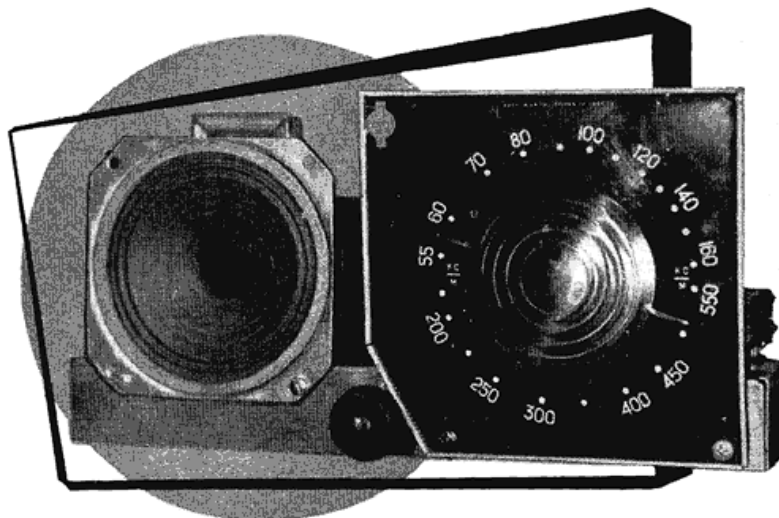


AN ADVANCED REGENERATIVE CIRCUIT

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A cathode follower in a novel application overcomes the old defects of a popular circuit.



The advanced regenerative receiver is built on a broadcast receiver type chassis.

MANY an amateur or short-wave enthusiast has cut his eyeteeth on the regenerative receiver, there-after maturing along a course of technical evolution marked by the construction of more complex super-heterodynes.

Very little progress has been made since the early days of radio in improving the performance of the regenerative detector. This is surprising considering that the gain afforded by this circuit is sufficient to render audible the thermal noise of the input circuit components. Certainly, any attempt to eliminate the shortcomings which have thus far attended reception with the regenerative detector is a worthwhile effort. It is the intent of this article to describe a modified version of the regenerative receiver which provides a measure of performance not hitherto obtainable with the ordinary regenerative circuit.

One of the drawbacks of the conventional regenerative detector is that much of the inherent sensitivity of this demodulation technique cannot be utilized for phone reception. If the regeneration control is advanced too far, the oscillatory state of the detector will fluctuate with the modulation envelope, thereby destroying the intelligibility of the signal. Closely as-

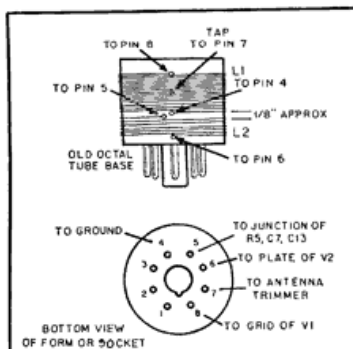
sociated with this defect is the fact that selectivity is poor for phone signals. These, and other undesirable features, such as critical regeneration control and detuning effect of regeneration adjustment can be attributed primarily to one cause. This will be brought out in the ensuing discussion on the operating characteristics of the conventional regenerative detector.

The regenerative detector is, in essence, a reflex circuit, i.e., the tube performs more than one function at a time. Actual demodulation, or "detection," takes place in the grid-cathode circuit. The grid is impressed with both audio and radio frequencies and these are amplified in the plate circuit. The radio frequency component of the signal is fed back to the input of the tube, therein reinforcing the original signal. The audio frequency component is passed on to subsequent audio amplifiers. Now, the demodulation process in the grid circuit involves the flow of current on alternate positive cycles of the radio frequency carrier which exists across the resonant circuit. In other words, the grid-cathode circuit acts as a diode rectifier and constitutes a load to the LC tuned circuit. This, of course, degrades the "Q" of the tuned circuit and, as a consequence, the amplitude of the signal en-

ergy existing across its terminals diminishes. As a corollary to this statement, it is also true that the selectivity of the tuned circuit is decreased by the grid-cathode loading effect. Not only is this effect inherent in such a diode circuit, but the actual amount of resonant-circuit loading will be determined by the strength of the signal.

The strength of a phone signal is continuously varying by virtue of modulation. Therefore, the "Q" of the tuned circuit changes at an audio frequency rate. We have now touched upon the basic weakness of the ordinary regenerative detector circuit. The loading of the resonant circuit by a diode detector is bad enough but it is particularly objectionable in the regenerative detector.

