June 11, 1935. P. BADENHAUSEN 2,004,152

SLAG BOTTOM FOR FURNACES

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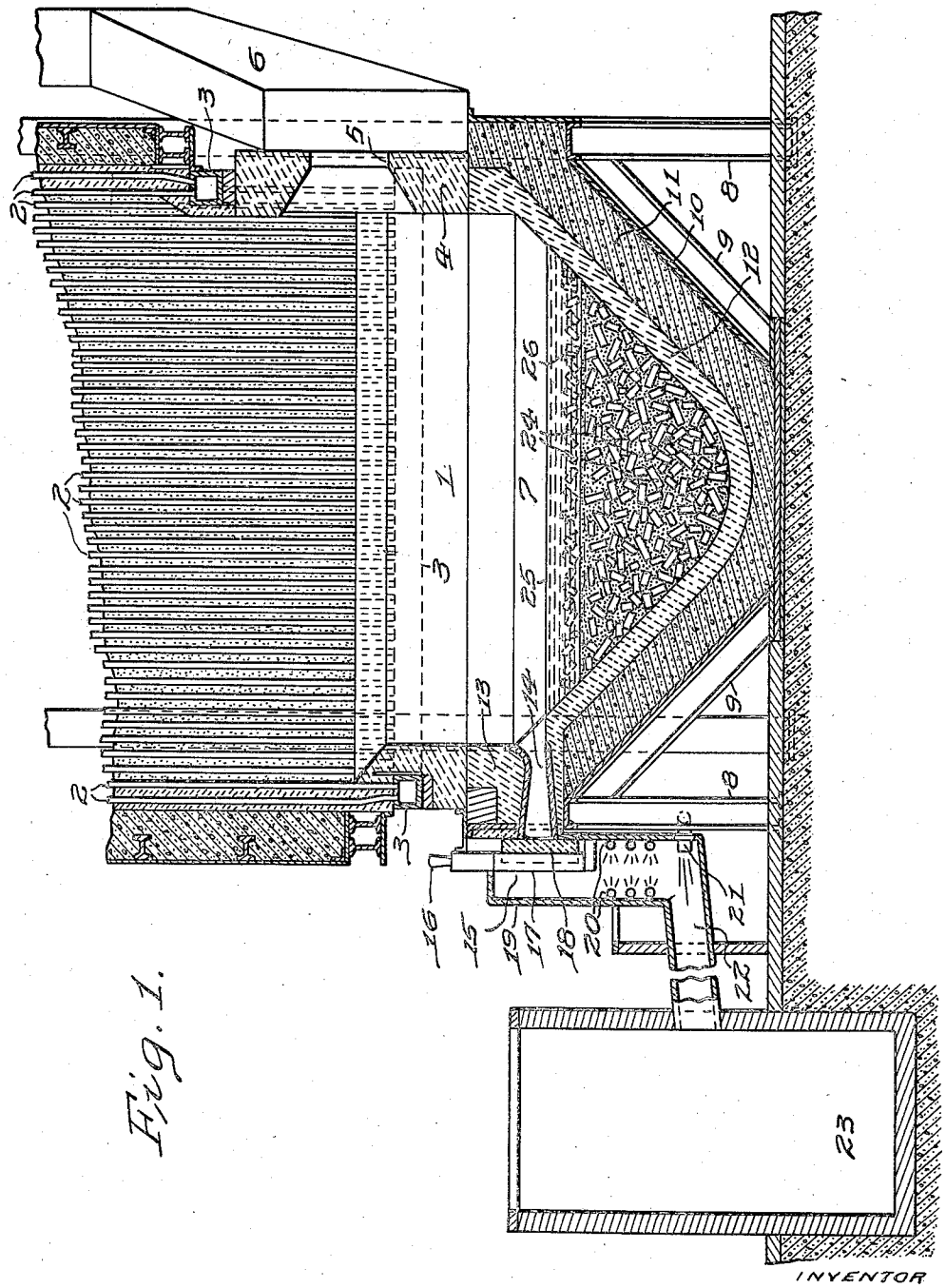

Fig. 1.

