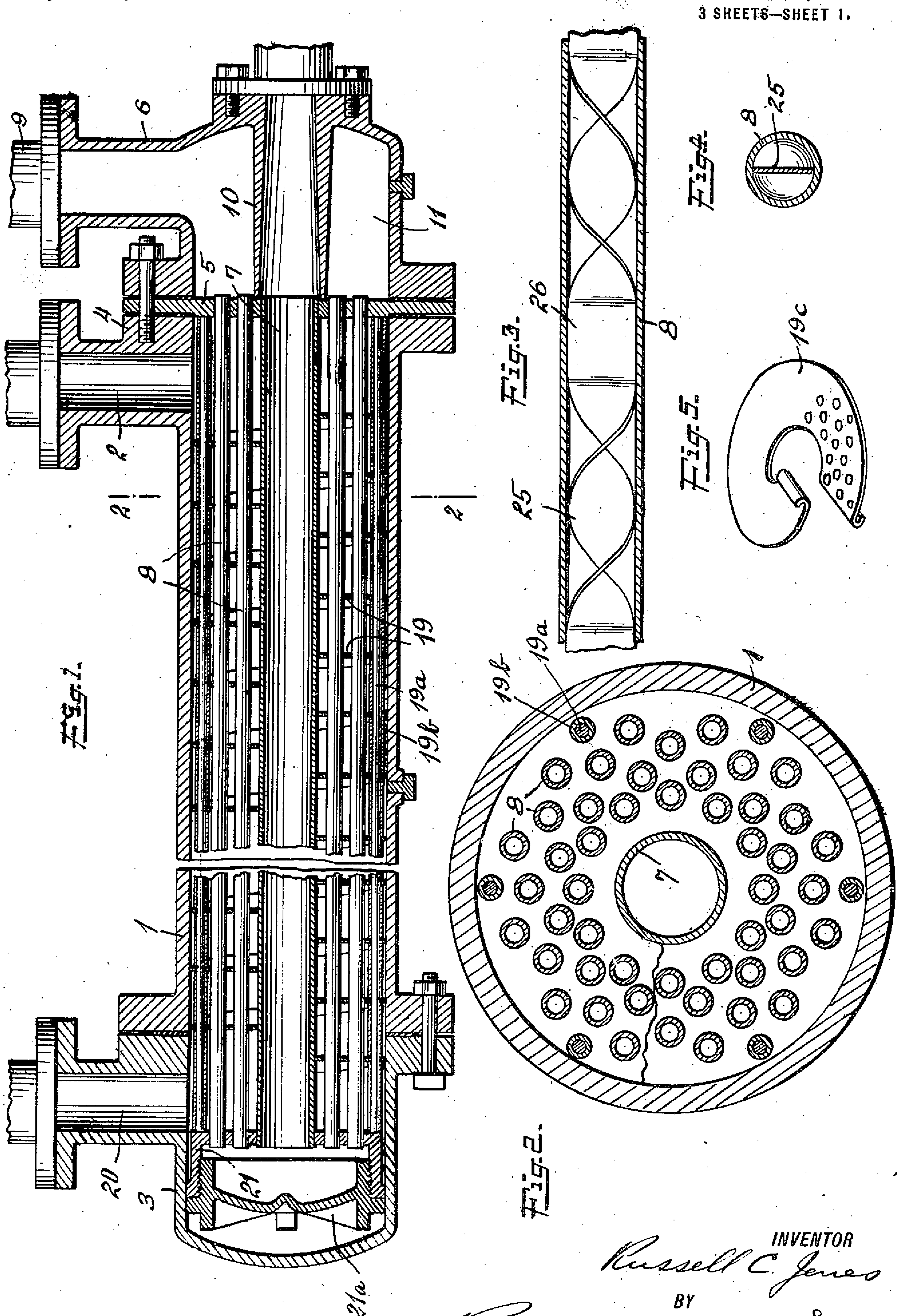
R. C. JONES.

OIL COOLER.

APPLICATION FILED JULY 16, 1917.

1,335,506. Patented Mar. 30, 1920.

3 SHEETS—SHEET 1.



INVENTOR

Russell C. Jones

BY

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3 SHEETS—SHEET 2.

Fig. 7.

