Feb. 23, 1937. J. L. REINARTZ 2,071,950

SUPER REGENERATIVE RECEIVER

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Fig. 1

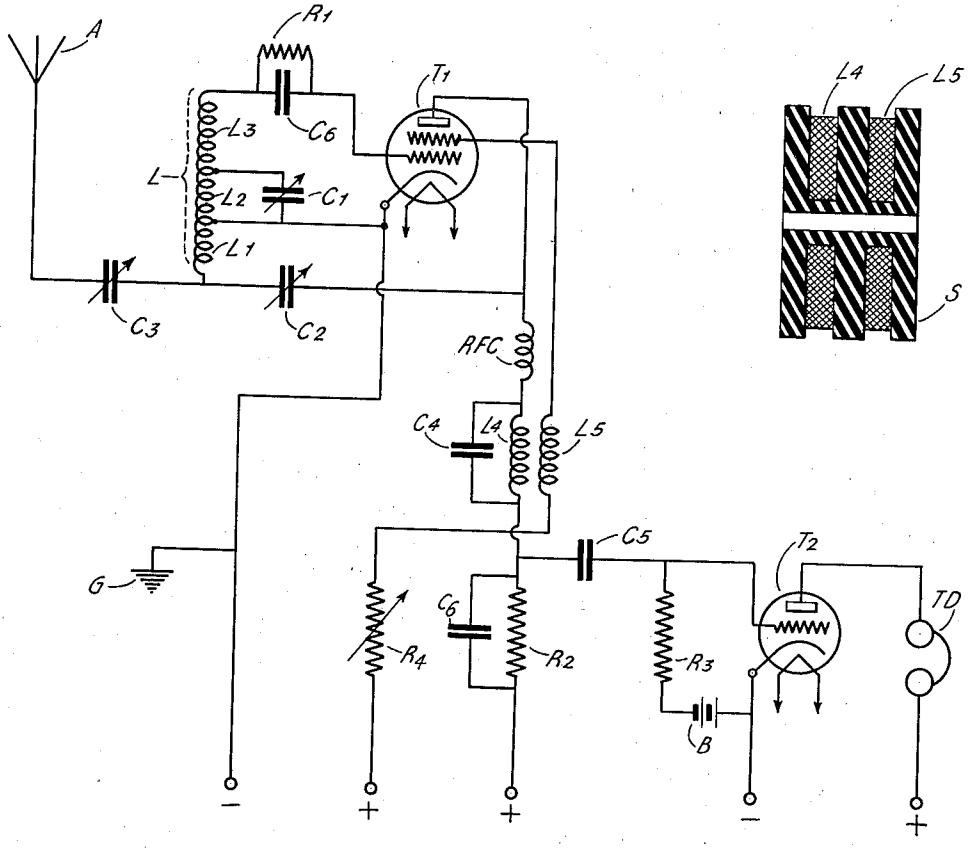


Fig. 2

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SUPER-REGENERATIVE RECEIVER

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7 Claims. (Cl. 250—20)

The present invention relates to super-regenerative receivers and more particularly to a novel circuit arrangement utilizing a screen grid type tube for detection and super-regeneration.

For the theory underlying the operation of a super-regenerative receiver reference may be had to United States Patent No. 1,424,065, issued July 25, 1922 to E. H. Armstrong. From a study of the above patent it is seen that in a super-regenerative receiver the coupling of a regeneratively connected electron discharge device is increased to such an extent that the tube or device is far beyond the oscillation point, thus giving the circuit a negative resistance characteristic. The oscillations, however, are stopped periodically by suitable means so that advantage of this negative resistance may be had for obtaining correct amplification of the signals. The oscillations may be stopped in the negative resistance circuit by introducing an effective resistance at definite intervals or by reducing the amount of regeneration. It is seen that by this means the circuit resistance becomes positive and negative alternately. The variations in the circuit resistance are usually accomplished by varying the plate voltage in some suitable manner as by a vacuum tube oscillator employed to produce a periodic change in the amount of regeneration.

