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SERVOMOTOR CONTROL SYSTEM MOVED WITH SELECTOR DEVICE

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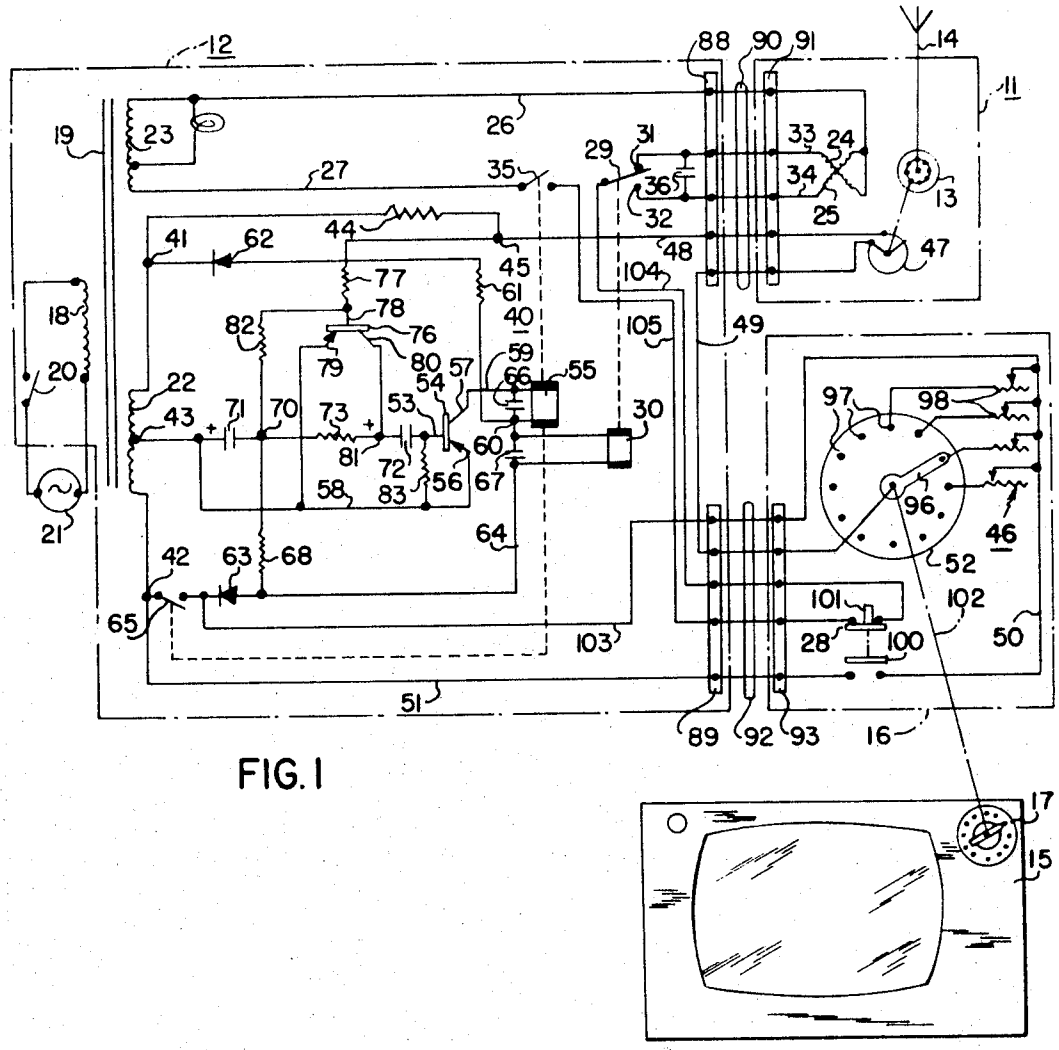


FIG. 1

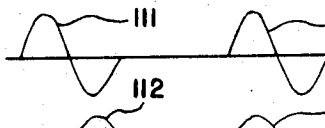


FIG. 2

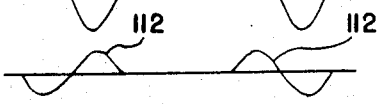


FIG. 3

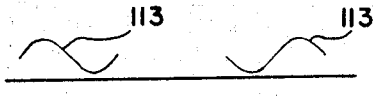


FIG. 4

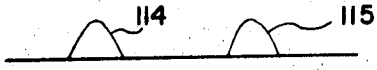


FIG. 5

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SERVOMOTOR CONTROL SYSTEM MOVED WITH SELECTOR DEVICE

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ABSTRACT OF THE DISCLOSURE

The disclosure relates to a controllable servomotor in the form of an antenna rotator which is controlled directly with the selector device of a television receiver. As this selector device is moved to select a new channel, a multiple position switch selects a different one of a plurality of resistances. The selected resistance, if of a different value from that formerly in the circuit, will establish an unbalanced condition of a bridge and the output of the bridge selects bidirectional rotation of the antenna rotator. Rotation of the rotator drives a potentiometer to rebalance the bridge and turn off the entire system. The multiple position switch may be attached directly to the selector device for concurrent rotation.

