NOVEMBER, 1926 25 CENTS

RADIO

(Reg. U. S. Patent Off.)

Cunningham RADIO TUBES

SINCE·1915 STANDARD FOR·ALL·SETS

ALL·TYPES·C·AND·CX IN·THE·ORANGE AND·BLUE·CARTON

SOLID, SUBSTANTIAL
as to value---

DELICATE, PRECISE
as to performance---

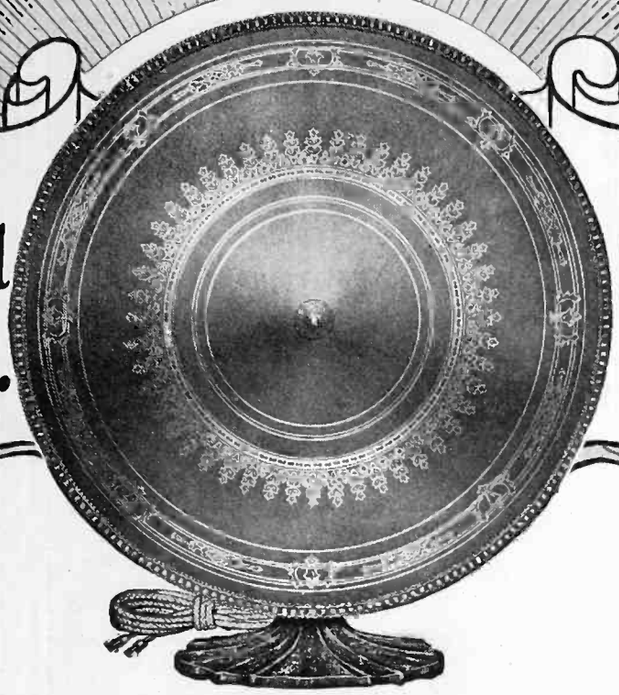
That, in a nut-shell, is the reason why Cunningham Radio Tubes won the complete confidence of radio owners away back in 1915 and why they hold this confidence today.

Radio tubes face a most extraordinary task. They must have rugged strength—a strength that will endure through hour after hour of gruelling service. Yet they must also have accuracy that transcends all normal scientific standards. Cunningham Radio Tubes meet these exacting requirements year after year. By sheer merit, they have won their way into the sockets of America's finest radio receivers.

E. T. Cunningham Inc.

NEW YORK CHICAGO SAN FRANCISCO

Manufactured and sold under rights, patents and inventions owned and/or controlled by Radio Corporation of America.



World's lowest priced Quality cone speaker

$9.50

The Tower cone

WHEN the public was paying inflated prices for radio equipment in 1922, Tower inaugurated a sales policy revolutionary in the extreme. Instead of marketing a headset at a high price, the best possible pair of phones was designed, priced at *less than half* competitive prices, and then produced on a volume scale hitherto unknown. In an incredibly short time Tower became the world's largest exclusive manufacturer of headsets.

Today, with equal foresight, confident that highest quality at lowest cost is forever the "best policy," Tower offers a new Cone Speaker—the outstanding value in radio reproduction with all the quality of many speakers costing two or three times as much.

See and Hear the Tower Cone.
On sale from coast to coast.

TOWER MFG. CORP.

BOSTON, MASS.

Instantly – they have set a *new* standard of what a tuning control should be

BRAND NEW... yet it is already the distinguishing mark of a 1927 model receiver.

Such is the reception accorded the MAR-CO illuminated control by leading technical authorities and circuit designers everywhere

... a reception paralleled only by the widespread acclaim which, a year ago, swept 500,000 MAR-CO vernier dials into use.

Today ... MAR-CO tuning is standard or optional equipment in virtually *every* important set-design of the season:

Radio Broadcast's
"LAB" Receiver
MAR-CO *controls specified equipment*

Cockaday's L. C. 27
Entirely MAR-CO-tuned, using the illuminated control and 2 MAR-CO rheostat dials.

Radio News'
"Auto-transformer"
MAR-CO *controls standard equipment*

Popular Science's
5-tube receiver
MAR-CO *dials standard equipment; illuminated controls optional*

Cardwell "Short-Wave" Set
MAR-CO *360° dials specified*

Radio News'
"Portable Super-Het"
MAR-CO *dials specified equipment*

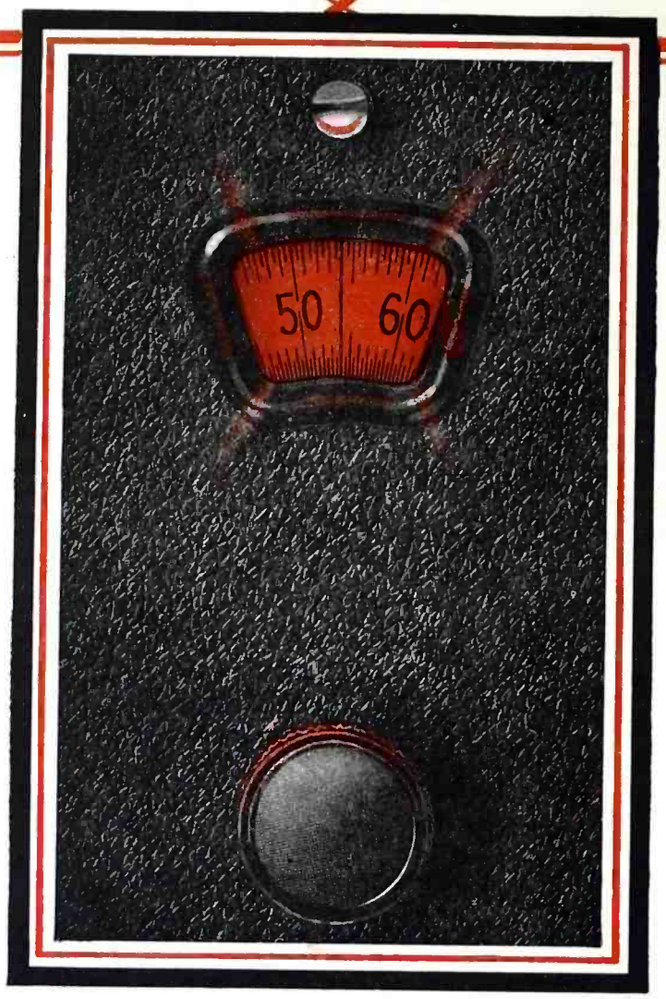
Radio World's
"Hi-Power" and Beacon Sets
MAR-CO *controls standard equipment*

Radio Age's "Super-9"
MAR-CO *360-degree dials standard equipment*

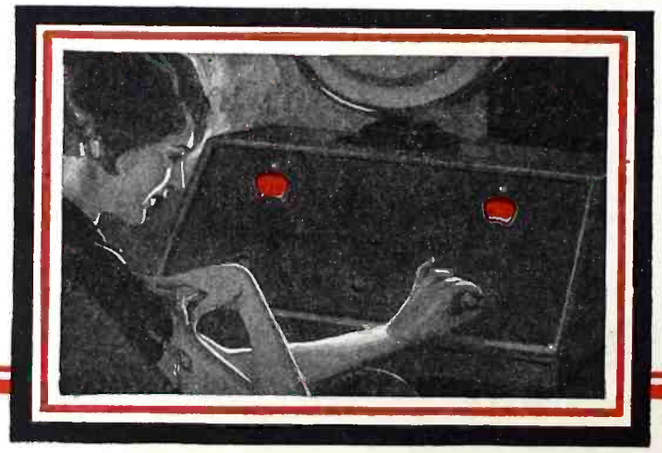
Radio Age "Four"
and "All-Range" Sets
MAR-CO *controls standard equipment*

Daven "Bass Note" circuit
MAR-CO *dials standard equipment*

Hammerlund-Roberts, 1927
MAR-CO *dials standard equipment*



MAR·CO
Illuminated
CONTROLS



The "VARION" A. C. set
MAR-CO *controls standard equipment*

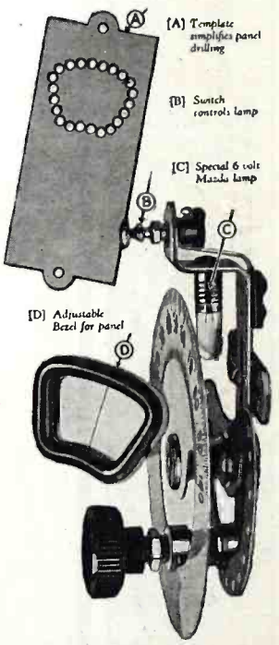
The "Infradyne"
sponsored by RADIO
MAR-CO *controls optional*

The 1927 Fenway
MAR-CO *controls standard equipment*

Ferguson Receivers
MAR-CO *controls built-in*

Let this impressive list be your guide when you select the tuning controls for the new set you build, or the old one you remodel. ANY set can have MAR-CO tuning. Write for booklet.

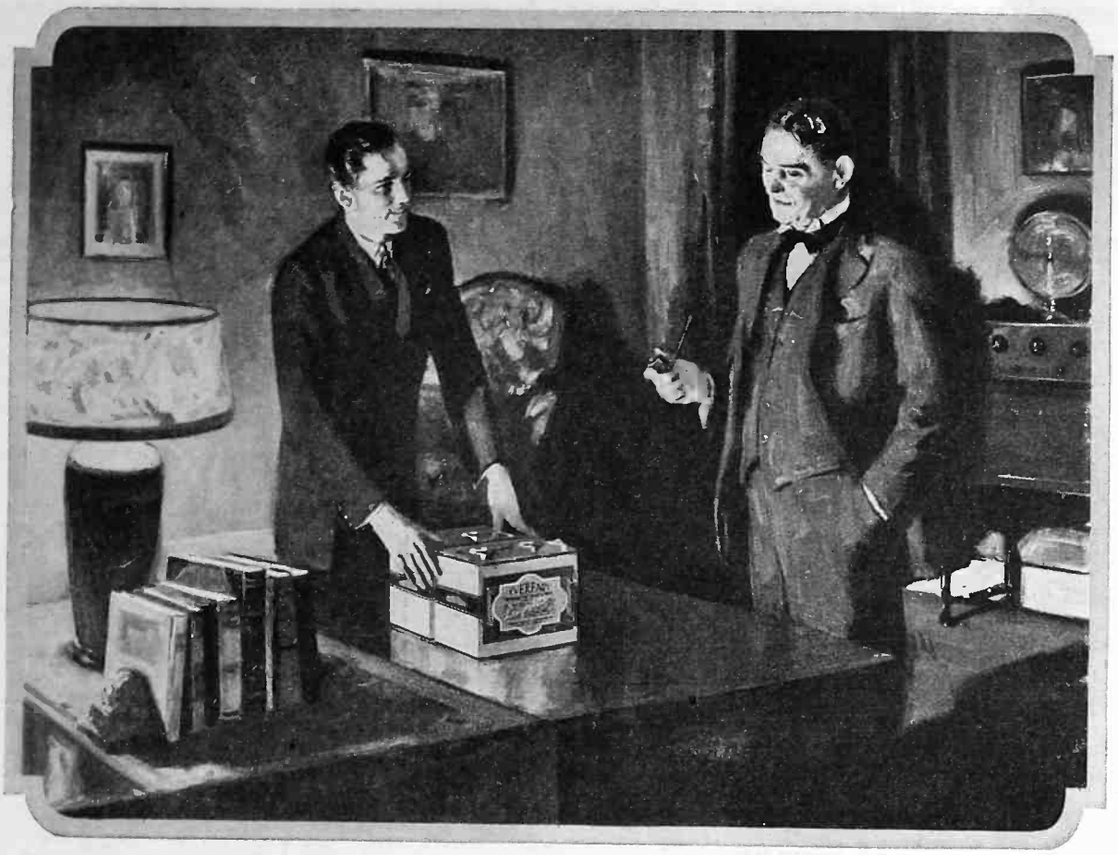
Martin-Copeland Company
Providence, R. I.



MAR-CO illuminated controls, (complete with template, bezel, and 6 Volt Mazda lamp) Scales 0 to 100, or 100 to 0, $3.50

MAR-CO vernier dials, 4 inch and 3 inch. Scales 0 to 100, or 100 to 0, and 360° vernier dials,
nickel plated $2.50
gold plated 2.75

MAR-CO 2 inch rheostat dial (matches vernier dials in appearance) ..... .75



Here's the most economical "B" battery ever built for radio

IN THE production of Heavy-Duty radio "B" batteries Eveready has established a new standard of "B" battery life and economy.

Eveready Heavy-Duty 45-volt "B" Batteries will outlast any Light-Duty 45-volt "B" two to one regardless of the number and kind of tubes used! Moreover, though lasting twice as long, they cost only one-third more!

To cap the climax of "B" battery economy, in Eveready Layerbilt No. 486, Eveready has perfected a Heavy-Duty "B" battery of unequaled endurance and dependability —positively the greatest "B" battery in service and satisfaction its price can buy.

You can make no mistake in buying Eveready Layerbilt No. 486 for any set at normal voltages (from 45 to 135 volts).

You will be buying the utmost in dependability of "B" power—the greatest "B" power operating economy—D. C. (direct current) in its purest form, which insures pure tone quality.

With colder evenings at hand, radio reception is vastly improving. Equip your set now with Eveready Layerbilt No. 486, the greatest "B" battery ever built for radio.

Manufactured and guaranteed by
NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

RADIO

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VOLUME VIII NOVEMBER, 1926 NUMBER 11

CONTENTS

Forecast of Contributions for December Issue

D. B. McGown recounts some interesting new developments in marine radio installations. This is illustrated by some unusually good pictures of modern ship sets.

G. M. Best has finally perfected an *A* battery eliminator that supplies 2 amperes of direct current at 6 volts from the 110 volt a.c. line without the use of any form of storage battery. Complete constructional data are given in the course of his discussion of this problem.

E. M. Sargent discusses the use of the infradyne amplifier in the reception of short wavelengths below 200 meters.

John Flam, patent attorney, specializing on radio inventions, has an authoritative article entitled "The Maze of Radio Patents." It constitutes a more complete analysis of the situation than has yet appeared in print.

O. C. Roos has designed a circular toroid coil which he finds to combine maximum inductance with minimum damping which he calls the "minimum decrement toroid" or "Mindector" coil. He gives full directions for its construction.

C. Sterling Gleason combines humor with common sense in a clever story on "The Radio Seasons." It is written in his characteristic Biblical style.

David Grimes has requested that his preliminary story on his new inverse duplex system, originally scheduled for the November issue, be held up till December. It is to be followed by a complete constructional article in January.

A. P. Peck describes a simple and effective means for measuring the fundamental wavelength of any antenna.

Frank C. Jones analyzes various types of radio frequency transmission lines or "energy coupling" as used by amateur transmitters and gives the results of a practical outfit which he has devised.

L. W. Hatry tells how to make and use an oscillator that will hold its calibration, giving many examples of its practical application.

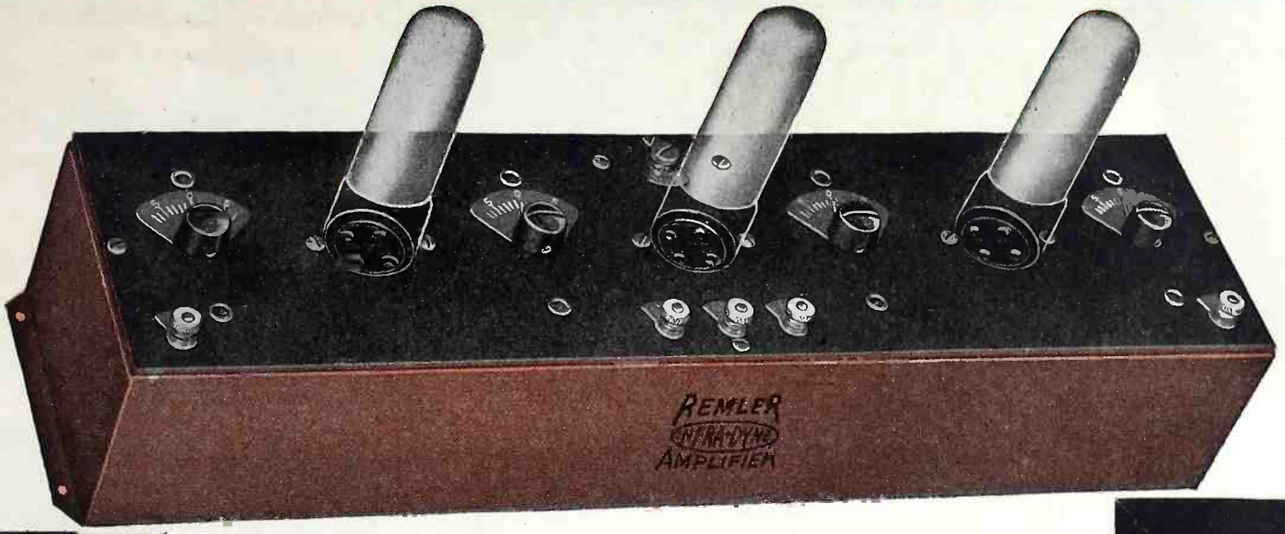
Sylvan Harris describes an "LCR" measuring box to facilitate laboratory measurement of inductance, capacity and resistance.

Elmore B. Lyford tells more about the Henry-Lyford receiver whose simple construction was described in the October issue.

The fiction feature is a desert story by G. W. Weight. Of course radio is an integral part.

The transmitting amateur should be especially interested in F. C. Jones' account of his tests with radio frequency transmission lines. L. W. Hatry also describes "An Oscillator That Holds Calibration."

C. Sterling Gleason contributes a cleverly written comment on "The Radio Seasons."



Bridge the Gap

between your set and 1927 standards of radio reception

Link the Remler Infradyne Amplifier with your neutrodyne or tuned radio frequency circuit and get reception such as you have never known.

The Amplifier gives:

1. Loud speaker volume to signals ordinarily inaudible.
2. Clear sharp reception through all the interference of conflicting stations.
3. Better separation of stations on the dial than you have ever had before.

The Amplifier and its component parts can be easily and simply added without breaking into the wiring.

IMPROVED

REMLER

SOCKET No. 50

Close, positive, gripping contact — Full floating springs — Brass contact levers — Meets the exact requirements of the X-type tubes.

Price $25.00 each

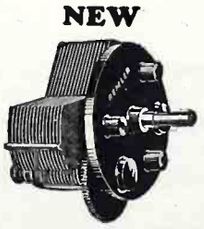
Write for two color descriptive circular and for reprints from RADIO.

REMLER

GRAY and (R) DIVISION OF DANIELSON Manufacturing Company

CHICAGO — 260 FIRST STREET SAN FRANCISCO — NEW YORK

NEW



REMLER
TWIN-ROTOR
CONDENSER

Straight-Line Frequency

Stations spread over 360° — Body capacity eliminated — Perfect balance — Adjustable minimum capacity.

Buy by the Name

Success in Set Building Begins at the Dealer's Counter

ALL BENJAMIN RADIO PRODUCTS ARE OF THE SAME HIGH STANDARD AS THE FAR-FAMED CLE-RA-TONE SOCKETS

Cle-Ra-Tone

Spring Supported—Shock Absorbing Sockets

Stop tube noises. Greatest aid to non-noisy operation. Contacts always clean.

75 cents each

When you buy your radio parts, buy them right. Everything else being equal, when a name has stood for a quarter of a century's striving toward technical perfection it is practically as safe as a formula as a guide to right buying. When your dealer sells you Benjamin radio products for your set you have already leaped a big hurdle on the way to success.

"Lekeless" Transformers

Uniform high inductance, low distributed capacity and low resistance. The external field is so slight that it permits placing coils close together without appreciable interaction.

Single Transformers, $2.50

Brackets

An aid to simplification in set construction. Supports sub-panel, with room underneath for accessories and wiring. Plain and adjustable.

Plain, 70 cents per pair
Adjustable, $1.25 per pair

Battery Switch

Quick, positive, clean-cut make and break. When it's "in" it's "off," eliminating danger of wasteful use of battery.

30 cents each

Improved Tuned Radio Frequency Transformers

Proved through exhaustive and comparative tests to be the most efficient coil for modern radio sets. Better in all important features and characteristics. Space wound. Basket weave. Cylindrical. Highest practical air dielectric. Gives wonderful sharpness in tuning, better volume and purer tone quality.

2¼" Diameter Transformer

Compact. Especially desirable for crowded assembly. Eliminates interfering "pickup."

Set of three, $5.75 *Single Transformer, $2.10*

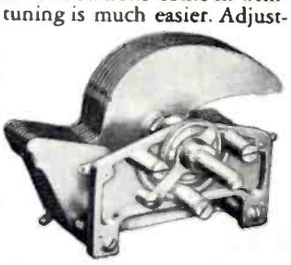
3" Diameter Transformer

Capacity coupling reduced to lowest degree. For use with .00035 Mfd. Condensers.

Set of three, $6.00 *Single Transformer, $2.25*

Straight Line Frequency Condensers

No crowding of stations. The broadcast range is spread evenly over the dial. Stations come in without interference, and tuning is much easier. Adjustable turning tension. Low loss characteristics give a definite and distinct radio reception. Beautiful in appearance—a credit to the looks and efficiency of any set. Finished in dull silver. Made in three sizes:



.00025 Mfd. $5.00
.00035 Mfd. $5.25 *.0005 Mfd. $5.50*

If your dealer cannot furnish you with Benjamin Radio Products send amount direct to our nearest sales office with his name and we will see that you are promptly supplied

REWARDS FOR RADIO REASONERS

Awards for novel and original hookups, modifications of existing circuits; trade names; slogans. Write our nearest office for full details.

Benjamin Electric Mfg. Co.

New York, 247 W. 17th Street
120-128 South Sangamon Street, Chicago
San Francisco, 448 Bryant Street

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario

Selected for the Infradyne

Approved by the designers of the Infradyne because it's

Metallized!

THE Durham Metallized Resistor is a laboratory perfected grid-resistor developed by two scientists of a leading university.

A tiny glass wire is passed through an ingenious, chemical and high-temperature process, forming a thin conducting layer of high resistance. The Metallized unit is next treated with a protective insulating material, rendering it impervious to atmospheric conditions. It is then mounted in a glass tube and soldered to terminal, brass caps.

10 megohms to 500 ohms, from 50 cts. to $1.00

DURHAM METALLIZED RESISTORS

INTERNATIONAL RESISTANCE CO.

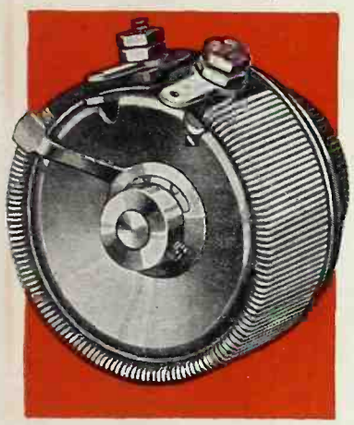
Perry Bldg., Philadelphia, Pa.

Use FROST-RADIO Parts When Building Your

INFRA-DYNE

TRADE MARK

IF YOU are to get the excellent results you naturally expect from your Infradyne, then use the best parts throughout. Pay particular attention to Rheostats, Sockets, Jacks, Switches and High Resistance Units. Once installed these parts are usually forgotten but are often a source of trouble that is hard to locate. Be sure they bear the name **FROST-RADIO** and you can be certain that they will function permanently without any variation. Listed below are the **FROST-RADIO** parts you should use in your Sargent Infradyne. Get them from your dealer.



FROST-RADIO RHEOSTATS

Type 700 Metal Frame ..... $ .50
Type 800 Bakelite ..... .75

FROST-RADIO Type 660
BAKELITE RHEOSTAT

Designed for base mounting. Has Bakelite base and knob nickel plated metal parts. 30 ohm type..... $ .75

FROST-RADIO PAN-TAB
TYPE JACK

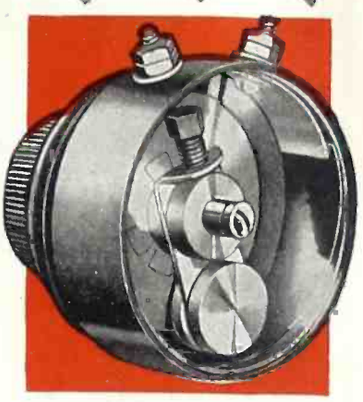
The Pan-Tab is made for either panel or table mounting. Its nickel silver springs are extra strong and about twice the usual width and thickness. Frame is electric brass, nickel plated and hand buffed.

	List
No. 660 **FROST-RADIO** Bakelite Rheostat, base mounting	$ .75
No. 530 **FROST-RADIO** Bakelite Socket	.40
No. 730 **FROST-RADIO** Metal Frame Rheostat, 30 ohm	.50
or, if preferred,	
No. 830 **FROST-RADIO** Bakelite Rheostat, 30 ohm	.75
No. 710 **FROST-RADIO** Metal Frame Rheostat, 10 ohm	.50
or, if preferred,	
No. 810 **FROST-RADIO** Bakelite Rheostat, 10 ohm	.75
No. 880 **FROST-RADIO** Super-Variable Resistance, 50,000 ohms	1.25
No. 608 **FROST-RADIO** Push-Pull Switch	.30
No. 954 **FROST-RADIO** Gem-Jac	.45
or, if preferred,	
No. 234 **FROST-RADIO** Pan-Tab Jack	.75
No. 953 **FROST-RADIO** Gem-Jac	.40
or, if preferred,	
No. 233 **FROST-RADIO** Pan-Tab Jack	.65

FROST-RADIO Accessories

It is a genuine pleasure to work with **FROST-RADIO** parts and accessories because of their practical design and fine finish. Electrically and mechanically you will find them perfect. The **FROST-RADIO** accessory line includes **FROST-FONES**, plugs, extension cords, loop plugs, protectors, ground clamps, antenna, etc. See them at your dealer's.

MEMBER RMA



FROST-RADIO SUPER-
VARIABLE RESISTANCE

No. 880. 50,000 ohm type. Brass case and metal parts, nickel plated and buffed. Works smoothly and possesses remarkable wearing qualities..... $1.25

FROST-RADIO No. 530
BAKELITE SOCKET

Its special spring construction grips tube prongs firmly, insuring superb contact..... $ .40

FROST-RADIO
GEM-JAC

A small, sturdy jack made to save space. The Gem-Jac projects only one inch behind the panel. It has strong springs and self-cleaning Sterling silver contacts.

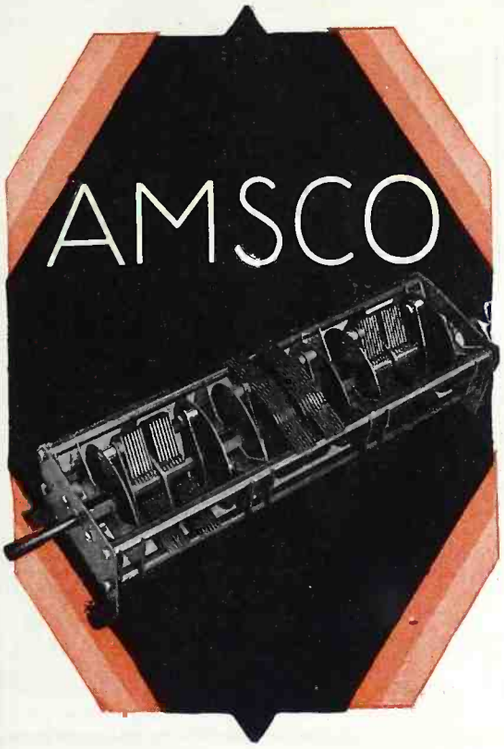
HERBERT H. FROST, Inc.

160 NORTH LA SALLE STREET · CHICAGO, ILLINOIS

NEW YORK CITY LOS ANGELES

MAKE YOURS A QUALITY

INFRA-DYNE



AMSCO FLOATING SOCKETS

Rugged and substantial, these sockets are space-saving and — "*they float!*" The tubes fit with the click that accompanies positive wipe contact yet they almost literally float on air, practically isolated from the base or panel. Microphonic noises, mechanical feed back and audio vibration are effectively eliminated.

You'll need seven AMSCO Floating Sockets for the Infra-dyne. Insist upon the genuine, approved by Sargent.

AMSCO METALOID GRID GATES are uniquely silent, due to a perfected colloidal Metaloid resistance element. Get two for the Infra-dyne—1 megohm and 2 megohms, respectively. Approved by Sargent for the Infra-dyne.

AMSCO 3-GANG ALLOCATING CONDENSERS

Build your Infra-dyne of the best, for the best results. Quality parts are an investment that pays in Perfection.

This is especially true of the heart of the Infra-dyne—the three-gang AMSCO Allocating Condenser. Each unit of the AMSCO triple is .00035 micro-farads capacity, matched within less than 1%.

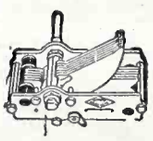
They allocate or "spread" the stations with engineering precision — their uniformity making practical the hitherto theoretical ideal of Simplified Control. Construction guaranteed mechanically and electrically perfect.

AMSCO PRODUCTS, Inc.
Broome & Lafayette Sts., N.Y.C.

All AMSCO Parts are manufactured in accordance with Standards of the Radio Mfrs. Association, Inc.

AMSCO TOM THUMB RHEOSTATS

A true midget for saving valuable space front and back of the Infra-dyne panel. No less effective because of its compactness — it has the normal amount of resistance, the normal electrical contacts. It is simply that needless bulk is eliminated by AMSCO design. Air cooled construction —Bakelite base and knob with indicator arrow. You'll need one 10 ohm and two 30 ohm Tom Thumb Rheostats. Approved by Sargent.



AMSCO SINGLE ALLOCATING CONDENSER. You'll need this single AMSCO Allocator for your Infra-dyne. Capacity .00035 mfd. Look for the name AMSCO—for Excellence!

APPROVED BY E. M. SARGENT

FOR EXCELLENCE

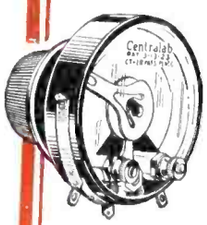
AMSCO
MEMBER R.M.A.

Improved and *Simplified* Radio Control

The superior control of Centralab variable resistance in radio circuits has been recognized by sixty-nine leading set manufacturers who are now using one or more of these controls on their sets.

Centralab Radiohms, with 2 terminals, and Modulators with 3 terminals, are specified for the INFRADYNE, S-C, Samson T-C, Henry-Lyford, Universal, and many other circuits. Used as standard equipment on a large number of commercial receivers, and by both the U. S. Navy and Signal Corps.

There is provided a perfect control of the circuit with simplified panel appearance. For all circuit purposes is available the correct variable resistance, together with an "A" battery switch, both controlled by a single knob. Cost and trouble in building the set are lessened, as the double purpose control costs little more than one, and only one hole to drill in the panel.



SWITCH TYPE

Centralab RadiohM

Has no sliding contacts carrying current, and is both permanent and noiseless in adjustment. A single knob turn gives full resistance variation from zero to 500,000 ohms, providing absolute control of oscillation at all wave lengths in all tuned frequency circuits.

SWITCH TYPE

Centralab ModulatoR

An ideal tone volume control for all audio circuits. Has 3 terminals, maintaining a fixed load of 500,000 ohms to provide even amplification of all tones. Control the volume by varying the potential applied to the grid of the tube. A sure cure for overloaded tubes and harsh amplifiers.

Centralab Switch Type Radiohm or Modulator **$2.30**

Centralab Standard Radiohm or Modulator without "A" battery switch **$2.00**

At dealers, or mailed direct

Mr. L. S. Hillegas-Baird, 9HO, will cheerfully answer inquiries and supply circuits and descriptive literature.

Central Radio Laboratories

14 Keefe Ave., Milwaukee, Wis.

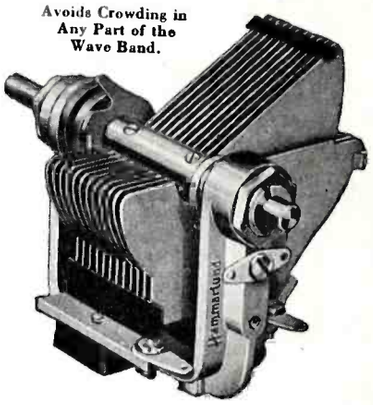
Makers of variable resistances for 69 makers of leading standard sets

Canadian Rep.: Irvine W. Levine, Montreal
Great Britain Rep.: Rothermel, Ltd., London
Australian Rep.: United Dist., Ltd., Sydney

Centralab CRL

The First *Universal* Condenser

Avoids Crowding in Any Part of the Wave Band.



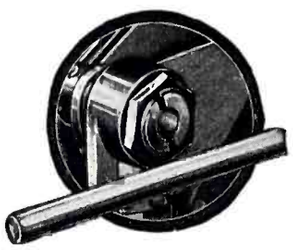
The New Hammarlund "MIDLINE" With Full-Floating Rotor Shaft

THE shaft may be adjusted to any desired length for accommodation of different dials, or it may be replaced by a longer shaft for direct coupling to other condensers. Gears, cams or pulleys may be attached for any arrangement or single-control multiple condenser operation.

As a testimonial to Hammarlund efficiency, the designer of the "Infradyne" has specified the Hammarlund Triple "SFL" Condenser for use in that interesting receiver.

Hammarlund Condensers are made in all standard capacities—single and Multiple.

AT THE BETTER DEALERS



HAMMARLUND MFG. CO.

424-438 W. 33rd St., New York

For Better Radio **Hammarlund** PRECISION PRODUCTS

Look 'Em Over!

EBY BINDING POSTS

Will stand the closest kind of inspection and get your O. K. on every point. Their drilled shanks and broad contact surfaces form a **good** electrical connection with practically every type of terminal — straight wire, looped wire, pin or slotted.

And the tops—engraved in 35 different markings—**don't come off!**

Eby posts are recommended and specified in the Infradyne, Hammarlund-Roberts, Cockaday, L. C. 27, Browning-Drake, Victoreen, Madison-Moore, Lynch and Varion Power Units and other popular circuits.

Eby Binding Posts sell for 15c at your dealer's.

EBY SOCKETS

Assure a positive three point wiping spring contact at all times. Everyone knows that this is the most scientifically perfect type of contact known.

Every time the tube moves in an Eby socket the contact gets tighter and checks the jar. No wabbling, no noises, no losses!

50c each at your dealer's or write us

THE H. H. EBY MFG. CO.

4710 Stenton Ave. Philadelphia, Pa.

MEMBER RMA

INFRA-DYNE

PANELS	**$6.85**
INDUCTANCES	**1.25**
BASE BOARDS	**2.85**
Binding Post Strips	**1.75**

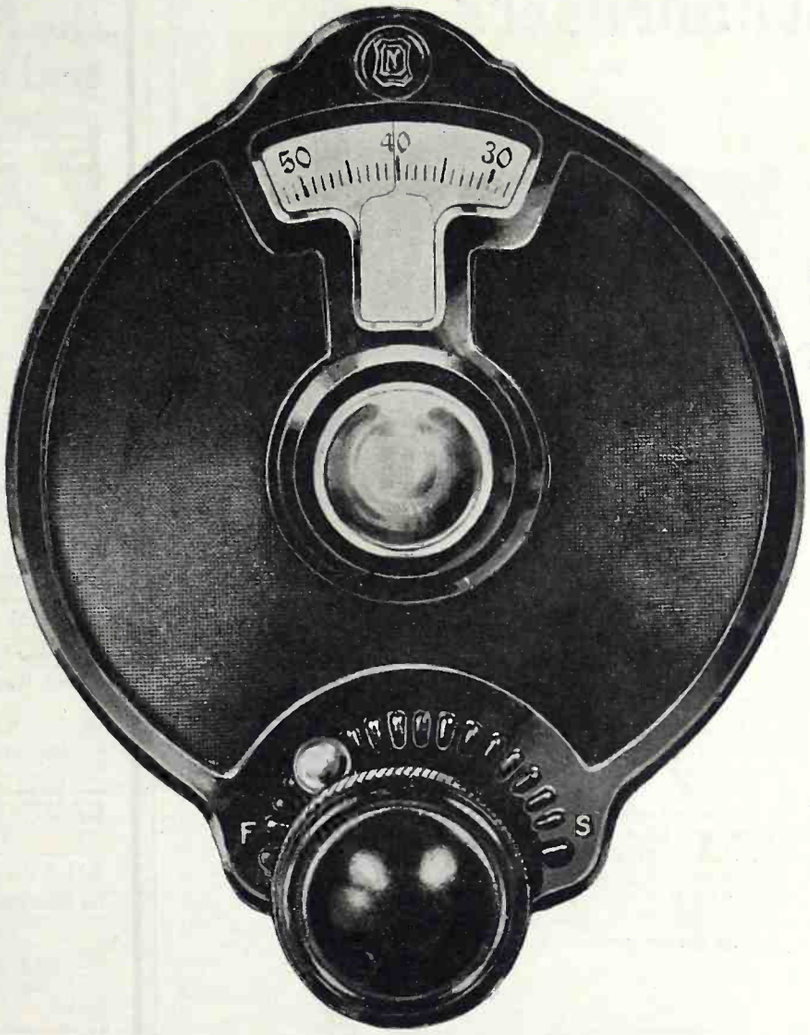
SET $11.40--Prepaid

Diamond-F

Twining-Scott
1125 Wall St.
Los Angeles, Cal.
WE 4227

NATIONAL

THE ILLUMINATED VELVET-VERNIER DIAL TYPE C



SPECIFIED FOR THE INFRADYNE

The NATIONAL ILLUMINATED VELVET-VERNIER Dial, Type C, is specified for the Infradyne by E. M. Sargent. The scale of this dial is brilliantly lighted by a tiny concealed 6-volt lamp, which is either connected to the filament wiring and acts as a telltale, or may be separately switched. It has every feature which has made the NATIONAL VELVET-VERNIER A and B Dials so universally used, with variable ratio of from 6-1 to 20-1, the rugged Bakelite case and finish which retains its fine appearance indefinitely, and the velvety action which never wears loose.

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[*NATIONAL Radio products include in addition to this dial the VELVET-VERNIER Dials, Type A and B; (the new type B Dial may be converted into an ILLUMINATED dial by the attachment of 6-volt lamp and lamp holder at 50c)—the NATIONAL Browning-Drake Radio-frequency coils and transformers,—now spacewound for sharper tuning;—the NATIONAL "EQUIMETER," SLW Condensers;—the NATIONAL "EQUICYCLE," SLF Condensers, with their 270° movement, to spread out crowded stations still more;—the NATIONAL Transmitting condensers;—the NATIONAL Impedaformers for quality audio;—and the NATIONAL equipment for B-Eliminators,—Power Transformers, Chokes and Tone Filters. Send for Bulletin 116-R. Be sure you get the genuine NATIONAL products.*]

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Type 22

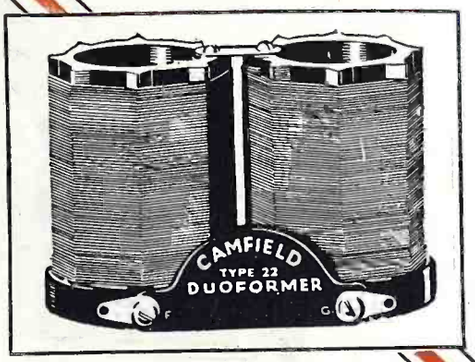
DUOFORMERS

The Finest Radio Frequency Transformer Obtainable for

THE INFRA-DYNE

Approved by E. M. Sargent

INFRA-DYNE



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1 The new 1927 model Camfield Duoformers now on sale have been specially designed to meet the requirements of the INFRADYNE —RADIO'S GREATEST CIRCUIT.

