

April 19, 1949.

C. F. HANCOCK
HEAT EXCHANGE APPARATUS

2,467,741

Filed Sept. 30, 1947

2 Sheets-Sheet 1

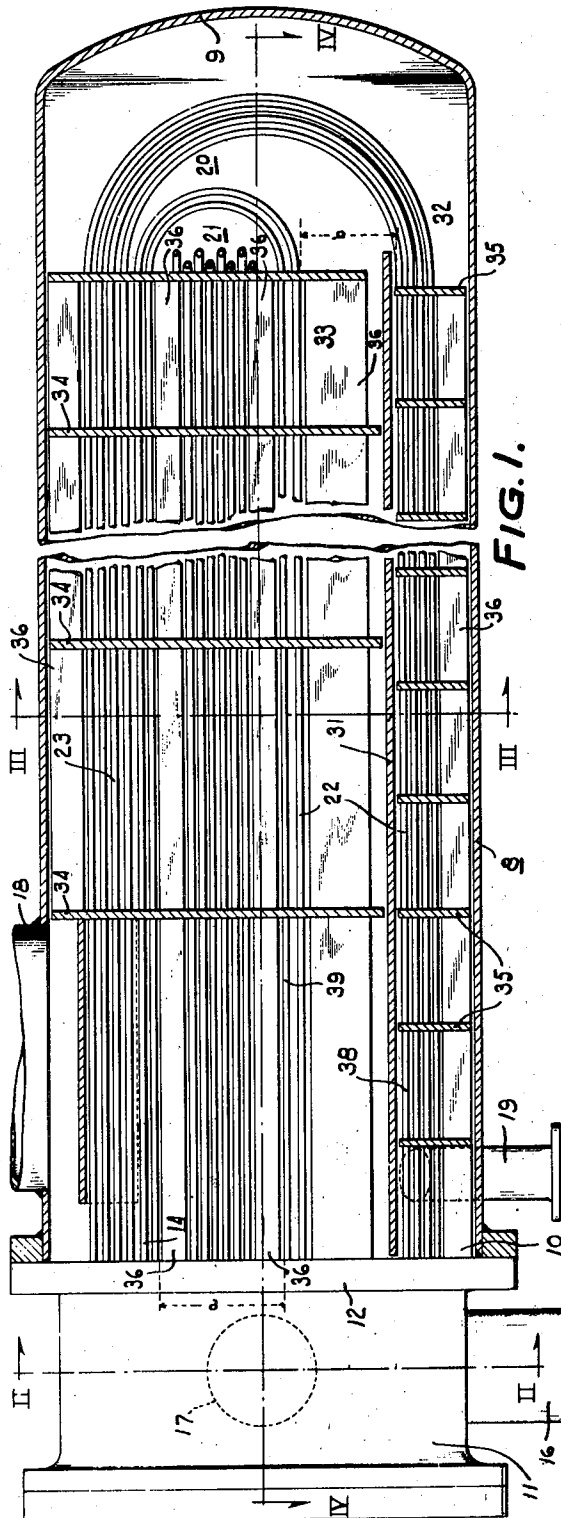


FIG. 1.

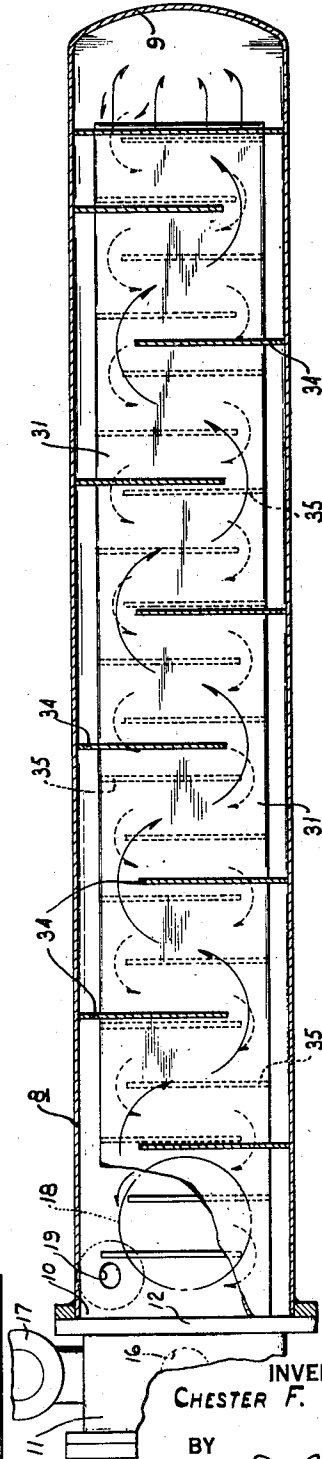


FIG. 4.

