April 28, 1936. W. A. RAY 2,038,675

MULTISTAGE FIRE CONTROL APPARATUS

Original Filed Nov. 8. 1930 4 Sheets-Sheet 1

Fig. 1.

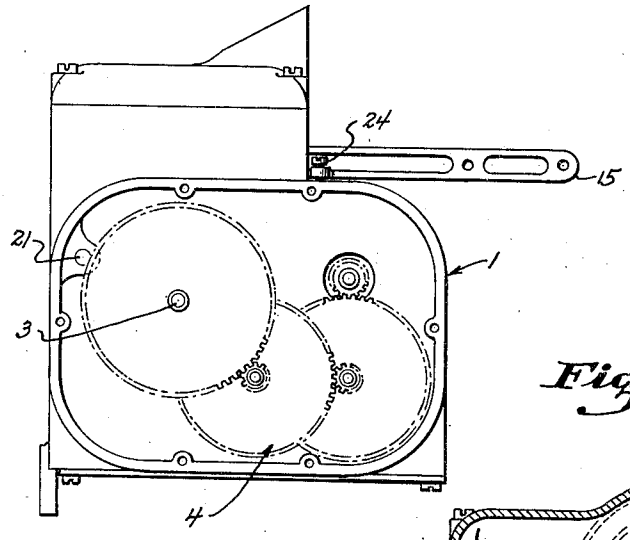


Fig. 2.

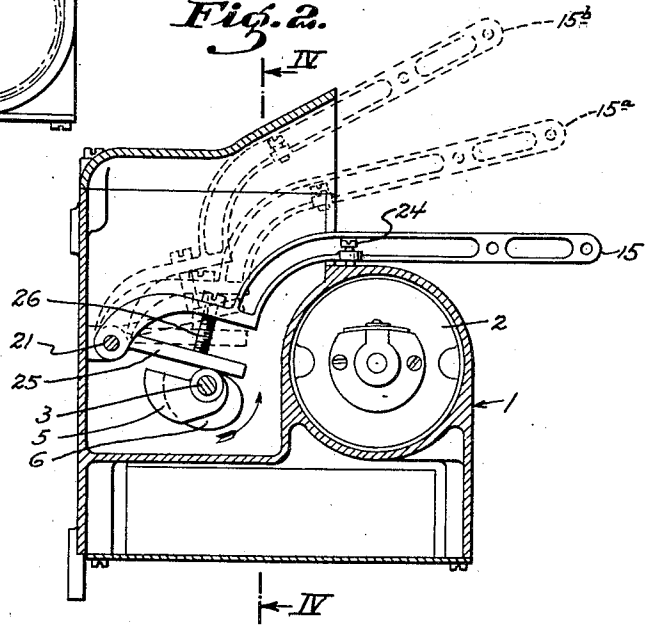
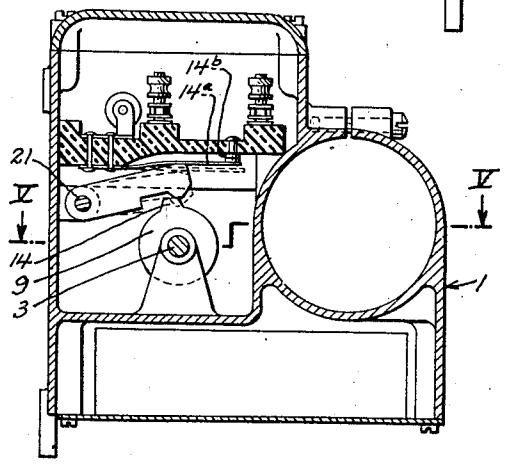


Fig. 3.



INVENTOR.
William A. Ray.
BY
Townsend & Loftus
ATTORNEYS.

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Fig. 4.

