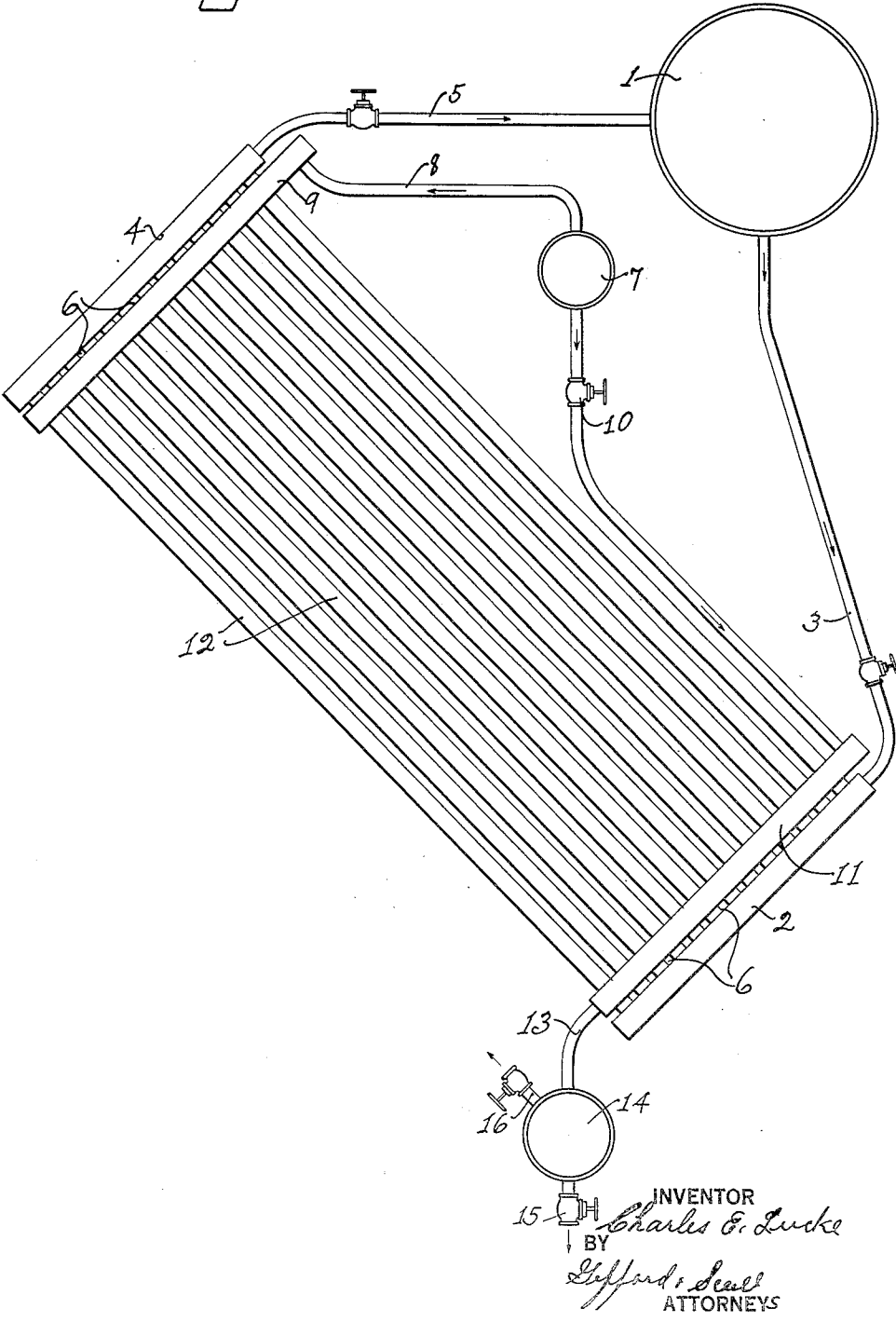


Dec. 6, 1932.

