

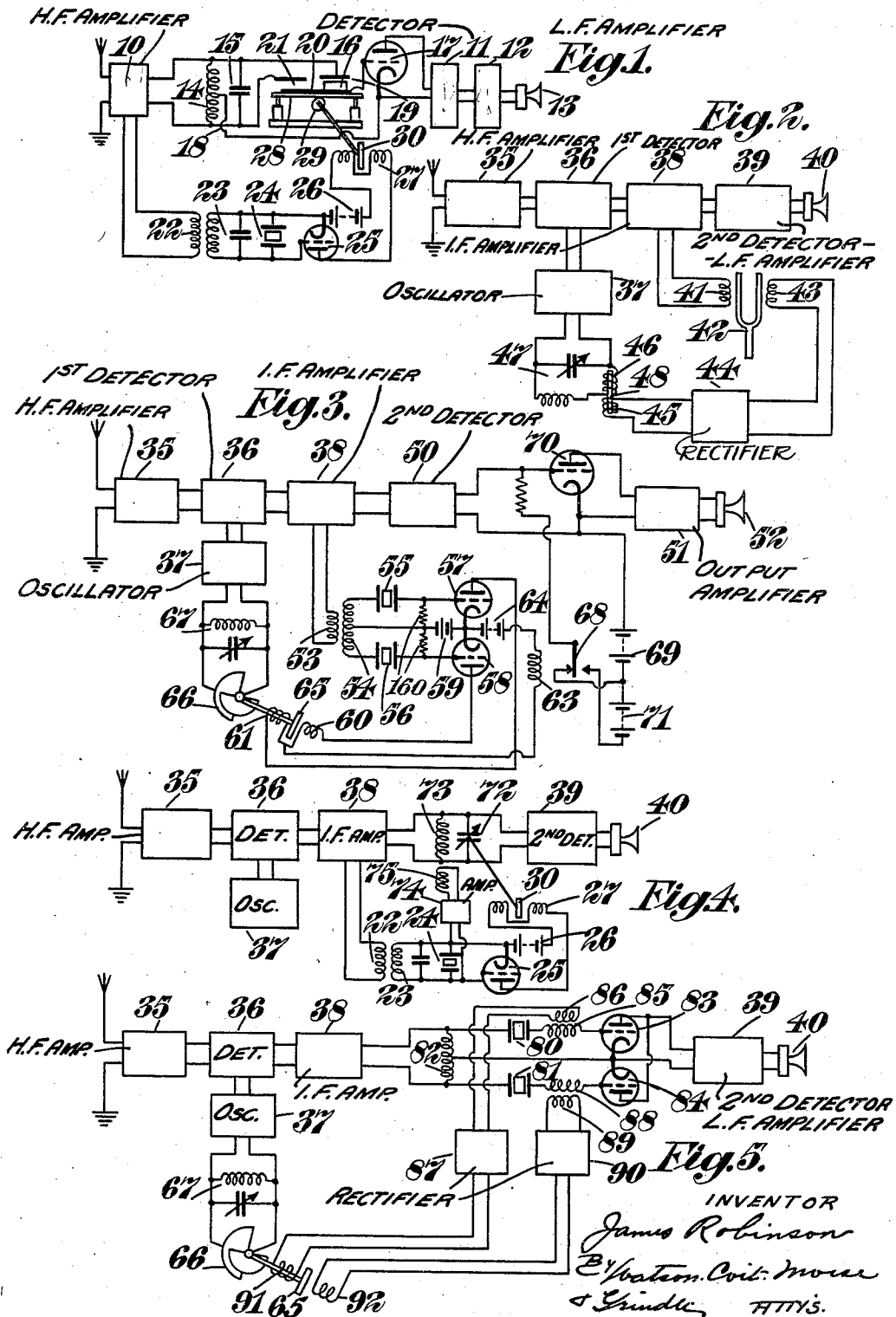
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SELECTIVE RECEIVER FOR WAVE SIGNALS

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SELECTIVE RECEIVER FOR WAVE SIGNALS

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This invention relates to selective receivers for wave signals. It is known that wave transmissions, such as wireless broadcast transmissions, are often subject to slight variation of the basic or carrier frequency of the transmission and it is therefore necessary, particularly with receiving apparatus of very high selectivity, to make occasional adjustments of the tuning of the receiver in order that the best results shall be obtained. It is an object of this invention to provide a receiver in which this disadvantage is overcome.

