

March 16 , 1926.

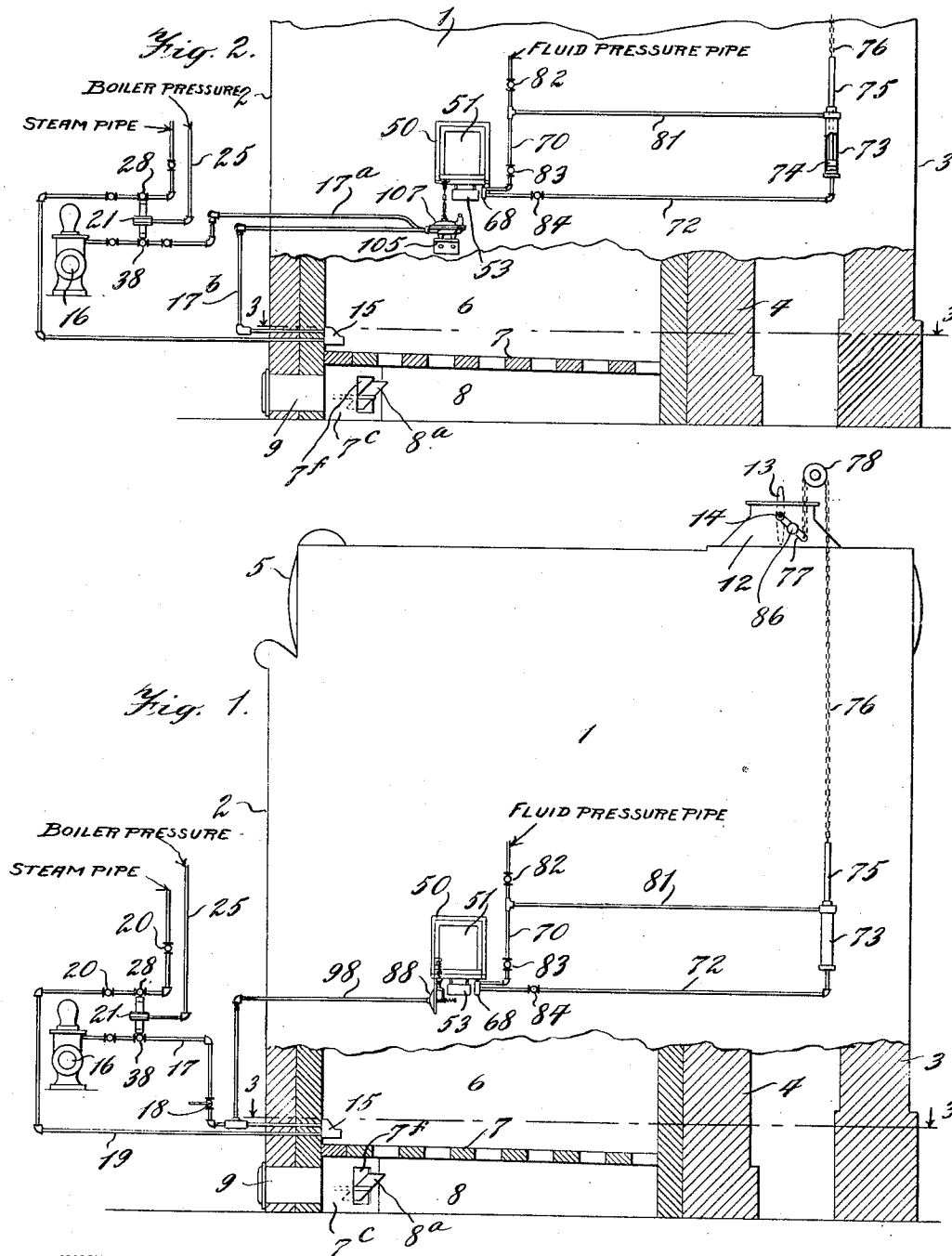
1,576,754

E. McLEAN

FURNACE CONTROL

Original Filed Dec. 10, 1921

4 Sheets-Sheet 1



WITNESS:

WITNESS.
J. O. Cheney,

INVENTOR.