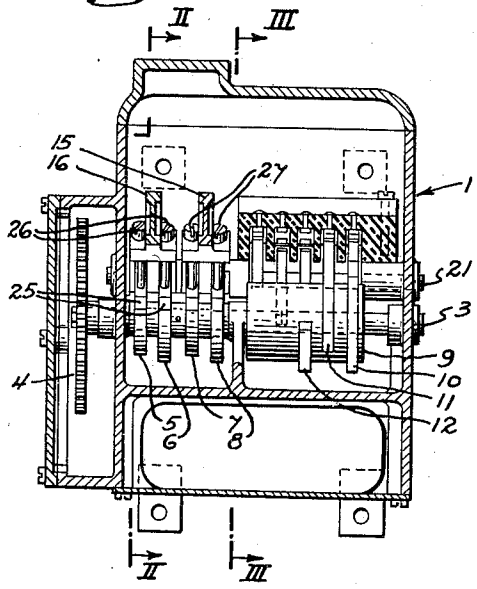
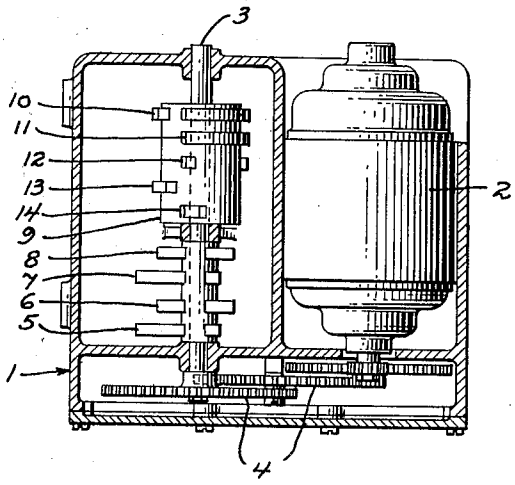


Fig. 5.



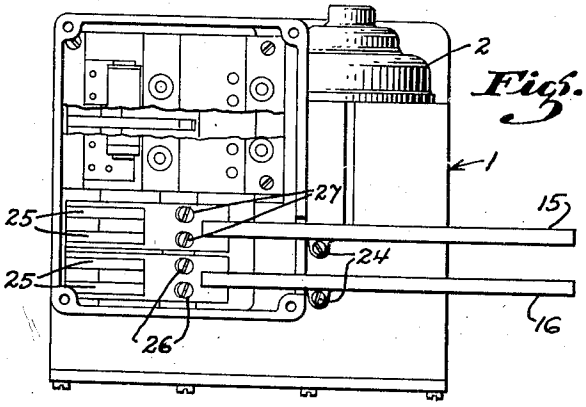


Fig. 6.

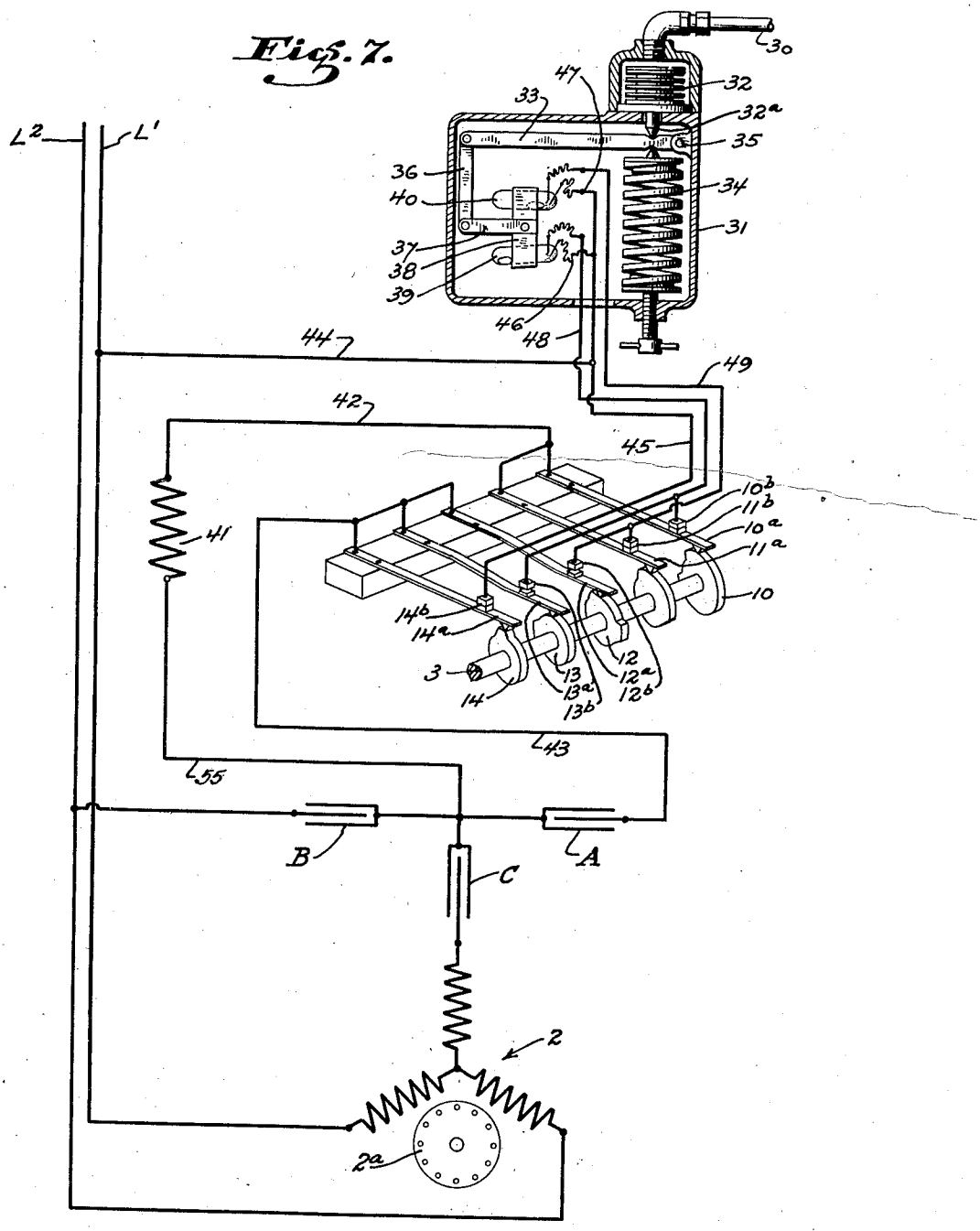
INVENTOR.
William A. Ray.
BY
Townsend & Loftus
ATTORNEYS.

