Oct. 14, 1941. J. D. REID 2,259,003

IMAGE REJECTOR CIRCUIT

Filed March 30, 1940

FIG. 1.

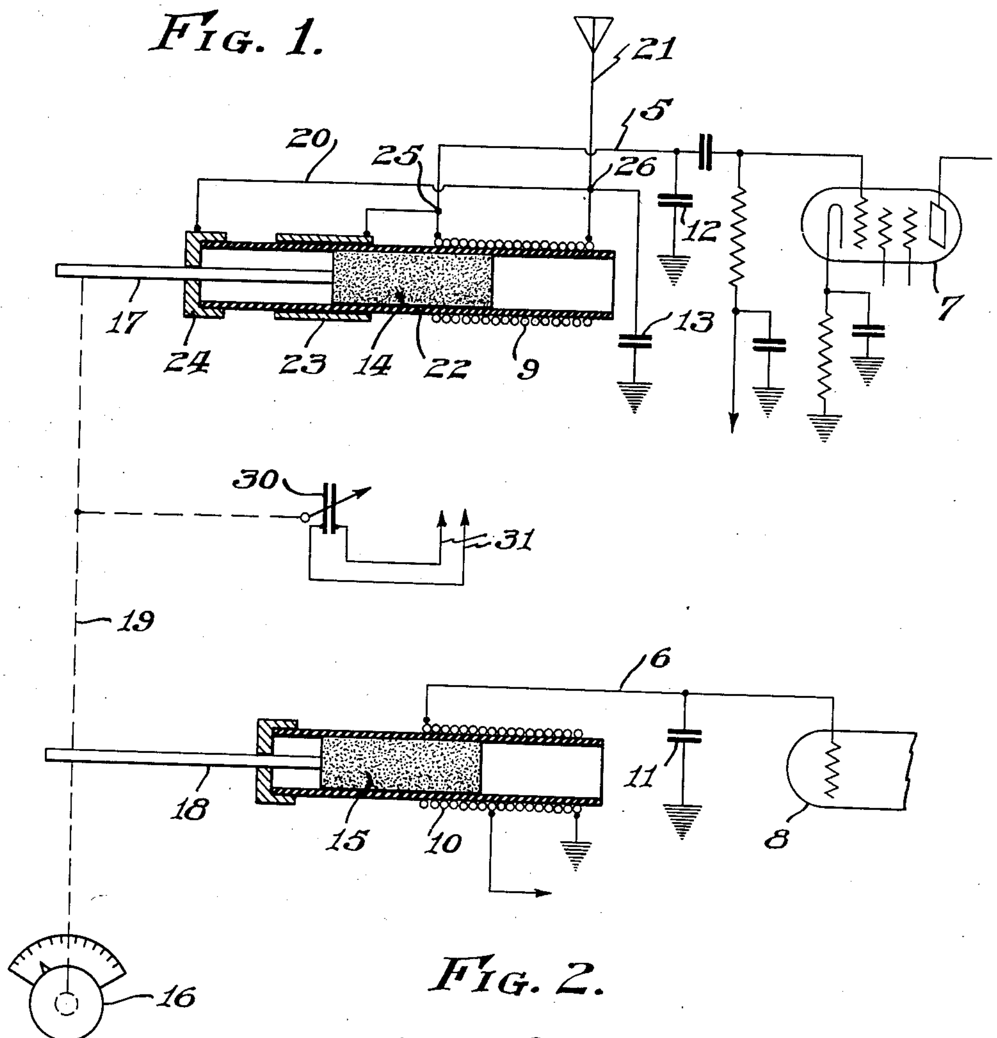
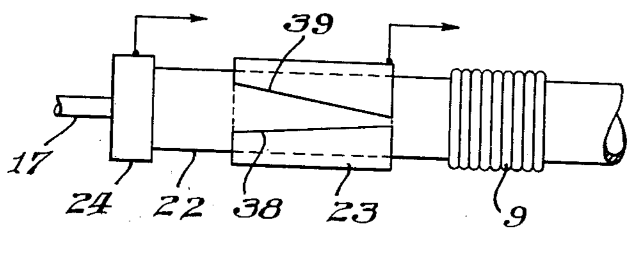



FIG. 2.

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Patented Oct. 14, 1941 2,259,003

# UNITED STATES PATENT OFFICE

2,259,003

## IMAGE REJECTOR CIRCUIT

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Application March 30, 1940, Serial No. 326,842

5 Claims. (Cl. 250—20)

This invention relates to an image rejector circuit for superheterodyne receivers, and has for its primary object to provide an improved tuning means adapted for use in a circuit of the character referred to.

