Dec. 31, 1935. C. M. SINNETT ET AL 2,025,783

REMOTE CONTROL APPARATUS

Filed Oct. 31, 1933 2 Sheets-Sheet 1

Fig. 1.

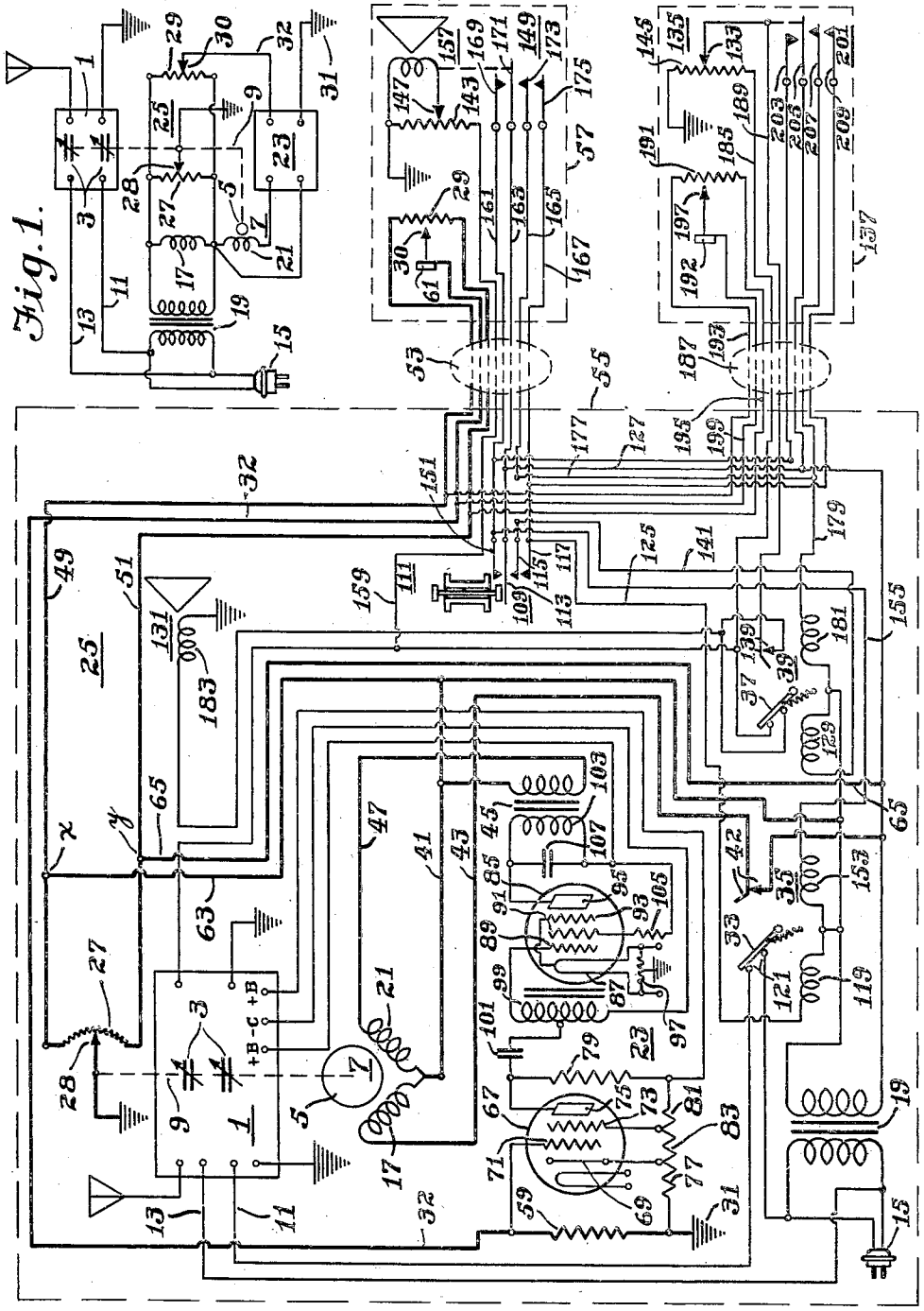


Fig. 2.

