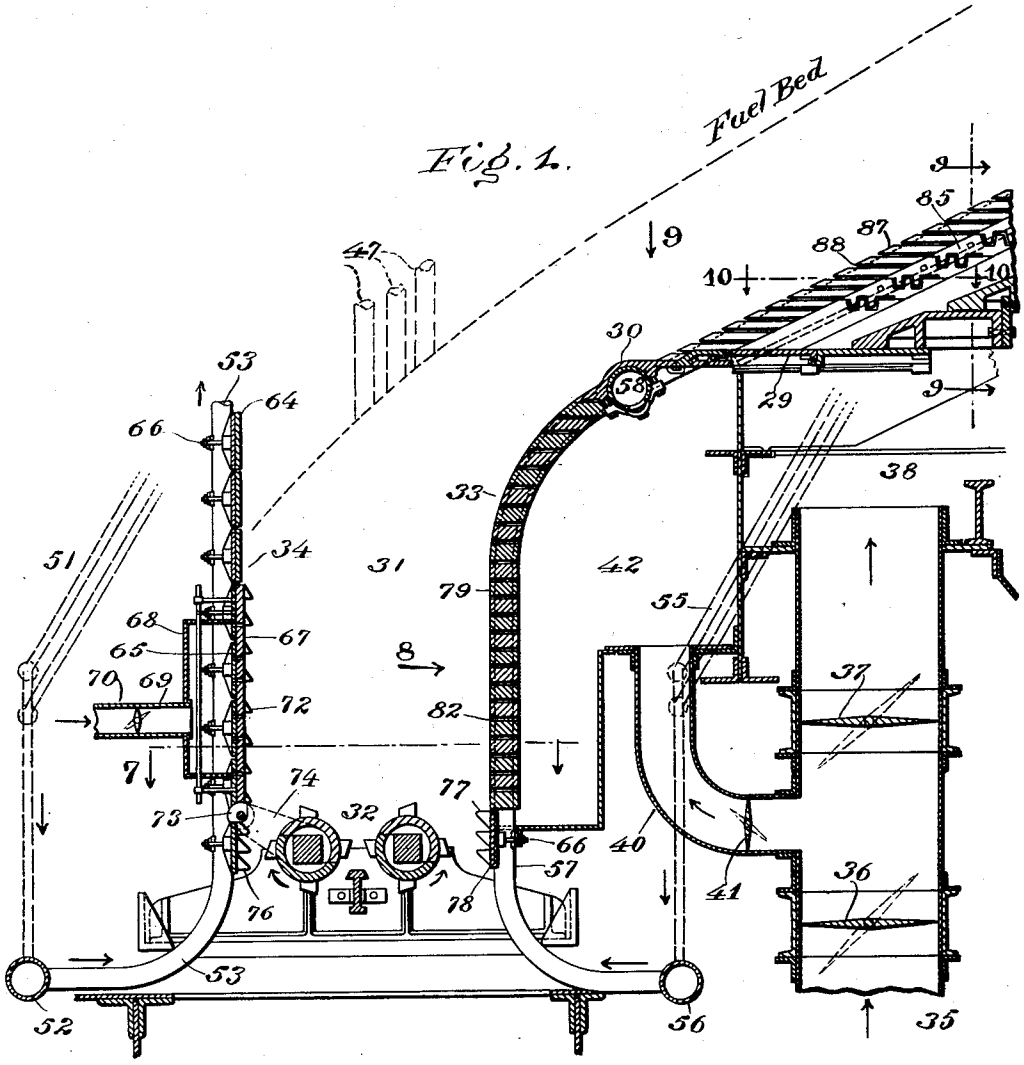
Sept. 25, 1934. E. B. PRIEBE ET AL 1,974,431

BOILER FURNACE

Filed Jan. 16, 1931 5 Sheets-Sheet 1

Fig. 1.



