

May 29, 1934.

S. BROWN

1,960,770

HEAT EXCHANGER

Filed May 21, 1932

2 Sheets-Sheet 1

Fig. 1.

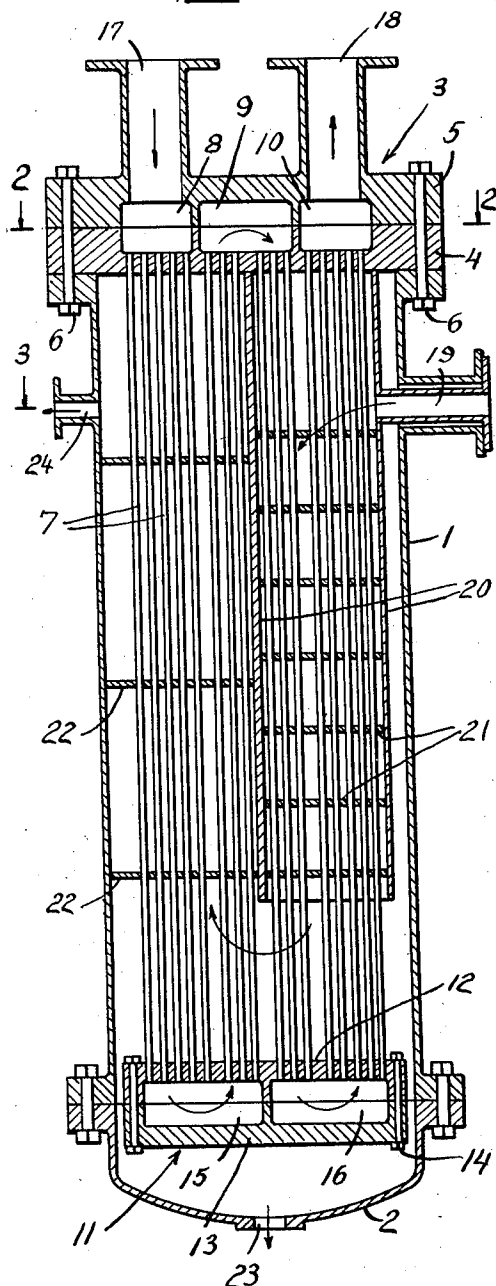


Fig. 2.

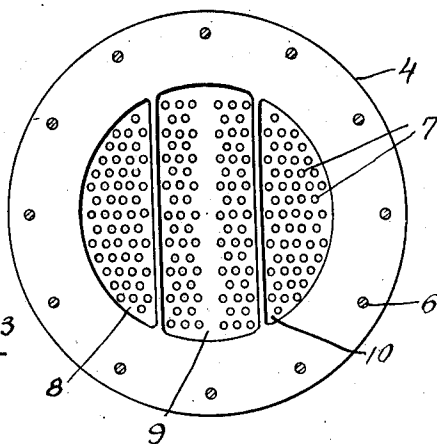
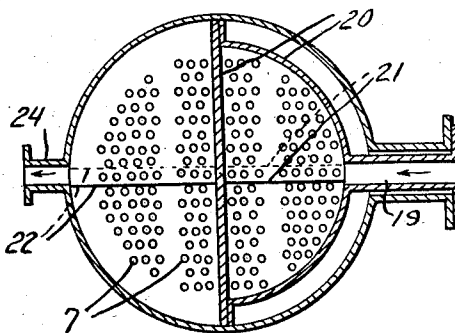


Fig. 3.



INVENTOR

Stanley Brown

BY

Perkins, Martin & Edwards

ATTORNEYS

May 29, 1934.

