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FURNACE CONTROLLING APPARATUS

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Fig. 1

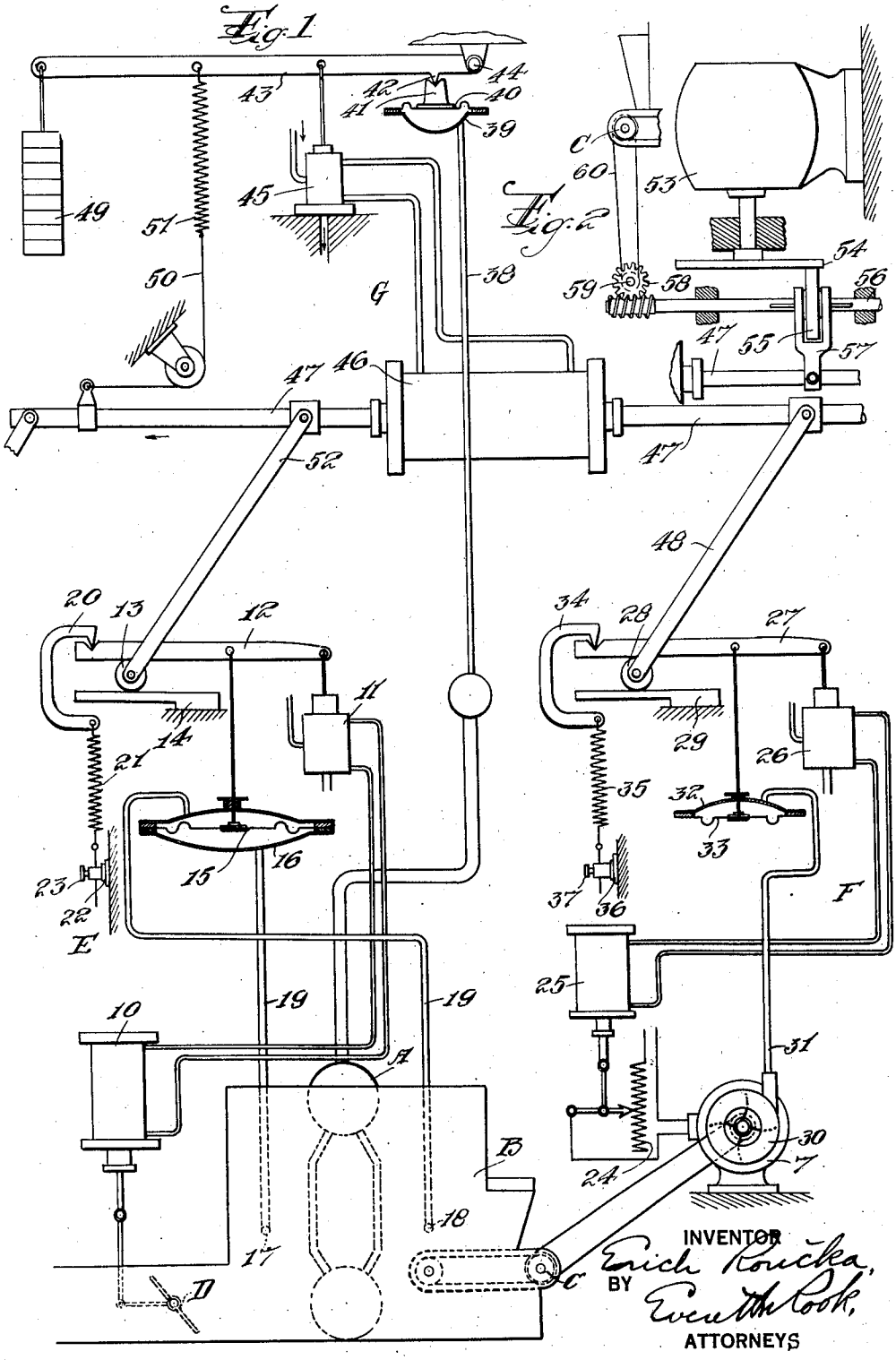


Fig. 2

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FURNACE-CONTROLLING APPARATUS.

