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RADIO RECEIVING CIRCUIT

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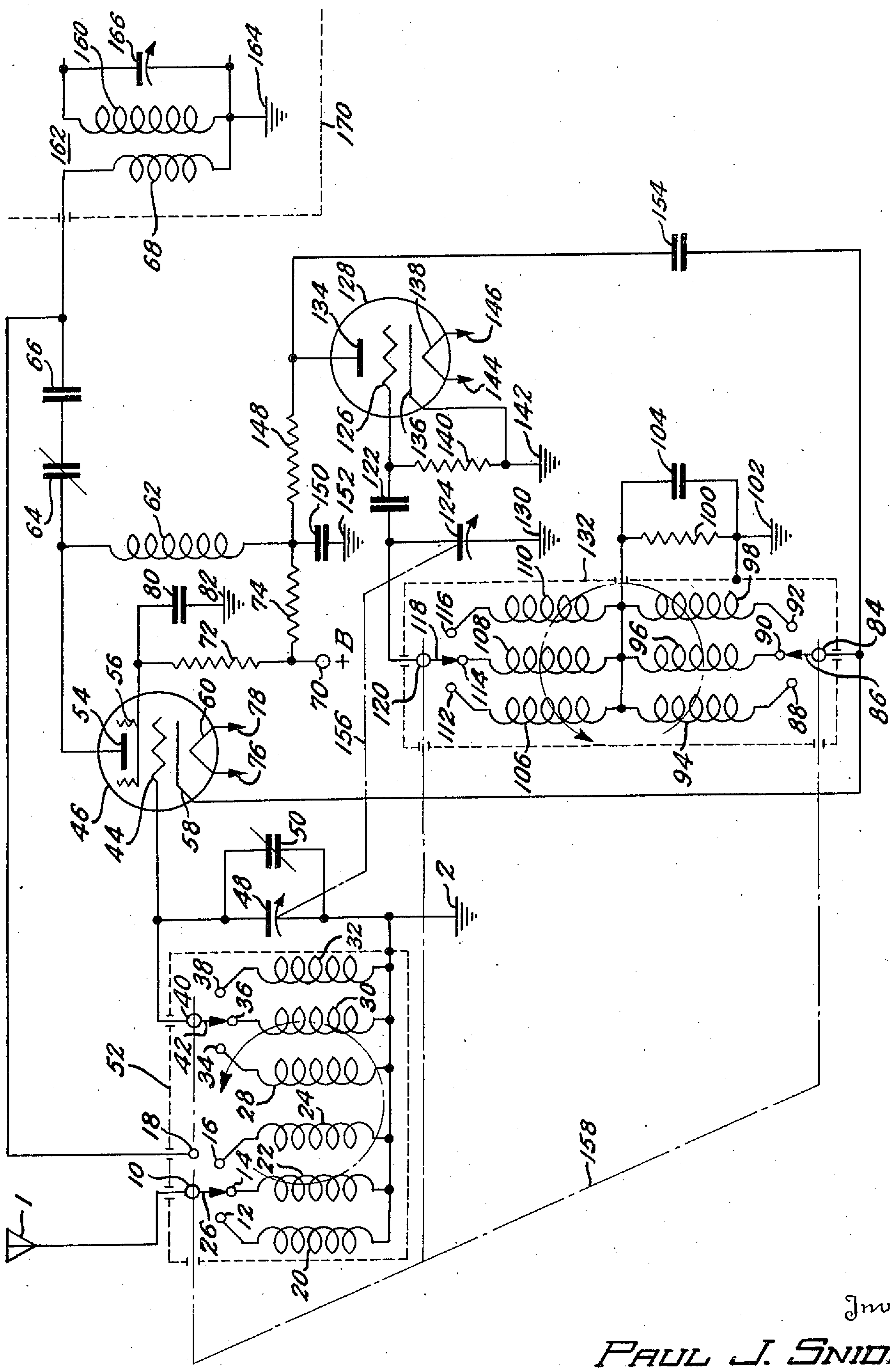

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RADIO RECEIVING CIRCUIT

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This invention relates to a radio receiving circuit, and more particularly to a circuit utilizing improved coupling means, which coupling means is adaptable to multi-range receivers capable of receiving signals in any one of several wave bands.