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HEAT TRANSFER DEVICE
Filed July 14, 1928

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Fig. 1



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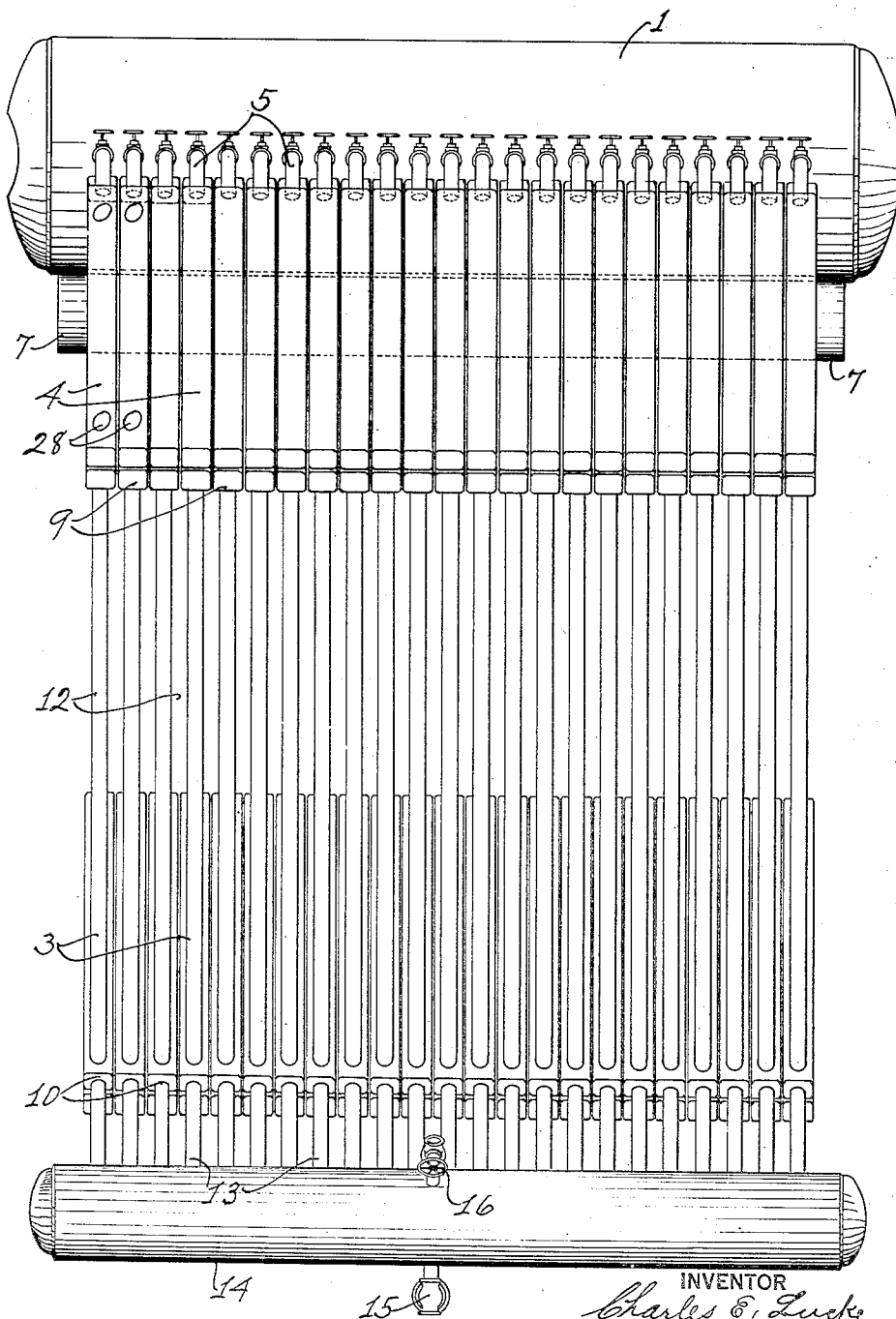
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Fig-2



