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HEAT EXCHANGING APPARATUS

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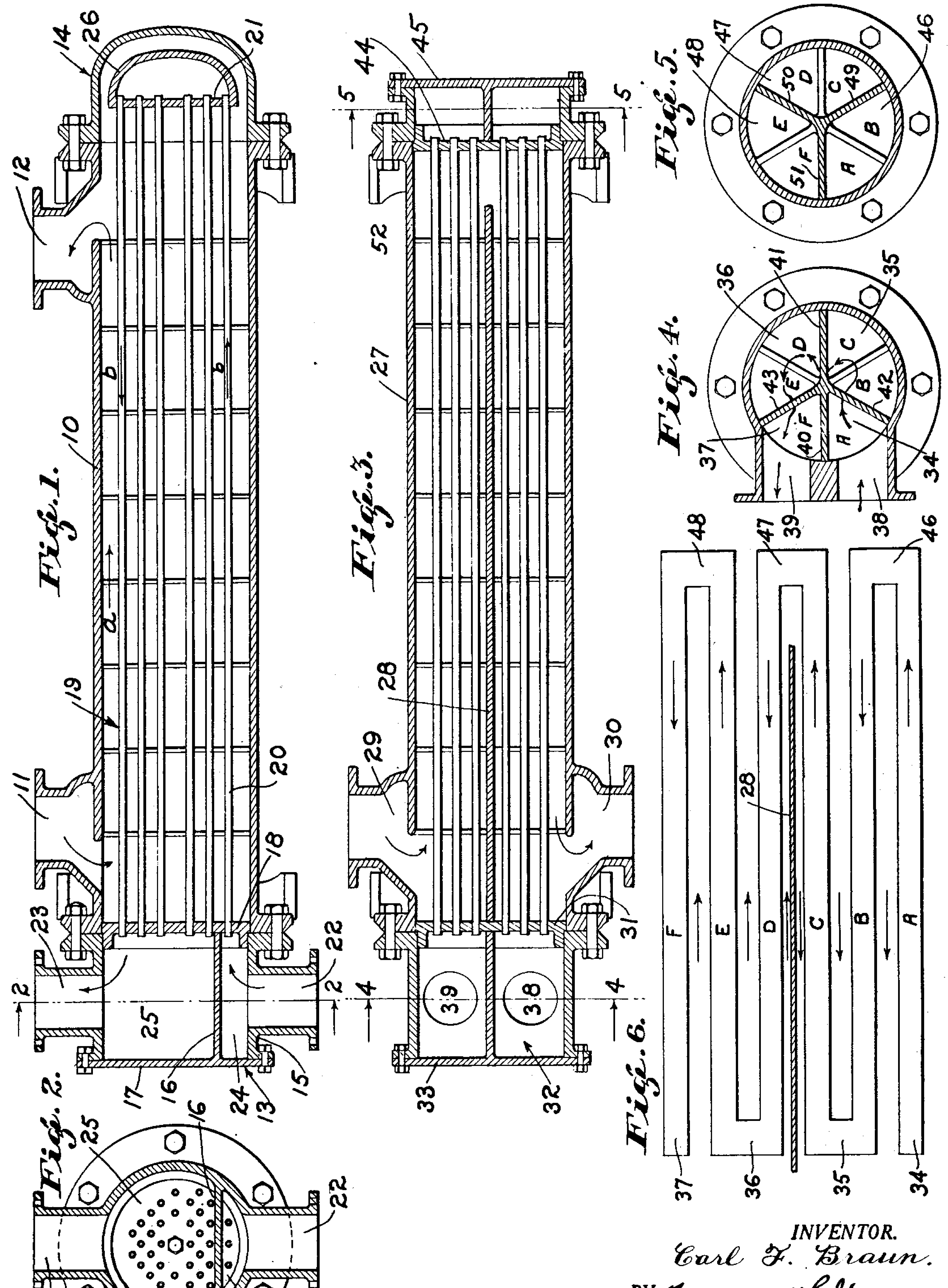

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HEAT-EXCHANGING APPARATUS.

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This invention relates to heat exchanging apparatus and particularly pertains to counterpassing condensers, fractionating condensers, coolers and the like.

It is common practice to construct heat exchangers with an outer shell, through which a flow of fluid to be cooled is maintained and within which shell a tube nest is positioned to provide a plurality of circulating passageways for a cooling fluid, a heat exchange taking place between the fluid outside of the tubes and the fluid inside the tubes.

Practice has demonstrated that in most cases counterflow of the two fluids is desirable.

