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SELECTIVITY CONTROL SYSTEM

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The present invention relates to means for controlling the selectivity of radio receiving systems. More particularly, it relates to a selectivity control system particularly adapted for superheterodyne receivers.

In accordance with the invention, a combination of inductive and capacitive coupling may be employed between two tuned signal circuits in a receiver, in conjunction with suitable switching means, whereby the capacitive coupling may be made to aid the inductive coupling thereby to adjust the selectivity and/or the fidelity characteristic of the receiver. In addition, the switching arrangement may include control of the audio frequency tone characteristic and of the selectivity of certain other high frequency signal circuits.

It is also a further object of the invention to provide an improved selectivity-fidelity control system which may be applied to the usual coupling circuits in an intermediate or high frequency amplifier and which may be controlled by simple switching means.

With a control system of this character, a receiving system may be operated with a high degree of selectivity for the reception of programs from distant broadcasting stations in adjacent frequency channels to local stations without appreciable interference, while for local stations broadcasting high fidelity programs, the fidelity of the receiver may be increased by decreasing the selectivity. In the system of the present invention this change is effected by introducing capacity coupling into inductively coupled tuned circuits without appreciably changing the tuning thereof, the tuned circuits being preferably in the intermediate frequency amplifier.

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

In the drawing, the figure is a schematic circuit diagram of a portion of a superheterodyne receiver provided with a selectivity control system embodying the invention.

Referring to the drawing, the receiving system is provided with a radio frequency amplifier stage comprising a high frequency amplifier tube 5 suitably coupled to a signal source, such as an antenna 7, through a coupling transformer 9. The secondary 11 of the transformer is tuned by a variable capacitor 13 connected in shunt therewith through a series resistor 15 and a fixed by-pass capacitor 17, the latter being of relatively

high capacity with respect to the tuning capacitor 13. The series capacitor has no appreciable effect upon the tuning of the circuit. The latter is designated at 19, and comprises the secondary 11, the capacitor 13 and the resistor 15.

The tuned circuit 19 is grounded at its low potential terminal 20 between the capacitor 13 and the resistor 15, as indicated at 21, and the cathode 23 of the amplifier device 5 is also grounded through a self-bias resistor 25 and a shunt by-pass capacitor 27 as indicated at 29. The control grid 31 is connected with the high potential terminal 33 of the tuned circuit 19 between the capacitor 13 and the winding 11.

The circuit 19 therefore provides a tuned input circuit for the high frequency amplifier 5 and includes in series therewith adjacent to the low potential terminal a resistor 15 for broadening the tuning of the circuit under certain conditions hereinafter described. The by-pass capacitor 17 permits biasing potential to be introduced into the circuit for the control grid 31 through a supply lead 35 which includes therein a filter resistor 37. The control grid may, therefore, be independently biased while the tuned circuit is grounded as indicated.

The high frequency amplifier 5 is preferably of the variable-mu screen grid pentode type as indicated, and is coupled through a suitable radio frequency coupling transformer 39 with the following tube 41 in the signal channel which, in the present example, is the first detector. This is also of the screen grid pentode type, comprising a cathode 43, a control grid 45, a screen grid 47, a suppressor grid 49 and an output anode 51.

The detector is also provided with a tuned input circuit 59 comprising the secondary winding 53 of the interstage coupling transformer 39, a shunt variable tuning capacitor 55 and a series resistor 57 corresponding to resistor 15 in the preceding high frequency circuit for broadening the tuning of the circuit. The low potential terminal 61 of the tuned circuit 59 is grounded as indicated at 63 and the high potential terminal indicated at 65 is connected with the control grid 45.

The cathode 43 is also connected to ground indicated at 67 through a cathode lead 69 in which is located a series resistor 71 provided with a high frequency by-pass capacitor 73 and the secondary 75 of a high frequency coupling transformer 77. The primary 79 of the coupling transformer is tuned by a shunt variable capacitor 81 and connected to the output terminals 83 of a suitable high frequency oscillator 85, the fre-

quency of the oscillator being controlled by the variable capacitor 81 or any suitable means to produce with the incoming signal a beat or intermediate frequency.

- 5 It will be seen that by this circuit arrangement, the oscillator signals are introduced into the cathode lead 69 through the coupling transformer 77 and are thus supplied between grid and cathode of the detector 41 along with the high
10 frequency signals from the tuned circuit 59. The control of the resistor 57 will hereinafter be described.

The detector 41 is coupled to the first intermediate frequency amplifier tube 87 through two inductively coupled tuned circuits 89 and 91 provided with means for supplementing the inductive coupling by capacitive coupling without changing the tuning adjustment of either of the circuits.

- 20 The tuned circuit 89 includes, as an inductance element, the primary winding 93 of an intermediate frequency amplifier coupling transformer 95 and is connected with the output anode 51 of the detector as a tuned output circuit therefor.

25 The anode is supplied with anode operating potential from a supply lead 99 through a suitable filter comprising a series resistor 101 and a by-pass capacitor 103 connected with the low potential terminal 105 of the primary winding 93.

