March 29, 1932. T. B. STILLMAN 1,851,464

SINGLE PASS MARINE BOILER

Filed June 16, 1927 2 Sheets-Sheet 1

Fig 1

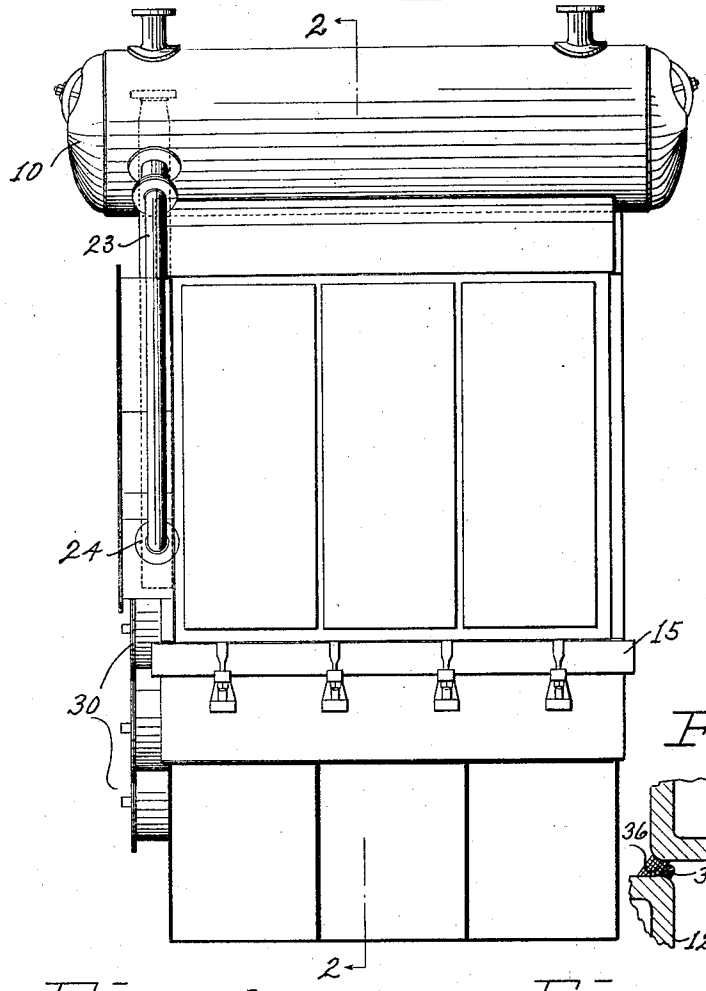


Fig 5

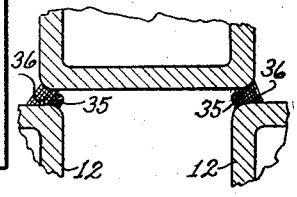


Fig 3

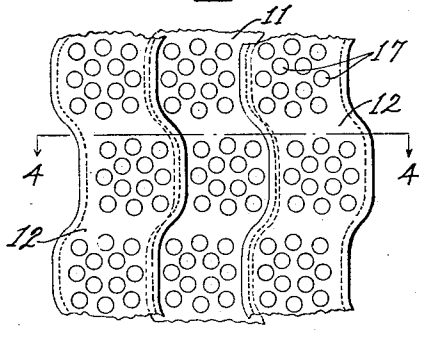
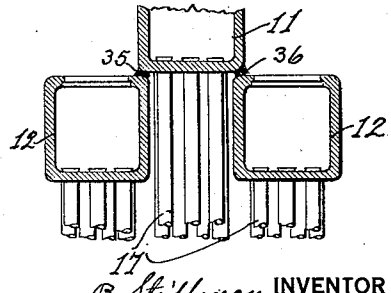