An advantage of a super-regenerative circuit is that its amplifying factor is much greater than that possible with detection combined with ordinary regeneration even when the latter is at its most sensitive adjustment.

It is known that super-regenerative circuits are especially effective in short wave communication, however, in short wave work super-regeneration has been confined to five to ten meter reception especially where a single tube in this connection has been possible because of the split Hartley type tuning circuit arrangement usually employed in these circuits but not readily adapted for use in connection with circuits for receiving longer wavelength bands.

It is an object of the present invention to devise a circuit arrangement that readily allows super-regeneration of signals on all frequencies.

The present invention in particular is concerned with circuit arrangements utilizing screen grid type tubes for super-regeneration without making any changes in the tuning circuits that may be used in any receiver and further without interfering with additional amplification stages if these are desired.

Briefly, the present invention uses a screen grid type tube as the detector and also as the generator of the interrupting frequency.

Referring now to the drawing and the following description, from which a more complete understanding of the invention may be had.

Figure 1 shows a preferred embodiment of the invention; and,

Figure 2 is a more complete showing of the coil system used in the circuit of Fig. 1.

Referring more specifically to Fig. 1, a regenerative circuit is shown in connection with tube T_1. Tube T_1 is of the screen grid type and as shown includes an indirectly heated cathode, however, it is to be distinctly understood that the present invention is not to be construed as being limited to the type of tube shown, in fact, the principles of the present invention may be incorporated upon any tube of the so-called screen grid type irrespective of whether it utilizes an indirectly heated cathode or a filamentary cathode.

In Figure 1, the specific type circuit illustrated includes a connection between the input grid and the cathode comprising a grid leak and condenser arrangement R_1, C_5 in series with portions L_2 and L_3 of coil L. Portion L_1 of coil L is included in a connection between the cathode and the anode of tube T_1 as shown, in series with a regeneration control condenser C_2. The main tuning element comprises a condenser C_1 preferably arranged so as to shunt coil L_2. Energy to be amplified is picked up in customary manner by means of antenna ground A, G and fed to the input of tube T_1 through the antenna coupling condenser C_3 and coil L_1. Condensers C_1, C_2 and C_3 are variable as shown.

Anode potential for the tube T_1 is supplied by means of a suitable source (not shown) through a connection from the anode through a radio frequency choke coil RFC, coil L_4 and resistance R_2 to a terminal of the source indicated by the plus sign. The cathode of tube T_1 is connected to ground G and also to the negative terminal of the source. Coil L_4 is preferably shunted by a tuning condenser C_4. The auxiliary electrode or screening electrode of tube T_1 is maintained at a suitable positive potential with respect to the cathode by a connection including coil L_5 and variable resistance R_4 to a suitable tap on the voltage supply.

Further amplification may be secured by feeding the output of tube T_1 through one or more stages of amplification and thence through the translating device. In Fig. 1 this has been indicated by tube T_2 and its associated circuits. Re-

sistance coupling between the output of tube T_1 and input of tube T_2 is preferably employed since in this way the proper plate impedance is available for the screen grid tube without special design. This resistance coupling is comprised of the resistance R_2 coupling condenser C_5 and grid resistance R_3. Tube T_2 is biased for proper operation by a suitable biasing means indicated for purposes of illustration as a battery B. A translating device TD indicated generally as earphones is connected in the output circuit of the tube T_2 in customary manner.

The coils L_4 and L_5 generate the interruption frequency and may be wound in a multi-groove spool *s* as shown in Fig. 2. In practice I have found that good results have been obtained by winding the two coils L_4 and L_5 with 1000 turns and 1500 turns respectively, of number 36 s. c. covered magnet wire in ¼ inch grooves of a wooden spool such as shown in Fig. 2, the grooves being ½ inch deep separated ⅛ inch and the diameter of the spool being about 1½ inches. It is important to note that for proper operation the connections of the two coils L_4 and L_5 must be so made that, if the two coils were connected in series, the beginning would be connected to the anode of tube T_1 and the end to the screen grid thereof.

