90 Illustrations

The How-to-Make-It Monthly

RADIO WORLD

REG. U.S. PAT. OFF.

Fourteenth Year

MAY 1935

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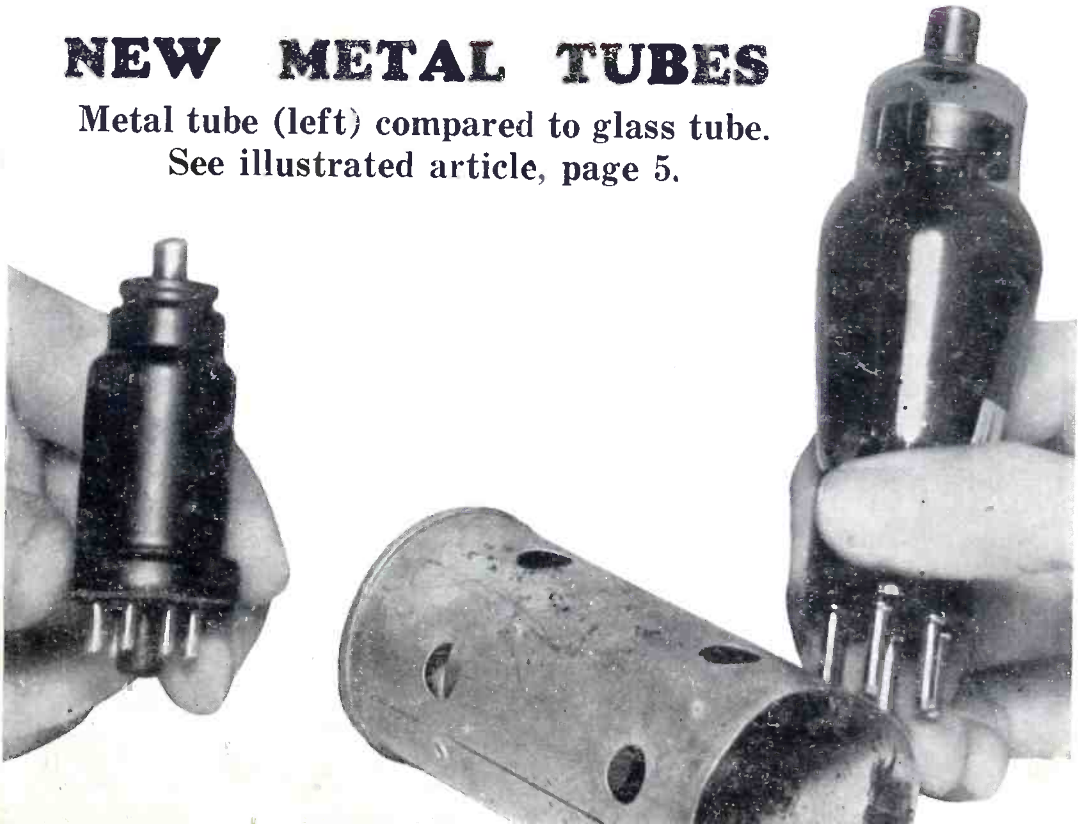
How to Make: Portable

High Fidelity Filter

Neon Gadgets

NEW METAL TUBES

Metal tube (left) compared to glass tube.
See illustrated article, page 5.



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FOURTEENTH YEAR

Table of Contents for MAY, 1935

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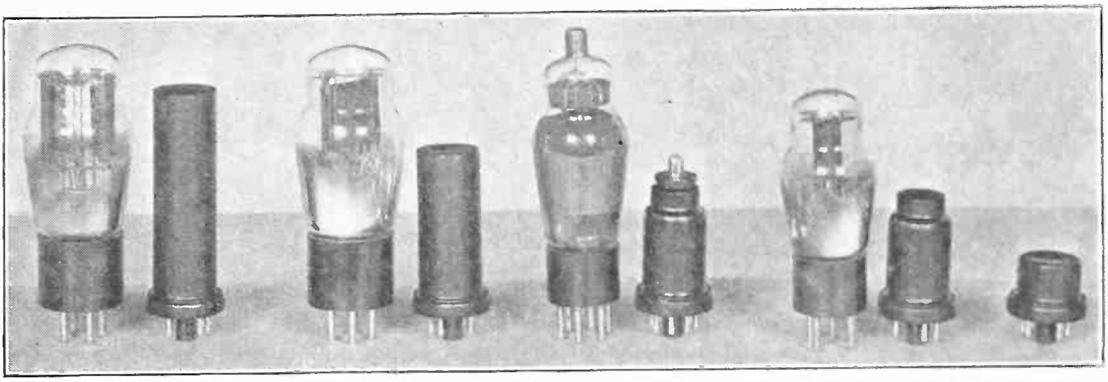
METAL SHELL TUBES

Construction and Connection Pointers for Radio's Latest Development

By Conrad L. Morrow



Contrast between the new metal radio tubes and glass-enclosed tubes of corresponding ratings. Left to right: rectifiers, power tubes, radio frequency tubes, small triodes, and, alone, the new duo-diode, available only as a metal tube.

METAL shell tubes have appeared on the American market. So far information is furnished on six types, and soon there are to be data on four more such tubes. The outstanding visual characteristic is the smaller size of the metal tubes. The shell, being metal, constitutes the shield, and the shield connection is brought to a base pin. Thus, no detachable shields are needed.

Moreover, the same type of socket may be used for the different tubes. For instance, some of the tubes have eight base pins, one of which is for the self-shield; others have total of seven, six, etc. Nevertheless the pins of all these tubes are so arranged that they will fit into the same eight hole socket. Moreover, all the pins are of the same diameter. The heater or filament pins are not larger in diameter than the others.

So that there will be no danger of misinsertion a locator is used. This is separate from any base pin, and is insulative. It consists of a circular protrusion from the base of the tube, at center, with a small perpendicular ridge built in. The socket must be so arranged as to accomodate the circular protrusion from the tube base part of the way, and then have a slot into which the ridge will fit when the pins are rightly disposed about the socket. The tube may then be pressed home.

THE TEN TUBES CLASSIFIED

The six tubes concerning which data are hereby presented are:

6A8 pentagrid converter
6C5 detector-amplifier triode
6D5 power amplifier triode
6H6 twin diode
6J7 triple grid detector-amplifier
6K7 triple grid super control amplifier

The four concerning which data are expected to be available soon are:

A full wave rectifier
A mixer
A Class B twin amplifier
A power amplifier pentode

It can be seen that the numbered and lettered six are of the 6.3-volt series and are electrical counterparts of existing tubes, except the 6H6. This is the first twin diode. The power amplifier triode is the first heater type such triode, but this is incidental, as in other tubes elements could be joined to the same effect.

SET IS DEMONSTRATED

The tubes were designed by the General Electric Company, which demonstrated them in a receiver it has ready, but the tubes will be made by Radiotron Division of RCA Manufacturing Company.

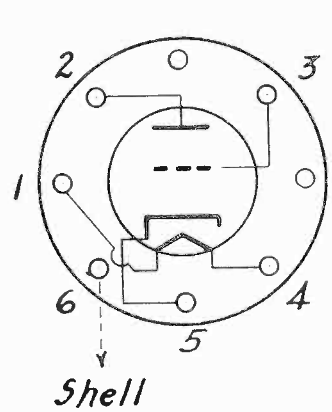
About the time that the receiver was released the tube was made available to manufacturers for experimentation, at $1 apiece, just to mark the end of the era of free samples. However, the charge was not indicative of the actual price at which the tube will be sold or listed, since the list prices prevailing for the similar type glass tubes are expected to apply to the new tubes, or, if there is no glass tube like a new metal one, for instance the duol diode, then the list price will be the same as that of a glass tube of similar construction and size.

The tubes will be released to stores for supply to experimenters, and it is expected the early sale of the tubes will be considerable through

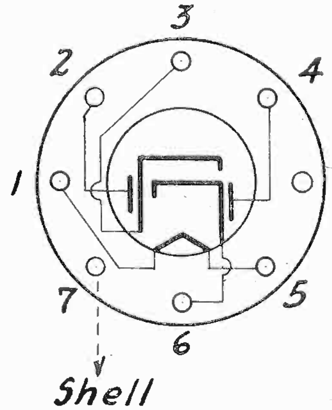
(Continued on next page)

Builders' Information on New Metal Tubes

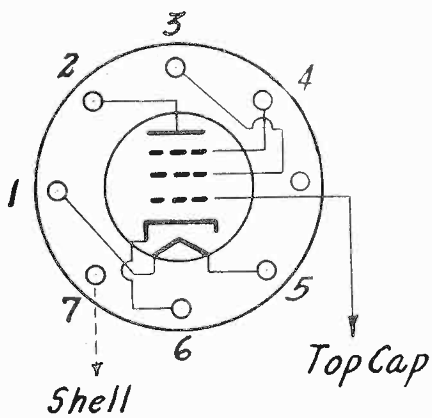
[Bottom view of sockets shown below. Elements identified, connections to pins verified. The same socket accommodates all six tubes. No tube has more pins brought out than needed. Two are five pin, one is six pin, two are seven pin, and one is eight pin.]



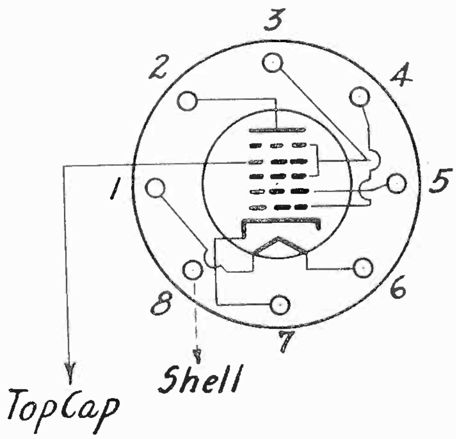
6C5
6D5



6H6



6J7
6K7



6A8

(*Continued from preceding page*)

this outlet, as the tubes are said to have some points of superiority for short wave reception, although the reasons are not set forth. In fact, the data on the tubes are frankly stated by RCA Manufacturing Company to be tentative, the developmental work on the series is acknowledged to be incomplete, and the time of availability of the tubes to the general public has not been fixed.

The circuit information applicable to the tubes is for the time being the same as that applicable to the existing similar glass tubes.

What About Your Analyzer?

Owners of analyzers will have to consider the effect of radically new tubes on their measuring equipment.

The cable has to accommodate the maximum number of leads, eight from bottom and one from top, total nine, to serve the extreme case, and so far the eight-lead cable is top. Since one of the tube pins is grounded the eight-wire cable can be made to serve if the ground is taken over independently from the tube shield. Place for a new socket, also adapter for plug, is required. Some improved analyzers have blank for new socket and other provisions for serving the metal shell tubes with plug adapter aid.

6C5

DETECTOR AMPLIFIER TRIODE

Heater Voltage (A.C. or D.C.)	6.3		volts
Heater Current	0.3		ampere
Plate Voltage	250	max.	volts
Grid Voltage	—8		volts
Plate Current	8		milliamperes
Plate Resistance	10,000		ohms
Amplification Factor	20		
Mutual Conductance	2,000		micromhos
Maximum Overall Length			2⅝"
Maximum Diameter			1⅜"
Base		Small Octal 6-Pin	

6D5

POWER AMPLIFIER TRIODE

Heater Voltage (A.C. or D.C.)	6.3		volts
Heater Current	0.7		ampere
Maximum Overall Length			3¼"
Maximum Diameter			1⅜"
Base		Small Octal 6-Pin	

As Single-Tube Class A Amplifier

Heater Voltage	6.3		volts
Plate Voltage	275	max.	volts
Grid Voltage	—40		volts
Plate Current	31		milliamperes
Plate Resistance	2,250		ohms
Amplification Factor	4.7		
Mutual Conductance	2,100		micromhos
Load Resistance	7,200		ohms
Undistorted Power Output	1.4		watts

As Push-Pull Class AB Amplifier (Two Tubes)

Heater Voltage	6.3		volts
Plate Voltage	300	max.	volts
Grid Voltage (Fixed Bias)	—50		volts
Plate Current (Per tube)	23		milliamperes
Load Resistance (Plate to plate)	5,300		ohms
Power Output	5		watts

6H6

TWIN DIODE

Heater Voltage	6.3		volts
Heater Current	0.3		ampere
A-C Voltage per Plate (RMS)	100	max.	volts
D-C Output Current	2	max.	milliamperes
Maximum Overall Length			1⅝"
Maximum Diameter			1⅜"
Base		Small Octal 7-Pin	

6J7

TRIPLE-GRID DETECTOR AMPLIFIER

Heater Voltage	6.3		volts
Heater Current	0.3		ampere
Plate Voltage	250	max.	volts
Screen Voltage (Grid No. 2)	100	*	volts
Grid Voltage (Grid No. 1)	—3		volts
Suppressor (Grid No. 3)	Connected to cathode at socket		
Plate Current	2		milliamperes
Screen Current	0.5		milliampere
Plate Resistance	Greater than 1.5		megohms
Amplification Factor	Greater than 1500		
Mutual Conductance	1,225		micromhos
Maximum Overall Length			3⅛"
Maximum Diameter			1⅜"

* *Maximum screen volts* = 125

6K7

TRIPLE-GRID SUPER-CONTROL AMPLIFIER

Heater Voltage (A.C. or D.C.)	6.3		volts
Heater Current	0.3		ampere
Plate Voltage	250	max.	volts
Screen Voltage (Grid No. 2)	100°		volts
Grid Voltage (Grid No. 1)	—3	min.	volts
Suppressor (Grid No. 3)	Connected to cathode at socket		
Plate Current	7.0		milliamperes
Screen Current	1.7		milliamperes
Plate Resistance	0.8		megohm
Amplification Factor	1,160		
Mutual Conductance	1,450		micromhos
Grid Voltage*	—35		volts
Grid Voltage**	42.5		volts
Maximum Overall Length			3⅛"
Maximum Diameter			1⅜"

* *For mutual conductance of* 10 *micromhos*
** *For mutual conductance of* 2 *micromhos*
° *Maximum screen volts* = 125

6A8

PENTAGRID CONVERTER

Heater Voltage (A.C. or D.C.)	6.3		volts
Heater Current	0.3		ampere
Plate Voltage	250	max.	volts
Screen Voltage (Grids No. 3 and No. 5)	100	max.	volts
Anode-Grid Voltage (Grid No. 2)	200	max.	volts
Control-Grid Voltage (Grid No. 4)	—3	min.	volts
Total Cathode Current	14	max.	milliamperes
Maximum Overall Length			3⅛"
Maximum Diameter			1⅜"

MORE GAIN
From New Coils with High Impedance Primaries

By Harry Miller

THE school of hard knocks has caused the production of better coils. Perhaps theory is not now followed too closely. For short wave coils the skinniest primaries used to be the rule. Now the primaries have high impedance. Their inductance is higher than the secondary inductance. The rule obtains in the broadcast band, may be abrogated for the next higher band, but is restored for the third band, and if there is a fourth band, then for that, too.

Results count. Competition is getting stronger. More concerns are learning how to produce coils and sets, and give satisfactory demonstrations on short waves. So coil designers are being coaxed day by day to make their coils better and better, meaning that the receiver should be made peppier and peppier. And something like that is being accomplished.

WHY THE THREADING

Of course, as the frequencies increase, things begin to sag. Circuit losses pile up. Better loading of plate circuits helps to overcome this effect. Hence the high impedance primaries.

For receivers of the not-elaborate type it is not necessary to resort to shielding, especially is it inadvisable to do so with the two-gang condenser jobs. The coils illustrated on this page work especially well, not being of the shielded type. The winding for the highest frequency band is on a threaded part of the form, to maintain the inductance of one coil exactly the same as that of another in the winding process, for the band where this is of particular moment.

A metal chassis is used for a receiver, as is customary, and the coils are mounted underneath the chassis.

Antenna coupling is of course a coil problem and is being given considerable attention. If a short aerial is used for all wave reception, the lower frequency bands of tuning suffer quite a drag, including standard broadcast, which can be compensated by special impedance matching transformers, which no doubt will be used more by experimenters and home constructors in months to come.

NO "PERPETUAL MOTION"

A good deal of the discussion and efforts concerning coils reminds one of the perpetual motion machine. It would seem that if you put some kind of winding on that the other fellow did not use, that wonders will be accomplished, all at no expense. Just as if a machine could be kept going forever without being fed anything, except being given a small push for start.

Coils are important but they are not the only things about a set. Especially where there is oscillation trouble already, the "ideal" coil problem may become secondary, as the gain is greater than the system can handle.

The very large primaries serve their purpose. The usual test is this: use one set one coils, then another, and see which set results in the greater volume. The set producing the greater volume is the "better." It is like saying that you should weigh two men. The heavier man is better morally, physically and intellectually. When the volume increased, what happened to the selectivity?

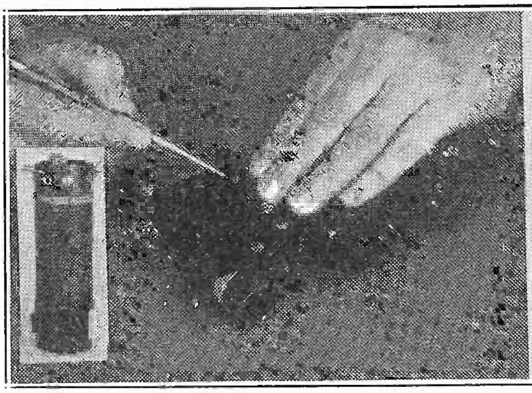
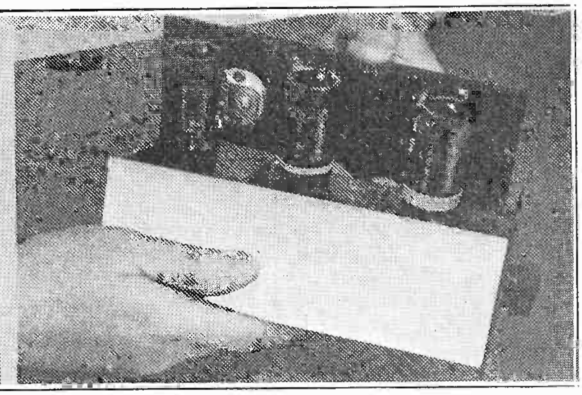
Really, as you increase the primary you decrease the selectivity. There are coils made, and to good purpose also, that have primaries for the broadcast band that resonate, with assumed antenna capacity, at far below the broadcast frequency limit, not far from the intermediate frequency level.

EX CATHEDRA

Naturally, with coupling that is strong inductively at this end, a powerful signal results from a low frequency station. But at the

Broadcast Band Data

When coils are wound solenoid style with turns side by cast band, on small side, for the broad-diameter form, e.g., 1 inch, the wire must be fine, otherwise the coil would be exceedingly long. The more the length of a coil exceeds the winding diameter the worse the coil is. Hence 132 turns of No. 30 enamel on 1 inch are used.

Drawer type plug-in coils are bracketed to an insulated strip that fits over the shield box. Inset shows coil for one band. Pencil points to tabs that switch fingers contact. Metal partitions separate the coils (right).

high frequency end the selectivity at the r. f. level is sacrificed, and there is no doubt about that. This comes from a practical coil man who has to do much more work with winding and soldering iron than with formulas and slide rules.

However, advantages of somewhat leveling the r. f. response must not be denied. It will be found that a high impedance primary is used for the broadcast band in one of the series of coils developed in our laboratories, the winding data for which are given herewith.

On account of my experience with coils in connection with the design of all wave receivers, the editor has asked me to discuss some topics close to the heart of experimenters who are perhaps mystified by some coil claims and processes.

Shielding already has been discussed. A point worth remembering is that the moment the sensitivity runs high, there should be shielding otherwise there will be loss of selectivity, due to entry of carrier without passing through the total intended path. This perhaps is only another way of saying that the sensitivity should not be pressed too high in the unshielded type set. If shielding results in so much loss that the old pep is gone, then the receiver, of course, should not have shielded coils, and the test is made by the design engineer.

INSIDE DOPE ON COILS

The unshielded type coil is illustrated on the opposite page, the lower picture showing oscillator coil at left and antenna coil at right. What seems to be a mistake—absence of a primary for the broadcast antenna coil—is not such, since an r. f. choke coil is inside the form. That is the high impedance primary mentioned before.

The illustrations above refer to the drawer type plug in coils and bring up the subject of shielding. There are three coils, one antenna coil, one r. f. coil and one oscillator coil, for each band. The coils under discussion are for tuning with the usual condensers that cover the broadcast band with one coil set.

The highest frequency coil is wound on ⅞-inch diameter tubing, instead of the 1-inch diameter that prevails for the other coils of the shielded type, because the extra ⅛-inch keeps the coils that much farther away from the shield, and the capacity is less, also the inductance drop is less, and the coil therefore performs better. This is true although the axial length of the winding is made a bit longer.

Using good insulating material, that has been well seasoned, meaning dried out, the inductance does not change enough to make any substantial difference. Then the question of the capacity alignment has to be considered.

THE PARALLEL TRIMMERS

The use of compression type trimmers is almost universal, practically all the factory made sets use them, and virtually all experimenters and home constructors of sets do likewise. It is true that air dielectric condensers do hold their capacity more closely, but the parallel trimmers on even the smallest coils—highest frequency band—are 3 to 15 mmfd., and considered in the light of minimum circuit capacity without them, of some 30 mmfd. suppose the trimmer is set at 9 mmfd. and changes 10 per cent., or 0.9 mmfd. out of 39 mmfd. This is not even enough to molest the tracking of the circuit with the frequency calibrated dial. That is, the compression trimmer is satisfactory within commercial tolerance. It is therefore also satisfactory for the home constructor.

The types of wires come up for discussion. Litz wire is used sometimes for short waves but it is better for low frequencies and is used on good intermediate frequency coils. The resistance becomes too high at relatively high frequencies. For the broadcast bank bank wound coils are favored by some, and present possibilities of improving the selectivity, because the axial length of the winding is kept down, for

(Continued on next page)

DIRECTIONS for Winding Coils for ALL WAVE COVERAGE

For Usual Capacities of Tuning Condenser That Cover the Broadcast Band Without Switching

(*Continued from preceding page*)
any given diameter of form. The fact that the coil gets a bit closer to the shield wall does not matter so much in the broadcast band.

But with this type of winding the distributed capacity runs pretty high.

WHAT ABOUT THE CAPACITY?

If this does not interfere with any tuning ratio, the increased capacity may be all right, provided, however, that coil capacity is not injurious to coil performance, a question that perhaps has not been fully studied and settled. Distributed capacity in coils, capacity between turns, between ends, etc., and the effect on circulating current, which is uneven, would require a lifetime to study properly, and evidently nobody yet has done it. Meanwhile meter tests summarily dispose of the problem, although maybe not permanently.

Few Even Values For Shunt Method

Unfortunately the values do not ordinarily come out even for resistances of unknowns compared to current readings, otherwise it would be easy to work the shunt method of measuring low resistances, and though having no direct reading meter scale of the sort, never even miss it. Take for example the following: 0.6 ohm, 20 microamperes; 3 ohms, 90 microamperes; 10 ohms, 250 microamperes; 15 ohms, 400 microamperes; 30 ohms, 500 microamperes; 45 ohms, 600 microamperes; 70 ohms, 700 microamperes. These are about the only round numbers, or easily remembered values, and might as well be committed to memory by any who will use this method much without a meter calibrated on its face scale for the purpose. So far as known no commercial meter has scale thus calibrated. The value of 100 ohms is represented by 780 microamperes, and the resistance jumps are large from then on, soon becoming too large to be of much service, although of course only a couple of hundred microamperes remain.

The unknown resistance by the shunt method is equal to (the product of the meter resistance and meter current) divided by (1 minus the meter current). Thus we find that the resistance of the unknown for the currents higher than 780 microamperes are: 120 ohms, 800 microamperes; 270 ohms, 900 microamperes; 570 ohms, 950 microamperes; infinity, 1,000 microamperes. It is thus obvious that it is practical to dovetail with the usual series resistance measurement methods where the minimum reading easily taken is from, say, 25 ohms to a few hundred ohms. See pages 46 and 56.

UNSHIELDED COILS

(Illustrations on page 8)

Outside diameter of form, 1¼ inches.

Broadcast Band—Antenna coil, 2 millihenry honeycomb primary inside form, inductively related to secondary of 85 turns of No. 29 enamel. Oscillator coil for 465 kc. i. f., 27 turns of No. 28 enamel; tickler, 22 turns No. 28 enamel, separated from secondary by ¼-inch. Padding condenser 300-600 mmfd.

Police Band—Primary, 10 turns No. 29 double cotton covered, secondary 21 turns of No. 25 enamel wire, separation between primary and secondary, ¼-inch; oscillator coil, primary, 12 turns No. 29 dcc, separation ¼-inch. Padding condenser, fixed capacity of 0.0011 mfd.

European Band—Antenna coil, 3½ turns of No. 29 dcc, very close to secondary of 11¼ turns of No. 20 enamel, spaced 12 turns to the inch. Oscillator coil, same as antenna coil. No series padding condenser.

SHIELDED COILS

(Illustrations on page 9)

Outside diameter of form 1¼ inches except as noted.

Broadcast Band—Antenna Coil: Primary 15 turns of No. 29 dcc; ⅛-inch separation; secondary, 132 turns of No. 30 enamel. R. F. coil, primary 30 turns of No. 30 enamel, ⅛-inch separation, secondary 132 turns of No. 30 enamel wire. Oscillator, for 465 kc i.f. tickler, 27 turns of No. 28 enamel, separation ¼-inch; secondary, 109 turns of No. 28 enamel. Padding condenser, 300-600 mmfd.

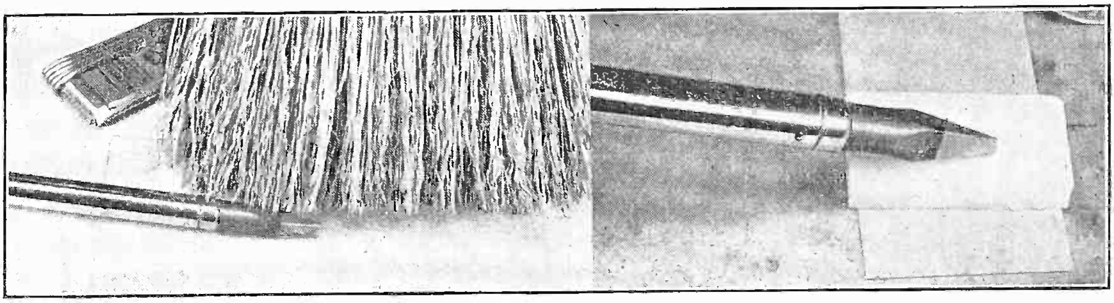
Police Band—Antenna Coil, primary, 23 turns of No. 30 enamel; ⅛-inch separation; secondary, 43 turns of No. 25 enamel. R. F. coil, primary, 21 turns of No. 30 dcc, ¼-inch separation, secondary, 43 turns No. 25 enamel. Oscillator coil for 465 kc, tickler, 20 turns No. 24 enamel, ¼-inch separation; secondary, 36 turns No. 24 enamel. Fixed padding capacity, 0.0011 mfd.

European Band—(Wound on ⅞-inch diameter)—Antenna coil, primary, 6 turns No. 30 dcc; secondary very close to primary, 28 turns of No. 24 enamel, spaced twice the diameter of the wire. R. F. coil, primary 10 turns No. 30 dcc; secondary wound close to primary, 28 turns No. 24 enamel, spaced twice the diameter of wire. Oscillator coil, tickler, 12 turns No. 30 dcc, close coupling, secondary 27 turns of No. 24 enamel spaced double the diameter of wire.

Tip for a Clean Sweep—
Try a Whisk Broom on Your Soldering Iron

By Jack Tully

RENOVATING THE "BUSINESS END"



The main consideration is to clean off the copper tip at the working end. The whisk broom is not so funny as it seems. A cake of sal-ammoniac does the trick, too.

CLEAN tips make soldering successful. Use causes any tip to become pitted, corroded, charred and possibly greasy. Always the end should be so clean on all facets or surfaces that solder will adhere.

A test consists of heating the iron, applying flux, and then either dipping the tip in a pot of molten solder, or melting solder on the tip, to ascertain if solder will adhere to the working surfaces. If the tip is dirty, the "infected" places are identified because the solder will not hold. Thus it is easy to locate the bad spots.

Next, use a file to shave down the copper tip so as to remove these trouble sources, and check again for successful cleansing by using flux anew and testing for the solder sticking. If the file is too rough for reducing the surface finely, finish off the cleansing with sandpaper or emery paper.

CLEANING OFF THE TIP

Careless work is done with unfit tips. The corrosion is allowed to continue. Finally no solder can be worked anywhere on the tip except at one point, and that is the point used time and again. To avoid causing a clean tip from becoming fouled, wipe the tip every now and again on a cloth. The stroke has to be rapid, to avoid the odor of burning cloth. Steel wool may be used without this danger. Strangely enough, a whisk broom does very nicely, if brisk, rapid strokes are applied to the tip. Only a few strokes are needed.

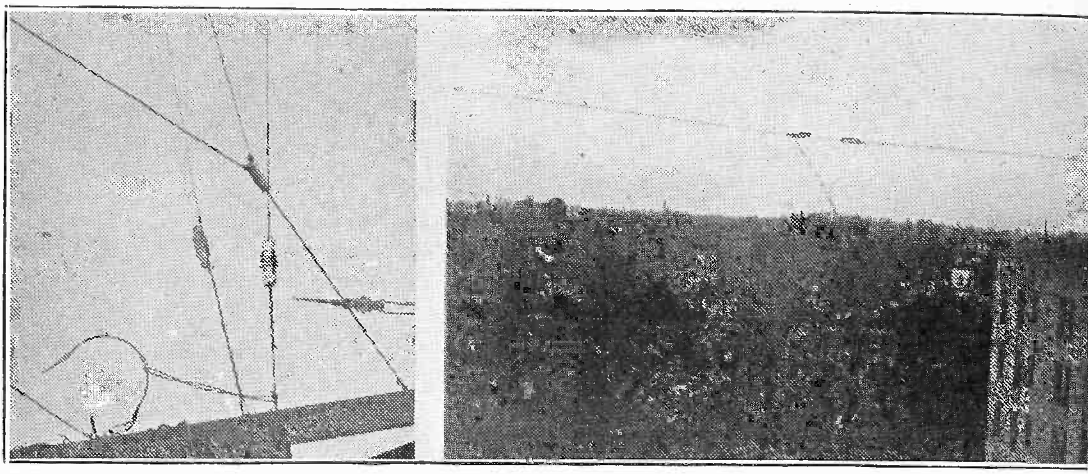
The process of covering the tip with solder preparatory to starting work with the iron is called "tinning." Hence a tip that will hold solder all over the working surfaces can be tinned completely. All irons should be worked with the tip in the tinned condition. As proof that the cleansing is complete, the newly tinned tip may be so fully cleansed with a whisk broom that for a few minutes, though the iron is hot, the tip looks as if it has emerged from a plating tank. Later on the sheen will disappear, but the healthy coat of tin should never be permitted to disappear.

FLUXES FOR RADIO

Iron temperature is not given much attention in radio soldering by home constructors. Factories sometimes keep irons at just a certain temperature, and even have a control that is used with the iron to maintain just that temperature. A warning that too much heat is being developed appears when the tip becomes covered with a carbon deposit that may be scraped off as dust.

The tip remains clean more readily if other than acid flux is used. Resin is a popular flux and in part constitutes the core of some solder. Also some salts are favorable for radio use. These are dissolved in water. The fluid lasts a long time and the preparation is very economical. However, the resin-core solder is handier. Some prefer uncored solder. That is simply plain solder, preferably in strips for radio use. Soldering paste is purchasable in cans and is sometimes used even as an auxiliary to a cored solder, for making a successful joint in a particularly repelling place, and of course for use with uncored solder.

