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3 Sheets-Sheet 1

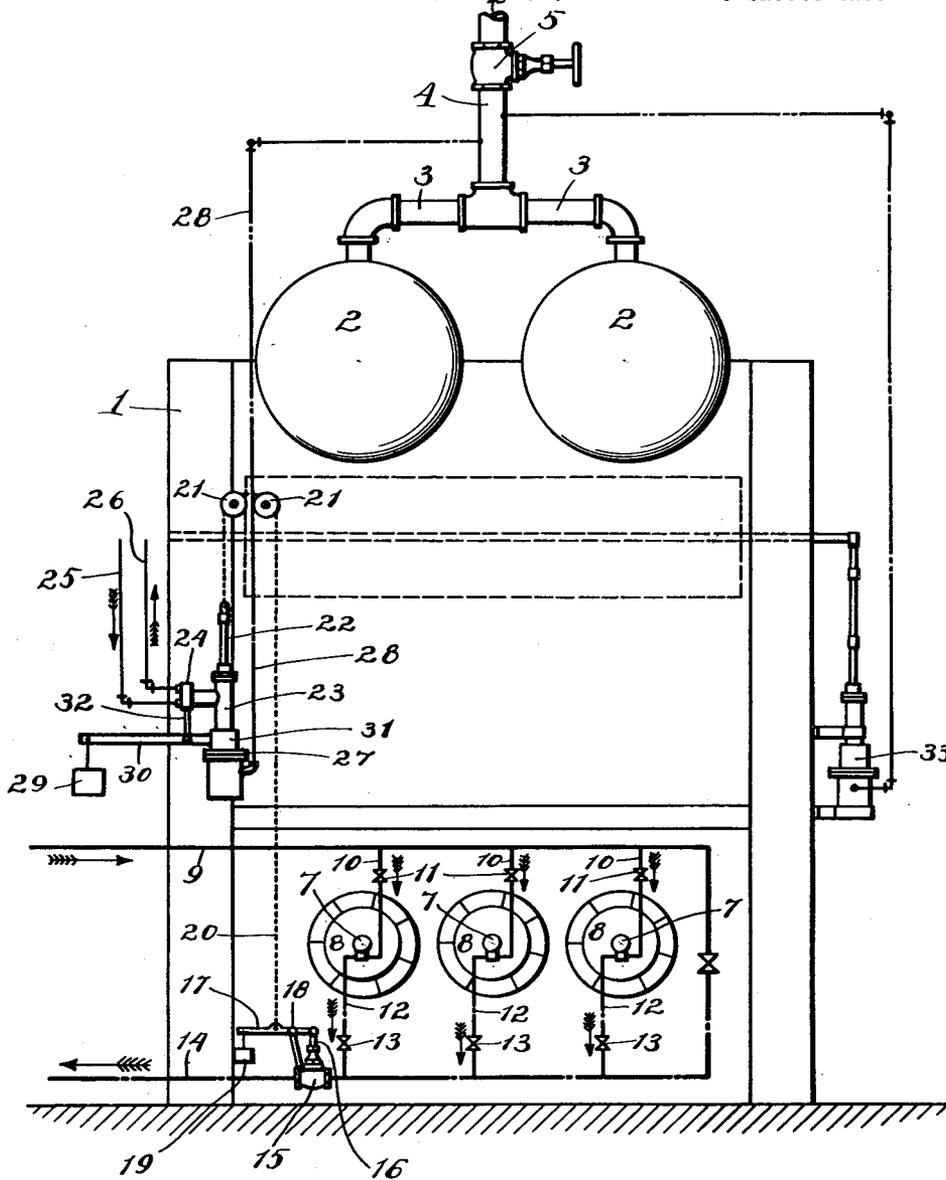


Fig. 1.

