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SERVOMOTOR SYSTEM FOR REMOTE CONTROL

Ralph C. Blauvelt, Willoughby, Ohio, assignor to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio

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The present invention is directed to an improved rotation control system and is primarily directed to an electrical indexing system for controlling the operation of motor operated devices.

The system of the present invention finds particular utility in control systems for orienting television antennae. The proper positioning of the television receiving antenna with respect to the transmitting antenna is, of course, desirable to secure the maximum signal strength at the input to the television receiver. While there have been other antenna orienting systems used in the past, none to my knowledge has proven to be completely satisfactory. Those systems which employ stepping relays are not completely satisfactory because the antenna in those systems is capable of adjustment only in rather large annular increments, so that it is impossible to adjust the position of the antenna precisely for maximum signal input.

In more elaborate installation, various servo mechanisms such as selsyns have been employed to secure a continuous adjustability of the television antenna. The inherently small torque of a selsyn system, and its high cost are factors which limit the usefulness of such systems in ordinary home installations.

Accordingly, an object of the present invention is to provide a control device for a motor operated system which is capable of operating smoothly and continuously.

Still another object of the invention is to provide an improved rotation control system in conjunction with an electric motor to provide for indexing the rotation of the motor in response to a simple control.

A further object of the invention is to provide an improved rotation control system which is particularly adaptable to control the positioning of a television antenna to thereby secure maximum signal input to the television receiver.

The control circuit of the present invention makes use of a Wheatstone bridge arrangement including a potentiometer which is mechanically coupled to and operated by rotation of a motor, and a control potentiometer which is manipulated at will by the operator. The particular motor employed is a phase sensitive motor whose direction of rotation is dependent upon the phase conditions existing in its energizing coils. The remainder of the bridge circuit consists of a pair of relay coils, which selectively actuate an armature into positions in which the armature connects a phase changing network into one or the other of the energizing coils of the motor, thereby changing the phase relationships and controlling the direction of rotation of the motor.

A further description of the present invention will be made in connection with the attached drawing which illustrates a preferred embodiment thereof.

In the drawing, the single figure is a circuit diagram, illustrating somewhat schematically the operation of the rotation control circuit of the present invention as it is applied to a system for controlling a television antenna rotator.

As shown in the drawing:

The system shown in the figure of the drawing may be divided into two separate components, a control system 10 located near the television receiver, and a rotator 11 electrically connected to the control system 10, but spatially remote from the control unit 10 as, for example, adjacent the television antenna itself.

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Starting with the control unit 10, a pair of power leads 12 and 13 energize a pair of primary windings 14 and 16 of transformers 17 and 20 respectively, provided that a normally closed thermally sensitive switch 18 remains closed. The function of the switch 18 is purely a safety device in order to provide for opening up the input to the transformers in the event that a failure occurs which would tend to cause the primary windings 14 and 16 to draw an excessive amount of current.

A switch 19 is also provided to initiate operation of the circuit, as closing the switch 19 initially energizes the transformers 17 and 20, whereupon a holding relay maintains the circuits energized even after release of the momentary contact switch 19.

The primary 14 is coupled to a secondary 21 having fewer turns than the primary 14, resulting in a step-down in the voltage. The secondary 21 is connected to the adjustable arm 24 of a control potentiometer 23, and an indicator lamp 26 is included across a portion of the secondary 21 to indicate when the secondary is energized.

The control potentiometer 23 represents one leg of a Wheatstone bridge circuit which also includes a pair of relay coils 27 and 28 on opposed legs of the bridge circuit. The fourth element in the bridge circuit is a potentiometer 29 having its movable contact 31 mechanically coupled to and driven by the rotation of the motor which drives the television antenna. A pair of current limiting resistors 33 and 34 are included in series with the potentiometer 29 and complete the bridge circuit with the control potentiometer 23, and the relay coils 27 and 28.

The coils 27 and 28 may contain an identical number of turns so that the strength of magnetic fields established at each of the coils will be directly dependent upon the current flow through each coil. The coils 27 and 28 are arranged to act upon an armature 37 which, in effect, provides a single pole, double throw switch whose relative position is dependent upon the respective current flow through the coils 27 and 28. When the current flow through these two coils is equal, the armature 37 is in a neutral position as indicated in the figure of the drawing. If, however, the current in coil 27 exceeds the current in coil 28 due to an unbalance in the bridge circuit, the armature 37 will be moved into a position where it establishes electrical contact with an upper contact 39. Conversely, if the current in coil 28 exceeds that in coil 27, the armature 37 will establish electrical contact with a lower contact 41. Operation of the armature 37 in either direction is effective to introduce a phasing network into the electrical system, thereby modifying operation of the driving motor.

The motor employed as the drive motor for the television antenna may be any of a variety of reversible, phase sensitive motors such as an induction motor of the split phase type. Such motors may, for example, include a pair of windings 43 and 44 arranged such that when the current flow through one winding leads the current flowing through the other winding, the rotor will rotate one direction, and in the opposite direction when the current in the second winding leads that of the first winding. The rotor is mechanically coupled both to the contact arm 31 of the potentiometer 29 and to the support rod 46 of a television antenna 47.

The phase difference between the windings is provided essentially by a capacitor 53 appearing across the windings 43 and 44.

The motor windings 43 and 44 are energized from a secondary 51 on the transformer 20. Thus, in one position of the armature 37, where it is in contact with the contact 41, the winding 44 is fed in phase with the secondary 51. At the same time, however, the winding 43 has applied to it an alternating voltage appearing across the series combination of the capacitor 53 and the secondary

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51, so that the current in the winding 43 is out of phase with the current in the winding 44 and the motor will rotate in one direction.