Soldering salts work well, too.



Haywire roof aerials of an apartment house, at left. A doublet antenna strung in the clear, at right.

Plain Talk on Aerials

"In the Clear" Helps Fight on Interference — Doublets Lay Down Weaker But Less Noisy Signal

By Connie Andover

FORMERLY sets were not so sensitive. Today they are very sensitive. Formerly an aerial sometimes had to be just so to make up for the shortcomings of the set. Today the aerial does not have to be just so. If the set is highly sensitive all the reception most persons want can be obtained on a piece of wire no longer than the distance from the set's antenna post to the floor. This includes foreign reception.

If a very long and high aerial is used, and connected to a receiver of the highly sensitive type, there will be comparatively less noise due to the set. True, the noise from the antenna and the leadin that is as much a part of it as the flat top, may be great, or the pickup from the antenna may be pure, consisting only of signal carrier, yet the noise arising from the set itself is still comparatively less. If some one speaks weakly, for example, and another shouts, the shout tends to drown the whisper, and that is what one desires in radio reception, that the program be the shout and have the floor, while the interference is floored.

SO THE DOUBLET IS USED

If a high, long antenna is used, how is it to be coupled to the receiver, without bringing in much noise? The leadin is a noise pickup device because nearer to ground where man-made static abounds. There is no ready way, except one requiring grounding at pole top, which isn't handy at or ready at that.

That is one reason we have recourse to the doublet. This consists of a single wire, cut in half, with an insulator between the severed portions, and a two-wire leadin from the ends of the insulators to the set. The two-wire system may consist of parallel tubing, known as the coaxial feeder, awkward but the best transmission line known to science, or it may consist of transposed wires, a popular method, or twisted pair. All three ways permit tapping the aerial with the input posts of the set without having to count the leadin as a contributant of anything.

The doublet, however, will bring in practically all signals with less intensity, because the pickup is less, and this is true of all doublets, and is particularly true of doublets that are for wide frequency coverage. On the broadcast band, and especially with automatic volume control sets, this cannot be noticed much. It cannot be claimed successfully that there is any known method of making a system paramount at all frequencies except by tuning specially to those frequencies. By adaptations less noise will result, of course, and doublets are splendid in that regard, but they are not for large pickup, and the more modest receivers fare better with their longer aerials, so far as more stations received, though not necessarily as to the clarity of the reception.

TWO TYPES OF NOISE

Now, the short antenna, a few feet of wire indoors, delivers a small input, and therefore much of the amplifiication of the receiver is used. Little pickup being taken from the air, the interference from the outside is little. No

SHORT ANTENNA REDUCES HIGHWAY NOISE

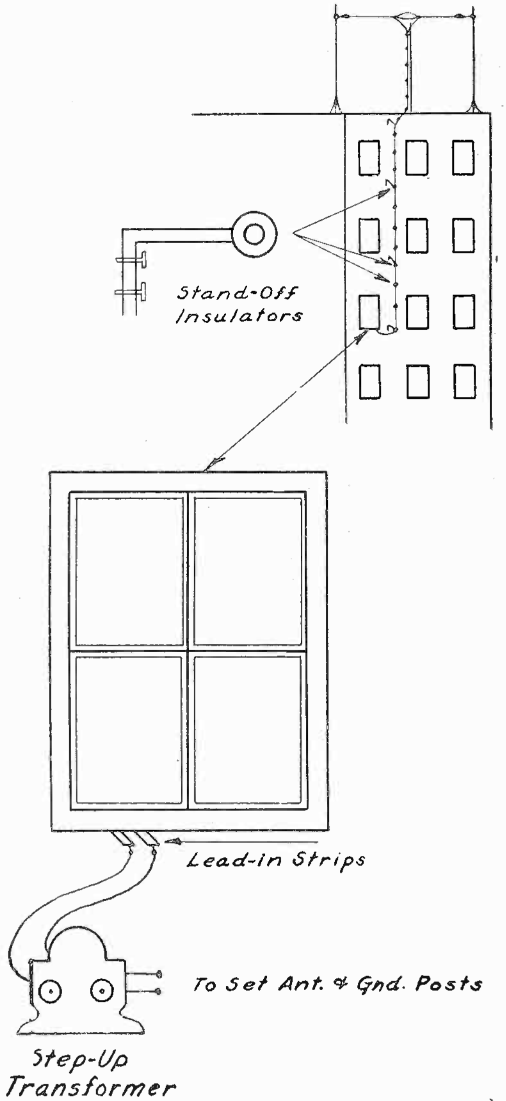
wire stretches upward to gather in noise on the way, and only sizable amplitudes get any real notice from the pickup, though subsequent amplification may be enormous.

Noise therefore from the outside is less by the short antenna method than by the long antenna method, particularly in the broadcast band. The receiver noise, inevitable and due to the irregular bombardment of electrons in the tubes and other causes, becomes greater the greater the set's sensitivity, hence we get rid of one type of noise and accentuate another type. Where does that lead us? Well, on the whole the receiver noise is less than from a noisy location, and if one lives near a vehicle highway, electric train road, power house, or suffers other forms of such interference, it is preferable to use a short antenna and use more amplification in the set. The resultant total of noise will be less, and it is the result that counts.

If the antenna is outdoors it should be in the clear. Notice how aerials of apartment house dwellers are clustered. Thus neighbors swap interference (photo at left). The fellow with doublet as right has things pretty much to himself, so fares better.

No matter if a short antenna is used, the actual input at low radio frequencies can be comparatively boosted, whereas otherwise they'd be weak on a t.r.f. set. The way to do it is to use a large primary and a smaller secondary for the matching coupler, and one may even connect a standard t.r.f. coil backwards, large winding to antenna and ground, small winding in parallel with the primary of the input coil in the set. No series condenser is used with such a setup. And the coupling is right for one band.

The method is familiar to many as the one used for automobile sets. The low frequency stations in which the riders are most interested (at least in the part of the world where the author exists) are made to come in with plentitude and pep, the pep being important, and never mind the rest. The difference, coupler in, coupler out, is marvelous. For instance, 570 kc comes in 1,000 times louder with the coupler in service. Reverse some coil with small primary and large secondary, as already suggested, to improvise a coupler. Maximum gain results only when the ratio is just right. Experiment to find that critical ratio.



Typical doublet antenna installation for serving the occupant of an apartment.

EFFECTIVE ANTENNA LENGTH

Just how little antenna one can get away with may be determined by experiment. Turn on the receiver, without any aerial attached. There will be hissing when the volume control is up all the way. That is, hissing if the receiver is at all sensitive. Then using a weak station as an index, say something semi-distant that you tune in familiarly, and lengthen the aerial until the hissing is tolerably low compared to the signal. That's enough pickup for the occasion. If the station is at one end or the other of the broadcast band (if the test is made, as likely, in that band), it makes no difference, provided the set is a superheterodyne, but if the set is a tuned radio frequency model there will be difficulty in obtaining enough practical selectivity unless the antenna is kept within short limits, and low radio frequencies may come in weakly, though compensation is possible, as will be told.

As the frequencies to be tuned in become higher and higher—short waves now—the antenna becomes more and more effective, short though it is. But there is only one region, literally only one frequency, for which any given antenna is IT and the best. It was said in the beginning and it is repeated now.

So it becomes advisable to put a variable condenser in series with the antenna and string up a longer aerial. The series condenser reduces

(*Continued on next page*)

(*Continued from preceding page*)

the effective electrical length. Since quite a variation is desired, the condenser for an all-wave set may be of 100 mmfd. maximum. It is variable, remember. Some manufacturers, though using smaller capacity, collected quite a few sheckles selling "marvelous" antenna adapters and impedance matchers and whatnot, nothing but variable capacity, but working like a charm. For any given band there is one setting that's best. For some other band some other setting. And so on until one gets tired.

CHECK FOR ONE BAND

Having discussed an antenna may one ask what an antenna is? Something that is used for collecting radio waves (reception all alone considered). Then how about the ground? If one connects ground to antenna post of set, does one hear programs or not? One hears them. Thus the ground is a collector of energy. Is it an aerial? The question to decide is, Which is the better aerial at your place? Antenna? Ground? It is not easy to answer. Comparative measurements should be taken. A compromise test is to put a very small capacity—say, 50 mmfd. or less—between set antenna post and regular aerial, with ground to ground post—hear how things go on, then reverse the connections to the set, with antenna to ground post or not connected anywhere, and ground connected to antenna post through the small series capacity. If the ground connection is louder the ground is a better aerial, at least for the band on which you are working.

Of course for standard broadcast and lower frequencies there are two waves you may receive and you do get both usually. They are the sky wave and the ground wave. They start off as one, part company, and may arrive out of step (after some miles of distance), creating a condition of fading. For higher frequencies the ground wave is small, since rapidly dissipated, and for what pass now as short waves—the favorite European band—the ground is just about no good whatever. Nothing doing on receiving the ground wave from Rome. That's why it doesn't make any sensitivity difference whether ground is connected to the set or not.

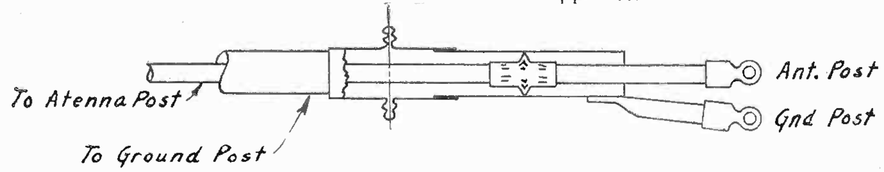
And yet if the so-called ground (the pipe the ground clamp grips) is connected to the antenna post, how come Rome pours in? Remember the wire between the pipe and the set? Dandy little aerial, that. And where is the pipe grounded? At the ground. Well, pipe from ground to ground clamp—dandy larger aerial, that. The sum of two aerials is thus being used when you say you "ground" the antenna post!

Ground does not figure in the doublet antenna. With the usual type of transmission line, both sides of the line are at a high potential. The transposition of the two leads, or the twisting of the paired wires, causes the cancellation of pickup in the leadin, due to neutralization. Therefore to use a doublet antenna either the receiver has to be equipped with input connections giving access to both sides of the primary of antenna coupler, neither side grounded, or a transformer has to be used between line and receiver, if the set's primary is grounded. There are instances where transformers are used anyway, though set's primary is ungrounded, and the purpose is to get the most out of the aerial and into the set.

Much experimenting is being done with such transformers, quite a few companies manufacture them commercially, and any constructor can have a lot of fun experimenting with extraordinarily large primaries, enormous ones in fact, connected toward doublet, and secondaries about of the inductance, or twice the inductance, of the primary of the set's antenna coupler. A good way to make the test is to see what happens to a d. c. meter in a detector plate circuit when low frequencies are tuned in, coupler and no coupler. The a. c. type meter (output meter across speaker) does not serve this particular purpose so well.

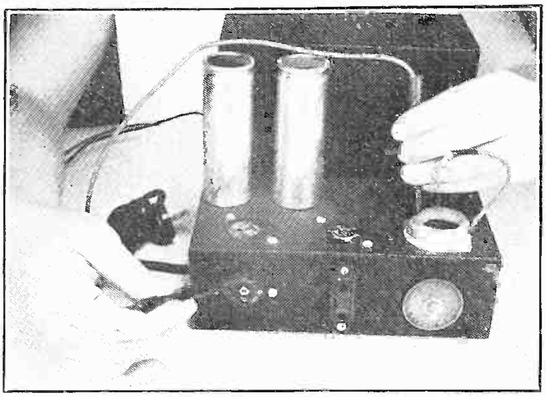
LEADIN STRIPS AND JANITORS

Most doublets are on the roof, under eaves, or strung from building to building, building to tree. The typical example of an installation in an apartment house is illustrated. Two high poles support the ends, which are tied to insulators. The insulator at center is exaggerated in the illustration to make it plain. The transposition blocks are exaggerated too for the same reason, the course of the line being to the window, where it is brought through leadin strips. These are handy, if the window is wood. Steel windows, found in a few apartment houses and numerous officce and factory buildings in large cities, require a different method. First of all, no window can be closed completely if the strip is used, unless a little sly work is done with a chisel to enable the perfect fit, if you know what I mean. As for the steel window. the chiseling method is out, because who can chisel steel, and besides the steel is a capacity to ground if not a short. So for the steel example, drill a hole in the window pane and put the wire through, or let a porcelain tubing through a small hole somewhere in the building, first getting the proprietor's permission, and in the absence of the proprietor, permission of the superintendent or jaintor, and in the absence of either, ask yourself what you would do in the circumstances if you owned the building, and do the opposite.



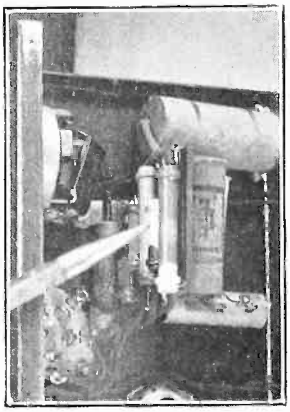
Best transmission line on earth, the co-axial feeder. How does one know? Judge by the transmitter test. The transmission line should not radiate. If it doesn't radiate it won't pick-up. Old Man Co-Ax, antecedent of Bracky Co-Ax, is only transmission line that does not radiate at all.

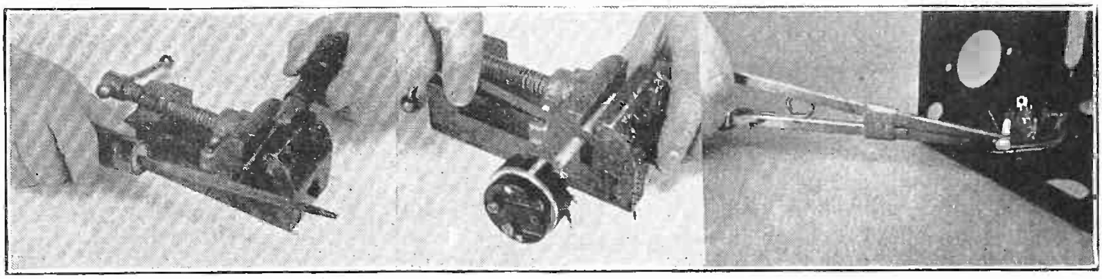
BOONDOGGLING



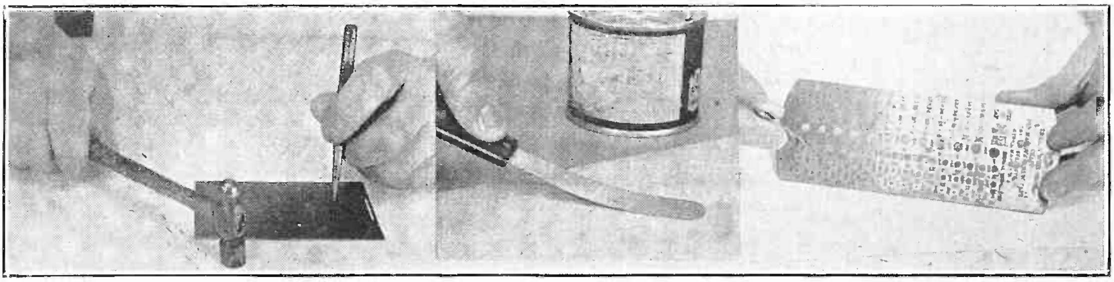
Electrolytics in cylindrical cans look like smokestacks, but that's not the point. Test leads applied to chassis check against shorts before turning on fatal juice.

At right, better use those leads to make sure resistors are not open, neither tubular condensers shorted.

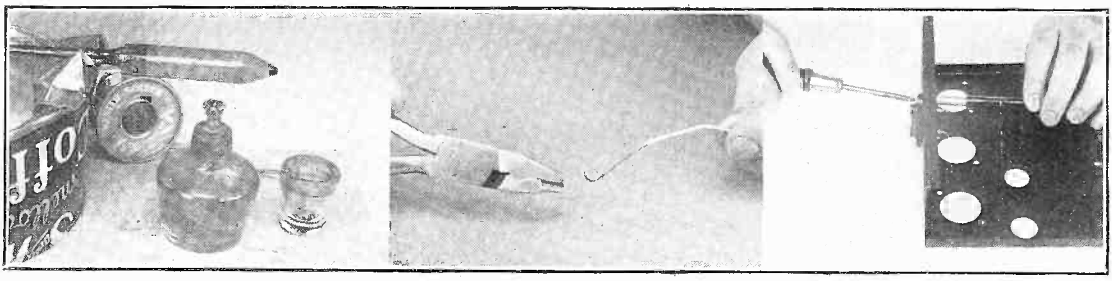




Sides of screw driver are filed so as to be at right angles with the flat tip, and "business edge" filed blunter, to give driver more strength. Next, small saw blade held only in hand will cut shaft of latest volume controls. Ant eater pliers grip things even when you remove hand, but not if you remove the spring.



Many a small hole need not be drilled in soft metal. Save time and effort. Use nail punch (not center punch, which has sharp point, or once did have). Center instrument levels ridges for restoring console finishes. Template at right receives drills, classifies them, reveals how to use them, but not how to stop neighbors from borrowing them.

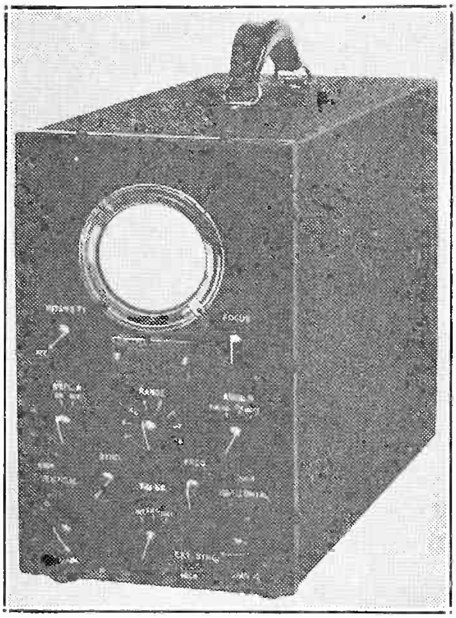


Can't read the brand of coffee on the label, but can is upside down, tin cover cut to remove coffee (just as important as anything else), and elevated resting place provided for soldering iron that needs alcohol lamp or pepper pot soup to become useful. Special pliers make neat lug end on wire. Socket wrench spares fingers for tightening in cramped places.

Alignment, All Levels

Flat-Top I.F., Separate A.V.C. Problems Solved

By Martin A. Gobin



Type of instrument used for flat top alignment of intermediate channels. The more usual type of alignment also may be accomplished with the cathode ray oscilloscope shown. A signal generator is always necessary.

FREQUENCY alignment of receivers has been relatively simple but is becoming more and more complex. For tuned radio frequency sets, parallel trimmers that are on the tuning condensers are turned until maximum response is heard near the high frequency end. There is no compensation at the low frequency region of tuning, so the one setting suffices. It would be possible to adjust series condensers inserted as they are on oscillators of superheterodynes, but it has not been done, and there remains the single adjustment per stage.

The superheterodyne requires adjustment at really three levels, instead of the one level of the t.r.f. set. In the order of adjustment these levels are (1) the intermediate, (2) the oscillator, (3) the r.f. (signal carrier frequency). That is not necessarily the best order but it is the order of practical use.

FLAT TOP ALIGNMENT

First, to line up the intermediate level requires some generator of the intermediate fre-
erate intermediate frequencies of known values, which enable him to align the channel. With the ordinary methods heretofore prevailing he may peak the intermediate channel, meaning establish the response at sharply one frequency, using tuning meter, glow lamp or aural response as guide.

When a peak is not desired, principally if there are two stages of intermediate frequency amplification, requiring three coils, a band pass effect is sought, and in the absence of better means of establishing the desired end, it is suggested by manufacturers of receivers that the plate circuits be peaked at one frequency and the grid circuits at some frequency a few kilocycles removed (the actual frequencies specified), and in that way the peak is avoided, but there is something lacking as to the certainty of close results.

If there is to be any flat-topping, that is, the establishment of a band pass, the checking is best done with the aid of a cathode ray oscilloscope. This is an instrument using a cathode ray tube, whereby the intermediate frequency is introduced on one set of plates and some harmonic frequency on the other set, the actual wave shape after passage of the generated voltage through the intermediate channel being observed. Tuning the channel for flat top by the visual method is the only assured way, and the manufacturers of high fidelity receivers using the flat top channel specifically so state. In fact, they recommend servicers who lack the cathode ray equipment to send the chassis back to the factory in case realignment is necessary.

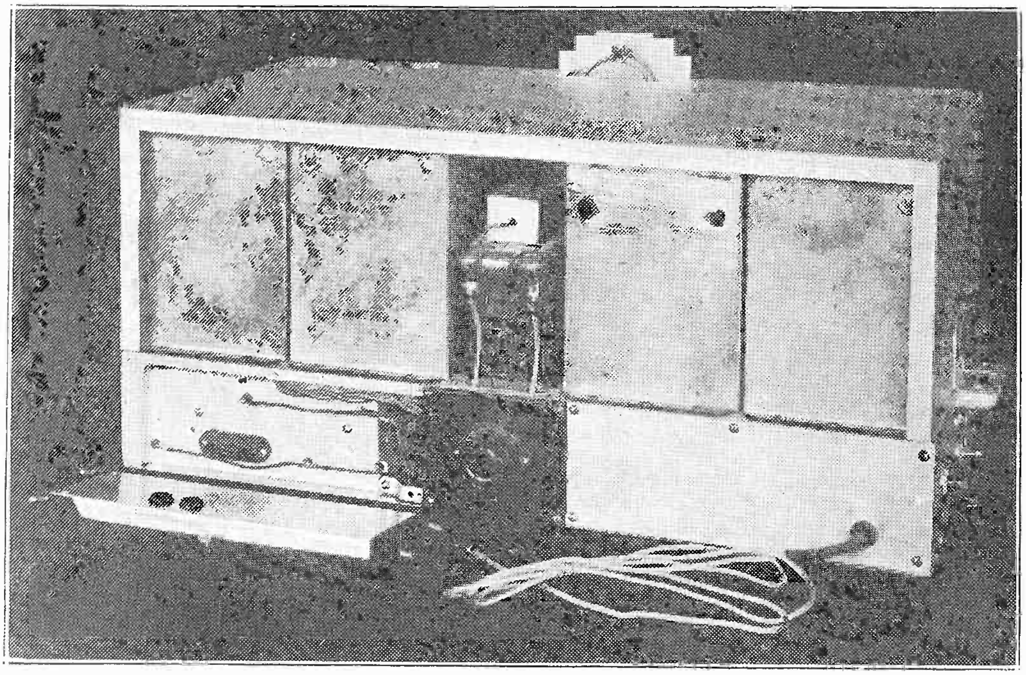
So a complexity, if one regards it as such, arises at the intermediate level. A stiff requirement that can be met only with expensive equipment openly deprives the casual experimenter and even quite a percentage of service men of the opportunity of creating a fully satisfactory intermediate channel for the high fidelity purposes.

COLOR CODING

The rest of the aligning is no different now than it has been for years, except that for a.v.c. attenuation of the generator is needed.

Some manufacturers give detailed advice as to how their sets are to be lined up, especially where the connections are to be made in generator practice. For the intermediate level it is always possible to connect the generator to the plate of the first detector tube, also called the modulator. This is one extreme of the primary of the first intermediate transformer and if there is color coding of leads the color in nine instances out of ten will be yellow. By
quency. If one does not possess an elaborate signal generator at least he is supposed to have some instrument that will enable him to gen-
the way, B plus would be red, while the secondary would be represented by black for return and green for "hot" potential, usually therefore black to ground or a.v.c. and green to grid. Two greens with black would denote

HOW TO APPLY GENERATOR TO EVERY-DAY USE



Swell tuner like this requires very close alignment, especially as a.v.c. is present. Weak output from generator must be used to do job well.

a center tapped winding and full wave diode detection.

If there are three intermediate coils and the tuning is to be peaked, which is very sharp, then it may become tedious to find the alignment for all three coils, really six windings, and six adjustments, so the generator may be put tentatively at plate of the second i.f. tube, thus the coil feeding the detector is adjusted. Moving the generator input to the previous plate, of first i.f. tube, the coil feeding the second i.f. tube is adjusted, the previously adjusted coil unmolested. Then there will be no difficulty whatever in adjusting the first coil, which is fed by the modulator or first detector. Single stage i.f. amplifiers do not present this situation.

Since so many of the receivers have pentagrid converter tubes, which combine the function of modulation and oscillation, and coupling of the two functions, it is entirely practical to put intermediate frequencies into the tube through grid circuits and otherwise, and the practice may be followed as the manufacturer directs. Indeed, if any directions here or elsewhere contravene what a manufacturer recommends, follow the manufacturer's advice, as he has reasons why his method best applies to his sets, and the general course may be pressed into service in the absence of specific advice about lining up the receiver.

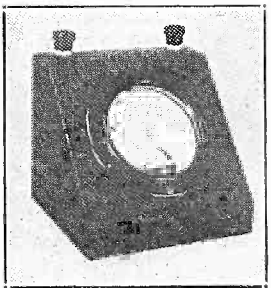
The alignment, when it should be close, must be as close as possible. Whenever only one stage of i.f. is used, peaking is resorted to, as by this method sharpest selectivity is attained, and that is what is wanted, because the selectivity never will be ruinous at the intermediate level where there is only one stage (using two coils), in the absence of regeneration. The reason why there is always one more coil than stage is that one coil couples the final or only intermediate tube to the detector, and the second detector is not an intermediate amplifier tube. If it is a diode it is no amplifier at all, while if there is a triode or pentode in the same envelope, then this part is an audio amplifier.

"ON NOSE" PUNCH DIFFICULT

It is easy to get an approximate alignment, but it is difficult to get a very close alignment. The preferable method is to have the input of the generator so weak that the result can barely be heard, or seen, or noted on the meter, when slight changes may be most readily noted, and ever so scant a mechanical displacement will change the frequency enough, when one works the adjusting screwdriver, to alter the sensitivity and selectivity. If a generator has no attenuator, the output may be reduced by avoiding coupling direct from generator to selected point of the intermediate channel, but interposing a condenser between, which may be any value small enough to reduce the coupling enough. The capacity will

(*Continued on next page*)

INDUCTIVE PADDING TO TRACK FREQUENCY SCALE



Typical output meter. It is an A.C. instrument.

(Continued from preceding page)

depend on the amplitude of voltage the generator emits, and on the sensitivity of the channel when the coils are nearly properly set.

SOMETIMES MUST BE

The listening method of attaining maximum response has to pass at times, for there is nothing else available, but listening to the speaker is not a good way. Earphones are possibly the most sensitive instruments commonly used in radio and some way should be contrived to use them if adjustments have to be made aurally. Otherwise a milliammeter in the detector anode leg (second detector in a superheterodyne), some capacity preferably across the meter, gives visual indexing. Comparisons may be worked by the neon lamp illumination method, and the output meter method. The meters are read more closely than the lamps, but the lamps are satisfactory. Just that hair's difference in the reading, for maximum or minimum deflection, will make some difference in the performance of the receiver.

If a diode detector is used, one may not have a sensitive enough meter to get a satisfactory swing from a weak signal or carrier from the generator, as a 0-1 milliammeter hardly suffices, unless the load resistor is reduced.

CLOSER MEASUREMENT

When a signal generator is used there is always a carrier, and usually there is modulation on the carrier, meaning that the emitted frequency is varied slightly by the audio frequency. Detectors eliminate the carrier and deliver the audio tones, or reduce the carrier to audible values of modulation, or reproduce the program, though in generators the program is simply a tone. Anyway, an audio frequency is at stake, and therefore a visual output device, like an output meter or a glow lamp. is really lit by the modulation, and not at all by the carrier, for the carrier has been removed. Now, if the modulation is not very steady, or if the carrier emitted by the generator is not very steady, there will be a change in the visual index without any change in the frequency to which the channel is resonant. What one is attempting to do is to establish an intermediate channel at a particular frequency, by tuning the components in that channel, according to the dictates of an input frequency from the generator, as measured, even if in relative values, by a meter.

METER DEFLECTION

It is obvious that before an audio frequency detector is reached there is amplification at radio frequencies (in superheterodynes these include intermediate frequencies, as a generic term). Hence, if a meter deflects solely on the basis of the radio frequency, it will be possible to make a still closer adjustment. This is the unmodulated alignment method. A meter put in series with the B feed common to the tubes of the channel could be read, but the change would not be very substantial, unless there was automatic volume control. Vapor lamps working on the principle of rising column of light could be used as indexes, the same as the neon tuning lamps in receivers, provided radio frequency actuation was the basis, or current or voltage change depending on radio frequency action. The meter in the diode leg would not fully meet the present requirement, as it would be affected by audio frequency values, even though it is the amplitude of the radio frequency that partly determines the current through the load. Since generators with 100 per cent modulation are not uncommon, audio as much as radio creates the result.

The quest is for maximum swing, for all peaking, meaning really maximum change, as the needle may move either to read more current or less current, compared to the steady state. In most circuits the current rises as the voltage rises. However, when the voltage in question is a biasing voltage, operating from zero to negative values, a rise in the carrier increases the negative bias, and then the plate current declines the greater the amplitude of the carrier. This is true of all diode-biased systems.

THE LOCAL OSCILLATOR

Next the oscillator would be lined up in a superheterodyne. This could be done by loosely coupling the signal generator to the oscillator, no conductive connection, merely perhaps a turn of output generator wire around grid cap of the tube used as oscillator. The high frequency end is lined up first on any band. Take the broadcast band, select 1,450 kc (or other recommended frequency), and adjust the parallel trimmer on the oscillator condenser for maximum response. It is assumed all trimmers are practically all the way out as starter.

If a frequency calibrated dial is to be followed, the dial is affixed to the condenser so that lowest frequency is equal to condenser plates totally enmeshed, then the setscrew is fastened and dial and condenser turned to read 1,450 kc, when the oscillator parallel trimmer is adjusted, as stated. Then the trimmer is turned down some more, less response resulting, until response rises again and becomes about as great as before. This does not always happen, but some inkling of a final rise should be present. For low i. f., 175 kc or so, the second strong response is inevitable for broadcast and higher frequency bands, but for 465 kc, etc., the second strong response may not be heard, though after the early drop some rise shows up. The second action is due to the oscillator being tuned to a frequency lower than the station-frequency carrier, instead of being higher. Nearly every receiver uses the higher oscillator frequency, for it provides better results, stronger and clearer signals. Therefore check to be sure that no oscillator adjustment is on the basis of establishing a frequency lower than the station-carrier frequency. Be sure the oscillator frequency is higher than 1,450 kc, for instance, by the i. f., that is, the oscillator frequency equals i. f. plus 1,450 kc.

SERIES PADDING

Only the oscillator determines what the response frequency of the receiver will be, since it is conjunctive with the intermediate frequency to that purpose. Although many think otherwise, the tuning at the station carrier frequency does not determine the frequency of response at all, except that if the pre-selection is weak, a station carrier frequency higher than the oscillator frequency will get by as well as the intended station carrier frequency lower than the oscillator frequency. The unintended reception is of an "image" frequency. An image means a frequency removed from the desired frequency of reception by twice the intermediate frequency. Thus, if the i. f. is 400 kc and the desired carrier is 1,400 kc, the oscillator is at 1,800 kc, that is, oscillator is higher, and station carrier frequency is lower. But 1,800 kc also permits a response to get through the 400 kc i. f. if the station carrier frequency is the sum of the oscillator and i. f., or 2,200 kc. Hence, in the absence of adequate pre-selection, both stations could be heard. It is obvious that the two frequencies differ by twice the intermediate frequency. That is, 1,400 from 2,200 equals 800 kc. How strong is the response of the image will become more and more important and may be determined by numerous measurement methods, including the oscilloscope. The image is said to be so many decibels down, the decibel being an expression of the ratio of two voltages or currents.

