RADIO-REF January 1935   SW Regenerative Receiver

An 0.V.1. Receiver for CW

At a time when people talk only about AC-powered superheterodyne receivers with N tubes, it might seem ridiculous to dwell on a simple two-tube battery-powered receiver. However, daily practice shows that such a setup, properly updated, is still suitable for nearly all circumstances of regular amateur telegraphy traffic.
The only flaw of the regenerative detector is its lack of "local selectivity," meaning such a receiver is completely deficient when it comes to separating a very weak signal from a much stronger one at a nearby frequency. A synchronization phenomenon occurs, and the apparent selectivity becomes zero.
Therefore, the regenerative detector is not suitable when several transmitters are located close to each other. Aside from this situation, it still perfectly meets current conditions for telegraphy work, as a complement to a medium-performance transmitter.
We propose to examine some of the characteristics and specific features of such a setup intended, as we mentioned earlier, solely for telegraphy.

1. Stability

This is the most essential quality.
The pursuit of stability must begin with the antenna: a small, very rigid dipole, weakly coupled to the detector, is recommended.
Next comes the choice of circuit design, and the Electron-Coupled Oscillator (ECO), tuned by sufficient capacitance, is currently the most suitable. To get the most out of it, battery power seems infinitely preferable to AC power, as the latter tends to be too erratic!
The components must be carefully chosen, and we will return to this later.
Finally, the RF and AF circuits should be separated as much as possible, and the ECO setup is well-suited for this. In addition to the usual capacitors and resistors, note the following:

1. Use of the chassis as shielding between the RF and AF circuits.
2. Π cells placed immediately after the plates to eliminate any residual RF.
3. The output transformer should have an electrostatic shield to prevent hand effects.
4. Remote control of the tuning capacitor, also to prevent hand effects. These measures allow for comfortable reception of 5-meter harmonics from local stations using crystal transmitters on 20 or 40 meters, which serves as a good reference for stability.

2. Selectivity

Regarding "local selectivity," as mentioned earlier, the apparent selectivity of the receiver is sometimes more a matter of stability. A stable detector has good "distant selectivity," meaning it can properly separate two signals of equally weak amplitude and nearby frequencies.
The HF selectivity of the setup has been reinforced by AF selectivity since we were only focused on receiving telegraphy.
Useful acoustic frequencies (around 1000 Hz) are enhanced by decoupling the AF grid with a circuit tuned to them. For unnecessary frequencies, the AF grid is automatically grounded to some extent.
Additionally, the "detector to AF" connection is made via a 100 pF capacitor to reduce the transmission of frequencies around 50 Hz (mains interference).

Finally, on the AF plate circuit, there is a capacitor-resistor combination to reduce high frequencies (background noise, interference, etc.).
Together, these measures create a very effective band-pass filter, making QRM interference rare, even during peak 40-meter activity.

3. The Detector

Such a receiver is only as good as the quality of its detector. We chose:

a) An indirectly heated pentode
because this type of tube has the best quality factor.
b) With variable slope
because, while a fixed-slope pentode performs slightly better, it requires a precisely determined screen grid voltage, which is a significant drawback in this case. In the ECO setup, regeneration is controlled by varying the screen grid potential.
c) Powered by batteries
for the reasons mentioned earlier, with as low power consumption as possible.

To meet these requirements, we chose the new Philips EF2, where all electrodes and even the metallization are connected to separate pins, offering great flexibility. Its key specifications are:
Heating current: 0.4 A.
Heating voltage: 6.8 V.
Maximum plate voltage: 200 V.
Slope: 2.8 mA/V.
Amplification factor: 2200.
With 120 volts on the plate and about 30 volts on the screen, the plate current is only around 1 mA.
Regeneration is smooth, gradual, reversible, and without noise.

4. Background Noise

The results depend primarily on the "signal-to-background-noise ratio." There's no point in amplifying if you don't amplify the signal more than the background noise.
To minimize background noise, we’ve already noted the following:

a) Choice of tube and circuit design.
b) Battery power instead of AC power.
c) An anti-interference dipole antenna.
d) Audio-frequency band-pass filtering.
e) Thorough decoupling of circuits.

