Nov. 5, 1957 R. R. THOMPSON 2,812,164

HEAT EXCHANGER

Filed Sept. 17, 1953

Fig. 1.

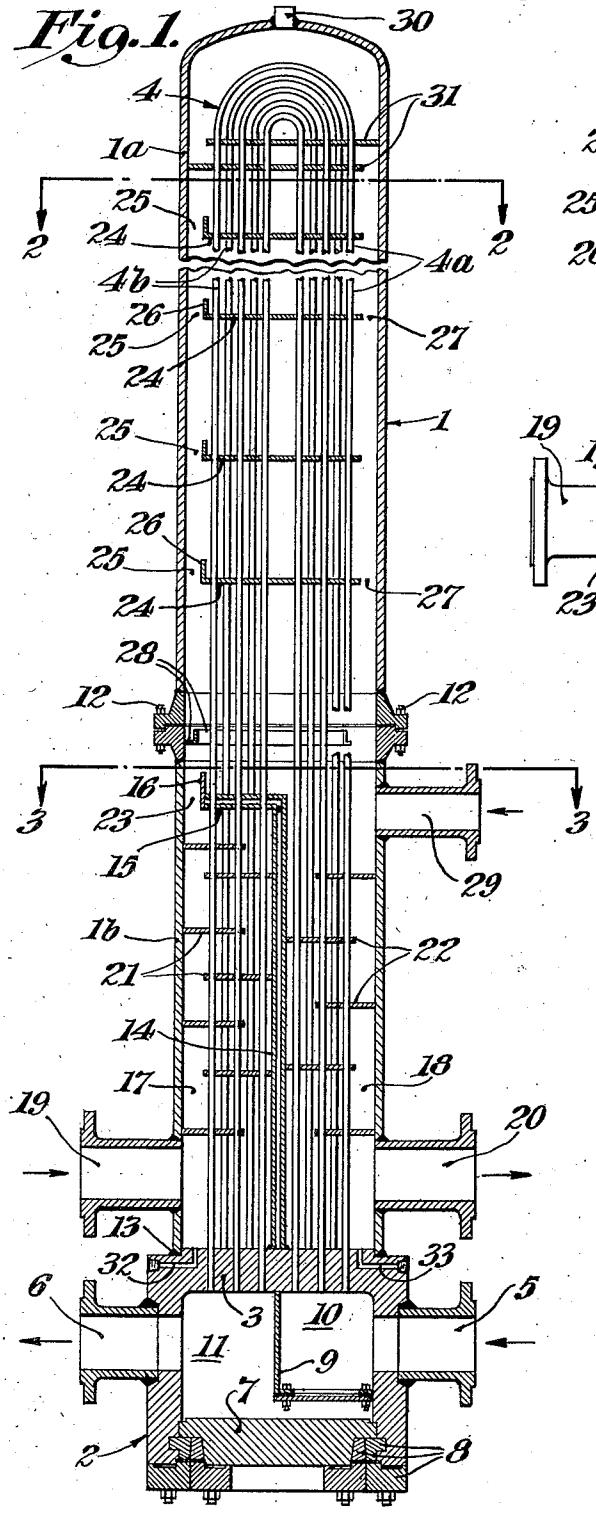



Fig. 2.

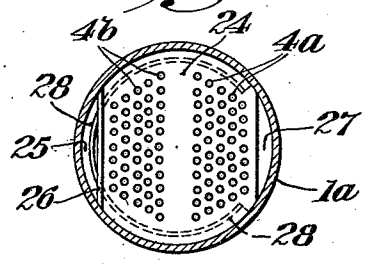
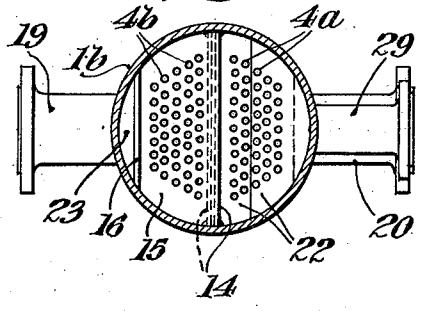



Fig. 3.




INVENTOR
Richard R. Thompson
BY
Nathaniel Ely
ATTORNEY

United States Patent Office 2,812,164 Patented Nov. 5, 1957



2,812,164

# HEAT EXCHANGER

Richard R. Thompson, East Rockaway, N. Y., assignor to The Lummus Company, New York, N. Y., a corporation of Delaware

Application September 17, 1953, Serial No. 380,844

2 Claims. (Cl. 257—32)

This invention relates to improvements in heat exchangers of the shell-and-tube type and more particularly to those employed for heating boiler feed water by circulating the water through the tubes and passing steam into the shell and around the tubes. In certain high pressure heaters of this type the space within the shell is divided into a condensing zone, a steam desuperheating zone and a condensate subcooling zone. The present invention is directed to improvements in heaters of this character.