- 30 The capacity tuning element of the circuit 89 is provided by an adjustable shunt tuning capacitor 107 connected with the high potential side of the circuit 97 and of the primary winding 93 and with the low potential terminal 105 of the winding 93 through a lead 109 in which is located
35 selector switch means comprising a switch arm 111 and a switch contact 113. A lead 115 from the switch means and a series fixed capacitor 117 of relatively large capacity with respect to the capacity of the tuning capacitor 107 completes
40 the circuit 89. The capacitor 107, therefore, provides the controlling element in the tuned circuit 89.

- 45 The switch means is provided with an additional contact 119 to which the arm 111 may alternatively be connected to complete the tuned circuit between the winding 93 and the capacitor 107, through a lead 121, a series resistor 123 and
50 a second series fixed capacitor 125, of the same relatively large capacity as the capacitor 117, to the same low potential terminal 105 of the primary winding 93.

- The second series fixed capacitor 125 is also included in the tuned circuit 91 which comprises
55 the secondary winding 127 of the intermediate frequency coupling transformer 95 and a shunt adjustable tuning capacitor 129, the capacitor 129 being therefore connected in shunt relation to the secondary winding 127 through the series
60 capacitor 125.

- Intermediate frequency signals developed across the tuned circuit 91 are applied to the control grid 131 of the intermediate frequency amplifier device 87 from a high potential terminal 133 through a suitable coupling capacitor
65 135. The amplifier stage 87 is provided with ground return connections 139 and is provided with a suitable tuned output coupling transformer 137 for further stages (not shown). The coupled tuned circuit 91, therefore, is connected
70 to ground from the terminal 105 through the by-pass capacitor 103 whereby intermediate frequency signals are applied across the input electrodes of the amplifier device 87. Biasing potential for the amplifier 87 is supplied from a bias
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supply lead 143 through a suitable filter 145 and grid leak resistor 147. The resistor 147 is of relatively high impedance with respect to the impedance of the tuned circuit 91, whereby the latter is not appreciably loaded, thereby since it is
5 connected substantially in shunt to the tuned circuit through the coupling capacitor 135 and the capacitor element 149 of the filter 145.

With the coupling arrangement shown between the first detector and the intermediate frequency
10 amplifier, the coupling is controlled by the switch 111-113-119 which may be termed the selectivity control switch. When the arm 111 is connected with the contact 113, the tuning is sharp and the selectivity of the coupling means is maximum. Under this condition, the primary tuned
15 circuit 89, which includes the tuning capacitor 107, is completed through the relatively large fixed capacitor 117. The secondary tuned circuit 91 which includes the tuning capacitor 129
20 is completed through the fixed capacitor 125 which has the same capacity as the capacitor 117.

The coupling between the two tuned coupling circuits 89 and 91 with the selective control
25 switch in the position as shown for sharp tuning and maximum selectivity, is obtained through the mutual inductance between two transformer windings 93 and 127 which is adjusted to give a desired high degree of selectivity.

30 When the switch is thrown to the broad position, the arm 111 making contact at 119, the primary tuned circuit is completed from the contact 119 through the resistor 123 and the capacitor 125. Under this condition the capacitor 125
35 is common to both tuned circuits and its capacity is so chosen that the coupling between the two tuned circuits, because this capacitive reactance is common to both tuned circuits, is of the correct value to give a frequency response characteristic
40 of the desired band width.

Furthermore, by this circuit arrangement, the tuning of the coupled circuits is not changed as the selectivity is changed. The capacitive coupling provided by the capacitor 125 predominates
45 to give a wide band width of frequency response of the receiving system and of the intermediate frequency amplifier. The band width is changed merely by changing the coupling whereby one type predominates, without changing the tuning
50 of the coupled circuits.

The series resistor 123 is provided to prevent the transformer characteristic from becoming double peaked when the selectivity control switch is thrown to the broad position and, in the present example, may have a resistance value of substantially 40 ohms.

The tuning capacitors 129 and 107 may have a capacity of 400 micro-microfarads, while the series capacitors 125 and 117 may have a capacity
60 of 6800 micro-microfarads for an intermediate frequency of 370 k. c.

The selectivity control switch is arranged to be operated simultaneously with selector switch means for short-circuiting the resistors 15 and
65 57 in the high frequency tuned input circuit 19 and 59 when the selectivity control switch is in the position as shown for sharp response or maximum selectivity. The switch means for each of the resistors 15 and 57 comprises switch arms
70 151 and 153 connected respectively through leads 155 and 157, with the ungrounded terminals 159 and 161 of the resistors 15 and 57 respectively. Each switch is provided with a grounding contact 163 connected to ground as indicated at 165.
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As shown in the drawing, the switches are closed to the grounding contacts 163 thereby short-circuiting the resistors 15 and 57 to ground and rendering the tuned high frequency circuits 19 and 59 more selective and providing a sharp selectivity characteristic corresponding to the sharp selectivity characteristic provided by the circuits 89 and 91 when the selectivity control switch is in the position shown.

The switches are preferably interconnected, as indicated by the dotted connection 167, for simultaneous control through a common control knob indicated at 169. It will be seen that with this arrangement when the selectivity control switch is moved to close the arm 111 with the broad selectivity control contact 119, the resistors 15 and 57 are, automatically at the same time, inserted in circuit with the tuned circuits 19 and 59 thereby broadening the tuning to permit an overall high fidelity of response in the receiving system.

