March 31, 1931. K. B. RIS 1,798,354

HEAT EXCHANGER

Filed March 27, 1928

Fig. 1.

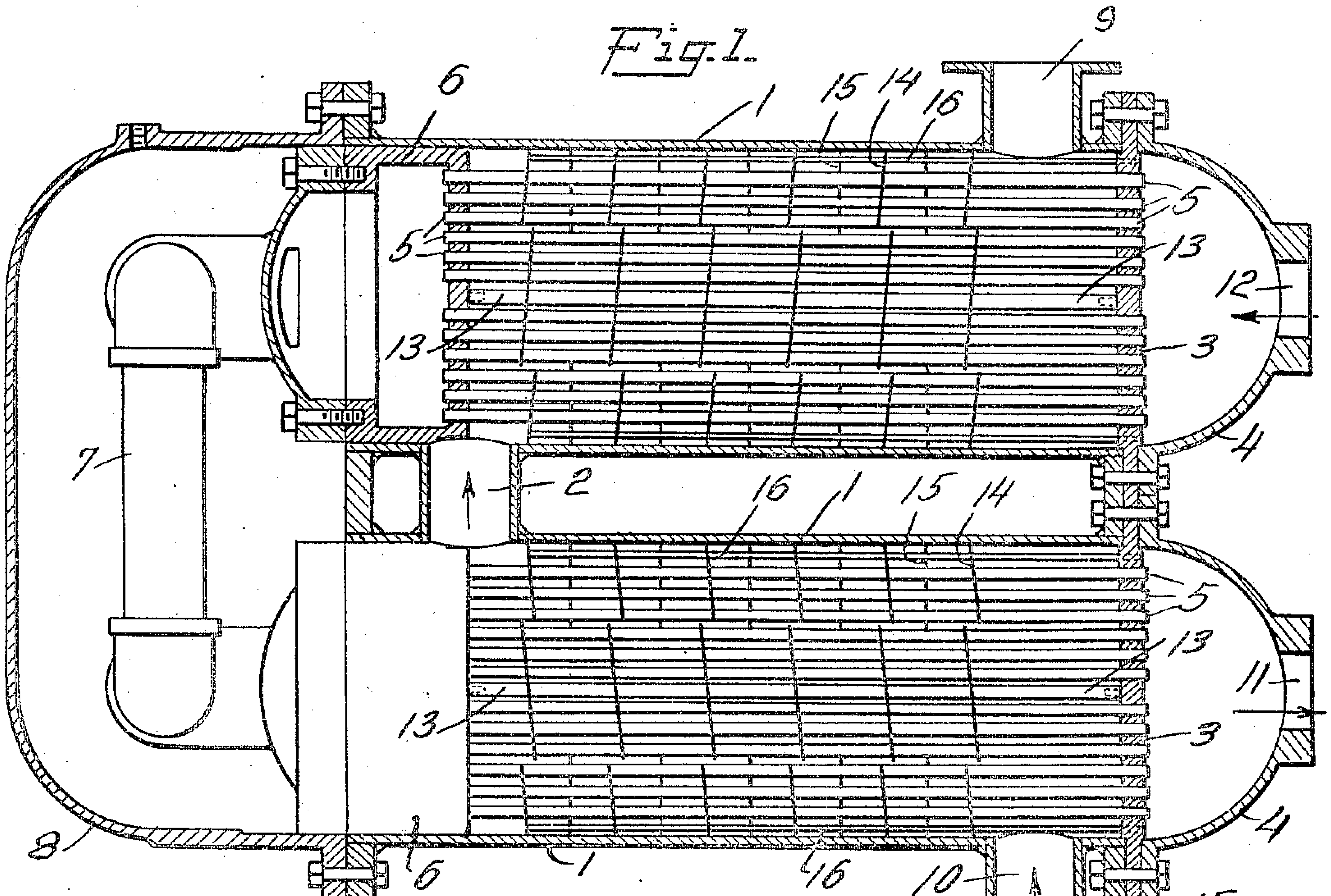


Fig. 3.

