June 22, 1937. D. H. N. MAYO 2,084,739

STEAM BOILER FURNACE

Filed Feb. 14, 1935 3 Sheets-Sheet 1

Fig. 1

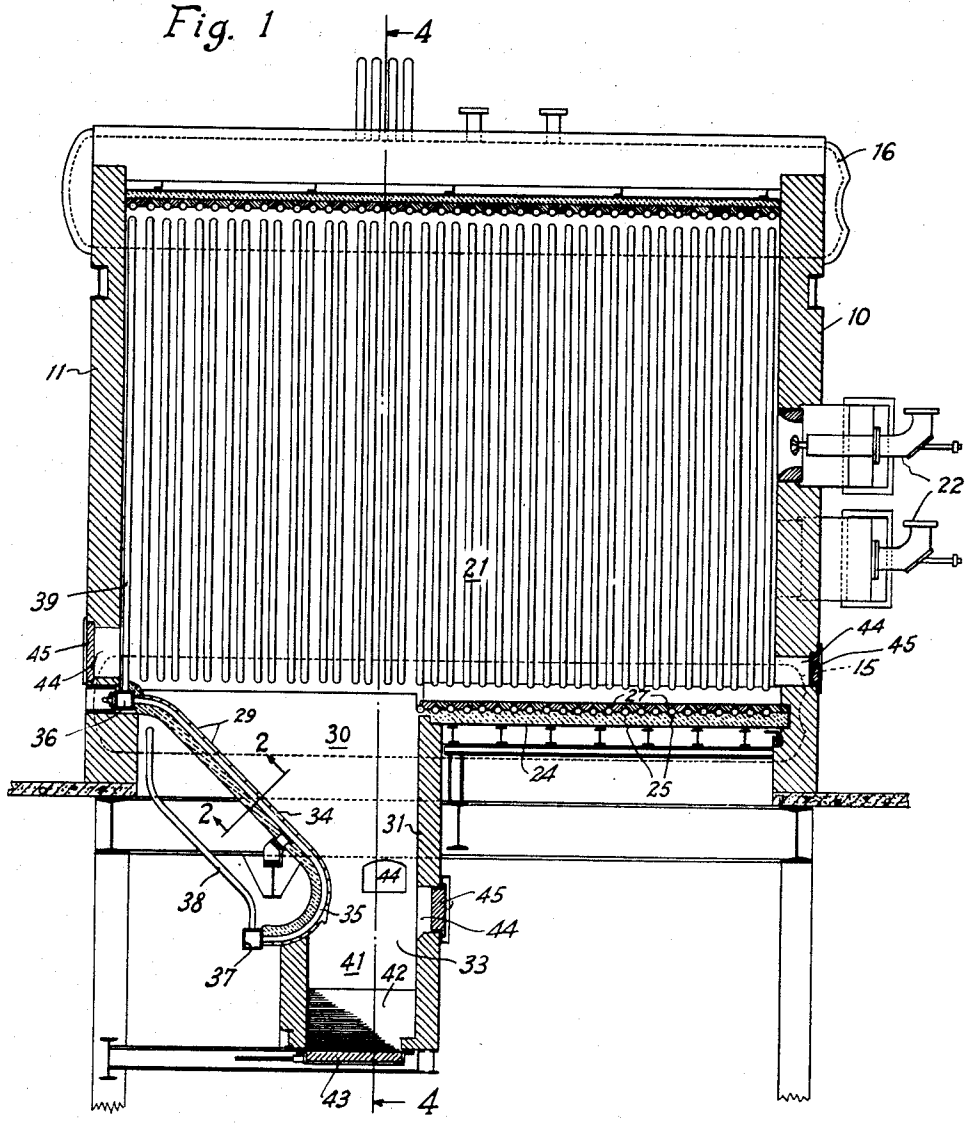


Fig. 2

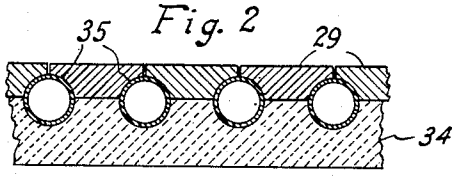
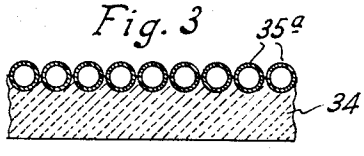