2 They combine HIGH AMPLIFICATION with extremely GOOD SELECTIVITY.

3 They use the highest quality of workmanship throughout. Each coil is wound of green silk wire on a low-loss ribbed frame of highly polished black Bakelite.

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5 Each Camfield Duoformer is carefully inspected for workmanship, and is given a high frequency test for uniformity and amplification before packing at the factory.

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Aug. 12, 1926.

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Very truly yours,
(Signed) E. M. SARGENT.

CAMFIELD TYPE 22K DUOFORMER KIT, Containing 3 Type 22 Duoformers..... $10.00

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Here is 25 cents in coin. Send me, postpaid, at once, the new Official Infradyne Manual by E. M. Sargent.

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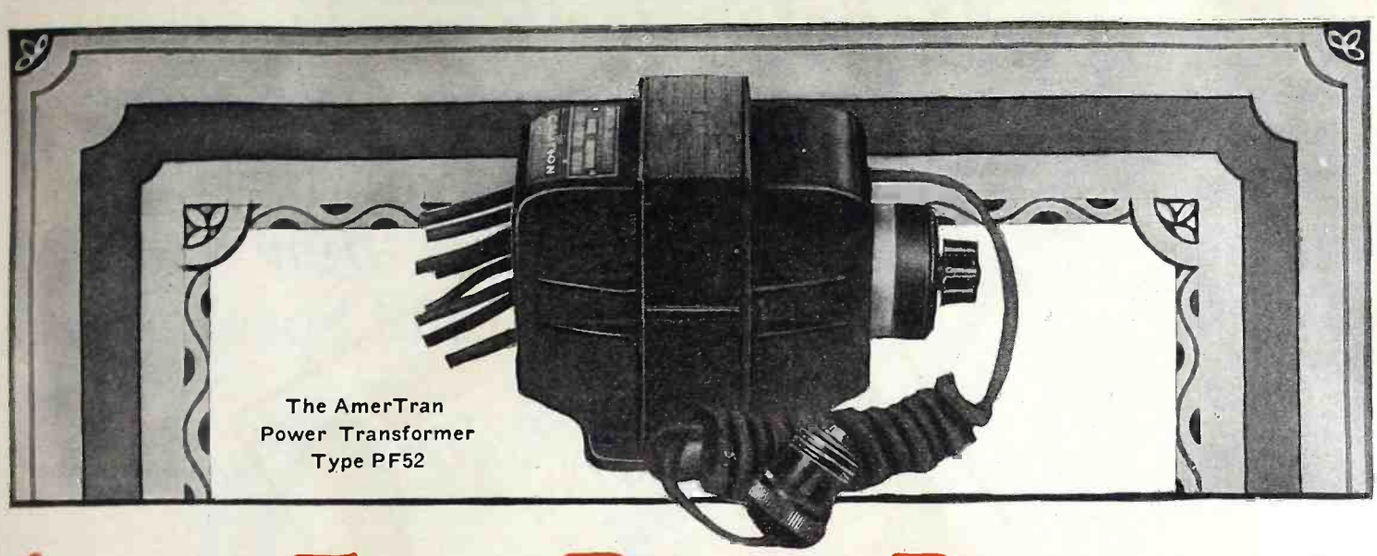

The AmerTran
Power Transformer
Type PF52

AMERTRAN RADIO PRODUCTS

A Real Power Transformer

Perfected on the firm foundation of twenty-five years' successful experience in transformer building, AmerTran Radio Products enjoy a reputation second to none in their respective fields. Their continued selection by leading engineers and experimenters gives ample proof of their high efficiency and dependable performance.

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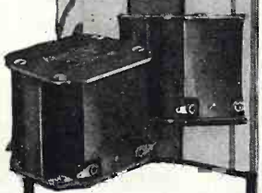
This is a scientifically designed impedance or choke coil of general utility, designed primarily for use in filter circuits. As an output impedance for by-passing direct current from the loudspeaker it is both efficient and economical.



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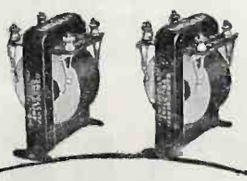

We shall be very glad to send you, upon request, a copy of our booklet, "Improving the Audio Amplifier," together with other interesting and constructional data.

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Hear this new Acme at your dealer's

TRY OUT this new Acme for yourself. See if all we have said about it is not true. Compare it with others in the dealer's store. Drop in at your dealer's today and hear this remarkable new speaker. Made by Acme Apparatus Co., Pioneer Radio and Transformer Engineers and Manufacturers, Cambridge, Mass., U. S. A.

Acme K-3 Enclosed Single Free Edge Cone Speaker, (shown above). Diameter of cone, 11 ins. Green bronze metal case. Price: $18.50

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Acme Enclosed Free Edge Cones and Acme Reproducing Units, (Designed for use exclusively with the free edge cone) eliminate resonance and preserve the tones, pure, round and clear. A fixed edge cone, to produce the same results, would have to be three times the diameter, too clumsy for your living-room. High notes are reproduced toward the center of the cone; low notes, toward the edge. The laws of vibration make it possible to produce low notes with a small cone, provided the edge is free and enclosed, and provided the reproducing unit is especially designed for use with a free edge cone.

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RADIO
WITH WHICH IS INCORPORATED "RADIO JOURNAL"

VOLUME VIII NOVEMBER, 1926 No. 11

Radiotorial Comment

THE increasing use of various devices for supplying rectified alternating current for the operation of radio sets introduces a new hazard which does not exist where dry batteries are used for this purpose. This hazard is not alone the chance of shock from the higher voltages but also the danger of fire.

While the probability of such trouble is small, especially in the case of factory-built devices, nevertheless care should be taken to prevent its occurrence. Approval by the Underwriters' Laboratories is the only positive insurance against this danger and therefore a summary of their requirements for battery eliminators is an excellent guide for the home construction or store purchase of the parts or complete equipment.

These requirements are not yet standard but are followed when investigating and testing the safety of such devices. They first provide that all current carrying parts except primary leads and secondary terminals shall be inclosed in a substantial enameled metal or wooden cabinet. If wood is used all individual units conductively connected to the light or power circuit shall be separately enclosed in metal. This includes transformers, inductances, and condensers. The cabinet should preferably be ventilated by means of holes small enough to forbid the entrance of anything which might come in contact with exposed circuits carrying more than 200 volts. All live wires should be properly insulated and no terminals or live parts should come in contact with the inclosing case.

All attachment plugs and bases, lamp sockets, flexible cord, and snap switches should be standard devices bearing the Underwriters' label. The supply cord should be soldered to the primary terminals, protected by strain relief, and enter the cabinet through an insulated bushing with smoothly rounded edges. Transformers connected to the light circuit should be of substantial construction and thoroughly insulated. Condensers should be able to withstand any heat developed under the most severe conditions of normal use and be protected against moisture. A standard fuse of not more than 15 amperes capacity should be connected in some relatively inaccessible part of the cabinet.

The laboratory requirements for approved factory-built eliminators are still more rigid, but those here summarized are the most vital to safety. They may be colloquially summed up by saying that no "hay-wire" shall enter into the construction. While "hay-wire" may be safely if not ornamentally used in a radio set, it is dangerous in a current supply device of any kind.

Although non-compliance with these requirements does not necessarily invalidate a fire insurance policy when the fire is proved to have been started by something other than an unapproved battery eliminator, these rules are no more severe than normal prudence would demand. Like the Code rulings for any radio installation they are intended for the protection of the user. They are not arbitrary but merely provide a sufficient factor of safety against fire. It is better to be safe than sorry.

NAVY DAY affords the opportunity to emphasize what the Navy has done for radio and what radio has done for the Navy. As most of the emphasis is ordinarily placed on the wonderful results that the Navy has accomplished in the development of radio, more consideration will here be given to the assistance that radio, and especially the radio amateur, has rendered the Navy.

Navy officials were originally responsible for limiting the power and the wavelengths that the amateur could use. They considered him a nuisance, as indeed he was to them. They forced him to use low power and short waves because these were considered useless for long distance communication.

So while the Navy installations were going up to greater and greater powers and longer and longer wavelengths, the amateur installations were going down to less and less power and shorter and shorter wavelengths. Finally the distance that could be covered by the great Navy sets began to approach a limit beyond which effective communication could not be maintained, whereas the amateurs were continually reaching out further and further in their traffic work.

Consequently the prodigal son, personified in the amateur, has been welcomed home. His experience in the far countries is being turned to profit by the old man. The husks upon which he fed are becoming the staple food of the Navy radio household. The fatted calf is not even worth killing but will possibly die from a lean old age.

Navy traffic, to an increasing degree, is being handled on short waves, which are proving to be more reliable than the long ones. Amateurs are being asked to check the range and audibility of Navy signals. Amateur experiments are being applied in Navy practice.

Without the amateur and his knowledge of code and transmitting technique the radio personnel of the Navy would have been seriously crippled during the Great War. Without his formerly-ridiculed materiel the Navy would today be hampered in its peace-time maneuvers. So on Navy Day, when you think of the great value of this important arm of our national defense, spare a good thought also for the amateur radio transmitter who has unostentatiously made possible much of the Navy's vital inter-communication.

Development of Radio Apparatus by the Navy

An Account of the Evolution of Transmitting and Receiving Equipment Used by the U. S. Fleet

By A. L. Young

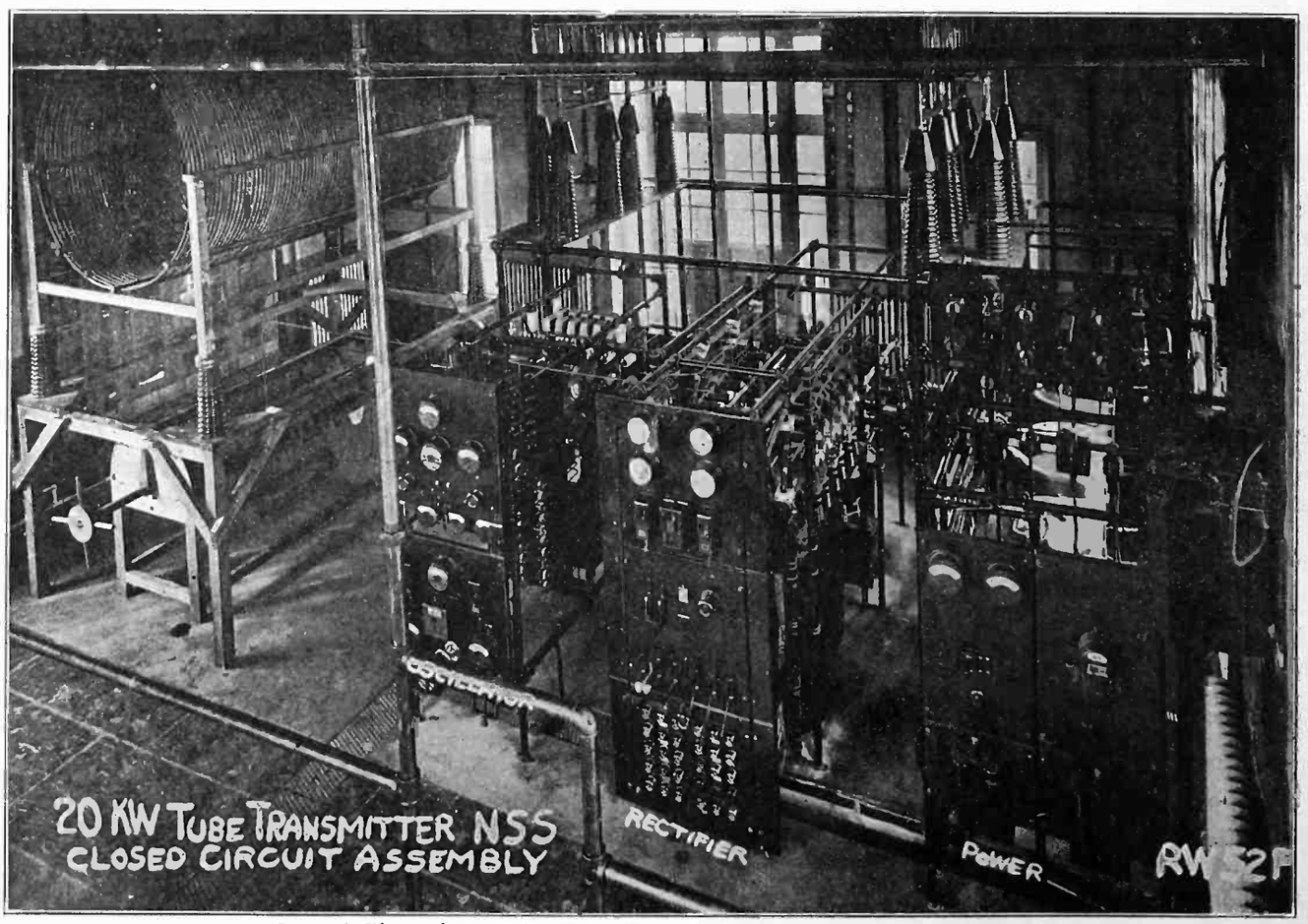
WHEN Navy Day comes we visualize the battleships, cruisers, destroyers, and other vessels that make up our National Defense at sea. We recall the prominent figures of our Navy in times past and present. But rarely do we think of the communication methods. Without means of long distance communication, there would be no scouting, no spotting of shots by airplanes. Vessels when maneuvering would of necessity remain within visual signalling as in times past.

With the advent of radio telegraphy a great change took place. It was then possible for the vessels to cover greater areas and still be in contact with the center of command. With the advancement of the radio art the efficiency of communications increased until now it is possible to communicate on several different channels simultaneously in the fleet.

The U. S. Navy was one of the first to recognize the great possibilities of radio communication. About 1900 a board composed of Naval Officers went to Europe to study the various types of radio apparatus then in existence with a view of procuring suitable apparatus for our vessels and shore stations. A number of Slaby-Arco sets were purchased and installed on battleships and on shore. Since this apparatus was entirely different from what we see today, the following short description will probably be of interest.

The transmitters were of the spark variety, now the bane of the broadcast listener. They were operated from direct current, the alternating current being obtained by means of a circuit breaker and induction coil. The circuit breaker in this case was a mercury turbine interrupter. A bowl of mercury in which there was a turbine pump connected to an electric motor was suspended in a frame under the operator's table. The turbine running at high speed would raise the mercury and discharge it through a small nozzle slightly above the surface. The jet of mercury from the nozzle would strike a concentric ring with portions cut out to form segments. The circuit would be completed each time the jet struck a segment, thus producing a pulsating current. By virtue of the induction coil in circuit with the interrupter the voltage was increased to several thousand volts necessary to charge the Leyden jar condenser. The discharge of the condenser across the spark gap produced oscillations in the antenna circuit in a manner similar to later types of spark transmitters. The mercury turbine interrupter caused considerable trouble because of frequent oxidation of the mercury and was subsequently replaced with motor generator sets which produced the alternating current.

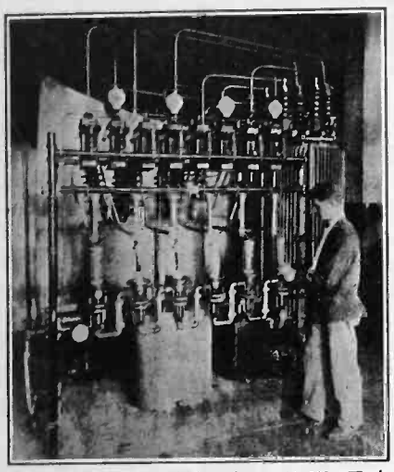
The receiver was a unique piece of apparatus. The tuning coil was a single layer type approximately 10 in. in diameter and stood on end with a height of about 15 in. There was no tuning condenser. The detector was called the coherer. This was a small glass tube containing nickel filings between two highly polished electrodes. In normal condition the filings offered high resistance, but when acted upon by an incoming wave they would cohere and close a circuit of an ink recorder which would produce a



General View of 20 K.W. Tube Transmitting Equipment at NSS, Annapolis.

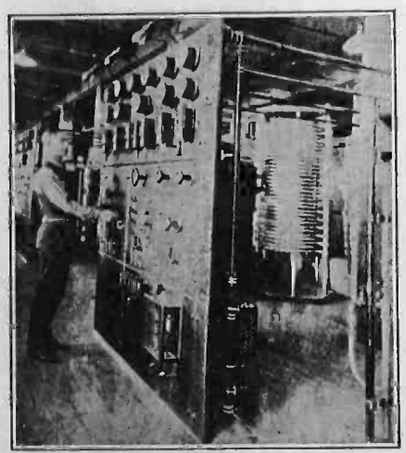
legible record of the message in Morse code. A device called a decoherer would continually tap the coherer and restore the filings to normal.

Inventors soon developed better methods of detection and the electrolytic detector was produced. This type of detector consisted of a small platinum cup, forming one side of the circuit, filled with a 20% solution of sulphuric acid into which extended a fine platinum wire. A potential of about 1½ volts



Rectifier Tube Unit of 80 K.W. Tube Transmitter at San Diego.

was applied to the detector and regulated by a potentiometer. When the battery current flowed through the cell, oxygen was liberated at the fine wire or anode and the cell was said to be polarized. The freed oxygen formed small bubbles at the anode, thus forming a minute condenser between the anode and solution of the cell. An incoming wave would break down this condenser and allow current to flow from the battery, the



Control Panel of 80 K.W. Tube Transmitter at San Diego.

action of which would be reflected in the headphones. When the incoming signals ceased the detector returned to its original condition. It was said to be self-restoring, thus differing from the filings coherer. Receiving was done by ear and was much faster because of the slow action of the ink recorder in the coherer receiver.

By this time the number of radio installations had increased considerably and when the news of the electrolytic detector, with its increased sensitiveness over the coherer, had been circulated among the radio operators, there was a sudden demand for the improved type. On account of lack of sufficient funds it was impossible to supply the demand and the inventive genius of the operators soon became evident.

"Home made" electrolytic detectors were manufactured from five candle power lamps by the more enterprising personnel. These lamps were used in indicators which formed part of the instruments on the bridge and engine-rooms and on account of their small size were readily adapted to their new life. The tip was broken and, with a piece of stiff wire, the filament was removed and one of the lead-in wires broken off close to the stem. The base was then screwed into a socket in an upright position and partly filled with 20% solution of sulphuric acid. In this form another electrolytic detector came into existence, the remaining lead-in wire corresponding to the platinum cup and the broken lead-in wire to the fine wire or anode.

On account of the coarseness of the lead-in wires of the lamps compared with the fine wire of the detectors furnished by the Bureau, the "home made" detectors were not as sensitive as could be desired, but they served their purpose and traffic was speeded up because receiving was done by ear as with the regular type.

Reception by ear gave more individuality to the work and became more interesting. An operator could distinguish one sender from another by his "fist" or style of transmitting as in wire telegraphy.

As the years progressed and the number of stations increased attention was directed to greater selectivity in tuning because of the increased interference. From the single layer tuner of the Slaby-Arco set there appeared the two and three coil tuners and finally the inductive tuner with the variable condenser. These were great strides in the art and traffic was benefitted accordingly.

The electrolytic detectors were followed by the crystal detectors, which included carborundum, silicon, perikon-pyron, galena, etc. These types were more satisfactory than the electrolytic detectors on account of ruggedness and absence of acid.

Following the crystal detectors came the vacuum tube and the consequent rapid improvement in radio communication. It was found possible to amplify the incoming signals thereby increasing the range of reception. The design of the early tubes varied considerably from present day types. In one type the filament leads terminated in a candelabra screw base and the grid and plate leads brought out to the sides of the glass bulb, one colored green for the grid the other red for plate. Later types appeared with the grid and plate terminating in prongs similar to present types but with the base as one side of the filament and a prong for the other. These were termed "3 prong" tubes as distinguished from "4 prong" tubes which contained an additional prong to serve as the other filament terminal.

The Navy is entitled to considerable credit in the development of the vacuum tube. Specifications covering the design of tubes were prepared along the lines of what should be expected from the manufacturers as to life and electrical characteristics. Considerable research work was necessary but the manufacturers saw the light in the greater use for better tubes until now we have very satisfactory tubes, with long life and reasonable cost.

It may be said that the present types of radio receivers in the Navy are the last word in this type of apparatus consistent with knowledge of the radio art

Control Panel of 20 K.W. Tube Transmitter at NAA, the U. S. Navy Station at Arlington, Va.

at the time of inception of their design. These receivers were designed by Navy radio engineers and are the result of exhaustive research work. In fact, all receivers produced for the Navy since 1917 have been of Navy design.

Receivers used by the Navy are much more complicated than most of those used by amateurs in that Naval radio communication requires a much greater band of frequencies or wavelengths to be covered by a single receiver. This is made necessary because of the great number of channels used by the Navy in communicating with the various classes of vessels, each of which is assigned a certain channel. It is necessary to use a number of channels in order to reduce interference.

Transmitters did not show much improvement until the advent of the vacuum tube. Of course there was great improvement in spark transmitters when the quenched gap was produced. This type of gap which succeeded the plain gap between two zinc points produced a

(*Continued on Page* 44)

What Radio Means Today

By Ellery W. Stone, President Federal Telegraph Company

RADIO, today, means communication. While this definition is entirely non-technical as regards the theory of the transmission and reception of radiant energy, it is eminently practical. Radio, tomorrow, with the further development of the radio compass, television and tele-mechanics, may have a far greater utilitarian application. But today it is used essentially as the quickest means of world communication yet devised.

Radio communication may be either two-way or one-way. It was originally developed as the two-way communication known as wireless telegraphy, but today is either radio telegraphy or radio telephony. One-way communication is familiar as broadcasting.

Two-way communication may be either through mobile or fixed transmission. In the former, we have radio communication to and from ships at sea, aircraft, trains or automobiles. In the latter, or point-to-point method, we have communication between cities separated by great distances over land or ocean. This has been developed as an effective competitor of wire and cable telegraphy in reducing rates. More than 50 per cent of the overland telegraph traffic between Portland, San Francisco and Los Angeles is handled by the Federal Telegraph Co. (radio) and more than 20 per cent of the total comunication across the Atlantic is handled by the Radio Corporation of America.

One-way communication, broadcasting, should be considered both under its engineering and merchandising aspects, particularly as regards the manufacture and sale of broadcast receivers.

The radio engineer, it is true, is a specialist in the field of electrical engineering, but the requirements in his branch are relatively severe when taken in comparison with those of other electrical engineers. The power engineer deals with relatively large currents, but at a single frequency. Give the radio engineer the problem of designing a transmitter or receiver to function on but one single frequency, high or low, and by contrast to his present work, it would seem mere child's play. It is true that the radio engineer is required to handle only relatively small currents, but he must be able to handle them with equal efficiency over the entire range of audible frequencies—16 to somewhere between 10,000 and 20,000 cycles—and over a still wider range of inaudible or radio frequencies extending from the upper end of the audible frequencies to—with the increasing use of short waves—as high as 30,000,000 cycles.

If a power engineer were given the task of designing a transmission line or a transformer for efficient operation over such a range of frequencies, as against the single frequency of 60 cycles, or the Heaven-sent direct current, which constitutes his customary field, I think he would better appreciate the problems with which we, in the radio field, must contend.

What are the engineering specifications of the radio broadcast receiver? I should say that first, a receiver must be selective. That is to say, it must have the ability to select any one of several locally broadcast programs to the exclusion of all others. Such selectivity as that, while by no means particularly great at present, was not attainable with the single circuit receivers of a few years ago. And while it is considered but moderate selectivity today, it may constitute very great selectivity in the future should the present frequency separation of station wavelengths be reduced.

The demands today is for a degree of selectivity much greater than I have mentioned. A good receiver must be able not only to select any one of local programs but it must be able to tune out all local stations, with their high received signal strength, so as to receive distant stations with much feebler signals and wavelengths perhaps but slightly different from the wavelengths of local stations. And since an increase in selectivity, or sharpness of tuning. usually goes hand in hand with a diminution of sensitivity, a gain in selectivity must be accompanied by some agency—usually the addition of more radio frequency amplifier tubes—for increasing the volume or signal strength of the received program.

In addition to selectivity, a radio receiver should be able to amplify uniformly, and at a high degree, over the entire range of wavelengths from 200 to 550 meters. Let us see what is the effect of this specification. Most radio receivers do not, and cannot, amplify uniformly over the entire wavelength range. To do so requires the employment of certain artifices wherever inter-circuit coupling is employed. Lacking such means, the average set is designed on the compromise basis. As a rule, it amplifies best at the mid-range, in which case stations on the longer and shorter waves are not received so efficiently. If it be designed to amplify most efficiently at the longer waves, then stations on short waves will be very poorly received, and vice versa.

That a receiver should amplify radio frequency currents "at a high degree" is only another way of saying that it must be sensitive or able to receive stations at great distances—an obvious desideratum.

The third specification which I would lay down for the perfect radio receiver is that it must amplify uniformly, and at a high degree, over the entire range of audio frequencies. This means equal reproduction of all tones, from the low notes of the drums and heavy brasses to the highest harmonics of the violin and the human voice. And that it should amplify these frequencies again "at a high degree" means in this case that there shall be adequate intensity or volume to bring out properly the low notes of high energy content, and to give—when desired—a general volume of sound approximating that of a small orchestra.

Much progress has been made in the last two years toward realizing these fundamental requirements. A little more than a year ago, as you know, the audio frequency reproduction of radio sets had so far surpassed the phonographs of that date that three large phonograph companies, after taking severe losses in their business, were forced to bring out new methods of phonographic reproduction. And it was the radio engineers who not only set the standard which the phonograph had to meet but who were the men who actually improved the modern phonographs.

But progress is still to be made in the engineering perfection of radio receivers. The better class of receivers is getting most of the low tones and the high notes of music and speech now, and soon we shall be able to uniformly amplify them all. And when we do, radio reproduction will be in every sense life-like.

Gratifying progress is also being made in the a. c. operation of receivers—that is to say, the ability to operate receivers without batteries off the commercial lighting circuits. This, while not so cheery for the great battery companies, is of interest to the power companies, who have already felt the benefit of an extended lighting load. I daresay that radio has induced later hours than any other single agency introduced into our national life. I should say that another two years will see a fairly complete solution of this problem; it is not solved until the last trace of 60 cycle hum is eliminated from your radio receiver or electric phonograph.

Increased perfection of loop reception for the complete elimination of exterior antennas is also being made. This enhances portable reception and ease of installation in crowded living centers such as we have in our large cities.

I have been discussing very briefly the technical side of the receiving set. There

(*Continued on Page* 46)

The Sargent-Rayment Infradyne

Involving Improved Filament and Volume Control, New Three-Gang Condenser and More Compact Arrangement of Parts

By E. M. Sargent

ACTUAL experience in constructing the infradyne circuit, garnered from questions asked by thousands who have built the set in accordance with the directions first published in August, 1926, RADIO, is the basis for the revised circuit here presented. To distinguish it from the original and to give due credit to Mr. L. C. Rayment for his part in developing the circuit during the two years of research of which it is the product, the new model is called the Sargent-Rayment infradyne.

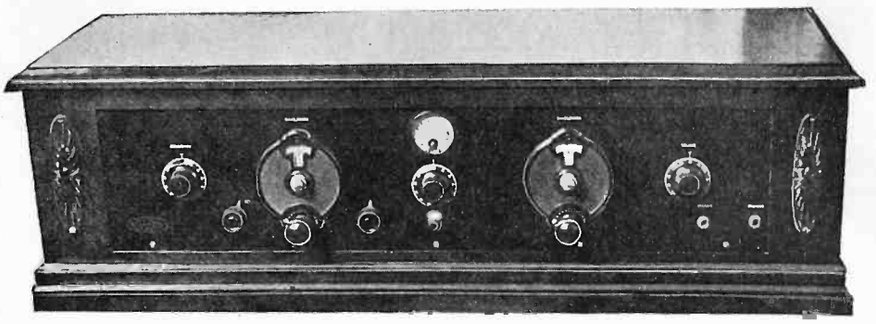


Fig. 1. Front View of Sargent-Rayment Infradyne.

The infradyne is a distinctly new development and is in no sense a superheterodyne. Both use an oscillator in combination with the incoming wave, as do also some other types of sets. But otherwise it is fundamentally different in operation and in characteristics.

The complete set is essentially a standard five-tube tuned radio frequency unit to which is added an oscillator tube, a mixer tube and a three-stage infradyne amplifier unit. This last unit is tuned to give maximum amplification at a constant frequency of 3,490,000 cycles, or 86 meters. This frequency is equal to the sum of the incoming signal's frequency and the oscillator frequency, this summation being made in the mixer tube. For instance if the incoming frequency is 1,000,000 cycles, roughly corresponding to 300 meters, the oscillator is set to generate 2,490,000 cycles so as to give a sum of 3,490,000 cycles. Or if the incoming frequency is 750,000 cycles, corresponding to 400 meters, the oscillator is set to generate 2,740,000 cycles, so as to give the required constant sum. The sum frequency is detected and then amplified through two stages as in any other standard circuit.

The advantages in the use of the sum frequency include the fact that each station can be heard at but one setting of the wavelength condenser and of the oscillator condenser. Furthermore, reception is quieter because circuits tuned to 86 meters will not pick up interference from long wave commercial transmitters nor can microphonic tube noises and other audio frequency currents generated in the tuned r. f. stages or in the mixer tube pass through the infradyne amplifier unit.

The infradyne does not radiate energy into the antenna and thus does not annoy your neighbor with squeals and howls. Due to its design it is extremely selective, more so than any other type of commercial receiver. With what virtually amounts to six stages of tuned radio frequency amplification it is very sensitive, picking up the most distant stations. Although the infradyne amplifier unit is so sharply tuned that its peak or resonance point is less than one meter wide, that represents a 20 kilocycle band at the high frequency employed, so that no distortion is introduced in the r. f. amplification and with good audio transformers perfect tone quality is attained.

The detailed method of constructing the Sargent-Rayment infradyne is obvious from the pictures and diagrams. The changes shown in the pictures of the front and rear views, in the schematic and pictorial wiring diagrams, and in the panel and baseboard layouts are summarized in the following paragraphs:

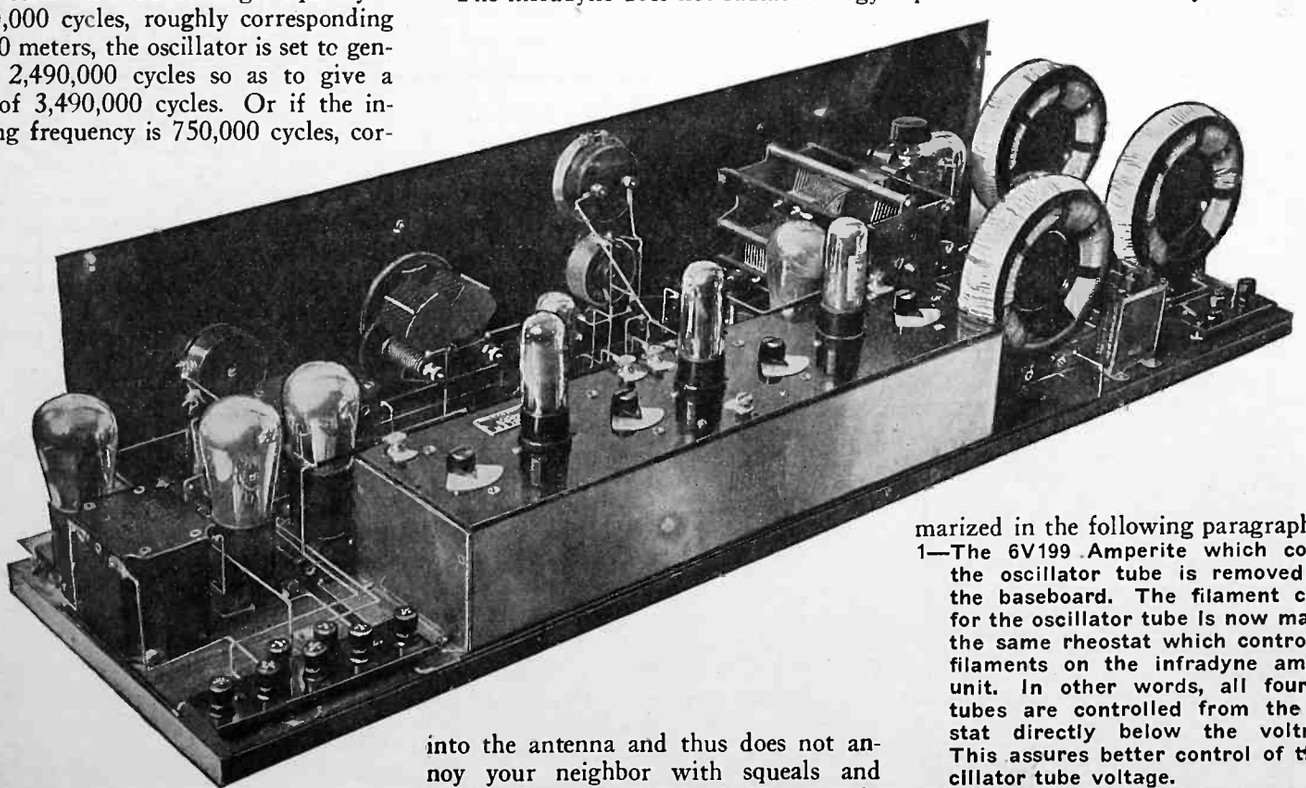


Fig. 2. Rear View.

1—The 6V199 Amperite which controls the oscillator tube is removed from the baseboard. The filament control for the oscillator tube is now made by the same rheostat which controls the filaments on the infradyne amplifier unit. In other words, all four "99" tubes are controlled from the rheostat directly below the voltmeter. This assures better control of the oscillator tube voltage.

2—A Cardwell or Hammarlund three-gang

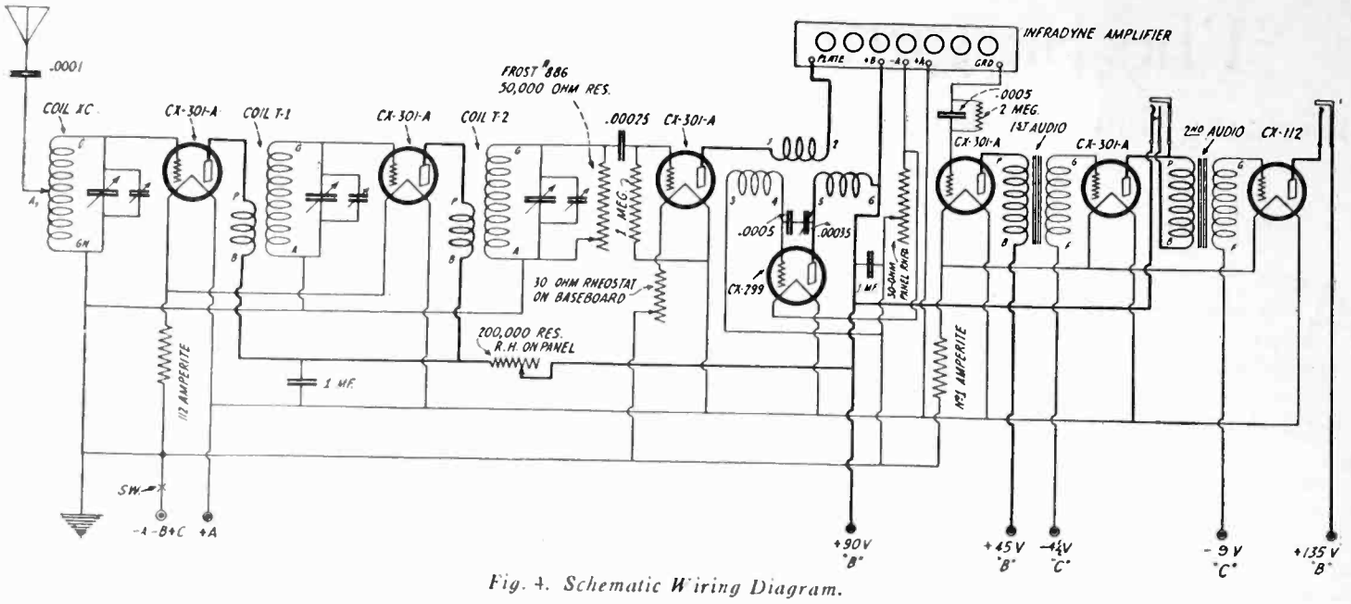


Fig. 4. Schematic Wiring Diagram.

variable condenser is used in the radio frequency circuit and "trimmer," or small vernier condensers are shunted across the gangs for finer tuning.

3—The 500,000 ohm variable resistance is removed from the panel of the original model. In its place a 200,000 ohm variable resistance is installed. This 200,000 ohm variable resistance controls the plate circuit of the tuned r. f. amplifier.

4—The 10-ohm rheostat on the left-hand end of the panel is removed from the original model. A 112 Amperite is used in place of this rheostat to control the r. f. tubes. Diagrams show how to wire this in its proper place.

5—In place of the 10-ohm rheostat mentioned in the preceding paragraph, install a 50,000 ohm variable resistance. This is shunted across the mixer tube. See diagram.

6—Take out the following Amperites, mounted on the baseboard of the original model:

Amperite 1A, controlling the detector tube.

Amperite 1A, controlling first audio tube.

Amperite 112, controlling the power tube.

In place of these three separate Amperites, install one No. 1 Amperite, which now controls all three of these tubes. The diagram shows how to connect the No. 1 Amperite in the circuit.

It will also be noted that the baseboard layout is somewhat different. The mixer tube has been moved over next to the infradyne amplifier so as to make the shortest possible wiring between the plate terminal of this tube and the plate connector on the infradyne amplifier. This being an 86 meter lead, it is essential that it be as short and direct as possible. For this reason the new layout is more efficient than the first one.

The variable plate resistance of (3) gives a much smoother method of control than the filament rheostat and reduces the drain on the *B* battery by nearly eight milliamperes. Any good 200,000 ohm variable resistance may be used here.