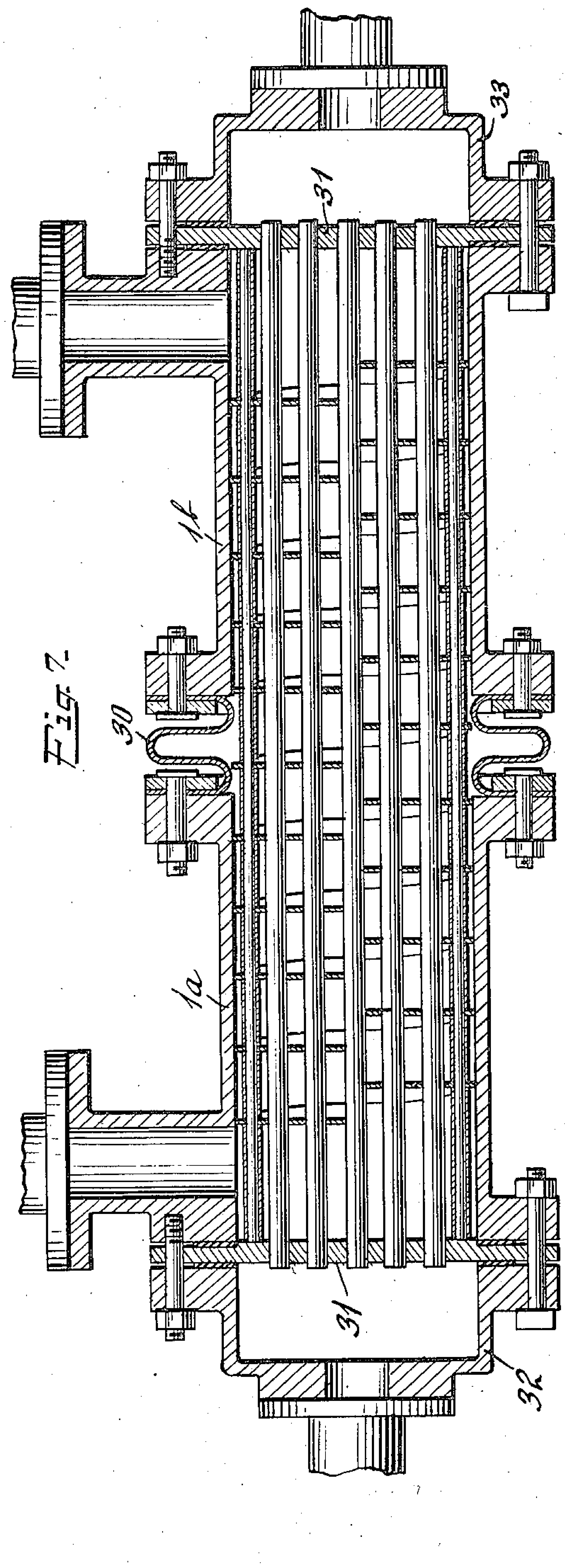


Fig. 6.

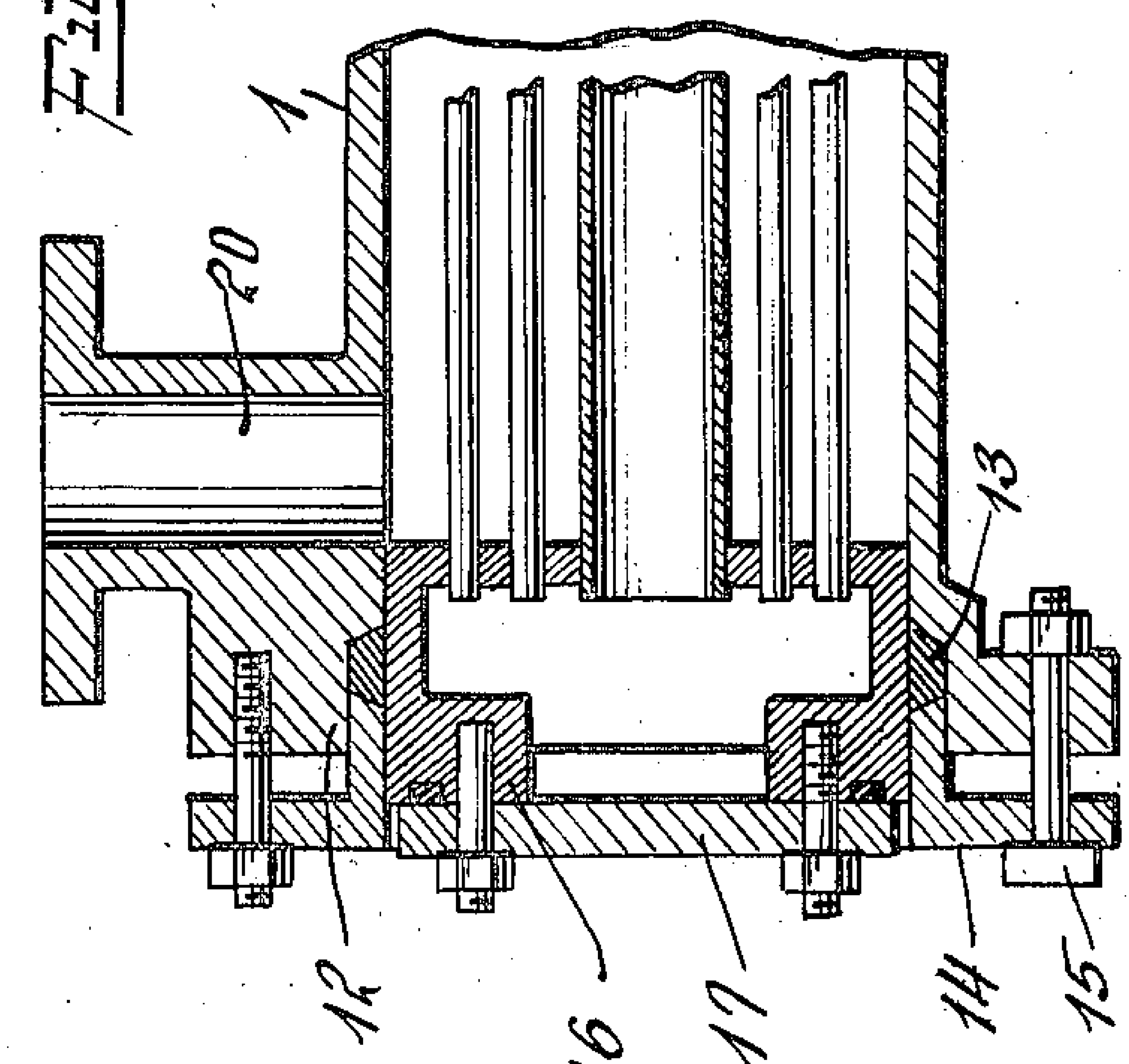
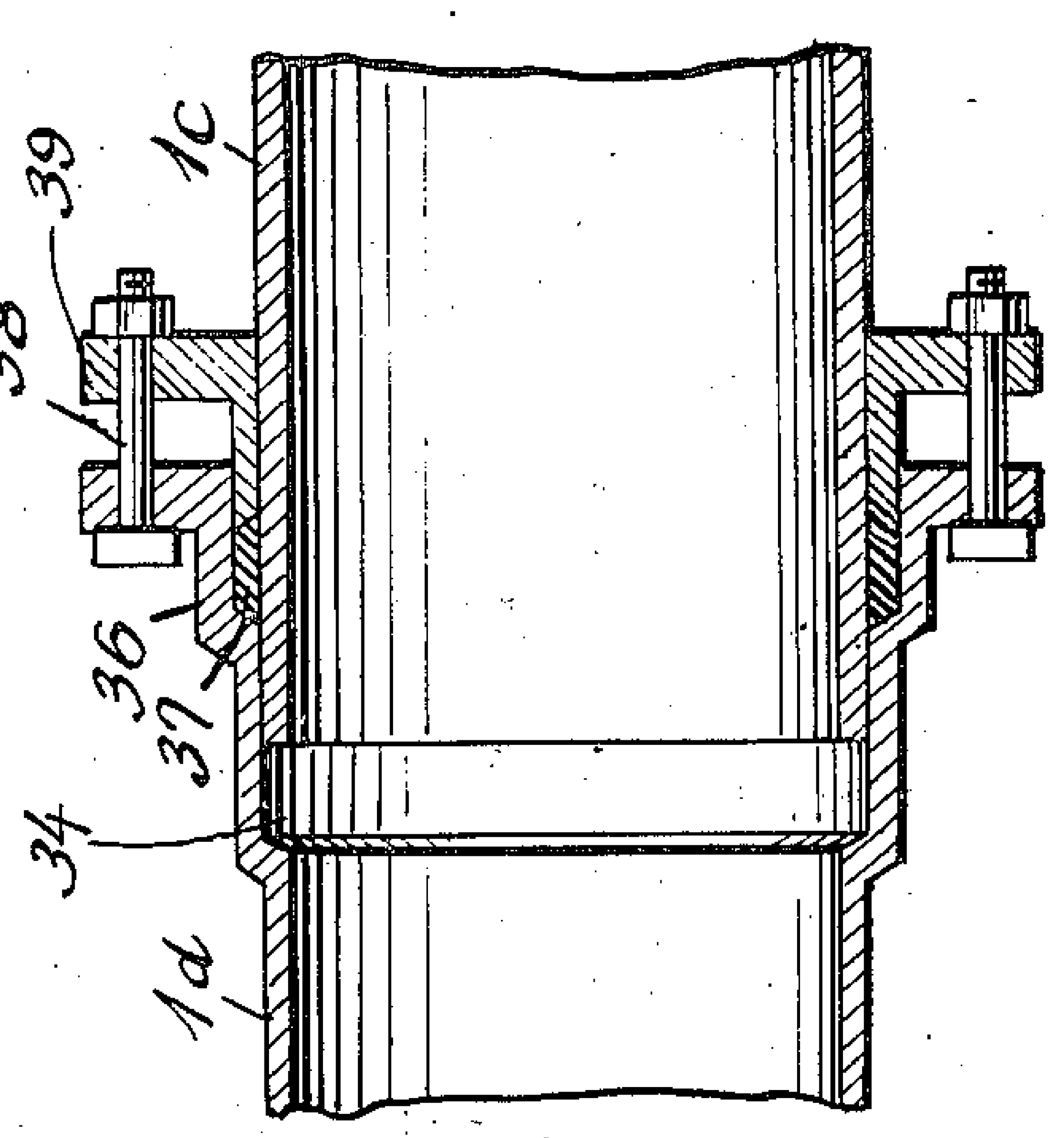


