

Oct. 28, 1941.

H. S. JONES

2,261,087

CONTROL SYSTEM

Original Filed Aug. 3, 1937

FIG. 1.

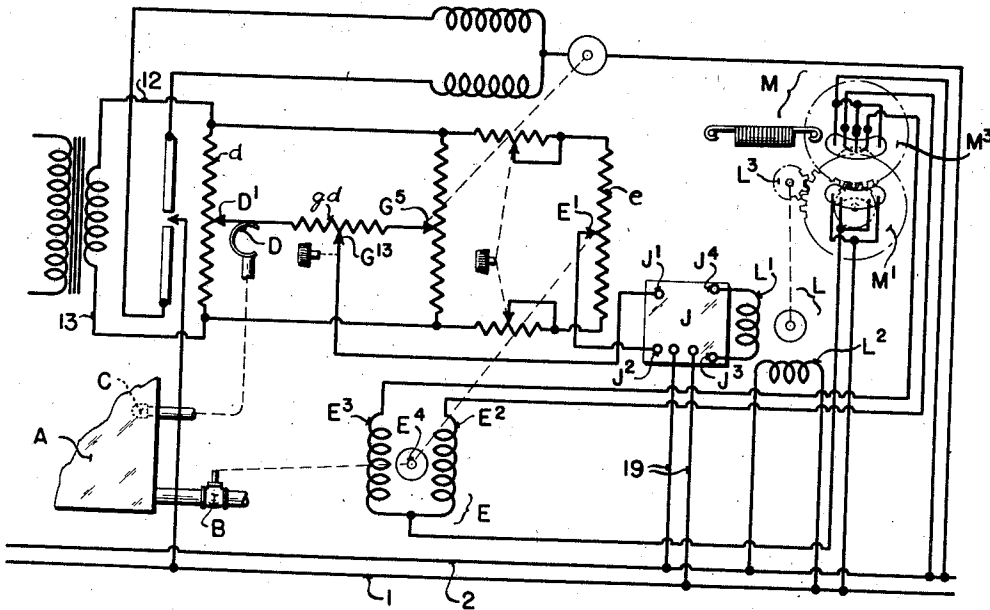
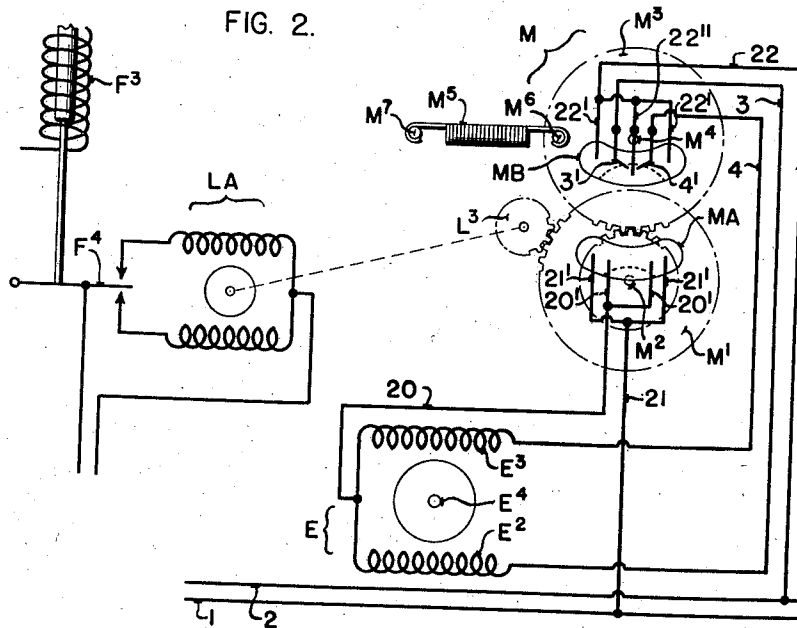


FIG. 2.



