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RADIO WORLD

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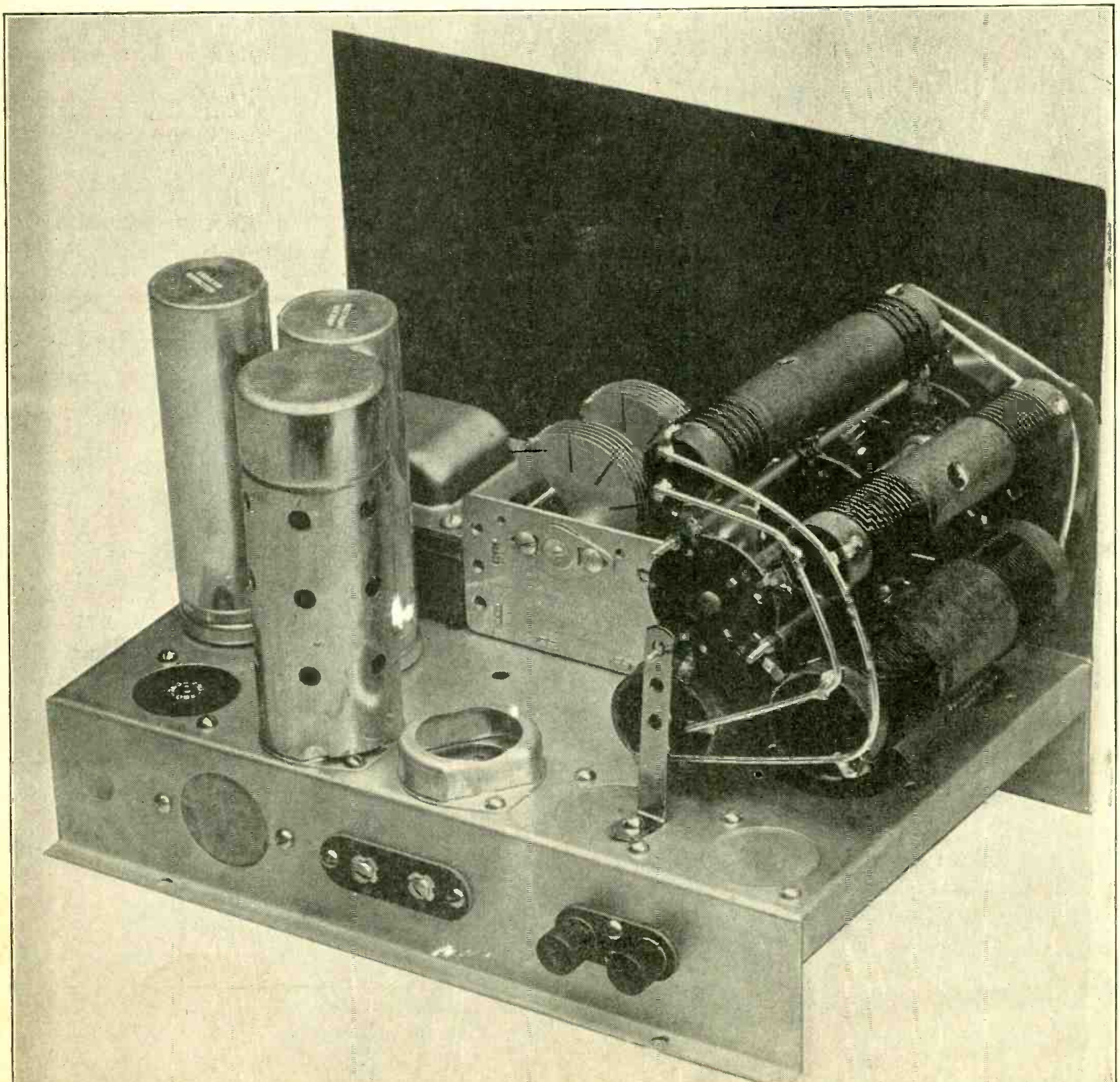
The First and Only National Radio Weekly
Eleventh Year *572d Consecutive Issue*

FIXED FREQUENCY I-F OSCILLATOR

NEW 9-TUBE A-C PUSH-PULL DIAMOND

TWO-TUBE BATTERY SHORT-WAVE SET

Coupling Coefficient Measurement



A three-tube short-wave converter, using a coil switch assembly, that works very well. See pages 12 and 13.

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Construction of the Push-Pull SUPER DIAMOND "9"

15 Watts Output, Using New 2A3's

By Herman Bernard

I
THEORY OF CIRCUIT

THE nine-tube Push-Pull Super Diamond consists of a tuned radio frequency amplifier, a combination oscillator and modulator called an autodyne; two stages of intermediate frequency amplification at 175 kc, a full-wave linear rectifier and three stages of audio frequency amplification, of which the first is direct-coupled to the triode unit of the 55, the second is resistance-coupled to the 56, and the third, or push-pull output, is fed by an audio transformer. The power output is 15 watts, as the new 2A3 tubes are used in a manner that is something like a cross between Class A and high negative bias Class B.

The radio frequency carrier is received by the antenna winding of the first coil, and the secondary, coupled inductively to the primary, is tuned to the carrier frequency. The radio frequency amplifying tube is biased a little higher than usual, around 5 volts or so, because of the increased selectivity resulting. The only object of the t-r-f stage is to increase the selectivity ahead of the mixer, although of course there is some amplification also, and might be more, if the biasing resistor were lowered.

Short-Wave Tap

There is a tap on the secondary, so that the tuning condenser stator may be switched to the tap, to tune in frequencies from about 70 to 200 meters, which includes police calls.

The plate circuit of the first tube is filtered through a bypassed resistor as a precaution against feedback, and this same method has been followed in succeeding plate circuits.

The next tube, which like the first is a 58, is the autodyne tube, into the control grid of which the carrier frequency is put, while being again subjected to tuning. The same tap method is followed here as in the first stage.

The bias on the autodyne tube is higher than that on the r-f amplifier, and may run around 9 volts. The biasing resistor is 2,700 ohms, which assumes about 3.3 ma plate plate-screen current.

The location of the biasing resistor in a "lifted" position, between the cathode and the pickup coil, is preferable from the viewpoint of assuring oscillation in the oscillator circuit at all points on the dial. In some instances if the resistor is shifted with its condenser to between pickup coil return and ground, oscillation will stop at around 600 kc, and the dial would have to be turned back to some much higher frequency before oscillation would be renewed for these higher frequencies, but would be always absent at the low ones. Whenever oscillation does stop due to the directly grounded position of this resistor it does so with a plop, and no signals are heard at lower frequencies. However, by the method outlined there will be no such trouble.

Feedback Slightly Modified

The bypass condenser across the biasing resistor is now made 0.001 mfd., instead of 0.002 mfd., which decreases somewhat the common coupling of oscillator and carrier frequencies in the resistor and also tends to make the oscillator become quieter in operation because of modification of feedback.

Oscillation is provided by taking some of the output of the tube and putting it into a tuned secondary, which is inductively coupled to the cathode circuit by the aforementioned pickup coil. The tuning condenser or trimmer that would be across the total primary of the first intermediate transformer instead is from plate to a center tap on the secondary of the oscillation transformer, so that the condenser current has to pass through part of the oscillation transformer's tuned winding. As this current sets up a magnetic field, there is plate circuit current throughout the entire tuned secondary of the oscillation transformer, and it is a.c. The direct current goes from the B plus line through the filter (10,000 ohms and 0.1 mfd.), through the primary of the 175 kc transformer, to plate and to cathode inside the tube and finally to ground through the pickup winding. The stated direction of direct current flow is the theoretical one, consistent with early expositions, but is not the actual direction, as the electron theory proves sufficiently that the true drift is in the opposite direction.

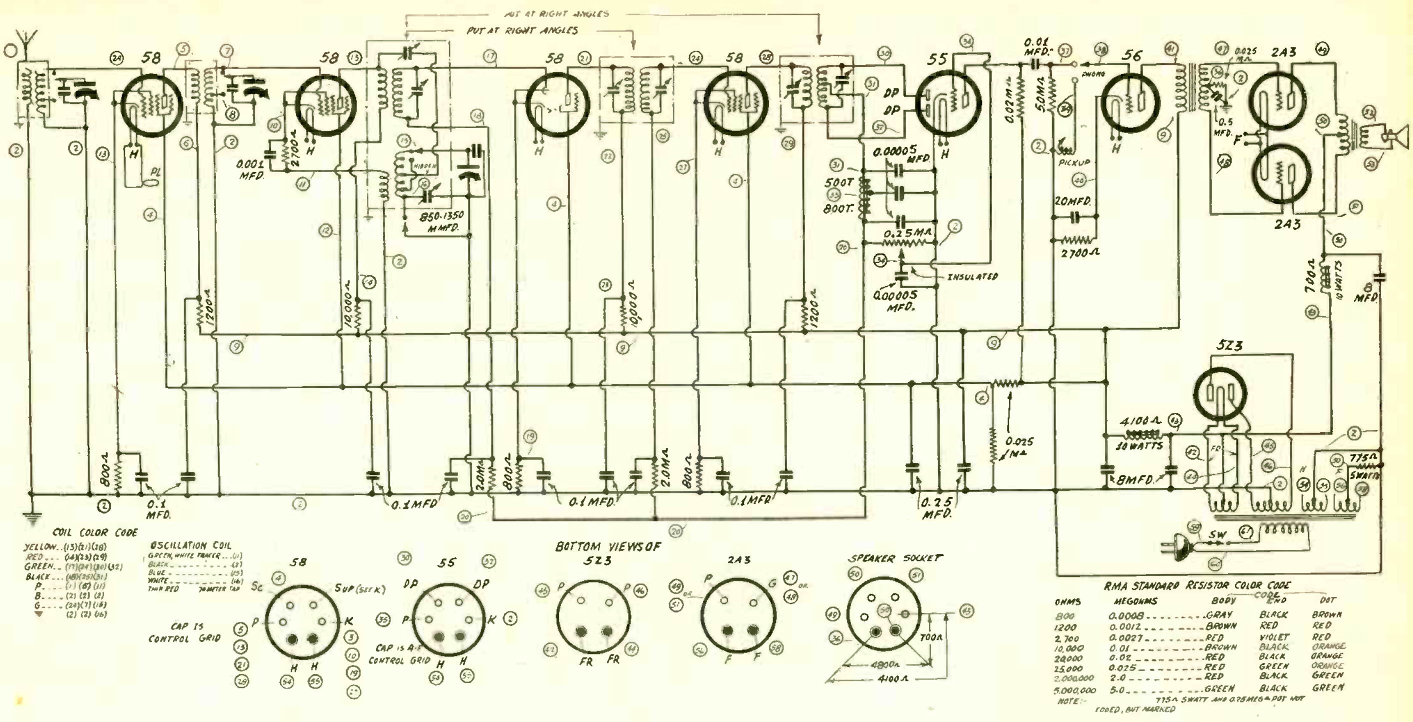
The Feedback Circuit

There would be no oscillation unless the output were coupled to the input. In the cathode leg there are both input and output current, so to speak, for the grid circuit is between cathode and control grid, and the plate circuit is between cathode and plate, so any cathode load carries common current. When the cathode current is put through the pickup winding, if the phase is right (and in commercial coils it is infallibly right) oscillation will result, because grid and plate are coupled in the right sense, but we desire the tuning to be at a frequency higher than the signal or carrier frequency, and therefore the oscillation winding has a lower inductance and also the condenser has a lower capacity. This lower capacity is the result of the introduction of a series capacity known as the padding condenser (850-1,350 mmfd.)

Thus a three-gang condenser is used and it has three equal sections originally, but the rear section is padded, so that for any given dial setting at low radio frequencies the oscillator therefore will be tuning to a frequency 175 kc higher than the carrier frequency. For the higher frequencies the trimming condensers provide compensation. Therefore, since we have two frequencies differing by 175 kc, and an intermediate amplifier of 175 kc, we have an output from the autodyne tube equal to the difference between the carrier and oscillation frequencies, and this difference is the resonant frequency of the i-f channel.

The plate tuning condenser is not very effective in some instances, from plate to tap, except that at high capacity settings of this trimmer, setscrew all or nearly all the way down, volume will decline. However, it does have some effect, and if a test oscillator produces too strong a note

(Continued on next page)



The codes for the coil connections and the resistors are given on the wiring diagram of the Push-Pull Super Diamond, as are details of socket connections, including the speaker socket. The 4,100 and 700-ohm choke windings may be field coils of dynamic speakers; however, there is latitude as to the devices to be used to drop the voltage, and also the drop to B plus for preliminary amplifiers may be anywhere from 100 to 175 volts, which leaves an opening for the use of chokes and resistors you may have.

(*Continued from preceding page*)
to make adjustment of this condenser to maximum response a simple matter, the condenser may be left at some medium position and later on when a weak, distant signal is tuned in, this condenser may be then adjusted for greatest response, using an insulated screwdriver.

Switching to Tap

The padding condenser is grounded, which virtually gets rid of body capacity effects in adjusting and makes it easier to get the padding right. But because the padding condenser is grounded the stator of the oscillator condenser can not be switched to some tap, and the adjustment left thus, because the padding condenser has to come out. Any padding is for some band of frequencies and not applicable to some other band. The padding here is for 1,500 to 530 kc. But on tap service we start, say, with 1,500 kc and wind up somewhere around 4,000 kc, and the oscillator's frequencies would have to be 1,675 and 4,175 kc for the extremes. The difference is small enough at 1,500 kc signal, the oscillation frequency being approximately 84 per cent. of the other, whereas at the high frequency end the oscillation frequency is approximately 95.6 of the signal frequency.

It is not practical to use dual padding—that is, inductance and capacity adjustment—under such circumstances of closeness to equality, and all that need be done is to compensate inductively for short waves, by having the oscillation inductance between tap and ground a little less than the r-f inductance between tap and ground of the secondaries that are tuned to the carrier frequencies.

A. V. C. on Both I-F Tubes

The tap is included only for experimental purposes, and to appease the desires of those who like to get at least some short waves on a receiver primarily intended for bringing in stations in the broadcast band.

The primaries and secondaries of the intermediate frequency transformers are tuned and the coupling is loose. The secondaries of the first and second i-f transformers are returned to the full-wave diode detector circuit, to pick up the most negative rectified direct voltage. The pickup circuits are filtered with bypassed resistors. Thus to the steady bias voltage due to the 800-ohm resistors is added the rectified voltage, and the bias increases as the signal increases. So far as the diode is concerned the action is linear, but the result is not. That is, the controlled tubes are amplifiers, and what happens to them in turn affects the diode's rectified voltage, hence not all values of antenna input voltage will develop the same detector output voltage. This is due to the non-linearity of the two controlled tubes.

However, for audio frequency purposes the detector is linear, and moreover it is full-wave, which supports quality.

Adequate filtration is advisable to keep radio frequencies out of the amplifier unit of the 55, hence a high inductance choke (20 millihenries) is used, and it has a tap. Fixed condensers of 0.00005 mfd. (50 mmfd.) are placed from the three choke terminals to ground.

For the present purpose the extreme lugs of the tapped choke are entirely reversible, so simply put the choke in the negative line of the second detector and the condensers from three choke terminals to ground.

The second detector suppresses the "second carrier" or intermediate frequency but retains the modulation, i.e., produces an audio-frequency output.

Noise Suppression

The voltage developed across the detector load resistor (0.25 meg.) is put into the control grid of the amplifier unit of the 55 by direct coupling, and the volume control consists of taking off as much as desired of this voltage by sliding the arm across the resistor that carries the total rectified loaded voltage.

Many who have built the seven-tube circuit, in which the tuner is practically the same, have been delightfully surprised at the absence of inter-channel noise, a nuisance accompanying a.v.c. because bias is least and the amplification is greatest when the signal is least. Elsewhere suppressor circuits are introduced, requiring an extra tube, a no-signal condition causing the noise suppression control tube to have its amplification cut off by a heightened bias developed by plate current flow in a preceding tube.

Here we have n.s.c. without an extra tube, because at no signal there is no voltage across the second detector load potentiometer, and since the triode unit of the 55 is direct coupled, at no voltage across the load there is no bias on the triode. Hence at no signal there is no amplification and no noise.

Location Options

The triode of the 55 is resistance-coupled to the 56 driver, and there is a single pole-double throw switch for those who desire to include a phonograph pickup input. This switch cuts off the audio frequency input from the set and introduces the pickup in the grid circuit. It is not included in the list of parts.

Some persons may use a phonograph often, others seldom if at all, so the choice will lie with the constructor whether to include the phonograph pickup connection and switch, and also whether this switch shall be at the front panel or at rear, there being provision for exercising the option. Also, as the short-wave feature is not fundamentally included, and as this would require a panel switch, the standard model has the volume control-a-c switch at center, but there are slotted openings to left and right at front, so that short-wave switch may be put at left front, volume control-a-c switch combination at right front, and, if desired, phonograph switch at center, or a-c volume control a-c switch at center, and phonograph switch at right. These details are left to the constructor's preference.

The grid leak in the 56 driver stage is made purposely high, 5.0 meg., as that tends to reduce hum, but if you have a milliammeter, read the 56 plate current when the set is operating, to determine

LIST OF PARTS

Coils

One antenna coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters.
One interstage r-f coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters
One combination oscillator coupler for padded 0.00041 mfd. and one 175 kc first intermediate transformer, both enclosed in one high aluminum shield; oscillator tapped for 70-200 meters.
One 175 kc intermediate transformer enclosed in aluminum shield.
One 175 kc intermediate transformer with center-tapped secondary; enclosed in aluminum shield.
One tapped 20-millihenry r-f choke.
One 12" dynamic speaker, field coil, 4,800 ohms, tapped at 700 ohms, windings reversed; output transformer (5,000 ohms impedance) matched to the 2A3's in push-pull, 32-inch cable and six-pin plug attached, connections conforming to diagram.
One power transformer: primary, 110 volts, 50-60 cycles; secondaries: 2.5 volts at 8 amperes center tapped (H); 2.5-volt 5 amperes, c.t., for output tubes (F); 5 volts at 2 amperes, c.t.; high voltage at 375 volts d-c between rectifier filament and ground at 120 ma.
One push-pull input transformer.

Condensers

One three-gang 0.00041 mfd. tuning condenser with compensators built in and with attached screws for mounting purposes; high shield walls between sections.
(*Note: the condensers across primaries and secondardies of intermediate coils are built into these transformers.*)
One 0.001 mfd. fixed condenser.
Five 0.00002 mfd. fixed condensers.
One 0.01 mfd. mica fixed condenser.
Two 8 mfd. electrolytic condensers, wet or dry; one dry 8 mfd.; one dry 20 mfd. 30 volts.
One 850-1,350 mmfd. padding condenser, isolantite base; brass plates.
One shielded block containing nine 0.1 mfd. condensers and two 0.25 mfd. condensers. Equipped with mounting lugs. Shield is to be grounded. Two outleads colored differently than others are the 0.25 mfd. Rest are 0.1 mfd. Block to be fitted on chassis front wall. Black lead goes to ground.
One separate 0.5 mfd.

Resistors

Three 800-ohm pigtail resistors.
Two 1,200-ohm pigtail resistors.
Two 2,700-ohm pigtail resistors.
One 0.02 meg. pigtail resistor.
Three 0.025 meg. pigtail resistors.
Two 2.0 meg. pigtail resistors.
One 5.0 meg. pigtail resistor.
One 0.25 meg. potentiometer, insulated shaft type; tapered; a-c switch attached.

Other Requirements

One chassis, 13.5 x 3 x 8.75 inches overall, drilled for sockets, coils, tuning condenser, for electrolytics and for power transformer.
12 insulated bushings, ends tapped for 6/32 machine screws, so that bushings may be used as if nuts on socket mounting screws, and maintain insulation for parts mounted on top of bushings by means of lugs held by short 6/32 screws.
One dozen lugs.
Two dozen 6/32 machine screws.
One roll of hookup wire.
Six aluminum tube shields.
Five grid clips.
One foot of shielded wire to be used between antenna post of set and antenna lug of antenna coupler; overall diameter ½-inch due to thick cotton insulation to prevent loss of signal to ground.
One frequency-calibrated dial, travelling light type, with 2.5-volt pilot lamp and escutcheon.
Six six-prong sockets, one UY socket and three four-prong sockets (the extra six-prong is for speaker plug).

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whether loudest signals cause the plate current to go up a great deal, say, more than double, for if so, then grid current is flowing, and the resistance should be made less, say, around 0.5 meg., or until such abrupt plate current changes disappear.

Transformer Ratio

The 8 mfd. bypass condenser across the biasing resistor is intended to prevent degenerative effects (reverse feedback) and also to eliminate hum that otherwise might develop between cathode and ground. There is always danger of hum when the cathode is considerably lifted above ground in the heater type tubes, and a large capacity is recommended to cure the trouble, although in this instance the potential difference scarcely can be rated as large. It would be around 13 volts, if the power transformer delivers the intended high voltage (350 to 375 volts d-c assumed between rectifier filament and ground under full load).

Speaker Field Choice

The coupler between the driver and the driven stages is a push-pull input transformer. The ratio usually will be around 1-3, 1-3.5 or 1-4, and although not very material in this region should not be much higher than 4-to-1, because ratios are normally built up at the expense of primaries, hence high ratios suggest low primary inductance, especially low as the direct current of the plate circuit passes through the primary.