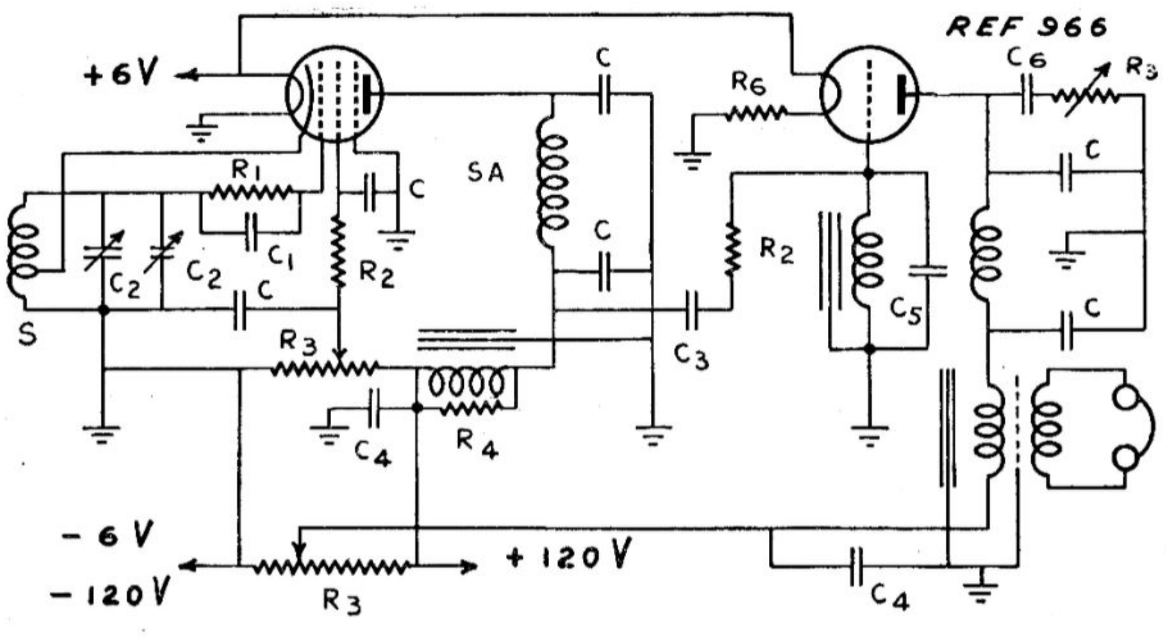
Additionally:

f) Choose a noiseless AF tube, and the Philips A414 K is perfectly suitable.
g) Select components with great care, especially:

1. Small fixed capacitors should be air or mica types, and if possible, vacuum-sealed.
2. Resistors should be either wire-wound or cathodic in a vacuum.

h) Ensure excellent contacts (very important). Everything that can be soldered should be. Pressure contacts should be firmly secured (see the diagram for coil fixation).
j) Use thick, rigid wiring.
In general, everything must either be a clear insulator or a clear conductor. Avoid hybrid components, made from agglomerated sweepings, that can act as either insulators or conductors!

Additionally, protect against deterioration caused by moisture, electrolysis, acidic vapors, etc.



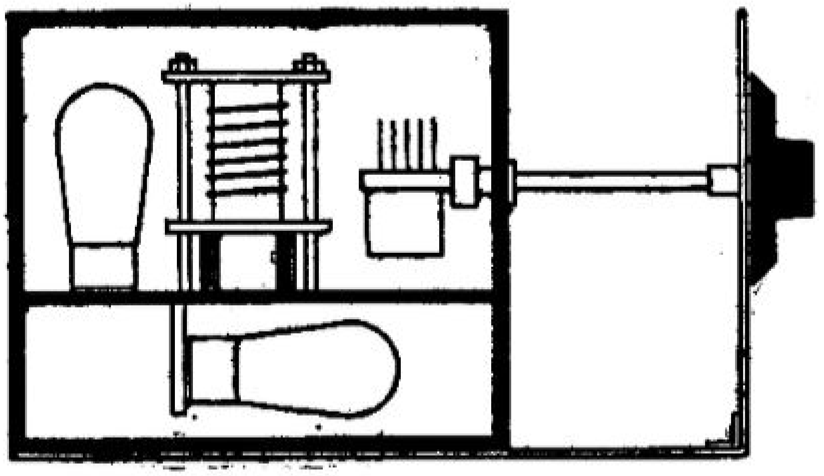
R_1 = 4 M Ω
R_2 = 20.000 Ω, 2 watts
R_3 = 50.000 Ω, 4 watts
R_4 = 230.000 Ω, 2 watts
R_5 = environ 30 Ω, 1 watt
C = 10/1000 μ F
C_1 = 100 μμ F
C_2 = voir texte
C_3 = 100 μμ F
C_4 = 0,1 μ F
C_5 = voir texte
C_6 = 50/1000 μ F
SA = self d'arrêt
S = selon QRG

5. Some Remarks

1. The large 100 pF tuning capacitor stabilizes the oscillation, while the small 30 pF capacitor

spreads the band.

