DOUBLE BANDSPREAD RECEIVER

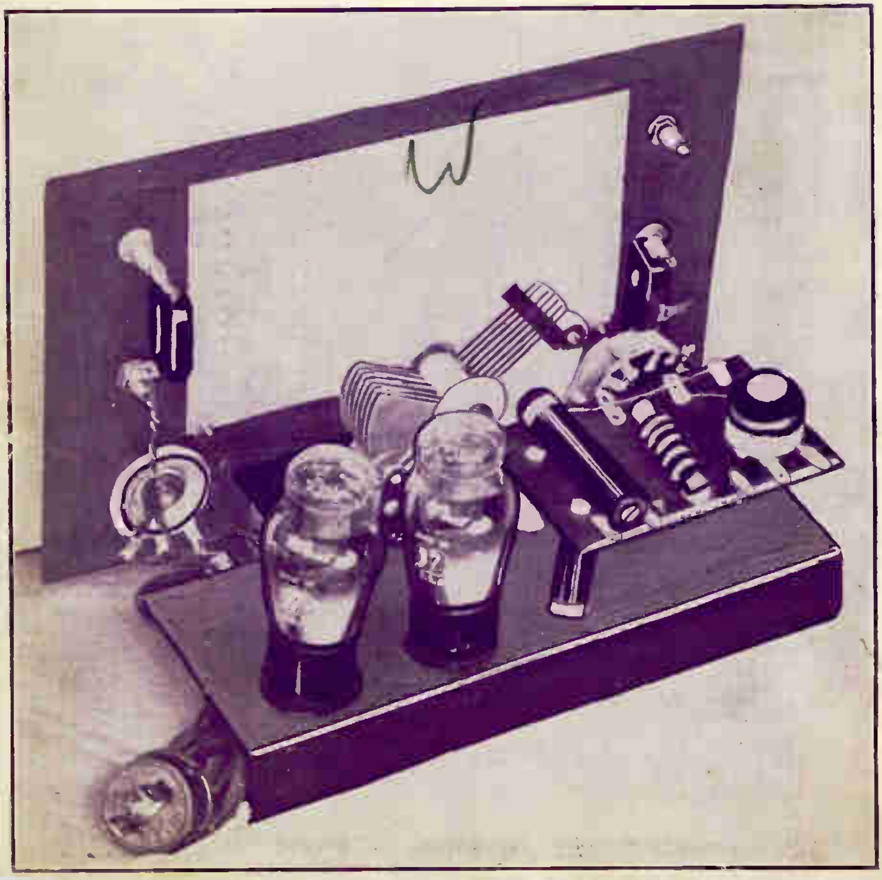
RADIO WORLD

REG. U. S. PAT. OFF.

THE HOW-TO-MAKE-IT MONTHLY— MAY, 1936—25c Per Copy

ALL-WAVE SIGNAL GENERATOR

SEE PAGE 19



EASY GOING PORTABLE

•

SMALL POWER AMPLIFIER

•

DE LUXE SKIP-BAND RECEIVER

•

UTILIZING READY-MADE TUNER

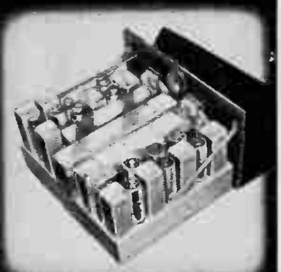
•

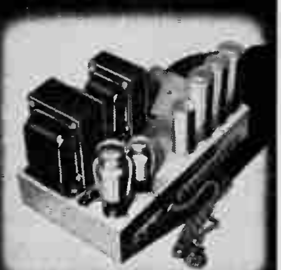
50-WATT PHONE X-MITTER

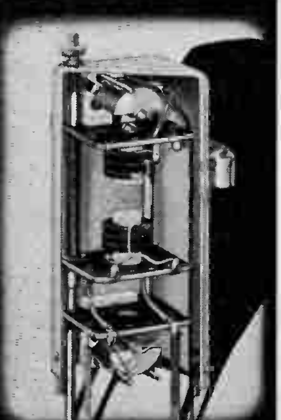
•

12 More Features

Hammarlund "Super-Pro"







■ The Hammarlund "Super Pro," the new special amateur-professional receiver, is replete with striking features. It is designed to meet every rigid, precision specification of the professional operator and advanced amateur. For the utmost in efficiency, the following precision controls have been incorporated: accurately calibrated tuning dial in megacycles and kilocycles; band spread tuning dial (both illuminated); five-band switch; audio frequency gain; radio frequency gain; intermediate frequency gain; selectivity; beat frequency; tone control; speaker-phone switch; send-receive switch; AVC-Manual switch, and CW-Modulation switch. ■ The tuning unit (illustrated at right) is an engineerng triumph of compactness and precision. It includes the main tuning and band spread condensers, and their respective dial assemblies; the band-changing switch; and all antenna coupling, radio frequency and high frequency oscillator coil assemblies.

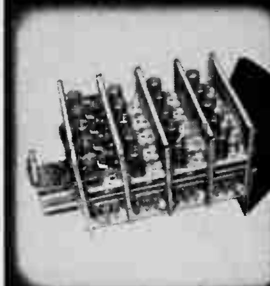
■ Other features of the "Super Pro" are—electrostatically shielded input; two tuned R.F. stages on all bands; four air-tuned I.F. transformers; continuously variable selectivity; three audio stages; silver plated five-band switch; visible tuning meter; separate power supply unit, and separate grid bias supply. ■ In the tuning dial arrangement (illustrated at right) the main tuning dial is accurately calibrated in megacycles in ranges of 2.5 to 5; 5 to 10; and 10 to 20, and in kc. from 540 to 1160 and 1160 to 2500. This dial has an ingenious mechanical shutter which operates in conjunction with the band-changing switch making visible only the frequency band in actual use. The high frequency ranges each have a 2 to 1 frequency range which places the three amateur bands at the same setting of the main tuning dial.

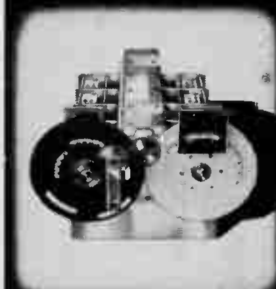
■ The band-changing switch (cutaway view shown at right) is an exclusive Hammarlund development and is a radical departure from switches commonly used for this purpose. Its design incorporates the well-known knife switch principle, actuated by eccentric cams. Specially designed bakelite sections with silver-plated phosphor bronze knife blades gradually slide into silver plated phosphor bronze spring clips, forming a 6-point positive contact. ■ As stated above the power supply (shown at left) is a separate unit. Here two rectifiers are used. A 5Z3 is used for the plate voltage, and a 1-V for the grid voltage. This unit supplies individual C-bias and B voltage. Due to the special filtering system employed, positive humless output is available. This unit is connected to the receiver by way of a special 10-lead cable. The speaker field connections are also obtained from this unit.

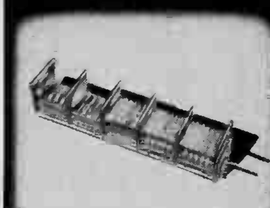
■ Unusual tuning coil assemblies formulate still another feature of the "Super Pro." Coils are wound on the highest grade bakelite available and mounted on Isolantite bases. Each of the units has an inductance adjuster (as shown at right), which aligns the circuits at the low frequency end of the band. A variable trimming condenser is used to align the circuits at the high frequency end of the band. This makes it possible to obtain not only perfect alignment in both circuits, but it also permits exact tracking of the calibrated dial. ■ The variable air transformers (cutaway view shown at left) constitute another of the many important features of the "Super Pro." These transformers permit continuous variation of the mutual inductance between the primary and the secondary throughout a wide range of values without otherwise affecting circuit constants. The approximate range of variation is from 1/3 critical coupling to over 3 times critical coupling. Any intermediate value is at the disposal of the operator at all times merely by turning a knob on the front panel.

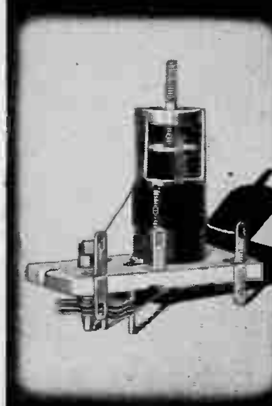
Write Dept. RW-5 for further details.

THE HAMMARLUND MFG. CO., INC.
424-438 W. 33rd Street New York
Canadian Office: 41 West Avenue, No.,
Hamilton, Ontario









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Surprisingly Comprehensive Performance!

TAKE, for example, two of the outstanding refinements: The radio-frequency output may be taken from a high impedance or a low impedance post, with attenuation present for either. Also, the front panel has two extra posts that enable leakage tests. Thus condensers may be checked for leakage, so may tubes, and other normally high resistance circuits, otherwise difficult to test. For instance, the usual ohmmeter will not check them; conditions in the megohm range must be handled.

The radio-frequency coverage is from 100 kc to 20 mc, in five bands, selected by front panel switch. These bands are:

(A) 6 to 20 mc (B) 2 to 6 mc
(C) 660 to 2,000 kc (D) 220 to 660 kc (E) 100 to 220 kc

The dial is direct reading in frequencies, and the five coil-switch positions are designated alphabetically, also in frequency ranges. Full particulars of other functions are imprinted on the panel scale.

Model T-37 works on 90 - 130 volts, a.c. or d.c. The a.c. may be of any commercial frequency.

Sensational in More Than Price Only!

Two type 37 tubes and a neon tube are used. One of the 37's is used as Hartley r.f. oscillator, the other as the rectifier. The neon tube is the audio oscillator.

The modulation, or tone, is about 1,000 cycles, and may be included or excluded, as desired, by front panel switching.

The purpose of Model T-37 is to enable adjusting the intermediate and radio-frequency amplifiers, 100 kc to 20 mc, at precisely the right frequency, getting each circuit in exact tune, for maximum gain and maximum selectivity. Model T-37 enables the lining up of superheterodynes and tuned radio frequency sets.

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Model T-37, All-Wave Signal Generator, wired, calibrated, tested; complete with three tubes, in shield cabinet with carrying handle and instructions (shipping weight 7 lbs.)............. **$12.40**

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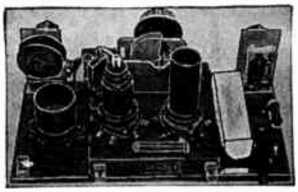

For Complete Assembled Kit, with instructions and picture diagram, ready to wire.

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Custom-built, wired, laboratory tested, $1.00 extra.

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3 Watt Air Scout PORTABLE AMPLIFIER

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ACCESSORIES

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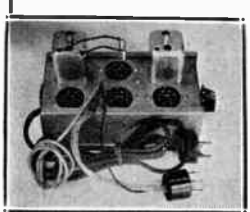

Install a "SILENT CAN" if your set has one IF stage. Complete with 4 RCA tubes and instructions, at

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If your dealer cannot supply you, order direct from R.W.-5.

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RADIO WORLD

The How-to-Make-It Monthly—Fourteenth Year

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Table of Contents for May, 1936

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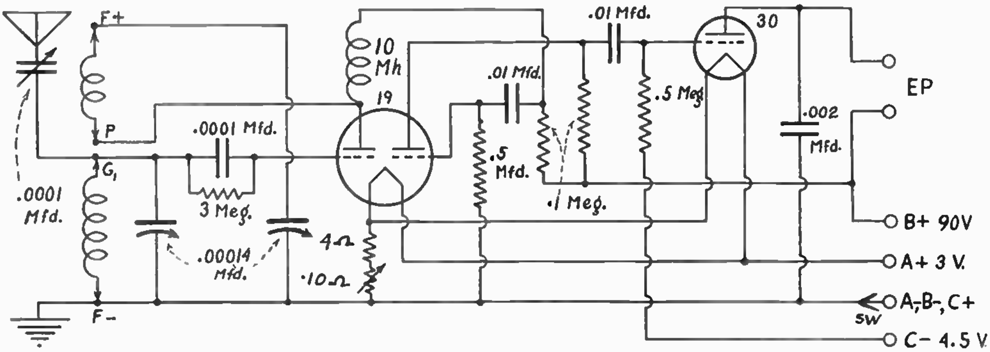
The Voyager Goes Places

Europe Rolls in on Two-Tube Battery Set

By Edwin K. Butler



This all-wave plug-in receiver contains only two tubes yet it has the sensitivity of a three-tube set because the first tube is a dual triode. A high audio gain, obtained in two stages, is added to the high sensitivity of the regenerative tuner and detector.

COUNTING tubes we should say that this is a two-tube set. But counting functions we must say that it is a three-tube regenerative all-wave receiver. Functionally the circuit is a three-tube set because the 19 tube contains two triodes in one envelope. One of the sections is used for detection and regeneration while the other is used as a first stage audio amplifier. The 30 tube is the output tube. Of course, the output is intended for earphones.

The circuit is all-wave because any desired coil may be plugged into the coil socket. There are five coils in a complete set and they cover the following ranges: 15-31 meters, 30-65 meters, 61-125 meters, 120-230 meters, and 220-550 meters.

How to Wind Coils

The winding data for these coils are given below.

Coil	Secondary Turns	Primary Turns
15-31 M.	7 of No. 26 enam.	5 of No. 26 enam.
30-65 M.	11 of No. 26 enam.	10 of No. 26 enam.
61-126 M.	21 of No. 26 enam.	15 of No. 26 enam.
120-230 M.	50 of No. 26 enam.	25 of No. 26 enam.
220-550 M.	121 of No. 32 enam.	28 of No. 30 enam.

All the coils are to be wound on circular tuning 1¼ inches in diameter and there should be a separation of 3/16 inch between the adjacent turns of the secondary and primary of each coil. These coils are supposed to be used with a variable condenser of 140 mmfd. capacity.

The Couplers

The tickler coil is connected between the plate of one section of the 19 and a second 140 mmfd. condenser the rotor of which is connected to ground. The purpose of this condenser is to control the regeneration. Since the rotors of both the variable condensers are grounded the tuning can be done and the regeneration can be controlled easily without any body capacity. The 0.0001 mfd. condenser in the antenna circuit is adjustable rather than variable and it is mounted on the sub-panel.

There are two resistance-capacity couplers in the audio amplifier, each composed of a 0.1 megohm plate resistor, a 0.5 megohm grid leak, and a 0.01 mfd. coupling condenser.

The receiver is operated entirely with batteries. The B voltage is 90 volts, obtained from two 45-volt blocks of dry cells. The grid bias for the 30 tube is obtained from a 4.5-volt dry cell. No grid bias is needed for the audio am-

LIST OF PARTS

One set of five plug-in coils are described.
One 10 millihenry choke coil.
Two 140 mmfd. variable condensers.
One 0.0001 mfd. adjustable condenser.
One 0.0001 mfd. fixed condenser.
One 0.002 mfd. fixed condenser.
Two 0.01 mfd. condensers.
One 4-ohm ballast.
One 10-ohm rheostat, with switch.
One 3 megohm grid leak.
Two 0.1 megohm plate resistors.
Two 0.5 megohm grid leaks.
One six-prong and two four-prong sockets.
Three knobs.
One vernier dial.
Two phone tip jacks.
One chassis with metal front panel.

plifier part of the 19, except that supplied by the drop in the filament ballast resistor. The filament current is supplied by a 3-volt dry cell battery.

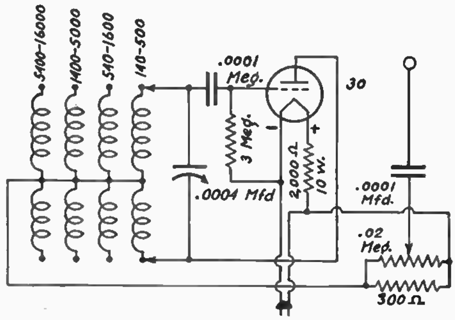
Current Drawn by Tubes

Since the 19 normally takes 0.26 ampere and the 30 takes 0.06, the total current when the tubes are operated full blast should be 0.32 ampere. This is more than a No. 6 dry cell should deliver and for that reason four of them should be used in series-parallel. It is not necessary, however, .to use full current on the tubes. For that reason a 10-ohm rheostat is connected in series with the 4-ohm limiting resistor.

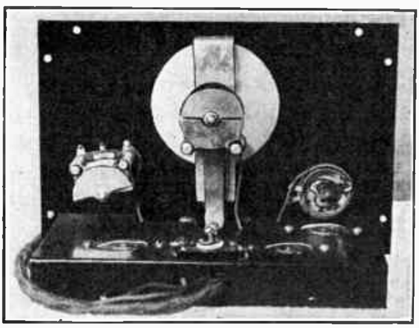
The finished receiver is very simple, as is seen by the three photographs below. The two upper pictures show the panel of the receiver from the rear and the front. The three controls on the panels are easily identified. The front view also shows the output pin jacks directly under the main tuning control.

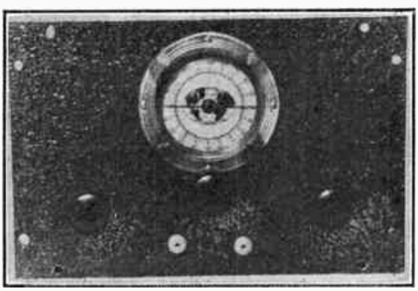
The lower picture discloses the wiring and the small parts under the sub-panel. On this picture the left-hand four-prong socket is that for the coil, the six-prong is that for the 19, and the remaining socket that for the 30 tube.

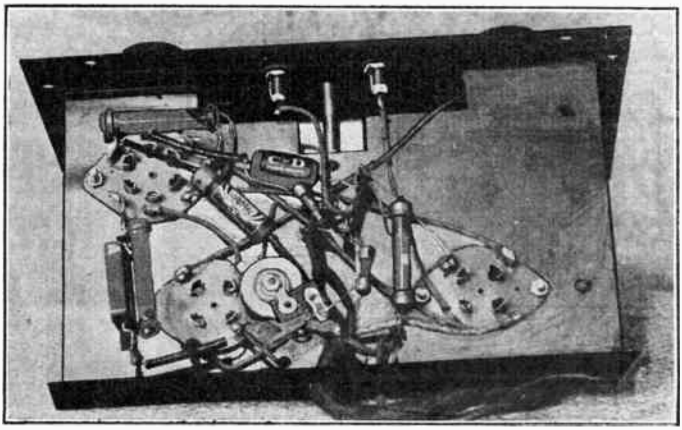
Battery Hartley



For universal operation the circuit may be used as shown, retaining the 30 tube. This works on a.c. or d.c., when connected to the 110-volt line. On a.c. the hum is pronounced and no other modulation is necessary. On line d.c. use, however, the grid blocking produces a note attenuator effective on i.f. only.







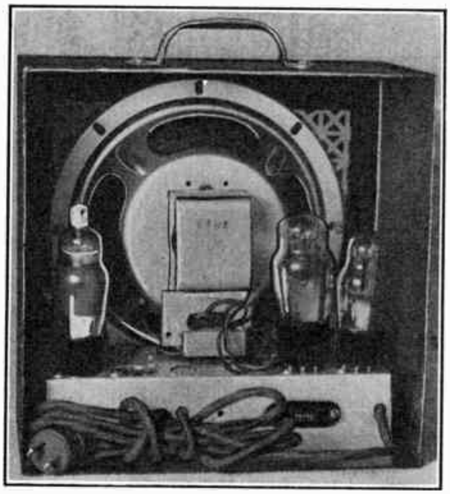
Three views of the two tube battery receiver shown on the preceding page. A small tuning condenser provided with a vernier dial and five tuning coils to cover the entire band insure ease of separating the stations. Grounded rotors of the tuning and regeneration controls permit close tuning and maximum regenerative gain.

Three Watts for You, Sir!

Campaign Coming! Watch Your Power Amplifiers!

By Harry G. Cisin

Allied Engineering Institute



Here's a portable, too, only it's an amplifier of the universal type.

ANYONE with an elementary knowledge of radio can make an excellent income by taking advantage of the strong demand for power amplifiers existing in every town and city. First of all, it is well to recognize the fact that there is nothing mysterious or complicated about a power amplifier. It is easier to put together and wire up than an ordinary radio set and it can be hooked up by anyone who can plug in an electric iron. Once connected up, it can be operated without a knowledge of radio and will last a long time without special attention or servicing.

A small, low priced amplifier is an absolute necessity in taverns, beer gardens, restaurants, carnivals, amusement parks, small concessions, airports, and in fact, every place where crowds congregate, either for amusement or instruction. The average small town will yield at least 100 good prospects for a low-priced power amplifier installation, whereas in the ordinary city the opportunities for amplifier sales are very extensive.

Possibilities Outlined

This easy money is lying around waiting for the man with energy enough to go out and pick it up. Best of all, he needs only a small investment, less than $20 to get started. This investment covers the cost of building up the initial demonstrator outfit. The demonstrator can then be used for making sales, and also can be rented out to local clubs for entertainments or for similar purposes.

The portable a.c. amplifier illustrated is a typical medium-priced job employing three of the latest tubes. The two audio stages are suf-

(Continued on next page)

Portable Receiver as Fun-Furnisher

The object of a portable is to enable enjoyment of standard broadcast programs, no matter where one may go, within reasonable distance of broadcasting stations, say fifty miles. Distance much greater than that can be covered, of course.

Life of the Party

There are many occasions when such a portable comes in handy, saves the day—or the night, more usually—and makes a success of a party. This is because the circuit is completely self-powered, and does not need the assistance of a storage battery, mechanical B supply, etc., which facilities sometimes are hopelessly lacking, hence you need such a device as this or you have no music.

Position of Batteries

The batteries are put in the under part of the carrying case, beside the speaker, consisting of two No. 6 dry cells in series to constitute the 3 volt supply to the filament, and three 45 volt B batteries in series. There are portable cells equivalent to No. 6 and also portable B batteries, so that this summer one finds the battery problem simplified or rather reduced from a weight consideration.

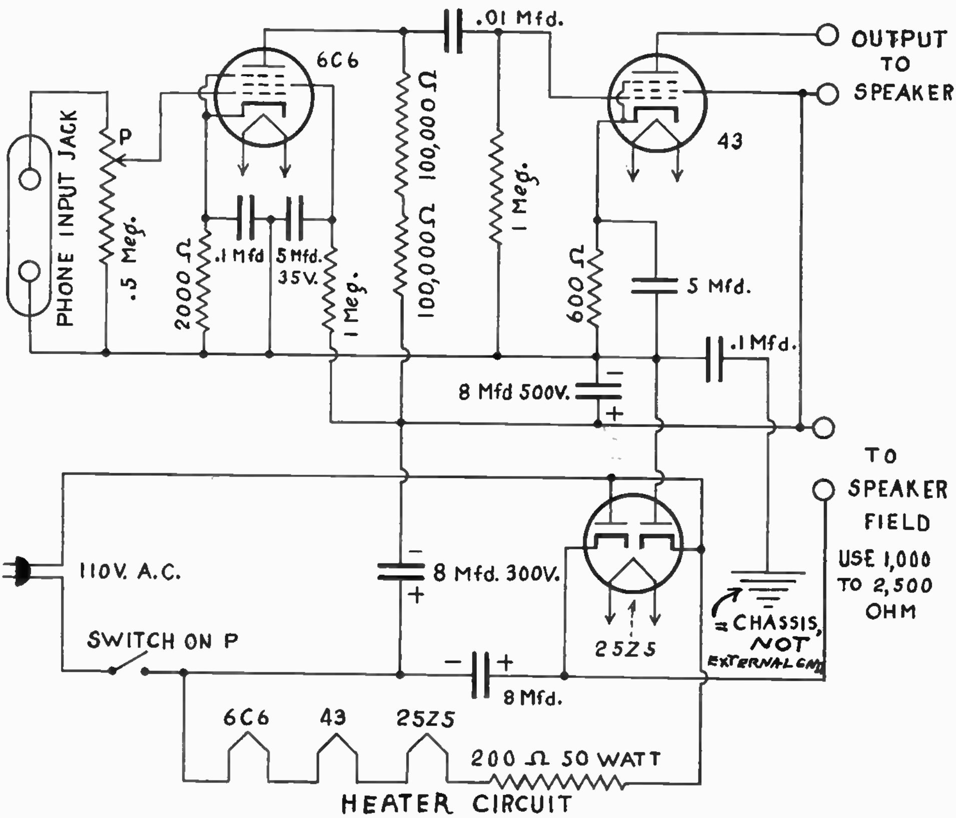
ficient to give an undistorted output of over three watts.

In the first stage there is a pentode 6C6 tube. This is resistively coupled to a pentode power output 43 tube. Full-wave rectification is obtained through the use of a 25Z5 tube connected in the latest voltage doubler circuit. The use of voltage doubler rectification gives greatly increased plate voltage without the use of a power transformer, thus adding to the portability and compactness of the complete amplifier and increasing the efficiency.

Low Hum Level

The hum level is kept extremely low through the use of a carefully designed, light weight filter system. A smooth volume control is pro-

(*Continued on next page*)



Simple three-watt power amplifier, using glass tubes.

LIST OF PARTS

Resistors

One 2,000 ohm, 1 watt.
Two 1 meg., 1 watt.
Two 100,000 ohm, 1 watt.
One 500,000 ohm Electrad potentiometer vol. control with switch, type S-203
One 600 ohm, 10 watt vitreous enamel Electrad resistor
One 200 ohm, 50 watt wire-wound Electrad resistor, type C-2.

Condensers

Two 5 mfd., 35 volt Cornell-Dubilier tubular electrolytic, type ED-2050.
Two 8 mfd. 300 volt Cornell-Dubilier electrolytic tubular, type ED-3008.
One 8 mfd. 500 volt Cornell-Dubilier electrolytic, cardboard container, type EH-9800.
Two .01 mfd., 400 volt Cub tubular Cornell-Dubilier Condensers, type BA-4S 1.
Three .1 mfd., 400 volt Cub tubular, Cornell-Dubilier, type BA-4P1.

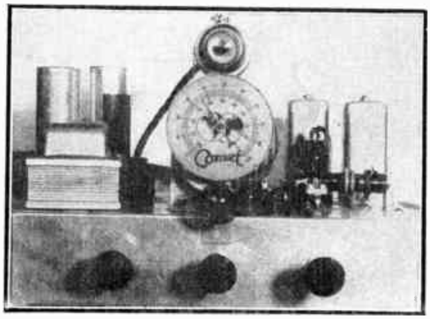
Other Requirements

One phono input twin jack.
One speaker and field supply jack.
One 6-inch dynamic speaker, 2,500 ohm field, output transformer for 43 tube.
Three 6-prong wafer sockets.
One a.c. connector cord and plug.
One metal chassis.
One metal carrying case with speaker grille.

Plug in Your Magic Eye!

Two-Band Super Has Cozy Convenience

By G. V. Dubuc
Comet Radio Company



The round-looking object staring at you from above the dial is the 6E5 ray indicator tube. This is used as a tuning guide. A sturdy receptacle is provided so the tube may be plugged in.

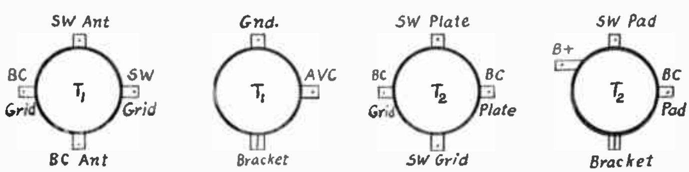
IF you already have a receiver incorporating a.v.c. or if you intend to build such a receiver, it is an easy matter to make it strictly up-to-date by building a magic eye into it. This little device is a convenient tuning aid which only those can appreciate fully who have already used it. There can be no guesswork about correct tuning when the magic eye is in the circuit to tell when the tuning is "on the nose."

The proper way to wire in the magic eye tube, the 6E5, is shown in the figure on page 13, where it is wired into a typical five-tube superheterodyne plus the magic eye. Note first that the 6E5 cathode is grounded. The two heater terminals, of course, are connected across the 6.3 volt winding on the power transformer. The plate is connected to the highest voltage available in the circuit and the target to the plate through a one megohm resistor. The control grid of the 6E5 is connected to the a.v.c. line.

