June 5, 1934. D. S. JACOBUS 1,961,222

MARINE TYPE SERIES BOILER

Filed April 9, 1929 3 Sheets-Sheet 1

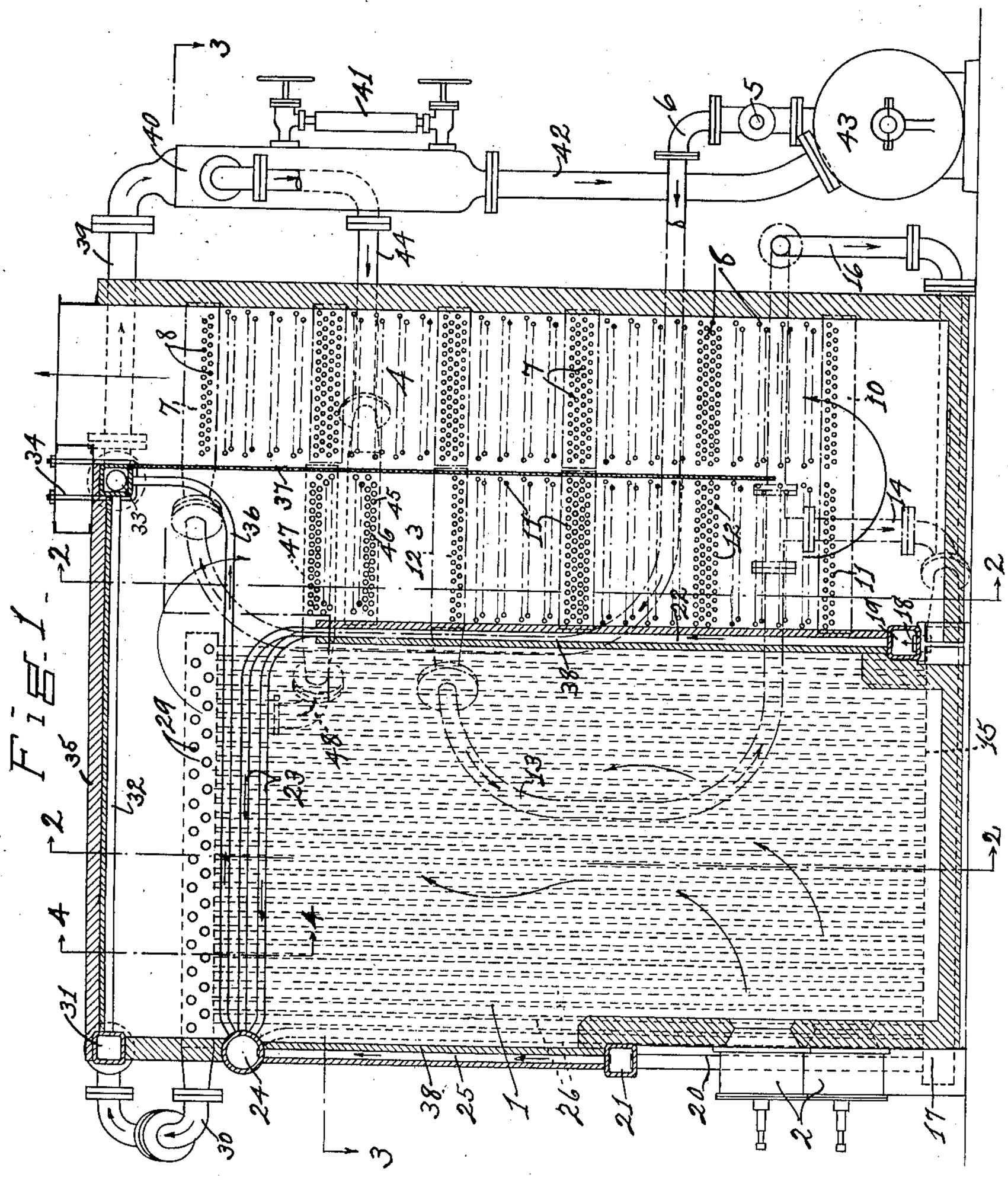

Fig. 1.

