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SHORT WAVE RADIO AMPLIFYING AND RECEIVING SYSTEM

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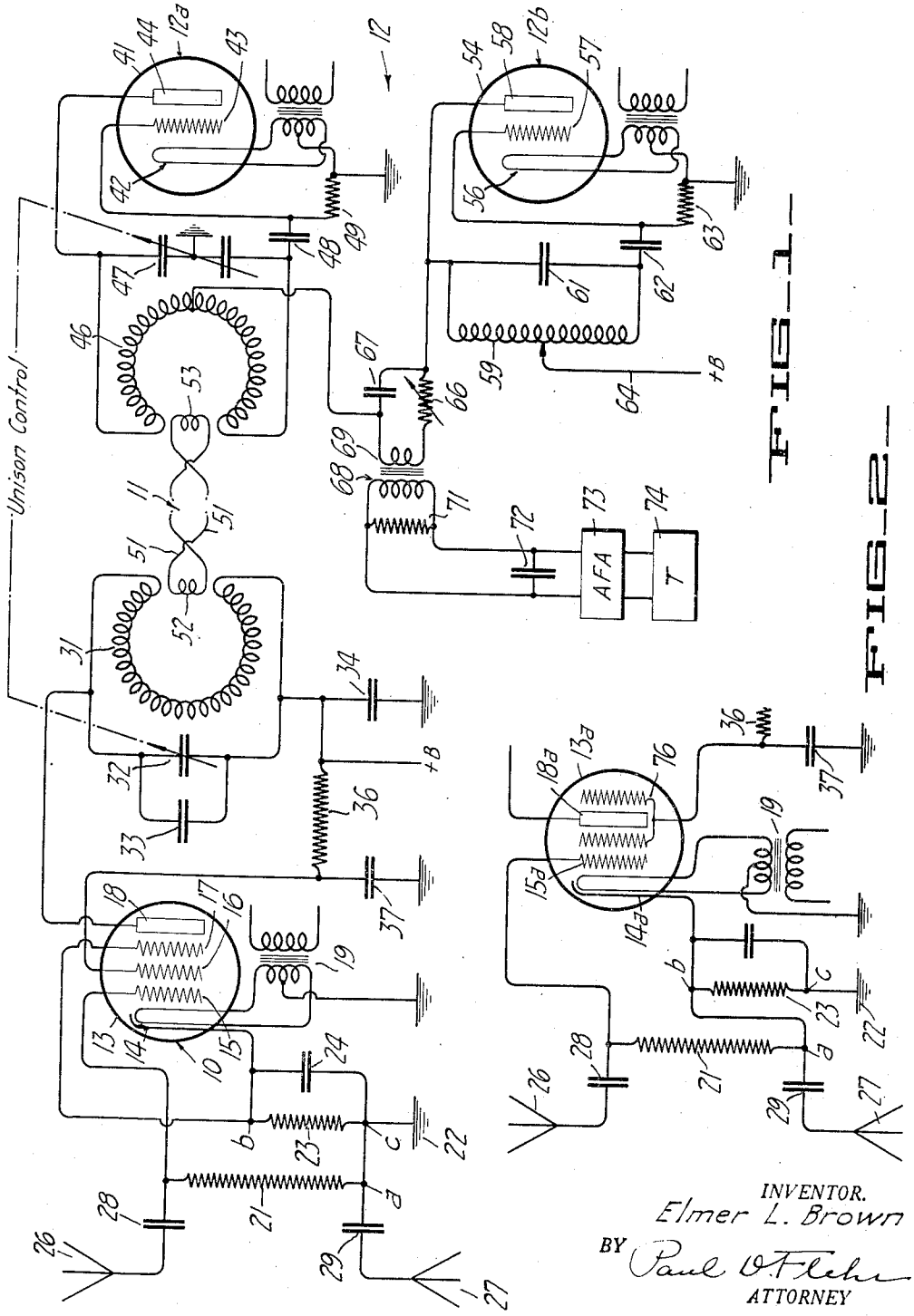


FIG. 1

FIG. 2

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SHORT WAVE RADIO AMPLIFYING AND RECEIVING SYSTEM

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5 Claims. (Cl. 250—20)

This invention relates generally to radio signalling systems adapted for ultra-high frequency radio energy, as for example radio signals between the wave length range of from 2 to 30 meters. It is particularly applicable to the efficient reception of such signal energy, whether the energy may be coded as in telegraphic signals, or modulated by voice frequencies.