Let us examine the reason: the magnitude of the feedback e.m.f. induced in the grid-cathode resonant circuit is, among other things, determined by its "Q". However, as we have seen, the "Q" of the resonant circuit varies with the amount of loading imposed by the grid. In turn, the grid loading effect increases with the strength of the impressed signal. As a consequence of these relationships, the feedback is not just a constant determined by the setting of the regeneration control. Instead, it varies with the modulation of the signal because modulation constitutes a continuous change in instantaneous signal strength. This causes the detector to become unstable with less regeneration than would be the case if the "Q" of the resonant circuit were independent of signal level and grid loading effect. We could, under such circumstances, expect non-critical approach to the threshold of oscil-



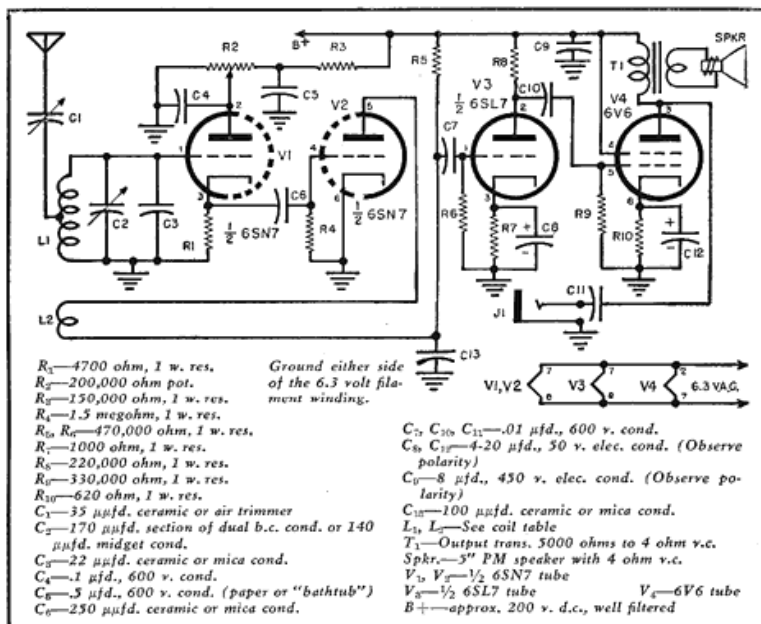
lation by the regeneration control. The receiver would operate with more positive feedback and, paradoxically in terms of the ordinary regenerative detector, with greater stability. Selectivity would also be better, inasmuch as positive feedback supplies the dissipative losses of a resonant circuit, thereby increasing the effective "Q".

Another improvement which could be anticipated from the foregoing discussion, if we could successfully isolate the resonant circuit from the grid loading effect, involves the elimination of the detuning influence of the regeneration control. This is so by virtue of the fact that the resonant frequency of an LC circuit is affected by resistance as well as inductance and capacitance, although to a lesser degree. Since the loading imposed by the flow of grid current is equivalent to that of a resistance which varies with signal strength, the conventional regenerative detector is bound to suffer in some degree from this undesirable feature.

The Solution

Now that the somewhat obscure and elusive shortcomings of the regenerative detector have been in large measure attributed to tuned circuit loading, the solution to the problem obviously entails the isolation of the resonant circuit from the current demands of the grid. This was accomplished by the author by the insertion of a cathode follower between the resonant circuit and the detector grid-cathode circuit. The feedback coil was then coupled to the input of the cathode follower rather than to the detector itself. The manner in which this is done is depicted in the schematic diagram. Control of regeneration is obtained by varying the plate voltage of the cathode follower. The smoothness of this control would, in itself, justify the circuit.

Since the resonant circuit is not loaded, it is well to wind the coils to display a high "Q". This results in the receiver showing good selectivity for strong phone signals when little regeneration is used. Therefore, it is advisable to use Litz wire in the construction of the coils. Any expedient which decreases the losses of the resonant circuit will pay much better dividends in this circuit than in conventional regenerative receivers.



Circuit diagram and parts list of the cathode-follower regenerative receiver.

The constructor should experiment with the spacing of the feedback coils in order to achieve optimum results. This adjustment is much easier than in the ordinary regenerative set. Superregeneration and fringe howl can result only from a gross departure from the specified parameters. Tighter antenna coupling and, likewise, closer coupling between the feedback coil and the resonant circuit are permissible in this system. In the conventional regenerative detector circuit, there is coupling from grid to plate as well as in the reverse direction. This only serves to make the threshold adjustment of the regeneration control more critical. In our modified receiver, the cathode follower stage makes the feedback path unidirectional, i.e., energy can be returned from output to input of the detector tube, but not in the reverse direction.

