May 26, 1942. R. SHELLENBERGER ET AL 2,284,601

STEAM GENERATOR

Filed July 31, 1940 2 Sheets-Sheet 1

Fig. 1

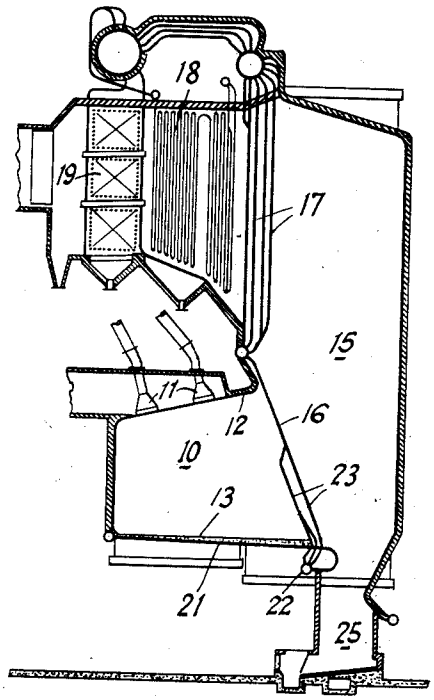


Fig. 11

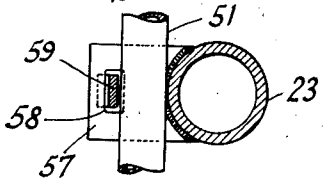


Fig. 8

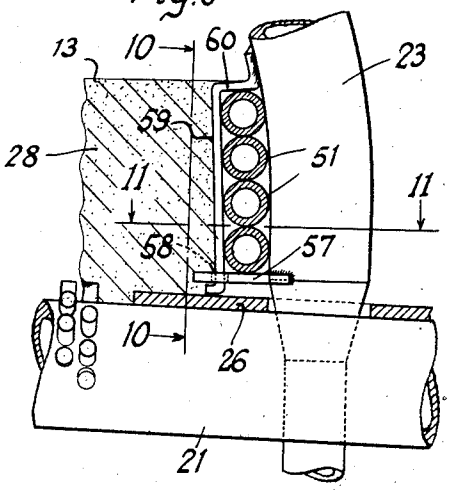


Fig. 10

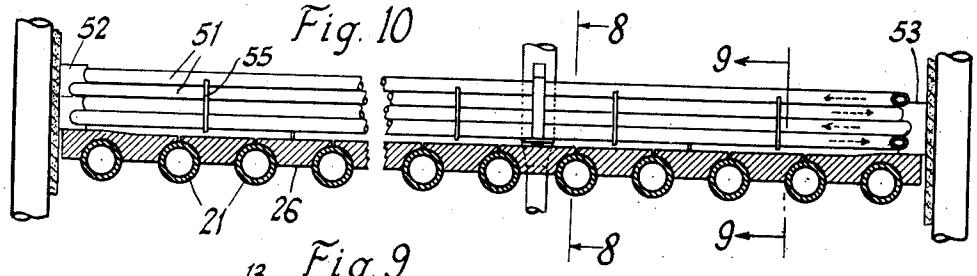
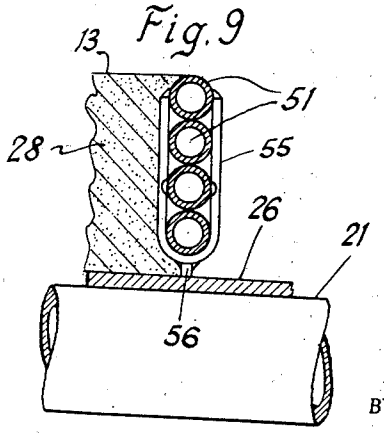


Fig. 9



INVENTORS
Rolfe Shellenberger
BY and Edward M. Freeman
Joseph P. Moran
ATTORNEY.