In carrying out the present invention I make use of a super-regenerative type of detector, which in the past was subject to the disadvantage that it tends to re-radiate energy from the receiving antenna system. Prior attempts to prevent such re-radiation by the use of a conventional radio frequency amplifier preceding the super-regenerative detector, have not been successful, for the reason that when the radio frequency amplifier has been adjusted to avoid re-radiation, it has afforded substantially no amplification gain, or has even operated at a loss with respect to signal strength. It is an object of the present invention to make possible a high amplification gain and at the same time prevent re-radiation of energy from the detector and afford high selectivity.

A further object of the invention is to provide a short wave receiving system which will afford high sensitivity with a low hiss level.

Another object of the invention is to provide a super-regenerative type of radio receiver which can be tuned over a broad range of frequencies, by movement of a single control member.

Further objects of the invention will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawing.

Referring to the drawing:

Fig. 1 is a circuit diagram, illustrating a receiver incorporating the present invention.

Fig. 2 is a circuit diagram illustrating a possible modification of the system shown in Fig. 1.

The system as illustrated in Fig. 1 consists generally of a radio frequency amplifier 10, which is coupled by means of a low voltage current transmission line 11, to a super-regenerative detector 12. The super-regenerative detector includes a regenerative detector means 12*a*, together with a local oscillator 12*b*, for regenerating a local quenching frequency to be applied to the detector 12*a*.

Referring first to the radio frequency amplifier 10, this includes an electron relay 13, having an indirectly heated cathode 14, grids 15, 16 and 17, and the plate or anode 18. The heater for cathode 14 can be supplied with current from any suitable source, such as a secondary of a transformer 19. The input circuit for the electron relay 13 includes a substantially non-inductive resistance 21 of relatively high value. One terminal of this resistance is shown connected to the control grid 15, and the other to a ground connection 22. To complete the input circuit, the cathode 14 and suppressor grid 17 are connected to ground through the substantially non-inductive resistance 23, which in turn is shunted by the radio frequency by-pass condenser 24. The resistor 21 is of relatively high value, as for example from 10,000 ohms to 1 megohm, while resistor 23 can be in the order of 2500 ohms. A short wave antenna system has been represented by the antenna elements 26 and 27, and is shown coupled across the resistor 21, through condensers 28 and 29. It will be evident that the input circuit described will respond to a wide range of radio frequencies, and that radio signal energy will be impressed directly upon the control grid 15.

The output circuit for amplifier 10 includes an inductance 31, shunted by the variable tuning condenser 32. If desired, the tuning condenser 32 can be in turn shunted by a small trimmer condenser 33. One side of inductance 31 is shown connected to the anode 18, and the other side to a source of B-battery potential, and also to ground through the radio frequency by-pass condenser 34. The screen grid 16 is connected to a suitable source of potential, as for example to the B-battery potential in series with a resistor 36. In practice, resistor 36 may be in the order of 0.1 megohm, where a B-battery potential in the order of 250 volts is being employed. That side of the resistor 36 connected to the screen grid 16, is also shown connected to ground, through the radio frequency by-pass condenser 37.

The regenerative detector 12*a* consists of an electron relay 41, having cathode, grid, and anode or plate elements 42, 43, and 44 respectively. The cathode 42 may be of the indirect heated type, but preferably a directly emitting filament. The circuits connected to the electron relay 41 include an inductance 46, shunted by the variable tuning condenser 47. While a standard type of variable tuning condenser can be employed, it is preferable to use a low loss condenser having a grounded rotor, as illustrated. One terminal of inductance 46 is shown connected to the anode 44, and the other terminal is shown connected through the blocking condenser 48, to the control grid 43. A resistor

49 is also shown connected from the control grid 43 and the cathode 42, and in practice should be of relatively high value, as for example in the order of from .1 to .5 megohm.

The current feed line 11 consists of two conductors 51 disposed in relatively close parallel relationship. These conductors are twisted upon each other, and can be provided with suitable shielding, to minimize direct absorption of energy. The ends of these conductors are shown connected to the terminals of inductances 52 and 53, which in turn are mutually inductively coupled to the inductances 31 and 46. In order to minimize direct absorption of energy by the inductances 31 and 46, they are preferably wound in the form of toroidal coils, with the inductances 52 and 53 disposed between the ends of the respective coils, as indicated. Such an arrangement is particularly effective because coils 52 and 53 are positioned adjacent the high potential ends of inductances 31 and 46, instead of adjacent points near zero radio frequency potential.