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FIG. 4

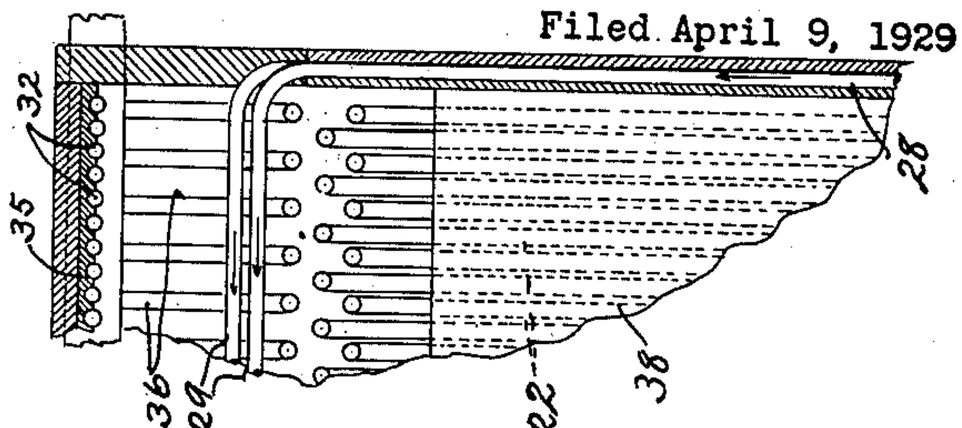
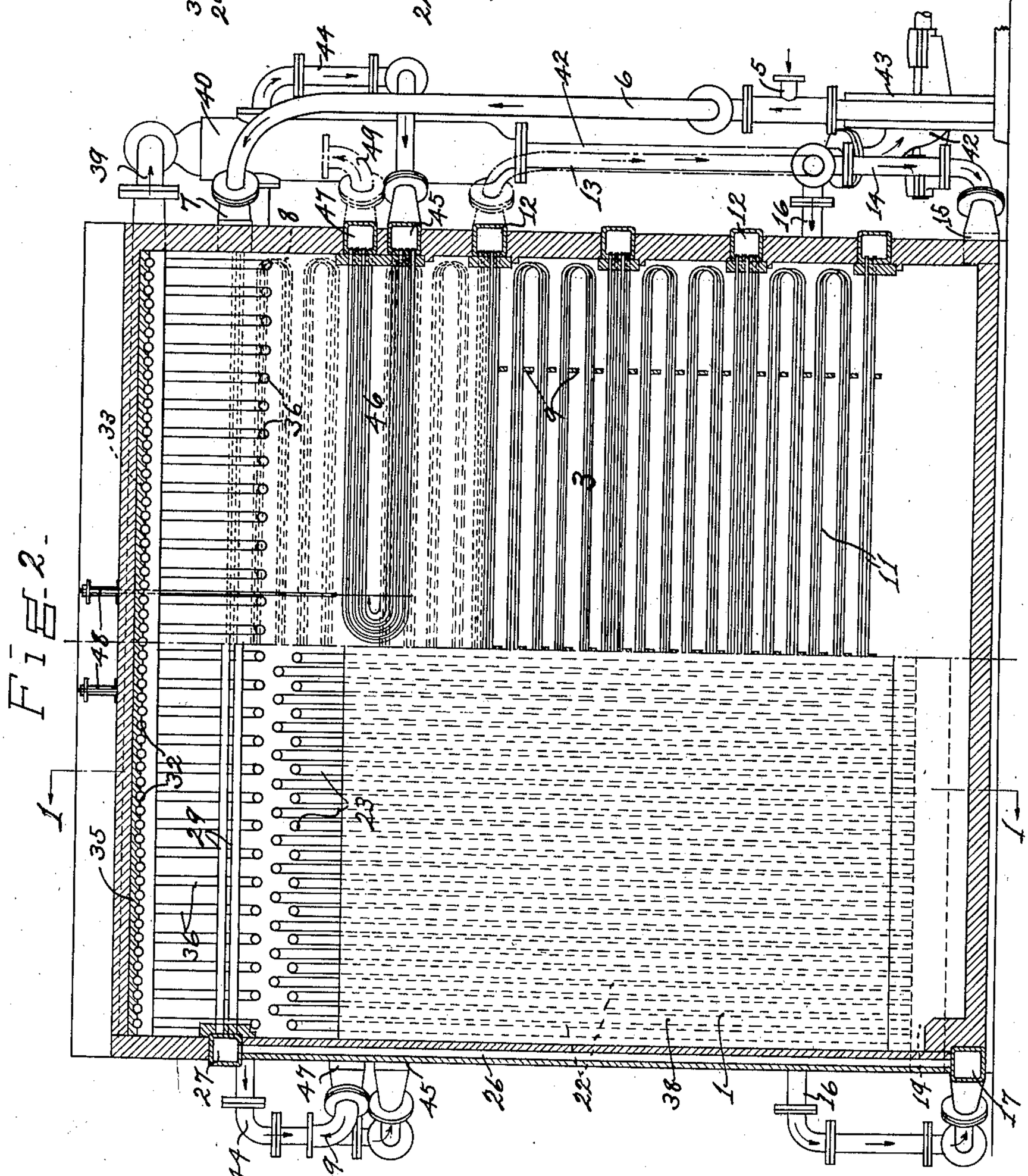


FIG. 2.



