(No Model.)

2 Sheets—Sheet 1.

O. D. ORVIS.

STEAM BOILER FURNACE.

No. 503,214. Patented Aug. 15, 1893.

Fig 1.

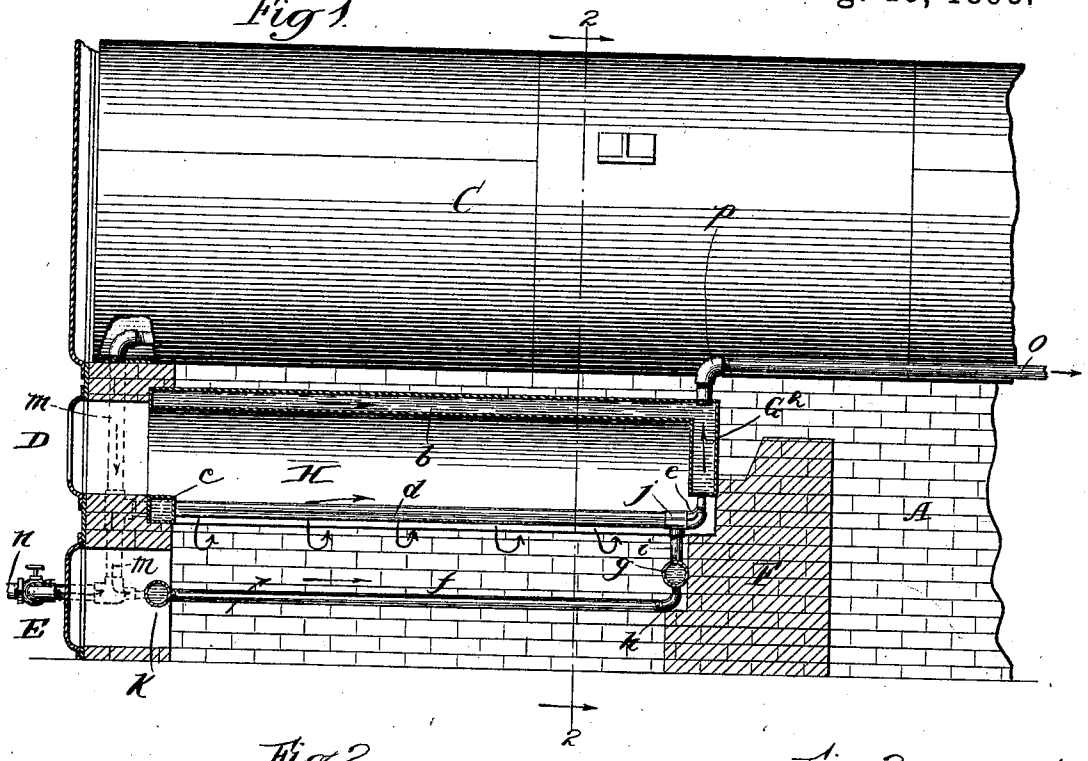


Fig 2.