In the usual type of circuit, the detector and oscillator tubes are magnetically coupled. That is, a pick-up coil is used to pick up the oscillating energy from the oscillating circuit that is to be mixed with the signal energy. This is an undesirable feature, because an extra coil is necessary, and beside that, where signals are to be received in several different wave bands, extra pick-up coils are necessary for each set of coils used for a wave band, or if a single pick-up coil is used, there is difficulty in obtaining the proper coupling between the pick-up coil and the coils for the different wave bands. Also, with a system which utilizes a pick-up coil, it is more difficult to completely and properly shield the units of the circuit.

It is therefore an object of this invention to provide an improved coupling system for use in a radio receiving circuit, and particularly adaptable to a receiver that is to be used for receiving signals in a plurality of wave bands.

Another object of this invention is to provide a coupling system for a radio receiver which lends itself readily to the changing of wave bands through the use of a switching mechanism.

Another object of this invention is to provide a means for preventing interlocking of detector and oscillator circuits, that is, to prevent the tuning of one of the circuits from appreciably affecting the tuning of the other.

Another object of this invention is to provide a band switching system for a radio circuit which permits the selection of various wave bands.

Another object of this invention is to provide a band switching system for a converter circuit which permits the selection of various wave bands by the converter, or the use of the receiver, with which the converter is connected, without the converter.

Another object of this invention is to provide an efficient means for coupling the output of a converter circuit to the input of a radio receiver.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawing:

The figure discloses a schematic diagram of the circuit of a converter that involves the novel features of the present invention.

With particular reference to the drawing, a switch 10 has an arm 26 and a plurality of contacts 12, 14, 16 and 18. The contacts 12, 14 and 16 are connected to the ends of inductances 20, 22 and 24 respectively. The other ends of the inductances 20, 22 and 24 are connected together and to ground at 2. An antenna 1 is connected to the switch arm 26 so that by changing the position of the arm 26 the antenna may be connected to any of the contacts 12, 14, 16 and 18. The inductances 20, 22, and 24 are magnetically coupled with inductances 28, 30 and 32. The inductances 28, 30 and 32 have their ends connected together and to ground at 2. The other ends of the inductances 28, 30 and 32 are connected to contacts 34, 36 and 38 respectively, of a switch 40. The switch 40 has an arm 42 connected to an input or control electrode 44 of a thermionic detector tube 46, and capable of contacting any one of the contacts 34, 36 and 38. A variable condenser 48 is connected to the switch arm 42 and to ground at 2. An adjustable condenser 50 is connected across the variable condenser 48. A shield 52, grounded at 2, encloses the inductances 20, 22, 24, 28, 30 and 32, and the switches 10 and 40.

The thermionic detector tube 46 has, beside the control or input electrode 44, an anode or output electrode 54, a screen grid 56, a cathode 58 and a heater 60 therein. The anode or output electrode 54 is connected to a radio frequency choke 62 and to one side of an adjustable condenser 64. The other side of the adjustable condenser 64 is connected to an input or primary inductance 68 of a succeeding radio amplifying device through a condenser 66. The contact 18 is connected to the inductance 68 intermediate that inductance and the condenser 66. The screen grid 56 is connected to a terminal 70 through a resistor 72. The anode or output electrode 54 is also connected to the terminal 70 through the choke 62 and a resistor 74. The terminal 70 is adapted for connection to a suitable source of potential for supplying the potentials to the screen grid 56 and anode 54. A condenser 80 connected to the screen grid 56 and to ground at 82 forms a bypass for alternating current from the screen grid. The heater 60 is provided with leads 76 and 78 for connection to a suitable source of heating current.

