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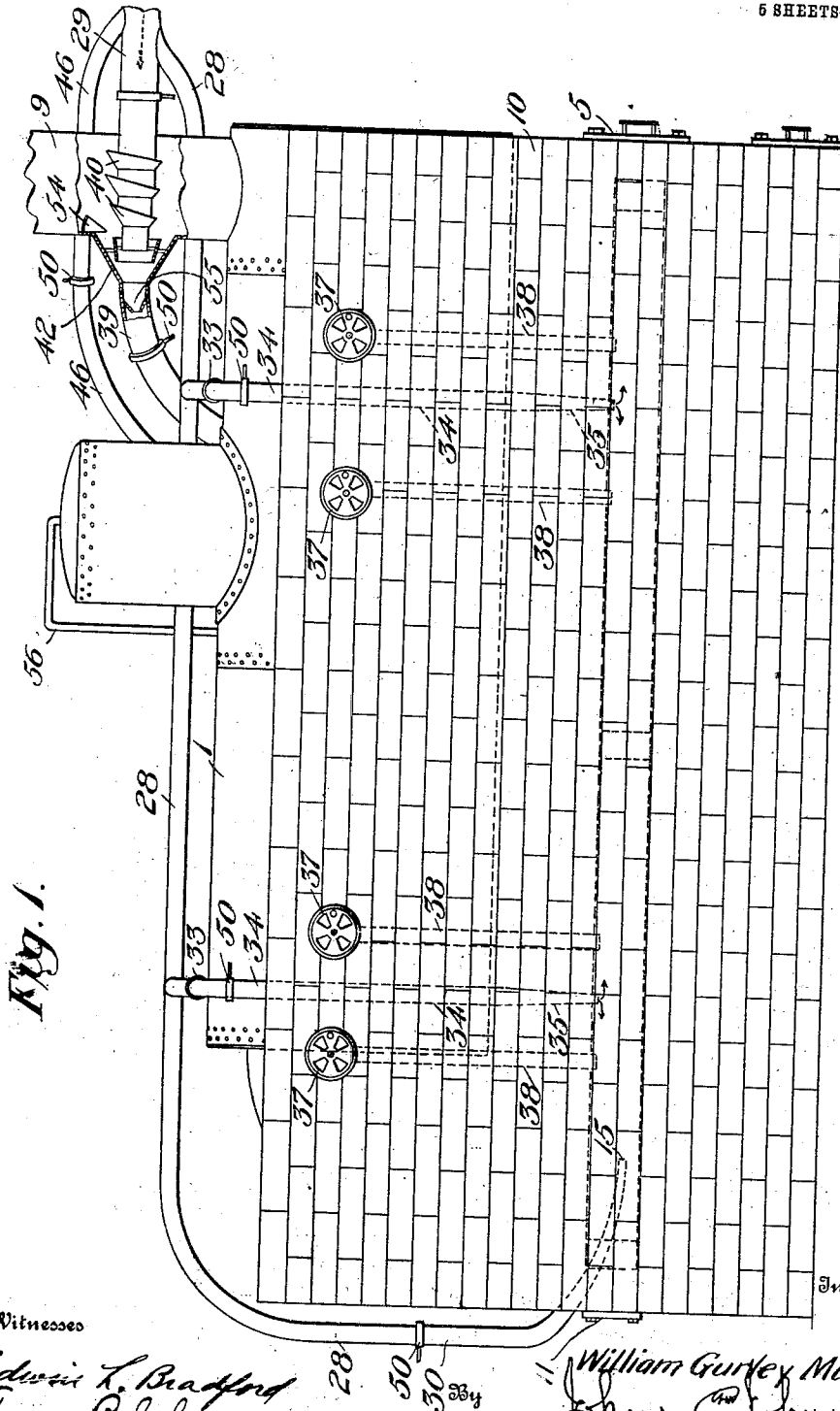


Fig. 1.

Witnesses

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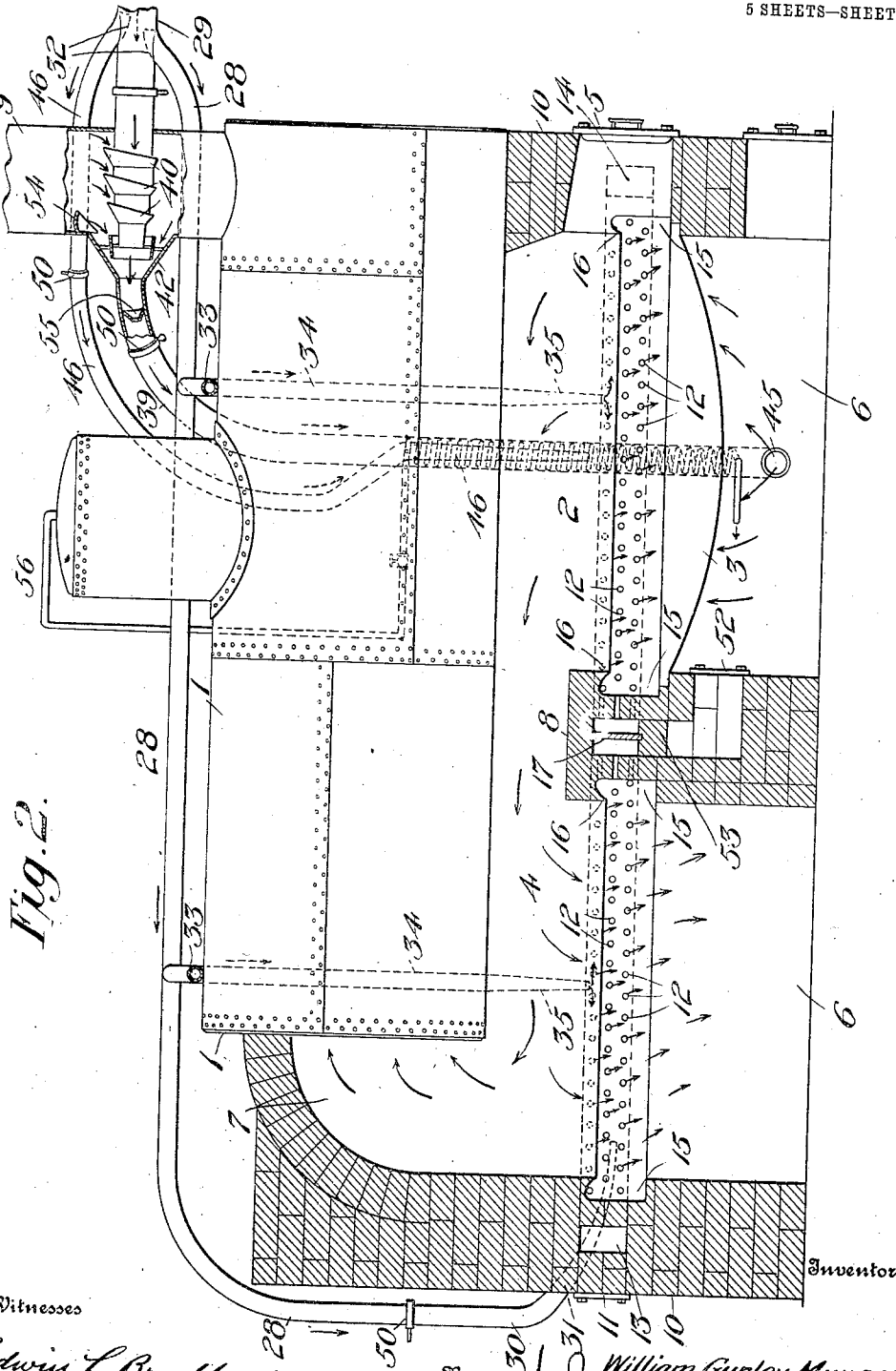