S. BROWN

1,960,770

HEAT EXCHANGER

Filed May 21, 1932

2 Sheets-Sheet 2

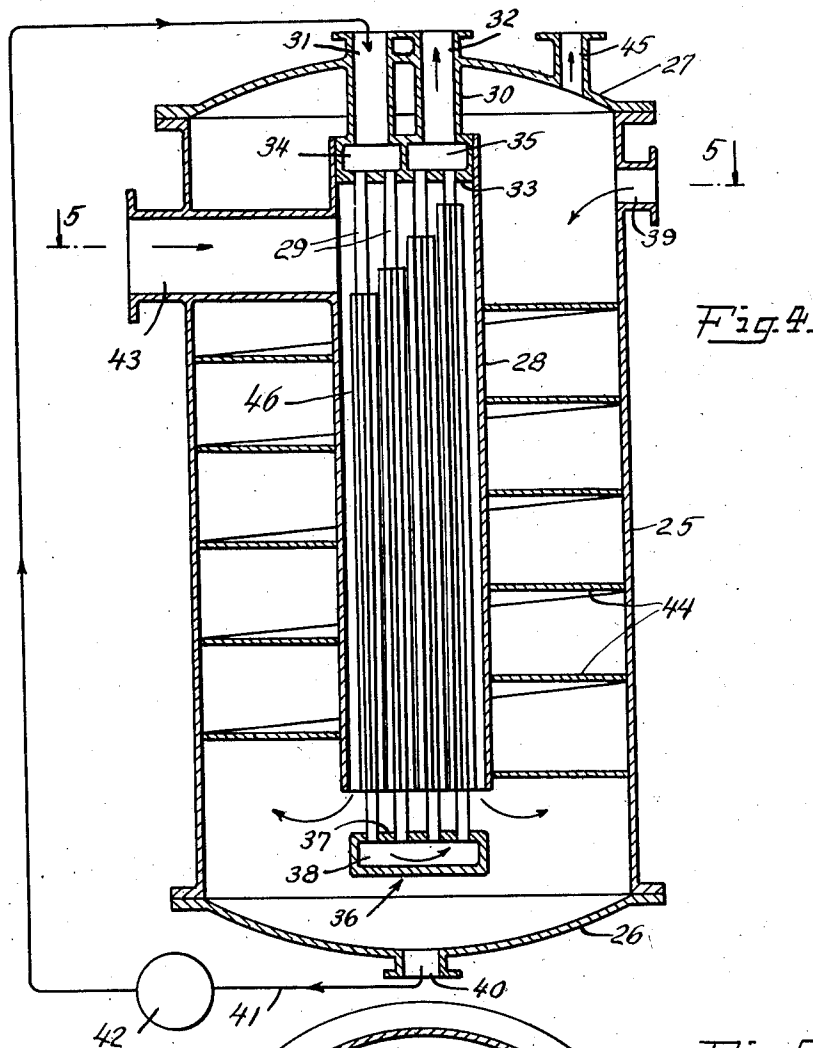


Fig. 4.

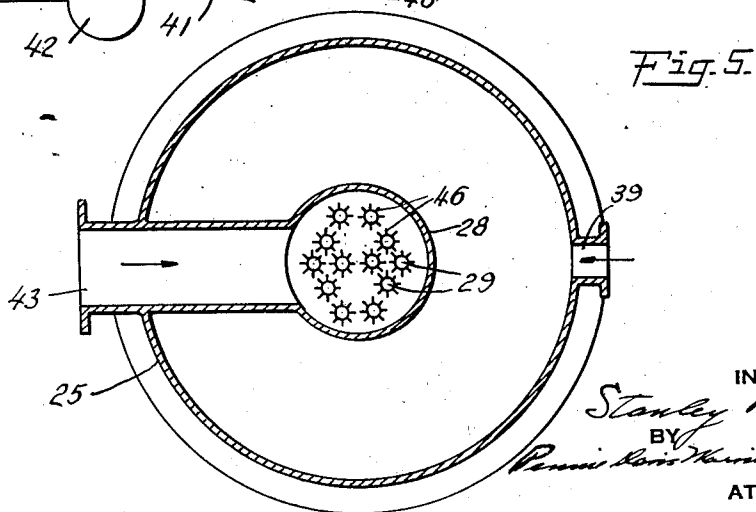


Fig. 5.

INVENTOR

Stanley Brown

BY

Pennington, Harris & Edwards

ATTORNEYS

UNITED STATES PATENT OFFICE

1,960,770

HEAT EXCHANGER

Stanley Brown, Garden City, N. Y., assignor to
The Griscom Russell Company, New York, N. Y.,
a corporation of Delaware

Application May 21, 1932, Serial No. 612,674

20 Claims. (Cl. 257—222)

This invention relates to heaters and particularly to feed water heaters of both the shell and tube type and the contact type.

In the contact type of feed water heater the steam used as a heating medium is brought into direct contact with the feed water and in the common shell and tube type of feed water heater the steam is brought into heat exchanging relation with the water through a heat transferring surface. Ordinarily exhaust steam is used for the purpose of heating the feed water.