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Filed Oct. 31, 1933 2 Sheets-Sheet 2

Fig. 3.

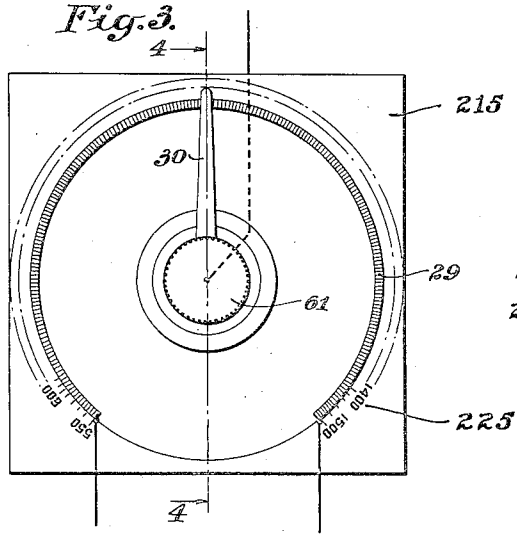
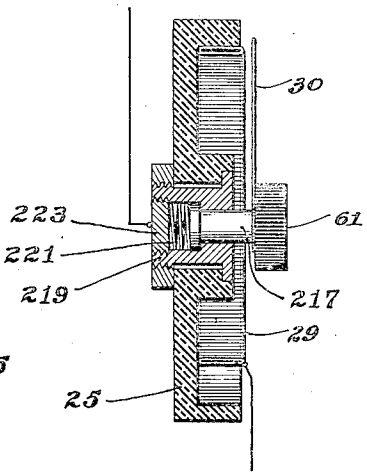


Fig. 4.



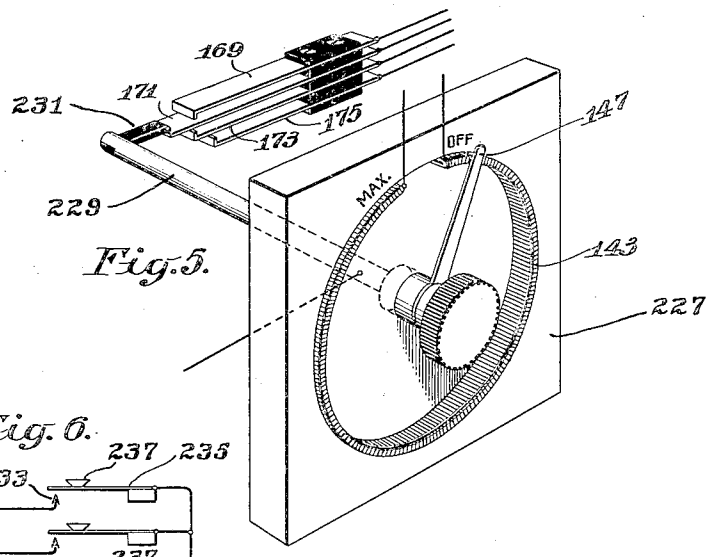
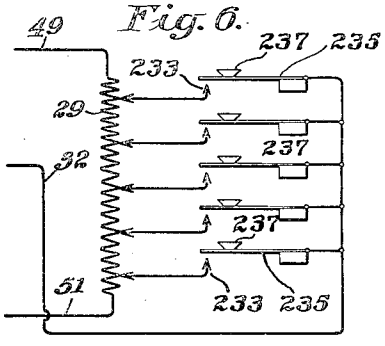


Fig. 5.

Fig. 6.



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2,025,783

REMOTE CONTROL APPARATUS

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Application October 31, 1933, Serial No. 695,962

3 Claims. (Cl. 250—20)

Our invention relates to remote control apparatus for actuating devices at a distance and particularly to remove control apparatus for radio receivers and the like.

Various remote control systems have been proposed for tuning radio receivers, but most of them have had serious defects. In circuits designed for the preselection of stations, it is usually necessary to employ a large number of conductors between the receiver and the remote control point if a reasonably large number of stations are to be tuned in by the system. Furthermore, such control systems are generally expensive.