How does it work? Well, when the negative voltage on the grid is increased the eye closes. Since the negative voltage of the a.v.c. line, measured in respect to the cathode, and hence to ground, increases as the signal intensity increases, the circuit is tuned exactly to a station when the eye is most nearly closed. The addition of the magic eye does not change the tuning, because the device is operated on d.c. potentials.

If the signal is so intense that the eye closes completely before maximum has been attained, it becomes necessary to decrease the intensity independently of the a.v.c. Although this rarely happens, there is a magic eye type tube available to handle the situation. It is one working on the variable mu principle.

(*Continued on page* 14)



Coil connections, bottom view, for two-band tuning, 530 to 1,600 kc. and 5,300 to 16,000 kc. These coils are made by Teleradio Company. They require padding capacities, Cp1 and Cp2=260-500 mmfd.

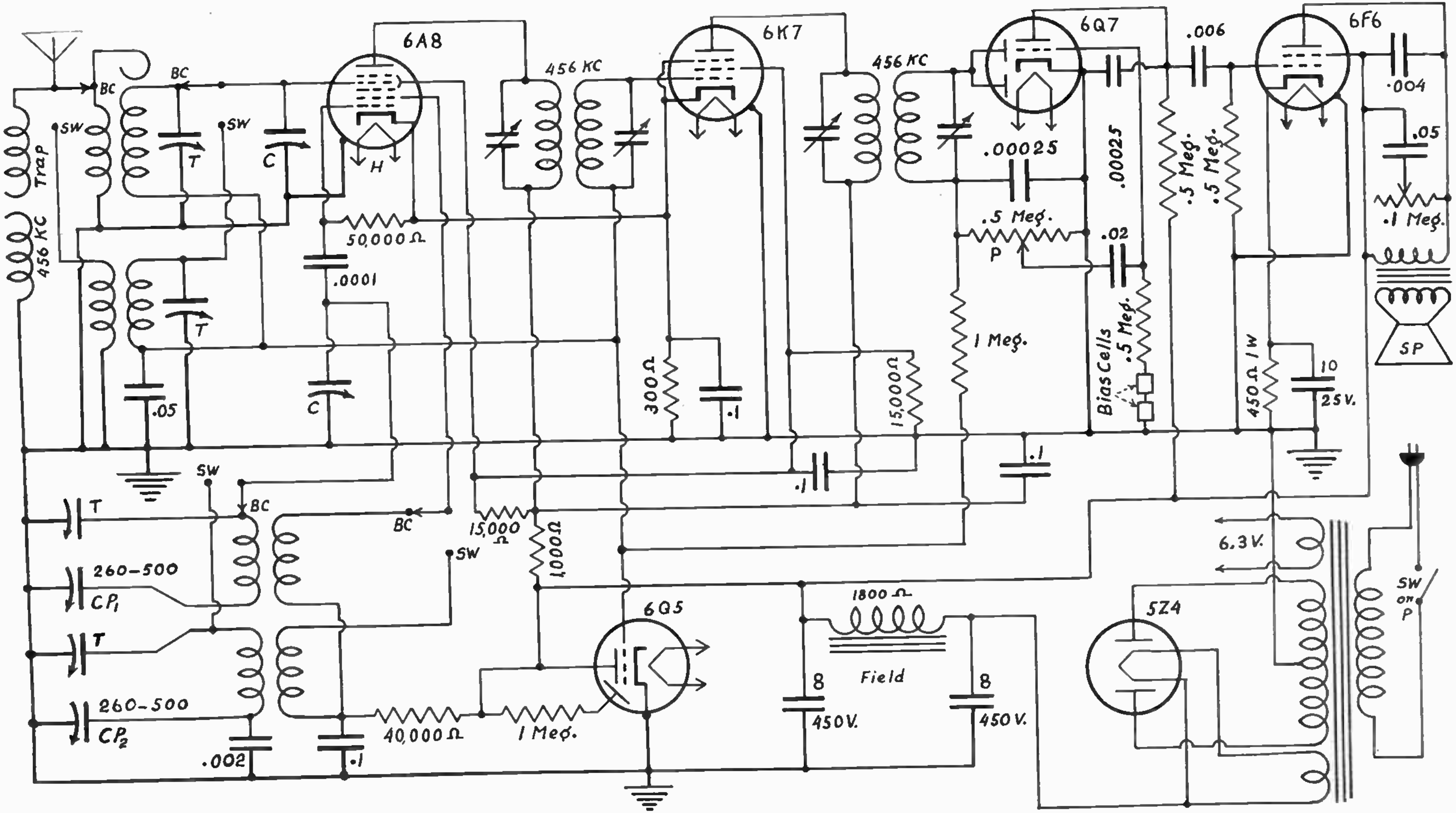
Advantages of Portable Amplifier

(*Continued from preceding page*)

vided which permits volume to be increased from a whisper to volume sufficient to fill a large hall. Such a range of volume is essential to any power amplifier for public use.

The amplifier is built on a sturdy lightweight metal chassis and the complete outfit, including a full tone, over-size dynamic speaker, is installed in a portable metal carrying case, which can be put up wherever it is to be used.

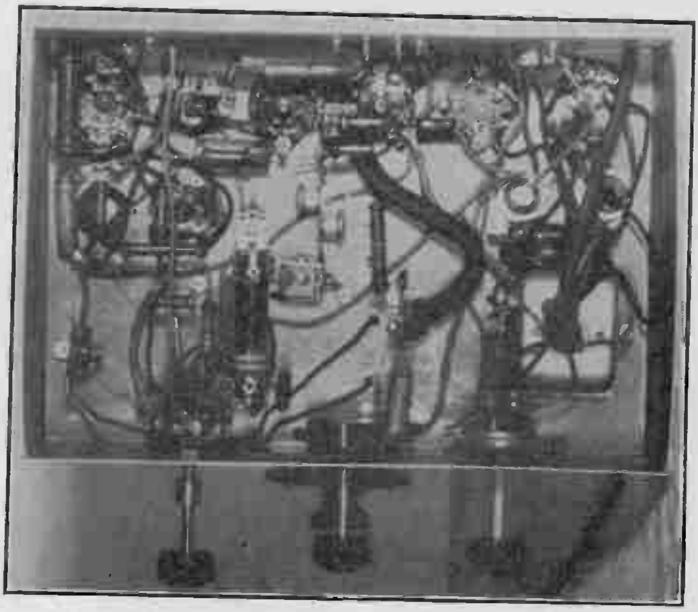
The schematic diagram shows how simple it is to wire up this amplifier. Once the job is completed, the amplifier can be carried in to the prospective purchaser and demonstrated without fuss of any kind. Simply plug it into any available lamp socket, connect the microphone, turn the switch and start to talk.



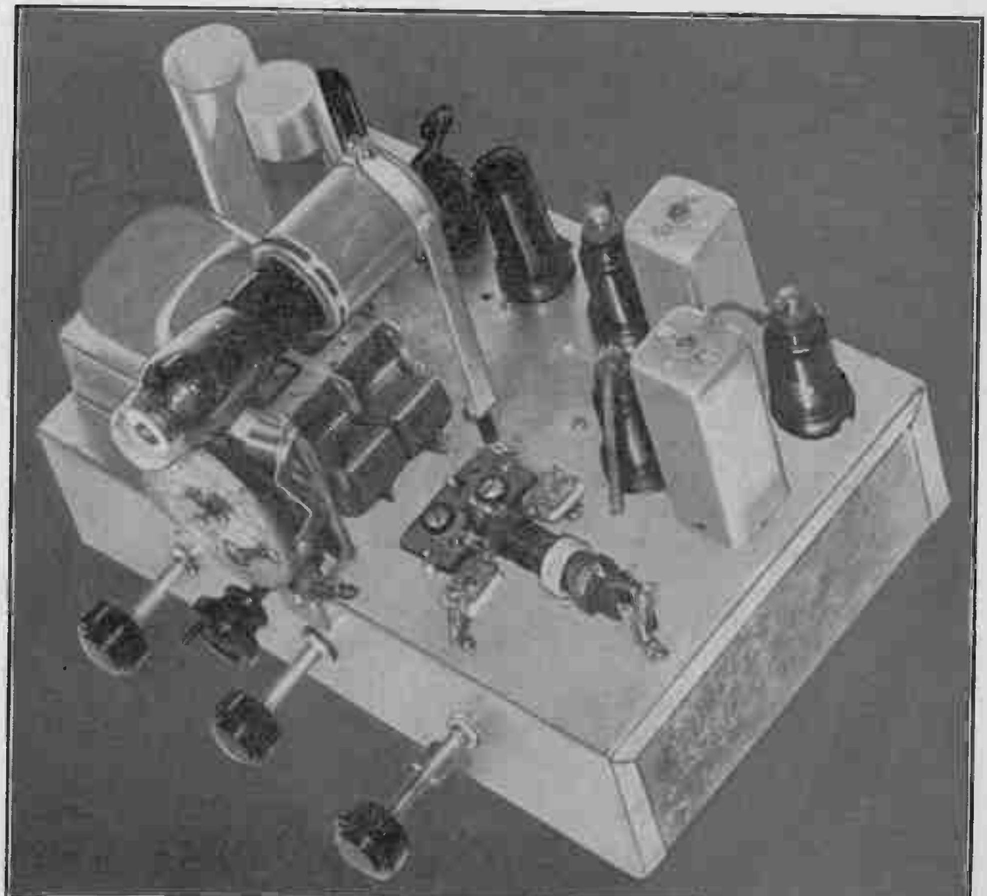
The skip-band set, using ray tube 6E5 or 6G5. The 6G5 is imprinted above.

(*Continued from page 12*)

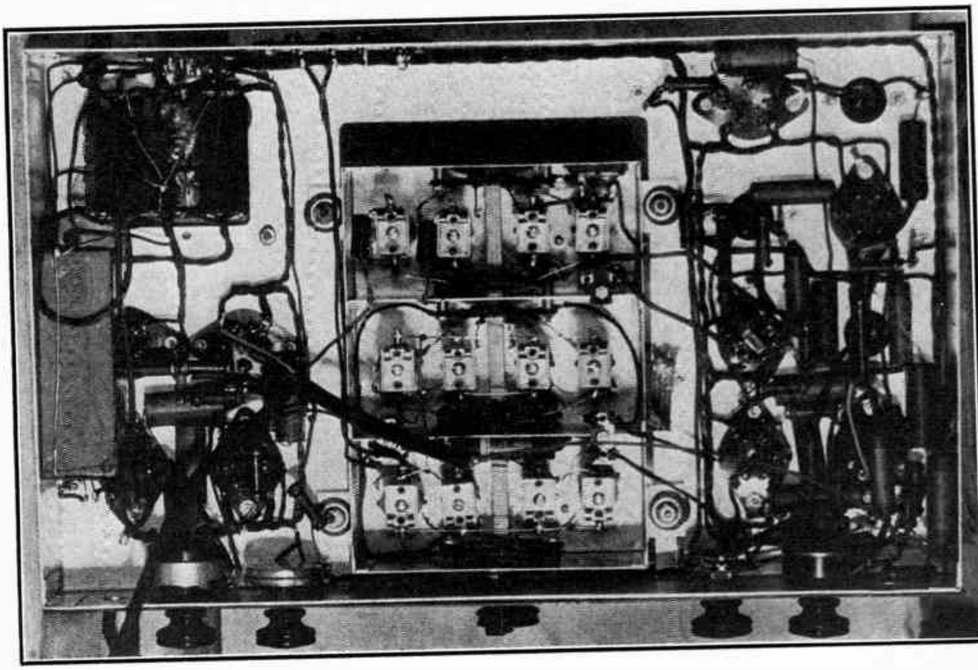
The two-band superheterodyne on page 13 is, except for the magic eye, an all-metal tube set, and it is a set of outstanding performance. There is only one r-f tuner but this, for the broadcast band, is of the high gain type. Any likely image interference is tuned out by means of a 456 kc trap in the antenna circuit.



Two bands are covered. The switch is shown at left in the upper illustration while the broadcast band modulator coil is at right in the lower illustration. The inductances for both bands are on one form for any one purpose. The oscillator coil is shown just behind the coil switch in the upper picture.



The Tobe Tuner Amid Appropriate Surroundings



Something very attractive greets the eye when one looks under the chassis, for the factory-wired tuner is right there, and surrounding it are the essentials for a. c. operation and speaker performance. Don't worry about all the knobs. They're worth while.

A Tuner in Right Quarters

Rectifier and Audio Compactly Supplied for Set

By Gustave L. Klein

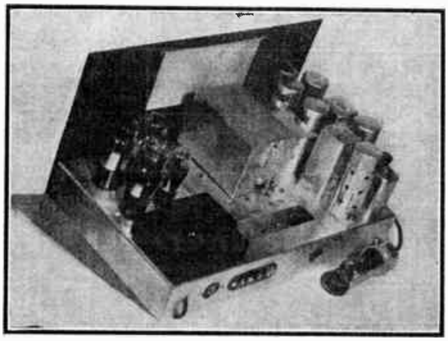
DEMAND for a sensitive and dependable all wave receiver is almost universal today, but for the discriminating listener who wants his program reproduced with real fidelity and to whom just station identification and the lower bands is not sufficient, a receiver built around the All-Wave Tobe Tuner fills the bill. The bands are: (1)—9 to 22 mc.; (2)—3.5 to 9 mc.; (3)—1.5 to 3.9 mc.; (4)—555 to 1,500 kc. The triple tuned i.f.'s with special coupling afford higher sensitivity and permit a broad flat top resonance curve, thereby giving high-fidelity response. These i.f.'s have previously been aligned, but due to the wiring in the set a slight change in the capacity of the trimmers on the transformers has to be made. The center condenser must not be touched, for once set it does not have to be realigned; that center trimmer is in the special link coupling circuit which affords the extreme high-fidelity and sensitivity.

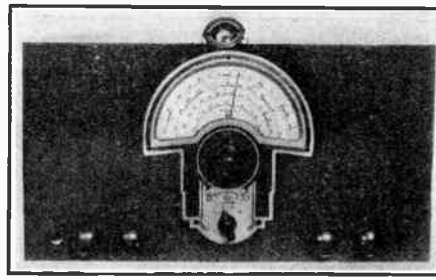
Tip About Amplifier

It is important to note that the amplifier in this receiver is designed for high efficiency. The special method of coupling the driver triode to the push-pull pentodes is extremely critical, for if not done right the frequency response will be seriously impaired. A special high-fidelity input push-pull transformer with a curve of $\mp$ 2 db, 30-10,000 cycles, was used to the best advantage. In the diagram it will be noted the method of coupling the 76 to the 42's.

With previous practice there was some difficulty in tuning in foreign stations, but with the combination of the magic eye and the beat

(Continued on next page)





Rear view to left of us, front view to right of us.

(*Continued from preceding page*)

note oscillator the tuning has become so simplified that anyone can easily receive even the faintest signal. The magic eye can easily be installed in this receiver merely by connecting five wires from a commercial adapter for the 6E5 to the receiver, two wires going to the filaments, one to B + 250 volts, one to the chassis, and the last wire to the common A.V.C. line. When a station is tuned to maximum volume the luminescent green of the magic eye is entirely covering the screen of the tube. This action will even take place when the volume control is set for low or the off position.

If the custom set builder is to obtain much business he must be ready to build all-wave receivers, either originally, or remodelling existing sets. Heretofore he has hesitated about attempting to build such receivers because of the difficulty of lining up the many tuners properly. There is no longer any need for hesitancy on this score because complete tuning units are now available with which first-class all-wave tuners can be built just as easily as a single-tuner receiver. Not only can the custom set builder and radio service man do it but also the amateur who builds sets as an avocation.

Uses the Tobe Tuner

In the schematic drawing on page 17 a nine-tube superheterodyne suitable for an all-wave receiver is shown. The coils, L1, L2, L3, L4, L5, and L6, are one set of coils in the Tobe Tuner, that is, the coils for one tuning band. When a gang switch is turned another set of coils, for another band, is switched into the same positions. The various decks on the gang switch are indicated in the drawing by encircled crosses. There are six of these. The condensers marked with a star, or asterisk, are units in the all-wave tuner. There are eight condensers so marked, which means that eight are used at a time. There are actually many more condensers in the unit, for each coil requires its own trimming and, for oscillation, its own padding condensers. The location of the

(*Continued on page 18*)

LIST OF PARTS

One complete Tobe tuner, (switch, coils and condensers).

Coils

Two special Tobe, 456 kc i.f. transformers.
One beat note oscillator tuner.
One power transformer.
One push-pull input transformer.
One push-pull speaker with 1,800-ohm field coil.

Condensers

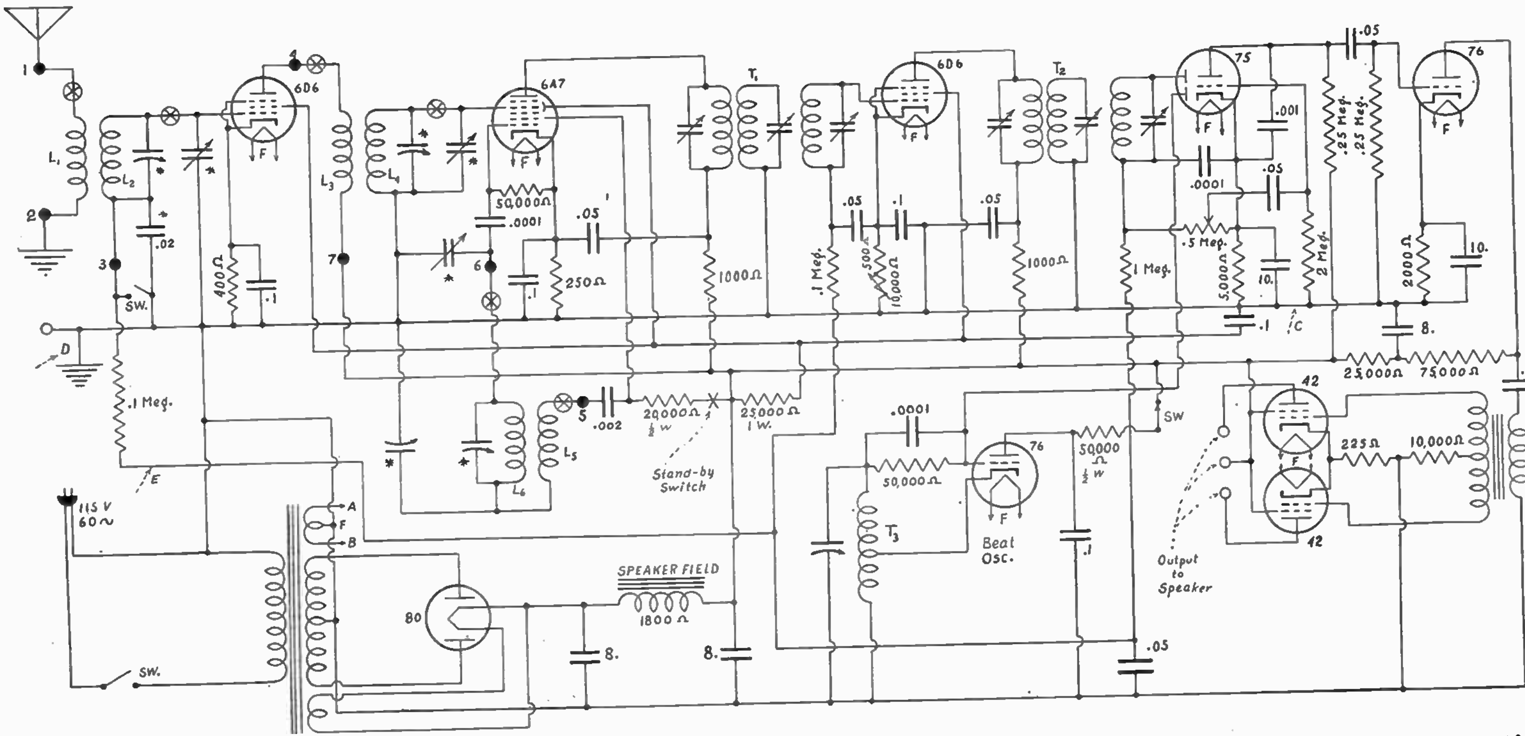
Two 0.0001 mfd.
One 0.001 mfd.
One 0.002 mfd.
Eight 0.05 mfd.
Five 0.1 mfd.
Three 8 mfd. electrolytics.
Two 10 mfd. electrolytics.

Resistors

One 400 ohm.
One 50,000 ohm.
One 250 ohm.
One 500 ohm.
One 5,000 ohm.
One 2,000 ohm.
One 225 ohm.
Two 1,000 ohm.
One 10,000 ohm.
Two 0.1 meg.
One 50,000 ohm.
One 20,000 ohm, ½ watt.
One 10,000-ohm variable.
Two 0.25 meg.
One 25,000 ohm.
One 75,000 ohm.
One 25,000 ohm, 1 watt.
One 1 meg.
One 2 meg.
One 0.5 meg. potentiometer.

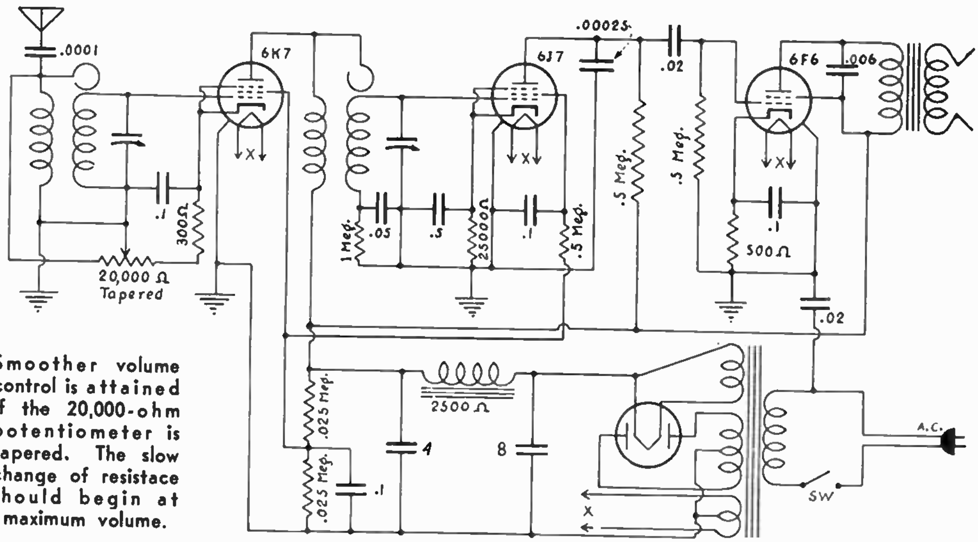
Other Requirements

Three single pole single throw switches.
Four grid clips.
Sockets:—One four-prong; two five-prong; four six-prong; and one seven-prong.



Asterisks represent condensers in the factory-wired Tobe Tuner. Heavy dots bearing numbers are connecting points explained in the text.

AC. T.R.F. on Only Four Tubes



Smoother volume control is attained if the 20,000-ohm potentiometer is tapered. The slow change of resistace should begin at maximum volume.

Connections for Magic Eye Explained

(*Continued from page* 16)

switch points in relation to the coils shows which condensers must necessarily be duplicated.

The large black dots, seven of them, are the points at which the all-wave tuner is connected to the rest of the circuit.

Other Features of the Set

In case it is desired to use a magic eye with this circuit as an aid in precise tuning, it may be done by making connections to the points marked A, B, C, D, and E.

A and B are connected to the heater of the magic eye, C to the cathode, D to the plate, and E to the eye control grid.

A beat note oscillator is incorporated in the circuit. A switch is provided, in the plate circuit, by which the heterodyne may be switched in or out. Whereas the beat note oscillator is primarily intended for reception of continuous wave signals, most persons who are not familiar with code use the oscillator as an aid in finding weak stations. For this purpose there is no other device that is nearly as sensitive and satisfactory.

Of course, the frequency of the beat oscillator is nearly the same as that of the intermediate frequency, namely, 456 kc. Provision is made for a slight adjustment of the oscillator frequency, just as there is in changing the intermediate frequency. The coupling between the beat oscillator and the receiver proper is effected by connecting the grid of the oscillator to one of the diode plates of the 75 tube.

The Intermediate Tuners

Only two intermediate frequency transformers are used, but they are of a special, new tobe type. There are three tuned circuits in each coil unit. One of these merely acts as a coupler between the other two. An intermediate transformer of this kind is more selective than the usual type and it has also a greater gain. It should also have a considerably lower side band suppression for a given amount of selectivity.

A very high gain is obtained in the audio channel. First there is the high voltage gain in the 75 triode, then the moderate gain in the 76, and finally a high gain in the push-pull amplifier, in which 42 power pentodes are used.

An Economical Generator

All-Wave, It Has Also Unique Features

By Sidney Fleischman

Superior Instruments Co.

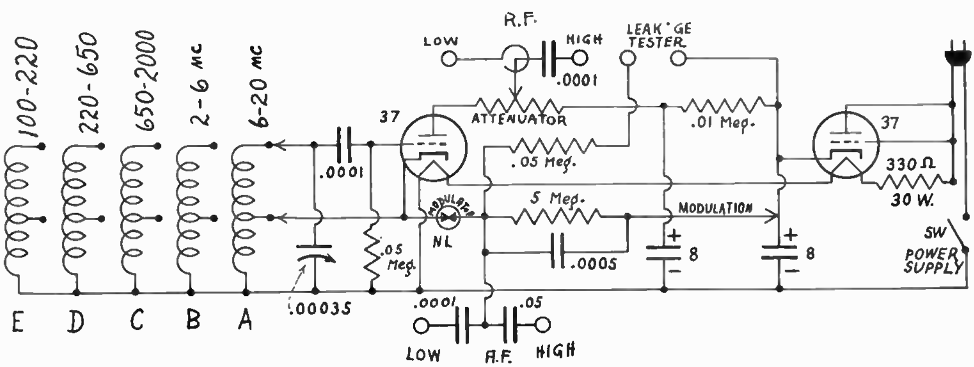
THE best oscillator of the small glass tubes is the 37 or the 76, having approximately the same characteristics, and since the type lends itself to a.c.-d.c. use it was selected as the oscillator in the universal all wave signal generator diagramed herewith. The only other tube is the rectifier, a 37. When the heaters of these tubes are connected in series, a 330 ohm line cord of 30 watts rating properly apportions the heater voltage at near 6.3 volts per tube, at 115 line volts.

D.C. for Plate

The plate voltage is d. c. always, for on a. c. there is rectification, while for connection to the d. c. line, if proper plug polarity is observed, is d. c. (lamp is dark when the plug is connected one way and lights when plug is connected the opposite way). Reverse the plug insertion in the convenience outlet when testing. This is a helpful service refinement, since an a. c. receiver connected to a d. c. line will blow a fuse.

Safety Factors

There is no harm done even if the line cord is accidentally or otherwise connected with reversed polarity to the d. c. line, as then the rectifier tube is an open circuit, since it conducts only in one direction, and then only when the plate is positive. So, too, no injury to the electrolytic condensers is caused by a reversal of intended connection, because an open circuit is between condenser and line.



Five bands are covered on fundamentals as designated, in this three-tube signal generator.

the rectifier is "floated" on the line, acting simply as a resistor. So this device works on a. c. or d. c. of any commercial frequency, but on d. c. will not perform unless the plug is connected to the convenience outlet the right way.

Polarities and Neon Tube

Since a small neon lamp is used for its audio oscillation, and will always light in a. c. use, and only on d. c. use when the line plug is connected the right way, observance of the lamp will disclose whether the connection is proper for d. c., without any further test. Moreover, the very fact that the neon tube remains dark when the line plug is wrongly connected to the d. c. source enables one to tell with this instrument whether the electricity at the location of operation is a. c. (connect plug both ways and lamp will always light), or whether the line

The neon tube in the circuit as shown oscillates at about 1,000 cycles.

When there is no audio oscillation the brilliancy is normal, because there is no oscillatory displacement current to break the main current.