Once the oscillator is rightly settled for the high frequency part of a band, the station carrier frequency is made to match up, by trimming adjustments. This is the popular practice. It is not the preferable one, because the so-called radio frequency tuning should be lined up, to match a frequency calibrated dial if one is used, and then the oscillator local adjusted to track that condition at the higher part of the frequency tuning in the band.

For lower frequencies there is no r. f. adjustment, but there is one for the oscillator, and that is the setting of the series padding condenser. This adjustment for the broadcast band is made for 600 kc. The condenser dial is turned so that the tuning is back and forth, slowly of course, from the point where 600 kc is expected to come in, and observation made for maximum response. When maximum, if firmly established, the padding condenser is left unmolested, and the high frequency end is rechecked as to oscillator trimmer, which may require just the slightest readjustment. The series capacity introduction or change may have upset the oscillator at the high frequency end just the least bit.

By the way, in reality, the tying down never is done for extreme frequencies, e.g., for the broadcast band the frequencies selected are 1,450 kc and 600 kc, though the terminals are 1,600 and now 530 kc at the other end (new Canadian station). Not such good tracking can be attained if the tie downs are made closer to the end frequencies.

The signal generator may be used instead of stations, for 1450 and 600 kc, especially if no stations of those frequencies, or frequencies close to the specifications, are receivable. For a. c. meter use (output meter) a generator must be used. In some instances couple the signal generator to the receiver by removing the set's antenna wire and wrapping output lead from the generator around the set's antenna post for a few turns, or, if stronger coupling is needed, bake the conductive connection to the post. Practically all "universal" oscillators will feed through the line, meaning that the line, a. c. or d. c., acts as antenna, and even a short wire aerial to set's antenna post will pick up this transmission at the station frequency levels without any more formal coupling.

CHANGING COUPLING

As the frequencies get higher, into the short wave realms, the coupling has to be seemingly tighter, even if the generator is worked on fundamentals. This is due to the receiver's sensitivity dropping off, as well as to the generator's oscillation being weaker at higher frequencies, notably in the highest frequency region, winding up at around 20 megacycles. The problem associated with these circuits is to adjust the padding condenser for one or two of them, and the oscillator parallel trimmer in particular for all of them. Again the oscillator frequency must be higher than the station frequency, the difference being the intermediate frequency. Be sure not to get the oscillator on a lower frequency and there will be a great reduction of trouble.

The series padding condensers become larger, the higher the frequency bands, so that for the last band the capacity may be 0.003 mfd. The difference in inductance between oscillator and modulator secondaries becomes less. In fact, for the final band the two coils may be equal, though seldom are.

Getting the Harmonic Habit

Facilitates Frequency Measurements of Receiver

By Albert J. Pierce

IN THE absence of frequency calibration direct reading on the dial one has to calibrate his own short wave set. This may be done with the aid of the stations on the broadcast band, which are used as standards for an oscillator built to cover the broadcast band. The harmonics may be spotted on the short wave set without much difficulty. In fact, the elimination of confusion is virtually a certainty, in the absence of error due to sheer indifference or carelessness.

If one is in the habit of using or building short wave sets that have 140 mmfd. condensers (0.00014 mfd.) he may set up a broadcast band oscillator and then have a short wave oscillator on the same chassis, using plug in coils for short waves. In this way the output of the broadcast oscillator is received by the short wave oscillator, and since both circuits are oscillating, no modulation is necessary, beats serving to yield the note, resolved as near as maybe to zero, or no frequency difference between the fundamental of the short wave oscillator and an harmonic of the broadcast oscillator.

GETTING CALIBRATION STARTED

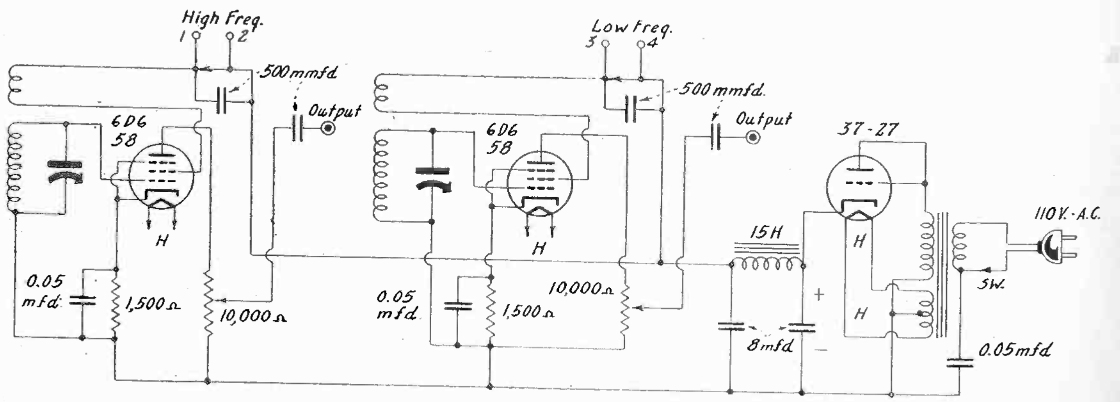
The first thing to calibrate is the broadcast band oscillator. This may be done against stations of known frequency. After a sufficient number of well distributed points is obtained, a curve is drawn on plotting paper, relating frequencies and dial readings, and whenever the frequency of generation is to be decided or selected, the chart is referred to, and if possible, as for some frequencies, recheck is made by beating with a station. Or, it is possible to purchase frequency calibrated dials, which are direct reading, matched to particular coils and condensers, in some instances requiring no compensation, as the coil would be specially accurate, while in other instances the tuning condenser has a trimmer to be adjusted on the basis of some frequency near the high frequency end of the broadcast band. A direct frequency reading dial system naturally is more convenient.

If plug in coils are used, take the one having the largest inductance intended for short waves, and this would begin tuning somewhere around 1,500 to 1,700 kc. Turn the condenser that tunes this coil until plates are entirely meshed, representing maximum capacity. Some condensers do not represent quite maximum capacity when the knob or dial turned to extreme, but when a bit less than extreme, due to the rotor plates beginning to recede a bit though rotation is in the same clock. Take note of the plates being exactly parallel—rotors and stators—and this is representative of maximum capacity. If a dial is to be set for full capacity, as to register 100, the full capacity is this parrallel condition, though maximum rotation of the rotor may be a bit farther on.

It will be easy enough to get the frequencies straight for this coil, as starting from near the low end of the broadcast band one may generate from the broadcast oscillator frequencies from 750 kc up and keep pace with the short wave condenser, noting the actual frequencies of the short wave oscillator (where earphones are located, point 1 and 2 with switch open) as twice the frequencies read on the other.

CAN GO FAR WITH THIS

For any especially accurate observations, beat with local or semi-distant broadcasting stations,



Put earphones between jacks 1 and 2 to listen to short waves or measure the frequencies of short waves when the broadcast oscillator at right is going. Put earphones at 3 and 4 to hear broadcasts, or to measure frequencies of still lower frequency oscillators.

resolving to zero beat between station and broadcast oscillator, and again to zero beat between broadcast oscillator and short wave oscillator. The coupling to broadcast oscillator is very slight, a turn of insulated wire from antenna around the grid lead near clip, while sufficient coupling between the two oscillators will be present due to their very location.

After the first or lowest frequency short wave coil has been explored this way, one has at first a new curve, or basis for it, representing a short wave oscillator. May not the generations from the short wave adjunct be put into a short wave receiver? And may not the harmonics of the short wave oscillator serve just as excellent a purpose now as the harmonics of the broadcast oscillator did? Yes, enough has been done already to enable accurate readings up to 30 mgc at least—down to 10 meters—especially if one is aware of a simple check method that seems to render all harmonic problems simple. This is that where the oscillator or generator is of lower frequency than the measured circuit, the difference in frequencies assumed to be substantial, if two known consecutive settings of the low frequency oscillator are used the unknown frequency of the receiver may be determined. Of course the generator itself already is calibrated. Read the two frequencies, subtract the lower from the higher frequency, divide the difference into one of the frequecies, and the answer is the harmonic order of the other read frequency. Multiply this other read frequency by the harmonic order and the answer is the unknown frequency.

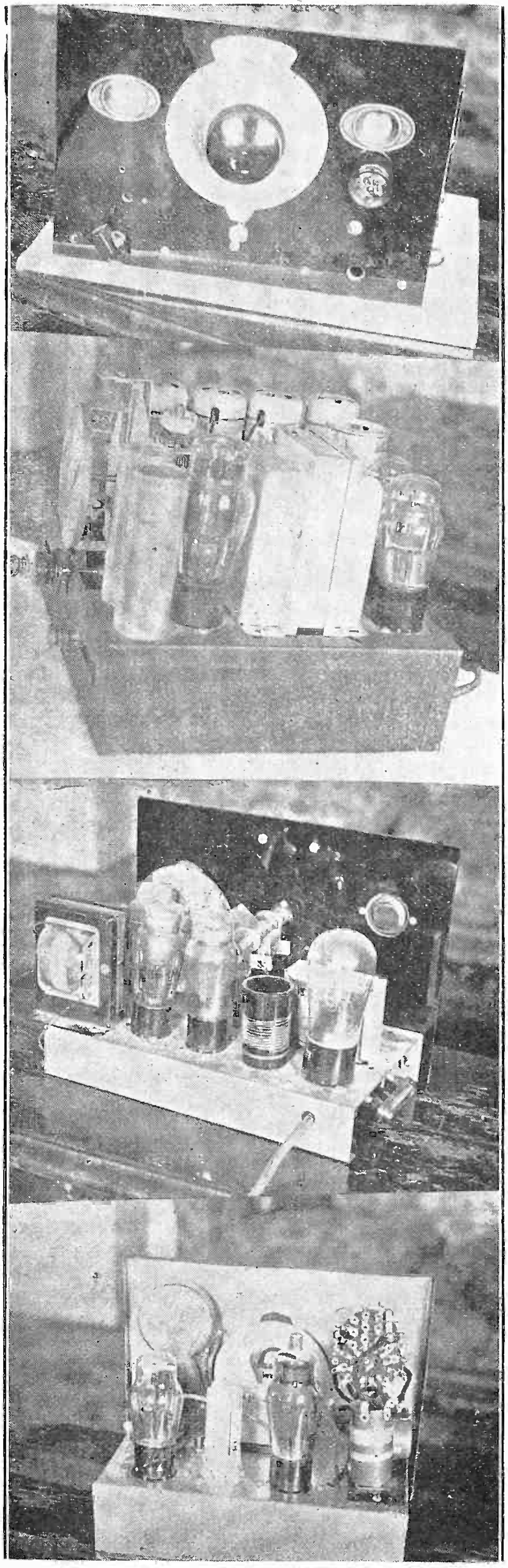
EXAMPLE WORKED OUT

Suppose that the newly calibrated short wave oscillator furnished readings of 2,000 and 2,400 kc. The difference is 400 kc, divided into 2,000 is 5, so the unknown is the fifth harmonic of 2,400 kc or 12,000 kc. The sixth harmonic of 2,000 kc would yield the same result. The closer together are the consecutive readings, the higher is the unknown frequency.

From what already has been set forth it is possible from this one calibration of a short wave coil and condenser system to measure short waves or high frequencies almost without limit for ordinary receiver purposes, and well below the lowest wave that any all wave set tunes in. Of course the same system could be applied, using the broadcast oscillator, but the reason for using higher frequencies fundamentally is to simplify the determinations, and improve the accuracy.

However, to proceed to calibrate the rest of the plug in coils, assuming there are three more. We may select some local station near the high frequency end of the broadcast band. Say there is one on 1,200 kc. Zero beat the broadcast

(*Continued on next page*)



Top and third from top are front and rear views of the combination generator. A tuned radio frequency set tested with this device is shown (same as described on page 26), while at bottom is a switch type a.c. signal generator, all wave, checked with the combination instrument. No, that choke won't fall off chassis.

(*Continued from preceding page*)
band oscillator with this. Simply for checking, find the 2,400 and 3,600 kc points on the lowest frequency short wave coil before inserting the next smallest coil, for location of 4,800, 6,000 and 7,200 kc. If one hears four responses in this band the tuning goes as far as 8,400 kc on this coil. Ordinarily with 140 mmfd. the tuning ratio is about 2.3. After the spot frequency points have been selected, so that we won't go off course, other points may be selected on the basis of the broadcast oscillator being swept through its frequency range. What the harmonic orders are may be computed at a glance, since the frequency is known by reference to the broadcast fundamental and the short wave dial section in which the harmonic falls. If between points for 4,800 and 6,000 kc one gets a response when the broadcast oscillator is at 800 kc, having heard one at 4,800 kc, naturally the in-between frequency is the seventh harmonic of 800 kc, yielding 5,600 kc.

USING ALTERNATE FUNDAMENTAL

The local station near the high end of the broadcast band—1,200 kc taken as example previously—is retained as reference point, and the charting frequencies found, in between which other frequencies may be read harmonically. Confusion becomes possible now, especially for the smallest coil, where jumps of 1,200 kc do not amount to so much in dial separation. Nevertheless the check may be made at any time by using 1,200 kc, then turning back to the next lower frequency that also yields a response in the short wave oscillator, the frequency of which has not been molested.

Suppose you wonder if the frequency is 12,000 or 13,200 kc. You have only the broadcast oscillator as guide, but it is calibrated, and 1,200 kc is being used. A response is heard in the short wave listening post. If the short wave frequency is 12,000 kc then the tenth harmonic is being received from the broadcast oscillator's fundamental.

The next higher harmonic of the next lower broadcast frequency would be the thirteenth of 923 kc. It is not likely that such close reading

(*Continued on next page*)

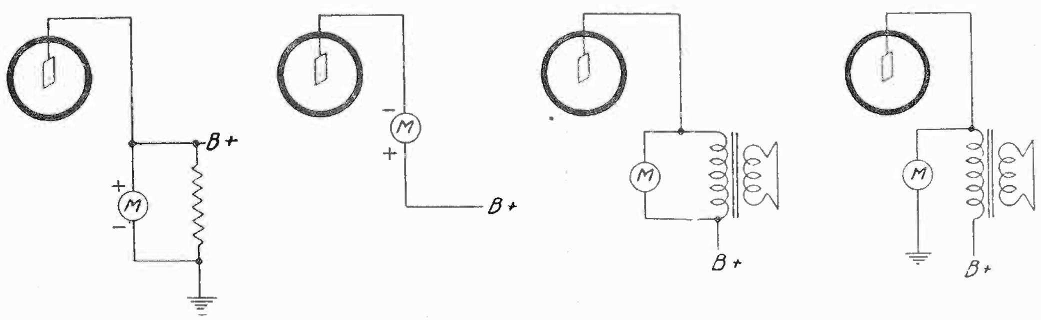
Measuring Low Frequencies Easy

Sometimes constructors and experimenters have trouble defining the frequencies of low frequency oscillators. If they have a calibrated broadcast band oscillator, as at right in the diagram, and put the unknown low frequency into the broadcast device, at output, and listen, reading one frequency and then the next consecutive one, as the broadcast oscillator is turned, other unmolested, the frequency of the low frequency oscillator is obtained. It is simply the difference between the two read frequencies. This should be known by heart by all: that if the unknown is lower, the measuring circuit will solve the problem by the measurement of the difference in frequencies between two consecutive responses.

When the unknown is higher in frequency, then the lower frequency device must be the generator exclusively, and not the receiver in any sense, and plain differences do not yield anything of immediate value. What must be applied is some formula relating the frequencies, and the one given in the text should be learned by all who desire proficiency in frequency measurement practice. This is simply that the difference in frequencies is divided into one frequency to yield the harmonic order of the other frequency read, and the order is applied to that other frequency to produce the unknown. The text herewith gives examples and shows how really simple the idea is.

It may be desired to use the generators in the diagram for stronger output than stray coupling, in which event output may be used for either. However, for input this is not a good point. It represents weak coupling for it must be so to keep the frequency intact despite coupling. Antenna couplings for reception would have to be closer, and a few loose turns from antenna wrapped around the coil, end of wire grounded, serve better. This will change the frequency somewhat, but the change may be measured.

Parallel Meter for Volts; Series Meter for Current



A meter is put in parallel with a voltage for measurement, but in series with a current. Left, meter B plus to ground; next milliammeter in series with plate; next two, voltages. D.c. voltmeters here would not measure a.c. But some a.c. voltmeters would be actuated by d.c. as well as by a.c.

(*Continued from preceding page*)
as 923 is possible but if the second position is around 920 kc then the unknown truly is 12,000 kc. Or, what the unknown is may be ascertained by striking the difference between the two read frequecies of the broadcast oscillator, and applying it as already explained. Be sure to familiarize yourself with that method so that after laying down the magazine you will feel you can apply the method at any time. It is a short cut to successful frequency testing, construction and servicing.

STRANGE BUT TRUE

While the circuits are treated as being generators they are also receivers. The negative bias is high enough for detection of a fair order. By loosely coupling antenna to either one, or inserting phones at the proper posts and opening the phone switch, reception by the zero beat method becomes practical. This method renders impossible the reception of more than one channel at a time (strange as it may sound, seeing as a one tube set is under consideration), but tuning has to be done on the very center of the wave, true zero beat, otherwise there will be interference due to the finite note. On the broadcast band the same holds true, and even 50,000 watt local WOR can be tuned out and the whistle if not the program of WLW, a semi-distant station, 10 kc removed, tuned in, depending on air conditions. Sometimes the program of the Cincinnati station is heard plainly, other nights only the whistle is heard.

A circuit such as either of the two shown contains its own oscillations fairly well, at least feeding through the line is at a minimum. This is no doubt due largely to use of separate filament excitation, possible because a transformer is used, as it has been noticed that generators that are conductive with the line can not be completely prevented from feeding into the very source of their voltage.

Government Short-Wave Log to Be Ready May 15

Department of Commerce
Bureau of Foreign and Domestic Commerce
Washington

April 1, 1935.

RADIO WORLD,
145 West 45th Street,
New York, N. Y.

Dear Sir:

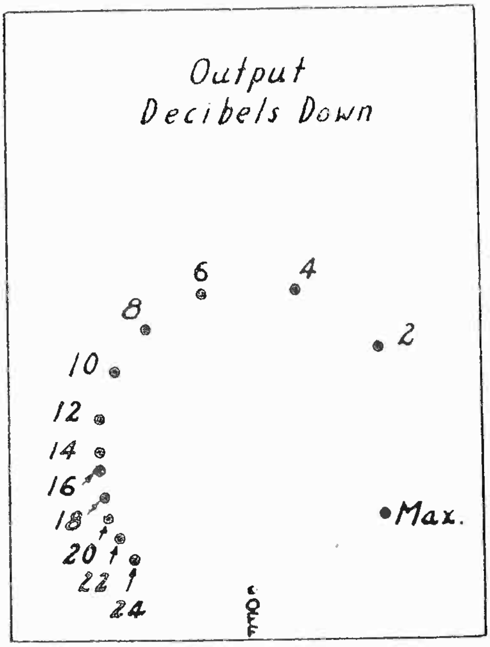
You are listed to receive the new edition of "World Short Wave Radiophone Transmitters," the issuance of which has unfortunately been delayed by conditions beyond the control of this organization.

It is now assured that this publication will be available for distribution on May 15, and your order will be filled on that date.

Appreciating your past indulgence, and asking that it be continued for this period, I am

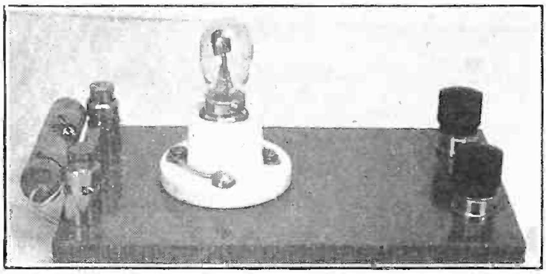
Yours very truly,
ANDREW W. CRUSE,
Chief, Electrical Division.

ATTENUATION SCALE



Linear resistance potentiometer gives this decibel calibration on power basis.

CONDENSER TESTER



Condenser at left is being tested. A.C. posts at top. Neon lamp lights brighten on short.

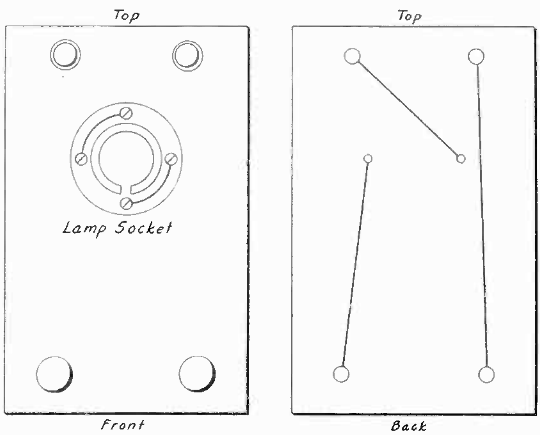
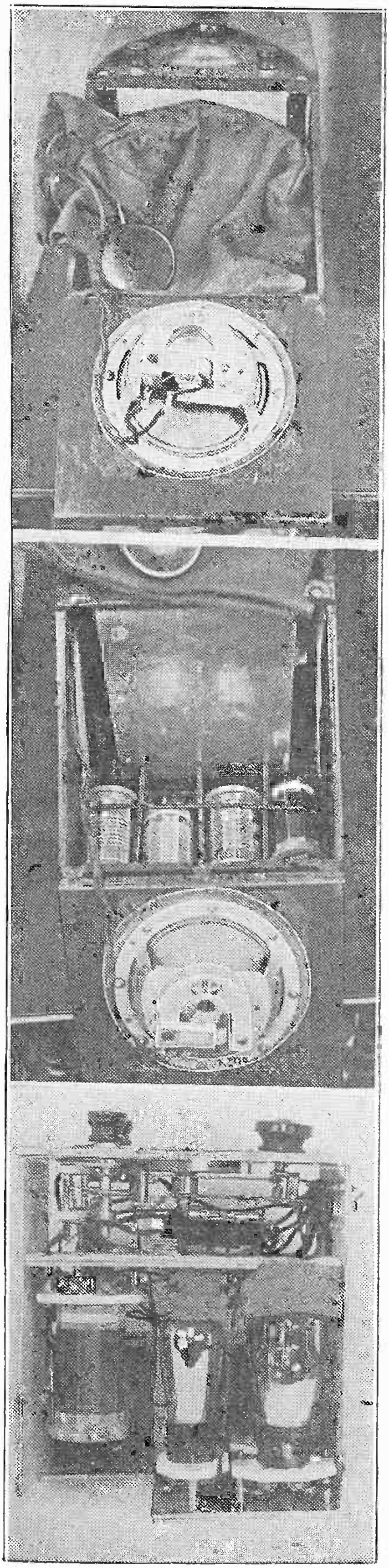


Diagram and top view. Condenser test post shorted, lamp is output meter.



ARMCHAIR PORTABLE

By J. C. Wall

THIS armchair portable is constructed in a novel manner. It is designed to operate at home, in autos or at camp. The outer cast, made of plywood, measures about 20 inches in length, with slanting front as shown in the photographs, and containing a four inch loudspeaker, position of which throws the sound upward.

The receiver proper is constructed as a unit within itself (see photo) containing three 30 tubes and other necessary parts, such as tuning elements as shown in circuit diagram. Two stages of transformer audio are used, and provision is made for insertion of headphones by installation of jack in center of panel.

The coil mounting is upside down in relation to the installation of the tube sockets, and is arranged in this fashion so that coils may be removed or inserted easily through the bottom of the shell carrying case, a small door having been cut into the case for the purpose.

SMALL TRIMMER

The tuning section is extremely simple in operation and consists of the four prong coils in connection with two tuning condensers, one the "tank" section with capacity of 140 mmfd., and the other a three plate trimmer connected to it in parallel (15 mmfd.).

The tank section is fitted with a small airplane dial as shown, or this arrangement may be reversed, the small three plate condenser connected to the airplane dial, and the tank section controlled by a small knob at upper left of panel. The regeneration is through the .250 mmfd. variable and is considered somewhat smoother than a resistance control for the same purpose, although the latter may be used if desired.

The loudspeaker, in the form of a 4 inch paper cone magnetic type, is installed on a hinged door at the extreme front end of the carrying case, as shown, and the necessary connecting wires brought back to the output through flexible wires.

The batteries consist of two standard dry cells, connected in series and fed to the tube filaments through a 10 ohm rheostat, which when properly set may be left in position for operating purposes by simplying turning on and off the battery snap switch.

WHERE STRAP GOES

The B batteries are the standard small portable type of 45 volts each, three being used and small C batteries to the extent of a value found necessary and desirable. All of these batteries are fitted into the case from the rear, directly in back of the set unit.

The handle is made of either heavy fabric material about 1¼ inches wide, or a leather strap may be used if preferred.

The placing of this strap, as shown in a photograph, is directly over the battery compartment, so that in carry-

Top, left, shows front of portable, hinged door pulled forward, exposing speaker compartment and head set. Middle photo shows additional space in bottom of cabinet used as storage for set of extra coils, designed to cover various wavelengths. Side view of the completed set as a unit, removed from outer shell or casing, is at bottom.

Uses Three Tubes—Serves as Home or Outdoor Set. How to Figure Resistance Need

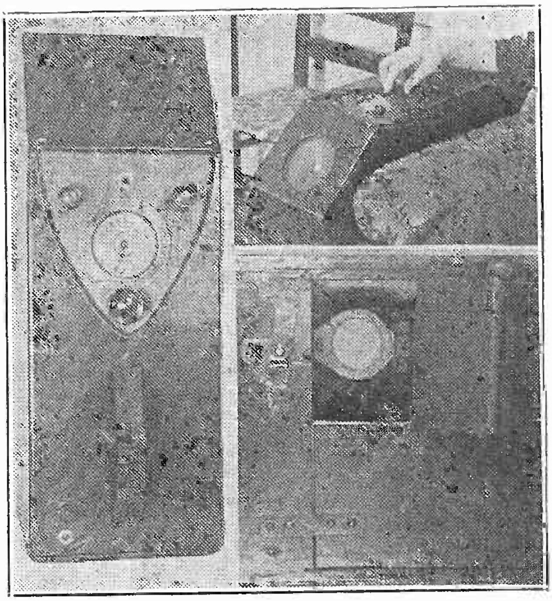
ing the apparatus, the weight is equally distributed, and carries evenly, although the photograph tends to suggest that it is badly out of line, which indeed it is pictorially, but not practically.

The selection of wavelength bands is made easy by insertion of suitable coils through the bottom of the set by opening a small door, placing the coil in the socket, closing the door and tuning the apparatus in the usual manner.

As regards aerial and ground, tests have shown that in some localities the receiver will function nicely on a wire about ten feet long, with no ground, and other places with two such lengths, one acting as a sort of counterpoise, or may be properly connected to a ground, if available. In an automobile, the frame of the car will do nicely for the ground, the aerial being strung along the upper section of the car moulding.

The volume control has been placed in the aerial circuit to serve two purposes. One as a volume control in the orthodox manner, and additionally to overcome any tendency at oscillation on occasion in some localities. This control is shown in the photograph at the rear left section of the carrying case.

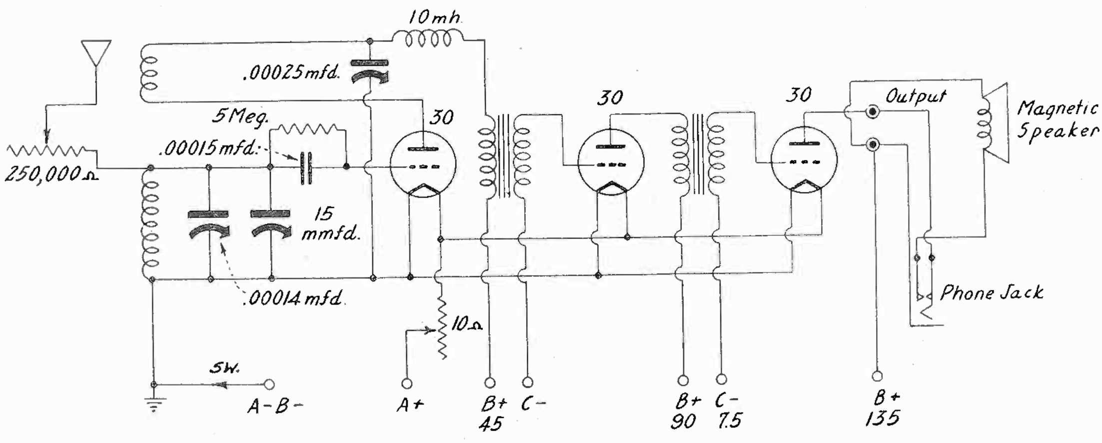
It is suggested that the case be painted with one of the standard lacquer paints which are waterproof and overcome any tendency to warpage, if the intention is to use the set in outdoor locations, especially during the summer months on camping grounds.



Top view, right, operating the portable as an armchair receiver. Lower right, small door in base of shell which opens outward, thus making it possible to remove and insert coils at will. Normally, this door is closed. Top view at left.

FIGURING RESISTANCE

The amount of resistance to interpose between the voltage source, such as battery, and tube filament, to reduce the source voltage to the required filament voltage, is determined by Ohm's law. This law sets forth that the required resistance in ohms is equal to the voltage in volts divided by the current in amperes. A point to be watched, however, is what is meant by the "voltage"? In this instance if two No. 6 dry cells are in series, furnishing 3 volts, the "voltage" of the formula is the difference between the source potential and that reqqired, or 3 minus 2, equals 1 volt. Thus, three No. 30 tubes draw 3x0.06 amperes, or 0.18 ampere, and the required resistance would be 1/.18 or not quite 6 ohms. Hence a 10 ohm rheostat would serve the purpose, being adjusted until the voltage across filament reads 2 volts.



Circuit diagram of the armchair receiver

Tuned Radio Frequency Set with Pentode or Triode Output

8 Tube Broadcast Receiver for Quality Reception

By Henry L. Marko

THREE stages of tuned radio frequency amplification are used in this set, and the detector input is tuned, so a four gang condenser is used for making the set as selective as practical. The radio frequency part of the diagram is on this page and the audio frequency and rectifier part on the opposite page.

Except for the rectifier filament, the tubes may have 2.5 or 6.3 volts on heaters, in one instance for serving 58's 57, 56 and 2A5's, and the other for 6C6's, 6D6, 76 and 42's. The rectifier may be an 80 or a 5Z3, filament voltage 5 volts in either instance.

The coils are alike and may be wound on 1 inch diameter tubing, and contain secondaries of 130 turns of No. 32 enamel wire, closely wound.

INSULATING PRIMARY

A piece of insulating fabric or wrapping paper is put between the primary and secondary, the primary being wound over the secondary near the end of the form that is to be secured to chassis. Over the coil is placed an aluminum shield of 2 inch diameter or more, and at least half an inch higher than the coil form. The shields must be grounded. The primary put on over the secondary has 25 turns.