Fig. 3



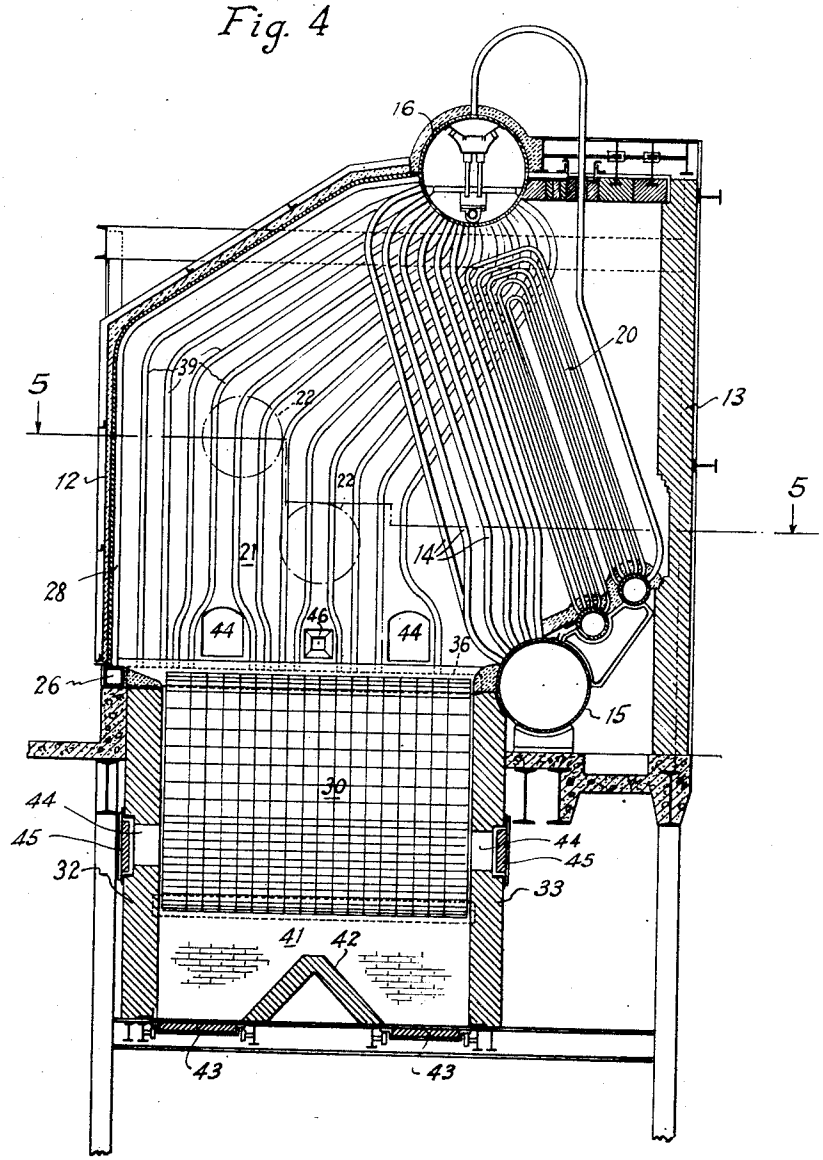
INVENTOR
Dana H.N. Mayo
BY Eug. R. Newcomb
ATTORNEY

