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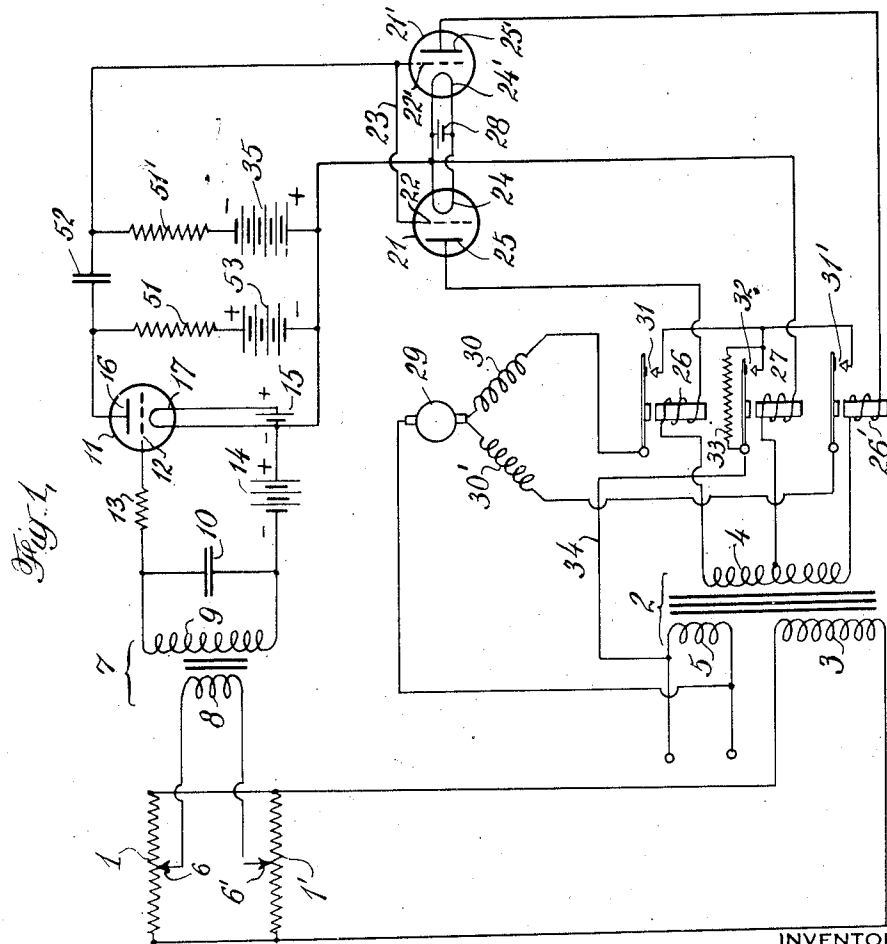
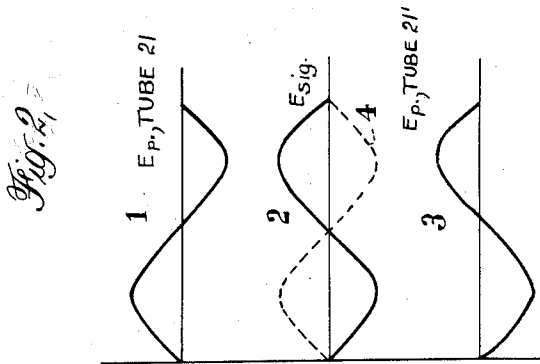
V. E. WHITMAN