30% Modulation

As the circuit is shown, the neon lamp produces a modulating effect of about 30 per cent., which is well below the limit that would produce distortion and consequent double responses in tuning, one close to the other, all over the band. It is of course possible to get double responses when measuring frequencies put into a superheterodyne at the carrier signal level, particularly on the foreign short wave band, and higher frequencies (say, 6,000 kc upward,

(Continued on next page)

LIST OF PARTS

Coils

Five tapped coils to cover the range, 100 kc to 20 mc, all on fundamentals

Condensers

One .00035 mfd. tuning
Three .0001 mfd. mica fixed
One .0005 mfd. mica fixed
One .05 mfd. tubular
One unit consisting of two 8 mfd. condensers, 150 volt continuous d.c. working voltage, or higher.

Resistors

One .01 meg. (10,000 ohms)
Two .05 meg. (50,000 ohms)
One 5 meg. (5,000,000 ohms)
One 30 ohm attenuator
One 320 ohm, 30 watt resistor built into line cord.

Other Requirements

One chassis and metal cabinet
One frequency calibrated dial
One line cord (with previously mentioned 320 ohm resistor built in), equipped with male plug.
Two five-hole sockets
One neon lamp without limiting resistor built in
One six position, two deck coil switch
Six output posts.
Plate for identifying bands and attenuator settings

(Continued from preceding page)

or 50 meters downward), but this is due to the receiver and not to the generator, and applies no matter what generator is used. The double response is due to the same generator frequency being tuned in by the set at one receiver dial position and at another receiver dial position removed from the first by twice the intermediate frequency. The guiding frequency in any tests then should be the lower of these two.

The higher one is called the image and is present due to the relatively low intermediate frequency of the receiver and the absence of sufficient preselection in view of the low i.f. It is scarcely practical in all wave receivers to attain a high enough intermediate frequency, so in the absence of most elaborate preselection the double responses are unavoidable, and are strictly the fault of the receiver.

The modulation is present or absent by switching the neon tube's d.c. voltage in or out, and this option is present both on a.c. and d. c. use, for the same modulation is used in both instances, no hum from the rectifier being used for auxiliary or other modulation on a. c. use. In fact, the filtration is made high to avoid distortion due to residual a.c. on the plate of the 37 generator tube.

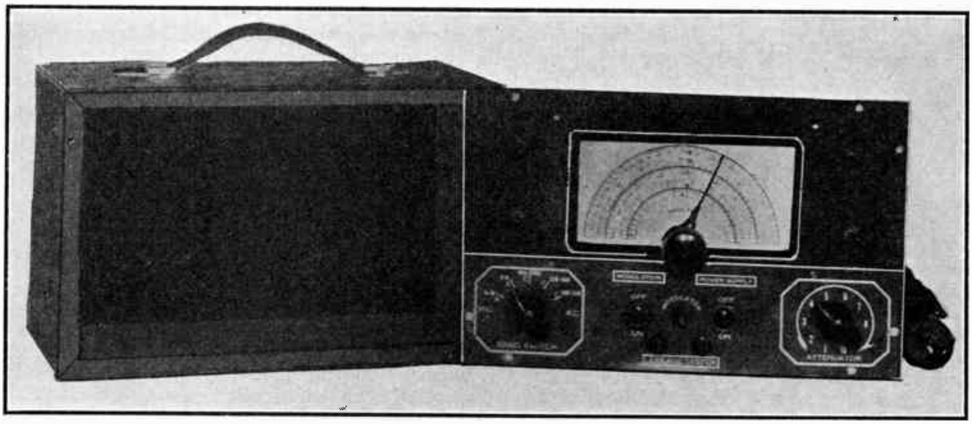
Value of Audio Output

This tone is valuable in testing amplifiers and public address systems, where no radio frequency operation is associated with the installation. The actual audio tone taken out is of sufficient amplitude to permit this testing of any amplifier, and may be used in checking the audio amplifier of a receiver, especially when there is weak reception, or no reception, and one has to ascertain whether trouble is at audio, radio or intermediate frequency levels.

It is easy to connect the output across the plate circuit of the detector tube and check for response. By moving toward the power tube, bringing connections of audio generator to driver output, if there is audio trouble, the stage in which it occurs may be identified, and that is most of the battle.

The connection to an audio amplifier alone actually may raise the pitch of the original 1,000 cycle note a little, because of the shunting effect on the neon oscillator circuit.

The little gas-filled tube has no limiting resistor built in and is commercially obtainable. An external limiting resistor of 5 meg. is used with a fixed condenser across it and the circuit



Front, which has chassis secured to it, is slid into metal cabinet at left.

then operates as a sawtooth oscillator. If the amplitude is one volt, any voltage taken off that is more than .2 volt or so will run into the sawtooth type, which yields an irregular output-that is, far from a sine wave. However, if only a small part of the voltage is taken off, the portion used for its modulating influence is substantially a sine wave.

The ascension is slow, the decline is rapid, in the neon tube oscillator, hence it is called a relaxation oscillator. However, the curve toward the base is nearly symmetrical, and if a cone is imagined with regularity near the bottom and crookedness above, if the cone is truncated there is regularity remaining. In the small amplitude realization from the neon oscillator this situation obtains with close similarity, and besides the system is not inertialess, and hence the flat top of the supposedly truncated cone tends to round itself out, to produce nearly a sine wave.

Leakage Tests, Too

The neon tube is used also for leakage tests on condensers and on tubes (grid to cathode particularly), an unusual feature.

The capacity-resistor filter is very effective and consists of a 10,000 ohm resistor (marked .01 meg. in the diagram) and two 8 mfd. electrolytic condensers, 150-volt rating or more. These are minimum capacities, and may be greater, any one increase preferably being at the position next to the rectifier. Not more than 16 mfd. should be used at this position with the small triode used as rectifier. After the 10,000 ohms capacity may be raised without limit.

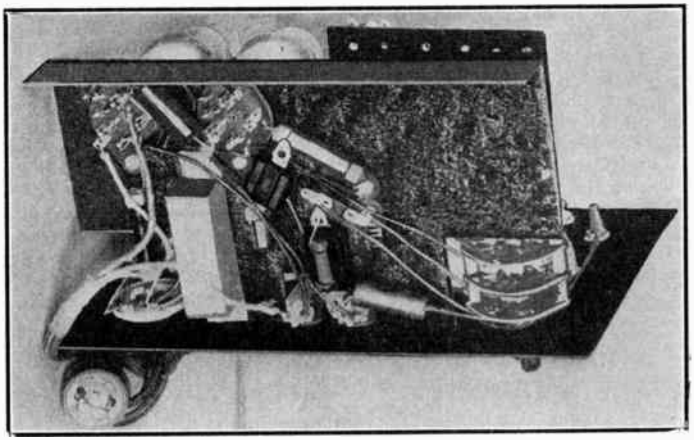
Carefully Engineered

About a month of spare time, four nights a week, was devoted to experiments with this signal generator. One of the principal objects was to obtain strong oscillation as high as 30 megacycles on fundamentals, and this was accomplished nicely with the 37 tube in a Hartley circuit. Also, no oversized tickler had to be used, and therefore the frequency ratio was maintained well. In fact, it was highest for the highest frequency

The frequency stability is good, due to maintenance of adequate grid current, which is fairly uniform, a measure of the frequency stability. When the tube oscillates it puts a positive a. c. voltage on the grid that causes the grid to rectify, hence draw current, and for substantial amplitudes of oscillation voltage the bias on the grid is fairly steady. Therefore practically no frequency shift due to changing plate impedance is introduced.

The resultant bias is negative because only when the grid is positive to a. c. will current flow in the grid circuit, and when it does flow, the current being d. c., really rectified oscillation voltage, the direction of flow is from cathode to anode. Here the grid serves as anode, and as d. c. flows (in conventional theory) from positive to negative, the anode (grid) is negative to d. c. The same bias arising from the positive alternation of the cycle carries over to the negative cycle because of the discharge current from the grid condenser. This is called displacement current. It is simply a case of the diode biased triode all over again, the diode consisting of the grid to cathode circuit, and the triode consisting of the plate to grid to cathode circuit. There is thus a doubling of function in the grid to cathode circuit.

Since the higher the amplitude of oscillation the greater the amount of grid current, and the higher the resultant negative bias, the plate current is reduced the greater the amplitude of the oscillation voltage. Hence a leveling effect is introduced, one reason why leak and condenser tend to stabilize an oscillator. The two effects, a. c. oscillation voltage and d. c. bias voltage, work oppositely, and to about the same degree, and therefore the tube is maintained in



Looking underneath the wired signal generator.

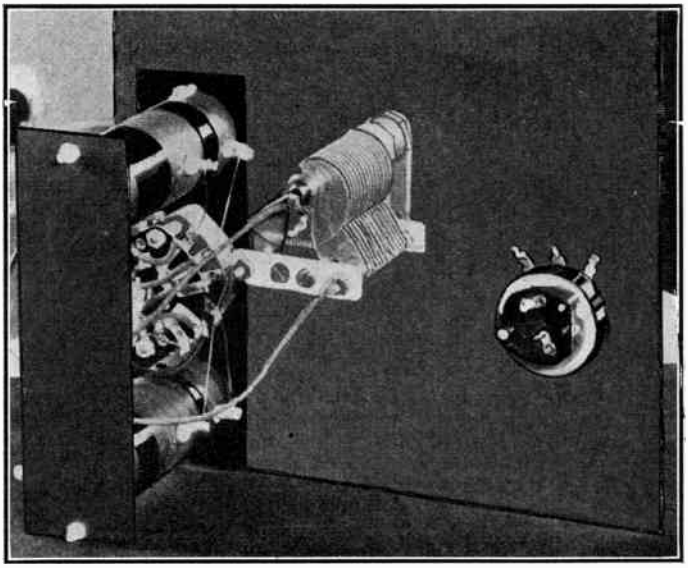
operation nearly like a pure resistance. When a circuit behaves as a pure resistance the frequency stability is complete. A pure resistance is one that has no capacity or inductance, hence is nonreactive, i. e., has the same behavior for all frequencies or zero frequency (d. c.).

Tracking a Dial

The circuit uses a .00035 mfd. tuning condenser, and this, along with the cathode connection, is switched to pick up any one of five coils to cover the whole radio frequency and intermediate frequency range, with sufficient overlap between adjacent bands. If the frequency calibrated dial is to be used with this circuit it will coincide the generated frequencies with the direct readings on the

(Continued on next page)

S.F.L. Tuning With National Condenser



BY using a straight frequency line condenser, something not many manufacturers make, one may enjoy short-wave tuning on equally-spaced frequency basis for equal linear displacement. This means no crowding any part of the dial to favor any other part. On this basis, also, straight numerical dials may be frequency related. This usually works most easily for maximum capacity reading 0 and minimum 100.

Herewith is shown a coil assembly for a Hartley circuit. Two 1¼ inch forms are used, two coils on each, and one half-inch form (not visible, by put at a 45 degree angle to the others). The short-wave band is covered in five steps, 530 to 22,000 kc, with the National .00015 mfd. s. f. l. condenser (Cat. No. SE-150), following the winding data given below. There is adequate overlap. Any Hartley oscillator circuit may be followed. If regeneration is to be applied to a heater tube, cathode is connected to an r. f. choke of 2 mlh. up and to one side of a 10,000-ohm rheostat. Other side of choke to ground and other side of rheostat to tap on the coil. Turn the rheostat to control the regeneration. Battery operation requires connecting tap of coil to B plus, farther coil terminal to grid condenser and nearer terminal to plate. Tuning condenser goes across the whole winding. A general idea of the circuits (without control) will be found in the diagram at top of page 9. A series resistor of 10,000 ohms between tap and B plus affords the battery type regeneration control.

COIL WINDING FOR .00015 MFD., HARTLEY CIRCUIT

			Turns		Inductance	
Band	***Diameter***	***Wire***	***Total***	***Tap***	***Total***	***Tap***
1	½"	22 DCC	13	4½	2.3	.33
2	1¼"	26 En.	11½	4	7.0	1.3
3	1¼"	26 En.	31½	6	39.0	2.5
4	1¼"	26 En.	57½	8	83.0	4.0
5	1¼"	26 En.	121½	9	215.0	4.8

Making Calibrated Dial Coincide

(Continued from preceding page)

dial only if a particular condenser is used, and the right inductances. Any who desire to calibrate their own oscillator may do so from data printed in the February, 1936, issue of RADIO WORLD (pp. 29 and 30). The present coils will suit any condenser, .00035 mfd. up, but much above .00035 mfd. will produce crowded, enlarged bands.

The schematic diagram gives in practically the only possible way a bird's-eye view of the circuit. This is seen to consist of the radio frequency oscillator, the audio frequency oscillator and the rectifier. The attenuator serves to adjust the output to the desired level for intermediate frequencies.

[Data on aligning signal generators were printed in the January, 1936, *issue, pp.* 45-47.]

A 50-Watt Transmitter

261-A Output for Phone—Coil Data Given

By M. N. Beitman

THE W9NSK phone transmitter, owned by A. Marx, of Chicago, is excellently suited for a medium power station. The rig is constructed in a manner to take the greatest advantage of inexpensive and simple parts without any sacrifice of operating efficiency or appearance.

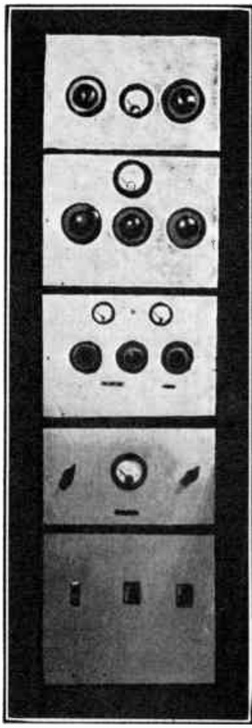
The unit is constructed in the conventional relay rack style, using a sturdy wooden frame for economy. The panels are three-ply wood attractively finished with shiny aluminum paint, giving the outfit a professional appearance. The black dials and meters are well set off by the lighter background. The top relap rack cover is also made of plywood and has two lead-in insulators for the transmission line.

Stages Explained

Conventional, well-filtered power supplies are employed and are controlled by means of the switches on the lower panel. Directly above the power supplies, on the second shelf, is located the modulating unit. This modulator is well designed and possesses exceptionally good frequency response characteristics. A double-button carbon microphone is coupled to a 56 type tube by means of a microphone matching transformer.

The first stage is resistance coupled to another 56 tube which in turn is transformer coupled to a pair of 2A3's in a push-pull Class A circuit. This 2A3's stage is used to drive without distortion a pair of 10's iin a class B circuit.

(*Continued on page* 26)



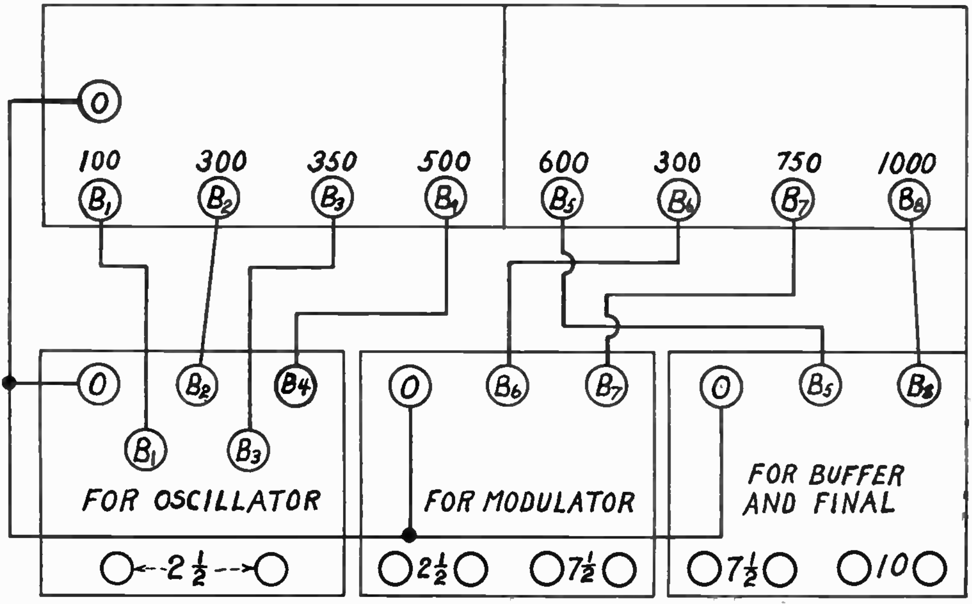
The final stage is on top. The meter reads the plate current of the 261A.

Next comes the buffer, on the way down. This is a 10 tube, plate current read by the meter.

The 59's, doubler and oscillator. Left meter reads plate current, right meter grid current when adjusting, both on oscillator.

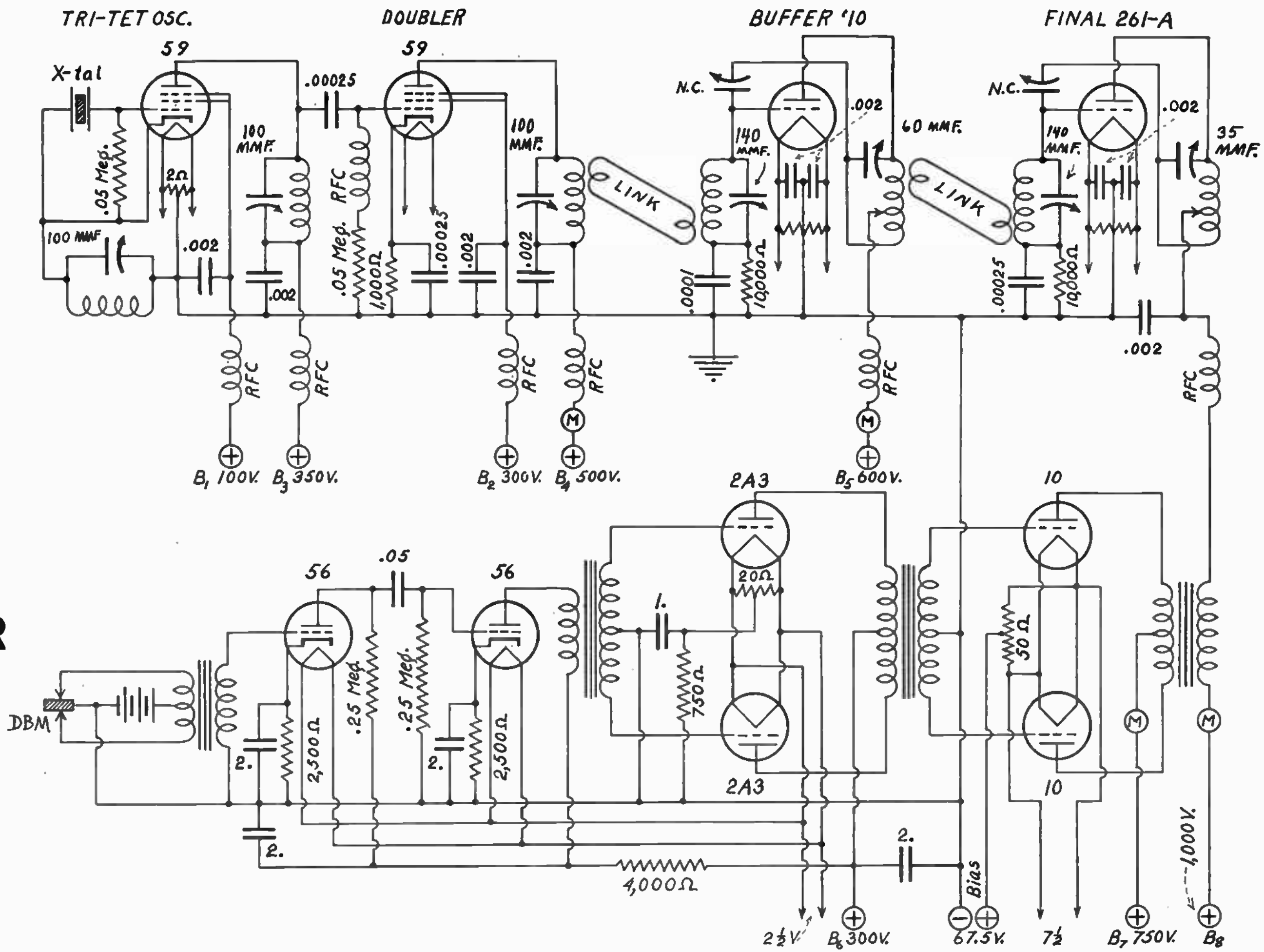
Modulator and power supply. Plate current of modulator's output is read by meter.

Two power supplies are in bottom space—the master p.s. for final and buffer, also the p.s. for the two 59's.

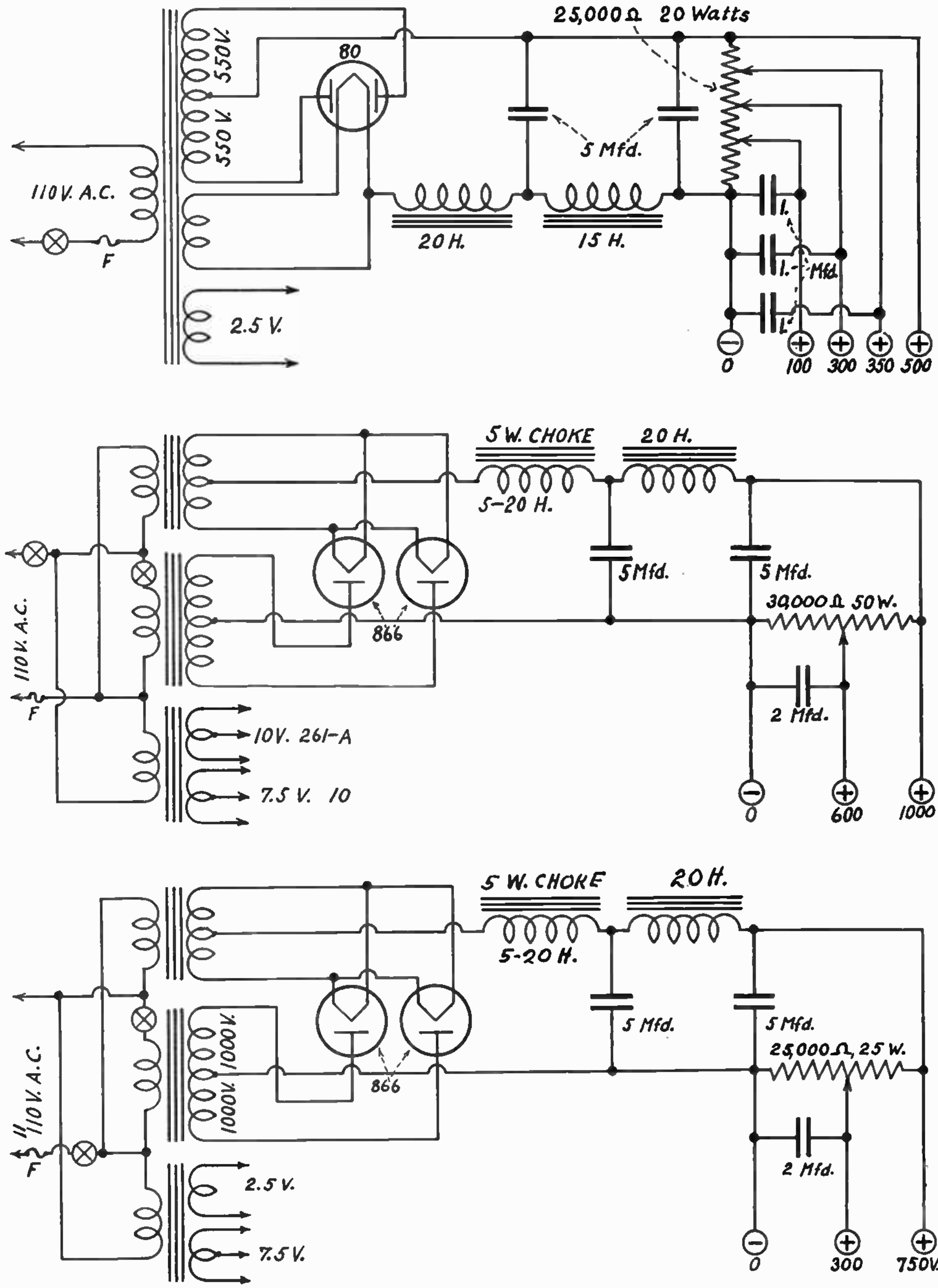


Power supplies above; oscillator, modulator, buffer-final below. Interconnection of units is shown.

CRYSTAL IS SAFE; "LINKS" JOINING STAGES. ALL HERE EXCEPTING THE POWER SUPPLIES (P. 25).

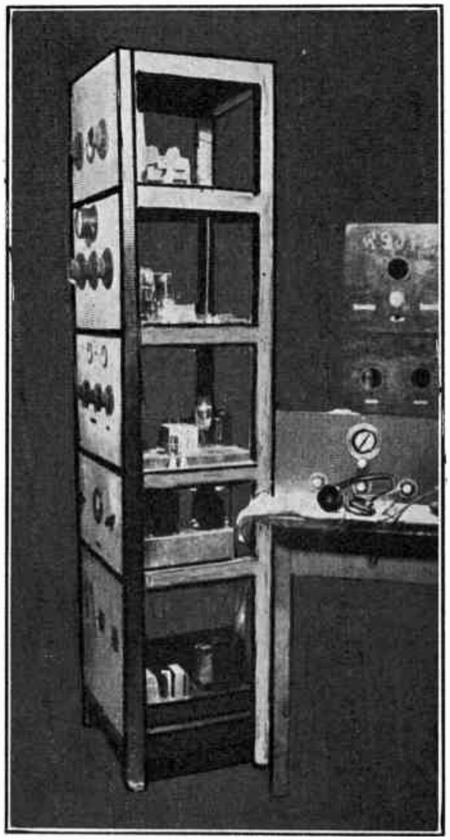


Transmitter's Three Power Supplies



The power supplies, top to bottom: (1) for oscillator and doubler; (2) buffer and final; (3) speech amplifier.

(*Continued from page 23*)
With 750 volts on the plates of the tubes of the last stage a maximum of 50 watts of audio power is obtainable.



Rack construction was used, although the rack was a home-made wooden affair. Careful workmanship and finishing made the appearance unusually attractive.

For stability and simplicity a 59 tube is used as a tri-tet oscillator. All danger of damage to the piezo-electric crystal is avoided by operating the oscillator within the safe limits. The oscillator is capacity coupled to another type 59 tube used either as r.f. amplifier or as frequency doubler, depending on the frequency desired.

Plate Modulation

This stage in turn is link coupled to a type 10 tube used as a buffer and neutralized in a conventional manner. The final stage uses a Western Electric type 261-A as a class C amplifier. All coils used in the buffer and final stages are of the plug-in variety for easy interchange of transmission frequency.

The last stage is also plate modulated by means of a suitable modulating transformer. The use of radio frequency chokes wherever effective completely eliminates undesirable r.f. radiation and coupling. The adjustment of operating frequency and neutralization is simple and direct. Milliammeters in the different plate circuits indicate whether correct operation obtains.

Worth Following

While this transmitter does not possess anything remarkably different from standard design, it does combine simplicity, economy and high efficiency. Any amateur thinking of enlarging or rebuilding his station would do well to make his transmitter along these lines.

Spring-Summer Catalogue Issued by Allied Radio

Allied Radio Corporation, of 833 West Jackson Boulevard, Chicago, has issued a 136-page complete Spring and Summer catalog. It shows the very latest lines of receivers, sound equipment, test instruments, replacement parts, radio builders' kits, amateur equipment, etc. It features beautiful rotogravure sections. It is intended for dealers, servicemen, amateurs, radio builders and experimenters.

Coil-Winding Information

FOR 20-METER OPERATION
WITH 40-METER CRYSTAL

Component	*Osc.*	*Doubler*	*Buffer*	*Final*	*Ant.*
Grid Coil	27 Turns No. 22 Wire 1½" Tube		5 Turns No. 18 Wire 2¼" Tube	6 Turns No. 16 Wire 2¼" Tube	Link Coupled
Grid Condenser	100 MMF.		140 MMF.	140 MMF.	
Plate Coil	15 Turns No. 18 Wire 3" Tube, Spaced 3/32"	20 Meter 6 Turns No. 18 Wire 2¼" Tube	9 Turns, Tapped 3 T. From Bot'm No. 16 Wire 2¼" Tube	9 Turns, Tapped 3 T. From Bot'm No. 14 Wire 3" Tube	
Plate Condenser	100 MMF.	100 MMF.	60 MMF.	35 MMF.	