Fig. 8.



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3 SHEETS—SHEET 3.

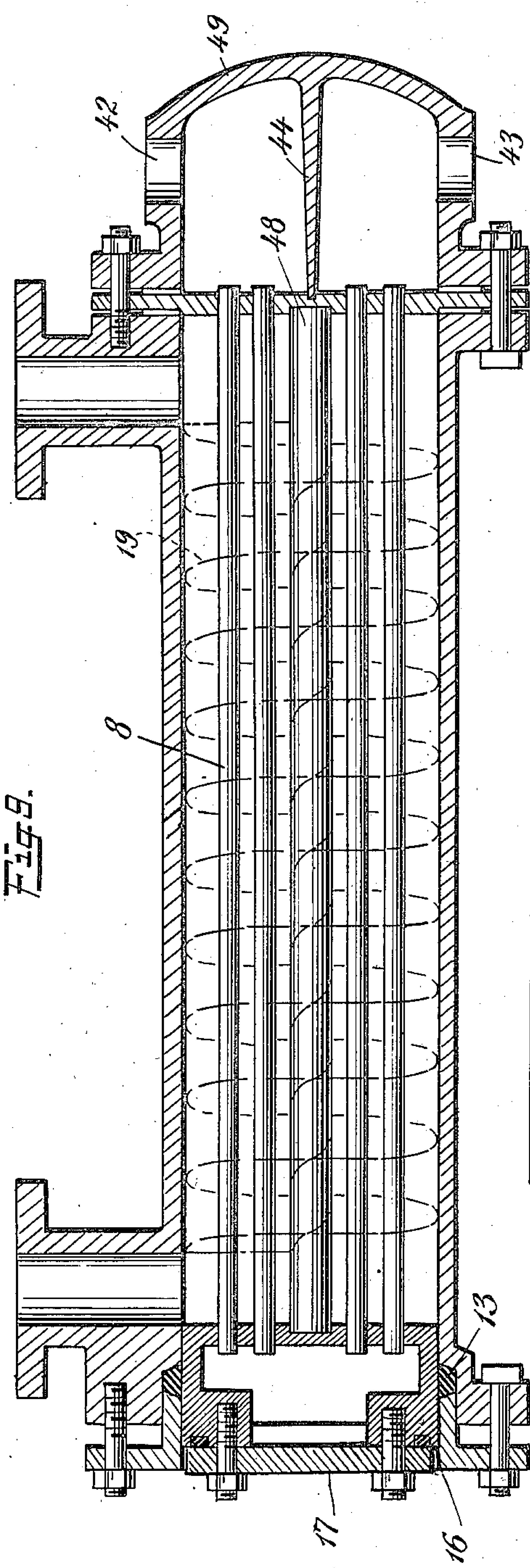

Fig. 9.