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Filed July 31, 1940 2 Sheets-Sheet 2

Fig. 2

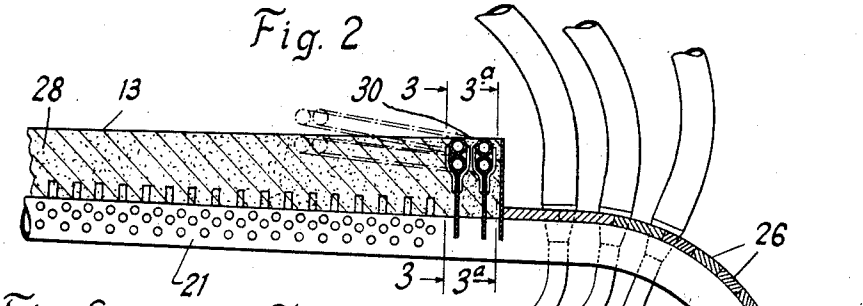


Fig. 6

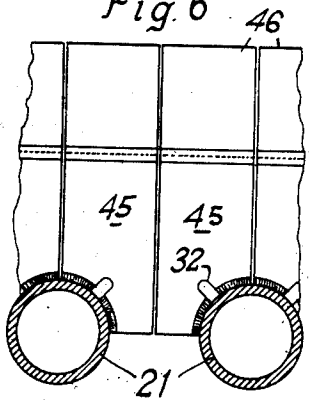


Fig. 7

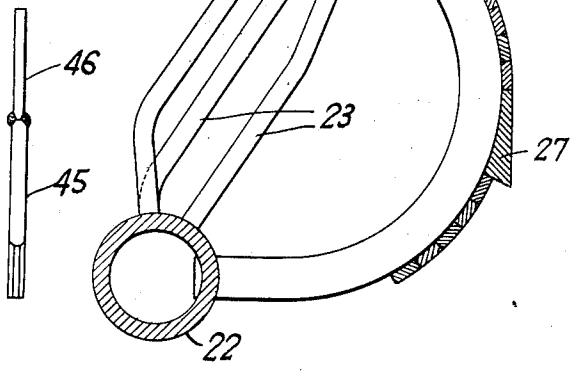


Fig. 3

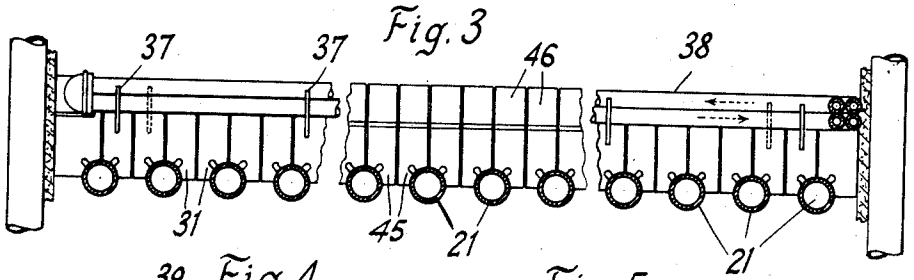


Fig. 4

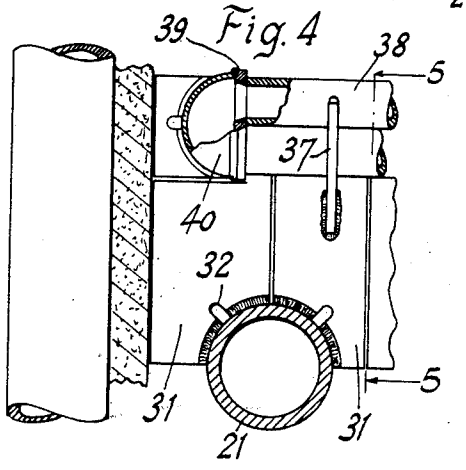
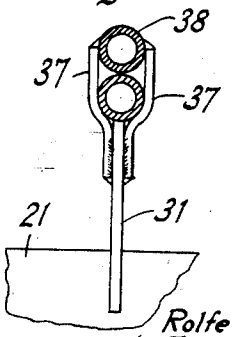


Fig. 5



INVENTORS
Rolfe Shellenberger
and Edward M. Freeman

BY Joseph P. Moran

ATTORNEY.