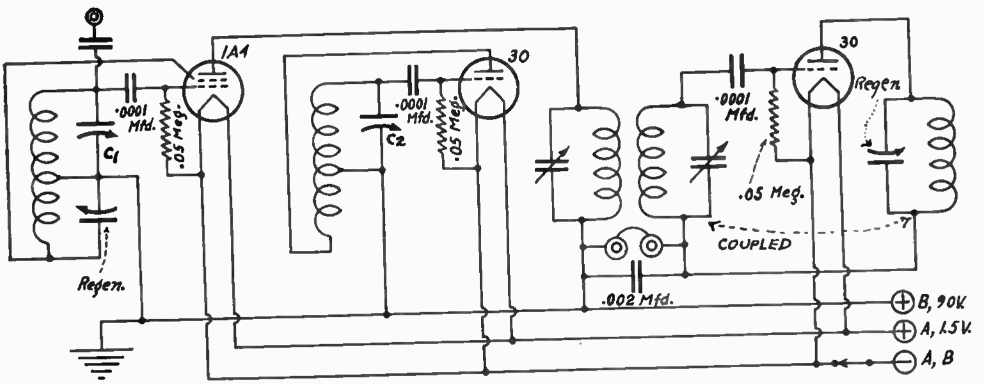
* * *

Link Coupling: 2 Turns No. 14 Wire.

The Three-Tube Pluperker

Scarcely Possible to Do More With These Tubes

By Edgerton Cady



Really a sensitive and selective receiver—a superheterodyne no less. Where's the intermediate amplifier tube? It's the second detector!

A THREE-TUBE circuit. What is it? You might say it was Colpitts oscillator, just looking at the two variable condensers at left. Then another oscillator for some reason, not clear. Then some kind of reflexing. Phones in the position occupied somewhat suggest a reflex. And we thought the days of reflexing were gone forever.

Well, the circuit is nothing like that. Three tubes are right, the rest is wrong. This is a complete superheterodyne for battery operation, earphones only. The first tube is the regenerative modulator. The second tube is the steady local oscillator. The third tube is the second detector, also regenerative.

Where's the intermediate amplifier tube? Possibly the draftsman forgot to put it in. We'll get along without it.

I.F. Amplification Nevertheless

This is to be a three-tube affair, remember, and if there were an intermediate amplifier tube we'd have four tubes. Besides, since the second detector is regenerated, we may say that this tube contributes amplification at the intermediate frequency (and it does), so there's your i.f. amplifier.

Now that the secret is out let us analyze the circuit line by line, as it were. First we may consider the antenna series condenser, upper left, which should be about 15 mmfd (.000015 mfd.), but as one may not have ready access to fixed capacities of such micromicrofaradacity, he may improvise a condenser by taking a foot of ordinary insulated hookup wire, bending it back on itself, so that now we have two six-inch prongs of a sort of hairpin, and twisting the wire together, thus bringing the length to about 3 inches, snip the U with pliers to make two separate wires, and use one end of one wire for connection to stator of the thing condenser and other end of the other wire for connection to aerial. Or it is all right to use one end of one piece of wire and the companion end of the other piece?

Our interest is short waves—broadcast band results being not so hot on this device, although that band may be included for completeness. For short waves or any other waves we must get our regeneration working properly.

Now, the input circuit is a Hartley oscillator of the parallel fed type, where the screen of the 1A4 is used for feedback, the amount of which is controlled by the regeneration condenser setting. It is not intended that there shall be oscillation, that is, generation of radio waves, but only so much feedback as needed to produce high sensitivity and selectivity in this stage.

The oscillator is not shown as coupled in any particular way. If the broadcast band were to be considered there would have to be some coupling that would appear on the diagram, but when we are dealing with short waves, and particularly where the modulator is regenerative, there is coupling even if the two tubes are close together.

Feedback Specialty

The position of the coils in respect to each

(*Continued on next page*)

Simple, Sound, Certain

Is This 2-Tube A.C. 9-600-M. Receiver

By Guy Stokely

Eilen Radio Laboratories

THIS little two tube short wave receiver has been designed to meet the needs of the short wave fan, whether beginner or old timer, seeking greatest possible results at least cost. All-electric in operation, requiring no batteries, and using two inexpensive tubes, with self-contained power supply, this sensitive receiver is capable of results surprising even to the most optimistic.

During a single evening, while listening in New York City, the author picked up with excellent headphone volume numerous stations in Europe, Central and South America, and Hawaii, as well as many North American stations. When the set is attached to an amplifier full loudspeaker volume is obtainable even on the overseas stations.

Cabinet 5 x 4 x 2½ Inches

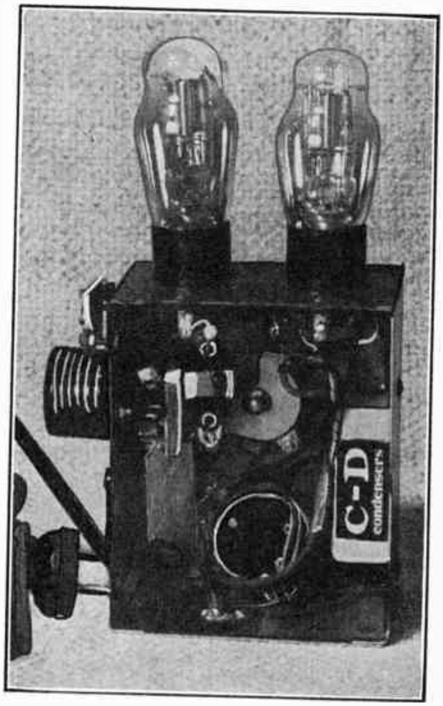
The entire receiving unit is built into a small metal cabinet, finished in black crackle lacquer, and measuring only 5 inches high by 4 inches wide by 2½ inches deep. This is an attractive size for the fan who wishes a portable receiver or who has limited space available for permanent installation.

The large dial is the main tuning control. Mounted directly underneath it is the regeneration control. On the right are the antenna series condenser, coil socket for the plug-in coils, and the headphone jack. Both tubes are mounted on the top of the framework.

Inspection of the diagram reveals the use of two type 37 (or 76) tubes, one functioning as a regenerative detector and the other as rectifier of the a.c. line voltage.

The aerial connects to the receiver through a series condenser, C1, and having a maximum capacity of 85 mmfd. This condenser is adjustable and should be reset each time a different coil is plugged into the coil socket.

The tuning condenser, C2, .00014 mfd., is mounted directly on the metal cabinet and tunes the coil L1. Feedback is accomplished by means of the second coil, L2, which is wound on the same form as L1.



Compactness is no name for it. To make it any smaller you'd have to ionize it.

(Continued on next page)

Getting Regeneration at the I.F.

(Continued from preceding page)

other, plus the stray coupling through the wiring, the common supply, etc., gives a beat, or difference frequency between oscillator and modulator, to enable the intermediate transformer to do its intended work.

That transformer is seen as if pedestaled on the earphones, having primary and secondary tuned, and is of the 465 kc type. So that a standard transformer might be used, feedback is accomplished by winding 60 turns of any fine insulated wire on ⅜-inch diameter dowel stick, raggedly or any other way, connecting intended coil return in the return of the transformer secondary to one side of this new coil, and cementing the new coil to the dowel on which the regular transformer is wound.

It is noted that the regeneration coil is "coupled" to the other as stated on the diagram, meaning of course inductively coupled, but if the regeneration coil is a small honeycomb, a few hundred microhenries, there will be regeneration possibilities without inductive coupling and an extra coil may be external.

(*Continued from preceding page*)

The choice of a suitable grid leak and grid condenser combination is very important in order to assure maximum sensitivity. Values of .00025 mfd. and 2 meg. will produce very good results. Regeneration is controlled by the potentiometer, R2, 100,000 ohms, of tapered resistance curve for smoother control. The bypass condenser C4, .00025 mfd., helps to keep radio frequency currents out of the phones and also serves as an aid to regeneration and detecting efficiency generally.

The output of the line rectifier tube is passed through the B filter system consisting of a dual 4 mfd. electrolytic condenser and a 50,000 ohm filter resistor. The result is a perfectly hum-free power supply which gives ample voltage to run the receiver. The heaters of both tubes are connected in series. A resistor, 350 ohms, which is built inside the line cord, serves to reduce the voltage to the proper value for the heaters.

Range Is 9 to 600 Meters

Five plugin coils enable the receiver to cover the entire range of 9 to 600 meters, picking up innumerable amateurs, short wave broadcast stations, police calls, experimental and television stations, as well as a host of code signals.

In tuning, turn the regeneration control until a hissing sound is heard in the phones. If none appears, then adjust the aerial series condenser slightly until one is audible. Next, turn the tuning dial until a station whistle is heard. Back off slightly on the regeneration control until the whistle disappears and the voice or music comes in clearly.

Farewell, Nick!

By Roland Burke Hennessy

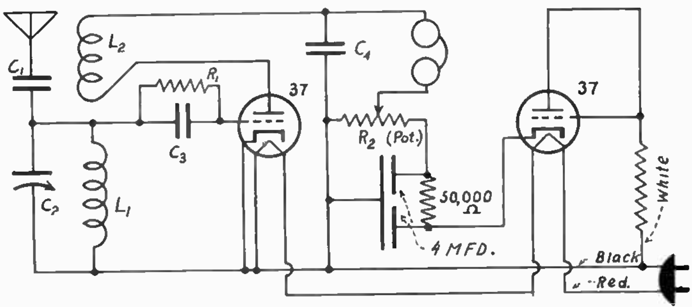
Nicholas Palumbo: 1903-1936. Nick came to Times Square as a newsboy of eight and for years he faithfully served the public at the Dave Farley stand in the Times Building. On February 1, 1936, following an auto accident, he passed out, after twenty-five years of devoted service to friends and employer, leaving behind him the reputation of a truly great human being.

Times Square has lost a treasured friend,
And one who served it well;
On him the Square did long depend
As all his pals could tell.
From little lad to manhood grown
He worked and kept his smile;
His trust with public, boss, his own
And happy all the while!

We saw him there, year in, year out,
All smiles, and kindly, too.
If he could help there's not a doubt
He'd see the whole thing through.
You didn't have to be a man
Of wealth or culture great;
What really fitted with his plan
Was helping out a mate.

The copper on that beat is sad;
The customers and boss
Are missing that fine, friendly lad,
And how they mourn his loss!
O Nick, you labored early, late,
Your life was decent, fair;
You've left us for St. Peter's gate,
You're making friends Up There!

—THE AMERICAN NEWS TRADE JOURNAL.



R2 is a 100,000-ohm potentiometer for regeneration control in this two-tube 9-to-600-meter universal receiver. This is the smallest practical all-wave set that can be built for humless operation.

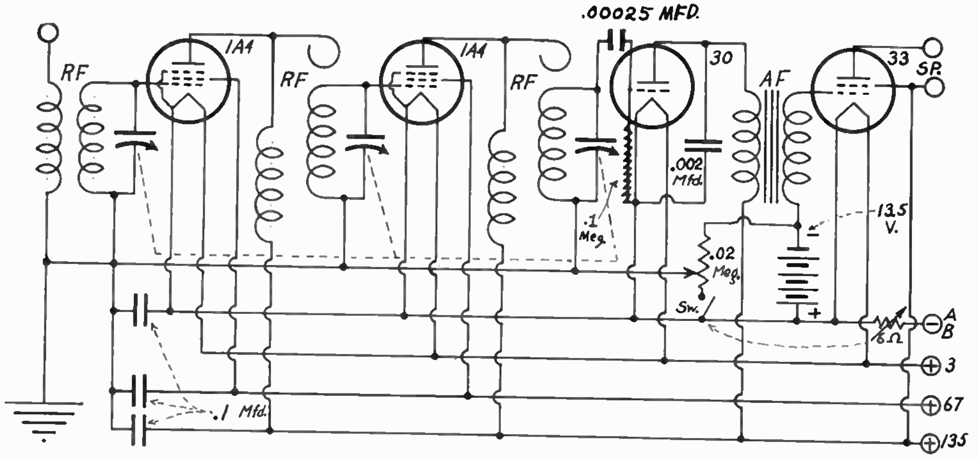
Phase Shifting as a Remedy for Fading

COULD not fading be cured by phase shifting, and might this not be accomplished by a capacity or coil circuit or a combination of the two?

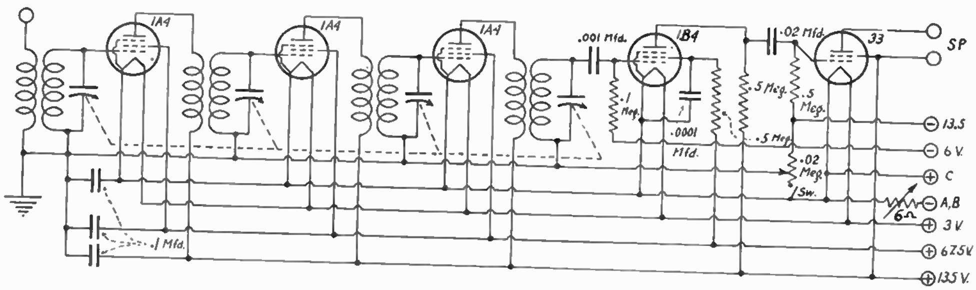
It should be possible to reduce fading effects greatly, by attacking the problem in the manner you suggest, as one involving phase shift. If nature introduces this shift it should be possible for man to get nature to supply the counteractive agency. So far this has not been accomplished. Automatic volume control as a deterrent of fading effects is a mild help and more completely effective means may well be expected, although there is nothing at yet in sight along this line.

A quick, complete relay is being sought.

Three Battery-Operated Sets

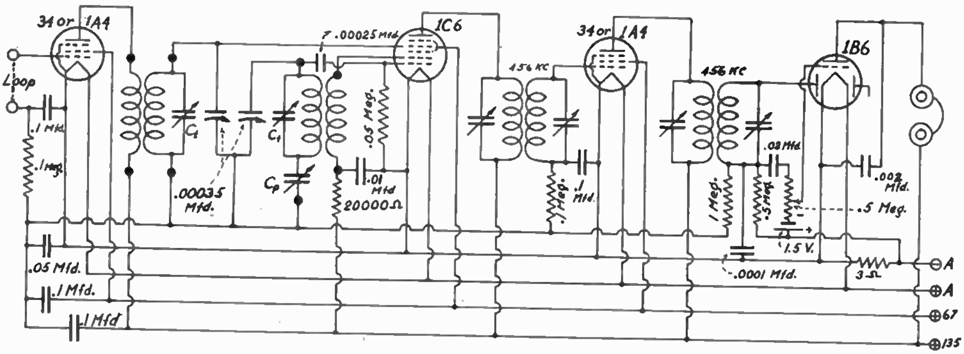


This one has four tubes, tuned radio frequency, 33 tube as output, and gives a tonal quality even at low volume that other types of output (e. g. Class B) do not provide at low levels.

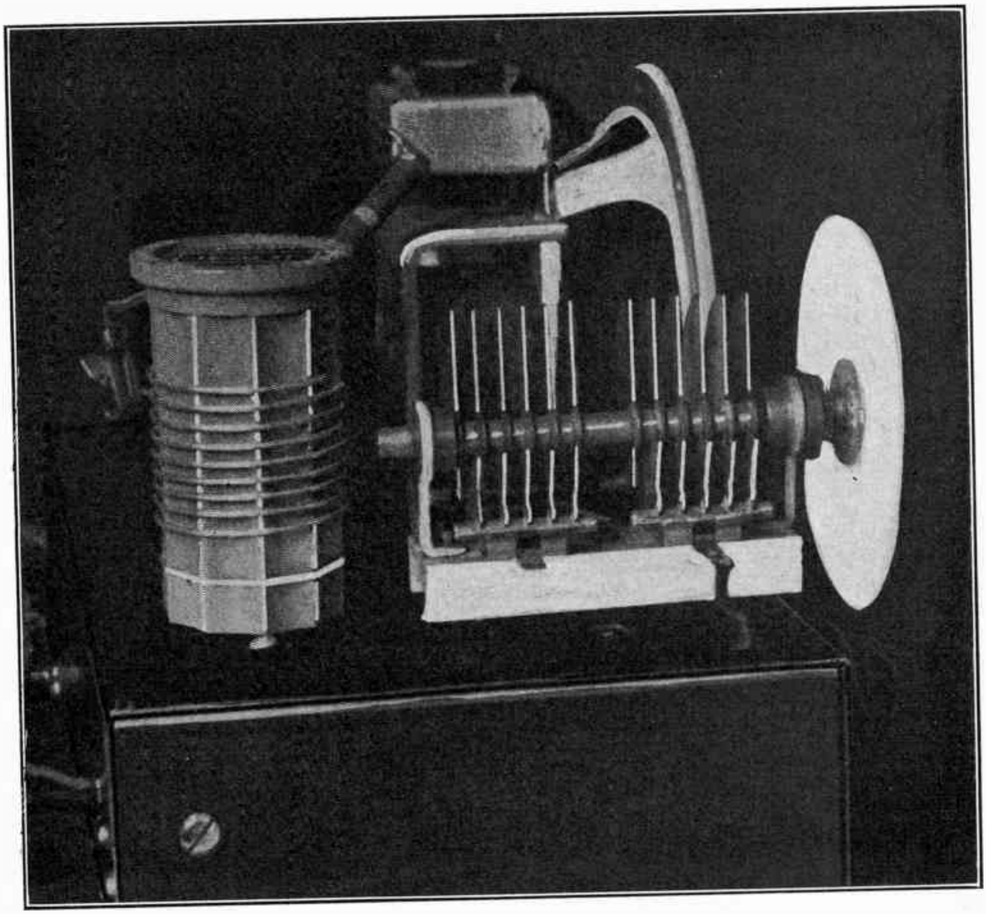


A four-gang condenser this time, otherwise about the same as above, only low gain coils must be used to prevent overloading.

Circuit for Locating Interference



This is a superheterodyne, loop operated for direction finding. Moving in the wrong direction there's decline, right direction, increased interference.



An end view of the universal all-wave set, showing the dual bandspread condenser C7 and C8.

More and More Bandspread

By Adding One or Both Gang Sections

By Harry G. Cisin

THIS five-tube a-c, d-c receiver is all-wave plug-in, regenerative, and resistance coupled. Besides, it has a stage of radio frequency amplification—this is needed and advantageous. To increase the selectivity on standard broadcast (1,600-530 kc) signals, provision is made for cutting out the r.f. amplifier and coupling the antenna directly to the regenerative circuit through a 3-30 mmfd. condenser. For highest selectivity this condenser is set at its minimum capacity.

The regeneration is controlled by variation of the plate voltage of the detector or second tube. The plate returns to a 75,000 ohm potentiometer which constitutes the lower part of a 100,000 ohm voltage divider across the maximum voltage available in the circuit. The voltage on the plate, therefore, may be varied from zero to about 75 per cent of the maximum. A greater range of control is not needed. The plate circuit is well by-passed in respect to the high frequencies so that there is no change in the tuning as the regeneration control is manipulated.

The tuning condenser across the secondary of the plugin coil consists of three parts. First there is a 140 mmfd. section which may be

(*Continued on page* 36)

Tally of Material for Bandspreader

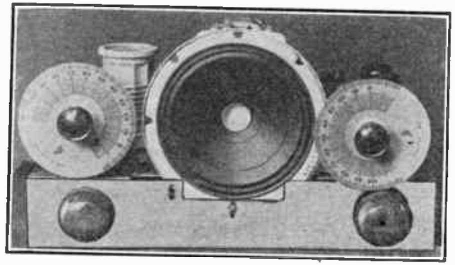
LIST OF PARTS

Coils

L1—One Set of 4-prong short wave coils, 17 to 270 meters, Hammarlund, type SWK-4.
L1—One four prong Broadcast Coil, 250 to 560 meters, Hammarlund type BCC-4.
One four prong wafer socket for plug-in coils.
CH1—2.1 mh. midget R.F. Choke, Hammarlund, type Ch-X.
CH2—300 ohm, 30 henry Audio Filter Choke.

Condensers

C1—Equalizer antenna trimmer, 2 to 30 mmf, Hammarlund type MEX.
C2—.1 mfd. 400 volt cub tubular, Cornell-Dubilier type BA-4P1.
C3—.1 mfd. 400 volt cub tubular, Cornell-Dubilier type, BA-4P1.
C4—Equalizer antenna trimmer, 2 to 30 mfd., Hammarlund, type MEX.
C5—.0001 mfd. Mica Condenser, Cornell-Dubilier, Type 3L.
C6—140 mmfd. variable condenser, Hammarlund, type MC-140-S.
C7, C8—33 mmfd. (each section) split stator double spaced condenser, Hammarlund, type MCD-35-MX.
C9—.1 mfd. 400 volt cub tubular condenser, Cornell-Dubilier, Type AA-4P1.
C10—.0005 mfd. Mica Condenser, Cornell-Dubilier, type 1W.
C11—.01 mfd. 400 volt cub tubular condenser, Cornell-Dubilier, type BA-4S1.
C12—.1 mfd. 400 volt cub tubular condenser, Cornell-Dubilier, type BA-4P1.
C13—.01 mfd. 400 volt cub tubular condenser, Cornell-Dubilier, type BA-4S1.



This is how the all-wave receiver looks from the front when the cabinet has been removed.

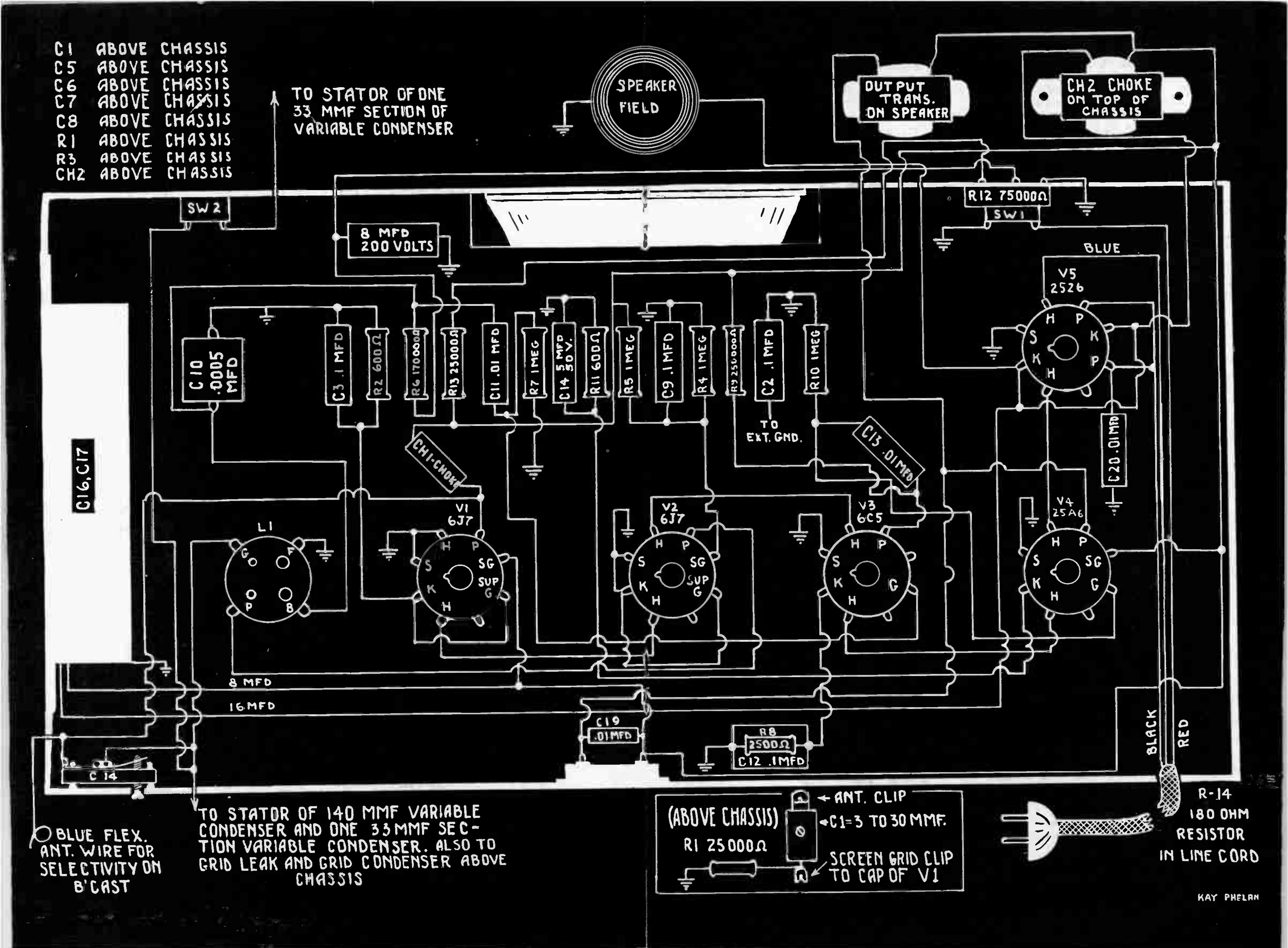
C14—5 mfd, 50 volt tubular electrolytic condenser, Cornell-Dubilier, type ED-3050.
C15—8 mfd, 200 volt tubular Electrolytic Condenser, Cornell-Dubilier, type ED-7080.
C16-C17—Dual section dry electrolytic condenser, cardboard container, 16 mfd, and 8 mfd, 150-200 volts, Cornell-Dubilier, type MA-11261.
C18, C19—.01 mfd, 400 volt cub tubular condenser, Cornell-Dubilier, type BA-4S1.

Resistors

R1—25,000 ohm ½ watt, I.R.C. Metallized Resistor.
R2—600 ohm 1 watt, I.R.C. Metallized Resistor.
R3—1 meg, ½ watt, I.R.C. Metallized Resistor.
R4—1 meg, ½ watt, I.R.C. Metallized Resistor.
R5—1 meg, ½ watt, I.R.C. Metallized Resistor.
R6—170,000 ohm, ½ watt, I.R.C. Metallized Resistor.
R7—1 meg, ½ watt, I.R.C. Metallized Resistor.
R8—2500 ohm, ½ watt, I.R.C. Metallized Resistor.
R9—250,000 ohm, ½ watt, I.R.C. Metallized Resistor.
R10—1 meg, ½ watt, I.R.C. Metallized Resistor.
R11—600 ohm, 10 watt Vitreous Enameled Electrad Resistor.
R12—75,000 ohm Electrad Potentiometer with Switch, (SW.2) type 202S.
R13—25,000 ohm ½ watt I.R.C. Metallized Resistor.
R14—180 ohm, 50 watt resistor in Line Cord.

Other Requirements

Five octal sockets for metal tubes.
Two 6J7 tubes V1, V2.
One 6C5 tube, V3.
One 25A6 tube, V4.
One 25Z6 tube, V5.
One Five inch Dynamic Speaker with 2500 ohm field and 5000 ohm output transformer.
SW1—S.P.S.T. Toggle Switch.
SW2—Switch on Potentiometer, R12.
One metal chassis 11 inches x 5½ inches x 1⅞ inches.
Two calibrated Crowe dials.
Four Crowe knobs.
One Fahnestock Clip, 2 Screen grid clips for metal tube caps.
One roll push-back hook-up wire.
One earphone twin jack.



