March 19, 1940. J. ROBINSON 2,193,843

WIRELESS AND LIKE RECEIVER

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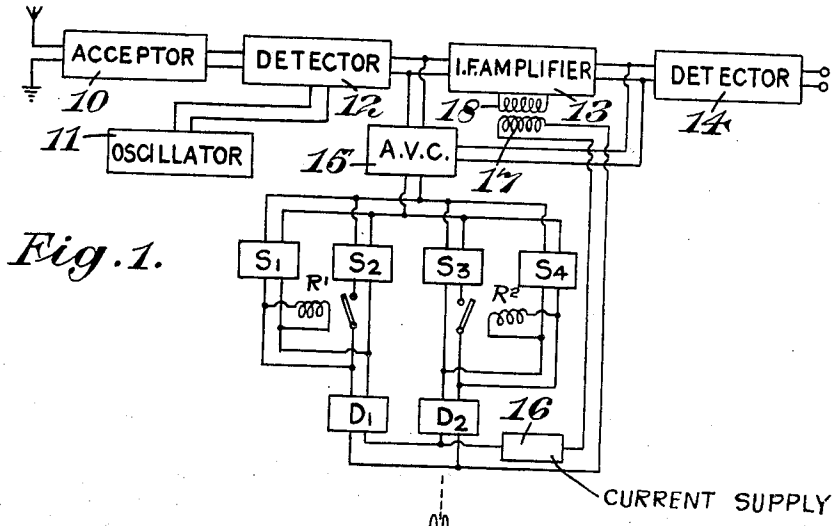


Fig. 1.

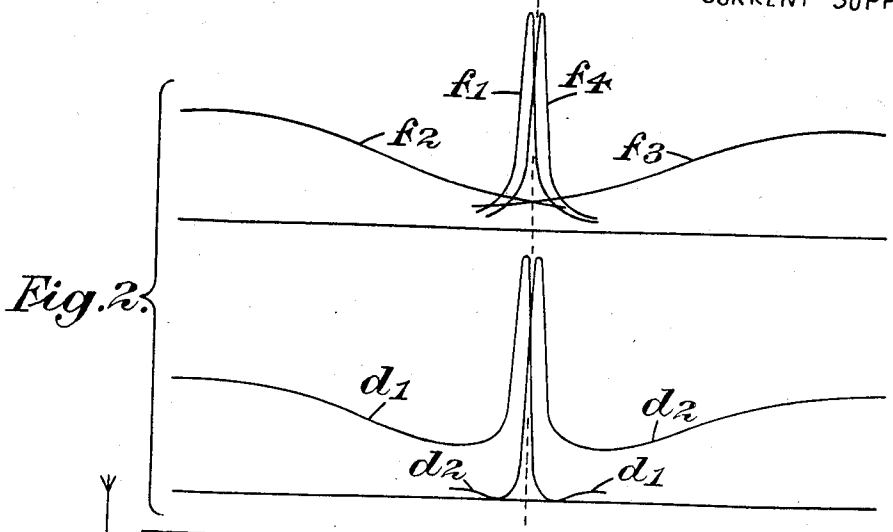


Fig. 2.