2. The grid of the A414 K is permanently biased at -2 volts, and the plate voltage is taken from a potentiometer. This not only provides volume control but also amplitude selectivity, allowing the tube to operate at the bottom of its characteristic curve. For instance, it is possible to change a signal from R8W3 QRMR7 to R4W5 QRMR2 because under these conditions, strong signals are preferentially amplified.
3. An additional EF2 could also be used as an HF amplifier, which would certainly increase both selectivity and sensitivity since the grid-to-anode capacitance of the EF2 is only 0.001 pF.



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Such a receiver has not been studied by the undersigned, as his current O.V.1. already allows him to hear many DX stations that he cannot QSO with. Therefore, he deemed it unnecessary to increase this "Tantalus' torment"!
This 0.V.1. is certainly recommended for phone communication, provided the excess AF selectivity is removed, which is an easy task.
For speaker listening, the A414 K could be replaced by a 5-watt pentode EL1, which belongs to the same series as the EF2.
Finally, we mention the excellent article by G. Grammer, "What About the Simple Receiver" — QST, June 1934 — in which a similar receiver is described, and we have tried to bring some improvements to it.

Let me know if you'd like further refinements!

Guy H. GrossIN F8RJ.

What About the Simple Receiver?

The Conditions With Which It Must Contend and a Description of a Two-Tube Receiver Using an Improved Band-Spread System

George Grammer, Assistant Technical Editor

IN THESE days of low-priced superhets and tuned-r.f. receivers it might seem something of a problem to justify the home construction of simple regenerative rigs. A two-tube receiver must give something that the other sets don't or there would be no real justification for its existence. What, then, does the simple receiver have to offer? First, small cost; second, ease of construction; third, sensitivity—the once-familiar claim that a regenerative detector will bring in anything that a more complicated rig can pick up still seems to be true, given reasonable freedom from QRM and a fair break on artificial background noise; fourth, a means of covering a wide range of frequencies without a regiment of plug-in coils. This last alone justifies the existence of the two-tuber as an adjunct to the ham-band superhet.

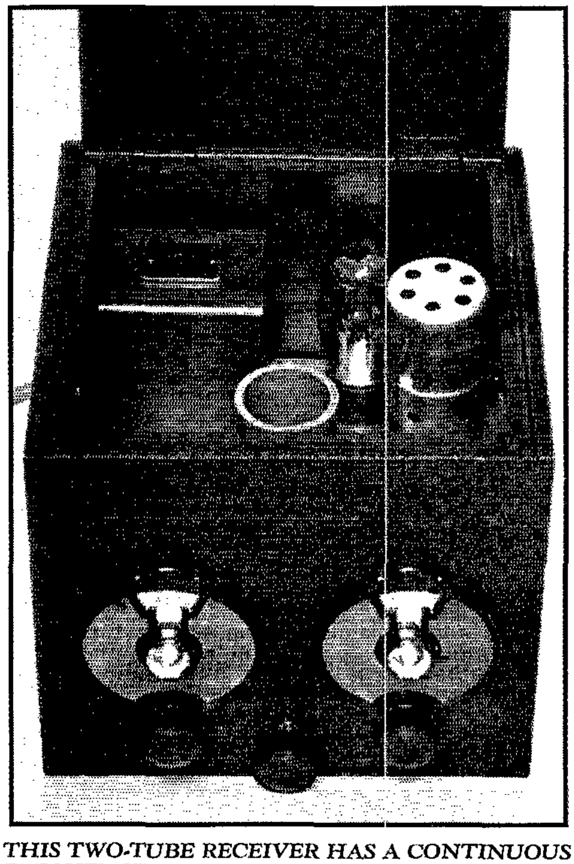
SELECTIVITY

These four make a pretty formidable list in favor of the simple receiver, especially since the ability to pick up distant signals is there in good measure. The "but"—somehow there always is a "but"—is the old bugbear, selectivity. A secondary "but" is that under certain conditions—or rather, lacking certain conditions—the two-tube set suffers by comparison with other types of receivers in stability.

In discussing selectivity for c.w. reception it is necessary to define some terms. We can conveniently classify selectivity into the "local" and "distant" variety.[1] Of all types of receivers except the kind having an untuned r.f. stage, the detector-audio type possesses the least "local" selectivity. Signals from near-by stations working on frequencies considerably beyond beat-note audibility with the desired signal can and do cause serious interference of a most annoying kind. So-called "shock" excitation of the detector by a local signal will cause interference-producing spurious harmonics on higher-frequency bands than the one on which the signal actually exists. The reverse can happen, too; harmonics of the oscillating detector can beat with a local signal on a higher frequency band to produce a second type of interfering signal which is not the fault of the transmitter. Also, the transmissions of near-by broadcast stations often will be bothersome, especially on the 1715- and 3500-kc. bands.

[1] For further discussion see, "Rationalizing the Autodyne," *QST*, January, 1933.