1,942,587

CONTROL SYSTEM

Filed Aug. 30, 1930

4 Sheets-Sheet 1



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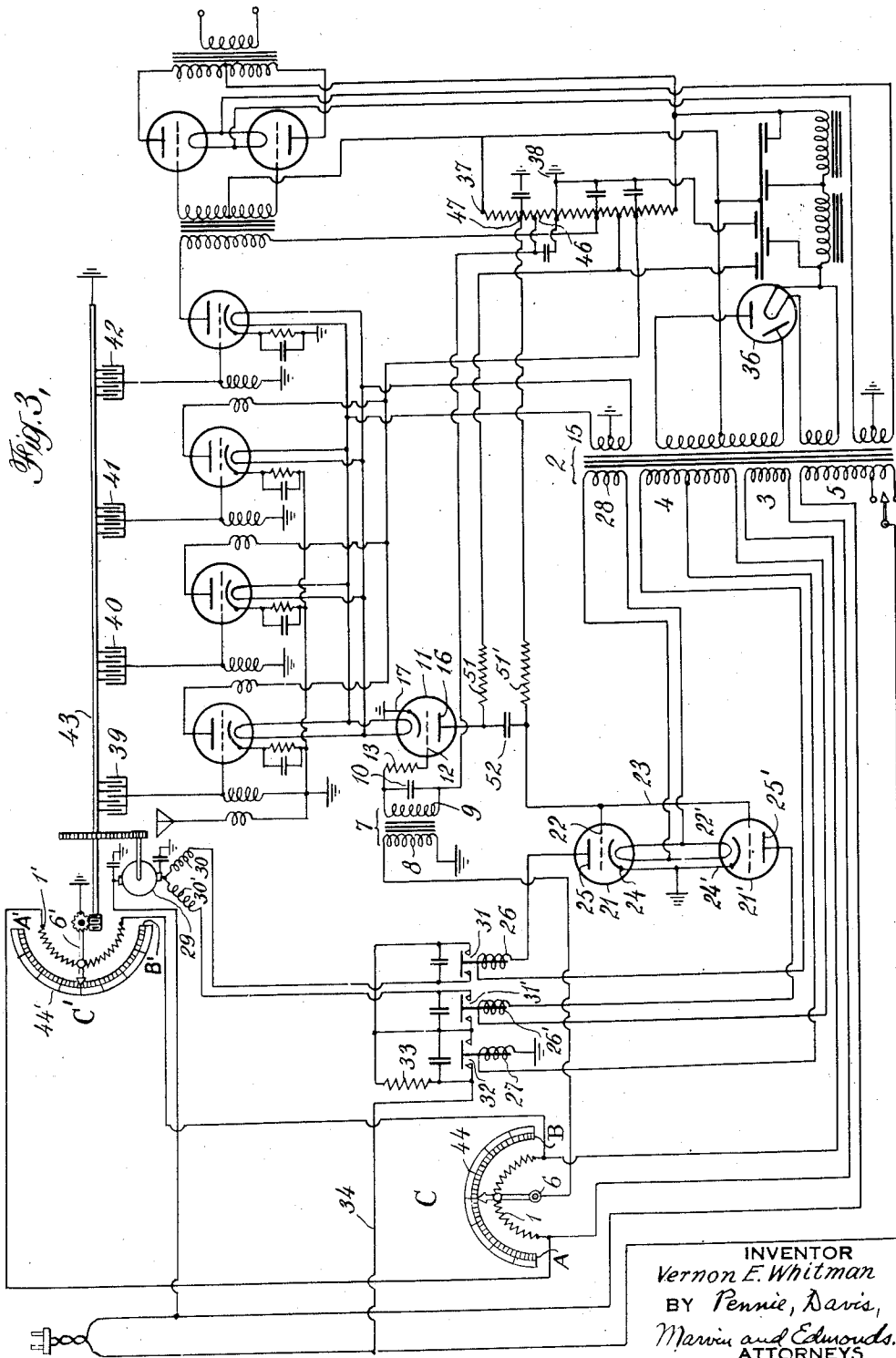
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CONTROL SYSTEM

