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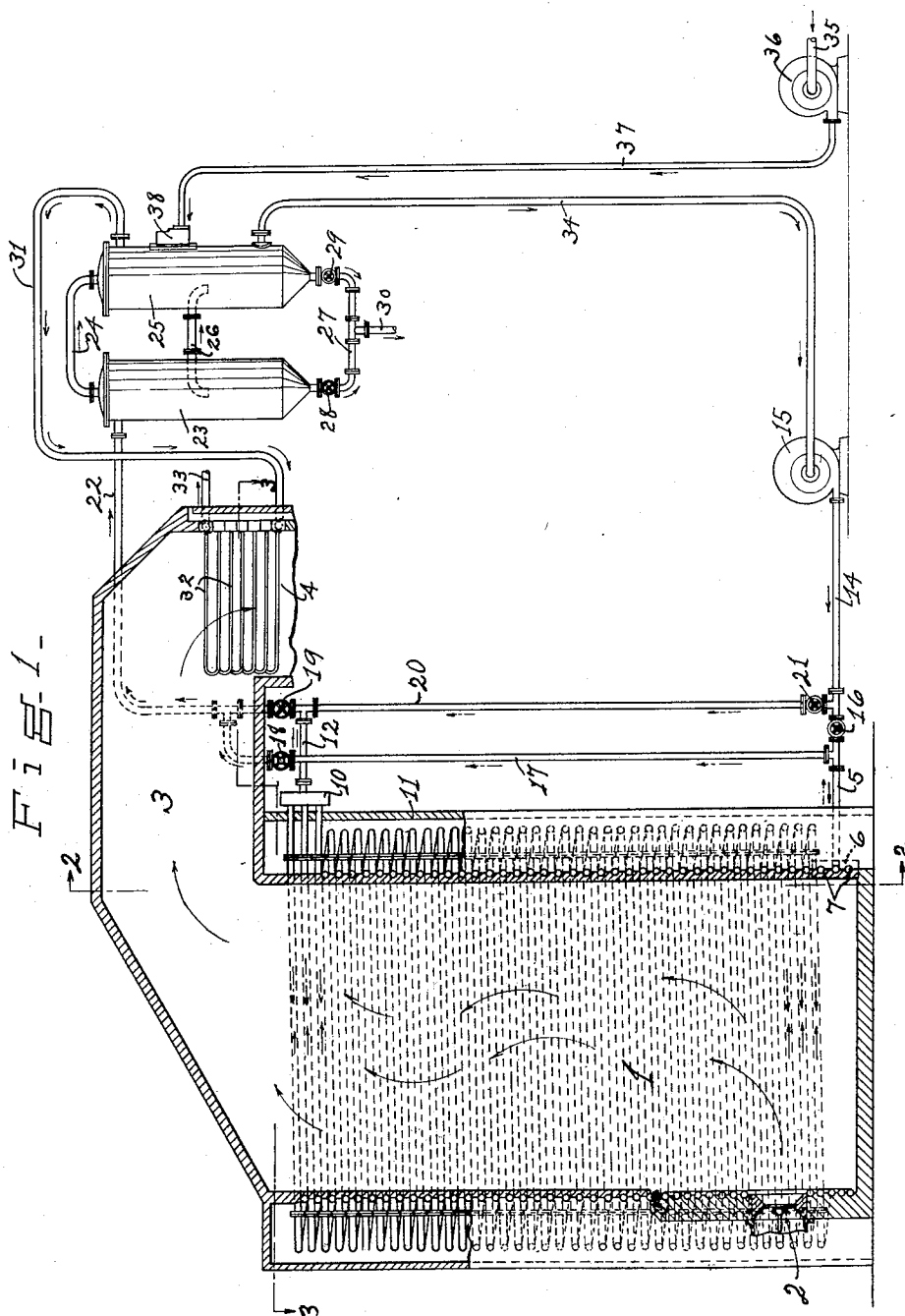
D. S. JACOBUS