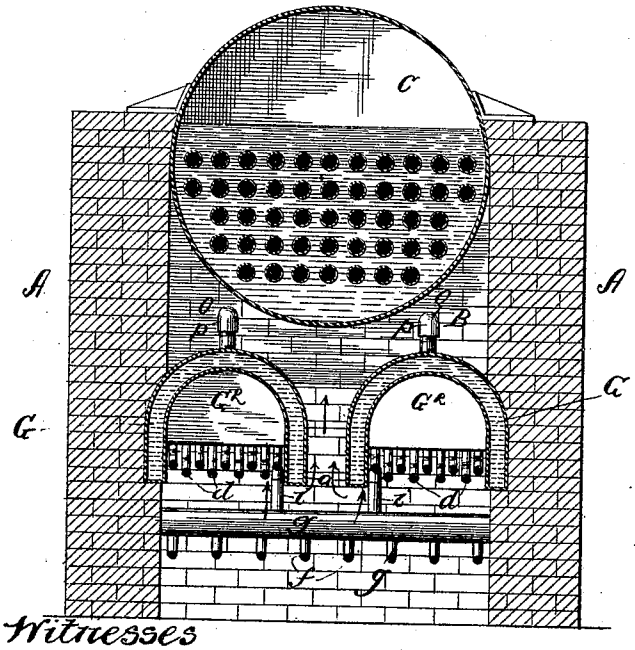
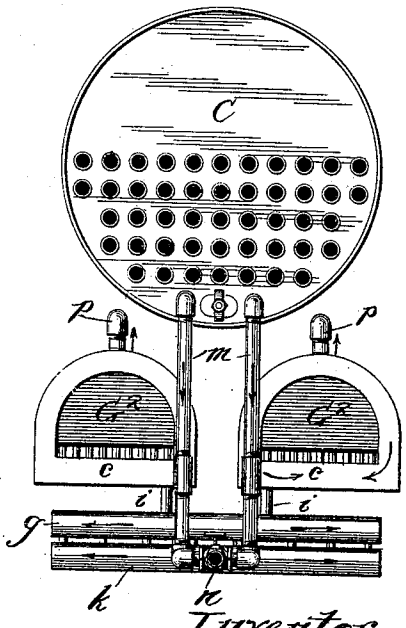


Fig 3



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(No Model.)

2 Sheets—Sheet 2.

O. D. ORVIS.

STEAM BOILER FURNACE.

No. 503,214. Patented Aug. 15, 1893.

Fig. 5.

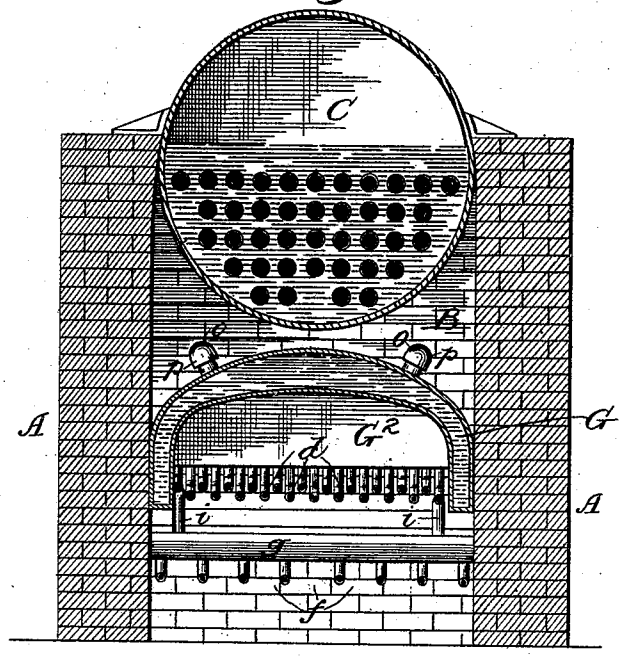


Fig. 4.