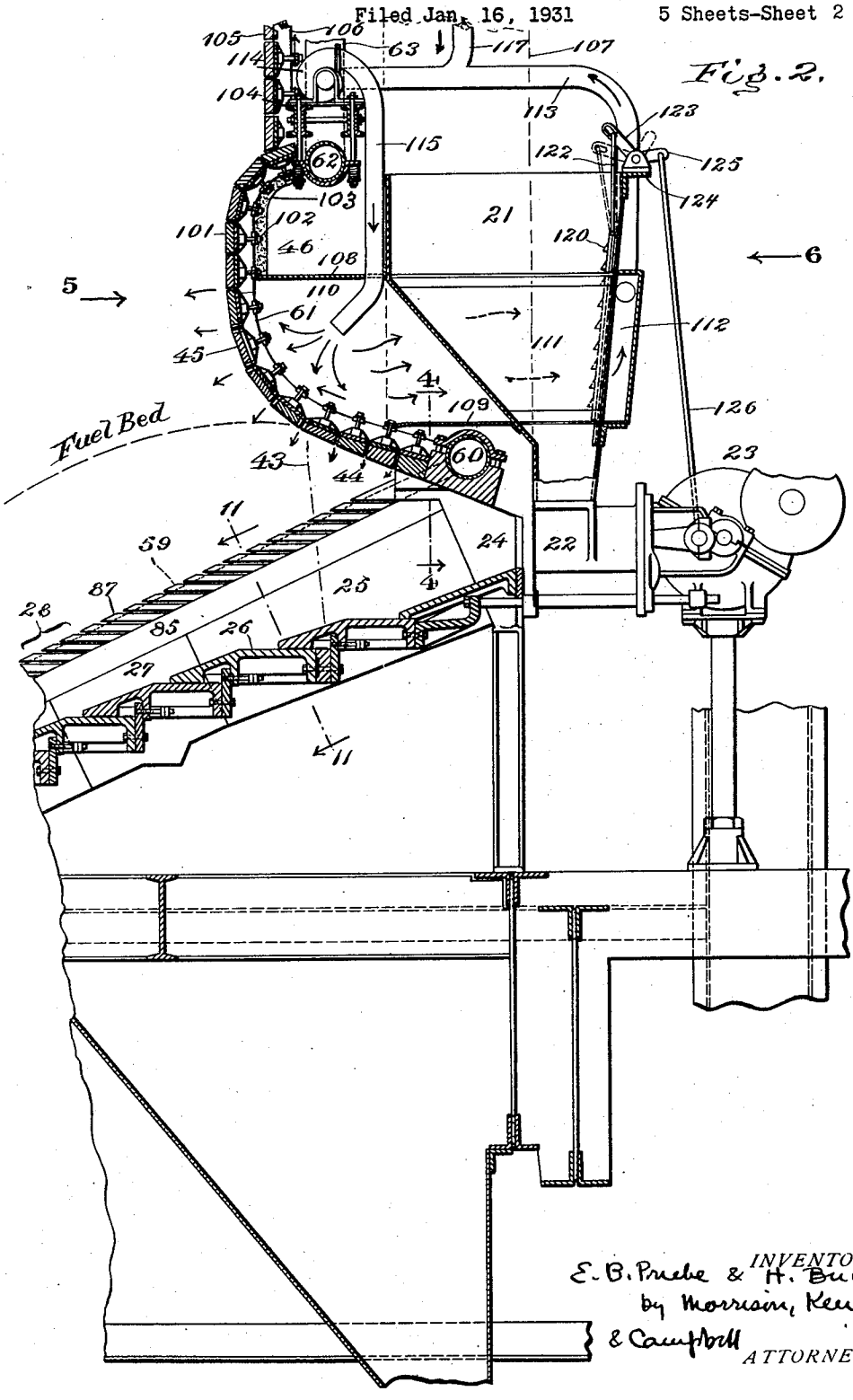
INVENTORS
E. B. Priebe & H. Buchert
BY
Morrison, Kennedy & Campbell
ATTORNEYS.

Sept. 25, 1934. E. B. PRIEBE ET AL 1,974,431

BOILER FURNACE

Filed Jan. 16, 1931 5 Sheets-Sheet 2

Fig. 2.