The volume control is a 50,000 ohm variable resistance having an "off" position. It is very important to have this "off" position and the builder should examine his 50,000 ohm resistance carefully to see that the contact in this position is fully broken. If it is not, a decrease of 50 to 75% on weak signals will be experienced. At the present time, the writer knows of only one such variable resistance, the Frost No. 886. This method of cutting down volume on a powerful local station has the advantage of reducing it near the input end of the receiver. When the volume control is placed in the audio frequency amplifier it is frequently too near the output end of the circuit to control it without spoiling

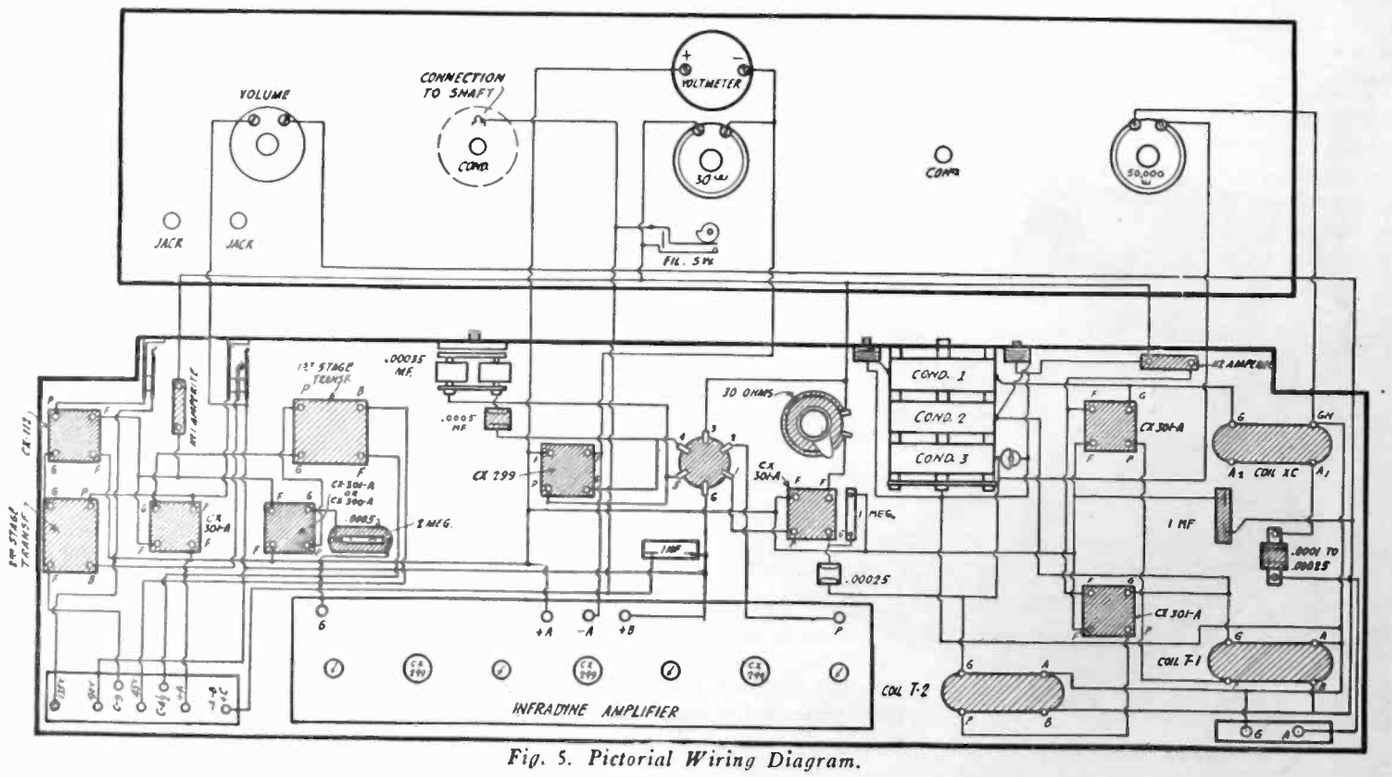


Fig. 5. Pictorial Wiring Diagram.

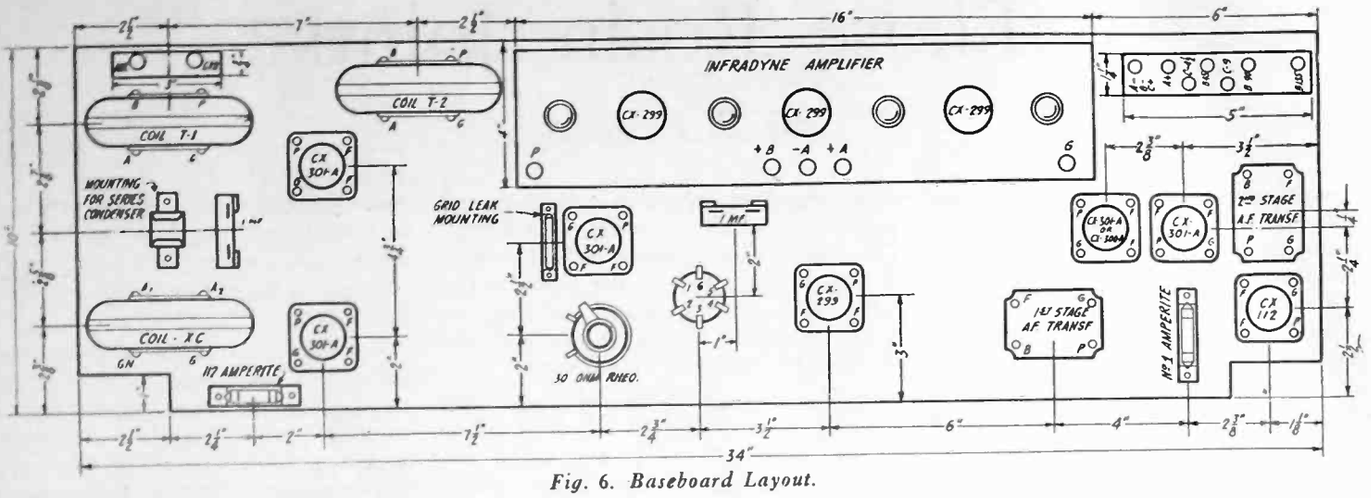


Fig. 6. Baseboard Layout.

the tone quality. A powerful local station coming in through six stages of radio frequency amplification is sometimes so strong that the detector tube is flooded with more energy than it can handle. Distortion results and no amount of cutting down after this point will save the tone quality. By reduction at the source obviously this trouble is eliminated and where the variable resistance has a full "off" position, the radio frequency losses caused by its introduction into the circuit are almost negligible.

The pictures show a binding post terminal block for battery connections. If desired, this can be replaced by a seven-wire cable and plug. If the plug-in arrangement is used the seven wires should be run to the batteries as follows: Red to positive *A*, green to negative *A*, blue to 45 volt *B*, yellow to 90 volt *B*, pink to 135 volt *B*. Of the two other wires which are not wrapped inside the cable, one is black and the other brown. These may be used as *C* battery connections, running the black to negative 3 volts and the brown to negative 6 or negative 7½ volts. In order to complete the battery circuit, the positive *C*, negative *B* and negative *A* are then joined together externally. The antenna and ground wires are connected to a small binding post block at the left-hand end of the set.

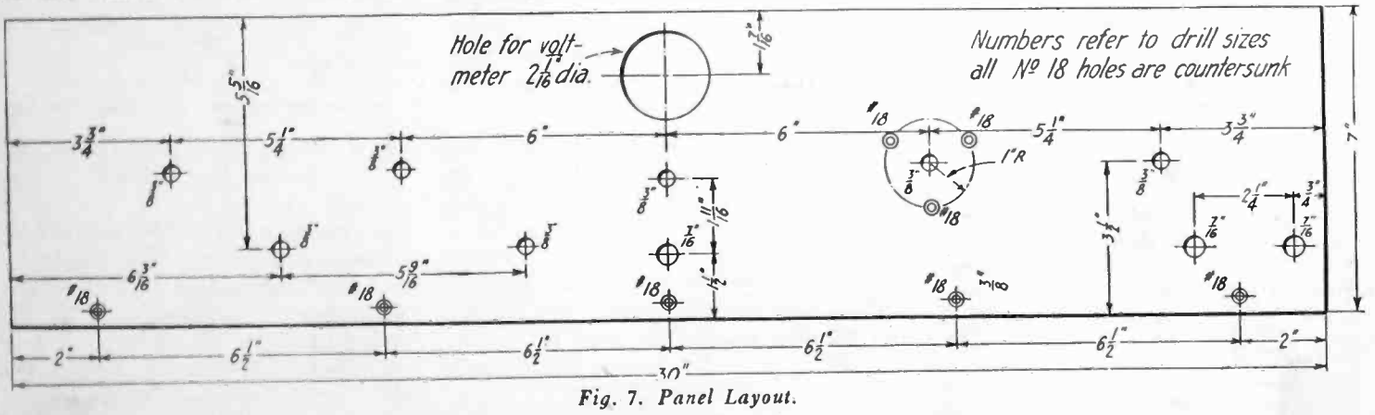


Fig. 7. Panel Layout.

The filament circuit is quite different and is more efficient and less expensive to build than that originally given. The two incoming wave radio frequency amplifier tubes are lighted through a half ampere ballast resistor and the detector and two audio tubes are controlled by a one ampere ballast. The oscillator filament is connected directly in parallel with the three infradyne amplifier tubes and all four are controlled by the 30 ohm rheostat in the center of the panel. This filament circuit eliminates several ballast resistors that were used in the first circuit and is therefore cheaper and easier to build.

The Cardwell and Hammarlund factories have designed a special three-gang condenser. An accuracy of 1 mmf. over the entire scale is secured by this new design. This makes the three midget vernier condensers of value only in balancing up the external wiring to the condenser. Two of the midgets are mounted on the panel and the third one can be supported on its bus-bar connections inside the set. The midget that is inside the set may be left set at one-quarter to one-half its maximum capacity.

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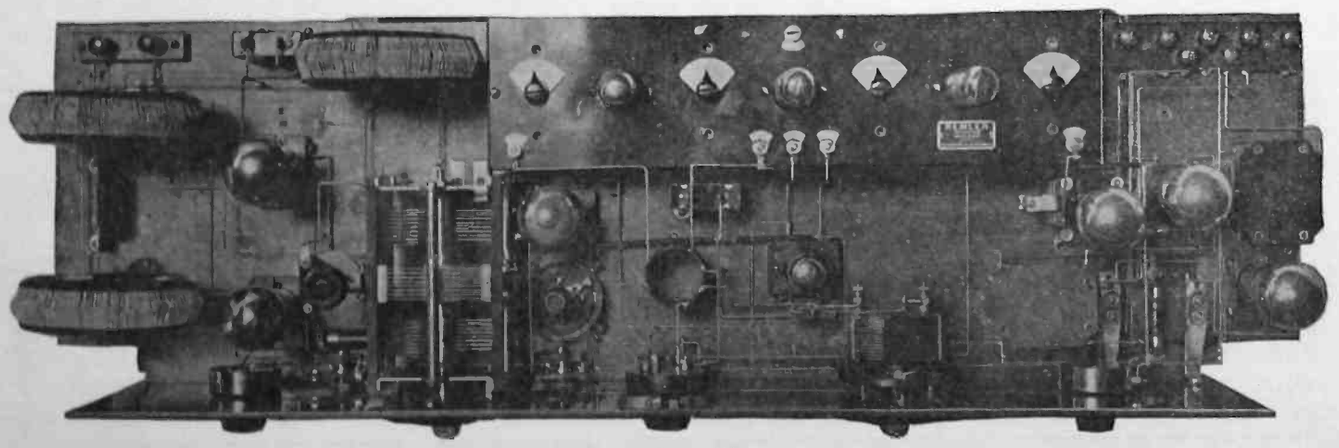


Fig. 3. Rear View.

Those Rosin Joints

By P. C. Ripley

Despite the fact that leading radio engineers and manufacturers have found rosin to be the safest and most dependable soldering flux, it is frequently assailed as being responsible for the failure of a radio receiver to function properly. Investigation invariably shows that such rosin joints are due either to poor technique, to using rosin and solder on material to which it is not adapted, or to a poor grade of rosin when used externally as a flux.

Solder is intended to provide a tenacious, flexible binding material which resists oxidation. For oxides are poor conductors. The first secret in all good soldering is to be sure that the joints are electrically conductive and mechanically secure before the solder is applied. This one precaution will largely prevent the

Fig. 1. Correct Method of Applying Soldering Iron to Work.

bug-a-boo of rosin joints. No person can hold a part absolutely motionless while applying solder. Yet the slightest motion while the solder is changing from a plastic to a solid state may induce a fracture which may become mysteriously evident at some later date.

The next precaution is to use an iron with enough capacity to heat the object to be soldered so that the object itself melts the solder. Otherwise there can be no guarantee that the solder will adhere to the object. A long or slender point on the iron will transmit enough heat for only the smallest and most delicate work.

Next the working faces of the iron must be thoroughly coated with solder so as to allow the fullest transmission of heat to the object to be soldered. This requires that the hot faces of the iron be filed to remove all oxide until they are clean and bright, when the rosin wired solder can be directly applied until they present a uniformly tinned appearance. Should your iron later become overheated so that the coating of solder is destroyed or oxidized, you will note that the iron immediately loses its efficiency as a heat transmitter. It should then be retinned.

Obviously the maximum surface of the iron must be applied to the work in order that its stored up heat be quickly transmitted to the object. With the working face flat on the work, as in Fig. 1, there is a far better chance to deliver more heat than where only the extreme point of the iron has contact, as in Fig. 2. Conduction and radiation of heat in Fig. 2 may be so rapid in the body of the work that a temperature sufficient to melt the solder cannot be attained and the result is apt to be a rosin joint.

Solder is an alloy of tin and lead. Its melting point is less than that of either of its components. The best solder for radio use is made from clean, new metal and has back of it the endorsement of a reliable manufacturer that it contains no scrap metal or reclaimed solder that may raise the melting point or render the alloy brittle.

The prime duty of the flux is to dissolve or remove the oxides from the surface of the metal to be soldered. This enables the solder to penetrate the minute pores which were formerly occupied by these oxides, thus allowing the molten solder to alloy with the clean metal surface. For radio use the best flux is noncorrosive and leaves a residue having no tendency to collect dust or moisture.

These requirements are admirably met by the best grades of fresh rosin, the darker grades being the least desirable of the twelve grades listed by the U. S. Department of Agriculture. Abietic acid, the active solvent in rosin, is driven off by heat and the carbon residual has no fluxing power, as may be readily proved by heating until the white smoke ceases.

For this reason the correct method of using rosin cored solder is to apply the iron to the work so as to slightly preheat it, then raise the iron a trifle from the work and introduce the rosin cored solder between the working face of the iron and the work itself. Then press the iron against the work and hold it there until you note the solder flowing smoothly and freely about the contact. Then lift the iron and allow the work to cool and you will find that you have executed a perfect joint.

Never attempt to carry your solder and flux to your work on the heated iron point, because it requires skill of a high degree to accomplish a satisfactory operation in this manner. If you melt solder on the upper faces of the iron it forces the flux and solder to run around the iron faces before it can reach the surface which we wish to solder. This allows the abietic acid to volatilize before it has any opportunity to accomplish its purpose. Then you are likely to secure one of those dreaded rosin joints. Those who are in doubt as to their skill in executing a successful soldered joint can adopt no better method than to solder coat the two surfaces which they intend to join; then bring them in contact and reheat, applying a small amount of the rosin cored solder directly to the union to complete the operation.

Considerable can be said concerning the metals upon which you will secure the best results when employing rosin-cored solder. Tin plated surfaces are the best, as tin does not oxidize very rapidly. However, cheap electro tin plated soldering contacts are often less desirable than the base metal upon which they rest. Any metal properly tin plated responds readily to the fluxing power of rosin. Raw copper surfaces, unless too heavily oxidized or sulphated, form a good surface for the use of rosin-cored solder. German silver, bright iron or steel, and

Fig. 2. Wrong Method of Applying Soldering Iron to Work.

zinc respond fairly well, while brass or nickel-plated metals offer a greater resistance. Aluminum and certain of its alloys are practically beyond the fluxing power of rosin. Insulated wires of the enameled type must be cleaned free of all enamel before any effort is made to solder them. This is best done mechanically, by scraping, or sand papering until the metal shows bright in its entirety where you wish the solder to flow. Cotton covered, rubber covered, or shellacked wires must also be cleaned mechanically before attempting to solder, and in case of some rubber covered wires you will note that a sulphate has formed and has practically destroyed the tinning of the wires. It is then best to clean down to the raw copper before doing any soldering. All oxidized or dirty metal surfaces should be cleaned thoroughly in order to prevent the over-burdening of the de-oxidizing agent of your flux.

By turning these points over in your mind and following the instructions laid down for the use of rosin-cored solder you will eliminate rosin joints and you will be surprised at the ease with which successful soldered joints can be executed on your radio receiver. Neither need you fear that at some later date your receiver will be forced into the discard by the action of a corrosive and conductive flux residual.

Yarns from the Static Room

By Aaron Nadell

"JACK JOHNSON," Burmese oiler aboard the ship *West Tararra,* of your Uncle Sammy's Shipping Board, imbibed too much bad whiskey in Havana. Consequently, when the *West Tararra* left bound for New York, and Johnson went on watch, he wasn't quite as fit for his duties as he ought to have been.

In the dim past he had been christened "Jack Johnson" because he was the meekest, most inoffensive man imaginable. He was a Burmese, a little organism of muscle and bone closely packed in a brown skin; he weighed altogether less than one hundred pounds. Insignificance was his specialty.

Yet he had pride. The least of us have pride. Jack Johnson's was his knowledge of marine engines. It was many years since he had stolen aboard a Japanese tramp at Rangoon and started his career. With pride went a grievance; that free America balanced his competence against the color of his skin, and refused him the license of an engineer, and the engineer's pay, prestige and status. In Havana Jack Johnson consoled himself with whiskey cheap and raw.

Now the beautiful steam turbine which drove this four thousand ton freighter smoothly through the Atlantic waters depended, for its proper operation, on a team-mate known as a "vacuum." The vacuum lived inside a big metal shell and required the constant services of a small pump. The pump was operated by a little auxiliary engine. And this particular engine bore on its surface a small ordinary screw, which had to be tight.

But the tightest thing aboard that ship was our Burmese oiler. The third assistant engineer, on watch, sneaked up to the pantry for a forbidden snack. The two wipers were aft in the fo'c'sle, swapping tales of the girls they had known in Havana. The fireman was attending to his arduous duties under the draft of the ventilator, half an eye on his gauges and one and a half on a story magazine. Jack Johnson was all alone in the engine room, filled with a sense of importance. He suddenly decided that it was his duty to take apart that pump and see if anything ailed it. And . . . he got a screw-driver and loosened the screw that had to be kept tight.

The little engine that drove the pump went on strike.

The pump was thrown out of a job.

The vacuum resented being deprived of its servant. It considered this a direct assault on its social status, and laid down and died of a broken heart.

The great engine that drove the ship felt obliged to mourn. It sobbed, and groaned, and wheezed, and finally stopped. So did the ship.

Up on the bridge the third mate left his chart and dividers with great suddenness and devoted himself to the engine room telephone. Below in the pantry, the third assistant engineer overturned a cup of coffee and beat Nurmi's record to the engine room stairs. Fluttering in the draft of the fire room ventilator, the pages of the story magazine advertised that the fireman had already found pressing business with the engine room's attendant.

Jack Johnson heard the engine stop; he heard the telephone ring; he heard the third assistant tear swearing down the iron ladders; he heard the fireman's insistent demand for immediate information. It dawned upon him that something had happened, and that he, the Burmese oiler was alone in charge of the engine room. Now was the time to show his competence, to do something before the shouting white man got down to the engine room floor.

These things raced through Jack Johnson's mind with great quickness. The handiest important thing to do seemed to be to blow off the boilers. Jack Johnson blew off steam every place he could think of. A mighty roar came down from above and quivered through the idle ship. The engineer, halfway down the ladders, was met by a blinding cloud of white vapor, out of which presently came charging a panic-stricken fireman. And behind the fireman Jack Johnson, no longer exalted, thoroughly frightened at the idea that something had gone wrong and he was responsible, shouted falsely that the ship was sinking. The electric lights began to dim as the steam that should have supplied the dynamos roared away through the open valves.

Three minutes later the crew were assembled by the lifeboats; the engineers stood in the darkened alley with flashlights waiting for the steam to clear out of the engineroom hatch, and the captain of the vessel, shivering in his underwear, was in the wireless cabin dictating information to the operator by the light of the emergency batteries.

Aboard the great Cunarder *Tourainia* the wireless operators were preparing their nightly message tape for its Wheatstone transmission to the shore station, when they picked up the *SOS* from the *West Tararra.* Their work was suspended.

Under the shadow of the Woolworth Building—you must imagine a shadow cast by moonlight—the operators at the Brooklyn Navy Yard were preparing many sheaves of code instructions for the fleet maneuvers, to be transmitted through NAH. They heard the *SOS* relayed by the big Cunarder. Their work was suspended.

Scattered abroad upon the ample bosom of the North Atlantic were some hundreds or thousands of vessels, nearly all of them carrying wireless operators, nearly all the operators, in the early evening, with some business or other to transact with shore. NAH cut in a

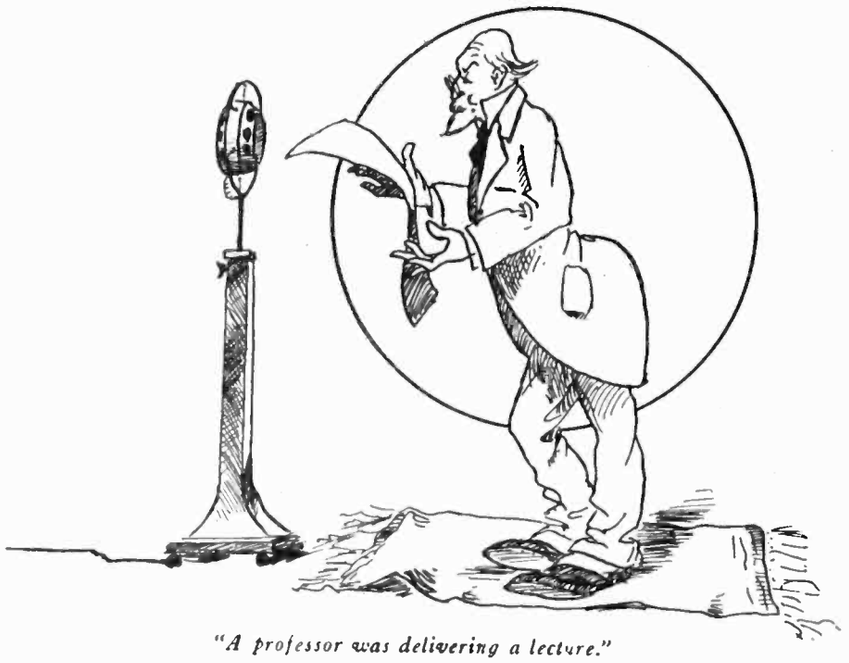
"Jack Johnson blew off steam."

high power, five hundred cycle synchronous spark that created an arc of silence from Newfoundland to the coast of Florida. Their work was suspended.

Behind NAH, in the skyscrapers, the broadcasting stations heard the high power spark. They made excuses over the air, and shut down incontinently. Their work, etc.

A professor of Columbia University, booed the unfortunate fan, and his girl put her chin in the air and went off with the other fellow.

In an East Side tenement, nine year old Izzy Cohen hooked up, before his skeptical parents, the crystal set he had bought with so many hard-saved pennies. Half an hour later he went crying to bed, and the precious set had been smashed by his angry father.



"A professor was delivering a lecture."

a most eminent scholar, was delivering a lecture on the use of the split infinitive in Chaucer, for the benefit of station WROT. His work was suspended.

A group of grand opera stars were assembled, at great expense, in the studio of station WATT, to give the public an evening of incomparable music. The Lucia sextette was stopped halfway, and their work was suspended.

A brace of so-called comedians were broadcasting a string of vaudeville jokes through station WHY, to the huge delight of millions. Their cleverness ended abruptly; their work, etc., etc.

And in a suburb of Hoboken an enthusiastic young radio salesman was conducting a demonstration in the home of a prospect. He got started about two minutes after the general call. The set produced no music, and his prospect became frigid and then sarcastic. The enthusiastic young salesman lost his poise and made a pitiful exit.

In a Philadelphia apartment house an enterprising fan had that day strung an aerial across his neighbor's; against the latter's objection. That night the neighbor's set could find no broadcast. In the fight that ensued the police intervened just in time to prevent one of the men being thrown off the roof.

In a drug store in Alabama, the village boys gathered to see Hank Gordon win a bet with a rival that his set would pick up New York. Hank's girl was with him to share his triumph. Fifteen minutes brought no New York, the boys

In the town hall of a Maryland village, a thousand women had gathered to hear a speech on the Volsted Act, delivered especially for their benefit by a famous leader of drys, before a microphone in Washington. They heard no speech, and prohibition enforcement has languished even unto this day.

In a thousand mid-Western farmhouses the radios were set to hear a local station re-broadcast programs from the cities of the East. Two banjos and a clarinet were the only emergency talent available, and had to substitute as best they could, for a thousand farmers' families, for the thrill of intimate contact with the bright lights.

Over in England an amateur was trying out a new circuit which had been recommended for receiving American broadcasts. The circuit was classed as "unreliable" in his report to a magazine.

In the afternoon sunshine of California a stray echo of the *SOS* occupied the attention of the coast stations and interfered with the traffic of ships as far off as Japan.

But deep in the night that blanketed the North Atlantic, the steam had thinned away in the engine room of the *West Tararra.* The engineers, armed with flashlights, had nobly penetrated the depths. They spent half an hour looking for any reason to lower away the lifeboats, but didn't find it.

Some four hours later, when they were about ready to turn over the engine, the chief engineer noticed the screw that was loose and tightened it without thinking about it. The *SOS* had long ago been rescinded. Wireless traffic and broadcasting had been resumed. All was well on the North Atlantic. Except in a little room where a thoroughly sobered Burmese oiler was applying fomentation to a discolored eye, a testimonial of regard from his chief engineer.

* * *

SIX men sat in the "static room" of a wireless company, awaiting assignment, and while they waited they exchanged "static." They were sea gypsies of the twentieth century, ocean-going wireles operators, the birds of passage of a scientific age. One of them told the story of Jack Johnson. They had stories of every port in the world, tales of all the seven seas. They wore silk socks and white collars, and they had covered more knots than ever a ragged old-time pirate of the Spanish Main.

The second man told a tale of a Chinese execution; twelve malefactors marching in line, without guards, kneel-

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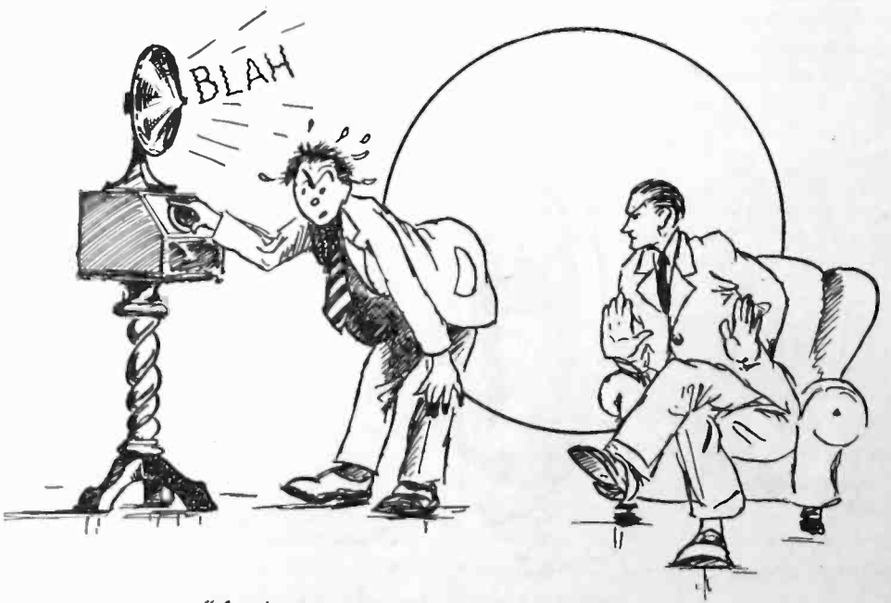


"A salesman was conducting a demonstration."

The Operation and Construction of Quartz Crystals

A Summarized Account of Their Theory Together with Detailed Directions for Their Preparation

By Jennings B. Dow, Lieut. U. S. N., M. S.

THAT the merits of the rigid control of the output frequency of radio transmitters have not led to the more general use of this device by amateurs is possibly due to the dearth of definite information such as it is the purpose of this article to furnish. The general theory of its operation has been treated so often in these columns and elsewhere as to require no further discussion.

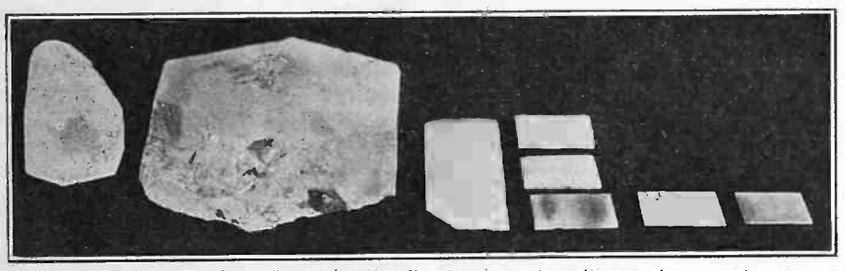


Fig. 1. Various Steps in the Production of a Finished Crystal.

The several steps in cutting and grinding a finished crystal from a rough one are shown in Fig. 1. The rough crystal may be of any size or shape, provided that the three axes may be located as shown in Fig. 2. When these are determined a number of sections parallel to that shown in the plane *OAB* may be cut from a single crystal.

The rough crystal is approximately hexagonal or six-sided. The *OA* axis is the central axis of the crystal parallel to all the sides and is known as the optical axis. The *EA* axis bisects the angle between two adjacent sides and is known as the electric axis. *AB* is perpendicular to the two other axes. So that the plane *AOB* is any plane perpendicular to *EA* or electric axis, the three axes being mutually perpendicular.

Now, let us take the finished crystal out of the rough one of Fig. 2 and put it between two brass plates which will hereafter be called the *electrodes*. Fig. 3 shows the resulting arrangement together with the previous designation of axes. The *OA* axis is shown perpendicular to the plane of the paper. If experiments are performed with this combination and suitable measuring apparatus it is possible to prove experimentally the following laws: I. Compression along the electric axis results in charging the electrodes with equal and opposite charges of electricity. Stretching the crystal along the *BA* axis produces charges on the electrodes having signs corresponding to those of compression along the electric axis. Stretching the crystal along the electric axis also produces equal and opposite charges on the

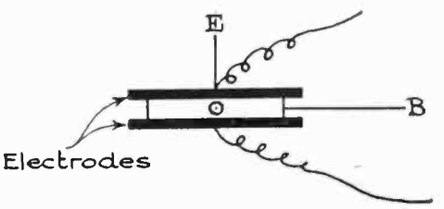


Fig. 3. Finished Crystal Between Electrodes.

electrodes but the signs of these charges are opposite to those produced by compression. Compressing the crystal along the *BA axis* produces charges having the same signs as those resulting from stretching the crystal along the electric axis. The electrical effects of compression or extension along the optical axis are negligible. It is quite well understood that a crystal is not entirely neutral along the optical axis. Absence of the neutral condition is believed due to actual deformation along the *EA* and *BA* axes even though the external force is applied along the optical axis.

II. If the electrodes are charged by connecting a battery to them and the charges have signs similar to those produced by compression along the electric axis, the crystal will contract along the electric axis and expand along the *BA* axis and will remain neutral along the optical axis. If the applied charges are opposite to those mentioned above, a converse effect results along the *E* and *B* axes.

The value of a quartz crystal for the control of a vacuum tube oscillator may readily be inferred from a consideration of these two laws and the fact that such a body may be made to vibrate mechanically along any one dimension at a fre-

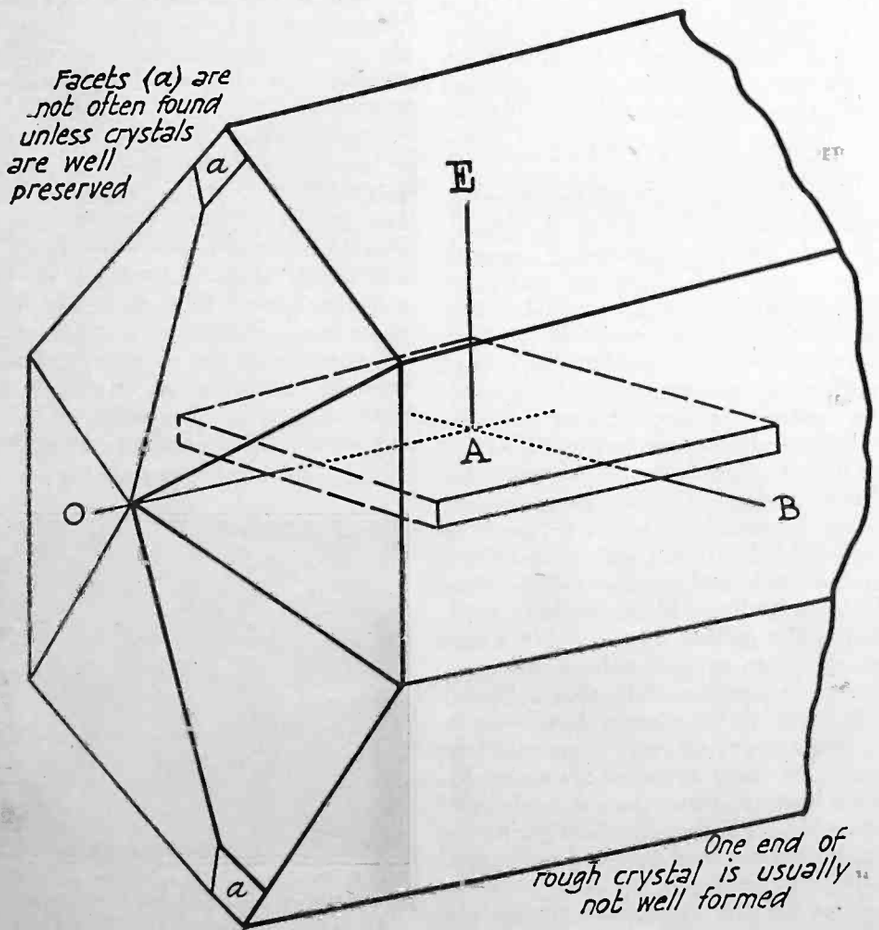


Fig. 2. Orientation of Axes in Quartz Crystal.

quency uniquely determined by that dimension.

In the present case, interest is confined to the longitudinal vibration along the electric axis and the crystal can be thought of as a rod having a length which is small compared to its other dimensions. If a rod is struck on its end with a hammer, its natural frequency of vibration is that one which makes the rod one half a wavelength long. This is fortunate because the maximum elongation and contraction are produced by such a vibration, and since the piezo electric charge is a function of the strain in the crystal, the maximum potential variation is produced at the electrodes.

If the finished crystal is placed in the grid-filament circuit of a vacuum tube, and mechanical vibrations are started, piezo electric potentials sufficient to control the plate current may be set up in the grid circuit. If sufficient energy is fed back to the crystal from the plate circuit at the proper time during each half cycle, the mechanical vibrations will not die out but will become sustained, and the tube will continue to oscillate. In practice, this feed-back of energy is accomplished through the plate-grid capacity of the tube.

A rigid mathematical discussion of a vibrating crystal in the grid circuit of a tube has not been developed to date and indeed, presents a very complex problem owing to the fact that the crystal is not uniformly elastic in all its dimensions. Moreover, this difficulty is accentuated by the fact that the dielectric "constant" varies throughout the vibration in a manner which is not well understood.

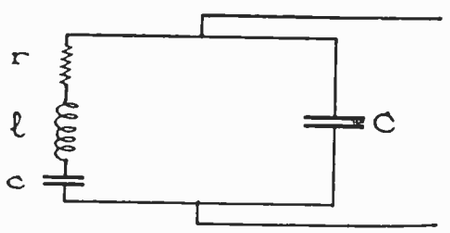


Fig. 4. Electrical Circuit Equivalent to a Thin Vibrating Crystal.

But on the basis of Curie's experiments with piezo crystals it can be shown that the electric charge developed on each electrode is proportional to the area of the face of the crystal multiplied by its change in dimension along the electric axis, due to the applied voltage. The mathematical treatment developed by Pierce in his Harvard lectures proves that this relation is the same as is the case of any other charged condenser.

The vibrating crystal is equivalent electrically to the circuit shown in Fig. 4 in which *r, l,* and *c* are due to the vibration and *C* is the non-vibrating capacity formed by the crystal and its electrodes. *r* is the small equivalent resistance introduced into the circuit by heat and sound energy losses during the crystal vibration. *l* is a very large inductance and *c* is a small capacity, probably not exceeding a value equal to 0.002 *C*.

Constructing the Finished Crystals

THERE are various sources of rough quartz crystals suitable for our purposes. The more important sources are Brazil, Madagascar, United States and Japan. As a rule, it is possible to obtain the rough crystals through mineral supply houses or through other advertisers in the technical journals. It is regretted that more advertising in this line does not appear in radio literature. In recent months, many of the optical supply houses have taken up the cutting of crystals for experimental purposes, and at least one company has been advertising finished crystals of excellent quality.

For best results, rough crystals should be selected with the following points in mind:

(1) One end of the rough crystal should have the typical configuration shown in Fig. 2, or at least, should possess as much of this detail as possible. The left hand picture of Fig. 1 shows the well preserved end of a small rough crystal. The facets *a* of Fig. 2 are usually not to be found owing to the rough handling which the crystals receive at the mines.

(2) As many as possible of the six prismatic edges should be intact.

(3) The crystal should be as regular (faces and edges parallel) as possible.

(4) There should be as much freedom from interior flaws and non-uniform structure as possible. If it is difficult to examine the interior owing to unpolished surfaces, the application of a generous coating of any clear oil will greatly assist in this examination. Only the perfectly clear portion of any rough crystal can be used.

After the rough crystal has been selected, the optical axis should be located. This axis may be considered for practical purposes to lie along the centers of all right sections of the crystal. The first cutting should consist in dividing the rough crystal into sections one inch in length along the optical axis. A specimen section of a large crystal is shown as the second from the left in Fig. 1.

The cuts must be made perpendicular to the optical axis. The rough crystal may be mounted in a power driven hack saw. A blade of mild unhardened steel, without teeth, and about the dimensions of a large hack saw blade should be used. During the motion of this blade across the crystal, an ample supply of carborundum grain (number 60) should be fed with water to the contact line between the saw and crystal, care being taken to insure that the grain is fed via both sides of the blade to make the cut as straight as possible. The carborundum grain may be collected and used over and over again during the cutting.

After the crystal has been cut up into slabs, an examination for *twinning* should be made. This examination is most important. During the growth of a quartz crystal, changes in pressure and temperature are manifested by changes in the crystal structure. Changes in structure result in shifting the previously designated axes in portions of the primary crystal with the result that those portions are unfit for use. The slabs may be examined for twinning by sending polarized light through them in the direction of the optical axis and observing the emergent light through a Nicol prism.