If the two fluids pass through the apparatus in a single pass each, the apparatus may become impracticable and uneconomical on account of size and cost.

In some heat exchangers, a multipass arrangement has been made whereby the fluids between which heat exchange takes place, make a plurality of passes back and forth throughout the length of exchanger; this construction has the advantage of compactness, but frequently at the expense of the counterflow principle.

The object of the present invention is to provide an arrangement whereby a plurality of passes through the apparatus is combined with counterflow of the fluids in a multipass heat exchanger.

The present invention contemplates the use of an enclosing shell through which a fluid may flow, and within which shell is disposed a set of tubes through which another fluid flows, said shell and tubes being so arranged that a counterflow of the two fluids will be effected through a length of counterflow passageways.

The invention is illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a view in longitudinal central section showing one form of the present invention.

Fig. 2 is a view in transverse vertical section as seen on line 2—2 of Fig. 1.

Fig. 3 is a view showing another form of the present invention as seen on its central longitudinal section line.

Fig. 4 is a view in transverse section through the form of the invention shown in Fig. 3, as seen on the line 4—4 of Fig. 3.

Fig. 5 is a view in transverse section through the opposite end of the exchanger as seen on line 5—5 of Fig. 3.

Fig. 6 is a diagrammatical view showing the flow of the two fluids through the shell and the groups of tubes.

Referring more particularly to Figs. 1 and 2 of the drawings, it will be seen that a shell 10 is provided having an induction port 11 and an eduction port 12. A fluid flows longitudinally through the shell from the induction port 11 to the eduction port 12. The opposite ends of the shell are closed by a dome 13 at one end and a cap 14 at the opposite end. The dome 13 is substantially cylindrical in shape and is formed with an outer cylindrical wall 15 having a transverse web or partition member 16. This member does not divide the interior of the dome into equal parts, but is so arranged as to form two compartments of predetermined unequal cross sectional area, as more clearly shown in Fig. 2 of the drawings.

The outer end of the dome is closed by a cover plate 17, while the inner end of the dome is closed by a tube sheet 18 of a tube nest 19. The tube nest comprises a plurality of parallel longitudinally extending tubes 20 connected to tube sheet 18 at one end and a tube sheet 21 at the opposite end. The dome member 15 is formed with an induction port 22 and an eduction port 23 communicating with the compartments 24 and 25, into which the dome is divided by the partition walls 16.

The compartment 24 as seen in Fig. 2 is of relatively small sectional area and communicates with a small number of tubes 20, as compared with the aggregate number of tubes in the tube nest. The compartment 25 communicates with the remaining tubes. All of the tubes terminating in the tube sheet 21 are in communication by a cap 26 which is secured over the end of the tube sheet 21 and diverts the fluid passing through the tube sheets in communication with compartment 24 to the tubes communicating with the enlarged compartment 25.

The entire volume of fluid circulating through the shell passes from induction opening 11 to eduction opening 12 in the direction of the arrow —*a*—. The fluid delivered through the induction opening 22 of the dome passes at high velocity through the tubes in communication with the compartment 24 and, of course, in the same direction, as the direction of flow of the fluid in the shell.

When passing through the ends of the tubes in the tube nest 21 the fluid from compartment 24 will return in counterflow through the tubes which communicate with compartment 25 and in the direction of the arrow —*b*—. This will provide counterflow of the two fluids.

In the form of the invention shown in Fig. 3, shell 27 is provided. This shell is formed with a central longitudinal partition wall 28 which extends from one end of the shell to terminate at a point adjacent the opposite end of the shell, although somewhat short of the full length of the shell.

At the end of the shell at which the longitudinal partition terminates substantially flush with the end, an induction port 29 and an eduction port 30 are provided upon opposite sides of the partition wall 28. The end of the shell adjacent the ports is closed by a tube sheet 31 on the outside of which is a cylindrical dome 32. The dome is provided with a cover plate 33 and is divided into passageways 34, 35, 36 and 37. These passageways are formed by radially extending partition walls, as indicated more particularly in section in Fig. 4 of the drawings.

