C. F. BRAUN.
HEAT EXCHANGER.
APPLICATION FILED SEPT. 12, 1918.

1,353,449. Patented Sept. 21, 1920.

3 SHEETS—SHEET 3.

Fig. 5.

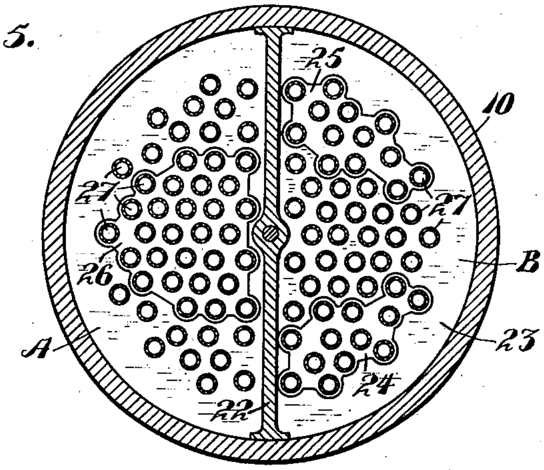


Fig. 6.

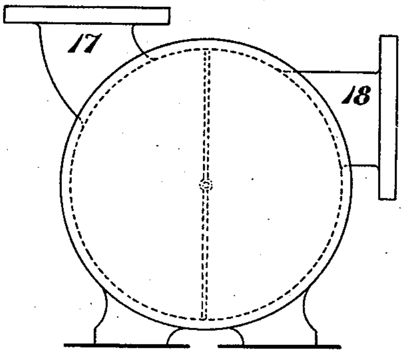


Fig. 7.

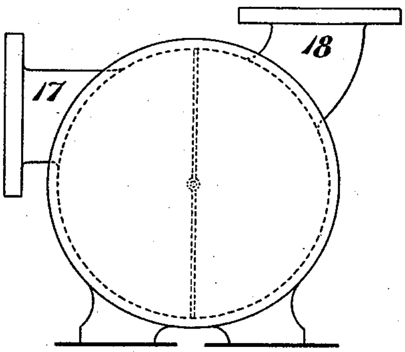


Fig. 8.

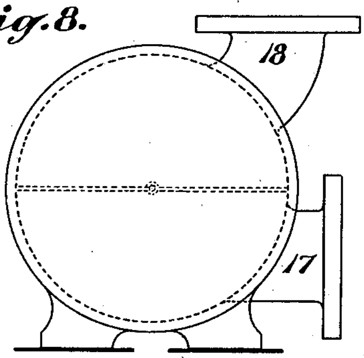
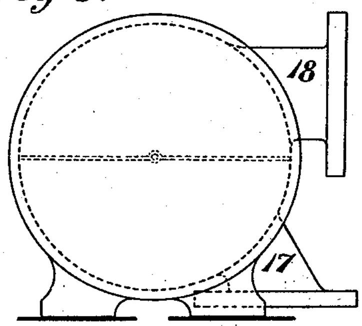


Fig. 9.



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3 SHEETS—SHEET 2.

Fig. 3.