The local oscillator 12*b* can consist of an electron relay 54, having cathode, grid and anode or plate elements 56, 57 and 58 respectively. The cathode 56 may be of the indirect heated type, but preferably a directly emitting filament. The circuit connections to the electron relay 54 include an inductance 59, shunted by the condenser 61. One terminal of inductance 59 is shown connected to the anode 58, and the other to the grid 57, through the blocking condenser 62. The cathode 56 is connected to the grid 57, through the resistor 63. A source of B-battery potential, represented by lead 64, is shown connected to an intermediate point on inductance 59.

Sensitivity of the regenerative detector 12*a* is controlled by adjusting the value of the B-battery potential applied, and the connection for supplying B-battery potential to the detector 12*a*, also serves to supply oscillatory energy from the local oscillator 12*b*, to enable the desired super-regenerative effect. Thus the anode of electron relay 54 is shown connected to an intermediate point on the inductance 46, in series with a variable resistor 66 and the secondary 69 of an audio-frequency transformer 68. By varying the value of resistor 66, the B-battery potential applied to the detector 12*a* can be controlled. In order to properly impress quenching potentials upon the detector 12*a*, resistor 66 and also the winding 69 are shown shunted by the radio frequency by-pass condenser 67. The primary of the audio-frequency transformer 68 is shown shunted by resistor 71 and condenser 72 in order to effectively shunt out any radio frequency currents, and in order to increase fidelity. The transformer output is shown connected to one or more stages of audio-frequency amplification 73, which in turn connect to the translator 74.

Inductances 31 and 46, together with inductances 52 and 53, are proportioned and coupled in such a manner that, when the output of the radio frequency amplifier 10 is tuned to the same frequency as the detector 12*a*, the inductance-capacitance ratios between inductance 31 and condenser 32, and also between inductance 46 and the condenser 47 are substantially identical. Therefore the tuning condensers 32 and 47 can be connected to a common control member, whereby the receiver can be tuned over a substantial range of frequencies by the turning of a single tuning dial.

The receiving system described above possesses the following characteristics: When properly tuned to a given frequency, radio frequency amplifier 10 affords a high amplification gain, as for example a gain as great as 30 to 1. This gain is efficiently transferred to the detector 12*a*, which is adjusted to have high sensitivity, according to the principles of super-regeneration. Radio energy created by virtue of the regenerative action of the detector 12*a*, and also by virtue of the quenching frequency generated by oscillator 12*b*, is effectively blocked, and is not re-radiated from the antenna. This is attributed to the fact that the radio frequency amplifier 10 is capable of effectively blocking such energy and that its input circuit is non-inductive and non-resonant. It is likewise attributed in part to the use of a current transmission line, for coupling the radio frequency amplifier to the super-regenerative detector. A relatively high degree of selectivity is obtained, particularly as compared to an ordinary super-regenerative receiver directly coupled to an antenna. This is attributed to the sharp tuning of the output circuit of the radio frequency amplifier, together with tuning of the regenerative detector means 12*a*.

I am aware of the fact that attempts have been made to place one stage of radio frequency amplification before a super-regenerative detector. However, as previously explained, such attempts have not proven successful, due to the fact that in order to properly block re-radiation of energy, it was necessary to operate the radio frequency amplifier at relatively low efficiency, to produce substantially no amplification gain, or to even cause a loss in the signal energy transferred. As explained above, my system not only effectively blocks the re-radiation of energy, but provides a high amplification gain.

My invention should be distinguished from so-called aperiodic radio frequency amplifiers which have been used in the past with radio receivers, as for example receivers of the so-called tuned radio frequency type using ordinary regenerative or non-regenerative detectors. In such systems an aperiodic radio frequency electron relay stage has preceded one or more stages of tuned radio frequency amplifiers, but the output of the aperiodic relay has included a small primary coil mutually inductively coupled with a tuned secondary, which in turn is included in the grid circuit of the next stage. In my system the output of relay 10 includes the coil 31, which is directly tuned. Likewise note that if one should directly connect the coil 53 in the output of relay 10 thereby eliminating coils 31 and 52, and transmission line 11, the system would be virtually inoperative.

