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ELECTRICAL CONTROL CIRCUIT FOR DOOR OPERATOR

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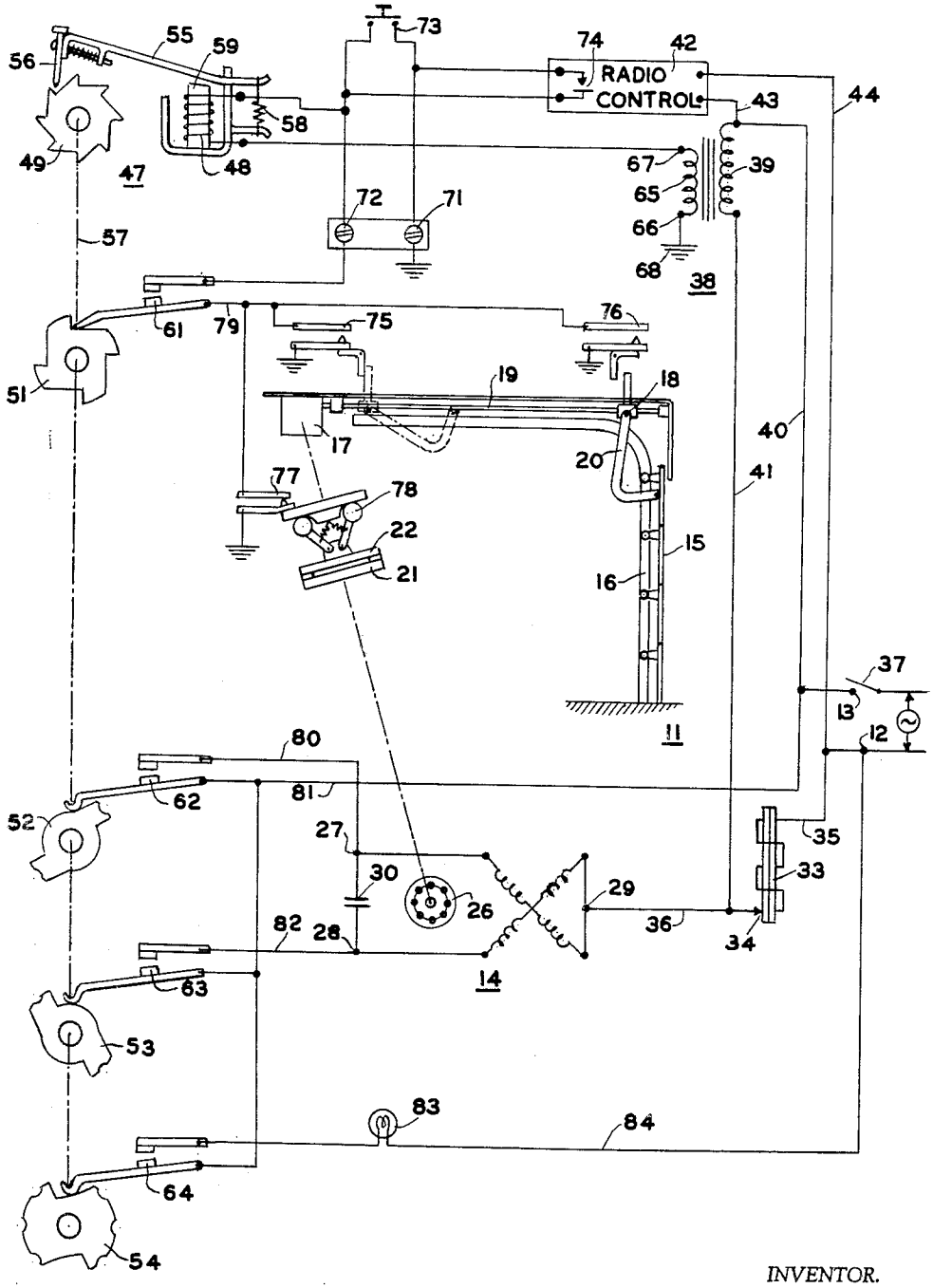

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ELECTRICAL CONTROL CIRCUIT FOR DOOR OPERATOR

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The invention relates in general to electrical control circuits and more particularly to control circuits for door operator controls such as the overhead type of garage door wherein an electric motor or other drive means moves the door between open and closed positions.

