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COMBINATION REGULATOR

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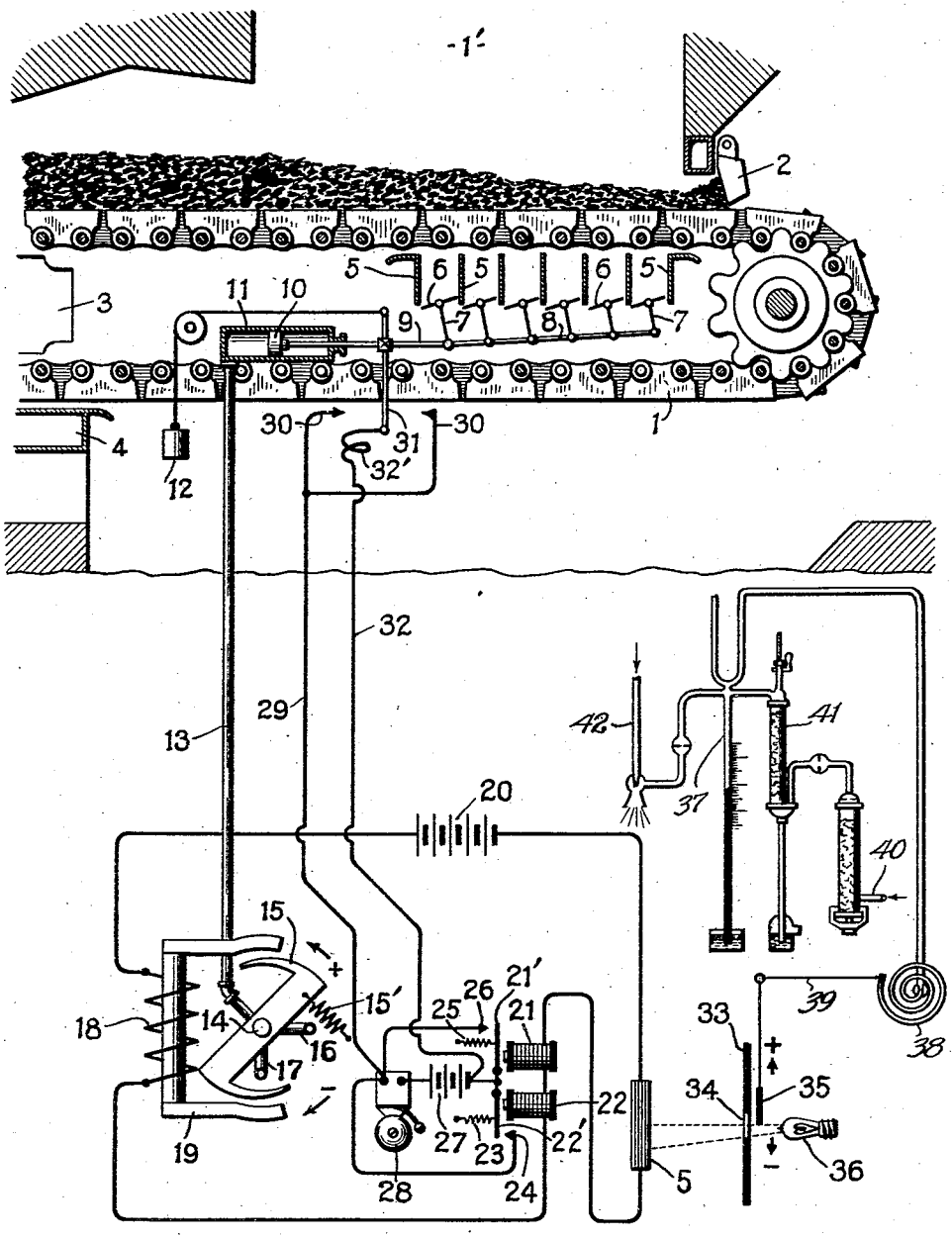

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COMBUSTION REGULATOR.

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As is well known in the burning of any of the usual kinds of fuels, the best combustion conditions are obtained when the percentage of CO_2 (carbon dioxide) in the gases resulting from the combustion is maintained at or near some definite point, say, from 13 to 15 per cent. If the CO_2 content exceeds the optimum found to give the best commercial conditions, CO (carbon monoxide) is contained in the gases of combustion, while if the content is less than this optimum, there is present an unnecessary surplus of air.

