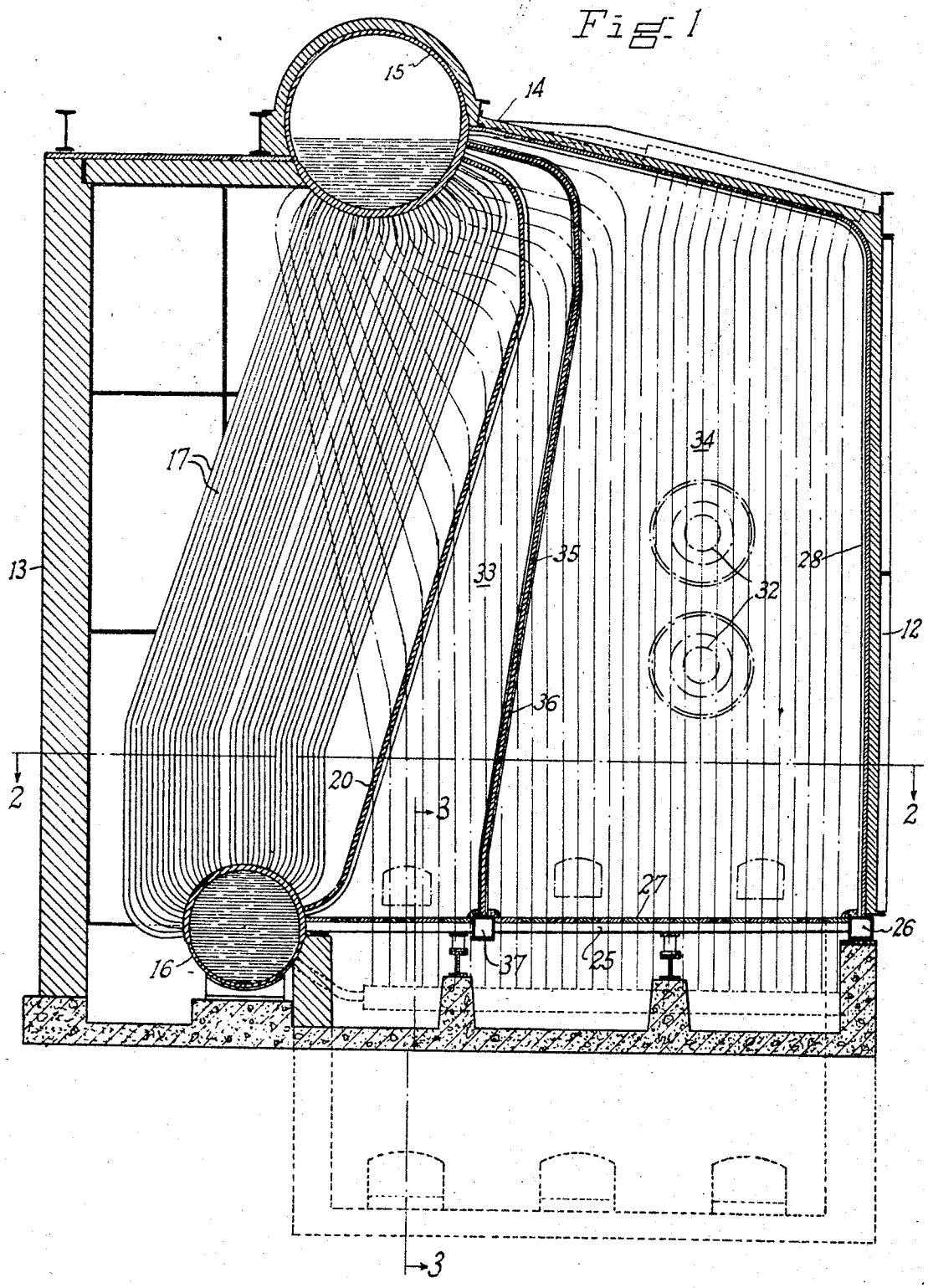
Oct. 29, 1940. L. W. HELLER 2,219,842

STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 1

Fig. 1



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Filed April 8, 1937 7 Sheets-Sheet 2