"Distant" selectivity for c.w. reception can be defined as the ability of the receiver to separate two signals of moderate strength operating on frequencies within audible beat of each other. The comparison between the two-tuber and practically any other type except the Single-Signal for this kind of selectivity is not so unfavorable. The detector-audio set is every bit as good as the tuned-r.f. receiver, and generally speaking is as good as the ordinary "10-kc." superhet. The actual separation of the signals must be done by the ear through its ability to distinguish between different tones. A trained ear can do a pretty fair job. Although real distant selectivity is achieved



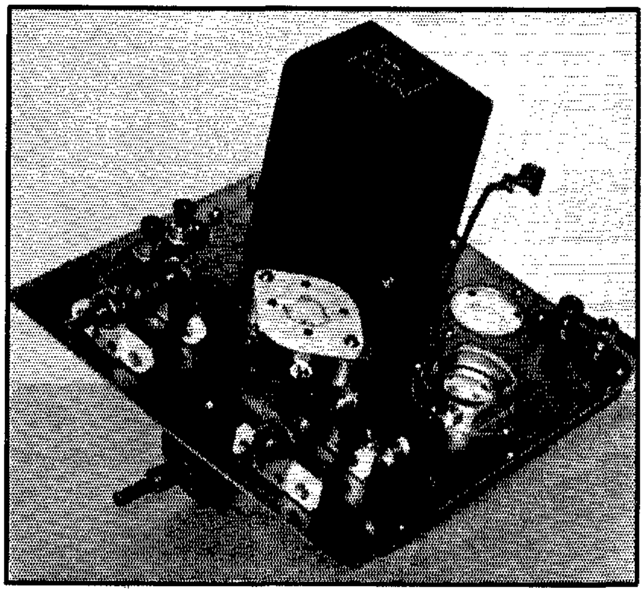
THIS TWO-TUBE RECEIVER HAS A CONTINUOUS FREQUENCY RANGE OF 1450 TO 41,000 KILOCYCLES AND GIVES COMPLETE BAND-SPREAD ON FIVE AMATEUR BANDS

It can be used with either 2.5- or 6.3-volt tubes without change in the wiring. The right-hand dial gives general coverage and that at the left gives band-spread around any frequency for which the general-coverage dial may be set.

only in the Single-Signal superhet, the amateur who perforce must use less expensive equipment does not expect 100% reception all the time. Unquestionably such an amateur can do excellent work with simple equipment—in fact, he always has.

STABILITY

A detector coupled to an antenna is not exactly in a favorable spot for stable operation. With reasonable coupling between the detector and antenna a change in the constants of the latter is bound to be reflected as a change in the frequency of oscillation, which in turn causes a change in the beat note. This sort of instability can be overcome by using a rigidly-strung antenna, preferably located indoors so the wind cannot start an unwanted shimmy. Secondly, a detector operated at its most sensitive point—just beyond the start of oscillation—is readily controlled by a strong signal and is often pulled into synchronism with it. One of the most familiar manifestations of this is the case of a strong signal subject to fading; if the beat note is set when the signal strength is "down," a rise in strength often will tend to pull in the detector and may cause the beat note to disappear entirely. If the fading is rapid the signal has a pronounced waver and is hard to copy. Ham signals do not often offend in this way with the two-tuber, however, unless the receiving antenna is quite long. It is interesting to note that a stage of tuned r.f. only makes matters worse since it puts a too-strong signal at the grid of the detector!



THE METAL BASE HOLDS ALL COMPONENTS—NONE ARE MOUNTED ON THE CABINET
Band-spread condenser C_1 is at the left, C_2 at the right.

A third factor is the inherent stability of the detector as an oscillation generator, especially its ability to maintain a single frequency during changes in plate voltage of the order encountered with a rectified-a.c. supply. The proper choice of circuit and constants can do much to improve this sort of stability, and it is not difficult to build a regenerative detector which is quite satisfactory in this respect.

Instability of a fourth type is peculiar to the oscillating detector coupled to an antenna, and evidences itself in the form of "body capacity" at the tuning controls. It results from coupling the detector to an antenna system which is approximately resonant, through the capacity of the receiver and power-supply to ground, at the operating frequency, and is especially likely to be encountered at 14 mc. and higher frequencies. A short ground connection, in terms of wavelengths on the wire, is difficult to secure at such frequencies, especially when the "ground" connection is made to a water pipe or heating system. The tuning controls and chassis of the receiver accordingly assume a potential different from that of the operator's body and hand-capacity effects result, often accompanied by an a.c. hum if the antenna is near power wiring. Addition or subtraction of a few feet in antenna length usually will move the resonance spot out of the band affected. Although an untuned coupling tube will eliminate this sort of antenna effect, the remedy may be worse than the disease because the coupling tube introduces a background of tube hiss and accentuates cross-modulation and local interference effects.