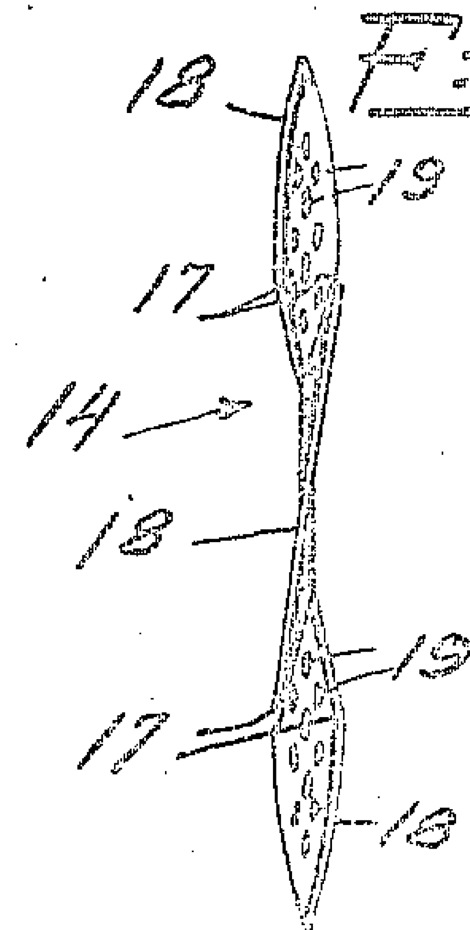


Fig. 2.

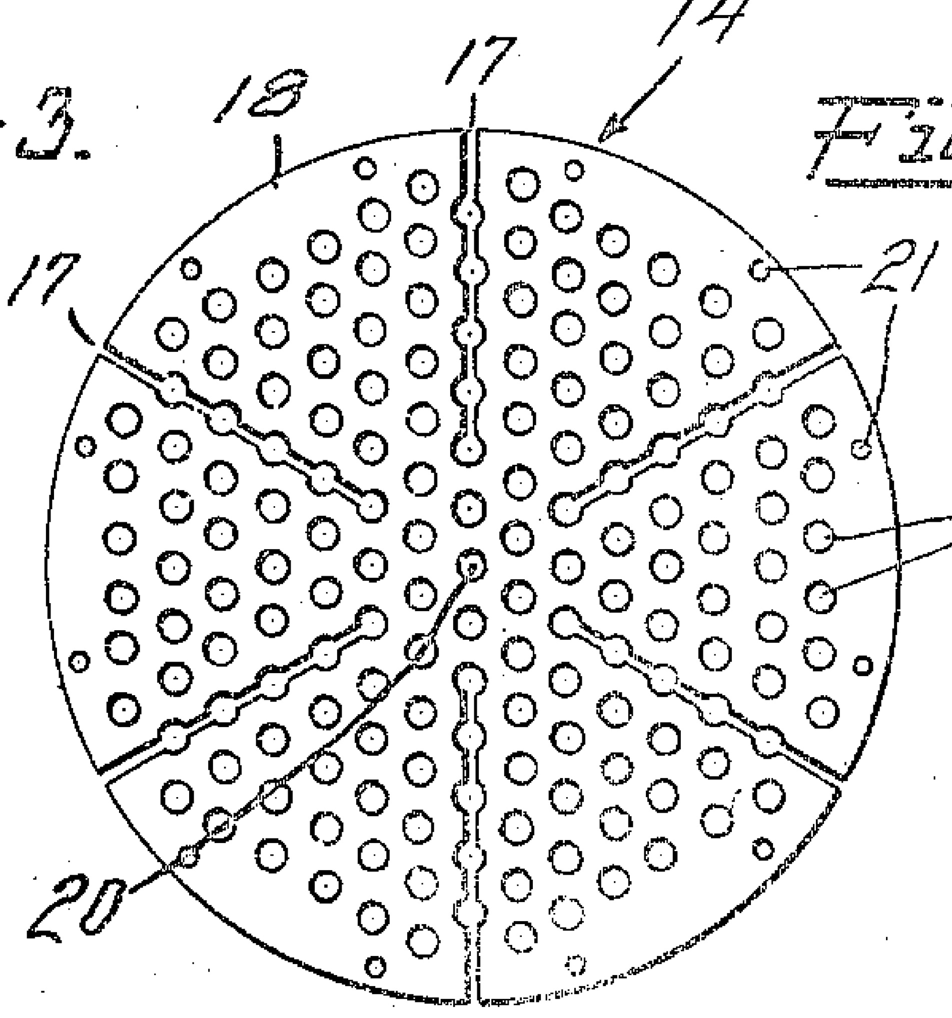


Fig. 6.