Fig. 2

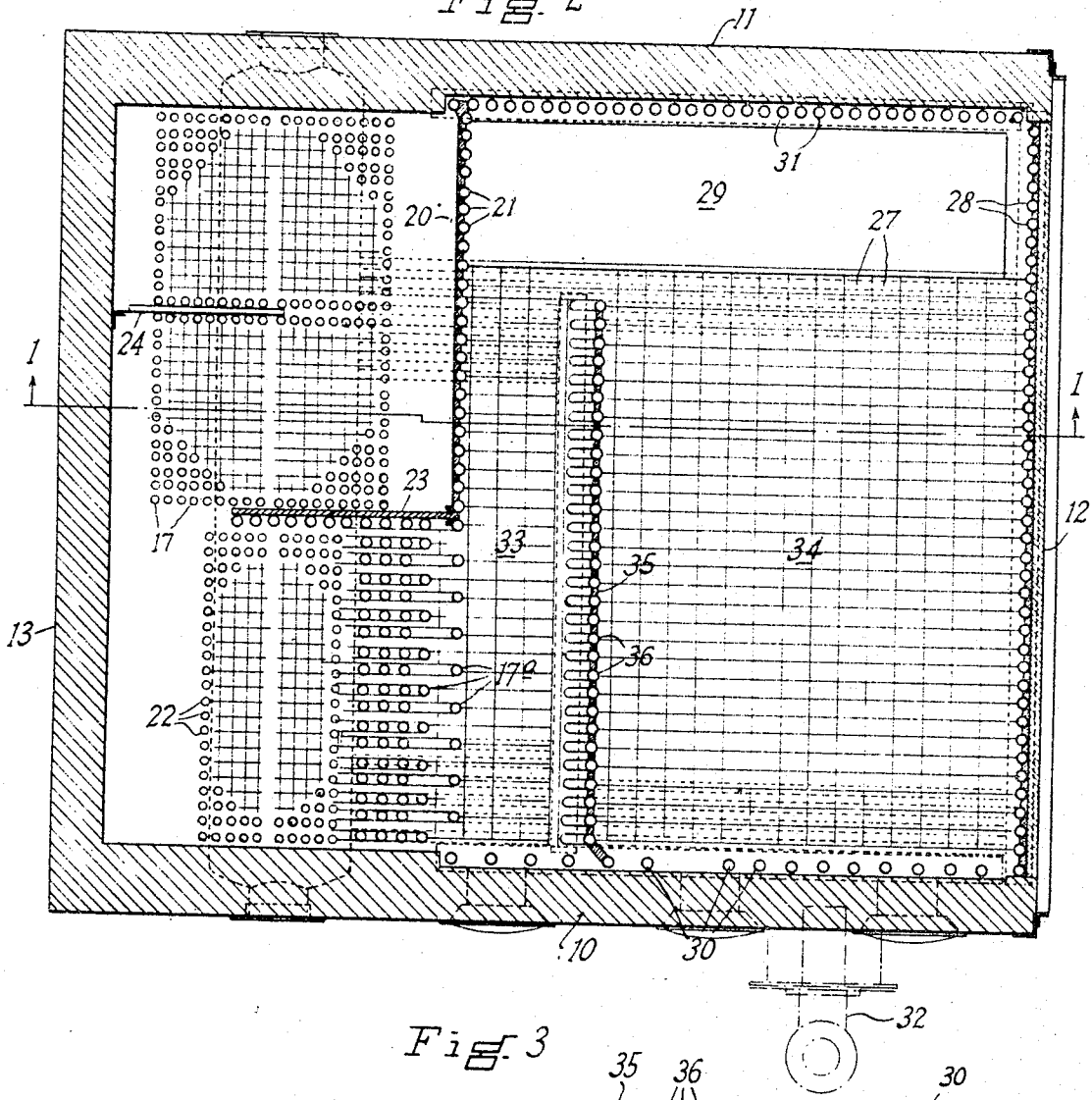
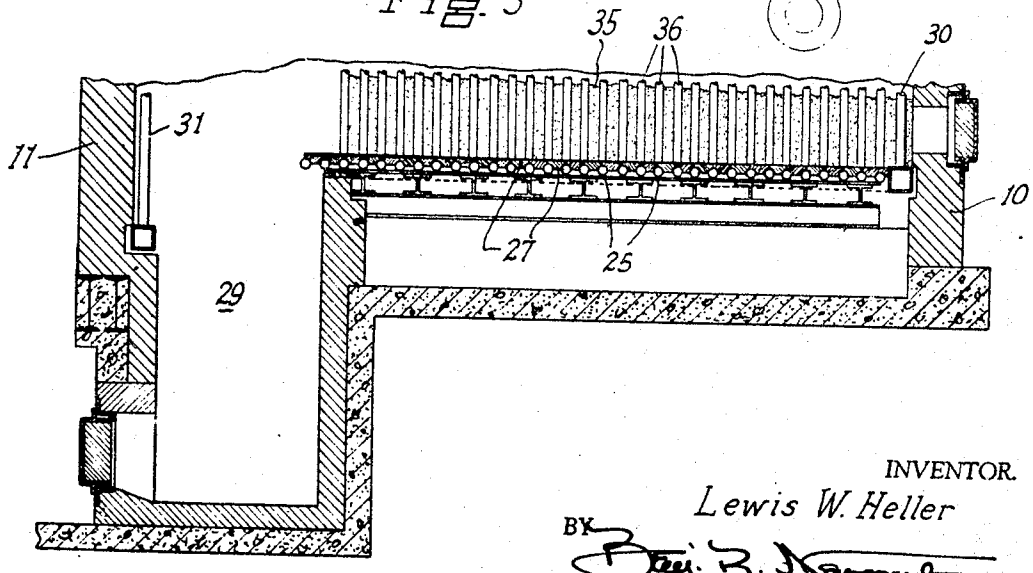


Fig. 3



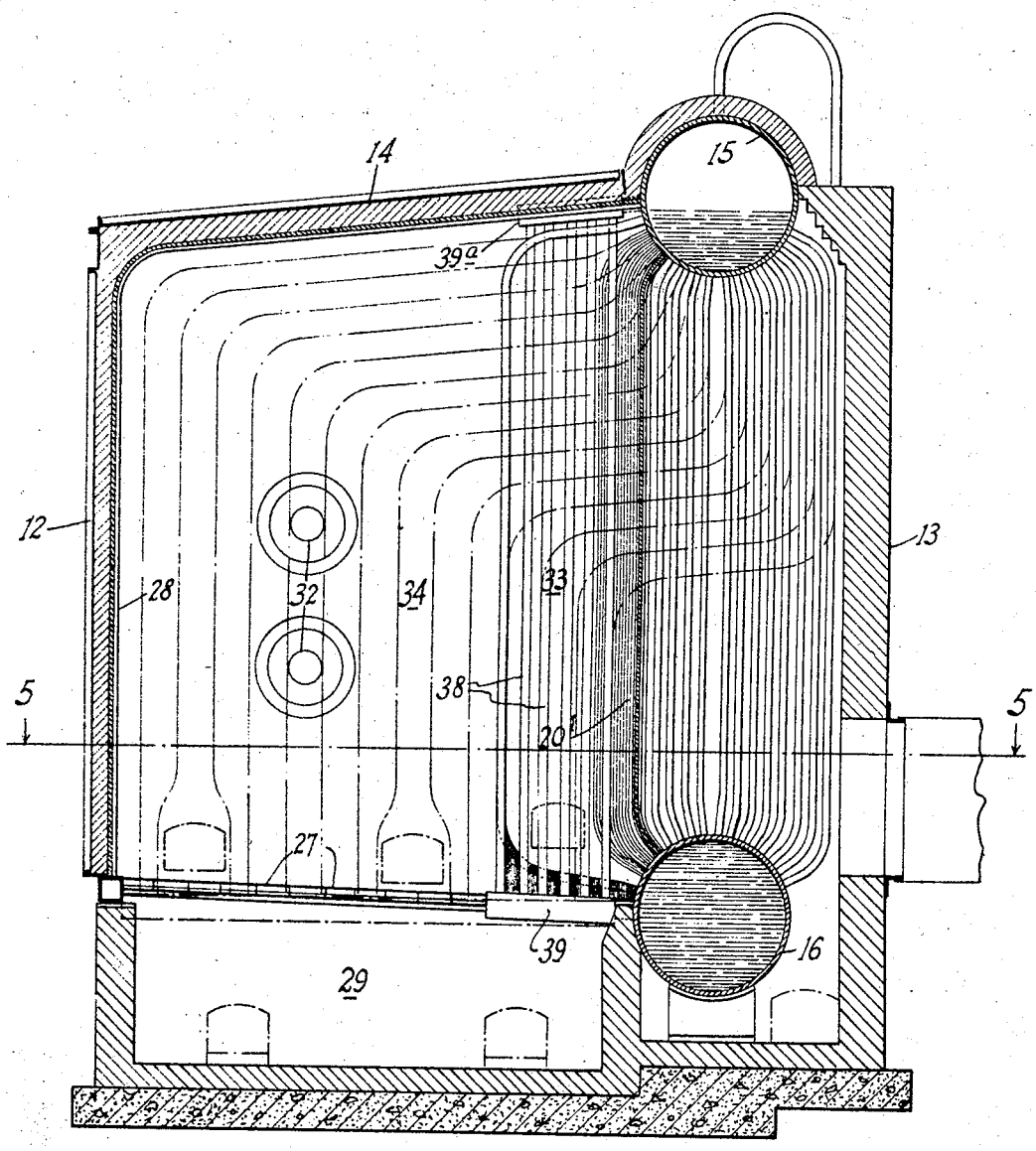
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STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 3

