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ROTATION CONTROL SYSTEM

Ralph C. Blauvelt, Willoughby, and Thomas J. Eppele, Cleveland, Ohio, assignors to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio

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The present invention is directed to an improved rotation system and is particularly adapted to control systems employed for positioning a television antenna and the like.

For maximum input signal to the television receiver, it is necessary that the television antenna be oriented in a direction such that the antenna intercepts the maximum field strength of the transmitting station at the particular locality of the antenna. In order to accomplish this objective, numerous rotation control systems have been devised for actuating the orientation of the television antenna at the control of the operator. Some of the systems make use of resistance networks and the like by means of which the antenna can be selectively positioned in any one of thirteen positions, the thirteen positions corresponding to the thirteen television channels presently being employed. Such systems, however, are not completely satisfactory because there is frequently no provision for “fine tuning” of the control system in order to produce the sharpest possible image on the television screen.

Other systems make use of rather elaborate and expensive electrical indexing devices which are normally too high priced for the ordinary television owner.

The need still remains, therefore, for a rotation control system particularly adapted to television antenna control which is inexpensive and which functions effectively over a wide range and which is capable of “fine tuning”. The satisfaction of that need is the principal object of the present invention.

Another object of the invention is to provide an improved rotation control system with excellent regulating characteristics.

Another object of the invention is to provide an inexpensive antenna rotation control system having the characteristics mentioned above.

In any antenna rotation control system, it is desirable that the system turn itself off automatically after the antenna has been oriented to the pre-selected position by the control system. Heretofore, it was considered necessary to employ two transformers in such system or an expensive transformer having good voltage regulating characteristics, in order to provide the proper voltage regulation because the removal of the load from the system when the indexing of the antenna was complete frequently caused a substantial increase in the voltage at the secondary winding of the main power transformer. This frequently caused an unintentional unbalance to be created in the control system. In the rotation control system of the present invention, however, only a single inexpensive transformer is employed which cuts down the cost substantially while actually improving the performance characteristics.

In the rotation control system of the present invention, there is employed a balancing circuit including a pair of potentiometers and a pair of relay coils in parallel connected networks. One of the potentiometers is mechanically coupled or otherwise driven by the object whose rotation is to be controlled, in the illustrated example, the mast of the antenna structure. The second potentiometer is selectively operable by the operator at the television set to introduce an error signal into the balancing circuit and thereby initiate operation of the motor control unit.

The system of the invention also includes a differential relay assembly whose pair of coils makes up the other two elements of the balancing circuit. The relay is so arranged that when a balance condition exists in the balancing circuit, equal voltages are applied in phase with each other to the separate windings of a split phase motor or the like. Thus, when the balance condition is achieved in the balancing circuit, a positive braking force is applied to the motor shaft to prevent hunting. At the same time, in the balanced condition, operation of the differential relay causes the energizing circuit for the rotation control circuit to be de-energized, preferably after a suitable time delay, while the load of the motor windings is still across the energizing transformer.

Other objects and advantages of the present invention will be apparent to those skilled in the art from the following description of the attached sheet of drawings which represents a somewhat schematic circuit diagram of the rotation control system as applied to the control of a television antenna.

As shown on the drawings:

The reference numeral 10 indicates generally a power transformer having a core 11, a primary winding 12 and a secondary winding 13. The winding 12 is connected by means of a pair of conductors 14 and 16 to a suitable source of alternating current potential (not shown). An energizing switch 17, when closed, permits application of the energizing voltage across the primary winding. The switch 17 is of a type which is spring biased into its normally open position, so that it has to be held down to complete the circuit. After initial energization of the circuit, the circuit remains energized even after release of the switch 17 by the action of a holding contact 18 of a primary relay assembly 20 which will be described in a succeeding portion of this description.

The secondary of the transformer 10 also includes a winding 19 which energizes an indicating light 21 which indicates when the transformer 10 is energized.