E. B. Priebe & H. Buchert INVENTORS
by Morrison, Kennedy & Campbell ATTORNEYS.

Sept. 25, 1934. E. B. PRIEBE ET AL 1,974,431

BOILER FURNACE

Filed Jan. 16, 1931 5 Sheets-Sheet 3

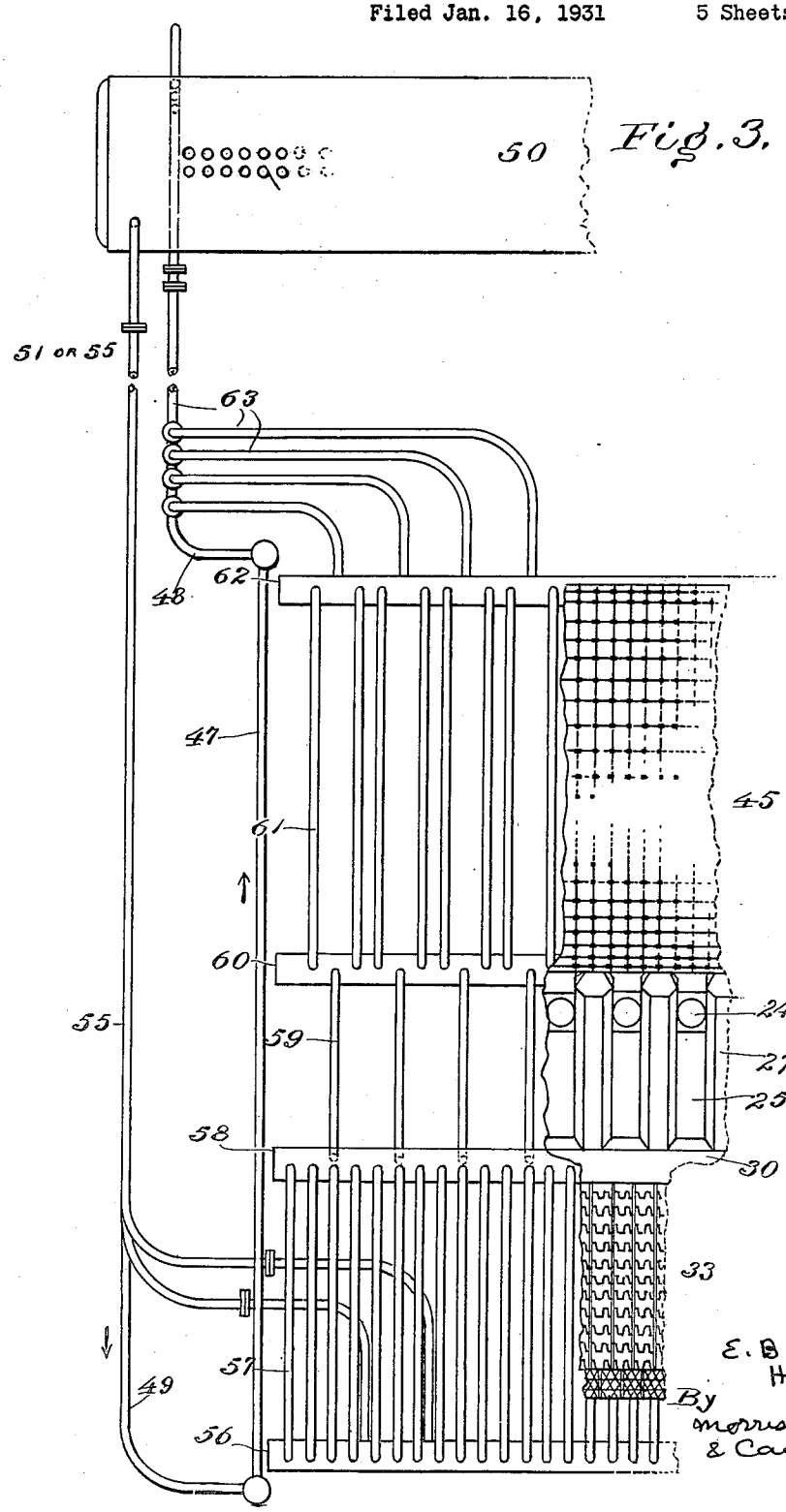


Fig. 3.

INVENTORS
E. B. Priebe &
H. Buchert,
By
by
Morrison, Kennedy
& Campbell
ATTORNEYS.

Sept. 25, 1934. E. B. PRIEBE ET AL 1,974,431

BOILER FURNACE

Filed Jan. 16, 1931 5 Sheets-Sheet 4

Fig. 4.

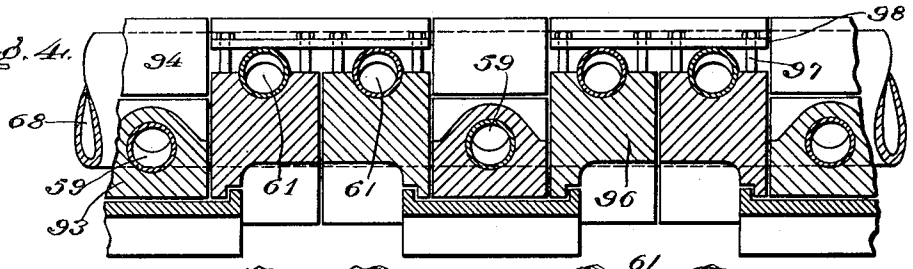


Fig. 5.

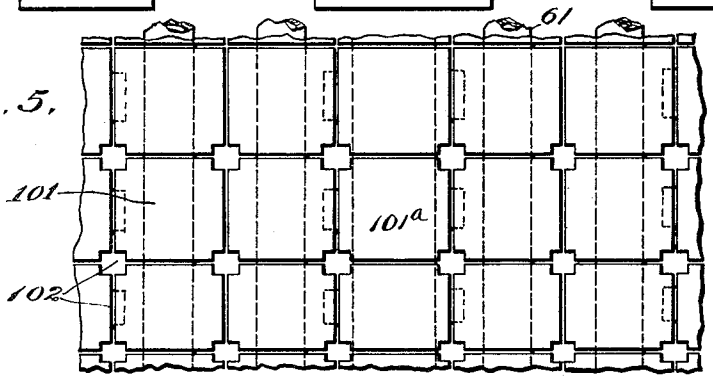
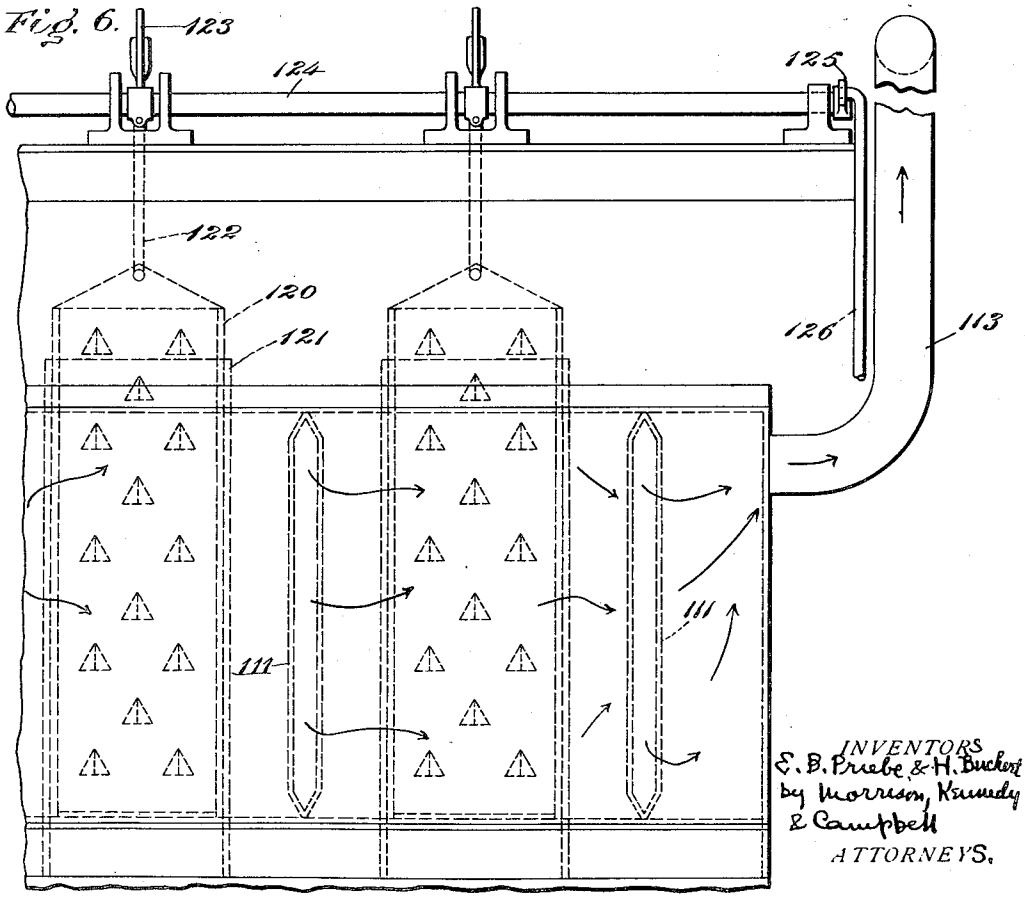


