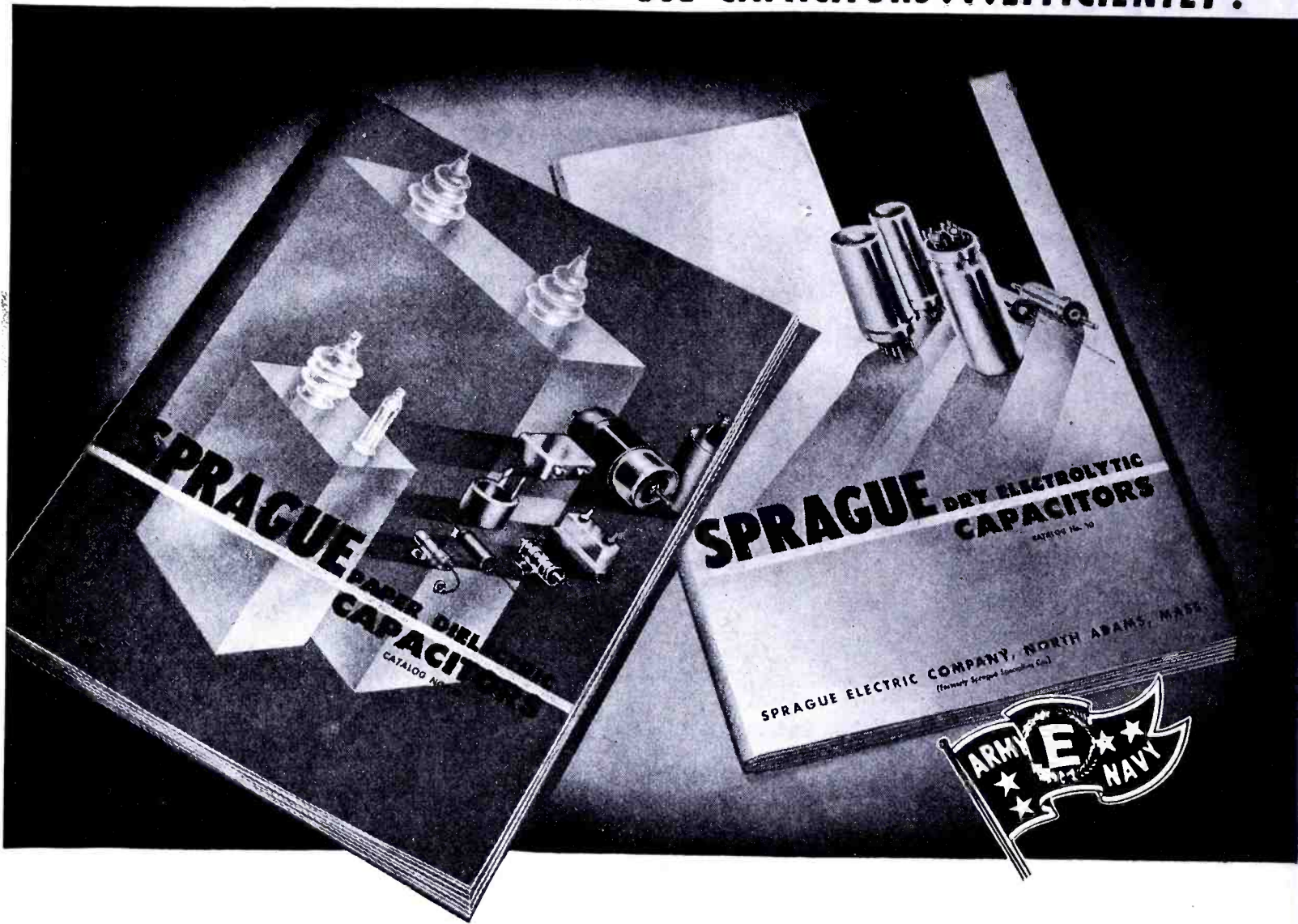
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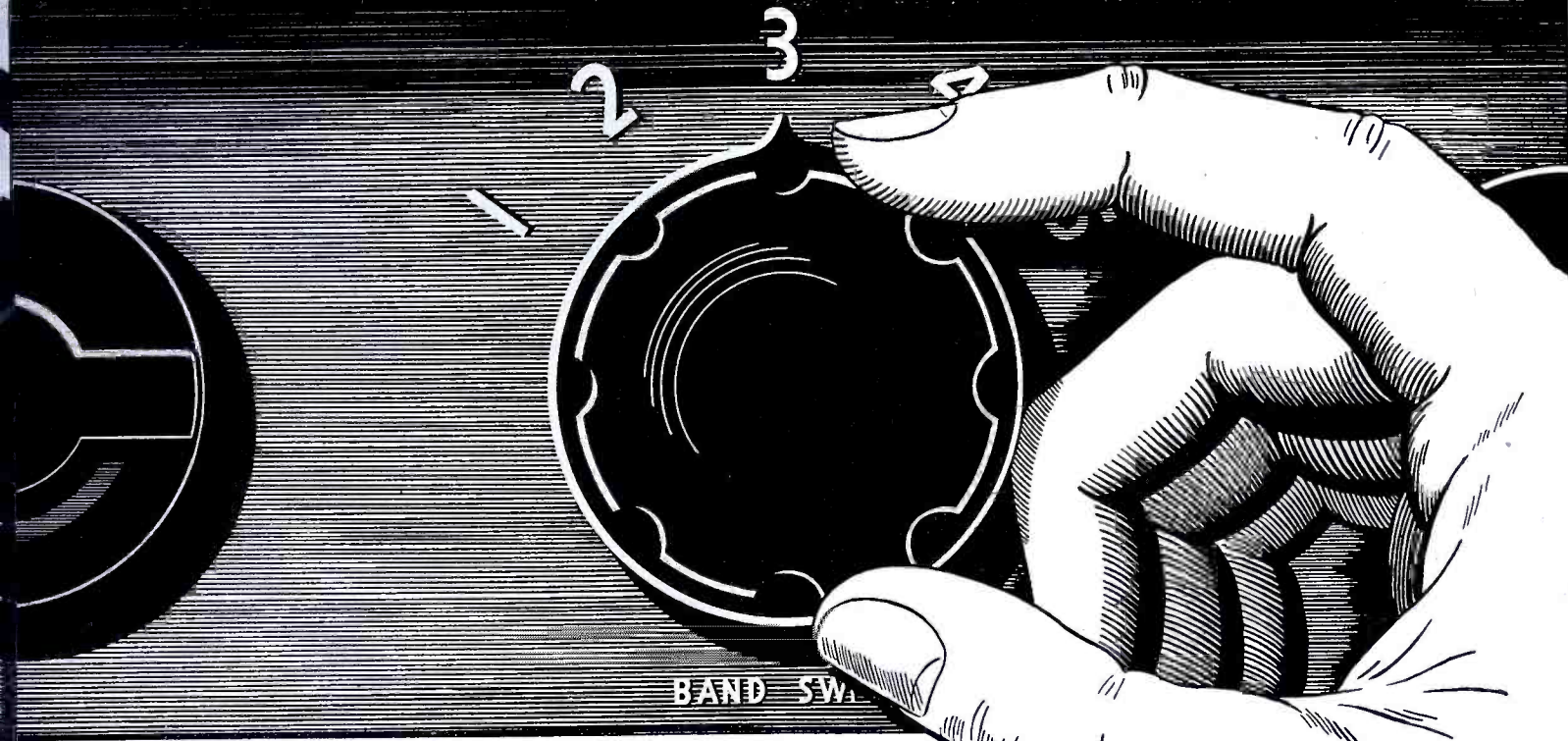
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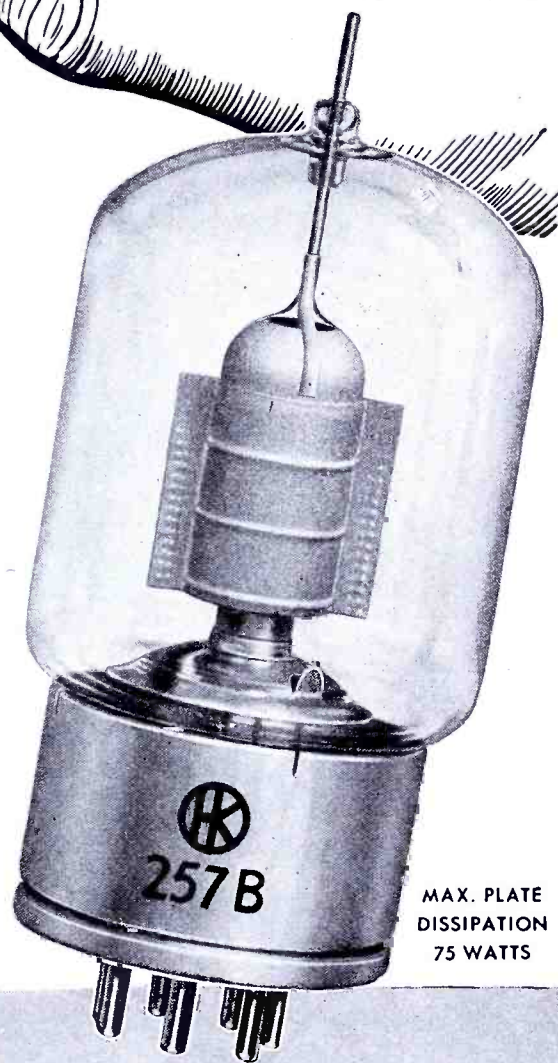


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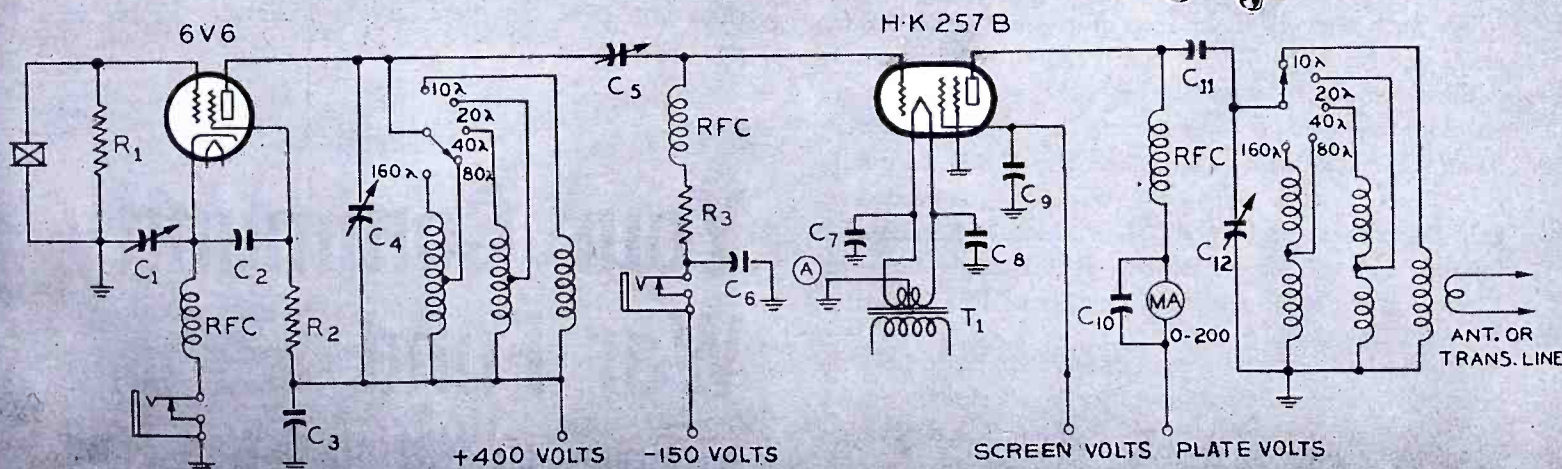
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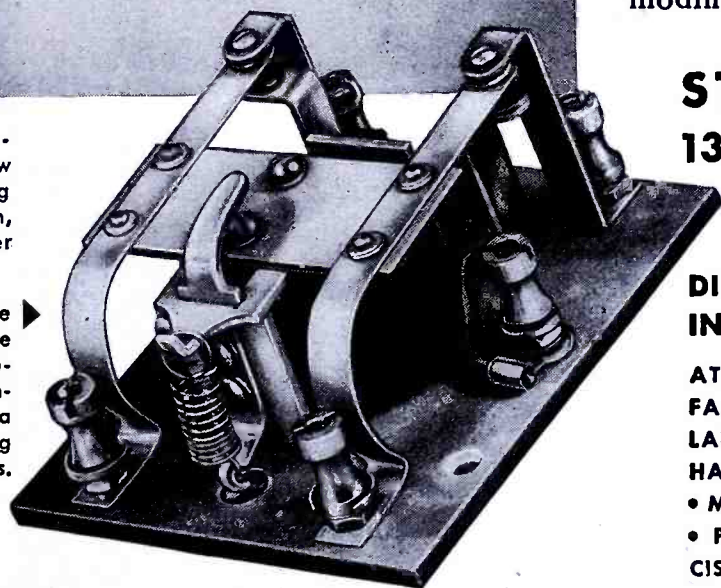
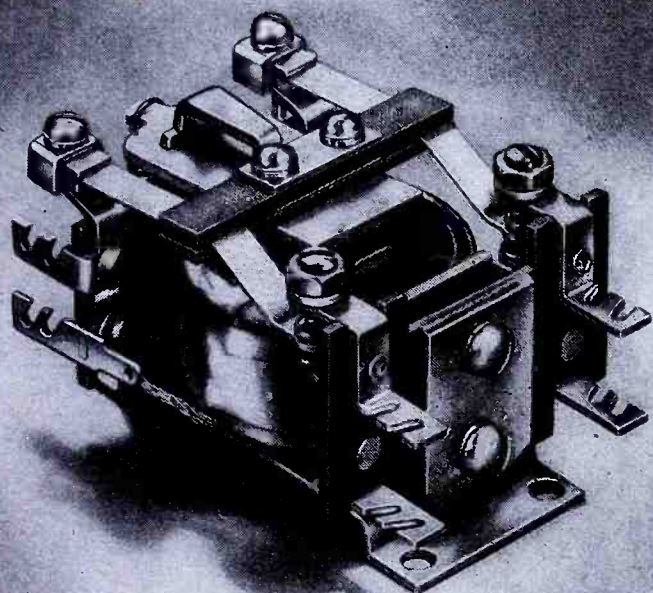
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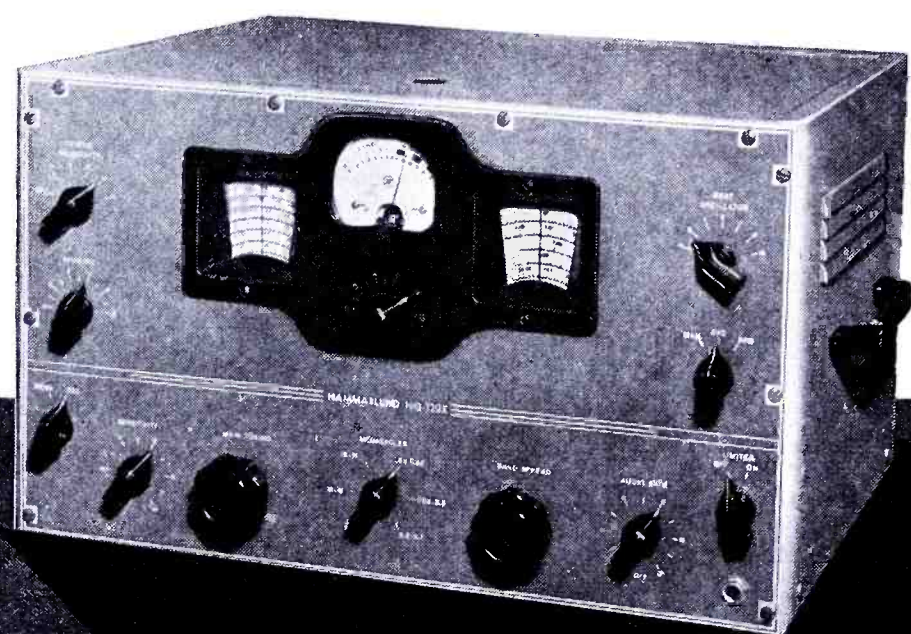
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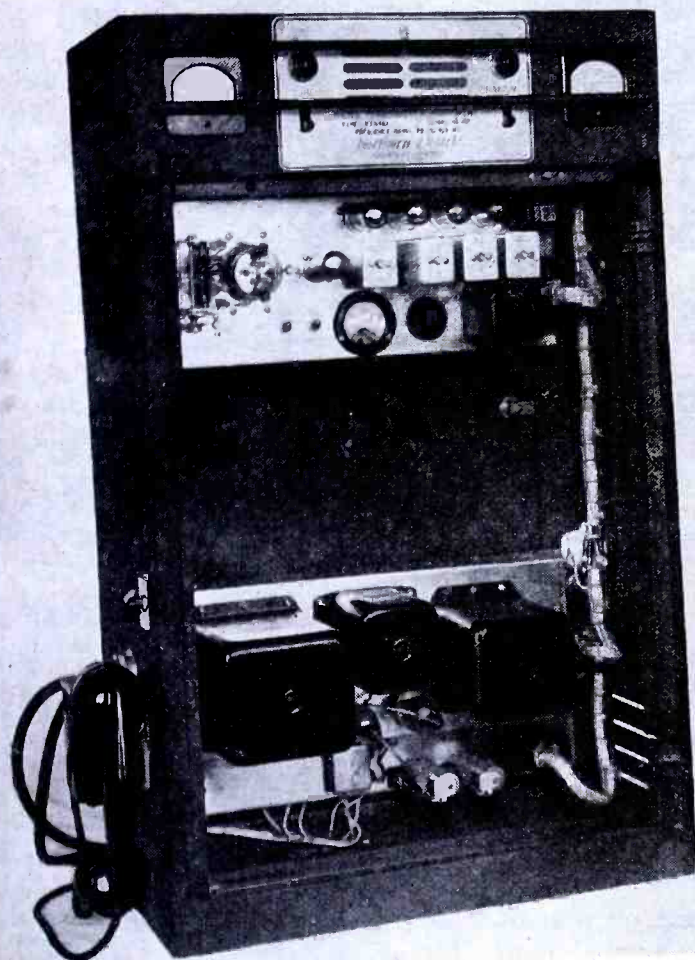
COMMUNICATIONS

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

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

**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

application to a ticket agent, the airline agent must first determine whether space is available on the flight in ques-

tion. In order that the public may be served rapidly in this respect it is necessary to maintain accurate central

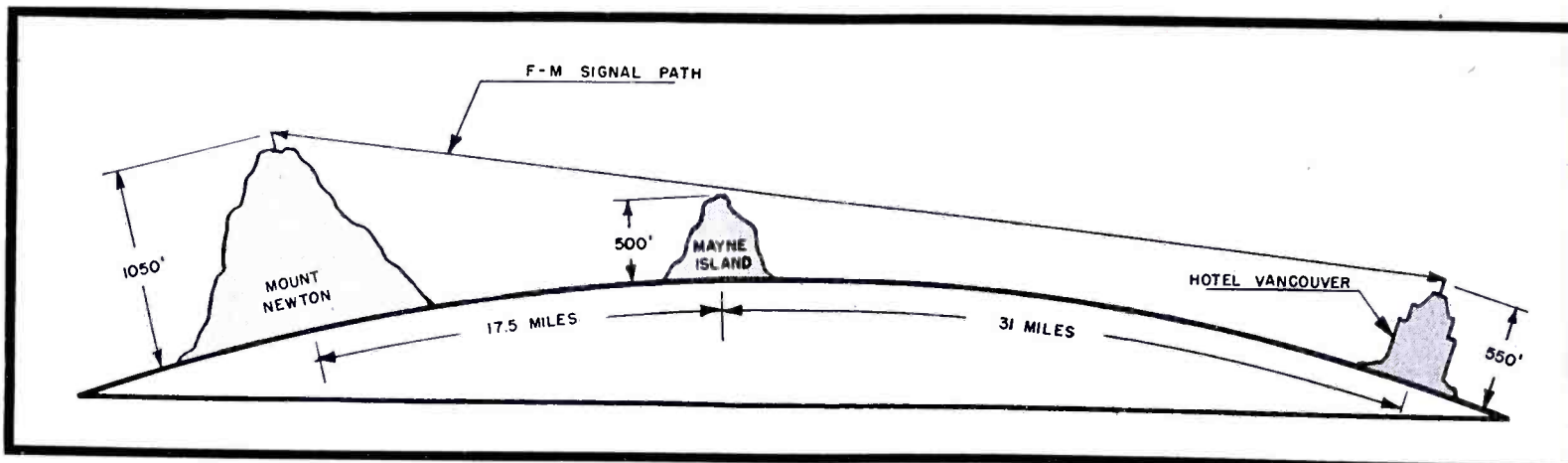


Figure 3
Antenna heights and signal paths between eastern and western terminals of the airline system.

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 i-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 $90 \mu\text{v}/\text{m}$ 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

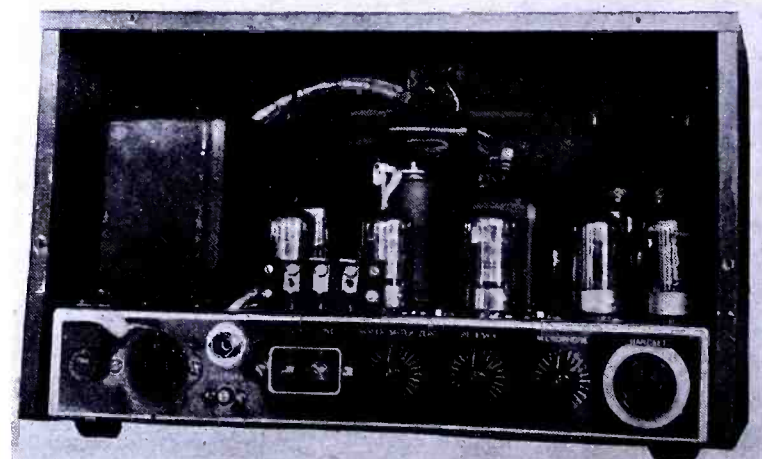
housed and two 90' masts were erected as closely as possible to the equipment, again to minimize feeder losses. Although an all-weather road to a public park about 100' below the summit provided a means of access to this site, it was necessary to construct power and control lines from the airport, a 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.)



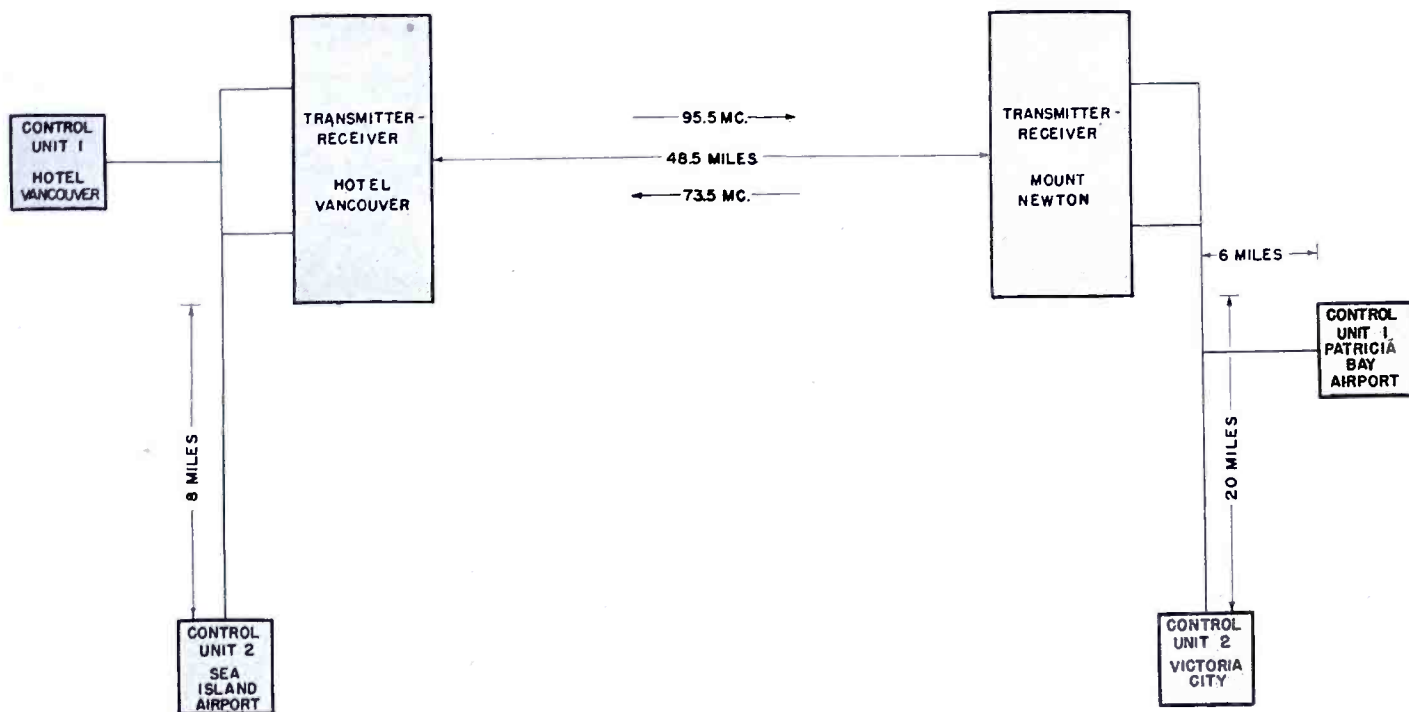


Figure 6
Control facility setup at airport and city traffic control quarters.

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-con-

version superheterodyne 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 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

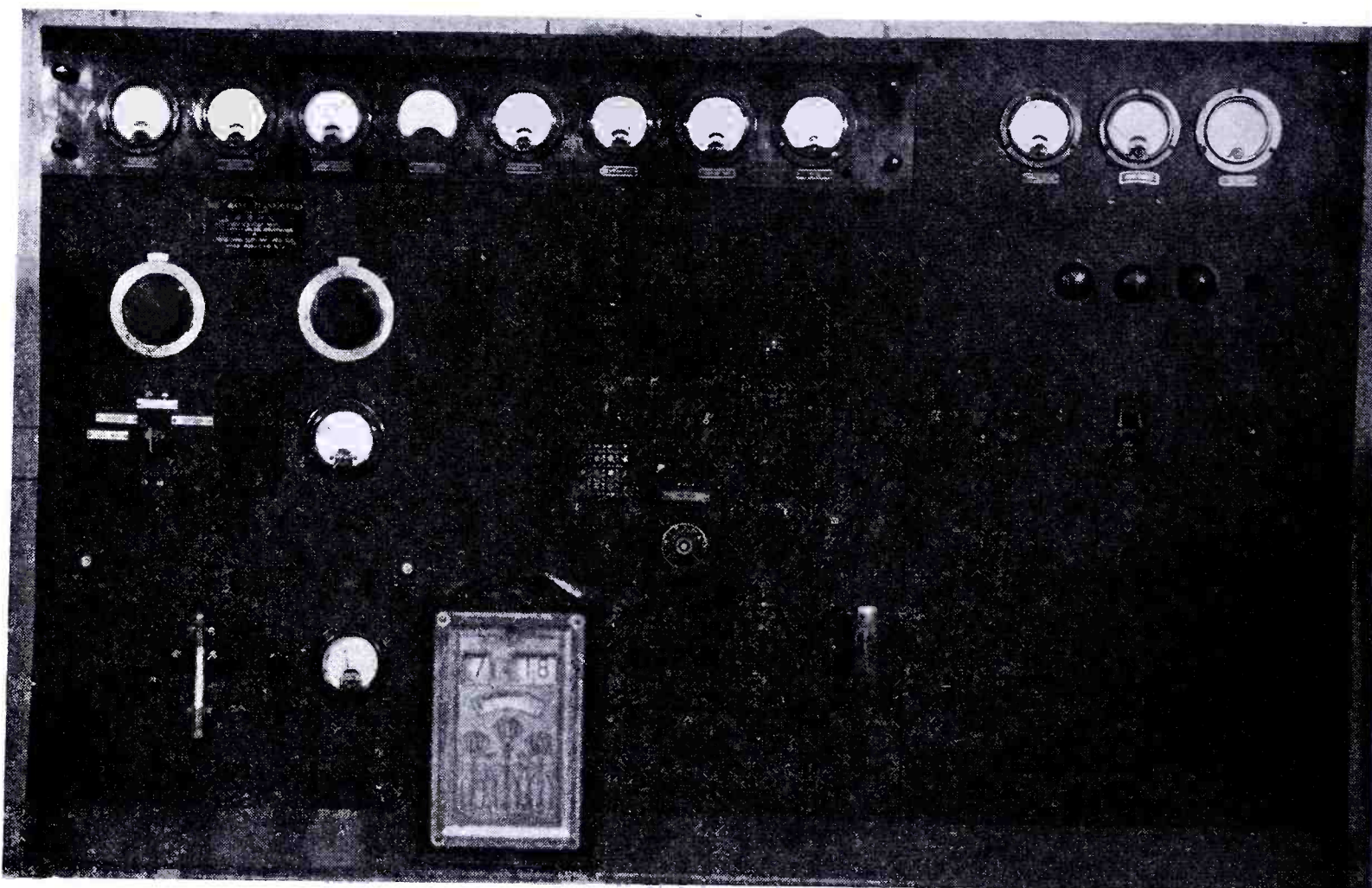


Figure 1

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

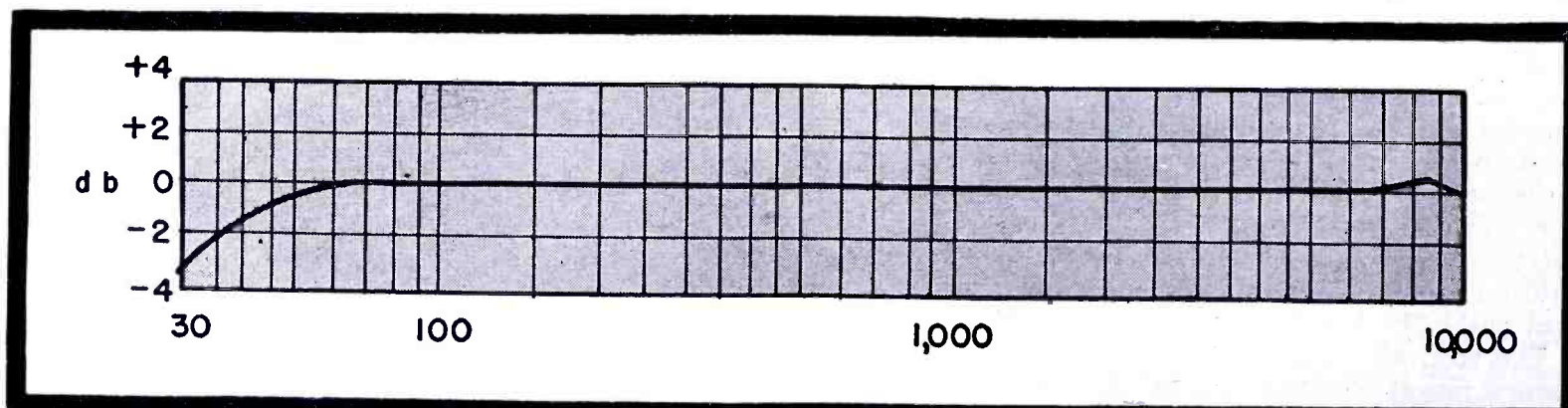
replace the eight 75-watt type 203A's in the final amplifier, and the four 203A's in the modulator we chose the HF-200. The HF-200, rated at 125 watts by the FCC, could use the 203A socket. Thus the required eight tubes could be substituted in the same sockets. And, since the characteristics were not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

Figure 2

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

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-



POWER FROM 500-W TO 1-KW

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

by LAWRENCE A. REILLY

Chief Engineer, WSPR

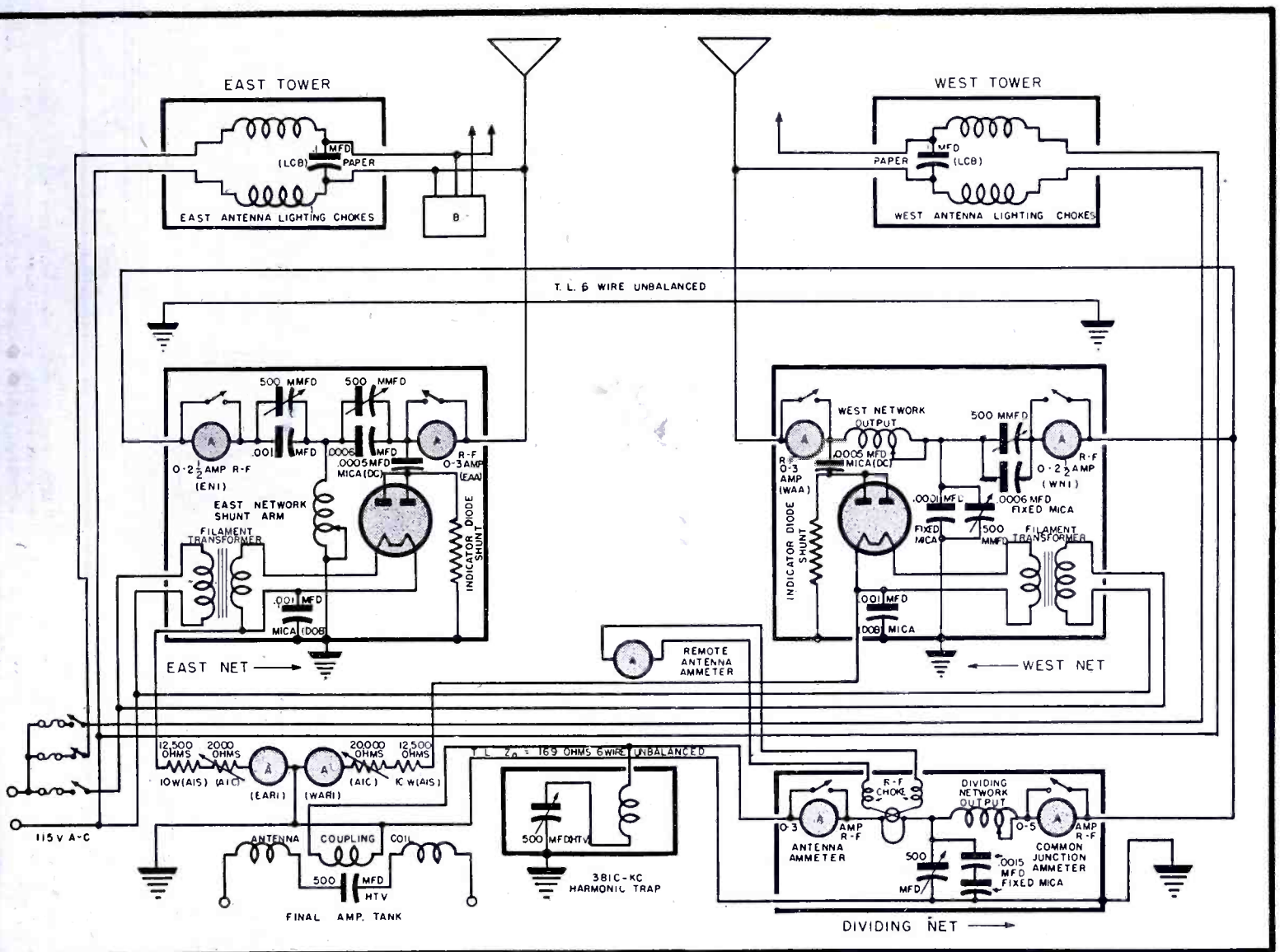


Figure 3

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.