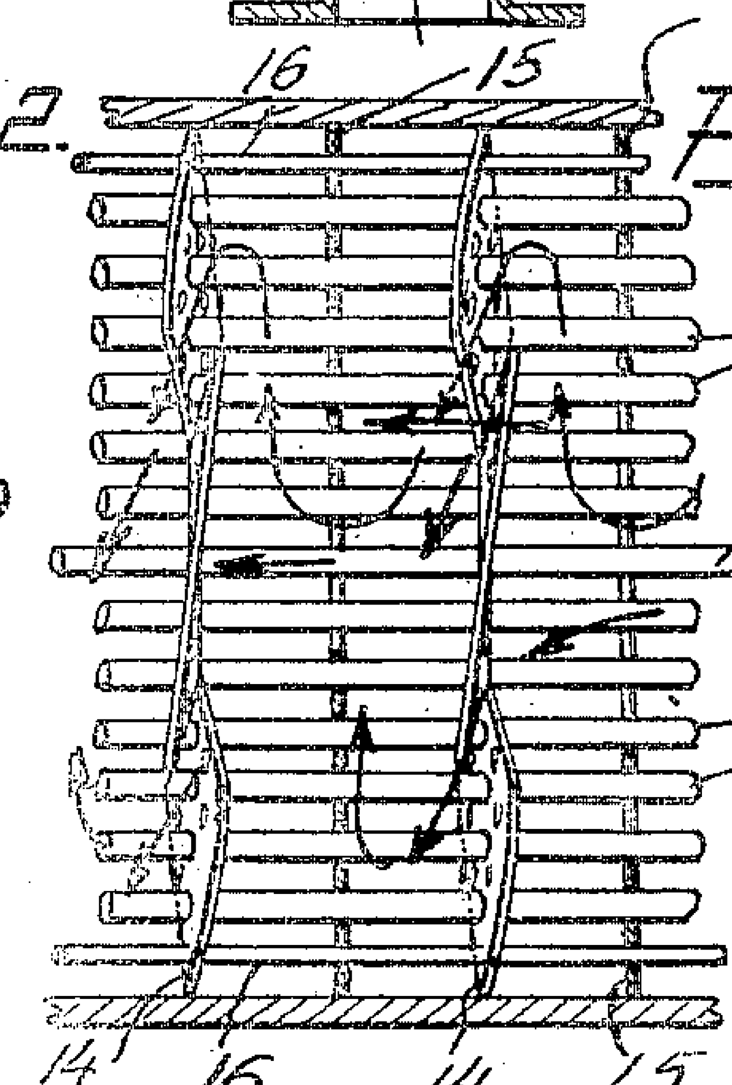


Fig. 5.