Fig. 6.



INVENTORS
E. B. Priebe & H. Buckert
by Morrison, Kennedy
& Campbell
ATTORNEYS.

Sept. 25, 1934. E. B. PRIEBE ET AL 1,974,431

BOILER FURNACE

Filed Jan. 16, 1931 5 Sheets-Sheet 5

Fig. 7.

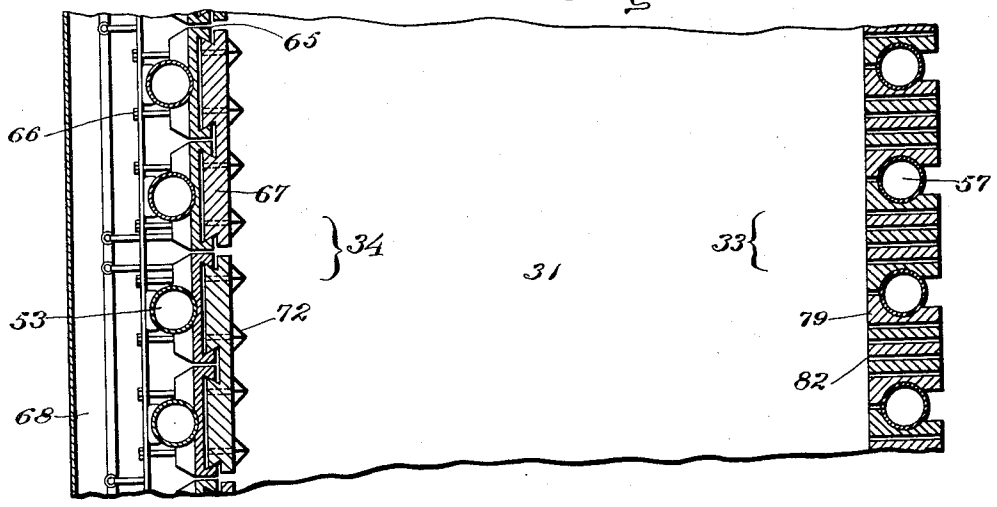


Fig. 8.

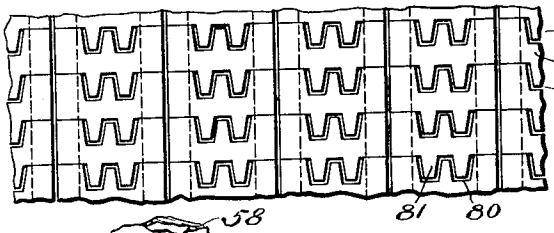


Fig. 10.

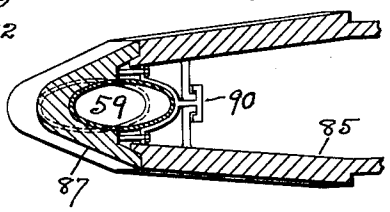


Fig. 9.

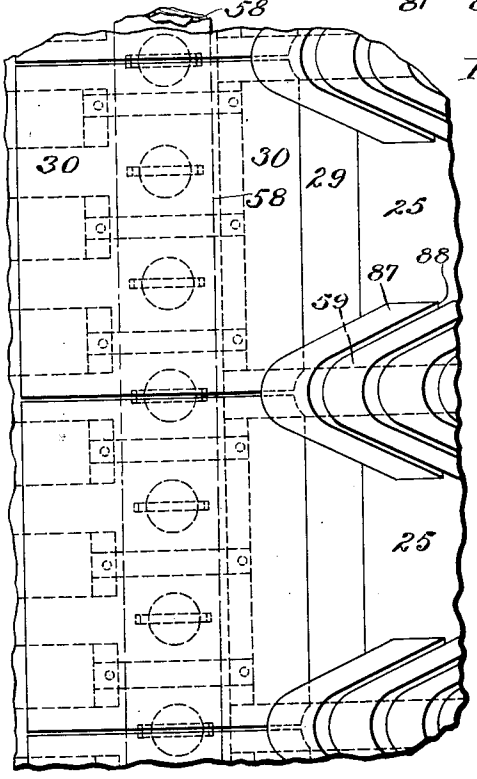
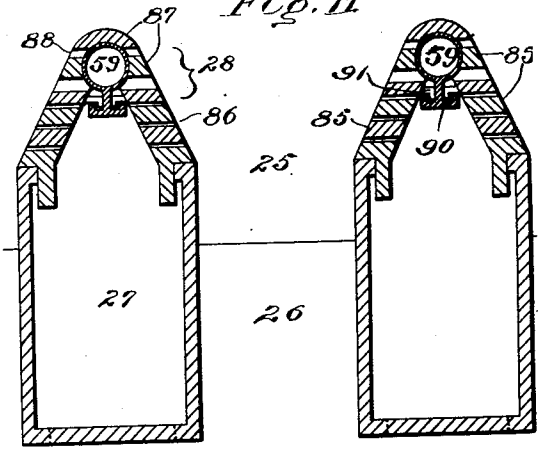


Fig. 11.