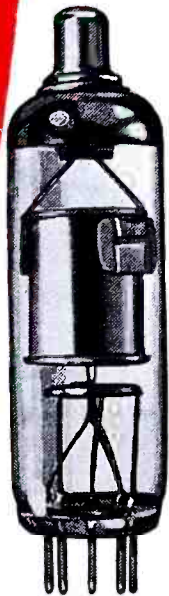
Because the transmitter must remain on the air from 7 a.m. to midnight, all work had to be done during the *off-air* hours. That meant going to work on section by section, taking one section per night and getting it back in order again in time for sign-on in the morning. Roughly, if work began at mid-

night, 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



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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.

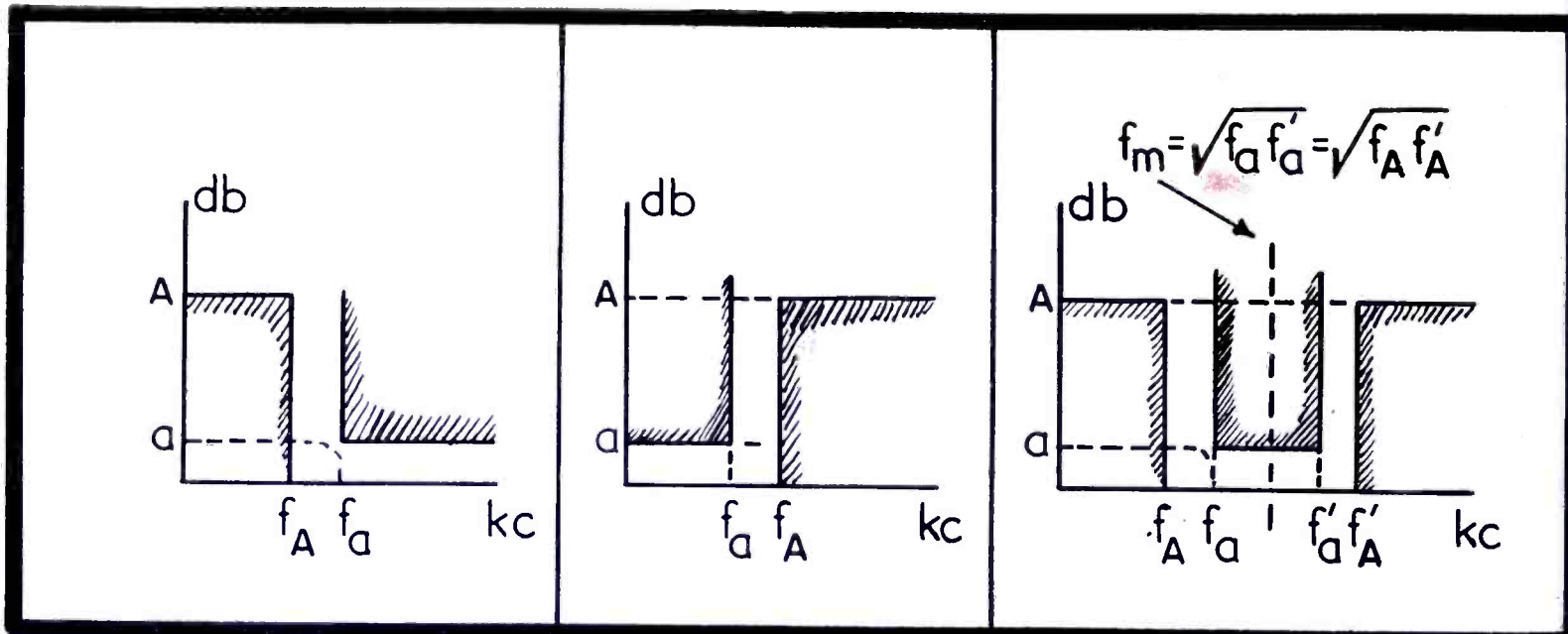
Maximum overall length.....	2.70"
Maximum seated height.....	2.37"
Maximum diameter.....	.75"
Bulb.....	T5½
Base Miniature Button.....	7 pin
Mounting position.....	Any

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EFFECT OF COIL Q

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



IN a previous paper¹ 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

by PAUL SELGIN

Research Engineer

Farnsworth Television and Radio Corp.

cases, but of course this may be poor economy.

Formulas are available in the literature² 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

¹COMMUNICATIONS: July 1945.

²T. E. Shea, *Transmission Networks and Wave Filters*, page 315.

Figure 1 (above)

Attenuation characteristics of high-pass filters (left), low-pass filters (center), and hand-pass filters (right).

ON FILTER PERFORMANCE

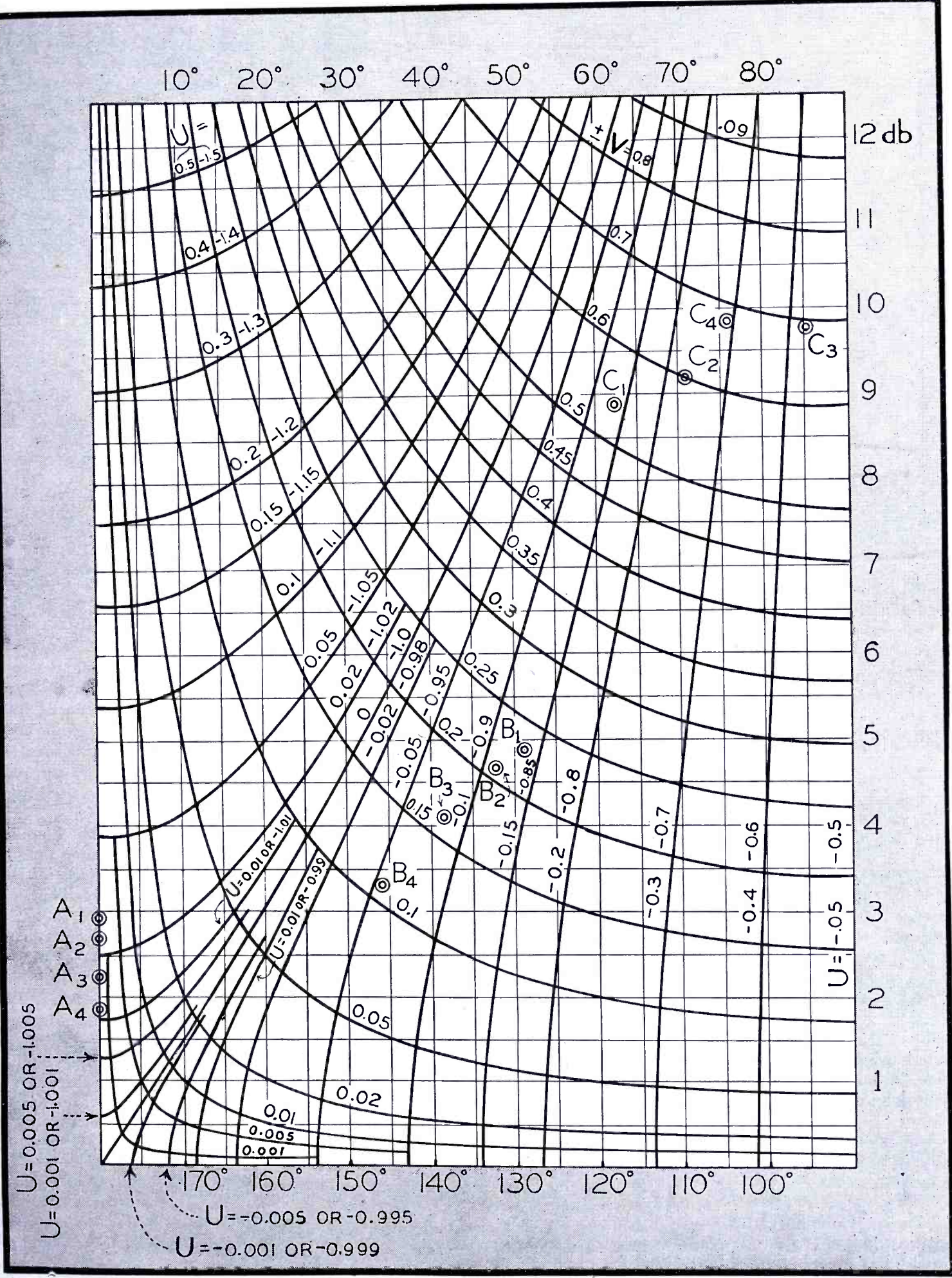


Figure 2

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).

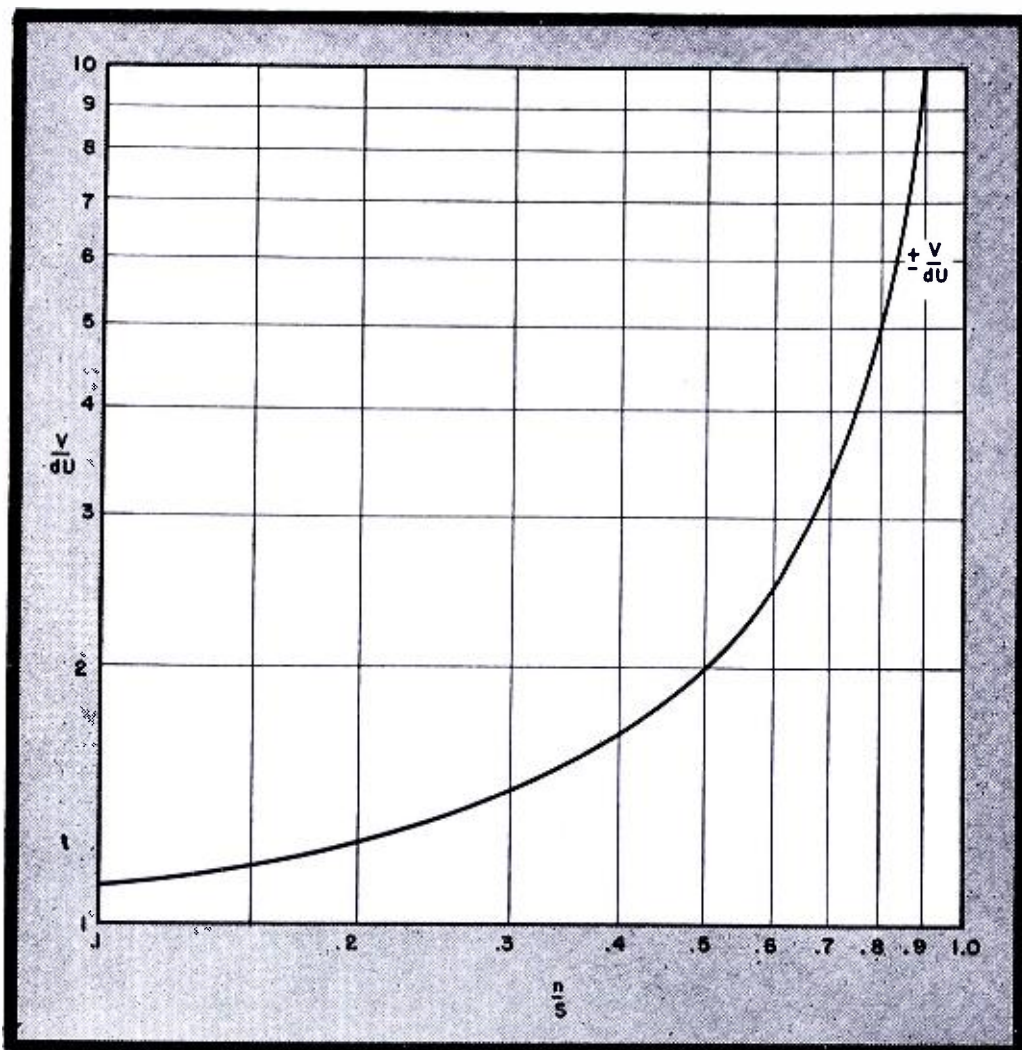


Figure 3
Values of $\frac{V}{dU}$ for dissipative low and high-pass filter sections. (Use + sign for low-pass.)

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)

$$V = \pm dU \frac{2(n + S) + nS}{n - S} \frac{1}{\sqrt{S + 4}} \frac{1}{\sqrt{n(S + 4)}} \quad (3)$$

(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 $\pm V/dU$ 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 $\pm V/dU$ 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 infinity³, 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)

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.

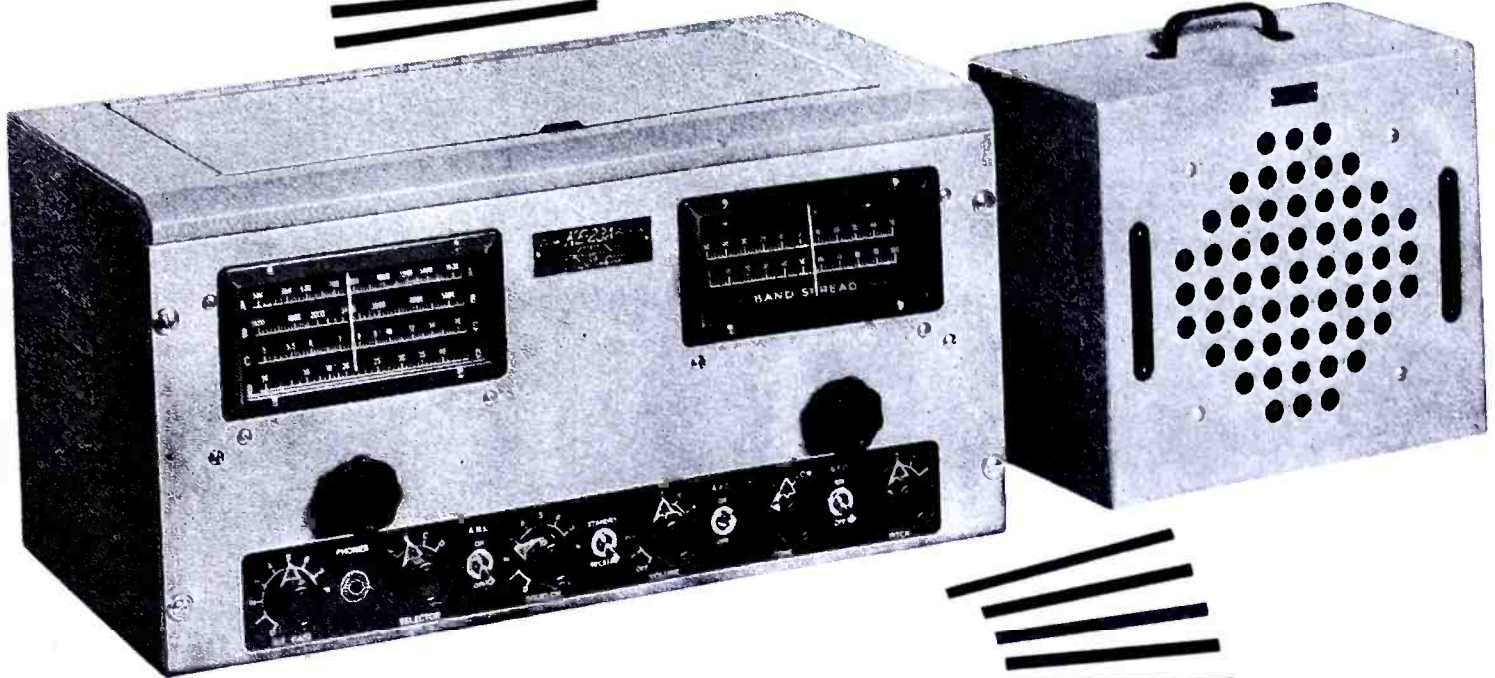
It should be noted here that d , the dissipation factor, is often used in place of Q , of which it is the reciprocal, for two reasons: First, it eliminates confusion due to the fact that Q is often used with a different meaning; and second, it is more convenient analytically.

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

*Derivations are available upon request.

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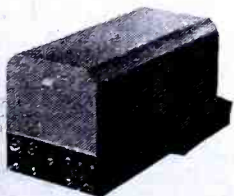
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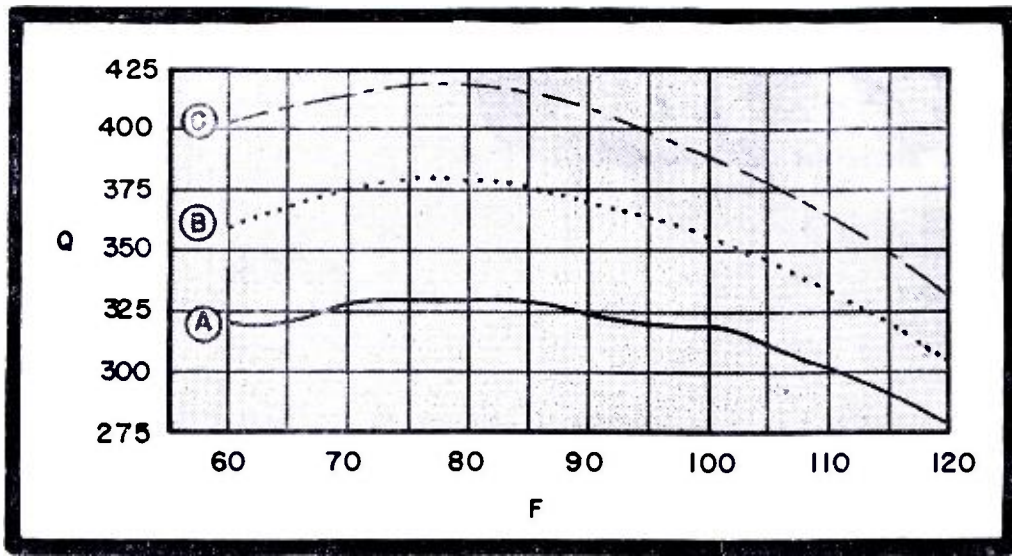


Figure 1
Q response curve for coils wound on a $\frac{3}{4}$ " form, 3 turns, wound 4 turns-per-inch, over the frequency range of 60-120 mc. Curve A is for No. 16 wire, curve B for No. 14, and curve C for No. 10 wire. *Q* improves rapidly with increase in wire size.

COIL DESIGN FOR

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

by **ART H. MEYERSON**

New York Fire Department
 Radio Laboratory

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 manner and shapes of coils were tried. Material which had been gathered previously for standard coil forms* was used as a guide in the determination of what standards to set and what course to pursue.

These previous experiments have shown that for standard coil form wound on lucite and polystyrene forms, highest *Q* was obtained with large diameter wires spaced slightly better than the wire diameter and coil lengths of about .8". Also, *Q* increased with coil diameter. For example, for size 10 wire, .102" diameter, greatest *Q* was realized at a winding pitch of 4 to 5 turns-per-inch, with 4 to 5 turns used.

However, in the design of coils for use at higher frequencies, the value of inductance must be kept quite small so that a large value of tuning capacitance may be used to minimize the effect of tube loading capacitance. Again, for large value inductance, slight changes in inductance value accompanying temperature variations would cause large frequency deviations. One solution to variation in inductance value with temperature, has been the use of tuning condensers with negative-temperature coefficients. However, this method has been found un-

*COMMUNICATIONS; April and May, 1944.

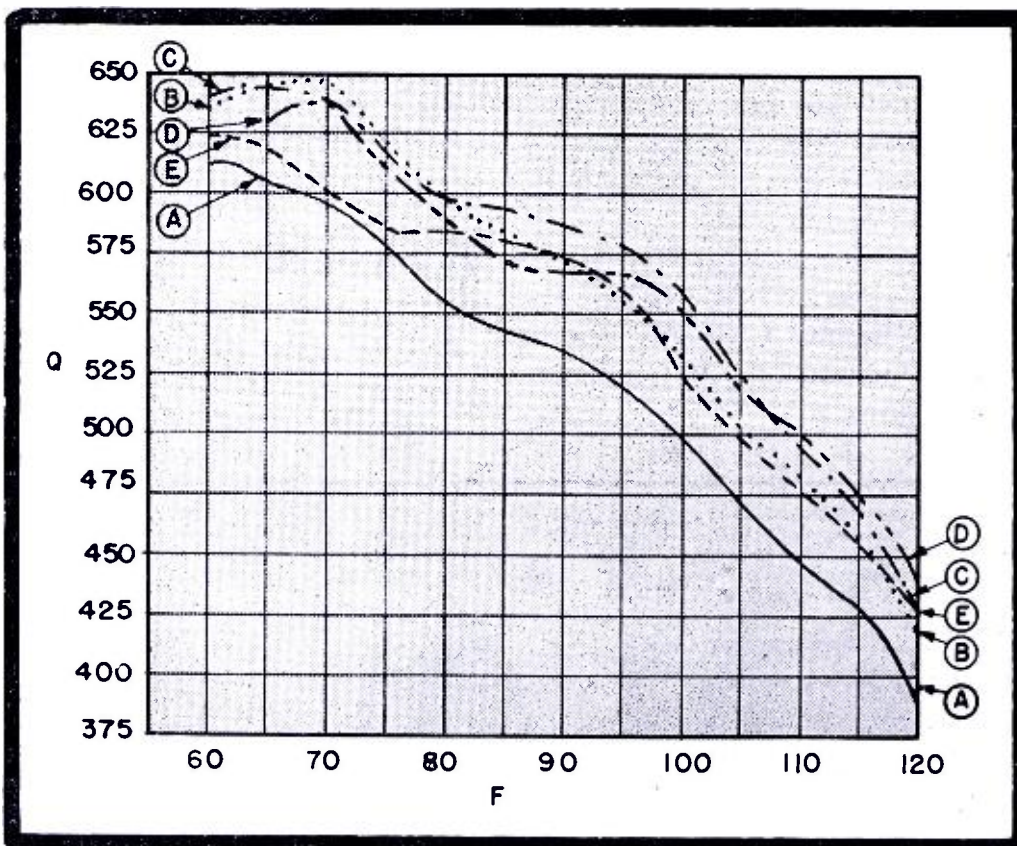
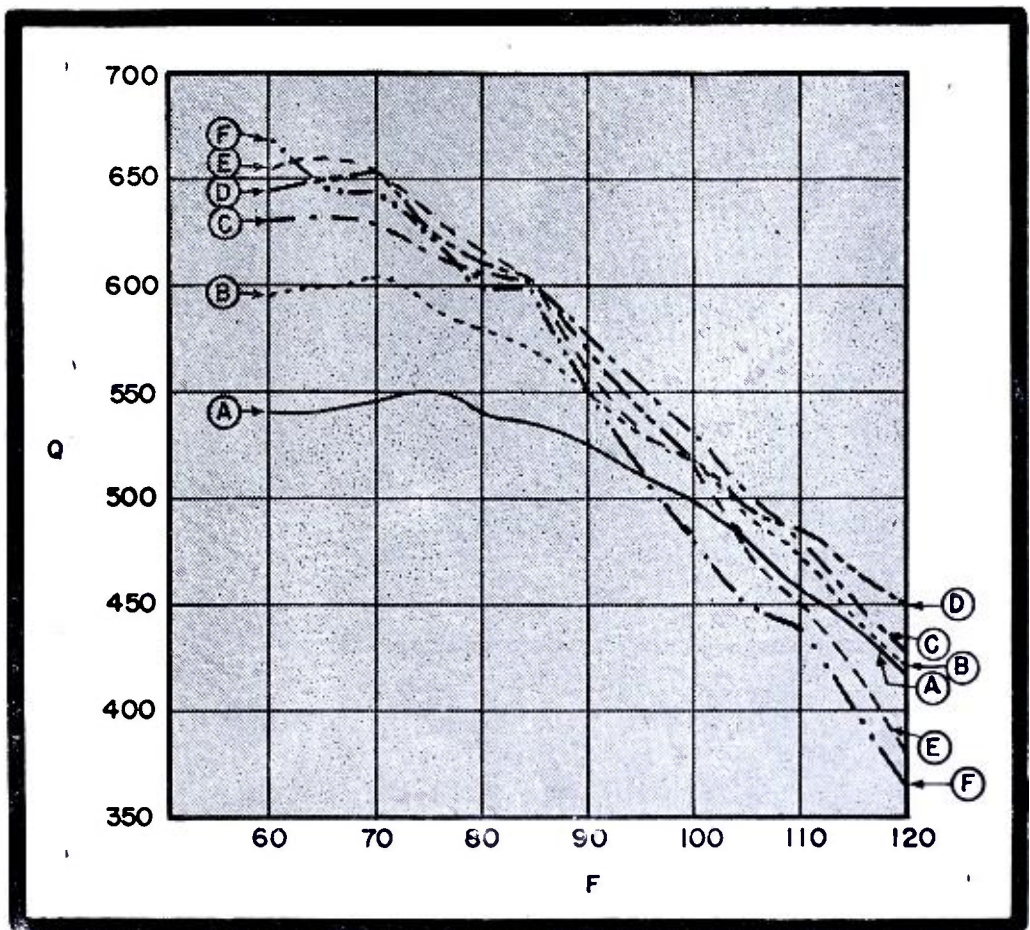


Figure 2a
Q response curves for 3" strap-type coils, constructed of No. 16 gage copper sheet, over frequency range of 60-120 mc. Curves A to E represent, respectively, $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " strap widths. Optimum over-all results obtained with $\frac{3}{8}$ " to $\frac{1}{2}$ " widths.

Figure 2b

Comparison of Q of strap-type coils constructed with varying widths and diameters, of identical inductance. Curves A to E represent, respectively, widths of $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " and 1".



V - H - F

satisfactory. The temperature source may not affect the coil and condenser at the same time. In one oscillator circuit tested, using the previous setup, the frequency would first decrease, and then start to rise after a few minutes of operation were used. The improvement in temperature coils as well as condensers offer the better solution.

Initially experiments were conducted to determine what coil shapes produced the highest Q . Standard coil forms were tried, using the data gathered at lower frequencies. Since the value of inductance was limited by tube input capacitance, the maximum inductance permissible was arbitrarily set at less than $.2 \mu\text{h}$. This would permit tuning to 120 mc with a 10-mmfd capacitor. Previous experiments had indicated that Q increased most rapidly with wire size. The next most important influence was coil diameter, and lastly the number of turns and turns-per-inch. Setting 2 to 3 turns as a minimum for optimum turn design, the largest permissible diameter for the coil form for an inductance of $.2 \mu\text{h}$ 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.

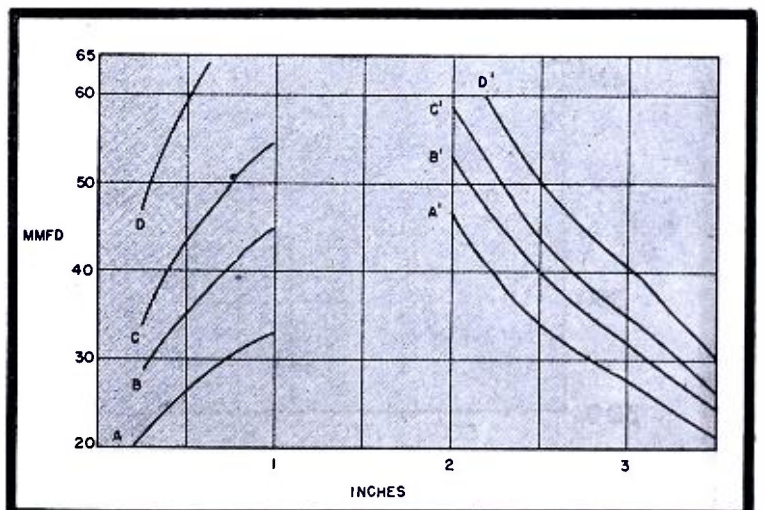
Since wire size exerted a greater influence on Q than number of turns, the next step was to determine the relative influence of form diameter as against number of turns. For this experiment, flat metal bands of 16-gauge copper were used. The improvement in Q is shown graphically in Figure 2a,b. Figure 2a shows the Q curve of strap type coils of 3" diameter, varying in width from $\frac{1}{4}$ " to $\frac{3}{4}$ " 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 $.12 \mu\text{h}$. Optimum results above 100 mc were obtained at strap widths of $\frac{3}{8}$ " to $\frac{1}{2}$ " diameter. Increasing the strap width lowered the highest frequency at which greatest Q was realized.

Several other experiments were con-

ducted 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, $\frac{1}{2}$ " wide, and of $3\frac{1}{8}$ " diameter was used, into which $\frac{1}{4}$ " 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

This graph indicates the increase or decrease in inductance with an increase in dimensions of strap-type coils at 80 mc. Curves A, B, C and D show the respective decrease in inductance caused by an increase in strap width for 2", 3", $2\frac{1}{2}$ " 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 respective increases in inductance for $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{3}{4}$ " wide straps, with increase in diameter. Note that all four curves are almost identical.