In systems which cause the tuning condenser to follow the movement of a tuning dial at the remote control point, a type of tuning which has certain advantages, either the expense has been too great or the system has not operated satisfactorily. For example, Selsyn motors have been too expensive for low cost radio receivers, while, heretofore, Wheatstone bridge circuits have been generally unsatisfactory, one of their defects being a sluggishness in action which prevents accurate tuning.

An object of our invention, therefore, is to provide a remote control system that shall permit accurate tuning of a radio receiver from a remote point and which will be comparatively inexpensive.

A further object of our invention is to provide a remote control system which requires only a small number of cable conductors between the radio receiver and the remote control point for tuning the receiver.

A still further object of our invention is to provide a remote control system in which the conductors in the remote control cable carry only a small amount of current.

In practicing one embodiment of our invention, the tuning condensers of a radio receiver are mechanically connected to the rotor of a two-phase motor, this type of motor having two field windings for producing a rotating field. One of the field windings is supplied with alternating current directly from the power supply line, while the other field winding is supplied with current out of phase with that in the first winding by means of a Wheatstone bridge and a tuned amplifier.

Two arms of the Wheatstone bridge are located at the remote point from which the receiver is to be tuned, so that the bridge may be unbalanced by rotating a tuning dial at this point. When the bridge is unbalanced by turning the dial to a new station setting, current is supplied to one of the field windings through the tuned amplifier and the motor drives the tuning condensers in the radio receivers.

Since the motor is also mechanically connected to a movable tap on the two Wheatstone bridge arms located at the radio receiver, the movable tap will be moved along the bridge arms until the bridge is again balanced; at this point the motor will stop, and the tuning condensers will be set at the correct point to receive from the new station.

Other objects, features and advantages of our invention will appear from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a simplified schematic diagram of our improved remote control circuits;

Fig. 2 is a circuit diagram of a preferred commercial embodiment of our invention;

Fig. 3 is a view in elevation of one of the remote tuning controls;

Fig. 4 is a view taken on the line 4—4 of Fig. 3;

Fig. 5 is a perspective view of a volume control and switching unit utilized in the circuit shown in Fig. 2; and

Fig. 6 is a circuit diagram of a modified form of tuning control for tuning in preselected stations.

Referring to Fig. 1, a conventional radio receiver is indicated at 1, the receiver having variable tuning condensers 3, the rotors of which are mechanically connected to the rotor 5 of a two-phase motor 7 as indicated by the dotted line 9. The radio receiver 1 is supplied with alternating current through the conductors 11 and 13 connected to a plug 15 adapted to be connected into a power supply.

The two-phase motor 7 has a field winding 17 which is connected directly to the power supply or line through a transformer 19. It has another field winding 21 which is supplied with current from the output terminals of a tuned amplifier 23, the input terminals of which are connected across a Wheatstone bridge 25.

It will be apparent that if the two field windings 17 and 21 of the motor 7 are supplied with alternating currents which are approximately 90 degrees out of phase, the motor 7 will rotate the rotors of the tuning condensers 3. If the current supply to one of the field windings is then cut off, the motor will stop and the tuning condensers 3 will remain set in their new position.

The Wheatstone bridge 25 comprising a resistor 27 located at the radio receiver 1 and a resistor

29 located in the remote control unit at the remote point from which the receiver 1 is to be tuned. The upper ends of the resistors 27 and 29 are connected together to form one terminal of a bridge diagonal, the lower ends of the resistors 27 and 29 are connected together to form the other terminal of this bridge diagonal, and across this diagonal the secondary of transformer 19 is connected.

The resistor 27 is provided with a variable tap 28 which is electrically connected to ground and which is mechanically connected to the rotor 5 of the two phase motor 7. The other resistor 29 is also provided with a variable tap 30 which is connected through a conductor 32 to one terminal of the input circuit of the tuned amplifier 23. The other terminal of the amplifier input circuit is connected to ground, as indicated by the conventional symbol 31, whereby the input circuit of amplifier 23 is connected across the other diagonal of the Wheatstone bridge 25.