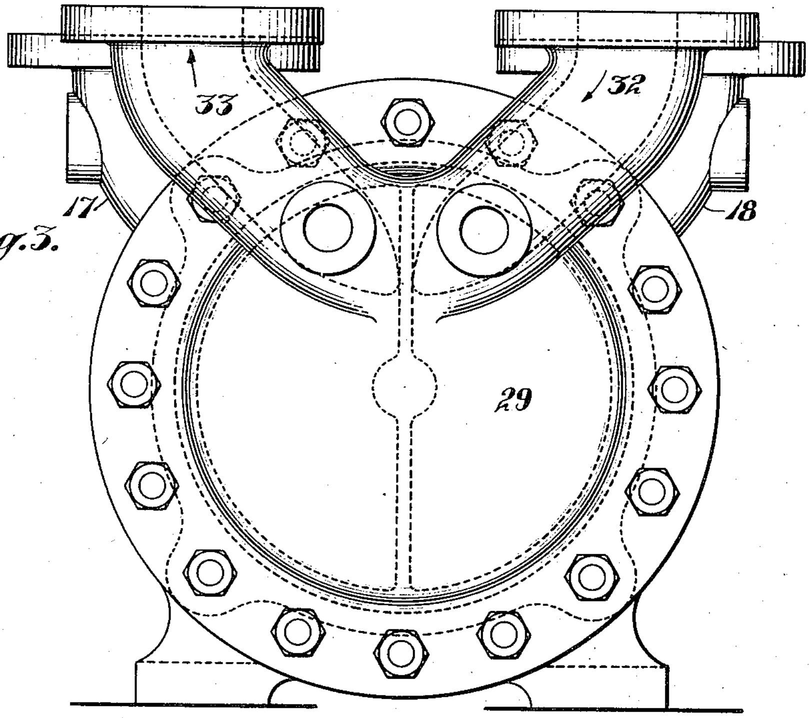
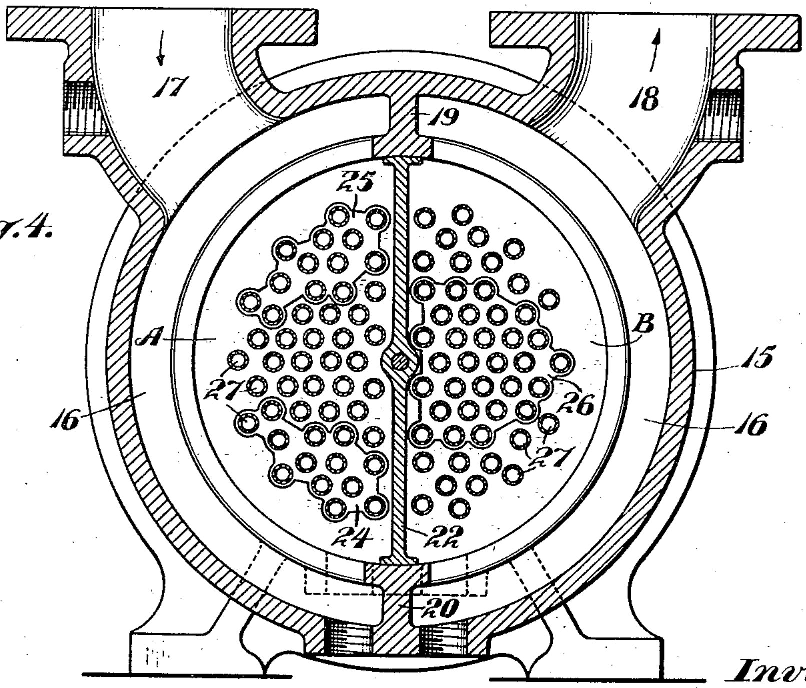


Fig. 4.



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3 SHEETS—SHEET 1.

Fig.1.