Important objects of the invention are, to provide, in such a heat exchanger, an improved arrangement of the desuperheating zone, the condensing zone and the subcooling zone providing maximum heat transfer efficiency; to provide for side-by-side arrangement of the desuperheating and subcooling zones with counter-flow of the shell-side and the tube-side fluid in both zones; to provide means for minimizing heat exchange between said side-by-side zones; and to provide means for effectually excluding, from the desuperheating zone, condensate formed in the condensing zone.

Further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawings.

In the drawings:

Fig. 1 is a vertical sectional view, partly broken away, of a feed water heater embodying the invention.

Fig. 2 is a horizontal sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view on the line 3—3 of Fig. 1.

The invention is shown embodied in a feed water heater having an elongated shell, vertically arranged, and a header or channel 2 at its lower end. The structure of the channel includes a tube sheet 3. A bundle of U-shaped tubes 4 extends from the tube sheet upward through the shell for most of the height of the latter. The channel 2 has a water inlet nozzle 5 and a water outlet nozzle 6. These nozzles are shown at diametrically opposite sides of the channel 2 but they can be otherwise suitably oriented. A removable closure 7 forms the lower wall of the channel and is shown held in closed position by locking and sealing means 8, such as that shown in U. S. Patent No. 2,268,507 of Gertzon. Other suitable locking and sealing means may be employed, however. The space within the channel is divided by a pass partition structure 9 into a compartment 10 communicating with the inlet nozzle 5 and a compartment 11 communicating with the outlet nozzle 6. Compartment 10 communicates with one leg 4*a* of the U-tubes 4, and compartment 11 communicates with the other leg 4*b* of said tubes. Hereinafter, in the specification and claims, the legs 4*a* and 4*b* will, for convenience, be referred to as "tubes," and in the claims, such term is intended to include either the legs of U-tubes or separate tubes, which may be connected to return header means other than the bends of the tubes.

The shell 1 is formed in upper and lower sections 1*a* and 1*b*, respectively, flanged and bolted together, as at 12. At the lower end thereof, shell section 1*b* is welded to the tube sheet portion of the channel 2, as at 13. Within the lower shell section there is a vertical diametrically disposed partition 14 extending upward from the tube sheet 3 to a point near the upper end of said section. At its upper end, said partition is formed with a welded-on baffle portion 15 extending laterally outward and terminating short of the adjacent wall of the shell section 1*b*. Along its outer edge said baffle portion has an upstanding lip 16 forming a dam. As shown, the partition, including its baffle portion, is formed of two walls spaced apart to form a dead air space therebetween, for heat insulation. Said walls and the lip 16 are welded along their opposite edges to the shell section 1*a* and the lower edges of the walls are welded therealong to the tube sheet 3. The partition divides the space within the lower shell section into a desuperheating zone 17 and a condensate subcooling zone 18. All of the tubes 4*a* extend through the subcooling zone and all of the tubes 4*b* extend through the desuperheating zone, the baffle 15 being perforated to admit the tubes 4*b* and all of said tubes being spaced inward of the lip 16. Near the lower end thereof the lower shell section has a steam inlet nozzle 19 opening into the desuperheating zone 17 and a condensate outlet nozzle 20 opening from the subcooling zone 18. Within the desuperheating zone there are transverse baffles 21 formed and arranged to cause serpentine flow of the steam, and in the subcooling zone, there are similar baffles 22 to cause serpentine flow of the condensate. The baffle lip 16 at the top of the desuperheating zone and the adjacent portion of the shell wall define an exit 23 for the steam to an upper portion of the shell space.

A condensing zone is formed by the portion of the shell space above the desuperheating and subcooling zones. All of the tubes of the bundle extend through this space and the bundle is provided with a series of spaced transverse baffles 24. Desirably, these baffles include the entire cross section of the bundle. At the side thereof, over the desuperheating zone, the baffles are cut away to provide openings 25 for upward passage of the steam and have an upturned edge forming a dam 26. At the opposite side thereof the baffles are cut away to provide openings 27 permitting the condensate to spill therefrom into the subcooling zone 18. The lower shell section 1*b* has a condensate baffle 28 in the form of a gutter located in a position spaced above the steam exit 23 of the desuperheating zone. The gutter extends around the inner wall of the shell to catch condensate draining therefrom and has open ends disposed over the subcooling zone to spill the condensate into said zone. The lower shell section also has a nozzle 29 near the upper end thereof and disposed to deliver to the subcooling zone "drips" or condensate from other parts of a power plant system in which the feed water heater is used.

At the top of the shell 1 there is an air vent 30 and adjacent the upper end of the tube bundle there are two staggered baffles 31 between which any air in the heater passes to the vent.

