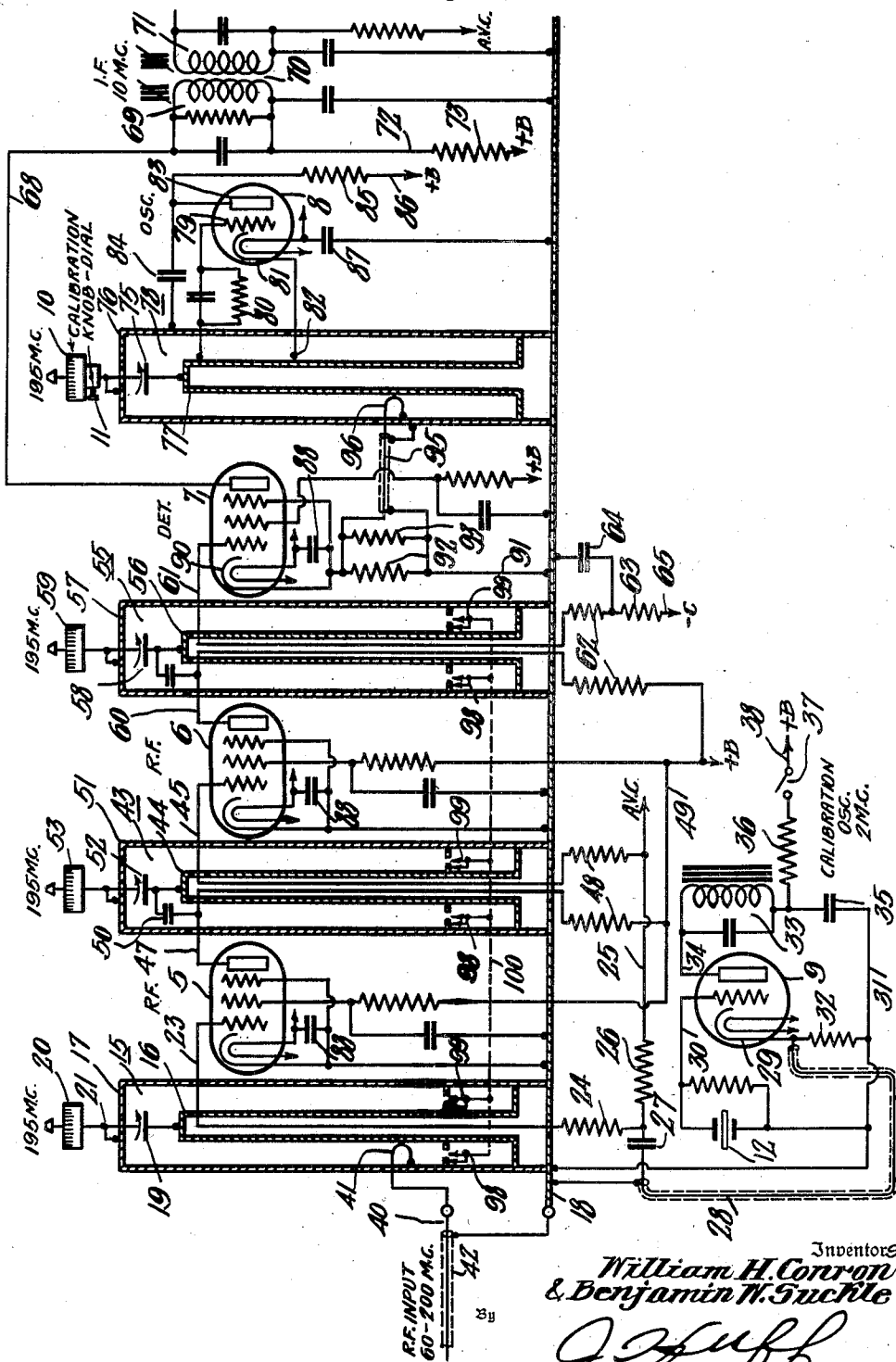


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HIGH FREQUENCY RECEIVER

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HIGH FREQUENCY RECEIVER

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This invention relates to high frequency receivers of the superheterodyne type, and has for a primary object to provide an improved receiver which may be calibrated or adjusted for the reception of high frequency signals within a predetermined frequency band, in the absence of signals and without recourse to calibrating means external to the receiving system.