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4 Sheets-Sheet 2



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CONTROL SYSTEM

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4 Sheets-Sheet 3

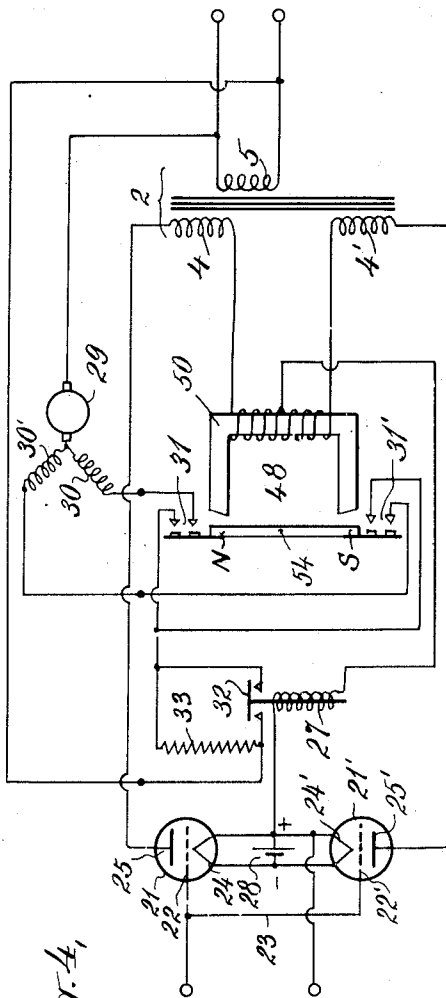


Fig. 4,

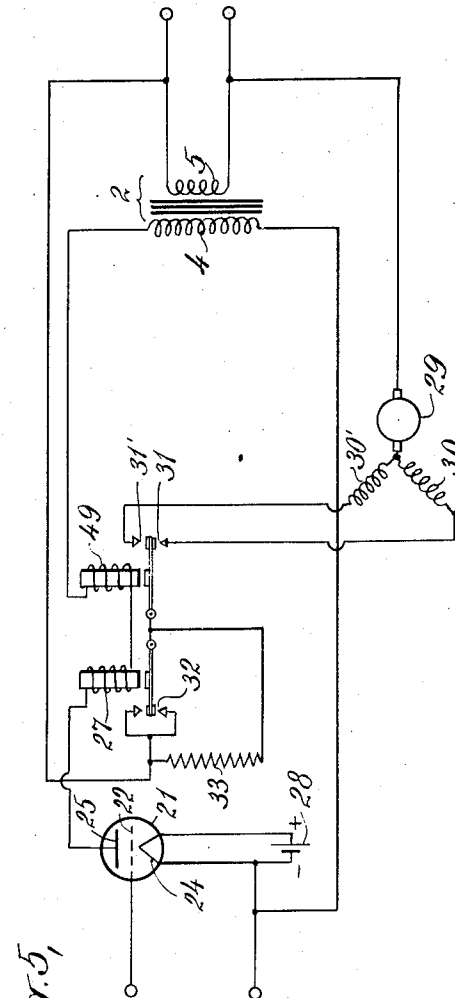


Fig. 5,

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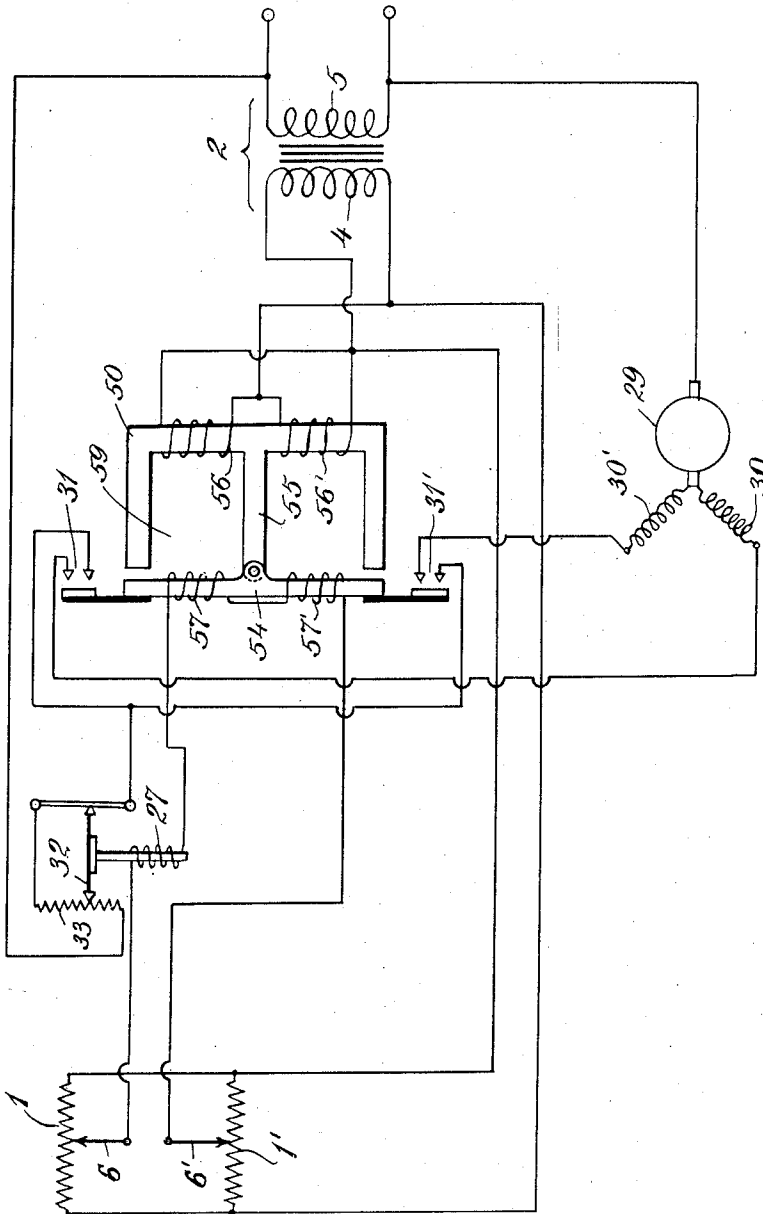
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CONTROL SYSTEM

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4 Sheets-Sheet 4

Fig. 6,



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UNITED STATES PATENT OFFICE

1,942,587

CONTROL SYSTEM

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Application August 30, 1930. Serial No. 479,041

7 Claims. (Cl. 172—239)

This invention relates to electrical control systems and particularly to systems in which the control is effected from a remote point, permitting of electrically actuating an assemblage of parts or apparatus at a distance.

The invention is particularly adaptable to radio receivers or transmitters where the control of tuning from a distant point is desired.

In the present state of the art, where radio receivers have been perfected in their tonal qualities to such high standards that they are capable of reproducing musical renditions of a large orchestra in its full volume and brilliancy of tone, it is usually more pleasing to the audience to listen to the program at a distance from the receiver, such as the adjoining room or rooms. In such and other cases it is of great convenience to be able to change the resonant frequency of the receiver from that of one broadcasting station to that of another without going to where the receiver is located, which in some cases may be a considerable distance.

The chief object of this invention is the provision of a remote control system for actuating the tuning elements of a radio receiver or transmitter whereby such receiver or transmitter can be accurately tuned to any desired frequency or station from a distant point.

An important feature resides in the use of the usual alternating current supply for actuating the control circuits, thereby greatly simplifying the electrical system as a whole.

Electrical systems for accomplishing this end have previously been proposed, but such arrangements have been limited as to the number of possible settings, their operation required delicate tuning adjustments, and a great number of wires were necessary to connect the remote control with the radio tuning apparatus.

Furthermore such systems have required a direct-current source to supply the remote control devices, while the radio apparatus itself operated from the usual alternating current power lines, thus complicating and making more expensive the necessary equipment. All of these disadvantages are overcome by the present invention.

It is also desirable that the person using the remote control should be able to adjust the tuning of the apparatus to known positions of the tuning element and have means at the remote tuning point to indicate at all times the position of the tuning element.

