Feb. 8, 1944. G. W. SPRENGER ET AL 2,341,297

CONDITION RESPONSIVE SYSTEM

Filed June 18, 1941

Fig. 1.

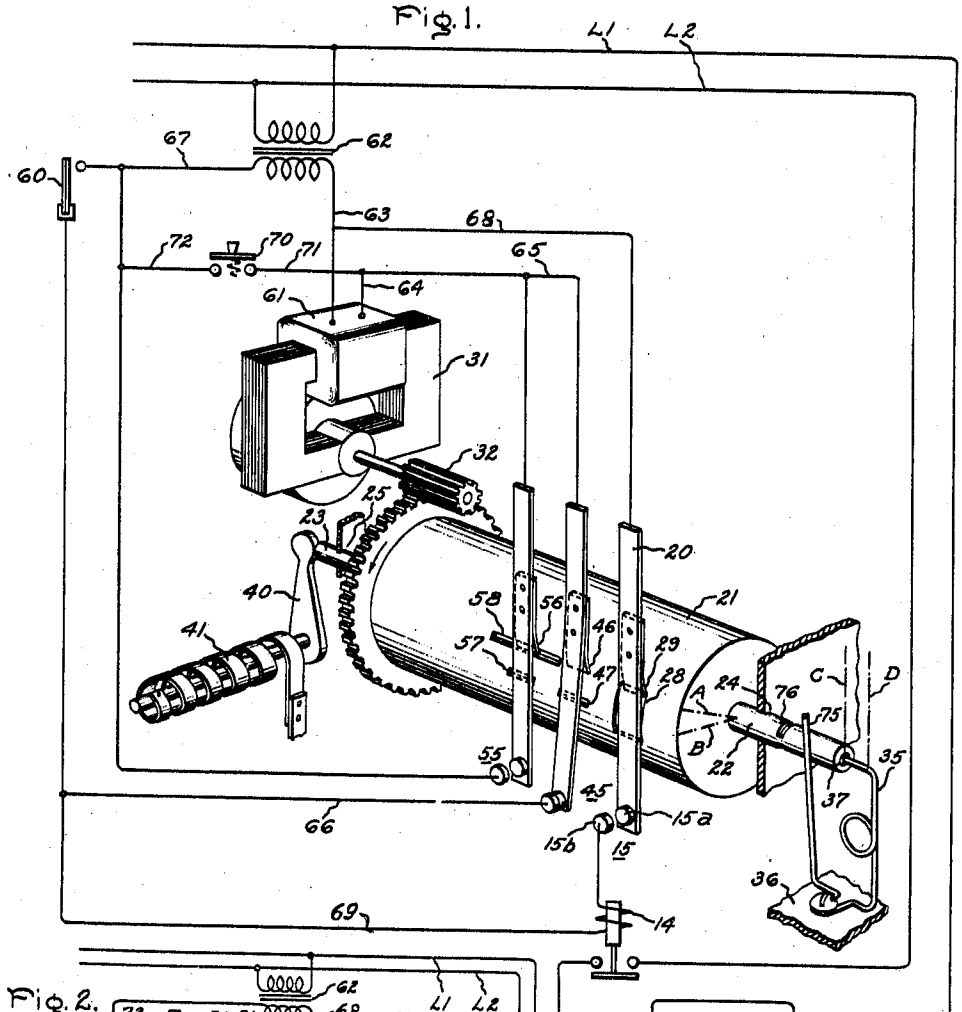
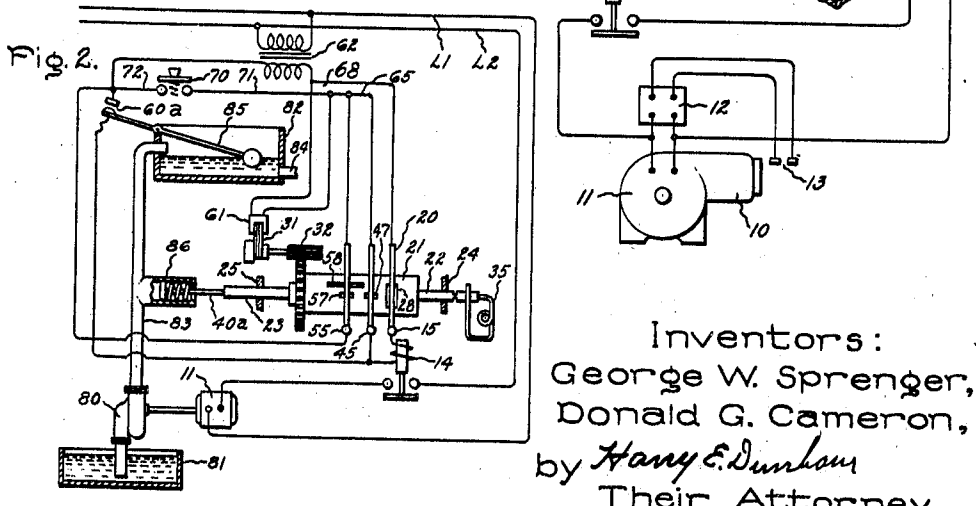