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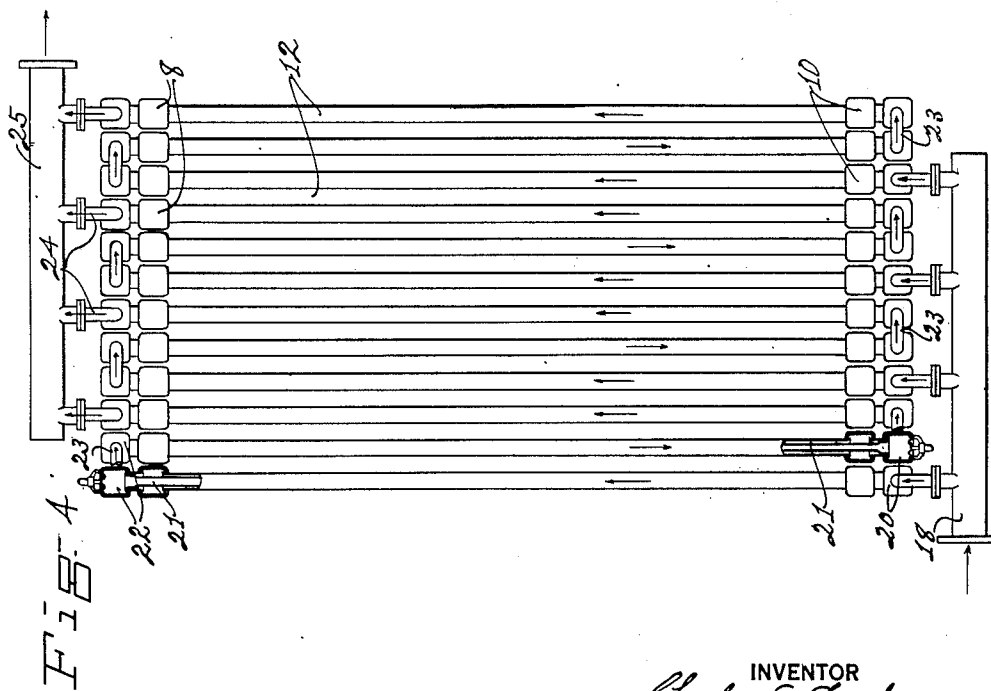
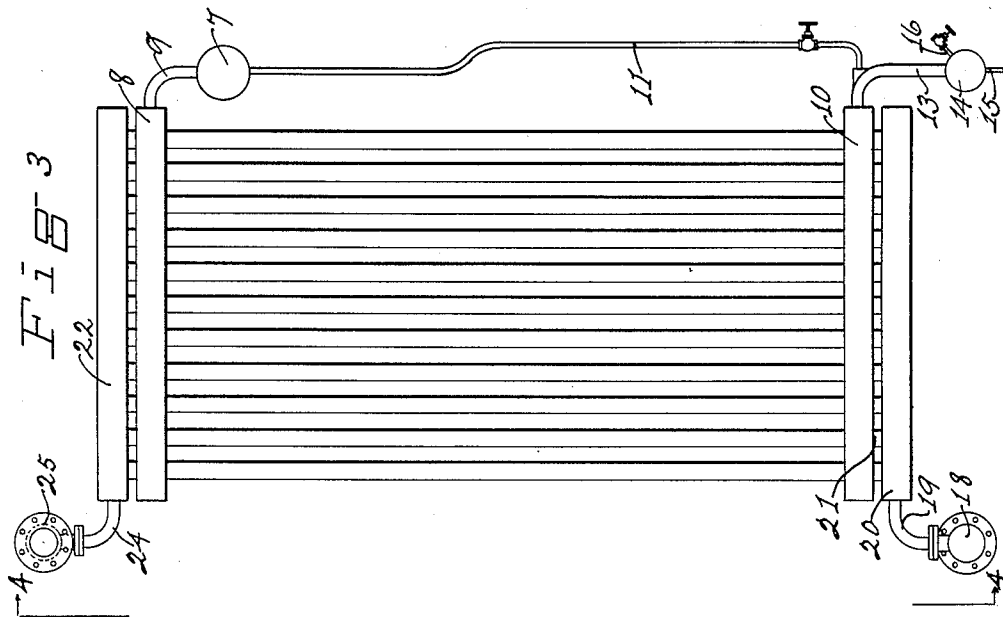
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Fig-5