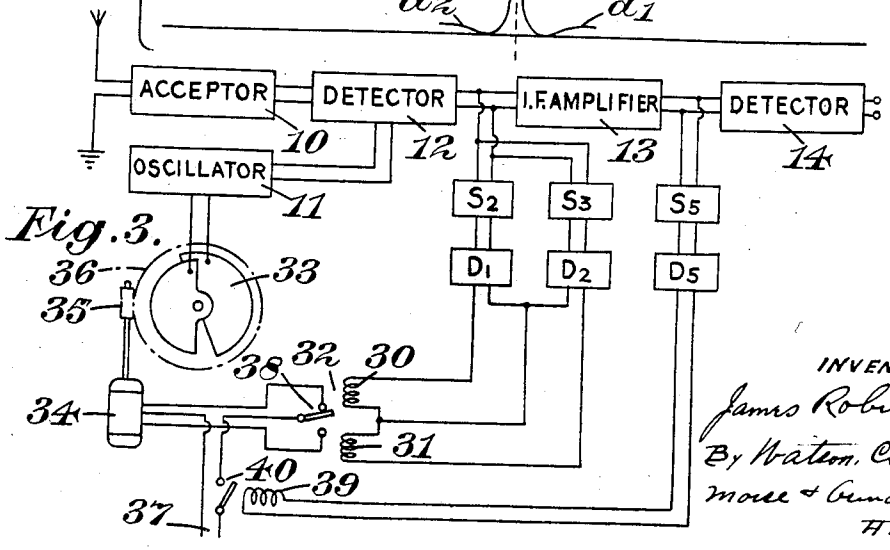


Fig. 3.

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Fig. 4.

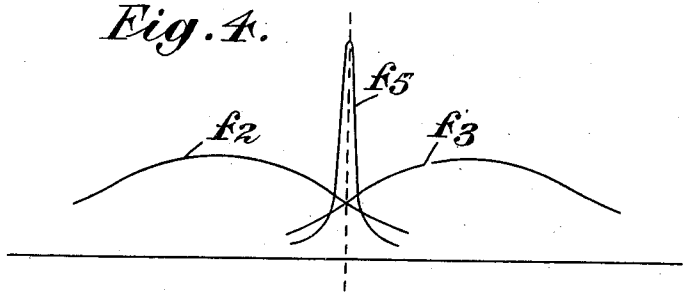
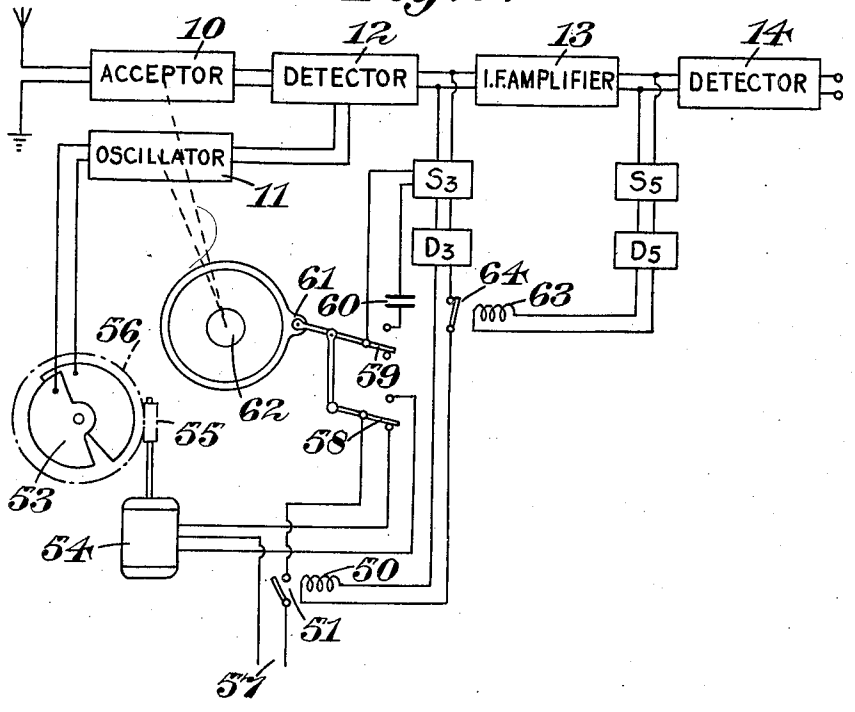


Fig. 5.



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WIRELESS AND LIKE RECEIVER

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4 Claims. (Cl. 250—20)

This invention relates to wireless and like receivers and is concerned with means for automatically controlling or altering the tuning of the receiver. For this purpose it has been proposed to employ two resonant devices tuned to frequencies one higher and the other lower than the frequency of the receiver. The incoming signals are applied to these resonant devices and their outputs are employed to vary the tuning of the receiver so as to tend to bring it into tune with the incoming signals.