At the other condition, when the armature 37 is in electrical contact with the contact 39, the winding 43 is fed in phase with the secondary 51, and the winding 44 carries the current which is out of phase with the current in the winding 43. Under these conditions, the motor will rotate in the opposite direction.

It is desirable to avoid the possibility of the system "hunting" as might occur if the relay armature 37 exhibited a low contact pressure when the bridge circuit was near balance, thereby making the relay subject to vibration and electrical disturbances. Accordingly, a time delay circuit is included to keep the transformer windings energized for a short, controllable period of time after the bridge circuit approaches the condition of balance. For this purpose, the circuit includes a rectifier 49 and a hold-out relay 54 having an energizing coil 56 across which the capacitor 48 is located. The relay 54 controls the operation of a switch arm 57 which is in parallel with the switch 19 and serves to energize the primaries 14 and 16 of the transformers 17 and 20 after release of the switch 19.

The operation of the device is substantially as follows. Let us assume that the operator wishes to change the orientation of the antenna 47 in conjunction with changing the turning of his television set to receive a different channel. From previous experience, the operator knows the setting on the control potentiometer 23 which will result in a maximum signal for each television channel. He then positions the contact arm 24 accordingly while pressing the switch 19 closed. The latter operation serves to energize the primaries 14 and 16. Under the conditions indicated, there will be an unbalance in the Wheatstone bridge circuit including the potentiometer 23, the coils 27 and 28, and the motor operated potentiometer 29. Hence, the current flow through the coils 27 and 28 will be unequal and the relay armature 37 will be attracted to either the contact 39 or 41, depending upon which of the coils 27 and 28 is carrying the greater current. If the armature 37 engages the contact 39, a voltage is immediately established across the relay coil 56, thereby closing the switch arm 57 and applying power to the transformers as long as the coil 56 is energized. The switch 19 can then be released without affecting the energization of the circuits.

In the condition assumed, the secondary 51 of the transformer 20 is connected across the winding 43, and the winding 44 is energized by a voltage appearing across the combination of the capacitor 53 and the secondary 51. The induction motor is thereby energized with a phase difference in its energizing field windings with the result that it will rotate in one direction. Continued rotation of the motor, of course, moves the contact arm 31 of the potentiometer 29 in a direction which would minimize the unbalance in the bridge circuit. As the circuit approaches the condition of balance, the relay armature 37 may be disengaged from the contact 39, the motor is deenergized, and the energizing voltage on the coil 56 is removed. However, because of the charge accumulated on the capacitor 48, the contact arm 57 will not open until a short time interval after this occurs, and a current will still flow through the transformer windings, and hence through the bridge circuit. Normally, the capacitor 48 will be of sufficient size, when considering the resistance of the energizing coil 56 to provide a time delay of approximately one-quarter second. After this delay, the contact arm 57 opens and the entire device is disconnected from the power line. When this occurs, the pilot light 26 is extinguished. In this condition, manipulating the control potentiometer 23 has no effect upon energizing the circuit until the switch 19 is depressed.

It will be appreciated that the reverse rotation of the motor is accomplished in identically the same manner, 75

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except that the motor windings are phased oppositely from the condition described.

From the foregoing, it will be apparent that the rotation control system of the present invention is quite simple, but highly effective to control the indexing of elements driven by phase sensitive motors. The system is quite economical to manufacture and install, and is accurate to a considerably greater degree than many similar systems presently being employed. With the system of the invention for example, it is possible to "fine tune" the position of the rotor, which is impossible in many mechanical or electrical systems designed for the same ultimate purpose.

It will be evident that various modifications can be made to the described embodiments without departing from the scope of the present invention.

I claim as my invention:

1. A rotation control system comprising a phase sensitive motor, a first potentiometer operated by said motor, a second potentiometer and a pair of relays including a pair of relay coils, both said potentiometers and said pair of relay coils being combined into a bridge circuit, means for applying a potential across opposed branches of said bridge circuit, each of said relays being selectively operable by unbalance in said bridge circuit, a switch controlling application of said potential, a phase shifting circuit actuated by an unbalance in said bridge circuit and connected by operation of said relays to said motor to drive said motor in one or the other direction of rotation, and a time delay means in parallel with said switch arranged to maintain current flow in said bridge circuit for a predetermined short interval after deenergization of said relays.

2. A rotation control system comprising a phase sensitive motor, a first potentiometer mechanically coupled to said motor, a second potentiometer electrically connected to said first potentiometer but spatially remote therefrom, a pair of relays including a pair of relay coils, both said potentiometers and said pair of relay coils being combined into a bridge circuit, means for applying a potential across opposed branches of said bridge circuit, each of said relays being selectively operable by unbalance in said bridge circuit, a switch controlling application of said potential, a phase shifting circuit actuated by an unbalance in said bridge circuit and connected by operation of said relays to said motor to drive said motor in one or the other of direction of rotation, and a time delay means in parallel with said switch arranged to maintain current flow in said bridge circuit for a predetermined short interval after deenergization of said relays.

3. A rotation control system comprising a phase sensitive motor, a first potentiometer operated by said motor, a second potentiometer and a pair of relays including a pair of relay coils, both said potentiometers and said pair of relay coils being combined into a bridge circuit, means for applying a potential across opposed branches of said bridge circuit, each of said relays being selectively operable by unbalance in said bridge circuit, a switch controlling application of said potential, a phase shifting circuit actuated by an unbalance in said bridge circuit and connected by operation of said relays to said motor to drive said motor in one or the other direction of rotation, and a time delay means including a holding relay and a capacitor connected in parallel with said switch arranged to maintain current flow in said bridge circuit for a predetermined short interval after deenergization of said relays.

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