No. 891,635. PATENTED JUNE 23, 1908.

A. W. PUDDINGTON.

SMOKE PREVENTING FURNACE.

APPLICATION FILED JUNE 18, 1906.

4 SHEETS—SHEET 1.

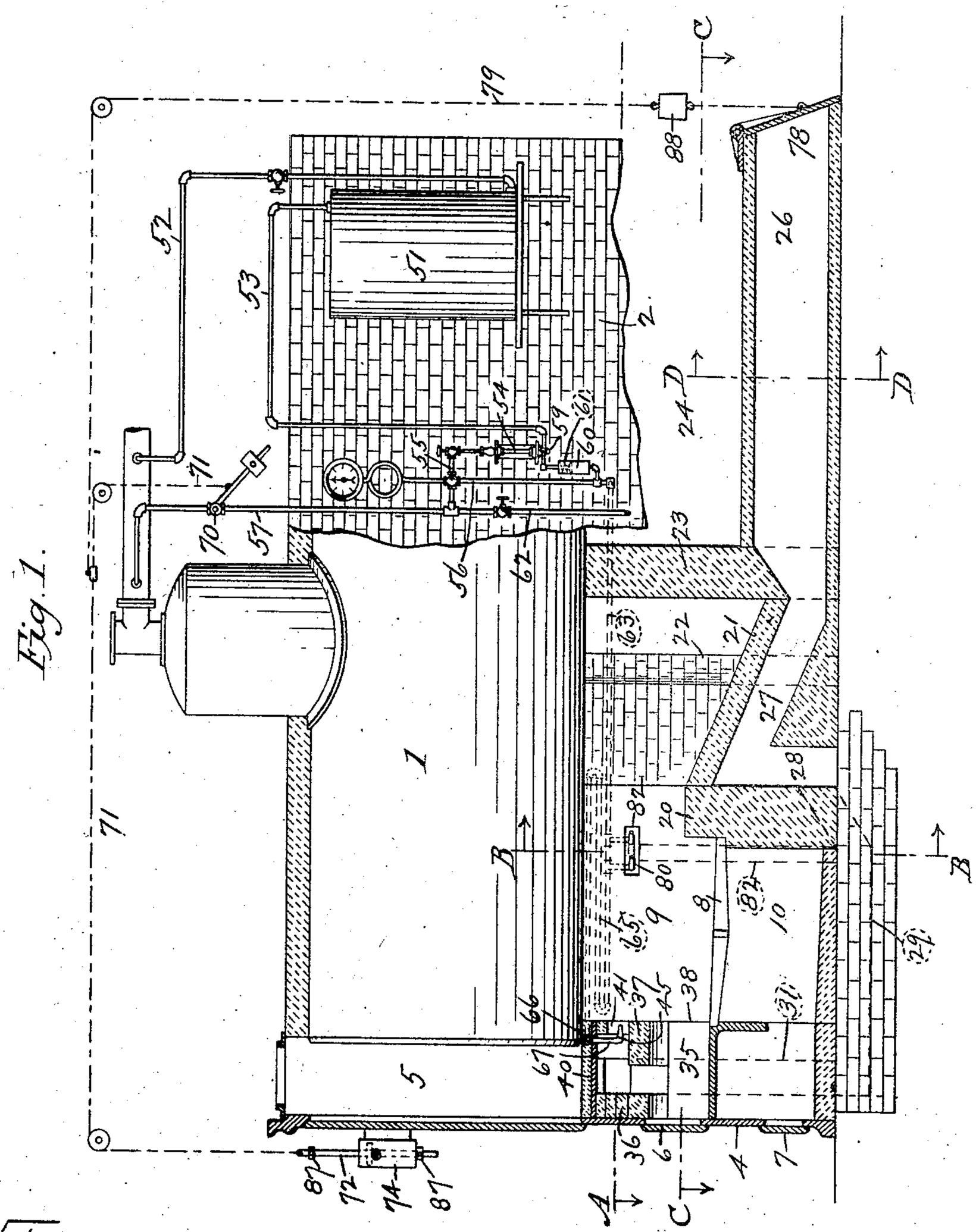

Fig. 1.