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MULTISTAGE FIRE CONTROL APPARATUS

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Fig. 7.



INVENTOR.
William A. Ray.
BY Townsend & Loftus
ATTORNEYS.

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Fig. 8.

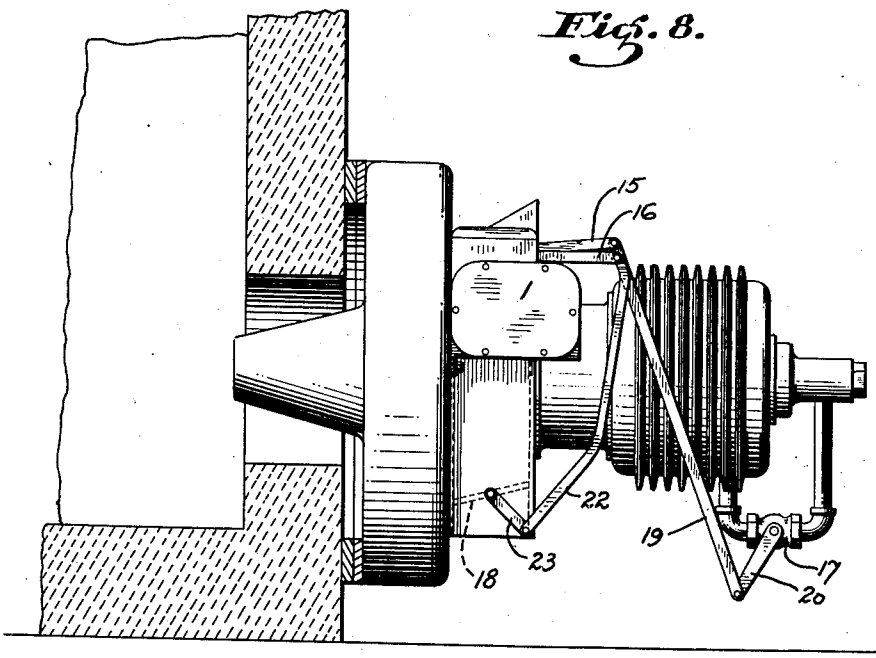


Fig. 9.

