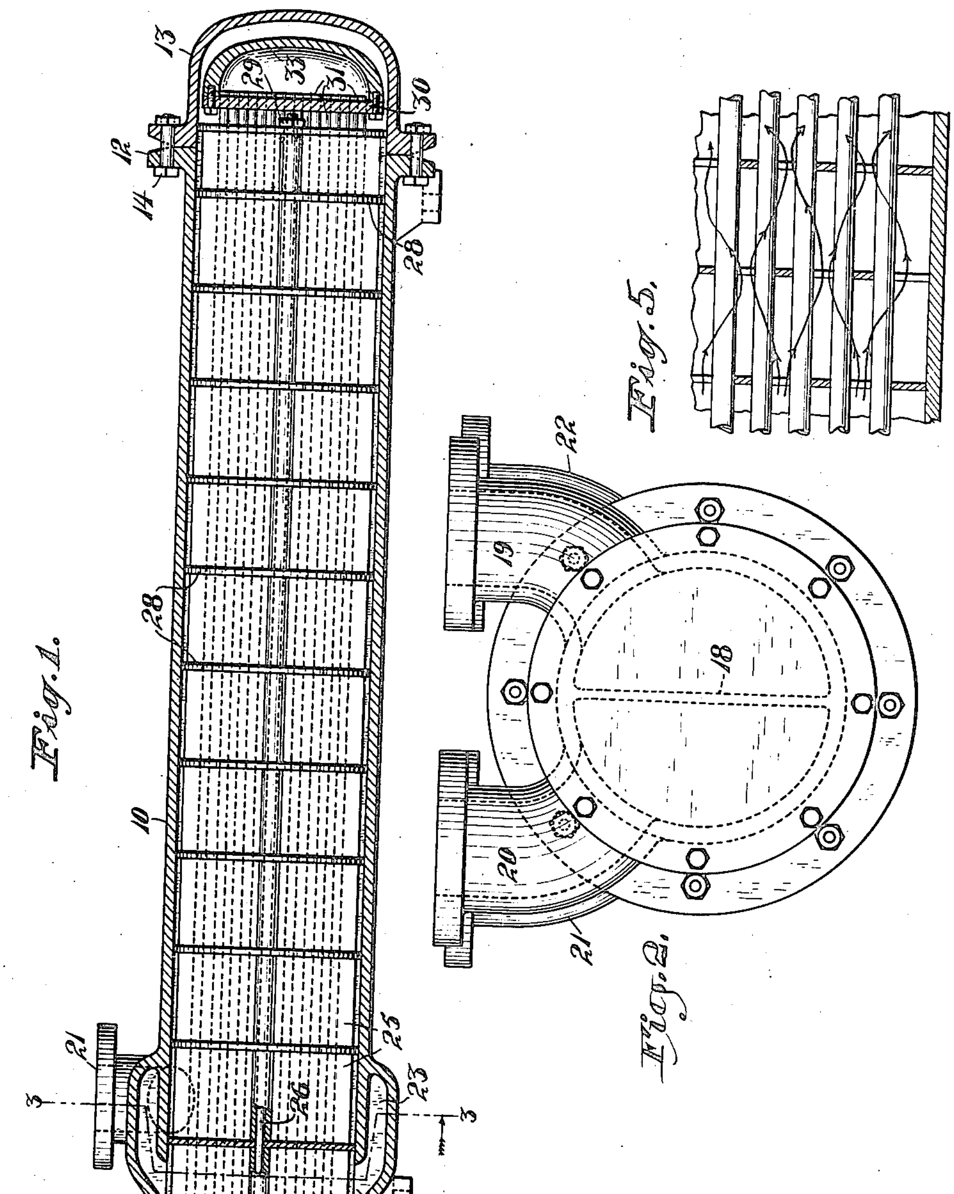
Jan. 16, 1923. 1,442,783.

C. F. BRAUN.

HEAT EXCHANGER.