INVENTOR
HARRY S. JONES
BY *Charles H. Wier*
ATTORNEY

UNITED STATES PATENT OFFICE

2,261,087

CONTROL SYSTEM

Harry S. Jones, Philadelphia, Pa., assignor to The Brown Instrument Company, Philadelphia, Pa., a corporation of Pennsylvania

Original application August 3, 1937, Serial No. 157,084. Divided and this application April 13, 1939, Serial No. 267,697

3 Claims. (Cl. 172-179)

The general object of the present invention is to provide improved electrical control apparatus. More specifically, the object of the invention is to provide improved electrical control apparatus comprising a meter, which, in many cases, is advantageously a self-balancing potentiometer instrument, for measuring a controlling quantity or value, and for actuating a relay mechanism to effect corrective control adjustments in accordance with variations in the controlling quantity.

More specifically still, the object of the present invention is to provide electrical control apparatus of the character above-mentioned, with simple and effective means for adjusting it for desirable operation, under different conditions of use.

In a preferred form, the improved control apparatus includes a reversible electric motor automatically actuated to effect a so-called "reset" adjustment, whereby on a change in an operating condition, such, for example, as a change in the load on a furnace which is being controlled to minimize variations in a furnace temperature, the tendency of the furnace load or other operating conditions change to decrease or increase the furnace temperature or other controlling condition may be neutralized.

Some forms of the improved control apparatus are characterized by the thermionic amplifying means through which the instrument acts upon a relay motor. The invention is characterized by improvements in automatic switches used in controlling the operation of the relay motor.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawing and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

This application is a division of my copending application, Serial Number 157,084 filed August 3, 1937, which issued into Patent 2,246,686 on June 24, 1941.

Of the drawing:

Fig. 1 is a diagrammatical view illustrating the invention; and

Fig. 2 is a diagrammatical view illustrating a modification of the device of Fig. 1.

In the embodiment of the invention diagrammatically illustrated in Fig. 1, the fuel supply

to a furnace A is regulated by the adjustment of a fuel supply valve B in automatic response to variations in a furnace temperature, as required to maintain that temperature approximately constant. The furnace temperature is measured by means shown diagrammatically as comprising the bulb C of a fluid pressure type thermometer, connected to a measuring instrument, including an actuating element in the form of an arc shaped Bourdon tube D to which the thermometer bulb pressure is transmitted. On an increase or decrease in the furnace temperature, the resultant flexure of the Bourdon tube D, moves a contact D' along a measuring instrument slide wire resistor d, up or down as seen in Fig. 1. The initial effect of any movement of the contact D', is to unbalance a normally balanced control circuit including the resistor d, and thereby to energize a reversible control motor E for operation in the direction to effect a corrective adjustment of the fuel valve B, and a corresponding circuit rebalancing adjustment of a contact E'. The motor E, as shown, operates in one direction or the other accordingly as one or the other of its two field windings E² and E³ is energized. The armature shaft E⁴ of the motor is operatively connected to the movable element of the fuel valve B and to the contact E', which is adjustable along a slide wire resistor e included in the control circuit. The control circuit is energized by the connection of the resistors d and e to supply conductors 12 and 13.

As shown, the energization of the motor E is directly controlled by control means including a switch mechanism M, a reversible switch actuating electric motor L, and an electronic amplifying device J. The latter makes the operation of the motor L dependent on a change in the relative potentials of points in the control circuit network, which have their relative potentials changed by a change in position of the contact D' and change in the reverse direction by the adjustments of contacts E' and G⁵, resulting from the change in position of the contact D'. The contact D' is connected to the contact G⁵ through a resistance gd, and one input terminal J' of the amplifier is connected to a contact G¹³ engaging and adjustable along the length of the resistance gd. The second amplifier input terminal J² is connected to the contact E'.

The amplifying unit J has power conductor connections 19 with the supply conductors 1 and 2, and has its output terminals J³ and J⁴ connected to the terminals of one winding L' of the motor L. The latter, as shown, is of a known

type, adapted, when current flows through the winding L' , to operate in one direction or the other, accordingly as that current flow lags or leads the current flow in a second winding L^2 of the motor, which has its terminals connected to the supply conductors 1 and 2.

