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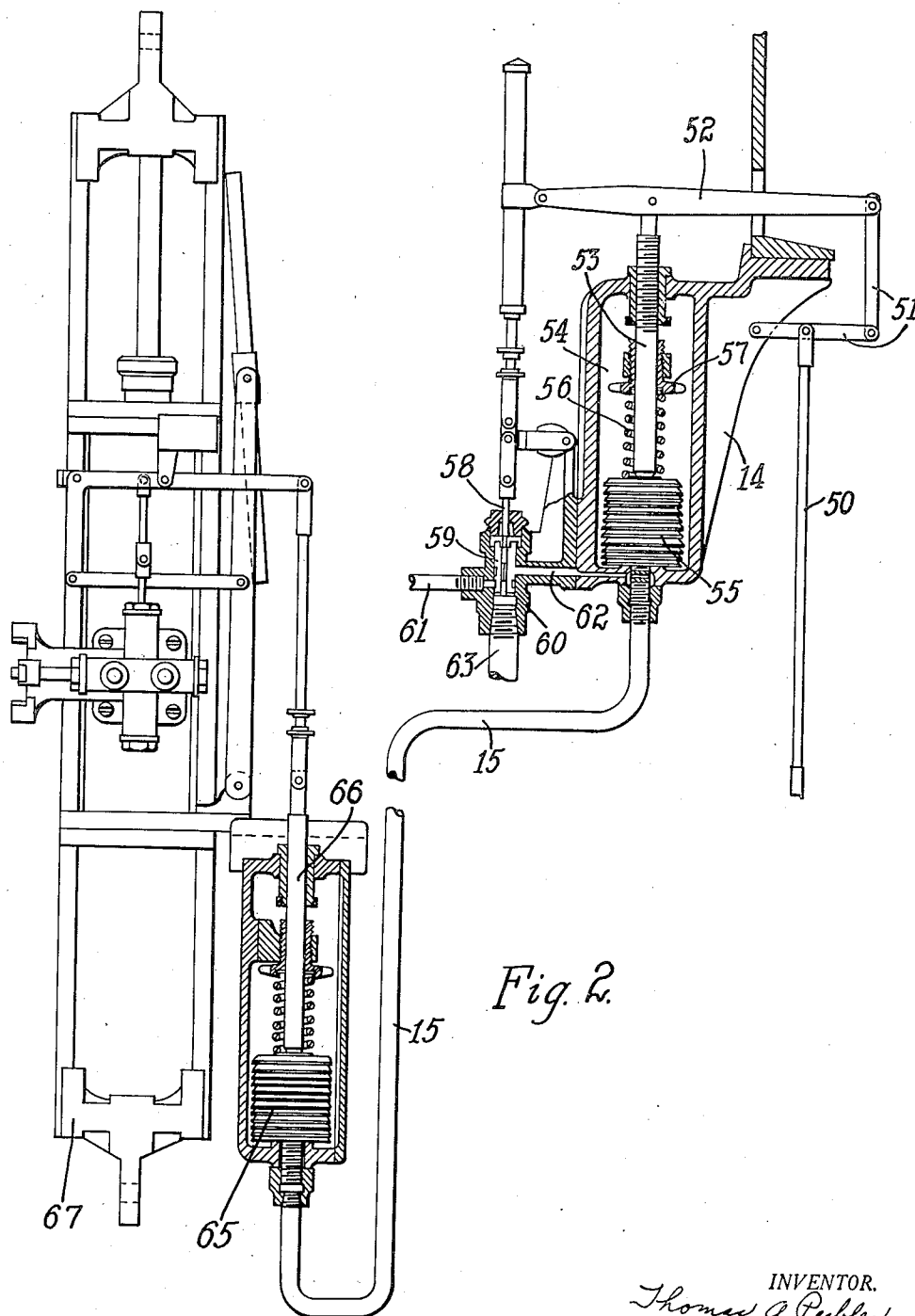
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1,787,407

COMBUSTION CONTROL APPARATUS

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2 Sheets-Sheet 2



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COMBUSTION-CONTROL APPARATUS

Application filed July 7, 1928. Serial No. 291,089.

This invention relates to systems for controlling the combustion of fuel in furnaces and more particularly to a system for use in connection with steam boiler furnaces.

An object of this invention is to provide an improved method and apparatus for controlling the combustion of fuel in furnaces.

A further object is to provide a system of the type set forth constructed and arranged so as to insure the delivery of a proper amount of fuel and air to the combustion chamber in accordance with the demand therefor and the coordinating of the operation of the fuel and air supply mechanisms.