In the case where the two windings L_4 and L_5 are 1000 turns and 1500 turns respectively, I have found that good results were obtained by making the value of condenser C_4 equal to .001 mf. In this particular circuit condensers C_1, C_2 and C_3 were all 100 mmf. midget variable condensers while coils L_1, L_2 and L_3 were each four turns for 20 meters reception, 6 turns for 40 meters reception and 8 turns for 80 meters reception.

The particular voltages used in the circuits set up using an RCA type 32 tube were 22½–45 volts for the screen grid and 135 volts for the plate through a 100,000 ohms coupling resistance (R_2 in Fig. 1). For a circuit set up with an RCA 24 type tube the screen voltage used was 22½–45 volts and the plate voltage 180 volts through a 250,000 ohms coupling resistor. In each case the grid leak condenser was .0005 and the grid leak resistance 3 megohms.

A particularly desirable feature of the present invention is that coils L_4 and L_5 will not interfere with the operation of the receiver in connection with CW reception. In that case the receiver is used as an ordinary regenerative receiver and the regeneration control C_2 is adjusted to give maximum sensitivity no changes in voltages applied being necessary. If now it is desired to use the tuner for super-regenerative reception of say radio-phone signals the regeneration is increased until the usual super-regeneration effect makes itself heard by the "swishing" sound produced in the headphones. If the receiver does not produce the desired super-regenerative action by this means it will be found that by adjusting the antenna coupling C_3 toward minimum while maintaining the regeneration condenser C_2 at maximum the desired effect will be produced. In this case the antenna coupling condenser C_3 is used to control the strength of the super-regeneration action as desired.

It has been found in practice that varying the screen grid voltage by means of the resistance R_4 will materially help to realize the possibilities of the circuit. This resistance may be used to accurately control the amount of super-regeneration and it has been found that it is capable of performing this function so well that a receiver incorporating the invention was able to bring in stations of small power that would have otherwise been lost.

In such cases the variable resistance R_4 is adjusted to the point where the "swish" is just discernible through the headphones.

In practice it has been found that in some cases it is necessary to place a by-pass condenser across resistance R_2 in order to prevent generation of audio frequencies usually due to a high resistance grid leak. In the drawing this has been indicated by a condenser C_6 shunted across R_2. For this purpose a condenser of .001 mf. capacity has been found in practice to give good results.

It will be appreciated that while only a single embodiment of the invention has been described by way of example, the invention is by no means limited to this embodiment, and many modifications may be made without departing from the scope of the invention.

I claim:

1. In a super-regenerative receiver provided with an electronic tube having at least two grids, means for providing a signal feedback between the anode and one of the grid electrodes including means for controlling the degree of feedback, a second feedback circuit between the anode and another grid of said tube for producing the interrupting frequency and means for controlling the intensity of the interrupting frequency.

2. A super-regenerative detector comprising an electronic tube provided with an anode, cathode and two grid electrodes, an input circuit including a connection between one of said grid electrodes and the cathode, said input circuit being tunable by variable tuning means, an output circuit including a connection between the anode and cathode of said tube and means for coupling said input and output circuits for producing regeneration, said means including a variable device for controlling the degree of regeneration, an antenna circuit and means including a variable coupling device for coupling the antenna circuit to said input circuit, a source of space current for said tube, means for connecting the anode thereof to a terminal of said source including a choke coil, a coupling coil and a resistor, means for connecting the other grid of said tube to a terminal of said source including a coupling coil and a variable resistor device in series, means for coupling said two coupling coils so as to produce a second feedback circuit and a condenser shunted across one of said coupling coils to tune said coupling coil system to a predetermined frequency.

3. In a super-regenerative receiver an electronic tube having at least two grid electrodes, a cathode and an anode, circuit connections between the cathode and the other electrodes of said tube, means for providing a signal feedback between the anode-cathode circuit and the circuit including one of the grid electrodes and the cathode, means for controlling the degree of feedback, a signal interceptor and a variable coupling device arranged so as to impress signals upon the last mentioned grid-cathode circuit, a second feedback connection between the circuit connecting another of said grids and the cathode and the anode-cathode circuit for producing interrupting frequency energy, means for controlling the intensity of the interrupting frequency energy, said second feedback connection including a first coil associated with the last named grid-cathode circuit and a second coil coupled to

the first coil, said second coil being in the anode-cathode connection and a condenser shunted across one of said two coils for tuning one of the coils to the interrupting frequency.