The invention relates in general to servomotors and more particularly to servomotor control systems which may be used with a transducer having a selector device with plural positions and the plural positions automatically control the servomotor.

The servomotor control system of the invention may be utilized in an antenna rotator for use with radio device such as a television receiver to rotate the antenna to a selected direction in accordance with the selected position of the television channel selector device.

The invention may be incorporated in a servomotor control system for a transducer having a selector device with plural positions and including a balanceable circuit, a plurality of discrete lumped resistances of different values, means to select different ones of said discrete resistances upon movement of the selector device to different selector positions, means connecting the selected resistance in the balanceable circuit, means connecting the servomotor to be responsive to the output of the balanceable circuit for movement of the output of the servomotor and means connecting the output of the servomotor to effect rebalance of the balanceable circuit.

Controlled servomotors have been used for antenna rotators and many of these have incorporated a control knob to select the desired position of the television antenna. The control device is usually positioned near the television receiver and the actual servomotor or rotator device is positioned at the antenna which may be outside the dwelling. If a person changes a channel to receive a television broadcast from a direction different from that of the previous channel, then the user must know the direction of the various broadcast signals and change the knob of the antenna rotator control device to the new direction. This controls the servomotor to orient the antenna to the new direction. Often considerable repeated adjustments are necessary to achieve the desired direction for the clearest received picture and sound of the television broadcast.

Accordingly, an object of the invention is to eliminate the necessity for manual selection of the antenna rotator direction and to provide an automatic control of the antenna direction in accordance with the selected channel of the television broadcast.

Another object of the invention is to provide an antenna rotator with a control system which is wired directly into the television receiver to be controlled by the channel selector device of the receiver.

Another object of the invention is to provide a servomotor control system controlled by selected resistance means of different values which are selected in accordance with a selected condition of a transducer.

Another object of the invention is to provide an antenna rotator automatically controlled by the channel selector of a television receiver wherein the portion of the control device which is incorporated in the television receiver is very simple and economical to manufacture and to install and which may be connected to the remainder of the control system by only a minimum number of conductors.

Another object of the invention is to provide an antenna rotator control system in which the control system is capable of cooperating with the television receiver so that rotation of the channel selector switch of the receiver selects the proper orientation of the antenna for the particular channel upon operation of a release switch which releases the rotator from its preliminary position to its reoriented position.

Another object of the invention is to provide an antenna rotator control system wherein the control elements added to the television receiver are limited to an additional switch plate and adjustable resistor assembly together with a manually operable release switch plus connection through a five-wire terminal board, and wherein all other components may be added in a separate control box at any time, with all interconnections between the receiver and the control box being made with low voltage wiring.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

FIGURE 1 of the drawing illustrates an antenna rotator control system embodying the invention; and

FIGURES 2 through 5 show voltage and current conditions in the circuit of FIGURE 1.

FIGURE 1 illustrates a servomotor shown as an antenna rotator **11** and a control system **12** therefor. The antenna rotator **11** includes a motor **13** to rotate an antenna **14**. The antenna may be a directional antenna for use with a transducer or radio device shown as a television receiver **15**. The directional properties of the antenna **14** help the receiver **15** receive signals broadcast from different directions. A control assembly **16** may be mounted in the television receiver **15** to be controlled by the channel selector device **17** of the receiver **15**.

The control system **12** includes a primary **18** of a transformer **19** with this primary energizable from an alternating current source **21** through a manual switch **20**. The transformer **19** has a secondary **22** and another secondary **23**. The motor **13** in the antenna rotator **11** has motor windings **24** and **25** having one end connected by a conductor **26** to one end of the secondary **23**. The other end of this secondary is connected through a conductor **27**, relay contact **35**, manual switch contacts **28** and a single-pole double-throw switch **29** to either of the motor windings **24** or **25**. The switch **29** is controlled by a relay **30**

and the switch blade 29 has contacts 31 and 32. Contact 31 is connected by a conductor 33 to motor winding 24 and contact 32 is connected by a conductor 34 to motor winding 25. A capacitor 36 is connected across the conductors 33 and 34 to provide reversible energization and rotation to the motor 13. With contacts 35 closed and the switch 29 in the position shown, motor winding 24 obtains direct energization and motor winding 25 is energized with a leading current through capacitor 36. This provides a certain direction of rotation, for example, clockwise. With the relay 30 energized and the switch 29 engaging contact 32, this will provide direct energization to motor winding 25 and leading current energization through capacitor 36 to the winding 24 for the opposite direction of rotation.

The secondary 22 has end terminals 41 and 42 and a mid tap 43. The secondary 22 energizes a bridge or balanceable circuit 40. This bridge 40 has two legs established by the upper and lower halves of the secondary 22. A third leg is provided by a first impedance 44 shown as a resistor. The bridge 40 has a first output terminal 45, and the second output terminal is the mid tap 43. Resistance means 46 is provided in the control assembly 16 and a potentiometer 47 is provided in the rotator 11. The resistance means 46 and potentiometer 47 are connected in series by conductors 48, 49, 50, 51 and a multiple position switch 52 to form the fourth leg of this bridge 40.