Application filed August 23, 1927, Serial No. 214,930, and in Germany September 1, 1926.

This invention relates to apparatus for controlling furnaces, particularly furnaces associated with steam boilers, one object of the invention being to provide novel and improved means for automatically controlling the drafts of the furnace and the supply of fuel to the furnace.

Another object is to provide such apparatus including novel and improved means for controlling the drafts and the supply of fuel in accordance with the demand or load on the furnace, for example the demand for steam on a steam boiler associated with the furnace.

A further object is to provide such apparatus including means for automatically controlling the drafts and means for automatically controlling the supply of fuel, in combination with means actuated in accordance with the load or demand on the furnace which in turn regulates the actuation of the draft control means and the fuel supply control means, so that the draft and the supply of fuel are controlled in accordance with the load on the furnace.

Other objects are to provide in such apparatus a normally balanced means for controlling the draft in the furnace, a normally balanced means for controlling the supply of fuel to the furnace, and means actuated in accordance with the load on the furnace for varying the balance of the first two-mentioned means so that both the draft and the supply of fuel are regulated in accordance with the load on the furnace; to provide in such apparatus a pair of movable members both actuated by a pilot motor controlled in accordance with the demand on the furnace and one of which varies the actuation of the means for controlling the draft, and the other of which varies the actuation of the means for controlling the supply of fuel; to provide such apparatus including lever systems for respectively controlling the draft and the supply of fuel, the leverage of said systems being varied by means actuated in accordance with the load on the furnace; and to obtain other advantages and results as will be brought out by the following description.

Referring to the accompanying drawings, in which corresponding and like parts are designated throughout the several views of the same reference characters,

Figure 1 is a schematic illustration of a furnace controlling apparatus embodying my invention, and

Figure 2 is a fragmentary schematic view of a modified form of apparatus for controlling the supply of fuel.

The apparatus embodying my invention includes certain features described and claimed in my copending application Serial No. 24,629, filed April 20, 1925, but in that application there is no means for controlling the supply of fuel.

Specifically describing the illustrated embodiment of the present invention, the reference character A designates a steam boiler in which steam is generated by a furnace B which includes an automatic stoker C. The draft through the furnace is regulated by a damper D which is automatically controlled by mechanism generally designated E. The supply of fuel by the stoker C is automatically controlled by mechanism generally designated F, and both of the mechanisms E and F are regulated by mechanism G actuated in accordance with the load on the furnace, or in the present instance the demand for steam on the boiler A. In this connection, it should be understood that any condition variable in accordance with the demand on the furnace may be utilized as the actuating force for the mechanism G, for example temperature, steam pressure, rate of flow of steam from the boiler, etc.

The mechanism E includes a fluid pressure operated servo-motor 10 including a cylinder and piston, the latter of which is operatively connected to the damper D so that reciprocation of the piston will oscillate the damper to open and closed positions. The flow of compressed air or the like to and from the motor 10 is controlled by a governor valve 11 of the cylinder and piston type, the piston of which is connected to one end of a lever 12 fulcrumed intermediate its ends upon a movable roller 13 interposed between the lever and a fixed support 14. Said end of the lever is also connected to the diaphragm 15 of a device 16 responsive to differences in pressure of the combustion gases in the furnace at the points 17 and 18, said device 16 being connected at opposite sides of the diaphragm to the furnace by pipes 19. The other end of the lever is connected by a bow 20 and a tension spring 21 to a fixed support 22. The

tension of the spring 21 is adjustable in any suitable manner by a set screw 23. With this construction, it will be understood that the tension of the spring 21 may be adjusted to balance the pressures exerted on the diaphragm 15 so that the apparatus will be in balanced condition with a predetermined draft pressure in the furnace; and when the draft pressures vary the change in the difference in pressure at opposite sides of the diaphragm 15 will cause an oscillation of the lever 12 which in turn will actuate the governor valve 11 and set the motor 10 in motion, whereby the damper D is adjusted to increase or decrease the draft, depending on the original variation. The apparatus E therefore automatically tends to maintain a constant draft pressure in the furnace.