Fig. 2.

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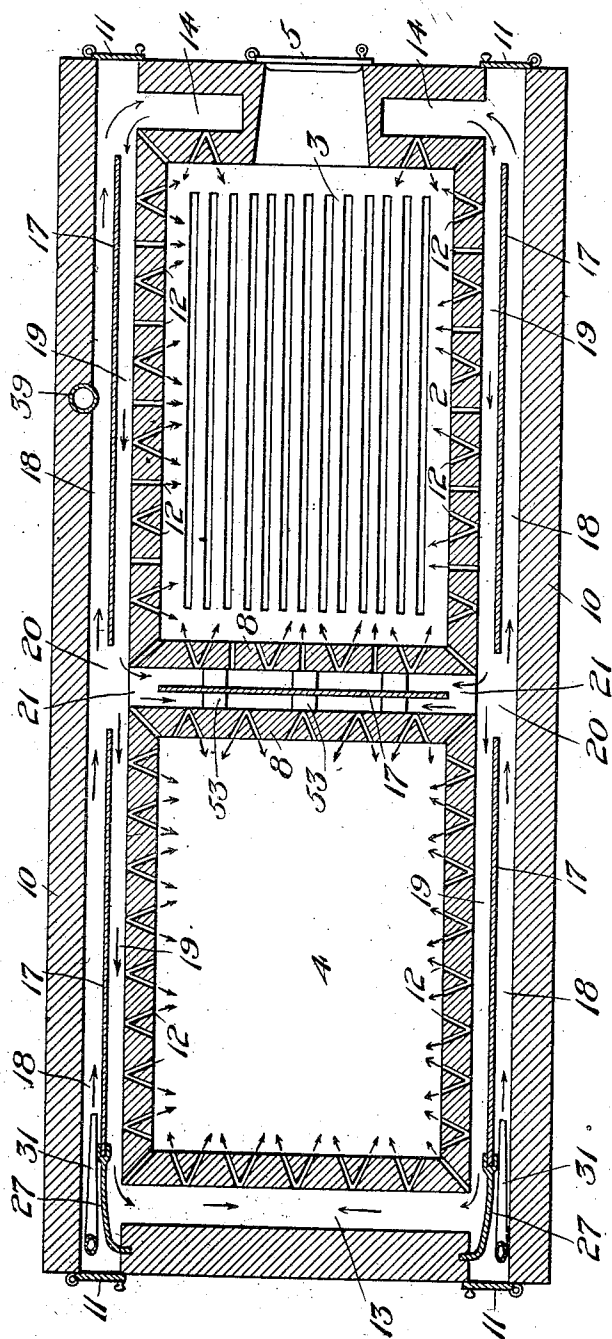
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W. G. MUNSON.
STEAM BOILER FURNACE.
APPLICATION FILED MAY 25, 1908.

Patented Aug. 24, 1909.

5 SHEETS—SHEET 3.

Fig. 3.