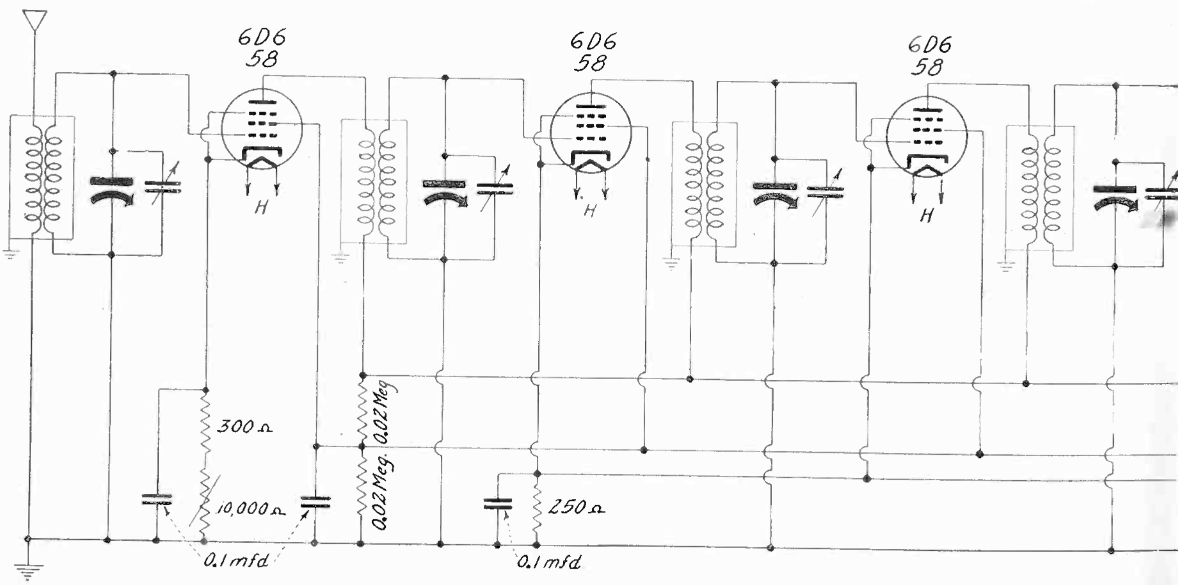
No resistor need be of more than 1 watt rating, except the one marked 2 watts, and this one is 200 ohms for use of the output tubes as pentodes, and 850 ohms for use of the output tubes as triodes. Tone correcting condensers present in the pentode model are not needed in the triode model.

With the pentode connection the sensitivity is much higher, but when the triode connection is used the tone quality is better. Unfortunately it is not practical to shift from one use to another, as the output transformer requirements are quite different. Relatively low impedance primary of output transformer is used for the triode purpose, whereas pentode push-pull transformer primaries have about twice as high an impedance, the general classification being "pentode push-pull output transformer."

The detector is of the negative bias type, and tone quality is served because the biasing voltage is obtained through a low resistance, 250 ohms, the required resistor being common to two of the radio frequency tubes as well. The detecting bias for the detector tube happens to be about the same as the required bias for the amplifying tubes.

LOW HUM LEVEL

Hum is made very low by the detector plate



The tuner itself is diagramed. Carry over the lines to the drawing on the next page.

circuit filter, the 0.2 meg. resistor and 1.0 mfd. condenser. The volume control is a 1.0 meg. potentiometer in the grid circuit of the audio driver tube. The transformer coupling driver to output tubes need not have a higher ratio than 1 to 3, and may be as low as 1 to 2, primary to one-half of secondary.

Besides the seven tubes in the receiver proper there is the rectifier, making an 8 tube broadcast receiver of the t.r.f. type, suitable for high quality reproduction, especially with the triode connection. Persons who live more than 50 miles from a broadcasting station would prefer the pentode connections, however, because of the extra sensitivity being more important to them.

For the field any ohmage between 1,800 and 2,500 ohms may be used. The speaker is a dynamic, the output transformer and field being built in.

A power transformer of the 90-milliampere high voltage secondary is used. The heater winding, H and H, rectifier and high-voltage winding, as well as primary, are described sufficiently, after voltages are given, by designation of the transformer as one "for an eight tube set."

LINING UP

After the set is built the only lining up that

(*Continued on next page*)

LIST OF PARTS

Coils

Four radio frequency transformers as described.

One push-pull input transformer, ratio primary to one-half secondary, 1 to 3.

One power transformer, primary, 115 volts, 50-60 cycles; secondaries, 2.5 volts, 2/5 10 amperes c.t.; or 6.3 volts, 3.5 amperes; high voltage, 300-0-300 a.c.; rectifier filament, 5 volts.

Condensers

One four gang tuning condenser with trimmers (capacity at maximum may be 350 to 400 mmfd.)

One 0.0001 mfd. mica fixed condenser.

Two 0.002 mfd. tubular condensers.

Three 0.1 mfd. tubular condensers.

Three 0.01 mfd. mica fixed condensers (two of these not needed for triode use of output tubes).

Two 8 mfd. electrolytic condensers, 500 volts rating.

One 1 mfd. 300 volt condenser, paper or electrolytic type.

Resistors

One 200 ohm pigtail resistor.

One 250 ohm pigtail resistor.

Two 1,500 ohm pigtail resistors.

Two 0.02 meg. (20,000 ohm) pigtail resistors.

Two 0.2 meg. pigtail resistors (1/4 watt sufficient; resistance may be up to 0.3 meg).

One 1 meg. potentiometer with a.c. switch attached.

Other Requirements

One dynamic speaker with output transformer for push-pull pentode A, or push-pull triode A; field coil of 1,800 ohms built in.

One speaker plug and four lead cable.

One chassis.

Five tube shields and bases.

Six 6 hole sockets, one 5 hole socket and two 4 hole sockets. (Extra 4 hole is for speaker plug.)

One airplane dial with two pilot brackets.

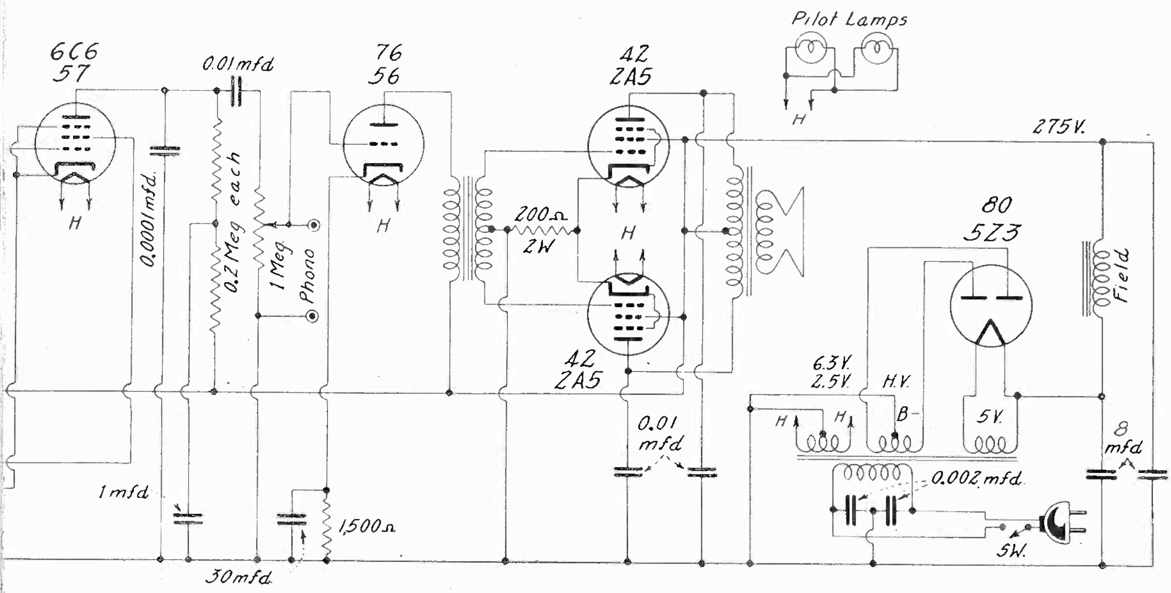
Two pilot lamps (6-volt type for series 6 tubes, 3.3 volt type for 2.5 series tubes).

Four grid clips.

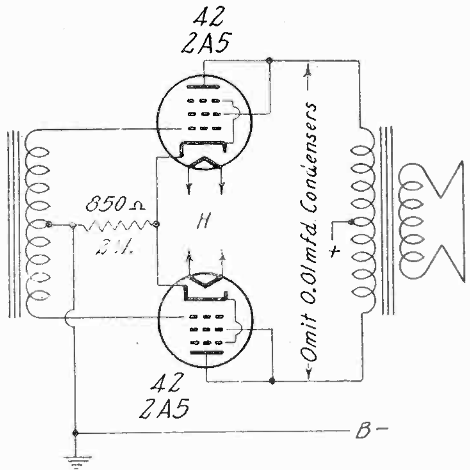
Antenna-ground twin assembly post.

Phonograph twin jack assembly.

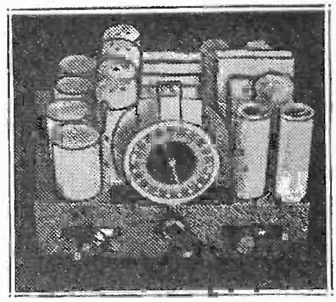
Two standoff insulators.



The detector, audio amplifier with pentode output, and rectifier, are shown above.



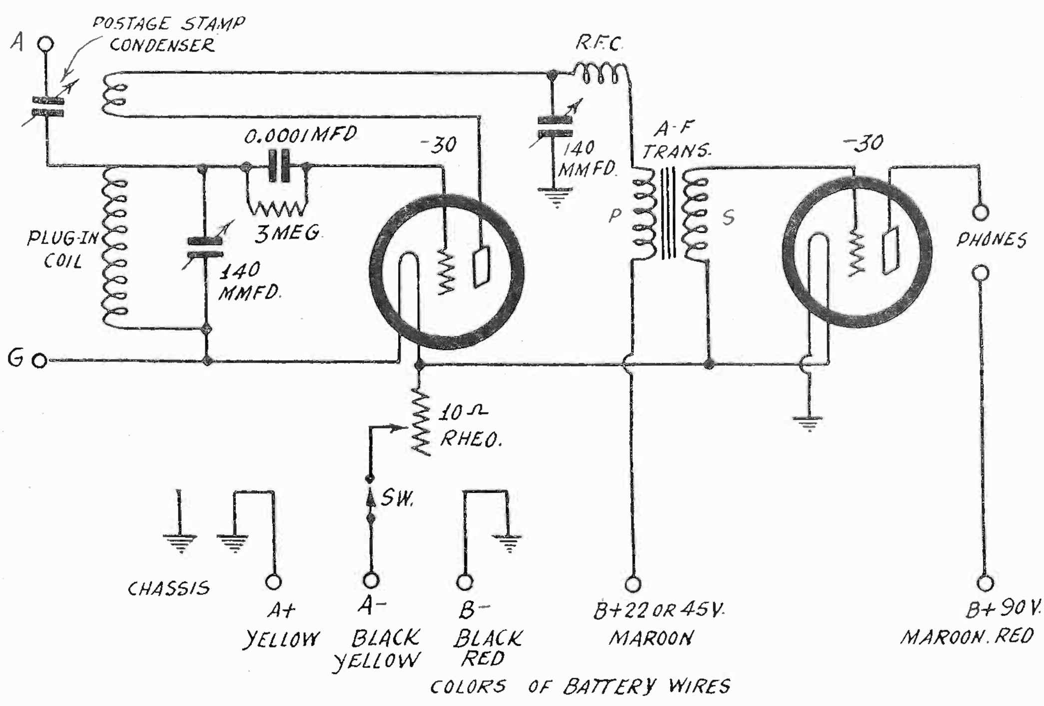
For triode connection screen and plate are tied together and the biasing resistor is raised to 850 ohms.



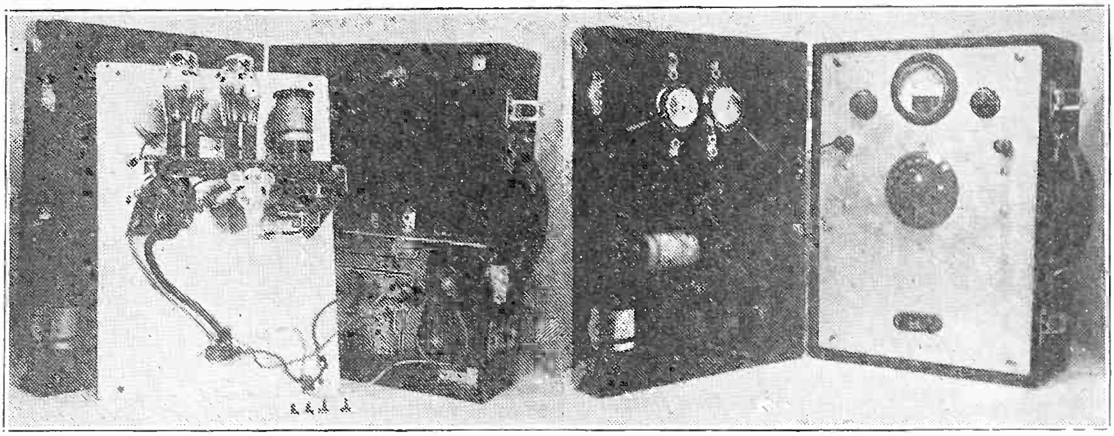
Front view of the tuned radio frequency receiver. A side view is on page 21. The chassis has to be specially cut for the airplane dial.

(Continued from preceding page)
has to be done is setting the trimmers on the tuning condenser. The antenna stage trimmer is turned nearly all the way out. Then the tuning condenser is rotated until a station or other signal is tuned in near the high frequency end of the band, 1,400 to 1,600 kc, and three trimmers adjusted to produce maximum response from a single station. It is possible to tune in different stations or radio frequencies by trimmer adjustment, so if the detector trimmer is turned about half way down, the two prior trimmers may be adjusted to match that frequency, then finally the antenna stage trimmer is adjusted. This one has little effect, except that response is reduced when the capacity is increased beyond a certain amount. Return to that trimmer position with plate just sufficiently far out to safeguard against such reduction of volume and the lining up is completed.

What's CHASSIS and GROUND



The tapering parallel lines used as ground symbol also are used as chassis symbol under conditions where chassis may or may not be grounded. To avoid any confusion the meaning of the symbol as used in a particular diagram is given, thus symbol above means chassis. That chassis in above example is not grounded is evidenced by negative filment going to G (ground).



This is the time of the year when the portable appeal begins to take deep root. A simple, inexpensive, well-performing circuit is used in a conventional setup, for truly all-wave coverage.

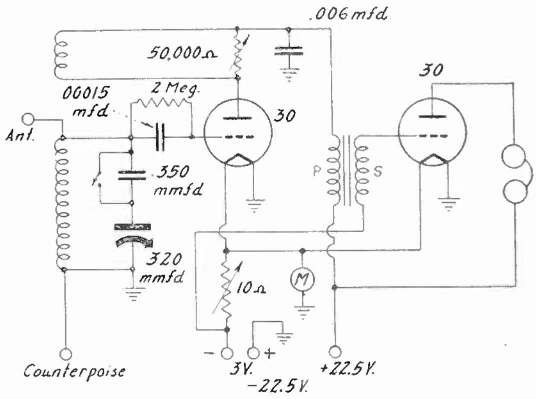
PORTABLE For All Waves

By Tom C. Bidwell

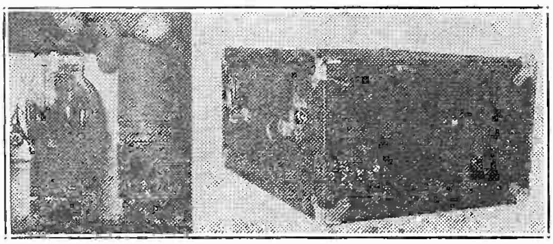
THE two tube circuit is used for this portable, with plug in coils. Also a series condenser is operated by a switch, so that for short waves the effective capacity is reduced for tuning. Normally that capacity is around 320 mmfd. See photograph reproduced lower right. For short waves this is too high a capacity, so is approximately halved. One of the fixed condensers in the photograph referred to is the grid condenser, the other is the 350 mmfd. on which is the improvised switch for shorting out the condenser when longer waves are to be received, broadcasts and still lower than that.

A suitcase is used for containing the entire works. The illustrations above reveal the panel removed, back of panel exposed, tuning condenser rear, tubes, coil and A battery clearly shown. Note that No. 6 dry cells are used, two of them. No use trying to get away with those dinky dry cells for A supply if you want any enduring service. Panel in place, earphone hangar, and coil rack, are revealed, upper right.

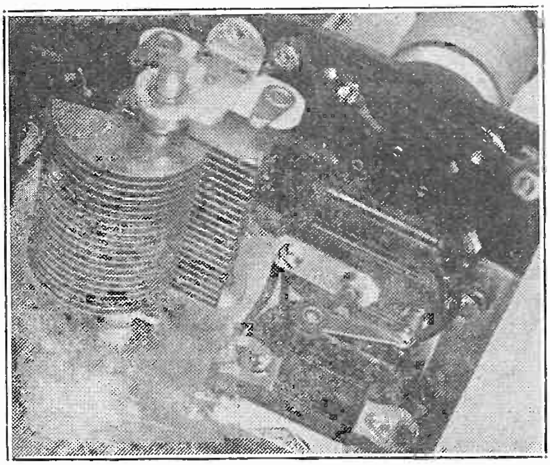
The diagram at right is so simple, the layout is so easy, that any one can accommodate the panel and compartments to the suitcase he has or can pick up reasonably. Splendid suitcases may be picked up any day, but when picking up a suitcase do not fail to leave at least a little money.



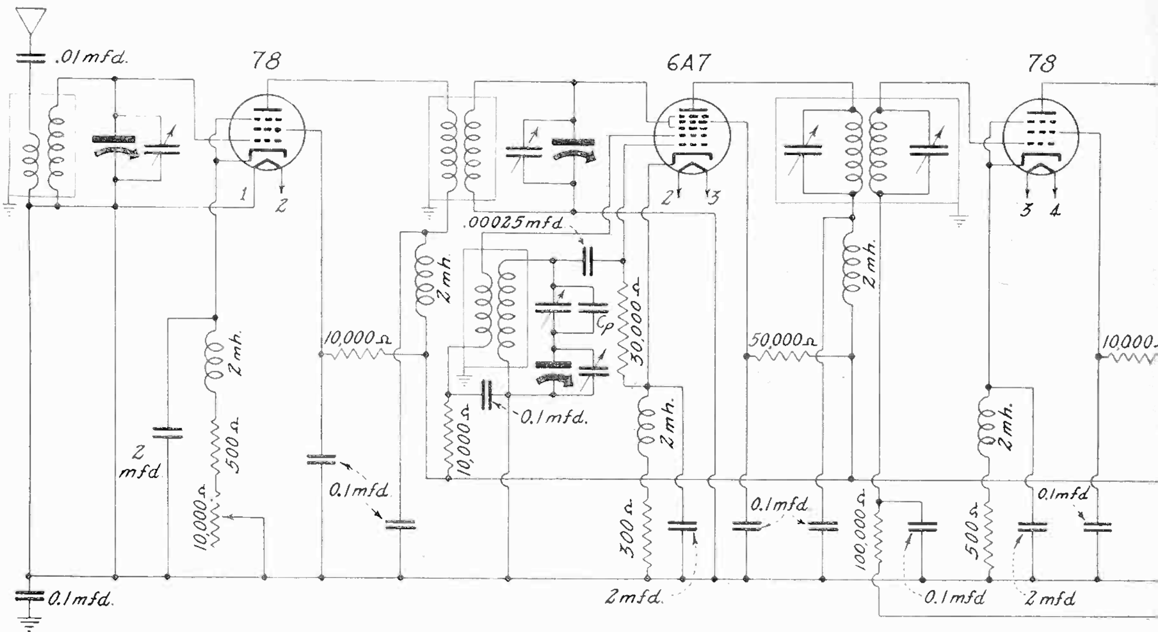
The circuit.



Even a 2,000 meter coil may be used.



Tuning condenser, grid condenser, series condenser.



Reception of every channel in the broadcast band could b few feet of wire were used as aerial. The author ascribe

What Air Co

Make a Superhete

By John

AIR dielectric condensers are as important as anything else in making a superheterodyne outperforming. I live in a district where the line is 110 volts direct current. Despite this limitation I built a receiver, the one shown in the diagram, that brings in *all* the channels at night. At present there are 102 channels, including five in the high-fidelity band, 1,500 to 1,600 kc, and a Canadian station added at the other end, 530 kc.

The tracking is exceptionally good. The best theoretical condition is one where the tracking is nowhere off more than 4 kc. This is not achieved in practice, largely because mica dielectric condensers cannot be trimmed so closely as to cause the circuit to be or stay within 4 kc of 1,500 kc. Yet all has been achieved splendidly, with right type condensers, and editors of RADIO WORLD have been over to my house to hear the every-single-channel results, all without interference. So the selectivity is equal to or better than 10 kc.

WHERE THE CONDENSERS ARE

Air dielectric condensers are across the radio frequency and oscillator tuning condensers, the primary and secondary windings of the intermediate coils, and across a fixed unit in the series padding circuit of the oscillator.

Another specialty is the rewinding of the oscillator primary, to afford a greater distance between primary and secondary. The tickler is large, as it is recommended for the pentagrid tube, but the insulation between primary, and the secondary over which primary is wound, instead of being 0.01 inch is 0.25 inch. In that way the capacity is kept down, giving more freedom to the trimmer condenser setting for the oscillator, and enabling reaching to above 1,800 kc at one end, while 530 kc is the other terminal.

The tie-down for the low frequency is 600 kc usually, and here the fixed condenser is used with variable across it. The fixed unit is 0.00035 mfd. So the usual range of about 350 to 350 mmfd. for 465 kc oscillator padding is present, although in my set-up the variable is practically at minimum.

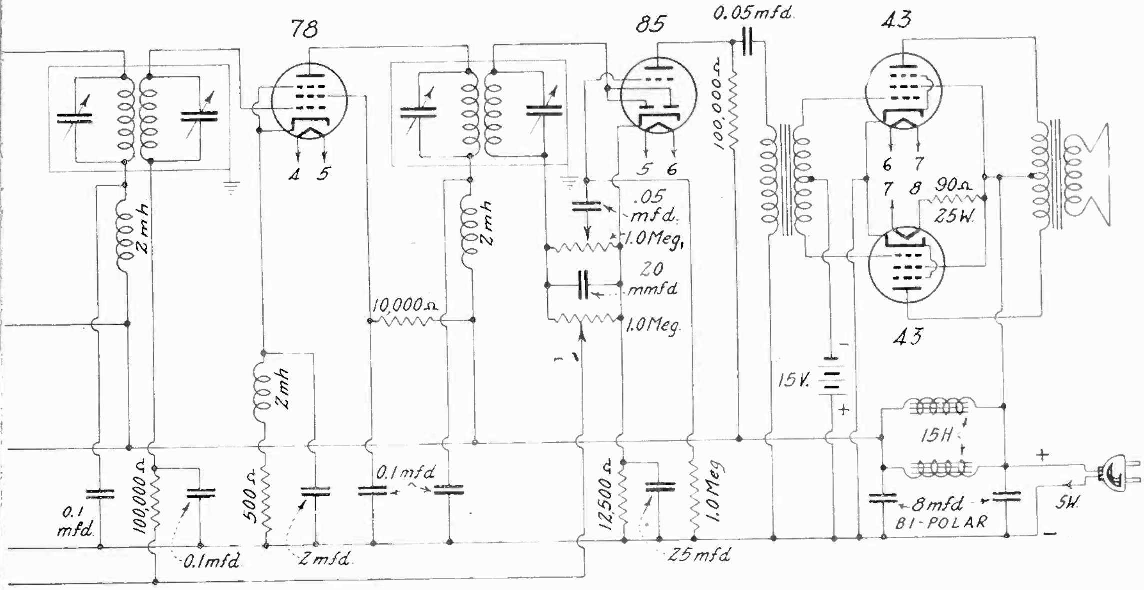
The coils used were of commercial make. The

Coils

Two r.f. coils, one oscillator coil for 465 kc.
Eight r.f. choke coils (2 millihenries or more).
Two 15 henry choke coils for B filter.
Three 465 kc. intermediate frequency transformers, with air dielectric condensers.
One push-pull input transformer.

Condensers

One three gang tuning condenser, compression trimmers removed (capacity 350 mmfd. to 400 mmfd. maximum).
One 250 mmfd, mica dielectric condenser.
Three 25 mmfd. trimming condensers (air dielectric).
One padding unit, consisting of 350 mmfd. fixed condenser and 100 mmfd. variable.
One 0.01 mfd. mica dielectric condenser.
One 0.05 mfd. tubular condenser.
Ten 0.1 mfd, tubular condensers.
Four 2 mfd. bypass condensers.
Two bi-polar electrolytic condensers, 8 mfd. each.



enjoyed with this d-c superheterodyne, although only a
the success largely to the use of air dielectric condensers.

ndensers Do
odyne Outstanding

Braden

antenna and radio frequency level coils may be wound on 1 inch diameter, secondary 130 turns of No. 32 enamel wire, 30-turn primary wound over secondary, with 0.01 inch insulation between, say, three turns of wrapping paper. The oscillator coil has 70 turns of No. 32 enamel wire, separating insulation about 1/4 inch, and 40 turns on tickler that is wound over secondary. The primary or tickler for the coils may be wound of any kind of fine wire, hence one may use the same kind of wire as for secondary. Each coil is enclosed in an aluminum shield about 2 inches in diameter.

AUTOMATIC VOLUME CONTROL

Automatic volume control is applicable to the two intermediate frequency amplifying tubes, so much of it as one likes. A separate potentiometer permits taking off maximum to zero voltage for extra bias by a.v.c., while the other potentiometer controls the amount of audio put into the sound amplifier. The third control affects the bias on the first tube, or radio frequency amplifier. Hence all three controls are sensitvity controls. One governs audio values, the two others radio frequency values.

There is a point below at and below which regeneration will be present at the intermediate level. Naturally operation in this region makes for very great selectivity, too much, in fact, and the operating condition used when the every-channel-at-night results are obtained is not with regeneration present, but with most of the a.v.c. voltage included.

The setting of the rheostat in the cathode leg of the radio frequency amplifier need not be changed from a "comfortable volume" position unless one desires to sweep the whole dial, when the position that gives satisfactory results from 1,600 kc down may have to be adjusted to somewhat higher sensitivity for stations below 600 kc.

The intermediate amplifier would be unstable were not filtration included as shown, even unto the 2 mfd. bypass condensers. With all the filtration included, the workable gain is much higher than it could be without such precautions. The result is that one hears stations that many a high-powered a.c. set could not bring in, if

(*Continued on next page*)

Resistors

One 300 ohm
Three 500 ohm
Four 10,000 ohm
One 30,000 ohm
One 12,500 ohm
One 50,000 ohm
Three 100,000 ohm
Two 1 meg.
One 10,000 ohm potentiometer with switch
One 90 ohm 25 watt

Other Requirements

A.C. cable and plug
Sockets
Tube Shields
Dial
Dynamic speaker with field coil across d.c. line
Tubes

(*Continued from preceding page*)
worked in the same location, and with the same small indoor aerial.

SETTINGS REMAIN CONSTANT

A close vernier dial was put on the receiver so that measurements of frequency changes could be made. There were no changes worthy of mention. The same dial positions, night after night, accounted for the very same frequencies or stations, though the dial was readable to an accuracy of one part in 1,000.

When the wiring of the receiver is finished, the frequency adjustments have to be made. First the intermediate amplifier is peaked at 465 kc. This requires the use of a signal generator. No antenna should be connected to the receiver at this time. With two intermediate stages, requiring adjustment of three coils, each consisting of two windings, and each winding tuned, there are six circuits to be tuned here alone. The simplest way to get the approximate frequency is to connect the signal generator to the plate of the second i.f. tube, the one ahead of the 85 tube. Then adjust the one of the windings of the coil leading to the second detector, next adjust the other winding, whereupon the signal generator may be connected to plate of the pentagrid tube (primary of first intermediate transformer) and the other intermediates adjusted for maximum response.

When one condenser is adjusted closely, preferably the grid circuit condenser, do not later molest that, but adjust only the plate circuit condenser for maximum response, which may be most sound or greatest deflection of an output meter. Lacking the a.c. meter, one may put a d.c. milliammeter in the plate circuit of the first audio amplifier (0-1 ma), or may use a more sensitive meter between the secondary return and the potentiometers. The d.c. meters will function even if the signal generator is not modulation.

MOST SENSITIVE TO WEAK SIGNALS

Adjust for biggest swing. Despite the absence of r.f. carrier there is a.v.c., since the signal generator supplies a carrier that works the second detector and produces the biasing voltage. So very small output from the generator is to be used, about as little as practical to hear or to cause an observable deflection. This way a.v.c. is aided, because the receiver is more sensitive to weak signals than to strong ones when set for weak signal reception. The actual alignment is changed by a strong signal, because of the effect of resistance on frequency. The tube's resistance is increased or conductance decreased as the bias is increased by a.v.c.

The intermediate frequency amplifier must be lined up at one frequency. That is of paramount importance. It is of less importance that the frequency be just what is recommended. If 465 kc is specified, 460, 461, 466, etc., would do as well. The tracking arrangements in the tuner part of the receiver would constitute the adjustment to the intermediate that exists.

The antenna trimmer should be nearly all the way out, the modulator trimmer should be in the same position, and the oscillator trimmer should be adjusted to bring in a frequency of 1,400 to 1,500 kc when the antenna is connected. This frequency may well be supplied by a station. If a generator is being used, 1,450 kc is a popular tie-down frequency.

TWO TIE-DOWN POINTS

For the coil system outlined, 1,450 kc would come in at about 12 on the dial, so turn to 12 (or 18 degrees) and turn the local oscillator trimmer so that the 1,450 kc carrier's modulation produces loudest aural response (assuming generator is modulated).

Now turn *out* the trimmer to see whether the very signal that disappears comes back. If so, the second position is correct, for the lesser capacity produces an oscillator frequency higher than the 1,450 kc (i.e., 1,450+465 or 1915 kc) which is what we want, not 1,450—465 kc or 985 kc. It is scarcely possible to make the mistake but the test should be included nevertheless. Carefully set the right frequency, then adjust the trimmer of the modulator for maximum response, and finally the antenna trimmer, which when turned down too far causes sensitivity to drop, and therefore capacity is reduced again until volume is as it was prior to the tentative adjustment of this capacity.

The second tie-down point is for a low frequency. Usually 600 kc is selected, if one has a signal generator. Otherwise a station on 550 to 650 kc would be used, but as close to 600 kc as practical. This adjustment consists solely of setting the series condenser or padder in the oscillator circuit for maximum response, "rocking" the tuning condenser, in the event the dial position for the frequency is not known. It could be ascertained by stopping the local oscillator in the set, putting modulated 600 kc into the antenna, and inserting earphones in series with the modulator plate coil. Loudest signal would denote the position, and then with circuit restored, the series padder would be adjusted until at this dial position the signal came through most strongly. A slight readjustment of the parallel trimmer on the oscillator might be needed now, due to the effect of the series condenser.

Now the circuit is finally lined up, with a minor exception, that if a weak, steady station is brought in, the plate circuit condensers on the intermediate coils may be trivially readjusted until the station is heard loudest.

Bi-Polar Condensers Offer a Safeguard

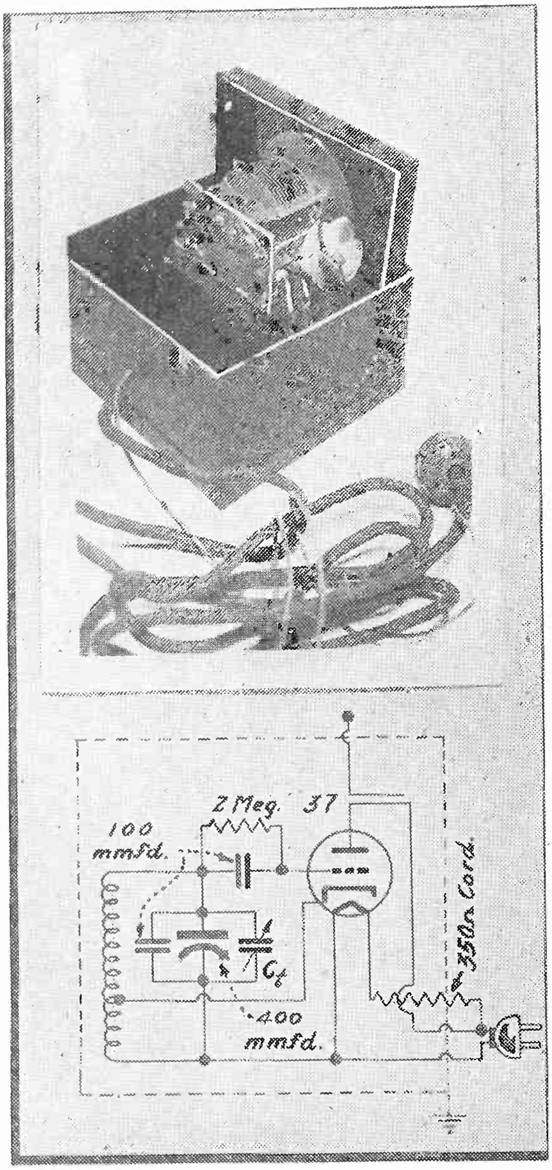
A strictly d.c. set usually is subject to ruin if the plug is inserted on the line socket the wrong way. The electrolytic condensers used in the filter are polarized, being high resistances in one direction of polarities and low ones in the other. When they are low resistances the current is too great and condenser destruction results. A live fuse may blow as well.