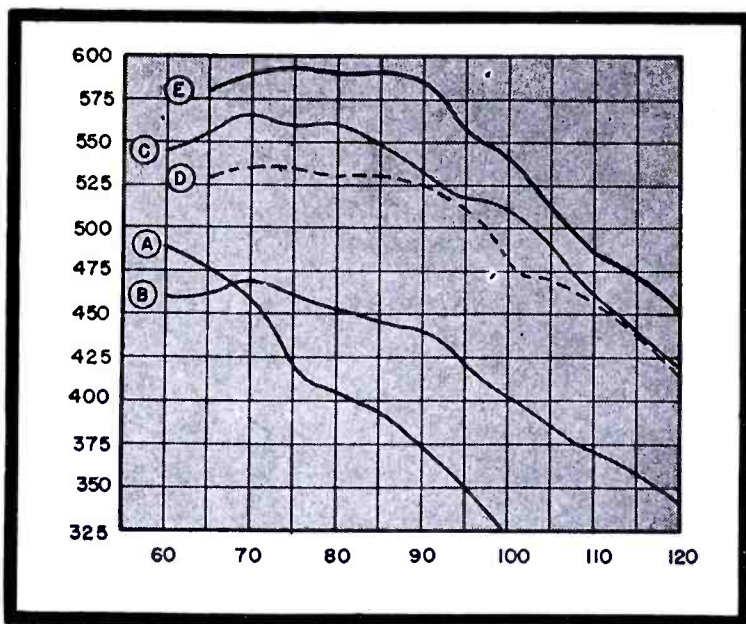
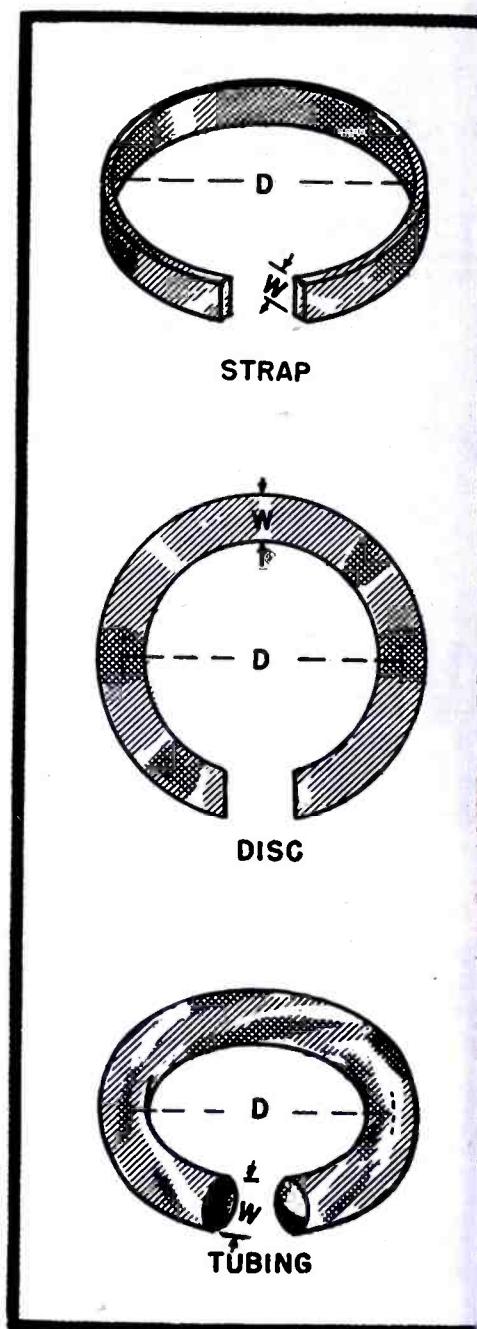
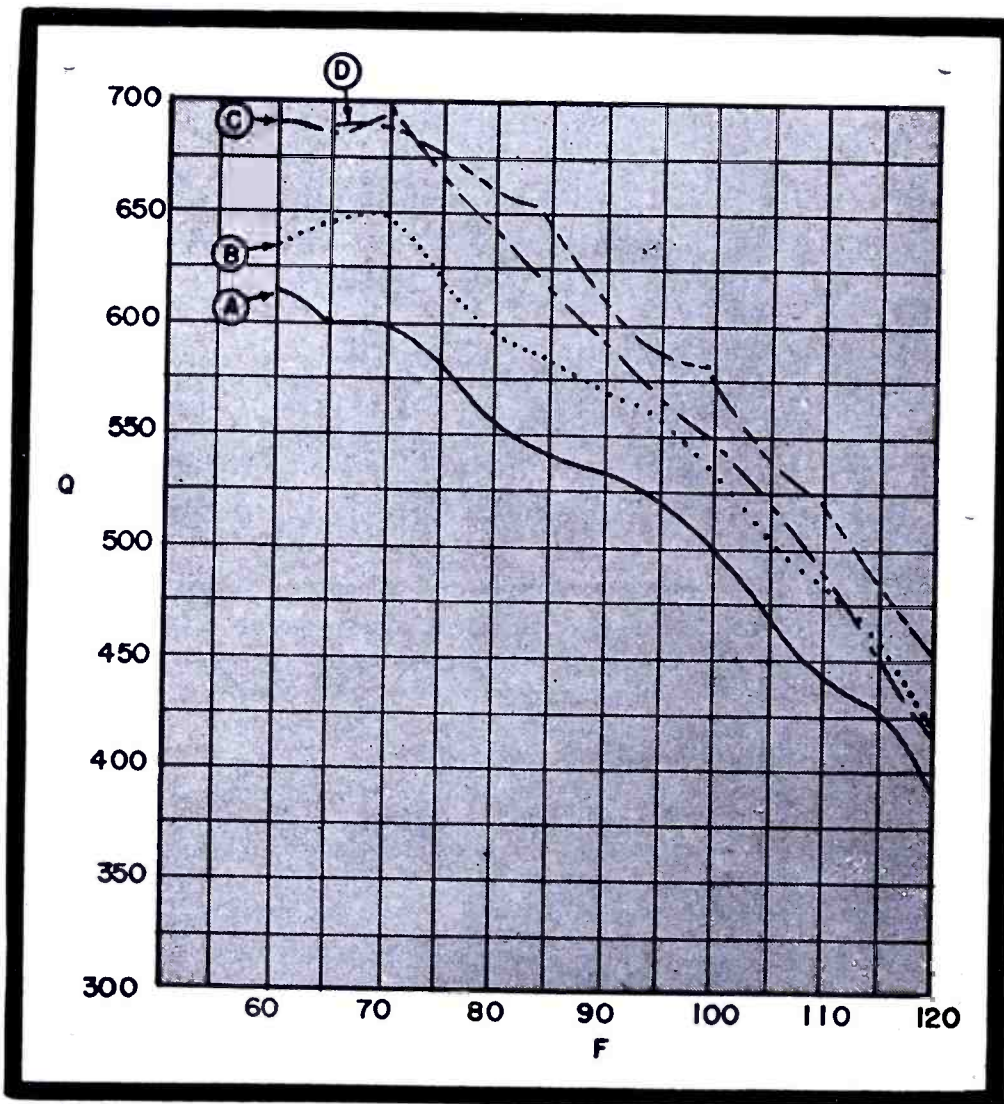


Figure 4
Comparative Q readings for five different types of coil construction. Curve A is for 3 turns of No. 10 wire on a 1" form, wound 4 turns per inch; curve B , $2\frac{1}{2}$ " loop of No. 10 wire; curve C , $2\frac{1}{2}$ " diameter strap coil; curve D , $2\frac{1}{2}$ " diameter disc-type coil; curve E , $2\frac{1}{2}$ " 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 $\frac{1}{4}$ " and $\frac{3}{8}$ " wide strap-type coils, respectively, of 3" diameter. Curves C and D are for 3" tubing-type coils of 3" diameter, and, respectively, $\frac{1}{4}$ " and $\frac{3}{8}$ " 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 with an increase in the number of holes, varying from $.119 \mu h$ for no holes, $.121 \mu h$ for 11 holes.

The next step was to determine the frequency stability of the coil shape. For this purpose, the graph shown in Figure 3 was drawn. The abscissa was plotted in inches, and the ordinate in mmfd. Curves A , B , C , and D demonstrate the increase in capacitance necessary to compensate for an increase in strap width, for various coil diameters. Curves A' to E' show the decrease in capacitance necessary to compensate for an increase in coil diameter for various width coils. No attempt was made to keep these curves absolutely accurate. However, for purposes of observation, they are sufficiently correct. Since both sets of curves are drawn to the same base, any variation in either width, or diameter may be compared.

Small-Width Coils

It will be noted that curves A' to E' (Continued on page 82)

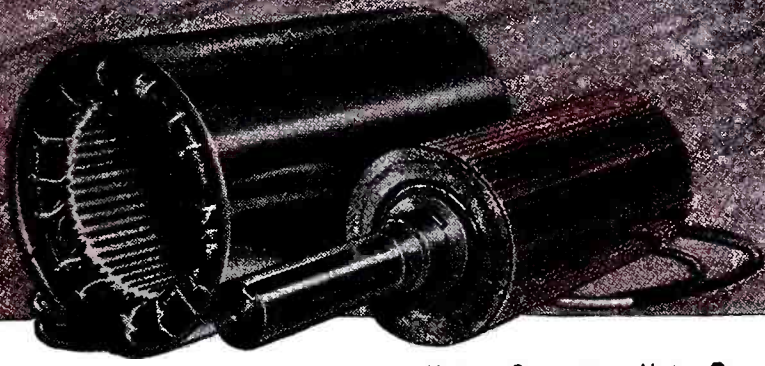
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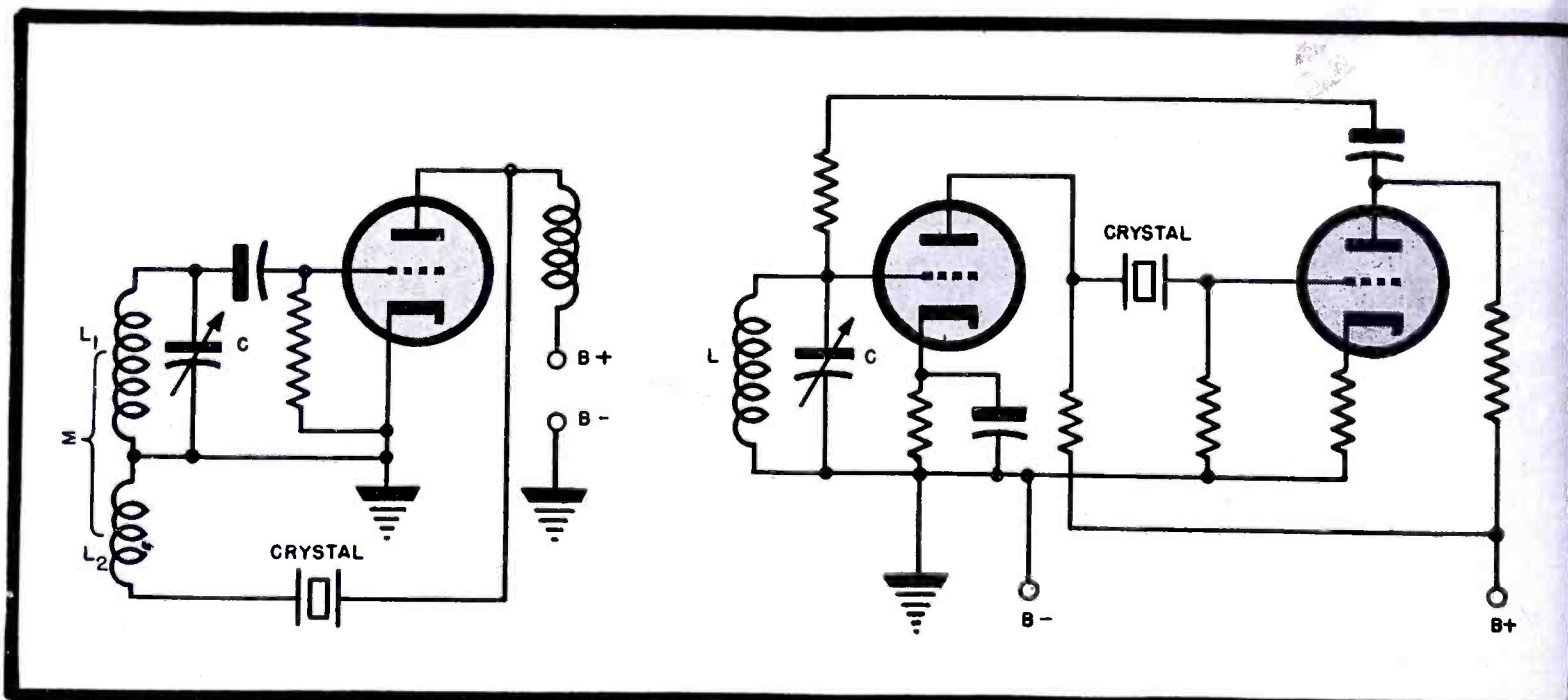


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CRYSTAL OSCILLATORS IN F - M AND TELEVISION

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 anti-resonant, 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

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]

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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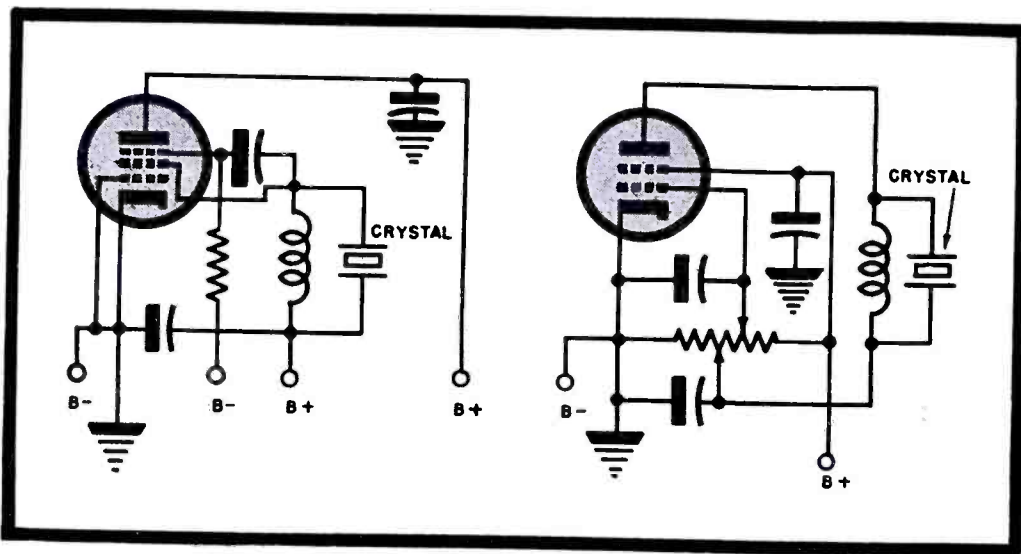
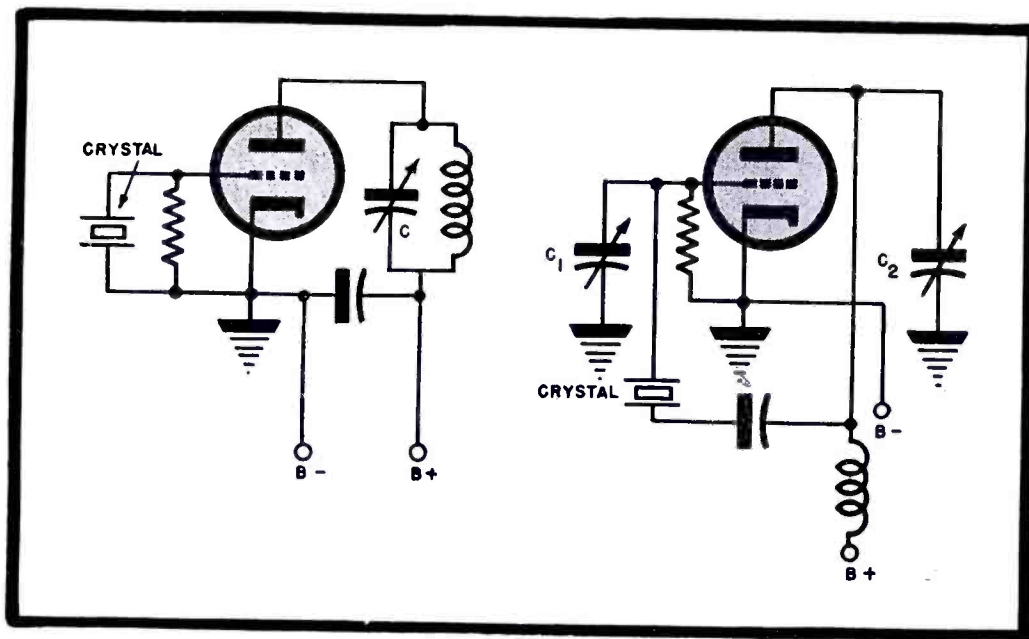


Figure 2 (above)
 Crystals may be resonated in negative-transconductance type circuits: Left, transistron oscillator, crystal-controlled; right, dynatron oscillator, crystal-controlled.



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 Colpitts or ultraaudio 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 ultraaudio oscillator.

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

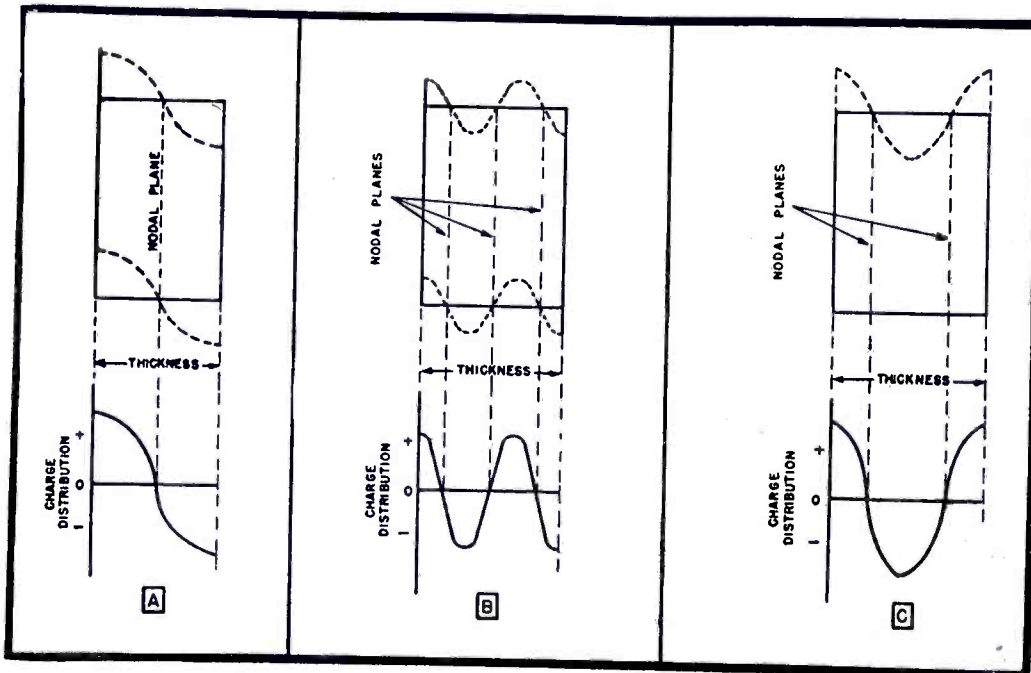
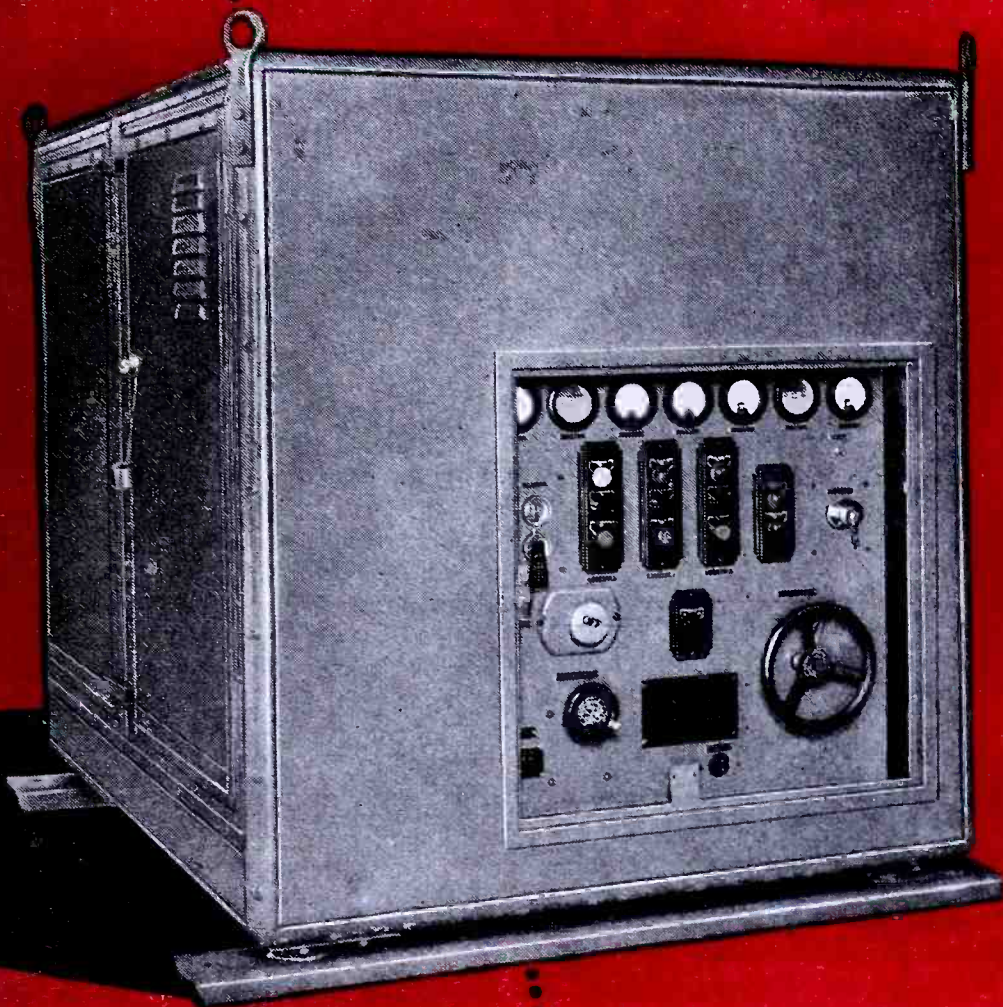


Figure 3a
 Diagrams illustrating the motion of planes parallel to the major faces of a thickness-shear oscillator plate in fundamental (A), second (B) and third (C) harmonic modes. Note, in the second (and all even) harmonic modes no voltage is developed across the two faces because the charge developed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



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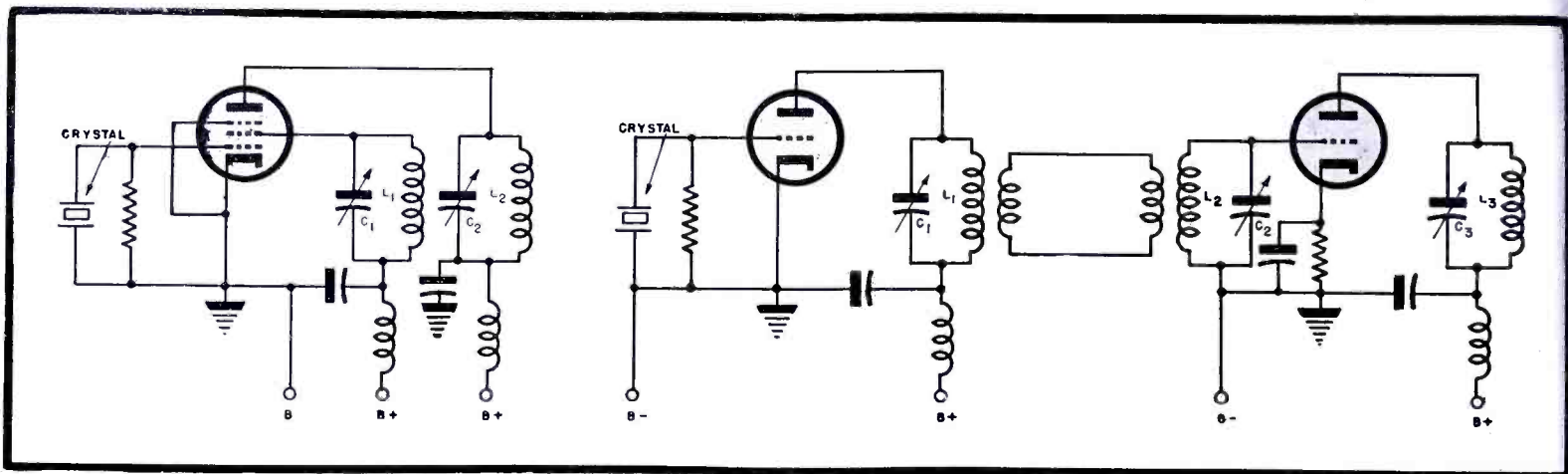


Figure 5

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 i-m receivers. However many of these commercial i-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 i-m bands, using a 10-mc i-f system. Crystal control by use of harmonic crystals for push-button tuning is easily applied.

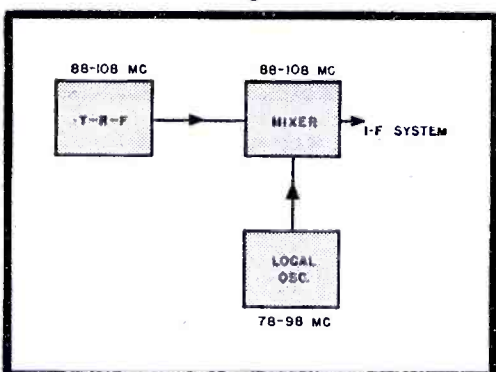
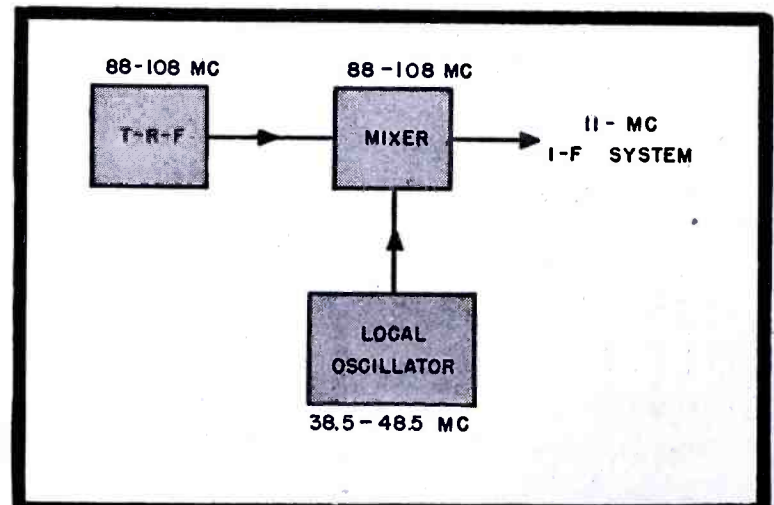
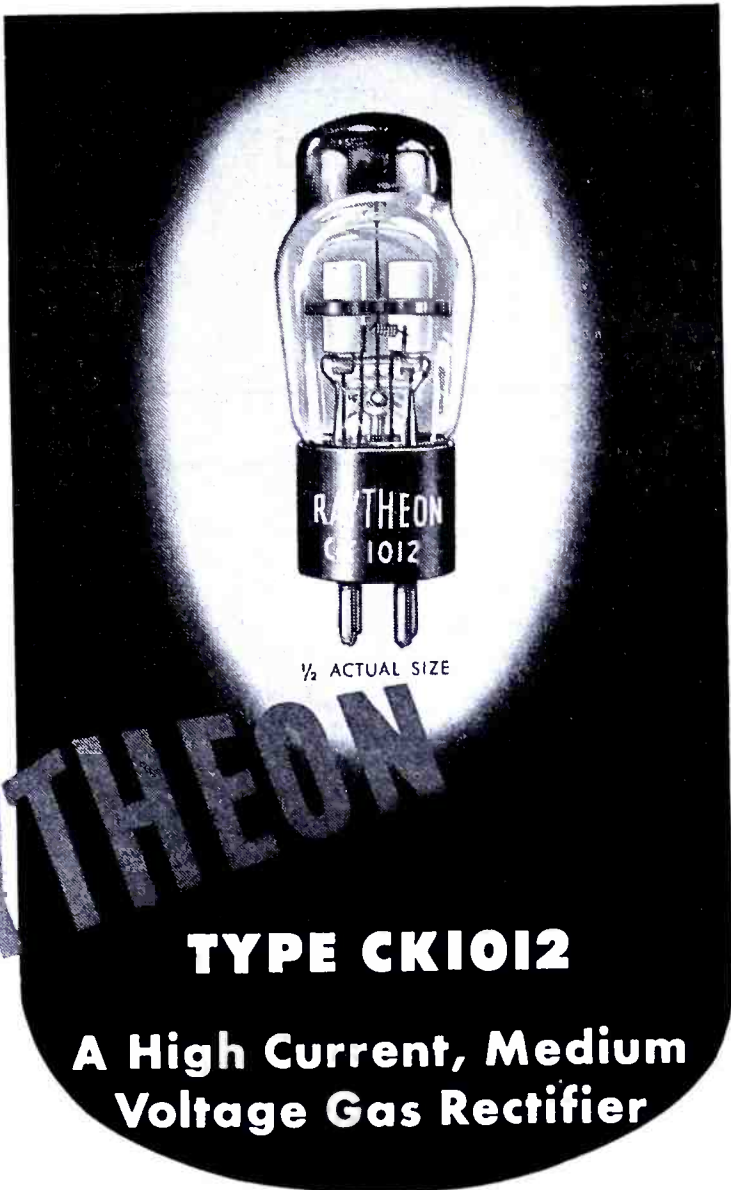


Figure 6a

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.





RAYTHEON

TYPE CK1012

A High Current, Medium Voltage Gas Rectifier

The Raytheon type CK1012 full wave gas rectifier was developed to supply the requirements at high rectification efficiency for those applications which require more power than is obtainable with conventional receiving tubes and yet cannot justify the size and expense of transmitting type tubes. In this category are the larger fm and television receivers and small fixed or mobile transmitters.

The CK1012 is contained in an ST-14 bulb, which is the size of a type 80. The emitter can be directly heated — or, under the proper conditions noted below, ionically heated for greater efficiency and elimination of heater windings.

The very rugged construction is ideal for mobile equipment, and the use of an inert gas allows it to operate over a wide range of ambient temperature. No preheating time is required, and consequently full output is obtainable almost instantly. Any tendency to generate noise in radio frequency applications can be minimized by proper filtering and shielding of the tube and associated wiring.

Whether or not CK1012 fits your requirements, it is an example of the advanced engineering and painstaking manufacture found in the entire Raytheon tube line. For best results, specify Raytheon High-Fidelity Tubes for your postwar products.

TYPE CK1012 RATINGS — FULL WAVE RECTIFIER SERVICE

	IONICALLY HEATED*	DIRECTLY HEATED	
Filament Voltage	0	1.75	volts
Filament Current	0	2.00	amp
Maximum Peak Inverse Voltage	1200	1200	volts
Average D.C. Voltage Drop	25	20	volts
Maximum D.C. Output Current*	300	300	ma
Minimum D.C. Output Current	70	0	ma
Minimum Starting Peak Voltage	400	300	volts
Maximum Steady State Peak Anode current per anode	900	900	ma

*This condition is not recommended for rapid intermittent operation



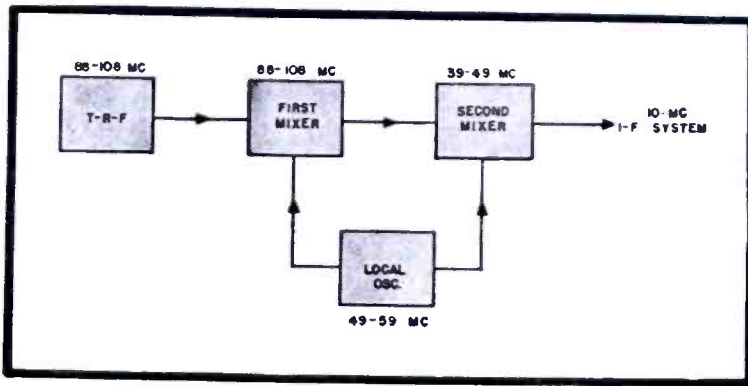
All Four Divisions Have Been Awarded Army-Navy "E" with Stars



Radio Receiving Tube Division

NEWTON, MASSACHUSETTS • LOS ANGELES
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DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS



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.

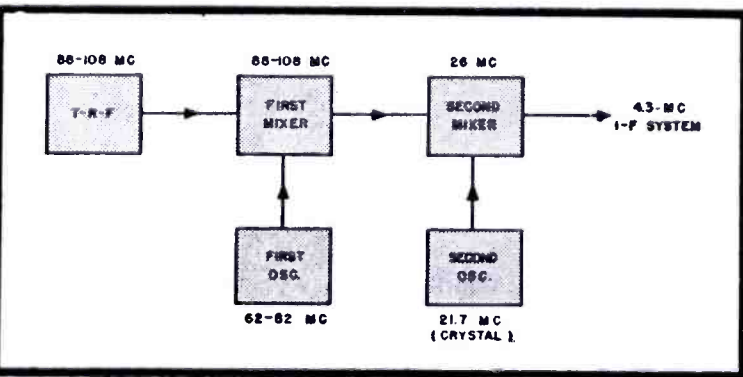
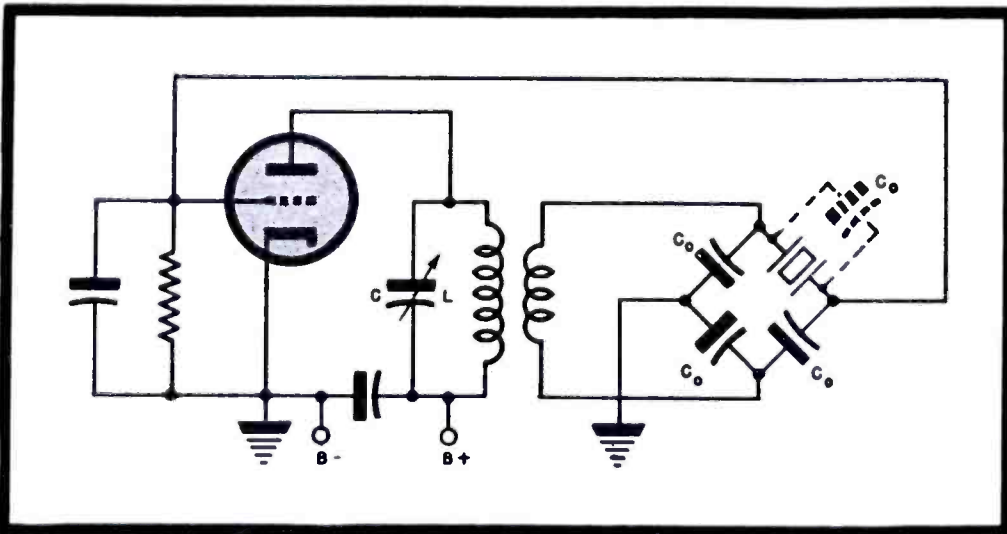


Figure 9

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.