It is a further object of this invention to provide an improved signal input circuit for a superheterodyne receiver which is jointly tunable with the oscillator circuit to provide image frequency rejection throughout a predetermined tuning range.

Another object of this invention is to provide a combined variable inductance and variable capacity device adapted for use in image rejecting circuits and the like, wherein a single movable tuning control element providing a movable core for varying the inductance by permeability change, and an electrode of the variable capacity device, whereby the inductance is varied inversely with respect to the capacity in response to movement of said tuning element.

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.

In the drawing,

Figure 1 is a schematic circuit diagram of a tuning system for a superheterodyne receiver including an image rejection circuit embodying the invention, certain of the tuning elements being shown substantially full size and in cross-section, and

Figure 2 is a view of the tuning element for the image rejecting circuit showing a modification.

Referring to Fig. 1, the variably tunable signal receiving circuits of a superheterodyne receiver are indicated at 5 and 6, comprising a first detector 7 and an oscillator 8, together with variable tuning inductances 9 and 10 and shunt capacity means comprising a capacitor 11 across the oscillator circuit 6 and two capacitors 12 and 13 connected to ground and effectively in series across circuit 5. The inductance elements 9 and 10 are tunable by means of movable cores 14 and 15, respectively, which are moved in unison by suitable means such as a tuning control device 16 connected with operating rods 17 and 18 for the cores, as indicated by the dotted line 19.

The tuning system shown represents any suitable tuning system for a radio signal circuit having movable tuning elements arranged for joint operation or control. For the suppression of image interference, the circuit 20 is provided and, in the present example, is connected between an antenna or signal input circuit 21 and the first stage of the receiving system which is here shown as constituting the first detector, although the circuit 20 may be included at any suitable point in the receiving system.

In radio receiving systems and the like, movable core variable inductance tuning elements are at present preferred, and for effective use with similar tuning elements in other circuits with unitary or conjoint tuning control thereof, the main tuning element in the image rejection circuit is preferably of the same movable core type.

In this system, the tuning range of the detector circuit 5 may extend from 550 to 1500 kc., involving a frequency change of 1:3, approximately. With an intermediate frequency output of 450 kc., for example, this will involve a tuning range for the oscillator circuit 6 of from 1000 to 1950 kc., approximately, and a frequency change of 1:2.

In providing for image rejection in the present example, the rejection circuit 20 is necessarily tunable over a range of from 1450 to 2400 kc., involving a frequency change of 1:1.6, indicating that the tuning of the rejection circuit must be considerably slowed, that is, the rate of change in frequency with movement of the tuning element must be lower than that of the other circuits in order to permit unitary control of the tuning of the rejection circuit with the other circuits. This is accomplished by the use of a tuning element including variable inductance and capacity in which the capacity and inductance vary inversely with tuning movement of the control element so that the frequency change is in the desired ratio, such as that above referred to.

In accordance with the invention, therefore, the image or signal rejection circuit 20 is provided by the tuning inductance 9 in the detector circuit and a small variable shunt capacity as will now be described. The inductance 9 is preferably of the single layer solenoid type, similar to that in the associated tunable circuit 6, and wound on a form 22 through which the tuning core 14 of iron or other suitable material in finely divided form is axially movable by means of the control rod 17.

A metallic sleeve 23 is provided in axially spaced relation to the inductance winding 9 and is preferably mounted on the coil form 22 as shown, in a manner to be axially adjustable, being so related to the movable core 14 that it forms one electrode of a variable capacitor, the other electrode of which is said movable core.

The arrangement is such that as the core is moved axially from a position within the inductance winding 9 for maximum inductance, it is caused to approach and gradually enter the sleeve 23, thereby gradually increasing the capacity provided between the core and the sleeve as the inductance of the winding 9 is decreased.

By including the variable capacitor thus provided in the circuit 20 with the inductance winding 9, the rate of change of the frequency response of the image rejection circuit 20, which consists solely of the inductance 9 and shunt capacity 14—23 and the distributed capacity of the winding 9, may be altered, as desired, to provide the desired ratio for effective tracking of the circuit 20 with the other receiving circuit or circuits represented by the oscillator circuit 6 and the circuit 5.

To this end, the core 14, the control rod 17 and the sleeve 23 are of suitable conducting material, as is also end bearing cap 24 for the tuning rod 16, which provides a terminal connection for the circuit 20. In this manner, the variable capacitor is connected in shunt with the winding 9, and in operation serves to increase the shunt capacity gradually as the inductance of the winding is decreased, thereby slowing the tuning or frequency variation rate of the rejection circuit, and also of the detector circuit 5 comprising the winding 9, shunt capacitor 14—23 and series connected capacity elements 12 and 13, as the core 14 is moved, since the increased capacity across the coil tends to lower the resonant frequency thereof, while the reduced inductance tends to raise the resonant frequency.