Witnesses:

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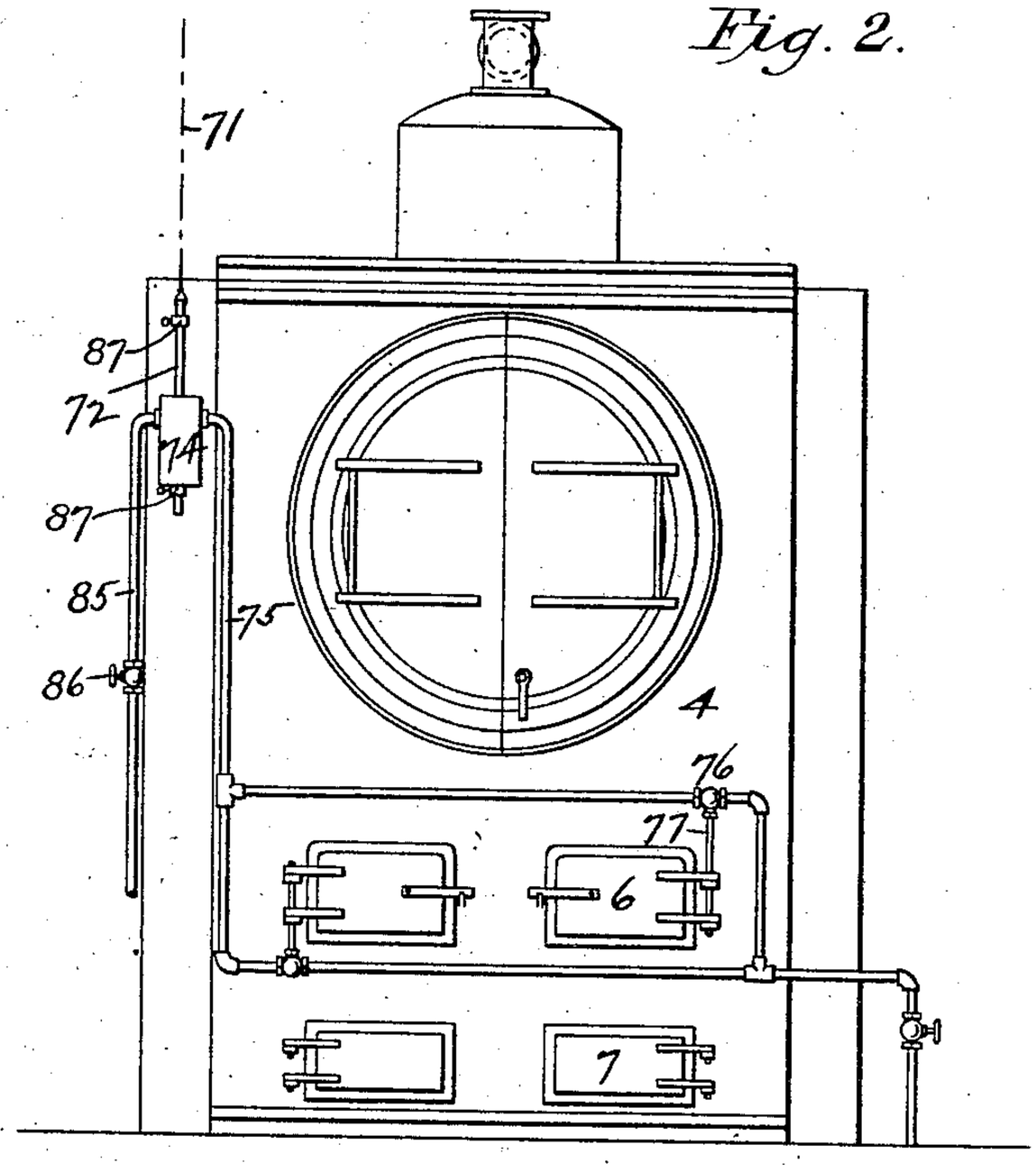
4 SHEETS—SHEET 2.

Fig. 2.