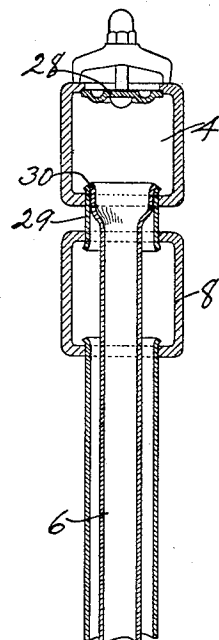


Fig-6

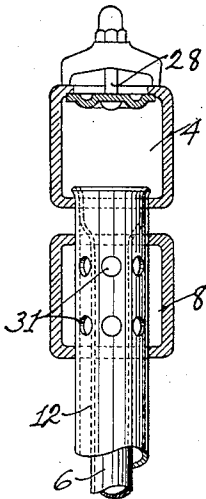


Fig-8

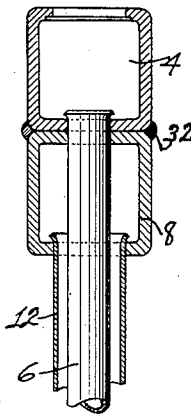


Fig-9

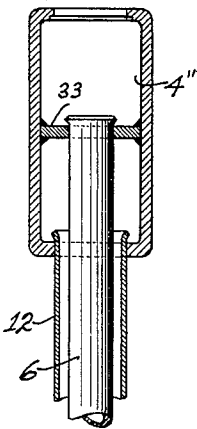


Fig-7

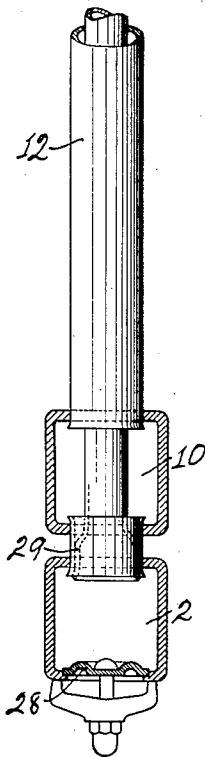
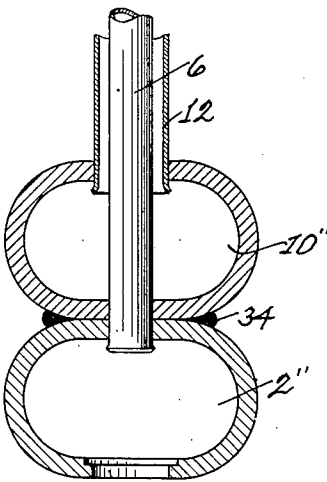


Fig-10



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Filed July 14, 1928

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Fig. 11.

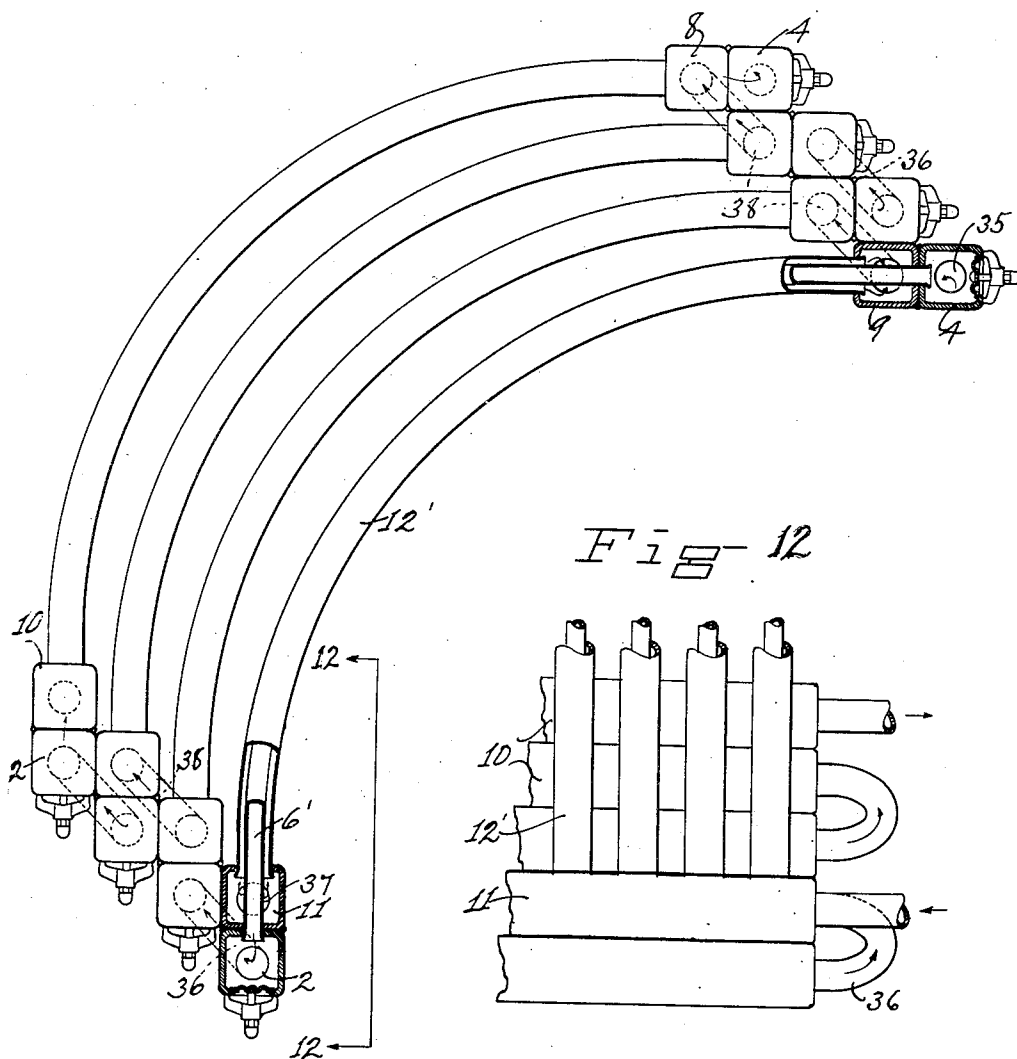
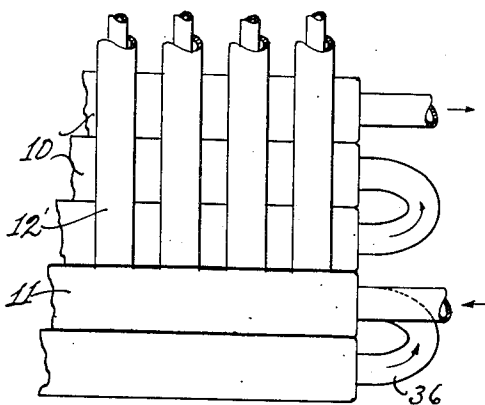