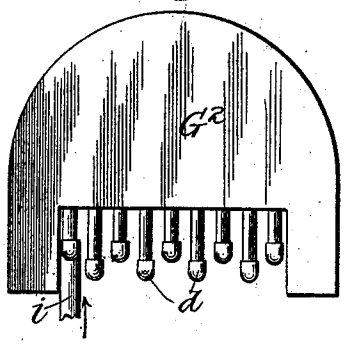
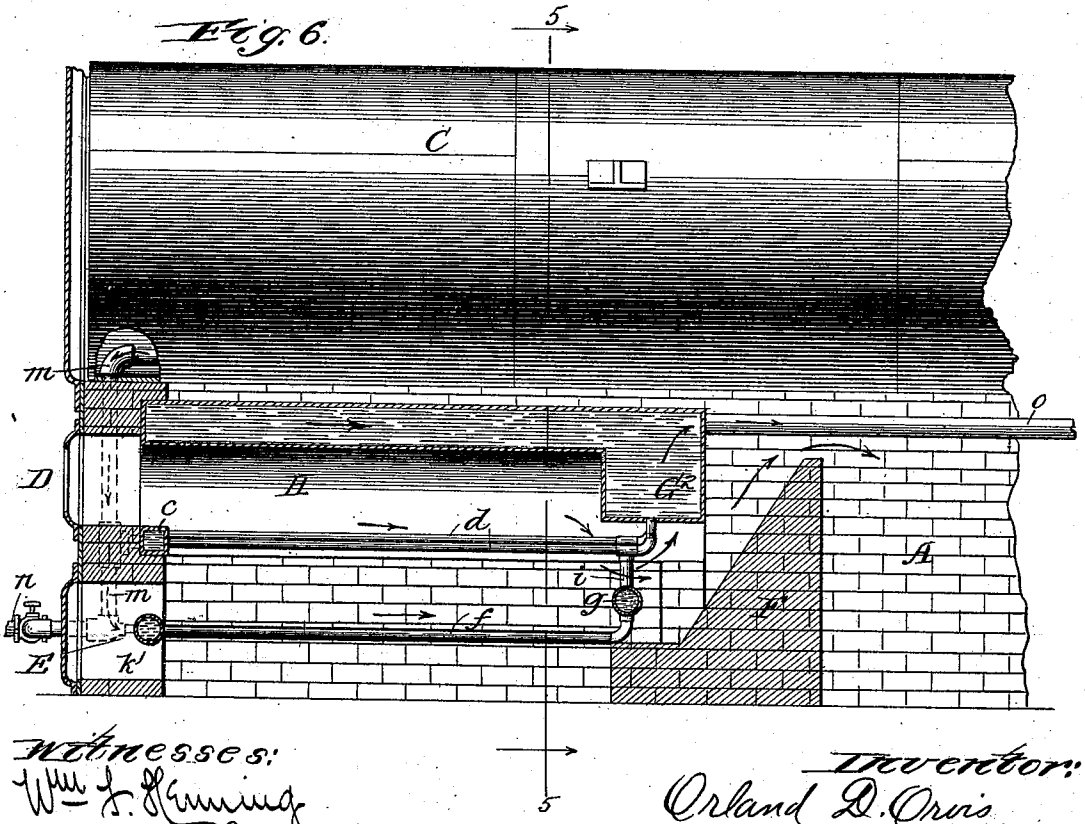


Fig. 6.



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UNITED STATES PATENT OFFICE.

ORLAND D. ORVIS, OF CHICAGO, ILLINOIS.

STEAM-BOILER FURNACE.

SPECIFICATION forming part of Letters Patent No. 503,214, dated August 15, 1893.

Application filed October 31, 1892. Serial No. 450,478. (No model.)

To all whom it may concern:

Be it known that I, ORLAND D. ORVIS, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Steam-Boiler Furnaces, of which the following is a specification.

This invention relates generally to improvements in steam boiler and other furnaces in which a fire chamber is entirely within the confines of a solid arch spanning a grate-bar surface, and whence the products of combustion must escape through its end, or else downward through the grate bars, before they can enter a combustion chamber either immediately above or rearward of the fire chamber; but more specifically to the structure shown, described and claimed in the pending joint application, Serial No. 429,735, filed by Orel D. Orvis and myself April 19, 1892, in which, in a down draft furnace there is a draft passage through which the down draft products of combustion are conducted to a combustion chamber over the fire chamber and at a point forward of the rear end of said combustion chamber.

The prime object of this invention is to successfully utilize to a maximum degree an arch-like fire chamber structure of a steam boiler or other furnace as a direct heating surface for boiler or other water, and at the same time promote the protection of that structure from the destructive effects of the high degree of heat to which it is necessarily subjected.

A further object is not only to utilize an arch-like fire chamber structure as a heating surface for boiler or other water, but in such a manner that the heat units, rising in a vertical line from the bed of burning fuel within the fire chamber, and at their highest temperature, shall impinge against the under water heating surface of the arch and be held in contact therewith the greatest possible time consistent with their successful after discharge into the furnace combustion chamber for further work, and that the upper surface of the heating chamber of the arch shall receive the direct contact and effect of said heat units before they have ascended substantially above the bottom of said combustion chamber, or in contact with the crown sheets of a boiler or other surface to be heated, whereby the water heating capacity of the surfaces of an arch is promoted to a maximum degree, while at the same time said surfaces and other surfaces beyond the arch are to a corresponding degree protected from the destructive effects of furnace heat.