It will be understood that by reference to a selective receiver is meant any receiver which discriminates between transmissions which are very close together as regards the basic or carrier frequency and including receivers having band-pass tuning, receivers having a highly selective resonator followed by tone correcting means and receivers in which the carrier wave component of the received signals is augmented in the receiver by locally applied oscillations obtained, for example, from the signals.

According to the present invention there is provided a selective receiver for wave signals comprising controlling means responsive to upward and downward changes of frequency of the signal energy applied to a selective part of the receiver and operative to control the tuning of the receiver. The controlling means is effective to adjust the tuning of the receiver over a range of frequencies including the frequency to which the receiver is normally tuned for the transmission to be received. Any departure of the incoming signals from this latter frequency provides a control for the tuning mechanism, such that, the receiver is automatically maintained properly in tune with the signals being received.

According to a feature of the invention the controlling means comprises a mechanical resonator, such as a piezo-electric device or a tuning fork (or more than one mechanical resonator) which is energized by the incoming signals and is tuned with respect to the signals as to provide a response which varies with variations of frequency of the signal energy in combination with means operated by the response of the mechanical resonator or resonators to control the tuning of the receiver.

In one arrangement there is employed a single mechanical resonator tuned to a frequency different from the frequency of the signals whereby a greater or lesser response is obtained for variations of signal frequency above or below the normal value. In an alternative arrangement the controlling means comprises two mechanical res-

onators tuned respectively to frequencies one higher and the other lower than the normal frequency of the signals in combination with means operative according to opposite electrical effects produced by the response of the resonators to control the tuning of the receiver.

The invention also comprises the combination of the automatic tuning control with means to suppress the output of the receiver when not in tune with incoming signals, and in one arrangement the output suppressing means is controlled by the response of a mechanical resonator which also controls the tuning of the receiver.

According to a further feature of the invention a single selective system (e. g. comprising one or more mechanical resonators) is provided for the dual purpose of selectively receiving the incoming signals and for providing a response automatically controlling the tuning of the selective system. In one arrangement there is provided the combination with the selective device of the receiver, of a highly selective resonator (e. g. a mechanical resonator) for controlling the tuning of the receiver and means connecting the controlling resonator to the receiving selective device in order to raise the degree of selective operation of the latter with respect to incoming signals.

In the accompanying drawing there are diagrammatically illustrated several forms of receiver according to the invention, and:

Figure 1 is a diagram of a receiver with tuning controlling means comprising a single mechanical resonator;

Figure 2 is a diagram representing a receiver of the super-heterodyne type having an electrically operated tuning fork for controlling the tuning of the receiver;

Figure 3 is a diagram of a receiver of the super-heterodyne type employing two mechanical resonators controlling the tuning of the receiver and also the output of the receiver;

Figure 4 is a diagram of a super-heterodyne receiver having a piezo-electric device controlling the tuning of the receiver and also assisting the selective operation of the receiver, and

Figure 5 is a diagram of a super-heterodyne receiver having a signal selective system which also controls the tuning of the receiver.

Referring to Figure 1, there is shown a receiver comprising a high frequency amplifier 10, a detector 11 and a low frequency amplifier 12 with signal reproducing means indicated at 13. The high frequency amplifier 10 comprises signal selective tuning means, and includes a tuned circuit comprising an inductance 14 and a con-

denser 15. A piezo-electric crystal 16 mounted between electrodes 19 and 20 is connected in series between one terminal of the tuned circuit and the control electrode of a thermionic valve 17 and a tapping on the inductance 14 of the tuned circuit at 18 is connected to the cathode of the valve 17. The other terminal of the tuned circuit is connected through a condenser 21 to the control electrode of the valve, one electrode of the condenser being shown as an extension of the electrode 20 of the piezo-electric device. There is thus provided an electrically balanced system in which the capacity of the piezo-electric device is balanced or compensated for by means of the condenser 21. It will be understood that the tuned circuit 14, 15 and the piezo-electric device 16 have a resonant frequency equal to the frequency of the signals to be received.