Fig. 4



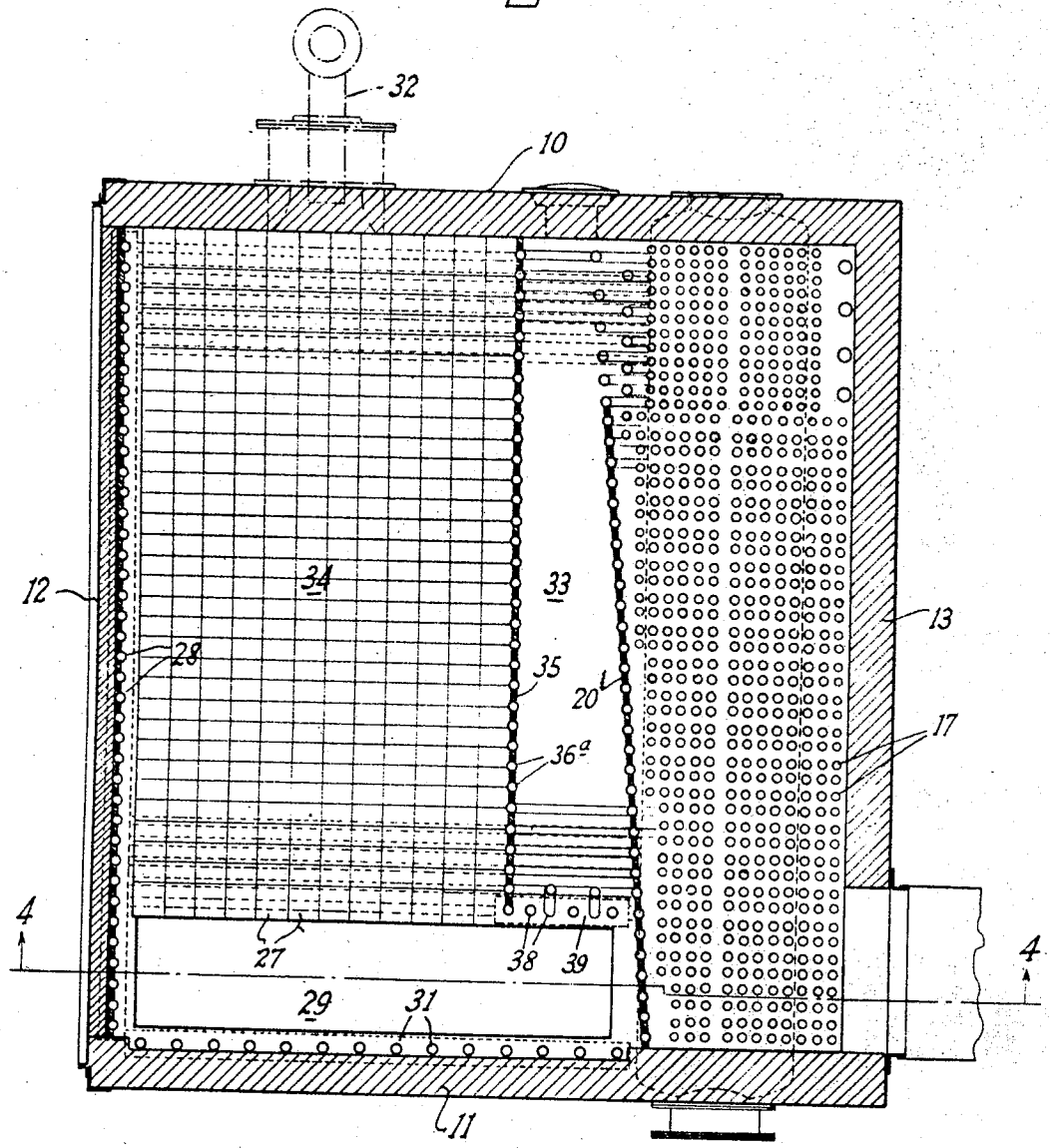
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STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 4

Fig. 5



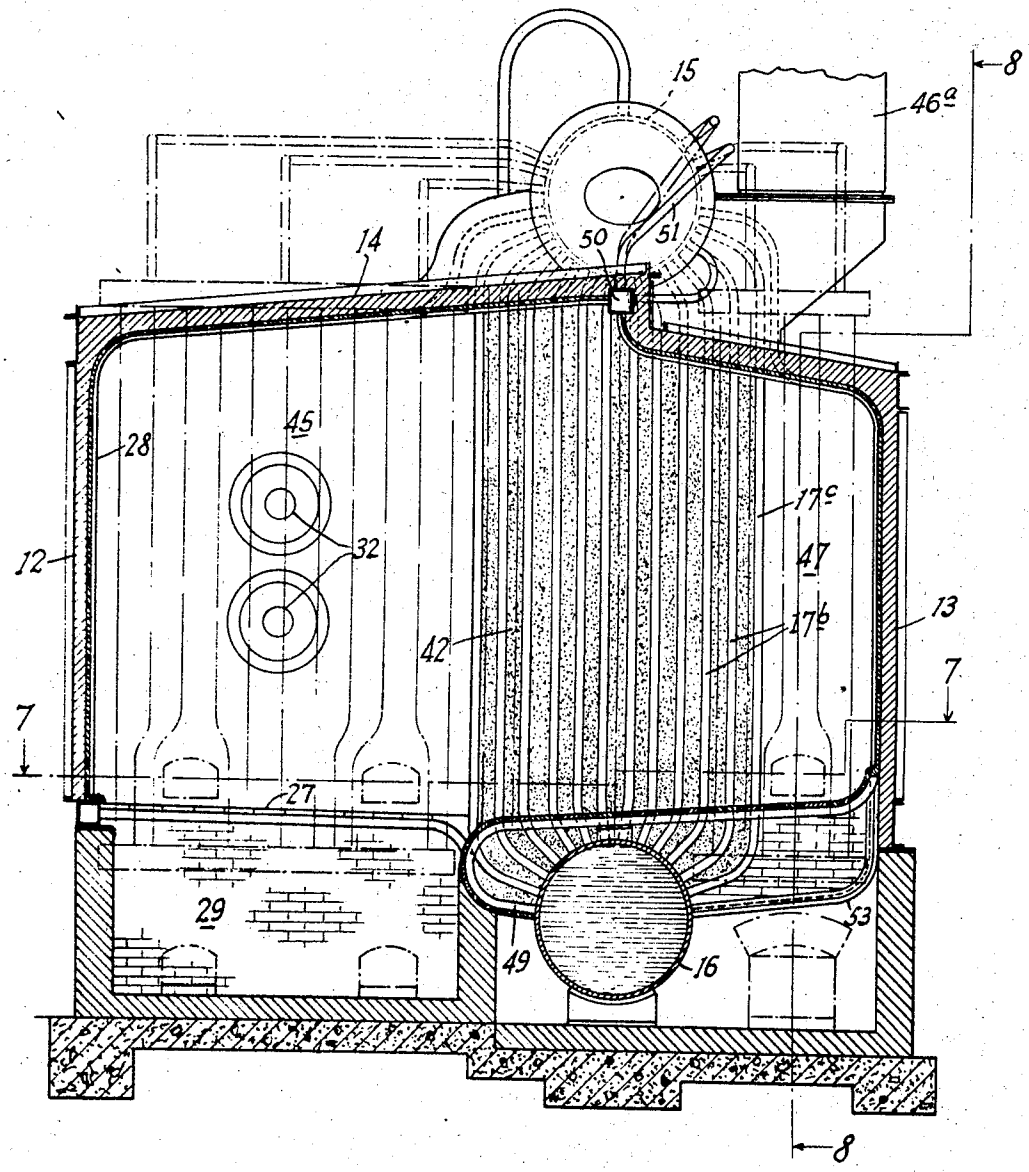
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STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 5