TUBES AND CIRCUITS

Summing up, then, we find marks on both sides of the ledger for the simple receiver. If the local selectivity is poor, the distant selectivity is at least fair, and the sensitivity is very good. Although the stability is not as good as that of a good superhet, it can, with proper precautions, be made satisfactory. The cost of the two-tube set is low, and the frequency range that can be covered with comparatively few coils is great.

So far as tubes are concerned little, if anything, is to be gained by using special types. A screen-grid detector is still the most satisfactory, and for headphone reception nothing larger than a small triode is needed for the audio stage. More gain could be secured from a power pentode—but at the expense of rather high plate current, which in turn calls for the use of an audio output coupling device to prevent burning out the phones. The small tubes will produce more than enough headphone strength. For the detector, the 57, 58, 77, 78, 6C6 and 6D6 types are most satisfactory. The results are about the same with all of them. The 56, 76 and 37 are satisfactory audio amplifiers.

The screen-grid feedback circuit which has had wide application in tuned-r.f. receivers [1] is equally satisfactory for the two-tube set. The stability of this type of circuit is good, and the coils are conveniently made. Regeneration control through varying the detector screen voltage is smooth and easy to effect. Essentially, then, neither the tubes nor circuits are startlingly different. There is no good reason why they should be.

BAND-SPREADING

Most band-spreading systems are unsatisfactory from one standpoint or another. At the moment two methods seem to hold the stage to the exclusion of practically all others: the parallel condenser and the tapped coil. The first has the advantage of giving both band-spreading and general coverage with the same coil, but suffers the defect that the band-spread is not readily adjustable to meet the varying widths of different bands. A parallel condenser which tunes across the 1.75- and 3.5-mc. bands usually covers entirely too much territory on 7 and 14 mc. unless the padding capacity is inordinately large. Generally, too, if maximum band-spread is given first attention on the higher-frequency bands it will be found that a set of four coils will not give complete coverage from 15 to 200 meters with 100-$\mu\mu$fd. padding condensers; there will be gaps at one place or another. If the range is made continuous, complete band-spread has to be sacrificed. The tapped-coil method has the advantage of giving complete band-spread on any and all bands without special tuning condensers, but as generally used, at least in commercial receivers, requires one set of coils for ham-band coverage and an additional set for the in-between frequencies on which there is no band-spread.

Since the two-tube receiver is a simple affair, we can do some things which might run into the realm of the cumbersome when applied to receivers with more than one tuned circuit. One of the things that can be done is to incorporate a tuning system which not only will give continuous coverage over any range desired, but which also will give as much or as little band-spread as may be wanted on any amateur band—and this without any extra coils. The receiver pictured herewith has a continuous range from approximately 7.5 meters to 205 meters —41,000 to 1450 kilocycles—and gives practically 100-division band-spread on each of the five amateur bands included in that range. And it is done with only five plug-in coils, using four-prong coil forms.

The system is quite simple. Using a 100-$\mu\mu$fd. main tuning condenser, the inductances of the coils are chosen so that overlapping ranges are secured over the whole spectrum covered, an amateur band falling somewhere within the range of each coil. This is thoroughly conventional. Then, for band-spreading, a second 100-$\mu\mu$fd. tuning condenser is connected to an experimentally determined tap on the coil to give complete band-spread on this condenser's dial when the main tuning condenser is set at the proper capacity. Both condensers are brought out to panel controls. The method, it will be seen, is simply a logical extension of the tapped-coil band-spread system.

A PRACTICAL RECEIVER

The circuit diagram of a receiver built along these lines is shown in Fig. 1. Several views of the set are given in the photographs. The actual layout used is not particularly important except that, as always, it is desirable to have short leads in the r.f. circuit. Metal chassis construction is strongly recommended, since the shielding thus afforded is helpful in reducing capacity effects and in cutting out hum pickup from the induction fields which permeate most homes having a.c. wiring. For these same reasons a metal cabinet is advan-

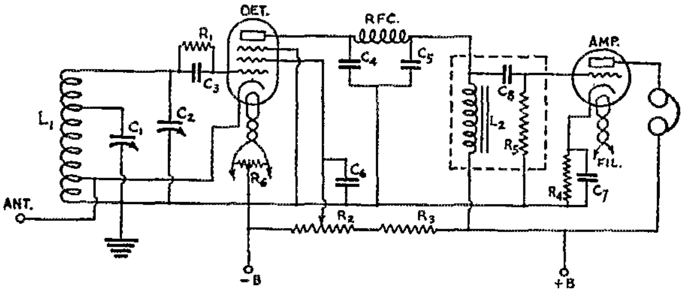


FIG. 1—CIRCUIT DIAGRAM OF THE TWO-TUBE RECEIVER

For 2.5-volt a.c. filament operation, the 57 and 58 are recommended as detectors and the 56 as the audio amplifier. For storage battery operation suitable detectors are the 77, 78, 6C6, and 6D6; audio amplifier, 76 or 37. These tubes also can be operated from a 6.3-volt transformer.