INVENTOR.
Embury McLean

BY

Gipps & Bull
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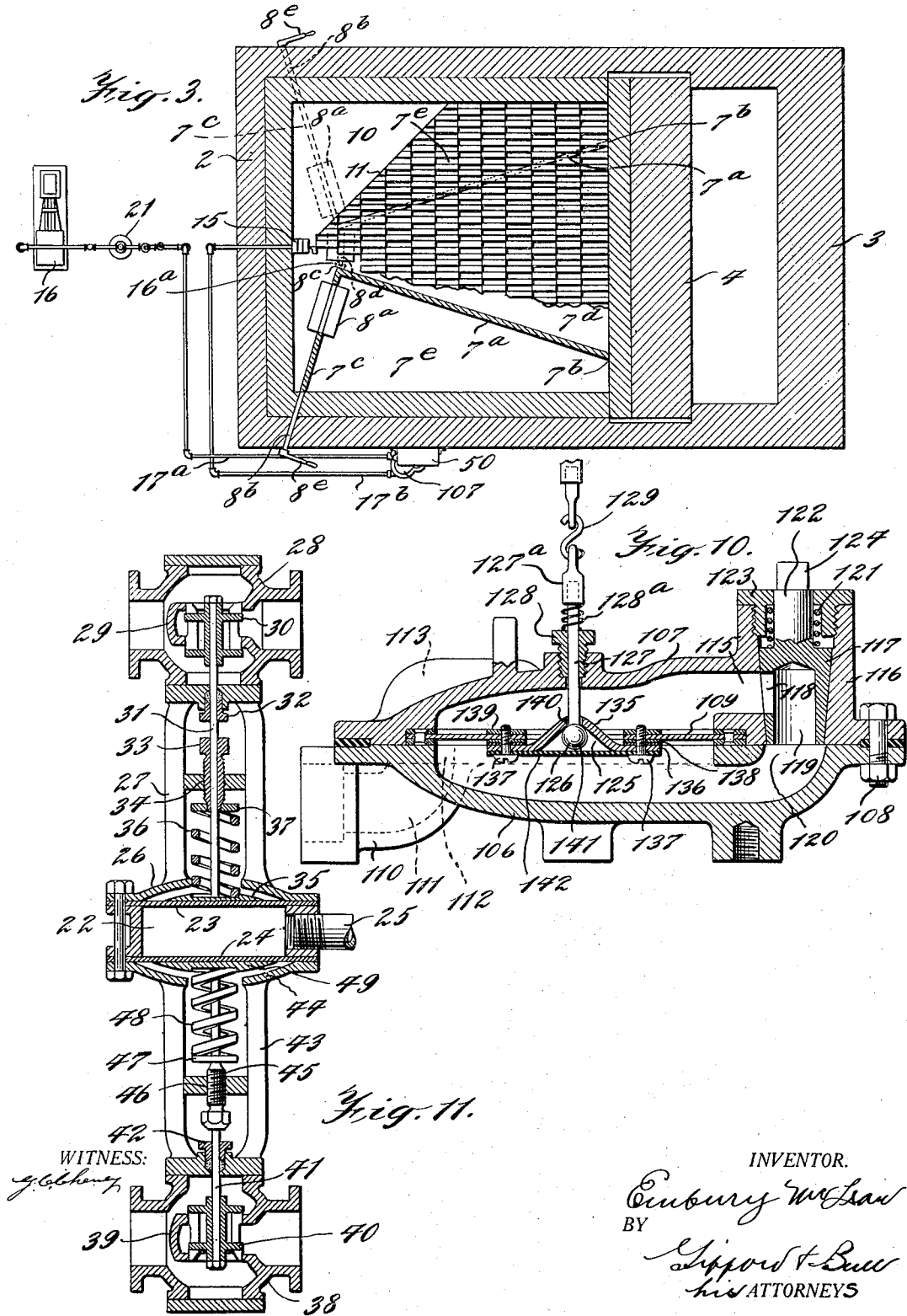
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Original Filed Dec. 10, 1921 4 Sheets-Sheet 2



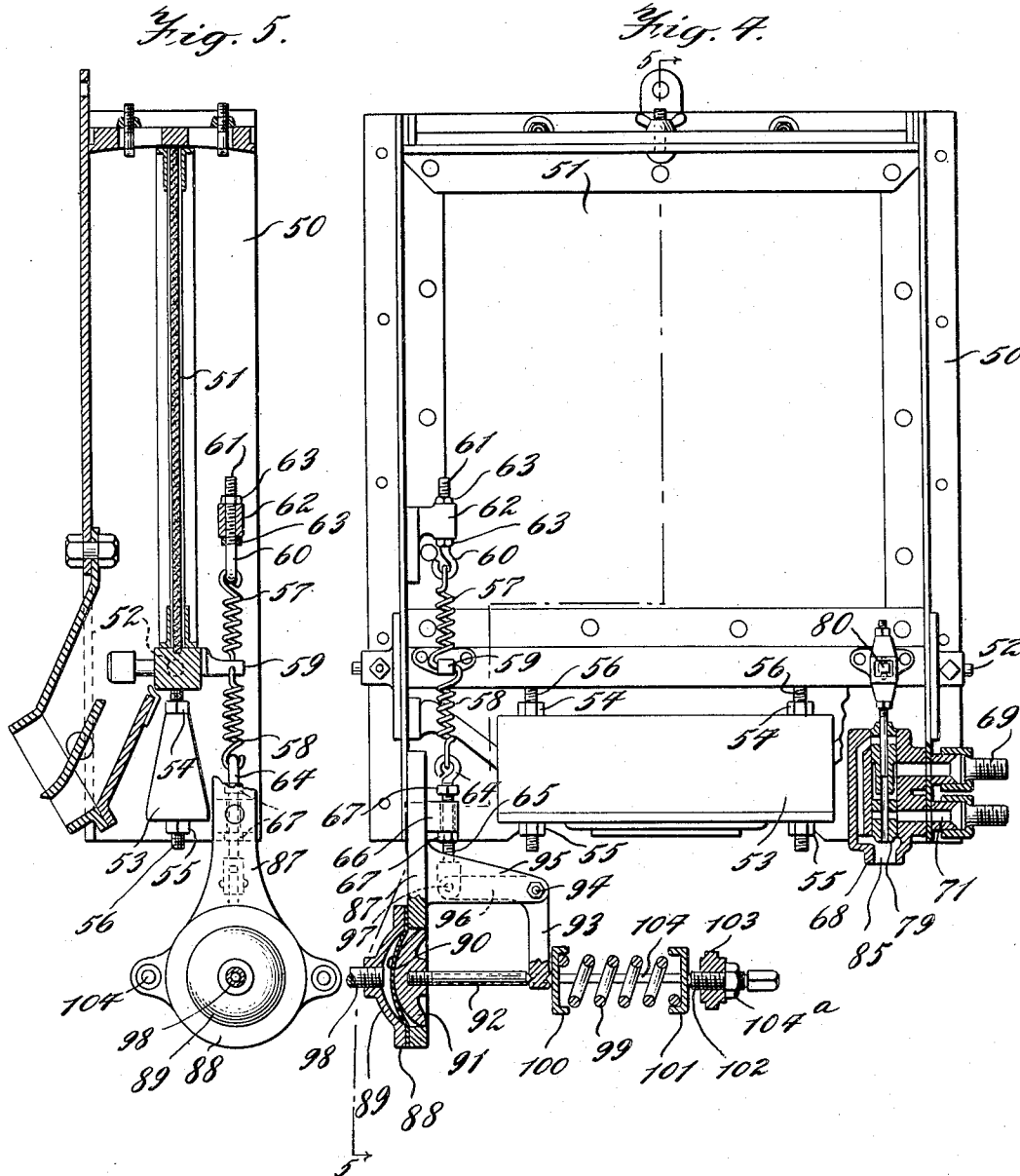
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FURNACE CONTROL