In the operation of the heater, boiler feed water to be heated enters the channel compartment 10 through the nozzle 5, flows upward through the tubes 4*a* which extend through the subcooling and condensing zones, and downward through the tubes 4*b* which extend through the condensing and desuperheating zones. Thence, the water flows out of the heater through channel compartment 11 and outlet nozzle 6. Steam enters the desuperheating zone 17 through the nozzle 19 and the desuperheated steam passes upward through the exit 23 of said zone into the condensing zone and into contact with the upper portions of the tubes 4*a* and 4*b*, and is condensed thereon. The steam ascends through the baffle openings 25 and is

directed in transverse parallel streams by the baffles **24**, for good contact with the tubes. Substantially all of the steam which remains uncondensed above the series of baffles **24** will be condensed on the upper end portion of the tube bundle, and air and any remaining steam escapes through the vent **30**.

The steam condensate falling from the tubes onto the baffles **24** is constrained by the dams **26** to flow off the opposite side of the baffles overlying the subcooling zone **18** and falls through the openings **27** to said zone. Any condensate collecting on the baffle top **15** of the desuperheating zone is shed to the subcooling zone, and condensate draining down the shell wall above steam exit **23** of the desuperheating zone is intercepted by the gutter and diverted to the subcooling zone. The baffles **15**, **24** and **28** thus cooperate to exclude condensate from the desuperheating zone. The condensate is subcooled in the zone **18** by the coldest portion of the tubes **4***b* and is drawn off through the nozzle **20**, the rate of withdrawal being such as to maintain a desired level of the condensate within said zone. In starting up the operation of the heater, any condensate formed in the desuperheating zone may be drained off through a normally closed passage **32** in the tube sheet. After operation, the subcooling zone may be drained through a normally closed passage **33** in the tube sheet.

The design and arrangement of the heater provides for counter-flow of the feed water and the steam in the desuperheating zone and for counter-flow of the feed water and the condensate in the subcooling zone. Side-by-side arrangement of the hottest and coldest zones of the heater with minimum heat exchange therebetween is rendered possible by the heat-insulating partition **14** and undesired submergence of tube surface is avoided. All the tube surface is rendered available for heat exchange purposes in a proper manner, with consequent substantial increase in heat transfer efficiency.

Access to the interior of the shell is had for servicing or repair by unbolting and removing the upper section of the shell. Since all of the nozzles for outside connections are borne by the channel and the lower section of the shell, there are no outside connections to be broken for the removal of the upper section of the shell.

While a very satisfactory form of the invention is disclosed, it will be understood that the disclosure is illustrative and not limiting and that the invention comprehends such modifications as will come within the scope of the following claims.

I claim:

1. A heat exchanger comprising an elongated vertically-disposed shell having a steam inlet and a condensate outlet, a plurality of tubes extending vertically within said shell, a tube sheet closing the lower end of said shell, means for circulating a fluid to be heated upwardly through a first leg of said tubes and thence downwardly through a second leg of said tubes and including a fluid directing channel structure at the lower end of said tubes associated with said tube sheet, means for dividing the lower section of said exchanger into desuperheating and subcooling zones, said desuperheating zone including the steam inlet and the lower relatively hot ends of tubes of said second leg and said subcooling zone including the condensate outlet and the lower relatively cool ends of tubes of said first leg, said means including a heat-insulating vertical partition within said shell and between said legs of tubes and extending from said tube sheet to a point short of the top of said shell and a horizontal heat-insulating partition extending transversely of the tubes of said second leg and having sealing engagement with the upper end of said vertical partition, said horizontal partition being spaced from the shell at its edge opposite said vertical partition whereby an opening is formed through which desuperheated steam may pass from said desuperheating zone, the section of the heat exchanger above said first mentioned zones forming a condensing zone communicating with the upper end of said desuperheating zone through the opening formed by said horizontal partition and with the upper end of said subcooling zone through the opening formed between the upper end of said vertical partition and said shell, and baffle means above the opening from the desuperheating zone to direct condensate from the condensing zone away from the desuperheating zone and into the subcooling zone.

2. A heat exchanger as claimed in claim 1, wherein the baffle means above the desuperheating zone includes the horizontal heat-insulating partition and a gutter baffle above the opening formed by the shell wall and said horizontal partition and positioned to catch condensate draining down the shell wall, divert it from said opening and direct it to said subcooling zone, said opening being arranged so that none of the tubes pass therethrough.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,640,746 | Braun | Aug. 30, 1927 |
| 2,259,604 | Banks | Oct. 21, 1941 |
| 2,299,455 | Bowman et al. | Oct. 20, 1942 |
| 2,412,573 | Fraser | Dec. 17, 1946 |
| 2,489,944 | Worn et al. | Nov. 29, 1949 |
| 2,661,190 | Kirkpatrick | Dec. 1, 1953 |
| 2,666,625 | Byerley | Jan. 19, 1954 |
| 2,723,109 | Kirkpatrick | Nov. 8, 1955 |