Apparatus for this purpose is usually available in any scientific laboratory where crystal structure or light phenomenon is observed. Most university laboratories have an instrument known as a polariscope for this purpose. When examining a slab of quartz in this way, the twinned portion will show up as one in which irregular or jagged regions of colored light will be seen. Again oil can be used to facilitate interior examination. In some cases, particularly close to the edges of the slab, regions of colored light may result from natural reflection phenomenon. If these particular regions of light are not jagged but quite regular, the cause is probably not due to twinning. The crystal should be turned slowly about the optical axis during the examination. The region in which twinning has not taken place will either be colorless or will show only the faintest shades of any color. The clear or untwinned portions of each slab should be marked out for use. In this connection, it might be well to mention that the whole crystal may be so badly twinned as to be unfit for piezo electric purposes.

The next part of the operation consists in choosing the direction of the electric axis. We have already fixed the optical axis as the center line. Should it be possible to locate one of the two facets, use a prismatic edge terminating at the facet, and the optical axis, to determine the plane of electric axes. In a perfect crystal, these facets are opposite one another whereas in a twinned crystal they are either adjacent or are separated by only one corner of the prism. Pass such a

(*Continued on Page* 60)

Fig. 5. Position of Electric Axis as Indicated by Heavy Line and Proper Cutting of Slices as Shown by Ruled Lines Perpendicular Thereto.

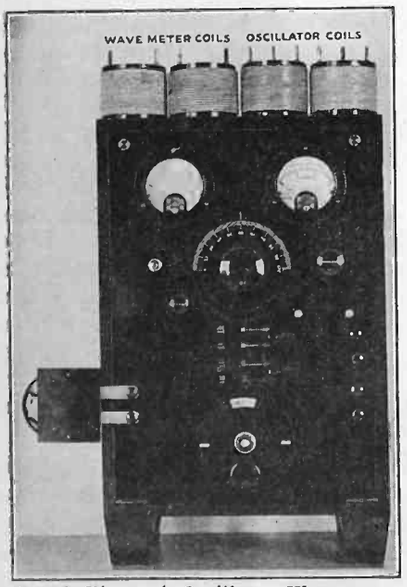
A Multi-Purpose Oscillator-Wavemeter

How it is Made and How Used to Match Condensers and Coils and Make Resonance Tests

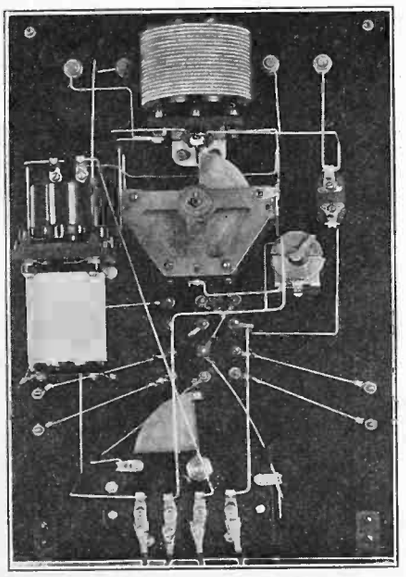
By W. H. Stirling

THE construction of single control radio sets by the amateur builder has been handicapped by lack of home facilities for the delicate balancing of condensers and of coils which is essential to the most efficient operation of the set. Each circuit must be adjusted to exactly the same frequency. Three similar coils must have exactly the same inductance and three condensers must have exactly the same capacity for any degree of displacement.

These accurate adjustments which make for the success of the factory-built receiver can also be readily made in the home laboratory by means of the simple oscillator-wavemeter here illustrated and described. Furthermore it can be used to calibrate any completed receiver or transmitter, determine the fundamental wavelength and capacity of an antenna, or make many other tests which depend upon a resonant circuit.



Panel View of Oscillator-Wavemeter.



Inside View of Oscillator-Wavemeter.

Such an oscillator can be easily assembled from material ordinarily found around a radio table by following the construction indicated in the pictorial wiring diagram. It will be seen to consist essentially of an oscillating vacuum tube with a milliammeter in the grid circuit to indicate resonance, together with associated coils, condensers and control equipment for various tests. The .0005 mfd. variable condenser in the upper portion of the panel is used to vary the wavelength or frequency of the oscillator circuit as defined by one of several different plug-in coils. Any well-constructed low-loss condenser will suffice.

The lower condenser in the wavemeter circuit should have a straight-line wavelength characteristic with vernier dial and should be of rugged construction so that it will hold its calibration. The small midget condenser, through which the oscillator couples to the external circuit, may be any one of the many types on the market, but should be modified so that it may be short circuited at a point beyond the maximum setting. This is because some circuits will require greater coupling than the maximum of this condenser will permit.

Three sets of oscillator and wavemeter coils are sufficient to cover a wavelength range from 80 to 1100 meters. The range from 80 to 213 meters is covered by 18 turns of No. 10 enamel wound on a plug-in General Radio coupler form or its equivalent, from 200 to 575 meters by 56 turns of No. 22 D.S.C., and from 375 to 1100 meters by 102 turns of No. 20 D.S.C. double bank wound. The oscillator coils should be tapped at the center turn of the winding.

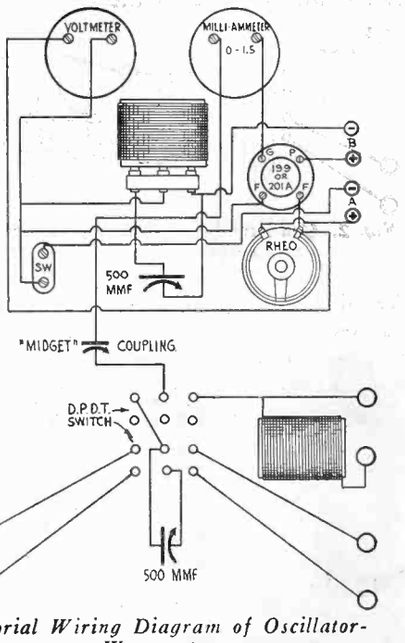
The coil permanently connected across the two upper right hand binding posts in the picture of the panel may be any coil used for broadcast reception or may consist of 70 turns of No. 24 D.S.C. wire wound on a piece of tubing 2 in. in diameter and 2½ in. long. It should preferably be mounted at right angles to the plane of the oscillator coil.

The milliameter may be a Weston model 301 or 506, which will register full scale deflection of 1½ milliamperes with 20 to 30 volts on the plate. But the plate voltage should be selected so as to give .5 to 1 milliampere deflection. The voltmeter is intended merely to guard against excessive filament voltage if a 199 type of tube is used.

The wavemeter portion of this device should be carefully calibrated and curves made for the condenser and several coils used.

Figs. 1, 2, and 3 show the connections for various tests, the positive of the knife switches being shown as from the front of the panel.

Fig. 1 shows the method of calibrating a condenser from a standard. The procedure is as follows: With the oscillator in operation and the upper switch to the right, set the unknown condenser, say, at 10 degrees. Throw the external switch so that the oscillator is connected to this condenser and adjust oscillator dial carefully until resonance is indicated by a "dip" (toward zero) of the ammeter pointer. The small coupling condenser should be set so that this dip is very slight—about one division is sufficient.



Pictorial Wiring Diagram of Oscillator-Wavemeter.

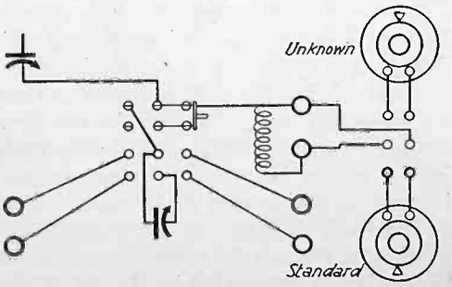


Fig. 1. Connections for Condenser Calibration.

Leave the oscillator set at this point and throw external switch to standard condenser, and adjust this condenser until the ammeter again registers a dip. The two condensers are now adjusted to exactly the same value of capacitance. Note this value against the degree setting of the unknown condenser. Next adjust the unknown condenser to 20 degrees, throw external switch to connect this to the oscillator and again adjust oscillator for the dip. Then throw external switch to the standard condenser, and adjust for the dip. Read this value of capacitance, and note against the 20 degree setting of the unknown. Repeat this for each 10 degrees on the unknown condenser dial, after which the figures thus adduced may be plotted as a curve, or marked directly upon the dial.

Fig. 2 shows the method of checking, calibrating or adjusting a single control receiver for wavelength. In this operation, only a single flexible lead, with a snap clip at its outer end, is used. This lead is first clipped on the grid connection of the first stage. With the receiver dial set at say 20 degrees, the oscillator condenser is adjusted until resonance is indicated by the milliammeter dip. Next move clip lead to grid connection of next stage, and this condenser adjusted to cause dip, then move to third stage, and adjust that condenser likewise. It is important in all single control receivers that exact resonance be effected at short wavelengths. Adjustments are more critical there. Next set oscillator so that resonance manifests at about 50 degrees on the receiver dial. Change clip from one stage to the next as before, adjusting the condensers if necessary at the center point. Next repeat the procedure at about 90 degrees.

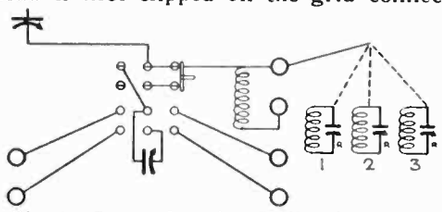


Fig. 2. Connections for Calibrating Single Control Receiver.

It would now be well to go back to first position and check settings to make sure that the latest adjustments have not affected the prior settings. Suppose that at 20 degrees the adjustments are undisturbed. We then go to 50 degrees on the first stage and carefully adjust oscillator at this point. Moving to the second stage with the clip, adjust receiver dial until dip occurs. Let us suppose this occurs at 52 degrees, and the third stage at 51 degrees. This shows us that we have too much capacity in the first stage, and a trifle less, but still too much in the second stage. The stator plates in the first and second stages should then be carefully adjusted at the center stud, so they more nearly approach center of the adjacent rotors. Or if this is not practicable, move the third stage stators slightly *away* from center. When exact resonance is obtained at the center point, set receiver at about 90 degrees, and take a set of readings on the three condensers, and follow the procedure as at center setting. The adjustment here, however, should be made at the stud nearest maximum setting of condenser.

By careful operation the three circuits may be brought into exact resonance throughout the entire range, and a great increase in efficiency will result. Bear in mind the fact that the capacity of a condenser for any setting is lowest when the rotor plates are exactly midway between the stator plates, and if the stators are moved ever so slightly away from center, the capacity of the condenser increases.

The procedure just outlined will of course only apply to a completed receiver. The proper procedure if the receiver is in process of construction would be to first mount the condenser gang upon the panel in the position in which they are to remain permanently, after having carefully centered the plates as well as possible. Then follow the procedure similar to that shown in Fig. 1. Use two flexible leads in this operation. Connection is made to the rotor and stator of No. 1 condenser, the dial set about 20 degrees, and the oscillator set for the dip. Always connect the lead from the top binding post to the stator plates. Take a tentative set of readings on all three condensers first to determine how closely they "follow" at this oscillator setting. Then adjust so that they all start off together. Next go to 50 degrees, take a set of readings at this point, and adjust if necessary. Next at 90 degrees. Then go back over, and make certain that they follow all the way through. Care and accuracy in making these adjustments will result in a set of condensers that will have exactly the same value of capacitance for each degree on the dial. That's half the battle.

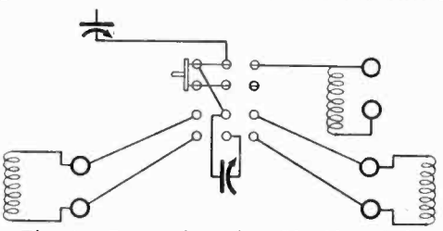


Fig. 3. Connections for Checking Coils.

In Fig. 3 is shown the method of checking two or more coils against a standard, or against each other. This is the first operation, where the bottom switch has been used. The top switch is now thrown to the left, connecting the oscillator to the bottom condenser. Suppose we have two similar coils and wish to determine if they have exactly the same inductance. One coil is connected to the lower right hand binding posts, and the other to the lower left hand binding posts. Set the oscillator at say 15 degrees. Throw the lower switch to the left, and adjust the lower condenser for the dip. Then throw the lower switch to the right, and see if it is necessary to readjust the condenser. If exactly the same setting of this condenser results, we may well feel encouraged. Next set the oscillator dial at 85 or 90 degrees, and let us assume here that the left hand coil shows the dip at 90 degrees, and the right hand coil at 91. This shows that the left hand coil has a trifle more inductance than the right hand coil. Let us try separating the end turn on the left hand coil a small fraction of an inch, and take our reading again. We should find that both indicate resonance at 91 degrees. A light touch of collodion on the turn we just moved will now retain it in place, and the third coil should be substituted for this and the readings taken again. If necessary adjust the end turn on this coil, so that it balances.

To calibrate the receiver for wavelength, connect the wavemeter coil to the lower left hand binding posts, throw lower switch to the left and upper switch to the right. Using the single flexible cord, connected to the top right hand binding post, clip on the grid lead of any one of the receiver condensers. Set receiver dial at 10 degrees and adjust oscillator for dip. Then throw top switch to the left and adjust wavemeter condenser for dip. Read wavelength at this setting and note against receiver degrees. Next throw upper switch to the right, set receiver at 20 degrees and adjust oscillator for dip. Again throw upper switch to the left, and adjust wavemeter for dip. Note this wavelength against the 20 degree receiver setting, and repeat this procedure for each ten degrees on the receiver dial.

The fundamental wavelength of an antenna may be taken by the following procedure: Connect antenna and ground lead together. Use single flexible lead from upper right hand binding post, and clip to the antenna. With upper switch to the right, adjust oscillator for dip. Then throw upper switch to the left and adjust wavemeter for dip. This wavelength will be the fundamental wavelength of the antenna.

To determine the capacity of the antenna; Connect the antenna to upper right hand binding post, and the ground to the binding post immediately below it. With upper switch to the right adjust oscillator for dip. Disconnect antenna and ground and connect the two upper right hand binding posts to the two lower binding posts, and adjust the lower condenser for dip. The capacity of this condenser at this setting is the capacity of the antenna.

If it is desired to use the wavemeter for the calibration of a transmitter, place a thermo-galvanometer between the lower left hand binding post, and the wavemeter coil, and proceed as with any standard wavemeter. Leave the upper switch open.

Shielding

Theoretical Considerations Governing Its Use and Practical Suggestions for Its Efficient Accomplishment

By H. Melchior Bishop

TO SHIELD or not to shield? It is indeed a problem,—a problem made all the greater by the difference in results obtained by shielding different types and designs of sets. Perhaps the best basis for decision is to first obtain an insight into the various effects produced by the shielding of a set, or of some parts of the set, and then to apply a little common sense to the particular problem in hand, always keeping in mind the bearing of these various factors on set performance and efficiency.

A set is usually shielded to make it more selective, especially when it is to be used close to a broadcasting station. It is easily possible, however, that the very shielding which is intended for this service, will, because of improper design or crowding, defeat its own purpose. This is because shielding which is contained within the magnetic field of a coil, for instance, is subject to the setting up of eddy currents within the metal comprising the shield, which in turn react upon the currents in the coil and thereby greatly increase its effective resistance.

Shielding is also used to prevent outside disturbances in vicinity from setting up counter currents in the receiver coils. These tend to reduce the general efficiency of the set and to cause unpleasant noises and interference in the phones or loud speaker.

Still another purpose of shielding is to cut out interference and interaction between the component parts of a set by preventing the crossing of various electromagnetic fields within the receiver. It is in this employment that shielding can make or break a receiver most easily, and for this reason very careful design and placement of instruments is necessary. This is because complete shielding requires fins or partitions between the various parts of the set. These fins necessarily pass close to the different working parts, and great accuracy of design is required to prevent undue spraying of the different magnetic fields into the shield itself. Where this does occur the effective resistance of the set is greatly increased; and the selectivity, volume, and general efficiency greatly lowered due to the reactive eddy current effect produced in the shield.

When properly executed, however, shielding of this type will add to a given set a high degree of rejectivity and almost entirely eliminate set noises and distortion due to the fact that practically all mixing of magnetic fields is prevented. For this reason the modern tendency in high grade manufactured sets is to use complete interstage and all-over shielding. It is the purpose of this paper to give the fundamental principles of successful shielding, and to give suggestions as to the proper practical application of these principles.

The first and most important consideration is to prevent undue spraying of the coil fields into the shield. This can be most easily accomplished by using one of the various restricted field (or so-called fieldless) coils. As usual, however, the easiest way is not the most expedient in all cases, as the actual efficiency of the restricted field coils is considerably lower than that of the plain solenoid. As before mentioned, however, if a solenoid be placed so that its electromagnetic field sprays into the shield the efficiency is lowered to a point below that of even a toroidal coil.

The accompanying figures show, by means of thin lines, the approximate fields of the three types of inductance coils in common use in the receivers of the present time.

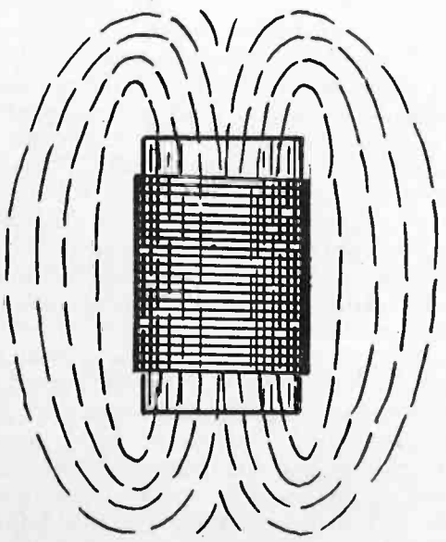


Fig. 1. Electromagnetic Field of Solenoid.

Fig. 1 represents a solenoid, the commonest, the simplest, and at the same time the most efficient of radio frequency inductances. It will be noticed that its field is extensive, but is less pronounced in a direction at right angles to the axis of the coil than it is parallel to this axis. This figure answers not only for simple solenoids, but for the various spider-web, basket-weave, and pancake coils also, as all of these are variations of the simple solenoid.

Fig. 2 portrays the astatic pair, more commonly known as "twin cylinder coils," or "binocular coils"—so-called on account of their double-barrelled appearance. Here, it will be observed, there is less spraying;—the coils, due to their peculiar placement with respect to each other, tending to absorb the field within themselves to a great extent. The efficiency of this type of inductance is about midway between that of the solenoid and that of the toroid, as the length of wire required to obtain a given inductance is greater in the toroid and less in the solenoid than in the astatic pair. Distributed capacity, the lowness of which is another governing factor in coil efficiency, tends to become somewhat higher in the restricted field coils,—not enough, however, to seriously impair their efficiency, all other factors being equal.

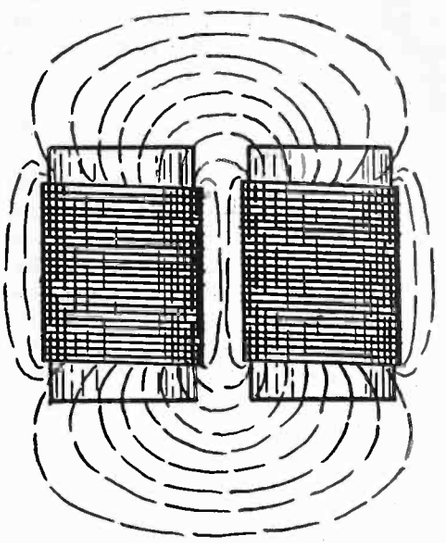


Fig. 2. Electromagnetic Field of Astatic Pair.

Third and last on our list comes the toroid, better known as "balloon circloids," or "doughnut coils," One of these coils, with lines representing its very restricted electro-magnetic field, is depicted in Fig. 3. It will be seen from this illustration that not even a toroidal coil is wholly fieldless, although it is manifestly much more restricted in its

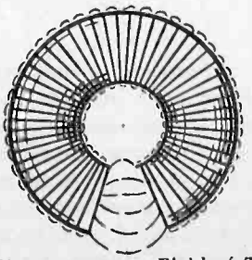


Fig. 3. Electromagnetic Field of Toroidal Coil.

spraying tendencies than is any other form of inductance.

It is the extremely restricted field, with little or no tendency either to dissipate or to pick up energy, that gives the "doughnut coil" its only strong bid for fame. For its efficiency, as measured by effective radio frequency resistance, is at best far lower than that of any other type of coil. It is, nevertheless (when properly designed and used with a high grade, low loss condenser) very sharp in its tuning qualities, due principally to the fact that its pick-up tendencies are almost negligible.

This brings us to the seemingly paradoxial statement that while it is far easier to efficiently shield a set employing restricted field inductances than one employing solenoids, it is not nearly so necessary to do so, unless the set in question is to be operated in the very shadow of a broadcasting station. This is due to the above mentioned fact that a restricted field inductance has less tendency to pick up signals and interferences than has a solenoidal form of coil.

In designing a shield, it is necessary to place the metal of the shield so that it is practically out of the active field of the coil. This does not mean that the coil and shield must necessarily be so placed that not a single line of force cuts the shield, for if judicious placing and sizing were carried to this extreme the resulting set would fill a small room, so large would it be necessary to make its shield. The thing to do is to so regulate the size, shape, and placement of the coil and shield that the more massed portions of the field are free of the shield.

It is desirable for purposes of shielding to keep the solenoid fairly small in diameter, as by this means the field is made long and narrow, instead of ball-shaped, as is the case with a coil whose

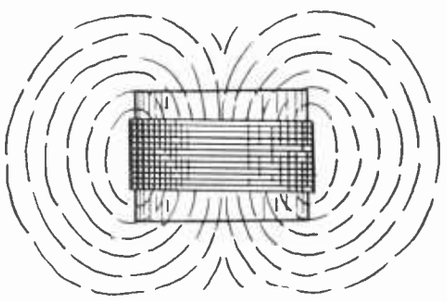


Fig. 4. Field of Short Coil with Large Diameter.

length is short in proportion to its diameter, as illustrated in Fig. 4. It will seem from this figure that the use of short coils with large diameter tends to make the set unwieldy as to length, besides requiring an abnormal amount of metal for the shield. A good proportion for these inductances is to make the length from one to one and one-half times as great as the diameter. It is also desirable to wind the coil with wire not larger than No. 24 gauge, as by this means sufficient inductance is easily obtained in a small coil. But smaller wire should not be used, as it tends to make the direct current resistance of the solenoid too high, and thereby greatly reduce its general over-all efficiency.

For the above mentioned reasons, the various basket weave and spider web coils are ill suited for use in shielded sets; as being merely a specialized form of solenoid, employing a peculiar form of spaced winding, and having a length which is usually very short as compared to the diameter (which is usually rather large), they naturally possess the undesirable round or ball-shaped electromagnetic field.

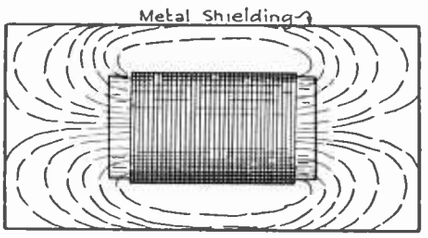


Fig. 5. Shielded Solenoid.

Fig. 5 shows a good example of a solenoid individually shielded, as would be done in a modern multistage radio frequency amplifier. When employing this ultra complete form of shielding, each radio frequency stage is completely enclosed by a metallic box which is electrically a part of the main shield. The only breaks in these individual shields are the necessary holes for instrument shafts, brackets, and wiring.

These holes, while they should be kept as small as practicable, should not be made so small that there is any danger of short circuiting. As an extra safeguard against this contingency, it is a good idea to use hollow rubber bushings in these holes. If the regular hard rubber bushings are not obtainable, satisfactory substitutes may be made by forcing short lengths of heavy walled rubber tubing into the holes.

Wherever it is necessary to ground a wire, or to connect it to the negative filament circuit, the simplest method is to connect it directly to the shield, making this the common negative *A* lead. In this connection it is well to point out the advisability of using the shield for the common negative *B* lead also, thus connecting negative *A* to negative *B*; instead of the more common method of connecting the positive *A* lead to the negative *B* terminal. This provides a common negative or low voltage line from which voltage measurements may be made, facilitating the use of panel meters.

This connection is also an effective safeguard against tube burnouts which might otherwise occur if the positive *B* lead accidentally touches the negative *B* and thus the positive *A* terminal or if a tube with a shorted grid and plate is placed in a socket of a set whose grid returns are connected to the negative filament terminal.

Aluminum, while perhaps the best material for shielding, is hard to solder. Zinc is cheap and easily worked, as are likewise brass and copper. No. 24 or 26 gauge is heavy enough unless some of the instruments are to be supported by the shield, which is bad practice.

A good shield can be made by heavily coating cardboard with gold or aluminum bronze powder, such as is used in painting radiators. The powder should preferably be "cut" in banana oil and not in glue, which is likely to soften if exposed to dampness. The cardboard can be shaped and held together by glue or paper fasteners and given a coating at least 1/64 in. thick on each side, a final coating of banana oil being used as a binder. Due to its low conductivity this kind of a shield cannot be used as a negative return lead so that all ground connections to it should be joined by bus bar. These connections are made by means of brass machine screws and copper washers drawn tight enough to bite deeply into the metallic coating.

Shielding properly planned and executed is a godsend. But shielding carelessly done is worse than no shielding at all. There is little necessity for shielding the set employing toroidal coils; although one using astatic pairs may be benefitted by a suitable shield, if it is to be used in a congested radio locality. The very highest type of receiver efficiency can only be obtained, however, by using properly designed solenoidal coils, and it is in connection with this type of coil that shielding of the correct sort attains its highest usefulness.

The edges of paper cones can usually be cemented together by shellac, holding them in place with paper clips or small clamps of any convenient type.

Glass rods or tubes may be used under storage batteries to insulate them, and keep the bottoms of the batteries from the floor.

Narrow "gummed paper" is handy when winding coils, either by hand or in a lathe. If necessary to keep the coil from unwinding, a paper strip can be stuck on immediately, the work thus being preserved until it can be continued and the paper then removed.

In finishing cabinets for radio sets wonderful results can be had by using lacquer finishes, such as are so popular in automobile work. In many cases, this work can be done at a nearby paint shop handling automobile finishing for a reasonable sum. Any color or shade can be used for this type of finish, as well as the "natural" or stained or colored wood effects, and extremely durable and satisfactory results obtained.

The strength of signals on a reflex set using a fixed crystal detector—such as a Harkness reflex—can often be doubled by substituting an adjustable crystal detector for the fixed one.

Effect of "B" Battery Impedance on Amplification

An Analysis of one Cause of Distortion in Audio Frequency Amplifiers with Practical Suggestions for its Correction

By J. E. Anderson

IN THE constant search for ways and means of improving the quality of sound reproduction by a radio receiver, the impedance of the plate potential supply has been investigated and found guilty of causing distortion. This is especially noticeable when the *B* supply is common to a number of different tubes, as is the usual practice in radio construction. Although ordinarily considered negligible, a high a.c. resistance in the *B* battery or eliminator circuit will herein be shown to be the cause of considerable distortion that can be remedied by reducing the impedance.

For instance, it is reported from the De Forest laboratory that a resistance of only 15 ohms in the *B* battery produces a perceptible distortion in the output from an ordinary two-stage audio frequency amplifier. This is not an especially high resistance for a battery. The writer has found the a. c. resistance of a 120 volt *B* battery composed of standard No. 6 dry cells to be slightly over 1000 ohms at a frequency of 1000 cycles per second. On the basis of 80 cells, 1½ volts per cell, and a short circuit current of 30 amperes, the d. c. resistance would be 4 ohms. A run-down 45 volt battery registering 38 volts gave a short circuit current of .1 ampere, equilavent to a d. c. resistance of 450 ohms. At this rate an old 80 cell battery would have a d. c. resistance of at least 1100 ohms, as compared to a resistance of 4 ohms for a fresh battery. Thus it is seen that both the a. c. and d. c. resistance increase rapidly with use of a battery.

The d. c. resistance of a storage *B* battery is almost negligible, although the a. c. resistance may not necessarily be so. The common impedance in the plate circuits of a *B* battery eliminator is quite considerable and may give rise to a great deal of distortion and even oscillation.

As an example of this the writer was recently consulted by a manufacturer of *B* battery eliminators regarding a "clucking" noise in the loud speaker when certain types of sets were served by his eliminator. This "clucking" was regular and occurred about four times a second. In receivers having two stages of resistance coupled audio frequency amplification there was never any "clucking," but in receivers having three stages of the same kind of coupling it was invariably present. The laboratory solution of this problem was simple, but its commercial solution offered greater difficulty, requiring the use of large and expensive condensers.

Some light may be thrown on the effect of the common impedance on the amplification by a mathematical investigation of some of the usual circuits. First take the case of a two-stage direct coupled amplifier like that shown in Fig. 1. This and the following circuits have been divested of all unnecessary appendages, that is, unnecessary to their analysis. Some of the omitted impedances may be considered as included in those given.

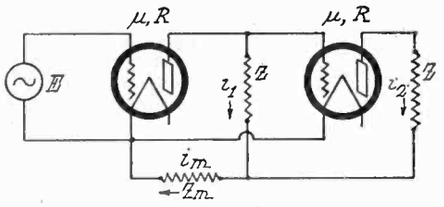


Fig. 1. Two-Stage Direct Coupled Amplifier.

In Fig. 1 let E be the input voltage on the grid of the first tube, R the internal a. c. resisance of either tube, μ the amplification constant of either tube, and Z the load impedance, or coupling impedance, and Z_m the common impedance to both the plate circuits. Like characteristics of both tubes have been assumed for simplicity. Let i_1, i_2, and i_m be the three currents flowing in the respective branches as indicated. One of these currents is inherently of opposite sign to the other two. To find the effect of the common impedance on the amplification we may obtain an expression for the amplification of the circuit, defined as the ratio of the effective voltage in the plate circuit of the second tube to the input voltage to the first tube.

The effective voltage in the plate circuit of the first tube is μE, and this is equal to all the voltage drops in the plate circuit, that is, to $(R+Z)i_1+Z_m i_m$. This gives us equation (1). In the same way we get equation (2) from the plate circuit of the second tube, where E_1 is the input voltage to that tube and is defined by equation (4). The minus sign is used in front of the μ to take care of the change of phase of the voltage in the tube. In equation (1) this was unnecessary because it is of no importance with what phase we begin.

Equation 3 states the fact that the algebraic sum of the two plate currents is equal to the current in the common impedance, that is, that both of the plate currents flow through Z_m. The value of E_1 from (4) may be substituted in (2) and this rearranged to take the form of (5). From equations (1), (3) and (5) we may obtain the values for the three currents, by solving the three simultaneous equations.

The result is given in equations (6), (7) and (8). The signs of these currents show that i_1 is flowing in the opposite direction from the other two. Having obtained the currents the appropriate values may be substituted in either (2) or (4) for obtaining E_1, and then we can get the ratio $M=\mu E_1/E$, the amplification. The value of M is given in (9), which shows clearly how the amplification is affected by the common impedance Z_m.

Observe that in (9) there is no negative sign. Therefore the denominator cannot become zero, and hence M cannot become infinite, from which we may conclude that an amplifier of the type in Fig. 1 can never oscillate no matter what the value of Z_m may be. But it may cause a certain amount of distortion. Suppose that in equation (9), R=10,000 ohms, Z=100,000 ohms, and μ=8, all more or less typical values in a resistance coupled amplifier. Then (9) takes the special form of (10). When Z_m=0, M=58.2; when Z_m is infinite, M=44.8. Therefore the greatest possible variation in the amplification is only 23% of the maximum. Hence any value of Z_m which may occur in practice is not likely to cause any noticeable distortion. If Z_m=1000 ohms, the reduction in the amplification is only about ⅓%. If the circuit is purely non-reactive there would be no distortion because all the frequencies in the audio signal would be affected the same amount. There would merely be a slight decrease in the amplification. But a few circuits are really non-reactive.

(*Continued on Page 68*)

Equations Applying to Fig. 1.

(1) $\mu E = r i_1 + Z_m i_m$

(2) $-\mu E_1 = r i_2 + Z_m i_m$

(3) $i_m = i_1 + i_2$

(4) $E_1 = Z i_1 + Z_m i_m$

(5) $0 = \mu Z i_1 + r i_2 + (1+\mu) Z_m$

(6) $i_1 = -\frac{\mu E}{D}[r + (1+\mu) Z_m]$

(7) $i_2 = \frac{\mu E}{D}[\mu Z + (1+\mu) Z_m]$

(8) $i_m = \frac{\mu E}{D}(\mu Z - r)$

(9) $M = \frac{\mu[rZ + (r+Z) Z_m]}{r^2 + (2r+\mu R) Z_m}$

$r = R + Z \quad D = -[r^2 + (2r+\mu R) Z_m]$

(10) $M = 64\left[\frac{367000 + .7 Z_m}{40300 + Z_m}\right]$

Practical Suggestions for Amateur Construction

Constructional Details for Some Necessary Parts, Usually Purchased

By A. Binneweg, Jr. 6BX

THE 'PHONE rang.

"Hello, Soakem Supply House? Have you any good, reputable, fifty-watt sockets on hand?"

"Yes, we have a few left at the regular price—two-fifty straight."

Bang! "More of 'em at large! now what?"

But, there's a solution to the problem and that's the story:

The sockets, particularly those for the larger power tubes, now on the market are not only expensive, but are sometimes inefficient at the high frequencies with which the amateur deals. It is also desirable to have these sockets cushioned so that occasional vibrations will not injure the large tubes, a feature found on but few of the purchased sockets. With these factors in mind the writer has succeeded in designing a really low-loss, low-priced socket that is better electrically, and otherwise, than those now on the market.

As previously stated, it was not only desired to have a socket that would not transmit vibrations to the tube, but the socket must also be designed so that the tubes could be readily removed in case some operation should be performed on the set that would endanger them. The number of tubes on hand is usually also rather limited, especially if they are of the larger type; hence the material from which the sockets are to be constructed must be available in sufficient quantities so that enough of the sockets can be made to go the rounds of the various experimental layouts and the main set. The socket here described seems to fulfill all these requirements rather nicely and also allows the tubes to be operated in parallel without difficulty.

A small porcelain fuse-holder measuring about ¾x¾x3 in., and found in any telephone junk-box, makes all this possible. They are made of well-glazed porcelain and have two metallic lugs set into the porcelain. The projections rise toward the center of the block and end about 2 in. apart and ½ in. above the porcelain. They are threaded at these ends and are fitted with small machine-screws and washers. Occasionally one will run across a pair that have different distances between screw centers, hence select only those having the same distance. This may be readily done by placing them side by side and selecting only those that line up, for any particular tube. Now look at Fig. 1. Set the two blocks a convenient distance apart so that the screws may be readily reached by a screw-driver after the tube is inserted, and select four strips of brass

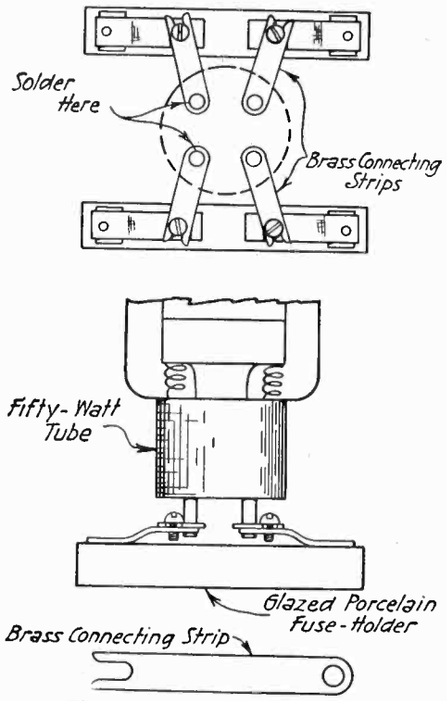


Fig. 1. Home-Made Socket for 50-Watt Tube.

for the tube connections. Almost any kind of brass will do, but spring brass is best. If the brass is rather thin and springy set the blocks closer together, if rather heavy set them a little farther apart. If space for the socket is limited, purchase brass that will allow some freedom but yet hold the tube in place well, for the given distance between blocks.

Drill holes in the strips to fit the machine screws and holes at the other extremities for the tube prongs, make the latter fit tightly. Screw the strips in place on the blocks and insert the tube prongs through the proper holes. If the strips have been made as shown in the figure their length may be adjusted until they look right. Then securely solder the strips to the prongs, being careful not to get the latter too hot. This may best be done, perhaps, by inverting the socket tube in place, and soldering from the bottom.

The sockets may be mounted on a small board of convenient size, or they may be screwed directly to the set, since holes are provided in the block. As many may be arranged in parallel as desired. It is often best to mount each socket on a small board, after the distance between blocks has been properly adjusted so that the particular tube fits the socket. The tubes are removed by merely removing the machine screws at the terminals and tube connections are soldered at the base of the small metallic supports.

An accidental blow on the table will have no effect on the tubes. It is surprising how vibrationless these sockets really are, and their electrical efficiency is certainly high, for the tube is practically mounted on air.

Antenna Series Condenser

SOME of the short-wave receiving circuits dispense with the primary coil and substitute a small antenna series condenser through which the antenna is conductively coupled to the secondary. It is sometimes a problem to construct one of these small condensers so that its capacity remains constant, after being once adjusted properly, and also to keep its insulation as good as that of the antenna. The insulation of the latter, of course, should be good.

Practically every amateur station is equipped with a throw-over switch by means of which the antenna may be connected either to the receiver or transmitter. These switches are usually highly insulated and hence an antenna series condenser placed in this position is all right. A very good series condenser may be made by merely bending the switch-contact away from the switch arm so that the proper capacity is secured, as shown in Fig. 2. A small stop should

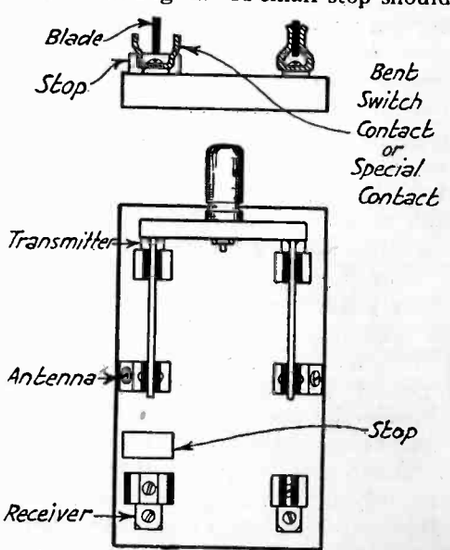


Fig. 2. Modification of Switch to Hold Service Condenser.

be provided so that the blade cannot touch the contact and so that it will come to rest in the same position each time.