Door operator controls have been known in the prior art wherein some form of linkage interconnects an electric motor so that the door, generally of an overhead type especially in recent years, may be moved upwardly to an open position or downwardly to a closed position. Many of these prior art door operators have been expensive to manufacture and install and many have been unreliable in operation, not being responsive to the many possible conditions which may affect the safe operation of the door and the control circuit.

Accordingly, an object of the invention is to provide a safe, simple, and reliable door operator control.

Another object of the invention is to provide a door operator and control which is economical to manufacture and install, is safe and reliable in operation, and which does not get out of order or get in an inoperative condition.

Another object of the invention is to provide a door operator control circuit which has two alternative conditions, in one of which one switch is operative and in another of which the same switch plus one or more other switches is operative.

Another object of the invention is to provide a door operator control circuit wherein one or a plurality of switches are alternatively rendered operative and inoperative in controlling the door control circuit.

Another object of the invention is to provide a relay in a control circuit which sets up two alternative conditions, a first of which renders a switch operative and a second of which renders the same switch inoperative.

Other objects and a fuller understanding of this invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which the single figure illustrates schematically and diagrammatically a door operator control circuit embodying the invention.

The drawing illustrates a door operator control circuit 11 operable from first and second voltage source terminals 12 and 13 to selectively energize a motor 14 to open and close a door 15. The door 15 has been shown for purposes of illustration only as an overhead type of garage door, in this case a sectional door, but it could just as well be a non-sectional door. The door 15 moves on a track 16 and is shown in the down limit or closed position. A suitable speed reducing drive mechanism 17 reciprocates a carriage 18 on a track 19 and the carriage is connected by a link 20 to the door 15. The drive mechanism 17 is driven from the motor or drive means 14 through a friction clutch which includes a drive member 21 and a driven member 22. The motor 14 and drive mechanism 17 are capable of being reversed so as to run the door 15 in open and closed directions, and in this case the motor 14 has been shown as being reversible to effect this door reversing function. The motor 14 is shown as a reversible capacitor motor having a rotor 26, forward and reverse energization terminals 27 and 28, and a common energization terminal 29. A capacitor 30 is connected across the terminals 27 and 28 to aid in this reversing function.

The motor 14 includes a thermal protector 33 having contacts 34. Conductors 35 and 36 connect the common energization terminal 29 through the thermal protector 33 and its contact 34 to the voltage source terminal 12.

The voltage source terminal 13 is adapted to be energized upon closing a main on-off switch 37. A step-down transformer 38 has a primary 39 which is connected through conductors 40 and 41 and the thermal protector 33 to the voltage source terminals 12 and 13. A radio control device 42 has an input connected by conductors 43 and 44 to the voltage source terminals 12 and 13.

A relay mechanism 47 includes generally a relay coil 48, an index cam 49, and first, second, third, and fourth cams 51 through 54. The relay mechanism 47 also includes an armature 55 which may move downwardly when the relay coil 48 is energized so that a hammer 56 on the armature 55 indexes the index cam 49 by one unit upon each energization of the relay coil 48. In the embodiment shown this unit of indexing is one-eighth of a revolution and linkage means 57 such as a rotating shaft links together all the cams so that the first through fourth cams 51 through 54 are also indexed by one-eighth of a revolution. A spring 58 urges the armature 55 away from the core 59 on which the coil 48 is mounted. The first through fourth cams 51 through 54 control respectively first through fourth relay contacts 61 through 64.

The transformer 38 has a low voltage secondary 65 with first and second terminals 66 and 67, respectively. The first terminal 66 is connected to ground 68. First and second control terminals 71 and 72 are provided in the control circuit 11 with this first control terminal 71 connected to ground and with the relay coil 48 connected between the second control terminal 72 and the second secondary terminal 67. A normally open manual push button switch 73 is connected across the first and second control terminals 71 and 72. The radio control device 42 has normally open contacts 74 which are connected across the control terminals 71 and 72 and the radio control device 42 is adapted to close these contacts upon receiving a radio impulse in any well-known manner.