Fig. 2.



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CONDITION RESPONSIVE SYSTEM

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20 Claims. (Cl. 158—28)

This invention relates to condition responsive systems, particularly selective multi-condition responsive systems wherein the continued operation of a dual condition changing apparatus to regulate one condition is made dependent upon the establishment of another predetermined condition during a predetermined time interval. While not necessarily limited thereto, the invention is particularly adapted for use in the automatic operation of burners under thermostatic or other automatic control.

The principal object is to provide an improved selective condition responsive system and apparatus having an axially movable rotatable timing control member provided with selective control means effective when the timed rotation of said member is stopped in different axial positions for selectively controlling the operation of a condition changing device.

Another object is to control the axial movement of the rotary timing control member selectively in response to the establishment and non-establishment of a predetermined condition during a limited timed rotation of said member to selectively control a timing device provided for effecting rotary movement of said member and a relay provided for controlling a condition changing apparatus.

A further object is to provide a selective multi-condition responsive system and apparatus of an improved axially movable combined selective and rotary timing type that is simple in construction and reliable in operation.

Other objects and advantages of the invention will be pointed out in the following description of the accompanying drawing in which Fig. 1 illustrates diagrammatically an automatic oil burner control system and apparatus embodying the improvements of the present invention in a preferred form, and Fig. 2 shows the improved system and apparatus of the present invention applied to selective pumping service.

As shown diagrammatically in Fig. 1, the oil burner mechanism 10 is operated by an electric motor 11. Suitable electric ignition apparatus 12 is connected to be energized whenever burner motor 11 is energized so as to supply a spark at the electrodes 13 to ignite the combustible mixture supplied by the burner mechanism 10 and thereby establish combustion. The burner motor 11 and ignition apparatus 12 are energized from the electric supply lines L1, L2 whenever the burner relay 14 is closed. The energization of relay 14 is controlled by the operation of control switch 15. The movable switch contact 15a is carried on a flexible member 20 supported at its upper end so as to bias the contact 15a away from contact 15b. In this way the switch 15 is biased open.

The closure of the burner operation control switch 15 is controlled by a movable member 21 which is mounted for both rotary and axial movement. In the preferred form illustrated, the movable member 21 is in the form of a cylinder having the stub shafts 22 and 23 rotatably and slidably mounted in suitable bearings 24 and 25. The cylinder 21 is provided with an open recess or slot 28 into which the finger 29 carried on the flexible member 20 is adapted to drop when the member 21 is in a predetermined axial position indicated by dotted line C in which the recess or slot 28 is in axial alignment with the finger 29 and is in either of the two angular positions indicated by the dotted lines A and B in the drawing. Thus whenever the finger 29 drops into the open recess or slot 28, the operation control switch 15 is opened. The burner operation control switch 15, however, is closed when the movable member 21 is rotated from angular positions A and B or moved axially from axial position C so that finger 29 no longer drops into the recess or slot 28.