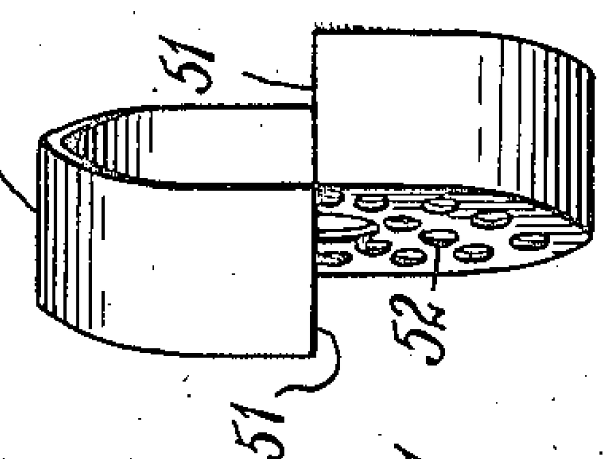

Fig. 13.

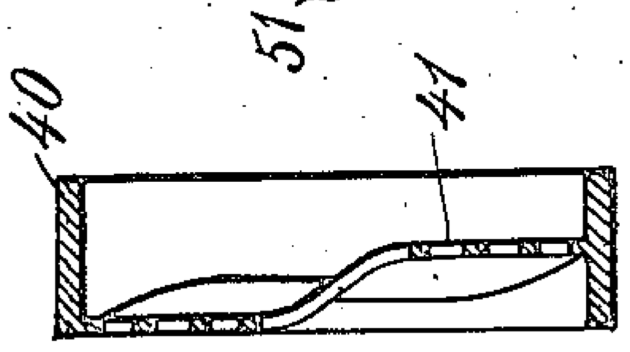

Fig. 11.

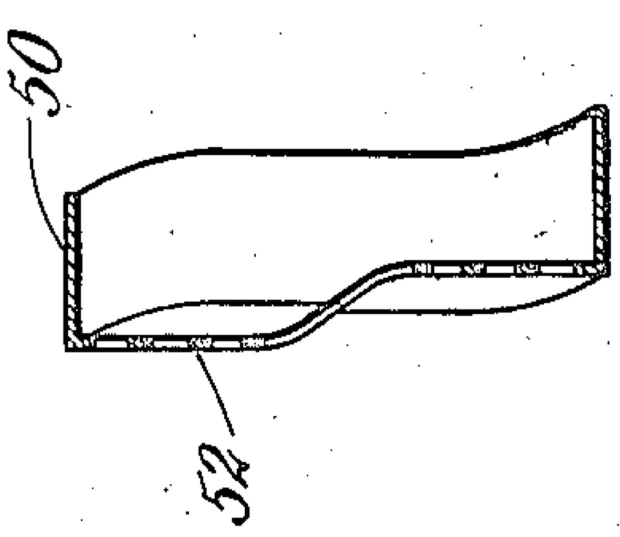

Fig. 12.