The secondary winding 13 is used to energize the bridge circuit and to supply energization to the motor unit which drives the antenna mast. One end of the secondary winding 13 is grounded through a normally closed thermal switch 22 and a conductor 23. The switch 22 is a safety device which opens the secondary of the circuit if the motor drive unit tends to become overloaded with an excessive amount of current.

A potentiometer 24 is preferably located on the control unit with the television receiver. The potentiometer 24 forms one element of a resistance bridge including a current limiting resistor 26 and a rheostat 27 having a contact arm 28 connected to one end of the potentiometer 24. By selecting proper values of resistance for the rheostat 27, the full scale movement of the potentiometer 24 will correspond to a 360 degree movement of the antenna mast.

A contact arm 29 associated with the potentiometer 24 is connected by means of a conductor 31 to a center spring arm 32 constituting the armature of a differential relay assembly. The spring arm 32 is composed of a magnetic material such as steel or is attached to a magnetic armature and has a pair of contacts 32a and 32b on opposite sides thereof. In the quiescent or balanced condition of the relay, the contacts 32a and 32b engage contacts 33a and 34a, respectively, on spring arms 33 and 34. The latter are both composed of a non-magnetic material such as a copper alloy.

The movement of the spring arm 32 is governed by the current flow through a pair of coils 36 and 37. When the current in the coil 36 exceeds the current in
the coil 37, the spring arm 32 is urged upwardly to break the contact between contacts 32b and 34c while maintaining contact between contacts 32a and 33a. When the current in coil 37 exceeds that in coil 36, the spring arm 32 is attracted downwardly to break the circuit between contacts 32a and 33a, while maintaining the circuit between contacts 32b and 34c.

The opposite ends of the relay coils 36 and 37 are connected to terminals 39 and 41, respectively. A terminal 42 is provided as a grounding terminal for the assembly. The spring arm 33 is connected by means of a conductor 43 to a terminal 44 while the spring arm 34 is connected to the opposite end of a conductor 47. The elements mentioned thus far are all preferably included in a compact control box associated with a television receiver. The terminals 39, 41, 42, 44 and 47 are connected by means of a suitable conductor cable to a motor control unit located in proximity to an antenna mast 51 of an antenna structure 52. Motive power for the antenna mast 51 is supplied by means of a phase sensitive motor 53, preferably of the split phase type, and including a pair of separate energizing windings 54 and 56. The windings 54 and 56 are center tapped by means of a conductor 57 which is at ground potential when the input to the motor control unit, designated at 39, 41, 42, 44 and 47, are connected to the respective terminals on the control box.

The motor shaft of the motor 53 is mechanically coupled or otherwise driven by a potentiometer 57 and a shunt resistance 58 is connected in parallel with the potentiometer 57, if necessary. A pair of current limiting resistors 59 and 61 are also included to limit the amount of current drawn by the motor control circuit.

The motor 53 is selectively driven in a given direction by changing the phase relationships between the voltage impressed on the windings 54 and 56. In order to accomplish this objective, the control circuit of the present invention also includes a capacitor 62 which is in series with a coil 63 of the primary relay 20 which operates the hold-in contact 18 previously described.

Thus, when the spring arm 32 is attracted away from its balanced condition in one direction, the presence of the capacitor 62 in the circuit causes a difference in phase between the voltages applied at the winding 54 and the winding 56, so that the motor 53 will rotate in one direction. Similarly, if the spring arm 32 is attracted in the opposite direction, the phase relationships will be reversed and the motor 53 will rotate in the opposite direction.

The potentiometer 24, the relay coils 36 and 37 and the potentiometer 57 thus form the four elements of a balancing circuit. An unbalance in the circuit created by operation of the potentiometer 24 thereby sets up a current unbalance in the relay coils 36 and 37 thereby displacing the spring arm 32 and completing the circuit to the motor 53 whereby the motor is driven in a given direction. The rotation of the motor simultaneously adjusts the potentiometer 57 into a condition which tends to neutralize the unbalance in the balancing circuit and bring it back to the condition illustrated in the drawings, where the motor contacts 32a and 32b engage their respective contacts on spring arms 33 and 34.