Fig. 12.



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UNITED STATES PATENT OFFICE

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HEAT TRANSFER DEVICE

Application filed July 14, 1928. Serial No. 292,638.

This invention relates to a device for heating one fluid by means of another fluid without permitting the fluids to come into contact with each other. The invention may be used, for example, for evaporating water or generating steam at a low temperature and pressure by means of steam at a higher temperature or by means of higher temperature mercury vapor, the high temperature steam or the mercury vapor being condensed. The invention is not, however, 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 side view of an illustrative embodiment of the invention; Fig. 2 is an end view of the same; Fig. 3 is a side view of a modification; Fig. 4 is a view taken along the line 4—4 of Fig. 3; Figs. 5 to 10 are sectional views showing modifications of some of the details; Fig. 11 is a side view of a modification of the device; and Fig. 12 is a view taken along the line 12—12 of Fig. 11.

In the drawings, reference character 1 indicates a drum that may serve as a steam and water drum when the device is operated as a steam boiler. The upper ends of a row of downtake headers 2 are connected to the lower portion of the drum 1 by means of valved tubes 3. The upper ends of a row of uptake headers 4 are connected to the drum 1 by means of valved tubes 5 that enter the drum some distance above the lower portion thereof. A bank of inclined tubes 6 connects the headers 2 to the headers 4, a row of these tubes being provided for each pair of headers.

A drum or manifold 7 is provided to receive a hot fluid, such as steam at high pressure or mercury vapor for example, from any convenient source. Pipes 8 lead from the upper portion of the drum 7 to headers 9 that are located between the headers 2 and 4 near the headers 4. Valved tubes 10 lead from the lower portion of the drum 7 to headers 11 corresponding to the headers 9 but located near the headers 2. The headers 9 and 11 may be parallel to the headers 2 and 4. Tubes 12 corresponding in number to the

tubes 6 connect the headers 9 and 11, the tubes 12 being larger than the tubes 6 and surrounding the same to leave annular spaces between the tubes 6 and 12. Pipes 13 lead from the headers 11 to a drum or manifold 14 to the bottom of which a valved condensate outlet pipe 15 is connected, and to the upper portion of which a valved outlet pipe 16 for uncondensed gases is connected.