A further object of this invention is to substantially and materially increase the water heating surface of a steam boiler furnace in such a manner that the entire surface of the boiler within the furnace, and this increased heating surface, shall be subjected to substantially all of the heat units of a furnace under the most favorable conditions possible for vaporizing water, and this without substantially increasing the dimensions of any portion of said furnace or boiler, or diminishing any chamber or the grate surface thereof.

Other objects of my invention, more in detail, are the untilization of the arch or arches inclosing the fire chamber of a down-draft furnace as a direct heating surface for boiler or other water, and as a means for promoting the circulation of water through a boiler and through a hollow grate-bar surface, and by such an arrangement of parts that every atom of heat produced in the fire chamber of a down-draft furnace, when at its highest temperature, and temporarily confined, shall be directed in straight and direct lines against and absorbed as fully as possible by an extended water heating surface in close proximity to the burning fuel, whereby water is rapidly reduced to vapor and the temperature of these vapors raised to the utmost capacity possible by a unit of heat of any given degree, and this without the employment of any degree of temperature therein unduly promoting the destruction of the boiler shell, while at the same time said arch or arches and grate-bar surface are effectively protected from destruction by furnace heat.

A further object is not only to convert the arch or arches of a down-draft furnace into a water heating surface and to employ in connection therewith a single or double hollow grate-bar surface, affording additional water surface, but to have such a connection of these hollow grate bars with each other and with the arch or arches that there shall be an open communication between all of these

parts; that the grate bars and arch or arches may be permanently connected and bodily placed in or removed from a furnace, and one or more grate bars removed or inserted conveniently, and without disturbing any other portions of the structure, whereby the necessity of putting together the arch and grate bar surfaces within the furnace is avoided, and time is correspondingly saved in combining my invention with an ordinary steam boiler furnace already in use.

Further objects of my invention, hereinafter described and claimed, are attained by the devices illustrated in the accompanying drawings, in which—

Figure 1 illustrates in detail a central longitudinal section of a down-draft steam boiler furnace embodying my invention; Fig. 2, a transverse section thereof on the line 2—2 of Fig. 1; Fig. 3, a front elevation of the same with the furnace walls removed; Fig. 4, an enlarged rear end elevation of one of the arches; Fig. 5, a transverse section on the line 5—5 of Fig. 6 of a down-draft steam boiler furnace, showing the embodiment of my invention in a single arch fire chamber structure; and Fig. 6, a central longitudinal section of the same.

Similar letters of reference indicate the same parts in the several figures of the drawings.

A, A, indicate the side walls, and B the rear end wall of a steam boiler furnace supporting a steam boiler C, of the ordinary construction, in the usual manner, and provided with one or more furnace doors D, and ash pit doors E, of the usual construction and arrangement, the rear end of the ash pit being closed by a bridge wall F, the front side of which is stepped, as shown, and for the purpose indicated.