It will be apparent from the above that while radio frequency amplifiers having an aperiodic grid circuit coupled to an antenna, have been known per se, I have discovered highly beneficial results obtained by the use of such an amplifier in a system making use of a super-regenerative detector, provided the system is arranged in accordance with the present invention. It appears that attempts to use conventional tuned radio frequency amplifiers, preceding a super-regenerative detector have failed in the past, because of the effect of oscillations fed back from the detector, which not only constitutes a load upon the detector to decrease its sensitivity, but also appears to have a paralyzing effect upon the preceding stage of tuned radio frequency amplification.

In the present system the current feed line 11 appears to be beneficial in enabling the preceding radio frequency amplifier to operate with a high amplification gain, and likewise the aperiodic grid circuit contributes to entirely nullify any paralyzing effect. Thus high amplification gain can be secured, without re-radiation.

It is also a characteristic of my invention that the system is capable of high sensitivity with a relatively low hiss level. In this connection best results are secured with relatively low plate potential on the relay 41. For example with a B-battery potential of about 110 volts on the oscillator 12*b*, good results are secured with a plate potential of about 6 volts on the relay 12*a*. I have also noted that when the system is affording best performance, there appears to be a super-sonic frequency excited in the circuit formed by the transformer secondary 69, condenser 67, and resistor 66. For example with a quench frequency of about 1,000 kilocycles, the super-sonic frequency appears to be on the order of from 20 to 40 kilocycles.

As shown in Fig. 2 it is possible to substitute a standard form of screen grid tube, in place of the electron relay 13 indicated in Fig. 1. Thus the electron relay 13*a* in this instance consists of the indirectly heated cathode 14*a*, control grid 15*a*, screen grid 76, and the anode or plate 18*a*. It will be noted that the screen grid 76 is connected to one side of the resistor 36, and the cathode 14*a* is connected to one side of the resistor 23, as in Fig. 1. The terminal *a* of resistor 21 is conductively connected to the cathode 14*a* in Fig. 2, which is a possible alternative arrangement, which can also be employed in Fig. 1. In other words, in Fig. 1, in place of conductively connecting points *a* and *c*, a conductive connection can be provided between points *a* and *b*.

I claim:

1. In an ultra high frequency radio receiver, a radio frequency amplifier for signal energy, said amplifier having an untuned input circuit and a sharply tuned output circuit, a super-regenerative detector having a sharply tuned circuit, and a low voltage current feed line serving to couple the output of the amplifier to the super-regenerative detector.

2. In an ultra high frequency radio receiver, a radio frequency amplifier having an untuned input circuit and a sharply tuned output circuit, a sharply tuned super-regenerative detector, the inductive-capacitance ratio of the tuned output circuit for the amplifier being substantially identical with the inductance-capacitance ratio for the super-regenerative detector, a low voltage current feed line serving to couple the output circuit of the amplifier to the super-regenerative detector, and means for effecting unison variation of the respective inductance-capacitance ratios of the amplifier and detector.

3. An ultra high frequency radio receiver comprising a radio frequency amplifier, a super-regenerative detector, a low voltage current feed line serving to couple the output of the amplifier to the super-regenerative detector, said super-regenerative detector including an electron detector relay having a regenerative circuit coupled to the same, a local electron relay oscillator, a source of B-battery potential for both the local oscillator and the detector relay, and means for varying the B-battery potential supplied to the detector relay, whereby the sensitivity of said detector is varied.

4. An ultra high frequency radio receiver comprising a radio frequency amplifier, a super-regenerative detector, a low voltage current feed line serving to couple the output of the amplifier to the super-regenerative detector, said super-regenerative detector including an electron detector relay having a regenerative circuit coupled to the same, a local electron relay oscillator, a source of B-battery potential for the local oscillator, and a connection including a variable resistor for applying both B-battery potential and quenching frequency from the oscillator, to the detector.

5. An ultra high frequency radio receiver comprising a radio frequency amplifier, a super-regenerative detector, a low voltage current feed line serving to couple the output of the amplifier to the super-regenerative detector, said super-regenerative detector including an electron detector relay having a regenerative circuit coupled to the same, a local electron relay oscillator, a source of B-battery potential for the local oscillator, a connection including a variable resistor for applying both B-battery potential and quenching frequency from the oscillator, to the detector, and audio amplifying and translating means coupled to said connection.

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