A further object is to provide a system of the type set forth which will be simple and reliable in operation and easy to install.

These and other objects which will be apparent to those skilled in this particular art are accomplished by means of the invention illustrated in the accompanying drawings in which Figure 1 is a diagrammatic layout illustrating a system constructed and arranged in accordance with one embodiment of this invention and Fig. 2 is a view on an enlarged scale, partly in section, of a portion of the apparatus illustrated in Fig. 1.

The illustrated embodiment of this invention is shown, for the purposes of illustration, in connection with a boiler furnace employing pulverized coal for fuel. Apparatus responsive to variations in the demand for steam are employed for controlling and varying the delivery to the furnace of one of the variables such, for example, as air, and the delivery of the other variable, such for example, as coal is coordinated to and varied by the variations in the supply of the first variable. In the drawings the variations in the demand for steam are employed for varying the flow of air to the furnace and variations in the air pressure are utilized for regulating and coordinating the delivery of fuel such, for example, as powdered coal.

The particular embodiment of this invention which has been chosen for the purposes of illustration is shown in connection with a boiler furnace 5 arranged to deliver steam in the usual way to a header 6. Air is delivered to the furnace through an air duct 7

by a forced draft fan 8 and an induced draft fan 9 is associated with the draft outlet 10 for moving the products of combustion through a heat exchanger 11 with which the air supply line 7 is also associated.

Variations in the rate of air flow to the furnace chamber are caused directly by variations in the demand for steam and as a result of variations in the steam pressure in the header 6. The illustrated arrangement includes a pressure responsive regulator 12 which is operated by variations in the steam pressure in the header 6 through a pressure line or tap 13. The regulator 12 may be of any desired type but it is preferably of the type described in Hopwood Patent No. 1,371,243 of March 15, 1921. The regulator 12 operates a pressure sending mechanism 14 connected by a pressure line 15 with a pressure receiving mechanism 16, the vertically movable frame of which is connected by a link 17 to the operating arm 18 of an induced draft controlling damper 19. The construction and arrangement of the pressure sending mechanism 14 and the damper operating, pressure receiving mechanism 16 will be hereinafter more fully described. For the present, it should be noted that operation of the regulator 12 by variations in the demand for steam results in variations in the operation of the induced draft mechanism. Obviously, the latter variations can be effected by control of a rheostat, a motor operating blower or a flow controlling damper as illustrated.

Operation of the forced draft mechanism 8 is varied and controlled as a result of the variations in the operation of the induced draft mechanism. As illustrated, this includes a regulator 20 of the well known inverted bell type having the interior of one bell responsive to variations of the pressure in the furnace chamber through a pressure tap 21, while the interior of the other bell is open to the atmosphere through a pipe 22. The pivoted bell supporting lever 23 of the regulator 20 is connected to a pressure sending apparatus 24, similar in all respects to the pressure sending apparatus 14, which is connected by a pressure line 25 with a

pressure receiving apparatus 26, similar to the pressure receiving apparatus 16 and operatively connected through a link 27, bell crank lever 28 and link 29 with the operating lever 30 of a forced draft controlling damper 31 for varying the operation of the forced draft mechanism in accordance with the pressure in the combustion chamber. As a result of this mechanism, the air flow to the boiler furnace is responsive to variations in the steam demand.

It will be apparent that any change in the steam demand results in a corresponding adjustment of the damper 19 through the operation of the regulator 12 and associated mechanism. This, in turn, changes the draft in the furnace, or, in other words, the furnace pressure, which change is transmitted through the pressure tap 21 to the regulator 20 and results in a corresponding change in the setting of the induced draft damper 31, so that the air flow to the furnace is always maintained at that amount necessary to produce the desired draft in the furnace chamber. It would also be apparent that the operation of the forced draft mechanism is regulated by and in accordance with variations in the operation of the induced draft mechanism. As a result, in case of any reduction in the capacity of the induced draft fan, or in its effect, such as occurs in case of an accumulation of slag or soot on the boiler tubes, the forced draft fan would be automatically prevented from operating at such a rate as would build up an undesirable pressure in the furnace chamber.