The operation will be described in connection with the generation of low pressure steam from high pressure steam. The water from which the low pressure steam is to be generated is introduced preferably into the drum 1 and passes downwardly through the tubes 3 into the headers 2, thence upwardly through the bank of tubes 6 where steam is generated. The mixture of steam and water passes into the headers 4, and thence through the pipes 5 into the steam and water drum 1. The steam may be taken off through an outlet (not shown), at the upper portion of the drum 1 in the manner well known in water tube steam boilers. The scale that may be deposited on the inside of the tubes 6 by the evaporation of water can be removed without interrupting the operation of the unit by closing the valves in the pipes 3 and 5 corresponding to one pair of headers at a time and the tubes cleaned mechanically through hand holes that are provided in the headers by devices well known in connection with water tube steam boilers. The high pressure steam for heating the tubes 6 is introduced into the manifold 7 and then passes through the pipes 8 and 10 into the headers 9 and 11, and thence through the annular spaces between the tubes 6 and 12, the condensate passing out through the pipes 13 into the manifold 14, and thence out of the outlet 15 to a point of use, from which the steam is returned to the manifold 7. The recirculated steam can thus be kept clean so that no scale will form on the outside of the tubes 6. If the steam entering the manifold 7 carries some air or other non-condensable gases mixed therewith, the valves in the pipes 10 can be closed periodically or permanently, thus causing the steam and air to pass through the pipes 8 into the headers 9, and so to sweep the air

downwardly into the manifold 14, from which the air can be removed through the outlet 16.

In the modification shown in Figs. 3 and 4, the fluid to be heated enters the manifold 18 and thence passes through pipes 19 to certain of the headers 20. The headers 20 are connected by the tubes 21 to the headers 22 and nipples 23 connect certain of the headers 20 as well as certain of the headers 22 so that the fluid to be heated passes in series through groups of the tubes 21. In this embodiment, the pipes 24 lead from certain of the headers 23 to an outlet manifold 25, the connections being such that the tubes are connected in groups of three for the material to pass in series through the tubes of the group and pass in parallel through the groups as indicated by the arrows in Fig. 4. The arrangement for introducing the heating fluid is similar to that described in connection with Figs. 1 and 2. This modification is adapted to heat a liquid without boiling it, or a gas by the heat of condensation of hotter vapors in the jacket space between inner and outer tubes.

Different arrangements of tubes for connecting the headers for the heating fluid and the fluid to be heated are shown in Figs. 5 to 10. In Fig. 5, the headers 2 and 4 are shown with handhole fittings 28 corresponding to the tubes 6. Nipples 29 connect the headers 2 and 10 as well as the headers 4 and 8. The ends of the tubes 12 are expanded into the headers 8 and 10 and the ends of the tubes 6 are expanded into the nipples 29 at the walls of the headers 2 and 4, the tubes 6 being enlarged in diameter as indicated at 30, if necessary. It will be obvious that the fluid to be heated passes from the headers 2 to 4 through the tubes 6 and the heating fluid passes from the headers 8 to 10 through the annular spaces between the tubes 6 and 12. The position of heating and heated fluids may be reversed.

In the modification shown in Fig. 6, the nipples 29 are dispensed with and the tubes 12 are prolonged so as to be expanded at two places in the headers 8 and at one place in the headers 4, the same arrangement being provided at the other end. The tubes 12 are provided with openings 31 inside of the header 8 so that the heating fluid can enter the annular spaces between the tubes 6 and 12.

In the modification shown in Fig. 7, the arrangement is similar to that shown in Fig. 6, except that the headers 2' and 10' are round, the walls thereof being thick enough to make seats for the tubes.

In the modification shown in Fig. 8, the nipples 29 shown in Fig. 5 are dispensed with and the headers 4 and 8 are welded together as indicated at 32. The modification shown in Fig. 9 is the equivalent of that shown in Fig. 8. In this modification the rectangu-

larly shaped header 4'' is used and a partition 33 is welded across the same to provide in effect two separate headers.

In the modification shown in Fig. 10, the arrangement is similar to that shown in Fig. 8 but the headers 2'' and 10'' are of oval shape in cross section and are welded together as indicated at 34.

In the modification shown in Figs. 11 and 12, the arrangement of the headers 2 and 4 and the headers 9 and 11 is similar to that shown in Figs. 1 and 2, except that the headers are offset to accommodate similar curved tubes 6' and 12', thus making provision for expansion and contraction to take place in the curved portions of the tubes without overstressing the tubes, tube seats or tending to displace the headers. The headers may be connected to each other, as explained above in connection with Fig. 8. Figs. 11 and 12 also show an inlet 35 for the fluid to be heated and nipples 36 connecting alternate pairs of headers 2 and 4, thus providing a series connection for the fluid passing through the tubes 6'. Similarly an inlet 37 is shown for a header 11 through which the heating fluid is introduced, and nipples 38 connect pairs of headers 9 and 11 to provide a series flow of the fluid through the tubes 12'. This arrangement is suitable for heating one fluid by the cooling of another without either boiling or condensation. A similar arrangement may, of course, be used in connection with Figs. 1 and 2, or the arrangement as shown in Figs. 1 and 2 may be used in connection with the embodiment shown in Figs. 11 and 12.