Witnesses

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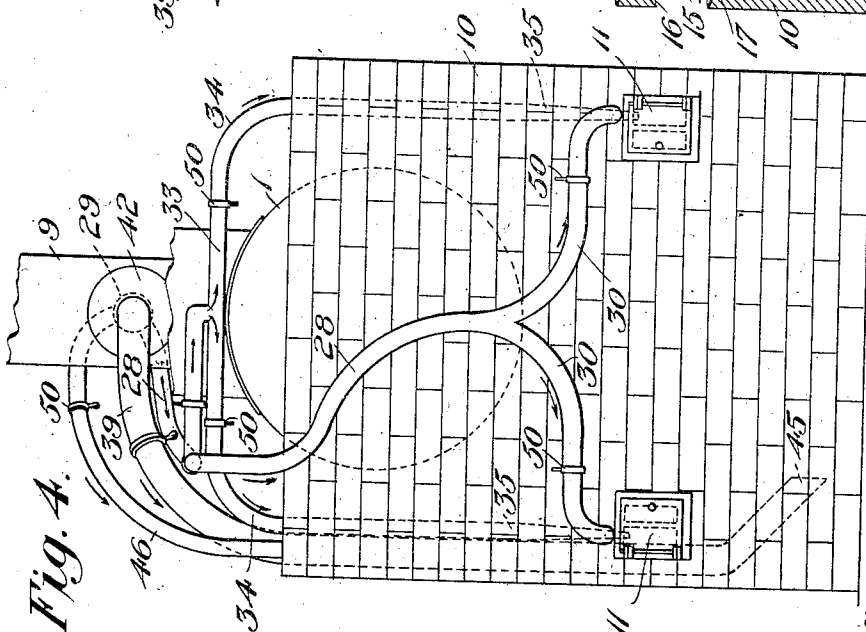
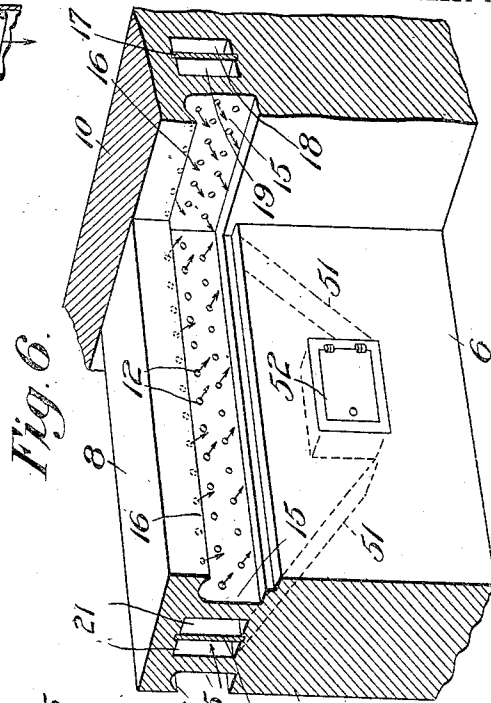
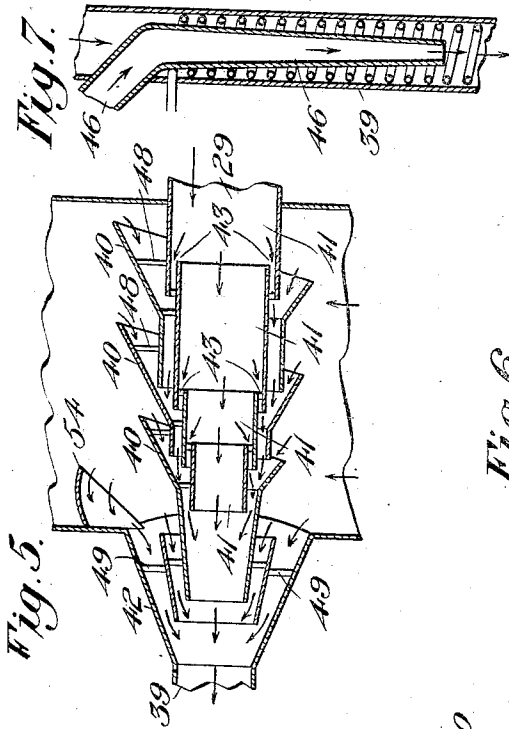
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Witnesses

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5 SHEETS—SHEET 5

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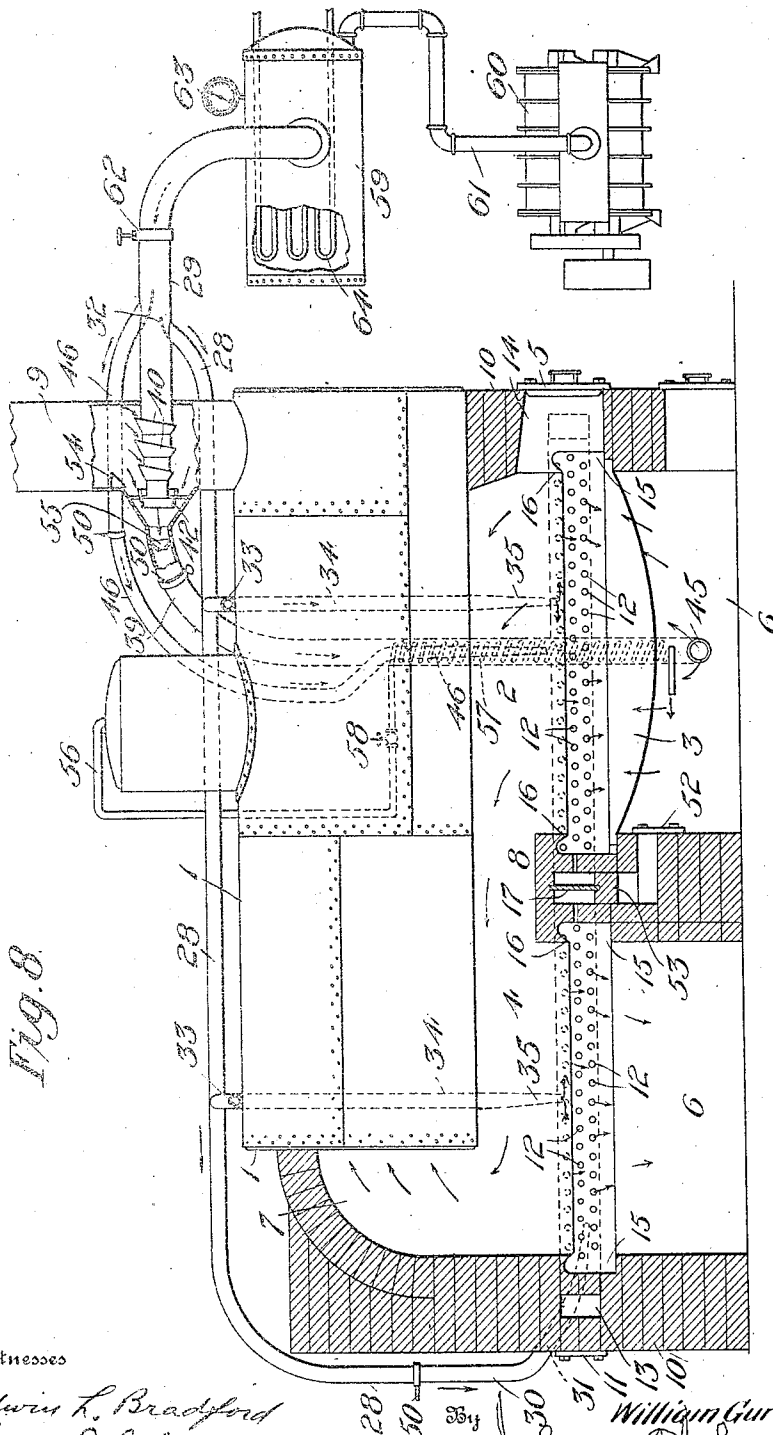


Fig. 8.