In this condition, the voltage applied across the coils 54 and 56 of the motor are equal and in phase so that an effective braking force is applied to the rotor of the motor. This, in effect, provides a short across the primary relay coil 63 and the holding contact 18 of the primary relay to drop out and de-energize the transformer 10. At the time of drop out, the load of the motor windings 54 and 56 is still across the secondary 13, so that no sudden voltage rise across the secondary 13 occurs.

In most cases, it is desirable to introduce some measure of time delay between the time that the balancing circuit reaches its balanced condition and the drop-out of the relay contact 18. This can be done, for example, by employing a dash pot or similar time delay mechanism in the operation of the primary relay contact 18.

The operation of the circuit will be evident from the foregoing discussion, but will be briefly summarized here. Assuming that the operator wishes to change the orientation of the antenna from its previous position, he presses down the switch 17 and commences the adjustment of the potentiometer 24 to a pre-selected point at which, from previous experience, he knows the maximum signal strength will be achieved for a certain television channel. As the potentiometer 24 is adjusted, it will create an unbalance in the balancing circuit so that either the coil 36 or the coil 37 will be drawing more current than the other coil of the differential relay system. Assuming that the coil 36 draws more current, the unbalance will cause the spring arm 32 to bear upwardly, and to break the circuit between contacts 32b and 34c.

When this happens, the voltage appearing at the terminal 44 will be out of phase with respect to the voltage appearing at the terminal 47, since the latter is impressed across the capacitor 62. Thus, there is a phase difference produced across the windings 54 and 56 of the motor and the motor will rotate in a direction which tends to correct the phase difference by a simultaneous variation in the potentiometer 57. At the balanced condition, the current flow through the coils 36 and 37 will be equalized, and the spring arm 32 will have both its contacts engaging the contacts 33a and 34a. This action effectively shuts out the capacitor 62, so that the voltages applied across the coils 54 and 56 are substantially equal and in phase. When this occurs, the rotation of the motor 53 is effectively stopped with a definite braking action.

All the time that only one of the contacts on the spring arm is engaging a contact, the relay coil 63 of the primary relay is energized and operates the hold-out contact 18 so that the switch 17 can be released. When the balanced condition is reached, however, the relay coil 63, like the capacitor 62, is shorted out. After a predetermined time interval, depending upon the characteristics of the time delay mechanism employed, the relay contact 18 opens up, thereby completely de-energizing the control circuit. During the time interval between the attainment of the balanced condition and the drop-out of the relay contact 18, the operator is able to make any fine adjustments of position which he desires.

With the system described, the regulation problem previously associated with circuits of this type has been substantially eliminated because the load is maintained on the transformer until the primary power is removed. Thus, instead of the transformer voltage rising as it did previously when the motor load was removed, the voltage actually drops slightly and thereby aids in causing de-energization of the circuit.

Furthermore, the arrangement is such that when the primary relay coil 63 and the capacitor 62 are shorted out, the relay coil 63 serves to limit the capacitor discharge current through the relay contacts, thereby increasing the effective life of the contacts.

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

We claim as our invention:
1. A rotation control system comprising a phase sensitive motor having a plurality of separate windings, a first potentiometer operated by said motor, a second potentiometer, a differential relay assembly including a pair of coils, said potentiometers and said relay coils being connected as parallel connected networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable contacts of said potentiometers, an armature in said relay assembly actuated in response to differences in current flow in said
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coils, and a reactance selectively connected to one of said windings in said motor by operation of said armature to thereby cause said motor to rotate in one direction.

2. A rotation control system comprising a phase sensitive motor having a plurality of separate windings, a first potentiometer connected to said motor, a second potentiometer, a differential relay assembly including a pair of coils, said potentiometers and said relay coils being connected in parallel networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable arms of said potentiometers, a pair of spaced contacts in said relay assembly, an armature whose movement is controlled by the current flow in said pair of coils, said armature selectively engaging only one of said pair of contacts when the currents in said networks are unbalanced, and engaging both said contacts when said currents are balanced, a reactance selectively connected to one of said windings in said motor when said armature engages only one of said contacts and means for introducing a phase difference into one of said windings to thereby cause said motor to rotate in one direction, and means operable after said networks reach a balanced condition to de-energize said rotation control system.