The door 15 may be protected by several safety control devices including a normally open momentary contact up travel limit switch 75 responsive only to upward door motion. A normally open momentary contact down travel limit switch 76 responsive only to downward door motion may optionally be provided and, since the drawing shows the door 15 in the closed position, this down travel limit switch 76 has previously been momentarily actuated to the closed position, but is now in the open position. A normally closed torque switch 77 is connected in the linkage mechanism between the friction clutch 21—22 and the door 15 so that it is responsive to the movement of the driven member 22 and, accordingly, responsive to the movement of the door 15. In the drawing the torque switch 77 is shown as actuated by a form of centrifugal mechanism 78 connected to the driven member 22. Since the drawing shows the door 15 in the closed and at rest condition the torque switch 77 has been shown as being in the normally closed position. At any suitable speed of the driven member 22, for example, at about half the operational speed, the centrifugal mechanism 78 is designed to overcome the force of the springs or other urging means therein to actuate the torque switch 77 to the open condition. Each of the limit switches 75 and 76 and the torque switch 77 are connected in parallel between ground and a conductor 79 which is connected through the first relay contact 61 to the second control terminal 72.

The first motor energization terminal 27 is connected

by conductors 80 and 81 and the second relay contact 62 to the second voltage source terminal 13. The second motor energization terminal 28 is connected by means of a conductor 82, the second relay contact 63, and conductor 81 to the second voltage source terminal 13. A lamp 83 is connected in circuit between the first and second voltage source terminals 12 and 13 by a conductor 84, conductor 81, and the fourth relay contact 64.

The first cam 51 of the relay 47 controls the first relay contact alternatively closed and open with this contact 61 being shown in the open position with the door 15 closed and at rest. The second relay cam 52 has a first position whereat the corresponding relay contact 62 is open; a second position whereat the contact 62 is closed; and the third and fourth succeeding positions at which the relay contact 62 is open. The cam 52 is double sided so that the same four positions are duplicated for the remaining four positions of the eight position index cam 49. The third relay cam 53 is similar in shape to the relay cam 52 but is phased differently so that the first, second, and third positions of this relay cam establish the corresponding contact 63 in the open position and the fourth position of this cam 53 establishes the contact 63 in the closed position. The fourth relay cam 54 has a first position establishing the corresponding contact 64 in the open position and the second, third, and fourth positions of the cam 54 establish the contact 64 closed. This cam 54 is again double sided to duplicate the first through fourth positions on the remaining half of the cam.

Operation

The door operator control circuit 11 has two general conditions, either a door stationary condition or a door moving condition. In the first of these, only the switch means connected across the control terminals 71 and 72 are effective to control the control circuit 11. In the second condition; namely, the door moving condition, any of the five switches 73, 74, 75, 76, or 77 is effective to control the control circuit 11. The switch means at the control terminals 71 and 72 are shown as being two in number; namely, the manual push button 73 or its counterpart, the radio control contacts 74. In many installations a radio transmitter in the automobile to be housed in the garage is controlled by a manual switch within the automobile, whereupon the transmitter emits a signal picked up by the radio control device 42 to close the contacts 74. Thus, the radio control contacts 74 are manually controllable just as is the manual push button 73.

More specifically the drawing shows the control circuit 11 as having four conditions, (1) the door closed condition, (2) the door opening condition, (3) the door open conditon, and (4) the door closing condition. Assuming that the main on-off switch 37 is closed, the transformer 38 is energized as is the radio control device 42. When the push button 73 is depressed, this closes the circuit between the control terminals 71 and 72 and this closing of the circuit could also be effected by closing the radio control contacts 74. This energizes the relay coil 48 to move the armature 55 and hence indexes the index cam 49 and all the cams 51 through 54 by one position. This establishes a door moving condition and more specifically a door opening condition. The contacts 61, 62, and 64 are closed with contact 63 open. The push button switch 73 need be only momentarily depressed just enough to energize the relay for the indexing function. With the contact 62 closed, energization for forward rotation of the motor 14 is accomplished, starting the motor, and this opens the torque switch 77 at about half speed. As the door 15 starts to move, the carriage 18 does not actuate the down travel limit switch 76 because of the one-way trip mechanism. In normal operation the door 15 continues its upward or opening travel until the up travel limit switch 75 is momentarily actuated by the carriage 18. This provides an energization circuit for the relay coil 48, and the relay 47 again indexes to the second position of the cams 51 through 54. This second position opens the relay contacts 61 and 62 so that only contact 64 is closed. This maintains the lamp 83 energized for illumination within the garage. With contact 62 open, the motor 14 stops and this closes the torque switch 77. Because the relay contact 61 is open, none of the switches 75, 76, or 77 are effective to control the control circuit 11. When next the push button switch 73 is closed or the radio control contacts 74 are closed, this energizes the relay 47 for another indexing. The relay cams thence move to the fourth position whereat contacts 61, 63, and 64 are closed and contact 62 is open. This provides energization to the reverse energization terminal 28 to drive the motor in the reverse direction and thus close the door 15. This is another door moving condition in which all five of the switches 73 through 77 are effective to control the control circuit 11. If the optional down travel limit switch 76 is used, then as the door reaches its closed position, this limit switch 76 will be actuated to momentarily energize the relay 47 and index it to the first position in the drawing. If this down travel limit switch is not provided, then the door 15 bottoms on the floor, stalling the door, and stalling the linkage mechanism which stalls the driven member 22. This causes the centrifugal mechanism to close the torque switch 77 which momentarily energizes the relay winding 48 to index the cam to the fourth position shown in the drawing.