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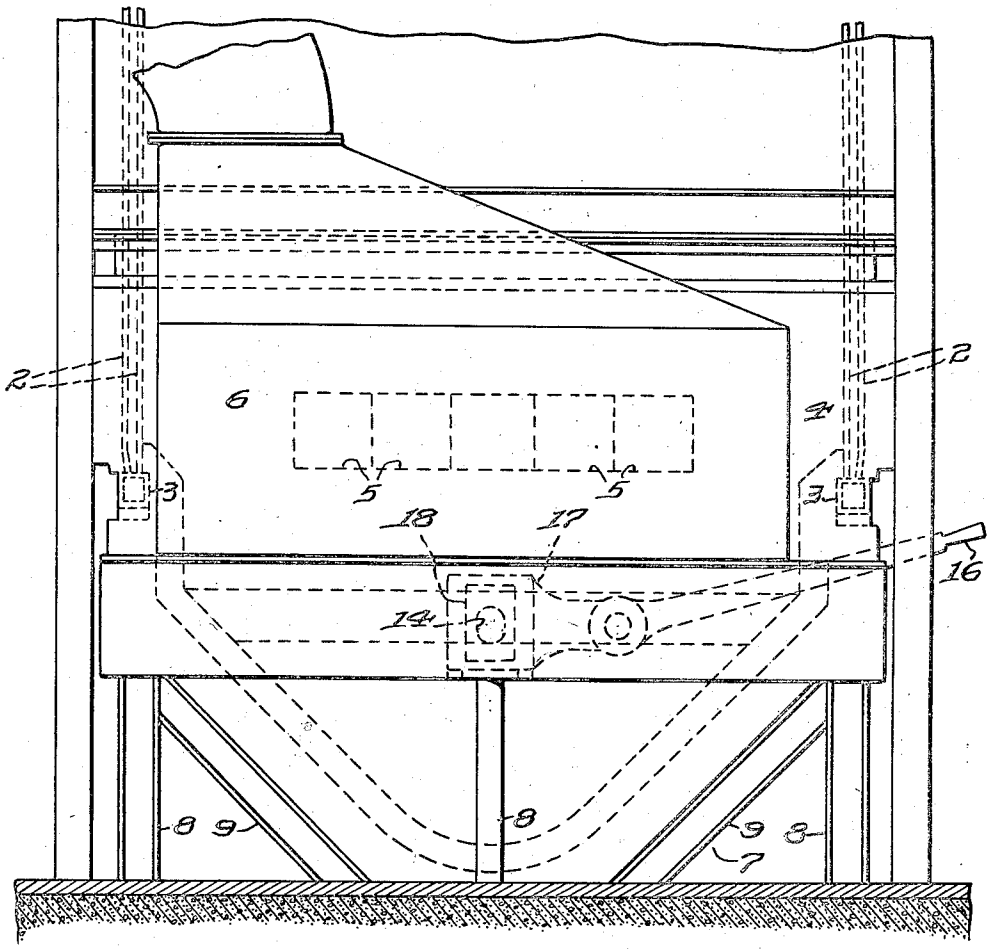
Fig. 2.



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SLAG BOTTOM FOR FURNACES

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5 Claims. (Cl. 110—165)

This invention relates to slag bottoms for furnaces, and more particularly to an improved bottom construction for furnaces fired by pulverized coal or similar fuels.

It has heretofore been proposed to operate such a furnace at a sufficiently high temperature to melt the ash and thus form a liquid slag which collects on the furnace bottom and which may be tapped out at intervals through a suitable opening in a side wall of the furnace. A construction of this type is known as a slag-tap furnace, and one of its principal advantages resides in the fact that no ash pit is required beneath the furnace, so that the overall height of the furnace and the building which encloses it are greatly reduced. The bottom or pit of the combustion chamber in such furnaces usually comprises a relatively shallow pan having vertical side walls, and the accumulation of slag therein presents a serious problem. When the operation of the furnace is stopped, as for instance for repairs, the molten slag solidifies, and it is difficult to remove it from the pan or pit. It must be dug out. If allowed to remain therein, upon the re-heating of the furnace, the solid slag in the pan expands substantially and this expansion of the solid slag puts the walls of the pan or pit under a great pressure which weakens and may actually rupture the walls of the pan.

It is one of the objects of the present invention to provide a construction which will permanently retain some of the slag in the pit at the bottom of the furnace to protect the walls of the pit, and which is so arranged as to avoid difficulties caused by expansion of solidified slag.