A portion of the signal energy is fed by means of a coil 22 to a tuned circuit 23 having a piezo-electric crystal 24 in parallel therewith. This tuned circuit and piezo-electric crystal have a resonant frequency differing slightly from the frequency of the signals so that the carrier frequency of the signals normally falls on one of the major sloping portions of the crevasse, typical of the response of a parallel connected piezo-electric crystal. The output from the piezo-electric crystal 24 is applied to the input of a thermionic valve 25 operating as a rectifier and the output circuit of the valve comprises a battery 26 and a control coil 27. The electrode 20 belonging to the piezo-electric device 16 and the balancing condenser 21 are mounted on a platform 28 which is movable to vary the spacing between this electrode and the co-operating electrodes of the condenser and piezo-electric device. The position of the electrode 20 is adjusted by means of a rotatable cam 29 which is mechanically coupled to an armature 30 under the control of the coil 27 and moved in one direction or the other according to a rise or fall of current in the coil 27.

In operation, when the receiver is properly in tune with the incoming signals the piezo-electric device 24 provides an output from the rectifier valve 25 which controls the armature 30 to maintain the electrode 20 in its normal position. Should the incoming signals vary as regards frequency a greater or lesser response as the case may be is obtained from the piezo-electric device 24 with a corresponding greater or lesser output delivered by the valve 25 to the coil 27. This produces a movement of the armature 30 adjusting the position of the electrode 20 by means of the cam 29. The adjustment of this electrode towards or away from the co-operating electrode of the piezo-electric device produces in known manner a change in the resonant frequency of the piezo-electric device and by means of the control the tuning of this piezo-electric device is maintained in resonance with the incoming signals. Also, the movement of the electrode 20 produces a change of capacity of the condenser 21 so that the balanced condition of the system is maintained.

The receiver diagrammatically shown in Figure 2 is of the super-heterodyne type and comprises the normal arrangement of a high frequency amplifier 35, first detector 36, oscillator 37, intermediate frequency amplifier 38 and second detector and low frequency amplifier 39 delivering output to a signal reproducing device 40. A portion of the signal energy from the intermediate frequency amplifier is applied through a coil 41

to a tuning fork resonator 42 and by the vibrations of the tuning fork electric currents corresponding to the vibrations of the tuning fork are produced. The tuning fork 42, together with the coils 41 and 43 constitute a selective device which is tuned to a frequency differing slightly from the normal frequency of the received signals falls upon one of the main sloping portions of the characteristic curve of this resonator. The output from the tuning fork resonator is fed to a rectifier 44 providing a uni-directional current which is delivered to a coil 45 in the field of which is situated an inductance 46 forming part of a tuned circuit 47 controlling the frequency of the oscillator 37. A laminated or divided iron core 48 is provided for the coils 45 and 46. In this arrangement should the incoming signals depart from the normal frequency there will be a corresponding change of frequency of the signals in the intermediate frequency amplifier 38. The response of the tuning fork 42 will therefore be changed in amplitude and will be either greater or less than the normal value according to whether the frequency of the incoming signals becomes higher or lower than the normal value. This change in the response of the tuning fork 42 produces a corresponding change in the output of the rectifier 44 as applied to the coil 45. The corresponding change in the field of the coil 45 changes in known manner the effective inductance of the coil 46 and thus varies the tuning of the oscillator such as to modify the intermediate frequency to maintain the normal value. It will be understood that in this arrangement the signal energy operative in the intermediate frequency amplifier is maintained constant in respect of slight changes either in the basic frequency of the incoming signals or of the frequency of the local oscillator.

Instead of controlling the frequency of the oscillator circuit 47 by altering the effective inductance, the output of the rectifier 44 may be used to control a resistance in the oscillator circuit, for example, by controlling the operation of a thermionic valve employed as an impedance in the oscillator circuit.

The circuit arrangement shown in Figure 3 also represents a super-heterodyne receiver having a preliminary amplifier 35, detector 36, oscillator 37 and intermediate frequency amplifier 38. In this case the detector is indicated at 50, the output amplifier 51 and reproducing device at 52.