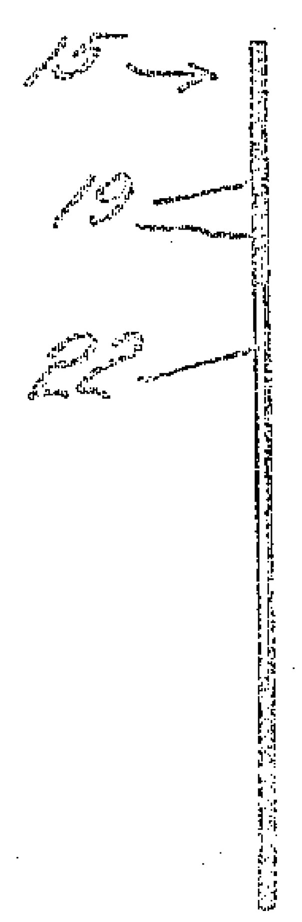
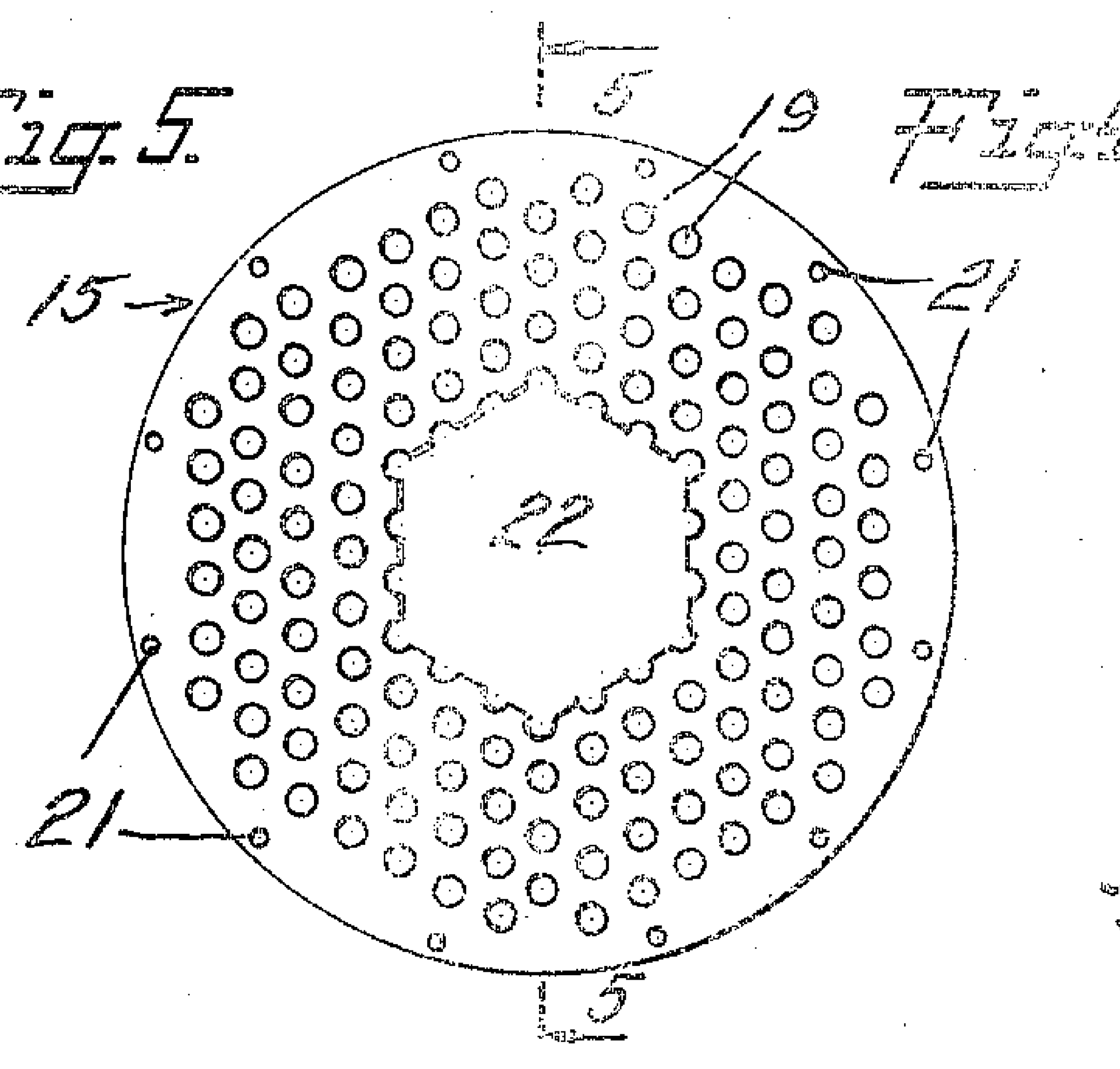


Fig. 4.



INVENTOR
Kenneth B. Ris
BY
Pennie, Davis, Marvin & Edmonds,
HIS ATTORNEYS

Patented Mar. 31, 1931 1,798,354

UNITED STATES PATENT OFFICE

KENNETH B. RIS, OF DALLAS, TEXAS, ASSIGNOR TO THE GRISCOM-RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

HEAT EXCHANGER

Application filed March 27, 1928. Serial No. 264,998.

This invention relates to heat transfer apparatus, and particularly to heat exchangers of that type in which there is a transfer of heat between one fluid flowing through a bundle of tubes and another fluid flowing through a container surrounding the bundle.

Thermal efficiency, or rate of heat transfer, which directly renders heat exchangers—especially of the shell-and-tube type—of a greater or lesser industrial efficiency, depends largely on the temperature difference between the tubes and the fluid surrounding the tubes. It has been determined that the best way to secure this temperature difference is to force thorough contact of the fluid under treatment with the tubes, and, what is equally important, to establish and maintain uniformity of thermal distribution throughout the bulk of the fluid.