The output transformer is built into the dynamic speaker, and for the 2A3 the impedance, plate to plate, should be 5,000 ohms, for the normal operating voltage conditions.

Since we have a higher voltage than need be applied to the power tubes' plate circuits, and it is advisable to introduce filtration for the power tubes, and also as we have a much higher voltage than will be required for the intermediate and radio frequency plate circuits, and filtration is required here, too, we may use a speaker that has a tapped field coil. Then the power tubes' plate current, total 80 ma, may be passed through one part of the winding and the current for the other tubes through the rest of the field coil. Hence, if the speaker has a field with total resistance of 2,770 ohms, then 2,100 ohms may be between maximum B plus and the B lead looking toward the forward part of the set, while the 670 ohms of the field would be from maximum B plus to return of the power tubes' plates. Or, from B plus maximum to i-f and r-f voltages, the resistance of the field may be around 4,000 ohms, provided the field will dissipate the wattage, actually 4 watts, the circuit to the power tubes being as shown. Then there would be no need for the fixed resistor marked 2,000 ohms, 3 watts.

The division of the current through B chokes this way is economical and avoids heavy current (125 ma) through any one choke.

Actually, the 3-watt rating will be all right for the resistor. Though about the same current flows through the 2,100-ohm choke, this is marked 10 watts, the reason being that field coils and the like seem to be less conservatively rated than fixed resistors, and a 10-watt commercial-rating winding will get warm but not too hot.

Rectifier and Power Tubes

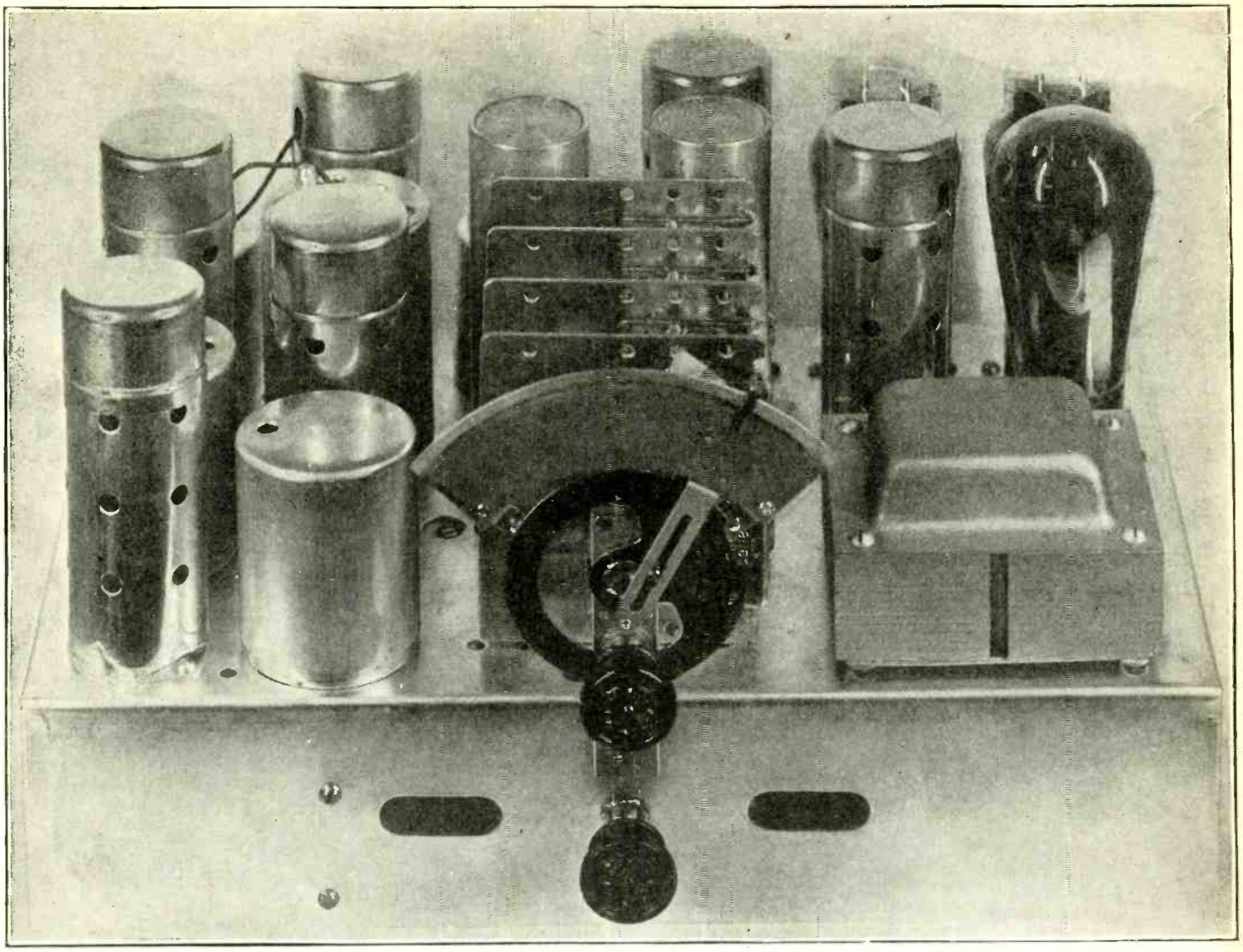
In the rectifier circuit a 5Z3 is recommended, because of its high current capacity due to multi-filament construction that greatly increases emission, but a 280 may be used. The 280 rating is 125 ma, and the present circuit draws about that, so it seems preferable to have a 250 ma tube, worked at half its maximum, rather than a 125 ma tube worked up to the hilt. So, too, if speaker with proper impedance is used (around 4,000 ohms), two 245's may be used in the present circuit. Neither substitution requires any change, and the bias on the 245's will be around 55 volts, which is all right, since the plate voltage will be around 300 volts instead of 250 volts. But the maximum power output would be around 5 watts instead of 15 watts.

II

CONSTRUCTION

THERE are a lot of parts to put on the chassis, which is 13.5 x 3 x 8.75 inches, but there is room for all of them. The audio transformer goes undernaeth the tuning condenser, on the

(*Continued on next page*)



The chassis view of the Push-Pull Super Diamond. The r-f tube is at left front, with antenna coil beside it. The next pair are the oscillator and its r-f input coil. Behind them are the combination oscillator-first intermediate coil and the first i-f tube. The 2A3 output tubes are at right rear. In front of them is the rectifier, represented by a 280, although a 5Z3 is preferable.

(*Continued from preceding page*)
under side of the chassis, while the block containing nine large capacity bypass condensers is fastened to the front flap of the panel, at left, in two holes provided for the purpose.

The various resistors are put generally in such positions as are most consistent with short leads, and where these resistors are grounded they may have one pigtail terminal soldered to the chassis itself. However, for those resistors at an elevated potential, and for other similar purposes, insulated bushings are used. These are pieces of fiber dowel about 2 inches high and about ¼-inch in diameter, and are tappd at both extruded ends. Thus at one end, where they are adhered to the chassis, they replace nuts of the 6/32 type, while at the other end a lug is fastened by a machine screw, and this lug is used for the higher potential anchorage.

Position of Parts

When mounting the parts it is well to start with the padding ocndenser, because that has to be put on ahead of the main tuning condenser, otherwise it could not well be put on at all. There is a large hole drilled for the padding condenser setscrew, and when the padding condenser is mounted on the under side of the chassis, the setscrew is accessible from the top of the chassis. It might appear at first sight that the heads of the screws holding the padding condenser's isolantite frame to the chassis would interfere with the shield partitions of the main tuning condenser, but it will be found that though the two meet there is no impediment.

Besides mounting the padding condenser before the main tuning condenser it is helpful to mount the audio transformer, and for this purpose some extra holes may have to be drilled in the standard chassis, particularly as you may use a push-pull input transformer you now have, or exactly the same type case and mounting may not be furnished by all the supply houses from which parts for this receiver are obtained. The audio transformer should not be mounted as close as possible to the power transformer, but rather the opposite trend should be followed, although even then the distance will not be great.

Numerous constructors like to use their own method of layout of individual parts, so far as a standard chassis permits, and with this circuit considerable room is left for ingenuity of this type. No exact pattern need be followed, although of course the circuit diagram should not be altered, unless you know just why you are altering it and have good reason to do so, but whether one part is just here or just there is of no great moment. The principle of making leads as short as practical should be followed, but the rule that the shortest lead always must be used is not adamant, either.

Right-Angled Coils

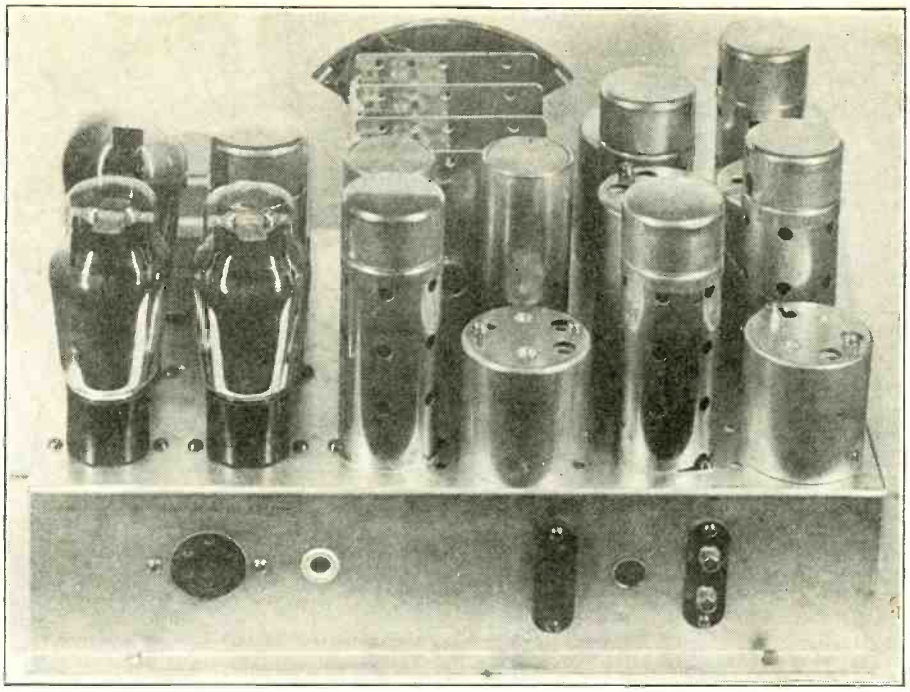
One instance is that the coil feeding the control grid circuit of the autodyne tube is to extreme left, and a lead is thereby made longer, but the reason was that the parts fitted better that way, although any who desire to put the tube on the outside left, and the coil nearer the condenser, may do so.

The fit is quite tight for the third intermediate transformer, for behind the tuning condenser, with little room to spare, is an 8 mfd. condenser, and directly behind this is the coil in question. The parts fit, using the mounting holes as they are, but if it is desired to leave more room between the electrolytic condenser and the coil, this may be done by drilling two holes so that the coil may be mounted ¼-inch farther back.

As the chassis is laid out the coils would be parallel if the mounting holes for the intermediates were followed literally, however the coils may be placed at right angles as directed in the schematic diagram wiring, by drilling two mounting holes to form a line between them which is at right angles to the line formed by the two existing holes. The coils diagramed should be put at right angles, because closer together, due to chassis layout.

The reason for suggesting the right-angle placement (which is not an imperative direction, but merely a good suggestion) is extra precaution against inductive feedback. However, the circuit has been built with the coils with fields in parallel, without oscillation in the intermediate amplifier, but it is conceivable that some will have higher line voltages than obtained during the tests of laboratory models, or will use a power transformer of higher voltage rating, or will use smaller resistance values, including field coils, to drop the maximum B plus voltage to the general amplifier plate voltage value.

Some small changes have been made in the circuit, compared to the diagram printed last week, and one of these has been to increase the value of the filter resistor in the plate circuit of the first intermediate stage, as an additional precaution against oscillation. As it is, the intermediate amplifier does not oscillate, but it is conceivable it may oscillate in reproductions, and therefore the suggestion is made that the filter resistor in the second intermediate plate circuit may be raised from 1,200 ohms, in such an instance, to whatever value will make the intermediate amplifier quiet, as it should be for best performance.



The speaker socket is at left rear. The shield next to the rectifier contains the 56 tube. Antenna-ground twin assembly, phonograph pickup, jack assembly, with opening for switch, and eyeletted a-c cable outlet are illustrated.

Voltages and Biases

Under the circuit conditions now depicted, the B voltage will be higher to the general amplifier line than formerly, and at the values stated, with specifid power transformer, will run around 270 volts, but the negative bias on the amamplifier tubes is now just a little under 5 volts, and the current through the tube is less than that which it would be at 250 volts applied to the plate, and 3 volts applied for bias. Actually, of course, a reading of 270 volts, plate to ground, and 5 volts, cathode to ground means that the total voltage applied in the tube circuit is 270 volts, that the applied plate voltage is 265 volts, and that the bias voltage is 5 volts, because the plate voltage is referred to the cathode, as is the bias voltage.

It is not known what type of power transformer the constructor will use, but from previous experience it is safe to say that many will use a power transformer they have, one that looks husky perhaps, yet one that will not meet the demands of this circuit. If the power transformer is of less capability than the circuit requires, it will be overloaded and there will be a strong magnetic field, whereupon the audio transformer, no matter where placed on the chassis, will pick up hum, and besides electrotatic hum fields will be communicated to the leads concerning the power tube stage and the connections to the speaker. Therefore the warning is given that a power transformer of adequate capability must be used, for this circuit draws 120 ma plate current, although for reasons of economy the power tube current is passed through one portion of the speaker's field coil, the B current for the remainder of the circuit through the higher resistance portion of this winding.

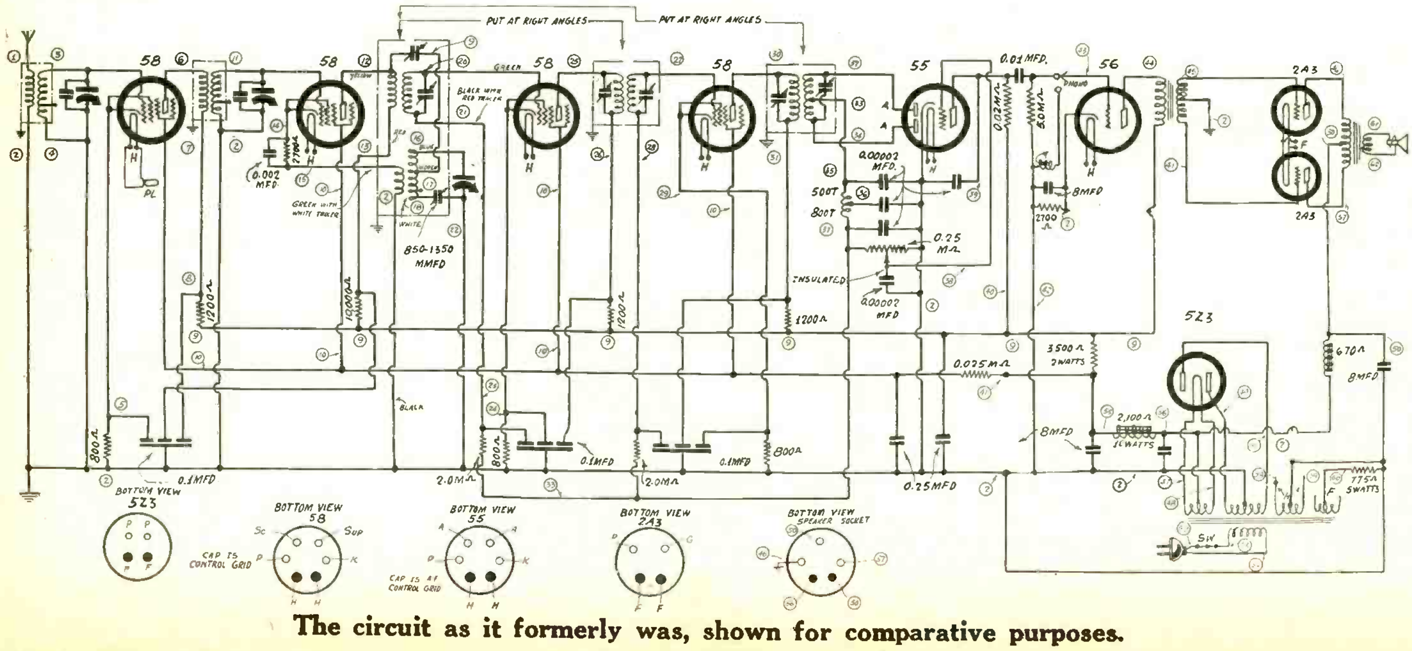
The fields would be bucking if the total field winding of 4,800 ohms were in one direction, and 700 ohms simply represented a casual tap, but if the field windings are wound in reverse fashion, then the inductance of the field windings will be well supported, otherwise the net inductance would be considerably less. However, it is not imperative to use the speaker with field coil as explained, as a 4,000-ohm field, more or less, may be used in the direction of the amplifier, and a separate choke, which may be the field of a second speaker, if twin speakers are to be used, may serve the power tubes' purpose.

Any who desire to use a speaker they have, if it has proper output transformer, may do so, and make up the remainder of the resistance of a fixd resistor of suitable wattage (around 5 watts generally), although the drop in the fixed resistor would be wasted power, whereas the drop in the field coil is utilized power. That is the reason for the substitution of a large-resistance field to take care of the desired drop.

The choking has to be exceptionally good in the B circuit, as a push-pull stage, with a resistance-coupled driver, opens up greater danger of hum than single-sided circuits, particularly than any circuits that do not have much audio. Here there are three audio stages, as follows: one in the triode of the 55, the second in the 56, and the third in the power output stage. This output stage will work without strain up to 15 watts, or at about three times as much power as 245's in push-pull. Nevertheless, 245's may be used instead of 2A3's, with the consequences as stated, and, as already pointed out also, a 280 may replace the 5Z3 rectifier, but will get deucedly hot, being worked to the hilt, whereas the 5Z3 is conservatively worked at half its maximum power rating.

The hum in this circuit is a little bit more than it is in the six and seven-tube Super Diamonds, but it is not bothersome, and is unnoticed when any signal or station is tuned in. To keep the hum as low as it is one must have a separate 2.5-volt winding for the power tubes' filament, to prevent positively biasing the heaters of the other tubes in respect to their cathodes.

(*Continued next week*)



The circuit as it formerly was, shown for comparative purposes.

The 2-TUBE "ROCKET"

Short-Wave Earphone Set in Compact Assembly

By F. Grimes
Try-Mo Radio Corporation

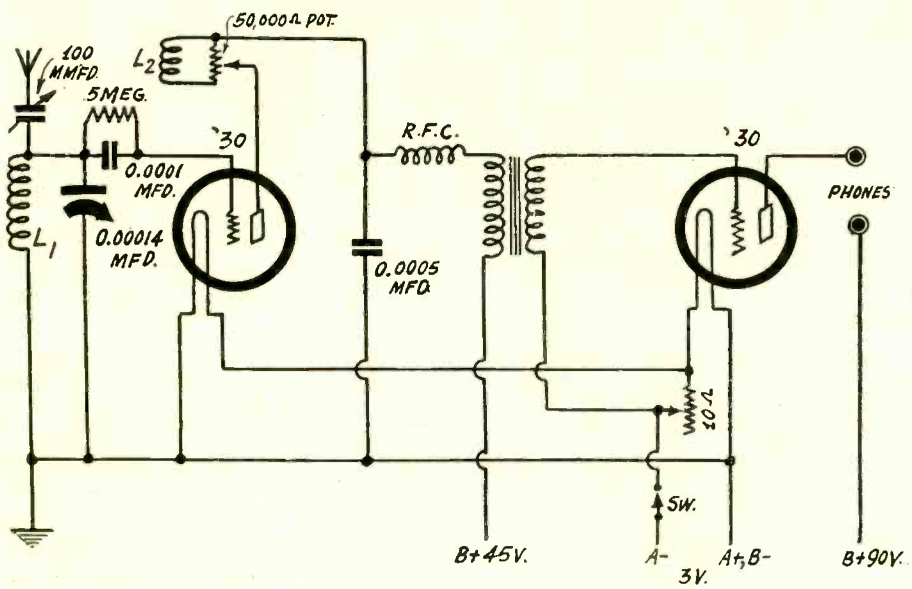


FIG. 1
The circuit diagram of a two-tube, short-wave receiver designed for earphone reception. It uses plug-in coils and is regenerative.

LIST OF PARTS

Coils

One set of four plug-in coils with four-prong bases
One 85-millihenry r-f choke coil
One audio-frequency transformer

Condensers

One 100 mmfd. variable condenser
One 140 mmfd. variable condenser
One 100 mmfd. fixed grid condenser
One 500 mmfd. fixed condenser

Resistors

One 5-megohm grid leak
One 50,000-ohm potentiometer
One 10-ohm rheostat

Other Requirements

Three knobs for auxiliary controls
One vernier dial for main tuner
Three four-contact sockets
One filament switch, attached to the 10-ohm rheostat
Four binding posts
One small steel chassis with panel
One fused five-lead battery cable.