The bridge 40 has the output at terminals 45 and 43 and the phase of this output controls the rotational direction of the motor 13 in the rotator unit 11. The output from the bridge 40 is applied through an amplifier 54, which in this case is illustrated as being a transistor 54. This transistor 54 has an output to a relay 55 and to the aforementioned relay 30. Relay 55 controls the aforementioned relay contacts 35. The transistor 54 has a base 53, an emitter 56 and a collector 57. The emitter 56 is connected by a conductor 58 to the mid tap 43. The collector 57 is connected by a conductor 59 to the relay coil 55 and the other end of this relay coil 55 is connected through a terminal 60, an optional voltage dropping resistor 61 and a diode 62 to the terminal 41. Current may also flow from terminal 60 through the relay 30 and a conductor 64 and a diode 63 to the terminal 42 through contacts 65 actuated by the relay 55. A filter capacitor 66 is connected across the relay coil 55 and a filter capacitor 67 is connected across the relay coil 30.

A filter resistor 68 is connected between the anode of diode 63 and a terminal 70. A filter capacitor 71 is connected between the terminal 70 and the mid tap 43. When the relay contacts 65 are closed, this provides a direct current source voltage across the filter capacitor 71 which is positive at the mid tap 43. This is used as an operating voltage for the transistor amplifier 54.

The amplifier 54 will operate the system but in order to increase the sensitivity, a transistor preamplifier 76 may be provided. The transistor 76 is provided with a load resistor 73 which is connected in series with a coupling capacitor 72 to the base 53 of transistor 54 and the other end of resistor 73 is connected to the terminal 70. The transistor 76 has a base 78 connected through a current limiting resistor 77 to the bridge output terminal 45. The transistor 76 has an emitter 79 connected to the mid tap 43 and has a collector 80 connected to a terminal 81 at the junction of resistor 73 and capacitor 72. A biasing resistor 82 is connected between the direct current source negative terminal 70 and the base 78 of the transistor 76. This biases the base 78 slightly negatively for a partial conduction as the normal state of transistor 76. This will establish a normal small current flow through the emitter and collector of transistor 76. This will be the load current which will flow through the load resistor 73 making terminal 81 slightly positive as a normal condition. A self-bias resistor 83 is connected between the base and emitter of the transistor 54.

The control system 12 has terminal strips 88 and 89. Each of these has five terminals to provide external connection to other units in the entire system. The terminal strip 88 may be connected by a five-conductor cable 90 to corresponding terminals on a terminal strip 91 located at the rotator unit 11. Also the terminal strip 89 may be connected by a five-conductor cable 92 to corresponding terminals on a terminal strip 93 in the control assembly 16. Means are provided to fasten this terminal strip 93 on the television receiver 15, for example, on the rear cover of this receiver.

The five-conductor cables 90 and 92 may be low voltage cables and the voltage of the secondaries 22 and 23 may be low votlage, for example, 24 to 28 volts. This provides ease and simplicity of interconnecting the units 11, 12 and 16.

The multiple position switch 52 has a movable blade 96 which may selectively contact a plurality of terminals 97 of this multiple position switch. The resistance means 46 includes a plurality of rheostats 98 connected between the individual contacts 97 and the conductor 50, only a few of which are shown. The conductor 50 is connected through manual switch contacts 100 to the conductor 51. A pushbutton 101 simultaneously actuates the manual switches 28 and 100 with the switch contacts 28 being normally closed and the switch contacts 100 being normally open. The pushbotton 101 is a release switch and is preferably spring return so that it is only momentarily actuated and then returns to the position shown.

The multiple position switch 52 is connected by a connection 102 to the channel selector device 17 in the reciver 15. Thus as a new frequency or a new channel is selected, the movable blade 96 is moved directly in accordance with this channel selector.

A conductor 103 is connected between the cathode of diode 63 and the first terminal on terminal strip 89. The first terminal on terminal strip 93 is connected by conductor 50 through the manual switch contacts 100 to the fifth terminal on this terminal strip 93. The conductor 49 is connected to the second terminal on terminal strips 89. A conductor 104 connects the relay contacts 29 to the third terminal on terminal strip 89. A conductor 105 connects relay contacts 35 to the fourth terminal on this terminal strip 89 and conductor 51 is connected to the fifth terminal on this terminal strip 89.

In most television receivers the VHF channel selector is a 12 position device to select the 12 channels, 2 through 13. These positions are established by a detent for definite positions of the selector device 17. For use with such a VHF channel selector the multiple position switch 52 would be a 12 position switch, as shown in FIGURE 1. On current UHF receivers there is usually a continuous tuning device without detents for the 60 UHF channels, however, it is the practice of the Federal Communication Commission to make certain that there is in a given geographical area a separation of at least six channels between broadcasting stations, for example, Youngstown, Ohio, calls for channels 21, 27 and 33. Accordingly a a multiple position switch with ten contacts thereon could be connected to be moved in accordance with the UHF tuner or channel selector device in the receiver 15. Each of these contacts of the multiple position switch would then be connected to individual rheostats or other separate resistances in the resistance means 46. By this means the multiple position switch 52 will select a separate resistance value for each different cotnact position of the multiple position switch 52. If any two channels have the same desired antenna orientation, then these contacts of the multiple position switch 52 may be paralleled into one rheostat 98 to thus eliminate some fo the rheostats.