FILED SEPT. 3, 1919.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

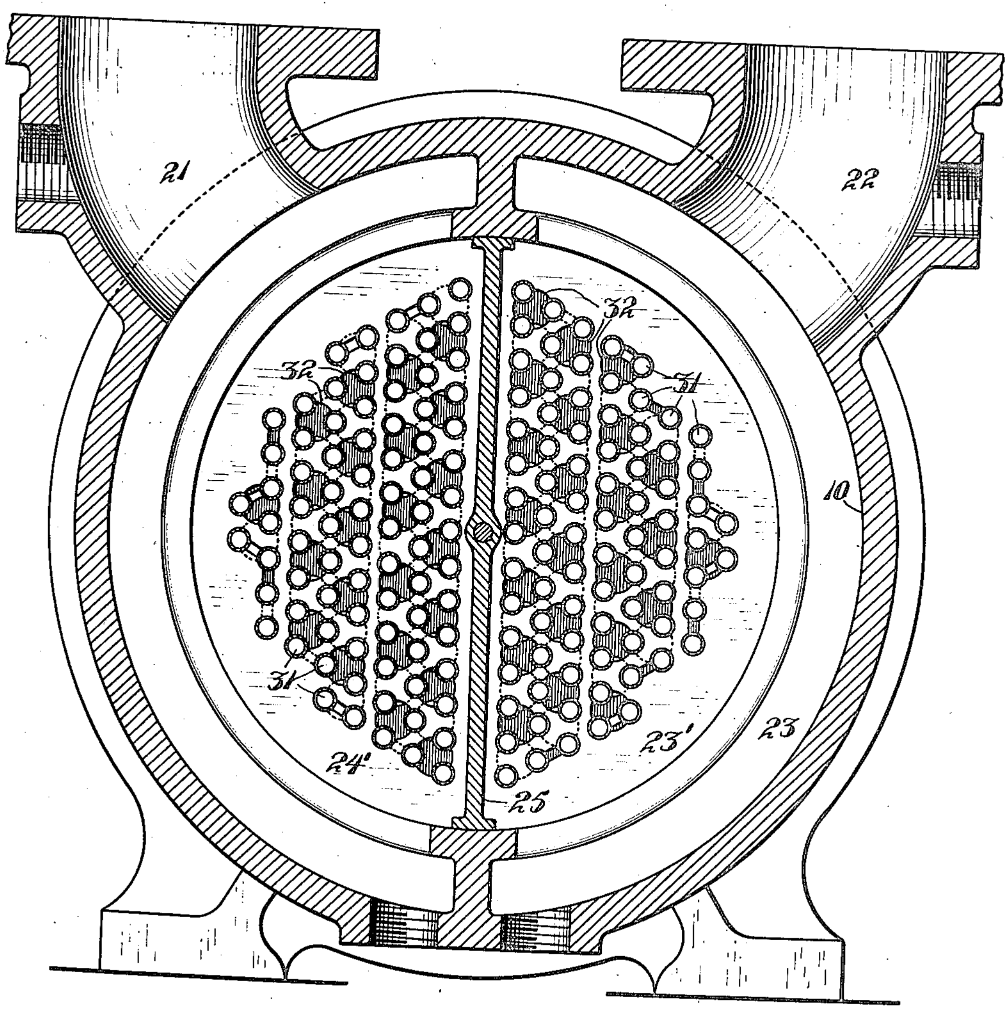

Fig. 3.

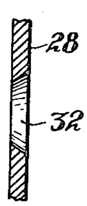

Fig. 4.

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Patented Jan. 16, 1923. 1,442,783

UNITED STATES PATENT OFFICE.

CARL F. BRAUN, OF SAN FRANCISCO, CALIFORNIA.

HEAT EXCHANGER.

Application filed September 3, 1919. Serial No. 321,450.