Original Filed Dec. 10, 1921 4 Sheets-Sheet 3



WITNESS:

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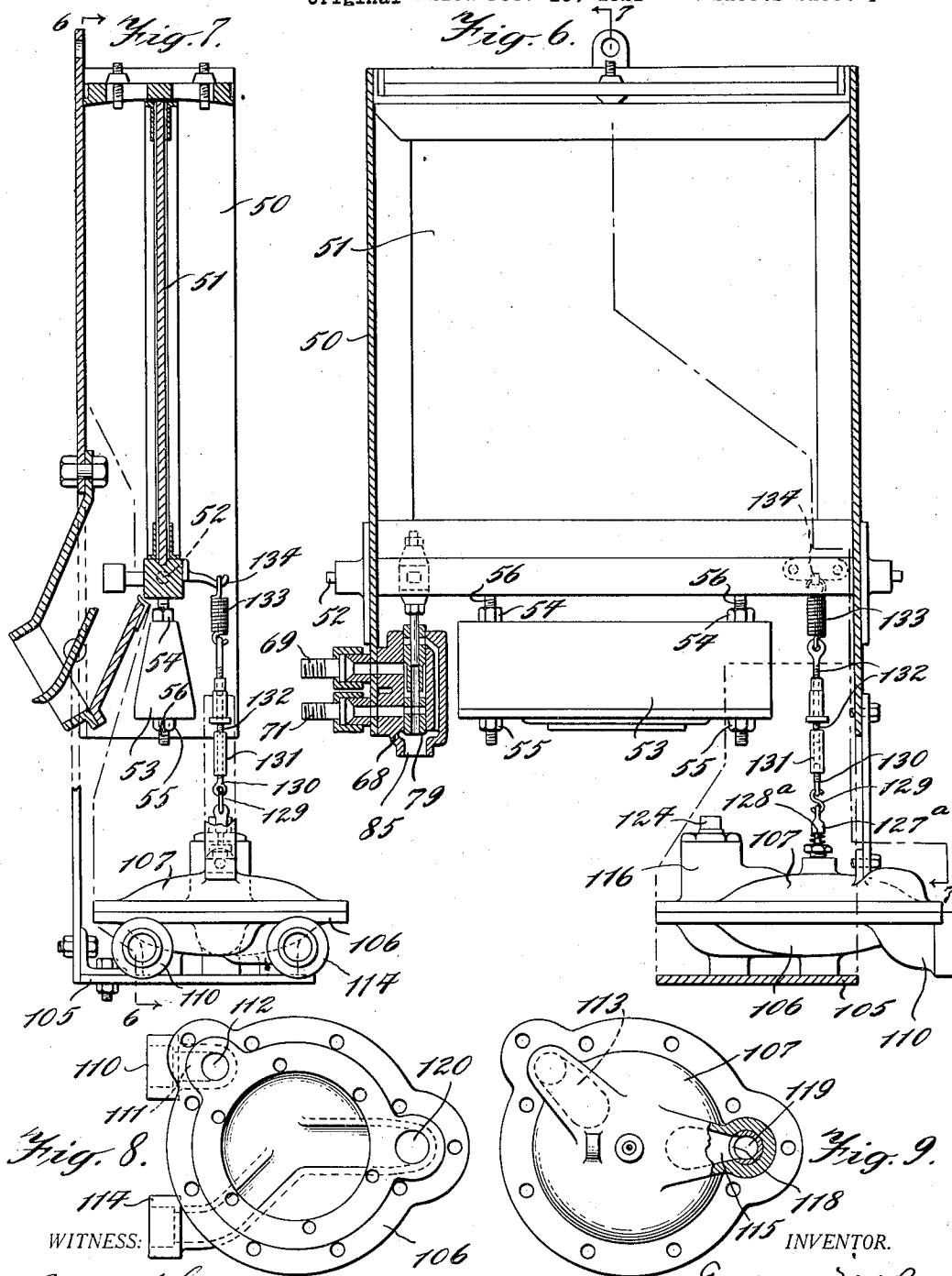
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FURNACE CONTROL

Original Filed Dec. 10, 1921

4 Sheets-Sheet 4



WITNESS:
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UNITED STATES PATENT OFFICE.