INVENTOR
CHESTER F. HANCOCK
BY *A. P. R. R. R.*
ATTORNEY

April 19, 1949.

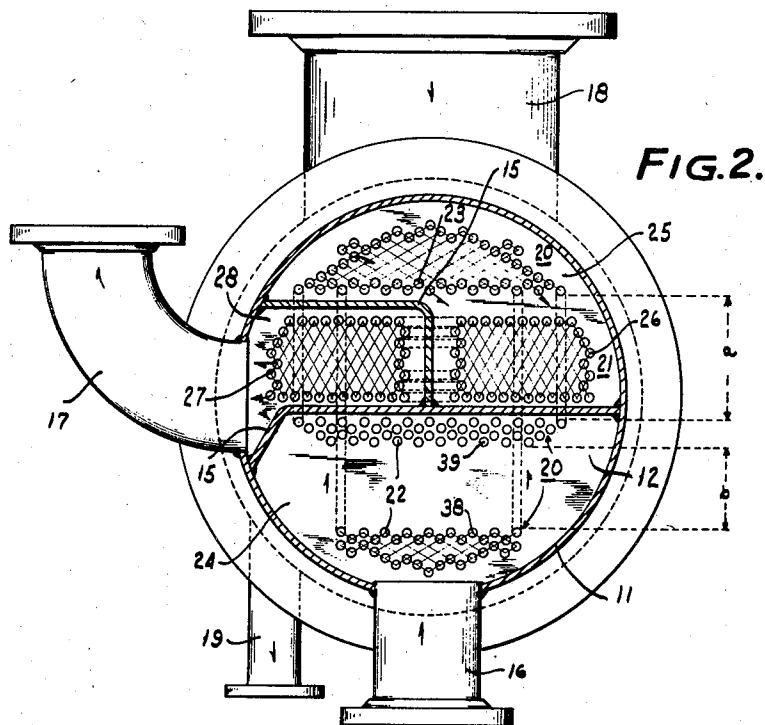
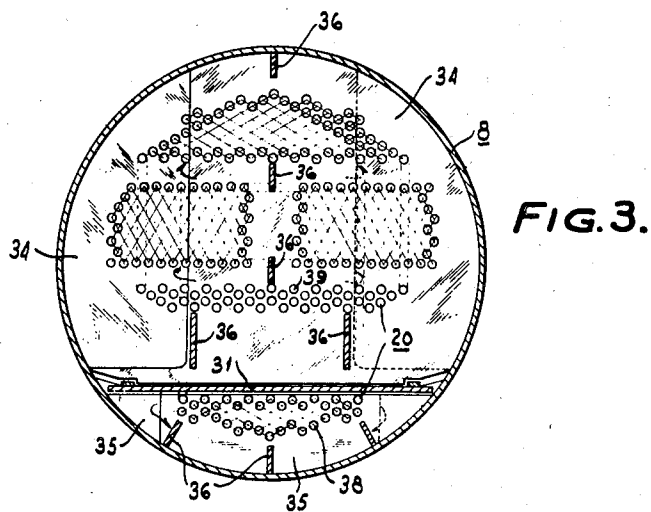
C. F. HANCOCK

2,467,741

HEAT EXCHANGE APPARATUS

Filed Sept. 30, 1947

2 Sheets-Sheet 2



WITNESSES:

V. W. Novak
D. J. McCarty

INVENTOR
CHESTER F. HANCOCK

BY *a. B. Davis*
ATTORNEY

UNITED STATES PATENT OFFICE

2,467,741

HEAT EXCHANGE APPARATUS

Chester F. Hancock, Primos, Pa., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Application September 30, 1947, Serial No. 776,900

2 Claims. (Cl. 257—32)

1

The invention relates to heat exchangers of the hairpin tube type and it has for an object to increase the tube surface accommodated in a given shell by providing groups of longer and shorter tubes with the space between the tube portions of the longer tubes partially occupied by the tube portions of the shorter tubes and with the tube bends of the latter extending transversely relative to those of the longer tubes.