In accordance with this invention, there is provided an electrically balanced alternating cur-

rent bridge network comprising a pair of potentiometers, the variable contact of one of which is actuated at a remote point to unbalance the network and the variable contact of the other of which is actuated by the device to be controlled. An alternating current potential is supplied across one of the two pairs of conjugate points of the network, or in other words, across each of the potentiometers. The other of the two pairs of conjugate points comprising the variable contacts of the two potentiometers is connected to an output circuit. When a current flows in the output circuit of said network, the output voltage is amplified and applied in the same phase through a common input circuit to each of the control grids of a pair of thermionic vacuum tubes. The separate plate or output circuits of the vacuum tubes are supplied 180° out of phase by the same alternating current potential, through the energizing coils of two selectively responsive relays. A third relay is connected in the common leg of the output circuit of the tubes. The first two relays control the direction of rotation of a reversible drive mechanism, such as a motor, which mechanism is mechanically connected to the contact of the local potentiometer as well as to the device to be controlled. The third relay controls the speed of rotation of the motor. The relays, which constitute control means independent of the drive mechanism, are responsive to the magnitude of the current in the output of the network and thus set the mechanism in operation. The tubes provide selective means for discriminating between the phase of the current in the output of the network relative to the current in the input circuit for determining the direction of operation of said mechanism, and control the current supplied to the reversible motor from a power source which is separate and independent from the current passing through the network.

While this invention in its preferred embodiment is herein illustrated and described as a remote tuning control for radio receivers, it will be obvious to anyone skilled in the art that it can be advantageously applied to control other devices where an accurate and flexible control is to be effected from any distance.

The invention may be more clearly understood from a consideration of the accompanying drawings in which:

Fig. 1 represents diagrammatically the electrical circuit of a control system in accordance with this invention.

Fig. 2 shows the plate-voltage curves of the

selector tubes 21 and 21' of Fig. 1 in reference to the signal voltage applied to their grids.

Fig. 3 represents the control system shown in Fig. 1 as applied to a radio receiver operating entirely from alternating-current power lines.

Fig. 4 shows a modification consisting in the use of a polarized relay in place of the relays 26 and 26' of Figs. 1 and 2.

Fig. 5 is a modification of Fig. 4 consisting in the use of only one selector tube and a pair of balanced-armature relays in place of the relay 48 of Fig. 4.

Fig. 6 illustrates a modification of the invention in which an alternating current relay replaces the selector tubes 21 and 21' and the relays 26 and 26' of Figs. 1, 3, 4 and 5.

Fig. 1, to which attention is now invited, shows an electrically balanced alternating current network connected to control the action of a reversible motor. The network includes two potentiometers 1 and 1' connected in parallel as a bridge and supplied with alternating current from the winding 3 of the transformer 2. Potentiometer 1', which shall hereinafter be referred to as the local potentiometer, has its movable contact 6' mechanically connected to the device to be controlled. The alternating current supply potential need not be high, and in practice it has been found satisfactory to use about 50 volts, the resistance values of the potentiometers being 2,500 ohms each. The sliders 6 and 6', of the potentiometers are connected to the primary winding 8 of the transformer 7. This transformer is of the audio-frequency type commonly used in radio receivers and preferably of high, about 1:30, winding ratio. The secondary winding 9 of the transformer 7, is tuned by means of a condenser 10 to the frequency of the alternating current used in the system, which under normal conditions is the house-lighting station, usually of 25 or 60 cycles. The winding 5 of the transformer 2 is the primary winding and connects to the alternating current supply mains.

The amplitude of the alternating voltage impressed on the primary winding 8 of the transformer 7 depends upon the magnitude of the difference in position of the potentiometer contact arms 6 and 6'; the phase of this voltage depends upon the sign of the algebraic difference in position of the potentiometer contacts 6 and 6'. Using the voltage supply to the potentiometer from the winding 3 of the transformer 2 as the reference standard, the phase of the voltage in the winding 8 of the transformer 7 shifts 180° as the algebraic difference in the position of the sliders 6 and 6' changes sign. The output of the transformer 7 is connected to the grid 12 of the tube 11 through the grid resistor 13, and to the cathode 17 in series with the battery 14 which supplies the necessary biasing potential to the grid 12. The filament 17 of tube 11 is supplied from the usual battery 15. The potential of the plate 16 of the tube 11 is derived from the battery 53 through the coupling resistance 51. The purpose of this tube is to amplify the output of the transformer 7 and is shown as a resistance-coupled amplifier, the functioning of which is well-known and need not be considered here.

The output circuit of the amplifier tube 11 is capacitively coupled through a condenser 52 to the common input circuit of a pair of thermionic selector tubes 21 and 21'. The filaments 24

and 24' of the selector tubes 21 and 21' are connected in parallel to the heating battery 28, the grids 22 and 22' of these tubes are connected together by wire 23. The required grid biasing potential is derived from the battery 35 through the resistor 51'.

The plate 25 of the tube 21 and the plate 25' of the tube 21' is supplied with an alternating potential through the energizing coils of the direct controlling relays 26 and 26' from each end respectively of the winding 4 of the transformer 2, the center tap of which forms the common return for the plate potential of both tubes through the energizing coil of the relay 27 to the filament 24 and 24' of the tubes 21 and 21'. It is clearly seen that the plate potential of the tube 21 and therefore the voltage across the energizing coil of relay 26 will be 180° out of phase with the plate potential of the tube 21', and the voltage across energizing coil 26', and the plate current of both tubes will depend upon both the magnitude and the phase of the voltage supplied to their grids, through the coupling to the output of the alternating current network.