My invention relates particularly to a method and apparatus for utilizing superheated steam, although it is to be understood that my improved apparatus can be used in a system employing steam at or near the saturation temperature. According to my invention superheated steam can be used in an efficient manner to heat feed water to the end that the water may be brought to a relatively high temperature before being supplied to the boiler. By utilizing my invention it is possible to raise the temperature of the water to a value in excess of that of the saturated temperature of the steam employed in heating the water. In general, the principal object of my invention is accomplished by continuously passing superheated steam and water in heat exchanging relation in such a manner that the water is first heated by steam at or near its saturated temperature and subsequently heated by the superheated steam at the maximum temperature of this heating medium. My invention contemplates the use of a heat transfer surface for transferring heat from the superheated steam to the water and after this has been accomplished the steam may be brought into direct contact with water at a lower temperature, or it may otherwise be brought into heat exchanging relation with the water.

In general, my improved apparatus comprises a shell equipped with means for supplying water thereto and with means for supplying superheated steam to the shell. I prefer to employ means within the shell for first confining superheated steam in heat exchanging relation with a portion of the water in the shell and for subsequently bringing the steam into heat exchanging relation with the remaining portion of the water in the shell. For example, the shell may be provided with two heating zones for the water, in the first of which the raw water is brought into contact with steam which has previously delivered its superheat to water in the second heating zone. In this first heating zone the steam may or may not be in direct contact with the water, whereas, in the second heating zone the superheated steam is preferably out of direct contact with the water but in efficient heat transferring relation with the water through metal surfaces, such as the walls of metal tubes through

which the water may be passed to the discharge port of the heater.

I may employ a cylindrical baffle enveloping a group of tubes within the shell and adapted to confine the superheated steam in contact with the tubes within the baffle. This baffle is preferably spaced from the wall of the shell to thereby prevent the superheated steam from coming in direct contact with the shell wall. This arrangement prevents excessive heating of the shell and the warping or buckling of the shell which might occur if the superheated steam were brought into direct contact therewith.

The various objects and advantages of my invention will be more apparent upon considering the following detailed description which is to be taken in conjunction with the accompanying drawings of which:

Figure 1 is a vertical sectional view of a feed water heater embodying my invention.

Figure 2 is a transverse sectional view taken on line 2—2 of Figure 1.

Figure 3 is a transverse sectional view taken on line 3—3 of Figure 1.

Figure 4 is a vertical sectional view partly in diagrammatic form, of another embodiment of my invention as applied to a feed water heater of the contact type, and

Figure 5 is a transverse sectional view taken on line 5—5 of Figure 4.

The embodiment of my invention illustrated in Figures 1 to 3 inclusive comprises a cylindrical shell 1, having a cap 2, closing one end thereof, and a header 3 closing the other end of the shell. The header 3 comprises a tube sheet 4 and a cover plate 5 secured thereto by any suitable means such as the bolts 6. A plurality of tubes 7 are expanded into or otherwise secured to the tube sheet 4. The tube sheet 4 and the cover plate 5 are formed so as to provide a plurality of chambers 8, 9 and 10. A floating head 11 is provided within the shell 1 and comprises a tube sheet 12 and a cover plate 13 secured to the tube sheet by bolts 14. The tube sheet 12 and the cover plate 13 are formed so as to provide chambers 15 and 16, communicating with separate groups of the tubes 7.

The chamber 8 is in direct communication with several of the tubes 7 within the shell 1, and this chamber also communicates with an intake port 17. In like manner the chamber 10 communicates with a discharge port 18.

The arrangement of the several parts referred to above, is such that water may enter the chamber 8 through the intake port 17 and pass through a group of the tubes 7 into the chamber 15 in the floating head 11. The water then passes back through an adjacent group of tubes into the chamber 9 which serves to direct the water into a third group of tubes communicating with the

chamber 16 in the floating head 11. From the chamber 16 the water flows through a fourth group of tubes to the chamber 10 from which it is discharged through the port 18. The tubes 7 are thus arranged to provide a four-pass flow of the water, or in other words, the water in passing through the apparatus traverses the length of the tube bundle four times before it reaches the discharge port 18. It is to be understood, however, that any desired number of passes may be employed. The water in passing through the tubes 7 within the shell 1 may be heated by means of a hot medium brought into heat exchanging relation with the tubes. I prefer to employ super-heated steam for this purpose and to first confine the super-heated steam in heat exchanging relation with a group of the tubes near the discharge port, to the end that the water in the tubes may be brought to a temperature close to that of the superheated steam entering the apparatus.