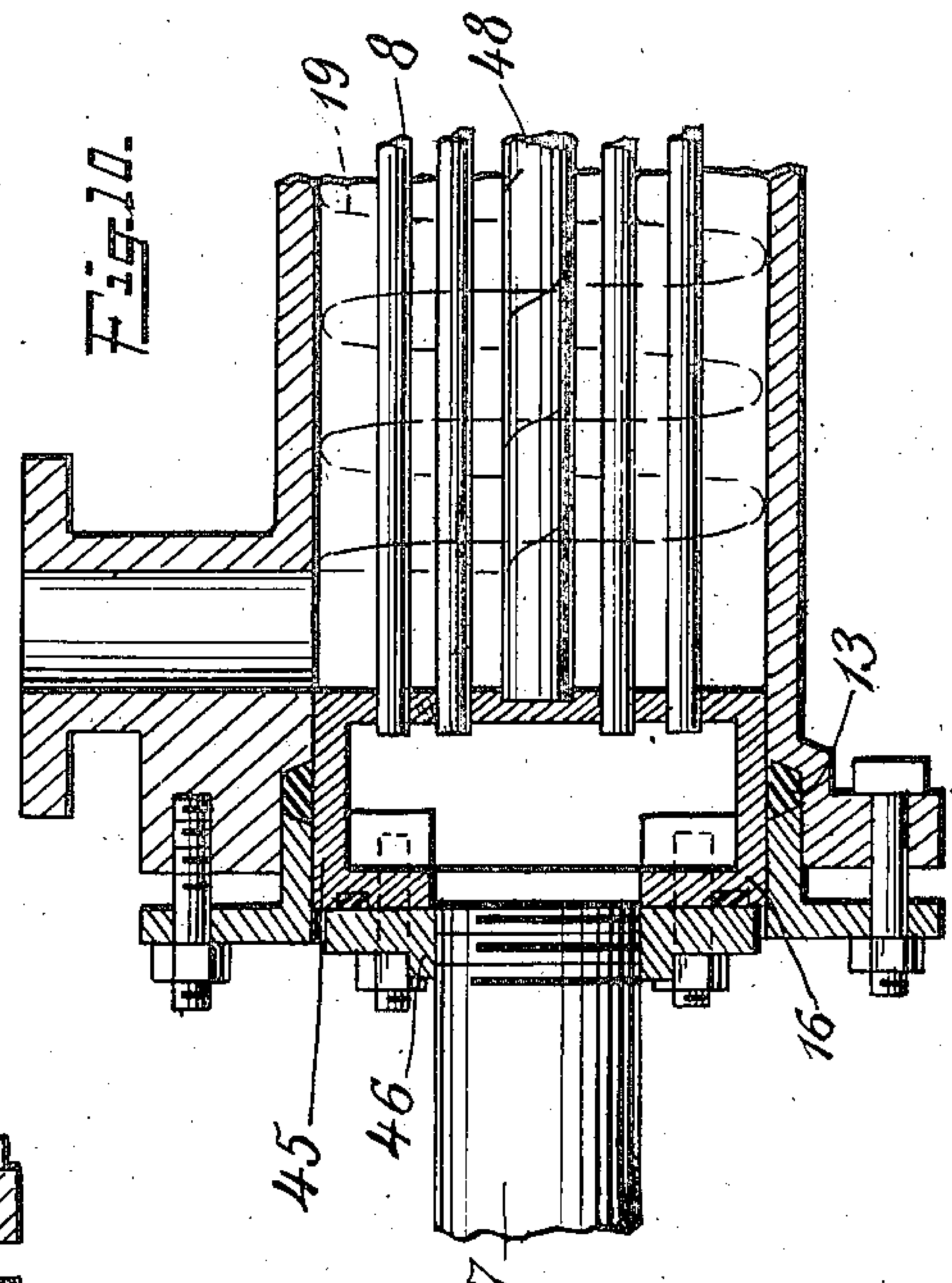

Fig. 10.

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UNITED STATES PATENT OFFICE.

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

OIL-COOLER.

1,335,506. Specification of Letters Patent. Patented Mar. 30, 1920.

Application filed July 16, 1917. Serial No. 180,885.

To all whom it may concern:

Be it known that I, RUSSELL C. JONES, a citizen of the United States, and a resident of Bronxville, Westchester county, State of New York, have invented certain new and useful Improvements in Oil-Coolers, and 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 apparatus for heating or cooling fluids in which the heat is transferred from one fluid to another. The apparatus is particularly applicable to the transfer of heat where there is no condensation or vaporization of either fluid, but it may be used also as either a boiler or condenser.

One object of the invention is to provide an apparatus of this character of small exterior dimensions but having a long path of movement for the liquid to be cooled, whereby the liquid in its passage through the apparatus may be kept in continuous motion at a sufficiently rapid rate to utilize the cooling surface to its greatest efficiency and at the same time obtain the desired drop in temperature of the fluid to be cooled.

A further object of the invention is to provide an apparatus of this character in which the fluid to be cooled is maintained in continuous motion in the same direction instead of in a zigzag direction with a reversing motion as heretofore practised, thereby avoiding the fluid friction and loss of pressure which result when the rate of flow is sufficiently rapid to efficiently utilize the heat transferring surface.

A further object of the invention is to provide an apparatus of this character which will work with equal efficiency in any position, either vertical, horizontal or angular, and is therefore particularly adaptable for use on shipboard where economy of space is always of maximum importance. With my improved cooler the interior of the cooling chamber is maintained entirely full of the oil or other fluid to be cooled under the circulating pressure so that air pockets can not form in the fluid in any position in which the cooler may set.

A further object of the invention is to provide a cooler in which there is no packed joint between the passages of the two liquids so that all leakage of either liquid is to the outside of the apparatus and not into the passages of the other liquid. This feature is particularly desirable for oils or other liquids of similar character which must be kept free from contact with the cooling liquid. My improved cooler is also designed so that the tubes and other parts of the device may freely expand and contract without straining the apparatus or loosening the joints between the several parts.

A further object of the invention is to provide a cooler which is of simple construction and cheap cost of manufacture, the long walls of the oil passages being formed of thin metal shaped to form a helical baffle or continuous screw extending from end to end of the shell or casing, or the helical baffle may be formed of identical sheet metal stampings which are readily assembled in the chamber of the cooler and which are interchangeable so that if any part becomes worn or corroded it may be readily replaced at small expense.

In the accompanying drawings I have illustrated a preferred embodiment of my invention which has been found highly satisfactory in actual use and also several modified forms of apparatus having certain special features of advantage.

In said drawings,

Figure 1 is a longitudinal sectional view of one form of my improved cooler;

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

Figs. 3 and 4 are detail views of a water tube baffle which may or may not be used, depending on conditions pertaining to the individual installation, as will be later described;

Fig. 5 is a detail perspective view showing a modified construction of the helical vane which forms the long passage for the fluid to be cooled;

Fig. 6 is a longitudinal sectional view of a portion of the apparatus showing a modified form of cooler;

Fig. 7 is a longitudinal sectional view similar to Fig. 1 of a modified form of cooler;

Fig. 8 is a sectional view of a portion of the shell of the cooler showing a further modification;

Fig. 9 is a longitudinal sectional view

similar to Fig. 1 showing a further modification of the apparatus;

Fig. 10 is a longitudinal sectional view of a portion of the cooler showing an additional modification; and

Figs. 11, 12 and 13 are detail views of modified forms of separate baffle members.

Referring to the drawings, particularly Fig. 1, 1 indicates the shell of the apparatus which as here shown is tubular and is provided near one end with a flanged inlet 2 for the passage of the oil or the liquid to be cooled. Adjacent the opening 2 the end of the shell is flanged as shown at 4 to provide a seat against which the tube-supporting plate 5 is clamped by the flanged water-head 6 through which the cooling fluid is both supplied and discharged.

Supported in the head 5 is a central tube 7 of relatively large diameter and a plurality of smaller tubes 8 surrounding the middle larger tube and arranged in concentric circles, the tubes of the alternate rows being staggered as shown more particularly in Fig. 2. All of the tubes are expanded in the head 5 after the manner of boiler tubes, to produce rigid and fluid-tight joints.