HERE we have a two-tube short-wave receiver, designed for earphone reception. It is of extreme simplicity, and for that reason it should be an efficient circuit, for it is almost axiomatic that the simpler a short-wave set the better it is. The present receiver has all the necessary "gadgets" but no more than those necessary. Let us examine it.

In the antenna circuit is a small variable condenser, with maximum capacity of 100 mmfd. This is necessary in order to permit the adjustment of the coupling between the antenna and the tuned circuit to suit the frequency that is being received. The coupling must be loose at all frequencies or there will be no selectivity, and the higher the frequency of the signal the smaller must the antenna condenser be for a given degree of coupling.

Regeneration an Essential

Regeneration is essential in a simple short-wave receiver. And if that is to do the maximum good there must be a satisfactory regeneration control. In this circuit the control consists of a 50,000-ohm potentiometer across the tickler winding, with the plate connected to the slider. This is superior to a rheostat across the tickler, for such a device would vary the resistance, and hence the selectivity, of the resonant circuit. The potentiometer does not vary it because there is always practically the same resistance across the tickler. And since it is a high resistance it does not affect the tuned circuit appreciably.

Moving the slider over the resistance varies the amount of signal current flowing in the coil. When the slider is at the upper end of the coil there is no feedback because there is no coupling between the plate circuit and the tickler. When the slider is at the bottom practically all the signal plate current flows through the tickler.

Plug-in Coils

Plug-in coils are used in the receiver to cover the various bands of short-wave signals. There are four in a set to go from 200 meters to about 10 meters. L1 and L2 are the tuned and the tickler windings, respectively, of one of these coils.

The coils have four independent leads and for that reason four-prong sockets and coil forms are used. The windings L1 are designed for a 140 mmfd. tuning condenser. The minimum capacity may be kept low enough to make this condenser cover the band from 200 to 10 meters with only four coils, with plenty of overlap between adjacent coils.

A small stopping condenser in the grid circuit and a large value of grid leak across the condenser are important features of sensitivity in a short-wave set. Therefore, the grid condenser is only 100 mmfd. and the grid leak is 5 megohms. This type of detection requires that the return of the grid be made to the positive side of the filament and for this reason both the coil L1 and the condenser are connected to this side of the filament and are also grounded.

The Filament Circuit

A 0.0005 mfd. condenser is connected between one side of the tickler and ground to facilitate the flow of high frequency currents in the plate circuit and thus to make the tickler more effective. A radio frequency choke of about 85 millihenries is put in series with the primary of the audio transformer to keep the r-f currents out of the audio end and also to keep down some high frequency audio noise.

Two 230 Tubes

There are two 230-type tubes in the circuit. These take a filament voltage of 2 volts and a current of 0.06 ampere each. Thus the two tubes take only 0.12 ampere. This is small enough to make the use of No. 6 dry cells practical for filament supply. Two of these cells will give a voltage of 3 volts, one volt in excess of requirements. Hence, it is necessary to use a rheostat. This is of 10 ohms and it is put in the negative lead. While the cells are fresh practically all of this resistance may be used as ballast but as the cells wear out, some of the resistance has to be removed. It is best to operate the circuit with as much resistance as possible in order to economize on filament as well as on plate current.

The output tube is also a 230. It is coupled to the detector with an audio transformer. A small negative bias is given the grid of this tube through the one-volt drop in the filament rheostat.

45 Volts on Plate

A plate voltage of 45 volts is applied to the plate of the detector. This is the value at which the usual grid leak detector works best as an audio amplifier. It should be remembered that a detector of this type is both a diode rectifier and an audio amplifier. On top of that it is also a radio frequency amplifier and for this reason it can be made regenerative.

The plate of the output tube is given 90 volts. However, since earphones are to be used for reception, 45 volts on this tube also would be all right. The value is optional and the one that gives the best all around results should be used, or the one that is most convenient.

The negative of B is connected to the positive of A. This, in fact, adds two volts to the effective values of plate voltage. The main reason why B minus is

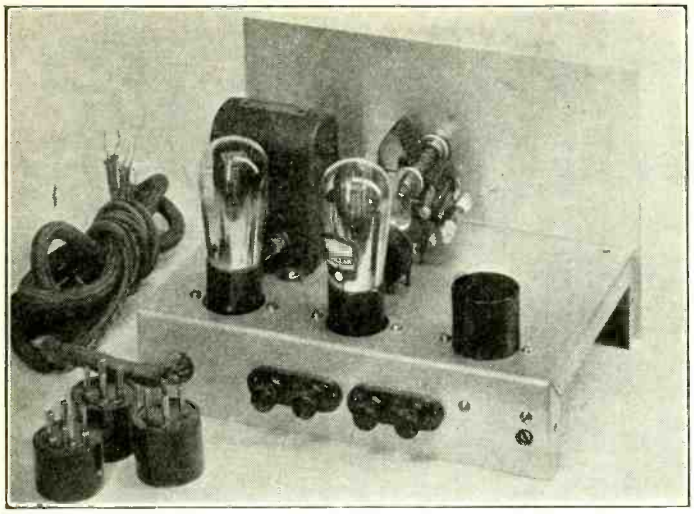


FIG. 2
Back view of the two-tube, short-wave set, showing the layout of the parts.

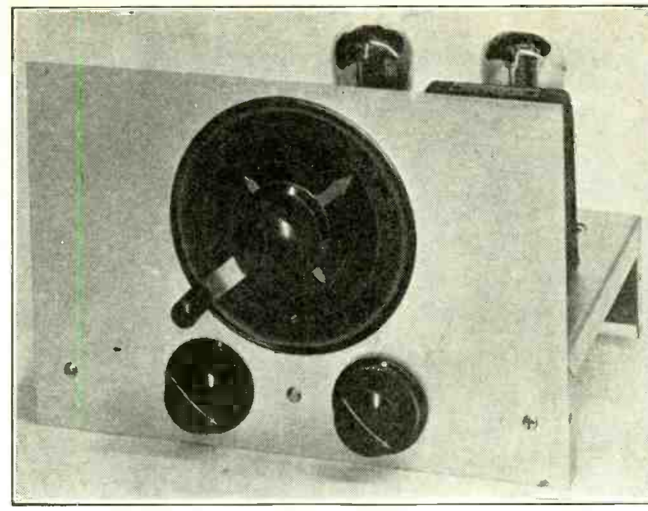


FIG. 3
Front view of the two-tube, short-wave set, showing the arrangement of the knobs and the dial.

connected to A plus is that A plus is grounded.

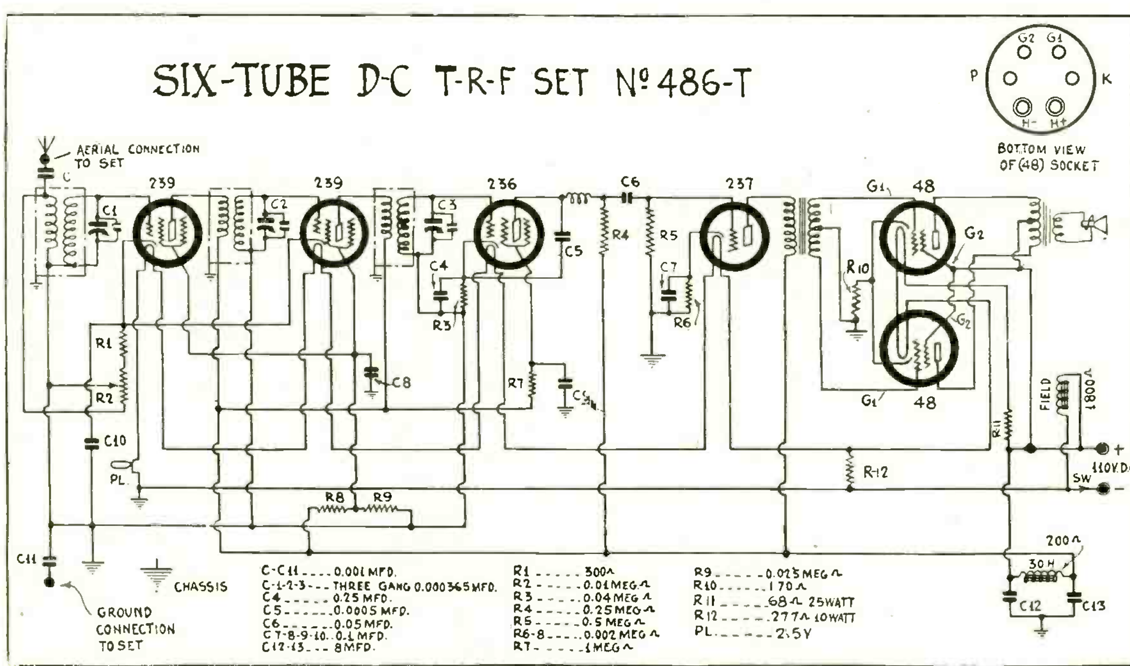
A filament switch is put in the negative leads.

A five-lead cable is provided for the voltage supply. There are two conductors for the filament battery and three for the B battery. One for minus, one for 45 plus, and one for 90 plus. A special feature of this cable is a built-in fuse to protect the tubes against possible short between the high voltage leads and the filament leads.

Signals are receivable in all the short-wave bands with this receiver. In the first band police signals come in, and plenty of them. In the next band come many code stations and amateur phone stations. On the other bands are short-wave relay stations and code from all over the world.

The set works and all that is necessary to bring in plenty of stations is to tune carefully and at the right time. Since the set is regenerative much depends on the use of the regeneration controls. There are really three controls for the regeneration in the set. There are the anetnna condenser, the plate circuit potentiometer, and the filament rheostat. Any one of the three, or any two of them, and all three may be used for obtaining the best control. The closer to the oscillating point the detector is worked the more sensitive will the circuit be.

Low Hum in D-C Set

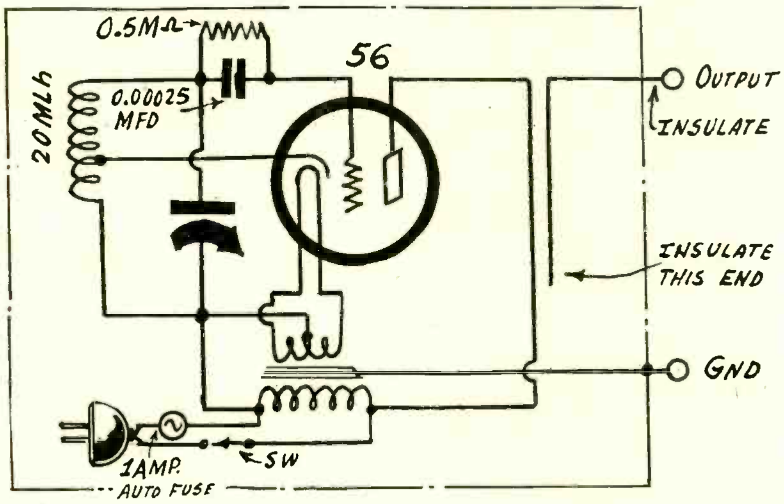


In a d-c receiver of this type the hum level is extremely low. There are many reasons for this. First, the line voltage contains a comparatively low hum voltage because of the type of machine used in its generation. Second, heater type tubes are used throughout so that no hum can enter by way of the heaters. Third, an adequate filter is used. This consists of a 30-henry choke coil and two electrolytic condensers, each of 8 mfd. The condensers alone are very effective in eliminating the ripple that exists on the d-c line. The use of electodytic condensers presents one danger because they have polarity. If the proper electrode is not connected to the positive side of the line the condenser breaks down and draws heavy current. This current will heat the condenser internally and the heat in turn may generate gases. There is a possibility that the condenser will blow up. There is no danger of this while the set is working normally with the voltage on the condensers on in the correct direction. The set will not work at all if the polarity is not right but it may take several minutes, the time required for the tubes to heat up, to find out that the voltage is on in the wrong direction. It is during that time that damage may be done to the condensers. In order to be on the safe side, even though the danger is only to the condensers, the polarity of the line should be tested and the plug should be inserted only so that the polarity is on the tubes and the condensers correctly from the beginning. The test may be made in a jiffy if a voltmeter that will read up to 150 volts is available.

AN I-F OSCILLATOR

Test Device for Lining Up Has Fixed Frequency

By Herman Bernard



A fixed frequency oscillator, useful for lining up intermediates. It consists of a Hartley oscillator of the grid leak type, with a-c on the plate of the 56 tube, providing 100 per cent. modulation by the frequency of the line voltage (60-cycle hum).

LIST OF PARTS

Coils

One 20 mlh tapped r-f choke coil, honeycomb type
One 2.5-volt filament transformer with center-tapped secondary

Condensers

One 350-450 mmfd. padding condenser
One 0.00025 mfd. grid condenser with clips

Resistors

One 0.5 meg. grid leak

Other Requirements

One steel box
One UY socket
One 56-tube
Two pin jacks for, one for ground, connected to box and to transformer core or case, other insulated for output
One 1 ampere auto fuse with holder
One a-c cable and plug

NUMEROUS experimenters have use for a fixed frequency oscillator to enable them to adjust to the particular intermediate frequency they virtually always use for constructing receivers. This may be 175 kc.

For the adjustment of trimming condensers and padding condenser at the broadcast frequency level, stations may be used, as one around 1,450 kc can be tuned in by nearly every one, and one around 600 kc is nearly as easy to get, although not quite so, and a slightly different frequency might have to be used here. Therefore a 175 kc oscillator is to be constructed, or, more correctly, an oscillator set at some fixed frequency, with condenser adjustable however, to provide as wide a choice as any one would ask.

If the oscillator is to be of the grid current type the capacity should be large, that is, an adjustable condenser should be used nearer the full capacity than the minimum capacity, as this makes for better frequency stability. As the frequency increases the stability of frequency becomes less. While this is not of vast importance for intermediate frequency adjustments, as these do not come within the realm of precision adjustments, it is well to select the more stable region, and if the condenser has a small capacity range the requirements are met.

Constant Modulation

By putting a.c on the plate there will be constant modulation. The frequency of modulation will be the frequency of the line current. It is just as well to keep the modulation going, rather than to have modulated-unmodulated service (though here of course there is no choice) because the frequency will change when the modulation is introduced, compared to unmodulated radiation. To render a circuit free from this condition of change of frequency due to presence or absence of modulation would require special stabilization of the modulating characteristic, that is, a linear modulator, and while this is possible, it introduces complications unnecessary for the present purposes, especially as we can not well remove the modulation without rectification and filtering.

As can be seen from the diagram, few parts are needed. It is well to have the oscillator contained in a steel box, the core or case of the filament transformer connected to the box, and the lead brought to a ground post. It is of small use to have an aluminum or copper box, as these types would not shield so intense an oscillator satisfactorily. Indeed, with either aluminum or copper there would be enough radiation, without any conductive connection to a receiver, to produce coupling between test oscillator and receiver at high broadcast frequencies. Broadcast frequencies in the set would beat with test oscillator harmonics.

Output Wire

Besides the shield box it is advisable to use a shielded wire to connect from the output post of the test oscillator to the tested circuit, and since the sheath of this wire is to be grounded, which may be done to the adjoining post, there should be ample separation between the internal and external conductors (the wire inside and the sheath on the outside). This prevents loss of power to ground due to bypassing through the capacity of the shielded wire. A suitable type of wire has a total manufactured thickness of about one-half inch, of which of course most is cotton insulation between the rubber covering of the internal wire and the external sheath. If practical, this wire may be grounded at the set end, also. The object is to prevent pickup by the connector, so the connector will not function as aerial for the set.

The tuning condenser may be of the type used in padding superheterodynes of 400 kc intermediate, and a capacity obtainable in the market would be selected, say, 350-450 mmfd. The frequency struck should be one of which the desired intermediate frequency is a harmonic. This system works out just as well and just as accurately as if the fundamental were used and has the great advantage of enabling a change at any time to use some other fundamental that will yield harmonically some other desired intermediate frequency. That is, though we are building what might be termed a fixed-frequency oscillator, since a condenser is present that has a set-screw adjustment, should the occasion arise for lining up some other intermediate frequency, we may tune the circuit to suit the purpose, as will be explained.

It is assumed that 175 kc is the intermediate frequency, so we shall finish with the determination of the fundamental to yield that by the use of an harmonic.

Coil Data

First, we must know something about the coil. There are commercial honeycomb coils of some hundreds of turns, which, when wound up, have an outside diameter of somewhere around 1 inch, the smaller-winding coils naturally of smaller outside diameter. Now, if we use two 300-turn coils we shall have an inductance of nearly 3 millihenries, and if we use a so-called "tenth harmonic coil," an inductance 20 millihenries, with a tap somewhat off center (though a center tap is perfectly acceptable), we shall have a still lower frequency.

Taking the honeycomb coils of popular types we find the following table applies approximately:

Type of Coil	Inductance mlh.	Capacity mmfd.	Frequency kc.
Two 300-turn coils...	2.6	350-450	145-185
One 300, one 800.....	11.3	350-450	75-90
13,000-turn, tapped...	20	350-450	52-60

It is our intention to use the 20 mlh coil, but we desire to see approximately where the frequencies would fall with other coils. It is obvious that if we are seeking 175 kc we can find it on the fundamental of the 300-turn coil. The combination of 300 and 800 turns enables us to use a fundamental of 87.5 kc, so that its second harmonic will yield 175 kc. The largest coil will permit use of a fundamental of 58.333 kc, so that the third harmonic would be used for 175 kc. So we have our choice.

The Frequency Adjustment

Under any system outlined above, to tune to the desired frequency, bring in a station on a frequency that is a harmonic of 175 kc, i.e., 700, 1,050 or 1,400 kc, and adjust the oscillator frequency by turning the setscrew of the condenser with an insulated screwdriver (neutralizing tool). The box has to be pierced to gain access to the condenser, but this work is done in the preparation of the box. Adjust for zero beat, or as close to zero beat as possible. Actual zero beat is usually impossible to achieve even with a vernier dial, unless it be of the precision laboratory type, but the closest adjustment you can make will be amply accurate for the purpose.

To register near-zero beat, the oscillator is set going, and its output is coupled to the receiver aerial by connecting some thin wire to the end of the shielded output lead and twisting this wire for a few turns about the aerial near where it enters the set.

Now the oscillator is ready for service.

Other Frequencies

Suppose that some other intermediate frequency is in mind. Assume it is 400 kc. The same process is followed. Taking the 20 mlh-350-450 mmfd. combination, we find that the seventh harmonic of 57.14 plus is 400 kc, and we adjust the condenser so that it beats with some broadcast frequency that is a multiple of 400 kc, i.e., 800, or 1,200 kc.

For obtaining a fundamental that will enable use with any intermediate frequency on the fundamental of the fixed frequency oscillator, or a harmonic of that fixed frequency, divide the desired intermediate frequency by the nearest whole number that will produce a frequency between 52 and 60 kc. To adjust to this frequency beat with a broadcast station whose frequency is an harmonic of the desired intermediate frequency.

The foregoing also explains how the test oscillator fundamental frequency may be changed as circumstances require, and also how it may be reverted to the original frequency, if desired. Also, the method is accurate, and the results will be good. The device was built as described and works fine.

Output Coupling

The diagram is mostly self-explanatory. The 20 mlh coil has three lug terminals. The one connecting to the outside of the winding, which outside is obvious from inspection, and has a piece of gelatin holding it in place, goes to grid. This is an extreme terminal, as is the return or inside coil terminal. The tap is between the two other lugs and goes to cathode.

The output coupling is simply that caused by the capacity between two wires, one the lead from plate to transformer, the other being parallel to it, twisted about it, if you like, or put in the same spaghetti sleeve, and terminating at the output post, other end free but insulated as a precaution. This insulation may consist of making the lead shorter than the spaghetti sleeve and pushing the sleeve all the way up to the output post.

WORTH THINKING OVER

MEET EDDIE CANTOR, stage comedian, radio star and—Editor! Mr. Cantor is letting the world know something it hasn't known before; this through the medium of a new publication which he sponsors. Welcome, Mr. Cantor, to our craft; may your musings be as humorous as are your air talks to millions of the public every week!

An Open Letter to a Fellow Publisher

New York, March 1, 1933

Mr. E. H. Harris, Publisher of "The Paladium-Item," Richmond, Ind., Chairman of the Radio Committees of The Inland Daily Press Association and The American Newspaper Publishers Association.

Dear Mr. Harris:

You introduced at a recent meeting of The Inland Daily Press Association a resolution to the effect that publishers of your organizations should charge advertising rates for publication of radio programs.

Have you forgotten, Mr. Harris, that the A. N. P. A. discussed this matter very solemnly a few years ago, with the result that certain publishers agreed to discontinue the publishing of radio programs except as paid matter? A good many publishers did immediately omit these programs from their columns. You will probably also recollect that the howl from the readers of these daily papers was so loud and prolonged that the publishers took another squint at the situation and then decided, without explanation or apology, to join their other brethren who had not been so foolish as to drop out something that had interested such a large percentage of their readers.

May I also call your attention to the very obvious fact that, while daily newspapers are not exactly tickled to death to devote so much space to baseball and accept more or less graciously the tiny ads given to the sporting pages by the baseball magnates, they continue to publish unlimited pictorial and type space for the very simple reason that their readers demand that they do so?