It is particularly difficult to obtain this necessary thermal efficiency when treating viscous fluids. For example, when heating such liquids as heavy hydrocarbon oils, the oil around the tubes may indeed become raised almost to the same temperature as that of the tubes,—at the points where it contacts therewith,—and thereby become limped enough; nevertheless, any heat reaching the bulk of the oil usually does so by conduction alone, and the conductivity of viscous fluids is usually very low. The same situation arises in cooling operations, as there usually forms on the cooling tubes, a thick film of congealing oil or residue, preventing the bulk of the fluid from cooling. Thus the apparent temperature is not indicative of the actual temperature difference between the fluid in the tubes and the fluid in contact with the outer surface of the tubes.

The apparatus disclosed in United States Patent No. 1,525,094 to Russell C. Jones, and United States Patent No. 1,597,479 to Joseph Price, relate somewhat to this situation, and the present invention is adaptable to these apparatus; in fact, it constitutes, in certain ways to be hereinafter made apparent, an improvement on them—though, as it will appear, the present invention is just as capable of being combined with and enhancing the value of practically any type of shell-and-tube heat-exchanger.

It is an object of the present invention to increase the thermal efficiency of heat-exchangers by providing a structure within the shell for forcing such a flow-path upon the fluid being operated upon that substantially every unit of volume of this fluid will be compelled to repeatedly contact directly, in thorough heat-exchanging relation, with all of the heat transferring surfaces.

Another object of the present invention is to increase the thermal efficiency of heat exchangers by compelling uniform distribution of heat throughout the body of the fluid by this same structure which enforces thoroughness and completeness of contact.

It is another object of the present invention to so increase the length of the path of flow in heat-exchangers, of liquids which are difficult to be cooled or heated,—and which therefore necessitate a longer flow,—without thereby increasing the length of the shell or of the tubes, that smaller, less expensive heat exchangers can be satisfactorily used.

The invention will be described in conjunction with the accompanying drawings, which are to be referred to merely for the purpose of definitely ascertaining one typical form, and are to be understood as not in any way limiting the invention to the particular construction of shell, tubes, headers, or the other well known parts shown therein. In these drawings,

Fig. 1 is a longitudinal sectional view taken centrally through an apparatus embodying the invention;

Fig. 2 is a plan view of one of the elements used in carrying out the invention;

Fig. 3 is a side elevation thereof;

Fig. 4 is a plan view of another element used in carrying out the invention;

Fig. 5 is a sectional view along line 5—5 of Fig. 4, and

Fig. 6 is an enlarged detailed view of a portion of one of the shells shown in Fig. 1.

In the drawings, the invention is shown as applied to a heat-exchanger comprising a unitary container 1 for the flow of the fluid to be treated,—usually a viscous liquid of some sort—and this container may be formed of upper and lower shells, connected at one end by an up-pass 2. These shells may be closed at one end by a twin tube-plate 3 to which may be attached twin caps 4. Tubes 5 anchored by one end in the sheet 3 form a bundle in each shell, and may terminate at their other ends in floating box-headers 6.

These headers 6 may be connected by a flexible down-pass 7, and covered by a large cover-all cap 8 secured over the ends of both shells. A suitable inlet opening 10 for the viscous liquid under treatment may be provided on the lower arm, and a suitable outlet 9 therefor may be provided on the upper shell. The other medium-steam or cold water, according as the viscous liquid is to be heated or cooled—may then be admitted, in counter flow if preferred, through a suitable inlet opening 12, which may be provided therefor in the upper cap 5. A suitable central core 13 may be provided as shown.

The present invention contemplates forcing the liquid to be treated into a flow-path such as that shown in Fig. 6, by the provision and employment of a baffle made up of members such as those shown in Figs. 2 and 4, these members being, further, spaced and arranged within the shell around the tubes in a particular manner, and preferably alternately at predetermined, equal intervals along the member 13. In order to secure the elements of the baffle unit against vibration and other stresses set up by the rush of a heavy liquid through the shell, as well as to help maintain the proper spacing, stay-bolts, tie-rods, or spacer bars 16 can readily be anchored in the tube sheet 3, passed through their peripheries at suitable places, and then secured over the other end of the baffle, as shown in Fig. 1.