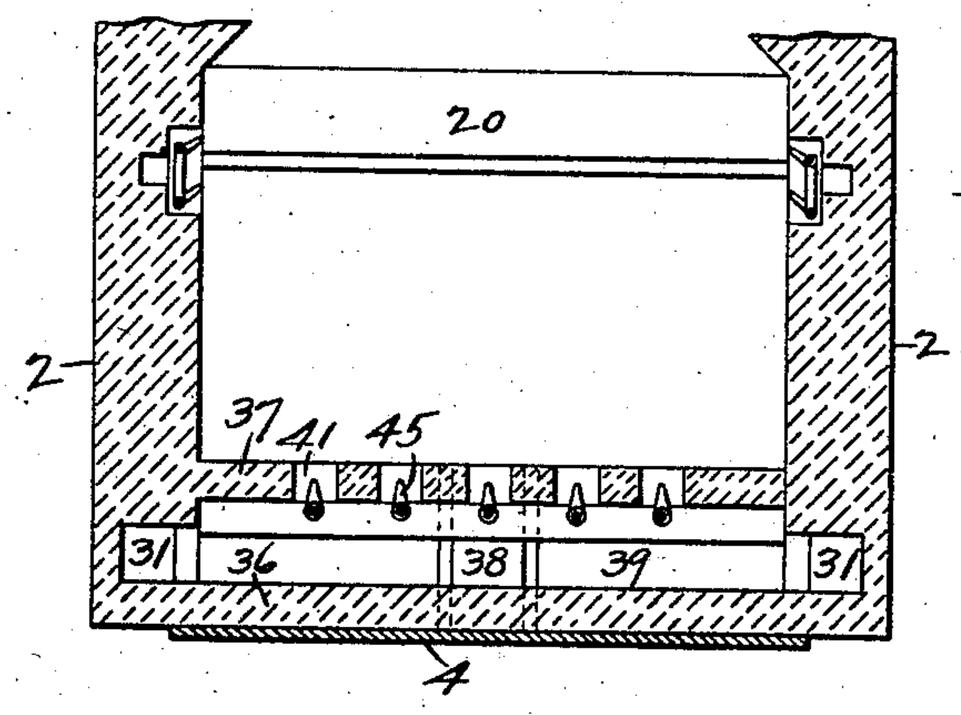


Fig. 3

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4 SHEETS—SHEET 3.

Fig. 4.

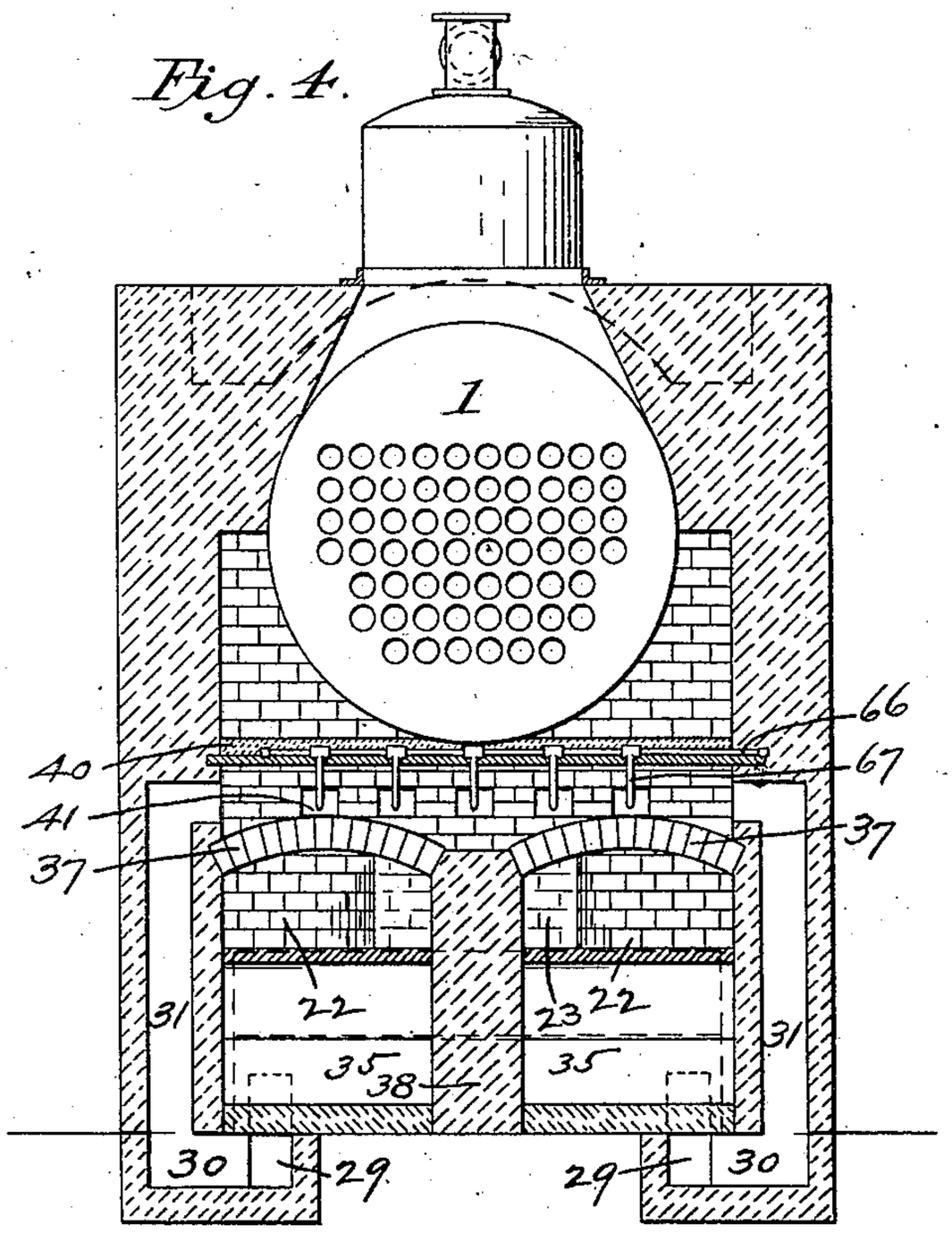
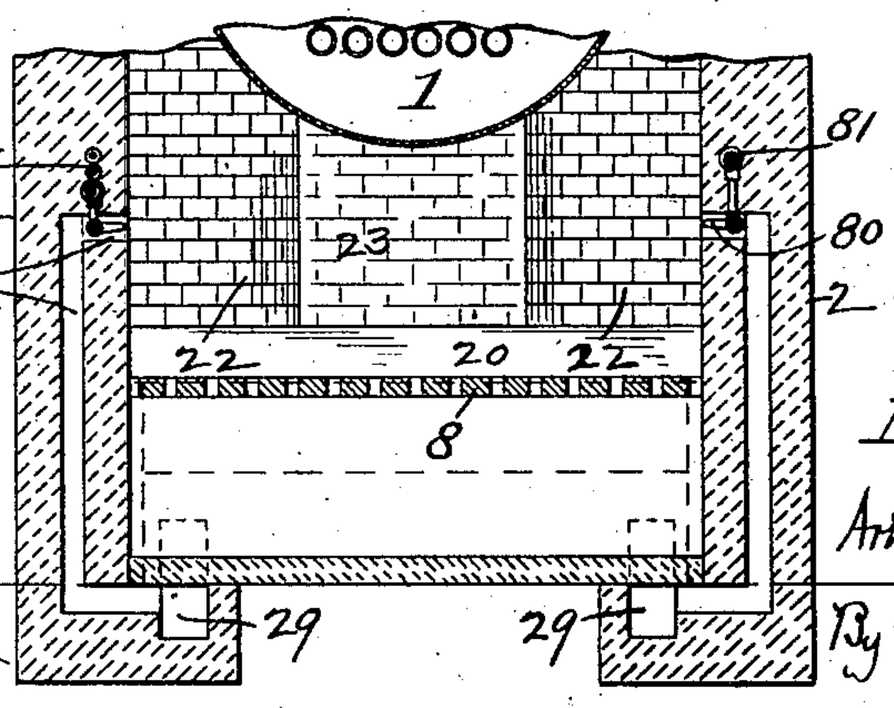


