

Oct. 25, 1932.

C. E. LUCKE ET AL

1,884,778

STEAM REHEATER

Original Filed May 16, 1928 5 Sheets-Sheet 1

Fig 1

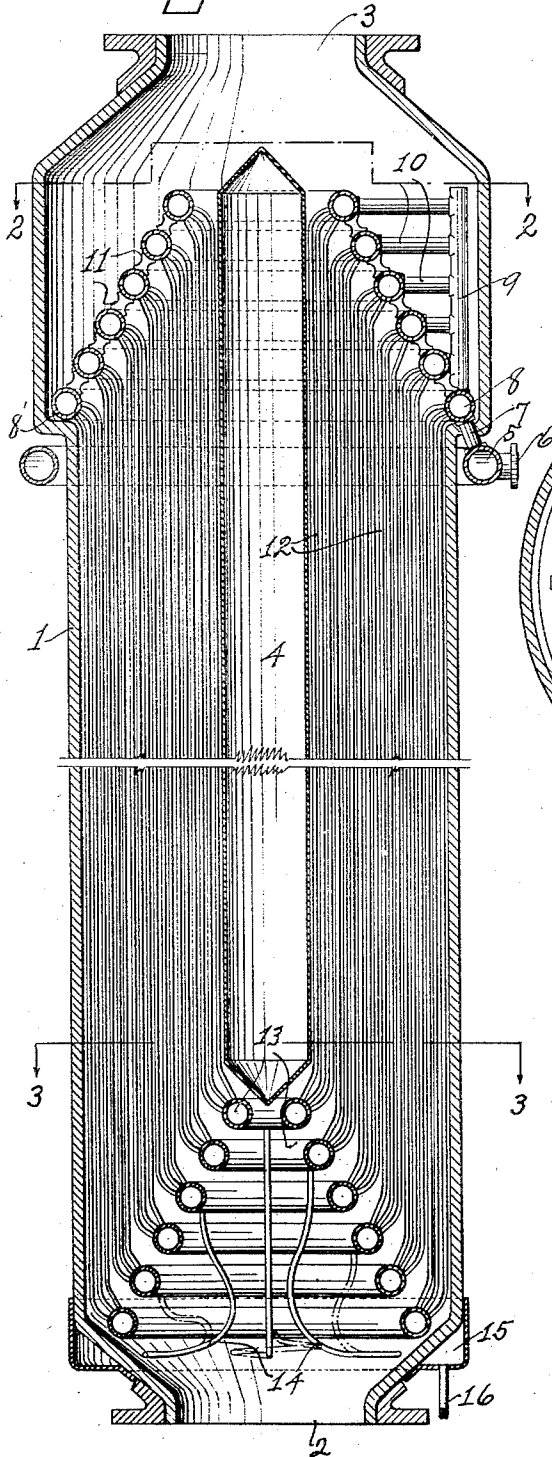


Fig 2

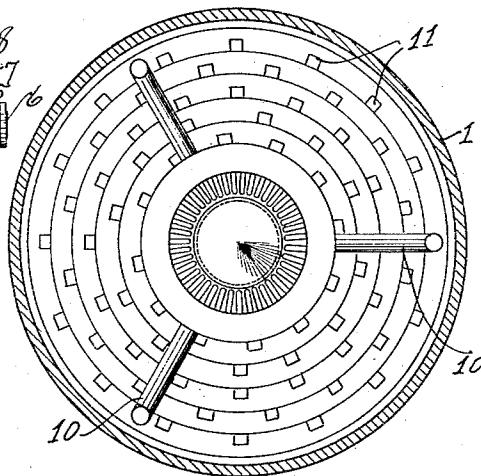
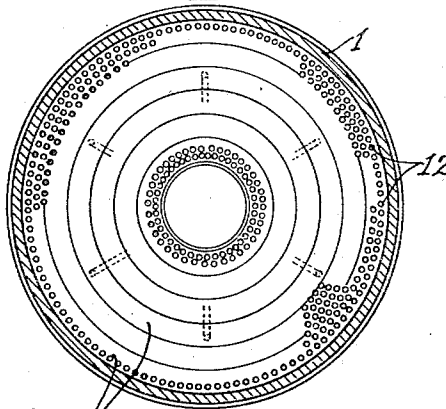