The cathode 58 is connected to an arm 86 of a switch 84. Contacts 88, 90 and 92, with which the arm 86 may connect, are connected to ends of inductances 94, 96 and 98 respectively. The other ends of the inductances 94, 96 and 98 are connected through a resistor 100 to ground at 102. A condenser 104 connected across the resistor 100 forms a high frequency by-pass circuit across that resistor. Inductances 106, 108 and 110 also have one of their ends connected to ground at 102 through the resistor 100. The other ends of the inductances 106, 108 and 110 connect to contacts 112, 114 and 116 respectively. A switch arm 118 of a switch 120, with which the contacts 112, 114 and 116 are associated, is connected to one side of a condenser 122 and to one side of a variable condenser 124. The other side of the condenser 122 is connected to a control electrode 126 of a thermionic oscillator tube 128, and the other side of the variable condenser 124 is connected to ground at 130. A shield 132 encloses the inductances 94, 96, 98, 106, 108 and 110, and the switches 84 and 120, which shield 132 is grounded at 102. The thermionic oscillator tube 128 has in addition to the control electrode 126, an anode 134, a cathode 136, and a heater 138. The control electrode 126 is connected to the cathode 136 through a resistor 140, and thence is grounded at 142. The heater 138 is provided with leads 144 and 146 for connection to a suitable source of heating current. The anode 134 is connected to the terminal 70 through a resistor 148 and a resistor 74, which resistors are connected in series. One side of a condenser 150 is connected to a common terminal of the resistors 74 and 148 and the choke 62, and to ground at 152. A condenser 154 has one side connected to the anode 134 and the other side connected to the switch arm 86 of the switch 84. The variable condensers 124 and 48 are indicated as being controlled from a common control element 156. The switches 84, 120, 40, and 10 are indicated as being controlled by a common control element 158.

The input or primary inductance 68 is magnetically coupled with a secondary inductance 160 to form a coupling device 162. An end of the inductance 68 is connected to an end of the inductance 160 and to ground at 164. A variable condenser 166 is connected across the secondary inductance 160 to tune that inductance to resonance at any desired frequency. The dashed line 170 indicates that the coupling device 162 and the apparatus which succeeds it may be in a separate unit from the apparatus of the circuit previously explained. In fact, if the circuit disclosed is utilized as a short wave converter, for which it is especially adapted, the coupling device 162 may be the input circuit of a conventional broadcast receiver.

The primary inductances 20, 22 and 24 are of different sizes, and each is magnetically coupled to one of the secondary inductances 28, 30 or 32, and they are so matched in coupled pairs that when a particular secondary inductance is connected in the circuit by the switch 40, and the proper primary is selected by the switch 10, the proper coupling will be provided for the frequency band coverable by the secondary and the variable condenser 48. The signals are picked up on the antenna 1 and transmitted to the primary inductance to which the switch arm 26 is connected, or directly to the primary of the coupling device 162 through the contact 18. When the signals are transmitted to one of the primary inductances 20, 22 or 24, they are in turn transmitted to a secondary inductance to which the arm 42 of the switch 40 is connected. Since the variable condenser 48 tunes the secondary that is being used, to resonance at the signal frequency, the selective action of the secondary tuned circuit tends to eliminate signals other than the one desired, and applies the desired signal to the control, or input, electrode 44 of the detector tube 46.

The inductances 106, 108 and 110 are different in size, and are selectable through the action of the switch 120 so that the selected inductance and the variable condenser 124 form a tuned circuit that governs the frequency of oscillation of the oscillator tube 128. Each one of the oscillator tuning inductances 106, 108 and 110 has an associated feed-back or tickler inductance electromagnetically coupled therewith. The action of the feed-back or tickler inductances 94, 96 and 98, coupled with the anode 134 of the oscillator tube 128, tends to cause the tube 128 to oscillate. Since it is desirable to have different sizes of tickler inductances for different sizes of oscillator tuning inductances, the switch 84 is provided to select the proper tickler inductance to operate with the oscillator tuning inductance selected by the switch 120.