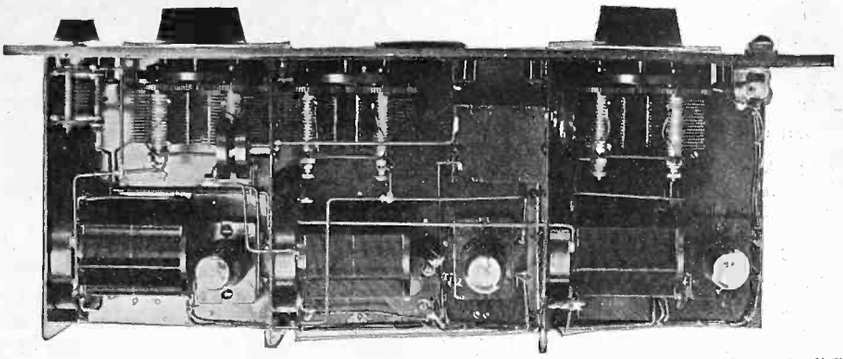
In this connection it may be well to say that the usual practice of using the same short vertical antenna for both receiving and transmitting is all wrong. It has been found, that much better signal strength from DX stations is secured on a long antenna and that the horizontal antenna is a big advantage. Hence use

(*Continued on Page 55*)

Additions to the Shielded Superheterodyne

By G. M. Best

IN October 1926 RADIO, a shielded 9-tube superheterodyne, including a stage of tuned r. f. amplification ahead of the first detector, and designed for use with either a loop antenna, or outdoor aerial was described. This receiver is particularly effective in congested city districts where there are many local stations on the air at all times, and where extreme selectivity is needed. The presence of three tuning controls on the panel, however, makes the tuning of the set difficult for the novice, and it is believed that the changes incorporated in the model which is shown in the picture will make for simpler operation, without reducing the efficiency of the set in any way.



Method of Gearing Tuning Controls of Shielded Superheterodyne.

Of the three tuned circuits controlled by .0005 mfd. variable condensers, two are identical in character, and when an outdoor antenna is used, the dial settings for the secondary of the antenna tuner, and the secondary of the r. f. transformer will be practically the same. The oscillator tuned circuit has the same inductance as that of the above mentioned secondaries, but the oscillator frequency must always be different from the incoming frequency by the value of the intermediate frequency, which in usual practice, with iron core transformers, is 50,000 cycles. Hence, if the superheterodyne were to be made a single control unit, it would be necessary to take this frequency difference into account.

As the r. f. and antenna tuner secondaries have identical dial settings, if factory made inductances are used, it goes without saying that the two tuning controls may be placed in tandem, and operated from one dial. This cannot be accomplished with the customary tandem condenser, having two sets of rotor plates mounted on a common shaft, with separately insulated groups of stator plates, for the reason that the grid returns of the two vacuum tubes connected to these tuned circuits are made to different points of the filament circuit, and the proper *C* battery could not be employed. The grid return of the r. f. amplifier tube goes directly to its filament, from the center tap of the inductance, the tuning condenser being shunted across the entire coil. The grid return of the first detector tube goes from the center tap of the r. f. transformer secondary to the minus 6 volt *C* battery, with the tuning condenser connected across the entire coil as is done in the antenna tuner. There being no condenser groups with completely insulated rotors and stators available, it is necessary to employ condensers equipped with coupling gears, as is shown in the picture. The condenser tuning the antenna coupling unit is made the master control, and has the shaft projecting through the panel in the usual manner. The r. f. transformer variable condenser is mounted on the brass back panel shield in such a manner that one of its gears meshes with a gear of the antenna condenser, so that when the dial is turned, both condensers move simultaneously, and both have identically the same capacity at any given dial setting.

The shaft of the trailing condenser should be cut off flush with edge of the shaft bushing, so that no screw holes or projecting shaft are visible from the front of the panel. As the shield is 1/16

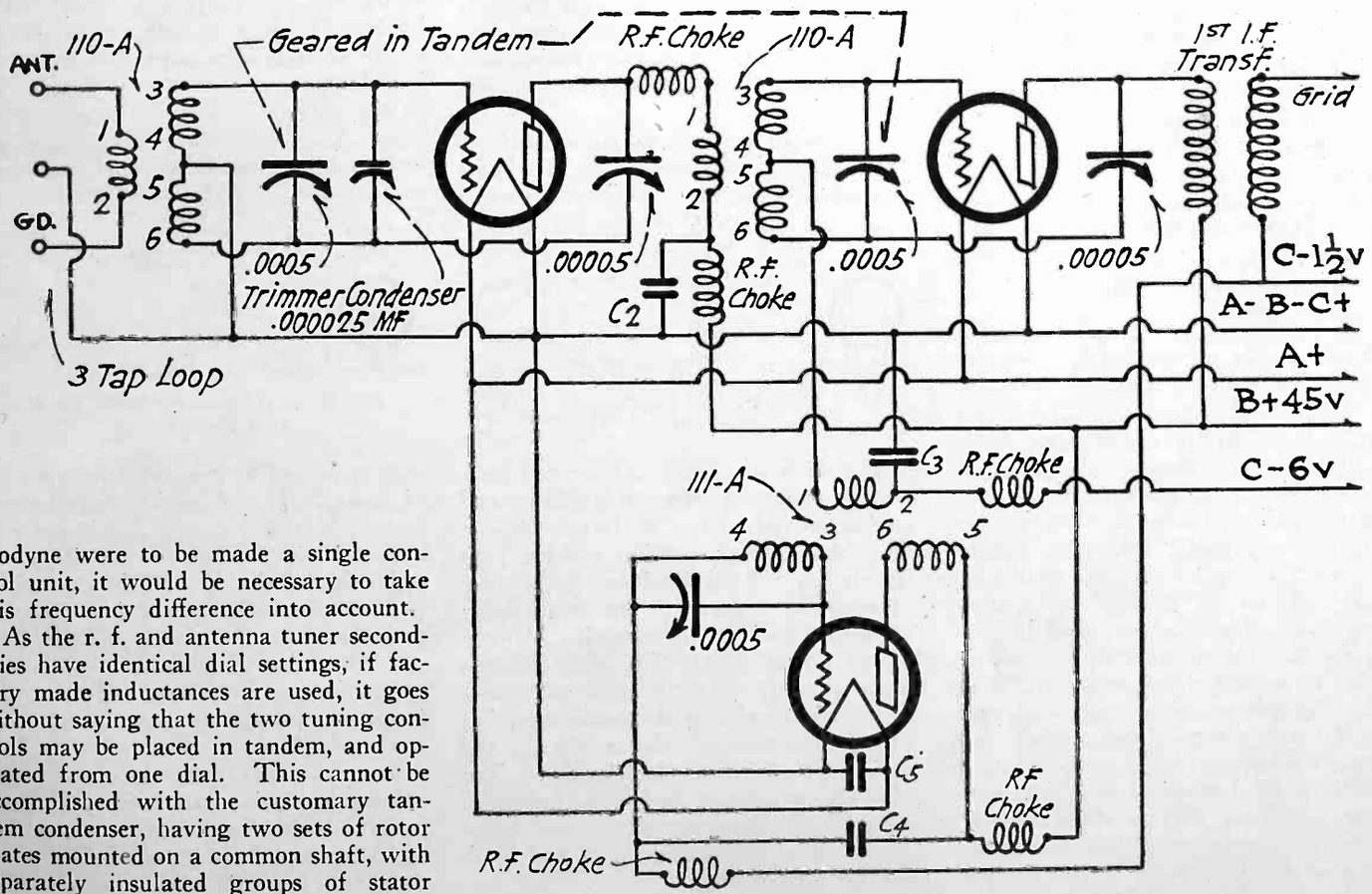


Fig. 1. Wiring Diagram for Tandem Control of Superheterodyne.

in. brass, it is heavy enough to support the condenser without any loose play. After the relative positions of the two condensers are found, and the trailing condenser mounted in place, the master condenser having the dial control can be adjusted to have the same capacity setting as the trailing condenser by loosening the screws holding the master condenser to the panel so that the gears may be thrown out of mesh temporarily.

Fig. 1 shows a part of the schematic wiring diagram of the circuit described in October RADIO, so that the position of the two tandem condensers in the circuit may be seen. As the capacity values of the two condensers, as well as the inductance of each coil may vary slightly, a trimmer condenser should be installed, and placed in shunt across the master condenser. This can be mounted at the lower left hand end of the panel, looking at it from the front, and it may be seen in the picture at the upper left end. Any small variable condenser, such as the General Radio, Precise, Silver-Marshall or Chelten will do, just so long as it has a low minimum capacity. It must be insulated from the shielding by drilling a hole in the shield large enough to clear the metal parts of the trimmer condenser.

The procedure in adjusting the trimmer is simple. Tune in a local station so that it is being reproduced with good volume and quality, and then vary the master condenser dial until it has been determined whether the station comes in at one point on the dial, or has two distinct resonant points. If the latter is true, the trimmer condenser should be varied until these two points become one. After this has been done, it should not be necessary to further adjust the trimmer. If advancing the trimmer spreads the points further apart, then the master condenser should be loosened from the panel and the gears between the two condensers slipped one cog, after which the two resonant points will probably be brought together.

Undoubtedly the set can be made into a single control by gearing the oscillator condenser to the other two, and installing a large trimmer condenser across the oscillator condenser. As the trimmer would have to be adjusted quite often, especially on distant stations, the controls are actually still two in number, so that no advantage would be gained. In one of the commercial superheterodynes this is acomplished by having the two tuning controls fastened together by a friction disc, so that if the oscillator condenser is not adjusted properly for any given setting of the tuned circuit condensers, the latter dial may be held in a fixed position while the oscillator condenser dial is slipped to the proper setting. Such a dial, however, is not available for the use of the home set builder.

Coupling the Loud Speaker

By Arthur Hobart

AS TWO of the four power tubes now available have plate currents of 20 milliamperes or more, an amount which would soon damage the windings of most loudspeakers, it is necessary to by-pass this plate current around the loudspeaker, without introducing an element which produces distortion.

In practically all radio sets of the past, the loudspeaker was connected directly in the plate circuit of the last audio tube, so that there were two distinctly different types of current passing through the loudspeaker windings, one a direct current of from 5 to 15 milliamperes, and the other an alternating current representing the demodulated radio signal. The direct current performed no useful purpose, and usually was a detriment, as it pulled the diaphragm or armature of the speaker away from its normal position, and limited the distance over which the armature could vibrate before striking the pole pieces of the permanent magnets in the speaker. Besides this, the magnets in time might become demagnetized, especially if the current were accidentally passed in the wrong direction. This condition was tolerated in order to eliminate extra apparatus, but now that the new UX-171, CX-371, and UX-210, CX-310 power tubes, with their heavy plate current, have forced a change in receiver design, we have two methods available for by-passing the direct current and permitting the alternating current component only to pass through the loudspeaker.

One of these methods is transformer coupling, and the other is impedance coupling. The latter method is shown

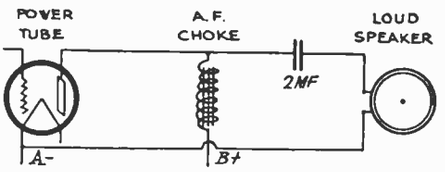


Fig. 1. Impedance Coupling of Loud Speaker.

in Fig. 1, where the direct current component is passed through a choke coil having an inductance of 100 henries or more, and the alternating current path is through a fixed condenser of 2 mfd. or more in series with the loudspeaker windings, back to the negative filament of the power tube. The plate current finds a ready path through the choke coil, as it is of low d.c. resistance, but cannot pass through the condenser, and so is kept out of the loudspeaker. The alternating current finds the choke coil a very high impedance circuit, and hence passes through the condenser and loudspeaker only.

Unfortunately, this method has a defect, in that the reactance or a.c. resistance of the condenser, is not the same for all frequencies. Its reactance at 30 cycles, which frequency is actually transmitted in modern broadcast transmitters, is 2650 ohms, and at 5000 cycles it is but 31 ohms. The impedance of the average high grade cone type loudspeaker is around 2000 ohms at 30 cycles, and as high as 20,000 ohms at 5,000 cycles, so that if we introduce 2650 ohms additional resistance at 30 cycles, it will have a material effect on the output of the speaker at the low frequencies, and the quality will be impaired.

Of course, the capacity of the condenser can be increased to 10 mfd. or more, so that the reactance at the low frequencies is very small, but this is expensive, and therefore cannot be considered. We can also shunt the loudspeaker with a compensating device in the form of a fixed condenser, which will introduce a loss at the higher frequencies, and compensate for the varying reactance of the coupling condenser, but this is not recommended, for if the wrong size condenser is used, the quality from the speaker may be worse than with no condenser at all.

The use of a transformer to couple the power tube to the loudspeaker, however, eliminates the trouble due to varying condenser reactance, and requires only that the transformer be carefully designed for the purpose in view. The loudspeaker is essentially a power device, and it is important that the input impedance of the loudspeaker be equal to the output impedance of the power tube. If the loudspeaker impedance were less than that of the tube, maximum current would be received by it, and the

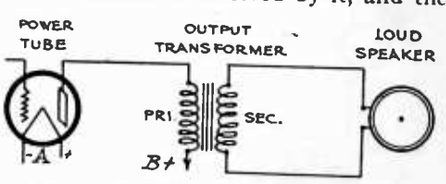


Fig. 2. Coupling the Speaker by Means of a Transformer.

voltage would be low, resulting in a loss of power. If the speaker impedance is higher, it would receive maximum voltage, and low current, so that either condition is undesirable. In the case of impedance coupled output, it is not possible to adjust the impedance of the loudspeaker to that of the power tube output except for one frequency, and so in most instances maximum energy transfer cannot be obtained.

In an output transformer, however, this compensation can easily be effected by giving the transformer a turns ratio of the proper value, and designing the secondary impedance to match the aver-

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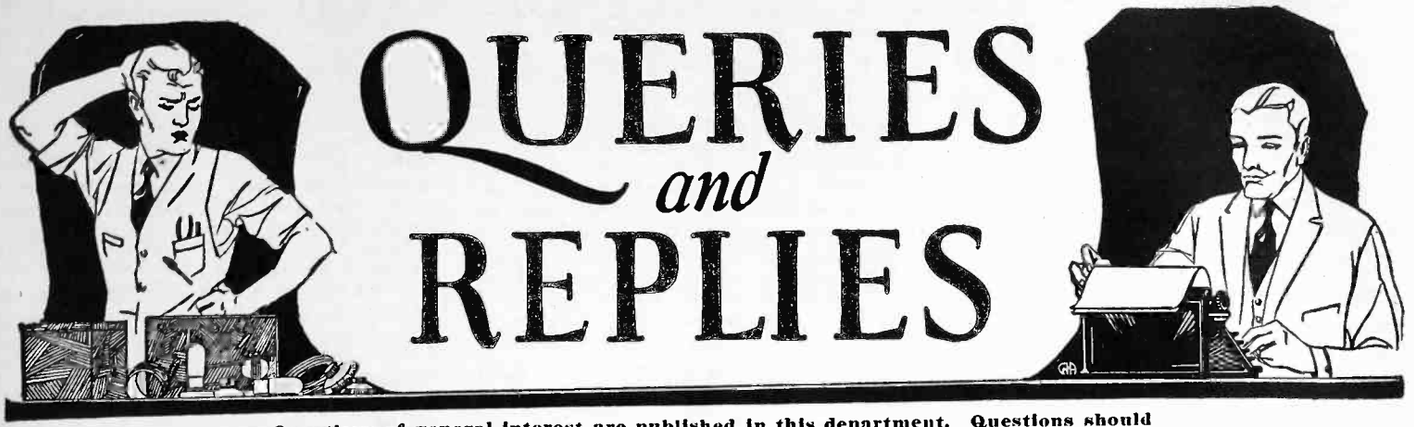


Questions of general interest are published in this department. Questions should be brief, typewritten, or in ink, written on one side of the paper, and should state whether the answer is to be published or personally acknowledged. Where personal answer is desired, a fee of 25c per question, including diagrams, should be sent. If questions require special work, or diagrams, particularly those of factory-built receivers, an extra charge will be made, and correspondents will be notified of the amount of this charge before answer is made.

Please publish a diagram of a battery charger using four electrolytic rectifier cells with a mazda lamp bank to control the charging current.—L. E. H., Oakland, Calif.

This circuit is shown in Fig. 1. The four rectifier jars are of the conventional lead-aluminum type, which have been described several times in these columns.

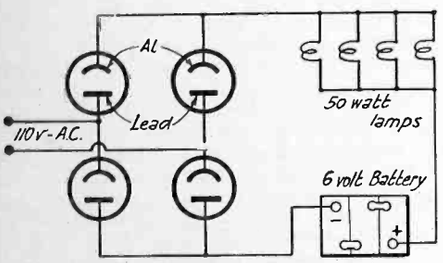


Fig. 1. The Electrolytic Battery Charger Circuit.

The electrolyte may be a saturated solution of common borax dissolved in distilled water. A number of ordinary electric light sockets may be placed in parallel in the positive charging lead and as many 50 or 75 watt lamps connected in the circuit as are desired. Each 50 watt lamp will pass about ½ ampere of current.

I have a Best's five tube superheterodyne using two crystal detectors. The tone quality is wonderful but I do not get the distance reception I would like. Would the addition of vacuum tubes in place of the detectors help matters.—H. C. L., Altoona, Penn.

You can increase the sensitivity of the set by installing a vacuum tube in the first detector circuit. You can then employ regeneration by means of a small feed-back condenser as is shown in the diagram in Fig. 2. There is sufficient room in the position occupied by the first crystal detector to install a vacuum tube socket and the extra wiring needed to connect the tube into the circuit is very simple. The feed-back condenser can be placed on the panel and by varying it the correct amount of regeneration can be obtained. There is no object in replacing the second detector with a vacuum tube. An improved oscillator circuit is shown in place of the one originally specified in order to minimize the body capacity. Connect the windings of the present oscillator coil in series and use them as the grid coil. At the filament end of the grid coil wind 25 turns of No. 28 or 30 silk covered wire for the plate coil, bunching the wires together in a compact group. Connect the rotor of the oscillator condenser to the filament end of the grid coil and the stator to the grid end.

I have commenced work on a ten watt Hartley transmitter, using the circuit which I have sent to you. Will I get good results with this circuit on 40 meters?—L. B., Merced, Calif.

The Hartley circuit is very popular and is used by many amateurs on the various short wave bands. Be sure to place a radio frequency choke of at least 200 turns wound on a ¾-in. tube, in each plate supply lead from the power transformer. Otherwise, you will have trouble due to radio frequency entering the power transformer and passing to ground through the capacity between the transformer primary and secondary.

I wish to improve my Western Electric 7-A amplifier by installing higher powered tubes. Can I use a pair of the new CX-371 power tubes in place of the 216-A tubes now used, and will it give me more volume?—R. T. S., Three Rivers, Canada.

The plate current of the CX-371 tube, with 180 volts plate and 40 volts negative grid will be between 20 and 25 milliamperes, and it is doubtful if the output transformer in the 7-A amplifier will stand this current without burning out the primary windings. The impedance of this output transformer is around 10,000 ohms on each side of the center tap of the primary, so as to match the impedance of the 216-A tube. As the output impedance of the CX-371 is less than half that of the 216-A, a considerable amount of energy would be lost in reflection loss, thus counteracting any gain due to using the higher powered tube. It would be better to increase the plate voltage to 160 and the "C" voltage to 10½ or 12 volts, which would not materially reduce the life of the 216-A tubes, and yet would increase the possible power output by a noticeable amount.

If the new infradyne is supposed to be more selective and sensitive than a superheterodyne, why is it necessary to use two stages of tuned r.f. amplification ahead of the mixer tube? I should think these extra radio stages would give more trouble in extra adjustments than they would be worth.—C. S. R., New York City.

The infradyne amplifier is tuned to about 3,500,000 cycles. Naturally it is not possible to obtain quite as much amplification, nor as good selectivity, in terms of kilocycles, at this frequency, as is possible in a superheterodyne, where the frequency is generally around 50,000 cycles and often as low as 30,000 cycles. The

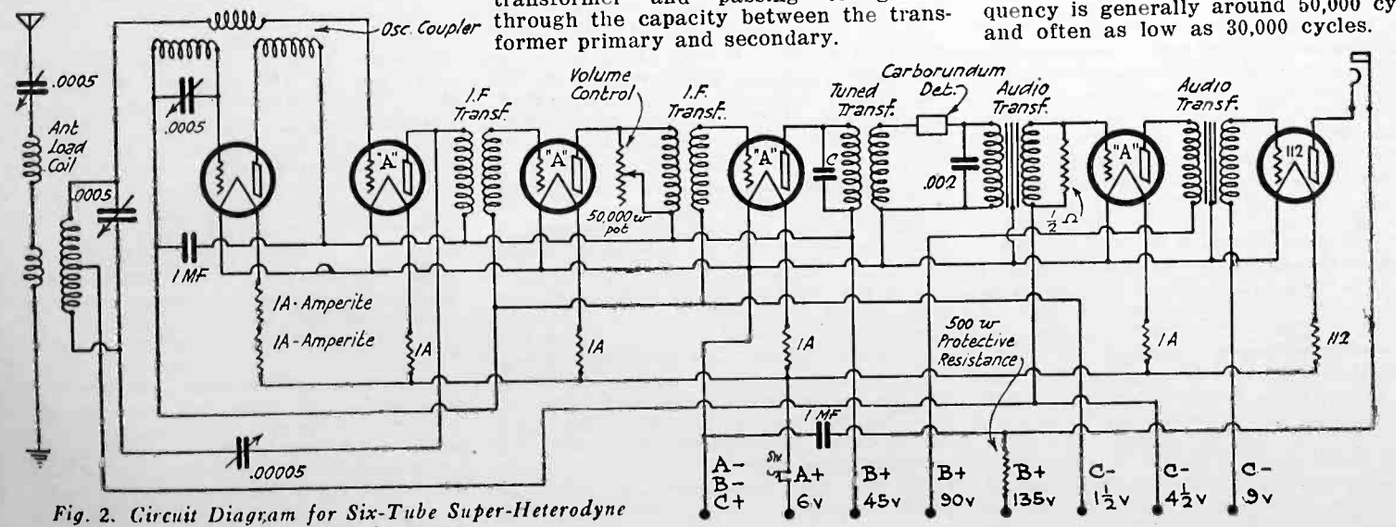


Fig. 2. Circuit Diagram for Six-Tube Super-Heterodyne With One Crystal Detector.

infradyne amplifier will pass a band of frequencies about 20 kilocycles wide, so that with stations 10 kilocycles apart, it is necessary to have additional tuned circuits to improve the selectivity, and this is obtained with ordinary tuned r.f. circuits. The purpose of the infradyne amplifier is to enable the use of the sum frequency, as has been explained in Mr. Sargent's articles, thereby eliminating oscillator harmonics, and background noise, troubles so common to the superheterodyne. The tuned r.f. stages, in addition to improving the selectivity, give a certain amount of amplification, making the total for the entire set a very large amount. The tuned r.f. stage also prevents radiation of energy into the antenna and consequent annoyance to the neighbors. Without the two stages of r.f amplification, the infradyne would be equal to an ordinary 7 tube superheterodyne in sensitivity, but would not be as selective.

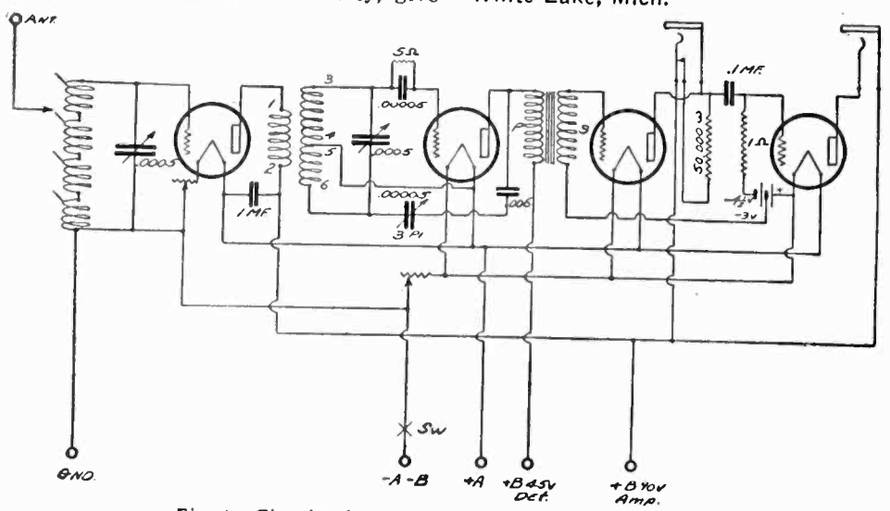


Fig. 3. Circuit of Four Tube Regenerative Receiver.

Have a chemical rectifier designed for charging storage "B" batteries. Would like to use it as a trickle charger, as well as to provide 2 amperes charging rate when desired. How may this be done?—J. S., Oakland, Calif.

The easiest way to limit the charging rate of a chemical rectifier is by the use of mazda lamps as resistances. A 75 watt lamp placed in series with the positive lead from the rectifier to the battery should provide about the right amount of trickle charge. I doubt very much whether it would be possible to obtain 2 amperes from your type of charger. Several cells would be required in order to obtain sufficient capacity so that the charging rate could be maintained without overheating.

In September RADIO, data for a 2-ampere tungar charger were given in the Queries and Replies column. Would like to use this charger for storage "B" batteries as well as for 6 volt "A" batteries. Please tell what additional turns are required for obtaining higher charging voltages.—A. C. G., Rochester, N. Y.

The present charging secondary consists of 85 turns of No. 18 D.C.C. wire. Add 500 turns of No. 20 or 22 D.C.C. wire to the secondary, to the high potential end, away from the connection to the filament of the bulb. In the positive lead of the "B" voltage tap, place a 50 watt mazda lamp. Do not attempt to charge more than 96 volts of storage "B" battery at one time, and if the charging rate with the 50 watt lamp is not sufficient, insert a 75 or 100 watt lamp.

Did you publish a circuit of a selective crystal receiver having a range of at least 200 miles, in a recent issue of RADIO? If so, please inform me as to the cost of a diagram.—J. P. K., New York City.

The selective crystal receiver you mention was described by E. M. Sargent in December 1925 RADIO. A reprint of the entire article will be sent on receipt of a stamped, self addressed envelope.

Please publish a diagram for one stage of tuned r.f. amplification, detector and two stages of audio, using "A" tubes except in the detector, where a UV-200 is to be used. What make of coils should be used in the tuned r.f. circuit?—D.I.J., White Lake, Mich.

A diagram for a four tube set is shown in Fig. 3. It shows the proper connections for four type "A" tubes, so that if the old style detector tube is to be used, a separate filament rheostat of at least 10 ohms should be placed in the positive detector filament lead. The r.f. transformer may be any type of coupler having a variable primary and two section secondary, such as the Silver-Marshall type 111-A. The antenna coil consists of 60 turns of No. 24 D.S. wire wound on a 2 in. tube, 2¾ in. long. A tap is taken out every 15 turns, with a spacing of about ⅛ in. between sections. The antenna connection is made to suit the conditions of the particular antenna used, and the best selectivity will be obtained by using but 15 turns for the antenna-ground system. A separate antenna coil wound on a 1 in. rotor, and placed inside the 60 turn coil will also give good results, and should consist of 25 turns of No. 28 silk covered wire. A Silver-Marshall type 110-A coil will also serve the purpose, in case it is not convenient to wind the coils. If a type 112 or 171 power tube is to be used in the power stage, the "B" and "C" voltages should be increased in accordance with the data given on the tube carton.

Would like to have information on the use of the "Inexpensive 'B' Eliminator" described by E. E. Griffin in July RADIO, with 220 volts a.c. input.—P. U., Manila, P. I.

The circuit shown in Fig. 3 of Mr. Griffin's article would be the most satisfactory. It would probably be necessary to increase the number of jars in the rectifier to a total of six, in order to carry the increased voltage. As the total available d.c. voltage in the output of the filter circuit would be about 200 volts, it would be necessary to install additional Clarostats to cut down the voltage to 90 or 135 volts. If the scheme shown in Fig. 5 of Mr. Griffin's article were used, the output voltage would be 400 volts, and additional jars and resistances would be required. No other changes need be made in the apparatus other than that mentioned above.

LETTERS TO THE EDITOR

An Honest Difference in Opinion

Sir: May I be permitted to take issue with the statement with which you open your first article under "Radiotorial Comment" in the September issue of RADIO? Possibly "chaos" is a little too strong a word to use in describing present conditions, but the remark "Nor does there appear to be much likelihood of any serious confusion, etc." is certainly not true in this section of the country at least.

I am using a very sensitive set, the Haynes De Luxe Superheterodyne first described in your magazine, and there is practically no spot where I can rest my dials without picking up heterodyne whistles. I dare say that you on the West Coast are not particularly bothered yet, but we in the central zone are in a very bad condition right now, and this condition is getting worse from week to week. The first paragraph under the heading "Broadcasts" on page 486 of the September issue of "Popular Radio" describes the conditions rather more accurately than your article.

> "Although it has been contested since the inception of broadcasting that Mr. Hoover's power to regulate and assign wavelengths has been more or less arbitrary the recent court decision abrogating his authority *has resulted in serious confusion.*" (Italics mine.)

The Radio Manufacturers' Association, through both its president and secretary, has industriously been sending our propaganda attempting to show that there is no confusion, but this does not in any way disprove the fact that *there is confusion.* I can readily see the motive back of their propaganda, for if prospective purchasers of radio outfits appreciate that a crystal set with which to listen to local stations is all that can be used to advantage sales of expensive sets will naturally fall off. Last evening I broke into the leads to the audio end of my Haynes set and connected a crystal, receiving the local stations at Cincinnati on the ordinary crystal and amplifying so as to secure loud speaker operation, and had the first really enjoyable reception I have had in a long time. In this section of the country there is now no use at all in attempting to do anything other than listen to local programs and even these are marred on a sensitive set by heterodyning.

I believe that you are wrong in editorially endorsing the position of the Radio Manufacturers' Association, as magazine articles of such tenor as the one I am taking the liberty of discussing may easily serve to mislead the members of Congress into believing that conditions are not as bad as they really are and thus cause Congress to postpone still further the enactment of suitable legislation or to produce legislation so politically arranged as to spare the feelings of broadcasters to such an extent as to be without practical value. What is needed is strong-arm tactics such as Mr. Hoover was using.

We may as well squarely face the issue that *there is confusion* and attempt to urge a procrastinating congress to correct it as soon as possible. Articles in radio magazines which state that conditions are all right, when every radio listener knows that they are really all wrong, do not in any way strengthen the confidence which the listeners have in the judgment of the editorial writers. It is true that only a small proportion of broadcasters have overstepped proper bounds but these few have been more than sufficient to make trouble, so when you say, "The good sense of the geat majority of present broadcasters saved the day," you may be speaking the truth with regard to the intentions of the great majority but you are certainly inaccurate in describing present conditions. The day is not saved.

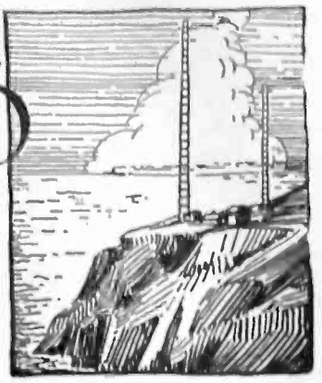
Very sincerely,

A. J. SHELDON.

Middletown, Ohio.

The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



R. O. KOCH, *Great Lakes Correspondent*

Edited by P. S. LUCAS

C. W. RADOS, *Boston Correspondent*

PACIFIC SHORT WAVE PRESS

By MICKEY DORAN

Out where the static roars, westward of the 180th Meridian it is sometimes a bit difficult to keep the daily press sheet up to standard. Old John Q.R.N. knocks the excellent KPH schedule into useless fragments and the combined NPO-NPL schedules will make up less than half a sheet after deleting the "back page" items which they send all too frequently. There is only one answer for the enterprising press hound who likes to turn out a readable paper.

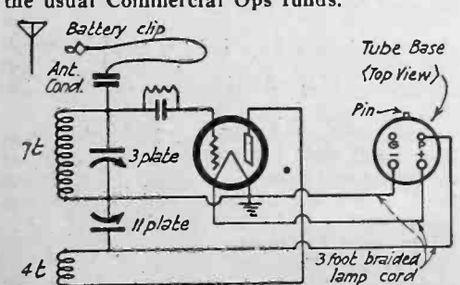
Intercept the night flies, NPM to NPO on short wave. NPM gets underway to NPO on approximately 37.4 meters every night except Sunday with press files and other traffic, taking upward to four hours to clear as the press files come at intervals in rotation with other traffic. The schedule starts at Midnight P.S.T., signal strength is excellent on a one-step amplifier, there is no QRN on these waves, and the traffic usually moves at pretty fair speed. NPM has two short wave transmitters about one meter apart. Be sure to get on the one clearing NPO.

A short wave adapter is not difficult to build and well worth the trouble and expense, considering that it will bring in a thousand or more words of press nightly. Here's how!

Short Wave Adapter

This rig is used in conjunction with the VT detector and amplifier installed aboard ship. Simply remove the tube from the ship's detector socket, replace it with the adapter plug-in base and put the tube in the socket on the adapter. (Changee for changee.) Then put the battery clip on the antenna lead and you are all set for S/W reception. The adapter can be plugged into the detector socket of *any type* of tube receiver in the same way.

The parts shown in the list can all be obtained in the Kress 5-10 & $1 stores at S. F. and L. A., (Kresge stores in the East) for less than $6.00 which is well within range of the usual Commercial Ops funds.

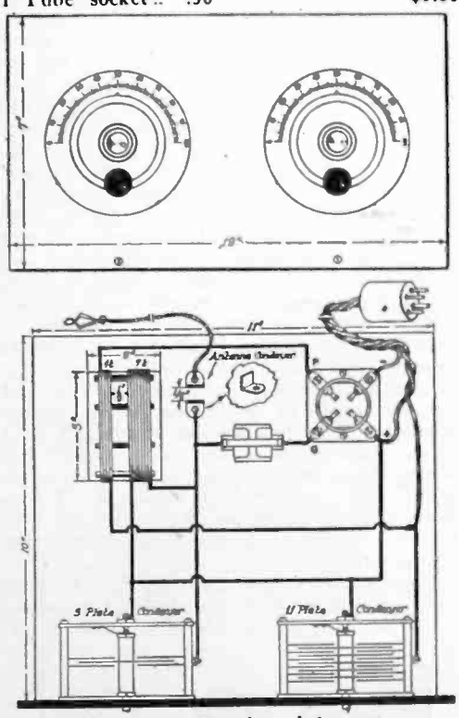


Circuit Diagram for Short Wave Adapter.

The circuit diagram and the drawings show all the necessary details. The tuning coil consists of 7 turns and the tickler coil of four turns of No. 18 bell wire wound on a Bakelite or cardboard tube, 3 in. in diameter and 2 in. long. The turns are raised from the surface of the tube by match sticks placed at ¾ in. intervals.

PARTS

1 Panel, 7x12	$1.00	1 Grid cond., .00025 mfd.	.40
1 Baseboard, 10x11		1 Grid leak, 7 megohm	.50
1 Var. cond., 3 plate	1.00	1 Base from burnt out tube	
1 Ditto, 11 plate	1.00	8 Ft. single lamp cord	.25
1 Vernier dial	.75	1 Ant. cond.	
1 Ordinary dial	.30		
1 Tuning coil	.25		
1 Tube socket	.30		$5.80



Panel and Baseboard Layout.

The tuning condenser is made from one of the "One-Buck" low loss condensers cut down to three plates. Take the condenser apart and reassemble using two stator plates and one rotor plate. The tuning is well spread out over a range of 33 to 45 meters which covers practically all of the Naval and amateur activities. One meter will occupy a half inch sector on a 4-in. dial making it easy to find stations. The 11 plate condenser controls regeneration and has little or no effect on the tuning so that the receiver can be calibrated directly in meters.

The *A* battery supply is taken from the ship's receiver through the plug-in tube base which also carried the output of the short wave set into the ship's amplifier. The rheostat on the ship's set controls the S/W detector voltage. The regular ship's antenna is used, size doesn't matter much on these waves and the antenna can be left connected to the ship's receiver while the short waver is in use. The little antenna condenser consists of two brass or copper angles mounted as shown. A ground can be added to the positive filament lead as shown in dotted lines but in most cases it will make very little difference in tuning or signal strength and can be left off. There is already a high capacity ground through the filament batteries and wiring in most ship installations and the addition of a straight ground connection will merely shift the tuning a degree or so on the dial.

ORIENTAL NOTES

By MICKEY DORAN

Pratas Island Weather Reports

Station XPI located on Pratas Island, approximately Latitude 20 North, Longitude 116 East in the China Sea sends weather reports in plain language giving general conditions in Oriental waters at 0600 GMT. The reports are sent out first on 650 meters spark and then repeated on 1450 meters CW.

Hong Kong Weather Reports

Effective July 1, 1926, VPS Cape d'Aguilar Radio, Hong Kong, broadcasts synoptic weather reports followed by plain language reports as follows: 600 meters spark at 0400 and 1200 GMT. 2800 meters CW at 0500 and 1300 GMT. Other schedules in effect prior to July 1st are cancelled.

Synoptic Weather Report: Seven groups of figures are transmitted according to the following arrangement:

1 2971 99 83 06 2 1

1st Group—Indicates the name of the Observation station according to the list given hereafter.

2nd Group—Barometer reading in inches corrected to 32° Fahrenheit at sea level and gravity at 45°.

3rd Group—Temperature, dry bulb thermometer, Fahrenheit.

4th Group—Ditto, wet bulb thermometer.

5th Group—Wind direction as in table below.

6th Group—Wind force, Beaufort scale, 9 used for force 9 and above.

7th Group—Weather as in table below.

Missing observations are indicated by the letter Z.

OBSERVATION STATIONS

1 Nagasaki	26 Surigao
2 Oshima	
3 Naha	WIND DIRECTION
4 Ishigakijima	00 N
5 Ichang	01 NNE
6 Hankow	02 NE
7 Changsha	03 ENE
8 Shanghai	04 E
9 Sharp Peak	05 ESE
10 Amoy	06 SE
11 Swatow	07 SSE
12 Taihoku	08 S
13 Koshun	09 SSW
14 Pescadores	10 SW
15 Hong Kong	11 WSW
16 Pratas Island	12 W
17 Phulien	13 WNW
18 Tourane	14 NW
19 Cape St. James	15 NNW
20 Basco	
21 Aparri	WEATHER
22 Manila	1 Fine and clear.
23 Legaspi	2 Cloudy or overcast.
24 Tacloban	3 Rain.
25 Iloilo	4 Fog.
	5 Thunder storm.

THE WIRELESS OPERATOR AND THE TOURIST

Some time ago we overheard the remark in answer to an inquiry about a man's business: "Oh, he doesn't work, he's in the radio game." Laugh that off, some of you men on a one man arc ship who take your breakfast before going to bed, or one of you fellows who spend the night from sundown to sunup trying to QSR some traffic to your company's shore station, and the afternoon in gathering up some TRs and messages to QSR.