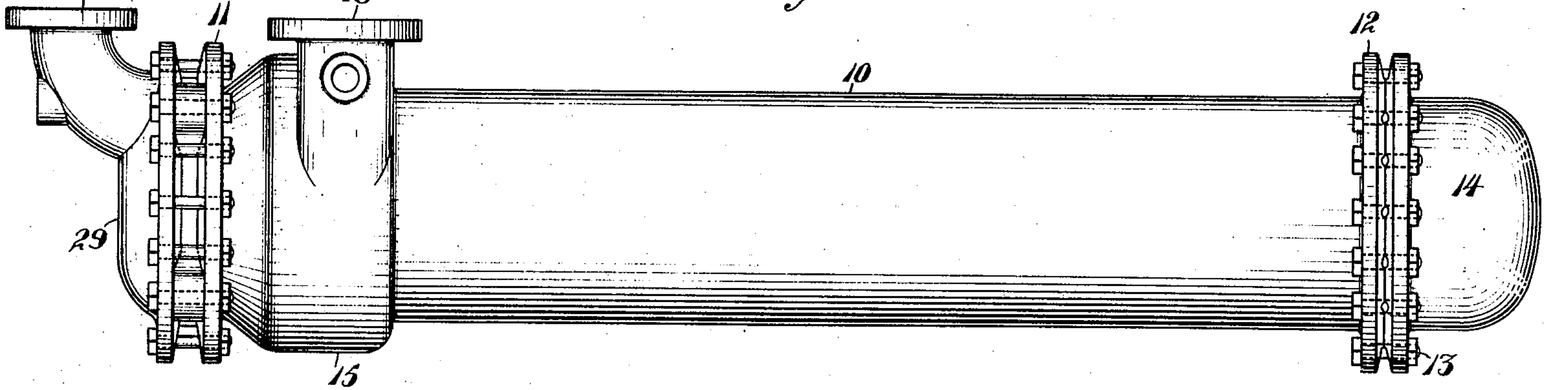
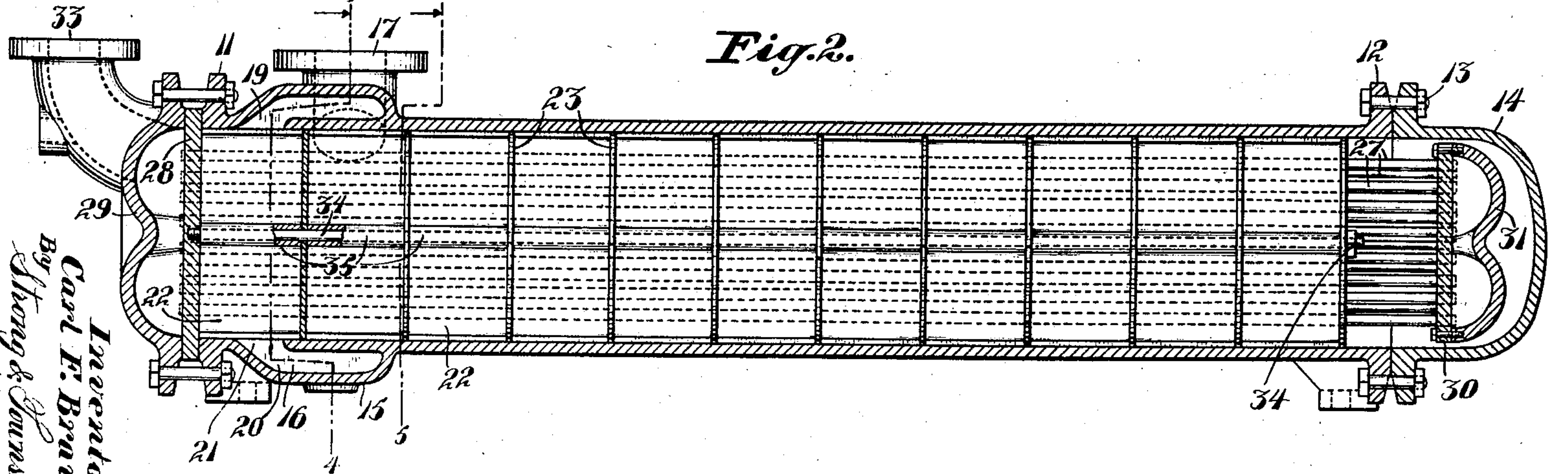


Fig.2.



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UNITED STATES PATENT OFFICE.

CARL F. BRAUN, OF SAN FRANCISCO, CALIFORNIA.

HEAT-EXCHANGER.

1,353,449. Specification of Letters Patent. Patented Sept. 21, 1920.

Application filed September 12, 1918. Serial No. 253,811.

To all whom it may concern:

Be it known that I, CARL F. BRAUN, a citizen of the United States, residing in the city and county of San Francisco and State of California, have invented new and useful Improvements in Heat-Exchangers, of which the following is a specification.

This invention relates to a heat exchanger.

In a surface heat exchanger in which heat is transmitted from a fluid to a metallic surface or from a metallic surface to a fluid the greatest part of the temperature head is required for transmitting the heat from the surface of the metal into the body of the fluid, and, since most fluids are very low conductors of heat, this can only be accomplished efficiently by designing apparatus to increase the convection currents to a maximum for any given pressure drop through the apparatus. If heat is to be transmitted from a liquid to a vapor satisfactory heat transfer can be obtained by passing the liquid through the tubes of the apparatus and surrounding the tubes by the vapor, the tubes being arranged in groups so as to give the liquid high velocity convection currents and it is not therefore necessary to agitate the condensing or evaporating fluid. If two liquids are involved, and, particularly, if one of them is a very viscous fluid, it is difficult to obtain sufficient agitation to produce the necessary convection currents, and in recent years a number of devices have been developed to accomplish this object. For commercial reasons nearly all of these structures have been of the tubular type and have been provided with a system of transverse baffle members. Most of these structures have proven objectionable in practice as they have been designed so that the nozzles have been on opposite ends and the flow of the fluid outside of the tubes has been parallel to the flow of the fluid inside the tubes. A further objection has been that the fluid has not been in contact with the tubes during its entire flow and therefore unnecessary friction has been introduced. The transverse baffles have also been excessive in number and expensive to manufacture.

It is the object of the present invention to overcome the above-mentioned defects by designing a heat exchanging apparatus having all of its nozzles at one end and being provided with longitudinally and transversely extending baffles which will determine that the current of the two liquids within the apparatus will flow counter to each other and that the fluid will be in substantially constant contact with the tubes.