EMBURY McLEAN, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE ENGINEER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

FURNACE CONTROL.

Application filed December 10, 1921, Serial No. 521,318. Renewed April 22, 1925.

To all whom it may concern:

Be it known that I, EMBURY McLEAN, a citizen of the United States, and resident of the city of New York, borough of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Furnace Controls, of which the following is a specification.

My invention relates to new and useful improvements in furnace control, and more particularly to that type of furnace fired with fluid fuel.

The object of the invention is to provide means whereby a supply of air necessary for combustion will be efficiently and properly controlled at all times so as to bear the proper relation to the supply of oil or fluid fuel fed to the furnace during a given period.

The invention consists in the improvements to be more fully described hereinafter, and the novelty of which will be particularly pointed out and distinctly claimed.

I have fully and clearly illustrated a preferred embodiment of my invention in the accompanying drawings to be taken as a part of this specification, and wherein—

Figure 1 is a view in side elevation, partly in section, of a furnace having one embodiment of my invention applied thereto.

Fig. 2 is a similar view showing another embodiment of the same invention.

Fig. 3 is a section on the line 3—3 of Fig. 1 and Fig. 2.

Fig. 4 is a view in front elevation, partly in section, of a controlling means shown in Fig. 1.

Fig. 5 is a section on the line 5—5 of Fig. 4.

Fig. 6 is a view in rear elevation, partly in section, of a controlling means shown in Fig. 2.

Fig. 7 is a section on the line 7—7 of Fig. 6.

Fig. 8 is a plan view of the lower portion of the controller shown in Figs. 6 and 7.

Fig. 9 is a top plan view of the top member of the controller shown in Figs. 6, 7 and 8.

Fig. 10 is a longitudinal central section through the controller shown in Figs. 6, 7, 8 and 9.

Fig. 11 is a longitudinal section through a control device for regulating the supply of

oil and atomizing steam to the burner in accordance with the steam pressure.

In the preferred embodiment of this invention the same is shown as applied to a furnace for heating a steam boiler, the structure of which furnace and boiler specifically forms no part of my present invention, as the latter is applicable to any furnace or boiler furnace fired by fluid fuel, and having means for controlling the draft or supply of air for combustion.

In the drawings, the furnace is shown as consisting of a side wall 1, front wall 2, rear wall 3, and an intermediate or bridge wall 4, a steam drum of a steam boiler being indicated generally at 5. Between the front wall 2 and the bridge wall 4 is located the combustion chamber 6, located over a substantially horizontal partition 7 extending from the front wall to the said bridge wall, and from one side wall to the other, so as to provide an air inlet chamber 8 beneath said partition. An area or portion of said partition may be open-work or checker-work structure so as to provide a plurality of openings from which air may flow from the chamber 8 to the furnace chamber 6, said area being substantially co-extensive with the size of the flame when the burner is working with a large volume of oil. By reference to Fig. 3, it will be seen that the checker-work is of flaring form, the tapering sides of which are provided by imperforated portions 10 of said partition at the forward corner of the furnace, the outwardly inclined edges 11 of said imperforate portions defining the forward boundaries of the flaring checker-work portion. In the present embodiment the said flaring edges 11 extend from a point adjacent the center of the front wall to a point substantially midway the length of the side walls of the furnace, so that the checker-work extends from said boundaries rearwards to the bridge wall lengthwise of the furnace, and the entire width of the furnace at points in rear of the points at which said boundaries merge with said side walls. It will be seen that the area of the open-work portion of the partition 7 conforms substantially to the maximum form of the flame in the furnace chamber.

The furnace is also provided with a suitable draft-controlling means, in this instance, consisting of a suitable outlet stack

12 through which the products of combustion find exit, the area of the passage through the stack being controlled by a suitable damper 13 pivoted, as at 14, on the stack, in any suitable manner.

The furnace is provided with any suitable nozzle or burner 15 for feeding fluid fuel to the furnace, and in which the fuel is atomized by steam or air under pressure fed to the burner simultaneously with the fluid fuel. The burner or nozzle is preferably located in the front portion of the furnace chamber above the partition 7 and central of the transverse width of the furnace chamber, and over the forward portion of the open-work area of said partition. Oil or other fluid fuel is fed to the said burner from a pump 16 through a pipe 17, in which is located a hand-valve 18 for establishing and cutting off supply of oil to the burner, and steam under pressure from a suitable source is fed to the burner through a pipe 19, the latter containing valves 20. The quantity of fluid fuel and atomizing steam which flows into the burner through the pipes 17 and 19 is controlled by a regulator, shown generally at 21, in Figs. 1, 2 and 3, and specifically, in Fig. 11, operating valves in the fluid fuel and steam pipes, the valve in the latter being located between the hand-valves 20. This regulator may be of any suitable type capable of adjustment so as to automatically regulate the amount of oil fed to the burner in accordance with the steam pressure of the boiler, and also the quantity of steam fed to the burner to atomize the oil.