A reversible series motor 29 with field windings 30 and 30' is shown as the device to be controlled and is connected to the primary winding 5 of the transformer 2, through its field winding 30 in series with the contacts 31 of the relay 26 or field winding 30' in series with contact 31' of the relay 26'. Both contacts aforementioned are in series with the contact 32, bridged by the resistance 33, of the relay 27, the circuit to the motor completed by wire 34 to the primary winding 5 of the transformer 2. The reversible motor 21 is mechanically connected to the moving contact 6' of the local potentiometer 1'.

Thus the relays 26 and 26' are made selectively responsive to the phase of the voltage impressed upon the input of the tubes 21 and 21', and the movement of the control potentiometer will cause the motor 29 to turn in one direction or the other to adjust the local potentiometer 1' to rebalance the alternating current network. Whenever the difference of the settings of the potentiometers 1 and 1' exceeds a predetermined amount, the third relay 27 will be actuated to short-circuit the resistance 33 and thus increase the speed of the motor 29. The operation of this system will be described more fully hereinafter.

Referring to Fig. 2 the curves 1 and 3 represent the instantaneous plate voltage of the tubes 21 and 21'. The curves 2 indicate the grid voltages of the same tubes referred to the same time scale as the curves 1 and 3. This will be explained in detail later.

Referring to Fig. 3 reference characters of Fig. 1, indicate identical parts of the circuit, which shows the control system connected to a radio broadcast receiver of present day design having tuned radio-frequency stages in cascade. The operating potentials as well as the filament heating currents for all tubes are derived from the common power transformer 2 which is identical to the one shown in Fig. 1, except that there are additional windings necessary for the operation of the radio receiver itself. The rectifier tube 36 supplies the necessary direct-current potentials to the plates and grids of all the tubes of the radio receiver including the amplifier tube 11 of the control system. These potentials are taken off from suitable taps of the voltage dividing resistor 37 which is grounded at the point 38, the positive potentials being taken off in

one direction and the negative potentials in another direction from this point.

The motor 29 is shown, diagrammatically, driving the rotor plates of the tuning condensers 39, 40, 41 and 42; and mechanically attached to the shaft 43 of the rotor plates is the arm 6' of the potentiometer 1'. The rotary motion of the condenser shaft 43 effects the tuning of the set and correspondingly moves the contact arm 6' of the potentiometer 1' which also serves to indicate the position of the tuning condensers, above mentioned, on the scale 44' calibrated in suitable units such as meters or kilocycles.

The operation of the remote control tuning system is as follows: The motor 29 is mechanically connected to the shaft of the tuning condensers or other tuning elements of the receiver. The two potentiometers 1 and 1' are supplied with an alternating potential from the winding 3 of the power transformer 2 and form an electrically balanced bridge circuit, as long as their arms 6 and 6' rest at corresponding points of the two scales 44 and 44', inasmuch as the resistance values on both sides of both arms 6 and 6' are equal and no current flows through the winding 8 of the transformer 7 to which the arms 6 and 6' are electrically connected. In this condition of equilibrium the grid 12 of the vacuum tube 11 receives no impulse, and no change in grid voltage takes place. The amplifier tube 11, therefore, does not impress potential changes on the grids of the selector tubes 21 and 21'. The grids 22 and 22' of these tubes are so biased from the tap 47 of the voltage dividing resistor 37 that practically no, or very little, plate current flows through the winding 4 of the transformer 2 in series with the energizing coils of the relays 26 and 26' and 27. The plate current being zero or of such low value that it is not sufficient to actuate the relays referred to, the relay contacts will remain open and no current can flow to the field windings 30 or 30' of the motor 29.

In tuning the receiver from the remote point the contact arm 6 of the remote potentiometer 1 is moved in the desired direction corresponding to the markings of the scale 44 and brought to rest at a point on this scale which indicates the wave length or the frequency of the broadcasting station desired to be received. The change in position of the contact arm 6 to unbalance the network will result in the disturbance of the electrical equivalence of the resistances of the bridge circuit, and an alternating current will flow through both contact arms 6 and 6' into the winding 8 of the transformer 7 from the winding 3 of the transformer 2 and thus impress across the output of the network an alternating current voltage. The amplitude of this current and the phase relationship of the input and output voltage will depend upon the magnitude of the difference in position of the arm 6 of the potentiometer 1 relative to the arm 6' of the potentiometer 1'. In other words the further the two contact arms are set in opposite directions the greater will be the current flowing through them, and it will reach its maximum value when one of the arms points to A while the other points to B', or vice versa.

The voltage impressed on the primary winding 8 of the transformer 7 is amplified by the tube 11 and impressed simultaneously on the grids 22 and 22' of the selector tubes 21 and 21'. The frequency of this voltage which is derived from the winding 3 of the power transformer 2 is, of course, the same as the frequency of the

voltages in the other windings, determined by the frequency of the line voltage supplied to the primary winding 5 of the same transformer, the phase of the voltage impressed on the grid 22 and 22', however, relative to the plate voltage of the selector tubes will depend upon the sign of the algebraic difference in position of the two sliders 6 and 6' of the potentiometers 1 and 1'. The voltages on the plates 25 and 25' of the selector tubes are 180° out of phase, and therefore, the impressed voltage on the grids of these tubes will be in phase with one plate voltage and out of phase with the other; in other words, aiding one and opposing the other. In Figure 2 the action of the grid voltage is clearly illustrated in the 3 curves of which 2 in full line is the instantaneous grid voltage for one condition of unbalance and the dotted curve is the instantaneous grid voltage for the other condition of unbalance of the potentiometers as considered above. It will be seen that in the first condition the grid voltage is in phase with the plate voltage of the tube 21' and that in the second condition it is in phase with the plate voltage of the tube 21.