INVENTORS

E. B. Priebe & H. Buchert

BY

Morrison, Kennedy & Campbell

ATTORNEYS.

Patented Sept. 25, 1934 1,974,431

UNITED STATES PATENT OFFICE

1,974,431

BOILER FURNACE

Ernest B. Priebe, Woodhaven, and Harry Buchert, New York, N. Y., assignors of one-third to Alfred J. Wheeler, Jr., New York, N. Y.

Application January 16, 1931, Serial No. 509,080

4 Claims. (Cl. 122—4)

This invention is a novel automatic boiler furnace, with particular reference to an underfeed retort stoker furnace for high duty operation of boilers. In such furnaces the coal is underfed into the retorts of the grate at what will be termed the front end or wall of the furnace, the coal advancing both longitudinally rearwardly, and upwardly, as combustion progresses, and the exhausted fuel or ashes traveling onward to a dumping point, which will usually be at the rear end beyond the grate, but may be at one or both lateral sides in the case of a furnace of the well known E-type exemplified by Patent No. 1,833,952 issued December 1, 1931 to Priebe and Miner.

Underfeed boiler furnaces of the kind referred to have heretofore been substantially limited by certain factors, in their capacity and operation, and the general objects of the present invention include the material increasing of the efficiency and capacity of such a furnace, and improving the combustion therein, and increasing materially the evaporation and capacity of the connected boiler. A further object is to afford a boiler furnace of the kind referred to which will be better protected against impairment or destruction from the excessive temperatures existing under conditions of high duty or service.

Other and further objects and advantages of the present invention will be explained in the hereinafter following description of an illustrative embodiment thereof or will be understood to those conversant with the subject. To the attainment of the objects and advantages referred to the present invention consists in the novel underfeed boiler furnace, and the novel features of combination, operation, arrangement and construction herein illustrated or described.

In the accompanying drawings Figure 1 is a vertical longitudinal section of the rear or dumping end of a boiler furnace embodying the invention, while Fig. 2 is a corresponding sectional view of the front or feeding end of the same furnace; these two figures combined constituting such a view of the entire furnace, excluding the walls, boiler etc.; but the grate may be intermediately prolonged beyond the length shown; and the fuel bed may be of a depth substantially as indicated by the dotted line marked "Fuel bed".

Fig. 3 is a diagrammatic and skeleton view in rear elevation showing mainly the water circulation system of the furnace, the term water including steam.

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 2 looking from the rear. Fig. 5 is a rear elevation of a part of the arch, looking in the direction of the arrow 5 on Fig. 2. Fig. 6 is a front elevation of the upper part of the furnace looking generally in the direction of the arrow 6 on Fig. 2.

Fig. 7 is a horizontal section taken on the line 7—7 of Fig. 1 looking from above. Fig. 8 is a rear elevation of a part of the front wall of the ash pocket looking along the arrow 8 of Fig. 1. Fig. 9 is a partial top plan view looking generally in the direction of the arrow 9 of Fig. 1. Fig. 10 is a horizontal section taken on the line 10—10 of Fig. 1. Fig. 11 is an inclined section taken on the line 11—11 of Fig. 2.

Referring first to some of the general or usual furnace parts, a coal hopper 21 is shown which may be supplied with coal in any usual manner. This hopper delivers the coal into the rearward end of an infeed channel or ram box 22, understood to contain the usual infeeding ram reciprocated by exterior mechanism 23, extended across the front of the furnace so as to operate methodically all of the infeed rams of the furnace.

From the ram box the coal is thus thrust rearwardly into the furnace through the throat 24, the coal thus entering the retort 25. As indicated in Figs. 9 and 11 there may be any desired number of retorts across the width of the furnace, with suitable furnace side walls, not shown. The retort bottom 26 may be composed of a number of pushers as shown, reciprocated fore and aft in unison with the ram. The sides of each retort are bounded by air boxes 27 capped by twyers 28 arranged to deliver air into the body of the fuel bed, which is piled considerably higher than the tops of the twyers.

At the rear or lower end of each retort is shown a supporting plate 29 on which the lowermost pusher 27 rests and reciprocates. To the rear of the supporting plate 29 is a delivery member, plate or casting 30 over which the burned out fuel bed travels and spills down into the ash pocket or clinker recess 31, bounded by front and rear walls which will be more specifically described. At the foot of the ash pocket is shown a clinker grinder device 32 comprising oppositely rotated cylinders with grinding teeth adapted, in a known manner, to feed the ashes and clinkers methodically from the pocket downwardly out of the furnace, at the same time grinding or reducing the clinkers to a suitably small size for convenience of disposal.

It will be understood that the ash pocket 31 is maintained substantially filled with ashes or clinkers as indicated by the dotted fuel bed line, thus maintaining a seal against air admission during the continuous removal of ashes. The ash pocket is shown as bounded by a front wall 33 which curves above forwardly to the grate or twyer system, and a rear wall 34, and of course side walls at the two sides of the furnace.

In Fig. 1 an air main 35 is shown bringing forced draft to the stoker. In the main 35 are shown a first damper 36 and a second damper 37, the latter when open delivering air to the general

air space or chamber below the grate or retort system, thus supplying the air boxes 27. Taking off from the air main 35, between the dampers 36 and 37, is shown an air duct 40 containing a damper 41 and extending rearwardly to an air box 42 in front of the ash pocket front wall 33 and supplying air thereto. It will be understood that the air system may be variously constructed, operated and controlled by damper or otherwise to give differential pressure and flow of air to various parts of the stoker.