Arranged longitudinally of the chamber thus formed between the bridge wall and the front wall of the furnace, are arches G, G, which, as shown, may be set partially into the side walls of the furnace, but if desired may be set against said side walls, or at a point removed therefrom, and supported at each end respectively by the front wall of the furnace and the bridge wall, but, in any event, are so arranged relative to each other that there is a passage *a*, at one or both sides, extending substantially their entire length. The forward end of these arches is open and registers with the fire chamber doorway, and their rear end closed by a head G^2, which head or end and the body of the arch consist of an inner and outer shell providing between them a closed water chamber *b*, of considerable capacity, the walls of which are preferably constructed of steel, but may be of any other suitable material adapted for a water tight chamber subject to furnace heat. At the forward end of the arch is a header *c*, in open communication at both ends with the base of the water chamber of the arch and having also in communication therewith grate bars *d*, the opposite ends of which are connected and in open communication with the chamber of the head G^2, as indicated in Fig. 1, which grate bars *d*, in connection with the arch or arches G, G, constitute the fire chamber, H, of the furnace. If desirable, for increasing the grate and water heating surface, the hollow grate bars may be "staggered," that is to say, alternately arranged in differing planes, and are preferably secured in connection with the header, *c*, by screwing them into the wall thereof and to the end G^2 by means of an ordinary elbow coupling, *e*, as shown in Fig. 1, which mode of connection of the grate bars with the arches provides for the construction of the fire chamber in its entirety before insertion into a furnace, and for the convenient bodily insertion and removal of one or more grate bars from a furnace, and also when at any time desirable. In other words, considerable saving of valuable time is effected in combining my invention with an ordinary steam boiler furnace, by reason of this construction providing for joining bodily all of the parts of a fire chamber structure, and in this condition setting them into the furnace, for any of the grate bars, though thus fitted and permanently joined to the arch or arches before insertion into the furnace, may be removed and inserted at any time thereafter without disturbing the arches, and also the entire fire chamber structure be removed for any purpose whatever.

In a plane below the fire chamber are grate bars, *d*, and in the ash pit of the furnace, arranged substantially parallel with the grate bar surface *d*, is a series of pipes, *f*, removably secured at their rear ends to a header, *g*, by ordinary coupling, *h*, and at their forward ends are screwed into a header *k*, the header *g* being connected with the grate bars *d* by means of a pipe *i*, and a T-coupling, *j*, (see Fig. 1,) whereby the rear ends of the pipes *f*, and the header *g*, may be suspended from the upper grate bar surface *d*, but are perfectly supported by a ledge of the bridge wall as indicated in Fig. 1, or may be suspended by projecting the header *g* into the side walls of the furnace, or supporting it upon suitable brackets secured thereto, as headers are commonly supported in furnaces. The supply of water to both the arch or arches, the grate bars and the water heating surface or pipes *k*, may be separately or conjointly from two sources, as, for instance, through a pipe *m*, communicating with the boiler and with the headers *c* and *k*, or by means of a pipe *n*, in communication with a water system or feed water heater, and connected with both the header *c*, and header *k*, by the pipe or pipes *m*, or, if desired, water from the boiler may be supplied to the water chamber of the arch and the grate bars of the fire chamber from the boiler, and the cold water be supplied to the pipes, *f*, in the ash pit through the pipe *n*. This latter mode is preferable, because a supply of water through the pipe *n*, is an addi-

tional supply for the boiler, having its temperature raised before admission thereto, and by first passing through the pipes *f*, the header *g*, and thence into the grate bars *d*, and water chamber of the arch, where it is combined with the more highly heated water in said chambers, and discharged with them into the boiler.

A continuous circulation of water through the arch chamber and the grate bar surface and pipe *k*, and a supply of said water to the boiler, are established by a pipe *o*, connected with the water chamber *b*, of the arch, preferably in a plane above the opening of the supply pipe *m* therein, and, as shown, by inserting the pipe *o*, into the top or crown of the arch, an ordinary elbow-joint *p*, being used for the purpose of this connection of the pipe *o* with the water chamber *b*, and providing for the convenient connection and disconnection of the arch with said exit pipe *o*. The exit or discharge pipe *o*, while not so shown, may be extended to the rear end of the boiler and connected therewith either in a plane with or above that of the orifice of the pipe *m*, which extension of the pipe, through the combustion chamber of the furnace, correspondingly increases the extent of the water heating surface therein, but it would be no departure from my invention, to provide a pipe connection from the arch water chamber to any point of the boiler, though obviously, a greater length of circulation of the water through the boiler, and an increase of heating surface are provided by the end connection before described.