Witnesses

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UNITED STATES PATENT OFFICE.

WILLIAM GURLEY MUNSON, OF INDIANAPOLIS, INDIANA.

STEAM-BOILER FURNACE.

931,952.

Specification of Letters Patent. Patented Aug. 24, 1909.

Application filed May 25, 1908. Serial No. 424,841.

To all whom it may concern:

Be it known that I, WILLIAM GURLEY MUNSON, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Steam-Boiler Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to furnaces for steam boilers and has particular application to certain improvements in furnaces for feeding air and returning smoke and gas by the same air feeding force for promoting combustion; and the invention consists in the construction, combination, mode of operation, and arrangement of parts set forth in and falling within the scope of the appended claims.

The object of my invention is to promote the combustion of the fire-bed, prevent the clinkering and crusting thereof, and supply thereto abundance of artificial fuel to produce the best results from the heat in the production of steam, with complete control of the furnace, and in preventing the waste of fuel.

In the accompanying drawings I have illustrated one embodiment of the invention and in which—

Figure 1 shows in elevation a steam boiler and its setting embodying my invention, the smoke-stack in partial section to expose the device by which the products of combustion are collected therein and delivered therefrom into the ash-pit. Fig. 2 shows in sectional elevation a steam boiler and its setting embodying my invention, in feeding air above, and the products of combustion below the grate for promoting combustion by the same air supply force. Fig. 3 is a horizontal section of the same taken through the feed-door and showing a grated and a non-grated combustion chamber, divided air conduits in the walls surrounding these chambers, air perforations in the surrounding walls of the latter above the grate, and air injector nozzles entering the conduits. Fig. 4 is an elevation of the rear end of the furnace showing the pipes for feeding air and the smoke and gases for promoting combustion. Fig. 5 shows in enlarged vertical section a portion of the smoke-stack and a plurality of cones arranged across the smoke-stack, whereby air under pressure is caused to be mixed

with the escaping products of combustion within the smoke-stack and expelling the mixture into the ash-pit. Fig. 6 is a view in perspective of the interior wall of one side of the bridge and a portion of the connecting side walls of the combustion chamber and the ash-pit showing the wall air receiving conduits, the perforations in said walls and air deflecting lips overhanging the said perforations for preventing the air jets from passing upward over the walls into the combustion zone. Fig. 7 shows in vertical section a detail of the conduit through which the products of combustion mixed with air under pressure are both forced and drawn from the smoke-stack and injected into the ash-pit, and the steam heating coil in said conduit. Fig. 8 represents in sectional elevation a steam boiler and its setting as a complete structure embodying my invention including an air compressor and an air storage-tank which are necessary elements in carrying out my invention for supplying air under proper force and volume to the air-feeding and smoke returning devices.

The boiler 1 is supported upon walls over two combustion chambers one 2, of which has the usual fire-box grate 3, the other chamber 4, being non-grated and both chambers occupy the entire space beneath the boiler and are about on the same horizontal plane. The grated combustion chamber is beneath the front end of the boiler and has the usual feed-door 5, and the ash-pit 6; while the non-grated chamber terminates in the arched uptake 7 at the rear of the furnace. The chambers are divided by a bridge-wall 8 so that the products of combustion pass from the grated chamber over the bridge-wall and over and into the ungrated chamber into which they are mixed with highly heated expanded air and from thence the flame produced thereby passes into and through the arched uptake into and through the boiler-flues, into the usual smoke box and into the smoke-stack 9.

A divided conduit for air under compression and expansion in separated spaces, is formed in the walls 10, entirely around each combustion chamber, interrupted only at the feed-door; and for this purpose the conduit passes through the bridge-wall as seen in Figs. 2 and 3 and into a division of these conduits air is forced under pressure from which it passes into the expansion division from which it passes into the combustion

chambers. These air conduits are in the side and end-walls and extend to and are provided with doors 11, at the front and rear corners of the furnace for a purpose which I will presently state. These conduits are parallel with and preferably a little above the line of the grate bars and are provided with perforations 12 which open into the combustion chambers all around their walls including both sides of the bridge-wall and the intersecting end conduits 13—14, so that the air in the conduits will be caused to pass therefrom in a highly heated condition by means which I shall presently explain, into the combustion chambers and thereby promote and maintain a high heat beneath the boiler. The perforations are preferably made quite close together and may be so formed as to cause the air jets to be delivered at opposite or divergent angles horizontally into the combustion chambers to give an even distribution and, as a result, a more uniform combustion. For this purpose I may make V shaped perforations alternating with perforations at right angles to the chamber walls with the branches of the V opening into the chambers so that the air jets will be caused to mix with the body of the fire on the grate. An important feature in connection with these perforations is the forming of recesses 15, in the inner walls of the combustion chambers and on both sides of the bridge-wall the recesses terminating at their upper ends in deflecting lips 16, which overhang the upper row of the perforations and thereby cause the air jets therefrom to be deflected downward and prevent them from being drawn up and along the vertical walls of the combustion chambers the air-jets thereby being practically confined to the fire-bed.