The torque switch 77 is always available during the door moving condition should the door strike an obstruction to stop or slow the door 15. The transformer 38 is energized through the thermal protector 33 so that, if the motor should become overheated through abuse or for any reason, energization from the source terminals 12 and 13 cannot be applied to the transformer 38 independently of the motor 14 and thus this prevents the relay 47 from getting out of synchronization with the motor energization condition.

The above description shows that two general conditions occur in the motor control circuit 11, in the first of which switch means across the control terminals 71 and 72 are solely effective to control a circuit 11 and in the second of which switches 75, 76, and 77 are additionally effective. This circuit therefore provides a door operator control which is safe and reliable, one which will not get out of synchronization and one which is responsive to all conditions which may affect the door 15.

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 the scope of the invention as hereinafter claimed.

What is claimed is:

1. A control system for drive means connected through a friction clutch to operate a door in opening and closing directions, said system comprising in combination, a normally closed torque switch connected to be actuated by the driven member of said friction clutch, first and second voltage source terminals, first and second control terminals, a normally open push button switch connected between said first and second control terminals, a relay having a winding, means connecting said relay winding for energization from said source terminals through said control terminals, first and second conditions of said relay, first and second relay contacts on said relay, means connecting said first relay contact in series with said torque switch between said first and second control terminals, energization terminals on said drive means, means connecting said energization terminals for energization from said source terminals through said second relay contact, a first condition of said relay establishing both said relay contacts open and coinciding with the door stationary condition, and a second condition of said relay

establishing both said relay contacts closed and effecting a door moving condition, whereby in said first condition of said relay only switch means at said first and second control terminals are effective to control said relay and whereby in said second condition of said relay both said switches are effective to control said relay.

2. A control system for a door and having an electric motor connected through a friction clutch to operate the door in opening and closing directions, said system comprising in combination, a normally closed torque switch connected to be actuated by the driven member of said friction clutch, a normally open travel limit switch connected to be actuated by said door near a travel limit thereof, first and second voltage source terminals adapted to be connected to a voltage source, first and second control terminals, a normally open push button switch connected between said first and second control terminals, a relay mechanism having a winding, means connecting said relay winding for energization from said source terminals through said control terminals, first and second conditions of said relay mechanism, first and second relay contacts on said relay mechanism, means connecting said first relay contact in series with said travel limit switch between said first and second control terminals, means connecting said torque switch in parallel with said travel limit switch, energization terminals on said motor, means connecting said motor energization terminals for energization from said source terminals through said second relay contact, a first condition of said relay mechanism establishing both said relay contacts open and coinciding with the door stationary condition, and a second condition of said relay mechanism establishing both said relay contacts closed and effecting a door moving condition, whereby in said first condition of said relay mechanism only switch means at said first and second control terminals are effective to control said relay mechanism and whereby in said second condition of said relay mechanism all three said switches are effective to control said relay mechanism.

3. A control system for a door and having an electric motor and linkage mechanism including a friction clutch connecting the motor and the door to operate the door in opening and closing directions, said system comprising, in combination, a normally closed torque switch connected to be actuated by the driven member of said friction clutch, a normally open travel limit switch connected to be actuated by said door linkage mechanism near a travel limit thereof, first and second voltage source terminals adapted to be connected to a voltage source, first and second control terminals, a normally open push button switch connected between said first and second control terminals, a relay having a winding, means connecting said relay winding for energization from said source terminals through said control terminals, first and second cams, means to index said cams one position upon each energization of said relay, first and second relay contacts actuated respectively by said first and second cams, means connecting said first relay contact in series with said travel limit switch between said first and second control terminals, means connecting said torque switch in parallel with said travel limit switch, energization terminals on said motor, means connecting said motor energization terminals and said second relay contact in series to said source terminals, a first position of said cams establishing both said relay contacts open and coinciding with the door closed position, and a second position of said cams establishing both said relay contacts closed and effecting a door moving condition, whereby in said first position of said cams only switch means at said first and second control terminals are effective to control said relay and whereby in said second position of said cams all three said switches are effective to control said relay.