To give a more clear definition of this important point, which is the salient feature of this invention, let it be assumed that the arms of the potentiometers referred to are both at rest at a point C, midway between the points A and B. It will be evident that the arm 6 of the potentiometer 1 can be moved in either direction toward A or toward B, and at equal points from the assumed resting point C of the arm 6 in either direction the magnitude of the voltage taken off will be equal, the resistance of the potentiometer being evenly distributed; the difference not being in magnitude will be, however, in the phase of this voltage, which will be impressed on the primary winding of the transformer 7. Assuming that the contact arm 6 of the potentiometer 1 is moved in the direction toward A to a point between A and the assumed point of rest C, the voltage then derived, and amplified by the tube 11, will be impressed on the grids of the selector tubes 21 and 21'. The plate voltages of these tubes being 180° out of phase, the impressed grid voltage will be in phase with the plate voltage of only one tube. Assuming that this tube is tube 21', the impressed voltage on its grid 22' will be out of phase with the plate voltage. This condition will tend to decrease any existing plate current, and the tube 21' will not actuate any of the relays. On the other hand, the voltage impressed on grid 22 of tube 21 will be in phase with the plate voltage, and therefore will be positive when the plate voltage is positive, causing an increase in the plate current. The increased plate current of tube 21 flowing through the coils of relays 26 and 27 will be sufficient to actuate the armature of relay 26 only and close the contacts 31, thereby completing the circuit through the field 30 of the reversible motor 29.

The motor will then start to turn in a direction, so chosen by the correct connection of its field windings to the relay contacts 31 and 31', that the turning of the tuning condenser shaft 43 will move the contact arm 6' of the potentiometer 1' in such direction as to gradually decrease the difference in the resistance values of the arms of the bridge circuit. When the contact arm 6' reaches the point corresponding to the setting of the arm 6, the bridge circuit resumes the state of electrical equilibrium, and the current in the primary winding 8 of the transformer 7 ceases. This in turn

reduces the plate current of the tube 21 to zero or to a sufficiently low value to de-energize the relay 26 thereby breaking the circuit to the motor. It will be evident from the foregoing that this control system has great flexibility and gives a smooth continuous control over the tuning range, the action being neither intermittent nor step by step.

The action of the third relay 27 with its associated resistor 33 further improves the tuning operation by providing a speed control for the motor 29. The speed of the motor is an important factor and must be slow enough to ensure that the momentum of the motor armature and associated apparatus shall not drive the contact arm of the potentiometer over the stopping point; for otherwise the motor would hunt back and forth before stopping. A slow speed of the motor, on the other hand, lengthens the time interval required for tuning from one setting to another, especially if the desired station is operating at a frequency remote from the one previously received. It is desirable, therefore, that the speed of the motor be increased until the arm 6' of the potentiometer 1' is near the point where the desired station is indicated, and then in order to insure fine tuning and avoid the overriding of the contact arm, the speed of the motor be decreased. The relay 27 accomplishes this result by controlling or regulating the speed of the motor in the following manner. When the relay 27 is de-energized the contact points 32 are open, and the current to the motor 29, provided that either one of the relays 26 or 26' is actuated, will flow through the resistance 33, the value of which is so chosen that the motor turns over at a speed that will insure fine tuning and instantaneous stopping. The closing of the contacts 32 shunts the resistance 33 and the full line voltage will operate the motor at greater speed. The relay 27 is so designed that it will close at a predetermined value of current which is greater than that sufficient to actuate either of relays 26 and 26'.

It has been above stated that the magnitudes of the currents in the plate circuits of the selector tubes 21 and 21' depend on the magnitude of the difference in position of the arms 6 and 6'. The device operates as follows: Let it be assumed that the receiver is tuned to a station of relatively low frequency, as indicated at the points A and A' of the scales 44 and 44' and it is desired to tune in another station of relatively high frequency, as indicated at the points B and B' on the scales. The arm 6, therefore, is moved from the point A to the point B, and the maximum value of the voltage from the winding 3 of the transformer 2 will be impressed on the winding 8 of the transformer 7 and, as previously described, the plate current in one of the selector tubes 21 or 21' will reach a maximum value which energizes the relay 27 and one of the relays, 26 or 26'. The resultant closing of contacts 32 shunts the resistance 33 and the motor starts at full speed. The tuning-condenser shaft, in turn, moves the contact arm 6' from the point A' towards B'. The movement of the arm gradually decreases the impressed voltage on the primary winding 8, thereby decreasing the plate current. As the arm 6' reaches a predetermined distance from the point B' the plate current is decreased to such a small value that the relay 27 opens, throwing the resistance 33 into the circuit and slowing down the motor. When the arm 6' reaches the point B' the plate current in the

selector tube becomes practically zero and whichever one of the relays 26 or 26', was energized, opens and disconnects the motor from the line.