Yep, a radio operator has an easy time of it alright. But all joking aside, why do the other officers of a ship get the idea that "Sparks" has such an easy job? Is it because his work doesn't require him to sport his gold braided "dink" out on deck while on watch? Or is it just an expression of a man's sense of humor No doubt the impression is partly due to the fact that his work is done quietly in his room while most of the others are asleep; and partly it is just "kidding," which has become a habit with some sea-going men, but the fact remains that some of them seriously believe that the radio operator gets by without doing much work.

Now the truth of the matter is that in some cases they are justified in their criticism. There never was an operator who ever saw the inside of a static room who hasn't had to listen to some "would be" old-timer brag about how little work he gets away with, or how he had his log made up from Manila to Frisco the day after leaving Manila. It's an old story, and in many cases slightly exaggerated; nevertheless, while the operator himself may be "getting by" alright, his profession suffers. Officers remember, and criticise. The marine manager for the shipping company gradually begins to take it for granted that the operator is a necessary evil, (rating the rank of an officer because of his license), who holds down the job of a tourist and gets paid for it.

This is one of the reasons why the wireless operator is the poorest paid officer on the ship; why his rank, even his reliability, is sometimes questioned by those in command. And conditions will remain as they are today until the commercial operator will realize that he is in a business, not just on a vacation.

Not for the sake of blowing our professional horn here where it won't do any good, but for a reminder, let's go over some of the reasons why the wireless operator has to be an officer and should receive recognition as such if he, individually, deserves it. At the minimum, he is expected to stand an eight-hour watch; his apparatus is complicated and its operation requires some education; he gets time ticks, weather and hydrographical reports as aids to navigation; when it's foggy, the deck officers are completely dependent upon him for their bearings and the ship's safety; and in time of distress he is the only one aboard who can do anything for the safety of the crew. All this is part of the wireless operator's duty aboard ship, and when it is considered that, in the majority of cases, he is all alone with his responsibility; that, while the deck officers and engineers can always get help from their associates when they are in doubt or trouble, he has to fight it out himself, we realize why "Sparks" should be an officer.

Enough of theory; the fact still remains that lots of operators get by with tourist stuff, and lots more claim they do, whether they do or not, all of which gives the profession one beautiful black eye in the sight of those who hold the radio operator's destiny in their hands, while the more conscientious of the crowd labor unceasingly for the advancement of their chosen line of work.

EXPOSURE COLUMN

Answering our frequent calls for suggestions, we have had several requests for a personal "write-up" each month, giving the "low-down," so to speak, on the history, character and complexion of some of the notorious (excuse, we mean prominent) men connected with the brasspounding industry. So here we start; and because the name of R. O. Koch is becoming pretty well known through our columns, while his personal "sine" "MP" (which to us means Military Police) is one of the best known on the Great Lakes, we picked him out as a good man to head the list. Then we got QSO with his life-long pal, who is splitting the ether on WDO, and had him write the following summary of Bob's radio life. When this came to us we were glad that we had decided to run this column for we believe we have opened up a channel for some mighty interesting stories. We only wish we had room to run about six an issue.

R. O. Koch

R. O. Koch, probably better known as "Bob" or "MP," was born at Manitowoc, Wisconsin, September 27, 1903. Contrary to the general rule, he has met with most of his success in the city of his birthplace—the home of old NTY, now WMW. He attended the public schools of Manitowoc and graduated from high school in 1921.

His first interest in radio was shown about the time that he was old enough to look at the steel tower on the top of the lofty Rahr Building which supported the aerial of old NTY. This tower was blown down by a violent gale in the winter of 1920 and has never been replaced, so don't look skyward for any huge tower if you ever go to visit WMW.

It was during Bob's high school days that he first started to memorize the code and study the theory of radio. True to form, his first receiver was an old loose coupler with a crystal detector, "hi-loss" condenser, Murdock fones, etc., etc. To be able to read the code at a high speed, immediately became one of his big ambitions in life, and we are forced to admit that he has gained that end. Due to excessive local QRM, the super loose-couplerodyne was finally removed to a room in the barn and shortly after, 9VA sprang into existence. Under these humble conditions, Bob, with his life-long pal, made some real progress in radio operating.

Like many young men, he found, after graduating from high school, that he was not fitted for any particular line of work, so tried his hand at several jobs with no particular success or interest. However, the experience he gained while working for the C. & N. W. Railway, later proved to be a valuable asset.

R. O. Koch of WMW

After working and saving his money for a year, he enrolled at Dodge's Radio School in December, 1922. He attended this school for eleven weeks—left with high honors and a splendid recommendation from Mr. Dodge—and on March 23, 1923, passed the commercial examination with a perfect copy of the code test and a mark of 86.2 out of a possible 90!

Soon after, he placed his application with the R.C.A. and was assigned to the *S.S. Manitou* as junior operator. July 18th he was made senior operator and resigned September 5th to do some relief work at WFK for the Ann Arbor Line. When the relief work was completed, he was offered a position on the *S.S. Ann Arbor No. 5* which he accepted and held until September 23, 1924, when he was given a position at WMW. Things didn't go very smoothly at WMW for the next few weeks and came to a climax October 18th when the other two operators were discharged and Bob was made chief operator. The combination of railroad and radio work seemed to be his real calling.

When his first ticket was about to expire, he took the 25 wpm test and so the new ticket was a "first-first."

The new ticket, however, did not conform to his delicate sense of art, and on April 9, 1926, Commercial Extra First Class license No. 108 was issued to him.

Under Bob's guiding hand, and the splendid co-operation of his company, WMW has grown from one of the worst to one of the finest stations we have. Somehow it seems that he could "take the wheel" of most anything and make it go. No finer man has ever poked a key. With such a start at his age, we naturally wonder what he will be "when he gets his growth." We are certainly glad and fortunate to be able to call him one of us.

WHO'S WHO AND WHERE

Keith Levy, first on the *Calawaii*, took the Y.L. out for a ride while in port last trip. Somebody else, however, got tired of walking, and seeing a likely looking car and pocketbook coming along, "acquired" both, leaving Levy and the Y.L. to do the walking. While the *Calawaii* sailed forth to Honolulu, her unfortunate chief operator stayed behind and located his car.

Speaking about the *Calawaii*, W. S. Chadwick, 2nd, came ashore last trip, being relieved by J. Gasnar of the Admiral Fiske. Pinkerton, of the *Yale*, relieved Levy.

H. R. Packwood, who for years unknown to the memory of man, has been the popular operator on the *Liebre*, came ashore recently on account of poor health. He was relieved by Opr. Davis.

Some things are too good to be true. When the *S.S. Hagan* arrived in Baltimore, the captain told H. E. Nahmens, the operator, that she would not leave port until the following Monday, and that he needn't come back until then. While Nahmens was out exploring the East Coast cities, the OM was fired, a new one assigned, and the ship was taken out to sea. All proving that when things seem too good to be true, they probably aren't. Nahmens went up to NYC, explained the situation and immediately shipped on the *Roger Lane*.

An unusual honor was paid to one of our fellow radio operators last month when the Associated Press, as a "tribute to a brain that works as fast as the busy radio that it directs" presented Stedman Fiske Todd, of the *S.S. President Wilson* with a gold

(*Continued on Page* 62)

Audio Frequency Amplification of Short Wave Signals

By Major R. Raven-Hart, Ch-9TC

Some very interesting experiments were recently made at Chilean station 9TC, which greatly increased the signal strength with one stage of audio amplification, by connecting the audio stage to the detector with a long two-conductor cord. Fig. 1 shows the

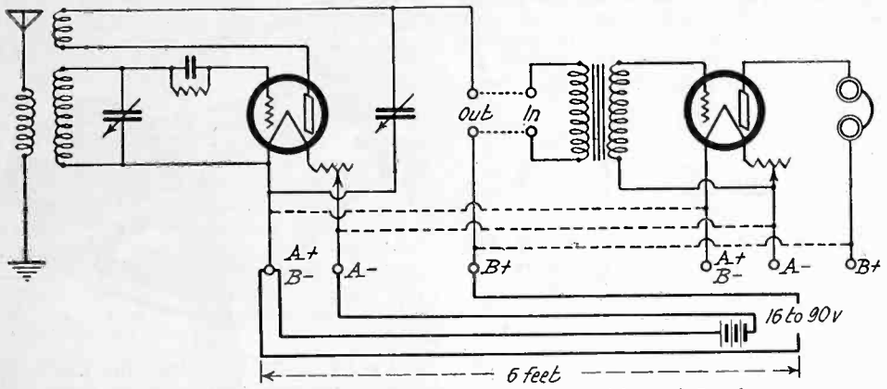


Fig. 1. Circuit Used at Ch-9TC, Showing Position of Leads.

circuit used at 9TC during the past winter, the receiver consisting of a "baseboard" type detector and audio stage, placed several feet apart, the wires connecting the terminals "Out" and "In" being used to connect the two parts together.

The detector was a simple regenerative tuner, with the batteries placed on the floor about six feet away, with separate wires, not cabled. This point is important, as will be described later, in order to enable the controlling condenser to function properly. It has been suggested that the improvement in signal strength on any given station is due to the cord acting as a distributed choke-capacity; the same result cannot be obtained by using short wires and inserting radio frequency chokes in them, as is usually done,

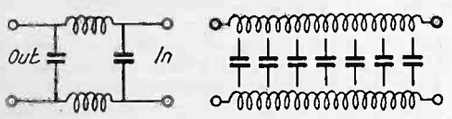


Fig. 2(a) Normal Arrangement of R.F. Chokes; (b) Theoretical Location of Capacity and Inductance of Connecting Leads.

and shown in Fig. 2a. What actually exists is as shown in Fig. 2b, and it should be noted that theoretically the losses in audio frequency current due to the condensers shown in Fig. 2b should be less in the case of Fig. 2a, as even the total value of all these imaginary condensers in parallel is very small indeed. If on the other hand this same end is attained in Fig. 2a by making the condensers smaller so as to reduce the audio-frequency losses, these condensers will not now effectively by-pass the radio-frequency current, whereas in Fig. 2b the choke effect, distributed throughout the whole cord, forces the radio-frequency current through the capacity of the cord indicated by the number of small condensers in the figure. No doubt something like Fig. 2b could also be obtained by using a number of small chokes and small condensers, but it would be very elaborate, and by no means cheap.

The proof that radio-frequency current is effectually kept out of the audio-frequency transformer by use of a four-foot cord is that no increase in r.f. current, which would be shown by increased feedback, can be obtained by shunting the audio transformer primary with a condenser of say .002 mfd. or more: the proof that the cord also acts as an efficient r.f. bypass is that no increase in the r.f. current can be obtained by shunting the "OUT" terminals with .002 mfd. or more—but in either case it is to be noted that any values of condenser above about .001 will cause a decided decrease in signals, owing to some of the audio-frequency current being bypassed.

In summary, therefore, the cord appears to have advantages over the usual condenser shunt to the transformer primary in that it keeps the radio-frequency current out of the transformer and forces it to take its proper path, without shunting an appreciable quantity of the audio-frequency current past this primary and so weakening signals. In addition, it has not the same "tuning" effect on the transformer as has the usual .001 or .002 mfd. shunt to its primary, and therefore does not tend to cause resonance at an audio frequency and therefore distortion: this is of course of interest only when receiving telephony.

It would be of interest to see whether a very much longer cord produces a decrease in signals: i.e. whether there is an optimum length. The use of a three-conductor cord with the third wire grounded at the OUT or at the IN terminals or both would be of interest also.

Results are the same whether the plate throttle condenser, which controls the feedback is connected from the plus *A* terminal to the upper or to the lower OUT terminal. In the latter position it is evident that we are controlling by bypassing the *B* battery *and its leads*, hence the remark above as to the need of long separate *B* battery leads, since obviously the condenser cannot function if it by-passes across only short leads, or leads which have considerable capacity between them. That the leads are the dominant factor and not the *B* battery itself can be shown by shunting the battery itself with a 2 mfd. condenser: this makes very little difference to the action of the control condenser.

A point of special interest is that we can now tune the circuit formed by these leads and the variable reaction-control condenser, to wavelengths within the tuning range of the set itself. In the case shown, using a .0005 mfd condenser for reaction control, this circuit can be tuned from about 90 to 70 meters. The effects resulting are somewhat striking, and run more or less as follows: (1) Tuning the set, using a 15½ turn secondary, to a wave above 90 meters, oscillations are obtained in the usual way, by increasing the capacity of the control condenser. (2) Tuning the set to any wave from 90 to 70 meters, we can now get oscillations in this way, or, using very much less feedback coupling (e.g. using 2½ turns tickler coil instead of 7½, and setting at three in. from the secondary) we can get oscillations by tuning the *B* battery lead circuit to the wavelength of the secondary. The difference between the amount of feedback required in the two cases is very striking: to get oscillations on about 80 meters, for instance, using the normal form of feedback control by increasing the control capacity, we need 45 volts and a 7½ turn tickler set close to the secondary, whereas using the "tuned leads" feedback we get oscillations with 16 volts and a 3½ turn tickler set 3 in. from the secondary.

What really happens on this wave, if we are using the normal form of feedback control, is that after we have increased the feedback coupling and the voltage to get the set to oscillate at the top end of the control condenser scale, where we expect maximum feedback to occur, we then cannot stop it, because with this voltage and feedback coupling, the other type of reaction occurs, not only close to the point on the control condenser that tunes the "leads" circuit with the secondary, but a long way each side of it. The only way we now can get control is by greatly reducing the voltage and feedback coupling, and either working on the top half of the scale of the feedback control condenser, "upside down" (i.e. increasing the feedback by decreasing the capacity), or else on the lower half of the scale in the normal way. (3) Tuning the set on any wave from 70 down to about 28 meters (using 15½, 7½ and 3½ turn secondaries) we get oscillation in the usual way, by increasing the capacity of the control condenser; but we can also get it by decreasing this capacity, since we are thus tuning the "leads" circuit to a wave approaching that of the secondary. As we tune the set lower and lower, we notice this effect of reversed feedback less and less, until at about 28 meters the "leads" circuit (which, even with the control condenser set to a minimum is still tuned to about 70 meters) is so far de-tuned from the present wavelength of the secondary that reaction of this type disappears. (4) Thence to about 18 meters (the limit of the set) only normal reaction is possible, by increasing the control condenser.

I leave to experimenters some very striking effects to be had on these "double" feedback wavelengths, merely remarking that a point to work on is the result of grounding the B plus terminal, unusual as this may appear.

NEW QRA

Australian 5WH is W. H. Barber, 50 Somerset Ave., Cumberland, So. Australia; wavelength 34 meters.

NEW RADIO CATALOGS

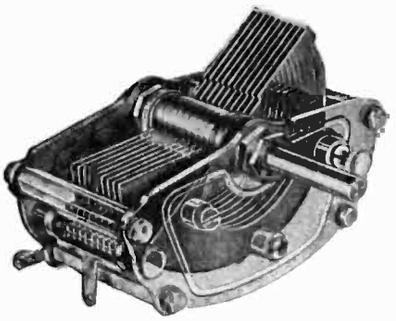
Benjamin Electric Mfg. Co., of Chicago have issued complete folders telling how to build an excellent three tube, four tube and five tube set, using their parts.

The Radiall Book from the Radiall Co. of New York City is a 24-page pamphlet showing the use of Amperites in a number of popular circuit diagrams. Full explanation is given of the theory and practice of these devices for the automatic control of tube filament voltages.

ERRATA NOTICE: In Raymond B. Thorpe's article in October RADIO the eighth line from the bottom of column 2, page 33, should read $a_1 a_2 b^2$ and equation 5-C on page 34 should read $h = a_2 e^2/2$.

FROM THE RADIO MANUFACTURERS

The Metralign SLT variable condenser has plates so designed as to give equal dial spacing or straight line tuning for all stations. The construction is so rugged that constant use will not change

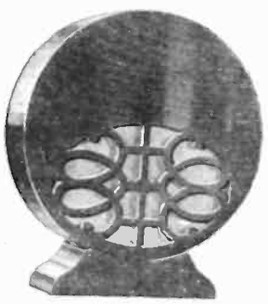


the capacity value nor the smoothness of operation. It is made with either aluminum or brass plate, as desired. The maximum capacity of the six sizes are 100, 150, 250, 300, 350 and 500 mmfd. respectively.

The Majestic current supply is a battery eliminator rated to furnish 60 milliamperes at 150 volts (40 milliamperes at 185 volts), which adapts it for use with

multi-tube sets with power tube in the last stage. It uses a Raytheon tube as a rectifier and has three adjustable resistances controlling the voltage delivered to various tubes.

The Teletone radiospeaker is of attractive appearance and has a beautiful tone. "Built like a violin," of either walnut or



mahogany, it gives full resonance to all tones over the entire audio scale.

The Exide master control switch places a remote storage battery or power unit with trickle charger "on" or "off" charge by the mere movement of the switch located at the set or other convenient point.

It simultaneously turns off or on the filament current to the set and does away with any possible hum due to the charger. It may also be attached to a "B" eliminator so that the same movement of the switch that lights or extinguishes the filaments also connects or disconnects the plate supply.

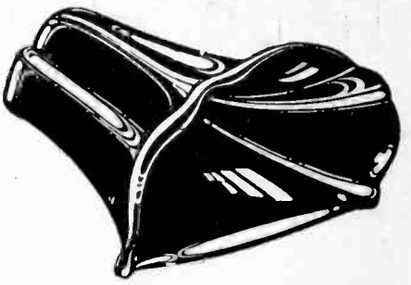
The White Cross Dialer is a 360 degree bakelite dial with a 6 to 1 ratio. It works by means of a friction disk that is claimed to give smooth action without

slip or back-lash. It can be used on either clockwise or counter-clockwise shafts. The reading plate has black letters on a satin-finished white metal disk.

Potter condensers for use in by-passes or filters are made in various capacities from 0.1 to 8 mfd. to withstand various required voltages from 200 to 2000 volts.

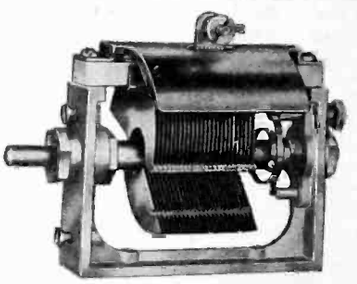
The plates are of tin foil and the insulation is linen paper and wax impregnation, all hermetically sealed in a case fitted with tinned copper terminals.

The Cook reproducer consists of a Baldwin telephone unit and a black porcelain sound chamber. The latter is mathema-



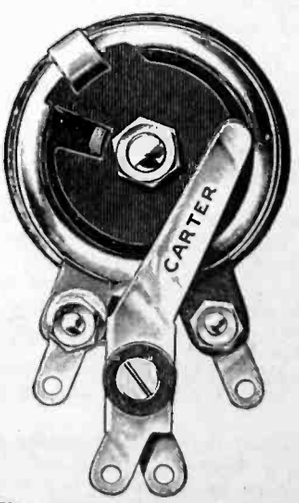
tically designed to give the finest tone quality without distortion or echo. It is compact in form, standing less than 9 in. in height.

Samson uniform frequency condenser plates are mathematically proportioned to give uniform station spacing throughout the entire range of the dial, thus obviating any crowding. They are made in five sizes, 75, 125, 250, 350, and 500 mmf.



and are guaranteed to be accurate within 1 per cent of their rated capacitances. They are small and compact and built to a tolerance of .001 in. With their one-hole mounting they can be placed either horizontally or vertically. The rotor is grounded.

The Carter Hi-ohm volume control is a 500,000 ohm variable resistance well adapted for use in several modern cir-



cuits. The variation in resistance is uniform and quiet in operation. It is marked by simplicity and ruggedness of construction.

"—remarkably good!"

ALL-AMERICAN
TRADE MARK
Reproducer

ALL-AMERICAN
TRADE MARK
Constant-B
Battery Eliminator

That is the judgment, without exception, of radio experts and enthusiasts who have examined and tested these two fine units.

They mean *better reception.* Both have a great deal to do with finer tone-quality. You owe it to your own enjoyment of radio, to know the facts about these fine-quality accessories.

ALL-AMERICAN *Reproducer*

For purity of tone this handsome product is outstanding among reproducers. It combines ingeniously all advantages of good cone-type reproducers —and the improved quality provided by a special sounding board and sounding chamber. A highly sensitive unit which reproduces voice and instruments naturally and clearly. Perfect uniformity is maintained over the entire musical range, whether amplifiers are turned to full volume, or down to a whisper. Absolute freedom from "inherent pitch" prevents low throaty tones or twangy nasal effects.

Price $25.00

ALL-AMERICAN *Constant-B*

An attractive compact unit of silent efficiency —insures a dependable supply of uniform plate current. Five output taps; negative, +45, +67, +90, and a power tube tap adapt "Constant-B" to all requirements. A "Detector" control provides voltage variation between 10 to 60 volts. An "Amplifier" control allows a variation of 10 to 120 volts on the intermediate tap, without affecting the 90 volts supplied to first audio stage. A High-low switch adapts "Constant-B" to receivers of various current requirements.

Price $37.50 Complete with Raytheon Tube

Prices are slightly higher West of the Rockies

New 1927 Radio Key Book

Learn more about the fundamentals of radio. This *new* 48-page book contains an interesting analysis of radio in language anyone can understand—also complete constructional details of the leading types of circuits. Sent for 10c (coin or stamps) to pay for postage and mailing.

ALL-AMERICAN RADIO CORPORATION

4215 Belmont Avenue, Chicago, Illinois

OWNING AND OPERATING STATION WENR ~ 266 METERS

RADIO IN THE NAVY

(*Continued from Page* 19)

sharper wave form thereby permitting greater sharpness of tuning with consequent increase of selectivity and less interference. Quenched gap transmitters were made in sizes of from ½ k.w. to 25 k.w. but the maximum size found most suitable on Naval Vessels was 10 k.w.

The Navy purchased a considerable number of arc transmitters many of which are still in use. This type of transmitter obtains its name from the arc which is formed between a water-cooled copper terminal or anode and a carbon or cathode. The arc transmitter produces a continuous wave and has a greater range than equally powered spark transmitters. The Navy used arc transmitters of from ½ k.w. to 500 k.w. while the arc transmitter built and installed under the direction of the Navy at the Lafayette Station in France is of 1000 k.w. capacity. Thirty kilowatts is the maximum size used on Naval vessels.

As the number of radio stations increased, and especially when broadcasting became so popular, the arc transmitters were found to be objectionable on account of the emissions inherent in this type of transmitter. The broadcast listeners living near a high power arc transmitter were "up in arms" when the programs were interspersed with the "mush" from the arc.

When the Navy started to use simultaneous transmission and reception, the short-comings of the arc were soon realized. With this system it is practicable to transmit with several transmitters and operate several receivers simultaneously on the same vessel. It will be seen that to carry out this operation successfully interference must be at a minimum. Arc and spark transmitters cannot be used in simultaneous transmission and reception or duplex system and they are being replaced with vacuum tube transmitters as funds become available.

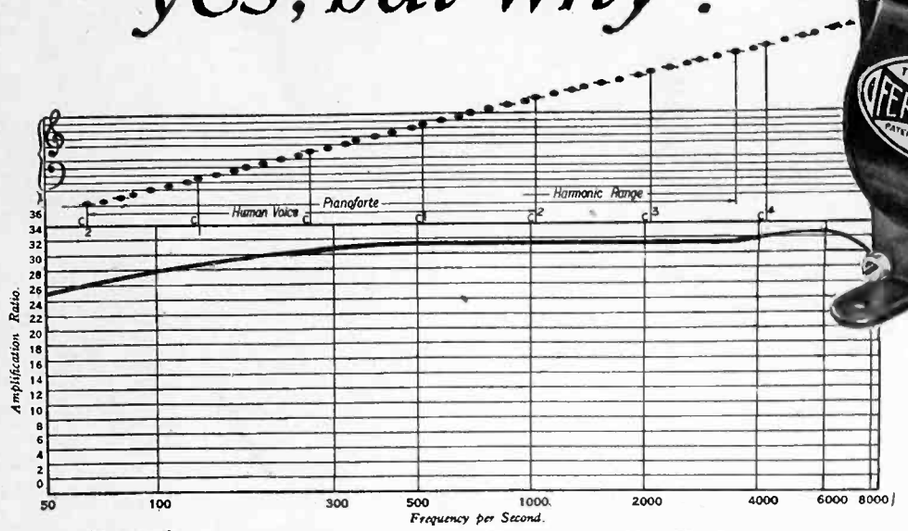
Tube transmitters are used extensively in the Navy. They are made in sizes of from 5 watts to several kilowatts and from the standpoint of operation have exceeded everything in the transmitter line so far produced. They, however, have their limitations in that they produce harmonics, or overtones as the musician knows this phenomena, which causes interference on frequencies other than the one intended for transmission. Fortunately, the harmonics in the receiver can be considerably suppressed but the cost for necessary parts increases with the degree of elimination. This is because of the additional apparatus such as trap circuits, etc.

Because of the higher degree of purity of the waves transmitted by tube transmitters, it is possible not only to eliminate much interference but to transmit farther with equally powered transmitters of the spark and arc variety.

(*Continued on Page* 46)

FERRANTI

supreme —yes, but why?



AMPLIFICATION CURVES. (BASED ON A MUSICAL SCALE.)

Audio Frequency Transformer
A. F. 3 $12

THIS graph is drawn on the musical scale—the only accurate way of showing the full value of each tone which your set receives. Note that the evenness and fullness of amplification extends throughout the range of the organ, the cello, and the human voice.

Analize these facts about the

FERRANTI TRANSFORMER

AFTER all is said, what is the truth about this transformer question? Is it important to you to get merely mediocre reception from your set, or do you value getting the very best from it that you possibly can?

The Ferranti Transformer is the Nearly Perfect transformer—nearly perfect because its amplification curve is almost a straight line. No other transformer approximates this degree of perfection.

And when you consider the fact that the scale of measurement is based on the musical scale, showing as it does true transformer value as applied to any tone which you can possibly receive in your set, you will appreciate that this is the only fair method of testing transformer performance.

The Ferranti Transformer does more than act as a superior transformer. It is designed to produce that depth of tone quality which is lacking without a worthy transformer. From the low notes of the organ and the kettle drum to the high pitch of the flute and the human voice, Ferranti Transformers "carry on" faithfully.

We welcome inquiries from responsible dealers and jobbers

No Better Transformer is Available at any price

FERRANTI, INCORPORATED

130 West 42nd Street New York, N. Y.

RADIO IN THE NAVY

(*Continued from Page* 44)

The Navy is now actively engaged in the development of high frequency transmitters. Surprising distances are being reached with equally surprising low power transmitters. During the World War it was considered a feat of considerable import when the *George Washington* lying in Brest, France, Harbor, was able to communicate with stations in this country using a 20 k.w. arc transmitter.

During last July the *Memphis,* with a ½ k.w. high frequency transmitter, worked directly with the Navy Department from the time of her departure from this side of the Atlantic to her destination in France, and she is still carrying on with better results than the old arc could hope to produce. The *Memphis,* on the European coast communicated with the *Denver,* off South America, and the *Finch* on the Asiatic station.

The introduction of high frequency transmission is proving of great advantage in many respects, particularly as regards conservation of funds. Greater distances with less power are accomplished which means low power bills, less expensive and simpler apparatus, lower upkeep etc. It has been found that static disturbance interferes less on high frequencies and this advantage together with better carrying property peculiar to high frequency waves accounts for the great distances covered by this new type of radio apparatus.

The Navy first started experiments in radio telegraphy in 1902, when, during the first tests, a distance of about 100 miles was covered. Today Naval Vessels are transmitting thousands of miles with apparatus designed and built by the Navy. When we consider this great work who can predict what will be accomplished in the next equal period?

WHAT RADIO MEANS TODAY

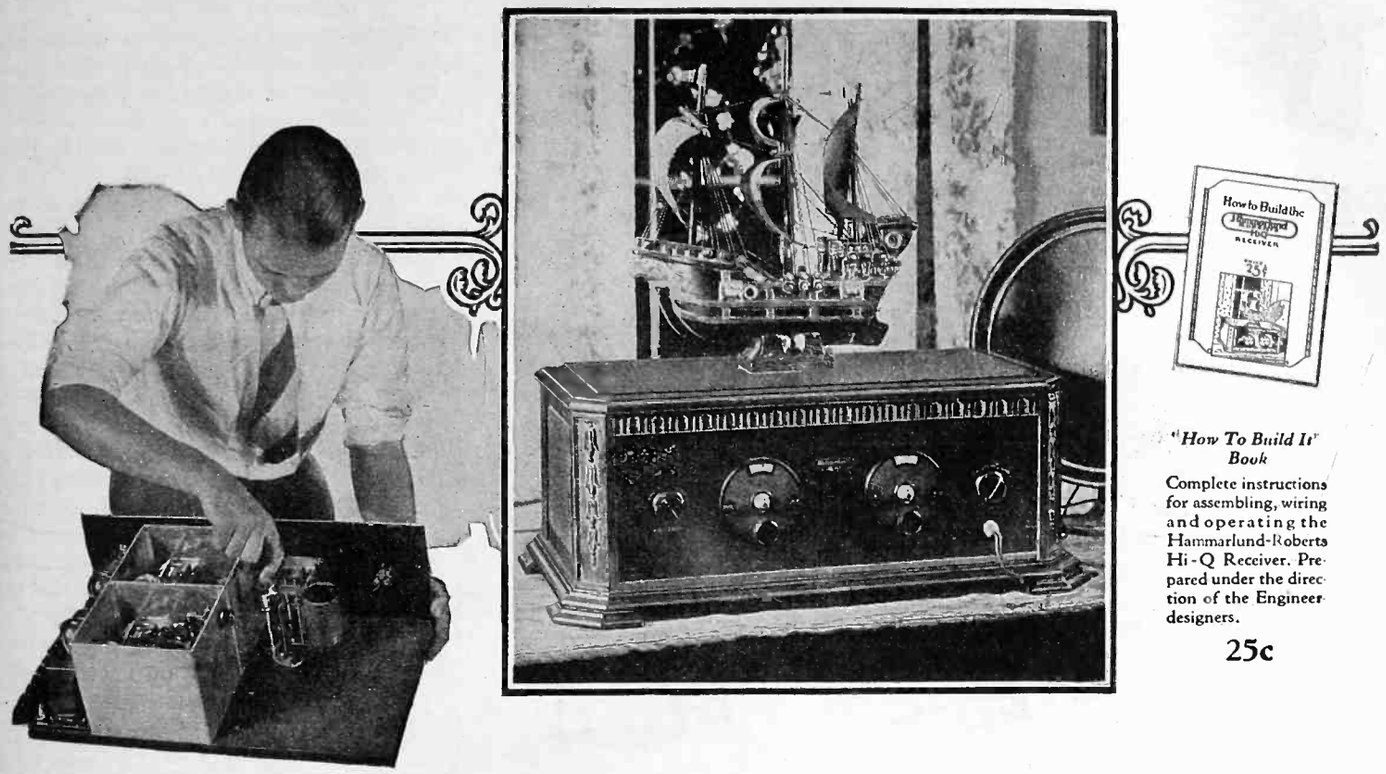
(*Continued from Page* 20)

is also, as you can imagine, an interesting field in the realm of broadcasting transmission. Engineers of the Western Electric Company and the American Tel. & Tel. Company have contributed largely to the progress that has been made in this branch of the art. Certainly it is true that practically all of the broadcasting stations of any consequence were either built by, or follow the technique of, these two companies.

The chief requirement of the transmitter is that it shall radiate waves so modulated by the human voice or music that when they are received on a radio set meeting the specifications I have previously outlined, the reproduction will simulate as closely as possible the sounds picked up by the transmitter microphone.

I think I am correct in saying that transmitting technique has been a little ahead of our receiving skill. In other words, properly modulated waves were

(*Continued on Page* 48)



"How To Build It" Book

Complete instructions for assembling, wiring and operating the Hammarlund-Roberts Hi-Q Receiver. Prepared under the direction of the Engineer-designers.

25c

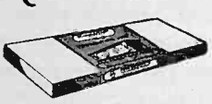
$63.05
Complete Parts (less cabinet)

Hammarlund-Roberts Performance Means A New Measure For All Radio

Automatic Variable Coupling, same control operates tuning condenser and primary coil coupling simultaneously, gives maximum and equal amplification and selectivity over entire tuning range.

Stage Shielding—prevents coupling between stages, eliminating oscillation and increasing selectivity. Clarifies reception.

Hi-Q Foundation Unit



Includes drilled and engraved Micarta Panel, drilled Micarta sub-panel, two complete shields, extension shaft, two equallizers, fixed resistance, hardware, wire, nuts and screws.

$10.50

Associate Manufacturers

Carter Radio Co.
Martin-Copeland Co.
Radiall Company
Samson Electric Co.
Sangamo Electric Co.
Benjamin Electric Mfg. Co.
Eby Manufacturing Co.
Hammarlund Mfg. Co.
Durham Resistors
Westinghouse Micarta

THE Hammarlund-Roberts Hi-Q is an outstanding example of scientific radio engineering. No ordinary standards of tone, selectivity or volume, can be applied to this new receiver.

In designing this Hi-Q Receiver, the Hammarlund-Roberts Board of Engineers representing twelve nationally known manufacturers, had at their disposal the finest experimental laboratories—and no handicap in building to establish specifications or to a set price.

This concentration of the leaders in the perfection of one radio Receiver has developed entirely new features that produce results unknown to the average radio man. Automatic variable coupling gives maximum and equal amplification and selectivity over the entire tuning range. Stage shielding eliminates coupling between stages, prevents oscillation and increases selectivity. Two dial control simplifies tuning.

ANYONE CAN BUILD THE HAMMARLUND-ROBERTS Hi-Q

All the research, the selection of parts, the exact placing of units, has been worked out in advance for you. And you have a receiver that will equal an eight tube set—simplicity of design and operation hitherto unthought of—all at less than half the price you would pay for a factory made set of anywhere near equal efficiency.

Hammarlund ROBERTS Hi-Q*

***High ratio of reactance to resistance. High ratio—Great selectivity—Loud signals**

Hammarlund-Roberts · 1182-F Broadway : New York

WHAT RADIO MEANS TODAY

(*Continued from Page* 46)

being radiated considerably before receivers were built to properly reproduce them. But this failing, as I have indicated, is being rapidly corrected and our standards of reproduction—already high—are being materially lifted.

Of course, inseparably linked to the engineering phase of radio is the much discussed patent situation. Both the layman and the man in the industry have been subjected to a plethora of propaganda concerning the alleged patent control of the art by a few large corporations. I must ask you to excuse me from even the most brief discussion of this question today because I am not able to treat on this subject in an unbiased manner. One either believes this propaganda or one doesn't. A man cannot be informed on this subject unless he is engaged in the industry, and if so he can hardly be neutral. But I do believe in the protection to an inventor or a corporation which ownership of valid patents is intended to bring.

But, since under U. S. Patent law the granting of a patent by the Government means no more than giving the patent holder a weapon of unproved strength with which he may go into Court, if he can afford to, to determine whether the patent should have been issued him or not, consequently the ownership of a long list of radio patents does not necessarily give to the holders thereof a monopoly of the business nor the right or ability to exclude others from participating in it. This fact should be obvious when we consider that the industry today is divided between a great many manufacturers, and no company of any consequence has been driven from the field through patent litigation. Recent judicial decisions have clarified the patent situation materially and have eliminated the danger of patent control by any one corporation or group of associated interests to the detriment of the industry as a whole.

Let us now consider the merchandising phases of radio which came into existence about 1921. That year marked the inception of broadcasting, no matter to whom we give, or by whom is assumed, the credit of first establishing it on a practical basis. Prior to that year, the only persons who purchased radio supplies for home use were the amateurs and experimenters. With such a limited market, distribution channels were not defined as they are today, and the few manufacturers in the business sold to either jobbers, dealers, consumers, or a combination of all three classes.

In the Spring of 1922, however, radio went over with—to use theatrical parlance—a wow. This was because the general public became radio conscious and realized that it was possible to have a new form of entertainment in the home.

(*Continued on Page* 50)

CROSLEY
BETTER—COSTS LESS
RADIO

One-Dial Control!
. . . *in this amazing 5-tube set at $50*

Already the new 5-tube Crosley set, at $50, has met such a tremendous demand as to confirm the prediction that it will replace thousands upon thousands of sets now in use.

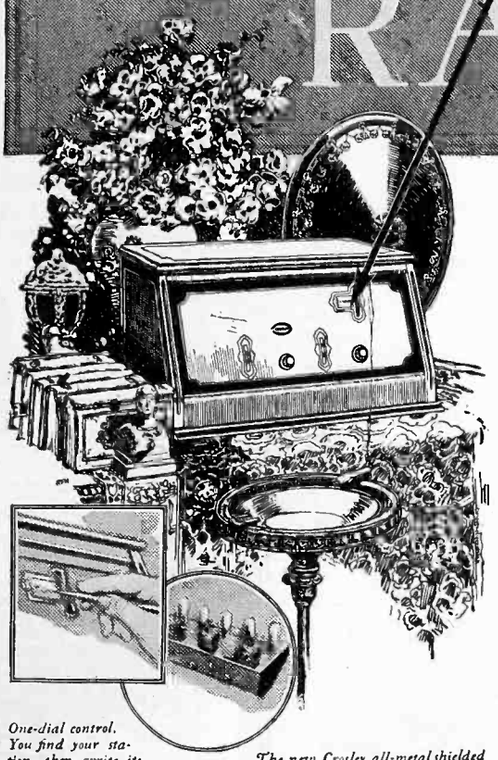
Confronted by high prices, many people who desired to replace their old sets have hitherto hesitated to do so. Now . . . in the new Crosley "5-50" . . they find the features and qualities they desire, formerly exclusive to very high priced sets . . . available at small investment.

The incomparable joys of Single-Dial Control! Uncanny selectivity, resulting from its metal-shielded chassis and the surpassing efficiency of the Crosley circuit's advanced design! Exquisite volume, thanks to the matchless Crescendon! Crosley Acuminators, power tube adaptability . . . all the attributes of radio at its best . . . for $50!

In all the Crosley line no instrument represents a greater triumph than this wonderful 5-tube set. Examine the line in full, as illustrated in the marginal column at the left . . . each item a victory for *mass production* in reducing radio prices. Then see the Crosley line at Crosley dealers . . . including the new "5-50" . . now on display!

See it . . hear it. View the refreshing beauty of its solid mahogany cabinet. Operate it yourself. Watch the stations, written in on the graphic dial, parade before you and usher in their programs with unerring accuracy. Sharpen the selection with the Crosley Acuminators. Release inspiring volume by means of the Crescendon.

Know what heights . . . in tone, volume, selectivity and sensitivity . . . radio of moderate price has reached!



One-dial control. You find your station, then write its letters on the graphic dial, locating it once and for all, to turn to whenever your fancy dictates.

The new Crosley all-metal shielded chassis not only aids in producing astounding selectivity, but standardizes manufacture and helps make possible the price of $50

$50

Slightly higher west of the Rockies. Never before, at anywhere near this price, has a radio set possessed all these advantages: 1. Single-dial control with graphic station selector. 2. Metal-shielded chassis, contributing to amazing selectivity and reducing cost. 3. Crescendon control, producing exquisite volume from distant stations. 4. Crosley Acuminators, which sharpen tuning and increase selectivity. 5. Power tube adaptability. 6. Beautiful, solid mahogany cabinet of distinguished design and exquisite two-tone finish.

