Aug. 11, 1925. 1,549,489

R. C. JONES

OIL COOLER

Filed Oct. 26, 1918 3 Sheets-Sheet 1

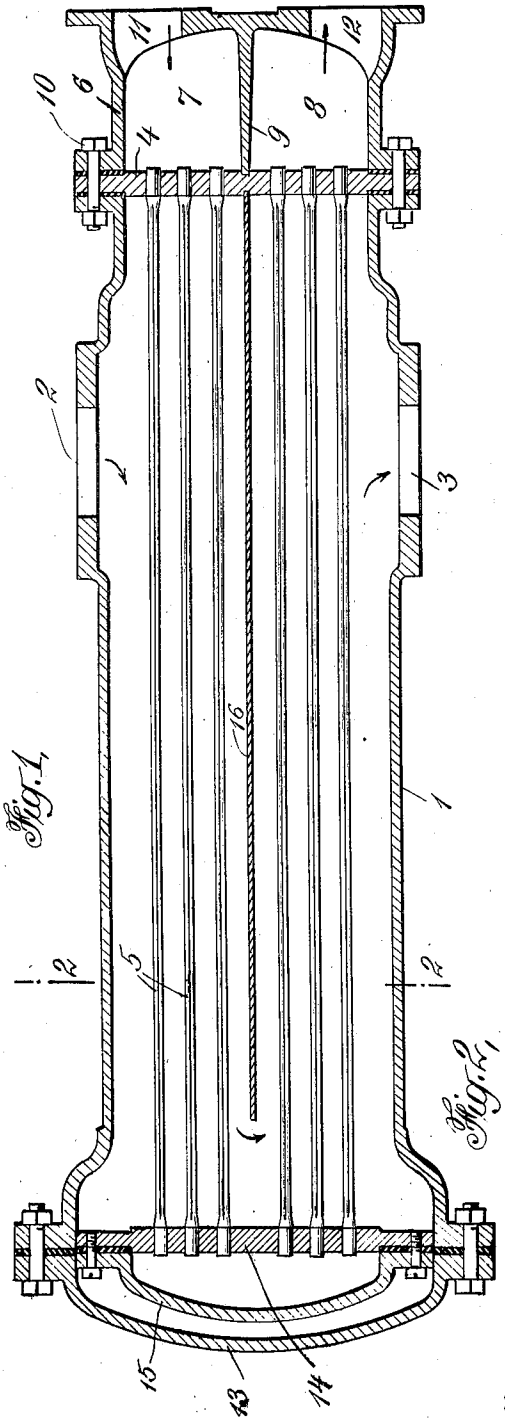


Fig. 1.

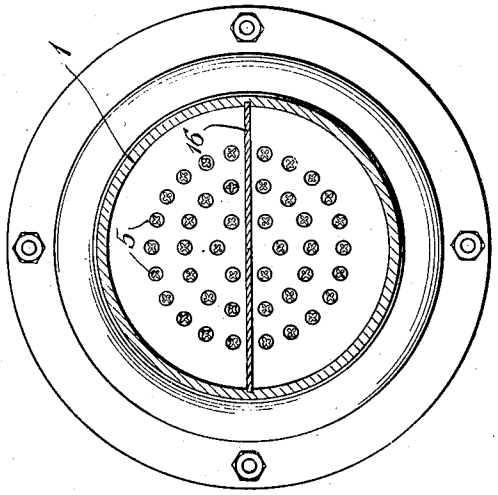


Fig. 2.