1,935,635

BOILER WITH WATER WALL TUBES

Filed April 9, 1929

4 Sheets-Sheet 1



INVENTOR
David S. Jacobus
BY
Clifford, Suel & Burgess
ATTORNEYS

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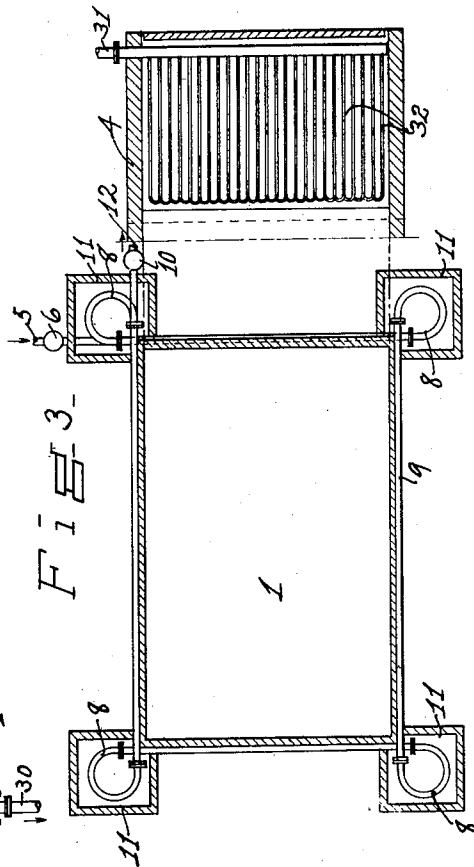
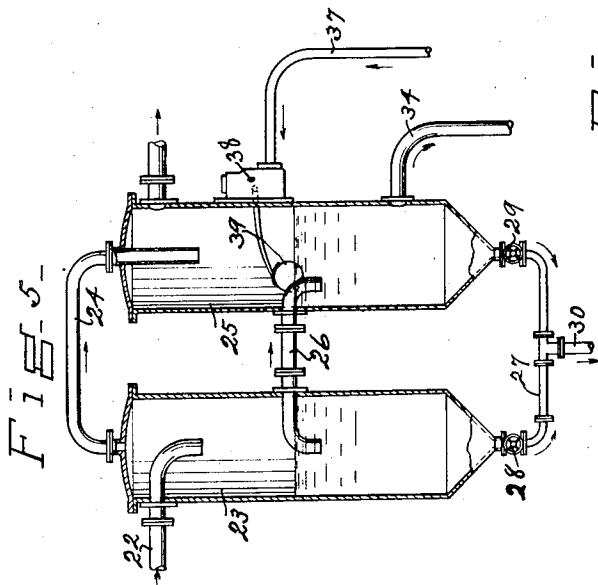
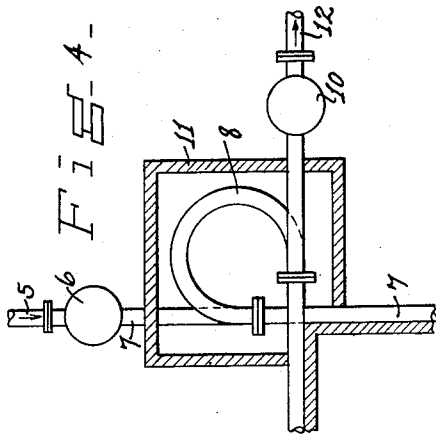
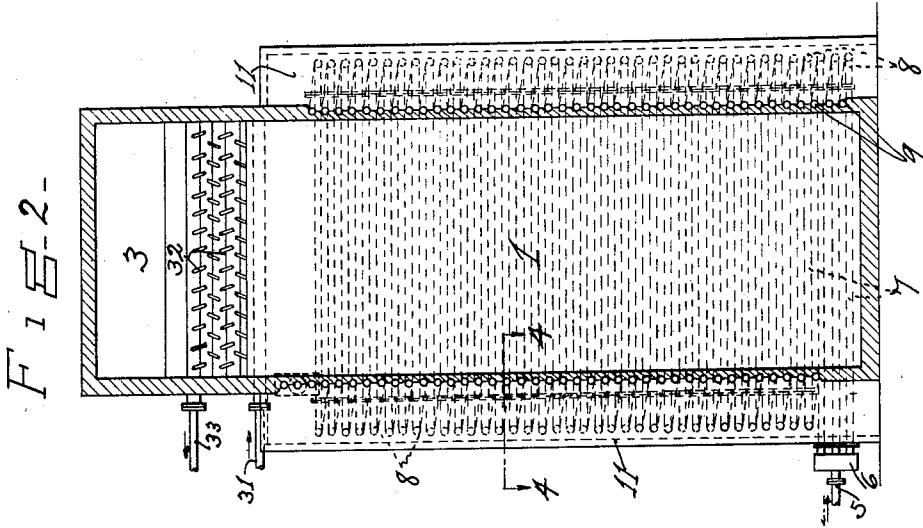
D. S. JACOBUS