With such apparatus, using, as the resonant devices, normal tuned circuits, there is the disadvantage that under some circumstances a strong unwanted signal operates the apparatus to pull the tuning of the receiver from resonance with wanted signals of lower field strength. On the other hand, by using only resonant devices of comparatively high-selectivity, such as piezo-electric devices, the range of control is restricted to a narrow frequency band.

According to the present invention there is provided in a wireless or like receiver, automatic tuning apparatus comprising resonant means having a maximum response at or near a resonant frequency of the receiver and a lesser but substantial response through an adjacent band of frequencies to one side only of the resonant frequency of the receiver, means for applying a portion of the received signals to the input of the resonant means, and means controlled by the output thereof for varying the tuning of the receiver. The width of the control band is selected for the range of control required in any given circumstances and may, for example be 5 kcs. under existing broadcasting conditions. Thus, the comparatively large response which is obtained at or near the resonance of the receiver with the required signals serves to ensure to a large degree that the receiver is not automatically adjusted out of tune by a strong unwanted transmission at a neighbouring frequency, but nevertheless by means of the broad band automatic control over a wide range of frequencies is obtained.

According to one embodiment of the invention the resonant means aforesaid comprises two highly-selective circuits tuned to frequencies one slightly higher and the other slightly lower than a resonant frequency of the receiver and two comparatively broadly tuned circuits providing a substantial response for bands of frequencies higher and lower respectively than the resonant frequency of the receiver, and means is provided for applying the outputs of both the highly-selective and broadly tuned circuits in opposition automatically to control tuning of the receiver. The highly-selective and the broadly tuned circuits may be arranged independently to control the tuning, or they may be connected in parallel in order to provide a combined signal output for controlling the tuning.

The invention further comprises a means for automatically controlling the intensity of the signals applied to the resonant means aforesaid in order to prevent automatic variation of the tuning of the receiver due to fading of the signals. Furthermore, the resonant means may be constructed to provide a substantial zero response at frequencies spaced from the resonant frequency of the receiver by a frequency interval of the order of 9 or 10 kcs.

According to another embodiment of the invention the automatic tuning apparatus comprises two broadly tuned circuits for producing a substantial response for bands of frequencies higher and lower respectively than a resonant frequency of the receiver, to which circuits received signals are applied, means for applying the outputs of these circuits in the opposed sense automatically to adjust the tuning of the receiver, a highly-selective circuit for received signals and in tune with a resonant frequency of the receiver, and means controlled by the output of the highly-selective device to stop automatic adjustment of tuning under the control of the broadly tuned circuits.

In a further embodiment of the invention as applied to a wireless or like receiver having a manual tuning control, the automatic tuning apparatus comprises a broadly tuned circuit providing a substantial response for a band of frequencies to one side only of a resonant frequency of the receiver and a highly-selective circuit in tune with the receiver, to which circuits received signals are applied, means automatically adjusting the tuning of the receiver according to the output of the broadly tuned circuit, means operated by the turning movement of the manual control to reverse the direction of automatic tuning adjustment, and means controlled by the output of the highly-selective device to stop automatic adjustment of tuning under the control of the broadly tuned circuit.

Several embodiments of the invention are illustrated diagrammatically by way of example in the accompanying drawings, in which:

Figure 1 is a diagram of a receiver employing two highly-selective devices and two broadly tuned devices for the control of tuning;

Figure 2 shows curves representing the operation of the receiver shown in Figure 1;

Figure 3 is a diagram of a receiver employing a single highly-selective device for the control of tuning;

Figure 4 shows curves representing the operation of the receiver shown in Figure 3, and

Figure 5 is a diagram of a receiver employing one highly-selective device and one broadly-tuned device for automatic tuning.