Referring particularly to Fig. 11, I have shown a well-known type of regulator for this purpose, the same consisting of a cylindrical chamber 22 having diaphragm heads 23, 24 sealing the chamber, the latter being connected by a pipe 25 with a source of steam at boiler pressure. Over the diaphragm 23 is a plate 26 supporting a frame 27 connected at its upper end, in any suitable manner to a valve body or casing 28 located in the steam pipe between the valves 20, as stated, said body having a valve seat 29 with which cooperates a valve 30 connected to a stem 31 guided by a stuffing-box 32, and a sleeve 33, the latter being threaded in the said frame 27, as at 34. The valve stem 31 is connected to a plate 35 resting on the diaphragm 23, heretofore described. Surrounding the stem 31 is an expansion spring 36, the ends of which respectively abut the said plate 35 and an abutment 37 resting against the lower end of said sleeve 33, the function of said spring being to urge the valve 30 toward open position in opposition to the pressure of steam within the chamber 22. The pressure of the spring 36 may be regulated by adjusting said screw sleeve 33 and consequent-

ly the position of said plate 37 so that the latter may be adjusted relative to the plate 35 to compress or relieve the compression of the spring 36.

A construction similar to the above is provided for regulating the quantity of fluid fuel, and includes a valve body or casing 38 in the pipe 17 having a seat 39 having a passage controlled by a valve 40, the latter being connected to a stem 41 guided through a stuffing-box 42 corresponding to the stuffing-box 32, heretofore described, and supported by a frame 43, which is in turn supported by a plate 44 similar to the plate 26, heretofore described. The stem 41 is guided through an adjustable screw sleeve 45 threaded through a portion of the frame, as at 46, and carrying an abutment plate 47 against which abuts one end of a coil spring 48 coiled about the said stem 41, and the other end of which spring is connected to the plate 49 on the outer face of the diaphragm 24. This spring 48 normally urges the valve 40 towards open position in opposition to the steam pressure within the chamber 22 tending to close the valve. By adjustment of the elements 33 and 46, heretofore described, the relative area of the opening in the steam supply pipe 9 and the oil supply pipe 17 may be regulated in accordance with a given steam pressure in order to determine the amounts or quantities of oil and steam fed to the boiler.

The fluid fuel fed from the burner or nozzle 15 to the furnace chamber, this being under pressure, is in a form which results in a flame which is either substantially cone-shape or fan-shape, according to the type of burner used. It is desirable that the air entering the furnace chamber be admitted over an area conforming as nearly as possible to the form or area of the flame, in order that the best results be obtained as regards complete combustion.

I will now describe improved means whereby the draft of the furnace or the air supplied thereto for combustion is varied or controlled by the oil fed to the furnace. This means includes a regulator, shown in the present instance as being of the same general construction as shown and described in my prior Patent No. 1,071,771, dated September 2, 1913. One adaptation of this regulator for the present furnace is shown in Figs. 4 and 5, wherein 50 designates a rectangular frame set in an opening in one of the said walls of the furnace and providing an opening between the furnace chamber and the external atmosphere. In this rectangular frame is arranged a swinging rectangular plate 51 fulcrumed at a point adjacent its lower end, as at 52 to the side members of the said frame, said fulcrum being located preferably at, or closely adjacent the center of gravity of the plate

so that said plate will remain stationary on its pivot at any point to which it may be moved. In order to assure the axis being through the center of gravity of the plate, a weight 53 is supported on the lower portion of said plate, said weight being adjustably supported and held by upper and lower nuts 54, 55 on threaded rods 56, secured to the lower portion of the plate 51. The movement of the plate on its fulcrum is opposed by upper and lower tension springs 57, 58, the former being connected at its lower end to a projection 59 on the lower end of the swinging plate, and at its opposite end to an adjustable anchorage consisting of an eye 60 on a threaded shank 61 extending slidably through a bracket 62 secured rigidly to the side of the frame 50, said threaded shank being adjustably held by means of upper and lower nuts 63, whereby the tension of the spring 57 may be adjusted.

The lower spring 58 is connected at its upper end to the said arm or projection 59, and its lower end is connected to a hook or eye 64, having a threaded shank 65 extending slidably through an opening in a bracket 66 (Fig. 4) on the frame 50, said shank carrying nuts 67, on opposite sides of said bracket 66 to limit sliding movement of the shank 65 relative to the said bracket. The springs 57, 58 serve to oppose swinging movement of the plate, and also to balance the action of the draft pressure in the furnace, in a manner to be presently described. The movements of this pressure regulator are employed to control the position of the stack damper 13 so as to control the rate of outflow of furnace gases through the stack.

In order to accomplish this result, I provide a pilot valve 68 having an inlet 69 connected by a pipe 70 with a source of fluid under pressure, and a combined inlet and outlet 71 connected by a pipe 72 to the lower end of an operating cylinder 73 containing a piston 74 connected to a piston rod 75, which in turn is connected by a flexible connection 76 with a lever arm 77 for operating the damper, said flexible connection being passed over an intermediate guide pulley 78. The pilot valve is provided with a piston valve 79 connected loosely to a bracket arm 80 on the lower portion of the swinging plate 51. The pipe 70 is connected by a pipe 81 to the upper end of the cylinder 73, above described. The pipe 70 contains hand-valves 82, 83 on opposite sides of the connection with said pipe 81, and the pipe 72 contains a hand-valve 84. The pilot valve casing is provided with an escape opening 85 at its lower end.

The operation of said pilot valve is to control the flow of fluid pressure to and from the lower end of the cylinder 73 in

order to operate the piston 74 to control the damper 13. On the lever 77 is a weight 86 normally tending to hold the damper in open position. The construction of this pilot valve is specifically shown in Fig. 4, but I do not deem it necessary to describe the same with greater detail, as it is of well-known construction, and specifically does not form a part of my present invention.