The proper phase difference in the current supply to the field windings L' and L^2 is obtained by means of the amplifier J which introduces a phase shift of nearly 90° in the current which it amplifies, as will be readily understood. In consequence, the current flow in the winding L' will lead or lag by nearly 90° the current in the winding L^2 , accordingly as the potential of one or the other of the contacts E' and G^{13} is the higher. Therefore, an up adjustment of either contact D' or G^5 will result in operation of the motor L in one direction, and the motor may operate in the opposite direction in response to a down adjustment of either contact D' , or G^5 .

The switch mechanism M through which the motor L controls the reversible relay motor E may take various forms, but is advantageously adapted to prevent coasting of the relay motor E, by subjecting the latter to a positive braking or stop action, as soon as the switch mechanism M is adjusted to interrupt the energization of the motor. The elimination of, or reduction in motor coasting, is of considerable practical importance, particularly in the case of a relatively large relay motor. The switch mechanism M shown in Fig. 1, and on a larger scale in Fig. 2, comprises a switch carrier M' rotatable about a shaft M^2 and rotated by a gear L^3 carried by the shaft of the motor L. The disc M' supports a mercury switch MA, which connects one terminal of each of the windings E^2 and E^3 of the motor E to, or disconnects said terminal from the supply conductor 1, accordingly as the switch MA is out of, or in its horizontal position, shown in Fig. 1. To this end, one terminal of each of the windings E^2 and E^3 is connected by a conductor 20 to two switch contacts 20' extending into the container of the switch MA, one adjacent each end of the latter. A conductor 21 connects the supply conductor 1 to two switch contacts 21', which extend into the container of the switch MA, one adjacent each end of the latter.

As shown, the disc M' is gear connected to a second switch carrying disc M^3 rotatable about a pivot shaft M^4 , the gear connection being such that the angular movement of the disc M^3 is appreciably smaller than that of the disc M' by which it is produced. The disc M^3 carries a mercury switch MB, into the container of which five switch contacts extend. Those contacts comprise a central contact 22'', and two end contacts 22', one at each side of the contact 22''. The contact 22'' and the two contacts 22' are connected by a conductor 22 to the supply conductor 2. The other two contacts 3' and 4' are located at opposite sides of the contact 22''. The contacts 3' and 4' are connected by the conductors 3 and 4, respectively, to the terminals of the motor windings E^2 and E^3 not connected to the conductor 20.

The switch mechanism M is biased for return into a neutral or normal position, in which the containers of both switches MA and MB are horizontal, when the energization of the control motor L is interrupted following its operation in either direction. As diagrammatically shown, the biasing means comprises a spring M^5 connecting a pin M^6 carried by the disc M^3 to a stationary anchorage M^7 . The spring M^5 is under

tension and the parts M^6 and M^7 are so arranged, that when the motor L is deenergized, the spring M^5 will return the disc M^3 to, and hold it in the angular position shown in Figs. 1 and 2.

In the operation of the apparatus shown in Fig. 1, on an energization of the motor L for operation in either direction, a small initial movement of the motor gives sufficient angular movement to the switch MA to connect the conductors 20 and 21, without giving sufficient movement to the switch MB to interrupt the normal connection of the contact 22'' with each of the contacts 3' and 4'. In consequence, the said initial movement of the motor L energizes both windings E^2 and E^3 , so that each neutralizes the tendency of the other to start the motor E into rotation. As the movement of the motor L continues, the further movement given the switch MB results in breaking the connection between contact 22'' and one or the other of the contacts 3' or 4'. When the motion of the motor L is clockwise, for example, it eventually interrupts the connection between the contact 22'' and the contact 3', and thereby deenergizes the motor winding E^2 , whereupon the motor winding E^3 effects rotation of the motor E in one direction. Rotation of the motor E in the opposite direction, occurs when unbalance in the control circuit network produces a counterclockwise rotation of the motor L, and a movement of the switch MB in the direction to interrupt connection between the central contact 22'' and the contact 4', thereby deenergizing the winding E^3 .