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BOILER WITH WATER WALL TUBES

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4 Sheets-Sheet 2



INVENTOR
David S. Jacobus
BY
Gifford, Seull & Burgess
ATTORNEYS

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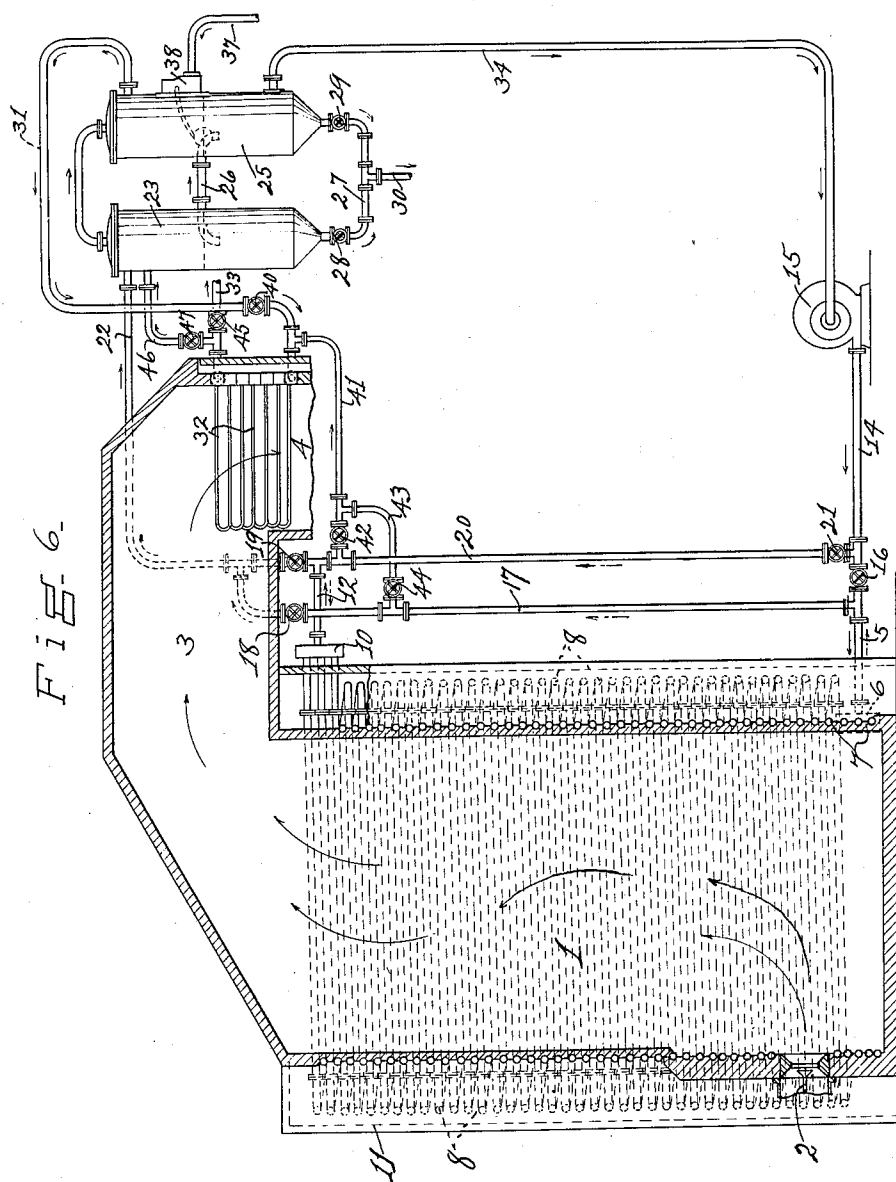
D. S. JACOBUS