Daily newspaper publishers have never devoted their columns to radio programs just because they loved and admired radio executives or air artists. They know that their public demands radio programs. If the radio fan does not find current programs in his morning or evening newspaper, it is ten to one that he will go over to a competitor that does publish this material—and there is the whole story in a nutshell.

Don't be foolish, Mr. Harris, and don't ask your brother publishers to be foolish with you. Those who agree temporarily to discontinue radio programs are going to get mightily sick of the bargain, and then they are all coming back into the fold again—for the simple reason that two and two still make four, and all the sophistry in the world isn't going to change that elemental fact.

Yours truly,

Publisher, RADIO WORLD.

New Tubes Numerous; Most Really Worthy

New tubes come out so often that it is difficult to keep up with the progression, and a few of them seem to have no other purpose than rendering older tubes obsolete. But often a tube that is really needed comes out. That was the case with the 55 and 85. Of course, many other tubes have really been needed although few persons saw the need until the tubes had been announced. But there are tubes which to four or five years have not made any impression on the radio engineers.

We have been promised a different new tube that seems to be needed. This is a combined oscillator and modulator. First of all it is an oscillator. Then it is a modulator. There is an extra grid on which the radio frequency signal may be impressed. In principle such a tube is already available in the 58. The tube may be used as an oscillator just as any other tube, and then the suppressor grid may be used for impressing the radio frequency signal on the generated oscillation. But the 58 tubes was not designed for this purpose especially. The promised new tube has been designed for this service, and it is to be expected that better results will be obtained.

Another tube that is needed and may indeed come very soon, and that is a duplex diode triode in which the triode is a power tube. A high gain duplex diode triode is already a reality, a tube that has such a high voltage gain in the triode section that the need of an interstage audio amplifier is obviated. But the new tube suggested is another step in the same direction. It dispenses with all the audio tubes, except the one built in with the diode detector. Of course, a tube like this would require a greater r-f input, but there is no trouble now getting high gain in the r-f and i-f amplifiers.

A second detector input from locals of 20 or 30 volts is not unusual.

Modulation Changes Oscillator Frequency

In radio oscillators that have not been stabilized as to frequency, the frequency of oscillation will depend on the modulation. The resulting change in frequency of the carrier is often called "wobbulation." The cause of this phenomenon is not far to seek. Suppose the circuit employs the Heising modulation system, in which modulation is effected by varying the plate resistance. Now the frequency of oscillation depends on the plate resistance to some degree, and therefore as the plate resistance is varied the frequency necessarily is varied also.

Now suppose that the modulation is effected in the grid circuit. This amounts to varying the grid circuit resistance. But the frequency of oscillation also depends on the grid resistance. Hence the modulating voltage necessarily changes the frequency.

Sometimes modulation is effected by energy absorption in the resonant circuit. This amounts to varying the resistance in the resonant circuit. But the frequency of oscillation depends on the resistance of the resonant circuit. Hence modulation by absorption changes the frequency.

These effects are due to the fact that the oscillator is not stabilized as to frequency. If it were stabilized there would be no frequency variation due to changes in the grid, plate, or resonant circuit resistances.

NOISE SUPPRESSOR'S FUNCTION

The object of the noise suppression control circuits is to stop the "hash" due to lowered bias on consequently greatly amplifying r-f or i-f tubes from coming through. The noise is due to non-action by an automatic volume control at no signal, hence is "cater-channel." It has nothing to do with static, man-made or natural, and is not an interference eliminator of the general type, but a distinctly special one.

THE PATHFINDER SHO

A Self-Powered, Switch-Oper

By Alan
Thor R

INTEREST in short-wave reception is no longer confined to the "ham" and experimenter but has extended to the man on the street, who now speaks of short waves as glibly as do the experts. The rapid extension of interest was, no doubt, due to the introduction of short-wave converters. The old-time regenerative detector was difficult to tune and not exceedingly sensitive. The old-time adapters failed to work more often than they did work, and when they did work there was only a makeshift short-wave detector and an audio amplifier.

The converter, on the other hand, makes use of the full sensitivity of the broadcast set—makes use of it from the antenna-ground binding posts to the loudspeaker baffle. New tubes, which greatly increased the sensitivity of broadcast receivers, were another factor in popularizing the converter, and satisfactory coil switching devices which have made their appearance did their part in making converters easier to handle so as to bring in the sought-for stations.

Definition of Converter

A converter is a mixing device, tunable over the short-wave range, that converts the short-wave signals to equivalent signals with a much longer wave, without changing the modulation contained in the original carrier. In terms of frequencies, the converter changes the frequency of the signal from a high one to one that falls inside the broadcast band, to which all ordinary receivers are responsive. The new frequency, which is a beat frequency between the signal and the converter oscillator frequency, is picked up by the broadcast set through some suitable coupling device and is amplified and detected in the same manner as any other broadcast frequency signal.

The coupling between the converter output and the broadcast receiver is direct, and it often happens that the input from a weak distant station is greater than the broadcast set will stand, unless that set is provided with a good automatic volume control.

Choice of Converter Design

The possible variations in the design of converters are almost endless, but regardless of the type used, a really good broadcast receiver is a prerequisite to good short-wave reception. Next in order of importance come the antenna and ground. It seems almost unnecessary to repeat, but a long, high antenna *is* best for converter use; and a good earth or cold water-pipe ground is one method of insuring that the converter will get the desired high value of input.

The coupling between the antenna and the converter should be loose. It is for this reason that a series condenser E is found in the antenna lead. This may be a small neutralizing or "equalizing" type of condenser, which is screw-adjusted. As the frequencies received increase, loose coupling becomes more and more vital.

Importance of Wiring

Since high-frequency currents travel on the surface of conductors it becomes of importance to use heavy conductors for making connections so that there will be as much surface conductivity and as little resistance as practical. No. 12 or No. 14 bus wire is very satisfactory, and all connections, except the output leads of the converter, should be made with such conductors.

One of the uncertainties of a converter-receiver combination is the coupling between the two components, and this should receive careful attention in the design of every converter. Most modern broadcast sets have high input impedance, and this fact simplifies the problem, for a simple arrangement like that shown in Fig. 1 proves to be efficient.

In some cases where the first tube in the set is of the screen grid type, the converter will function better if the output is connected directly to the grid of the tube. When this is done the grid clip normally on that tube should be removed and a clip connected to the output of the converter should be put in its place. A grid leak of about 0.5 meg. should be connected between the grid and ground to provide a leakage path. Of course, this connection is not nearly so convenient as the one that connects the output of the converter to the antenna binding post on the broadcast receiver.

Shield Output Wire

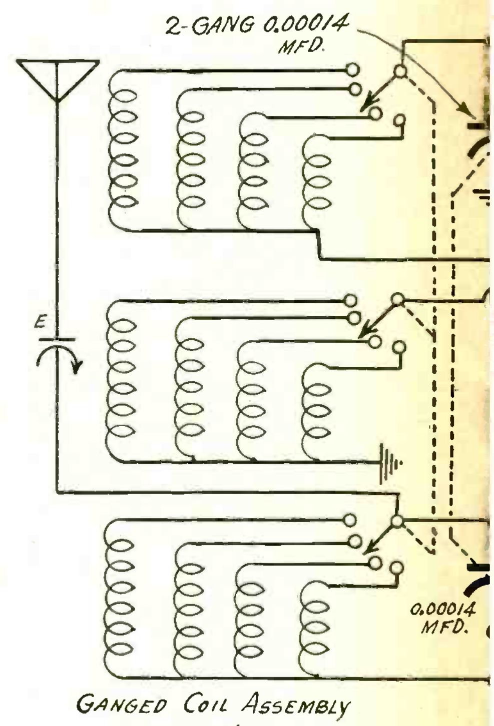
If the lead between the converter and the broadcast set is allowed to be exposed to broadcast signals, it will act as an antenna and broadcast signals will be received as well as short wave signals. This might cause considerable interference in some instances. To guard against this the output lead is shielded, the outside conductor being grounded at the converter as well as at the broadcast set.

A shielded wire of this type is really a long tubular condenser and it has a definite capacity. If this is too large there will be considerable loss. This is obviated by choosing shielded conductor in which there is a thick spacer between the inside and outside conductors. Of course, the longer the shielded conductor is the greater will be the loss. Hence, even if a low capacity conductor is chosen it should not be any longer than is necessary.

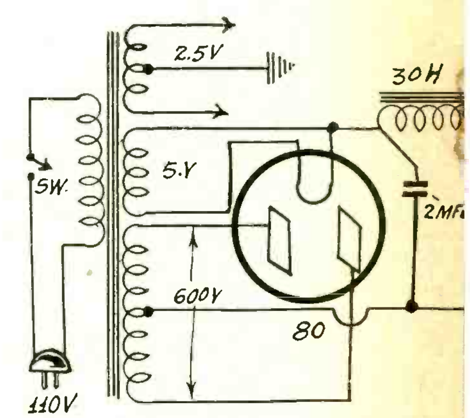
The Tuning Elements

In selecting a converter we have to choose, to some extent, between ease of operation and highest efficiency. The ganging of tuning controls usually means loss of sensitivity and selectivity. However, this loss may be overcome without sacrificing the simplicity of gang tuning. This is done partly by selecting the intermediate frequency and by padding.

The r-f and oscillator coils in the converter are designed with a definite intermediate frequency in mind. The intermediate frequency must be chosen so that the broadcast receiver is sensitive on that frequency and also so that there is little interference on it. These two may be conflicting requirements and for that reason the converter should be flexible enough to permit a slight change in the intermediate frequency.



GANGED COIL ASSEMBLY 10 TO 200 METERS



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The object of padding a circuit is to establish a desired rate of capacity change. In a converter this may be done by connecting a condenser in series with the oscillator tuning condenser or by connecting a condenser across the r-f tuning condenser. In the present circuit the padding condenser is connected in shunt with the modulator or r-f condenser section. Moreover, the shunt condenser is independently adjustable from the panel, and that gives a means of compensating for slight changes in the intermediate frequency.

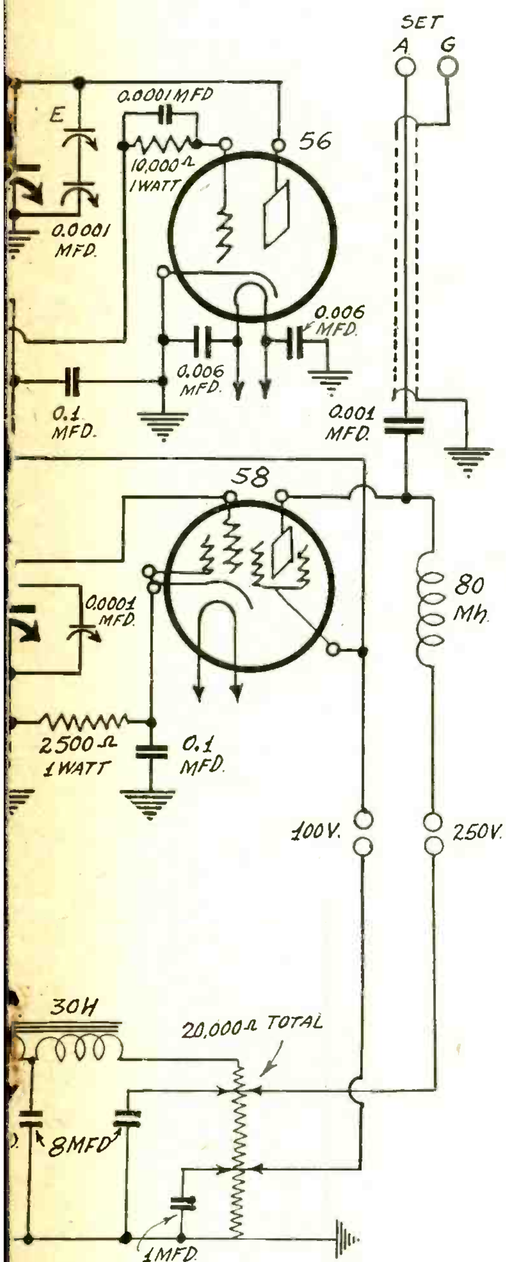
One essential in a short-wave set of

RT-WAVE CONVERTER

ated Three-Tube A-C Circuit

Mannion

adio Co.



IG. 1

any kind is that accurate tuning shall be possible. This is particularly true in a converter where the oscillator is extremely critical, particularly on the higher frequencies. An exceptionally satisfactory slow motion adjustment is provided in this converter by means of a shunt across the oscillator condenser. This shunt consists of a very small condenser E in series with a variable condenser of 100 mmfd. The smaller E is the finer is the possible tuning adjustment of the variable part of the shunt.

E is a trimmer type condenser having a maximum capacity of 20 mmfd. It is adjustable by means of a screw. The effective capacity of the series combination is always less than the capacity of the smaller of the two. A change of the variable condenser from maximum to minimum will change the total capacity very little, and what change there is is spread out over the entire dial.

The series shunt is particularly valuable as a band spreader. The main condenser gang is set at approximately the correct position and then a narrow band may be covered by means of the 100 mmfd. in the series shunt. The r-f tuner is sufficiently broad to permit this without any change in the setting of the r-f shunt or trimmer condenser.

In practice the value of E is set at about 5 mmfd., which is the capacity when it is wide open. With this capacity the total variation in the oscillator capacity over the whole range of the 100 mmfd. condenser is only 1.5 mmfd. This is out of a total capacity of about 150 mmfd. and therefore the whole range of the 100 mmfd. trimmer is only one per cent of the total capacity. That is equivalent to a frequency band of 150 kc at 30,000 kc.

LIST OF PARTS

Coils

One short-wave coil assembly, with switch, 10 to 200 meter coverage
One 80-millihenry r-f choke coil
One power transformer, 110-volt primary, 2.5-volt centertapped secondary, 5-volt secondary, and one 600-volt centertapped secondary
Two 30-henry choke coils

Condensers

One gang of two 0.00014 mfd. tuning condensers
Two 0.0001 mfd. variable condensers
Two 20 mmfd. equalizing condensers
Two 0.006 mfd. fixed condensers
One 0.0001 mfd. fixed condenser
One 0.001 mfd. fixed condenser
Two 0.1 mfd. fixed condensers
One 2 mfd. 450-volt condenser
Two 8 mfd. condensers
One 1 mfd. condenser

Resistors

One 10,000-ohm grid leak
One 2,500-ohm bias resistor
One 20,000-ohm, 50-watt resistor with sliders

Other Requirements

One length of three feet of shielded wire
One four-prong socket
One five-prong socket
One six-prong socket
Bus bar connecting wire
One drilled chassis and aluminum panel
One vernier dial
One line switch, plus and cord

Power for Converter

A wobbly signal, that is, one the frequency of which varies over a narrow range, can often be followed by means of this vernier control.

Power for the converter may in many cases be obtained from the set with which it is worked. But most satisfactory results are obtained when the converter is self-powered. Fig. 1 shows a power unit suitable for use with the Pathfinder converter, the diagram of which is shown at the top of the figure. A rather heavy bleeder current is recommended because this will insure steady d-c voltages on the tube elements, and that in turn will insure steadiness of the frequency of the oscillator at whatever value it is set.

When a separate power supply is provided for the converter, the use of this device in conjunction with a receiver places no extra load on its power supply and no voltages are changed.

It is essential for best results that the converter be well shielded as a whole, but individual shielding of tubes and coils is not advisable. A case made of heavy gauge aluminum is not only efficient as a shield but it gives a good appearance to the converter.

Guide in Tuning

Some advice concerning tuning in short waves will not be amiss for in most instances of complete failure of a converter or short-wave set the trouble does not lie in the apparatus but in the method of tuning, or perhaps in the lack of method. Short-wave stations cannot be tuned in, as a rule, by rapidly sweeping over the dial. There mav be a thousand short-wave stations within reach, yet none will be heard when this is done.

First of all, consult a good list of stations and make sure that those desired are on the air. And be sure to make due allowance for time difference in case the station desired is on the other side of the earth. Most European stations will come in during the afternoon in regions on Eastern Standard Time. At 7 o'clock, E.S.T. it is midnight in England and about that time the British stations will be signing off. GSA and GSB, Daventry, England, are exceptions, for they regularly broadcast for the benefit of Canadian listeners between 8 and 10 p. m., E.S.T.

"Something Doing"

There is always "something doing" on the short waves. If the particular station you want is not on the air, thousands of others will be. There are ship-to-shore, transatlantic phone, police, amateur phone and code, airplane signals, and many others to choose from. As Summer approaches reception from Europe will improve, and there should be plenty of thrills for everybody with a short-wave converter and a broadcast set.

Although there may be a large number of stations operating at any time, the necessity for careful tuning is paramount. Tune slowly. The main tuning control may be adjusted in small steps provided those steps do not cover a wider range than is covered by the trimmer on the oscillator. For the higher frequencies the steps must be exceedingly small and it is necessary to tune the main dial just as carefully as possible and then use the other as a vernier.

COUPLING COEFFICIENT

Obtained with the Aid of an Oscillator

By J. E. Anderson

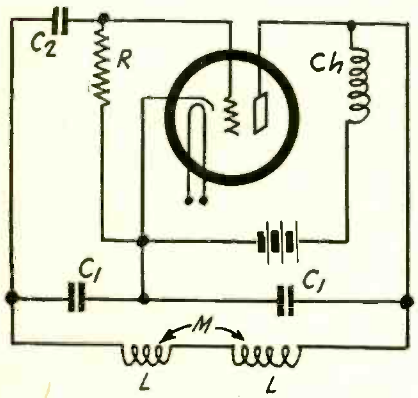


FIG. 1
A simple Colpitts oscillator that is suitable for calibration or for use in measuring coils and coupling coefficients.

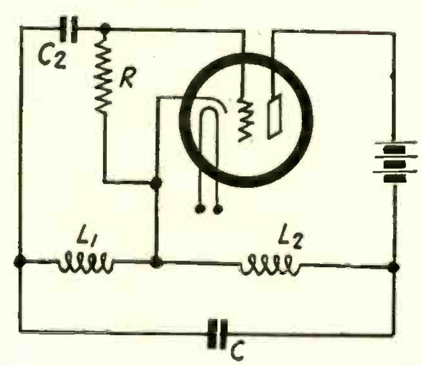


FIG. 2
A simple Hartley oscillator suitable for calibration, or for measurement of coils when there is no coupling between the two coils.

A SIMPLE method of measuring the coupling coefficient between two coils is convenient to have at times. There is a very simple way if a calibrated oscillator is available. The coils involved are wired into another oscillator such as that shown in Fig. 1. This Colpitts oscillator is convenient because it will oscillate regardless of the coupling between the two coils. It may be negative, positive or zero.

The idea is to connect the two coils in this oscillator with the coupling positive and measure the frequency generated with the calibrated oscillator. Then the leads of one coil are reversed so as to make the coupling negative and again measure the frequency. From the two frequencies measured the coefficient of coupling can be obtained if the two coils are equal. Let us prove the statement.

The circuit that determines the frequency is made up of the two condensers C1 and the inductance of the two coils. For simplicity let us call the capacity of the two condensers in series C. When the two coils are connected in series aiding, that is, so that the mutual inductance M is positive, the total inductance in the circuit is 2(L+M) and when the coils are connected so the coupling is negative the total inductance in the circuit is 2(L—M). If F_1 is the frequency obtained when the coupling is positive and if F_2 is that obtained when the coupling is negative, we have $F_1^2 = 1/2C(L+M)$ and $F_2^2 = 1/2C(L-M)$. Dividing the first by the second we have $F_1^2/F_2^2 = (L-M)/(L+M)$.

Obtaining k

If we knew L we could obtain the value of the mutual inductance from this formula, but we do not have L. If the coefficient of coupling between the two equal coils is k, M = kL. If this value of M is put in the formula we have, on dividing through by L, $F_1^2/F_2^2 = (1-k)/(1+k)$. From this k can be computed because the two frequencies are known by measurement. In fact k is equal to the difference between the squares of the two frequencies divided by the sum of the squares.

The method illustrated in Fig. 1 was devised particularly for the measurement of the coupling between the two coils in a doubly tuned i-f transformer. In this case k is very small but the method is quite capable of measuring it.

The circuit is also suitable for the measurement of single coils, once the effective capacity in the circuit has been found. Suppose a coil of known inductance and negligible distributed capacity is connected in the position of the two L coils in the figure. The frequency generated will have a certain value. If this is measured accurately with a calibrated oscillator, the effective value of the capacity of the circuit can be computed from the known inductance and the known frequency. Once this capacity is known, it may be used for the determination of other inductances. They are obtained from the measured frequencies and the known value of this effective capacity.

The Circuit Constant

The fixed effective capacity in the circuit can be regarded as a circuit constant to be used every time the inductance of a coil is to be measured. In view of the fact that some coils that are to be measured may have a rather high distributed capacity, if the circuit capacity has a rather large value errors due to this dis-distributed capacity will be small. Practically this means that both C1 condensers should be large. While they are indicated to be equal it is not necessary that they should be.

Ch would depend on the frequencies to be covered. For broadcast and intermediate frequencies it might be around 85 millihenries. C2 may be 0.001 mfd. and R, the grid leak, should have as high a value as possible because the higher it is the more stable will be the frequency of oscillation. How high it may be made depends on the frequency of oscillation and the lower the frequency the higher the resistance may be. What really determines the value that can be used is the blocking of the grid.