The multiple position switch 52 may be a wafer switch which may be built into the channel selector device 17 or which may be attached coaxially to the shaft of this tuner. In many tuners the shaft extends rearwardly beyond the rearmost bearing for this shaft, and accordingly

the multiple position switch **52** may be mounted on this tuner so that the movable blade **96** is actuated with this tuner shaft. Alternatively the control assembly **16** may be built into the television receiver **15** by the television set manufacturer. In this case the manual pushbutton **101** will be exposed to the user at some convenient place on the television set. In this case the television set is provided only with the terminal strip **93**, the multiple position switch **52** and the resistance means **46** as a bank of rheostats. Then if the television set user desires to add an antenna rotator **11** and a control system **12**, these may be purchased later and easily interconnected to complete the entire system.

OPERATION

The antenna rotator **11**, the control system **12** and the control assembly **16** may be interconnected as shown in FIG. 1. The closing of the manual switch **20** will energize the transformer **19** and the secondaries **22** and **23**. The bridge **40** of the amplifiers **54** and **76** are not energized, however, because the relay contacts **65** are open. The manual switch contacts **100** are connected across these relay contacts **65** and they also are open. Let it be assumed that the antenna **14** is oriented toward the northeast and that this is the proper orientation for channel 3 which is selected by the channel selector device **17** of the receiver **15**. Now if the channel selector **17** is moved to a new channel, for example, channel 4, then this might be Pittsburgh, Pa., and the antenna should be oriented toward the southeast. The movement of the channel selector **17** moves the movable blade **96** and selects a different one of the rheostats **98**. If this is of a different resistance value from that of the previously selected rheostat, this will unbalance the bridge **40**. To start the antenna rotator unit **11** to have it move to the new desired orientation, the manual momentary contact pushbutton **101** is actuated. This momentarily closes the contacts **100**. This closing energizes the bridge **40** and the transistors **54** and **76** which are the amplifiers connected to the output terminals **43** and **45** of the bridge **40**.

Assume that the rheostat now selected has a lower resistance value than the former rheostat. This decrease of resistance in the leg **46–47** of the bridge **40** will shift the phase of the output voltage **43–45** so that it is in phase with the bridge input voltage **43–42**. The decrease of impedance is illustrated by the voltage and current conditions on the left half of FIGURES 2 through 5. The input voltage is illustrated by a curve **111** in FIGURE 2. The bridge output voltage is now out of phase with the input voltage and the bridge output voltage **112** is illustrated in the left half of FIGURE 3. When the input terminal **41** is negative, the bridge output terminal **45** will be positive. This applies a positive voltage on the base **78** of transistor **76** to decrease the normal current therethrough. This decreases the voltage across the load resistor **73** and this is a positive voltage at terminal **81**. This current through transistor **76** is illustrated by a curve **113** in the left half of FIGURE 4. This decreasing positive voltage is a negative going voltage which is passed by the coupling capacitor **72** to the base **53** of transistor **54** to turn on this transistor. Accordingly transistor **54** has the opposite sense to transistor **76** and a turn off of transistor **76** turns on transistor **54**. A curve **114** in the left half of FIGURE 5 illustrates the pulse of current through transistor **54**. This flows from the emitter to the collector thereof and through relay **55**. All this is during the negative half cycle of the input voltage when terminal **42** is positive. Accordingly current flow through the relay **55** may not go through the diode **63** to the terminal **42** because it is positive at that time. Instead it goes through diode **62** to terminal **41**, which is negative. The current flow through relay **55** closes the contacts **65** thereof and these contacts are in parallel with the manual switch contacts **100**. Closure of these contacts accordingly maintains the bridge circuit **40** and amplifiers **54** and **76** energized. This will take place in about $\frac{1}{10}$ of a second and accordingly at any time thereafter the manual pushbutton **101** may be released without change in the circuit condition. It will be noted that relay **30** is not energized under these conditions, accordingly relay contacts **29** remain in the position shown. Energization of relay **55** also closes contacts **35**.

Release of the pushbutton **101** recloses the normally closed contacts **28** thereof. This provides a circuit for energization of the motor **13** from secondary **23** through the now closed contacts **35**. In this example it will be assumed that the direct energization of motor winding **24** and leading current energization of motor winding **25** provides clockwise rotation to the motor **13** and the antenna **14** and potentiometer **47**. This drives the antenna toward the desired orientation and drives the potentiometer toward increased impedance. At some value of resistance the potentiometer **47** will have increased to a value sufficient to compensate for the reduced resistance of the selected rheostat **98** to thus rebalance the bridge **40**. Upon rebalance the output voltage at terminals **43** and **45** will drop to a sufficiently low value or a null voltage which will cause the relay **55** to drop out. This opens the contacts **65** and de-energizes the bridge **40** and the amplifiers **54** and **76**. It also opens contacts **35** and stops the rotator **11**.