To all whom it may concern:

Be it known that I, Carl F. Braun, a citizen of the United States, residing at 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 surface heat exchangers maximum efficiency is obtained by producing a maximum heat transfer accompanied by a minimum friction loss and as these two factors are at variance with each other, it has been an important problem to design heat exchangers which will comply with the specifications of installation engineers. This is particularly true when two fluids are involved and one or both of the fluids are very viscous. In this case, it is necessary to produce the maximum heat transfer by increasing the amount of turbulence thus producing satisfactory convection currents for the transfer of heat, in addition to that transferred by conduction. It will readily be seen that by increasing the turbulency of the viscous fluid the friction loss will be increased and it is the principal object of the present invention to provide a heat exchanger structure which will in this manner produce a maximum turbulence accompanied by a minimum friction loss.

The present invention is concerned with a structure embodying the use of an enclosing shell, having inlet and outlet openings for two fluids at one end thereof and being further arranged with longitudinally extending compartments, through which one of the fluids may flow and which compartments are equipped with circulating tubes through which the other liquid may flow, the compartments being further separated by a plurality of transversely extending baffle members formed with a series of orifices systematically spaced thereover and preferably arranged in staggered relation to each other when the adjoining baffle plates are considered.

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

Fig. 1 is a view in longitudinal section showing one form of the present invention and the arrangement of the baffle plates therein.

Fig. 2 is a view in end elevation, disclosing the inlet and outlet connections of the heat exchanger.

Fig. 3 is an enlarged view in vertical section, as seen on the line 3—3 of Fig. 1, more particularly disclosing the baffle-plates and the arrangement of the circulating tubes and the baffle-plate perforations.

Fig. 4 is an enlarged fragmentary view in section through one of the distributing openings to the baffle plate.

Fig. 5 is a fragmentary view in section and elevation showing the staggered relation of the openings in adjacent baffle plates.

In the drawings a heat exchanger is illustrated, the general construction of which is more fully disclosed in my copending application, entitled Heat exchanger, filed March 13th, 1919, and bearing the Serial Number 282,258 which has matured into Patent No. 1,376,135, April 26, 1921. In this structure the tubular shell 10 is provided, having a continuous central passageway of uniform dimension extending throughout the length thereof. The opposite ends of the shell are provided with bolting flanges 11 and 12. A cap 13 is fitted against one end of the shell and bolted to the flange 12 by means of bolts 14. This cap has an interior bore agreeing in dimensions with the main passageway through the shell. The opposite end of the shell is provided with an extension drum 15 bolted to the flange 11 by bolts 16. This drum is formed with an interior bore of slightly smaller diameter than the shell passageway and is mounted concentric with the longitudinal axis of the shell. The outer end of the drum is normally closed by a removable cover plate 17. A central vertical partition 18 passes through the drum 15 and divides the cylindrical interior thereof into two equal compartments. One of these compartments is fitted with a fluid inlet pipe 19 and the other with a fluid outlet pipe 20, as more clearly shown in Fig. 2 of the drawings.

Formed integral with the opposite sides of the shell 10 and adjacent the flange 11 are fluid inlet and outlet pipes 21 and 22, respectively. These members do not connect directly with the shell but communicate with a circumscribing chamber 23, which has an annular opening 24 in communication with the interior bore of the shell.

The central passageway through the shell 10 is divided into two longitudinal compartments 23′ and 24′, by means of a plurality of longitudinally extending aligned partition members 25.

These members are arranged to extend substantially the full length of the shell and are secured upon a central tie rod 26. One end of this rod is fastened into a tube sheet 27 while the other end is secured through the last of the transverse baffle members 28, in order that the various partition sections 25 and baffle members 28 may be replaced or removed as convenience requires. The baffle-plates are interposed between the partition sections 25 and are thus spaced equal distance from each other, substantially throughout the length of the tubes, all of them being secured together by the central rod 26 and the nut 29. It is intended that a two-way flow will take place longitudinally of the shell and for this reason the series of partition members are interposed between each of the baffle plates 28, and also between the end baffle plate 28 and the tube sheet 27. This will insure a two-way flow throughout the length of the shell and around through cap 13. This space affords communication between the two compartments 23′ and 24′ of the shell and insures complete circulation of the viscous fluid from the inlet connection 21 to the outlet connection 22 along a path of travel twice the length of the shell.