Fig 3



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Fig 4

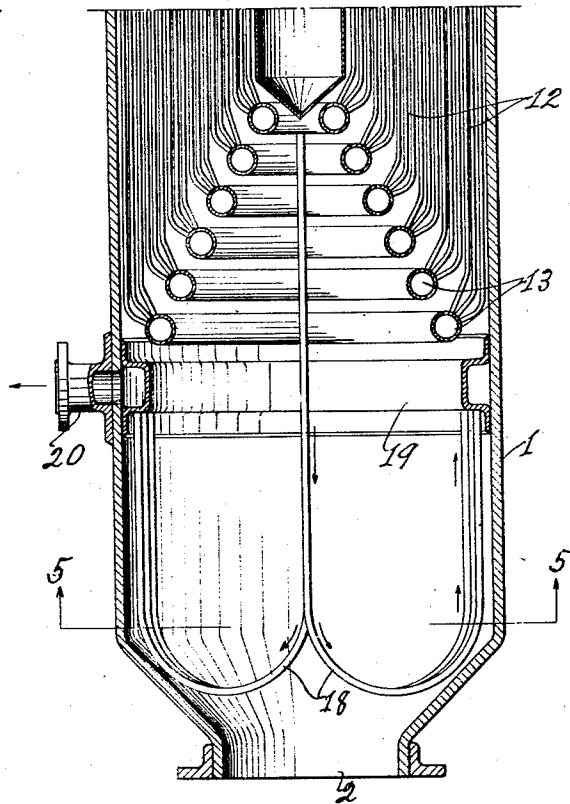
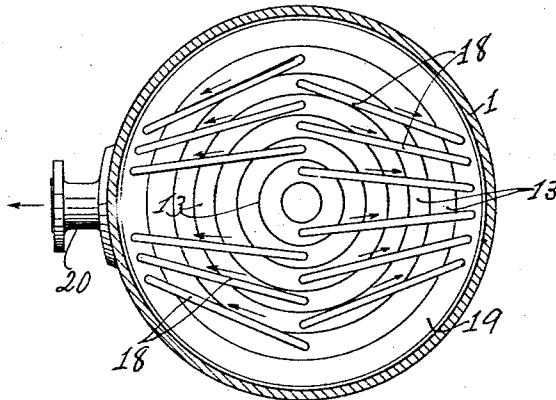