It is also an object of this invention, to provide an improved high frequency signal receiving system of the superheterodyne type providing direct reading dial means and oscillator tuning adjustment permitting rapid and accurate calibration of the receiving system in the absence of signals, whereby the system may be preset in readiness to receive signals at a predetermined wave length.

It is a further object of this invention, to provide an improved high frequency signal receiving system of the superheterodyne type which permits rapid and accurate tuning adjustment to any desired frequency within a predetermined high frequency band and to exact resonance with a predetermined signal, prior to transmission of said signal.

A receiving system embodying the invention is particularly adapted for receiving intelligence transmission for command purposes, the receiving system being adjusted to receive the intelligence transmission on differing wave lengths which are periodically shifting.

It is also a further object of this invention to provide an improved superheterodyne signal receiving system for high frequency wave bands, which covers a relatively wide tuning range and which may be continuously calibrated or adjusted throughout the full tuning range.

The invention will be further understood from the following description, when considered in connection with the accompanying drawing, and its scope is pointed out in the appended claims.

Referring to the drawing, the single figure is a schematic circuit diagram of a tuning system for an ultra high frequency superheterodyne receiver embodying the invention. The system includes one or more high frequency R.-F. amplifier stages comprising amplifier tube 5 and 6, a detector or mixer tube 7, a main oscillator tube 8 and a calibration oscillator tube 9. The main oscillator is tuned by straight-line-frequency or SLF variable tuning means including a dial 10 which may be calibrated directly in frequency and which is provided with means indicated schematically at 11 to permit the frequency of

the oscillator to be shifted a limited amount without shifting the dial reading.

The calibration oscillator 9 is controlled in frequency by a crystal 12 or other suitable means for maintaining an accurate and fixed frequency output, and operates at a low frequency compared with the frequency band within which the main oscillator operates. Furthermore, the calibration or low frequency oscillator 9 operates at a sub-harmonic frequency of the intermediate frequency derived from the detector or mixer 7.

The radio frequency amplifier, detector and main oscillator circuits are variably tunable in a high frequency band which may be of the order of 140 megacycles in width between 60 and 200 megacycles, for example. For this purpose, the main oscillator dial 10 is calibrated in one megacycle divisions, equally spaced with vernier tuning means included therein which divides each of the one megacycle divisions into 100 parts, so that the vernier reading of the dial is in 10 kilocycle steps. By allotting the vernier readings in this manner, the tuning operation is facilitated in that coverage of 140,000 kilocycles or 14,000 divisions of 10 kilocycles each is provided by one dial. This degree of accuracy is sufficient for tuning to signals in the band indicated.

In operating a receiving system in the high frequency band indicated or similar ultra high frequency bands, concentric line inductances are provided for the tunable circuits. In the present example, the tuning inductance for the R.-F. stage 5 comprises a concentric line inductance 15 having an inner conductor 16 and an outer conductor 17, the latter being connected to the chassis or ground element 18 of the receiver. The line is tuned by a variable capacitor indicated at 19 connected in shunt with the concentric line between the inner and outer conductors adjacent one end thereof. This may readily be connected with a tuning dial 20, the rotor element of the capacitor being connected with the dial through a shaft indicated at 21 having a ground connection with the outer conductor.

The signal input grid circuit 23 of the first R.-F. amplifier stage 5 passes through and thereby is coupled to the inner conductor 16 at a suitable point. The inactive portion of the circuit extends through the center of the conductor to the lower end thereof where it is connected through a decoupling resistor 24 to an A. V. C. lead 25.

The conductor is also capacitively coupled to the calibration oscillator 9 across the impedance of a resistor element 26 interposed between the A. V. C. lead 25 and the decoupling resistor 24. Capacity coupling is provided through a capacitor 27 and a shielded lead 28 connected with the cathode 29 of the oscillator tube 9. The crystal of the oscillator is connected in the grid circuit 30 which is returned to a ground lead 31 connected with the chassis 18 and with the cathode through a biasing resistor 32. A tuned circuit 33 is included in the oscillator anode circuit 34 which is returned to the ground lead 31 through a capacitor 35.