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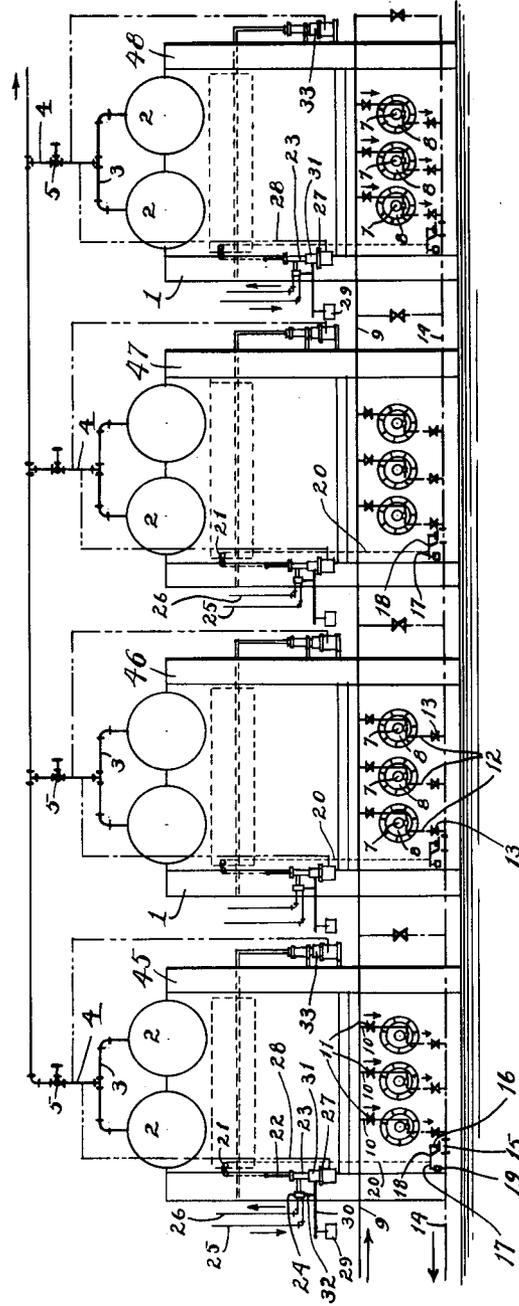


Fig. 3.

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR CONTROL OF THE BURNING OF LIQUID FUEL.

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My invention relates to an improved method of automatically controlling combustion of liquid or other fuel injected into a furnace in small particles and mixed with the proper amount of air for combustion, and more particularly to the use of oil fuel injected into a boiler furnace by means of mechanical atomizers of the type which are controlled over a wide range in capacity by returning a portion of the oil through a return manifold which may be fitted with one control valve.

It is obvious that if proper combustion and maximum efficiency are to be obtained with a fluctuating load condition, not only must the fuel and air be varied in accordance with the demand for heat, but on an increasing load the increase in fuel supply should be slightly preceded by an increase in air supply, and conversely on a diminishing load, the decrease in fuel should take place slightly before the decrease in air. In other words, for an increasing load the fuel should lag behind the air and for a diminishing load, the air should lag slightly behind the fuel, otherwise there will be a tendency for the existence of brief periods where the air is less than required and smoke and loss in economy will result.

This and other objects of my invention will be evident from inspection of the following drawings.

Figure 1 is a front elevation of a boiler and furnace, showing three air registers and mechanical atomizers installed thereon, together with the necessary piping and regulators.

Figure 2 is a side elevation of same, partly in section.

Figure 3 is a front elevation of a number of boilers connected with a main steam header, but each fitted with oil and damper control, as shown in Figures 1 and 2.

A steam boiler of any approved type is shown at 1 fitted with steam and water drums 2, which discharge steam through the branch piping 3, to the main pipe 4 fitted with the valve 5, and thence to the piping system of the plant, as shown in Figure 3. The boiler furnace is shown at 6 in the front wall of which are installed the atomizers 7 and the air registers 8.