C1 ABOVE CHASSIS
C5 ABOVE CHASSIS
C6 ABOVE CHASSIS
C7 ABOVE CHASSIS
C8 ABOVE CHASSIS
R1 ABOVE CHASSIS
R3 ABOVE CHASSIS
CH2 ABOVE CHASSIS
TO STATOR OF ONE 33 MMF SECTION OF VARIABLE CONDENSER
SPEAKER FIELD
OUTPUT TRANS. ON SPEAKER
CH2 CHOKE ON TOP OF CHASSIS
SW 2
8 MFD 200 VOLTS
R12 75000Ω
SW1
BLUE
V5 25Z6
C10 .0005 MFD
C3 .1 MFD
R2 600Ω
R6 170000Ω
R13 25000Ω
C11 .01 MFD
R7 1 MEG
C14 5 MFD 30 V.
R11 600Ω
R5 1 MEG
C9 .1 MFD
R4 1 MEG
R9 250000Ω
C2 .1 MFD
R10 1 MEG
TO EXT. GND.
CH1-CHOKE
C13 .01 MFD
C20 .01 MFD
C16, C17
L1
V1 6J7
V2 6J7
V3 6C5
V4 25A6
8 MFD
16 MFD
C19 .01 MFD
R8 2500Ω
C12 .1 MFD
C 14
BLACK
RED
BLUE FLEX. ANT. WIRE FOR SELECTIVITY ON B'CAST
TO STATOR OF 140 MMF VARIABLE CONDENSER AND ONE 33 MMF SECTION VARIABLE CONDENSER. ALSO TO GRID LEAK AND GRID CONDENSER ABOVE CHASSIS
(ABOVE CHASSIS)
R1 25000Ω
ANT. CLIP
C1=3 TO 30 MMF.
SCREEN GRID CLIP TO CAP OF V1
R-14 180 OHM RESISTOR IN LINE CORD
KAY PHELAN

(*Continued from page* 31)

called the major control. Then there are two smaller variables used for double bandspreading. Condensers C7 and C8 are a two-gang.

Since C6 is the tank or tuning condenser, when one section of the two-gang is permanently across C6 another section may be switched across both C6 and C7 to afford double bandspread. For instance, C7 may be left at minimum capacity, when it has negligible effect upon C6. Then no matter what position C6 is at, C7 may be used to lower the frequency. When the lowest possible frequency is reached, considering C6 unmolested and C7 at maximum, then the second section, or C8, may be switched in and the frequency is lowered some more and a desired band is spread out on the dial.

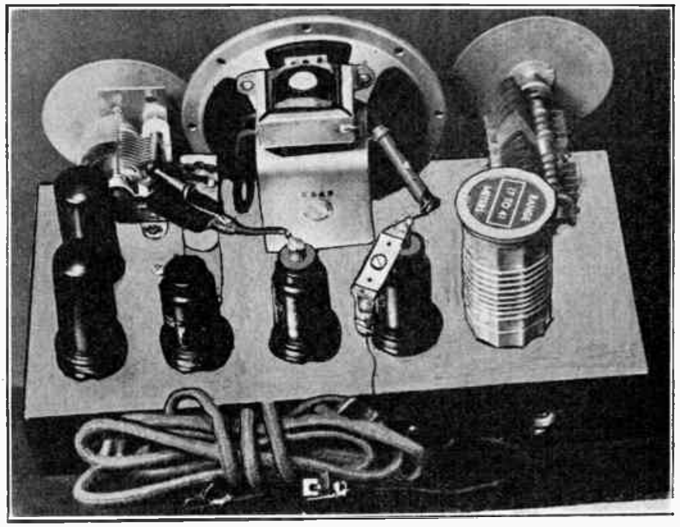
The series antenna condenser C1 should be adjusted so that there is oscillation on the highest frequency of the highest frequency band. C4 is adjusted so that the squeal due to the beating with a station around 50 meters is maximum.

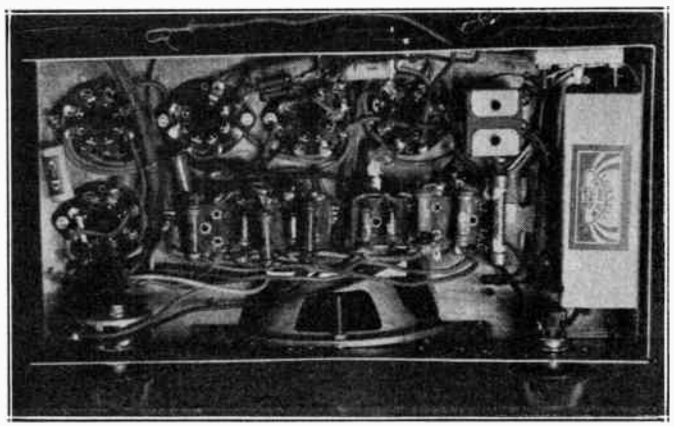
In building any universal set always be careful not to have a direct ground connection to the returns of the circuit that are made to the line. Therefore read what is commonly taken as the ground symbol not as representing external ground but simply as denoting the chassis. Between external or real ground and chassis is a condenser of .1 mfd., denoted C2, at left in the schematic diagram. The highest number on any condenser is C19, which is the .01 mfd. across the phones. In the pictorial or so-called blueprint, read C20 as C18.

The untuned r.f. stage stabilizes reception against swinging antennas or other reactive effects and also reduces radiation practically to nothing.

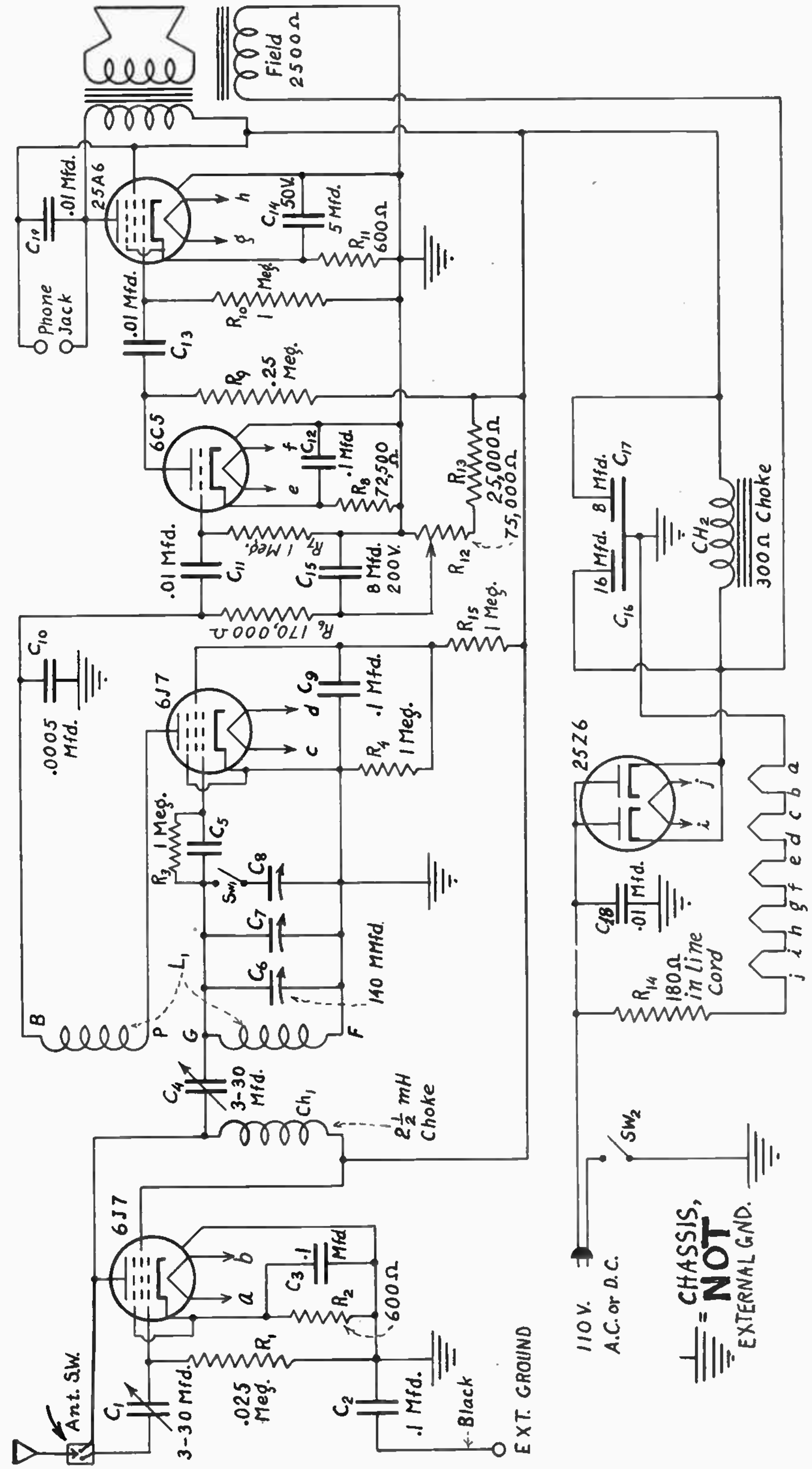
'Phone Provision

The provision for listening in with phones is under circumstances of maximum reduction of static effects, since these when heard are in the relatively high audio frequency region. The .01 mfd. condenser across the phones almost wipes them out and also reduces the general intensity which otherwise would be too high for phones. Taking phones as found, the impedance is relatively low so that a condenser of .01 mfd. is not fatally large. That appliies also to the primary of the output transformer, across which the 'phone connection is taken. The companion bypass condenser across the signal line is .0005 mfd., because it shunts a high impedance, .25 meg.





A clear top rear view of the universal receiver with all the tubes and the coil in place is shown above, while at left is a picture of the wired bottom plane of the universal receiver.



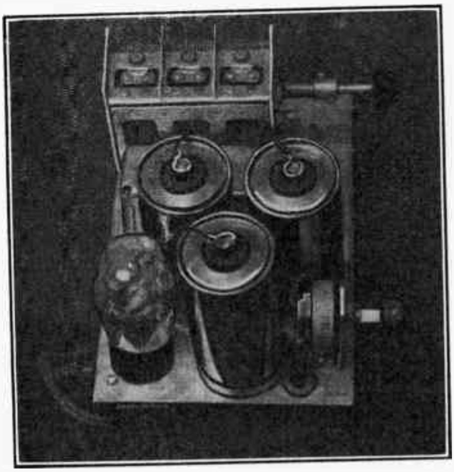
The complete diagram of the five-tube universal receiver, indicating values of all essential parts. Blueprint is on following two pages.

Easy-Going Portable

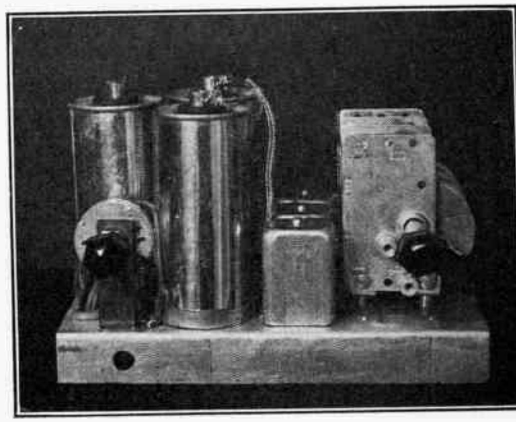
Sensitive, Low-Drain Output Tube Helps a Lot

By Thomas Waite

Thor Radio Company



An inexpensive yet almost imperative tube for a portable such as this is the special 950, shown at left. The three other tubes are in shields.



The volume control with switch is at left and the three-gang tuning condenser is at right. The three high-gain r. f. coils are shown nearly in the center, running front to back.

THE broadcast band portable pictured herewith has four tubes, one of which is the 950, a sensitive output tube, which is advisable for portables of this type, because of low filament drain, only 60 milliamperes, unusual for a power tube. The particular model receiver has been used in metropolitan service, where more selectivity than ordinarily found in a tuned radio frequency set is advisable. This was attained by using very closely matched coils and an excellent grade three-gang condenser for tuning.

The coils are of the high gain type, with honeycomb primaries, and with capacity coupling to the secondary, on account of a turn or two of wire from primary, other end open.

Coils for Volume Reasons

Since there will scarcely ever be any large antenna voltage input, volume on the low frequency stations—say, 700 kc to 530 kc—is supported by the type coils used.

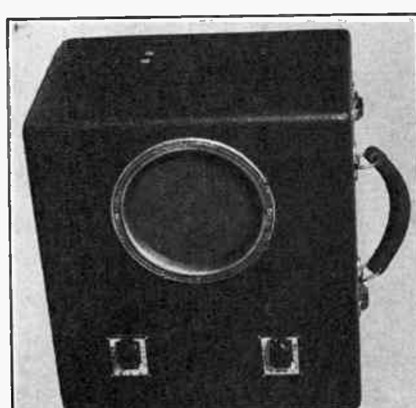
The pictured arrangement may be followed very readily, using a magnetic type speaker put below, and a small chassis put above the horizontal partition. Then the two controls are (1) tuning and (2) volume control with switch attached.

Must Avoid Oscillation

It is imperative to use shields on the tubes, except the power tube. Otherwise the gain can not be pressed as high as required for satisfactory portable performances, without squealing danger. Also, the coils must be shielded. The tubes are in the large cylindrical shields, but the coils are hidden. The rear view of the completed portable, in its carrying case (see next page) affords a view of one of the coil shields, and gives the general idea of the layout.

There is no occasion for going into any

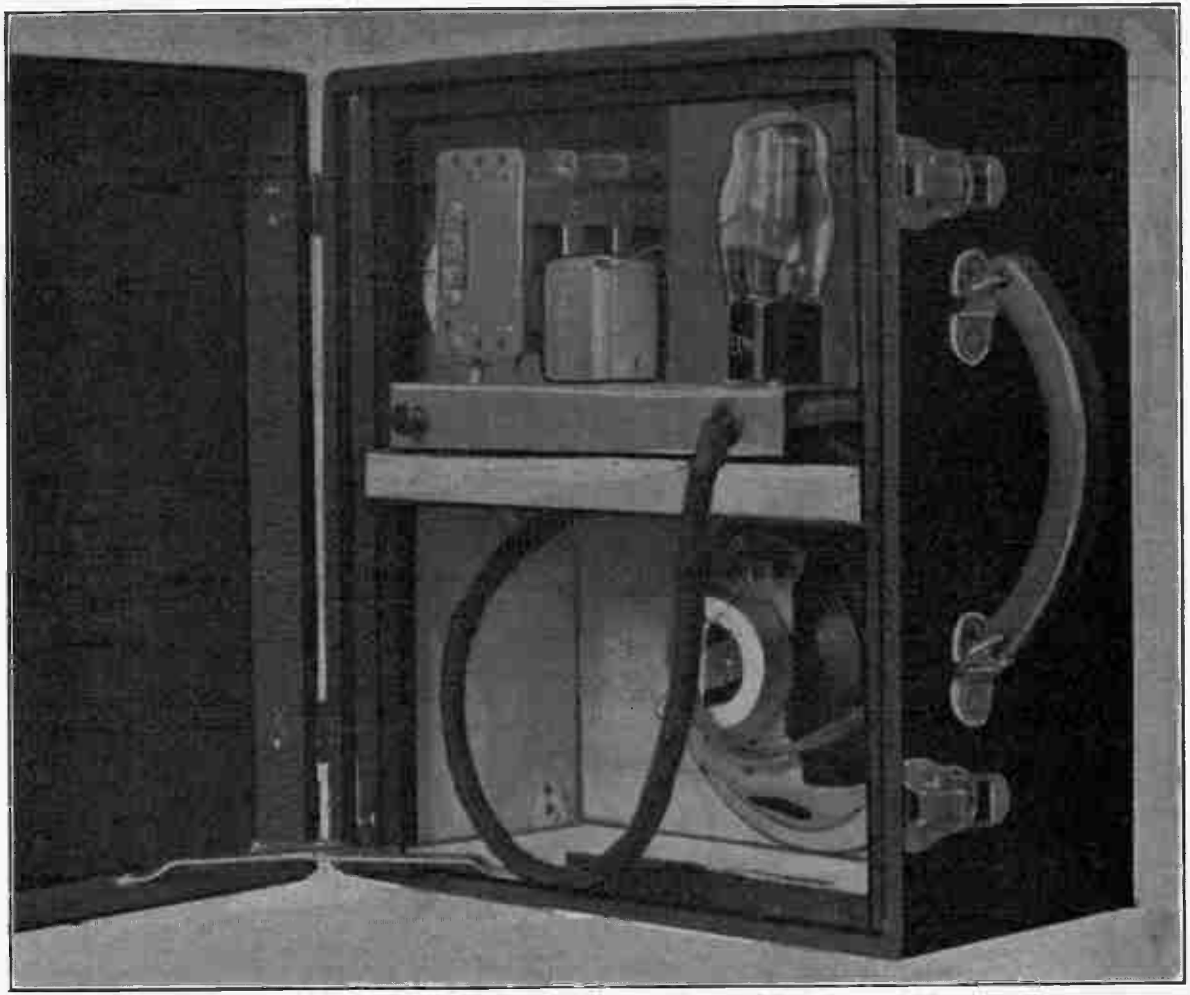
(*Continued on page 39*)

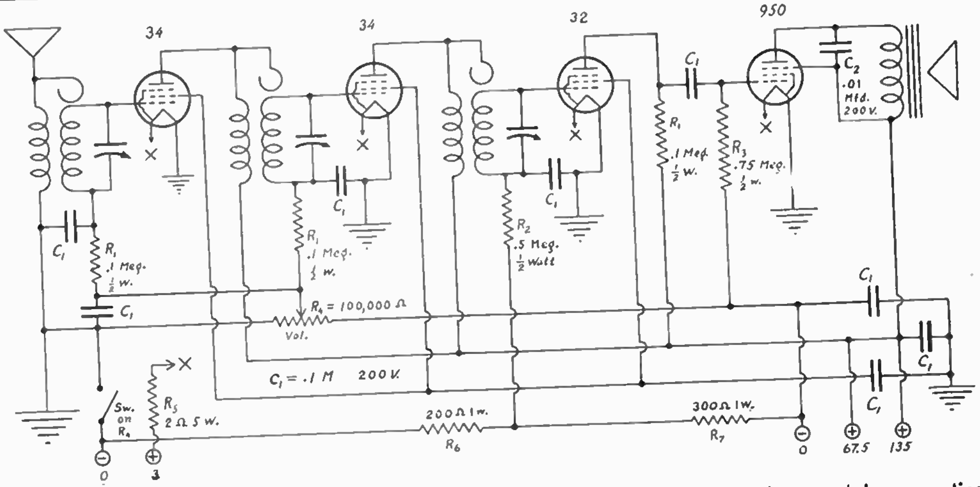


The carrying handle is on the side, so stand up cabinet this way.

PICK UP BY HANDLE AND GO!

(After Closing Cover)





Between A minus and B minus are interposed two series resistors totalling 500 ohms, and by apportionment of grid returns of r. f. and detector tubes, the biases are made different. The A battery is represented at lower left, B battery lower right.

LIST OF PARTS

Coils

Three shielded high gain r.f. coils for broadcast band.

Condensers

One three gang .000365 mfd. tuning condenser, with trimmers (trimmers not shown in diagram).
One .01 mfd., 200 volts.
Eight .1 mfd., 200 volts.

Resistors

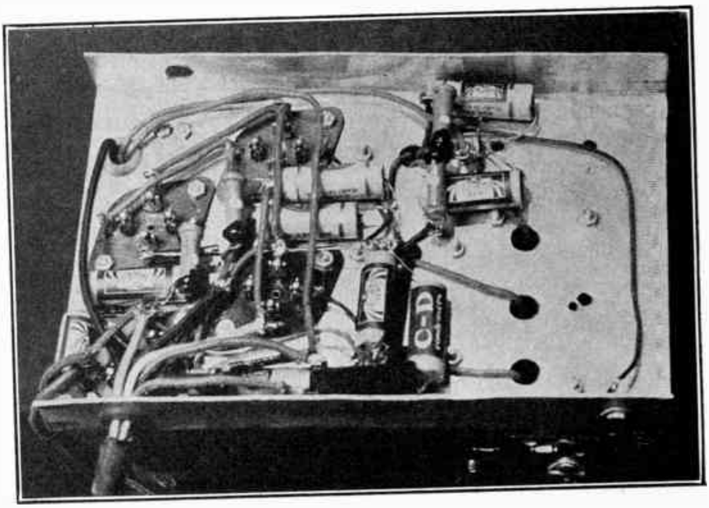
One 2 ohm filament resistor (5 watts).
One 200 ohm (1 watt), one 300 ohm (1 watt).
Three .1 meg. (half watt).
One .1 meg. potentiometer.

Other Requirements

One magnetic speaker.
One carrying case.
One chassis. One five lead cable.
Three four-hole sockets and one five-hole socket.
Four tubes (two 34's, one 32 and one 950).

(*Continued from page 37*)

vernier refinements for the dial, as a knob suffices for such a portable.



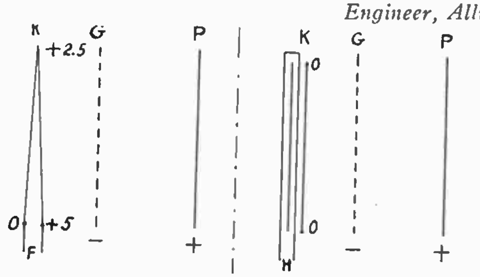
A peek underneath the wired chassis confirms the suspicion there's little work to the connection of the wires of the four-tube broadcast portable.

Basic Facts on Tubes

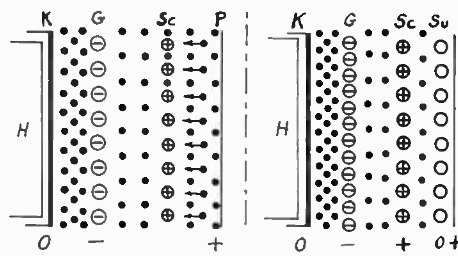
Old Principle Unchanged, Refinements Numerous

By M. N. Beitman

Engineer, Allied Radio Corp.



Relativity of elements of a triode, filament type (left) and heater type (right). Filament F and cathode K are identical (left), but potential is nonuniform, so K is shown at mean. Grid G is the dashed perpendicular, negatively biased, while plate P is the solid line. In the heater type, H is the heater, warming the separate cathode sleeve inside, there being zero potential difference between cathode and grid (unless bias is introduced).



The heater H heats the cathode K and causes emission from the cathode. The current flow is of a certain density, the negative grid G stopping some of the electrons from reaching the plate (fewer dots), the screen SC attracting same electrons rebounding from plate P. At right, the suppressor Su prevents the secondary emission, or rebound current. In that way the suppressor greatly improves the plate efficiency, vastly important in power tubes.

RECEIVING type tubes have had many additional elements added, have been put to new and more versatile applications, have appeared in metal envelopes, but all tubes still operate on the same principles that are associated with the first DeForest audion.

The operation of all vacuum tubes depends on electrons. For the purpose of this article it is sufficient to realize that an electron is an extremely small particle of definite size and mass and having measurable, but very minute, negative charge of electricity.

In all matter, at all encountered temperatures, the electrons are in violent state of motion, revolving usually around their respective positively charged nucleus, but at times leaving their orbits. At such times electrons pass from one molecule or atom to another, or completely free themselves with the aid of some energy present such as some form of heat, X-rays, etc.

Cathode is the Emitter

In ordinary solid matter, although electrons are consistently passing out of the boundaries of the matter, the number of fugitives, comparatively speaking, is insignificant. However, when matter is heated many more electrons escape in the surrounding space.

The element of a vacuum tube used to supply the electrons for the tube operation is known

What's What About Modulation Percentage

WHAT is the significance of percentage modulation as applied to a program modulated carrier, and as applied to a carrier modulated by two tones steady differing somewhat in frequency?

Percentage modulation where two equal amplitude tones of unequal frequencies are introduced into the carrier is a substitute to get the condition approximating that of speech. Where the complex values of a musical program are concerned the percentage modulation can not be stated as being anything in particular, as it is ever changing. One might say that it is so much at a given instant, or that the average is so much. Speech has its complexities, too, therefore the two-tone substitute is far from veracious. The single tone is significant. For that, the percentage modulation is 100d/i, where d is the difference between the peak voltages or currents, with and without modulation, and i is the peak voltage or current without modulation. For complex values the term "percentage modulation" is sometimes used for expressing the capability of the system, hence 100 per cent. modulation expresses the practical depth of the modulation without introduction of modulation distortion. Percentages beyond 100 always represent distortion, although percentages less than 100 may be accompanied by modulation distortion because of inequality.

as the cathode. The cathode may be directly or indirectly heated and may be made of a large variety of materials. A simple directly heated cathode of historic importance is a tungsten wire filament heated by means of electric current.

The phenomenon of electron emission has been carefully analyzed mathematically by Richardson and others, and the emission current has been shown to depend on the nature of the emitting substance and is a function of the absolute temperature.

Variations in Substances

Work is done when an electron is removed from the surface of the cathode and this is accomplished by supplying energy in the form of heat. The smaller the affinity of a substance for electrons, the easier will it be to remove electrons. Tungsten has a great affinity for electrons, so this substance, of itself, is not an efficient emitter and must be operated at very high temperatures, almost white heat, to supply a suitable amount of electrons.

Substances show great variation in their thermionic emitting properties. In selecting a suitable substance for the cathodes of vacuum tubes quite a number of different factors must be considered. In many cases it is possible by combining two substances, each possessing certain favorable factors, to obtain the needed operating conditions.

Indirection and Unipotentiality

Thoriated-tungsten is one such combined substance that is used in commercial application. Although tungsten has a very high melting point, hence may be heated to high temperatures, its strong affinity for electrons makes it by itself an emitter of poor efficiency. However, by coating a tungsten wire with thorium which has very good emitting qualities excellent results are obtainable.

Oxide coated cathodes are also very good emitters. Usually oxides of barium and strontium are used. These oxides are deposited upon a metal core that acts as the filament heater. A great many different materials are utilized for the core, including many alloys. The exact behavior of oxide coated cathodes is not understood and the theories advanced are conflicting in parts.

For alternating current operation an indirectly heated cathode is used, except possibly for an output power tube. In common practice a tungsten wire, carrying the heater current, is surrounded by refractory insulating material that serves as the insulation for the external nickel sleeve. This sleeve is coated with an oxide and serves as the cathode.

In this manner the nickel sleeve keeps relatively constant temperature, although alternating current is actually used to heat the inner tungsten filament. Of advantage also are the facts that an indirectly heated cathode is at constant potential at all points of its surface and is insulated from the heater circuit.

Making Use of Electrons

Electrons by themselves, of course, have no practical application and it is only by employing other elements to receive and to control the stream of electrons that we obtain the invaluable devices made possible by modern vacuum tubes. Because of the insignificant mass and extremely high speeds of electrons, they may be instantaneously controlled. Also because electrons are negatively charged and are only attracted to positively charged bodies, they may be used to rectify alternating current.

This latter principle is used in a diode or two

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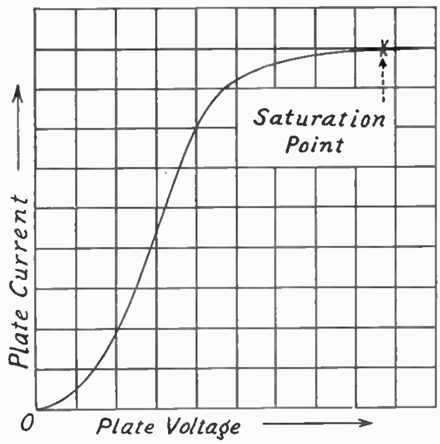
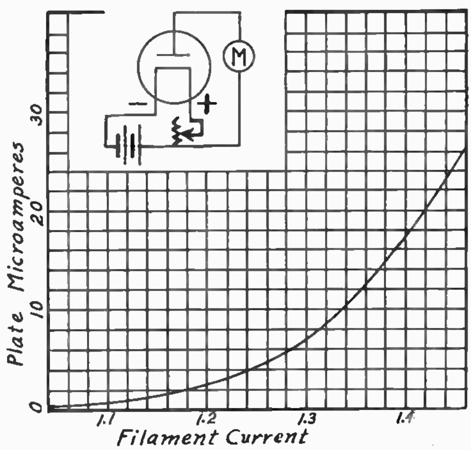


Normally when plate voltage is increased (left to right) the plate current through the tube increases (bottom to top). However, when all the electrons from the cathode reach the plate, increasing the plate voltage can not increase the current. The tube is then said to be saturated.