Mounted within the cap is a floating tube sheet 30. This sheet is of smaller dimensions than the inside bore of the cap 13, and thus allows free circulation of the viscous fluid therearound and at the same time permits the cap 33 to be readily removed therefrom.

The tube sheets 27 and 30 are thus disposed at opposite ends of the structure and are adapted to receive a plurality of circulating tubes 31. The exact arrangement of these tubes is more particularly indicated in Fig. 3 of the drawings, where it will be seen that they are systematically disposed upon opposite sides of the partition members 25 and will insure that a substantially uniform cooling action will be produced by the viscous fluid as it passes around the pipes and through the compartments 23′ and 24′. The tubes all communicate with the drum 15 at one end and at the opposite end are in communication with each other by means of the tube sheet cap 33, which is secured over the end of the floating tube sheet 30, as shown in Fig. 1. Attention is directed to the fact that the end of the tube nest carrying cap 33 projects a sufficient distance beyond the shell flange 12 to ensure that when the shell cap 13 is removed the cap 33 and the tube sheet to which it is attached will be entirely uncovered and accessible so that the cap 33 may be readily attached to the tube sheet from the opposite side thereof.

By reference to Fig. 3 of the drawings, it will be seen that two sets of perforations are formed through the baffle-plates. One set of perforations is designed to receive the tubes 31, while the other set is provided to permit a circulation of the viscous fluid through the baffle-plate. This second set of perforations is indicated at 32 and will be seen to be of such dimensions as to overlap the perforations for the tubes and thus form a central opening between certain of the tubes and partially around their exterior surfaces.

At the point of perforation, it will thus be seen that each of the passageways 32 has a sidewall made up of a part of the surface of three of the tubes 31 and a portion of the baffle-plate intervening between these tubes. The baffle-plate portion of the perforations may be cut away as more clearly shown in Fig. 4 to form what is commonly known as a frictionless orifice, although when thin gage metal is used the same result will be obtained without making the counterbore. These openings are thus provided with substantially knife-shaped edges upon the sides of the baffle against which the fluid is flowing. By comparison of the two halves of the baffle-plate shown in Fig. 3, it will be seen that the circulating orifices 32 are staggered in relation to each other and that by reversing the alternate baffle-plates throughout the length of the shell, the space defined by three of the tubes will be in alternate communication, and interruption throughout the length of the shell. This will make it necessary for the circulating fluid to change its direction between each of the baffle-plates 28 and thus to partially circumscribe the various tubes as the viscous liquid proceeds along its path of travel. Other arrangements of openings of different dimensions and shape could also be used to advantage under certain conditions. It will, therefore, be evident that due to the uniform distribution of circulating orifices throughout the baffle plate that a uniform distribution of the viscous fluid will take place over the surface of the tubes 31. Maximum turbulency will be obtained due to the inversion of the jets, especially through the peculiar triangular-shaped orifices; the high velocity attained by the fluid as it passes through these orifices and the acceleration and retardation of flow due to the change of the jet, as it alternately passes through one baffle-plate and strikes the wall portion of the next baffle-plate.