If the channel selector **17** is moved to a new location requiring a different antenna orientation, for example a counterclockwise rotation of the antenna, then the rheostat **98** connected to this contact of the multiple position switch **52** will call for an increased impedance. The conditions of this increased impedance are illustrated in the right half of the FIGURES 2 through 5. In order to achieve this desired reorientation of the antenna, the push button **101** is depressed thus connecting into the bridge circuit the new value of resistance of the newly selected rheostat **98**. The increased impedance in the leg **46–47** of the bridge **40** shifts the phase of the output voltage **43–45** to be in phase with the input voltage **43–41**. The input voltage **111** is illustrated in FIGURE 2 and the bridge output voltage **112** on the right half of FIGURE 3 is illustrated as being in phase therewith. This means that terminal **45** is positive relative to terminal **43** at the time that terminal **41** is positive relative to terminal **42**. During the positive half cycles of the input voltage the terminal **45** is positive tending to turn off the transistor **76** and to turn on the transistor **54**. The right half of FIGURE 4 illustrates the current **113** through transistor **76** and the right half of FIGURE 5 illustrates a curve **115** of the current through transistor **54** which will be during the positive half cycle. This transistor current flow will flow through relay **55** but it can not flow through diode **62** to terminal **41** because this terminal is positive on this half cycle. Instead it flows through the relay **30** and diode **63** to terminal **42**, which is negative. Initially this current flow is through conductors **103** and **50**, switch contacts **100** and conductor **51**. Upon energization of the relay **55**, the contacts **65** thereof will be closed to shunt the connection through the manual contacts **100**. This energization of the relays **55** and **30** will take place within $\frac{1}{10}$ of a second and at any time thereafter the pushbutton **101** may be released to open the contacts **100** without change of circuit condition. The relay **30**, having been energized, moves the contacts **29** thereof to engage contact **32**. This provides reverse energization through the now closed relay contact **35** to the motor **13**, in this example, a counterclockwise rotation. This drives the antenna **14** toward the new orientation and drives the potentiometer **47** toward a decreased resistance. The decreasing impedance of potentiometer **47** will eventually reach a balance condition for the bridge **40** at which point the relays **30** and **55** will drop out, this de-energizing the bridge **40**, amplifiers **54** and **76**, and rotator **11**.

The relay contacts **65** parallel the manual switch contacts **100** to maintain the bridge **40** energized after the

momentary contacts **100** are opened. Whenever the bridge **40** returns to a balanced condition, the relay **55** drops out opening contacts **65** and **35**. Opening of contacts **65** de-energizes the bridge **40** and amplifiers **54** and **76**. Also it terminates any output from the bridge **40** and terminates any output from the amplifier **54**. Opening of contacts **35** terminates energization of the motor **13**.

The capacitor **66** may be made of smaller capacity than that of capacitor **67** in order to provide a shorter time constant. This will assure that relay **55** will be the first to pull in and the first to drop out of the two relays. This will provide all circuit make and break functions on the contacts **35** and **65** thus permitting contacts **29** to be light duty contacts for economy. Also, it makes certain that the direction of motor rotation has been established before current flows through relay contacts **29**. This means that there will not be any false direction of motor rotation at the start up of the rotator unit **11** and thus the motor **13** will not be called upon to accelerate in one direction and then immediately be reversed. Also, it means that with relay **30** being the last to drop out, there will not be any last minute reversal of rotation of motor **13** as the bridge **40** is de-energized.

The pushbutton switch **101** is provided to eliminate needles starting of rotation of the motor **13**. For example, if channel 3 and channel 8 are both assigned to Cleveland, Ohio, then in switching from channel 3 to channel 8, it would not be desired to initiate rotation of the rotator and hence pushbutton **101** would not be actuated. Also, channels 3 and 8 may be paralleled to the same rheostat **98** to eliminate one rheostat. If the push button **101** and its functions were eliminated, then the rotator would still operate the same way but the rotator would hunt back and forth as the channel selector device **17** passed through channels 4, 5, 6 and 7, which might be active channels assigned to other television broadcasting stations in the geographic area of the receiver **15**.

The resistance means **46** are discrete lumped resistances of different values which are selected in accordance with different selected positions of the selector device **17** and are selectively inserted into the bridge **40**.

Selection of a rheostat **98** of a value less than the previously selected rheostat unbalances the bridge **40** in a first direction to cause conduction of the amplifier **54** on negative half cycles and selected energization of the relay means **55** and causes rotation of the rotator motor **13** in one direction. Selection of a rheostat **98** of a value greater than the previously selected rheostat unbalances the bridge **40** in a second direction to cause conduction of the transistor amplifier **54** on positive half cycles to cause selected energization of the relay means **55** and **30** and causes rotation of the rotator motor **13** in a second direction. In either case the potentiometer **47** is driven in a direction to effect rebalance of the bridge **40** which thus shuts off the bridge and terminates motor rotation.