In heat exchangers, it is customary to arrange the tube passes so that fluid flows through the tubes from the bottom to the top of the shell, where the latter is horizontal; and from side to side of the shell, where the latter is vertical. If tubes of the hairpin type are used, this arrangement of successive passes limits the number of tubes that can be installed in a given shell because of contour of the latter and the wide central lane occurring because the minimum radius of tube bending must be several times the tube diameter. To make more effective use of the shell with hairpin tubes, the first and second tube passes are arranged so that the tubes go from one side to the opposite side of the shell, thereby taking full advantage of the shell contour, and the central space between such passes is partially occupied by shorter hairpin tubes having their tube bends arranged transversely or at right angles to the bends of the first tubes and arranged to define third and fourth tube passes and which also go from one side to the opposite side of the shell. This arrangement is particularly useful for a horizontal shell where the first pass tube portions are at the bottom and are used to subcool condensate resulting from condensation of vapors by the other passes.

A further object of the invention is to provide a horizontal heater wherein a group of longer hairpin tubes provide a first pass along the bottom of the shell and a second pass along the top of the shell and a group of shorter hairpin tubes provide third and fourth passes along the sides of the shell, this arrangement of tube portions providing for first pass tube portions spaced below the other tube portions to afford room for change in level of condensate submerging tube portions of the first pass and being cooled by media passing therethrough.

The foregoing and other objects are effected by the invention as will be apparent from the fol-

2

lowing description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a longitudinal sectional view of a heat exchanger incorporating the present improvement;

Fig. 2 is a sectional view taken along the line II—II of Fig. 1;

Fig. 3 is a sectional view taken along the line III—III of Fig. 1; and

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 1 and looking in the direction of the arrows.

Referring to the drawings more in detail, there is shown a cylindrical shell 8 having a spherical wall 9 closing one end and having its other end 10 open. The open end of the shell is closed by a box construction 11 having a tube plate 12. The tube plate 12 carries a nest of hairpin tubes, at 14. The box construction is compartmented by partitions or walls 15 so that fluid entering the inlet 16 flows through the tubes to the outlet 17. The shell has an inlet 18 and an outlet 19 providing for flow of medium therethrough and about the tubes.

In order that the shell may accommodate the maximum number of hairpin tubes, the latter are divided into two groups comprising a longer group of hairpin tubes, at 20, and a shorter group of hairpin tubes, at 21, the group of longer hairpin tubes being nested and arranged to define a space *a* between the first and second pass tube portions 22 and 23 thereof and the group of shorter hairpin tubes being arranged to occupy partially such space, with the bends of the latter tubes extending transversely of, or at right angles to, the bends of the tubes of the longer group. The tubes of each group vary in length and radius of bend to provide for the tubes of both groups conforming to the cylindrical contour of the shell, to provide for the tubes of the longer group conforming to the spherical contour of the closed end of the shell, and to provide for increase in nest depth inwardly from the sides of each group so that tubes may occupy the interior space of the shell to the maximum extent.

Flow of medium within the tubes of each group of hairpin tubes occurs in two passes. For example, the inlet 16 may supply medium to the compartment 24 for flow through the first pass

3

tube portions 22 and the second pass tube portions 23 of the longer group of tubes to the compartment 25. As the compartment 25 places the second pass tube portions 23 in communication with the third pass tube portions 26 of the tubes of the shorter group, fluid flows from such compartment through the third pass tube portions 26 and the fourth pass tube portions 27 of the tubes of the shorter group to the outlet compartment 28 and the outlet 17.

As shown, the heater is horizontal and arranged for subcooling of condensate. To this end, the first pass provided by tube portions of the longer group extends along the bottom of the shell and the second pass provided by the tubes of such group extends along the top thereof, and the third and fourth passes provided by the tubes of the shorter group extend along the sides of the shell, the bends of the tubes of the longer and shorter groups being arranged at right angles so that the tubes of the shorter group may be located in the space between the first and second pass tube portions, whereby submerged tube portions of the first pass may be spaced below the remaining tube portions to provide a space or lane *b* for change in level of submerging liquid. As shown in Figs. 1, 3 and 4, submergence of tube portions of the first pass is assured by having the condensate outlet 19 opening into the shell interior above the lowermost point thereof.

Preferably, the shell interior is divided by a horizontal baffle 31 into a lower subcooling space 32 and an upper condensing space 33. Vertical baffles 34 in the condensing space constrain condensable heating medium entering the inlet 18 to flow to and fro across tubes of the nest, as indicated in Fig. 4. Condensate collecting on top of the horizontal baffle 31 runs off the tube bend ends thereof and enters the lower subcooling space 32. The subcooling space has baffles 35 which constrain condensate to flow to and fro across the tube portions therein before leaving through the outlet 19. Wherever necessary, clearance spaces between tube portions of the passes and between the shell and tube portions are blocked by baffles 36 to insure flow across tubes of the nest without by-passing.