A fluid induction port 38 communicates with the segmental passageway 34 and a fluid eduction port 39 communicates with the segmental compartment 37 of the dome. The compartments 34 and 37 are sectors of the circle, each being measured by substantially one-sixth of the circumference of the circle and separated by a partition wall 40 which also separates the induction port 38 and the eduction port 39. The compartments 35 and 36 are sectors of the circle, each including substantially one-third of the circumference of the circle and divided by a partition wall 41 extending diametrically opposite from the partition wall 40. The compartments 34 and 35 are separated by radially extending partition wall 42 and the compartments 36 and 37 are separated by radially extending partition wall 43. The opposite end of the shell 27 from the end upon which the cylindrical dome 32 is mounted is closed by a tube sheet 44, on the outside of which is a cap 45. The cap 45 is divided into three compartments of sector shape, as indicated at 46, 47 and 48. These compartments are separated by radially extending walls. Such a wall 49 separates compartments 46 and 47, and wall 50 separates compartments 47 and 48, and a wall 51 separates compartments 46 and 48.

By comparing Figs. 4 and 5 of the drawings, it will be seen that wall 40 in the dome 32 is in the same plane and in longitudinal alignment with wall 51 of the cap 45, and that walls 49 and 50 in the cap 45 are spaced at one hundred twenty degrees to wall 51, so that viewed collectively the radial walls in the dome 32 and the cap are arranged at sixty degrees to each other, which divides the set of tubes into six sets indicated by the reference characters A, B, C, D, E and F, each set being defined by a sector representing approximately one-sixth of the sectional area of the shell.

In operation of the apparatus shown in Figs. 3 to 5 inclusive, a fluid to be cooled may pass into the shell 27 through induction port 29 and then flow lengthwise of the shell along the passageway of the semi-circular section, as defined by the shell wall, and the longitudinal partition member 28. When the fluid has reached the opposite end of the partition member from its induction end, it will pass around the end of the partition member 28 and between this end and the tube sheet 44 through a passageway 52. The fluid will then return along the lower passageway of semi-circular section to the eduction port 30.

Cooling fluid is delivered to the dome 32 through induction port 38 and into compartment 34 defined by the radial walls 40 and 42. The cooling fluid will then flow lengthwise of the set of tubes indicated by the character A. This fluid will pass out of this set of tubes A and into compartment 46 formed in the cap 45 at the opposite end of the shell. The compartment 46 is represented by a sector of twice the arcuate length of compartment 34 and so arranged that the compartment 46 will overlap the compartment 34 by substantially one-half its arcuate length. This will cause the fluid which flowed through the pipes A in exclusive communication with compartment 34 to be diverted into pipes B exclusively communicating with the compartment 46 at the cap end of the shell and the compartment 35, at the dome end of the shell.

The fluid which has now passed to compartment 35 in the dome by flowing through tubes B will be diverted from compartment 35 to tubes C which communicate with the other half of compartment 35 and extend to the opposite end of the shell where they communicate with compartment 47 of the cap. The fluid will then flow through compartment 47 of the cap. The fluid will then find its way into the set of tubes D in communication with the compartment 47 at one end and the compartment 36 in the dome. The fluid in compartment 36 will be diverted from the set of tubes D to the set of tubes E and will again flow throughout the length of the shell to compartment 48 in the cap. Here the fluid will pass from pipes E into compartment 48 and then into tubes F which communicate with this compartment and also communicate at the opposite end with compartment 37 of the dome. When the fluid reaches this compartment it passes from the exchanger through education port 38.

By considering the apparatus, it will thus be evident that in a shell of relatively small area and length it is possible to obtain a large area of heat exchange surface distributed throughout length of fluid passageway while the fluid is flowing countercurrent. By further analysis it will be seen that in the upper half of the heat exchanger, fluid flows in the direction of the arrow —*a*— and that in the lower passageway the fluid flows in the direction of the arrow —*b*—. However, the cooling fluid which flows through the tubes makes six passes while the fluid in the shell makes two passes. Thus, the two fluids will be unidirectional in their flow while fluid passes through the groups of pipes B and E and will flow in counter direction in pipes A, C, D and F. This insures that the fluids will only have one-third of their flow unidirectional and that two-thirds of their flow will be in a counterdirection which is desirable for producing efficient heat exchange in a multi-pass apparatus.

While I have shown the preferred form of my invention as now known to me, it is to be understood that various changes may be made in its construction without departing from the spirit of the invention as defined in the appended claim.

Equally it is to be understood that the cooling medium and the medium to be cooled may each flow either through shell or tubes.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

In a device of the character described, a shell through which a fluid flows longitudinally from end to end of the shell and returns in a single pass in each direction, a tube nest extending longitudinally of the shell and through which a cooling medium flows, means at the opposite ends of the tube nest for dividing the tubes into three times as many groups as there are longitudinal passes of the fluid in the shell and creating a circulation of a cooling medium through said tubes in a manner to establish a countercurrent flow of the two fluids in a ratio of one portion parallel current to two portions countercurrent.

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