1,935,635

BOILER WITH WATER WALL TUBES

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4 Sheets-Sheet 3



INVENTOR
David S. Jacobus
BY
Gifford Sewell Burgess
ATTORNEYS

Nov. 21, 1933.

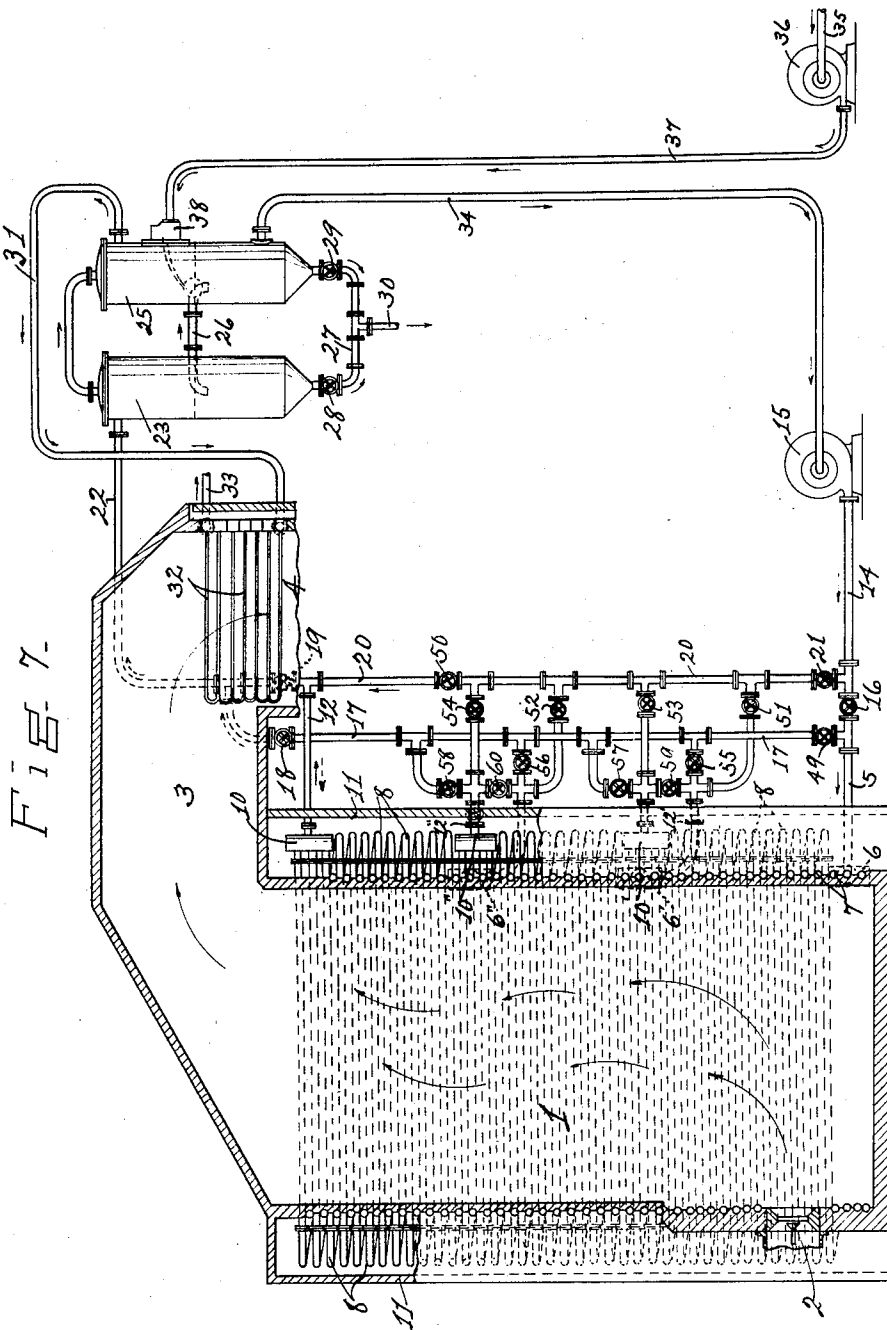
D. S. JACOBUS

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BOILER WITH WATER WALL TUBES