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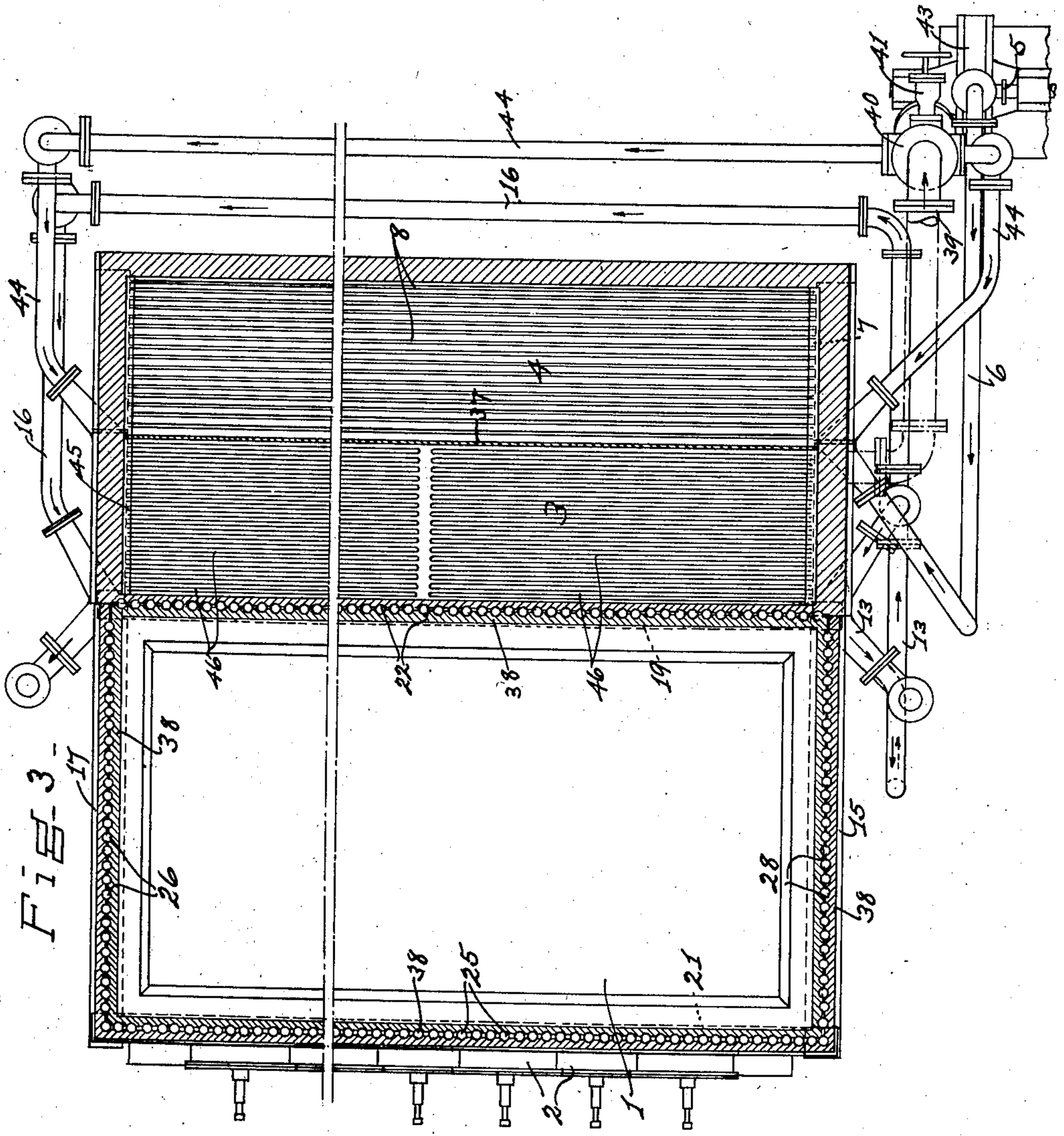

FIG. 3.

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UNITED STATES PATENT OFFICE

1,961,222

MARINE TYPE SERIES BOILER

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Application April 9, 1929, Serial No. 353,841

8 Claims. (Cl. 122—235)

This invention relates to a boiler that has a section comprising tubes connected in series through which feed water is passed and may be heated to the steaming temperature and another section having tubes in parallel. The end of the series section is connected to the end of the parallel section and water is circulated through both sections.