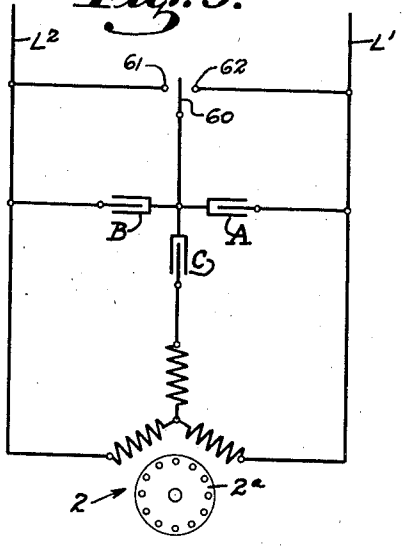
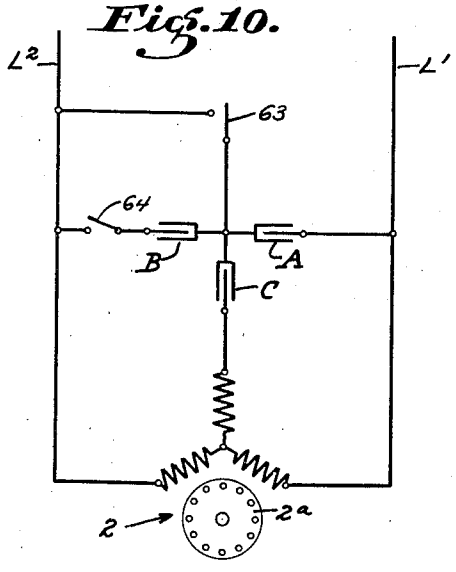


Fig. 10.



INVENTOR.
William A. Ray.
BY Townsend & Loftus
ATTORNEYS.

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2,038,675

MULTISTAGE FIRE CONTROL APPARATUS

William A. Ray, San Francisco, Calif., assignor to General Controls Co., a corporation of California

Substitute for application Serial No. 494,355, November 8, 1930. This application December 5, 1932, Serial No. 645,813

2 Claims. (Cl. 137—139)

The present invention relates to an apparatus whereby the amount of fuel and air delivered to a furnace may be regulated, and especially to an apparatus whereby predetermined fire conditions such as low fire, medium, high fire, etc., is automatically maintained; the present application being a substitute of my previous application Serial Number 494,355, entitled "Multi-stage fire control apparatus", filed November 8, 1930.

The apparatus embodied in the present invention comprises a housing in which is mounted a controller shaft on which is mounted two sets of cams, one set actuating a pair of levers whereby the air and fuel flow is controlled and a second set of cams which actuates a plurality of electric positioning or limiting contacts. An electric motor of the induction type is employed for imparting movement to the controller shaft and manual, temperature or pressure actuated means are employed in conjunction with the positioning contacts whereby the motor is automatically stopped, started, and reversed.

The object of the present invention is to generally improve and simplify the construction and operation of apparatus of the character described; to provide an improved, simplified motor control; and, further, to provide independently adjustable means for regulating the air and fuel supply to obtain the most efficient fire conditions during the different fire stages.

The invention is shown by way of illustration in the accompanying drawings, in which—

Fig. 1 is an end view of a housing which encloses and supports the control mechanism, said end view disclosing the reduction gears whereby rotary movement is transmitted from the electric motor to the controller shaft,

Fig. 2 is a cross section of the housing and the apparatus carried thereby taken on line II—II of Fig. 4,

Fig. 3 is a similar cross section taken on line III—III of Fig. 4,

Fig. 4 is a vertical, longitudinal section taken on line IV—IV of Fig. 2,

Fig. 5 is a longitudinal plan section taken on line V—V of Fig. 3, said view showing the controller shaft, the motor and the reduction gear connecting the motor and the controller shaft,

Fig. 6 is a plan view of Fig. 1 showing the cover removed, said view being also broken away to disclose one of the contact actuating levers,

Fig. 7 shows the wiring diagram of the apparatus,

Fig. 8 shows the installation of the apparatus and the manner in which it is connected with the oil controlling and air regulating valve of an oil burner,

Figs. 9 and 10 are diagrammatic views showing different methods of unbalancing the motor circuit.