As soon as the motor L is deenergized, or its energizing force is sufficiently reduced, the switch mechanism M is returned to its normal or neutral position by the action of the spring M^5 . In the course of the switch mechanism return, the switch MB is adjusted into the position in which its contact 22'' is connected to both of the contacts 3' and 4', before the movement of the switch MA is sufficient to interrupt connection between the conductors 20 and 21. In consequence, both motor windings E^2 and E^3 are energized during a portion of the time required for the return of the switch mechanism. This subjects the motor E to an electromagnetic braking or stalling action, effectively opposing coasting movement of the motor.

As will be apparent, the motor actuated mercury switch mechanism M may be adjusted or controlled by means other than the amplifier controlled motor L shown in Fig. 1. For example, as shown in Fig. 2, the switch mechanism M may be actuated by a reversible motor LA, which is controlled by a relay switch F^4 , adjusted and controlling the motor LA, in response to the unbalance of an alternate electrical control system disclosed in my copending application referred to above, in which the relay F^3 serves the same general purpose of amplifier J in detecting bridge unbalance.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the forms of the apparatus and methods disclosed without departing from the spirit of my invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I

claim as new and desire to secure by Letters Patent is:

1. In a control system, the combination with an electric motor having two windings and adapted to operate in one direction or the other accordingly as one or the other of said windings is energized and to stall when both windings are energized and motor controlling means comprising a switch mechanism selectively responsive to changes in a controlling quantity and adapted to start said motor into operation by energizing one or the other of said windings, on an increase or decrease, respectively, in said condition, and to interrupt said operation of the motor by energizing the winding not previously energized, and thereafter to deenergize both windings, said switch mechanism comprising two switches in series with each winding, each biased for movement into a neutral position and being turned out of said position in one direction or the other, on an increase or decrease, respectively, in said quantity, and each movable in each direction in timed relation with the movements of the other, one of which switches permitting energization of both of said windings when in its said position, and the other switch preventing energization of each of said windings when in its said position.

2. In a control system, the combination with a normally deenergized electric motor having two windings and adapted to operate in one direction or the other accordingly as one or the other of said windings is energized and to stall when both windings are simultaneously energized, motor controlling means comprising a switch mechanism having a plurality of positions and adapted to be selectively actuated from one of its positions in which both of said windings are deenergized into one or another of its remaining positions responsively to changes in a controlling quantity and adapted to energize one of said windings in each of said remaining positions respectively, thereby starting said motor into operation in one direction or the other, and adapted to be adjusted into another of its remaining po-

sitions on a return of said switch mechanism to said one position thereof to maintain said one of said windings energized momentarily and to momentarily energize the other of said windings to thereby positively interrupt the operation of said motor, and thereafter adapted to be adjusted into said one position to deenergize both windings.

3. In a control system, the combination with an electric motor having two windings and adapted to operate in one direction or the other accordingly as one or the other of said windings is energized or to stall when both windings are energized and motor controlling means comprising a switch mechanism selectively responsive to changes in a controlling quantity and adapted to start said motor into operation by energizing one or the other of said windings, on a decrease or increase, in said condition, and to interrupt the operation of said motor by energizing the winding not previously energized, and thereafter to deenergize both windings, said switch mechanism having a plurality of positions and being normally biased into a first one of said positions and being adapted to be moved out of said first position into a second position on an increase in said quantity and being adapted to be moved into the opposite direction from said first position into a third position on a decrease in said quantity, said switch mechanism being adapted to be momentarily adjusted to a fourth position on a return thereof from said second position to said first position and being adapted to be momentarily adjusted to a fifth position on a return thereof from said third position to said first position, said switch mechanism permitting energization of one of said motor windings when in its second position and permitting energization of the other of said motor windings when in its third position and permitting energization of both of said motor windings when in its fourth and fifth positions and preventing energization of each of said windings when in its first position.

HARRY S. JONES.