The fuel supply mechanism F includes an electric motor 7 which actuates the automatic stoker C, the current to said motor being controlled by a rheostat 24 actuated by a servomotor 25 similar to the motor 10, the flow of compressed air to and from which is controlled by a governor valve 26 similar to the valve 11. The piston of the valve 26 is connected to one end of a lever 27 fulcrumed intermediate its ends on a movable roller 28 interposed between the lever and a fixed support 29. The motor 7 drives a blower fan or the like 30 the outlet of which is connected by a pipe 31 to a pressure responsive device 32 at one side of the diaphragm 33 the other side of which is exposed to the atmosphere. The diaphragm 33 is connected to the same end of the lever 29 as the piston of the valve 26, and the other end of said lever is connected by a bow 34 and a tension spring 35 to a fixed support 36. The tension of the spring 35 is adjustable by suitable means 37. With this construction it will be observed that the blower fan 30 constantly exerts pressure on the diaphragm 33, which pressure varies in accordance with the supply of fuel by the stoker C for the reason that both the fan and the stoker are actuated by the same motor 7. The difference in pressure at opposite sides of the diaphragm 33 may be initially balanced by setting the spring 35, so that the mechanism will be in balanced condition when a predetermined rate of fuel supply obtains, and the mechanism will therefore tend to maintain a uniform rate of fuel supply.

The rate of fuel supply must vary in accordance with the demand or load on the furnace, more fuel being required when the load increases and less fuel when the load decreases. Accordingly, means is provided for regulating the actuation of the mechanism F in accordance with the demand on the furnace, in the present instance the withdrawal of steam from the boiler A. The boiler is connected by a pipe 38 to a pressure responsive device 39 at one side of a diaphragm 40 the other side of which is exposed to the atmosphere and carries a fulcrum pedestal 41 upon which bears a knife edge 42 on a lever 43 pivoted at one end adjacent the knife edge 42 as at 44 to a fixed support. The piston of a fluid pressure governor valve 45, like the valves 11 and 26, is connected to the lever 43 and controls the flow of fluid pressure to and from a piston and cylinder pilot motor 46, the piston rod 47 of which projects from opposite ends of the cylinder and has one end provided with a lateral arm 48 operatively connected to the roller 28 so as to move said roller longitudinally of the lever 27 upon longitudinal movement of the piston rod. The pressure exerted by the steam from the boiler A on the diaphragm 40 is balanced by a counterweight 49, so that when a predetermined steam pressure obtains in the boiler A the lever 43 is at rest and the mechanism G is in balanced condition. When the steam pressure increases or decreases, the lever 43 is moved in one direction or the other and actuates the governor valve 45 so that the piston rod 47 is moved in one direction or the other, whereby the balance between the spring 35 and the difference in pressure at opposite sides of the diaphragm 33 will be disturbed. Such disturbance will cause an actuation of the governor valve 26 which in turn produces movement of the piston of the motor 25 which actuates the rheostat 24 to vary the current supplied to the motor 7. The speed of the motor is thereby varied and accordingly also is the supply of fuel by the stoker C. Obviously the pressure created by the fan 30 is also varied. It will be clear that an increase in the steam pressure in the boiler A due to a slack in the demand, will cause a reduction in the rate of fuel feed, while a decrease in the steam pressure due to increased demand on the boiler will cause an increase in the rate of fuel supply. The rate of fuel supply will continue to be varied until the pressure created by the fan 30 again balances the tension of the spring 35. The piston rod 47 is connected by a flexible cable 50 and a tension spring 51 to the lever 43 so that movement of the piston rod tends to return the lever to normal or neutral position. In other words, when the lever 43 is moved upwardly by an increase in steam pressure, the piston rod 47 moves in the direction of the arrow so as to increase the tension of the spring 51, thereby tending to return the lever 43, and upon a decrease in steam pressure a reverse action takes place. It will be understood from the foregoing that the supply of fuel is controlled in accordance with the demand on the furnace.