In the present example, and as a preferred arrangement for the image rejection circuit, the inductance winding 9, together with its shunt variable capacity 14—23, is connected between two low impedance terminals 25 and 26 of a filter for the image frequency, with the antenna connected to the input terminal 26. The low impedance input circuit for the filter is provided by the capacitor 13, which is of a relatively high capacity with respect to that of the variable capacity provided at 14—23. Thus variation of the capacity at 14—23 also slows up the tuning of the signal circuit comprising the winding 9 series resonant with the capacitor 12, and aids in tracking this circuit with the oscillator 6.

In this connection, it may be noted that a small variable capacitor 30 connected for operation by the tuning device 16 as indicated, may be utilized to further modify the tuning rate of the rejector circuit, suitable terminal leads 31 being provided for connection with the terminals 25 and 26.

By proper design of the capacitor 30 or by properly shaping the sleeve or capacity element 23 and adjusting its location or spacing with respect to the core along the coil form when aligning the circuits, the image rejection circuit is caused to track effectively in any desired manner with the signal circuits, following the ratio of frequency change hereinbefore referred to.

In case it is desired to produce any predetermined variation curve for the capacity, for effecting tracking, the sleeve and the core may relatively be so shaped that the capacity variation is other than linear with movement of the core, a preferred arrangement being shown in Fig. 2, wherein the sleeve 23 is shaped as shown at 38 and 39, whereby the capacity variation effected by movement of the core is non-linear.

In the case of a rejector circuit of the type shown, it will be seen that the variable capacitor required for effecting tracking may be provided at relatively low cost by the simple addition of a metallic sleeve to the coil form at one end of the inductance winding and spaced therefrom with suitable connections to the core and sleeve for the winding.

I claim as my invention:

1. A radio signal receiving system including a tunable signal circuit, variable inductance means in said circuit, variable capacity means in shunt therewith, a common movable control element providing a combined magnetic tuning core for said inductance means and a variable control electrode for said capacity means, and a second electrode for said capacity means associated with said element and comprising a sleeve of conducting material into which said element moves from the inductance thereby to modify the tuning in opposition to the effect of the inductance variation, said sleeve being so shaped that a predetermined modification of the tuning of said device is effected in response to tuning movement of said element.

2. A radio signal receiving system, comprising signal input and output circuits, in combination, an inductance winding connected between said circuits, a magnetic tuning core for said winding, means for moving said core with respect to said winding to vary the inductance of said winding, a member of conducting material associated with said core in spaced relation to said winding to provide a capacitor variable in response to movement of said core, said capacitor being connected in shunt with said winding, and means for causing said core to move from said winding to said capacitor member, thereby to provide conjoint variation in capacity and inductance inversely by movement of said core for slowing the tuning variation of said winding for a predetermined tuning movement of the core.

3. In a radio signal receiving system, the combination with a variably tunable signal circuit, of a signal input circuit comprising a shunt input capacitor, a tuning inductance and capacity means series resonant therewith for tuning said circuit, means for varying the tuning of said last-named circuit through a predetermined frequency range comprising a magnetic core element for said inductance movable in response to tuning variation of said first-named circuit, and means associated with said core element and responsive to movement thereof providing a variable shunt capacitor for tuning said winding through a higher image frequency range and for modifying the rate of frequency variation of said signal input circuit in response to movement of said core, thereby to effect tracking in the tuning of said circuits through a predetermined band of frequencies.

4. In a radio signal receiving system, the combination with a signal conveying network having an input and an output circuit, of two shunt tuning capacitors for said input and output circuits, a series tuning inductance connected in said network between said capacitors, a movable magnetic tuning core for said inductance, a variable capacitor having a relatively low maximum capacity with respect to that of said first-named capacitors, said variable capacitor being connected in shunt with said inductance for modifying the tuning thereof as the core is moved and comprising said core element as one elec-

trode, and a second electrode associated therewith in spaced relation to said inductance.

5. The combination with a plurality of tunable radio signal circuits, of a tunable filter circuit comprising a series tuning inductance and shunt input and output capacity elements, a movable tuning control member for said circuit connected for unitary tuning control jointly with the first-named circuits, said member comprising a movable magnetic core for variably tuning said inductance element through a predetermined band of signal frequencies in conjunction with said capacity elements, and shunt variable capacity means for said inductance of relatively low capacity value effective to tune said inductance through a second and higher frequency range and comprising said core as one element thereof and an electrode member associated with said core in spaced relation to said inductance.

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