In operation of the present invention, it will be understood that one fluid passes in through the connection 19 and thence from the drum 15 through the tubes in the shell compartment 23'. When this fluid reaches the opposite end of the shell, it then passes to the other set of tubes by way of the tube sheet cap 33 and returns to the outlet passageway 20 through the tubes in compartment 24'. At the same time, another fluid is passing into the shell through the connection 21 and along the compartment 24' to the shell cap, from which point it flows into the compartment 23' and returns to the outlet connection 22. During this flow the fluid will pass through alined orifices 32 in the alternate baffle-plates, said orifices as before explained being preferably staggered in relation to each other on alternate baffles. This condition is brought about by the reversal of the successive duplicate baffle-plates which will cause the various jets of liquid to deviate slightly from their direct course of travel and wipe the sides of the tubes. This deviation will produce a minimum friction loss, as compared to other types of heat exchangers, in which large openings have been used without obtaining turbulence and in which instance the spacing of the openings has been such as to make it necessary for the liquid to flow along the sidewalls of the shell and baffles. This action would, of course, increase the friction losses, which are materially reduced in the present instance by the slight variation in the direction of the flow throughout the length of the tubes and the high degree of localized turbulence obtained without increased skin friction along ineffective surfaces.

It will thus be seen that by the use of the present structure a maximum turbulence will be produced, which action will be localized between and around the various pipes and longitudinally of the shell and will be practically uniform in its effect upon all of the tube surfaces. This is in contradistinction to most of the present heat exchangers in which the turbulence in them decreases as the area of the passage increases. This is, of course, due to the fact that considerable of the fluid has passed over other surfaces than the tubes. In the present case turbulency is accompanied by a high velocity flow of the liquid through the orifices, a maximum distribution of the liquid over the surfaces of the tubes and a minimum friction loss due to the slight deviation of travel of the jets through the shell. It is apparent that any friction loss due to disturbance at the tube surface is beneficial, as it is the friction loss due to the travel over the surface of the baffles and sheet which is detrimental, and this has been reduced to a minimum in the present invention.

While I have shown the preferred form of my invention, as now known to me, it will be understood that various changes in the combination, construction and arrangement of parts may be made by those skilled in the art, without departing from the spirit of the invention, as claimed.

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

1. A heat exchanger comprising an outer shell, a plurality of transverse baffle plates therein disposed in spaced relation to each other, said plates each being formed with a plurality of perforations other than the perforations for the tubes, the perforations of adjacent plates being staggered relative to each other, and a set of tubes extending longitudinally of the shell and through the plates.

2. A heat exchanger comprising an outer shell, a set of tubes extending longitudinally of the shell, a plurality of transverse baffle plates disposed in spaced relation to each other within the shell and through which the tubes extend, said plates each being formed with a plurality of perforations disposed intermediate groups of the tubes.

3. A heat exchanger comprising a shell through which a fluid is to flow, a nest of tubes within said shell and through which another fluid may flow and a plurality of transverse baffle walls, through which the tubes may extend, said walls being formed with systematically arranged openings between adjacent groups of pipes, whereby the flow of the fluid within the shell will be subdivided into a plurality of turbulent jets passing along and around the tubes.

4. A baffle-plate for a heat exchanger of the plural tube type, characterized by the provision of tube-receiving openings symmetrically arranged with respect to a median line, and additional openings staggered with respect to similar openings on the opposite side of said median line.

5. A baffle-plate for a heat exchanger of the plural tube type, characterized by the provision of rounded corner triangular holes, each of said rounded corners being of such size as to receive one of the tubes.

6. A baffle-plate for a heat exchanger of the plural tube type, characterized by the provision of tube-receiving openings and additional openings merging into certain of said tube-receiving openings, said additional openings being staggered with respect to a median line, extending longitudinally of the shell.

7. In a heat exchanger, an outer shell, a plurality of transverse baffle-plates in said outer shell, a longitudinal partition member between each pair of baffle-plates, and means for securing said baffle-plates and said partitions in position in said outer shell.

8. A heat exchanger comprising an outer shell, a plurality of tubes extending longitudinally therein, means for establishing a flow of fluid through said tubes, means for establishing a flow of fluid through the shell and around the tubes, and baffles having openings whereby the fluid flowing through the shell will be recurrently directed towards a plurality of tubes at high velocity and interrupted by intermediate periods of fluid flow at decreased velocities.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CARL F. BRAUN.

Witnesses:
H. S. HOUGHTON,
C. H. SHATTUCK.