The water-head comprises a lateral water inlet 9 and a central longitudinal water outlet 10, the inlet leading into an annular chamber 11 communicating with all the small tubes 8. The wall between the outlet 10 and the chamber 11 terminates in the same plane as the attaching flange of the water-head so that when the water-head is clamped against the shell, the outlet passage will be cut off from the water inlet, the former communicating with the large central tube and the latter with the smaller tubes.

At the opposite end the shell is similarly flanged to provide a seat for the end cap 3. The end cap 3 is open at one end and flanged to provide a seat to be clamped against the flange of the shell to form a fluid-tight joint therewith. Adjacent to the open end the cap is provided with a lateral flanged opening forming a seat for the connection of the outlet pipe for the oil to be cooled. The water tubes project into the cap beyond the opening 20 and are all connected to a floating head or return drum 21 whose cylindrical wall fits loosely in the cap to permit free expansion and contraction of the water tubes. The outer end of the drum is closed by a head 21^a having a deep flange threaded into the drum to form a secure joint easily rendered fluid-tight to prevent leakage of the circulating water into the oil.

To cause the oil in passing through the cooler to follow a path sufficiently long to be cooled to the desired degree by its passage through the shell at a moderately rapid rate of flow, the shell is provided with a helical baffle or continuous screw 19 of sheet metal of a diameter substantially equal to the internal diameter of the shell. The large middle tube 7 forms an axial support for the helix and the surrounding tubes 8 intercept the helical passage formed by the vanes of the helix passing through suitably arranged holes in the vanes. The vanes of the helix are maintained in suitably spaced relation by means of rods 19^a, which may be six in number as shown, the rods extending between the inner faces of the tube plates through holes near the periphery of the helix and abutting at each end against the tube plates 5 and 21. Spacing sleeves 19^b are supported between each two adjacent turns or vanes of the helix and between the end vanes and heads of the shell. The spacing sleeves may be formed of ordinary pipe sections or nipples of a size to slip over the rods.

Instead of making the helix as a single unitary structure, each turn or vane of the helix 19 may be made of a separate sheet of metal of the shape shown in Fig. 5, that is, a sheet metal disk or stamping 19^c of substantially the diameter of the interior of the shell and perforated for the passage of the tubes, the disk being radially slit and twisted or bent to form a single complete turn of a helix. The separate vanes may be connected at their edges in any suitable manner, for instance, the radial edges of the vanes may be crimped as shown and interlocked one with the other by clamping the adjacent crimped edges together to form a continuous screw or helix substantially filling the interior space of the shell and providing a continuous spiral passage for the oil from the inlet 2 of the shell to the outlet 20.

In one size of the apparatus as manufactured for the market the pitch of the helix is about two inches and the shell from end to end of the helix about four feet, therefore requiring twenty-four separate disks to form the helix and giving a smooth helical path of fluid having a length of twenty-four times the mean circumference of the small tube space of the shell.

The separate sheets forming the modified helix of Fig. 5 will also be maintained in properly spaced relation by means of rods and spacing sleeves so that the disks may be made of thin metal without danger of a vane becoming distorted and interfering with the circulation.

In operation the oil or other liquid to be cooled will be pumped into the inlet opening 2 under sufficient pressure to force the oil through the helical passage at a fair rate of flow. Although the passage is long, there will be little friction loss for the reason that the direction of flow is continuous and except for the water tubes and spacing rods, is free from obstructions. By this rapid circulation all particles of the oil are brought rapidly and successively against the cooling surface under the circulating pressure without dependence upon convection, thereby maintaining the heating surface at its maximum efficiency of operation. This is a feature of prime importance in oil coolers for the reason that there is not a great difference in temperature between the oil to be cooled and the circulating water, as the water usually available for the purpose is seldom at a temperature below 60 or 70 degrees.

Where water is to be had in unlimited quantities, as upon shipboard, the water tubes may be left fully open so that the water will pass rapidly through the device, thus maintaining as low a temperature as possible throughout the entire passage of the water. When, however, the quantity of water used is limited, or the cost of pumping is a factor to be considered, it is sometimes desirable to mix or agitate the flow of water through the tubes and for that purpose each of the tubes may be provided with a mixer of the character shown in Figs. 3 and 4 consisting of a strip of sheet metal 25 substantially equal in width to the inside diameter of the tube and twisted in the form of a succession of reversed connected twists, here shown as four in number for each strip. The mixers may be easily formed by successively twisting the different parts in opposite directions, the metal between the twists being clamped during the twisting operation at the flat connecting portions 26.

With a mixer of this character the flow of the water through the tube first in one direction and then in the other balances the pressure on the mixer circumferentially, whereby the mixer will remain in place in the tube without fastening of any kind. With a mixer consisting of a single helix of the same direction throughout its length, the mixer will be rotated by the passage of fluid through the tube and will screw itself out of the tube by reason of the engagement of its edges on the wall of the tube.

The return drum or head 21 may be easily maintained fluid-tight by means of a single packed joint, for the reason that the head is free to move axially in the shell under the expansion and contraction of the tubes, and consequently no strain can come upon the joint between the drum and cap 3.

The apparatus may be designed to avoid all packed joints between the oil and the circulating liquid without sacrificing the other advantages of the construction. I have shown an apparatus of this character in Fig. 6. This form of the apparatus is of the same construction at the water head end as the type of apparatus heretofore described. At the other end, the shell 1 is flanged beyond the opening 20 and is counterbored as shown at 12 to form a seat for a packing ring 13 which forms a packed joint between the shell and a water-head 16. The water-head 16 consists of a drum in the face of which all the tubes are expanded so as to provide a connection between the outer small tubes and the inner large tube which forms the outlet passage for the circulating water. The outer end of the drum is closed by a cap plate 17 bolted to the flange of the drum against a suitable packing ring to form a water-tight joint to prevent leakage of the circulating water. The packing ring 13 is clamped in its seat by means of a flanged ring 14 connected by draw bolts 15 with the flange of the shell, thereby forming an oil-tight joint between the drum and the exterior of the water head so that any leakage of the joint will merely result in a waste of oil and will not result in the water getting into the oil.