In Figure 1, there is represented a receiver of the super-heterodyne type comprising a signal-acceptor 10, local oscillator 11, first detector 12, intermediate frequency amplifier 13 and second detector 14. A portion of the signal output of the detector 12 is applied through automatic volume control means 15 to four selective devices S_1, S_2, S_3 and S_4. The selective devices S_1 and S_4 are tuned to frequencies, one slightly higher and the other slightly lower than the intermediate frequency of the receiver and these selective devices are also very sharply selective and comprise piezo-electric crystals for this purpose. The signal response obtained by these selective devices S_1 and S_4 is shown at f_1 and f_4 respectively in Figure 2. The selective devices S_2 and S_3 are comparatively broadly tuned to frequencies well removed from the intermediate frequency of the receiver and one higher and the other lower than this frequency. The selective devices S_2 and S_3 may for example be tuned to frequencies removed from the intermediate frequency by 4 or 5 kcs. The response obtained by the selective devices S_2 and S_3 is indicated at f_2 and f_3 respectively in Figure 2.

The outputs of the selective devices S_1 and S_2 are combined and applied to a rectifier D_1 and the outputs of the selective devices S_2 and S_4 are combined and applied to another rectifier D_2. The combined input to the rectifier D_1 is represented by the curve d_1 in Figure 2 and the combined input to the rectifier D_2 is represented by the curve d_2. The outputs of the rectifiers D_1 and D_2 are connected in the opposed sense with a source 16 of electric current and a coil 17 inductively coupled to a coil 18 in each tuned stage of the intermediate frequency amplifier 13.

Thus, in operation, when the signals are not in resonance with the intermediate frequency amplifier 13 but are within a predetermined range depending upon the broadly tuned selective devices S_2 and S_3, an output will be obtained at one of the rectifiers D_1 or D_2, greater than the output at the other, to oppose or assist, as the case may be, the current flowing in the coil 17 from the source 16. This variation in current will, in the known manner, change the tuning of the intermediate frequency amplifier, and this change is arranged to be in a direction to bring the intermediate frequency amplifier into resonance with the signals at the output of the detector 12. By the use of the highly-selective devices S_1 and S_4 a high degree of accuracy is obtained in the control of tuning owing to the steep slope of the characteristic curves of these selective devices and moreover, by reason of the high amplitude compared with that of the broadly tuned selective devices a measure of protection is ensured against the effect of an interfering signal at a remote frequency adversely affecting the proper control of tuning for the required signal by means of the automatic control. For the purposes of adjustment means may be embodied in either of the selective devices S_1 and S_2 and in either of the selective devices S_3 and S_4 to control their relative outputs as combined at the rectifiers D_1 and D_2 respectively. By means of the provision of automatic volume control for the signals used for automatic tuning, undesirable variations in the tuning due to variation in signal strength due to fading are avoided. In cases wherein automatic volume control is independently employed in the receiver, the volume control means 15 especially for automatic tuning, may be dispensed with and the signals necessary for tuning control are then extracted from a part of the receiver which is subject to this normal volume control.

A further means for preventing this disturbing effect of a remote interfering signal on the automatic control of tuning for the required signals, consists in the provision of relays R_1 and R_2, e. g., mechanical relays, thermionic valve relays, or other conventional relays, in circuit with the broadly tuned devices S_2 and S_3, which relays R_1 and R_2 are controlled respectively by the outputs of the selective devices S_1 and S_4 in such a manner that when these outputs exceed a predetermined intensity the relays R_1 and R_2 are operated to interrupt or reduce the output of the broadly tuned devices S_2 and S_3 as applied to the rectifiers D_1 and D_2 respectively. Thus, under these conditions, which arise when the receiver is approximately in correct tune for the required signals, only the highly-selective control devices S_1 and S_4 are operative to control tuning. It will be appreciated that instead of combining the output of each highly-selective device with that of the associated broadly tuned device these outputs may be separately rectified and the rectified components then combined or applied individually to control the tuning of the receiver.