The movable member 21 is rotated by an electrically operated timing motor 31 which is connected to rotate member 21 preferably through a suitable speed reducing gearing 32 in the direction indicated by the arrow. The gearing 32 permits axial movement of the member 21.

The movable member 21 is biased to the axial position C in which it is shown by the biasing spring 35 which is mounted upon a suitable support 36 with the pointed end of spring 35 engaging the central depression 37 formed in the end of the stub shaft 22 so as to exert a force tending to bias the member 21 for movement in an axial direction to position C.

The member 21 is moved in the opposite direction against the biasing spring 35 to an axial position indicated by the dotted line D by means of an arm 40 which operates against the end of the stub shaft 23 and is actuated by any suitable condition responsive means responsive to the establishment of a predetermined condition such, for example, as the establishment of combustion by the oil burner 10. In the form shown, a spiral bimetal element 41 is responsive to the temperature of the combustion established by the burner 10 and operates to force the arm 40 against the end of the shaft 23 when combustion is established.

The switch 45 is similar in construction to the switch 15 and is provided with a finger 46 which drops into the open recess of slot 47 formed in member 21 in angular position B and axial position C to permit the contacts of switch 45 to separate in accordance with their bias. Switch 55 also is of similar construction to switch 15 and is provided with a finger 56 which drops selectively into the open recesses or slots 57 in angular position B and 58 in angular position A to permit the contacts of switch 55 to open in ac-

cordance with their bias. The slot 58 is axially elongated so that upon axial movement of the member 21 to axial position D by the combustion responsive device 41, finger 46 will drop into slot 58 in angular position A and thereby permit switch 45 to open.

Operation

As shown the various parts of the improved control system and apparatus of the present invention are in their relative positions which they will occupy when the oil burner 10 is not in operation. Operation of the improved control to start burner operation is effected upon closure of a master control switch 60 which may be a room thermostat, a boiler thermostat, a pressure switch or any other automatic switch responsive to a predetermined condition to be controlled by operation of the burner 10. Upon closure of master switch 60 an energizing circuit for the operating winding 61 of the timing control motor 31 is established. This circuit extends from the low voltage secondary of the transformer 62, the primary of which is energized directly from the supply lines L1, L2, through the conductor 63, motor winding 61, conductor 64, 65, switch 45, which is closed since finger 46 is not in either slots 47 or 58, conductor 66, the master switch 60 and conductor 67. As a result motor 31 starts to rotate the movable member 21 from its angular position A in the counterclockwise direction as indicated by the arrow. As a result finger 29 is raised out of the slot 28 so as to close the contacts of switch 15 thereby energizing the burner relay 14, the circuit extending from the secondary of the transformer 62 through conductors 63 and 68, switch 15 in its closed position, the winding of relay 14, conductor 69, the master switch 60, and conductor 67. As a result, relay 14 closes its contacts and completes the circuit from supply lines L1, L2 to correspondingly energize the burner motor 11 and the ignition apparatus 12 to produce a spark between the ignition electrodes 13. Under these conditions combustion should occur upon effective operation of the burner which is a prerequisite condition to continuing the operation of the burner to regulate the other condition to which the master switch is responsive after the timed rotation of the axially movable rotating control member 21 is stopped.

The rotation of movable member 21 in the counterclockwise direction as just described also raises finger 56 out of the slot 58 thereby closing switch 55 which shunts the master switch 60 and switch 45. This insures that the energizing circuit of the timing motor 31 is maintained closed until switch 55 is reopened upon rotation of member 21 to either position B or A.

Let us assume that for some unexplained reason combustion is not established upon the energization of the burner motor 11 and ignition apparatus 12 in the manner just described. Under these conditions, the timing motor 31 will continue rotation of the movable member 21 until the angular position indicated by the dotted line B is reached. Thereupon finger 29 drops into slot 28 and shortly thereafter finger 46 drops into slot 47 and finger 56 drops into slot 57. Thus the switches 15, 45, and 55 are all opened and thereby prevent further energization of the burner motor 11 and also the timing motor 31 after the end of the predetermined time required for timing motor 31 to rotate member 21 from its angular position A to its angular position B.