The oil delivery pipe line 9 carries oil under pressure to the atomizers through the branch lines 10, fitted with stop valves 11. The oil which is by-passed or returned from the atomizers at partial loads is carried by the branch line 12, fitted with stop and check valves 13 to the main return line 14, which leads back to the storage tank or pump suction (not illustrated). A single master valve 15 is fitted on the return main and is so designed as to close when the stem 16 moves downward and open when the stem moves upward. This stem is actuated by a lever 17 pivoted at the fixed fulcrum 18. A counter weight 19 is attached to the lever 17, and the chain 20 leads over the pulleys 21 to a piston rod 22 of a standard type of damper regulator. This piston rod is actuated by a piston in the cylinder 23, which is forced up and down by water under pressure controlled by the valve 24 which admits water from the hydraulic connections 25, either above or below the piston, the exhaust passing through the pipe 26. A diaphragm 27 is so arranged as to be subjected to steam pressure from the boiler through the pipe 28, on its under side, and to the pressure on its upper side exerted by the weight 29, acting through the lever 30, resting on a fulcrum within the hood 31. Thus as the steam pressure falls the pressure under the diaphragm is lessened and the lever drops slightly under the influence of the weight 29. This motion actuates a rod 32, which moves the valve 24, which then admits water to the upper end of the cylinder 23 and forces the piston and piston rod 22 downward.

The weight 29 is so adjusted that the lever 30 takes a horizontal or neutral position when the pressure of steam in the boiler, which is transmitted to the diaphragm 27 is at a certain predetermined point, say 100 pounds per square inch. It is obvious therefore that as the steam pressure drops, the beam or lever 30 will fall slightly and, as described above, the rod 22 will be forced downward. If, however, the steam pressure should rise, the beam 30 will be lifted slightly on account of the increased pressure acting on the lower side of the diaphragm

27. The valve 24 will thus be moved up, so as to admit water under pressure to the lower side of the piston in the cylinder 23 and the rod 22 will be forced upward. It will be obvious that as the piston rod 22 is moved upward and downward, the valve 15 on the oil return line will be opened or closed, through the action of the chain 20 and the counterbalance weight 19. Therefore, as the steam pressure falls, the valve 15 will be closed, and as the steam pressure rises it will be opened. It is to be remembered further that in the wide range mechanical burner, when the return valve is closed, more oil is fed into the furnace, and as the valve is opened, less oil is fed into the furnace. It follows, therefore, that in the above described apparatus, when the steam pressure falls, more fuel is delivered to the furnace, and as the steam pressure rises, less oil is fed into the furnace, and this fluctuation in the fires follows the fluctuation in the demand for steam, which causes the fluctuation in steam pressure.

Referring to Figure 2, a second regulator 33, operating on exactly the same principle as the first, is installed in such a way as to operate the damper 34, which controls the flow of the waste gases from the boiler into the breaching 35. This breaching is connected to a chimney (not illustrated), or some other means of producing a draft or suction. The opening or closing of the damper 34 therefore, permits a greater or less draft pressure to be transmitted to the furnace 6, so that more or less air will be drawn through the air registers to support the combustion of the fuel. The member 36, Figure 2, is firmly attached to the shaft 37 of the damper 34. The rod 38 connects with the piston rod of the regulator, so that as the latter moves upward the damper will tend to close and vice versa. As in the case of the first regulator, as the steam pressure falls, the piston rod moves downward and as the steam pressure rises the rod moves upward, so that the apparatus described will tend to close the damper as the demand on the boiler falls off and open the damper as the load comes on.

The two regulators, one actuating the oil return valve, and the other actuating the damper are exactly alike as to construction and operation except that they are set for different pressures, the regulator 31 operating the oil valve being set for a pressure about a pound or two lower than that at which the damper regulator 33 is set. Thus, assume that the regulator 31 which controls the oil valve is set for a pressure of 100 pounds per square inch, that is the balance weight 29 is so adjusted that the lever 30 will take a horizontal position when the steam pressure is 100 pounds. This will place the valve 24 in a neutral position and

there will be no movement of the piston in the cylinder 23. The regulator 33 will be set for a pressure of say 101 pounds, that is the balance weight 39 will be adjusted to bring the lever 40 in a horizontal or neutral position when the steam pressure is at 101 pounds.