The invention will be understood from the description in connection with the accompanying drawings in which Fig. 1 is a vertical section through an illustrative embodiment of the invention taken along line 1—1 of Fig. 2; Fig. 2 is a sectional view, one half of which is taken along one line 2—2 of Fig. 1 and the other half is taken along the other line 2—2 of Fig. 1; Fig. 3 is a horizontal section taken along the line 3—3 of Fig. 1; and Fig. 4 is a section taken along the line 4—4 of Fig. 1.

In the drawings, reference character 1 indicates a furnace that may be provided along the front wall thereof with fuel burners 2. A downwardly directed flue 3 is located at the rear of the furnace and an upwardly directed flue 4 is located behind the flue 3, the flues 3 and 4 being connected at their lower ends. An economizer and a superheater are located in the flues and some of the economizer tubes may operate as steam generating tubes.

A feed water inlet 5 from a feed pump (not shown) is connected to the pipe 6 which leads to the upper header 7 of the economizer located along one side of the flue 4. The upper header 7 is connected to the next lower header by rows of staggered tubes 8 that pass back and forth across the flue, as indicated in Fig. 2, and so on to the bottom of the flue 4. The successive bends of the tubes 8 may be supported by cross supports 9 located at intervals along the tubes. The lowest rows of tubes 8 in the flue 4 are connected to the lowermost header 10 that extends across the side of both flues 4 and 3 and rows of tubes 11, similar to the tubes 8, connect the end of the header 10 that is alongside the flue 3 with a header 12 and so on to the uppermost header 12 from which a pipe 13 leads away.

The pipe 13 is provided with a branch 14 leading to the header 15 located along the lower edge of one side wall of the furnace 1. Another branch 16 from the pipe 13 leads to a header 17 located along the lower edge of the other side of the furnace 1. Short nipples 18 connect the rear ends of the headers 15 and 17 to a header 19 located at the lower edge of the rear wall of the furnace. Nipples 20 connect the front ends of the headers 15 and 17 to a horizontal header 21 located in the front wall of the furnace above the burners 2.

A row of furnace wall tubes 22 leads upwardly from the rear header 19 and thence horizontally as indicated at 23 into the header 24 located at the upper edge of the front wall of the furnace. The tubes 22 are staggered where they bend over, as shown at 23, to permit hot gases from the furnace to pass between them. A row of tubes 25 for the front wall of the furnace extends from the header 21 into the header 24. A row of side wall furnace tubes 26 extends from the header 17 to the header 27 that is located near the upper edge of the side wall of the furnace. A row of tubes 28 extends from the header 15 upwardly along the other side wall of the furnace, thence over the upper end of the furnace, as shown at 29, into the header 27, the tubes being staggered along the portion 29 to permit the gases from the furnace to pass between the tubes.

A tube 30 connects the header 27 to a header 31 located at the upper front corner of the furnace. A row of roof tubes 32 connects the header 31 to the header 33 that is located above the flues 3 and 4, and is supported by straps 34 from a fixed support. The tubes 32 support the roof 35 of the furnace. A row of spaced tubes 36 extends from the header 24 horizontally between the sets of tubes 23 and 29, thence across the flue 3 and thence upwardly into the header 33. A partition 37 extends downwardly from the header 33 to separate the flues 3 and 4. Tile 38 or Bailey blocks, having metal on one side and refractory material on the other side, are provided as indicated on the drawings to line the tubes 22, 25, 26 and 28 around the walls of the furnace.

A tube 39 connects the header 33 to the steam and water separator 40 that is provided with a water level gauge 41. A pipe 42 leads from the lower end of the steam and water separator 40 to the circulating pump 43. The outlet or discharge side of the pump 43 is connected to the pipe 6.

Pipes 44 lead from the upper portion or steam space of the steam and water separator 40 to superheater inlet headers 45 located on opposite sides of the flue 3. The superheater headers 45 are connected by rows of U-shaped superheater tubes 46 to the superheater outlet headers 47. Each set of tubes 46 extends approximately half way across the flue 3, and the bent ends thereof are supported by means of the

supports 48. The superheater outlet headers 47 are connected by outlet pipes 49 to the steam main.

The operation is as follows:

Feed water passes from the inlet pipe 5 through the pipe 6 into the uppermost header 7 of the economizer, thence through the economizer tubes and headers to the outlet header 12 and thence through the branch pipes 14 and 16 and into the lower headers 15, 17, 18 and 21, and thence upwardly through the furnace wall tubes in parallel to the headers 24 and 27, thence through the tubes 36 and the tubes 32 to the header 33. The mixture of steam and water from the headers 33 passes through the pipe 39 into the steam and water separator 40. The steam passes from the separator 40 through the pipes 44 to the superheater, and thence to the main, while the water from the separator 40 passes through the pipe 42 and is returned through the economizer and furnace wall tubes, as just described for the feed water. The water from the separator 40 can be kept circulating by means of the pump 43, whether feed water is entering or not.