In the form of receiver shown in Figure 3 of the drawings a portion of the output of the first detector 12 is applied to two broadly tuned devices S_2 and S_3 tuned as in the preceding construction to frequencies, one higher and the other lower than the resonant frequency of the intermediate frequency amplifier 13 by an amount corresponding to four or five kcs. The outputs obtained from these devices S_2 and S_3, shown diagrammatically at f_2 and f_3 in Figure 4, are applied to rectifiers D_1 and D_2. The output circuits of these rectifiers are connected in opposition and include energising coils 30 and 31 respectively of a polarised relay 32.

The local oscillator 11 of the receiver includes a variable condenser 33 which is adjusted by means of an electric motor 34 driving a worm 35 in mesh with a worm-wheel 36 which is rotatable with the movable element of the condenser 33. The motor 34 is of a reversible type to which the electric supply is applied at 37, and is controlled for producing appropriate rotation of the motor 34 by means of reversing contacts 38 of the relay 32. Thus, in operation, when the receiver is not properly in tune with the received signals, the output obtained from one of the rectifiers D_1 and D_2 is greater than that obtained from the other, thus energising one of the coils 30 and 31 to a predominating extent to operate the reversing contacts 38. The motor is thus operated to rotate the tuning condenser 33 in the appropriate direction to bring the receiver into tune with the signals.

A single highly-selective device indicated at S_5 and comprising for example a piezo-electric crystal is in this case in tune with the intermediate frequency amplifier 13 and is fed from the output of this amplifier. The output of the selective device S_5, as represented at f_5 in Figure 4,

is applied to a rectifier D_5. The output of this rectifier is applied to a relay coil 39 controlling switch contacts 40 in the electric supply to the motor 34 in such manner that when a response of predetermined amplitude is obtained from the selective device S_5, that is to say, when the receiver is in tune with the signals, the motor circuit is opened at the switch contacts 40 to stop rotation of the motor.

In Figure 5 there is shown a further modification, employing only a single broadly-tuned circuit. In this arrangement, a portion of the signal output of the detector 12 is applied to the broadly tuned device S_3 having a frequency response of the character indicated at f_3 in Figure 4. The output of this device S_3 is applied to a rectifier D_3, providing an energising current for a relay coil 50. The local oscillator 11 of the receiver includes a variable condenser 53 which is adjusted by means of an electric motor 54 driving a worm 55 in mesh with a worm-wheel 56 which is rotatable with the movable element of the condenser 53. The motor 54 is of a reversible type, to which the electric supply is applied at 57 through switch contacts 51 controlled by the relay coil 50. The direction of rotation of the motor 54 is controlled by a reversing switch 58. Associated with the device S_3 there is provided an additional tuning element such as a condenser 60 arranged to be connected in circuit by means of a switch 59 and thereby to alter the effective tuning of the device S_3 to the opposite side of the intermediate frequency of the receiver as indicated at f_2 in Figure 4. The movable contacts of the switches 58 and 59 are linked to a member 61 frictionally engaged with a normal manually rotatable tuning member 62 controlling both the oscillator and acceptor circuits. By this arrangement the initial movement of the tuning control 62 in one direction closes the switch 59 and also closes the switch 58 for one direction of rotation of the motor. The initial movement of the tuning control 62 in the opposite direction opens the switch 59 and operates the switch 58 to reverse the rotation of the motor 54.

Thus, in operation, assuming the switches 58 and 59 to be in the position shown in Figure 5, as a consequence of the movement of the tuning control 62 in an anti-clockwise direction, a signal response from the device S_3 serves to energize the relay coil 50 and close the contacts 51. The motor 54 is thus energised and is arranged to drive the condenser 53 to vary the frequency of the oscillator 11 in a direction to bring the receiver into tune with the signals. Similarly, when the tuning control 62 is moved in the clockwise direction towards tuning for a given transmission, the switches 58 and 59 are reversed. A signal output then obtained from the device S_3 in association with the condenser 60 serves to energise the relay 50, 51, for operation of the motor, but in the reverse direction owing to the change in position of the switch 58, thus automatically advancing tuning towards resonance but from the opposite direction. When the receiver is in tune with the signals, an output is obtained from the highly-selective device S_5 which provides at the output of the rectifier D_5 a current energising a relay coil 63 to open normally closed contacts 64 in the circuit of the relay coil 50, thus disconnecting the motor 54 and arresting automatic tuning at the correct tuning position.