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4 Sheets-Sheet 4



INVENTOR

David S. Jacobus

BY

Clifford, Scull & Burgess
ATTORNEYS

UNITED STATES PATENT OFFICE

1,935,635

BOILER WITH WATER WALL TUBES

David S. Jacobus, Montclair, N. J., assignor to
The Babcock & Wilcox Company, Bayonne,
N. J., a corporation of New Jersey

Application April 9, 1929. Serial No. 353,842

13 Claims. (Cl. 122—235)

This invention relates to a boiler having a furnace that is provided with water wall tubes connected in series through which water is circulated by a pump so arranged that circulation can be changed in direction in all tubes or in some of them or made to flow through the tubes in series or in a series-parallel relation or in reverse series direction.

The invention will be understood from the description in connection with the accompanying drawings in which Fig. 1 is a side view partly in section, showing an illustrative embodiment of the invention; Fig. 2 is a section taken along the line 2—2 of Fig. 1; Fig. 3 is a section taken along the line 3—3 of Fig. 1; Fig. 4 is a section taken along the line 4—4 of Fig. 2; Fig. 5 is a vertical section on an enlarged scale, showing some of the details; Fig. 6 is a section similar to Fig. 1, showing a modification; and Fig. 7 is a section similar to Fig. 1 showing another modification.

In the drawings, reference character 1 indicates a furnace that may be fired by means of the burners 2 located in the front wall of the furnace. An outlet 3 is provided at the top rear portion of the furnace and leads to a downwardly extending flue 4 in which flue a superheater may be located.

A water pipe 5 leads to a vertically disposed header 6 located near a rear corner of the furnace and shown with three horizontally disposed furnace wall tubes 7 leading therefrom along the rear wall of the furnace at the bottom. These three tubes 7 are connected by means of circularly shaped connectors 8 (Figs. 3 and 4) to three side wall tubes 9, which are in turn connected by connectors 8 to three horizontally disposed front wall tubes which are connected by connectors 8 to three side wall tubes and so on around and around the furnace to a vertically disposed header 10 near the upper end of the furnace. Housings 11 are provided at the corners of the furnace for the connectors 8.

A pipe 12 leads from the header 10.

The pipe 5 is connected to the outlet pipe 14 from the circulating pump 15, a valve 16 being interposed between the pipes 5 and 14. A pipe 17 provided with a valve 18 leads from the pipe 5 to the far side of a valve 19 in the pipe 20 that leads from the pipe 14 and is provided with a valve 21 between the pipe 14 and the valve 19. A pipe 22 leads from the pipe 20 to a primary separator 23. A pipe 24 leads from the steam space of the primary separator 23 to the steam space of the secondary separator 25. A pipe 26 connects the intermediate portions of the sepa-

rators 23 and 25 near the normal water level in these separators, and a pipe 27 provided with valves 28 and 29 connects the lower ends of the separators 23 and 25. A drain pipe 30 is connected to the pipe 27.

A pipe 31 leads from the steam space of the steam and water separator 25 to the superheater 32 that is located in the upper portion of the flue 4. A pipe 33 leads from the superheater 32 to a steam main.

A pipe 34 leads from the water space of the steam and water separator 25 to the circulating pump 15. A feed water pipe 35 leads from a source of feed water to the feed pump 36 from the outlet of which a pipe 37 leads to the steam and water separator 25 that is provided with a valve 38 (Fig. 5) controlled by a float 39 in the separator to regulate the amount of feed water that enters the boiler.