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 6.

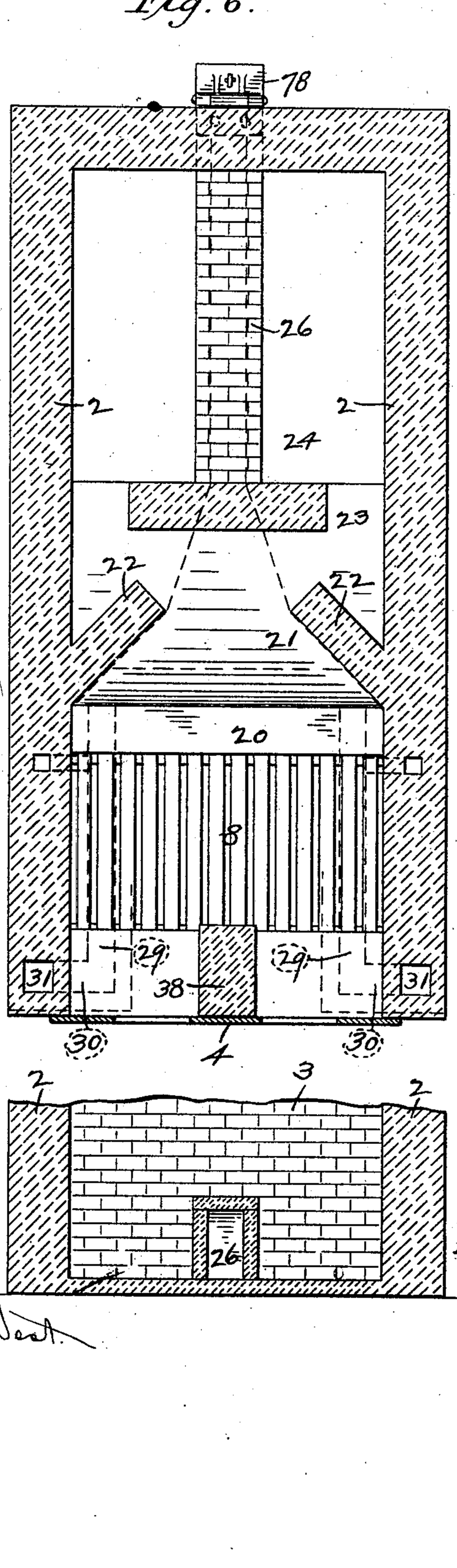

Fig. 7.