There is no other oscillator than the Colpitts that lends itself so readily to the measurement of coils and the couplings between them. It is true that the Hartley in which there is no mutual between the plate and grid coils could be used. This circuit is shown in Fig. 2. R and C2 may have the same values as the corresponding values in the Colpitt's circuit and C may have the same values as the capacity of the two C1 condensers in series.

One of the coils, say L1, may be a fixed and known coil. Then L2 may be any coil that is to be measured. Its inductance can be determined in terms of L1. The frequency of oscillation in any case is determined by $F^2 = 1/C(L_1 + L_2)$. In order to use this oscillator the as the preceding it would be necessary to determine the effective value of C, which can be done with a centertapped coil of known inductance. Then this known inductance could be put in either the grid or the plate circuit alone and another coil to be measured could be put in the other circuit. By measuring the frequency of the new combination the inductance of the added coil could be found. The formula given above could be used, F being the measured frequency, C the determined circuit capacity, L1 the known inductance, and L2 the unknown inductance. There is to be no mutual inductance between L1 and L2.

General Utility of Oscillator

The measurements discussed above depend on a calibrated oscillator. Hundreds of other measurements in radio depend on a calibrated oscillator. Because of the general utility of a calibrated oscillator and because of the ease with which it may be calibrated accurately, every serious experimenter in radio should equip himself with one of them. And he should remember that the better he makes it the more useful it will be. It should have a high frequency stability so that the generated frequency may be depended on. It should have a good vernier dial that could be read to at least one part in 1,000 of the full scale, and this should be entirely without lost motion. Besides this, the tuning condenser should be comparatively small so that one sweep of the dial from zero to 100 will cover only a narrow range of frequencies. This means that there should be many coils.

The reason for the necessity of high accuracy in the oscillator is that many applications depend on the measurement of frequency differences, and such measurements will not be accurate unless the frequencies involved are accurately known. As an example, suppose we wish to measure a small capacity change in a condenser having a value 500 mmfd. This condenser may be in an oscillator the inductance of which is such that the frequency is 1,000,000 cycles per second. Then the capacity is increased by a small amount, say by an amount that will change the frequency to 990,000 cycles per second. We must measure both the 1,000,000 and the 990,000 cycle frequencies very accurately in order that their difference shall be known with fair accuracy, in this case the one per cent. Unless the accuracy of the oscillator is at least one part in 10,000 we have no chance of making the measurement to better than 10 per cent accuracy. Of course, this is an extreme case for the change in capacity was only 5.05 mmfd, or slightly over one per cent.

Less Accuracy Practical

Such high accuracy and stability are not needed in a large number of im-

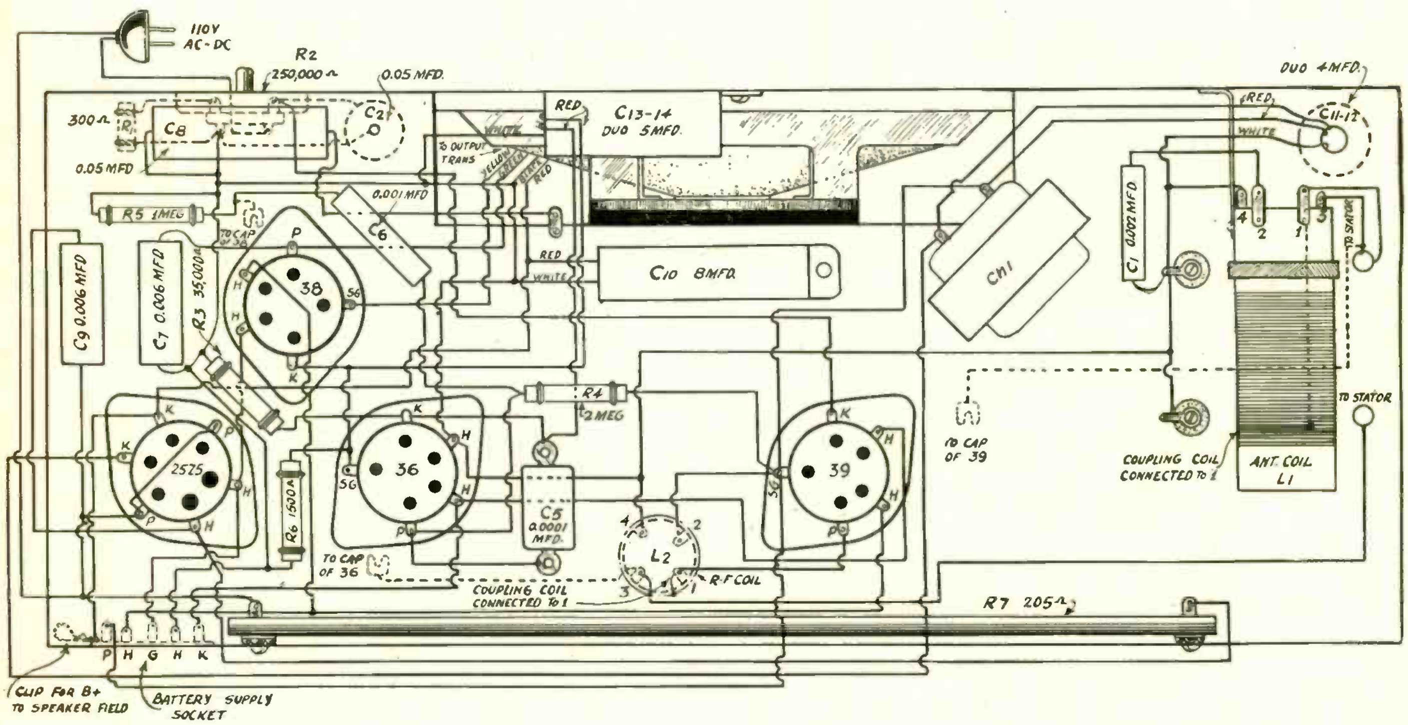
(*Continued on next page*)

Picture Diagram of Universal

Four-Tube A-C, D-C, Battery Set of T-R-F Design

By N. M. Haynes

Postal Radio Co.



THERE has been demand for a sketch showing the layout of the four-tube universal receiver published in the March 4th issue (last week). In that issue were shown in detail the circuit diagram, a sketch giving the arrangement of the battery plug-in adapter, and the details of the r-f coils and of the connections to the terminals on the four sockets. But no diagram of the actual layout followed in building the set was shown. This important detail is now supplied and is shown in Fig. 1. The sketch is self-explanatory.

After laying out the parts in a manner which has been found by experiment to give satisfactory results, there are still certain things that must be observed in wiring the set if best performance is to be obtained. This time it should be unnecessary to enjoin the set builder to make all leads "as short as possible," but there are still many who never heard of that good rule. In witness of this, many sets may be pointed to as expert violation of the rule. In one particular set there was so much superfluous wire that after rewiring, two other similar sets were wired with what was left over, and there was some for the third. The extravagant wirer had heard about the "short as possible" rule at that.

The proper length of wire to go between two points is the shortest practical distance between those two points, plus ever so little for slack just to keep the insulation from rubbing off at corners if any.

There are certain critical wires that must be watched particularly. The most critical are those on the "hot" side of a tuned circuit. This includes the lead from the stator of a tuning condenser to the grid or the lead running from the stator of the condenser to the tuning coil. These leads should be kept away from other conductors as far as practical and where they must be close together they should be crossed at an angle, preferably at right angles. These leads should be kept away from the chassis or any metal connected to the chassis, for otherwise a high minimum capacity will result in the circuit. In this connection it should be pointed out that by "far" is not meant several inches. In many cases half an inch is far and even one-quarter may not be too close.

The next most critical leads are those running from the plate of a tube to the top of the primary of an r-f coil. They, too, should be kept away from other leads and from the chassis.

Most important of all is to see that the plate and the grid leads are not close together. When these leads are considered together they may be entirely too close if they are two or three inches apart. Perhaps these leads may be much closer if they belong to the same tube but if they belong to different tubes they may have to be even farther apart. Much depends on the gain in the set and the type of coupling.

If the amplifier oscillates as a result of close coupling between leads the offending conductors can quickly be detected by body capacity test. Tune the set until the frequency it generates zero-beats with some signal. Then poke around the set with the index finger, without actually touching anything, and note that leads are most sensitive, judging by the change in the heterodyne.

Determination of Coupling Coefficient

(Continued from preceding page)

portant applications of an oscillator. For example, for adjusting receivers, for padding oscillators, and tuning intermediate frequency amplifiers, an accuracy of about 2 per cent. is satisfactory. It is only when the measurement involves the difference between two very nearly equal frequencies that high accuracy is essential.

Either of the oscillators in Figs. 1 and 2 can be calibrated. If Colpitts oscillator in Fig. 1 is selected for calibration the condensers C1 should be about 350 mmfd. each. They should be ganged and the common rotor should be connected toward the cathode. The coil LML should be of the plug-in type. Single winding coils are needed. Since the effective tuning capacity is only 175 mmfd. each coil will cover only a relatively narrow band of frequencies, but this is one of the desirable features in an accurate oscillator. Many coils will be needed to cover the entire useful band of frequencies. A ground should be used and it should be connected to the cathode.

If the Hartley circuit is selected for calibration, the tuning condenser C should have a maximum capacity of about 200 mmfd. and the ground should be on the side to which the battery is connected. The oscillator coils L1 and L2 should be centertapped single winding coils and they may be of the plug-in type.

The important thing about a calibrated oscillator is the calibration and not the size of the tuning condenser, nor the type of coils used, nor the type of circuit. No, the calibration is the important thing, and the calibration includes the dial which is actually calibrated and on which readings are made. Every calibrated oscillator should have a first class dial, preferably one with a real vernier on it.

FOR BATTERY FOLK

A Seven-Tube Superheterodyne With 85 Detector and 89 Output

By Einar Andrews

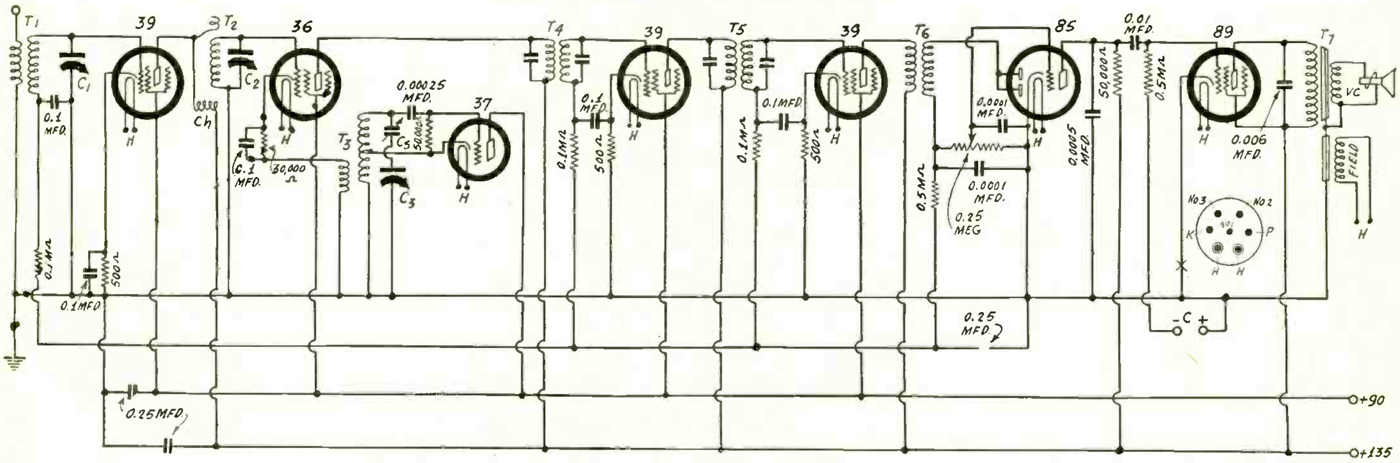


FIG. 1
This seven-tube superheterodyne is suitable for use where batteries must be employed. A good antenna should be used with it if extreme distance is sought.

THOSE who live where electric power lines have not yet penetrated are asking for battery-operated receivers comparable in sensitivity and selectivity with those of modern a-c receivers. And why should they not have them?

Really, such receivers have been described many times but they have been called automobile sets. An automobile set is normally used in places where electric power lines have not penetrated, that is, in the car. They are operated off the car storage battery. A receiver not especially designed for a car but designed for use where there is no electric power available must necessarily be designed in about the same way. There is one difference. If the set is not to be used in a car it does not have to be quite so sensitive because it can be used with a regular antenna. Not only that, but if there is no electric power available, chances are that the place is such that there is no difficulty in erecting the very best kind of antenna.

Sensitivity and Selectivity

The requirements for high selectivity are not likely to be so great in these remote places, for there will not be any powerful stations close. But if a receiver is to reach out thousands of miles, it must be selective enough to separate stations 10 kc apart when these are located at some distance. It is easier to separate these stations if they are 1,000 miles away than to separate two stations 50 kc apart if one of them is a few blocks away. Fair selectivity should be satisfactory provided that the sensitivity is adequate. While a very high selectivity is not essential, it will do no harm if the set is capable of it.

In view of the fact that a good antenna is practical, a set of the type used in automobiles, but with one stage of audio omitted, would be satisfactory. The omission of the extra audio stage is permissible for another reason. A duplex diode triode of extremely high gain will be available shortly and when it comes out it can be substituted for the 85 with very few changes. The reported gain in this tube is higher than that afforded by an 85 and an extra stage of 37 with resistance coupling. Even without this extra gain there would be plenty of sensitivity on a set utilizing a good antenna.

High Gain R-F

The circuit herewith, which is a modified automobile set, should have ample sensitivity for the most remote places and it should have enough selectivity for a congested radio district. With the substitution of the new supersensitive detector, the set should also have ample sensitivity for automobile use.

In the r-f amplifier are two tuned circuits. The first transformer, T1, is a regular antenna coupler for 350 mmfd. tuning condenser. It should be of the midget type. The second coil is of the so-called high-gain type. That is, it is effectively of the direct coupled type, with a radio frequency choke in the plate circuit, a parallel tuned circuit before the grid of the mixer, and a tiny capacity between the plate and the grid. The choke is proportioned so that its capacity and the plate-cathode capacity together cause resonance at a frequency just below the broadcast band. The net effect is to make the gain approximately uniform from one end of the band to the other, and at the same time make it high. Of course, the parallel resonant circuit on the grid side is always tuned to the signal.

The Oscillator

A simple oscillator of the Hartley type is used. As connected in this circuit the oscillator coil may consist of a single winding with two taps on it. Between one end and the first tap are from five to ten turns and this small winding is used for pick-up. The other tap, which is connected to the cathode of the oscillator, should be near the middle of the remaining turns.

There is a stopping condenser of 250 mmfd. and a grid leak of 50,000 ohms. A higher value of leak resistance is likely to cause blocking.

If the radio frequency inductance is 246 microhenries and the intermediate frequency 175 kc, the oscillator inductance should be 192 microhenries, counting the part of the winding across which the tuning condenser is connected. This will be given by 102 turns of No. 32 enameled wire on a form one inch diameter. The cathode tap may be put at the 51st turn. At the ground end the winding should be continued from 5 to 10 turns more.

The series padding condenser Cs is connected on the stator side of the oscillator tuning condenser because this special type of oscillator admits no other arrangement. The value of this condenser should be approximately 900 mmfd. so that if a 700-1,000 mmfd. padding condenser is used it will be all right.

Intermediate Amplifier

There are two stages in the intermediate amplifier, and three intermediate transformers, two of which are doubly tuned and one of which is aperiodic. The two doubly tuned transformers are standard i-f couplers but the untuned, T6, should be made of a couple of 800 turn r-f choke coils. These may be mounted on the same form or on two similar forms placed end to end. The closer the coupling between these two coils the greater will be the voltage transfer, but if they are too close the circuit will be noisy. They might be placed half an inch apart, measuring from the nearest sides of the coils.

This i-f amplifier has a very high gain and more than compensates for the omission of the extra audio tube. That is to say, the set is more sensitive for the same number of tubes if a 39 is used as i-f amplifier than if a 37 is used as a-f amplifier.

Volume Control

A set that is to be used primarily at long distances from broadcast stations will undoubtedly be in the fading zone of

LIST OF PARTS

Coils

T1—One shielded r-f tuning transformer for 350 mmfd. condenser.

T2—One high-grain r-f coupler for 350 mmfd. condenser.

T3—One oscillator coil as described.

T4, T5—Two doubly tuned and shielded i-f transformers.

T6—One untuned i-f transformer as described.

T7—One loudspeaker for 6-volt field and 89 power tube.

Condensers

C1, C2, C3—One gang of three 350 mmfd. tuning condensers.

Cs—One 700-1,000 mmfd. padding condenser.

Five 0.1 mfd. by-pass condensers.
One 250 mmfd. condenser.
Two 100 mmfd. condensers.
One 0.006 mfd. condenser.
One 0.01 mfd. condenser.
Three 0.25 mfd. by-pass condensers.

Resistors

Three 500-ohm bias resistors.
One 30,000-ohm resistor.
Two 50,000-ohm resistors.
Three 0.1-megohm resistors.
Two 0.5-megohm resistors.
One 0.25-megohm potentiometer.

Other Requirements

Five five-contact sockets.
Two six-contact sockets.
Two six-contact sockets.
Five grid clips.
Six binding posts.
One filament switch (May be attached to the volume control potentiometer).
One chassis.

sistance should be shunted by a condenser of 4 mfd. or more. The grid leak should then be connected to ground, or the two C points should be shortened.

The filament circuit is left floating. Hence any six-volt source of voltage may be connected. But in this case it is supposed to be a six-volt storage battery. Polarity need not be observed since the heater circuit is entirely free of the rest of the receiver.

If a-c is available, it may be used on the heaters without any change in the connections. However, if a-c is used on the heaters some other source of d-c must be provided for the field of the heater.

Power Dissipation

The maximum plate current that the circuit will draw out of the B battery is about 40 milliamperes, assuming normal adjustment of bias values. On strong signals it will draw much less because even then the a.v.c. will be effective in increasing the bias on the 39s.

The current drawn from the 6-volt storage battery by the tubes will be only 2.2 amperes. The total current will depend on the requirements of the field. If the field has a resistance of 4 ohms, which is a common value for a speaker that is to be used on 6 volts, the speaker will take 1.5 amperes and the total drain will be 3.7 amperes. This is not a heavy drain if a 100 ampere-hour storage battery is used.

Socket Arrangement

The socket sketch on the diagram shows the connections for the 89 tube. No. 1 is the control grid and it is at the top of the tube. No. 2 is the screen and is connected to the high voltage. No. 3 is the suppressor and is connected to the cathode.

DETERMINING FUNDAMENTAL

IN CALIBRATING an oscillator of a low frequency against one of higher frequency I have run into difficulty in deciding what harmonics are causing the heterodynes. If there is any rule by which to go please give it.—F. W. K., Portland, Ore.

Suppose the fundamental frequency of the oscillator is f. Then the harmonic frequencies will be 2f, 3f, and so on. The difference between any two successive harmonics is always equal to the fundamental, and that gives us a guide. Suppose there are two prominent squeals at F1 and F2 on the higher frequency oscillator and that there is none between. Then we know that F1—F2 is equal to f, assuming F1 is the higher frequency. As a check on this each should be divided by the difference and in each case the result should be a whole number. Moreover, the number obtained by dividing F1 by (F1—F2) should be one greater than that obtained by dividing F2 by the same difference. If these relations are obtained we are sure of the fundamental frequency of the low frequency oscillator. Sometimes it will happen, quite often in fact, that the numbers obtained will not be whole but will be 3/2, 4/3, 5/2, 5/3, and so on. The heterodynes are then obtained from beats of the higher frequency oscillator. As an illustration of the use of this method, an intermediate frequency oscillator was calibrated against an oscillator that covered the broadcast band. Two prominent beats were heard at 600 and 720 kc. The difference between these two is 120 kc and the inference is that the fundamental of the i-f oscillator is 120 kc. Dividing 600 by 120 we obtain 5 and dividing 720 by 120 we obtain 6. Hence the i-f was 120 and the two harmonics were the fifth and the sixth. Fractional harmonics are not very troublesome when the harmonics used are so high but the harmonics themselves are weak and sometimes not easy to locate.

many of them. Hence the receiver should be provided with an automatic volume control. In the present set the r-f and the two i-f amplifiers are automatically controlled by the d-c portion of the output of the diode rectifier. This automatic control is very effective.

Since the a.v.c. controls the radio frequency amplification the manual volume control is put in the input of the audio amplifier, that is, in the grid circuit of the triode of the 85.

All the tubes with the exception of the output tube are self biased. Thus each of the 39s has a 500-ohm resistor in its cathode lead, shunted by a 0.1 mfd. condenser. The first detector is biased with a 30,000-ohm resistor and this also is shunted with a 0.1 mfd. condenser. The oscillator is biased by grid current through the grid leak. The triode of the 85 is diode biased.