To restart the equipment after the cause of the failure of the burner 10 to establish combustion has been remedied, the normally open restart push button 70 is operated to its closed position. This energizes the operating winding 61 of the timing motor 31 directly from the secondary transformer 62 through the conductors 63, 64, 71, 72, and 67. Thereupon the movable member 21 is rotated from its angular position B through its angular position A, thereby closing switches 15, 45, and 55 in the manner previously described. Thereupon the restart push button 70 may be released and the timing motor 31 will continue to rotate the movable member 21 from position A to position B.

In case combustion is successfully established by the burner 10 any time during the period of rotation of the movable member 21 from its angular position A to its angular position B then the combustion responsive device 41 will respond to this establishment of combustion and operate the lever 40 against the end of the stub shaft 23. As a result the movable member 21 is moved axially from position C to position D against the bias of the spring 35 thereby moving the slot 28 out of axial alignment with the finger 29, the slot 47 out of axial alignment with the finger 46 and the slot 57 out of axial alignment with the finger 56. This axial movement of movable member 21 also enables the spring finger 75 to enter the segmental slot 76 formed in the periphery of the stub shaft 22 so as to hold the member 21 in the axial position D to which it is operated by the combustion responsive device 41 until the angular position B is reached. Thereupon the spring finger 75 is forced out of the slot 76 so as to permit the biasing spring 35 to return the movable member 21 to its initial axial position unless the arm 40 is still operated against the stub shaft 23 due to the response of the combustion responsive device 41 when position B is reached.

With combustion successfully established during the rotation of movable member 21 from it angular position A to its angular position B, the combustion responsive device 41 will maintain the member 21 in its axial position indicated by the dotted line D. As a result fingers 46 and 56 both will drop into the elongated slot 58 when the member 21 is rotated into its angular position A. This opens switches 45 and 55 to deenergize the starting motor 31 and thereby stop further rotation of the member 21. The operation control switch 15, however, remains closed in angular position A and axial position D. This leaves the energization of relay 14 under the control of the master control switch 60 and any other safety switches that may have been included in the relay circuit. As a result relay 14 remains energized and the operation of the burner continues until the master control switch 60 opens. This deenergizes relay 14 and stops the operation of the burner 10. Thereupon the combustion responsive device 41 no longer actuates the arm 40 against the end of the stub shaft 23. Consequently, the biasing spring 35 moves the member 21 from its axial position D to its axial position C. This enables the sloping right-hand end of the slot 58 to raise the finger 46 out of the slot so as to reclose the switch 45. At the same time finger 29 drops into recess 28 so as to reopen switch 15, while finger 56 slides in slot 58 so as to maintain switch 55 open. In this way all parts of the control equipment are returned to their initial position in which they are shown in the drawing.

Thus in the improved selective control system

and apparatus the movable operating member 21 not only is mounted for both rotary and axial movement, but also is provided with means for effecting a predetermined selective operation of the three switches 15, 45 and 55 upon axial movement of the member 21 from its axial position D to its axial position C with the member 21 in angular position A. In this predetermined selective operation, switch 15 is operated from the closed to the open position, switch 45 is operated from the open to the closed position, while switch 55 is maintained in the open position.

Upon rotation of member 21 in axial position C from its angular position A to its angular position B, a different selective operation of the switches results. The switch 15 is first closed upon rotation of member 21 from angular position A and is reopened when angular position B is reached. Switch 45 is maintained closed upon rotation from angular position A until angular position B is reached. Switch 55 is first operated from the open position to the closed position upon rotation from angular position A, but is reopened when angular position B is reached.

A still different selective operation of the switches occurs in case member 21 is rotated in axial position D. In this case, switch 15 is maintained closed during the entire revolution of member 21 while both switches 45 and 55 are maintained closed in all angular positions of member 21 except position A. Thus the improved selective circuit controlling combination enables the switch 15 to control the starting and stopping of the burner 10 or other condition changing apparatus through the agency of the relay 14 while the pair of switches 45 and 55 cooperate to control the stopping of the timing motor 31 with the movable member 21 in either its angular position A depending upon the occurrence of axial movement of the member 21 from its position C to its position D during the rotary movement of member 21. With this improved control combination, the condition responsive master switch 60 is effective only to start operation of the timing device 31 while the stopping of the timing device always is under the selective control of the pair of switches 45 and 55.