4. A control system for an electric motor connected through a friction clutch to operate a door in opening and closing directions, said system comprising, in combination, a normally closed torque switch connected to be actuated by the driven member of said friction clutch, a normally open travel limit switch connected to be actuated by said door near a travel limit thereof, first and second voltage source terminals adapted to be connected to a voltage source, a stepdown transformer having a secondary, conductors connecting the primary of said stepdown transformer to said voltage source terminals, first and second control terminals, a normally open push button switch connected between said first and second control terminals, a low voltage relay mechanism having a winding, conductors connecting said relay winding and said transformer secondary in series between said control terminals, first and second conditions of said relay mechanism, first and second relay contacts on said relay mechanism, means connecting said first relay contact in series with said travel limit switch between said first and second control terminals, means connecting said torque switch in parallel with said travel limit switch, energization terminals on said motor, means connecting said motor energization terminals and said second relay contact in series to said source terminals, a first condition of said relay mechanism coinciding with the door closed position and establishing both said relay contacts open, and a second condition of said relay mechanism establishing both said relay contacts closed and effecting a door moving condition, whereby in said first condition of said relay mechanism only switch means at said first and second control terminals are effective to control said relay mechanism and whereby in said second condition of said relay mechanism all three said switches are effective to control said relay mechanism.

5. A control system for an electric motor connected through a friction clutch to operate a door in opening and closing directions, said system comprising in combination, a normally closed torque switch connected to be actuated by the driven member of said friction clutch, a normally open travel limit switch connected to be actuated by said door near a travel limit thereof, first and second voltage source terminals adapted to be connected to a voltage source, a stepdown transformer having a secondary, conductors connecting the primary of said stepdown transformer to said voltage source terminals, first and second control terminals, a normally open push button switch connected between said first and second control terminals, a low voltage relay having a winding, conductors connecting said relay winding and said transformer secondary in series between said control terminals, first and second cams, means to index said cams one position upon each energization of said relay, first and second relay contacts actuated respectively by said first and second cams, means connecting said first relay contact in series with said travel limit switch between said first and second control terminals, means connecting said torque switch in parallel with said travel limit switch, energization terminals on said motor, means connecting said motor energization terminals and said second relay contact in series to said source terminals, a first position of said cams coinciding with the door closed position and establishing both said relay contacts open, and a second position of said cams effecting a door moving condition and establishing both said relay contacts closed, whereby in said first position of said cams only switch means at said first and second control terminals are effective to control said relay and whereby in said second position of said cams all three said switches are capable of controlling energization to said relay.

6. A control system for a reversible motor connected through a friction clutch to operate a door in opening and closing directions, said system comprising in combination, a normally closed torque switch connected to be actuated to open condition by rotation of the driven member of said friction clutch, a normally open travel limit switch connected to be actuated by said door near a

travel limit thereof, first and second voltage source terminals adapted to be connected to a voltage source, first and second control terminals, means connecting said first control terminal to ground, a normally open manual push button switch connected between said first and second control terminals, a relay having a winding, means connecting said relay winding for energization from said source terminals through said control terminals, a multiposition index cam, means to index said index cam one position upon each energization of said relay, first, second, and third cams directly connected for movement with said index cam, first, second, and third relay contacts actuated respectively by said first, second, and third cams, means connecting said first relay contact in series with said travel limit switch between said second control terminal and ground, means connecting said torque switch in parallel with said travel limit switch, forward and reverse energization terminals and a common energization terminal on said motor, means connecting said common energization terminal to said first voltage source terminal, means connecting said forward energization terminal through said second relay contact to said second source terminal, means to connect said reverse energization terminal through said third relay contact to said second

source terminal, a first position of said cams coinciding with the door closed position and establishing all said relay contacts open, a second position of said cams effecting a door opening condition and establishing said first and second relay contacts closed and said third relay contact open, a third position of said cams coinciding with a door open position and establishing all said relay contacts open, and a fourth position of said cams effecting a door closing condition and establishing said first and third relay contacts closed and said second relay contact open, whereby in said first and third positions of said cams only switch means at said first and second control terminals are effective to control said relay and whereby in said second and fourth positions of said cams all three said switches are capable of controlling energization to said relay.

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