In the operation of the boiler the feed water is forced into the system by means of the pump 36 and passes with other water previously fed and separated from steam through the circulating pump 15 and thence through the furnace wall tubes in series to the separators 23 and 25 from which the steam passes to the superheater 32 and thence to the main. The excess water together with the incoming feed water maintains the desired water level in the separators and water may be withdrawn from either or both separators 23 and 25 through the drain pipe 30 to remove water in which the impurities have become too concentrated such water being replaced by feed water.

When the valves 16 and 19 are open and valves 18 and 21 closed, the circulation of the water through the furnace wall tubes will be from the bottom to the top, and when the valves 18 and 21 are open with the valves 16 and 19 closed the circulation of the water will be from the top to the bottom through the furnace wall tubes.

By the reversal of the flow through the tubes, the tubes can be kept cleaner than with the water always flowing in the same direction through the tubes. Also, under certain conditions of operation it is better to have more water and less steam in the upper tubes than in the lower tubes of the furnace wall and vice versa, so that by this invention the water can be made to flow through the tubes in such a manner as to provide most satisfactory operation of the boiler. In addition, when the heat absorption is great, the last tubes in the series may have too much steam and too little water in them for safety requirements, in which case the tubes can be divided up into a series-parallel system, as will be described below.

In the modification shown in Fig. 6, provision is made whereby water can be sent through the superheater tubes 32 to avoid burning them out during the starting up period. A valve 40 is provided in the pipe 31 leading from the steam space of the steam and water separator 25 to the superheater 32. A pipe 41 leads from the pipe 20 to a point in the pipe 31 between the valve 40 and the superheater 32 and is provided with a valve 42. A pipe 43 provided with a valve 44 leads from a point in the pipe 41 between the valve 42 and the pipe 31 to a point in the pipe 17 between the valve 18 and the pipe 5. A valve 45 is provided in the superheated steam outlet pipe 33 that leads from the superheater 32 to the main. A pipe 46 provided with a valve 47 leads from a point in the pipe 33 between the valve 45 and the superheater 32 to the steam space of the steam and water separator 23.

The arrangement for protecting the superheater, as described above in connection with Fig. 6, may be used in connection with the other modifications shown in the drawings. During the starting up period with the water flowing upwardly through the furnace wall tubes, the valves 16, 42 and 47 are open while the valves 18, 19, 21, 40, 44 and 45 are closed until the boiler begins to steam, thus causing water to pass to the separator through the superheater tubes 32 to protect them. The water may, however, be caused to pass downwardly through the furnace wall tubes and then through the superheater during the starting up period by opening the valves 21, 44 and 47 and closing the valves 16, 18, 19, 40, 42 and 45.

In the normal operation with upward flow through the furnace wall tubes, the valves 16, 19, 40 and 45 are open and the valves 18, 21, 42, 44 and 47 are closed. In the normal operation with downward flow through the furnace wall tubes, the valves 18, 21, 40 and 45 are open and the valves 16, 19, 42, 44 and 47 are closed.

In the modification shown in Fig. 7, the furnace wall tubes are illustrated as being divided into three sections, each section comprising three tubes connected in parallel, the sections being joined through connections capable of connecting the sections either in series or in parallel relation with each other. In this modification, headers 6, 6' and 6'' are provided at the lower ends of the three sections and headers 10, 10', and 10'' are provided at the upper ends of the sections, each section corresponding somewhat to all of the tubes in Fig. 1. Pipes 12, 12' and 12'' are connected to the headers 10, 10' and 10'' similar to the way pipe 12 in Fig. 1 is connected to the header 10.