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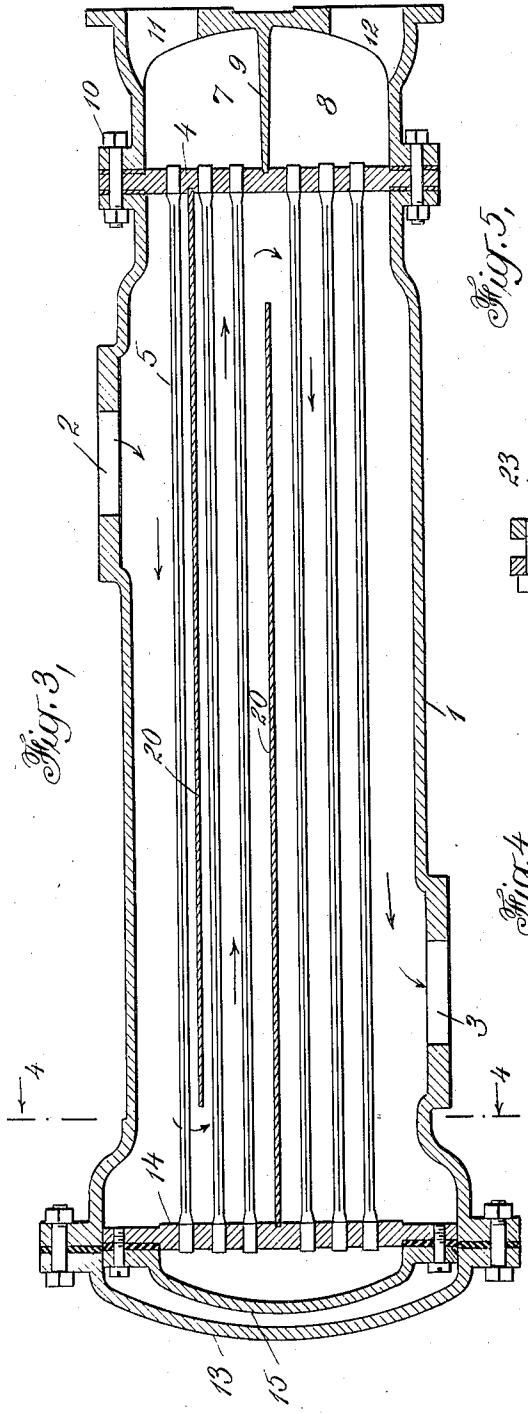