A way out is to use bi-polar condensers. Then the condensers are effective in either direction. The only trouble is that the set won't play on reversed polarity.

For Lining I.F. Channel

This Little Device Serves Handy Purpose

By Lee Ballou



The box and the simple signal generator it contains. This generator works on a.c. or d.c. but has no modulation on d.c.

EVERY one needs a signal generator at some time, for he will want to line up an intermediate amplifier, and how else is he to to do it at a particular frequency? It is possible to line up the station carrier signal part of a superheterodyne, and even the oscillator in the super, using broadcasting stations, but first the intermediate channel must be just so, and this generator will do the trick.

Remove antenna from the set, connect signal generator output to the plate of the modulator (first detector) tube of the set and adjust the condensers on the intermediate coils for maximum aural response.

TUNING 110 TO 200 KC

A simple generator that takes care of the intermediate frequencies largely on fundamentals, and also on early harmonics, is one with a fairly large inductance coil tuned by the usual capacity condenser, around 350 to 400 mmfd, across which is a large fixed capacity (100 mmfd.) to give straight frequency line tuning. If the coil has an inductance of around 4 millihenries, and is tapped, the Hartley circuit may be used as shown, and with permanent trimmer of 100 mmfd., the variable trimmer is adjusted so tuning will be approximately from 110 to 200 kc. There will be never any need of using more than a third harmonic for any intermediate frequency, and scarcely ever more than

(*Continued on page* 43)

LIST OF PARTS

Coil

One tapped radio frequency choke, 4 millihenries.

Condensers

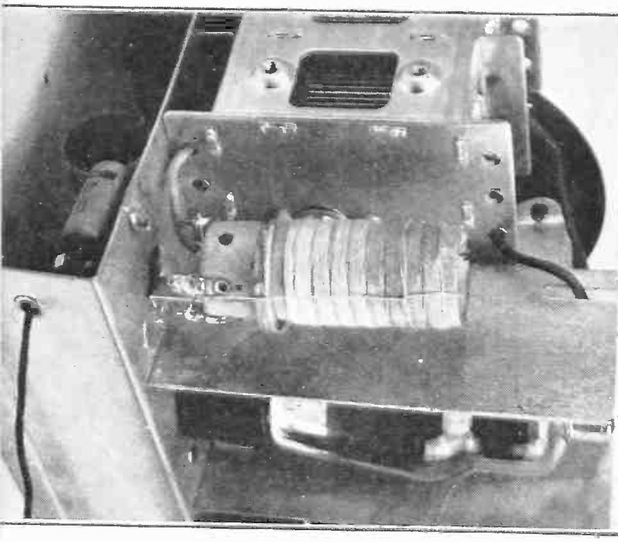
One 400 mmfd. tuning condenser, with trimmer built in.
Two 100 mmfd. fixed mica condensers.

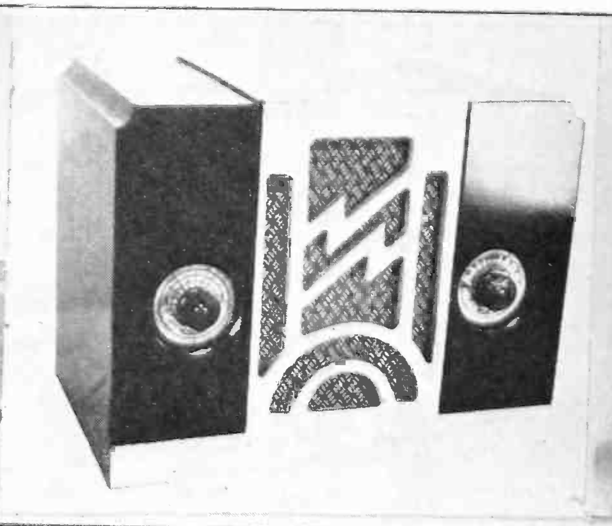
Resistors

One 2 meg. pigtail resistor.
One 350 ohm, 50 watt resistor built into line cord.

Other Requirements

One a.c. line cord and plug (resistor built into cord assembly as stated above).
One panel with bracket affixed for holding tube socket.
One box into which panel fits.
Six insulators, to insulate tuning condenser from metal box.
One five hole socket.
One short wire for output (anchored anywhere near coil or plate of tube, though not made conductive).
One dial (commercial frequency calibrated types available).
Two escutcheons to read two parts of dial at a time (latter for commercial type dial).
One 37 tube (or 76).





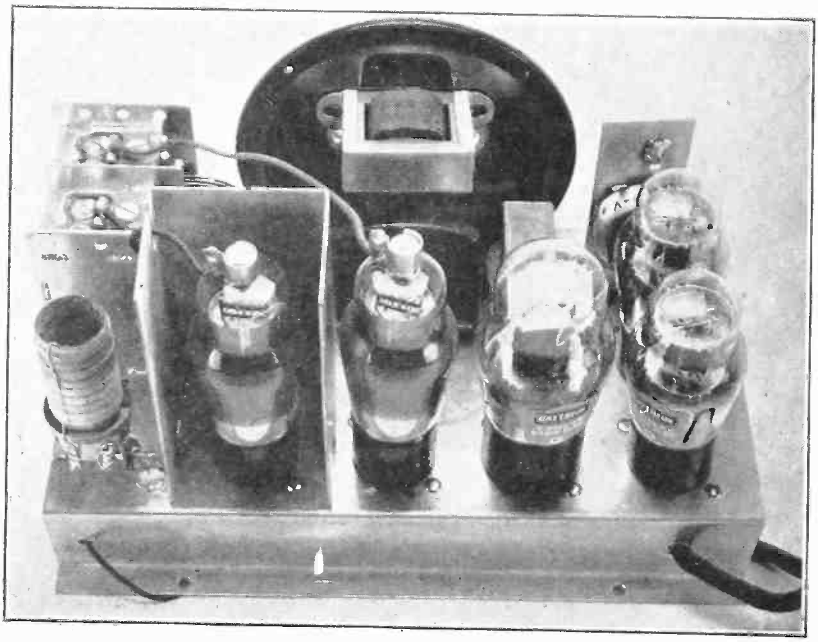
·WHA

on 5 Tube T

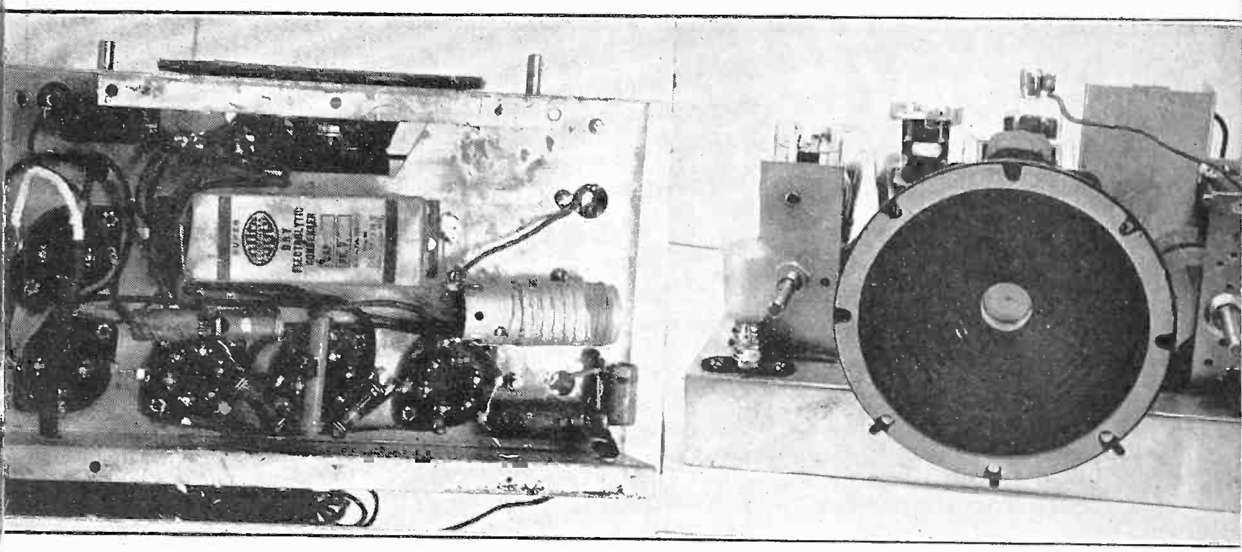
By Jack

IN both the antenna and the interstage coil a high impedance primary is used in this five tube tuned radio frequency design. The results are excellent. In fact, the receiver works well enough to avoid trouble from WOR (now 50,000 watts) even in New York City, if a short antenna is used. Besides, the receiver does not oscillate even when a short antenna is used, which is an oddity, for it seems that most t.r.f sets suffer from this nuisance, which must be associated with poor design.

The layout is interestingly presented in the photographs reproduced on this page. In conjunction with the circuit diagram they reveal sufficient information for any one with a small knowledge of radio to reproduce the results. As for the coils, however, they have secondaries of bank wound Litz, and honeycombed primaries, and



The two-gang conde and the two coils pro sufficient results to regular local recept amid trying conditions to selectivity and also ford some distance rec tion. The circuit diag at right was built into formation shown at the antenna coil being vealed at top, while interstage coil (not sho is at bottom. The 200 c 50 watt resistance is the line cord.

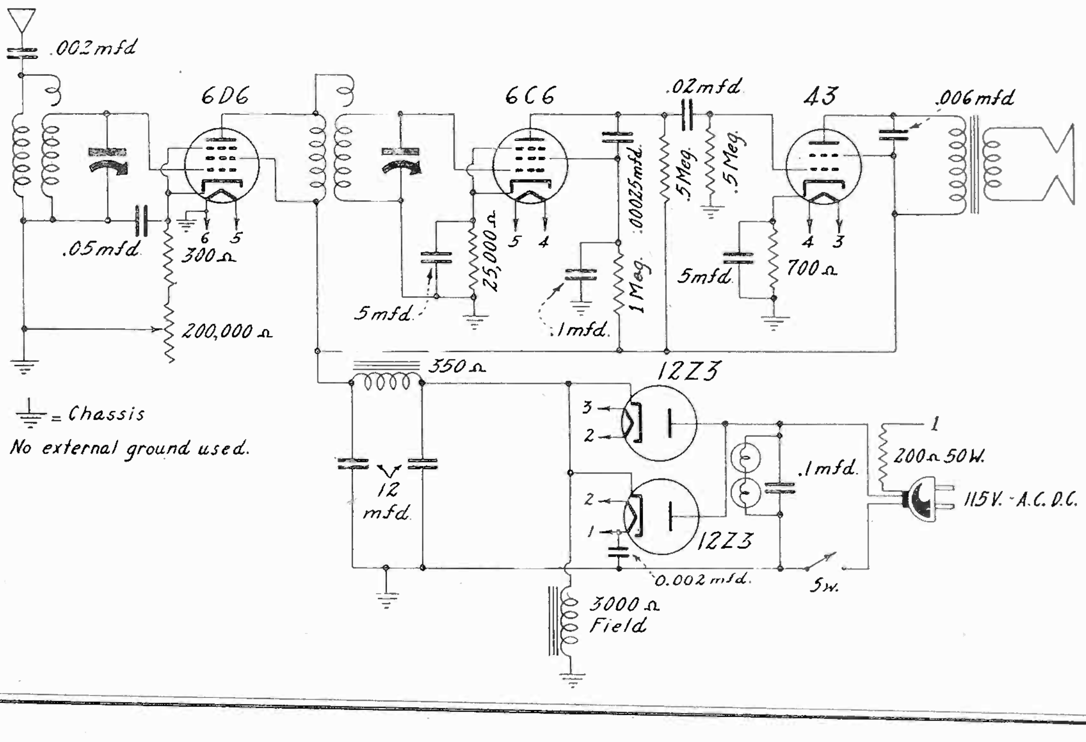


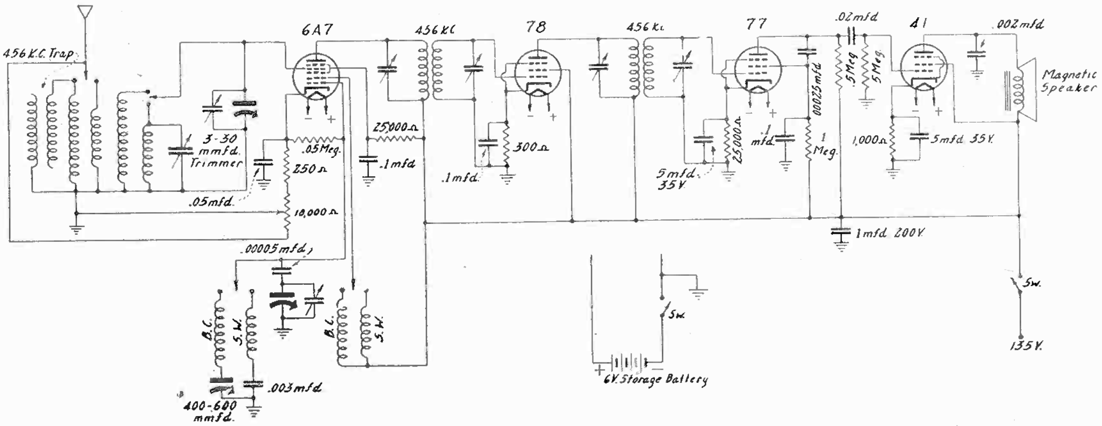
T PEP.

R.F. Receiver

Sullivan

bank winding is scarcely anything that the home constructor can duplicate. An intimate view of the antenna coil is shown at top left, the high impedance primary at left as shown, and connected to it at one extreme is the wire that is turned once around the secondary for the resultant capacity, so that when the coupling tends to become less on the high frequencies due to inductive relationship, the capacity begins to take more serious effect as coupling adjunct. And the interstage coil is of the same type. The single turn and its connection are shown clearly in the diagram. The whole set is contained in a midget cabinet of familiar pattern and size and is, of course, easy to tune. Moreover, it is peppy at low radio frequencies, which is a stiff requirement for t.r.f sets as a rule.





The battery version, in four tubes, of the midget superheterodyne with which Jack Goldstein has been amazing the wiseacres of Cortlandt Street. The demonstrations given in Radio World's laboratories certainly proved Goldstein's circuits outstanding.

For Use on Batteries:

An Astonishing Four-Tube Super

By Jack Goldstein
Set Designer

THE battery operated counterpart of the five-tube superheterodyne described by me in the March 30th issue is the four-tube model diagrammed herewith. The same layout is used as for the a.c. set and those interested in the battery model will find particulars about the placement of parts in that issue.

A six-volt storage battery is used. Naturally, the full voltage is applied directly to the heaters. The B voltage is 135 volts maximum. Since a magnetic speaker is used, which is the more economical type where battery operation is involved, of course, the circuit is suitable also for automobile service.

ELIMINATOR INCLUSION

Besides the storage battery feed of the heater, it is quite practical to obtain the B voltage from an eliminator such as the vibrator type, or from a small motor generator.

The vibrator type is less expensive, renders good service, but the vibrator will stand one or two repairs and then has to be replaced. The motor generator will last almost as long as you want it to last, and is in the more dependable class, but costs more.

One reason for selecting the 135-volt type B supply, where 40 milliamperes rating will suffice, is that the cost is less than the higher powered devices, or rather, the set is selected so as to keep the drain within reasonable limits. There would be no need to have a bigger capacity from vibrator or generator, for this set.

It has been a matter of mild surprise to me to find how even some of the radio experts react to a demonstration of the receivers based on this simple fundamental circuit—the same one embodied in the March 30th a.c. set, the battery type diagrammed now, and the universal type, which has not been described by me yet, but it amounts merely to the usual adaptations for voltaging, with no fundamental circuit alterations.

The 78 tube is shown as the intermediate amplifier and does not require a tube shield. However, if the 6D6 is used, a tube shield is required.

HIGH IMPEDANCE PRIMARY

In the antenna circuit is the improvised 456 kc i. f. trap, not fully effective, but helpful, and an inexpensive inclusion. The primary is of high impedance, along with the current of popular choice. The coupling is mostly through the same capacity of a turn or so open-ended a wire from the choke primary. The two bands are covered, broadcast and European short wave, by switching, and all the constants necessary for this will be found imprinted on the diagram, except coil construction, and for this purpose the secondaries may be patterned after those of coils described by Harry Miller in this issue. The special trap idea may be omitted from home constructed coils, as not readily accomplished without close adherence of choke inductance.

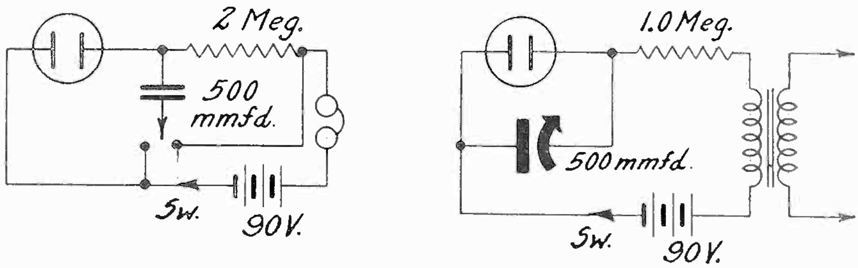
As stated in the previous issue, I was for seven years production manager of a licensed set manufacturer, and the circuits I am discussing in these columns from month to month are based on really twelve years of experience, and are outstanding in performance. I get very much excited when anything better, tube for tube, is encountered, but as yet I have no occasion to lose my temper.

NEON GADGETS

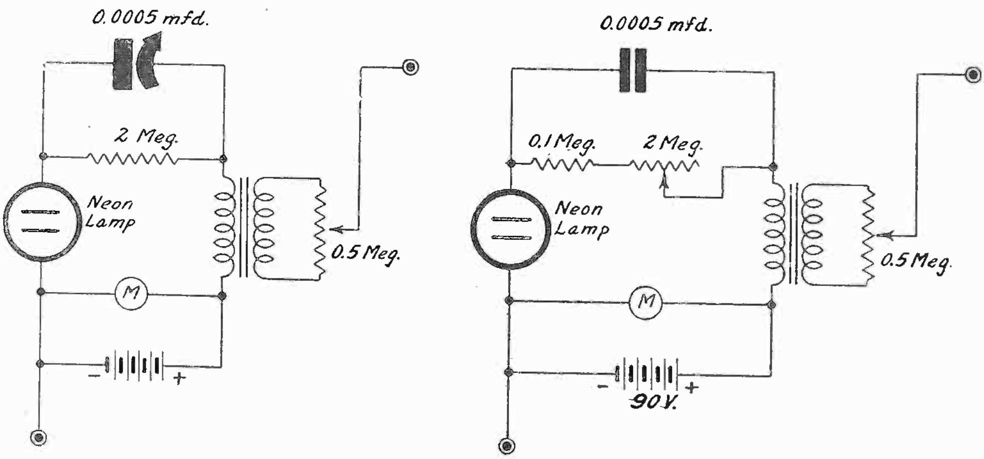
Audio Oscillators, Output Meters, Relay, Tuning Meter and Overload Index

By Will Ellington

AUDIO FREQUENCY OSCILLATOR WITH GLOW DISCHARGE



Intensity control is exercised at left by flipping the switch. The frequency remains practically unchanged. At right a variable condenser is used, for wide frequency change. The tubes must be of the type without limiting resistor built in.



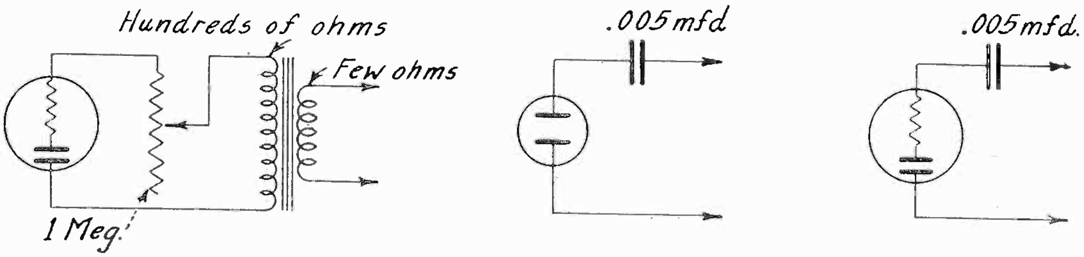
Variable frequency neon audio oscillators, with attenuation. The resistor is fixed, the condenser variable, at left, while at right the condenser is fixed and the resistor is variable. The meter should be left in circuit during operation of the oscillator, as any calibration would be upset by a small change in the applied voltage. One side of the output transformer may be grounded.

THE neon tube serves numerous purposes in addition to furnishing the soft orange light on advertising signs. In radio and audio practice it is most interesting as an oscillator, as a voltage level indicator, a visual tuning or output device or a relay.

A simple circuit indeed, equipped with volume control, is the one showing the lamp, a resistor, a condenser, a battery and a pair of earphones. A low frequency will be heard in the phones. It will be lower the higher the capacity used and the higher the resistance, and higher in frequency the lower the resistance and the lower the capacity. The volume control gives two levels, medium and loud, depending on whether

(Continued on next page)

VISUAL OUTPUT METER, WITH AND WITHOUT ATTENUATION



Lamp with built-in resistor has potentiometer across it, resistance rheostat further to limit current, so the lamp may be operated at normal current despite source voltage. A 0.005 mfd. condenser may supplant limiting resistor (center) or be used additional to such resistor.

(Continued from preceding page)

the condenser is across the lamp (medium) or across the resistor (loud), there being practically no difference in frequency.

It is therefore practical to have a variable condenser and thus create an audio oscillator with quite a range. In this instance it would be preferable to use a transformer for freeing the output from any conductive connection to the generator. The points X would be connected to the delivery, which might be phone terminals, or even a speaker. If a dynamic speaker is used, P is the usual primary and S is attached already to the speaker voice coil. Otherwise S is the secondary, with more turns than the primary.

THE LIMITING RESISTOR

A circuit for use as an output indicator utilizes a condenser in series with the lamp. If the device is connected between plate of power tube and B minus (nearly always chassis), no d.c. will be applied, as the condenser stops that, but a.c. of sufficient voltage will light the lamp. Since the only a.c. present here is that due to the modulation, the light will go on and off according to the modulation. When no sound is put into the microphone there is no light.

Even the midget sets have enough a.c. voltage at the power tube output to light the lamp, at least on local stations.

Although the type of lamp shown for audio oscillation has no limiting resistor built in, the one usually obtainable through stores without special order, may be used for the output indicator, level indicator and relay. If the lamp is overbright the capacity would be made smaller; if too little light, increase the capacity to 0.1 mfd. The wattage rating of the lamp is unimportant. Even the tiny type (¼ watt) will suffice for any of the purposes illustrated.

A voice-coil connecting system is shown. Here a transformer with high-impedance secondary is connected with potentiometer arm to one extreme and one side of lamp to the other extreme. The other transformer winding is of low impedance, usually 4, 8 or 15 ohms, and is connected across the voice coil of a dynamic speaker. The d.c. ohmages are indentified on the diagram.

LINING UP SETS

Most transfer is achieved when the impedance of the primary, P, is equal to the impedance of the voice coil winding of the speaker. However, more than enough voltage than needed to cause the lamp to strike is present anyway, and since only visual results are used, a mismatch is not serious.

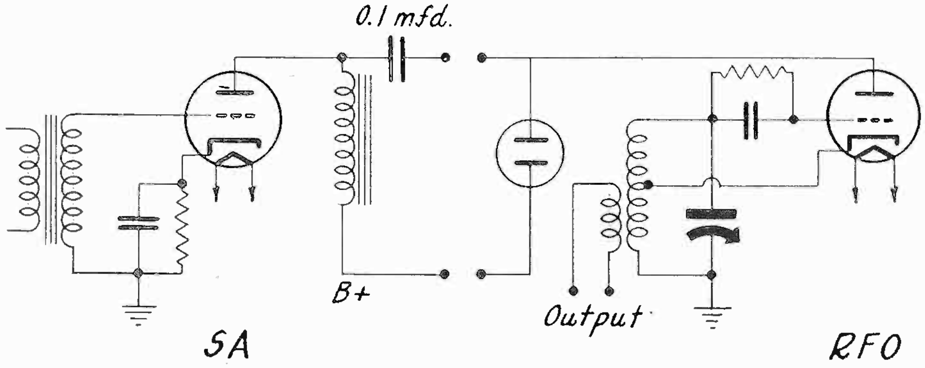
The output indicator is used principally for lining up receivers. A signal generator is connected to the input to the intermediate amplifier of a superheterodyne, and that channel lined up for maximum illumination, indicator from output tube plate to chassis. The generator has to be modulated because only the modulation is left at the position where the lamp is connected. The carrier has been wiped out by detection and filtration. For tuned radio frequency sets or for radio frequency level adjustment of a superheterodyne the signed generator is connected to the antenna post and the same watchful test made. A station's modulation can not be used as it is unsteady or interrupted and the illumination is jumpy. A steady tone gives a steady light.

BLINKER RECEPTION

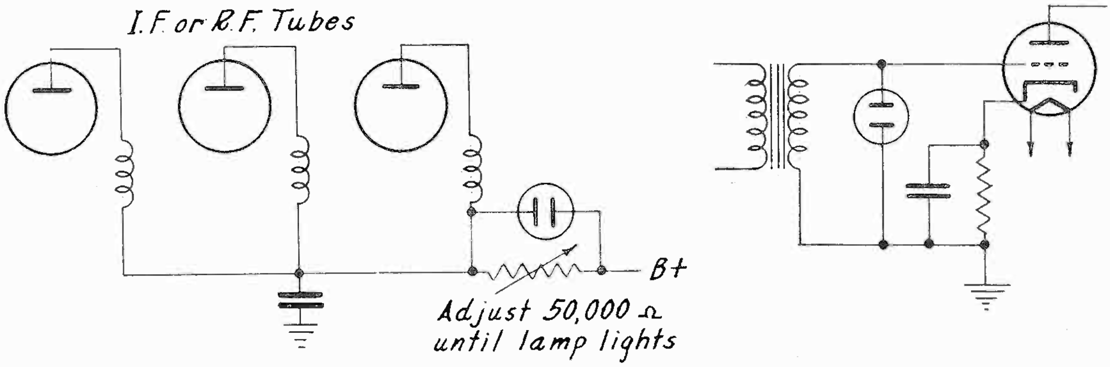
Naturally, with so many receivers able to tune in short waves, where code abounds, the output indicator may be used as a blinker, and code read from the illumination, without the "listener" hearing anything. Very rapid sending can not well be read this way, because of the persistence of vision, as existing in the eye, but 30 or 40 words a minute can be copied very well.

The neon tube is an open circuit until the voltage applied is high enough to cause the gas to break down, when the tube is a closed or conductive circuit. Therefore the tube may be used as a relay, for instance, to have a wave kept off the air unless there is modulation on it, which is useful in some services. Also amateurs might get to liking the method. The neon tube does the trick without causing "clip-

RELAY, TUNING METER AND OVERLOAD INDICATOR



The left-hand tube is the output of a speech amplifier and the audio frequencies are put into a neon tube, which acts as a closing relay to apply plate voltage to the radio frequency oscillator RFO.



The resistor is adjusted until lamp is comfortably bright as tuning meter. Level indicator at right.

ping," for the tube acts almost instantaneously. The lag of usual illumination tubes being absent, the oscillator goes on the air the moment it is spoken to.

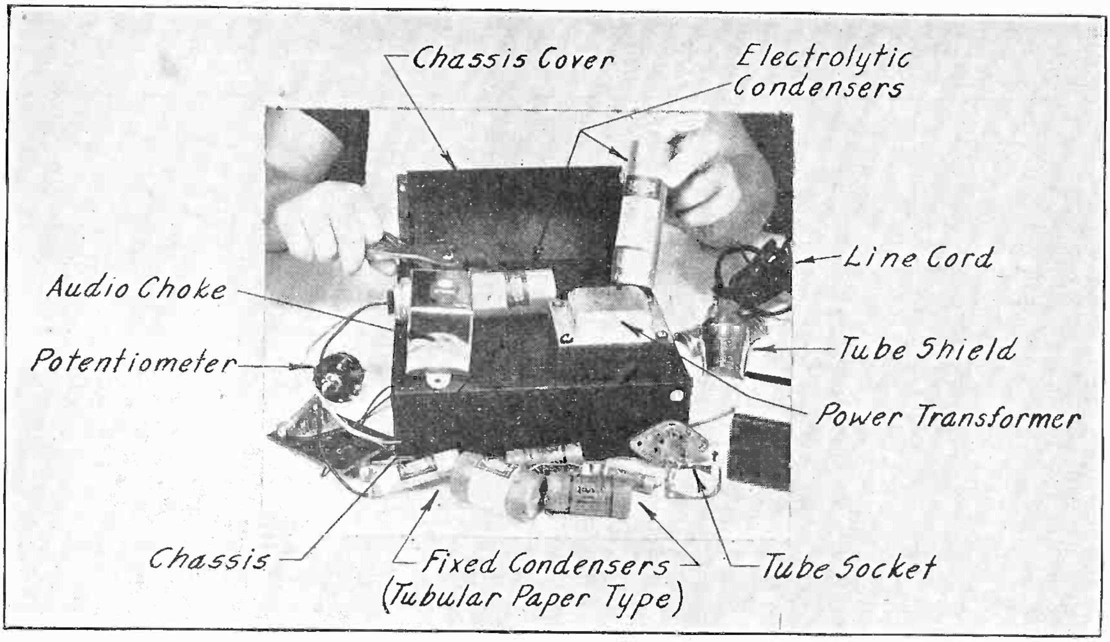
AVOIDING A STRIKE

Use in a common supply circuit is shown. The microphone input is amplified in the speech amplifier SA. The output tube of the speech amplifier is loaded by an audio choke to B plus A stopping condenser keeps the d.c. away from the neon lamp. When the microphone is actuated, the amplification is sufficient to cause the neon tube to strike, thus changing it from an open circuit that keeps B voltage off the plate of the radio frequency oscillator RFO to a closed circuit that applies the B voltage. As the radio frequency tube oscillates only when the B voltage is applied, and as that voltage is applied only when something is being put into the microphone, the carrier is never on the air unless modulated. The output from the small oscillator is usually amplified in a power stage of radio frequency, and then connected to antenna.

The B voltage should be such as not to permit the neon lamp to strike, (say, under 70 volts), or connect the neon tube so that the intended positive anode is toward negative, so no current will flow, though on a.c. the tube would strike.

LEVEL INDICATOR

As a level indicator the neon lamp may be connected across the power stage input, where the tube bias is about the same as the striking voltage. The 2A3 is an example. Also by passing d.c. of radio frequency tubes through the neon lamp resonance indication is achieved. This differs from output indication as the lamp is always lit, but is brighter the stronger the carrier. Modulation has only a small and indirect effect. The system works best on sets having automatic volume control, and the resistor should pass B current to all tubes so controlled.