3. A rotation control system comprising a phase sensitive motor having a plurality of separate windings, a first potentiometer operated by said motor, a second potentiometer, a differential relay assembly including a pair of coils, said potentiometers and said relay coils being connected in parallel networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable arms of said potentiometers, a pair of spaced contacts in said relay assembly, an armature whose movement is controlled by the current flow in said pair of coils, said armature selectively engaging only one of said pair of contacts when the currents in said networks are unbalanced and engaging both said contacts when said currents are balanced, a reactance selectively connected to one of said windings in said motor when only one of said contacts is engaged by said armature to thereby introduce a phase difference in said winding and cause said motor to rotate in one direction, switch means operable after the currents in said networks reach a balanced condition to de-energize said rotation control system, and a time delay means associated with said switch means to delay de-energization of said system for a short time interval after said balanced condition is reached.

4. An antenna rotation control system comprising a split phase motor arranged to drive an antenna mast, a first potentiometer actuated by said motor, a second potentiometer remote from said first potentiometer, a differential relay assembly including a pair of relay coils, means connecting said potentiometers and said relay coils in parallel networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable arms of said potentiometers, an armature in said differential relay assembly actuated by a difference in currents in said networks, a pair of contacts associated with said armature, said armature engaging only one of said contacts when said currents are unequal, and both of said contacts when said currents are equal, a primary relay coil energized when one only of said contacts is engaged by said armature, a capacitor in series with said primary relay coil, and arranged to introduce an out of phase current into one of the windings in said split phase motor when only one of said contacts is engaged by said armature, and switch means actuated by said primary relay coil to de-energize said control system after said primary relay coil is de-energized.

5. An antenna rotation control system comprising a split phase motor arranged to drive an antenna mast, a first potentiometer actuated by said motor, a second potentiometer remote from said first potentiometer, a differential relay assembly including a pair of relay coils, means connecting said potentiometers and said relay coils in parallel networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable arms of said potentiometers, an armature in said differential relay assembly, a pair of contacts in said differential relay assembly selectively engageable by said armature when the currents in said networks are unbalanced, said armature engaging both said contacts when said currents are balanced, a transformer having a primary and a secondary winding, means connecting said secondary winding across opposed ends of said networks, a primary relay coil energized when said armature engages only one of said contacts and deenergized when said armature engages both said contacts, a capacitor in series with said primary relay coil and arranged to introduce an out of phase current into one of the windings of said split phase motor when said armature engages only one of said contacts, and switch means in said primary winding of said transformer actuated by said primary relay coil to de-energize said transformer when said primary coil is de-energized.

6. An antenna rotation control system comprising a split phase motor arranged to drive an antenna mast, a first potentiometer actuated by said motor, a second potentiometer remote from said first potentiometer, a differential relay assembly including a pair of relay coils, means connecting said potentiometers and said relay coils in parallel networks, each network comprising one relay coil and one potentiometer, means for applying a potential between the variable arms of said potentiometers, an armature in said differential relay assembly, a pair of contacts in said differential relay assembly selectively engageable by said armature when the currents in said bridge circuit are unbalanced, said armature engaging both said contacts when said currents are balanced, a transformer having a primary and a secondary winding, means connecting said secondary winding across opposed ends of said bridge circuit, a primary relay coil connected across said contacts and energized when said armature engages one of said contacts, a capacitor in series with said primary relay coil and arranged to introduce an out of phase current into one of the windings of said split phase motor when said armature engages only one of said contacts, switch means in said primary windings of said transformer actuated by said primary relay coil to de-energize said transformer when said primary coil is de-energized, and a time delay means associated with said switch means to delay actuation of said switch means for a short interval after de-energization of said primary relay coil.

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