In the apparatus shown in Figures 1 to 3 inclusive, the shell 1 is provided with a gland 19 adapted to receive super-heated steam and discharge the same into a chamber within the shell 1, formed by a baffle 20 arranged in such a manner that it envelopes a group of the tubes 7 within the shell. In the construction illustrated in Figures 1 to 3 inclusive, the baffle 20 encloses one half of the tubes and these tubes are in relatively close proximity to the discharge port 18 and the chamber 10 in direct communication therewith. The baffle 20 engages the tube sheet 4 but terminates short of the tube sheet 12, and accordingly the chamber formed by the baffle is adapted to discharge steam from within this chamber into heat-exchanging relation with the tubes 7 located outside of the baffle chamber. If desired, a plurality of transverse baffles 21 may be provided within the baffle chamber to cause the super-heated steam flowing through this chamber to follow a circuitous path before it is discharged into the space within the shell 1 not occupied by the baffle chamber. Other transverse baffles 22 may be provided for the purpose of directing the steam into efficient heat-exchanging relation with the tubes located outside of the baffle chamber.

The cap 2 closing one end of the shell 1 is provided with a discharge port 23 for removing condensate from the apparatus, and a discharge port 24 is provided in the shell 1 for removing uncondensed vapor from within the shell. It will be understood that the super-heated steam entering the apparatus through the gland 19 heats the water flowing toward the chamber 16 and toward the chamber 10, to a temperature near that of the super-heated steam entering the apparatus, and that thereafter the steam is brought into heat-exchanging relation with the tubes communicating with the chambers 8 and 15, and which carry water at a much lower temperature. That portion of the steam which condenses within the apparatus is discharged through the drain port 23 and the uncondensed vapor passes off through the port 24. It will be noted that the baffle 20 which forms a baffle chamber containing a group of the tubes 7, is spaced apart from the wall of the shell 1 and this serves to confine the superheated steam entering the apparatus, in a region remote from the shell wall, thus preventing excessive heating of the heat-exchanger shell. At the same time the baffle forms a passage of restricted cross section which brings about a high velocity of the superheated steam and greatly im-

proves the efficiency of the heat transfer. The steam is brought into contact with the heat-exchanger shell only after it is discharged from the baffle chamber, and this does not take place until the temperature of the steam has been lowered considerably by contact with the tubes within the baffle chamber.

The apparatus shown in Figs. 1 to 3 inclusive, is of the shell and tube type wherein the water being heated is at all times out of direct contact with the heating medium.

In Figs. 4 and 5, I have illustrated an embodiment of my invention as applied to a feed water heater of the contact type, wherein the steam employed as a heating medium is brought into direct contact with the water being heated, at one stage of the operation. The apparatus of Figs. 4 and 5 comprises a cylindrical shell 25 having a cap 26 closing the lower end thereof and a cap 27 closing the upper end of the shell. The apparatus of Figs. 4 and 5 is similar to that shown in Figs. 1 to 3 inclusive, to the extent that it includes a baffle 28 within the shell and forming a baffle chamber enclosing a plurality of tubes 29. The enveloping baffle 28 is spaced apart from the shell wall and is supported by the cap 27 by means of a fluid connection 30 having an intake port 31 and a discharge port 32. A tube sheet 33 is located near the upper end of the baffle 28 and supports the tubes 29. The tubes 29 may be regarded as consisting of two groups one of which communicates with the chamber 34, and the other of which communicates with the chamber 35. The chamber 34 communicates with the intake port 31 and the chamber 35 is in direct communication with the discharge port 32. The floating head 36 is provided with a tube sheet 37 and with a chamber 38 communicating with the lower ends of the tubes which are mounted in the tube sheet 37. The arrangement is such that water entering the port 31 flows first into the chamber 34, then through a group of the tubes 29 into the chamber 38 in the floating head 36, then through the remaining group of tubes to the chamber 35 and to the discharge port 32.

The shell 25 is provided with a water inlet 39 and with a drain connection 40. In diagrammatic form I have illustrated a pipe connection 41 connecting the drain port 40 with the inlet 31, and a pump 42 is provided for pumping water from the lower end of the shell 25 to the intake port 31 which communicates with the tubes 29 within the baffle chamber.