The packed joint permits ready expansion of the tubes with relation to the shell, the water-head or drum 16 being free to slide longitudinally. The water joint between the drum and its cap is beyond the packed oil joint so that any leakage of the water will simply drip from the end of the drum without possibility of reaching the oil chamber.

It will be noted that the spacing rods 19^a are arranged close to the inner surface of the shell, in which position they serve the additional function of baffles for impeding the circulation of the fluid at the outer edge of the helical passage, thereby causing a greater flow of the fluid through the portions of the passage occupied by the tubes. This is an important feature of the construction, for it would be impractical to arrange the tubes close to the outer edge of the header in which they are supported, particularly where floating heads such as shown in Figs. 1 and 6 are employed. Without the rods located adjacent the shell wall in the manner shown there would be less resistance to the flow of the fluid at the outer edge of the helical passage, with the result that the efficiency of the apparatus would be much reduced.

In Figs. 7 and 8 I have shown a further modified form of apparatus in which packed joints between the oil and water compartments are obviated and in which the parts are free to expand and contract without straining the joints. As here shown the shell is formed of two parts 1^a and 1^b, connected at their adjacent ends by a suitable expansion joint, for instance, a corrugated tube section 30 with its opposite ends clamped to the end flanges of the shell sections in the manner shown.

With this form of shell the circulating water need not be returned through a large central tube, but the entire shell space may be filled with tubes of uniform size, the tubes being expanded in heads or disks 31 at each end, which heads are clamped against the ends of the shell sections by drums 32, 33, forming inlet and outlet chambers respectively for the circulating water.

The interior space of the shell sections will be filled with helical baffles forming the spiral passages for the oil from the oil inlet opening adjacent one end of the shell, preferably the water outlet end, to the oil outlet opening adjacent the other end of the shell.

Instead of employing the expansion joint shown in Fig. 7 I may use instead a packed expansion joint such as shown in Fig. 8. In this case the parts of the cooler may be of exact design shown in Fig. 7, except that the adjacent ends of the two shell sections 1^c and 1^d are designed to overlap, the section 1^d being counterbored or expanded as shown at 34 to receive the end of the section 1^c. Beyond the portion 1^d, the shell section is further expanded as shown at 36 to provide a seat for the packing ring 37 which is held in place by clamping ring 39 and draw-bolts 38 between the clamping ring and the flange of the shell section 1^d.

By using a joint of this character the shell is substantially rigid except for permitting relative longitudinal movement of its two parts, and may be mounted in substantially the same manner as the one shell of the first described construction.

In Fig. 9 I have disclosed a further modification of the cooler design in which I employ in place of the large central tube for the return of the circulating fluid, a central rod or core 48 forming an axis for the helical baffles 19. To effect a return passage of the circulating fluid I employ at one end of the shell a water-head 49 having inlet and outlet openings on opposite sides as indicated at 42, 43 and a middle transverse partition 44, whereby all the tubes above the partition will be connected with the inlet opening 42 and those below the partition with the outlet opening 43, whereby the circulating fluid will flow first through the upper tubes, thence through the return head and through the lower tubes to the discharge.

In this form of apparatus I may employ either the return head construction of Fig. 1 or the construction of Fig. 6, the latter being preferable for the reason above stated.

In place of the expansible shell construction of Figs. 7 and 8 with the tubes running through from end to end for a single passage of the cooling fluid, I may use a modification of the above described floating head.

In Fig. 10 I have shown a modification of this character in which the baffles 19 are supported on a central core 48 with the tubes 8 extending from one water-head to the other. The water-head at one end may be the simple water-head shown in Fig. 7, while at the other end there is provided a floating head 45 having a packed joint connection with the shell similar to the construction shown in Fig. 6. In place, however, of the imperforate cover for the head the cover 46 is tapped for the connection of the inlet or outlet pipe 47 for the cooling fluid.

The floating head may of course be at both ends of the shell if desired, but it is not necessary except at one end. The relative movement of the shell and head may be readily taken up by the pipe line by means of the expansion joints, or other provisions made for the expansion and contraction of the pipe line itself.

In Fig. 11 I have disclosed a modified form of baffle whereby the baffle may be made of cast metal and may be assembled in the shell in sections without permanent connection between the separate turns of the helix.

Each separate turn comprises an outer ring 40 to fit the internal diameter of the shell with an inner vane 41 of thinner metal shaped for a complete turn of the resulting helix. The ring 40 is of a width equal to the pitch of the helix and the vane 41 is perforated for the passage of the tubes 7 and 8. The ring and the vane may be made in one piece or in separate pieces.

The rings 40 serve to properly space the turns of the helix and also fit snugly within the cylinder shell forming in effect a lining for the shell. The water tubes 8 hold the several rings against relative rotation so that the vanes form with each other a continuous helical passage from one end of the shell to the other.

In this structure the rods 19^a and spacing nipples 19^b may be dispensed with as the rings 40 give sufficient rigidity to the vanes to maintain them against distortion. A spacing sleeve may be provided at each end of the shell to properly position the helix with reference to the intake and outlet passages for the oil.

If desired, the vane 41 may be made of sheet metal brazed or otherwise fastened in the ring.