THE CROSLEY RADIO CORPORATION, CINCINNATI—POWEL CROSLEY, Jr., President

For Catalogue write Dept. 19

Crosley manufactures radio receiving sets, which are licensed under Armstrong U. S. Patent No. 1,113,149 or under patent applications of Radio Frequency Laboratories, Inc., and other patents issued and pending. Owning and operating station WLW, first remote control super-power station in America. All prices without accessories.

CROSLEY RADIO
All prices slightly higher west of Rocky Mts.

This little double-circuit 1 tube set has made long distance records.

4 tubes Amazing efficiency, Crescendon equipped!

The 4-29 in portable form.

Five tubes, tuned radio frequency. Two stages non-oscillating radio frequency amplification, Crescendon, two stages audio frequency amplification.

5 tubes, 1-dial control acuminators, Crescendon, power tube adaptability.

6 tubes. True-cascade amplification; non-oscillating and non-radiating.

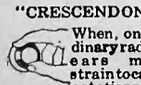
In solid mahogany console. 5-tube $50 instrument, Crosley Musicone speaker, ample compartment for batteries.

Double drum station selector! Musicone and room for batteries and accessories.

12-inch size, $12.50. Super Musicone, $14.75. Musicone Deluxe, $23.60. Also beautiful Musiconsole with room for batteries and accessories, as below.

Crosley Features

"CRESCENDON"



When, on ordinary radios, ears must strain to catch a station miles away, a turn of the Crescendon on Crosley radios instantly swells reception to room-filling volume. An exclusive Crosley feature.

ALL-METAL SHIELDED CHASSIS

This truly great radio achievement, found in several Crosley sets, furnishes a substantial frame for mounting elements, produces excellent alignment of condensers, shields the units from each other, prevents interstage, improves the stability of the circuit, increases selectivity and saves costs by standardizing this phase of manufacture.

THE SINGLE-DIAL STATION SELECTOR

Nothing in radio equals the joy or the convenience of single dial control. Crosley single drum control enables you to find the stations sought without log book or "tuning"

THE "ACUMINATORS"

Crosley Acuminators provide sharp tuning where reception spreads broadly over dial, easily tune out local and bring in far stations. Ordinarily, once adjusted and they need not be touched again.

USE OF POWER TUBE

Power tube adaptability marks the Crosley "5-50" "5-75" and "RFL" sets. This feature typifies Crosley provision for best radio reception at moderate cost. This feature is in keeping with all that is most progressive.

QUALITY AND BEAUTY IN CABINETS AND CONSOLES

WHAT RADIO MEANS TODAY

(Continued from Page 48)

That year marked the beginning of crystallization of distribution channels similar to those which obtain in industries marketing similar merchandise. That is to say, the general practice now is for the manufacturer to sell distributors or jobbers in the major and secondary trading areas of the country, depending upon these strategically located distributors to promote the sale of his merchandise from whom, in turn, the consumer may buy.

At first, almost all radio manufacturers succumbed to the temptation of selling all distributors whose credit ratings would justify such procedure—even more than this number in some cases. And while quick and relatively large volume followed forthwith, the evils of unrestricted distribution began to creep in. With four and five jobbers selling the same line in a given territory, you can imagine the mad scramble for dealers particularly in the smaller towns. The result was that good merchandise found its way into the hands of dealers who could not render proper service to the buying consumers, which, on the ground of public interest and necessity, is probably a safer subject for discussion than the delicate one of price cutting on the part of both jobbers and dealers under such a set-up.

But certainly the legitimate jobbers and dealers, the men who are trying to render a real service to the buying public, are entitled to be protected against such unfair business practices as price cutting. (The Federal courts have upheld this doctrine so I think I am safe in mentioning it). In any event, and irrespective of the reason therefor, we find a tendency toward restricted distribution which can be justified alone on the ground that it has worked out to best advantage in other similar industries.

That is to say, the wise manufacturer of receiving sets today appoints not more than one or two distributors in each primary trading area and himself carefully scrutinizes, even actually appoints, the dealers to whom his distributors can sell. The manufacturer of accessories—tubes, batteries, and acoustical devices—need not follow so restricted a policy, just as in the electrical business we find more jobbers and dealers in lamps than we do in washers or ranges.

The tendency in distribution, then, is toward increasing restriction and this is justified, practically as well as legally, from the consumer's viewpoint alone—in view of the technical progress of the art. Let me explain.

At the outset, the radio manufacturer transferred the burden of radio reception to the consumer. That is to say, the manufacturer—realizing the intricacies involved in tuning and otherwise controlling a radio receiver—wisely decided to let George do it. Hence the receiver

(Continued on Page 52)

THE *finest* TRANSFORMER IN THE WORLD!

RADIO ENGINEERS and those who know, pronounce MADISON-MOORE TRANSFORMERS the most perfect. Their superiority has been unquestionably demonstrated under every possible test.

You are assured greatest satisfaction in the essentials of perfect Radio reception.

SELECTIVITY: Silent nights are no longer necessary. MADISON-MOORE Transformers can always be depended upon to make distant stations like locals on your dials.

QUALITY: From the tenor's falsetto notes, to the rumbling bass of a great pipe organ, they faithfully reproduce the beauty and shading of every tone.

DISTANCE: Repeated tests prove that stations out of reach of the finest receiving sets are easily brought in with MADISON-MOORE Transformers.

VOLUME: These Transformers, when used with only a two-foot loop, produce loud speaker volume on stations that have never before been heard in that locality by the broadcast listener.

MADISON-MOORE Transformers are precision-made and subjected to most exacting laboratory tests until they are electrically and mechanically perfect.

TO HAVE MADISON-MOORE TRANSFORMERS IS TO HAVE THE BEST IN RADIO

Write us for name of nearest dealer

Madison-Moore Radio Corp.
2524 Federal Boulevard
Denver, Colorado

Read This Guarantee. It Is Attached to Every Instrument.

MADISON-MOORE

WHAT RADIO MEANS TODAY

(*Continued from Page* 50)

of two years and more ago had anywhere from three to six tuning controls, not to forget volume and filament battery controls. It was grand for the manufacturer but it put a terrific strain on Nature. I mean to say, the average man was accustomed to getting along quite well with two hands and two feet—now he was confronted with a device which required simultaneous operation of an average of five controls. Such a situation and such design was of course absurd, and really hurt the business.

Today, we find the manufacturer offering single tuning control receivers; no tube rheostats—only a tuning control and a volume regulator. But in transferring complex tuning from the human consumer to a mechanical instrument, we have had to evolve a device mechanically much more intricate within even if it appears much more simple on its surface to the layman. Now with any complex mechanical device, the purveyor thereof must be prepared to furnish the purchaser with service. By service, I mean the sort of post-purchase service to which the automobile owner is accustomed. The itinerant radio dealer—corresponding to what in the electrical business is called the "curb-stoner"—the cut-price dealer, realizing just enough gross profit to carry the small expense of over-the-counter selling, obviously is not set up to render such a technical service to the consumer as present day radio receivers properly require.

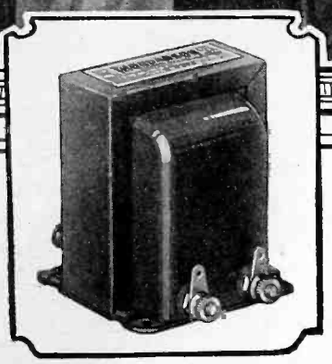
You cannot eat your cake and have it. If the burden of intricate tuning is to be borne by the set and not by the owner thereof, you are buying an intricate piece of machinery and it is no criticism thereof, to say that it must have periodic service as must the high grade motor car. This is why dealer distribution, in fairness to the buying public, must be restricted to a few high grade dealers.

I foresee no radical changes in radio merchandising other than an increasing restriction in channels of distribution and such restriction, as I have pointed out, works to the benefit of both the public and the industry.

It is obvious that the sale of radio receivers and their accessories, a business which is estimated to be approximately $500,000,000 annually, would be impossible without broadcasting—the *sine qua non* of our industry. We can look for many changes in this branch of the industry in the future.

It must be apparent that the industry as a whole must support the single agency which makes it possible. It is to the credit of most of the large manufacturers that they are meeting their responsibilities in this respect. The work, however, at this time is not—in my opinion—coordinated to the extent which it must be to be of greatest benefit. From a com-

(*Continued on Page* 54)



THORDARSON

R-200

AMPLIFYING TRANSFORMER

Supreme in MUSICAL PERFORMANCE!

THE secret of good reception lies not in attempted correction of the deficiencies of *poor* broadcasting, but in faithfully reproducing the programs of the *better* stations.

Thordarson transformers employ neither a "rising" or a "falling" characteristic for corrective purposes. They are designed to give, as nearly as possible, equal attention to all notes.

The majority of leading quality receivers are equipped with Thordarson transformers—a substantial evidence of the musical supremacy of Thordarson amplification.

ZENITH
SPARTON
Neutrowound
Pfanstiehl
The Wells BEAR CAT
KENNEDY
MU-RAD
OZARKA
Valleytone
RADIODYNE
Howard
Murdock
Deresnadyne
EAGLE
ARGUS
RADIOMASTER
AUDIOLA
HARTMAN
Buckingham
Monoruk
ALADDIN
Perlesz
Signola
Heraldyne
and many others

Standard on the Finest

THORDARSON ELECTRIC MANUFACTURING CO.

Transformer Specialists Since 1895

WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS

Huron and Kingsbury Streets — Chicago, Ill. U.S.A. 3445

WHAT RADIO MEANS TODAY

(*Continued from Page 52*)

mercial viewpoint, I think we may look forward to joint operation of a chain of stations by the major interests in the industry. Overtures on the part of certain manufacturers have already been made to the group now operating the more important high power stations to permit them to assist in the support of these stations, but the complex patent situation apparently has operated to prevent the co-operative action which should obtain in this work. Time, however, will clarify this situation one way or the other to the benefit of the industry and the public. But too great dependence on the sporadic activities of broadcasting interests primarily engaged in realizing purely advertising benefit from broadcasting, and not interested in building up of the radio industry *per se*, should be guarded against. We must all be prepared to support broadcasting and we should work for restriction in this field also. We have too many broadcasting stations now to properly serve the public, just as formerly our distribution channels suffered by unnecessary duplication.

Technically, we may look to increased power in broadcasting stations and increasing application of chain operation, either through wire or radio interlinking of transmitting stations. This means that your local station will continue to serve the purely local interests of the community, but we may expect the programs of exceptional merit to originate at the large centers from which the best talent can be drawn. Thus, a program from a New York studio will be broadcast to you from your local station wherever it may be located.

Ability to receive programs of high standard from distant cities in this country and abroad, but through a local station, will tend—I hope—to overcome the present mad fetish for distance reception. "DX" hunting identifies what may be termed the radio moron but it is a stage through which we all must pass, I suppose, before we are willing to settle down to the normal pleasures of radio reception. But the unreasonable and unreasoning demand for distance, I can assure you, has broken the heart and disposition of many a radio engineer and the purse of many a manufacturer.

Here we have a great and growing industry in but its infancy and still experiencing its growing pains. Yet even a conservative must concede that it gives fair promise of bringing a fundamentally new contribution to our civilization. If radio brought nothing more, as it has, than the means for enabling the Chief Executive of the nation to personally address the majority of the citizenry, and thus to return in a measure to the closely knit political structure of ancient Rome when a Caesar could frequently address his fellow citizens, it would seem to warrant serious appreciation.

AMATEUR CONSTRUCTION

(*Continued from Page* 34)

a separate antenna for the receiver and make it long and part of it horizontal.

All short-wave receivers have some means of controlling oscillation. The point of maximum signal strength is, of course, at the point of oscillation. If the receiver be adjusted just at the point of oscillation and the antenna switch be thrown to use the transmitter, and again thrown back to use the receiver, it is often found that the set is no longer oscillating. This is a big disadvantage for it requires a readjustment of the controls and sometimes a loss of the station entirely. If a separate antenna can be used and placed so that it need not be switched off, this difficulty may be overcome. This cannot be done when a powerful transmitter is used unless the receiving antenna is well away from the transmitting one, which is quite impossible unless remote control is used on the transmitter. Here's where the fiver has the advantage.

Some amateurs find it difficult to transmit code unless they can hear what they are sending and some of them go so far as to wind a few turns around the antenna lead and attach this to the antenna lead of the receiver to secure this result. Since the primary coil is usually left grounded a nice lot of power is finding its way into the ground which would otherwise be radiated. Another more satisfactory method is shown in Fig. 3.

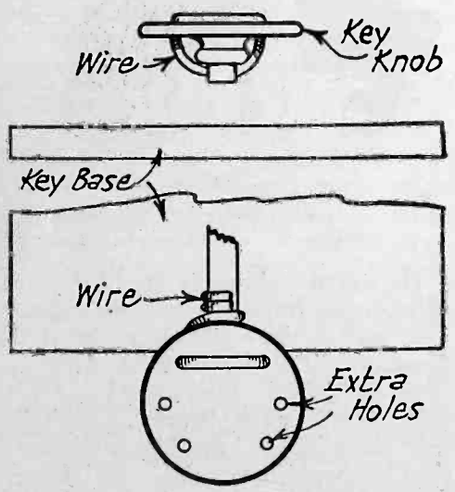


Fig. 3, Simple Connection for Hearing What You Are Sending.

Small holes are drilled in the key knob through which a small wire is passed and wrapped around the key arm. When sending, the fingers are held on this wire. The transmitter can now easily be heard and a better grip on the key is provided. Don't try this on transmitters employing over 750 volts and don't touch the ground lead at the same time! These transmitters can usually be heard anyway.

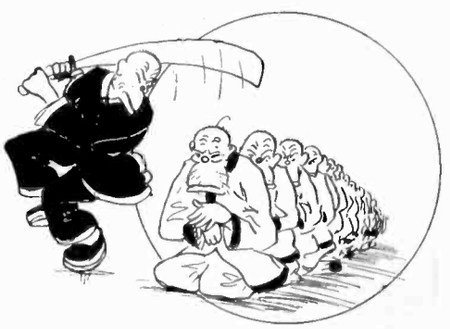
YARNS FROM THE STATIC ROOM

(*Continued from Page 26*)

ing in line at a word, and waiting, without emotion, while the single executioner chopped off one head after another, in turn. They believed they would die when their time came, and nothing they could do would hasten the event or hinder it.

They passed cigarettes and the third man harked back to the topic of distress calls at sea, and spun the yarn of the Norwegian *Gruntov* tramp that foundered in a gale, with loss of all hands. Her operator sat at his key to the last. "This is no night to be out without an umbrella," he sent; and as he described the storm that had disabled the engines and crushed the lifeboats—"God pity the poor sailors on a night like this." This was followed by the "hi hi" that indicates laughter on the wireless; but when the rescuer sent word to hold out, that they'd soon be alongside, he came back; "Sorry we can't wait for you. Pressing business elsewhere. Skoll!" And the American vessel that was hurrying to the rescue never found the *Gruntov* or any of her men.

Then the buzzer reeled off dots and dashes, and he who had told the tale went in to see the chief, and came back with an assignment to a ship bound for the South Sea Islands, where hurricanes are frequent.



"A tale of a Chinese execution."

He stayed to hear a story of the war, of escorting transports past the submarines, and of the espionage tricks of the Germans. The skipper of an American vessel had joined a little party in a Havre cafe. Drinks were plentiful, ma'm'selles were charming, and the skipper told more than he should have. His ship left next day, and within sight of the French coast was torpedoed. All hands took the boats, and when the ship with her defense guns was under water, the sub that had done the job came alongside, and her captain invited the Yankee captain and the chief engineer to come in and have a drink.

"Thank you, I never drink," said the old man.

"You're a bl--dy liar," said the sub captain. "You had plenty of drinks last night—and I was one of your party!"

(*Continued on Page 58*)

A $20,000,000 IDEA

TEN YEARS ago Charles Grover Smith began the intensive study of the possibilities of handling electrical power by gaseous conduction. With the resources of the Raytheon Research Organization behind him, he produced the Raytheon Rectifier, giving for the first time full wave rectification with simplicity, long life, and absolute reliability, and making possible in the one year since its introduction, a business in Raytheon-equipped B-Power units of approximately $20,000,000.

Raytheon has many ideas. For their development Raytheon maintains a Research Organization housed in a separate building, and with a staff headed by such men as Mr. Smith, Dr. Vannevar Bush of M. I. T., Monsieur Andre of the La Radio Technique of Paris, Mr. J. A. Spencer, inventor of the Million Dollar Thermostat, and many others. The equipment at their disposal cannot be duplicated anywhere. It is little wonder that those close to radio power problems look to Raytheon for their most effective solution.

RAYTHEON MANUFACTURING COMPANY
CAMBRIDGE, MASSACHUSETTS

"Approved by Raytheon"

Manufacturers of Complete B-Power Units, Raytheon-equipped:

Acme Apparatus Co., Cambridge, Mass.
All-American Radio Corp., Chicago, Ill.
American Electric Co., Chicago, Ill.
Apco Mfg. Co., Providence, R. I.
Cornell Elec. Mfg. Co., L. I. City, N. Y.
Electrical Research Labs., Inc., Chicago
General Radio Co., Cambridge, Mass.
Grigsby-Grunow-Hinds Co., Chicago, Ill.
King Elec. Mfg. Co., Buffalo, N. Y.
Kokomo Electric Co., Kokomo, Indiana
Mayolian Radio Corp., Bronx, N. Y.
The Modern Elec. Mfg. Co., Toledo, O.
Pathe Phonograph Co., Brooklyn, N. Y.
Sparks-Withington Co., Jackson, Mich.
The Sterling Mfg. Co., Cleveland, Ohio
Storad Mfg. Co., Cleveland, Ohio
J. S. Timmons, Inc., Germantown, Phila.
Valley Electric Co., St. Louis, Mo.
The Webster Co., Chicago, Ill.
Zenith Radio Corp., Chicago, Ill.

The Romance of Raytheon

By DONALD WILHELM

BETWEEN the time Mr. Smith set to work on his research, and the time that the Raytheon Rectifier was produced there were many hours, days, and months of dreams, discouragement, thrilling discovery, and patience. It makes good reading. For example, we think of copper as being an excellent conductor, yet Mr. Smith found that he could pass seventy times as much current through a column of gas as through a copper wire of the same diameter.

If you are interested to know more about the years of research resulting in the development of the Raytheon Rectifier, we shall be glad to mail you a leaflet telling the story in the words of Mr. Donald Wilhelm, author of "The Story of Steel," "The Story of Wrought Iron," and many other publications. Drop us a line.

RAYTHEON rectifier

YARNS FROM THE STATIC ROOM

(*Continued from Page 56*)

RADIO attracts the romantic souls. There is something that grips the imagination in the idea of buying a few bits of wire and brass, arranging them in the most fantastic manner conceivable, and as a result listening to a man talk Spanish in Havana. The next thrill is to get an amateur license, buy a few more bits of wire and grass, and let a man in Havana hear you talk. And the third is to get a commercial license and *go* to Havana. Many are the young fellows who have followed that road.

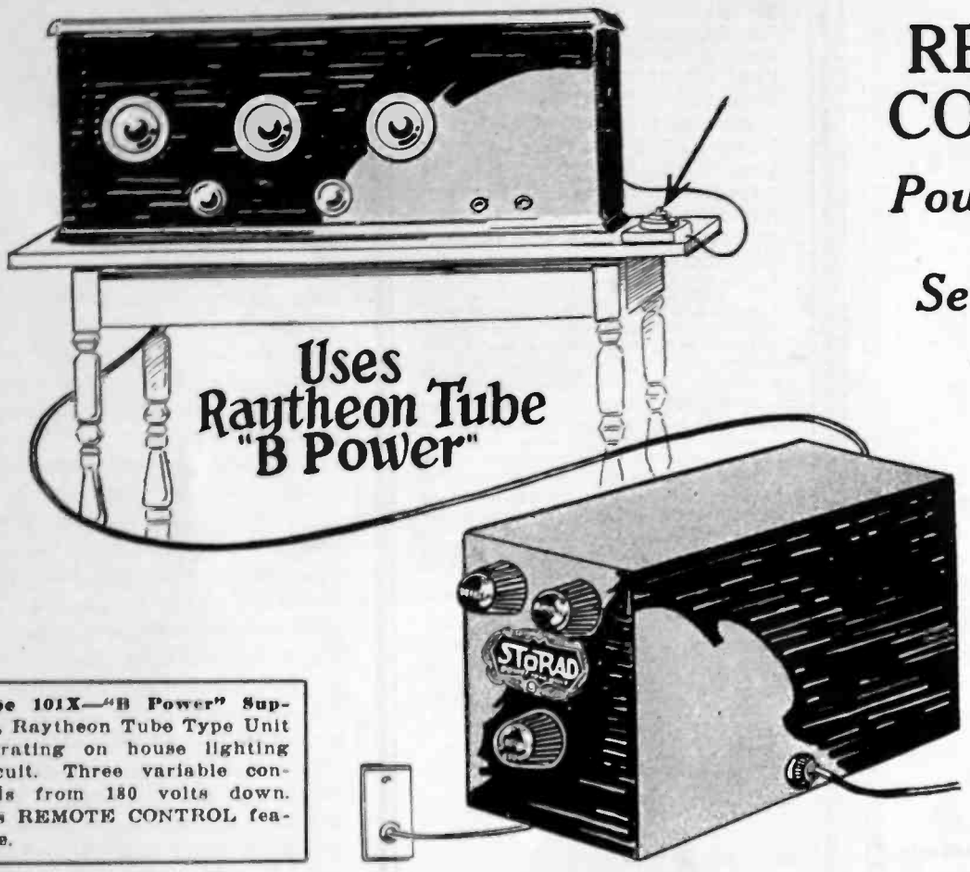
When things at home go crosswise; when the same old streets, the same faces, the familiar routine, become too boring, the rich man goes down to a steamship office and books a passage. The poor young man, if he happens to have the requisite license, goes down to a steamship office and books a job. He will live about as well as the other chap, eat as well, see as much in foreign ports, and do just about enough work on board to keep the voyage from being monotonous.

For "Sparks" has about the finest job of all the jobs on the sea. In port his time is his own. From the time the vessel docks till the time she sails, he is off duty, to go where he likes. At sea he has the least work of any man on the ship, and the most interesting. He looks out of his port hole at the coast of Japan, and talks to San Francisco. He copies a press broadcast from Germany and a weather report from Honolulu. He knows what ships are around him, and all their intimate business. He hears the skipper of a freighter explain that the first assistant has struck a fireman with a stillson wrench and that doctors and a shipping commissioner will be needed in Colon.

Ashore, he sees the world. He looks out at it from the top of a Fifth Avenue bus in New York or from a rickshaw in Shanghai. Sometimes he stops the rickshaw and gets out and pulls the rickshaw man. But he doesn't try to pull the bus. Pulling the rickshaw man is a favorite trick with American seamen; it *is* galling to see a ninety-pound Chinese coolie perform feats of endurance a two-hundred-pound white man cannot equal.

Wherever you see the bluejackets or the marines in the recruiting posters, there you will find the commercial wireless operator; under no strict discipline, able to quit when he pleases, better paid, ranking as an officer and privileged as a civilian. In Great Britain and other foreign countries the merchant marine operators are under contract and must serve a set term of years, going where and in what they are ordered; but America forbids contract labor and Sparks is at liberty to pick his ships and his cruises, to repeat a voyage or to refuse to just as he likes. The sea-gull and the wireless operator are the two freest creatures in the world.

Marvelous New STORAD

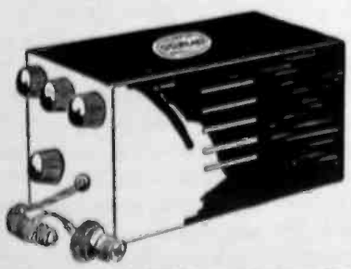


REMOTE CONTROL

Power Supply with Set Control Button

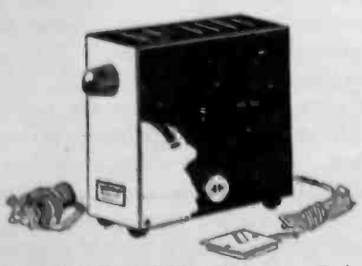
Type 101X—"B Power" Supply, Raytheon Tube Type Unit operating on house lighting circuit. Three variable controls from 180 volts down. Has REMOTE CONTROL feature.

Unique, Practical and an Exclusive Storad Feature



Type 201X—"B Power" Supply and Trickle Charger

Combination unit illustrated here, combines Raytheon type "B" Eliminator with Storad Trickle Charger. Operates with REMOTE CONTROL.



Type 701X Trickle Charger. Sufficient capacity for "A" batteries used with larger sets. Variable Control regulates charging current from ¼ to 1 amp. Has REMOTE CONTROL feature.

Here is the kind of Power Supply you have been waiting for—REMOTE CONTROL—the kind that is controlled with one button placed where you want it. Place your eliminator, charger and batteries where you wish—cellar, clothes press, or cabinet—you do not have to touch them to turn them on or off. The control button turns off the set and eliminator and turns on the Trickle Charger at the same time.

Interchangeable With Other Units

You do not have to use all Storad Units to enjoy this REMOTE CONTROL feature. A Storad Trickle Charger will work with any make of eliminator and operate it by REMOTE CONTROL, or you can use a Storad 101X "B Power" with another make Trickle Charger and enjoy the same advantages.

Raytheon "B Power"

Storad "B Power" Units having the REMOTE CONTROL feature are Raytheon Tube Type.

Storad Exclusive Circuit (Patent Pending).

Tobe Deutschmann Heavy Duty Condensers are used throughout.

100% Over Capacity

That's why Storad Power Supply will work on any set without hum.

Storad Heavy Duty Units have ample power for UX171 Power Tubes even when used on the largest sets.

No More Power Worries

Put a Storad on your circuit and your power worries are over. You will have current—lots of it—when you want it.
Storad Power Supply is the result of three years of research work and one year of actual test.

Insist on Storads from your dealer or write us direct.

The Storad Manufacturing Company
2429 Detroit Avenue, Cleveland, Ohio.

QUARTZ CRYSTALS

(*Continued from Page* 28)

plane and mark its intersection across each slab.

In case the facets cannot be found, pass the plane through the optical axis and the prismatic edge of each slab which makes the plane most nearly parallel to the two longest sides of the polygonal top. The heavy line of Fig. 5 shows the intersection of this plane with the top of the slab.

Next, mount a slab in the power saw and cut out strips of quartz such as are shown in Fig. 1, making the cuts perpendicular to the electric axis. The ruled lines of Fig. 5 show the marks for cutting. The strips obtained in this manner should be less than ⅛ in. in thickness since the finished crystals will require grinding to probably not over 0.035 in., assuming that a 4000 kilo-cycle fundamental is wanted.

The next step consists in cutting the strips into 1 in. lengths as shown in Fig. 1. For this cutting, either the modified power hack saw or a circular saw is useful. A suitable circular saw may be made by cutting out a disc of 0.020 in. mild unhardened sheet steel and mounting it upon a motor driven spindle. Such a disc 6 in. in diameter and revolving at 400 to 800 r. p. m. makes an excellent saw when used with carborundum abrasive and an ample supply of water. With a saw of this kind, it is possible to cut through a 1 in. square section of quartz in about one half hour. For this step, No. 60 grain carborundum is recommended for use with the hack saw and No. 90 for the circular saw.

For the rough grinding operation, a circular grey iron plate, 6 to 12 in. in diameter, mounted with its upper surface horizontal upon a motor driven spindle is most useful. The speed of this plate should be 200 to 400 r. p. m. Rough grinding is accomplished by keeping the plate well supplied with water and No. 90 carborundum grain, and holding the crystal on the plate with the fingers. Micrometer calipers must be used during all grinding operations to insure that the crystal is of uniform thickness at the end of each stage of the grinding. Keep the micrometers free of abrasive for obvious reasons.

For crystals cut as here directed, wavemeter measurements upon the controlled circuits show approximately 105 meters wavelength per millimeter thickness of the crystals. This may be used as a rough guide in the grinding operations. When the thickness of the crystal is within 0.020 in. of the finished dimension, the edges should be squared up. A rough ground 4000 kilocycle crystal is shown as the second from the right in Fig. 1.

An intermediate grinding operation using No. 220 carborundum grain should next be made and for this operation a second wheel like the first is recom-

mended. In case an additional wheel is not available, the former may be used after careful washing to remove all traces of the coarse abrasive. This operation should carry the grinding to within 0.005 in. of the finished dimension along the electric axis. Particular care should be taken to see that the plane surfaces are parallel to within 0.001 in. at this point.

The final grinding operations can now begin and for this purpose two stationary grey iron plates are required. Plates 6 to 10 in. in diameter will suffice and these should be machined flat and lapped. The first of the final operations is made by applying a thin coating of water and No. 302 emery grain to the plate, and moving the crystal about on this plate with the fingers. One plate should be reserved for this abrasive, and the other for the next operation which requires the use of a still finer one. It might be well to mention here that the plane surfaces of the finished crystal must be parallel to within 0.0001 inch and success in obtaining this esential accuracy depends greatly upon frequent measurement with the micrometer during the grinding. During this operation, all nicking of the edges and scratches which have been carried along from previous cuttings and grinding, should be removed.

After careful washing, the second of the final grinding operations should be made using No. 303 emery grain and the remaining disc. The first part of this operation should carry the grinding to within 0.001 in. of the final dimension along the electric axis and at this point the plane surfaces of the crystal should be parallel to within 0.0001 in. Bevel all edges very slightly at an angle of about 45 degrees, thoroughly wash the crystal with soap and water, and test same in a small tube circuit. The diagram for such a circuit is shown in Fig.

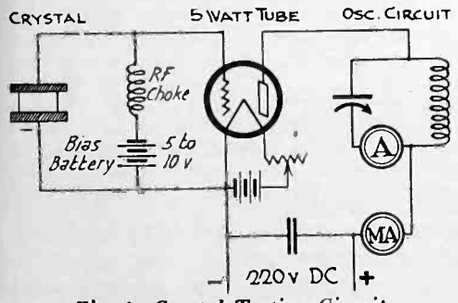


Fig. 6. Crystal Testing Circuit.

6. If the oscillating circuit is of fairly low loss construction, the ammeter *A* will indicate from 1 to 2.5 amperes when the condenser *C* is turned through the resonance point.

If the crystal does not oscillate, it may be due to any of the following possible causes in order of probability:

(1) Plane surfaces of crystal not parallel to required accuracy.

(2) Slight nicks in edges. Crystal contains scratches or flaws.

(3) Crystal not clean. Finger prints will frequently prevent oscillation.

(4) Crystal ground from twinned section of rough crystal. A thorough examination of the slabs should have prevented this.

(5) Poor quality of quartz used.

(6) Axes not correctly determined. The selection of a well preserved rough crystal is important in determining the axes.

After investigating the above possibilities and rectifying the deficiencies if any exist, and the crystal is found to oscillate, a wavemeter should be coupled to the circuit. As the thickness is still 0.001 in. in excess, the wavelength of the resulting oscillation will be found in excess of that desired. By additional grinding, the crystal can be worked down to whatever thickness is suggested by the wavelength measurement. It frequently happens that after a crystal has been made to oscillate it ceases to work after further grinding. This trouble can usually be traced to a lack of parallelism of the faces resulting from the last grinding. Grinding a small amount off the *B* dimension will sometimes improve the output of an apparently weak crystal.

Fig. 7. Hand Grinding Equipment.

WHO'S WHO AND WHERE

(*Continued from Page* 40)

watch bearing the engraved legend: "Presented by the Associated Press to Stedman Fiske Todd, rescue of crew Daishin Maru III, upon enrollment as honorary member of staff, February 19, 1926." The watch was presented by Joseph R. Knowland, publisher of the Oakland Tribune and director of the Associated Press, at a luncheon in the dining salon of the big liner, and in the presence of a distinguished company of newspaper executives, Dollar Line officials and others. Todd, on February 19, last, was the first to give the world the news of the plight of the *Daishin Maru, III,* the unlucky little Japanese freighter which was wrecked in a storm at that time.

Wallace A. Clemmons, who runs the Gulf Radio School at 844 Howard Ave., New Orleans, sincerely invites all radio operators to drop in and visit him while in that port. He hopes to have his place the headquarters for the gang in N.O.

Operators running in and out of Los Angeles are invited to drop in the Los Angeles Radio Club and make themselves at home. This club has a fine, big room, fitted out with everything interesting to a brass-pounder; including a short wave transmitter for those who don't get enough key pushing at sea, and is open all day and evening until midnight. There are no strings tied to this invitation, fellows, so let them know that you appreciate their courtesy.

THE INFRADYNE

(*Continued from Page 23*)

The two midgets on the panel will then be used to balance the other two sections to the one across which this fixed midget is connected. This new triple condenser is responsible for the increased selectivity of the Sargent-Rayment infradyne, and if it is used, the midgets can be practically neglected in tuning as all three condenser sections will increase equally. Hammarlund has also announced a new 3-gang condenser for the infradyne. It has been approved for this circuit.

When the set is first put into operation, be sure that the 99 tubes are turned up to a full 3 volts as otherwise the oscillator tube will not oscillate. If this tube does not oscillate, the oscillator dial can be turned over the entire scale and it will make no difference whatever in the tuning.

LIST OF PARTS USED IN SARGENT-RAYMENT INFRADYNE

1 Remler Infradyne Amplifier
1 Three Gang Condenser, Cardwell 317CL or Hammarlund.
3 General Radio type 318-A midget vernier condensers or Hammarlund five-plate midget.
1 Remler .00035 mfd. Condenser
1 Frost No. 886 50,000 ohm Resistance or Centralab special 50,000 ohm.
1 Tapped Inductance (see text)
1 30 ohm Baseboard Type Rheostat, Frost or General Radio
1 Set (3) Thorola or Camfield coils for .00035 condenser.
2 National Type B CCW Dials
7 UX base sockets. Cushion type (Benjamin).
1 112 Amperite
1 No. 1 Amperite
1 30 ohm Panel Mounting Rheostat, Frost or Yaxley.
1 200,000 ohm Centralab Variable High Resistance
3 2-inch Dials
1 Filament Switch, Yaxley.
1 Single Closed Jack
1 Single Open Jack
1 Jewell 0-5 D.C. Pat. 135 Voltmeter
1 Electrad Grid Leak Mounting
1 1 meg. grid leak, Durham, Lynch, Electrad or other good leak.
1 2 meg. grid leak, Durham, Lynch, Electrad or other good leak.
1 .0001 Fixed Condenser, Electrad.
2 .0005 Fixed Condensers, Electrad.
1 .00025 Fixed Condenser, Electrad.
2 Audio Transformers, AmerTran, Silver-Marshall.
2 1 mfd. Condensers, Tobe.
1 Panel, 3/16x7x30 in.
1 Baseboard, 3/4x10x34 in.
9 Eby Binding Posts, or 2 Eby Posts and a Jones Battery Plug and Cable

Sometimes it is less confusing when the set is first put into operation to adjust the input amplifier separately from Infradyne amplifier. This may be done as follows: Take the four 99 tubes and the detector tube out of the set. Lift the wire from the plate terminal of the infradyne amplifier and connect this wire through an extension directly to the plate terminal of the detector tube socket. The set will now operate as a straight five-tube tuned radio frequency receiver and while in this condition may be adjusted for full efficiency for these five tubes. After this adjusting has been done, it will be an interesting experiment to tune in a station just barely audible on the five tubes and then connect in the Infradyne amplifier and see the tremendous

increase in volume that results.

The original infradyne receiver was designed to work on a short inside antenna. This revised model, because of its much greater selectivity, works best with a 75 or 100 ft. antenna with a .0001 mfd. condenser in series. The pictures of the revised infradyne show a few parts different from those specified in the original article. This must not be taken to mean that these new parts are to be preferred as, in most cases either will work equally well. In the list of parts, the only ones that are specified by name are those that cannot be substituted for. All those parts that are not specified by manufacturer's name are left to the option of the builder, and any high-quality parts will work in those places.

Regarding the choice of the midget balancing condensers, low minimum capacity is essential. The General Radio No. 368-A five-plate vernier is ideal for this purpose.

The tapped inductance can be very easily constructed by the builder. It consists of three coils wound on a piece of bakelite tubing 1½ in. in diameter and 2 in. long, as shown in Fig. 4. These coils are of 14, 14, and 8 turns respectively and are all wound with the same direction with No. 24 d.s.c. wire. There

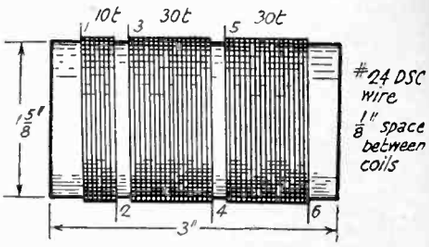


Fig. 8. Tapped Inductance.

should be a space of 1/16 in. between the two 14 turn coils and of 3/16 in. between the 14 and 8 turn coil. Commencing with the 8 turn coil, the terminals should be numbered from 1 to 6 as shown in the sketch of Fig 8, *1* being the outside and *2* the inside terminal of the 8 turn coil, *3* the terminal of the 14 turn coil nearest the 8 turn coil and *4* the other end of this 14 turn coil, *5* the inside terminal of the second 14 turn coil and *6* the outside terminal of this coil.

These numbers correspond to those used in the wiring diagram. To insure operation of the set these directions for coil winding should be followed exactly, particularly as regards their all being wound in the same direction. This tapped inductance should be mounted in the position of the oscillator coupler as shown in the baseboard layout.

To Put the Set in Operation

AFTER the set has been carefully constructed according to the diagrams and the wiring checked, the set is put in operation as follows:

(*Continued on Page* 66)

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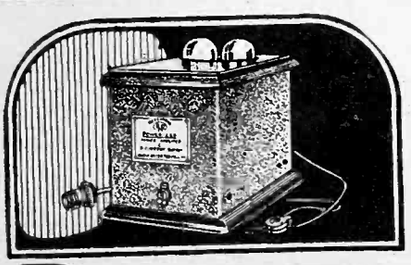

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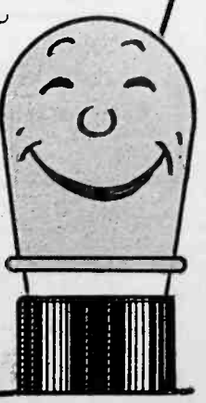

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THE INFRADYNE

(*Continued from Page 64*)

Connect the 6 volt *A* battery to the terminals of the filament circuit. Turn the filament switch to the "off" position. Insert 201A or 301A type tubes in the two incoming wave radio frequency amplifier sockets, in the mixer tube sockets, and in the detector and first audio. Put a 112 tube in the second audio and 99 type tubes in the infradyne amplifier and in the oscillator. Turn the 30 ohm rheostat that controls the 99 tubes so that nearly all the resistance is cut in. Turn up the rheostat on the baseboard so that it is in the half-way position. Then turn on the filament switch and see if all the tubes light. Do not turn the 99 tubes up any higher than 3 volts.