Patented May 26, 1942

2,284,601

UNITED STATES PATENT OFFICE

2,284,601

STEAM GENERATOR

Rolfe Shellenberger, Westfield, N. J., and Edward M. Freeman, North Pelham, N. Y., assignors to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application July 31, 1940, Serial No. 348,772

10 Claims. (Cl. 122—235)

The present invention relates to the construction of furnaces for burning a slag-forming solid fuel in suspension under furnace conditions resulting in the separation of the ash in the furnace and its deposition on the furnace floor in the form of molten slag, and more particularly to the construction of the floors of such furnaces.

The main object of our invention is the provision of an improved floor construction for furnaces of the type described which is characterized by the maintenance of a predetermined level of the deposited slag layer on the floor, an increased resistance to erosion of the refractory portion of the floor, and generally a more durable floor construction.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which we have illustrated and described several embodiments of our invention.

Of the drawings:

Fig. 1 is a somewhat diagrammatic sectional elevation of a steam generating unit incorporating our invention;

Fig. 2 is an enlarged view of the discharge end portion of the furnace floor shown in Fig. 1;

Fig. 3 is a transverse section partly on the line 3—3 and partly on the line 3^a—3^a of Fig. 2;

Fig. 4 is an enlarged view of an end portion of Fig. 3;

Fig. 5 is a section taken on the line 5—5 of Fig. 4;

Fig. 6 is an enlarged view of an intermediate portion of Fig. 3;

Fig. 7 is an end view of one of the plates of Fig. 6;

Fig. 8 is a sectional view of a modified dam construction taken on the line 8—8 of Fig. 10;

Fig. 9 is a view similar to Fig. 8 taken on the line 9—9 of Fig. 10;

Fig. 10 is a broken transverse section taken on the line 10—10 of Fig. 8 with the refractory layer omitted; and

Fig. 11 is a section taken on the line 11—11 of Fig. 8.

In Fig. 1 is illustrated a high capacity high pressure steam generating unit having a two-stage furnace especially designed for burning pulverized bituminous coal in suspension which is disclosed and claimed in the copending application of Ervin G. Bailey et al., Ser. No. 137,196, filed April 16, 1937. The furnace has a high temperature primary section 10 fired by a plurality of pulverized coal burners 11 located in the furnace arch 12 and discharging downwardly towards the rearwardly sloping furnace floor 13. The primary furnace section is partly separated from the lower part of a secondary furnace section 15 by a partition 16 extending downwardly from the rear end of the furnace arch towards the rear end of the furnace floor. The secondary furnace section extends upwardly to the convection heated portion of the unit wherein the heating gases pass successively across the main steam generating tube bank 17, a superheater 18, and economizer 19.

Both the primary and secondary furnace sections have their defining walls including the floor 13 and partition 16 cooled by steam generating tubes. A row of transversely spaced water tubes 21 extends longitudinally of the floor from the front wall of the unit to the rear end of the floor, curving downwardly around the rear or slag discharge end of the floor to a supply header 22, as shown. The partition 16 is defined by rows of water tubes 23 extending upwardly from the header 22 between the floor tubes 21. The spaces between the upper portions of adjacent tubes 23 are closed by refractory means to form the partition, while the lower portions of those tubes are bent and grouped to form heating gas passages therebetween, through the bottoms of which molten slag deposited on the furnace floor can flow down over the curved end of the floor to the slag hopper 25, wherein it is quenched.

The furnace floor has a thick layer of suitable refractory 28, such as plastic chrome ore, held in position by metallic studs mounted on the peripheral surface of the floor tubes 21, and extending from the front wall of the furnace to a point near the row of screen tubes 23. Beyond the rear end of the refractory layer, the tubes are covered with blocks 26 held on the tubes, the block area terminating in a row of overhanging nose blocks 27 adjacent the rearmost portion of the bend in the tubes 21.