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UNITED STATES PATENT OFFICE.

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SMOKE-PREVENTING FURNACE.

No. 891,635. Specification of Letters Patent. Patented June 23, 1908.

Application filed June 18, 1906. Serial No. 322,142.

To all whom it may concern:

Be it known that I, ARTHUR W. PUDDINGTON, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Smoke-Preventing Furnaces, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to a system of equipping steam boiler furnaces with means for preventing smoke and economizing fuel.

It is well known that all bituminous coals are rich in gases and volatile carbon. Perfect combustion of this kind of fuel in hand fired furnaces requires an air supply, varying in quantity at different stages of the combustion. When fresh fuel is added to the fire rapid distillation of the volatile matter occurs for a brief period. The whole interior of the furnace is at the moment filled with gases and floating carbon requiring instantly a largely increased supply of intensely hot air forced into intimate contact to enable their combustion. Lacking sufficient air at ignition temperature this valuable fuel cannot burn and is instantly swept out of the furnace unignited. Just at the time it is needed, this excess air cannot be supplied through the grate. The freshly stoked fuel has partially choked the openings through the fire bed while the burning fixed carbon takes up the oxygen as fast as it passes through the grate bars. If the draft were of sufficient intensity to supply the quantity of air required at this stage of the fire, there would be a wasteful excess after the coking process was completed.

To accomplish the desired result, supplementary air must be admitted above the fire, during the process of coking. Admitting air through fire doors, dead plate or openings through front of the furnace will be of no service at this time. If the required quantity is admitted it cannot be preheated sufficiently to prevent chilling the gases below the point at which their complete combustion can take place.

I am aware that furnaces and boiler settings have been constructed with long flues through the walls in which air has been highly heated, but it has been found generally impractical. In the ordinary furnace walls it is impossible to make them of sufficient length and size to heat the required quantity of air without too greatly weakening the walls and injuring the setting.

It is the object of the present invention to provide a furnace with an improved method for supplying automatically at the proper time and for the proper length of time a proper quantity of air at the proper temperature to unite with the gases and floating carbon in the fire box, thereby attaining substantially perfect combustion, preventing smoke and increasing the efficiency of the furnace. In accomplishing this, I provide from the rear a large passageway for hot air under the furnace, but without disturbing the walls thereof, so arranged that it will effectively heat the air and control this passageway by means actuated by the opening of the fire door. At the rear of the fire box I supply a mixing pocket which becomes incandescent, into and through which the gases pass, insuring their thorough mixture. Underneath this pocket, in heating relation thereto, is located a large air chamber or reservoir into which the air passageway leads from the rear of the combustion chamber and from which it leads forward under the furnace, communicating with the air chamber over the fire doors. I also supply automatically, when the fire door is opened, jets of combustible gas which act downwardly and rearwardly over the fuel bed. These jets thoroughly intermix the hot air and gases while acting as a torch to compel instant ignition of the mixture.

The various features of invention are hereinafter more fully described and the essential characteristics set out in the claims.

In the drawings, Figure 1 is a sectional side elevation of the furnace. Fig. 2 is a front view thereof. Fig. 3 is a horizontal section through the air chamber substantially on the line A—A of Fig. 1. Fig. 4 is a vertical section through the smoke space and the admission openings. Fig. 5 is a vertical cross section on the line B—B of Fig. 1. Fig. 6 is a horizontal section substantially on the line C—C of Fig. 1. Fig. 7 is a vertical cross section on the line D—D of Fig. 1.

As shown in the drawings, 1 represents the boiler which is of the return-tube type. The furnace has the usual side walls 2 and rear

wall 3. As shown in the drawing, the furnace has a cast iron front 4, which provides a smoke space 5 leading to the stack, not shown. In this front are fire doors 6 and ash doors 7.

8 represents the grate, above which is the fire box 9 and below which is the ash pit 10. This much of the construction is of the usual form and varies with conditions.

The rear end of the grate rests on the bridge wall 20. At the rear of this wall is an inclined floor 21, from which rise a pair of wing walls 22 extending inwardly diagonally from the side walls of the furnace. A short distance behind the wing walls is the baffle wall 23, extending from the floor up to the boiler shell, leaving a space between its vertical edges and the side walls of the furnace. The wing walls and the baffle wall form a mixing pocket to insure the gas and air being thoroughly mixed when they pass into the final combustion space 24 back of the baffle wall. Moreover, the baffle wall and wing walls are maintained incandescent and act as a reservoir of heat to preserve at all times a more even temperature under the boiler.