At the front of the furnace, above and inward of the line or throats 24, back to the imaginary line 43, is formed a transverse channel 44, produced by an incurved front or arch wall 45 which overhangs the grate and with the latter encloses the channel 44 as a continuation of the throats. This fuel infeed channel or chamber not merely confines and shapes the entering fuel into a proper fuel bed, thus protecting it from being disturbed by the underfire air rising through the bed until the fuel is partially coked, but expediting the coking action by applying heat from the overhanging wall as well as from the fire. The wall or arch 45 trends inwardly from the throat, above the fuel bed, thence curves upwardly and forwardly to a point protected from the radiant heat; and above which extends any desired type of front wall construction 105, to be further described. In the space within or in front of the curved front wall 45 is an air chamber 46 to be later referred to.

The furnace side walls may be water cooled by tubes 47 therein, see Figs. 1 and 3, delivering by uptakes 48 to the boiler and receiving water by downtakes 49.

Referring next to the water circulation system of the present invention, a boiler drum 50 is indicated in the rear elevation diagram Fig. 3. This may be one of a plurality of drums comprised in a water tube boiler of any desired type. From convenient points of the drum 50 extend downtakes conducting water to the circulation system to be described. One of these downtakes 51 is shown in Fig. 1 as extending to a lower header 52 at the rear of the ash pocket wall 34, and from this header extends a system of uptakes 53 carried through the wall 34 so as to water-cool the wall and generate steam from the heat in the ash pocket. The mode of construction of the wall and protection of the tubes will be later more fully described. The spacing of the tubes may be similar to that of the tubes 57 to be described.

Other downtakes 55 from the drum 50 extend to a lower header 56 in front of the ash pocket, and as seen in Figs. 1 and 3 a system of curved uptake pipes 57 extends from the header through the front pocket wall 33, thus extracting heat from the hot ashes and clinkers descending through the pocket, owing to the continuous circulation of water or steam through the described system of tubes. At their upper ends the uptakes 57 deliver into a transverse header 58 located preferably between the ash pocket front wall and the lower end of the grate or twyer system, for example formed or embedded in the delivery member or casting 30. By this arrangement the upwardly traveling water or steam is redistributed in the header 58 and carried on upwardly.

From the header 58 extends a system of uptakes 59 as shown in Figs. 1, 2 and 3. These, for example, may be spaced further apart than the uptakes 57, so that each uptake 59 may be embodied within and near the apex of one of the twyers 28, as shown also in Fig. 11, thus cooling the twyer members and receiving heat for evaporative purposes. At the top of the inclined grate the several uptakes deliver into a header 60 located above the throat 24, at the front wall of the furnace and at the foot of the arch 45. From the header 60 is shown a series of uptakes 61, spaced in pairs alternately with the uptakes 59, as shown in Fig. 3, the uptakes 61 extending through the arch to maintain it in cooled condition and to receive heat therefrom. The series of uptakes 61 deliver into a common header 62 at the top front end of the arch, and from the header 62 extends upwardly a series of uptakes 63 which, as seen in Fig. 3, deliver steam into the upper side of the drum 50, or the header may deliver by uptakes 106 to be described.

Referring to details of construction, and taking first the rear wall 34 of the ash pocket 31, this may consist of the lower portion of any desired form of furnace rear or bridge wall. The water tubes 53, relatively spaced equivalently to the tubes 57 at the other side of the pocket, as shown in Fig. 7, are preferably provided with protecting blocks 64, which may comprise iron and may be faced with silicon carbide, these giving ample heat conduction rate to absorb heat and convey it to the water ascending through the tubes. At the lower part of the pocket these are replaced by similar but dove-tailed blocks 65. In both cases the blocks are shown secured rigidly to the tubes by clamping means 66, consisting of bolts extending through the wall at the sides of the tubes and externally secured to backing pieces or strips.

At the lower part of the wall 34, below the fuel bed line, the tube protecting blocks 65 are preferably faced with iron or other blocks 67 fitting slidingly the dove-tails of the blocks 65, the formation and attachment of clinkers being prevented by the injection of air through the perforations of or between the blocks 67, as clearly shown in Figs. 1 and 7. For this purpose an air chamber 68 is formed by suitable enclosing walls, behind the wall 34, this chamber being fed with forced draft air through a duct 69 controlled by a damper 70.

If desired the downward feed of ashes through the pocket may be assisted by including in the wall 34 a system of vertically reciprocable serated pushing members. These may be for example the wall members 67, with projections or teeth 72 thereon, and arranged for example to be dropped by gravity and to be lifted intermittently by a cam 73 operated by a sprocket connection 74 from the rotary clinker grinder device 32. Opposed to the clinker grinder devices may be certain fixed projections or teeth 76 at the rear wall 34, and at the front wall 33 there may be similar fixed teeth 77, supported by clamped blocks 78, these cooperating with the clinker grinder in preventing large clinkers passing through to the ash pit below until broken up by the rotary grinding device. It will of course be understood that in lieu of the continuously operating clinker grinder device the ash pocket or the grate may be intermittently dumped.