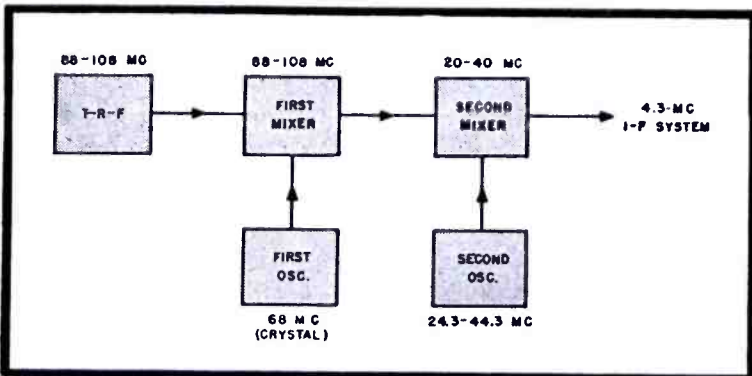


Figure 10

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

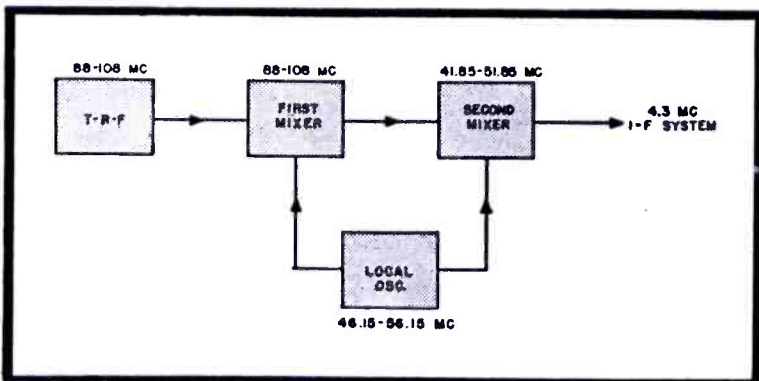


Figure 11

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 6B illustrates this case (Figure 6A 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 3A.)

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)

England Calling!



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The American aircraft industry knows what Englishmen meant when they said *so many owe so much to so few*. For it was our aircraft industry that squeezed out every available plane to add to their own so that England could fight... and win the Battle of Britain in 1940.

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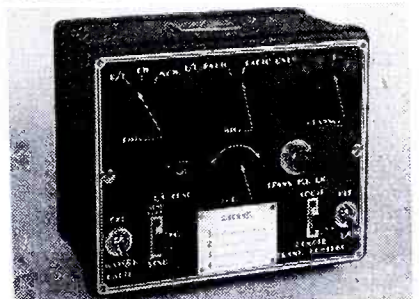
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Soon Pacific Division will announce a new line of peacetime VHF Communication Systems for industry which we have been perfecting over the past three years. Our experience and research, which have resulted in these developments, are at your disposal to make the greatest possible use of them for your own application. Information and engineering assistance are available to you NOW without obligation.

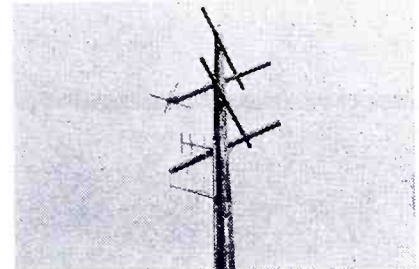
1945, Bendix Aviation Corp.

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COMMUNICATION SYSTEMS



This control unit was one of many pieces of equipment built for inter-communication in British airplanes.



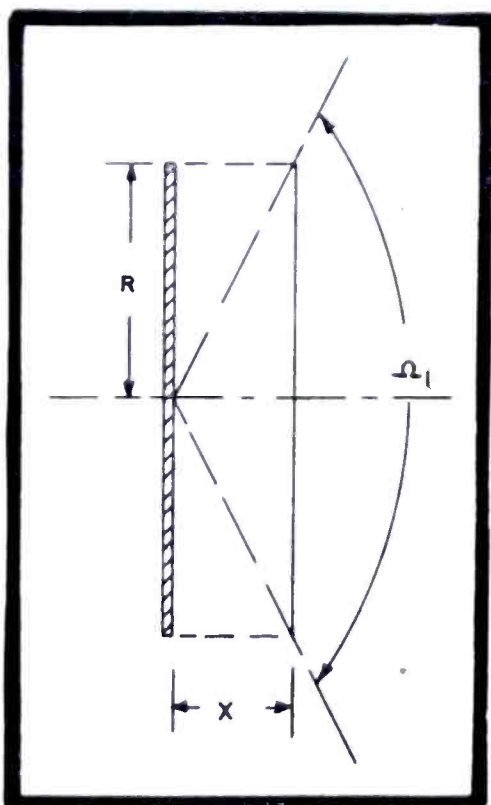
To determine most efficient antenna for VHF communication Pacific Division is testing numerous types.



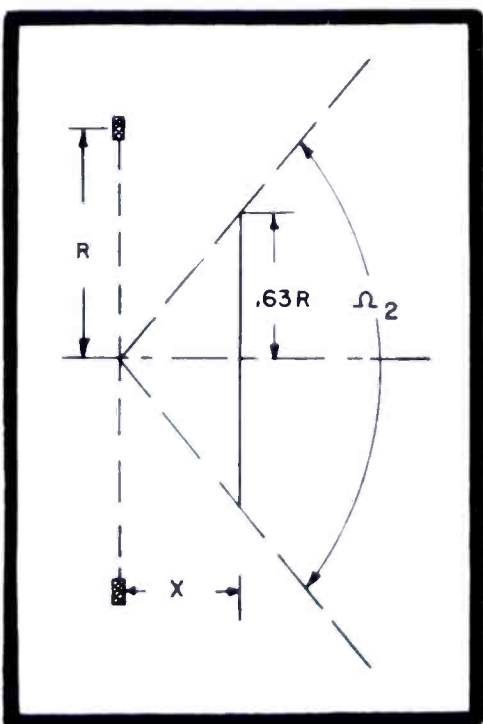
Interior of Pacific Division's mobile laboratory used in VHF communication development program.

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, 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

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

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 Massa³ 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

$$A_R = \frac{A_P}{\text{antilog}_{10}(4/10)} \\ = A_P/2.5$$

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

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

³Massa, *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.

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

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

BY INCREASED DIRECTIVITY IN ELECTRIC MEGAPHONES*

by **ARTHUR J. SANIAL**

Chief Engineer
Atlas Sound Corporation

annular 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 $A'O^1$ 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 par-

allel. We can then take Ω_3 as the angle of divergence, i.e., the solid angle subtended by the surface $A'O^1A^1$ 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 $A'O^1A^1$ 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 $\lambda 2R^1$.

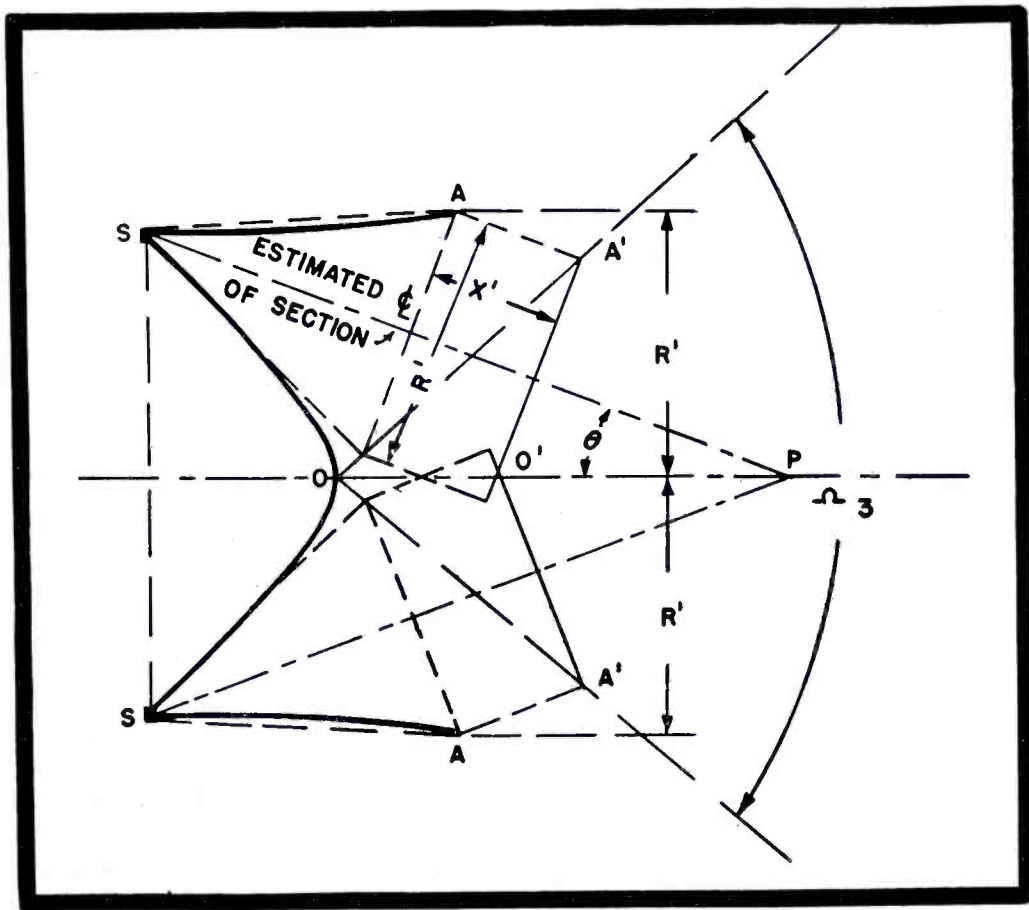
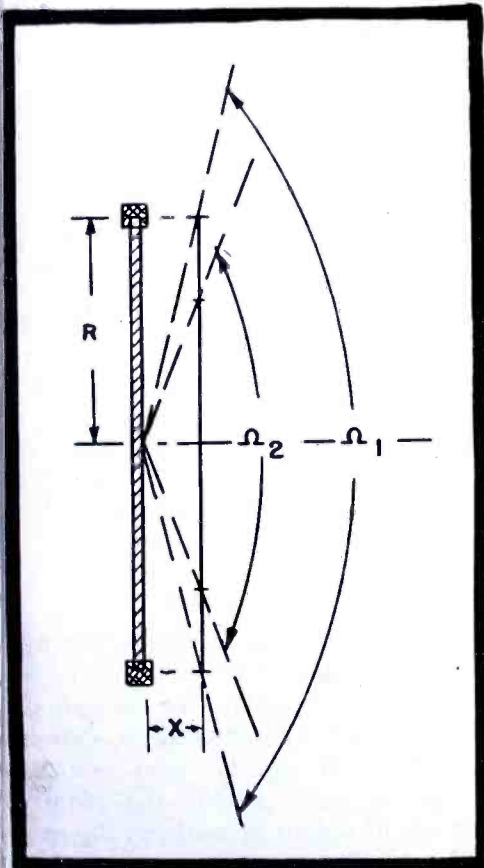
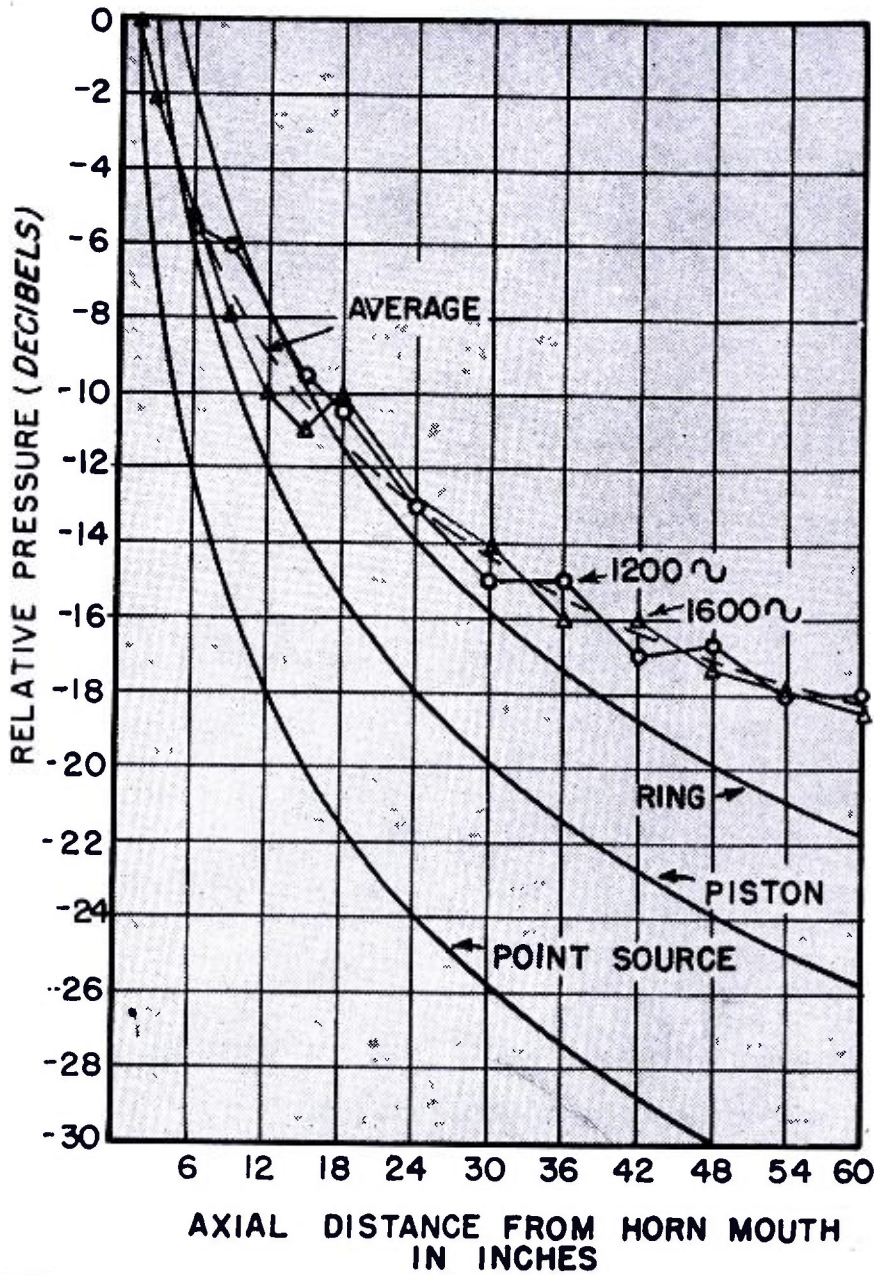


Figure 5

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 $D = \lambda$ approximately for the latter three.



on a horn built with a mouth of this shape (at $\lambda = Dm$ 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 $1\frac{1}{2}$ " (equal to the strength of the megaphone output at this point). Similarly, *B* is the inverse square law curve for a source 6 db stronger representing the increase to be expected from a piston, $D = \lambda$ 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.⁹ 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

⁹Massa, Loc. Cit.

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

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

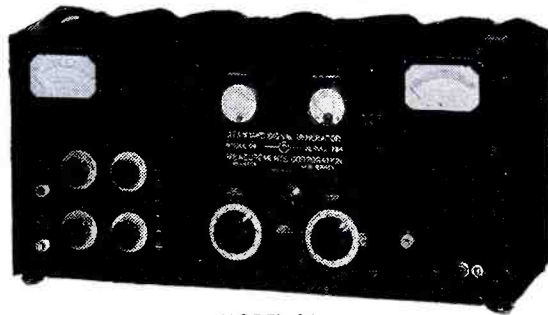
This was the figure cited previously for the original megaphone system output.

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

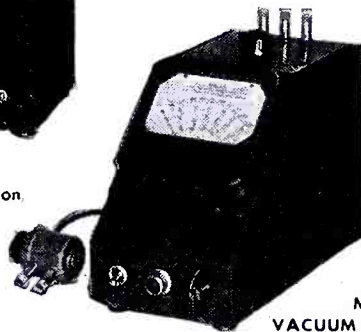
$$49\frac{1}{2} \times 2.24 = 111 \text{ bars}$$

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.

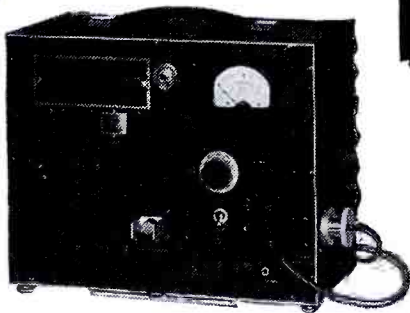
Laboratory Standards



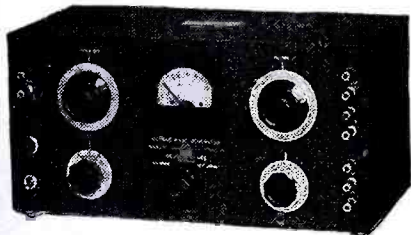
MODEL 84
U.H.F. STANDARD SIGNAL GENERATOR
 300 to 1000 megacycles, AM and Pulse Modulation



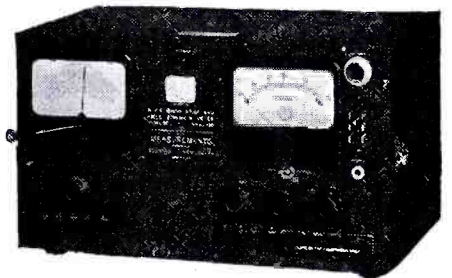
MODEL 62
VACUUM TUBE VOLTMETER
 0 to 100 volts AC, DC and RF



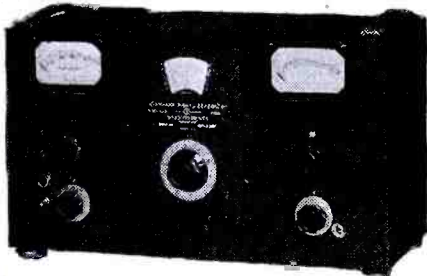
MODEL 78-B STANDARD SIGNAL GENERATOR
 Two Frequency Bands between 15 and 250 megacycles



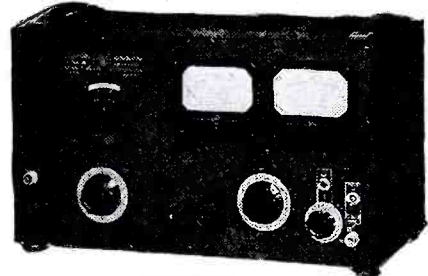
MODEL 71 SQUARE WAVE GENERATOR
 5 to 100,000 cycles
 Rise Rate 400 volts per microsecond



MODEL 58 U.H.F. RADIO NOISE
AND FIELD STRENGTH METER
 15 to 150 megacycles



MODEL 65-B
STANDARD SIGNAL GENERATOR
 75 to 30,000 kilocycles
 M.O.P.A., 100% Modulation



MODEL 80
STANDARD SIGNAL GENERATOR
 2 to 400 megacycles
 AM and Pulse Modulation



MODEL 79-B PULSE GENERATOR
 50 to 100,000 cycles
 0.5 to 40 microsecond pulse width

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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,

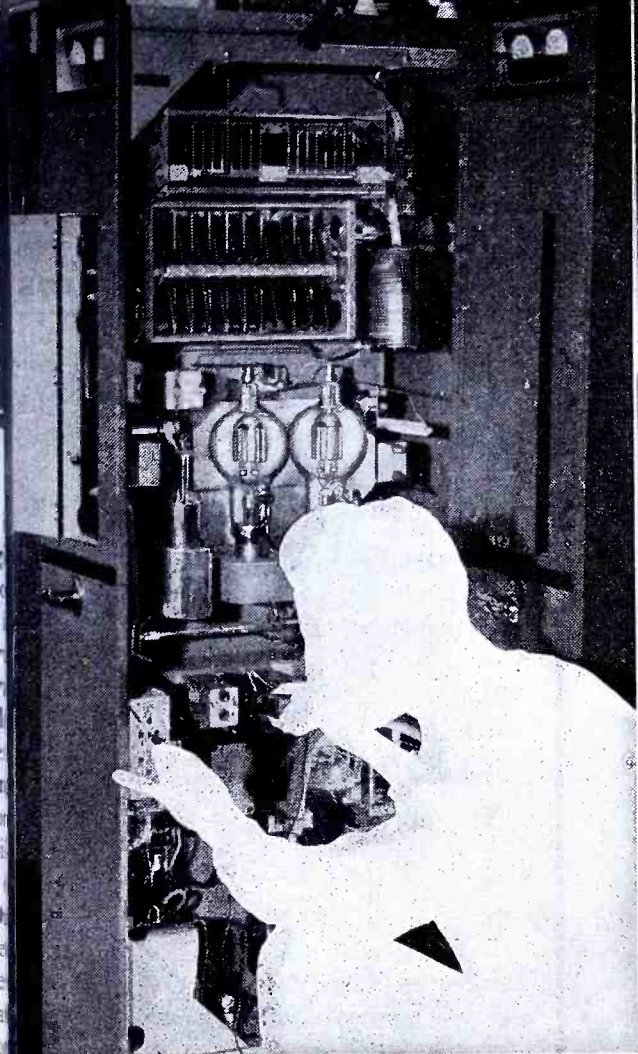


G. E. Sterling, assistant chief engineer of the FCC, who has become a VWOA member.

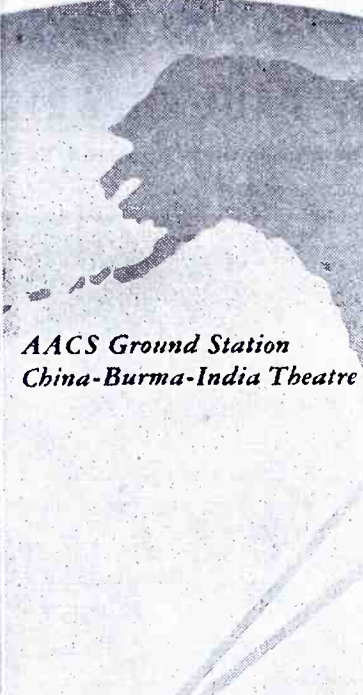
president of the Aeronautical Radio Company in Washington, has become a VWOA member. Welcome. . . . Harry Cornell, radio supervisor for the Standard Oil Company, is another veteran who recently joined our ranks. Besides being a veteran operator Mr. Cornell also holds a master's license. . . . E. A. Nicholas, 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, is expanding his consulting radio-engineering organization. . . . Clarence Seid, a former wireless operator, is a practicing attorney in Brooklyn, N. Y. . . . E. K. Price is at the Naval Air Station at Floyd Bennett Field, Brooklyn, N. Y. . . . D. Carruthers and J. T. Maloney have been lending a hand at the Radio Supervisor office of the War Shipping Administration during the recent illness of VWOA director C. D. Guthrie. Our best wishes to CD for his complete recovery soon. . . . VWOA member V. Ladeveze and R. S. Henery are members of the RCA Communications staff at Rocky Point L. I. . . . Carl Coleman, radio supervisor of Arnesen Electric Company, has become a VWOA member. . . . C. S. Anderson, who did so much to insure the editorial excellence of many *Year Books* is now living in retirement in New Jersey. Good health, CSA. . . . Benjamin Titow is now manager of the RCAC office in the Chrysler 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 Norfolk, Va. . . . Veteran member V. A. Kamin is now Lt. Col. Kamin. . . . Lt. Fred T. Bowen has been a Cincpac Advance Headquarters for some time. . . . George Street, chairman of the Honolulu chapter of VWOA, is manager of RCA Communications in Hawaii. . . . Life Member Capt. C. H. Maddox, USN, a submarine expert, has been working out of Pearl Harbor for over a year. . . . Lt. Col. R. L. Duncan, who as RIA director signed "Bill" McGonigle's 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 the early 1900's, when George Clark was the certifier of skill, is now assistant to the vice president of Majestic Radio and Television Corporation. . .

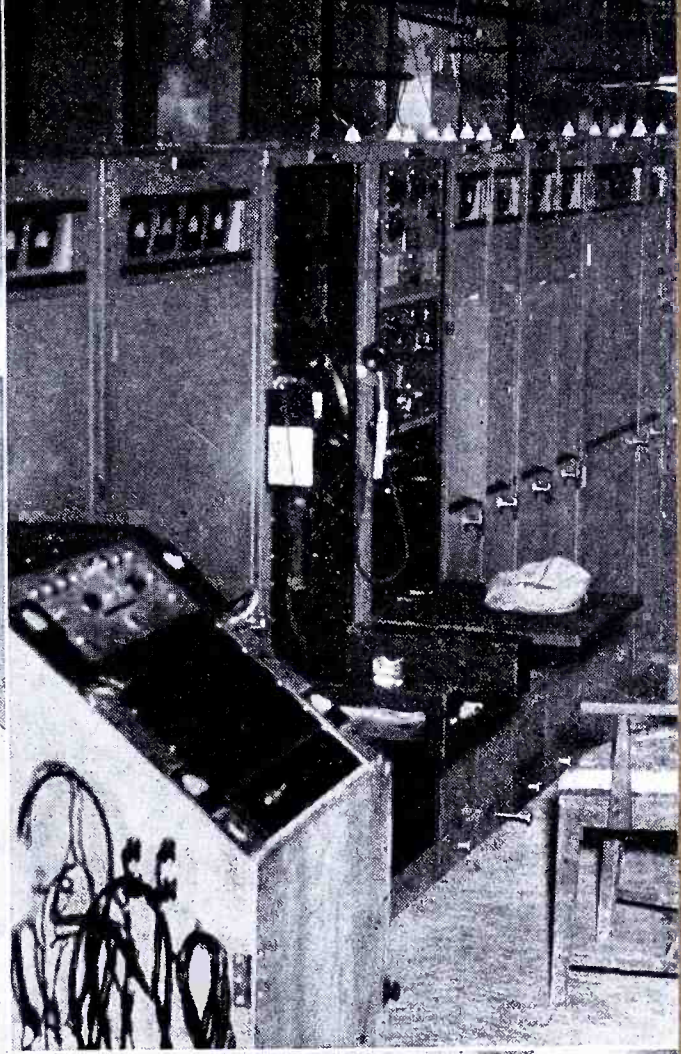
(Continued on page 81)



*AACS Domestic Station
showing a pair of
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*AACS Ground Station
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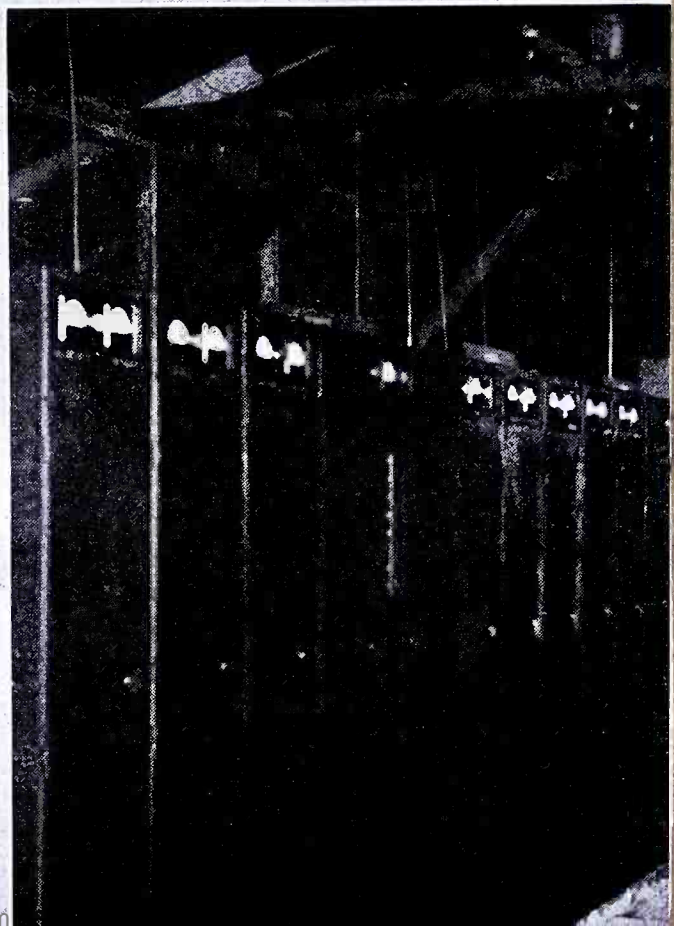


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RESISTIVE ATTENUATORS,

An Analysis of Their Applications in Mixer and Fader Systems

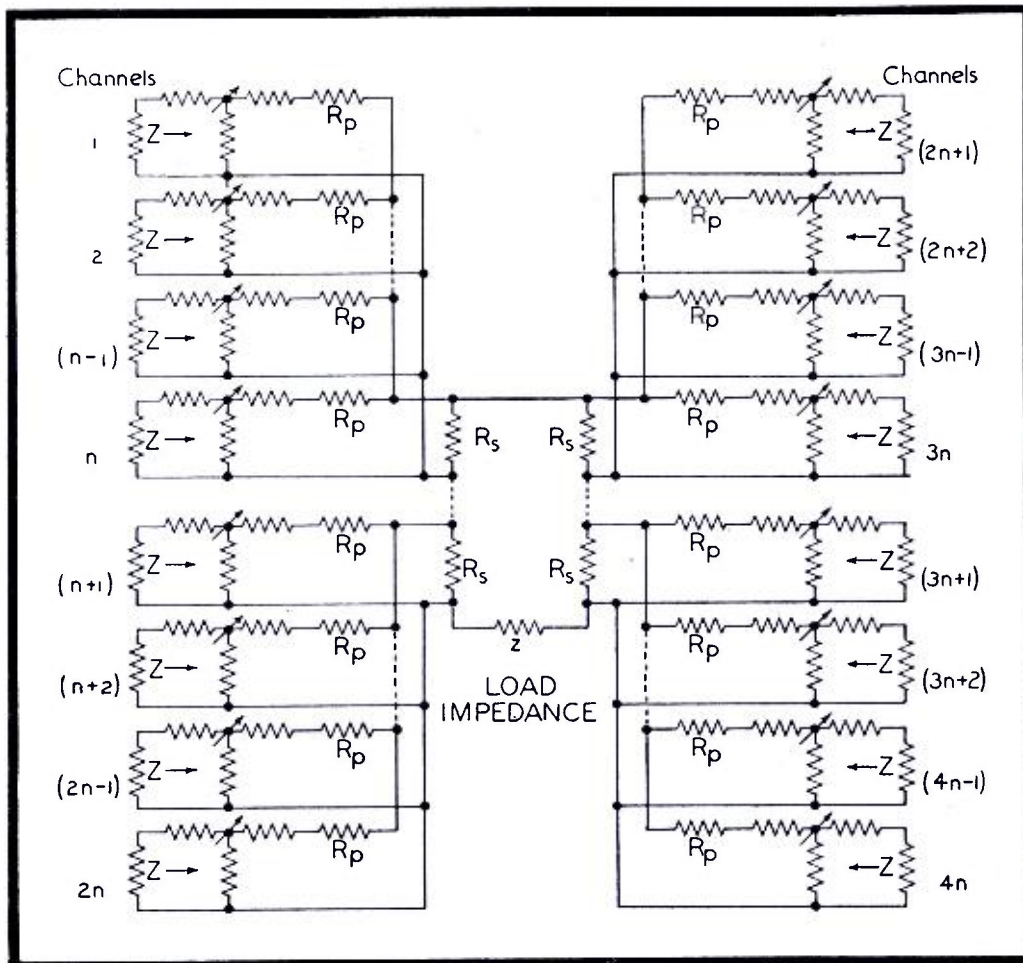
[Part Eight of a Series]

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

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

$$\frac{R'_s}{R'_p} = \frac{2g s_s^2}{C_p s_p^2} = \frac{2s_s^2 \operatorname{csch} 2 \Theta_s}{s_p^2 \tanh \Theta_p} = \frac{s_s^2 n_p (2n_s - 1)}{s_p^2 n_s (n_p - 1) (n_s - 1)} = \frac{R_s z_p}{R_p z_s} \quad (27)$$

$$\frac{s_s^2 E_s \cosh^2 \Theta_s}{s_p^2 E_p \cosh^2 \Theta_p} = \frac{n_s^2 2n_p - 1}{n_p^2 2n_s - 1} = \frac{z_p}{z_s} = s^2 \quad (28)$$

When the number of groups in parallel equals the number of fader channels connected in series, $n_p = n_s = n$; $\Theta_p = \Theta_s = \Theta/2$, and $z_s = z_p = z$. 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

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

while 28 reduces to the condition

$$\frac{s_p^2 z_s}{s_s^2 z_p} = 1 \quad (30)$$

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

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

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

$$R_p = z_s \frac{n_s^2 n_p - 1}{n_p 2n_s - 1} \quad (32)$$

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

$$R_s = 2z_p \operatorname{csch} 2 \Theta_s \cosh^2 \Theta_p = 2z_p E_p g_s \quad (33)$$

and

$$R_p = z_s \cosh^2 \Theta_s \tanh \Theta_p = C_p E_s z_s \quad (34)$$

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

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

and

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

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-connected system having input and output impedances of z_p and Z was shown to be equal to

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

By using proper subscripts for the series and the parallel portions of the series-parallel mixer network, from equation (12), the losses caused by these portions may be written directly without further appeal to circuit theory as

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

for the series-connected fader channels, and

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

for the parallel groups of series-connected channels.