In the modification as shown in Fig. 2, the improved control system and apparatus of the present invention is shown schematically applied to the control of a pumping control system in which a float switch corresponds in its master control function to the room thermostat and a fluid pressure switch corresponds in its control function to the flame detector of the oil burner control system previously described. In this case the electric motor 11 drives a pump 80 instead of an oil burner. The pump 80 draws fluid from a suitable supply source 81 and supplies the fluid under pressure into a tank 82 from which the fluid flows through the outlet pipe 84. A float switch 85 is responsive to the level of the fluid in the pressure tank 82 and a pressure responsive device 86 is responsive to the pressure of the fluid supplied from the pump 80.

In operation, when the level of the fluid in the tank 82 decreases sufficiently to cause the float switch 85 to close its contacts, the timing motor 31 is energized to rotate the movable control member 21 in substantially the same manner as described in connection with the oil burner control. The rotation of member 21 closes contact 15 and energizes the relay 14 to complete the energizing circuit of the motor 11 in the same way as previously described. If the resulting operation of the pump 80 produces a pressure in the pipe 83, then the pressure responsive device 86 responds to operate the arm 40a against the end of the stub shaft 23 so as to produce axial movement of the member 21 to the right in a manner corresponding to the operation of the flame detector thermostat described in Fig. 1. This will result in deenergizing the starting motor 31 after the rotation of member 21 to its angular position A with, however, contact 15 remaining closed to maintain relay 14 energized under the control of the float switch. Consequently, when the liquid level in tank 18 rises sufficiently to open the contacts of the float switch, relay 14 is deenergized thereby stopping further operation of the motor driven pump.

In case the operation of pump 80 after the initial energization of motor 11 is for some reason, as for example lack of fluid in the supply source 81, unable to produce a pressure in pipe 83 to which the pressure responsive device 86 can respond, then there will be no axial movement of the member 21 to the right. As a result the timing motor 31 will continue rotation of member 21 until the angular position B is reached in which all of the contacts 15, 45, 55 are opened just as in case of flame failure as previously described. However, when the failure of fluid in tank 81 has been corrected then restarting is accomplished by closing the restart button 70 in exactly the same way as described in connection with the burner control.

While the invention has been illustrated and described in a preferred form and also a modified form, it will be apparent that various changes may be made in the apparatus shown. For example, if direct action of the condition responsive device on the stub shaft 23 is not desired, it will be apparent that suitable relay means such as an electromagnet controlled by the combustion responsive device may be employed, if desired.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, condition control means including a movable member mounted for both rotary and axial movements, means including a timing device for rotating said member, means for starting said timing device, means including a condition responsive device for axially moving said member, and means selectively responsive to rotary and axial movement of said member for stopping said timing device upon rotation of said member in different axial positions to correspondingly different angular positions.

2. In combination, condition control means including a movable cam member mounted for both rotary and axial movements, means including a timing device for rotating said member, means for starting said timing device, means including a condition responsive device for axially moving said member, and means including a pair of cam operated control elements selectively responsive to both rotary and axial movement of said cam member for stopping said timing device upon rotation of said member in two different axial positions to correspondingly different angular positions.

3. In combination, a movable member having different movements, means including a timing device for causing one of said movements, means for starting said timing device, means including a condition responsive device for causing another of said movements, and means selectively responsive to different combinations of said movements

for stopping said timing device upon movement of said member to different positions.

4. In combination, a movable member mounted for both rotary and axial movement, means including a timing device for causing one of said movements, means for starting said timing device, means including a condition responsive device for causing the other of said movements, and means selectively responsive to different combinations of said movements for stopping said timing device upon movement of said member to different angular and axial positions.