Fig. 6



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Oct. 29, 1940. L. W. HELLER 2,219,842

STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 6

Fig. 7

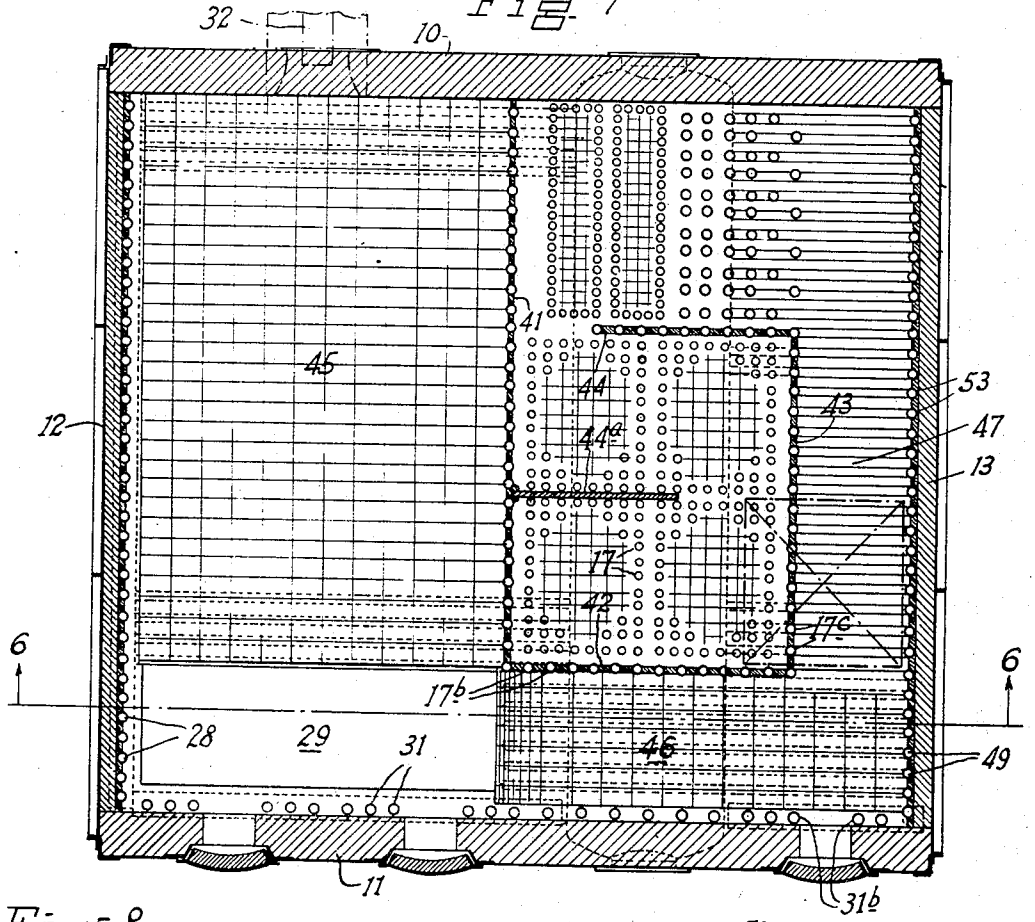
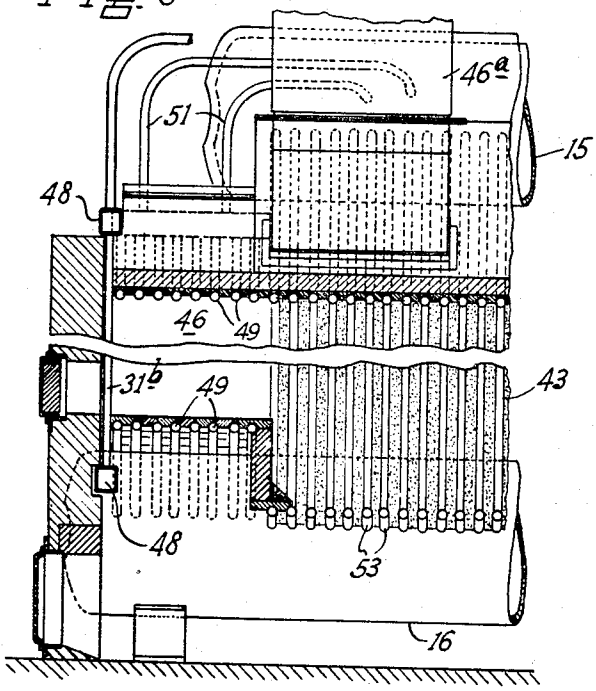