June 22, 1937. D. H. N. MAYO 2,084,739

STEAM BOILER FURNACE

Filed Feb. 14, 1935 3 Sheets-Sheet 2

Fig. 4



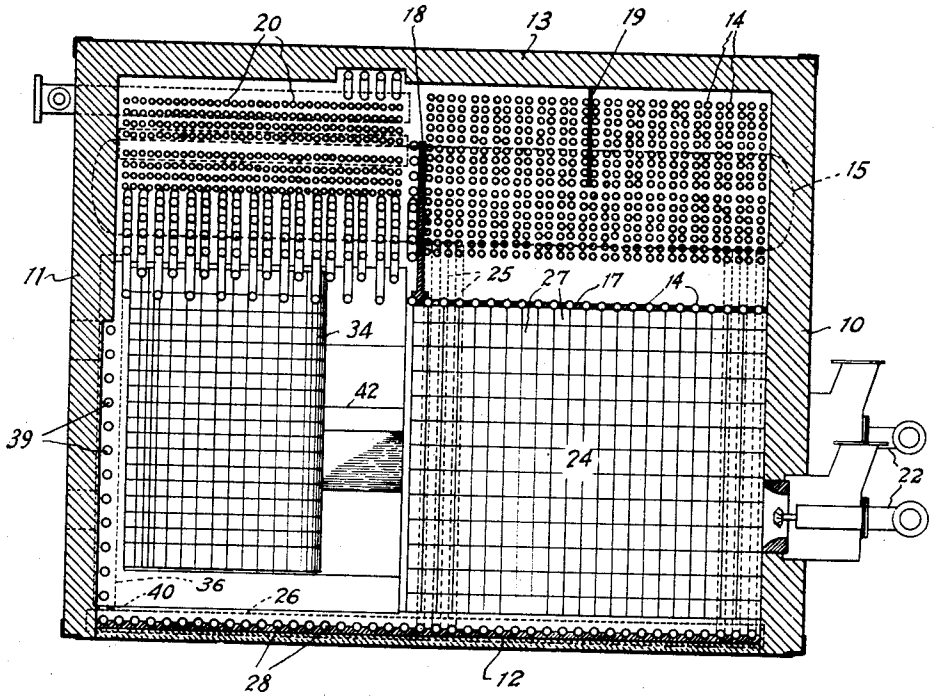
INVENTOR
Dana H.N. Mayo
BY Eug. R. Newcomb
ATTORNEY

June 22, 1937. D. H. N. MAYO 2,084,739

STEAM BOILER FURNACE

Filed Feb. 14, 1935 3 Sheets-Sheet 3

Fig. 5



INVENTOR
Dana H.N. Mayo
BY Eug. R. Newcomb
ATTORNEY

Patented June 22, 1937 2,084,739

UNITED STATES PATENT OFFICE

2,084,739

STEAM BOILER FURNACE

Dana H. N. Mayo, Ridgewood, N. J., assignor to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application February 14, 1935, Serial No. 6,450

15 Claims. (Cl. 122—338)

The present invention relates in general to the construction of pulverized fuel firing furnaces, and more particularly to the construction of the bottoms of furnaces in which pulverized fuel is to be burned in suspension under conditions permitting the removal of the ash in a relatively dry, i. e. unfused, condition and the available floor space surrounding the furnace is limited.

When in integral furnace steam generating units, for example, such as illustrated in the pending application of Ervin G. Bailey et al., Serial No. 701,426, filed Dec. 8, 1933, the ash fusion temperature of the pulverized coal burned and the furnace temperatures are such as to permit dry ash removal, the ash depositing on the furnace bottom is ordinarily removed by periodically raking it out through clean-out openings in one or both end walls of the furnace. In larger size units of this type, the available floor space surrounding the unit must be of substantial size to permit proper handling of the ash removal implements. Where in such units the furnace exceeds a predetermined length, it has been found that the amount of external floor space required and the size of the necessary implements renders it impractical to remove all of the ash from the furnace floor in this manner.

The main object of my invention is the provision of an improved bottom construction for a pulverized fuel firing furnace adapted for dry ash removal, which is characterized by the ease in which most of the ash can be removed from the furnace, protection of accumulated ash from the radiant heat of the furnace, and the relatively low amount of external floor space required for the ash removal operation.

A more specific object is the provision of a simple and relatively low cost water cooled ash hopper construction for integral furnace steam generating units.