Extending through the final combustion space 24 is a flue 26 which is shown as centrally located and leading from the rear end of the furnace to the baffle wall 23. This flue passes diagonally downward through the baffle wall and beneath the inclined floor of the mixing pocket, where the flue flares outwardly and passes diagonally upward parallel with the inclined floor, as shown at 27. Thence the flue passes downward (28) and divides into two portions 29, passing diagonally downward beneath the bridge wall and forward beneath the floor of the fire box adjacent to the side walls of the furnace. Near the forward end of the furnace, the flues turn laterally as at 30 and then pass upwardly in the wall of the furnace as at 31. At their upper ends, these flues 31 connect with an air chamber over the entrance openings, which will now be described.

The entrance openings 35 in the furnace behind the fire doors are each surmounted by a pair of separated arches 36 and 37 resting on skew-backs in the walls 2 and on the internal pier 38. These arches leave between them a long open space 39, establishing communication between the entrance openings and the space above them which constitutes the air chamber. At its front this air chamber is closed by the cast iron front 4, and at the top by a suitable plate and a layer of bricks 40.

Through the wall of the air chamber carried by the arch 37 are formed openings 41. These openings are occupied by nipples 45, which inject hydrocarbon, as hereinafter explained,—the arch extending forward beneath the nipples to protect them. The operation of the flues and openings, as described, allows a large quantity of hot air to pass from beneath the furnace to the air chamber and to discharge downward between the arches, at the same time that combustible gas and air are discharged downward and rearward through the openings 41. This discharge of air and gas is initiated when the fire door is opened, and is automatically controlled, as hereinafter explained.

Located at some suitable point is a tank 51 adapted to contain petroleum or other hydrocarbon and connected at its lower portion with the steam pipe 52 from the boiler. A pipe 53 leads from the upper portion of this tank to the lower end of a sight feed device 54. From the upper end of this device, a pipe 55 leads to a pipe 56. Joining this pipe 56 is a pipe 57 which leads from the steam space into the boiler. Between the sight feed device and the pipe 53 is a valve 59 connected with a plunger in the cylinder 60. This cylinder is connected with the pipe 56. A spring 61 tends to hold the valve closed, while the pressure on the piston from the pipe 56 tends to open it.

62 represents a drain pipe leading from the pipe 57, but normally closed.

Leading from the lower end of the pipe 56 is a pipe 63 which is embedded in one of the walls 2 of the furnace and forms a retort alongside of the fire box, being coiled back and forth on itself, as shown at 65. Leading from this coil, a pipe extends crosswise at 66 within the brickwork 40 above the air chamber, and extending downwardly from this pipe are a number of branch pipes 67 terminating in the nipples 45 referred to, which freely occupy the discharge openings 41 in the wall carried by the arch 37 and point rearward and downward toward the fire box.

The operation of the system of piping just described, when steam is admitted from the boiler to the pipe 57 is that the back pressure of the fluid in the pipe 63 acting against the piston in the cylinder 60, opens the valve 59, admitting oil to the pipe 56, and oil and steam pass together through this pipe and through the retort 65, where the same are heated sufficiently to decompose the steam, making carbon monoxid and hydrogen, which is discharged through the nipples onto the fire. The force of this discharge draws air through openings 41 around the nipples. This keeps the nipples comparatively cool. At the same time, by having the pipe 66 embedded in the brickwork, the gases within the pipe are maintained at the proper temperature to prevent their separation.

The discharge of combustible gas, as well as the large quantity of air through the flues, above described, is caused to take place automatically when the fire door is opened by mechanism which is the subject of my application No. 298,907, filed Feb. 1st, 1906. Briefly described, this mechanism is as fol-

lows: In the steam pipe 57 is a throttle valve 70 which is shown as connected by a chain 71 and a dash pot 74. Leading to the cylinder of this dash pot is a pipe 75 connected with water under pressure, as for example, with the city water main. In the pipe 75 is a valve 76 arranged to be opened and closed by substantially a half rotation of its stem. This stem 77 extends upward as the hinge-pintle of the fire door 6, being journaled in the stationary ears of the fire door hinge and rigidly connected with the ears which are rigid with the fire door. When the fire door is closed, this valve 76 is closed, but when the fire door is opened, to admit fuel, the valve is thereby automatically opened. This admits water under pressure to the hydraulic dash pot 74, the piston of which moving under the force of water, opens the throttle valve 70 in the pipe 57, whereupon as stated, steam and hydrocarbon are forced through the retort and the resulting water-gas is discharged onto the fire.