The rear end of the refractory layer is defined by a fluid cooled dam structure 30 extending the full height of the refractory layer as installed. The dam structure is formed in three sections, arranged in parallel planes spaced longitudinally of the floor. The first and second sections of the dam are each formed by a row of slightly spaced rectangular steel plates 31, double the number of floor tubes, so that each tube has welded thereon

a pair of plates 31 cut away at a lower corner to fit the tube surface. A short slot 32 is formed in the tube contacting edge of each plate to compensate for temperature stresses in the plate. At intervals along each plate row is welded a pair of bent rods 37, uniting with the upper edge of the plates to form transversely spaced fork members in which is positioned a long hairpin shaped tube 38 formed by superposed contacting leg portions connected at one end by a plate 39 and a cup type cap 40 forming a 180 deg. return bend. The fork members are welded to the upper tube leg only, as shown in Fig. 5. A flow of a suitable cooling fluid, such as service water, is maintained in operation through each tube 38, as indicated by the arrows in Fig. 3.

The third section of the dam structure is formed by a row of steel plates 45 similar in construction to the plates 35, but slightly shorter. The remaining height of this section is formed by plate sections 46 of corrosion-resistant metal, welded to corresponding plates 45, as shown in Fig. 7. Plastic refractory is also packed in between the described sections of the dam structure. A substantial cooling effect is thus effected by the cooling tubes 38 on the rear or discharge end of the refractory layer, thus reducing the erosive action on the refractory and dam of the slag flowing over the dam structure.

In operation, the molten slag separating in the furnace chamber 10 collects on the furnace floor 13 and flows rearwardly over the dam structure onto the block covered section of the floor tubes, through the spaces between the screen tubes, and down over the curved end of the floor to the slag hopper. As the furnace continues in operation, the slag tends to penetrate the refractory layer, causing some of the refractory to be washed away. Eventually an equilibrium point is reached, at which time a shallow pool of slag will be supported on the refractory floor, overflowing the fluid cooled dam structure as additional molten slag is deposited thereon. The height of the dam thus determines the level of the slag layer maintained on the floor.

In the modified construction illustrated in Figs. 8–11, the fluid cooled dam structure for the refractory layer 28 is located alongside the first row of screen tubes 23 and partly supported thereby. As shown, the dam structure is formed by a row of four superposed horizontally arranged contacting tubes 51 arranged for a serial flow of a cooling fluid downwardly therethrough by connections of certain tube ends to short vertical manifolds 52 and 53 at opposite ends thereof. The manifold 52 is divided as indicated and only the two intermediate tubes 51 connected to the manifold 53 to provide the described serial flow through the tubes.

The supporting provisions for the tubes 51 include U-shaped support rods 55 spaced along and enclosing the tube row. The rods are welded to alternate tubes, as shown in Fig. 9, and to a subjacent bar 56 resting on the floor tube blocks 26. The tube row is partly supported and held against the spaced screen tubes 23 by horizontally arranged support plates 57 welded to the corresponding tubes superjacent the floor blocks 26. Each plate 57 has an opening 58 therein into which fits the lower bent end of an alloy steel clip bar 59 and engages therewith. The upper end of each bar 59 has a horizontal L shaped extension 60 fitting across the top of the tube row and welded to the corresponding tube 23.

With the described dam construction, the refractory layer on the floor will extend substantially up to the tube screen and the molten slag depositing thereon will flow over the refractory layer and dam and drop onto the black covered floor between the screen tubes, flowing down over the curved end of the floor to the slag pit 25. The fluid cooled dam effectively maintains the refractory layer in position and controls the level of the slag on the furnace floor.

While in accordance with the provisions of the statutes we have illustrated and described herein the best forms of the invention now known to us, those skilled in the art will understand that changes may be made in the form of the construction disclosed without departing from the spirit of the invention covered by our claims, and that certain features of our invention may sometimes be used to advantage without a corresponding use of other features.

We claim:

1. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to support slag in a molten condition and discharge the same at one end thereof, a fluid cooled dam extending transversely of said floor adjacent the discharge end thereof and including a transversely extending cooling tube, a vertically arranged furnace tube extending upwardly past an intermediate portion of the discharge end of said floor, means for supporting said cooling tube from said vertically arranged furnace tube, and a layer of refractory material covering said floor in front of said dam.

2. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and discharge the same at one end thereof, a row of transversely spaced water tubes extending longitudinally of said floor, a fluid cooled dam extending transversely of said floor adjacent the discharge end thereof and including a transversely extending cooling tube, plate members extending transversely of and supported on said floor tubes, means for supporting said cooling tube on said plate members, and a layer of refractory material covering said floor tubes in front of said dam.

3. A furnace for burning finely divided solid fuel under slagging tempertaures comprising a floor constructed to receive and support slag in a molten condition and discharge the same at one end thereof, a row of transversely spaced water tubes extending longitudinally of said floor, a fluid cooled dam extending transversely of said floor adjacent the discharge end thereof and including a transversely extending cooling tube, means for supporting said cooling tube on said floor tubes, and a layer of refractory material covering said floor tubes in front of said dam.

4. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and having a slag discharge section at one end thereof, a group of transversely spaced screen tubes extending through said floor adjacent the discharge end thereof and having slag discharge passages on the floor portions therebetween, a row of transversely spaced water tubes extending longitudinally of said floor, a fluid cooled dam extending transversely of said floor adjacent the front of said screen tubes and including a transversely extending cooling tube, means for supporting said cooling tube, and

a layer of refractory material in front of said dam.

5. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and having a slag discharge section at one end thereof, a group of transversely spaced screen tubes extending through said floor adjacent the discharge end thereof and having slag discharge passages on the floor portions therebetween, a row of transversely spaced water tubes extending longitudinally of said floor, a fluid cooled dam extending transversely of said floor adjacent the front of said screen tubes and including a transversely extending looped cooling tube, means for supporting said cooling tube from said floor, and a layer of refractory material covering said floor tubes in front of said dam.

6. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and having a slag discharge section at one end thereof, a group of transversely spaced screen tubes extending through said floor adjacent the discharge end thereof and having slag discharge passages on the floor portions therebetween, a fluid cooled dam extending transversely of said floor adjacent the front of said screen tubes and including a transversely extending cooling tube, means for supporting said cooling tube from said screen tubes, and a layer of refractory material in front of said dam.

7. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and having a slag discharge section at one end thereof, a group of transversely spaced screen tubes extending through said floor adjacent the discharge end thereof and having slag discharge passages on the floor portions therebetween, a row of transversely spaced water tubes extending longitudinally of said floor, a fluid cooled dam extending transversely of said floor adjacent the front of said screen tubes and including a row of superposed transversely extending cooling tubes contacting with said screen tubes, means for supporting said cooling tubes from said floor and screen tubes, and a layer of refractory material covering said floor tubes in front of said dam.

8. A furnace for burning fine divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and having a slag discharge section at one end thereof, a group of transversely spaced screen tubes extending through said floor adjacent the discharge end thereof and having slag discharge passages on the floor portions therebetween, a row of transversely spaced water tubes extending longitudinally of said floor, a dam extending transversely of said floor adjacent the front of said screen tubes and including a transversely extending row of plate members having upper portions formed of metal highly resistant to corrosion, means for supporting said plate members from said floor tubes, and a layer of refractory material covering said floor tubes in front of said dam.

9. A furnace for burning finely divided solid fuel comprising a floor constructed to receive slag in a molten condition and discharge the same at one end thereof, means for burning finely divided solid fuel under conditions resulting in the deposition of slag in a molten condition on said floor, a row of transversely spaced water tubes extending longitudinally of said floor, and a fluid cooled dam extending transversely of said floor adjacent the discharge end thereof and including a transversely extending looped cooling tube, and means for supporting said cooling tube from said floor tubes, and a layer of refractory material covering said floor tubes in front of said dam.

10. A furnace for burning finely divided solid fuel under slagging temperatures comprising a floor constructed to receive and support slag in a molten condition and discharge the same at one end thereof, a row of transversely spaced water tubes extending longitudinally of said floor substantially throughout its length, a fluid cooled dam extending transversely of said floor adjacent the discharge end thereof and including a transversely extending cooling tube, means for supporting said cooling tube above and in spaced relationship to said floor tubes, and a layer of refractory material covering said floor tubes in front of said dam.

ROLFE SHELLENBERGER.
EDWARD M. FREEMAN.