Fig 4



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SINGLE PASS MARINE BOILER

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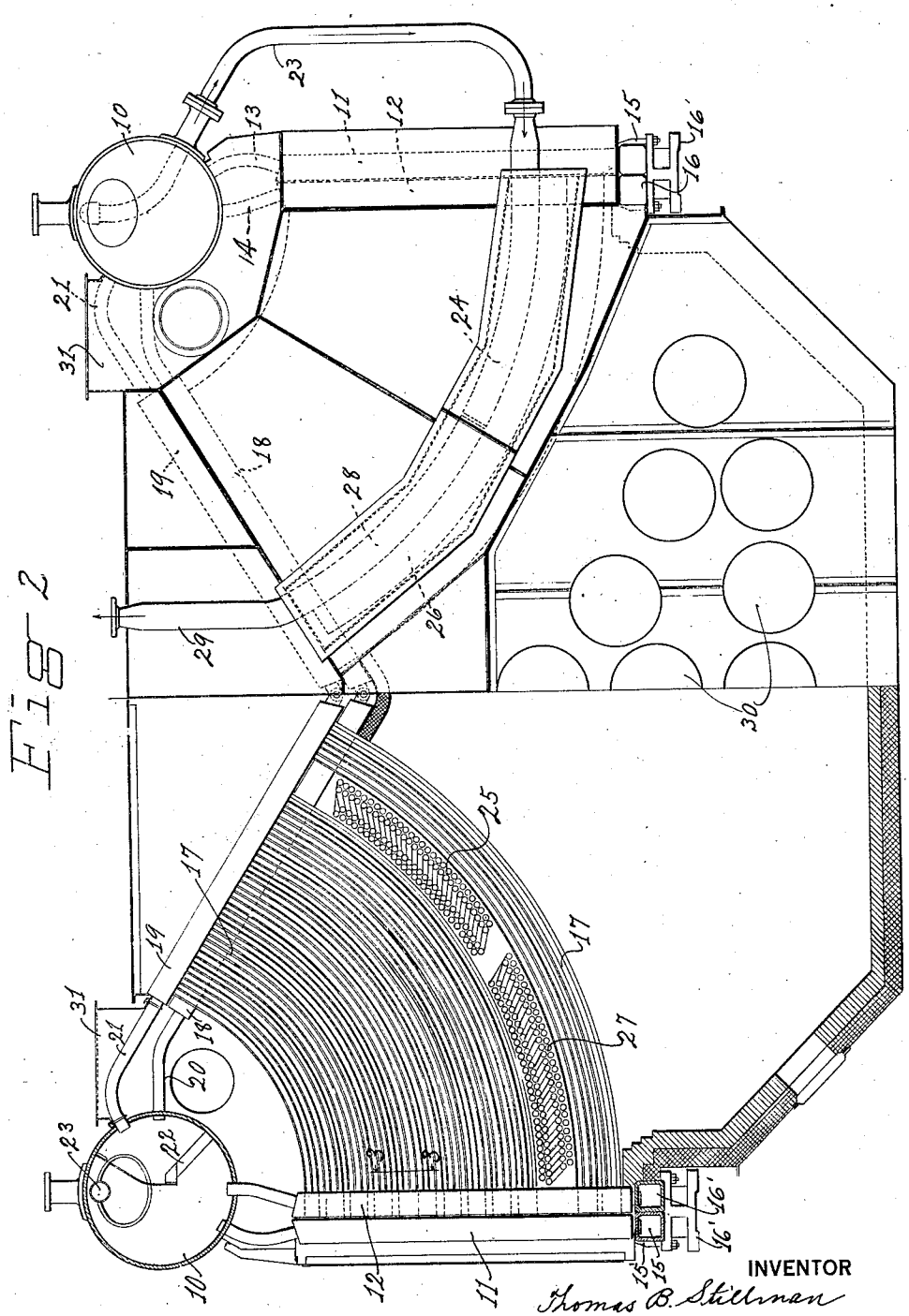

Fig 2

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UNITED STATES PATENT OFFICE

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SINGLE PASS MARINE BOILER

Application filed June 16, 1927. Serial No. 199,167.

This invention relates to a marine boiler having two units located above a furnace with a steam and water drum for each unit, and will be understood from the description in connection with the accompanying drawings, in which Fig. 1 is a side view of the boiler; Fig. 2 is a half section along the line 2—2 of Fig. 1; Fig. 3 is a section along the line 3—3 of Fig. 2; Fig. 4 is a section along the line 4—4 of Fig. 3, and Fig. 5 is a section similar to Fig. 4 partly broken away and shown on an enlarged scale. Since the two units of the boiler are duplicates, it is thought sufficient to describe only one of them.