78 represents a damper at the rear end of the flue 26 hereinbefore described. This damper is connected by a chain 79 with the chain 71. The same operation of the dash pot therefore which causes the injection of the gas opens the air flue so that a sufficiently large quantity of heated air is discharged immediately onto the fresh fuel. This air is sufficient in quantity to combine with the gases and carbon rising from the fresh fuel and it is hot enough, from the heat it received beneath the combustion chamber, and mixing chamber, and the heat added by the burning injected gases, to cause it to unite with the floating carbon and carbon monoxid, thereby insuring substantially complete combustion. The force of the injected gas blows this air and the ascending carbon rearward across the bridge wall and between the wing walls and against the baffle wall, which not only causes a thorough mixture but by the highly heated surfaces of the wing and baffle walls insure complete combustion.

To further insure the heat of the air supply and the combustion of the floating carbon, I may provide in the side walls of the furnace, nipples 80, which are respectively connected with the retort 65 and with a pipe 81 connecting with pipe 66 conveying the hydrocarbon gas. These nipples stand within air passageways 82, communicating with the flues 29. Two nipples are shown on each side occupying a longitudinal extension of the vertical flues 82. These nipples point diagonally rearward toward the bridge wall. They are of special use in case the fire box is very long, augmenting the rearward force of the gases injected from the front.

Extending from the dash pot 74 is a drip pipe 85 having a valve 86. After the fire door is closed, the action of the injected water-gas and air continues until the dash pot plunger is returned to its normal position,—this return being accomplished by the gradual escape of the water from the dash pot cylinder through the pipe 85. The time of this escape is regulated by the valve, so that the injection of air and water-gas may continue, after each firing, for just the length of time necessary to consume those volatile constituents of the fuel which ordinarily cause smoke. This period of time will vary considerably with different fuels,—a usual period being from two to four minutes.

Adjustable collars 87 on the rod 72 of the hydraulic dash pot may furnish convenient means for limiting the amount of opening of the throttle valve and the air damper. The dash pot rod is shown as having an upward tendency by a weight 88 on the chain. When the rod is in its uppermost position, the damper is closed, and the throttle valve is held by its weight in its lower position, which is its closed position. When the dash pot rod is forced downward, the chain opens the throttle valve and the damper. This arrangement of chains and weights is simply illustrative and will vary with particular installations. Springs may be substituted for the weights, and links for the chains.

The regulation of the flow of hydrocarbon is controlled by the back pressure of the steam and the combustible gases forming in the retort, with the result that just the right amount of oil is continually supplied to form such gas. A decrease of steam reduces the gas pressure and this operates to allow the spring to close the valve sufficiently to reduce the oil supply. The supply of oil therefore regulates itself automatically.

It will be seen from the above description that air of the right temperature and of the proper quantity is automatically discharged onto the surface of the fresh fuel. This discharge takes place at the right time and for the right length of time. This together with the automatically regulated flow and discharge of the combustible gas causes substantially complete combustion,—doing away with all smoke and endowing the furnace with much greater efficiency. The heated air discharged downward into the entrance opening very much reduces the quantity of cold air drawn in through that opening. What cold air does come in is immediately heated by the hot burning gas injected, and this gas being discharged rearwardly above the entrance opening, forms a protector for the boiler shell, preventing it being chilled.

It is to be particularly noted that my hot air flues do not weaken the wall of the furnace,—being located between the walls, except at the forward end of the furnace where there is ample strength for the passage of the vertical flues to the air chamber. My arrangement also provides a hot air reservoir

where a large quantity of hot air is maintained, which is immediately available when the fire door is opened.

Having thus described my invention, I claim:

1. The combination, with a grate, of a mixing pocket behind the grate and formed with a floor, a hot air reservoir beneath such floor, a narrow inlet passageway communicating with such hot air reservoir, a pair of flues leading from such hot air reservoir alongside of the two furnace walls, and between them, said flues being adapted to discharge onto the upper side of fuel on the grate.

2. The combination, with a grate and bridge wall, of wing walls behind the bridge wall, and a baffle wall behind the wing walls, whereby a pocket is provided behind the bridge wall, a hot air reservoir beneath the floor of said pocket, a passageway from the rear communicating with such hot air reservoir, a flue leading from such hot air reservoir, passing beneath the bridge wall and adapted to discharge onto the upper side of fuel on the grate.