It is also desirable that the draft be controlled in accordance with the demand on the furnace, and accordingly the piston rod 47 is provided with a second arm 52 which is operatively connected to the roller 13 so that movement of the piston rod varies the balance of the lever 12, an increase in the demand

on the furnace causing a movement of the roller 13 so as to increase the draft, while a decrease in the load on the furnace causes actuation of the mechanism E to reduce the draft.

A modified form of apparatus for controlling the fuel supply is shown in Figure 2 of the drawings, and includes the electric motor 53 the current supply for which is controlled by a rheostat, as shown in Figure 1 of the drawings. The motor is preferably disposed with its shaft vertical and has secured to said shaft a disk 54 against which bears a wheel 55 mounted upon a countershaft 56 to rotate therewith but slidable longitudinally thereof. The wheel 55 is actuated longitudinally of the shaft 56 by a bifurcated arm 57 secured to the piston rod 47 of the motor 46. The shaft 56 has a worm which meshes with a worm gear 58 on a second countershaft 59, which is in turn geared by chain and sprocket gearing 60 to the automatic stoker C. With this construction, it will be observed that the speed of actuation of the stoker C will vary in accordance with the relative position of the wheel 55 and the disk 54, the greater the distance of the point of contact of the wheel 55 with the disk 54 from the center of the disk, the greater being the speed of actuation of the stoker. This point of contact is controlled by movement of the piston rod 47 which as above described is controlled in accordance with the demand on the furnace.

Obviously the piston rod 47 may be connected to additional mechanisms like E and F by merely adding other arms like 48 and 52.

Having thus described the invention, what I claim is:

1. Furnace controlling apparatus, comprising means for varying the flow of combustion gases in a furnace, means responsive to variations in the pressure of said combustion gases, means cooperating with said responsive means to produce a normally balanced relation, a movable member for varying said relation, means actuated by cooperation of the two last-mentioned means upon departures from said balanced relation to cause actuation of the first-mentioned means, a fuel supplying means, means automatically responsive to the rate at which said fuel supplying means operates, means cooperating with the last-mentioned means to produce a normally balanced relation, a second movable member for varying the last-mentioned relation, means actuated by cooperation of said means responsive to the rate of fuel supply and said means producing a balanced relation to vary actuation of said fuel supplying means, a common means for actuating both of said movable members, and means responsive to a condition variable in accordance with the heat demand on the furnace for controlling actuation of said common means.

2. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a servo-motor for actuating said means, a governor for controlling said motor, a movable pressure sensitive means responsive to variations in the pressure of the combustion gases of the furnace, means to cooperate with said sensitive means to produce a balanced relation, a movable member for varying the cooperation of said two last-mentioned means for varying the flow of combustion gases, means for supplying fuel to the furnace, means for varying the speed of said means for supplying fuel to vary said supply, a second movable member to cooperate with the last-mentioned means so as to regulate the variations in said speed, the position of said member having a predetermined adjustable relation to the magnitude of the fuel feed, an auxiliary pilot motor for actuating both of said movable members, a governor for controlling said pilot motor, a movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

3. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a servo-motor for actuating said means, a governor for controlling said motor, a movable means responsive to variations in the pressure of the combustion gases in the furnace, means to cooperate with said responsive means to produce a normally balanced relation, a movable member for varying the cooperation of the two last-mentioned means so as to vary the flow of combustion gases, means for supplying fuel to the furnace, means for varying the rate of operation of said means for supplying fuel, a second servo-motor for actuating the last-mentioned means, a governor for controlling said second servo-motor, means actuated according to the rate of fuel supply to produce a force which has a certain relation to the rate of fuel supply, a movable means responsive to said force, means to cooperate with the last-mentioned responsive means for balancing said force, a second movable member for varying the relation of the two last-mentioned means, a common auxiliary pilot motor for actuating both of said movable members, a governor for controlling said motor, movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

4. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a servo-motor for actuating said means, a governor for controlling said motor, movable means respon-

sive to variations in the pressure of said combustion gases in the furnace, means including a lever system to cooperate with said responsive means to produce a normally balanced condition, a movable member for varying the relation of the two last-mentioned means so as to vary the flow of combustion gases, means for supplying fuel to the furnace, means for varying the rate of operation of said fuel supplying means, a second movable member to cooperate with the last-mentioned means so as to control the variations in said rate of operation of the fuel supplying means, a common auxiliary pilot motor for actuating both of said movable members, a governor for controlling said motor, a movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

5. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a pilot motor for actuating said means, a governor for controlling said motor, movable means responsive to variations in the pressure of said combustion gases in the furnace, means including a lever system to cooperate with said responsive means to produce a normally balanced relation, a movable member for varying the relation of the two last-mentioned means so as to vary the flow of combustion gases, means for supplying fuel to the furnace, means for varying the rate of operation of said fuel supplying means, a second pilot motor for actuating the last-mentioned means, a governor for controlling said second pilot motor, means actuated according to the rate of fuel supply, a movable means responsive to variations in the actuation of the last-mentioned means for producing a force which has a certain relation to the rate of fuel supply, means to cooperate with the last-mentioned responsive means for balancing said force, a second movable member for varying the relation of the two last-mentioned means, a common auxiliary pilot motor for actuating both of said movable members, a governor for controlling said motor, movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

6. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a servo-motor for actuating said means, a governor for controlling said motor, movable means responsive to variations in the pressure of said combustion gases in the furnace, means including a lever system to cooperate with said responsive means to produce a normally balanced condition, a movable member for varying the leverage of said lever system to vary the relation of the two last-mentioned means, means for supplying fuel to the furnace, means for varying the rate of operation of said fuel supplying means, a second movable member to cooperate with the last-mentioned means to control the variations in said rate of operation, a common auxiliary pilot motor for actuating both of said movable members, a governor for controlling said motor, movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive adapted to be actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

7. A combustion controlling system, comprising means for varying the flow of combustion gases in a furnace, a servo-motor for actuating said means, a governor for controlling said motor, movable means responsive to variations in the pressure of said combustion gases in the furnace, means including a lever system to cooperate with said responsive means to produce a normally balanced condition, a movable member for varying the leverage of said lever system to vary the relation of the two last-mentioned means, means for supplying fuel to the furnace, means for varying the rate of operation of said fuel supplying means, a second servo-motor for actuating the last-mentioned means, a governor for controlling said second servo-motor, means adapted to be actuated according to the rate of fuel supply, a movable means responsive to variations in the actuation of the last-mentioned means for producing a force which has a certain relation to the rate of fuel supply, means to cooperate with the last-mentioned responsive means for balancing said force, a second movable member for varying the relation of the two last-mentioned means, a common auxiliary pilot motor for actuating both of said movable members, a governor for controlling said motor, movable means sensitive to a condition variable with the heat demand to actuate said governor, and a return drive actuated by said auxiliary motor for cooperating with the last-mentioned movable sensitive means.

8. Furnace controlling apparatus, comprising means for varying the flow of combustion gases in a furnace, means responsive to variations in the pressure of said combustion gases, means cooperating with said responsive means to produce a normally balanced relation, a movable member for varying said relation, means actuated by cooperation of the two last-mentioned means upon departures from said balanced relation to cause actuation of the first-mentioned means, a fuel supplying means, means automatically responsive to the rate at which said fuel supplying means operates, means including a lever system cooperating with the last-men-

tioned means to produce a normally balanced relation, a second movable member for varying the leverage of said lever system to vary the last-mentionel relation, means actuated by cooperation of said means responsive to the rate of fuel supply and said means producing a balanced relation to vary actuation of said fuel supplying means, a common means for actuating both of said movable members, and means responsive to a condition variable in accordance with the heat demand on the furnace for controlling actuation of said common means.

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