Battery Bias

The 89 is not self biased because this would take too much voltage from the B supply and it would be a waste of power. Besides, it would cause reverse feedback. The most economical way to give this tube the required bias is by means of a grid battery, which may be a very small one, provided that it has the required voltage. With an applied plate voltage of 135 volts the bias should be about 13.5 volts. The bias battery should be connected between the points marked "C," with polarity as indicated.

Floating Filament Circuit

In case the B supply is other than a battery and there is plenty of voltage available, self bias is all right. A resistor of 800 ohms should be connected in the cathode lead at X and this re-

Magnet Wire Table

Of considerable use to the experimenter, and occasionally of great value to the service man, is the magnet wire table, printed herewith. There are various tables, compiled by wire manufacturers, standards boards and the like, and there is a small difference in the numbers of turns per inch and other factors. The accompanying table was prepared by RADIO WORLD laboratories, and represents average values.

The magnet wire table herewith is based on measurements at 68° Fahrenheit. Different temperatures will give slightly different results. In practice some slight variations are to be expected from the tabulated values, including particularly turns per inch, as the number of turns stated is based on accurate machine winding. Even so, slight variations will arise from difference in the size of wire of any one type.

Abbreviations: *B & S*, Brown & Sharpe, same as American wire gauge. There are six other gauges in use, but *B & S* is used in radio in the United States. *SS* is single silk, *DS* double silk, *SC* single cotton and *DC* double cotton. For direct current *CC* is used to avoid confusion with *DC*, that represents double cotton. *CC* stand for continuous current, which is synonymous with direct current.

Turns Per Inch

B. & S. Gauge	*cc. Ohms per 1,000 Feet*	*Single Silk*	*Double Silk*	*Single Cotton*	*Double Cotton*	*Enameled*	*Enameled SS*	*Enameled DS*	*Enameled SC*	*Enameled DC*
14	2.525			15.6	13.6	15.2			14.1	13.3
15	3.184	16.9	16.3	16.1	15.1	17.0			15.6	14.8
16	4.016	18.9	18.2	17.9	16.7	19.1	18.4	17.7	17.4	16.3
17	5.064	21.2	20.3	19.9	18.2	21.5	20.5	19.7	19.3	17.9
18	6.385	23.6	22.6	22.1	20.2	23.9	22.8	21.8	21.4	19.7
19	8.051	26.3	25.1	24.4	22.2	26.8	25.4	24.2	23.6	21.5
20	10.15	29.4	27.8	27.0	24.3	30.1	28.4	26.9	26.1	23.6
21	12.80	32.7	30.8	29.8	26.7	33.7	31.6	29.8	28.9	25.9
22	16.14	36.6	34.2	33.0	29.2	37.7	35.0	32.8	31.7	28.1
23	20.36	40.6	37.7	36.2	31.6	42.3	39.0	36.4	34.9	30.6
24	25.67	45.2	41.6	39.8	34.4	47.1	43.1	39.8	38.1	33.1
25	32.37	50.2	45.8	43.6	37.2	52.9	47.8	43.8	42.8	35.8
26	40.81	55.8	50.5	47.8	40.1	59.1	52.9	48.0	45.7	38.6
27	51.47	61.7	55.5	52.0	43.1	66.2	58.4	52.9	49.7	41.4
28	64.90	68.4	60.9	56.8	46.2	74.1	64.5	57.8	54.0	44.4
29	81.83	75.1	67.1	61.3	49.2	83.3	71.4	64.1	58.8	47.6
30	103.20	83.1	73.2	66.5	52.5	92.2	77.8	69.2	63.0	50.3
31	130.10	91.5	79.3	71.9	55.8	103.4	85.6	75.3	68.1	53.5
32	164.10	100.5	86.5	77.2	58.9	115.6	93.8	81.6	73.2	56.6
33	206.90	110.1	93.6	82.8	62.1	129.3	102.7	88.2	78.5	59.7
34	260.90	120.4	101.0	88.4	65.3	144.9	112.3	95.2	84.0	62.8
35	329.00	131.4	108.5	94.3	68.4	162.3	122.5	102.4	89.6	65.9
36	418.80	142.8	116.2	100.0	71.4	181.8	133.3	109.8	95.2	68.9
37	523.10	155.0	124.2	105.8	74.3	202.4	144.1	117.1	100.6	71.7
38	659.60	167.7	132.2	111.6	77.1	227.7	156.4	125.1	106.4	74.6
39	831.80	180.5	140.2	117.2	79.8	252.5	167.7	132.2	111.6	77.1
40	1,049.00	194.5	148.3	122.8	82.3	280.1	179.5	139.4	116.6	79.5

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Bypass in Push-Pull

THERE IS SOME DOUBT in my mind about putting a condenser across the common resistor that biases the push-pull output tubes. Usually there is a condenser across any biasing resistor.—U. R. V., Valhalla, N. Y.

In a symmetrical stage, such as true push-pull, there would be no need of a condenser where the bias is due to the voltage drop in a resistor through which the tubes' B current flows, because the signal through the resistor is effectively zero. The signal voltages are equal in quantity but opposite in phase. The direct current component of the B current of course requires no bypassing, as it is zero frequency. However, a symmetrical stage is assumed, and that would require that the balance be perfect, in the input and output transformers, in the tubes themselves, and even that the d-c voltages and currents be just the same in both circuits. That is, the balance would have to be statically and dynamically symmetrical. It may be assumed that such an order of symmetry will not be developed in practice, hence some commercial circuits seem to favor inclusion of a bypass condenser across the self-biasing resistor. As a d-c check, the voltages may be read on the positive potential elements, to be sure they are the same; the plate current may be read in first one tube, then in another, with a meter of very low resistance, and any disparity noted. Equalization of static characteristics may be approximated by biasing a little more negatively the tube that shows greater plate current. However, the main consideration is the dynamic balance, and this is difficult to check up without precision instruments. One helpful consideration, however, is the fact that in an a-c-operated set the hum will be greater with the condenser out than with it in, if there is dynamic unbalance particularly. So if the condenser reduces hum, put it in. But remember that the capacity should be large. Electrolytic condensers of extremely small size but large capacity (10 to 20 mfd. for instance) are obtainable for the low voltages concerned with biasing.

* * *

I-F Oscillation

IN A SUPERHETERODYNE I have built I find that there is oscillation in the intermediate amplifier when the circuit is peaked, but that by slight detuning the oscillation disappears, but the sensitivity then drops. Can you suggest a method of getting rid of oscillation without sacrificing so much sensitivity?—O. W., Taormina, Italy.

A simple method is to put a resistor in series with the plate lead to each intermediate tube and bypass that resistor to ground. The value of the resistor depends somewhat on the intensity of the oscillation, and the amount of plate current that normally flows in the tubes used. However, a good value to try is 5,000 ohms, and the bypass capacity may be as high as you desire, but should not be less than 0.1 mfd. Also you may try putting succeeding stage coils at right angles to their preceding coils of the same frequency (all intermediates, for instance), as this greatly reduces, or eliminates, inductive feedback.

* * *

Test Oscillator Calibration

HAVING BUILT A TEST oscillator for intermediate frequencies, using a variable condenser across a coil of high inductance, I know I am in the intermediate region, but I can not calibrate the device. Please give me a few brief hints.—I. S., Cleveland, O.

It is assumed you have a broadcast receiver and that you have it calibrated in frequencies, at least to the extent that you know what frequencies are represented by most of the numerical settings of the scale. Therefore you know the frequency difference between points. If you will set your test oscillator going at the lowest frequency, and beat with some broadcast station, listening to the squeal on your receiver, then tune the broadcast set to a higher frequency and note where this next squeal comes in, the low frequency of the oscillator is equal to the difference between these two broadcast frequencies. At the high frequency end of the test oscillator this plan would work out the same way. Having obtained the extremes, you can beat with some low broadcast frequency, as the one used to attain test oscillator's low extreme, and get several points by continuing to tune the receiver to higher frequencies. Knowing your approximate frequencies, you can accurately check all you need for a curve that has 12 points or more, and then use the curve as a chart or for converting the result to a dial you will calibrate yourself. Scales on existing dials may be removed with kitchen cleansing powder and a moist rag, and you may register your frequencies with a sharp pencil, filling in later with a fine lettering penpoint and india ink.

* * *

Oscillation of Amplifiers

WHAT ARE the conditions for the self-oscillation of radio frequency amplifiers? That is, will a circuit oscillate if there is a tuned circuit in the plate or must there be a tuned circuit on both sides of the tube? I have reference to oscillation due to stray capacity.—E. W. H., Chicago, Ill.

If there is a tuned input and if there is capacity between the plate and the grid, the condition for oscillation is that there be an inductance in the plate circuit. How large this inductance must be depends on the value of the plate to grid capacity and on the frequency to which the grid circuit is tuned, or rather on the frequency that is being amplified, assuming that the circuit is tuned to that frequency. A parallel tuned circuit on the plate side will cause oscillation because at certain settings a parallel tuned circuit is a high inductance. It is also a capacity for certain settings and then there would be no oscillation. When the plate is tuned to exactly the same frequency as the grid circuit and when the resonant frequency is impressed there is no oscillation. The difficulty is to effect this adjustment.

* * *

Coupling and Amplification

IN A DOUBLY tuned i-f transformer what is the relationship between the amplification and the coupling between the coils? Does the gain go up in direct proportion to the coupling or is there an optimum degree of coupling that gives the maximum amplification?—G. W. B., Des Moines, Iowa.

There is a coupling that gives maximum amplification. If k is the coefficient of coupling between the coils and if these coils are equal in all respects, then the optimum coefficient is determined by $k^2 = R^2 C/L$, in which R is the resistance of either coil, C the tuning capacity across either, and L is the inductance of each coil. This formula assumes that the plate resistance of the tube is very large compared with the resistance R. This approximation is surely permissible for the plate resistance of a 58 tube is 0.8 megohm and the resistance of a coil that would be used in a 175 kc transformer would not exceed 100 ohms. Hence we neglect, approximately, one part in 10,000.

* * *

Effect of Stabilizing Resistance

IF A RESISTOR be put in the feed-back circuit of an oscillator for the purpose of stabilizing the frequency, is the reduction in the error proportional to the external resistor?—W. H. A., New York, N. Y.

No, the stabilizing effect is much greater than that expected from a linear relationship. In one instance of a tuned plate oscillator the improvement in the stability by the addition of an external resistance equal to the plate resistance of the tube was in the ratio of 4.2/1.1, the plate resistance being assumed to vary by 10 per cent. upward.

* * *

Single Meter Laboratory

IF ONE can only afford to get one meter for experimenting in radio, which meter would be the most useful, that is, with which meter could the most experiments be performed?—A. B. S., Fresno, Calif.

Undoubtedly, one of the new universal meters would be the most useful. With it current and voltages can be measured, provided suitable voltage multipliers and current shunts also were obtained. It can be used on a-c as well as on d-c, and that is its most useful feature. If a meter is to be really useful around a radio laboratory it should have a full-scale reading of 1 milliampere so that when it is used as a voltmeter it will be a 1,000 ohms per volt instrument.

* * *

Supersonic Heterodyne

WHAT IS a supersonic heterodyne and in what way does it differ from a superheterodyne? I have seen this expression in papers on receivers but the supersonic circuit was never given.—G. L., Stamford, Conn.

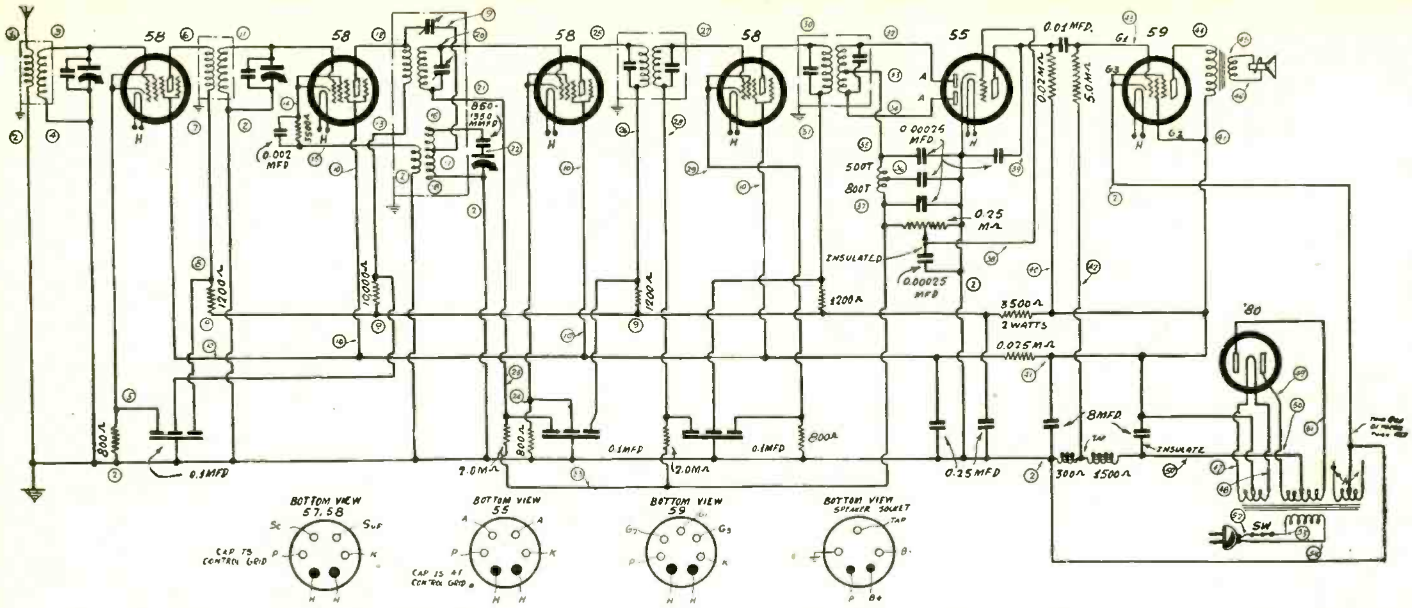
The supersonic heterodyne is the same thing as the superheterodyne. Perhaps it is the proper name for the circuit. At least it is the most logical. A superheterodyne works because a heterodyne is produced between the signal and a locally generated oscillation. But this heterodyne is above audibility. Hence it may be called supersonic. But there is an objection to that also. A sound does not necessarily cease to be a sound just because it passes above the audible limit. But that depends on the definition of sound. If we called the superheterodyne a superaudible heterodyne we might be more logical. But even that is a figure of speech. The heterodyne is not the receiver. The word superheterodyne is well established by usage.

* * *

D-C Versus A-C Resistance

WHAT is the difference between the a-c and the d-c resistance of a conductor or of a tube? Is there any difference in definition or is the difference one of magnitude?—S. E., Hoboken, N. J.

The difference is one of magnitude only. In all cases the resistance is a measure of the power dissipated in the device. If W is the power dissipated and I is the current, then the resistance is defined as $R = W/I^2$. Thus the resistance is the power dissipated per ampere flowing in the resistor or in the tube. The definition is quite general and



This seven-tube superheterodyne employs the 55 tube as detector and a.v.c., the 58 as modulator and oscillator, and the 59 as output tube.

applies to a-c as well as d-c, and it applies even when Ohm's law does not apply. Hence it applies to the plate and grid circuits of vacuum tubes. In a vacuum tube the d-c plate resistance is the ratio of the plate voltage to the plate current. Obviously, this ratio varies according to the current for the relationship between the plate current and the plate voltage is not linear. The a-c resistance in the plate circuit is the slope of the plate voltage plate current curve at the point where the resistance is measured.

* * *

Seven-Tube Super

PLEASE PUBLISH a circuit diagram of a seven-tube superheterodyne using the 55 as detector and a.v.c. and a 59 as output tube. If you do not have such a receiver the nearest to it will do if you will explain the necessary changes.—J. B. Y., Baltimore, Md.

The circuit you wish appears herewith. It employs the autodyne detector. Incidentally, this is a very sensitive receiver and it has a high output capability.

* * *

Oscillator Amplitude

ABOUT HOW GREAT is the amplitude of oscillation in an oscillator such as is used in a superheterodyne? That is, what is the voltage across the tuning coil or across the total tuning capacity? What determines the amplitude?—R. H. W., Syracuse, N. Y.

The amplitude depends on many things, the tube, the filament voltage, the grid voltage, the plate voltage, the ratio of tickler and tuned turns of the coil, the goodness of the tuned circuit, the ratio of the inductance to the capacity in the tuned circuit, and on the load on the circuit. As a rule the circuit oscillates over the entire grid voltage plate current characteristic. The voltage across the tuned circuit may be many times that across the grid-cathode. Very high voltages may be obtained across the tuned circuit.

* * *

Motorboating

THERE IS A noise similar to motorboating in my receiver, the audio of which consists of a 55 diode, a 56, and a 59, resistance coupling being used throughout. Do you think that this circuit could motorboat? If so, please recommend remedies.—H. A. W., Detroit, Mich.

You have an amplifier of three tubes with resistance coupling. That is one of the most unstable circuits of all, at least of those ordinarily seen. It is an odd circuit, having three plates on the same supply, and odd circuits are unstable. The remedy is to by-pass the B supply more thoroughly or to use individual filters in the three plate circuits. If the frequency of the motorboating is low, say 50 cycles per second or less, the trouble may also be stopped by lowering the values of the stopping condensers and the values of the grid leak resistances.

* * *

Obtaining Greater Gain

IN THE high-gain tubes like the 58, 235, 234, and the like the plate resistance is very high. This limits the amplification that can be obtained from these tubes. Would it not be desirable to have screen grid tubes with very low internal plate resistance and at the same time a high amplification factor? Why are not such tubes produced—W. R. A., Chicago, Ill.

No doubt such tubes would be desirable. We would have them too if they could be made. If you have any suggestions regarding the construction of the tubes, send them along.

* * *

Doubly Tuned Oscillator

IF AN oscillator is made of a doubly tuned i-f transformer and a tube which tuned circuit will determine the frequency in case the two are different? Is there a better chance of getting oscillation with a circuit of this type than with one having only one tuned circuit?—F. A. C., San Diego, Calif.

The frequency generated is a compromise between the natural frequencies of the two circuits. The one that is more selective, if there is a difference in this respect, will exert the stronger influence. If the two natural frequencies are too far apart there will be no oscillation at all. Whether or not the circuit oscillates also depends on the degree of coupling between the two coils. In a doubly tuned transformer the coupling is very loose and it may be that the two circuits have to be tuned to exactly the same frequency before there will be oscillation.

* * *

Measuring Selectivity

PLEASE GIVE a simple method by means of which the selectivity of a circuit may be measured. I have a 0-100 thermogalvanometer so that I can measure relative values of current in a tuned circuit.—R. L. B., St. Louis, Mo.

Connect the galvanometer in series with the tuned circuit and couple a source of a-c loosely to the coil. Adjust the frequency to resonance, that is, until the galvanometer reads maximum. Note carefully the frequency Fr and the deflection Dr. Detune in one direction or the other by varying the frequency impressed. Adjust the frequency until the deflection is just one-half of what it was at resonance. Note the frequency F. Then if Q is the selectivity, that is, the ratio of the inductive reactance at resonance to the resistance, $Q(F/Fr—Fr/F)$ equals one. This gives the selectivity since both frequencies involved have been observed. Repeat this measurement by detuning the circuit in the opposite direction. If the second value differs from the first, take the mean of the two. Note that the detuning should be carried to the point where the deflection is just half of the deflection at resonance. This applies to the deflection of a thermogalvanometer only, or to any current measuring device in which the deflection is proportional to the square of the current. This is, perhaps, the easiest way of getting the selectivity of a circuit and of getting the resistance as well. After the selectivity Q has been measured the resistance in the circuit may be obtained from $6.2832LFr/Q$. It is necessary to know the inductance of the coil as well as the frequency of resonance, or rather the frequency at which Q was measured. But L can usually be computed with fair accuracy, or it can be compared with a coil already known.

* * *

Sound Power Reserve

WHAT is the use of having a power amplifier and loudspeaker capable of handling 15 watts of power without distortion when in the home the maximum that can be used with comfort is about three watts?—J. M. B., Brooklyn, N. Y.

The idea is not to have an amplifier capable of this output to give this output all the time, but the idea is to have a reserve of power for sudden requirements. Occasionally there will be moments when the amplifier will give out 10 or 15 watts on the low tones. If the reproducer cannot handle the output then there will be distortion. Possibly a 500 per cent. safety factor is more than is needed.

* * *

Value of Resistor

WHAT should be the value of a grid resistor in an audio circuit? What are some of its effects?—C. L., Yonkers, N. Y.

To support low-note response it should be as high as practical. This may also make the hum less, though the statement is anomalous. But if the succeeding tube may draw grid current, the second tube would lose bias if the resistor were high. Therefore circuit conditions determine the value as much as does anything else.

TRIO APART IN SKYSCRAPERS SYNCHRONIZED

The first four-point synchronized broadcast ever attempted in radio was heard over the Columbia network when the Do Re Mi feminine harmony trio presented a program from three of the world's tallest buildings. Each girl was stationed in the tower of a building, while the pianist accompanying them broadcast from a WABC studio on Madison Avenue, New York.

The three buildings were the Empire State, tallest in the world; the Chrysler Tower, and the Bank of Manhattan. Each was connected by a wire circuit with Columbia's master control room. The three harmonizers were equipped with earphones through which each heard the melodies broadcast by the other members of the trio. The voices of all three were blended with the sounds of the piano accompaniment and sent out over the Columbia network just as if the entire program were being broadcast from a single studio.