The construction which is the subject of this invention is well adapted to work at any pressure on the hotter or cooler tubes and headers, but is especially suited for high pressure as no parts of large diameter are subjected to the pressure. The parts used are those that are commonly used in water tube boiler construction and are well known and generally available. Heat exchangers of large and small capacity may be made of the same parts by varying lengths of headers, connecting two or more short headers by nipples, and by varying the number of rows of pairs of headers, thus varying the number of tubes in a bank, and by varying the length of tubes.

I claim:

1. In a heat transfer device, a pair of outside headers located at the respective ends of said device, a pair of inside headers located at the opposite ends of said device, the headers at each end of said device being connected by nipples, tubes connecting said outside headers secured to said nipples and tubes surrounding and spaced from said first mentioned tubes and connected to said inside headers.

2. In a heat transfer device, a pair of out-

- side headers located at the respective ends of said device, a pair of inside headers located at the opposite ends of said device, the headers at each end of said device being connected by nipples, tubes connecting said outside headers secured to said nipples and tubes surrounding and spaced from said first mentioned tubes and connected to said inside headers, means for passing steam and water through said inside tubes and means for passing steam through said outside tubes.
3. In a heat transfer device, outside headers at opposite ends of said device, inside headers at opposite ends of said device, the adjacent inside and outside headers at each end of said device being connected by nipples, tubes connecting said outside headers and secured to said nipples, tubes surrounding and spaced from said first mentioned tubes and connected to said inside headers, said outside headers being provided with means affording access to the ends of said inner tubes, means for passing steam and water through said inside tubes and means for passing steam through said outside tubes.
4. In a heat transfer device, a pair of outside forged headers with the headers of each pair at the opposite ends of said device, a pair of inside headers with the headers of each pair at opposite ends of the device the adjacent inside and outside headers at each end of said device being connected by nipples, forged tubes connecting said outside headers and extending into said nipples, and forged tubes surrounding and spaced from said first mentioned tubes and connected to said inside headers.
5. In a steam heated steam boiler using high pressure steam as the heating medium to generate low pressure steam, forged steel inlet and outlet headers, parallel outer tubes communicating with those headers and conducting high pressure steam from the inlet headers to the outlet headers, uptake and downtake headers outside the first mentioned headers and constituting parts of a water circulation system, rows of steam generating tubes each of which extends through an outer tube and establishes circulatory communication between an uptake and a downtake header, a steam and water separation chamber, and connections between said chamber and separate uptake and downtake headers establishing separate circulations through separate groups of the generating tubes, all of the generating tubes discharging steam and water in the same direction with all of the fluid movement in said tubes being toward the same side of the boiler.
6. A steam generator comprising two banks of tubes, the tubes of one bank being within the tubes of the other bank, each bank being composed of several groups of tubes, separate headers for each group of tubes of each bank, means associated with the bank of inner tubes for completing individual circulatory systems, the tubes and headers being so arranged that there is parallel flow in all the inner tubes and means for supplying a heat exchange fluid to the outer tubes.
7. In a steam heated steam generator, opposite heating steam headers, outer tubes connecting said headers for conducting heating steam from one to the other, opposite water circulating headers each spaced beyond one of the first headers, nipples connecting each water circulating header with the adjacent header for heating steam, steam generating tubes each of which extends through one of the first tubes and connects the nipples at the opposite ends thereof, and means for maintaining independent and parallel water circulations in the generating tubes, the generating tubes being less than one-half the diameter of the outer tubes.
8. In a steam heated steam boiler, a plurality of inside steam generating tubes extending through a heating zone and all conducting water in the same direction, outside chambers connected by said tubes for water circulation, a steam and water separation drum, means connecting the chambers to the steam and water drum so that the tubes are submerged, a plurality of outside steam conducting tubes each enclosing one of the first mentioned tubes, separate steam conducting chambers positioned between the first chambers and connected by the last mentioned tubes to maintain a separate envelope of heating steam around each of the first tubes, and means draining condensate from the outside tubes and their connected chambers.
- CHARLES E. LUCKE.

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