It will be seen that if the variable tap 30 at the remote point is in a certain position with respect to the variable tap 28 on the other bridge resistor 27, the bridge 25 will be balanced and there will be no voltage applied to the input circuit of the amplifier 23. If the variable tap 30 is then moved up on the resistor 29, the bridge will be unbalanced, the amplifier 23 will supply current to the field winding 21, and the motor 7 will move the variable tap 28 on the resistor 27 up to a point where the bridge is again balanced, at the same time rotating and tuning condensers 3.

If the variable tap 30 at the remote tuning point is now moved down, the bridge will again be unbalanced and the motor 7 will be driven in the opposite direction since the phase of the voltage applied to the input circuit of the amplifier 23 has been reversed. The proper phase difference in the current supply to the field windings 17 and 21 is obtained by means of the tuned amplifier 23 which introduces a phase shift, as will be fully explained hereinafter.

Fig. 2 shows a commercial embodiment of our invention which permits control of the radio receiver 1 either at the receiver itself or at either one of two or more remote points. In Figs. 1 and 2 like parts are indicated by the same reference numerals. In describing the circuit, it will be assumed that the armature 33 of a power relay 35 is in the left-hand position and that the armature 37 of a loud spreaker relay 39 is also in the left-hand position.

The rotors of the tuning condensers 3 and the variable tap 28 of the Wheatstone bridge resistor 27 are connected to a common shaft, as indicated by dotted line 9, which is driven by the two-phase motor 7. The field winding 17 of the motor is connected by means of conductors 41 and 43 through the right-hand contact points 42 on the power relay 35 to the secondary of the power transformer 19.

The field winding 21 of the motor 7 is connected across the secondary of an output transformer 45 in the amplifier 23 by means of conductors 41 and 47. It will be noted that alternating current is supplied to the field winding 17 so long as the power relay 35 is in the left-hand position. The manner in which alternating current is supplied to the other field winding 21 to drive the motor 7 will now be described.

The input circuit of the amplifier 23 is connected across one diagonal of the Wheatstone bridge 25 formed by the resistors 27 and 29. The bridge circuit 25 includes the conductors 49 and 51, a portion of which are in a cable 53 extending between the main receiver unit, shown enclosed by the dotted line 55, and a remote control unit which is shown enclosed by the dotted line 57.

The upper terminal of the amplifier input circuit, which circuit includes a coupling resistor 59, is connected to the variable tap 30 on the bridge resistor 29 at the remote point by means of a conductor 32 which extends from the main receiver unit to the remote point through the cable 53. This connection to the variable tap is made, however, only when a button 61 is depressed, as will be more fully explained in connection with Figs. 3 and 4.

The lower terminal of the input circuit of amplifier 23 is connected to ground as indicated at 31, and from ground to the variable tap 28 of the resistor 27 at the main receiver unit, which tap has been grounded. Thus the input circuit of the amplifier is connected across one diagonal of the bridge.

The other diagonal of the Wheatstone bridge 25 is connected to the power supply through a circuit which may be traced from the diagonal point x through a conductor 63 to the upper end of the secondary winding of transformer 19, through the secondary winding and through conductor 65 to the diagonal point y.

From the above description it will be seen that if the button 61 at the remote point is depressed and the variable tap 30 moved to unbalance the bridge 25, a voltage will be impressed upon the input circuit of the amplifier 23.

Referring now to the amplifier 23, itself, it comprises a vacuum tube 67 having an indirectly heated cathode 69, a control grid 71, a screen grid 73, and an anode 75. The cathode 69 is connected to the lower end of the coupling resistor 59 by means of a grid biasing resistor section 77. The control grid 71 is connected to the upper end of the coupling resistor 59. The anode 75 and the screen grid 73 are connected to one of the plate supply terminals at the receiver 1 through resistors 79 and 81, respectively. A bleeder resistor 83 is connected between the screen grid 73 and cathode 69 to aid in supplying the screen grid with the proper voltage.