C_1, C_2—100-$\mu\mu$fd. midget variable (Hammarlund MC-100-S).
C_3, C_4, C_5—100-$\mu\mu$fd. fixed mica condenser (Aerovox Type 1460)
C_6, C_7—.5 μfd. or larger.
R_1—5 megohms.
R_2—50,000-ohm potentiometer (Frost) small size.
R_3—25,000 ohms, 10 watts (Ohmite).
R_4—75 ohms, center-tapped (Ohmite).
RFC—Universal wound short-wave choke (Hammarlund).
L_2, C_8, R_5—Screen-grid coupler (National Type S-101). Suitable values are; L_2, 500 henrys; C_8, .01 μfd.; R_5, 0.5 megohm.

Coil Data

Frequency Range	*Total turns, L_1*	*Cathode Tap*	*Band-Spread Tap*
1450 to 3400 kc. (1.75)	54½	3¼	29¾
3050 to 7100 kc. (3.5)	27½	1¼	11¾
6100 to 14,200 kc. (7)	13½	¾	4¼
10,600 to 24,000 kc. (14)	7½	½	1¼
18,000 to 41,000 kc. (28)	3½	⅓	½

All coils are wound with No. 24 d.s.c. wire on 1½-inch diameter forms, the length of the coil being 1½ inches in all cases. The figure in parenthesis after each frequency range indicate the amateur band for which that coil is used. The taps are counted off from the lower or ground terminal. Assuming that the tuning dials have 100 divisions and that the 0 end of the scale represents maximum condenser capacity, the setting of C_2 to give amateur band coverage on C_1 will be approximately as follows, using appropriate coils: 1.75 mc., 44; 3.5 mc., 38; 7 mc. 28; 14 mc., 54; 28 mc., 78. See text on coil construction.

tageous, and since it is now possible to purchase metal boxes for less than the cost of the aluminum that would go into one of the same dimensions—to say nothing of getting a better mechanical job unless the builder is particularly handy with tools—this set was made to fit such a box, in this case a National Type C-SRR. The aluminum base or chassis on which all the parts, including the tuning condensers and the regeneration control, are mounted measures 7½ by 7½ inches. Quarter-inch square brass rods, drilled and tapped for 6-32 screws, are fastened along two edges of the base to furnish a convenient means of securing it in place in the cabinet.

The two tuning condensers are mounted along the front edge of the base with their shafts projecting beyond the edge so the dials can be fastened to them when the set is put in the box. Behind the tuning condensers is the socket for the plug-in coils, an isolantite socket mounted on metal pillars so the socket prongs clear the base. The grid condenser and leak are just behind the right-hand tuning condenser, the far end of the condenser being supported from the base by a small piece of bakelite drilled and tapped to serve as a mounting.

To the rear of the grid condenser is the detector tube socket, and in the rear right-hand corner the binding posts for the phones. The audio tube socket is next, and occupying the rear left-hand corner is the audio coupler. The antenna and ground terminals are along the left edge of the base. These terminals, incidentally, are an assembly of two push-type binding posts mounted on a bakelite strip, a convenient gadget which can be purchased at most radio stores. A similar terminal was first used for the headphone connections, but the push-posts proved to be unsatisfactory for holding phone tips and regular binding posts were substituted, retaining the insulating strip.

The coil socket is mounted so that the leads to the tuning condensers are short and convenient. The rear right-hand socket terminal (No. 4) is connected to the cathode of the detector tube; the wire from the coil socket drops down through a hole in the base and runs underneath to the tube socket. A wire from this same prong also runs through another hole in the base to the antenna post. The connection to the ground terminal is similarly made to the rear left-hand terminal (No. 2) on the coil socket. The feedback coil—the part of the coil included between the cathode tap and ground—is thus made to serve as the antenna coupling coil as well. Experiment has shown that this method provides just about the right amount of coupling, keeping antenna effects to a minimum while providing plenty of signal strength.