Mechanism is employed for varying the supply of fuel by and in accordance with the variations in the delivery of air to the furnace. As illustrated, this mechanism includes a regulator 32 similar to the bell lever regulator 20 and having the interior of one bell connected by a pressure tap 33 with the air conduit 7. The interior of the other bell is connected through a tap 34 to the atmosphere and the fulcrumed lever 35 is connected to a pressure sending mechanism 36 connected by a line 37 with a pressure receiving mechanism 38 adapted to operate the rheostat 39 for controlling the coal feeder 40. When, as illustrated, a pulverizer mill 41 of the variable speed type is employed, it too will be controlled by a second pressure receiving mechanism 42 that is responsive to variations in the line 37 through a pressure tap 43 for controlling the rheostat 45 associated with the pulverizer mill. With such an arrangement, the speed of the pulverizer is varied simultaneously with and corresponding to the variations in the supply of fuel to the pulverizer and both the speed of the pulverizer and the supply of fuel thereto are varied in accordance with the delivery of air to the furnace.

The regulator 32 is provided with a

counter weight 46 which normally hangs in vertical position when the beam 35 is in one extreme position. As the pressure under one or the other of the floats or inverted bells is varied, tending to swing the bell float mechanism from its extreme position, the swinging counter weight must also leave its vertical position, and therefore, exert a certain force on the mechanism in opposition to that exerted by the pressure of air under the bells. As a result, the beam 35 and the regulator mechanism will assume a definite position for each given pressure of air in the duct 7. Since the resistance of the furnace itself to air flow remains constant and the burners are of fixed dimensions, it will be apparent that the flow of air from the duct 7 to the burners will be a function of the air pressure in the duct. Therefore, the regulator 32 will have a different position for each different pressure in the air duct 7 and the feed of fuel will be coordinated to this particular air pressure, the latter varying in accordance with the variations in the steam demand. The coal feed regulator 38 which is responsive to the regulator 32 operates the rheostat 39 through a cam lever 47 in order to compensate for the fact that the flow of air from the air duct to the burners varies as the square root of the air pressure, and since the regulator 32, and hence regulator 38, move directly in response to changes in air pressure, the cam is formed so that the feed of coal will vary directly as the air flow and proportional thereto, and not in proportion to the square root of such air flow, as would be the case were some such arrangement not provided. This latter mechanism is more fully described and claimed in my copending application Serial No. 267,628 filed April 5, 1928.

The pressure sending and receiving mechanisms 14-16, 24-26, 36-38 and 36-42, respectively, by means of which the various regulators 12, 20 and 32 control the associated dampers and rheostats 19 and 31, 39 and 45, respectively, are preferably constructed and arranged in the manner illustrated in Fig. 2. Each sending station, so-called, such, for example, as the apparatus 14, is connected to the associated regulator by a link 50, the upper end of which is connected through suitable movement multiplying links and levers 51 with one end of an operating lever 52 pivotally mounted at the upper end of a plunger 53 extending into a chamber 54 and bearing on the top of a metal bellows 55 which is yieldingly pressed downward by a helical spring 56 surrounding the plunger and interposed between the top of the bellows and a spring holding collar 57 mounted on the plunger. The interior of the bellows 55 communicates directly with the pressure tap 15. The other end of the operating lever 52 is pivotally connected with a valve stem 58

connected to a valve plug 59 mounted in a valve housing 60 formed so as to control the flow of fluid pressure from a pipe 61 connected to any desirable source of fluid pressure (not shown). The valve is provided with a passage 62 communicating directly with the interior of the metal bellows 55 and with the pressure line 15 and a third passage is connected to the atmosphere through an associated line 63. The arrangement of the valve plug is such that on downward movement of the valve 58 fluid pressure is admitted through line 61 to the fluid pressure line 15 and to the interior of the bellows 55. The latter expands under the increased fluid pressure, raising the operating lever 52 by upward movement of the plunger 53, in turn raising the valve stem 58 and returning the valve plug 59 to balanced condition, cutting off the passage 62 from the fluid pressure supply line 61. Upon upward movement of the valve stem 58 the valve plug is moved so as to connect the passage 62 and pressure line 15 with the atmosphere through the outlet 63, thus permitting fluid pressure to escape from the line 15. This also reduces the pressure in the metal bellows 15 allowing the plunger 53 to be lowered, in turn lowering the operating lever 52 for returning the system again to a balanced condition. The raising and lowering of the operating lever 52 is caused by operation of the regulator 12 which is directly connected to the link 50. As a result of this arrangement, the pressure in the line 15 is raised and lowered by and in accordance with the variations in the steam pressure in the header 6. The other end of the pressure line 15 is connected to a metal bellows 65, similar to the metal bellows 55 disposed to press against a plunger 66 which operates the vertically movable frame 67 of a regulator which is constructed preferably in the manner described in Patent 1,338,923 of May 4, 1920, except that the pressure chamber of this regulator is replaced by the metal bellows 65.