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

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

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

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

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

These equations give the insertion loss which will be incurred from the input of any single channel to the common output load of the complete system of faders, compensating resistances 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, hyperbolic 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

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

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

and

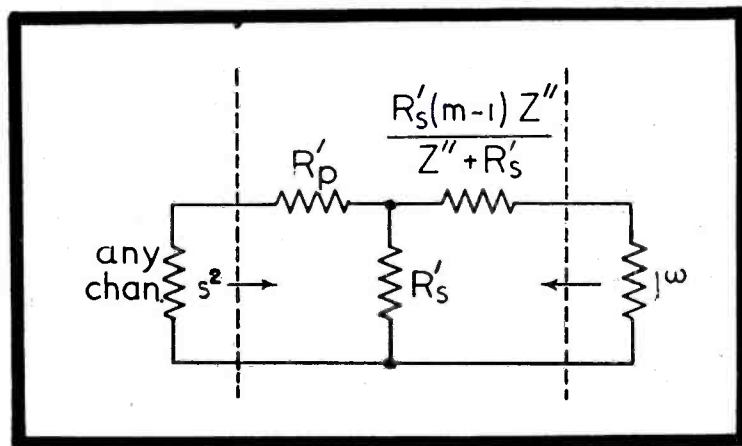
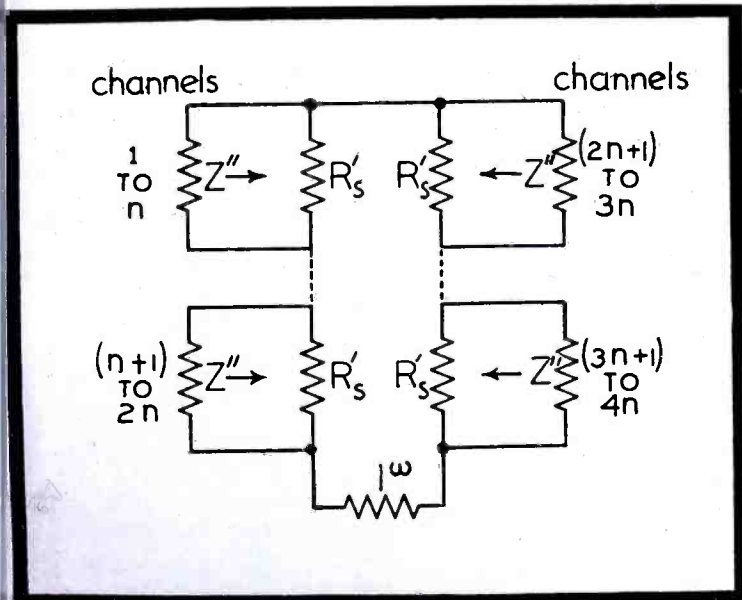
$$s = B = \cosh \theta \quad (17b)$$

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. $R'_s = R_s / z_s$.

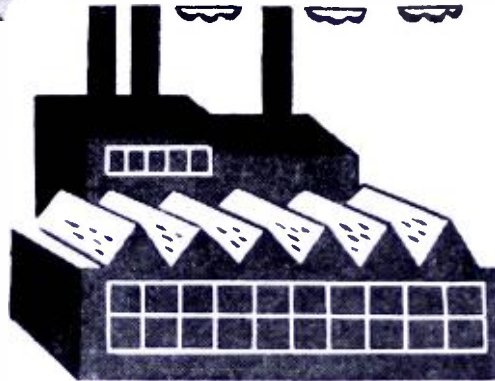


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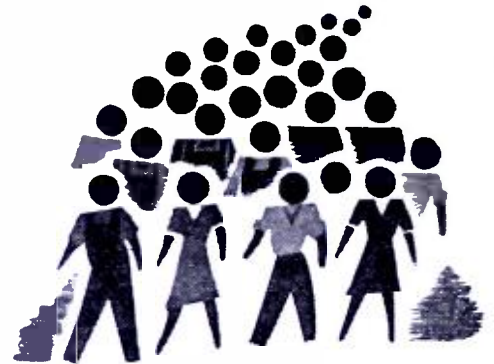
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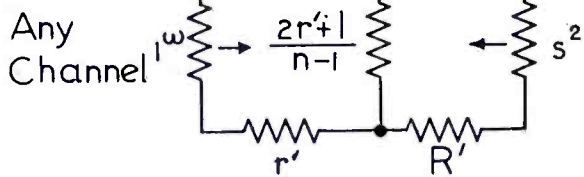
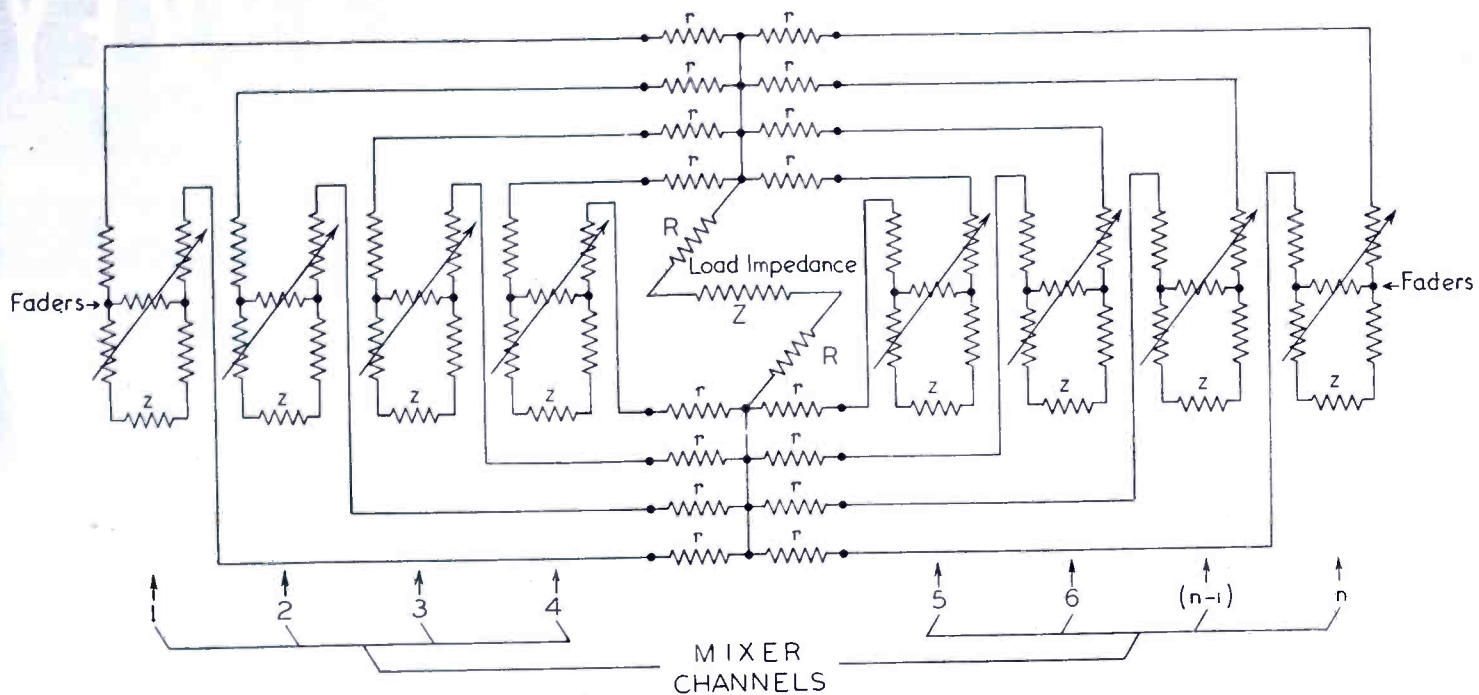
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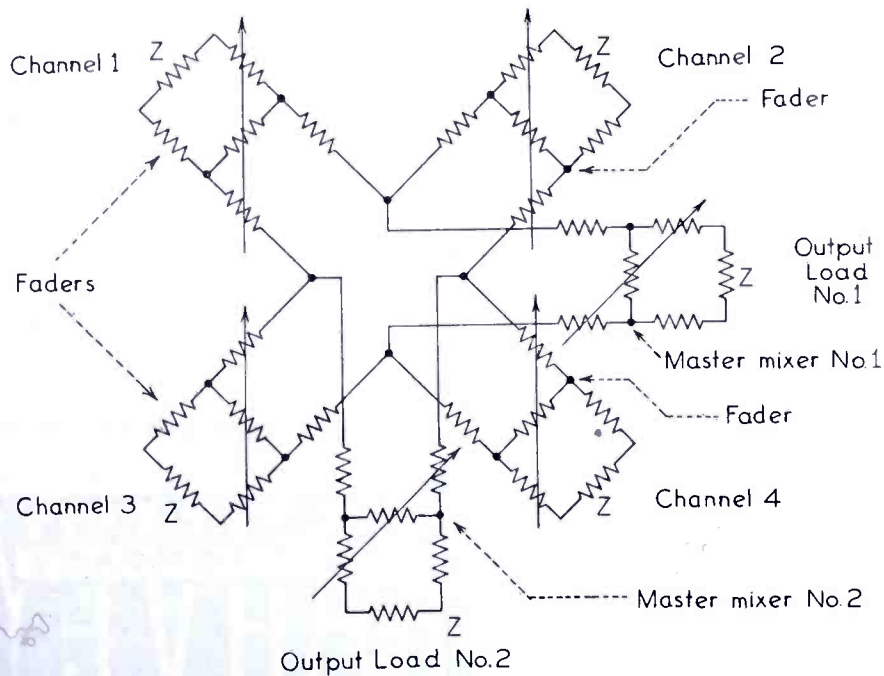
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Figures 11 (above), 12 (left) and 13 (below)
 Figure 11. An n -channel system of mixer and faders in balanced form. Figure 12. A single-channel representation of Figure 11 with the faders set for zero insertion loss. Figure 13. A lattice-type bridge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



$$R'_p = \frac{n_p(n_p - 1)}{2n_p - 1} = \frac{1}{2} \sinh 2\theta_p$$

$$= \frac{1}{2} G = \frac{R_p}{z_p} \quad (41)$$

or

$$R'_p = s_p^2 \frac{n_p - 1}{n_p} = s_p \sinh \theta_p$$

$$= A_p s_p = \frac{R_p}{z_p} \quad (42)$$

and

$$s_p^2 = \frac{n_p^2}{2n_p - 1} = \cosh^2 \theta_p = E_p = \frac{Z_p}{z} \quad (43)$$

for the parallel-connected fader channels, and

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

or

$$R'_s = s_s^2 \frac{2n_s - 1}{n_s(n_s - 1)} = 2s_s^2 \operatorname{csch} 2\theta_s$$

$$= 2g_s s_s^2 = \frac{R_s}{z_s} \quad (45)$$

and

$$s_s^2 = \frac{n_s^2}{2n_s - 1} = \cosh^2 \theta_s = E_s = \frac{Z_s}{z} \quad (46)$$

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

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



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RESISTIVE NETWORKS

(Continued from page 71)

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

or

$$\frac{R'_p s_p^2 n_s (n_s - 1) (n_p - 1)}{R'_s s_s^2 n_p (2n_s - 1)} = \frac{s_p \sinh \theta_p}{2s_s^2 \operatorname{csch} 2\theta_s} = \frac{A_p s_p}{2g_s s_s^2} = \frac{R_p z_s}{R_s z_p} = \frac{R_p}{R_s} \quad (48)$$

and

$$\frac{s_p^2}{s_s^2} = \frac{n_p^2 (2n_s - 1) \cosh^2 \theta_p}{n_s^2 (2n_p - 1) \cosh^2 \theta_s} = \frac{E_p Z_p}{E_s Z_s} = \frac{Z_p}{Z_s} \quad (49)$$

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

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

and from 49, the relationships of

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

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

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

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

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

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

$$R_p = \frac{1}{2} Z_s \sinh 2\theta_p \operatorname{sech}^2 \theta_s = \frac{1}{2} Z_s G_p e_s \quad (54)$$

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nd

$$Z_s = Z_p \operatorname{sech}^2 \theta_p \coth \theta_s = c_s e_p Z_p \quad (55)$$

When $n_s = n_p = n$; $\theta_p = \theta_s = \theta/2$,
 nd $Z_s = Z_p = Z$, equations 54 and
 5 become

$$Z_p = Z \tanh \frac{\theta}{2} = DZ \quad (56)$$

nd

$$Z_s = 2Z \operatorname{csch} \theta = 2aZ \quad (57)$$

Insertion Loss of a Parallel-Series Mixer System

The losses for each section and group of this type of mixer system may be written directly from equations 37 and 38. Their sum results in equation 39 which is the total loss of the system from any single channel input to the output of the system. For the special condition of $n_s = n_p = n$, the loss is given by equations 40. Hence, the insertion loss of the series-parallel and the parallel-series systems is equal, and are both given by equations 38 to 40 inclusive.

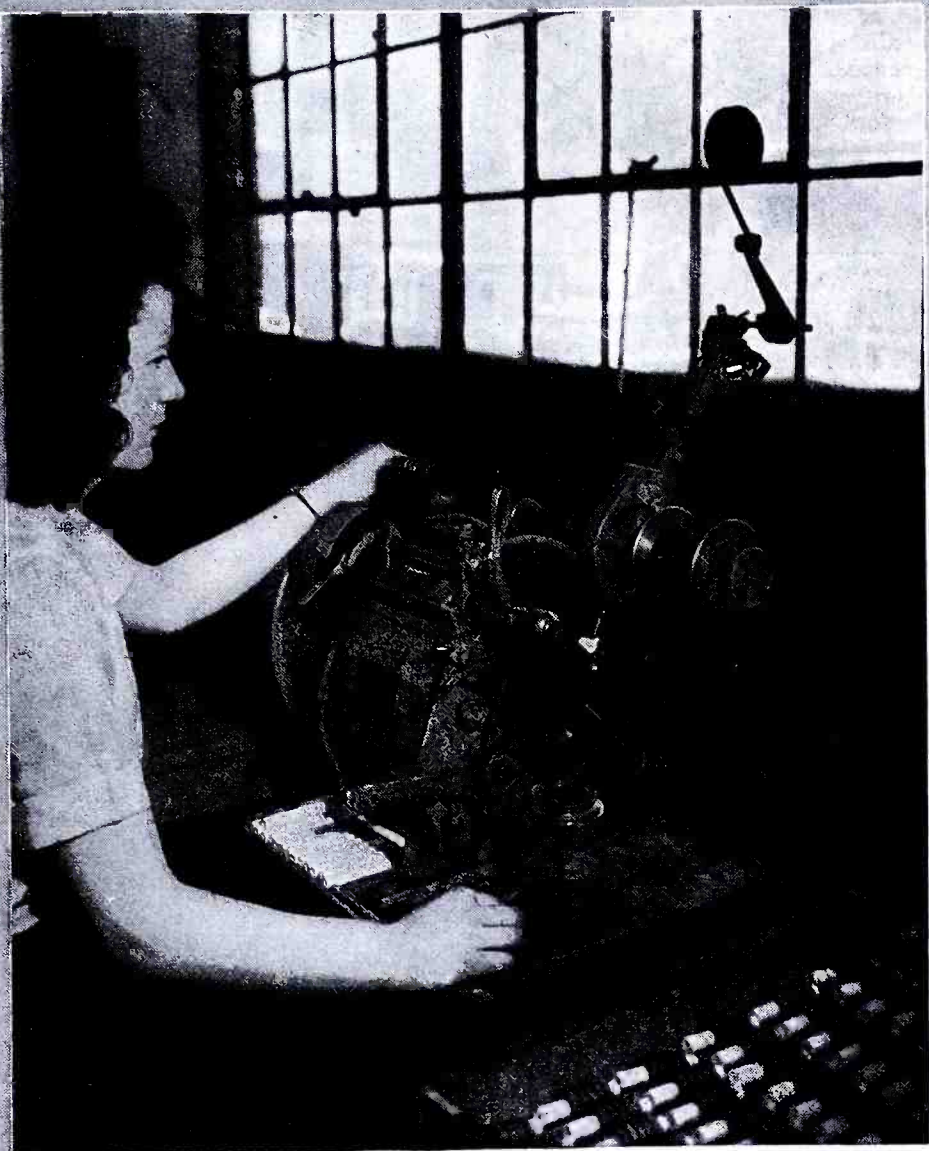
Tables for Fader and Mixer System Design

Values of the compensating resistances required for the series, parallel, series-parallel and parallel-series types of mixers are available from the tables offered in this installment. The ratios of the terminating impedances as well as the ratios of the compensating resistances are given so that the designer may determine quickly whether or not any set of conditions or relationships between the network parameters and the terminating impedances are either possible or practicable. A table of insertion losses accompanies each type of mixer considered. These tables show directly the losses which will be incurred through the use of any given type mixer for any desired combination of series or parallel connections. These tables will minimize the amount of work otherwise necessary in interpolating the required values of insertion losses and the further interpolation of the untabulated hyperbolic functions. This is because the number of channels is an integral number and therefore only certain and definite losses are permissible if good matching 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)



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	2	3	4	5	6	7	8	9	10		
$G_{p,e_s}/2$											
2.....	0.50000	0.90000	1.28571	1.66667	2.04545	2.42308	2.80000	3.17647	3.55263	$\frac{1}{2} G_p = \frac{1}{2} \sinh 2\theta_p$	
3.....	.37037	.66666	0.95237	1.23455	1.51514	1.79485	2.07405	2.35291	2.63155	$n_p (n_p - 1)$	
4.....	.29166	.52500	.75000	.97222	1.19318	1.41346	1.63333	1.85294	2.07237	$= \frac{2n_p - 1}{n_p}$	
5.....	.2400	.43200	.61714	.80000	0.98182	1.16308	1.34400	1.52470	1.70526	$c_s = \frac{\text{sech}^2 \theta_s}{2n_s - 1}$	
6.....	.20370	.36666	.52380	.67900	.83333	0.98716	1.14072	1.29409	1.44737	$= \frac{n_s^2}{n_s}$	
7.....	.17687	.31837	.45481	.58958	.72358	.85714	0.99049	1.12366	1.25673	$Z_s = \text{mixer output impedance}$	
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	$R_p = \text{compensating resistance to place in series with each fader output channel}$	
10.....	.12667	.22800	.32571	.42222	.51818	.61385	.70933	.80470	.90000	$c_s = \text{coth } \theta_s$	
$c_s e_p$											
2.....	1.50000	1.11111	0.87500	0.72000	0.61110	0.52062	0.46874	0.41976	0.38000	n_s	
3.....	1.12500	0.83333	.65625	.54000	.45832	.39796	.35156	.31482	.28500	$= \frac{n_s - 1}{n_s}$	
4.....	1.00000	.74074	.58333	.48000	.40740	.35375	.31249	.27984	.25333	$c_p = \frac{\text{sech}^2 \theta_p}{2n_p - 1}$	
5.....	0.93750	.69444	.54687	.45000	.38194	.35164	.29296	.26235	.23750	$= \frac{n_p^2}{n_p}$	
6.....	.90000	.66666	.52500	.43200	.36667	.31837	.28124	.25186	.22800	$Z_p = \text{fader input impedance}$	
7.....	.87500	.64815	.51042	.42000	.35647	.30952	.27343	.24486	.22167	$R_s = c_s e_p Z_p$	
8.....	.85714	.63492	.50000	.41143	.34920	.30321	.26786	.23986	.21714	$R_s = \text{compensating resistance to place in shunt with each group of channels}$	
9.....	.84375	.62500	.49219	.40500	.34374	.29847	.26367	.23611	.21375	$Z_p = \cosh^2 \theta_p$	
10.....	.83333	.61728	.48611	.40000	.33950	.29479	.26041	.23320	.21111	$= z \frac{2n_p - 1}{n_p^2}$	
Z_p/Z_s											
2.....	1.00000	1.35000	1.71428	2.08333	2.45454	2.82693	3.20000	3.57353	3.94737	$\frac{Z_p}{Z_s} = \frac{E_p}{E_s}$	
3.....	0.74074	1.00000	1.26983	1.54319	1.81817	2.09400	2.37035	2.64702	2.92394	$= z \frac{2n_p - 1}{n_p}$	
4.....	.58332	0.78750	1.00000	1.21527	1.43182	1.64904	1.86667	2.08456	2.30263	$Z_s = z \cosh^2 \theta_s$	
5.....	.48000	.64800	0.82285	1.00000	1.17818	1.35693	1.53600	1.71529	1.89473	$= z \frac{2n_s - 1}{n_s}$	
6.....	.40740	.55000	.69840	0.84875	1.00000	1.15169	1.30368	1.45585	1.60816	$z = \text{Output impedance of each parallel fader group}$	
7.....	.35374	.47755	.60641	.73697	0.86830	1.00000	1.13200	1.26412	1.39637	$E_p = \cosh^2 \theta_p$	
8.....	.31250	.42187	.53571	.65102	.76703	0.88339	1.00000	1.11670	1.23352	$E_s = \cosh^2 \theta_s$	
9.....	.27984	.37778	.47972	.58300	.68688	.79109	0.89549	1.00000	1.10463	$R_p = \frac{1}{2} z \sinh 2\theta_p$	
10.....	.25334	.34200	.43428	.52778	.62182	.71616	.81066	0.90529	1.00000	$n_p (n_p - 1)$	
R_p/R_s											
2.....	0.33333	0.60000	0.85714	1.11111	1.36363	1.61539	1.86667	2.11765	2.36842	$= z \frac{2n_p - 1}{n_p}$	
3.....	.44444	.80000	1.14284	1.48146	1.81817	2.15382	2.48886	2.82394	3.15786	$R_s = z \coth \theta_s$	
4.....	.50000	.90000	1.28572	1.66667	2.04546	2.42308	2.80000	3.17648	3.55264	$= z \frac{n_s - 1}{n_s}$	
5.....	.53333	.96000	1.37142	1.77778	2.18182	2.58462	2.98667	3.38822	3.78947	$G_p = \sinh 2\theta_p$	
6.....	.55555	1.00000	1.42855	1.85182	2.27273	2.69225	3.11105	3.52934	3.94737	$C_s = \tanh \theta_s$	
7.....	.57143	1.02859	1.46940	1.90482	2.33775	2.76926	3.20000	3.63033	4.06026	$\theta_s = \frac{1}{2} \text{Log}(2n_s - 1)$	
8.....	.58333	1.05000	1.50000	1.94437	2.38628	2.82681	3.26663	3.70574	4.14459	$\theta_p = \frac{1}{2} \text{Log}(2n_p - 1)$	
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		

T-network configuration and design data presented by Figure 1 in Part III¹, the element values may be written directly by inspection, resulting in the equations

$$R = (cZ - ay)/2$$

$$= (Z \coth \theta - (Zz)^{1/2} \text{csch } \theta)/2 \quad (58)$$

and

$$r = (cz - ay)/2$$

$$= (z \coth \theta - (Zz)^{1/2} \text{csch } \theta) \quad (59)$$

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

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

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

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

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

No. of Series Groups in Parallel	SERIES-PARALLEL MIXER No. of Channels in Series										Network Elements and Impedance Terminations	Requirements and Definitions
	2	3	4	5	6	7	8	9	10			
	$2g_s E_p$											
2	2.00000	1.11111	0.77778	0.60000	0.48889	0.41270	0.35714	0.31481	0.28148		$2g_s = 2 \operatorname{csch} 2 \theta_s$ $2n_s - 1$ $= \frac{\quad}{n_s(n_s - 1)}$ $E_p = \operatorname{cosh}^2 \theta_p$ n_p^2 $= \frac{\quad}{2n_p - 1}$ $z_p = \text{mixer output impedance}$ $R_s = \text{compensating resistance to place in shunt with each fader output channel}$ $C_p = \tanh \theta_p$ $n_p - 1$ $= \frac{\quad}{n_p}$ $E_s = \operatorname{cosh}^2 \theta_s$ n_s^2 $= \frac{\quad}{2n_s - 1}$ $z_s = \text{fader input impedance}$ $R_p = \text{compensating resistance to place in series with each group of channels}$ $z_s = Z \operatorname{sech}^2 \theta_s$ $2n_s - 1$ $= Z \frac{\quad}{n_s^2}$ $z_p = Z \operatorname{sech}^2 \theta_p$ $2n_p - 1$ $= Z \frac{\quad}{n_p^2}$ $\frac{z_s}{z_p} = \frac{E_p}{E_s}$ $\frac{z_s}{z_p} = \frac{\quad}{\operatorname{cosh}^2 \theta_p}$ $Z = \text{Output impedance of each series fader group}$ $E_p = \operatorname{cosh}^2 \theta_p$ $E_s = \operatorname{cosh}^2 \theta_s$ $R_p = \frac{1}{2} z_p \sinh 2 \theta_p$ $n_p(n_p - 1)$ $= z_p \frac{\quad}{2n_p - 1}$ $R_s = z_s \coth \theta_s$ n_s $= z_s \frac{\quad}{n_s - 1}$ $G_p = \sinh 2 \theta_p$ $C_s = \tanh \theta_s$ $\theta_s = \frac{1}{2} \operatorname{Log}(2n_s - 1)$ $\theta_p = \frac{1}{2} \operatorname{Log}(2n_p - 1)$	
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	0.90000	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	$\frac{z_s}{z_p} = \frac{E_p}{E_s}$		
6	2.45454	1.81817	1.43182	1.17818	1.00000	.86830	.76703	.68688	.62182	$\frac{z_s}{z_p} = \frac{\quad}{\operatorname{cosh}^2 \theta_p}$		
7	2.82693	2.09400	1.64904	1.35693	1.15169	1.00000	.88339	.79109	.71616	$\frac{z_s}{z_p} = \frac{\quad}{\operatorname{cosh}^2 \theta_s}$		
8	3.20000	2.37035	1.86667	1.53600	1.30368	1.13200	1.00000	.89549	.81066	$Z = \text{Output impedance of each series fader group}$		
9	3.57353	2.64702	2.08456	1.71529	1.45585	1.26412	1.11670	1.00000	.90529	$E_p = \operatorname{cosh}^2 \theta_p$ $E_s = \operatorname{cosh}^2 \theta_s$		
10	3.94737	2.92394	2.30263	1.89473	1.60816	1.39637	1.23352	1.10463	1.00000	$R_p = \frac{1}{2} z_p \sinh 2 \theta_p$ $n_p(n_p - 1)$		
	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	1.96482	1.94437	1.97535	2.00000	$\frac{R_p}{R_s} = \frac{1}{2} C_p C_s$		
6	1.36363	1.81817	2.04546	2.18182	2.27273	2.33775	2.38628	2.42429	2.45454			
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			

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

The algebraic form of equation 58 and 59 as found from the defining key

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

chart substitutions yield the forms of

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

and

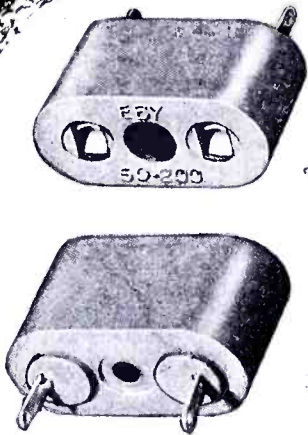
$$r = \frac{1}{2} \left(z \frac{k^2 + 1}{k^2 - 1} - (Zz)^{\frac{1}{2}} \frac{2k}{k^2 - 1} \right) \quad (63)$$

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

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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

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

and

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

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

$$R = r = Dz = z \tanh \frac{\theta}{2} \\ = z \frac{k-1}{k+1} = z \frac{n-1}{n+1} \quad (66)$$

Transmission Loss of the Multiple Bridge Mixer

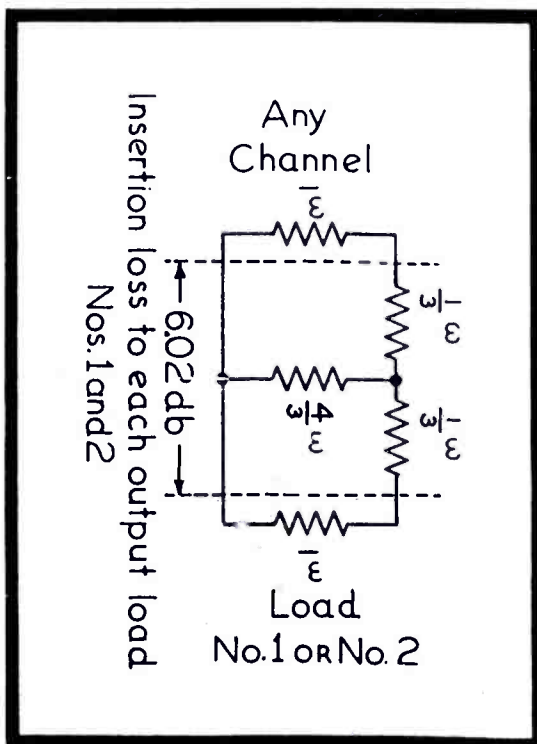
From the definition of the power transmission loss for the T network of

$$\text{db} = 10 \text{Log}_{10} k^2 \quad (67)$$

by using $\delta 1$, the power transmission loss in decibels of the multiple bridge mixer from the input of any fader

Figure 14

An individual channel representation of Figure 13 (see page 11).



channel to the common output of the mixer may be written

$$\text{db} = 20 \text{Log}_{10} (ns) \quad (68)$$

which becomes simply

$$\text{db} = 20 \text{Log}_{10} n \quad (69)$$

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

²COMMUNICATIONS; September, 1943.
³COMMUNICATIONS; August, 1944.



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

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

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

$$\begin{aligned} \delta &= 20 \text{Log}_{10} \left(1 + \frac{v+z}{w} \right) \\ &= 20 \text{Log}_{10} \left(1 + \frac{\frac{Z}{3} + Z}{4Z/3} \right) = 6.02 \end{aligned} \quad (71)$$

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 separate 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)



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RESISTIVE NETWORKS

(Continued from page 77)

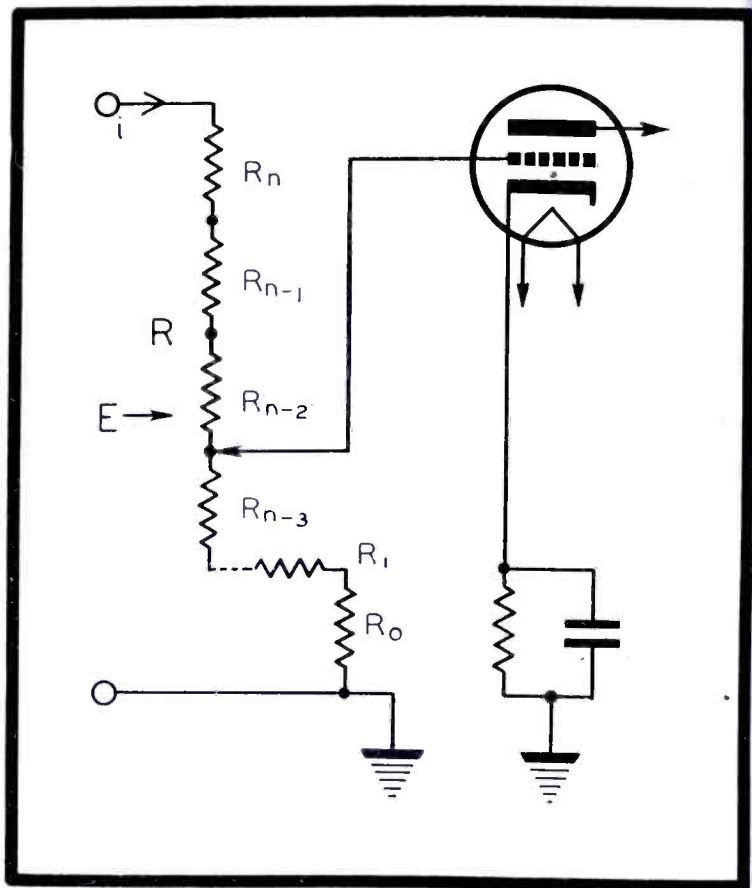


Figure 15

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 article⁴ and only the final design results will be utilized here.

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

$$R_0 = R/k_t = Rr_t \quad (72)$$

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,

$$R_n = R_0 (k_s^n - k_s^{n-1}) \quad (73)$$

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

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⁴COMMUNICATIONS; 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 h 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 , $k_n = 2.51189$ as found on the row for 8 db; $k_{n-1} = 1.99526$ as found on the row for 6 db. From equation 73, therefore, the value of $R_n = 0.51663 \times R_0$. 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, $R_0 = 500,000 \times 0.01 = 5,000$ 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.]