Anode potential for the oscillator anode circuit 34 is supplied through a filter resistor 36 provided with a filter capacitor 35, a switch 37 and a positive anode supply lead 32. The oscillator is energized by closing the switch 37. Oscillations at the crystal frequency, which by way of example may be considered to be 2 mc. are applied across the cathode impedance 32 and the impedance 26 to the grid circuit 23 through the lead 28, the coupling capacitor 27 and the resistor 24.

The oscillator circuit described is shown only by way of example, as any suitable low frequency oscillator may be provided which is adapted for coupling with the R.-F. amplifier of the receiving system and which is stable in operation at a fixed frequency. However, the frequency chosen is such that production tolerances are readily maintained, the oscillator frequency being relatively low with respect to the operating frequency of the main oscillator 8 and preferably is a sub-harmonic of the intermediate frequency.

High frequency signals are applied to the input circuit of the R.-F. amplifier from a suitable supply source such as a transmission line 40 by suitable coupling with the concentric line inductance 15. In the present example, the line extends through the outer conductor to a coupling loop 41 adjacent the inner conductor 16. The lead is suitably shielded as indicated at 42.

The second stage R.-F. amplifier 6 is tuned by a similar concentric line inductance 43 having an inner conductor 44 coupled to the input grid circuit 45 of the stage 6 and to the output anode circuit 47 of the first stage 5, both of which comprise conductors extending through the outer and inner conductors and thence through the center of the inner conductor to decoupling resistors 48 which connect the grid and anode circuits, respectively, with the A. V. C. lead and a positive anode supply lead 49.

The anode circuit 47 is provided with additional coupling to the inner conductor through a capacitor indicated at 50 if sufficient coupling is not provided by the passage of the lead for the circuit through the high potential end of the inner conductor. The outer conductor is indicated at 51 and is connected to chassis or ground 18.

The concentric line inductance 43 is tuned by a variable capacitor 52 connected between the inner and outer conductors, and having a tuning dial 53 similar to the dial 20 for the input circuit.

The second R.-F. amplifier stage 6 is coupled to the detector by a third concentric line inductance 55 having an inner conductor 56 and an outer conductor 57, the latter being connected to ground or chassis 18. The line is tuned by a shunt variable capacitor 58 connected between the inner and outer conductors and having a

tuning dial 59. The output anode circuit 60 and signal input grid circuit 61 of the second R.-F. amplifier 6 and the detector 7, respectively, extend through the inner and outer conductors and thence through the inner conductor to decoupling resistors 62 providing the grid bias and anode connections for the grid and anode leads. In the present example, the anode connection is provided with the anode supply lead 49 while the grid lead is connected through a filter resistor 63, having a bypass capacitor 64, to a bias supply lead 65.

The output anode circuit 60 of the detector includes the tuned primary 69 of an I.-F. amplifier coupling transformer 70, the tuned secondary circuit 71 of which may be connected with suitable utilization means, not shown, but which is understood to be an intermediate frequency amplifier. Anode potential for the detector is supplied through a lead 72 provided with a decoupling resistor 73.

The oscillator straight line frequency tuning is provided by a variable capacitor 75 operated by the dial 10 and connected between an outer conductor 76 and an inner conductor 77 for a concentric line tuning inductance 78 similar to those provided for the R.-F. and detector circuits. The grid 79 of the oscillator 8 is connected through a grid leak and capacitor circuit 80 with the high potential end of the inner conductor. The cathode 81 is connected with an intermediate tap 82 on the inner conductor, while the outer conductor 76 is coupled to the anode 83 through a coupling capacitor 84 across an anode circuit impedance 85 through which the anode is supplied with operating current from a positive supply lead 86.

One side of the heater of the oscillator cathode 81 is coupled to ground through a bypass capacitor 87, and a similar arrangement is provided in connection with the other tubes of the tuning system as indicated at 88 whereby the heaters of the tubes 5, 6 and 7 are at ground R.-F. potential.