Referring to the drawings in detail and particularly Figs. 1 to 6, inclusive, 1 indicates a housing on one side of which is arranged an electric motor of the induction type as will hereinafter be described. This motor is indicated at 2 and its function is that of imparting rotary movement to a controller shaft 3 which is journaled within the housing, rotation being transmitted from the motor to the shaft 3 through a set of reduction gears generally indicated at 4. Mounted on and secured to the controller shaft are a plurality of cams which are divided into two groups. The first group contains two pairs of cams indicated at 5, 6, 7 and 8. The second group of cams are formed on a drum 9 secured on the controller shaft and the cams formed thereon are indicated by the numerals 10, 11, 12, 13, 14. The function of the last named cams is that of actuating a plurality of electric contact arms generally indicated at 10*a*, 11*a*, 12*a*, 13*a*, and 14*a*, while the function of the cams indicated at 5 to 8, inclusive, is that of actuating a pair of main operating arms indicated at 15 and 16, arm 15 being connected with an oil controlling valve 17 and arm 16 being connected with an air regulating valve generally indicated at 18, see Fig. 8.

The control apparatus illustrated in the present instance is particularly intended for regulating the flow of oil and air to a burner and the control apparatus is so constructed and operated that a plurality of fire stages will be maintained, for instance a low fire, a medium fire, and a high fire. Means are provided for independently regulating the adjustment of the arms 15 and 16 for each stage so that the most efficient fire may be maintained. This is accomplished as follows:

By referring to Figs. 2 and 6, it will be noted that arm 15 is shown in three positions, the full line position at 15 and the two dotted line positions shown at 15*a* and 15*b*. The full line position is assumed by the arm when the low fire is maintained. The dotted line position at 15*a* when a medium fire is being maintained and the dotted line position shown at 15*b* when a high fire is being maintained. Arm 15, see Fig. 8, is connected through means of a link 19 with a crank arm 20 which, in turn, is secured to the valve 17 and as arm 15 swings about its pivotal support 21 it will transmit rotary motion to the valve 17 and thereby increase or decrease the flow

of oil to the burner. Arm 16 is similarly connected through means of a link 22 with a crank arm 23 and this is connected to the air valve 18 and as arm 16 swings about its pivotal support 21 the air valve will be opened or closed and thereby regulate the quantity of air supplied to the burner. Each arm is provided with an adjusting screw such as shown at 24, these screws engaging the top of the motor housing and by being adjusted arms 15 and 16 may be raised or lowered with relation to said housing thereby adjusting the respective air and oil valves to obtain maximum efficiency of combustion during the low fire stage.

The cams indicated at 5 to 8, inclusive, do not engage and do not actuate the arms 15 and 16 when low fire position is maintained, hence by providing the adjusting screws 24 any desired regulation of air and oil may be obtained during the low fire state. The cams 5 to 8, inclusive, are secured on the controller shaft and they only actuate arms 15 and 16 during medium and high fire, this being accomplished by closing a circuit through the motor and causing rotation thereof in a direction which will rotate the controller shaft to swing the cams into operative position. When a circuit is closed through the motor the direction of rotation of the controller shaft will be in the direction of arrow *a*, see Fig. 2. When changing from low fire to medium fire four follower arms indicated at 25 engage the respective cams, these follower arms are pivoted on the shaft 21 and each main arm 15 and 16 is provided with a pair of adjusting screws such as shown at 26 and 27. These adjusting screws engage the respective follower arms and by adjusting the individual screws it is possible to obtain the best adjustment of oil and air for medium fire and for high fire.

The furnace operated by the burner shown in Fig. 8 may operate a steam boiler, a hot water heater, a hot air furnace, or whatever the case may be. If a steam boiler is being operated the pressure of the steam is depended upon to control the apparatus here disclosed. By referring to Fig. 7 a steam pipe connected with the boiler is shown at 30. This is connected with a housing 31 in which is mounted a sealed bellows tube 32, a lever 33 and an adjustable pressure spring 34. The lever 33 is pivoted as indicated at 35 and its opposite end is connected through a link 36 with a crank arm 37 secured to a pivotally mounted bracket 38 which in turn supports a pair of mercury actuated circuit making and breaking tubes indicated at 39 and 40. As the pressure in the boiler increases or decreases movement of the bellows tube 32 is transmitted through a pin 32*a* to impart motion to the arm 33 against the tension of the spring 34 and as the lever 33 swings about its pivot motion is transmitted to the bracket 38 causing this to swing about its pivot and to tilt the tubes 39 and 40 to assume different positions so as to make or break circuits through the contacts carried thereby. That is, when the tubes are tilted in one direction the mercury runs down the tubes and engages the contacts and closes a circuit through the same. During the reverse movement the circuit is broken as the mercury runs to the opposite end of the tube. The apparatus just described and shown in the upper part of Fig. 7 will be referred to as the actuating apparatus and the circuit making and breaking tubes actuated thereby and indicated at 39 and 40 will be referred to as the high fire and medium fire contact breakers, respectively.