In Figs. 12 and 13 I have shown a further modification of a separate vane for the helical baffle. In this case each baffle is made of a stamping of sheet metal with its radial portion or vane 52 similar to the baffle 19^c shown in Fig. 5. The baffle of Fig. 11, however, is provided with a flange 50 along its outer edge, the flange being of a depth equal to the desired distance between the baffles, that is, the pitch of the helix. The flanges are of uniform depth throughout, forming on one side shoulders 51 by means of which each baffle may be properly positioned with respect to the next baffle of the series for their vanes 52 to form a continuous helical passage for the fluid to be cooled. It is not necessary to connect the baffles one with the other, as they will be maintained against relative movement by the interlocking shoulders and also by the tubes.

Various other modifications and details of construction may obviously be made, and it is to be understood that my invention includes all such modifications as fall within the scope of the appended claims.

I claim:

1. In an apparatus of the character described, the combination of a shell forming a chamber for the fluid to be acted upon, inlet and outlet passages near the opposite ends of said shell, a plurality of tubes within said shell for the circulation of the working fluid, a series of baffles in said shell extending transversely to the said tubes, said baffles being formed of separate interchangeable thin metal units with the edge of each baffle alined with the adjacent edge of the next succeeding baffle to form a circuitous path for the fluid to be acted on from its inlet to its outlet passage and independent means for clamping said baffles fixedly in their proper relative positions.

2. In an apparatus of the class described the combination of a shell having inlet and outlet ports for the passage of one of the liquids, a plurality of tubes within said shell for the passage of the other liquid, a series of baffles extending transversely of the tubes and connected to form a continuous helical passage for the fluid in the shell from its inlet to its outlet ports, and means for maintaining said series of baffles properly positioned with reference to each other and to said ports comprising spacing members of equal length interposed between the adjacent baffles, and spacing members of unequal length between the baffles at the ends of the series and the adjacent ends of the shell.

3. In an apparatus of the class described the combination of a shell having inlet and outlet ports for the passage of one of the liquids, a plurality of tubes within said shell for the passage of the other liquid, a series of baffles extending transversely of the tubes and connected to form a continuous helical passage for the fluid in the shell from its inlet to its outlet ports, and means for maintaining said series of baffles properly positioned with reference to each other and to said ports comprising rods extending through said baffles in parallelism with tubes, and sleeves supported on said rods abutting at their opposite ends against adjacent baffles and the end baffles of the series and the adjacent ends of the shell respectively.

4. In an apparatus of the class described the combination of a shell having inlet and outlet ports for the passage of one of the liquids, a plurality of tubes within said shell for the passage of the other liquid, a series of baffles extending transversely of the tubes and connected to form a continuous helical passage for the fluid in the shell from its inlet to its outlet ports and means for maintaining said baffles in properly spaced relation comprising rods passing through the baffles in parallelism with the tubes, and sleeves mounted on said rods with their end faces abutting against the surfaces of the adjacent baffles and the adjacent ends of the shell, the sleeves between the adjacent baffles being of substantially equal length and those between the end baffles and the adjacent ends of the shell of unequal length.

5. In an apparatus of the class described, the combination of a shell having inlet and outlet passages, a helical baffle within said shell forming a circuitous path for the liquid, a plurality of tubes within said shell extending substantially parallel to its axis, and forming a passage for a second fluid, said tubes being arranged in groups for the seried passage of the second fluid therethrough, one end of each tube being connected to a service header fixedly attached to said shell, the other end of each tube being connected to a floating head, allowing separate expansion of the containers of the separate fluids, said tubes passing through holes provided for this purpose in said helical baffle and the elements of said baffle provided with interspacing means supported independently of said shell.

6. In an apparatus of the class described, the combination of a shell having inlet and outlet passages, a plurality of tubes in said shell extending longitudinally thereof, said tubes being supported at one end by a service header adapted to be attached to said shell, a floating head attached to the other ends of said tubes and a helical baffle also supported on said tubes and forming a continuous passage from the inlet to the outlet passages of said shell, said baffle being supported independently of said shell whereby the tubes and the baffle may be removed as a unit from the shell.

7. In an apparatus of the class described, the combination of a shell having inlet and outlet passages, a plurality of tubes in said shell extending longitudinally thereof, said tubes being supported at one end by a service header adapted to be attached to said shell, a floating head attached to the other ends of said tubes and a helical baffle supported on said tubes and forming a continuous passage from the inlet to the outlet passages of said shell, said baffle being formed of separate elements arranged with their adjacent edges in alinement, and spacing devices also supported independently of said shell for maintaining said elements in properly spaced relation.

8. In an apparatus of the class described, the combination of a shell, inlet and outlet passages, a plurality of tubes within said

shell extending longitudinally thereof, a helical baffle within said shell forming a circuitous passage for the liquid from the inlet to the outlet passage, said baffle being formed of separate elements with spacing devices for maintaining said elements in their proper relative positions, said spacing elements comprising a plurality of rods extending parallel with said tubes and adjacent the shell surface to impede the circulation of the liquid at the surface of the shell and cause a greater flow through the portions of the circuitous path occupied by the tubes.

9. In an apparatus of the class described, the combination of a shell, a plurality of tubes in the shell extending longitudinally thereof, detachable headers supporting said tubes, a helical baffle within the shell supported on said tubes, said baffle being formed of independent elements and spacing devices for maintaining said elements in properly spaced relation, said devices being wholly upported on said headers, and said headers, tubes, baffles and spacers being removable as a unit from said shell.

10. In an apparatus of the class described, the combination of a shell, a plurality of tubes in the shell extending longitudinally thereof, detachable headers supporting said tubes, a helical baffle within the shell supported on said tubes, said baffle being formed of independent elements and spacing devices for maintaining said elements in properly spaced relation, said devices being wholly supported on said headers and arranged around said tubes to lie close to the inner surface of the shell, said header, tubes, baffle and spacers being removable as a unit from said shell.

In testimony whereof I affix my signature.

RUSSELL C. JONES.