Fig. 3,

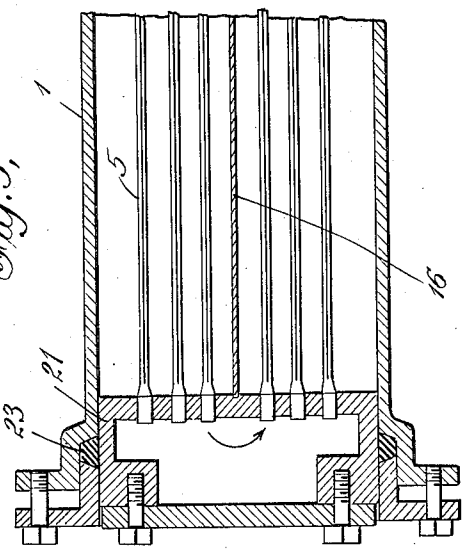


Fig. 5,

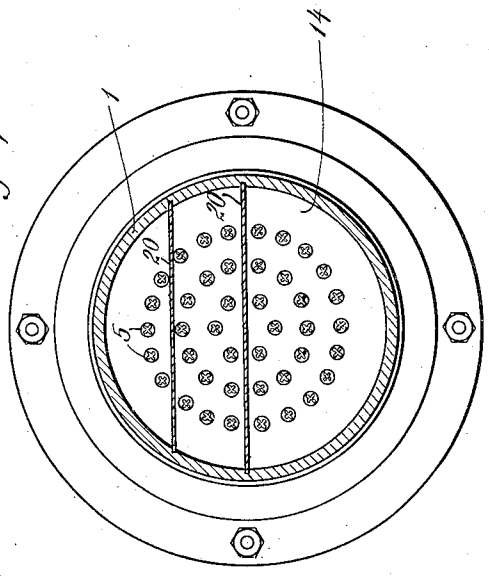


Fig. 4,

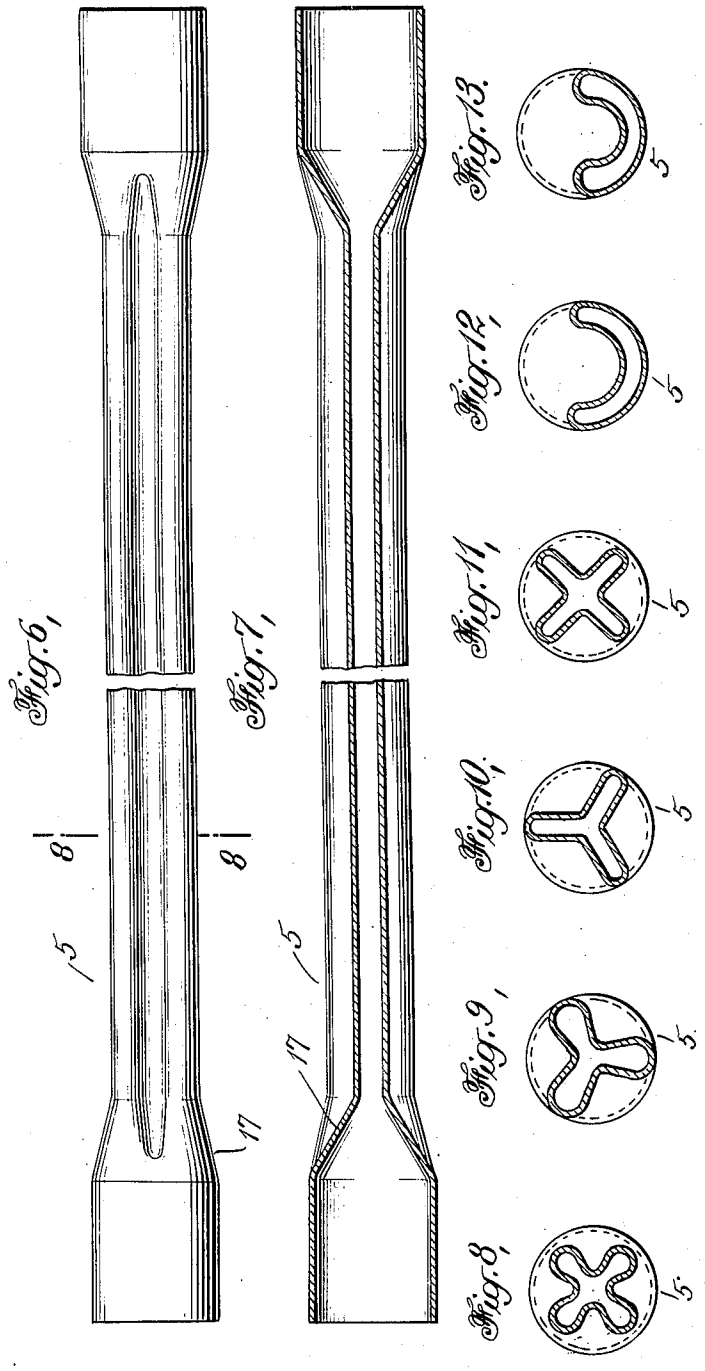
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OIL COOLER

Filed Oct. 26, 1918 3 Sheets-Sheet 3



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Patented Aug. 11, 1925. 1,549,489

UNITED STATES PATENT OFFICE.

RUSSELL C. JONES, OF BRONXVILLE, NEW YORK, ASSIGNOR TO THE GRISCOM RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

OIL COOLER.

Application filed October 26, 1918. Serial No. 259,797.

To all whom it may concern:

Be it known that I, RUSSELL C. JONES, a citizen of the United States, residing at Bronxville, in the county of Weschester, State of New York, have invented certain new and useful Improvements in Oil Coolers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to cooling apparatus and has for its object to provide an apparatus for facilitating the exchange of heat from one fluid in circulation to another, the invention being particularly applicable to the cooling of lubricating oil in circulation through engines or other machinery and for the cooling of quenching oil used in heat treating processes.