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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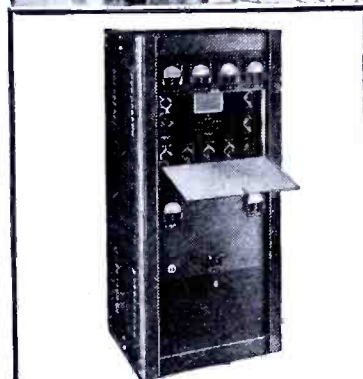
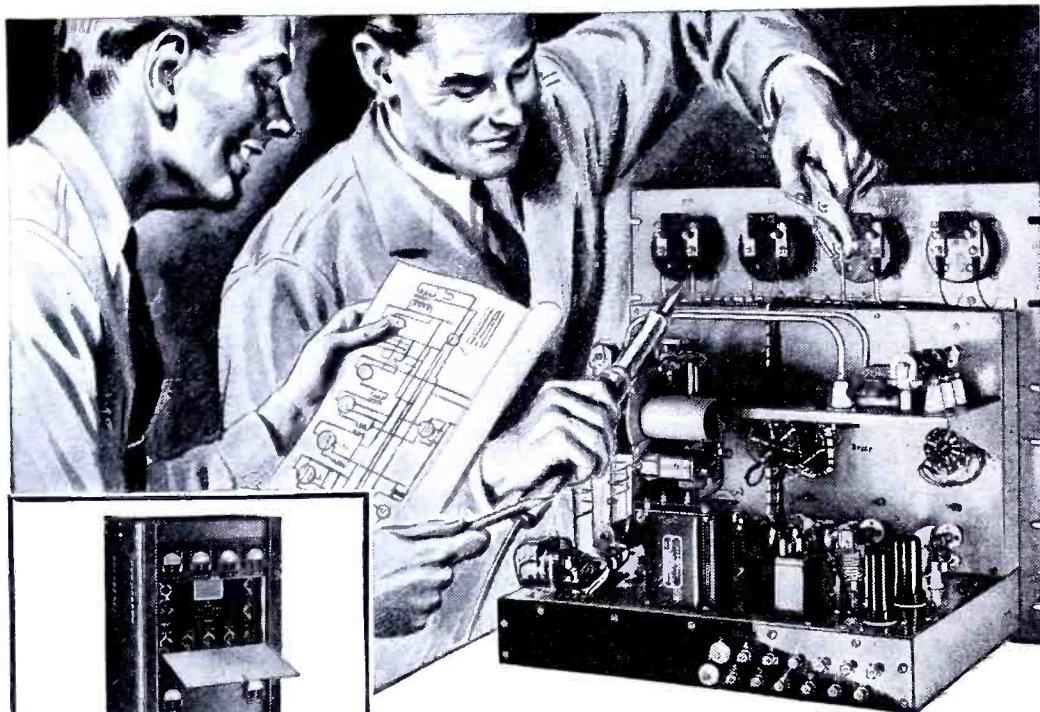


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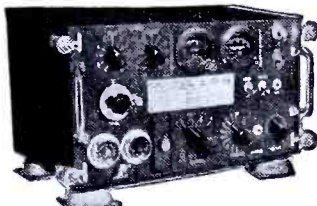
RADIO AND ELECTRONIC EQUIPMENT



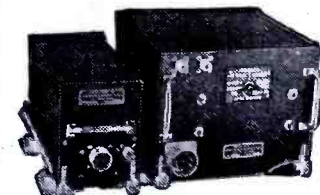
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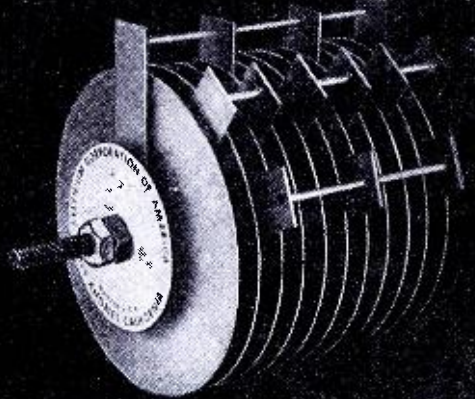


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RESISTIVE NETWORKS

(Continued from page 79)

No. of groups in Series or in Parallel	PARALLEL-SERIES OR SERIES-PARALLEL MIXERS No. of Channels in Parallel, or in Series									
	2	3	4	5	6	7	8	9	10	Requirements and Definitions
2.....	9.54	11.76	13.22	14.31	15.18	15.91	16.53	17.08	17.56	Channels in parallel are used with groups in series, and channels in series are used with groups in parallel. The insertion loss in db = $10 \text{Log}_{10}[(2n_s - 1)(2n_p - 1)]$ n_s = No. channels in series n_p = No. channels in parallel
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	

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.

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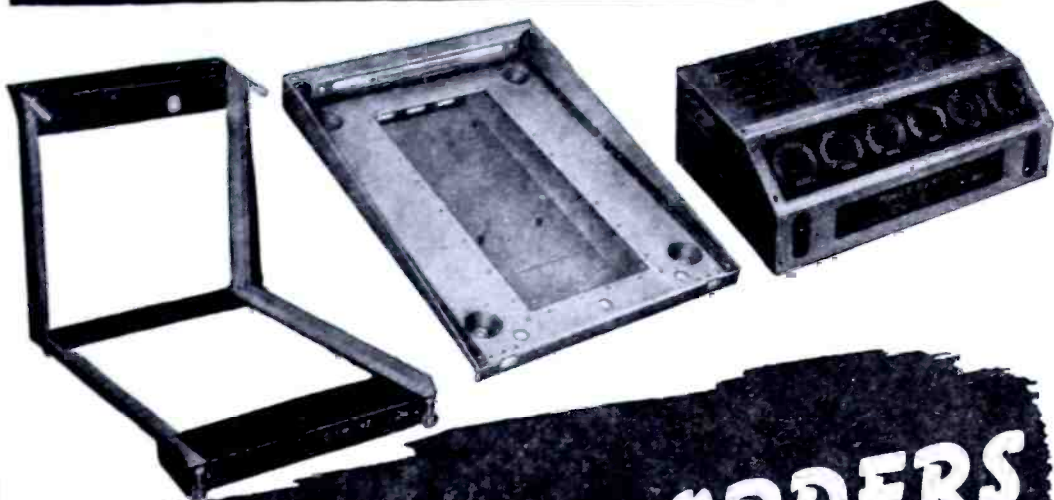
52 Vanderbilt Ave., New York 17, N. Y.

VWOA NEWS

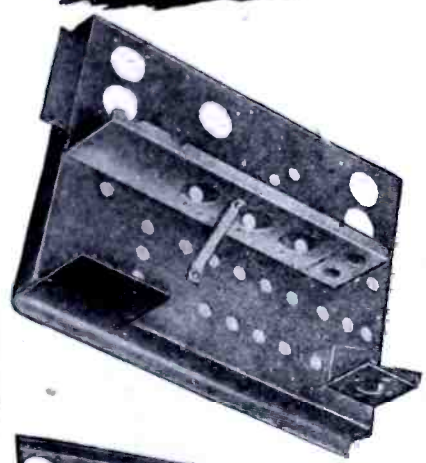
(Continued from page 66)

... 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.

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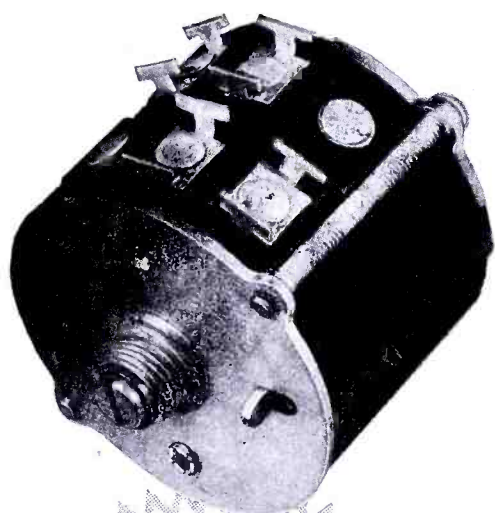


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V-H-F COIL DESIGN

(Continued from page 52)

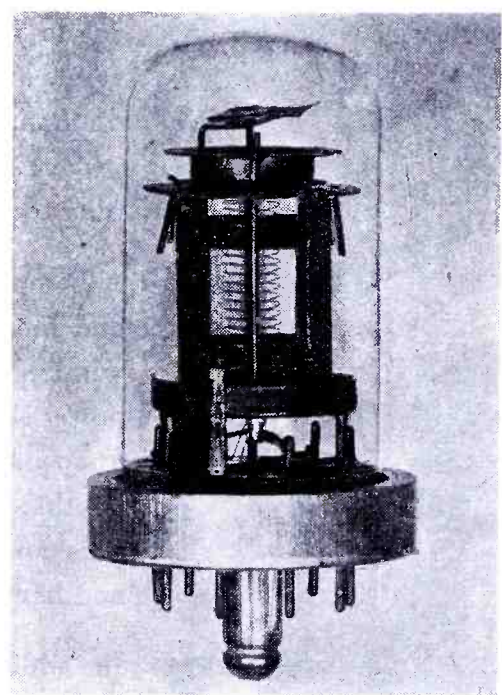
D' respond almost equally to increases in diameter, as measured in mmfd; also, the curves are steeper as the diameter decreases. At the same time the compensation for this change, as shown by the curves *A* to *D*, increases with a reduction in coil diameter. In addition, each of the latter curves is 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

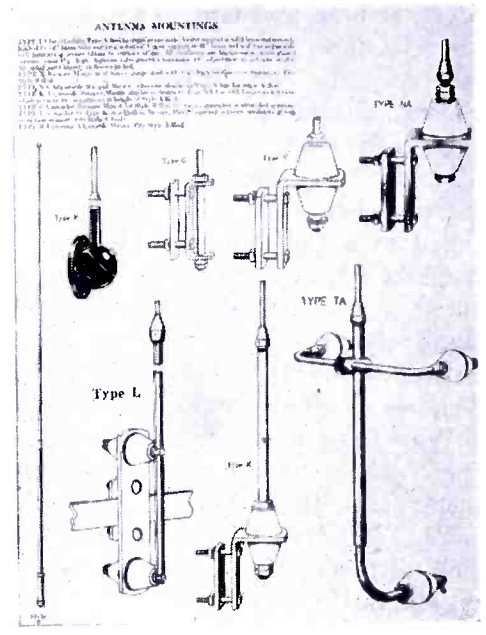
For example, let us take a strap coil of 1/2" width and 3" diameter. We note that any expansion due to temperature will affect both the width and the diameter proportionately. An increase in length of 10%, due to temperature, will effect an increase in diameter of 10%, as well as a 10% increase in width. At 80 mc a

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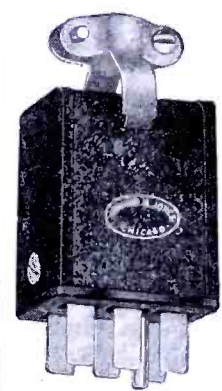
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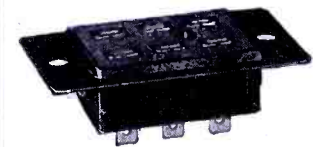
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10% increase in diameter is equal to a capacitance of 5.22 mmfd; a 10% increase in width is equal to a capacitive decrease of 1.2-mmfd. or a net increase or 4.02 mmfd. This would be responsible for a very definite frequency decrease with temperature rise. An equal inductance made with $\frac{1}{4}$ -wide copper strap and $2\frac{1}{2}$ " 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 $\frac{1}{4}$ " tubing had less inductance than a strap coil made with $\frac{1}{4}$ " 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 $2\frac{1}{2}$ " diameter, $\frac{1}{4}$ " 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 $2\frac{1}{2}$ " 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 inductance.

(Continued on page 84)

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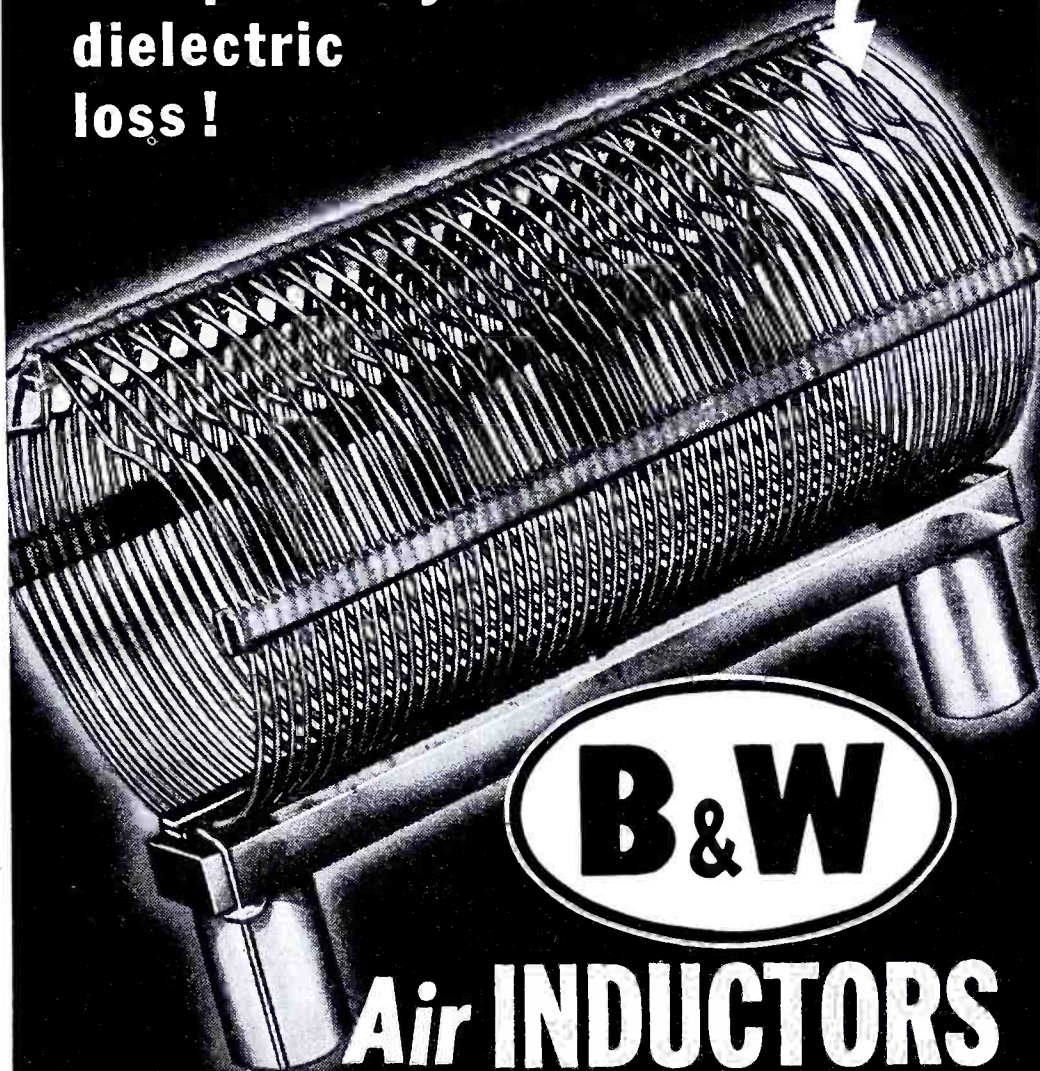
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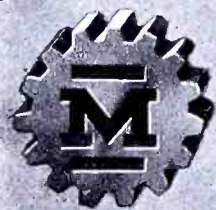


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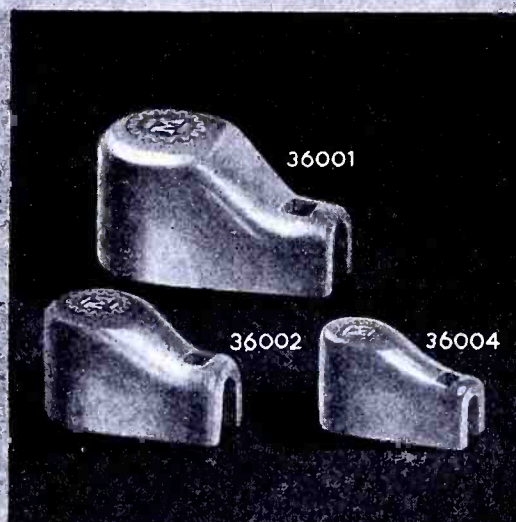
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V-H-F COIL DESIGN

(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 irregu-

lar 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 mmd.

2 1/2" Diameter—1/4" 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—1/4" 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	

2 1/2" Diameter—3/8" 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—3/8" 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.

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V-H-F OSCILLATORS

(Continued from page 60)

attainable for a satisfactory commercial crystal used this way is limited by the minimum safely reproducible 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

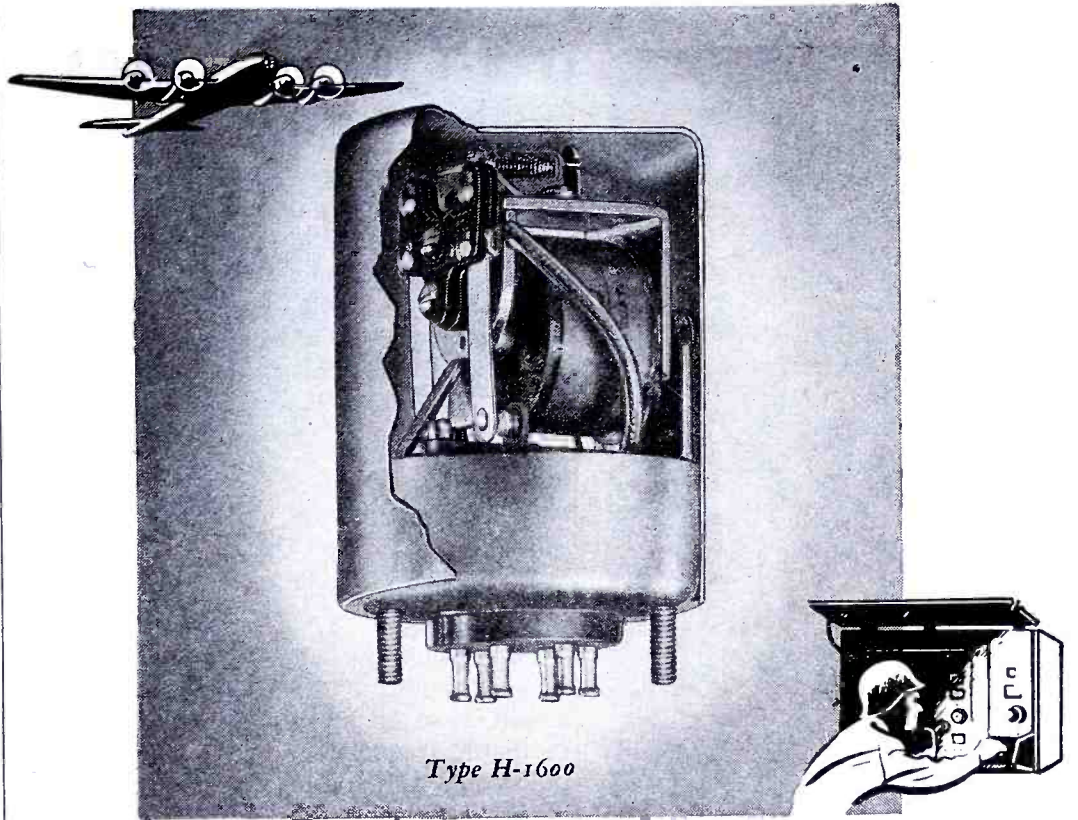
One of the most interesting solutions to the high-frequency stable-crystal oscillator requirement is the bridge circuit oscillator, Figure 8. The crystal forms one leg of a reactance bridge which is used to neutralize the shunt capacity of the crystal so that it may show a positive reactance at the natural frequency of oscillation, either fundamental or harmonic. I. E. Fair of Bell Laboratories has patented a simple crystal-holder design which includes the neutralizing capacitors C_1 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)



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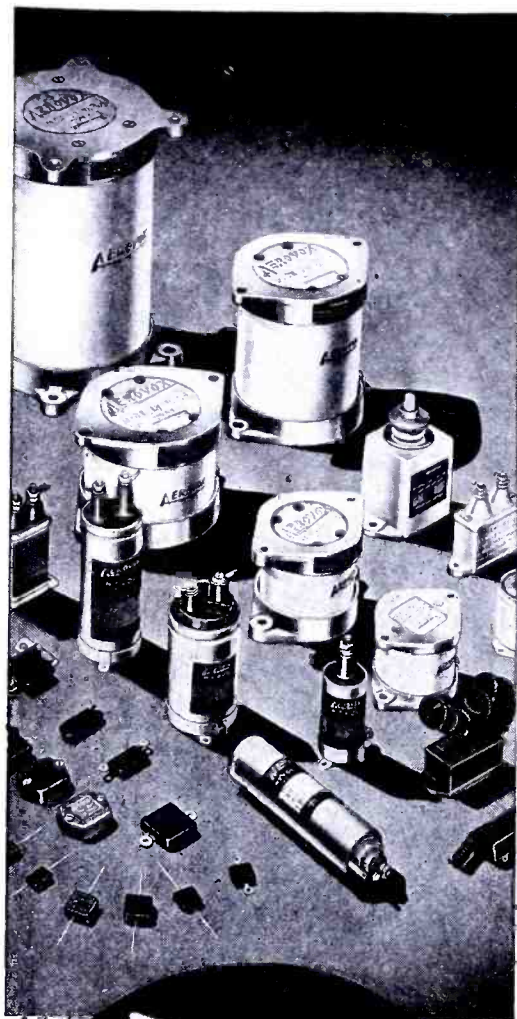
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V-H-F OSCILLATORS

(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 push-buttons 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

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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.

$$l-o = r-f - i-f_1 \quad (1)$$

$$l-o = i-f_2 + i-f_1 \quad (2)$$

where *l-o* means common local oscil-

(Continued on page 88)

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NOTE: Amalgamated Engineers will gladly consult with you on the design and development of Plugs and Jacks for special applications—present or postwar.



PLUG PL-55 and N.A.F. 1136-1

Long sleeve, two-conductor plug, mate to Jack JK-34-A. Withstands minimum of 500 cycles AC, potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F at humidities up to 100%.



PLUG, STYLE "A"

Two-conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.



PLUG, STYLE "D"

Two-Conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.



PLUG PL-204

Hand set. A special plug wherein both a modified plug, PL-55 and PL-68, are held in place by a phenolic case. Same specifications as PL-55 and PL-68.



JACK JK-26, N.A.F. 215284-2

Two-conductor Jack, mate to PL-54. Tropicalized. Withstands 60 cycle AC potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F , at humidities up to 100%.



JACK JK-48

Light duty, two-conductor Jack, mate to Plug PL-291 and Plug 291-A.



PLUG PL-54, PL-540, PL-354, N.A.F. 215285-2

Short sleeve, two-conductor plug, mate to Jack JK-26. Same specifications as PL-55.

AMALGAMATED RADIO TELEVISION CORP.

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Toroids..

by

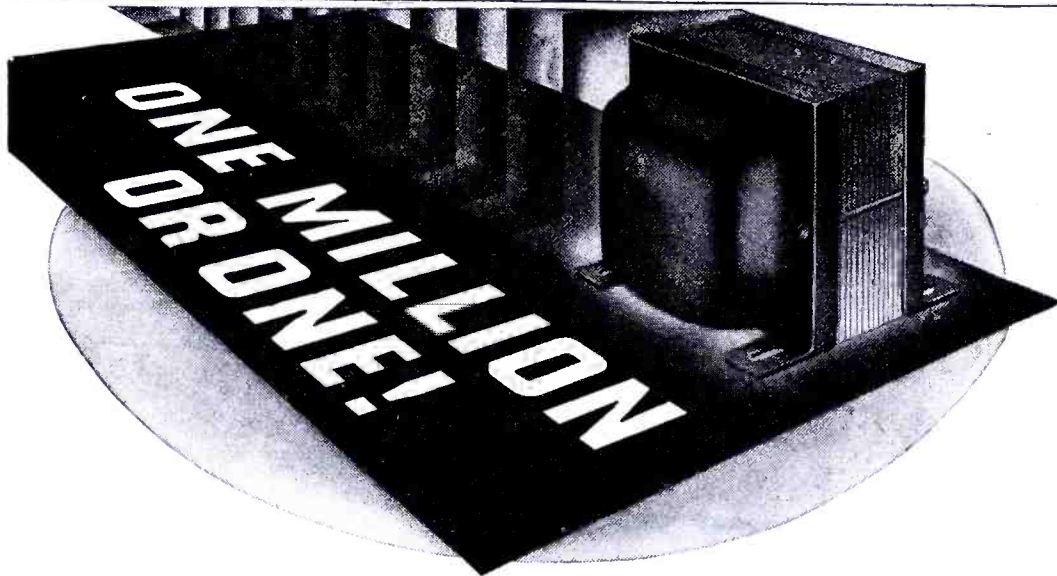
DX



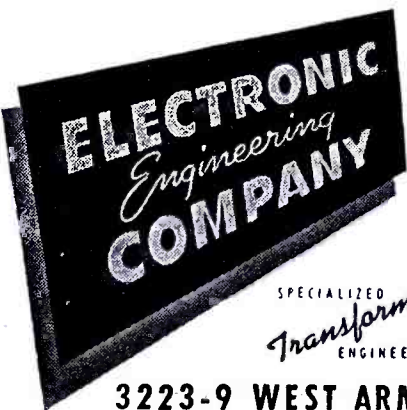
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V-H-F OSCILLATORS

(Continued from page 87)

lator frequency; r-f, frequency of the incoming signal; i-f₁, first i-f or the beat between the incoming r-f signal and l-o; and i-f₂, 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

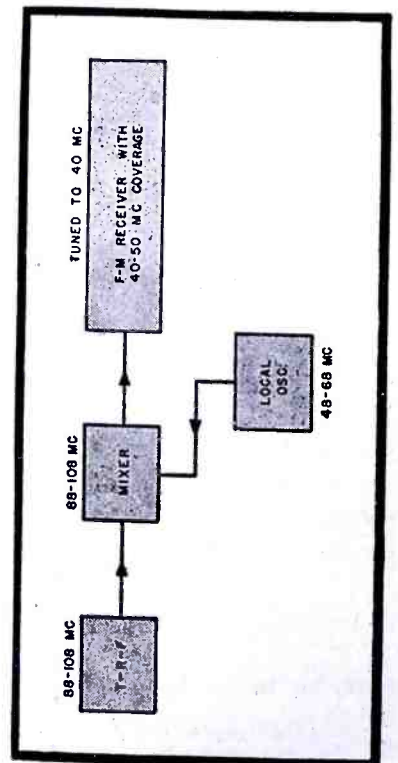
Of course the present f-m receivers may be used in conjunction with a converter system as a double superhet. The procedure is indicated in Figure 12. A frequency of 40 mc for i-f₂ was designated because it is available on prewar f-m receivers and it is somewhat removed from the lowest frequency postwar television channel.

References

- ¹I. Koga, *Characteristics of Piezo-Electric Quartz Oscillators*, IRE Proc.; November, 1930
- ²F. B. Llewellyn, *Constant Frequency Oscillations*, IRE Proc.; December, 1931
- ³K. A. McKinnon, *Crystal Controlled Dynatron*, IRE Proc.; November, 1932.
- ⁴I. E. Fair, *Crystal Controlled Oscillator for Ultra-High Frequencies*, U. S. Patent 2,260,707; October 28, 1941
- ⁵W. P. Mason and I. E. Fair, *A New Direct Crystal-Controlled Oscillator for Ultra-Short Wave Frequencies*, IRE Proc.; October, 1942
- ⁶W. P. Mason, *Negative Transconductance Tube Oscillator*, U. S. Patent 2,332,102; October 19, 1943.
- ⁷I. 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.

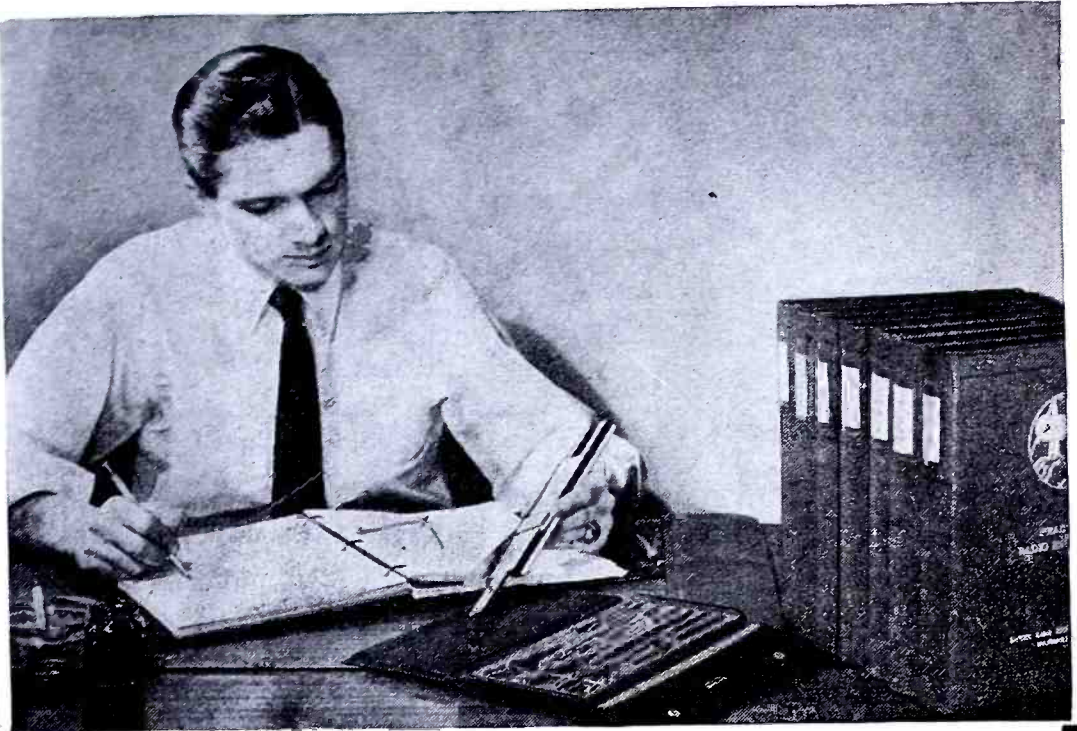
Power Consumption

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 equip-

(Continued on page 90)



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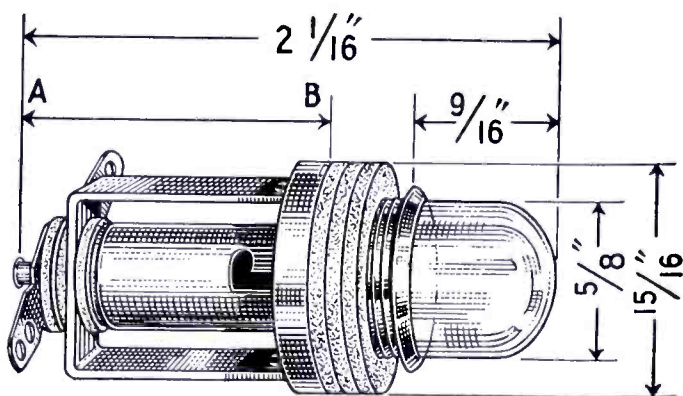
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built-in resistor permits direct connection to 115 volt circuits. Furnished with three 1/16" thick fibre spacing washers which are removable when unit is mounted in thick panels, thus keeping Neon glow at top of dome. The new No. 51N is only one of many fine Drake Socket and Jewel Light Assemblies; many incorporating patented features developed by our research staff. Do you have an up-to-date Drake catalog?



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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.

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

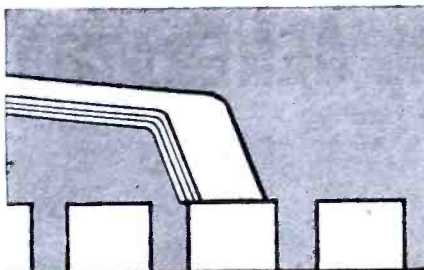
line to the receiver line to facilitate initial line level adjustments and to assist the operator in maintaining the correct speech level. Normally this meter is across the output of the microphone amplifier. A loudspeaker mounted on the front panel is used for alling purposes only and is maintained at sufficiently high level to be heard any place within the office concerned. Immediately upon receiving a call, it is merely necessary for the operator to lift the handset from its hook to establish contact. The control units were originally wired for carrier control by means of the *push-to-talk* button on the handset. However, inasmuch as this system operates full duplex, the operation was simplified somewhat by disconnecting this feature and connecting two formerly unused contacts on the hang-up switch so that the carrier control relays are operated upon removal of the handset.

Installation and Maintenance

Installation of the equipment proved to 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.

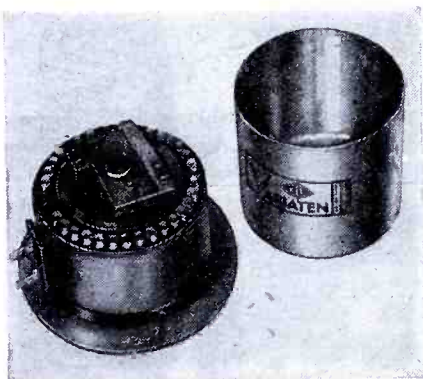


FLAT Contacts

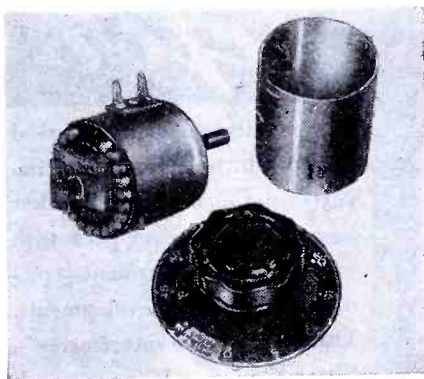
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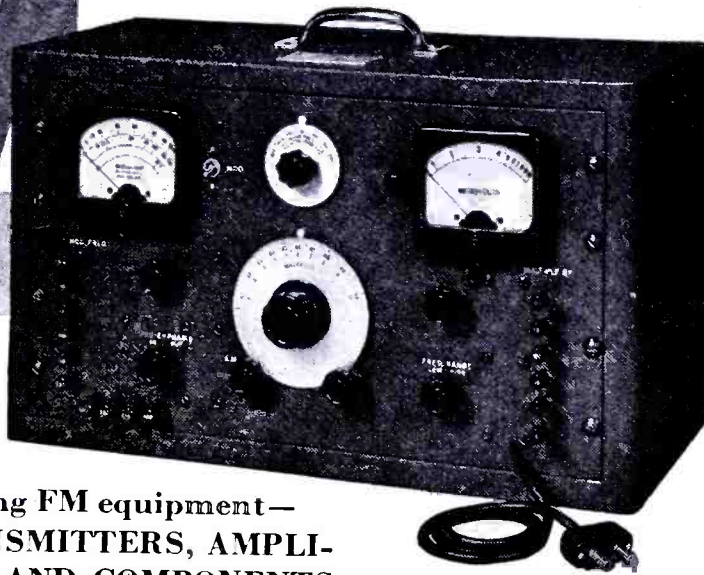
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 Type 152 A—Frequency 20-28 mc. and 0.05-5 mc.
 Type 154 A—Frequency 27-39 mc. and 1-7 mc.
 Frequency and Amplitude Modulation available separately or simultaneously.