In the drawings, reference character 10 indicates a steam and water drum on one side of and above the furnace. Outer and inner vertically disposed downtake headers 11 and 12 that are staggered with respect to each other, as shown in Fig. 4, are connected to the water space of the steam and water drum 10 by nipples 13 and 14, and mud drums 15 and 16 are connected by nipples to the lower ends of the headers 11 and 12, respectively. The mud drums may be strapped by means of straps 15′ to the girders or supports 16′. The headers 11 and 12 are connected by means of curved tubes 17 to the inner and outer inclined headers 18 and 19, respectively. These headers 18 and 19 are also staggered with respect to each other, and are connected by nipples 20 and 21 to the steam space of the drum 10, and a baffle 22 is placed in the drum to facilitate separation of steam and water. An outlet 23 leads from the steam space of the drum to the inlet 24 of a superheater that is divided into two sections as for example by a diaphragm near its center. U-shaped superheater tubes 25 connect the inlet header 24 at one side of the boiler to a header 26 at the other side thereof, and from header 26 similar U-shaped tubes 27 lead to the outlet superheater header 28, disposed on the same side of the boiler as the header 24, and from which a connection 29 leads to a steam main. The U-tubes 25 and 27 extend through the space between rows of tubes 17 that is left for that purpose, and the tubes 25 and 27 are transverse to the tubes 17. Fuel burners 30 are located along the front of the furnace wall in such a position that fuel is projected into the furnace in a direction transverse to the tubes 17, and a waste gas outlet is located above the nipples 20 and 21, as shown at 31.

The headers for the tubes 17 are spaced slightly apart with their edges overlapping, as indicated in Figs. 4 and 5, so that expansion and contraction can take place without displacing the tubes 17. The headers 11 and 12 may form a portion of the side walls of the furnace. Rods 35 may be welded to one side of the headers at each end of the tubes 17, which rods are not quite large enough to entirely close the space between the corners of the headers. The headers are preferably made sinuous in shape, and the rods 35 are correspondingly shaped. The rods 35 serve as stops for packing material 36, such as asbestos, that is placed in the spaces between the headers to prevent leakage of gas or air.

The operation is as follows: Fuel is introduced into the furnace through the burners 30 in a somewhat horizontal direction and as it undergoes combustion, the hot products of combustion rise on each side and pass once across the tubes 17, and also across the superheater tubes finally passing between the nipples 20 and 21, and through the outlet 31 to the stack. Water circulates downwardly through the nipples 13 and 14 into the downtake headers 11 and 12, and passes through the tubes 17 where steam is generated, and the mixture of steam and water passes into the headers 18 and 19, thence through the nipples 20 and 21 into the steam and water drums. The waste gases pass only once across the tubes 17, where steam is generated, thence across the nipples 20 and 21 that are heated by some of the heat remaining in the hot gases, thus facilitating the circulation through the system.

The space between the rows of tubes 17 in which the superheater tubes 25 and 27 are located, may be made as near the furnace as is desirable, so that the hot products of combustion will pass across the superheater tubes after they have first passed across the desirable number of water tubes.

This boiler is suitable for operation at high steam pressure; the velocity of the

gases across the tubes is kept approximately constant by the contracting area of the gas passage in the direction of gas flow; and boilers with very high tube banks can be constructed in accordance with this invention.

The boiler may be considered as composed of a plurality of sections, each section comprising a pair of headers connected by nipples to the steam and water drum and connected together by means of a plurality of nests of tubes. In the form shown, the headers are sinuous so that the nests are staggered with relation to one another, and as plainly shown in Figs. 3 and 4, the clear space between any two tubes in a nest is less than a tube diameter, and each tube is staggered with relation to the other tubes in the nest. This arrangement promotes heat absorption by sub-dividing the gas stream across the tubes into a plurality of relatively narrow or thin layers or streams and makes possible an increase in the heating surface per cubic foot of space occupied by the tubes, thereby making a high capacity boiler of relatively light weight and giving it high efficiency. At the same time, the arrangement renders it difficult to remove tubes in a nest by movement transversely of their lengths. However, such removal and replacement of tubes is made possible in this construction, by arranging them substantially on arcs of concentric circles and by providing handholes in the headers of sufficient size to permit removal of tubes therethrough. Each tube may be then removed and replaced by movement along the arc of the circle to which it corresponds.

It will also be noted that the nests of tubes are staggered with respect to each other and that the headers are preferably sinuous so that it would be difficult if not impossible, to remove and replace an entire section by movement of the section transversely of the length of the tubes. According to my invention, however, an entire section may be removed and replaced by movement about the common center of the circles on which the tubes are disposed. In the form shown, a single section could not be entirely removed by this method, without severing the tubes connected to one of the headers, because of the overlapping relation of the headers in adjacent sections. Obviously, however, if the headers were placed on a line with each other as is common practice, then the entire section could be removed without cutting the tubes. Obviously, the connecting nipples at the ends of the headers must be cut, before such removal can be had.