As the filament current is decreased the plate current is decreased. The curve shows that the relationship is not a straight line but approximates the usual characteristic curve of vacuum tube operation. Reduced filament voltage increases plate resistance.

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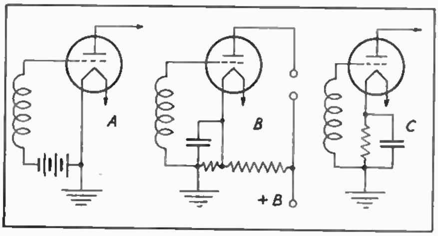
element tube. A second element designed to receive the electrons and called the anode is placed in a high vacuum bulb together with the electron emitting cathode. The anode is also called plate and will attract electrons if it is at a positive potential with respect to the cathode. This rectification action is easy to analyze.

Positive Plate Attracts Electrons

From a heated cathode many electrons venture out, forming a cloud around it. If a negative potential is applied to the plate, the electrons around the cathode will be repelled back into the cathode and no current will pass between these two elements. If, however, the plate becomes positive with respect to the cathode, the electrons around the cathode will be attracted to the plate, since unlike charges attract, and current will pass between these two elements.

If an alternating current is applied, during the positive cycle current will flow, but not during the negative. In this manner the alternating current will be rectified into pulsating direct current.



Three ways of getting a negative bias on the grid of a tube: Left to right, by using a battery; by using the potential difference due to bleeder current; by filament resistor. Assume ground is always negative A.

Of the electrons leaving the cathode not all, of course, reach the plate. Many return to the cathode while others remain for short periods of time between the cathode and the plate forming a *space charge.*

Space Charge a Limiting Effect

Since this charge consists of electrons it is electrically negative and has a repelling force exerted upon other electrons and thereby impedes the passage of current between cathode and plate. By increasing the plate voltage more electrons will be attracted and the tendency to form the space charge will be decreased.

Once the plate voltage reaches a certain maximum when all the electrons leaving the cathode are attracted to the plate, a further increase of the plate voltage will have no effect on the plate current. This maximum current is known as the *saturation* current.

Tubes having a third electrode for control purposes are known as triodes. This control electrode is usually called the grid because it is made of fine wire in the form of a mesh. The current flowing through the tube depends on the voltage distribution in the tube between the cathode and the plate. By placing the grid much closer to the filament or cathode, it is possible to control the plate current with very small changes of grid voltage. By varying the grid voltage from some negative to some positive value, it is possible to control the plate current from complete cutoff or zero to values even greater than those obtainable with the grid completely missing.

Mu or Amplification Factor

A much smaller change in the grid voltage will produce the same change in the plate current as a much larger plate voltage change. The ratio of the small change in the plate voltage (E_p) to the smaller change in the grid voltage (E_g) that will vary the plate current by an equal amount is called the amplification factor, or μ. Mathematically:

$$\mu = \frac{dE_p}{dE_g}$$

where d means the differential, a very small change.

The grid may be made to assume either positive or negative values with respect to the cathode. When the grid is negative with respect to the cathode, the grid will not attract electrons and no current will flow between it and the cathode. This means that the grid will not take power from the circuit connected to it. In this manner minute power can be used to control comparatively large plate power. Because of this and other reasons, it is desirable to keep the grid at some negative potential at all times. The negative potential applied to the grid must therefore be at all times larger than the greatest positive swing of the grid input voltage.

Suppressor Does a Vital Job

This constant negative potential is called the bias and may be obtained from batteries, but usually a section of the voltage divider is tapped off for this purpose or a resistor of correct value is placed in the cathode return circuit and causes a drop of potential because of the passage of the direct plate current. A bypass condenser offering very low impedance to the alternating current component of the plate current is employed to act as an easy path for all currents except the direct current component.

A certain amount of capacity exists between the different tube elements. The grid-plate capacity especially has a detrimental effect upon the operation of a vacuum tube of the triode type. This is reduced greatly by the introduction of a fourth electrode, called the screen grid, placed between the grid and the plate. This screen in ordinary application is connected to a positive potential somewhat lower than the plate potential. Since the screen voltage largely determines the electron flow, large changes in plate voltage will have little influence on the plate current.

Secondary Emission Is Retarding

The electrons striking the plate dislodge other

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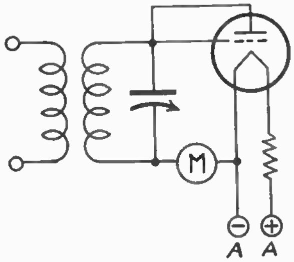
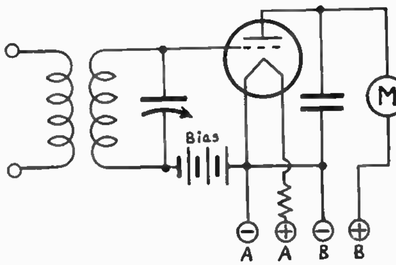
Rectifier, Detector, Mixer

What Is the Difference? How Do They Work?

By Nicholas C. Ambrose



A diode detector. This one is composed of externally united plate and grid to constitute anode. No biasing is necessary.



Here a negative bias is applied to a triode, high enough to afford rectification. Input increases plate current.

RECTIFIER, detector, mixer, converter, all refer to the same principle of operation, alternating current subjected to some change concerning frequency. When the change is from unmodulated alternating current to current of zero frequency, called direct current, the word rectification applies. When a modulated carrier is processed, so that the carrier is expunged and modulation alone remains, the word is detection.

When a frequency is changed to a new frequency, that is, the result is not one of the originals as in detection, we have mixing or conversion. Thus with mixture we put in at least two distinct frequencies. We take out one resultant frequency, usually the difference.

Looking at the subject broadly, since vacuum tubes are used, we may say that those tubes that help to increase the amplitude are amplifiers, and it is the goal to have the amplifying circuits function in such a way as to change the frequency not at all. Those tubes that purposely are made to play a part in changing frequency, and do not increase the amplitude at all, are the rectifiers, detectors, mixers, converters.

Not Settled Yet

The terms are not wholly settled yet. It has been only two years since the terms first detector and second detector were dropped in

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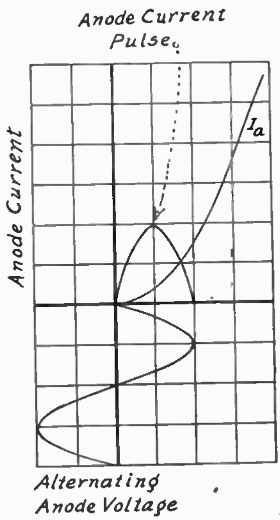
What Next in Vacuum Tubes?

(*Continued from preceding page*)

electrons from it. This indirect emission of electrons from the plate is called secondary emission in contrast to primary emission from the heated cathode. In diode or triode this action does not cause any difficulties because of the absence of any positive bodies in the vicinity of the plate. In the screen grid type tetrode, however, the screen is positive and close to the plates and does attract electrons emitted by the secondary emission action. This effect lowers the plate current and limits the permissible plate swing.

This limitation in turn may be removed by a further introduction of another electrode, known as the suppressor, between the screen and the plate. The suppressor may be connected directly to the cathode or in some tubes for special application have an external prong. Since such tubes have five distinct elements they are called pentodes.

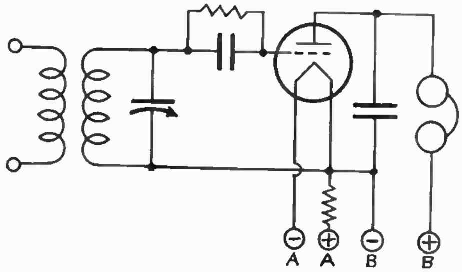
There are also many multi-element tubes used for two or more functions.



The intersection of the heavy lines represents the operating point of a diode detector. A.c. is introduced between anode and cathode. To left of heavy perpendicular line is negative, to right of it is positive. The anode pulse appears only during positive alternation. The mean anode current Ia would increase with increase of a.c. potential of anode.

(*Continued from preceding page*)
superheterodyne application. The first detector is more closely a frequency changer, or better yet, a mixer, since the result taken out is not equal to any one of the original causing frequencies, for instance, not equal to the oscillator frequency nor equal to the signal station's carrier frequency, but to the difference between them. The second detector is simply the detector.

The rectifier is used to obtain d. c. where the supply is a. c. Naturally, the tube is not a perfect rectifier. There is d. c. present, of course, but it is pulsating with the frequency of the original a. c. Indeed, there is even some a. c. flowing on the rectified side of the tube. Therefore coil and condenser filters are inserted, also



Grid bias detection. As no external bias is applied, diode action takes place, current flowing from cathode to grid. It must pass through the leak. Thus the grid is negatively biased. Increased input therefore decreases output plate current.

resistance-capacity filters, to afford a path of low impedance for the pulses in the d. c., so that nearly pure d. c. is attained finally.

Principle of Rectification

The principle of rectification is that current will flow in one direction only. Say a tube has two elements. One of these is the anode or plate and the other is the cathode or emitter. When the plate is made positive, current will flow. The greater the a. c. voltage put in, between cathode and anode, the greater amount of direct current that will flow. If there is a load resistor, interposed between cathode and the coil return, then the higher the greater the a. c. voltage input, the higher the d. c. voltage drop, or potential difference across the resistor.

In a rectifier on the line a. c. there may be large changes of current, due to the changes involved in operation of a set served by the rectifier, and also there will be considerable drain on the rectifier tube. It is necessary to supply relatively large current to the set. This is the B current for the operation of the tubes.

Good Regulation Sought

Naturally there can not be a very high resistance in series with this feed, for that would reduce the current below the amount required by the set. Also, the high series resistance would cause violent fluctuations of actually delivered voltage, because the large current changes through the high resistance would swing the d. c. voltage over a large difference. This is called poor regulation, and it is desired to have good regulation, so that there is relatively large B current flowing and the amount of current does not change too much due to the unevenness of the set's demands on the rectifier.

Hence a bleeder resistance often is used across the total B supply, after the filter choke or speaker field, because this introduces a steady drain, one independent of what the set itself may occasion, hence is a steadying influence. Aside from that it is wasteful, as it reduces the filtration effect on the hum, by reducing the effective inductance of the choke, hence the effectiveness of the filter.

Non-Current-Drawing Detector

The rectifier is a current drawing device always. The detector may be or may not. If it is a diode it will draw current from the a. c. input circuit. If it is a grid leak type detector, it will draw current from the a. c. source of supply because it is then a diode. The tube previously discussed as a rectifier was a diode, only of larger proportions than the diodes used as detectors in receivers.

If a tube with three or more elements is operated at a very high negative grid bias, and the amount of a. c. voltage put into the grid circuit is amply less than the bias, though of opposite sign, then the tube is a detector, though it will draw no current from the source. Of course this has nothing to do with terminal voltages, heater current, B current, etc., only the modulated carrier that it is have the modulation electrically sheared off, the carrier itself discarded.

This highly negative bias type of detector draws no current from the a. c. source because the grid is never effectively positive.

Negative Alternation Suppressed

Since the grid is negatively biased, and since the a. c. put into the grid circuit is negative and positive by turns, the negative alternation simply cuts off the plate current, while during the positive alternation the plate current is flowing. in ascending quantity, until maximum positive potential of the input voltage is reached. Hence we have detection—plate current flowing during only half the cycle, the same half as was the case with the rectifier, the positive half. This is calleed plate circuit detection and responds to the carrier peaks. The rectifier does not rectify when the plate is negative. The highly negatively biased detector does not rectify when the grid is negative in respect to the operating point.

Besides the type of detection wherein steady negative bias is very high, and which may be called Class C detection, there is also the type for a tube of three or more elements where the bias, though negative, is not nearly so much so, and there is plate current flow during positive and the negative alternations.

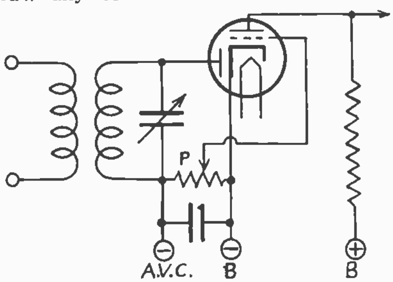
The Dissimilarity Creates Detection

For a given a. c. input the resultant plate current increase is larger on the positive alternation than is the decrease of plate current on the negative alternation, therefore the net effect is an increase in plate current. Because there is a greater change in one direction than in the other there is a difference and one may consider this difference as the basis of detection. The grid does not have to be positive, as no current is to flow in the grid circuit.

Anomaly Explained

If the curve were a straight line, in the sense that for equal change of voltage in either positive or negative direction there was a corresponding change of plate current in the same direction, there would be no detection. The tube would be a straight line amplifier.

When we consider the diode we find that the change of current with change of voltage is not quite uniform either, but since we do not have to draw any considerable current to energize



Example of a diode triode. Such a tube has two diode anodes but only one would be needed for this circuit. Diode biasing is illustrated.

an external circuit, we may now introduce the high resistance load that was prohibitive in the rectifier.

The load is a pure resistance, the diode itself is somewhat impure, and since the load is very high compared to the resistance of the tube, we get a change in current directly proportionate to the change in voltage, or straight line detection.

How does it happen that the previous example, of a straight line, converted a tube from detector to amplifier, whereas now we have a straight line and have a detector that can not be an amplifier?

In the first place, the tube with the grid was not a diode, but a triode, tetrode, quadrode, pentode, etc., and therefore could amplify. When it was theoretically considered unable to detect, all it could do was amplify. And it did that on both positive and negative excursions of the input cycle.

Why No Amplification

Now if we have a diode it is dead during the negative input alternation, since negative anode makes rectification or detection impossible. Hence only during the positive excursion of the input cycle do we get direct current through the tube and load, and when there is current for only part of the duration of the active cycle we have detection. If it is straight line, that is, current is directly proportional to the voltage, we have high quality detection, the only kind associable with high fidelity.

We get no amplification because diodes can not amplify. To amplify, the tube must at least be a three-element type (triode), hence have a grid, because the fluctuations or changes of potential across the grid circuit control larger potential changes across the plate load, hence we get out more potential than we put in, and that is amplification.

The function of detection is always dissociated from that of amplification in a current drawing detector. We found that the diode draws current. There is no way for it to detect without drawing current.

If instead of having merely an amplifier or detector circuit we have a purposeful combination in one tube or envelope, as when we use a grid stopping condenser and a grid leak, whereupon we have diode detection and triode amplification, but the functions are separate. The diode consists of the grid to cathode circuit. When the a. c. voltage is put between cathode and grid, current flows the same as in any other diode. As the current is made to flow through the leak, the d. c. that results produces a potential that biases the tube. The bias is negative because the cathode is the positive terminal of the external d. c. path of a rectifier. And, by the way, in any rectifier there must be a continuous path through which direct current can flow.

Grid Leak Detection

The leak and condenser are included in nearly all oscillators, even where no detection as such is desired, because automatic bias adjustment results in improved stability of the oscillator, provided the grid current is made substantial. This would hold true for most of the small tubes used as local oscillators in receivers if the grid current is 100 microamperes or so, not exceeding 500 microamperes.

The detection arises because of the diode, but the grid serves a double purpose. It is the anode of the rectifier, so this type is called none too properly grid detection; also grid is the control electrode of the amplifier, the two other members being the cathode and the plate. Hence in the plate circuit appears a potential that is a pattern of what is in the grid circuit, although enlarged, and we may now realize the grid-leak-condenser detector to be the same as a diode-biased triode.

Whenever detection takes place there has been a change introduced independent of amplitude. The original is not quite what it was in frequency, indeed it may be quite different.

Detection Efficiency

Detectors are measured as to their efficiency by comparing the changes of input voltage with the changes of output current through a given load, or potential changes across that load. The detector alone should be measured. Thus, for a plate bend detector the measurement could be made by comparison of input to the grid circuit at the modulated carrier frequency (radio) against plate circuit at the modulation frequency (audio). The grid circuit detector, being really a diode, should be measured as to the rectified

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component through the leak, and the plate circuit ignored, since the triode acts as amplifier, and a measurement of detecting efficiency should not include the amplification, even if it takes place in the same envelope, unless the amplification is in inseparable from the detection, as in plate bend detection.

The plate current changes differently for plate bend and grid leak detection, in that detected current decreases for the grid leak type and increases for the plate bend type.

Increase and Decrease

For the high negative bias example of plate bend detection, the plate current must increase, since it must change and can not decrease, being already too near cutoff. For a medium detecting bias, we have found, the average effect is an increase of plate current with applicaion of a. c. When we interpose the leak in the triode grid circuit we have the grid end of the resistor polarized negatively all the time, because d. c. is flowing, and d. c. flows in one direction only. So the greater the amplitude of the input a. c. voltage, the greater the negative bias and the less the plate current. So the leak-condenser detector is said to modulate downward and other detector types to modulate upward. Of course, tubes behave the same to all types of input and all purposes, in that the more negative the grid, the smaller the plate current, if plate voltage is held constant.

The same type of circuit used for extracting the audio values from a carrier modulated with them is used for obtaining d. c. without modulation.

A.V.C. Uses

It sometimes happens that we do not need the modulation characteristic, but just a resultant d. c. depending on the carrier intensity. That is the case with automatic volume control. To have such control we must have detection, since bias must be d. c. We get rid of the modulation by putting a high resistance between coil return and a.v.c. source and bypassing this resistance. The product of these two units, the resistance and the capacity, should not be too high, otherwise the a.v.c. will cause the set to respond too sluggishly to tuning, nor should it be too small, lest some of the higher frequencies of modulation be removed. The rule is to multiply the value of megohms by the capacity in microfarads, and not have a resultant less than .04 nor greater than .09.

A separate detector may be used for the a,v.c. feed. It then becomes somewhat handier to introduce a bias delay voltage. This consists of making the plate of the a.v.c. rectifier negative in respect to its cathode by a selected voltage. Say it is 6 volts. So positive 6 volts goes to cathode, negative to the load, be it coil or resistor, the other end of the load to anode. Note the anode is negative. Now before this particular detector will work the input voltage has to exceed the reversed bias voltage, therefore no bias is contributed by the a.v.c. circuit until the carrier reaches nearly 6 volts, r.m.s.

Therefore weak stations are not subject to a.v.c., neither to its benefits nor its disadvantage of deprivation of sensitivity.

Literature Wanted

Readers whose names and addresses are printed herewith desire trade literature on parts and apparatus for use in radio construction. Readers desiring their names and addresses listed should send their request on postcard or in letter to Literature Editor, Radio World, 145 West Forty-fifth Street, New York, N. Y.

Manager, The Radio & Engineering Service Co., 100 Gloucester Street, Christchurch, New Zealand (particularly on service instruments).
Dan E. Dulaney, Houston, Miss.
L. Burtman, 385 Fort Washington Ave., New York, N. Y.
Raschol H. Heard, Super-Service Radio Shop, 523 E. Penna. Street, Hawthorne, Calif.
Fred A. Pilgrim, 2237B 62nd Ave., Oakland, Calif.
Martin's Radio Service, 311 N. First Street, Miamisburg, Ohio.
L. E. Killmer, 148 Bradford St., Albany, N. Y.
Vincent J. Hoier, 4343 Hirsch St., Chicago, Ill.
C. A. Fraul, 909 Penn Street, Jeffersonville, Indiana.
Oliver F. Klein, c/o O. K. Radio Service, 2235 N. 39th St., Milwaukee, Wis. (short-wave, auto, and radio parts).
John F. Gallant, 207½ Pa. Ave., S. E., Washington. D. C. (radio repairing and sound equipment).
Charles Prentice, 405 Willowwood Dr., Dayton, Ohio for use in teaching a class in Y.M.C.A. Jr. College).
Herman Kabernagel, 1810 N Broadway, Baltimore, Md.
R. W. Shoupe, Box 633, Findlay, Ohio.
Ivan Quackenbush, 5907 W. North Ave., Chicago, Ill. (broadcast band receivers of all descriptions, and sound systems).
T. Tump, N. V. Ingenieursbureau Connector, Prinsengracht 634, Amsterdam-C., Holland (all articles in the radio, gramophone and sound-on-film line.
Leslie A. Harber, 21 Arkinson St., Rochester, N. Y.
Edward Dornbush, 618 Jefferson St., Sheboygan Falls, Wis.
Oscar Seville, Apartado No. 2165, Lima, Peru, So. Amer. (apparatus, especially on sets for use on 220-250 volts, AC and DC, and miscellaneous parts).
Yongue's Electric Shop, South Eighth St., Murray, Kentucky (Point to point test manual).
W. E. Morehouse, Box 403, San Clemente, Calif.
James Dunlop, P. O. Box 432, Diamond Springs, Calif.
David Rosenstein, 100 Geneva Ave., Dorchester, Mass.
John T. Lipani, 6 Ashland St., Boston, Mass.
John F. Gallant, 207½ Penna. Ave., S. E., Washington, D. C.—on radio repairing and sound equipment.
Rawlins Eastwick, 425 Beechwood Ave., Haddonfield, N. J.—on analyzers, tube testers and other testing equipment
Frank A. Bodey, 144 Hampton Ave., Toronto, Ont., Canada

WHEN RADIO WAVE ENDS

WHEN a radio wave is generated it quickly dies down. Can one explain when the wave becomes completely extinguished; that is, exists no more than it did before it was generated?

That time never arrives. As they say, the generation quickly dies down, but that does not connote dying in the usual sense of ceasing to exist, of all life being extinguished. As far as is known, a radio wave, once generated, is immortal. It keeps getting weaker and weaker all the time, but never declines to zero. Ten seconds after its origin the wave could not be picked up any more on earth but would have to be detected, if at all, at distances from the earth's surface of 25,000 miles or more.

SERVICE BUREAU

Capacity Measurements, All Ranges

Something New

Servicing expands, as measured by the increased demands for measurements. Recently there has been a great increase in the demand for measuring capacities. Later on no doubt the demand for measuring inductance, slight now, will catch up with the capacity exactions.

Herewith is a simple capacity measuring method, using the Triplett Universal Model 321 instrument. The method is generally applicable. It is based on a.c. input and ascertaining the current flow when capacities are inserted in series with the meter circuit, correlating the resultant current to the d.c. ohmage scale, as if a resistor were being measured. It required some figuring to obtain the relationship, which does not exist naturally, and so here is something new in capacity measurement, easily applied.

THE two facts desired about condensers are (1) condition, (2) capacity. If the condenser is no good nobody cares what its capacity is, and it may have none.

So we might state the first question to be: Is this thing that I hold in my hand a condenser?

The main reason we are interested in answering this question is that we have to make the capacity test in connection with some meter. We do not mind much if the condenser is no good, but we do mind if the present good meter gets damaged or ruined.

It is not necessary that the needle be bent for meter damage. A sensitive instrument may lose its calibration because of impaired freedom of the pivots on the bearings on which they are no longer properly seated.

So, just as the first test of a tube is for shorted elements, the first test of the condenser is for shorted terminals. This may be made with an ohmmeter of the direct current type, as all condensers have a resistance to d. c., the electrolytic condensers having a low resistance and the electrostatic condensers a high resistance, when both types are in good condition. The resistance determined by the d. c. test is the leakage resistance.

For testing electrolytic condensers for shorts and opens, remember that the electrolytic condenser is polarized. So it will pass more current in one direction than in another. This applies to d. c. This is not true of paper condensers (electrostatic), and so one may say that the electrolytic type is a rectifier. It is not a condenser basically as it is a cell that has a large capacity in a small space.

Thus, the electrolytic condenser has two terminals, negative and positive, meaning that these terminals must be connected in regular use to polarities as intended. On the low voltage test with d. c. for short or open, the connections may be made either way. *There will be less current flowing and smaller current change with capacity or voltage change when the condenser is wrongly connected.*

The rule about both kinds of condensers is that the higher the capacity the higher the d. c. current through the condenser in this test, because the higher the capacity the lower the resistance.

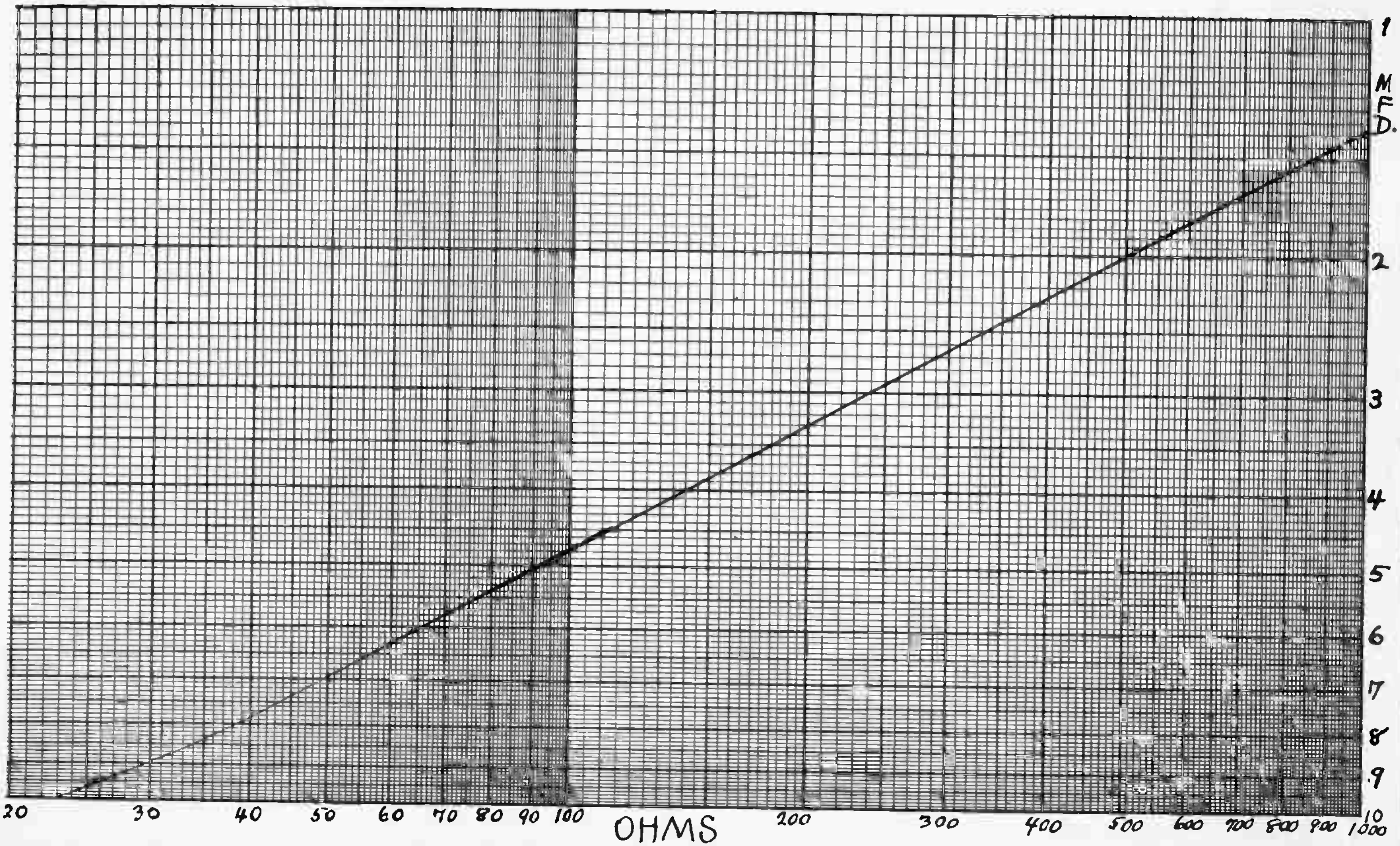
So to tell whether a condenser is any good it is necessary to get some information on its leakage, and d. c. is applied to both electrolytic and electrostatic types. For resistance measurements, an ohmmeter showing zero resistance for the unknown discloses a shorted condenser, an ohmmeter showing infinite resistance would suggest a perfect condenser (one having

(*Continued on page* 49)

Table That Enables Capacity Measurement

TABLE 1.