When tuning in stations closely allocated in frequency the magnitude of the voltage impressed in the winding 8 due to the relatively little difference in position of the arms 6 and 6', will not cause a large enough current-flow in the plate circuit of a selector tube to energize the relay 27 and the motor will turn at slow speed due to the resistance 33 in the circuit. It would, of course, be possible to employ another relay like 27 to cut out an additional resistance, giving three speeds and so on; but in practice it has been found that two speeds are adequate to cover the present broadcast bands. Instead of employing the relay 27 and resistance 33 to provide an additional motor speed, other variable speed devices may be used, as, for example, the coil and plunger 27 of Fig. 3 may operate a brake on the motor which will slow it up in proportion to the current flowing in the relay winding.

Figure 4 shows a simplified embodiment in the use of a polarized relay 48 in place of the relays 26 and 26' of Figs. 1 and 3. Reference characters identical to those of the other figures indicate identical parts of the circuits. The action of the polarized relay is similar to the action of the relays 26 and 26', the contacts 31 and 31' leading to the respective field windings 30 and 30' of the motor 29. The windings 4 and 4' of transformer 2 are combined in the center-tapped energizing winding of the relay 48. The plate current flowing in either half of the relay winding will attract the permanently magnetized armature 54 and close either contacts 31' or 31 depending upon which half of the winding is energized.

Referring to Fig. 5, the circuit shows a modification of Fig. 4 in the use of only one selector tube and a pair of balanced-armature relays. The operation of these relays in one direction depends on the rise of the current above a predetermined value, and in the other direction on the decrease of the current below that predetermined value. The current-flow in the energizing windings of both relays is the plate current of the tube 21, as both windings are in series between the filament 24, the plate 25 and the potential source 4. The plate current is so adjusted that when no signal voltage is impressed on the input circuit of tube 21 the plate current is of such value that it energizes the relay coils sufficiently to attract the armatures so that they clear the lower contacts but do not touch the upper contacts. During this normal plate current flow the armatures of the relays 27 and 49 are floating midway between the contact points. Should the impressed voltage on the grid of the tube 21 be in phase with the plate voltage, as previously described, the rise in plate current attracts the armature of the relay 49 and the circuit will be completed through contact 31' to one of the field windings 30' of motor 29. However, should the impressed voltage be out of phase with the plate voltage of tube 21 the normal plate current will drop to a considerably low value and the winding of the relay 49 becomes de-energized, allowing the armature to drop and complete the circuit to the motor through the lower contact 31 and to the other field winding 30 of the motor. The action of the relay 27 is similar to the previously described arrangements, except that it is adjusted to close at a predetermined maximum and also at a predetermined

minimum of plate current of the selector tube 21, thereby short-circuiting the resistance 33 in both instances so as to increase the motor speed. When the armature of relay 27 is floating the motor will run at slow speed because resistance 33 will then decrease the series-field current. In order that the armatures of relays 27 and 49 may at such time remain out of contact, a suitable spring will be required to balance the pull of the electromagnet. Such springs are not shown in Fig. 5, nor in the other figures, because the constructions of relays of the types herein referred to are well known.

In reference to Figure 6, the arrangement shown is a modification without the use of vacuum tubes. A specially constructed alternating current relay 59 selectively controls the closing of the motor circuit. Reference characters used in the previous figures designate parts identical in the arrangements formerly shown. The relay 59 has a divided core 50 on either half of which connected in parallel are the field windings 56 and 56'. These windings are in such magnetic relation that both ends of the core 50 will be instantaneously similarly poled.

The armature 54 is pivoted on core portions 55 and equipped with field windings 57 and 57'. The potentiometer 6 and 6' and the field windings 56 and 56' of the relay 59 are supplied with alternating current from the secondary winding 4 of transformer 2, the primary winding 5 of which connects to the house-lighting mains.

The armature windings 57 and 57' of the relay 59 are in series and aiding each other in magnetic polarity and connected to the contact arms 6 and 6' of the potentiometers. In series with this circuit is the speed regulating relay 27, the purpose and action of which has been previously described and is shown with sliding contact over the resistance 33 in order to give a more flexible control at a plurality of speeds. The speed controlling action of relay 27 is preferably so arranged through well-known electrical or mechanical devices as to maintain the motor speed relatively high and fairly constant until the contact arm 6' of potentiometer 1' reaches a certain distance from the point of balance and then decrease the speed of the motor 29 at a rate which will assure instantaneous stopping at the desired point without unduly lengthening the time interval for the arm 6' in reaching it from its original starting point.

The action of the relay armature 54 in one way or the other depends upon the phase relation between the current in the field winding and that in the armature winding and there is thus provided selective relay means for discriminating between the phase of the current in the output of the network relative to the current in the input circuit. From the diagram it is clearly seen that the phase of the current in the armature windings 57 and 57' shifts 180° as the algebraic difference in position of the potentiometer contact arms changes sign, whereas the current in the field windings 56 and 56' remains in uniform phase relation with the current in the potentiometers. The movement of the relay armature in either one direction closes the respective switch contacts whereby the circuit is completed to one of the field windings 30 and 30' of the motor 29.