It will be noted referring to Fig. 3 that the air conduit is divided centrally of its width by a partition 17, which extends nearly the length of the walls of the combustion chambers, the function of which partition is to divide the conduit into a space 18 next to the outer side wall, into which air under pressure is injected, and a communicating space 19 next to the chamber walls into which the injected air is expanded before it passes through the perforations into the combustion chambers. The partitions are separated or interrupted at the bridge conduit, so that the air will pass from the outer space 18, through the space 20, between the ends of the partitions, into the inner expansion spaces 19, formed by the partitions, into the cross conduit 21, of the bridge and into the end cross conduits 13—14. Removable partitions 27 connect the rear ends of the partitions to the rear wall, so that the air under pressure entering the conduits at their ends will be caused to pass along the outer sides of these partitions and

by back pressure return in the spaces 19, and into the cross spaces, so that in use the outer conduit spaces are always filled with air under pressure; while the inner spaces are filled with air under less force and which it will be understood, is constantly supplied from the outer spaces into which the air is received from a source of supply under pressure.

The provision for supplying the wall conduits with air under pressure consists, in the construction shown, of a branch-pipe 28 connecting a supply-pipe 29 preferably at a point between the source of the air supply and the smoke-stack, and extending from such connection to the rear of the furnace, has a duplex branch each branch 30 terminating in a nozzle 31 which, piercing preferably the rear furnace wall, extends within each conduit space 18 between its outer wall and the partition so that the nozzle terminates in lapping relation to the latter, and thereby injects the air under pressure into the outer conduit spaces from which it is expanded into the inner conduit space and thence into the combustion chambers. For this purpose the branch-pipe 28 preferably enters the wall of the main supply-pipe 29, the air from which is deflected into the branch pipes by hoods 32 which are placed over the entrance to said branch pipes and extend into the main supply-pipe. As adjunct to the air supplied by these nozzles I provide the branch-pipe 28, with a branch-pipe 33, which enters the wall of said pipe 28, and is bifurcated so that its parts 34—34 straddle the boiler as in Fig. 4, and, passing down through the side walls, terminate in injecting nozzles 35 in the outer spaces 18 of the wall conduits that is, between their outer walls and the partitions, on each side of and about medially of the length of the grated combustion chamber. A similar branch-bifurcated pipe 33, is provided for the non-grated combustion chamber and is shown in Fig. 2 as connecting the branch pipe 28, and straddling the boiler, its branches 34—34 passing down through the side walls and terminate in injecting nozzles 35, in the outer spaces 18, of the wall conduits on each side of and about medially of the length of the non-grated combustion-chamber.

Each branch of the bifurcated pipes is provided with a cut off cock 50 and it will be understood that all the air pipes may be used together or controlled as may be desired. The air issues from these nozzles 35 in opposite directions and is thereby caused to spread each way and assists in maintaining a uniform volume of air in the conduits and particularly at and around the grated chamber where it is important that the air shall be kept at a full volume under less force to supply the fire-bed. The advantage

of the partitions is to equalize the quantity and pressure of the air in the divided conduits and to cause it to be of less force before it is expelled through the perforations to every part of the fire because, without
 5 these partitions the air would, under compression, pass directly through the perforations and fail to produce the desired results. I find that in supplying air in a condition
 10 of reduced force to the fire-bed avoids the clinkering and crusting of the fire-bed. In the non-grated chamber the air from the perforations mixing with the smoke and gases from the fire-bed, produces flame of
 15 intense heat which passes directly into the boiler flues.

In the event of the air compressor becoming disabled from any cause I provide an emergency means whereby air under atmospheric pressure may be supplied to the conduits and referring to Figs. 1, 3 and 4 this
 20 construction is seen as consisting of the doors 11, at the end walls of the furnace which, when opened, supply air to the conduits at
 25 both ends. Registers 37 which open at the side walls and which lead to ducts 38, therein down to and open into the outer conduits, also provide for the inflow of air therein, there being for this purpose preferably a
 30 pair of such registers and ducts provided for each side of each combustion-chamber. When the furnace is operating under a forced draft these doors and registers are closed.

The bridge wall is provided with passages
 35 51, leading from the cross air conduits to a door 52, in the ash-pit as in Figs. 2 and 6 wherein it will be seen that the bridge wall is hollow, and that the partition therein is
 40 supported upon blocks 53.

The feed door and the ash-pit door, and the clean out doors, are closely fitted and closed at all times when the furnace is
 45 working with a forced draft, and when so working the partitions 27 crossing the ends of the rear end cross conduits are removed, to allow the hot air from the end conduit to come in contact with and heat the injector
 nozzles.

To give greater efficiency to the heating capacity of the furnace I employ the direct draft produced by the air compressor supply-pipe in connection with a smoke and gas
 50 exhausting device mounted within and extending across the smoke-stack draft by which the products of combustion passing with the draft are intercepted and collected in a zone across the smoke-stack, mixed
 55 therein with the forced air and delivered into the ash-pit, so that one source of forced air effects under the same pressure the separate and distinct functions of supplying air to the fire-bed above the grate, and of ex-
 60 hausting the products of combustion from the smoke-stack and delivering them beneath

the grate and this operation is effected by the following means. The main air supply-pipe enters the wall of the smoke-stack and to it is connected an exhausting device consisting in the example shown of a plurality
 70 of cones arranged within and across the smoke-stack so as to form a sort of baffling device for checking the outflow of the smoke and gases, collecting them and expelling them mixed with the expelling air success-
 75 sively from said cones into a pipe 39 which connects with the smoke-stack and extends to and opens into the ash-pit, whereby practically all the smoke and gases that would pass out of the smoke-stack are taken there-
 80 from and forced up through the grate to promote combustion. For this purpose a group of tubular sections 40 preferably of conical form are arranged in lapping relation to each other with the flaring ends of
 85 each opening into the smoke-stack and their smaller ends opening into the flaring ends, so that the smoke and gases are, by the entraining action of the air caused to be sucked simultaneously into the flaring end of each
 90 cone, by the force of the air passing through a central conduit composed of tubular lapping sections 41 and connected in such manner as to cause each cone to form a suction zone in the draft space, the effect of which is to cause
 95 the smoke and gases to be drawn within the cones and mixed with and ejected therefrom by the force of the incoming air. The initial cone, laps within the stack with the end of the air supply-pipe; while the terminal cone,
 100 laps within a mixing hood 42 projecting from and secured to the outer wall of the smoke-stack. The sections forming the central conduit lap with each other preferably at the lapping ends of the cones so that an-
 105 nular spaces 43 are formed between the lapping ends of said central sections and open into the flaring ends of the cones. Preferably the cones decrease in diameter from the intake to the exit cone, and the central conduit sections are correspondingly decreased and this construction has the effect of giving
 110 the device the function of an ejector, the action of which causes the air which is forced through the central conduit and through each cone to draw the smoke and gases from the smoke-stack into the flaring end of each
 115 cone in the direction of the air flow and into the mixing-hood. In this way and by this construction the central air volume in its passage under force, has the effect of producing a partial vacuum at the flaring end of each cone into which the smoke and gases
 120 and cinders are thereby caused to be sucked and, each cone has an identical effect. The cones in their joint action create co-acting partial vacuum zones around the intake ends of the cones which are thereby rendered effective in transferring substantially all the
 125 smoke and some of the gases from the smoke-
 130