Fig 5



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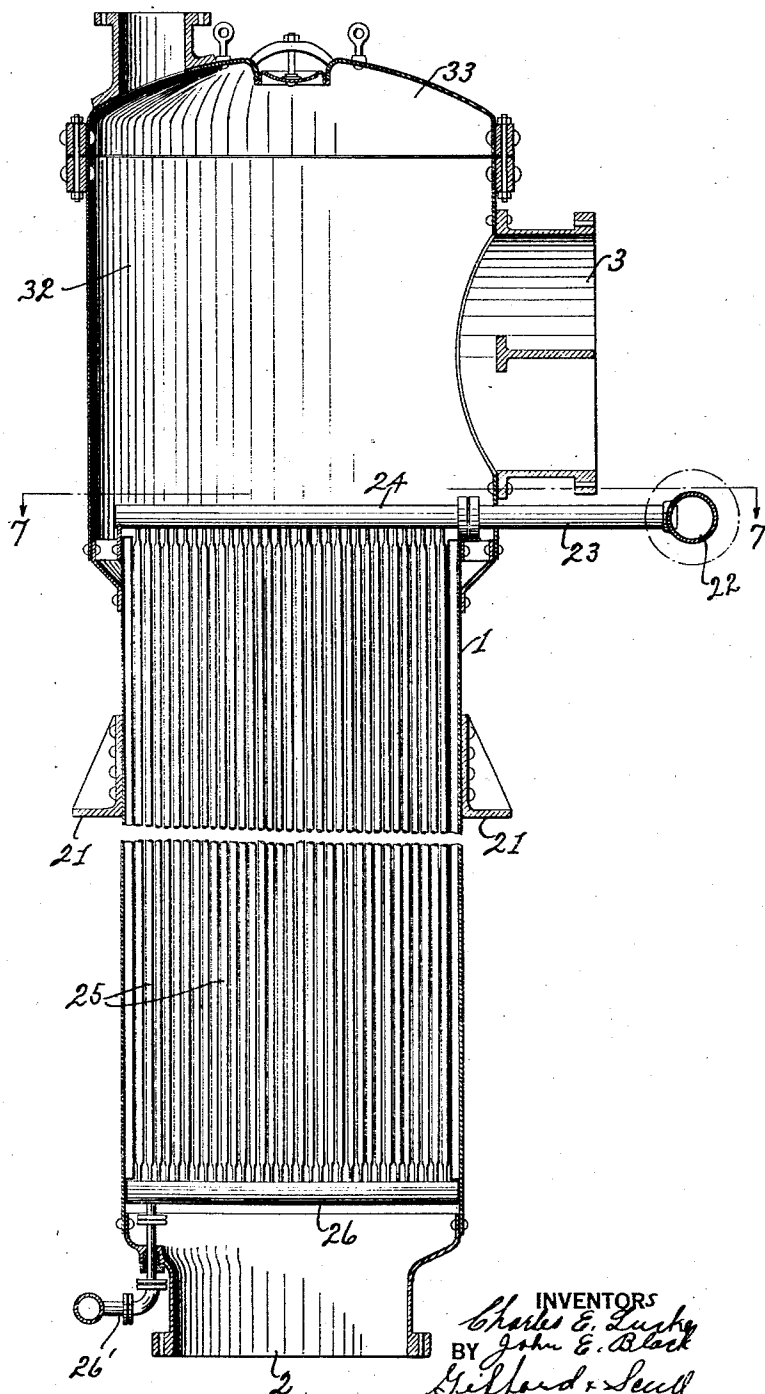
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STEAM REHEATER