The highly-selective circuit S_5 in Figures 3 and 5 may conveniently be constituted by a piezo-electric device. Alternatively, it comprises a more complex system, with the object of providing a very sharp characteristic and may consist for example of two piezo-electric devices connected in series, or again, of two piezo-electric devices having resonant frequencies, one slightly higher and one slightly lower than the intermediate frequency of the receiver and arranged to operate in opposition.

The devices employed as aforesaid for controlling the tuning of the receiver may be energised by signals derived from the output of the normal selective part of the receiver or they may constitute the means for selecting the required signals for reproduction by the receiver. The potentials or currents derived from the signals may be applied to produce tuning adjustment in any convenient manner, for example as described in United States Patent applications Serial No. 688,198, filed September 5, 1933, and Serial No. 43,265, filed October 2, 1935; for instance, instead of the specific arrangements shown in Figures 1, 3 and 5, the control potentials may be applied to control the operation of a thermionic valve which is associated with a tuned circuit of the receiver in order to produce the required change of resonant frequency of the circuit in the known manner.

I claim:

1. A receiver system comprising automatic tuning means, a tuned amplifier, a broadly tuned circuit connected ahead of said amplifier, said circuit providing a substantial response for a band of frequencies to one side only of the resonant frequency of the receiver and a second broadly tuned circuit providing a substantial response for a band of frequencies to the other side only of the said resonant frequency, and means for applying the outputs of said broadly tuned circuits in the opposed sense automatically to adjust the tuning of the receiver, and means for applying the output of the said tuned amplifier automatically to stop the automatic adjustment of tuning by said broadly tuned circuits.

2. A superheterodyne system comprising means to receive incoming signals, a local oscillator, means for combining the received signals and the output of the oscillator to yield an intermediate frequency, a circuit broadly tuned to one side of the intermediate frequency, a circuit sharply tuned to the intermediate frequency to afford maximum output at such frequency, means applying a portion of the signal energy at the intermediate frequency to said circuits, automatic means for varying the frequency of said oscillator operable by said broadly tuned circuit, and means operable by the output of said sharply tuned circuit, whenever such output exceeds a predetermined minimum, to terminate the operation of said automatic means.

3. In a wireless or like receiver automatic tuning apparatus comprising two broadly tuned circuits producing a substantial response for bands of frequencies higher and lower respectively than a resonant frequency of the receiver, to which circuits received currents are applied, means for applying the outputs of said circuits in the opposed sense automatically to adjust the tuning of the receiver, and means comprising a circuit sharply tuned to resonance with the desired incoming signal and operable while said receiver is approximately in tune with said desired signal to stop the automatic adjustment of tuning under the control of the broadly tuned circuits,

said last named means being unaffected by simultaneously received interfering signals of which the frequency differs from that of the desired signal but falls within the pass range of said sharply tuned circuit.

4. In a wireless or like receiver, automatic tuning apparatus comprising a sharply tuned circuit approximately in tune with the resonant frequency of the receiver to afford maximum output at such frequency, a broadly tuned circuit providing a substantial response for a band of frequencies to one side only of the resonant frequency of the receiver, a second broadly tuned circuit providing a substantial response for a band of frequencies to the other side only of the said resonant frequency, means applying a portion of the received signals to said highly-selective device and said broadly tuned circuits, means for applying the outputs of said broadly tuned circuits in the opposed sense automatically to adjust the tuning of the receiver, and means operable by the output of the said sharply tuned circuit, whenever said output exceeds a predetermined minimum, automatically to stop the automatic adjustment of tuning by said broadly tuned circuits.

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