It was previously stated that motion was transmitted to the control shaft 3 by means of an induction type of motor such as indicated at 2. The motor is equipped with a polyphase winding as shown in Fig. 7, which forms a portion of a balanced bridge. When the circuit is balanced the rotor indicated at 2*a* remains stationary but when the circuit is unbalanced the rotor will rotate in one direction or the other depending upon the manner in which the circuit has been unbalanced. The balancing or unbalancing means employed are three condensers generally indicated at A, B, and C. One side of each condenser is connected through a wire 55 with a resistor 41 functions to reduce surge currents in the circuit. The opposite terminal of this resistor is connected with a wire 42 and this is in turn connected with the contactor arms 10*a* and 11*a*. The other side of condenser A is connected through wire 43 with contactor arms 12*a*, 13*a* and 14*a*. The other side of the condenser C is connected with the polyphase windings of the motor and the other side of the condenser B is connected with a line wire L2, this wire being also connected with one terminal of the polyphase windings. The other side of the line wire indicated at L1 is connected with the second terminal of the polyphase windings as shown and it is also connected through wire 44 with wire 45, one end of this wire being connected with contact 14*b* and the other end being connected with the terminals 46 and 47 of the high and medium circuit breaking tubes indicated at 39 and 40, respectively. The opposite terminal of tube 39 is connected through wire 48 with contacts 10*b* and 13*b* and the opposite terminal of tube 40 is connected through wire 49 with contacts 11*b* and 12*b*.

Before explaining the operation it might be stated that in the low fire position contacts 10*b*, 11*b* and 14*b* are closed and contacts 12*b* and 13*b* are open. The contacts in the main circuit breaking tubes 39 and 40 are also open.

In medium fire position contacts 10*b* and 12*b* are closed. Contacts 11*b*, 13*b* and 14*b* are open and the circuit through tube 40 is closed.

In high fire position contact 13*b* is closed. Contacts 10*b*, 11*b*, 12*b* and 14*b* are open and the circuits through the tubes 39 and 40 are closed.

The operation is as follows: If the furnace is operating under low fire and the pressure drops it means that the spring 34 will overcome the pressure on the bellows tube 32 thereby causing lever 33 to swing in an upward direction and as this swings in that direction motion is transmitted through link 36 to rock the bracket member carrying the tubes 39 and 40 in a direction which will cause the mercury to flow from one end to the other. That is, towards the ends where the contacts are mounted. By referring to Fig. 7, it will be noted that the lower tube 39 is set on a slight angle, hence as the bracket tips, a circuit through the tube 40 will be closed prior to the closing of the circuit through the tube 39; hence if the pressure in the boiler drops it means that the low fire position is not producing sufficient steam to maintain the pressure. A medium fire is accordingly required to maintain the pressure and as the spring tension overcomes the pressure of the bellows tube lever 33 gradually moves upwardly and tilts bracket 38 to a position where a circuit is closed through the

contacts contained in the medium fire tube indicated at 40. This immediately completes a circuit from the line wire L1 to the common connecting wire 55, which connects the several condensers, the circuit being traced through wire 44, tube 40, wire 49, contact arm 11a, wire 42, resistor 41 and wire 55. This circuit unbalances the bridge causing a phase rotation in the windings of the motor. With the motor rotating in one direction motion is transmitted to the controller shaft rotating this to a medium fire position. During such rotation contact 12b is closed and contactor 11b is opened, thus reestablishing the balanced circuit which causes the rotor of the motor to come to a stop in the medium fire position.