In Figs. 5 and 6, my invention is illustrated as embodied in a down-draft furnace, in which all of the products of combustion escape downwardly through the grate bars, and from the rear end of the arch, over the bridge wall, to the usual furnace combustion chamber rearward thereof, and hence rendering the space or chamber between the arch and the boiler a dead-air space, correspondingly reducing the water heating surface of the boiler, and this by reason of there being no passage or passages up, through which the down-draft products can ascend to said chamber. In this connection it is proper to observe that it would be no departure from the spirit of my invention, as set forth herein, to embody it in any up-draft furnace wherein the grate surface is spanned by an arch extending throughout its length, and the products of combustion from the fire chamber pass directly through the end of said arch to and over the bridge wall. Nor would it be a departure from my invention in so far as it broadly includes the utilization of a fire chamber arch as an extended heating chamber, to substitute the ordinary solid grate bars for the hollow bars herein shown and described, nor to embody it in a furnace wherein is employed a baking, heating or other oven instead of a steam boiler, for obviously the water heating capacity of the arch and the utilization of the products of combustion in the fire chamber for heating the water of said chamber and the protection of the arch by that water will remain the same in all of these different structures, wherein there is the same arrangement of arch, though obviously the heating capacity of the water chamber arch is materially and substantially increased in a down-draft furnace, when there is a direct up-draft passage at one side of and extending the length of the arch or arches thereof, by means of which a heretofore dead-air chamber above said arch or arches is converted into a direct draft chamber, and by this means the outer water heating surface of the arch or arches is subjected to the heat of these products of combustion, as they are not in the construction shown in Fig. 4, and in the open rear end arch of the direct upward draft furnace referred to.

The embodiment of my invention in the side draft structure of a down-draft furnace illustrated herein in Figs. 1 to 4, is a very substantial improvement in down-draft furnaces, as compared with the structure shown in Figs. 5 and 6, and this not only because of the subjection of the upper and outer water heating surfaces of the arch to direct draft heat, but for the additional reason that a much more effective draft, and correspondingly rapid combustion, is secured, for that by this exclusively end discharge in a down-draft furnace practice demonstrates, there to be a choking of the heat products in the passage between said end and the combustion chamber rearward of the bridge wall; whereas, in my particular structure, an extended up-draft passage at one side of the arch receives the down-draft products as fast as they can descend through the grate bars, and as rapidly conducts them to the combustion chamber or chambers of the furnace or boiler, as may be; and this is true whether the combustion chamber extending the length of the arch is immediately over or in part or wholly at one side thereof, as I have discovered since filing the joint application aforesaid. For these reasons the invention embraced by the arrangement of the arches shown in Figs. 1 and 2, is not to be limited specifically to a down-draft furnace, wherein there is a draft passage through which the down-draft products of combustion are conducted to the combustion chamber directly over the fire chamber, and at a point forward of the rear end of said combustion chamber, as claimed therein, but includes a down-draft furnace, the grate bar surface of which is inclosed by an arch or arches so arranged as to provide a direct draft passage at one side of and extending the length of said arch or arches, whether or not said direct draft passage communicates with a chamber immediately over or in part or wholly at one side of said arch or arches, and this whether or not the arch or arches are solid or provided with a water heating chamber partly or wholly throughout their surface.