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Fig-6



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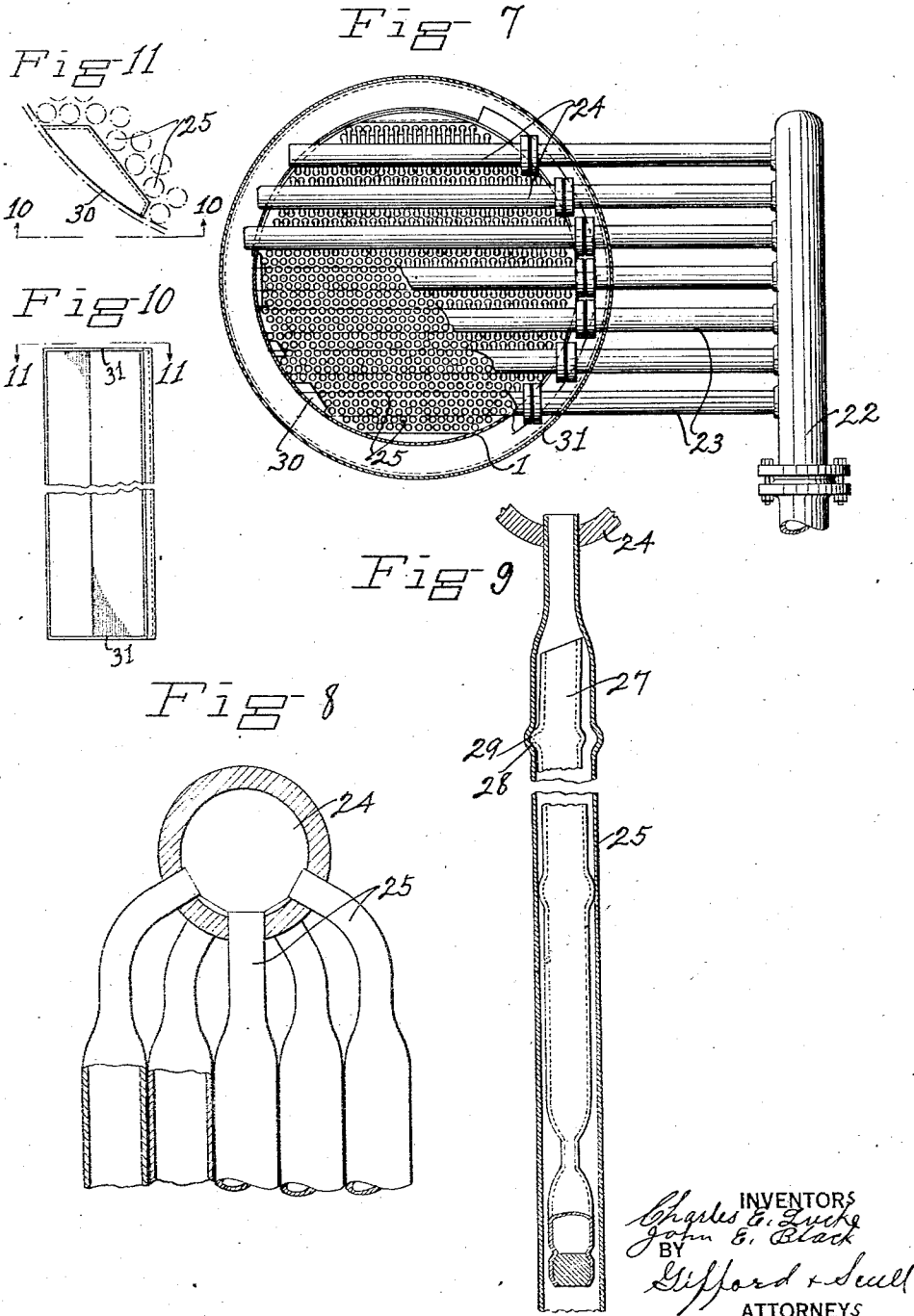
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STEAM REHEATER