The present invention contemplates the use of an outer shell having removable heads at the opposite ends thereof, one of said members being provided with inlet and outlet connections and the shell being formed with inlet and outlet connections at the end adjacent said head. The interior of the shell is further formed to receive a plurality of parallel tubes, a longitudinal baffle wall and a series of transverse baffle walls.

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

Figure 1 is a view in side elevation illustrating the completely assembled apparatus.

Fig. 2 is a view in longitudinal, vertical section disclosing the parts shown in Fig. 1 and their relation to each other.

Fig. 3 is a view in end elevation illustrating the connections for the various induction and eduction pipes.

Fig. 4 is a view in transverse section as seen through the shell on the line 4—4 of Fig. 2 and as particularly disclosing the longitudinal baffle wall, the inlet and outlet passageways communicating therewith and the formation of one of the transverse baffle plates.

Fig. 5 is a view in transverse section through the shell as seen on the line 5—5 of Fig. 2 and illustrates the formation of the other transverse baffle plate.

Figs. 6, 7, 8 and 9 are end views in diagram illustrating various arrangements of the connecting passageways in relation to the shell.

Referring more particularly to the drawings, 10 indicates a cylindrical tubular shell which extends horizontally and has enlarged annular bolting flanges 11 and 12 at its opposite ends. One of these flanges is provided to receive bolts 13 by which an end cap 14 is secured in position. This cap is dome-shaped and forms a cavity which is a continuation of the cylindrical passageway through the shell. The opposite end of the shell is formed with an encircling jacket 15 to which the flange 11 is united and which is spaced from the terminating end of the continuous tubular wall of the shell, as particularly shown in Fig. 2. This arrangement provides an annular circulating chamber 16 passing around the end of the side wall of the shell and communicating with the interior thereof. As shown in Fig. 4, this annular chamber is fitted with an induction passageway 17 and an eduction passageway 18. These passageways are provided with appropriate flanges by which pipes may be bolted to the shell.

Extending longitudinally of the shell, substantially midway between the two passageways 17 and 18, is a partition wall 19 which divides the upper part of the annular chamber 16. A similar partition wall 20 is disposed diametrically opposite from the wall 19 and completes the division of the chamber 16 into two equal halves. One half of this chamber will then be in communication with the passageway 17 and the other half with the passageway 18.

Due to the throat 21 which occurs between the end of the shell wall and the end of the shell as defined by the flange 11 of the shell, a communication will be established between the separate parts of this outer chamber and the interior of the shell. As particularly shown in Fig. 4 the cylindrical passageway through the shell is divided longitudinally by means of a longitudinal baffle wall 22 which extends vertically and separates the shell into passageways of semi-circular section, as indicated at A and B. These passageways are in communication with the complementary portions of the chamber 16 and are therefore connected with the inlet and outlet passageways 17 and 18, the inlet passageway 17 being in communication with the longitudinal chamber A and the outlet passageway 18 being in communication with the longitudinal chamber B.

Circulation is effected between these chambers by the elimination of a length of baffle wall at the opposite end of the shell, thus allowing a free flow of liquid from one of the compartments to the other. Interposed throughout the length of the shell and spaced equidistant from each other is a series of transverse baffle plates 23. These plates are made in two forms and are arranged alternately throughout the length of the structure. The first baffle plate in the series is shown in Fig. 4 as having irregular-shaped circulating openings 24, 25, 26, as well as a plurality of small perforations through which tubes 27 extend. The openings 24 and 25 are disposed along one side of the longitudinal baffle wall, while the opening 26 is disposed along the other. The next transverse baffle is reversed so that the opening 26 will occur in the chamber A, while the openings 24 and 25 will occur in the chamber B. Due to this arrangement the flow of liquid throughout the length of the shell will be first through the openings 24 and 25 which are spaced a distance from each other, and then through the central opening 26, this action taking place alternately throughout the length of the shell and thus thoroughly exposing the liquid to the surface of the tubes and insuring that sufficient convection will take place to produce the proper heat transfer.