The output circuit of the first tube 67 is impressed upon a second amplifier tube 85 which has a cathode 87, a control grid 89, a screen grid 91, a suppressor grid 93 and an anode 95. The cathode 87 is supplied with alternating current and shunted by a resistor 97 which has its midpoint grounded for reducing hum.

The control grid 69 is connected to the upper end of an inductance coil 99, the lower end of which is connected to the negative grid biasing terminal at the receiver 1. The anode 75 of tube 67 is coupled to a point on the inductance coil 99 through a coupling condenser 101.

The anode 95 of tube 85 is connected through the primary winding 103 of the output transformer 45 to the other plate supply terminal at the receiver 1. The screen grid 91 is connected through a resistor 105 to the same plate supply terminal.

Both in order to obtain the necessary phase shift and in order to obtain more efficient operation, the amplifier 23 is tuned to the frequency of the input voltage, which ordinarily will be 60 cycles per second. The primary winding 103 of the output transformer 45 is tuned to the frequency of the input voltage by means of a condenser 107 shunted thereacross.

The coupling stage between the vacuum tubes 67 and 85 is tuned broadly to the same frequency as primary 103, the tuned coupling circuit being traced from the upper end of the coupling resistor 79, through the coupling condenser 101, the inductance coil 99, the power supply in receiver 1, and through the resistor 79 back to the condenser 101.

A phase shift of approximately 60 degrees is obtained in this coupling circuit, since the input electrodes of the vacuum tube 85 are connected across the inductance coil 99 of the above described tuned circuit. If the inductance coil 99 had no resistance and no distributed capacity, the phase shift introduced by the coupling circuit would be exactly 90 degrees, but it has been found in practice that a 90 degree phase shift is difficult to obtain. It has also been found that a phase shift of the order of 60 degrees is entirely satisfactory.

Referring now to the local controls of the radio receiver, the receiver 1 is turned on and off by means of a switch 109 operated by a double button 111. Assuming now that the armatures of the relays 35 and 39 are in their right-hand or "off" position, the receiver may be turned on by depressing the center element of button 111, whereby the switch arm 113 is caused to make electrical contact with the two lower switch arms 115 and 117. This energizes the left-hand winding 119 of the relay 35 and pulls the armature 33 over to the left-hand position to close the supply circuit to the radio receiver 1 through the contacts 121. At the same time, the contact points 42 close to connect the motor field winding 17 to the secondary of the power supply transformer 19.

The circuit through which the relay winding 119 is energized may be traced from the upper end of the secondary of the power supply transformer 19 through the relay winding 119, a conductor 125, the lower switch arm 117, the contact point of the switch arm 115, and through the switch arm 113 and a conductor 127 to the lower end of the secondary of transformer 19. It will be noted that when the power supply circuit for the radio receiver is closed at the contacts 121, the tuned amplifier 23 is energized, since it derives its operating potentials from the power supply of the radio receiver 1.

When the center element of button 111 was depressed, it also energized the left-hand winding 129 of the relay 39 to pull the armature 37 over to the left-hand position and connect the loud speaker 131 of the local radio receiver unit 1 to the output of that unit. At the same time, the variable tap 133 of a volume control device 135 at a remote control unit 137 was disconnected from the circuit of loud speaker 131 at the contact points 139.

The circuit through which the coil 129 is energized may be traced from the upper end of the secondary of transformer 19 through the winding 129, the conductor 141, the switch arms 115 and 113, and through the conductor 127 to the lower end of the secondary of transformer 19.

Attention is called to the fact that the radio receiver 1 may be tuned in the conventional manner with the circuit in the condition above described, since the tuning buttons at the remote control units are not in contact with the Wheatstone bridge arms. For example, at remote control unit 57 the contact point 30 is put in contact with the bridge arm 29 by an operator at the remote point when it is desired to tune the receiver 1 from that point.