However, this manner of spacing and supporting the elements of the baffle structure is more or less a result of the particular structure of the elements themselves, and is not the principal feature of the invention, and is employed only in order to allow the baffle elements themselves to perform their particular functions, in accomplishing the objects of the invention, and hence this arrangement may well be varied according to the particular circumstances.

The baffle is, as already stated, composed of two different kinds of members, 14 and 15. The elements 14 may well be similar to those disclosed in the above mentioned Patent No. 1,525,094 to Russell C. Jones, and are here shown as consisting of flat metal plates perforated with tube holes 19 to slip over the tubes, and provided with radial slits 17, the sectors formed by these slits being then twisted in a plane perpendicular to the original flat plane of the body, so as to form of the sectors, propeller like blades. There is also provided an aperture 20 in the center of the element, to slip over the central column 13 in stringing the elements along in the shell. For the passage of the stay-bolts 16, apertures 21 may be provided around the periphery of the element at suitable places.

The employment of a series of elements similar to those designated as 14, by themselves, has resulted in certain improvements in the functioning of heat exchangers, as explained in the above mentioned patent to Russell C. Jones but by employing the improved two-element baffle-structure of the present invention, the thermal efficiency and general performance of heat-exchangers is still further increased.

Each element 15 comprises a flat circular plate of sheet metal perforated with a plurality of tube holes 19 to slip over the tubes and also has holes 21 for the passage of the stay-bolts 16. At or near the middle or central portion of the plate, there is formed or left an aperture substantially coextensive with the centres of the elements 14, which are left solid. Tubes 5 are supported by the solid or peripheral part of the plate 15, by passing through the apertures 19, but there is a clear passageway for the fluid through the central portion 22, since the tubes 5 pass through the aperture 22 unsupported and therefore without obstructing it to any appreciable extent.

It is now clear that the fluid under treatment as it passes through the members 14 is broken up by the fan blade action into a plurality of identical streams, each tending to be forced positively by the propeller-like action of the element 14 outwardly and then circumferentially around the outermost periphery of the tube-bundle as a whole, in a plurality of helices. That is, the fluid then is given a general helical flow and this helical flow has a component force longitudinal of the tubes and another component circumferential of the tubes, the resultant path being an oblique movement from the center of the shell out to the circumference. The baffle 15 then causes the fluid to flow transversely across the tubes to the center, where it passes through the opening 22 parallel with the tubes. Some of the fluid will, of course, pass straight through the openings between the blades of the members 14, moving coaxially with the tubes instead of swirling out and around the periphery of the bundle, and this is a distinct advantage when the tubes are set closely to each other. All the streams, however, are suitably brought back to the region of the center-tubes, instead of continuing on lengthwise, sticking to the shell inside.

In the structure of the Jones patent, the cross-currents produced at each successive baffle element are the same as in the preceding, but in the structure of the present application, a more complete mixing of the fluid, a more uniform temperature throughout the entire cross section of the shell, and a more thorough contact of the fluid with the working surfaces is obtained by means of the coaction of the plates 15. That is to say, in the heat exchanger of the Jones patent, there is produced a change in direction from axial to circumferential, as the liquid passes the successive baffles, but it is possible for the liquid at the shell surface to follow the surface without mixing with the liquid at the middle of the shell, possibly causing pockets and dead spots to form particularly if the liquid is viscous. By means of the elements 15 it is assured that the center tubes 5 will also be equally thoroughly used and contacted with by all the viscous liquid; every time it passes through one of the vane-plates 14 and is thrown out towards the shell, and around the tube bundle and lengthwise it is inevitably drawn back to the central tubes again before it can pass on farther through the shell.

The fluid is thus thoroughly forced against all the portions of the heat transferring surface, being broken up into outflowing, circumferentially moving streams, on passing through an element 14, and immediately thereafter being gathered together into a central stream, on reaching an element 15, thus alternately expanding and contracting, and hence contacting with all the tubes, setting up cross-currents, and scouring each tube to remove any congealed fluid, in cooling operations; or, in heating operations, to mix the limpid film thereon with the rest of the fluid, and by all these changes of direction securing increased uniformity of thermal distribution.