It will be apparent that such an arrangement provides a means and mechanism for controlling the induced draft apparatus by a regulator which is directly responsive to the demand for steam, such, for example, as the regulator 12. The same mechanism permits the control of the forced draft mechanism by variations in the furnace pressure through a regulator such as the inverted bell regulator 20 and also the control of the rate of fuel feed as well as the speed of the pulverizer by variations in the pressure of the air in the air duct leading to the furnace.

In operation a change in the plant load, that is to say, in the demand for steam, results in operation of the pressure responsive regulator 12 so as to vary the operation of the induced draft mechanism. This in turn, changes the pressure of the combustion cham-

ber thereby causing the regulator 20 to coordinate the operation of the forced draft mechanism to that of the induced draft mechanism. As a result, the pressure in the air duct is changed and this change in pressure is employed for operating the regulator 32 so as to vary the delivery of fuel to the furnace and to coordinate such delivery to the delivery of air.

Although I have described in more or less detail a specific embodiment of this invention, it will be apparent that various changes, additions, substitutions and omissions can be made therein without departing from the spirit of this invention or the scope of the appended claims.

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

1. The combination with a boiler furnace having forced and induced draft mechanisms, of means for varying the operation of one of said draft mechanisms in accordance with the demand for steam, and means for operating the other of said draft mechanisms in response to variations in the furnace pressure.

2. The combination with a boiler furnace having separate forced and induced draft mechanisms associated therewith, of a fuel feeding mechanism, means for varying the operation of said induced draft mechanism in accordance with the demand for steam, a regulator operated in response to variations in the operation of said induced draft mechanism for coordinating the operation of said forced draft mechanism to the operation of said induced draft mechanism and means responsive to variations in the delivery of air to the furnace for varying the operation of said coal delivery mechanism.

3. The combination with a boiler furnace and means for delivering air to the furnace of fuel delivery mechanism including a variable speed pulverizer and means for delivering coal thereto, and means for varying the rate of delivery of coal to said pulverizer and controlling the speed of operation of said pulverizer in accordance with the rate of delivery of air to the furnace.

4. The combination with a boiler furnace having separate forced and induced draft mechanisms associated therewith, of a fuel feeding mechanism including a variable speed pulverizer and means for delivering coal to said pulverizer, means for varying the operation of said induced draft mechanism in accordance with the demand for steam, a regulator operated in response to variations in the operation of said induced draft mechanism for coordinating the operation of said forced draft mechanism to the operation of said induced draft mechanism and means responsive to variations in the delivery of air to the furnace for simultaneously varying the rate of coal delivery to said pulverizer and the speed of operation of said pulverizer.

5. In a control system for boilers having forced and induced draft mechanisms, in combination, means for controlling the induced draft mechanism in response to changes in steam pressure, means for controlling the forced draft mechanism in response to changes in the induced draft, a burner for fuel, means for supplying fuel to the burner, means for supplying air to the burner from the forced draft mechanism, and means responsive to the pressure of the air supplied to the burner for controlling the fuel supplying means.

6. The combination with a boiler furnace having forced and induced draft mechanisms, and means for supplying fuel to the furnace, of means for varying the operation of one of said draft mechanisms in accordance with the demand for steam, means for operating the other of said draft mechanisms in response to variations in the furnace air pressure, and means for controlling the supply of fuel to the furnace in response to variations in the pressure of the air supplied to the furnace.

7. The method of supplying fuel and air to a boiler furnace having forced and induced draft mechanisms affecting the supply of air to the furnace, that consists in measuring the steam pressure, controlling one of said draft mechanisms in accordance with changes in steam pressure, controlling the other of said draft mechanism in accordance with changes in pressure within the furnace, and then in supplying fuel to the furnace in accordance with the quantity of air supplied to the furnace.

8. The combination with a boiler furnace having a source of air supply therefor and means for supplying fuel to the furnace, of means for controlling the supply of air in accordance with variations in pressure in the furnace combustion chamber, means for regulating the furnace chamber pressure in accordance with the demand for steam, and means for controlling the fuel supplying means in accordance with variations in the pressure of air supplied to the furnace.

In testimony whereof, I have hereunto subscribed my name this 28th day of June, 1928.

THOMAS A. PEEBLES.

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CERTIFICATE OF CORRECTION.**Patent No. 1,787,407.****Granted December 30, 1930, to****THOMAS A. PEEBLES.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 90, claim 1, before the word "pressure" insert the word air; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of January, A. D. 1931.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.