The voltage input terminals **41** and **42** together with the diodes **62** and **63** provide first and second power supply means connected to alternating current source means which are each conductive only on opposite half cycles of the source voltage. When the bridge is unbalanced in one direction, this causes conduction of the amplifier through one of the first and second power supply means, depending upon the direction of bridge unbalance.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of the circuit and the combination and arrangement of circuit elements may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A servomotor control system for a transducer having a selector device with plural positions comprising, in combination, a balanceable circuit having an output,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistance means of different values connected to different ones of said switch contacts,

said multiple position switch adapted to be mounted to have said movable switch member moved with the selector device of the transducer to select different resistance means upon movement of said selector device to different selector positions,

means connecting said multiple position switch and a selected resistance means in said balanceable circuit,

a manual start pushbutton switch having normally open contacts,

means to energize said balanceable circuit through said normally open contacts,

means responsive to the output of said balanceable circuit to establish a connection across said manual switch normally open contacts,

means connecting said servomotor to be responsive to the output of said balanceable circuit for movement of the output of said servomotor,

and means connecting the output of said servomotor to effect rebalance of said balanceable circuit.

2. An antenna rotator control system for a radio receiver having a frequency selector device comprising, in combination, a balanceable bridge having an output,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistance means of different values connected to different ones of said switch contacts,

said multiple position switch adapted to be mounted on the frequency selector device of the radio receiver to have said movable switch member moved with said selector device to select different resistance means upon movement of said selector device to different frequency selector positions,

means connecting said multiple position switch and a selected resistance means in said bridge,

a manual start pushbutton switch having normally open contacts,

means to energize said bridge through said normally open contacts,

means responsive to the output of said bridge to establish a connection across said manual switch normally open contacts,

means connecting said rotator to be responsive to the output of said bridge for rotation of the output of said rotator,

and means connecting the output of said rotator to effect rebalance of said bridge.

3. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable bridge having an output,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistance means of different values connected to different ones of said switch contacts,

said multiple position switch adapted to be mounted on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different resistance means upon movement of said channel selector device to different channel selector positions,

means connecting said multiple position switch and a selected resistance means in said bridge,

a manual start pushbutton switch having normally open and normally closed contacts,

means to energize said bridge through said normally open contacts,

means responsive to the output of said bridge to establish a connection across said manual switch normally open contacts,

means connecting said rotator through said manual switch normally closed contacts to be responsive to the output of said bridge for selective bi-directional rotation of the output of said rotator,

and means connecting the output of said rotator to effect rebalance of said bridge.

4. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable alternating current bridge having an output,

potentiometer means in said bridge,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistors of different value each connected to a different one of said switch contacts.

said multiple position switch adapted to be mounted coaxially on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said resistors upon movement of said channel selector device to different channel selector positions,

means connecting said multiple position switch and a selected resistor in said bridge,

a manual start pushbutton switch having normally open and normally closed contacts,

means to energize said bridge from alternating current source means through said normally open contacts,

means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup.

means responsive to the output of said bridge to establish a connection across said manual switch normally open contacts,

means connecting said rotator through said manual switch normally closed contacts to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,

whereby movement of the channel selector device and selection of a resistor of a value less than the previously selected resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,

and whereby movement of the channel selector device and selection of a resistor of a value greater than the previously selected resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

5. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable alternating current bridge having an output,

potentiometer means in said bridge,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of variable resistors each connected to a different one of said switch contacts,

said multiple position switch adapted to be mounted coaxially on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,

means connecting said multiple position switch and a selected resistor in said bridge,

a manual start pushbutton switch having normally open and normally closed contacts,

means to energize said bridge from alternating current source means through said normally open contacts,

means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,

relay means having normally open contacts,

means connecting said contacts of said relay means across said manual switch normally open contacts,

means connecting said relay means to the output of said bridge to be energized upon output therefrom,

means connecting said rotator through said manual switch normally closed contacts to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,

whereby movement of the channel selector device and selection of a variable resistor of a value less than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,

and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

6. An antenna rotator control system for a radio receiver having a frequency selector device comprising, in combination, a balanceable circuit having an output,

a terminal strip having first through fifth terminals,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistance means of different values connected to said first terminal on said terminal strip and to different ones of said switch contacts,

means connecting said movable switch member to said second terminal,

said multiple position switch adapted to be mounted on the frequency selector device of the radio receiver to have said movable switch member moved with said selector device to select different values of said resistance means upon movement of said selector device to different frequency selector positions,

means connecting said first and second terminals in said balanceable circuit,

means establishing a connection across said first and fifth terminals to energize said balanceable circuit,

switch means,

means connecting said switch means across said third and fourth terminals to be momentarily opened upon initial energization of said balanceable circuit,

means connecting the output of said balanceable circuit to establish a connection across said first and fifth terminals to maintain energization to said balanceable circuit,

means connecting said rotator through said third and fourth terminals to be responsive to the output of said balanceable circuit for rotation of the output of said rotator,

and means connecting the output of said rotator to effect rebalance of said balanceable circuit.

7. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable bridge having an output,

a terminal strip having first through fifth terminals,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of resistance means of different values each connected to said first terminal on said terminal strip and to a different one of said switch contacts.

means connecting said movable switch member to said second terminal,

said multiple position switch adapted to be mounted on the channel selector device of the television receiver to have said movable switch member moved

with said channel selector device to select different ones of said resistance means upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having normally open and normally closed contacts,
means connecting said normally closed contacts to said third and fourth terminals,
means connecting said normally open contacts to said first and fifth terminals,
means to energize said bridge through said first and fifth terminals,
relay means having normally open contacts,
means connnecting said contacts of said relay means across said first and fifth terminals,
means connecting said relay means to the output of said bridge to be energized upon output therefrom,
means connecting said rotator through said third and fourth terminals to be rsponsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,
and means connecting the output of said rotator to effect rebalance of said bridge.

8. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable alternating current bridge having an output,
potentiometer means in said bridge,
a terminal strip having first, second and third terminals,
a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,
a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,
means connecting said movable switch member to said second terminal,
said multiple position switch adapted to be mounted on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having normally open contacts,
means connecting said normally open contacts to said first and third terminals,
means to energize said bridge from alternating current source means through said first and third terminals,
means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup.
relay means having normally open contacts,
means connecting said contacts of said relay means across said first and third terminals,
means connecting said relay means to the output of said bridge to be energized upon output therefrom,
means connecting said rotator to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,
whereby movement of the channel selector device and selection of a variable resistor of a value less than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,
and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

9. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable alternating current bridge having an output,
potentiometer means in said bridge,
a terminal strip having first through fourth terminals,
a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,
a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,
means connecting said movable switch member to said second terminal,
said multiple position switch adapted to be mounted on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having normally closed contacts,
means connecting said normally closed contacts to said third and fourth terminals,
means to energize said bridge from alternating current source means,
means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,
means connecting said rotator through said third and fourth terminals to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator.
whereby movement of the channel selector device and selection of a variable resistor of a value less than the previously selected variable resistor unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,
and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

10. An antenna rotator control system for a television receiver having a channel selector device comprising, in combination, a balanceable bridge having an output,
potentiometer means in said bridge,
a terminal strip having first through fifth terminals,
a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,
a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,
means connecting said movable switch member to said second terminal,
said multiple position switch adapted to be mounted coaxially on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having normally open and normally closed contacts,
means connecting said normally closed contacts to said third and fourth terminals,

means connecting said normally open contacts to said first and fifth terminals,
means to energize said bridge through said first and fifth terminals,
means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,
relay means having normally open contacts,
means connecting said contacts of said relay means across said first and fifth terminals,
means connecting said relay means to the output of said bridge to be energized upon output therefrom,
means connecting said rotator through said third and fourth terminals to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,
whereby movement of the channel selector device and selection of a variable resistor of a value less than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,
and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

11. A wired-in-set followup control system for an antenna rotator having a reversible output comprising, in combination, a balanceable alternating current bridge having an output,
potentiometer means in said bridge,
a terminal strip having first through fifth terminals,
a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,
a purality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,
means connecting said movable switch member to said second terminal,
said multiple position switch adapted to be mounted coaxially on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having normally open and normally closed contacts,
means connecting said normally closed contacts to said third and fourth terminals,
means connecting said normally open contacts to said first and fifth terminals,
means to energize said bridge from alternating current source means through said first and fifth terminals,
means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,
relay means having normally open contacts,
means connecting said contacts of said relay means across said first and fifth terminals,
means connecting said relay means to the output of said bridge to be energized upon output therefrom,
means connecting said rotator through said third and fourth terminals to be responsive to the output of said bridge for selective bidirectional rotation of the output of said rotator,
whereby movement of the channel selector device and selection of a variable resistor of a value less than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,
and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

12. A wired-in-set followup control system for an antenna rotator having a reversible output comprising, in combination, a balanceable alternating current bridge having an output,
potentiometer means in said bridge,
a terminal strip having first through fifth terminals,
a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,
a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,
means connecting said movable switch member to said second terminal,
said multiple position switch adapted to be mounted coaxially on the channel selector device of the television receiver to have said movable switch member moved with said channel selector device to select different ones of said variable resistors upon movement of said channel selector device to different channel selector positions,
means connecting said first and second terminals in said bridge,
a manual start pushbutton switch having a normally open and a normally closed contact,
means connecting said normally closed contact to said third and fourth terminals,
means connecting said normally open contact to said first and fifth terminals.
means to energize said bridge from alternating current source means through said first and fifth terminals,
a transistor amplifier,
means connecting the output of said bridge to the input of said amplifier,
means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,
relay means having normally open contacts,
means connecting said contacts of said relay means across said first and fifth terminals,
means connecting said relay means to the output of said amplifier to be energized upon output therefrom,
means connecting said rotator through said third and fourth terminals to be responsible to the output of said amplifier for selective bidirectional rotation of the output of said rotator,
whereby movement of the channel selector device and selection of a variable resistor of a value less than previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,
and whereby movement of the channel selector device and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said manual switch unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