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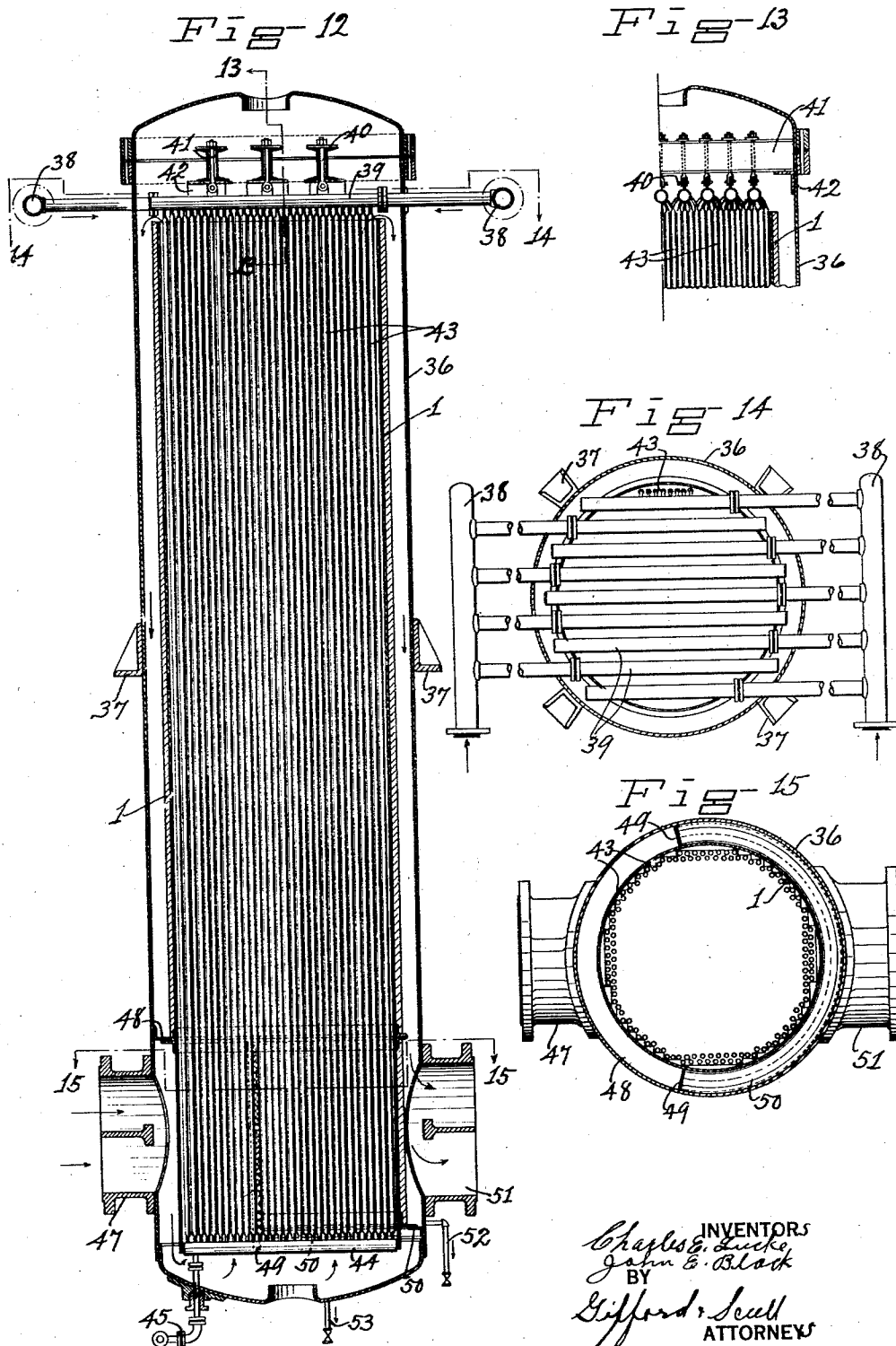
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STEAM REHEATER

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UNITED STATES PATENT OFFICE

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STEAM REHEATER

Application filed May 16, 1928, Serial No. 378,193. Renewed June 15, 1933.

This invention relates to a device by which heat can be transferred from a fluid at high temperature to a fluid at a lower temperature without causing the two fluids to contact. The invention is especially useful in connection with heating steam between stages of a turbine by means of steam at a high pressure and temperature, but is not restricted to this particular use.

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; Fig. 2 is a section along the line 2—2 of Fig. 1; Fig. 3 is a section along the line 2—3 of Fig. 1; Fig. 4 is a section similar to Fig. 3, partly broken away showing a modification; Fig. 5 is a section along the line 5—5 of Fig. 4; Fig. 6 is a vertical section showing a second modification; Fig. 7 is a section partly broken away along the line 7—7 of Fig. 6; Fig. 8 is a side view through a header and its tube bank partly in section showing the tube arrangement; Fig. 9 is a section through the upper part of one of the tubes on an enlarged scale; Fig. 10 is a side view of a filler or box to be used in connection with the reheater and is taken along the line 10—10 of Fig. 11; Fig. 11 is an end view taken along the line 11—11 of Fig. 10; Fig. 12 is a vertical section through another modification; Fig. 13 is a section along the line 13—13 of Fig. 12; Fig. 14 is a section along the line 14—14 of Fig. 12 and Fig. 15 is a section along the line 15—15 of Fig. 12.