One of the objects of the present invention is to provide an arrangement by which the correct combustion conditions may be automatically maintained in the furnace, such regulations being controlled by the percentage of CO_2 in the combustion gases. Such combustion conditions may be controlled either by regulating the supply of combustion air or the supply of fuel, and the invention may be applied to furnaces burning any of the usual forms of fuel.

One embodiment of the invention is illustrated more or less diagrammatically in the annexed drawing in which the invention is shown applied to a chain-grate stoker with coal as the fuel.

In the drawing, 1 is a chain-grate stoker of the usual type and carrying a fuel bed beneath a furnace chamber 1'. An air sealing and ash and clinker collecting device 2 is provided at the rear of the fuel bed, the front part of the grate, in the illustrative embodiment, being cut off from the rear portion by the boxes 3 and 4. Forced draft is supplied to the rear part of the chain gate, the plates 5 forming a series of ducts each having a damper 6 to regulate the flow of air through the duct. Each of the dampers is provided with an arm 7 connected to a rod 8, the length of the arms 7 preferably varying from front to rear, so that for a given movement of the rod 8, the dampers at the rear of the grate will be open farther than the corresponding dampers at the front of the grate.

As a means for moving the damper 6, a water-power operated motor has been illustrated. This motor has a cylinder 11 in which is a piston 10 connected through the piston rod 9 with the rod 8. A weight 12 is arranged to draw the rod 8 normally to the left of the figure. To the rear of the cylinder 11 is connected a pipe 13 which, in turn, may be connected to a pressure supply pipe 16 or to an outlet pipe 17 by means of a three-way valve 14. When the valve 14 is set in position to connect pipe 16 with pipe 13, the water pressure will move piston 10 to the right of the figure to open the dampers 6, and correspondingly when the valve 14 is moved to close the connection between pipes 16 and 13 and to open the connection between pipes 13 and 17, the pressure in the cylinder 11 is decreased and the weight 12 will draw the rod 8 to the left of the figure to close the dampers 6.

In the illustrative embodiment, the three-way valve 14 is operated electrically by means of an armature 15 connected to the valve 14 and turned clockwise by the spring 15'. A magnet 19 having a field coil 18 cooperates with the armature 15 and will be energized by some source of electrical energy, as the battery 20, this battery and the field 18 having in its circuit a selenium cell S, the resistance of which will be varied by the amount of light falling thereon from a source of light 36 passing through an opening 34 in a screen 33. The amount of light will be determined by the position of the pointer 35 of any of the well-known measuring apparatus, such as the Ranarex, Siemens' or Uhling fuel gas testers, adapted to register continuously the CO_2 content of the fuel gases.

With the apparatus so far described, if the CO_2 content of the fuel gases exceeds the predetermined amount, the pointer 35 will then move upward or in the direction of the "plus" arrow of the figure. This exposes more of the opening 34, so that a larger portion of the selenium cell is exposed to the light and its resistance is correspondingly decreased. The current strength in the winding 18 and correspondingly the strength of the magnet 19 are thus increased, whereby the armature 15 is attracted against the tension of its spring 15'. This turns the three-way cock 14 so that water under pressure is admitted from the pipe 16 to the pipe 13 to move the rod 8

to the right of the figure, and thus open the damper 6 to supply more air into the fuel, this motion continuing until the percentage of CO_2 is brought again within the desired limit.

Correspondingly if the percentage of CO_2 decreases below the desired limit, the indicator 35 will be moved downward or in the direction of the "minus" arrow of the figure to close the opening 34, so that the selenium cell S will receive less light. This, in turn, will decrease the strength of the magnet 19 and the armature 15 will be returned toward its original position by the spring 15' and thus move the three-way cock to close the connection between the supply pipe 16 and the pipe 13 and open the connection between the outlet pipe 17 and the pipe 13 to relieve the pressure back of the piston 10. The rod 8 will now be moved to the left of the figure by the weight 12 to close the dampers to decrease the supply of combustion air.

The means for actuating the indicator or shutter may consist of a CO_2 recorder of the Uhling type, the indicating tube 37 of which is connected to a Bourdon tube 38 or other means sensitive to minute changes in pressure. The free end of the latter is then connected by means of a cord 39 with the shutter 35. Gases from the furnace enter the recorder through tube 40 and pass through the CO_2 absorbing column 41, the inlet and outlet to which are equipped with the usual standard orifices, as shown. The outlet terminates with the aspirator 42. Fluctuations in the CO_2 content then produce variations in the suction maintained by the aspirator 42, and these changes of pressure alter the position of the free end of the Bourdon tube in a manner well understood.