The D. C. biasing potential for the detector tube 46 is applied between the control or input electrode 44 and the cathode 58 by virtue of the D. C. drop in potential across the resistor 100. This potential is applied to the cathode 58 through the tickler inductance that is selected by the switch 84. Since the cathode 58 is directly coupled to the anode circuit of the oscillator tube 128, oscillating energy is applied to that element of the detector tube at the same time the signal energy is applied to the control electrode 44. Hence, the oscillating energy and signal energy are mixed in the detector tube, so as to produce a current flow from the anode 54 having a frequency proportional to the difference in frequency between the oscillating frequency of the oscillator tube 128 and the signal frequency applied to the control electrode 44. By properly designing the variable condensers 48 and 124 and the inductances which those condensers tune, as well as adjusting the condenser 50 to the proper value, the resultant output frequency in the circuit of the anode 54 may be kept constant regardless of the frequency of the signal being received. The condenser 154 prevents the potential of the anode 134 from being applied to the cathode 58, but permits the alternating current to pass through the tickler or feed-back inductance being used, as well as permitting that alternating current to be applied to the cathode 58. The control electrode 126 is coupled to the oscillator tuning inductance being used, through the condenser 122. The resistor 140 connected between the control electrode 126 and the cathode 136 provides a grid leak.

The choke 62 and the condensers 64 and 66 are so chosen that a high gain may be produced between the detector tube and the succeeding amplifying unit. The adjustable condenser 64 is preferably set so as to produce series resonance, at the output frequency, in the anode circuit of the detector tube 46. The output signals from the anode 54 of the detector tube are thus applied to the input of an amplifying, detecting and reproducing device especially constructed for use with the oscillator and detector disclosed, or to the input terminals of a conventional type of radio receiver. If the oscillator and detector unit is used with a succeeding unit which by itself is capable of the reception of signals, the oscillator and detector unit may be rendered inoperative in its effect upon its signal reception by causing the contact arm 26 of the switch 10 to make connection with the contact 18. By so doing, the antenna is connected directly to the succeeding unit, and the signals are not caused to pass through the tuning elements or to be mixed with the generated oscillations. If the switches 10, 40, 120 and 86 are controlled by a common control element as indicated by 158, the switching of frequency band may be accomplished by a single switching operation.

It is a common difficulty experienced in the design of a circuit such as the one disclosed and using the heterodyne principle of operation that the tuning of one of the tunable circuits will tend to influence tuning of the other one. This action or phenomena is commonly called interlocking. The interlocking action tends to be even more prevalent in a circuit utilizing direct coupling such as that in the present circuit. However, it has been found that by shielding the primary and secondary inductances from those associated with the oscillator, and by keeping the value of the resistor 140 as high as possible, this interlocking action may be avoided.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a heterodyne receiver system, a first detector tube, a local oscillator tube, a signal collector, means for coupling said collector to the signal control electrode of said detector tube, a variable condenser, connected to the said electrode, for tuning the coupling means through a desired signal frequency range, a reactive path regeneratively coupling the anode and control grid circuits of said oscillator tube, a variable condenser in the oscillator grid circuit for tuning the latter through a range of local oscillation frequencies, a non-reactive path directly connecting the cathode of said detector tube to the said reactive path whereby local oscillation energy produced in the local oscillator is impressed on the detector solely through said non-reactive path, said reactive path including a reactance of high impedance to direct current, said last reactance being connected between the oscillator tube anode and said non-reactive path.

2. In a heterodyne receiver system, a first detector tube, a local oscillator tube, a signal collector, means for coupling said collector to the signal control electrode of said detector tube, a variable condenser, connected to the said electrode, for tuning the coupling means through a desired signal frequency range, a reactive path regeneratively coupling the anode and control grid circuits of said oscillator tube, a variable condenser in the oscillator grid circuit for tuning the latter through a range of local oscillation frequencies, a non-reactive path directly connecting the cathode of said detector tube to the said reactive path whereby local oscillation energy produced in the local oscillator is impressed on the detector solely through said non-reactive path, said reactive path including a reactance of high impedance to direct current, said last reactance being connected between the oscillator tube anode and said non-reactive path, and means for shielding said collector coupling means from said reactive coupling path.