On the frame 50 is a bracket arm 87, upon the lower end of which is supported a pressure chamber 88 formed by a rigid side wall 89, and an opposing diaphragm wall 90 against which engages a plunger head 91 on a plunger stem 92, having one end in engagement with one member 93 of a bell-crank lever fulcrumed as at 94 on a bracket 95, and the other member 96 of which lever is pivotally connected at 97 to the lower end of the threaded shank 65. The diaphragm chamber is connected by a pipe 98 with the pipe 17 leading to the burner 15, so that the pressure of oil in the pipe 17 is communicated to the diaphragm chamber and acts against the diaphragm 90 and the plunger head 91. The pressure of oil against the plunger head 91 is opposed by an expansion spring 99, one end of which is located in the spring head 100 engaging the opposite side of the bell-crank lever 93 from that which engages the plunger rod 92, and the other end of which spring is seated in a spring seat 101 which abuts an adjusting screw 102 threaded through a fixed abutment 103 supported by the rods 104 attached to the diaphragm chamber structure. The screw 102 is adjustable to vary the force of the spring 99, and may be held in adjusted position by a jam nut 104.

When the pressure of oil is at the minimum for firing the furnace, the tension of the springs 57, 58 is adjusted so that the excess tension on the lower spring over the upper spring added to the draft pressure on the inside of the plate is just sufficient to balance the atmospheric pressure on the outside of the plate; whereby the plate is held in neutral position, as shown in Fig. 5, and the pilot valve 68 is maintained in position to cut off flow of fluid under pressure to the bottom of the cylinder 73. The lower adjusting nut 67 is then set against the bottom of the bracket 66, and the upper adjusting nut 67 is moved toward the eye 64 to give play to the threaded shank 65 through the said bracket. The feed of fluid fuel to the burner is then increased to the maximum pressure desired, and this pressure exerted on the diaphragm 90 pushes the plunger head 91 and plunger rod 92 outward toward the right of Fig. 4 against the force of the spring 99 moving the bell-crank in a direction to increase the tension on the lower spring 58. The adjusting screw 61

is then turned until the bracket and the plate 51 are pulled outward enough to cause the damper 13 to open sufficiently to give the desired amount of draft in the furnace chamber 6 for a maximum supply of oil. The action of the spring 99 opposing the diaphragm will now hold the bell-crank controlling the tension on the lower spring 58, in such position that every pressure of oil to the burner intermediate between the minimum and maximum of the regulator will automatically hold the flue damper 13 in a position to give a draft in the furnace chamber 6 that will give the desired air supply for the fuel being fed to the furnace at that time. The spring 99 should be of such proportions that for the range of variation of pressure of oil to the burner it will give the desired travel to the threaded shank 65 to give the desired variations in tension of the lower spring 58 to control the draft to the desired amount for minimum pressure of oil supplied to the burner, and for maximum pressure of oil supplied to the burner.

In the form of the invention shown in Figs. 2 and 6 to 10 inclusive, the operation of the regulator is controlled by the rate of flow of oil passing to the burner as distinguished from control by pressure of oil fed to the burner, as heretofore described. In this form of the invention, I employ a plate regulator, such as heretofore described, and in view of the similarity of the structure I do not repeat the description as to features which are in common, but have applied similar reference numerals to similar parts, to which reference may be made by the description previously given.

Upon a suitable bracket 105 is supported a regulator of my invention for controlling the operation of the swinging plate in accordance with variations in the rate of flow of oil or other fluid fuel fed to the burner. This regulator is shown specifically in Figs. 6 to 10 inclusive, wherein 106 designates a lower half or member of a diaphragm chamber, the upper half of which is shown at 107, said members being connected by headed bolts 108 and nuts thereon, and said members clamping between them a flexible diaphragm 109 shutting off communication between said members, except as hereinafter described. Integral with the lower member is an inlet connection 110 having a port 111 leading to an opening 112 through the flange of the member 106 leading into a passage 113 in the wall of the upper member 107, said passage 113 communicating with the space in said upper member above the said diaphragm. The connection 110 is connected to that portion of the pipe 17^a of Fig. 2 (corresponding to the pipe 17, heretofore described) leading from the pump 16. Connected to the lower member 106 is an outlet