It will also be seen that the local loud speaker 131 is connected directly to the output of the receiver 1 so that the output of this loud speaker may be adjusted by the volume control knob on the receiver itself. In this connection, it may be noted that the local loud speaker 131 is shunted by the volume control resistors 143 and 145 at the remote control units 57 and 137, respectively, but that these resistors have a sufficiently high value of resistance to prevent any detrimental shunting of energy around the speaker.

The full value of resistance of the volume control resistors 143 and 145 is always in shunt to the local loud speaker 131 when that loud speaker is in use because the movable contact point 133 of the volume control resistor 145 is disconnected from the loud speaker circuit at the contact points 139; and the movable contact point 147 of the resistor 143 at the remote point 57 is always moved to the grounded end of the resistor 143, that is, to the position of minimum volume, when the radio receiver 1 is turned off at that point. This is accomplished by actuating the on-off switch 149 through the volume control adjustment, as will be described hereinafter.

When it is desired to turn the radio receiver off at the receiver itself, the outer element of button 111 is depressed to move the upper switch arm 151 into contact with the adjacent switch arm 113. This energizes the right-hand winding 153 of the relay 35 to pull the armature 33 over to the right-hand position, whereby the power supply circuits to the radio receiver 1 and the motor field winding 17 are broken.

The energizing circuit for the right-hand winding 153 may be traced from the upper end of the secondary of transformer 19 through the relay coil 153, a conductor 155, the switch arms 151 and 113, and the conductor 127, to the lower end of the secondary of transformer 19.

While there may be any number of control units for the receiver 1 at remote points, only two such units have been illustrated. At one of these units indicated at 57, a loud speaker 157 is provided which is connected across a volume control resistor 143 permanently connected to the output circuit of the radio receiver 1 through a cable conductor 159.

The on-off switch 149 is connected to the local receiver circuit through four cable conductors 161, 163, 165, and 167, the switch arms 169, 171, and 175 being connected to the switch arms 151, 113, and 117, respectively, of the local switch 109. The switch arm 173 of switch 149 is connected through the cable conductor 165 and the conductors 177 and 179 in the local receiver circuit to the right-hand relay winding 181 of the relay 39.

The radio receiver 1 is turned on at the remote unit 57 by turning the volume-control knob to move the variable tap 147 downwardly on the resistor 143, which movement at the same time depresses the switch arm 171 momentarily (by means of mechanism later described) to bring it into electrical contact with the two lower switch arms 173 and 175. This energizes the left-hand winding 119 of the relay 35 and connects the receiver 1 and remote control apparatus to the power supply in the manner previously described.

It also energizes the right-hand winding 181 of the relay 39 to move the armature 37 into the right-hand position and connect the movable contact point 133 on the volume control resistor 145

in remote control unit 137 to the coil 183 of loud speaker 131.

When it is desired to turn the receiver 1 off, the volume control knob is turned to move the movable tap 147 to the grounded end of the resistor 143, and this movement moves the switch arm 171 upwardly to make contact with the upper switch arm 169. This completes a circuit through the right-hand winding 153 of the relay 35 and turns the set off in the manner previously described.

At the other remote-control unit 137 there is no loud speaker since this unit is for use in the immediate vicinity of the radio receiver where the loud speaker 131 of the radio receiver 1 will be utilized.

The volume may be controlled at this remote-control unit 137, however, by adjusting the variable contact point 133 on the volume control resistor 145 which is permanently connected across the output of the radio receiver 1 through a conductor 185 of the cable 187. It will be noted that the variable contact point 133 is connected to the loud speaker coil 183 through a cable conductor 189 when the armature 37 of the relay 39 is in its right-hand position.

Remote tuning of the receiver 1 is accomplished at remote-control unit 137 in the same way as at the other remote control unit 57 by means of a Wheatstone bridge resistor 191 which is connected across the local Wheatstone bridge resistor 27 by means of cable conductors 193 and 195. The variable tap 197, which makes contact with resistor 191 when a button 192 is depressed, is connected through a cable conductor 199 to the conductor 32 leading to the input circuit of the tuned amplifier 23.