What's What and WHY

A Word of Sane Advice to the Women

(Novices May Listen in Gratis)

By Imlay Worcester

IF the lady of the house picks up the how-to-make-it radio magazine when there is not another scrap of reading matter in the house she perhaps cannot make head or tail of anything save the running heads, dates and folios (see line atop page). But here's a big assist. She can wonder what it is that the boy or man works over until late, aye, too late at night, on occasions when she has to scamper out herself for replenishment of the baby's powdered milk preparation.

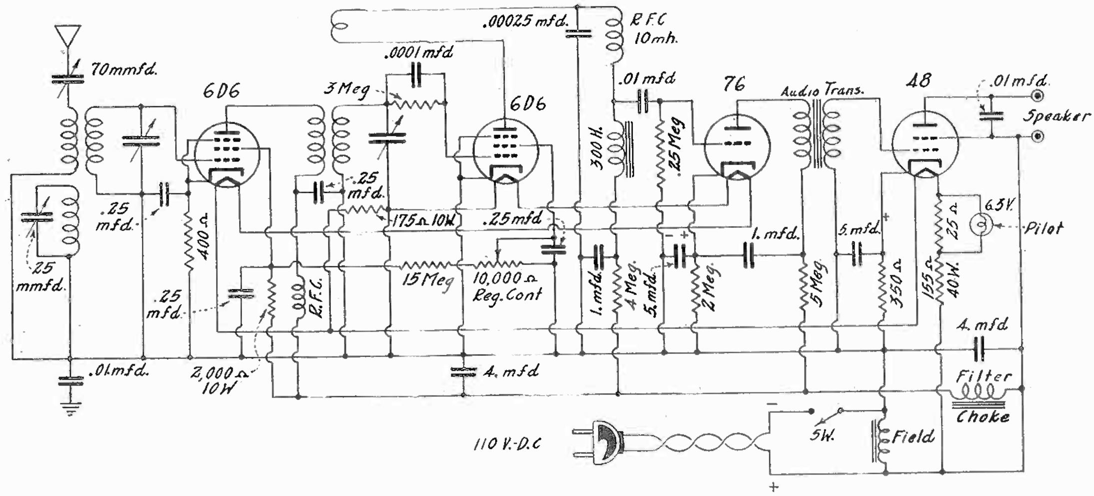
Starting at left and going to the right, an editorial habit, we find a squarish can of some sort identified as an audio choke. Truth to tell, almost anything may be in a can, but this one contains stacks of iron around which are wound turns of wire. Thus we have a heavy choke or large inductance, meaning the same thing: that when current is passed through the winding the choke so behaves as to oppose changes. Hence where fluctuations occur a measure of steadiness is introduced. This particular instrument therefore offers electrical inertia. Here with condensers the choke will help kill off hum.

ELECTROLYTICS A PUZZLE

The chassis cover is, as its name implies—but you guessed it, so we'll pass on to the electrolytic condensers. It would be easy to explain about them if one knew. They are not really condensers. They are polarized conductors. They have the capability of storing electricity and therefore have capacity. The stored electricity is released as a spark when the two terminals are touched. But don't get frightened. There's nothing injurious in this discharge. Electrolytics consist of fluid or paste as the medium between which are placed two different metals. Somehow reminds one of a dry or wet battery.

FAMILIAR NOTE

Line cord should strike a familiar note. It is the same as what connects the wall plug to the appliance plug, as used on the vacuum cleaner and the electric iron. The cord conducts the electricity from the house wiring to the primary of the power transformer. Arrow under the word tube shield indicates the transformer. Little need be said about the shield, now that metal tubes are on the way, or here. The tube socket is what the tube is put into, the fixed condensers were never broken, let us hope, but are called fixed because they are not purposely variable. The chassis is the box or frame on which everything is built. The potentiometer literally means meter that reads potentials, but it is no meter whatever, just a three-terminal resistor, two terminals for extremes, third terminal movable over the stretch.



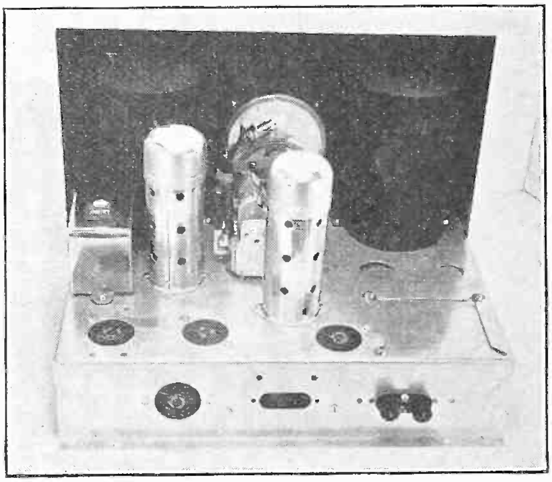
Proved D. C. Design

By Robert G. Herzog, E. E.

AMONG d.c. sets the four tube regenerative all-wave model using plug in coils is popular. The authenticated design is given above, and the layout of parts is at right. The same chassis obviously is used as for an a.c. set, but the transformer opening is covered by a piece of aluminum.

The receiver has been in operation in a radio store in downtown New York City and attracted considerable attention. It was easy to bring in European stations on short waves, with only 20 feet of wire strung under a low ceiling.

The 48 was selected for output because it is such a sensitive tube; that is, permits such large power output at low voltage. Even though it takes a bit more current, the extra pains of including a resistor to shunt the other series filaments, to equalize the current, are worth while.



LIST OF PARTS

Coils

Two sets of six prong coils (8 coils).
Two 10 millihenry r.f. choke coils.
One 300 henry choke.
One filter choke.
One Special speaker for 48.

Condensers

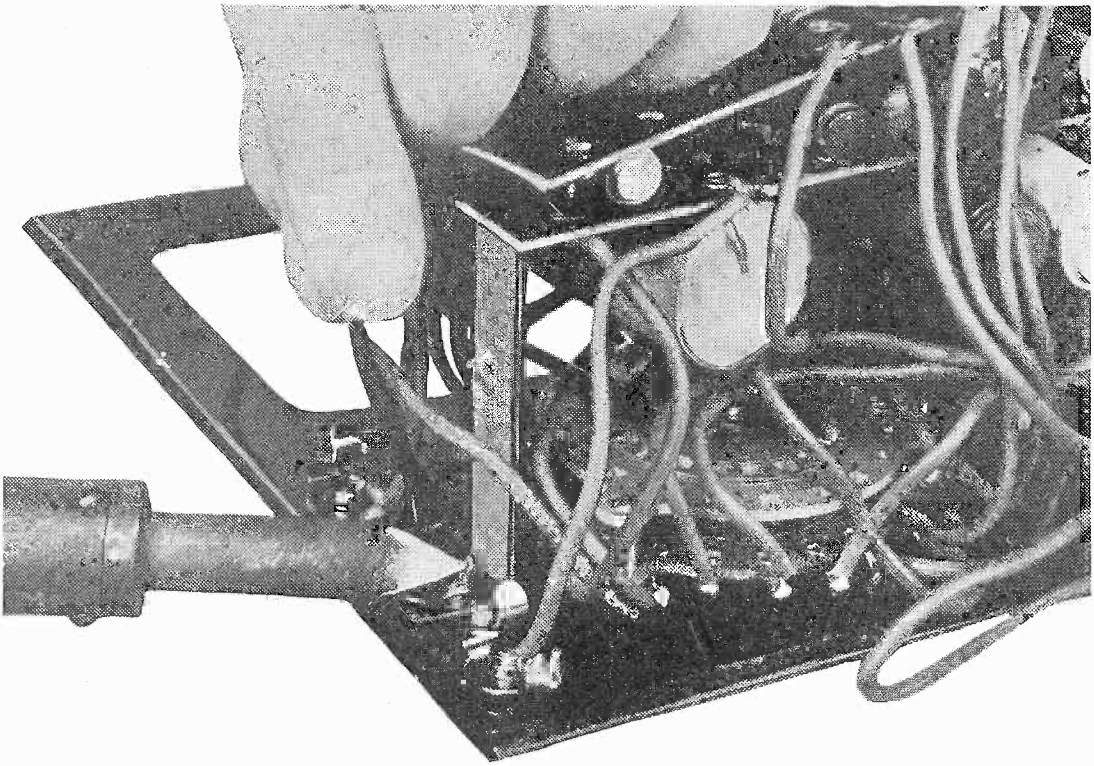
One 140 mmfd. two gang.
One 25 mmfd. midget (variable).
One 70 mmfd. antenna trimmer.
Two 4 mfd. 200 volt.
Block of four .25 mfd.
Two 5 mfd, low voltage electrolytics.
Two 1 mfd. 200 volt.
Three .01 mfd.
One .00025 mfd. mica.
One .0001 mfd. mica.

Resistors

One 10,000 ohms potentiometer with switch.
One 155 ohm 40 w.
One 175 ohm 10 w.
One 25 ohm 10 w.
One 350 ohm 2 w.
One 2000 ohm 1 w.
One 2000 ohm ½ w.
One 15000 ½ w.
One 5000 ohm ½ w.
One 400 ohm ½ w.
One 3 meg ½ w.
One 4000 ohm ½ w.
One .25 meg ½ w.

Other Requirements

One chassis, coil shields and panel.
One airplane dial, escutcheon plate and pilot bracket.
Four knobs.
Two 58 tube shields.
Five wafer sockets.
Antenna posts.
Line cord and plug.
Grid clips.



The final joint is being soldered at a binding post. The switch must be carefully wired and soldered.

VOLTS OHMS AMPERES A.C. D.C.

By Harry S. Wand

TWO meters, one a.c., other d.c., are being used considerably in testing and measuring equipment. One example of a kit-constructed volt-ohm-ammeter is shown. The diagram is below. By switch operation the posts connecting to the meters are made available for a.c. or d.c. readings, the currents being d.c., as well as the resistance measurement. Range extension of the fundamental sensitivity of an a.c. current meter is not very practical. There isn't so much use for this aspect, anyway.

The voltage ranges are accommodated to the panel engraving, which gives 1,000 volts as top, while 10 is low for volts, and 1 is minimum for current (milliampere). How the switch is located under the 0.5 mfd. output condenser is shown at upper left, with the soldering iron putting on a final joint.

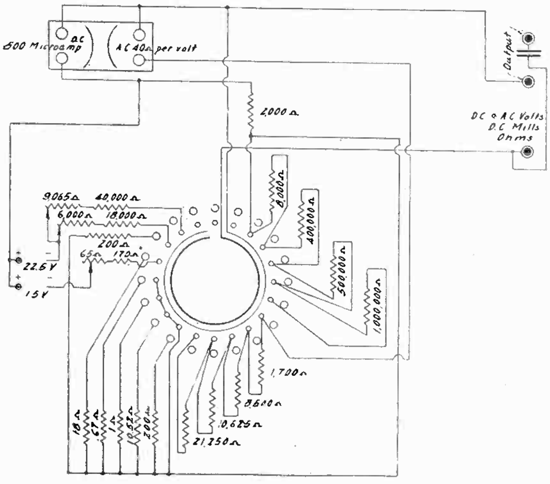
SERVES GENERAL UTILITY

The object of the condenser is to keep d.c. out of the meter for output measurements. That is, one of the functions of the meter is as an output meter.

Resistance may be measured up to 3 meg., which is sufficiently high for all servicing purposes, as values from 3 meg. up never are in critical circuits, and otherwise the combination serves the objects of general utility.

The batteries, condensers, resistors and the twenty-throw, double pole switch are detailed in the circuit herewith, values being imprinted,

(*Continued on next page*)



Wiring connections diagramed.

the multiplier resistors being in series with one another.

POST CONNECTIONS

The top photograph at right shows panel that comes with a kit and drilled for the switch, jacks, etc., intended to be made part of a larger panel with cutout. For legibility the engraving is completed with filler, part of the kit. The scroll saw makes room for the twin meter. Connections to the meter are shown in the photograph where the shunts are in foreground.

There are three zero adjusters: one for meter, one for the other meter, and the third for the resistance purposes of the d.c. meter. There are three posts at lower right of the completed instrument panel picture, top post not visible, the two lower ones for all purposes except output meter service.

Intermediate Generator

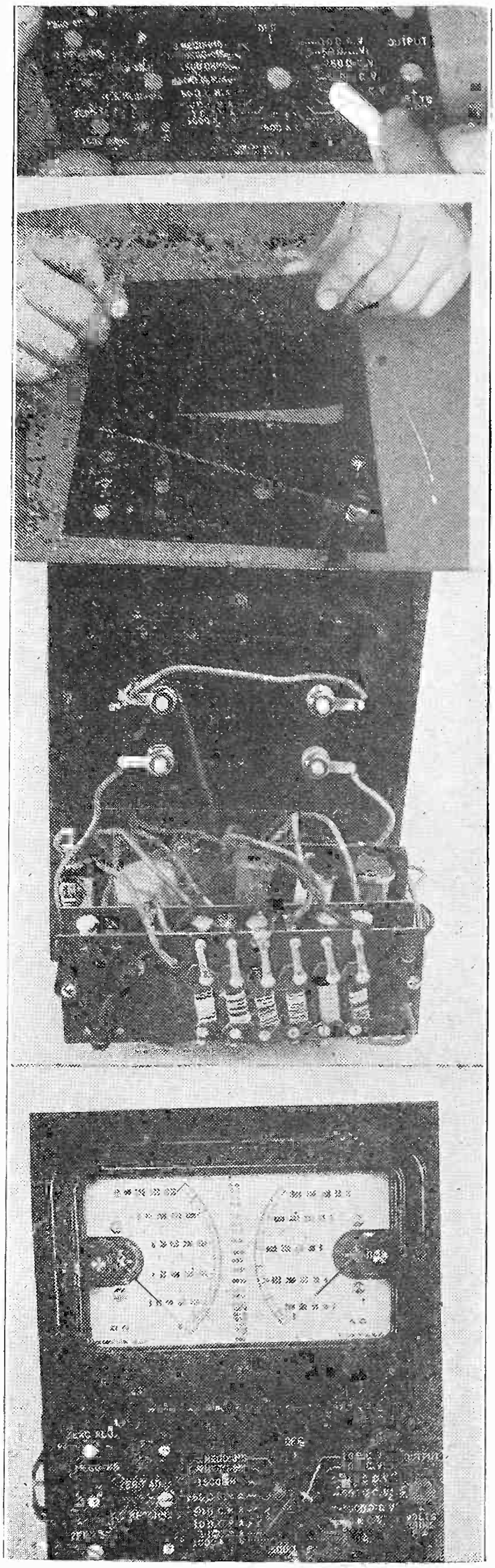
(*Continued from page* 33)

a second harmonic, hence no confusion should result.

If the tap is off center the larger part of the winding is put between grid and cathode, and the smaller part between cathode and B minus. At these low frequencies not much of the inductance need be between tap and B minus.

If a frequency calibrated dial is used, make the generator beat with a low frequency broadcast station, divide this low frequency by numbers that successively yield frequencies within the prescribed generator scope. For instance, if 660 kc is used, 110 is the result of dividing 660 by 6; 132 dividing by 5; 165 dividing by 4. So the variable trimmer is adjusted at 165 to read 165 on the dial for producing zero beat, and then the other beats come in as generator dial is turned, at 132 and 110 kc. If the dial is not pre-calibrated, the total calibration curve can be run by using several low frequency broadcasting stations and applying the foregoing method to a numerical dial (100-0).

The model shown is built on the box cover. Attached to this cover is a small platform, bent in the shape of an L, the socket hole being in the short base of the L. Thus the tube is under the tuning condenser. On the near side is the tuning coil, to the left of it the grid condenser. If cramped for room, you may use the leak from grid to rotor of the tuning condenser, instead of as shown. The box is insulated from the condenser. The condenser's frequency ratio is cut down by a parallel fixed capacity of 100 mmfd. (0.0001 mfd.), while the adjustment for tracking is made with the trimmer condenser Ct.

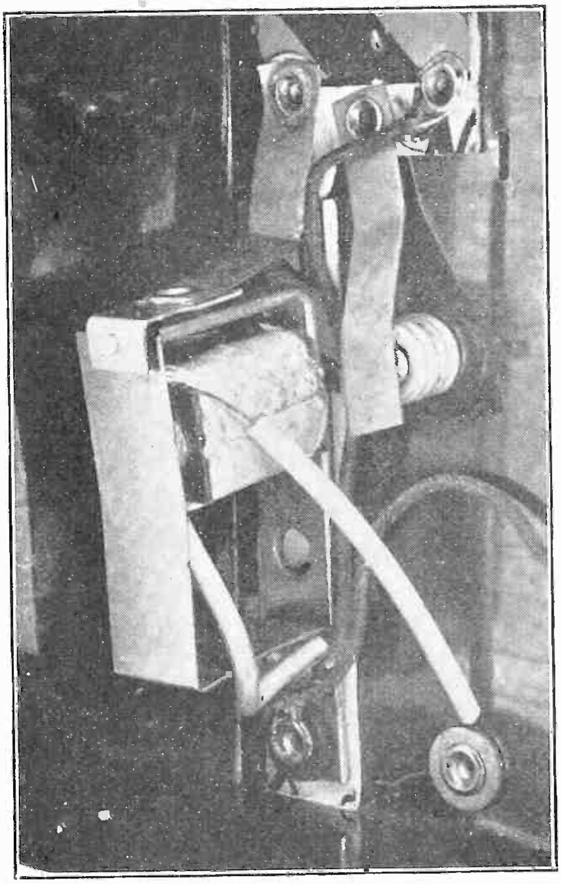


At right, top to bottom, engraver's filler used to bring out imprinted indentations of meter panel. A large insulated piece is sawed so that the separate panel of the dual meters may be slipped into place. Connections to meter and closeup of of shunts are shown. Finally, the finished front. Circuit of the wiring of the universal volt-ohm-ammeter. Two meters are used, and all scales and purposes are direct reading.

B-U-Z-Z-E-R

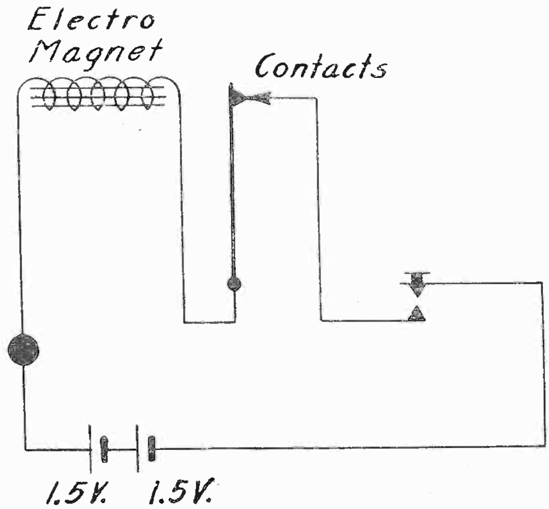
Practice Code...---...With This

By Leon Wolf



Close up of completed buzzer, showing make and break contacts on metal work at upper left.

How to Hook Up Noise Machine



Circuit diagram of the buzzer and standard flashlight dry cells. Two cells used to supply the necessary energy. Depressing the key closes the circuit electrically, causing the electro magnet to become energized, which in turn pulls over the armature which breaks contact, thus opening the circuit again and armature returns to normal position, closing contacts. The cycle is repeated rapidly, thus resulting in the familiar buzzing sound.

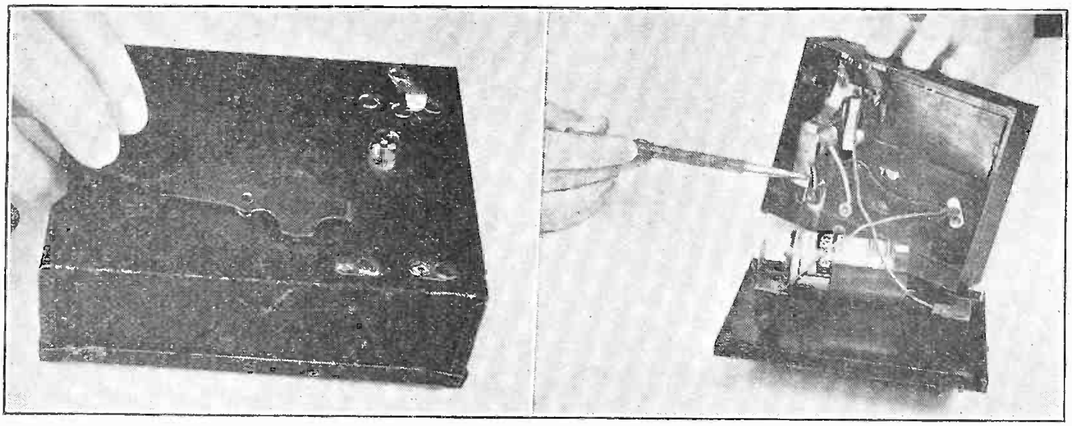
PUT together a key and buzzer and you may practice the code in a realistic way. Every time you press down on the key the buzzer buzzes. Hold down longer for dashes than for dots. Take a short rest between words. After a while you will be able to send and even receive messages.

For sending, the binding posts shown on outside of case are connected, one to the breaker, or contact points, and the other to the opposite side of the battery. A transmission line connects to apparatus of similar construction in adjoining room, and the two in series make it possible even to send and receive on the same set. It is usually preferable then to parallel the batteries now there.

The can with cover is constructed from light metal, such as tin or brass, or some small container that occasionally finds its way around the house serving no useful purpose for the time being.

FOR SERIOUS THINKERS

The key handle may be constructed from a wooden checker, or it may be a button taken from an old overcoat, in either case held to the small sending key with the aid of a 2/56 or 4/36 machine screw.



Upper left, completed apparatus in small metal box, with fingers properly placed on key knob for sending a practice signal. The little switch at rear of panel is used to change over circuit from buzzer to small flash lamp, thus giving visual signal, and no buzz. Pencil (right) points to "works" inside can and flashlight cells for supplying necessary electricity.

While a small practice set of the type described and pictured may appear to be an unimportant toy it is really the basis of practical understanding of telegraphy, radio, or the land line Morse alphabet. In simple form, it nevertheless provides the user with a definite piece of apparatus for serious work in learning the code, and in exchanging messages with another, so inclined.

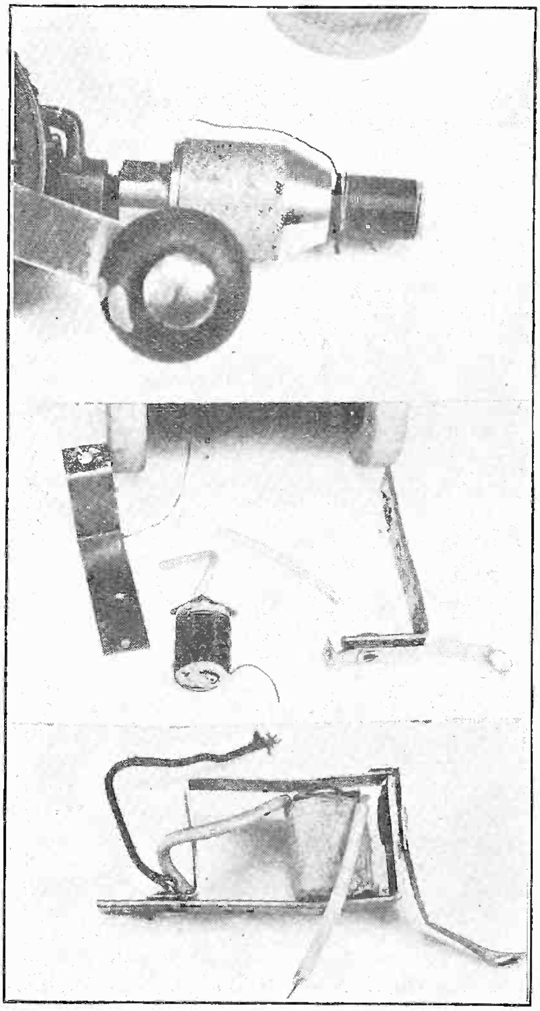
As a matter of fact, arrangements can be made to place several headsets in series, suitably connecting them to the sparking contacts of the buzzer, and the signals received by the group wearing such devices, with one person at the sending apparatus. In this fashion a number of persons is enabled to learn accurately, and with slow sending. One good plan to follow is to send from the daily newspaper, not following any message form whatever, just the text as you go along, not omitting the numbers.

This should be done for periods of, say, ten minutes at a time, after which the work is compared with the original test, and the sending resumed.

NO MORE BOOP BOOP A DOOP

In a surprisingly short time the group will have developed a real sense of "code hearing" and will be able to write down the messages that are going through the air, and which up to the time of learning were just so much beep beeps or dit dit dah dahs.

If the boondogglers could work this in as part of the present dance routine who is there among us who can say the time is wasted? One word of caution, however: Destroy any message or parts of it received over the air since it is a Federal offense to disclose a telegraph message of any nature. You can't even tell your wife what you heard, but, on the other hand, who will want to?



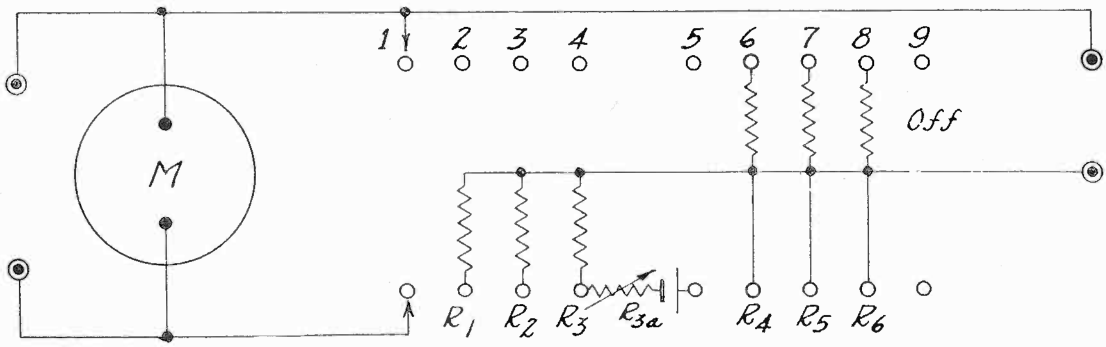
Wind the small electro magnet, by first rolling a number of soft iron wires in bundle about 1/4-inch diameter, 2 inches long. Then slide on two fibre washers, spacing them about an inch apart. Cement the assembly together. Then wind entire space full of No. 22 magnet wire, a piece of paper each layer. The two ends are brought out as shown at top.

Organizing a Meter

For More Extensive and Quicker Service

Switch Type Instrument With Home-Made Shunts

By B. M. L. Ferris



Direct access to the meter is at posts at left, for 0-1 milliampere, or for low resistance measurement when the switch is at position 5 and the right hand posts shorted for full scale deflection.

A SINGLE scale meter can be made suitable for resistance, current and voltage measurements by the switch method. Some improvisations are used in the absence of direct-reading universal scale. Normally one might have a 0-1 milliammeter. It would read 0 to 1, that's all, and the present case has to do with extending the usefulness of the meter without taking the meter apart, as would be necessary, to an extent, if the scale were to be replaced. Also resistors suited to the scale would be needed. At present we intend to make some of the resistors simply.

The reason a 0-1 milliammeter is mentioned is that it is a popular instrument, may be obtained inexpensively and represents the compromise for general service, especially as the resulting voltmeter has a rating of 1,000 ohms per volt.

MAKING FIRST SHUNTS

What one has at once is a current meter, 1 milliampere full scale deflection. The next objective is to extend the current ranges. This is done by using resistors across the meter, called shunts. More current than the meter will read will be passed, but more of it will go through the shunt than through the meter.

So that the scales will be direct reading as far as practical the current ranges selected may as well be 10 and 100 and 1,000 milliamperes (the last figure may also be written as 1 ampere). Now you may use a small dry cell, 1.5 volts, with a rheostat of somewhat more than 1,500 ohms, or a fixed resistor with variable in series, total to exceed 1,500 ohms, and adjust the rheostat when the meter is in series so that full scale deflection is registered. This reads 1. Short the meter terminals. Now no current goes through the meter. Use more and more wire across the meter until the reading is 0.1, whereupon the full scale deflection would be 10 milliamperes. This way of determining the shunt is not the preferable one, but is used as a safeguarding starter. Now get a milliammeter that reads 10, 25 or even 50 milliamperes full scale, and put that in series with the circuit. The same current will flow through the whole circuit. Adjust until the current is 10.

WIRE LENGTH ADJUSTED

The wire across the meter is readjusted now until the shunt causes the full scale reading to be full scale. Now the wire for shunting may be coiled on a nail, ends of wire bared, and wire gently removed from the nail for attachment to the meter switch later on. Some will prefer to use a small insulating piece, with lugs fastened to the ends, and solder the terminals of the wire to the lugs, after winding the wire on the flat form.

For the 100 milliampere range the wire may be thicker and there will be only a small amount of it necessary, while for the 1 ampere range the wire may be No. 20 or 22 or so. The safety method of checking is to have one end of the wire fastened to one meter terminal and using a practically short circuiting stretch of the No. 20 or 22 wire put from meter post to meter post, the current being shut off as more wire is included to create greater length, wee bit at a time, until the desired reading obtains. It may not be handy to get 1 ampere of d.c., therefore the adjustment may be made on the basis of a few hundred milliamperes, as obtained from a power pack, or a receiver, a suitable range of good current meter being used as standard as before, in series with the rest of the circuit.

Thus one may make his own shunts. These are the resistors represented by R4, R5 and R6. It will be observed that the shunts are made without any knowledge of what the resistance of the meter is. If the meter resistance is known, the value of the shunts can be computed, and the resistance of the shunts measured so that the shunts will be correct. The manufacturer will give the approximate resistance of the meter. However, one may measure this himself without danger to the meter.

MEASURING THE METER

Here is how to measure the resistance of the meter. Again establish full scale deflection with 1.5 volts and 1,500 ohms. Now get a rheostat of 50 ohms maximum and connect it across the meter, turning the rheostat knob until the former full scale meter deflection is reduced exactly to half scale. Then the resistance of the shunt is exactly the same as the resistance of the meter, because the same current is flowing through each of two resistors across which is the same potential difference. Now all we have to do is to measure the resistance of the rheostat setting, which can be done safely. as the rheostat will stand a lot of current through it. The meter would not stand large current, hence we had to resort to this expedient.

Some source of large direct current then is used. If as much as 1 ampere is obtainable, the resistance of the rheostat setting as it now stands is equal in ohms to the voltage drop in volts across the resistor. Therefore measure the drop as 30 volts, for instance, the rheostat then is 30 ohms, and the meter resistance is 30 ohms, a likely figure.

ABOUT THOSE THOUSAND MA

Specifically, some large current is put through the rheostat, and may be 50 or 100 milliamperes, and the voltage drop across the resistor is measured. Ohm's law is applied: resistance in ohms equals voltages in volts divided by current in amperes. Since a milliampere is 1/1000 ampere, the resistance computation would look like this: resistance in ohms equals 3 divided by 0-1, where 3 is the voltage, and 0.1 represents 100 milliamperes. The answer is again 30 ohms.

So the meter resistance is determinable readily. The shunts are approximately inversely as the current, that is, for 10 milliamperes, or ten times as much current, the resistance is one tenth the meter resistance, or 3 ohms. For this example, however, 2.7 ohms would be better. For the rest, the computation is applicable on the basis of inverse proportion to the current, i.e., 100 milliamperes, 0.3 ohm; 1 ampere, 0.03 ohm. It so happens that even 100 milliamperes may be passed through many a 0-1 milliammeter without causing injury. This is a fact though the meter manufacturers don't like to tempt their customers by advertising it. However, 1,000 milliamperes, well, they're a different matter. If the shunt fails, the meter goes west. Many do not like to have a sensitive meter shunted for heavy current around the meter, hence do not favor anything like a 1,000 milliampere range for a 0.1 milliammeter. Others do not hesitate to introduce the shunt, especially as they state that sometimes they must read a few hundred milliamperes, and how else are they to do it, unless they resort to another meter?