connection 114 (Fig. 8) opening into the lower chamber of the device below the diaphragm 109, said connection being connected to a pipe 17^b leading from said regulator to the burner 15. The chamber in the upper member 107 above the diaphragm 109 opens through a port 115 into a valve casing 116, preferably formed integral with the member 107 and containing a tapered turn-plug valve 117 (see Fig. 10), the latter having a port 118 adapted to communicate with the said port 115, and leading to the internal bore 119 of the valve, which in turn communicates with a passage 120 leading into the member 106 beneath the diaphragm 109. In order to provide for a tight fit, the valve 117 is preferably tapered and fitted to a correspondingly tapered bore in the casing 116, and is urged to its seat by a spring 121 surrounding a stem 122 on said valve and at one end abutting a packing gland 123 threaded into the casing 116, and at its other end abutting the upper end of the said valve 117. The valve is provided with a head 124 adapted to be engaged by a wrench or other suitable means, by which it may be rotated. Connected to the diaphragm 109, in a suitable manner, as at 125, is one end 126 of a rod 127 extending upwards through a stuffing-box 128 in the upper wall of the member 107, the upper end of said rod 127 being fitted with an eye piece 127^a and connected by a link 129 to one threaded member 130 of a turn-buckle 131, the other threaded member 132 of which is connected to one end of a tension spring 133, the opposite end of which is connected to a bracket arm 134 rigidly fixed to the swinging plate adjacent the axis thereof. Around the rod 127 and between the stuffing box 128 and the shoulder of the eye piece 127^a is placed a compression spring 128^a. The means for connecting the rod 127 to the diaphragm 109 consists of a dished plate 135 having a flange 136 secured by a fluid tight joint to the lower face of the diaphragm 109, by means of screws 137, extending through said flange and packing washers 138 between the said flange and the diaphragm, and threaded into a washer or ring 139 on the upper side of the diaphragm. The dished portion of the plate 135 extends upwards through a central opening in the diaphragm and has a central opening 140 through which the rod 127 extends, the rod having beneath said plate an enlargement or head 141 of greater diameter than the opening in the said plate, so that the rod and plate are connected. The under side of the plate is closed against leakage by a plate 142 held in place by the screws 137.

When there is a minimum rate of flow of oil to the burner the nut 131 is adjusted to increase the tension on the spring 133 pulling the plate outward, which moves the

damper towards its open position. As soon as the damper is moved sufficiently to give the desired draft in the furnace chamber 6 to give the requisite quantity of air for proper combustion of the volume of oil then fed to the furnace, the nut 131 is left in that position. The flow of oil to the burner is then increased to the maximum rate of flow required, with the restriction valve 117 wide open. This valve is then gradually closed until the restriction is sufficient to cause a difference in pressure between the upper and lower member, so that the diaphragm is pushed downward, and acting through the rod 127 the tension of the spring 133 is increased, pulling the plate outward and moving the damper 13 toward open position. The restriction valve 117 is then moved towards its closed position until the draft in the furnace chamber 6 is sufficient to give the desired amount of air for the maximum rate of flow of oil fed to the furnace. For any intermediate rate of flow between the minimum and the maximum, the regulator will now assume an intermediate position, holding the damper in correspondingly intermediate positions between those corresponding to minimum and maximum rate of flow of oil, and will give a draft in the furnace chamber 6 which will give the desired proportion of air to the rate of flow of oil being fed at any time. The compression spring 128^a should be sufficiently strong so that with minimum flow of oil to the burner there will be no downward movement of the rod 127.

The fluid fuel fed from the burner or nozzle to the furnace chamber 6 being under pressure is in the form which results in a flame which is either substantially cone-shaped or fan-shaped, according to the type of burner employed. It is desirable that the air entering the furnace chamber 6 be admitted over an area conforming as nearly as possible to the form or area of the flame, in order that the best results be obtained as regards complete combustion. My invention provides an efficient means for regulating the area of air distribution, and for this purpose I provide means for controlling the area of the open-work portion of the partition 7 through which the air flows from the space 8 to the chamber 6, so that said area will conform substantially to the area of the flame, and will supply a quantity of air desirable for combustion. For this purpose I divide the chamber 8 into a plurality of air chambers, each preferably having an independent air supply, and having outlets upwards into the furnace chamber 6 through that portion of the open-work partition 7 immediately over the particular chamber beneath said partition. In the present embodiment, I preferably divide chamber 8 into three such air supply chambers, and do

this by providing two vertical partitions 7^a extending in a general direction lengthwise of the furnace and having their inner ends closely adjacent each other to provide a passage, as at 16^a, adjacent the nozzle. 15, from which point they flare outward to the point where they abut or join the bridge wall, as shown at 7^b. The inner ends of said partitions 7^a are connected by outwardly-directed end partitions 7^c with the side walls of the furnace, respectively. The partitions 7^a and 7^c extend from the floor of the furnace to the underside of the partition 7, so as to form three separate independent chambers. It will be seen that by the arrangement of partitions 7^a and 7^c, the space beneath the partition 7 is divided into a central flaring chamber 7^d and two wing compartments 7^e, said central chamber being approximately the shape and area of the flame when the burner is being operated at a relatively low pressure, and the air through the open-work portion of the partition 7 from the wing compartment 7^e being available for an increased area of the flame when the burner is operated at relatively high pressures. It will thus be seen that I am able to control the area of air supplied through the partition 7 in order to conform substantially to the area of the flame when the burner is operated at different pressures. As stated, I preferably provide separate means for controlling the supply of air to each of the chambers 7^a and 7^c, such means preferably consisting of dampers 8^a, the same being pivoted, respectively, in the passage between the inner ends of the walls 7^a, and openings 7ⁱ in the said partitions 7^c. In the present embodiment, I desire it understood, however, that my invention, as regards the method of air distribution to conform to the area of the flame, is not limited to any particular means for controlling the amount of such supply, as such amounts may be regulated by either automatic or hand control. In the present embodiment, where the dampers are manually controlled, the outer dampers 8^a are mounted on horizontal shafts 8^b mounted in suitable bearings, carrying operating levers 8^c, for swinging the dampers. Any suitable manual operating means may be used for this purpose. The central damper is mounted on a shaft 8^d connected by a universal joint 8^e with one or both of the said shafts 8^b, so as to move all three of said dampers in unison. The connection between the central damper and the outer dampers is so adjusted that when the outer dampers are closed, the central damper will be partially open, so as to admit air to the central chamber 6^a, but as the outer dampers are moved toward open position, the inner damper will be moved to increase the area of the opening controlled thereby to the central

chamber 6^a. Air is admitted to the front portion of the furnace beneath the partition 7, and in front of the walls 7^c, through an air duct 9 in the front wall of the furnace.