If during medium fire operation the consumption of steam is so great that a predetermined pressure cannot be maintained, spring 34 will again overcome the pressure on bellows tube 32 and arm 33 will move upwardly, this motion being transmitted to the bracket 38 causing it to tilt still further in the same direction, thus bringing tube 39 to a point where the mercury will run down and close a circuit through the contacts. With this circuit closed the balance of the bridge is again destroyed in the manner previously described causing the motor to rotate in the same direction as before and to raise the control arms 15 and 16 to a high fire position. During such rotation contact 12b is opened and contact 13b is closed. When the control finally assumes high fire position contact 10b opens thereby balancing the circuit and causing the motor to be electrically locked and to come to a stop.

When the control apparatus has reached high fire position it can go no further as maximum fire is being maintained and the next position assumed, if any, will be a medium fire and this is accomplished when the high fire circuit controlling tube 39 breaks the circuit. This of course will not open unless the boiler pressure increases. In that case lever 33 moves in a downward direction transmitting a reverse tilting movement to the bracket 38, hence causing the mercury in the tube 39 to run down and break the circuit through the contacts. Such breaking of the circuit again causes unbalancing of the motor circuit by disconnecting the condenser A from the line wire L1, hence leaving wire 55 connected to the line wire 12 through condenser B. The unbalancing of the bridge in this manner again causes phase rotation in the motor windings but in a direction opposite to its previous rotation, hence reversing the motion of the controller shaft and causing lowering of the control arms 15 and 16 until they assume a medium fire position. During such movement or rotation of the control shaft contact 10b is closed and contact 13b opened. Contact 12b is again closed thereby balancing the motor circuit, that is, providing the medium fire contactor 40 is closed. If this should be broken by further downward movement of the lever 33 the motor would continue to rotate in the same or reversed direction and the apparatus would finally assume low fire position. On the other hand, if the circuit through the medium fire contactor 40 is closed the motor circuit will be balanced and the motor and apparatus will come to a stop.

If the pressure in the boiler still increases further downward movement of lever 33 will take place and rotation will be transmitted to the bracket 38 causing the circuit in the tube 40 to be broken. The breaking of this circuit again unbalances the motor circuit and the motor will continue to rotate in the same direction. During this movement contact 11b will be closed and contact 12b opened and when the controller shaft reaches full low fire position contact 14b will close again balancing the motor circuit thereby causing the motor and apparatus to come to a stop.

It is apparent that any number of stages can be worked out by adding more positioning contacts and more controlling tubes similar to the tubes shown at 39 and 40. Also the control of the motor is obtained by the balancing and unbalancing of the motor circuit through the wire 55. Further, it follows that a set of contactors could be inserted in branch B of the balance circuit as well as in branch A, as here shown, or the contactors could be inserted in both branches A and B for any number of arrangements and stages.

By referring to Figs. 9 and 10, two different methods whereby the motor current may be unbalanced are disclosed. In Fig. 9, if switch arm 60 engages contact 61a phase displacement in the windings takes place and the rotor will rotate in one direction. On the other hand, if the switch arm engages contact 62 the phase displacement is changed and the rotor will be reversed. In Fig. 10, two switches 63 and 64 are employed. If switch 63 is open and switch 64 closed the circuit is balanced, if switch 63 is closed phase displacement takes place and the rotor will rotate in one direction. If both switches are opened, phase displacement is changed and the rotor is reversed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In an apparatus of the character described, a controller shaft, a plurality of operating arms pivotally mounted adjacent said shaft, a plurality of cam members secured on the controller shaft and being one pair of cams for each operating arm, a plurality of pivotally mounted follower arms one for each cam and engageable therewith, a pair of adjusting screws carried by each operating arm one of each pair of screws engaging an adjacent follower arm, a reversible electric motor, a reduction gear train connecting the motor and the controller shaft, and automatically actuated means for stopping, starting and reversing the motor to impart a step by step rotary movement to the controller shaft and the cams carried thereby in one direction or another.

2. In an apparatus of the character described, a controller shaft, a plurality of operating arms pivotally mounted adjacent said shaft, a plurality of cam members secured on the controller shaft and being one pair of cams for each operating arm, independently adjustable means whereby movement of the cams is transmitted to raise or lower the free ends of the operating arms about their pivots, a valve connected with each operating arm and actuated thereby, a reversible electric motor, a reduction gear train connecting the motor and the controller shaft, and automatically actuated means for stopping, starting, and reversing the motor to impart a step by step rotary movement to the controller shaft in one direction or another.

WILLIAM A. RAY.