Referring next to the details of construction of the ash pocket front wall 33, this is shown in Figs. 1, 7 and 8. As with the rear wall the tubes of the front wall are preferably covered by a system of heat conducting blocks, but in the case of the front wall the blocks 79 are preferably of a particular shape, not requiring clamping or unclamp-

ing for attachment or removal. Thus each block is shown constructed to extend from tube to tube, spanning the space between two tubes, and with concave surfaces fitting the tubes. The blocks being of greater horizontal than vertical dimension may be inserted or fed into place from above by a tilting motion, each block being let down to rest by gravity on the block below, and each column or panel of blocks, between two tubes, resting down upon the clamped lowermost blocks 78 carrying the serrations 77. Each block is shown as having recesses 80 at its upper side and relatively smaller lugs or projections 81 at its lower side, entering but not closing the recesses of the block below, so that air apertures 82 are left between the blocks, thus permitting ample air delivery from the air box 42 through the apertures 82 into the ashes and residue of fuel descending through the ash pocket. The topmost block 79 in each vertical column or panel may be specially constructed so as to permit ready removal and insertion at the face side without tilting.

The main grate of the furnace comprises the several retorts and the air boxes with overlying twyer structures separating the retorts. The preferred structure is indicated in Figs. 1, 2, 9, 10 and 11. Each twyer structure 28 may be built up of a system of outstanding, and preferably horizontal twyer bars or blocks 85, which may be constructed substantially as the wall blocks 79, to the extent of allowing air apertures 86 between the bars for delivery of air from the air boxes 27 into the fuel bed. Each twyer, thus built up of bars 85, may be capped with special top pieces 87, also preferably horizontal in arrangement, overlapping, and arranged for delivery of air through apertures 88 into the fuel bed.

As already stated the uptakes 59 are located within the upper part of the respective twyers 28, as best seen in the inclined section view Fig. 11 and the horizontal section view Fig. 10. Each tube 59 is shown as having a depending projection 90, this being of inverted T-shape with locking extensions engaging complementary extensions 91 on the twyer bars. The cap pieces 87 may be separately attachable and detachable from the upper side of the tubes 59, or may if desired be permanently welded on, thus giving superior heat conduction, maintaining the cap pieces sufficiently cool to prevent substantial deterioration. In Figs. 1, 2 and 11 the cap pieces are welded on to the tubes, while Fig. 10 shows a detachable form, sometimes desirable, with the parts 87 and 90 clamped to the tube.

At the upper end of the grate structure, and assembled about the header 60 which forms the communication between the uptakes 59 and the uptakes 61 is shown a special construction of wall closing members, comprising shapes 93 engaging the uptakes 59 and the header 60, as shown in Fig. 4, with complementary blocks 94 above, and comprising also special blocks 96 engaging the header 60 and the under sides of the uptakes 61, with bolts 97 extending upwardly therefrom and engaging complementary members or strips 98, by which the parts are clamped in position.

The overhanging front wall or arch construction is shown in Figs. 2 and 5. A system of blocks 101, preferably faced with silicon carbide or other refractory, is clamped upon the system of uptakes 61, in a manner to leave air apertures between the blocks for directing air into the combustion chamber at and above the fuel bed line. Each block is shown as removably attached by clamping device 102 to a tube. Those blocks 101^a not clamped to the tubes are of refractory material and secured by back lugs to adjacent blocks as indicated in Fig. 5. The upper part of this wall structure is preferably closed and sealed by a refractory layer 103.

The upper header 62 for the tubes 61 is shown hung by a suspension device 104 from fixed parts of the furnace structure. Above the curved front wall 45 is indicated a vertical continuation 105 which may comprise tubes 106 with blocks 101 clamped thereto. The entire front wall 45, 105 is seen to stand substantially inwards of the usual position of an underfeed furnace front wall, indicated by dotted lines at 107.

Preferably, as shown, upper and lower walls 108 and 109 are provided forming a chamber 110 behind the lower part of the wall 45, within which chamber air may be heated, to pass partly into the furnace, and partly as next described, to warm up and dry the coal in the hopper 21, thus to improve combustion. From the chamber 110 are shown a series of thin air channels or flues 111 as best shown in Figs. 2 and 6. These extend directly through the supply of coal descending through hopper 21 and bring enough heat to effect substantial drying of the fuel. These hollow members also act as ties, being attached to the hopper front and rear walls. The outer or forward end of each channel 111 delivers into a transverse chamber 112 at the front, from which extends upwardly an air pipe 113 leading to the intake of a suction blower or centrifugal fan 114, the delivery 115 of which is extended downwardly and into the chamber 110, thus maintaining continuous circulation through the chamber and the channels 111. Since the pressure in chamber 110 delivers both through wall 45 and flues 111, additional air may be supplied to the fan by air pipe 117, for example from an air preheater.

In connection with this improvement it may be desirable to provide means for insuring the down travel of coal within the hopper 21, and Figs. 2 and 6 indicate a series of serrated pushing members 120 mounted slidably in vertical guides 121 alternated with the channels 111. Each pusher member 120 is shown connected by a link 122 with a rock arm 123, the several rock arms mounted on a fulcrum shaft 124, which at a convenient point is provided with a rock arm 125 connected by a pitman 126 with a crank on the driving shaft of the infeed mechanism 23.

The above disclosure indicates substantially the water cooling of the entire stoker, namely by circulation connections from the boiler including downtakes to the wall or walls of the ash pocket, a first header at this point, a set of uptakes through the pocket wall and a second header at the upper ends thereof, a second set of uptakes through the grate leading to a third header at the top of the grate from which the fluid is carried to the boiler, preferably through a third series of uptakes through the overhanging front wall and thence by final header to a steam pipe leading back to the boiler. This entire combined equipment, and each part of it, is of substantial value in boiler furnaces of various types, especially central station power houses where the load fluctuates greatly and the furnace and boiler at times have to be pushed to a very high percentage of duty or service.