Let us assume therefore that the pressure on the boiler stands at 98 pounds. Then the levers 30 and 40 of the regulators 31 and 33 will both have dropped and the valves 24 and 41 will have opened to admit water to the upper side of the pistons in the cylinders 23 and 43, and the rods 22 and 42 will have been forced downward, opening the damper 34 and closing the valve 15. This will set the draft at the maximum and the oil burners will be delivering oil at the maximum.

Let us assume further that the rate at which the fuel is being consumed, under these conditions, is more than the normal requirement of the boiler. The steam pressure will therefore gradually rise. When it reaches a pressure of 100 pounds the beam 30 on the regulator 31 will assume a horizontal position, the valve 24 will be at a neutral point and there will be no movement of the piston in the cylinder 23, and the oil valve will not be changed. As the pressure continues to rise to 101 pounds, however, the beam 30 will be lifted and the control valve 24 will admit water pressure to the lower side of the piston in cylinder 23. The rod 22 will be forced up and the valve 15 will be opened by the action of the weight 19. This will have the effect of cutting down the oil fires, thus checking the steaming of the boiler.

Coincident with the increase in the pressure to 101 pounds, the regulator 33 controlling the damper will have been brought into a neutral position and any further increase in steam pressure, say to 102 pounds, will have the effect of lifting the beam 40 operating the valve 41 and admitting water pressure in the piston in cylinder 43. This will force up the rod 42 and close the damper 44 through the mechanism 36 and 38. The fires having thus automatically been checked and the damper closed immediately thereafter, the steam supply to the plant will be reduced and if there is no change in the demand for steam, the pressure will begin to fall. As it reaches 101 pounds the beam 40 on the damper regulator 33 will fall to a neutral position and on further lowering of the steam pressure to 100 pounds, beam 40 will fall and admit water to the upper end of the piston 43 and again open the damper. As the steam pressure reaches 100 pounds, the beam 30 on the oil valve regulator 31 will assume a horizontal position and immediately as the pressure falls slightly below 100 pounds, beam 30 will fall, admitting

water to the upper end of cylinder 23 and again closing the by-pass valve on the burners, so that the fires will again be increased and the boiler will again be in full operation.

It will be obvious from the above explanation that as the steam pressure rises and falls, the damper and oil control valve are automatically operated and the oil supply will be shut off slightly in advance of the closing of the damper and vice versa the damper will open slightly in advance of the increasing of the fires. This is the desired result.

Referring further to Figure 3, it will be evident that if in a series of boilers each is fitted with a set of two regulators, they can be arranged so that by suitable adjustment of the counter balance weights, on the individual regulators, each boiler will be successively cut in and out of service according to the steam pressure which is of course a function of the steam supply and demand.

Thus, assuming that on boiler 45 the oil control regulator is set for a pressure of 100 pounds and the damper regulator for 101 pounds and on boiler 46 the oil control regulator is set at 102 pounds and the damper regulator at 103 pounds, on boiler 47, the oil control regulator would be set at 104 pounds and the damper regulator at 105 pounds and so on, through any desired number of boilers which it will be necessary to control in order to maintain the steam pressure within the desired range. Under these conditions therefore at 100 pounds, all boilers would be under full steaming conditions. The fires would be at their maximum and the dampers wide open. It is, of course, assumed that the dampers and burners are so regulated that with the dampers wide open and the fires at their maximum, the proper air supply would be admitted to the furnaces. Also that with the fires at the reduced point the dampers will be closed sufficiently to reduce the air to the desired quantity. As the steam pressure increases, the oil fires on boiler 48 would be lowered and immediately after the damper on this boiler would close. As the steam pressure continued to rise, the oil fires on boiler 47 would be lowered and immediately after the damper on this boiler would be closed, and so on depending on how much the load fluctuated and how much the steam pressure varied. The reverse action would take place as the pressures were lowered, until all boilers were again in operation at full power.

I wish it distinctly understood that my automatic control herein described and illustrated is in the form in which I desire to construct it and that changes or variations may be made as may be convenient or desirable without departing from the salient features of my invention and I therefore intend

the following claims to cover such modifications as naturally fall within the lines of invention.