The various features of novelty which characterize my 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 I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is a sectional elevation of an integral furnace steam generator unit constructed in accordance with my invention;

Fig. 2 is a section through one of the ash hopper walls taken on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 illustrating a modified construction;

Fig. 4 is a transverse vertical section taken on the line 4—4 of Fig. 1; and

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

In the drawings I have illustrated an integral furnace steam generator unit of the general type disclosed in said application of Bailey et al., which comprises a setting having a vertical front wall 10, rear wall 11, and opposite side walls 12 and 13. Adjacent the side wall 13 is located a substantially vertical bank of steam generating tubes 14 having opposite end portions connected to a lower mud drum 15 and an upper steam and water drum 16. The spaces between the innermost row of tubes 14 are closed by refractory material to form a baffle 17 which extends rearwardly from the front wall 10 and terminates short of the rear wall 11. Transverse baffles 18 and 19 divide the space occupied by the tube bank 14 into three transverse gas passes. The innermost rows of tubes 14 in the gas pass between the baffle 18 and the rear wall 11 are spaced to form a slag screen and a superheater 20 is positioned therein adjacent the side wall 13. The space defined by the baffle 17, screen tubes, rear wall 11, side wall 12 and front wall 10, forms the furnace 21 separated from the tube space except at the rear ends thereof. One or more pulverized fuel burners 22 are mounted in the front wall 10, and constructed to discharge a combustible mixture of pulverized fuel and air substantially horizontally through the furnace towards the rear wall thereof. The furnace is suitably proportioned to secure substantially complete combustion of the fuel while in the furnace. The heating gases generated successively contact with the screen tubes 14, superheater 20 and the tubes 14 in the remaining gas passes.

Steam generator units of this type have been heretofore constructed with a substantially horizontal flat water cooled floor extending substantially the full length of the furnace. In such a construction with ash depositing on the furnace floor, the ash is removed by raking or blowing it towards one or both ends of the furnace and removing it through clean-out openings in one or both end walls of the furnace.

In accordance with my invention the furnace is provided with a flat water cooled floor 24 for only a portion of its length, and the remaining portion

occupied by an ash hopper 30. As illustrated, the flat floor portion is advantageously located at the forward end of the furnace, and includes a row of water tubes 25 extending between the mud drum 15 and a header 26 extending the full length of the side wall 12. The tubes 25 are covered and the intertube spaces closed by blocks 27 of heat resistant material. The header 26 is connected throughout its length by a row of wall tubes 28 to the steam and water drum 16, the tubes 28 serving to protect the side wall and roof of the furnace.

In the embodiment illustrated, the flat part of the furnace bottom terminates at approximately the rear end of the baffle 17, but in any case in front of the rear wall, and the remaining portion of the furnace bottom is constructed with a downward incline to form the ash hopper 30. The ash hopper is formed by a vertical refractory front wall 31, vertical side walls 32 and 33, and an inclined rear wall 34 extending downwardly and forwardly from the rear wall 11 of the setting, thus providing a downwardly tapering ash hopper of rectangular cross-section. With this arrangement, the hopper rear wall 34 will receive most of the ash particles falling directly into the ash hopper and will be exposed to the radiant heat from substantially the highest temperature section of the furnace. The hopper wall 34 is desirably constructed with cooling provisions which comprise a row of correspondingly shaped water tubes 35 covered throughout their length by blocks 29 of heat resistant material. The blocks 29 between adjacent tubes unite to form a substantially flat upper surface for the hopper wall 34. The upper and lower ends of the tubes 35 are connected to transverse horizontal headers 36 and 37 respectively at opposite ends of the wall 34. The hopper wall cooling provisions are connected into the boiler circulation system by downcomer tubes 38 connecting the mud drum 15 and header 37, and by a row of water tubes 39 extending from the header 36 upwardly along the rear wall of the boiler, with their upper ends connected to the steam and water drum 16. As shown in Fig. 5, the outer end of the rear wall header 36 is connected to the rear end of the side wall header 26 by a nipple 40 to improve the fluid circulation through the rearmost wall tubes 28. Under certain conditions the tubes 35 and blocks 29 may be omitted and an increased number of bare tubes 35a used in lieu thereof, as shown in Fig. 3; also the side walls 32 and 33 may be similarly fluid cooled.

Below the lower end of the ash hopper 30 is located an ash pit 41 divided into laterally adjoining sections by an inverted V-shaped wall 42. The bottom of each ash pit section is formed by a reciprocable discharge gate 43, operable to allow the accumulated ash to discharge into any suitable ash disposal system.