In the drawings, reference character 1 indicates a vertically disposed cylindrical casing that is provided with an inlet 2 at the lower end and an outlet 3 at the upper end through which steam to be heated passes. A cylinder or filler member 4 with both ends closed is located at the center of the casing 1. A circular header 5 for high pressure steam is provided near the upper end of the casing 1 on the outside thereof, and an inlet 6 from a source of high pressure steam leads to the header 5. The header 5 is connected by one or more connections 7 to the lowest one of a series of ring shaped headers 8 on the inside

of the casing, this header resting upon a ledge 8' of the casing 1. Pipes 9 extend upwardly from the the lowest header 8 and are connected by connections 10 to the other headers 8 arranged one above the other and decreasing progressively in diameter upwardly with spacer blocks 11 between them to support each one upon a lower one. Circular rows of vertical tubes 12 are suspended from the headers 8 and extend longitudinally through the casing 1 to lower circular headers 13 also arranged one above the other and increasing in size downwardly in a manner similar to the upper headers 8. The area between the headers should be at least as large as the area between the tubes 12. The tubes drain downwardly and drain pipes 14 for condensate connect the headers 13 to a collector 15 from which a valved outlet 16 extends. Any air that may enter with the steam will also pass downwardly.

In the modification shown in Figs. 4 and 5, the drain pipes 13 from the lower headers 13 are U-shaped with one leg longer than the other and connect the headers 13 to the collector 19 on the inside of the casing 1 from which an outlet 20 leads away.

In the modification shown in Figs. 6 and 7, the headers to which the tubes are connected are made straight and the casing 1 is supported by brackets 21 upon any convenient support and the inlet header 22 for the high pressure steam is connected by a plurality of connections 23 to straight parallel headers 24 that rest upon or are supported by the upper end of the casing 1. Rows of tubes 25 extend from the headers 24 longitudinally through the casing 1 to corresponding headers 26 at the lower end and drain pipes 26' are connected to these headers.

The ends of the tubes 25 are reduced in diameter. The tubes are staggered and preferably enter the headers 24 and 26 radially along a plurality of longitudinal rows of holes in the headers, the reduced ends of some of the tubes being curved as shown in Fig. 8. The headers 24 and 26 are separated to provide spaces between them for the passage of steam through the casing 1. The

tubes 25 are spaced closely in their major straight parts. In order to increase the velocity of superheated steam flowing through the inside of the tubes 25, and before it begins to condense, they may be provided in their upper parts with cores 27 (Fig. 9) with projections 28 extending into recesses 29 in the tubes to keep the cores in place and provide narrow annular passages between the cores and the inside walls of the tubes. These cores give a higher heat transfer rate for the upper superheat section of the tubes.

The arrangement of tubes 25 in the casing 1 enables the casing 1 to be substantially filled with the tubes 25 and also enables the headers 24 to be placed sufficient distances apart to permit the low pressure steam to pass freely between them.

In order to prevent the low pressure steam that passes through the casing 1 longitudinally of the tubes 25 from passing through the spaces near the inner wall of the casing 1 that are not filled with tubes, boxes 30, that may be made of sheet metal to fill these spaces, are provided with closed ends 31 for this purpose.

An extension 32 (Fig. 6) is provided above the headers 24 having a removable cover 33 and the outlet 3 extends from the side of the extension 32.