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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 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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central control transmitter. The Greyhound Corporation in cooperation with several other city bus lines running into Chicago, will participate in the project. The system is expected to begin operations around November. The tentative plans, which are expected to lead to the development of a nationwide system of two-way radio on highway buses, provide for the operation of a 250-watt central transmitter in the Chicago Loop. Negotiations are under way for this installation atop the Board of Trade Building.

The buses will be equipped with 50-watt transmitters, combined with receivers. Greyhound plans to install the radio sets on buses of four of its lines—Pennsylvania, Central, Northland and Illinois—running into Chicago. In addition, three relay receiving stations will be located in outlying sections of Chicago. These stations will serve to pick up messages from buses on the highways for automatic relay and wires to the main control points of the various operating companies in Chicago. While the 250-watt central transmitter should be able to reach buses on the highways as far distant as 75 miles, low power of the bus transmitter and static interference of the Chicago Loop may not always permit clear reception except through the remotely-operated relay stations. Antennas at these relay stations may therefore be installed atop the large gas storage tanks that ring the city.

The development of the project is under the direction of Frank W. Walker, formerly chief radio engineer of the Michigan State Police, who recently joined Greyhound as communications engineer.

JOHN WANAMAKER TO INSTALL TELEVISION STUDIOS IN N. Y. STORE

Men B. DuMont Laboratories, Inc., will install three television studios in the main New York store of John Wanamaker. The studios will be operated in conjunction with DuMont television station WABD, New York.

The installation will include one giant studio 60' x 60' with a 50' ceiling, two smaller studios, a telecine room housing television cameras, and facilities for art work, property storage, dressing rooms and accommodations for live audiences.

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

CAPT. GEO. F. SCHECKLEN NAMED CAP AND G-M OF RADIOMARINE

Captain George F. Shecklen, USNR, has been selected vice president and general manager and also a director of the Radiomarine Corporation of America. Before entering the Navy on active duty in December, 1941, Captain Shecklen was commercial manager of RCA Communications, Inc.



FCC APPROVES A. T. & T. COAXIAL CABLE EXTENSION

A new coaxial link, extending from Meridian, Miss., to Shreveport, La., with 6 coaxials between Meridian and Jackson, Miss., a distance of about 99 miles, and 8 coaxials between Jackson, Miss., and Shreveport, La., a distance of about 240 miles, was approved recently by the FCC.

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

With the current approval the number of miles of the proposed project approved by the commission totals 1,482. With additional construction proposed by the company to complete the route of Los Angeles, the total route miles will be 3,287.

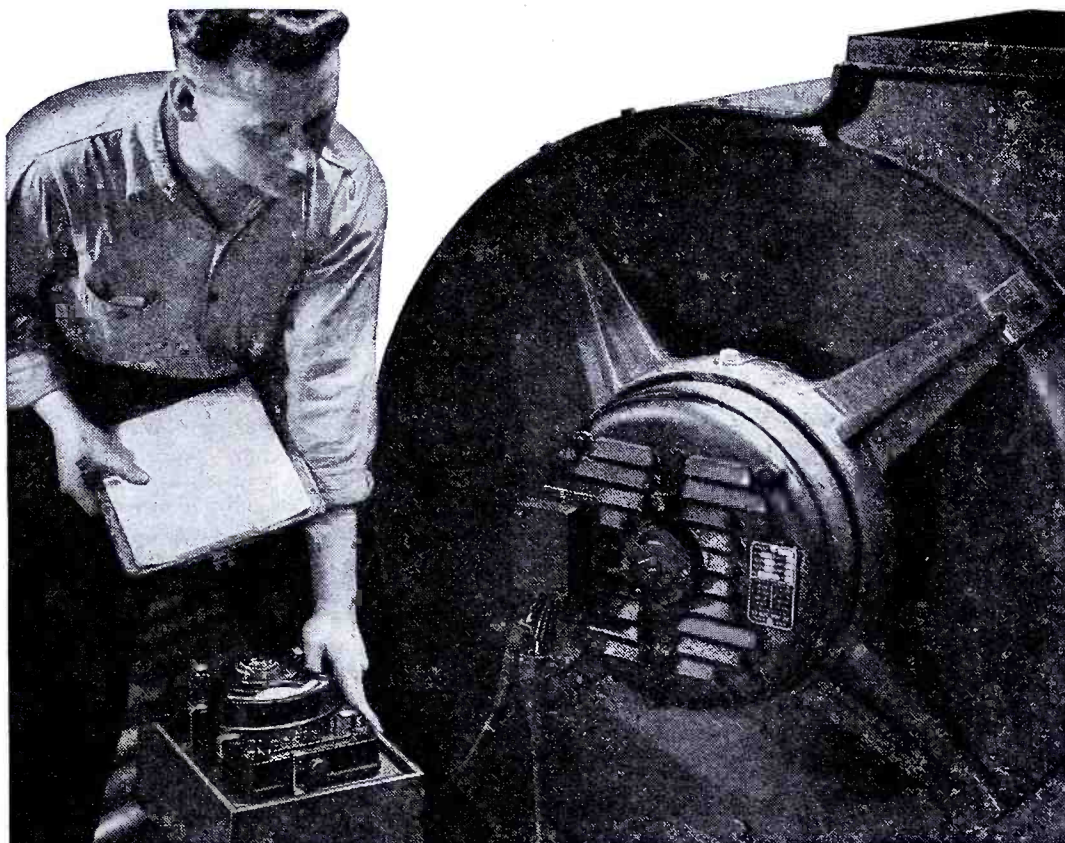
CBS U-H-F TELEVISION UNIT TO GO TO CHRYSLER BLDG., NEW YORK

The Columbia Broadcasting System expects to install their 485-mc color television transmitter

(Continued on page 94)

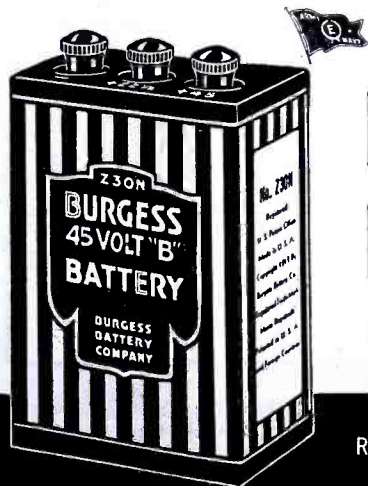
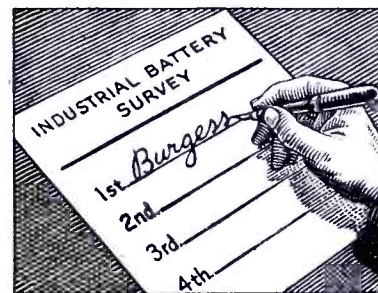
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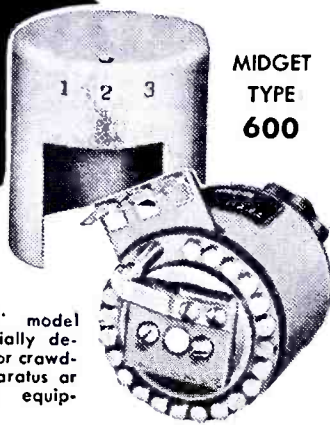
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NEWS BRIEFS

(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.

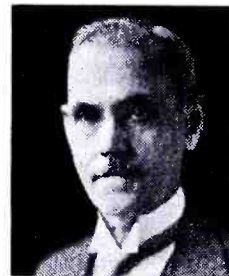
L. C. F. HORLE NOW RMA ENG. DEPT. CHIEF ENGINEER

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.

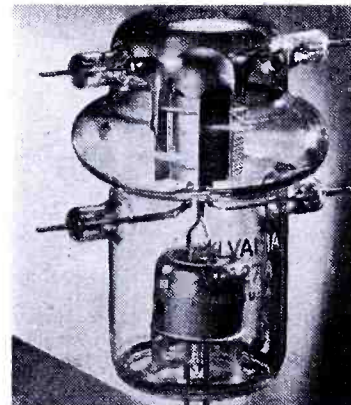
AIREON OPENS SAN FRANCISCO OFFICE

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

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.

MICROTORQUE

SENSITIVE • ACCURATE
RELIABLE

FUNCTIONS

- 1 Can be directly coupled to low torque indicating meters or movements (existing pressure, temperature gauges, etc.) by simple yoke on instrument pointer without interfering with instrument indicating function.
- 2 Ideal for take-offs from bellows elements (pressure, temperature, flow, etc.) causing negligible drag on control element.
- 3 Ideal amplifier follow-up components in bridge-type outputs—relatively large electrical outputs for small mechanical inputs.
- 4 Operate directly recorder-controllers, recording galvanometers, millimeters, oscillographs or polarized relays.
- 5 Indicate or record remotely positions of shafts, meters, or other mechanical elements.

WRITE SECTION V

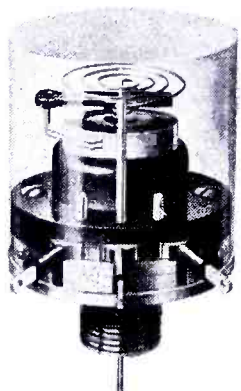


POTENTIOMETER

FOR REMOTE RECORDING
INDICATION CONTROL

FEATURES

- 1 Less than .003 oz. in. input torque
- 2 Linearity 1/2% or better.
- 3 Weight less than 3/4 oz. space envelope 1" x 7/8" cylinder
- 4 Vibration-proof, 4 to 55 cycles up to 6 g's.
- 5 2.5 Watts power dissipation.
- 6 Resistance 100 to 2500 ohms.
- 7 Jewel bearings, platinum metal brush and resistance material, highest quality contact performance.
- 8 Long life and dependability proved in many airborne and industrial applications.
- 9 Available in 270° potentiometer arrangement or continuously rotatable transmitter type—toroidal coil tapped at 120° intervals with twin brush take-offs separated by 180°



G. M. GIANNINI & CO., INC.

161 EAST CALIFORNIA STREET
PASADENA 5, CALIF., U. S. A.

York office of the RCA Frequency Bureau, 60 Broadway Street. He will direct RCA frequency allocation and station license activities.

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

Richard A. Glidewell is now sound products sales manager of the RCA International division; Lucien Begin has become technical consultant on RCA film recording.

Hubert H. Kronen has been elected vice president and general manager of RCA Victor Radio, a subsidiary of American Brazilian subsidiary with headquarters in Rio de Janeiro.

J. Chisholm has been named sales manager of the radio and appliances department, the position previously held by Mr. Kronen.

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

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

Lawrence B. Morris has resigned from the RCA Victor division of RCA. He was formerly vice president and general counsel and recently director of labor relations.

"E" AWARDS

John E. Fast & Company, Chicago, received the Army and Navy "E" pennant recently.

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

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

S. McCOMB, ACRO ELECTRIC, DIES

John S. McComb, Acro Electric Company, Cleveland, died recently.

WESTINGHOUSE NAMES LANDELLS COMMUNICATIONS ENGINEER

Joseph H. Landells has been appointed communications application engineer at San Francisco for Westinghouse Electric.

Mr. Landells will be responsible for coverage of the communications industry and radio broadcasting stations throughout the San Francisco Bay area.



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

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

The equipment will consist of a fixed radio transmitter and receiver, and mobile transmitter-receiving units installed on switching engines. Three main control points will be installed so that the yard office may be in constant communication with the crews in charge of engines switching the trains.

G. C. FELT JOINS MERTRAN AS AD MAN

George G. Felt has been appointed advertising and sales promotion manager of the American Transformer Company, Newark, N. J. During the war, Mr. Felt directed personnel relation activities in the Paterson plant of Wright Aeronautical.

R. E. FULTON BECOMES RCAC SUPERVISOR OF TRAFFIC OPERATIONS

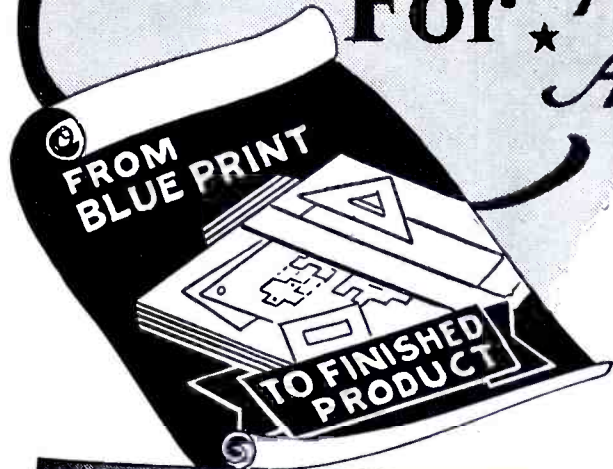
Harold E. Fulton has been appointed supervisor of traffic operations of RCA Communications, Inc. Mr. Fulton was formerly superintendent of the central radio office, New York. N. R. Cherrigan, district manager of RCAC in San Francisco, will move to New York to replace Mr. Fulton, and Harry E. Austin, district commercial manager, San Francisco, will succeed Mr. Cherrigan as district manager in that city.

F. Wilhelm, assistant district manager, San Francisco, has joined the administrative division.

(Continued on page 96)

Willor

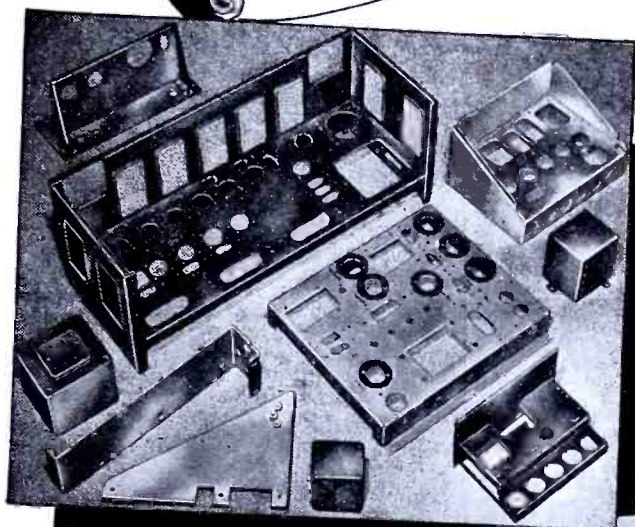
For *Precision Accuracy*



WILLOR STAMPINGS

A modern plant, including designing, Tool and Die making — automatic stamping — machining — welding — assembling — spraying — large or small production runs — special custom built products, at low cost.

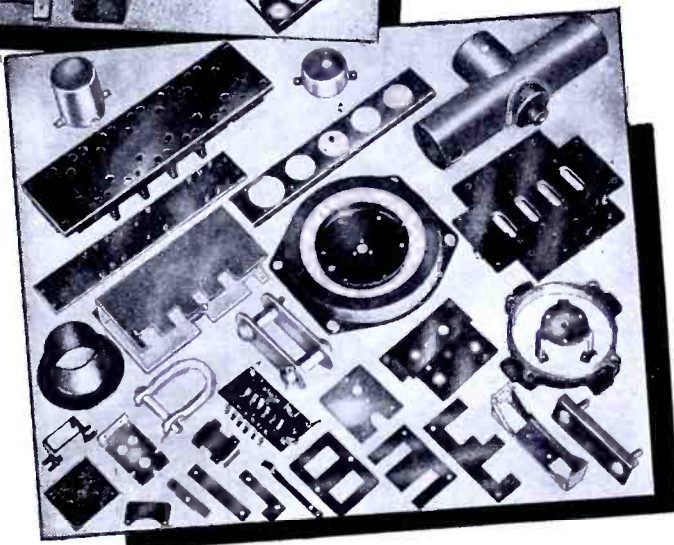
A Service . . .
Complete from
Design to
Finished Product



WILLOR

is your definite assurance of **SKILL** and **ACCURACY** for **PERFORMANCE**.

If your product is in the development stage or finished blueprint, write WILLOR for quotations. You will find our plant is prepared to produce to meet your needs.



Our large assortment of stock dies may fit your requirements and result in real savings for you.



WILLOR

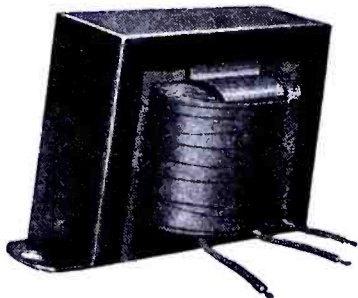
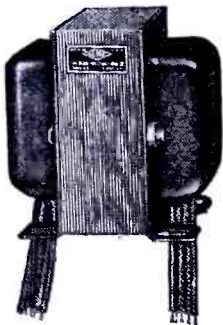
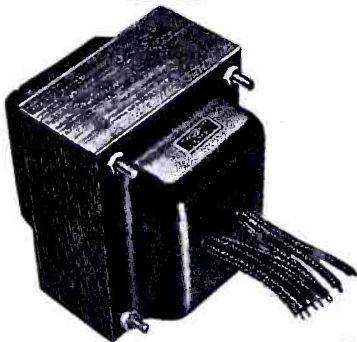
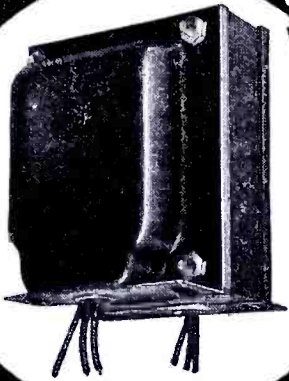
manufacturing Corp.

794 C EAST 140th STREET, NEW YORK 54, N. Y.

MELROSE 5-6085

OVER 40 YEARS OF EXPERIENCE

POST WAR RADIO TRANSFORMERS



THE ACME ELECTRIC & MFG. CO.
CUBA, N. Y.

Acme  Electric

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 Com-

pany, was recently elected president of the Acoustical Society of America.

Mr. Knowles was also recently honored by the Fellowship Award of the Institute of Radio Engineers for his outstanding contribution to acoustics.



EMERSON RADIO BUYS RADIO SPEAKERS, INC.

Emerson Radio & Phonograph Corporation acquired 100 per cent of the authorized and issued capital stock of Radio Speakers, Inc., Chicago Ill., recently.

Henry C. Forster has resigned as president and director of the company. Mr. Forster will remain with the company as consultant. Max Abrams has been elected president of the corporation and Morton E. Ornitz has become vice president and treasurer. George S. Holly remains as vice president in charge of engineering and production.

WESTINGHOUSE PROMOTIONS

A. C. Monteith has been named assistant manager of headquarters engineering and director of education of the Westinghouse Electric Corporation.

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

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

WUNDERLICH JOINS FTR

Norman Wunderlich has been appointed executive sales director of radio equipment and allied products for the Federal Telephone and Radio Corporation, Newark, N. J. Mr. Wunderlich

VACUUM CHECKING



Vacuum checking units used to check sealing glass-to-metal 2½" and 3½" hermetically sealed instruments, developed by Marion Electrical Instrument Co., Manchester, New Hampshire. Instruments are submerged in glass jars, partially filled with alcohol. A vacuum of 25" is drawn in accordance with Jan. 1-6 spec. During production checkers watch for air bubbles which would indicate imperfect sealing. Spot checks for a period of four hours are made in a 29" vacuum.

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

- Impervious to moisture, grease, oils, acids, alkalis.
 - Printing guaranteed not to wash or rub off.
 - Non-inflammable, non-corrosive plastic.
 - Printed and laminated vinylite and cellulose acetate.
- SAMPLES AND ESTIMATES GLADLY SUPPLIED ON REQUEST
WRITE DEPARTMENT C

THE HOPP PRESS, INC.
PRINTING - FABRICATING - FORMING

460 W. 34th STREET, N. Y. C.
ESTABLISHED 1893

sh was formerly manager of the communications and electronic division of the Galvin Manufacturing Corporation.
his new post Mr. Wunderlich will direct sales sections embracing broadcast equipment, industrial electronics, rectifier equipment, aerial navigation, mobile radio equipment, components.



GATES EXPANDS

Gates Radio Company, Quincy, Ill., has moved to larger quarters in a new building. The Specialty Distributing Company will report Gates in the Southeast: Atlanta, Georgia; Chattanooga, Tennessee; Savannah, Georgia; and Macon, Georgia. The Houston Radio Company of Houston, Texas, has been named Southcentral distributors in Texas, Louisiana and Mississippi.

WINNE NAMED HEAD G.E. ENGINEERING

Ray A. Winne, vice president in charge of engineering for the G. E. apparatus department, has been appointed vice president in charge of engineering policy for the entire company. Ernest E. Johnson, assistant engineer of the nautics and marine engineering division, succeeds Mr. Winne.

MORROW BECOMES RME G-S-M

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



ARCO NAME CHANGE

Steel Construction Co., Inc., 1180 East 12th Street, Elizabeth, N. J., will hereafter be known as Harco Tower, Inc.

PERSON-TRAVIS TO MAKE MARINE, AIRCRAFT, MOBILE AND FIXED UNITS

erson-Travis, N. Y., will soon begin the mass production of marine, aircraft, mobile and fixed station equipment. Marine equipment will include a 10-watt radio-telephone, with four crystal controlled transmitting and receiving channels; 25-watt radio-telephone, with five crystal controlled transmitting and receiving channels; 75-watt radio-telephone, with ten crystal controlled transmitting and receiving channels; direction finder, and a high-gain top-loaded antenna. Projected aircraft units include a 2-watt light-transmitter-receiver; and 15-watt cabin transmitter-receiver.

Mobile and fixed station equipment planned includes a 30-watt, f-m transmitter and receiver for police, fire and general mobile and radio communications service; a high gain top-loaded vehicular antenna; and a 15 tube

ANTENNAS

EST.



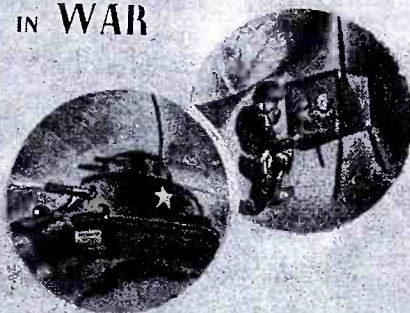
1906

For every radio purpose

BRACH ANTENNAS

since the beginning of radio broadcasting have been pace-makers in their field

IN WAR



IN PEACE



BRACH Antennas, tested and perfected to meet Army and Navy standards, are doing their part for victory on land, on sea, and in the air.

After the war, BRACH Puratone* Antennas will again resume their established leadership for Home and Auto Radios, Television, Marine, F.M. and other services.

TODAY AND IN THE FUTURE

... FOR *antennas* REMEMBER

*Reg. Patent Trade Mark



World's Oldest and Largest Manufacturers of Radio Antennas and Accessories

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.

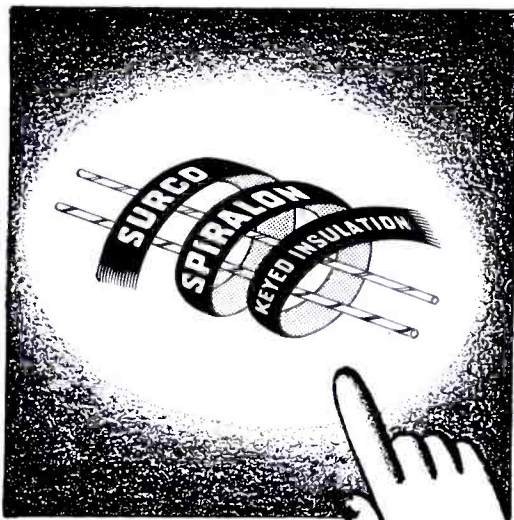


FRANCIS SMITH BECOMES ROLA CHIEF ENGINEER

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)



EASILY, QUICKLY IDENTIFIED!

**Unlimited coding
plus maximum
insulation resistance**

Spiralon, a new Surco plastic insulated wire, spiral striped, offers the widest range of tracer code identification in small as well as large sizes of wire, in short as well as long lengths. By avoiding use of color pigments, the primary covering retains full insulation resistance.

With Nylon Jacket

Spiralon reduces weight, permits a smaller OD., increases fungi and abrasion resistance, allows increased voltage, improves all electrical properties, eliminates all voids in the covering which ordinarily weaken such properties, resists creepage when terminals are being soldered or injury to wire insulation when accidentally touched by a hot soldering iron in production and overcomes deterioration from age. This high heat, low temperature non inflammable nylon jacket has already proved to be ideal for many applications.

A complete presentation on Spiralon is on the press. Please ask for your copy.

Address Dept. L

Surprenant
ELECTRICAL INSULATION CO.
84 Purchase St., Boston 10, Mass.

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

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.

recently elected a vice president of the International Telephone and Telegraph Corporation.

NORAN E. KERSTA RETURNS TO NETWORK

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

HOLLIDAY-HATHAWAY TO COVER NEW ENGLAND FOR CARTER

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

JOHNSON TO HANDLE MAGUIRE EXPORTS AND IMPORTS

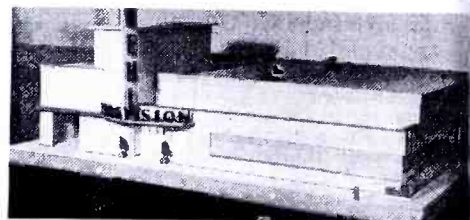
Harold E. Johnson has been named managing director of Maguire Internacional, S.A., a division of Maguire Industries, Inc., in Mexico Central America.

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

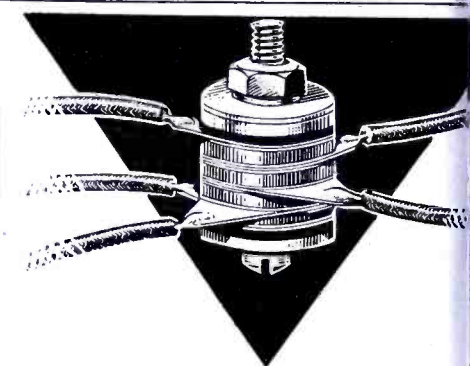
JENSEN LOUDSPEAKER MONOGRAPH

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

MODEL TELEVISION STATION



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



ELECTROX
Low-Capacity
RECTIFIERS

Full-wave and half-wave copper-oxide rectifiers for instruments, test-sets and similar applications. Supplied, since 1930, to leading manufacturers.



Write for illustrated Bulletin 446.

SCHAUER MACHINERY COMPANY
2075 READING RD., CINCINNATI

The New Speed-Chek Tube Tester

MORE FLEXIBLE • FAR FASTER • MORE ACCURATE

Three-position lever switching makes this sensational new model one of the most flexible and speediest of all tube testers. Its multi-purpose test circuit provides for standardized VALUE test; SHORT AND OPEN element test and TRANSCONDUCTANCE comparison test. Large 4" square RED • DOT life-time guaranteed meter.

Simplicity of operation provides for the fastest settings ever developed for practical tube testing. Gives individual control of each tube element.

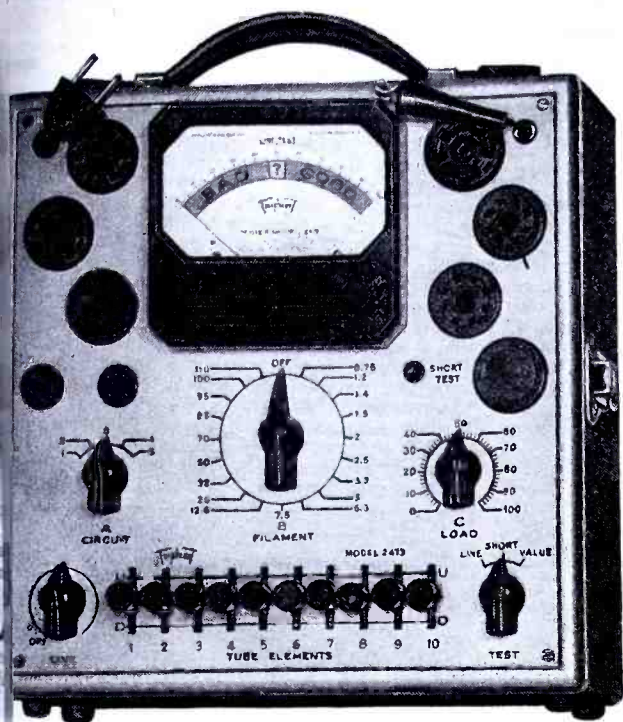
New SQUARE LINE series metal case 10" x 10" x 5½", striking two-tone hammered baked-on enamel finish. Detachable cover. Tube chart 8" x 9" with the simple settings marked in large easy to read type. Attractively priced. Write for details.

Model 2413

is another member of the **NEW TRIPLETT Square Line**

Additional Features

- Authoritative tests for tube value; shorts, open elements, and transconductance (mutual conductance) comparison for matching tubes.
- Flexible lever-switching gives individual control for each tube element; provides for roaming elements, dual cathode structures, multi-purpose tubes, etc.
- Line voltage adjustment control.
- Filament Voltages, 0.75 to 110 volts, through 19 steps.
- Sockets: One only each kind required socket plus one spare.
- Distinctive appearance makes impressive counter tester.



*Precision first
...to last*



Triplet

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO



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

HENNING NAMED WOOD-LINZE SECRETARY

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



FISHER TO REPRESENT HETHERINGTON ON WEST COAST

Robert Hetherington & Son, Inc., Sharon Hill, Pa., has opened an office at 5607 W. Adams Street, Los Angeles, California. Sales activities will be under the direction of C. E. Fisher, formerly with the Glenn L. Martin Company, Baltimore, Md.

VULCANIZED RUBBER COMPANY TO CHANGE NAME

The Vulcanized Rubber Company, New York and Morrisville, Pennsylvania, has decided to change its name to Vulcanized Rubber and Products Company.

LEE TO INSTALL

A new television transmitter is being built by the Don Lee television and broadcasting company, New York, N.Y., for the west-coast network has filed with the FCC for permission to install the transmitter

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.

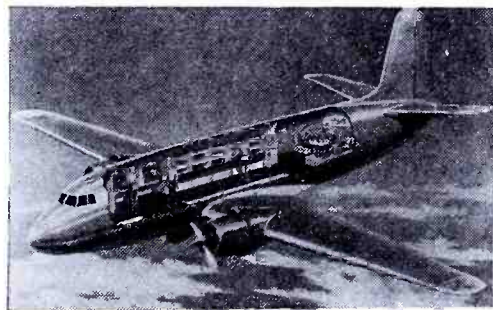
IRC SUPPLEMENTAL RESISTOR CATALOG

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 capaci-

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.

tors 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

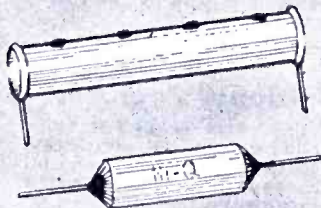
A 36-page electrical contact catalog and data book, No. 12, has been issued by the Stackpole Carbon Co., St. Marys, Pa. Presented are data on contact materials with notes on the applications of each type; materials; contact types, shapes, and sizes; methods of attaching contacts; contact metal compositions,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

PIEZO MANUFACTURING CORP. TO MAKE PIEZOELECTRIC CORP. REMOTE CONTROLS

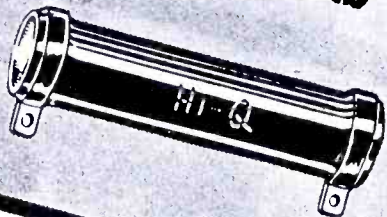
The Piezo Manufacturing Corporation, 110 East 42nd Street, New York 17, New York, has become exclusive manufacturer of remote control equipment formerly manufactured by Piezoelectric Corporation. The successor company will continue to sell remote control joints, assemblies and related accessories throughout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

Hi-Q

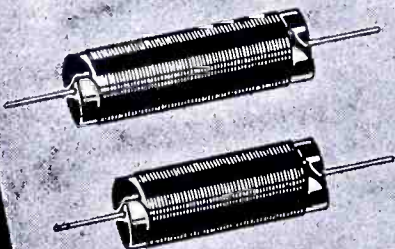
CERAMIC CAPACITORS



WIRE WOUND RESISTORS



CHOKE COILS



ELECTRICAL REACTANCE CORPORATION

FRANKLINVILLE, N. Y.