D. C. Ohms	Mfd.	D. C. Ohms	Mfd.
51,500	.05	850	1.5
25,000	.1	750	1.6
12,000	.2	670	1.7
7,500	.3	600	1.8
5,300	.4	550	1.9
4,000	.5	500	2
3,100	.6	240	3
2,500	.7	180	4
2,100	.8	92	5
1,800	.9	65	6
1,550	1.0	50	7
1,400	1.1	38	8
1,200	1.2	30	9
1,100	1.3	23	10
970	1.4		



By connecting 1.5 volts a.c. to a rectifier type meter (Triplett Universal Model 321), and using a 1,000 ohm rheostat adjusted to give full scale, capacity may be measured for 60 cycle input by putting the unknown in series with the voltage, and reading the 0-10,000 ohms d.c. scale. The ohms read are on abscissas, the unknown capacities on ordinates. The above curve coincides with Table I on page 47. Unever values are obtainable from the curve.

(*Continued from page* 47)

no leakage resistance) or an open. Naturally, the open circuit is to be suspected.

Fons on Electrolytics

Taking a paper condenser of 1 mfd. as a basis, the leakage resistance may be expected to range from 50 and 150 megohms, therefore one needs an ohmmeter that will read very high resistance. As the capacities are increased the resistance is decreased. For capacities below 1 mfd. a paper condenser reading from 1 to 10 meg. could be called defective on leakage test and for capacities of 1 mfd. up. defective for readings of .1 to 1 meg.

"What's New," the house organ of Triplett Electrical Instruments, contains in a translation from the Spanish of Jose Fons as follows:

"The resistance of an electrolytic condenser is very variable and different, taking it in one sense or the other of the polarity. Generally, at the time of connecting the electrolytic to the ohmmeter the resistance is relatively low, but it grows larger immediately as the condenser is formed. In the correct sense it becomes high from 100,000 to 200,000 ohms for 8 mfd., and in the inverse sense it is very irregular (generally it does not increase, or it decreases), in any case it is much less, reaching in some cases zero or almost zero.

"The variations in the needle of the ohmmeter corresponding to variations of the internal resistance of an electrolytic condenser should not be confounded with the rapid variations of the needle due to the loading or discharging of the condenser.

Red and Black Jacks

"The polarity of the electrolytic condenser is usually marked either with the sign + on the side which should be connected to the positive side current, or with color leads which usually are red for positive and black for negative. Nevertheless, on the Universal Triplett instruments, when they are used as ohmmeters, the red jack corresponds to the negative pole of its interior battery and the black to the positive pole. so that the correct method is to connect the black jack to the positive side of the condenser and the red one to the negative."

Tally of Opposition Vote

What is being measured is the current and that depends on the frequency, the voltage, the capacity and the resistance. In short, if voltage is wanted the current depends on the impedance, which is the total opposition to the flow. So little of this is capacitative in the measuring circuit that all the capacity present may be ascribed to the unknown condenser, although allowance must be made for the meter resistance and any series resistance used with the meter.

When the current is noted for the application of a given voltage of any frequency, the quantity of current is determined by the circuit impedance to that frequency. That is, take all the resistance in any type circuit and the limitation of the current by such resistance is accounted for by the impedance. *The impedance is the tally of all the votes of the opposition.*

Now, the meter itself has an internal resistance, also there may be some extra resistance by way of addition (series type, found in voltmeters) or reduction type (shunts in current meters).

The Rectifier Resistance

If a rectifier type instrument is used, then the resistance of the rectifier has to be considered, also perhaps its capacity. However, the capacity is generally kept low. A given instance proved that the copper oxide rectifier had a d. c.

(*Continued on next page*)

Pointed Facts About Testing Condensers

Unknown condensers first should be checked to determine if they are shorted or open, to protect the meter in any capacity measuring device you use. The preliminary comes under the head of "leakage resistance" test of a condenser and is made for electrolytic or electrostatic condensers the same way, and the same rule applies: the higher capacities will have higher leakage. D. c. is used in this test.

Electrolytic condensers pass more current one way than the other. No such difference shows up on other condensers.

Alternating current applied to a circuit in which meter and unknown capacity are in series enables measurement of the capacity of electrostatic condensers but seldom of electrolytic condensers. If the voltage and frequency are fixed, capacities from .05 mfd. to 10 mfd. may be measured by the high capacity meters, while below .05 mfd. capacities are better measured by a bridge, or for small capacities, by the substitution method, using radio frequencies.

TABLE II.

Values of Capacity Reactance in Ohms for Capacities at 60 Cycle Frequency:

Mfd.	*Ohms*	*Mfd.*	*Ohms*
.05	53,000	1	2,650
.06	44,000	2	1,325
.07	37,800	3	883
.08	33,300	4	662
.09	28,400	5	530
.1	26,500	6	440
.2	13,250	7	378
.3	8,830	8	333
.4	6,620	9	284
.5	5,300	10	265
.6	4,400	11	241
.7	3,780	12	220
.8	3,330	13	204
.9	2,840	14	187
		15	176

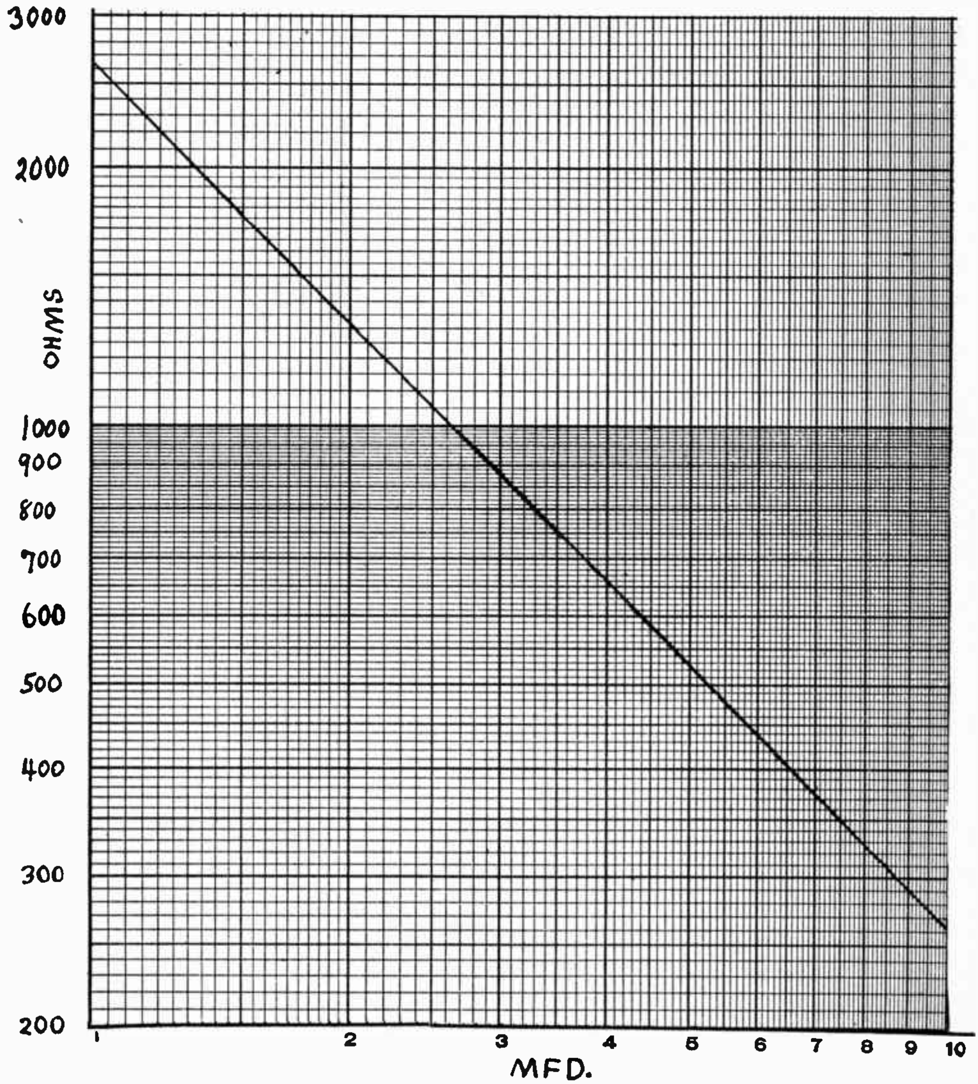
(*Continued from preceding page*)
resistance of 1,225 ohms in the correct sense and a capacity reactive component of 100 ohms. The meter itself had 250 ohms resistance but was shunted to give an effective of 100 ohms. Therefore for capacity measurements the resistance added by the meter circuit may be taken as 1,425 ohms, roughly the equivalent resistance (really the capacity reactance) of 2 mfd. at 60 cycles. It can be seen that allowance must be made for the series limiting effects before the capacity can be assigned to the unknown on the basis of current.

If a given voltage is applied, a given current will cause full scale meter deflection, and the series resistor referred to previously is the one that limits the current.

Like an Ohmmeter Circuit

Therefore the circuit is just the same as that of an ohmmeter, and indeed the net term comes down to an expression in ohms, equalling the capacitive reactance, but we tell it in terms of capacity only, since the frequency is known. The capacity itself will not change with frequency, except very slightly.

The capacity reactance does not appear, but it is well to know what capacity reactance (X_c)



Capacities from 1 to 10 mfd., inclusive, are compared to their capacity reactance at 60 cycles. The reactance is at left in ohms. Multiply capacities by 10 and divide ohms by 10, or divide capacity by 10 and multiply ohms by 10, to extend range. This is not the curve for capacity measurement by reference to a d.c. ohmmeter scale.

means. We have found that a condenser has resistance (true of every condenser ever made), not the leakage resistance we measured with d. c., but a. c. resistance. That is the opposition offered by the condenser to a. c., independent of the frequency of the current (except to a small extent). But any change of frequency has a comparatively large effect on the current, without any difference in capacaities, so capacity is sensitive to frequency.

Finding the Capacity Reactance

The capacity reactance is therefore the effect the condenser has in limiting the current due solely to the capacity aspect of the condenser. Since we are interested in finding out only the capacity, we have to find out the relationship between the current and the capacity. This we do through the capacity reactance. This is equal to $\frac{1}{2}\pi fC$, where π is 3.1416, f is frequency in cycles and C is capacity in farads. If the frequency is 60 cycles the capacity reactance is equal to 10,000,000/3,768 C mfd. We now have capacity in microfarads, hence we find that 1 mfd. the capacity reactance at this frequency is 2,650 ohms.

Proportionate Table

Therefore a pure resistance of 2,650 ohms will reduce the 60 cycle current exactly to the same extent as would a pure capacity of 1 mfd. Hence if we eliminate the effect of the meter and its resistor and rectifier (if any), we could read the capacity reactance in terms of current, calling it ohms, or the capacity in terms of current, calling it microfarads, except for the sharp reactive component over part of the scale.

The higher the capacity the lower the capacity reactance, or the more current that will flow through the meter, therefore we may ascribe capacity values to current readings.

Therefore for .05 mfd., which is one-twentieth of 1 mfd., the capacity reactance is 20 times 2,650 ohms, or 53,000 ohms, and for 10 mfd. the capacity reactance is one-tenth of 2,650 ohms or 265 ohms.

If one does not always retain one frequency, nor a prescribed voltage, and desires to calculate for capacity, it may be done by the formula.

$$Cx = \frac{160\ I}{f\ V}$$

where Cx is the unknown capacity in microfarads, I is the current in milliamperes, f the frequency in cycles per second, and V the impressed voltage of the alternating current.

Cx by Voltmeter Method

The above is for current considerations. The following is for voltage considerations (a. c. meter used as voltmeter):

$$Cx = \frac{160{,}000\ Vc}{f\ R\ \sqrt{V^2 - V_c^2}}$$

where Cx is the unknown in microfarads, Vc the voltage read on the meter when the condenser is in series; V is the voltage and f the frequency in cycles of the alternating current voltage applied, and R is the sum of the internal resistance of the meter and shunt.

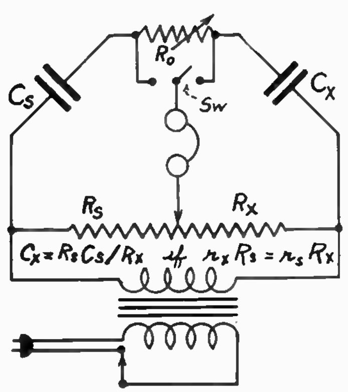
The actual multipliers for the numerators are 159 and 159,000.

High capacities have been considered. The next step is to measure capacities from .05 to .0005 mfd. This is best done by using a bridge.* Alternating current is used for the capacity measurement. A known standard capacity has to be obtained.

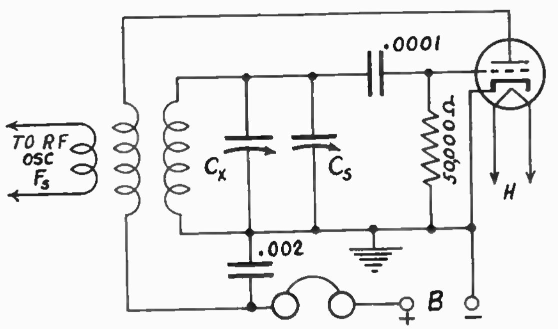
The unknown capacity should be connected in the X-arm and a known standard capacity should be connected in the S-arm. No exact

(*Continued on next page*)

*A Handy Bridge, by Frank G. Simonds, March, 1936, RADIO WORLD.

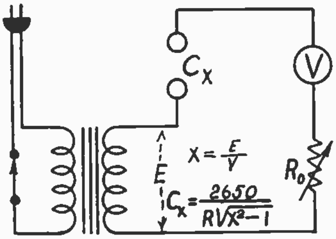


Medium capacity measured on a bridge. Rs x Rx equals the total resistance of the potentiometer. Ro is a rheostat. Cs is a standard capacity. Cx is the unknown. The a.c. resistance of Cx may be greater or less than Cs. Hence Ro is used.

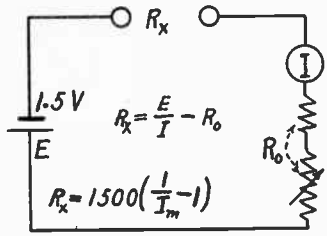


$$C_x = \frac{C_m m^2 - C_n n^2}{n^2 - m^2}. \quad \left.\begin{matrix} m=1 \\ n=2 \end{matrix}\right] \; C_x = \frac{C_1 - 4C_2}{3}$$

Small capacity measured by displacement on a calibrated variable condenser Cs, in a generating circuit. Harmonics are used. Cm is one capacity read, m^2 is the harmonic order squared, Cn the other capacity read, n^2 the square of the other harmonic. At right, the formula treats of first harmonic m and second harmonic n. For smaller capacities of Cs use higher harmonics.



V is an a.c. voltmeter. Ro is the sum of the meter resistance, series (multiplier) and of the rectifier (if any). Cx is the unknown capacity. E is the voltage across the secondary. The formula for Cx is given in the diagram for 60-cycle current.



The standard ohmmeter circuit, using d.c. Rx is the unknown resistance. Ro is the sum of the meter multiplier and cell resistances. For a scale for resistances of 0 to around 20,000 ohms or more, capacities may be measured. See curve on page 48.

(*Continued from preceding page*)
balance can be obtained with more resistance in series with one condenser than the other. A known variable resistor should be added to one of the arms, as required. A condenser with a negligible series resistance to radio frequencies may have 1,000 ohms or more at 1,000 cycles, the frequency at which measurements are often made. The lower the frequency used the higher will be the effective series resistance of the condenser. This series resistance must be compensated for if an exact balance is to be expected. Separate and simultaneous balances must be made for the a. c. resistance and the capacities. When exact balance has been effected the capacity formula is $C_x=R_sC_s/R_x$. Both R_s and R_x should be non-reactive.

Measuring Small Capacities

Besides the foregoing it is likely that the experimenter desires to measure capacities generally referred to as "radio frequency values" because they are effective at radio frequencies, capacities of 10 to 500 mmfd. Therefore radio frequencies should be used, and the best and handiest method is to use a calibrated variable condenser. This may be in a generator or, preferably, in a trap circuit, coupled to a generator, so that the unknown is put across the coil of the trap circuit, the frequency of the generator is found where generation is stopped by the trap, and the calibrated variable condenser is put in the trap circuit in place of the known to find out what the capacity was needed to stop the generator. That is Cx.

Isolation Process

Going back now to large capacities (to use ohmmeter scale), let us consider the problem.

Since the tests for high enough leakage resistance may be readily made, we establish that the condenser is good and proceed to measure something that reflects the capacity, or decide the condenser is bad and reject it. For the good condenser we have a leakage resistance high in comparison to that special resistance due only to capacity, and which we call the capacity reactance.

The trouble with the capacity reactance is that it alone does not show up, and we can depend on it only if the a.c. resistance is small and the leakage resistance large compared to the capacity reactance. Making this assumption, we may then proceed by assigning capacity values on the basis of readings in ohms, using a.c.

Use of D.C. Resistance Scale

Before doing that we would like to be on firmer ground concerning the a.c. resistance, which we may easily measure, by putting an adjustable resistor in series with the condenser, adjusting this resistance until the current is halved, finding the d.c. resistance of this series member, and assigning that value to the condenser and meter as their sum a.c. resistance. The meter resistance is known or ascertainable from the manufacturer. Subtract it and the condenser resistance is the answer.

Considering the rectifier type meter, such as the Triplett Universal Model 321, which also has a d.c. ohmmeter scale, it is practical to get an idea of the capacity by using the meter as if to measure resistance.

Since the rectifier type meter is of the type that enable use of the same multipliers for a.c. as for d.c., necessary corrections are automatically applied whereby one milliampere a.c. constitutes full scale deflection as does one milliampere for d.c. That is, compensation is made for the copper oxide rectifier (its presence or absence or both) by shunting a meter which of itself is more sensitive.

Arranging Interposition

Since the particular measurement we are to make applies to a 0-10,000 ohm scale, we need only apply 1.5 volts a.c. (measured by the same meter) and insert in series a non-inductive resistor of 2,000 ohms at full resistance, using the meter in its 0-1 milliammeter a.c. position. Reduce the resistance until the needle reaches full scale. Then arrange to have one lead open, with two posts to permit interposing the unknown condenser, the "resistance" of which is now read as if a d.c. test were being made.

Capacity values are taken from the table herewith. Closely accurate capacity answers will not prevail, but the answers will be good enough for general purposes, since condensers from .25 mfd. to 15 mfd. are not critical as to function, and readings to 10 per cent are all-sufficient, and most persons would be satisfied with 20 per cent accuracy.

The capacities are not frequency determining. They don't help do any "tuning" as such. It matters not if an 8 mfd. label is on a condenser that reads 7 mfd. or 9 mfd. in this test. The only real requirement is that the capacities shall not be grossly overrated, for the perils come from too small a capacity to do a particular job. The capacity for these filtering purposes scarcely can be too large.

At the low voltage under discussion, electrolytic condensers may be measured, in view of the high limiting resistance (around 1,500 ohms). In fact, some electrolytic condenser manufacturers test for capacity by using a low a.c. voltage, usually 5 volts instead of 1.5 volts.

The d.c. ohmmeter scale is used for measuring capacity, by connecting a rectifier type meter (Tripplett Universal Model 321) to a 1.5 volt a.c. source, using a limiting rheostat, adjusted until full scale deflection is attained, and inserting the unknown condenser in series. Then by referring to the d.c. ohmmeter scale (although a.c. is used), the capacity is related to the ohmage as set forth in the table herewith. A curve is printed on graph paper, relating values for 1 to 10 mfd. capacity, enabling close readings within that range, but the table herewith extends the range from .1 to 10 mfd.

Since there is no natural relationship between the d.c. ohmmeter scale and the condenser capacity, even for a fixed frequency, the solution was worked out mathematically, in terms of current flowing due to the impedance of the total circuit, and the ohmage values for such currents were computed, and correlated to the capacities. The series resistance totals 1,500 ohms, composed partly of meter resistance, more of rectifier resistance, and a little of the 400 ohm rheostat resistance. Adjustment to full scale deflection on shorting of the "unknown" terminals takes care of this condition. It is necessary to apply about 1.5 volts a.c. This may be taken from a 1.5 volt winding of a small power transformer, or from one-half of a 2.5 volt winding (thus yielding theoretically 1.25 volts, but since practically unloaded will likely be nearer 1.4 volts). The series rheostat takes care of the adjustment satisfactorily, even for such a voltage difference, and including line voltage drainage.

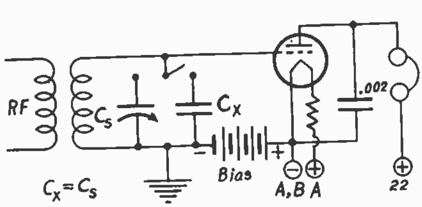
The data are assembled for 60 cycles and do not apply to any other frequency. The ohmmeter scale for a 1.5 volt dry cell and total of 1,500 resistance for a 1 milliampere sensitivity runs to around 50,000 ohms maximum, in this case 45,000 ohms are read at extreme (1,500x3). Also, 1,500 ohms unknown happen to fall at the center of the scale, approximately, and this ohmage coincides closely with 1 mfd. Thus capacities from 1 mfd. up are read in terms of ohms from center of scale to zero, and capacities from 1 mfd. down are read from center of scale to maximum. The terminals refer to resistance values of the unknown, not to current quantities, which are the reverse.

Here are the ohmage and capacity relationships, applicable closely to paper mica condensers, and approximately to electrolytics:

CORNELL-DUBILIER CATALOGUE

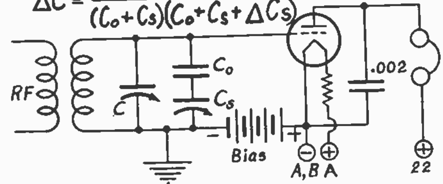
The Cornell-Dubilier Corporation, 4377 Bronx Boulevard, New York City, announces Catalog No. 127 for the transmitting and industrial fields, containing 24 pages.

The newly designed Cornell-Dubilier line of Dykanol transmitting capacitors is fully illustrated and listed. Copies are furnished upon request to the manufacturer.



Small capacities measured by substitution. Cx is the unknown, Cs the calibrated variable condenser. The frequency generated when Cx is switched in is duplicated when Cs is switched in instead and rotated. Thereupon Cs is read and equals Cx. Confusion due to harmonics must be avoided. This may be done by noting fundamental as creating only one response for a capacity ratio less than four.

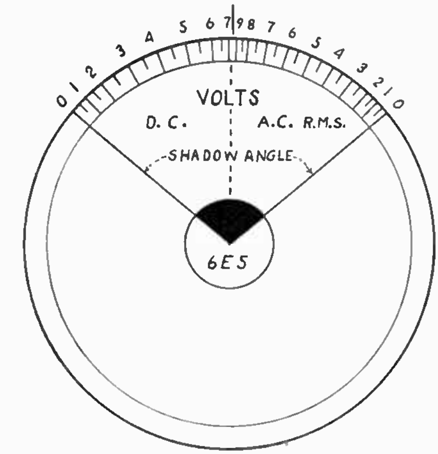
$$\Delta C = \frac{\Delta C_s C_o^2}{(C_o + C_s)(C_o + C_s + \Delta C_s)}$$



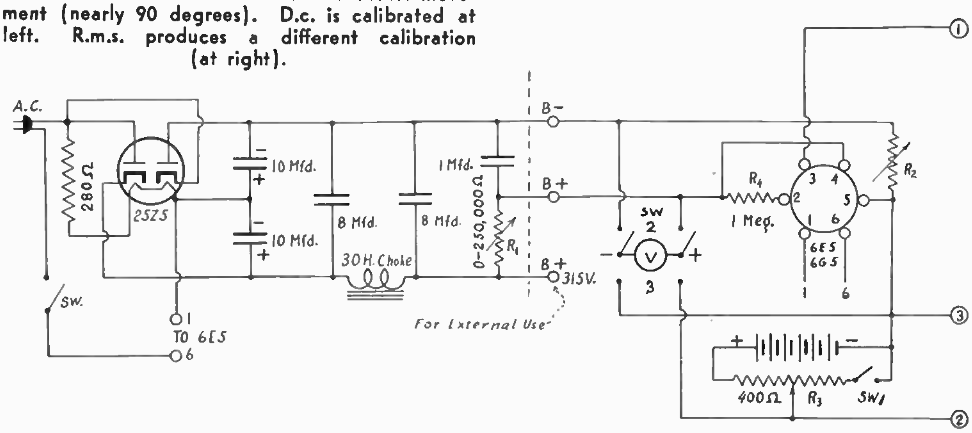
A minute change in a capacity C can be measured with the aid of a large standard capacity Cs in series with a small known capacity Co. Tune to zero beat with C then change C slightly by addition or subtraction of delta C. Retune to zero beat with Cc. The capacity change can then be computed with the formula. The method is more sensitive the larger Cc compared with Co. If the change is a decrease, change the sign of delta Cs in the formula.

A SERVICE EYE

By George F. Baptiste



Around the periphery of the tube illumination is the calibration for the extent of the actual movement (nearly 90 degrees). D.c. is calibrated at left. R.m.s. produces a different calibration (at right).



The tube voltmeter with rectifier. B voltage is correctly adjusted, using voltmeter V as guide (SW-2). On lower range, V is used at SW-3 for measuring a tricking voltage, 6E5 then null indicator.

THE magic eye 6E5 electron ray tuning indicator tube has many useful applications in the servicing of radio receivers and any one engaged in such work cannot afford to be without it.

Circuits involving high resistances., a.v.c. leakage, bypass condensers, direct shorts, open circuits, etc., can be tested with almost exact accuracy. The magic eye can be used as a vacuum tube voltmeter, leakage indicator with a useful range of .1 meg. to 60 meg., output meter to measure d.c. or a.c. peak voltages, audio or power pack tests, a.v.c. circuits, output of signal generator, calibration of generator, alignment of r.f. or i.f. circuits, etc.

The circuit diagram does not use a transformer but operates in conjunction with a 25Z5 rectifier, or the new 25Z6 metal tube rectifier used as a source of power supply for complete a.c. operation. The rectifier is connected up as a voltage doubler which supplies about 300 volts. This is sufficient for the operation of the 6E5 tube. The use of a variable bleeder is highly desirable so that any variation in the a.c. line voltage may be corrected. One may obtain good accuracy at all times. Also any one with service equipment having a built-in power pack can omit the rectifier circuit at the left of the dotted line. Use a variable bleeder.

The variable resistor R1 is adjusted to a normal plate voltage of 250 volts. This is done by throwing switch (2 and 3) to the proper position. Then the variable resistor R2 is adjusted to supply the 8 volts negative bias to the control grid of 6E5 through the 1.5 meg. grid leak R5 with switch SW-1 closed. This bias causes the ray of the screen to be completely luminous.

For voltages, a.c. or d.c., there may be a direct reading scale. To make a scale, cut out an aluminum or cardboard disc about 3 or 4 inches in diameter and then cut out the center to fit over the top of the 6E5 tube. Pasting the disc to panel. This will permit the use of the luminous pattern as an accurate indication of voltages. When SW-2, 3 is thrown to C battery or bucking battery, adjust the potentiometer

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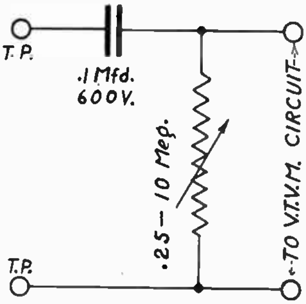


To avoid possible d.c. conflicts when using the VTVM, this circuit may be used for frequencies down to 60 cycles. The upper limit is 25 megacycles.

Design Notes

The following data were supplied by RCA Mfg. Co., Inc.:

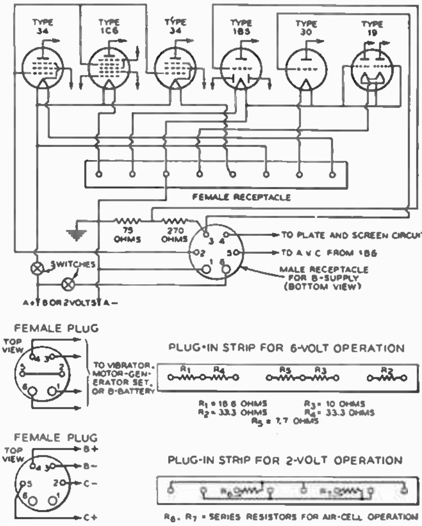
SERIES FILAMENTS

(a) Series filament operation of the two-volt series is recommended, provided certain precautions are taken to insure normal life performance. First, the filament circuit should be arranged so that removal of a single tube does not cause excessive rise in the filament voltage of the remaining tubes. Second, shunt resistors should be employed across certain filaments to by-pass the plate current flowing in the filament circuit.