In operation, streams of pulverized fuel and combustion air are discharged by the pulverized fuel burners 22, ignite and flow rearwardly in the furnace. The velocity and direction of the fuel and air streams and of the products of combustion in the furnace and the rate of combustion are normally such that most of the ash separates in the rear portion of the furnace and falls into the ash hopper. To permit the removal of ash depositing on the hopper walls, and particularly the inclined wall 34, clean-out and access openings 44, provided with doors 45, are located in the rear wall 11 of the setting immediately above the header 36, in the hopper side walls 32 and 33 and front wall 31. The openings 44, in the rear wall 11 and hopper wall 31 are desirably located in line with the upper surface of the hopper wall 34 to facilitate the cleaning thereof. Similar clean-out openings 44 are located in the lower part of the furnace front wall 10 to permit removal of ash deposits on the flat floor section of the furnace bottom. An inspection opening 46 is located intermediate the clean-out openings in the rear wall 11, and the adjacent tubes 39 are suitably bent to avoid obstructing these openings.

The furnace bottom construction described provides a particularly effective solution of the problem of dry ash removal in furnaces having a relatively long horizontal flame travel, and substantially reduces the amount of external floor space required for ash removal operations.

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

I claim:

1. In a furnace having means for burning pulverized fuel in suspension, a bottom divided into two sections, one sufficiently flat to retain deposited ash and the other forming an ash hopper having opposite walls of different inclination, the wall of greater inclination being more exposed to ash erosion and the radiant heat of the furnace than the opposite wall, and means for cooling said wall of greater inclination.

2. A furnace comprising front and rear vertical walls, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat floor at the forward portion of said furnace, walls forming an ash hopper at the rear portion of said furnace including an inclined wall extending downwardly and forwardly from said rear wall, and a clean-out opening in said rear wall arranged to permit the manipulation therethrough of implements for cleaning said inclined wall.

3. A furnace comprising front and rear walls, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat floor at the forward portion of said furnace, an ash hopper at the rear portion of said furnace having an inclined wall extending downwardly and forwardly from said rear wall, and means for fluid cooling said hopper wall.

4. A furnace comprising front and rear vertical walls, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat fluid cooled floor at the forward portion of said furnace, an ash hopper at the rear of said furnace floor having an inclined wall extending downwardly and forwardly from said rear wall, and a row of cooling fluid tubes lining said hopper wall.

5. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, means for discharging a stream of ash forming fuel into the furnace adjacent

said front wall to be burned in suspension in said furnace, and a fluid cooled ash hopper at the rear portion of said furnace having an inclined wall extending downwardly and forwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, and tubes lining said rear wall and connecting the upper ends of said inclined wall tubes to said upper drum.

6. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat fluid cooled floor for the forward portion of said furnace, and a fluid cooled ash hopper at the rear portion of said floor having an inclined wall extending downwardly and forwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, and tubes lining said rear wall and connecting the upper ends of said inclined wall tubes to said upper drum.

7. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, means for discharging a stream of ash-forming fuel into the forward portion of said furnace adjacent said front wall and burning the same in suspension in said furnace, a substantially flat fluid cooled floor for the forward portion of said furnace including a row of tubes connected to said lower drum, a row of wall tubes connecting the opposite ends of said floor tubes to said upper drum, and walls forming a fluid cooled ash hopper for the rear portion of said furnace including an inclined wall extending downwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, and tubes connecting the upper ends of said inclined wall tubes to said upper drum.

8. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, a baffle separating said tube bank and furnace except at the rear ends thereof, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat fluid cooled floor for the forward portion of said furnace including a row of tubes connected to said lower drum, a side wall header connected to said floor tubes, a row of wall tubes connecting said header to said upper drum, and walls forming a fluid cooled ash hopper for the rear portion of said furnace including an inclined wall extending downwardly and forwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, and tubes lining said rear wall and connecting the upper ends of said inclined wall tubes to said upper drum.

9. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat fluid cooled floor for the forward portion of said furnace including a row of tubes connected to said lower drum, a side wall header connected to said floor tubes, a row of wall tubes connecting said header to said upper drum, and walls forming a fluid cooled ash hopper for the rear portion of said furnace including an inclined wall extending downwardly and forwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, a rear wall header connected to the upper ends of said inclined wall tubes, a nipple connecting said side and rear wall headers, and tubes lining said rear wall and connecting said rear wall header to said upper drum.

10. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear vertical walls partly defining a furnace along one side of said tube bank, a baffle separating said tube bank and furnace except at the rear ends thereof, means for discharging a stream of finely divided solid fuel through said front wall to be burned in suspension in said furnace, a substantially flat fluid cooled floor for the forward portion of said furnace including a row of refractory covered tubes connected to said lower drum, a side wall header connected to said floor tubes, a row of wall tubes connecting said header to said upper drum, and walls forming a fluid cooled ash hopper at the rear of said furnace floor including an inclined wall extending downwardly and forwardly from said rear wall, a row of water tubes extending along said inclined wall, a conduit connecting said lower drum to the lower ends of said last mentioned tubes, tubes lining said rear wall and connecting the upper ends of said inclined wall tubes to said upper drum, an ash pit at the lower end of said ash hopper, means dividing said ash pit into laterally adjacent sections, and a reciprocable gate controlling the discharge from each ash pit section.

11. A steam generator comprising upper and lower longitudinally extending drums, a steam generating tube bank extending between and connected to said drums, front and rear walls arranged substantially normal to the longitudinal axes of said drums and partly defining a furnace along one side of said tube bank, means for discharging a stream of ash forming fuel into the forward portion of said furnace adjacent said front wall and burning the same in suspension in said furnace, a fluid cooled floor for the forward portion of said furnace including a row of tubes extending transversely of said furnace and having their inner ends connected to said lower drum and their outer ends connected to said upper drum, an ash hopper between the rear end of said floor and said rear wall and having an inclined wall exposed to the radiant heat of said furnace and arranged to receive ash falling from the burning fuel stream, and means for fluid cooling said inclined hopper wall.

12. In a steam generator comprising upper and lower drums and a steam generating tube bank

extending between and connected to said drums, front and rear walls arranged substantially normal to the longitudinal axes of said drums and partly defining a furnace along one side of said tube bank, means for discharging a stream of ash-forming fuel into the forward portion of said furnace adjacent said front wall and burning the same in suspension in said furnace, a floor adjacent the front wall of said furnace, an ash hopper adjacent the rear wall of said furnace and having an ash receiving inclined wall extending downwardly below the level of said floor, and means for fluid cooling said ash hopper inclined wall.

13. In a steam generator comprising upper and lower drums and a steam generating tube bank extending between and connected to said drums, front and rear walls arranged substantially normal to the longitudinal axes of said drums and partly defining a furnace along one side of said tube bank, means for discharging a stream of finely divided solid fuel through said front wall and burning the same in suspension in said furnace, a substantially flat floor extending rearwardly from the front wall of said furnace, an ash hopper extending between the rear end of said floor and the rear wall of said furnace and having a downwardly and forwardly extending rear wall, and means for fluid cooling said floor and said ash hopper rear wall.

14. In a steam generator comprising upper and lower drums and a steam generating tube bank extending between and connected to said drums, front and rear walls arranged substantially normal to the longitudinal axes of said drums and partly defining a furnace along one side of said tube bank, means for discharging a stream of ash-forming fuel into the forward portion of said furnace adjacent said front wall and burning the same in suspension in said furnace, an ash hopper adjacent the rear wall of said furnace and having a downwardly and forwardly extending rear wall, means for fluid cooling said ash hopper rear wall, and conduits connecting said ash hopper wall cooling means into the boiler circulation system.

15. A furnace comprising vertically extending front and rear walls defining opposite ends of an elongated furnace chamber, means for discharging a stream of ash-forming fuel into the forward portion of said furnace chamber adjacent said front wall and burning the same in suspension while traveling longitudinally of said furnace chamber, a substantially flat floor forming the forward portion of the furnace chamber bottom, means for fluid cooling said floor, an unobstructed ash hopper forming the furnace chamber bottom between the rear end of said floor and said rear wall and having an inclined ash receiving wall extending downwardly below the level of said floor and arranged to absorb heat by radiation from said furnace chamber, and means for fluid cooling said ash hopper inclined wall.

DANA H. N. MAYO.