In the modification shown in Figs. 12 to 15, a jacket 36 surrounds the casing 1 and is supported by brackets 37 on any convenient support. A pair of steam inlets 38 is provided on opposite sides of the device and the inlet on one side is connected to alternate horizontal parallel headers 39 and the inlets on the other side are connected to the other headers 39. The connections from the inlets 38 to the headers 39 extend through the jacket 36 and the headers 39 are supported by hangers 40 on cross beams 41 that rest upon angle bars 42 attached to the inside of the jacket 36. Tubes 43 which may be similar to those already described connect the headers 39 to corresponding headers 44 at the bottom, and drain pipes 45 are connected to the headers 44. An inlet 47 for the steam to be heated is provided in the jacket 36 near the lower end thereof. A curved plate 48 closes a portion of the annular space between the casing 1 and jacket 36. Plates 49 extend longitudinally of the casing 1 from the ends of the plate 48 downwardly across the space between the casing 1 and jacket 36. A curved plate 50 at the lower ends of plates 49 closes the annular space between the casing 1 and jacket 36, on the other side of the plates 49 from the plate 48. An outlet 51 leads from the lower side of the jacket 36 opposite the inlet 47. A drain pipe 52 leads from the space above the plate 50 and a drain pipe 53 leads from the lower end of the jacket 36.

In operating the device as illustrated in

Fig. 1, for example, steam to be heated, such as relatively low pressure steam from a stage of a turbine, enters through the inlet 2 and passes upwardly between the headers 13, thence along the outsides of the tubes 12, between the headers 11, and thence out through the outlet 3. High pressure steam entering through the inlet 6 and header 5 passes to the series of superposed headers 8 and thence enters the inside of the tubes 12 where, after losing its superheat, it may be condensed and whatever condensate is formed passes out from the headers 13 through the drain pipes 14 at the bottom into the collector 15, thus heating the steam that enters through the inlet 2 to the maximum possible temperature.

The operation of the other embodiments of the invention is similar to that just described. The embodiment illustrated in Figs. 12 to 15 differs somewhat from the others in that the steam to be heated which enters through the inlet 47 passes under the lower edge of the casing 1 between the headers 44, thence upwardly along the outside of the tubes 43 over the upper edge of the casing 1, thence downwardly in the annular space between the casing 1 and jacket 36, finally passing out through the outlet 51 in its heated condition. The high pressure steam enters the headers 39 from the inlets 38 and then passes into the tubes 43 and lower headers 44 from which the condensate escapes through the outlets 45. Any moisture of steam that may condense in the annular space between the casing 1 and jacket 36 or in the lower end of the jacket 36 can be withdrawn through the drain pipes 52 and 53.

We claim:—

1. A reheater for steam comprising a casing, a plurality of headers near each end of said casing, vertical tubes connecting said headers, and means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, said headers having an outline similar to a cross-section of the casing.

2. A reheater for steam comprising a casing, a plurality of headers near each end of said casing, vertical tubes connecting said headers, means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, and means for passing steam at a lower pressure along the outside of said tubes, said headers having an outline similar to a cross-section of the casing.

3. A reheater for steam comprising a vertically disposed casing, a plurality of headers near each end of said casing, vertical tubes connecting said headers, and means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, said headers hav-

ing an outline similar to a cross-section of the casing.

4. A reheater for steam comprising a casing, a plurality of headers near each end of said casing, vertical tubes connecting said headers, means for admitting steam to the headers at the upper end, and means for passing steam at a lower pressure along the outside of said tubes in a direction counter-current to the direction of steam on the inside of said tubes, said headers having an outline similar to a cross-section of the casing.

5. A reheater for steam comprising a casing, upper headers and lower headers near opposite ends of said casing, vertically disposed tubes connecting said headers, means for admitting superheated steam to the upper headers at one end and withdrawing condensate from the headers at the other end, means to increase the velocity of flow in the upper ends of said tubes and for withdrawing condensate from the lower headers, and means for passing steam to be heated upwardly over said tubes.

6. A reheater for steam comprising a casing, a plurality of circular headers near each end of said casing, tubes connecting said headers, and means for admitting steam to the headers in parallel at one end and withdrawing condensate from the headers at the other end.

7. In a steam reheater, a casing, a set of upper headers, a set of lower headers, one of said sets of headers being supported by said casing, vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to introduce a hot fluid into the upper ends of said tubes, and means to pass steam to be heated over the outside of said tubes.