Fig. 8



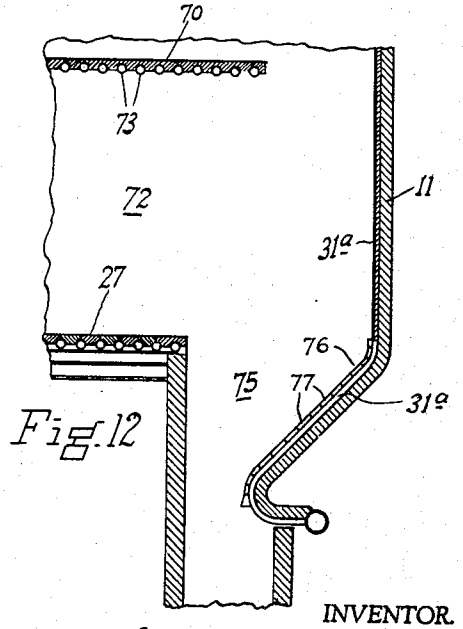


Fig. 12

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STEAM BOILER

Filed April 8, 1937 7 Sheets-Sheet 7

Fig. 10

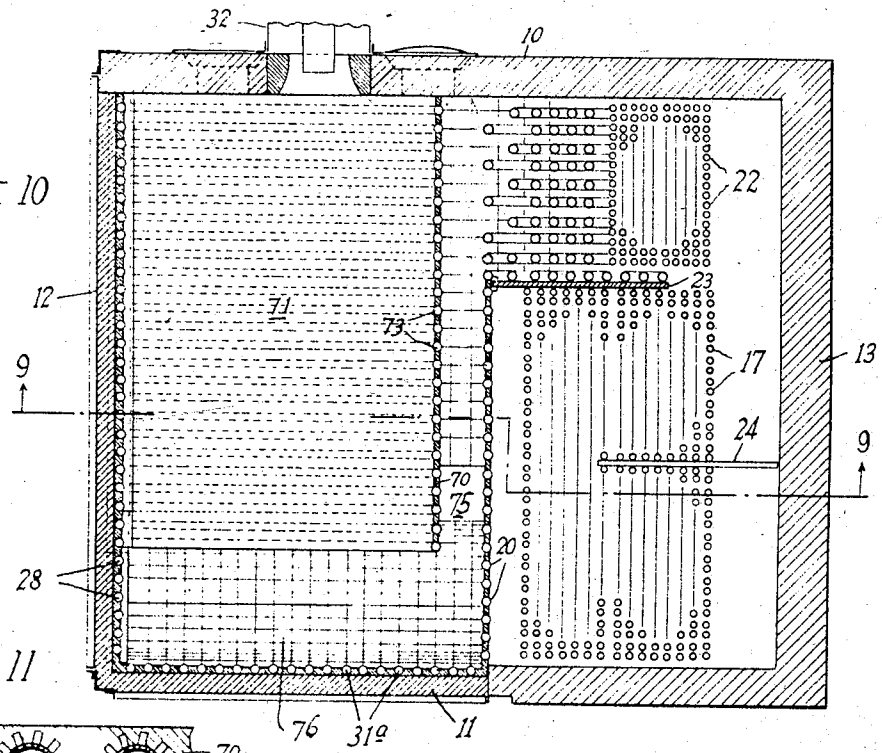


Fig. 11

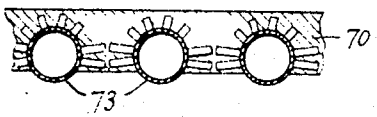


Fig. 9

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2,219,842

UNITED STATES PATENT OFFICE

2,219,842

STEAM BOILER

Lewis W. Heller, East Orange, N. J., assignor to The Babcock & Wilcox Company, Newark, N. J., a corporation of New Jersey

Application April 8, 1937, Serial No. 135,616

22 Claims. (Cl. 122—336)

This invention relates to the construction and operation of steam generating units of the integral furnace type, i. e., units having a furnace chamber laterally adjoining the main bank of steam generating tubes and fluid cooled by tubes connected into the boiler circulation system. In steam boilers of this type the furnace chamber and space containing the main tube bank are usually separated except at one end, with a steam superheater located at the communicating end of the tube bank space and the fuel burning means located at the opposite end of the furnace chamber. Such an arrangement generally provides a path of flame travel of adequate length before the tube bank is reached with units of moderate capacities and rates of heat release, but with high steam generating capacities and rates of heat release or limitations in the floor space available, a longer path of flame travel is highly desirable to avoid the heating gases reaching the tube bank and steam superheating tubes at temperatures above the fuel ash fusion temperature or at which the superheater tubes are liable to be overheated. The standard arrangement of tube bank and furnace chamber in steam boiler units of this type also causes the portion of the tube bank receiving the heating gases at the highest temperature to be subjected to the radiant heat of the furnace chamber, and the combined convection and radiant heating effects cause these tubes to be heated to higher temperatures than is desirable.

The main object of my invention is the provision of a steam generating unit of the type described with an improved fluid cooled furnace construction affording a relatively long path of flame travel before the heating gases enter the main convection heated section, while cooling the gases to the desired temperature and minimizing the draft loss through the furnace chamber by absorbing heat mainly by radiation in the furnace chamber.

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, similar parts having similar reference numerals.

Of the drawings:

Fig. 1 is a vertical section taken on the line 1—1 of Fig. 2 illustrating one embodiment of the invention;

Fig. 2 is a horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a partial longitudinal section taken on the line 3—3 of Fig. 1;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 5 illustrating a modified construction;

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

Fig. 6 is a vertical section taken on the line 6—6 of Fig. 7 illustrating another modification;

Fig. 7 is a horizontal section taken on the line 7—7 of Fig. 6;

Fig. 8 is a partial longitudinal section taken on the line 8—8 of Fig. 6;

Fig. 9 is a vertical section taken on the line 9—9 of Fig. 10, illustrating another modification;

Fig. 10 is a horizontal section taken on the line 10—10 of Fig. 9;

Fig. 11 is a partial longitudinal section taken on the line 11—11 of Fig. 9; and

Fig. 12 is a partial longitudinal section taken on the line 12—12 of Fig. 9.

In the embodiment illustrated in Figs. 1 to 3, the steam generating unit comprises a setting substantially rectangular in horizontal and vertical cross-section and including a front wall 10, rear wall 11, side walls 12 and 13, and roof 14 A steam and water drum 15 and lower water drum 16 are horizontally arranged along one side of the setting and connected by a bank of vertically disposed inclined water tubes 17. A partition 20 extends between the drums from the rear wall 11 along the inner side of the main tube bank for a major portion of its length with its forward end spaced from the front wall 10 to form an entrance throughout the height of the tube bank into the setting space occupied by the tube bank. The partition 20 is formed by a row of tubes 21 connected to the drums 15 and 16 and refractory filling the intertube spaces and held in position on the tubes in any suitable manner. The innermost rows of tubes 17a between the end of the partition 20 and front wall 10 are arranged to form a boiler slag screen, as shown in Fig. 2, and a group of inverted U-shaped superheater tubes 22 is positioned at the outer side of this section of the bank. Transverse baffles 23 and 24 extend from the partition 20 and side wall 13 respectively to define a plurality of serially connected transverse gas passes through the space occupied by the main tube bank.

The remaining portion of the setting space is occupied by the furnace chamber of the unit. The furnace chamber is entirely fluid cooled to permit the burning of a fluid fuel, particularly pulverized coal, in suspension at high rates of heat release. The furnace cooling provisions include a row of horizontally arranged inclined tubes 25 connected to the lower drum 16 at their inner ends and to a longitudinal header 26 at their outer ends. Metallic blocks 27 thereon unite to form a substantially horizontal smooth floor for the combustion chamber. A row of tubes 28 extend upwardly along the side wall 12 and are bent laterally at their upper ends along the roof 14 into the drum 15. The tube row 25 and associated blocks terminate adjacent the rear wall 11 above an ash pit 29 extending across the rear end of the furnace chamber. The front wall 10 is protected by a row of vertically disposed tubes 30 having their upper and lower ends in circuit with the drums 15 and 16 respectively. A similar series of tubes 31 extend along the rear wall 11. One or more fuel burners 32 adapted for the burning of pulverized coal in suspension, are mounted in ports in the front wall 10, as indicated in Figs. 1 and 2.