stack into the mixing-hood. A pipe 39 connects this mixing-hood and, passing down through the side wall opens at 45, into the ash-pit and delivers therein the mixture of smoke, gases and air. To give such delivery the force of an injector a branch-pipe 46 is connected with the main air supply-pipe between the source of the air supply and the smoke-stack, and passing down and into the side wall enters the wall of the pipe 39, which leads from the mixing-hood and terminates a suitable distance above its outlet. In this action of the central sectional conduit and separate cones the smoke and gases are taken from the smoke-stack and mixed with air in the hood into which the central air conduit terminates.

The exhausting device is kept firmly in line and supported at its inlet end upon the end of the air supply-pipe by strips 48, and at its exit end the device is supported within the mixing-hood by strips 49, the group of cones being connected and supported upon each other and upon the central sections by like strips; while the central conduit sections are supported in separated relation at their lapping ends by like strips so that the air has free passage through the central conduit sections, through the spaces 43, between their lapping ends and through the cones keeping all the passages clear and causing each cone of the group to form an individual ejector within the smoke-stack; while the group as an entirety forms a partial vacuum across the smoke-stack. The number of the cones may be varied to suit the diameter of the smoke-stack but of whatever number and form, their arrangement must be such as to cause a plurality of transverse drafts internally of each cone by the action of the passage, under pressure, of a volume of air centrally through the separate conduit of connected tubular sections for taking and delivering the smoke and gases from the smoke-stack. In effecting this operation the important matter is to cause the collection of the products of combustion within an exhausting device composed of an outer and an inner group of tubular connected sections having such relation that the outer group will have transverse openings in communication with the stack draft space, while the inner group of sections will form an air conduit and have transverse openings in communication with the outer sections.

Coöperating with the external mixing-hood which opens into the smoke-stack a supplemental hood 54, is fixed to the inner wall of the latter in overhanging relation to the upper edge of the external hood so as to arrest and cause the deflection of the products of combustion which might pass the vacuum producing device, into the external hood. As a means of causing the arrest of the stack-draft the flaring end of each outer

section of the partial vacuum producing device is projected toward the inlet end of the compressed air supply-pipe so that at its upper edge each section will overhang its lower edge and thus assist the suction function of the central conduit and increase the exhausting capacity of the device. In the mixing function of the hood it is also caused to produce a partial vacuum at the receiving end of the smoke-pipe and to cause the extension of this partial vacuum into the smoke-pipe I provide it near the outlet of said hood with a contracted neck 55 of conical form and having the function of a nozzle and producing thereby a more acute partial vacuum at the entrance of the smoke-pipe.

It is important that the mixture ejected from the smoke-stack be as highly heated as possible before it is delivered into the ash-pit, and for this purpose I utilize steam preferably taken from the boiler dome by a pipe 56 Fig. 2 leading to and entering the wall of the smoke-pipe 39, and connected within said pipe to a coil 57 which surrounds therein the air-branch-pipe 46, and passes out of said pipe 39, into the ash-pit. This steam coil heats the air passing from the compressor to the smoke-stack and to the ejector pipe 46; while the delivery of the steam within the ash-pit serves to further heat the mixture therein and to agitate and effect its complete mixture before it passes up through the grate into the fire-bed, as the steam will leave the coil under pressure and spread beneath the grate, and the ash-pit being air-tight, the mixture fed to the fire therefrom will be smoke, gas, air and steam; the steam pipe for that purpose having a regulating valve 58, Fig. 8. The steam coil does not contact with the inner walls of the smoke-pipe and is of a size to give free passage therein to the products of combustion.

I find in practice that the ordinary blower used as an air-compressor will not produce the required air pressure for the stack-smoke exhauster and for all the air and smoke-pipes, or a uniform pressure in all the pipes and particularly in the conduit injectors and to overcome this objection I supplement the air-compressor with an air storage-tank 59 located between the air-compressor 60 and the smoke-stack which not only provides for the required pressure, and volume but serves as the means by which such pressure may be made to predominate over the stack-draft whatever it may be and this is a matter which conduces to the success of my invention. The storage-tank connects by a supply-pipe 61, with the air compressor and may have a capacity of from forty to one hundred pounds pressure to the square inch and this will give the advantage of complete control over the air and smoke-pipes by the pro-

vision of a regulating gate 62 in the pipe 29, which connects the storage-tank with the exhausting device of the smoke-stack. The pressure in the storage-tank is indicated by a gage 63. To obtain the full advantage in the use of the storage-tank provision is made by a coiled pipe 64 therein having connection (not shown) with the steam space of the boiler, for heating by radiation from the coil, the air stored in the tank so that the air that supplies all the pipes is first heated in the storage-tank, then in the smoke-stack exhausting device, then in the smoke-pipe leading to the ash-pit, then in the ash-pit, then by the heated walls of the conduits which surround the combustion-chambers, and in this way the force of the air is reduced before its entrance into the fire-bed, the supply in the ash-pit being always stronger than that delivered into the combustion chambers, and as a result the draft is at all times in the direction of the smoke-stack.