I claim:

1. In a remote control system, as for actuating the tuning elements of a radio receiver; a reversible motor; a current source for said motor; two relays for controlling the current to said

motor to cause it to run in one direction or the other, respectively; a third relay for controlling the speed of said motor; an electrically balanced alternating-current network including an alternating-current supply, a local potentiometer mechanically connected to said motor, and a control potentiometer located at a remote point and operable to unbalance said network and thereby cause an alternating-current voltage, the phase of which will depend upon the relative settings of the two potentiometers, to be impressed across the output of said network; and a pair of thermionic tubes having a common input circuit coupled to the output of said network and having separate output circuits, each output circuit comprising the energizing coil of one of said direction controlling relays, an alternating-current voltage supply, the voltage in each circuit being 180° out of phase, and the energizing coil of said third relay, whereby the relays are selectively responsive to the phase of the voltage impressed upon the input of said tubes, and movement of the control potentiometer will cause the motor to turn in one direction or the other, thus adjusting the local potentiometer to re-balance the alternating-current network, the third relay being operated to increase the speed of the motor whenever the difference between the settings of the two potentiometers exceeds a predetermined amount.

2. In a remote control system, as for actuating the tuning elements of a radio receiver; a reversible motor; a current source for said motor; a polarized relay having two energizing coils for controlling the current to said motor to cause it to run in one direction or the other, respectively; relay means for controlling the speed of said motor; an electrically balanced alternating-current network including an alternating-current supply, a local potentiometer mechanically connected to said motor, and a control potentiometer located at a remote point and operable to unbalance said network and thereby cause an alternating-current voltage to be impressed across the output of said network; and a pair of thermionic tubes having a common input circuit coupled to the output of said network and having separate output circuits, each output circuit comprising one of the energizing coils of said polarized relay, an alternating-current voltage supply, the voltage in each circuit being 180° out of phase, and the energizing coil of said speed controlling relay means, whereby the polarized relay is selectively responsive to the phase of the voltage impressed upon the input of said tubes, and movement of the control potentiometer will cause the motor to turn in one direction or the other, thus adjusting the local potentiometer to re-balance the alternating-current network.

3. In a remote control system, as for actuating the tuning elements of a radio receiver; a reversible motor a current source for said motor; two relays for controlling the current to said motor to cause it to run in one direction or the other, respectively; an electrically balanced alternating-current network including an alternating-current supply, a local potentiometer mechanically connected to said motor, and a control potentiometer located at a remote point and operable to unbalance said network and thereby cause an alternating-current voltage to be impressed across the output of said network; and a pair of thermionic tubes having a common input circuit coupled to the output of said network and having separate output circuits, each output circuit comprising the energizing coil of

- one of said direction controlling relays, and an alternating-current voltage supply, the voltage in each circuit being 180° out of phase, whereby the relays are selectively responsive to the phase of the voltage impressed upon the input of said tubes, and movement of the control potentiometer will cause the motor to turn in one direction or the other, thus adjusting the local potentiometer to re-balance the alternating-current network.
4. In a remote control system, as for actuating the tuning elements of a radio receiver; a reversible motor; a current source for said motor; a polarized relay having two energizing coils for controlling the current to said motor to cause it to run in one direction or the other, respectively; an electrically balanced alternating-current network including an alternating-current supply, a local potentiometer mechanically connected to said motor, and a control potentiometer located at a remote point and operable to unbalance said network and thereby cause an alternating-current voltage to be impressed across the output of said network; and a pair of thermionic tubes having a common input circuit coupled to the output of said network and having separate output circuits, each output circuit comprising one of the energizing coils of said polarized relay, and an alternating-current voltage supply, the voltage in each circuit being 180° out of phase, whereby the relay is selectively responsive to the phase of the voltage impressed upon the input of said tubes, and movement of the control potentiometer will cause the motor to turn in one direction or the other, thus adjusting the local potentiometer to re-balance the alternating-current network.
5. In a remote control system, as for actuating the elements of a radio receiver; a reversible motor; two relays for controlling the current to said motor to cause it to run in one direction or the other, respectively; an electrically balanced alternating-current network including two potentiometers one of which is mechanically connected to said motor and the other of which is located at a remote point and operable to unbalance said network and thereby cause an alternating-current voltage to be impressed across the output of said network; and a pair of thermionic tubes having a common input circuit coupled to the output of said network and having separate output circuits, each output circuit comprising the energizing coil of one of said direction controlling relays and an alternating-current voltage supply, the voltage in each circuit being 180° out of phase, whereby the relays are selectively responsive to the phase of the voltage impressed upon the input of said tubes, thereby determining the direction of rotation of the motor.
6. In a remote control system, a reversible drive mechanism, an electrically balanced alternating current bridge network, a source of alternating current of fixed voltage connected as an input circuit across one pair of conjugate points of said network, an output circuit connected across the other pair of conjugate points of said network, said last-mentioned points being adjustable to vary the output voltage, control means for adjusting one of said points and thereby disturbing the balance of said network to cause an alternating current to flow in said output circuit, and control means independent of said drive mechanism responsive to the magnitude of said current for setting said mechanism in operation and including selective relay means for discriminating between the phase of the current in said output circuit relative to the current in said input circuit for determining the direction of operation of said mechanism.
7. A remote control system in accordance with claim 6, in which the reversible drive includes a separate power source.

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45	120
50	125
55	130
60	135
65	140
70	145
75	150