Thus the radio receiver 1 may be tuned by depressing the tuning button 192 and moving the contact point 197 along the Wheatstone bridge resistor 191 to the desired setting. The bridge resistor 29 at the other remote-control unit 57 has no effect on the tuning since the tuning button 61 is not depressed.

The on-off switch 201 of the remote control unit 137 is operated simultaneously with the volume control tap 133 in the manner described in connection with the remote control unit 57. The switch arms 203, 205, 207, and 209 of the switch 201 are connected through conductors in the cable 187 to the switch arms 169, 171, 173 and 175, respectively, in the remote control unit 57.

Since the two switches 149 and 201 are connected in parallel, their operation is the same. If the volume control tap 133 is moved downwardly toward the maximum volume position, the switch arm 205 is moved downwardly into contact with the two lower switch arms 207 and 209 and the radio receiver 1 is turned on in the manner previously described. If the volume control tap 133 is moved upwardly to the minimum volume position, the switch arm 205 is moved upwardly into contact with the upper switch arm 203 and the radio receiver 1 is turned off.

Figs. 3 and 4 show one type of impedance unit and variable tap construction which may be utilized in the Wheatstone bridge at the remote tuning points. In these figures, parts corresponding to parts in the remote tuning unit 57 are indicated by like reference numerals.

Referring to Figs. 3 and 4, a wire-wound resistor 29 of the type commonly employed in potentiometers is supported in a block 215 of insulating material. A variable tap or pointer 30 is mounted on a potentiometer shaft 217 which is rotatably supported in a metallic member 219 fastened in an opening at the center of the block 215. A knob 61 is provided for rotating the pointer 30.

The pointer 30 is normally held out of engagement with the resistor winding 29 as shown in Fig. 4, by means of a spring 221 positioned between the end of the shaft 217 and a metallic closure member 223.

The usual radio station markings, such as markings in kilocycles, are provided on the supporting block 215 for co-operation with the pointer 30, as indicated at 225. It will be apparent that a radio station is tuned in by pushing in on the knob 61 to bring the pointer 30 into contact with the resistor winding 29 and by then rotating the knob 61 to a point corresponding to the desired station. After the station has been tuned in, the knob 61 is released and a different station can then be tuned in at another remote point if desired, by means of another unit similar to the one just described.

From the description of the circuit shown in Fig. 2 it will be understood that at the remote tuning points 57 and 137 it is desirable to have the "on" and "off" switches 149 and 201 so co-operating with the volume control units that each volume control unit is always set at the minimum volume position when the receiver is turned off. One satisfactory construction for obtaining such operation is shown in Fig. 5, where parts similar to those in remote tuning unit 57 are indicated by like reference numerals.

Referring to Fig. 5, the volume control resistor 143 comprises a wire wound resistor, of the type commonly employed in potentiometers, which is supported in a block 227 of insulating material. The pointer 147, which is held in contact with the resistor winding 143, is fastened to a shaft 229 which is rotatably mounted in the block 227.

A projecting arm 231 of insulating material is fastened to the end of the shaft 229 and positioned to co-operate with the switch arm 171. It will be apparent from an inspection of the drawings that when the pointer 147 is rotated towards the maximum volume position, the insulating arm 231 forces the switch arm 171 downwardly into contact with the switch arms 173 and 175, sliding past the end of arm 171 as it does so. This immediately turns the receiver on and the pointer 147 may then be moved farther towards the maximum position until the desired volume is obtained.

The receiver is turned off by rotating the pointer 147 towards the "off" position. As the pointer is moved toward this position, the arm 231 moves upwardly into contact with the switch arm 171 and moves into contact with the switch arm 169, at the same time sliding past the end of the switch arm 171 to the position shown in Fig. 5. It is evident, therefore, that the entire value of the volume control resistor at a remote control point is connected in shunt to the radio receiver output circuit when the receiver is turned off at that point. This prevents loss of signal energy at a remote tuning point which might otherwise occur by the volume control tap or pointer being left near its maximum volume position.

In some cases it may be found desirable to so design the remote control unit that any one of several preselected stations may be turned in by pressing a button corresponding to that station. A circuit arrangement for accomplishing this is shown in Fig. 6 where the bridge resistor 29 is shown tapped at a plurality of points corresponding to the desired stations to be received.