It will be perfectly obvious that the control of the air supplied can be obtained by other means than by a damper in a stack such as any well known forced draft regulation and that I do not intend to limit myself to natural draft regulation.

I claim:

1. A method of burning liquid fuel in the combustion chamber of a boiler which comprises delivering the fuel under pressure to a point of atomization, controlling the amount of air supplied, returning an unatomized portion of the fuel from a point adjacent the point of atomization, controlling the amount of fuel atomized by varying the amount returned, regulating the amount returned by the pressure variation of steam generated in the boiler, and controlling the air supply by a predetermined higher pressure of the steam both when the pressure is rising and when it is falling.

2. A method of controlling the combustion of liquid fuel in a boiler furnace which comprises controlling the amount of air supplied, regulating the amount of fuel delivered to the combustion chamber by a variation of the steam pressure, and adjusting the air control means by a predetermined higher steam pressure both when the pressure is rising and when it is falling.

3. A method of controlling the combustion of liquid fuel in a boiler furnace which comprises controlling the amount of air supplied, regulating the amount of fuel delivered to the combustion chamber and the air control means in sequence by successively higher steam pressures, so that an increasing load automatically opens the air control means and then the fuel supply, while a decreasing load automatically shuts off the fuel supply and then closes the air control means.

4. A method of controlling the combustion of liquid fuel in a boiler furnace which comprises controlling the amount of air supplied, regulating the amount of fuel delivered to the combustion chamber and the air control means in sequence by successively higher steam pressure, so that a decreasing load automatically shuts off the fuel supply and then closes the air control means.

5. A method of controlling the combustion of liquid fuel in a series of boiler furnaces which comprises controlling the amount of air delivered to each furnace, and regulating the amount of fuel delivered to each furnace and the air control means thereof by a variation of steam pressure but at successively higher points for each furnace whereby the boilers will be put into and out of service in sequence according to the fall or rise of the steam pressure.

6. An apparatus for burning liquid fuel in a combustion chamber of a boiler comprising a nozzle adapted to deliver liquid fuel under pressure to the combustion chamber, a damper, means for returning a portion of the liquid fuel from the nozzle, means for varying the amount of fuel returned in accordance with a variation in the steam pressure, and means for controlling the air supplied by a predetermined different steam pressure.
7. An apparatus for burning liquid fuel in a combustion chamber of a boiler comprising an apparatus which delivers the fuel to said chamber with a whirling motion, means for by-passing a portion of said fuel from said apparatus, a damper, and means for regulating the amount of fuel by-passed and the damper by successively higher steam pressures.
8. An apparatus for burning liquid fuel in a combustion chamber of a boiler provided with a damper comprising means operable by the pressure variation of the steam generated to regulate the amount of fuel supplied to the combustion chamber, and means operated by a pressure variation slightly in excess of the before mentioned pressure variation to operate the damper.
9. A method of controlling the combustion of fuel which comprises atomizing the fuel at a series of points, supplying air, and regulating the air supply and the amount of fuel supplied each point by the variation of the steam pressure at successively higher pressures for the points of the series.
10. The combination with a series of mechanical atomizers, of means for regulating the air supply and the amount of fuel supplied to each atomizer by the variation of steam pressure, but at successively higher points whereby the atomizers will be put into and out of service in sequence by either the fall or rise of the steam pressure but in reverse order.
11. An apparatus for burning fuel in a combustion chamber of a boiler, means for delivering fuel to said chamber, an air supply, and means for regulating the amount of fuel delivered and the air supply by successively higher steam pressures.
12. An apparatus for burning liquid fuel in the combustion chamber of a boiler, in combination a combustion chamber, an air supply thereto, a supply pipe for delivering finely-divided fuel to said combustion chamber, a control mechanism for the air supply, operated by steam pressure, and a control device for the fuel supply, operated by steam pressure, the air control mechanism operating at a higher steam pressure than the control mechanism for the fuel supply.
- In testimony whereof I affix my signature.
ERNEST H. PEABODY.