The Empire State Building, where "Do" was stationed, is 102 stories high. "Re" was in the Chrysler Tower, which is 77 stories, and "Mi" sang her blues notes from the Bank of Manhattan Building at 40 Wall Street, 70 stories high.

The four points of the broadcast were spread over the entire length of mid-town and lower Manhattan. The Columbia studios are at 485 Madison Avenue, at Fifty-second Street; the Chrysler Tower is at Lexington Avenue and Forty-second Street; the Empire State Building is at Thirty-fourth Street and Fifth Avenue; and the Bank of Manhattan Building is near the tip of Manhattan.

League's Manchurian Report Is Broadcast to World in 9 hr., 22 min.

Radio records were set when the League of Nations Committee of Nineteen transmitted its report on Manchuria to the world. The report contained 15,000 words and was sent as one continuous message from 9 a.m., to 7.22 p.m., New York time. This constituted a record of transmission. The reception of this message by the New York "Times" without error constituted another.

Two operators of the "Times" received the message and typed the words as they came over the air in code. Besides, the message was recorded automatically by means of a machine. This constituted a double check on the reception.

The message was transmitted from Geneva, Switzerland, on two waves, 20.64 meters and 38.47 meters. The signals on the first were directed toward the west for this wave is more suitable for daylight. The other wave was directed toward the east for this wave is more suitable for night transmission. When the 20.64-meter wave became weak in New York, due to darkness over the Atlantic, the receiving operators switched to the longer wave and the strong signals returned.

Sets With Many Tubes Gain Quite a Market

More and more tubes are being used in radio receivers. There is quite a demand for 12-tube, 13-tube and 14-tube sets, considering the price in comparison to economic conditions. However, 14-tube sets, or kits, complete with tubes are selling for half the price of 6-tube sets or kits of four years ago, when the sets or kits were sold less tubes.

Special purposes require the multi-tube sets, while at least two, and sometimes four, output tubes are used.

A.P. SUES KSOO; SAYS ITS NEWS WAS "PIRATED"

Sioux Falls, S. D.

Suit has been begun by the Associated Press against KSOO for a permanent injunction and damages on the ground that the station broadcasts A.P. dispatches, infringing the copyright and the property rights of the association. The A.P. is an co-operative association of newspapers for gathering and interchanging news, and is the largest one of its kind in the world.

Instances have been called to the attention of the A.P. to the broadcasting of its news, and the present action is being taken in Federal Court so that a final determination may be reached that will affect all stations in the United States regarding the use of A.P. material. It is not a question of giving "credit" to A.P., but of using the material at all, with or without "credit."

Judge Elliott signed a decree granting a temporary injunction. Normally this would be effective until the trial of the case, unless meanwhile the station can convince the court it has a sufficiently adequate defence to warrant the assumption it might prevail at the trial, when the temporary injunction would be vacated.

The station is accused of "pirating" and disseminating to the general public the news to which the A.P. and its members are exclusively entitled, and that it gets the news by "lifting" it from a local newspaper that is a member of the association. This, the complainant states, "works a direct and irreparable injury" to the A.P.

FORUM

Three Criticisms, One Favorable

THERE ARE two criticisms that I wish to make:

In the past several articles have been started and left for completion in subsequent issues. In the majority of cases they have been completed later but in several instances they have not been finished and there was no statement as to just why. This leaves you with an opinion that possibly someone has forgotten something.

Would it not make things more interesting to complete an article in an issue instead of carrying several parts of different articles in one issue? In other words, where an article is special, devote more space to it in one issue and leave some of the shorter articles to a later issue.

I know that there is a file kept of the different articles with respect to the issues and am wondering why you don't issue once a year a cross-index of the subjects treated, so it would be possible to look up a certain discussion without having to dig through back numbers to find something that otherwise would be found at once.

I enjoy the way the articles are put forward and the completeness of the discussions in RADIO WORLD much more than in any magazine.

HAROLD L. ROSS,
Greensboro, N. C.

A THOUGHT FOR THE WEEK

IS S. L. ROTHAFEL (Roxy) a fixed executive at Radio City? Some say he is and some say he isn't. He knows. Please tell us, Roxy!

STATION SPARKS

By Alice Remsen

A Barnyard Symphony

For "Jack and Jill"

WLW; each week-day-10:30 a.m., and Monday, Wednesday, Thursday, and Friday, 6:P.M.

In the barnyard you will find
Animals of every kind;
Hens and chickens, ducks and geese,
Sheep and lambs with woolly fleece;
Piggies all with curly tails,
Even funny little snails;
Cows and horses, cute colts, too—
In the barnyard greeting you.

Hear the old cow go moo-moo!
And the sheep go baa-baa-baa!
Hear the white duck go quack-quack,
For nothing in particular;
The rooster's cock-a-doodle-doo—
He's as proud as he can be!
A lot of funny things you hear
In the barnyard symphony.

See the chickens being fed
Just before they go to bed;
All the piggies in their styes
Now are closing weary eyes;
Hear the horses—how they neigh
For their evening feed of hay;
Cows and sheep and lambies white—
All are shut up for the night.

Hear the old cow go moo-moo,
And the sheep go baa-baa-baa.
Hear the white duck go quack-quack
For nothing in particular;
The rooster's cock-a-doodle-doo—
He's as proud as he can be!
A lot of funny things you hear
In the barnyard symphony.

—A. R.

* * *

AND IF YOU AND THE CHILDREN LISTEN IN TO JACK AND JILL you will hear all the denizens of the farmyard, for Jack is an adept at all animal impersonations, as well as human mimicry, and Jill is such a cute kid herself. Both children and grown-ups like to listen to this clever pair. Tune in; it will be worth your while.

* * *

The Radio Rialto

Have you fallen prey to the jigsaw puzzle craze yet? A great many radio artists are addicts. Ilo May Bailey and her husband, Lee Sims, whom you have probably heard from the Chicago NBC studios, are among the more ardent jigsaw fans. Ilo May conceived the idea of framing the completed puzzles and using them for pictures on the walls of her snug little den; the den is now full to overflowing; the living room looks more or less like the Metropolitan Museum of Art, the bedrooms are filled with choice specimens of ships in full sail, Washington at Mount Vernon, and other colorful jigsaws; they are now starting with those new ones, made with plain wood—so nice for the billiard room in the basement...

Even Charlie Wilson, the Loose Nut of vaudeville fame, has gone radio; he appeared on the Household Musical Memories program, as guest artist recently, and shook the nuts off his family tree all over the studio. . . . Al Jolson is at it again; he says the farmer is in sore traits because everything these days goes against his grain . . . and Eddie Cantor says his birthstone is a grindstone. . . . Did you know that Vincent Lopez was born in Brooklyn, the son of a Portuguese father and a Spanish mother, both accomplished musicians . . . and that Lowell Thomas, news commentator, is the son of a surgeon and spent the first ten years of his life in Cripple Creek, Colorado . . . and that Rosaline Green, dramatic actress, is the daughter of Israel Greene, a retired merchant of Bayshore, L. I., and was educated as a school teacher? . . . that Lawrence Tibbett, Metropolitan opera star, earned his first money as a singer by rendering solos at funerals in Los Angeles? He made his first great hit at the Metropolitan on Jan. 2nd, 1925, when he sang Ford to Antonio Scotti's Falstaff. He was a front page "riot" in next day's newspapers. When 22 he was ambitious to become a Shakespearian actor. Welcomes autograph hunters and will cheerfuly sign anything except a blank check. . . .

Vernon Radcliffe's only hobby, sport or what have you, is golf. . . . Josef Bonime, the conductor, was once accompanist for Mischa Elman. . . . Ray Perkins knows a delicatessen dealer who is a little hard of herring. . . . Nellie Revell recently celebrated her second anniversary on the air. . . . Olive West, NBC character actress, is a direct descendant of Priscilla Alden; on her mother's side of the family tree, the line of ancestry goes straight back to the "Speak-for-yourself-John" girl. . . . Jackie Heller, youthful NBC singing star, is making stage, studio and night club appearances with a patch over one eye, the result of an accidental and painful contact with one of Ben Bernie's cigars. . . .

Of course, it's almost impossible to write a radio page these days without Gracie Allen's brother popping up; the latest development is the following telegram addressed to Gracie at Columbia's New York studios from the Lone Star State: "Miss Grace Allen: Am holding man answering description of your brother. Answer as to disposition of him and state amount of reward. (Signed) Wm. Shely, Chief of Police, Corpus Christi, Texas. ". . . Smart people, these Texans. . . . Ernest Hutcheson, eminent CBS pianist, and Conductor Howard Barlow spent half an hour the other night measuring the dimensions of Studio 3 and recording the figures in a little black book; it was all part of the experimental work in piano acoustics which Hutcheson is conducting in behalf of a prominent musical organization; piano music has always been difficult to broadcast faithfully, the harmonics and overtones offering particular obstacles to accurate reproduction; Hutcheson has evolved certain ideas as to how the difficulties may be overcome, and his present series of experiments is designed to test those theories; as a part of his research, he is placing his piano in various positions in the studio, recording the results and having them studied by acoustical experts....

Thomas L. Stix, who supervises the CBS "Grub Street" programs, has frequently been forced to request his male guests to comply with studio rules by refraining from smoking cigarettes, but it was almost too much for him the other day when he had to ask Miss Viola Ilma to lay aside her pipe while being interviewed on the air; Miss Ilma, who edits "Modern Youth" magazines, says she considers a pipe more healthy than cigarettes. . . . Among the incurables afflicted with jigsaw-itis you may count Les Reis and Artie Dunn. They argued for fifteen minutes the other night trying to get their pianist to leave the top of the piano closed during the broadcast so as not to disturb the puzzle which they had started to assemble on it. . . . Jim Stanley, leader of the Travelers Quartet, is an old friend of Grantland Rice; in consequence, he has often aided the sports authority in making motion pictures. . . . Isn't it nice to hear Fred Waring and his Pennsylvanians on the Old Gold program? I like their music and brother Tom's voice sounds like old times. . . .

Out here in Cincinnati things are just about the same. . . . Jack and Jill are two very versatile entertainers over the Nation's Station. Jack impersonates anything from a cow to a flea; from Bing Crosby to Floyd Gibbons; from Amos n' Andy to Jake and Lena; Jill has a most delightful little giggle which she uses very effectively over the air; she's a swell pianist, too and harmonizes like anything with Jack; and oh, yes, her impersonation of Edna Wallace Hopper is a classic; don't miss these clever folk over WLW at 10:30 each week-day morning. WLW is right in the middle of the dial and at any time of the day you will find good programs emanating from that up-to-date station. . . . Tony Cabooch and his daughter, Jimmy Dew, are still as popular as ever with the Middle Western folk. So is Old Man Sunshine and Oklahoma Bob Albright. . . . Ed McConnell is known as one of the best air salesmen in the entire radio world; listeners just go for him, that's all. . . . The Threesome are making a name for themselves out here, and Joe Emerson is fast annexing friends through his daily 9:15 a.m. programs; Joe has a voice of which one never tires. . . . Billie Dauscha is still entertaining listeners with her sweet voice on the Merrill program, Thursday nights. . . . Franklin Bens has a lovely little program on Sunday evenings at 5:00. His delightful tenor voice is heard in a series of solos accompanied by a string ensemble consisting of Anthony Esposito, violinist; Dorothy Kempe, cellist; and Herschel Leucke, pianist. Your time will not be wasted if you tune in on this program. . . . Well, it's about time for me to be blown by the wind over to the post-office; we have a pint-sized gale on today and it sure whistles, comin' down from them thar hills.

* * *

Biographical Brevities

ABOUT WILLIAM O'NEAL

One of the latest comers to the ranks of radio stars is William O'Neal, CBS tenor. Born in Louisiana, New Orleans, twenty-seven years ago, he was the fifth of nine children—with four to the right of him and four to the left of him; which accounts for the fact that he is a middle-of-the-roader. His father was a hotel owner, so the youthful William came into contact with all sorts of entertainment, and no sooner had he been taken to hear opera than the ambition to appear on the lyric stage possessed him; however, that laudable ambition had a rival, as Bill also wanted to be a fireman. So he decided to be an electrical engineer, wherefor he entered Louisiana State University. His singing advanced more rapidly than his knowledge of transformers and rheostats.

And so, after breaking his nose on the football field, he found out that as an electrician he sang successfully and well, which gave impetus to his desire for a New York audition; he obtained one from the Shuberts and got a job, and thus his career was begun. He was picked to understudy Walter Woolf in "The Lady in Ermine." From this he graduated to "May Flowers" and "The Desert Song." After touring the country and appearing in "The New Moon," he turned to vaudeville, and made a big success. When O'Neal made his first appearance before a microphone he was scared stiff;

(Continued on next page)

Station Sparks

By Alice Remsen

(*Continued from preceding page*)

this was during the run of "The Desert Song" when he joined the Columbia Broadcasting System he still objected to singing before a "dead pan gadget," as he called the mike, preferring an audience to warm him up. Gradually he's overcoming this aversion, but he still likes to have an audience in the studio while he is on the air. William insists that New Orleans has the best food of any place in the world; but New York has many attractions for the tall tenor, notably the theatre, concerts and circuses—the latter his favorite diversion. O'Neal is a fine looking man, stands over six feet in his socks, and weighs over two hundred pounds, and is goodnatured as most big men are.

Westinghouse Pays RCA Stock as Dividend

The Board of Directors of Westinghouse has paid a dividend consisting of one-half share of common stock of Radio Corporation of America for each share of preferred stock and common stock of the Westinghouse Company, to stockholders of record at the close of business on January 23rd, 1933. This dividend was declared to carry out the requirements of a decree of the Federal Court entered November 21, 1932.

In view of the preferential right of the preferred stock of this Company, the Board of Directors has also declared an optional dividend of $3.50 per share upon any share of Westinghouse Company's preferred stock, the holder of which may desire to accept such cash dividend in exchange for the one-half share of common stock of the Radio Corporation.

Standard Resistor Code

For First or Second Significant Figure		*Number of Ciphers After the Significant Figures*
Black	0	None
Brown	1	0
Red	2	00
Orange	3	000
Yellow	4	0000
Green	5	00000
Blue	6	000000
Violet	7	——
Gray	8	——
White	9	——

The color for the first or second significant figure follows this code: body color denotes first significant figure; end color denotes second significant figure; dot denotes number of ciphers after the first two significant figures.

A CAUSE OF NOISE

Noise in a receiver is often due to excessively close coupling between the windings of a radio or intermediate frequency transformer. If the noise is of the hiss variety it may be reduced by means of a by-pass condenser.

SHORT-WAVE CLUB

A. A. Kostak, Box 25, Rita, La.
Nick Vrettos, Jr., 2602 N. Springfield Ave., Chicago, Ill.
E. H. Wellman, Box 237, North Cohasset, Mass.
W. R. Newcomb, 196 Tache Ave., Norwood, Winnipeg, Canada.
Sam Price, Box 153, San Angelo, Texas.
Dick N. Makio, Opibikao, Hawaii.
Jose F. Sandoval, Empresa Reparadora de Radios, Zaragoza 104 Norte, Monterey, N. L.,

TRADIOGRAMS

By J. Murray Barron

Wego Condensers, Inc., 729 Seventh Avenue, New York, announces a complete line of paper dielectric condensers in a complete range of capacities and rated from 200 volts to 7,000 volts. The policy of the organization will be directed by Leon L. Adelman, vice-president and general sales manager.

* * *

Postal Radio Corp., 135 Liberty Street, N. Y. City, announces the distribution of a new line. It includes the Postal B Battery Eliminator for use in motor cars, boats or other places where a unit of this type will prove an advantage. Some features are full-wave interrupter in one assembly, full-wave rectification with mercury vapor rectifier and completely automatic load delay circuit. Full particulars with descriptive illustrated circular may be had from the Postal Radio Corp.

* * *

Thor Radio Co., which conducts Thor's Bargain Basement at 167 Greenwich Street, N. Y. City, announces a big demand for short-wave apparatus and especially for their converter. To those living within reach of the metropolitan district a demonstration may be arranged and all information had from Alan Mannion, in charge of the radio engineering department. Those out of town are invited to write to Thor's for full particulars.

* * *

The Universal Microphone Co., Inglewood, Calif., announces an addition to their recording microphones (condenser type). The new model is bullet type and is extremely light weight and compact. The condenser microphone with a two-stage amplifier weighs only 4½ lbs., is three inches in diameter and 10½ inches in length.

* * *

Nat. Lager is now in charge of the 179 Greenwich Street store of Try-Mo Radio Corp., N. Y. City. He has a wide knowledge of radio merchandise having been associated with Moe and Louis Lager in their various stores.

* * *

In the retail radio field quite a few dealers find it pays to cater to the public's wants and not try and educate them to something else, therefore to handle live merchandise. This has been illustrated by some of the leading radio retail stores in New York who always keep abreast in the latest models of radio products.

* * *

F. Grimes, who is well known to the amateur and the experimenter and who has not only been associated in the radio industry since its inception but likewise has been a commercial operator and a radio merchandiser, is now technical consultant for the Try-Mo Radio Corporation. He has been developing various short-wave receivers for them. Those interested may obtain information by addressing the corporation.

Measures to Protect Police Radio Killed

Washington.

Various measures have been before the House of Representatives regarding the regulation and protection of police radio transmissions, but the Committee on Merchant Marine, Radio and Fisheries declined to hold hearings on them. It is believed that these measures are dead.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor,* RADIO WORLD, *145 West 45th Street, New York, N. Y.

William Stankywick, Windsor Radio Lab., 151 Walsh Ave., Newburgh, N. Y.
Fred L. Hall, Box 446, Stuart, Fla.
E. Gerald Barolet, 5838 Laurendeau St., Montreal, Canada.
R. H. Watkins, Box 233, Winona, Minn.
Vernon Steckel, 3149 Mapleleaf Ave., Pl. Ridge, Cincinnati, Ohio.
Paul Kuczynski, 2830 Keeley St., Chicago, Ill.
Francis Curry, Curry's Radio Service, 3929 No. 14th St., Milwaukee, Wisc.
John I. Harris, 321 Coolidge Ave., Syracuse, N. Y.
Ernest P. Day, 524 Spruce Ave., Sharon, Penna.
M. R. Wilson, 9 Caly Rd., Manchester, N. H.
G. Clay Goodloe, 1722—19th St., Apt. 303, Washington, D. C.
Robert J. Strong, 311 South Aberdeen St., Chicago, Ill.
A. W. Radio Co., Fairview, Okla.
Joseph R. Mello, Mello's Radio Service, 3 Omega St., Stonington, Conn.
M. Oliveira, P. O. Box 296, Middletown, N. Y.
W. H. Hoover, Tippecanoe City, Miami County, Ohio.
R. L. Biggs, McMannen St., Durham, N. C.
Clarence L. Power, 503 Hendryx Ave., Wichita, Kans.
Geo. W. Adams, 1611 Oberlin Ave., Lorain, Ohio.
Quincy Taylor, Box 75, Owenton, Ky.
R. A. Hall, 814 Penn Ave., Wilkinsburg, Penna.
L. Cecil Johnson, 4035 Brooklyn, N.E., Seattle, Wash.
James Hulbruun, 89 Centerbury P. O., Rochester, N. Y.

Corporate Activities

DE FOREST BOUGHT BY RCA

The receivers for the De Forest Radio Co., of Passaic, N. J., manufacturers of receiving vacuum tubes, radio telephone, telegraph and television transmitters, photo-electric cells, etc., have accepted from The Radio Corporation of America, subject to the approval of the Federal District Court of Newark, N. J., a bid of $400,000 in cash for the assets of the De Forest Radio Co. This is exclusive of accounts receivable amounting to $100,000, which would be left to the receivers for collection and distribution among the creditors, thus making a total of $500,000 available for the creditors.

The total assets on March 31, 1932 were $5,034,441.

BANKRUPTCY PROCEEDINGS

Taylor More, James P. Callendar and Chester A. Boynton, trustees in Bankruptcy for Algonquin Electric Co., Inc., Bankrupt, of New York City, have filed their final report and account, showing a balance of $12,913.99, in the office of Oscar W. Ehrhorn, Referee, at 280 Broadway, New York. On March 10, 1933, the following applications will be passed upon:

Taylor More, James P. Callendar and Chester A. Boynton, Trustees' commissions	$476.71
James P. Callendar, Trustee, disbursements	6.90
Tolbert, Ewen & Patterson, attorneys for Trustee	1,000.00
and disbursements	164.58
Prager, Boehm & Prager, attorneys for Petitioning Creditors	1,000.00
Allowances heretofore paid:	
Tolbert, Ewen & Patterson, attys. Trustees on a/c	3,000.00
David Berdon & Company, accountants	500.00

Dated, New York, February 23, 1933.
OSCAR W. EHRHORN,
Referee in Bankruptcy.

Petitions Filed—By

Ray-Dine Radio Sales Co., Hollywood Calif.; voluntary; no schedules filed.