While an oscillator circuit of the Hartley type is shown, any suitable oscillator circuit may be provided which is adapted for straight line frequency tuning over a predetermined frequency band, and the oscillator may be coupled to the mixer or detector also in any suitable manner for deriving oscillations at uniform amplitude throughout the tuning range.

In the present example, the detector cathode 90 is connected to ground or chassis through a cathode circuit 91 including terminating resistors 92 and 93 for the transmission line 95 which is connected with a pickup loop 96 connected between the cathode and ground across said resistors. The ground connection is made to the outer conductor 76 which is connected to the chassis 18, and the input lead 95 to the coupling loop is shielded as indicated. The loop 96 is closely associated with and inductively coupled to the inner conductor 77, and provides coupling between the oscillator and the mixer cathode in a similar manner to the input coupling provided for the transmission line 40 at the input end of the receiving system.

The operation of the system is as follows: Assuming that a signal of 195 mc. is to be received, the concentric line inductances 15 and 43 for the R.-F. stages 5 and 6, and the concentric line inductance 55 for the detector, are tuned to that frequency by adjusting the dials 20, 53 and 59 to read 195 mc., as indicated. The input cir-

cuits are then broadly tuned for response at that frequency.

The calibration oscillator is energized by closing the switch 37, and the dial 10 of the main oscillator is adjusted to read to the nearest even megacycle which may be chosen as 196 mc. The calibrating control 11 is unlocked and the oscillator tuning capacitor 75 is then adjusted, without moving the dial setting, to shift the frequency until a zero beat signal in the output is obtained with the main dial still reading 196 mc.

The zero beat signal is the result of the fifth harmonic of the calibration oscillator beating with the difference frequency signal provided by the ninety eighth (196 mc.) harmonic of the calibration oscillator and the output frequency of the main oscillator when adjusted to 196 mc. The main oscillator is then actually tuned to 186 mc. thus providing a 10 mc. beat which is applied to the I. F. amplifier along with the fifth harmonic of the calibration oscillator and this results in the zero beat signal referred to when the main oscillator is properly adjusted to 186 mc. with a dial reading of 196 mc. This dial reading is provided as it corresponds to the desired signal so that all dials may be adjusted to the same kilocycle reading.

Upon obtaining the exact zero beat by adjustment of the main oscillator, the calibrating device, or knob, 11 is adjusted to permit the dial and oscillator tuning to move together, and the dial is reset to read 195 mc. This tunes the oscillator to 185 mc. with an accuracy much greater than is possible with the straight line tuning means provided, since the tuning has been calibrated at a point separated only a maximum of 1 mc. from the final point of tuning or by a relatively small increment. Since the beats are only 2 mc. apart in the present case, the straight line frequency tuning means should be accurate within $\pm \frac{3}{4}$ mc. (750 k. c.) in order to identify each beat.

When a signal at 195 mc. is received, the difference frequency is then 10 mc. which is applied to the intermediate frequency amplifier. The calibration oscillator 9 is deenergized by opening the switch 37, when receiving signals.

It should be noted that while the stray coupling in the receiver is sufficient to convey the fifth harmonic or 10 mc. signal from the calibration oscillator to the I. F. amplifier circuits, the higher harmonics, such as the 98th harmonic for the 2 mc. calibration signal, is conveyed through the broadly tuned R. F. amplifier and detector circuits, being amplified thereby before reaching the detector or mixer tube.

Tuning adjustments to other signal frequencies and made in the same manner, the receiver being calibrated for receiving signals at any particular frequency within the tuning range by the same method as that outlined. Therefore, the receiver may be set up rapidly and accurately for reception of signals to be received but not yet on the air, or to be in readiness to receive signals at a predetermined frequency, without additional equipment or apparatus external to the receiving system.

For changing the wave band of the tuning in the present example, means are provided for connecting the inner conductor, of each concentric line for the input circuits, to the outer conductor at an intermediate point, thereby to reduce the inductance of the lines, such switching means being indicated at 98 and 99 in each circuit and arranged to be operative as a unit as indicated

by the dotted connection 100. Movement of the contacts 98 and 99 serves to bridge connections between the inner and outer conductors as indicated.