In all down-draft furnaces, prior to the invention, of my joint application, the fire chamber grate bars must be so far apart in order to have a sufficient draft for their practical operation that a large amount of unconsumed coal fuel drops through them, to save which, the common practice has been to have in a plane below the fire chamber grate bars, a supplemental grate surface with its bars closer together than the fire chamber grate bars, for catching and sustaining said unconsumed fuel until reduced to ashes. There are however, several unavoidable, objectionable results due to the use of a supplemental grate surface among which may be mentioned the necessity of raking down two grate surfaces for every fire chamber; the additional expense in first cost and after repairs and renewals; and the occupancy of space more valuable solely for water heating purposes. Furthermore, the application of these prior down draft structures to ordinary furnaces already in use and of which there are thousands in basements and under sidewalks and elsewhere is impossible, wherein on account of drainage, the bottom of the ash pit cannot be lowered, as must be, in order to provide between the fire chamber grate surface and the supplemental grate surface a chamber of a capacity sufficient for the commingling and expansion of the products of combustion from both grate surfaces, to a degree necessary for the successful utilization of those products, and as a condition precedent to their successful discharge to and over the bridge wall, even under the most favorable conditions for a furnace draft. At best however, the consumption of fuel on a supplemental grate surface requires an air supply upwardly therethrough from the ash pit, which supply unavoidably causes a draft opposing and consequently retarding a downdraft of the products of combustion in the fire chamber to a degree practically rendering null any advantages accruing to the saving of fuel by means of the supplemental grate surface. Not only does this updraft oppose the descent of the products of combustion through the fire chamber grate surface but so does the rising of the products of combustion by their natural tendency from the supplemental grate surface, and when, to these combined forces, is added in any prior down-draft structures, the further requirement that a very large portion of the products of combustion must traverse the length or a substantial portion of the intermediate chamber horizontally before the possibility of their escape to and over the bridge wall, it is obvious, that at best, the employment of a supplemental grate surface in these prior structures or in any down draft structure, is a serious obstruction to this successful operation.

Now my invention may be applied to any ordinary furnace already in use without increasing or diminishing the depth of the ash pit or the original distance between the bottom of the ash pit and the fire chamber grate surface, while at the same time, the downdraft of the furnace and the rapid and complete combustion of fuel on the grate surface of the fire chamber and without any waste of fuel, are promoted to a substantial degree as compared with any of the prior downdraft structures, and all this by reason of the fact, that there are no air currents or draft opposing the descent of the downdraft products, and that immediately they discharge downwardly through the grate bars they are free to escape laterally from beneath them along the entire length of the fire chamber and in the most direct path therefrom, and to rise by their natural tendency or gravitation into an enlarged chamber in which they are free to fully expand and discharge thence to and over the bridge wall without crowding or choking at any point, while at the same time, their onward movement is accelerated by an unobstructed and perfectly free combustion-chamber draft. In other words, by my invention the combustion of fuel in the fire chamber of a down draft furnace, the rapidity of its combustion, the discharge of the products of combustion therefrom and through the entire length of the furnace and over the surfaces therein to be heated, are promoted to a maximum degree and this without any waste of fuel, and by devices requiring no objectionable changes in an ordinary furnace to incorporate them, while, at the same time, as shown by the pipes *k*, the chamber below the fire chamber grate surface is successfully utilized for increasing the water heating surface of a furnace, and this without any obstruction to the draft of the furnace or objectionable obstruction to the ash pit.

In the operation of my device, with a bed of burning fuel on both of my grate bar surfaces, and a circulation of water from any source through the arch or arches and these grate bar surfaces, to any supply, it is apparent that the inner water heating surface of the arch structure will be subject in all of the arch structures I describe to products of combustion rising from and confined between the surface of the fuel and said inner water heating surface, and that said products of combustion, after substantial absorption by this heating surface, will pass directly from the fire chamber to the combustion chamber very little reduced in temperature, and in downdraft furnaces of this character, not reduced at all in temperature, but in the highest degree possible, by reason of their after passage through the body of burning fuel. In my special structure, however, and by reason of the extended up-draft side passage, the heat units are utilized with substantially better effect upon this inner water heating surface of the arch than in any of the other structures herein shown and described, and for the reason that the heat units, coming in contact with the arch, ascend thereto and descend therefrom on practically direct lines, at which they best impart their heat to a contacting sur-