3. In a furnace, the combination with a grate, of a pair of horizontal flues between and alongside of the furnace walls and beneath the grate, a vertical flue in each wall of the furnace near the forward end communicating at its lower end with the flue alongside of such wall, an air chamber extending across the furnace over the entrance opening and adapted to discharge into the furnace, the ends of such air chambers communicating with such vertical flues, a hot air reservoir beneath the furnace at the rear of the ash pit with which such horizontal flues communicate, and an air passage leading from the outer air to said reservoir.

4. The combination with a grate and bridge wall, wing walls behind the bridge wall and a baffle wall behind the wing walls, whereby a pocket is provided behind the bridge wall, a hot air reservoir beneath the floor of such pocket, an inlet passageway communicating with such air reservoir, a pair of flues leading from such hot air reservoir along side of the furnace walls, and between them, a vertical flue in each wall of the furnace near the forward end communicating at its lower end with the flue alongside of such wall, an air chamber extending across the furnace over the entrance opening and adapted to discharge into the furnace, the ends of such air chamber communicating with such vertical flues.

5. In a steam boiler furnace, the combination with the grate, a hot air reservoir adapted to be heated by the products of combustion, a flue leading from outside the furnace to such reservoir a flue leading from said reservoir to the front of the furnace, and adapted to discharge above the grate, means for injecting fluid above the fuel on the grate, and means initiated by the opening of the fire door for causing the injection of the fluid and opening such air flue.

6. In a steam boiler furnace, the combination, with a grate and a mixing pocket at the rear of the grate, of a hot air reservoir beneath the mixing pocket an inlet flue for such reservoir, flues from said hot air reservoir leading to the front of the furnace and adapted to discharge above the grate, means for injecting fluid above the fuel on the grate, and means initiated by the opening of the fire door for controlling the injection of such fluid and the flow of air through the flue.

7. In a steam boiler furnace, the combination with a grate, a mixing pocket, a hot air flue leading through the space behind said pocket, a lateral reservoir beneath the floor of the mixing pocket with which said flue communicates, two flues leading forward from the reservoir beneath the bridge wall substantially to the front end of the furnace and then passing upward, an air chamber over the entrance opening with which such upward passageways communicate, and exits from the air chamber into the fire-box.

8. In a steam boiler furnace, the combination of a grate, an entrance opening thereto, a pair of parallel separated arches over the entrance opening, an air chamber over the arches adapted to discharge into the entrance opening through the space between the arches, hot air flues in the furnace walls communicating with opposite ends of said air chamber, horizontal flues beneath the grate and adjacent to the inner sides of the furnace walls and communicating with the lower ends of the flues in the furnace walls, and a reservoir beneath the floor and behind the bridge wall with which said horizontal flues communicate.

9. The combination with a grate and a bridge wall at the rear thereof, of a mixing pocket behind the bridge wall and having a floor inclining upwardly toward the bridge wall, there being an inclining space beneath such floor constituting a hot air reservoir, a flue leading from the rear to such reservoir, and a pair of flues leading forward from such reservoir, and an air-chamber over the entrance opening to the grate and communicating with the fire-box, said last mentioned flues communicating with said air-chamber.

10. The combination with a grate, a bridge wall behind it, a mixing pocket behind the bridge wall having a slanting floor, a reservoir beneath such floor, a narrow inlet flue communicating with such reservoir, a pair of flues passing from such reservoir beneath the bridge wall and passing forward adjacent to the furnace walls and turning upwardly, and an air chamber over the entrance opening with which such upwardly extending flues communicate, said air chamber having an exit opening communicating with the fire-box.

11. The combination with a grate, a bridge wall at the rear thereof, a mixing pocket at the rear of the bridge wall provided with a floor, a hot air reservoir beneath such floor, an inlet flue for said reservoir, a pair of discharge flues from the reservoir leading forward on opposite sides of the furnace, a pair of upwardly extending flues leading from such forward flues and discharging into the fire-box from the said walls of the furnace, and nipples located within the exit portion of the last-mentioned flues, and means for conveying fluid to said nipples.

12. In a steam boiler furnace, the combination of a grate, a bridge wall at the rear of the grate, a mixing pocket at the rear of the bridge wall, said pocket having a floor, a hot air reservoir beneath such floor, an inlet passageway leading from the rear to said reservoir, two outlet flues leading from the reservoir forward adjacent to the furnace walls, said flues turning upwardly at their forward ends, an air chamber located over the entrance opening to the grate and communicating at its ends with such upwardly turned portions of the two flues mentioned, said air-chamber having exit openings leading into the fire-box, flues in the side walls of the furnace extending upwardly from the two outlet flues first-mentioned and having exit openings into the fire-box, nipples occupying the various exit openings mentioned, and piping adapted to convey fluid to the various nipples.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

ARTHUR W. PUDDINGTON.

Witnesses:
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