As shown, tube portions 22 of the first pass are arranged to provide a group 38 below the horizontal baffle and in the subcooling space and a group 39 spaced a suitable distance above the baffle and in the condensing space, the spacing of the baffle and of the tube portions of the group 38 below the remaining tube portions assuring of adequate room above the baffle for change in level of condensate in the shell and submerging the tube portions below the baffle.

From the foregoing it will be apparent that the invention improves generally hairpin tube heat exchange apparatus in that the arrangement of tubes provides for increased surface in relation to shell size and for the tubes conforming to the shell contour. In particular, the invention improves subcooling horizontal heaters, as the subcooling section provided by the first pass tube portions of the longer group of tubes at the bottom of the shell assures, not only of high thermal efficiency, but of the temperature of the condensate leaving the heater being depressed sufficiently to avoid flashing of the condensate into steam unless the pressure is very substantially reduced. In addition, this arrangement of tubes has the latter disposed and baffled so as to secure the most effective condensing and cooling actions.

4

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. In heat exchange apparatus, a shell having one end open and the other end closed; a box closing the open end of the shell and including a tube plate; hairpin tubes carried by the tube plate; said tubes including first and second pass tube portions joined by vertical bends and including third and fourth pass tube portions joined by horizontal bends so that the latter tube portions may be located vertically in space between the first and second pass tube portions; said box including an inlet and outlet connections and means for causing liquid medium entering the inlet connection to flow in series through the first, second, third and fourth pass tube portions to the outlet connection; said shell including an inlet for condensable medium located at the upper portion thereof adjacent to said box and an outlet for condensate located at the lower portion thereof adjacent to said box; said first pass tube portions including a first group extending along the bottom of the shell and a second group spaced thereabove and arranged below the third and fourth pass tube portions; a horizontal baffle dividing the shell interior into upper condensing and lower cooling spaces which communicate at the closed end of the shell; said tube portions of the first pass being located in the cooling space and such tube portions and the horizontal baffle being spaced below the remaining tube portions of the passes; vertical baffles in the condensing space and arranged to constrain medium entering the inlet and flowing toward the closed end of the shell to pass to and fro across the tube portions therein; vertical baffles in the cooling space and constraining condensate flowing therealong from the closed end of the shell to the outlet to pass to and fro across the tube portions therein; and means providing for discharge of condensate through the shell outlet so as to maintain submergence of tube portions below the horizontal baffle.

2. In heat exchange apparatus, a shell having one end open and the other end closed; a box closing the open end of the shell and including a tube plate; hairpin tubes carried by the tube plate; said tubes including first and second pass tube portions joined by vertical bends and including third and fourth pass tube portions joined by horizontal bends so that the latter tube portions may be located vertically in space between the first and second pass tube portions; said box including an inlet and outlet connections and means for causing liquid medium entering the inlet connection to flow in series through the first, second, third and fourth pass tube portions to the outlet connection; said shell including an inlet for condensable medium located at the upper portion thereof adjacent to said box and an outlet for condensate located at the lower portion thereof adjacent to said box; said first pass tube portions including a first group extending along the bottom of the shell and a second group spaced thereabove and arranged below the third and fourth pass tube portions; a horizontal baffle dividing the shell interior into upper condensing and lower cooling spaces which communicate at the closed end of the shell; said horizontal baffle being arranged between said

first and second groups of tube portions of the first pass and spaced below the second group thereof; vertical baffles in the condensing space and arranged to constrain medium entering the inlet and flowing toward the closed end of the shell to pass to and fro across the tube portions therein; vertical baffles in the cooling space and constraining condensate therealong from the closed end of the shell to the outlet to pass to and fro across the tube portions therein; and means providing for discharge of condensate through the shell outlet so as to maintain submergence of the tube portions below the horizontal baffle.

CHESTER F. HANCOCK.

5

10

15

Number
729,400
1,139,549
1,738,848
1,990,251
2,060,078

Number
447,195

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Name	Date
Patterson -----	May 26, 1903
Lovekin -----	May 18, 1915
Starr -----	Dec. 10, 1929
Potter -----	Feb. 5, 1935
Hobbs -----	Nov. 10, 1936

FOREIGN PATENTS

Country	Date
France -----	Oct. 21, 1912