A further object of my invention is to make the upper surface of the furnace pit or bottom concave, with upwardly flaring walls, so that when the pit or bottom is filled with solid matter, including solidified slag, the expansion thereof upon re-heating does not exert any substantial pressure tending to injure or weaken the walls, but merely produces an upward creep or slide of the outer surface of the contents of the pit over the inner surface of the pit.

Other objects of my invention will appear in the specification and claims below.

Referring now to the drawings forming a part of this specification and in which the same reference characters are employed throughout the various views to designate the same parts,

Fig. 1 is a vertical longitudinal section of the lower part of the combustion chamber of a boiler; and

Fig. 2 is a front elevational view of the same.

Only the lower part of the combustion chamber 1 of the boiler is shown in the drawings. The side walls may be provided with water cooling tubes 2 connected with suitable headers 3, in the usual manner. The front of the boiler is provided with a heavy wall or plate 4 of refractory material having openings 5—5 in which to mount burners (not shown) to which fine powdered fuel commingled with air is supplied through the conduit 6 in the front of the boiler. The bottom 7 of the boiler may be supported on a metal framework 8 and braces 9 or in any other suitable manner, and when so supported I preferably use an upwardly and outwardly sloping sheet-metal shell 10 on which to form a concrete shell 11, preferably provided with a lining 12 of dolomite or plastic chrome ore, or other suitable refractory material to which molten slag does not firmly adhere. But any other support, e. g., an all concrete support or base provided with an upper concave surface, may be used.

The concave portion of the bottom 7 is imperforate but the wall 13 is provided with a port or tap-hole 14 preferably located just above the concave portion, said port being normally closed by a valve or gate 15. This closure is shown as a heavy hand lever 16 carrying on its short end 17, a plate 18 of refractory material. When the lever 16 is forced downwardly the plate 18 moves upwardly uncovering the port and molten slag in the bottom above the level of said port, will flow through the port 14.

The valve 15 is preferably located within a housing 19 in which are located a number of water jets or sprays to cool the slag falling therethrough and the lower part of the housing is also preferably provided with a jet 21 for driving the slag falling to the bottom thereof rearwardly through the pipe or conduit 22 to the sump 23.

Before the furnace is started, the concave bottom is preferably substantially filled with loose pieces of refractory material 24, such as broken pieces of fire brick and the like, to a point near the level of the porthole 14. After the furnace has been operated for a time, a layer 25 of molten slag forms on the top of the mass of broken pieces of refractory material 24, due, in part, to the fusion of the pieces of brick at the top or upper surfaces thereof where it is exposed to the direct heat of the burning fuel and to the accumulation of molten ash falling thereon as a result of the deflagration of the fuel.

The molten slag 25 is not extremely fluid. It flows relatively slowly and, therefore, slowly works down into the mass of refractory material 24, but before it has penetrated very far it cools sufficiently to become practically solid, and, therefore, the slag in a molten condition rarely reaches the bottom of the concave pit, but forms a crust or layer 26 of refractory material with the voids between the pieces of relatively refractory material filled with solidified lava resting on the top of the balance of the refractory material and on which the molten layer 25 is retained.

The crust 26 and the mass of refractory mate-

rial 24 with the spaces therebetween filled with air or voids between contiguous pieces of said material practically heat-insulate the bottom of the pit from the intense heat of the interior of the combustion chamber 1 and of the molten ash layer 25. From time to time, the gate or valve 15 may be opened and the excess lava or molten slag may be allowed to flow out from the furnace bottom through the port 14 and falling between the jets of water, become broken up into small loose particles which are more or less granular and in that condition they are driven by another jet of water or steam 21 into the sump 23.

When for any reason it becomes necessary or desirable to put the boiler out of commission for a time as, for instance, for the purpose of making repairs or for cleaning, the supply of fuel is cut off from the furnace in the usual way and the boiler is allowed to cool. The layer 25 of slag within the bottom 7 and lying on the crust 26 then solidifies into a relatively solid mass. In ordinary boilers of this kind, it is customary to then remove the slag from the bottom, but this is arduous, difficult work in the doing of which harm is likely to come to the lining 12.