It has been proven by comparative experiments that it is necessary to thoroughly agitate lubricating oil in its passage through a cooling apparatus for the reason that the oil has a tendency to form a film on the cooled surfaces over which it is circulated. The film of oil is a poor conductor of heat and acts in effect to insulate that part of the cooling surface on which the film forms, and virtually destroy its usefulness. If the oil is sufficiently agitated, the film-forming tendency is materially lessened, and the most successful coolers heretofore have been those of the design shown in my prior Patent No. 1,335,506, granted March 30, 1920, in which the sea water or other cooling liquid is circulated through the tubes and the oil to be cooled is directed in a helical path by suitable baffles through the shell of the cooler at substantially right angles to the tubes so that the latter serve as agitating baffles in the moving current of oil.

I have found, however, that an advantageous cooling effect may be had with coolers in which the liquid to be cooled is circulated through the tubes and the cooling liquid through the shell by using a novel tube design constructed so as to be self-cleaning, as it were, that is, a tube in which the oil passing through the tube, acts against the surface of the tube in such a way as to clean off the oil as it thickens on the cooling surface of the tube, thus keeping the latter at its maximum efficiency.

My invention consists further in an arrangement of the tubes in the headers in such fashion that a broken or corroded tube may be withdrawn and replaced without interfering with any of the other tubes. My invention also comprises other features of the cooler construction wherein a practical apparatus of acceptable design is provided which is of durable and satisfactory construction throughout without excessive manufacturing cost.

In the accompanying drawings, I have shown several different forms of my improved cooler design and also various modifications of the tube structure itself. It will be understood, however, that the invention is not limited to the modifications shown, but that the construction may be altered in various other details without departing from the spirit of the invention.

In the said drawings,

Fig. 1 is a longitudinal vertical section of one type of my improved cooler;

Fig. 2 is a transverse section on line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1 but showing a modified type of cooler;

Fig. 4 is a transverse sectional view on line 4—4 of Fig. 3;

Fig. 5 is a longitudinal sectional view of a portion of the cooler showing a modified end structure for the shell;

Fig. 6 is a side elevation of one type of my improved tube structure;

Fig. 7 is a longitudinal sectional view of the tube shown in Fig. 6;

Fig. 8 is a transverse section on line 8—8 of Fig. 6; and

Figs. 9–13 inclusive are views similar to Fig. 8 but showing different designs of tubes.

Referring to the drawings, particularly to Fig. 1, 1 indicates the shell of the cooler, here shown as of the ordinary substantially cylindrical construction open at each end and provided with inlet and outlet passages 2 and 3, respectively, for the cooling liquid. The shell is closed at one end by a

header or tube plate 4 in which are supported one end of each of the tubes 5 through which the oil is to be circulated.

The tubes are preferably expanded in the tube plate after the usual manner of boiler tubes, and the tube plate is supported against the end of the shell 1 by means of a feed drum 6 through which the oil enters and leaves the cooler. Tubes may be sweated in, brazed, or held by ferrules as in condensers, etc.

The feed drum comprises upper and lower chambers 7 and 8, provided with inlet and outlet ports 11 and 12, respectively, and separated by a division plate 9 which is held against the face of the header by the clamping bolts 10 which hold the feed drum in place. The bolts 10 pass through the flanges of the shell and feed drum and the interposed margin of the tube plate on each side of which is a suitable packing ring, whereby the single series of bolts forms a fluid-tight closure for both feed compartments and also for the shell interior.

At the other end of the shell there is provided an outside cover or closure 13 having a fluid-tight joint with the shell and an inside floating tube plate 14 in which the opposite ends of the tubes 5 are set.