A portion of the signal energy in the intermediate frequency amplifier 38 is fed by means of coils 53 and 54 to two piezo-electric devices 55 and 56 respectively. These piezo-electric devices have resonant frequencies, one slightly higher and the other slightly lower than the intermediate frequency and separated, for example, by 40 cycles. The outputs of these crystals are connected respectively to the inputs of thermionic valves 57 and 58. The cathodes of the valves are connected together and to a centre tapping on the coil 54 through a biasing battery 59 operative through resistances 160 to apply a bias potential to the valves such that they will operate as rectifiers. The output circuits of these valves include coils 60 and 61 respectively and also a relay coil 63 and a battery 64 common to both circuits. The coils 60 and 61 control a polarized armature 65 rotatably mounted and coupled to a moving vane of a condenser 66 connected in the control circuit 67 of the oscillator 37. The relay coil 63 controls electric switch contacts 68 having two alternative positions one

in which to connect a battery 69 to provide a normal bias for a valve 70 of the output amplifier 51 and the other to provide an increased bias by means of the battery 71 such as to render the valve 70 inoperative.

In operation, under normal conditions, the signal energy which is fed from the intermediate frequency amplifier 38 to the piezo-electric crystals 55 and 56 produces equal outputs from the valves 57 and 58. The resulting currents in the coils 60 and 61 are equal and opposite and no effect is produced on the armature 65. The currents are accumulative in the relay coil 63 and maintain the switch contacts 68 in the position providing normal bias for the amplifier 70. The arrangement is such that for all signal frequencies between the resonant frequencies of the piezo-electric devices 55 and 56 the current in the relay coil 63 is sufficient to operate the switch contacts. Should the frequency of the signals in the intermediate frequency amplifier 38 depart from the normal value, either because of variations in frequency of the incoming signals, or because of variations of frequency of the local oscillator 37, then one of the crystals 55, 56 will provide a bigger response than the other, depending on whether the frequency error is positive or negative and the currents in the coils 60 and 61 will be unbalanced with the result that the armature is rotated together with the moving plate of the compensating condenser 66 connected in the oscillator circuit. It will be understood that the direction of rotation of the compensating condenser will be so arranged that the adjustment of the oscillator frequency compensates for the frequency error of the signals in the intermediate frequency amplifier. Should the signals in the intermediate frequency amplifier develop an error in the opposite direction the currents in the coils 60 and 61 are unbalanced in the opposite sense and a reverse adjustment of the compensating condenser 66 is obtained in the opposite direction. When the signals in the intermediate frequency amplifier are considerably out of tune, for example, by a frequency of 100 cycles, substantially no response is provided by either of the piezo-electric devices 55 and 56, with the result that a minimum current flows in the relay coil 63 which is insufficient to energize the relay. Thus, by means of the contacts 68 the battery 71 is brought into use to provide the higher negative bias for the signal amplifier such as to suppress any output from the receiver. Therefore, in any circumstances in which the receiver is not properly in tune with incoming signals the receiver output is suppressed so that signals are heard only when the receiver is approximately in tune with the incoming signals.

Instead of employing the relay 63 to control the biasing circuit of the amplifier 70, the drop in potential across an impedance connected in the output circuit of the valves 57 and 58 in place of the relay may be employed to provide the controlling bias potentials directly or through additional thermionic valve means.

A further form of receiver is shown in Figure 4 which is also of the super-heterodyne type comprising a high frequency amplifier 35, a detector 36, an oscillator 37, an intermediate frequency amplifier 38, second detector 39 and an audio-frequency amplifier and signal producing means 49 similar to the receiver shown in Figure 2. In this receiver a portion of the signal energy from the intermediate frequency amplifier 38 is fed

to a controlling system of the form illustrated in Figure 1 and comprising an input coil 22 and a tuned circuit 23 and piezo-electric crystal 24 tuned to a frequency slightly different from the normal signal frequency. This circuit operates as described with reference to Figure 1 to provide an input for a rectifying valve 25 having an output circuit including a coil 27 controlling a polarized armature 30. In the circuit shown in Figure 4 the armature 30 is mechanically connected to a variable condenser 72 in a tuned circuit 73 forming part of the amplifier 38, and controls the tuning of the amplifier in a manner similar to the control of the receiving piezo-electric device in Figure 1.

A portion of the output response of the piezo-electric crystal 24 is fed to an amplifier 74 to a coil 75 electro-magnetically coupled to the inductance of the tuned circuit 73. Although the piezo-electric device 24 is tuned to a frequency which is not exactly in resonance with the signal energy in the tuned circuit 73 an appreciable amount of energy is fed from this piezo-electric device to the amplifier 74 and owing to the characteristic low damping of the piezo-electric device the percentage modulation of the signals will be reduced so that this energy is approximately an unmodulated oscillation of signal frequency. By applying this energy to the tuned circuit 73 the percentage modulation of the modulated signals in this circuit is diminished and this in known manner produces in effect an improvement in selectivity by demodulation of weaker interfering signals at the following detector 39.