The products of combustion from the furnace pass upwardly across the sets of tubes 23, 36 and 29, thence toward the rear, as indicated by the arrows and again across the tubes 36 into the upper end of the flue 3, and across the superheater tubes 46 and the economizer located in the flues 3 and 4, and thence to the stack. Forced circulation is maintained in the side wall furnace cooling tubes and in the tubes across which the gases pass before the gases strike the superheater, so that the tubes that are subjected to the highest temperatures are sure to have rapid circulation through them to avoid the danger of these tubes becoming burned out.

I claim:—

1. In a forced flow boiler, a section having tubes connected in series, a section having tubes connected in parallel, a furnace in the walls of which the lower portions of said last named tubes are located, the upper portions of said tubes being bent across the top of the furnace, said series tubes being directly connected to the lower ends of said wall tubes, and means to cause hot gases from said furnace to pass across the upper portions of said last named tubes and then across said series tubes.

2. In a boiler, a furnace having vertically disposed tubes connected in parallel, sets of said tubes being bent across the upper end of said furnace at an angle to each other, walls providing a flue at the rear of said furnace, a row of boiler tubes extending across the upper end of said flue, and means to cause gases from said furnace to pass across said bent portions and into said flue, and an economizer in said flue and connected to one of said sets of tubes.

3. In a boiler, a furnace having vertically disposed tubes connected in parallel, sets of said tubes being bent across the upper end of said furnace at an angle to each other, the tubes in each set being staggered, a row of tubes across said furnace between said sets and connected to receive fluid from the other tubes, and means to cause forced circulation through said tubes, said tubes forming a part of the circulation system of said boiler.

4. In a boiler, a furnace having vertically disposed tubes connected in parallel, some of said tubes being bent across the upper end of said furnace, a steam and water separator connected to the upper ends of said tubes, tubes connected in series located between and connected to said separator and vertically disposed tubes, and means to force water from said separator through said series tubes into said vertically disposed tubes.

5. In a forced flow boiler, a furnace having tubes in the walls thereof, walls providing a downwardly extending flue for gases from the furnace at the rear of the furnace, and an upwardly extending flue connected to said first named flue, tubes transversely arranged in serially connected groups in said flues, means to circulate more water than can be converted into steam thereby through all of said tubes, the water circulating through the last named tubes countercurrent to the gases in the flues and through the furnace wall tubes concurrent with the gases, and a steam and water separator receiving the discharge from the wall tubes.

6. In a forced flow boiler, a furnace having tubes in the walls thereof, walls providing a downwardly extending flue for gases from the furnace at the rear of the furnace, and an upwardly extending flue connected to said first named flue, tubes transversely arranged in serially connected groups in said flues, means to progressively circulate more water than can be converted into steam thereby through all of said tubes, the water circulating through the last named tubes countercurrent to the gases in the flues and through the furnace wall tubes concurrently with the gases, and a steam and water separator receiving the discharge from the wall tubes.

7. A drumless vapor generator including a furnace and tube groups heated thereby some of said tube groups arranged for series parallel movement of fluid therethrough in a direction countercurrent to the flow of combustion gases from the furnace, another of said groups connected therewith and arranged for parallel flow of fluid therethrough in a direction concurrent with the hot gases and supplied with fluid from the first mentioned group, some of the tubes of the last mentioned group crossing the gas path in advance of the series parallel group, a liquid and vapor separator exteriorly of the furnace and connected to receive the fluid flow from the parallel flow groups, and means for returning unvaporized liquid to the tube groups.

8. A drumless vapor generator including a furnace and tube groups heated thereby some of said tube groups arranged for series parallel movement of fluid therethrough in a direction countercurrent to the flow of combustion gases from the furnace, another of said groups connected therewith and arranged for parallel flow of fluid therethrough in a direction concurrent with the hot gases and supplied with fluid from the first mentioned group, some of the tubes of the last mentioned group crossing the gas path in advance of the series parallel group, a liquid and vapor separator exteriorly of the furnace and connected to receive the fluid flow from the parallel flow groups, means for returning unvaporized liquid to the tube groups, and a superheater in the gas path shielded by the tubes of the group crossing the gas path in advance of the series parallel group and connected with the separator to receive steam therefrom.

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