In accordance with my invention the furnace chamber described is subdivided into laterally adjoining inner and outer sections 33 and 34 respectively by a fluid cooled partition 35 extending between the furnace chamber floor and the upper drum 15 and from the front wall 10 to a point adjacent the ash pit 29. The partition 35 is formed by a special row of water tubes 36 and intervening refractory held in position preferably by studs formed on the tubes. The tubes have their upper ends directly connected to the drum 15 and their lower ends to a longitudinal header 37 incorporated in the row of floor tubes 25 intermediate their length, so that the inner portions of most of the tubes 25 extend between the lower drum and the header 37. The partitions 20 and 35 converge towards their upper ends, so that the inner furnace section 33 will be of upwardly converging cross-section. This cross-sectional formation aids in maintaining a heating gas flow through the lower portion of this section and also into the lower portion of the tube bank space.

With this arrangement the fuel streams introduced by the burners 32 first pass substantially horizontally and rearwardly through the outer section of the furnace chamber. The flame path is unobstructed and a substantial amount of heat absorbed throughout this section mainly by radiation to the tubes 25, 28, 30, 31 and 36, most of which are wholly or partly exposed to the furnace chamber. The gases turn at the rear end of the partition 35 and pass forwardly through the inner section of the furnace chamber between the partitions 20 and 35, and at the front end thereof turn into the space occupied by the main tube bank, successively contacting with the slag screen tubes 17ª, generating tubes 17, and superheater tubes 22 in the first transverse pass and through the boiler tubes in the second and third gas passes. The partitions 20 and 35 include a considerable amount of tube area directly exposed to and receiving heat by radiation from the hot gases, so that the gas temperature is further reduced before reaching the tube bank. The partitions in effect form a narrow unobstructed or open pass between the high temperature or outer section of the furnace chamber and the tube bank, with the partitions relatively arranged so that the gas flow area through the inner section approximates the free gas flow area at the entrance to the first convection pass of the main tube bank. The partition 35 is also effective in shielding the tubes in the first convection pass from heat radiation from the outer section of the furnace chamber. The effective length of the furnace chamber is thus substantially increased by the construction described with little, if any, increase in the floor space occupied by the unit or the draft loss through the furnace chamber.

The modified construction illustrated in Figs. 4 and 5 is generally similar to the construction shown in Figs. 1 to 3, except that the main tube bank is vertical, the superheater eliminated, and the partitions 23 and 24 absent to provide a single pass longitudinally of the tube bank. The fluid cooled partition 20' is arranged at an oblique angle to the front and rear walls, so that the inner section 33 of the furnace chamber and the space containing the tube bank will be of tapering cross-section forwardly and rearwardly respectively, and consequently more efficient gas flow conditions in these sections. The stud tubes 36ª in the outer partition 35 have their lower ends curved and directly connected to the drum 16 and the intertube spaces closed by refractory material. A furnace slag screen is arranged across the rear end of the inner furnace section, being formed by alternately bent transversely spaced vertical tubes 38, which extend between a short transverse header 39 connected to the lower drum 16 and a similar upper header 39ª connected to the upper drum. The construction is otherwise substantially the same as that shown in Figs. 1 to 3.

In the modified construction illustrated in Figs. 6 to 8, the main tube bank 17 is located in an intermediate portion of the setting and terminates short of the rear wall 11, with the tubes 17 substantially vertical. The tube bank partition 41 extends from the front wall 10 the full length of the tube bank, and at its rear end is provided with a lateral extension 42 incorporating the rearmost tubes 17ᵇ of the main bank, and a forward extension 43, incorporating the tube row 17ᶜ at the opposite side of the bank, with the intertube spaces closed by refractory, as previously described. The partition extension 43 terminates at a point spaced from the front wall 10 to provide a heating gas entrance into the tube bank space. Transverse baffles 44 and 44ª define successive transverse gas passes across the tube bank leading rearwardly to a stack connection 46ª.

The upper drum 15 terminates adjacent the partition 42, while the lower drum 16 extends the full length of the setting. The portion of the drum 16 beyond the partition 42 is protected by an inclined fluid cooled floor formed by a row of block covered tubes 49 extending from the inner side of the drum 16 to the inner end of the ash pit 29 and reversely curved over the drum to the side wall 13, thence extending upwardly along the wall 13 and across the roof 14, to a short longitudinal header 50. The header 50 is connected to the rear portion of the drum 15 by tubes 51. The header 50 also provides a connection to the drum 15 for the side wall tubes 28 which are rearwardly of the drum 15. A row of tubes 53 extends from the outer side of the lower drum 16 along the side wall 13 and roof into the upper drum 15. The tubes 49 and 53 adequately protect the side wall 13 and superjacent portion

of the roof from excessive temperature conditions and provide a supporting structure for that portion of the roof. As shown in Figs. 7 and 8, the lower laterally extending portions of the tubes 53 form a fluid cooled screen structure above the bottom of the setting and the heat absorption thereof insures that ash particles separating in the open pass will be in a dry form when reaching the floor.

With the construction of Figs. 6 to 8 the fuel streams are introduced by the burners 32 passing rearwardly in the furnace chamber 45. The gases turn adjacent the rear wall into the transverse passage 46 formed between the partition 42 and rear wall, and then forwardly through the longitudinal section 47 between the partition 43 and side wall 13. A flow path of considerable length is thus provided for the heating gases before entering the space occupied by the main tube bank and the substantial amount of cooling surface lining the sides of this flow path insures a heating gas temperature of the desired value at the tube bank. The heating gases enter the front end of the tube bank and pass rearwardly through the serially connected gas passes. The portion of the rear wall at the opposite side of the drum 16 is cooled by tubes 31b extending between short transverse headers 48 connected to the drums.

In the modified construction illustrated in Figs. 9 to 12, the drums and main tube bank are arranged substantially as shown in Figs. 1 to 3, with the partition 20 extending forwardly from the rear wall along the inner side of the tube bank. The fuel burners 32 in this construction are grouped in the upper half of the front wall 10, and the furnace chamber is divided by a horizontally extending partition 70 into an upper section 71 and a lower section 72. The partition 70 is formed by a row of tubes 73 sloping upwardly from the side wall 12, being connected at that point into a longitudinal header 74 incorporated in the side wall tubes 28, and having their inner ends extending upwardly and connected to the drum 15. The tubes 73 are fully studded along their upper sides to provide a support for refractory material covering the upper sides of the tubes and filling the intertube spaces to form a flat sloping floor for the upper section 71. The upper section 71 is advantageously of less cross-sectional area than the lower section. The relatively small volume and refractory faced boundary surfaces contribute to the maintenance of high temperatures in this section and to permit ash separation and deposition in a molten condition and continuous removal thereof, a fluid cooled ash hopper 75 is provided at the rear end of the floor 27, as shown in Fig. 12, and the partition 70 arranged to extend rearwardly beyond the rear end of the floor. The rear wall tubes 31a extend downwardly along the inclined rear wall 76 of the ash pit and are covered with metallic tube blocks 77 to provide a smooth ash receiving surface. The upper portions of the tubes 31a are partly studded and the intertube spaces closed by refractory. In this form of my invention the lower furnace section 72 and bounding tubes serve as the second or open pass for increasing the effective length of the furnace chamber and substantially reducing the gas temperature before the gases enter the tube bank. On entering the tube bank the heating gases flow through the serially connected convection gas passes in the previously described manner.