After passing through, say, the lower shell 1, the fluid may be forced up the up-pass 2 into the upper shell, where the action first described as occurring in the lower shell is repeated, and the fluid is finally forced out of the outlet 9, having been thoroughly treated and leaving no congealed residue on the tubes, and having a uniform final temperature throughout its bulk.

I claim:

1. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid to be treated, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure within said container and traversed by said tubes, for directing the fluid under treatment helically around, and then co-axially with, said tube-bundle.

2. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes enclosed therein for the flow of the other fluid, and a series of alternately identical members traversed by said tubes and fitting against the inside of said container for impressing upon said fluid, a movement in a direction circumferential of said tube bundle, a movement in a direction oblique to the length of said tube bundle from the center of said bundle to the circumference thereof, a movement from the circumference to the center and a movement in a direction co-axial with said tube-bundle.

3. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure traversed by said tubes and having members fitting against said container for first directing said fluid simultaneously in two directions substantially at right angles to each other and then co-axially with the bundle.

4. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes therein for the flow of the other fluid, and a series of members within said container traversed by said tubes, alternate ones of said members having solid centers and having their peripheries shaped to direct the fluid impinging thereupon simultaneously in two different directions, and others of said members having solid peripheries and having their centers formed to direct the fluid in a single direction.

5. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid to be treated, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure within said container and traversed by said tubes for directing the fluid under treatment alternately radially of, and co-axially with said tube-bundle, said member comprising a multi-unit baffle, certain ones of said units being formed and placed to direct the fluid under treatment tangentially outwards towards the shell-inside and transverse said tubes and in a plurality of separate helical currents, and alternate ones of said units being formed and placed to interrupt the flow of said helical currents along the shell-inside, to collect said currents, and to direct said currents to and through the center of the tube-bundle.

6. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure within said container, certain ones of said units directing the fluid centrifugally radially outward toward the periphery of the tube-bundle from the center thereof and circumferentially around the bundle, in a plurality of helical currents, and others of said units interrupting the passage of said helical currents at and near the periphery of said tube-bundle and directing said currents to and through the center of the tube bundle.

7. In a heat-exchanger, a container for a fluid to be treated, a tube-bundle enclosed therein, and means for maintaining a high temperature difference between the tubes and the fluid to be treated, comprising a multi-unit baffle strung along the tubes from substantially end to end thereof, said baffle including units for splitting up the fluid passing therethrough into a bundle of separate intertwining helical currents and directing said currents tangentially and transverse said tubes, and units for gathering said helical currents into the center of the tube-bundle from their outflung paths near the inner periphery of the container, whereby said fluid is maintained in constant agitation around all the tubes of the heat-exchanger sufficient to thereby secure a uniform heat-distribution and a maximum temperature difference at the heat-transferring surface.

8. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure within said container, certain ones of said units having solid central portions and peripheries formed and placed to thereby direct the fluid simultaneously in two directions substantially at right angles to each other, one of the directions impressed upon said fluid being radially outward and then circumferentially of said tube-bundle, and the other direction being parallel to the tube-bundle, and others of said units being so placed and shaped with reference to the first as to impress upon the fluid passing therethrough, a movement transversely of the tube bundle toward the center and then co-axially with the tubes thereat.

9. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid under treatment, a bundle of tubes enclosed therein for the flow of the other fluid, and a multi-unit structure within said container, certain ones of said units having solid central portions and peripheries formed and placed to thereby direct the fluid simultaneously in two directions substantially at right angles to each other, one of said directions being radially outward and then circumferentially of said tube bundle, and the other being substantially parallel to the tube-bundle, and the other units of said structure having solid peripheries and central portions so formed as to direct said fluid to and through the center of said heat-exchanger and substantially co-axially with said tube-bundle.

10. Apparatus for the transfer of heat between two fluids, comprising a container for the flow of the fluid to be treated, a tube-bundle enclosed thereby for the flow of the other fluid, and a baffle-structure therein having means for initially impressing upon the fluid to be treated, motion in a path first directed helically outward from the central portion of the tube-bundle to and around the circumference of the bundle, and also longitudinally of the shell, and thereafter motion in a path substantially parallel to the bundle, and substantially co-axial with the central portion of the tube-bundle.

In testimony whereof I affix my signature.

KENNETH B. RIS.