So much for the shunting of the meter for current extension, the shunts being R4, R5 and R6. Latter on we shall consider shunting the meter itself for low resistance measurements. but meanwhile shall proceed to the series resistors and the high resistance measurement.

THE VOLTAGE MULTIPLIERS

The series resistors are R1, R2 and R3, and for a meter of 1 milliampere full scale deflection the resistance should be 1,000 ohms for every full scale volt. Thus, if 1 volt maximum were desired the resistor would be 1,000 ohms. We hardly want 1 volt maximum for general purposes. To follow the only scale that is on the meter—just as we followed it for current extension, by the decimal multiplaction method—we shall select 10, 100 and 1,000 volts. The

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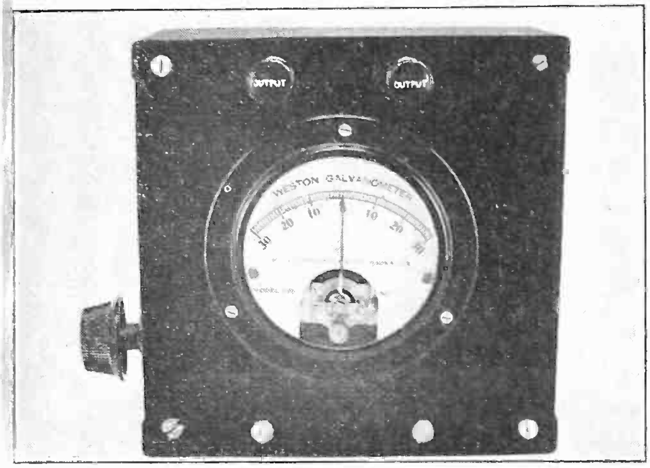

The switching system was applied to a galvanometer, switch mounted at left side of the box. The posts marked "Output" were used for shunting the meter. Test leads normally went to tip jacks.

(*Continued from preceding page*)

resistors required are 10,000, 100,000 and 1,000,000 ohms. These should be wire wound, and that would mean ordinarily that factory products would have to be used. Pending the inclusion of wire wound resistors metalized and similar resistors may be used, selected as close to the required value as possible, which means that opportunity to check the resistors closely should be at hand, and one have the liberty of making a selection, as 10 per cent. tolerance is allowed in commercial practice for these grid leak types, whereas the wire wound may be obtained at 2, 1, 0.5 and 0.25 per cent. accuracy.

For measuring resistances up to 10,000 ohms, and down to 100 ohms perhaps, 1.5 volts from a dry cell, and 1,500 ohms in series, suffice. However, many want to measure higher resistances. The 10,000 ohm resistor for the 10 volt scale may be used, with a variable in series, say, of 1,000 ohms, and the battery voltage 10.5 volts. This will enable resistance readings safely to 1 meg., and values higher than that need not be differentiated in common practice. The lower limit may be several hundred ohms. From there down to 0.3 ohms the meter shunting method may be used.

However, we have to do something about a scale. Really we need two calibrations. One will show resistance values 0.3 to a few hundred ohms, the other a few hundred ohms to 2 meg. It is not known what voltage the builder will use, nor what meter, therefore simply the statement is made that the resistance in ohms is equal to a constant (the voltage) divided by the current in amperes. The answer includes the meter resistance, here negligible, and also the limiting resistor. Therefore deduct for the limiting resistor and put the resultant unknown resistance value as one factor and the current for it as the other. Reduce the results to a curve on plotting paper.

LOW RESISTANCES

The same procedure is to be followed for the low resistance calibration. The calibration may be prepared, as in the foregoing example, without any test work, as the calculations will give the true story, provided no mistakes are made.

The unknown resistance Rx by the shunting method may be considered at first as to whether it is greater than or less than the meter resistance, the equality case already being understood. If the unknown is of less resistance than the meter, more current will flow through the unknown than through the meter, so if the current read is less than half of full scale the unknown is less than the meter resistance, while if the current read is more than half scale the unknown is of higher resistance than the meter. So we could tell at a glance whether

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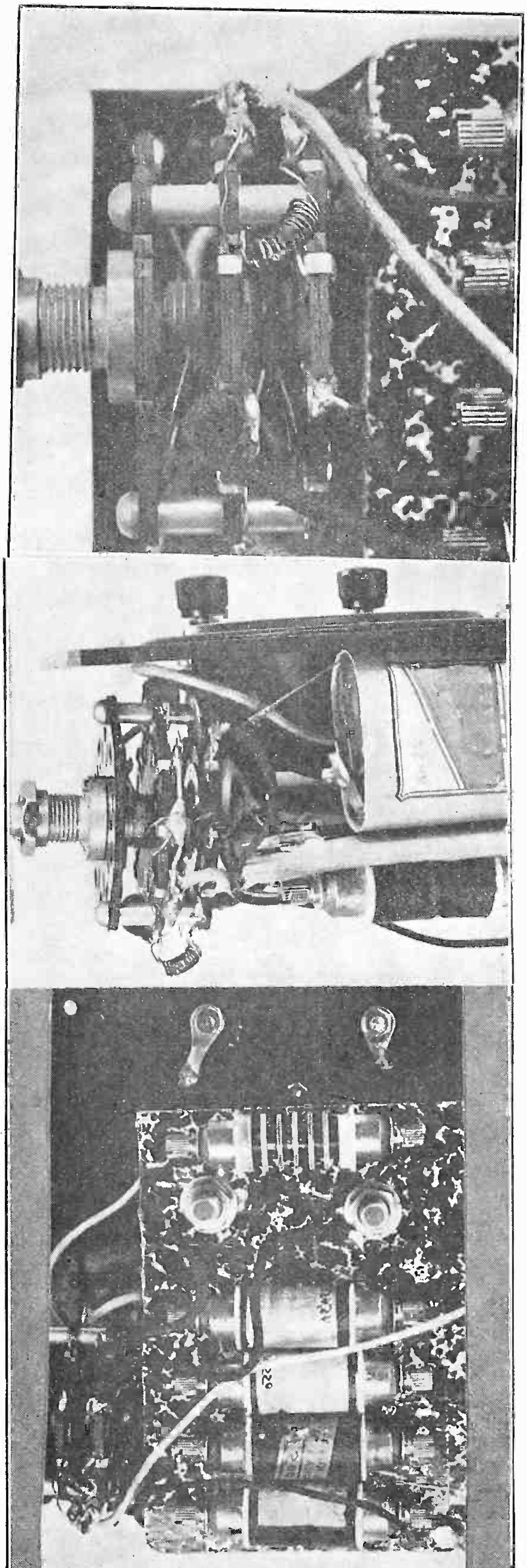
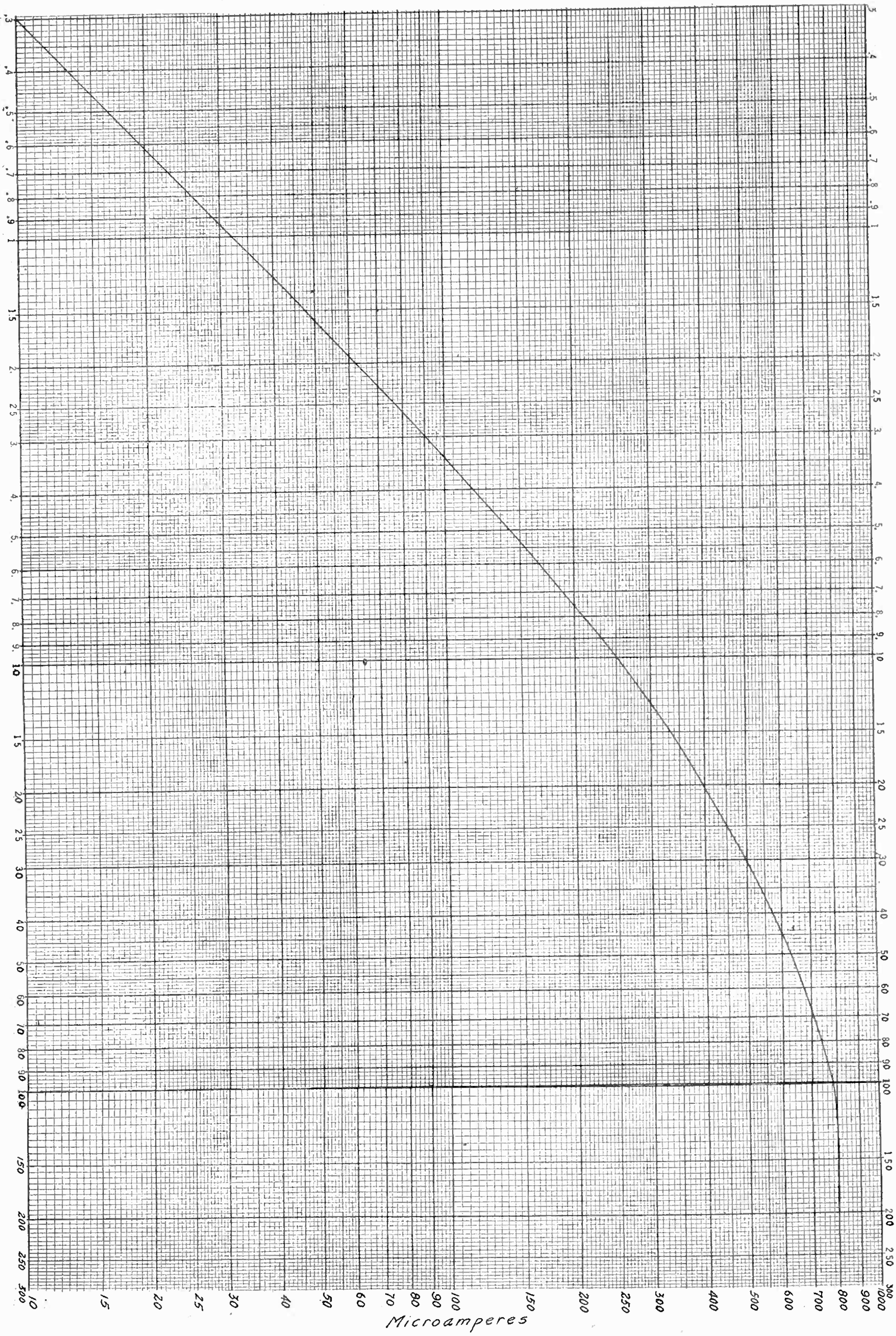


Coiled wire shunt can be seen mounted on switch (top center). A small 3 volt battery or 1.5 volt cell may be placed as shown at center. The multipliers are held on a platform attached to meter posts.



Current is read 10 to 1,000 microamperes, resistance, 0.3 to 150 ohms.

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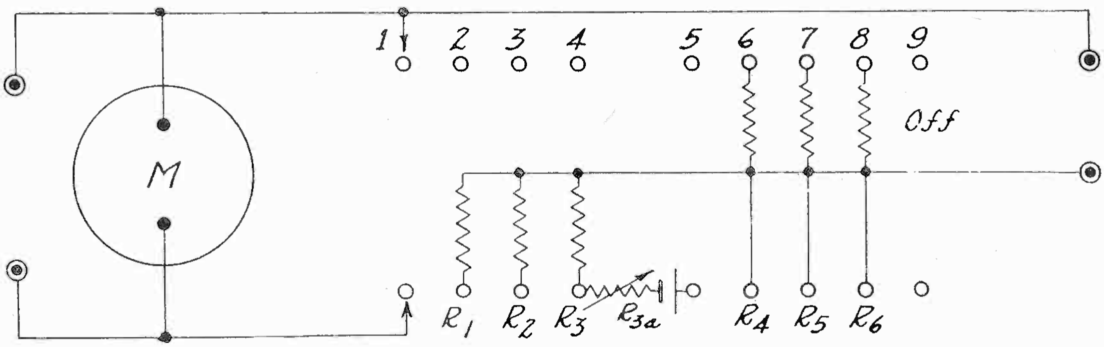

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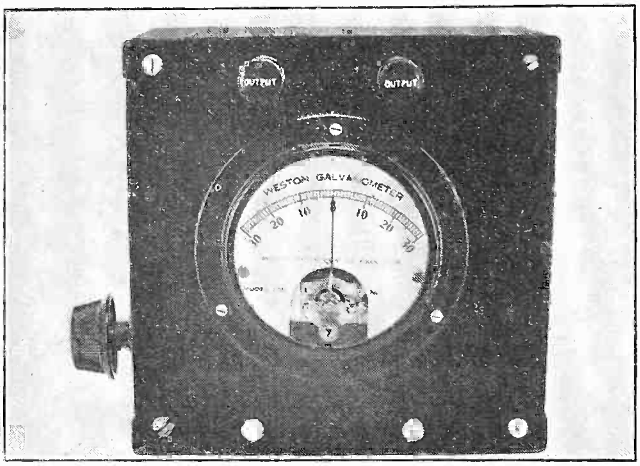

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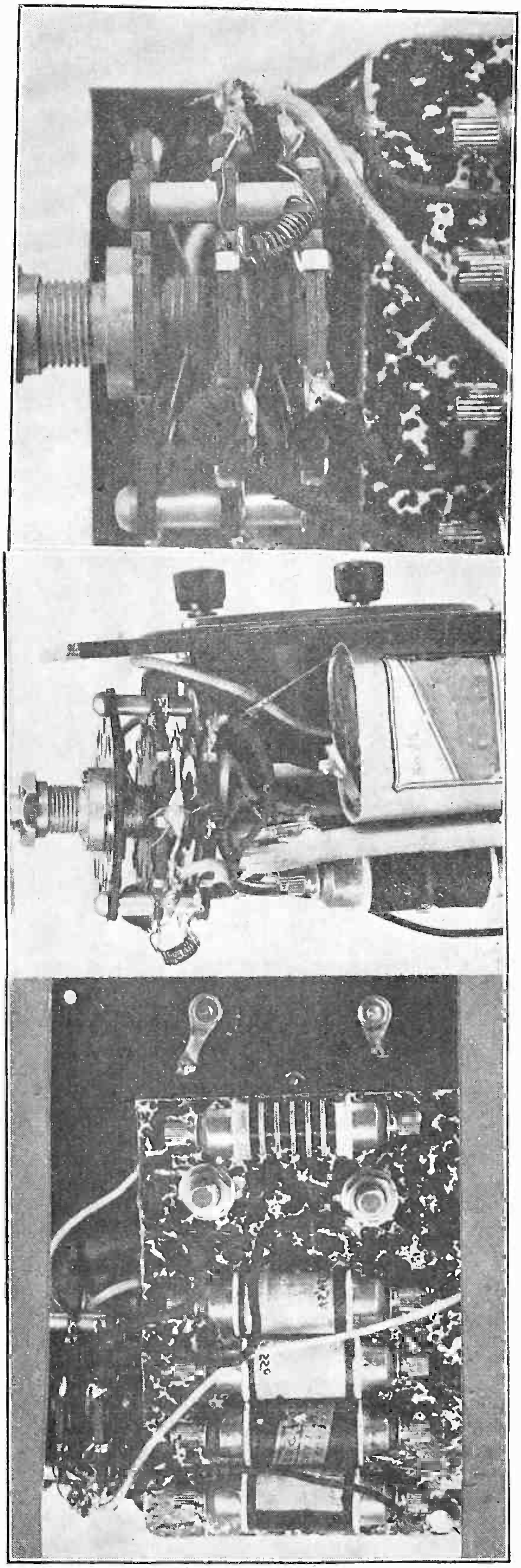

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resistors required are 10,000, 100,000 and 1,000,000 ohms. These should be wire wound, and that would mean ordinarily that factory products would have to be used. Pending the inclusion of wire wound resistors metalized and similar resistors may be used, selected as close to the required value as possible, which means that opportunity to check the resistors closely should be at hand, and one have the liberty of making a selection, as 10 per cent. tolerance is allowed in commercial practice for these grid leak types, whereas the wire wound may be obtained at 2, 1, 0.5 and 0.25 per cent. accuracy.

For measuring resistances up to 10,000 ohms, and down to 100 ohms perhaps, 1.5 volts from a dry cell, and 1,500 ohms in series, suffice. However, many want to measure higher resistances. The 10,000 ohm resistor for the 10 volt scale may be used, with a variable in series, say, of 1,000 ohms, and the battery voltage 10.5 volts. This will enable resistance readings safely to 1 meg., and values higher than that need not be differentiated in common practice. The lower limit may be several hundred ohms. From there down to 0.3 ohms the meter shunting method may be used.

However, we have to do something about a scale. Really we need two calibrations. One will show resistance values 0.3 to a few hundred ohms, the other a few hundred ohms to 2 meg. It is not known what voltage the builder will use, nor what meter, therefore simply the statement is made that the resistance in ohms is equal to a constant (the voltage) divided by the current in amperes. The answer includes the meter resistance, here negligible, and also the limiting resistor. Therefore deduct for the limiting resistor and put the resultant unknown resistance value as one factor and the current for it as the other. Reduce the results to a curve on plotting paper.

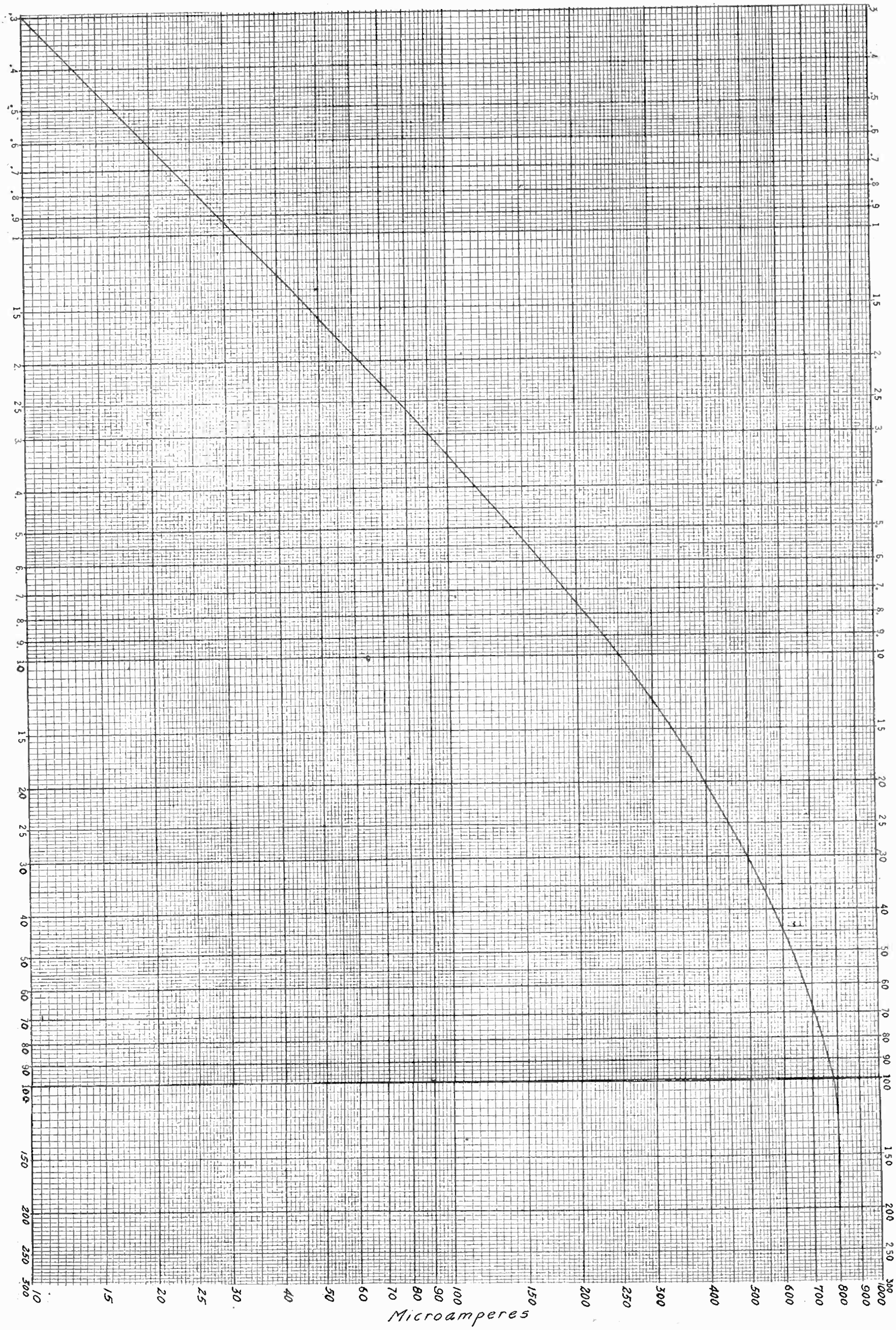
LOW RESISTANCES

The same procedure is to be followed for the low resistance calibration. The calibration may be prepared, as in the foregoing example, without any test work, as the calculations will give the true story, provided no mistakes are made.

The unknown resistance Rx by the shunting method may be considered at first as to whether it is greater than or less than the meter resistance, the equality case already being understood. If the unknown is of less resistance than the meter, more current will flow through the unknown than through the meter, so if the current read is less than half of full scale the unknown is less than the meter resistance, while if the current read is more than half scale the unknown is of higher resistance than the meter. So we could tell at a glance whether

(*Continued on page* 50)

Coiled wire shunt can be seen mounted on switch (top center). A small 3 volt battery or 1.5 volt cell may be placed as shown at center. The multipliers are held on a platform attached to meter posts.



Current is read 10 to 1,000 microamperes, resistance, 0.3 to 150 ohms.

(*Continued from page 48*)
the unknown is greater or less than the value

MENTAL ARITHMETIC

Many of the determinations may be made by mental arithmetic. It is handy to have direct reading scales but they cause us to think less of what we are doing, so we might try out our thinking processes with this shunting method for a while. Suppose we put a combination of voltage and resistance in series with the meter to establish full scale deflection, then put an unknown resistance across the meter (terminals at left in diagram), and the 0-1 milliammeter now reads 0.2 milliampere. That is less than 0.5 milliampere, so the shunt takes the difference, of 0.8 milliampere, and has lower resistance than the meter. The ratio is 4 to 1, so the unknown has a resistance value of 20 per cent. of the meter resistance. It is that because the units are 4 and 1, and of the five parts thus constituted, 4 go to the meter and 1 to the unknown, or 1/5 of the meter resistance is the unknown. As we measured the meter resistance we know that the unknown is 30/5 or 6 ohms. Notice that low resistance is being read with very small current.

SCALE PREPARED

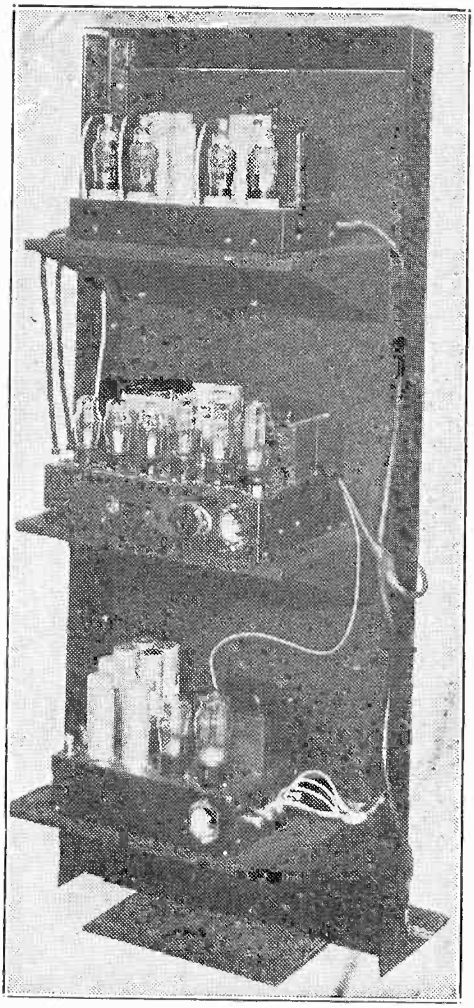
We may prepare a scale and consult that, but for the case of the 0-1 milliammeter of 30 ohms internal resistance, a standard example, the curve is standard, and may be used as found.

It has been said that measurements may be made to 0.3 ohm. Let us see what current we have to read. We know that the current will be less than 0.5 milliampere because the unknown resistance is less than the meter resistance. The meter resistance is 30 ohms, the unknown resistance is 0.3 ohm. The meter divisions re usually 50. One may estimate halfway between bars, or to 1/100 of maximum current or 10 microamperes, and then, when the meter current is 0.00001 ampere, the ratio of current readings to full scale is 1 to 100, and the unknown is 30/101, or, closely enough, of 30 ohms.

ABOVE 30 OHMS

Higher resistances than 30 ohms cause the needle to read more than half scale, so what is the highest resistance to be considered? Let us invert the previous example, now with meter reading 990 microamperes, shunt taking the difference or 10 microamperes. Now the ratio is 99 to 1, and of the 100 current parts 1 part flows through the shunt and 99 parts flow through the meter, so the shunt is 99 times the meter resistance, or 2,970 ohms. Actually this part of the scale is too crowded for service, and useful top would be a few hundred ohms, or high enough to enable the series high resistance method to overlap with the shunt low resistor method.

DANDY SETUP FOR AMPLIFIERS

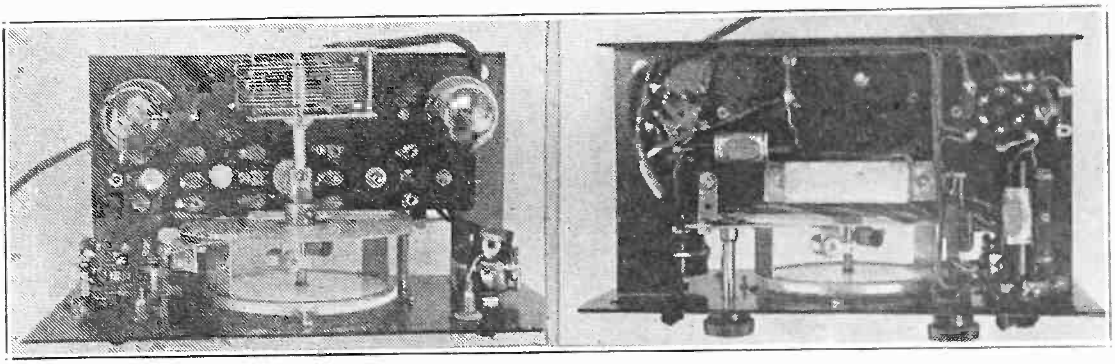


Many persons, after getting hookups to work swell, like to set up their rigs in suitable containers. The rack and panel method of construction is growing in its popularity because of its professional appearance as well as all-around suitability, except for parlor, bedroom and bath. A microphone pre-amplifier, a power amplifier and a speaker field exciter are shown (top to bottom).

Fundamentals Most Useful

In Signal Generator Practice—Construction of All Wave Model

By Herman Bernard



Top and bottom generator views.

AN irreducible minimum of parts is used in the five-band fundamental signal generator, covering 54 to 17,000 kc. The chassis is affixed to the front panel and the whole circuit is then wired and when completed may be slipped into a finished box. This is usually an iron box with a black spray or crinkle finish.

The 6C6 is used as the generator, really in quadrode service. The conventional screen is the effective plate, while the conventional plate is the pickup element for electron out-coupling. Also the attenuator (0.01 meg.) may be worked practically without changing the generation frequency.

Besides the radio frequency oscillator there is an audio frequency oscillator (neon tube), the modulation being removable from the r.f. tube by opening the switch that then cuts out the capacity across the 4.0 meg. resistor.

How the parts are arranged is shown photographically, while the wiring is presented pictorially as well as schematically. The tuning condenser is used without a trimmer and has a maximum capacity of 402 mmfd. However, any condenser, down to 350 mmfd. may be used, and still the bands could be covered, with suitable inductances. If a frequency calibrated dial is to be used it will be tracked only by a specific make and capacity of condenser of particular closing direction.

INDUCTANCE DECLINES DECIMALLY

The largest inductance is 20 millihenries and each succeeding inductance is one-tenth its predecessor. So the values are 20,000, 2,000, 200, 20 and 2 microhenries. The three largest coils are tapped at one quarter the number of turns from the ground end. The three largest coils are honeycombs, while the first short-wave coil, Band 4, is a solenoid, 60 turns of No. 29 single silk covered wire on ½ inch diameter, tapped at the 20th turn from the ground end, while the smallest coil has 14 turns of No. 22 enamel wire, same diameter form, tap at 5 turns from the ground end. The coils are mounted on an insulation strip and put atop the inside of the chassis, between the tube sockets and the rear of the front panel, so that the tuning condenser shaft passes above the broadcast coil, clearing it well.

For insulation purposes a coupling shaft and insulation bushing are used between condenser and dial, while the condenser frame is insulated from the chassis by six insulating washers at the three mounting holes. The picture diagram identifies these positions.

TYING DOWN CRITICAL END

When the wiring is completed the dial is set at maximum capacity to read lowest frequency, and then rotated to near the high frequency end, to produce a frequency that will beat with a broadcasting station of known

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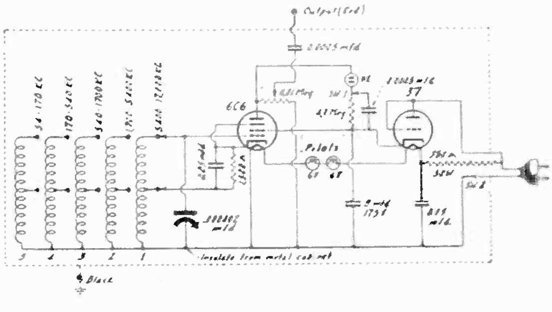
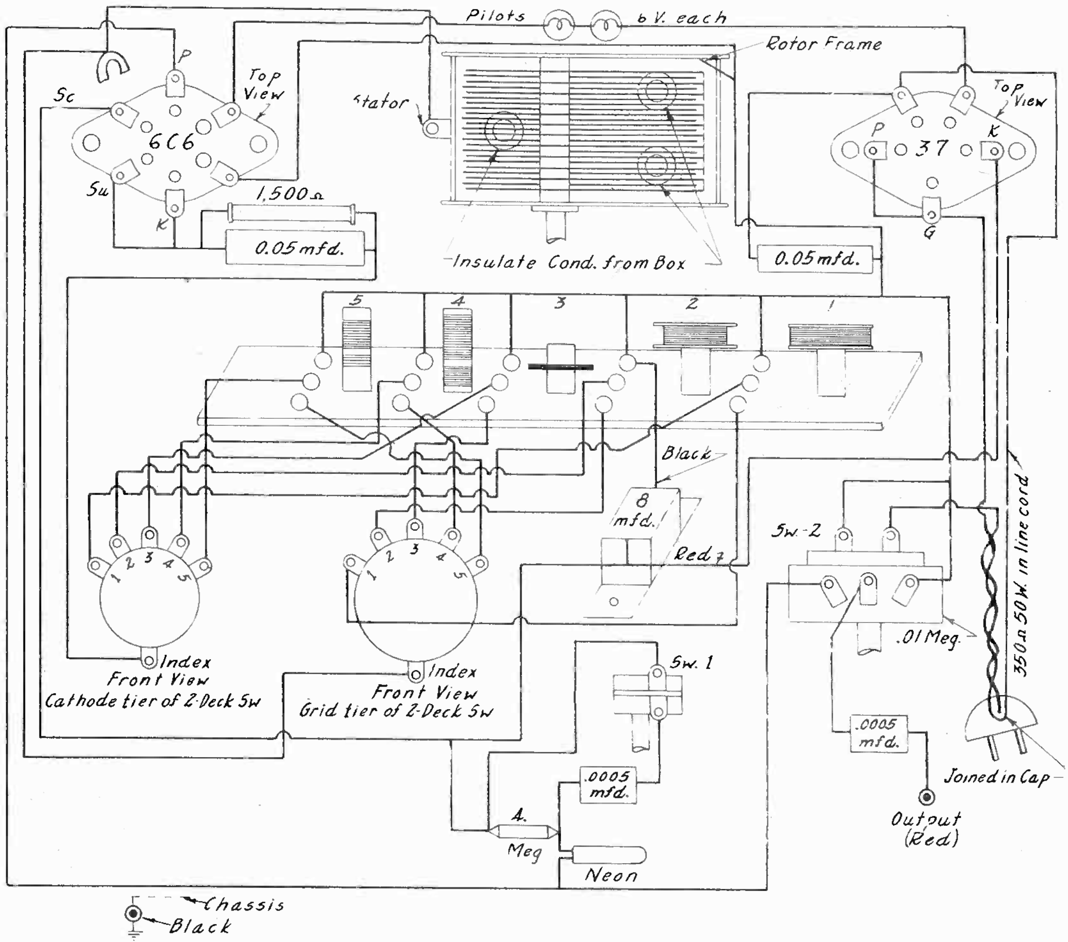


Five-band fundamental signal generator.