4. A super-regenerative detector comprising an electronic tube provided with an anode, a cathode and at least two grid electrodes, an input circuit including a connection between one of the grid electrodes and the cathode, said input circuit being tunable by a variable tuning device, an output circuit including a connection between the anode and cathode of said tube, means for coupling the output circuit to the input circuit for producing regeneration, an antenna circuit and means including said last named coupling means for transferring energy from the antenna circuit to the input circuit, a source of space current for said tube, means for connecting the anode of said tube to a terminal of said source, said connection including a coupling coil, means for connecting the other grid of said tube to a terminal of said source including a second coupling coil, said two coupling coils being coupled to each other so that energy flowing in one thereof may be transferred to the other thereof and tuning means shunted across one of the coupling coils.

5. In a super-regenerative receiver an electronic tube provided with an anode, a cathode and at least two grid electrodes, an input circuit including a connection between one of the grid electrodes and the cathode, said input circuit being tunable by a variable tuning device, an output circuit including a connection between the anode and cathode of said tube, means for coupling the output circuit to the input circuit for producing regeneration, an antenna circuit and means for transferring energy from the antenna circuit to the input circuit, a source of space current for said tube, means for connecting the anode of said tube to a terminal of said source said connection including a coupling device and an impedance device in series, a by-pass condenser shunted across said impedance device, means for connecting the other grid of the tube to a terminal of said source said means including said coupling device and a tuning means for said coupling device.

6. In a receiver of the super-regenerative type, an electronic tube provided with an anode, a cathode and at least two grid electrodes, an input circuit including a connection between one of the grid electrodes and the cathode, said input circuit being provided with a variable tuning means for tuning the input circuit over a band of frequencies, an output circuit including a connection between the anode and the cathode of the tube, means for coupling the output circuit to the input circuit for producing regeneration, an antenna circuit and means for coupling the antenna circuit to the input circuit, a source of space current for the tube, means for connecting the anode of the tube to a terminal of said source comprising a circuit including a coupling coil, means for connecting the other grid of the tube to a terminal of said source, said means including a second coupling coil, said second coupling coil being coupled to the first named coupling coil, said two coils being wound with respect to each other so that if the two coils were connected in series the beginning would be connected to the anode of said tube and the end to the last named grid electrode of the tube and means for tuning said coupling coils to the desired interrupting frequency.

7. In a super-regenerative receiver, an electronic tube provided with an anode, a cathode, a signal grid and an auxiliary grid, a connection between the signal grid and the cathode including a grid leak and condenser means and an inductance coil in series connected in the order named, means for tuning said circuit throughout a band of frequencies including a variable tuning condenser shunted across at least a portion of said inductance coil, a source of space current for said tube provided with negative and positive terminals, means for connecting the cathode to the negative terminal of said source, a connection between the anode of said tube and the cathode thereof including a variable condenser and an inductance coil in series connected in the order named, said two inductance coils being coupled to facilitate the transfer of energy from one of the circuits to the other thereof for producing regeneration, a connection between said anode and a positive terminal of said source including in series in the order named, a radio frequency choke coil, one of the windings of a coupling transformer shunted by a tuning condenser and an impedance device shunted by a by-pass condenser, a connection between the auxiliary grid electrode and a positive terminal of said source including in series in the order named the secondary winding of the coupling transformer and a variable impedance device, said tuning means acting to tune said transformer to the interrupted frequency, a signal collector device and means for impressing the energy collected thereby upon the signal grid of said tube, said windings of the transformer being wound with respect to each other so that if the two windings were connected in series the beginning would be connected to the anode of the tube and the end to the auxiliary grid thereof.

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