It is preferable also to control the response characteristic of the audio frequency system of the receiver, which is represented by audio frequency input leads 171 connected with an audio frequency coupling transformer 173 and, in turn, coupled through capacitors 175 on its secondary side with a suitable audio frequency amplifier represented by the rectangle 177. The amplifier may in turn supply output signals to any suitable sound producing device such as a loudspeaker 179.

To control the tone of the audio frequency signals, for example, by reducing the high frequency response when the receiver is adjusted for a sharp response or a high degree of selectivity, a capacitor 181 may be shunted across the audio frequency signal circuit 171 through selector switch means comprising a switch arm 183 and a switch contact 185, the switch means being mechanically connected with the other switches to be operated simultaneously therewith.

As shown, the switch 183—185 is closed to connect the capacitor 181 across the audio frequency circuit 171 thereby to reduce the high frequency response with the control system adjusted for maximum selectivity and sharp tuning. This is desirable in order to minimize high frequency noises which are received when distant stations may be tuned in. The audio frequency response range may be increased when the receiver is adjusted for high fidelity, the switch 183—185 being opened as the selectivity control switch arm 111 is moved to the contact 119.

In order to prevent noise from the loudspeaker device 179 during the switching operation, the audio frequency system may be controlled as by short circuiting the secondary 187 of the transformer 173 through a ground connection 189 and an elongated switch contact 191 over which a grounded contact arm 193 moves while the control switches are in intermediate positions between contacts. The short circuit is removed at either end of the travel of the switch arm by connection with ungrounded contacts 195 corresponding in position to the switch contacts in the other switch elements. The tone control and audio frequency short-circuiting switch means are preferably connected through the means 167 for simultaneous control with the selectivity control switch.

With this switching arrangement it is preferable that the audio frequency coupling transformer be isolated from the audio frequency amplifier by the coupling capacitors 175. In this manner the switching contact arm 193 and one

side of the transformer secondary may be interconnected through ground.

From the foregoing description, it will be seen that the improved selectivity control system is provided by simple switching means in connection with a tuned interstage coupling transformer. In the present example, the primary and secondary low potential terminals are connected together and with two series capacitors of equal value, one of which is in the secondary tuned circuit and the other of which is in the primary tuned circuit, with switching means for selectivity connecting one tuned circuit through either of said capacitors.

The switching means further includes contacts for controlling the selectivity in certain of the high frequency tuned circuits and the audio frequency tone characteristic of the system.

I claim as my invention:

1. In a superheterodyne radio receiving system comprising a radio frequency amplifier, a first detector, an intermediate frequency amplifier and an audio frequency amplifier circuit, the combination of means connected with the radio frequency amplifier and first detector for broadening the frequency response characteristic thereof, a coupling transformer for said intermediate frequency amplifier comprising a primary winding and a secondary winding inductively coupled to provide a relatively high degree of selectivity, a shunt tuning capacitor for each of said windings, a capacitor of relatively high capacity value with respect to the secondary tuning capacitor in series therewith, a selector switch, a capacitor having a capacity value equal to that of the secondary series capacitor connected in series with the primary winding and the tuning capacitor therefor through one contact of said switch, said switch having a second contact providing a series connection between said primary winding and the tuning capacitor therefor through said secondary series capacitor whereby said circuits are capacitively and inductively coupled for decreasing the selectivity, tone control means for said audio frequency amplifier circuit, and means providing a connection between said tone control means, said selector switch and the first named selectivity control means for simultaneous operation thereof.

2. In an intermediate frequency amplifier, the combination with an inter-stage transformer having a primary winding and a secondary winding, of a tuning capacitor connected with a terminal of the primary winding, a second tuning capacitor connected with a terminal of the secondary winding, a conductive connection between the remaining terminals of the primary and secondary windings, a series coupling capacitor connected between said conductive connection and each of said tuning capacitors to provide primary and secondary circuits, selective switching means for connecting the primary tuning capacitor with said conductive connection through the secondary series coupling capacitor to the exclusion of the series coupling capacitor for the primary circuit, and means in said last named connection for inserting resistance in the primary circuit, thereby to prevent the response characteristic of the transformer from becoming double-peaked.

3. In an intermediate frequency amplifier, the combination with an inter-stage transformer having a primary winding and a secondary winding, of a tuning capacitor connected with a terminal of the primary winding, a second tuning

capacitor connected with a terminal of the secondary winding, a conductive connection between the remaining terminals of the primary and secondary windings, a series coupling capacitor connected between said conductive connection and each of said tuning capacitors to provide primary and secondary circuits, selective switching means for connecting the primary tuning capacitor with said conductive connection through the secondary series coupling capacitor

to the exclusion of the series coupling capacitor for the primary circuit, means in said last named connection for inserting resistance in the primary circuit, selectivity control means preceding said transformer in circuit, low frequency amplifying means in circuit following said transformer, and means for controlling the response characteristic of said last named amplifier conjointly with said selectivity control means.

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