The builder will find that the combination of feedback coil spacing and antenna coupling which allows the threshold of regeneration to occur approximately between the first 20 and

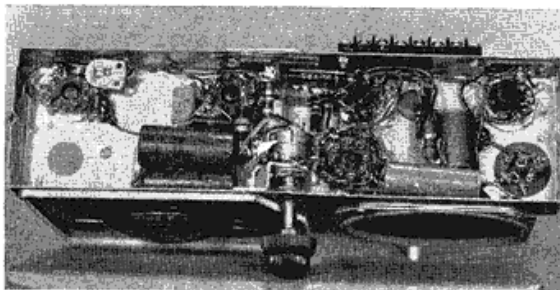
60 degrees of rotation of R_2 will provide good results.

The fixed condenser, C_5 , is included in order to make the "Q" of the resonant circuit more uniform over the tuning range. This helps to reduce the effect of tuning on the setting of the regeneration control. This effect is negligible over a frequency spectrum as wide as that used by the amateur bands. As a result, once the regeneration control is set, the set has the "feel" of a superhet when it is tuned.

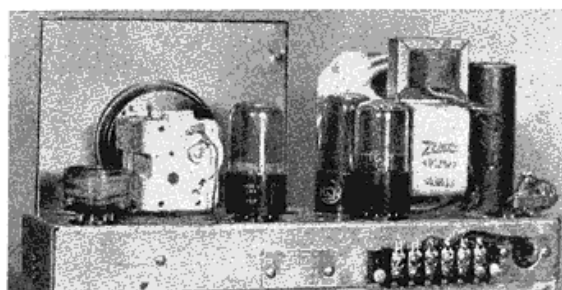
Although many signals will be heard with a short piece of wire strung up around the room, it is highly desirable that a reasonably good outdoor antenna be used. This receiver definitely overcomes several of the shortcomings of the ordinary regenerative set. In common with small receivers however, the antenna system plays a major role in governing the quality of performance.

The receiver was constructed around a broadcast radio chassis. The 170 μ fd. section of the original dual variable condenser was used for tuning. (Continued on page 98)

Under-chassis view. Good use is made of the sockets and holes of the original broadcast receiver. Wiring is rather simple.



Rear view. The tuning condenser, dial, and speaker are from the old broadcast set, but new parts and chassis may be used.



Regenerative Circuit

(Continued from page 49)

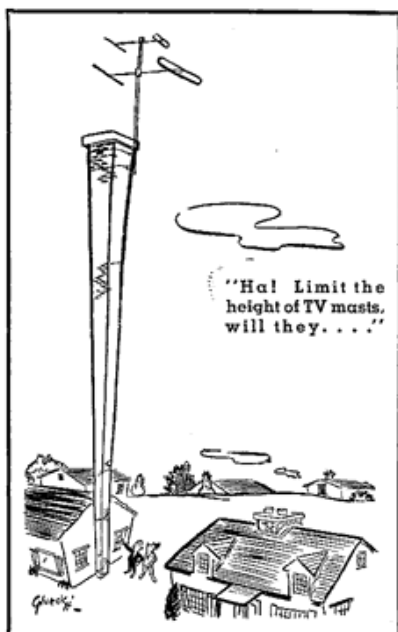
ing L_1 . This, in conjunction with the fixed condenser C_2 , gives sufficient station separation for satisfactory tuning of the short-wave bands. If more bandspread is desired, this can be achieved by connecting a small variable condenser of about 30 $\mu\text{fd.}$ in parallel with C_2 .

The coils were wound on old octal tube bases. This permitted the least modification of the broadcast receiver chassis used as a base. Of course, the constructor who is starting out with a new, blank chassis and all new parts could substitute a different socket and other coil forms, although the coil data would have to be recalculated for the different form diameter used. The diameter of an octal tube base is slightly over $1\frac{5}{16}$ ".

All the coils are closewound, and with the specified number of turns, the amateur bands will fall approximately in the middle of the tuning range. L_1 should be wound rather loosely so that its spacing from L_2 can be adjusted for best performance. Once the optimum spacing has been found, the whole coil should be coated with radio cement or coil dope. If 5/40 Litz wire is not readily available for the coils, #26 enameled or Formvar wire can be used.

L_1 and L_2 should be wound in the same direction and the relative polarity of the connections should be observed. This is the familiar precaution with regenerative sets, for, as is well known, if the polarity of the connections or induced voltages is wrong, the feedback will be degenerative and the set will not work. While this is an important matter its handling turns out to be very simple.

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