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. A steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed tubes connecting said drums, an obliquely arranged partition extending along one side of said tube bank and separating a space of rearwardly tapering cross-section containing said tube bank from a laterally adjoining furnace chamber except at the front end thereof, fuel burner means at the front end of said furnace chamber, a second partition extending longitudinally of said furnace chamber and dividing the same into a pair of laterally adjoining outer and inner sections serially connected at their rear ends, said outer furnace section including said fuel burner means and said inner furnace section having a forwardly tapering cross-section and opening at its front end to said tube bank space, and radiant heat absorbing tubes lining the sides of both of said furnace chamber sections.

2. A steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed tubes connecting said drums, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber except at one end thereof, fuel burner means at one end of said furnace chamber for burning fuel in suspension, a second partition extending longitudinally of said furnace chamber and dividing the same into a plurality of laterally adjoining serially connected sections one of which includes said fuel burner means and another of which opens to said tube bank space, radiant heat absorbing tubes lining the sides of said furnace sections, and a group of screen tubes extending across the serially connected end of said last named furnace section and having their ends connected to said upper and lower drums.

3. A steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed tubes connecting said drums, an obliquely arranged partition extending along one side of said tube bank and separating a space of rearwardly tapering cross-section containing said tube bank from a laterally adjoining furnace chamber except at the front end thereof, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, a second partition extending longitudinally of said furnace chamber and dividing the same into a pair of laterally adjoining outer and inner sections serially connected at their rear ends, said outer furnace section including said fuel burner means and said inner furnace section having a forwardly tapering cross-section and opening at its front end to said tube bank space, radiant heat absorbing tubes lining the sides of both of said furnace sections and connected to said upper and lower drums, and a group of screen tubes extending across the rear end of said inner furnace section and having their ends connected to said upper and lower drums.

4. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged

drums positioned in an intermediate portion of said setting, a bank of vertically disposed tubes connecting said drums, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the end of said furnace chamber, an L-shaped partition extending across one end and the opposite side of said tube bank and uniting with the setting walls to form an L-shaped continuation of said furnace chamber extending along said opposite side of the tube bank and opening to the fuel burner end of the space containing said tube bank.

5. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drums positioned at an intermediate portion of said setting, a bank of vertically disposed tubes connecting said drums, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber, and an L-shaped partition extending across the rear end and the opposite side of said tube bank and uniting with the setting walls to form an L-shaped continuation of said furnace chamber extending along said opposite side of the tube bank and opening to the front end of the space containing said tube bank.

6. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drums positioned at an intermediate portion of said setting, a bank of vertically disposed tubes connecting said drums and terminating short of the rear wall of said setting, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, and a second partition extending across the rear end of said tube bank and uniting with the setting walls to form a transverse unobstructed continuation of said furnace chamber opening to the opposite side of the space containing said tube bank.

7. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drumms positioned at an intermediate portion of said setting, a bank of vertically disposed tubes connecting said drums and terminating short of the rear wall of said setting, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, an L-shaped partition extending across the rear end and the opposite side of said tube bank and uniting with the setting walls to form an L-shaped continuation of said furnace chamber opening to the front end of the space containing said tube bank, and fluid heating tubes lining the sides of said furnace chamber and continuation and connected to said upper and lower drums.

8. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drums positioned in an intermediate portion of said setting, a bank of vertically disposed tubes connecting said drums and terminating short of the rear wall of said setting, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, an L-shaped partition extending across the rear end and the opposite side of said tube bank and uniting with the setting walls to form an L-shaped continuation of said furnace chamber opening to the front end of the space containing said tube bank, and a fluid cooled floor for the portion of said furnace chamber extension at the rear end of said tube bank.

9. A steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed tubes connecting said drums, a partition extending along one side of said tube bank and separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, and a second partition extending longitudinally of said furnace chamber and dividing the same into a pair of upper and lower unobstructed sections serially connected at their rear ends, the upper furnace section including said fuel burner means and the lower furnace section opening at its front end to said tube bank space.

10. A steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed tubes connecting said drums, a partition extending along one side of said tube bank and partly separating the space containing said tube bank from a laterally adjoining furnace chamber, fuel burner means at the front end of said furnace chamber for burning fuel in suspension, a second partition extending longitudinally of said furnace chamber and dividing the same into a pair of upper and lower unobstructed sections serially connected at their rear ends, the upper furnace section including said fuel burner means and the lower furnace section opening at its front end to said tube bank space, radiant heat absorbing tubes lining said second partition and connected to said upper and lower drums, and an ash pit extending across the rear end of said lower section.

11. A two-drum steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed water tubes connecting said drums, means defining a fluid cooled furnace chamber laterally adjoining the space containing said tube bank, said means including a row of substantially horizontal floor tubes extending laterally from said lower drum, a row of water tubes extending along the outer side wall of said furnace chamber between said floor tubes and said upper drum, means for burning fuel in suspension in said furnace chamber, and means forming a fluid cooled partition extending longitudinally of said furnace chamber and dividing the same into a plurality of adjoining serially connected sections, one of said furnace sections including said fuel burning means and another section opening at one end to said tube bank space, said partition-forming means comprising a row of water tubes having their upper ends connected directly to said upper drum and their lower ends to said lower drum via said floor tubes.

12. A two-drum steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed water tubes connecting said drums, means defining a fluid cooled furnace chamber laterally adjoining the space containing said tube bank, said means including a row of substantially horizontal floor tubes extending

laterally from said lower drum, a header receiving the outer ends of said floor tubes, a row of water tubes extending along the outer side wall of said furnace chamber between said header and said upper drum, means for burning fuel in suspension in said furnace chamber, and means forming a fluid cooled partition extending longitudinally of said furnace chamber and separating a pair of outer and inner furnace sections serially connected at one end, said outer furnace section including said fuel burning means and said inner section being connected to one end of said tube bank space, said partition-forming means comprising a row of vertically extending radiant heat absorbing water tubes having their upper ends connected directly to said upper drum and their lower ends to said lower drum via said floor tubes.