(b) Some six-volt, series-filament receivers that employ mechanical B-supply units use a separate rectifier tube to obtain bias voltage for the output tube. When such a circuit arrangement is used, it is suggested that the filament of this rectifier be connected in series with that of the output tube. This arrangement insures that the output tube is inoperative when the rectifier is removed from the circuit. If this precaution is not observed, the plate current of the output tube may rise to an abnormally high value when the rectifier is removed from the circuit.

(c) The grid biases for certain tubes in most six-volt, series-filament receivers are obtained by connecting grid-return leads to appropriate points in the filament circuit. If the comparatively large plate current of the output tube flows through a filament circuit to which grid-return leads are connected, the potential of all these grid-return leads will vary in accordance with the plate current of the output tube. Thus, regeneration or degeneration may be present. To minimize the effects of this condition, the filament of the output tube should be connected in series with that of another tube whose input

Voltage Flexibility



Circuit for switching arrangement to enable use of a variety of supply voltages on a battery set using two-volt tubes

signal is large compared to the possible variation in bias. For example, the filament of the output tube should be connected in series with that of the final i-f. amplifier tube. The filament of the second detector should be connected in series with that of the oscillator-mixer tube.

(d) By means of a suitable switching scheme, a receiver that employs the two-volt series of tubes can be designed to operate from several types of A-minus and B-minus voltage sources. For example, the switching scheme can easily permit series filament operation from a six-volt storage battery or parallel-filament operation from a two-volt air cell. If B voltage is furnished by a mechanical B supply unit, the switching scheme can also connect the grid-return leads to the proper points in the filament circuit in order to obtain bias. Thus, a single switching arrangement can provide for the operation of a receiver from either a six-volt storage battery and mechanical B-supply unit or a two-volt air cell and dry B and C batteries. The exclusive use of filament type tubes will insure low power consumption, regardless of the source of filament power.

(e) Herewith is the diagram of a simple a-v-c. circuit that delays a-v-c. action until the carrier voltage at the detector exceeds a certain value. This circuit uses the filament voltage of the 1B5 as the delay voltage; hence, no separate battery is required for delay purposes. When no signal is received, diode D_2 is positive with respect to the negative side of the filament; therefore, current flows through R_1, R_2, and the D_2-filament circuit. When the carrier voltage at the detector exceeds ($E_1 + E_2$), the a-v-c.

(Continued on next page)

A Service Eye

(Continued from preceding page)

to 1.5 volts. This will give a range of about .2 meg to 5 meg. and so right up the resistance scale by adding more bucking battery voltage. If a large C battery is used increase the resistance of the potentiometer.

* * *

[*Any one desiring further information on use of the tube for measurements along the lines indicated may write to George F. Baptiste, care* Radio World, 145 *West 45th Street, New York City.*]

DESIGN NOTES

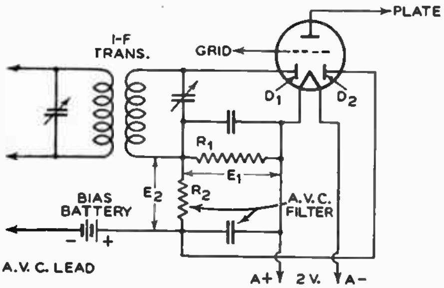
(Continued from preceding page)

diode (D_2) does not conduct; the full a-v-c. voltage is then applied to the controlled tubes. No a-v-c action occurs until the carrier voltage at the detector equals ($E_1 + E_2$). The voltage drops across R_1 and R_2 must be considered when the bias applied to the controlled tubes is determined.

* * *

RECTIFIER TUBE SPUTTER

If a close-spaced rectifier tube is connected between a power-supply line of low impedance and a condenser-input filter, the initial charging current of the first filter condenser may be high enough to damage the cathode of the tube. This



Dual diode-triode tube for battery operation, using filament voltage drop for a. v. c. delay voltage.

effect is also present when plate voltage is applied repeatedly while the cathode is emitting electrons. To remedy this condition, it is necessary to limit the initial charging current to a safe value. A receiver that employs a power transformer is not subject to such rectifier-tube failures, because the leakage inductance and resistance of the usual power transformer is great enough to limit the initial charging current to a safe value. However, the effect is prevalent in 220-volt receivers that do not use transformers. The remedy in this case is to insert a 100-ohm resistor in series with each plate of the rectifier tube. This connection has the advantage of retaining the current-limiting action of 100 ohms of resistance for each half of the rectifier; yet, it produces the same line-voltage drop as only 50 ohms connected in a circuit that is common to both rectifier plates.

* * *

INCREASED 6H6 RATING

The direct current output rating of the 6H6 has been increased to 4 milliamperes, maximum, for either full- or half-wave operation. The a-c. voltage per plate remains at 100 volts (rms), maximum. This higher current rating permits the use of the 6H6 in a wider variety of circuits than was heretofore possible. The use of this tube as a power rectifier to furnish a fixed C bias to a power amplifier is suggested.

* * *

6R7 POWER OUTPUT

When the triode section of the 6R7 is operated as a Class A amplifier, an output of about 300 milliwatts at 6 per cent distortion can be obtained. This output was measured under the following conditions: Plate voltage, 250 volts; grid bias, minus 9 volts; a-c. plate load, 8,500 ohms; d-c. plate load, nearly zero. These conditions are easily satisfied in practice, since the low plate impedance of this tube permits coupling it to the following tube by a transformer. Another desirable characteristic of the 6R7 is that power output and distortion are not critically dependent on plate load. Output measurements show that a decrease in load impedance from 20,000 ohms to 6,000 ohms produces an increase in power output from 260 to 275 milliwatts, respectively; the maximum output of about 300 milliwatts is obtained with a load of 8,500 ohms. The distortion, which increases with decreasing load impedance, is 3 per cent with a 20,000-ohm load and 8 per cent. with a 6,000-ohm load.

* * *

VOLTAGE RATING OF TUBES

It is common practice to design the power-supply system of a radio receiver to deliver recommended maximum voltages to the plates and screens of the tubes at a specified line voltage. When the line voltage exceeds the specified value, the electrode voltages may rise high enough to shorten tube life appreciably. As a remedy, it is suggested that the equipment provide recommended heater voltage for a line voltage of 117 volts and maximum plate and screen voltages for a line voltage of 125 volts. The design of heaters is such that a rise in line voltage from 117 to 125 volts does not seriously reduce tube life.

Harrison Lists Sets in New Catalogue

A receiver catalogue has just been released by Harrison Radio Company, 12 West Broadway, N. Y. City. The catalogue is devoted exclusively to short wave and all wave receivers and their accessories.

Every well known receiver from the biggest super to the tiniest one-tube set is included. There is a time purchase plan.

Siegel Heads Fox Radio

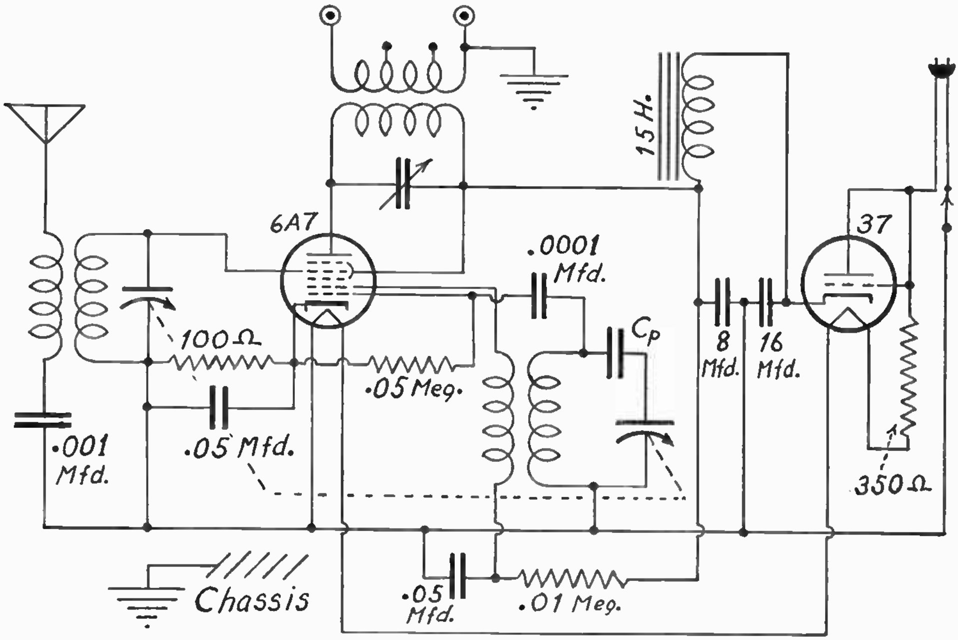
Murray Siegel heads the new Fox Radio at 60 Cortland Street, New York City.

The establishment has been completely renovated with better display space and test booths where prospective buyers may listen to favorite radio sets and programs, making comparisons of all the very latest receivers which are on display.

Single Band Converter

Foreign Short Waves Brought In

By Henri B. Lavelle



Very simple, yet this converter, using neither plugin coils or switching, enables reception of foreign short waves on a standard broadcast band receiver. The secondary of the output transformer (upper center) should be matched to receiver's input.

THE wide possession of old broadcast receivers of good performance, plus an interest in the foreign short wave band, augur for enjoyment of programs from abroad by using a short wave converter. If a condenser that provides a frequency ratio of about 3 or a little more is used, then the entire band may be tuned in without switching. This is the band of greatest interest and is approximately from 5,400 to 17,000 kc, or, in meters, approximately from 55.5 meters to 17.5.

It is not only possible to build such a converter that works well, but it is possible to use a standard broadcast frequency calibrated dial, by adjusting the inductance and the padding, assuming that a tuning condenser used is of exactly the same model and capacity as the one for which the dial was calibrated. The frequencies imprinted are simply numbers that reflect capacity differences as the tuning condenser is turned, and result from the selection of the correct inductance, which does not change the capacity.

Selection of Inductance

Considering the radio frequency level, meaning the circuit that tunes in the stations at their transmission frequencies, all that is necessary is to select the right inductance on the basis of the condenser capacity. If this capacity is not known, then the problem can not be solved with much mathematical assistance, but a coil could be wound with the right number of secondary turns until the lowest frequency coincides with the lowest frequency on the dial. It can be seen that the band now considered has frequency values just ten times those in the broadcast band, hence the object is to make the registrations effective for tenfold the imprinted frequencies.

While it is very easy to establish the correct status for the radio frequency level, the oscillator requires special consideration. Always the oscillator is adjusted to be at a fixed difference from the radio frequency level. In all superheterodynes and converters today that difference is in only one direction; the oscillator frequency is higher than the carrier frequency.

Checking Up On What You Have

If one does not have any satisfactory infor-

(Continued on next page)

(*Continued from preceding page*)

mation about the condenser, at least he can rig up a coil for oscillation at the radio frequency level, and, using a signal generator, find the extreme frequencies of this improvised test oscillator, by putting bypassed phones in its plate circuit, and listening to the beats. When the terminal frequencies are measured, the lowest is divided into the highest, and thereby the frequency ratio is obtained. It may be 3 or some more, if the condenser is .00035 mfd. For higher capacities the ratio will be greater.

For the frequencies mentioned in the beginning the ratio would be 3.15. If there is a frequency calibrated dial, and it is not calibrated for the entire displacement of the condenser rotor, consider only that part that is calibrated, and ascertain the ratio with a coil of broadcast band proportions. Now the capacity ratio is computable, by multiplying the frequency ratio by itself. In other words, the capacity ratio is the square of the frequency ratio, and in the mentioned example would be 3.15 x 3.15, or 9.9225.

LIST OF PARTS

Coils

One antenna coil and one oscillator coil as described in the text.
One output transformer, as described in the text.
One 15 henry B supply choke coil.

Condensers

One .0001 mfd. mica fixed.
One .001 mfd. mica fixed (Cp).
One .001 mfd. paper or mica.
One two gang .00035 mfd. tuning.
Two .05 mfd. tubular.
One 8 mfd. and one 16 mfd., 150 volt rating, in cardboard container (Cornell-Dubilier).

Resistors

One 100 ohm. One 350 ohm, 30 watt.
One 10,000 ohm. One 50,000 ohm.

Other Requirements

One chassis. One grid clip.
One male plug and a.c. cable (350 ohm resistor may be built into line cord).
One seven hole and one five hole sockets.
One dial. One knob. Ant.-Gnd. Posts.

Deciding the R.F. Coil

Now if we have verified the ratio, so that the ends of the dial will track when there is a proper coil at the r. f. level, the next thing to do is to wind the coil that will bring in the lowest obtainable, or lowest calibrated, frequency as 5,400 kc. If the dial reads 530, then 5,300 kc would be the lowest. For this check again we need the signal generator. We may insert a coil somewhat of the r. f. inductance specified later for a particular converter, use the fundamental of a generator to ascertain the true frequency in a separate test circuit, preferably oscillatory, and if the frequency near full capacity reads too low, add secondary turns, while if it reads too high, remove secondary turns, until you strike the frequency just right.

If you establish a frequency close to the desired one, since small removal of wire from the coil makes large frequency difference, we may press the turns closer together to obtain greater inductance or separate them a bit, to reduce the inductance, and thus establish coincidence of generated frequency with indicated dial frequency. Then some collodion or other "coil dope" is put on the coil to enable retention of the same inductance.

Attacking Oscillator Problem

That much settled, we have the antenna coil, provided with primary and secondary, and to be used for tuning, in conjunction with one deck of a two-gang condenser, at the station frequency level.

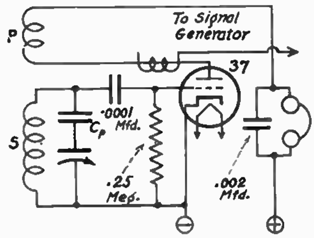
But then there is that other level, the oscillator, and we must determine the inductance and the padding capacity, and in reality the capacity is ruling, the inductance being selected when the capacity is properly selected.

Since the oscillator is higher in frequency than the frequency of any carrier to be received. and since the difference in frequency is, or should be, always the same, what shall that difference be, and how shall it be established? What it shall be is decided when the intermediate frequency is selected. This is the third frequency level of a superheterodyne, and when we use a converter with a set, whether the set is a tuned radio frequency circuit or itself a superheterodyne, we have a superheterodyne, in the second example a double superheterodyne. The intermediate frequency then is somewhere in the broadcast band, the only span to which the receiver itself will respond, it is assumed, as we started with the proviso that short waves are to be tuned in with the aid of a set that can not now bring them in.

Respect for the Image

The choice of the intermediate frequency is a debatable topic and every conceivable reason has been advanced for the choice of frequencies at or near one end or the other of the band, as well as in the middle, or somewhere else within the electrical limits, but since we are desirous of receiving very high frequencies, there can not be any stronger argument against the use of a high i. f. than the one in favor of improved image impression. It is not necessary to go into a long discussion of images. It is enough to say that when the i. f. is low, say, between 550 and 600 kc, a frequent converter choice, stations in the short wave band we are discussing may be received at two points on the dial, one representing the truly desired reception, at the lower frequency setting, and the other, at the higher frequency setting, representing the image. The desired frequency is called the object frequency, to distinguish it from the image. And image trouble simply means two-spot tuning and besides some pecu-

Coil Winding Data for .001 Mfd. Padding



The part of the tube to be used as oscillator in the converter is represented above, set up for listening to generator response. Set the generator at the frequency desired. For the local oscillator check include Cp as .001 mfd.

The winding directions for the secondaries are given here for No. 18 enamel, close winding, both for the r.f. (station frequencies) without series padding, and for the oscillator with .001 mfd. padding. The tubing diameter is given in the first column. Otherwise the number of turns appears.

Diameter	*R.F.*	*Oscillator*
3/4"	13	11
7/8"	11	9.3
1"	8.5	8.2
1 1/8"	7.8	7.2
1 1/4"	7.1	6.6
1 3/8"	6.6	6.0
1 1/2"	5.8	5.6

The inductance is 2.6 microhenries for r.f., 2.0 microhenries for oscillator. However, inductance may be decreased by spacing of wire even after winding. Data suppose a two gang .00035 mfd. condenser. Coils with specified secondaries will work well also with higher capacities, to .0004 mfd. but frequency range will be greater.

Primary or tickler depend on various factors. The tickler should be large enough to support oscillation at 7,000 kc. The r.f. primary then would be no smaller than the tickler.

The presence of oscillation depends partly on the tube used and its voltages. For the tube shown, tickler of fine wire (No. 32 will do) may be 1/16" removed from secondary, and have half as many turns as secondary.

liar kinds of interference resulting from the reception of stray disturbances.

Two I.F. Values Compared

The frequency difference between these two settings is twice the intermediate frequency, therefor if the i. f. is low, twice the i. f. will represent a small difference, whereas if the i. f. is high, twice the i. f. will represent a large difference. Assume one choice is 560 kc for i. f., meaning that the receiver is tuned to that frequency, and the converter changes short wave frequencies to 560 kc for amplification at that level in the set. Assume another choice is 1,600 kc. In the first example the image will be removed from the object by 1,120 kc, in the other by 3,200 kc, or, in the second instance, the frequency difference is almost three times as great, just as in the two selected i. f. examples one is almost three times as great as the other. Their ratios are the same. The absolute difference is what counts for a single range or band, and that difference in the 1,600 kc instance is more than 2,000 kc greater than in the 560 kc instance.

Two Kinds of Selectivity

Against the high i. f. some arguments may be presented, too. For instance, the interchannel selectivity is not as great, particularly if the broadcast receiver is of the tuned radio frequency type.

Hence there are two kinds of selectivity to keep in mind. One is the selectivity against images, aided only by a high intermediate frequency or much pre-selection, or both, and the other interchannel selectivity, which is greater the lower the i. f.

It is a case of what one regards as the more serious trouble, and image trouble is deemed by the author to be the source of more annoyance, particularly as it renders logging less effective, brings about confusion in coinciding dial with generated frequency, and sometimes permits reception of two stations at once, though they are on different frequencies, an interference that no amount of i. f. selectivity will aid in the slightest.

So going ahead with 1,600 kc as the basis of operation, meaning we must tune the receiver to that later on, when converter is to be hooked up, we proceed to try for a solution of the local oscillator problem.

The Oscillator Frequencies

It is obvious that the frequencies of oscillation are known as soon as the i. f. is selected, because we simply add the i. f. to the extreme carrier frequencies, and the oscillator must be higher in frequency by the value of the i. f. If the end frequencies then are 5,400 and 17,000 kc we have to contend with 5,400 + 1,600, or 7,000 kc, and also with 17,000 + 1,600, or 18,600 kc.

Formerly we struck the frequency ratio by dividing one end frequency into the other, and squared the result to get the capacity ratio. Here we do the same thing. We divide 7,000 into 18,600 and get 2.657. The squared term is

(Continued on page 62)

RADIO CONSTRUCTION UNIVERSITY

Answers to Questions on the Building and Servicing of Radio and Allied Devices.

Zero Beat Reception

USING the zero beat method of reception, single tuned circuit, how close may selectivity be? Please detail squelcher in zero beat receiver, April issue.—E. G.

The discrimination well may be of the type generally referred to as "10 kc selectivity," especially on the broadcast band, provided the coil has a good figure of merit. If it has not, or if the coupling to antenna is too strong, or if any other conditions equivalent to introducing much a. c. resistance into the tuned circuit are present, stations in the broadcast band 10 kc apart could not be separated, and particularly cross-modulation would be suffered in large centers of population. As for the type 6C6 tube that serves as a squelcher to a new purpose, the fixed condenser bypassing may be made effective even into the audio spectrum, say, cutoff at 8,000 cycles, the condenser-resistor combination in the first tube's output, thereby taking up a part of the burden. However, departure from approximate zero beat is serious, so stability of the oscillator is vital, hence the Colpitts circuit. In usual sets beats to 100 cycles could be countenanced because the audio amplifier does not give them much headway, or if the amplifier does, the speaker doesn't. Beats above 100 cycles will produce a tone of high intensity, and on this the squelch tube must work.

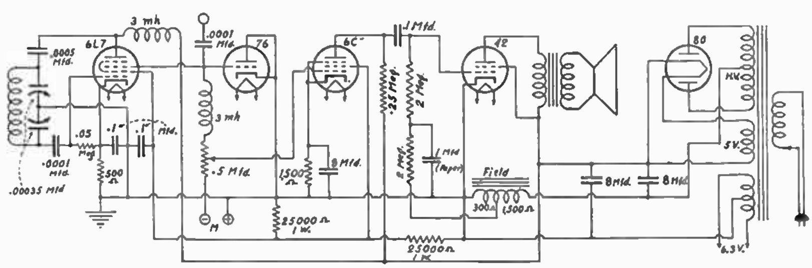
Moreover, if any disturbance outside the receiver, such as man-made static, produces a large audio voltage, as it normally does, such presence will invoke the action of the squelch tube, thus introducing a noise silencer. As a matter of fact, the whole system is one of noise silencing, since the audible beats constitute noise, in the sense of interference that carries no intelligence. But only the stronger forms of man-made static will act upon the relay tube that closes the valve to audio amplitudes substantially higher than those of the modulation. So that the system shall work well the local oscillator must be one of strong amplitude compared to the amplitude of any carrier to be received. Lest the demand for strong oscillation be greater than small tubes would furnish, squeals, along with the program, are given a stage of audio amplification. That makes it somewhat easier to find the correct operating point for the third tube. True zero beat seldom is accomplished. The degree of coupling and the necessary resistance of the tuned circuit, though "negative" in respect to non-oscillating condition, prevents zero beat. That is why it is at all practical to tune in stations, as a finite frequency results. A high pass filter, immunizing the detector from any influence by finite frequencies below 100 cycles, would improve sensitivity and make tuning easier. At all hazards, a close vernier dial is essential.

* * *

Surprised at A.V.C. Effect

AFTER having operated a superheterodyne that I built, I decided to include automatic volume control. However, I don't think I have quite the right circuit, as the volume was reduced about half, particularly the loud locals.—I. J. F.

The circuit is probably right. A.v.c. acts thus.



When the frequency generated in the 6L7 beats with an incoming modulated carrier, the beat is so strong that the 6C6, third from left, becomes biased to cutoff. At zero beat, or no audible sound due to beating, the modulation or program comes through.

CONVERTER

(*Continued from page* 59)

7.06. It is obvious we do not need as great a capacity ratio or frequency ratio, and that is true because the frequencies are higher, and the difference between oscillator and station carrier frequencies constant, and we are dealing with the oscillator.

We rig up an oscillator coil in a test circuit, somewhat after the fashion of the oscillator coil to be discussed, and using the signal generator, we have just enough secondary wire on the coil to bring in 18,600 kc at minimum capacity of the tuning condenser, after making the same sort of inductance adjustment as was discussed for the other coil. Note that the high frequency end must be used. The low frequency depends on right inductance primarily, padding capacity secondarily.

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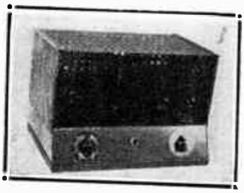

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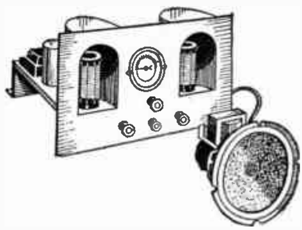

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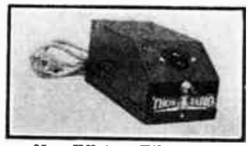

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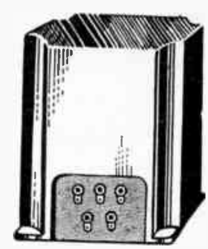

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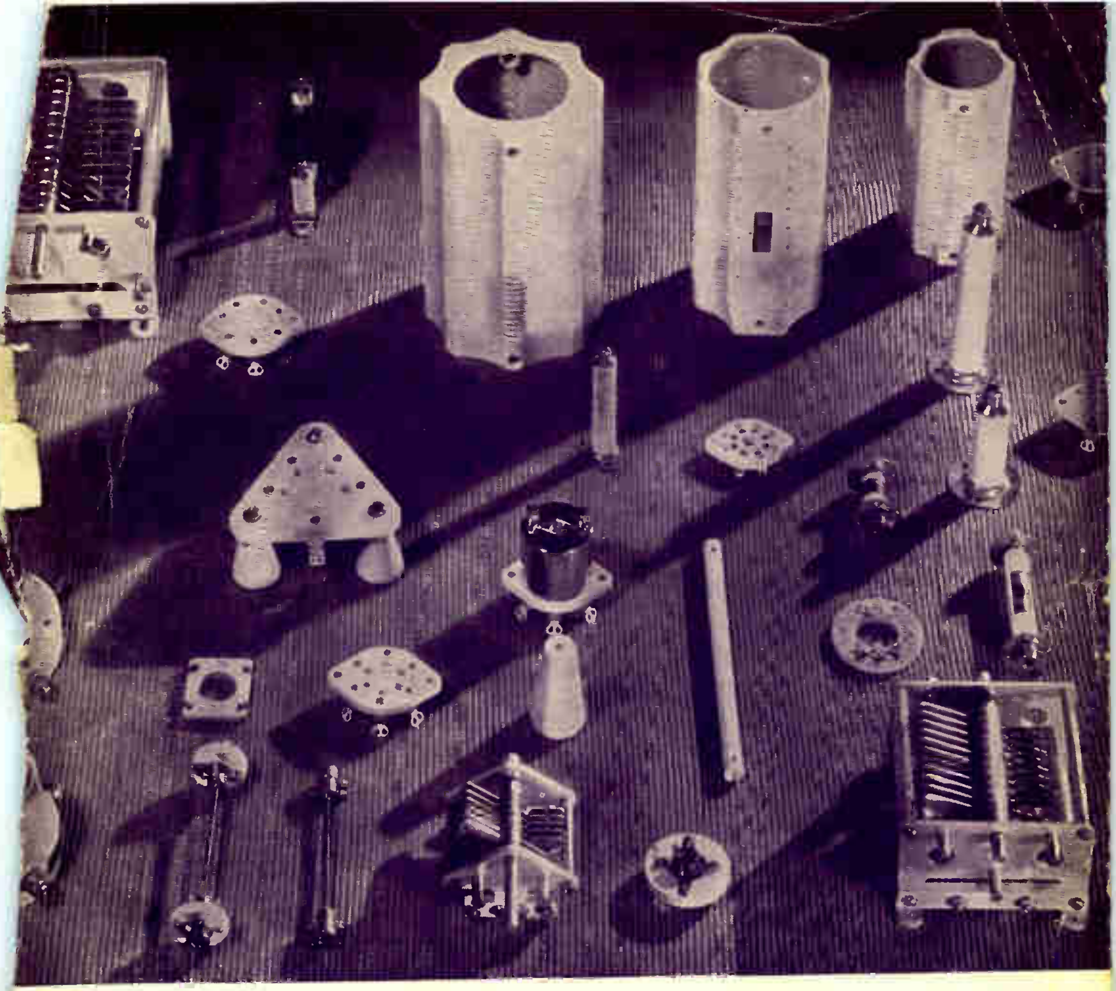

● National offers a thoroughly engineered part for nearly every radio purpose. The entire line cannot be compressed into our twenty-page catalogue, much less a single page. But look over the group above. Transmitting condensers from the little 1000 volt TMS in the foreground to the 12,000 volt TMA at the rear. Low loss ceramic coil forms for every amateur band. Low loss sockets for nearly every tube type, from acorns to power pentodes. Flexible couplings from the little TX-12, which will work around a corner, to the big fellows for heavy condensers, high voltages, and low-losses. Strain insulators, spreaders, lead-ins for the antenna; stand-offs, chokes, dials for the rig. National has what it takes.

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