In using a boiler equipped with my invention, it is not necessary to remove this slag which solidifies in the bottom of the pit. It forms, in fact, a part of the bottom itself. When the furnace is again started the intense heat within the combustion chamber soon makes fluid again the slag at the upper part of the bottom and the whole mass may expand in re-heating, but in expanding the mass merely creeps or slides upwardly on the slanting walls of the concave surface of the lining 12, not adhering firmly thereto, but sliding over it and exerting substantially no lateral pressure tending to disrupt the lining 12 or the shell 11. What cracks may appear in the layer 26 as it heats and expands, are quickly filled with the lava from the layer 25 at the top of the mass which solidifies in the crack, filling it and thereby preventing too deep a penetration of the molten lava into the voids between the pieces of the mass of refractory material 24.

While I usually prefer to first fill the bottom with broken pieces of substantially infusible material and to form the crust at the top thereof, as above described, it is not necessary so to do. It may be omitted and the molten ash or lava may be allowed to slowly accumulate and fill the bottom. In the operation of the furnace, the lava or molten slag at the bottom of the pit or well will slowly solidify as the bottom fills so that by the time the accumulation is well over the vent or tap-hole 14, only a shallow depth of molten lava will be at the top of the accumulation.

When the level of the accumulated molten ash rises substantially above the port or tap-hole 14, it may be brought down to the level shown in Fig. 1 by opening the valve 15 and allowing the excess to flow off.

When the furnace or boiler is put out of commission and allowed to cool, the slag will solidify within the bottom and, shrinking somewhat, cracks or fissures may form therein. Upon a re-heating of the boiler without removing this accumulation of solidified slag, the mass will expand but will not exert any injurious pressure horizontally against the outwardly flaring or tapering side walls of the bottom for the slag will not adhere so firmly to the impervious lining 12 as to rupture it or weaken the main walls of the bottom. As the operation of the furnace continues, the upper surface of the accumulated slag may soften and become fluid, and more fluid molten slag may accumulate at the top thereof, but the heat from the interior of the furnace will be substantially insulated from the greater portion of the bottom by the relatively thick layer of solidified slag or slag and brick filling the lower part of the bottom.

I, prefer, however, to use the pieces of refractory material 24 in the usual practice of my invention, because the air in the voids in the solid material below the crust or layer 26 also contribute substantially to the heat insulation of the bottom lining and walls of the bottom from the intense heat of the combustion chamber.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:

1. A combustion furnace for pulverized fuel comprising a closed furnace bottom having upwardly flaring walls and filled with loose pieces of refractory material providing air-filled voids between contiguous pieces thereof, and a layer of molten ash supported on the top of said pieces of material and filling the voids at the top surface thereof.

2. A combustion furnace for pulverized fuel comprising a closed furnace bottom having upwardly flaring walls and filled with loose pieces of refractory material normally providing air-filled voids between contiguous pieces thereof, the spaces between the pieces near the top of said material being sealed into a crust with solidified slag or lava and a layer of molten ash or lava supported on said crust, the material below said crust and the air-filled voids therein forming a heat-insulating layer to protect the walls from the intense heat of combustion.

3. A combustion furnace for pulverized fuel comprising walls forming a closed furnace bottom having an upper surface which slopes upwardly and outwardly in all directions, said bottom being lined with a material to which fused ash does not firmly adhere as it solidifies, a permanent bed of fused ash retained by said bottom to form a protecting layer, and means to withdraw from the furnace liquid ash which collects on the upper surface of said permanent bed.

4. A combustion furnace for pulverized fuel comprising a closed furnace bottom having side walls all of which slope upwardly and outwardly, said bottom being impermeably lined with a material to which fused ash does not firmly adhere as it solidifies, the slope of the walls being sufficiently gradual to permit the solidified slag in said bottom to expand upon re-heating and slide upwardly on said walls without exerting substantial pressure horizontally against the walls, and means providing an opening near the top of one side wall through which fused ash may be withdrawn in liquid form.

5. A combustion furnace for pulverized fuel comprising a closed furnace bottom lined with a material to which fused ash does not firmly adhere as it solidifies, said bottom having side walls sloping upwardly and outwardly in at least two directions at right angles to each other to permid solidified slag on said bottom to expand upon re-heating and slide upwardly on said walls without exerting substantial pressure horizontally, and means providing an opening in one side wall and spaced a substantial distance above the lowest point in said bottom through which fused ash may be withdrawn in liquid form.

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