8. In a steam reheater, a casing, a set of upper headers, a set of lower headers, one of said sets of headers being supported by said casing vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to introduce a hot fluid into the upper ends of said tubes, and means to pass steam to be heated over the outside of said tubes and between said headers.

9. A reheater for steam comprising a casing, a plurality of headers near each end of said casing, vertical substantially straight tubes connecting said headers, and means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, said headers having an outline similar to a cross-section of the casing.

10. A reheater for steam comprising a casing, headers near opposite ends of said casing, vertical tubes connecting said headers, means for admitting steam to the headers at the upper end and withdrawing conden-

sate from the headers at the lower end, and means for passing steam at a lower pressure along the outside of said tubes and longitudinally thereof, and means comprising sheet metal parallel to said tubes to prevent steam from short circuiting past said tubes.

11. A reheater for steam comprising a casing, headers near opposite ends of said casing, vertical tubes connecting said headers, means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, and means for passing steam at a lower pressure along the outside of said tubes, said tubes being closely spaced with the headers at opposite ends at different heights.

12. A reheater for steam comprising a casing, a plurality of headers near each end of said casing, vertical tubes connecting said headers, means for admitting steam to the headers at the upper end and withdrawing condensate from the headers at the lower end, and means for passing steam at a lower pressure along the outside of said tubes, said tubes being closely spaced with the ends of said tubes bent to enter said headers, said headers having an outline similar to a cross-section of the casing.

13. A reheater for steam comprising a casing, headers located at different heights near opposite ends of said casing, vertically disposed tubes connecting said headers, means for admitting steam into the upper ends of said tubes and withdrawing condensates from the lower ends, and means for introducing into said casing steam to be heated.

14. In a steam reheater, a vertically disposed casing, a plurality of headers in the upper portion of said casing, a plurality of vertically disposed tubes having their upper ends connected to said headers, cores in the upper portions of said tubes, means to introduce superheated steam into said headers, and means to contact said tubes with steam to be heated.

15. In a steam reheater, a casing, a set of upper headers, a set of lower headers, vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to support said last named set of headers, means to introduce a hot fluid into the upper ends of said tubes, and means to pass steam to be heated over the outside of said tubes.

16. In a fluid heat exchange device, a casing, a set of separate upper headers, means to space said headers so that each of said headers is laterally offset with relation to the adjacent header and is located at a different elevation, a set of lower headers, vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to support said last named set of headers, means to introduce a heating fluid into the upper ends of said tubes and means to

pass steam to be heated over the outside of said tubes.

17. In a fluid heat exchange device, a casing, a set of upper headers each of which is offset laterally with respect to an adjacent header and at a different elevation, a set of lower headers offset horizontally and vertically with respect to each other, vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to support said last named set of headers, means to introduce a hot fluid into the upper ends of said tubes, and means to pass steam to be heated over the outside of said tubes.

18. In a fluid heat exchange device, a casing, a set of upper headers, a set of lower headers, vertically disposed tubes connected to said headers and supported by one of said sets of headers, a filler member extending longitudinally of the casing between the tubes so as to prevent short circuiting by which a fluid passing through the casing would have a substantial part of its body failing to contact with the tubes, means to support the headers of said last named set, means to introduce a hot fluid into the upper ends of said tubes, and means to pass steam to be heated over the outside of said tubes.

19. In a fluid heat exchange device, a casing, a set of inlet headers disposed within the casing at one end so that each of said headers is offset horizontally and vertically with respect to the adjoining header, an upright distributing header, separate means establishing communication between each of said inlet headers and the distributing header, a set of lower outlet headers at the other end of the casing, vertically disposed tubes connected to said headers and supported by one of said sets of headers, means to support said last named set of headers, means to introduce a hot fluid into the distributing header, and means to pass steam to be heated over the outside of said tubes and through the casing.

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