The floating tube plate is provided with a cover 15 forming a floating oil compartment common to all the tubes whereby the oil entering the feed compartment 7 will pass through the tubes forming the upper half of the set, thence through the drum 15 and return to the outlet opening 12 through the tubes forming the lower half of the set.

The circulated liquid is also caused to pass from end to end of the shell by means of a longitudinal baffle plate 16 supported in the shell along its middle diameter and separating the shell into two compartments at the end adjacent the inlet and outlet ports 2 and 3 for the circulating water, the baffle being terminated at its other end short of the face of the tube plate to provide for the passage of the water.

The tubes employed in the above described cooler form the essential part of my invention, and the particular tube shown in Fig. 1 is shown in enlarged detail in Figs. 6, 7 and 8. This tube comprises cylindrical ends to be expanded in the tube plates and an intermediate part of cruciform cross section, having a perimeter of substantially no greater length than the circumference of the cylindrical part of the tube, whereby the overall diameter of the cruciform portion will be less than the cylindrical part, permitting the tube to be inserted through the hole in the tube plate from one end, in the same manner as an ordinary tube of uniform cross section throughout.

My improved tube is preferably made from ordinary tubing by die-shaping with suitable roller dies, the method of procedure being to open the rollers and insert the tube between the rollers far enough to provide a cylindrical part of the desired length and gradually bring the rollers together, at the same time advancing the tube longitudinally so that the walls of the tube will be gradually tapered in as indicated at 17. After the tube has been advanced through the rollers almost its entire length, the rollers will be gradually separated before the tube is entirely withdrawn so as to provide a duplicate cylindrical portion at the other end of the tube. The action of the roller dies may slightly draw the metal of the tube in shaping it, but the depressions will be deep enough to take up sufficient metal for the overall diameter of the tube to be less than that of the cylindrical portions. The tubes may also be shaped by die rollers having their axes parallel with the axis of the tube or by means of a die press, as will be readily understood.

The purpose of shaping the tube in the manner shown is to reduce the cross sectional area of the tube, thereby increasing the velocity of the oil in passing through the tube, so that the moving oil column scours the surface of the tube, removing any oil tending to congeal and adhere thereto, and also to so shape the tube that the oil stream will be "thin" in all parts, that is, at all points in the oil stream there will be two opposite faces of the tube but slightly spaced apart, preventing the formation of a relatively hot core of oil far removed from the cooling surface.

The tube shown in Figs. 6, 7 and 8 is also advantageous in that it presents a structure which is mechanically rigid, so that long tubes may be employed without sagging in the middle. Also, as the overall diameter is less than the diameter of the cylindrical ends, a defective tube may be withdrawn and a new one replaced without taking down the apparatus, other than removing the heads to get access to the tube plates, whereas with other shapes of tubes, such as a simple flattened tube in which the middle portion has its greatest dimension larger than the diameter of its end, the tube must be inserted in each header or tube plate from the inside.

The design of the cooler may be variously modified without departing from the spirit of the invention, as may also the shape of the tube.

In Fig. 3 I have shown a further slight modification in the shell design in which, instead of a single return, as in Fig. 1, for the cooling water, a double return is provided by means of two baffle plates 20, one supported at one end and one at the other end to cause the water to follow a zigzag path through the shell. I have shown the

several compartments produced by the baffle plates as containing different numbers of tubes. This is done in order to have the circulating water uniformly effective for cooling. The water will not in most cases be much altered in temperature in passing through the cooler, as there is usually an unlimited supply of water where such apparatus is used. The oil, however, will be materially cooled by its passage through the apparatus and will, of course, present less temperature difference to the water as it approaches the outlet passage with a constant decrease in heat transferring effect per unit of surface. Hence, by having the cooling water make but a single turn around the lower half of the tubes which receive the heated oil, and a double pass around the tubes receiving the cooled oil, the tube surface will be effective throughout.