face; and furthermore, because by this ascending and descending in the fire chamber above the burning fuel, their time of confinement therein and their contact with the water heating surface are substantially prolonged; whereas, in an up-draft furnace, and also in a down-draft furnace having exclusively an end discharge, the heat units are constantly moving in a horizontal direction against this inner surface. In the mean time the products of combustion from the grate bars, after descending therethrough upon the pipes *f*, raise the temperature of the water therein, thus making said pipes a desirable auxiliary water heating surface. As the temperature of the water is raised both in the arch water heating chamber, the grate bars and these pipes, it rises and discharges through the pipe *o*, the circulation of the water to this end being substantially promoted by means of the header, and also by the connection of these grate bars with the water chamber *b*, of the arch. When this arch and grate bar structure are employed in connection with a steam boiler furnace, as, for example, by the pipes *m* and *o*, as before described, water at quite a high temperature will be supplied to the boiler in starting the furnace, and this is a considerable time before the heat of the furnace imparted to the crown sheets of the boiler can possibly raise the temperature of the water therein. In view of this operation, the arch water chamber is not only an extended water heating surface, auxiliary to the boiler when the furnace is in full operation, but is an important factor in the initial heating of the boiler water, and also in raising the temperature of the boiler water quickly when already heated.

The capacity for heating boiler water and the extent of the heating surface of the arch chamber may be appreciated when it is borne in mind that by the use of these arches in the usual fire chamber of a steam boiler, the heating surfaces are increased two hundred and fifty square feet, and that as five square feet of these highly heated water surfaces are equal to one horse power, the addition of two hundred and fifty square feet of heating surfaces adds fully fifty horse power to the boiler.

The importance of my invention in connection with a steam boiler furnace is not confined to the fact of the extended water heating surface it provides, but more largely to the manner of utilizing that surface so as to subject it to heat of the degree, and in the manner already described.

In conclusion it is proper to observe, that an important advantage is gained by having an updraft passage along the side of the arches, in that the length of the grate surface may be extended without limit and a correspondingly larger area of grate surface be operated without any reduction or retardation of the draft in any portion of the furnace, and as cannot be when an exclusively end up draft passage is employed, because, even with a length of grate surface very short as compared with the usual length of mine, to say nothing of the extension permissible by my side up draft passage, the objectionable crowding and choking of the products of combustion and retarding of draft, before stated, are correspondingly increased as the length of grate surface is increased, and said products are compelled to travel a greater distance before reaching the updraft passage.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The combination in a down-draft furnace, of grate bars, a fire chamber, an arch inclosing said fire chamber, a direct updraft passage at the side of said arch, and a water heating chamber internally of the arch, substantially as described.

2. In a down draft furnace the combination of the grate bars, an arch spanning the same, a direct updraft passage at one side of and extending the length of said arch, and a water heating chamber internally of and extending throughout said arch, substantially as described.

3. In a down draft furnace, the combination with the grate bars, of an arch or arches inclosing the same, and arranged to provide a direct updraft passage at one side of and extending substantially the length of said arch or arches, substantially as set forth.

4. In a down draft furnace, the combination with an arch or arches spanning the grate bar surface and inclosing the fire chamber, which said arches are so arranged as to provide a direct draft passage at one side of and extending substantially the length of said arch or arches, and a water chamber inclosed by the opposing surfaces and extending substantially throughout said arch or arches, substantially as set forth.

5. In a steam boiler furnace, the combination with the grate bars, of a closed arch or arches spanning but not surrounding the grate bars and inclosing the fire chamber, a water chamber forming a closed arch internally of said arch or arches, and pipe connections between said chamber and the boiler whereby a continuous circulation of water from and through the boiler and said arch or arches and the grate bars, is maintained, substantially as and for the purpose described.

6. In a furnace, the combination with hollow grate bars, of a closed arch spanning but not surrounding the grate bars, and provided throughout its length with an internal water chamber forming a closed arch connected with said grate bar surface, and also with a suitable source and supply whereby a continuous circulation of water is maintained through the hollow grate bars and arch water chamber substantially as and for the purpose described.

7. In a down draft steam boiler furnace, the combination of hollow grate bars, an arch or arches spanning the same, inclosing the fire chamber and arranged to provide a direct

draft passage at one side of and extending the length of said arch or arches, a supply and discharge pipe connection between said arch or arches and the boiler, and a water connection between said arch or arches and the grate bar surface or surfaces thereof whereby a continuous circulation of water in the boiler and in said arch or arches and grate bars is maintained, and the initial and subsequent heating of the boiler water is promoted, substantially as set forth.

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