There are several important results to be noted from my improvements and among these are, referring to the means for causing the feed of air in jets into the combustion chambers, that the air passing from the injectors into the wall conduits will be driven down one side of the conduit to the front cross conduit and return under less force in the other side of the same conduit and be caused to be highly heated in its course and to be fed through the perforations into the combustion-chambers; that the air from these horizontal injectors is under greater pressure than the air from the vertical injectors and therefore the return flow of the air in the conduits is not interfered with; that the feeding of the air in this way will produce an approximately white heat in the combustion-chambers; that the several air and smoke-pipes are provided with controlling cocks 50, by which full control may be had of the pressure and supply; that the branch-pipe 46, serving as an air injector for the smoke and gases is heated in the pipe 39, by which they are conducted to and delivered into the ash-pit; that this injector air branch-pipe aids in producing a partial vacuum in the smoke delivering pipe and also assists in forming a stronger partial vacuum in the exhausting cones; that the air, smoke and gases, are mixed in the hood of the exhausting device practically within the smoke-stack and again mixed in the delivering pipe by the branch-pipe 46, and that this branch-pipe prevents any back pressure of the mixture; that from the forced draft and mode of promoting combustion, the smoke-stack need not extend more than fifteen feet out of the roof of a building; that the controlling cock in the smoke delivering pipe serves to cut off any back draft through to the smoke stack in case the air-compressor or engine may be out

of working condition; that by the provision of the controlling cocks, air at atmospheric pressure may be supplied to the wall conduits through the end doors thereof, which also afford access for cleaning out the conduits; that in such case the smoke exhausting device is rendered inoperative while the draft of the smoke-stack will be effective.

While I have shown my invention in connection with a stationary steam boiler obviously it may be used in traction engines, locomotives, fire engines, garbage crematories and in fact any plant having a steam boiler.

In the attainment of the ends sought by my improvement I do not wish to be limited to the precise details herein set forth, inasmuch as minor changes in the form, proportion, and exact manner of assembling of the parts may be made without departing from the spirit of the invention. Nor do I wish to be confined to the use of the duplex combustion chambers as some of the features of my invention could be used with the grated combustion chamber only.

It is important to note that the force and capacity of the exhauster be effectively maintained to insure the most complete exhaustion of the smoke and gases from the smoke-stack and for this purpose the exhausting device is rendered functional by the joint action of three forces which together insure the effectiveness of the exhausting device in diverting substantially all the smoke and gases from the smoke-stack. For this purpose the injector in the receiving end of the smoke-pipe coöperates with the injector in the delivering end of said pipe, the two ejectors acting with a suction force upon the delivering end of the exhauster and the storage-tank acting with a driving force in the same direction upon the receiving end of the exhauster.

Except for the purposes of the combination of devices herein set forth in the claims, I do not in the Letters Patent to be issued on this application claim returning smoke for promoting combustion by means of an exhausting device comprising a plurality of hollow cones mounted in the walls of the smoke-stack across the draft-space and an air conduit of lapping sections extending centrally through the cones, the cones and the central sections having annular communicating passages between them, the connected cones and the connected central sections opening into the draft space, a pipe leading from a source of compressed-air supply and lapping in the draft-space with one end or the central sections forming an annular passage between it and said central section, a mixing-hood at the other end of the exhausting device, and a pipe connecting said hood and leading to the ash-pit, as the said invention constitutes the subject matter of claims

in a divisional application filed by me on December 1, 1908 under Serial Number 465,546 for improvements in smoke and gas consuming furnace; nor do I claim herein the features of construction whereby the function of the storage-tank is reinforced by an ejector within the receiving end of the smoke-pipe and an ejector within the delivering end of the said pipe.

10 I claim—

1. The combination in a steam-boiler furnace, a grated and a non grated combustion-chamber, a bridge-wall dividing the combustion-chambers, the walls surrounding and forming the combustion chambers having conduits which are divided longitudinally into separate communicating passages, and the said chamber walls having perforations opening into the inner passages of said conduits and into said chambers, and means for forcing air into a division of the conduits.

2. The combination in a steam-boiler furnace, a grated and a non-grated combustion-chamber, a bridge-wall dividing the combustion-chambers, the walls surrounding the combustion-chambers and the bridge-wall provided with separate parallel communicating conduits or passages, one of said passages having perforations, opening into said chambers at their sides, ends, and at both sides of the bridge-wall, and means for forcing air into the other passage of the conduit from which it enters into the combustion-chamber.

3. The combination in a steam-boiler furnace, a grated and a non-grated combustion-chamber, a bridge-wall dividing said chambers, the walls surrounding said chambers provided with communicating conduits having perforations opening into said chambers, the side conduits being divided longitudinally into communicating spaces, a pipe leading from a source of compressed air supply and having connections extending to, entering and terminating in an injecting nozzle within a division of each conduit at one end of the furnace, and cocks in said pipe connections for controlling the volume and regulating the force of the air injected into said divided conduits.

4. In a steam-boiler furnace, a grated and a non grated combustion-chamber, a bridge-wall dividing said chambers, the walls surrounding said chambers provided with conduits having perforations opening into said chambers, partitions dividing each conduit into communicating parallel spaces, into one of which the perforations open, a pipe leading from a source of compressed air supply and having divided connections each division thereof extending to, entering and terminating in an injecting nozzle within the outer of the divided spaces of the conduits at the rear of the furnace, whereby the air

under compression injected into the conduits on one side of their dividing partitions is caused to expand into the spaces on the other sides of the partitions and forced through the wall perforations into the combustion-chambers.

5. In a steam-boiler furnace, a grated and a non grated combustion-chamber, a bridge-wall dividing said chambers, the walls surrounding said chambers provided with longitudinally divided communicating conduits having perforations opening into said chambers, a pipe leading from a source of compressed air supply and having pipe connections extending to, entering and terminating in an injecting nozzle within a division of said conduits at one end of the furnace, a branch-pipe having communication with said air supply-pipe and extending down on each side of the boiler, terminating in a nozzle within the conduits at each side of the combustion-chamber, and cocks in said pipe connections for controlling the volume and regulating the force of the air injected into said conduits.