In many cases it will not be possible to vary the combustion conditions automatically between the extremes which may be found, and to warn the operator when the limits of adjustability have been reached, a system of signals have been provided. In the form illustrated, a bell 28 is connected with one pole of a battery 27, the other pole being connected through a wire 32 having a flexible portion 32' with a rod 31 attached to the piston rod 9. The other terminal of the bell 28 is connected to each of a pair of contacts 30 arranged respectively on opposite sides of the rod 31. When the piston 10, and with it the rod 9, is moved to either end of its possible travel, contact is made between the rod 31 and one of the contacts 30 to close the circuit through the battery 27 and the bell 28 to notify the operator that the furnace conditions are out of the control of the automatic apparatus, heretofore described. As a further means of notifying the operator of the operating conditions, solenoids 21 and 22 may be placed in the circuit containing the selenium cell S, the solenoid 21 having an armature 21' held normally against a contact piece 26 by a spring 25 and solenoid 22 having an armature 22' normally held away from the contact member 24 by a spring 23. Each of these armatures 21' and 22' is connected to one pole of the battery 27 and each of the contacts 24 and 26 is connected to the terminal of the bell 28, which is not connected to the battery 27. When the resistance of the selenium cell S causes the current through the solenoids to increase, the solenoid 22 overcomes the resistance of the spring 23 and closes the circuit through the contact 24 to ring the bell 28. Similarly, when the resistance of the selenium cell S causes the current through the solinoids to decrease, the spring 25 will close the contact between 26 and 21' to ring the bell. The signalling devices last described may be used alone or in combination with the signal control by the rod 31.

While the invention has been shown in connection with a chain-grate stoker, it will be understood that this is merely an illustrative embodiment, and that the invention may be used in connection with other forms of fuel. Moreover, while preferably the supply of combustion air is the element of combustion which is to be regulated, it will be understood, particularly where liquid or gaseous fuels are used, that the proper combustion conditions may be brought about by regulating the supply of the fuel while the supply of air remains substantially constant, or if desired, both the fuel and the air supply may be varied.

I claim:

1. In a furnace, means for supplying fuel to the furnace, means to supply combustion air to the fuel, and automatic means, controlled by the CO_2 content of the combustion gases, to increase the supply of combustion air when the CO_2 content of the combustion gases exceeds a predetermined percentage, and to decrease the supply of combustion air when the CO_2 content of the combustion gases is less than a predetermined percentage, an alarm device, and means for actuating said device when the CO_2 content reaches a given limiting value.

2. In a furnace, a fuel supporting grate, means to supply combustion air to the entire area of the grate, and means controlled by the CO_2 content of the combustion gases, to vary the supply of combustion air to one part of the grate relatively to the amount of combustion air supplied to the remainder of the grate.

3. In a furnace, a fuel supporting grate, arranged to move the fuel through the furnace chamber from front to rear as the fuel is being burned, means to supply combustion

air to the fuel during its travel through the chamber, and means, controlled by the CO_2 content of the combustion gases, to vary the supply of combustion air to the fuel at the rear part of the grate relatively to the amount of combustion air supplied to the front part of the grate.

4. In a furnace, a fuel supporting grate, means for supplying combustion air thereto, a plurality of ducts spaced longitudinally beneath a portion of the grate, dampers in said ducts, means controlled by the CO_2 content of the combustion gases to vary the positions of said dampers, said position varying means including means permitting a greater movement of the dampers located toward the rear end of the grate than those at the front end of said grate

5. In a furnace, a chain grate, means to supply combustion air to the entire fuel bed on the grate, and means, controlled by the CO_2 content of the combustion gases, to vary the supply of combustion air to the fuel at the rear part of the grate relatively to the amount of combustion air supplied to the remainder of the grate.

6. In a furnace, a chain grate, means to supply combustion air to the entire fuel bed on the grate, and means, controlled by the CO_2 content of the combustion gases, to vary the supply of combustion air to the fuel at the rear part of the grate relatively to the amount of combustion air supplied to the remainder of the grate, and to increase or decrease the supply more to the rear end of said rear part than to the front end of said rear part for a given variation of the CO_2 content.

7. In a furnace, a chain grate, means for supplying combustion air thereto, a plurality of ducts placed longitudinally beneath the rear portion of the upper run of said chain grate, and means controlled by the CO_2 content of the combustion gases for varying the amount of air admitted to each of said ducts.

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