3. In a heterodyne receiver system, a first detector tube, a local oscillator tube, a signal collector, means for coupling said collector to the signal control electrode of said detector tube, a variable condenser, connected to the said electrode, for tuning the coupling means through a desired signal frequency range, a reactive path regeneratively coupling the anode and control grid circuits of said oscillator tube, a variable condenser in the oscillator grid circuit for tuning the latter through a range of local oscillation frequencies, a non-reactive path directly connecting the cathode of said detector tube to the said reactive path whereby local oscillation energy produced in the local oscillator is impressed on the detector solely through said non-reactive path, said reactive path including a reactance of high impedance to direct current, said last reactance being connected between the oscillator tube anode and said non-reactive path, means for shielding the collector coupling means from said reactive coupling path, and a resistor of high magnitude connected between the control grid and cathode of said oscillator tube for preventing adjustment of one of said variable condensers from affecting the tuning of the circuit associated with the other variable condenser.

4. In a heterodyne receiver system, a first detector tube, a local oscillator tube, a signal collector, means for coupling said collector to the signal control electrode of said detector tube, a variable condenser, connected to the said electrode, for tuning the coupling means through a desired signal frequency range, a reactive path regeneratively coupling the anode and control grid circuits of said oscillator tube, a variable condenser in the oscillator grid circuit for tuning the latter through a range of local oscillation frequencies, a non-reactive path directly connecting the cathode of said detector tube to the said reactive path whereby local oscillation energy produced in the local oscillator is impressed on the detector solely through said non-reactive path, said reactive path including a reactance of high impedance to direct current, said last reactance being connected between the oscillator tube anode and said non-reactive path, a resonant circuit, tuned to the beat frequency, following said detector tube, and a series resonant path, tuned to said beat frequency, coupling the anode circuit of said detector tube to said resonant circuit.

5. In a heterodyne receiver system, a first detector tube, a local oscillator tube, a signal collector, means for coupling said collector to the signal control electrode of said detector tube, a variable condenser, connected to the said electrode, for tuning the coupling means through a desired signal frequency range, a reactive path regeneratively coupling the anode and control grid circuits of said oscillator tube, a variable condenser in the oscillator grid circuit for tuning the latter through a range of local oscillation frequencies, a non-reactive path directly connecting the cathode of said detector tube to the said reactive path whereby local oscillation energy produced in the local oscillator is impressed on the detector solely through said non-reactive path, said reactive path including a reactance of high impedance to direct current, said last reactance being connected between the oscillator tube anode and said non-reactive path, said collector coupling means consisting of a plurality of pairs of transformer windings and a selector for connecting a desired one of said pairs between the collector and said detector signal control electrode.

6. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances, switch means for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said two switches and said switch means, means for simultaneously adjusting said variable condensers and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

7. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances. switch means for selectively connecting a desired one of said couping reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said two switches and said switch means, means for simultaneously adjusting said variable condensers, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer and a series resonant network, tuned to the operating beat frequency, connected in the frequency changer output.

8. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, means for completely shielding said coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances, switch means for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said two switches and the switch means, means for simultaneously adjusting said variable condensers, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

9. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a direct current blocking condenser between the second switch and the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances, switch means for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said two switches and the switch means, means for simultaneously adjusting said variable condensers, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

10. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a screen grid tube, a common source of positive potential for the anodes of both tubes and the screen grid of the changer tube, a signal collector, a plurality of coupling reactances, switch means for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said two switches and the switch means, means for simultaneously adjusting said variable condensers, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

11. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances, a switch for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said switches, means for simultaneously adjusting said variable condensers, a condenser in the connection between the first switch and the oscillator grid, and a resistor of high magnitude connected between the oscillator grid and its cathode, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

12. In combination, a local oscillator stage including a tube, a plurality of pairs of magnetically coupled coils, a switch for selectively connecting a desired one of said pairs to the oscillator control grid, a second switch for selectively connecting said desired pair to the oscillator

anode, a variable condenser for tuning the oscillator through a range of oscillation frequencies, a frequency changer stage including a tube, a signal collector, a plurality of coupling reactances, means for completely shielding said coils, and additional means for completely shielding said coupling reactances, a switch for selectively connecting a desired one of said coupling reactances between said collector and the input electrodes of the changer tube, a variable condenser for tuning the selected coupling reactance through a signal frequency range, means for simultaneously adjusting said switches, means for simultaneously adjusting said variable condensers, and a direct connection between the frequency changer cathode and the said second switch for impressing the local oscillation energy upon said frequency changer.

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