13. A wired-in-set followup control system for an antenna rotator having a reversible output comprising, in combination, a balanceable alternating current bridge having an output,
means to energize said bridge from alternating current source means,
potentiometer means in said bridge,
a terminal strip having first and second terminals,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,

means connecting said movable switch member to said second terminal,

said multiple position switch adapted to be mounted coaxially on the channel selector switch of the television receiver to have said movable switch member moved with said selector switch to select different ones of said variable resistors upon movement of said selector switch to different channel positions,

means connecting said first and second terminals in said bridge,

a transistor amplifier,

means connecting the output of said bridge to the input of said amplifier,

means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,

means connecting said rotator to be responsive to the output of said amplifier,

whereby movement of the channel selector switch and selection of a variable resistor of a value less than the previously selected variable resistor unbalances said bridge output in a first direction and causes rotation of the output of said rotator in one direction,

and whereby movement of the channel selector switch and selection of a variable resistor of a value greater than the previously selected variable resistor unbalances said bridge output in a second direction and causes rotation of the output of said rotator in a second direction.

14. A wired-in-set followup control system for an antenna rotator having a reversible output comprising, in combination, a balanceable alternating current bridge having an output,

means to energize said bridge from alternating current source means,

potentiometer means in said bridge,

a terminal strip having first and second terminals,

a multiple position swtich having a plurality of contacts selectively contacted by a movable switch member,

a plurality of variable resistors each connected to said first terminal on said terminal strip and to different one of said switch contacts,

means connecting said movable switch member to said second terminal,

said multiple position switch adapted to be mounted coaxially on the channel selector switch of the television receiver to have said movable switch member moved with said selector switch to select different ones of said variable resistors upon movement of said selector switch to different channel selector positions,

means connecting said first and second terminals in said bridge,

first and second power supply means connected to said alternating current source means,

one of said power supply means being conductive only on half cycles of said alternating current source voltage,

a transistor amplifier,

means connecting the output of said bridge to the input of said amplifier,

means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,

means connecting said rotator to be responsive to the output of said amplifier on first and second half cycles of the alternating current source voltage for selective bidirectional rotation of the output of said rotator,

means connecting the output of said amplifier to said first power supply means whereby movement of the channel selector switch and selection of a variable resistor of a value less than the previously selected variable resistor unbalances said bridge output in a first direction to cause conduction of said amplifier on a first one of first and second half cycles of the alternating current source voltage and causes rotation of the output of said rotator in one direction,

and means connecting the output of said amplifier to said second power supply means whereby movement of the channel selector switch and selection of a variable resistor of a value greater than the previously selected variable resistor unbalances said bridge output in a second direction to cause conduction of said amplifier on a second one of first and second half cycles of the alternating current source voltage and causes rotation of the output of said rotator in a second direction.

15. A wired-in-set followup control system for an antenna rotator having a reversible output comprising, in combination, a balanceable alternating current bridge having an output,

potentiometer means in said bridge,

a terminal strip having first through fifth terminals,

a multiple position switch having a plurality of contacts selectively contacted by a movable switch member,

a plurality of variable resistors each connected to said first terminal on said terminal strip and to a different one of said switch contacts,

means connecting said movable switch member to said second terminal,

said multiple position switch adapted to be mounted coaxially on the channel selector switch of the television receiver to have said movable switch member moved with said selector switch to select different ones of said variable resistors upon movement of said selector switch to different channel selector positions,

means connecting said first and second terminals in said bridge,

a manual start pushbutton switch having normally open and normally closed contacts,

means connecting said normally closed contacts to said third and fourth terminals,

means connecting said normally open contacts to said first and fifth terminals,

means to energize said bridge from alternating current source means through said first and fifth terminals,

first and second power supply means connected to said alternating current source means,

one of said power supply means being conductive only on half cycles of said alternating current source voltage,

a transistor amplifier,

means connecting the output of said bridge to the input of said amplifier,

means connecting said potentiometer means to be moved in accordance with movement of the output of said rotator as a followup,

means connecting said rotator through said third and fourth terminals to be responsive to the output of said amplifier on first and second half cycles of the alternating current source voltage for selective bidirectional rotation of the output of said rotator,

relay means having normally open contacts,

means connecting said contacts of said relay means across said first and fifth terminals,

means connecting said relay means to the output of said amplifier to be energized upon output therefrom,

means connecting the output of said amplifier to said first power supply means whereby movement of the channel selector switch and selection of a variable

resistor of a value less than the previously selected variable resistor and actuation of said push button switch unbalances said bridge output in a first direction to cause conduction of said amplifier on a first one of first and second half cycles of the alternating current source voltage and causes rotation of the output of said rotator in one direction,

and means connecting the output of said amplifier to said second power supply means whereby movement of the channel selector switch and selection of a variable resistor of a value greater than the previously selected variable resistor and actuation of said push-button switch unbalances said bridge output in a second direction to cause conduction of said amplifier on a second one of the first and second half cycles of the alternating current source voltage and causes

rotation of the output of said rotator in a second direction.

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