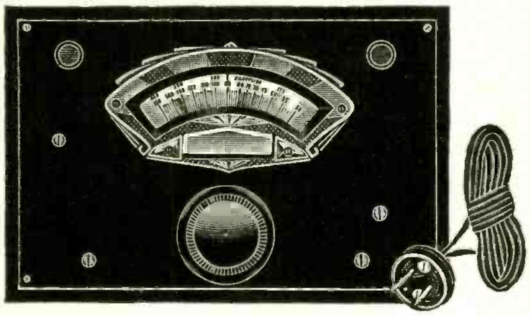
CORPORATION REPORTS

Arcturus Radio Tube Company, year ended December 31, 1932, shows a net loss of $464,603 after taxes and charges, compared with net loss of $266,103 in 1931.

Grigsby-Grunow Company for year ended December 31, 1932, shows net loss $2,775.569 after taxes and charges. In seven months to December 31, 1931, net loss was $2,901,305. Fiscal year changed to end Dec. 31 instead of May 31.

Westinghouse Electric and Manufacturing Company, preliminary report for 1932: Net loss of $8,903,540 as compared with a net loss of $3,655,659 for 1931. Total sales billed, $77,073,586, compared with $115,393,082 in 1931. Depreciation and obsolescence of buildings and equipment provided for and included in cost of operation amounted to $5,274,857, compared with $5,173,914 in 1931. The company received orders in 1932 to the amount of $69,082,486, compared with $128,014,820 in 1931. On Jan. 1, 1933, the unfilled orders amounted to $26,836,494. Cash and marketable securities at the end of 1932, $32,851,763, compared with $32,148,727 at end of 1931.

All-Frequency Service from a Test Oscillator



The test oscillator has a frequency-calibrated dial, registering 50 to 150 kc, while above this tier of frequencies are registered all the popular commercial intermediate frequencies. So just consult the dial scale.

A COMPLETELY self-operated a-c test oscillator, fundamental frequencies from 50 to 150 kc, with the line frequency, 60-cycle hum, used as modulation but not heard except at resonance, affords all-frequency service, from 50 kc up. This is true because the fundamental may be used as registered on the exclusively frequency-calibrated dial, and harmonics may be used for any higher frequencies, almost without limit. All oscillators are tested up to the 28th harmonic, but response of sufficient intensity may be obtained even beyond the 50th harmonic, and there are proven cases of good results up to the 150th harmonic.

Therefore when fundamental frequencies are low, as here, you may set down the lowest, 50 kc, as one extreme, while the harmonic orders give almost unlimited service to line up short-wave receivers, converters and broadcast receivers that respond to police frequencies.

Average Accuracy 1% or Better

The a-c test oscillator, 105-120 v., 50-60 c., uses a 56 tube, a frequency-stabilized grid circuit, Hartley oscillator and a-c on the plate. Special pains have been taken to assure accuracy, and the test oscillator is guaranteed to be accurate to within 2 per cent. However, at some settings the accuracy is almost perfect, while the average accuracy is 1 per cent. or better. The 2 per cent. rating is the extreme deviation, present in only a few instances.

Therefore in possessing one of these oscillators one knows that he has an instrument of a degree of accuracy more than sufficient for the purposes to which the oscillator will be put, i.e., lining up intermediate amplifiers and padding, in superheterodynes, or lining up condenser gangs in t-r-f systems.

The oscillator will yield sharp zero beats with carriers, and the accuracy may thus be checked at any time against broadcast carriers, using the tenth harmonic (500 to 1,500 kc). This harmonic is used for all broadcast frequencies.

If any particular frequency setting that is a multiple of 50 is ascertained for a receiver or other tested device, frequencies separated therefrom in steps of 50 kc may be registered by setting the test oscillator at 50 kc and tuning the tested device. This is particularly handy in frequency calibration and for finding frequency extremes in receivers that cover some of the police frequencies.

Get One of These Test Oscillators *Free!*

The oscillator is self-powered as an a-c device, but may be obtained also in battery model. The circuits used are simplifications of the Hartley oscillator and the construction of all oscillators is under the supervision of graduates of the Massachusetts Institute of Technology, who test each oscillator to verify its accuracy.

The a-c model is constantly modulated and yields zero beats at all times. The battery model has a switch at left for modulated-unmodulated service, and yields zero beats on unmodulated but not on modulated service.

The a-c test oscillator parts may be obtained free with a one-year subscription for RADIO WORLD, 52 issues, one each week, at $6.00, the regular subscription price, while the cost is $1.50 extra for wiring and calibrating. The $1.50 is turned over by us to an outside laboratory. Order Cat. PRE-ACOW and remit $7.50 with order. The 56 tube is 72c extra.

The battery model requires a 230 tube, a 22.5-volt small B battery, and a 1.5-volt dry cell. Order Cat. PRE-BATOW and remit $7.50 with order. The 230 tube is 78c extra. Batteries not supplied.

The main scale of the frequency-calibrated dial reads from 50 to 150. The bars are 1 kc apart from 50 to 80 kc and 2 kc apart from 80 to 150 kc. Thus for broadcast work, using the 10th harmonic, the separation as registered by the bars is 10 kc from 500 to 800 kc and 20 kc from 800 to 1,500 kc. On an upper tier the intermediate frequencies are printed: 175, 260, 400 and 450 kc, with a bar to the left of 175, representing 177.5, and a bar to the right of 175, representing 172.5. These, with 130 on the fundamental, represent all the popular commercial intermediate frequencies. Any other intermediate frequency may be obtained either directly from the fundamental, or by dividing a higher desired frequency by the nearest whole number to yield a frequency represented on the fundamental.

DIRECTIONS FOR USE

Remove the four corner screws and the cover, insert the 56 tube in its socket, restore the cover and screws, connect the a-c attachment plug to the wall socket, and the a-c test oscillator is ready for service at broadcast frequencies. No other coupling is necessary, as radiation is strong enough. Mentally affix a cipher to the registered frequencies on the lower tier (so 50 is read as 500, and 150 as 1,500), and set the dial for any desired frequency. At resonance the hum will be heard. Off resonance it will not be heard. For testing intermediate frequencies, connect the bared end of a wire to the output post of the test oscillator, other bared end of this wire to plate of the first detector socket. The first detector tube may be removed and bared wire pushed into the plate spring. The intermediates then are tuned for strongest hum response. If an output meter is used, tune for greatest needle deflection.

The battery model is connected to voltage sources as marked on oscillator outleads and is used the same way, except that output lead may have to be wrapped around the aerial near set for a few turns to effectuate coupling at broadcast frequencies. The modulation is a high-pitched note, instead of hum.

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

ALL SHIPMENTS MADE EXPRESS COLLECT.

DIAMOND PARTS

Tuned Radio Frequency Sets

FIVE-TUBE MODEL

A-C operated circuit, 50-60 cycles, 105-120 volts, using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @............$15.69

Wired model, Cat. D5CW (less cabinet) @.... 17.19

Kit of five Eveready-Raytheon tubes for this circuit. Cat. D5T 4.07

FOUNDATION UNIT, consisting of drilled metal subpanel, 13¼ x 8⅝ x 2¼"; three-gang Scovill 0.00035 mfd., brass plates, trimmers, full shield; shields for the 58 and 57 tubes; six sockets (one for speaker plug); two 8 mfd. electrolytic condensers; set of three coils. Cat. D5FU....... 6.19

Super Diamond parts in stock.

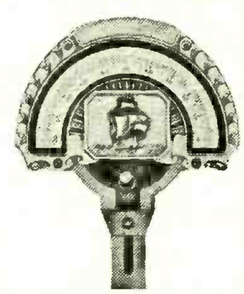
FOUR-TUBE MODEL

The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat. D4CK $13.58

Kit of four Eveready-Raytheon tubes for this circuit. Cat 4D.TK 3.89

FOUNDATION UNIT, consisting of drilled metal plated subpanel 13¼ x 2½ x 7"; two-gang 0.00035 mfd. SFL condenser; full shield; two shields for 58-57; center-tapped 200-turn honeycomb coil; five sockets (one for speaker plug); two 8 mfd. electrolytics; set of two shielded coils; 20-100 mmfd. Hammarlund equalizer for antenna series condenser. Cat. D4FU $5.48

INDIVIDUAL PARTS



Travelling light vernier dial, full-vision, 6-to-1 vernier, projected indication prevents parallax; takes ¼" or ⅜" shaft; dial, bracket, lamp, escutcheon.

0-100 for 5-tube Diamond, Cat. CRD-0, @ $0.91.

100-0 for 4-tube Diamond, Cat. CRD-100, @ $0.91.

[If dial is desired for other circuits state whether condenser closes to the left or to the right.]

8 mfd. Polymet electrolytic, insulating washers, extra lug. Cat. POLY-8 @.....................$0.49

Three 0.1 mfd. in one shield case, 250 volt d-c rating. Cat. S-31 @............................ .29

Rola 8" dynamic for 47, with 1800 ohm field coil tapped @ 300 ohms. Cat. FP @........ 3.83

2 coils for 4-tube. Cat. DP @.................. .90

3 coils for 5-tube. Cat. DT @.................. 1.35

DIRECT RADIO CO.

143 WEST 45th STREET
NEW YORK, N. Y.

BLUEPRINTS

627. Five-tube tuned radio frequency, A-C operated; covers 200 to 550 meters (broadcast band), with optional additional coverage from 80 to 204 meters, for police calls, television, airplane, amateurs, etc. Variable mu and pentode tubes. Order BP-627 @ ....25¢

RADIO WORLD

145 WEST 45TH ST., NEW YORK, N. Y.

Quick-Action Classified Advertisements

7c a Word—$1.00 Minimum Cash With Order

PICTORIAL WIRING DIAGRAM made from any schematic. Send number of tubes for estimate. Super Engineering Lab., 1313 - 40th Street, Brooklyn, N. Y.

FILAMENT TRANSFORMERS FOR TUBE TESTER. Tapped at 1.5 - 2 - 2.5 - 3 1/10 - 5 - 6-3/10 and 7.5 Volts. Price $2.00. Sparty Radio Service, 93 Broadway, Newark, N. J.

THE FORD MODEL—"A" Car and Model "AA" Truck—Construction, Operation and Repair—Revised New Edition. Ford Car authority. Victor W. Page. 708 pages, 318 illustrations. Price $2.50. Radio World, 145 W. 45th St., New York.

115 DIAGRAMS FREE

115 Circuit Diagrams of Commercial Receivers and Power Supplies supplementing the diagrams in John F. Rider's "Trouble Shooter's Manual." These schematic diagrams of factory-made receivers, giving the manufacturer's name and model number on each diagram, include the MOST IMPORTANT SCREEN GRID RECEIVERS.

The 115 diagrams, each in black and white, on sheets 8½ x 11 inches, punched with three standard holes for loose-leaf binding, constitute a supplement that must be obtained by all possessors of "Trouble Shooter's Manual," to make the manual complete

Circuits include Bosch 54 D. C. screen grid; Balkite Model F, Crosley 20, 21, 22 screen grid; Eveready series 50 screen grid; Erla 224 A.C. screen grid; Peerless Electrostatic series; Philco 76 screen grid.

Subscribe for Radio World for 3 months at the regular subscription rate of $1.50, and have these diagrams delivered to you FREE!

Present subscribers may take advantage of this offer. Please put a cross here ☐ to expedite extending your expiration date.

Radio World, 145 West 45th St., New York, N. Y.

"HANDBOOK OF REFRIGERATING ENGINEERING," by Woolrich—Of great use to everybody dealing in refrigerators. $4. Book Dept. Radio World, 145 W. 45th St., N. Y. City

BARGAINS IN FINEST PARTS! — Highest grade, new parts, few of each on hand. National dial, flat type, modernistic escutcheon, type G, clockwise, $2.19; Pilot drum dial No. 1285 @ $1.89; a-c toggle switch, 19c; triple pole, four-throw Best switch, insulated shaft, $1.62; double pole, four throw, $1.08. Direct Radio Co., 145 West 45th St., N. Y. City.

"TALKING MOVIES," by James R. Cameron. A History of the Talking Movie since 1899, with an elementary explanation as to how the pictures are produced and reproduced. Paper cover, $1.50. Radio World, 145 W. 45th St., New York, N. Y.

The Set That Brought In 96 Channels Out of 96!

A SEVEN-TUBE receiver, designed by Herman Bernard, with highly accurate padding, and using a frequency-calibrated dial, the Super Diamond 7 is just the thing for DX enthusiasts. The circuit has full automatic volume control, full-wave diode detection, diode-biased 55 triode, and, except for the second detector, triple-grid tubes throughout. Stations 10 kc apart sharply separated though antenna power input of one is 100 times that of other. A circuit with beautiful tone. Complete kit of parts for this receiver, including everything, even speaker, except cabinet, front panel and tubes. (Cat. CKSD7) **$19.62**

FOUNDATION UNIT

The Foundation Unit for the Super Diamond 7 consists of a shielded antenna coil, a shielded interstage r-f coil, a combination oscillator and 175 kc assembly in one high shield, a shielded regular 175 kc transformer, and a shielded 175 kc transformer with center-tapped secondary; also a 0.00041 mfd. tuning condenser, three-gang, with compensators; an 850 to 1,350 mmfd. padding condenser, a frequency-calibrated dial and a drilled chassis. Cat. FU-SD7 ●........................ **$6.55**

[The coils for r-f and oscillator are wound exactly according to specifications of Herman Bernard and are of a higher order of accuracy than in commercial practice, and moreover provide for matching the tuning to the scale of the frequency-calibrated dial that bears Mr. Bernard's name.]

Complete parts, Push-Pull 9-tube Diamond, speaker; less tubes, front panel and cabinet $23.41

ADDITIONAL PARTS

The nine 0.1 mfd. and two 0.25 mfd. bypass condensers for the Super Diamond 7 are specially made up in one shield, with mounting brackets, and is the same as used in the designer's model. Cat. CU-SD7 @ **$1.20**

Three-gang 0.00041 mfd. tuning condenser, compensators. Cat. TC-SD7 @ **$1.80**

Drilled chassis for the Super Diamond 7. Cat. CH-SD7 ●.............. **$ .80**

The tubes used in this receiver are four 58's, one 55, one 59 and one '80. Total, 7 tubes. Tube kit is Cat. TK-SD7 @.. **$5.35**

850 to 1,350 mmfd. padding condenser, 50c; knobs for ¼ inch shafts, 7c each, four for 25c; Bernard's frequency-calibrated dial, 90c; electrolytic condensers, 8 mfd., 49c each; power transformer, $1.95.

SUPER DIAMOND 6

This is a 6-tube a-c receiver, like the "7," only there is one intermediate stage instead of two. Good sensitivity and selectivity, with finest tone yet developed in a super. Uses the same accurate padding system as the "7," same frequency dial. Gets plenty of distance, too.

Complete parts, including speaker (less tubes, less front panel, less cabinet). Cat. SD-CMP @ **$16.22**

Set of shielded coils, consisting of antenna coil, modulator input coil and combination oscillator and first 175 kc intermediate coil (latter two in one shield), and separate intermediate coil with center-tapped secondary. Cat. SDCK................ **$3.95**

Combination oscillator and 175 kc only, in one shield. Cat. OSN @.... **$1.80**

Three-gang 0.00041 mfd. condenser with trimmers built in; ⅜ inch shaft, 1⅛ inches long. Cat. DJ-41-T.......... **$1.98**

250,000-ohm potentiometer with switch. Cat. R25S @............... **$ .72**

Pigtail resistors, 9c each; Rola speaker, $3.83; tube shields, 11c each; UX, UY sockets, 10c; six-pin, 11c; 7-pin, 15c.

The tubes required for the "6" are two 58, one 57, one 55, one 59 and one '80. Cat. TK-5D6 @ **$4.53**

AUTHENTIC CIRCUITS

The Super Diamond series—the six-tube and seven-tube models—are most excellent circuits, carefully engineered and tested. "Everything fits." You will be amazed at what results these circuits yield. They are real "hot" and we unqualifiedly recommend them.

DIRECT RADIO COMPANY
143 WEST 45TH STREET NEW YORK CITY

Two for the price of One

Get, EXTRA, one-year subscription for any One of these magazines:

- ☐ Q.S.T. (monthly, 12 issues; official amateur organ).
- ☐ POPULAR SCIENCE MONTHLY.
- ☐ RADIO-CRAFT (monthly, 12 issues).
- ☐ RADIO INDEX (monthly, 12 issues), stations, programs, etc.
- ☐ RADIO (monthly, 12 issues; exclusively trade magazine).
- ☐ EVERYDAY SCIENCE AND MECHANICS (monthly).
- ☐ RADIO LOG AND LORE. Bi-monthly; 5 issues. Full station lists, cross indexed, etc.
- ☐ AMERICAN BOY—YOUTH'S COMPANION (monthly, 12 issues; popular magazine).
- ☐ BOYS' LIFE (monthly, 12 issues; popular magazine).
- ☐ OPEN ROAD FOR BOYS (monthly, 12 issues).

Select any one of these magazines and get it free for an entire year by sending in a year's subscription for RADIO WORLD at the regular price, $6.00. Cash in now on this opportunity to get RADIO WORLD WEEKLY, 52 weeks at the standard price for such subscription, plus a full year's subscription for any ONE of the other enumerated magazines FREE. Put a cross in the square next to the magazine of your choice, in the above list, fill out the coupon below, and mail $6 check, money order or stamps to RADIO WORLD, 145 West 45th Street, New York, N. Y. (Add $1.50, making $7.50 in all, for extra foreign or Canadian postage for both publications.)

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☐ If renewing an existing or expiring subscription for other magazines, please put a cross in square at the beginning of this sentence.

RADIO WORLD, 145 West 45th Street, New York. (Just East of Broadway)

Coated Filament Type Pigtail RESISTORS

Finest Grade Fixed Resistors Made.
RMA Color Coded

1 Watt, 11c Each

RESISTANCE Ohms	Meg.	COLOR CODE Body	Dot	End
175	0.000175	Brown	Violet	Brown
350	0.00035	Orange	Green	Brown
800	0.0008	Gray	Black	Brown
1,200	0.0012	Brown	Red	Red
2,000	0.002	Red	Black	Red
2,700	0.0027	Red	Violet	Red
3,500	0.0035	Orange	Green	Red
4,200	0.0042	Yellow	Red	Red
5,000	0.005	Red	Black	Red
10,000	0.01	Brown	Black	Orange
20,000	0.02	Red	Black	Orange
25,000	0.025	Red	Green	Orange
50,000	0.05	Green	Black	Orange
60,000	0.06	Blue	Black	Orange
100,000	0.1	Brown	Black	Yellow
250,000	0.25	Red	Green	Yellow
500,000	0.5	Green	Black	Yellow
600,000	0.6	Blue	Black	Yellow
1,500,000	1.5	Brown	Green	Green
2,000,000	2.0	Red	Black	Green
5,000,000	5.0	Green	Black	Green

2 Watts, 16c Each

3,500 0.0035 { Not Color Coded, but Marked. Size 1½" long x ⅜" diameter.

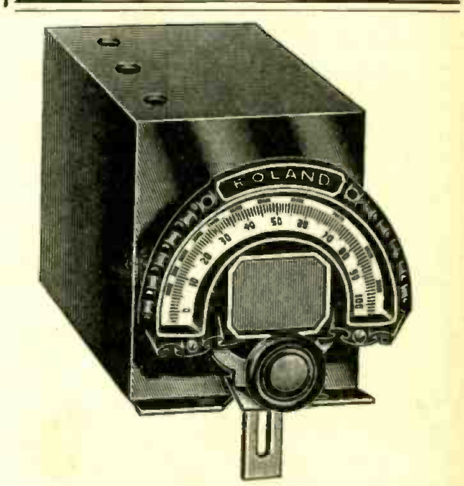
3 Watts, 24c Each

2,000 0.002 { Not Color Coded, but Marked. Size 2½" long x ½" diameter

5 Watts, 32c Each

{ Not Color Coded, but Marked. Size 2½" long x ⅝" diameter.

DIRECT RADIO COMPANY
143 WEST 45TH STREET
NEW YORK, N. Y.



0.0005 mfd. Scovill tuning condenser, brass plates, shaft at both ends so condenser takes 0-100 or 100-0 dials and two can be used with drum dial; sectional shields built in, trimmers affixed; total enclosed in additional shield as illustrated. Access to trimmers with screwdriver. Side holes for bringing out leads to caps of screen grid tubes. Cat. SCSHC @....$1.95

Same as above, with ghost type dial (travelling light). Cat. SCSHC-DL @......................$2.85

DIRECT RADIO CO., 143 W. 45 St., New York City

ANDERSON'S AUTO SET

Designed by J. E. ANDERSON

FOREIGN RECEPTION ON 6-INCH AERIAL

This new auto set is the most sensitive car receiver we have ever come across. Mexican and Canadian stations were tuned in from New York City on a 6-inch aerial. The circuit, an 8-tube superheterodwne, with automatic volume control.

The complete parts, including set chassis and set shield, battery box, remote control, battery cable, all condensers, resistors and coils, speaker with shielded cable; and a kit of RCA tubes (two 239, two 236, two 237, one 89, and one 85) are supplied less aerial. Cat. 898-K @........$34.60

Wired model, licensed by RCA, with complete equipment, less aerial, but including RCA tubes. Cat. 898-W $37.40

DIRECT RADIO CO.
143 West 45th St. N. Y. City