Super-heated steam may be admitted to the apparatus through a pipe connection 43 which communicates directly with the interior of the baffle chamber. The super-heated steam is thus brought into heat-exchanging relation with the water flowing through the pipes 29 whereby the temperature of the water is brought to a value near that of the entering steam. The steam is then discharged from the lower end of the baffle chamber into the surrounding space within the shell 1 where it comes into direct contact with water entering the shell through the pipe connection 39. If desired, one or more baffles 44 may be provided within the shell around the outside of the baffle chamber to insure intimate contact between the steam, and the water passing downward through the shell. The uncondensed vapor escapes through a discharge port 45 located in the cap 27, and the condensate mingles with the feed water and is removed from the lower end of the shell by the pump 42. The water passing through the shell 1 is thus heated by steam at the satura-

tion temperature and is then supplied to the tubes 29 by means of the pump 42 where the water is brought into heat-exchanging relation with the super-heated steam entering the apparatus. In order to facilitate the transfer of heat from the super-heated steam to the water in the pipes 29, these pipes are preferably provided with longitudinal fins 46. Fins of this character increase the effective surface of the heat exchanger tubes without materially interfering with the free passage of the steam through the baffle chamber. The desired distribution of the super-heated steam within the baffle chamber is obtained by eliminating the longitudinal fins from the upper extremities of the tubes 29 in the vicinity of the super-heated steam connection 43, as best illustrated in Figure 4. This provides ample space in the upper end of the baffle chamber for transverse flow of the steam whereby the steam is brought into intimate contact with all of the tubes in the baffle chamber.

Regardless of whether my invention is applied to a feed water heater of the contact type or to apparatus of the shell and tube type, it is of particular value because of the possibility of heating the water to a temperature above the saturation temperature of the steam, and this is accomplished without bringing super-heated steam into direct contact with the shell. In this way the full advantage of using super-heated steam can be realized without heating any portion of the shell to an abnormally high temperature.

It is to be understood that my invention is not limited to the particular embodiments illustrated and described in detail, but includes such modifications thereof as fall within the scope of the appended claims. For example, the invention may be applied to single pass exchangers as well as to heat exchangers of the multipass type, certain forms of which are illustrated in the accompanying drawings. In single pass apparatus the internal enveloping baffle, or the like, may be employed for the purpose of keeping the heating medium initially out of contact with the shell while providing high velocity of flow in heat exchanging relation with a portion of the fluid to be heated.

I claim:—

1. Apparatus of the type described comprising a shell, means for supplying a fluid to said shell, means for supplying a heating medium to said shell to heat the said fluid, and means within the shell for first confining said heating medium out of contact with the shell wall and in heat exchanging relation with a portion of said fluid and then discharging the heating medium into contact with the shell wall and into heat exchanging relation with the remaining portion of the said fluid.

2. Apparatus of the type described comprising a shell, means for supplying a fluid to said shell, means for supplying a heating medium to said shell to heat the said fluid, and means within said shell and spaced from the wall thereof for first confining the said heating medium in heat exchanging relation with a portion of said fluid and then discharging the heating medium into contact with the shell wall and into heat exchanging relation with the remaining portion of the said fluid.

3. Apparatus of the type described comprising a shell, means for supplying a fluid to said shell, means for supplying a heating medium to said shell to heat the said fluid, and means within said shell for first confining said heating medium in

heat exchanging relation with a portion of said fluid and then discharging the heating medium into direct contact with the remaining portion of the said fluid.

4. Apparatus of the type described comprising a shell, means for supplying a fluid to said shell, means for supplying a heating medium to said shell to heat the said fluid, and means within the shell and spaced from the wall thereof for first confining said heating medium in heat exchanging relation with a portion of said fluid and then discharging the heating medium into direct contact with the remaining portion of the said fluid.

5. Apparatus of the type described comprising a shell containing two heating zones arranged so that fluid to be heated may be passed through the zones in series, means for supplying a fluid to one of said zones and for discharging the same from the second zone, and means for supplying a heating medium, first to said second zone and then to the other zone into direct contact with said fluid.

6. Apparatus of the type described comprising a shell containing at least two heating zones arranged so that fluid to be heated may be passed through the zones in series, means for supplying a fluid to one of said zones and for discharging the same from the second zone, and means for supplying a heating medium, first to said second zone and then to the other zone, said zones being arranged so that the heating medium is out of contact with the shell wall while in said second zone and in contact with the shell wall while in the first zone.

7. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, a baffle enveloping at least a portion of said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle being arranged to confine the heating medium out of contact with the shell wall and to then discharge the heating medium from within the baffle into heat exchanging relation with the fluid entering said shell.

8. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, a baffle enveloping at least a portion of said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle being arranged to discharge the heating medium from within the same into heat exchanging relation with the fluid entering said shell and the said baffle being out of contact with the shell wall.

9. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, a baffle enveloping at least a portion of said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle being arranged to discharge the heating medium from within the same into direct contact with the fluid entering said shell.

10. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, means for supplying fluid to said tubes and for discharging the fluid therefrom, headers ar-

ranged to produce multi-pass flow of the fluid through said tubes, a baffle separating the tubes of the final pass from the tubes of the initial pass and disposed out of contact with the shell, and means for bringing a heating medium into heat exchanging relation, first with the tubes of the final pass and subsequently with the tubes of the initial pass.

11. Apparatus of the type described comprising a shell, a fluid inlet port, a group of tubes within said shell communicating with said inlet port, a fluid discharge port, a second group of tubes within said shell communicating with the first group of tubes and with the fluid discharge port, a baffle separating the said groups of tubes, and means for bringing a heating medium into heat exchanging relation with said second group of tubes, the said baffle being arranged to confine the heating medium in heat exchanging relation with said second group of tubes and out of contact with the shell wall and to then discharge the said heating medium into heat exchanging relation with said first group of tubes.

12. Apparatus of the type described comprising a shell, means for supplying a fluid to said shell and for discharging the fluid from said shell, a plurality of tubes within said shell, means for supplying a heating medium to said shell, means for withdrawing fluid from said shell and then circulating the same through the tubes within said shell, and means within the shell for first confining the heating medium supplied thereto in heat exchanging relation with said tubes and then discharging the heating medium into direct contact with the fluid in said shell.

13. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, a baffle enveloping at least a portion of said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle and the tubes therein forming a passage of restricted cross section for the flow of the heating medium in contact with the tubes and out of contact with the shell wall and the said baffle being arranged to discharge the heating medium from within the same into heat exchanging relation with the fluid entering said shell.

14. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, the said tubes having longitudinally extending fins thereon, a baffle enveloping said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle being arranged to discharge the heating medium from within the same into heat exchanging relation with the fluid entering said shell.

15. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, a baffle enveloping at least a portion of said tubes, means for supplying a fluid to said shell and for causing the fluid to flow through the tubes within said baffle, means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, and a plurality of baffle plates within said tube enveloping baffle for causing the heating medium to flow in a circuitous

path in contact with the tubes, the said tube enveloping baffle being arranged to discharge the heating medium from within the same into heat exchanging relation with the fluid entering said shell.

16. Apparatus of the type described comprising a shell, a fluid inlet port, a group of tubes within said shell communicating with said inlet port, a fluid discharge port, a second group of tubes within said shell communicating with the first group of tubes and with the fluid discharge port, a baffle separating the said groups of tubes, means for bringing a heating medium into heat exchanging relation with said second group of tubes, the said baffle being arranged to confine the heating medium in heat exchanging relation with said second group of tubes and out of contact with the shell wall and to then discharge the heating medium into heat exchanging relation with said first group of tubes, a plurality of baffle plates within said separating baffle for causing the heating medium to flow in a circuitous path in contact with said second group of tubes and a plurality of baffles within said shell for causing the heating medium to flow in a circuitous path in contact with said first group of tubes.

17. The method of heating water with superheated steam which comprises continuously passing the superheated steam and water into heat exchanging relation with each other in counter-current relation, whereby the water is heated to a temperature above the saturation temperature of the steam, the steam being at first out of direct contact with the water and subsequently in direct contact therewith.

18. Apparatus of the type described comprising a shell, a fluid inlet port, a group of tubes within said shell communicating with said inlet port, a second group of tubes within said shell communicating with said first group of tubes, a baffle separating the said groups of tubes, and means for bringing a heating medium into heat exchanging relation with said second group of tubes, the said baffle being arranged to confine the heating medium in heat exchanging relation with said second group of tubes and out of contact with the shell wall and to then discharge the said heating medium into heat exchanging relation with said first group of tubes.

19. Apparatus of the type described comprising a shell, a plurality of tubes within said shell, the said tubes having fins thereon, a baffle enveloping said tubes, means for supplying fluid to said shell and for causing the fluid to flow through the tubes within said baffle, and means for supplying a heating medium to the interior of said baffle to heat the fluid in the tubes therein, the said baffle being arranged to discharge the heating medium from within the same into heat exchanging relation with the fluid entering said shell.

20. Apparatus of the type described, comprising a shell containing at least two progressive heating zones in communication with each other, means for supplying a heating medium, first to one of said zones and then to the other zone, and a baffle means separating said first zone from the shell wall whereby the heating medium is prevented from coming into contact with the shell wall until after its temperature has been considerably reduced.

STANLEY BROWN.