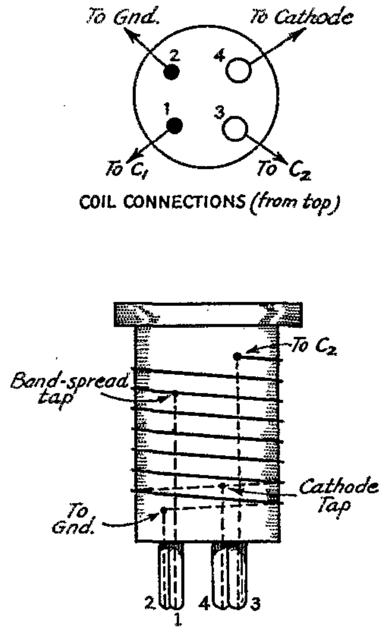


FIG. 2—COIL SOCKET CONNECTIONS AND THE METHOD OF BRINGING OUT COIL TERMINALS

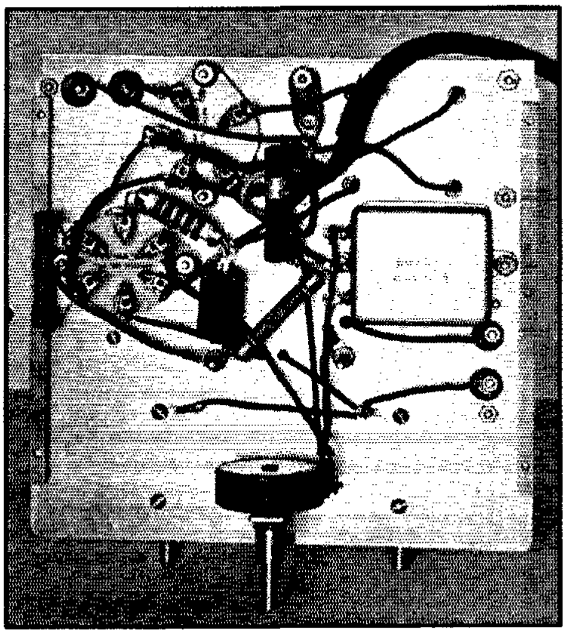
FURTHER CONSTRUCTIONAL DETAILS

Parts mounted below the base include the regeneration control, the plate by-pass condensers and plate choke, and the screen and audio cathode by-pass condensers. This last is a double condenser having two sections of 0.5 μfd. each. Increasing each to 1 μfd. will reduce regeneration-control resistor noise and aid in amplification of the lower audio frequencies. The audio cathode resistor and the screen dropping resistor also are mounted underneath the base. The regeneration control resistor is mounted on a bracket made from half-inch brass strip, from which it must be insulated. An extension shaft gives the necessary length so that this resistor can be controlled from the panel.

Fitting the set to the box requires a little care, but presents no particular problems. The back and bottom of the box should be removed, after which the receiver can be pushed in from the rear. A space of about two inches between the bottom and the base will be sufficient; lines should be ruled along the inner sides of the box as guides so the chassis will be square with the box. Then the points at which the shafts of the tuning condensers and regeneration control go through the front should be marked and holes drilled to correspond. These may be made fairly large, and small inaccuracies will not matter. The next step is to drill small holes along the sides of the box for the screws which fit into the brass-rod mounting strips. Drilling and tapping of these rods for the side screws should be left until after the holes in the sides of the box have been drilled, so that their exact location can be easily spotted when the set is in its final position. The dials should not be fastened in place until all the other mechanical work has been finished; if dials similar to those shown (National Type B Midget) are used, the drilling template should be lined up with the condenser shafts after the receiver is securely mounted in the box. This will avoid the embarrassment of having condenser shafts and dials refuse to line up. The only precaution to be observed in connection with the regeneration-control shaft is to see that it does not touch the box as it comes through.

COIL CONSTRUCTION

Fig. 2 shows how the connections are made on the coil forms, while the specifications are given under Fig. 1. In all cases the grid and ground ends of the coils come through the forms directly over their respective pins, and the tap specifications are given in turns and fractions of turns from the ground end. The length of the winding should be exactly 1½ inches on all coils, and on all but the 1.75-mc. coil the turns should be separated to give an even spacing throughout. The 1.75-mc. coil is close-wound with the wire specified. Different brands of wire vary a bit in insulation thickness, so if the completed close-wound 1½-inch coil has a turn or two more or less than indicated in the coil table it is quite in line with what would be expected. A small variation in the total number of turns on this coil is unimportant so long as the taps are counted off from the ground end as specified. The turn spacing on the 3.5-mc. coil is adjusted by putting another winding of the same size wire between the turns of the actual coil, the auxiliary winding being removed after the coil terminals are soldered in place. Spacing on the higher-frequency coils is adjusted by hand. Taps are made by drilling a hole through the form at the proper point, cutting off the wire and running it down to the proper pin. A new piece of wire with its end fastened in the same pin continues the winding. When finished, the windings should be given a coat of clear Duco or coil dope possessing good adhesive properties.