13. A two-drum steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed water tubes connecting said drums, means defining a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and connected thereto at its front end, said means including a row of substantially horizontal floor tubes extending laterally from said lower drum, a header receiving the outer ends of said floor tubes, a row of water tubes extending along the outer side wall of said furnace chamber between said header and said upper drum, means at the front end of said furnace chamber for burning fuel in suspension therein, and means forming a fluid cooled partition extending longitudinally of said furnace chamber and dividing the same into a pair of outer and inner sections serially connected at their rear ends, said outer furnace section including said fuel burning means and said inner section opening at its front end to said tube bank space, said partition-forming means comprising a row of vertically extending radiant heat absorbing water tubes having their upper ends connected to said upper drum and their lower ends to said lower drum via said floor tubes.

14. A two-drum steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed water tubes connecting said drums, means defining a fluid cooled furnace chamber laterally adjoining the space containing said tube bank and connected thereto at its front end, said means including a row of vertically disposed partition-forming tubes connected to said drums and separating said tube bank space from said furnace chamber, a row of substantially horizontal floor tubes extending laterally from said lower drum, and a row of water tubes extending along the outer side wall of said furnace chamber between said floor tubes and said upper drum, means at the front end of said furnace chamber for burning fuel in suspension therein, and means forming a second fluid cooled partition extending longitudinally of said furnace chamber from said front end and dividing the same into a pair of outer and inner unobstructed sections of substantially the same vertical extent and serially connected at their rear ends to define a substantially horizontal U-shaped heating gas flow path therethrough before the heating gases enter said tube bank space, said outer furance section including said fuel burning means and said inner section opening at its front end to said tube bank space, said second partition-forming means comprising a row of vertically extending longitudinally spaced radiant heat absorbing water tubes terminating short of the rear end of said furnace chamber and connected to said upper and lower drums.

15. A two-drum steam boiler comprising upper and lower horizontally arranged drums, a bank of vertically disposed water tubes connecting said drums, means forming a furnace chamber extending along one side of the space containing said tube bank, fuel burner means at one end of said furnace chamber, and means forming a horizontally extending partition arranged longitudinally of said furnace chamber and dividing the same into a pair of upper and lower serially connected unobstructed furnace sections, one including said fuel burner means at one end thereof and the other opening to the same end of said tube bank space.

16. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drums extending longitudinally of said setting, a bank of vertically disposed tubes connecting said drums, means forming a furnace chamber in said setting having a plurality of longitudinally extending sections laterally adjoining the space containing said tube bank and serially connected adjacent one end of said tube bank space, means at one end of one furnace section for burning fuel therein, the second furnace section opening at its end opposite its serially connected end to said tube bank space, and water tubes lining the sides of said furnace chamber sections and connected to said upper and lower drums and including laterally extending tube portions arranged to form a fluid cooled screen across the bottom of said second furnace section.

17. A steam boiler comprising a bank of steam generating tubes, means forming a pair of fluid cooled furnace chamber sections serially connected for heating gas flow successively therethrough, means for introducing a slag-forming finely divided solid fuel into one furnace chamber section and burning the fuel in suspension therein at furnace temperatures above the fuel ash fusion temperature, said one furnace chamber section having a fluid-cooled floor constructed to receive and support molten slag depositing thereon and terminating at one end in a slag discharge edge, and a common ash pit for said pair of furnace chamber sections arranged below the communicating end of the second furnace chamber section and having an inclined fluid-cooled floor in position to receive directly thereon slag dropping from the slag discharge edge of said furnace chamber section floor.

18. A fluid heater comprising means forming a pair of superposed furnace chamber sections serially connected for heating gas flow, means for introducing a slag-forming finely divided solid fuel into the upper furnace chamber section and burning the fuel in suspension at furnace temperatures above the fuel ash fusion temperature, said upper furnace chamber section having a floor constructed to receive and support molten slag depositing thereon and terminating in a slag discharge edge, and an ash pit below the lower furnace chamber section and having an inclined fluid-cooled floor arranged to receive slag dropping from the rear end of said upper furnace chamber section floor.

19. A fluid heater comprising means forming a pair of superposed fluid cooled furnace chamber sections serially connected for heating gas flow at their rear ends, means for introducing a slag-forming finely divided solid fuel into the

front end of the upper furnace chamber section and burning the fuel in suspension at furnace temperatures above the fuel ash fusion temperature, said upper furnace chamber section having a fluid-cooled floor constructed to receive and support molten slag depositing thereon and terminating at its rear end in a slag discharge edge, and an ash pit at the rear end of the lower furnace chamber section and having an inclined fluid-cooled floor arranged to receive slag dropping from the rear end of said upper furnace chamber section floor.

20. A fluid heater comprising means forming a pair of superposed furnace chamber sections serially connected for heating gas flow at their rear ends, means for introducing a slag-forming finely divided solid fuel into the front end of the upper furnace chamber section and burning the fuel in suspension at furnace temperatures above the fuel ash fusion temperature, said upper furnace chamber section having a floor constructed to receive and support molten slag depositing thereon and terminating at its rear end in a slag discharge edge, an ash pit at the rear end of the lower furnace chamber section and having a fluid cooled floor inclined at a substantially greater angle than the angle of repose of the slag and arranged to receive slag dropping from the rear end of said upper furnace chamber section floor, and a row of cooling fluid tubes extending along and arranged to cool said inclined floor.

21. A steam boiler comprising walls forming a setting, upper and lower horizontally arranged drums extending longitudinally of said setting, a bank of vertically disposed tubes connecting said drums, means forming a furnace chamber in said setting having a plurality of longitudinally extending sections laterally adjoining the space containing said tube bank and serially connected adjacent one end thereof, means at one end of one furnace section for burning a finely divided solid fuel in suspension therein, the second furnace section opening at its end opposite its serially connected end to said tube bank space, water tubes lining the sides of said furnace chamber sections and connected to said upper and lower drums, and means defining an ash collection chamber below and arranged to receive ash directly from said second furnace section.

22. A two-drum steam boiler comprising walls forming a setting, a pair of upper and lower horizontally arranged drums extending longitudinally of said setting, a bank of vertically disposed tubes connecting said drums, means forming a furnace chamber in said setting having a longitudinally extending section laterally adjacent the space containing said tube bank and a second longitudinally extending section laterally adjacent said tube bank space and serially connected to said first furnace section adjacent one end of said tube bank space, means for burning an ash-forming fuel in said first furnace section, the second furnace section opening at its end opposite its serially connected end to said tube bank space, rows of fluid heating tubes arranged to cool longitudinally extending sides of said furnace sections and connected to at least said upper drum, one of said rows of fluid heating tubes including laterally extending tube portions arranged to form a fluid cooled screen across the bottom of said second furnace section, and means defining an ash collection chamber below and arranged to receive ash directly from said second furnace section.

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