3 The general construction is the same as that shown and described in my copending application, Serial No. 391,779, filed June 25, 1920, but in the present instance the automatic control of the air dampers shown in
10 said prior application is omitted, and said dampers are set by hand as stated herein, to give sufficient opening to admit sufficient air, the amount of which is controlled by the automatic regulator which controls the draft
5 in the furnace.

While I have shown an efficient means for supplying air to the combustion chamber distributed in accordance with the shape of the flame, I desire it understood my present
20 invention is not limited to such means but that any suitable means may be employed for supplying air to the combustion chamber.

So far as I am aware, I am the first to
25 utilize a characteristic of the flow of fluid fuel to the furnace, and illustrated either as pressure or rate of flow for varying the action of a means controlled by the furnace gas pressure, which in turn controls the supply
30 of air to the furnace.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the
35 furnace, means for varying a characteristic of the flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, means controlled by furnace gas pressure for operating
40 said means for controlling the supply of air, and means capable of acting in accordance with a characteristic of the flow of the fluid fuel to the furnace for varying the action of said means controlled by furnace gas pressure.
45

2. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the furnace, means for varying the rate of flow
50 of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, means controlled by furnace gas pressure for operating said means for controlling the supply of air, and means capable of acting in accordance with
55 variations in the rate of flow of fluid fuel fed to the furnace for varying the action of said means controlled by furnace gas pressure.

3. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the
60 furnace, means for varying a characteristic of the flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, means controlled
65 by furnace gas pressure for operating said

means for controlling the supply of air, a regulating spring for controlling the action of said means controlled by furnace gas pressure, and means capable of acting in accordance with variations in a characteristic
70 of the fluid fuel fed to the furnace for varying the action of said spring.

4. In a fluid fuel fired furnace, in combination, means for feeding fluid fuel to the furnace, means for varying a characteristic of
75 the flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a member exposed to internal furnace pressure and to atmospheric pressure, an adjustable resistance
80 opposing atmospheric pressure on said member, and means capable of acting in accordance with variations in a characteristic of the flow of the fluid fuel fed to the furnace for varying said resistance.
85

5. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the furnace, means for varying the rate of flow
90 of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a member exposed to internal furnace pressure and to atmospheric pressure, an adjustable resistance opposing atmospheric pressure on said member, and means capable of acting in accordance with
95 variations in rate of flow of fluid fuel fed to the furnace for varying the action of said resistance.

6. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the
100 furnace, means for varying the rate of flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a member exposed to internal furnace pressure and to atmospheric pressure, and adjustable resistance opposing atmospheric pressure on said member, and means capable of acting in accordance with variations
105 in rate of flow of fluid fuel fed to the furnace for increasing said resistance when the rate of flow of oil increases and decreasing said resistance when the rate of flow of oil decreases.
110

7. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the
115 furnace, means for varying the rate of flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a swinging plate exposed on one face to furnace gas pressure and on the other face to the atmosphere, an adjustable resistance opposing atmospheric pressure on
120 said plate, and means capable of acting in accordance with variations of the rate of flow of fuel fed to the furnace for automatically adjusting said resistance in accordance with variations in the rate of flow of fluid
125 fuel fed to the furnace.

8. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the
130

- furnace, means for varying the rate of flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, means controlled by furnace gas pressure for operating said means for controlling the supply of air, a regulating spring for controlling the action of said means controlled by furnace gas pressure, and means capable of acting in accordance with variations in the rate of flow of fluid fuel fed to the furnace for varying the action of said spring.
9. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the furnace, means for varying a characteristic of the flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, means controlled by furnace gas pressure for operating said means for controlling the supply of air, a regulating spring for controlling the action of said means controlled by furnace gas pressure, and means capable of acting in accordance with variations in a characteristic of the fluid fuel fed to the furnace for increasing the tension of said spring when the rate of flow of oil increases and for decreasing the tension of said spring when the rate of flow of oil decreases.
10. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the furnace, means for varying a characteristic of the flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a member exposed to internal furnace pressure and to atmospheric pressure, a spring opposing the movement of said member under atmospheric pressure, and means capable of acting in accordance with variations in a characteristic of the fluid fuel fed to the furnace for varying the resistance of said spring.
11. In a fluid fuel fired furnace in combination, means for feeding fluid fuel to the furnace, means for varying the rate of flow of fluid fuel fed to the furnace, means for controlling the supply of air to the furnace for combustion, a swinging plate exposed on one face to furnace gas pressure and on the other face to the atmosphere, a spring resisting atmospheric pressure on the plate, and means capable of acting in accordance with variations in the rate of flow of fluid fuel fed to the furnace for varying the resistance of said spring.
12. In a furnace, means for controlling the supply of air to the furnace for combustion, means controlled by furnace gas pressure for operating said means for controlling the supply of air, and means for automatically varying the action of said means controlled by furnace gas pressure.
- In testimony whereof, I have hereunto signed my name.

EMBURY McLEAN.