With the arrangement shown, however, a single section can be moved substantially its entire length, until the header at the other end of the section comes in contact with the headers on either side of the section. For example, in Fig. 4, this section including the header 11, can be moved outwardly, so as to move the header 11 away from the headers 12, until the header at the other end of the tubes connected to the header 11, comes in contact with the headers 12. For some purposes, this movement may be sufficient and if it is desired to remove an entire section, this may be done by removing a pair of adjacent sections. After one section has been moved longitudinally with respect to the other in a pair, sufficient lateral movement of this adjacent section in the pair is possible to permit the two to be removed together. Therefore, if one section alone is to be removed, it may be done with a minimum amount of labor, by merely removing it together with one of the sections adjacent thereto.

By my invention, I achieve all the advantages which are inherent in a single tapering gas pass, which pass is formed by the inclined headers and, at the same time, I make it possible to remove and replace individual tubes, or indeed sections of tubes without difficulty and without sacrificing close spacing, in order to obtain easy removability. The tapering gas pass results in uniform gas flow resistance from the fire side of the tubes to the flue side thereof, thus increasing mass flow of the gases as they cool, without draft loss caused by the use of baffles.

By my invention, I have retained the advantages of the tapering gas pass and, at the same time, have made it possible to employ relatively small tubes closely spaced, thereby obtaining increased efficiency. It will also be noted that the longest tubes are disposed on their convex side to the heat of the fire, for substantially their entire length, which is another advantage adding to the efficiency of the entire structure.

Another feature which adds to the efficiency of this boiler, is the arrangement of the interdeck superheater with the headers preferably curved concentrically with the water tubes between which the superheater tubes are disposed. This construction gives a high superheat and uniform steam temperature in a superheater and, at the same time, conserves space, thereby making possible the use of the maximum number of tubes and, at the same time, permitting easy removal and replacement of the superheater tubes and sections as well as the water tubes.

Changes may be made in details without departing from the spirit or scope of the invention.

I claim:

1. In a boiler, a plurality of sections, each comprising a pair of headers connected by a plurality of water tubes spaced apart a distance less than a tube diameter and disposed substantially on arcs of concentric circles, said tubes being arranged in spaced banks and the headers in each section being dis-

posed at an angle to each other and corresponding headers in adjacent sections being substantially parallel to each other, means forming closures between adjacent headers whereby the headers of the section form a tapered gas pass, means for burning fuel adjacent the wide end of said pass, a gas outlet at the other end thereof, a superheater disposed in said wide end of the pass in the space between said banks and having headers curved substantially concentric with said water tubes and having tubes extending transversely of said water tubes.

2. In a boiler, headers inclined to each other and forming a single tapered gas pass, a plurality of water tubes connecting said headers and disposed substantially on arcs of concentric circles, said tubes comprising two spaced banks, and a superheater having tubes extending into said pass between spaced banks of said water tubes, and having headers curved concentrically with said water tubes for the purposes set forth.

3. In a boiler, a plurality of sections, each comprising a pair of headers connected by nests of tubes staggered with relation to nests of tubes in adjacent sections and with the clear space between tubes less than a tube diameter, whereby removal of a section or a tube therein transversely of the length of the tubes is rendered difficult, the headers defining a single pass across the tubes and the headers of a pair of adjacent sections overlapping each other, whereby complete removal of a single section is rendered difficult, the tubes being arranged substantially on arcs of concentric circles, whereby an individual tube may be removed by rotating it about the common center of said circles, and whereby an entire section in said pair may be moved in the same manner as a single tube and thereby permit removal of said pair of sections.

4. In a boiler, headers inclined to each other and forming a single tapered gas pass, a plurality of water tubes connecting said headers and disposed substantially on arcs of concentric circles, said water tubes comprising two spaced banks, and a superheater having tubes extending into said pass between said spaced banks, and having headers curved concentrically with said water tubes, the tubes of said superheater extending transversely of the water tubes.

5. In a boiler, headers inclined to each other and forming a single tapered gas pass, a plurality of water tubes connecting said headers and disposed substantially on arcs of concentric circles, said water tubes comprising two spaced banks, a superheater having headers extending lengthwise of and generally parallel to the space between said banks, and tubes connected to said headers and extending into said space transversely of the lengths of the water tubes.

6. In a steam boiler and its setting, a steam and water drum, vertically disposed front headers and inclined rear headers arranged in staggered relation and connected to said drum by staggered nipples, said front headers being located beneath said drum and connected thereto by short nipples, tubes connecting said front and rear headers and curved on the arc of a circle and concentrically located for substantially their entire lengths, and an outlet flue above said staggered nipples, the gases flowing over the tubes in a single pass from the long tubes to the short ones and passing between said staggered nipples to said outlet flue.

THOMAS B. STILLMAN.