5. In combination, condition control means including a movable member mounted for both rotary and axial movement, means biasing said member for axial movement in a predetermined direction, means including a condition responsive device for axially moving said member in the opposite direction, means rendered effective upon axial movement of said member in said other direction for rendering said biasing means ineffective during a predetermined rotation of said member, means including a timing device for rotating said member, and means selectively responsive at the end of said predetermined rotation to the axial position of said member for selectively controlling said timing device.

6. In combination, a plurality of switches, means including a movable member mounted for both rotary and axial movement and provided with means for selectively controlling said switches, means including an electrically operated timing device for rotating said member, means including one of said switches and a condition responsive switch for energizing said timing device, means including another of said switches for independently maintaining said timing device energized for an internal dependent upon both rotary and axial movement of said movable member, means including a condition responsive device for axially moving said member, and electroresponsive means having the energization and deenergization thereof selectively controlled by another one of said switches responsive to both rotary and axial movement of said member.

7. In combination, condition changing means, control means therefor including a movable member mounted for both rotary and axial movements, means biasing said member to a predetermined axial position, means including a timing device for rotating said member, means including a condition responsive device responsive to a condition established upon effective operation of said condition changing means for axially moving said member to a different axial position, and means selectively responsive to rotary and axial movement of said member for rendering said condition changing means ineffective with said member in said biased axial position and in either of two rotary positions and for rendering said condition changing means effective with said movable member in all other rotary and axial positions, and means selectively responsive to rotary and axial movement of said member for stopping said timing device with said member in either of said rotary positions.

8. In combination, a circuit control switch, a movable member mounted for both rotary and axial movement and provided with means for opening said switch only with said member in a predetermined axial position and in either of two rotary positions, means including a timing device for rotating said member, means including a condition responsive device for starting said timing device into operation, means including a second condition responsive device for axially moving said member to another axial position during the rotation thereof, and means selectively responsive to rotary and axial movement of said member for stopping operation of said timing device with said movable member in each of said two rotary positions.

9. In combination, a circuit control switch, a movable member mounted for both rotary and axial movement and provided with means for opening said switch with said member in a predetermined rotary and axial position, means including a timing device for rotating said member from said position, condition responsive means for starting said timing device into operation, means including a condition responsive device for axially moving said member during rotation thereof, and means selectively responsive to rotary and axial movement of said member for stopping operation of said timing device upon a partial revolution of said member in the absence of axial movement thereof during said partial revolution and upon a complete revolution of said member when axial movement thereof occurs during said partial revolution.

10. In combination, a burner circuit control switch, a movable member mounted for both rotary and axial movement and having means selectively responsive to both said movements for selectively controlling the closing and opening of said switch, means including a timing device for rotating said member to close said switch for a limited time, condition responsive means for starting said timing device into operation, means including a combustion responsive device for axially moving said member during said limited time to maintain said burner switch closed thereafter, and means selectively responsive to rotary and axial movement of said member for limiting the time of operation of said timing device.

11. In combination, a movable control element having an operating member mounted for both rotary and axial movement, means for biasing said member to a predetermined axial position, said member having means for operating said control element to one position during a predetermined part of each revolution of said operating member in said predetermined axial position and to another position during the remainder of each revolution of said member in said axial position, means including a timing device for rotating said member, means for starting said timing device, means including a condition responsive device for axially moving said member against its bias from said predetermined axial position to another axial position, means effective upon axial movement of said member to said other axial position for maintaining said member in said other axial position during said predetermined part of each revolution of said member, and means responsive to rotary and axial movements of said member for stopping operation of said timing device upon a partial revolution of said movable member in said predetermined axial position and upon a complete revolution of said member when axial movement of said member to said other axial position occurs during said partial revolution of said member.

12. In combination, control means including a plurality of switches, means including a member mounted for both rotary and axial movement and provided with cam means for selectively opening and closing said switches in different angular and axial positions of said member, means including a timing motor under the control of a pair of said

switches for rotating said member, means for starting said timing motor, and means including a condition responsive device for axially moving said member to effect selective operation of said pair of switches to stop operation of said timing device with said movable member in different angular and axial positions.