The tubes 27 are mounted within a head plate 28, which is bolted between the flange 11 of the shell and a removable head cap 29. The opposite ends of the tubes are held by a bolting cross head 30 through which the tubes extend, and which is also provided with an end cap 31 which will insure that the sets of tubes will communicate with each other at this end. The opposite or forward end of the tubular core thus formed is adapted to communicate with inlet and outlet pipes 32 and 33. These pipes form a part of the head cap 29 and are in separate communication with the tubes which extend down the opposite sides of the longitudinal baffle wall 22, the head cap 29 and the cap 31 being properly divided to agree with the positioning of the tubes in relation to the longitudinal baffle member. The core formed of the plate 28, the cross head 31 and the transverse baffle plates 23, is secured together by a longitudinal bolt 34 which extends through a series of spacing sleeves 35. These sleeves are in section and are interposed between the baffle walls 23. It is also to be noted that the longitudinal baffle member 22 is in section and that its oppositely disposed plates are formed integral with the sleeves 35. Due to this sectional construction of the entire core it is quite easy to remove any of the elements when damaged and to readily replace them.

In operation, one of the liquids which passes through the apparatus is admitted through the passageway 17 and thereafter flows through a part of the divided annular chamber 16 into the longitudinal compartment A of the shell. Here it will travel alternately through the baffle walls and will first be dispersed over the baffle plates to pass through the openings 24 and 25 and then be restricted to pass through the opening 26. This action will expose the entire body of liquid to all of the pipes in the apparatus, and, after it has passed the last longitudinal baffle section, it may then return along the compartment B of the shell. During its return course the action of the transverse baffles will be the same as formerly specified, and the fluid will eventually pass outwardly through the outlet passageway 18. While a fluid has been circulating from the inlet passageway 17 to the outlet 18 another fluid has been circulating in an opposite direction through the tubes 27. In this instance, the fluid passes into the apparatus through the pipe 32, and, after entering the compartment in the head cap 29, will circulate in the tubes in the compartment B of the shell. Upon reaching the opposite end of the core this liquid will be returned to the head cap 29 through the tubes in the compartment A and will thereafter pass outwardly through the pipe 33. It will thus be noted that the flow of current will be opposite in direction in each of the compartments, and that while the fluid within the shell is passing to one end of the apparatus along one of the compartments the fluid in the tubes is passing in the opposite direction in the same compartment, thus insuring that the fluids of extreme temperature will be in contact at all times, and thereby causing a more efficient heat absorption to take place.

While the major portion of the present description has been concerned with the use of inlet and outlet passages, as shown in Figs. 3 and 4, it will be understood that by the proper arrangement of the heads of the shell and the longitudinal baffle walls the inlet and outlet passageways could be disposed, as shown in either of the Figs. 6, 7, 8 and 9.

It will thus be seen that the apparatus here disclosed may be readily constructed without the use of expensive or complicated parts and so that the parts may be easily removable and maintained in an operative condition, at the same time insuring that an efficient transfer of heat will take place and that a maximum circulation of fluid and convection may be produced within the apparatus.

It will be understood that the transverse baffle plates may be disposed at any desired angle to the longitudinal axis of the shell, and, furthermore, that additional longitudinal baffle plates may be provided to cause the liquid to traverse the length of the shell a plurality of times.

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

1. In a heat exchanger, an end cap, a tube head adapted to rest thereagainst, a plurality of open-ended tubes extending through said head and parallel to each other, a bolting head through which the opposite ends of said tubes extend, a cap secured to said bolting head whereby communication between all of the tubes may be established, sectional longitudinal baffle members adapted to divide the tubes into two groups, transverse perforated baffle members interposed between the sections of said longitudinal baffles and a connecting bolt upon which all of said baffles are secured.

2. In a heat exchanger, a shell, a nest of tubes therein, fluid inlet and outlet openings at one end of said shell, means for circulating a fluid around the tubes throughout the length of the shell and to return therein, and means for alternately dividing and converging the fluid flow in said shell during its longitudinal course of travel whereby the fluid is spread and the velocity thereof decreased and thereby decreasing the friction between the surface of the shell and the fluid to a minimum.

3. In a heat exchanger, an end cap, a tube head adapted to rest thereagainst, a plurality of open-ended tubes extending through said head and parallel to each other, a bolting head through which the apposite ends of said tubes extend, a cap secured to said bolting head whereby communication between all of the tubes may be established, sectional longitudinal baffle members adapted to divide the tubes into two groups, transverse perforated baffle members interposed between the sections of said longitudinal baffles, a connecting bolt upon which all of said baffles are secured, and means for retaining said transverse baffle members in spaced relation upon said connecting bolt.

In testimony whereof I have hereunto set my hand in the presence of a subscribing witness.

CARL F. BRAUN.

Witness:
J. H. HERRING.