6. In a steam-boiler furnace, a grated and a non grated combustion chamber, the walls surrounding said chambers provided with longitudinally divided communicating conduits having perforations opening into said chambers, a pipe leading from a source of compressed air supply and pipe connections therefor extending to, entering and terminating in an injecting nozzle within a division of said conduits at one end of the furnace, independent means for supplying air from the main supply-pipe to and within a division of the conduits at each side of the combustion-chamber, and cocks in said pipe connections for controlling the volume and regulating the force of the air injected into said conduits.

7. In a steam-boiler furnace, a grated combustion-chamber, the walls surrounding said chamber and the bridge-wall having air conduits and perforations opening into said chamber, partitions dividing each conduit into communicating spaces into one of which the wall perforations open, an air injecting pipe terminating in an injecting nozzle within each conduit between the partition and the outer wall of the furnace, and means for feeding air under pressure to said nozzles.

8. In a steam-boiler furnace, a grated combustion-chamber the side walls forming which provided with conduits and having perforations opening into said chamber, partitions dividing each conduit into communicating passages into one of which the said perforations open, the said partitions each having a removable section at the inlet end of each conduit, an air injecting pipe terminating in a nozzle within the end of the outer passage, and means for feeding air to said nozzles.

9. The combination in a steam-boiler furnace, a grated combustion-chamber the outer walls surrounding which are divided longitudinally into separate communicating passages, and the said chamber walls having perforations opening into the inner of the divided passages, means for injecting air horizontally into one end of each of said inner passages, and means for injecting air under pressure vertically into the same passages.

10. In a steam-boiler furnace, a grated and a non-grated combustion-chamber the outer side walls forming which provided with conduits extending horizontally the length of said chambers and having perforations opening horizontally into said chambers, a bridge-wall dividing said chambers and having a passage through it in communication with said side wall conduits, the opposite sides of the bridge-wall having perforations opening into said chambers, the said chambers and bridge-wall having recesses into which said perforations open, and an imperforate lip continuous around and overhanging said perforations with a downward deflecting under wall, and means for feeding air into said conduits.

11. In a steam-boiler furnace, a grated and a non-grated combustion-chamber the walls forming which and the bridge-wall having air conduits extending to and opening at each end of the furnace walls, a door closing each end opening, the said conduit walls including the bridge-wall having perforations opening into the chambers on a plane above the grate, and registers in the vertical walls on each side of the boiler, each register having an air-duct extending to and terminating within the conduits, said registers being on each side of each combustion-chamber.

12. In a steam-boiler furnace, a grated combustion-chamber the walls forming which having conduits side by side each having free communication, that conduit which is next to the chamber having perforations opening therein, the two outside conduits each opening at the end walls, and doors closing such openings, whereby air under atmospheric pressure may be admitted through said end openings into said conduits heated and passed through said perforations into the combustion-chamber.

13. In a steam-boiler furnace, a grated combustion-chamber the walls forming which having conduits side by side each having free communication, that conduit wall which is next to the chamber having perforations opening into said chamber, an injector nozzle entering the end wall of each of the outside conduits, and means for supplying air under compression to said injectors, whereby the outer conduit receives the compressed air and freely supplies it to the inner conduit which thereby is caused to have the

function of an expansion-chamber from which the air is supplied to the combustion-chamber for the purpose stated.

14. In a steam-boiler furnace and in combination, a grated and a non-grated combustion-chamber the walls forming which having conduits side by side in free communication with each other and the wall of the inner conduit having perforations opening into said chambers, an injector nozzle entering the non-perforated outer conduit, branch-pipes terminating each within said outer conduit, and stop cocks in said pipes, whereby the air supplied by the injectors is under greater pressure than the air supplied by the branch pipes to said conduits, substantially as described.

15. In a steam-boiler furnace and in combination, a grated and a non-grated combustion-chamber the walls forming which having conduits side by side in free communication with each other, the wall of the inner conduit having perforations opening into said chambers, an ejector nozzle entering the end wall of each outside conduit, supplying pipe connections for each injector nozzle, branch pipes connecting said air supply pipe one for each combustion-chamber and terminating each within the said outer conduit, said pipes and injectors supplying air under pressure to said conduits, a smoke and gas exhausting-device within the smoke-stack, an air compressor, and a storage-tank connecting the exhaust-device with the storage-tank, a pipe connecting the exhaust-device with the ash-pit of the combustion-chamber, and stop-cocks in said pipes whereby the air supplied by the branch-pipes to said conduits by the injectors is under greater pressure than the air supplied by the branch-pipes to said conduits substantially as described for the purpose specified.

16. In a steam-boiler furnace, a combustion-chamber, the ash-pit, and a smoke-stack, a smoke and gas exhausting device across the smoke-stack, an air supply-pipe connecting the stack with the exhausting device, an air-storage tank connected to the air supply-pipe, an air-compressor connected to the storage-tank, a pair of injectors in communication with the combustion-chamber and with the supply-pipe, a pipe connecting the injectors with the supply pipe, and a pipe connecting the exhausting device with the ash-pit, whereby the air supply force for the exhausting device, the combustion-chamber and the ash-pit is provided by the same volume and under the same pressure.

17. In a steam-boiler furnace, the following instrumentalities, a combustion-chamber, the ash-pit and the smoke-stack, a smoke and gas exhausting device across the smoke-stack, an air supply-pipe connecting the stack with the exhausting device, means for supplying air under compression to said

pipe, a pair of injectors, means for connecting the injectors with the combustion-chamber, a pipe connecting the injectors with the air supply-pipe, and a pipe connecting the
5 exhausting device with the ash-pit, the said injector connecting pipes being connected to the air-supplying-pipe in advance of its connections with the exhausting device, whereby the feeding of the air to the injectors and to

the exhausting device is effected from the same air supply under the same pressure.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM GURLEY MUNSON.

Witnesses:

CHARLES R. YOKE,
CECILIA A. BEACH.