Each tap on the resistor 29 is connected to a contact point 233 which co-operates with the spring arm 235 of a switch. All the spring arms 235 are connected to the conductor 32 leading to the input of the tuned amplifier 23.

Each spring arm 235 has a button 237 mounted thereon whereby the conductor 32 may be connected to any one of the taps on resistor 29 by pressing down on the proper button. The operation of this circuit is obvious in view of the foregoing description of the operation of the circuit shown in Fig. 2.

While only five preselected station settings have been indicated in Fig. 6, it will be understood that any desired number of stations may be preselected by providing the necessary number of taps on the bridge resistor 29. If it is desired to select, by pressing one of the buttons, a different station than the station set up for that button, it is only necessary to shift the tap along the resistor 29 to a point corresponding to the desired different station. It may be noted that, when combined with a time clock, this circuit presents a very accurate and relatively cheap means of obtaining time preselection.

Various other modifications may be made in our invention without departing from the spirit and scope thereof, and we desire, therefore, that only such limitations shall be imposed thereon as are necessitated by the prior art and are set forth in the appended claims.

We claim as our invention:

1. In a control system for a radio receiver having a tuning device and in which the receiver is to be controlled from a plurality of points remote therefrom, a motor coupled to said tuning device, a Wheatstone bridge having one arm located in the vicinity of said motor, an impedance unit located at one of said remote points and connected to function as another arm of said bridge, an impedance unit located at another of said remote points and connected to function as another arm of said bridge, a source of alternating current connected across one diagonal of said bridge, coupling means between said motor and said first bridge arm whereby said bridge may be balanced by running said motor, and means for selectively connecting said motor to one of said impedance units and across the other diagonal of said bridge, said system being characterized in that the receiver includes a loudspeaker and further characterized in that at each remote point there is a volume control element, a switch having two positions, means for closing said switch momentarily in one position in response to moving said volume control element in one direction and for closing it momentarily in the other direction in response to moving said volume control element in the opposite direction, a power switch which is normally biased to one of two positions, means for supplying power to said receiver in response to said power switch moving to one of said positions, means for moving said power switch to one of said two positions in response to the momentary closing of said first switch in said one position, and means for moving said power switch to its other position in response to the momentary closing of said first switch in said other position.

2. In a control system for a radio receiver having a tuning device and in which the receiver is to be controlled from a plurality of points remote therefrom, a motor coupled to said tuning device, a Wheatstone bridge having one arm located in the vicinity of said motor, an impedance unit located at one of said remote points and connected to function as another arm of said bridge, an impedance unit located at another of said remote points and connected to function as another arm of said bridge, a source of alternating current connected across one diagonal of said bridge, coupling means between said motor and said first bridge arm whereby said bridge may be balanced by running said motor, and means for selectively connecting said motor to one of said impedance units and across the other diagonal of said bridge, said system being characterized in that said receiver includes a loud speaker in the immediate vicinity thereof, and further characterized in that the system includes a volume control element and a switch at one of said remote points, means for connecting said receiver to a source of power in response to an actuation of said switch, means for connecting said loud speaker to said receiver through said volume control element in response to said actuation of said switch, means including a local switch at said receiver for connecting said receiver to a source of power in response to an actuation of said local switch, and means for connecting said loud speaker directly to said receiver in response to said actuation of said local switch.

3. In a control system for a radio receiver having a tuning device and in which the receiver is to be controlled from a plurality of points remote therefrom, means for operating said tuning device at either the receiver or at one of said remote control points, a loud speaker in the immediate vicinity of the receiver, a volume control element and a switch at one of said remote control points, means for connecting said receiver to a source of power in response to an actuation of said switch, said volume control element being ineffective prior to said actuation of said switch, means for making said volume control element effective in response to said actuation of said switch, means including a local switch at said receiver for connecting said receiver to a source of power in response to an actuation of said local switch, and means for making said volume control element ineffective in response to said actuation of said local switch.

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