It will be understood that in the foregoing arrangement the intermediate frequency amplifier 38 may comprise a plurality of tuned circuits 73 connected in cascade in which case condensers 72 in each circuit may be ganged together for simultaneous operation by the armature 30.

A further form of receiver is shown in Figure 5 comprising a high-frequency amplifier 35, a detector 36, an oscillator 37, intermediate frequency amplifier 38 and detector and low-frequency amplifier 39 with signal reproducing means 49. The oscillator 37 comprises a tuned circuit 67, a compensating condenser 66 and an armature 65 controlling this condenser, as described with reference to Figure 3.

In the arrangement shown in Figure 5 the intermediate frequency amplifier 38 comprises two piezo-electric devices 80 and 81 energized in opposite phase from an input coil 82. These piezo-electric devices are connected respectively to thermionic valves 83 and 84, and the outputs of these valves are combined and applied to the succeeding detector of the receiver. The piezo-electric devices 80 and 81 have resonant frequencies, one slightly above and the other slightly below the normal intermediate frequency of the receiver, and operate as a highly-selective device for frequencies lying between the two resonant frequencies. A portion of the energy delivered by each of the piezo-electric crystals to the associated valve is utilized to control the tuning of the oscillator 37, as described with reference to Figure 3. A coil 85 connected in series between the crystal 80 and the valve 83 is coupled to a coil 86 feeding a rectifier 87, and similarly a coil 88 in series between the crystal 81 and the valve 84 is coupled to a coil 89 feeding a rectifier 90. The output effects from the two rectifiers are fed to coils 91 and 92 controlling the armature 65. In this receiver, when the input signal energy in the intermediate frequency am-

plifier 38, departs from a value which is the mean of the resonant frequencies of the piezo-electric devices 80 and 81, the resulting currents delivered by the rectifiers 87 and 90 will be unbalanced and produce the required movement of the armature 65 to adjust, by means of the compensating condenser 66, the tuning of the oscillator circuit 67 to correct for the frequency error of the signals. It will be understood that the controlling currents in the coils 91 and 92 will, under normal conditions, be equal in value and opposite in effect, so as to produce no movement of the armature 65.

I claim:

1. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two resonators tuned to frequencies one higher and the other lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said resonators and for reproducing the signals, tuning means for the local oscillator, and means controlled by a portion of the output of each resonator individually to operate the tuning means of the local oscillator in order to maintain constant the frequency of the signals applied to the resonators.

2. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two piezo-electric devices tuned to frequencies one slightly higher and the other slightly lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said piezo-electric devices and for reproducing the signals, tuning means for the local oscillator, and means controlled by a portion of the output of each piezo-electric device individually to operate the tuning means of the local oscillator to maintain constant the frequency of the signals applied to the piezo-electric devices.

3. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two resonant circuits tuned to frequencies one higher and the other lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said circuits and for reproducing the signals, and

means responsive to variation of the relative output of said resonant circuits for altering the characteristics of the receiver to the extent required to compensate for variation of the carrier frequency of the incoming signals.

4. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two mechanical resonators tuned to frequencies one higher and the other lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said resonators and for reproducing the signals, and means responsive to variation of relative energy output of said resonators for maintaining substantially constant said intermediate frequency regardless of variation of the carrier frequency of the incoming signals.

5. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two mechanical resonators tuned to frequencies one higher and the other lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said resonators and for reproducing the signals, and means responsive to variation of relative energy output of said resonators for maintaining substantially constant said intermediate frequency regardless of variation of the carrier frequency of the incoming signals, said last named means including devices associated with said local oscillator and operable by a portion of the output of each of said resonators for altering the frequency of the output of said local oscillator.

6. In a radio receiver of the superheterodyne type having a local oscillator producing oscillations which are combined with incoming modulated carrier wave signals to produce signals of an intermediate frequency, the combination of intermediate frequency signal selective means comprising two piezo-electric devices tuned to frequencies one higher and the other lower than the intermediate frequency, means combining at such intermediate frequency the outputs of said piezo-electric devices and for reproducing the signals, and means responsive to variation of relative energy output of said piezo-electric devices for maintaining substantially constant said intermediate frequency regardless of variation of the carrier frequency of the incoming signals.

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