The water cooling of the grate and other parts contacted by the fuel bed cooperates with the water cooling of the lateral walls of the combustion chamber to permit very high service and evaporation. The invention is applicable to any

boiler furnace of the class mentioned, for example the B & W, or Stirling, with water cooled side walls, the addition of the water cooled stoker or grate adding substantially to the capacity of a given plant.

The described boiler furnace affords a materially improved efficiency and permits substantially higher rates of service. Not merely do the water circulating tubes in the furnace increase the evaporation of the boiler and thus improve output, but the cooling and protection of the several parts of the furnace and stoker allow materially greater rates of combustion, at periods of high service. In other words with this invention a greatly increased number of pounds of coal per hour per square foot of grate surface may be consumed. The circulating system gives ample cooling and protection to the several parts of the stoker and prevents the tendency to burn out parts thereof during maximum service. With this invention moreover the forced draft air pressure introduced beneath the grate can be materially reduced, since the usual large amount of such air is no longer necessary for cooling and protection purposes; and this in turn permits greater percentages of air to be introduced into the combustion space above the fuel bed at the front wall or the side walls or both, and through the ash pocket, thus increasing the efficiency of combustion at every part of the furnace.

The action of the prolonged vestibule or coking channel or chamber 44, into which the underfeed throats deliver, is of importance. From the throat 24 to the line 43 the fuel is positively confined during its expansion to the fuel bed depth. Therefore the high forced draft pressure rising through the fuel bed can not lift or blow away the individual coal pieces, and by the time the fuel reaches the line 43 it has been coked sufficiently to hold its own shape as a fuel bed, namely by the heat communicated from the hot fuel bed further to the rear, and from the overhanging wall 45. To afford a deeper fuel bed and greater service of the furnace the overhang of the wall 45 may be carried further inward and the boundary 43 of vestibule 44 thus displaced to enlarge the latter. The wall 45 is more of a confining ceiling than an arch in the ordinary sense. The preheated secondary air injected through it directly into the fuel bed at the entrance chamber creates a temperature assisting the coking process, which thereby commences relatively earlier, considerably in advance of the ignition point.

The grate itself, with its twyers water cooled, affords flexibility of action and self adjustment. At periods of high service when the twyers are subject to great temperatures, there will be rapid evaporation and flow through the tubes 59, thus conveying away excess heat and preventing deterioration of the twyers, even if bared to the furnace atmosphere, in extreme cases. At periods of low service the rate of flow and heat removal is reduced, and thus is avoided excessive cooling, as might impair completeness of combustion. These considerations apply also to the ash pocket walls and their cooling.

Many details of construction have been ignored in the hereinabove description, and in some cases omitted from the drawings, as being either unnecessary to the description of the present invention, or as known or understood to those conversant with the art. For example, the general form of twyer members over the air boxes is shown in certain prior patents; and in other prior patents are shown certain of the forms of covering blocks, facing the water tubes, and the means of clamping the same in position, all owned by applicants or their assignee company.

There has thus been described an underfeed boiler furnace, embodying the principles and attaining the advantages of the present invention; and since various matters of combination, operation, arrangement and construction may be modified without departing from the principles it is not intended to limit the invention to such matters except to the extent set forth in the appended claims.

What is claimed is:

1. A boiler furnace having a progressive feed stoker supporting and advancing the coal bed toward the dumping point, and at the front thereof one or more throats for the entrance of coal to the stoker; and characterized by an overhanging rearwardly and upwardly extending wall above the front part of the stoker grate and therewith enclosing a vestibule into which the throats deliver, said wall located and shaped to contact and protect the coal bed beneath it and to confine the depth thereof through a substantial extent of travel beyond the throats, and said wall composed of fluid cooling passages with refractory members covering the same and constructed with apertures for injection of air through the wall directly into the upper side of the fuel bed, and an air chamber behind said wall supplying preheated air under pressure to traverse such apertures and enter and heat the fuel bed.

2. A boiler furnace having an underfeed retort stoker supporting and advancing the coal bed toward the dumping point, and at the front thereof one or more throats for the entrance of coal to the furnace; and characterized by an overhanging rearwardly and upwardly extending wall above the front part of the stoker and therewith enclosing a vestibule into which the throats deliver, said wall located and shaped to contact and protect the coal bed beneath it and to confine the depth thereof through a substantial extent of travel beyond the throats, and said wall composed of refractory members constructed with passages to admit air directly into the upper side of the fuel bed, and an air chamber behind said wall supplying preheated air under pressure to traverse such passages and enter and heat the fuel bed.

3. A boiler furnace having a progressive feed stoker supporting and advancing the coal bed toward the dumping point, and at the front thereof one or more throats for the entrance of coal to the stoker; and characterized by an overhanging rearwardly and upwardly extending wall above the front part of the stoker grate and therewith enclosing a vestibule into which the throats deliver, said wall located and shaped to contact and protect the coal bed beneath it and to confine the depth thereof through a substantial extent of travel beyond the throats, and said wall being composed of water cooling passage members and constructed with apertures to admit air directly into the upper side of the fuel bed, and an air chamber behind said wall supplying preheated air under pressure to traverse such apertures and enter and heat the fuel bed.

4. A furnace as in claim 3 and wherein the fuel bed in said vestibute is supplied also with preheated air through said grate, and said grate is water cooled.

ERNEST B. PRIEBE.
HARRY BUCHERT.