In Fig. 5 I have shown a preferred modification of the oil cooler. In this figure the tubes at the return end are set in a drum 21 having a floating fit in a packed joint, or stuffing box, 23, formed in the end of the shell, the arrangement being such that there is no joint directly between the oil and the water through which the water can get into the oil and contaminate it. Any leakage of the water past the stuffing box joint will merely drip from the apparatus, and as the joint between the return drum and its cover is beyond the stuffing box, the water cannot be forced into the drum should the packing be defective, although the oil may drip out of it.

My improved tube may also be variously modified without departing from the spirit of my invention, the essential features of which are tubes shaped to provide an intermediate portion of less over-all diameter than the hole in which it is to be expanded, and operating as a flat tube as regards the skin friction of the contained fluid, the velocity of the flow and the cooling effect.

Fig. 11 shows a cruciform shape generally similar to Fig. 8, but with the sides of the ribs or corrugations flat instead of curved, as in Fig. 8. This tube presents somewhat more surface for its cross section than Fig. 8.

Figs. 9 and 10 show a further form of tube shapes differing from each other in the same way that the tubes of Figs. 8 and 11 differ. That is to say, the tube is shaped into three longitudinal ribs or corrugations instead of four, and Fig. 9 shows the ribs of curved outline, whereas those of Fig. 10 are straight.

Figs. 12 and 13 show two other modifications of the tubes differing one from the other in the same manner. This is a comparatively simple form of tube, but nevertheless effective. In this form of tube the cylindrical wall of the original tube is retained throughout approximately half the perimeter and the other half perimeter is depressed to form a concave exterior, as more clearly shown in the drawing.

The principle of operation of all the tubes is the same, and it is obvious that the cross section and design may be otherwise variously modified.

I claim:

1. In an apparatus for effecting the exchange of heat between two fluids, one of which is relatively viscous at temperatures attained by it in the apparatus, the combination of a shell or vessel for one of the fluids, tubes for the said viscous fluid, said tubes having end portions of circular cross section and an intermediate portion of a perimeter substantially equal to the circumference of the end portions and its cross-sectional area and maximum diameter not greater than the corresponding dimensions of the end portions; substantially as described.

2. In an apparatus for effecting the exchange of heat between two fluids, one of which is relatively viscous at temperatures attained by it in the apparatus, the combination of a shell or vessel for one of the fluids, tubes for the said viscous fluid, said tubes having end portions of circular cross-section and an intermediate portion having its perimeter shaped to provide opposite walls having a shorter distance between them than the diameter of the end portions and with the maximum cross-sectional dimension of the intermediate portion no greater than the diameter of the end portions; substantially as described.

3. In an apparatus for effecting the exchange of heat between two fluids, one of which is relatively viscous at temperatures attained by it in the apparatus, the combination of a shell or vessel for one of the fluids, tubes for the said viscous fluid, said tubes having end portions convex throughout and an intermediate portion having at least one side concave, whereby the cross-sectional area of the tube is reduced and the stream of contained fluid is flattened; substantially as described.

4. In an apparatus of the class described, the combination of a shell having inlet and outlet openings for the circulation of the cooling fluid, tubes supported in said shell for the passage of oil to be cooled, tube plates or headers closing the ends of the shell and supporting said tubes, said tubes having the portions set in said plates of continuous convex perimeter and having their intermediate portions concave on one side, whereby the cross-sectional area of the tube is reduced and the stream flattened, said intermediate portion being of no greater over-all diameter than the end portions, whereby the tube may be inserted through

the hole in the tube plate; substantially as described.

5. In an oil cooler the combination of a shell having inlet and outlet openings for the circulation of the cooling fluid, tubes for the circulation of the oil to be cooled, said tubes having their intermediate portions formed with a longitudinal depression in at least one side so that the oil is maintained in a stream all parts of which are close to the wall of the tube and at an increased velocity to thereby prevent the formation of a film of oil and the adhesion of the film to the wall of the tube; substantially as described.

In testimony whereof I affix my signature.

RUSSELL C. JONES.