PICTORIAL OF SIGNAL GENERATOR



frequency. Take a low frequency local or semi-distant station, divide its frequency by 3, 4, 5 etc., until a number is produced ranging from 160 to 170. In the metropolitan New York district use WEAF, 660 kc, and turn the dial until a beat is heard near but not quite at the high frequency end of calibration, and this will

(*Continued on next page*)

LIST OF PARTS

Coils

Five tapped coils to cover 54 to 17,000 kc.

Condensers

One tuning condenser (ranges in five steps accomplishable with capacities 350 mmfd. up)
Two 0.05 mfd. tubular bypass condensers
One 8 mfd. 175 volt electrolytic condenser
Two 0.0005 mfd. mica fixed condensers

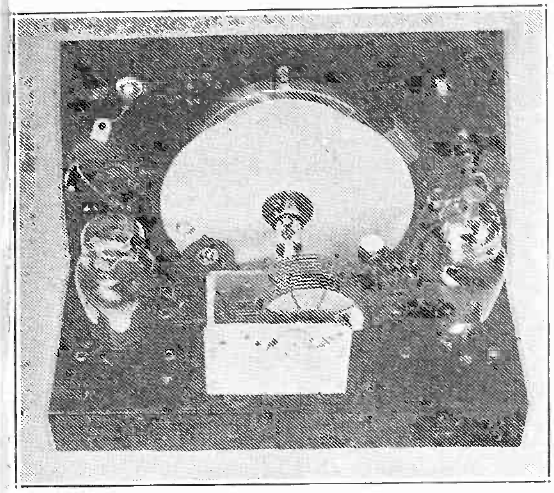
Resistors

One 1,500 ohm pigtail
One 4.0 meg. pigtail resistor
One 0.01 meg. potentiometer with a.c. switch
One line cord with 350 ohm, 50 watt resistor built in

Other Requirements

One chassis attached to front panel
One metal box fitted to front and chassis
One six hole socket and one five hole socket
Two 6 volt pilot lamps
One airplane dial with fastening bracket; escutcheon for dial; four small screws and nuts for escutcheon
One grid clip
Two pup jacks (black for conduction to box, red for insulated output)
One a.c. plug
Eight self-tapping screws for holding panel to box
Three tubes: one 6C6, one 37 and one pigtail type neon lamp without limiting resistor built in
One five position, two deck switch (two pole, five throw)

(*Continued from preceding page*)
be 165 kc, which may be written down as such, or coincided with a frequency calibrated dial by removal of a turn or so to make the pointer read a lower frequency or putting on a turn or so to make the pointer read a higher frequency. This minor inductance change will not affect the low frequency reading more than trivially.



Rear view of generator with one insulating washer under condenser visible.

The second and third coils may be treated similarly, the fourth and fifth by pushing turns closer together or farther apart.

At the capacity position where 54 came in for the low frequency band (1), the next coil should produce 170 kc. The third coil (Band 3) will produce 540, or ten times the previous frequency for the same position on this scale, and the fourth coil ten times the next scale (1,700). The last or fifth coil causes the frequencies to be 5,400 to 17,000 kc. Therefore a decimal repeating scale may be used, two calibrations, one read, then the next, the first multiplied by ten, the second multiplied by ten, and the first multiplied by 100, all for direct reading.

Old Friend Changes

From The American News Trade Journal

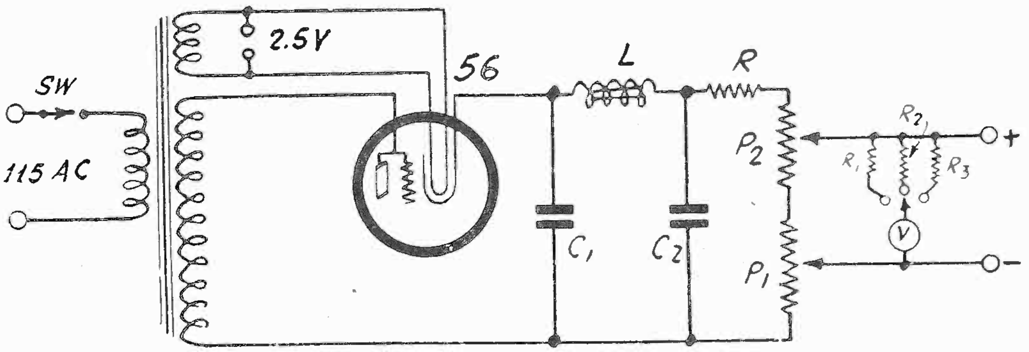
RADIO WORLD, edited by Mr. Roland B. Hennessy, who has often contributed verses to this Journal, will become a monthly magazine, changing from a weekly.

It is one of the oldest radio magazines in the country and has always given full measure of value to its readers. Probably every owner of a radio set, who has wanted to know more about his radio, has bought it and liked it.

The magazine will change also to a more engaging format. It will, as before, be well illustrated, and will have colored covers rather than the self cover style of the past few years.

Mr. Hennessy has always been a great friend to the dealers, and it is hoped that they will like and push RADIO WORLD in its new make-up and style. It will retail for 25 cents; the trade price is 19 cents, and it's fully returnable.

Ohmmeter Voltage from Rectifier



If batteries prove annoying in resistance measurements, use a simple rectifier. The voltmeter will read the voltage, which will not change when the sensitive milliammeter is used for resistance measurements at plus and minus at right, with proper limiting resistors. The same meter used for resistance measurements may be the voltmeter V. Extremely high resistance may be read, due to the high voltage 50 meg., easily.

A Filter for High Fidelity

Control Atones for Conditions Created by Ear

By Sidney Wald, E.E.

THE keynote of receivers is quality of reproduction, although "round-the-world" reception is important.

One has only to hear a high fidelity receiver to be struck by remarkable realism.

We will assume that a receiver is already built, either a tuned radio frequency or superheterodyne. It is desired to construct a high quality audio system.

To take advantage of the low level tone compensating circuit about to be described it is advisable that there be three stages of comparatively low gain audio: one single and two push-pull circuits. The object of the first push-pull stage is to minimize hum which in a multistage audio amplifier may become a very disturbing factor even with excellent filtering. If the set is a superheterodyne it will be necessary to see that the intermediate stages have at least a 10 kilocycle band pass in order that the higher audio frequencies are not attenuated excessively. If we are dealing with a tuned radio frequency receiver there is little danger of losing quality at the r.f. level unless there is undue regeneration in which case it will be necessary to redesign the tuner so that there is negligible feed back between stages.

When the Tone Disappears

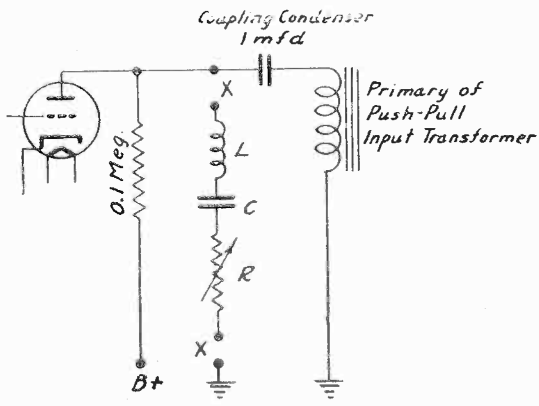
The detector should be linear and may be combined with a triode in one tube (as the 55). We may have resistance coupling to a 27, transformer coupling to push-pull 27's and transformer coupling to push-pull 2A3's or 50's.

It is essential that the speaker be well constructed and have sufficient baffle area, at least three feet square and preferably inclined upward at a small angle so that the very high frequencies, radiated in straight lines, reach the ear.

Up to this point much has been left to the individual serviceman. By now he should have a receiver that leaves nothing to be desired in the way of quality of reproduction at relatvely high volume levels. However, it will invariably be found that when the volume is reduced to a degree tolerable in the average living room, the set sounds very mediocre. The heavy bass tones are conspicuously absent as are also the brilliant highs.

Where to Connect Control

It will do no good to tear the set apart and try another circuit. At high average volume levels the ear has a flat response from about 30 to well over 6,000 cycles. On the other hand, at low volume levels, the ear is insensitive to frequencies below about 200 and above 1,000 cycles. The band between 200 and 1,000 cycles evokes good ear response at all levels.



L, C and R are connected between X and X for compensating filter.

So a flat amplification frequency characteristic is not desirable in apparatus to be used to reproduce a wide audio range at variable output levels adjustable from very loud to very soft.

The existing frequency response of the receiver requires compensation to create apparent loudness over the audio register at weak room volume.

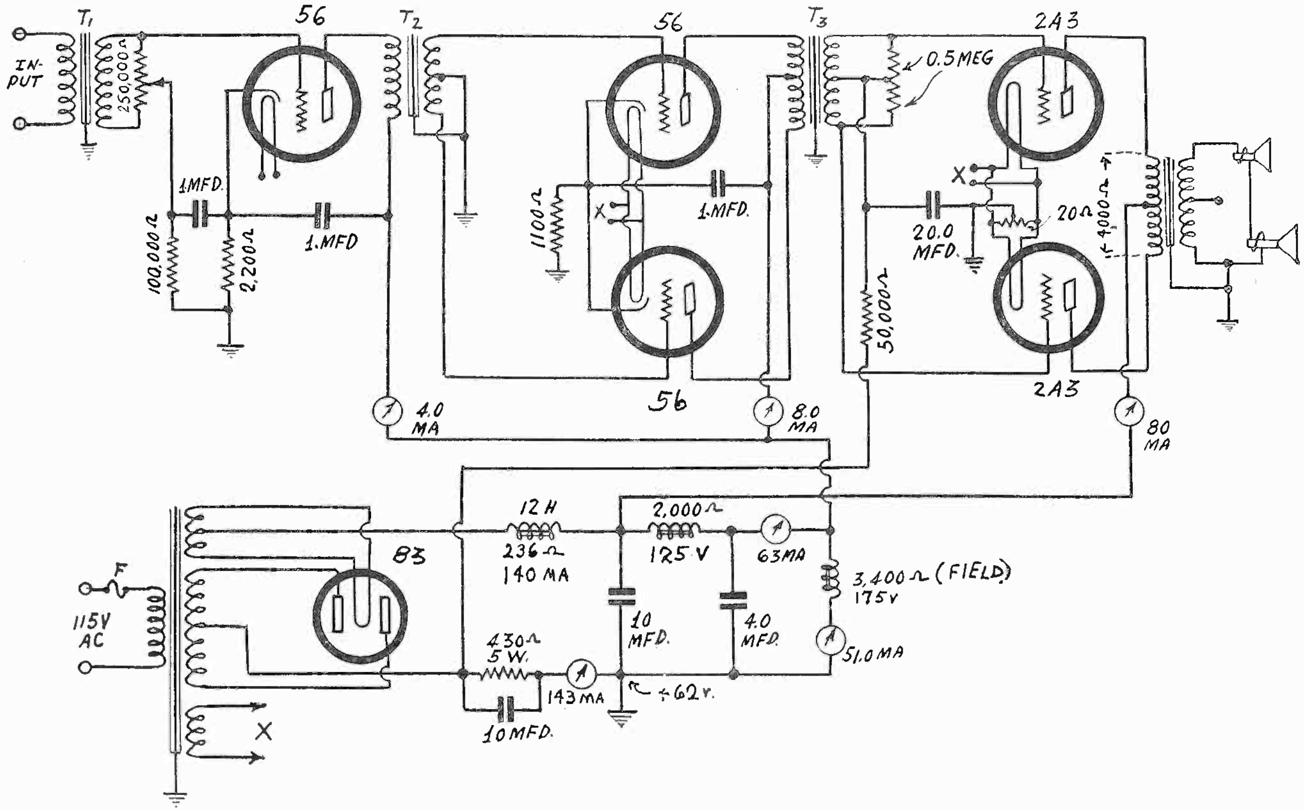
In other words it is necessary to vary the amplifier characteristic for each volume control setting. This may be accomplished simultaneously with variation of the volume control by the use of a special tapped potentiometer or preferably by having a separate control.

Across points XX in Fig. 1, which represents the plate circuit of our first audio tube, we connect an industor, a condenser and a variable resistor in series. By using the proper values of L, C and R, and adjusting R for each volume level, remarkable fidelity may be obtained.

If we connect an inductor, a condenser and a resistor in series then at given frequency maximum current will flow for a given applied voltage, and the impedance of the circuit will be independent of the inductance and capacity and will be equal to the value of the resistance.

Now, although any values of L and C may be used to obtained the same resonant frequency, that is, L may be small and C large or vice versa, the impedance offered by the circuit off resonance is dependent on the relation between L and C. Suitable values are L = 0.2 henry and C = 0.25 mfd.

Audio Channel for High Fidelity



The amplifier diagramed has three stages of audio, of which only the first is single, the next two each push-pull. Thus 56's in push-pull drive 2A3's in push-pull. Semi fixed bias is used, as plate current of other tubes than the power tubes affects the bias, in fact all the B current in the set, included bleeder, does affect the output bias. Of the two speakers one may be boomer and other tweeter. The speaker would have to be well baffled for low note fidelity. The simple potentiometer level control is a makeshift. A high impedance pad would be far better.

New Approach to Measuring Multi Megohms

A method of measuring resistance values up to hundreds of megohms, indeed one that is more sensitive in these high resistance regions than at lower resistance values, is due to Edward M. Shiepe, of 135 Liberty Street, New York City. It consists simply of a vaccum tube with low B voltage, grid open, until closed by the unknown.

It is found that when the filament switch is closed the grid voltage gradually builds up in the negative direction, until practically plate current cutoff exists. Then when an unknown resistor is placed across the open terminals, grid to cathode (negative filament), the current rises, and the new current is utilized as an index of the unknown resistance. The curve is plotted originally against standard resistors, or long series of resistors the values of which were determined otherwise, and cutting in from the series chain permits the original calibration.

OPEN GRID IS CLOSED

While the statement has been made that the grid is open at first, that is hardly the truth, as the device used is a vacuum tube, which has a glass envelope, the leads emerging from the press at bottom, so the resistance of the glass is between the grid and other elements. This may be an enormous resistance, probably around 500 megohms, nevertheless the grid is not open, in the light of the present purpose of the vacuum tube application.

Besides the glass there is the base of the tube, likely to be a phenolic compound, and this has a lower resistance paralleling the glass resistance, and as a socket, also with lower resistance, is used, the total result is that these parallel resistors keep reducing and reducing the resistance, until instead of having perfect insulation, or anything like it, we have imperfect insulation, or an order of conductance that is described as leakage. Hence not only may one decide whether the tube circuit has high or low leakage, but the actual resistance or its reciprocal, leakage.

WORK UNFINISHED

The actual industrial application of this method to the measurement of high resistances is not completed yet, as there are some problems to be solved. If it is assumed that much of the leakage is due to the socket and the tube base, the leakage to cathode may be finally by way of plate to battery to negative filament, possibly because the voltage at the plate is higher than elsewhere, hence the electrons are attracted in this direction by indirection through the socket as well as by direction through the space stream. Hence some experiments are being conducted, including the piercing of the socket and base near the plate and negative filament points, for the insertion of contacts for a bucking battery, so that the stress and strain on the dielectric due to d.c. potentials will be cancelled, and only the dynamic function, otherwise uncontrollable, is intact.

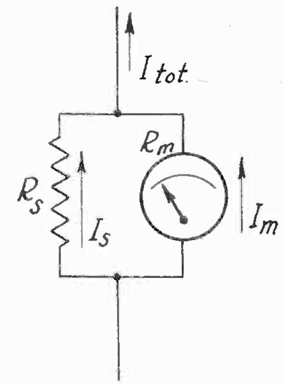
The meter used was of the 0-5 milliampere type, when the plate battery was 22.5 volts. However, if the dual battery system is to be used, a more sensitive meter would be advisable, on account of the necessity of two batteries of equal voltage, and these might be 7.5 volt C battery type sources.

REPETITION DESIRED

Due to parasitic conditions, including perhaps the condition of equal and changing stresses and strains on the dielectric, the system as yet does not fully repeat itself at all times, although conditions for good repetition may be artifically produced. Meanwhile the method is told for its value as a constructional experimental rig that will interest many, but without the assurances that they will obtain constancy from it, until and unless they solve the problems associated with uncertainty of repeated results.

How to Tell Unknown Using Any D.C. Meter

The idea of shunting a meter is illustrated. There is a certain current flowing. Call this I_{tot}. In the parallel circuit this current is divided, part of it flowing through the meter, part of it through the resistor that is put in parallel with the meter. This parallel unit is called the shunt and for the present purpose it is the unknown resistance, R_s. The current through it is I_s. The meter resistance is represented by R_m. The current through the meter is I_m.



If the meter resistance, the meter sensitivity, and the current through the meter are known, the value of the unknown shunt across the meter may be computed. It is equal to the product of the meter resistance and the meter current, divided by the difference between full scale meter deflection and the current actually flowing through the meter. See article, page 48.

AUDIBLE RADIO FREQUENCIES

Radio frequencies are heard by some animals as audible sounds. Try waking canaries with 30,000 to 50,000 kc from an oscillator.

RADIO CONSTRUCTION UNIVERSITY

Answers to Questions by Readers on the Building of Radio and Allied Devices. Readers Should Address Questions to Radio Construction University, Radio World, 145 West 45th Street, New York, N. Y.

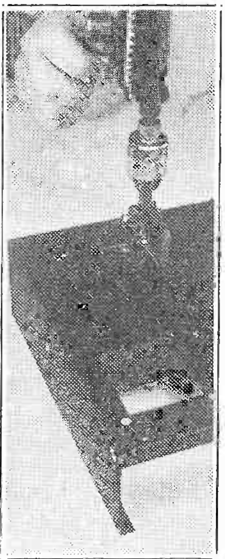
NEON TESTER

WHAT ARE the possibilities of a neon condenser tester? How does it work?—L. E.

When used as a paper condenser checker it will test condensers from .001 to 2 mfd. for opens and loose pigtail connections, as a continuity tester or condenser checker the lamp is connected in series with one side of line. The lamp used may be any neon lamp having a rating of from ¼ watt up. It also should have a candelabra base with the correct resistance inside glass envelope for 115 volts. Two binding posts are used for the 110-120 volt line and two others for the test prods. It can be used also as a makeshift output meter by connecting a condenser of about .1 capacity in series with one side of neon lamp, other side of condenser to plate of output tube and other side of neon lamp to chassis. The lamp will light brightest when best peak is had either when trimming i. f. or lining up variable condensers. For a. c. sets use a resistor of about 10,000 to 15,000 ohms. When checking paper condensers if lamp lights, condenser is O. K., if lamp flickers, condenser is either leaky or the pigtails are making bad contact. The tester may be mounted on a small piece of bakelite with small bushings in each corner and all wiring done on bottom of panel.

INDIVIDUALIZING CHASSIS

WILL YOU PLEASE give a few hints as to the adaptation of a chassis to a particular receiver. As you know already, punched chassis may be bought, but it is difficult for me to put in new holes, not possessing machine shop.—K. W. C.



One of the simplest ways of providing original socket holes, and openings for r.f. and intermediate coils, is to use a punch. This may have a diameter of 1¼ to 1½ inches. Such punches are not readily procurable in hardware stores, but can be obtained by them for you on special order. Another handy tool is a circle cutter strong enough to handle the metal of which chassis are made. One of this type has been put on the market recently. The small holes should be drilled with a sharp drill, after the location has been indented with a center punch. It is well to avoid drilling all the way through, so that one may drill in reverse from the other side, to avoid the jagged effect of puncturing the flat metal. If any burrs are present after drilling or punching, remove them with file or countersink.

* * *

PREFERS TRIODE

WHY IS THERE not a heater type triode of modest power proportions, at least? There is none, and we have to use pentodes if we want heater type tubes, while the triodes afford better quality, don't they?—I. K. C.

The triodes in general do afford better quality,

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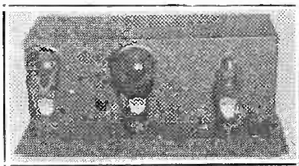
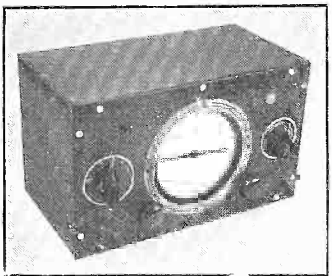


(*Continued from preceding page*)
and filament type tubes are available, or pentodes converted to triode use by interconnections. That there is no heater type is not serious. However, the new metal shell series of tubes includes one of the kind you mention, a heater triode.

» » » INTRODUCING « « «

NEW RACO PRODUCTS PRODUCTS

ALL WAVE SIGNAL GENERATOR



MODEL 339

THE new 339 Signal Generator operates on fundamentals from 54 to 17,000 kc, 5500 to 18 meters, on a.c. or d.c., with modulation option in either use, and sells at approximately half the price of equivalent instruments. Bands are shifted by a front panel rotary switch.

One of the outstanding features of the 339 is the vernier airplane dial. This has direct-reading scale both in frequencies and wavelengths and is of the decimal-repeating type, a new invention of Raco. Thus the top scale, in frequencies, is 54 to 170 kc. The lower scale in frequencies is 170 to 540 kc. The other bands are read as 10 or 100 times these frequencies.

As wavelengths are calibrated on the dial, too, division by the same factors, applied to the wavelength scales that adjoin the frequency scales, gives the answer in wavelengths. Raco signal generators are the only ones that yield determinations both in frequencies and wavelengths.

The dial is 3.5 inches in diameter and has a double pointer enabling close readings. The decimal repeating dial itself enables close readings because the circumference of scales is not diminished for succeeding bands. The 54 to 170 kc. scale has graduation in spaces of only 1 kc. Thus for the broadcast band, 540 to 1700 kc, 10 kc. separation prevails. The 170 to 540 kc. scale has graduations in 1 kc. from 170 to 200 kc. and bars separated by 5 kc. for 200 to 540 kc.

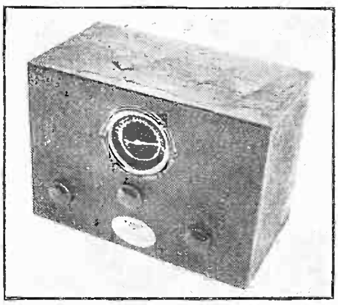
Coincidence of generated frequency and scale reading is very close. Never is the accuracy less than 1 per cent., and for most settings there is no observable difference between the true frequency and the read frequency. This high order of accuracy obtains in no other instrument, selling at less than three times the cost of the 339.

Many, no doubt, have been somewhat confused by the numerous types of signal generators, but will note that the best of them cover wide ranges on fundamentals, have an attenuator, and permit of presence or absence of modulation. Also they have a vernier dial and are direct-reading in frequencies, accurate to at least 3 per cent. The 339 has all these advantages, besides affording wavelength determinations as well, and operation on 90-125 volts a.c. (any commercial frequency) or d.c. And the accuracy is three times as great. Moreover, the 339 is well built, for lifetime use, and covers all waves fundamentally, besides permitting measurements of frequencies up to 100 mgc (down to 3 meters) by resort to a slight calculation method, applying a simplified harmonic system to the 5,400 to 17,000 kc fundamental band.

The 339 has a 37 rectifier tube, so that d.c. is used on the plate. Modulation is provided by a neon tube relaxation oscillator at a frequency of about 1,000 cycles.

Model 339, wired, calibrated, adjusted, complete with three tubes, ready to operate; instructions (shipping weight, 5 lbs.) **$16.00**

ALL WAVE 1 TUBE A.C. & D.C. 15-2000 METERS



ABSOLUTELY NEW

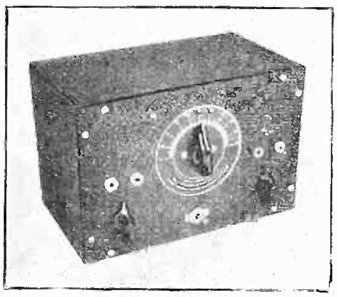
Raco Multi (7) Band 1 tube A.C. - D.C. Receiver 12-2000 meter

Long - awaited thrills which cannot be had with similar S.W. receivers are now made possible for fans. This receiver will not fit in the palm of your hand, but is guaranteed to bring in foreign reception. The only **All-Wave Receiver** at such a low price, guaranteed by the **Raco trade-mark.** Uses the new multi-purpose 12A7 tube. A custom-built job, this set features a friction type drive airplane dial, generally found only in more expensive receivers.

Dimensions: 5" x 6½" x 9".

- Complete kit (12-200 meters) $3.95
- Shield cab. 1.00
- No. 5 coil, 200-550 meters .... .39
- No. 6 coil, 550-1150 meters .... .59
- No. 7 coil, 1100-2100 meters .... .69
- R.C.A. license 12A7 tube 1.00
- Wired and tested 1.00
- Simple wiring diagrams and complete instructions included in every kit.

1 TUBE TRANSCEIVER



AT LAST ! ! !

An inexpensive 1 tube 5 and 10 meter Transceiver.

This extremely efficient transceiver is recommended for the short wave enthusiast who is interested in exploring the fascinating 5 and 10 meter bands.

The circuit utilizes the type 19 two-volt twin tube, and is exceedingly sensitive since the super-regenerative principle is employed when the receiving position is switched on. A double pole single throw switch is the means by which the instrument may be switched to either receiving or transmitting. Dimensions: 5" x 6" x 9".

- Complete Kit with 5 meter Coils $4.75
- Shielded Cabinet .... .75
- 10-Meter Coils .... .50
- R.C.A. Licensed tube .... .65
- Wired and tested 1.00
- Wiring diagram and complete instructions included in every kit.

FEATURES

- Will operate on 5 or 10 meters by simply changing plug-in coils ● Utilizes the multi-purpose 19 tube.
- Highest Quality Parts. ● Weight only 4 lbs.

TO RADIO EXPERIMENTERS:

We can supply any coils specified in leading radio publications.

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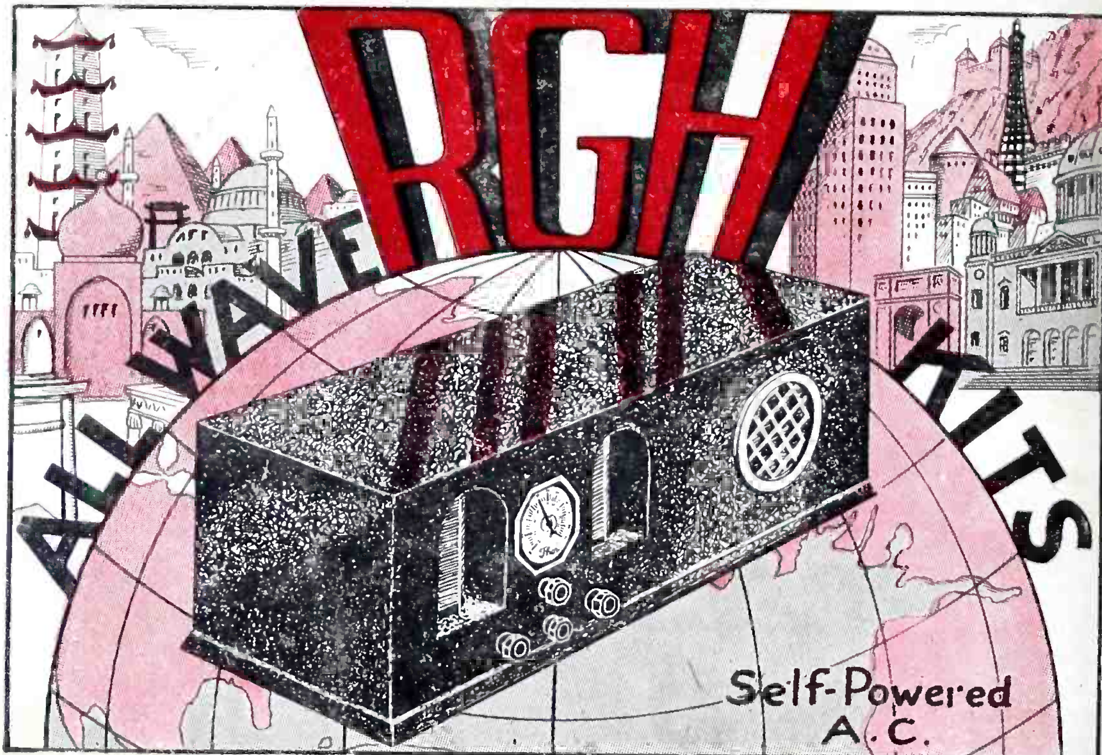


Robert G. Herzog's most popular all wave sets now available in kit form. All kits are shipped ready mounted on the famous RGH black crackle chassis with the easily accessible front panel niches for the plug-in coils. **THEY ARE CAPABLE OF COVERING THE COMPLETE AMATEUR, EXPERIMENTAL AIRPLANE, POLICE AND FOREIGN BANDS AND GIVE LOUD SPEAKER VOLUME. ENTIRE BAND FROM 11 TO 600 METERS.**

Large size construction diagrams free with each kit.

RGH 5

Uses 2-58, 2-2A5, 1-80

A five-tube regenerative circuit employing a **tuned** r.f. stage and high gain power pentode amplifiers.

COMPLETE KIT—
Stock No. 9012 .... **$12.95**
(Including 8 S.W. coils.)

4 Broadcast coils, Stock No. 7016.... **$1.80**
6" Dynamic Speaker, Stock No. 613.. **$2.50**

Super RGH

Uses 1-2A7, 1-58, 1-57, 1-2A5

A five-tube **band spread** superheterodyne circuit of exceptional merit. Tremendous volume on even weakest distance.

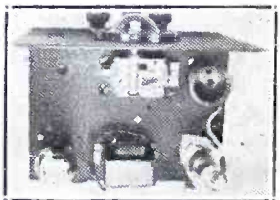
COMPLETE KIT—
Stock No. 9016 .... **$14.95**
(Including 8 S.W. coils.)

4 Broadcast coils, Stock No. 7015.... **$1.58**
6" Dynamic Speaker, Stock No. 614.. **$2.50**

A handsomely decorated all metal 9 x 9 x 19 black crackle cabinet, Stock No. 8536, as pictured above, to house any of the RGH Gothic series, can be purchased for only..................... **$2.89** Extra

FOR THE NOVICE

The Jr. 2 comprises a real AC-DC self-powered radio with standard full size coils and tuning units. A 12/1 vernier dial is also included in the kit for building this circuit, which uses 6F7 and 37.



RGH, JR., 2

The 6F7 is the combination regenerative detector audio amplifier stage and a 37 rectifier.

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(Including 4 S.W. coils)
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