THIS UNDERNEATH VIEW SHOWS THE REGENERATION CONTROL RESISTOR AND THE VARIOUS BY-PASS CONDENSERS AND RESISTORS

The positive "B" terminal is on a small piece of fibre which insulates it from the base. Each filament lead in the six-wire cable consists of two wires soldered together to lower the voltage drop. All ground connections from the tuning condensers and coil are bonded together.

With the coils specified, the band-spread is between 80 and 100 dial divisions on the band-spread condenser on all except the 3500-kc. coil. In this case the tap has been adjusted to spread the 400-kc. c.w. portion over the whole dial. Good spread on the 'phone portion is obtained by resetting the main tuning condenser, C_2, so that the high-frequency end of the band is covered on C_1.

Any desired degree of spread can be obtained by changing the position of the tap. Moving the tap toward the ground end will increase the spread—decrease the frequency coverage—on C_1, while moving the tap toward the grid end will make C_2 cover a wider frequency range. Unfortunately the position of the tap for a predetermined amount of band-spread cannot be readily calculated, and the work must be done experimentally.

ELECTRICAL POINTERS

So much for the mechanics of the set. Electrically, there are only two pitfalls to avoid. The first is to make sure that the part of the coil included between the cathode tap and ground end is as close to specifications as possible. It does not take much "tickler" in this circuit to provide all the needed feedback, and too much feedback not only reduces the sensitivity but also may lead to howls of astonishing proportions. Variation in the other direction is likewise bad, although there is of course some leeway.

The second thing to avoid is the use of a makeshift audio coupler between the detector and amplifier. While audio transformers often have been pressed into service as coupling impedances, a good many of them show a pronounced tendency to produce fringe howl. This is not to say that an audio transformer cannot be used, but simply to point out that if one *is* used and the set has a fringe howl, the audio transformer is very likely the cause of it. Trouble of this sort can be side-stepped by acquiring a coupler made especially for the job of coupling a screen-grid detector to an audio amplifier. There are several of them on the market.

The receiver can be used with either 2.5- or 6.3-volt tubes of the types previously enumerated, and is suitable for either a.c. or storage-battery operation of the filaments of 6.3-volt tubes. Plate voltage can come either from a "B" pack or batteries, with voltages from 90 to 250 volts being satisfactory. Somewhat greater signal strength will be obtained at the higher "B" voltages.

The set should first be tested with the antenna disconnected to make sure that it goes into oscillation smoothly, and, incidentally, to make sure

(*Continued on page 82*)

to the voltage drop across the resistor and the grid will be negative by this amount in respect to the filament. Neglecting grid current which also flows through the resistor, the voltage drop across the resistor, in other words the grid bias voltage, will be equal to the product of the value of the resistance in ohms and the plate current in amperes. The actual bias will be somewhat higher than this calculated value due to the grid current previously mentioned in the case of all but Class-A amplifiers. The calculated value, will, however, be satisfactory for all practical purposes.

From the above, it follows that bias to complete plate current cut-off cannot be obtained, since at cut-off the plate current is zero and with zero plate current no voltage drop could be developed across the biasing resistor. The proper resistance in ohms for Class-C operation will be equal to the biasing voltage necessary for Class-C operation divided by the plate current in amperes; and the necessary wattage rating for the resistor may be determined from the product of the plate current in amperes squared and the resistance of the resistor in ohms. This method may be used, of course, for either transmitters or receivers. For transmitters, it is usually advisable to make the resistor variable for final adjustment. It should be remembered that, when using this system of biasing, the available plate voltage is lowered by the amount of biasing voltage used.

—*D. H. M.*

What About the Simple Receiver?

(*Continued from page 13*)

that the plate power-supply, if an eliminator, is free from tunable hums. If the receiver is quiet and stable throughout the entire range, the antenna may be connected. If hum and body capacity now appear at some part of the range, the antenna length should be investigated, as described previously. It should not be difficult to find a length which will permit stable operation in the amateur bands at least.

RESULTS

Despite inherent shortcomings, particularly with respect to selectivity, the service-per-dollar ratio of a two-tube receiver of this type can be satisfyingly high. Listening in on the gadget restores one's faith in the ability of inexpensive apparatus to do a good job for the amateur who makes up in enthusiasm and operating ability what he lacks in cash. The operating ability, in fact, is bound to be acquired; one can't do the concentrating required to pull a wanted signal out of a mess of QRM without learning something. There are plenty of times, though, when QRM is not much of a problem, and at such times the two-tuber can hold its own with the best of them. Don't be surprised if the signal strength is considerably more than "comfortable" headphone volume; modern receiving tubes have a real punch. And the DX still rolls in on a detector-and-one-step.