After the filament circuit has been checked in this way, connect up the rest of the batteries and the antenna and ground. Set the four indicator knobs on the infradyne amplifier at zero, turn down the screw marked "increase" so that it is about half as far as it will go and turn the rheostat on the baseboard all the way on. Turn the Remler oscillator condenser to the minimum capacity position and then tighten up the set-screw on the dial with the dial set at 170 degrees. This dial should read in a counter clock-wise direction. After the dial has been fastened to the condenser in this way, turn it to the zero-to-100 degree range.

Next tune in a station, preferably a local. To do this, both dials must be moved. When the station is tuned in, leave the antenna tuning condenser set on that wavelength and turn the oscillator dial over the whole scale. Two or three or even four oscillator settings will probably be found and the loudest of these will be infradyne setting.

Leaving the oscillator dial at this loudest setting, turn down the plate resistance which controls the first two tubes until the signal is just comfortably audible. Then using the wooden adjustor that is furnished with the infradyne amplifier reset all four indicator knobs on the amplifier for maximum signal strength. If this throws the amplifier into oscillation, loosen up the increase screw until the oscillation stops. If it does not throw it into oscillation, tighten up the screw until it does, and then loosen it to just before this point. If it does not oscillate with the screw tightened all the way down, lift the wire from the plus *B* terminal on the infradyne amplifier and connect a little coil of about eight turns wound around the finger in series between the wire and the *B* terminal of the amplifier. In most cases this choke is not necessary, but when it is used it should suffice to throw the amplifier into oscillation. No more than eight turns should be used in this place.

The 30 ohm rheostat mounted on the baseboard should next be turned until the most sensitive filament temperature for the mixer tube is found. This will probably be at about the half-way position and will be indicated by a sharp rise in signal strength as the point of efficiency is reached. The signal strength should fall away rapidly on each side of this peak. If moving this rheostat throws the set into oscillation, loosen up on the increase screw on the Remler amplifier and try again.

Because of the fact that the sum frequency is used, the oscillator condenser works in an opposite direction from the antenna condenser when the set is tuned. In order to make the dials read in the same direction, the oscillator condenser is equipped with a dial which reads opposite to its capacity increase.

It was mentioned above that with the antenna condenser set on a given station, two or three oscillator dial settings could be found. It should be pointed out, however, that this is the only condition under which more than one oscillator setting can be found. These other settings are freaks, which are likely to appear in any set using an oscillator tube. Under normal operation of the set when both dials are turned together no more than one setting per station will be found. The oscillator condenser is connected between the grid and plate of the tube and both sides of the condenser are therefore alive to hand capacity. This limits the choice of an oscillator condenser to one in which the shaft is not connected electrically to either set of plates.

COUPLING THE LOUD SPEAKER

(*Continued from Page* 36)

age loudspeaker impedance at the lowest frequency used, 30 cycles. In this way, maximum power is delivered to the loudspeaker at 30 cycles, which could not be possible with the impedance coupling method. As the transformer impedance rises more rapidly than the loudspeaker impedance, the power fed into the loudspeaker decreases as the frequency increases, with the result that the output transformer compensates for some of the defects of the loudspeaker, and better results are to be had than without the transformer.

If the output transformer is not designed to match the speaker impedance at the lowest frequency, and has a rising frequency characteristic, then the results will be worse than with impedance coupling, and the latter would be preferable. It is hoped that the output transformer manufacturers will furnish curves of their products, so that the proper selection of the transformer to best suit the conditions in the speaker will be possible.

EFFECT OF "B" BATTERY IMPEDANCE

(*Continued from Page* 33)

When a third stage is added the case is widely different. Fig. 2 shows a three-stage direct coupled amplifier, stripped of all parts not essential to the analysis. The characteristics of all the tubes are supposed the same, as are the three load impedances.

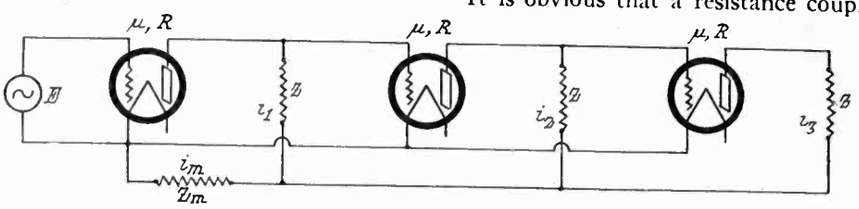


Fig. 2. Three-Stage Direct Coupled Amplifier.

The voltage equations for three plate circuits are given in (11), (12), and (13). Two minus μ's are used in this case to take account of the phase changes in the two last tubes. Equation (14) states the fact that all the plate currents flow through the common impedance Z_m, and equations (15) and (16) define the input voltages E_1 and E_2, respectively. From these six simultaneous equations the four currents and the voltage E_2 may easily be obtained. But we are only interested in the amplification so that it is not necessary to solve for all the currents, just those which are involved in E_2. If (16) is used for finding E_2, currents i_2 and i_m will suffice. Upon solution of the equations and the determination of the gain ratio, M will be found to be the complex expression given in (17).

Equations Applying to Fig. 2.

(11) $\mu E = ri_1 + Z_m i_m \quad r = R + Z$

(12) $-\mu E_1 = ri_2 + Z_m i_m$

(13) $-\mu E_2 = ri_3 + Z_m i_m$

(14) $i_m = i_1 + i_2 + i_3$

(15) $E_1 = Zi_1 + Z_m i_m$

(16) $E_2 = Zi_2 + Z_m i_m$

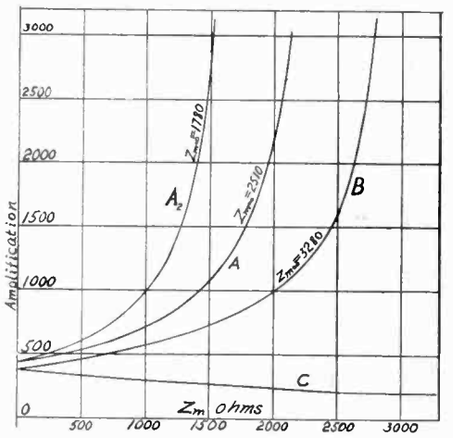
(17) $$M = \frac{\mu^2 \{ \mu r Z^2 + Z_m [\mu Z(2r+Z) - Rr] \}}{r^3 Z^2 - Z_m [\mu^2 Z^2 - (1+\mu) r^2]}$$

(18) $$M = \frac{r^3}{\mu^2 Z^2 - (1+\mu) r^2}$$

(19) $$M = \frac{1.06 \times 10^6 + 30.7 Z_m}{2{,}510 - Z_m}$$

A study of this equation will show why the B battery eliminator "clucked," and why certain resistance coupled amplifier distort and squeal. Note that the denominator of the expression for M is composed of two main terms of different signs, one of which is the cube of $(R+Z)$ and the other containing Z_m. It is evident that Z_m may have such a value as to make both terms equal. When that occurs the denominator vanishes and the amplification becomes infinite; that is, the set will oscillate or "cluck." The value of Z_m required to reduce the denominator to zero is given in equation (18), which is a condition for oscillation. If the values $\mu = 8$, $R = 10{,}000$, and $Z = 100{,}000$ be substituted in (17), this takes the special form of equation (19). This shows that for these values the critical value of Z_m is 2510 ohms, which lies within the limits that may be met in practice. In Graph A the amplification for various values of Z_m is shown graphically for this case.

It is obvious that a resistance coupled amplifier having three stages may oscillate or otherwise distort the signal if the common impedance in the plate circuits of the tubes is high enough, and that high enough values are likely to be met in practice. Again it may be pointed out that in a non-reactive circuit the effect of Z_m does not necessarily mean distortion, merely an increase in the amplification. But a very few receivers used in radio are sufficiently free from reactance



Amplification for Various Values of Common Impedance in Plate Circuit.

to merit the name non-reactive. There are always stopping and by-pass condensers and the inductance of the loud speaker winding.

How is the case with transformer coupled amplifiers? One would naturally think that the common impedance would not have as great effect on the amplification in transformer coupled circuits as in direct coupled, since in them the common impedance is not in the grid circuits. Still some effect must be expected because the primary voltage is affected. It will be shown that the effect may be much greater in transformer coupled circuits, because of the influence of the step-up ratios.

First take a circuit comprising two tubes and one transformer, as is shown in Fig. 3. Assume for simplicity that the tubes are alike and that the two load impedances are also the same. For in-

(*Continued on Page* 70)

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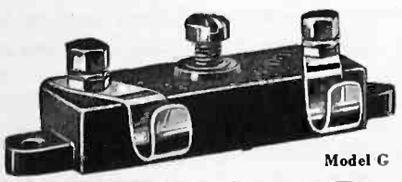

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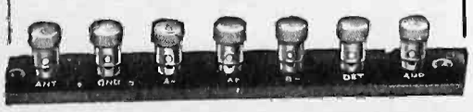

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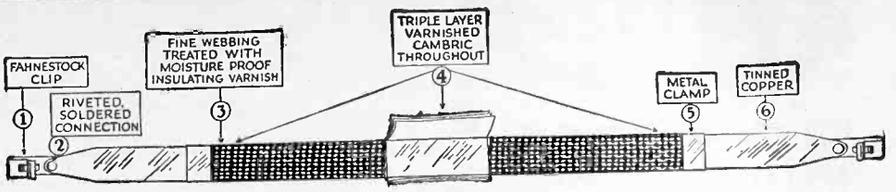

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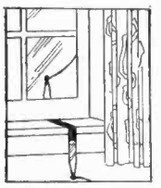

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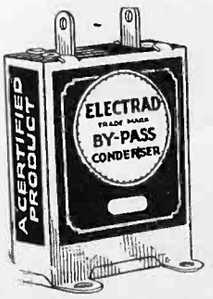

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EFFECT OF "B" BATTERY IMPEDANCE

(*Continued from Page 68*)

stance, the loads may be the primaries of two transformers of the same characteristics. The equations for the voltage drops in the plate circuits are given by (20) and (21), and the current equation in (22). The voltage E on the second grid is given by equation (23), in which Zi_1 is the primary voltage and a is the step-up ratio of the transformer. The ratio is regarded as fixed, although it may vary slightly in actual transformers. But it is fixed for any one frequency. Two cases are to be considered, depending on which way the transformer

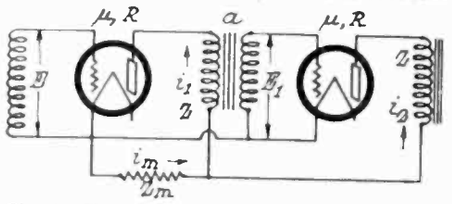

Fig. 3. Two Tubes and One Transformer.

is connected. It may be so connected that there is no change of phase in the voltage transformation, in which case a is positive. It may also be so connected that the phase is changed by 180 degrees, in which case a is negative. The latter method is the usual way, provided that the transformer is connected up as marked.

Equations Applying to Fig. 3

(20) $\mu E = ri_1 + Z_m i_m$

(21) $-\mu E_1 = ri_2 + Z_m i_m$

(22) $i_m = i_1 + i_2$

(23) $E_1 = aZi_1$

(24) $M = \dfrac{a\mu^2 Z(r+Z_m)}{r^2 + Z_m(2r - \mu aZ)}$

(25) $M = \dfrac{a\mu^2 Z(r+Z_m)}{r^2 + Z_m(2r + \mu aZ)}$

The solution of these equations is very simple, and need not be repeated in this article. The result when the ratio is positive is given in equation (24). To obtain the solution when the ratio is negative it is only necessary to change the sign of a in denominator. The sign of the numerator is not important as it does not change the numerical value of the amplification. Equation (25) shows the value of M when a is negative.

Equation (25) contains no negative sign. Hence the corresponding circuit cannot oscillate no matter what the value of Z_m. But as Z_m is increased the amplification decreases. The manner of decrease for selected values of the constants and impedances is shown in Graph B. Equation (24) shows a negative sign in the denominator, in the coefficient of Z_m. For all practical conditions the negative term μaZ is much greater than $2(R+Z)$. Hence for some value of Z_m the negative term will equal the positive $(R+Z)^2$, and the amplifier is likely to oscillate.

For values of Z_m smaller than that required for oscillation the amplification increases as Z_m increases. The rate of increase of M is shown in Graph C, using the same values of the constants and impedances as in Graph B, namely, R=10,000 ohms, Z=150,000 ohms, a =3.5, and μ=8. Since R is a pure resistance and Z is mainly an inductive reactance, they are in quadrature, and since the square of R is very small in comparison with the square of Z, the former may be neglected in comparison. Therefore the denominator in M for a positive becomes zero when Z_m=5,770 ohms. This is so large that it is not likely to be encountered in practice. But the value of Z_m required for oscillation decreases almost in direct ratio as the product of μ and a increases, which is to be expected.

Now let us add another tube and transformer. The circuit shown in Fig. 4 results, which is a typical audio frequency amplifier. There are now four possible connections of the transformers; the first when both step-up ratios are positive, the second when both are negative, the third when the first is positive and the second negative, and the fourth when the first is negative and the second positive. It is also possible that the ratios may be different, that the tubes may have different characteristics, and that the load impedances may be different. Hence in this case it is convenient to use different symbols to keep the various parameters dis-

Equations Applying to Fig. 4

(27) $\mu_1 E = r_1 i_1 + Z_m i_m$

(28) $-\mu_2 E_1 = r_2 i_2 + Z_m i_m$

(29) $-\mu_3 E_2 = r_3 i_3 + Z_m i_m$

(30) $i_m = i_1 + i_2 + i_3$

(33) $M =$

$$\frac{\mu_1\mu_3 a_2 Z_2 \{ a_1 Z_1 r_3 + Z_m [r_3 + \mu_2 Z_1] \}}{r_1 r_2 r_3 + Z_m Z_2 a_2 \mu_3 (r_1 - \mu_2 Z_1 a_1)}$$

(31) $E_1 = a_1 Z_1 i_1$

(32) $E_2 = a_2 Z_2 i_2$

(34) $D = Z_1 Z_2 [r_3 + Z_m a_2 \mu_3 (1 - \mu_2 a_1)]$ (approximately)

(35) $Z = \dfrac{r_3}{a_2\mu_3(a_1\mu_2 - 1)}$

$r_3 = R_3 + Z_3$

(*Continued on Page 72*)

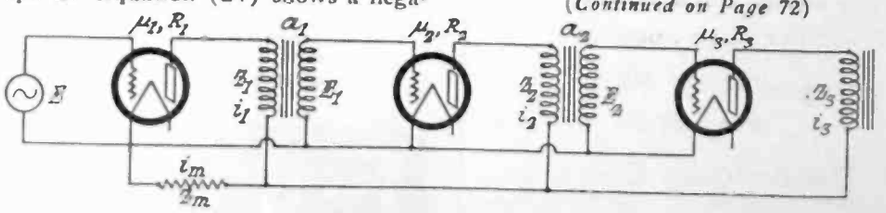

Fig. 4. Typical Audio Frequency Amplifier.

EFFECT OF "B" BATTERY IMPEDANCE

(*Continued from Page 70*)

tinct. The solution of the problem will be no more difficult, but the result will be more flexible. The equations required for the solution are given in (27) to (32), inclusive, and the amplification obtained from them is given in equation (33). In these equations both the step-up ratios are positive. To obtain the solution for the other cases it is only necessary to change the sign of the appropriate ratio.

In the denominator of (33) there is one negative sign, and the corresponding term is dominant for all practical values. Hence when both the step-up ratios are positive the circuit will oscillate when Z_m is sufficiently high. When both step-up ratios are negative the quantity in parenthesis becomes positive but the sign of the coefficient Z_m as a whole remains negative. Hence for this case the amplifier will oscillate for a sufficiently high value of Z_m, and in this case it will oscillate sooner than in the previous case, because the coefficent of Z_m is greater. In the third case the first ratio, a_1, is negative and the second a_2 is positive. That will make all the terms in the denominator positive, and there is no value of Z_m for which the amplifier as a whole will oscillate. The larger the value of Z_m the smaller will be the amplification. In the fourth case a_1 is positive and a_2 negative. In this case also, all but a very small term will become positive, and there is no value for Z_m for which the circuit will oscillate as a whole under any practical conditions.

Although two of the above connections will render the circuit as a whole stable for all values of Z_m, it does not mean that the amplifier will not howl. Any two adjacent tubes may oscillate if the conditions are right, as was shown in the two tube circuit of Fig. 3; and that is no better as far as satisfactory reception is concerned. It is plain, therefore, why the usual injunction to reverse one pair of leads often fails to enjoin oscillations. "My set howls no matter what I do to it," is a frequent reply by the fan who has been advised to reverse one pair of transformer leads. The advice should have been to reduce the common impedance by getting new B batteries or by putting an enormous condenser across the common branch. Even a 4 mfd. condenser will be of no avail if the battery is run down.

Now let us see at what value of Z_m the circuit is likely to start howling for certain assumed values of ratios and impedances. Suppose that $a_1=6$, $a_2=2$, $R_1=R_2=10{,}000$ ohms, $Z_1=150{,}000$ ohms, $Z_2=150{,}000$ ohms, $R_3+Z_3=25{,}000$ ohms, $\mu_1=8$, $\mu_2=8$, $\mu_3=6$. As before, the squares of the resistances may be neglected in comparison with the squares of the load reactances in the first two tubes. Hence the denominator in (33) reduces to equation (34), in which D is zero for infinite amplification or oscillation. Therefore we get equation (35) from which to obtain the value of Z_m at which the circuit will oscillate. When both a_1 and a_2 are positive, $Z_m=43.3$ ohms; and when both are negative, $Z_m=42.5$ ohms. This circuit, then, will oscillate very quickly.

With the values assumed above, and with the same approximations, the amplification when $Z_m=0$ is 636. When $Z_m=25$ ohms and the a's are positive, $M=1322$; and when both a's are negative, $M=1400$. Thus a resistance in the common lead of 25 ohms will more than double the amplification with either of the two connections.

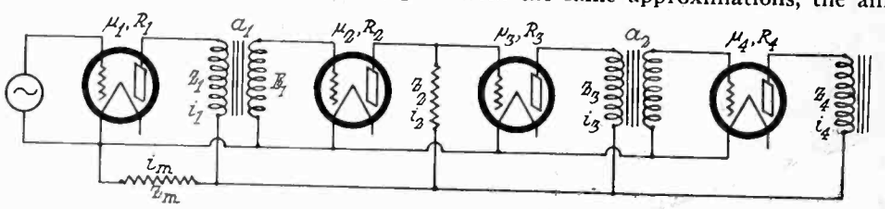

Fig. 5. Detector and Three-Stage A.F. Amplifier.

One more circuit, as shown in Fig. 5, is of interest in connection with this discussion, chiefly because it was used to test the theory qualitatively. The audio frequency amplifier and the detector tube only are shown, although the circuit was a complete five-tube regenerative receiver. It was built by the writer with the greatest care to obtain sensitivity and good quality. It turned out to be an erratic oscillator. Sometimes when it was on good behavior, it performed as well as had been hoped for. Much of the trouble experienced with it could have been avoided had the circuit been analyzed by the method employed in this article, but then much about circuits in general would have remained unknown to the writer. It is not necessary here to go through with the analysis, though it is very simple in this case, but only to set down the result. It is even not necessary to set all of that down, but only the denominator in the expression for amplification, or in the expressions for the various currents. It is (36) $D=r_1r_2r_3r_4-a_1a_2\mu_2\mu_3\mu_4Z_1Z_2Z_3Z_m$, in which $r=R+Z$, the appropriate subscript being used in each case.

There are only two terms in the right-hand member of the equation in the preceding paragraph, one of which is negative and one positive. The amplifier will

therefore oscillate for certain values of Z_m. It does not matter whether both of the a's are positive or negative, just so both have the same sign. The result in either case is oscillation. If, however, one of them only is changed, the circuit as a whole will not oscillate, but it may surely oscillate in part. The middle tube will pair with either of the other two to form an oscillator, that is, provided the sign of the remaining a is right for such a condition. The set will oscillate if the first tube is taken out of the socket.

In the set in question the values for the various impedances and constants were as follows: $R=10{,}000$, $Z=150{,}000$, $R_2=10{,}000$, $Z_2=100{,}000$, $R_3=10{,}000$, $Z_3=150{,}000$, $R_4+Z_4=25{,}000$, $\mu_1=\mu_2=\mu_3=8$, $\mu_4=6$, $a_1=3$, and $a_2=2$. The first and the third R's may be neglected in comparison with the load impedance in the corresponding circuit. When these values and approximations are inserted in equation (36) it will be fund that D will vanish when $Z_m=12$ ohms, that is, when the common impedance is 12 ohms the circuit will break into oscillations. And the behavior of the circuit certainly verified that conclusion.

In this circuit, Fig. 5, only one 45 volt unit was common to all the audio tubes. When this was new the set would not oscillate. However, when a 10 ohm resistance was inserted in the common lead, the amplifier oscillated violently. When a separate battery was used for the detector and the preceding tubes, the set behaved properly even when this battery was relatively exhausted, because the last two tubes cannot oscillate when a_2 is negative.

By means of the separate battery for the detector the effect of the common impedance could be observed very easily. Three 45's were used on the last two tubes with a unit approximate half exhausted next to the filament. This was good enough so that the amplifier did not oscillate when it was used for the detector also, but it must have been near the oscillating point. Then the plus 45 lead from the detector was alternately connected to the separate battery and to the 45 volt point on the main battery. When the separate battery was used normal volume was obtained, since there was not common impedance.

When the lead was switched to the main battery the volume went up fully 50%, perhaps a meter would have shown 100%. The change in volume was striking. And this increase was, of course, due to the effect of the resistance of the first 45 volt unit in the main battery. Now one pair of leads was reversed in the amplifier, that is, a_1 was made positive. The test was repeated. This time when the common battery was used the volume was down from 25% to 50% as compared with the

volume when the separate 45 volt battery was used. The effect of the common impedance was to produce damping, whereas in the preceding case it produced regeneration. Making a_2 positive instead of a_1 had a similar damping effect.

In an endeavor to stop regeneration without the necessity of using an extra *B* battery the a.c. current in the last tube was detoured from the common impedance by using a choke coil and a condenser. The condenser in series with the speaker was 4 mfd. and the choke coil was an audio transformer with its windings connected in series aiding. Of course, the return lead from the speaker was connected to the minus filament. This improved the set a great deal. It would not oscillate nearly as easily, but it did oscillate as a whole when the common battery was old. Some of the a.c. went through the choke. This was cut down by putting another choke coil in series with the first, and that stopped the oscillations. This was due in part to decreased amplification in the last tube, the effective plate potential being less, but it was mainly due to the detouring of the a.c. from the common impedance.

There are many things that may be done to a receiver which is prone to oscillate to remedy the condition. The best is undoubtedly to use a separate *B* battery for the detector, or for some selected tube in the circuit, depending on which will prove the more effective. In some cases the separate battery may be used for the detector and another audio tube. If it is not desired to use a separate battery, then a fresh one must be used in the common branch. When it runs down to the point of oscillation or distortion of the signal, it may be replaced by one of the others in the amplifier which may be relatively fresher. The common battery runs down the quickest because it handles all the plate currents.

Another way of improving the set if it oscillates too readily is to use a choke and condenser, as pointed out above, for detouring the a.c. current from the common battery. This, however, is not recommended for any but the last tube, where there is another reason for doing it, because the parallel choke and series condenser have the effect of eliminating the low tones in the signal.

Still another way of keeping down oscillations is to put a very large condenser across the common battery or impedance. But this condenser must be very large or it will not help much. This is obvious when it is remembered that the impedance of a 4 mfd. condenser at 1000 cycles is 40 ohms and at 100 cycles 400 ohms. The troublesome oscillation may have any frequency within the audible range, and those below 100 are not infrequent. All of the above methods for improving an oscillatory amplifier are based on minimizing the effect of the

(*Continued on Page 76*)

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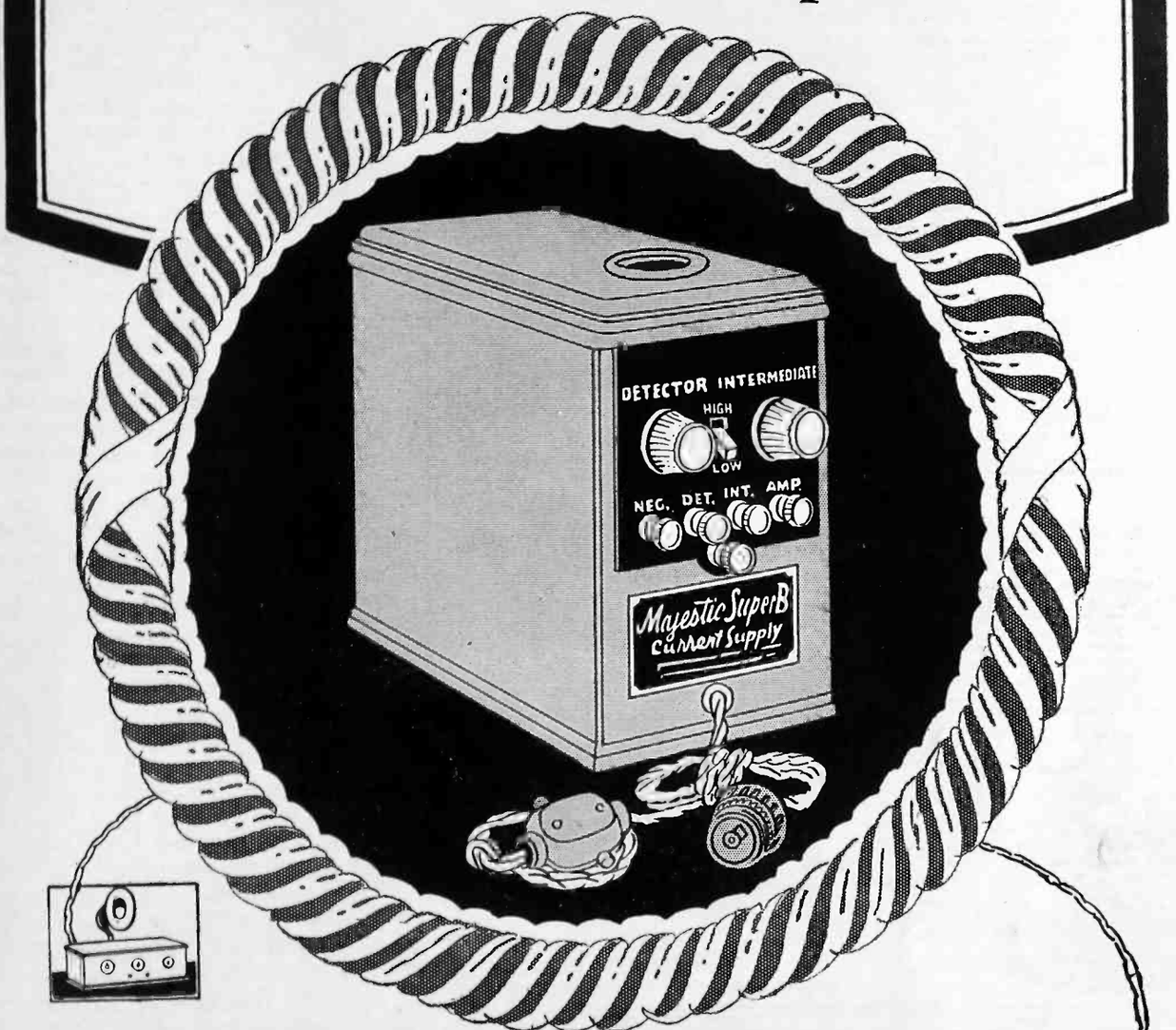

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EFFECT OF "B" BATTERY IMPEDANCE

(Continued from Page 74)

common impedance, or the elimination of the common impedance itself.

The case of *B* battery eliminators is of especial interest now. Suppose the impedance of such an eliminator be measured, looking from the set into the filter. There are series choke coils and shunt condensers. The chokes are of high impedance even at sixty cycles. The condenser across the line, the first condenser from the amplifier, is not always of a high capacity. Hence the common impedance for all but the very highest audio frequencies must be considerable. Certainly it will be more than 12 ohms for the bass notes.

Before closing let us return to the resistance coupled amplifier shown in Fig. 2. As is well known, amplifiers of this type often distort the signal terribly, or they actually howl at an audio frequency. The usual explanation of this is that it is blocking of the grids at an audible rate. But this is not the case at all. The grids will not block unless they go positive during part of the signal cycle. Of course, they may do that in circuits not properly designed, but it is likely to occur often. The writer has successfully operated an amplifier of this type without any intentional leak, that is, with the clips open. The only leak there was took place through the volume and over the surface of the insulator, and this was hard rubber with dry and dust free surface. The grids were isolated as thoroughly as they possibly could be. Yet there was no howling. The usual remedy for a howling set of this kind is to use lower values of grid leak for the second and third stages, on the theory that it is necessary to let the accumulated charge leak off faster. The howling stops because the amplification is reduced by so doing.

The true explanation in the writer's opinion is contained in equation (17) of this article. The howling is due to feed-back through the common impedance in the plate circuits. For any given value of Z_m, the denominator in (17) decreases as the coefficient of Z_m increases, and there may be a value of this coefficient at which the denominator vanishes, at which the circuit will howl. The coefficient of Z_m increases as the true gain of the circuit increases, and one way of increasing the gain is to increase the grid leak resistances. Conversely, the amplification may be decreased by decreasing the grid leak resistances, and the more this is done the farther will the circuit be taken from the oscillating point. Hence oscillations may be stopped even if there is a considerable common impedance. But this may not be perhaps until the grids have been practically short-circuited, when the output of the circuit will be infinitesimal but of good quality. Next time

the "grids block" in a resistance coupled amplifier, try stopping the howling by replacing the *B* batteries. Chances are that that proceedure will be as successful as reducing the grid leak resistances, and it will leave much more to listen to.

The impedances used in the preceding formulas are, of course, complex; that is, they contain, or may contain, both resistance and reactance. Therefore they hold generally. But the specific applications of them in the several cases above are only true for purely non-reactive circuits, since no account was taken of the phase angles of the impedances. When the quantities involved are complex the denominators in the various expressions for amplification cannot in general reduce to zero. To do so both the real and the imaginary terms must separately vanish. This they cannot do except at one frequency. It is at this frequency that the amplifier howls.

It is obvious that if the denominator is to vanish in the case of a circuit having reactance, Z_m must be complex, since the other impedances are complex. In a *B* battery Z_m is composed of a series resistance and a shunt capacity, sometimes small, sometimes very large. In an eliminator it is composed of series resistance and inductance and shunt capacity. The phase angle of this common impedance is one of the factors which determine the frequency at which the circuit howls. The frequency may be changed by either changing the resistance or the shunt capacity. The frequency may be calculated if the phase angles of all the impedances that enter into the circuit are known. The method is to equate the critical value of Z_m as obtained from the amplification formula to the actual value of Z_m as obtained from the common impedance devices. In some of the simpler cases, (36) for example, the quickest way is to equate the angles of the impedances and solving for the frequency. Values thus determined in connection with the circuit in Fig. 5 and equation (36) were consistent with the howl that came from the set. For instance, one calculated value was 156 cycles and the actual value was around 100 cycles.

The important thing to remember in connection with this discussion is that a run-down *B* battery that is used in common for two or more tubes in an amplifier is likely to cause howls in the loud speaker, and that the remedy is a fresh battery, or a separate battery for part of the circuit. It should also be remembered that a *B* battery eliminator which has been inadequately by-passed next to the receiving set may be a similar offender. The remedy in this case may be more by-pass condensers, another eliminator, or another amplifier. In either case the real remedy is to reduce the common impedance.

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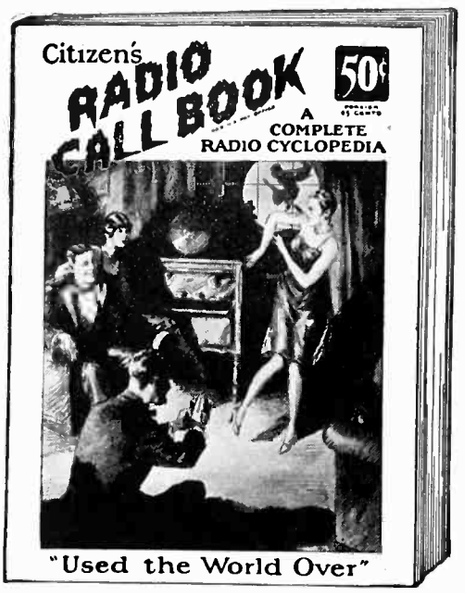

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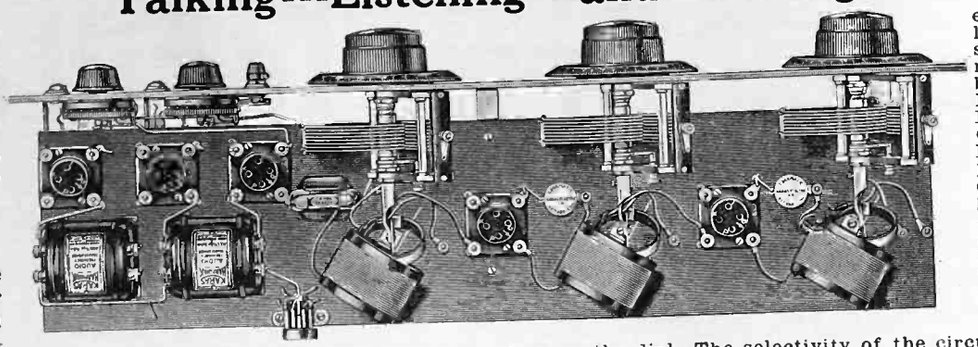

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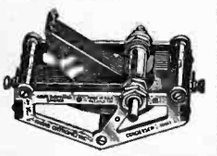

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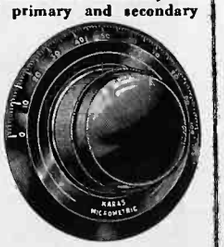

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MAIL THIS COUPON TODAY

J. E. SMITH, President
NATIONAL RADIO INSTITUTE
Dept. PV9, Washington, D. C.

Dear Mr. Smith—Without obligating me in any way, send me your free book, "Rich Rewards in Radio" and all information about your practical, home-study Radio Course.

Name..... Age.....

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EMPLOYMENT SERVICE TO ALL GRADUATES

Originators of Radio Home-Study Training

For All Popular Makes and Circuits *of radio receiving sets*

A Constant "B" Voltage Supply Unit with Power Amplification

TYPE 400
Price
$68.

The New GENERAL RADIO "B" Eliminator *and* Power Amplifier

Broadcast listeners everywhere are now demanding above all else "B" elimination and reception that is NATURAL.

The answer to this demand is the new General Radio Type 400 "B" eliminator and Power Amplifier, which is designed to operate with all popular makes and circuits of radio receivers, regardless of whether they may be operated by a storage battery or dry cell tubes.

Wherever A. C. 110 volt (60 cycle) lighting current is available the use of the Type 400 unit is the most practical and satisfactory method of supplying all necessary "B" voltages. The Power Amplifier in conjunction with the "B" eliminator permits the convenient use of a high power tube in the last audio stage. This overcomes the tendency toward tube overloading and removes the most common cause of distortion in loud speaker operation.

An outstanding feature of the General Radio Type 400 "B" Power Unit is that it has no variable resistance voltage controls to get out of order and cause noisy reception.

Voltages in this unit are controlled by fixed resistances which are properly designed to make the Type 400 readily adaptable to all average receivers.

Once installed it requires no further alteration and is ready for years of unfailing service.

The Type 400 Unit is designed to use the UX-213 Rectron rectifier tube and UX-171 power tube in the amplifier.

See one at your dealer's or write for our booklet 400 containing full information.

GENERAL RADIO CO.
CAMBRIDGE, MASS.

GENERAL RADIO INSTRUMENTS

Behind the Panels of Better Built Sets

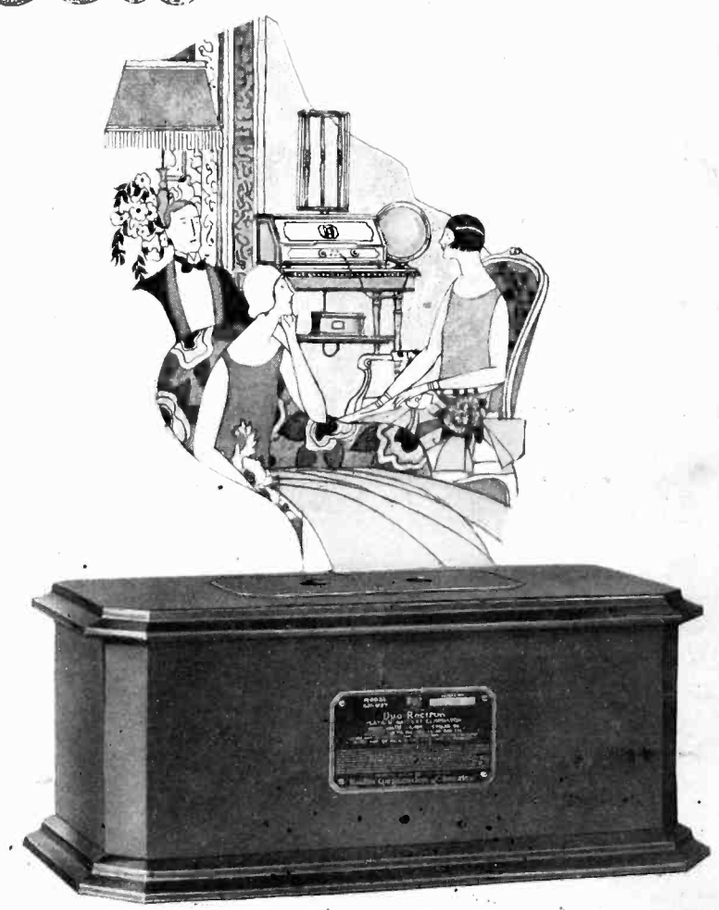
the "B" eliminator for the big radio sets

AWAY with "B" batteries on those many-tube sets! Have you tried to work a "B" eliminator on a six, seven, eight tube set? Here's *one* that was designed specially to take care of the heavy current drain of these sets —the RCA Duo Rectron.

It delivers power aplenty for big or little sets. It delivers it smoothly, steadily, silently. And economically! It supplies up to 135 volts for the power tubes—taps for less if you want it—and a voltage regulator to keep the current exactly right for your radio set.

And also—it's a proved product of RCA!

For Christmas, what better idea than an RCA Duo-Rectron to do away with "B" batteries forever, and give improved reception. It means top-notch performance all the time, with no care at all.



Buy with confidence Authorized Dealer RCA *where you see this sign*

RCA
"B" BATTERY ELIMINATOR
(DUO-RECTRON)

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