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 electrofilm 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.

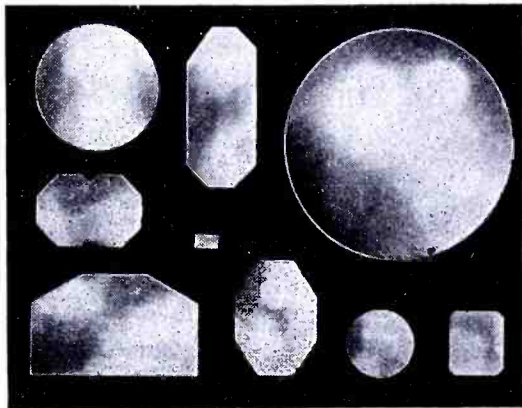
ZENITH OPTICAL MIRRORS AND REFLECTORS

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.

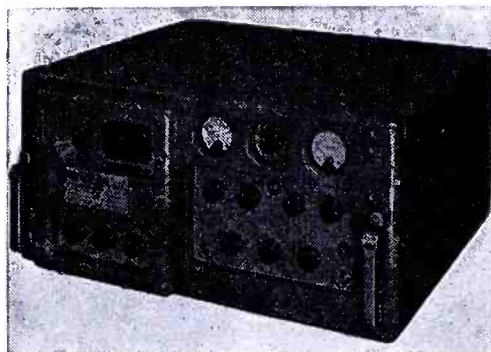
Mirrors are said to have permanent reflectivity characteristics. Aluminum alloy mirrors are said to be particularly useful because their reflectivity curve is virtually a straight line from the infra-red to the ultra-violet.



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.



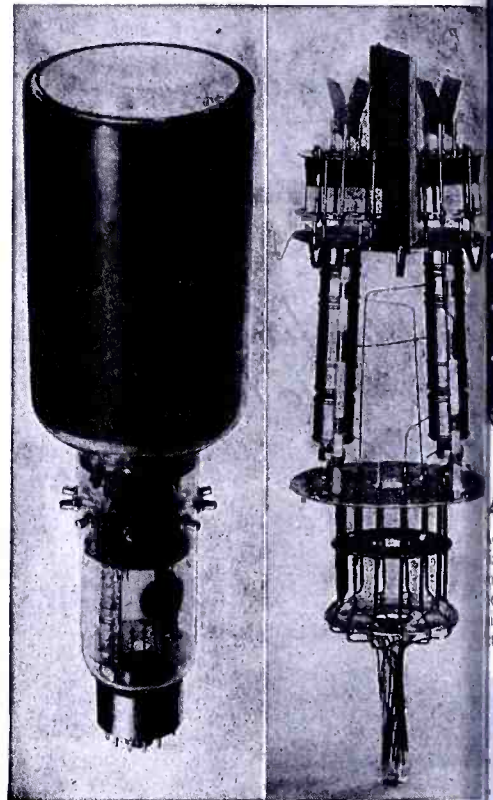
DUMONT DOUBLE-BEAM TUBE

A double-beam c-r tube, 55P, 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 placed side by side, or by using an electronic switch present first one phenomenon and then other on the same tube screen in rapid succession.

The two guns are contained in a 5" envelope. Independent control of the X, Y and Z functions for each beam are provided. Deflection 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 is the standard socket. The electrode voltage ratings are similar to those of the Army-Navy preferred type 5CP1. Constant connectors electrode leads are supplied with the tube.



GOODRICH PLASTICS

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

Kriston monomer is a somewhat viscous, water-clear, anhydrous liquid having a specific gravity of 1.25 which can be cast in simple molds. It sets to a hard, heat-resistant plastic. No water or other volatile products are said to be released during the polymerization, facilitating the preparation of dense, non-porous articles.

Kriston polymer is said to have a refractive index of about 1.57. The material can be made into a water-clear plastic or made in a wide range of colors which can be transparent, translucent or opaque.

STANDARD PIEZO MIDGET CRYSTALS

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

TRIPLETT VOLT-OHM-MILLIAMMETER

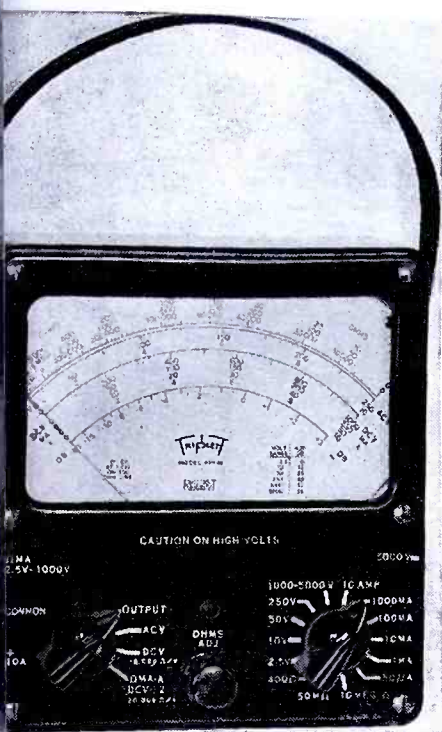
A volt-ohm-milliammeter, 62 5-N, with dual sensitivity d-c voltage ranges (10,000 and 20,000 ohms-per-volt) has been produced by the Triplett Electrical Company, Bluffton, Ohio.

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

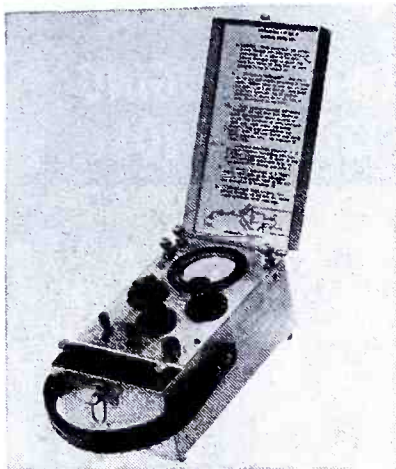
Resistance ranges: 0-400 ohms (60 at cent

); 0-50,000 ohms (300 at center scale); 0-10 ohms (60,000 ohms at center scale). Direct reading output level decibel ranges: +3, +15, +29, +43, +55, +69 db. A sensor is in series with a-c volt ranges for its readings. Indicating instrument is 6"; 5" scale. Black, metal case, 6" x 5½" x 2½".



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

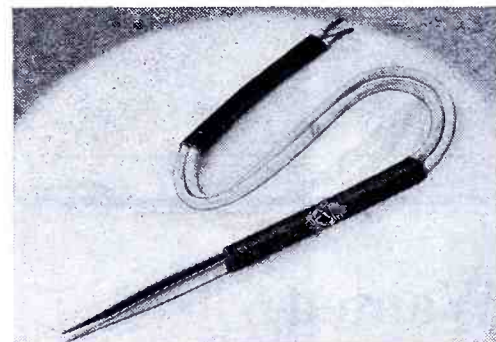
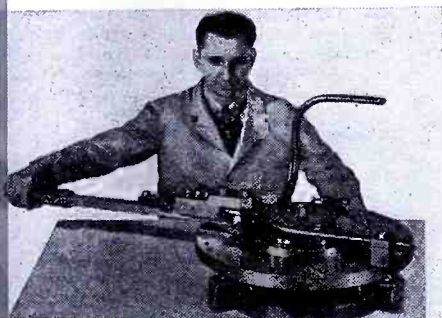
Spot welding tweezers have been announced by the New Jersey Jewelers' Supply, 280 Plane Street, Newark 2, N. J.

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.

CRO BENDERS

Cro benders, featuring Torrington roller rings have been produced by the O'Neil Mfg. Co., Minneapolis 15, Minn. Larger No. 2 and 3 size benders have control levers which reverses forming direction of the bender nose.



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)

NILSSON LINEMAN'S BRIDGE

Lineman's bridge to measure the resistance of wires as well as the unbalance between two lines has been developed by Nilsson Electrical Laboratory, Inc., 103 Lafayette Street, New York 13, N. Y. Reading on loop can be changed to unbalance reading by throwing a switch changing the position of three decade dials.

SPEAKER LABORATORY ASSISTANT

Eastern manufacturer many years in business, with fine post-war picture, can use young engineer, preferably with some speaker experience, to assist in design and development work. Fine opportunity. Salary open. State age, education and experience.

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VHF RECEIVER KIT
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FM*AM



88.6 to 107.6 Mc

115 to 140 Mc

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ACORN TUBES

Ideal for Communications Work,
Instruction, Training, etc.

A unique 10 tube Concord Kit for FM-AM and VHF reception with a separate tuning unit employing the new acorn tubes. Circuit design is straightforward and simple with no frills or unnecessary components. Extremely compact, sturdy and easily assembled. Has only two controls on the front panel—the tuning control and the volume control. There's a standard headphone jack for output, a switch for change-over from FM to AM, and a power switch in the AC line.

Comes complete with all necessary parts including holes punched and all tubes, wire, solder, hardware, and detailed instructions. Chassis is 10" x 12" x 3" black finish. Dull black panel is 6¼ x 12" wide. Two models—CRC-130—Range 88.6 to 107.6 Mc (for the new FM Band), and CRC-140—Range 115 to 140 Mc. Quantity limited—while they last—Use coupon below to order to—\$54⁹⁵ day or to ask for literature giving detailed information and specifications.

CONCORD RADIO CORPORATION
Lafayette Radio Corporation
CHICAGO 7, ILL. ATLANTA 3, GA.
901 W. Jackson Blvd. 265 Peachtree Street

Concord Radio Corp.
901 W. Jackson Blvd., Dept. R-95 Chicago 7, Ill.
Please ship at once the Concord VHF Receiver Kit—or special descriptive literature—as checked below.

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 Send literature giving details and specifications

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Address.....
City..... State.....



**THERMOSTATIC METAL TYPE
DELAY RELAYS
PROVIDE DELAYS RANGING
FROM 1 TO 120 SECONDS**

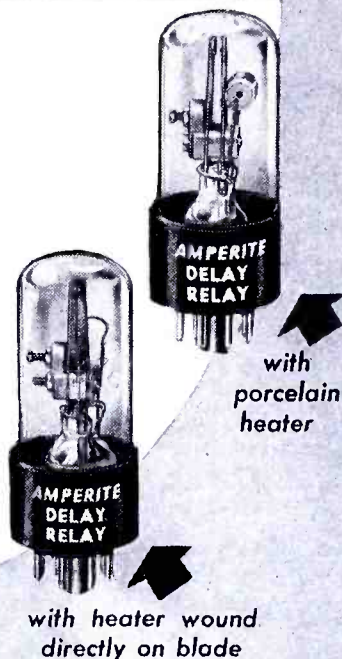
Other important features include:—

1. Compensated for ambient temperature changes from -40° to 110° F.
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5. Compact, light, rugged, inexpensive.
6. Circuits available: SPST Normally Open; SPST Normally Closed.

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**AMPERITE CO. 561 BROADWAY
NEW YORK 12, N. Y.**

**In Canada: Atlas Radio Corp., Ltd.
560 King St. W., Toronto**

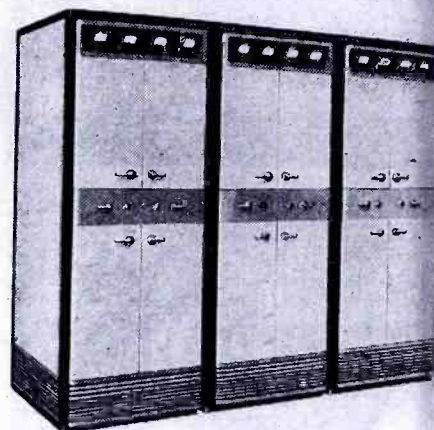


THE INDUSTRY OFFERS . . .

(Continued from page 101)

ial lines, combining high power gains with critical tuning, and consist of from 1 to 12 more loops, each embodying two or more wave elements. The arrays are factory-tuned for easy installation.

Center frequency stability is obtained by phase discriminator in the basic unit which locks the center frequency to the crystal oscillator frequency. Negative feedback is used in the last power stage of the exciter.



G. E. SMALL CAPACITORS

Small capacitors with removable mounting brackets have been announced by G. E. Brackets can be obtained with all small, rectangular case capacitors for use in either a-c or d-c applications, and can be clamped over either top or bottom flange of the case permitting unit to be mounted in an upright or inverted position.

AIRADIO PRIVATE AIRCRAFT RECEIVER-TRANSMITTER

A lightweight two-band two-way receiver-transmitter for private aircraft has been developed by Airadio, Incorporated, Stamford, Connecticut. The set offers standard plane-to-ground communication, radio range, weather broadcast and standard broadcast reception, as well as interphone between pilot and passengers. Incorporated in receiver is a radio-range filter.



HEXACON SOLDERING IRONS

Electric soldering irons for operation off 12-24-volt batteries have been announced by Hexacon Electric Company, 173 W. Clay Avenue, Roselle Park, New Jersey.

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



BUCHANAN PLUG CONNECTOR

A plug connector, with multiple-fingered spring inserts that are said to provide uniform pressure on long-wiping contacts, has been developed by Buchanan Research Laboratories, 100 West Jersey St., Elizabeth, N. J., and by Pe Union Electrical Corporation, Erie, Pa.

Known as Lok-Plug Connectors, they are furnished for surface or flush mounting; available for snap-on installations.

To facilitate circuit identification, insulation

Draftsmen Wanted

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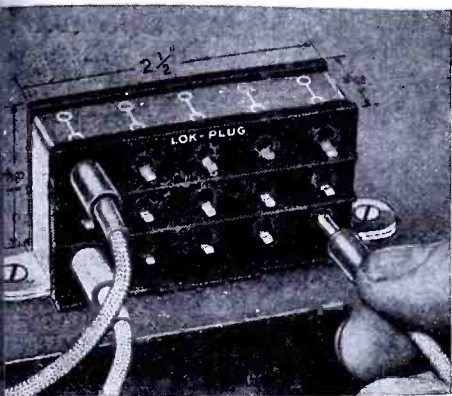
Federal Telephone & Radio Corp.

the Mfg. unit of the International Tel. & Tel. Corp.

591 BROAD ST., NEWARK, N. J.

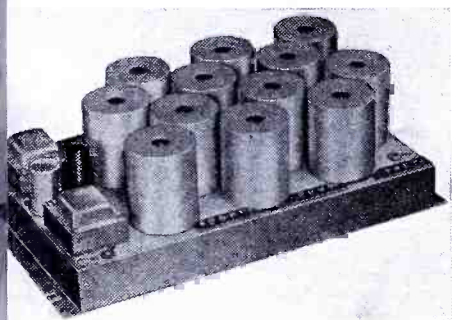
W M C Rules Observed

...es are available in six solid colors and in
...y color combinations.



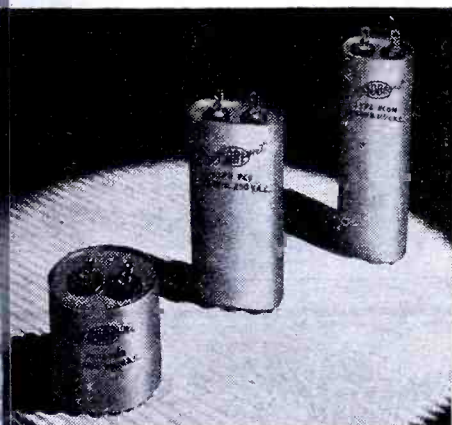
ANDREW ANTENNA TUNING UNIT

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



**DEUTSCHMANN POWER
CORRECTION CAPACITORS**

...mpregnated, oil-filled capacitors for fluores-
... lamp service, have been announced by the
... Deuschmann Corporation, Canton, Mass.
... mined in hermetically sealed metal cases;
... regnated and filled with pure mineral oil.
... ating temperatures range from -67° to
... 5° F.
... -tight terminals are insulated with phen-
... bushings and provided with tinned copper
... ring lugs.
... available sizes include capacitances from 2.0
... 25 mfd and working voltages* from 165 a-c
... 0 a-c. The standard capacitance tolerance
... + 20%.

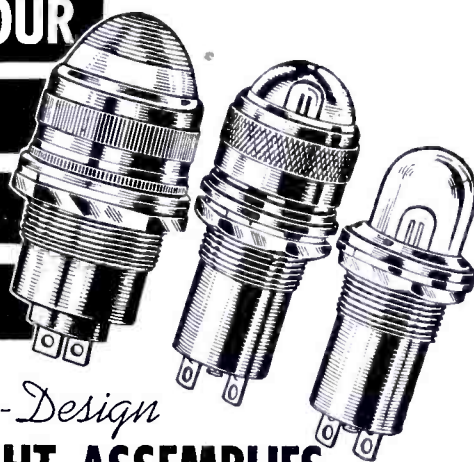


**R. U-H-F HETERODYNE
FREQUENCY METER**

... battery-operated 10-3,000-mc heterodyne fre-
... quency meter, type 720-A, has been produced
... by General Radio Company, 275 Massachu-
... Ave., Cambridge 39, Mass.
... The internal oscillator covers a frequency
... range of 100-200 megacycles. For frequencies
... below 100 megacycles harmonics of the un-
... known frequency are made to produce beats
... with the internal oscillator. For frequencies
... above 200 megacycles, harmonics of the internal
... oscillator produce beats with the unknown fre-
... quency.
... The internal oscillator uses the butterfly cir-
... cuit in which capacitance and inductance are
... (Continued on page 104)

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This book furnishes the links in mathematical reasoning necessary to use the available feedback amplifier theory and mathematical methods in solving problems in servomechanisms.

It is therefore a direct aid to the man who must make practical applications of servomechanisms. In addition to the basic mathematical theory, it includes a study of a simple, yet frequently used servomechanism.

A few of the chapter headings indicate the scope of the book: Provisional definition; Description and rudimentary theory; Auxiliary formulae; Stability; Performances. Also included is much hitherto unpublished information—on oscillating control and sampling.

Emphasis is placed upon the essential identity of servomechanism theory with the highly developed theory of feedback amplifiers. This volume, therefore, may well be used in conjunction with "Network Analysis" by Dr. Bode, described here.

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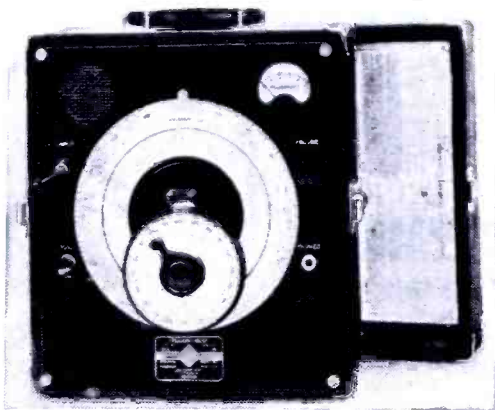
ADDRESS

CITY STATE

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, 10¼" x 11¼".



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 5/8"-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 1½ 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.

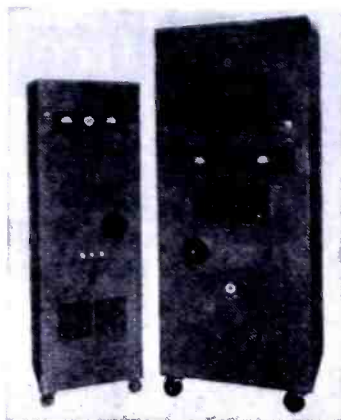
The life-test cabinet accommodates six triodes with total plate dissipation of over 2 kw. This unit incorporates continuously variable filament supply, a filament voltmeter, regulated grid supply, plate ammeter, circuit breaker, supervisory lamps, door safety switches and interlock circuits associated with the plate supply rectifier. The interlock cir-

THE INDUSTRY OFFERS . . . —

(Continued from page 103)

cuts cut off plate supply if the grid bias fails, or if the access doors are opened.

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 balance whereas slightly off balance the eye is open a small angle.

A-M-P SOLDERLESS WIRING ADAPTER

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

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

Adapters for vertical or horizontal conversion 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 by Precision Scientific Co., 1750 N. Spring Ave., Chicago 47, Ill.

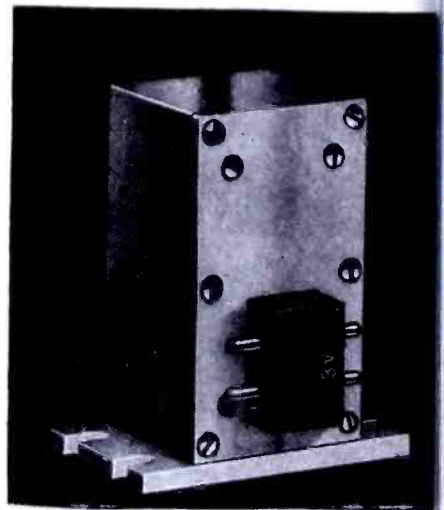
Precision Scientific engineers say that used with a moderately high-speed pump system, the gage actually outgasses its filament is protected before and during operation automatically in that current will not filament before pressure of 1 micron has established and turns off automatically if pressure rises above 1 micron.

STATHAM ACCELEROMETERS

A series of accelerometers whose sensitive element consists of unbonded strain sensitive elements has been developed by Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, California. Grid-form filaments are connected Wheatstone bridge circuit of which all arms are active. The bridge circuit is balanced in assembly. There are four electrical terminals, one at each corner of the bridge. A small dry-cell battery is connected to two of them, and the other two are connected directly to a recording galvanometer.

The natural frequencies of these accelerometers vary from 100 to 1,000 cycles per second, depending upon their acceleration range. The 12 G accelerometer has a natural frequency of 400 cps.

Weight is 2 ounces.



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FILTER PERFORMANCE

(Continued from page 48)

charts are necessary, although Figure 1 includes a plot for the prototype pass-band (straight line). To illustrate the practical use of the charts, we will make up the filter of the preceding paper and determine what grade of coils (A, B or C) should be used in its construction.

Example

The specification for the filter in the preceding paper included the following:

Maximum attenuation for the pass-band

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

Frequency number for the boundary frequencies of the pass-band, or edge frequencies

$$n_a = 0.134$$

The filter number had the value

$$F = 0.1875$$

We are particularly interested in the edge frequencies, because if the attenuation requirement is met at these frequencies, we may be sure that it is met throughout the pass-band. Elementary considerations show that

*In a previous paper, July COMMUNICATIONS, statement . . . for prototype sections, $S = 0$ could read . . . for prototype sections, $S = \infty$.

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Genuine Birtcher, Locking-style Tube Clamps, manufactured from type 302 Stainless Steel, have proven their worth in over THREE MILLION APPLICATIONS.

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the attenuation introduced by dissipation 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.

1—Prototype section ($S = \infty$)

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 ($d = 1/200$)

$$V_a = \mp 0.00975$$

$$\alpha = 0.2 \text{ db (from Figure 2)}$$

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

$$V_a = \mp 0.0195$$

$$\alpha = 0.4 \text{ db (from Figure 2)}$$

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

$$V_a = \mp 0.039$$

$$\alpha = 0.75 \text{ db (from Figure 2)}$$

2—Derived section ($S = 0.605$)

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)

$$\alpha = 0.4 \text{ db}$$

Type B

$$V_a = 4.42/100 = 0.0442$$

$$\alpha = 0.8 \text{ db}$$

Type C

$$V_a = 4.42/50 = 0.0884$$

$$\alpha = 1.51 \text{ db}$$

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

$$V_a = 4.72/200 = 0.0236$$

$$\alpha = 0.4 \text{ db}$$

Type B

$$V_a = 4.72/100 = 0.0472$$

(Continued on page 106)

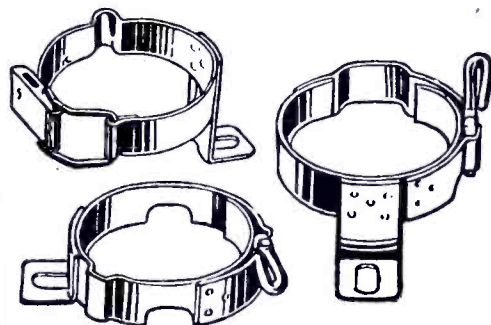
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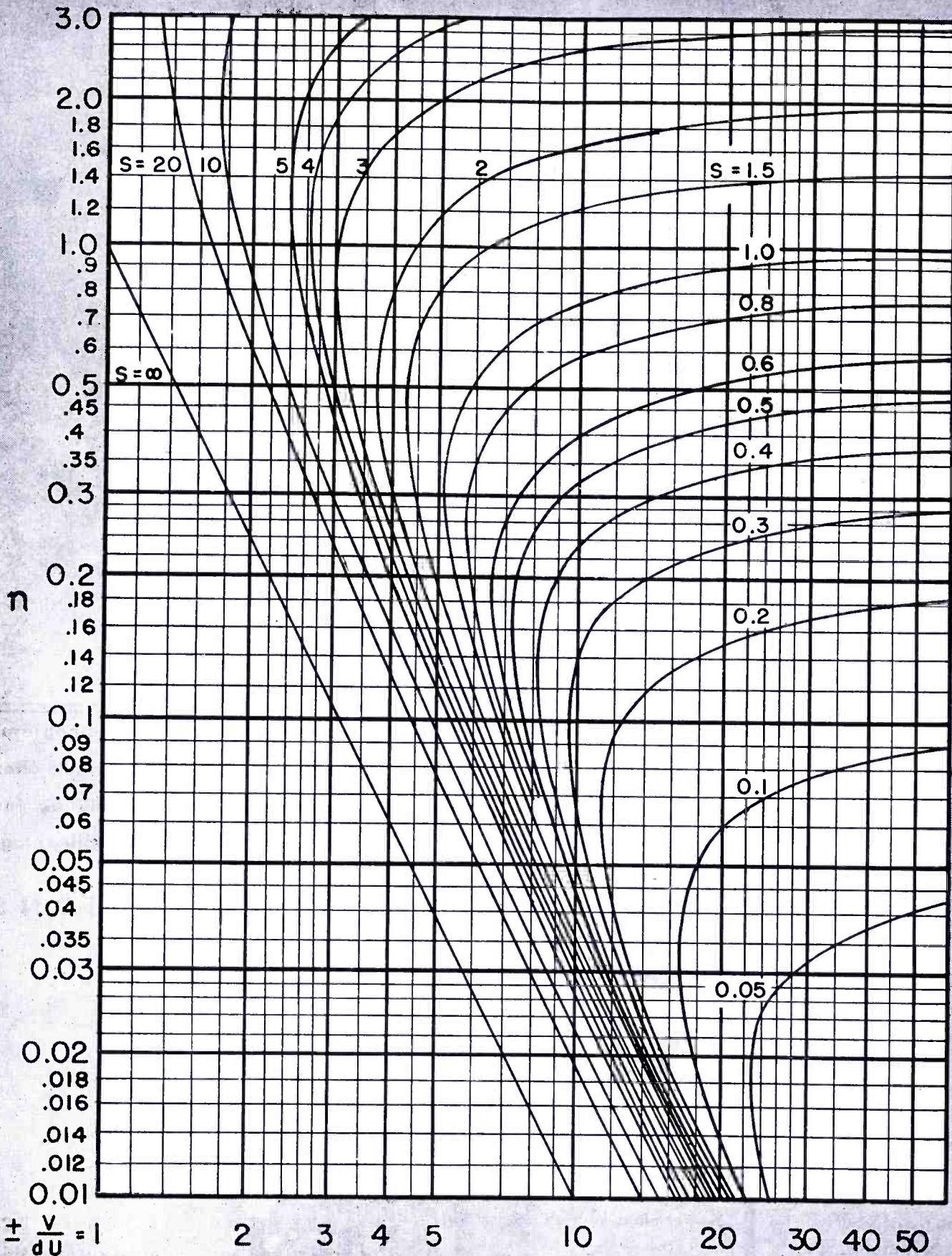


Figure 4
Values of $\frac{V}{du}$ for dissipative band-pass filters.

$\alpha = 0.85$ 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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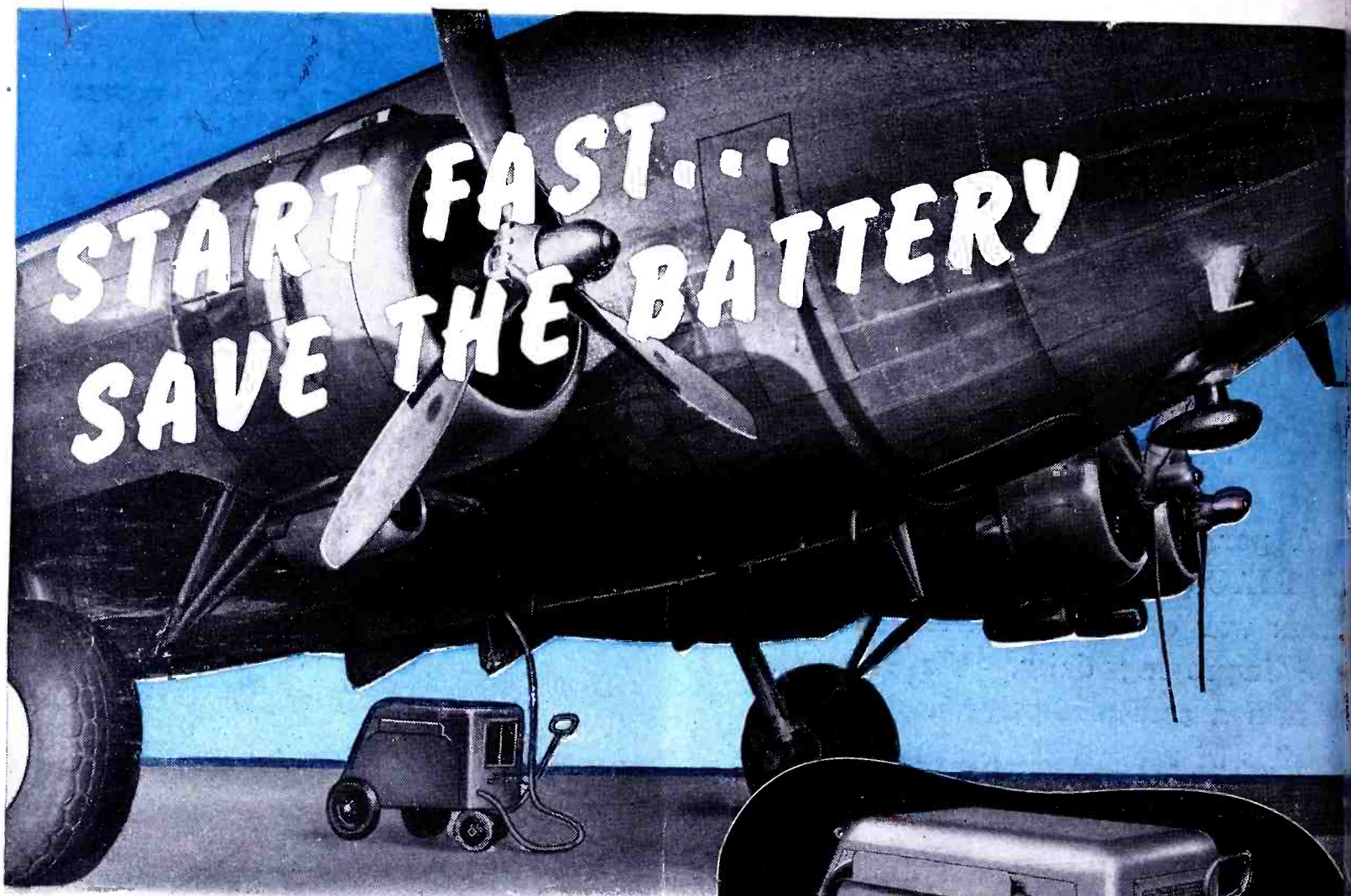
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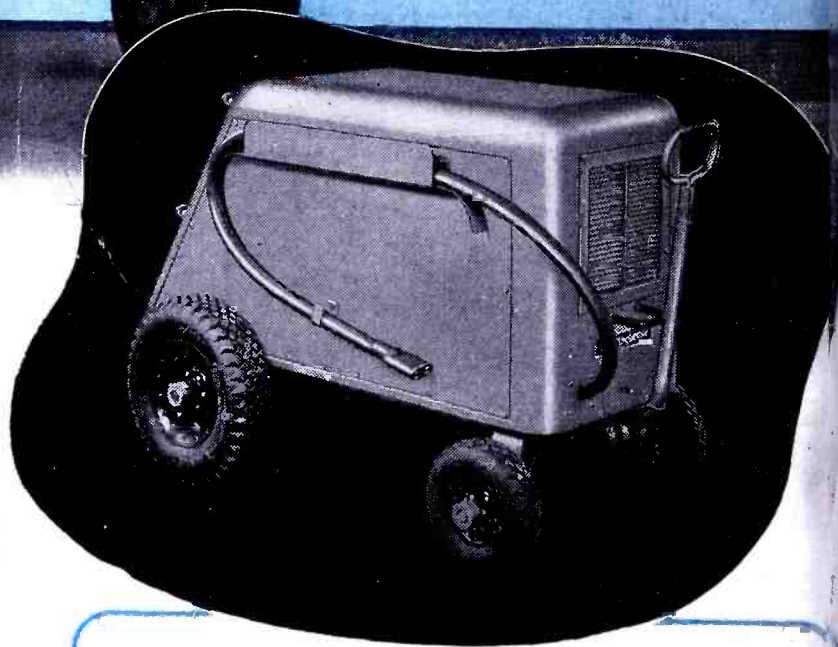


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