A valve 49 is provided in the pipe 17 near the pipe 5, and a valve 50 is provided in the pipe 20 near the pipe 12. Valved pipes 51 and 52 lead from the pipe 20 to the pipes 12' and 12''. Valved pipes 53 and 54 lead from the pipe 20 to the headers 6' and 6''. Valved pipes 55 and 56 lead from the pipe 17 to the pipes 12' and 12''. Valved pipes 57 and 58 lead from the pipe 17 to the valved pipes 53 and 54. A valved pipe 59 connects the pipe 12' and valved pipe 53, and a valved pipe 60 connects the pipe 12'' and the valved pipe 54. By the connection of pipes as shown in Fig. 7 water can be made to circulate by means of the pump 15 from the bottom to the top of the furnace wall tubes in series or can be made to pass from the top to the bottom in series, or the water can be passed through the three sections of furnace wall tubes in parallel either up or down, in accordance with the way the valves are manipulated. For example, if it is desired to have the

water pass through the three sections in parallel and to flow upwardly, the valves 16, 21, 51, 52, 57, 58, 18 and 19 are open while the other valves near the furnace are closed, thus permitting water to enter the headers 6, 6' and 6'' and leave through the headers 10', 10'' and 10.

By opening and closing the proper valves in this arrangement, not only can the parallel-series upward flow be obtained as above described, but also a parallel-series down flow or a series upward flow or a series down flow or other combinations through the furnace wall tubes can be obtained.

The variations enable the boiler to be operated most satisfactorily in accordance with different conditions under which it may be operating. The reversal of water through the furnace wall tubes helps to keep them clean. At high capacities, when there is a tendency for the upper part of the furnace to be hotter than the lower part, the water may be supplied to the upper tubes. When the load is light and there is a tendency for steam to concentrate in the top of a tube and water in the bottom with the return bends tending to act like a trap to prevent steam from flowing downward as freely as the water, the water may be supplied so as to have an upward flow through the tubes. When heat absorption is great and a tube coil is very long there may be too much steam and too little water near the exit for safety of the tubes, and the very high resistance to flow may necessitate large circulating pump power. For this reason, it is frequently desirable to vary the series parallel relations of the tubes.

I claim:—

1. In a boiler, a furnace having water wall tubes, means for forcing water through said tubes and means for changing the direction of flow at will.
2. In a boiler, a furnace having horizontally disposed water wall tubes, means for forcing water through said tubes and means for changing the direction of flow at will.
3. In a boiler, a furnace having water wall tubes connected in series, means for forcing water through said tubes and means for changing the direction of flow at will.
4. In a boiler, a furnace having water wall tubes, means for forcing water through said tubes a plurality of times around said furnace and means for changing the direction of flow at will.
5. In a boiler, a furnace having water wall tubes, a steam and water separator to which said tubes are connected, means for passing water from said separator to said tubes, and means for reversing its direction through the tubes.
6. In a boiler, a furnace having water wall tubes, a steam and water separator to which said tubes are connected, a circulating pump for passing water from said separator to said tubes, and means for reversing its direction through the tubes.
7. In a boiler, a furnace having water wall tubes, said tubes being divided into sections with connections to both ends of each section, means for forcing water through said tubes and means for changing the direction of flow at will.
8. In a boiler, a furnace having water wall tubes, said tubes being divided into sections with connections to both ends of each section, and means for changing said sections from series to parallel relation and vice versa.
9. In a boiler, a furnace having water wall tubes, said tubes being divided into section with

connections to both ends of each section, and means for passing water in either direction through said sections.

groups for series flow or parallel flow with respect to each other selectively.

10. In a boiler, a furnace having wall tubes, 5 said tubes being divided into sections with connections to both ends of each section, means for passing water in parallel through said sections, additional means for changing the parallel flow to series flow at will, and means for reversing 10 the flow through the sections.

12. In a boiler of the class described, a substantially rectangular furnace, water tubes located in the walls of said furnace, said tubes 80 crossing each other at the corners of the furnace, adjacent tubes being joined together through substantially circular tubular connections, said tubes extending from the bottom of the furnace wall to the top thereof and hous- 85 ings surrounding said circular connections.

11. In a boiler, a furnace having water wall tubes, a superheater, a separator between said tubes and superheater, means to pass water through said tubes and superheater on starting 15 up, means to reverse the direction of water flow through said water wall tubes, means to divide the tubes into groups with parallel flow in the tubes of each group, and means to relate the

13. In a boiler of the class described, a furnace, water tubes located in the walls of said furnace, said tubes crossing each other at their 90 ends, adjacent tubes connected together through substantially circular tubular connections.

DAVID S. JACOBUS.

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