13. In combination, control means including a movable cam member mounted for both rotary and axial movement, means biasing said member to a predetermined axial position, means including a condition responsive device for axially moving said member against its bias to a second axial position, latching means for maintaining said member in said second axial position against its bias during a predetermined rotary movement of said member, means including a timing device for rotating said member, means for starting said timing device, and cam operated control means responsive to both rotary and axial movement of said cam member for stopping operation of said timing device with said cam member in one angular position upon rotation of said member in said one axial position and for stopping operation of said timing device with said cam member in a different angular position upon rotation of said member in said second axial position.

14. In combination, a plurality of switches having a movable operating member mounted for both rotary and axial movement and provided with means for effecting a predetermined selective operation of said switches upon rotation of said member in one axial position and a different selective operation of said switches upon rotation of said member in a second axial position, means including an electric motor energized under the selective control of a pair of said switches for rotating said operating member to different angular positions, and means including a condition responsive device for axially moving said member from said one axial position to said second axial position.

15. In combination, a selective circuit controlling device having at least three switches, a movable operating member therefor mounted for both rotary and axial movement and provided with means for effecting a predetermined selective operation of said switches upon axial movement of said member from one axial position to a second axial position with said member in a predetermined angular position and different selective operations of said switches upon rotation of said member in each of said axial positions, means for biasing said member to move from said one axial position to said second axial position, means including an electric motor energized under the control of a pair of said switches for rotating said member, and means including a condition responsive device for axially moving said member against its bias.

16. In combination, a selective circuit controlling device having at least three switches, a movable operating member therefor mounted for both rotary and axial movement and provided with means for effecting a predetermined selective operation of said switches upon a predetermined axial movement of said member and different selective operations of said switches upon rotation of said member in different axial positions, means under the control of a pair of said switches for rotating said member, and means including a condition responsive device for axially moving said member.

17. A selective circuit controlling device having at least three switches and a movable operating member for said switches mounted for both rotary and axial movement and provided with means for effecting a predetermined selective operation of said switches upon a predetermined axial movement of said member and different selective operations of said switches upon rotation of said member in different axial positions.

18. In combination, a condition changing means having a predetermined condition established upon effective operation thereof, an axially movable rotating timing control member having means for stopping rotation thereof after a limited angular movement and provided with means effective upon rotation of said member in one axial position for starting and subsequently stopping operation of said condition changing means during said limited angular movement and effective in another axial position of said member for continuing the operation of said condition changing means after the rotation of said member has stopped, and a device responsive to the establishment of said predetermined condition during said limited angular movement for axially moving said member from said one axial position to said other axial position.

19. In combination, a condition changing means having a predetermined condition established upon effective operation thereof, an axially movable rotating timing control member biased to one axial position and having means for stopping rotation thereof after a limited angular movement and provided with selective control means responsive to both rotary and axial movement of said member for selectively operating said condition changing means only during said limited angular movement in said one axial position and continuing the operation of said means after the rotation of said member has stopped in another axial position, and a device responsive to the establishment of said predetermined condition during said angular movement for axially moving said member from said one axial position to said other axial position.

20. In combination, a dual condition changing means operable for regulating one condition and having another condition established upon effective operation thereof, a combined timing and selective control member mounted for both rotary and axial movement and provided with means dependent upon the axial position of said member for selectively operating said condition changing means during and after a limited timed rotation of said member, means including a control device responsive to said one condition and having a timing device controlled thereby for effecting a limited timed rotation of said member in one axial position to operate said condition changing means during said limited timed rotation of said member, and means including a control device responsive to the establishment of said other condition for axially moving said member from said one axial position to another axial position to continue operation of said condition changing means after said limited timed rotation of said member.

GEORGE W. SPRENGER.
DONALD G. CAMERON.

CERTIFICATE OF CORRECTION.

Patent No. 2,341,297. February 8, 1944.

GEORGE W. SPRENGER, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 38, for "internal" read --interval--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A. D. 1944.

Leslie Frazer

Acting Commissioner of Patents.

(Seal)

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