In case a tuning meter or other indicator tuning device is provided in the system, the same method of tuning adjustment is followed except that the oscillator is adjusted for maximum signal output from the system instead of for zero beat.

We claim as our invention:

1. The method of adjusting a superheterodyne receiver for signal reception, which comprises tuning the input circuits to a predetermined signal frequency, generating oscillations at a relatively low frequency, applying said oscillations to said receiver through said circuits, adjusting the main oscillator to a frequency differing in frequency from a higher harmonic of the first named oscillations by the amount of the intermediate frequency, and then readjusting the tuning of said oscillator and the tuning indication thereof by such a small increment that the deviation from the accuracy of the first adjustment is negligible, to provide an oscillator frequency differing from the tuning of the input circuits by the amount of the intermediate frequency.

2. The method of presetting the tuning of a superheterodyne receiving system for signal reception at a predetermined frequency, which comprises adjusting the tuning of the input circuits of the system to provide a tuning indication corresponding to said signal frequency, generating oscillations at a relatively low fixed frequency, applying said oscillations to the receiving system through said circuits, adjusting the tuning of the main oscillator to provide a tuning indication corresponding to the nearest even higher harmonic of the first named oscillations with respect to the first named tuning indication, adjusting the tuning of the main oscillator, without changing said second named tuning indication, to a frequency which differs from the tuning of said input circuits by the amount of the intermediate frequency plus a relatively small increment less than the frequency of said first named oscillations, and then readjusting the tuning of said oscillator by said small increment and the tuning indication thereof to agree in frequency with the tuning of the input circuits.

3. In a superheterodyne receiver, the combination of a plurality of broadly tunable signal input circuits, a variably tunable oscillator circuit, tuning indicator dial means for said circuits calibrated to provide the same indication for a selected signal, a calibration oscillator for providing a fixed signal output at a constant frequency, coupling means between said calibration oscillator and said input circuits for transferring a higher harmonic of said calibration oscillator through said receiver to beat with the generated frequency of the first named oscillator, means for adjusting the tuning of the main oscillator to beat with said higher harmonic of the calibration oscillator to provide the intermediate frequency without changing the tuning indication provided by the oscillator dial means, and straight line frequency tuning means for adjusting the tuning and dial indication of said oscillator to provide the said intermediate frequency in response to said selected signal and a predetermined common dial reading for said signal.

4. A radio receiving system, comprising in combination, a tunable ultra high frequency ampli-

fier, a mixer and a main oscillator coupled to said amplifier, means including straight line frequency tuning means for said oscillator for varying the tuning of said system through a predetermined ultra high frequency signal receiving band, means for indicating the tuning adjustment of said amplifier, mixer and oscillator, a calibration oscillator coupled to said amplifier for transferring oscillations therethrough to said system for beating with the generated frequency of the first named oscillator, means for operating said calibration oscillator at a relatively low fixed frequency which is a sub-harmonic of the intermediate frequency, means for adjusting the main oscillator tuning independently of the tuning indicator means for response to a lower and a higher harmonic of the calibration oscillator, and means for readjusting the tuning of the main oscillator to a difference frequency with respect to the frequency of a desired signal, corresponding to the intermediate frequency, with the tuning indicator means of the main oscillator in accord with the tuning indicator means of said amplifier and detector.

5. In an ultra high frequency superheterodyne receiver, the combination of a plurality of broadly tunable ultra high frequency signal input circuits, a variably tunable ultra high frequency main oscillator circuit, an intermediate frequency amplifier circuit, a detector coupled to said last named circuit and to said first named input circuits, a calibration oscillator coupled to one of said input circuits and having a fixed signal output at a constant frequency which is a sub-harmonic of the intermediate frequency, coupling means between said detector and the first named oscillator circuit, means for adjusting the tuning of the main oscillator to beat in said detector with a higher harmonic of the calibration oscillator to produce the intermediate frequency with a predetermined tuning indication, and means for readjusting the tuning of said oscillator to provide the said intermediate frequency in response to a selected signal in accordance with a change in the tuning indication by a relatively small increment.

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